IAGA Bulletin No. 19

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

ASSOCIATION OF GEOMAGNETISM AND AERONOMY

Transactions
of the
Helsinki and Berkeley Meetings

JULY 25 - AUGUST 6, 1960
AND
AUGUST 20-30, 1963

Edited by
J. O. CARDUS, S. I.

SUGRAÑES HNOS., EDITORES
TARRAGONA
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TRANSACTIONS

OF THE

HELSINKI MEETING

PART I

AGENDA AND MINUTES

PROGRAMME OF THE MEETINGS

MONDAY, 25th JULY

14^h10^m IAGA Executive Committee.

TUESDAY, 26th JULY

15^h00^m IAGA Opening session.

1. Lecture on Memory of Adolf Schmidt, by Prof. Dr. Fanselau.
2. Presidential adress by Prof. Kaplan.
3. Secretary's report.
4. Nomination of temporary committees for the Helsinki meeting: Committees on nominations, on finances and on resolutions.

WEDNESDAY, 27th JULY

9^h30^m IAGA Plenary session.
National Reports.

13^h30^m Group Meetings:
A: Committees 2 and 3.
G: Committees 1, 6 and 7.
Closed meeting of Committee 2.

16^h00^m Group Meeting:
A: Committees 2 and 3.

THURSDAY, 28th JULY

9^h30^m Symposium on Cosmic Rays.

13^h30^m Symposium on Cosmic Rays.

14^h30^m Closed meeting of Committee 4.

16^h00^m Symposium on Cosmic Rays.
Group Meeting:
G: Committee 4.

FRIDAY, 29th JULY

This day was reserved for the IUGG Symposium on the July Events.

9h30m Closed meeting of Committee 5.

SATURDAY, 30th JULY

9h30m Group Meeting:
G: Committee 5 on World Magnetic Survey.

11h00m Meeting of the Nominations Committee.
Afternoon: Visit to Nurmijärvi Observatorium.

MONDAY, 1st AUGUST

9h15m IAGA Plenary Session: Announcement of Chairmen of Committees.

9h30m Group Meeting:
A: Committees 2 and 3.
with IAMAP: Joint Committee on Atmospheric Electricity.

13h30m Group Meetings:
A: Committees 2 and 3.
G: Committees 1, 6 and 8.

15h30m Closed meeting of Committee 5.

16h00m Group Meetings:
A: Committees 2 and 3.
G: Committee 4.

TUESDAY, 2nd AUGUST

9h30m Group Meeting:
G: Committee 9.

13h30m Group Meeting:
G: Committee 9.
G: Committee 5.

16h00m Group Meeting:
G: Committee 10.

WEDNESDAY, 3rd AUGUST

9h30m Group Meeting:
A: Committees 2 and 3.
G: Committee 4.

11h00m Meeting of the Nominations Committee.

13h30m Group Meeting:
A: Committees 2 and 3.
G: Committee 4.
Closed meeting of Committee 10.

14h00m Closed meeting of Joint Committee on Atmospheric Electricity.

16h00m Group Meeting:
A: Committees 2 and 3.
G: Committee 4.

THURSDAY, 4th AUGUST

9h30m Group Meeting:
A: Committee 2.

13h30m Meeting of the IAGA Executive Committee.
Group Meeting:
G: Committee 10.

16h00m Group Meeting:
G: Committee 10.

FRIDAY, 5th AUGUST

9h30m Group Meetings:
A: Committees 2 and 11.

13h30m Meeting of the IAGA Executive Committee on Resolutions.
Group Meeting:
Committee 11.

SATURDAY, 6th AUGUST

9h00m IAGA Final Plenary Session.

1. Report of the Nomination Committee.
2. Nomination of Members of Special Committees.
3. Report of the Finances Committee.
4. Budget.
5. Resolutions.

Meeting of the IAGA Executive Committee.

MEETINGS OF THE EXECUTIVE COMMITTEE

It was not an easy task to arrange the IAGA General Assembly on account of the great number of participants (329 registered) and of the great number of scientific communications submitted for presentation (about 200). It was necessary to arrange the Time-Table in such a way that meetings of different groups were held at the same time and in this respect, as in all others, it must be said that, the arrangements made by the Finish Committee have proved most valuable and efficient.

The Executive Committee of IAGA had three formal meetings (25th July, 4th and 5th of August). First of all the *nominations* of IAGA representatives made during the interval between Toronto and Helsinki were ratified f.i.: Mr. V. Laursen as Reporter for Geomagnetism in CIG, Dr. M. Nicolet for the Inter-Union Committee on the Ionosphere, Prof. J. Veldkamp as representative of center C in CIG, Prof. Bartels and Dr. Nicolet for the Mixed Commission on Solar Terrestrial Relationship. There were also appointed: *Nomination* Committee: Prof. Bartels (Chairman), Drs. Benkova, Bouska, Coulomb, Elvey and Romañá; *Resolutions* Committee: Drs. Ianovsky, Jacobs and Selzer; *Finances* Committee: Profs. Thellier (Chairman), Nagata and Nicolet.

Some time was devoted to the problem of *publications:* After a long discussion it was decided not to propose to the General Assembly a change in the Statutes of the Association in order to include the Editor in the Executive Committee.

It was the general feeling that the IAGA publications appear too late and remedies were sought: it was decided to draw a dead line for the submission of manuscripts (which for documents to be printed in the Helsinki Transactions was fixed on the 31st December 1960); in future, National Reports should be brief (not more than 10 pages) and in a standard form to be prepared; afterwards, following a IUGG recommendation, it was decided not to include the National Reports in the Transactions). It seems desiderable that the reports prepared by the chairmen of the IAGA Committees should be in general more comprehensive including also if possible bibliography.

The free distribution of the Transactions will be followed in future but for Symposia the free distribution should be very restricted not more than one or two copies per National Committee.

It was resolved that in the next period IAGA would arrange three *symposia:* in 1961 «Earth Storms» at Kyoto, in 1962 «Paloeomagnetism and Paloeoclimates» in Paris, and in 1963, just before the General Assembly on Aeronomy in California. The conveeners will be Prof. Nagata, Thellier and Nicolet.

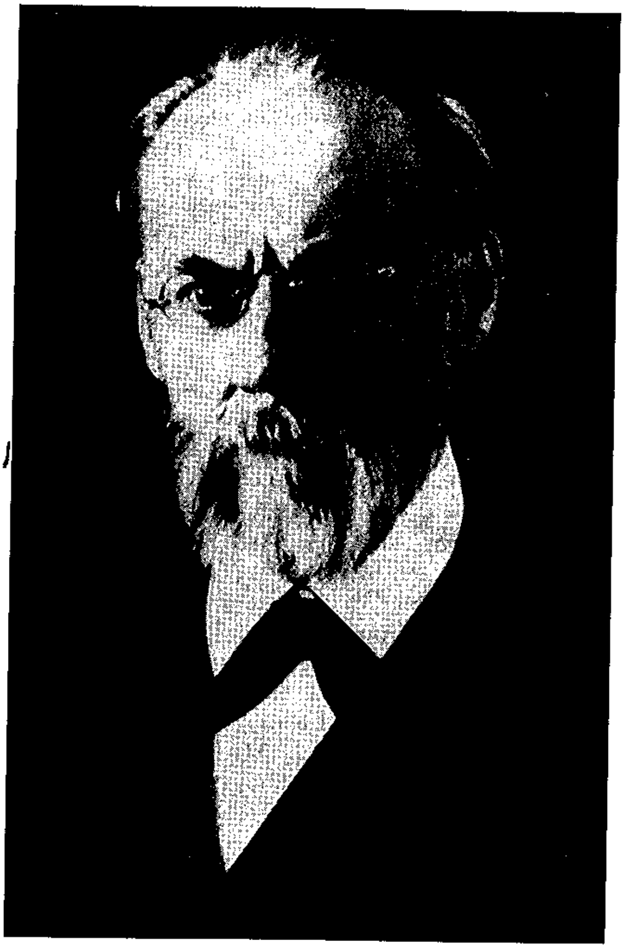
As for the future of the *WDC* IAGA was in favour of the continuation of them at least until the end of 1965 (see Resolution 9).

There was also a very good agreement on the importance of conducting a world-scale study of geophysical phenomena during the period of minimum solar activity as some sort of a reduced and voluntary IGY during the next solar minimum.

A great deal of time was devoted to the study of the *World Magnetic Survey.* Unfortunatelly there were too many different opinions to be put toghether to obtain a very precise agreement. The IAGA Executive Committee finally agreed in a list of responsabilities in the conduction of the WMS (Resolution 10), adopted a few resolutions which will help the implementation of the project (Resolutions 2-4) and endorsed the technical recommendations prepared by IAGA Committee No. 5 (see IUGG Chronicle No. 26, pp. 29-30, 1960). It was also decided to aproach the CIG to obtain its agrement on the compilation of the rough and reduced data, and through a IUGG Resolution proposed to the CIG the addition of a discipline member for WMS; if the proposal is accepted by the CIG, nomination of Dr. Vestine as discipline member.

Many other problems were discussed during the Meetings: some of them came finally in the form of resolutions adopted by IAGA or by the IUGG and some others of minor importance were circulated to interested persons or organisations.

The Secretary of IAGA was not able to produce before the end of the General Assembly a Budget for the next triennium because the Finances Committee of the Union could not indicate until the last day the yearly allowances to the Association; the Secretary was instructed to prepare a Budget on the same lines as the Toronto one and to circulate it to members of the new Executive Committee for comments and approval.



Adolf Schmidt

IN MEMORY OF ADOLF SCHMIDT

by G. FANSELAU, Potsdam *)

Contribution No. 105 from Geomagnetic Institute Potsdam

On July 23rd, 1960 Adolf Schmidt would have celebrated his 100th birthday. This is a welcome occasion to say words of thank, esteem and appreciation in honour of this prominent scientist and great man (Ill. 1).

To estimate his life-work completely, here are some biographical notes about him.

Adolf Schmidt was born on July 23rd, 1860 in Breslau. His family did not live in well-to-do conditions. His father was foreman and engineer at a factory in Breslau, and we may assume that his income was not excessively high. The fact that the family had four children may have contributed to their education to utmost economy and modesty. Adolf Schmidt had two fundamental qualities that were decisive for his life, modesty and reserve on one hand, and a highly developed intellect and prominent mental capacities on the other hand. Whereas his mental capacities enabled him to gain a materially secure position in life in a short time, his modesty and reserve, respectable and valuable as these human qualities are, were sometimes an obstacle to his personal and professional progress.

It surely is no coincidence that he was especially interested in natural sciences from his early youth. Probably this was the inheritance of his father. Also we may assume that his father, Friedrich Schmidt, often discussed technical problems, as may occur in a factory, with his intelligent son.

Adolf Schmidt attended a high school in Breslau which he left with his leaving certificate to take up studies in mathematics and physics at the Breslau university. He graduated at an age of 22, summa cum laude, with a purely mathematical dissertation «On the Theory of the Cremona Transformations, Especially Those of Fourth Order». His teachers, who had recognized the extraordinary gifts of their scholar, proposed him to choose the academic career, but he declined. His refusal was fully justified, such a career at that time being rather insecure from the material point of view.

Moreover he was anxious on paying back the money his family had spent on his education or, at least, to contribute to the main-

(*) Prof. Dr. Gerhard Fanselau, Geomagnetic Institute of the German Academy of Sciences in Berlin, Postdam, Telegrafenberg.

tenance of his relatives. He passed government examination for a teaching qualification at the Breslau university not only in mathematics and physics, but also following a special interest in languages, in the modern languages English and French. After probationary years in Breslau and Gotha he got a permanent job as gymnasium teacher at the Ernestinum gymnasium in Gotha in 1885.

It is not necessary to emphasize that as polyhistor he was a welcome teacher to any gymnasium head-master. Those years as young teacher in Gotha were some of the best of his life, as he has said himself. Here in Gotha he met open-minded people by whom he received various inspirations.

In Breslau Adolf Schmidt already had come into contact with geophysics, which later on was to become the subject of his scientific work. In 1882-83 the First International Polar Year was carried out, a scientific enterprise in which a great number of nations united to explore the geophysics of the yet relatively unknown polar regions of the earth. In Breslau Adolf Schmidt took part in the analysis of observations made during the International Polar Year, especially in the field of geomagnetism. No wonder that this contact with an important special branch of geophysics became decisive for his later work. Last not least in Gotha the Justus Perthes Publishing House, which published internationally appreciated atlases and maps, among others geophysical and geomagnetical ones, helped to develop his interest in geomagnetism already gained in Breslau and led him to important scientific research.

In Gotha he wrote some of his most important works, dealing with the calculation of the potential of the geomagnetic field. The results attained in the works were of such far-reaching importance that he received an invitation to take part in the International Conference on Terrestrial Magnetism and Atmospheric Electricity of the British Association for the Advancement of Science which was held in Bristol in 1898. This caused his premature nomination as a professor.

The Gotha astronomical observatory also gave him various inspirations. He took advantage of the situation, and sometimes used the limited instrumentarium of the observatory.

Adolf Schmidt also became known by some other scientific publications during his years in Gotha, so that he was appointed successor of the late Prof. Max Eschenhagen as director of the Potsdam Magnetic Observatory in 1902. Although there was no doubt as to his outstanding theoretical capacities, he was not yet versed in practical experiments. In a short time however he showed that he was able to perform pioneer work also in the field of practical research. As already mentioned the inheritance of his father may have given him joy and intimacy in practical tasks. Entering into the office as director of the Magnetic Observatory Adolf Schmidt had on hand all means to apply his capacities in a large scale. He was excellent in all fields of geophysical research, as well in experiments as in statistics and mathematical research. The only thing he never turned to, at least not acting himself, was measuring in the field and on expeditions. But also in this branch of research he was interested very much, and not one expedition only asked his scientific and technical advice. Also known are his theoretical numerical analyses of magnetic ordenance surveys.

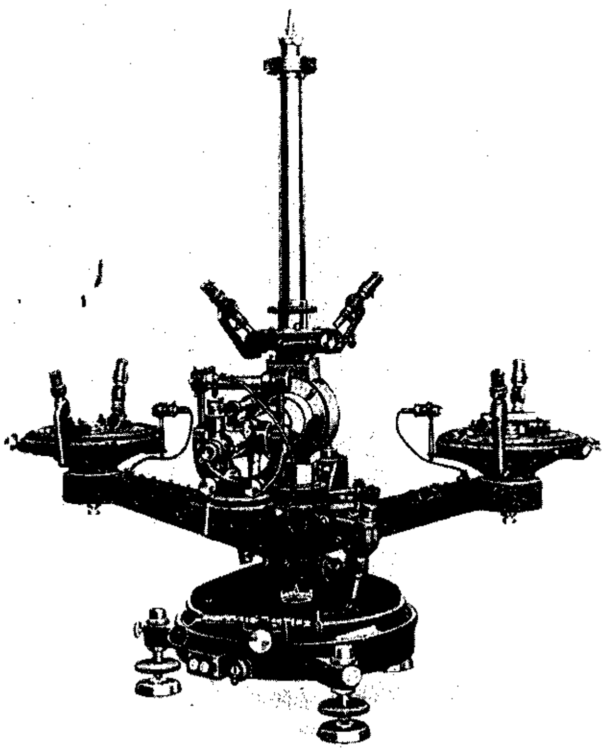


Illustration No. 2

An equal interest in all methods of scientific research in geophysics was especially valuable, enabling him to find connections between the separate sectors. For example some of his experimental results were possible on account of his theoretical and mathematical research only.

A few words to his most important works and their results. Only two of the most important experimental ones shall be mentioned. The first deals with the modification of the deflexion experiments, as used in measuring the absolute magnetic horizontal intensity. The combination of such deflexion experiments and continuous registrations had been proposed by Gauss in his fundamental work «Intensitas Vis Magneticae Terrestris Ad Mensuram Absolutam Revocata». Up to now this method is related in every physical textbook, and at most geomagnetic observatories of the world measurements are made by this method. Consideration of the inhomogenity of the artificial magnetic field presented difficulties to the deflexion experiments. In some pioneering works Adolf Schmidt succeeded in solving these problems in a final and universal way. At first this was a purely mathematical and theoretical solution. But he was not satisfied with that and proceeded to put it into practice. The theodolite, named after him, and coming into use more and more (Ill. No. 2), provided the experimental possibility of utilizing the theoretical knowledge. Even now the pos-

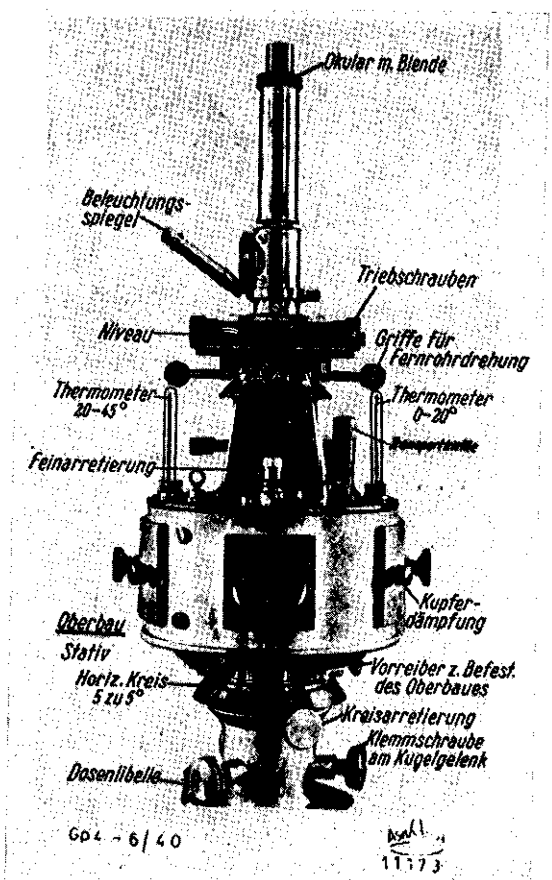


Illustration No. 3

sibilities of the new Schmidt method are not yet completely utilized, especially with regard to purely physical-magnetic observations of highest precision.

A further result of practical research is the construction of the magnetic field balance (Ill. No. 3). During the first years of the 20th century, the perception that geophysics is able to supply geology and geotectonics with valuable informations, gained ground more and more. Moreover, magnetic measurements in the field became more interesting, making it relatively easy to achieve knowledge about the distribution of the magnetic properties of matter of the upper strata of the earth's crust. The only problem was to supply the geophysicists, working in the field, with a practicable instrument. Adolf Schmidt ventured to

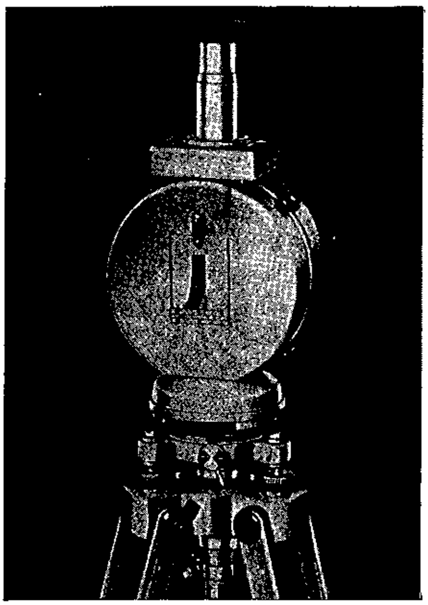


Illustration No. 4

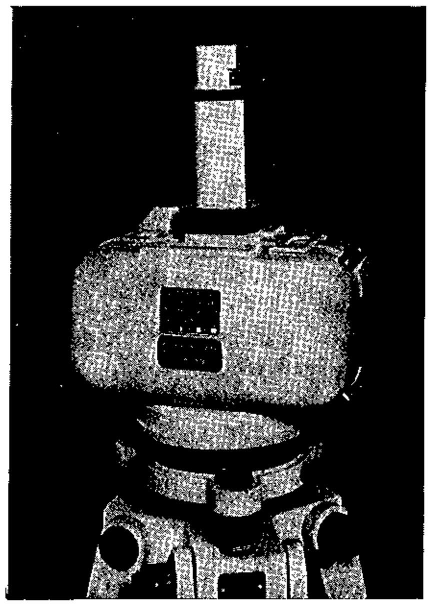


Illustration No. 5

adjust the well-known Lloyd's balance for use in the field. This was especially difficult a task, this balance being the most delicate instrument for magnetic variation-registrations, as every expert knows, and furthermore, that it is easily subject to trouble for different reasons, especially because the magnet is put on a knife-edge. It is characteristic of his extraordinary technical and constructive capacities that Adolf Schmidt succeeded in designing a practicable instrument. The first balance he developed in 1907 in collaboration with the precision-mechanics' workshop O. Toepfer in Postdam. In 1915 Adolf Schmidt for the first time reported on the results, obtained with the new balance. Further development was taken over by the Askania-Werke in Berlin-Friedenau. Illustration no. 4 shows the now usual Schmidt balance with the magnet put on knife-edge, as produced by this firm still now.

During his last years in office he dealt among other things with the idea of substituting a file-suspension for the usual way of putting the magnet on a knife-edge. I had the opportunity to help him with his measurements, and to profit by various discussions. So it was possible to take up also the production of magnetic field-balances with file-suspension, as now produced by the VEB Geophysikalischer Gerätebau in Brieselang (Ill. 5). About 1,000 balances of each construction have been sent to all continents up to now, and are used for research in the field of prospecting.

The statistical work of Adolf Schmidt at first dealt with a problem already approached by Max Eschenhagen. It was the question of summing up numerically the activity of the magnetic variation during the day, as they are caused by ionisation processes and the state of the upper atmosphere. In order to define this so-called geomagnetic activity Eschenhagen had introduced five categories (1, 2, 3, 4, 5). Adolf Schmidt took up this idea, which he recognised to be absolutely right in its principle, and simplified it by reducing the categories to three (0, 1, 2). They were accepted at the international congress in Innsbruck in 1905. The international character figures are used still now, and lead to extraordinarily useful perceptions, in spite of some insufficiencies found out since then. Right from the beginning so great a number of observatories took part in this work, which is quite simple and easy for the single observer, that by adequate averaging and by changing to the tenth parts in 21 categories, a sufficient measure of the activity could be obtained.

The progressing development of ionospheric exploration has caused an enlargement of this activity measure in two ways. First a more detailed entering into the single disturbances required a reduction of the time interval the activity numbers are effective in. Then the amplitudes of the activity had to be determined more exactly. Both these requirements were met by the Potsdam geomagnetic character figures, introduced by Bartels and internationally accepted in Washington in 1939.

Adolf Schmidt tried to realise the numerical definition of the geomagnetic activity in yet another way. But in would lead too far to detail these investigations. Only one of his statistical works shall be mentioned here. It is the investigotion in the geomagnetical effects of the tides on the ionosphere. The so-called lunar diurnal variation in the geomagnetic field indeed was known, but its treatment required numerical calculations that were almost impossible for the single scientist with the then existing computers. Adolf Schmidt thought it an important task of the observatories to publish the obtained data in yearbooks, as far as already treated, so that only summarizing theoretical investigation was left to the scientists. He developed a relatively simple and easily to be calculated method which he continually published in the magnetic yearbook of the Potsdam observatory. Unfortunately only a few scientists have followed his example, so that in principle the theoretical treatment of the lunar diurnal variation has not changed much.

One of the most important theoretical investigations has been mentioned above already, namely the calculation of the geomagnetic potential of the epoch of 1885. This is not the place to deal with the various new mathematical and theoretical-physical ideas, first published by Schmidt in this work. His investigations are directive even now.

Especially prominent were Adolf Schmidts' purely mathematical investigations with regard to the transformation of the spherical harmonics into different co-ordinate systems. He succeeded in universally solving these problems, and these formulas gave him the theoretical basis for the above-mentioned improvements of the reflexion experiments for the definition of the horizontal intensity. These works lead to important results in theoretical geophysics too, as it has been found out recently.

Adolf Schmidt already very early dealt with the outer parts of the geomagnetic field. Although the term «ionosphere» in the sense of the highest and strongly ionized strata of the atmosphere was not yet common property of geophysical perception, he took up with a sure eye some special problems in this direction. First his investigations on the so called ring current shall be mentioned. Indeed, the discovery, that such a ring current must be surrounding the equator, was not his alone; for Birkeland and Stoermer had already pointed out this phenomenon, but Schmidt, relying on the existing material of several observatories, was probably the first to show the real existence of the ring current, and to give data on its intensity. In illustration no. 6 the regular variations at various observatories, designed by him and now being classical property of geo-electro-dynamics, are reproduced. Although today the conception of the geometrical configuration and of the physical origin of the ring current has changed considerably, due to new perceptions, the fundamental physical conception is still the same one.

Adolf Schmidt worked on a further problem when he turned to the analysis of the simultaneous observation material, obtained during a ionospheric storm on February 28th, 1896, following a suggestion by Eschenhagen. He was able to show the course of the storm could be reproduced quite well by assuming current whirls speeding with 1 km p. h. Furthermore Schmidt could prove that these whirls must be located outside the earth, that is in those heights we now use to regard as the ionosphere. This perception was at the time Schmidt reported on his investigations —in 1899— very important; for the real existence of those strata was experimentally proved only in 1925. With that Adolf Schmidt simultaneously had taken up one of the most important problems of the ionosphere, namely the so-called tur-

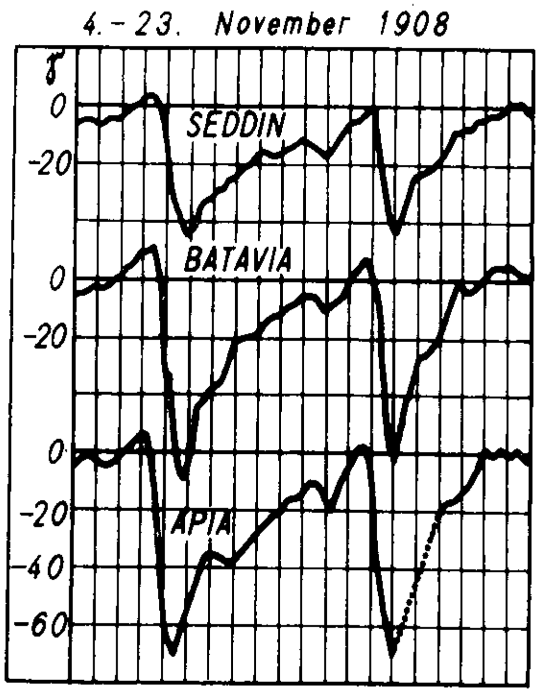


Abb. Tagesmittel der Nordkomponente von 6 zu 6 Stunden in Abweichungen vom Normalwert.

Illustration No. 6

bulence and the drift. The drift velocity of the mentioned whirls of 1 km p. h., given by him, corresponds very well to the newest measurements.

Finally one more investigation shall be mentioned that is of special interest, because it connects the geomagnetic variation-field with certain electrical inductive processes, caused by it in the interior of the earth. In a note about the great ionospheric storm of September 25th, 1909, Adolf Schmidt points to the fact that the two neighbouring observatories of Potsdam and Seddin registrated clearly different courses of the vertical intensities during this storm (Ill. no. 7). Although he did not go into details of physical explanation of the effect, this perception hit upon an important geophysical process, only recently come into the centre of exploration. For these temporal variations of the outer geomagnetic field can be used in order to obtain, by means of the electromotoric voltage induced in the interior of the earth, informations about the conductivity of those strata.

It must be mentioned that Adolf Schmidt not only worked in his very own branch of research, that is geo-electro-dynamics, but also published some works dealing with neighbouring geophysical problems.

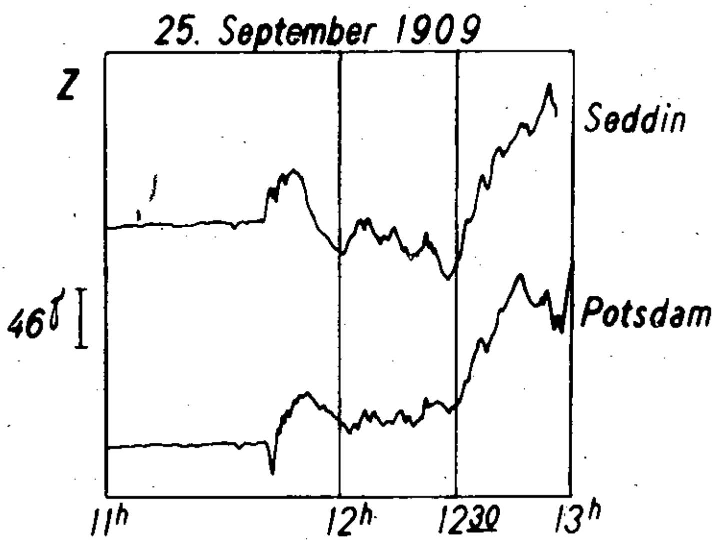
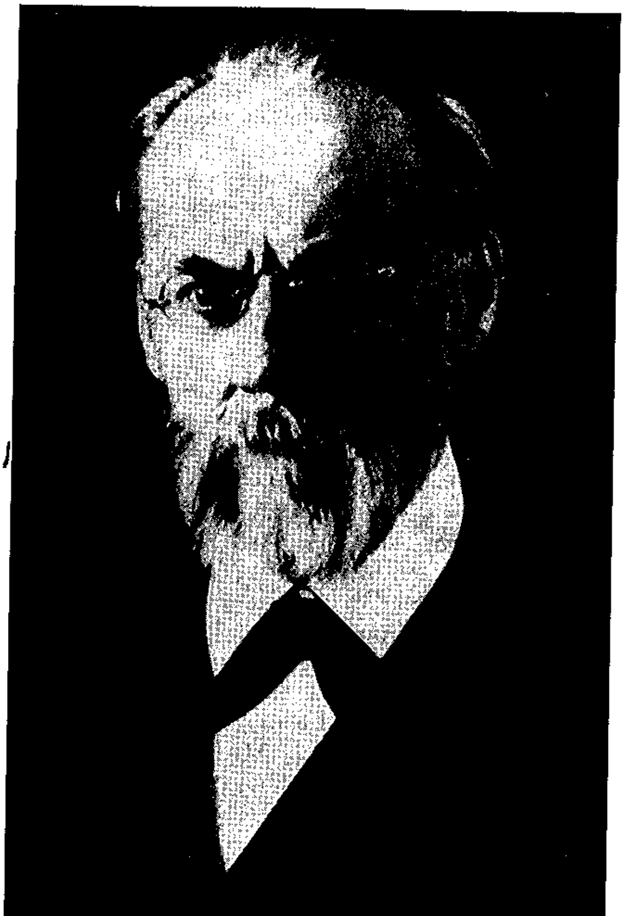


Illustration No. 7

Especially his meteorological research shall be mentioned, first of all his contribution to the competition of the Koenigsberg Physical and Economical Society. In 1891 Adolf Schmidt succeeded in solving the given problem, namely to work up the Koenigsberg ground-temperatures, and so won the prize.

His note on the use of trigonometric series in meteorology is even today important and worth while reading. Finally there is a work, written in high age, «On the Possibility and Probability of Long-standing Periodicities Within Meteorological Phenomena». This article written in Esperanto has been published in «Gerlands Beiträge zur Geophysik» in 1931.



Adolf Schmidt

It shall also be mentioned that Adolf Schmidt dealt with problems of art, lying entirely outside his actual spheres of interest. For example, he published two works on the numerical demonstration of musical intervals, containing some new aspects of theoretical harmonics. Both works were published in the «Zeitschrift für Physik» in 1920 and 1921.

In this short summary of his scientific activity naturally only the most prominent results that were obtained by him, have been compiled.

Scientific research was only one field of his activity. A second field of activity, none the less important and voluminous, is his work at the observatory itself, with regard to securing the quality and continuity of the geomagnetic experiments. With great zeal and remarkable energy he devoted himself to this task. At first he was anxious to clear off such overdues in treating the data obtained in Postdam, as arose from the death of Prof. Eschenhagen.

Further on he was always anxious to secure and improve the accuracy and reliability of both, the absolute geomagnetic measurements and the continuous registration. A good deal of technical and mathematical innovations were initiated, about which further information can be gathered from the magnetic yearbooks of the observatory.

Especially he took care that the highly sensible magnetic registrations in Potsdam were not influenced by industrial disturbances. Three times altogether he was forced to intervene. The first time was when electrical towing was initiated on the Teltow-Canal in 1903 und 1904; the second time was when the Postdam horse tramway was electrified in 1907. Although on his protest the joints had been connected especially good leading, and suction dynamos had been installed at the power-station, in order to minimize vagabond currents, Adolf Schmidt thought it to be the right moment to transfer the geomagnetic registrations from Postdam to Seddin. On his initiative a small observatory was built at Lake Seddin, where continuous geomagnetic registrations were carried out. Sometimes absolute measurements were also carried out there, in order to transfer the niveau of the geomagnetic field-intensity from Potsdam to Seddin. This observatory, set up in Seddin by Adolf Schmidt, proved to be the only rescue of the complete registration work, when in 1928 electrical traffic was established on the Berlin Suburban train service. The Potsdam-Erkner line was electrified first, and put into service at an earlier date than planned by the railway management. Although the Ministry of Sciences at an early date had known as well enough details of the plan of electrification, as the due dates, the negotiations had taken such slow progress, that no final decisions and preparations had been made when electrical train service was installed. So Seddin observatory, as already said, was the only rescue from this difficult situation.

professor at Berlin University in 1907. The Academies of Berlin, Goettingen and Christiania elected him member, and the German Geophysical Society made him honorary member. The Technical High School of Berlin-Charlottenburg made him Dr.-Ing. h. c. He was also awarded many decorations.

Now something about his linguistic capacities. It has already been mentioned that he had zealously studied the modern languages English and French. Later on he also turned to the classical languages Greek and Latin, which he commanded at least as well as many a pupil of a humanistic gymnasium.

Adolf Schmidt also dealt with the Russian language, and commanded it so far as to be able to read works in the original.

In connection with his qualities, mentioned at the beginning, namely modesty and reserve and high mental capacities, Adolf Schmidt already at an early date developed social consciousness and a sense of justice. It is no wonder that both affected his political attitude. Very early he turned to circles that were open-minded to social problems. He also joined the League of Human Rights, in order to demonstrate his attitude. For this reason Adolf Schmidt was no «persona grata» for the National-Socialist government. This fact did not ail him as long as he could enjoy undisturbedly his years of pension in Gotha, and was able to do scientific research. This changed completely, however, when the quiet and peaceful town of Gotha was bombed during World War II. Soon a housing shortage became perceptable, and Adolf Schmidt had to leave his beautiful home, that he inhabited with his sister Agnes. He was given dark groundfloor rooms that were no adequate home for the aging scientist. Unfortunately his aged sister accidentally fell on the removal, and died of her injuries in the Gotha hospital. No wonder that the originally so vital man became weary of life after those ordeals, and died shortly after, on October 17th, 1914.

With Adolf Schmidt not only one of the greatest German geophysicists has died, but also a great man with a remarkable character. May his life be an example not only for the now working geophysicists, but also for the generations to come. May it be an example not only with regard to the sientific accomplishments, but also with regard to character and mental attitude. It be allowed to place at the end of this statement those words Adolf Schmidt wrote down into the visitors' book at the inauguration of the Adolf Schmidt Observatory for Geomagnetism in Niemegk on his 70th birthday

„Αἰὲν ἀριστεύειν καὶ ὑπείροχον ἔμμεναι ἄλλων."

in English, «Always to be excellent, and to distinguish oneself before others».

PRESIDENT'S REPORT

by Prof. J. Kaplan

I know of no better way to begin my presidential address than by quoting the next to closing paragraph of the 1951 presidential address delivered by Professor Sydney Chapman at the meeting of the International Association of Terrestrial Magnetism and Electricity held in Brussels as part of the General Assembly of the International Union of Geodesy and Geophysics. You will recall that it was at that Assembly that Professor Chapman initiated the action that eventually extended the scope of our Association to include the upper atmosphere and related topics, and that resulted in the name under which we now carry out our activities.

In this paragraph, entitled «Future Work», Professor Chapman made the following statement:

«At this Assembly a proposal for a third International Polar Year is to be discussed. The advances in radio technique since the second Polar Year in 1932/3 in themselves constitute a strong argument for a repetition, and the proposed interval of 25 years, bringing the date to 1957-8 has the merit of giving a year expected to be of high sunspot number. Since 1933 the North American nations, Canada and the United States, have increased the number of their geophysical stations in their belt of the polar regions to a degree that justifies one in regarding every year as being for them, equivalent to a Polar Year. Thus, in seeking their cooperation along with that of other nations in a new International Polar Year, their enhanced regular program must be taken into account. The world situation is no more propitious for the scheme than the one that preceded the Second Polar Year, but that great enterprise was carried through to success by the energy, enthusiasm and skill of many nations, led by Dr. La Cour, and it seems to me faithless to shrink back from a renewed attempt.»

The story of the last nine years is a triumphant justification of the faith expressed by Professor Chapman. All of you know this story well because you have played important roles in the planning and carrying out of the International Geophysical Year, the IGC-1959 and in the development of post IGY plans for research in geophysics. However, on this occasion, I want to recall with justifiable pride and I hope reasonable modesty, the part played in these historic events by the IAGA and by those whose activities have been closely tied to the IAGA.

I start by reminding you that historically magnetism was the first field of international cooperation, when Gauss founded the magnetic union in 1833. I need not remind you that geomagnetism and the study of the aurora were important aspects of the programs of the first two Polar Years. In telling the story of the International Geophysical Year in his excellent book. «IGY: Year of Discovery», Professor Chapman points out that in 1950 Dr. L. V. Berkner proposed that in 1957-58 there should be a third International Polar Year-25 years after the second. He pointed out that this suggestion was made in the home of J. A. Van Allen at Silver Springs, Maryland, to him and his other guests. It is interesting to note that the other guests were J. W. Joyce, S. F. Singer, E. H. Vestine and Professor Chapman, all of whom are active in the affairs of the IAGA. And finally, I certainly do not need to remind you that all of those present at Dr. Van Allen's home have played significant roles in the IGY and continue to do so during these exciting post-IGY times.

The composition of the CSAGI also reflects heavily the membership of the IAGA. As all of you know, Professor Chapman served as President of the CSAGI, Dr. L. V. Berkner as Vice-President until he was succeeded by Dr. H. E. Newell; Dr. M. Nicolet as Secretary-General and our pastpresident, Dr. J. Coulomb, as a member of the executive of the CSAGI.

The list of CSAGI reporters contains the names of several of our colleagues, including our Vice-President V. Laursen for Geomagnetism; S. Chapman for Aurora and Airglow; J. A. Simpson for Cosmic Rays and M. Nicolet for Nuclear Radiation.

The direct successor to the CSAGI is the «Comite International de Geophysique», known as the CIG. Among its members are Nicolet for Aeronomy, Laursen for Geomagnetism, Elvey for Aurora and Airglow, and Vernov for Cosmic Rays. We wish the CIG great success and I know that the IAGA joins with me in promising its fullest cooperation to the ICG in its task of completing the work of the IGY and in carrying out its other tasks.

Since the last meeting of the IAGA in Toronto in 1957 much has happened in the fields of geomagnetism and aeronomy and in areas of science closely related to them. Possibly the best way to demonstrate these facts is simply to compare the scientific meetings in Toronto with those that will take place at this Assembly. Even before the start of this Assembly, the Committee on Aeronomy, under the presidency of Dr. M. Nicolet, has completed a successful symposium in Copenhagen. The aim of this symposium was to bring together international experts in the field of Aeronomy in order to arrive at a more complete understanding of the physical processes occurring the high atmosphere. The desirability of holding such a symposium just prior to the general assembly, was recognized after the success of the sessions on aeronomy in Toronto. In fact, it has been the increasing success of our symposia on aeronomy, starting in 1948, that led Dr. Nicolet to propose the Copenhagen symposium and the events of the past week have certainly justified his proposal.

I had the honor last week of making a few introductory remarks in Copenhagen and also of being the official delegate of the Committee on Space Research, established by the ICSU. I share this honor with our colleague Professor Vernov here in Helsinki as representative of the COSPAR to the general assembly of the IUGG. One of the most interesting meetings that have taken place during the interval between our general assemblies was the First International Space Symposium held under the sponsorship of the COSPAR in Nice, France, on January 11-15, 1960. I have singled out this meeting for special notice because of the significant part that scientists, whose background of international activity is closely associated with the IAGA, played in this important program.

This symposium was organized by sessions according to the following subject matter headings:

The Earth's Atmosphere
The Ionosphere
Cosmic Radiation and Interplanetary Dust
Solar Radiation
The Moon and the Planets
Meteorites
Tracking and Telemetering

There were 101 scientific papers presented by scientists of 12 countries. The symposium was attended by about 300 scientists from some 20 countries. Thanks to Dr. H. Kallman-Bijl, who acted as scientific secretary to the Symposium, and thanks to the remarkable support by so many nations, the symposium was a successful one and the proceedings have now been published.

Your President had the honor of attending this Symposium as a representative to COSPAR from the IUGG and also had the privilege of presiding over the opening session. While many of the contributors to the Symposium were well known to the IAGA, having been brought into international scientific activity through our own symposia, many of those present were new contributors, brought into the picture by the IGY, and more recently by the many scientific successes of the space and rocket research programs. It should be emphasized that much of the space science program is of direct interest to the membership of IAGA, and that the IAGA should consider carefully its future role in the space science field.

The fundamental part played by magnetic phenomena in nearly all aspects of space science, combined with the basic role of aeronomy, points to the IAGA as the most significant single international specialized group in the field. It must be recognized that the COSPAR will probably devote its future symposia to periodic overall reviews of the results which are of interest to the many scientific disciplines included in the COSPAR. It will be up to the specialized groups, such as the IAGA, to develop their areas of interest and thereby contribute to the advancement of space science.

Perhaps I should have first called attention to the scientific achievements which led to the establishment of the COSPAR. I refer here, of course, to the successful carrying out of the rocket and satellite programs during the IGY, IGC-59 and the period following the IGC. It was, in fact, only a few weeks after the close of the Toronto Assembly of the IUGG that the first satellite was successfully launched. Since that time, the success of satellite and space probes have been such as to make these last three years the most notable period between assemblies in the history of the IUGG. It should be a matter of pride that active participants in the past affairs of the IAGA were the leaders in these new and exciting developments, Having brought Aeronomy to the IUGG through our Association and its predecessor, the IATME, the IAGA must take the necessary steps to maintain its leadership.

I have spent a considerable portion of my time discussing the space program, but I have done so in order to emphasize the significance of the Association of Geomagnetism and Aeronomy into a single scientific group in the IUGG. When the proposal to include aeronomy in the title of the association was first discussed, none of us could have predicted how successful this wedding of the two fields would be.

As I look at the future, I am impressed by the remarkable breadth of interests covered by our association and of the reasons for this. I am particularly impressed by the increasingly significant role played by the magnetic field in space and in solar physics. This then points to the fact that the IAGA must be alert to the opportunities that space research will present and to its capabilities to contribue. While I am no prepared now to propose another change in our name, perhaps it is not too early to consider such a change. Possibly the name, International Association of Planetary Magnetism and Aeronomy might already be discussed at this Assembly. Regardless of the change, we must recognize now that with the new tools available to us, we are no longer limited to the earth and its immediate environment, and that in our minds we must always recognize this new and greater mission.

As many of you know, the Executive Committee of the Association met at The Hague in April, 1959. This was desirable because a number of the members were already in the Hague for a meeting of the COSPAR and of course, because of the increasing responsibilities of the Association. This meeting was useful, and it is hoped that such a meeting between assemblies can be held in the future.

I want to call the attention of the Association to the successful Symposium on Rapid Variations of the Geomagnetic Field, which was held in Utrecht, 1-4 September 1959. The thanks of the Association go to Committee No. 10 and its Chairman, Father A. Romañá, and to the DeBilt Observatory and the University of Utrecht for their part in the planning and carrying out of the Symposium.

At the meeting of the Executive Committee at The Hague approval was given for the holding of the IAGA Symposium on the Earth's Storms in Kyoto, Japan, in September, 1961, following the General Assembly of the IAU in the United States. Our colleague, Professor T. Nagata, is responsible for the arrangements of this symposium and the interest shown so far indicates that it will be a notable one.

Following the suggestion of Professor Nagata, I have invited the IAU and the URSI to participate in the planning of the Kyoto Symposium on Earth's Storms and the response has been immediate and favorable. I hope that our Association, recognizing its broad interests, will follow the pattern of inviting general participation in its future symposia, and in this way not only maintain but expand its prestige and influence.

At the conclusion of the 1959 meeting of the IAGA Executive Committee I decided to attempt to obtain some private funds for the purpose of aiding the activities of the ICSU in general and the IAGA in particular. A good friend in California responded to my appeal and established a fund of $ 50,000 in the United States National Academy of Sciences for the specific purpose of supporting the travel of younger scientists to international meetings. $ 6,000 of this fund have been sent to the ICSU for transmittal to the IAGA to help the Copenhagen Symposium, and an additional $ 6,000 has been promised by the Geophysics Research Directorate of the United States Air Force, and by the Office of Naval Research, for the Copenhagen Symposium. The availability of these funds will enable the IAGA to proceed with rapid publication of the Copenhagen Symposium. The second $ 6,000 will also cover administrative expenses connected with the Symposium. I wish to thank Mrs. Leo Bing of California for this generous help and I hope that with the approval of the IAGA Executive Committee it will be possible for me to obtain additional funds for future symposia of the IAGA. I hope also to continue to build up the fund in the National Academy of Sciences for the more general support of international meetings.

It is important here to emphasize the role of the ICSU in our affairs. It is my firm belief that wherever possible, the ICSU and its adhering national organizations, must be called to the attention of the public and support for its activities encouraged. The great success of the IGY can in part be ascribed to the non-governmental character of the ICSU and the significance of this cannot be overstated. ICSU and its constituent unions have an important role to play in these times of rapid change and we who are ultimately responsible for the success of ICSU enterprises, must also recognize the need for increased support.

I want at this time te call special attention to the work of the IAGA Committee on World Magnetic Surveys and Magnetic Charts. As all of you know, Professor Sydney Chapman initially proposed the WMS during the IGY, to be carried out during a quiet interval in the solar cycle. The CIG has taken special notice of the WMS and has affirmed the need and merit of this Survey. It also expressed the opinion that adjoint programs in the field of upper atmosphere research should be considered for conduct during the same period. Dr. E. H. Vestine, Chariman of the IAGA Committee on World Magnetic Surveys and Magnetic Charts has arranged for a symposium on the WMS at this meeting of the IAGA. The preliminary plans already made indicate that this project will be a successful one and that it will follow in the tradition of the IGY. I want to thank Dr. Vestine and his colleagues for their devoted work in this area of our activities.

An examination of the scientific program of this meeting will quickly reveal the expanding nature of the work of the IAGA. I note with particular pleasure the meeting arranged by our new Committee on the History of Geomagnetism and Aeronomy and recommend that as many as possible attend that meeting.

As I pointed out earlier in my address, the period of my presidency has coincided with the most exciting period in the history of our areas of interest. During this time all of us were busy with the tasks presented by the IGY, IGC and related interests. I don't know how the work of the IAGA would have proceeded without the able and faithful work of our Secretary, Father J. O. Cardus and in closing, I want especially to thank him for making my life as President an easy and pleasant one. I want also to thank the other members of your Executive Committee for their interest and support. It has been a privilege and a pleasure to have served as the President of the IAGA, and I hope that as I now join my distinguished predecessors, I will be allowed to serve the Association for many more years.

REPORT OF THE SECRETARY AND DIRECTOR OF THE CENTRAL BUREAU FOR THE PERIOD 1957-1959

General

The period between the 11th and the 12th General Assemblies of the International Union of Geodesy and Geophysics has been characterized by the occurrence of the International Geophysical Year and the Year of Geophysical Cooperation, Our Association has taken a leading part on both programs and the result has been a gratifying increase on the work done by our Association.

At the same time that the activity of the Association becomes more and more world wide due to the increase in the number of Observatories and of scientists collaborating in our task, new fields of activity are open to our consideration with the new techniques of rockets and satellites: not only the very high atmosphere but also the interplanetary space is now of particular interest to our Association. A good proof of it is that our President, Professor Kaplan, has been acting as the IUGG representative in COSPAR.

Executive Committee

During the period under consideration the Executive Committee held a meeting in The Hague (16-17 March 1959) to consider the rapidly changing picture of science today and to study some points of interest to the Association.

The agenda was fixed as follows:

1. The future of the IUGG from the viewpoint of IAGA. This will involve the question of the way in which the IAGA may best function in the period after the IGY and how IAGA may remain the principal international body in Geomagnetism and Aeronomy.
2. The International Cooperation in Geophysics.
3. COSPAR and other space science progress to see the IAGA's role in an expanded program of international cooperation.
4. The World Magnetic Survey.
5. The Helsinki Meeting: main points of its provisional agenda.
6. The future symposia, their organisation and finances.
7. Publications of the Association and its distribution.
8. General questions.

In order not to be too long I shall try to summarize here the main conclusions of the Meeting:

In connection with the two first points of the Agenda: «Future of the IUGG from the view point of IAGA» and «the International

Cooperation in Geophysics» the general principle agreed was that Unions should take over the work of CSAGI after the end of the IGY, and the Executive Committee was of the opinion that IAGA could take over the work with only small changes in our organisation. Considering that there is a CSAGI proposal to carry on the observations for a complete solar cycle and that our committee on Aurora has not in the past been very active it was deemed necessary to study the ways in which IAGA could reinforce its activity in such a field; the problem is not too difficult as many of the most active members of the IGY working group on aurora are members of IAGA committee No. 2 on Aurora and Airglow; two possible steps could be: to become a permanent service into FAGS and to publish a yearly Bulletin corresponding to IAGA Bulletin No. 12. No decisión was reach in this matter.

The E. C. was against the stablishment of many special committees *directly under ICSU;* they will create with Unions an unnecessary overlapping of functions with the result that a lot of time will be passed in coordinating the work of the Committees and of the Unions rather than to plan the scientific work; nevertheless it was strongly feld that *Inter-Union Committees* were necessary: f. i. solar activity-geomagnetism, ionosphere-aeronomy and the following recommendation was adopted:

«The Executive Committee of IAGA recommends that the membership of SCG, in keeping with its name, should be confined to Union members, and that the number of delegates per Union should be appointed according to their importance for SCG, in order to achieve an effective representation in all fields involved.

Recognizing the fact that there are scientific domains which are of interest to more than one union the E. C. of IAGA further recommends that activities of the former Joint Commissions on the Ionosphere, and on Solar and Terrestrial Relationships should be continued. It is suggested that the SCG would be the appropiate body of ICSU to take on the above responsability.» (1)

The Association expressed its wish that Profs. Chapman, Nicolet and Laursen would continue as IAGA representatives in the International Cooperation in Geophysics.

I am glad to announce you that in the new membership of CIG Dr. Laursen has been appointed IAGA representative for Geomagnetism.

Following the ICSU resolution to abolish the Joint Commission on Ionosphere and on Solar-Terrestrial Relationships the International

(1) Under new developments of SCG and ICSU this last sentence may perhaps require new consideration.

Unions of Astronomy, Geodesy and Geophysics and Scientific Radio have agreed in the constituion of an Inter-Union Committee on the Ionosphere (the IUGG representative being Dr. Nicolet), and also in the creation of an Inter-Union Committee on Solar and Terrestrial Relationships (no nomination has been done until now). Draft constitutions for these two Inter-Union Committees are now under study.

As for COSPAR the executive Committee was of the opinion that as COSPAR already exist, IAGA should collaborate with it although the present statutes of such Committees may create very difficult problems, as national representatives, etc. (2)

An important task for our Association is the World Magnetic Survey. Dr. Vestine has been very active and technical recommendations were circulated to National Committees for comments. I am sure that during this General Assembly we shall see our plans take a very clear shape towards the success of such an important activity.

The Executive Committee took into review the Symposia to be organized; and the following ones were accepted:

Rapid-Variations and Earth-Currents at Utrecht in September 1959. It was a success and its transactions are now under press.

Geophysical Aspects of Cosmic-Rays, World Magnetic Survey, and Polar Wandering to be held during this General Assembly. The first one has been organized by Prof. Ehmert and the second one by Dr. Vestine. The last one at the suggestions of the IUGG General Secretary has been delayed until 1961 or 1962 in order to include in it Palaeomagnetism and Palaeoclimates.

It was also accepted to collaborate in the Symposium on Geophysical Study of data provided with rockets and artificial satellites, organized by the IUGG General Secretary but at the last moment it was turned over into a Symposium on the July 1959 events organized by our former President Prof. Bartels.

The organization of a big Symposium on Aeronomy just before the Helsinki meeting was agreed. As you know it has taken place a few days ago in Copenhagen under the Chairmanship of Dr. Nicolet.

A first symposium on Rapid Variations was held in Copenhagen from the 9th to the 11th of April 1957 and in it very clear and usefull indications were given on how Rapid Variations were to be reported to Com. 10.

Publications

As you see the Association has been very active in planning its work. It is intersting to note that it has tried to publish its results.

Committee No. 9 through the care of its Chairman, Prof. Bartels

(2) These difficulties have now disappeared and COSPAR has an effective charter.

has published regulary the K and Kp indices and the musical diagrams; it is worth noting that the K indices were the first complete set of data published after the end of the IGY.

The quarterly list of Rapid Variations have been distributed regulary to all participant Observatories; and I am glad to thank here Prof. Veldkamp who is in is in charge of their reproduction and Fr. Romañá, Chairman of Com. 10 who prepares them. Since the IGY lists of pulsations (pt and pc) registered with quick-run instruments have been added.

Committee No. 10 issued an instruction for reporting Rapid Variations and a Provisional Atlas of Geomagnetic Rapid Variations which has been distributed to corresponding Observatories and has been also printed in the Annals of the Geophysical Year.

The Transactions of the Rome Meeting, IAGA Bulletin No. 15, have been distributed during this period.

The scientific communications presented at the two Symposia of the Toronto Meeting have been published in the «Annales de Geophysique» and are distributed theses days in the form of reprints to National Committees through the International Exchange Office:

IAGA Bulletin 16 a — Paleomagnetisme et Variation Seculaire

IAGA Bulletin 16 b — Aeronomie

In the series of IAGA Bulletins 12, Geomagnetic Indices and Rapid Variations, the following volumes have been published:

Bull. 12 j — Geomagnetic Indices K and C, 1955

Bull. 12 k — » » K and C, 1956

These Bulletins have been prepared for printing by Prof. J. Veldkamp, Father A. Romañá and Prof. J. Bartels and printed in Holland under the supervision of Prof. J. Veldkamp.

Thanks to the work of Captain Roberts. Chairman of Com. 1, a third volume of the «Description of Geomagnetic Observatories» has been printed in USA and distributed.

I cannot avoid at this point of the report to mention the delay in the publications of the Association; it is a fact which has been regretted by all concerned; at the Toronto Meeting an Editor was appointed and although his work has been most effective and I wish to express here to him the thanks of the Association I am sorry to say that the delay in the publications has not been avoided.

It is not worth noting the delay if we do not look for adequate solutions and to do this we must try to find the causes of the delay; in my opinion three causes coexist: first of all the great increase of work that IGY and CIG has caused to all concerned in the publications and that has prevented them to give their time to the matters of the Association. This has been partially arranged with the appointment of the Editor but still it would be convenient to see if it is possible to offer more clerical assistance, if required, although it may mean an increase in the expenses of the Association. The second cause is the increase in the publications themselves: in the past only the Transactions of the General Assemblies were published and a short Bulletin on Indices K and C, now we have to take care of Symposia, etc. In the case of Magnetic Indices and Rapid Variations I wish to note that the first volume issued in 1948 had 55 pages and in it there were listed 67 collaborating Observatories; and that in the last volume published 12 k. issued in 1959 there are 160 pages and 87 collaborating Observattories, and from reports of those in charge of the preparation of the following volumes with data of the IGY such numbers will be again greatly increased: from 93 cases of polar sudden commencements reported in Bulletin 12 e for 1950 we shall pass to some 1100 cases in the Bulletin 12 j for 1957. The last but not least reason of the delay is the fact that not all send the reports in due time: I may say that the final version of the report of one of the IAGA Committees to the Toronto Assembly was presented to this secretariat by the end of 1958; and that a list of Rapid Variations with data belonging to 1957 were sent to Com. 10 only a month ago; I am afraid that it is almost impossible to ask everyone to collaborate in a most efficient form. They are also over-burdened by work in their stations or institutions; the only way to avoid delays caused by this cause may be to fix a dead-line for presentation of papers and to keep to it also if some papers arrive after the fixed date but before the publication; the inclusion of them in the manuscripts already prepared for printing requires a lot of time and of trouble.

These are the causes which I could find and some of the remedies I like to suggest; from my part and from the part of all the officials of the Association I can assure you that every effort will be made in order to cut down as much as possible the delay in the publications and with the kind help that you and your National Committees will offer by sending the manuscripts in due time I hope that the Secretary's Report at the next General Assembly will be a more optimistic one.

Toronto resolutions

The Resolutions adopted by the Association at Toronto were transmitted to various National Committees; practically all of them aknowkedge receipt of them but only a single one has sent any report on the action taken, if any.

Correspondance

During the period between the Toronto and the Helsinki Meetings the Central Bureau has received over 1000 letters or copies of letters circulated between members of the Associations and some 750 letters have been sent in addition to several hundred copies of a number of circular letters.

Finances

The budged adopted by the Association at Toronto for the period 1st January 1957 to 31st December 1959 is as follows:

ESTIMATED RECEIPTS

		$
Balance 1/1, 1957		19.000
From Union for the period 1/1 1956 to 31/12 1959		
1/1 1956-31/12 1956 . .	3.000	
1/1 1957-31/12 1959 . .	4.000	7.000
(£ 500 a year)		
Total		26.000
Estimated payements		24.300
Estimated balance 31/12 1959 . .		1.700

ESTIMATED PAYMENTS

	$
Management expenses	1.200
Rome Transactions including Bull 15b	5.500
Toronto Assembly	500
Toronto Transactions	7.000
Copenhagen Symposium	1.600
Magnetic indices	2.000
Comparisons	1.000
Lunar Studies	2.000
Rapid Variations (Comite 10). .	1.000
1959 Symposium	2.500
Total	24.300

Actual receipts and payements for the period are listed in the appended statement of the accounts. This statement is a summary statement based on three part-statements, one for Washington, one for Copenhagen, and one for Tortosa. The three part-statements will be submitted to the special Finance Committee appointed for the Helsinki Assembly.

This statement is complemented with an appendix giving the accounts receivable and payable. Taking into consideration these accounts the ammount actually at disposal of the Association for future expenditures is of about 2,776 $ as against 19,142.08 at the beginnig of the period under review. This reduction was imposed at the Toronto Meeting by the new policy of the Finances Committee which thinks that Associations must keep in hand only a sum of the order of the annual IUGG allocation. Such a reduction will make more difficult for the period 1960-1963 to follow the policy of increasing the activity of the Association, but I feel confident that the problem of funds will not be a serions one.

UNESCO grants-in-aid have again most efficiently contributed to the furtherance of the programme of the Association. The total of the grants for the period here considered was $ 8,050: $ 550 were for the publication of the Toronto Transactions, $ 3,100 for an intensive comparison of magnetic instruments in connection with the IGY and $ 4,400 for the Symposia at Copenhagen and Utrecht.

We have omitted from our statements the sums granted by UNESCO to the Permanent Service of Geomagnetic Indices because following a new policy of the Union these grants go directly to the Permanent Service from FAGS; but it must be mentioned here that due to these grants-in-aid the Permanent Service of Geomagnetic Indices has been able to cope with the very large ammount of raw material sent to him in connection with the IGY without drawing from the Association any considerable ammount of money.

PREPARATIONS OF THE HELSINKI MEETING

The first circular letter announcing the Association's plans and a provisional agenda was sent to National Committees and Officers of the Association and its Committees as well as to Oficers of the Union and of the other Association during the month of November 1959. A second letter with a new agenda and the list of titles of technical communications has been circulated at the beginnig of July.

Finally a preliminary bulletin for distribution at the Assembly has been prepared and duplicated in June and contains the agenda, national reports and abstracts of techincal communications which were received in time for inclusion.

FINANCES REPORT AND BUDGET

SUMMARY STATEMENT OF ACCOUNTS FROM 1st JANUARY 1957 THROUGH 31st DECEMBER 1959

RECEIPTS	$	$
Balance 31st Dec. 1956		
Dan. acc.	11.744,—	
U.S. acc.	7.397,77	19.141,77
Allocation from the Union		
Dan. acc.	3.136,—	
Span. acc.	1.000,—	4.136,—
UNESCO grants in aid		
Publication of Toronto Trans. (Dan. acc.)	550,—	
Symposia (Copenhagen) (Dan. acc.)	2.400,—	
Symposium (Utrecht) (Span. acc.)	2.000,—	
Comparisons (Dan. acc.)	3.100,—	8.050,—
Interests:		
Dan. acc.	779,—	
U.S. acc.	962,08	1.741,08
Sale of Publications:		
Dan. acc.	185,—	
U.S. acc.	7,—	
Span. acc.	3,90	195,90
Miscellaneous:		
Gain in rate of exchange	1,—	
From Dr. Harang, Oslo (Dan. acc.)	268,—	269,—
Total		33.533,75

PAYEMENTS	$	$
Subvention from Association funds to Permanent Services:		
K Indices (Dan. acc.)	553,—	
K Indices (Span. acc.)	349,75	
Lunar Studies (Span. acc.)	1.400,—	
Comparisons (Dan. acc.)	2.634,—	4.936,75
Publications:		
Bull. 15b + 15 + 16 part payement (Dann. acc.)	6.548,—	
Bull. 16a and 16b part payement (Span. acc.)	3.000,—	9.548,—
Secretariat:		
Dan. acc.	764,—	
Span. acc.	377,74	
U.S. acc.	7,63	1.149,37
Toronto Assembly (Dan. acc.)	235,—	235,—

Symposia:		
Copenhagen (Dan. acc.)	3.795,—	
Utrecht (Span. acc.)	4.298,67	8.093,67
Meeting of the Executive Committee:		
The Hage (Span. acc.)	1.435,18	1.435,18
Miscellaneous:		
Dan. acc.	312,—	
U.S. acc.	111,67	423,67
Total Payments		25.821,64
Balance 31st Dec. 1959		
Dan. acc.	2.269,—	
U.S. acc.	4.360,62	
Span. acc.	1.082,49	7.712,11
Total		33.533,75

The above statement is summarizing the three sub-accounts of the Association: the U. S. sub-account prepared by Dr. J. W. Joyce, the danish sub-account prepared by Mr. V. Laursen and the spanish sub-account prepared by the Secretary of the Association. In the danish sub-account all receipts and payements in danish crowns have been converted to U.S. dollars using the rate of exchange 1 U.S. dollar to 6,90 danish crowns and the results have been rounded to the nearest dollar. In the spanish sub-account the rate of exchange has been 42 ptas. or 60 ptas. per dollar in accordance with the official rate of exchange.

Observatorio del Ebro, July 9th, 1960
J. O. CARDUS, S. I.
Secretary, IAGA

Rapport du Comité de Finances de l'IAGA

Les trois membres du Comité des Finences de l'IAGA

Prof. E. Thellier,
Prof. T. Nagata,
Prof. M. Nicolet,

se s'ont réunis le 4 Août 1960 pour examiner le rapport du Dr. Cardús, Secrétaire, sur le budget de l'Association pour la période allant du 1er. Janvier 1957 au 31 Décembre 1959. Le Rapport ayant été approuvé, le Comité a remercié le Dr. Cardús de la clarté de sa présentation et il propose à l'Association d'adresser à son actif Secrétaire ses félicitations pour les efforts qu'il dépense au profit de l'Association, en particulier pour la bonne gestion de ses finances.

Helsinki, le 4 Août 1960.

E. Thellier, M. Nicolet, T. Nagata

BUDGET

The Budget adopted for the Period 1st January 1960-31st December 1962 is as follows:

ESTIMATED RECEIPTS	$
Balance 1/1 1960	7.712,11
IUGG Allocation	
Part 1957-1959	3.000,—
1/1 1960-31/12 1962	10.500,—
From Permanent Services . .	349,05
Sales of Publications	47,67
Total	21.608.83
Estimated Payements	20.824,28
Estimated Balance 31/12/62 .	784,55

ESTIMATED PAYEMENTS	$
Secretariat (from last period).	632,14
Subvention to Permanent Services from last period . . .	730,—
CR Assembly Toronto	2.550,—
CR Symposia Toronto	512,14
Helsinki General Assembly. .	900,—
Helsinki Transactions	5.000,—
Menagement Expenses	1.500,—
Meeting of the Executive Com.	3.000,—
Tokyo Symposium	2.000,—
Magnetic Indices	1.000,—
Comparisons	1.000,—
Rapid Variations: Pub. Utrecht Symposium	1.000,—
Lunar Studies	1.000,—
Total	20.824,28

NATIONAL REPORTS

The following NATIONAL REPORTS were presented at the first General Meeting and (or) distributed to the participants:

Argentina
Belgium
Canada
Czechoslovakia
Denmark
Finland
France
Germany
India
Iran
Ireland
Italy
Japan
Mexico
Netherlands
New Zealand
Portugal
South Africa
Spain
Sweden
Turkey
United Kingdom
U.R.S.S.
U.S.A.
Yugoslavia

PART II

SPECIAL REPORTS

REPORT OF COMMITTEE NO. 1 ON OBSERVATORIES

The Committee has functioned since the previous assembly with the following composition:

Prof. J. Bartels
Dr. L. Constantinescu
Prof. J. Coulomb
Prof. G. Fanselau
Dr. A. A. Giesecke
Prof. M. Giorgi
Dr. P. Herrinck
Dr. J. D. Kalinin
Prof. E. Lahaye
Dr. V. Laursen
Dr. O. Lutzow-Holm
Dr. R. Glenn Madill
Dr. S. L. Malurkar
Dr. L. S. Prior
Capt. E. B. Roberts
Dr. J. Rodriguez-Navarro de Fuentes
Prof. J. Veldkamp

In 1957 and 1958, the Committee corresponded actively on current problems in its field. Of these the subjects receiving principal attention were the possible adoption of fiber suspensions for Z variometers, the use of portable recording stations as a means of frequent intercomparison of regular observatory instruments, temperature coefficients and several incidental ideas such as: the use of magnetic tape recordings, the use of punch cards, etc. It is reported that the general discussion of the foregoing matters serve useful informational purposes and many valuable opinions were compiled, but no specific recommendations were adopted. However, these and other problems relating directly to instruments were transferred to the jurisdiction of Commitee No. 8 on instruments, which will report thereon.

A proposal to establish standards to govern the spacing of observatories was deferred for later study in the light of IGY results. The Committee notes with approval a proposal that observatories be established at Dougherty Island in the South Pacific and at South

Georgia and Bouvet Islands in the South Atlantic. Information and procedural advice were given on request to the interested officials at the new observatory at Pendeli, Grece, and at a proposed new observatory in Burma.

Jurisdiction of the proposal to publish a tabulation of annual and monthly observatory means was transferred by agreement to Committee No. 9, on the Characterization of Magnetic Activity.

The Committee agreed to accept responsibility for the assignment of abbreviation symbols for all world observatories.

Following a recommendation of the Fifth CSAGI conference, the Committee undertook to complete Volume III of the world catalog of magnetic observatories, including those recording gradient measurements or earth current measurements. All known magnetic observatories were sent questionnaires and the responses were compiled, edited, and put into suitable form for publication of 500 copies in a format consistent with that of Volumes I and II, published previously by the Committee. In 1959 Volume III was distributed, and 200 copies deposited with the Association Secretary. It contains an index of all observatories that have responded, with references indicating which of them may be found in Volume I and II. Newly reporting observatories or those reporting changes are listed in detail in Volume III.

Observatory reports received too late for inclusion in Volume III included the new Pendeli Observatory in Greece and the observatory on the French island of Kerguelen in the South Indian Ocean. Supplement sheets referring to these have been prepared for distribution.

It is believed desirable to continue the work of Committee No. 1.

E. B. ROBERTS
Captain, C&GS (Ret.)
Chairman

REPORT OF COMMITTEE NO. 4 ON SECULAR VARIATION AND PALAEOMAGNETISM

1. *Members of Committee No. 4 during 1957-60 period*

T. Nagata (Japan) Chairman
G. Angenheister (Germany)
Edward Bullard (Great Britain)
G. E. Gjellstad (Norway)
T. A. Jacobs (Canada)
R. G. Madill (Canada)
B. Peters (India)
T. Rikitake (Japan)
E. H. Vestine (USA)
T. R. Balsley (USA)
M. Giorgi (Italy)
G. Ising (Sweden)
I. C. Jaeger (Australia)
J. H. Nelson (USA)
G. N. Petrova (URSS)
E. Thellier (France)

2. *Isoporic charts for 1950-55 and 1955-60*

Isoporic charts for the geomagnetic three components, X, Y and Z, for the period of 1955-60 were compiled as an activity of this Committee, in continuation of the preceding isoporic charts for 1950-55, which were presented to the XIth meeting of IAGA and has been published. The armonic coefficients of spherical harmonic analysis of the distribution have also been obtained. The work of compilation and analysis was actually made by the chairman, with strong support by all magnetic observatories as well as the members of the committee. The result is presented in a separate form distributed to participants at this Assembly. A remark which seems to be worthwhile to be noted is that the isoporic charts for 1955-60 cover the Antarctic area, where secular variation data at 12 stations were available for the period concerned, and that amount of annual rate of secular variations over Antarctica is anomalously large compared with that in any part in the Northern hemisphere, amounting to about 200 γ/year and to more than 100 γ/year for Z and horizontal vector change H respectively at their maximum points. It has been found thus that Antarctica and its vicinity are extremely important from viewpoint to know exact future of distribution of geomagnetic secular variation over the earth. For the period of 1955-60, including IGY and IGC 1959, such significant geomagnetic data over Antarctica could be obtained through CSAGI and SCAR, both under ICSU. It seems desirable that Committee 4 of IAGA should keep very close contact with SCAR in future also in order to continue or even to promote accumulation of suitable and reliable data of geomagnetic secular variation over the Antarctic area.

As for general tendency of the geomagnetic secular variation as a whole, it is recognized in the above-mentioned report that moment of the earth's magnetic dipole is still decreasing, being 8.024×10^{25} e.m. at 1960.0, and that the eccentric dipole is still continuing to drift westwards and northwards, its position at 1960.0 being 17° 29′N and 149° 58′E.

3. *Theoretical Investigations on Origin of Geomagnetic Field and its Secular Variation*

Since the model of self-exiting dynamo within the earth's core was proposed by Elsasser and Bullard as a possible mechanism of producing the geomagnetic field, many trials to attack this problem in detail have been made by a number of scientists from both observational and mathematical sides. Now, most people concerning this problem are believing that the core's self-exciting dynamo is the only possible explanation of origin of the geomagnetic field and its secular variation.

However, mathematical treatments of the exact hydromagnetic equations for this problem, which are essentially non-linear, are so extremely difficult that only solutions of some approximation have been obtained. In the past three years, efforts to solve this problem have been mostly concentrated to examining stability of dynamo system with regard to geomagnetic secular variation, especially with reversal of the main geomagnetic field postulated from palaeomagnetic research group. Two somewhat different types of «two-eddy» model were proposed by Rikitake and Herzberg in 1958. In both the models, two dynamos are coupled electromagnetically with each other, resulting in coupled oscillatory changes. Even for such a relatively simple model, mathematical treatments are very complicated, solution being obtainable by means of electronic computors. As far as the two-eddy dynamo model is concerned, the results of studies carried out by a number of investigators seem to be succesful, showing general behaviour of repeated reversals of the dynamos accompanied by oscillations of smaller periods. It seems likely that this kind of theoretical work, though it is much elaborate, must be encouraged in the future in order to get real physical picture of the earth's magnetic field.

4. *Rock Magnetism*

As the fundamental basis of archaeo- and palaeomagnetism, basic knowledge of magnetic properties of ferromagnetic minerals is absolutely important. Archaeomagnetism as well as palaeomagnetism deal with the earth's physical state at old pre-historical or geologic age, time factor in which is much beyond our common sense in empirical physics. Only exact knowledge of microscopic and crystallophysical characteristics of ferromagnetic minerals may be able to offer method of criteria for archaeo- and palaeomagnetic researchs.

In the past three years, basic studies on magnetic properties of rock-forming minerals, mostly metallic oxides, have been much developed, and their physical understanding has almost been established. According to the results, ferromagnetic minerals in nature are classified in three groups, namely, titanomagnetite series, hematite-ilmenite series and titanomaghemite series (including maghemite-ilmenite series). The last one, titanomaghemite series, which are solid solutions of inverse spinel type in crystal structure between titanomagnetites and unstable maghemite-ilmenite series, are mostly due to oxidization of titanomagnetites. It has been found that most of ambiguous and doubtful results in palaeomagnetic researchs hitherto obtained are due to ignorance of these dangerous minerals. On the other hand, magnetic viscosity of magnetite and hematite has been quantitatively examined and the result shows that remanent magnetization of these stable minerals should be absolutely stable, its life being far longer than the earth's whole age, provided that there is no chemical change in crystals themselves. More detailed description of the above mentioned fundamental basis of rock magnetism is presented in a separate form.

As for mechanism of causation of remanent magnetism of rocks and other materials including ferromagnetic minerals, two new processes have been discovered in the past three years. They are chemical remanent magnetization (Haigh 1958, Nagata-Kobayashi 1958) and piezo-remanent magnetization (Kawai 1958, etc.) in addition to already known three processes, i.e. isothermal, thermo-, and detrital remanent magnetizations. The former (chemical) is related to change in remanent magnetization caused by chemical reaction in rocks, and its process has been physically understood even quantitatively to some extent. The latter (piezo-) is of course related to change of remanent magnetization caused by dynamic pressure on the materials, but little has been known so far about its physical mechanism. Perfect knowledge of these two kinds of remanence is exclusively significant in interpretation of archaeo- and palaeomagnetic results, especially for metamorphic rocks, and therefore studies on these phenomena must be encouraged in the future.

It must be noted also that real mechanism of self-reversal of thermoremanent magnetism has been clarified (Uyeda, 1958), the reversal being attributed to exchange interaction among neighbouring domains in the crystal. Now detailed atom-physical studies on this problem have been put forward to hands of crystal physicists.

5. *Archaeomagnetism*

Archaeomagnetic studies have been quite well developed in the past three years by close cooperation among geophysicists and archaeologists, especially in France, Great Britain and Japan. In addition to fairly reliable knowledge about variation of direction of the geomagnetic field in the past five thousand years, it has been reported by Thellier (1959) that the earth's main field has been decreasing during, at least, 2500 years in the past, it being 2000 years ago about 1.5 times as much as that at present.

6. *Palaeomagnetism*

During the past three years, palaeomagnetic studies have been extended almost to all continents, in addition to Europe, North America, Australia, and some parts of Far East where this kind of research had been done before. The main object in the palaeomagnetic research may be classified into two subjects, namely, reversal of the geomagnetic field, and wandering of the earth's pole relative to the several continents.

As for the reversal of the earth's magnetic polarity, it may now be agreeable among researchers to state that the earth's magnetic field has been reversed repeatedly, and that period of reversing process would be much shorter than that of wandering of the magnetic pole around either north or south geographic pole. It has been concluded that the latest reversal of the earth's magnetic field took place in the early Quaternary, and the latest but one in the later Tertiary. There are undobtedly, in addition, reversed magnetization found in nature which are not due to this cause, but arise from complex physico-chemical causes (self-reversal of thermo-remanent magnetization).

Assuming then that the mean geomagnetic pole was situated near the earth's rotation pole during most of the earth's life, the position of the earth's pole at various geologic epochs has been obtained by palaeomagnetic method, using many rocks collected at various parts of the world. The pole position in the past thus obtained is fairly scattered, but it may be concluded, without exception, that the pole position was nearer the equator in older geologic epoch. This general conclusion can fit even to the data obtained recently from Antarctica, separately from the East and West Antarctica.

It has been noticed further that there is general tendency in the most data that the pole position was farer distant for older rocks from the locality where the concerned rock samples were collected, roughly along meridian line passing through the locality and the north pole. This result has led palaeomagneticians to propose anew the possibility of continental drift. By combining palaeoclimatological data, it has further been confirmed, for example, that northward drift of England relative to the pole during the past geologic time is quite possible.

In the Xth Assembly of IAGA (being IATME at that time), members of this Committee 4 tried to discuss palaeomagnetic results, palaeoclimatological data, and results of age determination of rocks altogether for the purpose of initiating modern synthetic physical research of the earth's past history. It was general feeling at that time, however, that each of the three branches of science was still at its too early stage to be jointly discussed on reliable basis. It seems likely now that each of the branches has been developed sufficiently to make a joint meeting valuable in order to determine the evolution of the earth's surface as quantitatively as possible.

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REPORT OF COMMITTEE NO. 5 ON WORLD MAGNETIC SURVEY AND MAGNETIC CHARTS

1. *General technical remarks*

The World Magnetic Survey was proposed by Professor Sydney Chapman, at the Toronto meeting of IUGG in 1957, and established as a deferred item of the IGY program at the Moscow meeting of ICSU, the Special Committee for the International Geophysical Year (CSAGI) in 1958.

The IAGA Committee on World Magnetic Survey and Magnetic Charts, in addition to technical recommendations made at Toronto, and at the request of CSAGI following its Moscow meeting has continued its deliberations at the Helsinki meeting. As a part of the Survey program it strongly reaffirms the need for continued surface magnetic surveys over the oceans by non-magnetic ships and urges intensification of land survey programs, airborne magnetometer survey programs over both sea and land, and observations by rocket and earth satellite in the atmosphere and extending to nearby space as a part of the program. The plan to describe the geomagnetic field not only over the earth's surface but to about 15 earth radio requires an adjoint program in space research involving measurements of magnetic, ionospheric, and cosmic-ray disturbances with the aid of rockets and satellites during magnetic surveys since these disturbances affect the magnetic field in the region of measurement. It is also urged that existing magnetic, auroral, ionospheric and cosmic ray stations at ground level be continued and maintained as a feature of the survey.

2. *Report on Recommendations*

Secular changes in the Earth's magnetic field call for periodic surveys leading to revisions of world magnetic charts. This subject has been discussed in the report World Magnetic Survey, UGGI Chronicle No. 26, pp. 29-30, 1960 (see appendix 1). In this report the program for a World Magnetic Survey was outlined, and it is gratifying that steps have already been taken to implement the proposed program. In particular, the Committee notes with great satisfaction the extensive magnetic surveys by the non-magnetic ship Zarya, of the USSR, by airplane in Project Magnet, of the US Hydrographic Office, and also by airplane in other areas by the Dominion Observatory in Canada, and by earth satellite using Sputnik III and Vanguard III.

The essential features of a thorough and careful survey of the Earth's magnetic field have at least two values of great scientific import: first, the World Survey would permit the preparation of currently correct world magnetic charts, effectively accounting for secular changes and maps for navigation since last a survey was conducted; and, second, the availavility of modern techniques if fully utilized, permits the acquisition of data of considerable research importance. The latter values could and should be appreciably increased by appropriate studies in several disciplines of the Upper Atmosphere and Space concerned with fields, particles and variation. Accordingly the task before the world is largely two-fold:

1. The conduct of a World Magnetic Survey in extenso, calling for (a) magnetic field measurements at the Earth's surface, both on land masses and at sea; (b) in the Earth's atmosphere, using aircraft and sounding rockets; (c) in near space, using appropriately instrumented satellites; and (d) in space to about fifteen Earth radii range, using space probes.

2. The conduct of adjoint studies in fields whose phenomena affect or are affected by the magnetic field: notably, ionospheric physics, aurora, particles and the radiations in space (including the radiation belts), electric currents in the Earth and near space, and cosmic rays, using instrumented rockets and earth satellites and an instrumented network of ground based stations measuring these adjoint parameters.

The successful pursuit of these studies calls for cooperation analogous to that witnessed during the IGY when, as matter of fact, the World Magnetic Survey was first suggested along with expression of interest in adjoint studies during a period of minimum in the sun spot cycle. The prosecution of the program now proposed calls for adequate scientific planning (underway for sometime within the IAGA), effective stimulous and coordination internationally for the conduct of the enterprise, and interchange of data and results. For these reasons, the IAGA calls attention to the above considerations and urges the IUGG to adopt and act upon the following recommendations:

First, whereas the significance to service of the World Magnetic Survey and the adjoint studies has been examined carefully by appropriate specialists and has been found to be most important, it is resolved that the program be conducted as a major international endeavor with the Survey conducted during the period 1960-1965, that the Survey be intensified in every magnetic area as outlined earlier during the coming sun-spot minimum, and that appropriate adjoint studies be conducted during the latter minimum. (Current estimates indicate the sun-spot minimum will occur during the interval 1963-64; this interval can be better estimated by solar physicists in the course of the coming year.) To achieve international cooperation most broadly and effectively, the IUGG calls upon the ICSU and interested ICSU Unions and Committees to assist accordingly.

Second, whereas the IAGA of the IUGG provides appropriate scientific guidance, whereas the CIG is appropriately established for coordination purposes and for the purposes of effective data interchange through the World Data Centers, and whereas the CIG has offered its services in this endeavor, it is resolved that the CIG be called upon to conduct and coordinate the international enterprise of surface studies and of the interchange of data through those centers of the World Data Centers under the cognizance of the CIG.

Third, whereas, rocket, space probe, and satellite activities are important to the endeavour, whereas the COSPAR is authorized to conduct international coordinated activties in this area on behalf of ICSU and the Unions, and whereas the COSPAR has offered its assistance, it is resolved that the COSPAR be called upon to conduct and coordinate international aspects of the endeavour in the space sciences area and to coordinate the data interchange through the Rocket and Satellite subcenters (under the cognizance of COSPAR) of the World Data Centers.

Fourth, whereas the conduct of the enterprise entails the activities of several ICSU bodies, it is resolved that the CIG establish a small Working Group for the World Magnetic Survey and adjoint studies consisting of representatives of IAGA, CIG, and COSPAR, and possibly SCAR and SCOR.

Fifth, whereas the eliciting of interest and activity among scientists everywhere is necessary and whereas national support in various countries will be required, it is resolved that appropriate steps be taken to this end: specifically, (a) that the President of ICSU advise the adhering scientific institutions of the nature and importance of the enterprise, call upon them to participate, and call upon them to assist in securing support in their respective countries and (b) that the CIG and COSPAR similarly and subsequently take appropriate actions vis-à-vis their respective adherents.

Sixth, whereas there is need for data covering many associated scientific disciplines in this project, that those in possession of such magnetic and related data assisting the project take early cognizance of the need for prompt interchange of the reduced observations, and of these observations reduced to epoch where appropriate, and forward these promptly to the World Data Centers.

Seventh, whereas a few countries already have basic surveys of satisfactory quality and extent, such countries are urged to make repeat observations at selected stations in order to derive secular magnetic change rates useful for reduction of their older data to epoch 1965.

Appendix I

At the Twelfth General Assembly of the IUGG at Toronto, September 3-14, 1957 the need for the World Magnetic Survey was indicated in terms of the Resolution 16, pp. 182-183 of the Proceedings:

The International Union of Geodesy and Geophysics

CONSIDERING that the need for World Magnetic Surveys stems from two principal sources, as follows

1. The requirement for data for theoretical studies of the source and origin of the earth's magnetic field and of the secular changes occurring therein.

2. The preparation of more accurate world magnetic charts as a primary source of information for nautical and aeronautical navigation.

RECOMMENDS that

the principal maritime and aeronautical nations should share that task of a world magnetic survey by sea and air;

all countries which can do so plan and execute individual magnetic surveys of a type which will contribute to a unified world survey as prepared by the Association of Geomagnetism and Aeronomy.

all countries give consideration to the establishment of airborne magnetic surveys to provide data on all elements of the geomagnetic field, and that such surveys be extended to all feasible areas whether adjacent to or remote from the operating countries, in order to establish world-wide continuity.

the USSR, now operating a non-magnetic survey ship, should give primary attention to areas of (a) Indian Ocean, (b) South Atlantic Ocean, and (c) South Pacific Ocean, which will be difficult to cover by airborne survey equipment.

all other countries which can do so, give consideration to arrangements for making magnetic measurements at sea.

the USA and Canada, now possessing instrumental equipment suitable for airborne all-component magnetic surveys give immediate consideration to assigning equipment for world surveys.

the United Kingdom and the USA, who have published magnetic charts of the world, to designate areas having the greatest need of prompt coverage for the guidance of all who may be in a position to conduct survey operations.

all countries participating in the world magnetic survey exchange and publish promptly the data derived from their operations.

Also, more detailed specifications were adopted in draft (UGGI Chronicle, No. 16, pp. 29-30, 1960) as follows

1. (a) That the epoch of the world magnetic survey be 1960-65 reduced to epoch 1965,0, with cognizance of later need for reduction to epoch 1975.0 for inclusion of later results.
   (b) That charts be compiled on a scale of 1 : 10,000,000 in order to be published at some suitable scale.
2. (a) That the URSS be urged to undertake surveys over the oceans with the «Zaria» for secular magnetic change.
   (b) That as a general aim survey stations on the ground be located about 200 km apart where feasible.
   (c) That aeromagnetic surveys over the oceans provide profiles spaced about 300-400 km apart.
3. That the general aim intends that the intervals of the isolines be 1° in declination (D) with a coarser interval of 6° near the poles, and at 500 gamma intervals in horizontal intensity (H), vertical intensity (Z), total intensity (F), north intensity (X), and east intensity (Y), For inclination (I) a contour interval if 2° is suggested for equatorial regions, 1° in middle and higher latitudes. The contour interval for anomalies where indicated should be about 500 gammas; this contour interval can be reduced in the case of detailed anomaly surveys, if the scale of charting permits this reduction.
4. That a potential analysis be made providing spherical harmonic terms up to and including a degree and order useful for adequate representation of the data.
5. That the height of aeromagnetic surveys should be noted by observers.
6. That earth satellite measurements of the geomagnetic field or other suitable data of useful accuracy be used where feasible to supplement the values at and near the ground.
7. That the prompt provision of observatory and other estimates of secular change be stressed and facilitated.

REPORT OF COMMITTEE NO. 6 ON LUNAR VARIATIONS

(a) The members of the IAGA/IAMAP Committee on Lunar Variations at the present time are as follows:

1. J. Bartels
2. N. P. Benkova
3. M. Bossolasco
4. J. C. Cain
5. J. O. Cardus
6. S. Chapman (Chairman)
7. E. J. Chernosky (Secretary)
8. J. Egedal
9. H. F. Finch
10. R. Gallet
11. B. Haurwitz
12. P. Herrinck
13. H. H. Howe
14. S. L. Malurkar
15. D. F. Martyn
16. S. Matsushita
17. P. Rougerie
18. V. Sarabhai
19. O. Schneider
20. J. A. Thomas
21. K. K. Tschu
22. A. M. van Wijk

(b) The researches that come within the scope of this Committee include lunar variations in the geomagnetic field, in the earth currents, in the ionosphere (e. g., height, electron density, reflectivity, absorption, horizontal and vertical motions), cosmic rays, and meteorological elements (e. g., barometric pressure, wind, temperature). At Toronto in 1957, the International Association for Meteorology and Atmospheric Physics (IAMAP) —formerly IAM— renewed its former co-sponsorship of this Committee, which for some years had been purely an IAGA Committee. Dr. Ramanathan and Dr. Thomson were nominated to represent IAMAP on the Committee. Regrettably both later found it necessary to decline the nominations.

(c) At Toronto, in 1957, a grant of $1000 was made by the IAGA to the Committee. This sum augmented the grant of $1000 made by IAGA at Rome in 1954, so that $2000 was then available to the Committee. It was agreed by the Committee that the Chairman, Professor Bartels and the Secretary would act for the Committee in administering the fund allotted. The combined sum has been allocated as indicated herein.

(d) A grant of $600 was allocated to Dr. Herrinck for the determination of the lunar tidal variation of the horizontal component of the magnetic field at Elisabethville.

- (i) The classical method described by Chapman and Bartels is being used to study the data from 1938 to 1950.
- (ii) A critical examination of this method has been made, using a new point of view developed in connection with (iii).
- (iii) A new method of analysis has been developed using a well-designed linear combination of equi-distant ordinates (hourly

values of the field). Such a combination works as a filter for the lunar semi-diurnal variation, and is extremely selective.

The classical method used in (i) is a linear combination of ordinates of a particular type which, unfortunately, is not sufficiently selective. Transient phenomena, such as magnetic storms, may be removed from the data by using a previons combination and subtracting the results from the data. This removes long-period phenomena and also the storm variation. It is expected that examination of data from an equatorial station will permit satisfactory evaluation of the amplitude from fewer observations. The relationship of amplitude to sunspot counts should also be better determined. Further data and results obtained will be reported at the Helsinki meeting.

(e) A grant of $600 was allocated to Rev. J. O. Cadus, S. J. to aid in the computing of the lunar influences in the geophysical data from Tortosa (Observatorio del Ebro) for nearly fifty years. The geophysical data includes magnetic component values, earth currents and pressure data, and takes solar activity into account as well. The study is similar to the one undertaken by Cain and Chapman for the Sitka (Alaska) data. The funds granted cover salaries for the transcription of data and preliminary computations for one half or one third of the work. All other costs and work of computing and checking are being borne by the Observatory and staff. Further details and results will be given as they become available.

(f) A grant of $800 was allocated to Professor M. Bossolasco for a study of lunar daily ionosphere variations at Genoa for a three-year period. This study is being made particularly for the E_s layer, as Matsushita has done, and for the lower ionosphere, the D layer, using the absorption measurements made at Genoa. In an attempt to analyse geomagnetic control of the lunar semi-diurnal variations, all available data have been examined, and calculations made for various stations. The significance of these chosen station is to:

(i) confirm the normal character of lunar semi-diurnal variation in Europe;

(ii) investigate the behavior of a station such as Leopoldville which lies nearly on the geographical and geomagnetic equators, but not on the zero dip equator;

(iii) forecast the characteristics of the lunar semi-diurnal variation at station for which calculations are not yet made.

Details of the results will be presented at the Helsinki meeting.

(g) Dr. P. Herrinck has offered to maintain a library of lunar effects reprints of interest to the Committee, if these were supplied to him. All members are invited to send reprints to him for this purpose. Additional copies may be sent to the Chairman and to the Secretary.

(h) The following persons have found it necessary, during the past triennium, to decline nomination to the Committee: Dr. C. H. Cummack, Professor K. R. Ramanathan, Dr. A. Thomson, Dr. K. Weekes and Dr. M. V. Wilkes.

(i) Dr. N. P. Benkova agreed verbally to be a member of the Committee, during a visit of the Chairman to Dr. Pushkov's Institute. Dr. Bernhard Haurwitz has accepted cooption to the Committee. It is under consideration whether he will be an IAMAP representative.

(j) Activities connected with the International Geophysical Year have occupied much of the time of many members of the Committee during the past triennium. Some researches have been reported, however, and it is expected that more will result from investigations made during the IGY. A bibliography of papers known to the Secretary is given at the end of this report. Information on these papers is given in the following sections («B—» denotes bibliography number).

(k) *Lunar Geomagnetic Tides:*

(i) New results and especially the fact that an abnormally larger lunar-diurnal variation during night hours of the magnetic element Z is found for Amberley (New Zealand) have made the idea of a close and simple relation between lunar-diurnal and solar-diurnal variations untenable (B6).

(ii) B4 —Prêmiers resultats sur la Variation Diurne Lunaire de la Composante Horizontale du Champ Terrestre à Tamanrasset— abstract unavailable at this time.

(iii) Magnetic records obtained from November 1955 to June 1957 at Ibadan, Nigeria, have been analysed harmonically for lunar and luni-solar variations (B16). The results are statistically significant. The L-variations in H and Z are abnormally large at Ibadan. The L-variation in H is comparable with that of Huancayo and about three times greater than at other observatories of comparable latitude. The L-Variation in Z is larger than any previously reported. These resuts are explained as the effect of the equatorial electrojet. The ratio of S to L in H is small at Ibadan as at Huancayo. S/L in Z is equally small at Ibadan. The Chapman (1913) expression for L is fully confirmed in all aspects.

(iv) The lunar semi-diurnal variation of geomagnetic horizontal intensity (H) at Kodaikanal is derived from the hourly values for the period 1950-1954 (B17). This gave the amplitude (ΔH) and lunar time (t) for the winter solstice as follows:

$$\Delta H - 3.32 \sin (2t - 39°04')$$

using the Chapman-Miller-Tschu method. The lunar geomagnetic tide is maximum when the sun and the moon are 135° apart.

(v) The lunar semi-diurnal variation of geomagnetic horizontal intensity (H) at Alibag is derived from the hourly values for the period 1940-1944 (B18). This gave the amplitude L(H) and lunar time (t) for the equinoctial season as follows:

$$L(H) = 1.2 \sin (2t + 62^\circ) \pm 0.3$$

Comparison with Kodaikanal suggests that the solar and lunar variations are independent of each other.

(vi) B9 —Lunar Diurnal Variation at Addis Ababa— abstract unavailable at this time.

(vii) B19 deals with facts lending support to the view that the long-sought seat of the L current system causing geomagnetic tides may be situated in the F2 layer.

(viii) B23 —Note on the Average Lunar Diurnal Variation at Kakioka— abstract unavailable at this time.

(ix) Lunar Influences on Geophysical Elements in the Equatorial Region (B7) —abstract unavailable at this time.

(x) In a study of hourly electron density profiles for the period February to December, 1959, it was found that the phase of the lunar tidal variations of the true height of the maximum F2 electron density was significantly different from the phase previously obtained from virtual height data by a number of workers (B15).

(l) *Lunar Effects on the Ionosphere:*

(i) Note on analysis of f^oF2 and h^oF2 data for quiet days for Calcutta for the period 1947-1952 (B1). The amplitudes of the mean annual lunar semi-diurnal harmonic are 0.09 Mc/s and 2.50 km respectively. The phases of the two oscillations are almost in quadrature.

(ii) Brief details are given (B2) of apparatus which has been set up at Ottawa for the observation of moon-echoes on a frequency of 488 Mc/s. Specimen recordings are reproduced, but no detailed results are presented.

(iii) Analysis of two years' h'E2s data has detected a lunar semi-diurnal variation of mean amplitude 1.5 km, with a maximum at 1.5 hr (B8).

(iv) Observations of the direction of the E region drift obtained in fall 1956 and 1957 are analysed with respect to supposed 12 hour solar and lunar components. Both exist day and night, the amplitudes of both are of the same order of magnitude (B10).

(v) The lunar effect in the times of sudden day-time disappearance of equatorial Es, formerly demonstrated by Matsushita has been studied on the Es-Q observed every day at Huancayo from May 1957 to April 1958 (B12).

(vi) This paper (B13) examines the direct effects of the vertical electron drift, due to the electric fields accompanied by electric currents producing the observed geomagnetic S_p- and L-variations, upon the F2 region of the ionosphere on the magnetic equator. It is shown that the calculated results may explain the main features of the observed disturbance daily variations (S_p [f2]) and of the observed lunar daily variations (L [F2]) in the F2 region.

(vii) The disappearance of the equatorial E seems to depend on the lunar phase near the time of new and full moon. Equatorial Es often disappears in early afternoon, and this relationship is more evident during the December solstitial months than during the June solstice (B14).

(viii) An analysis of the lunar semi-diurnal tides in f'Es and h'Es is made for Ibadan (B22). The results are presented in the form of harmonic dials. Comparisons are made between these results and those of other stations.

(m) *Lunar Tidal Effects in Cosmic Rays:*

(i) B5 —Cosmic Ray Data— abstract unavailable at this time.

(n) *Lunar Tidal Effects on Meteorological Elements:*

(i) An attempt has been made to correlate the solar semi-diurnal oscillation, and also the lunar semi-diurnal tide, with solar parameters. Data for Manila and Batavia have been correlated with the Zurich relative sunspot number, and a lag correlation was also studied. No significant correlation was found (B11).

(ii) The temperature profiles which have cool ozonospheres (262-271° K) give more satisfactory atmospheric lunar tides than do warm ozonospheres. The dependence of the surface pressure oscillation to the temperature of the top atmospheric layer is established. Surface wind components show a sensitive dependence of the phase angle to the ozonospheric temperature. Vertical structure of tides show that the most sensitive changes in the phase angles of tides occur in the lowest atmosphere, below 25 km, above which practically no dependence to the temperature of the ozonosphere is shown to the plase angles, but this is not so for the amplitudes (B21).

(o) The determination of lunar geophysical effects is involved and usually requires much computation. Some such researches may be more practical by hand than by machines methods, despite the labor involved. It might be expected that each country should undertake and provide for such work on the data obtained within its borders, particularly with the stimulus afforded by the occurrence of the IGY. But where interest or support is still lacking, moderate international assistance towards the execution of this work seems appropriate. It is hoped that further effort can be devoted to such studies before the 1963 General Assembly. To assist such researches a request to IAGA is proposed, that a grant of $ 1000 be made available for the coming triennium.

(p) At the Helsinki General Assembly, the Committee should further consider what can be done to promote research of the kind it is appointed to study.

(q) The continuance of this Committee is considered desirable.

S. CHAPMAN, *Chairman*
E. J. CHERNOSKY, *Secretary*

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REPORT OF COMMITTEE NO. 7
ON COMPARISON OF MAGNETIC STANDARDS

The period under review was characterized by a marked increase in the activity of the Service of Comparisons, an increase which may partly be ascribed to the following two facts:

(a) that thanks to the UNESCO grants received during recent years the instrumental equipment at disposal could be completed so as to cover in an adequate way a fairly large part of the surface of the earth,

(b) that with the beginning of the International Geophysical Year the many activities of the Danish magnetic observatory at Rude Skov in connection with the supply of magnetic instruments to IGY stations gradually decreased, so that more time could be devoted to the project of international comparisons.

(*) Listed in 1957 Toronto Report.

As in previous report periods most of the comparisons were carried out by means of calibrated QHM-magnetometers sent from the Rude Skov observatory to the participating observatories and back. On the occasion of the CSAGI-meeting at Moscow August 1958 the Chairman of the Committee brought a set of QHMs with him for comparison observations at the Krasnaya Pakhra observatory, and this comparison was later repeated by measn of another set of Association instruments which is actually placed at the disposal of the non-magnetic USSR vessel «Zarya» and which during a temporary stay of the vessel in an USSR port was sent from Krasnaya Pakhra to Rude Skov and back.

The complete list of comparisons carried out is as follows:

1. A double comparison by means of QHM-magnetometers Nos. 90, 91 and 92 between Rude Skov and the Witteveen observatory (Netherlands).
2. Comparison by means of QHM-magnetometers Nos. 228, 229 and 230 between Rude Skov and the observatories of Toolangi, Watheroo and Port Moresby (Australia).
3. Comparison by means of QHM-magnetometers Nos. 90, 91 and 92 between Rude Skov and the Krasnaya Pakhra observatory (Moscow, USSR).
4. A repetition of this comparison by means of QHM-magnetometers Nos. 32, 33 and 34.
5. Comparison by means of QHM-magnetometers Nos. 477, 478 and 479 between Rude Skov and the Fredericksburg observatory (USA).
6. Comparison by means of QHM-magnetometers Nos. 90, 91 and 92 between Rude Skov and the Wingst observatory (Germany).
7. Comparison by means of QHM-magnetometers Nos. 480, 481 and 482 between Rude Skov and the Kakioka observatory (Japan).
8. Comparison by means of QHM-magnetometers Nos. 477, 478 and 479 between Rude Skov and the observatories of Hartland, Eskdalemuir, Lerwick and Stonyhurst (Great Britain).
9. Comparison by means of QHM-magnetometers Nos. 90, 91 and 92 between Rude Skov and the Valentia observatory (Ireland).
10. Comparison by means of QHM-magnetometers Nos. 228, 229 and 230 between Rude Skov and the Coimbra observatory (Portugal).
11. Comparison by means of QHM-magnetometers Nos. 228,

229 and 230 between Rude Skov and the Vienna observatory (Austria).

12. A repetition of this comparison by means of QHM-magnetometers Nos. 477, 478 and 479.
13. A comparison by means of QHM-magnetometers Nos. 228, 229 and 230 between Rude Skov and all Spanish magnetic observatories. This comparison has not yet been completed.

The Committee wishes to express its most sincere appreciation of the care with which the observations have in all cases been carried out, and of the clear-cut manner in which the results have been presented. It is also highly creditable to the observers that it has been possible to carry out the numerous observations, not always under ideal conditions, without one single accident to the QHMs used.

As long as the Rude Skov magnetic observatory serves as centre for the comparisons it is natural to give the results as differences in gammas between the Rude Skov standard value (as represented by the travelling QHMs) and the standard value of the observatory where the observations are made. For a more general comparison between the participating observatories the differences can easily be converted into percentages of the horizontal field at the individual observatories.

The detailed results of all the comparisons mentioned above under 1 to 12 are given below:

Witteveen

1958 June	QHM 90 — Witteveen. . . =	—9,3 γ
	QHM 91 — Witteveen. . . =	—7,4 γ
	QHM 92 — Witteveen. . . =	—8,4 γ
	Mean . . .	—8,4 γ
1958 November	QHM 90 — Witteveen. . . =	—6,8 γ
	QHM 91 — Witteveen. . . =	—9,2 γ
	QHM 92 — Witteveen. . . =	—8,6 γ
	Mean . . .	—8,2 γ

Toolangi

1958 July- 1959 January	QHM 228 — Toolangi . . . =	—5,8 γ
	QHM 229 — Toolangi . . . =	—8,4 γ
	QHM 230 — Toolangi . . . =	—7,9 γ
	Mean . . .	—7,4 γ

Watheroo

1958 September	QHM 228 — Watheroo. . . =	0,8 γ
	QHM 229 — Watheroo. . . =	—0,2 γ
	QHM 230 — Watheroo. . . =	0,1 γ
	Mean . . .	0,2 γ

Port Moresby

1958 October-	QHM 228 — P. Moresby . .	=	— 36,3 γ
1959 January	QHM 229 — P. Moresby . .	=	— 34,7 γ
	QHM 230 — P. Moresby . .	=	— 34,9 γ
	Mean . . .		— 35,3 γ

Krasnaya Pakhra (Moscow)

1958 August	QHM 90 — Moscow . . .	=	12,0 γ
	QHM 91 — Moscow . . .	=	12,4 γ
	QHM 92 — Moscow . . .	=	11,8 γ
	Mean . . .		12,1 γ
1959 February-April	QHM 32 — Moscow . . .	=	12,2 γ
	QHM 33 — Moscow . . .	=	12,0 γ
	QHM 34 — Moscow . . .	=	12,4 γ
	Mean . . .		12,2 γ

Fredericksburg

1958 October-November	QHM 477 — Fredericksburg .	=	3,2 γ
	QHM 478 — Fredericksburg .	=	3,4 γ
	QHM 479 — Fredericksburg .	=	3,3 γ
	Mean . . .		3,3 γ

(Pending a remeasuring of the dimensions of Sine Galvanometer No. 1 on which the Fredericksburg standard is based the quoted differences must be considered provisional.)

Wingst

1958 November-December	QHM 90 — Wingst. . . .	=	— 6,9 γ
	QHM 91 — Wingst. . . .	=	— 6,6 γ
	QHM 92 — Wingst. . . .	=	— 6,6 γ
	Mean . . .		— 6,7 γ

Kakioka

1959 February-April	QHM 480 — Kakioka . . .	=	4,1 γ
	QHM 481 — Kakioka . . .	=	4,5 γ
	QHM 482 — Kakioka . . .	=	3,3 γ
	Mean . . .		4,0 γ

Hartland

1959 March	QHM 477 — Hartland . . .	=	2,1 γ
	QHM 478 — Hartland . . .	=	2,0 γ
	QHM 479 — Hartland . . .	=	2,7 γ
	Mean . . .		2,3 γ
1959 May	QHM 477 — Hartland . . .	=	0,8 γ
	QHM 478 — Hartland . . .	=	0,9 γ
	QHM 479 — Hartland . . .	=	1,8 γ
	Mean . . .		1,2 γ

Eskdalemuir		
1959 April	QHM 477 — Eskdalemuir . . =	— 1,6 γ
	QHM 478 — Eskdalemuir . . =	— 1,5 γ
	QHM 479 — Eskdalemuir . . =	— 1,1 γ
	Mean . . .	— 1,4 γ
1959 May	QHM 477 — Eskdalemuir . . =	— 0,7 γ
	QHM 478 — Eskdalemuir . . =	0,1 γ
	QHM 479 — Eskdalemuir . . =	— 0,3 γ
	Mean . . .	— 0,3 γ
Stoneyhurst		
1959 April	QHM 477 — Stoneyhurst . . =	— 18,6 γ
	QHM 478 — Stoneyhurst . . =	— 21,7 γ
	QHM 479 — Stoneyhurst . . =	— 15,8 γ
	Mean . . .	— 18,7 γ
Valentia		
1959 July-October	QHM 90 — Valentia . . . =	— 2,9 γ
	QHM 91 — Valentia . . . =	— 2,3 γ
	QHM 92 — Valentia . . . =	— 2,6 γ
	Mean . . .	— 2,6 γ
Coimbra		
1959 August	QHM 228 — Coimbra . . . =	— 9,1 γ
	QHM 229 — Coimbra . . . =	— 10,3 γ
	QHM 230 — Coimbra . . . =	— 8,6 γ
	Mean . . .	— 9,3 γ
Vienna		
1957 August	QHM 228 — Vienna. . . . =	— 5,0 γ
	QHM 229 — Vienna. . . . =	— 4,4 γ
	QHM 230 — Vienna. . . . =	— 4,3 γ
	Mean . . .	— 4,6 γ
1960 June	QHM 477 — Vienna. . . . =	— 7,7 γ
	QHM 478 — Vienna. . . . =	— 4,5 γ
	QHM 479 — Vienna. . . . =	— 8,0 γ
	Mean . . .	— 6,7 γ

When interpreting the differences here quoted it should of course be borne in mind that the Rude Skov standard can by no means be considered as an international standard for horizontal force. But for the purpose of the comparison programme it is highly important that the standard of the central observatory is reasonably *stable*, so that the result of any comparison could readily be referred to an international standard, could such a one be defined.

It is thought that the stability of the Rude Skov standard is fairly well illustrated by the following summary of all the comparisons which have so far been carried out between Rude Skov and Cheltenham/Fredericksburg by means of QHMs. The USA standard value is based on Sine Galvanometer No 1, and it is reported from the U.S. Coast and Geodetic Survey, that in July 1958 there was a change of standard of 0,3 γ (the older value being the higher one) as the result of a new observing and computing procedure.

1948, April			
(QHM 33, 51, 52)	Rude Shov - Cheltenham	=	3,0 γ
1949, Dec.			
(QHM 90, 91, 92)	Rude Skov - Cheltenham	=	— 0,6 γ
1949, Dec.			
(QHM 29, 58)	Rude Skov - Cheltenham	=	3,1 γ
1951, March			
(QHM 34, 50)	Rude Skov - Cheltenham	=	4,6 γ
1953, May-Sept.			
(QHM 50, 51, 52)	Rude Skov - Cheltenham	=	2,5 γ
1956, Aug.			
(QHM 32, 33, 34)	Rude Skov - Cheltenham	=	— 1,6 γ
1958, Oct.-Nov.			
(QHM 477, 478, 479)	Rude Shov - Fredericksburg (prov.).	=	3,3 γ

When the CSAGI met at Moscow in 1958, international comparisons of geomagnetic standards was thoroughly discussed, and in conclusion the following resolution was adopted:

> The CSAGI expresses its thanks to the IAGA Committee on Comparisons for its valuable and extensive work in continuing the international comparison of magnetic standards. The CSAGI recommends to the IAGA the utilization of magnetometers employing atomic phenomena, such as the proton precession principle or others for the establishment and maintenance of geomagnetic intensity standards, and recommends that an appropriate committee of the IAGA investigate the most suitable value of the nuclear constant to be adopted and used.
>
> The CSAGI further recommends that studies be made leading to an increase in accuracy of measuring the angle of Inclination.

It has been encouraging to note that the comparison programme is generally recognized as a very useful branch of the Association activity, and it is strongly felt that this programme should be continued. The Committee is aware that a number of leading observatories all over the world now dispose of precession magnetometers of different types, and since it seems unlikely that the Rude Skov observatory will be able to acquire or to build such an equipment in the near future it is thought that the IAGA should consider whether it would be desirable to move the centre of comparisons away from Rude Skov to an observatory with a more modern equipment for the establishment and maintenance of geomagnetic standards. It would seem very unfortunate for the continuation of the comparison programme if the participating observatories could no longer have full confidence to the reliability of the standard values of the observatory on which the comparisons are actually centred.

In an interesting memorandum Prof. Pushkov has suggested that the Comparison Committee should considerer the possibility of arranging, in connection with the Helsinki General Assembly, a mass comparison of QHM-magnetometers. The idea was that each national delegation from interested countries should bring with them one or more QHM from their home observatory in order to have them mutually compared at the Nurmijärvi observatory, which is situated 40 km to the north of Helsinki. The Chairman of the Committee took up the question with Dr. Sucksdorff, who is in charge of the Finnish observatory, but seeing that it would be difficult to arrange the comparison during the days of the General Assembly, and feeling also a little uncertain as to what technical procedure should be adopted in order to make such a mass comparison of maximum benefit to the participating observatories, it was considered impracticable to include the suggested comparison in the official programme for the Helsinki meeting. The Committee has been happy to note, however, that Dr. Ambolt, Stockholm, in cooperation of course with Dr. Sucksdorff, has planned an informal comparison on a limited scale to be carried out at Nurmijärvi after the end of the meeting, and the Committee would appreciate very much to be informed of the results of this comparison and of any experience that may be gained with regard to a future comparison of the same type but on a larger scale.

Meteorologisk Institut
Charlottenlund, the 11th July 1960

V. Laursen
Chairman of the Committee

REPORT OF COMMITTEE NO. 8
ON MAGNETIC INSTRUMENTS

Members of the Committee:

Mr. J. H. Nelson, USA, Chairman
Dr. S. Dolginov, USSR
Mr. J. Dooley, Australia
Mr. E. J. Chernosky, USA
Mr. H. F. Finch, UK
Prof. G. Grenet, France
Dr. Y. Kato, Japan
Mr. J. Olsen, Denmark
Dr. O. Meyer, Germany
Prof. E. Thellier, France
Dr. P. H. Serson, Canada
Dr. I. Tsuborkawa, Japan
Dr. B. M. Yanovsky, USSR

Since the XIth General Assembly of the IUGG at Toronto in 1957, three principal subjects of discussion have been considered by the Committee on Magnetic Instruments. These are listed under the following headings:

A. The development of an improved suspension system for Z variometers to replace knife-edge or pivot supports for the Z magnets.

B. The use of a portable recording instrument for temporary installation at magnetic observatories having only one magnetograph, to check on the operation of the permanent recording instruments.

C. The adoption of a nuclear precession magnetometer as a world-wide standard for measurement of geomagnetic intensity.

A. *Suspensión systems for Z Variometers*

There is general agreement that the performance of most Z variometers is not as good as that of most H variometers, and that the chief source of any difficulties is probably in the suspension system knife edges or pivots, and bearing surfaces on which they rest, and dirt or moisture that might collect in the immediate area of the contact surfaces. There is, however, a virtually unanimous agreement that the La Cour Z variometer with its one-piece magnet construction gives very little trouble, and is, in general, the most satisfactory of all permanent-magnet Z variometers.

Prof. Dr. Gerhard Fanselau, of Potsdam, has apparently done a great deal of experimental work with fiber suspensions for Z variometers. He feels that the fiber suspensions are clearly superior to the knife-edge balances, and undoubtedly his operating experience has been completely satisfactory.

A few comments from other sources are given here:

From Dr. K. Whitham, Dominion Observatory, Canada. Canada has no difficulties with the La Cour and Ruska balanced magnet types other than occasional slow changes in magnetic moment. Canada feels that there would be difficulty in trying to adapt an existing Z variometer by eliminating knife-edge or pivot support and substituting horizontal fibers.

From Dr. O. Meyer, Deutsches Hydrographisches Institut. Feels that there is not sufficient experience with fiber-suspended Z variometers to justify replacing knife-edges in present instruments with fibers. Reports an effect of change of relative humidity (even at constant temperature) on base-line values of instruments equipped with knife edges.

From Mr. H. F. Finch, Royal Greenwich Observatory. Finds La Cour variometers satisfactory; almost daily absolute observations for many years show day-to-day variations of 1 or 2 gammas, with the mean value remaining virtually unchanged for months at a time. Does not believe that substitution of fibers for knife edges in normal-run recorders would effect any improvement.

From Mr. J. C. Dooley, Australian Bureau of Mineral Resources. Most of their observatories are equipped with La Cour magnetographs, which are satisfactory. Doubts the desirability of attempting to substitute fiber suspensions for knife edges or pivots.

From Mr. J. H. Nelson, U. S. Coast and Geodetic Survey. The USA operates a few La Cour Z variometers and a considerable number of Ruska instruments. No fiber-suspension instruments have been used for many years, except that during the IGY a number of Askania Variographs were used. Performance of the fiber suspensions in Z variometers has not been very satisfactory.

The Committee agrees that an improved Z-variometer suspension system would contribute appreciably to the general reliability and accuracy of vertical component magnetographs, and it suggests to Prof. Fanselau that it would be helpful if he would prepare very exact instructions for making these suspension systems, illustrated with clear photographs and diagrams.

B. *Portable Magnetograph*

The suggestion has been made that it would be helpful to some observatories to have a means of checking on the operation of a standard magnetograph, to discover whether the variometers are operating in a stable, satisfactory manner without changes in the base-line values (either sudden or slow) that might occur without obvious cause. A second use for such an auxiliary recording instrument would be to help in determining the temperature coefficients of a magnetograph or to assist in adjusting the temperature compensation to obtain minimum temperature coefficients. The suggestion is that a suitable portable instrument be available for loan to an observatory, and that the period of operation be from two to four weeks or longer.

Comments on this suggestion have been received by the Committee from various sources. Most of the comments may be summed up as follows:

There is not available at present an instrument suitable for the purpose, that would be sufficiently stable and reliable and simple to operate, that could be sent by ordinary shipping facilities at reasonable cost, that could be operated by an observer not especially trained on the equipment. The only instrument that might be used is the Variograph by Askania, but to obtain reasonably satisfactory performance it must be attended by an expert with long experience and complete knowledge of the instrument. This would be very expensive.

Furthermore, a standard magnetograph operating on stable piers at a permanent magnetic observatory should be expected to perform better than a portable instrument. For this reason it seems a bit anomalous to consider using a less-reliable equipment to check on the performance of something expected to be better. If an observatory has a second magnetograph —for example, a storm magnetograph or a rapid-run instrument— a more satisfactory method of checking on the standard magnetograph is to use the second instrument at the observatory.

A number of statements were received by the Committee to the effect that observations for temperature coefficients of the magnetograph were made very satisfactorily by using the QHM and the BMZ as control instruments. The Committee feels that this procedure can be recommended.

C. *The Nuclear Precession Magnetometer as a Standard*

During the past three years a very large number of Proton-precession magnetometers have been made and are now in extensive use for many purposes. They are employed in geophysical exploration work, in oceanographic studies, in rockets and satellites, and as standards in magnetic observatories. Since the proton-precession magnetometer is not sensitive to orientation, it measures the total field in which it is placed. In practically all cases where the proton-precession magnetometer is now used it does measure only the total field. The only exceptions to this, so far as the Chairman of this Committee knows, are the Proton Vector Magnetometer now in routine use at the Fredericksburg Magnetic Observatory and Laboratory of the U. S. Coast and Geodetic Survey, where measurements of H and Z as well as F are regularly made for base-line control purposes, and the ground-level monitoring instruments used by Dr. James P. Heppner and his colleagues at the U. S. National Aeronautics and Space Administration to measure absolute variations in magnetic dip and declination (as well as in F) in connection with the U. S. satellite program. («The Vector Field Proton Magnetometer for IGY Satellite Ground Stations» by I. R. Shapiro, J. D. Stolarik, and J. P. Heppner, Journal of Geophysical Research, v. 65, pp. 913-920, March 1960.)

Dr. Paul H. Serson of the Dominion Observatory, Ottawa, has proposed a slightly different method of applying auxiliary magnetic fields with Helmholtz coils to permit the measurement of components with a total-field measuring device, such as the nuclear magnetometer. By this method the measured component is that which lies in the direction of the coil axis. However, no actual application of this idea in an operating instrument has come to the attention of the Committee Chairman.

The absolute accuracy of magnetic field intensities measured with the proton-precession magnetometer depends on only one calibration constant —the gyromagnetic ratio of the nucleus of the hydrogen atom—. The gyromagnetic ratio has been measured by several different individuals or groups. Two of the more recent determinations yielded the following results:

(a) From USA $2.67513 \pm 0.00002 \cdot 10^4$ radians gaus^{-1} sec^{-1}
(b) From USSR $2.67520 \pm 0.00015 \cdot 10^4$ radians gaus^{-1} sec^{-1}

The first value is reported by R. L. Driscoll and P. L. Bender of the National Bureau of Standards, in Physical Review Letters; vol. 1, no. 11, Dec. 1, 1958; H521 1/2. The second value is reported by B. M. Yanovsky, N. V. Studentsov, and T. Tikhomirova of the All-Union Scientific Research Institute of Metrology, in Izmeritelnaia Tekhnika (Measurement Techniques); vol. 20, no. 2, Feb. 1959, pp. 39-40. The two values are in complete agreement within the specified limit of error.

A suggestion has been made by Prof. Yanovsky (of the University of Leningrad) that the matter of deciding on a final value of the gyromagnetic ratio of the proton be referred to the XIth General Conference on Measures and Weights being held in 1960. However, the Committee feels that it would be better to postpone this action until a number of experiments for the determination of this constant have been completed. It is understood that such work is now being carried on in Japan, in England, in the USSR, and in the USA.

The Committee recommends that the IAGA adopt a resolution designatig a provisional value for use in all geomagnetic work pending a final selection by a suitable international organization. The value proposed by the Committee is the one determined by Driscoll and Bender: $2.67513 \cdot 10^4$ radians $gauss^{-1}$ sec^{-1}. The uncertainty claimed by the experimenters is 0.00002, or 1 part in about 133,0000. This value was determined in a relatively weak field (12 gauss) and was based on free precession, with distilled water as the proton medium.

During the Moscow meeting of CSAGI in 1958, Dr. H. Schmidt of Niemegk, a member of the Geomagnetism Working Group, raised the question whether the gyromagnetic ratio, determined with high fields and sustained (forced) precession, could be used unhesitatingly for measurement with free precession. He said that, generally speaking, the frequency needs an amplitude correction with damped oscillations; therefore, it seems desirable to inquire whether the frequency changes during the time of decay.

This question was put to Bender, who stated that with properly designed electronic circuits there should be no detectable difference. His recent work at Fredericksburg on the measurement of the gyromagnetic ratio was on the basis of free precession, and he said that he was unable to detect any change of frequency, and that if there was such a change it must be less than 1 part per million.

Other types of nuclear magnetometers have been developed and are in various stages of development. The Rubidium-vapor magnetometer has been intensively studied and refined under the auspices of the National Aeronautics and Space Administration (USA) for use in satellites and space vehicles. One model of the instrument is now said to be capable of accurate measurement of field intensities as low as 10 gammas. It is possible that further work on the optical-pumping principles (such as those used by the rubidium-vapor magnetometer) will produce a magnetometer suitable for observatory standard instruments, but as of this date the Committee Chairman believes the advantage lies with the proton-precession instrument. At least two papers dealing with operation of the Rubidium-vapor magnetometer, and the results obtained, are being offered for presentation at the meetings of IAGA during the XIIth Assembly.

A note has been received from Dr. Kenneth Whitham of the Dominion Observatory, Canada, to the effect that Intersciences Publishers will shortly publish a book «Methods and Techniques in Pure Geophysics» by (author's name not yet ascertained), in which there is a chapter devoted to a review of the basic methods of measurement of the geomagnetic elements. At the time the chapter was written (April 1958) it was quite complete and up to date. The Committee has not received a copy of the book.

The Chairman of the Committee has made inquiry of two American manufacturers of magnetic instruments to determine whether a commercial design of a nuclear magnetometer suitable for measuring components of the field intensity might be developed at a reasonable price. To the present date (March 15, 1960) no proposal has been received. The two manufacturers are the Ruska Instrument Corporation of Houston, Texas, and Varian Associates of Palo Alto, California. The inquiry sent to these companies did not include a complete set of plans and specifications, but it did include a photograph of the Proton Vector Magnetometer now being used et Fredericksburg. A fixed price was not suggested, but the Chairman's inquiry stated that in order for the proposed instrument to be attractive to a substantial number of observatories throughout the world it should cost not over about $ 5,000.

REPORT OF COMMITTEE NO. 9

ON CHARACTERIZATION OF MAGNETIC ACTIVITY

1. *Present membership*

Dr. E. J. Chernosky, Bedford, Mass., USA
Dr. N. Fukushima, Tokyo
Dr. H. H. Howe, Boulder (Col.)
Dr. H. F. Johnston, Chevy Chase, Maryland
Dr. W. Kertz, Göttingen
Dr. P. N. Mayaud, Lyon
Prof. A. P. Nicolsky, Leningrad
Dr. L. S. Prior. Melbourne
Prof. J. Veldkamp, De Bilt
(Director of the Permanent Service of Geomagnetic Indices)
Prof. J. Bartels, Göttingen (Chairman)

2. *General remarks*

It is a pleasure to note that the geomagnetic indices produced on behalf of the Committee —especially K, Kp, Ap and Cp— are increasingly used by many research workers (special notice should be given to the extensive paper by D. H. Mc Intosh «On the Annual Variation of Magnetic Disturbance», Bibliogr. No. 11). Kp-indices belong to the most frequently cited measures of geophysical phenomena. The great effort spent by magnetic observers on those indices is thereby justified. Nearly 200 copies of the tables and musical diagrams showing Kp and derived indices are mailed monthly —sometimes half-monthly— to interested institutions all over the world, reaching them about 3 to 4 weeks after the end of each month. After some time of interruption, tables of Kp etc. appear again, now monthly (e.g., for January 1960 in the May 1960 number) in the Journal of Geophysical Research, thanks to the efforts of J. Virginia Lincoln of the CRPL at Boulder (Bibliogr. No. 13).

After Kp had been introduced in 1949, tables for Kp were originally provided for all years since the beginning of the international K-scheme (1940). Due to special efforts by observatories and individuals, that series could be extended backwards: The first addition (1950) was the Second International Polar Year 1932/33, followed (in 1953) by the three years 1937 to 1939. In the present report, thanks to extensive K-scalings made by our member Dr. P. N. Mayaud, we can announce that our Kp-series now extends back to 1 January 1932 —an unbroken table providing more than 80,000 Kp-indices, each of which is based on about 11 K-indices—. The Kp for the years 1932-1936 will appear in IAGA Bulletin No. 121.

> While the K-index, and especially the Kp-index, serve their purpose, and are worth the labour spent to derive them, it should not be forgotten that such a single index for three-hour-intervals is far from a complete description of geomagnetic activity. Much more information is contained in the magnetograms; as to short-period variations in the spectrum, they are more conspicuous in earth current records. The Q-index, by dividing the three-hour interval into 12 quarter-hourly intervals, will have the obvious advantage of more detailed information about the time-variations of activity; but, being also a range-index, it cannot express any indication about the spectrum of the variations. The Committee is keenly aware of the need for further studies on other expressions of magnetic activity and welcomes proposals, especially if they are accompanied by actual applications of new measures on polar records.

3. *Report of the C + K-centre De Bilt 1957-1960*
by Dr. J. Veldkamp

Geomagnetic data have been received from about 105 observatories. From these reports preliminary Ci-figures were calculated; selected quiet and disturbed days were derived with the aid of Kp-indices.

Three-monthly reports were regularly issued to more than 100 addresses. They contain the geomagnetic indices, selected days, sudden commencements, sudden impulses, bays, pulsations and solar-flare effects.

Final values are published in the IAGA Bulletins No. 12 (Bibl. 3, 4). In the period 1957-1960, the numbers 12 j (1955) and 12 k (1956) have appeared.

Some special cases of solar-flare effects and giant pulsations have been studied for the Symposium on Rapid Variations (Utrecht 1-4 September 1959). Some more cases were selected for a further investigation (Comm. No. 10).

4. *Proposal of Dr. A. P. Nicolsky*

On an extension of the function of Committee No. 9: Prof. A. G. Kalashnikov, Vice-President of IAGA, and Chairman of the Section of Geomagnetism and Aeronomy in the IUGG National Committee of the USSR, sent me, with a letter of 14 Febr. 1959, proposals of Dr. A. P. Nicolsky, Leningrad, to extend the scope of IAGA Committee No. 9 to the study of irregular magnetic disturbances. This proposal was communicated, on 15 April 1959, by the Chairman of Committee No. 9, to all members of the IAGA Executive Committee, and to the members of IAGA Committees No. 9 and 10, together with comments by the Chairman, and with a request to voice opinions. The response was very gratifying: quite detailed answers were received from nearly all members, namely, in alphabetical order, from J. O. Cardús, S. Chapman, E. J. Chernosky, J. C. Dooley, N. Fukushima, G. Gjellestad, Y. Kato, P. N. Mayaud, J. H. Nelson, L. S. Prior, A. Romañá, E. Selzer, J. Veldkamp, A. H. de Voogt, K. Whitham. There was unanimity that IAGA need not have a Committee for every topic within its domain. It was also felt mostly that the existing committees No. 9 and 10 should best continue to work as at present. It was proposed by many —including Dr. Nicolsky himself, in his letter of 12 June 1959— that the symposium in Kyoto on «Earth Storms in Geomagnetism, Aurora, Ionosphere and Cosmic Rays», scheduled for 1961 would provide a good occasion to discuss the question of an «Inter-Union Committee on Earth Storms», with preliminary discussions at Helsinki.

5. *Study of K-indices in quiet times*

Very quiet three-hour-intervals, with Kp = 0o or 0+, are rare; in particular, longer sequences of such intervals, lasting a whole day or longer, occur less frequently than magnetic storms. That such times really denote an exceptional absence of magnetic disturbance, that is, of solar corpuscular radiation, has been verified by Nagata and Mizuno, who found that even in polar regions the solar diurnal variation was of purely Sq-type, without a trace of SD. However, looking down the columns of K-indices for such times as printed in our Bulletins No. 12, one often finds, among the many K = 0, occasional indices of 1, 2, 3 and even 4. Two reasons for these higher indices are possible.

a) The first reason is trivial: Unexperienced observers may mistake part of Sq for a K-variation. In spite of the often repeated warning (Bibl. 2) to observers to make themselves familiar with the day-today variability of Sq + L, these exhortations do not seem to penetrate to all those who are actually charged with the routine derivation of measuring K-indices; it is astonishing to realize how many observatories still cling to the notion that Sq is given by a certain «iron curve» changing only with season. The best way to cure that habit is to re-read one's K-indices, after the Kp are available, for the times with Kp = 0o or 0+.

b) The second reason is physical: Even in times of quiet conditions over most of the globe, stations just inside the auroral zone may have a local disturbance. In the report on 1932-33 indices (Bibl. 9), this was exemplified for such «irritable» stations as Fort Rae (geomagnetic latitude 69°) and Godhavn for the exceptionally quiet day 1933 Febr. 17.

This question has recently been studied in great detail by *Dr. P. N. Mayaud,* for the following very quiet intervals

1933 Febr. 16d 00h to 18d 15h
1947 Jan. 8d 12h to 15d 18h
1955 Jan. 24d 03h to 27d 09h
1955 Aug. 21d 09h to 24d 06h
1958 Nov. 29d 18h to Dec. 1d 24h
1958 Dec. 31d 21h to 1959 Jan. 2d 09h

On the request of our Committee, about 70 observatories made their magnetograms available to Dr. Mayaud, who undertook to remeasure personally all the K-indices. His preliminary findings are summarized in a valuable memorandum «Etudes de K» (in French). Of which a final version will be given for discussion at Helsinki. The result confirms, more or less, the former experience, especially the occasional occurrence of localized corpuscular radiation effects confined to stations inside the auroral zone. As to the reason given under a) above, it is interesting to note that Dr. Mayaud, from his extensive experience in measuring K-indices, has come to the opinion that the standard prescription for measuring K-indices will lead to satisfactory results even for quiet times and for equatorial stations, if only the observer has made himself familiar with the variability of Sq + L.

6. *Equatorial Ring Current Project (ERC)*

Dr. W. Kertz has continued his work on the ERC, and his first paper (Bibl. 10) has been distributed to all members of our Committee.

He reports as follows: «Without regard to the true distribution of the electric currents in the space around the earth, we understand the ERC-variations of an almost homogeneous magnetic field, antiparallel to the geomagnetic axis. An increase of the ERC means a decrease of the horizontal intensity H as observed at equatorial stations. The ERC-variations throughout the IGY will be derived from night-time values of H from observations near the equator. About 30 observatories cooperated in this program; most of them continued to send data for 1959. It will thus be possible to study in detail the interesting ERC-effects which occurred during that year, among them the large H-decrease (about 250 gammas) on 1959 March 28.

The data indicate clearly that not only the *decreases* in H are world-wide phenomenae, but also the unusual *increases* in H. A good example is the sudden increase of H in the middle of April 1958, with its maximum on April 12. This would tend to show that the decreases in the ERC (increases in H) are controlled by particle radiation from the sun rather than by a sort of recombination process.

One of the troublesome problems in deriving the ERC-variations is the elimination of the secular variation for the observing stations. One way of avoiding that is to start from deviations from the monthly means (like Vestine) or, as was done in (12), from running 27-day-means. Data for the years 1946-1951, giving daily ERC values, will form the continuation of the series 1905-1945 presented in (12).»

7. *Q-indices*

A number of polar observatories have scaled Q-indices for the IGY and the IGC 1959. A few have continued after 1959. It is a pleasure to cite here the excellent tables of Q-indices produced currently, a few days after the end of each month, by Sodankylä observatory. These, and other Q-indices from other stations, clearly indicate how useful the Q-index, properly derived, can be. An example of the study of characteristics of polar magnetic disturbances by means of Q-indices is given in Bibl. 8 and 8a.

Dr. N. Fukushima has studied the question to what extent the general request for Q-indices from all polar observatories during the IGY should be upheld. While it is clear that complete tables of Q are desirable, Dr. Fukushima thinks that, for a special study on the physical meaning of Q, it would be feasible to press at first the demand only for Q-indices from a number of selected days in the IGY. He has proposed a Table of such days, of three categories.

A: Great storms with maximum Kp = 8+ or higher,
B: Remarkable activity of short duration preceded by very quiet interval or some days with typical pg, pt, pc, si or b,
C: Other days of considerable geomagnetic activity.

He lists 26 A-days, 34 B-days, and 50 C-days, a total of 110, or roughly an average of 6 days for each of the eighteen months of the IGY; these, of course, are very un-evenly distributed, e.g., 16 days in September 1957, but only 1 day in November 1958.

This question will be discussed at Helsinki.

8. *27-day recurrence tendency*

Charts of Cp arranged in 27-days rotations are now issued from Göttingen every few months to exhibit 27-day recurrence tendencies. An extensive study to express this tendency numerically, based on daily character figures 1884-1960 is under way; first results will be given at Helsinki.

9. *Expression of thanks*

Our Committee bases its work on contributions from nearly all geomagnetic observatories. While we feel grateful for the generous support given to us, we also feel the heavy responsibility for asking su much labour spent on scaling indices etc. The schemes of the three-hourly K- and Kp-indices are now firmly established as reliable standardized expression for geomagnetic activity. The quarter-hourly Q-index, demanding about 12 times as much labour than the K-index, has likewise proved its usefulness; but while some observatories have already taken the Q-index into their routine, the question how much of Q-work should be asked from all polar stations will have to be decided at Helsinki. It is, of course, also possible, just as in the case of K-indices for past years, to enlist volunteers to scale Q-indices from the magnetograms available at the world data centres. The ERC-project demands only the quick scaling of hourly H-means from equatorial observatories, which are worked up centrally.

The Chairman takes pleasure to thank all observatories who have helped to make our work possible, and all those who have contributed remarks, in particular, Dr. J. Veldkamp, Dr. Mayaud, Dr. Fukushima, Mr. Johnston, Dr. Nicolsky, Dr. Kertz and Dr. Whitham.

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REPORT OF COMMITTEE NO. 10

ON RAPID MAGNETIC VARIATIONS AND EARTH CURRENTS

I. Les membres actuels du Comité, désignés à Toronto, sont les suivants:

A. Romañá, Président
R. Bock
L. Cagniard
L. Constantinescu
J. Dooley
V. C. A. Ferraro
Miss G. Gjellestad
G. Grenet
Y. Kato
E. Maple
L. Koenigsfeld
O. Meyer
J. H. Nelson
E. Selzer
Mme. V. Troitskaya
J. Veldkamp
A. H. de Voogt
K. Whitham.

II. *Service des Variations Rapides*

A. *Le nombre d'observatoires collaborateurs* a été de 69 en 1957; 91 en 1958; et 92 en 1959.

B. Voici un petit *schéma du mode de fonctionnement:*

a) Tous les observatoires collaborateurs remplissent tous les mois les formulaires «Ordinary magnetograms and tellurigrams» et les envoient à l'Observatoire de l'Ebre (Tortosa), soit directement, soit par l'intermédiaire de l'Institut Météorologique des Pays-Bas (De Bilt). Un certain nombre d'observatoires envoient aussi les formulaires «Quick-run magnetograms and tellurigrams».

b) Aves ces données le Comité prépare les listes trimestrielles qui sont publiées par De Bilt avec les indices K et C. Ces listes comprennent les phénomènes suivants:
   1. Ordinary magnetograms: ssc, si, b + bs + bp + + bps + pt, pt (and pg), minor disturbances;
   2. Quick-run magnetograms: pt, pg, pc;
   3. Solar-flare effects.

c) Après la publication de la liste du 4ème trimestre de l'année, on envoie à tous les Observatoires une checking-list comprenant en principe tous les phénomènes signalés par plus de deux observatoires, pour qu'ils soient confirmés (ou rejetés) par l'ensemble des observatoires.

d) Avec les réponses aux checking-lists le Comité prépare les listes définitives qui sont publiées dans le Bulletin n.° 12 de l'I.A.G.A.

C. *Données publiées*

a) Les listes trimestrielles ont été publiées jusqu'à la fin de 1959. Celles du 1er trimestre 1960 ont été préparées, mais non pas publiées à cause des possibles modifications qu'il puisse être nécessaire d'y introduire d'après les résolutions que l'on adopte à l'Assemblée.

b) Les listes définitives pour 1957 ont été finies et envoyées à De Bilt pour être publiées.

c) Les checking-lists pour 1958 ont été distribuées aux observatoires et l'on a commencé à recevoir un certain nombre de réponses. Celles de 1959 sont déjà prêtes, mais elles n'ont pas été distribuées par la meme raison exposée dans le paragraphe a).

Le retard dans ces publications est dú à une cause double:
— le nombre de phénomènes compris dans les checking-

lists est passé de 758 pour 1956 à 1428 pour 1957, et malgré tous les efforts pour le diminuer, il est encore de 1498 pour 1958.

— l'envie de publier des données aussi complètes que possible; or, comme quelques observatoires tardent beaucoup à envoyer leurs données, l'on se trouve en face du dilemme suivant: ou fixer une date de publication et laisser de coté les données arrivées plus tard, ou attendre tant qu'il faudra pour que la totalité (moralment parlant) des données aient été reçues. C'est à l'Assemblée de décider; l'on pourrait peut être adopter de critères differents pour les listes trimestrielles et les listes définitives.

III. *Symposium d'Utrecht*

Il a été tenu à l'Universitée d'Utrecht, du 1er au 4 Septembre 1959, comme suite aux vœux exprimés par les réunions plenières du CSAGI à Barcelone et à Moscou et comme continuation et ampliation du Symposium de Copenhague de 1957. Celui-ci ayant été consacré surtout à la partie pratique de l'organisation de l'observation des variations rapides, le Symposium d'Utrecht a embrassé aussi le plan théorique et a examiné les premiers résultats de l'AGI. Un premier compte-rendu des séances et des résolutions a été publié dans le n.° 29 de la «Chronique de l'U.G.G.I.», Mars 1969, pages 130-135. Le volume comprenant l'ensemble des exposés et des discussions est en train d'être imprimé et il sera prêt pour être distribué bien avant la fin de l'année. Comme les résolutions ont été rédigées sous forme de souhaits à exprimer à l'Assemblée Générale, elles se trouvent comprises dans les points traités au paragraphe suivant.

IV. *Orientation du travail futur*

Bien que la plupart de ces orientations ne regardent directement que les membres du Comité et les observatoires collaborateurs, l'on en donne pourtant ici un court résumé parce qu'il est possible qu'il y ait d'autres personnes qui s'intéressent à ces matières et puissent apporter leur concours.

a) Modifications à introduire dans les listes trimestrielles et définitives et par conséquent dans les checking-lists (diminution du nombre de phénomènes soumis au contrôle, examen en deux échelons, plus de précision dans certaines données, etc.).

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b) Modifications à introduire dans les rapports mensuels des Observatoires:

ssc: heure plus précise (à la seconde près, si possible, pour les observatoires disposant de quick-runs);

si: détermination plus exacte des conditions dans lesquelles ils doivent être rapportés en ordre à une étude plus systématique de ce type de variation rapide;

pulsations: fixation d'une période maximum pour les pulsations individuelles dans le cas des *pt* — extension de l'étude des pc aux très courtes périodes — subdivision des pt en divers types mieux élaborés — introduction des ps — limite inférieure de l'amplitude des pg et de la durée totale du phénomène, etc.;

b et *sfe:* durée totale des bais arctiques et antarctiques; moyens de sélection des sfe; etc.

c) Sélection d'un certain nombre d'observatoires devant contribuer spécialement à l'étude des *pt* et des *pc*, dans le but d'obtenir une plus grande uniformité dans la forme d'enregistrement et de dépouillement des pulsations, en ordre à une meilleure connaissance du problème à échelle universelle et à la résolution du problème des sources des pulsations et du mécanisme de leur excitation.

d) Participation aux études de géomagnetisme expérimental.

e) Orientation pour l'Atlas définitif des Variations Rapides et forme de recueillir les données.

f) Manière de fournir des données plus complètes et rapides aux chercheurs intéressés aux problèmes des variations rapides.

g) Enregistrement simultané dans les mêmes observatoires des pulsations magnétiques et telluriques.

Etc.

PART III

RESOLUTIONS

ENGLISH TEXT

Resolution No. 1

The IAGA *recommends* the adoption of the report of the sub-committee of Committee No. 2 on the revision of the photographic atlas of auroral forms and the revision of the international nomenclature of aurora and requests the IUGG to give financial support to the project (see page 80).

Resolution No. 2

The IAGA, *recognizing* the importance of the publication of the most recent data on the Earth's magnetic field, *requests* all magnetic observatories to send regularly, and as soon as possible, the annual mean values of the magnetic elements to the chairman of the committee on Secular Variations and Palaeomagnetism, who will be responsible for the prompt compilation of the data as well as its publication in an appropriate form.

Resolution No. 3

The IAGA, *considering* the importance of accurate knowledge of geomagnetic secular variation for the reductions necessary for magnetic surveys, especially in connection with the world magnetic survey, *recommends* that all magnetic observatories maintain their base-line values as accurately as possible, at least to the accuracy requested for the IGY programme and *requests* those magnetic observatories which have been in operation for many years to continue their routine observations for as long as possible, in order to secure continuous series of records of geomagnetic variations.

Resolution No. 4

The IAGA *considering* that improved isomagnetic charts of the Indian Ocean are now possible because of the recent surveys by the nonmagnetic ship Zarya of the USSR, and that such charts could be further improved by inclusion of geomagnetic survey data obtained since 1920 on islands, and other land areas adjacent to and bordering the Indian Ocean *recommends* that such data be forwarded to Professor Pushkov as soon as possible.

Resolution No. 5

The IAGA, *considering* that for the understanding of world-wide cosmic ray phenomena, data should be available from stations from different points all over the earth, and since there is no other station within many thousands of kilometres of Hermanus, Cape Province, Union of South Africa, *emphasizes* the importance of having the flow of data from Hermanus continue, and *hopes* that the authorities will continue to support the operation of the cosmic ray observing equipment at this station.

Resolution No. 6

IAGA *stressing* the importance of having correct measurements (by variographs) at some special «variation repeat stations» for periods of several days, *recommends* that repeat stations be set up in regions where the magnetic field is anomalous because of geological conditions, or where it is varying rapidly because of the nearness of the station to the auroral zone.

Resolution No. 7

The IAGA, *considering* the need for a universal agreement regarding the value of the gyromagnetic ratio of the proton for measurements of the geomagnetic field, *strongly recommends* that, pending the agreement and specification by an appropriate international scientific organization of a final value, all measurements of the geomagnetic field with a proton free-precession magnetometer, using pure water as the proton sample, shall be based on the following value of the gyromagnetic ratio:

$$2.67513 \times 10^4 \text{ radians/gaus, second}$$

Resolution No. 8

The IAGA, *appreciating* the excellent series of geomagnetic Q-indices provided by a number of observatories, *recommends* that other polar observatories scale Q-indices at least for a limited number of days (about 110) to be selected from the IGY period by the Committee on Magnetic Activity.

Resolution No. 9

The IAGA, *aware* of the fact that the work of the World Data Centers for Geomagnetism established for the IGY must necessarily continue for a considerable time in order to complete the collection of data for the IGY/IGC period, and *realizing* the need for an interchange system by which geomagnetic data, for the years following the IGY/IGC period may also be made readily available to investigators, *urges* that all observatories continue to supply geomagnetic data for the WDC until the end of 1965, if possible on the same scale as adopted for the IGY/IGC period.

Resolution No. 10

The *IAGA* considering the CIG resolution on the meeting held in Paris (1960) *recommends* that the following lists of responsabilities be stablished for the conduct of the WMS:

IAGA will take the responsability for the scientific program and consultation related to the project, and if a Bureau is required this will be the responsability of IAGA and IAGA must support its finances. Coordination with national IUGG committees will be secured by IAGA through the IUGG.

CIG will help in coordinating the work through national CIG/IGY committees and in obtaining financial support for the project.

For interdisciplinary areas, CIG, COSPAR, SCAR, and other similar bodies will be aproached by IAGA through the IUGG-COSPAR or other pertinent committees.

Resolution No. 11

The IAGA *considering* the usefulness of the resolutions adopted by Committee No. 10 after the conclusions of the Symposium of September 1959 at Utrecht, relating to the study of Rapid Magnetic and Telluric Variations, *adopts* the resolutions made by this committee and requests the observatories to put them in force.

The IAGA *recommends* to observatories in the equatorial and polar regions to take steps to obtain equipment necessary for the recording of pulsations of very short period; and in order to obtain comparable results, *recommends* that the maximum uniformity be obtained in the following parameters:

a) recording speed,

b) sensitivity sufficient to allow pulsation «pearls» to be distinguished,

c) recordings be made at the same Universal Time when it is not possible to carry out continuous recording.

It also *recommends* that Committee No. 10 determine the geographic regions which are most important for the distribution of stations able to record pulsations and *invites* the IUGG to request the countries concerned to stablish such stations.

The IAGA *recommends* that a Symposium on Rapid Magnetic and Telluric Variations and particularly on pulsations with a period of less than 20 seconds, be organized during the next IUGG General Assembly.

Resolution No. 12

The IAGA *considering* the fact that the IAMAP has established a Committee on «Meteorology of the Upper Atmosphere» and *considering* the need for complete information on this type of work, *urges* its secretary to pass to the IAMAP secretary all pertinent information.

Report of Working Group on Revision of the Photographic Atlas of Auroral Forms and Revision of the International Nomenclature, or Classification, of Aurora

1. The Working Group notes that the present use of auroral nomenclature is not uniform in the different countries and observing networks. It also notes that the Photographic Atlas of Auroral Forms is now out of stock. An illustrated guide on auroral morphology to secur uniformity of nomenclature on which most auroral workers can agree is considered a necessity for observational and theoretical purposes. It is the belief of the Working Group that it is the responsibility of the IAGA to provide such a standardized nomenclature.

2. This could best be achieved by establishing within the IAGA Committee No. 2, a Sub-committee on Revision of Auroral Forms and Revision of Auroral Classification, which should be instructed as follows:

3.1. Discuss the convenience of maintaining, altering, or broadening the morphological classification given in the present Atlas, taking into account the more complete observational data and experience now available from within, under, and outside the auroral zones of both hemispheres.

3.2. Select a set of representative photographs suitable for printing a new atlas to illustrate the classification, taking advantage of the present Atlas, and of any additional photographic data available, including Professor Störmer's collection if accessible.

3.3. Decide upon the possibility of including color photographs, which is considered desirable, provided that a reasonable degree of color fidelity can be attained in their reproduction.

3.4. Give full morphological description (including time, place, color, intensity, stability) as well as photographic references for each selected picture.

3.5. Consider the possibility of an abridged version of the new Atlas, suitable for non-professional observers.

3.6. Include a section with characteristic examples of All-Sky camera pictures, classified in accordance with the nomenclature adopted.

3.7. Accomplish the selection of pictures, wording of definitions, and editing, not later than July 31, 1962.

3.8. Submit to the Executive Committee of the IAGA an estimate of extent and probable cost of publishing, not later than December 31, 1961.

4. The IAGA should invite the collaboration of individual scientists, institutes, and amateurs all over the world in providing auroral photographs and descriptions, as well as suggestions.

5. The new Atlas should be published by, or under the auspices of the IAGA, or the IUGG.

6. The present Working Group suggests for nomination to the proposed Sub-committee of IAGA No. 2, the following: Paton (Chairman), Isaiev, Gartlein, Jacka, Schneider and an auroral investigator from Scandinavia or New Zealand. The Sub-committee should be free to request the collaboration of others.

7. The present Working Group considers that it would also be advisable to attempt a better international standardization of schemes for visual observation and photographic recording, and suggests that a Sub-committee on Methods of Observation be established.

TEXTE FRANÇAIS

Résolution No. 1

L'AIGA *recommande* l'adoption du rapport du sous-comité créé au sein de son Comité No. 2, relatif à la révision de l'Atlas photographique des diverses formes d'aurores et de la nomenclature internationale des aurores, et prie l'UGGI de bien vouloir donner un appui financier à ce projet (voir page 80).

Résolution No. 2

L'AIGA, *reconnaissant* l'importance de la publication des valeurs les plus récentes du champ magnétique terrestre, *demande* à tous les observatoires magnétiques de bien vouloir envoyer régulièrement et dans les moindres délais leurs valeurs annuelles moyennes des éléments magnétiques, au Président de son Comité des Variations Séculaires et du Paléomagnétisme, qui aura la responsabilité d'assurer une prompte mise au net des valeurs et leur publication sous une forme appropriée.

Résolution No. 3

L'AIGA, *considérant* l'importance d'une connaissance précise de la variation séculaire géomagnétique, dans les réductions nécessaires au depuillement des campagnes magnétiques, tout particulièrement ceux qui concerneront la carte magnétique mondiale, *recommande* que tous les observatoires magnétiques soient priés de veiller avec toute la précision possible à la correction des valeurs de leurs lignes de base, de façon à les maintenir en tout cas dans les limites de précision demandées pour le programme de l'AGI, et *prie* aux observatoires magnétiques en opération depuis de longues années de bien vouloir poursuivre leur activité dans le futur, aussi longtemps que ce sera possible, de façon à assurer des séries continues des enrégistrements des variations géomagnétiques.

Résolution No. 4

L'AIGA, *considérant* qu'il est maintenant possible d'établir de meilleures cartes isomagnétiques de l'Océan Indien grâce aux campagnes récentes du navire non magnétique Zarya de l'URSS, et considérant que de telles cartes pourraient être encore améliorée si on tenait compte des valeurs obtenues depuis 1920 dans des illes et sur les bords de cet Océan, recommande que de telles valeurs soient envoyées au Professeur Pushkov le plus tôt possible.

Résolution No. 5

L'AIGA, *considérant* d'une part qu'il est important pour la compréhension des phénomènes cosmiques mondiaux que les résultats d'observation puissent être fournies par des stations situées en divers lieux de la Terre, et d'autre part qu'il n'y a aucune autre station dans un rayon de plusieurs milliers de kilomètres autour de Hermanus (province du Cap, Union Sudafricaine), *demande* que l'envoi des valeurs par Hermanus puisse continuer et *espère* que les autorités voudront bien apporter leur aide à la marche de cette station de rayons cosmiques.

Résolution No. 6

L'AIGA *insiste* sur la nécessité de mettre en action à certaines stations de répétition particulières, des variomètres dont l'enregistrement sera poursuivi pendant plusieurs jours.

De telles stations de répétition sont particulièrement nécessaires dans les régions où existent des anomalies magnétiques d'ordre géologique ou qui se trouvent affectées par des variations rapides du fait de la proximité de la zone aurorale.

Résolution No. 7

L'AIGA, *considérant* la nécessité d'un accord général sur la valeur à adopter pour le rapport gyromagnetique du proton intervenant dans les mesures du champ magnétique terrestre, *demande* que, dans l'attente d'une décision sur la valeur définitive qui sera adoptée éventuellement par un organisme international compétent, la valeur

$$2{,}67513 \times 10^4 \text{ radians/gauss, seconde}$$

soit celle retenue pour toutes les mesures du champ magnétique terrestre faites au moyen d'un magnétomètre à protons à précission libre, utilisant de l'eau pure comme source de protons.

Résolution No. 8

L'AIGA, *appréciant* les excellentes séries d'indices géomagnétiques Q données par un certain nombre d'observatoires, *recommande* que les autres observatoires polaires mesurent leurs indices Q au moins pour un nombre déterminé de jours pris durant l'AGI (environ 110 jours), dont le choix sera fait par le Comité sur l'Activité Magnétique.

Résolution No. 9

L'AIGA, *consciente* de la nécessité pour les Centres Mondiaux des Valeurs Magnétiques établis pour l'AGI, de continuer leur activité encore longtemps, afin qu'ils puissent complèter le rassemblement des valeurs relatives à la période AGI/CGI, et *considérant* la nécessité d'un organisme d'échange de valeurs magnétiques grace auquel ces valeurs, étendues aussi sur les années suivantes, pourront être mises facilement à la disposition des chercheurs, *demande* expressément que tous les observatoires continuent à envoyer leurs valeurs aux Centres Mondiaux jusqu'à la fin de l'année 1965 et si possible suivant les mêmes normes que celles adoptées pour la période AGI/CGI.

Résolution No. 10

L'AIGA, *considérant* la résolution du CIG adoptée à la réunion de Paris de 1960, *recommande* que pour la conduite du WMS l'on établisse la liste de responsabilités suivante:

L'AIGA aura la responsabilité du programme scientifique et des consultations relatives au projet et si un Bureau est nécessaire ce sera aussi du ressort de l'AIGA de l'établir et d'assurer sa finantiation. La coordination avec les Comités Nationaux de l'UGGI sera également assurée par l'AIGA à travers l'UGGI.

Le CIG aidera à coordiner le travail au moyen de ses Comités

Nationaux CIG/AGI et à obtenir les ressources nécessaires pour le projet.

Dans les matières interdisciplinaires les rapports avec le CIG, le COSPAR, le SCAR et d'autres organismes similaires seront assurés par l'AIGA à travers des comités UGGI-COSPAR ou d'autres Comités appropriés.

Résolution No. 11

L'AIGA considérant l'utilité des résolutions qui ont été adoptées par le Comité No. 10 d'après les conclusions du Symposium d'Utrecht de Septembre 1959 relatives à l'étude des variations magnétiques et telluriques rapides, fait siennes ces résolutions et prie les observatoires de bien vouloir s'y adopter.

L'AIGA *recommande* aux observatoires placés dans la zone équatoriale et les régions polaires de prendre des mesures en vue de l'installation d'apparails enregistreurs des pulsations de très courtes périodes.

Dans le but d'obtenir des résultats aussi homogènes que possible, elle *recommande* que l'on arrive à la plus grande uniformité dans les paramètres suivants:

a) vitesses de déroulement

b) sensibilités suffisantes pour mettre en relief les pulsations «en perles»

c) heures d'enregistrement communes dans le cas où des enregistrements continus pendant les 24 heures de chaque jour ne seraient pas possibles.

Elle *recommande* aussi au Comité No. 10 de déterminer les lacunes géographiques les plus importantes dans la distribution des stations capables d'enregistrer ces pulsations et prie l'UGGI de bien vouloir faire des recommandations aux différents pays en vue de l'organisation de ces sortes d'observations.

L'AIGA *recommande* que l'on organise à l'occasion de la prochaine Assemblée de l'Union un Symposium sur les variations magnétiques et telluriques rapides et tout particulièrement sur les pulsations de périodes inférieur à 20 secondes.

Résolution No. 12

L'AIGA *considérant* que l'AIMPA a constitué un Comité sur la «Météorologie de l'Atmosphère supérieure» et *considérant* la nécessité d'avoir des informations complètes sur les travaux faits dans ce domaine, *charge* son secrétaire de transmettre au secrétaire de l'AIMPA toutes les informations convenables.

PART IV

IAGA COMMITTEES

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Vice-Presidents: M. Nicolet (Belgium)
N. Pushkov (USSR)
Secretary and Director of the Central Bureau: J. O. Cardús (Spain)
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J. Bouska (Czechoslovakia)
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P. Herrinck	Congo	J. Rodríguez-Navarro	Spain
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H. Elliot	England	V. I. Krasovski	USA
V. C. O. Ferraro	England	A. Lundbak	USSR
H. Friedman	USA	M. Maeda	Denmark
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K. Rawer	Germany	R. S. Unvin	New Zealand
E. C. Ray	USA	J. A. Van Allen	USA
M. H. Rees	USA	T. E. Van Zandt	USA
J. G. Roederer	Argentina	S. N. Vernov	URSS
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G. Grenet	Alger	C. G. Sucksdorff	Finland
V. P. Hessler	USA	V. Troitskaya	USSR
V. R. S. Hutton	Ghana	J. Veldkamp	Netherlands
J. A. Jacobs	Canada	H. Weise	Germany
A. G. Kalashnikov	USSR	C. S. Wright	Canada
Y. Kato	Japan		

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HISTORY OF GEOMAGNETISM AND AERONOMY

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J. W.Beagley	New Zealand	C. W. Gartlein	USA
Z. Berkes	Hungary	N. C. Gerson	USA
L. Gagniard	France	J. Keränen	Finland
S. Chapman	U.K.	Kimpara	Japan
E. Chernosky	USA	L. Koenigsfeld	Belgium
L. Constantinescu	Rumania	A. Lundbak	Denmark
G. Fanselau	Germany	D. J. Malan	South Africa
H. F. Finch	UK	N. Malinina	USSR
E. Flórián	Hungary	S. L. Malurkar	India

S. Matsushita	Japan	T. N. Rose	USSR
M. Z. Nodia	USSR	Réthly	Hungary
T. Nagata	Japan	A. Tárczy-Hornoch	Hungary
J. Paton	U.K.	P. N. Tverskoy	USSR
St. Procopui	Rumania	A. M. Van Wijk	South Africa
E. B. Roberts	USA		

IAGA-CIG COMMITTEE

Chairman: *V. Laursen* Denmark

J. Bartels	Germany	M. Nicolet	Belgium
C. T. Elvey	USA	N. Pushkov	USSR
T. Nagata	Japan	E. H. Vestine	USA

JOINT COMMITTEE ON ATMOSPHERIC ELECTRICITY

Hon. Chairman: *H. Norinder* Sweden

Chairman: *L. Koenigsfeld* Belgium

Clark	USA	H. W. Kasemir	USA
S. C. Coroniti	USA	R. P. Mühleisen	Germany
I. M. Imianitov	USSR	Y. Tamura	Japan
H. Israël	Germany	T. W. Wormell	U.K.

IUGG/COSPAR COMMITTEE (IAGA MEMBERSHIP)

J. Bartels	Germany	M. Nicolet	Belgium
J. E. Blamont	USA	J. A. Van Allen	USA
R. Jastrow	USA	S. N. Vernov	USSR
V. I. Krasovski	USSR		

TRANSACTIONS

OF THE

BERKELEY MEETING

PART I

AGENDA AND MINUTES

FINAL AGENDA FOR THE MEETING

SUNDAY, AUGUST 18, 1963
A.M.: Executive Committee

MONDAY, AUGUST 19, 1963
A.M.: Executive Committee

TUESDAY, AUGUST 20, 1963
P.M.: Opening Plenary Session

WEDNESDAY, AUGUST 21, 1963
A.M.: Symposium on Aeronomy
Committee No. 1
P.M.: Symposium on Aeronomy

THURSDAY, AUGUST 22, 1963
A.M.: Symposium on Aeronomy
Committee No. 10
Presentation of Papers: Committee No. 4
Presentation of Papers: Committee No. 9

FRIDAY, AUGUST 23, 1963
A.M.: Symposium on Aeronomy
Committee No. 4
Committee No. 8
Presentation of Papers: Committee No. 5
Presentation of Papers: Committee No. 10
P.M.: Symposium on Aeronomy
Committee No. 5
Presentation of Papers: Committees Nos. 1, 6, 7, and 8
Presentation of Papers: Committee No. 9

Saturday, August 24, 1963

A.M.: Upper Atmosphere Meteorology and Aeronomy Symposium (with IAMAP)
Presentation of Papers: Committee No. 10

Monday, August 26, 1963

A.M.: Presentation of Papers: Committee No. 2
Presentation of Papers: Committee No. 10
P.M.: Committee No. 3

Tuesday, August 27, 1963

A.M.: World Magnetic Survey Operation
Committee on Atmospheric Electricity (with IAMAP)
Presentation of Papers: Committee No. 2
Presentation of Papers: Committee No. 10
P.M.: Symposium on Methodology and Instrumentation of Aeromagnetic Surveys
Committee No. 6
Committee No. 11
Presentation of Papers: Committee No. 2
Presentation of Papers: Committee on Atmospheric Electricity (with IAMAP)

Wednesday, August 28, 1963

A.M.: Palaeomagnetism and Palaeoclimatology Symposium (with IAMAP)
Committee No. 2
Committee No. 10
Presentation of Papers: Committees Nos. 2 and 3
Presentation of Papers: Committee on Atmospheric Electricity (with IAMAP)
P.M.: Palaeomagnetism and Palaeoclimatology Symposium (with IAMAP)
Presentation of Papers: Committee No. 3
Presentation of Papers: Committee on Atmospheric Electricity (with IAMAP)
Executive Committee Meeting

Thursday, August 29, 1963

A.M.: Final Plenary Session
P.M.: Executive Committee
Presentation of Papers on Space Problems

Friday, August 30, 1963

A.M.: Presentation of Papers on Space Problems
P.M.: (Same as a.m. session)

LIST OF DELEGATES ATTENDING THE MEETING

The following list gives the names of delegates who attended the Berkeley Meeting.

Name	Country
Afshar, H. K., Dr.	Iran
Aikin, A. C.	USA
Akasofu, S.	USA
Alksne, A., Mrs.	USA
Allan, T. D., Dr.	Italy
Alldredge, L. R., Dr.	USA
Ambolt, N. P., Dr.	Sweden
Anastassiades, M., Prof.	Greece
Andison, G. W.	U. K.
Angenheister, G., Prof.	Germany
Ashburn, E. V.	USA
Balakrishna, S.	India
Balsley, J. R., Prof.	USA
Baranov, V. N., Dr.	France
Barbier, D. A., Dr.	France
Bartels, J., Dr.	Germany
Barth, C. A.	USA
Barthel, C. E. Jr., Dr.	USA
Behrendt, John, Dr.	USA
Belmont, A., Dr.	USA
Benkova, N. P., Dr.	USSR
Benson, W. E.	USA
Berger, J.	Canada
Berkner, L. V., Dr.	USA
Best, W. J., Chief Major	USA
Beynon W. J. G., Prof.	U. K.
Bhuyan, G. C.	India
Biondi, M. A.	USA
Blamont, J. E., Prof.	France
Bojkov, R.	Bulgaria
Bolin, B. R. J., Prof.	Sweden
Bomba, S.	USA
Bomke, H. A., Prof.	USA
Borsum, A. W., Capt.	USA
Bossolasco, M., Prof.	Italy
Bostick, F. X., Prof.	USA
Bowin, C., Dr.	USA
Briggs, B. R.	USA
Briglia, D. C.	USA
Broadfoot, A. L., Dr.	USA
Bronner, F. E.	USA
Bullard, Sir Edward	U. K.
Bullerwell, W., Dr.	U. K.
Burger, A. J., Dr.	Rep. of South Al
Byerly, P. E.	USA
Cagniard, L. P. E., Prof.	France
Cain, J. C., Dr.	USA
Caner, B.	Canada
Cardús, J. O., Rev.	Spain
Carmichael, Ch. M., Dr.	Canada
Clark, J. F., Dr.	USA

Name	Country
Clar, K. C., Prof.	USA
Cook, A. B., Miss	Canada
Corpacius, A. J.	USA
Coulomb, J., Prof.	France
Crary, A. P.	USA
Creer, K. M., Dr.	U. K.
Currie, B. W., Prof.	Canada
Chamberlain, J. W., Dr.	USA
Chapman, S., Dr.	USA
Chargoy, A., Prof.	Mexico
Chernosky, E. J.	USA
Christofis, C. N.	USA
Dalgarno, A.	USA
Dalrymple, G. B.	USA
D'Arnaud Gerkens, J.C.	Netherlands
Davies, T. V., Prof.	U. K.
Davis, T. N., Dr.	USA
Del Pozo, S.	Bolivia
Deutsch, E. R., Dr.	Canada
De Vuyst, A. P., Dr.	Belgium
Dieminger, W. E., Prof.	Germany
Doell, R. R., Dr.	USA
Dolezalek, H.	USA
Drajvicevic, M.	Chile
Droessler, E. G., Dr.	USA
Duclaux, F.	France
Duffee, R. A.	USA
Egeland, A., Dr.	Sweden
Ehmert, A., Prof.	Germany
Epstein, E. S., Dr.	USA
Fahim, M., Dr.	Egypt
Fanselau, G., Prof.	Germany
Fejer, J. A.	USA
Filloux, J. H.	USA
Fischel, D.	USA
Fitch, J. L.	USA
Flowerday, T. W., Prof.	USA
Fogle, B.	USA
Forsyth, P. A., Prof.	Canada
Fournier, H. G.	France
Fournier d'Albe, E. M.	France
Friedman, H., Dr.	USA
Fuller, M. D.	USA
Gabriel, V. G.	USA
Gallavardin, J. A. M. L.	France
Geddes, W. H.	USA
Geldart, L. P., Dr.	Canada
Geromini, V. Peña	Spain
Gershanik, S.	Argentina
Geyer, R. A.	USA
Giorgi, M. M. G., Prof.	Italy

Name	Country	Name	Country
Girdler, R. W., Dr.	U. K.	Kosinetz, O. I.	USSR
Giret, R. I.	France	Kozlosky, J. A.	USA
Gjellestad, G. E., Prof.	Norway	Krynski, S.	Poland
Gnevychev, M. N., Dr.	USSR	Kuno, H., Dr.	Japan
Goldberg, R. A., Dr.	USA	Kvifte, G. I., Prof.	Norway
Gouin, P. L., Prof.	Ethiopia	Laclavère, G., Ing. Gen.	France
Green, A. E. S., Prof.	USA	Lal, D., Prof.	USA
Green, A. W. Jr.	USA	Lange-Hesse, G., Dr.	Germany
Gregory, J. B., Dr.	New Zealand	Larochelle, A., Dr.	Canada
Grenet, G., Dr.	France	Larsen, J.	USA
Griffiths, D. H., Dr.	U. K.	Lassen, K.	Denmark
Hagan (R. M.?), Prof.	USA	Laursen, V.	Denmark
Hahn, A., Dr.	Germany	Lauter, E. A. L., Prof.	Germany
Hansen, R. T.	USA	Lavergne, M.	France
Hanson, W. B.	USA	Lebeau, A. F.	France
Harrison, C. G. A.	USA	Lebedinsky, A. I., Prof.	USSR
Harrison, J. C., Dr.	USA	Levin, S. B., Dr.	USA
Haurwitz, B., Prof.	USA	Lincoln, J. V., Miss	USA
Heacock, J. G.	USA	Lokken, J. E., Dr.	Canada
Hedley, I. G.	U. K.	Loncarevic, B. D.	Canada
Heirtzler, J. R., Dr.	USA	Loomer, E. I.	Canada
Helbig, K., Dr.	Germany	Lowes, F. J., Dr.	U. K.
Hess, W. N., Dr.	USA	Lyon, G. F., Dr.	Canada
Hessler, V. P.	USA	Maeda, H., Dr.	Japan
Hesstvedt, E., Dr.	Norway	Magnitzky, A. W.	USA
Heuring, F. T.	USA	Malurkar, S. L.	USA
Hibberd, F. H., Dr.	USA	Mange, P. W.	USA
Hochstim, A. R.	USA	Maple, E.	USA
Hones, E. W., Dr.	USA	Mariani, F., Dr.	USA
Horton, C. W., Prof.	USA	Mather, K. B., Prof.	USA
Howe, H. H., Dr.	USA	Matsushita, S., Dr.	USA
Hunten, D. M., Dr.	USA	May, B. T.	USA
Hutton, V. R. S., Dr.	Northern Nigeria	Mayaud, P. N., Rev.	France
Hyun, B. K., Dr.	Rep. of Korea	McDonald, K. L., Dr.	USA
Irving, E.	Australia	McElhinny, M. W., Dr.	USA
Isaev, S. I., Dr.	USSR	McGregor, P. M.	Australia
Jackson, J. S.	Ghana	McNamara, A. G., Dr.	Canada
Jacobs, J. A., Prof.	Canada	McNicol, R. W. E., Dr.	USA
Johnson, F. S., Dr.	USA	Mead, G. D.	USA
Jorgensen, T. S.	Denmark	Meyer, O., Dr.	Germany
Joyce, J. W., Dr.	USA	Meisser, O., Dr.	Germany
Juan, V. C.	Rep. of China	Middlehurst, B. M., Miss	USA
Kallmann-Bijl, H. K.	USA	Minnis, C. M., Dr.	U. K.
Kamiyama, H., Dr.	USA	Morelli, C.	Italy
Kaplan, J., Prof.	USA	Morley, L. W., Dr.	Canada
Kaplan, L. D.	USA	Mühleisen, R. P., Prof.	Germany
Karo, H. A., Rear Adm.	USA	Nagata, T., Prof.	Japan
Kasemir, H. W., Dr.	USA	Nakada, M. P., Dr.	USA
Kato, Y. K., Dr.	Japan	Nelson, J. H., Dr.	USA
Kaufman, F., Dr.	USA	Nesbitt, J. D., Miss	U. K.
Keen, M. J., Dr.	Canada	Nesbitt, R. H.	USA
Kellogg, W. W., Dr.	USA	Newell, H. E., Dr.	USA
Kertz, W. G., Prof.	Germany	Newell, R. E., Prof.	USA
Khosla, K. L., Lt. Col.	India	Niblett, E. R.	Canada
Knapp, D. G.	USA	Nicholls, R. W., Prof.	Canada
Kobayashi, K., Dr.	USA	Nicolet, M., Prof.	Belgium
Koenigsfeld, J. L., Dr.	Belgium	Nier, A. O. C., Prof.	USA
Kondratiev, K.	USSR	Nikolsky, A. P., Prof.	USSR

Name	Country	Name	Country
Nishida, A., Dr.	Japan	Siebert, M., Dr.	Germany
Noxon, J. F.	USA	Silgado, E.	Peru
Obayashi, T., Prof.	Japan	Silver, S., Prof.	USA
Odishaw, H., Dr.	USA	Sinha, E., Dr.	USA
Ogbuehi, P. O.	Nigeria	Siry, J. W.	USA
Oguti, T., Dr.	Japan	Sison, A. J.	Philippines
Oldham, C. H. G.	U. K.	Slaucitajs, L., Dr.	Australia
Osborne, D. G., Dr.	Ghana	Slutz, R. J.	USA
Ota, M., Dr.	Japan	Smith, H. W., Prof.	USA
Ozima, M., Dr.	Japan	Smith, Waldo E.	USA
Pachimkul, S.	Thailand	Smylie, D. E.	Canada
Paetzold, H. K., Prof.	Germany	Spreiter, J. R., Dr.	USA
Parkinson, W. D., Dr.	USA	Srivasta, S. P., Dr.	Canada
Parry, J. H.	U. K.	Stacey, F. D., Dr.	U. K.
Patapoff, M.	USA	Stanbury, A. C.	New Zealand
Paton, J., Dr.	U. K.	Stocchino, M. C.	Italy
Patterson, T. N. L., Dr.	USA	Stockard, H. P.	USA
Paulson, J. F., Dr.	USA	Stone, D. B.	U. K.
Pearce, J. B.	USA	Stoyko, N.	France
Peavey, R. C.	USA	Strangway, D. W.	USA
Piggott, W. T.	U. K.	Sucksdorff, C. G.	Finland
Pillet, G. M., Dr.	France	Sugiura, M.	USA
Praus, O.	Czechoslovakia	Summers, A. L., Mrs.	USA
Price, A. T., Prof.	U. K.	Surkan, A. J., Dr.	Canada
Prior, L. S.	Australia	Swainson, O. W., Capt.	USA
Quenby, J. J.	U. K.	Talwani, M., Dr.	USA
Raja Rao, K. S.	India	Thellier, E., Prof.	France
Ramanathan, K. R.	India	Therian, A., Dr.	Iran
Ramanisarivo, M.	Madagascar	Tozer, D. C., Dr.	U. K.
Razdan, H., Dr.	USA	Trefall, H., Dr.	Norway
Rees, A. I., Dr.	USA	Trent, E. M., Mrs.	USA
Rees, M. H., Dr.	USA	Troitskaya, V. A., Dr.	USSR
Rikitake, T., Prof.	Japan	Tryggvason, E.	USA
Rivers, D. G.	Sierra Leone	Tsubokawa, I., Dr.	Japan
Robertson, W. A., Dr.	Canada	Turajlic, R.	Yugoslavia
Roederer, J. G., Prof.	Argentina	Twitchell, P. F.	USA
Rofe, B.	Australia	Udebiuwa, M. E. P.	Nigeria
Romañá, A., Rev.	Spain	Untiedt, J., Dr.	Germany
Rourke, G. F.	USA	Ursin-Smith, R.	USA
Rubin, M. J.	USA	Vacquier, V.	USA
Ruttenberg, S.	USA	Vadhanapanich, C., Dr.	Thailand
Sancier, K. M.	USA	Vajk, R.	USA
Sato, T., Dr.	USA	Van der Bijl, W.	USA
Schiff, H. I., Prof.	Canada	Van Voorhis, G. D.	USA
Schlich, R. E.	France	Van Zandt, T. E., Dr.	USA
Schmidt, R. A.	USA	Vassy, A. J., Dr.	France
Schneider, O., Dr.	Argentina	Veldkamp, J., Dr.	Netherlands
Schoen, R.	USA	Vestine, E. H., Dr.	USA
Schott, D.	USA	Vila, F., Prof.	Argentina
Schultheis, W. B.	USA	Vincenz, S. A., Dr.	USA
Selzer, E. J. E., Prof.	France	Wade, L. C.	USA
Serson, P. H., Dr.	Canada	Walker, G. P., Dr.	U. K.
Shafrir, U.	USA	Ward, F. W. Jr.	USA
Shand, J. A.	Canada	Ward, S. H., Prof.	USA
Shapley, A. H.	USA	Watanabe, T., Dr.	Canada
Shepherd, G. G., Dr.	Canada	Watkins, N. D.	USA
Shneiderov, A. J., Prof.	USA	Weaver, J. T., Dr.	Canada
Short, W. W.	USA	Wentworth, R. C.	USA

Name	Country	Name	Country
Wescott, E. M.	USA	Wollenberg, H. A.	USA
West, M. L., Mrs.	USA	Wolstencroft, R. D., Dr.	USA
Whitham, K., Dr.	Canada	Woollard, G. P., Prof.	USA
Wienert, K. A., Dr.	Germany	Wormell, T. W., Dr.	U. K.
Wilcox, C. H.	USA	Worden, S. P.	USA
Wilcox, J. M., Dr.	USA	Wright, Sir Charles	Canada
Wilson, C. R., Dr.	USA	Wukelic, G. E.	USA
Witthoft, J., Dr.	USA	Yungul, S. H.	USA

MINUTES OF THE MEETINGS

A) PLENARY SESSIONS

First Plenary Session

The first plenary session of IAGA at the Berkeley XIII General Assembly was called to order by the President, Dr. Laursen, at 14^h10^m, August 20, 1963.

The agenda of the meeting was unanimously adopted as follows:

(1) Presidential Address.

(2) Secretary's Report.

(3) Establishment of ad hoc Committees for the Berkeley Assembly:

Committee on Nominations.
» on Finances.
» on Resolutions.

(4) New Structure of the IAGA.

(5) Presentation of National Reports (if time permits).

(1) Then Dr. Laursen proceeded to deliver his presidential address (see page 150).

Afterwards the President called for a moment of silence in memory of Colleagues who have passed away during the last three years, and especially of Professor A. G. Kalashnikov, who from 1957 to 1960 was Vice-President of our Association.

(2) The meeting proceeded with the Report of the Secretary (see page 156).

In commenting on the report the President drew attention to the change of chairmanship in Committee No. 2 on Aurora. For reasons of health Professor Elvey has unfortunately had to resign from his post as Chairman of the Auroral Committee, and at the request of the Executive Committee Professor Chamberlain has kindly taken over the chairmanship for the remaining part of the three years period. The President suggested that the Association expressed its deep appreciation of Professor Elvey's good services as Chairman of the Auroral Committee, and its gratitude towards Professor Chamberlain for his willingness to take over the chairmanship at such short notice.

The Secretary's Report was accepted as presented.

(3) The following ad hoc Committees were established for the Berkeley General Assembly:

Committee on Nominations:
- Prof. Kaplan (convener)
- Prof. Bartels
- Dr. Benkova
- Prof. Coulomb
- Dr. Rikitake

Committee on Finances:
- Prof. Veldkamp (convener)
- Dr. Schneider
- Prof. Thellier

Committite on Resolutions:
- Mrs. Troitskaya (convener)
- Dr. Kaiser (*)
- Dr. Selzer

(4) *The New Structure of IAGA*

This subject was introduced by the President with reference to the letter which all National Committees and IAGA members had received with the 2nd IAGA Circular. A copy of the proposed structure, including slight modifications suggested by the Executive Committee, was distributed at the meeting (see page 162).

The President expressed the hope that the discussion could be confined to the meeting of a change of structure and, if this idea was accepted, to the broad lines of the suggested new divisions; details concerning either titles or small modifications in the terms of reference should, if necessary, be left for further discussion.

The discussion that followed the President's presentation was most interesting, and at some moments very lively. The discussion can be summarized under the following items:

a) Relation between IAGA and other international bodies interested in the same fields of geophysical research.
b) Proposed new grouping of the Commissions.
c) Division of Commissions into scientific and technical ones.
d) Small changes in the titles and in the terms of reference.

a) The discussion on this topic over the relationship between our new structure and the new structures of other International Bodies was opened by Prof. Jacobs, who asked whether the new IAGA Structure takes into account the fact that URSI, at its General Assembly, in September 1963, is going to consider the creation of new groups, some

(*) Upon receipt of a telegraphic notice from Dr. Kaiser that he would be unable to come to Berkeley, he was replaced on he Resolutions Committee by Dr. Nelson.

of which may cover approximately the same fields of research as now suggested for the new IAGA Commissions. Professor Beynon and Dr. Berkner expressed the views that IAGA, before considering a new structure involving subjects which will be discussed in other international bodies, ought to consult such bodies.

The President remarked that there is no doubt that our Association has the full right to discuss its own structure and to change this structure without consulting other bodies; on the other hand he wanted to make it absolutely clear that IAGA is fully prepared to get in touch with other Unions in order to ensure that its organization will help to the furtherance of Science and not be a hinderance to it. Prof. Nicolet stressed the point that before entering into a discussion with other Associations or Unions it was necessary for IAGA to have a good scientific and operational organization; the lack of such an organization might easily lead to the disappearance of our Association. Father Cardus pointed out that our Association is in a rather delicate position: on one hand the importance of the magnetic field for many studies of geophysics and space science is being recognized, and therefore many scientists, also from distant fields of science, are becoming more interested in the subjects of our organization; on the other hand this increasing interest causes the Scientific Bodies to create new Committees that in several cases have terms of reference which are clearly covered by IAGA. He explained that although he does believe that any one presenting a valuable contribution to Geomagnetism or Aeronomy must be most welcome we cannot accept the principle that if some other organization takes an active interest in the field of IAGA, IAGA must automatically step out; if we accepted this principle it is easy to see from programs presented by other international bodies, that IAGA has nothing left and that the work of our Association has already come to an end.

b) Professor Coulomb opened the discussion on the second item: merging of two or more Commissions into only one: he found that Commissions 5 and 8 were very closely connected and that it might be better if they were combined into one. Professor Nicolet expressed as follows the difference between Commissions 5 and 8: Commission 5 deals with high energetic particles and Commission 8 deals mainly with particles with thermal energy. Father Mayaud pointed out that the title of Com. 5 is Solar-Terrestrial and Cosmic-Terrestrial relationships, and that the relationship between the Sun and the Eearth exists not only in the high energy particles but also in the particles with low energy. Also Professor Lebedinsky, Dr. Selzer and others contributed to the discussion.

Another proposal was of combining Commissions 4 and 5 into one, but after a short discussion and following Professor Bartels' advice it was decided, that it was better to keep them separate as their terms of reference were quite different.

Finally Dr. Alldredge suggested that the Commissions 6, 7 and 8 might be combined into one, following the actual practice of the Association of having a very small number of Committees on Aeronomy. It was considered, however, that the new Divisions will lead to an increased activity and thereby strengthening the position of IAGA.

c) Finally Professor Coulomb suggested that in order to get o more uniform division into Commissions, covering the whole field of our Association but without unnecessary overlappings in their terms of reference, it might be convenient to classify Commissions 1, 2 and 4 as Services and the other ones as scientific Commissions. Prof. Bartels and the President objected to such a distinction, because it would put Commissions 1, 2 and 4 into an unfavourable position, and because these Commissions are expected to carry on, as in the past, both scientific work and research.

d) Some small changes in the wording of the titles of the Commissions or in the terms of reference were proposed, but it was agreed that such modifications could appropriately be suggested to the chairmen of the Commissions and that afterwards the IAGA could take such actions as might be considered necessary.

It was agreed that a small ad hoc working group (Prof. Nicolet, Prof. Lebedinsky and Prof. Bartels) shall study the problem of Commissions 5 and 8 and report to the General Assembly.

At the end of the discussion Prof. Kaplan moved a proposal which was seconded by Dr. Ambolt and approved by the meeting that the new IAGA structure be accepted as presented, it being understood that the Association will at any time be prepared to enter into negotiations with other international bodies for the purpose of obtaining the most efficient organization of the research work within the domains in which the Association is interested.

On behalf of the Executive Committee the President then presented the following tentative list of Chairmen of the new IAGA Commissions:

Commission	1:	Prof.	Thellier
»	2:	»	Vestine
»	3:	»	Nagata
»	4:	»	Bartels
»	5:	»	Roederer
»	6:	»	Chamberlain
»	7:	»	Barbier
»	8:	»	Friedman
»	9:	»	Pushkov

After the delegates named in this list had left the room, the list was accepted without discussion.

Dr. Laursen explained afterwards how the Executive Committee expects the Commissions to be organized: The chairmen should present as soon as possible a list of the working groups which they consider necessary for the carrying out of the programs assigned to each Commission, with names of the proposed leaders of these working groups. The chairmen with the leaders will form the responsible Groups for each Commission. Persons interested in the work of each Commission will apply for membership to the chairmen. It was pointed out that not all the members of a Commission will be called upon to participate in the discussion of any specific question referred to the Commission. An application for membership in a certain Commission should be considered as an offer to assist in the scientific work of the Association within the domain of that Commission, and such assistance could then be rendered in one of the following ways:

a) by accepting membership of a Working Group established for the performance of certain tasks or by accepting appointment as Reporter,
b) by placing expert knowledge at the disposal of the Commission, should such knowledge be solicited by the Chairman of the Comission, by one of the Working Groups or by a Reporter,
c) by acting as national representatives for the Commission in such cases where the carrying out of a project or the preparation of a report requires the cooperation of national institutions.

The Commission members will be appointed by the Executive Committee direct, or by the Executive Committee at the suggestion of the Commission Chairman.

Working Groups will be established by the Executive Committee in consultation with the Commission Chairman.

At 16^h30^m the meeting was adjourned.

Second Plenary Session

The Meeting was called to order by the President at 9^h15^m, who called upon the chairman of the Nominations Committee to present the list of candidates for Officers of the Association. The list was unanimously accepted and therefore the officers of the Association for the next period will be:

President:	M. Nicolet (Belgium)
Vice-Presidents:	T. Nagata (Japan)
	J. O. Cardús (Spain)
Secretary and Director of the Central Bureau:	L. R. Alldredge (USA)

Members:	V. Laursen (Denmark) H. Friedman (USA) S. R. Isaiev (USSR) J. G. Roederer (Argentina) E. Thellier (France) J. Veldkamp (Netherlands)

On behalf of the Committee on Finances, Prof. J. Veldkamp presented the report of the Committee expressing aproval of the accounts for the financial period January 1, 1960 to December 31, 1963 as presented by the Secretary (see page 160).

The Budged for the next period as prepared by the Association's Secretary (see page 162) was accepted.

The Secretary presented then the list of the new Commissions with terms of references and Chairmen of the different Working Groups as follows:

IAGA Commission I

Title: *Observatories and Instruments*
Chairman: Prof. E. Thellier (France)
Responsability: (Old Committees Nos. 1, 7 and 8)

Deals with all problems relating to the operation of magnetic observatories and to the carrying out of magnetic measurements. This may incluye instrumental equipment for observatory and field use, and for use in rockets and satellites, international comparison of geomagnetic standards, form and contents of observatory publications, etc.

Working Groups:	Reporters:
Magnetic Observatories	Prof. G. Fanselau (Germany)
Magnetic Instruments (ground and air)	Mr. J. H. Nelson (USA)
Magnetic Instruments for Space	Dr. J. P. Heppner (USA)
Comparisons of Standards	Dr. V. Laursen (Denmark)
Instrumental for Earth Currents	Prof. L. Cagniard (France)

IAGA Commission II

Title: *Magnetic Charts*
Chairman: Dr. E. H. Vestine (USA)
Responsability: (Old Committee No. 5)

Works as an advisory group to the WMS Board. Prepares reports and recommendations on methodology, equipment and other technical matters pertaining to land, sea, air, and space surveys and on the analysis and presentation of the data in chart form.

Working Groups:	Reporters:
Land and Airborne Surveys	Dr. P. H. Serson (Canada)
Ocean Shipborne Surveys	Dr. M. M. Ivanov (USSR)
Rockets and Satellites	Dr. J. P. Heppner (USA)
Data Analysis	Dr. G. J. F. MacDonald (USA)
Cartography	Dr. H. F. Finch (England)

IAGA Commission III

Title: *Magnetism of the Earth's Interior*
Chairman: Prof. T. Nagata (Japan)
Responsability: (Old Committee No. 4)

Deals with observations, analyses and theoretical interpretations of all phenomena relating to the magnetism of the earth's interior, including the main geomagnetic field and its secular variation, magnetic induction within the earth, archaeomagnetism and palaeomagnetism, etc.

Working Groups:	Reporters:
Electro-Dynamics	Sir E. C. Bullard (U. K.)
Secular Variations	Dr. V. P. Orlov (USSR)
Electromagnetic Induction	Prof. T. Rikitake (Japan)
Rock Magnetism	Prof. C. M. Carmichael (Canada)
Archaeomagnetism	Prof. E. Thellier (France)
Palaeomagnetism	Dr. R. Doell (USA)
Geomagnetic Anomalies	Dr. A. Hahn (Germany)
Analysis of the Earth's Main Magnetic Field	Dr. A. J. Zmuda (USA)

IAGA Commission IV

Title: *Magnetic Activity and Disturbances*
Chairman: Prof. J. Bartels (Germany)
Responsability (Old Committees No. 9 and 10):

Deals with magnetic indices, solar flare effects, storm sudden commencements, other rapid variations, micropulsations and their connection with interplanetary space and the corresponding earth currents.

Working Groups:	Reporters:
Magnetic Activity Indices	Rev. P. N. Mayaud, S. J.
Dst	Dr. M. Sugiura (USA)
Classification of Days	Dr. G. Fanselau (Germany)
Sq	Dr. A. T. Price (U. K.)
Equatorial Electrojet	Dr. D. G. Osborne (Ghana)
Geomagnetic Storms and Interpretations	Dr. S. Akasofu (USA)

Forecasting	Miss J. V. Lincoln (USA)
Morphology of Rapid Variations	Rev. A. Romañá, S. J. (Spain)
Microstructure of Magnetic and Telluric Disturbances	Dr. V. Troitskaya (USSR)
Micropulsations pc1, pc2, pi1	Dr. Y. K. Kato (Japan)
Conjugate Points	Dr. R. Schlich (France)
Relations between Ground and Satellite Rapid Variations	Dr. J. A. Jacobs (Canada)

IAGA Commission V

Title: *Solar-Terrestrial and Cosmic Terrestral Relationship*
Chairman: Prof. J. G. Roederer (Argentina)
Responsability: (Old Committees Nos. 2 and 3)

Deals with the interaction between solar emissions, and the plasma and magnetic field in the solar system, involving the geomagnetically trapped corpuscles, magnetospheric phenomena and the geophysical aspects of cosmic rays. This Committee represents part of the IAGA contribution to the IAU-IUGG Joint Committee on Solar-Terrestrial Relationship.

Working Groups:	Reporters:
Satellite and Space Probe Plasma Measurements	Dr. V. Gringauz (USSR)
Geomagnetic Boundary	Dr. A. Dessler (USA)
Cosmic Ray Propagation and Modulation	Dr. H. Carmichael (Canada)
Solar Energetic Particle Ionization Effects and Ground Measurements	Dr. T. Obayashi (Japan)
Solar Energetic Particle High Altitude and Space Measurements	Dr. A. Ehmert (Germany)
Cosmic Ray Particle Motion in the Geomagnetic Field	Dr. J. J. Quenby (U. K.)
Cosmic Ray Cascades in the Atmosphere	Dr. L. I. Dorman (USSR)
Radiation Belts	Dr. W. N. Hess (USA)

IAGA Commission VI

Title: *Aurora*
Chairman: Dr. J. W. Chamberlain (USA)
Responsability: (Old Committee No. 2)

Deals with all auroral observational techniques, procedures of data acquisition and processing, auroral morphology and problems relating to the various phenomena that result from charged particles entering the earth's upper atmosphere.

Working Groups:	Reporters:
Morphology	Dr. F. Jacka (Australia)
Spectroscopy and Excitation	Prof. A. Omholt (Norway)
Radio - Aurora	Prof. P. A. Forsyth (Canada)
Particles and Fields	Dr. B. J. O'Brien (USA)
IQSY	Mr. J. Paton (U. K.)

Reporters-at-large:

Prof. A. I. Lebedinsky (USSR)
Dr. B. Hultqvist (Sweden)
Dr. D. M. Hunten (Canada)

IAGA Commission VII

Title: *Airglow*
Chairman: Dr. D. Barbier (France)
Responsability: (Old Committees Nos. 2 and 3)

Deals with chemical aeronomy, and the results of reactions such as emissions without a direct effect of the magnetic field.

Working Groups:	Reporters:
Instrumentation and Observation	Dr. F. E. Roach (USA)
Spectroscopy and Temperature	Dr. G. I. Galperin (USSR)
Photometry	Dr. D. Barbier (France)
Physical Data	Prof. H. I. Schiff (Canada)
Airglow Theories	Dr. M. Nicolet (Belgium)

IAGA Commission VIII

Title: *Upper Atmosphere Structure*
Chairman: Dr. H. Friedman (USA)
Responsability: (Old Committee No. 3)

Deals with the electro-dynamics involving the aeronomic processes on neutral and ionized particles.

Working Groups:	Reporters:
Composition	Dr. A. A. Pokhunkov (USSR)
Structure and Its Variations	Dr. L. Jacchia (USA)
Meteors	Dr. T. R. Kaiser (U. K.)
Geo-Corona and Magnetosphere	Dr. F. S. Johnson (USA)

Dynamics of the Neutral Atmosphere	Prof. J. E. Blamont (France)
Hydromagnetic and Gravity Waves	Dr. M. Sugiura (USA)
Theory of Radiation Processes and Particles Interaction	Mr. A. Dalgarno (N. Ireland)
Ionospheric Properties	Prof. W. E. Dieminger (Germany)

IAGA Commission IX

Title: *History*
Chairman: Prof. N. Pushkov (USSR)
Responsability: (Old Committee No. 11)

Deals with the history of geomagnetism and aeronomy, involving reports on progress in geomagnetism and aeronomy obtained from national reports and other sources.

Working Groups:	Reporters:
History of Geomagnetism	
History of Aeronomy	

IAGA WMS BOARD

The World Magnetic Survey (WMS) Board was reorganized as follows:

Chairman:	Dr. V. Laursen (Denmark)
Vice Chairmen:	Prof. N. Puskkov (USSR)
	Rev. J. O. Cardús, S. I. (Spain)
Secretary:	Dr. E. H. Vestine (USA)

Members:
Prof. Nagata (Japan)
Representative of SCOR
Representative of SCAR, Prof. T. Nagata (Japan)
Representative of COSPAR, Prof. J. D. Kalinin (USSR)
President of IAGA, Dr. M. Nicolet (Bergium)
Secretary of IAGA, Dr. L. R. Alldredge (USA)

The list was accepted without ammendements.

Finally a list of Resolutions was presented and with a very small changes all resolutions but one was approved (see resolutions on pages 351-367).

The President expressed his thanks and the thanks of the Association to all who have contributed to the success of the General Assembly and Prof. Ramanathan proposed also a vote of thanks for the retiring

President and Secretary of the Association that was unanimously accepted.

The President then declared the General Assembly closed.

B) MEETINGS OF THE EXECUTIVE COMMITTEE

August 18, 1963

The meeting was called to order by the President, Dr. Laursen, at 10^h10^m of the 18th of August, in Dwinelle, University of California, Berkeley.

The following members of the Executive Committee were present: Dr. Laursen, President; Dr. Nicolet, Vice-President; Fr. Cardús, Secretary; Prof. Kaplan, Prof. Bartels, Prof. Nagata, Prof. Schneider, and Prof. Thellier; Prof. Pushkov and Prof. Bouska, could not come to Berkeley.

The Agenda adopted was as follows:

(1) New Structure of the IAGA
(2) Structure of IAGA Commissions
(3) Suggested new Structure of IUGG
(4) IUGG Committee for Atmospheric Sciences Research
(5) Atmospheric Electricity
(6) Fanselau's suggestion
(7) Analytical Centres
(8) Guide to International Data Exchange through the World Data Centres
(9) Ad hoc Committees for the Berkeley Assembly
  a) Nomination
  b) Finances
  c) Resolutions
(10) Future Symposia
(11) Any other business

(1) New structure of IAGA

At the Paris Meeting of the IAGA Executive Committee (March, 30-31, 1962) a new structure for IAGA was proposed (see IUGG Chronicle n. 47, p. 44) and a letter signed by the President was sent to all National Committees before the Berkeley Assembly asking for comments.

After an interesting discussion rised by Prof. Schneider, and in which all members of the E. C. took an active part the text of the terms of reference of the proposed commissions was adopted with slight modifications:

Commission I

Commissions on Observatories and Instruments: Deals with all problems relatitng to the operation of magnetic observatories and to the carrying out of magnetic measurements. This may include instrumental equipment for observatory and field use and for use in rockets and satellites; international comparison of geomagnetic standards, form and contents of observatory publications, etc.

Commission II

Commission on Magnetic Charts: Works as and advisory group to the W. M. S. Board.

Commission III

Commission on Magnetism of the Earth's Interior: Deals with observations, analyses and theoretical interpretations of all phenomena relating to the magnetism of the earth's interior, including the main geomagnetic field and its secular variation, magnetic induction within the earth, archaeo and palaeomagnetism, etc.

Commission IV

Commission on Magnetic Activity and Disturbances: Deals with magnetic indices, solar flare effects, storm sudden commencements, other rapid variations, micropulsations and their connection with interplanetary space, and earth-currents.

Commission V

Commission on Solar-Terrestrial and Cosmic-Terrestrial Relationships: Deals with the interaction between solar emissions and the plasma and magnetic filed in the solar system, involving the geomagnetically trapped corpuscles, magnetospheric phenomena, and Geophysical aspects of Cosmic Rays. This Committee represents part of the IAGA contribution to the IAU-IUGG Joint Committee on Solar-Terrestrial Relationship.

Commission VI

Commission on Aurorae: Deals with all auroral observational techniques, procedures of data acquisition and processing, auroral morphology and problems relating to the various phenomena which result from corpuscular radiation impinging on the geomagnetic field.

Commission VII

Commission on Airglow: Deals with Chemical Aeronomy, and the results of reactions such as emissions without a direct effect of the magnetic field.

Commission VIII

Commission on Upper-Atmospheric Structure: Deals with the electrodynamics involving the aeronomic processes on neutral and ionisized particles.

Commission IX

Commission on History: Deals with the history of geomagnetism and aeronomy, involving reports on progress in geomagnetism and aeronomy obtained from national reports and other sources.

Joint Committee with IAMAP on Lunar effects

Continuation of existing Committee.

Joint Committee with IAMAP on Atmospheric Electricity

Continuation of the existing Committee.

World Magnetic Survey Board

To take care of the implementation of the WMS.

(2) STRUCTURE OF IAGA COMMISSIONS

The discussion on this subject was opened by the President who after stating that he thought that all members of the E. C. agreed that the actual principle of having very large Committees in which all the work is left to the Chairman should be abandoned, proposed two possibilities for the future:

(A) That the Chairman of the Commission be appointed by the General Assembly and, if possible, immediately after the new structure has been approved. In this connection he did not see any formal objections to the Chairman being suggested directly by the Executive Committee without waiting for the establishment of a Nomination Committee and for this Committee to meet and to make proposals. (The concern of the Nomination Committee would then be limited to the constitution of the new Executive Committee of the Association.) It would then be the job of the Commission Chairman to review the expected future activity of his Commission and to suggest to the Executive Committee the membership of small Working Groups, one for each of the special tasks to be performed, or perhaps the appointment of special Reporters for the investigation of certain problems. These Working Groups, each Group with its Chairman or Convenor, should then, together with such special Reporters as may have been appointed, constitute the Commission. There would be no passive members, and the General Assembly would have no influence on the constitution of the Commissions. It would seem that such a procedure would be in strict accordance with our Statutes, which state in paragraph 13:

«Subject to the general or special directions of the General Assembly, the Executive Committee shall have power: ...to entrust to special commissions or to particular individuals the preparation of reports on subjects within the province of the Association.»

(B) That the Chairman of the Commission be appointed by the General Assembly as above, but that we otherwise stick to the traditional procedure of virtually inviting everybody to join any Commission in the subject of which he is interested. We would then again have the very large Commissions, but it should be pointed out that not all the members would be called upon to participe in the discussion of any specific question referred to the Commission. An application for membership in a certain Commission should be considered as an offer to assist in the scientific work of the Association within the domain of that Commission, and such assistance could then be rendered in one of the following ways:

(a) by accepting membership of a Working Group established as under (A) above for the performance of certain tasks or by accepting appointments as Reporter,

(b) by placing expert knowledge at the disposal of the Commission, should such knowledge be solicited by the Chairman of the Commission, by one of the Working Groups or by a Reporter,

(c) by acting as national representatives for the Commission in such cases where the carrying out of a project or the preparation of a report requires the cooperation of national institutions.

The second proposal was accepted and the following proceadure was adopted:

i) The Chairman will be proposed by the E. C. and elected by the General Assembly,

ii) The Chairman will have the right to appoint to his Commission as many members as he thinks convenient,

iii) The Executive Committee in consultation with the Chairman will select among the members of the Commission those to form the Working Groups and will appoint the conveners.

iiii) The conveners of the working groups with the Chairman will be responsible for the affairs of the Commission.

At a question from Prof. Schneider it was decided that this organization applies to the Commissions and not necessarily to the Joint Committees.

A first possible list of Chairmen of Commissions and of conveners of some working groups was proposed for future discussion: the names of the Chairmen being:

Commission	I:	Prof. Thellier (France)
»	II:	Dr. Vestine (USA)
»	III:	Prof. Nagata (Japan)
»	IV:	Prof. Bartels (Germany)
»	V:	Prof. Roederer (Argentina)
»	VI:	Prof. Chamberlain (USA)
»	VII:	Dr. Barbier (France)
»	VIII:	Dr. Friedman (USA)
»	IX:	Prof. Pushkov (USSR)

For the WMS Board the following constitution was accepted:

President:	Dr. Laursen
Vice-Presidents:	Prof. Pushkov
	Fr. Cardús
Secretary General:	Dr. Vestine
Members:	Ex officio: President of IAGA
	Secretary of IAGA
	Prof. Nagata
	Representative of COSPAR,
	» SCAR,
	» SCOR.

(3) New IUGG Structure

The E. C. had before him the document circulated by the IUGG Secretariat and there was agreement on three points:

a) a reorganization of the IUGG is necessary,

b) the division of the domain of interest of IAGA into two or three diferent Divisions is not advisable, specially at this time when the interest for the Geomagnetic field is increasing constantly,

c) that the IAGA could accept the new organization if its field of activity was kept together.

As Prof. Kaplan explained that the IUGG will request a member of IAGA to take part in an ad hoc Committee to study the new structure, Prof. Nicolet was unanimously elected.

(4) IUGG Committee for Atmospheric Sciences Research

At the Rome meeting of the Executive Committee of the Union (March, 14-17, 1963) it was decided to create in the IUGG an Inter-Union Committee for Atmospheric Sciences Research, and it was requested from IAMAP to pursue its proposals to set up such a Committee and to ensure adequate participation by IAGA, IASH and IAPO.

The IAGA E. C. after considering the document submitted non officially by IAMAP found that this document did not offer proper ground for an Inter-Union Committee and that therefore IAGA will not be interested in the proposed participation; nevertheless if the document was changed, IAGA would readily discuss again the problem.

(5) Atmospheric Electricity

This point was left for the next meeting.

(6) Fanselau's suggestion

This point was left for the next meeting.

(7) Analytical Centers

At the 2nd CIG-IQSY Assembly in Rome (March, 1963) (Working Group III on Geomagnetism) it was recommended that IAGA investigates whether a demand for common «data reduction» exist which might be satisfieed by the establishment of Analytical Centers.

It was also recommended there to stablish a uniform procedure for description, scaling and calibration of geomagnetic micropulsations.

The IAGA E. C. after carefull study of the needs of each of its Special Committees and of the work done by some of them, agreed unanimously that the needs of the Association for the time being are well covered with the three existing centers at Göttingen, De Bilt and Tortosa and that no new Analytical Center is required.

As for micropulsations it was recognized that some work has been done by Committee 10 in the way indicated by the resolution mentioned above and it was decided to pass the recommendation for calibration to Commission I in consultation with the old Committee 10.

(8) Guide to International data Exchange through the World Data Centers

A document with a Revised Guide to International Data Exchange through the WDC was circulated to the Associations by Dr. Odishaw, Chairman of the CIG-IQSY working group on WDC with the request that the content of the the Guide will be a topic for discussion at the Berkeley Assembly, the IAGA has considered the proposal for data exchange on Palaeomagnetism, and following a suggestion from Profesor Thellier it was the general feeling that, as Palaeomagnetism is usually personal work and not routine work, it is not practical to send to WDC all the primary data suggested in the Guide; nevertheless the IAGA E. C. would be in favour of sending all publications containing results on this subject.

(9) Ad hoc Committees for the Berkeley Assembly

The following ad hoc committees were selected for proposal before the General Assembly:

a) *Nomination Committee:* Prof. Kaplan (convener), Prof. Bartels, Dr. Benkova, Prof. Coulomb, Dr. Rikitake.

b) *Finances Committee:* Prof. Veldkamp (convener), Prof. Thellier, Prof. Schneider.

c) *Resolutions Committee:* Dr. Troitskaya (convener), Dr. Kaiser, Dr. Selzer.

(10) Future Symposia

After a general discussion it was agreed in principle to try to arrange two symposia before the next General Assembly:

a) in autumn 1964: a symposium organized by the new Commission on Eearth-Interior,

b) in autumn 1964: a general symposium in connection with the Quiet Sun.

It was also agreed that in all probability there will be necessary some meetings of the new Commissions.

The meeting was then adjourned until next day.

August 19, 1963

The meeting was called to order by the President Dr. Laursen at 9^h05^m. The membership was as in the former meeting:

The Agenda followed in the meeting was:

(1) IQSY Reporter for Geomagnetism and creation of a subgroup for Earth-Currents,
(2) Joint Committee on Lunar Variations,
(3) Joint Committee on Atmospheric Electricity,
(4) Inter-Union Committee on the Ionosphere,
(5) Inter-Union Commission on Solar and Terrestrial Relationship,
(6) Resolution on the WMS and WMS Board,
(7) Fanselau's suggestion,
(8) Any other bussiness.

(1) IQSY Reporter for Geomagnetism and creation of a subgroup for Earth-Currents

Following a strong request from Dr. Laursen, the IAGA E. C., much to its regret, considered advisable to accept his resignation from the post of IQSY Reporter for Geomagnetism and after expressing him its thanks for the efficient way in which he had carried on such an important task, at the suggestion of Dr. Nicolet, it was decided to propose to the IUGG the name of Fr. Cardús as IQSY Reporter.

The Executive Committee studied then the proposal of Prof. Pushkov in a letter to Dr. Laursen for the creation of a sub-group for Earth-Currents, and after a clear exposition presented by Dr. Laursen the creation of such a sub-group was agreed and Mme. Troitskaya was elected as convener; this sub-group will act under the general direction of the Reporter for Geomagnetism.

As a result of this resolutions the membership of the IAGA/IQSY Group for Geomagnetism established at the Rome Meeting was modified as follows.

Reporter and Chairman:	Fr. Cardús
Members for Geomagnetism:	Prof. Bartels, Prof. Kalinin, Dr. Laursen, Prof. Nagata, Dr. Vestine
Sub-group for Earth-Currents:	Mme. Troitskaya (convener), Dr. Hessler, Dr. Selzer

(2) Joint Committee on Lunar Variations

After a short report from Prof. Schneider, Chairman of the Joint Committee, the E. C. agreed unanimously that we would welcome the continuation of the Joint Committee on Lunar Variations and that our suggestions would be: Prof. Schneider, Chairman, and Prof. Chapman, Honorary Chairman.

(3) Joint Committee on Atmospheric Electricity

There was a lively discussion on this matter; Prof. Nicolet expressed his feeling that all the work is done by the Association of Meteorology and that it would be better to pass all the responsability to the IAMAP, Prof. Bartels, Prof. Schneider and Fr. Cardús were of the opinion that if IAGA gives up his interest in this Committee, people interested f.i. in some points like Electric Gradient in the atmosphere will have no place in the international organization; Prof. Nagata suggested that it would be a good arrangement if IAGA were the parent Association for the Joint Committee on Lunar Variations and IAMAP were the parent Association for Atmosphere Electricity. Dr. Laursen finally sumarized the discussion and it was agreed that the IAGA E. C. is in favour of the continuation of the Joint Committee on Atmospheric Electricity and that our suggestion for Chairmanship is the continuation of Dr. Koenigsfeld as Chairman and Prof. Norinder as Honorary Chairman.

(4) Inter-Union Committee on the Ionosphere

The present membership for this Committee by IAGA is: Dr. Bates, Dr. Friedman and Dr. Nicolet plus another representative. The E. C. is in favour of the continuation of the present membership and of the nomination of Prof. Nagata as the representative to be appointed.

As for the continuation of this Inter-Union Committee the IAGA E. C. was of the opinion that while the new IUGG structure is under discussion no change is advisable, but that the ad hoc Committee on the new structure should discuss the further existence of this Inter-Union Committee.

(5) Inter-Union Commission on Solar and Terrestrial Relationship

Regarding the continuation of this Inter-Union Commission the same opinion was adopted that in the case of the Inter-Union Committee on the Ionosphere.

At the suggestion of Dr. Nicolet it was proposed that the IAGA nomenees were, in consultation with IAMAP, Dr. Benkova and Profesor Obayashi.

(6) Resolution on the WMS and WMS Board

The E. C. unanimously agreed in passing to the Union a resolution asking all Nations to participate in the WMS. This resolution was afterward endorsed by the General Assembly and accepted as a Union Resolution.

In connection with the WMS Board it was decided, in order to keep it as small as possible, to writte to COSPAR and SCAR informing them of the creation of this body, of the proposed membership and that the IAGA E. C. would like that their representatives be chosen among the members already nominated.

(7) Prof. Fanselau's suggestion

The IAGA Executive Committee received from Prof. Fanselau a suggestion on a programme for repeat calculation of the geomagnetic potential using electronic machines and by means of an international collaboration. The suggestion was reffered to IAGA Committee 4 in consultation with Committee 5.

(8) Any other bussines

The various matters discussed at the IUGG Executive Committee and that have relation with IAGA were considered and appropriate action was taken. A summary of them is as follows.

a) To call the attention of the Associations on the list of topics for future symposia. (No action needed.)

b) To revise the future terms of reference and the composition of the IUGG/COSPAR Committee. (We refered it to Prof. J. Kaplan.)

c) To revise the Report on FAGS and to make suggestions. (No action required.)

d) To propose representatives for the Inter-Union Commissions (see IAGA Executive Committee II, 4 and 5).

e) To express their interest in the proposed Inter-Union Committee on Geochemistry (if it is created IAGA will be interested in it).

f) Nomination of a Liason Officer with Pan-American Institute of Geography and History: Prof. Schneider was nominated (IAGA is certainly interested and the nomination of a IAGA Officer for this post was most welcomed).

g) The IUGG E. C. expressed its willingness to take any action required by IAGA in connection with the WMS (if any action is required we shall apply for it).

h) To nominate a member for the ad hoc Committee on the new IUGG structure (Dr. Nicolet was appointed).

August 28, 1963

In the afternoon of the 28th of August, in the office of the President the Executive Committee had its third meeting to revise the Resolutions proposed by the Committees and prepared by the Resolutions Committee, and to discuss a few items of interest to the Association.

The Agenda was:

(1) Resolutions
(2) Space Sciences
(3) New IAGA structure
(4) Budget of the Association for the period 1963-1965

(1) Resolutions

With slight changes the Resolutions presented were accepted for proposal at the Final Plenary Session of the IAGA next morning.

(2) Space Sciences

A Report on Space Sciences prepared by the ad hoc Committee of the Union was presented by Prof. Kaplan. The IAGA Executive Committee took notice of the report and decided to take the appropiate action when officially requested by the Union.

(3) Vice-Chairmen

The proposal to nominate Vice-Chairmen for the new Commissions was not accepted, as it was the common feeling that Chairmen will get enough support from the reporters of the working —groups created in each commission.

(4) Budget

The budget prepared by the Secretary was accepted for presentation next morning at the General Assembly.

August 29, 1963

The meeting in the afternoon of the 29th of August was divided into two parts: the first one with members of the old and new Executive Committee and with some of the Chairmen of the new Commissions was devoted to the new IAGA structure; at the second part only members of the Executive Committee were present.

1st part

a) A proposal by one of the new Commission that Com. 5 and 8 merge into one was not accepted.

b) Prof. Chamberlain in a letter to Dr. Laursen requested a small change in the terms of reference of Commission 6: change: «phenomena which result from corpuscular radiation impinging in the geomagnetic field» to read: «phenomena that result from charged particles entering the earth's upper atmosphere». This change was adopted.

c) Following a letter from Dr. Godson, IAMAP Secretary, a short discussion was hold on the Joint Committees for Lunar studies and Atmospheric Electricity and on the resolution adopted by the latter at the Montreux Symposium asking Atmospheric Electricity to be included in the IQSY programme. The Association referred this last topic to the new Executive Committee.

d) As general policy in the new IAGA structure it was decided that:

i) working groups should not have more than 10 members

ii) Chairmen of Commissions were ex officio members of all the working groups in their Commission

iii) Commissions may have members of the Commission although they are not members of the working groups; these members have full right to receive proper information and to send proposals to Chairmen.

e) it was finally decided that the IAGA Secretary will produce as soon as possible a booklet with the resolutions adopted at Berkeley and the list of Commissions with terms of reference, working groups and reporters.

2nd PART

The second part of the meeting was devoted mainly to the study of the action to be taken on the Resolutions adopted by the General Assembly and instructions were given to the Secretary of the Association.

The nomination of an ad hoc Committee requested in the IAGA Resolution n. 1 was left to the new IAGA President in consultation with the Executive Committee.

On the problem of Atmospheric Sciences the following decission was adopted: «The IAGA in response to the request of the IAMAP regarding the IUGG Executive Committee Resolution on Atmospheric Sciences taken in Rome in March 1963, does not feel that an Inter-Union Committee for Atmospheric Sciences Research, with the IUGG as parent Union, has been fully justified. However, it recognizes the responsability placed on the ICSU by the United Nations Resolution 1802 and therefore it suggests the possibility of an ad hoc interim committee to study the functions of a permanent ICSU Committee».

Finally in connection with the WMS Board it was decided to write to COSPAR and to SCAR informing them that the IAGA wishing to keep the number of members as small as possible would like to see Dr. Vestine and Prof. Nagata, already members of the Board, appointed representatives of COSPAR and of SCAR. The proposal that Dr. Stockard be presented as representative of SCOR was not accepted.

C) SYMPOSIA

(1) Symposium on Aeronomy

A six-session Symposium on Aeronomy was held on August 21, 22, and 23, and a related one-session Symposium was held on the morning of August 24 jointly with the IAMAP. This joint Symposium is covered in the report of that Association under the designation Upper Atmosphere Meteorology and Aeronomy Symposium. The printed abstracts do not include any papers from this Symposium; they will be published as a separate publication of the IAGA.

First and Second Sessions: Reactions of Neutral Particles

AUGUST 21, 1963

(1) CH. A. BARTH: *Three-Body Reactions.*
(2) H. I. SCHIFF: *Reactions Involving Nitrogen and Oxygen.*
(3) F. KAUFMAN: *Reactions Involving Hydrogen.*

These papers provided excellent summaries of the rates determined in the laboratory for reactions involving molecules and atoms common in the atmosphere. Little unpublished work was given.

Barth presented laboratory data on seven three-body reactions of nitrogen, oxygen, carbon monoxide, and hydrogen, and then discussed the possibility of using the upper atmosphere as a laboratory for the study of molecular reactions. As an example, he showed how the distribution of airglow brightness with height can be used to determine the deactivation processes important for oxygen atoms in the atmosphere, the distribution of nitrogen with altitude, and tentative values for the reaction rates for various deactivation processes. Laboratory spectra of the O 5577 A line and the Hertzberg bands were also presented.

Schiff presented an excellent comprehensive survey of raction rates and energies for nine reactions involving nitrogen and oxygen. While a few discrepancies are unresolved for most reactions, the laboratory data seemed good.

Kaufman discussed the laboratory technique he and his co-workers used for the study of hydrogen and oxygen reactions, particularly those involving OH and O_3. After warning that an H_2O discharge is not desirable as a source of OH, he discussed several reactions. Among the surprises emerging from the study of the $H + O_3 \rightarrow OH + O_2$ reaction were the facts that very little of the resulting OH was unexcited and a good deal of atomic oxygen appeared in the products.

Kaufman's final caution, that we know little about the behavior of molecules and radicals in excited states, was echoed in a short report by Benson on the behavior of atomic oxygen in the ^1D state and in the general discussion which followed. Among the questions which remained unresolved was whether recombinations into excited molecular states were in accordance with the statistical weights of these states. The gist of the remaining discussion was that the laboratory data refer only to conditions of thermodynamic equilibrium usually at temperatures near 290° K, which is probably a good approximation to conditions in the atmosphere below about 100 km. However, very little is known under conditions in which the reactants are not in thermodynamic equilibrium.

Third and Fourth Sessions: Reactions of Charged Particles

AUGUST 22, 1963

(1) J. F. PAULSON: *Thermal Charge Transfer and Ion-Atom Interchange Processes.*
(2) L. FITE: *Charge Transfer in Ion-Atom Interchange Collisions above Thermal Energies.*
(3) L. M. BRANSCOMB: *Negative Ions.*

Paulson defined his talk as pertaining to energies less than 2 volts. He pointed out that there is agreement on cross sections of the reaction $O^+ + O_2^+ \rightarrow O_2^+ + O$ to within a factor of 10 and of $O^+ + + N_2 \rightarrow NO^+ + N$ to within a factor of 5. These observations were made in gas disk charge tubes and agree on $H_2^+ + H \rightarrow H_3^+$ and $H_2^+ + He \rightarrow HeH^+ + H$. Although the cross sections are small enough so that there is a question as to geophysical significance, there is an implication that helium may enter into some important atmospheric processes. Xeron products are noted but their significance is not established; this is an indication of the need to look carefully into laboratory techniques of this class of experiments and to attempt to simulate actual atmospheric conditions more closely.

Fite discussed a wealth of detailed information on various interactions, some of which have aeronomical significance. There is a problem in deducing geophysical applications and ascertaining some details of reactions due to ambiguities in the experimental details that arise from not knowing the excitation levels of source ions. Some work using mono-energetic electron beams to produce only ground state source ions, however, appears promising. There seems to be a great deal of work by physical chemists or gas dynamicists in this field, and it would seem fruitful to foster closer collaboration with aeronomists.

Branscomb made his remarks in the general framework of the polar cap absorption (PCA) and auroral absorption (AA) and the role of negative ions therein. He introduced the subject with the delineation of PCA to the region 70-80 km as detected by ionospheric forward scatter, and 50-70 km as detected with riometers. After discussing a few possible reactions, he noted that the interpretation of proton fluxes and rigidity spectra in terms of absorption heights and intensity rests upon a determination of the electron affinity of oxygen, which is still in considerable question. A considerable discussion was then launched on many possible negative ion reactions, a few of which have geophysical implications. Branscomb also took the opportunity to point out that CN^-, CNO^-, and CN_2^- have high electron affinities (approximately 3 ev) and may be of significance in the atmospheres of other planets. He concluded by noting that the role of negative ions in PCA and AA is in conflict, partly because different regimens are involved, that PCA offers the best test for laboratory experiment, and that the day-night relationships in PCA remain to be understood.

The discussion centered about several reactions of possible geophysical significance, the sudden enhancement of 6300 and 5577 A lines in the tropics in a ratio of 5 : 1 linked to lowering of hF max, and the question of nighttime ionization of the *F* layer. The discussion pointed out the severe necessity for more direct measurements and possibly more laboratory work oriented to reactions of possible geophysical interest as far as possible and under conditions more nearly simulating the real atmosphere.

Fifth and Sixth Sessions: Results of Reactions

AUGUST 23, 1963

(1) M. A. BIONDI: *Electron and Ion Recombination.*
(2) R. W. NICHOLLS: *Probabilities of Atomic and Molecular Spectra.*
(3) A. DALGARNO: *The Role of Charged Particles.*

Biondi discussed ion-electron and ion-ion recombination reactions. By considering the rates of the several electron-ion processes he determined that dissociative recombination is most important in the atmosphere and gave rate coefficients of $(2.8 \pm 0.5) \times 10^{-7}$ cm^3/sec for N_2^+, and $(1.7 \pm 1) \times 10^{-7}$ for O_2^+, and $\alpha \simeq 10^{-6}$ cm^3/sec for NO^+. He discussed problems of measuring values of α, involving generation of other ions such as N_3^+ and N_4^+, and of diffusion and the identification of the vibrational states involved. In ion-ion recombination, Biondi said that three-body reactions are not important in the upper atmosphere and that mutual neutralization is the dominating process with $\alpha \simeq 10^{-8}$ cm^3/sec. He noted that electron attachment is important in the *D* region, and indicated that more work is needed on α (NO^+) and values of α for mutual neutralization.

Discussing the problem of transition probabilities in connection with the upper attmosphere, Nicholls divided the problem into three parts: (1) lower atmosphere absorption, (2) auroral emission, and (3) airglow. He also discussed the spectra observed in each region and thereby enumerated the important transitions present. After showing the relationships between measured absorption or emission intensities and oscillator strengths, band strengths, Einstein coefficients and transition matrix elements, he showed how to calculate the transition probabilities using experimental intensities as a function of *r*, the interatomic spacing (which is different for different transitions in one band spectrum). The theoretical approach to calculating the transition probability is to calculate the Frank-Condon factor, which is an overlap integral of molecular wave functions (obtained empirically by the Morse method, or more realistically by the Klein-Dunham method). Summarizing the available data he noted that atomic transition probabilities are relatively well known, although much of the work is theoretical and more experimental work is needed. Although relative values for molecular transition probabilities are in good shape, absolute values are not well known.

Dalgarno, in discussing various aspects of corpuscular radiation in the upper atmosphere, pointed out that the absence of observable N_2^+ first bands and of the Doppler-shifted hydrogen lines H_α and H_β can place severe restrictions on the energy flux of corpuscular radiation. Some effects of the fast electrons produced by ionization by extreme solar ultraviolet radiation were described, and it was suggested that the fast electrons were the source of metastable helium and of the O I 1304 A line. Dalgarno remarked that the electron temperature will exceed the gas temperature, the excess being of the order of 1000° K in the region of 220 km. A larger excess may occur at high altitudes near dawn. The possible atmospheric heating by corpuscular radiation during auroras was briefly discussed.

The discussion following the talks was limited to relatively minor technical matters and did not add much. An attempst was made to compare laboratory values of α with ionospheric values. The decay of f_{crit} at nighttime gives $\alpha_{E\ layer} = 0.68 \times 10^{-7}$, which is in reasonable agreement with the laboratory dissociative recombination rates of O_2^+ and N_2^+. Van Zandt said that one gets an $\alpha \sim 10^{-7}$ for the ionosphere by using Hinteregger's solar ultraviolet spectrum and measured values of the electron density and by using $q = \alpha_{eff} n^2$.

2) Symposium on Methodology and Instrumentation of Aeromagnetic Surveys

August 27, 1963

(1) P. H. Serson: *Methodology of Aeromagnetic Surveys in Canada.*

(2)* De LeBorgne: *French Aeromagnetic Surveys over Land and Sea.*

(3) S. Utashira: *Equipment and Reduction of Results of Ocean and Land Aeromagnetic Surveys in Japan.*

(4) I. Tsubokaawa: *Equipment and Results of Comparisons of Airborne Surveys in Japan with Surface Data.*

(5) G. N. Ivanov: *Report on Work of Zarya.*

(6) T. N. Simonenko and G. N. Ivanov: *Main Results of Aeromagnetic Surveys of Russia.*

(7)* W. Geddes: *Instrumental Control Problems and Project Magnet Reductions.*

* In the following pages an * means that a summary of the paper appears in Part III.

The printed abstracts included only two papers relating to this session, the second and the last. Two of the other papers given were added papers.

Serson noted that there are two kinds of aeromagnetic surveys conducted in Canada. The first is detailed total intensity surveys for geological purposes whereby all of Canada will be covered with tracks spaced 1/4 mile apart at low altitude. In the second kind, the component survey, all of Canada will be surveyed at 90 km track spacing. In the discussion a question was raised about a statement by Serson that more details should be shown on world declination charts.

LeBorgne's paper, read by E. Thellier, noted that France is conducting land surveys, marine measurements, and aeromagnetic surveys of the land and extending 100 km out to sea. The aeromagnetic survey, flown at a 3000 meter altitude with flight lines north and south spaced 10 km apart, uses a cesium magnetometer installed on a B17 aircraft.

Utashira's paper, read by Y. Kato, noted that the magnetometer is a gyro-stabilized flux gate installed in the tail section of the Beechcraft airplane. The celestial reference is a sky camera. Some results of the survey over the Japan trench were given.

Tsubokaawa noted that the accuracy of total field measurements with aircraft field of 100 is about 100.

A paper by Ivanov, related to the work of Zarya, was read by L. L. Morozovskaya. Zarya has taken observations over the Atlantic, Pacific and Indian oceans. The magnetometer is a three-component flux gate that measures H, Z, and D. All data, which have been filled in World Data Centers A, B and C, will be compared with Project Magnet data. The main work of Zarya relates to secular change and to the structure of the ocean bottom.

The paper by Simonenko and Ivanov noted that all anomalies investigated did not indicate a magnetic field reversal. Contour interval on maps is 100 γ.

An adequate summary of the Geddes paper is included in the printed abstracts.

3) Symposium on Palaeomagnetism and Palaeoclimatology (with IAMAP)

August 28, 1963

(1) *Participants*

About fifty people attended. Prof. T. Nagata and Dr. R. R. Doell took the chair in the morning and in the afternoon respectively.

(2) *Papers*

The following papers were presented.

1. *Palaeomagnetic and palaeoclimatic data*

* S. K. RUNCORN: *The interrelation of palaeomagnetism and palaeoclimatology.*
* F. G. STEHLI: *Palaeontologic evidence of Permian temperature gradients.*
* C. E. HELSLY and F. G. STEHLI: *Comparison of Permian palaeontologic and palaeomagnetic data concerning climate.*
* R. L. DUBOIS: *Some palaeomagnetic results and their evidence of palaeolatitudes.*
* E. R. DEUTCH and F. L. STAPLIN: *Palaeomagnetism, palaeoclimatology and the distribution of oil fields.*
S. K. KHRAMOV: *Review of palaeomagnetic data within the USSR.*
* M. R. RUTTEN and J. VELDKAMP: *Palaeomagnetic research in the Nederlands.*
* N. D. WATKINS: *A palaeomagnetic investigation of the Miocene lavas of southern Oregon.*
* V. BUCHA: *Palaeomagnetic research of rocks of Cambrian and Ordovician age in Czechoslovakia.*
R. W. GIRDLER: *The remanent magnetization of some Jurassic volcanic rocks from Suthern France.*
* E. IRVING and J. G. BRIDEN: *Palaeolatitude spectra.*
* R. R. DOELL and A. COX: *Secular variation in the western Pacific region.*
G. N. PETROVA: *Evaluation methods of palaeomagnetic determination validity.*
K. M. CREER: *Palaeomagnetic data from the South America.*

2. *Reversal of the earth's magnetic field*

* A. COX, R. R. DOELL and G. B. DALRYMPLE: *Radiometric dates of several recent reversals of the geomagnetic field.*
B. M. JANOVSKY: *Magnetic axis inversion of the globe of the self reversal of rocks magnetization* (read by T. Nagata).
* N. KAWAI: *Switching of the geomagnetic field in the tertiary period.*

3. *Depositional remanent magnetization and red sediment problems*

* R. F. KING and A. I. REES: *Detrital remanence and anisotropy in sediments: an examination of some theoretical models.*
* E. IRVING: *Post-depositional detrital remanent magnetization.*
* K. KOBAYASHI and L. F. TASHBOOK: *Palaeomagnetic measurements for the Triassic basins in the North-Eastern United States.*

This was a joint symposium with IAMAP. Adequate printed abstracts were available for all papers except the ones by Khramov, Janovsky, Girdler, Petrova and Creer, the latter three being additions to the program. Girdler presented data on the Jurassic Age from Europe, and Creer on the Paleozoic Age in South America. Scheduled papers by R. L. Dubois and V. Bucha were not presented.

Khramov presented a wealth of paleomagnetic results of the Paleozoic Age from the Siberian platform and the European part of the USSR.

Janovsky's study concerned very close stratigraphic control regarding Paleozoic polarity epochs. It was noted that the Palaeontologic data presented by Stehli, which included the objective mathematical interpretations, tended to conflict with the paleomagnetic results reviewed by S. K. Runcorn. Though his data were not numerous, his analysis and results stimulated considerable interest. The papers by Cox and his colleagues presented new data from the eastern Pacific region, giving paleomagnetic and radioactive data that clearly established the occurrence of geomagnetic field results.

As a result of these sessions, two informal study groups were formed, one to discuss the differences in laboratory deposition experiments further, and the other to consider the possibility of a unified international system of naming geomagnetic polarity epochs.

D) MEETINGS OF COMMITTEES

August 23, 1963

On the afternoon of August 23, the following Committees held successive sessions in the same location: Committee 1, Observatories; Committee 6, Lunar Variations; Committee 7, Magnetic Comparisons; and Committee 8, Magnetic Instruments. Committee 8 also held a brief business session on the morning of August 23.

Committee 1: Observatories

G. Fanselau, Chairman of Committee 1, gave a brief report on the activities of the Committee during the last triennium. *B. Caner presented a paper, The Semi-Automatic Magnetogram processing Device, which was covered by an adequate printed abstract.

Committee 6: Lunar variations

Report by Chairman.

(1)* S. Matsushita: *Lunar variations of geomagnetic fields.*
(2)* E. K. Bigg: *Lunar and planetary influences on some geophysical phenomena.*
(3)* N. P. Benkova, V. A. Zaguliaeva, N. A. Katziashvili, B. E. Marderfeld, K. V. Martinova and M. Z. Nodia: *Lunar tidal variations by the observation data of magnetic and ionospheric stations of the Soviet Union.*
(4)* S. Chapman and W. L. Hofmeyr: *Diurnal oscillations of pressure at Kimberley due to solar and lunar effects.*
(5)* K. S. Raja Rao, P. K. Sprinivasan: *On the lunar semi-monthly waves in the magnetic equatorial region.*
(6)* O. Schneider: *Lunar geomagnetic variation at Isla Año Nuevo (New Year's Island).*
(7) P. Melchior: *Earth-Tides.*

Seven papers, six of them with printed abstracts, were scheduled, but only four were given. Rao and Srinivasan's paper, an added paper, confirmed the well-known behavior of lunar variations using Indian data.

Chairman O. Schneider reported on the scope and activities of the Committee, including bibliographic and technical aspects.

COMMITTEE 7: MAGNGETIC COMPARISONS

and

COMMITTEE 8: MAGNETIC INSTRUMENTS

Report by the Chairman.

(1)* G. V. HAINES: *An automatic-three-component proton precession magnetometer.*

(2)* VON H. SCHMIDT: *Precessionfrequency-errors of proton magnetometers.*

(3)* V. N. BOBROV: *Quartz geomagnetic instruments.*

(4)* L. R. ALLDREDGE and I. SALDUKAS: *An automatic magnetic observatory.*

(5) G. PETIAU and E. SELZER: *Apareillages spéciaux pour enregistrement permanent des micropulsations magnétiques.*

The Chairman of Committee 7, Dr. V. Laursen, gave a brief report on the work of the Committee.

J. H. Nelson as Chairman of Committee 8 presented his report. Of the 5 papers scheduled for Comm. 8, only four were given; the one by Bobrov was cancelled. Schmidt's paper was presented by K. A. Wienert. All papers, but n. 5 were covered by adequate printed abstracts.

AUGUST 27 and 28, 1963

COMMITTEE 2: AURORA AND AIRGLOW

Report by the Chairman.

(1) C. S. DEER and M. H. REES: *Preliminary results of measurements of sodium dayglow radiations during the solar eclipse of 20 July 1963 from a high flying aircraft.*

(2)* L. M. FISHKOVA: *H emission in the airglow.*

(3) A. I. LEBEDINSKY: *Planetary distribution of aurorae.*

(4)* O. V. KHOROSHEVA: *Investigating planetary propagation of solar aurorae.*

(5)* S. K. VSEKHSVYATSKY and N. I. DZJUBENKO: *Some results of the polar lights structure studies.*

(6)* V. P. SAHSONOV and N. S. ZARETSKI: *The spatial and time distribution of auroras over the territory of Yakutya.*

(7)* JN. A. NADUBOVICH: *The auroral «Coast Effect».*

(8)* V. I. IVANTCHUK: *On the classification of polar aurorae spectra.*

(9)* F. W. J. EVANS and A. V. JONES: *Observations of type-b red aurora.*

(10)* K. SPRENGER and P. GLÖDE: *Some properties of radio aurorae in medium latitude.*

(11)* B. A. BAGARIATSKY: *Auroral radio-echoes and their dependence on the constant and variable magnetic fields.*

(12)* S.-I. AKASOFU: *The dynamic morphology of the aurora polaris.*

(13)* A. G. MCNAMARA: *An analysis of IGY-IGC auroral radar observations in Canada.*

(14)* J. I. FELDSTEIN: *Morphology of aurorae and geomagnetism.*

(15)* E. A. PONOMAREV: *Local geophysical effects and auroral theory.*

(16)* A. I. KUZ'MIN, D. D. KRASIL'NIKOV, G. F. KRIMSKI, G. V. SKRIPIN, I.-P. CHIRKOV, YU. G. CHAFER and G. F. SHAFER: *The main results of the research in the variations of cosmic rays in Yakutsk.*

(17)* A. N. CHARAKHCHYAN and T. N. CHARAKHCHYAN: *Cosmic radiation levels in the stratosphere during the period from July 1957 to July 1962.*

(18)* Y. L. BLOCH, L. I. DORMAN, N. S. KAMINER and L. I. MIROSHNICHENKO: *Some methodic questions cosmic ray variation investigation on the basic of the IGY experience.*

(19)* M. V. ALANIA, L. I. DORMAN, J. V. KEBULADZE, V. K. KOIAVA, V. G. KORIDZE and A. M. IKHETIA: *Analysis of a number of cosmic ray effects during the magnetic storm in the period of the solar activity maximum accordingly to the data of the stations all over the world and its comparison with the results in the period of the solar activity minimum.*

(20)* G. V. SHAFER, G. F. KRIMSKI, N-P. CHIRKOV and V. A. FILIPPOV: *The relation between the mean characteristics of Forbush decreases and the Sun activity.*

(21)* E. G. BOOS, V. V. VISKOV, L. I. DORMAN and E. V. KOLOMEETZ: *Coupling coefficients for various components of cosmic ray intensity.*

(22)* L. I. DORMAN and L. H. SHATASHVILI: *Cosmic ray 27-day variations by the data of the world networld for the periods of IGY and IGC and the general characteristics of electromagnetic conditions in the interplanetary space.*

(23)* E. V. KOLOMEETZ, L. V. KOZACK, V. I. PIVNEVA and G. A. SERGEEVA: *Anomalies in cosmic ray intensity during magnetic storms.*

(24)* Y. L. BLOCH, L. I. DORMAN and N. S. KAMINER: *Cosmic rays variations during storms of various types.*

(25)* A. A. STEPANYAN: *About fundamental features of Forbush effect.*

(26)* K. K. FEDCHENKO: *Directional anisotropy of Forbush effect mechanism.*

(27)* A. A. LUSOV and G. W. KUKLIN: *The disturbed diurnal variations in cosmic ray intensity during the Forbush decreases.*

(28)* V. S. SMIRNOV: *Anisotropy effect of little cosmic ray flares.*

(29)* B. M. VLADIMIRSKY: *The small effects of the solar flares in cosmic rays of the period of Forbush decrease's recovery.*

(30) V. L. GUINZBOURG, L. V. KOURNOSSOVA, V. I. LOGATCHEV, L. A. KAZORENOV and M. I. FRADKIN: *L'étude d'une composante nucléaire des rayons cosmiques à l'aide des satellites artificielles et des fusées spatiales.*

(31)* N. P. CHIRKOV, G. V. SKRIPIN, G. F. KRIMSKI and A. I. KUZ'MIN: *Variations of cosmic rays and changes in the magnetosphere.*

(32)* G. F. KRIMSKI, A. A. KUZ'MIN and G. V. SKRIPIN: *Variation of cosmic rays and the interplanetary magnetic field.*

(33)* L. I. DORMAN and N. S. KAMINER: *Solar wind and its display in cosmic ray variations.*

(34)* Y. L. BLOCH, L. I. DORMAN, N. S. KAMINER and E. V. KOLOMEETZ: *Cosmic ray flares by the data of the world stations and the questions of solar cosmic ray generation and propagation.*

(35)* A. N. CHARAKHCHYAN and T. N. CHARAKHCHYAN: *Cosmic ray flares at the Sun.*

(36)* L. I. DORMAN, E. S. GLOKOVA and O. I. INOZEMTZEVA: *Nature of cosmic ray daily variations during the minimum and maximum of solar activity.*

(37)* L. I. DORMAN: *Theory of cosmic ray variations.*

(38)* A. C. DURNEY, H. ELLIOT, R. J. HYNDS and J. J. QUENBY: *The energy spectrum of the Heavy Primary Cosmic Rays.*

(39)* A. C. DURNEY, H. ELLIOT, R. J. HYNDS and J. J. QUENBY: *The artificial Radiation-Belt produced by the «Starfish» Nuclear explosion.*

This Committee held three sessions. The scheduled program is given above, but some of the papers were not presented. Others were summarized by someone other than the author. Most of the papers were covered by printed abstracts. The paper by Khorosheva, presented by A. I. Lebedinsky, noted that the present concept of the auroral zone is a statistical one and that the instantaneous auroral zone could be quite different. He suggested that the instantaneous zone is oval, and its center is shifted from the geomagnetic pole to the dark side along the Sun-Earth line.

T. Oguti noted the well-known spiral feature shown by various geophysical phenomena over the polar cap, and W. T. Piggott commented that such a feature is only a statistical one and instantaneous features could be different.

Lebedinsky and Akasofu showed that the auroras are distributed in a wide range of longitude (more than 60°) and can be activated within a few minutes, although changes of auroral forms vary at different locations. Detailed radio studies of the aurora, based on data obtained during the IGY, were also presented by McNamara and Bagariatsky. Lebedinsky presented a summary of the papers by Samsonov and Zaretski, Nedubovich, and Ponomarev dealing with geographical effects concerning aurorae. He presented data which tended to show that a maximum occurrence of aurorae exists along the Siberian coastline, which might be related to currents in the ocean causing magnetic effects. He also noted that there were longitudinal peaks in the occurrences of the aurorae, a second geographical effect that is not understood.

Another summary was based on the Charakhchyans' two papers on the variation of cosmic-ray intensity at various balloon altitudes during the interval from 1957 to 1962. Several thousand flights were made at latitudes of 41°, 51°, and 64°, using a single counter and a two-fold telescope, and the flux change with time was measured. At 64° an increase of about 50 per cent was seen, but at 41° the increase was only about 10 per cent, confirming the idea that increase in cosmic-ray flux near solar minimum is mostly low energy, less than 2 or 3 bev. Data, which were presented for several solar proton events, gave an energy spectrum of $N(\rightarrow E) \equiv kE^{-5.0}$, based on analysis of flux versus depth in atmosphere curves. Analysis of the May 4, 1960, event gave a different diffusion model; the equation for the diffusion coefficient was 5.5×10^{-20} cm^2/sec or a scattering mean free path of $\lambda = 1/10$ AU. The diffusion coefficient varies as $P^{0.7}$, where P is the particle's momentum.

J. J. Quenby presented two papers on the results of the Ariel satellite, the first dealing with cosmic rays of $Z > 6$ studied by a Cerenkov counter. He found that the integral flux $\Phi \simeq P^{-1.2}$ for $P < 8$ bv and $\Phi \simeq P^{-1.5}$ for $P > 8$ bv, and suggested that this indicated solar modulation of $\Phi \simeq P^{0.3}$ below $P = 8$ bv. He also presented a brief discussion of the Ariel results on the Starfish high-altitude explosion electrons. A particle burst at + 20 sec, seen by a GM counter on Ariel but not on the Cerenkov counter, was attributed to outer belt electrons scattered by magnetic disturbances produced by the bomb. He stated that, starting at + 6 min, fission electrons were observed by both the Cerenkov and GM counters.

August 28, 1963

Committee 3: High Atmosphere

Report by the Chairman.

(1) V. I. Krassovsky: *Results on Cosmos 3 and 5.*

(2)* H. K. Paetzold: *Variations of the upper atmosphere from 1957 to 1963.*

(3)* H. Kallman-Beijl: *Day and night time variations of tempesature molecular-weight and composition between 100 and 250 km.*

(4)* A. D. Danilov and G. S. I. Kholodny: *Experimental data on the power of the energy source in the ionosphere.*

(5)* J. L. Alpert: *The results of radioinvestigations of the ionosphere by artificial satellites.*

(6)* P. B. Babadjanov, B. L. Kashcheyev, E. N. Kramer and V. P. Zessevithc: *The research of the meteors during the IGY in the USSR.*

(7)* Y. Sobouti: *Fluorescent scattering in planetary atmospheres.*

(8)* K. H. Schmelovsky and R. Knuth: *Variation of plasma temperature in the outer ionosphere.*

(9)* R. L. Hilliard and G. G. Shepherd: *Measurement of Doppler temperature with a wide angle Michelson interferometer.*

(10)* A. T. Price, G. A. Ferris and J. A. Lawrie: *Effects of hall conductivity on currents in the ionosphere.*

(11)* E. A. Lauter and G. Entzian: *Regular variations in the ionosphere.*

(12)* J. TAUBENHEIM: *Ionospheric measurements during the total solar eclipse of February 15, 1961.*

(13)* M. ANASTASIADES: *Ionospheric observations carried out during the solar eclipse of February 15, 1961 at Athens.*

(14)* E. A. LAUTER and R. KNUTH: *High energy particles in the lower ionosphere at medium latitudes.*

(15)* E. S. KAZIMIROVSKY: *Wind systems at the lower ionosphere.*

(16)* V. N. KESSENIKH, E. S. KAZYMYROVSKY and U. A. NOVIKOVA: *IGY-IGC ionosphere-atmosphere dependence as revealed by somme mid-latitude and middle-Assian stations of USSR.*

(17)* V. D. GUSEV, S. F. MIRKOTAN, M. P. KIJANOVSKY and I. B. BERESIN: *Phase investigations or the ionosphere drifts.*

(18)* M. P. RUDINA: *On the morphology of radio wave absorption in the lower ionosphere.*

(19)* CHR. -ULR. WAGNER: *Some remarks about the efficiency of negative ions in the lower ionosphere.*

(20) A. LEBEAU: *Effects ionsphériques de l'agitation diurne dans les régions de très haute latitude.*

(21)* J. E. LOKKEN, J. A. SHAND and C. S. WRIGHT: *The diurnal and seasonal variation of the earth-ionosphere cavity modes recorded at Byrd station.*

(22)* G. V. BUKIN: *On the wave and corpuscular events in the Antartic ionosphere.*

(23)* E. I. BOGILEVSKY, R. A. ZEVAKINA, E. V. LAVROVA and L. N. LJAKHOVA: *On the nature and space —and time— distribution of ionospheric disturbances.*

(24)* A. S. BESPROZVANNAJA and G. N. GORBUSHINA: *Irregular phenomena and disturbances in the polar ionosphere.*

(25)* A. P. NICKOLSKY: *About existence of three sporadic ionized regions in high latitudes.*

(26)* A. J. ZMUDA, B. W. SHAW and C. R. HAAVE: *VLF disturbances caused by high-altitude nuclear bursts.*

(27)* T. OBAYASHI: *Wide-spread ionospheric disturbences due to nuclear explosions during October 1961.*

Eleven scheduled papers were cancelled. Abstracts were available for most of the papers presented. In addition, a paper by V. I. Krassovsky, presented by Chairman M. Nicolet, gave results on Cosmos 3 and 5, showing the presence of low-energy electrons ($E > 40$ ev) with fluxes greater than 10^7 electrons/cm^2 sec. These electrons were found only during the day-time condition, and Krassovsky concluded that they were photoelectrons due to solar radiation with $\lambda < 220$ A. Krassovsky also reported that the ratio of the neutral helium to the neutral atomic oxygen is about 10^{-1} at 500 km altitude.

Paetzold determined density variations of the upper atmosphere from the accelerations of artificial satellites; from the variations atmospheric composition and temperature were deduced. In the period 1958-1962 a semidiurnal and diurnal variation in density was found in accord with similar variations in other atmospheric and ionospheric disturbances.

The paper by Lauter and Knuth presented some results on low-frequency ionospheric absorption, which frequently begins with the onset of a magnetic storm but has its maximum three or four days after the storm. In the following discussion the general consensus was that the temporal behaviour of the absorption days after the storm could not be explained through solar protons. Lauter suggested that the phenomena relate to electron dumping from the outer Van Allen belt, although the mechanism causing this precipitation is unknown.

The paper by Zmuda related the β rays from nuclear explosions with ionospheric disturbances at regions considerably displaced from the detonation point. The β rays fall into two categories: β rays from fission fragments and β rays from the radiactive decay of neutrons. The spectra of the two groups are drastically different in that the delayed effects they produce in the trapped condition have temporal variations which are readily distinguishable.

Obayashi treated ionospheric effects associated with Russian nuclear bursts at Novaya Zemlya. These bursts, which were probably near ground level, produced changes in the F_2 region over Japan and Europe but not over the United States. They were probably caused by acoustic gravity waves propagated from the burst region, the F_2 changes indicating a moderately efficient coupling of energy from the ground levels to the ionospheric regions. The changes in the critical frequency following the nuclear explosion are readily distinguishable from changes occurring during natural disturbances.

August 22, 1963

Committee 4: Saecular Variation and Palaeomagnetism

Report by the Chairman.

Secular Variations

(1)* B. R. Leaton: *Geomagnetic secular variation for the epoch 1960.0.*

(2)* V. P. Orlov and V. P. Sokolov: *Secular variation anomalies in seismic districts of Tadjikistan and over eastern-european platform.*

(3)* V. P. Orlov and V. P. Sokolov: *Geomagnetic field secular variation in the Antarctic.*

(4)* N. V. Adam, N. P. Benkova, V. P. Orlov, N. K. Osipov and L. O. Turmina: *Spherical analysis of a constant magnetic field and of secular variations.*

(5)* K. L. McDonald: *Vector field structures and secular geomagnetism.*

Archaeomagnetism

(6)* S. P. Burlazkaja: *Some features of annual variation of geomagnetic field.*

(7)* T. Nagata, Y. Arai and K. Momose: *Secular variation of the geomagnetic total force during the latest 5.000 years.*

(8) R. R. Doell and A. Cox: *Palaeomagnetism of Historic Hawaian Lava flows.*

Rock Magnetism

(9)* F. D. STACEY: *The seismo-magnetic effect and the possibility of earthquake forewarning.*

(10)* K. KOBAYASHI and T. NAGATA: *Magnetic study on the oxdiation of titano-magnetites.*

(11)* T. NAGATA and M. OZIMA: *Acquisition mechanism of a stable remanent magnetization for multidomain case.*

(12)* H. STILLER and F. FLOLICH: *Discussion of magnetic properties of rocks by means of exchange. coupling models.*

(13) K. M. CREER: *Origin of the natural remanent magnetization of red sediments.*

(14) M. FULLER: *Magnetism of red sediments.*

(15) R. W. GIRDLER: *The remanent magnetization of some Jurassic volcanic rocks from southern France.*

(16) R. W. GIRDLER: *Some preliminary experiments on the effect of hydrostatic preasure on thermal remanent magnetization.*

(17)* M. D. FULLER: *Magnetic expression of transcurrent faulting.*

(18)* CH. M. CARMICHAEL: *Magnetization of a pyroxenite at Wilberforce, Ontario.*

(19)* C. RADHAKRISHNAMURTY: *On the TRM properties of Rajmahal traps.*

(20)* P. W. SAHASTABUDHE: *On the normal and reversed magnetization of the Deccan trap lavas.*

(21)* M. YAMA-QI, A. COX and R. R. DOEL: *Magnetic properties of the bassalt in Hole EMT, Mohole Project.*

(22) CH. CARMICHEL: *A magnetized artificial meteorite.*

Theory of Main Geomagnetic Field and Secular Variation

(23)* S. K. RUNCORN: *Electromagnetic coupling of the core and mantle and irregular changes in the length of the day.*

(24) S. K. RUNCORN: *Aspects of the theory of the Earth's magnetic field.*

(25) F. J. LOWES: *A laboratory homogeneous self-maintaining dynamo.*

(26) F. J. LOWES: *Coupled dynamo models.*

(27)* B. A. TVERSKOY: *Thermal convection in the earth core and the origin of the main geomagnetic field.*

(28)* B. A. TVERSKOY: *On the origin of the earth magnetism.*

(29)* D. E. SMYLIE: *Electromagnetic excitation of the Chandler wobble.*

T. Nagata was the Chairman of this Committee which held two sessions on four specific themes. Three of the themes were Summary Reports on Geomagnetic Variations, Archaeomagnetism, and Rock Magnetism, respectively. The fourth theme was the Theory of Main Geomagnetic Fiel dand Secular Variation. Printed abstracts were available for most papers. The Leaton paper was presented by T. Nagata; the Orlov and Sokolov paper by N. P. Benkova; the Burlazkaja paper by E. Thellier; and the Stiller and Frolich paper was presented by K. Kobayashi. Eleven papers were given only by title.

August 23 and 27, 1963

Committee 5: Magnetic Charts

Report by the Chairman.

(1)* D. G. Knapp: *Position parameters in the rise of geomagnetic cartography, specifically dip versus latitude.*
(2)* A. Chargoy M.: *Simetrias del campo magnético terrestre.*
(3)* L. Slaucitajs: *The simple cylindric propection —plate carree— for magnetic charts.*
(4)* L. R. Alldredge and L. Hurwitz: *Radial poles as the source of the earth's main magnetic field.*
(5)* H. Kautzleben and W. Mundt: *Estimation of errors in the representation* of geomagnetic surveys.
(6)* H. P. Stockarg: *Proyect Magnet progress.*
(7)* K. Karaczun: *Normal field of vertical component Z of the earth's magnetism in Poland for epoch 1957,5.*
(8)* E. Dawson and E. I. Loomer: *The north magnetic dip pole.*
(9)* D. G. Knapp: *Some notes on field patterns in relation to dip poles.*
(10)* M. J. Keen and H. McPherson: *Magnetic anomalies on the eastern seaboard of Canada.*
(11)* U. D. Parkinson: *The conductivity anomaly in the upper mantle found in Australia and the Ocean effect.*
(12)* A. J. Zmuda and F. T. Heuring: *The analytic description of the geomagtic field at points in the upper atmosphere.*

Printed abstracts were available for all papers given; three scheduled papers were not presented. Under the Chairmanship of E. H. Vestine, this Committee held two sessions. The second on the World Magnetic Survey was posted as an open meeting of Committee 5. The first session opened with a business meeting at which Vestine presented the Chairman's Report on the activities of the Committee since the Helsinki meeting, including developments in the program for the World Magnetic Survey. In the business meeting the Committee reaffirmed the description given in IUGG Monograph 11, *Instruction Manual for the World Magnetic Survey,* but took the occasion to stress the importance of supplying *observed* data. *Derived* values should be identified as such. The Committee also recommended that measurements of the total magnetic force for the World Magnetic Survey from satellites below 100 km altitude should be conducted in a manner such that the absolute accuracy of measurements at each point is within 10 γ, without applying corrections for instrument drifts or satellite-generated fields. It is recommended that magnetometers of the nuclear or atomic resonance type be used; that latitude, longitude, and altitude coordinates of each measurement be known and specified to an accuracy of 1000 meters in the horizontal plane and 250 meters in the vertical direction;

and that the magnetic field of the satellite be such that its contribution to the field at the magnetometer sensor be small and consistent with the absolute accuracy specified above. The date of the observation should be given for each measurement in universal time. The Committee also endorsed the recommendation of the CIG-IQSY Committee that «one special feature of the IQSY contribution to the land and ocean survey of the World Magnetic Survey should be precision of magnetic survey measurements at repeat stations through their re-occupation during the IQSY or at least within the five year period prior to the ending of the IQSY».

The second session, on the World Magnetic Survey, consisted of two parts. Part one was a general technical discussion which included five presentations. T. Nagata described recent analyses of secular variations made by British, Russian, and Japanese scientists with particular emphasis on the limitations imposed by the poor distribution of magnetic observations. N. P. Benkova presented a paper by several authors describing the compilation of a world magnetic chart for epoch 1960 to a scale of 1 to 50,000,000. The methods used were identical to the graphical interpolation techniques previously used in the USSR charts, but approximately 5000 new observations were incorporated. Questions were raised about the availability of these data to the World Data Centers. L. R. Alldredge, in presenting studies on anomaly sizes, stressed the point that although local anomalies are undesirable on world charts, a means of designating areas of large-amplitude local anomalies should be found. M. Sugiura reviewed the various types of temporal variation of the magnetic field that influence survey measurements, stressing particularly the need to remove temporal variations from satellite survey data. Preliminary studies of methods of routine rapid reduction of observatory records in support of satellite surveys were illustrated. V. Laursen outlined the organization of World Data Centers for geomagnetism.

The second part of the session was really the first meeting of the recently created World Magnetic Survey Board. Business items included the presentation and discussion of the minutes, recommendations of the business meeting of Committee 5 reported above, the preparation of recommendations to SCAR and SCOR requesting that all expedition ships in the Antarctic and Indian Ocean regions tow magnetometers for survey measurements, and the preparation of a recommendation supporting the efforts of the Scandinavian countries to have an aerial magnetic survey conducted by the Canadian Dominion Observatory. Much of the discussion was centered on the worldwide distribution of data since 1900 shown by J. Cain. Presenting maps illustrating the distribution of approximately 400,000 observations in intervals of 10 and 15 years between 1900 and 1962, Cain discussed recent analyses of these data for obtaining spherical harmonic coefficients for both the main and secular change fields. Representatives of several countries used the illustrations to show how measurements which they are planning will help to fill the gaps in coverage.

August 22, 1963

Committee 9: Characterization of Magnetic Activity

Report by the Chairman.

(1) J. Veldkmap: *Report by Director of Permanent Services of Geomagnetic Indices.*
(2)* P. N. Mayaud: *Report on special studies on K-Indices and Sq-Variability.*
(3) W. Kerz: *Report on current measures of the intensity of the Equatorial Ring Current (ERC).*
(4)* M. Sugiura: *The recovery phase of geomagnetic storms.*
(5) M. Sugiura: *Hourly values of Equatorial Dst for IGY.*
(6) K. Witham: *Hourly Ranges.*
(7)* A. T. Price and D. J. Stone: *The Sq field during the IGY.*
(8)* M. P. Hagan and E. J. Chernosky: *A study of low-latitude IGY data disturbances effects in Sq.*
(9)* G. F. Rourke: *Magnetic activity in the Antartic during the IGY and IGC.*
(10) K. Witham: *Anomalies in magnetic variations in the Artics Archipielago of Canada.*
(11)* L. G. Mansurova and S. M. Mansurov: *Some results of the investigation of the Antartic variable geomagnetic field.*
(12)* M. I. Pudovkin: *The nature of geomagnetic disturbences in high latitudes.*
(13)* M. J. Pudovkin: *The origin of geomagnetic disturbances in the auroral zone.*
(14)* V. M. Mishin, N. A. Mishina, E. J. Nemzova and R. H. Zapitova: *About the wave-nature of the magnetic storms and the second (around-the-pole) zone of the magnetic activity maximum.*
(15)* I. A. Zhulin and V. P. Shabansky: *On the nature of geomagnetic storms.*
(16)* J. V. Lincoln: *The contrasts of the great geomagnetic storms of October 6, 1960 and November 12, 1960.*
(17)* A. Yacob, K. B. K. Khanna: *Day and night dissimilarities in the magnitude of magnetic disturbances near the magnetic equator.*
(18)* A. J. Dessler and J. A. Fejer: *Interpretation of Kp index and M-region geomagnetic storms.*
(19)* P. Bernard: *On the variations of magnetic storms lag behind solar flares.*
(20) P. Gouin: *Some aspects of magnetic daily variations at Addis Ababa.*
(21)* A. Grafe: *The existence of the equatorial ring current during undisturbed geomagnetic periods.*
(22)* D. G. Osborne: *Seasonal changes in the equatorial electrojet.*
(23)* K. S. Raja Rao: *On the equatorial electrojet over the Indian region.*
(24)* Ogbueti: *Daily and seasonal changes in the equatorial electrojet in Nigeria.*

Many papers were presented only by title. Five papers were presented at the morning session: other four were presented in the afternoon and were preceded by Chairman Bartels' report which gave the highlights of his printed report entitled Characterization of Magnetic Activity. He noted Jacchia's discovery of a linear relationship between upper atmosphere temperatures and A_p index with pleasure, and stated that among the problems raised and still unanswered was whether K index should be based on H component alone or whether the upper limits should be changed. He noted that good magnetograms and storms, as well as regular magnetograms, are essential. S_q must be eilminated from the K-index determinations. Presenting slides from his paper in *Annales de Géophysique, 19,* 1, January-March 1963, he offered the following conclusions: a semiannual wave of equinoctial disturbance appears in the data of the more disturbed days, not in the five quiet days; A_p is small, on the average, in sunspot minimum years and the year following; and there are more $K_p = 0$ in minimum years. The data covered the years 1932-1961 with histograms of K_p, A_p, and sunspot numbers intercompared.

Gouin noted that north- and south-type curves appeared in the records at Addis Ababa, although Onwumechilli had previously noted that they are making observations at different locations relative to the equator.

Mayaud, stressed that further studies on S_q variability are possible because he visited the observatories and used original magnetograms. For such a study the World Data Center microfilms would not be satisfactory. In the discussion Mayaud stated his belief that observers can be trained to eliminate S_q from the K indices even though it is complicated and differs at each observatory. He noted that personal instruction rather than an atlas type of approach is necessary.

Kerz described computation of U values from Huancayo, Watheroo, and Apia data for 1939 to 1945 and May 1957 through December 1958. Three-hourly values were smoothed in units of 3 γ. He attempted to remove secular, S_q and S_D, variations by using night values, tropical stations well spaced in longitude, and a linear secular trend correction only. Kerz found local irregularities for five daily means as great as $\pm$ 50 γ. The highest monthly mean was 25.8 for September 1957; the second highest was 16.2 in March 1958. The first was a month of many severe storms; the latter was merely a relatively high average throughout the month.

Sugiura based his second paper on a NASA, Goddard Space Flight Center, report X-611-63-131 issued in June 1963. Eight low-latitude stations spaced as uniformly as possible in longitude were used. He stated his belief that the Dst, due mainly to the ring current, also includes the magnetic field caused by the currents on the interface between the magnetosphere and the solar plasma and some residue of the polar disturbances. With hourly D_{st} the development and decay of a magnetic storm ring current is shown. He compared his values with Kerz'; because hourly rather than three hourly values were used, greater detail is shown. He concluded that the polar disturbance dies away more quickly than the ring current.

August 23, 24, 26 and 27, 1963

Committee 10: Rapid Variations and Earth Currents

Report by the Chairman.

(1)* G. Fanselau: *Geomagnetic effect of solar eclipse and irregularities of Sq.*
(2)* T. Sato: *Periodic geomagnetic variations in higt latitudes.*
(3)* V. A. Troitskaya, R. V. Schepetnov, O. M. Barsukov, O. V. Bolshakova, K. Yu. Zybin and E. T. Matveeva: *Characteristics features of rapid variations in polar regions.*
(4)* K. N. Mather and E. M. Wescott: *Relationships at geomagnetically conjugate points.*
(5)* J. A. Shand, C. S. Wright and J. E. Lokhen: *Micropulsations in conjugate auroral zones and associations with some other ionospheric phenomena.*
(6)* R. Schlich: *Micropulsations de période comprises entre 0,5 et 6s observées aux hautes et moyennes latitudes.*
(7)* v. H. Wiese: *Influence of large electrical conductivity differences in the underground on geomagnetic variations.*
(8) E. Selzer: *Classification et modes d'études proposées pour les micropulsations magnétiques. Principaux résultats obtenus à Chambon-la-Forêt.*
(9)* Y. Kato, T. Tamao and T. Saito: *Studies on geomagnetic micropulsations.*
(10)* A. C. F. Binaghi Pages and E. G. Linzuain: *Form index for the identification of geomagnetic pulsations.*
(11)* N. E. Goldstein and S. H. Ward: *The effect of a magnetic permeability environment on micropulsations.*
(12)* J. Roquet et E. Selzer: *Essais d'interprétation à l'echelle mondiale des variations magnétiques rapides enregistrées à une seule station.*
(13)* E. T. Matveeva and V. A. Troitskaya: *General regularities of the PP type oscillation.*
(14)* J. A. Shand, C. S. Wright and J. E. Lokken: *Some directional properties of signals in the lower elf band recorded at widely separated stations.*
(15)* J. A. Jacobs and T. Watanabe: *Geomagnetic micropulsations during the daylight hours.*
(16)* M. Siebert: *On the latitude-dependence of the period of geomagnetic micropulsations.*
(17)* D. G. Osborne and D. Rivers: *Large magnetic pulsations near the equator.*
(18)* A. I. Ohl: *Longperiodical giant pulsations of the geomagnetic field.*
(19)* V. A. Troitskaya, M. V. Melnikova and G. A. Bulatova: *The fine structure of magnetic disturbances.*
(20)* S. Matsushita: *On the different types of sudden commencements, sudden impulses and micropulsations.*

(21)* C. R. Wilson and M. Sugiura: *The sudden commencement of geomagnetic storms: morphology and interpretation.*

(22) R. Schlich et Selzer: *Comparison entre les instants d'occurrence de mêmes* ssc *et* si *observés à Kerguelen et en France.*

(23)* K. G. Ivanov: *Storm sudden commencements (ssc's) according to the IGY data.*

(24)* V. M. Mishin, N. I. Naydenova and M. L. Platonov: *About diurnal variations of the probability of commencements, activity period and termination of magnetic storms appearance.*

(25) J. Roquet, R. Schlich and E. Selzer: *Effects magnétiques mondiaux d'explosions nucléaires à haute altitude.*

(26)* H. A. Bomke, H. H. Grote and A. K. Harris: *Near and distant observations of the 1962 Johnston Island high-altitude nuclear tests.*

(27)* A. J. Shirgaokar, A. S. Prabhavalkar: *Geomagnetic effects of nuclear explosions.*

(28)* V. V. Kebouladze: *On the results of the earth currents investigations in the Georgian Republic for the IGY period.*

(29)* S. K. Runcorn: *Earth current measured by Pacific cables.*

(30)* A. T. Price: *Electric currents induced in the Oceans and the measurement of magnetic variations at sea.*

(31)* N. F. Maltzeva: *On the amplitude spectra of the typical short-period-oscillation disturbances of the earth electromagnetic field.*

(32)* A. T. Price and A. A. Ashour: *Night-time earth currents associated with Sq.*

(33)* R. Scrinnikov and N. Maltzeva: *Earth electromagnetic field micropulsations in the auroral zone.*

(34)* G. W. Gross: *The direct-current conductivity of ice doped with ionic impurities. A progress report.*

(35)* S. B. Levin: *Electromagnetic propagation through the lithosphere.*

(36)* J. Pecova, V. Petr and O. Praus: *Determination of the electrical conductivity by magneto-telluric measurements.*

(37) L. R. Tepley: *Conjugate relationships of hon emissions at low latitudes.*

A. Romañá was the Chairman of this Committee which held four sessions. Thirty-seven papers (listed above) were scheduled, but a number of them were not given because of the absence of the authors. In other cases, the summaries of the papers were given by colleagues.

As most of the papers have the summaries printed elsewhere we do not give a further explanation of the meetings that in several occasions gave rise to lively discussions.

August 27, 1963

Committee 11: History of Geomagnetism and Aeronomy

In absence of Prof. N. Pushkov, chairman of this committee, Doctor Chernowski took the chair. A number of informal reports were given at the session: Hugh Odishaw reported on the U. S. Geophysics

Research Board, and T. Nagata compared the American and Japanese organizations. Maldonado Koerdell commented on the organization of the work in Mexico and presented a report of the Instituto de Geophysica on the history of geomagnetism in Mexico, noting that magnetic observations were made there as early as the 16th century. The Canadian National Report was presented by E. R. Neblett, and a report on the derivation of the magnetic dip versus magnetic latitude by D. G. Knapp. The work of Alexander von Humboldt in geomagnetic sciences was cited.

There was discussion of the Committee's functions and goals. A plan was discussed to encourage the commissioning of retired scientists to prepare reports on geomagnetic work with which they are familiar and to encourage students to prepare brief histories of particular subjects in connection with their studies, incidentally giving each a background for his work.

AUGUST 27 and 28, 1963

JOINT COMMITTEE: ATMOSPHERIC ELECTRICITY (WITH IAMAP)

Report by the Chairman.

(1)* J. D. SARTOR: *The Role of Particle Interaction in the Distribution of Electricity in Thunderstorms.*

(2)* J. LATHAM: *The Electrification of Frost Deposit and Snowstorm.*

(3)* G. RIES: *Survey to the Problem Thunderstorm Activity-Atmospheric Field.*

(4)* L. E. SALANAVE: *A Photoelectric Investigation of the Intensity Distribution in the Optical Spectrum of Lightning.*

(5)* N. KITAGAWG: *Propagation and Nature of Thunder.*

(6)* H. R. ARNOLD and E. T. P(ERCE: *Leader and Junction Processes in the Lightning Discharge as a Source.*

(7)* A. S. DENNIS and E. T. PIERCE: *The Return-Stroke of Lifhtning Flash to* Earth as a Source of VLF Atmospherics.

(8)* H. ISRAEL and H. DOLEZALEK: *The Application of Facy-Forces to Atmospheric Ions.*

(9) J. BRICARD: *Application de la Théorie de Smoluchowsky a l'Etude de la Recombinaison des Petits Ions et de Leur Fixation sur les Aerosols Atmospreriques.*

(10) J. BRICARD, J. PRADEL, and A. Renoux: *Noyaux de Condensation Radioactif Electriquement Neutres et Repartition Granulométrique de la Radioactivité de lAair.*

(11)* S. GATHAM: *The Reduction Factor at Shenandoah National Park.*

(12) H. W. KASEMIR: *The Atmospheric Electric Ring Current in the Ionosphere.*

(13) A. RENOUX: *Etude de la Charge des Petits Ions Radioactifs et de Leus Fixation sur les Aerosols Atmosphériques.*

(14) L. A. RUHNKE: *A New Radiosonde Electrometer.*

(15) W. D. CROZIER: *Atmospheric Potential Measurements with Passive Antennas.*
(16)* A. MANI, G. P. SRIVASTAVA, B. B. HUDDAR and M. S. SWAMINATAN: *Potential gradient and conductivity measurements in the free atmosphere over Poona and Hyderabad.*
(17) W. A. HOOPEL and J. H. KRAAKEVIK: *Airborne Measurements of Atmospheric Ions.*
(18)* R. V. ANDERSON: *Measurement of Effective Relaxation Times and the Calibration of Current Measuring Devices.*
(19)* E. M. TRENT: *Statistical Analysis of Atmospheric Electricity and Meteorological Data.*
(20) G. GREVET: *Mesure de l'Intensité d'Ionisation au Voisinage du Sol.*
(21) R. MUHLEISEN: *The Atmospheric Electric Relations in Maritime Aerosols and Their Possible Consequences for Measurement on the Oceans.*
(22)* J. R. HERMAN: *Atmospheric Radio Noise at Byrd Station, Antarctica.*
(23)* J. BRICARD: *Effect of Electric Field on Freezing of Water.*

Dr. Koenigsfeld, Chairman of the Joint Committee, pointed out that although only three months had passed since the meeting in Montreux, he had over 20 of the papers in hand, indicating strong continued interest. Urging wider participation in the IQSY programme, particularly in the use of aircraft and radiosondes, he also mentioned the desirability of comparative measurements, wherever possible, in order to standardize results. He presented changes in the Atmospheric Electricity Committee with specialized programme chairmen as listed in the general report for this Association.

In addition to papers which he authored or co-authored, Bricard also presented the papers by Renoux and Grevet, which described studies of the combination of small ions on atmospheric aeresol. Ruhnke, whose paper has no printed abstract, described an electrometer circuit which will work into a standard United States radiosonde for balloon measurements. Crozier's paper dealt with measurements using a passive antenna, and Kasemir's paper on space electricity suggested a modification of the conventional spherical-condenser model of world-wide atmospheric-electrical current flow. This model gives a role to the Earth's magnetic field in the way the thunderstorm charging current distributes itself over the ionosphere. Kasemir's paper elicited considerable discussion, emphasizing the need to secure more data to support the proposed modification of the model. Joppel and Kraakevik presented results in which the ion mobilities of both signs were measured with the instruments carried in aircraft. The ratio of the to polar mobilities was found to be much closer to unity than the ratio found by other workers using dry, clean, laboratory air. A near-unity ratio tends to remove the need to account for a space charge, which measurements show do not exist. It was also found that the atmospheric columnar resistance is down by a factor of 2 to 3 from the resistance measured by similar instrumentation about seven years ago, which tends to indicate a worldwide change in atmospheric conductivity. Comparing atmospheric-electric field measurements over a lake area with measurements over a land area, Muhleisen found comparatively large fluctuations over the water. He suggested that the difference was caused by air turbulence in the electrode effect layer over the water or by the electrification of sea or lake bubbles, which tends to make the measurements of the Carnegie and the Maud expeditions somewhat questionable. The final paper by Bricard (an added paper) showed the interesting effect of an electric field changing the degree of supercooling of a given water sample, a field raising the freezing point by as much as 16° C.

AUGUST 29 and 30, 1963

SPACE SCIENCE SESSIONS

These meetings were arranged by the Secretary in order to provide adequate place for the presentation of many papers, some of them of great interest, that could not be included in the regular framework of the existing committees. Dr. Roederer took the chair in these meetings.

(1)* O. LUCKE: *The adiabatic invariants of the movements of electric charged particles in the earth's magnetic field and the dynamic of plasma in the magnetosphere.*

(2)* H. KAUTZLEBEN: *Shock waves in the plasma of the earth's outer atmosphere.*

(3)* SHABANSKY: *About the behaviour of an energetic particle on the front of the hydromagnetic shock-wave.*

(4)* A. V. GUIJELMI: *On the desintegration influence of the alfven wave in the exosphere upon the character of the short-period oscillations of the earth electromagnetic field.*

(5)* E. I. GLUSHKOVA: *Peculiarities of the magneto-ionosphere disturbances in transitional zone.*

(6)* J. R. SPREITER: *On the stability of the boundary of the geomagnetic field.*

(7)* B. R. BRIGGS: *Theoretical determination of the magnetosphere boundary and the enclosed geomagnetic field.*

(8)* R. J. SLUTZ: *Geomagnetic field distortion from currents in the magnetosphere boundary.*

(9)* G. D. MEAD and D. B. BEARD: *The magnetic effects of currents at the boundary between the geomagnetic field and the solar wind.*

(10)* M. SUGIURA, T. D. DAVIS and J. P. HEPPNER: *Solar wind modulation of the geomagnetic field as observed at the earth's surface.*

(11)* A. S. DVORYASHIN: *Proton flares and the geometry of the interplanetary magnetic field.*

(12)* V. M. MISHIN: *About the structure Sa. the position of the magnetosphere neutral points and the spectrum of the soft solar corpuscular radiation.*

(13)* E. W. HONES JR.: *Trapped particle distributions within the earth's magnetosphere.*

(14)* I. P. IVANENKO and V. P. SHABANSKY: *On the origin of the earth's radiation belts.*

(15) V. E. NESTEROV, N. E. PISSARENKO, I. A. SAVENKO and P. I. SHAVRIN: *L'étude des ceintures de radiation au cours du vol des appareils cosmiques.*

(16)* M. S. BOBROV: *Geomagnetic belts of the earth and solar corpuscular radiation.*

(17)* B. A. TVERSKOY: *On the theory of radiation belts of the earth.*

(18)* F. WARG and MACDONALD: *The effect of sunspots on the prediction of magnetic activity.*

(19)* T. OGUTI, E. KANEDA and T. NAGATA: *Inter-relationship among geomagnetic disturbances, auroral displays and anomalous ionization in the ionosphere in the polar regions.*

(20)* V. E. STEPANOV, E. F. SHAPOSHNIKOVA and N. N. PETROVA: *The catalogue of strenghs and polarities of magnetic fields of sunspots for the period of international geophysical year.*

(21)* G. W. KUKLIN and V. E. STEPANOV: *The motion of the gas and magnetic field in the sunspots.*

(22)* A. B. SEVERNY, E. F. SHAPOSHNIKOVA, N. V. STESHENKO, S. I. GOPASJUK and M. B. OGIR: *The solar flares and their forecast.*

(23)* M. N. BNEVYSHEV: *On the nature of the 11-year cycle of solar activity.*

(24)* D. E. GAULT: *The terrestrial accretion of lunar material.*

Only ten of the twenty four scheduled papers were presented. Abstracts of all these papers were available. The first eight papers presented at the first session, noted that conditions arising from the confinement of the geomagnetic field and the magnetosphere within a finite volume or cavity in the streaming solar plasma formed a common bond linking all these papers.

The shape and location in space of the boundary of the geomagnetic field in a steady solar wind, and the field distortions resulting from the current system defining the boundary, were discussed in accordance with the classical Chapman-Ferraro model in three papers by Briggs, Slutz, and Mead and Beard. Although the methods and approximations employed differed, the results were strikingly similar for the single case considered, namely, the case in which the magnetic dipole axis is normal to the direction of the solar wind. This problem may, therefore, be considered to be essentially solved, although completion of the analysis for other orientations of the dipole relative to the wind direction remains.

The corresponding model for unsteady winds was used by Spreiter to study the dynamical response of the boundary to a variety of initial distortions such as might be caused by irregularities in the density or velocity of the solar wind. Small distortions were shown, to a first order, to drift along the boundary with the tangential component of the solar wind and to damp exponentially with time. The time constant increases to infinity, however, for distortions in the form of corrugations aligned with the local magnetic field. Higher-order analysis of aligned waves reveals that curvature of the equilibrium boundary introduces a destabilizing influence in small regions over the poles immediately downwind from the neutral points in the boundary, and a stabilizing effect elsewhere. A snapping type of dynamical response culminating in multiple collisions, which appears capable of injection of widely separateed elongated columns of solar plasma into the magnetosphere, was also revealed.

Using a simplified model for the asymmetric distortion of the distant geomagnetic field, Hones described the motion of energetic charged particles trapped in a magnetosphere corotating with the Earth. It was shown that such considerations drastically affect the calculated drift paths of particles in the energy range below a few tens of kilovolts. Theoretical spectral and spacial distributions of energetic electrons and protons were presented and compared with recent particle measurements by Explorers 12 and 14.

Analysis of selected geomagnetic data observed at the Earth's surface and the deduction of suggestions for the nature of the fluctuations of the solar wind and of the interaction with the magnetosphere formed the subject of three papers. Sugiura, Davis, and Heppner examined worldwide IGY magnetic records obtained in 1958 for periods in which the Earth's magnetic field changes its level rather suddenly and returns to the original level with similar abruptness one or two hours later. In low and moderate latitudes these changes are characterized by a level change in the horizontal force such as might be expected from a sudden compression or rarefaction of the magnetosphere by an abrupt change in the solar wind momentum. In auroral latitudes the variations are often larger and much more complex than at lower latitudes, and in high latitudes the variations are often not indicative of a simple level change, but have characteristics similar to those of an elliptically polarized magnetic perturbation. This is interpreted to suggest that the impulse produced by an abrupt change in the solar wind is transmitted from the magnetosphere boundary to the Earth's surface at high latitudes along the magnetic field lines. Bobrov examined other aspects of the planetary pattern of the IGY geomagnetic disturbances and arrived at similar general conclusions. He suggested that the irregular part (D_i) of a magnetic disturbance be classified into three types, depending on the geomagnetic latitude: synphase (S) in low and moderate latitudes, local (L) in higher latitudes, including the outer auroral zones, and permanent (P) in the polar caps. The location and peculiarities of the magneto-ionosphere disturbances of the transitional region between the zones characterized by S- and L-type behavior were discussed by Glushkova. In the eastern hemisphere, this zone extends between 55° and 62° N, and in the western hemisphere between 35°-42° N. The zone shifts, moreover, with the magnetic activity. It was noted that since Gorchakov has observed that the outer radiation zone is associated with the part of the geomagnetic field that connects with the Earth's surface between 55° and 65° geomagnetic latitude, that is, the location of the transitional zone, therefore some peculiarities of the magnetic ionosphere disturbances characteristic of the transitional zone can be explained by particle motions in the outer radiation belt.

E) CLOSED MEETINGS OF COMMITTEES AND OF WORKING GROUPS

August 23, 1963

Committee 4

(1) *Participants*

Prof. T. Nagata, Chairman (Japan)
Prof. J. R. Balseley (USA)
Dr. C. M. Carmichael (Canada)
Dr. R. R. Doell (USA)
Dr. M. Fahim (Egypt)
Dr. A. Hahn (Germany)
Dr. K. Helbig (Germany)
Dr. H. H. Howe (USA)
Prof. W. G. Kertz (Germany)
Dr. K. Kobayashi (Japan)
Dr. M. Ozima (Japan)
Prof. T. Rikitake (Japan)
Prof. E. Thellier (France)
Dr. K. Whitham (Canada)

(2) *Chairman's report*

The chairman briefly reported the activity of the committee during the past three years. He also reported that the draft report of the Committee has been submitted to the Executive Committee.

(3) *Composition of the IAGA Commission No. 3*

It was suggested by the chairman that the composition of the new Commission No. 3 should be discussed. It was unanimously agreed to form the following working groups:

Working group:	Reporter:
(1) Electrodynamics	Sir E. Bullard
(2) Secular variation	Prof. V. P. Orlov
(3) Electromagnetic induction	Prof. T. Rikitake
(4) Rock magnetism	Dr. C. Carmichael
(5) Archaeomagnetism	Prof. E. Thellier
(6) Palaeomagnetism	Dr. R. R. Doell
(7) General anomalies	Dr. A. Hahn
(8) Analysis of geomagnetic field	Dr. A. H. Zmuda

AUGUST 28, 1963

COMMITTEE 2

The following people were in attendance: Barbier, Chamberlain (Chairman), Davis, Halliday, Hunten, Kvifte, Lange-Hesse, Lassen, Lincoln, McNamara, Oguti, Paton, Rees, Schneider, A. Vassy.

The agenda consisted of the following items:

(1) *Reorganization of IAGA Committees.* The Chairman outlined the organization of the new Commission VI (Aurora), which is also explained in the attached memorandum. Barbier outlined the organization of Commission VII (Airglow).

(2) *Definition of Areas of Interest for Commission VI (Aurora).* Schneider noted that the definition of interest as proposed by the IAGA Executive Committee left something to be desired. The Committee voted to recommend to the Executive Committee the following definition, which was communicated by the Chairman to the Executive Committee:

> *Commission VI*
>
> Commission on Aurora, dealing with all auroral observational techniques, procedures of data acquisition and processing, auroral morphology, and problems relating to the various phenomena that result from charged particles entering the earth's upper atmosphere.

(3) *New Auroral Classification.* Paton reported on the classification scheme developed by the subcommittee of which he was Chairman and exhibited a copy of the new International Auroral Atlas (Edinburgh, University Press). As this subcommittee received its mandate from the Executive Committee of IAGA, rather than from the parent Committee 2, no action was taken on the report.

(4) *Magnetic Indices.* Schneider noted that the geomagneticians were in the process of devising new procedures for compiling the magnetic indices and advocated that Q-indices should be retained

as being convenient for auroral research. Some Committee members felt that K-indices were sufficient, others felt that adequate analysis required use of the magnetic records by the auroral researcher himself. As there was clearly no agreement, no resolution was introduced.

(5) *Other Business.* There being no other business, the Chair was turned over to Paton for a meeting of the IAGA-IQSY Advisory Committee on Aurora.

August 27, 1963

Committee 6

The following agenda was discussed:

(1) Committee report to the IAGA and IAMAP.
(2) Criteria for grouping of data and lunar work (season, solar activity, magnetic activity, lunar parameters).
(3) Measures to promote world wide representation of lunar variations and to extend lunar studies geographically and to other domains.
(4) Terminology (lune-solar; lunar solar; geomagnetic tides; partial tides).
(5) Lunar bibliography.
(6) Financial support for lunar studies.
(7) Discussion on convenience of continuing the committee.

August 28, 1963

Committee 10

En dehors des séances générales de présentation des communications le Comité N.° 10 a eu deux séances privées le 22 et 28 Août. Outre les membres du Comité prèsents à l'Assemblée un certain nombre de chercheurs s'intéressant surtout aux problèmes du commencement des orages magnétiques et de la classification des micropulsations y ont été invités. A la séance du 22, l'on s'est mis d'accord sur la nécessité de choisir un certain nombre d'Observatories dûment outillés et bien distribués en latitude et longitude chargés de fournir au plus tôt les données sur l'heure précise du commencement des orages à début brusque (ssc). Quant à la nouvelle classification des pulsations, l'on rendit compte des différentes methodes proposées au Comité et particulièrement de elles de Sir Charles Wright et Messieurs Jacobs, Smith, Matsushita, Selzer, Kato et Saito. Un souscomité de cinq membres constitué par Mme. Troitskaya et Messieurs Jacobs, Kato, Nelson et Selzer fut chargé d'étudier davantage la matière et préparer les resolutions concernant les deux questions. Celles-ci furent présentées au Comité à la séance du 28 et après quelques retouches elles furent approuvées sous la forma exprimée dans les résolutions 28 de l'UIGG et 13 de l'IAGA. Les stations choisies sont les suivantes. Dans les régions polaires Heiss (Tichaya Bay) et Mirny, dans les régions approximativement conjuguées à l'intérieure de la zone aurorale; Great Whale et Mary Bard, dans des conditions semblables; Lovozero et Kerguelen, dans des régions approximativement conjuguées dans la zone aurorale; et finalement College et Macquarie Island, dans les mêmes circunstances. Pour les latitudes moyennes Chambon la Forêt, Borck, Irkutsk, Onagawa, Tucson, Friedericksburg, Trelew et Hermanus. Et pour les régions équatorielles M'Bour, Bangui, Guam, Honolulu, Zaria et Addis Ababa. Quelques unes de celles-ci n'étant pas encore dûment outillés (Great Whale, Trelew, Zaria et Addis Ababa), l'installation en elles d'enregistreurs rapides fut instamment recommandée. Pour le reste l'on décide que cette liste devait être considérée comme provisoire et que d'autres stations pourraient y être aggrégées dans l'avenir à fur et à mésure qu'elles fussent en situation de rendre efficacement le service envissagé.

August 29, 1963

Working Group on Geomagnetic Anomalies

(New IAGA Structure)

The group is concerned with magnetic structures in the earth's crust between surface and Curie-depth, which may be detected by interpretation of sufficiently detailed geomagnetic maps. *Main objects* should be the big structures with an extension of *50 km* and more.

Suggestions and recommendations have been made on the following topics:

1. *Geomagnetic Map*

a) Scale

The following scales are recommended as suitable:

1 : 250 000
1 : 500 000
1 : 625 000
1 : 1000 000

b) Maps available

It is desirable to get a review of all published geomagnetic maps which may be used in this work. The area covered by those maps should not be smaller than about 200 × 200 km². Furthermore, it should be tried to obtain suitable information from unpublished maps as far as possible.

c) Regional Field

Attention is drawn to the fact that on each map showing anomalies after subtraction of a regional field, *this regional field should clearly be indicated.* Additional maps, where only corrections of time variations are applied, are desirable.

2. *Interpretation*

a) A list of literature concerned with the problems of the w. g. will soon be send to all members of the working group who are kindly requested to complete this list.

b) Each member is requested to send reprints of publications concerning the work of the group to all members.

c) A questionnaire shall be sent to all members in order to get a review on interpretation methods usually applied. At the same time, lists of published maps shall be gathered.

3. It is recognized that the work of the group needs *contact with rock magnetism, gravity measurements, seismology, heat flow studies, geology.*

4. Professor Rikitake suggested, as a special task for the working group, *the interpretation of the pronounced geomagnetic anomalies* frequently observed *above the boundary between shelf and deep sea.*

F) PRESIDENTIAL ADDRESS

The Old Association and the New One

by V. LAURSEN

As you will know it has been suggested, and the suggestion will be one of the principal subjects for discussion at this General Assembly, that the structure of our Association shall be changed or modernized in order to correspond better to the actual stage of development of the geophysical sciences, which the IAGA is representing in the Union of Geodesy and Geophysics — those of Geomagnetism and Aeronomy.

Is has been felt that the actual structure of the Association is perhaps too much bound by traditions. Traditions which are reflected for instance in the maintenance of a standard set of Special Committees, carrying out certain tasks in accordance with instructions given to them many years ago. These Committees have certainly been working faithfully within their domains, most valuable results have come out of their activities, and all of them have tried to cope with the recent amazing development within practically all the classical domains of geomagnetism and aeronomy; but what about the many new and fascinating domains which have opened up during recent years, for instance in connection with the extension of geophysical investigations into space? How can we modify the structure of our Association in order to make proper allowance for such new domains, thereby maintaining the position of the Association as the adequate forum for discussion of all problems relating to geomagnetism and aeronomy?

Before entering into a discussion of possible change of the structure of our Association, it may be worth while to review in a few words the historical development, which has led to the IAGA of today, and I feel convinced that such a review will prove to anyone, who may be in doubt, that the Association has always been a most active organization, which has played an important role in the development of the science with which it is concerned.

The Association, or what should be the Association was formed in Brussels in 1919 as a Section of the new International Geodetic and Geophysical Union, the Section of Terrestrial Magnetism and Electricity.

The first ordinary meeting of the Section was held in Rome in 1922, and when Dr. Chree, as Vice-President of the Section, addressed a few words of welcome to those present at the opening meeting he was facing an audience of 18 delegates, representing 7 countries. The questions to be discussed at the meeting were mainly of a technical nature, concerning instruments, the working up of magnetograms, magnetic surveys, etc., but also the characterization of days and magnetic activitty, and at the end of the meeting five Special Committees were established:

(1) Committee on Magnetic Surveys and International Comparisons of Instruments.
(2) Committee on Observational Work in Atmospheric Electricity.
(3) Committee on Measures of Magnetic Characterization of Days.
(4) Committee on Methods, Instruments and Compilations for Polar-Light Observations.
(5) Committee on Methods and Instruments for Earth Current observations.

Also the following meetings, in Madrid 1924 and in Prague 1927, were to a large extent devoted to practical observational subjects, thereby reflecting the fact that nearly all the participants in these first meeting were scientists responsible for the operation of magnetic observatories or for the carrying out of magnetic survey work.

From the very beginning it has been considered one of the main tasks of the Section or the Association to study the distribution of magnetic stations over the surface of the globe, and to make recommendations with regard to the establishment of new stations in regions where such stations are most badly needed. It can be safely concluded that such an official recommendation from our Group has in many cases played an important role in the considerations which have eventually led to the creation of a new magnetic station, and from this point of view it is gratifying to note that the number of magnetic observatories has increased during the lifetime of the Association from about 50 in 1919 to about 150 in 1963.

At the Stockholm meeting 1930 one of the main items on the agenda was the forthcoming International Polar Year 1932-1933, and it should be emphasized that although the Polar Year was carried out under the auspices of the International Meteorological Organization, the Section or the Association of Terrestrical Magnetism and Electricity as it was now called, made most substantial contributions to the accomplishment of this large international research project. The Association financed the publication of the well-known Photographic Atlas of Auroral Forms, which proved so very important for the auroral observations during the Poler Year. It also provided special auroral, cameras and auroral spectroscopes for use at Polar Year stations, it contributed largely towards the establishment of comprehensive archives of photocopies of magnetic registrations and other magnetic data, obtained during the Polar Year, a forerunner of the present day World Data Centres, and it defrayed the expenses of the publications of the magnetic character, figures for the Polar Year.

Otherwise the publication of magnetic character figures was up to 1937 the responsibility of the International Meteorological Organization, but since then the continuation of this important publication has been one of the outstanding tasks of our Association.

At the Washington meeting 1939, it was recommended that for a trial period of three years, 1940-1942, magnetic observatories should be invited to supply, in addition to the classical daily character figures C, the so-called K-indices or three-hour-range indices, especially as an attempt to meet the requests made by the International Union of Scientific Radio and other bodies for more detailed information with regard to the magnetic activity and its variation. Due to the outbreak of World War II the trial period of three years became one of eight, and when the Association met for the first time after the war (Oslo 1948) there was a general agreement that the scheme of K-indices should be continued on a permanent basis. Most of you will know that the series of Association Bulletins 12 have been suplemented recently by a composite volume, Bulletin 18, containing planetary three-hour-indices Kp, and other derived quantities for the thirty years 1932-1961.

On behalf of the Association Father Mayaud is making a detailed study of the original magnetograms at a great number of observatories all over the world in order to arrive at an even better basis for the derivation of geomagnetic activity indices. We hope that Father Mayaud will be able to give a preliminary report of his investigation at this meeting.

At the Brussels General Assembly 1951 the attention of the Union was drawn to the fact that the actual structure of the Union and its Associations did not provide an appropriate organization to which to refer questions relating to the rapidly developing domain of upper atmospheric physics. A joint commission of the Association of Meteorology and the Association of Terrestrial Magnetism and Electricity was established under the chairmanship of Professor Chapman, the President of the Union, to study the problem, and an agreement was obtained, which was later approved by our Association at its meeting in Rome 1954. The agreement specified the fields of upper atmospheric physics which fall within the domain of either Association, and in order to express in the very name of our Group this formal extension of its activities, it was decided at the Rome meeting that the future name of the Assoriation of Terrestrial Magnetism and Electricity should be the Association of Geomagnetism and Aeronomy. The name was suggested by Professor Chapman who defined as follows this new word aeronomy:

«Aeronomy is the science of the upper atmosheric regions where dissociation and ionization are important.»

The activities of the Association within the domain of upper atmospheric physics have to a large extent been the responsibility of the IAGA Special Committee on Aeronomy, and to characterize these activities it will suffice to call to mind two highly successful symposia arranged by the Committee, one in Toronto in connection with the 1957 General Assembly, the other in Copenhagen in connection with the Helsinki Assembly 1960. To judge from the agenda there is every reason to believe that the aeronomy symposium planned for the Berkeley meeting will be equally successful.

Needless to say that the International Geophysical Year 1957-58 was from the very outset a primary concern of our Association, and that the Association and its Special Committees played an important role in the establishment of the observational programme within the domains of Geomagnetism and Aeronomy. One main item of the programme was the investigation of rapid variations in geomagnetism and earth currents, and a heavy burden was placed on our Committee No. 10, who was entrusted with the establishment of a classification scheme for such variations and the preparation of an atlas of typical forms. The first condition of a fruitful discussion of the rapid variations and their origin is of course that those discussing are using the same designation for the same thing.

Another outcome of the participation of the Association in the programme of the IGY is the extensive collection of descriptions of geomagnetic observatories, prepared by our Committee on Observatories at the request of the CSAGI and published in three volumes as a IAGA publication.

In continuation of these few words about the role of the IAGA in the IGY it seems natural to mention that the planning of the IQSY, the International Years of the Quiet Sun, has also to a large extent been basd on the cooperation of the Association in so far as geomagnetic and aeronomical observations are concerned. Four IAGA advisory groups have been formed for the IQSY, one for geomagnetism, one for aeronomy, one for aurora and one for airglow, our Committee on Instruments is working hard on a survey of the present situation with regard to available instrumental equipment for geomagnetic and earth current observations, and our Committee on Aurora has, through its very active Sub-Committees, made most remarkable progress in the preparation of guide books to be used by auroral observers during the IQSY. A new and modernized atlas of auroral forms has just been published, and a manual for amateur observers will follow.

Those who have been attending the latest General Assemblies of the IAGA will have noted the rapidly increasing interest which our Association is taking in that fascinating object of paleomagnetism. The symposium on palaeomagnetism, arranged by our Committee on Palaeomagnetism and Secular Variation as part of the General Assembly in Toronto, was rightly recorded among the highlights of that meeting. Another symposium under IAGA auspices was held in Kyoto in 1961, and we can be looking forward with interest to the symposium on palaeomagnetism and palaeoclimatology which has been planned for the Berkeley meeting as a joint arrangement with the Association of Meteorology and Atmospheric Physics.

Also the World Magnetic Survey has had a high priority among the topics discussed at recent IAGA meetings. The World Magnetic Survey was suggested at the Toronto Meeting as a deferred item of the IGY, and for a long time the project was quite naturally considered part of the responsibility of the CSAGI and later of the CIG. At the same time the IAGA has given consideration to the technical problems involved; our Special Committee on World Magnetic Survey and Magnetic Charts has been acting as an advisory group for the project, and a WMS manual has been prepared and issued as IUGG Monograph No. 11.

At its XIV meeting at Prague in October 1962 the Executive

Board of ICSU —the International Council of Scientific Unions— decided that the World Magnetic Survey should be the sole responsibility of the IUGG. This means in reality that from now on the full responsibility rests with our Association, and in order to meet this new obligation the Executive Committee has found it advisable to create within the IAGA a special group, the World Magnetic Survey Board, which has been entrusted with the organization and coordination of the project. The Board will have a small secretariat located at the United States National Academy of Sciences, Washington D. C., under the direction of Dr. Vestine. It has been one of the first tasks on the secretariat to prepare a programme and a budget for certain WMS pilot studies, and it is our hope that UNESCO will find it possible to give financial support to this programme in accordance with a proposal submitted through the IUGG.

It has been most gratifying to note the general interest with which the WMS project has been met all over the world. A great number of countries have found it profitable to combine their participation in the geomagnetic programme of the IQSY with a magnetic survey programme within the framework of the WMS. At one of the meetings during the Berkeley Assembly there will be a general discussion of the World Magnetic Survey project, with the participation of national representatives responsible for or engaged in magnetic survey work. There will also be a meeting on methods and instruments for aeromagnetic surveys.

In many fields the sphere of interest of our Association has points in common with that of the Association of Meteorology and Atmospheric Physics, a fact which is reflected in the establishment of two joint Committees of the two Associations, one on Lunar Variations the other on Atmospheric Electricity. The latter Committee has recently been active as co-sponsor of a Conference on Atmospheric and Space Electricity which was held in Montreux, Switzerland, earlier this year.

The list of scientific meetings held during the last triennial period under the auspices of the IAGA would not be complete without mentioning the Symposium on Earth Storms, held in Kyoto in 1961, and the Symposium on Equatorial Aeronomy, held in Peru in 1962.

This was just a very brief outline of the history of our Association, with some emphasis on IAGA activities during the last three years. I am aware, of course, that in giving this outline I am trespassing on the preserves of our Special Committee on the History of Geomagnetism and Aeronomy, established in Toronto 1957 and justifying its existence so convincingly during the Helsinki meeting 1960.

It has been my intention to prove that the Association of Geomagnetism and Aeronomy has contributed and is contributing greatly to the advancement of the sciences with which it is traditionally concerned. If we now propose a change of its structure, we are doing so in the hope that we shall succeed in transforming the IAGA into an even better and more active organization, not only for the handling of the many tasks which by tradition fall into the domain of the Association, and which should certainly not be neglected, but also for the discussion of the many new problems which arise out of the growth of our sciences, and which are so markedly reflected in the agenda for this General Assembly.

G) REPORT OF THE SECRETARY AND DIRECTOR OF THE CENTRAL BUREAU FOR THE PERIOD 1960-1962

General

The period between the 12th and the 13th General Assemblies has been characterized by the increasing activity of the Association in many fields, and I think that a good summary appears in the problems discussed at the meeting of the Executive Committee that took place in Paris on the 30th and 31st of March 1962 with all its members in attendance.

The agenda adopted was as follows:

(1) Reorganization of the IAGA Structure and of its Committees,

(2) Major projects in which IAGA is involved,
- a) IQSY
- b) World Magnetic Survey
- c) Upper Mantle Project
- d) Atlas of Auroral forms.

(3) Future Symposia,
- a) Aeronomy (Berkeley)
- b) Palaeomagnetism
- c) Atmospheric Electricity
- d) Equatorial Geophysics.

(4) Organization of the Berkeley General Assembly.

(5) Miscellaneous.

As I shall deal afterward with the Reorganization of the IAGA Structure and the World Magnetic Survey, let us drop for the moment these two items of the Agenda.

The participation of the IAGA in the IQSY, has been accepted from the very beginning and our reporters for the IGY (Dr. Laursen for Geomagnetism and Dr. Nicolet for Aeronomy) were appointed reporters for the IQSY; it was decided to propose to CIG the names of Dr. Barbier and of Mr. Paton to serve as reporters for Airglow and for Aurorae; both names have been accepted and they have already been present in the IQSY Groups in this capacity.

Following a CIG reccommendation it was decided to nominate the following IAGA-IQSY advisory groups to help the reporters in their tasks:

Airglow

Dr. Barbier (France). Reporter and Chairman

Bates (U. K.)	Huruhata (Japan)	Nicolet (Belgium)
Chiplonkar (India)	Krasovsky (USSR)	Roach (USA)

Aurorae

Mr. Paton (U. K.). Reporter and Chairman

Chamberlain (USA)	Hultqvist (Sweden)	Schneider (Argentina)
Chapman (U. K.)	Jacka (Australia)	Stoffregen (Sweden)
Elvey (USA)	Lange-Hesse (Germany)	Omholt (Norway)
Gartlein (USA)	Lebedinsky (USSR)	

Aeronomy

Dr. Nicolet (Belgium). Reporter and Chairman

Blamont (France)	Friedman (USA)	F. Johnson (USA)
Carmichael (Canada)	Gringaus (USSR)	Maeda (Japan)
Dalgarno (U. K.)	Istomin (USSR)	D. F. Martin (Australia)
Ehmert (Germany)		

Geomagnetism

Mr. Laursen (Denmark). Reporter and Chairman

Bartels (Germany)	Nagata (Japan)	Vestine (USA)
Kalinin (USSR)	Troitskaya (USSR)	

There was in and after Helsinki the feeling that the work of the Association in the field of Aurorae was not as good as it should be, and it was therefore agreed to create in our Com. n. 2 a sub-committee on instruments and to continue the existence of the sub-committee on the Auroral Atlas. These groups have been active since its creation and my thanks go specially to Mr. Paton, who through a very efficient leadership and, with the collaboration of his colleagues, has produced the new Atlas of Auroral forms which, I am sure, will be a very great help to all scientist interested in these studies.

Our President has outlined already the new organization of the IAGA that the Executive Committee proposes for your consideration and approval. It is up to you to discuss it and to suggest changes for improving it. Let me only tell you here that it is essential that the Secretary of the Association may have fully reliable and specialized scientist to consult in the many problem that arise in handling the affairs of the Association and to state clearly that the old Committees, in some cases with over 30 people listed, were not a practical and efficient organism.

The World Magnetic Survey, has grown considerably and I hope that in the open meeting of the WMS that will be held during this General Assembly you will see the progress done so far. At the Rome meeting of the Executive Committee it was decided the creation of a WMS Board, and for the period until this Berkeley General Assembly the following membership was adopted:

Chairman:	President of IAGA (Dr. Laursen)
Vice-Chairman:	N. V. Pushkov
	E. H. Vestine
Members:	Secretary of IAGA (J. O. Cardús)
	T. Nagata

with a small secretariat under the supervision of E. H. Vestine.

If is muy pleasant duty to thank Dr. Vestine for the very good work done in the Board and for the production in the IUGG Monographs of an Instruction Manual that is a very great help to all people interested in this programme.

As for the symposia decided at Paris the one on Atmospheric Electricity (jointly with IAMAP) took place in Switzerland and the other on Equatorial Geophysics was organized in Peru. Both of them were very satisfactory on account of the number of participants and of the quality of the communications presented. The other two Symposia on Aeronomy and on Palaeomagnetism will take place during this General Assembly and I am sure they will also be a success.

The Association has also been rather active on its regular publications: Our Permanent Service (under FAGS) has issued regularly the K-Indices and the preliminary quarterly lists of Rapid Variations and has continued the publication of the Bull. n. 12; I wish to point out here that since number 12m this Bulletin has been divided into two parts 1) K and C Indices and 2) Rapid Variations:

IAGA Bulletin n.	12 l	Geomagnetic Indices and Rapid Variations, 1957.
	12m1	Geomagnetic Indices, 1958.
	12m2	Rapid Variations, 1958.
	12n1	Geomagnetic Indices, 1959.
	12n2	Rapid Variations, 1959.

Other publications are:

IAGA Bulletin n. 18 - Collection of Kp Indices 1932-1961,

IAGA Symposium n. 1 - Aeronomy Symposium 1961

and we have also distributed:

IAGA Bulletin n. 16c - Utrecht Symposium on Rapid Variations.

At this point of the Report I cannot avoid to mention the delay in the publications of the Transactions of the Helsinki Meeting; the always increasing work in the Secretariat and the lack of proper clerical help have prevented its issue. I can only promisse you that I shall do muy best to see them published by the end of this year and the Transactions of this meeting by the end of next March.

HELSINKI RESOLUTIONS

The Helsinki Resolutions were transmited to various National Committees and interested organizations, but as usual, very few answers were received and it is impossible from them to judge how effective they were.

Finances

The budged adopted by the Association at Helsinki for the period 1st January 1960 - 31st December 1962 was as follows:

ESTIMATED RECEIPTS	$	ESTIMATED PAYEMENTS	$
Balance 1/1/1960	7,712.11	Secretariat (from last period)	632.14
IUGG Allocation Part 1957-1959	3,000.00	Subvention to permanent Services from last period	730.00
1/1/1960-31/12/1962	10,500.00	CR Assembly Toronto	2,550.00
From Permanent Services	349.05	CR Symposia Toronto	512.14
Sales of Publications	47.67	Helsinki General Assembly	900.00
Total	21,608.83	Helsinki Transactions	5,000.00
		Menagement expenses	1,500.00
		Meeting of the Executive Committee	3,000.00
		Tokyo Symposium	2,000.00
		Magnetic Indices	1,000.00
		Comparisons	1,000.00
		Rapid Variations: Pub. Utrecht Symposium	1,000.00
		Lunar studies	1,000.00
Estimated payements	20,824.28	Total	20,824.28
Estimated balance 31/12/62	784.55		

Actual receipts and payements for the period are listed in the appended summary statement of the accounts, that is a summary of the part-statements from Washington, Copenhagen and Tortosa. All these statements will be submitted to the Special Finance Committee appointed for the Berkeley Assembly.

In general I must say that the finances of the Association are certainly not affluent but they are in good shape and the main reason for it is the very valuable contribution the Association receives from many Institutions and scientist who contribute to the work of the Association and to the preparation of its publications free or charge.

Thanks

Af the end of my six-years period as Secretary of the Association I wish to express my most sincere thanks to all of you, to the members of the two Executive Committees and in a very special way to the two Presidents of the Association under whom I had the privilege of serving, Prof. Kaplan and Dr. Laursen, my most sincere thanks for having done my task as easy and pleasant as possible; Thanks to all of you!

H) STATEMENT OF ACCOUNTS AND BUDGET

International Association of Geomagnetism and Aeronomy

Summary statement of Accounts from January 1st 1960 through December 31st 1962

RECEIPTS

	$	$
Balance 31st Dec. 1959		
Dan. Acc.	2,269.—	
U. S. »	4,360.62	
Span. »	1,082.19	7,712.11
Allocations from the Union		
Part payement 1957-1959 (3 × 500 £ - 1,000 $)	3,200.—	
1960-1962 (3 × 1,300 £)	10,920.—	14,120.—
UNESCO GRANTS IN AID		
Comparisons (Dan. Acc.)	1,000.—	1,000.—
Sales of publications		
Span. Acc.	335.47	335.47
Interests		
Dan. Acc.	233.—	
U. S. »	562.16	795.16
Miscellaneous		
Refund from K-indices (Span. Acc.)	349.05	
Arrangement in Exchanges (Span. Acc.)	19.17	368.22
		24,330.96

PAYEMENTS

	$	$
Subvention from Association funds to Permanent Services		
K-indices (Span. Acc.)	1,130.—	
Lunar Studies (Span. Acc.)	1,320.—	
Comparisons (Dan. Acc.)	861.—	3,311.—
Publications:		
Bull. 16 (part payement) (Dan. Acc.)	2,411.—	
Bull. 16a + 16b (part payement) (Span. Acc.)	512.14	
Bull. 16c (Span. Acc.)	360.—	
Post of publications (Span. Acc.)	256.19	
» » (Dan »)	249.—	3,788.33

Secretariat:		
Dan. Acc.	79.—	
Span. »	1,483.54	
» » (from last period)	632.14	2,194.68
Helsinki Assembly		
Span. Acc.	884.89	884.89
Meeting Executive Committee (Span. Acc.)	2,076.—	2,076.—
Balance 31st Dec. 1962		
Dan. Acc.	1,202.—	
Span. »	5,951.28	
U. S. »	4,922.78	12,076.06
		24,330.96

The above statement is summarising the three sub-accounts of the Association: the U. S. sub-account prepared with references from Dr. Joyce, the danish sub-account prepared with the yearly accounts of Mr. Laursen and the spanish sub-account prepared by the Secretary of the Association. In the danish sub-accounts all payements in danish crowns have been converted into U. S. dollars using the rate of exchange 1 $ to 6.90 danish corons and the results have been rounded to the nearest dollar. In the spanish sub-account the range of exchange has been 60 ptas. per dollar.

Ebro Observatory,the 4th of March, 1963.

J. O. Cardús, S. I.
IAGA Secretary

Report of the Committee on Finances of the IAGA

The three members of the Committee on Finances of the IAGA (Prof. Thellier, Dr. Schneider and Dr. Veldkamp, convenor) have examined on August 26, 1963, the financial report by Dr. Cardús, secretary of the Association for the period January 1, 1960 through December 31, 1962.

The report was found to be quite clear and satisfactory, and the Committee proposes the Association to convey to Dr. Cardús its deep appreciation for the way in which he has taken care of the finances of the Association.

Berkeley, August 27, 1963.

J. Veldkamp *E. Thellier* *O. Schneider*

Approved IAGA budget for the period 1st January 1963 to 31st December 1965

ESTIMATED RECEIPTS

	$
Balance 1/1/1963	12,076.06
IUGG Allocation	18,000.—
Sales of publications . . .	1,000.—
Total	31,000.
Estimated payements . . .	29,000.—
Estimated balance 31/12/65 .	2,000.—

ESTIMATED PAYEMENTS

	$
Subvention to permanent services:	
K-indices (travel-expenses).	2,500
Atlas Rapid Variations . .	1,500
Rapid Variations	1,000
CR Helsinki Assembly . . .	5,000
CR Berkeley Assembly . . .	5,000
Menagement Expenses . . .	2,000
Meeting of the Executive Committee	3,000
Comparisons	1,000
Lunar Studies	1,000
Expenses Berkeley Assembly. .	3,000
Symposia	4,000
	29,000

I) REORGANIZATION OF THE IAGA STRUCTURE

Introduction

The rapid development of the Geophysical Sciences which are the main concern of the IAGA has outgrown in many circumstances the present structure of the Association. The numerous scientific and technical achievements which have been recorded during recent years within Geomagnetism and Aeronomy have usually been well reflected in the agenda of the triennial General Assemblies of the Association, but it is felt that in many cases the present structure of the IAGA, with its system of more or less permanent Committees, does not provide, between the General Assemblies, an adequate organization for discussion and further development of the many new and important fields of research which are continuously opening up as a result of the progress made.

For the time being the list of IAGA Special Committees is composed as follows:

Committee	No.	1	Observatories.
»	»	2	Aurora and Airglow.
»	»	3	High Atmosphere.
»	»	4	Secular Variation and Palaeomagnetism.
»	»	5	World Magnetic Survey and Magnetic Charts.
»	»	6	Lunar Variations (Joint Committee with IAMAP).

Committee No.	7	Comparisons.
» »	8	Magnetic Instruments.
» »	9	Characterization of Magnetic Activity.
» »	10	Rapid Variations and Earth-Currents.
» »	11	History.
Joint Committee with IAMAP		Atmospheric Electricity.

The whole question was thoroughly discussed when the IAGA Executive Committee met in Paris in March 1962, and instead of making an attempt to distribute the many new problems among the Committees already in existence, or to create a number of additional Committees to which these new problems could be referred, it was proposed to adapt the structure of the Association to the new needs, by dissolving the present system of Committees and by building up a system of Commissions which from the very outset should be organized so as to cover as adequately as possible the whole field of research which today falls within the domain of the IAGA. In creating this system due regard should of course be paid to all the modern aspects of the sciences with which the Association is concerned, but at the same time the system should provide an efficient mechanism for the carrying on of the many traditional activities which for years have formed part of the Association programme, and which are reflected in the above list of existing Committees. The proposed new Commissions are listed below with a brief description of their fields of activity. In such cases where a new Commission is supposed to take over the activity or part of the activity of one or more of the existing IAGA Committees, the number or the numbers of such Committees are indicated.

List of Proposed Commissions

Commission I

Commission on Observatories and Instruments, dealing with all problems relating to the operation of magnetic observatories and to the carrying out of magnetic measurements. This may include instrumental equipment for observatory and field use, and for use in rockets and satellites, international comparison of geomagnetic standards, form and contents of observatory publications, etc. (IAGA Committes Nos. 1, 7, and 8).

Commission II

Commission on Magnetic Charts (IAGA Committee No. 5).

Commission III

Commission on Magnetism of the Earth's Interior, dealing with observations, analyses and theoretical interpretations of all phenomena relating to the magnetism of the earth's interior, including the main geomagnetic field and its secular variation, magnetic induction within the earth, earth currents, archaeo- and palaeomagnetism, etc. (IAGA Committes Nos. 4 and 10).

Commission IV

Commission on Magnetic Activity and Disturbances, dealing with magnetic indices, solar flare effects, storm sudden commencements, other rapid variations, micropulsations and their connection with interplanetary space; earth currents (IAGA Committees Nos. 9 and 10).

Commission V

Commission on Solar-Terrestrial and Cosmic-Terrestrial Relationship, dealing with the interaction between solar emissions and the plasma and magnetic field in the solar system, involving the geomagnetically trapped corpuscles, magnetospheric phenomena and the geophysical aspects of cosmic rays. This Committee represents part of the IAGA contribution to the IAU-IUGG Joint Committee on Solar-Teerrestrial Relationship.

Commission VI

Commission on Aurora, dealing with all auroral observational techniques, procedures of data acquisition and processing, auroral morphology and problems relating to the various phenomena which result from corpuscular radiation impinging on the geomagnetic field (IAGA Committee No. 2).

Commission VII

Commission on Airglow, dealing with chemical aeronomy, and the results of reactions such as emissions without a direct effect of the magnetic field (IAGA Committee Nos. 2 and 3).

Commission VIII

Commission on Upper-Atmospheric Structure, dealing with the electrodynamics involving the aeronomic processes on nuetral and ionized particles (IAGA Committee No. 3).

Commission IX

Commission on History, dealing with the history of geomagnetism and aeronomy, involving reports on progress in geomagnetism and aeronomy obtained from national reports and other sources (IAGA Committee No. 1).

Joint Committee with IAMAP on Lunar Effects (continuation of existing Committee).

Joint Committee with IAMAP on Atmospheric Electricity (continuation of existing Committee).

WMS Board: to take care of the implementation of the WMS.

J) LIST OF NATIONAL REPORTS PRESENTED AT THE IAGA ASSEMBLY

Following a resolution adopted at the Helsinki Assembly no National Reports are reproduced in the Transactions, we only give the list of those received in time for distribution at the Meeting:

- Argentina
- Australia
- Bolivia
- Canada
- Czeckoslovakia
- Denmark
- Egypt
- Finland
- Germany
- Hungary
- India
- Iran
- Ireland
- Italy
- Japan
- Mexico
- Nigeria
- Pakistan
- Peru
- Portugal
- Roumanie
- Spain
- Union of South Africa
- U.S.S.R.
- U.S.A.

PART II

SPECIAL REPORTS

COMMITTEE ON OBSERVATORIES (No. 1)

Report by G. Fanselau, Chairman

During the triennial period of this report three circular letters have been sent to the observatories in all countries. A copy of the circular letters is enclosed.

The first circular letter was used to prepare the observations and registrations during the solar eclipse of February 15th, 1961 and was sent only to those observatories, which lie within or near the region, where it was possible to see the solar eclipse.

The second circular letter deals with the marking of geomagnetic measurements and registrations, which are influenced by artificial disturbances. The attention of the coworkers of the observatories was focussed on the effect of nuclear explosions on the magnetograms. In the last two years as much dates about nuclear explosions as possible have been collected. Further in this circular letter some symbols are given, which seems suitable for marking artificial disturbed registrations such as those influenced by nuclear explosions, by vagabond currents or other local electromagnetic disturbances, by disturbance of the instrument and by seismical —natural and artificial— disturbances.

The purpose of the third circular letter was to complete the descriptions of geomagnetic observatories, published in the three volumes of «Description des Observatoires Géomagnétique» from May 1957 till July 1959. It also seems necessary to extend these descriptions. Unfortunately only 47 observatories have answered to this circular letter up till now. For complement of the list of observatories it is necessary that all stations which have not yet done so, send their notices as soon as possible. Most desirably are such notices of the Soviet Union and the USA, where it gives a great number of observatories. But it is not clear whether there will be any possibility to publish this new collection of descriptions of geomagnetic observatories.

At this occasion it may be recommended to proof at which observatory the accuracy of measurements, especially of base line values, could be improved. In statistical research it is often an obstructing fact that many observatories have no sure base line values.

It may also be mentioned that it would be desirable to change over from registrations of D and H to the registrations of components of astronomical or still better of geomagnetic orientation.

In conclusion it may be permitted to give a recommendation for selecting equally quiet or disturbed days. Researching the field of geomagnetic variations it is often necessary to select equally quiet or disturbed days. If no special methods are used, the international quiet and disturbed days for every month are available. It is not necessary to point out here that by this way no uniform material can be gained, because in active periods other days are nominated as quiet than in inactive ones. Therefore it is better to select days with equal magnetic activity instead of selecting certain quiet and disturbed days for every month. In this case the number of quiet days is less in active periods and reverse. This nonuniform distribution is a natural fact and is convenient to the problem being solved. In the magnetic year book of the observatory at Niemegk rules of selection are used for characterizing single days. These rules were made by H. Wiese [1] in connection with those given by J. Bartels [2].

I want to propose a rule which is a bit altered against the rule used in Niemegk up till 1960. By this alteration it is prevented that the same day may belong to two groups. Five groups are provided:

Group I: very quiet days
$K_1 = 0, 1$
no $K_1 \geq 2$

Group II: quiet days
$K_1 = 0, 1, 2$
no $K_1 \geq 3$, at least one $K_1 = 2$

Group III: $K_1 = 1, 2, 3, 4$
at least one $K_1 = 3$ or 4
at least five $K_1 = 2$ or 3
at most one $K_1 = 1$
at most two $K_1 = 4$
no $K_1 \geq 5$
no $K_1 = 0$

Group IV: $K_1 = 2, 3, 4, 5$
at least four $K_1 = 4$ or 5
at most one $K_1 = 2$
no $K_1 \geq 6$
no $K_1 \leq 1$

Group V:	$K_1 = 3, 4, 5, 6, 7$	
	at least four $K_1 = 5, 6$ or 7	
	at most one $K_1 = 3$	
	at least one $K_1 = 6$ or 7	
	no $K_1 \geq 8$	
	no $K_1 \leq 2$	
Group I:	$\Sigma K_1 = 0 - 8$	$A_K = 0 - 3$
Group II:	$\Sigma K_1 = 2 - 16$	$A_K = 1 - 7$
Group III:	$\Sigma K_1 = 16 - 26$	$A_K = 8 - 18$
Group IV:	$\Sigma K_1 = 27 - 40$	$A_K = 20 - 48$
Group V:	$\Sigma K_1 = 37 - 56$	$A_K = 43 - 140$

A discussion of that proposal would be useful in order to find out the best rule for the definite recommendation.

In the third circular letter also the following proposal was given: Up to now the Committee is composed of a certain number of coworkers. The work was collected in a suitable manner by the chairman. I think it difficult and unfavourable to rest only upon some coworkers in this Committee, even if they were chosen under very expedient aspects. Rather it seems to be more profitable to know the opinion of all observatories. Therefore I would like to propose, each observatory should name a coworker, who would discuss the questions submitted by the Committee.

P. S. Kp must be used for the selection of the days, so that all observatories select the same days.

(1) WIESE, H.: *Gerlands Beiträge zur Geophysik 63* (1954), pp. 282-301, 302-317.
(2) BARTELS, J.: *Zeitschrift für Meteorologie* (1951), vol. 5, p. 236; Assoc. of Terr. Magn. and Electr., Bull. 11, Washington, 1949.

Circular Letter No. 1

Potsdam, 21st December 1960.

Geomagnetic effects of the solar eclipse on Feb. 15, 1961

Dear Sir,

as is generally known, there will be a total solar eclipse on Februery 15, 1961. However small, by experience, geomagnetic effects will be, it appears to be necessary that this event be given particular attention. The central line of shadow at various altitudes is presented in Fig. 1, i. e., for the altitudes 100 and 2,000 km in solid lines, for the other levels marked by «X». The path on the earth was obtained, as is usually done, by normal projection onto the earth's surface. Due to the integral nature of the solar eclipse effects on the earth these paths are, of course, of a somewhat hypothetical character.

Permit me to draw the observatories' attention to this event and to invite you to provide for the records being carried out with particular accuracy during the solar eclipse itself, or, preferably, during the whole month of February 1961. In this connexion the main concern is not only with the usual geomagnetic and geoelectric records, but to the same extent with the rapid run magnetograms for the determination of pulsations. Investigation of these pulsations may yield important information concerning solar eclipses. In this respect the following observatories are addressed:

Addis Ababa	Hermanus	Surlari
Chambon-la-Forêt	Kandilli	Stephanovka
Duscheti	Panagjurischte	Sverdlovsk
Grocka	Regensberg	Zaimische
Helwan		

The Potsdam Geomagnetic Institute of the German Academy of Sciences, Berlin, is establishing, during the solar eclipse, the following auxiliary observing stations to be recording, as from January 1 up to the end of February, geomagnetic and geoelectric variations: 1. Tirana (Albania), 2. Bansko (Bulgaria), 3. Burgas (Bulgaria), 4. Cluj (Roumania). In addition, the Geophysical Institute of the Czechoslovakian Academy of Sciences will maintain the station Tschirpan. Locations are shown in Fig. 2.

It is intended to utilize, apart from the determination of the geomagnetic solar eclipse effect, the ad hoc temporarily close observational network in Bulgaria and Roumania for the investigation of the conductivity in the upper crust of the earth. Observatories which are interested in the evaluation of the records are invited to announce at their earliest convenience their specific requests.

Yours faithfully
Prof. Dr. Gerhard Fanselau

Circular Letter No. 2

Potsdam, 26th April 1961.

Marking of measurements influenced by artificial disturbances

Dear Colleague,
as it is generally known, geophysical measurements are more and more falsified by artificial disturbances during the last two decades. «Artificial» means man-made.

There are natural and artificial rectifiers within the soil changing alternating currents (50 Hz, commercial currents) into direct currents. Moreover there are vagabond currents disturbing the registrations of earth-current, and if more intensive (mining and industrial districts and near railways with electrical ground connection) even the geomagnetic ones. But above all it means effects due to artificial disturbances of the ionosphere. The Argus-experiments from August, 27th and 30th, and from September, 6th, 1958, and the observations influenced by the nuclear explosions at Johnston Island (16,7° N, 169,4° W) from August, 1st and 12th, 1958, show, that nuclear explosions in higher altitudes may cause some geophysical phenomenons as there are auroras, geomagnetic and ionospheric storms, pulsations and so on. The electrons, decaying from fission fragments were trapped in the geomagnetic field. They move along the lines of magnetic force until they reach the geomagnetically conjugated point, where they are mirrored. They form a shell of suprathermic particles. The limitation of this shell is fixed by the magnetic lines taking a course near the explosion point. Therefore also the region near the geomagnetically conjugated point shows a higher ionization. This region is disturbed too. Within a region of about 2,000 km in diameter around Johnston Island an extreme increase of ionization (factor 10) due to suprathermic particles and X-rays was measured. Shock waves have a great influence too. These disturbances may cause very different effects as unusually short magnetic storms with a sudden commencement, magnetic storms with SSC*, very intensive bay disturbances, pulsations, ionospheric storms a. s. o. The amplitude of the artificial geomagnetic storms from August, 1st, 1958, came up to 150 γ. The magnitude of these artificial events is very dependent on the altitude of the explosion. Due to this propagation in the ionosphere, they may operate far about 1,000 km in diameter around the particle source, and the geomagnetically conjugated point.

I want to send you a table of nuclear explosions, next time, in order to give you the possibility, to proof whether your observatory has measured artificial disturbances caused by nuclear explosions during the last years. But it is very difficult, to get such a table, and therefore I would appreciate, if you would send me all dates about nuclear explosions (like day of the explosion, time, place, magnitude, altitude of explosion a. s. o.), you know.

However artificial disturbances do not only occur in connection with nuclear explosions. The problem of artificial disturbances is not only a geomagnetically or ionospherically one. Another example concerning astronomy and radioastronomy shall be mentioned: During the U.R.S.I.-Conference in September 1960 in London scientists took notice of a proposed space communication project which involves the injection of larger numbers (109-1012) of resonant dipoles (length: 6 cm) into one orbit around the earth within the equator-plane and one, lying in the pole-plane. Calculations have shown, that the geophysical effects are small. The changes of the geomagnetic fields are at most 10^{-2} γ. Some new lines may occur in the spectrum of aurorae due to atoms detached from the resonant dipoles. But this project is a danger to future astronomical and radioastronomical research, and the U.R.S.I. should take urgent steps to ensuree that such projects cannot endanger future research.

In order to get a good statistic, specially of world-wide events, it would be desirable to mark the artificial effects. Then it is possible to eliminate them or to give them a particular weighting coefficient.

Permit me, therefore, to propose to you a method of marking values influenced by artificial disturbances or perhaps by difficulties due to the instrument.

Σ	influenced by nuclear explosions or experiments in higher altitudes
■■	influenced by vagabond currents or other local disturbances
■	disturbances of the instrument
S	seismical —natural and artificial— disturbances (at normal and also at short-period-variometers)

Furthermore it would be desirable, that all observatories which are situated in especially unquiet districts would note this fact in the preface of each volume of their yearbooks, and —if it is possible— would give a measure in order to characterize the mean level of the technical disturbances.

I would appreciate to get perhaps some other proposals, how to improve geomagnetic statistics.

Yours faithfully
Prof. Dr. Gerhard Fanselau

Circular Letter No. 3

Potsdam, 25th June 1962.

Dear colleague,
the geomagnetic observatories and their records give the basis of research in geomagnetism and in some parts of aeronomy. Therefore the Committee on Observatories, which must treat all problems concerning geomagnetic observatories, is an important one, and it seems necessary to check the question of its inner constitution.

Up to now the Committee is composed of a certain number of coworkers. The work was collected in a suitable manner by the chairman. I think it difficult and unfavourable to rest upon only some coworkers in this Committee, even if they were chosen under very expedient aspects. Rather it seems to be more profitable to know the opinion of all observatories.

Therefore I want to propose, each observatory should name a co-worker, who should discuss the questions submitted by the Committee. It is possible, of course, to comprehend a group of observatories with an uniform central administration. Perhaps the same collaborators should be named, who are listed in «Geomagnetic Data 1958, Indices K and C» by J. Bartels, A. Romañá, J. Veldkamp, Amsterdam 1962.

I want to ask you for naming a collaborator out of your observatory or of a group of observatories, who could be addressed by the Committee on Observatories, and who is able to answer and to discuss questions. I think, this is a basis to intensify the work of the Committee.

In order to realize this proposal it is necessary to have a complete list of all observatories. I believe, each observatory addressed by the Committee possesses «The Description of Geomagnetic Observatories» volume I-III, published 1957-1959 by the Committee on Observatories. Dear colleague, I ask you for checking all statements concerning your observatory, and to send me further particulars, if it should be necessary. Further I enclose a list of all observatories and stations, where addresses are missed. I would appreciate, if you would answer, as far as possible, the questions, printed in volume I-III (see above), with regard to these observatories and stations. It is possible, of course, that some of thse stations worked only a short time, for instance during the IGY. Then I would appreciate, if you would write some words about their first and their last working day. Facilitating the answer I repeat these questions in the list, enclosed here.

Next time I want to discuss two important problems concerning all observatories:

(1) How to get scientific and practical aspects concerning distribution and establishment of observatories?

(2) How to test the exactness of the records and observations by the observatory itself or by teamwork between a group of observatories?

Dear colleague, I would appreciate, if you would write to me as soon as possible, because I think each observatory must be interested in closer teamwork.

Yours sincerely
Prof. Dr. Gerhard Fanselau

List of observatories, where only the names are known

1. Angmagssalik
2. Binza
3. Bossekop
4. Castellacio
5. Calm Bay
6. Chesterfield Inlet
7. Campbell
8. Cape Town
9. Dehra Dun
10. Fernando Poo

11. Fort Rae
12. Gr. Raum
13. Heard Island
14. Kerguelen
15. Magallanes
16. Macquarie Island
17. Mogadiscio
18. Mai-Toon
19. Nijnedewithzsk
20. Petsamo
21. Scoresby Sund
22. Sveagruvan
23. Asiago
24. Val Joyeux
25. Gibilmanna
26. Maddalena
27. Nertschinsk
28. Baldwin
29. Zinsen
30. Bonzareah
31. Los Angeles
32. Taiboku
33. Barrackpore
34. Toungoo
35. Corinaldo
36. Santiago
37. Isla de Ano Nuevo
38. Laurie Island
39. Station Plateau
40. McMurdo Sound

1. *General information*

Name of observatory
Address of observatory (village, province, country)
Telephone number of observatory
Institution from which it depends
Address of this institution
Address at which copies of records and observations may be obtained

2. *Geographical location*

2.1 Latitude (with a precision of at least one tenth of a degree)
2.2 Greenwich longitude (id.)
2.3 Geomagnetic latitude
2.4 Geomagnetic longitude
(N.B. In order to ensure uniformity of geomagnetic coordinates, it is advisable to use the coordinates fixed by the C.S.A.G.I. which are based upon the following coordinates of the geomagnetic North Pole: 78°5 N - 69° W)
2.5 Altitude (in meters and in feet)
2.6 Appearance and nature of the site near the observatory

3. *Brief historical notice*

Date of establishment. If the present observatory replaces another observatory, give name of the former and its approximate distance from the new observatory. Date of installation of instruments in present use. Etc.

4. *Short notice on building containing the instruments*

Lay-out of the floor space; dimensions; materials used in building, type of heating; etc.

5. *Artificial perturbations*

State whether electric tram lines or railway lines produce slight perturbations; whenever possible, specify the nature of such perturbations, and also state approximate distance of nearest line.

6. *Recording equipment*

6.1 Variometers: State particulars about:
- 6.1.1 Their type, approximate date of construction
- 6.1.2 Their sensitivity
- 6.1.3 Orientation of magnets:
  - a) with respect to the magnetic meridian (declination)
  - b) with respect to the plane perpendicular to the magnetic meridian (component H)
  - c) with respect to the horizontal plane (component Z)
- 6.1.4 Devices used to check orientations
- 6.1.5 Control and compensation of temperature
- 6.1.6 Devices used to measure scale values; precision reached, number of measurements per year

6.2 Recorders: State particulars about:
- 6.2.1 Their type; approximate date of construction
- 6.2.2 Speed of recording
- 6.2.3 Time-marking device used; precision of time marks N.B. This paragraph should also contain information about recording equipment for short-period variations of magnetic components

7. *Equipment for absolute measurements*

7.1 Absolute instruments used. Very brief description or reference. Precision of measurements.

7.2 Number of absolute measurements for each component which are normally carried out in one year.

7.3 State whether comparisons have beeen made with absolute instruments of other observatories. If so, give dates and results of such inter-comparisons and manner in which they were made.

8. *Equipment for field measurements*

Type of instrument used; very brief description or references; precision of measurements.

9. *Other equipment for magnetic measurements not in constant use*

For example, for measuring magnetic susceptibility of rocks, etc.

10. *Other geophysical installations depending from the observatory, or situated in its vicinity*

Short descriptions of earth's current installations, of ionospheric soundings, cosmic radiation, etc.

11. *Publication of magnetic data*

11.1 Title of publication containing these data, periodicity of publication (annual, six-monthly, etc.); date of most recent publication stating period covered.
Address where publications may be obtained.

11.2 Time used. Difference between local and universal timee.

11.3 Components whose values are published (D, H, Z, X, Y...).

11.4 State whether these are hourly values or not.

11.5 If they are not hourly values, state how they are calculated.

11.6 If they are hourly values:

11.6.1 Are they measured at the whole hour.

11.6.2 Or are they mean values for a period of one hour; Does this one-hour period cease at the whole hour or 30 minutes after the whole hour.

11.7 Other published values (daily sums and means; monthly hourly sums and hourly means; mean values for the five quiet days and the five disturbed days; daily maxima and minima; times of sudden commencements; crochets; pulsations; geomagnetic indices, etc.

11.8 State whether any magnetograms are published and how they are selected.

11.9 State whether resolutions (these resolutions are to be found in paragraph 22 of the resolutions. A copy of these is given in volume I) adopted by IAGA in Rome in September 1954, concerning the publication of magnetic data, will be applied wholly in the next collection of data, or only partially. If only partially, state which resolutions will not be carried out.

11.10 State whether any data is not published. If so, state whether it is possible to obtain them and how.

11.11 State whether the observatory contributes to the international publication of magnetic indices.

11.12 State whether data and recordings of observatory may be obtained on micro-film; what are the condition for obtaining them; address at which to ask for these micro-films.

12. *Publications other than those containing magnetic data*

Titles of publications containing papers relevant to IAGA activities: geomagnetism, earth's currents, ionospheric observations, etc. Address where such publications may be obtained.

COMMITTEE ON SECULAR VARITION AND PALAEOMAGNETISM (No. 4)

Report by T. Nagata, Chairman

I. We note with deep regret that Professor A. G. Kalashnikov of USSR, a Member of this Committee, died on the 1st of January 1962. Until his sudden death, he had made great contributions to the Committee, particularly in the field of palaeomagnetism.

II. ADMINISTRATIVE WORK OF THE COMMITTEE DURING THE PERIOD 1960-3.

(a) *General Activity of the Committee*

General activities dealing with studies of geomagnetic secular variation and palaeomagnetism (including archaeomagnetism) since 1960 were reported by the Committee members to the Committee Chairman, in response to a circular letter issued on February 27, 1963, by the Chairman. Eleven members kindly reported the activities of those studies in the areas they are concerned with. They are briefly summarized in Items (III), (IV) and (V) in this report. According to these reports, provisional agenda of the Committee Meeting scheduled on August 23, 1963, at Berkeley were prepared by the chairman, and were submitted to the membres for comments in a circular letter dated May 31, 1963.

(b) *A Symposium on Rock Magnetism and Palaeomagnetism in 1961*

In connection with the International Conference on Magnetism and Crystallography held September 25-30, 1961, at Kyoto, an international symposium on rock magnetism and palaeomagnetism was held also at Kyoto on October 2 under auspices of IAGA, IUGG. This Symposium was organized according to requests from a number of the Committee members, with the consent of the IAGA Executive Committee.

In the session on «physical problem of rock magnetism» of the International Conference on Magnetism and Crystallography, 9 papers (Neel, Cohen et al, Creer, Takada and Kawai, Kobayashi, Blackett, Akimoto, Carmichael and Ishikawa and Syono) were presented. These papers were published in the Proceedings of the Symposium, Vol. I, Magnetism.

In the IUGG Symposium on Rock Magnetism and Palaeomagnetism, 13 papers (Nagata, Domen, Janovsky and Sholpo, Kawai and Kang, Runcorn, Cox, Thellier, Blackett, Ma, Kawai et al, and three papers by Creer) were presented. The Proceedings of this Symposium were published as a special number of Journal of Geomagnetism and Geoelectricity, Vol. 13, Nos. 3-4.

(c) *Compilation and publication of annual mean values of geomagnetic elements*

Resolution No. 61 of the XII General Assembly of IUGG stated as follows:

«The International Association of Geomagnetism and Aeronomy
RECOGNIZING the importance of the publication of the most recent data on the Earth's magnetic field,
REQUESTS all magnetic observatories to send regularly, and as soon as possible, the annual mean values of the magnetic elements to the Chairman of the Committee on Secular Variation and Palaeomagnetism, who will be responsible for the prompt compilation of the data as well as its publication in an appropriate form.»

A circular letter to notify the magnetic observatories concerned and the Committee members of this resolution was delivered on March 20, 1963. In response to the circular letter, 61 magnetic observatories supplied the necessary data to the Committee Chairman. As the Royal Greenwich Observatory kindly offered the best possible informal help in the implementation of this resolution by supplying a number of additional data to the Chairman, he has obtained the recent annual mean values observed at 156 magnetic observatories over the world.

The first table of compiled annual mean values of geomagnetic elements up to 1962 will be distributed in August 1963 to all magnetic observatories, the Committee members, and organisations and scientists who may request it and it will be published in «Journal of Geomagnetism and Geoelectricity». It is expected that in the future a similar table will be published once every year in the same journal.

(d) *Reorganization of the Committee*

The IAGA Executive Committee has suggested that the Association be reorganized for the purpose of adapting it to the present situation in geomagnetism and aeronomy. In the draft proposal, it was suggested that the Committee on Secular Variation and Palaeomagnetism be dissolved,and instead a Commission on Magnetism of the Earth's Interior be newly set up. Mr. Laursen, President of IAGA has suggested that the task of the new Commission should be as follows:

«Commission on Magnetism of the Earth's Interior, dealing with observations, magnetism of the earth's interior, including the main geomagnetic field and its secular variation, magnetic induction within the earth, earth currents, archaeo- and palaeomagnetism, etc.»

Since it seems likely that the new members of this Committee will have to take important posts in the new Commission if it is set up, the above-mentioned draft proposal was circulated to the Committee members on February 4, 1963, to be considered by the members. In the circular letter concerning this matter issued by the Chairman, his personal opinion that «this Commission should consist of several sub-commissions, such as

(a) Archaeomagnetism and Palaeomagnetism

(b) Geomagnetic secular variation

(c) Electromagnetic structure of the earth's interior, etc.

was added.

Six members commented on the draft proposal. All of them are in favor of the new structure of the proposed Commission, in principle, but with certain reservation for names and order of the proposed sub-commissions.

The final decision of the Committee on this problem will be made at the Committee Meeting on the occasion of the IUGG General Assembly at Berkeley.

(e) *Organization of IAGA/IAMAP Joint Symposium on Palaeomagnetism and Palaeoclimatology*

The IAGA Aseembly at Helsinki in 1960 resolved that a symposium on palaeomagnetism and palaeoclimatology be held under the joint auspices of IAGA and IAMAP. In consultation with IAMAP, the IAGA Executive Committee proposed that the Symposium be held at Berkeley in 1963, and the proposal was accepted by the IUGG Bureau. The IAGA Executive Committee, at its meeting in March 1963, nominated the chairman of this Committee as a convenor of this Symposium, representing IAGA. In consultation with the IAMAP Secretary, the Committee Chairman prepared a provisional program of the Symposium, scheduled for August 28, 1963, at Berkeley, which was distributed on May 31, 1963 for further possible addition or amendment.

III. Geomagnetic Secular Variation

During the period 1960-63, extensive morphological and analytical studies on secular variation were made in several countries, particularly by Orlov of USSR, Leaton of U.K. and Yukutake in Japan.

A technical report on geomagnetic secular variation by the Committee Chairman, entitled «Two Main Aspects of Geomagnetic Secular Variation-Westward Drift and Non-drifting Components» was distributed to the Committee Members in May, 1963. According to the report, it seems almost established that the major parts of geomagnetic secular variation are due to the westward drift of the geomagnatic non-dipole field at a rate of about 0.2 degree/year. The residual parts of the secular variation may be considered as due to change in the pattern of the geomagnetic non-dipole field owing to growth and decay of higher harmonic poloidal magnetic fields which are caused by convective motions within the earth-core dynamo.

In connection with the «World Magnetic Survey (WMS)» program, the WMS Board, IAGA, IUGG and IAGA Committee on Magnetic Survey and Charts have called the attention of this Committee to significance of the problem of secular variation. Possible practical measures of cooperation of this Committee with the WMS program should be considered promptly.

IV. Archaeomagnetism

Archaeomagnetic studies have been developed effectively in a number of countries. Particular attention has recently been paid to the problem of secular variation of the geomagnetic field intensity, F(t), during the past several thousand years. Following Thellier's pionnering work, Burlatsukaya and Petrova in USSR and Arai and Momose in Japan have deduced F(t) secular variation based on samples in their respective regions.

From these three series of observed results, there is evidence that F about 2,000 years ago was approximately 1.5 times as large as at present, decreasing with time till the present, probably accompanied by regional secular variation of appreciable magnitude.

The Soviet and Japanese results indicate that F increased with time from about 5,000 years ago to about 2,000 years ago, when F took its maximal value.

The secular variation in geomagnetic declination and dip during several thousand years in the past has also been studied more precisely using a number of newly found samples. It seems highly desirable, however, that a standard method of dating the ages of samples such, for example, as referring to the C^{14} dating method, must be established in direct connexion with archaeomagnetism.

V. Palaeomagnetism

The fact that palaeomagnetic studies have been rapidly developed in various countries, in addition to those where the scientific research in this field had been fairly well developed, may be considered as extremely fortunate for the purpose of palaeomagnetic studies, which should base on data of global distribution.

Palaeomagnetism may include a number of significant problems in earth science. One of them is the problem of reversal of the geomagnetic field in geologic time. Evidence of reversals of the geomagnetic field in Quaternary and Tertiary has been reported on the basis of palaeomagnetic studies of rock samples in various regions over the earth's surface. Repeated reversals of the field in recent geologic time, clarified by Doell and Cox of U.S.A., seem to be especially interesting because the ages of some key samples were measured by the isotope dating method.

Systematic studies on reversal of the field have been continued also in France, Japan, Republic of South Africa, U.K., U.S.S.R. and other countries. The chief difficulty in synoptic studies on this problem seems to be casued by lack of exact ages of rock samples. For dating Quaternary rocks, an accuracy of 10^5 years is desirable, and for Tertiary rocks, errors of 5×10^5 years will be the maximum allowable value. Although the highly accurate dating of rock samples by means of K-A and Rb-Sr methods is not easy at present, it has become possible nowadays.

One of the tasks of the Committee in the future will be to organize an affective scheme for determining both the ancient geomagnetic field and the epoch, on the basis of rock magnetism and isotope geochronology.

Palaeomagnetism for older geologic time is concerned with the problems of polar wandering and continental drift of the earth. Palaeomagnetic research in this direction carried out in many countries is now being linked with palaeoclimatological studies to find synthetically probable evidence of polar wandering or continental drift. Series of works made by Blackett, Runcorn in U.K. and others have already shown the propriety of this kind of synthetic study.

The IAGA/IAMAP Symposium on Palaeomagnetism and Palaeoclimatology at Berkeley is one of the steps toward this desirable purpose taken by IAGA as well as by IUGG.

VI. Rock Magnetism

Archaeomagnetism and palaeomagnetism are based upon rock magnetism. However, rock magnetism itself has not yet been completely established. The concepts of isothermal remanent magnetism (IRM), thermo-remanent magnetism (VRM), detrital remanent magnetism (DRM), and anhysteretic remanent magnetism (ARM) have been clarified in fair detail, but the exact effect of pressure upon remanent magnetism of rocks has not yet been made clear, though the term «pressure remanent magnetism» (PRM) has already been proposed. The existing knowledge of remanent magnetism of rocks was reviewed by Nagata and by Stacey during the period 1960-1963.

One of the important problems in rock magnetism is the self-reversal of remanent magnetism. It has been reported, for example, that a number of rocks having self-reversed remanent magnetization were found in USSR. Although the mechanism of reverse TRM of the Haruna type rocks was almost completely cleared by Ishikawa and Syono, Carmichael of Canada has found a new type of reverse TRM for ilmenohaematite containing 10-20 % of ilmenite. Further, several examples of reversed remanent magnetization which are certainly caused by some unknown self-reversal mechanism *in situ* have also been found. In connexion with the reversal of geomagnetic field, it seems that self-reversal of remanent magnetization of rocks still deserves further extensive study.

It has been noticed that the magnetocrystalline anisotropy energy plays an important role in remanent magnetization of rocks. For example, the inverse type of TRM which has been newly found in Japan seems to be almost entirely due to change in the anisotropy energy with temperature. As the basis of rock magnetism studies, therefore, systematic measurements of the anisotropy energy and magnetostriction of single crystals of all rock-forming ferrimagnetic minerals will have to be encouraged. Results of experimental studies on these problems for titanomagnetites have shown that the anisotropy energy and the magnetostriction coefficients change remarkably with content of Ti.

The magnetostriction of rock-forming ferrimagnetic minerals ought to have a direct connexion with the pressure effect on rock magnetism. Studies of PRM of rocks based upon such intrinsic characters of ferrimagnetic minerals must also be encouraged.

Another problem in rock magnetism will be the effect of chemical change of ferrimagnetic minerals on remanent magnetization. Particularly oxidation of ferrimagnetic minerals during a long time may cause a serious effect upon remanent magnetization. The CRM and the combined effect of chemical and thermal changes on remanent magnetization of rocks may well deserve further detailed studies.

The effects of size and shape of ferrimagnetic grains in rocks are also serious problems in rock magnetism. Superparamagnetism of rocks owing to extremely small size of ferrimagnetic or antiferromagnetic minerals, pointed out by Neel, Creer, Kawai and others, is one of examples of this kind of problem. TRM and CRM, and probably VRM also, depend significantly on the grain size of magnetic minerals in rocks.

Anisotropic behavior of magnetic properties of rocks is largely dependent on the shape of the magnetic grains and their configurations in the rocks. These problems have to be studied in further detail.

VII. National Activities of Research

National research activities in the field of secular variation and palaeomagnetism during the last three years were reported to the Committee Chairman from Argentina (Dr. Slaucitajs), Canada (Dr. Witham for Professor Jacobs), Czechoslovakia (Dr. Bucha), France (Professor Thellier), Germany (East) (Dr. Lucke), Japan (Professor Rikitake), U.K. (Sir Edward Bullard, Drs. Finch and Griffiths) and USSR (Dr. Petrova).

Some important points described in these reports are dealt with in the above sections of this report. It will be worthwhile to note further the following several topics.

(1) Studies of mechanism of DRM under various conditions have been promoted in U.K.

(2) Quite extensive studies on palaeomagnetism and its application to general and mining geology have been expanded in USSR.

(3) Theoretical studies on the origin of the main geomagnetic field and its secular variation have been continued with some fruitful results in Canada, Japan, U.K. and USSR.

COMMITTEE ON WORLD MAGNETIC SURVEY AND MAGNETIC CHARTS (No. 5)

Report by E. H. Vestine, Chairman

Since the time of the Helsinki meeting of IUGG, the great international project, the World Magnetic Survey has progressed favorably. The present status of many aspects of the project have been documented in some detail in the working documents of the WMS Board, so that only a few general statements need to be made here.

Various recommendations have been prepared and published in the IUGG Chronicle and a Manual of Directions for the World Magnetic Survey prepared. These provide descriptions of the data to be secured, particulars respecting the spacing of stations on land, sea, and by earth satellite, for the period 1955-1965, which continues to provede the principal data. The Committee has also recommended that the WMS data be promptly forwarded to one of the World Data Centers, in general accord with the descriptions of data given in the WMS Manual. An active program of magnetic repeat station work, during the period 1955-65, and especially during the IQSY is recommended.

The Committee notes with high satisfaction the initiation of land surveys over many nations, the active development and execution of aeromagnetic surveys now under way over various oceans and land areas, the continued sea observations of the non-magnetic ship the *Zarya*, and the plans for magnetic surveys by polar orbiting earth satellite such as *Pogo*, and also by the use of rockets.

The Committee also has sought and received valuable assistance from other international bodies such as COSPAR, CIG, and SCAR.

The technical work of the Committee is now entering a phace more closely associated with the processing, mapping, and presentation of results of the survey.

CΦMMITTEE ON LUNAR VARIATIONS (No. 6)

Report by O. Schneider (Chaiman)

(a) *Scope of the Committee*

The researches that come within the scope of this committee include variations due to lunar effects in the following: geomagnetic field, earth currents, ionosphere (e. g. height, electron density, reflectivity, absorption, horizontal and vertical motions, etc.), cosmic rays and the meteorological elements (e. g. barometric pressure, wind, temperature, etc.). At Toronto, in 1957, the International Association for Meteorology and Atmospheric Physics (IAMAP) renewed its co-sponsorship of this committee which for some years had been purely an IAGA committee. During the period covered by this report, close contact was maintained with the Secretaries of both Associations.

(b) *Helsinki meeting*

I) *Attendance:* A meeting of the IAGA/IAMAP Committee on Lunar Variations was convened by its Chairman, Professor Sydney Chapman in Helsinki at 1930 Thursday, July 27, 1960. Members present at the meeting were: Benkova, Bossolasco, Cain, Cardus, Chapman, Chernosky, Finch, Goulin, Haurwitz, Herrinck, Howe, Schneider, and van Wijk.

II) *Current business:* After hearing the report, the following proposals were considered:

1. It was proposed that to make possible an improved tracing of the equivalent lunar current system that would account for the geomagnetic variation at ground level, a compilation should be attempted that included all available lunar magnetic studies. (Professor Chapman offered to undertake such a task if some capable young scientist could be found to work under his guidance.)

2. The proposal was made and adopted that a grant of $1,000 should be requested from the IAGA to stimulate analyses for lunar effects on data from potentially valuable sources during the triennium 1961-1963. It was proposed and agreed by the Committee that if such a grant was received from the IAGA for the work of the Committee that its allocation would be effected by Professor Chapman, Professor Bartels, and the Committee Secretary in order to facilitate action.

3. The proposal was made and adopted that the committee be continued. This continuation is proposed with the purpose of enhancing further derivation of lunar variation data in geomagnetic, aeronomic and other atmospheric phenomena.

III) *Progress reports on lunar studies:* In the discussion of the work of the Committee, several of the members reported as follows:

Dr. Schneider presented a review of his lunar studies concerning distance terms and quarter-monthly partial tides.

A report was made by Mr. Finch on his continuation of the Chapman studies of lunar variations in H and Z for Greenwich and Abinger observatory data with an electronic computer.

Father Gouin discussed his study of lunar variations in Addis Ababa data using the Egedal method (and the surprising low error that resulted).

In the Leopoldville data Herrinck found no effect of sunspot number.

Father Cardús reported on the total independence of lunar variations from K indices and sunspot numbers for a 17 year period in the Ebro data.

IV) *Discussion on technical aspects:* Further discussion on techniques of analysis and particular results included the following topics: the use of true lunar time or mean lunar time; corrections required in the analysis of series comprising both instantaneous and mean hourly values; advantages of analyzing single days; grouping of the data according to lunar, solar, and geomagnetic parameters; evaluation of the influence of solar activity by means of daily indices (for example, sunspot numbers), or by monthly (or other) averages; estimation, in the light of probable errors, of the significance of diurnal terms being greater than the semi-diurnal terms.

V) *Bibliography:* It was the feeling of the Committee that references to, and original papers on, lunar studies should become more easily accessible to those interested in this field; as a first step, it was resolved that the Secretary of the Committee shall keep a list of references, and if possible, a stock of reprints or copies of lunar papers.

VI) *Chairmanship:* Professor Chapman stated that he wished to decline continuation of his position as Chairman of the Committee. He recommended that Dr. Schneider be nominated as Chairman. The Committee agreed to this proposal. As Professor Chapman had to leave Helsinki for another engagement he asked that Dr. Schneider and Mr. Chernosky attend to any further business of the Committee.

Dr. Schneider proposed and it was unanimously agreed that Professor Chapman should be asked to remain as Honorary Chairman. Professor Chapman accepted with thanks.

VII) *Resolution proposed to IAGA:* At the Helsinki meeting the following resolution was circulated to the Committee members present by the incoming Chairman:

In view of the significance of lunar studies for geophysical research, IAGA urges geophysicists to investigate lunar influences in the different fields of terrestrial sciences, and offers the assistance of its Lunar Committee to this purpose.

Of the thirteen members contacted, twelve gave their approval. Mr. Egedal felt that the resolution would have little effect and proposed that the importance of deriving lunar variations near the magnetic equator be stressed instead.

VIII) *Scientific Communications:* At the second meeting of the Committee on August 1st, following the meeting of the Committee on Magnetic Instruments, several papers and reports were presented:

Dr. Schneider presented his paper on «Lunar Distance Terms and some other Partial Tides in Geomagnetic Recordings of the East Component at Batavia, now Kuyper, near Djakarta».

Other reports were given by Father Gouin, Drs. Van Wijk, Howe and Turajlic.

(c) *Membership:*

The present membership of the Committee on Lunar Variations is as follows:

J. Bartels	B. Haurwitz
N. P. Benkowa	P. Herrinck
M. Bossolasco	H. H. Howe
J. C. Cain	S. Matsushita
J. O. Cardus	P. Rougerie

S. Chapman
E. J. Chernosky
J. Egedal
G. Fanselau
H. F. Finch
P. Gouin
V. Sarabhai
O. Schneider
J. A. Thomas
R. Turajlic
K. K. Tschu
A. M. van Wijk

(d) *Grant from IAGA*

Since the Helsinki meeting a grant of $1,000 was made by the IAGA te the committee on Lunar Variations for the conduct of its work *.

Dr. O. Schneider requested and was allocated $320 for clerical assistance for research on:

a. Search for a 24-hourly lunar partial tide in the data from an earlier analysis, of the magnetic east component at Batavia during the Southern summer 1901-1929.

b. Search for lunar effect in geomagnetic ring current indices.

c. A new analysis of lunar magnetic variation at Apia, Samoa.

(e) *General progress of lunar studies since the Helsinki Meeting:*

It is gratifying to note that a considerable number of lunar studies was made in the three years period under review, covering a broad variety of geophysical phenomena such as air pressure, optical properties of the atmosphere, atmospheric ozone, air motion and drift in the ionosphere, geomagnetic variations, earth currents, geomagnetic activity, meteor rate and heights, virtual heights and other properties of ionospheric layers including the D, normal E, sporadic E and F regions, cosmic ray neutron component at ground level, satellite motion, variation of useable frequencies for radio communications, intensity of the green oxygen line in the airglow, presence of ice nuclei in the atmosphere, and rainfall; we have also been informed of several similar studies being under way.

It is not the purpose of the present report to comment on, or summarize, these studies, with details. The titles of many of them are included in the bibliographic reference list mentioned in the last section of the report. Only in one case, dealing with an analysis of lunar magnetic variations at Tamanrasset, Algeria, our advice was sought on methods of analysis.

Some members of the Committee have reported on the progress of their work, as follows:

In letter of April 18, 1963, Dr. B. Haurwitz offers the informa-

(*) Professor Julius Bartels requested and was allocated $ 400 for further studies of lunar magnetic variations.

tion that: «As part of our continuing investigation of the lunar semidiurnal oscillation of surface meteorological parameters the following results have been found for Balboa, Canal Zone (lat. 85° 9′ N, long. 79° 34′ W, altitude 20 feet), based on 20 years of data:

Paramenter	L_2	λ_2	P. E.
Pressure	58.3 microbars	77°	± 2.7 microbars
Wind comp. to E.	0.6 cm/sec.	194°	± 0.8 cm/sec.
Wind comp. to S.	1.2 cm/sec.	29°	± 0.6 cm/sec.
Temperature	$0.3 \cdot 10^{-2}$ K	116°	$\pm 0.7 \cdot 10^{-2}$ K

Here L_2 denotes amplitude; λ_2 phase constant; P. E. radius of the probable-error circle. The oscillation is given in the form $L_2 \sin (2t' + \lambda_2)$ where t′ is local mean lunar time.»

«It will be noted that the wind determination in only partially successful since the amplitude of the eastward component is less than the radius of its probable-error circle while even for the southward component the amplitude is only twice P. E.

That the determination of the lunar temperature variation is not successful is not surprising. It should be noted that Chapman obtained with a 3.2 times larger material for Batavia an error of only $0.3 \cdot 10^{-2}$ K which is smaller than the one for Balboa even if allowance is made for the longer record.

The results given here should replace those obtained earlier from only one year (1952) of data for Balboa and communicated to the lunar committee.

The investigation will be continued in order to augment the information on the lunar air tide at the ground which has been obtained mainly through the work of S. Chapman.»

Prof. G. Fanselau (April 24, 1963) has reported as followows:

«As I already advised you, we have begun special research on irregularities of the Sq variations and have found so far that on selected very quiet days there exists a clear influence on Sq of the sinking rate of the virtual height of the D region, especially, of course, in the early morning hours. The selection of the quiet days was made subjectively according to the aspect rather than by an objective procedure based on some activity measure; an absolutely quiet Sq variation was considered essential. In this way, some 140 days were selected from 4 years' record, and some 650 days from 12 years. The procedure was based on the ampitudes and times of occurrence of maxima in Sq(D) and Sq(H).

It seems as if L manifests itself in the irregularities of Sq, and it should be possible to deduce it without too great difficulties in computing. At the present time I am still busy with the computation, and no definite results can be expected te be at hand for the Berkeley meeting. A report on the studies on Sq will be published in the next issue of 'Gerlands Beitrage zur Geogpysik'.»

Dr. Schneider has given the following details on lunar work (June 10, 1963):

«1) The search for 'geomagnetic partial tides' involving other terms in addition to those described by Chapman's phase law, was continued. In a preliminary communication presented at Helsinki, terms Ξ_1 and Ξ_2 with arguments $(\tau + 3\nu + \lambda_1)$ and $(2\tau + 4\nu + \lambda_2)$, τ being mean lunar time and ν the age of the Moon, were shown to exist in the lunar variations of the East component at Batavia (now Kuyper, near Djakarta), during the southern summer. In the mean time the presence of the wave Ξ_1 could also be demonstrated in the results of Chapman's analysis of Greenwich D, published in 1925, and based on more than 20,000 individual daily recordings.

2) With the same set of data from Greenwich D and Batavia Y, it could be shown that there is some evidence for a further term Ξ^*_1 with the argument $(\tau + 2\nu + \lambda^*_1)$. It is believed that this term, and possibly another one with an argument not involving ν, may arise from a small lunar diurnal component of the air motion in the ionosphere.

3) Bullen and Cummack kindly forwarded unreduced harmonic coefficients of their analysis of L at Amberly (1931-1935) separated according to lunar age. These data are now being analyzed in search of similar geomagnetic partial tides.

4) An analysis of lunar variations in magnetic declination at Apia, Samoa, was begun, comprising the years 1947-1957. The Chapman-Miller method is used, the data are grouped according to Bartels' season-number, sunspot-number, and geomagnetic activity.

5) With a different approach, a lunar study was also started with data of the magnetic declination recorded at Isla Año Nuevo (New Year's Island) where an observatory was run by the Argentine Navy from 1902 to 1917. The coordinates of the observatory were 54° 39′ S; 64° 8′ W; this seems to be the southernmost place for which a lunar geomagnetic analysis has been made so far. The D data of six years, from May 1907 to April 1913, have already been processed, using the fixed epoch method, with an harmonic analysis of individual days up to the six-hourly term. Some 8,900 pairs of harmonic coefficients are thus available for grouping according to season, solar and magnetic activity. In summer, the amplitude of L is somewhat above 1/10 of S.»

(f) *Measures to promote world-wide representation of lunar variations, and extension of lunar studies to other fields:*

I) Several ways of actions were suggested by which the Committee may contribute to promote a more complete understanding of lunar influences in geophysics. As already mentioned under (b)-II), Prof. Chapman was prepared to envisage supervising a comprehensive re-interpretation of global aspects of lunar magnetic variations. The matter was further discussed by correspondence since the Helsinki meeting, and Prof. Chapman may report on the present possibilities at Berkeley.

II) It has also been suggested that the scope of lunar studies should be extended both geographically (especially by a more complete coverage of southern hemisphere middle and higher latitudes), and in space. Dr. Matsushita has made a specific suggestion recommending that the possibility of lunar effects in the exosphere and even in the magnetosphere should be investigated. At Berkeley, we may consider the convenience of supporting these suggestions by a recommendation.

III) Some Committee members partook in a discussion by correspondence, on the convenience of standardizing the methods of analysis, to secure a better comparability of results. When discussing this problem at Berkeley, we should give careful consideration to the fact that complete uniformity of procedures is probably neither desirable nor attainable.

IV) Your chairman does feel, on the other hand, that a higher degree of uniformity is desirable in certain particular regards, concerning criteria for grouping the data according to season, solar indices, magnetic activity, and lunar parameters, as well as for discarding disturbed values or periods. By Circular Letter LC-13, of April 23, 1962, suggestions were invited in connection with this problem, and the comments received from Prof. Chapman, Prof. Fanselau, Mr. Finch, and Mr. Egedal were later circulated among members. It is hoped that, after discussing this questions at Berkeley, a Sub-Committee or small Working Group can be set up to analize the requirements and possibilities, and make specific recommendations.

(g) *Bibliograpry:*

I) Following the suggestion of the Committee Chairman, to have an inclusive bibliography compiled, the Secretary found it possible to request such through the cooperation of Mr. D. W. MacLeod and the Air Force Cambridge Research Laboratories. This Bibliography will be published in the Meteorological and Astrogeophysical Abstracts some time this fall. In view of this bibliography, it was not considered necessary to include the usual list of references in the present report. It is hoped that a preliminary copy of the list of abstracts will be available for review at the Berkeley Assembly.

II) The committee expresses its thanks to the members and colleagues who have responded to the request for reprints.

A reference list of the reprints received is appended.

REPRINTS RECEIVED

BARTELS, JULIUS: «A Table of Daily Integers, 1902-1952 Seasonal Solar, Lunar and Geomagnetic». *Scientific Rpt.*, No. 2 AF19(604)-503, Geophysical Instiute of the University of Alaska, College, Alaska, 1954.

BOSSOLASCO, M., and A. ELENA: «Some Results on the Lunar Semidiurnal Variation of the *D* and F_2 Layers». Int. Assn. of Geomagnetism and Aeronomy (I.G.G.U.), Committee on Lunar Variation, XII Assembly, Helsinki, 1960.

BOSSOLASCO, M., and. A. ELENA: «On the Lunar Semidiurnal Variation of D and F_2 Layers». *Geofisica Pura E Applicata,* vol. 46, pp. 167-172, Milan.

BOSSOLASCO, M., and A. ELENA: «The Anomalous Ionospheric Absorption on Winter Days». *Geofisica Pura E Applicata,* vol. 47, pp. 89-100, Milan.

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COMMITTEE ON COMPARISON OF MAGNETIC STANDARDS (No. 7)

Report by V. Laursen, Chairman

During 1960-1963 comparison observations have been carried out as in previous report periods by means of calibrated QHM-magnetometers sent by air freight from the Rude Skov observatory to the participating observatories and back. In addition the Chairman of the Committee has had the opportunity of making two journeys to magnetic observatories in Africa, and on both occasions he has brought with him a set of Association QHMs with which comparisons were made at the observatories visited.

A set of Association instruments is placed at the disposal of the non-magnetic USSR vessel «Zarya». The constants of the instruments were controlled when «Zarya» called at Copenhagen in May 1963.

The complete list of comparisons carried out is as follows:

(1) A comparison by means of QHM-magnetometers Nos. 228, 229 and 230 between Rude Skov and all Spanish magnetic observatories. This comparison was mentioned in the report presented at Helsinki 1960, but was not completed at that time.

(2) A comparison by means of QHM-magnetometers Nos. 228, 229 and 230 between Rude Skov and the Kandilli observatory (Turkey); results not yet available.

(3) A comparison by means of QHM-magnetometers Nos. 513, 514 and 515 between Ruwe Skov and the Pendeli observatory (Grece).

(4) A comparison by means of QHM-magnetometers Nos. 477, 478 and 479 between Rude Skov and the Fredericksburg observatory (USA).

(5) A repeated comparison by means of QHM-magnetometers Nos. 228, 229 and 230 between Rude Skov and Spanish observatories; results not yet available.

(6) A comparison by means of QHM-magnetometers Nos. 480, 481 and 482 between Rude Skov and the observatories et Ibadan (Nigeria), Addis Ababa (Ethiopia) and Misallat (Egypt).

(7) A comparison by means of QHM-magnetometers Nos. 480, 481 and 482 between Rude Skov and the observatories et Misallat (Egypt), Addis Ababa (Ethiopia), Tananarive (Madagascar), Lwiro and Binza (Congo) and Bangui (Central African Republic).

The results of the comparisons are given below in the form of differences between observatory standards:

1960 Rude Skov - Toledo = — 33.3 γ
(the Toledo standard based on the Schmidt-magnetometer)

1960	Rude Skov - Almeria = — 1.5 γ (the Almeria standard based on the Sartorius magnetometer)
1960	Rude Skov - Logroño = — 13.9 γ (the Logroño standard based on QHM 396)
1960	Rude Skov - San Fernando = — 28.4 γ (the San Fernando standard based on QHM 249)
1960	Rude Skov - Ebro = — 14.2 γ (the Ebro standard based on the Ruska magnetometer)
1960	Rude Skov - Santa Cruz de Tenerife = 5.2 γ (the Santa Cruz standard based on QHMs 107 and 225)
1961 May	Rude Skov - Pendeli = 12.3 γ (the Pendeli standard based on the HTM-magnetometer)
1961 Nov.	Rude Skov - Fredericksburg = 0.6 γ (the Fredericksburg standard based on Sine-Galvanometer No. 1)
1961 Nov.	Rude Skov - Ibadan = — 12.2 γ (the Ibadan standard based on QHM 345)
1961 Dec.	Rude Skov - Addis Ababa = — 15.8 γ (the Addis Ababa standard based on QHM 377)
1961 Dec.	Rude Skov - Misallat = — 11.0 γ (the Misallat standard based on the Schuster-Smith magnetometer)
1963 March	Rude Skov - Misallat = — 7.8 γ (the Misallat standard based on the Schuster-Smith magnetometer)
1963 April	Rude Skov - Addis Ababa = — 15.9 γ (the Addis Ababa standard based on QHM 377)
1963 April	Rude Skov - Tananarive = — 26.2 γ (the Tananarive standard based on QHMs 303 and 304)
1963 May	Rude Skov - Lwiro = — 6.2 γ (the Lwiro standard based on QHMs 380 and 382)
1963 May	Rude Skov - Binza = — 0.4 γ (the Binza standard based on the Schmidt magnetometer)
1963 May	Rude Skov - Bangui = — 28.2 γ (the Bangui standard based on QHM 349)

The above results of comparison observations at African observatories during March - May 1963 must be considered provisional.

It should again be emphasized that the Rude Skov standard can by no means be considered as an international standard for horizontal force. What is of immediate interest for the purpose of the comparison programme is the *stability* of the standard maintained at the central observatory, and it is thought that the stability of the Rude Skov standard is fairly well illustrated by the following summary of all the comparisons which have so far been carried out between Rude Skov and Cheltenham/Fredericksburg by means of QHMs:

1948, April	
(QHMs 33, 51, 52)	Rude Skov - Cheltenham = 3.0 γ
1949, Dec.	
(QHMs 90, 91, 92)	Rude Skov - Cheltenham = — 0.6 γ
1949, Dec.	
(QHMs 29, 58)	Rude Skov - Cheltenham = 3.1 γ
1951, March	
(QHMs 34, 50)	Rude Skov - Cheltenham = 4.6 γ
1953, May - Sept.	
(QHMs 50, 51, 52)	Rude Skov - Cheltenham = 2.5 γ
1956, Aug.	
(QHMs 32, 33, 34)	Rude Skov - Cheltenham = — 1.6 γ
1958, Oct. - Nov.	
(QHMs 477, 478, 479)	Rude Skov - Fredericksburg = 0.6 γ
1961, Nov.	
(QHMs 477, 478, 479)	Rude Skov - Fredericksburg = 0.6 γ

At the Helsinki General Assembly 1960 the use of proton precession magnetometers or other atomic magnetometers for the establishment and maintenance of geomagnetic intensity standards, was thoroughly discussed. The General Assembly passed a resolution recommending that pending the agreement and specification by an appropriate scientific organization of a final value, all measurements of the geomagnetic field with a proton free-precession magnetometer, using pure water as the proton sample, shall be based on the following value of the gyromagnetic ratio:

$$2.67513 \times 10^4 \text{ radians/gauss, second}$$

The Comparison Committee is happy to report that it has been possible to use the balance of a UNESCO grant for the construction of a proton precession magnetometer, which is now installed at Rude Skov. The equipment has so far been used only for total field measurements, but it is hoped that experiments which are going on at the observatory will lead to a reliable method for the determination also of the horizontal component by means of the proton instrument.

Commenting upon a suggestion put forward by the Irish National Committee for Geodesy and Geophysics in connection with the World Magnetic Survey project, Dr. H. F. Finch of the Royal Greenwich Observatory makes the following interesting proposal concerning the standardizing of Z values at magnetic observatories:

«International comparisons of standard instruments are clearly very desirable so long as differences in these instruments are likely to exist. With the introduction of the proton vector magnetometer the necessity for such comparisons might be removed, provided all observatories adopt the PVM as their standard. It is likely to be many years, however, before this happy state of affairs is realized, though I feel that the general use of these instruments should be encouraged. In the mean time the use of the simpler proton magnetometer for measuring total field provides an excellent means of standardizing the Z results of many observatories. Total field proton magnetometers can now be bought over the counter; they are compact, reliable and relatively cheap, considering their potentialities. With such an instrument and a reliable H standard instrument good values of Z can be obtained, except near the magnetic equator. If international H comparisons are continued with QHMs, errors of comparison of Z should be small at places where H/Z does not exceed 2 or 3, i.e. where I is not numerically less than $\pm 27°$ or $\pm 18°$ respectively. If QHMs can yield comparisons good to say 2 γ, then in these regions Z comparisons obtained in this way should be good to something not much greater than 4 γ or 6 γ (and in general much less), which should be considerably better than anything effected hitherto.

Since $H/Z > \beta$ in Brazil, Equatorial Africa and the East Indies, in these regions the method would not be very satisfactory, but there seems no reason to suppose that for well over 90 per cent of the world's magnetic observatories the method should not prove satisfacttory. For the remaining observatories the vector magnetometer provides the answer.»

COMMITTEE ON MAGNETIC INSTRUMENTS (No. 8)

Report by J. H. Nelson, Chairman

This report has been compiled by the Chairman of the Committee, using information contributed by a number of the committee members. It is divided essentially into three main parts:

I. Reports of instrumental development and use, in the field of geomagnetism.

II. Suggestions for discussion at the Berkeley meeting, and proposals for committee activity.

III. A listing of some of the manufacturers of magnetic instruments and the types of equipment available.

Resolution No. 66, published in the Report of the XII General Assembly of the I. U. G. G. at Helsinki, recommended that, pending the agreement and specifiction by an appropriate international scientific organization of a final value, all measurements of the geomagnetic field with a proton free-precession magnetometer, using pure water as the proton sample, shall be based on the following value of the gyromagnetic ratio:

$$2.67513 \cdot 10^4 \text{ radians/gauss second.}$$

Shortly after the Helsinki meeting this resolution was published, as an item of general information for all geophysicists, in the Journal of Geophysical Research and in the Journal of Atmospheric and Terrestrial Physics. The chairman of this committee believes that the adoption of this resolution and its subsequent publication in scientific journals has resulted in a recognizable standardization of the results from proton magnetometer measurements throughout the world.

It will be of further interest to note that, on April 30 and May 1, 1963, a Working Group on the Methods and Results of Measurement of the Gyromagnetic Coefficient of the Proton met at the National Physical Laboratory, Teddington. This was a working group of the Consultative Committee on Electricity of the International Bureau of Weights and Measures. In a brief report the group presented a table of the measured values, as follows:

Laboratory	Value
P. T. B. (Germany)	2.67521×10^8
N. B. S. (U. S. A.)	515
N. P. L. (U. K.)	515
I. M. M. (U. S. S. R.)	504
I. M. I. M. K. (U. S. S. R.)	508
Mean	2.67513×10^8

The units are in the mks system, and are based on the unit of electrical current defined by the standard «ohm» and «volt» maintained by the International Bureau. The report further states: The working group thinks that the mean value given here should be considered as provisional until more precise results have been obtained.

Optical pumping magnetometers have come into extensive use both for installation on the ground and for rocket and satellite work. The elements most commonly employed in the sensing head are Rubidium and Helium. Some work has also been done in France with Cesium.

The relationship between precession frequency and the total intensity of the field, for rubidium and helium, cannot be stated in simple terms. In both instruments there is an apparent orientation effect amounting to several gammas. In the case of rubidium there are several transition frequencies in the radio-frequency spectrum. The constants to be used depend on which line is being observed. For the two dominant lines of the spectrum of Ru^{85}, Mr. Raymond Driscoll of the U. S. National Bureau of Standards has given the following constants in a personal communication to the Chairman of this Committee:

$$f = 466{,}739\, B \pm 359.4\, B^2 + 0.22\, B^3$$

where f is the frequency in cycles per second, B is the magnetic field intensity in gauss. The positive coefficient for the second term corresponds to the transition between the quantum state with total quantum number of 3 and magnetic quantum number of 3, and the state with total quantum number of 3 and magnetic quantum number of 2; the negative coefficient corresponds to a similar transition where the magnetic quantum number changes from -3 to -2. If the rubidium magnetometer is designed as a self-oscillating instrument, different constants must be used because the control circuits respond to the resultant frequency of six resonance lines rather than to just one line.

At this stage of development of the optical pumping magnetometers it is suggested that an absolute calibration of the instrument should be made by comparison with a proton magnetometer, unless a single known Rb line is used.

Part. I. Report of Instrumental Development and Use

Australia

The Bureau of Mineral Resources has built a proton magnetometer with vector coils for observatory standardization, and plans a portable instrument for regional field work. It is reported that satisfactory observations for declination have been made with QHM's, using a telescope attached to the circle and not to the QHM tube. Special adaptors have been made for fitting QHM tubes to circles of C. I. W. and Askania magnetometers.

Belgium

Dr. A. De Vuyst, of the Royal Meteorological Institute, reports that he has had a great deal of personal experience with the U. T. M. (Askania's Universal Torsion Magnetometer). He reports that the instrument is capable of measuring D, H, and Z; that it has a range of $-50{,}000\gamma$ to $+50{,}000\gamma$; that it has good stability and is easy to handle; that its only inconvenience is that it is very delicate.

Canada (From a communication by Dr. P. H. Serson)

Development of Magnetic Instruments in Canada, 1960-1962.

A proton precession magnetometer has been developed which indicates and records the intensity of the geomagnetic field directly in gammas or tenths of gammas. In addition to presenting the results in a more convenient form than conventional proton magnetometers, the new circuit improves discrimination against noise in the signal by at least an order of magnitude. (8, 10) [Numerals refer to bibliography at end of this section.]

An experimental three-component proton precession magnetometer, which records a complete set of readings every minute in digital form on punched tape, has been operated successfully for periods up to 20 days. Digital computer programs for reduction of the data, rejection of erroneous readings and calculation of hourly means have been developed. (9)

Portable, battery-operated precession magnetometers have been developed for measurements in the field at repeat stations.

A new gyro-stabilized platform for the three-component airborne magnetometer is under construction, making use of the improved gyroscopes now available. A Marconi Doppler Navigator has been incorporated into the instrument, to supply more accurate ground speed and drift information to the navigational computers.

A semi-automatic magnetogram reader has been designed and is now in use at Victoria magnetic observatory. With this system, the operator tracks the magnetogram manually, while the machine computes hourly means, multiplies by the appropriate scale factor, adds baseline values, and types the result in tabular form, ready for reproduction in observatory publications. (2).

The Geological Survey of Canada has developed a new proton magnetometer system for low-level aeromagnetic surveys. The signal from a proton magnetometer carried by a light aircraft or helicopter is telemetered by frequency-modulated radio, through an airborne repeater station to a ground station. Signals from a fixed proton magnetometer at the ground station are compared with the airborne signals, and the difference in the magnetic fields is recorded. The system presents a great advantage in mountainous country, because complicated flight patterns can be flown according to the terrain without the necessity of control lines and datum adjustment.

At the Pacific Naval Laboratory, the development of low-noise, low-impedance, micropulsation receivers has continued. Three-component systems for the measurement of geomagnetic activity between 0.01 and 30 cps are now in general use. (3).

At the University of Alberta, systems for recording micropulsations using coils and photo-cell amplifiers have been built. Signals are recorded with seven-channel tape recorders in the field, and later converted to digital form by a special machine in the laboratory, for analysis by digital computer.

A review of modern methods of geomagnetic measurement has been published by Whitham (11).

Commercially Available Instruments for Geomagnetic Measurements Manufactured in Canada

A great variety of instruments for magnetic and electrical prospecting are manufactured in Canada. Short descriptions are given of four magnetometers of more interest to members of. I. A. G. A.

Portable Magnetometer Type 323 (The De Havilland Aircraft of Canada Limited, Malton, Ontario, Canada)

A fluxgate detector mounted on the telescope of a nonmagnetic theodolite is connected by a 10-meter cable to a control box containing a transistor oscillator, amplifier and center-zero meter. The meter indicates the sense and magnitude of the geomagnetic component parallel to the axis of the telescope. Declination and inclination are measured by rotating the telescope horizontally and vertically to obtain a null meter indication, and reading the graduated circles of the theodolite. Total intensity is measured by nulling the earth's field by a direct current passing through a solenoid surrounding the fluxgate. The direct current is measured with a potentiometer circuit, standard cells and galvanometer included in the control box. The probable error of a single measurement is 0.3′ in declination, 0.2′ in inclination, and 10 to 50 gammas in total intensity, depending on frequency of standardization. (5, 7).

Portable Magnetometer Type 327 (The De Havilland Aircraft of Canada Limited, Malton, Ontario, Canada)

This is a newer version of the Type 323 magnetometer, giving sufficient output to operate (with heavy negative feedback) a 1 milliampere recording meter. A weatherproof head containing 3 mutually perpendicular fluxgates is supplied as well as the single fluxgate. Any one of the 3 fluxgates can be selected by a switch on the control box. The instrument operates from a self-contained battery. Approximately $2300, not including theodolite or recording meter.

Station Magnetometer Type 613 (The De Havilland Aircraft of Canada Limited, Malton, Ontario, Canada)

Three mutually perpendicular fluxgates in a weatherproof head are connected by a cable (up to several hundred meters in length) to a console containing a stabilized power supply, oscillator and amplifiers. The fluxgates are continuously maintained at a magnetic null by feedback. A strip-chart recording meter provides a visible record of the three dc output signals (1 volt = 100 gammas). Calibrated baseline controls permit biasing the detectors for operation at different locations. Although intended for mains operation at fixed stations, these instruments have proved useful for the investigation of anomalies in magnetic variations at temporary field stations. Maximum noise level of output is 3 gammas, and maximum drift is 10 gammas in 10 hours. Approximately $2400, not including recording meter. (4, 6, 7).

Portable Proton Precession Magnetometer Type GM 102 (Barringer Research Limited, 145 Belfield Road, Rexdale, Toronto, Canada)

A detector head containing kerosene is connected by a short cable to a non-magnetic control box containing flashlight batteries, amplifier, a tuning fork and counting circuits. The sample is polarized by operation of a manual switch. The frequency of the proton precession signal is multiplied by four, and the number of cycles of the multiplied frequency occurring in 0.5872 seconds is counted. The resulting count is displayed on four Nixie indicator tubes, and is equal to the total intensity in tens of gammas. The instrument weighs 5 kg, and costs approximately $3000. (1).

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France (From a communication by Prof. E. Thellier)

Nuclear and Optical Pumping Magnetometers. (For more information apply to Dr. Le Borgne, head of the magnetic department at the Institut de Physique du Globe in Paris.)

Two French firms constructed magnetometers that give a continuous measure of the intensity of the earth's field: the Southern Aviation firm utilizes the precession of protons, the General Wireless Telegraph firm (C. S. F.), the optical pumping of Cesium vapor.

The Southern Aviation magnetometer comes from an instrument made at the Nuclear Research Center at Saclay, an instrument which has been working for three years at Chambon-la-Forêt Observatory. Polarization of the protons is obtained according to the method advocated by Abragam: the aqueous solution of a paramagnetic radical (Nitrous disulphate of potassium) being subjected to a high-frequency field, 56 Mc; perpendicular to the earth's field, the interaction between the protonic spins of the water and the electronic spins of the radical causes a polarization of the protons. With the help of the Nuclear Research Center at Grenoble, the Southern Aviation firm put in use a commercial instrument for ground exploration, an instrument that also records continuously, and a version used to measure at airports, which has digital recording and analog recording. A marine version with also digital and analog recording is actually in preparation.

The Cesium vapor magnetometer constructed by the C. S. F. comes from a prototype made in the physics laboratory of l'Ecole Normale Supérieure. In a field of 0.5 oersted, the frequency of the transition between the sublevels of Zeeman effects is of the order of 160 Kc. The transitions are induced by a high frequency field produced by a generator of standardized variable frequency; the equality between the generator frequency and the frequency of the resonance ray is assured by a control mechanism (3). The C. S. F. constructed a commercial version for aeromagnetic observations having digital and analog recording. This version will be used by the general Geophysics department for constructing the total intensity (F) map of France. The observations made in the airplane will be reduced to the mean of the analogous earth's magnetic field.

(1) «Magnétomètre à champ terrestre utilisant la résonance paramagnétique nucléaire avec polarisation dynamique des noyaux».
«I - Notions théoriques», par S. Freycenon et I. Solomon.
«II - Réalisation et mise en œuvre», par S. Freycenon. *L'Onde Electrique,* t. XL, No. 402, 1960, pp. 590-601.
(2) G. Bonnet: «Les possibilités nouvelles des magnétomètres à protons». *Annales de Géophysique,* t. 18, No. 1, 1962, pp. 62-91, et t. 18, No. 2, 1962, pp. 150-178.
(3) L. Malnar et S. P. Mosnier: «Un magnétomètre à pompage optique pour l'étude du champ spatial». *Annales de Radioélectricité,* t. XVI, No. 63, 1961.

VARIOMETERS, P. A. Blum (Institut de Physique du Globe, Paris).

These are magnetometers with magnet attached to torsion fibers of quartz, mounted in supports made completely of fused quartz and for which the deviations, picked up by the photoelectric cells, are recorded by the method of following the light spots to the associated SEFRAM galvanometers, standard model «Graphispot». These magnetometers operate in the series of «semi-rapid» recording (paper speed about 1.2 mm/minute) with sensitivity of the order of 0.5γ per mm on the paper.

The two magnetometers of this type actually in use (at the Chambon-la-Forêt observatory since January 1962) record D and F. They must be completed by a magnetometer for I to have a homogeneous recording of the three elements F, D, and I better adapted to the classical components H, D, and Z for comparison and standardization with absolute nuclear magnetometers.

Special Mounting (Selzer-Petiau) for continuous recording of «pulsations in series or pp». (For more information apply directly to M. E. Selzer, head of the magnetic section at the Institut de Physique du Globe, Paris.)

The desired objective is to be able to record continuously and yet aconomically not only the storm pearls (and the secondary microstructures of the bays), but also the series (pearls) during quiet times in a statistically valid manner. The band searched for goes from 1/3 second to 3 seconds without too much attenuation. The «pc» and the strong «pt» are filtered in such a way. The recording is made tellurically and magnetically.

A. By telluric method: (Installed at Chambon-la-Forêt since November 1960)
Lines of 150 meters (500 m and 1000 m at Garchy).
Connecting line-galvanometer by transarmature (Electro-Acoustical Construction Company, C. E. A.) Kipp-A-23 galvanometer (micro Moll) period 1/4 second. Sensitivity $2 \cdot 10^{-8}$ amp/mm at 1 meter. Filtering by condensers L. C. S. M. (The

Modern Static Condenser) in range (elimination of long periods) and in frequency (elimination of 50 cycles per second).

B. By magnetic method. (Used at Chambon-la-Forêt since October 1961)

Induction method: Same winding of armature as that for assembling A. G. I. «barres-flumetres», but replacing the Kipp A-54 fluxmeter galvanometer by an instrument of two galvanometers connected by a photoelectric cell.

Salient features of the galvanometers:

1st galvanometer -- Kipp A-23 (micro Moll) of T = 1/4 second; sensitivity = $2 \cdot 10^{-8}$ amp/mm at 1 m.

2nd galvanometer -- Sefram of T = 1.8 sec; sensitivity = $0.5 \cdot 10^{-8}$ amp/mm at 1 m.

Photoelectric cell SEGOR of several elements.

Amplification coefficient of the signal leaving from the first galvanometer, about 200. Total sensitivity of the instrument: 0.001 gamma/mm on the recording.

In both cases, A and B, the recording is made by following the light spot, SEFRAM type «photodyne», to single or double trace.

Actually the recording of «pp» at Chambon-la-Forêt by this method, made by following the double «PH-2», gives two traces, the telluric and magnetic in juxtaposition. The normal speed of the recording paper is 30 mm/minute. An accordion fold permits an economic distribution of the total width (each record is used for 10 days). A complete installation for «pp» by this method (two horizontal components each of magnetic and telluric) requires then:

6 galvanometers (4 micro-Moll Kipp and 2 Sefram)
2 recorders - spot followers PH-2
2 photoelectric cells
2 sensing elements
filters and accessories

A 3-component version of instrument B is being developed. Stefant-Gendrin equipment for the study of very rapid magnetic variation. (For more information apply to M. Stefant or M. Gendrin, Institut de Physique du Globe, Paris.)

The instrument is designed to explore the band 1-50 cycles per second. It operates by the magnetic method.

The detector is made of a combination of coils on a core of ferrite (6 coils connected in the direction of the horizontal component H, each having 2000 turns, on a core 3 cm in diameter). The signal actuates an immersion (Schlumberger-Picard type) galvanometer connected as a slave galvanometer which controls, through a photoelectric cell, a part of the current which is electronically amplified and fed back. Thus the recording galvanometer always operates in the immediate vicinity of its equilibrium position.

The other part of the amplified current is integrated (by condensers) before being used for recording.

In the more recent version the recording is made on slow-speed magnetic tape of the entire width of the band (tape speed of about 1 cm per minute). This is later analyzed with the «sondgraph» after increasing the speed of the tape by a factor of 1000.

Standardization is made by means of 2 coils of 1.20 m diameter placed symmetrically at 30 m from the sensing coils and fed by a TBF (low frequency) generator.

This instrument, installed at Chambon-la-Forêt Observatory, was used to study the resonance frequency of the Earth-Ionosphere cavity (and its variation under the effects of the thermonuclear explosion at high altitude) and the pulsations known as «pearls».

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R. Gendrin et R. Stefant: «Magnetic records between 0.2 and 30 cycles per second». *Comm. at the Agard Conf.*, München, Germany, Sept. 1962.

DIGITAL MAGNETOMETER (for additional information apply directly to M. R. Schlich, head of the magnetic department for French Southern Hemisphere Regions and the Antarctic, Institut de Physique du Globe, Paris).

The Institut de Physique du Globe, at Paris, undertook to set up an instrument capable of measuring numerically and to punch by perforation on teletype tape at regular intervals the values of the three components of the earth's magnetic field. The practical application of this instrument would eventually solve the problem of examining the hourly values for K and Q indices by the systematic utilization of the electronic ordinates. In particular it will also be possible to reconstitute point by point the variation of a component not recorded. It is planned to place equipment of this kind at the French Antarctic and sub-Antarctic stations.

South Africa

A question has been raised concerning the behavior of QHM's and BMZ's at very low temperatures. Dr. van Wijk of the Hermanus Magnetic Observatory reports as follows:

«Readings taken at temperatures below —15° C with QHM's and BMZ at the South African Base (Norway Station) in Antarctica during 1960 gave highly inconsistent results. The erratic behavior of the instruments is ascribed to the formation of rime on the moving parts, due to the rapid drop in temperature on taking the magnetometers into the open air. In the case of the QHM the presence of rime is almost certain to affect both the torsion coefficient and the temperature coefficient. In the case of the BMZ, the asymmetrical deposition of rime on the magnet, and/or any contamination of the bearings, might very well affect the performance of the instrument. In both cases the solution would appear to be to ensure that the air inside the instruments is completely dry during the cooling process.» (Mr. Dooley, of Australia, reports that there has been no evidence of this effect at the Australian Antarctic Observatories. Most readings at those observatories are taken inside heated huts, at 0° C or higher temperatures. Field observations have been made at temperatures below —15° C, and it is possible that some such effect has remained unnoticed because of lack of any variograph control; however there is nothing in the observations to suggest that it has occurred.)

United Kingdom (Reported by Mr. H. F. Finch)

Advances made in the United Kingdom during recent years in the development and use of geomagnetic instruments:

The Meteorological Office is now finalising its negotiations for the purchase of three digital recording proton vector magnetometers, which are expected to be fully operational within 12 months. The general desing of the magnetometers is similar to that described by Alldredge (A proposed Geomagnetic Standard Magnetic Observatory, J. Geophys. Research, *65*, 3777-3786, 1960), there is no intention of changing to metastable helium. It is intended that the instruments will be caravan mounted for transportability during the experimental period of a few years, during which time operation will be under the direction of the Gassiot Fellow in Geomagnetism, Dr. F. D. Stacey. Ultimately, two of these magnetometers will become observatory instruments at Lerwik and Eskdalemuir respectively. No attempt is being made at this stage to achieve an absolute accuracy of magnetic components to 1 gamma, but changes in the components will be recorded with this accuracy. The possibility of acquiring better coils, on a suitable rotating base, may be considered at a later date, but these are not needed for the proposed experiments or for the observatories, where absolute values are already established. The frequency of measurement provides for a complete picture of the field every 30 seconds, allowing frequencies up to 1 cycle/minute to be analysed.

The Signals Research and Development Establishment has designed a three-channel fluxgate magnetometer with sensitivity of 0.1

gamma which is being used to investigate field fluctuations in the 0.1 to 1 cycle region. Facilities are also provided for operation on predetermined narrow bands up to 30 cycles. Two such instruments will be operational soon, as well as single channel prototypes. One instrument is being shipped to Halley Bay, Antartica, at the end of 1962.

A total field magnetometer designed by Maurice Hill for use on tow behind a ship has been described in deep Sea Research, 1959, 5, 309-311. An instrument based upon this design and recording on both chart and on five hole paper tape is now being made by Bruce Peebles of Edinburgh.

A system for the automatic reduction of data supplied by such an instrument has been worked out at Cambridge and is described by E. C. Bullard in a paper «The Automatic Reduction of Geophysical Data» in the Geophysical Journal of the Royal Astronomical Society, *3* (1960), pp. 237-343.

John D. Mudie, also at the Department of Geophysics, Cambridge, has developed a Differential Proton Magnetometer designed for measuring low space gradients as encountered in Archaeological Surveys. To reduce the effects of transients two bottles are employed, one as a search unit and the second as a reference standard located at a fixed point. In a single operation the count from the first bottle is offset by that from the second, leaving a figure on the counter which represents the difference in the field strengths at the two sites. This is effected at a cost, over and above that of a normal proton magnetometer, of only an extra bottle and amplifier assembly and an extra decade unit with two gate circuits. A patent has been filed for this instrument.

United States of America

The Coast and Geodetic Survey has installed Proton Vector Magnetometers (PVM) at three observatoires: Fredericksburg, Tucson, and College. Portable total-field proton magnetometers are being used at several other observatoires for absolute observations in conjunction with QHM's and standard magnetometers for the complete determination of the vector field. At near-equatorial stations the earth inductor and proton magnetometer appear to be a reasonably satisfactory combination for determining the horizontal and vertical components.

Development work is continuing on the Automatic Standard Magnetic Observatory which uses a Helium or Rubidium magnetometer and biasing coils for the complete measurement, once each minute, of the vector field. The output, on punched paper tape, forms the input to an electronic computer that is used to compute all desired components together with magnetic-activity character figures which are comparable to the K and Q indices.

Two new magnetic observatories have been installed within the past year within the continental United States, one at Dallas, Texas, in cooperation with the Graduate Research Center of the Southwest and Texas Instruments, Inc.; the other at Boulder, Colorado, in cooperation with the Boulder Laboratories of the National Bureau of Standards. Both observatoires are intended to emphasize the development of research activities as well as provide standard magnetic observatory operation.

A new magnetic observatory in Puerto Rico is now under construction. It will replace the existing San Juan observatory hich is subject to frequent magnetic disturbance due to nearby traffic and commercial construction. The new installation is expected to be ready for routine operation in the summer of 1964, and it will be equipped to record telluric currents and micropulsations in the magnetic field in addition to the standard magnetograms.

Towed magnetometers are now operated regularly as standard equipment on six Coast and Geodetic Survey oceanographic vessels, all of them being of the proton-precession type. Plans are being made to automate the recording to the greatest practicable extent so that the output record on paper tape or magnetic tape will contain complete information on magnetic readings, geographic position, and time.

A floating pier top has been constructed for the observatory at Point Barrow. It is expected to be installed in the Fall of 1963, and is intended to reduce or eliminate the trouble resulting from tilting of the pier due to frost action. The pier top, which supports the three standard variometers, consists of a sheet of heavy aluminum resting on four pontoons or floats which float on mercury contained in four inter-connected cups. Horizontal spring-loaded tension wires maintain the horizontal position and orientation of the pier top. Preliminary tests at Fredericksburg have given promising results.

A three-component flux-gate recording magnetometer will be used in some of the IQSY operations. The flux-gate, or saturable-core, magnetometer has proved to be reasonably stable for recording changes in Declination, where a constant nulling field generated by an electric current in a coil is not required. Tests have been made, with promising results, on the use of small permanent magnets mounted about 15 cm from the flux-gates to reduce the horizontal (or vertical) component of the field to approximately zero. The sensing element will then respond to variations from this zero condition. A bimetallic strip used in the supporting bracket of the compensating magnet reduces the temperature effect to a negligible amount.

Field parties doing magnetic repeat work in the Unites States during the past several years have used portable magnetographs (Askania Variograph) operated within some 200 to 300 km of the observing points. This has permitted more accurate correction of the observations for diurnal and irregular changes of the field and has resulted in better determination of the secular change.

The U. S. Naval Oceanographic Office (formerly the Navy Hydrographic Office) is using two aircraft in the conduct of the World Magnetic Survey under Project MAGNET. The C-54 Skymaster, used since 1955, is currently assigned to low-altitude short-range survey missions. The second craft, an EC-121K Super Constellation, replaces the craft that crashed in Antartica in 1960, and is used for long-range high-altitude servey work primarily in the southern hemisphere.

Both aircraft are outfitted with Vector Airborne Magnetometers, Doppler Radar Navigation Systems, and Loran A and Loran C navigation systems. In addition, the C-54 is equipped with a Metastable Helium Magnetometer installed in a «bird», and the Super Constellation is equipped with an airborne digital recording system. The airborne digital data recording system provides a capability for digital recording data on magnetic tape in a format suitable for direct input to the IBM 7070 computer. The recorder system accepts data from the Vector Airborne Magnetometer along with time and identification data. The data is correlated with position information (from card input to the 7070 computer) and run through a computer program which produces output cards containing: track number, latitude, longitude, date, time, declination, inclination H, Z, F, and altitude. The system consists of an operator's control panel, data sensing equipment, logic section, Ampex FR 400 tape transport, and a Hewlett Packard printer.

Nuclear precession magnetometers are utilized to make total magnetic intensity measurements on shipboard surveys of the Naval Oceanographic Office. The instruments in present use are various airborne, helicopter and station magnetometers which have been adapted for marine survey work. The magnetic sensor, a set of solenoid coils immersed in kerosene and contained in a «fish» approximately 45 cm long and 15 cm in diameter, is towed 150 to 200 meters astern of the survey ship to reduce the effect of the ship's magnetic field on the sensor. A two-conductor, shielded cable with a non-magnetic stainless steel strain-member is used for towing. Streaming and retrieving of the fish is accomplished with small power winches or in some instances by hand.

All electronic units (tuners, amplifiers, counters, and recorders) are located on board. Present systems utilize analog recorders. One magnetometer, the Varian Model V-4931, has an analog recorder and a digital print-out unit. All systems are accurate to 1 or 2 gammas and record in terms of magnetometer counts. These units are inversely related to the field intensity in gammas and must be converted by using templates or computer programs.

Plans are being made for an integrated shipboard survey system which will incorporate direct-reading magnetometers with 1 gamma accuracy and a central digital recording system.

Under the auspices of the Goddard Space Flight Center of the National Aeronautics and Space Administration, research and developpment efforts on magnetometers for space measurements were directed toward: saturable-core flux-gate magnetometers, Hall generator magnetometers, and optical pumping magnetometers using both rubidium vapor and metastable helium. The earlier development of proton precession magnetometers culminated in the successful performance of Vanguard III in 1959. The replacement of proton magnetometers by Rb-vapor magnetometers for absolute measurements in space took place in 1960 with the successful firing of a self-oscillating Rb-vapor magnetometer in a Javelin rocket. Subsequently Rb-vapor magnetometers were successfully flow in the Explorer X satellite in 1961 and unsuccessfully, as a consequence of vehicle failure, in Rangers I and II in 1961.

Development of flux-gate magnetometers centered on achieving zero stability and low noise levels for use in very weak fields. On Explorer X weak field (saturation values of ± 30 gammas) flux- gates were successfully flown in a system in which in-flight calibration was obtained by applying a bias field to the Rb-vapor magnetometer and making cross comparison of values. Combinations of flux-gate magnetometers and Rb-vapor magnetometers employing programmed bias fields for vector measurements will be used in late 1963 and in 1964 in at least two satellites: the Interplanetary Monitoring Probe (IMP) and the Eccentric Orbiting Geophysical Observatory (EOGO). The development of optical pumping magnetometers was accompanied by the development of data reduction equipment for digital handling of the data in high speed computers.

U.S.S.R. (From a report submitted by Prof. S. Dolginov)

(Note by the Chairman of the Committee: The numbers in parentheses refer to items in a Bibliography provided by Prof. Dolginov. Unfortunately the bibliography, in Russian, could not be reproduced herein, but the Chairman will undertake to prepare a copy for anyone who requests it by letter.)

In 1960-62 the Soviet literature published papers on the instrumentation for magnetic measurements, based on different principles and designed for measurements under various conditions.

I. Measurements of the magnetic field from satellistes and cosmic rockets.

Papers (1, 2) give a detailed description of the instruments of the Earth's 3rd Artificial satellite used for measuring the Earth's magnetic field, and present the methods of eliminating from the satellite magnetograms the magnetic disturbance caused by the satellite itself.

Paper (3) gives a general idea of the three-component magnetometer used for measuring the magnetic field of the Earth and the Moon from the soviet cosmic rockets. This paper gives the grounds for the possibility of applying three-component magnetometers with magneto-saturated monitor for absolute measurements, using them in the rotating containers.

II. Measurements from planes, ships, and towed gondolas.

Paper (4) deals with magnetic investigations on the nonmagnetic schooner «Zarya» during the expeditions of 1960-61, gives a brief description of the apparatus designed to measure a scale value of the full vector of the field (by a magneto-saturated and proton magnetometers), Z and H components, and the magnetic declination.

Papers (5, 6) deal with experimental surveys of the Earth's magnetic field by the magnetometers towed by iron ships.

The measurements were made by a proton-magnetometer and a freely suspended magneto-saturated magnetometer for measuring the vertical component of the field.

Paper (7) gives information about metrological parameters of an airomagnetometer of full power with magneto-saturated core of a self-orienting type AM-13.

Papers (8, 9) present a nuclear aeromagnetometer of AYaAM-6 and the results of its preliminary summer tests.

III. Magnetometers based on the principle of free-nuclear precession.

Paper (10) gives a description and the results of investigation of the proton-magnetometer PM-1, with which the observatories of the Soviet Union are equipped. The device operates in a getoradinal way of measuring the frequency of free-nuclear precession.

Papers (11, 12, 13) give the results of the magnetometer PI-1 test under various conditions.

The description of a portable proton-magnetometer PM-5 mainly aimed at measuring secular variation at the points is given in paper (14). The instrument has an automatic device for frequency measurement of free precession and an acoustic indicator of signal quality. The small weight and the reduced size make the device convenient for work under field conditions. Papers (15, 16) give other variations of nuclear magnetometers. Papers (17, 18) deal with the questions on measurement of the geomagnetic field components and the direction of the field with the help of proton-magnetometers.

Papers (19, 20) deal with the questions on Overhauzer's effect used for intensification of a free-precession signal and on obtaining equipment of quasi-continuous action.

Papers (21, 22, 23) give the analysis of geomagnetometers' errors, based on the phenomenon of free-nuclear precession.

IV. Magnetometers based on the principle of automatic pumping.

Papers (24-25) report about the devive with a double radio-optical resonance with the line width of C^{135} 25-30 gammas where the relation of signal-noise is 100-300. A 0.05-gamma sensitivity of the device is guaranteed.

V. Magnetometers, magnetic variometers with quartz fibers.

Papers (26-29) give a description of sensitive elements and microvariation stations of high sensitivity, based on magnetic elements with quartz suspensions in combination with electron-optical transformers.

Paper (30) gives a description of a field magnetic station.

Papers (31-39) describe variuos elements of magnetic systems with quartz fibres for measuring component variations and the full vector of the magnetic field and the experience of their usage.

VI. Magnetometers with magneto-saturated sensors.

The papers (40-47) deal with the questions on projecting magnetometers with magneto-saturated sensors, on sensitivity calculation, metrological characteristics, the effects influencing the stability, sensitivity and the estimates of noises and sensitivity thresholds.

VII. The question of the noise compensation in magnetic measurements.

Papers (2) and (48, 49, 50) consider the questions on compensation of magnetic disturbances under various conditions of the experiments.

VIII. Observatoires, the methods of work, etc.

Papers (51-58) deal with separate parts of magnetic observatory work, variometer installation, temperature compensation, and other questions.

PART. II. SUGGESTIONS FOR DISCUSSION; PROPOSALS FOR COMMITTEE ACTIVITY.

Dr. De Vuyst has proposed for committee discussions and action an inquiry concerning absolute standardization and comparison, as follows:

A suggestion for which Committee No. 8 should take the initiative is the following: Several observatories in the world have established with great care absolute bases for H and Z with classical instruments or with some electromagnetic instruments. (For example, Niemegk, Fredericksburg, Dourbes, Hermanus, ...) One notices in the majority of observatories differences between the total intensity deduced from the classical instruments and from nuclear magnetometers. It seems to me that the Committee should send to the magnetic observatories a questionnaire concerning the differences found and the methods used to determine them.

Dr. De Vuyst calls further attention to the necessity for considering the standardization of micropulsation recording equipment. The following is taken from his letter of April 27, 1963, to the Chairman of this committee:

During the month of March I attended the meeting of the IQSY in Rome. It was evident that it would be definitely necessary to discuss at Berkeley:

1. The standardization (calibration) of instruments that are used to record rapid variations (pp, pc, pt).

2. The definition of the scale value and its limits. At Dourbes station we are using, referring to the first point, a «Low Frequency Function Generator 202A» from Hewlett-Packard. This generator is used by several seismological stations.

With reference to the second point, it would be necessary to discuss the method of expressing the scale value (gammas/second/mm or mm/gamma). The limits at Dourbes are:

for dX/dt	0.3	gammas/sec/mm
for dY/dt	0.03	gammas/sec/mm
for dZ/dt	0.1	gammas/sec/mm.

Beyond these values the background noise should be too large.

3. Standardization of the instruments. This is probably impossible at this time, due to the different instruments used. In the future it will be possible perhaps to standardize by using Rb or He magnetometers. Still, the last ones are not adequate for periods less than a second. In my opinion it would be necessary to distinguish two types of recording: (a) Magnetic, for periods up to 0.5 second; (b) Telluric, for the shorter periods.

Dr. O. Meyer has suggested a discussion concerning how it might be possible to:

1. Determine the bases of an observatory by means of a proton magnetometer and the angles of inclination and declination (T, I, D) instead of, as has been done in the past, by means of the horizontal intensity and the two angles (H, I, D);

2. Undertake comparisons of the bases of one observatory with another by means of a proton magnetometer.

For this purpose Dr. Meyer suggests a discussion among the chairmen of committees No. 1 (Observatoires), No. 7 (Comparisons of Magnetic Standards), and No. 8 (Magnetic Instruments). A further comment from Dr. Meyer's letter to your Chairman is as follows:

> Closely linked with the above questions is a discussion on the basis niveau of the various observatories. The niveau of the horizontal intensity is often compared (e. g. with QHM against Rude Skov) but not changed. If we consider measuring by means of Proton Magnetometers as absolutely right — which could hardly be doubted — then why should we not think of generally adapting the bases of the stations? This surely should be striven for.
>
> Here the important question is: when can or when should this be started on? I propose that a recommendation is set up, expressing that until the General Assembly in 1967 all observatories should if possible be equipped with a Proton Magnetometer. Thus would be given the possibility of having the date for a general adaptation of the bases fixed on the occasion of the Assembly in 1967.

Dr. H. Schmidt writes from the magnetic observatory at Niemegk that he has found in the proton-precession magnetometer two sources of error in addition to those caused by mal-performance of the electronic circuits or due to incorrect value of the gyromagnetic ratio. The errors he discusses are due to spurious magnetic fields, H_a and H_b, which are added vectorially to H, the total intensity of the earth's magnetic field. H_a is produced in the coil winding by influence of alcoholic vapor on the lacquered wire and becomes quite large after the coil is heated in continuous use of the magnetometer. Dr. Schmidt reports changes in the precession frequency as high as 3 parts per thousand. H_b is a field produced by insulation defects in the switching equipment. If the insulation of the relay that controls the polarizing current is defective, a leakage current fom the direct-current power source might flow through the coil and generate a small field. (For example, 1 microampere in a typical coil might generate a field of 10 gammas.)

The Coast and Geodetic Survey uses water, Kerosene, or heptane as the source of protons; alcohol has not been used. However, no effect of Dr. Schmidt's H_a field has ever been noticed. It seems difficult to explain how such a field migh be generated. The H_b field has not been considered, but the possibility of such an effect is quite real. Steps are being taken to determine the leakage current. If the instrument is always used with the coil oriented perpendicular to the field being measured (as is customary in the C&GS magnetic observatories) the resulting effect should be negligible even for an H_b of several gammas. But a precise control of the coil orientation is not always possible (in field work with portable instruments, rocket magnetometers, and with some types of observatory installations). It appears necessary, then, that all users of proton magnetometers should guard against errors of this type by careful choice of equipment used in building the magnetometer and careful maintenance to see that accumulations of dirt or deterioration of insulation does not, over a period of time, introduce an increasing error of the H_b type.

PART. III. SOURCES OF MAGNETIC INSTRUMENTS.

The following is a partial list of the manufactures from whom instrumental equipment suitable for geomagnetic measurements and recording may be obtained. It is surely not a complete list, for the Chairman of the Committee can report only what he knows about and what has been sent to him:

Canada (See Part I of this Committee Report, information from Dr. Serson).

De Havilland Aircraft of Canada Limited
Malton, Ontario, Canada

Fluxgate magnetometers, for use in field surveys on the ground.
Fluxgate recording magnetometers, for observatory and temporary field station use.

Barringer Research Limited
145 Belfield Road
Rexdale, Toronto, Canada

Portable Proton Precession Magnetometer (using a tuning fork as a frequency standard.)

Canadian Applied Research
Post Office Box 4004
Terminal A
Toronto, Canada

Fluxgate magnetometers, portable, for field use. (The instrument is described in an article by P. H. Serson and W. L. W. Hannaford, Canadian Journal of Technology, vol. 34, pp. 232-243 (1956).)

E. J. Sharpe Instruments of Canada Ltd.
P. O. Box 279
Willowdale, Ontario, Canada

Fluxgate Vertical Component Magnetometer, portable.

Germany

VEB Geophysikalischer Gerätebau,
Brieselang Kr. Nauen,
Forstweg 1,

German Democratic Republic

Vertical and horizontal force magnetometers by means of band suspended magnets (after Fanselau).

Recording equipment for telluric currents and magnetic pulsations, named «Tellurikanlage» with 4 channels; sensitivity 80 mm/mV.

Mating and Wiesenberg
Geschwister-Scholl-Str. 76
Postdam

Magnetic theodolite after Ad. Schmidt for absolute determination of H and D.

Earth Inductor for absolute determination of I.

Torsion susceptometer S M2 to determine the volume susceptibility of rocks, minerals, solutions, etc.

Recording field station for D, H, and Z variations, by means of bare magnet variometers; sensitivity 2-4 gammas/mm.

Institut für Regelungstechnik
Neue Bahnhofstr. 9-17
Berlin 0 116.

Shipborne flux-gate magnetometer to record H, Z, and D.

Continental Elektroindustrie Aktiengesellschaft

Askania-Werke
Grossbeerenstr. 2-10
Berlin-Mariendorf

Askania Universal-Torsion-Magnetometer UTM; portable, for field measurements of D, H, and Z.

Askania Earth-Variograph; portable, for continuous recording of D, H, and Z, on 12-cm paper or 16-mm film.

Conventional types of magnetic field balances, magnetometer-theodolites, earth inductors, and magnetographs for observatory installation.

A very comprehensive treatise on magnetic instruments is contained in vol. 2 of «Geomagnetismus und Aeronomie», edited by Prof. G. Fanselau. The title of vol. 2 is «Geomagnetische Instrumente und Messmethoden». The publisher is Deutscher Verlag des Wissenschaften, Berlin (1960).

France

Information regarding sources of magnetic instruments in France is given in Prof. Thellier's report of magnetic work, in Part I of this Committee Report. Also a Nuclear Magnetic Resonance Magnetometer, for continuous measurement of the earth's magnetic field, has been described by A. Salvi, Section d'Électronique, Centre d'Études Nucléaires de Grenoble.

Japan

Geographical Survey Institute
Ministry of Construction
1000 7-Chome, Kamimeguro
Meguro-Ku, Tokyo

Various types of magnetometers for observatory and field use and for airborne survey work.

Denmark

Danish Meteorological Institute
Charlottenlund

QHM
BMZ
La Cour Magnetographs

U. S. A.

Varian Associates, Inc.
611 Hansen Way
Palo Alto, California

Proton-precession magnetometers; for observatory installation, for towing by ship, for airborne towing, for rocket and satellite installation.

Rubidium-vapor magnetometers; for observatory installation, for rocket and satellite work.

Proton-precession magnetometers, portable; for field use.

Marshall Laboratories
3530 Torrance Boulevard
Torrance, California

Fluxgate magnetometers; for observatory and laboratory use, and for rocket and satellite work.

Schonstedt Engineering Co.
9170 Brookville Road
Silver Spring, Maryland

Fluxgate magnetometers; for observatory and laboratory use, and for rocket and satellite work.

Ruska Instrument Corporation
Post Office Box 36010
Houston 36, Texas

Magnetometers and Earth Inductors, field and observatory types; vertical intensity field balances; standard and rapid-run magnetographs for observatory installation.

Texas Instruments, Incorporated
Post Office Box 6015
Dallas 22, Texas

Metastable Helium Magnetometer, for observatory or recording-station installation.

Dalmo-Victor Company
Belmont, California
Fluxgate magnetometers.

United Kingdom

Littlemore Scientific Engineering Company
Railway Lane
Littlemore
Oxford, England
Proton-precession magnetometer, portable (Elsec magnetometer).

Bruce Peebles and Company Limited
Edinburgh, 5, Scotland
Marine towed magnetometers
Proton-precession magnetometers.

S. Smith & Sons (England) Limited
Colubus House
Wembley Park Drive
Wembley, Middlesex, England
Fluxgate Magnetometers (3-axis).

COMMITTEE ON CHARACTERIZATION OF MAGNETIC ACTIVITY (No. 9)

Report by J. Bartels, Chairman

This draft submitted by Chairman, J. Bartels, will be changed after it will have been discussed by the Committee at Berkeley.

Introduction

Since the Report of the Committee adopted at the Helsinki Assembly in 1960 ist not available in print (the Helsinki Transactions have not yet appeared), no reference to the 1960 Report will be made. However, a collection of resolutions taken at Helsinki is available in Comptes Rendus de la 12e Assemblée Générale de l'UGGI Helsinki (1960), published by the General Secretary G. Laclavère. Two resolutions touched the field of our Committee, namely, Nr. 67 (recommending geomagnetic Q-indices) and Nr. 12 (urging the study of lunar influences).

Your Chairman holds his office since 1948. I suggest that a change be considered at Berkeley; il will be necessary anyway if the plans for the re-organization of IAGA will be adopted.

Whatever may be changed in the structure of IAGA or even IUGG, it is believed that the Permanent Service of Geomagnetic Indices producing K, Kp, character-figures, Ap etc. should be continued perhaps with some improvements suggested below. It is gratifying to note the ever-increasing interest in our Service since the advent of Space Science: Our indices, of which we have now published a complete collection for the 30 years 1932 to 1961, have proven to provide reliable indications on certain changes in the high atmosphere and the interplanetary medium. I quote JACCHIA's result on upper atmospheric density variations as inferred from the braking of satellites: the temperature change in the outer atmosphere is linearly related to our daily index Ap.

However, there is no reason for too much self-complacency: A few members of our Committee are dissatisfied with our work. These criticisms will be discussed at Berkeley.

The extensive visits of Dr. Mayaud to many observatories, in preparation for his Atlas of K-variations, have resulted not only in a comprehensive study on the variability of the solar diurnal variations, but also in the prospect of an improvement of future K-indices form those. We may expect special communications by Dr. Mayaud on these subjects at Berkeley.

Part A: Current work

1. *Publications*

Fast information on magnetic activity is provided by half-monthly tables of final three-hour-range planetary indices, Kp, mailed from Göttingen to more than 300 addresses all over the world. Every month, a 27-day recurrence diagram is added, the «musical diagram». These leaflets give also preliminary notice about distinct sudden commencements reported by several of the Kp-observatories.

Quarterly reports are sent to 150 addresses by Dr. Veldkamp's Office, containing indices, selected days, character figures and provisional data on rapid variations collected by Committee No. 10.

IAGA Bulletin No. 12-series, finally, is the extensive publication of all data scaled by all observatories. In the report time 1960-1963, the following issues have appeared: Bull. No. 121 (for 1957); 12 m 1 and n 1 (Indices C and K for 1958 and 1959); No. 12 m 2 (Rapid Variations, 1958). Two more issues will appear in 1963: 12 n 2 (Rapid Variations, 1959) and 12 o 1 (Indices K and C, 1969). The aim is to speed up the publication of the Bulletin, so that the time-lag will be no greater than about 18 months. The Bulletins are sent to about 600 addresses; the North-Holland Publishing Co., Amsterdam, serves as publisher.

A complete collection of Kp-indices and derived data for 30 years 1932-1961 has appeared as IAGA Bulletin No. 18, to facilitate the use of those indices in geophysical and space science studies. A first discussion of this long series has appeared in Annales de Géophysique, Tome 19, 1-20, 1963.

2. *Proposed changes in scaling K-indices*

Dr. Mayaud will introduce a discussion which might lead to resolutions, on two questions

a) Should the K-index be based, like the Q-index, on the variations of the two *horizontal* components only, excluding the Z-variations?

b) Should the lower limits for the K-index at some polar stations be re-adjusted so that a relative number of K-indices 8 or 9 comparable to that given by the Kp-index is attained?

Although this would mean an undesirable break in the homogeneity of the series, I think these changes might be made, except, of course, for the observatories collaborating in Kp, who should continue their present way of scaling K.

3. *Q-indices and Hourly-Ranges*

Dr. Fukushima will report on his work on Q-indices (for 19 polar observatories during IGY/IGC) and will introduce a proposal in accordance with Resolution No. 67 adopted at Helsinki. However, Dr. Witham, speaking for the important group of Canadian polar observatories, will propose instead to drop the Q-index in favor of hourly ranges at polar observatories; A. Nikolski likewise used hourly ranges in his studies on the diurnal variation of activity at Soviet polar stations. Since opinions diverge, and since our Committee relies on voluntary cooperation, it looks as if some scheme of co-existence of different measures besides K must be found.

4. *Equatorial ring current*

Current measures of Dst(H), in Chapman's notation, for the IGY will be published in the IGY Annals by W. Kertz and M. Sugiura; separate communications by these authors may be expected at Berkeley.

Part B: General Remarks

The present IAGA-structure aimed at a program of Committee work mainly for such topics which needed international agreement, like in the field of characterization. The proposed new structure will provide for commissions which divide between themselves the whole scope of IAGA-interests. At this point, it may be permitted to outline briefly what our Committee has been doing so far.

1. *History*

Work along our lines started around 1906, when the scheme of the International Magnetic Character Figures was established, yielding a character-figure between 0.0 and 2.0 for each Greenwich day. Details on this and other older measures of magnetic activity may be found in Chapter 11 of CHAPMAN + BARTELS, Geomagnetism.

Mainly to satisfy the needs of ionospheric workers for a subdivision of the day, the K-index was introduced, first at Postdam in 1938, and later at the IAGA-Meeting at Washington, 1939. A summarizing three-hourly index, Kp, based on the K-indices of 11 or 12 selected observatories poleward of about 50° geomagnetic latitude, was proposed at the Brussels Meeting, 1951, and adopted as a trial measure. Meanwhile, the series of planetary indices Kp has been extended backward to 1932. Together with its linear equivalent, ap, and the daily average Ap, it is now the most widely used index for what has been called intensity of that part of solar corpuscular radiation causing geomagnetic disturbance.

At the Rome-Meeting, 1954, the topic of rapid variations and earth currents was assigned to a newly formed committee, No. 10. Our Committee, No. 9, joints No. 10 in the Permanent Service of Geomagnetic Indices.

2. *Other measures of activity*

Because of the general interest in geomagnetic disturbance, it is no wonder that a great numer of other measures of activity have been proposed. Some of these measures and their merits are described in Chapter 11 of «Geomagnetism» cited above. It must be gratefully acknowledged that a few observatories have provided the geophysicists with valuable long series of such measures, such as the Norwegian «Storminess», or the current series of quarter-hourly Q-Indices issued by Kiruna (Sweeden) and Sodankyla (Finnland). My own u-measure has served for some time, but will probably be superseded by some measure for Dst as far as the fluctuations of the equatorial ring current are concerned, and by frequencies of Kp-indices as a general measure of the level of disturbances in months and years.

3. *Opinions on K-indices*

K-indices for more than 80 stations have been printed in Bulletin No. 12 m 1 (1958). Glancing down the columns, one gains the impression that K-scaling is reasonably correct at many stations, while some stations obviously have difficulties during quiet times. What can be done by the Committee in this situation? Dr. Mayaud is preparing his Atlas of K-variations with model cases; the personal contacts which he has had with so many observers during his visits will also certainly improve the quality of K.

Since I have been responsible for the introduction of K and Kp, I may be permitted to state some personal opinions:

a) First of all, it should not be forgotten that no single index nor an array of a few characteristics can replace the great amount of information on time variations given by the *original magnetograms*. Everybody who has had the opportunity to inspect at one glance a great number of simultaneous magnetograms from stations distributed all over the globe will agree that such a synoptic picture provides a vivid and rich impression of the actual time-variations of the geomagnetic field and their geographical distribution. This impression cannot be well replaced completely by one or more indices or descriptive symbols. The K-index is nothing but a pale —though useful— abstract of a certain aspect of the variation for a single station, and the Kp-index is an attempt to combine the K-indices into a planetary measure. It is mainly a matter of personal preference whether one likes a quasi-logarithmic measure like Kp (resembling decibels) or a linear measure like ap or its daily average Ap.

b) The demands on the skill of the observer to derive proper K-indices for three-hour-intervals with a low level of disturbance increases with the distance of the station from the nearest auroral zone. This is only natural, because the Sq + L variations, and likewise their variability from day to day, are biggest at the equator, while the disturbances of corpuscular origin to be expressed by K are, in general, smaller. An observer with good experience in the vagaries of Sq + L will, nevertheless, be able to eliminate Sq + L and to provide a satisfactory K-index even for quiet intervals at such stations. If such an observer is not available, the Committee has suggested to use an index q for K up to 2, without trying to distinguish between 0, 1, and 2. Some tropical observatories use that scheme, and there is no objection against that use of the index q for other stations who believe to have similar difficulties.

c) Should the Committee expect every observatory to derive K-indices? The answer is: In some cases, there is no need to scale K-indices. For instance, at Göttingen, we scale K-indices only for a few intervals just prior to the issue of the musical diagram for Kp in order to bring that picture up-to-date as far as possible. It would be futile to scale K-indices for Göttingen for all intervals, since we are surrounded by a number of good, fully equipped stations deriving K-indices; we obtain K-indices from Wingst daily in the URSIGRAM. Similar conditions may apply elsewhere. At some tropical station where there is no trained magnetician available it may even be advisable to stop scaling K.

A member of our Committee has questioned the value of K-scaling, if no mathematical method employing a small finite number of parameters can be devised to give a reliable estimate of K. Such a pessimism is hardly justified; the sometimes erratic variability of Sq + L from day to day can hardly be judged quite accurately, it is true, but this element of personal judgment entering K-scaling is by no means prohibitive. In fact, the agreement of the K-indices for the 12 Kp-observatories is satisfactory, it occurs quite often even that all Kp-observatories scale K = 0 for an interval!

d) Should we aim at improving K-indices by the introduction of more stringent directions? A reasonable demand on the attention of the observer seems to be justified, but I should be opposed to overloading the observer by expecting from him a perfection which, in any case, would not much increase the intrinsic value of the produced K-index. Even the restriction of K-scaling to the horizontal components will not result in a more representative geographical distribution of K: In Germany, an underground anomaly in electric conductivity raises hourly horizontal ranges at some places by 30 per cent over the ranges measured about 50 km further south or north, and K. Whitham and F. Endersen have found a similar anomaly in Alert, Northern Canada (Quart. Journ. Roy. Astron. Soc. 7, 220, 1962). In all, it must be doubted whether even the greatest perfection in K-scaling would result in an adequate improvement in our understanding of the physics of geomagnetic disturbance.

e) There have been complaints that one cannot infer from the K-index information about certain phenomenae like ssc, bays, etc. This, of course, cannot be expected from a simple index running from 0 to 9. K-scaling must be supplemented by more detailed studies, perhaps in the manner of additional indices as they have been proposed by Fanselau. Committee No. 10 already works in that direction.

f) Looking through the K-tabulations in our Bulletins No. 12, we still find many gaps in the series indicating loss of records, especially during big storms. That is, at a time when the magnetograms would be of greatest interest. The principal task of an observatory should be to provide complete and readable records of all gemagnetic variations, not only by normal magnetograms, but also by storm variometers and pulsation recorders. As long as these demands are not met, it would be misleading to ask for K-indices from such stations.

4. *Final remarks*

It has been an advantage in the past that the official domain of our Committee has been so narrow, namely, to organize international cooperation in the quantitative description of certain geophysical phenomena which can be abstracted from the records of geomagnetic observatories. In this capacity, the Committee has been responsible for requests of rather burdensome and laborious work expected from the observers. Any such requests must be carefully considered at our Assemblies as to the justification in view of the needs not only of geomagneticians, but also of solar physicists and space scientists. It may have been sometimes rather dull to spend so much time on these subjects at the international meetings; many of our members would have preferred to listen to interesting accounts of new observations and theories. But we have always managed to reserve time to hear many valuable contributions on all aspects of geomagnetic disturbance.

After 15 years of chairmanship, it is a pleasure for me to thank all members of our Committee for their collaboration, in particular Dr. J. Veldkamp (De Bilt) for his work as Director of the Permanent Service of Geomagnetic Indices, and Dr. P. Mayaud (Paris) for his untiring and successful work on topics interesting our Committee. Likewise, we are indebted to our colleagues W. Kertz, M. Sugiura, S. Chapman and S. E. Forbush for their work on the ERC-project for the IGY, and to Dr. N. Fukushima for his work on Q-indices. Finally, we thank all those who have contributed indices K and Q, and especially the 12 observatories who have contributed to Kp, namely: Meanook, Sitka, Lerwick, Eskdalemuir, Lovö, Rude Skov, Wingst, Witteveen, Hartland, Agincourt, Fredericksburg and Amberley.

COMMITTEE ON RAPID VARIATIONS AND EARTH CURRENTS (No. 10)

Report by A. Romañá, S. I., Chairman

1. *Service des variations rapides*

a) Le mode de fonctionnement a été décrit dans le Rapport du Comité pour l'Assemblée de Helsinki. Aucune variation importante y a été introduite, sauf que dans le but de réduire le nombre des phénomènes compris dans les checking-lists, l'on a mis dans celles-ci seulement les phénomènes qui avaient été signalés tout au moins par dix observatories dans la région comprise entre 37°5 W et 52°5 E ou par quatre observatories dans le reste du globe. Malgré cela, le nombre de phénomènes apparaissant dans les checking-lists est encore trop grand.

b) Le nombre des observatories collaborateurs a beaucoup diminué cette dernière année. Il a été de

83	en 1960,	dont 25	avec des enregistrements rapides
81	1961	27	
75	1962	17	
52	1963	14	

Il peut être intéressant de voir leur distribution géographique:

Nombre d'Observatories	entre 330° et 60°	entre 60° et 150°	entre 150° et 240°	entre 240° et 330°
à enregistrements normaux	49	11	14	13
à enregistrements rapides	7	8	5	3

Quant à la régularité de l'envoi des données

11 %	ont tout envoyé dans le délai prévu		
44 %	ont envoyé dans le même délai	75 %	des données
25 %	» » » » » »	50 %	
16 %	» » » » » »	25 %	
4 %	» » » » » »	25 %	

Le reste est arrivé définitivement en retard ou non arrivé.

Pour ce qui regarde les checking-lists voici les réponses reçus

Observatories ayant réspondu à la liste	1956	1957	1958	1959
des sfe	56	62	75	77
des autres phénomènes	58	66	76	76

La conséquence est un retard considérable dans la publication des données. Quant aux Bulletins trimestriels, celui du 1er. trimestre 1963 a été déjà distribué et celui du deuxième trimestre est prêt pour l'imprimérie. Quant au Bulletins definitifs le n.° 12n2 est sur le point de paraître; quant au n.° 12o2 on est en train d'attendre l'arrivée d'un nombre considérable des réponses, surtout celles des Observatories russes et américains, qui comprent une partie trop importante du globe pour être négligés.

Ce retard étant surement dû au nombre trop grand des phénomènes compris dans les checking-lists, l'on propose de la réduire considérablement, se bornant à n'introduire en elles que les ssc, si et sfe et decidant pour les autres de publier le Bulletin définitif sur la base des données trimestriells publiées, plus celles qui sont arrivées en retard.

2. *Micropulsations*

La question de l'adoption de différents types de pulsations et la façon de les rapporter a inquiété de plus en plus les chercheurs. Quelques uns croient périmée la division adoptée à Copenhague (1957) en pulsations continues (pc) et trains de pulsations (pt). D'autres ne regardent pas avec sympathie de nombre croissant des symboles (pp, PIDP, pg...) et déclarent aimer mieux une division basée sur le période on la fréquence que l'actuelle basée plutôt sur des caractères morphologiques.

D'accord avec la résolution prise à l'Assemblée de Helsinki une lettre circulaire envoyée à tous les Observatories ayant des enregistrements rapides les priait de diviser pour la suite les pc en trois groupes et de les élarger des deux côtés vers les pulsations en perle et les largues-pc de Jacobs et Kino:

«Dear Colleague:

In order to improve the data of pc and in accordance with the practical resolutions of the Utrecht Symposium on Rapid Variations and of the IAGA Assembly at Helsinki, the Observatories having rapid -run magnetographs are kindly requested to report in the future all the pc with periods from 5 to 90 seconds and not only the pc with periods between 10 and 50 seconds.

It is desirable that the pc be distributed in the three following groups:

a) pc of period about 5 - 15 sec, usually regular
b) pc of period about 20 - 40 sec, usually regular
c) pc of period about 50 - 90 sec, usually irregular

It is evident that pc of different groups can partly or entirely overlap. In this case pc of each group should be reported separately.

In reporting all these pc, time of beginning and ending of the whole phenomenon and special intervals should be given as before; but the period and range of the largest oscillation should be substituted by the dominating period and range of the whole phenomenon or of the special interval.

Observatories having the possibility to register pp, viz. pc of period about 1 - 3 seconds, are also invited to report them. The instrument's requirements to be sure that pp are properly registered seem to be

Time - scale of variometers .	10 - 15 mm/min
Scale - value of variometers .	0.005 - 0.01 mm
or	0.01 - 0.1 mV/Km/mm

Thanking you in advance for your kind and fruitful cooperation.

Yours sincerely,

A. Romañá, S. I., Chairman»

Mais cette providence ne semblant pas encore suffisante, d'accord avec les souhaits exprimés dans le Symposium sur l'Aéronomie équatorielle et dans la 2ème. réunion de l'IQSY, le Président s'adressa à un certain nombre de charcheurs, savoir, les Prof. Jacobs, Kato, Selzer et Smith, Mme. Troitskaya et Sir Charles Wright, en les invitant à préparer un rapport sur la meilleure manière de diviser et rapporter les pulsations. La même invitation fut adressée plus tard au Prof. Matsushita. Ces rapports ayant été reçus pendant le mois de Juillet, ont été apportés à Berkeley pour être discutés aux meetings du Comité.

3. *D'autres activités du Comité*

Une réunion a eu lieu à Paris en Octobre 1960 avec quelquesuns des observateurs antarctiques pour examiner la convenance d'introduire dans la routine du Comité de nouveaux types de phénomènes plus propres aux régions polaires.

A l'ocasion de l'éclipse totale de soleil du 15 Février 1962 le Comité s'est adressé à tous les observatoires devant être affectés par le phénomène en leur envoyant un memorandum de Mr. Egedal sur la façon de conduire l'observation des possibles effects magnétiques de l'éclipse. Finalement la préparation de l'Atlas des Variations Rapides avec exemples réels obtenus pendant l'AGI est assez avancée et l'on peut espérer qu'il soit prêt avant la fin de l'année on tout au moins pour l'année 1964.

COMMITTEE ON HISTORY OF GEOMAGNETISM AND AERONOMY (No. 11)

Report by N. Pushkov, Chairman

The Committee on History of Geomagnetism and Aeronomy was established at the XI IAGA Assembly at Toronto in 1957. At that time there were only seven members from five countries. The first meeting of the Committee took place at Helsinki during the XII IAGA Assembly in 1960. At that time the Committee received 16 communications from 10 countries which were reproduced and distributed at the Assembly.

At the meeting only a few papers were presented by the authors. Chairman N. Pushkov reported on the work of the Committee. After this meeting the Committee had the opportunity to increase its membership to 34 members representing 13 countries. It is now known that only a limited number of papers bearing on the history of geomagnetism and aeronomy is published in scientific journals. According to the information in the Russian bibliographic journal «Referativny

Journal» not more than 30 of such papers were published throughout the world during the three years 1960-1962. Of these thirty papers, only one was presented to our Committee meeting in 1960. It also appears that most of the papers presented at Helsinki have not been published up to the present. Since the Helsinki meeting I have received three papers from members of our Committee, Drs. A. Lundback, N. Malinina and L. Slaucitajs. These have not been published yet.

At the Paris meeting of the IAGA Executive Committee in March 1962, N. Pushkov suggested that the Committee on History should be authorized to draw up the reports on recent progress in geomagnetism and aeronomy. This proposal was adopted. Thus the objective of the Committee (Commission) is now defined as follows:

1. To deal with the History of geomagnetism and aeronomy.
2. To report on recent progress in geomagnetism and aeronomy.

My idea as to how this obligation may be carried out is as follows: At each IAGA Assembly, the Committee on History, together with the other IAGA Commissions, will determine what reports in various fields of geomagnetism and aeronomy are most desirable and invitations given to prepare these reports. These invitations can be extended to any competent scientist, not necessarily a member of our Commission. It would be especially desirable to have young scientists take part in this work. I hope that many young Soviet scientists will actively participate in such an effort.

The reports on progress may be based on the national reports presented to the Assemblies, on special reports of the IAGA Commissions, on the papers published in scientific journals, and on communications presented to the Assemblies. As a general rule the reports must be devoted to the achievements on the different fields of geomagnetism and aeronomy for the three-year interval between successive Assemblies. Each author will, of course, be free in the treatment of the material.

The reports may be published in the Russian Journal: «Geomagnetism and Aeronomy». This journal is now translated into English and reprinted in the U.S.A. This arrangement will provide for a wide distribution of the reports. The translation of the original reports into Russian will be made in IZMIRAN, Moscow.

It would be useful to determine and list at the preseent meeting of the Committee (Commission) the most acutely needed and desirable reports on various fields of geomagnetism and aeronomy as well as list the possible authors. When preparing this agenda it is necessary to keep in mind the summary papers presented at IGY Symposium in Los Angeles. It would also be very useful to obtain the consent or agreement of some of the scientists at the Assembly to participate in the planned work. Other authors may be recruited later by correspondence.

It would also be desirable at the meeting to consider different possibilities for printing the work of the members of the Committee (Commission). At the Helsinki meeting we planned that as a general rule, the papers of members of the Committee related to History should be printed in the scientific journals of different countries. At the Paris meeting, N. Pushkov suggested to the IAGA Executive Committee that in some cases, with the general approval of the Committee on History, some papers may be published by IZMIRAN in Russian or in the original language. If the Committee (Commission) approves this proposal, IZMIRAN will print all non-published papers completed since the Helsinki meeting.

I do not recommend revising the present membership of the Committee now; il may be done later by correspondence. However, I think it would be useful to have new members, especially from American countries.

It would be desirable to elect, at the meeting, a small Bureau or Working Group of the Committee (5 persons). It would be helpful if the Bureau members were selected to have a knowledge of English, French, German, Russian and Spanish in the group.

I am afraid that many members of the Committee might be absent for one reason or another. At the same time, however, there is perhaps a better opportunity to have more than the usual number of representatives from American countries. This circumstance was taken into consideration when the provisional agenda for the meeting was planned.

At the Paris meeting of the IAGA Executive Committee it was decided that national reports would not be given at the Plenary Session of the Assembly. I included the reports of American countries in our agenda for two reasons. Such a procedure may help us to find the best way to write the history of geomagnetism and aeronomy in the American continent. It would also be useful to write a number of articles on the development and present state of geomagnetism in American countries. Such articles can be published in American journals and papers.

For reasons of health I cannot be present at this meeting. I am very thankful to Dr. Chernosky who agreed to fullfill my duty at this meeting. I hope that our meeting will be a successful one.

PART III

COMMUNICATIONS

SYMPOSIUM ON METHODOLOGY AND INSTRUMENTATION OF AEROMAGNETIC SURVEYS

Programme français de mesures aéromagnétiques

Dr. E. Le Borgne

Institut de Physique du Globe, Paris

Le programme français de mesures aéromagnétiques prévoit la mesure du Champ Total, F, le long de profils nord-sud espacés de 10 km et le long de traverses est-ouest espacées de 100 km; ces profils couvriront le territoire français et le plateau côtier.

L'altitude de vol sera de 3000 m, sauf pour la région alpine où le relief impose une altitude de vol de 4500 m.

Les mesures seront effectuées au moyen d'un magnétomètre remorqué à pompage optique de vapeur de césium, de construction française (C.S.F.). Les valeurs des pointés, un pointé par seconde, seront enrigestrées sur un ruban magnétique.

Pour la réduction des mesures aéromagnétiques, on utilisera un ensemble magnétométrique analogue, installé au sol, de telle sorte que la distance de l'avion à la station terrestre ne dépasse pas 200 km.

En plus des profils magnétiques à l'échelle de 1/50.000e, on établira une carte, à l'échelle de 1/1.000.000e, des valeurs de F réduites au 1-1-63.

Les mesures doivent commencer dans le courant du mois de Juin 1963.

Project magnet instrumentation control and data reduction

W. H. Geddes

U. S. Naval Oceanographic Office, Washington 25, D. C.

The U. S. Naval Oceanographic Office's World Magnetic Survey uses two modified transport type aircraft. These aircraft are equipped with Vector Airborne Magnetometers which continuously measure the total intensity, declination and inclination of the earth's magnetic field during flight. The magnetometers are of the saturable core inductor type and must be periodically calibrated and standardized at a magnetic observatory. Since the detectors are installed inside the aircraft, it is necessary to compensate for the aircraft's magnetic field. Magnetic observations are recorded on graphic recorders in analog form and on magnetic tape in digital form. The final reduction and tabulation of survey data are accomplished on a high speed electronic computer.

SYMPOSIUM ON PALAEOMAGNETISM AND PALAEOCLIMATOLOGY (WITH IAMAP)

The interrelation of palaeomagnetism and palaeoclimatology

S. K. Runcorn

King's College, Newcastle upon Tyne

Review of palaeomagnetic observations shows that the geomagnetic field direction varies on three time scales: (1) a few hundred to a few thousand years (the secular variation), (2) reversals of the polarity (occurring irregularly at a time scale of millions of years) and (3) wandering of the pole (at a rate of about a degree per million years). Scales (1) and (2) seem to arise from hydromagnetic processes in the core while (3) is caused by flow or creep in the earth's mantle. The divergences between the polar wandering paths from the different continents can be explained either by supposing that the mean geomagnetic field in pre-Tertiary times was non-dipolar or that there has been relative drift of the continents since at least the Triassic. Speculation on the former hypothesis is limited by the fact that a study of the core-mantle coupling leads to the result that the mean field has always been an axial one and arguments from symmetry show that any higher harmonics present must either be all odd or all even. If the non-dipole hypothesis rather than continental drift is involved as an explanation of the discrepancies between the palaeomagnetic data from Europe, N. America and Australia, it is found that in the late Palaeozoic and

early Mesozoic, Australia must be in low latitude, a conclusión in evident conflict with the palaeoclimatic evidence.

On the other hand, the latitudes inferred from the palaeomagnetic directions, assuming that the mean field has always been dipolar, fit the palaeowind data from Great Britain and the Western U.S.A. and from Southern Brazil and Uruguay.

Palaeontologic evidence of Permian temperature gradients

F. G. Stehli

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Modern organisms show a pronounced response to temperature. The distribution of living forms has been used to provide models of temperature response in terms of (1) presence or absence distribution data, (2) ratios of warm climate to cold climate forms, and (3) diversity gradients. In these models, the pervasive effect of the earth's latitudinal temperature gradient is clearly seen above a background of minor variations. Calculated surfaces fitted to the data have been used to minimize the effect of local variations and reveal in simple form the major temperature gradient. Data similar to that of the models have been accumulated for Permian faunas. Calculated surfaces fitted to the Permian data reveal with reasonable clarity the form of a latitudinal temperature gradient. The gradient is sufficiently pronounced and well controlled in the Northern Hemisphere to suggest that neither large scale latitudinal continental movements nor polar wandering is likely to have occurred here since Permian time.

Comparison of Permian palaeontologic and palaeomagnetic data concerning climate

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Data presented by Stehli (1963) concerning the diversity of certain Permian organisms has been used to reconstruct a generalized temperature model for the earth in Permian time. This data shows a temperature gradient from equator to pole when plotted with respect to the present distribution of the continents with a minimum temperature in the vicinity of the present geographic pole.

The existing palaeomagnetic data provides a virtual magnetic pole for Permian time near the east coast of Asia about 45° from the present geographic pole. When the above mentioned diversity data is plotted on a magnetic model of the earth and reconstructed in conformity to the averaged palaeomagnetic data (i. e. assuming coincidence of goegraphic and magnetic poles), the palaeolatitude lines derived from the diversity data and the paleomagnetic data are discordant by up to 70°. This suggests that the magnetic pole was not the temperature pole for the Permian and leads to questions concerning the currently accepted model for the magnetic field of the arth.

Some palaeomagnetic results and their evidence of palaeolatitudes

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Palaeomagnetic results of recent investigations of sedimentary and igneous rocks of various geological ages are described and paleogeomagnetic poles located. Interpretations of these data with regard to palaeoclimatology are made and some contrasts with other evidence of palaeoclimates are considered.

Palaeomagnetic measurements of rocks locate the geomagnetic poles for various periods of geologic time and suggest a direct method for the location of palaeolatitudes. The present magnetic field of the earth approximates that of a slightly displaced dipole with an axis inclined 11° to the rotational axis. Geomagnetic poles or polar positions of the dipole axis for different ages suggest polar wandering or continental drift. The magnitude of the relative movement is in contrast to the polar wandering of the present magnetic pole which measures in hundreds of miles. Consideration given to palaeomagnetic aspects of rocks of recent age emphasizes this magnetitude and points to the relationship between geomagnetic pole, magnetic pole, and geographic pole. The position of the geomagnetic pole is little changed in the last 20 million years but during Mesozoic and Early Tertiary its position was significantly different. The difference suggests that special attention be given the parameters of palaeomagnetism —palaeodirection ad palaeointensity— for this period of geologic time with emphasis on the Cretaceous and the interpretations of the results in light of palaeontology and palaeoclimatology. Older rocks give geomagnetic poles quite removed from Cretaceous or younger rocks, and some geochemically dated Precambrian rocks give poles as far away as the central Pacific area.

Palaeomagnetism, palaeoclimatology and the distribution of oil fields

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Irving and Gaskell (1962) used rock magnetic data to infer that the palaeolatitude λp of some pre-Tertiary oil fields now predominantly in temperate regions was mostly less than 20°. They concluded that rock magnetism might be used to judge oil potential in suitable rock structures. The method is assessed with reference to possible application in the Canadian Arctic. Major palaeomagnetic trends show that the North pole relative to North America moved from a Cambrian position near the present equator to its present site. Apparently, most of the Canadian Arctic passed from low to high latitudes, pre-Mesozoic rocks were deposited in favourable latitudes and, during Mesozoic time, intermediate latitudes crossed the northern part of the continent. In plotting areas of relatively «probable» oil occurrene, $\lambda p = 30°$ is selected as a rough boundary, to allow for a 10° uncertainty in palaeomagnetic pole positions. The belt between 30° N and 30° S now comprises 44 % of the total land area, and if the continents drifted 20° northward since Mesozoic time, as much as 60 % of northern hemisphere land may have had latitudes less than 30°. Hence only crude predictions result from the application.

Anomalous results are present in an analysis of major Tertiary fields, as well as in Irving and Gaskell's study. If palaeolatitude were the only criterion, Tertiary fields in Sakhalin and Alaska and the Triassic Moonie field of Australia should not have been drilled. Source rock data are direct, rapid and cheap. Rock magnetism can be of major importance in determining basic patterns of earth structural features and can contribute to studies of palaeogeography and palaeoclimatology. As an oil exploration tool, however, its application is narrow and probably unreliable.

Palaeomagnetic research in the Netherlands

M. G. Rutten and J. Veldkamp

Since 1956 palaeomagnetic research is carried out in cooperation between geologists of the Utrecht University and geophysicists of the Meteorological Institute in De Bilt. A number of studies concerning rock magnetism has been published on Iceland, Norway, Germany, France, Spain and Italy. The position of the magnetic pole for these countries has been studied from rock samples of Palaeozoic to Quartenary age.

Special attention has been paid to the magnetic cleaning of the samples. A method of cleaning was developed by As and Zijderveld by which the remanent magnetism is observed after exposing the sample to alternating fields of increasing strength. The special point in this method is that not only the intensity but also the direction of the magnetization is studied.

The pole positions for stable parts of Europe are generally in agreement with measurements by other authors; however, in regions which have been subjected to considerable tectonic movements large deviations are found.

Palaeomagnetism is used as a tool in many geologic field studies. In Iceland a detailed stratigraphy of basalt flows and intercalated tillites is built up. In southern Europe the Permian of the Alpine fold belt is found consistently with pole positions quite aberrant from those of «Meso Europa». Large scale crustal drift must have occurred in the Tethys during the Mesozoic. Movements of up to 4800 km have been postulated, far exceeding those needed by the most nappist of alpine tectonicians.

To test the secular variation in the recent past, Wensink and collaborators and Hantelman are studying continuous section of lava flows in Iceland, respectively from the Plio-Pleistocene and from the earlier Tertiary. The variation found is surprisingly large, the magnetic dipole axis is wandering up to 30° from the axis of rotation. In Permian ignimbrites, both of the Oslo Graben and of northern Italy, the secular variation seems, however, to have been much smaller; a difference requiring more research.

A palaeomagnetic investigation of the Miocene lavas of southern Oregon

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Seven hundred orientated cores have been collected from two hundred and fifty lava flows of Miocene age in southern Oregon. The samples were taken from ten different exposures, which vary from one hundred and fifty to over one thousand feet in vertical extent. The distance between the most widely separated sections is over one hundred miles.

Determination of the direction of N.R.M. has been carried out for each sample, and unstable components have been removed using alternating fields. The behavior of the samples in alternating fields is characteristically that of rocks possessing T.R.M. Eighty per cent of the samples possess reverse polarity, and parallelism between the magnetic directions found in baked interbasaltic soils and the associated lavas suggests the absence of a self-reversal mechanism. The results include an analysis of the geomagnetic secular variation, obtained from very intensive sampling covering twenty five flows from one site. The most significant result of the survery is the revelation of a systematic variation of the palaeomagnetic declination from northerly to northeasterly across the area. Explanation of this variation by differential tectonic rotation of the units involved is inconceivable when the results from three sections in the center of the area are examined in detail. Two of these sections, which differ in petrology and magnetic polarity, exhibit a sudden counterclockwise rotation of T.R.M. with increasing age. The third section possesses a very well defined dual grouping of magnetic directions. This grouping is separated stratigraphically, and is repeated for five cycles. Tests to determine the validity of this variation of the T.R.M. have been made.

It is likely that the separation of magnetic directions within single sections represents a relatively sudden movement of the dipole or non-dipole field.

Palaeomagnetic research on rocks of Cambrian and Ordovician age in Czechoslovakia

V. Bucha

Geophysical Institute, Prague

Sofar palaeomagnetic observations on rocks of Cambrian and Ordovician age in comparison with younger geological periods show a relatively large scatter and nonsystematic pole positions computed from the mean directions. For this reason a systematic investigation on more than 800 rock-samples from 60 localities in Czechoslovakia was undertaken. The total known thickness amounts in our country to roughly 3000 m for Cambrian and 2000 m for Ordovician rocks. Thus the chronological succession and the possibility of successive time correlation of palaeomagnetic results with all the main geological stages from lower Cambrian to upper Ordovician is possible. The rock-samples have been subjected to laboratory stability tests by demagnetization in AC fields 1000 Oe. The results of measurements were derived from red-coloured sedimentary and volcanic rocks. Certain conclusions can be drawn from the chronological succession of values D and I. Although there is a scatter within certain of groups investigated, the direction of the polar wandering curve is quite unambiguous, i.e. in a direction from West to the East from the region of central America through Africa in relatively low geographical latitudes. It appears that the velocity of polar wandering is relatively higher for these two epochs (approximately 15° for 20 mil. of years) than has formerly been supposed. For rocks of upper Cambrian age it shows a good agreement with the results acquired in England (Creer, Irving, Runcorn, 1954) if we use the reverse pole position for the latter. The same is true for the comparison of Ordovician poles from America (Collinson, Runcorn, 1960) and from our country. The values for lower and middle Cambrian as well as for upper Ordovician contribute to the data especially for palaeomagnetically hitherto unknown epochs.

Palaeolatitude spectra

E. Irving and J. C. Briden

Palaeolatitude spectra have been calculated for a wide range of sedimentary rock types and fossils and these are compared, where possible, with the latitude spectra of their modern equivalents. The comparison is good for occurrences of marine origin. It is less good for occurrences of terrestrial deposits (evaporites, desert sandstones) particulary in the Palaeozoic. This indicates that a broad latitude gradient of climate has persisted since the early Palaeozoic but that important fluctuations due to the effects of a varying land distribution have occurred. The results are consistent with the hypothesis that in the late Palaeozoic there was a large concentration of land in regions within 30° of the palaeoequator.

Secular variation in the western pacific region

R. R. Doell and A. Cox

U. S. Geological Survey, Menlo Park, California

Palaeomagnetic methods have been used to determine geomagnetic secular variation from Pliocene, Pleistocene, and Recent lava flows in Hawaii, Alaska, and western North America. An analysis of errors inherent in the palaeomagnetic techniques employed, together with an application of these same techniques to lava flows which have cooled in known geomagnetic fields, permits an evaluation of the accuracy with which secular variation of the ancient geomagnetic field can be determined. The main conclusions of this study are (1) ancient secular variation exhibits strong regional characteristics; (2) the spectrum of time changes of the ancient geomagnetic field contains periods considerably longer than the several hundred-year periods determined from observatory data; (3) the older secular variation cannot be completely explained by theoretical models based on moving the present irregularities of the non-dipole field along circles of latitude.

RADIOMETRIC DATES OF SEVERAL RECENT REVERSALS OF THE GEOMAGNETIC FIELD

A. Cox, R. R. Doell and G. B. Dalrymple

U. S. Geological Survey, Menlo Park, California

Radiometric ages and magnetic polarities of extrusive igneous rocks from the western United States have been measured to determine the ages of horizons where the magnetic polarity of rocks, and presumably of the geomagnetic field, undergoes 180° reversals. Minerlogic and thermomagnetic experiments have been carried out to detect and eliminate samples in which magnetic self reversals controlled by the mineralogy have occurred. The data now available indicate that the most recent magnetic polarity epochs were all of the order of one million years duration.

SWITCHING PERIOD OF THE GEOMAGNETIC FIELDS AT TERTIARY AND QUATERNARY EPOCKS

N. Kawai

Osaka University

In this paper are summarized and reviewed Japanese tertiary palaeomagnetic results, to clarify how the geomagnetic field had been changed during the time from middle tertiary to the quaternary epoch.

When those author's results were all arranged in the chronological order and plotted against natural time scale of the abscissae, it is evidently shown in the diagram that field reversal took place at least twice since Upper Miocen to the present, one occuring at Pleo-Pleistocene geologic boundary about 1 millions years ago and the other at Upper Miocene time about 18 millions years ago.

The assumable duration in which the main field had been kept unchanged in either plus or minus signe is about 6 million years, while the duration in which the main magnetic field had been switching from reverse to normal or from normal to reverse is about 1 million years or slightly less.

The results strongly suggest that some rythmic alternation of the fields from plus to minus and vice versa has actually been occurring periodically since Upper Miocene.

It is also indicated that during the field reversal conspicuous decrease of the intensity of the field and the simultaneous change of the direction might have taken place.

To see whether the phenomenon above-mentioned is a world wide evidence or a local incidence was our next direction of the study. This is to be clarified when similar results made at different places over the world by many investigators would be compared with each other to find synchronism or asynchronism of the self reversal in those data.

Therefore the data so far obtained at France, Iceland, Russian, England, Australlian, New Zealand, North American and Antartica and our data were put together to be compared.

And it was found that the rythmic field reversal at the Tertiary epoch is a global evidence and due to an intrinsic nature of the geomagnetism.

Detrital remanence and anisotropy in sediments. An examination of some theoretical models

R. F. Kings and A. I. Rees

Department of by Geology University of Birmingham, U. K.

The remanent magnetization and anisotropy of susceptibility of some sedimentary rocks are both the development of preferred particle orientations during deposition. In order to account for them theoretically it is necessary to describe the depositional process in a simplified way, starting with a grossly simplified model of the sedimentary particles themselves. The paper discusses some of the simplifications that are permissible and to what extent they are adequate to account for the presently available results.

It is concluded that a modification of the «four ball» model of Griffihs et al. (1960) does so to a close approximation. Further refinements may, however, be necessary as the range of experimental observations is increased.

Post-depositional detrital remanent magnetism

E. Irving

A study has been made of the magnetic stability of wet unconsolidated sediments containing detrital iron ore. The experiments have been carried out in magnetic fields of varying directions and strengths. The grain sizes studied are in the range coarse silt to fine sandstone, and both synthetic and natural sediment has been used. It is found that in a matter of a few tens of hours the sediment after deposition acquires a remanent magnetization accurately parallel to the applied field for all inclinations between 0° and 90°, and there is no inclination error such as occurs in deposition experiments.

It is inferred that detrital magnetization in many sediments may be stabilized until long after deposition as is consistent with the observation of uniform directions of magnetization in slump beds. These results also relate to the general question of the inclination error in sediments and of the usefulness of their paleomagnetic directions as a basis for estimating paleolatitude.

PALAEOMAGNETIC MEASUREMENTS FOR THE TRIASSIC BASINS IN THE NORTH-EASTERN UNITED STATES

K. Kobayashi and L. F. Tashbook

University of Pittsburgh

Oriented specimens were collected from 46 outcrop localities of rocks of the Upper Triassic in the Connecticut Valley, North-Eastern United States. The samples consist of diabese, basalt, red sandstones and shales, and baked red shales. The measured natural remanent magnetization of the specimens may be related to thermal, crystallization and depositional processes.

Some similar specimens were previously cited from adjacent location by Graham (1955), DuBois, Irving, Opdyke, Runcorn and Banks (1957), and by Collinson and Runcorn (1960). Recent measurements for magnetic direction and pole position are generally in reasonable agreement with previous results.

Tilt corrections permit inference concerning the stratigraphic relations of sediments and volcanic rocks. Correlation of the Triassic basins of Connecticut and New Jersey is possible when the «Fold Test» is applicable.

COMMITTEE No. 1

A SEMI-AUTOMATIC MAGNETOGRAM PROCESSING DEVICE

B. Caner

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A hybrid analogue-digital device is described which can be used to provide tabular hourly mean values directly from the magnetogram in one operation including integration, multiplication by scale-factor, addition of base-line correction, and automatic printout in a form suitable for direct photo-offset publication. Its features are moderate cost, high reliability and simplicity of operation. Accuracy of the machine in operational use is described and discussed.

COMMITTEE No. 2

HYDROGEN H_α EMISSION IN THE AIRGLOW

L. M. Fishkova

1. Systematic observations of neutral hydrogen H_α 6563 Å emission in the airglow spectrum carried out at Abastumani during IGY and IGC gave the possibility of studying intensity time variations of H_α line and its variations over the sky.

2. H_α intensity seasonal variations with maximum in July and distribution over the sky with minimum at antisolar point were obtained. The influence of galactic component and possibility of its substraction from observed H_α was considered.

3. It is shown that observational data about H_α emission in the airglow confirm the hypothesis of airglow H_α as a result of resonance scattering of solar Lyman radiation by neutral hydrogen atoms in the Earth's upper atmosphere and geocorona.

4. Investigation of H_α emission in the airglow spectrum is one of the effective ground methods of studying solar Lyman radiation and geocoronal structure.

INVESTIGATION PLANETARY PROPAGATION OF SOLAR AURORAE

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According to the materials of synchronous observations by all-sky cameras it has been established that aurorae are present both on the night and day sides of the earth simultaneously. They propagate within a certain ring with a width of the order of a few degrees and a radius of the order of 19-20°.

This ring of aurorae performs a regular drift round the geomagnetic pole during twenty-four hours, at each moment shifting towards the night-side so that it passes there over geomagnetic latitudes 60-65°. The diameter of the ring is such that its area passing over the day-side of the earth rounds up the latitudes of 75-80°.

The presence of the closed ring aurorae and its diurnal drift accounts for statistical regularities of aurorae behaviour: 1) one night maximum of aurorae appearance at the zenith at the latitudes of 60-65°; two maxima (evening and morning) at the latitudes of 65-75°; and one day maximum at the latitudes of 75-80°; 2) the great length of aurorae arcs and the diurnal variation of their azimuths; 3) the diurnal variation of aurorae shift in the direction of N-S. Two aurorae zones (the main and the inner) are, apparently, to be considered as envelopes of instantaneous positions of a single closed ring.

The scheme described is confirmed by the results of observations both in the Arctic and Antarctic.

Some results of the polar lights structure studies

S. K. Vsekhsvyatsky and N. I. Dzjubenko

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During several winter periods (1959-1962) were made special visual and photographic observations of polar lights on the IGY Tixi-bay station. Very interesting features of auroral structure were studied, in particular, the displacement of brightness maximum of arcs, the existence of «sweeping» regions and of recurrence of its luminescence, the discovered new twofold form of the rays in corona and the other auroral rays, the luminescence life-times of auroral elements and so on.

The possibility of the filming of some very quick changing forms of aurorae was shown.

The definite sequence of different forms of aurorae depending on geomagnetic latitude was observed. The distribution of brightnes and filament structure of homogeneous arcs were studied. The dimensions, life-times and velocities of structural elements of some active auroral forms were determined; on several ray bands it was found the true periodicity in longitudinal structure of elements with periods from 3 to 6 km.

The spatial and time distribution of aurorae over the territory of Yakutya

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1. Methods of analyses of ascafilms are discussed to define the spatial and time distribution of aurorae.

2. The spatial and time aurorae distribution is studied on the basis of the results from analysing instrumental observations of aurorae carried out by the stations in the region of Yakuthk during the IGY. The discovered effects of the irregular distribution of aurorae («patchiness») are reported.

3. The frequency of ocurrence of various auroral forms, their integrated luminous flux during the day, as well as the latitude-longitudinal effect in daily variations are analized.

4. The results of compariing spatial and time aurorae characteristics with the data of magnetic observations are discussed.

The auroral «coast effect»

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The «coast effect» of aurorae is a very dynamic phenomenon lasting for a short time. This hinders its registration. Due to this fact as well as to the possible influence of the coast effect on spatial aurorae redistribution an attempt is made to find out this phenomenon statistically.

From the ascafilms, made in Tixie isochasms are constructed for various forms of aurorae resembling the coast outline of the continent.

The frequency of auroral occurrence near the coast is higher. For the Tixie region the rise is about 10 %.

On the classification of polar aurora spectra

V. I. Ivantchuk

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Some remarks on the different methods for obtaining the spectra of polar aurorae are given. Numerons observations with an usual grating spectrograph СП-48 (dispersion 85A/mm in the region H_β) can help to reveal general and local peculiarities of aurorae spectra.

It was discussed more than 100 aurorae spectra in the region 4700-6000 A obtained in the Tiksi bay station during the winter 1958-1959 on the IGY programme.

A sequence of the aurorae spectral types are established. New classification (containing ten groups) based on the intensity ratio of the lines λ 5200 [NI] and λ 5228 A (N_2^+) is proposed. It is same reason to think that the effective height of aurorae is a foundamental of this classification. A very close correlation is established between the spectra types and the auroral brightness that confirms this conclusion; the brighter is the aurorae the lower is the type of spectra and vice versa. There are some exceptions for very bright aurorae with red summits.

The possibility of determining the height of an aurora by spectral method is shown.

Observations of type-B red aurora

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A 5-channel interference filter photometer was used to make observations of the relative brightnesses of the first positive group N_2 bands, the λ 3914 N_2^+ band, the λ 5577 [OI] line, and the first negative O_2^+ bands in type-B red aurora. It was found that the time delay between the emission of the 1NG N_2^+ bands and the 1PG N_2 bands was less than 0.1 sec. in disagreement with Malville's (1959) charge neutralization mechanism for the enhancement of the first positive group bands.

The lifetime of the $O(^1S)$ atoms emitting the green line was determined by the method of Omholt (1959) by comparing fluctuations in the emission of the green line with those of the N_2^+ bands. In type-B red aurora it was found that this lifetime corresponded to $0.48 \pm .06$ sec. compared to $0.67 \pm .06$ sec. in normal aurora. This may indicate that collisional deactivation of the $O(^1S)$ state occurs in type-B red aurora and is one factor contributing to the reddening.

The relative brightness measurements showed for type-B red aurora compared to normal aurora, an appreciable intensification ($\leq 50\%$) of the 1PG emission compared to the 1NG N_2^+ bands. At the same time there was observed a decrease of about 30 % in the intesity of the green line compared to the 1NG bands.

Malville, J. M.: *J. Atmos. Terres. Phys., 16,* 59 (1959).
Omholt, A.: *Geofys. Pub., 21,* No. 1 (1959).

Some properties of radio aurorae in mediun latitude

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From 54 aurorae recorded at Kühlungsborn (54° N; 12° E) since 1958 by a 10 kW radar at 33 Mc/s with rotating antenna the following observational results may be summarized:

a) Auroral echoes have been obtained only from a narrow zone north of the station approximately corresponding with the locus of points where radar beam intersects the earth's local magnetic field lines perpendicularly at a height of about 100 km.

b) The height variations of the echo region have been found to be not more than 10 or 20 km.

c) The correlation between auroral echo activity and magnetic activity seems to be different in summer and winter. In summer no echoes have been found at Kp 7, and the echo occurrence became 100 % only at Kp = 9. But in winter auroral echoes sometimes could be detected even at Kp = 5, and 100 % echo occurence was already reached at Kp = 7.

d) The seasonal variation of radio aurora activity is somewhat different from the one of geomagnetic activity. There are the equinox maxima but the summer minimum is very much deeper than the relatively high winter minimum.

e) The diurnal variation of auroral echo activity shows two distinct maxima one in the afternoon and the other at about local midnight separated by a sharp minimum in the early evening hours. There seems to be a pronounced seasonal modification of the diurnal variation, the afternoon maximum and the evening minimum being systematically one or two hours later in winter than in summer. Nearly no auroral echoes have been detected in the forenoon.

Auroral radio-echoes and their dependance on the constant and variable magnetic fields

B. A. Bagariatsky

1. In accordance with many observations the preferably occurring reflected signal azimuths are conditioned by the structure of the auroral magnetic field measured near the Earth's surface, and not of the geomagnetic field.

2. Both the direct magnetometer measurements of the field at the heights of 300 km (Sputnik 3) and the general considerations of the magnetic field structure in the Central Arctic regions enable to suppose the magnetic field at heights of E-layer in the Arctic latitudes to differ essentially from the central dipole field and to be similar to that measured at the Earth's surface.

3. For the northern stations the orthogonal reflection altitudes calculated on the base of actual field are usually much smaller than those permitted. Under the quiet field conditions one cannot explain the appearance of echoes for all the high-latitude stations (and some of the middle-latitude) if the theory of only orthogonal reflections is used.

4. The hypothesis of the polar circular electrojet consisting of the day and night components gives a satisfactory explanation for the middle latitude stations of the possibility of echoes during magnetic disturbances and the statistical picture of diurnal echo variation, as well as some features of correlation between auroral reflections and magnetic disturbances provide that there is a region near the auroral zone where the reflected signals are formed.

5. For high-latitude stations the region where the signals are formed is placed much more to the north than the auroral zone. The explanation of echo appearances for these stations is likely to be found in giving up the rigorous orthogonality, as Bullough does in his paper (Ann. Geophys. 1961).

The dynamic morphology of the aurora polaris

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Simultaneous changes of auroral form, brightness, and motion over the whole polar region have been studied using IGY all-sky camera records, from widely distributed stations on an intercontinental scale.

During very quiet periods, and sometimes for brief intervals during magnetic storms, the aurora may consist of faint, diffuse, quiet arcs extending along the whole of the auroral zone that is in darkness. The onset of a polar magnetic sub-storm suddenly changes this quiet state of the aurora, especially on the morning part of the auroral zone. The aurora becomes active all along the zone, but in different local time. Several remarkable dynamical features of the displays during active periods are also discussed.

Drastic changes in the distribution of the arctic aurora occur during great magnetic storms, such as those of February 11, 1958 and of September 13, 1957. It is shown that at about the maximum epoch of the main phase of the February 11, 1958 storm, the aurora was completely absent from the region of the auroral zone, where normally it is most frequent and intense. The strip in which overhead auroras are seen descended to geomagnetic latitude 50° N at that time.

An analysis of IGY-IGC auroral radar observations in Canada

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Continuous radar observations of auroral echoes were made with four identical 48 Mc/s radar installations in Canada during the period June 1957 to May 1958. The four stations provided overlapping coverage by the switched beam pattern. The stations were located at geographic latitudes of 45, 51, 64 and 75° N.

Echoes were obtained at all four stations on a regular basis, during the 24 months of operation. The arctic stations at Baker Lake and Resolute recorded echoes from all direction, whereas the mid-latitude stations at Ottawa and Saskatoon obtained echoes mainly from the north. The results of an analysis of geographical and diurnal occurrence as functions of latitude, direction, and time will be presented.

Morphology of aurorae and geomagnetism

J. I. Feldstein

The peculiarities of morphology of aurorae connected with the character of the main geomagnetic field of the Earth and variations of this field for the period of magnetic disturbances are considering:

The Main Geomagnetic Field

a) The position of aurorae zone for night and day aurorae in Northern and Southern hemisphere.

b) Changes in the position of aurorae zone during magnetic disturbances.

c) Changes in the position of aurorae zone and southern boundary of aurorae depending on the cycle of solar activity.

The Transient Geomagnetic Field

a) Daily changes in frequency of aurorae appearance and magnetic activity: the form of aurorae zone.

b) Aurorae orientation and the direction of the disturbance vector of the geomagnetic field.

Local geophysical effects and auroral theory

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The tendency of aurorae to take the forms of the coastline and concentrate at it can be explained by and assumption that the sea current being in antiphase with that in aurora arcs is concentrated near the coastline.

The observations in the Antarctic confirm this assumption.

The uneven «magnetic relief» of the constant field results in the appearance of «patchines» in the distribution of aurorae. «Break-ups» of aurora arcs over islands, shallows and fresh water outfalls and the formation of «forbidden zones» for aurorae at such places cannot be explained by the influence of magnetic anomalies.

A supposition is made that all these phenomena result from the great dissipation in backing of the energy of the alternating current flowing in aurora arcs. The mechanism of the generation of the alternating current in aurora arcs is suggested.

THE MAIN RESULTS OF THE RESEARCH IN THE VARIATION OF COSMIC RAYS IN YAKUTSK

A. I. Kuz'min, D. D. Krasil'nikov, G. F. Krimski, G. V. Skripin. I.-P. Chirkov, Yu. G. Chafer and G. F. Shafer

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From records of the Yakutsk complex of sets for registration of cosmic rays at wide energy range:

1. The main results of measuring meteorological effects, muon, nucleon components and extended air showers are given.
2. The characteristics of primary variations are defined.
3. The results received are interpreted by the modulation of galactic particles, and by the existence and variation of magnetic fields in outer space.

COSMIC RADIATION LEVELS IN THE STRATOSPHERE DURING PERIOD FROM JULY 1957 TO JULY 1962

A. N. Charakhchyan and T. N. Charakhchyan

More than 4 thousand measurements of the cosmic ray intensity in the stratosphere were made.

Regular data on the trend of increase in the small energy primary cosmic ray intensity for the period from the maximum to the minimum of solar activity are obtained. The results concerning the primary cosmic rays with the energy more than 0.1, 1.3 and 40 Bev (for protons) are discussed.

SOME METHODIC QUESTIONS COSMIC RAY VARIATION INVESTIGATION ON THE BASIC OF THE IGY EXPERIENCE

Y. L. Bloch, L. I. Dorman, N. S. Kaminer and L. I. Miroshnichenko

1. Here are given the calculations of the expected effects of solar cosmic ray flares for various devices and various station distribution all over the world with different assumptions about the degree index in the differential spectrum of the additional stream impulses.
2. Here is given the theoretical calculation of μ-mesons generation multiple for the absorber different thicknesses at the sea level in one-measured approximation and there is calculated the coupling coefficients for the telescopes, registrating μ mesons at the sea level and different depths under the ground.
3. There are calculated the coupling coefficients for solar activity minimum and maximum and elaborated the method of determing

the variation of coupling coefficients for any moment of solar activity by the data of the stations all over the world. It is shown that the knowledge of the absolute device constants (world correction of all devices of the same type) allows to determine the spectrum of the initial variations up to 15 Bev more precisely.

4. There is shown the importance of the initial variation investigation by the complex method using the data from the various devices. It is necessary to take into account a probable latitudinal anisotropy of the initial variation sources in investigating energetic spectra of initial variations (for this purpose it is important to take into account the data of the crossed telescopes).

ANALYSIS OF A NUMBER OF COSMIC RAY EFFECTS DURING THE MAGNETIC STORM IN THE PERIOD OF THE SOLAR ACTIVITY MAXIMUM ACCORDINGLY TO THE DATA OF THE STATIONS ALL OVER THE WORLD AND ITS COMPARISON WITH THE RESULTS IN THE PERIOD OF THE SOLAR ACTIVITY MINIMUM

M. V. Alania, L. I. Dorman, J. V. Kebuladze, V. K. Koiava, V. G. Koridze and A. M. Ikhetia

The investigation of the magnetic storm of October 22, 1958 accordingly to the data of the stations all over the world shows the presence of a number of effects in cosmic rays. The analysis of a daily wave first harmonic before the geomagnetic storm, during and after it, shows the amplitude increase and the phase shift to early hours. The phase shift also remains the same during normal intensity recovery.

Here is also observed the increase of cosmic ray intensity during the main phase of the magnetic storm. There is found a planetary distribution of an increase amplitude, longitudinal and latitudinal effects.

The comparison of the natures of corpuscular stream interaction with the geomagnetic field during the maximum and minimum of solar activity allows to draw a conclusion that they do not substantially differ from each other, as the variation of rigidity in the maximum is of the same nature as in the minimum of Solar activity. Here is the interpretation of the obtained results on the basis of the dynamic model of cosmic ray modulative effects.

THE RELATION BETWEEN THE MEAN CHARACTERISTICS OF FORBUSH DECREASES AND THE SUN ACTIVITY

G. V. Shafer, G. F. Krimski, N.-P. Chirkov and V. A. Filippov

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1. About 500 magnetic storms and Forbush decreases in the intensity of cosmic rays have been studied. The mean characteristics of decreases are statistically shown to be dependent on the level of the activity, the position of the earth on its orbit, the heliolongitude of chromospherie flares etc.
2. The results received are discussed with a view to determining properties of the modulation mechanism.

COUPLING COEFFICIENTS FOR VARIOUS COMPONENTS OF COSMIC RAY INTENSITY

E. G. Boos, V.JV. Viskov, L. I. Dorman and E. V. Kolomeetz

There are calculated the coupling coefficients with the account of elementary acts of the charged particle interaction with the atoms of atmosphere. The calculations are made for the μ-mesons component, falling down at different angles.

There are also made the calculations of the coupling coefficients of the nucleon component for the vertical part and for the particles, coming at different angles.

COSMIC RAY 27-DAY VARIATIONS BY THE DATA OF THE WORLD NETWORK FOR THE PERIODS OF IGY AND IGC AND THE GENERAL CHARACTERISTICS OF ELECTROMAGNETIC CONDITIONS IN THE INTERPLANETARY SPACE

L. I. Dorman and L. H. Shatashvili

Planetary investigation of 27-day variations of cosmic ray neutron and hard component using the data on solar and geomagnetic activities shows that the tendency to repetition with the Sun revolution period is not always displayed at the same time in all analysed phenomena. The tendency to 27-day repetition during the first half of the IGY is vividly observed in the cosmic ray intensity variations.

Here is the definition of number of peculiarities of cosmic ray 27-day variations. It is shown, that the duration of 27-day cosmic ray variations for the IGY period is equal to the period of 9-10 revolutions of the Sun.

A detailed analysis shows that the established peculiarities of

27-day cosmic ray variations can be explained by the idea of assymetrical wind of magnetic irregularities from the Sun.

There is a ground to suppose that 27-day variation of cosmic ray anisotrophy may stimulate false lunar-daily variations of cosmic rays. The compiling of the vector epitcyclogramus accordingly to daily-variation harmonic coefficients, averaged by the Cree-method on zero-days of planetary intensity of cosmic ray neutron component, shows the reality of 27-day modulation of cosmic ray anisotrophy, that during some Sun revolutions of the IGY period is rather substantial.

To distinguish lunar-daily variations is rather difficult. However, these difficulties could be overcome, analysing lunar-daily variations, depending on the mutual situation of the Moon, Sun, and Earth. There is shown the reality of the lunar-daily variation and defined its main properties. There is a supposition that a lunar-daily variation may arise with the stream modulation of cosmic ray charged particles, because of magnetosphere oscillations in the region of radiation belts with the period equal to the lunar-day period.

Anomalies in cosmic ray intensity during magnetic storms

E. V. Kolomeetz, L. V. Kozack, V. I. Pivneva and G. A. Sergeeva

Here is the analysis of the effects of the cosmic ray intensity increase for the cases, occured during 1957-1959 accordingly to the data of the stations all over the world. The paper reveals the dependence of the effects on a geomagnetic latitude and geographical longitude. Here is the calculations of the expected effects.

It is shown some cases have a vividly expressed latitudinal and longitudinal dependence whereas other analogical cases have not similar dependence. There is neither effect dependence on the size of the Earth's magnetic field horisontal component variation.

Here is a possible interpretation of the expected effects.

Cosmic rays variations during magnetic storms of various types

Y. L. Bloch, L. I. Dorman, N. S. Kaminer

The model of Forbush-effect mechanism, based on scattering of initial cosmic rays by corpuscular stream regular magnetic fields, with the presence of scattering irregularities, allows to carry out quantity estimation of the stream and frozen field parameters. This estimation is made by the data of more than 40 Forbush-effects registered during the period of IGY and IGC. It was shown, that the stream front is characterized by a substantial intensification (5-10 times) of the field that explains a rapid decrease of cosmic ray intensity. Anisotropic intensity increase before the Forbush-effect commencement, caused by cosmic ray reflection from the fore non-magnetic stream front was for the first time experimentally discovered. There is discovered the anisotropic increase of cosmic ray interesity in Forbush's effect minimum caused by the peculiarities of interaction of the corpuscular stream with the geomagnetic field.

On the basis of the intensity variation investigation of cosmic ray different components from the world stations carried out the analysis of the Forbush's-effects superposition character observed in July 1959. It is shown, that the observed variations are caused by the scattering of initial radiation by means of regular magnetic fields, frozen into solar-corpuscular streams, and that the Forbush-effect succession in July 1959 is caused by a successive entering of one corpuscular stream into another. There is defined the properties and sizes of these streams as well as the tensions of the frozen magnetic fields. There is estimated the effects in cosmic rays, expected as one corpuscular stream entering another. There is shown a satisfactory agreement of the theoretical results with those obtained experimentally. There is also discussed some other possible models of Forbush-effect superposition, and on their basis there is given quantitative estimations and the comparison with the experimental data.

Summarizing the obtained results there is considered the picture of the corpuscular stream removal from the Sun active region and of its spreading in the interplanetary space.

About fundamental features of Forbush-effect

A. A. Stepanyan

1. The general regularities of Forbush-type decrease in cosmic rays were studied using data of several stations for the IGY period. These stations are approximately uniform distributed for a longitude. The isotropic intensity and anisotropic intensity during Forbush effect were found using data of these stations. The importance of correct separation of these parts of effects in noted.

2. The parameters of Forbush effects for nucleon and meson components of the intensity such as amplitude, the duration, the rigidity of variation's spectrum were found using isotropic intensity.

3. From our and derived from world literature data of relation of variation on many couple of detector has found that the variation spectrum is in good agreement with the electric field theory.

4. It is shown that the intensity decreases simultaneously over all primary perticle spectrum using data for a large Forbush decrease

(> 4,0 %) of isotropic intensity of nucleon and meson component. It is in agreement for electric field theory.

5. It is found that the rate of the recovery of the intensity is approximately constant. The duration of Forbush decrease (the time of the recovery) in average is proportional to the amplitude of the effect.

6. An angle of the corpuscular outburst at the ecliptical plane which is derived from comparison of Forbush-effect and corresponding to the solar flares is ~ 120°. The amplitude of the effect in cosmic rays rises with increasing of the importance and duration of the solar flare.

Directional anisotropy of Forbush effect mechanism

K. K. Fedchenko

In the present study where the author continues the investigations published in a paper under the same title a quantitative discussion has been given on the results previously achieved with estimating the degree (amplitude) of Forbush-type decreases. In addition to 17 examples on the Forbush effect mentioned above for the period of IGY here have been studied other two large Forbush decreases in 1959. As a result of this the anisotropy character of the effect has been more exactly stated.

In discussing all these examples there have been studied the relationship with magnetic storms and stated a regularity in the onsets of sudden magnetic storms relatively to the initial moments of decreased intensity of cosmic-rays coming down from various directions to the Earth-Sun line.

The given investigations have also confirmed the conceptions previously advanced by some other authors on the nature of intensity pre-decreases observed before the Forbush effect and also on some features of interplanetary magnetic fields.

The investigations have resulted in the construction of an averaged «time-direction» diagram (model) on the base of which there have been predicted the initial moments of pre-decreases with a comparison to the observations of 12 pre-decrease examples at 32 stations of the world network. A good conformity of the predicted moments with the observed data has given an opportunity to make clear the regularity in the distribution of pre-decrease moments over the globe.

The achieved results are discussed here.

The disturbed diurnal variations in cosmic ray intensity during the Forbush decreases

A. A. Lusov and G. W. Kuklin

The diurnal variations in cosmic ray intensity during the Forbush decreases with a help of the sliding harmonic analysis were investigated. The investigation was made on materials of the world net of neutron monitors. The variations of amplitude and phase depending on the universal and the local time, the planetary situation of recording neutron monitors and the Forbush decrease type are discussed. There are observed «jumps» of the phase and the small variations of amplitude not having the world character (for example only the european stations). Perhaps the obtained results are explained by the Earth Magnetosphere deformation.

Anisotropy effect of little cosmic-ray flares

V. S. Smirnov

Anisotropy of little cosmic-ray flares is studied in explorying diurnal cosmic-ray intensity variations on days of increased activity of solar flares. As a unit for measuring the flare activity here has been used the total area of all flares observed in the visible hemisphere of the Sun. For quiet days (relatively to Forbush-type decreases of cosmic-ray intensity and to magnetic storms) and for disturbed days the analyses are carried out separately.

It is shown that in Murmansk for the period of 1959-1960, diurnal variations on days of high activity of solar flares were observed considerably increased at 2 o'clok (LT). It is supposed that this increase was caused by solar particles coming down at about 60° westward the Earth-Sun line. The analysis of diurnal variations at the station of Churchill for the same period has confirmed our supposition concerning the nature of this increase, whereas the diurnal variations at the same station for the period of 1957-1958 show no considerable disturbances. Here the obtained results are discussed.

The small effects of the solar flares in cosmic rays of the period of Forbush-decrease's recovery

B. M. Vladimirsky

1. The small effects of the solar flares in cosmic rays (an amplitude $< 1\%$ for the nucleonic component) at the period of Forbush decrease's recovery were studied on the world cosmic ray data. 55 events of the importance ≤ 2 for 6 Forbush-effects were considered.

The data of nucleonic component were corrected for diurnal variation. The averaging of the world data and Chri method were used simultaneously.

2. The events were divided into two groups: 1) the flares recorded in the same active region which were connected with Forbush decrease; 2) the flares observed in the other active regions. Is is shown that there are differences for these two groups. The first group has a more short time-scale of the event and a distinct impact-zone-effect. These impact zones are not in agreement with Firor's impact-zone. The second group has a long time scale of the event and has no the impact zone effect. The flares which took place at the period of high magnetic activity have no effects in cosmic rays. These facts are in coincidence with data about the big cosmic ray flares and the polar blackout event's information.

3. A configuration of the interplanetary magnetic field at the period of Forbush decrease recovery's derived from this data is a field tube attached to active region which excited the corresponding Forbush-effect.

Variations of cosmic rays and changes in the magnetosphere

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Yakut Branch of the S. P. of the A. S. of the U. S. S. R.

1. Anomalous effects in Forbush decrease of the intensity of cosmic rays and lunar daily variations are analized. The results obtained are compared with the Obayashi model for changes of the magnetosphere and reasons of disagreement between theory and experiment are discussed.

Variation of cosmic rays and the interplanetary magnetic field

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From the analysis of the variations of cosmic rays the characteristics of the interplanetary magnetic field are determined. It is shown that all the main effects are in agreement with the existence of an interplanetary magnetic field of the stretched dipole type, the axis of which is parallel to that of the equator.

Solar wind and its display in cosmic ray variations

L. I. Dorman and N. S. Kaminer

There is the criticism of Parker's hypothesis about the permanent solar wind on the basis of the analysis of this hypotesis consequences variations of various types should be played not by the permanent wind but by a stream of the magnetic field irregularities from the Sun, and the scattering of solar and galactic cosmic rays should take place outside the Earth's orbit as well as in the space between the Sun and the Earth. There is used the data about 11-year and 27-day variations of galactic cosmic ray stream as well as the data on the rises, connected with powerful chromospheric flares. There is given the results of solution of diffusion the equation of galactic cosmic rays from the galaxy into the interplanetary space with the presence of the quasiradial magnetic field and the radial motion of the magnetic irregularities scattering cosmic rays, in the supposition that the transport run for scattering of particles increases with the removal from the Sun (proportionaly to this distance). The presence of assymetry in the irregularity stream brings to 27-day variations and the quasiradial field substantialy decreases the diametrical diffusion. Solar-daily variations of cosmic rays are caused by the anisotropy in the interplanetary space. To explain Forbush's effects there is proposed a model of simi-transparent magnetic piston with the irregular magnetic field diametrical to the Earth-Sun line. The galactic particle removal by this piston brings to intensity decrease and the following diffusion, diametrical to the quasiradial magnetic field, brings to the gradual intensity recovery.

Cosmic ray flares by the data of the world stations and the questions of solar cosmic ray generation and propagation

Y. L. Bloch, L. I. Dorman, N. S. Kaminer and E. V. Kolomeetz

Here is the analysis of small and large flares of solar cosmic rays by the data of the world stations by the rigid and neutron components as well as by the stratospheric data. Here is a detailed investigation of the flare of May 4, 1960, a consideration of the geophysical phenomenon, accompanying this flare, the analysis of the hit zones. Here is shown the nature of the observed distribution of the flare effect over the world. Here is the definition of the variation spectrum, its variation in time and the structure of the interplanetary space. Here is the calculations of the zones of solar particle hits and their seasonal and daily variation. Here is a statistic analysis of the data by small flares (neutron and rigid components) on quiet and disturbed days;

the paper investigates the hit zone existance as well as the effect dependence on the location of a chromospheric flare on the Sun disk and on the flare existence in the active region at the previous moments. Here is the analysis of individual cases, the discussion of a possible interpretation of the discovered regularities, on the basis of the theory of solar particle anisotropic diffusion with the account of the removal of scattering magnetic irregularities from the Sun. The attention is drawn to a substantial difference of the observed spectrum from the generated one on the Sun and its substantial softening with time, as well as to the nuclear structure variation with the particles, speading from the Sun.

Cosmic ray flares at the Sun

A. N. Charakhchyan and T. N. Charakhchyan

In this report the experimental results on the cosmic ray measurements in the stratosphere at the northern latitudes during the cosmic ray flares at the Sun are considered.

General features of these flares and data on the interplanetary space magnetic fields effectively scattering the small energy solar protons are discussed.

Nature of cosmic ray daily variations during the minimum and maximum of solar activity

L. I. Dorman, E. S. Glokova and O. I. Inozemtzeva

There is the investigation of solar daily variations of cosmic ray intensity by the data of ionization chambers, neutron monitors and crossed telescopes during the periods of solar activity maximum and minimum. The obtained results are used for locating daily-variation sources for these periods. The first source causes the modulation of the particles, coming only from the directions near to the ecliptic plane. It is situated to the left from the Sun-Earth's line and probably connected with the Sun corpuscular streams and mainly acts during the solar activity maximum. The second source is highly latitudinal and mainly acts during the solar activity minimum and explains well the experimental data, if we assume that it is connected with the cosmic rays of more than 5-100 Bev energy. The direction to the source is connected with the preferable particle come from the centre of the Galaxy. The registration data of the rigid component from 1937 to 1955 prove the existence of stardaily variation from 1952 to 1954 (inclusive).

On the basis of the directed properties of crossed telescopes the paper investigates the anomalous daily variation during the main phase of effective magnetic storms by the data of continuous registration of the rigid component at the sea level in Moscow and Yakutsk and at the depths of 7, 20 and 60 MB in the northern and southern directions. It is appeared that in this period alongside the far source of anisotrophy, connected with the influence of electromagnetic field of solar corpuscular streams, a local source that is caused as a result of the direct influence of assymetry distorted geomagnetic field on cosmic rays, influences cosmic rays. This supposition is checked in detail by the data of the crossed telescopes of st. Cape Town and 40 neutron monitors of world stations during the main phase of the magnetic storm of February 11, 1958. There is given the theoretical calculations of the expected effect. The obtained results are compared with the data of the experiment.

THEORY OF COSMIC RAY VARIATIONS

L. I. Dorman

This paper gives an attempt to a single theory of cosmic ray variations of the Galactic as well as of the solar origin on the basis of investigations during the IGY and IGC period. It gives the calculations of the sideral-diurnal variation for various models of the magnetic field distribution as well as the distribution of cosmic ray sources in the Galaxy. It also gives the results of modulation calculations of this variation and its disguise within the solar system as a result of scattering on magnetic irregularities with the solar activity rise. The picture of cosmic ray modulation effects (11-years, 27-days, Forbush's effects, solar-daily variation, variations connected with the geomagnetic field distortion etc.) as well as the connection of the parameters determing these effects with the process of solar cosmic ray propagation are considered in complex. Here is investigated the nature of cosmic ray generation in the Sun and the connection with the accompanying circumstances, here is given the theory of cosmic ray anisotropic diffusion in interplanetary space. Here are discussed the questions of connection of cosmic ray variations of several types with the processes within the radiation belts of the Earth. The results of the theoretic calculations are compared with the main experimental data, obtained from the stations all over the world on the rockets and satellites. Here are given the consequences of the suggested theory of cosmic ray variations that are in need of further experimental test during the IGC period.

The energy spectrum of the heavy primary cosmic rays

A. C. Durney, H. Elliot, R. J. Hynds and J. J. Quenby
Imperial College of Science and Technology, London

The magnetic rigidity spectrum of primary cosmic rays with $Z \geqq 6$, in the rigidity interval $2 \cdot 5$ to $16 \cdot 0$ GV, has been determined by means of a Cerenkov counter carried in the satellite Ariel. The integral spectrum shows a well defined change in slope near $8 \cdot 5$ GV, indicating that this is probably the upper limit to the solar modulation process at this time (May and June 1962). In the rigidity interval covered by these measurements the integral spectrum is adequately represented by a power law with an exponent $\sim 1 \cdot 2$ below $8 \cdot 5$ GV and $\sim 1 \cdot 5$ above this rigidity. Under the plausible assumption that the integral galactic spectrum of these particles is represented by a power law with exponent $1 \cdot 5$, it follows that the solar modulation process in the $2 \cdot 5$ to $8 \cdot 5$ GV region is of the form

$$\int_E = \int_\infty \left[\frac{P}{P_0} \right]^{0.3}$$

Where $\int_E$ is the intensity at the earth of particles with rigidity greater than P, where P is in GV, $\int_\infty$ is the corresponding intensity outside the solar system, and $P_0 \sim 8 \cdot 5$.

The artificial radiation belt produced by the «Starfish» nuclear explosion

A. C. Durney, H. Elliot, R. J. Hynds and J. J. Quenby
Imperial College of Science and Technology, London

Analysis of energetic particle flux measurements from Ariel has led to a number of interesting conclusions about the effects of the «Starfish» nuclear explosion. It appears that the hydromagnetic shock wave generated by the explosion and propagated through the magnetosphere resulted in the disrupting of some outer belt electrons into the atmosphere. Following the explosion, a shell of electrons, centred at $L = 1 \cdot 12$ and continuously fed by fission fragments remaining in the vicinity of Johnston Island, was formed and lasted for at least one day. Arguments are given to support the view that the majority of the β-particles from the fission fragments were injected into the earth's magnetic field at altitudes less than 1000 km, although some electrons —which probably came from the decay of neutral fission fragments— appeared as far out as $L = 6 \cdot 5$. At high L values the spectrum of the additional electrons was softer than that of the β-decay electrons from fission fragments.

COMMITTEE No. 3

VARIATIONS OF THE UPPER ATMOSPHERE FROM 1957 TO 1963

H. K. Paetzold

Institute of Geophysics and Meteorology University Cologne

Density variations of the upper atmosphere has been derived from the accelerations of artificial satellites. The model for the variability of densities has been found valid also for the year 1962, and the first half of 1963 as it has been formerly proposed by us. Especially the semi-annual and annual variation —now also found by other authors— was as consistent for this period as in the years before. This periodical variation —first detected by us— agrees extremely well in phase with the variation of the electronic density in the exosphere found by Carpenter and others.

DAY AND NIGHTTIME VARIATIONS OF TEMPERATURE, MOLECULAR WEIGHT AND COMPOSITION BETWEEN 100 AND 250 KM (1)

H. Kallman-Bijl

Rocket and satellite observations, made in the U. S. A. and in the U. S. S. R. of atmospheric densities and oxygen ratios $n(O)/(O_2)$ have been used to determine the diurnal variations of *preasure, temperature,* and *composition* in the region between 100 and 500 km altitude. Six constituents of the earth's upper atmosphere have been included: molecular nitrogen and oxygen, argon, helium, and hydrogen.

It has been found that for late 1960:

(a) The nighttime mass densities are higher than the daytime densities in the region between 100 and ~ 200 km; the opposite is the case above 200 km.

(b) The nighttime temperatures are always lower than the daytime temperatures in the region between 100 and 500 km. In the exosphere the nighttime temperature is approximately 1000° K; the daytime temperature is approximately 1350° K.

(c) Between about 110 and 200 km altitude the molecular weight

(1) The complete paper has been accepted for publication in the journal *Planetary and Space Science,* under the title «Diurnal Variation of Temperature and Particle Density Between 100 km and 500 km».

during the night is higher than during the day. Above 200 km the opposite occurs.

(d) Between 100 and 160 km altitude the number densities of molecular nitrogen and molecular oxygen are higher during the night than during the day. Above this level the situation is reversed.

(e) With regard to the behavior of hydrogen and helium, it has been found that the number density of the lighter constituent, hydrogen, is higher than that of helium during the night at levels above 250 km. During the day the opposite is true, that is, the number density of helium during the day is higher than during the night and it is greater than that of hydrogen over the entire region between 100 and 500 km.

The results of this investigation have been obtained without assuming a temperature-, scale height-, or molecular weight-gradient, as has been done in previous investigations. It is also the first attempt to make calculations which include major and minor constituents together, based on observed composition data. As a result of this it is shown how the numerical values of composition, and, thus, the role of major and minor constituents, vary with altitude and from day to night.

Experimental data on the power of the energy source in the ionosphere

A. D. Danilov and G. S. I. Kholodny

Different experimental data can be used for estimation of the upper atmosphere energy balance. The investigations of solar extreme ultraviolet radiation give in the maximum solar activity the energy of radiation from about 3 erg/cm^2 sec (Hinteregger) to 10 erg/cm^2 sec (Ivanov-Kholodny and Nikolsky). The observed value of the ionospheric effective recombination coefficient gives the total rates of recombinations in the ionospheric column, which correspond to ionisying energy about 6 erg/cm^2 sec. The laboratory data concerning the coefficient of molecular ion dissociative recombination together with the experimentally received by rockets ion density in the atmosphere allow to get idea of large rates of recombination in the atmospheric column per second, which correspond to energy about 10-25 erg/cm^2 sec. The laboratory data on ion-exchange reaction constants confirm the idea of fast recombination processes, which take place in the ionosphere. The energy estimates, which is necessary to hold the observed upper atmosphere temperature gradients give the values about 2-10 erg/cm^2 sec. Presently the more reliable estimates of the power of energy source in the ionosphere give the value 3-10 erg/cm^2

sec. A number of problems concerning the source of energy and upper atmosphere energy balance are discussed.

THE RESULTS OF RADIOINVESTIGATIONS OF THE IONOSPHERE BY ARTIFICIAL SATELLITES

J. L. Alpert

Here is described a method of investigation of the ionosphere by the transmitter of the coherent frequencies. The results of measurements, fulfilled by «Cosmos» are discussed.

Here is presented the new data on the properties of ionosphere horizontal gradients of electron densities, electron-clouds and the angles of refraction.

The results of the theoretical investigation of the interaction of the satellite with the ionosphere and interplanetary medium are given.

THE RESEARCH OF THE METEORS DURING THE IGY IN THE USSR

P. B. Babadjanov, B. L. Kashcheyev, E. N. Kramer and V. P. Zessevitch

The study of the luminosity and drag of the meteors allow us to draw a conclusion about the earth's atmosphere characteristics and in the meteoric body itself. Exept it the obtained statistic data give us the information about the meteoroid's density in the cosmic space near the earth's orbit and also about the parameters of the meteoroid orbits in the solar system.

The investigators of the meteors agreed to the following conclusions:

a) During the IQSY it is necessary to concentrate the main attention to the study of the drifts of the meteor trains with all three methods —radar, photographic (giving rare but very full informations about the change of the velocity and direction of wind depending on the hight) and visual.

b) It is necessary to study the latitude and longitude effects for which it is very useful to distribute the stations up to the equator and in the Southern Hemisphere.

c) Conducting the observation of drifts it is necessary to fulfil by the full programme the photographic observations of the meteors. The last has its own interest as it is necessary to check up the discovered latitude and landscape effects in ionosphere. It is necessary to set them in planetary scale.

d) The examination of the discovered facts needs the renewal of the photographic equipment (the cameras must be replaced by more long-focal ones and so on).

Fluorescent scattering in planetary atmospheres

Y. Sobouti

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At temperatures of the order of 100-300° K, typical of the upper atmosphere of the earth and probably Mars, nitrogen molecules are virtually all in the lowest vibrational level of the ground electronic state, X $^1\Sigma_g^+$. When excited by ultraviolet solar radiation, they make transitions to a $^1\Pi_g$ state and then back to the ground state emitting the Lyman-Birge-Hopfield (LBH) bands. This mechanism, which may give rise to both resonant and fluorescent bands, is thought to be responsible for the daytime ultraviolet spectrum of a planet observed from above.

Based on the theory of multiple scattering, the formation of the LBH bands of N_2 has been investigated. The band intesities have been calculated for model atmospheres of Mars and the Earth. The effect of continuous absorption by O_2 which photodissociates to atomic oxygen is taken into account.

Variations of plasma temperature in the outer ionosphere

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Mean temperatures of electrons and 0+ ions between 500 and 900 km have been obtained from the electron density distributions as deduced by two years Faraday fading observations of 1958 δ_2 at Kühlungsborn (54° N; 12° E). Assuming diffusive equilibrium of the ionized constituents well above F2 maximum the effective scale heigh H_{eff} has been determined by approximating the mean electron density decrease by an exponential law $N_e = N_{e_0} \cdot \exp - \frac{h - h_0}{H_{eff}}$. From H_{eff} by means of theoretical considerations the true plasma scale height $H_P = \frac{R \cdot T_P}{M \cdot g}$ could be derived being about 5 or 10 % smaller than H_{eff}, and from H_p the plasma temperature T_p has been computed using M = 8. The results obtained in this way for the period from May 1958 to February 1960 are shown in the table.

T_P in 10^3 °K:

	day	night	mean
summer	3,85	(1,85)	2,85
winter	1,75	(1,35)	1,55
year	—	1,60	—

( ) = interpolated values

In order to get a rough estimate of the plasma temperature, also from a single satellite passage, another method has been developed based upon a comparison of the quotient of total electron content $N_{tot} = \int_0^h N_e \, dh$ (after Faraday fading observations) and electron density at F2 maximum (after ionosonde measurements) with corresponding theoretical values computed for different plasma scala heights. Thus, the disturbances in the period of 20-3-1959 to 30-4-1959 have been studied. It has been found that immediately after the first ssc T_P increases by a factor of 2 or 3 within one or two days. Thereafter T_P seems to be closely correlated with the enhanced ionization in the lowest ionosphere lasting for several days as measured by LF-propagation. It is supposed that both phenomena in this latitude are due to precipitating radiation belt electrons.

Measurement of doppler temperature with a wide angle Michelson interferometer

R. L. Hilliard and G. G. Shepherd

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During the past few years, a number of measurements have been made on the Doppler widths of certain optical emission lines in the aurora and the nightglow. The only instruments so far employed have been Fabry-Perot interferometers, using both photographic and photoelectric recording. With photoelectric detection, profiles of the OI line at 5577 A can be obtained in a few seconds with faint aurora. For the same line in nightglow, or for fainter emission lines in aurora, an instrument of higher light-gathering-power is desirable.

Such a device will be described. It is a Michelson interferometer, using the field compensation principle so that light from a large solid angle may be collected. A conventional Michelson interferometer has the same light-gathering-power as a Fabry-Perot interferometer; the wide angle instrument provides a gain approximately equal to $\sqrt{R}$, where R is the resolving power. For line-width studies, the gain is spectacular, lying between 500 and 1000. Finally, since the analytical form of the input spectrum is known, only a small region of the interferogram need be explored. This makes possible a fairly simple instrument. Some preliminary results obtained on the nightglow will be presented.

Effects of Hall conductivity on currents in the ionosphere

A. T. Price, G. A. Ferris and J. A. Lawrie

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Theoretical studies of the behaviour of electric current systems in the lower ionosphere indicate that the Hall-current conductivity produces a rotation of these systems from west to east about the geomagnetic axis, a result first noted for a freely decaying system by Ashour and Ferraro. Using likely values of the conductivity tensor for the E - layer, Ferris and Price estimate that in latitude λ the current pattern shoult move with a velocity of about 10 sin λ to 100 sin λ Km./sec. A study by Lawrie of the spatial distribution of geomagnetic fluctuations during a typical magnetic storm has indicated a general motion eastwards of the pattern of disturbance of about this speed, while no evidence of motion in any other direction has been found.

Studies by Ferris and Price of the currents induced in a non-isotropic ionosphere by an oscillating field of external origin have shown that, for frequencies greater than a certain value depending on the Hall conductivity, the currents are actually of greater intensity than those which would be induced in an isotropic shell of infinite conductivity by the same field. The ionosphere has in fact a resonance property due to its anisotropic conductivity. The resonance can be explained in terms of the above rotation phenomenon.

Regular variations in the ionosphere

E. A. Lauter and G. Entzian

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Contrary to the other atmospheric layers there exists neither a satisfying observation method nor a worldwide measuring-program for a continuous control and study of the mesopause-region with ground based equipments.

Low frequency propagation observations over several years have been used to study the regular behaviour of the lower ionosphere in heights between 70 and 95 km, to test the possibility to get diurnal and seasonal variations. From phase-height analysis, from observations of reflection-coefficients and from drift-measurements in the frequency-range 100-250 kc/s the following results may be presented:

1. The diurnal variation of h', derived from oblique incidence propagation, may be nearly described by a ln. sec - law. h'varies between 95 and 80 km in winter and between 95 and 75 km in summer.

2. There are considerable interdiurnal fluctuations in the variation of h', often uniformly over distances of 800 km.

3. The striking feature of all forms of observations is the evidence of a semiannual variation in this atmospheric region at medium latitudes.

a. The effective scale heights H, varying between 4 and 6 km, show clear maxima in March/April and September/October and minima in winter and summer.

b. Simultaneously with the maxima of H, low frequency reflection coefficients, measured at low sun heights, show also clear maxima. This behaviour is quite contrary to what should be expected from an equinoctial corpuscular effect. Therefore this semiannual variation was observed better at minimum solar activity by this method.

c. Low-frequency drift measurements, just at the same time in spring and autumn, gave also evidence of distinct reversals in drift directions.

4. At least in the lower part of the mesopause region, there exists an annual variation in atmospheric paramenters with a meteorological-like time delay of one or two month with respect to the solstices.

IONOSPHERIC MEASUREMENTS DURING THE TOTAL SOLAR ECLIPSE OF FEBRUARY 15, 1961

J. Taubenheim

The results of ionospheric measurements made in Bulgaria during the total solar eclipse of February 15, 1961, as well as their physical interpretation, are summarized. The conclusions, that the effective recombination coefficient in the E region is $\alpha_{eff} \geq 1 \cdot 10^{-7}$ cm^3 sec^{-1}, and that about 40 per cent of the ionizing radiation are emitted from local sources at the east and west limbs of the sun, are of great importance for the theory of layer formation, and have been confirmed by a comparison with observations in the region of partial eclipse. The behaviour of the F region during the eclipse is similar to that during an ionospheric disturbance, whereas the day of the eclipse was geomagnetically very quiet. Real eclipse effects are found in the F2 region and in the F1 layer, the latter stratification appearing only during the eclipse. Both pulse absorption (A1) and cosmic-noise absorption (A2) measurements have been carried out in the zone of totality. During totality, the ionospheric absorption on 3.0 Mc/s (A1 method) decreased to about half its normal value. A quantitative interpretation of the solar eclipse variation of ionospheric absorption is attempted.

Ionospheric observations carried out during the solar eclipse of February 15, 1961 at Athens

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Data are presented showing the variations of the critical frequency of the E region, F1 and F2 over Athens (Scaramanga) during the eclipse of Feb. 15, 1961. This eclipse was partial (93 %) as observed at ground level, but was total at the height of the F region. Different values of the effective recombination coeficient are calculated against height by the use of true height profiles N(h), and the values obtained ($1.5.10^{-8}$) during maximum phase, are in accord with those published by other investigators. An attempt is made to relate sharp changes of gradient in the electron density curves with features on the solar disc. To this end fine structure continuous MUF recordings are correlated with data obtained at Florence on 1270 and 9700 mcs. Two regions are localised and one of these is characterised as cold. Because of disturbances in ionization before maximum phase, no accurate values could be obtained for the distribution of the radiation on the solar disc, but an estimate is given for the contribution of the brighter west limb.

High energy particles in the lower ionosphere at medium latitudes

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Strong enhancements of low frequency ionospheric absorption are regularly observed during and well after very strong magnetic storms in medium geomagnetic latitudes ($\Phi = 50$-$55°$). This excessive absorption is strongest at great zenith angles ($75° < \chi < 100°$) and may be observed from the beginning of the magnetic storm up to a fortnight later. Maximum absorption occurs 3-4 days after the main-phase of the storm in a magnetically quiet period. Properties of these low frequency absorption anomalies (LFAA) during magnetic storms and during the after-effects may be described as follows:

a) storm-time LFAA occur not earlier than $Kp \geqq 6$ in $\Phi = 55°$ and can be observed down to $\Phi = 50°$. They are well correlated to radio aurora echoes in medium latitudes, so that the observed ionisation in 70-80 km height may be caused by incoming high energy particles (HEP).

b) LFAA well after the magnetic disturbance occur only if

$Ap \geq 60$ and the duration of this after-effect increases with storm-time Ap. They are normally not observed in $\Phi < 52°$.

c) LFAA seem to be stronger and of longer duration in summer than in winter. There is also a strong dependence from sunspot cycle.

d) For all notified satellite data, there is a so well correlated behaviour between HEP-counting rate and the LFAA, that electrons from the inner part of the outer belt are strongly supposed to be the origin of this excessive ionisation. Specially the duration of strong overfilling of the inner region of the outer belt corresponds to that of the after-effect.

e) Taking account of the observed energy spectra of trapped electrons and their precipitation rates, electron-density profiles for the lower ionosphere were calculated, which satisfy the observed LFAA during storm-time and after-effect. Maximum of excessive electron-density is about 10^{-2} cm^3 at 80 km, which is far too small to be detected by HF-absorption measurements.

Wind systems at the lower ionosphere

E. S. Kazimirovsky

USSR

The results of world-wide measurements of horizontal ionospheric drifts during IGY and IGC are under discussion. The results for D, E and Es regions of the ionosphere obtained by the closely spaced method and the meteor trail method have been analysed. The analysis is based on the IGY WDC B-2 (Moscow) data from 21 stations and on some papers published by various authors. It is assumed that the movements of the irregularities at the heights up to 140 km are similar to those of neutral wind. The global distribution for prevailing 24-hour and 12-hour drift components has been computed for every season. It is shown that the steady zonal drift is directed to the East in local summer and to the West in local winter in both hemispheres. In the equinoxes the movements were irregular and frequent reversals in direction took place. The steady zonal drift obtained by meteor trail method and that obtained by closely spaced method have the same direction in local summer and opposite directions in local winter. The diurnal and semidiurnal harmonics have a large seasonal amplitude and phase changes. At lower lattitudes the diurnal drift component is predominant in all seasons. The amplitude of the semidiurnal component has maximum in winter for middle lattitudes of the north hemisphere and in the equinoxes for higher and lower lattitudes. The rsults have been compared with theoretical wind systems.

IGY-IGC IONOSPHERE-ATMOSPHERE DEPENDENCE AS REVEALED BY SOME MID-LATITUDE AND MIDDLE-ASIAN STATIONS OF USSR

V. N. Kessenikh, E. S. Kazymyrovsky, U. A. Novikova

Following the suggestions of the V-th Assembly of CSAGI, Moscow, August 1958 and further discussions, the IGY-IGC ionospheric data were investigated for stations: Moscow, Sverdlovsk, Tomsk, Rostov on Don, Irkutsk, Alma-Ata and Ashkhabad in comparison with h_{200}-geopotential level for 200 millibar isobaric surface, p-sealevel barometric pressure and R-solar activity index for 1958 and 1959 years (f^o_{F2}; h_{200}; p, R) and for the period 1951-1960 (only for f^o_{F2}; p and R).

It was attracted the chief attention to the question: «Is there any factors of clymatic origin, changing themselves from year to year and causing incoordinated regional variations in F2 ionization».

In order to exclude the effect of symultaneous large scale ionospheric disturbances for 1958 and 1959 years it was made the comparison for each month of the relative values of following quantities: 1) Maximum f^o_{F2} value for monthly median 24 hour curve, 2) Monthly median value h_{200}-1100 in geopotential decameters, 3) Monthly mean p/p_o in millibars, p_o being the mean for the same month in many years series.

For each quantity as unity serves the value of the same quantity for Moscow.

The comparison distinctly shows, that the relative geographical run displays from year to year a well remarkable change.

A method of binary correlation indices was proposed and used to make the evaluation of range of divergency of ionospheric and tropospheric data more objective.

The most remarcable is that for October 1958, in comparison with October 1959, a consentient variation both ionospheric and tropospheric indices for 5 stations is recorded.

The pecularities of atmospherical dynamics for transition from autumn equinox to winter suggest the more detailed investigation of above-mentionned indices during the last heliocycle.

Such a comparison made for October-values from 1951 to 1960 for 77 stations detects a significant decrease of variability of ionospheric data by the change from the minimum to the maximum of solar activity.

PHASE INVESTIGATIONS OF THE IONOSPHERE DRIFTS

V. D. Gusev, S. F. Mirkotan, M. P. Kijanovsky and I. B. Beresin

This report includes some new results about drifts and parameters of large-scale irregularities in the F2 layer. Presented data differ from those published as following: 1. Number of samples used for statistical processing increased thrice. 2. A careful selection of applicability of the data for the correlation analysis was carried out.

The following parameters of the irregularities were found: value (V_g) and direction of the real drift velocity; index of the anisotropy (e) and orientation of the large axis, «time of life» of the irregularities (τ_c) and so on. The main seasonal and diurnal variations of these parameters are analysed. In particular it was established:

The large-scale irregularities have rather pronounced anisotropy of form. The mean value $\bar{e} = 2.71$. The predominant direction of the preelongation is near to meridian with larger dispersion then it was previously found in.

The value and direction of the drift have the same features as it was published before. The predominent drift direction is north-south. The mean value $\tau_c = 8.3$ min ($\tau_c = \tau_{os} v_c'/v_c$).

e and V_g have not significant seasonal and diurnal variations, but the drift direction and τ_c have ones.

The spaced reception supplemented by frequency-shifted studies. For these cases the common correlation analysis was generalised and applied to the medium with three-dimentional characteristics. It was obtained that the large-scale irregularities have an ellipsoidal form with radio of axes 4 : 2 : 1. They occupy a considerable part of F2 layer in height. The major anisotropy axis was orientated in NS direction.

According to above mentioned between the magnetic field and the anisotropy form of irregularities exists the relation-ship.

On the morphology of radio wave absorption in the lower ionosphere

M. P. Rudina

The preliminary results of ionospheric radio wave absorption measurements in the USSR, made by pulse method at 2.2 Mc, are presented. Seasonal variations of the midday median values of absorption, f-min and foE are discussed and compared with the solar activity. It is noted that there is good correlation between diurnal variations of absorption and the values of cos χ (solar zenith angle).

Some remarks about the efficiency of negative ions in the lower ionosphere

Chr.-Ulr. Wagner

Geomagnetisches Institut Potsdam der DAW

In a recent paper the concentration of negative ions of oxygen and its combination was computed for some electron density distributions in a stationary quasineutral model of the undisturbed ionosphere, taking into account some improved values of attachment and detachment coefficients received by laboratory experiments and by theoretical calculations. A discussion of the density of negative ions at 12.00 local time and at 00.00 local time in dependence on height shows that in the region above 95 km both in day-time and at night it is n_O-which prevails while in lower regions n_{O_2}-is predominant. Further it must be concluded that negative ions must be considered only in the lower ionosphere at most up to 130 km. In order to check these calculations it was necessary to compare the negative-ion-density-height-diagrams with measurements by rocket-borne instruments. The correspondence is to be regarded as a good one.

The importance of negative ions for sun-rise-effects being observed with reflected waves from 16-300 kHz is discussed here, too. Using the ion density-height-diagrams it seems possible to explain these sunrise-effects as being produced by photo-detachment of electrons from negative ions. The investigations of echo duration anomalies of meteor train radar observations by Greenhow, Davis a. o. and the conclusions received by these authors are also in agreement with the densities computed here. The conclusions of the author seem to fit and to explain the conception of Greenhow and Davis.

Finally the importance of negative ions with regard to the theory of conductivity in the lower ionosphere is treated.

The diurnal and seasonal variation of the earth-ionosphere cavity modes recorded at Byrd Station

J. E. Lokken, J. A. Shand and C. S. Wright

Pacific Naval Laboratory, Esquimalt, B. C.

Recordings of the ELF band between 2 and 40 cps taken at Byrd Station, Antarctica, between April and December 1961, were used to obtain the diurnal and seasonal variation of the earth-ionosphere cavity resonance modes. The statistical behaviour of the band was determined from slow-speed chart recordings of the vertical component while magnetic tape records were used for a detailed analysis of each mode. Mean values for successive days might vary by a factor of two or more but ten day means were relatively stable. All modes were found to peak between 1900 and 2400 hrs and to have a secondary maximum between 0800 and 1200 hrs U. T. Seasonal variations as well as differences between modes occur as perturbations on the general pattern.

On the wave and corpuscular events in the Antarctic ionosphere

G. V. Bukin

The general picture of Antarctic ionosphere is considered; some regularities in the F2-, F1-, and E-layers are found and the question of influence on them of the corpuscular radiation is discussed. The division of the nature of Es on the wave and corpuscular nature for the north and south polar caps is made. The relation between Es-layer and the regular layers is found which is the most clear on the geomagnetic poles. It is revealed the asimmetry in the behaviour of the III-rd type absorption in north and south hemisphere.

On the nature and space- and time-distribution of ionospheric disturbances

E. I. Mogilevsky, R. A. Zevakina, E. V. Lavrova and L. N. Liakova

1. Here is built the general scheme of ionospheric disturbances, which is capable of explaining the observed planetary distribution of ionospheric disturbances.

2. By means of synoptic charts of polar ionospheric absorption the main features of two independent types of absorption is discussed: the polar-cap absorption (after the flare) and auroral-zone absorption (during the geomagnetic disturbances). Qualitative explanation is given of two possible ways of solar proton streams propagation responsible for the polar absorption.

3. Here is discussed the solar stream model, which consists of the succesion of individual plasma clouds with force free magnetic fields. The Earth magnetosphere and ionosphere interact in the main with the magnetic field of this solar stream. Without the direct solar plasma injection when solar stream runs against the magnetosphere the system of collision free shock waves arises (the energy of the magnetic disturbance), and beginning from the heights of about three Earth radii magneto-sound waves and low-frequency Alfven waves, rousing the ionospheric disturbance.

4. The analysis of the planetary distribution of ionospheric disturbances shows, that there are some regions with highest degree of activity of ionospheric disturbances. This regions are situated near

the world geomagnetic anomalies. Such a distribution of ionospheric disturbances in the accepted scheme is attributed to an influx of dissipating in the F2-region magneto-hydrodynamic waves.

5. Without the direct injection of corpuscles (out of the auroral-zone) the considerable stability of the deflection of a region F2 ionization is observed during disturbances. This stability decreases in the auroral zone; that is in accordance with the proposed scheme of the ionospheric disturbances.

Irregular phenomena and disturbances in the polar ionosphere

A. S. Besprozvannaja and G. N. Gorbushina

The results of statistical analysis of the geographical-time distribution of the main irregular phenomena in the polar ionosphere are given. Also the results of the analysis of ionospheric disturbances are given. The data of 30 stations of vertical sounding north to 55° geomagnetic latitude mainly in the IGY period are used.

The ionospheric disturbances in high latitudes are analysed for two classes separately. The first class is conected with arrival of solar cosmic rays of low energy and is known in scientific literature as polar cap absorption (PCA). The second class of disturbances is observed during magnetic storms and is connected with corpuscular streams reaching the Earth a day or more after the effects on the Sun. This class of disturbances is called ionospheric storms by analogy with magnetic storms.

Two types of ionosphere disturbances were observed: The F-storm and the FD-storm; the first is limited mainly to the F region, and coincides mainly with magnetic storms of the ssc-type; the second affects also the lower ionosphere and coincides mainly with magnetic storms with gradual commencements.

These two types of ionospheric storms confirm the hypothesis about the existence of two types of solar streams. The FD-storm corresponds with corpuscular mature stream, connected with M-region on the Sun. The F-storm conforms to corpuscular nascent-stream type.

Many other features of the irregular phenomena were investigated.

ABOUT EXISTENCE OF THREE SPORADIC IONIZED REGIONS IN HIGH LATITUDES

A. P. Nickolsky

Arctic and Antarctic Research Institute

1. The data analysis of:

a) Cosmic radio-noise on Bear Island.

b) Magnetic activity on Cape Chelyuskin and drifting station SP-4 and SP-6.

c) Radar reflections from aurorae north to the auroral zone.

d) Magnetic bays on the stations north to the auroral zone and.

e) Some parameters of disturbed ionosphere,
shows that the stations in $\Phi = \sim 65° - 72°$ and $\lambda = \sim 300° - 0° - 225°$ on average three times a day pass under the sporadic ionized regions.

2. Momenta of passage under these sporadic ionized regions in all considering stations date at 6-10, 15-17 and 22-24 hours Geomagnetic Time.

3. The observed geographical distribution of these three maxima for different phenomena may be represented as three spiral-like regions.

4. At present the outer radiation belt is used for interpretation of the phenomena caused by solar particles. This is rather likely for two maxima in diurnal variation of these phenomena. However the similar interpretation for the third maximum is rather difficult.

5. These sporadically arising ionized regions mentioned above may be connected with appearance of three impact zones on Störmer's precipitation spiral.

VLF DISTURBANCES CAUSED BY HIGH-ALTITUDE NUCLEAR BURSTS

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The high-altitude nuclear bursts of the summer of 1962 produced phase perturbations of very low frequency waves monitored at APL/JHU. These stabilized signals are transmitted along paths considerably displaced from the point of detonation and shielded by the earth from direct effects of the explosion. Some of the VLF disturbances are produced practically instantaneously and are explicable through the model of Crain and Tamarkin, wherein neutrondecay electrons are geomagnetically guided into the lower ionosphere. Other VLF perturbations show temporal variations, including delays in the onset and maximum of geomagnetically trapped electrons from the decay of fission fragments and neutrons. In one case, a sequence of two VLF disturbances connects with electrons that made a complete revolution around the world before being dissipated at the relatively low altitudes of interest for VLF transmission. The temporal correlation between the VLF disturbances and the trapped electrons indicates that the electrons initially have a pitch angle distribution that is independent of energy.

Wide-spread ionospheric disturbances due to nuclear explosions during October 1961

T. Obayashi

Ionosphere Research Laboratory, Kyoto University

Nuclear explosion tests on October 23 and 30, 1961 at Novaya Zemlya revealed the evidence of strong blast waves propagating through the ionosphere over several thousands kilometers. A sudden increase and subsequent fluctuations of f_0F2 were found, which traveled over the world with an average speed of 1000 m/s, while violent turbulences were followed, spreading out a slower speed of about 250 m/s. These travelling disturbances are explained as the propagation of acoustic-gravity waves in the high atomosphere excited by the strong explosion.

COMMITTEE No. 4

Geomagnetic secular variation for the epoch 1960.0

B. R. Leaton

Estimates of the secular change of geographic components of annual secular change at one hundred and ten magnetic observatories for the epoch 1960.0 have been subjected to a series of spherical harmonic analyses. Attempts have been made to minimize the effects of errors in interpolation or extrapolation of the initial data and to determine the magnitude and significance of the external part of the field.

Secular variation anomalies in seismic districts of Tadjikistan and over Eastern-European platform

V. P. Orlov and V. P. Sokolov

1. Repeated magnetic surveys, carried out in 1947, 1948, 1955 along some traces in Tadjikistan showed some secular variation anomalies. Two of them, the most significant ones, were located along the

motor-road Dushanbe-Horog, near Kishlak Obi-Garm and at Habu-Rabat pass (Darvas-ridge).

2. Both anomalies have been connected with the location of the deep tectonic breaks, stretched along the Gissar-ridge and in the Northern Pamirs.

3. The surveys of 1958, 1960 and 1962, carried out at other parts of those breaks ,also showed the secular variations anomalies. It must be noted that a number of earthquake foci is located along these breaks. So the connection of the secular variation anomalies with the deep breaks was reliably established.

4. The summary anomalous deflections of the secular variation from its mean values for 15 year interval (1947-1962) near Habu-Rabat pass have amounted to 100 γ and 80 γ, in Z and H, consequently.

5. Repeated magnetic surveys along the Oka-river from Rjazan to Gorky, carried out in 1940, 1941, 1946, 1951 and 1956 revealed a secular variation anomaly between Rjazan and Kasimov.

There is a tendency to a connection of this anomaly with differences in the vertical motions of the earth crust in the region of platform formation.

Geomagnetic field secular variation in the Antarctic

V. P. Orlov and V. P. Sokolov

1. The distribution patterns of the secular variation in the Antarctic are given by a series of isoporic charts for D, H, Z, X, Y, I and T, based on the observational data, obtained during the IGY and ICY.

2. The peculiarity in the secular variation distribution is the decrease of its intensity in Antarctica and the adjoining parts of the Atlantic and Pacific oceans. This decrease has reached especially large values near Siova (over 160γ) and on Graham-Earth (about 130γ). The secular variation of the vertical component is similiar to that in T. For the horisontal component the secular variation values over the Southern part of the Atlantic ocean exceed -80γ.

3. As the result of secular variation during the last century, the South magnetic Pole was moving towards the nord-west. H-minimum to the South of Africa remarkably increased. At present H-values are less than 13000γ at latitude 40° S, while they are more than 19000γ at the same longitude near the Antarctic shore. 150 years ago there was no minimum of H at all, or perhaps it was almost insignificant. If the present secular variation is maintained for the next 150 years, the South magnetic Pole would move to the Southern shore of Africa.

4. The comparison of the Antarctic isoporic charts clearly shows that the secular variation for the Antarctic is strikingly large and complicated.

5. To get the reliable picture of the secular variation and its change with time in the Antarctic a regular international service of secular variation must be organised.

Spherical analysis of a constant magnetic field and of secular variations

N. V. Adam, N. P. Benkova, V. P. Orlov, N. K. Osipov and L. O. Turmina

For solving some morphology problems and geomagnetic field nature and for clearing up of some methodical questions of the spherical analysis of the field, the spherical analyses of F and SV field have been carried out.

According to the analyses group the accuracy of the coefficients definition F $\simeq$ 200-300γ. On this base it is impossible to judge about the coefficients variation for short (10-20 years) time intervals.

The comparison of SV coefficients in our analyses with the analyses made by Nagata and Vestine shown that at the presence of changes in isopores configuration and extremal zones shifting SV remains almost constant for the last 100-130 years.

Decrease in M of the Earth from 1829 is confirmed but their decrease velocity became less for the ten years (1940-1950).

The displacement of the geomagnetic pole for the last 40 years is 15′ in latitude and 1° in longitude.

Phase angles λ_m^m of the harmonic members confirm the West field drifting as a whole.

For the combination of our and Vestine analyses a question of non-potential part (N) of the F field has been discussed.

A possibility of the coefficients approximation of the internal part of the field for the whole group of the analyses (from 1829) is discussed. Coefficients of the approximating polynome of the degree K = 5.

Correlations between the internal part of the field harmonics of the analyses for 1955 and 1958 are examined. The spectra of the energy density at different levels against the Earth surface are also examined.

All the analyses are made with the division of fields into internal and external parts. The data on the external part F for 1955 do not contradict the assuption, that the source of the external field component depending on are the radiation zones and the main part in the external field is the external radiation zone ($a = 3.5 - 4R$). It is calculated the magnetic field of the radiation zone model at different zone parameters and their different configuration.

VECTOR FIELD STRUCTURES AND SECULAR GEOMAGNETISM

K. L. McDonald

University of Utah

The invariant properties of vector singular points [P_0] and nodal points [Q_0] are further described and field structures in their neighborhoods are elucidated by means of assemblages of lines of force. Singularities may be generated instantaneously in the dynamic field and their motions are not limited by the velocity of light. The confluent vector singular points is introduced. Calculations on the propagation of aperiodic waves of various geometrical configurations in dielectric media establish the initially large internal redistribution of electromegnetic energy, but without accompanying field diffusion at the pulse boundaries.

Comparison of the cases with and without diffusion is made. Fluid upwelling motions at the core-mantle boundary produce the earth's secular magnetic field, which is attenuated in its passage through the mantle. In analyzing these motions it is shown that the lowest ordered vector velocity mode in the Taylor expansion of a steady compressible viscous fluid at P_0 is divergenceless. Thus the realistic problem may be assimilized by a consideration of divergenceless fluid velocity modes and their associated magnetic fields. The general problem is also treated of reproducing the global geomagnetic secular variation fields by means of a distribution of velocity modes in the core.

SOME FEATURES OF ANNUAL VARIATION OF GEOMAGNETIC FIELD

S. P. Burlazkaja

1. The anual variations of inclination and intensity of geomagnetic field were studied with the help of Prof. Thellier method on the collection of baked clays (tiles, tubes, bricks). The collections were gathered in Georgia, Armenia and Azerbaijan.

2. The Caucasus collections of the models gave the possibility to track the variations I and H for the last 2000 years. I for this time varied according to sinusoidal law. The period from the beginning of a new era to our days varied from 1300 years to 700 years, the amplitude did from 30° to 25°. The variation of the intensity for this

time can be described with a curve, closed to dropping part of sinusoid. The value of a intensity varied from 1,5 H present to H present.

3. The comparison of the curves of the variation of I during the last 2000 years, which have been obtained with the help of the rigth (according to observatory data), paleomagnetic and archeomagnetic methods, showed, that all the European curves for the points, which are in latitude 40°-50° have common max. and min., while the curve for Japan is in counterphase.

44. Leaning upon a true correlation of amplitudes, equality of periods and counterphase of periods of Japan and Caucasus curve, it is possible to construct hypothetic curve of the variation of interval of 6000-1000 years till new era. Separate experimental data are laid well on this curve.

5. The value H is increasing during 3000 years till new era-the beginning of our era; has max. near the beginning of our era and decreasses to our days.

6. Because the results of models measurement from Azerbaijan, Armenia and Georgia are laid well on one curve, the region of similar annual variation is distributing approximately on 500 km.

7. The variation H on the data of Paris and Caucasus is the same, it corresponds to planet character of this phenomenon.

Secular variation of the geomagnetic total force during the latest 5000 years

T. Nagata, Y. Arai and K. Momose

Japan

Intensities of geomagnetic total force (F) at various epochs during the latest 5000 years are deduced from the intensity of natural remanent magnetization of basaltic lavas and baked potteries of known ages in Japan. The results show that F increased with time from about 5000 years ago to about 2000 years ago when F reached its maximum value, being about 1.5 times as large as at present, and then decreased gradually till the present time, probably accompanied by regional secular variation of appreciable magnitude.

The ratio of intensity of the ancient geomagnetic field (F) to that at present ($F_o = 0.461\ \Gamma$) are as follows.

Age	F/Fo	Age	F/Fo
1778 AD	1.20	~ 765 AD	1.08
1552 »	1.20	~ 735 »	1.05
1421 »	1.33	~ 565 »	1.14
~ 1300 »	1.09	~ 525 »	1.37
~ 1070 »	1.02	~ 300 »	1.53

Age	F/Fo	Age	F/Fo
~ 150 BC	1.54	~ 2000 BC	0.94
~ 300 »	1.22	~ 2500 »	0.84
~ 1000 »	1.00	~ 3100 »	0,78

THE SEISMO-MAGNETIC EFFECT AND THE POSSIBILITY OF EARTQUAKE FOREWARNING

F. D. Stacey

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When igneous rocks are subjected to directed stresses their remanent magnetizations are deflected and susceptibility becomes anisotropic with a change in magnitude of about 1 part in 10^4 per 1 kg/cm^2 of stress. Rock with susceptibility χ in a horizontal field H, subjected to a shear stress δ kg/cm^2 across a fault at an angle θ to H, has a piezomagnetically induced magnetization of intensity $(3/2 \cdot 10^{-4} \chi H \delta)$ at an angle $(2\theta \pm \Pi/2)$ to H, the opposite signs representing right- and left-lateral faults. The surface field arising from the stress of a shallow earthquake is similar to that of a buried dipole with this orientation. Its peak magnitude $(3 \cdot 10^{-4} \chi H \delta)$ oersted, is of the order of 10 gammas, smaller than the observations of Kato indicate but larger than Kalashnikov's estimate. Since earthquake stress is time-dependent, it should be readily observable with a suitable array of magnetometers, differentially connected. The possibility of earthquake forecasting on this basis deserves urgent consideration. It seems possible that the stress build-up for an earthquake will be observable from its piezomagnetic effect several weeks in advance of the shock. It is also possible that micro-foreshocks can be observed piezomagnetically with sensitive micropulsation detectors, connected differentially to observe differences in magnetic field as small as 10^{-3} gammas in a limited frequency range over baselines of tens of kilometres.

MAGNETIC STUDY ON THE OXIDATION OF TITANOMAGNETITES

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Magnetic study of the oxidation process of titanomagnetic solid solution minerals $xFe_2TiO_4 \cdot (1\text{-}x)\ Fe_3O_4$ toward titanomaghemites $\gamma\, yFeTiO_3 \cdot (1\text{-}y)\ Fe_2O_3$ has been carried out. Remanent magnetization acquired by the oxidation under the effect of a magnetic field has been measured. In some compositional range the Curie temperature of the titanomagnetite specimen is originally lower than the experiment temperature but it exceeds the experiment temperature after

oxidation. Remanent magnetization acquired in such an environment might be called thermo-chemical remanent magnetization. Change in saturation magnetization, Curie temperature, etc. which was already reported by Akimoto, Katsura and Yoshida has also examined more extensively.

ACQUISITION MECHANISM OF A STABLE REMANENT MAGNETIZATION FOR MULTIDOMAIN CASE

T. Nagata and M. Ozima

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A phenomenological theory of the acquisition mechanism of a general type of thermo-remanent magnetization (TRM, ITRM) for multidomain ferromagnetic body is proposed. Here, ferromagnetics is assumed to consist of a large number of elementary domains, each of which is characterized by a certain microscopic coercivity. Assuming a Gaussian type of a distribution of the microscopic coercivity, a simple formula is derived:

$$(\text{Remanent magnetization})^{T_2}_{T_1,\,H} \cong (\text{IRM})_{T_1,\,H} \times \frac{[Hc(T_2)]\ \text{bulk}}{[Hc(T_1)]\ \text{bulk}}$$

where $(\text{Remanent magnetization})^{T_2}_{T_1,\,H}$ is the intensity of the remanent magnetization acquired by a temperature change from T_1 to T_2 (TRM for $T_1 > T_2$, ITRM for $T_1 < T_2$) at an ambient magnetic field of H, $(\text{IRM})_{T_1,\,H}$ the intensity of IRM produced at T_1 and H, $[H(T_1)]_{\text{bulk}}$ and $[H(T_2)]_{\text{bulk}}$ are the value of the bulk coercivity at T_1 and T_2 respectively.

It is also shown that the above phenomenological theory yields a semiquantitative interpretation of the stability of a remanent magnetization against a-c demagnetizing field.

The theory is compared with experimental results on magnetite single crystal, magnetic grain assemblage $Co_{0.02}Fe_{3-0.02}O_4$ grain assemblage, 8 mol. % ulvospinel titanomagnetic grain assemblage and cobalt chips. The agreement between the theory and the experimental results is quite satisfactory.

DISCUSSION OF MAGNETIC PROPERTIES OF ROCKS BY MEANS OF EXCHANGE COUPLING MODELS

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In reference 1 a qualitative exchange coupling model for interpretation of changes of CURIE-temperatures in magnetite caused by impurities is developed. The most important features of this model are:

a) direct proportionality of changes of CURIE-temperatures with changes of strengths of the I_{AB} interactions (A: tetrahedral site cations, B: octahedral site cations),

b) the I_{AB} are influenced by the degree of occupation of the splitted ionic orbitals (t_{2g}, e_g). In this connection the bond character is to be respected, too (cf. reference 2).

A similar model is applicated to antiferromagnetic hematite containing Ti impurities. Thus, it is possible to interpret the observed changes of CURIE-temperatures. The qualitative model is supported by discussion of quantitative formulae determining the connection between CURIE-temperatures and magnetic exchange interactions. Magnetic exchange couplings in hematite are compared with those in ilmenite.

(1) Interpretation of changes in CURIE-temperatures observed on rocks. *Geophys. Journal Roy. Astr. Soc.* (1963). In press.

(2) The nature of chemical bond of magnetic and consequences. *Geofisica pura e appl.* (1963). In press.

MAGNETIC EXPRESSION OF TRANSCURRENT FAULTING

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The magnetic method of analysis of transcurrent faulting has proved its utility in the demonstration of E-W faulting in the East Pacific. By the use of cross-correlation techniques, quantitative comparison may be achieved between magnetic profiles on either side of postulated faults. Hence the fit obtained with different offsets across proposed faults may be assessed. An estimate of the significance of such correlations is then available. Examples of the use of the method will be given. Comparing these results with those previously obtained by other workers in the Pacific and Atlantic, it appears that there may be a pattern of E-W faulting of greater than continental dimension. Initially this pattern and other trends found in magnetic surveys appear to be related to the present axis of rotation of the earth. They, therefore, seem to deny major polar wandering. However, the shear patterns in the crust of the earth appropriate to the paleomagnetic polar wander curves may also be obtained. It is then seen that they are compatible with the observed magnetic patterns. Thus the response of the equilibrium figure of the earth to a change in the rotation axis may explain the strike of these major transcurrent faults.

Magnetization of a pyroxenite at Wilberforce Ontario

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A deposit of a pyroxene rich rock at Wilberforce Ontario produces a negative anomaly of 1700 γ on an airborne magnetometer map. The negative anomaly is due to a strong inverse remanent magnetization having the north end of the vector pointing upward at about 60° and to the east. The origin of the thermoremanence is magnetite containing 1 to 2 % Titanium having a Curie point of about 535° C. This is present in two forms as small grains between the silicates and as oriented needles and plates within the pyroxene crystals. These needles have a coercive force of 600 to 1000 oersteds and are the magnetic constituent suitable for paleomagnetic purposes. The calculated pole position falls on the east coast of Australia. A preliminary age by the whole rock Potasium-Argon method is slightly less than 800 million years.

On the TRM properties of Rajmahal traps

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Oriented samples were collected from seventeen sites covering at least ten different flows from the Rajmahal traps of Jurassic age, and their remanent magnetization was determined both in direction and intensity. The various flows showed a remarkably stable and consistent magnetization. However, the intensity of magnetization has been found to vary between 1×10^{-3} and 20×10^{-3} C. G. S. The Curie temperature of the magnetic constituents in rocks from different flows has been found to vary between 275° to 600° C. Flows having a high intensity of magnetization generally gave a lower value of Curie temperature.

A critical study of these properties indicates that the variation in intensity of magnetization in these lavas is due to the type of magnetic mineral rather than its proportion in the individual flows. An additional important result emerging from these studies is that the flows having different values of intensity and Curie temperature give remanent directions agreeing within rather narrow limits and this can be regarded as an extra and independent evidence for their high degree of magnetic stability.

On the normal and reversed magnetization of the Deccan trap lavas

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The earlier palaeomagnetic studies of the Deccan trap flows have shown that these lavas comprise of sets of flows magnetized either normally (N) with an upward dip, or reversely (R) with a downward inclination. Recently extensive studies have been made on samples from a number of localities, including a sequence of 30 flows at Mahabaleshwar, covering large parts of the trap area. These studies show that the (R) flows occur up to heights of around 2000′ above sea level whereas the N flows generally occur only above this boundary.

A critical examination of the thermomagnetic behaviour of both the N and R rock types has been made employing the standard laboratory techniques. Out of a large number of specimens studied none has indicated any tendency of a self reversing character. Similar studies have also been made on samples from a number of dykes intruding the lava flows in a few localities. The results of these studies strongly indicate that the R rocks in this formation owe their reversed magnetization to the possible reversal of the earth's dipole field during the period the R flows and dykes were laid down.

Electromagnetic coupling of the core and mantle and irregular changes in the length of the day

S. K. Runcorn

Further studies of the electromagnetic coupling between the core and the mantle will be presented and a fuller interpretation than hitherto given of the cause of the irregular fluctuations of the length of the day.

Thermal convection in the earth core and the origin of the main geomagnetic field

B. A. Tverskoy

The turbulent convection in the earth core without magnetic field is considered. It is shown, that a rotating fluid has an effective hydroscopical elasticity and therefore turbulence is two-dimensional. The main turbulence scale, corresponding velocity and temperature distribution being computed.The superisontropical temperature gradient increases rapidly near the equator and therefore the motion becomes three-dimensional in the thin equatorial belt. The anisotropy of the temperature distribution leads to slow non-uniform rotation of the core. Direction and velocity of such rotation, computed theoretically, coincides with suitable data about western drift of the geomagnetical variations.

Hydromagnetic properties of such convective motion are investigated. It is shown, that the magnetic field in the core is oriented by the two dimensional convection along the rotational axis. Three-dimensional turbulence has superconductive properties in the thin equatorial belt and conserves magnetic flux through equatorial plain for a long time. The distribution which is established outside the core, is nearly like dipole distribution. The fluctuative processes, connected with reorientation of force tube of the field at the boundary of the core will lead to self-excitation of the field. The theoretical and experimental dipole moment have the same order.

On the origin of the Earth magnetism

B. A. Tverskoy

It studied the character of the turbulent convection in the Earth core while the magnetic field is absent. It is shown that the rotation gives the effective hydroscopic elasticity to the liquid, and therefore the turbulence is two-measured. The main scale, the turbulence velocity in it and the temperature distribution are calculated. The temperature gradient increases sharply near the equator, as a result motion in a thin equatorial belt becomes three-measured. Anisotropy in the temperature distribution occuring at the convection leads to the slow rotation of the core against the mantle. Such a rotation direction and the velocity, calculated theoretically, coincide with the corresponding observational data of the West drifting of geomagnetic variations.

The hydro-magnetic properties of the given regime of the convection are examined. It is shown that the two-measured turbulence orientates the magnetic field in the core along the rotation axis. The three-measured turbulence in a narrow equatorial belt has the property of a super-conducter and can keep the magnetic flow through the equator cavity for a long time. Here, outside the core a field distribution is settled close to the dipole. Fluctuation processes connected with the re-orientation of the field force pipes at the core border can lead to the self-generation of the field. The theoretical value of the Earth dipole moment is close to the observed one.

Electromagnetic excitation of the Chandler wobble

D. E. Smylie

Departmtent of Physics, University of Toronto

Excitation of the Chandler wobble by electromagnetic core-mantle coupling has been ruled out by Munk and Hassan using a rough argument based on the work of Rochester. This dismissal is premature since Rochester's work is on axial coupling and is not immediately applicable to the problem of equatorial coupling. In this paper, the equatorial coupling is studied rigorously using a model made plausible by the dynamo theory for the origin of the main geomagnetic field, and applying perturbation theory. It is found that at most only 10^{-3} of the observed wobble amplitude can be excited by electromagnetic core-mantle coupling within a decade. Moreover, the time constant of the coupling predicted by this model is about 200 years, far too long to account for the observed rate of damping of the Chandler wobble. In the apparent absence of alternative sources of excitation of the Chandler wobble, it is suggested that the effect of the conductivity distribution assumed for the lower mantle on the tightness of the equatorial coupling be investigated more thoroughly.

COMMITTEE No. 5

Position parameters in the rise of geomagnetic cartography, specifically dip versus latitude

D. G. Knapp

U. S. Coast and Geodetic Survey

After reviewing the early discoveries and experiments that let to William Gilbert's empirical construction for determining dip from latitude, the subsequent development of the topic is traced, showing how Alexander Humboldt's extended observations in South America in 1799-1803 led to the Humboldt-Biot-Krafft relation $\tan I = 2 \tan \Phi$, and this in turn to the concept of magnetic dip latitude; some of the applications of this concept and of the cited relation are reviewed. The earliest was in rectifying the position of the magnetic equator. Subsequently these concepts figured in the development of compass deviation theory, and in the use of a latittude factor in correcting declination results obtained at field stations to remove the effects of the transient fluctuations such as the daily variation.

Symmetries of the terrestrial magnetic field

A. Chargoy M.

Institute of Geophysics, NAUM, Mexico

The OZ axis coincident with the direction of the eccentric dipole, with origin in C (geomagnetic centre, as defined by Schmidt), and the XOZ, YOZ, planes containing the directional axis OH_1, OH_2, of the eccentric quadrupole, which are perpendicular to each other, are proposed as a system of reference.

The potential equation with reference to this system is

$$V = \frac{1}{r^2}\bar{g}_1^o p_1^o + \frac{1}{r^3}\sin 2\lambda p_2^2 + \frac{\bar{g}_3^o}{r^4} p_3^o + \ldots$$

The terms P_j^i are polynomials of Legendre.

The term $\frac{1}{r^3}\bar{g}_1^o p_1^o$ is proved to have symmetries with respect to the OZ axis, while the term $\frac{1}{r^3}\bar{h}_2^2 \sin 2\lambda p_2^2$ has symmetries with respect to the XOY plane.

If certain anomalies of planetary type, as the one occurring where the H intensity is at a minimum, and marking an anomaly between America and Africa are going to be explained, they should be looked for on basis of the term of the octipole, i. e., $\frac{1}{r^4}$.

The system of reference is determined by elements of the same field, immediately suggesting that the geomagnetic equator is the XOY plane, as pointed in a paper published in the *Journal of Geophysical Research*, Vol. 55, No. 1, March 1950.

It was studied again and published in Anales del Instituto de Geofísica, Vol. 3, 1377-156, 1957.

The quadrupole axis are rotating in their plane, they describe an angle of about 40° moving to the west, during the epoch of 120 years, corresponding to the coeficients given by Gauss 1835 and his followers, until Finch-Leaton 1955.

The simple cylindric projection-plate carree-for magnetic charts

L. Slaucitajs

If we take the plate carree projection, the whole Earth's surface can be seen, as is necessary for many geomagnetic questions. With the meridional length of πR and the equatorial of $2\pi R$, the wellknown projection is easy to draw. As an example, the distribution of magnetic observatories with the geographical contours in the system of *geomagnetic* coordinates is given.

RADIAL DIPOLES AS THE SOURCE OF THE EARTH'S MAIN MAGNETIC FIELD

L. R. Alldredge and L. Hurwitz

U. S. Coast and Geodetic Survey

It has been fashionable since the time of Gauss to obtain analytic descriptions of the earth's main field in terms of spherical harmonic analyses. In this paper a new approach to an analytic description of the earth's main magnetic field is reported.

It is assumed that the earth's main magnetic field is caused by electric current loops in the core of the earth and that magnetic dipoles are useful as a first approximation to these current loops. The model is restricted to a centered dipole and several additional radial dipoles at equal distance from the center of the earth.

A least square method is used to adjust the amplitude, latitude and longitude of each dipole for a best fit to the observed field components on the earth's surface. Originally 10 dipoles were used at the core mantle interface of 0.54 earth radius. Progressively better fits were obtained as the dipoles were placed deeper and one of the dipoles was expelled as unwanted at greater depths.

The work is not finished, but with only 31 parameters it has already produced a fit to the 1945 field which is nearly as good as Vestine's 48 coefficient fit.

ESTIMATION OF ERRORS IN THE REPRESENTATION OF GEOMAGNETIC SURVEYS

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Usually the aim of geomagnetic surveys is to get the general contours of geomagnetic field by means of observations at separate points or along some profiles, and to construct isomagnetic charts. The errors of these charts are defined by the standard deviation between linear interpolated values and observations.

For estimation of errors detailed statistical investigations are necessary. Such statistical analysis was applied to the geomagnetic surveys in the GDR.

The results of the investigations can be summarized as follows:

a) Usually the errors of charts some times surpass the errors of observation at single points.

b) Generally the scale in cartographic representation is too large; the appropriate accuracy is not significant.

c) Representing the accuracy of the survey cartographically the isomagnetic lines are to be changed over to «isomagnetic stripes».

d) The geomagnetic field in the territorium of GDR shows two different types of structural elements: local anomalies with scales smaller than 10 kilometres and regional ones with scales larger than 100 kilometres.

e) Supposing a linear relation between amplitudes and corresponding geometrical scales of anomalies it is possible to represent the survey by isomagnetic charts. Otherwise, the local anomalies with large amounts must be eliminated.

f) The frequency distribution of the differences between values of interpolation and observations is not a GAUSS distribution.

g) To take account of the autocorrelation of the fiel in calculating normal fields it is necessary to use also observations in some zones beyond the boundary of GDR.

Project MAGNET progress

H. P. Stockard

U. S. Naval Oceanographic Office, Washington 25, D. C.

During the three years since the XIIth General Assembly of IUGG, Project MAGNET has flown over 300,000 nautical miles of geomagnetic survey tracks. Observations which define the complete magnetic vector have been made over all oceans and continents and both polar areas, and the basic world-wide survey is now about 60 % completed. In late 1962, all available Project MAGNET data, approximately 32,000 observations, were placed in the IGY World Data Center. In addition to regular surveys, special surveys were made in support of Project MOHOLE. Operations planned for the near future will emphasize coverage of the southern hemisphere and the polar regions.

Normal field of vertical component Z of the Earth's magnetism in Poland for epoch 1957, 5

K. Karaczum

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In this paper the author discusses technique applied during elaboration of a formula for normal field of vertical component Z of the Earth's magnetism in the area of Poland, for epoch 1957, 5.

The formula was elaborated by means of analytical method on Taylor's formula together with the second degree expressions this latter.

Data from 34 magnetic observatories, as well as results obtained during the measurements conducted using La Cour's BMZ magnetometers, in the entire area of Poland, were base materials for this elaboration.

The north magnetic dip pole

E. Dawson and E. I. Loomer

Dominion Observatory, Ottawa

A survey of the north magnetic dip pole area was carried out in August 1962. Six field stations were occupied within a 100 mile radius of the predicted dip pole position. A pole position of 75.1° N and 100.8° W has been computed based on these observations for 1962.5. The 1948 dip pole position has been recomputed to 73.9° N and 100.9° W. The predominant secular motion of the dip pole has been northward and over the past 58 years it has averaged 5 nautical miles per year in this direction. Over the same period, the dip pole had a westward motion of 2 nautical miles per year until the last 15 years when this motion has shifted to the east.

Some notes on field patterns in relation to dip poles

D. G. Knapp

U. S. Coast and Geodetic Survey

The elongated configuration of potential in the Arctic calls for special treatment when attempting to coordinate the observational data over any considerable region. A basic question concerns the kind of simplifying assumptions that are admissible as to the geometry of the field. It is shown that the field configurations generated by one category of model sources conforms closely to the assumptions that the potential contours are ellipses having virtually uniform eccentricity and a spacing corresponding to parabolic profiles through the dip pole. The sources considered are those depicted by two equal radial dipoles placed at a depth of one-half the earth's radius and sufficiently close together to produce a single dip pole. Although the real configurations are undoubtedly less simple, these findings lend support to the principles underlying certain methods that have found use for detailed treatment of Arctic data. The paper also includes some discussion of the latter methods, involving the resolution of horizontal components of the field vector and of the secular-change vector into components parallel and perpendicular to a chosen meridian.

Magnetic anomalies on the eastern seaboard of Canada

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Studies of the magnetic field at the southern edge of the Grand Banks have been made to see whether the geological structures trend northeast-southwest, parallel to the Appalachian trend, or northwest-southeast, parallel to the edge of the continental shelf in this area. A regional field has been estimated from aeromagnetic observations made by the Department of Mines and Technical Surveys of Canada and this has been used to find the magnetic anomalies from measurements of the total field made at sea. Anomalies at the edge of the shelf are seen to trend parallel to the edge.

The conductivity anomaly in the upper mantle found in Australia and the ocean effect

U. D. Parkinson

Rand Corporation, Santa Monica, USA.

Regional changes in the vertical component of the variation geomagnetic field have been found in Australia. The horizontal components of the variation filed are much more uniform than is the vertical component. These regional changes are probably due to a secondary field induced in non-uniform conductors by the primary field originating in the upper atmosphere.

In the southern half of Australia the vertical component of the variation field is closely connected with coastlines, or the edge of the continental block. A similar connection is found in many other parts of the world.

It is important to determine whether this coastal effect is due to conductivity in the water of the oceans, or to a systematic conductivity difference between the mantle under the oceans and continents. An experiment to evaluate the effect of the oceans will be described.

THE ANALYTIC DESCRIPTION OF THE GEOMAGNETIC FIELD AT POINTS IN THE UPPER ATMOSPHERE

A. J. Zmuda and F. T. Heuring

Johns Hopkins University, Silver Spring, Maryland

The Vanguard observations of scalar magnetic intensity are compared with values computed using harmonic coefficients derived by various authors. For each of seven sets of coefficients the root-mean-square difference between the observed and computed values are calculated for four altitude ranges in the Vanguard range of 510 to 3753 km. In each case the rms difference is determined as a function of the number of terms in the harmonic series. In general, the field of the centered dipole describes about 89 per cent of the observed field; the field of the centered dipole and quadrupoles accounts for about 93 per cent. The contributions of higher-order terms are also discussed, as is the differences between the various sets of coefficients.

COMMITTE No. 6

LUNAR VARIATIONS OF GEOMAGNETIC FIELDS

S. Matsushita

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Lunar variations of each component of geomagnetic fields are obtained at several stations and are compared with previous results obtained at other stations.

It is suggested that the well-known lunar current system derived from the data obtained at five stations should be reexamined, and it is emphasized that more studies of lunar variations should be made at stations which have data covering long periods of time.

LUNAR AND PLANETARY INFLUENCES ON SOME GEOPHYSICAL PHENOMENA

E. K. Bigg

Systematic variations in the frequencies of magnetic storms and radar meteor rates which are centred on New Moon, Full Moon and the Moon at a right ascenssion of about 18^h are discussed. Lunar modulations of ice nuclei and rainfall are consistent with these observations if a delay of about 30 days between events in the upper and lower atmosphere is assumed.

The planets Mercury and Venus also cause variations in magnetic storm frequencies, and the implications of this result are discussed.

Lunar tidal variations by the observation data of magnetic and ionospheric stations of the Soviet Union

N. P. Benkova, V. A. Zaguliaeva, N. A. Katziashvili, B. E. Marderfeld, K. V. Martinova and M. Z. Nodia

There is calculated the lunar tidal variations of H, D and Z components of the magnetic field by the data of the observatories Tbilisi, Moscow and South-Sakhalinsk. The results are compared with the lunar tidal variations of the ionospheric parameters foF2, h'F, foE at the stations Ashkhabad, Moscow, South-Sachalinsk, Tomsk, Irkutsk.

Here is obtained daily and seasonal dependence of various magnetic and ionospheric parameters, as well as the data on these parameter change with the solar activity cycle. Here is given an attempt to estimate a geographical dependence of lunar-daily variations, considering the data of the tides at other points of the Earth.

Diurnal oscillations of pressure at Kimberley due to solar and lunar effects

S. Chapman and W. L. Hofmeyr

Kimberley diurnal pressure changes at the surface due to solar (four harmonics) and lunar (second harmonic) effects were analysed over a twenty-eight year period. The first two solar harmonics are found to contribute most to the observed diurnal variation. The parameters for these two harmonics are significant in all months, those for the third harmonic are so in most months and for the fourth harmonic only in certain months. The parameters for the second lunar harmonic have much the same magnitude and standard error as those for the fourth solar harmonic. Harmonic dials are given to indicate the annual change of the semi-diurnal air tide. Of special physical importance are the small relative standard errors of the parameters for the second solar harmonic, particularly so in winter.

On the lunar semi-monthly waves in the magnetic equatorial region

K. S. Raja Rao and P. K. Srinivasan

The ranges in horizontal intensity of the geomagnetic field at Trivadrum during the period 1958-1960 have been used to determine the lunar semi-monthly wave for each of the twelve months and for each of the three seasons. The results obtained are compared with similar results for Huancayo and Kodaikanal. The lunar and solar daily ranges are separated and their dependence on the phase of the moon is examined. The interdependence of the variabilities in lunar and solar ranges and their dependence on the lunar phase have been studied. The method of analysis has been applied to the study of data for Annamalainagar.

Lunar geomagnetic variation at Isla Año Nuevo (New Year's Island)

O. Schneider

Instituto Antártico Argentino

A six-years' record (May 1907 to April 1913) of magnetic declination at Isla Año Nuevo (Ney Year's Island; lat.: 54° 39′ S., long.: 64° 08′ W.) was analyzed for lunar variations, using the fixed-epoch method. Harmonic coefficients for individual days were computed up to the six-hourly term. The data were grouped according to Bartels' season number (six seasonal groups), daily sunspot-number, and daily magnetic character-number C_9. The present report covers quiet and moderately disturbed days ($C_9 \leq 5$), with sunspot-numbers under 30. The results, which are of general interest because of the relatively high southern latitude (if compared with previous work), show a strong seasonal variation of the lunar variation, particularly of the semidiurnal component L_2, which is greater than 1/10 of the semidiurnal solar component S_2 only in summer. There is some evidence confirming the existence, at this observatory, of partial waves other than those described by the phase-law of lunar magnetic variations.

COMMITTEE No. 8

An automatic three-component proton precession magnetmoeter

G. V. Haines

Dominion Observatory, Ottawa

Two components of the earth's magnetic field are determined by a method, devised by P. H. Serson, of addition and subtraction of auxiliarly fields. A third component, the total field, is also obtained, and data for all three components are recorded each minute, with the time, on paper tape. An IBM 1620 computer processes the data, and gives hourly means for each component after rejecting those components with statistically large errors.

The auxiliary fields are produced by a double fourcoil system with telescope and theodolite base. For best results, this field should be the order of magnitude of the earth's field, and to be accurately measurable must be uniform (1 gamma/cm or better) over the detecting sample.

PRECESSION FREQUENCY-ERRORS OF PROTON MAGNETOMETERS

Von H. Schmidt

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It is commonly asserted that proton magnetometers yield absolute values of magnetic field intensity without special calibration devices and are free from drift errors. As contrasted with this maintainance the application of several proton magnetometers to differential magnetometers has shown a drift effect. The drift begins after one or two hours and increases with time. The amount varies between some tenth of γ per hour and some hundred γ per hour. There is much reason to believe that an interaction between the lacquered wire of signal coil and alcoholic vapour produces small disturbing magnetic fields in the coil winding. These fields reduce the time constant of precession signal and change the indicated frequency. The drift seems to be due to the intensity of alcoholic influence, because a minimum alcoholic influence produces only a small drift and the maximum alcoholic influence (coil dipped in alcohol) yields very short signals with high frequency errors. The effect depends also on the intensity and direction of the polarising magnetic field and on the coil temperature. After interruption of polarising pulses and refrigeration of coil the drift vanishes.

It was possible to demonstrate this effect with other magnetic methods than free proton precession, for instance saturable core magnetometers.

New testing methods have been developed to find materials and constructions to avoid these drift effects. A new torsion susceptometer has been used to determine magnetic properties of coil materials, especially magnetic susceptibility in the range of 10^{-7} cgs.

Further investigations of other substances producing drift effects are planned.

It is important to know that tests of proton magnetometers are necessary and that comparisons of proton magnetometers only for a short time are insufficient.

QUARTS GEOMAGNETIC INSTRUMENTS

V. N. Bobrov

At the Institute of the Earth Magnetism, Ionosphere and Radio Waves Diffusion of the USSR Academy of Sciences a construction is worked out and the technology is mastered of the serial production of the quartz sensitive elements for magnetometers, variometers and microvariometers which record any component of the Earth magnetic field. The data of the sensitive elements have a very stable zero and do not depend on the temperature or the humidity of the air. The sensitive element is turned out in a hermetically sealed casing with the necessary certificate applied and is used in instruments in such a form. On the base of the quartz sensitive elements a series of different geomagnetic instruments is worked out. Among them quartz variometers for the record recording D, H, Z variations as well as T variation in magnetic observatories. One, two and three-component variational stations are designed for operation in the field conditions.

Quartz and geomagnetic instruments are simple in construction, portable and convenient in work.

AN AUTOMATIC MAGNETIC OBSERVATORY

L. R. Alldredge and I. Saldukas

U. S. Coast and Geodetic Survey

An instrument which was proposed at the last IUGG Assembly to digitally record magnetic observatory data has been constructed and tested with excellent results.

The automatic magnetic observatory uses an atomic total field magnetic detector placed inside a helmholtz coil system. Each minute, 5 frecuencies which are proportional to magnetic fields are digitally recorded; one with no bias field and 4 with selected bias fields produced by the coil system. From these five frecuencies, the magnetic vector is determined once a minute.

Data taken on the first prototype instrument at Fredericksburg have been reduced and compared with normal magnetograms at the same station. In every case differences between the hourly means from the 2 records are traceable to errors in the hand scaling of the normal magnetograms. Suitable magnetograms are constructed using the digital component data in an automatic plotter. K indices automatically computed from the digital data occasionally differ from hand scaled values by one.

A new fully transistorized model using a rubidium detector is now being built.

COMMITTEE No. 9

Raport on special studies on SQ-variability

P. N. Mayaud

From the study of three and a half year samples of records in a chain of observatories located between the equator and the pole in European longitudes, as also in some other observatories of the Southern hemisphere, a systematic description of the day-to-day variability of the magnetic field diurnal variation is made for the two horizontal components, such as it appears in the individual records. It is found that:

1. The very great variability observed on H, for the transition forms between the P-type (having a single minimum) and the E-type (having a single maximum), can be explained by three different currents-models. The first one, very rare, is made up of an elliptical system whose major axis is oriented in a West-East direction; the second one, dominant in winter, is tilted in a WNW-ESE direction (WSW-ENE in the Southern hemisphere); in the third one, very frequent in summer, although appearing also in winter and then superposed on the preceeding, the focus is shifted towards upper latitudes.

2. The variability on D, weak at mean latitudes, very great in tropical regions, but whose continuity can be established from one hemisphere to the other, suggests a superposition at two different heights, in a wide zone, of the currents-system of each hemisphere.

3. Another type of variability, connected with the universal time, appears on H and D at the sub-auroral latitudes; and, inside the auroral zone, a very intense regular variation, different from Sq, can be identified. These two facts raise the problem of the existence of a currents-system peculiar to the polar regions; the U.T. effect is interpreted by an extension of this system, around a given U.T. hour (different in each hemisphere), outside the auroral zone.

The recovery phase of geomagnetic storms

M. Sugiura

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Using the hourly Dst values for the IGY, the recovery phase of several magnetic storms is examined. In comparison to the frequent complex features of the development of the main phase the recovery phase is remarkably regular and much less complex. The time constant for the decay of the Dst main phase is determined and is interpreted

A study of low-latitude IGY data disturbances effects in Sq

M. P. Hagan

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Air Force Cambridge, Bedford, Mass.

The geomagnetic Sq variation is ordinarily defined as the mean diurnal variation of the international quiet days (here abbreviated by 5Q days). The main feature of Sq in the equatorial and low geomagnetic latitudes below the Sq focal latitude is a rise in H during the day with a maximum near noon; the maximum value may vary from day to day. Hence, in presenting Sq it is desirable to show this variation for the entire local day, from midnight to midnight for the station, rather than for the Greenwich day. To derive such Sq, quiet (local) days were selected for the IGY period for ten low latitude stations. The selection was made in such a way that each local quiet day falls within two successive Greenwich days of C_i less than or equal to the maxximum C_i of the 5Q days of the month. The stations were divided into two groups: namely, stations with east longitudes and stations with west longitudes. For the former group the Greenwich day preceding each of the international quiet days, and for the latter group the Greenich day following each of the international quiet days were examined with the above criterion. By this method 65 quiet Greenwich days were selected for each of the two station groups; of the 65 days, 45 days for the east stations group and 47 days for the est station group were 5Q days. Sq as derived from these selected quiet days and Sq as derived from international quiet days are compared for each of the ten stations.

Magnetic activity in the Antarctic during the IGY and IGC

G. F. Rourke

AVCO Corporation, Wilmington, Massachusetts

Based on a study of the K index, Q index, and hourly ranges at fifteen Antarctic stations during the IGY and IGC, the geographic distribution of magnetic activity is examined. Latitudinal variations in the magnitude of activity are best described as a function of distance from the auroral zone rather than geomagnetic or geographic coordinates. Time of maxima in activity is dependent on local geomagnetic time. Seasonal movements of the auroral zone maximum in magnetic activity change the relative position of the Stagg transition zone from winter to summer.

K indices have been used to rank each day in each month according to the degree of magnetic activity. Studies of locally selected quiet

in terms of charge transfer from protons to ambient neutral hydrogen atoms. A possibility of using this time constant to determine the density of neutral hydrogen atoms in the magnetosphere is discussed.

THE Sq FIELD DURING THE IGY

A. T. Price and D. J. Stone

Exeter University, England

New methods of interpolating and analysing surface magnetic fields, developed by Price and Wilkins (Phil. Trans. Roy. Soc., 1963) are being applied to the study of the Sq field during the IGY. The changes in the pattern of the daily variation field with U. T. throughout a Greenwich day are being studied, as well as the changes from month to month throughout the year.

A first step in this study is to calculate from the published mean hourly values of D, H, Z, which are usually centred at the half hours of nearest local meridian time of each station, the mean hourly values on quiet days of X, Y, Z. These values are required for the exact local time of the station, which may differ from the local meridian time by up to half an hour. Hence some interpolation is necessary. Tables of X, Y, Z for each month of 1958 and for all stations for which we have been able to obtain data are being published in the Annals of the IGY. These tables should be of value in a number of different investigations.

Some of the features of Sq which can be seen from inspection of these tables are discussed. These include:

(1) The changes of the Sq field through the year are not of a simple seasonal type. There is a lack of symmetry between the northern and southern hemispheres.

(2) The intensity, width and position of the equatorial jet varies at different longitudes and possibly at different times.

(3) The Sq field is controlled not only by the position of the magnetic equator but also by other large scale features of the main field.

(4) The line of demarcation between the northern and southern ionospheric current systems does not coincide with the magnetic equator as has sometimes been assumed.

and disturbed days versus international quiet and disturbed days indicate a seasonal dependence on (a) the Sq current system foci and (b) the latitudinal change in the degree of magnetic activity from winter to summer.

During international quiet periods, inner auroral zone perturbations are evident which are world-wide in nature. Polar magnetic agitation at the dipole stations Thule and Vostok is examined. Hourly ranges and K indices indicate some variability in an inner maximum of magnetic activity at Vostok. Causes for the above phenomena are discussed.

SOME RESULTS OF THE INVESTIGATION OF THE ANTARCTIC VARIABLE GEOMAGNETIC FIELD

L. G. Mansurova and S. M. Mansurov

On the base of the observational data from a number of the Antarctic observatories for IGY period it is obtained geographic distribution and seasonal changes of the solar-diurnal quiet and disturbed geomagnetic variations. Geographic distribution of the annual variations of the geomagnetic elements and of geomagnetic activity annual variation is also obtained.

The results obtained confirm already known regularities for the North hemisphere.

Essential change in the form of the quiet solar-diurnal variations depending on cyclic recurrence of the solar activity is also marked.

To study the nature of the quiet solar-diurnal variations in high latitudes the geomagnetic effects of the solar flash is taken into account.

THE NATURE OF GEOMAGNETIC DISTURBANCES IN HIGH LATITUDES

M. I. Pudovkin

1. The geomagnetic bays occurrence is closely connected with the ionosphere non-uniformity motion. The bay symbol is defined by the direction of the ionosphere wind and geomagnetic field. In the North hemisphere negative bays are connected with the drifting from the South to the North, while positive bays from the North to the South.

2. The study of the return velocity of H to the normal level during separate bay disturbances showed that at night the ionization density in the clouds Es decreases at the recombination rate by means of the effective coefficient $\alpha = 10^{-9}$ cm^3 sec^{-1}. Here, $\alpha = \frac{C}{N}$ where $C = 5 : 10^{-4}$ sec^{-1}.

3. The study of the auroral arcs spatial connection with the

electric currents in the ionosphere showed that the latter are displaced 200 km to the South against the arcs during the positive bays and to the North during the negative bays. This phenomenon can be explained by the ionization evacuation by means of ionosphere wind from the region of the corpuscular flow intrusion. The magnitude of this displacement makes it possible to value the recombination velocity in the E region. Calculations give: $C = 5.10^{-4}$ sec^{-1}.

4. The study of the auroral glow intensity during magnetic disturbances showed that δH value depends on both the amplitude impulse δI and on its duration. Here δH maxima are 1-10 min. slow against the δI maxima. These facts are easily explained by the assumption that δH is proportional to the ionization density and δI to the velocity of the ions formation. Here $\alpha = 1.10^{-9}$.

5. The above mentioned facts show that the currents, responsible for the field of geomagnetic bays, occur in Es clows as a result of the dynamo-action of the ionosphere winds.

6. The study of the field morphology of the irregular disturbances from the connection with the variations of the aurorae glow and from the return velocity of H to the normal level showed that D peaks on their nature do not differ from the geomagnetic bays.

7. Similar results are obtained for S_D magnetic variations.

The origin of geomagnetic disturbances in the auroral zone

M. J. Pudovkin

1. A clear connection between auroral brightness and bay shaped disturbances suggests the electric currents causing these disturbances run at the height where the maximum of aurora intensity takes place that is at about 100 km. At the same time the aurora luminescence intensity is proportional to ionization rate.

2. A certain connection between the sign of the bays and the direction of ionospheric wind speed and geomagnetic field shows that the electric currents causing the bays are a result of dynamo-action of ionospheric winds.

3. Investigation of morphology of irregular disturbances of geomagnetic field and their connection with the variations of aurora luminescence intensity shows these disturbances have the same origin as geomagnetic bays.

4. Diurnal variations of the velocity of ionospheric winds is investigated. It is shown that the 24-hourly component in these variations is predominant. At night the vector of wind velocity having nearly constant value (about 100 m/sec) turns clockwise with the speed 12 degrees/hour about.

5. Comparison of diurnal variations of the ionospheric wind velocity with S_D-variations of geomagnetic field shows their close connection at all the stations considered. On the basis of experimental data of the geophysical observatories at Murmansk and College it is shown that the value and sign of S_D-variation of geomagnetic field (H-component) are determined by the product of aurora luminescence intensity and ionospheric wind velocity. That suggest electric currents causing S_D-variations are a result of dynamo-action of ionospheric winds.

About the wave-nature of the magnetic storms and the second (around-the-pole) zone of the magnetic activity maximum

V. M. Mishin, N. A. Mishina, E. J. Nemzova and R. H. Zatipova

1) The analysis of the dependence of the magnetical activity K-index from the time of day (t, T), the season (τ) and the latitude (Φ, φ) deduce to the notion in form of:

$$k = k_1 \ (t, \ \varphi, \ \Phi) + k_2 \ (t, \ \varphi, \ \Phi)$$

It is found that the component k_1 is distributed in space and time according the law: $k_1 = f(\Phi) . \sqrt{\cos Z}$, where Z is the zenithal angle of the sun.

2) Take for:

a) $k_1 \sim j_1$ (j_1 = density of current)

b) $j_1 \sim \sigma.v.H.$ (σ = conductivity,
v = speed of the wind,
H = magnetic field).

The dependence of $k_1 \sim \sqrt{\cos Z}$ cannot be stipulated by the conforming distribution of the conductivity (although for a quiet ionosphere $\sigma^* \sim \sqrt{\cos Z}$).

Consequently, $v \sim \sqrt{\cos Z}$.

3) The disturbances of the type $k_1 \sim \sqrt{\cos Z}$ predominate during the day time and the local summer. In the latitudinal distribution they have a sharp maximum near Φ = 76-80, where these disturbances create a second (around-the-pole) zone of the increased activity. In conformity with the law $\sqrt{\cos Z}$, this zone appears only during day time of the local summer.

4) In generation of magnetic disturbance of the type $k_1 \sim \sqrt{\cos Z}$ the corpuscular invasions act a part of a trigger mechanism, which puts in action the ionosphere winds $v \sim \sqrt{\cos Z}$ arising from the absorption of the sun wave-radiation with the energy $E \sim \cos Z$.

ON THE NATURE OF GEOMAGGNETIC STORMS

I. A. Zhulin and V. P. Shabansky

At first a critical review of available theories of geomagnetic storms is given. Then authors set forth a most probable (from their standpoint) representations on the Earth's environment events which cause storm effects on the Earth; in some relations these ideas are different from Chapman-Akasofu ones. The initial phase of storm is due to enhanced pressure of corpuscular stream on the geomagnetic field (phase of hydromagnetic compression). The main phase is considered as a consequence of hydromagnetic expansion of magnetosphere due to the heating of magnetospheric plasma by hydromagnetic waves arising in the interface region between solar plasma and geomagnetic field. Injection of solar plasma into the magnetosphere appears not to have happened. Even though such injection takes place it is doubtful whether injected charged particles can be responsible for the expansion of magnetosphere (or for the origin of ring current). Possible processes of energy transfer from solar streams to the Earth's magnetosphere are considered. Some energetic estimates are given.

THE CONTRASTS OF THE GREAT GEOMAGNETIC STORMS OF OCTOBER 6, 1960 AND NOVEMBER 12, 1960

J. Virginia Lincoln

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The two storms beginning October 6, 1960 and November 12, 1960 were among the most severe of the present solar cycle. During both storms periods of Kp equal to 9_0 were recorded, and the Ap-indices exceeded 200. The storm beginnigs, however, differed. Only the November 12, 1960 storm had an unambiguous storm sudden commencement. The solar activity to associate with each storm was in sharp contrast. There was little solar activity preceding the October storm, but great activity preceding the November one. The statistics of these two storms will be presented in detail. Problems associated with predicting such storms will be raised.

DAY AND NIGHT DISSIMILARITY IN THE MAGNITUDE OF GEOMAGNETIC DISTURBANCES NEAR THE MAGNETIC EQUATOR

A. Yacob and K. B. K. Khanna

Geomagnetic disturbances of all types in H (S_D, storm -time changes, and short period fluctuations) occuring at the magnetic observatories Trivandrum and Annamalainagar, stations close to the

magnetic equator are compared with those occuring at Alibag (mag. lat. 13° N) to show that all disturbances are of about the same magnitude during the night-time at the three observatories, while during the day-time disturbance magnitudes near the magnetic equator are enhanced in varying degrees depending on the type of disturbance. It is inferred that day-time geomagnetic disturbances arise partly or wholly from E-layer electric currents and that such currents are augmented at the magnetic equator. The fact that the disturbances are not enhanced at the magnetic equator during the night-time must be due to the insignificant ionization in the E-layer at night.

Interpretation of K_p index and M-region geomagnetic storms

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It is pointed out that the traditional interpretation of the K_p index is no longer tenable. The K_p index, generally taken to be a measure of the strength of the solar-wind flux, may be more acceptably interpretated as a measure of the time rate of change of the sum of plasma plus magnetic pressure acting on the magnetosphere. The stability of the magnetospheric surface in the solar wind is demonstrated theoretically when reasonable assumptions are made for the plasma density just inside the magnetosphere. The magnetic irregularities that have been observed outside the magnetosphere are not hydromagnetic waves, but most likely are quasi-static irregularities that are swept past the detectors by the solar-wind flow. As a corollary to this new interpretation of K_p it is proposed that M-region geomagnetic storms are due to sheets of turbulence or irregularities that are generated by the collision of a region of high solar-wind velocity with a low velocity region.

On the variations of magnetic storms lag behing solar flares

P. Bernard

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The july 1959 events were remarkable by the shortening delay between three solar flares 3+ occurring july 10, 14 and 16, and the respectively correlated magnetic storms (1). The shorter delay of a second disturbance was statistically confirmed taking for the solar events the type IV radio outbursts (2). This result could de easily explained by our theory of the magnetic storms origin (3), which considers the corpuscular emission as movements of interplanetary gas (visible as zodaical light) directly by the radiative peaks of the Sun.

Successive impulses from the solar radiation to these ionised clouds should move them farther and farther from the Sun and nearer to the earth, so that the terrestrial magnetic effect of a given flare will be quicker if a previous disturbance took place.

During the solar cycle, we have also found (4) a progressive diminution of the mean lag from 40 h. before the sunspot maximum to 25 h. three years after this maximum. Then it increases again up to the sunspot minimum. This also could be explained by the above mechanism, as discussed in full in our paper published in the «Bulletin» de la Société d'Astronomie de Toulouse, n.° 449, jan. 1963, p. 8.

(1) A. Freon: *L'Astronomie*, déc. 1960, p. 513.
(2) C. Caroubalos: *C. R. Ac. Sc.*, 1962, 255, p. 2620.
(3) P. Bernard: *C. R. Ac. Sc.*, 1947, 224, p. 209.
(4) P. Bernard: *C. R. Ac. Sc.*, 1945, 220, p. 179.

The existence of the equatorial ring current during undisturbed geomagnetic periods

A. Grafe

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For the first time *Adolf Schmidt* advocated in the year 1921 the opinion that the geomagnetic ring current was continiously existent.

I had to find out for myself a full valid proof for the steady effectiveness of the equatorial ring current. This evidence was based on the following consideration: The field of the equatorial ring current in first approximation can be conceived as a homogeneous magnetic field, the direction of which is in accordance with that of the magnetic dipole axis. This fact was verified by the investigations of *Adolf Schmidt*. He carried out a balancing calculation for the average monthly values of the X- and Z- components for several years. It was shown that the relation $tg\Psi = Y/X$ is valid for the formation of the quotients of Y and X. At this balancing calculation *Adolf Schmidt* obtained for a value of -19°. This amount is in accordance with the geomagnetic azimuth of Niemegk. It remained only to demonstrate that for magnetic undisturbed times alone this constant relation of the ring current is also valid. For this purpose I used the deviations of the average daily values of the respective standard values in the X-, Y- and Z- component, published for Seddin-Niemegk. These differences mainly contain D_{st} and DS. The geomagnetic azimuth was determined by the GAUSS' method of the smallest squares for the years 1920-1958 from the X- and Y- components, separately for the positive ΔX-values and the negative ΔX-values. For the negative ΔX-values an amount of $\Psi = -18,9°$ was found and a Ψ-value of -15,9° for the positive ΔX-values. It is superfluous to infer a deviation of the ring current direction from this divergence of 3° to the required value. Rather this deviation is caused by the low intensity of the ring current during undisturbed times.

Thereby it is shown unequivocally that a magnetic ring current field must be existent also during geomagnetic undisturbed periods.

Seasonal changes in the equatorial electrojet

D. G. Osborne

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Methods for estimating the stregth and axis position of the equatorial electrojet are outlined. These are applied to published hourly magnetic values for a chain of stations in Peru for the years 1957-1960 and to more recent unpublished measurements made in Ghana.

It is shown that any seasonal changes in the electrojet are small.

On the equatorial electrojet over the Indian region

K. S. Raja Rao

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Making use of the daily ranges of the horizontal intensity of the earth's magnetic field at Trivandrum (Dip 0°43′ S), Kodaikanal (Dip 3°36′ N) and Annamalaibagar (Dip 5°22′ N) on international quiet days during the I. G. Y. - I. G. C. period, the intensity and width of the equatorial electrojet in the Indian region are evaluated. The seasonal and sunspot cycle variations in the electrojet are also estimated. The physical characteristics of the electrojet in the Indian region are compared with those in South America and Africa by comparison with observations at Huancayo, Addis-Ababa and Ibadan.

Daily and seasonal changes in the equatorial electrojet in Nigeria

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Using data from three observatories across the magnetic dip equator, daily positions and widths of the equatorial electrojet have been obtained. These characteristics have been calculated for the same

days in the following seasons: December solstice, March equinox and June solstice.

The mean distances (positive to the north) of the jet axis from the dip equator were: December solstice, —35 ± 3 km, March equinox — 24 ± 3 km and June solstice — 9 ± 4 km. The statistically significant differences between the seasonal means indicate that the electroject moves with season, its direction being the same as that of the sun.

The average width of the jet for the entire period was 165 ± 5 km. A comparison of this with previously reported values shows that the jet decreases in width with decrease in solar activity.

The method can be extended to obtain daily jet intensities. The relationship between corresponding jet and normal intensities is being studied.

COMMITTEE No. 10

Geomaqnetic effect of solar eclipse and irreggularities of *Sq*.

G. Fanselau

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The Sq-variations of 9 selected quiet days were studied according to the registrations of four stations of the Geomagnetic Institute Potsdam in Albania, Bulgaria and Rumania. It was found a remarkable influence of solar eclipse upon amplitude and phase of the extrema in SqD and SqH. The phase of the maximum SqD shows a physically significant difference of about —60 minutes to the usual trend. The phase of minimum SqH shows a difference of +40 minutes. This effect is not to be found at the phase of maximum SqH. Naturally the amplitudes are affected too, but not in such an evident manner. That is to be seen specially clear in the amplitudes of the minimum of SqD. The phase of maximum SqD and minimum SqH lie within the zone of the solar eclipse, but the phase of maximum SqH is earlier. It seems to exist therefore a broad influence of the moon on the current system of Sq.

In connection with this research the irregularities of Sq were studied. The investigations were based on registrations of the observatory in Niemegk. It is clear that it is not possible to get exact knowlege of current system of Sq by using only one single station; but one obtains remarkable results by using statistical methods on phases and amplitudes of extrema of SqD and SqH. The calculations were based on 160 selected quiet days. The deviations from the mean curve of the single elements were discussed. It is clear, that these single elements are connected with each other by the changes of the figure of the current system in time and space.

It could be shown that there exist local differences even in corpuscular disturbances between neighbouring stations. Such irregularities as large as 5γ were found comparing by the registrations between the neighbouring observatories in GMT. It may be considered that here are regarded only magnetically quiet days.

Periodic geomagnetic variations in high latitudes

T. Sato

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Periodic geomagnetic variations of 2 to 5 minutes in high latitudes are analyzed using the IGY and IGC geomagnetic data. The individual variations on quiet days, variations accompanied by magnetic storms, and their relations between conjugate points in Northern and Southern hemispheres are discussed. The relation between periodic variations and ionospheric absorption of cosmic radio noise is shown.

It is concluded that there are two kinds of variations. One type is in phase and of the same order of magnitude over the entire earth and seems to be related to the hydromagnetic wave. The second type is seen in high latitudes and has usually different phases at different stations. The amplitude is generally larger than the first type. The second type is considered to be related to charged particle bombardment of the ionosphere. In high latitude both types are frequently superimposed.

Characteristic features of rapid variations in polar regions

V. A. Troitskaya, R. V. Schepetnov, O. M. Barsukov, O. V. Bolshakova, K. Yu. Zybin and E. T. Matveeva

1. Rapid variations of the Earth's electromagnetic field have specific peculiarities in high latitudes which usually change with the cycle of solar activity.

2. Oscillations of the «pt» type in the years of maximum of solar activity are practically absent. With the diminishing of solar activity the number of regular «true» «pt» increases, and their differences from pt in moderate latitudes become less significant.

3. Continuous pulsations (pc) of the Earth's electromagnetic field are the characteristic phenomenon. For «classical» pc (T 15-50

sec) a clear polar night effect is observed. A characteristic feature of polar pc is the presence on the records of high latitude stations of the oscillations with great period (2-5 min L pc) and the dependence on the permanency of regimen of pulsations of different periods on latitude.

4. Intensive short irregular pulsations (sip) are most typical for polar latitudes. A close connection with aurora and X-ray bursts was discovered for this type of pulsations. The frequency of occurrence of such pulsations and especially their duration and intensity depends on the solar cycle.

5. Pulsations of pearl type (pp) or hydromagnetic emissions are also very characteristic for high latitudes. Their frequency of occurrence and duration are in opposite dependence on the cycle of solar activity.

Besides the cases of simultaneous excitation of pp oscillations with the same period in middle and high latitudes there is a strong tendency of occurrence of pp of greater periods in high latitudes. A correlation with the injection of solar cosmic rays into the high atmosphere of the Earth was observed for these oscillations.

6. New data about rapid variations are used for the analysis of the fine structure and supplementary classification of macroscopic disturbances of the magnetic field in polar regions.

Relationships at geomagnetically conjugate points

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A progress report on the study of related phenomena at conjugate points will be presented under the main readings: (i) Observations concerning magnetic (M), telluric current (T), auroral (A), and ionospheric absorption (I), (ii) The latitude dependence of conjugacy, with special reference to very high latitude stations, polewards of the auroral zone, where field lines are subject to major distortion by solar pressure. Paired stations, McIlwains's L-parameter, and the instrumentation were:

—Cold Bay (Alaska) and Oamaru (New Zealand); L ~ 2.6; M, T
—Farawell (Alaska) and Campbell Island; L ~ 4; A, I
—Kotzebue (Alaska) and Macquarie Island; L ~ 5; M, T, A, I
—Reykjavik (Iceland) and Showa (Antarctica); L ~ 6; A
—Shepherd Bay (Canada) and Scott (Antarctica); L ~ 25; M, T, I

Within the auroral zone, and equatorwards, the M and T disturbances show the usual midnight maximum for which the correlation of the forms of the disturbances in good. This applies also to A in the case of Farewell-Campbell. Conjugacy in I is fairly good at Farewell-Campbell and Kotzebue-Mackuarie. A study of T polarization at Oamaru indicates a definite diurnal pattern. Power spectrum analysis of Oamaru data shows a predominant period of 40 sec, with lesser peaks at ~ 10 and ~ 300 sec.

Slightly polewards of the peak of the auroral zone (Reykjavik-Showa), conjugacy is inferior to that at lower latitudes (Farewell-Campbell)

At very high geomagnetic latitude (Shepherd-Scott), M and T show strong day and night disturbances. Correlation is best during the midnight period, fair at about midday, and worst for periods in the morning and afternoon.

Due to the precession of the magnetic axis about the spin axis, the magnetosphere is alternately more exposed to the solar stream over the northern and southern poles. This is probably the reason for the diurnal variation of the relative magnitude of related disturbances observed at Shepherd and Scott.

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Micropulsations in conjugate auroral zones and associations with some other ionospheric phenomena

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The results of micropulsation observations at three auroral stations —at Fort Churchill, Great Whale, River and Byrd Stations— are reported. Special attention was given to the short sudden micropulsation commencements which coincide in time at the same station with the sudden commencements of Birkeland's negative polar elementary storms, with the breakup of auroral arcs near the zenith with associated ionospheric events. These micropulsation events include higher frecuencies during the corresponding sudden magnetic negative changes in H. but not for positive H changes. There is a pronounced and similar diurnal U.T. variation of occurrence of these sudden brief events at all three stations. The agreement in time between sudden commencements which appear at two conjugate points is generally within the accuracy of our timing, and this is true also of the combination of micropulsations at Byrd and riometer records at Cape Jones, which is nor far from Great Whale.

The SC's and si's of world wide events are aqually simultaneous but differ from the events with which we are dealing by the restriction of the latter to the night time with a pronounced occurrence maximum not far from midnight. The most reasonable cause is probably the dumping from the magnetosphere of particles bunched in quantity and for energy. While statistically, the diurnal variation of occurrence of the micropulsation events fits into the Oxford-Hines model of day and night activity, the mystery is what causes the quiet intervals suddenly to explode into impulsive activity at the commencements of «DP» sub-storms, or bays; we call these sudden changes «events». They are night frecuency components. They can also be recorded on micropulsation equipment in middle latitudes, presumably «leakage» ionospheric currents which have not closed their circuits wholly over the polar cap.

The circunstance that they can be so recorded on micropulsation equipment, and even sometimes on slow run magnetograms, opens the way to further investigations relating to assotiation with the equatorial electrojet and to the shape and simultaneity of events on the day and night sides of the earth.

The night time impulsive events seem to the simultaneous on magnetograms, micropulsations, aurora, his, riometer and probably other ionospheric events. The day time regime has not been studied in detail, but does exhibit regular type, magnetic, micropulsation and auroral oscillations.

Influence of large electrical conductivity differences in the underground on geomagnetic variations

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Geomagnetic variations especially of the vertical component sometimes are very different from each other at places a few ten kilometers distant. This has been shown by several authors in Japan, America and Europe. Such features are very frequent on the whole earth and have not yet been detected because sufficient tight network of registrations was not existent. By means of magnetic registrations at one point it is possible to determine the direction of large conductivity structure as far as the vertical magnetic variations are sufficient large. Consider two masses of different electrical conductivity lying side by side which have a common vertical or inclined boundary. According to the skin effect in the mass of higher conductivity there must be an enlarged density of inclined currents at the boundary. The vertical magnetic variations are therefore relatively large in this region, far away from the boundary vertical magnetic variations vanish. In middle and low latitudes the ionospheric current density is relatively homogeneous so the vertical magnetic variations caused by these ionosphere currents are very small. The augmentation of induced currents will be biggest if the ionospheric currents are flowing in the direction of the boundary. If one makes a statitical investigation of the amplitude of vertical variations in relation to the magnetic horizontal variations it is possible to find the direction of the boundary. This has been done at about 100 places in Middle and SE-Europe, where registrations had been made during IGY. Several important regional structures had been found and the results are very clear for stations near such a boundary. The sign of the vertical component may be parallel or anti-parallel to the horizontal component, this depends on the geographical situation of the stations to the boundary. When underground structures are more complicated the mean current-flow in the underground will be received. By investigations of the same kind for several periods it is possible to examine the ground progressively with depth. Wiese: Geomagnetische Tiefentellurik, Teil I, Geofisica Pura e Applicata 51 (1962/I), p. 59-78, Teil II, dto., 52/1962/II), p. 83-103.

Studies on the geomagnetic pulsations

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In order to discuss the characteristics of the geomagnetic pulsations, we investigated the 1) period 2) apparent damping time 3) polarization of disturbing vector, and discussed these quantities under some simple models.

Considering the characteristics of polarization of disturbing vectors of pc III, I propose a simple model capable for explaining the diurnal variation of these sense of rotation of the vectors.

If these pulsations are isotropic HM-oscillations of the fluctuations of pressure and viscous radial stress of the solar wind, resulting oscillations have the elliptic polarizations and their diurnal behaviour consist with the observed one, that is in the northern hemisphere clockwise in the afternoon and anticlockwise in the morning.

Form index for the identification of geomagnetic pulsations

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To make a complete study of pulsation given the planetary characteristics of his shapes it is theoricaly necessary to obtain all the world magnetograms. But this work is impossible to do, because the number of information to meet is very rich.

We thought to save these difficulties in this manner: First, choosing only 26 observatories distributed conveniently around the world; second, by the form index that appears in the usual bulletins it will permit to solicit only the magnetograms of our interest.

The index is formed by: signs, numbers, and letters; conveniently grouped and built in according to a key. It'll be able to give to the scholars a complete and syntetic information to rebuilt the phenomenons.

This index is formed by: only one first sign who give the direction of initial deformation; next, two letters that identify the type of pulsation; inmediately three numbers, the first gives the average period, the second, the average amplitude, and the third, the amplitude or defformation coefficient. The last term is named «the configuration term», and lastly a number who given estimately the frequence deformation given by a key.

The effect of a magnetic permeability environment on micropulsations

N. E. Goldstein and S. H. Ward

While extensive investigation has been made of the effect of electrical conductivity variations in the Earth on the amplitude of micropulsations, little attention has been paid to the effect of subsurface magnetic permeability variations. To elucidate the latter, several local magnetic anomalies in the Earth's main field, related to near surface and deeply buried magnetite concentrations, were investigated. Total field micropulsation activity was recorded at two stations by measn of two rubidium-vapour magnetometers, spaced 1000 feet apart, along profiles normal to the strikes of the main field anomalies. Amplitude variations were analyzed numerically and the results clearly indicate the effect of the permeability environment; up to a 30 % amplitude difference at stations 1000 feet apart is encountered.

Volcanic extrusives with a high ratio of remanent to induced magnetism do not appear to alter the micropulsation field. Magnetite bodies, on the other hand, possessing a high absolute induced magnetism, exhibit a low ratio of remanent to induced magnetism and clearly alter the micropulsation amplitudes over distances of hundreds of feet. It has been possible to estimate the apparent magnetic susceptibility contrasts devoid of remanence effect, due to the local disturbances, from the spatially-dependent amplitude variations of the micropulsations field.

Hence, by means of micropulsation amplitude analyses it is possible to separate remanent from induced magnetism of rocks in situ.

General regularities of the PP type oscillation

E. T. Matveeva and V. A. Troitskaya

The most complete data on temporary, frequency and amplitude regularities of the PP type oscillations or of the so-called pearls are given.

All of the PP oscillations are divided into four types: oscillation series, singular, PP on the disturbed phone and scattered oscillations. The pearl series prevail over all these types of oscillations and they have been studied in detail. The diagrams of daily, season and annual changes, the diagrams of distributions according to periods and amplitudes, the data on comparison of the PP with the other oscillation regimes are presented. The comparative characteristics of the PP for middle latitude and polar stations are also presented. The connection of these oscillations with the upper atmosphere phenomena is marked. The results of studying of the PP field structure are given.

Some directional properties of signals in the lower ELF band recorded at widely separated stations

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During 12 days in early February 1963 the ELF background between 2 and 40 cps was received on magnetic detectors in three orthogonal components (X, Y, Z) at one station in Antarctica and at three widely spaced sites in Canada, all remote from thunderstorm activity. The first five Schumann modes were prominent but the flux changes measured in the first and fifth were generally larger than those in the intermediate three modes. Simultaneous discrete signal bursts were received at all stations. In general the apparent directions of individual bursts varied widely, although the signal averages on all X and Y components were approximately equal.

Geomagnetic micropulsations during the daylight hours

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It is proposed that geomagnetic micropulsations which occur in the daylight hemisphere in middle and low latitudes are caused by a system of ionospheric electric currents whose origin lies in a narrow region in high latitude zones. This hypothesis is checked by several observational facts. An oscillatory frequency shift in a sounding radio wave with a frequency of several megacycles which appears to be associated with the geomagnetic micropulsations is atributed on our theory to an ionospheric oscillation caused by an alternating electric field induced in the ionosphere. A process is suggested whereby a hydromagnetic oscillation of a magnetic line of force gives rise to the proposed current system mentioned above.

On the latitudde-dependence of the period of geomagnetic micropulsations

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Micropulsations are recorded at the German observatories Wingst (Wn), Göttingen (Gt), and Fürstenfeldbruck (Fu) by means of entirely equal induction-coil variometers of the Grenet-type. The three observatories have nearly the same geomagnetic longitude and cover a latitude-range of 5,6^0. The following observational results have been obtained thus far: Pulsation trains (pt) completely agree at the three stations, except for an increase of the amplitudes to north. Simultaneous continuous pulsations (pc) are sometimes similar and sometimes different in shape. There is, however, a very systematic increase of the pc-period to north. Strictly speaking, this result was found for the H-component only and not at all for the D-component. The latitudinal differences of the periods show a clear daily change with a maximum just before local noon. Then the difference between the peirods of Wn and Fu amounts 30-35 % with regard to the period of Gt as the middle station. The same behavior, but still much more marked, could be read from the records of a new type of micropulsations, called pulsation single effect (pse). As yet there have been about three effects of this kind per month.

The latitude-dependence of the period and the quite different appearance of pc- and pse-type pulsations in the H- and D-components remind of the results of the wellknown theory by Dungey (1954). According to these results, however, the change of the period with latitude should appear in the D-component and not in the H-component. This is just the reverse of the observational results. Nevertheless, an explanation of these pulsations as hydromagnetic oscillations in the magnetosphere is possible under the assumption that the plasma density of the region concerned has lamellar structure. This means that the density is continuous in the direction of the earth's magnetic field but discontinuous normal to the lines of force.

Using this model for a theoretical treatment of the problem, many features of the observations could be quantitatively explained.

Large magnetic pulsations near the Equator

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Continuous pulsations of amplitudes up to four gammas and periods up to three minutes have been observed on normal run magnetograms from Tamale, Ghana, and Freetown, Sierra Leone. Both these stations are close to the magnetic equator but at different longitudes. The pulsations are described and it is noted that they occur simultaneously at the two stations in many cases. Their association with magnetic disturbances and continuous pulsations at other latitudes is considered.

Longperiodical giant pulsations of the geomagnetic field

A. I. Ohl

This name is given to the regular sinusoidal oscillations of geomagnetic field which have considerable amplitude (tens and hundreds of γ) and great periods (about some hundreds seconds). They occur only near the auroral zones. The diurnal variation of the occurrence frequency of these pulsations shows two maxima about 0800 and 1600 Local Geomagnetic Time. The first of these maxima is more pronounced near the polar side of the auroral zone, and a second near the equatorial side of the zone. In winter the first maximum predominates, and in summer - the second one (it was shown also by Sugiura). These pulsations are very local phenomena but they can arise on both conjugate points in the Northern and Southern hemispheres simultaneously. The mean periods for these pulsations increase with geomagnetic latitude ($T \propto 1/\cos^2 \varphi$). The pulsations appearing about 1600 LGT have greater periods than pulsations occurring about 0800 LGT. The periods of these pulsations increase with solar activity; mean yearly periods on Cape Chelyuskin have a close linear correlation with Wolf's numbers ($r = + 0.98$). These pulsations usually occur after moderate magnetic disturbances, especially after the bays.

All these facts suggest that here we deal with hydromagnetic waves which are propagating along the geomagnetic lines of force from the boundary of magnetosphere to the Earth. It is shown that the period of these waves can be expressed as $T \propto \sqrt{n_e}/\cos^8 \varphi$, where n_e is the number density of charged particles in the geomagnetic equatorial plane at some Earth's radii. It may be supposed that $\frac{1}{2} n_e mv^2 = H^2/8\Pi$ in the boundary region of the magnetosphere. In this case it is found that $T \alpha 1/\cos^2 \varphi$ it is in agreement with the observations.

THE FINE STRUCTURE OF MAGNETIC DISTURBANCES

V. A. Troitskaya, M. V. Melnikova and G. A. Bulatova

1. The 24 hours running records of rapid variations of the Earth's electromagnetic field (up to fractions of seconds) are used for the investigation of the fine structure of the main types of macroscopic disturbances of the field and especially of the magnetic storms.
2. It is shown that the main elements of magnetic storms: ssc, the first and the main phases have different and specific fine structure which reflects the peculiarities of the interaction of corpuscular streams with the magnetosphere of the Earth.
3. For a great number of storms there is an evidence that in advance of main corpuscular stream arrive more energetic particles which are trapped into the magnetosphere of the Earth. This phenomenon can be traced either in middle or high latitudes (or both) by the excitation of series of oscillations of pp type.
4. The difference in the elements of the fine structure of magnetic storms is investigated for the period of the maximum of solar activity and the period of its diminution.

It is found that the characteristic intervals of oscillations diminishing on periods (IPDP) are practically absent in the main phase of the storms during the years of mean solar activity.

5. An endeavour is made to distinguish the differences in the fine structure of magnetic storms for storms due to flares and to flocculi (classification of E. R. Mustel and M. S. Bobrov). The preliminary data show that for the storms due to flocculi (with gradual beginnings) oscillations of pc type and significantly shorter series of short irregular pulsations are observed much more frequently than for the storms with ssc due to flares.

ON THE DIFFERENT TYPES OF SUDDEN COMMENCEMENTS, SUDDEN IMPULSES, AND MICROPULSATIONS

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After a study of the morphology of geomagnetic sudden commencements and their accompanying phenomena, they are classified into three types. From a similar study of sudden impulses, four types are found, three of which are completely analogous, both in their morphologies and in their accompanying phenomena, to the corresponding types of sudden commencements. The fourth type of sudden impulse has quite different behavior from any type of sudden commencement. Based on physical interpretations of these different types, it is emphasized that the present international notations, such as ssc, ssc* and si, are not sufficient.

Various notations of micropulsations previously suggested by many workers are reexamined in view of recent observations. The result shows that we need new internationally adopted notations, particularly for the IQSY. Taking into consideration well-accepted notations of the slow variation field and the physical meanings of different types of micropulsations, two basic classifications and new notations of micropulsations are proposed.

THE SUDDEN COMMENCEMENT OF GEOMAGNETIC STORMS: MORPHOLOGY AND INTERPRETATION

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The polarization of the magnetic perturbation of the sudden commencement of magnetic storms was examined using rapid-run magnetograms for the IGY and the post-IGY years; the analysis reported earlier (1961) by the present authors was extended. The polarization is found to be linear in low latitudes and is elliptical in high latitudes. The sense of rotation of the magnetic vector for the elliptical polarization obeys definite rules as was reported in our previous paper (1961). The reversed impulse in H that precedes the main impulse is mainly the result of the projection of the perturbation magnetic vector of an elliptically polarized wave in the direction of the unperturbed total horizontal force. This projection produces a reversed impulse in H for certain directions of the initial perturbation in the magnetosphere. Various shapes of the storm sudden commencement in H can be reproduced by superposition of a linearly polarized and a circularly polarized wave with several varying parameters. Power spectra of magnetic field oscillations following sudden commencements are determined and discussed with reference to the oscillations of the magnetic field lines. A model is presented for the storm sudden commencement that can account for the observed major features.

STORMS SUDDEN COMMENCEMENTS (SSC'S) ACCORDING TO THE IGY DATA

K. G. Ivanov

More than 50 ssc's were observed by the world net of magnetic observatories for IGY. It is useful to utilize that rich data, in order to obtain a united morphological scheme of the distribution of the field of ssc on the earth surface. It will permit to obtain more fundamental base for a theoretical treatment of ssc.

A part of this problem, the variations of the form, the size of ssc on the local solar time and on the geographical latitude of an observatory, were studied according to the IGY data of 30 observatories of the northern hemisphere between 0 and 60° North. The distributions of the H, D and Z components of ssc's were constructed on hourly intervals of LMT and on three belts of latitudes (0-30°, 30-45° and 45-60° North). More than 4000 magnetograms of ssc's were studied.

As a result of that work, the regularites of the daily variations of the form, the size and the hourly frequency, obtained not long ago, were confirmed. And the scheme of the distribution of the field of ssc, proposed not long ago, was confirmed too. It is revealed, that the size of ssc are increased with the latitude at the night side of the Earth, and ssc*'s appear in any time and at any latitudies in the East Asia.

The first impulse of ssc raises a second geomagnetical effect when is propagated through the outer radiation belt, the ionosphere and the Earth.. For a calculations of these second effects it is necessary to solve, in particular, a problems about the disturbance of the geomagnetical field by a local rise in conductivity of the ionosphere, and about an electromagnetical induction in the ionosphere with anisotropical conductivity of the ionosphere.

ABOUT DIURNAL VARIATIONS OF THE PROBABILITY OF COMMENCEMENTS, ACTIVITY PERIOD AND TERMINATION OF MAGNETIC STORMS APPEARANCE

V. M. Mishin, N. I. Naydenova and M. L. Platonov

There are examined the data of the Irkutian catalogue of magnetic storms for the period from 1905 to 1917 and from 1928 to 1959 years containing the description of 820 storms including 589 storms with a gradual beginning. It is ascertained, that the probability of commencement and termination of the magnetic storms appearance is sharply dependent on time of day represent simple waves. The phase of the diurnal variation commencements of the magnetic storms (ssc) outstrips the phase Sa by 90 approximately, and the phase of the diurnal variation termination of the magnetic storms Sts lags behind the phase Sa so much approximately.

Supposing that Ssc and Sts are a sequence of Sq the calculations of the diurnal variations of the probability of magnetic storms beginning and termination are made; the results of these calculations are well in accordance with the experimental data.

It is ascertained, that the beginning of the disturbances, registrated at the station in question are on the whole shifted relatively to the moment of the stream contact with the earth as to the retardation.

The retardation can last several hours, and it is useful to take it into consideration when correlating the magnetic disturbances with other geophysical processes.

As parallel results the values of the stream-density distribution along the Earth-Sun line are given.

NEAR AND DISTANT OBSERVATIONS OF THE 1962 JOHNSTON ISLAND HIGH-ALTITUDE NUCLEAR TESTS

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During the 1962 Johnston Island high-altitude nuclear tests, USAELRDL operated high-sensitivity, high-time-resolution magnetometers in the Pacific area and in the continental U. S. A. Large loops of up to 100 km^2 area, spin-resonance (metastable-helium) and telluric probes were used. Shot Star Fish (the 9 July explosion of about 1-1/2 megatons at 400 km altitude) produced very strong osciliatory signals of many minutes duration at all our stations (Hawaii, Samoa, Florida, South Carolina, New Jersey, and Maine). The signals consist of several physically different parts: a practically instantaneous broad-band pulse containing mainly higher frequencies, a strong oscillatory signal starting 1.9 seconds later simultaneously at all stations, a complex portion lasting several minutes which is probably a superposition of different hydromagnetic modes, and an extremely long-period disturbance (observed only in the Pacific area), carrying considerable energy, which we interpret as a hydrodynamic-gravitational mode. The maximum signal amplitude (occurring within 3 to 5 seconds post-shot), when plotted vs. distance from Johnston Island, results in a smoothly decreasing curve. The curve is interpreted as the result of two effects, the near-field decrease with the inverse square of distance and the modifying influence of the curvatture of the earth at distances greater than about 6000 kilometers. The fact that the values obtained by stations generally east of Johnston Island, as well as by one in the conjugate area, fall on the same smooth line of the maximum-amplitude vs. distance curve is strong evidence for highly isotropic propagation of the mode that arrived with a 1.9-second delay at all stations.

Of the four other high-altitude nuclear tests above Johnston Island between 20 October and 4 November, which were at various heights, but in all cases considerably lower than the Star Fish explosion, none gave magnetic signals clearly above the noise level at the mainland stations. Three of these events produced clear effects at Hawaii (1488 km to the magnetic ENE of Johnston) and at Samoa (3419 km magnetically south of Johnston). The signal-amplitude ratio (Samoa to Hawaii) becomes, for sufficiently low shot heights, a pronounced function of the explosion height, indicating that the magnetic-signal propagation becomes more and more confined to the North-South direction as the explosion height is lowered. Furthermore, the absolute efficiency of the conversion of kinetic explosion energy into VLF electromagnetic and hydromagnetic effects is also a function of the explosion height, and becomes very inefficient for explosions in or below the E layer.

Geomagnetic effects of nuclear explosions

A. J. Shirgaokar and A. S. Prabhavalkar

A number of nuclear explosion tests have been carried out notably by the U.S. and U.S.S.R. during the course of the last few years. Several workers have reported on the geophysical effects attributed to such nuclear explosions. The present paper makes a comparative study of the geomagnetic disturbances recorded at the three Indian magnetic observatories, Alibag, Annamalainagar and Trivandrum which can reasonably be attributed to such explosions.

On the results of the Earth currents investigations in the Georgian Republic for the IGY period

V. V. Kebuladze

Continuous every day and night registration of the Earth currents variations on the IGY programme was carried out by the Geophysical Institute of the Georgian Academy of Sciences, at the Dushety electrotelluric stations ($\varphi = 42° 05'$ North latitude, $\lambda = 44° 42'$ E longitude) operating from 1947. As a result of the statistical data analysis and the use of the observational data for 1947-56 the following regularities are revealed:

1. Diurnal-solar variations of the latitudinal (E_y) and horizontal (E_H) components are a double wave with the two main maxima

and minima, which occur year by year at the same daytime but vary according to the season.

2. E_y component variations are 3-4 times the E_x variations. The field is polarized approximately in the latitude direction.

3. It is found a complete analogy of E_y and the horizontal component H of the geomagnetic field.

4. The analysis of the hourly three-member characteristics tables and the catalogues of the long electro-telluric storms and disturbances for the period of 1948-1960 shows that the disturbances with gradual commencements occur more often than those with sudden commencements. The second part of the twenty-four hours is characterized by the higher activity as compared to the first part. The most active are equinoccial months.

5. Depending on the local conditions the amplitude-frequency short-period oscillations characteristics of the constant regime (Pc) and trains (Pt) have been studied. It is ascertained that the diurnal variation of the Pc occurrence frequency proceeds according to the local time. The maximum quantity of regular Pc is observed in summer and minimum in winter. Pt occurrence frequency is characterized by the distinct diurnal variation with a maximum between 18-21 hours of the universal time. Seasonal variations of the Pt occurrence frequency are not observed. These revealed main regularities in Pc and Pt well co-ordinate with the data of other Earth current stations.

6. To study the upper layer of the Earth crust the method of regional survey is worked out.

Earth currents measured by Pacific cables

S. K. Runcorn

Regular recording of earth currents have been abandoned in many observatories because of man-made disturbances.

It has recently become possible to study the earth currents over long distances in the South Pacific because of the abandonment of telegraph cables between Fiji, Australia and New Zealand.

An account will be given of some measurements which show the following:

1. These records, on disturbed days, show up remarkably well the correlation of earth current disturbances with the rapid variations of the magnetic field. In particular distinct earth current fluctuations are observed at exactly the same times as bays and pulsations are observed on the magnetograms.

2. The records on quiet days show a semi-diurnal wave, of amplitude of about a volt, on the Sydney/Auckland and Fiji/Auckland

cables, and a smaller amplitude wave on the Sydney/Norfolk Island cable.

An interpretation of these measurements will be given.

ELECTRIC CURRENTS INDUCED IN THE OCEANS AND THE MEASUREMENT OF MAGNETIC VARIATIONS AT SEA

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Because of the relatively high conductivity of seawater, geomagnetic variations originating in the upper atmosphere will induce appreciable electric currents in the oceans. Calculations indicate that these currents make a significant contribution to the magnetic variations observed at the earth's surface, and in particular lead to anomalous variations of the vertical component at coastal stations. They also tend to shield any conducting material in the mantle from external field variations and thus make the problem of discovering the distribution of conductivity in the mantle more difficult.

The attenuation and other changes of magnetic variations with depth in the sea are calculated. It is found that the variations at the bottom of a deep ocean differ significantly in form as well as in magnitude from those at the surface. The changes with depth depend not only on the conductivity of the sea-water, but also on the distribution of conductivity beneath the ocean bottom and on the form and dimensions of the external inducing field. Hence, without some knowledge of these factors, it is not possible to deduce accurately the field variations at the bottom of the ocean from those at the surface, or conversely. This has a bearing on the problem of interpolating certain variation fields (e. g. the Sq field) over the earth's surface. Further progress in these studies would be greatly assisted if actual measurements were made of the variations at different depths in the sea. It might be possible to do this by using self-recording instruments placed in submerged buoys.

ON THE AMPLITUDE SPECTRA OF THE TYPICAL SHORT-PERIOD-OSCILLATION DISTURBANCES OF THE EARTH ELECTROMAGNETIC FIELD

N. F. Maltzeva

Some calculation results of the amplitude spectra of the typical short-period-oscillation disturbances of the Earth electromagnetic field are examined. These results are obtained by means of electronic computers.

NIGHT-TIME EARTH CURRENTS ASSOCIATED WITH Sq

A. T. Price and A. A. Ashour
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The theory of induced earth currents leads to an interesting result in connection with the Sq field. The field can be pictured as arising in the main from a system of ionospheric currents flowing in the sunlit hemisphere, and it is the motion of this system following the sun around the earth which gives rise to the induced currents. Calculations show that, even if there are no ionospheric currents in the night hemisphere, there will be earth currents brought into existence in this hemisphere by the ionospheric currents in the day hemisphere. These earth currents will not be as intense as those in the day hemisphere, but will not be insignificant if generally accepted estimates of the conductivity of the earth are correct. The currents will flow at night along the circles of latitude, the current circuits being completed by north-south portions in the daylight hemisphere.

The possible existence of these currents is of some importance in deciding the correct base line from which to measure the magnetic variations in any detailed analysis and separation of the Sq field into parts of internal and external origin. Mr. Scott Forbush has suggested a method for detecting these currents.

EARTH ELECTRO-MAGNETIC FIELD MICROPULSATION IN THE AURORAL ZONE

R. Scrinnikov and N. Maltzeva

Some types of the Earth electro-magnetic field micropulsations in the Arctic regions are closely connected with the aurorae and with the processes in the ionosphere.

The analysis of the simultaneous observational data of variations of aurorae glow intensity (the data were received by means of a 180°-photometer) and of geomagnetic and electric field variations shows coincidence of the variations types of the aurorae glow and the geomagnetic field. The spectrum of the aurorae «scintillations» coincides with the short-period oscillations spectrum of the geomagnetic field with periods 4-60 sec. A correlation is found for the both types of variations.

$$\delta H = [(3 \div 4) \cdot 10^7 \delta]\, f_{of}$$

Z component micropulsations of the magnetic field of «polar disturbances» types correlates with the occurrence E_s of r type for $f_0 \varepsilon_s(\tau) >$

3-4 m and magnetic bay disturbances. It is made an analysis for the days with the weak magnetic activity (K 5).

THE DIRECT-CURRENT CONDUCTIVITY OF ICE DOPED WITH IONIC IMPURITIES. A PROGRESS REPORT

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The direct-current conductivity has been measured on a large number of ice samples doped with ionic impurities, as a function of ionic species, concentration and temperature (1). Electrolytes studied thus far are hydrofluoric acid, hydrochloric acid, and potassium fluoride.

Both acids show a linear dependence of conductivity on the square root of concentration at constant temperature as required by the mass-action law in conduction is due primarily to protons (2). It has further been established that, within experimental error, the conductivity at identical concentration and temperature is the same for samples prepared with either acid.

For hydrofluoric acid, the concentration range covered up to date lies between 10^{-3} and 10^{-7} moles per liter in the melted ice. The range for hydrochloric acid is between 4×10^{-6} and 8×10^{-4} moles per liter.

The activation energy for hydrofluoric and samples of all concentrations between —20° C and —85° C is roughly $0,6 \pm 0,05$ ev/° C.

Samples prepared with solutions of $2,5 \times 10^{-4}$ N potassium fluoride, frozen both under conditions of open circuit and with an external low-resistance shunt between water and ice phase (3) show an activation energy identical to that of hydrofluoric acid samples.

This is a new experimental confirmation for the charge separation that takes place at the growing ice-water interphase as well as for the selective rejection of cations from the ice, according to the mechanism suggested by Workman and Reynolds (3). Further studies are in progress (4).

(1) G. W. GROSS: *Ccience* 138: 520-521, 1962.
(2) C. JACCARD: *Helv. Phys. Acta* 32: 116, 1959.
(3) E. J. WORKMAN and S. E. REYNOLDS: *Physical Review* 78: 254-259, 1950.
(4) The Research discussed in this report is being carried out under Office of Naval Research contract No. Nonr 815 (01).

Geophysical Factors in Electromagnetic Propagation through the Lithosphere

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The study of electromagnetic propagation deep within the crust of the earth, over paths hundreds to thousands of kilometers long, is significant for the information it may disclose concerning the structure and properties of the crust, as well as for its potentialities in novel systems of cummunication, detection, and remote control. Such communications systems would be less vulnerable than above-ground systems to interference by natural and by manmade events such as storms and nuclear explosions. Factors critical to electromagnetic propagation in the crust are: 1) the gross and intermediate scale structures of the crust; 2) the composition of the constituent rock facies and their compositional variations and discontinuities laterally and in depth; 3) the primary electronic properties of the dominant rock facies, specially the dielectric constant, the loss tangent, and the conductivity as functions of temperature, pressure, and frequency; 4) the absolute temperatures and pressures within the crust and the temperature-pressure gradients; 5) the frequency and effective wavelengths of the EM wave in the medium; 6) the magnitude and spectrum of the EM noise in the lithosphere; 7) the characteristics of the antenna, of its emplacement in the crust, and the coupling parameters.

Laboratory measurements of typical dry granitic medium of the continental basement are favorable to the transmission of EM energy at low frequencies (10^3 cycles per second) with tolerable intrinsic attenuation (of the order of 5×10^{-6}db per meter). Greatest uncertainty stems, however, from the fact that the refractive index $\sqrt{\varepsilon}$ increases markedly with increasing temperature. A projected gradient of 100° C per 3 km of depth would result in an acceptable downward refraction of horizontally launched VLF waves within a few wavelengths. The feasibility of long-distance propagation may, therefore, depend upon the possible influence of a minimum velocity duct or waveguide in which the radiated energy would be conserved either 1) by reflection between an upper and a lower discontinuity; or 2) by refraction along a zone of refractive index inversion; or 3) by a combination of these, that is, a favorable gradient plus a discontinuity. While current knowledge of crustal structure and mineral phase changes at depth do not rule out such gradients and discontinuities, neither do they provide any reliable basis for postulating the existence of such a favorable propagation channel. The possible occurrence of Conrad type discontinuities is relevant here.

Determination of the Electrical Conductivity by Magnetotelluric Measurements

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The first results of MT sounding on the territory of Tzechoslovakia were obtained from the data of the field station in Srobárová where the horizontal electric and magnetic components of the field were recorded simultaneously over a range of period from 1 second to 24 hours. The field data were analysed a) by direct amplitude determination of PP, PC and other short-period variations. b) by harmonic analysis of the daily variation and groups of special types of short-period variations. c) by Fourier spectral analysis of bays, Pts and other non-periodic fluctuations.

The material obtained was interpreted on the assumption that the sources of all variations are of global dimensions. The impedance of a plane electromagnetic wave was computed for groups of variations of nearly equal periods in dependence on $\sqrt{T}$. From smoothed graphs $E/H = f(\sqrt{T})$ the resistivity curves ς_{zx} and ς_{zy} were derived according to the formula

$$\varsigma_{zx|y} = 0.2\,T \left| E_{x|y}/H_{y|x} \right|^2, \tag{1}$$

where ς is in Ωm, T in sec, E in mV/km, Hx, y in γ. Fig. 1 (not reproduced here) shows the curve $\varsigma_{zy} = f(\sqrt{T})$ at Srobárová (S), another curve ς_{zx} could not be constructed in the short-period branch because data are lacking for periods $T < 20$ sec. The two curves are identical within the limits of accuracy of their determination. In the same graph a part of curve from Budkov (the stationary observatory) and a curve taken from other authors are included.

The short-period part of curve ς_{zy} corresponds to the geological conditions in the surface parts of the neogene basin. An interpretation based on the two-layer theoretical curve gives 2 km for the depth of the non-conducting fundament. This estimate is in good agreement with local geoelectric resistivity prospecting.

The long-period branches of curves ς_{zx}, ς_{zy} show that a highly conductive layer may exist in the deeper part of the crust in the region under consideration. The interpretation was made from asymptotes I. and II. corresponding to different smoothing of the function $E/H = f(\sqrt{T})$ over the range of periods $50 < \sqrt{T} < 120$. We get an average estimate of 138 km for the depth of this layer. Its resistivity must be of order 1 Ωm. The curve is very uncertain in the range of periods $170 < \sqrt{T} < 300$ because of the small number of determinations. We get higher resistivities than would be the case for monotonous decreasing of the resistivity following from bays. Resistivities are in the range of B and US curves. If this increase of resistivity were real the conductive layer, determined at a depth of 138 km would probably correspond to a zone of increased electrical conductivity, supposed by H. Wiese at a depth of 50-150 km in Central Europe. According to his data the field station Srobárová may be in the neighborhood of this zone. Further data are required to support this conclusion.

(1) L. Cagniard: *Ann. de Geophys.*, 9 (1953), 95.

(2) A. N. Tichonov, N. V. Lipskaja et all.: *DAN SSSR* 140 (1961), 41.

(3) H. Wiese: *Tiefentellurik*, Akademie-Verlag, 1956.

JOINT COMMITTEE: ATMOSPHERIC ELECTRICITY (WITH IAMAP)

The role of particle interaction in the distribution of eletricity in thunderstorms

J. D. Sartor

National Center for Atmospheric Research

The rate of charging by induction of colliding and separating particles in a polarizing electric field is compared with the basic charging mechanisms of Latham and Mason and of Workman and Reynolds. The results suggest that particle interaction should play an important role in the subsequent distribution of charges on particles and the final electrical configuration of a cloud. It is concluded that a combination of charging mechanisms including the rearrangement of charge resulting from particle interactions and convective motions are necessary to explain the observed charged particle distributions and electrical behabior of thunderstorm clouds.

The electrification of frost deposits and snowstorms

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It has been shown that growing pellets of soft hail become charged at a rate sufficient to account for the generation of electricity in thunderstorms. This electrification was shown to be explicable in terms of a quantitative theory of charge transfer associated with temperature-gradients in ice.

It appeared possible that this temperature-gradient effect may be responsible for other electrical phenomena involving ice which occur in the atmosphere. Analysis shows that all recorded observations on the electrification of both frost deposits (or snowflakes) exposed to gentle air streams and of snowstorms are explicable quantitatively in terms of the temperature-gradient theory; however, experiments had to be performed to see if there were quantitative agreement. They are summarized below.

Frost deposit experiments. Air currents were alloved to flow past frost deposits, and the charge acquired by the deposit and by small ice splinters torn off it was measured as a function of the temperatures of the air-stream and the deposit, the air-speed and the number and size of the ejected splinters, all of which could be independently varied. The measured electrification was found to be explicable both qualitatively and quantitatively in terms of the temperature-gradient theory.

Snowstorm experiments. Snowstorms were simulated in the laboratory by allowing snow-filled air to blow over a snow surface. Measurements were made of the charge acquired by the snow surface, the blown particles and by the air as a function of the temperatures of the snow and the air, the type of snow and of the air-speed, all of which could be independently varied. Again, the measured electrification was found to be explicable entirely in terms of the temperature-gradient theory.

Survey to the problem thunderstorm activity-atmospheric electric field

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The hypotesis that the thunderstorm activity of the whole world is the main source of the atmospheric electric field is generally accepted, but there are many difficulties in demonstrating this coherency for the instantaneous values. In recent times many attempts have been made to measure the worldwide thunderstorm activity by spherics. An attempst of measuring the thunderstorm activity of the american tropical area in Germany following the earlier experiments of Israel is described. The number of spherics arriving out of the corresponding direction and exceeding a certain fieldstrength will be counted and the conditions of propagation will be eliminated by measurement of V. L. F. attenuation of the path from Panama to Germany. The problems of this measurements are discussed and some results of the last two years are presented.

A PHOTOELECTRIC INVESTIGATION OF THE INTENSITY DISTRIBUTION IN THE OPTICAL SPECTRUM OF LIGHTNING

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Theories on the radiation from lightning during the high current phase should be checked against an observed distribution of intensity as a function of wavelength particularly in respect to the continuous spectrum produced. When a wide range of wavelengths is considered, photographic observations are difficult to interpret quantitatively. Photoelectric measurements at narrow wavelength bands passed by appropriate interference filters are more readily compared, but the strictly limited view over the spectral range is a disadvantage. However, spectral features most likely to give the desired information can be chosen on the basis of what has already been learned from photographs. The method is limited by the feasibility of an arbitrary number of photocell-filter units and their corresponding channels on a recorder.

During the summer of 1963 an array of photocells with appropriate filters will be mounted at the Lightning Observatory of the University of Arizona in Tucson, and recordings of the relative intensities of the selected spectral regions will be made. Time resolution will be adequate to separate the strokes in a flash. Results and conclusions obtained up to the time of presenting the paper will be reported.

PROPAGATION AND NATURE OF THUNDER

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In the vicinity of the lightning channel, the thunder propagates much faster than the ordinary sound wave as a presure or shock wave. The propagation velocity is the highest at the channel site, diminishes rapidly as it proceeds and finally slows down to the ordinary sound velocity. The range of this extraordinary propagation is a function of the explosion energy of a stroke which produces each shock wave front, and is estimated to be of the order of 300 meters for a representative stroke of a multiple cloud-to-ground flash. Since both the range and the velocity of individual wave fronts produced by a number of discharge elements involved in a flash, diverge very widely, disorder of the wave fronts occurs while they are propagating. This propagation behavior will account for the complexity of thunder waveforms recorded for close storms.

Leader and junction processes in the lightning discharge as a source of VLF atmospherics

H. R. Arnold and E. T. Pierce

Stanford Research Institute, Menlo Park, California

Both source and atmospheric observations are considered in a dual approach.

The amplitude spectrum, at 100 km, of the signal radiated by a single pulse in a stepped leader, is deduced from close observations by giving the current variation in the pulse. Fourier methods enable the spectrum corresponding to the characteristic train of several leader pulses to be obtained. This is compared with results extrapolated back from atmospherics observations. Agreement is reasonably good.

An amplitude distribution, relative to a return stroke signal, for the K pulses accompanying processes within a cloud, is established. Amplitude spectra at 100 km are calculate for individual K pulses and for several such pulses, using plausible forms of current variations. A comparison with extrapolated atmospheric results is made. Agreement is fair.

A comparison of the average spectra at 100 km for a return stroke, a series of K pulses, and a train of leader pulses, shows that the spectral peaks lie respectively at 5, 8, and 20 kc; the respective amplitudes at the peaks are approximately in the radio of 10 : 2 : 1. There is strong evidence that observations of atmospherics using triggering methods are biassed towards the more intense disturbances.

The return-stroke of the lightning flash to earth as a source of VLF atmospherics

A. S. Dennis and E. T. Pierce

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The dual approach of considering source and atmospherics observations is made.

The field radiated during the current surge at the source is derived by a new method. The effects of changing such parameters as rate of current rise, speed of channel development, and so on, are indicated. Mean amplitude spectra at 100 km are deduced for the first and subsequent strokes in the discharge carrying negative electricity to earth, and for a positive stroke. The radiated amplitudes follow a log-normal distribution with a standard deviation of about 8 db.

Mean amplitude spectra at 100 km are also deduced by extrapolation back, making allowances for propagation, of atmospherics observations. The average spectrum for a group of atmospherics obeys a simple normalized relation involving the frequency of maximum amplitudes; this changes between groups over the range of 4 to 7 kc. The amplitudes, both on a broad-band and a single frequency basis, are long-normally distributed with standard deviations of some 7 db.

Comparisons of the results derived by the two approaches show excellent agreement. However, it is found that the spectral shape varies extensively between individual atmospherics, a variation largely masked by averaging.

THE APLICATION OF FACY-FORCES TO ATMOSPHERIC IONS

H. Israël and H. Dolezalek

The «micro-diffusion» occurring during the processes of condensation and evaporation of atmospheric water vapor exerts, according to the theory of L. Facy a force upon aerosol particles in the atmosphere, directed towards the condensation nuclei during condensation, and away from the droplets during evaporation (FACY - Effect). It is assumed that forces of this kind will be exerted also on atmospheric small ions, which will be moved towards the condensation nuclei and water droplets may have or will acquire electric charges, the outcome is different from that of the original FACY - Effect. In particular, a colletion of ions may occur, in a distinct area around the nucleus, which will not contribute to the electric conductivity of the atmosphere as long as the condensation process exists, but which will be free inmediately afterwards. This allows, in principle, the atmospheric electric detection of a certain state of the atmospheric condensation-evaporation processes. It is assumed that this phenomenon plays a role in the atmospheric electric fog effect.

THE REDUCTION FACTOR AT SHENANDOAH NATIONAL PARK

S. Gathman

U. S. Naval Research Laboratory

The necessity of using a weatherproof mounting for an unmanned, continuously operating electric field mill precludes an absolute value of the electric field without an accurate knowledge of the local «Reduction factor», R. The finite size of the weatherproof measuring apparatus distorts the electric field in its vicinity so that any attempt to determine the undistorted value, E_0, must depend on the relation:

$$E_0 \text{ (undistorted)} = R\,E \text{ (measured)}.$$

In order to investigate this reduction factor more thoroughly, two identical U.S. Naval Research Laboratory Model MVIII field mills made continuous simultaneous measurements of the undistorted and distorted fields. One instrument was installed in the usual, grounded, weatherproof mouting at a height of about one meter, while the other was mounted flush with the earth's surface in an open plain within 100 yards of the first. An analog recording of the ratio of undistorted to distorted fields was made and compared with the atmospheric space charge as measured with an Obolensky filter and a vibrating-reed electrometer. These data are analyzed for diurnal variation and compared to the Benndorf reduction factor:

$$R = K(1 + \bar{q})$$

where K is the geometric relief factor and $\bar{q}$ is a factor which depends on the average space charge.

Potential gradient and conductivity measurements in the free atmosphere over Poona and Hyderabad

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Meteorological Office, Poona - 5

Electrical potencial gradient and conductivity in the free atmosphere over Poona and Hyderabad have been measured on a number of days using techniques developed at Poona. The day-to-day and diurnal variations of potential gradient in the troposphere over the two stations are discussed and the differences observed are explained as arising from changes in the meteorological factors over the two stations.

The vertical distribution of potential gradient and conductivity in the stratosphere over Hyderabad has also been studied using special high-altitude balloons. Simultaneous profile measurements of radioactive aerosols and submicron particles in the stratosphere over Hyderabad using balloon borne air-filters, impactors and nuclei counters by Junge and his collaborators show interesting correlationships with the atmospheric electricity.

Measurement of effective relaxation times and the calibration of current measuring devices

R. V. Anderson

U. S. Naval Laboratory

The Wilson plate has long been used for the measurement of atmospheric current densities, while the use of a grounded horizontal wire had been proposed as an alternative technique for this measurement. The necessity of obtaining an accurate match between the antenna system and lumped circuit elements in the electrometer circuit has been generally conceded for many years; but accurate measurement of distributed parameters such as atmospheric relaxation time and antenna capacity has, at best, been difficult. In addition, the possible formation of an electrode layer at the antenna surface minimizes the validity of these parameters as they are commonly determined.

Analytic and experimental techniques are described which allow the measurement of the true effective atmospheric relaxation time and of the true effective capacity of a horizontal wire antenna. Data from the NRL Blue Ridge Station are presented which show the variations in relaxation time as determined in various ways.

STATISTICAL ANALYSIS OF ATMOSPHERIC ELECTRIC AND METEOROGICAL DATA

E. M. Trent

U. S. Naval Laboratory

The importance of basic knowledge concerning the interdependence of atmospheric electricity and meteorogical phenomena motivated the U.S. Naval Research Laboratory to place atmospheric electricity stations at a few selected locations to continuously record the earth's electric field and electrical conductivity. Locations were chosen where meteorological observations were made routinely on a 24-hour basis. Statistical analysis of the resulting data is presented to show correlation between the behaviour of atmospheric electric parameters and meteorological phenomena, fog in particular.

ATMOSPHERIC RADIO NOISE AT BYRD STATION ANTARCTICA

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Atmospheric radio noise received at Byrd Station, Antarctica, consists principally of noise generated by lightning flashes and similar phenomena in thunderstorm regions near the equator and propagated southward by ionospheric modes. Thus, the variations in received noise power are indicative of changes in the propagation properties of the ionospheric reflecting and absorbing layers.

In this paper, radio noise measured at Byrd Station during IGY and IGC on eight frequencies spaced between 0.051 and 20 Mc/s is analyzed. The average measured noise power is treated briefly to illustrate diurnal, seasonal, and frequency variations. These include, for example: the small diurnal range in summer relative to the other seasons because of perpetual daylight (D region absorption) at the receiving end of the propagation paths; the relatively higher wintertime noise level in the HF band (2.5 - 20 Mc/s) compared to summer;

and the decrease in noise power with increasing frequency. It is shown that changes in noise source location and strength, as well as in the propagation properties, contribute to the variations in noise power measured at Byrd.

An index is presented which permits selection of ionospheric absorption events using noise data. Previously reported PCA's based on VHF, fmin, and riometer observations (Bailey, Bookin, Besprozvannaya, and others) are detected by this method. Several individual PCA's are discussed to show hour-to-hour changes in noise power as well as changes in the noise amplitude probability distributions. It is shown that during southern hemisphere polar cap absorption events the noise power on 2.5, 5.0 and 10.0 Mc/s is decreased by as much as 25 db.

SPACE SCIENCE

THE ADIABATIC INVARIANTS OF THE MOVEMENTS OF ELECTRIC CHARGED PARTICLES IN THE EARTH'S MAGNETIC FIELD AND THE DYNAMICS OF PLASMA IN THE MAGNETOSPHERE

Prof. O. Lucke

The theory of C. Stoermer is extended for axialsymmetric magnetic fields. The validity of H. Alfvén's approximation and of other adiabatic invariants is examined, considering especially the role of collective interactions.

SHOCK WAVES IN THE PLASMA OF THE EARTH'S OUTER ATMOSPHERE

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Supposing the hydromagnetic interpretation a very simplified model of sudden disturbances in the geomagnetic field is discussed in terms of plasma shock waves. The shock wave is assumed to be caused by solar plasma clouds in the interplanetary plasma and influence by the interplanetary magnetic field. By interaction between shock wave and the boundary layer of the Earth's outer atmosphere under presence of the geomagnetic field some complicated effects are to be expected. This interaction is discussed in terms of hydromagnetic theory neglecting the internal structure of shock waves. First of all there is some rising of the geomagnetic field resulting in the observed sudden commencements. Further effects are fluctuations of the interface between Earth's atmosphere and interplanetary plasma and the excitement of a variety of hydromagnetic waves in the magnetosphere. The possible interpretation of these fluctuations in terms of geomagnetic pulsations is investigated.

About the behaviour of an energetic particle on the front of the hydromagnetic shock-wave

Shabansky

The problem of passing of an energetic particle through the front of hydromagnetic shock-wave propagation in the direction perpendicular to the magnetic field is considered. The Larmour radius of gyration particle in the magnetic fields is supposed to be much more than the width of the front of the shock-wave. The energetic particle moves some time with the front and after some periods of its rotation the particle penetrates in the region behind the front. It may be shown, that (1) magnetic moment of the particles is constant; (2) the guiding centre of particle rotation drifts in direction of propagation of the wave on the distance of about one Larmour radius (for the strong shock-wave) in the medium behind the front, (3) the guiding centre drifts along the front plane of the wave on the distance much more than the Larmour radius of gyrating particle.

On the disintegration influence of the Alfven wave in the exosphere upon the character of the short-period oscillations of the Earth electromagnetic field

A. V. Guijelmi

The Alfven wave is unstable against the disturbances which are the combination of Alfven and magneto-sound waves. As a results of the unsteadiness the Alfven wave energy passes into irregular pulsations and finally is dissipated. The unsteadiness grouth increment is proportional to the amplitude and inversely proportional to the wave period.

To calculate the distance at which the Alfven wave disintegration takes place at the spreading from the generation place to the Earth surface an approximate exosphere model is used. Correlations between the amplitude, period and distance at which this unsteadiness occurs are found. Some comparisons are made with the observational data of the Earth electro-magnetic field short-period oscillations.

PECULIARITIES OF THE MAGNETO-IONOSPHERE DISTURBANCES IN TRANSITIONAL ZONE

E. I. Glushkova

The zone of latitudes which is located on the border of the auroral zone and middle latitudes is usually called a transitional zone.

The main characteristics of this zone is that usually ionosphere phenomena are of middle latitude nature. During the intensive magnetic storms the phenomena characteristic of the auroral zone are observed.

According to the peculiarities of the magneto-ionosphere disturbances the limits of the transitional zone are determined.

In the East hemisphere the upper limit goes in latitude near the 62° North parallel and the lower in latitude near the 55° North parallel. In the West hemisphere the upper limit goes in latitude near 42° North and the lower in latitude near 35° North parallel. According to the magnetic activity the zone can be shifted from the North to the South.

According to E. V. Gorchakov paper (Artificial satellites, issue 9, 1961) the outer radiation zone leans upon the latitude zone situated between 55° and 65° of the geomagnetic latitude, i. e. that is approximately over the transitional zone. Therefore, some peculiarities of the magneto-ionosphere disturbance in the transtional zone can be explained by the particles motion in the outer radiation zone.

ON THE STABILITY OF THE BOUNDARY OF THE GEOMATNETIC FIELD

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The stability of the boundary of the geomagnetic field in a steady solar wind is investigated in accordance with the classical model of Chapman and Ferraro. If the wave length and amplitude are sufficiently small that curvature and second-order effects can be disregarded, all perturbations, except those having wave fronts alined with the direction of the local magnetic field, are found to diminish with time while drifting along the boundary in the direction of the tangential component of the solar wind. Since alined waves are neutrally stable in this approximation, they are studied further by inclusion of curvature and higher-order effects. It is found that curvature introduces a stabilizing effect everywhere except in small regions immediately downwind from the neutral points. Inclusion of higher-order effects discloses the possibility of a mechanism involving multiple collisions that appears capable of injection of widely separated elongated columns of solar wind plasma into the magnetosphere. Geophysical consequences, such as the persistent magnetic agitation of the polar regions, of the results are discussed.

THEORETICAL DETERMINATION OF THE MAGNETOSPHERE BOUNDARY AND THE ENCLOSED GEOMAGNETIC FIELD

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The coordinates of the complete boundary of the magnetosphere and of the field lines of the associated distorted geomagnetic field are calculated according to the approximate formulation of the steady-state Chapman-Ferraro problem given by Davis and Beard (Journal of Geophysical Research, 67, 4505-4507, 1962). Various orientations of the dipole axis and the solar wind direction are considered in order to assess seasonal and diurnal effects. At the equinox the neutral points, to which all field lines in the boundary converge, lie in the noon meridian plane at about 19 degrees colatitude. Field lines from the neutral points remain in the noon meridian plane and intersect the earth at about 6ı degrees colatitude. As the solstice approaches, the neutral point and the terrestrial point to which it is connected move farther from the polar axis in the winter hemisphere and closer to the polar axis in the summer hemisphere. Except in the vicinity of the neutral points, seasonal and diurnal effects upon the shape of the boundary are small. It is found that the effect of the boundary is to compress the lines of force of the geomagnetic field on the nighttime side as well as on the daytime side.

GEOMAGNETIC FIELD DISTORTION FROM CURRENTS IN THE MAGNETOSPHERE BOUNDARY

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Theoretical solutions have been obtained for the three-dimensional shape of the boundary between the magnetosphere and an external solar wind. These solutions include the effect of a static (thermal) pressure of the solar wind as well as the pressure of its mass motion. Electric currents flowing in this outer boundary of the magnetosphere produce both static and dynamic distortions of the internal geomagnetic field. The static distortions are discussed, and their effects on the magnitude of the geomagnetic field, the length of geomagnetic field lines, and the location of conjugate points on the earth's surface.

The magnetic effects of currents at the boundary between the geomagnetic field and the solar wind

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Using a method described previously, we have obtained a selfconsistent, three-dimensional solution giving the shape of the magnetopause, i. e., the boundary between the solar wind and the earth's magnetic field, on both the daytime and nighttime side. This problem has been formulated mathematically by Beard and Davis and Beard. The surface currents which flow along the boundary increase the magnetic field inside the surface and everywhere cancel the earth's field outside the surface.

In this paper we present results of calculations giving the modified field at all points within the magnetosphere. The exact shape of the modified field lines are shown. The diurnal effects of the earth's rotation under a relatively fixed magnetopause are calculated. And the effects of a sudden increase in the solar wind, as is observed during a sudden commencement, is calculated as a function of latitude, longitude, and height above the earth's surface.

Solar wind modulation of the geomagnetic field as observed at the earth's surface

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The earth's magnetic field at times changes its level rather suddenly and returns to the original level with similar abruptness one or two hours late. A selection of such level changes of the magnetic field that occurred in 1958 is examined with the world-wide IGY magnetic records. In low and moderate latitudes these changes are characterized by a level change in the horizontal force H as might be expected from a sudden compression or rarefaction of the magnetosphere by an abrupt change in the solar wind pressure; cases of both positive and negative H level changes are examined. In these latitudes, changes in declination D are found to be small. Changes in H are augmented under the equatorial electrojet. At auroral latitudes the variations are often larger and much more complex than at lower latitudes. Variations in D become comparable with, or even larger, than those in H, and the field changes are not aligned in the direction of the magnetic meridian as in lower latitudes. In high latitudes the variations involved are often not indicative of a mere level change, but bear characteristics similar to those of magnetic storm sudden commencements; namely, the magnetic perturbation is elliptically polarized, suggesting that the impulse produced by an abrupt pressure change in solar wind are transmitted from the magnetosphere to high latitudes along the magnetic field lines. The distortion of the earth's magnetic field by the solar wind adds complexity to the level change in high latitudes.

* National Academy of Sciences - NASA. Post-Doctoral Resident Research Associate.

PROTON FLARES AND THE GEOMETRY OF THE INTERPLANETARY MAGNETIC FIELD

A. S. Dvoryashin

Solar, ionospheric and geomagnetic data and the data on solar radio outbursts have been examined for 1957-1961. The flares producing P.C.A. («proton flares») have been identified.

It is assumed that interplanetary magnetic field was produced by means of carrying of general magnetic field of the Sun and the local magnetic field of active regions by corpuscular radiation of the Sun. It is supposed that corpuscular radiation in principal consists of the following components:

a) «Solar wind» responsible for the magnetic disturbances in polar caps ($n \sim 5$-10 protons/cm^3, $v \sim 300$-500 km/sec) which is the constant component of the solar corpuscular radiation.

b) Corpuscular streams responsable for the magnetic disturbances in high, middle and low latitudes (magnetic storms with gradual commencement) is the intensification of solar wind over the active region ($n \sim$ up to 10^2 protons/cm^3, $v \sim 300$-500 km/sec).

c) According to a) and b) the interplanetary space has a plasma density $n \sim 5$-10 protons/cm^3 ($n \sim$ up to 10^2 prot/cm^3 in streams). This plasma flows from the Sun with the velocity $v \sim 300$-500 km/sec. As far as the disturbance from solar flare propagates across the interplanetary space with the velocity $v \sim 1000$-2000 km/sec we may suggest that a disturbance represents the shock wave. This shock front is responsible for the SC magnetic storms.

d) Plasma clouds ejected during the solar flares arrive at the Earth after shock front. Plasma cloud drows out a loop of magnetic lines of force and produces magnetic «bottle». In time the geometry of the field tends to that of corpuscular streams responsible for magnetic storms with the gradual commencement and for the 27^d variations of galactic cosmic rays. It is clear that the passage of the shock front modifies the average picture of the magnetic field and the plasma streams in the interplanetary space.

e) High energy component of the corpuscular radiation of the Sun (protons with the energy $\sim$ 10-100 Mev) produces P.C.A.

About the structure Sa, the position of the magnetosphere neutral points and the spectrum of the solar corpuscular radiation

V. M. Mishin

1. Geomagnetic latitude of the sun-earth line Φ_s: a) reaches its external values at 16,6 h. and 4,6 h. G.M.T. b) varies in counterphase during the seasons V-VIII and XI-II.

The variations Φ_s are stipulated by the diurnal earth magnetic axis rotation.

The diurnal variation of the magnetic activity contains the component S″, well described by a simple wave. The component S″ is characterized in the following way: a) The function S″ (T) arrives to its extremes at 16,6 h. and 4,6 h. G.M.T. b) These extremes are opposite for the seasons V-VIII and XI-II.

2. Let us assume, that the trajectory of the agents causing the magnetic storm coincides with the line of force of the geomagnetic dipole near the magnetosphere which thouches the magnetosphere near the point S (neutral point). Its geomagnetic latitude Φ_s and the earth surface crossing latitude Φ_m are connected

$$\cos^2 \Phi_m = \frac{R_\oplus}{R_s} \cos^2 \Phi_s$$

hence Φ_m and Φ_s arrive to extremes simultaneously.

It is easy to be convinced, that $S''(T) \sim \cos^2 \Phi_m (T)$.

Therefore the extremes Φ_s come at 16.6 and 4.6 h. G. M. T. Hence the neutral point S lies near the line Earth-Sun.

3. The amplitudes S″ (T) must depend upon the energy of the conforming agents and consequently upon the geomagnetic latitude of the point of observation and the 11-year cycle phase. The experiment confirms this supposition: the amplitudes S″ (T) are growing towards the pole and change during the 11-year cycle. Consequently, the amplitudes of the function S″ (T) characterize the energetical (latitudinal) spectrum of the agents, causing magnetic disturbances.

There is a curve $N(\Phi_m)$ obtained from these considerations, where N - is the spectral density.

Trapped particle distribution within the earth's magnetosphere

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The dynamic processes of the earth's magnetosphere determine, and are thus reflected by, the spacial and spectral distributions of the energetic charged particles trapped in the magnetosphere. For example, Axford and Hines have suggested that a gross convective motion of the magnetospheric plasma toward the sun may explain certain asymmetries in the aurora-producing particles. More recently the author has shown that daily «rotation» of the magnetosphere within the elongated cavity which it carves out of the solar wind affects, drastically, the energies and drift paths of particles in the energy range below a few tens of kilovolts.

This paper presents theoretical spectral and spacial distributions of energetic electrons and protons within a «rotating» magnetosphere, compares these with recent particle measurements by the satellites Explorer 12 and Explorer 14, and sets forth some conclusions regarding magnetospheric motions which can be inferred from the comparisons.

On the origin of the earth's radiation belts

I. P. Ivanenko and V. P. Shabansky

The origin of the Earth's radiation belts is studied. An acceleration mechanism of the particles in the outer radiation belt is presented. The particles may be accelerated by some shockwaves propagating through the Earth's magnetosphere. The width of the wave front may be about the radius of gyration of particles of plasma in geomagnetic field, i. e. much less than the free path length of the particles. Protons which may be accelerated by the hydromagnetic waves have energies about 1 eV, electrons, about 10^3 eV. So one can imagine any other mechanism for electron's acceleration to the energies 10^3 eV. Energetic particles are effectively drifted in the dens shifts of the atmosphere by hydromagnetic waves generated by the solar wind. This mechanism gives an upper limit of energies of particles in the outer radiation belt.

Geomagnetic belts of the earth and solar corpucular radiation

M. S. Bobrov

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Since 1958 we have been studying systematically geomagnetic disturbances of solar corpuscular origin. The purpose of the research is to obtain information on the various types of the solar corpuscular radiation and its interaction with the magnetosphere of the Earth.

The examination of the planetary pattern of the IGY geomagnetic disturbances for more than 60 days with Kp ranging from 0o to 9o reveals the following facts:

The features of the irregular part (D_i) of a magnetic disturbance depend strongly on the geomagnetic latitude Φ. There are three qualitatively different types of D_i: the symphase (S) type in low and moderate latitudes, the local (L) type in higher latitudes including the outer auroral zones, and the permanent (P) type on the polar caps.

Other features were investigated and from them the following interpretation may be infered:

The stability of the boundaries of the geomagnetic belts with respect to the level of the magnetic activity shows that the position of the belts is first of all due to the geometry of the magnetic lines of force frozen into the magnetosphere.

The cause of the permanent disturbances on quiet days is likely the solar wind. One may suggest that the solar plasma easily penetrates the magnetosphere through points with zero pressure of magnetic field. The interpretation is supported by the fact of the winter minimum of the P-activity on quiet days.

The inhomogeneous structure of the symphase disturbances is very likely a reflection of the inhomogeneous (cloud) structure of the corpuscular streams from chromospheric flares.

On the theory of radiation belts of the Earth

B. A. Tverskoy

It is supposed that electron component of the radiation, belts consists of two groups of particles. The first group is the electrons, having energy of 100 keV - 1 MeV. The electrons of the second group have energy of 10 keV. It is shown that neutron decay hypothesis and Coulomb collissions theory allow to interpret the latitudinal and altitudinal distribution of intensity of the first group. During the investigation of diffusion of such electrons at the small altitudes it is necessary to take into account albedo of a very dense atmosphere layers and the longitudinal drift.

The second group is generated by the statistical acceleration and Coulomb collisions. The energy spectrum and altitudinal distribution of the intensity strongly depends on the spectrum of hydromagnetic waves. The most general properties of the altitudinal distribution are «stepped» form at the oxygen atmosphere and the maximum at 1500-2000 km.

THE EFFECT OF SUNSPOTS ON THE PREDICTION OF GEOMAGNETIC ACTIVITY

F. Ward and N. Macdonald

Air Force Cambridge Research Laboratories

Equations have been developed by statistical regression procedures for the prediction of the geomagnetic activity index, C_i, for periods 1, 2, 7, and 27 days in advance. A substantial fraction of the variability of C_i (as much as 30 % for one day prediction) can be explained by properly weighted past values of C_i itself. The selected past values containing the effects of persistence and the single and double recurrence tendency of C_i. When the one day prediction equation

$$C_i(1) = .1988 + .559\, C_{i(o)} - .134\, C_{i(-1)} + .102\, C_{i-(-25)} + \\ + .101\, C_{i(-261)} + .065\, C_{i(-53)}$$

was applied to an independent time sample, all of the linearly predictable internal componets of C_i were removed.

A large number of sunspot parameters have been used in the search for additional useful external predictions. These parameters consist of the daily values of

(1) The area of sunspot groups (A).

(2) The distance of these groups from the center point of the sun (D_{CP}).

(3) The distance from the east limb (at the equator) and the west limb (at the equator) of all groups D_{EL} and D_{WL} respectively.

(4) The daily change of the total area covered by all spots (Δ A).

(5) The complexity of the magnetic fields of the spot groups (Mt. Wilson classification).

The internal predictors, shown to be useful in our earlier study, were screened along with a total of 143 possible external predictors generated from simple and compound combinations of basic sets of sunspot parameters.

For periods of one, two, and twenty-seven days in advance, the internal predictors were consistently more effective in explaining the variability of C_i than any of the combinations of the solar parameters. However, a small contribution was found (especially for 7-day forecasts) from some of the more complex combinations of the basic set of solar parameters. The physical interpretation of these useful external predictors is discussed.

INTER-RELATIONSHIP AMONG GEOMAGNETIC DISTURBANCES, AURORAL DISPLAYS AND ANOMALOUS IONIZATION IN THE IONOSPHERE IN THE POLAR REGIONS

T. Oguti, E. Kaneda and T. Nagata

Geophysical Institute, University of Tokyo

The inter-relation among geomagnetic disturbances, auroral displays and anomalous ionization in the ionosphere were examined systematically on the data obtained at Syowa Station, Little America, Point Barrow and College. The numerical relation among the magnitude of horizontal disturbance vector of geomagnetic bay disturbance (H), auroral zenith luminosity (J) and increase in the ionospheric electron density in the E region (n) at Syowa is found as follows:

$$J/(\Delta H)^2 \text{ — } 3 \times 10^{-3} \text{ KR}/\gamma^2 \quad (1)$$
$$J/n^2 \text{ — } 5 \times 10^{-3} \text{ KR/(electrons/cm}^3)^2 \quad (2)$$
$$H/n \text{ — } 4 \times 10^{-4} \ \gamma\text{/electrons/cm}^3 \quad (3)$$

The relation (3) was shown to be supported theoretically, provided an electric field in the ionosphere of the order of 104 emu.

J/H values obtained at Point Barrow, and College are nearly the same with that obtained at Syowa such as

$$J/(\Delta H)^2 \text{ — } 5.6 \times 10^{-3} \text{ KR}/\gamma^2 \text{ at College} \quad (4)$$
$$\text{ — } 3.2 \times 10^{-3} \text{ KR}/\gamma^2 \text{ at Point Barrow} \quad (5)$$

The value obtained at Little America, however, is one order less than those above as

$$J/(\Delta H)^2 \text{ — } 4.0 \times 10^{-4} \text{ KR}/\gamma^2 \quad (6)$$

This difference is suggested being due to the situation of Sy, PB and Co in the auroral zone while that of LA in the polar cap, and consequently due to the fact that the electromotive force and the mode of the equivalent current system are different with each other.

As to the relationship between CNA and bay disturbance, from the data obtained at College is found that the CNA intensity at night is roughly proportional to the magnitude of coincident bay disturbance such as

$$H/A \text{ — } 280\text{-}50 \ \gamma\text{/db} \quad (7)$$

This relation is rewritten with relation (3) as

$$n/A \text{ — } 7 \times 10^{-5} \text{ electrons/cm}^3\text{/db} \quad (8)$$

which reveals itself to be one order larger than the theoretical estimation provided energy spectrum of primary electron as E^{-5} in the energy range from 10 kev to 400 kev.

The occurrence pattern of these disturbance phenomena is also discussed briefly. The correspondence of disturbance patterns in the morning and in the evening with proton precipitation zone, both the electron and the proton from their respective trapped orbits, are presumably concluded.

THE CATALOGUE OF STRENGTHS AND POLARITIES OF MAGNETIC FIELDS OF SUNSPOTS FOR THE PERIOD OF INTERNATIONAL GEOPHYSICAL YEAR

V. E. Stepanov, E. F. Shaposhnikova and N. N. Petrova

The Catalogue contains the strengths and polarities of magnetic fields of the sunspots observed during IGY by six observatories: Mount-Wilson observatory, Potsdam observatory, Crimean astrophysical observatory, General Astronomical observatory (Pulkovo), Mountain solar station of Kislovodsk and IZMIR. Ac. Sc. of USSR. The source of errors inherent to different methodes which are used at the observatories are investigated.

The building of systeme of the Catalogue is described; it is made in two approximations: 1) with the equal weights and 2) with the calculation of the weight of the observations of each observatory.

The stability of the systeme of observations of each observatory is examined. The mean accuracy of the Catalogue is $\pm$ 100 gauss.

THE MOTION OF THE GAS AND MAGNETIC FIELD IN THE SUNSPOT

G. W. Kuklin and V. E. Stepanov

For the investigation of the motion of gas maps of the radial velocities and magnetic fields were used both of the longitudinal and of the transversal components obtained with the magnetograph and with the radial velocity recorder at the Crimenan Astrophysical Observatory for the sunspot observed 1-8.IX.1962 ($\Phi = 12°$ $L = 85°$).

It is determined that the mass of gas in the leader of the sunspot group rotated to the right vertical direction, rising at initial period of observation and falling at end of the period. The comparison of the fine penumbral structure on the photoheliogrammes with the direction of the magnetic force lines in the frontal plane indicates that the magnetic field is frozen in gas.

The application of the method of the decomposition of velocity vector to the four components permits to determine the velocities of the magnetic field and the stream along the magnetic force lines. On the 6th of September the magnetic field in the sunspot was falling, expanding and rotating with the velocities about 1 km/sec. The average velocity of motion of the gas outwards along the magnetic fields is 0.5 km/sec.

The solar flares and their forecast

A. B. Severny, E. F. Shaposhnikova, N. V. Steshenko, S. I. Gopasjuk and M. B. Ogir

The examination of magnetic fields of cosmic ray flares and some other flares appearing during IGY-ICY has been completed at Crimean Astrophysical Observatory. The magnetic fields before and after flares determined visually and photographically in groups of sunspots were analysed. These determination were carried out during IGY on regular programme at different observatories (with complete amount of 3-4 observations for a day). For 1959-1962 were used the observations of the Crimean Observatory (twice or more on the day).

The well pronounced changes of configurations of the magnetic field and sunspots when comparing them before and after a flare were found. Namely, in most of cases we found that the magnetic polarities of the opposite sense are approached a little and the 3-dipole on the same sense is pushed out. This is most pronounced in flares generating cosmic rays recorded with the aid of balloons. It was found that the importance of a flare (and its duration) is in strong dependence with the gradient of magnetic field near its neutral point. There were no flare of importance 3 and 3+ with the gradient < 0.1 gs/km as well as there were no flares of importance ≤ 2 with gradient exceeding this value. For the cosmic ray flares the mean gradient is 0.73 gs/km. The bigest change of the gradient is observed for flares with cosmic ray effect on balloons and flares producing PCA, this change is proportional to the duration of the flare.

Using these results and basing on the detailed measurements of magnetic fields in groups of sunspots we have carried out some experimental forecast of flares and their importance in 1961-1962 (147 cases). During that period 800 flares of different importance were observed. The comparison of the forecast importances of the flares with the observed importances during 1962 (102 forecast) shows, that the forecast for nearest two days was found correct in 75.5 % of cases, overtaken in 12.7 % of cases, in 11.8 % of cases forecasts of the importances were below the observed importances.

On the nature of the 11-year cycle of solar activity

M. N. Gnevyshev

The results of measurements of the 5303 A coronal line intensity made at the Kislovodsk, Pic-du-Midi, Mt. Norikura, Climax and Pic Sacramento solar stations have been compared. The results of Kislovodsk and Pic-du-Midi are very similar as regards absolute values and variations. This indicates that the photometric systems of both these stations are identical and stable and that the data obtained are very probably close to the true values. The data of the other stations can be reduced to those of Kislovodsk and Pic-du-Midi by means of linear relations.

It is shown that the intensity of the corona and the appearance of prominences and sunspots in the present 11-year cycle had two maxima: one during 1956-1957 and the second during 1959-1960. The first maximum is characterizid by an emission intensity increase at all latitudes from the equator to the pole with a maximum at $\varphi = 25°$. During the second maximum there was an intensity increase only in the equatorial zone with a maximum at $\varphi = 10\text{-}15°$. Both maxima are similar as regards to the amount of energy emitted by the corona and prominences. At both maxima the spot formation activity attained maximal development one year before maximum coronal emission.

Maximal coronal emission was observed during the periods of greatest decrease of spot formation activity. Arguments are given in favor of the possibility of application of the above conclusions to all the previous solar cycles.

THE TERRESTRIAL ACCRETION OF LUNAR MATERIAL

D. E. Gault

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The bombardment of the moon by cometary and asteroidal debris provides a mechanism for injecting lunar material into cislunar and interplanetary space. A conservative estimate for the mass ejected from the gravitational field of the moon is 10^6 to 10^7 grams per day based on results of laboratory studies of hyper-velocity impact in rocks and sands and using minimum rates for the flux of interplanetary debris. The estimated mass loss is equivalent to the erosion of the lunar surface at a rate of one to ten grams/cm^2/10^9 years.

Analysis of moon-earth trajectories indicates that most of the mass lost from the moon is placed into either highly elliptic geocentric orbits or approximately circular heliocentric orbits. Material ejected from the moon's gravitational field, therefore, should contribute to a geocentric concentration of lunar particles which eventually are swept up by earth (and by the moon). Even if all the mass lost by the moon is acquired by earth, the contribution of the lunar material to the rate of terrestrial accretion would appear to be negligibly small. Higher rates for the accretion of lunar particles would be expected after periods of increased meteor activity. Evidence of such an increase was recorded by the artificial earth satellite Vanguard III during the Leonid shower of 1959.

PART IV

RESOLUTIONS

IUGG RESOLUTIONS

ENGLISH TEXT

The following Resolutions were passed by the IAGA and were later approved by the IUGG as Union Resolutions at the XIII General Assembly in Berkeley, California, 1963: (Resolution numbers refer to official IUGG numbers.)

RESOLUTION No. 18

The IUGG, calling attention to the fact that the World Magnetic Survey (WMS) is now being coordinated by the WMS Board of IAGA, urges all nations to participate in the WMS and to contribute observations in accordance with the various technical recommendations of IAGA as set forth in IUGG Monograph No. 11, «Instruction Manual for the WMS.»

RESOLUTION No. 19

The IUGG notes with satisfaction the proposed Canadian-Swedish-Norwegian-Danish-Finish-Icelandic cooperative plan for a detailed three-component aeromagnetic survey over Greenland, Iceland, the Norwegian Sea, Baltic Sea, Sweden, Norway, Denmark, and Finland, with flight lines spaced 35 km apart and flown at an altitude of 300 m, and highly endorses this planned program as an important contribution to the WMS.

RESOLUTION No. 20

The IUGG recommends that the possibility be investigated of securing observations from aeromagnetic surveys made for geophysical prospecting purposes, particularly in regions where a vector or absolute aeromagnetic survey is available as a reference, and considers that the detailed maps are not needed but only a sufficient number of observations useful to the WMS project, for example, observations spaced approximately 20 km apart.

Resolution No. 21

The IUGG notes with satisfaction the work done by a number of countries conducting aeromagnetic measurements that contribute to the World Magnetic Survey, and recommends that efforts be made to extend greatly the coverage thus far obtained, over oceanic areas adjacent to the various countries as well as over the central portion of the oceanic basins, using, for example, longer range aircraft than currently employed.

Resolution No. 22

The IUGG reaffirms the description given in IUGG Monograph No. 11, «Instruction Manual for the World Magnetic Survey», of the WMS data to be supplied, but wishes to stress the importance of supplying observed data and recommends that any derived values supplied be identified as such.

Resolution No. 23

The IUGG endorses the recommendation of the CIG-IQSY Committee:

«It is recommended that one special feature of the IQSY contribution to the land ocean survey of the WMS should be provision of magnetic survey measurements at repeat stations through their re-occupation during the IQSY or at least within the 5 year period prior to the ending of the IQSY», and

urges (a) the intensification of repeat station surveys during the IQSY, in accordance with previous IAGA technical recommendations for repetat station observations and (b) the listing of the kinds of repeat stations and the values secured during previous reoccupations useful to the WMS.

Resolution No. 24

The IUGG recommends that repeat station data from 1950 be supplied to the World Data Centers as a contribution to the WMS, recognizes that earlier repeat station data may be supplied in addition if they are of sufficient accuracy to permit reduction to epoch 1965 with reliability commensurate with the standards set by IAGA for the WMS, and considers that survey charts earlier than 1950 may be useful in the historical sequence leading to the WMS charts 1965.0.

Resolution No. 25

The IUGG recognizes that the present time delay of one year or more in transmitting the magnetic variometer data to the World Data Centers presents serious difficulty in the rapid evaluation of the magnetic records, and recommends that the National Committees advise their observatories to transmit copies of magnetograms together with provisional base line and scale values to the World Data Centers as soon as possible after observation in accordance with the resolution made by the IQSY Committee.

Resolution No. 26

The IUGG considering the observatory, repeat station and survey data now in the World Data Centers and available to the World Magnetic Survey project, and recognizing that, in spite of the extensive program initiated during the IGY and subsequently carried forward under the auspices of SCAR, there are still significant gaps in magnetic coverage of the Antarctic continent and adjacent seas, and particularly of the southern Pacific, Atlantic and Indian Oceans, calls to the attention of SCAR:

(a) the desirability of urging the various national participants in the scientific program in the Antartic to undertake in so far as possible extensive magnetic survey work in the Antarctic,

(b) The valuable contributions to the WMS that are now being made by many expeditionary vessels through the use of towed total-field magnetometers and the desirability of increasing this work by the participation of even more countries so that coverage over the southern oceans can be extended, and recommends that this last point be communicated to SCOR, for referral to the Inter-Governmental Oceanographic Commission with particular regard to urging all countries participating in the International Indian Ocean Expedition to add towed magnetometers to their ship programs in the Indian Ocean.

Resolution No. 27

The IUGG recommends that measurements of the total magnetic force for the WMS from satellites below 1000 km altitude be conducted in such a manner that the absolute accuracy of measurement at each point is within 10 gammas without application of corrections for instrument drifts or satellite generated fields, and that the date and universal time of each measurement be specified to permit removal of time variations in the final analysis of survey measurements, and recommends particularly:

(a) that magnetometers of the nuclear or atomic resonance type be used,

(b) that the latitude, longitude, and altitude coordinates of each measurement be known and specified to an accuracy of 1000 m in the horizontal plane and 250 m in the vertical direction, and

(c) that the magnetic field of the satellite be such that its contribution to the field at the magetometer sensor be small and consistent with the absolute accuracy specified above.

Resolution No. 28

The IUGG, considering the importance of better understading of the distribution in time of the onset of magnetic storms at the Earth's surface, and noting that the IAGA has chosen a preliminary network of stations having equipment with necessary precision and time control covering as far as possible all the regions of the Earth (8 in polar regions, 7 in middle latitudes and 4 in equatorial regions) and noting further the need to fill the gaps still existing in this preliminary network of stations with the necessary equipment:

(a) invites the collaboration of Reykjavik Observatory,

(b) recommends the installation of a permanent station in the region of Great Whale, Canda, and

(c) would appreciate the installation of quickrun equipment at Trelew, Zaria and Addis Ababa.

Resolution No. 29

The IUGG, considering the difficulties for Sq-studies in the Southern Hemisphere, recommends to the National Committees responsible for magnetic observations on islands of middle and tropical latitudes in the Atlantic, Pacific and Indian Oceans, the installation or reactivation of magnetic observatories in these regions, at least during the IQSY period.

Resolution No. 30

The IUGG notes with concern the breaks in the activities of the magnetic station at La Karavia (Elizabethville), which is of such a great importance in the African network of magnetic stations, and wishes that all possible effort be made in order that this observatory can resume its regular operation.

TEXTE FRANÇAIS

Les résolutions suivantes ont été présentées par l'Association Internationale de Géomagnétisme et d'Aéronomie (AIGA) et ont été ensuite approuvées par l'UGGI lors de sa XIII^e Assemblée Générale à Berkeley, Californie, USA.

RÉSOLUTION n.° 18

L'UGGI, considérant le fait que le levé magnétique mondial est actuellement coordonné par le Conseil du Levé Magnétique Mondial de l'AIGA, recommande à toutes les nations de participer au levé magnétique mondial et de présenter leurs observations conformément aux différentes recommandations techniques de l'AIGA, telles qu'elles sont énoncées dans la monographie n.° 11 de l'UGGI «Manuel d'Opérations pour le levé magnétique mondial».

RÉSOLUTION n.° 19

L'UGGI note avec satisfaction le plan de coopération Canadien-Suédois-Norvégien-Danois-Finnnois-Islandais pour un levé aéromagnétique, portant sur trois composantes du champ, au-dessus du Groenland, de l'Islande, de la Mer de Norvège, de la Baltique, de la Norvège, de la Suède, du Danemark et de la Finlande ,avec espacement de 35 km des lignes de vols effectués à une altitude de 3000 m et approuve vivement ce programme comme une importante contribution au levé magnétique mondial.

RÉSOLUTION n.° 20

L'UGGI recommande que l'on envisage la possibilité d'obtenir des observations des levés aériens effectués dans des buts de prospection, particulièrement pour les régions où le levé aéromagnétique a comporté des mesures du vecteur champ ou de la valeur absolue de l'intensité et considère que des cartes détaillées ne sont pas indispensables, mais seulement un nombre d'observations suffisant pour le levé magnétique mondial; par exemple, avec un espacement de 20 km.

Résolution n.º 21

L'UGGI note avec satisfaction le travail par un nombre de pays effectuant des levés aéromagnétiques, qui contribuent au levé magnétique mondial et recommande que des efforts soient faits pour étendre la couverture ainsi obtenue aux régions océaniques voisines de ces différents pays et aussi aux parties centrales des bassins océaniques en utilisant, par exemple, des avions de plus grand rayon d'action que ceux couramment employés.

Résolution n.º 22

L'UGGI rappelle la description des données à fournir pour le levé magnétique mondial, telle qu'elle est énoncée dans la Monographie n.º 11 de l'UGGI «Manuel d'Opérations pour le levé magnétique mondial», mais désire souligner l'importance de fournir des données d'observation et recommande que les données calculées soient identifiées comme telles.

Résolution n.º 23

L'UGGI approuve la recommandation du Comité CIG-IQSY: «Il est recommandé qu'une part spéciale de la contribution de l'IQSY au levé continental et océanique du levé magnétique mondial soit la production de mesures magnétiques effectuées aus stations de répétion pendant les Années Internationales du Soleil Calme ou au moins au cours des cinq années précédant la fin de l'IQSY», et recommande (a) d'intensifier les levés aux stations de répétition pendant l'IQSY, effectués conformément aux anciennes recommandations techniques de l'AIGA relatives aux observations aux stations de répétition et (b) de dresser la liste des types de stations de répétition et des valeurs obtenues au cours de ré-occupations antérieures présentant un intérêt pour le levé magnétique mondial.

Résolution n.º 24

L'UGGI recommande que les données des stations de répétition se rapportant à la période postérieure à 1950 soient envoyées aux Centres Mondiaux des Données à titre de contribution au levé magnétique mondial; reconnaît que les données antérieures de telles stations peuvent en outre être envoyées si leur précision est suffisante pour permettre une réduction à l'époque 1965,0 en respectant les prescriptions définies par l'AIGA pour le levé magnétique mondial et considère que les cartes de levés antérieurs à 1950 présentent un intérêt historique dans la suite des cartes aboutissant à celles du levé magnétique mondial 1965,0.

RÉSOLUTION n.° 25

L'UGGI *reconnait* que le délai actuel d'une année ou plus pour la transmission des données des variomètres magnétiques aux Centres Mondiaux des Données entraîne de sérieuses difficultés dans l'utilisation rapide des enregistrements magnétiques et
recommande que les Comités nationaux prient leurs observatoires de transmettre les copies de magnétogrammes, avec leur ligne de base et leur valeur d'échelle provisoire, aux Centres Mondiaux des Données aussi vite que possible après les observations, suivant la résolution adoptée par la Comité des Années du Soleil Calme (IQSY).

RÉSOLUTION n.° 26

L'UGGI, considérant les données des observatoires, des stations de répétition et des levés magnétiques, actuellement disponibles dans les Centres Mondiaux des Données pour le levé magnétique mondial, et reconnaissant qu'en dépit du vaste programme entrepris pendant l'AGI et continué ensuite sous les auspices du SCAR, il existe encore d'importantes lacunes dans le réseau magnétique du continent antarctique et des mers voisines, et en particulier des régions australes des Océans Pacifique, Atlantique et Indien, attire l'attention du SCAR:

a) sur l'avantage de recommander aux différentes nations participant au programme scientifique antarctique d'entreprendre un levé magnétique aussi vaste que possible dans l'Antarctique;

b) sur les contributions précieuses apportées au levé magnétique mondial par de nombreuses expéditions maritimes utilisant des magnétomètres remorqués pour la mesure du champ total, et sur l'avantage d'accroître ce programme par la participation d'un nombre plus élevé de pays de manière à étendre le levé des mers australes, et recommande que ce dernier point soit communiqué au SCOR pour en référer à la Commission Océanographique Intergouvernementale, avec attention particulière à la recommandation adressée à tous les pays participant à l'Expédition Internationale de l'Océan Indien, de compléter le programme de leurs bateaux croisant dans l'Océan Indien par l'addition de magnétomètres remorqués.

RÉSOLUTION n.° 27

L'UGGI recommande que les mesures de l'intensité totale du champ magnétique effectuées dans le cadre du levé magnétique mondial à l'aide de satellites placés à moins de 1000 km d'altitude soient conçues de manière que la précision absolue de la mesure en tout point soit supérieure à 10γ, sans l'application de corrections dues à la dérive de l'appareil ou aux champs engendrés par le satellite, et que la date et le temps universel de chaque mesure soit spécifié afin de permettre l'élimination des variations au cours du temps lors de l'analyse finale des mesures du levé et recommande en particulier:

a) que des magnétomètres à résonance nucléaire ou atomique soient utilisés;

b) que la latitude, la longitude et l'altitude de chaque mesure soit connue et donnée avec une précision de 1000 m dans le plan horizontal et 250 m dans la direction verticale, et

c) que le champ magnétique du satellite soit tel que son influence sur l'élément sensible du magnétomètre soit faible et compatible avec la précision absolue définie ci-dessus.

Résolution n.° 28

L'UGGI, considérant l'importance d'obtenir une meilleure connaissance de la distribution dans le temps du commencement des orages magnétiques à la surface du globe, notant que l'AIGA a choisi un réseau préliminaire d'observatoires dûment équipés en ce qui concerne la précision requise et le contrôle du temps et couvrant autant que possible toutes les régions du Globe (régions polaires: 8; latitudes moyennes: 7 et régions équatoriales: 4), notant d'autre part la nécessité de combler les lacunes qui existent encore dans ce réseau préliminaire

a) invite l'Observatoire de Reykjavik à apporter sa collaboration,

b) recommande l'installation d'une station temporaire dans la région de la Great Whale Bay, Canada,

c) souhaite l'installation d'appareils à enregistrement rapide à Trelew, Zaria et Addis Ababa.

Résolution n.° 29

L'UGGI considérant la difficulté des études du Sq dans l'hémisphère Sud, recommande aux Comités Nationaux dont dépendent les observatoires magnétiques aux latitudes moyennes et tropicales dans les Océans Atlantique, Pacifique et Indien, l'installation ou la remise en service d'observatoires magnétiques dans ces régions, au moins pendant la période du Soleil Calme (IQSY).

Résolution n.° 30

L'UGGI déplore les interruptions du fonctionnement de la station magnétique de La Karavia (Elizabethville), si importante dans le réseau des observatoires africains, et souhaite que toute disposition soit prise pour la remise en marcha régulière de l'Observatoire.

IAGA RESOLUTIONS

ENGLISH TEXT

The following Resolutions were approved by the IAGA at the XIII General Assembly of IUGG held at Berleley, California, U.S.A. August 1963.

Resolution No. 1

The IAGA requests its Executive Committee to appoint a committee to study and discuss with other bodies within the framework of the ICSU the most appropriate and suitable organnzation of the broad and rapidly developing field of solar and terrestrial physics.

Resolution No. 2

The IAGA recommends that magnetic observatories mark on their magnetograms, and indicate in their publications the time at which artificial magnetic distrubances or other spurious effects are recorded.

Resolution No. 3

The IAGA recommends that observatories already measuring K-indices separately for three magnetic elements send tables of these data to the Permanent Service of Geomagnetic Indices at De Bilt. The publication of daily ranges may be discontinued.

Resolution No. 4

The IAGA recommends:

a) that from the lst of January 1964, the Z-component will not be used for the measure of the three-hourly K-index, except by the standard Kp-observatories, and

b) that for new observatories, the lower limit for K=9 should be chosen in consultation with the working group on magnetic activity indices of Commission No. 4.

Resolution No. 5

The IAGA notes that for some observatories in geomagnetic latitudes higher than about 65°, an additional index will be available, namely an hourly R-index, indicating the absolute hourly range in each horizontal component expressed in tens of gamma. A circular concerning these data will be distributed soon to observatories wishing to take part in such a tentative scheme which is to start on January lst, 1964.

Resolution No. 6

The IAGA recommends that extensive research on electromagnetic induction within the earth's interior in as many areas as possible be encouraged in connection with the Upper Mantle Project (UMP).

Resolution No. 7

The IAGA recommends with particular reference to the Upper Mantle Project:

a) that in view of the present ambiguity in separating ocean water effects from those produced by deep structures, magnetic observations and recordings at continental margins as well as at sea be encouraged,

b) that magnetic and magneto-telluric measurements be encouraged in the most recently active tectonic zones, and in particular work on Tertiary rifts, be undertaken by responsible workers in this field, and

c) that an attempt be made to correlate determinations of deep electric conductivity with the results of heat flow measurements.

Resolution No. 8

The IAGA recommends that well coordinated palaeomagnetic researches should be encouraged in connection with the Upper Mantle Project.

Resolution No. 9

The IAGA recommends that all observatories use Nuclear Magnetometers for the measurement of absolute total intensity and components where possible.

Resolution No. 10

The IAGA recommends that observatories finding corrections in their standard of intensity (for instance, when taking up nuclear magnetometer measurements) publish full information for the benefit of the users of the data.

Resolution No. 11

The IAGA recommends that all recording stations provide complete calibration data for the records and instruments including curves for sensitivity and phase angles when those parameters vary with frequencies of oscillation.

Resolution No. 12

The IAGA recognizes that for the studies of the secular variations, magnetic storms, Sq, and other geomagnetic variations the determination of Dst is of great importance and that in space research and in the studies of the relatinships between geomagnetic variations and other geophysical phenomena, data giving the Dst variation are frequently required. The IAGA, therefore, recommends the publication of the hourly values and a graphical representation of the equatorial Dst variation on a regular basis with shortest possible delay from the time of observation and invites the cooperation of interested organizations.

Resolution No. 13

On account of experimental knowledge obtained since the IGY, the IAGA recognizes the need of improving the present classification of pulsations. Pulsations fall into two main classes: those of a regular, and mainly continuous character, and those with an irregular pattern.

The first class, for which the name pc is retained, covers the whole range of pulsations (0.2-600 sec). This class is provisionally divided into five sub-groups:

pc 1:	0.2	to	5	sec
pc 2:	5	to	10	sec
pc 3:	10	to	45	sec
pc 4:	45	to	150	sec
pc 5:	150	to	600	sec

The second class of pulsations is characterized by their irregular form, their close connection with disturbances of the magnetic field and their correlation with upper atmospheric phenomena. This class provisionally is divided into two sub-groups covering different frequency ranges:

pi 1: 1 to 40 sec
pi 2: (primarily pt) 40 to 150 sec

Observatories making such analyses are strongly urged to take into account the classification given above, which will be circulated with more details by the working group on Morphology of Rapid Variations of Commission No. 4.

Resolution No. 14

The IAGA Commission on History of Geomagnetism and Aeronomy recognizes that a complete history of effort and progress will contribute to the further development of the sciences of geomagnetism and aeronomy and encourages the writing of adequate histories of different aspects or disciplines in geomagnetism and aeronomy.

TEXTE FRANÇAIS

Les résolutions suivantes ont été approuvées par L'AIGA lors de la XIII Assemblée Générale à Berkeley, California, USA, August 1963.

Résolution n.° 1

L'Association de Géomegnétisme et Aéronomie prie son Comité Exécutif de constituer un Comité pour étudier et discuter avec d'autres groupes dépendant du Conseil International des Unions Scientifiques, l'organisation la mieux adaptée au vaste domaine d'étude, en continuelle expansion, que constitue la physique hélioterrestre.

Résolution n.° 2

L'AIGA recommande aux observatoires magnétiques de noter sur leurs magnétogrammes, et d'indiquer dans leurs publications, les moments où des perturbations magnétiques artificielles ou tout autre phénomène parasite ont été enregistrés.

Résolution n.° 3

L'AIGA recommande que les observatoires, qui mesurent déjà les indices K séparément pour chaque composante magnétique, adressent leurs tableaux de résultats au Service permanent des indices adressent leurs tableaux de résultats au Service permanent des indices magnétiques à De Bilt. La publication des amplitudes de variation journalière peut être suspendue.

Résolution n.° 4

L'AIGA recommande que

(a) à partir du 1er. janvier 1964, la composante Z ne soit plus utilisée pour la détermination de l''indice trihoraire K, excepté pour les observatoires participant à l'élaboration de l'indice Kp, et

(b) pour les nouveaux observatoires, la limite inférieure pour K = 9 soit choisie après consultation du groupe de travail sur les indices d'activité magnétique de sa Commission Núm. 4.

Résolution n.° 5

L'AIGA note que pour certains observatoires de latitude géomagnétique supérieure à environ 65°, un indice supplémentaire sera établi: à savoir un indice horaire R donnant l''amplitude horaire absolue de chaque composante horizontale, exprimée en dizaines de gammas. Une circulaire relative à cet indice sera bientôt envoyée aux observatoires désirant prendre part à cet essai qui doit commencer le 1er. janvier 1964.

Résolution n.° 6

L'AIGA recommande que des recherches approfondies sur l'induction électromagnétique à l'intérieur du Globe, s'étendant sur le plus grand nombre possible de régions, soient encouragées, en relation avec le projet du Manteau Supérieur (UMP).

Résolution n.° 7

L'AIGA, considérant en particulier le Projet du Manteau Supérieur, recommande:

(a) qu'en raison de la difficulté rencontrée à séparer les effets produits par les eaux océaniques de ceux qui sont dus à la structure profonde, des mesures et des enregistrement magnétiques soient encouragés tant sur les bordures continentales que sur les océans,

(b) que des mesures magnétiques et magnéto-telluriques soient encouragées dans les zones d'activité tectonique récente, et, en particulier, que des travaux sur les «rifts» tertiaires soient entrepris par les chercheurs compétents, et

(c) que des essais soient faits pour confronter les déterminations de conductibilité électrique en profondeur avec les résultats des mesures de flux thermique.

RÉSOLUTION n.° 8

L'AIGA recommande que des recherches paléomagnétiques bien coordonnées soient encouragées en liaison avec le Projet du Manteau Supérieur.

RÉSOLUTION n.° 9

L'AIGA recommande à tous les observatoires magnétiques, d'utiliser des magnétomètres nucléaires pour leurs mesures absolues de l'intensité totale et, si possible, des composantes.

RÉSOLUTION n.° 10

L'AIGA recommande aux observatoires qui trouvent des corrections dans leurs étalons d'intensité (par exemple quand ils adoptent des mesures par magnétomètres nucléaires) de publier des informations complètes à ce sujet, à l'intention des utilisateurs de leurs données.

RÉSOLUTION n.° 11

L'AIGA recommande que toutes les stations fournissent des données complètes sur les étalonnages de leurs enregistrments et de leurs appareils, y compris les graphiques donnant les sensibilités et angles de phase quand ces paramètres varient avec la fréquence des oscillations.

RÉSOLUTION n.° 12

L'AIGA reconnait que, pour les études relatives aux variations séculaires, aux orages magnétiques, au Sq et autres variations géomagnétiques, la détermination du D_{st} est très importante, et que dans les recherches spatiales et les études des relations entre les variations magnétiques et les autres phénomènes géophysiques, les données sur la variation du D_{st} sont souvent demandées.

L'AIGA recommande donc la publication régulière et aussi rapide que possible des valeurs horaires et d''une représentation graphique de la variation D_{st} équatoriale et elle invite les organismes intéressés à y coopérer.

RÉSOLUTION n.° 13

Par suite de la connaissance des faits expérimentaux acquise depuis l'AGI, l'AIGA reconnait la nécessité d'améliorer la classification actuelle des pulsations. Les pulsations sont divisées en deux groupes principaux: les pulsations de caractère régulier et en général continues, et celles d'allure irrégulière.

Le premier groupe pour lequel on retient le nom de pc couvre tout le spectre des périodes 0,2-600 secondes et il se divis provisoirement en cinq sous-groupes:

pc 1:	0,2	à	5	sec
pc 2:	5	à	10	sec
pc 3:	10	à	45	sec
pc 4:	45	à	150	sec
pc 5:	150	à	600	sec

Les pulsations du second groupe sont caractérisées par leur forme irrégulière, leur relation étroite avec les perturbations du champ magnétique et leur corrélation avec des phénomènes de la haute atmosphère. Elles se subdivisent provisoirement en deux sous-groupes couvrant différents intervalles de fréquences:

pi 1:	1	à	40	sec
pi 2: (primitivement pt)	40	à	150	sec

Les observatoires faisant de telles analyses sont instamment priés de se conformer à cette classification qui sera diffusée avec plus de détails par le groupe de travail sur la Morphologie des variations rapides de la Commission Num. 4.

RÉSOLUTION n.° 14

La commission de l'AIGA sur l'Histoire du Géomagnétisme et de l'Aéronomie reconnaît que l'histoire complète des efforts et des progrès réalisés doit contribuer au développement futur des Sciences du Géomagnétisme et de l'Aéronomie et elle encourage la rédaction d'histoires adéquates des différents sujets ou disciplines du géomagnétisme et de l'aéronomie.

IAGA - IAMAP RESOLUTIONS

The following Resolutions which originated in the IAGA-IAMAP Joint Committee on Lunar Effects were favorably considered by both of the parent Associations at the XIII General Assembly held at Berkeley, California, 1963:

Resolution No. 1

The Joint Committee

a) *noting* Professor Chapman's intention to devote himself again to lunar tidal studies, and

b) *recognizing* that the moon's tidal action (mainly but not entirely semi-diurnal) slightly perturbs the Earth's atmosphere —a dynamical system whose distribution and motions are complex, changing, and not fully known, affecting not only such meteorological variables as pressure, wind and temperature, but also geomagnetic, ionospheric and cosmic ray variables,

c) *considers* that these various phenomena deserve enchanced study, and that such study would produce valuable and interesting results, especially because the field of lunar tidal acceleration acting on the atmosphere is completely known, and simpler in its operation than the similarly large scale solar actions upon the atmosphere,

d) *considers* that a theoretical and computational study of the dynamical aspects of the lunar atmospheric tide, and comparison with the observed meteorological effects, would add to our factual knowledge of the properties of the atmosphere,

e) *recommends* such a dynamical study, and also, for comparison with theoretical and computed predictions of lunar tidal meteorological effects, a comprehensive effort to improve our observational knowledge of them by use of all suitable existing series of meteorological data,

f) likewise *recommends* that the associated lunar geophysical effects be comprehensively studied by means of all suitable existing series of geomagnetic, ionospheric, earth-current and cosmic ray data, according to a systematic plan determined after careful examination of the most appropriate methods and tools of computation,

g) further *recommends* global studies of these lunar geophysical variations, including the determination of the ionospheric electric current system that is associated with the lunar daily geomagnetic and earth-current variations.

Resolution No. 2

The Joint Committee recommends that any type of studies on lunar effects in geophysical phenomena should be supplemented by adequate statistical analyses preferably performed by means of fine subdivision of available material into a sufficient number of groups.

Resolution No. 3

The Joint Committee *recognizing* the need for comprehensive studies of lunar geophysical effects in a global scale, and the necessity of a more complete and more homogeneous coverage of the Earth's surface, *recommends* that every effort should be made to extend lunar studies of geophysical effects to a greater number of middle and higher latitude stations in the Southern Hemisphere.

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Following a CIG recommendation, there were created at the Paris meeting of the IAGA Executive Committee, IAGA-IQSY committees as advisory groups to help IQSY Reporters with their work. The present membership of these committees follows:

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Corrections to IAGA - Bulletin No. 39, page 95 - 102

Revised aa-indices, 1969 - 1975

In the course of the year 1977, a clear deterioration of the standard of the K scalings used in the derivation of aa index appeared. For instance the activity level for June 1977 was twice greater in the Northern hemisphere than in the Southern hemisphere. Furthermore Dr. Siebert drew Dr. Mayaud's attention to a possible shift of the aa-index with respect to the am-index during preceding years. After enquiring, it was decided to rescale the years 1969 - 1977 at both the antipodal observatories. Accordingly, the aa-values as published in IAGA-Bulletin No. 39 (1969 - 1975) and in IAGA-Bulletin No. 32g (1976) had to be revised. Also, the aa-values for 1977 published in IAGA-Bulletin No. 32h differ from those distributed in the monthly bulletins of the International Service of Geomagnetic Indices or in the Journal of Geophysical Research. The revised aa-indices for the years 1969 - 1975 are published in this supplement to the IAGA-Bulletin No. 39 and sent to recipients of that Bulletin. Those for 1976 are included in IAGA-Bulletin No. 32h (Table 1a).

Steps have been taken in view of avoiding in the future any slow deterioration of the quality of the aa-indices. This will be done in a way similar to that described in the report on Km-observatory visits to be published in the next issue of the IAGA-Bulletin No. 32.

Note: The table of aa for the year 1968 is reprinted for completeness only. Small differences in the mean values are caused by a change in procedure for the computation of these mean values.

	JAN.				FEB.				MAR.			
	N	S		M	N	S		M	N	S		M
1	36	32	39	29	18	14	12	20	18	20	18	20
2	42	69	57	55	33	32	26	39	21	23	21	24
3	16	11	18	10	26	27	26	28	27	28	15	41
4	16	9	9	16QKK	23	30	42	11	34	25	22	38
5	19	22	12	29	19	14	9	24 K	28	29	28	29
6	37	21	26	32	6	2	5	3QCK	17	11	12	16
7	18	12	19	11	10	6	3	14QCK	10	10	10	10QCK
8	13	11	11	12QKC	29	28	29	29	11	6	8	10QCC
9	5	7	4	8QCK	28	30	29	29	10	5	7	8QCK
10	10	16	17	10QCC	60	56	25.	91	25	24	22	27
11	26	21	8	40	60	81	84	58	16	13	20	10
12	28	26	21	33	23	19	24	18	18	13	13	19 K
13	20	13	21	13	28	28	22	34	10	7	11	6QC
14	24	14	16	23	10	13	11	12QC	45	28	27	47
15	21	16	10	27	51	37	28	60	47	37	39	45
16	24	23	14	34	24	27	21	30	42	29	28	43
17	25	25	24	27	41	23	20	44	23	16	22	18
18	20	21	27	14	42	38	33	47	19	15	19	16
19	26	22	16	33	21	11	26	5	20	22	25	17
20	24	25	30	19	50	70	70	50	35	26	35	26
21	13	15	17	12	45	30	38	37	16	11	13	14
22	16	24	17	24	16	13	19	11	12	8	11	9QCC
23	23	14	14	23	10	5	5	11 CC	21	15	7	29
24	23	17	13	28	12	7	12	8 CC	43	34	31	46
25	11	8	9	11QC	10	5	6	9QCC	35	39	38	36
26	25	30	13	43	10	4	4	9QCC	26	24	23	28
27	20	18	18	21	21	13	9	26	26	24	24	26
28	34	17	16	36	51	45	21	75	26	19	23	23
29	27	17	21	24	29	24	33	21	25	22	19	28
30	23	16	24	16					48	44	43	50
31	15	27	30	12					32	30	20	43
	22.0	20.1	21.1		27.8	25.2	26.5		25.3	21.1	23.3	

	APR.				MAY				JUNE			
	N	S		M	N	S		M	N	S		M
1	45	34	38	41	21	22	9	35	31	20	16	36
2	25	23	22	27	24	22	33	13	38	21	25	34
3	24	19	23	21	21	12	22	11	36	22	24	34
4	16	13	18	12	12	6	11	7QCC	18	15	15	18
5	50	40	9	81	8	4	6	7QCC	16	5	9	13QCC
6	54	57	65	47	8	5	5	8QC	12	7	7	12QCC
7	16	21	24	13	66	76	82	61	18	21	16	23
8	6	6	8	4QCC	15	8	13	10 C	29	12	14	29
9	5	4	3	6QCC	36	31	30	38	22	11	16	17
10	18	10	11	17 K	21	12	15	18	50	46	50	47
11	22	15	17	21	30	24	31	24	119	83	123	79
12	22	15	12	26	45	27	47	26	48	47	50	46
13	42	27	29	40	29	19	27	22	50	44	48	46
14	40	43	41	42	25	15	23	18	38	37	37	39
15	23	25	19	29	20	12	18	14	20	9	11	18
16	29	20	24	26	21	18	19	20	27	18	12	34
17	26	20	20	26	29	22	11	41	30	30	46	14
18	18	17	20	16	36	17	13	40	24	18	16	28
19	5	5	7	4QCC	26	18	12	33	28	30	29	29
20	5	4	5	4QCC	36	33	39	30	14	7	10	11 C
21	10	7	7	11QCC	42	27	23	46	9	4	5	8QCK
22	20	17	19	19	32	17	29	21	25	21	23	23
23	24	21	27	19	26	14	13	27	19	13	19	13
24	21	8	18	13 K	31	20	29	22	5	2	3	4QCC
25	15	9	5	19 K	14	8	8	14 CK	12	4	4	12QCK
26	42	29	21	50	8	3	6	5QCC	30	17	24	24
27	32	33	39	27	10	4	5	9QCC	24	19	18	25
28	26	29	36	19	19	5	9	15 CK	16	6	9	13 C
29	26	29	27	28	22	16	16	22	26	15	9	33
30	17	7	13	11 C	21	14	17	19	28	18	26	21
31					23	13	17	19				
	24.1	20.2	22.3		25.1	17.5	21.4		28.8	20.7	24.9	

	JULY				AUG.				SEP.			
	N	S		M	N	S		M	N	S		M
1	25	13	20	18	11	3	7	8QCC	20	12	20	12
2	25	18	24	19	9	4	6	8QCK	23	23	20	26
3	31	26	41	16	28	18	26	21	40	23	24	40
4	23	15	23	16	13	7	15	5 C	25	24	29	21
5	19	11	17	13	30	18	18	30	19	22	20	21
6	16	6	14	8 CK	36	22	36	23	34	32	25	41
7	18	11	17	13 K	24	24	29	20	32	30	23	39
8	13	9	12	10 CC	28	13	25	17	53	56	67	42
9	11	7	7	12QC	26	16	17	26	29	18	27	21
10	54	46	45	56	18	12	16	15	14	16	20	11
11	22	14	19	17	15	7	15	7 CC	9	6	12	3 CC
12	21	5	12	14 C	13	6	9	10 CC	33	30	13	50
13	37	21	11	48	25	10	5	30	62	42	47	58
14	38	28	39	27	47	34	41	39	45	45	45	46
15	21	10	16	15	38	37	39	36	52	39	43	48
16	22	15	13	25	64	59	39	84	21	16	23	15
17	16	7	9	14 C	50	54	55	50	12	8	13	8 CC
18	24	14	17	22	45	32	39	38	9	5	5	9QCK
19	19	13	13	19	19	17	22	14	18	18	27	10
20	15	4	12	7QCK	12	13	11	15 CC	13	10	14	10 KK
21	20	7	8	20	8	7	9	7 CC	21	18	17	22
22	34	24	32	27	12	7	5	14 CC	24	15	14	26
23	27	17	25	19	26	21	17	31	33	29	29	34
24	9	3	6	6QCK	40	32	46	26	9	4	4	9QCK
25	18	7	9	17 KK	10	2	4	9 CK	6	4	4	6QCC
26	32	17	21	29	8	7	7	9 CC	10	7	9	9QCC
27	25	18	29	14	11	5	10	6 CC	6	4	5	5QCC
28	18	9	10	18 K	7	5	7	6QCC	19	13	14	18 C
29	11	5	9	8QCC	5	3	3	5QCC	20	14	16	18
30	18	7	9	16 CC	6	2	3	5QCK	14	10	4	21 K
31	14	7	14	7QCC	27	31	21	38				
	22.4	13.3	18.0		23.0	17.0	20.1		24.1	19.8	22.0	

	OCT.				NOV.				DEC.			
	N	S		M	N	S		M	N	S		M
1	30	26	31	26	136	132	49	220	19	22	16	26
2	57	57	68	46	81	86	92	75	12	18	12	19
3	40	47	78	8	50	41	44	47	37	27	26	38
4	7	5	5	7 CC	42	47	49	41	43	38	35	46
5	6	7	8	5QCK	15	8	9	15 C	38	29	37	30
6	16	14	17	14	16	11	7	21	14	11	18	8 K
7	36	24	20	40	26	20	35	12	10	8	7	12QCK
8	15	11	12	14 C	18	20	11	28	18	25	23	21
9	19	11	11	19	42	51	53	40	17	14	12	19
10	9	6	11	4 CK	28	25	20	34	25	30	42	13
11	5	10	7	8QC	21	23	25	19	17	14	9	22
12	68	74	67	75	8	5	10	4QCK	14	18	21	11
13	47	34	46	34	14	10	10	14 CC	13	10	8	15 CC
14	29	21	24	27	8	9	6	11QCC	7	7	7	8QCC
15	11	9	10	11 C	5	10	11	4QCK	18	17	16	19
16	11	15	9	18 K	29	36	17	48	23	20	22	21
17	19	19	19	20	32	43	27	49	11	8	13	7QCK
18	15	14	21	8	34	30	41	24	16	15	13	18
19	33	20	12	42	13	14	19	9	24	31	28	26
20	15	12	19	9	26	39	27	39	8	7	11	5QC
21	5	5	7	4QCC	15	13	10	18	27	35	25	37
22	4	3	3	4QCC	13	9	8	14 C	28	20	25	24
23	7	7	4	10QCC	11	12	17	7 KC	29	27	18	40
24	15	15	8	23 K	11	12	6	16 KK	18	13	13	19
25	12	17	12	17	22	14	16	20	37	57	77	17
26	11	8	7	13 C	16	13	10	20	7	11	10	8QC
27	15	14	18	12 K	20	15	19	16	28	31	42	18
28	12	13	9	17 K	18	14	11	22	15	11	9	18 C
29	68	57	38	88	10	11	12	10QCK	22	17	11	29
30	27	27	19	35	6	4	2	7QCC	15	12	12	15 C
31	126	140	98	169					24	14	15	24
	25.5	24.0	24.8		26.3	25.8	26.2		20.5	19.9	20.3	

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	JAN.				FEB.				MAR.			
	N	S		M	N	S		M	N	S		M
1	17	19	18	19	6	10	8	8QCC	27	19	12	34
2	8	11	9	10 CC	88	75	8	155	18	15	22	11
3	4	6	4	5QCC	81	74	62	94	4	6	4	7QCC
4	5	13	7	11 CC	24	26	22	29	17	8	2	22QKK
5	4	7	8	4 CC	20	17	24	14	23	20	23	21
6	2	4	4	2QCK	26	24	39	12	36	29	25	40
7	15	26	15	27	22	23	20	25	36	30	24	43
8	16	19	18	17	24	15	22	18	26	25	29	23
9	9	12	13	9 CC	7	8	8	8QCC	27	19	17	30
10	6	7	6	8QCC	26	25	14	37	15	12	20	8Q
11	11	12	8	16 CK	81	86	61	106	36	43	21	56
12	11	23	18	15	20	12	11	22	50	48	67	32
13	4	9	8	6QCK	19	18	17	21	20	11	14	18
14	18	20	17	22	21	18	19	21	17	14	9	23
15	30	20	24	28	36	27	31	33	32	30	30	32
16	21	18	16	23	23	18	22	20	28	29	35	22
17	38	36	32	41	9	7	9	8QCK	64	56	58	62
18	41	44	46	39	4	4	2	5QCC	23	16	23	17
19	27	26	29	25	12	17	11	19 K	29	21	13	37
20	20	22	17	25	17	18	19	17	32	32	34	31
21	13	13	15	11 C	14	10	17	8 KK	21	21	23	19
22	7	7	8	6 CC	9	9	4	13QCC	19	26	22	22
23	10	12	5	17 KC	21	16	18	20	63	53	12	105
24	25	22	6	41	13	12	15	11 C	63	79	119	23
25	50	59	53	57	15	10	19	7 K	30	38	34	35
26	36	51	50	37	24	34	37	21	20	18	17	22
27	23	25	18	31	45	54	37	62	14	7	13	9QC
28	11	9	12	9 C	30	33	30	33	12	12	11	14QCC
29	6	6	7	5QCC					25	18	12	32
30	13	11	19	6 KK					29	22	21	30
31	15	12	11	18 K					33	21	22	32
	16.7	18.7	17.8		26.4	25.0	25.8		28.7	25.8	27.3	

	APR.				MAY.				JUNE			
	N	S		M	N	S		M	N	S		M
1	34	36	17	53	15	16	17	15	12	7	9	11 C
2	28	28	15	41	50	31	14	67	11	13	12	12 CC
3	30	21	23	29	24	32	29	27	18	7	11	15 CC
4	22	21	20	24	19	16	15	21	10	10	10	11 CC
5	20	21	22	19	23	21	18	26	14	7	13	8 CC
6	23	22	14	31	16	15	15	17	12	4	4	12QCC
7	36	24	32	28	11	10	17	4QKK	18	10	14	14
8	16	11	13	14 K	15	8	6	18 KK	32	17	26	24
9	22	24	15	32	28	14	19	24	26	17	13	31
10	14	18	12	20Q	22	15	20	18	22	13	20	15
11	12	16	17	11	11	6	9	8QCC	18	11	18	12
12	22	16	8	32	17	8	4	21 K	34	19	30	24
13	35	42	32	45	56	56	53	58	33	26	27	33
14	23	22	21	24	69	49	40	79	59	41	51	49
15	20	25	27	19	130	132	133	128	15	17	15	18
16	36	32	31	37	54	35	67	22	33	25	26	33
17	31	32	27	36	24	20	23	22	40	21	38	24
18	32	20	36	16	40	28	30	38	13	5	7	12QCK
19	12	7	7	12QCK	26	13	18	22	15	7	10	12 C
20	18	9	11	16	18	9	14	13 C	20	22	27	15
21	16	9	16	10QK	28	24	29	23	15	10	9	15 KK
22	21	21	27	15	24	18	18	25	6	4	6	4QCC
23	10	10	9	11QCK	24	14	16	23	12	10	10	13 CC
24	18	11	16	13	20	12	14	19	25	17	21	22
25	20	15	22	14	16	7	13	11 CK	23	13	10	26
26	14	10	9	16QC	10	7	10	7QCC	14	17	15	16
27	26	18	26	19	7	5	6	7QCC	14	10	10	14 CK
28	66	64	79	51	18	12	14	16 K	12	4	8	9QCC
29	23	24	16	31	11	8	7	12QCK	10	4	6	9QCC
30	48	34	43	40	24	19	17	26	10	6	6	11 C
31					26	22	19	29				
	24.9	22.1	23.6		28.2	22.1	25.2		19.9	13.2	16.7	

	JULY				AUG.				SEP.			
	N	S		M	N	S		M	N	S		M
1	40	30	35	35	6	8	8	6QCC	5	4	6	4QCC
2	12	11	18	5 K	15	4	4	15 CC	4	3	4	3QCC
3	7	4	4	8 CC	22	22	13	31	11	8	8	12 CC
4	6	3	4	4QCC	29	23	30	22	12	7	10	10 CC
5	7	4	5	6QCC	18	17	20	15	32	30	6	57
6	14	6	4	17 KC	14	6	14	6 CK	33	33	44	22
7	19	8	10	17 K	17	12	14	18 C	23	21	16	29
8	17	6	6	17 CK	22	14	15	22	29	30	43	16
9	17	12	14	15	23	16	22	18	21	26	15	32
10	15	12	8	19 KK	14	13	18	10 K	21	11	14	18
11	15	7	6	16 C	10	5	4	11QC	17	17	18	17
12	27	12	22	17	34	36	41	30	11	8	14	5 CC
13	27	21	26	23	15	15	18	13	5	5	5	5QCC
14	32	24	33	23	12	12	13	12 CC	22	18	7	34
15	11	9	11	9 C	15	6	5	16 CC	31	29	33	28
16	25	14	19	21	9	7	5	11 CK	15	14	18	11
17	10	7	8	10 CK	16	9	17	8 KK	24	25	13	36
18	8	9	5	12 CC	16	11	8	20 K	36	30	20	47
19	4	3	4	3QCC	25	24	18	31	17	10	18	10
20	10	6	8	9QCC	13	20	20	12	16	23	18	21
21	15	11	6	21 KK	16	10	11	16 CC	11	7	9	9 CK
22	22	14	13	23	12	6	5	13 C	8	6	10	4QCC
23	16	9	5	20 K	22	21	24	19	19	26	8	37
24	12	5	8	10 CK	15	15	15	16	11	12	15	9 C
25	8	4	6	6 CK	5	5	7	3QCK	22	19	23	19
26	45	30	20	56	27	24	24	28	7	9	10	6QCC
27	57	49	78	28	32	37	49	20	13	9	4	18 K
28	10	6	10	7 CK	15	9	11	13 CK	69	74	64	79
29	7	3	4	6QCC	9	7	7	10QCC	65	93	67	111
30	29	14	8	35	7	8	7	9QCC	85	105	133	57
31	19	7	13	13 C	12	8	11	9 CC				
	18.2	11.5	15.0		16.8	13.8	15.3		23.8	23.8	23.8	

	OCT.				NOV.				DEC.			
	N	S		M	N	S		M	N	S		M
1	36	32	34	34	5	3	3	5QCC	12	12	12	12 C
2	50	44	55	40	26	17	15	29	7	6	4	9 CC
3	33	29	27	35	27	25	22	31	10	8	3	15 KK
4	24	16	18	23	8	10	12	7 C	13	18	14	18
5	16	14	15	16	13	15	12	17 C	37	27	23	41
6	29	23	21	31	7	7	6	8QCK	33	25	31	28
7	12	12	15	9 C	23	20	19	25	13	10	10	13 C
8	9	10	8	12QCC	22	29	14	37	16	10	11	15 C
9	31	11	7	34	55	67	70	53	21	19	23	18
10	45	37	34	48	58	52	54	57	16	11	8	20 K
11	22	17	19	21	23	28	18	34	19	25	27	17
12	18	17	19	17	14	11	15	10 K	10	10	13	8 CC
13	10	10	12	8 KK	11	12	11	12 CC	6	6	6	7QCC
14	8	7	5	10QCC	5	4	5	4QCC	9	11	8	14 CC
15	7	6	7	6QCC	4	2	3	3QCC	13	12	11	14 C
16	15	10	4	21 KK	6	8	5	9 CC	25	27	29	24
17	13	7	7	14 K	6	7	5	9 CC	9	6	8	8 CK
18	11	13	15	10 C	10	15	11	15 CC	8	6	8	5 CC
19	21	26	29	19	13	13	7	20 KK	7	8	7	9 CC
20	10	5	6	9 CK	8	7	10	6 CC	7	7	7	8QCC
21	19	22	18	24	6	11	8	10QCK	5	5	6	4QCC
22	16	22	16	22	16	19	21	14 K	14	23	18	19
23	11	8	7	12 C	10	13	8	16 CC	26	23	17	33
24	24	29	32	21	19	14	11	23	17	17	20	15
25	13	11	14	10 K	14	18	13	19	18	22	20	21
26	8	12	11	10QCC	24	17	11	31	18	18	14	23
27	18	14	10	23	40	42	39	43	14	14	21	8
28	13	14	12	15	18	17	21	15	8	8	5	11 CC
29	8	5	8	6 CC	26	25	17	35	8	8	11	6 CC
30	3	3	4	2QCC	37	33	41	29	6	6	6	6QCC
31	9	14	12	12 CC					5	9	8	6QCC
	18.2	16.1	17.2		18.5	18.8	18.7		13.9	13.5	13.8	

ANNUAL MEAN N 21.18 S 18.69 M 20.03

	JAN.				FEB.				MAR.			
	N	S		M	N	S		M	N	S		M
1	18	19	11	27	16	13	12	18	31	42	46	27
2	43	44	39	48	32	25	23	34	22	21	27	16
3	22	16	26	12	15	14	22	7	35	25	18	43
4	7	8	6	10QCC	26	25	17	34	32	30	24	39
5	12	13	11	15 KK	19	12	17	15	27	30	21	36
6	10	14	14	12 KK	6	5	7	4 CC	46	41	41	46
7	10	11	6	16 KK	5	2	3	4QCC	54	48	32	70
8	13	12	7	19 K	5	5	4	7QCC	183	161	58	286
9	18	21	24	16	5	4	5	4 CC	63	57	54	66
10	14	6	14	6 KK	13	14	8	20 K	13	14	15	13
11	8	7	8	7QCC	6	9	9	5QCK	5	4	2	6 CC
12	15	13	13	15 C	8	6	5	9 CC	8	13	15	7 CK
13	12	15	12	16Q C	10	16	14	13 K	16	17	15	19 K
14	6	8	7	7 CC	21	18	25	14	6	4	7	4 CK
15	15	16	17	15	16	13	17	13 K	14	11	14	11 CC
16	32	27	23	38	9	10	9	10 CC	5	6	6	5QCC
17	18	10	20	8	20	20	11	29	10	11	6	15 CC
18	10	14	13	11 CC	18	15	17	17	12	14	12	15 KC
19	13	10	6	17 KK	9	7	10	7 CC	11	9	9	11 CC
20	17	17	12	23	5	7	5	7 CC	11	8	4	15 CC
21	11	15	12	15 K	5	5	5	5QCC	5	4	4	5QCC
22	12	8	11	9 CC	4	3	2	5QCC	4	6	7	4QCC
23	14	7	10	12 CC	7	7	4	11 CC	9	13	13	9 CC
24	16	11	14	13 CC	19	22	13	28	5	4	4	5QCC
25	5	4	5	5QCC	7	10	12	5 C	6	4	4	6QCC
26	5	4	4	5QCC	17	15	11	21 K	11	7	10	8 CK
27	12	12	13	12 CC	18	14	11	22	24	25	21	28
28	13	8	5	16 KK	24	25	21	29	34	33	36	32
29	11	20	20	12					28	32	22	38
30	19	36	20	35					32	28	29	32
31	14	11	17	9 K					70	76	81	65
	14.5	14.1	14.4		13.1	12.2	12.7		26.9	25.8	26.4	

	APR.				MAY				JUNE			
	N	S		M	N	S		M	N	S		M
1	10	8	9	9 K	22	18	14	26	41	34	38	38
2	13	13	10	16 C	19	14	18	16	23	24	27	20
3	19	23	25	17	25	14	11	29	23	17	18	23
4	16	18	22	12	16	10	14	12 C	22	16	15	23
5	21	17	17	22	20	18	15	23	11	8	13	6 CK
6	33	28	37	24	14	6	7	13 C	7	5	9	3QCC
7	17	20	29	8	17	9	12	14 CC	19	10	6	24
8	23	17	28	13	11	4	4	11QCC	23	26	35	15
9	26	23	23	27	8	4	5	8QCC	12	6	8	11 CC
10	10	4	5	9QC	2	2	2	2QCC	11	11	10	13 CC
11	13	12	17	9 CC	6	3	2	7QCK	13	7	5	15QKC
12	11	12	10	13 CC	31	25	21	36	14	7	10	12QCK
13	6	8	8	7QCC	18	7	14	11 C	18	18	14	22
14	7	4	6	5QCC	29	20	19	31	17	9	11	15 K
15	9	10	7	13QCK	20	12	24	9	25	26	26	25
16	27	15	19	24	14	11	9	16 C	23	13	19	18
17	43	32	39	36	25	20	32	13	24	22	15	31
18	28	35	24	40	12	9	15	6 CC	40	54	36	58
19	30	35	46	19	14	11	14	12 C	19	13	13	20
20	40	27	20	48	26	27	23	29	29	28	22	36
21	92	103	53	142	22	16	15	23	34	20	34	21
22	45	34	70	9	15	20	16	19	9	6	5	10QCK
23	25	25	20	31	15	10	8	17 C	8	4	4	7QCC
24	31	30	24	37	18	11	12	17	14	7	5	16 CC
25	28	32	34	26	15	16	23	9 K	15	10	12	13 C
26	23	16	14	26	5	4	3	6QCC	22	18	15	26
27	20	17	24	14	26	26	13	39	51	46	52	45
28	10	6	9	8QCC	56	52	51	56	18	12	20	10
29	17	9	9	18 C	29	17	31	15	11	7	6	12 CC
30	31	26	36	21	21	20	24	17	8	7	9	6 CC
31					12	9	9	13 C				
	24.2	21.9	23.1		18.8	14.3	16.6		20.1	16.4	18.3	

	JULY				AUG.				SEP.			
	N	S		M	N	S		M	N	S		M
1	24	20	18	27	8	8	9	8QC	32	38	34	36
2	19	22	30	12	14	10	16	8 CC	31	35	34	33
3	37	33	36	33	10	5	8	7QCC	22	25	15	33
4	41	41	73	9	11	8	5	14QCC	24	23	24	24
5	26	30	29	27	7	3	5	4QCC	19	17	13	24
6	29	22	36	16	18	10	10	18 C	12	9	5	16QCK
7	11	6	5	12QCK	35	15	13	37	14	10	7	18 KK
8	16	12	8	20	34	44	36	43	15	23	11	27
9	79	105	74	111	37	31	48	20	12	12	8	16QC
10	57	51	45	63	18	14	16	17	14	8	19	4 KK
11	23	17	19	22	19	15	16	19	4	4	3	5QCC
12	29	21	22	29	17	15	20	12	9	9	14	4QCK
13	24	12	18	18	13	14	9	19 C	37	35	26	46
14	23	16	18	22	11	2	5	8 CC	31	44	34	41
15	12	7	10	9QC	17	9	8	19 KK	19	18	23	15
16	17	15	17	15 K	33	18	10	41	15	17	19	13
17	20	13	6	28	144	110	164	89	14	17	18	14
18	12	6	9	9QCK	47	49	43	53	21	18	20	20
19	10	6	8	9QCC	26	19	24	21	31	33	30	34
20	16	8	7	18 K	7	8	8	7 CK	26	23	26	23
21	48	44	31	62	10	4	9	6 CC	31	30	28	33
22	22	15	18	20	14	12	6	20 KK	24	17	20	22
23	26	14	18	22	19	14	21	12	12	12	14	11 C
24	50	29	31	48	9	6	6	9QCC	16	11	15	12 CC
25	90	99	128	62	13	13	12	14 C	8	9	12	6 CC
26	27	28	36	20	28	36	29	35	14	13	14	14
27	30	24	22	33	21	22	16	27	38	30	29	39
28	9	4	6	8QC	25	25	14	36	14	10	17	8 K
29	52	71	72	52	19	14	22	12	10	13	12	12QK
30	18	10	12	16	9	6	11	5 CK	19	23	27	15
31	29	21	22	29	24	24	20	28				
	29.9	26.6	28.4		23.1	18.8	21.0		19.6	19.6	19.7	

	OCT.				NOV.				DEC.			
	N	S		M	N	S		M	N	S		M
1	20	16	14	23	4	4	4	4QCC	2	4	3	3QCC
2	21	13	16	18	8	17	11	14 CC	12	13	4	21 KK
3	30	20	19	32	21	17	14	25	7	10	11	7 CK
4	36	36	48	25	15	12	14	13 C	11	12	9	15 C
5	20	12	19	13	20	17	15	23	16	29	25	20
6	13	11	12	13 CC	20	27	25	22	11	24	20	16
7	8	5	6	8QCC	71	69	97	43	17	15	10	23
8	5	3	4	4QCC	15	11	16	11 C	25	30	36	19
9	4	4	4	4QCC	15	17	15	18	10	10	14	7 CK
10	16	15	10	21	30	30	27	33	7	10	8	10QCC
11	20	30	32	18	38	28	31	36	2	6	5	4QCC
12	23	25	41	8	16	19	20	16	7	7	7	9 CC
13	13	21	17	18	15	18	15	18	11	9	9	12 C
14	15	11	16	10 CK	16	14	15	16	62	105	111	56
15	7	7	8	6QCK	8	10	7	11QCC	23	18	26	15
16	45	54	23	77	12	17	10	20	6	8	8	7 CC
17	62	37	29	70	12	16	20	8	6	6	7	5QCC
18	52	41	64	29	31	37	12	56	6	7	2	10 KK
19	21	15	21	16	22	30	48	5	21	24	20	25
20	11	13	14	10 CC	7	8	7	8QC	13	21	25	10
21	5	4	3	6QCC	32	56	41	48	8	8	10	7 CC
22	24	37	18	53	28	34	36	26	10	12	10	13 CK
23	52	37	34	55	34	53	34	53	12	20	20	12
24	23	18	26	15	26	47	46	27	23	17	28	13
25	14	13	11	16 KK	27	17	18	28	11	13	9	17 CC
26	7	8	10	5 CK	21	12	10	24	8	9	10	8 CC
27	13	10	9	14 C	19	21	15	25	13	22	14	22
28	31	35	27	39	16	16	12	21	36	34	20	49
29	28	25	16	38	4	6	5	5QCK	26	26	17	36
30	16	14	22	9	3	6	4	4QCC	22	25	26	22
31	9	8	9	9 CC					7	11	9	9QC
	21.8	19.2	20.6		20.2	22.9	21.6		14.7	18.2	16.5	

ANNUAL MEAN N 20.58 S 19.17 M 19.95

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	JAN.				FEB.				MAR.			
	N	S	M		N	S	M		N	S	M	
1	14	12	15	11 C	28	35	36	27	9	9	11	7 CC
2	33	26	29	30	20	13	13	20	8	12	10	11 CC
3	68	52	48	72	7	9	10	7QCC	22	15	14	24
4	27	29	32	25	10	11	6	16QCC	26	24	31	20
5	19	18	17	21	9	7	11	5QCC	8	11	11	9 CK
6	10	11	12	9 CC	14	13	14	13 CC	10	5	6	10 CC
7	2	4	3	3QCC	14	13	16	12	9	8	8	10 C
8	2	3	3	2QCC	21	15	16	20	35	21	28	29
9	3	4	4	4QCC	19	29	25	23	14	15	20	10
10	10	13	8	16 KK	21	17	10	29	24	23	25	22
11	16	19	16	20	12	11	9	15 C	14	15	17	12
12	8	8	8	9QCK	15	12	11	16 CC	39	30	13	56
13	10	22	15	17	8	6	11	4QCK	64	61	46	79
14	16	12	14	15	30	33	20	43	40	49	44	45
15	22	15	22	16	58	37	28	67	39	41	56	24
16	16	12	17	12	43	34	41	36	27	24	26	25
17	14	17	15	17	25	25	24	27	23	23	19	27
18	28	40	21	48	27	25	22	31	19	11	15	15
19	30	30	18	43	15	12	20	8	35	29	18	46
20	42	56	61	37	22	15	17	21	25	15	33	8
21	20	17	22	16	12	21	16	17	7	6	8	6QCC
22	19	12	17	14	7	5	10	2QCK	7	4	4	6QCC
23	14	14	17	12	29	27	10	46	7	7	5	9QCK
24	23	18	14	28	23	13	9	28	28	25	25	30
25	17	21	26	13	69	49	29	89	23	26	33	16
26	4	4	4	4QC	42	37	48	31	29	29	33	24
27	53	81	56	79	22	15	16	22	16	18	17	17
28	66	54	39	81	10	7	13	4 CK	5	4	5	4QCC
29	25	46	53	19					5	4	4	4QCC
30	44	46	48	43					19	11	5	24
31	33	28	29	33					51	42	37	56
	22.9	24.1	23.5		22.6	19.5	21.2		22.2	19.8	21.1	

	APR.				MAY				JUNE			
	N	S	M		N	S	M		N	S	M	
1	20	20	31	9	17	9	9	17 C	35	41	25	51
2	10	24	12	22	33	20	40	13	54	49	50	53
3	29	31	25	36	18	11	8	21	48	37	51	34
4	40	48	37	51	13	6	13	6 CK	22	17	19	21
5	20	19	15	25	18	13	6	25	14	6	11	9 C
6	20	22	25	17	57	52	44	65	12	11	16	8 CC
7	9	9	13	6 CC	56	49	58	47	7	3	4	7QCC
8	12	12	10	15QC	23	31	26	27	17	10	17	10 C
9	66	81	58	89	24	19	19	25	9	10	8	12QCC
10	41	37	37	41	24	16	22	19	11	7	8	11 CC
11	36	49	44	41	10	8	11	8 CK	12	11	12	11 CC
12	17	19	16	21	8	6	6	9QCC	7	7	9	6QCC
13	13	18	15	16	10	6	7	9QCC	16	20	4	32 K
14	69	42	11	101	31	21	17	36	9	10	8	11 C
15	46	35	46	36	21	18	21	19	12	9	12	9 CC
16	30	23	27	26	10	13	7	17 K	12	9	6	15 C
17	11	12	15	9 C	95	69	67	98	21	17	27	12
18	23	15	15	24	47	58	62	44	13	11	15	9 CC
19	14	14	20	9	21	17	19	20	6	3	4	4QCC
20	10	7	10	8QCC	10	9	12	7 CK	7	4	7	5QCC
21	28	41	13	56	14	7	9	13 CC	12	5	6	12 CC
22	24	28	29	24	12	7	11	9 C	12	8	7	14 CK
23	24	15	14	26	28	18	24	23	16	18	20	14 K
24	5	4	4	4QCK	16	12	7	22	13	6	5	15 C
25	3	4	4	3QCC	15	11	12	14 C	43	33	25	52
26	13	10	4	19QKK	19	20	20	20	21	27	37	11
27	15	14	18	12	4	2	4	3QCK	10	9	8	10 CC
28	29	35	26	39	12	4	3	13QCC	21	10	4	27
29	17	18	19	17	15	6	10	12 C	36	42	22	57
30	13	17	20	10	33	35	32	37	22	17	16	24
31					8	4	8	4QC				
	23.7	24.1	23.9		23.3	18.6	21.1		18.3	15.5	17.0	

	JULY				AUG.				SEP.			
	N	S	M		N	S	M		N	S	M	
1	26	17	22	22	13	11	9	15 C	22	17	29	15
2	26	27	27	26	32	33	48	18	4	2	3	4QCC
3	16	10	9	17 C	11	6	5	12QCK	10	11	12	9QCC
4	18	12	11	19	18	16	15	18	17	12	3	27
5	20	10	13	17	23	19	33	10	29	33	28	34
6	20	10	16	15	7	2	2	7QCC	22	19	14	28
7	8	5	7	6QCK	12	5	5	13 CK	41	30	30	41
8	19	12	15	16 K	24	24	25	22	20	15	21	15
9	12	8	13	7 CC	22	19	16	26	18	12	11	19
10	7	4	4	7QCC	22	16	18	21	11	10	16	5 CK
11	15	16	9	22 K	28	19	30	18	14	15	13	17 C
12	18	11	9	20	24	22	23	23	13	13	16	11 C
13	20	20	23	18	19	14	17	16	35	25	41	19
14	15	19	16	18	9	10	7	13QCK	17	20	22	15
15	16	13	18	12	14	7	4	16 CK	16	17	18	15
16	13	11	10	15 CC	23	9	17	16	22	14	21	15
17	12	4	11	6QCC	22	13	7	29	28	21	15	35
18	17	10	11	16 KK	30	15	27	19	48	54	73	29
19	21	10	18	13 K	10	4	10	5 CK	14	23	22	15
20	11	7	5	12QCC	7	5	3	10QCC	22	29	22	29
21	31	42	15	58	16	14	11	19	10	9	8	12QC
22	15	8	17	7 K	19	24	16	27	9	7	8	8QCC
23	23	8	10	22 K	27	18	27	18	6	6	4	8QCC
24	12	7	12	7 KK	19	13	11	21	24	7	3	28
25	8	4	4	9QCC	19	13	13	19	40	41	48	33
26	35	21	4	52	27	28	32	23	40	29	11	59
27	21	12	17	16	8	4	5	6QCK	54	53	65	42
28	11	10	18	4 KK	14	12	5	21 KK	18	18	21	16
29	16	13	6	24 K	14	9	11	14 C	14	9	12	12 C
30	15	18	19	14	14	10	11	13 K	38	34	19	53
31	21	21	16	26	61	36	47	50				
	17.4	12.9	15.2		19.7	14.4	17.1		22.6	20.1	21.4	

	OCT.				NOV.				DEC.			
	N	S	M		N	S	M		N	S	M	
1	38	44	46	36	10	8	13	5 CC	11	13	12	13 CC
2	34	32	34	32	6	4	3	8 CC	11	12	6	17 K
3	41	26	41	27	5	5	5	5QCC	27	27	24	31
4	31	22	24	29	10	8	9	9 CC	15	14	16	14
5	30	29	32	28	8	11	8	11 CC	8	10	11	8 CC
6	32	43	36	38	6	5	5	6 CC	6	7	9	4QCC
7	32	30	12	51	11	14	18	8 KK	5	6	5	6QCC
8	40	32	43	30	20	16	10	27 K	6	8	8	7QCC
9	71	39	67	43	6	6	7	5 CK	13	15	17	11 C
10	17	13	19	12	11	9	5	16 CK	7	6	5	9QCC
11	21	18	11	28	28	25	24	29	13	21	8	27 K
12	17	15	5	27	19	11	15	15	19	19	10	28
13	29	28	25	32	9	6	8	8 CC	26	23	19	31
14	21	22	14	29	5	4	3	6QCC	4	9	9	5QCK
15	19	16	19	17	6	4	7	4QCC	7	7	7	7 CC
16	8	9	6	11 CC	3	4	4	3QCC	21	14	7	28
17	7	7	7	7QCC	4	3	2	4QCK	87	89	56	120
18	5	4	4	5QCC	15	20	22	14 K	31	50	46	36
19	5	2	4	4QCC	13	19	12	21	19	24	25	18
20	12	9	8	13 CC	12	14	13	14	10	7	4	14 CK
21	12	7	8	12 CK	21	24	19	26	19	18	9	29
22	19	20	15	24	50	52	46	56	31	30	27	34
23	12	19	8	23	73	64	72	65	24	26	23	27
24	23	29	20	33	68	54	53	69	15	18	19	14
25	16	11	12	15 C	58	69	73	54	13	15	13	16
26	7	4	3	8QCC	31	37	42	26	26	16	21	23
27	8	7	8	8QCK	18	19	16	22	9	7	13	3 CK
28	35	25	17	43	21	16	21	17	6	13	7	12 CK
29	57	43	55	45	11	11	7	16 CK	23	25	22	27
30	26	23	34	14	10	11	10	12 CC	25	31	40	16
31	12	9	9	13 CK					17	13	14	16
	23.8	20.5	22.2		19.0	18.5	18.8		17.9	19.1	18.6	

ANNUAL MEAN N 21.12 S 18.93 M 20.10

1971

	JAN.				FEB.				MAR.			
	N	S	M		N	S	M		N	S	M	
1	16	13	10	19	16	18	14	20	16	16	11	22 K
2	16	18	13	21	21	23	25	19	22	18	9	31
3	12	18	19	11	17	20	14	23	27	33	28	32
4	18	16	24	10	14	22	21	14	15	18	18	16
5	9	13	13	10 CC	11	13	8	17 KC	13	8	8	13 CC
6	5	7	9	3QCC	15	11	10	16 KK	33	31	14	50
7	9	7	7	10QCC	19	13	10	22	59	83	102	40
8	8	10	10	9QCC	12	12	16	8 CK	20	22	16	26
9	15	11	12	14 CC	6	7	6	8QCC	19	23	19	23
10	16	14	8	24	19	24	18	25	7	5	4	8QCK
11	26	29	34	22	8	17	15	11 K	15	12	17	9 KK
12	9	10	9	10 CK	7	7	9	6QCK	9	6	4	11QCK
13	7	7	6	8QCC	34	34	16	53	11	14	16	10 KK
14	8	6	8	6QCK	29	18	29	19	7	8	7	8QCC
15	37	37	21	53	22	19	23	17	13	12	6	20 K
16	43	49	42	50	14	13	13	15	36	31	41	26
17	32	27	25	34	52	36	24	65	32	23	24	32
18	34	39	39	35	20	15	13	23	21	21	30	12
19	18	22	16	24	22	30	27	24	10	9	8	12QCC
20	19	15	12	23	18	17	21	15	10	8	11	8 CC
21	23	41	20	45	20	14	15	20	12	9	12	9QCC
22	41	41	27	55	9	10	8	11QCK	22	15	18	20
23	54	36	48	42	12	14	11	15 C	15	23	19	20
24	18	17	16	20	43	60	48	55	30	30	29	32
25	35	23	22	36	34	25	22	38	19	18	23	14
26	32	32	37	27	13	8	11	10 K	22	17	8	31
27	24	30	21	33	10	8	5	13QCC	31	22	23	31
28	36	44	21	59	11	8	12	7 CC	29	9	31	7
29	23	25	16	33	4	6	5	4QCC	37	39	29	47
30	18	10	14	14					38	40	39	38
31	14	11	7	19 KK					34	22	23	34
	21.8	21.8	21.9		18.4	17.9	18.3		22.1	20.7	21.5	

	APR.				MAY				JUNE			
	N	S	M		N	S	M		N	S	M	
1	28	24	18	36	31	32	31	32	12	7	12	7 CC
2	13	15	21	8	33	26	31	29	15	7	8	14 CC
3	8	4	3	9QCK	15	10	11	14 C	23	16	18	22
4	32	28	24	38	12	10	8	14 CC	34	16	22	30
5	30	18	34	14	12	6	8	11 CC	22	23	25	20
6	16	16	13	19	20	14	13	22 K	16	10	4	22 K
7	14	20	14	20	7	4	5	5QCK	20	15	15	20
8	10	11	4	17 KK	9	6	2	13QCK	14	11	9	17 CK
9	7	4	8	3QCK	27	33	26	34	7	5	7	5QCC
10	9	9	8	11 CC	16	21	15	22	7	6	7	7QCC
11	9	5	8	7 CC	15	13	10	18	7	4	5	5QCC
12	18	14	10	23	17	17	18	16	6	4	5	5QCC
13	20	18	18	21	16	12	12	17	9	5	5	10 CC
14	11	12	12	11 CK	15	12	12	16 K	20	12	11	21
15	12	11	10	13 CC	41	31	4	68	26	14	22	18
16	14	8	11	12 CC	27	17	36	10	12	14	12	15 C
17	8	8	9	9 C	20	17	20	18	75	89	31	133
18	36	36	35	37	17	18	25	9	130	110	134	106
19	15	22	22	16	9	5	7	7QCC	25	31	44	13
20	18	11	9	20	11	5	9	7QCC	18	11	20	10 K
21	29	33	34	28	8	3	5	6QCC	11	4	4	12 CK
22	25	18	3	40	14	4	8	10 CC	25	22	16	31
23	14	18	17	16	22	8	7	23 K	23	21	20	24
24	9	6	9	7QCC	11	5	11	5 CK	31	23	17	39
25	6	4	4	6QCC	9	6	7	9 CC	14	8	6	16 C
26	6	4	4	6QCC	24	11	12	24 K	19	19	14	25
27	19	8	4	24 K	16	12	5	24	29	24	14	40
28	26	39	28	38	39	27	23	43	26	24	31	20
29	57	69	51	76	22	17	22	18	18	24	17	25
30	32	34	39	26	30	14	19	26	4	5	6	3QCK
31					23	17	23	18				
	18.5	17.6	18.1		19.0	14.0	16.6		23.3	19.4	21.5	

	JULY				AUG.				SEP.			
	N	S	M		N	S	M		N	S	M	
1	11	7	4	14 CC	20	11	19	13 K	10	7	11	6QCC
2	19	8	7	20	11	6	10	7 CC	11	15	9	18 KC
3	17	10	14	13 K	12	8	7	14QC	8	9	7	11 CK
4	8	3	4	7 CC	202	158	125	236	10	9	12	8 CC
5	7	3	5	5QCC	194	236	261	170	9	6	8	8QCK
6	8	3	4	7 CC	119	76	123	72	26	14	22	19
7	21	16	12	25	32	34	44	22	7	13	11	10 C
8	19	14	23	11	23	16	6	33	18	25	23	20
9	16	16	11	22	90	103	147	47	14	12	16	10 C
10	18	12	12	19	35	25	22	38	30	19	18	32
11	15	13	13	15	33	27	23	38	17	23	22	18
12	16	12	10	19 K	16	9	10	15 C	6	12	13	5 CK
13	7	3	4	6QCK	15	8	9	14QCK	71	63	10	123
14	9	4	5	8QCC	24	16	14	27	67	57	88	36
15	14	6	10	11 CC	22	11	22	11	31	39	42	27
16	20	12	13	20	13	9	10	12 CC	31	35	21	46
17	17	14	14	17	13	13	10	17 CC	44	39	46	36
18	13	8	12	10 CC	23	19	13	28	19	23	27	15
19	18	13	12	19 K	23	17	18	23	9	8	13	4 CC
20	10	8	10	9 CC	25	17	12	31	6	5	7	4QCC
21	5	2	4	4QCC	26	20	23	24	4	4	5	3QCC
22	22	12	4	30 K	15	19	23	11	8	8	5	12QCC
23	22	14	15	21	5	4	5	4QCC	23	23	12	34
24	33	27	11	50	5	5	3	7QCC	32	32	25	39
25	57	46	48	55	10	10	8	13QK	9	10	13	7 C
26	27	32	27	32	28	27	34	21	12	16	14	15 C
27	14	18	19	13	29	50	60	20	13	10	13	10 CC
28	10	10	12	8 CC	16	12	9	20	17	14	12	20
29	8	4	4	8QCC	17	12	12	17	45	37	26	57
30	10	6	4	11 CC	13	9	11	12 CC	18	8	16	11 C
31	11	5	4	12 CK	9	6	9	7 CC				
	16.2	11.6	14.0		36.1	32.1	34.2		20.9	19.8	20.4	

	OCT.				NOV.				DEC.			
	N	S	M		N	S	M		N	S	M	
1	12	12	13	11 CC	90	93	142	41	9	11	16	4 CC
2	15	5	6	14 CC	69	61	66	64	10	12	11	12 CC
3	10	8	8	11QCK	31	14	38	7	15	12	14	14 K
4	11	11	18	5 KK	12	8	10	12 CC	6	9	9	7 CC
5	4	4	3	5QCC	9	6	7	9QCC	4	4	4	4QCC
6	4	3	2	4QCC	12	12	12	13 CK	5	5	4	6QCC
7	15	17	6	27 K	14	17	16	15	19	20	18	22
8	8	4	7	6QCK	14	11	11	14 CC	13	15	11	18
9	9	7	3	13 CC	17	16	11	22 K	9	6	5	10 CC
10	14	14	11	18	7	7	5	8QCK	4	7	6	4QCC
11	25	23	30	18	17	15	11	23	6	4	6	4 CC
12	47	28	12	64	9	15	16	8 CK	12	19	8	24
13	32	20	24	29	4	3	4	4QCC	56	59	57	58
14	42	42	46	38	5	8	5	8QCC	14	14	14	15
15	16	12	10	18	35	28	17	46	56	38	25	69
16	24	22	24	22	50	35	45	41	57	44	58	43
17	4	2	3	4QCK	21	18	18	22	26	27	29	24
18	21	22	12	31	15	18	14	20	17	20	15	22
19	45	43	58	30	20	20	22	19	12	13	9	17 C
20	29	25	27	27	44	35	36	44	6	8	8	7 CC
21	30	22	21	32	17	10	18	9	4	9	4	9QCC
22	25	22	20	28	27	31	11	48	28	27	11	45
23	34	25	25	34	22	18	18	23	69	37	59	48
24	21	20	15	26	9	11	13	8 C	21	29	42	7
25	11	18	15	14	15	13	12	16	9	10	6	13 CC
26	14	15	15	15	17	22	24	16	7	15	12	11 CC
27	18	16	16	20	25	22	15	32	4	7	7	4QCC
28	19	17	25	11	21	33	22	32	10	14	9	16 CK
29	26	42	32	36	19	13	16	17	26	25	24	27
30	31	32	32	32	13	10	8	15QC	41	27	25	43
31	48	44	9	83					24	24	22	26
	21.5	19.3	20.4		22.7	20.7	21.8		19.3	18.4	18.9	

ANNUAL MEAN N 21.67 S 19.44 M 20.62

	JAN. N	S		M	FEB. N	S		M	MAR. N	S		M
1	19	17	29	8	29	34	31	32	42	21	17	46
2	3	4	3	4QCC	26	21	19	29	62	52	57	59
3	5	7	4	8QCC	34	29	27	37	28	16	27	17
4	21	23	17	28	14	11	13	12QC	10	5	11	5QCC
5	39	33	21	52	13	25	26	13	13	14	3	23 K
6	32	22	36	19	28	32	20	41	36	47	32	51
7	14	15	9	21	24	30	19	36	12	16	13	15
8	26	27	18	36	38	37	34	41	13	12	6	19 K
9	34	30	23	41	31	28	34	26	19	19	23	16
10	52	37	43	47	21	19	17	24	16	14	12	19
11	40	30	31	40	15	18	20	14Q	15	19	15	20
12	44	41	29	55	16	13	12	17 C	25	19	19	27
13	25	34	30	28	5	8	4	9QCK	11	12	11	13QK
14	15	13	20	9	11	16	16	12QKK	5	7	7	5QCC
15	15	21	19	17	15	11	16	10QCC	4	5	4	5QCK
16	18	10	16	13	21	15	6	30	22	27	20	29
17	8	11	10	9QCC	28	28	32	24	14	13	10	17Q
18	4	8	7	5QCC	23	18	10	31	30	33	17	46
19	21	21	7	36	20	18	12	27	93	96	83	106
20	48	28	48	28	19	19	8	31	111	86	92	104
21	31	32	45	19	85	66	26	125	68	77	66	79
22	10	9	8	12QC	74	62	39	98	59	71	63	67
23	21	25	23	23	68	77	62	84	73	83	67	89
24	42	39	31	50	79	69	56	92	60	69	51	79
25	35	36	31	40	56	42	34	64	64	69	63	70
26	46	32	31	48	56	41	38	58	54	38	36	56
27	54	56	48	62	73	61	50	84	46	47	39	55
28	48	44	45	48	29	25	31	24	38	38	26	50
29	38	32	30	40					35	29	28	36
30	25	12	20	17					25	25	22	29
31	15	20	19	17					54	51	19	86
	27.4	24.7		26.1	34.0	31.2		32.7	37.3	36.5		36.9

	APR. N	S		M	MAY N	S		M	JUNE N	S		M
1	112	81	28	165	26	26	17	37	7	3	4	5QCK
2	62	77	85	55	19	14	17	17	37	31	30	38
3	38	36	43	31	16	13	19	11	30	19	25	25
4	16	16	18	14	12	13	11	15 KC	27	27	21	33
5	11	8	14	5QKK	12	5	6	12 CC	22	19	24	17
6	6	6	8	4QCC	28	15	4	39	19	17	22	13
7	6	7	10	4QCC	31	19	25	26	7	4	6	5QCC
8	11	11	8	15 KK	30	33	24	40	16	6	9	13 CC
9	12	7	11	9 CK	18	24	18	25	22	8	10	21
10	4	4	3	5QC	13	13	15	12 C	42	30	15	58
11	31	43	45	30	14	8	10	12 CC	44	54	43	55
12	5	5	4	7QC	14	10	11	13 C	52	47	46	54
13	51	67	61	58	29	25	27	28	39	41	44	36
14	71	62	87	46	74	101	92	83	33	32	44	21
15	14	11	13	12 C	45	47	36	57	26	25	22	29
16	74	93	87	80	42	48	46	43	22	22	19	25
17	66	74	70	70	40	56	51	44	32	25	24	34
18	66	61	58	69	40	36	43	33	47	44	50	41
19	52	64	58	58	38	32	34	36	62	46	62	47
20	61	59	58	62	42	52	41	53	34	37	39	32
21	52	61	59	53	71	77	111	37	11	11	15	7 C
22	45	62	68	39	36	24	36	24	6	2	4	4QCC
23	34	36	41	29	26	40	48	18	21	9	11	19
24	24	23	27	20	9	6	8	7QCC	54	43	38	59
25	35	18	23	31	14	11	9	17QCK	12	7	7	12 C
26	54	43	25	72	18	9	18	10	10	7	11	6QCC
27	33	40	44	29	19	14	14	20	8	4	4	8QCK
28	35	35	21	48	21	12	17	16	30	36	30	36
29	71	57	62	67	6	4	5	5QCC	62	56	67	52
30	27	30	29	29	5	3	2	5QCC	48	47	48	48
31					9	3	4	9QCC				
	39.2	39.9		39.6	26.4	25.6		26.1	29.4	25.2		27.3

	JULY N	S		M	AUG. N	S		M	SEP. N	S		M
1	32	38	34	37	26	31	36	21	7	7	7	7 CC
2	20	16	21	16	31	30	31	31	14	8	7	16 CC
3	16	12	14	14 C	15	11	10	17 K	13	6	6	14 C
4	9	5	8	6QCC	15	12	11	16 KK	27	19	20	27
5	8	5	6	8QCC	19	9	8	21	38	20	24	34
6	5	5	4	6QCC	29	23	28	24	15	15	15	15
7	6	3	4	4QCK	17	18	8	27	16	18	19	15
8	24	33	21	36	20	13	19	15	14	17	11	21
9	20	25	17	29	9	10	12	7 CC	66	46	23	89
10	13	8	13	8QC	8	7	10	5 CC	47	44	27	65
11	14	9	10	13 CC	7	9	7	10QCC	28	18	22	24
12	14	9	8	16 CK	10	5	3	12 CK	17	10	9	19
13	21	16	15	23	23	17	17	24	17	17	14	20
14	18	8	12	14 C	22	13	16	19	8	6	7	4QCK
15	46	47	37	57	11	7	8	11QCC	23	20	13	31
16	30	29	38	21	7	4	3	8QCC	21	23	29	14
17	11	13	17	8 K	5	3	2	4QCC	15	16	18	13
18	17	6	11	13 CK	8	10	8	11QCC	17	13	15	15 K
19	19	19	18	20	13	8	9	13 CK	5	4	4	6QCC
20	21	15	18	19	17	18	16	19	24	16	9	31
21	10	10	10	10 CK	11	9	13	8 CC	24	25	27	23
22	13	5	11	8 C	25	14	6	34	37	27	15	50
23	28	28	36	20	43	44	26	61	85	83	75	93
24	10	14	12	12 C	52	49	69	33	42	41	32	50
25	19	21	25	14	42	45	52	35	38	34	24	48
26	48	47	36	60	34	27	33	29	28	44	46	26
27	40	44	44	39	47	36	44	39	16	21	18	20
28	26	25	27	25	47	37	33	52	8	13	9	13QCK
29	35	30	36	29	33	30	36	27	8	7	9	7QCC
30	31	26	24	34	18	29	30	17	7	6	5	8QCC
31	41	52	65	28	16	19	20	16				
	21.4	20.1		20.9	21.9	19.2		20.6	24.2	21.4		22.8

	OCT. N	S		M	NOV. N	S		M	DEC. N	S		M
1	11	4	5	11QC	9	13	7	15QCC	8	6	10	4QCC
2	43	40	48	36	13	11	11	13 CC	3	6	5	4QCC
3	48	61	72	37	9	9	10	8QCC	11	13	8	16 KK
4	22	19	15	26	42	28	11	58	51	42	23	70
5	28	15	7	36	21	32	25	28	28	26	26	29
6	28	19	21	26	15	16	12	20	16	18	19	16
7	14	6	14	6 K	50	39	41	48	14	10	12	12 CK
8	11	12	14	9 CC	15	19	20	15	14	14	12	17
9	24	14	7	33	19	28	23	24	32	39	27	44
10	40	37	34	43	13	13	18	9 K	13	11	16	8 K
11	21	19	19	22	9	15	12	13 CC	15	18	17	18 K
12	25	25	23	27	6	7	7	7QCC	4	11	9	7 CC
13	28	31	37	22	22	21	13	30	7	7	10	4 CC
14	16	13	12	17	14	16	13	18	12	17	4	26 K
15	8	11	16	4QC	13	23	17	19	9	19	13	15
16	44	45	40	50	20	22	13	30	6	7	6	8QCK
17	43	45	42	46	31	25	29	28	12	11	10	13 CC
18	34	31	23	43	25	30	38	17	5	5	5	6QCC
19	27	32	33	26	6	7	7	6QCC	32	29	10	51
20	36	40	36	41	7	10	7	11 CK	59	42	33	68
21	60	49	44	65	38	41	21	58	54	57	41	70
22	34	28	36	26	9	12	14	8 C	36	36	36	36
23	11	9	10	10 C	16	17	10	24 K	32	24	26	31
24	12	14	11	15 CC	42	49	12	79	5	7	9	3 CK
25	11	9	10	10QCC	55	61	63	53	6	8	4	11QCC
26	7	6	10	3QCC	24	24	31	18	6	10	8	9 CC
27	7	7	5	9QCK	22	25	15	32	11	14	9	17 KK
28	36	32	18	50	13	14	13	14	21	23	19	26
29	130	88	75	142	7	9	8	9 CC	38	32	32	38
30	34	43	42	35	11	7	4	15QCC	25	25	24	27
31	22	24	36	11					26	32	29	29
	29.6	26.7		28.2	19.9	21.4		20.7	19.8	19.9		19.9

ANNUAL MEAN N 27.55 S 25.99 M 26.82

	JAN.				FEB.				MAR.			
	N	S		M	N	S		M	N	S		M
1	32	26	31	28	25	23	14	34	29	35	27	37
2	20	18	17	22	20	15	19	16	29	26	27	29
3	20	23	20	23	12	13	17	9 C	32	39	30	41
4	28	21	19	31	13	11	13	11 KC	19	19	26	13
5	36	23	29	30	16	16	8	24 K	36	29	17	48
6	25	17	29	14	12	13	9	17 K	40	29	31	39
7	5	5	6	4QCC	17	15	18	14	28	24	15	38
8	22	16	8	31	12	10	6	17QKK	24	27	23	28
9	10	19	14	16	10	7	9	8QCK	57	34	29	62
10	24	27	18	34	33	23	16	41	57	39	48	48
11	11	11	15	7 C	44	40	25	60	54	41	45	50
12	9	11	10	11QCC	76	48	74	51	25	22	23	24
13	8	12	11	10 CC	45	24	26	44	13	14	19	8QK
14	17	14	13	19	20	18	20	19	34	27	24	38
15	19	39	17	41	6	5	6	5QCC	6	4	3	7QC
16	26	26	25	27	16	12	6	22	54	61	25	90
17	33	22	28	28	21	20	22	19	11	12	16	7QC
18	44	39	33	50	2	5	4	3QCC	4	5	4	5QCC
19	14	15	14	16	7	7	6	8QCC	5	6	5	6QCC
20	25	17	20	23	24	20	10	34	28	32	9	52
21	25	23	29	19	33	37	33	38	88	69	56	101
22	10	7	8	11QCK	25	26	17	34	48	57	65	41
23	8	7	11	4QCC	76	54	43	68	46	47	39	55
24	12	8	6	13QK	48	37	43	43	42	42	39	45
25	85	86	65	106	54	50	46	58	47	37	41	43
26	54	44	53	45	47	43	52	38	40	37	29	48
27	69	45	53	62	40	39	24	55	36	39	48	28
28	35	26	20	42	50	43	38	55	28	28	27	29
29	40	45	39	46					56	45	31	70
30	44	32	23	53					30	30	33	28
31	32	23	25	31					42	43	41	44
	27.2	24.2	25.8		28.7	24.0	26.4		35.1	32.2	33.7	

	APR.				MAY				JUNE			
	N	S		M	N	S		M	N	S		M
1	29	26	26	29	17	9	7	20 K	36	37	39	34
2	26	23	16	34	34	30	22	43	34	24	32	27
3	64	61	43	82	36	28	45	20	33	37	40	30
4	40	49	46	43	54	37	34	57	16	17	20	14
5	22	35	26	31	42	47	50	39	12	10	11	11QCC
6	38	36	43	31	13	9	15	7QC	14	11	14	12QKK
7	30	33	37	26	22	21	13	30	6	4	3	7QCC
8	24	24	19	29	21	15	12	24	13	10	8	15QKC
9	30	30	23	38	20	19	24	15	17	13	6	25Q
10	38	44	41	41	5	3	4	4QCC	32	19	21	31
11	28	32	36	24	9	6	6	9QCC	46	49	26	70
12	4	4	4	4QCK	10	4	8	5QCC	50	38	62	27
13	12	8	9	12 CC	9	7	6	10QCC	40	42	43	39
14	9	4	6	8QCC	24	15	10	30	30	32	22	41
15	6	4	5	5QCC	43	47	38	53	50	61	41	70
16	8	4	4	8QCC	46	49	43	53	28	39	41	26
17	13	9	6	16QC	48	57	56	50	33	32	31	34
18	64	66	74	57	32	47	44	34	20	22	16	26
19	48	54	36	67	33	45	36	42	17	25	15	28
20	60	72	59	74	32	39	34	37	32	30	27	36
21	54	56	56	53	32	43	40	35	12	7	9	10 C
22	45	44	44	45	44	41	33	52	18	15	16	17
23	43	61	59	45	43	46	36	53	16	13	13	17
24	32	30	25	37	57	63	62	58	22	14	17	19
25	32	37	35	34	26	31	28	29	18	10	10	19
26	45	23	31	38	24	23	21	27	60	72	68	65
27	27	39	48	19	27	20	28	20	78	74	86	67
28	34	37	27	45	18	16	23	11	38	36	34	40
29	28	33	17	45	16	15	14	18	34	39	31	43
30	29	32	23	38	31	25	17	40	30	31	31	30
31					48	36	34	50				
	32.2	33.6	32.9		29.5	28.7	29.2		29.6	28.7	29.2	

	JULY				AUG.				SEP.			
	N	S		M	N	S		M	N	S		M
1	20	15	18	18	14	8	11	11QCC	40	44	39	45
2	21	22	23	20	32	39	8	63	61	44	53	52
3	17	16	16	17	54	61	43	72	24	36	30	29
4	48	32	31	50	42	28	41	29	41	27	25	43
5	78	74	72	80	31	35	34	32	30	32	44	18
6	116	127	164	79	41	32	25	48	22	25	23	24
7	23	16	21	19	34	36	25	45	21	23	23	21
8	52	41	31	62	29	30	35	24	12	14	15	12
9	31	21	32	20	28	25	25	29	11	5	9	8QCC
10	38	37	32	43	30	24	34	21	10	10	11	9QCC
11	26	21	21	27	17	19	19	18	7	5	8	4QCC
12	40	33	19	55	12	7	10	10QCC	10	9	4	14QKK
13	27	24	29	23	11	9	11	9QCC	24	22	17	29
14	31	31	35	28	9	6	10	6QCC	17	14	11	21
15	21	14	18	18	11	4	7	9QCC	69	70	11	128
16	15	19	19	15	12	8	9	12 CC	91	102	154	40
17	19	10	13	16	10	10	7	13 CC	4	7	6	5QC
18	9	10	10	9QCC	21	13	11	24	23	31	6	48
19	13	11	9	16QCC	48	56	43	62	52	46	60	38
20	20	19	16	23	59	48	62	46	52	54	52	53
21	17	13	11	19	42	69	63	48	66	56	24	98
22	14	13	12	16Q	50	49	46	53	31	37	37	31
23	95	83	84	94	47	54	58	43	28	26	16	39
24	55	74	75	55	46	41	48	40	34	43	40	38
25	33	32	36	29	24	25	25	24	50	37	25	62
26	31	25	29	28	17	13	10	21	54	57	53	58
27	33	39	43	29	30	28	30	28	36	54	36	54
28	30	28	39	19	38	26	24	41	25	26	19	33
29	24	24	28	20	43	53	56	40	24	30	22	32
30	14	19	23	10Q	35	23	29	29	30	37	28	39
31	12	11	11	12QCC	41	29	31	40				
	33.0	30.7	32.0		30.9	29.3	30.2		33.3	34.1	33.7	

	OCT.				NOV.				DEC.			
	N	S		M	N	S		M	N	S		M
1	48	49	47	51	10	8	9	9 CC	13	17	6	24Q
2	57	48	22	84	10	11	13	8QCC	23	27	23	27
3	19	19	24	15	9	11	10	10 CC	28	30	25	34
4	16	13	12	18Q	5	8	8	5QCC	12	17	22	8
5	19	13	11	21	11	9	7	13QCC	22	16	10	29Q
6	16	18	25	10	12	22	16	18	7	9	10	6QC
7	11	11	10	12QCC	15	17	16	17	12	21	16	18
8	20	21	10	32	37	33	9	62	26	32	17	41
9	56	66	53	68	41	55	56	40	72	69	54	87
10	19	16	22	14	19	12	13	19	38	27	34	31
11	11	8	14	5QKK	74	72	24	123	36	31	24	43
12	30	22	11	41	85	93	95	83	25	31	28	28
13	90	94	111	73	66	44	41	69	44	30	20	55
14	42	31	17	57	38	45	48	36	22	16	24	14
15	64	47	74	38	18	19	12	25	26	20	20	27
16	81	71	64	89	25	25	20	31	16	14	6	25Q
17	68	74	64	79	24	15	19	21	33	32	22	43
18	59	44	53	50	16	12	15	14	45	56	51	50
19	57	44	39	62	24	20	16	29	50	41	36	55
20	68	59	61	65	41	37	41	38	42	37	41	38
21	18	18	22	15	41	30	27	45	34	32	25	41
22	26	26	21	32	28	26	27	27	26	21	26	22
23	8	8	8	8QC	28	23	21	31	40	35	19	56
24	54	64	78	39	50	30	29	52	26	24	20	31
25	46	35	35	46	35	26	29	32	26	21	10	37
26	48	47	45	51	32	30	20	43	19	22	22	19
27	45	42	37	50	13	17	13	18	40	39	44	34
28	42	45	34	53	7	14	15	7 CC	16	22	23	15
29	27	30	34	24	3	7	6	4QCC	13	18	15	17 C
30	18	18	15	22	4	6	5	5QCC	10	9	8	12QC
31	12	9	11	11QCK					20	21	22	20
	38.6	35.9	37.3		27.4	26.0	26.8		27.8	27.0	27.5	

ANNUAL MEAN N 31.11 S 29.53 M 30.39

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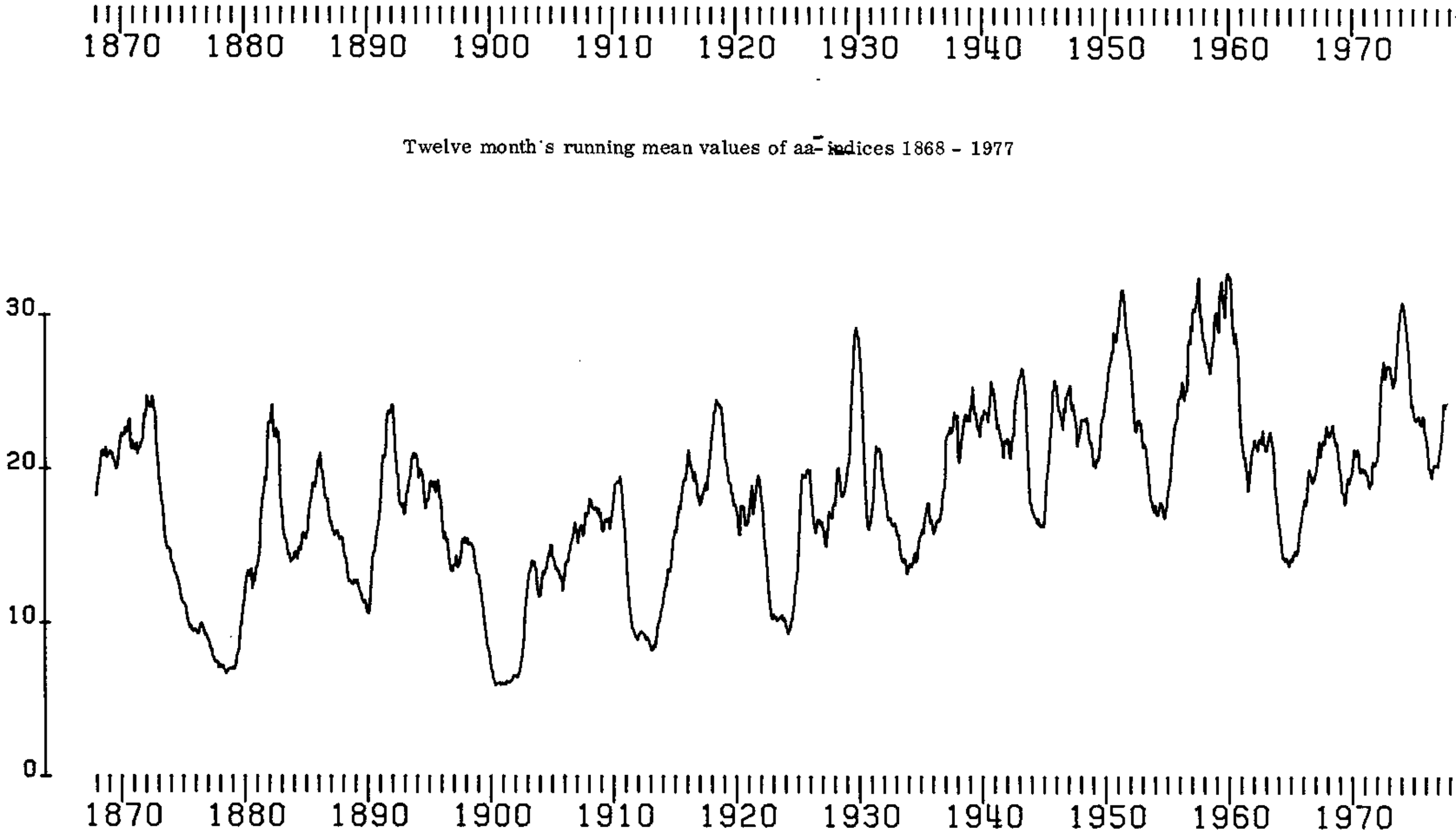
	JAN.				FEB.				MAR.			
	N	S	M		N	S	M		N	S	M	
1	18	17	22	14	68	49	53	64	38	32	36	34
2	9	5	6	8QCC	46	40	50	36	17	19	21	16
3	12	21	16	18	21	18	23	17	24	14	15	24
4	73	54	46	81	18	16	13	22	17	14	17	14
5	59	47	44	62	38	28	22	45	50	47	43	56
6	51	32	17	66	15	15	14	16Q	34	32	26	41
7	52	54	84	22	22	25	20	27	5	7	5	7QC
8	54	72	66	60	13	11	15	9QC	2	4	4	3QCC
9	13	13	12	14 C	26	18	22	22	22	14	7	30
10	9	10	14	6 CC	64	54	44	74	100	99	99	101
11	8	8	10	7QCC	78	49	38	89	76	77	99	55
12	7	10	6	11QC	61	57	55	64	56	64	44	75
13	57	64	54	67	45	36	27	53	54	34	29	58
14	57	57	47	67	45	37	38	45	47	47	36	58
15	29	28	21	38	34	29	25	38	27	37	27	37
16	45	39	33	52	56	36	36	55	36	52	45	43
17	43	36	34	45	31	25	25	31	23	21	23	22
18	40	26	29	38	28	24	26	26	32	26	18	41
19	21	21	26	16	19	19	19	20	20	21	11	30
20	20	14	15	20	13	13	18	9QK	36	29	25	40
21	15	11	8	19 KK	17	17	13	22	5	5	8	3QC
22	14	13	6	22	15	16	17	15Q	14	13	16	12Q
23	30	21	18	34	46	66	65	48	19	17	27	9
24	20	16	21	15	30	25	16	39	26	33	17	43
25	10	10	7	14QKK	39	34	43	30	13	18	13	18Q
26	8	9	9	8QCK	13	16	19	10	27	33	31	30
27	23	27	21	29	9	11	10	10QCC	40	52	17	75
28	21	22	28	16	29	14	13	31	62	47	52	58
29	8	12	11	9 CC					29	43	42	30
30	16	17	14	19					17	16	17	17
31	42	34	20	57					25	17	15	28
	28.6	26.4	27.6		33.5	28.6	31.1		32.1	31.8	32.0	

	APR.				MAY				JUNE			
	N	S	M		N	S	M		N	S	M	
1	13	10	14	9 C	12	12	9	16 C	46	27	11	62
2	12	6	8	11 CC	30	36	21	45	50	54	72	33
3	13	9	11	11 CC	34	34	34	34	23	23	22	24
4	16	12	10	19 C	28	23	25	27	22	23	25	20
5	21	11	11	21	57	37	45	50	27	31	25	33
6	31	25	19	38	54	47	60	41	26	23	22	28
7	44	28	16	57	37	46	30	53	13	9	11	12 C
8	49	51	31	69	28	23	18	34	9	7	7	10QCC
9	68	69	58	79	28	34	21	41	11	9	12	8 CC
10	57	52	53	57	32	32	43	22	6	8	4	10QCK
11	50	59	62	48	3	2	3	2QCK	25	18	19	25
12	40	47	37	50	5	3	2	6QCC	45	39	34	50
13	38	34	46	26	12	7	6	14 CK	26	22	24	25
14	31	25	32	25	18	24	26	17	19	21	18	22
15	13	14	10	18	4	4	4	3QC	27	26	13	41
16	7	11	11	8 CC	41	49	36	55	31	30	27	34
17	11	9	8	13QCC	26	29	33	23	23	24	18	29
18	9	18	10	18 K	18	14	17	16	25	24	27	22
19	9	8	9	9QCK	32	18	22	28	26	21	19	29
20	39	32	10	62	34	30	47	18	11	9	8	12 C
21	38	27	30	35	24	15	14	26	21	16	16	22
22	21	23	22	22	19	22	23	18	9	9	12	7 CK
23	40	28	36	32	17	12	17	12	8	4	4	8QCC
24	31	23	32	22	10	9	10	9 CC	5	3	5	3QCC
25	12	13	15	11 C	36	18	14	40	9	10	7	13 CC
26	19	16	20	16	24	20	35	9	12	9	12	9 CC
27	8	10	14	4QCC	22	21	18	26	10	4	7	8QCC
28	7	3	5	5QCC	10	5	7	9QC	9	7	8	9 CC
29	6	4	6	4QCC	26	23	26	23	41	36	14	63
30	11	11	12	11 CC	13	10	12	12 CK	45	35	51	29
31					9	4	4	9QCC				
	25.6	22.9	24.3		24.0	21.3	22.7		22.0	19.3	20.7	

	JULY				AUG.				SEP.			
	N	S	M		N	S	M		N	S	M	
1	23	30	30	23	17	11	21	8 K	18	14	10	22
2	16	11	14	14	13	8	11	11 CC	13	10	14	9 CK
3	15	13	13	15 C	9	6	6	10QCC	6	3	3	6QCC
4	15	8	8	16 CC	12	7	6	13 C	6	4	4	6QCC
5	11	7	8	11QCC	46	39	48	38	6	5	4	8 CK
6	13	7	4	16 CK	14	11	21	4 K	30	22	26	27
7	25	22	24	24	12	14	2	23 K	13	7	12	8 C
8	42	52	55	39	23	21	36	9	14	15	11	19
9	46	46	48	44	29	28	21	37	43	42	26	60
10	33	35	31	38	23	26	33	16	38	40	43	36
11	28	45	48	26	14	11	13	12 KK	52	36	46	41
12	13	9	8	15QC	7	3	5	6QCC	34	29	34	30
13	19	15	8	26	10	13	11	12QC	33	23	39	17
14	32	25	28	29	29	29	41	17	21	27	32	16
15	27	29	26	30	34	34	27	41	14	12	11	16 K
16	24	27	27	24	13	12	10	16 K	7	6	7	7 CC
17	27	24	23	29	20	17	20	18	22	18	13	27
18	27	24	26	25	14	10	13	11 CK	24	21	16	29
19	19	15	12	23	8	7	6	10QCK	16	14	15	16
20	11	11	15	8 C	25	34	11	48	15	12	9	18 KK
21	14	15	11	19 K	31	21	18	35	12	8	8	12 CC
22	13	10	9	14 CC	26	21	27	20	7	5	7	6 CC
23	10	10	12	9 CC	17	18	20	15	9	5	11	4 CC
24	14	11	15	10 C	15	11	7	19 K	4	5	5	4QCC
25	54	59	56	57	18	19	16	22	4	3	3	4QCC
26	34	41	30	45	11	6	8	10QCK	27	24	13	39
27	22	25	27	20	11	5	11	5 CC	23	29	28	25
28	20	19	19	21	13	8	8	13 C	16	16	13	19
29	9	7	7	10QCK	47	32	43	36	7	9	11	6 CK
30	11	9	11	10QCC	26	20	33	14	4	4	4	4QCK
31	12	4	5	12QCK	17	11	12	16 C				
	21.9	21.3	21.7		19.6	16.5	18.1		18.0	15.6	16.9	

	OCT.				NOV.				DEC.			
	N	S	M		N	S	M		N	S	M	
1	11	16	21	6 K	13	15	10	18	56	41	41	55
2	7	3	4	6QCC	56	43	26	73	34	44	37	41
3	18	17	9	26	88	67	73	82	22	22	19	26
4	20	10	20	11	68	55	65	58	22	21	19	24
5	12	11	14	8 C	44	34	39	39	17	18	14	21
6	40	38	32	46	21	22	22	21	18	15	9	25
7	71	46	59	59	22	21	18	25	9	5	7	8QC
8	68	59	48	79	16	11	13	14	35	34	18	51
9	57	54	67	45	48	60	39	68	30	32	34	28
10	48	36	44	40	45	23	17	51	13	17	10	21
11	18	20	13	25	30	32	26	36	9	12	10	12 CK
12	23	18	18	24	14	16	18	13	4	8	8	4QCC
13	18	12	11	19	6	4	8	3QCC	5	6	4	8QCC
14	16	29	20	25	6	7	6	7QCC	10	12	7	16 CC
15	7	9	11	6QC	9	7	6	10QCC	15	15	17	13
16	21	25	21	25	10	9	11	8QCK	26	18	20	25
17	17	17	19	15	38	35	14	60	16	17	15	19
18	8	11	5	15 CC	12	15	19	9	13	13	10	17 C
19	9	6	4	10QCC	14	16	20	11 K	13	12	9	16 KK
20	11	8	8	12 CC	21	15	14	23	7	4	7	3QCK
21	11	9	13	7 CC	30	27	36	22	18	26	10	34
22	14	12	13	14 CC	97	80	57	120	18	20	16	22
23	15	8	13	10 CC	14	11	18	8 K	15	17	16	16
24	7	6	10	4QCC	25	23	10	38	10	5	4	10QC
25	6	11	8	9QCC	26	23	26	24	29	36	31	34
26	11	9	7	14 KK	21	34	37	18	54	54	43	65
27	10	9	14	6 CK	10	7	12	6QCK	54	46	41	60
28	21	15	6	31	13	15	16	12	26	24	29	22
29	26	14	25	16	60	44	45	60	29	24	27	26
30	18	14	17	15	59	43	38	64	17	19	21	16
31	28	29	37	20					16	10	15	11 CC
	21.5	18.7	20.2		31.2	27.1	29.3		21.3	20.9	21.1	

ANNUAL MEAN N 24.94 S 22.55 M 23.81



Twelve month's running mean values of aa-indices 1868 - 1977