Document No. T

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

ASSOCIATION OF TERRESTRIAL MAGNETISM AND ELECTRICITY

Advance Print from IATME Bulletin No. 12e

"An attempt to standardize the daily international magnetic character figure"

by

Julius Bartels

Document No. T

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

ASSOCIATION OF TERRESTRIAL MAGNETISM AND ELECTRICITY

Advance Print from IATME Bulletin No. 12e

"An attempt to standardize the daily international magnetic character figure"

by

Julius Bartels

Advance Print from:
Int.Ass.Terr.Magn.Electr. Bull. No. 12e, Washington 1951

An attempt to standardize the daily international magnetic character figure.

By Julius Bartels, Göttingen.

1. Introduction. As a measure for the intensity of geomagnetic disturbance, the daily international magnetic character figure - here designated Ci - has become comparable in popularity to the Zürich relative sunspot number as a measure of solar activity. An unbroken series of Ci from 1884 to the present is available, as the result of a remarkable collaboration of nearly all magnetic observatories. Ci is now being derived under the auspices of the International Association of Terrestrial Magnetism and Electricity (IATME), through its Committee on Characterization of Magnetic Disturbances (CCMD), by Dr.J.Veldkamp (De Bilt).

Since 1940, the K-index has been introduced to measure magnetic disturbance for three-hour intervals. At the Oslo Meeting 1948 of the IATME [1] it was

> "recommended that the Committee (CCMD) develop proposals for a method of determination of Ci from K-indices which would give a homogeneous series of the former. When this fact could be demonstrated, the matter of discontinuing the present method of determining Ci could be taken up with URSI (Union Radio-Scientifique Internationale) and other interested groups"

The following proposal for a daily planetary character figure Cp to be derived from planetary three-hour-range indices Kp is submitted to the members of the CCMD and to others interested. The underlying studies and calculations are reproduced so far only as they seem relevant to describe Cp and its relations to Ci; a few Notes will give additional details.

---

*) Symbols and abbreviations are underlined where they occur first.

2. Remark on Notation and Scales. The reader is asked to excuse some changes in symbols etc. introduced to simplity the typing. Kp is [2, 3] the planetary three-hour-range index, (scale of 28 steps, from Oo, O+, 1-, 1o, 1+, 2-, ... to 8+, 9-, 9o). Kp is currently computed from the K-indices of 11 observatories [3], and now available for the 13 months of the Second International Polar Year (August 1932 to August 1933) and for every day since 1940 January 1. It is hoped eventually to obtain Kp-indices for the 3 years 1937 to 1939.

The daily character assigned at a single observatory (scale O, 1, or 2) is C. If necessary, such symbols like C(Si) shall denote C for Sitka, with the two-letter abbreviations for the names of observatories used in the tables listing C or K. Ci (scale o.O to 2.O) is the daily international magnetic character figure, derived as the arithmetic mean of the individual characters C for all collaborating observatories. Cp, (same scale as Ci, with the option to split 2.O into 2.O to 2.5) is the new planetary character figure. To avoid decimals, the ten-fold values of Ci, Cp, as well as of the "excess" (Ci - Cp) are used occasionally, and called Ti, Tp, and Ei = Ti - Tp.

A more detailed classification of storm days by splitting, for Cp, the conventional maximum 2.O into steps 2.O to 2.5 will be indicated in § 4. Anybody who wishes to preserve, in Cp, the conservative scale of Ci, ending with 2.O, may simply regard all Cp = 2.O to 2.5 as 2.O. For the purpose of comparisons and correlations with Ci, this contraction of the last steps into Cp = 2.O will be used anyway.

3. Purpose. The time-variations of the geomagnetic field are superpositions of four main parts

(a) secular variation,

(b) daily variations, solar (Sq) and lunar (L), of the type most distinctly shown on quiet days,

(c) disturbances, of the type most intense in polar regions,

(d) post-perturbation, most clearly shown at equatorial stations in a depression of H, slowly recovering.

Just as K and Kp, Cp will refer to part (c) only. With the usual assumption that this "magnetic activity" is due to solar corpuscular radiation P (= particle radiation), Cp can be regarded as daily index for the intensity of P for the entire earth. The scale for Cp will be the same as that for Ci, ranging from o.O to 2.O, with the option to split the range for the highest figures to extend to 2.5. The formula for Cp has been adjusted so that, in the 10 years 1940 to 1949 - the standardization basis -, there will be, in Ci as well as in Cp, about equal numbers of days with each of the 21 steps o.O, o.1, ..., 2.O.

4. Derivation of Cp from the indices Kp. Cp is based exclusively on the planetary three-hour-range index Kp, described previously [2].

After several trials, the following procedure was adopted: Each value of Kp is replaced by a weight g according to Table 1, and the sum G of the 8 values of g for each day is computed. G determines, according to Table 2, the daily planetary character-figure Cp. The two tables necessary to compute Cp from the Kp are

Table 1. Weights g assigned to Kp.

Kp	g	Kp	g	Kp	g	Kp	g	Kp	g
		2-	6	4-	22	6-	67	8-	179
0o	0	2o	7	4o	27	6o	80	8o	207
0+	2	2+	9	4+	32	6+	94	8+	236
1-	3	3-	12	5-	39	7-	111	9-	300
1o	4	3o	15	5o	48	7o	132	9o	400
1+	5	3+	18	5+	56	7+	154		

Table 2.

Key for Cp as a function of the daily sum G of the weights g.

Limits of G	Cp	Limits of G	Cp	Limits of G	Cp
0... 22	0.0	121... 139	0.9	562... 729	1.8
23... 34	0.1	140... 164	1.0	730... 1119	1.9
35... 44	0.2	165... 190	1.1	1120... 1399	2.0
45... 55	0.3	191... 228	1.2	1400... 1699	2.1
56... 66	0.4	229... 273	1.3	1700... 1999	2.2
67... 78	0.5	274... 320	1.4	2000... 2399	2.3
79... 90	0.6	321... 379	1.5	2400... 3199	2.4
91... 104	0.7	380... 453	1.6	3200...	2.5
105... 120	0.8	454... 561	1.7		

Examples

1940 March 1,
Kp = 1o 3o 3- 2o 2o 1+ 1o 0+
g = 4 15 12 7 7 5 4 2
G = 56, Cp = 0.4; Ci was 0.3

1940 March 24,
6+ 6o 5o 4+ 8o 9o 9o 8+
94 80 48 32 207 400 400 236
G = 1497, Cp = 2.1; Ci was 2.0

Reasons for choosing this procedure: The weights g in Table 1 have been chosen so that the average three-hour-range of the most disturbed field-component at a standard station like Wingst or Cheltenham, in an interval with Kp, would be about 2 g gammas. The limits of G for Cp in Table 2 were chosen so that, in the 10 years 1940 to 1949, the number of days with Cp = 0.0, 0.1, ..., 2.0 should about equal the number of days with the same values of Ci. In other words, the frequency-distribution, for the 3653 days in the 10 years, is practically the same for Cp and the original Ci.

Table 3 gives daily values of Tp = 10 Cp and Ei = 10 (Ci - Cp); 10 Ci can easily be derived as Tp + Ei. Thus, e.g., for 1940 January 3, Ci = 1.8, Cp = 1.5.

(Text continued on page C 12)

Table 3.

Daily values, planetary character-figures Cp, and differences (Ci - Cp).

To avoid decimals, the table lists the tenfold value
Tp = 10 Cp
and the excess
Ei = 10 (Ci - Cp)
International Polar Year 1932/33 and all months 1940 January to 1949 December. For the months 1950 January to 1951 February, for which final Ci are not yet available, only Tp = 10 Cp is given. Days with Cp = 2.1 or 2.2 are marked; for these, Ci = 2.0, and Ei has been given as 0.

1932	Aug 32	Sep 32	Oct 32	Nov 32	Dec
1	6 +3	6 +2	3 +1	11 +1	2 +4
2	12 0	4 +4	5 +3	6 +2	3 +2
3	11 +3	2 -1	5 +1	4 +1	1 +3
4	8 +3	2 +1	3 +4	4 +4	3 +1
5	8 +3	3 +5	3 +3	5 +1	1 -1
6	2 +3	13 +2	1 +1	2 -1	2 +2
7	1 0	3 +6	1 +2	1 +4	0 0
8	1 0	10 +2	2 +2	1 +2	8 +5
9	4 -1	8 +2	5 +4	1 -1	8 +2
10	0 0	1 0	7 +3	1 0	5 +3
11	1 +3	1 0	3 +3	1 +2	1 +2
12	7 +4	1 +1	2 +2	4 +4	1 0
13	7 +4	2 0	1 +1	5 +2	6 +5
14	2 +3	3 +1	0 +3	9 +3	13 +5
15	1 +1	2 0	13 +5	6 +5	11 +5
16	1 -1	1 -1	10 +3	14 +2	10 +5
17	1 0	1 0	9 +3	8 +4	10 +3
18	1 0	7 +2	3 +3	6 +3	6 +2
19	0 +1	9 +3	3 +2	4 +2	6 +2
20	0 +1	7 +3	12 +3	4 +2	1 +1
21	6 +4	5 +1	12 +3	1 +1	0 0
22	6 +4	6 +5	6 +4	1 -1	1 +1
23	5 +3	12 +4	11 +1	1 +1	0 +1
24	0 +1	14 +2	7 +3	0 0	1 +1
25	2 +2	15 +3	4 +3	4 +6	4 +5
26	1 0	10 +1	1 0	1 +1	5 +3
27	13 +4	8 +2	7 +4	1 0	6 +3
28	17 +2	3 0	1 0	4 +3	6 +3
29	13 +4	5 +3	1 +2	8 +2	2 0
30	12 +1	6 0	8 +1	2 +2	4 +4
31	6 +1		3 0		7 +2

1933	Jan 33	Feb 33	Mar 33	Apr 33	May 33	Jun 33	Jul 33	Aug
1	8 +4	0 +1	3 +1	5 0	18 +1	11 0	3 +2	0 0
2	6 +2	6 +2	3 +1	4 0	10 +1	3 +2	3 +1	1 0
3	2 0	1 +2	4 +1	7 +2	8 0	3 +1	3 +2	1 0
4	0 0	1 +2	2 0	7 +1	9 +1	1 0	2 +2	0 +1
5	0 0	1 +2	0 0	3 +2	8 0	1 -1	2 +1	14 +4
6	9 +3	0 +1	1 0	5 +1	10 0	0 0	2 +2	11 +2
7	5 +3	4 +1	0 +1	9 +1	5 +2	1 0	1 +1	3 +1
8	2 +1	1 +3	1 +1	6 +2	2 -1	7 +3	4 +5	2 +1
9	1 0	3 0	1 -1	7 0	0 0	5 +3	10 +3	0 +1
10	0 0	1 +1	3 +1	5 +2	1 0	2 +1	5 +4	1 0
11	0 +1	0 0	6 +2	1 0	1 0	1 0	6 +3	0 0
12	0 +1	1 +2	3 +1	0 0	0 +1	2 +2	4 0	0 +2
13	1 0	0 0	5 +3	0 +1	4 0	14 +2	1 0	11 +4
14	2 +5	4 +4	4 +2	2 +3	8 +2	9 +3	1 0	6 +4
15	10 +2	6 +3	1 +1	10 +2	8 +1	5 +3	0 0	4 +4
16	4 +1	0 +1	1 0	10 +3	4 +2	1 0	1 +2	2 +2
17	3 -1	0 0	1 +3	13 +1	6 +2	2 0	5 +5	7 +3
18	1 0	1 +2	13 +2	11 0	10 +1	1 0	6 +4	10 +3
19	7 +5	12 +5	13 +2	12 0	5 +2	4 +4	2 +1	8 +2
20	7 +2	12 +2	14 +2	10 +2	1 +1	9 +3	3 +2	8 +3
21	0 +1	14 +3	12 +3	11 +1	2 0	3 +3	1 0	10 +3
22	9 +5	13 +3	12 +3	10 +2	2 +1	1 +2	2 +1	2 0
23	9 +2	13 +2	13 +2	10 +1	2 0	0 +1	10 +5	8 +2
24	9 +2	13 +2	13 +2	5 +1	1 0	1 0	13 +3	8 +3
25	8 +1	10 +1	8 +2	4 +1	2 +1	5 +5	3 +2	5 +4
26	10 0	11 +1	4 +2	6 +2	0 0	3 +3	3 +4	5 +4
27	12 +2	7 -1	9 +2	3 +1	3 +4	6 +3	7 +4	2 +1
28	11 +1	2 +1	9 0	4 -1	3 +3	9 +1	2 0	1 0
29	7 +2		7 +1	1 0	6 +5	6 +2	1 +1	1 0
30	7 0		5 +1	10 +3	9 +3	3 +1	1 0	1 +1
31	4 +1		5 +1		11 +1		2 +1	0 +1

1940	Jan 40	Feb 40	Mar 40	Apr 40	May 40	Jun 40	Jul 40	Aug 40	Sep
1	5 0	14 +1	4 -1	17 +1	4 0	1 0	4 0	6 +1	11 +1
2	8 -1	10 0	2 -1	13 +1	2 +1	4 +1	1 +1	7 +1	6 +2
3	15 +3	9 +2	4 -1	19 0	2 0	3 +2	8 +1	14 +1	11 0
4	12 0	4 +2	1 +1	9 +2	1 0	1 +1	11 0	5 -1	9 +1
5	7 0	6 -1	1 0	5 +1	2 0	5 +2	9 0	6 +1	6 0
6	10 +2	8 +2	0 +1	5 -1	0 0	14 -1	8 0	9 +1	4 +1
7	10 +2	7 +2	1 0	0 0	3 +1	13 -1	3 0	8 +1	13 -1
8	7 -2	6 +1	7 +1	1 0	1 +1	10 0	2 +1	6 +1	8 +1
9	7 +3	5 -1	12 -1	0 +1	6 0	8 +1	8 +1	14 +2	9 -1
10	12 +3	3 +1	3 -1	0 0	8 +3	3 0	12 +1	4 +2	0 +1
11	11 +3	5 +2	1 0	2 +1	8 +2	1 +1	5 +1	9 0	1 +1
12	12 0	9 +1	7 +3	1 0	9 +2	2 +1	2 0	6 0	1 0
13	4 -1	5 +2	6 0	6 +1	6 0	1 +1	17 +1	3 +1	1 +1
14	1 +1	3 0	6 -2	6 0	7 +1	15 +1	10 +2	4 0	9 +2
15	3 0	5 -1	0 +1	9 +1	8 +2	12 +1	8 0	0 +1	7 0
16	7 +1	4 0	2 +2	8 -1	2 +2	8 +1	4 0	1 0	7 +1
17	11 +1	2 0	0 +1	4 -1	5 +2	8 0	1 +1	1 0	0 +1
18	14 +3	0 0	0 0	1 0	13 +2	9 +1	0 +1	7 +3	1 0
19	4 +1	0 +1	10 +2	3 0	5 +2	6 +1	2 +1	5 +3	1 0
20	4 +1	11 -1	12 0	5 +2	5 +2	1 0	1 +1	6 +1	6 +2
21	1 0	10 0	6 +2	7 +2	4 +2	1 0	5 +1	3 +1	7 +2
22	4 +2	8 -2	6 0	10 0	13 0	4 +4	8 +1	5 +2	4 +1
23	3 +2	6 0	16 -1	4 +1	10 +2	4 +1	3 +1	2 +1	0 0
24	8 +1	9 0	21 0	5 -1	18 0	9 +1	6 +1	0 0	1 0
25	8 +1	14 +2	21 0	17 +1	7 +1	19 +1	5 0	1 +2	11 0
26	0 +2	4 +3	16 0	15 -1	12 0	12 0	2 +1	10 +1	15 +2
27	2 0	3 -1	13 0	6 +2	11 -1	4 +1	1 +1	8 +1	15 +1
28	0 +1	3 0	11 0	5 +1	9 0	3 +2	3 0	6 +2	15 -1
29	6 +3	7 +2	19 0	6 -1	4 0	2 +4	5 0	5 0	6 +1
30	10 +2		21 0	6 +2	1 0	7 0	10 +1	1 +1	4 +3
31	13 +2		19 0		0 0		9 +1	4 +1	

1940	Oct 40	Nov 40	Dec	1941 Jan 41	Feb 41	Mar 41	Apr 41	May 41	Jun
1	15 +1	7 +1	8 -1	9 +1	2 +1	21 0	3 +1	4 +1	5 -2
2	8 +1	3 0	12 0	4 0	4 0	14 0	6 +1	3 -1	0 +1
3	10 0	7 0	9 +1	3 0	11 0	12 0	8 0	3 -1	1 +1
4	6 0	11 +2	7 +1	4 0	6 -1	14 0	3 -1	7 +2	1 0
5	4 +1	9 +2	5 -1	1 +1	9 +1	14 -1	3 -1	2 0	1 0
6	7 +2	4 0	2 0	10 0	12 -1	10 0	5 -1	5 0	3 +2
7	17 0	5 0	0 0	7 +2	13 -1	9 +1	8 +2	2 +1	1 +1
8	16 -2	1 0	0 0	5 -1	10 -1	8 0	6 +1	4 +2	2 +2
9	4 0	7 +2	7 -1	9 -1	9 -2	8 0	10 -2	6 -1	4 +6
10	3 +2	0 +1	6 +2	6 -1	6 -2	5 -1	12 0	5 0	13 +1
11	4 +1	0 +1	4 +2	6 0	3 0	8 -1	11 -1	2 0	11 +1
12	5 0	11 +5	6 +1	4 0	2 0	6 +1	10 -3	2 +1	6 0
13	1 0	16 -1	7 -1	3 0	12 +2	8 +1	4 -1	5 0	14 +2
14	0 0	9 +1	10 0	1 0	12 -1	18 0	1 0	3 0	10 +1
15	8 0	7 0	7 +1	3 -1	12 -1	11 -1	2 +2	3 +1	11 +1
16	5 +3	9 +2	6 0	5 +3	8 -2	3 0	7 0	9 0	1 +1
17	2 +2	8 +2	4 +2	15 +2	10 0	3 -2	4 -1	12 0	10 +2
18	7 +1	3 0	3 +1	13 +1	4 -1	4 +1	9 +1	5 0	8 +2
19	9 +1	3 0	2 +1	11 +1	3 +1	11 +1	14 -1	2 0	4 +1
20	5 +1	4 +4	15 +2	8 0	7 +1	13 0	7 -1	1 +1	11 0
21	9 +2	11 +1	13 +2	3 +1	14 0	13 +1	6 -2	10 +3	6 +1
22	9 +1	14 -1	11 +1	4 +1	15 +1	14 -1	2 0	13 -1	5 +2
23	0 0	12 0	9 +3	11 +2	14 0	11 -1	1 0	11 0	2 0
24	0 0	2 +2	6 -1	13 +2	11 0	6 0	17 +1	10 +1	4 +1
25	8 +3	14 +3	8 0	12 +1	10 0	5 -2	15 -2	9 0	2 +1
26	12 +3	12 0	7 +1	11 -1	9 -2	1 0	10 -2	6 0	5 +1
27	9 +2	5 +3	7 0	10 +1	1 +1	0 +1	2 0	3 0	5 +2
28	7 +1	3 +1	8 0	7 +1	5 0	17 +1	9 +2	5 0	4 -1
29	3 0	14 +1	11 0	3 0		15 0	8 0	5 0	4 +2
30	2 +1	9 0	13 +2	8 -1		18 +1	1 0	4 +2	2 0
31	3 +2		11 +2	2 -1		18 -2		6 +1	

1941	Jul	41 Aug	41 Sep	41 Oct	41 Nov	41 Dec	1942 Jan	42 Feb	42 Mar
1	5 0	4 +1	9 +1	2 0	18 -1	18 0	1 0	2 +1	19 +1
2	4 -1	14 -1	8 -1	3 +1	1 +2	12 -1	7 +4	9 0	15 0
3	5 +2	7 +1	2 0	1 +1	2 +2	5 +2	9 +2	4 -1	15 0
4	12 +1	19 -1	1 0	1 +1	3 -1	9 +1	12 0	1 +1	9 0
5	22 0	12 -1	0 0	3 0	8 +1	6 +2	11 0	11 +2	16 +1
6	15 +1	11 0	1 -1	2 0	15 0	5 0	7 +1	13 +2	11 0
7	16 -1	9 +2	10 +2	1 0	9 +1	4 0	7 -2	6 0	10 +1
8	8 +1	2 0	5 +1	5 +1	10 0	3 +2	1 +1	1 0	14 -1
9	8 +2	1 0	5 +1	3 0	7 +2	4 +1	2 +1	1 0	15 -1
10	11 0	0 +1	3 +1	3 +3	11 0	2 +1	6 0	5 +2	8 0
11	4 +1	4 0	4 +1	15 +1	11 -1	0 +1	5 -1	5 0	6 -1
12	5 +1	3 0	1 0	12 -2	5 +1	1 +1	5 +1	1 0	2 0
13	1 +1	3 +1	12 +1	5 0	3 +1	5 +4	2 +1	3 -1	13 -1
14	1 0	3 0	12 +1	7 +2	2 +1	12 -1	1 +3	3 +2	12 0
15	2 0	1 0	12 +1	9 -1	0 +2	5 +1	4 +1	8 +1	7 -2
16	7 +1	1 0	10 0	8 +1	2 +1	7 +1	5 +3	7 0	2 0
17	5 0	1 0	6 0	2 0	13 +2	6 +1	10 +1	5 -1	5 -1
18	3 0	2 +1	22 0	2 0	10 +2	7 +2	10 0	1 0	8 +2
19	3 0	9 +2	21 0	6 0	10 0	2 +1	9 0	1 +1	10 +1
20	5 0	1 +1	14 +1	3 0	4 0	1 +1	2 +1	4 +1	9 -2
21	14 0	4 +1	13 0	1 +1	6 -1	1 +2	1 +1	6 0	11 0
22	10 0	1 +1	2 0	13 +3	8 +1	1 +1	5 +1	4 -1	9 -2
23	8 +1	1 -1	8 +2	8 +1	8 0	4 +3	3 -1	14 +3	7 0
24	5 +2	5 -1	12 +1	8 +1	2 0	4 +1	1 +1	12 +1	5 -2
25	5 +2	5 +2	11 0	3 +1	2 +1	1 0	2 0	9 0	3 -1
26	1 0	11 +2	1 +1	5 +3	1 0	4 0	1 0	3 0	12 +3
27	1 -1	17 -1	7 -1	3 +1	5 +2	7 +1	2 +1	5 +3	4 0
28	1 +1	11 +2	4 0	3 0	16 0	5 -1	6 0	12 +2	1 -1
29	1 0	13 0	10 -2	3 0	4 +1	6 0	1 +1		8 +1
30	1 +1	12 0	7 0	4 0	3 +1	3 +1	2 +1		7 0
31	3 0	6 0		15 +1		2 +1	1 -1		5 0

1942	Apr	42 May	42 Jun	42 Jul	42 Aug	42 Sep	42 Oct	42 Nov	42 Dec
1	5 +2	7 +1	1 +1	8 0	2 0	6 +2	0 +1	7 +1	3 +1
2	12 +1	6 +2	0 0	2 0	3 0	9 -1	16 +1	8 +1	2 0
3	13 -1	4 -1	5 +2	1 0	4 -1	3 0	15 0	5 +1	2 +1
4	17 +1	8 +2	1 +1	0 0	1 +1	4 +1	13 0	7 -2	7 -1
5	6 -1	10 -1	3 +1	2 0	2 +1	5 0	10 +1	3 0	1 +1
6	3 -1	3 0	2 0	3 +1	7 +1	12 0	3 0	4 -1	1 +1
7	1 0	1 0	1 0	3 +1	9 +2	6 0	9 -3	5 -1	6 +2
8	12 0	1 0	1 +1	13 0	1 -1	5 -3	4 0	8 +1	9 -1
9	5 0	1 -1	0 0	7 +1	2 +2	3 -1	3 -1	3 0	11 +3
10	2 +2	3 +1	0 0	4 +3	12 +1	4 -2	3 +2	6 +2	11 -1
11	15 -1	2 0	11 +1	15 +1	5 +2	12 0	6 +2	8 -1	9 0
12	3 -1	1 -1	7 +3	9 +3	6 0	16 +1	14 0	6 -2	7 +1
13	11 +1	1 -1	9 +1	5 0	1 0	11 0	13 -1	7 +1	2 0
14	12 0	10 0	8 +1	7 0	1 0	13 -1	13 0	9 -1	4 0
15	1 0	3 +1	2 -1	12 0	5 +2	12 -1	12 0	7 -2	2 +1
16	10 -1	3 +1	4 0	9 0	14 -1	11 0	11 0	3 0	4 0
17	15 -1	2 0	5 0	6 0	10 +2	14 0	8 -3	3 0	1 0
18	13 0	2 0	4 0	2 0	11 +1	12 0	10 0	6 -1	0 0
19	8 -1	1 0	9 +3	2 0	12 0	12 -1	13 -1	3 -1	1 0
20	5 0	5 +1	5 0	9 +3	9 +1	12 -1	10 -1	8 +2	6 +1
21	1 0	5 -1	2 0	8 0	5 +2	14 -1	4 0	5 -1	13 +2
22	1 -1	8 0	0 +1	3 0	7 -1	11 -1	1 0	2 0	9 +1
23	12 +1	4 0	2 +4	5 -1	15 -1	4 -1	2 0	9 +3	13 +2
24	4 +2	2 +1	5 0	4 +1	10 +1	3 0	1 0	17 0	10 0
25	0 0	2 0	3 +1	11 +1	10 0	2 -1	7 0	13 +1	8 -1
26	1 -1	0 0	2 +1	5 +1	7 +1	3 -1	4 +2	14 0	12 -1
27	7 +2	9 +2	1 +1	12 -1	7 0	4 +1	4 0	8 +1	3 0
28	10 -1	9 0	6 +3	8 +2	1 0	2 0	16 +1	12 +1	2 0
29	2 0	2 0	7 +3	5 0	1 0	2 0	18 0	9 0	1 +1
30	6 +3	2 0	9 0	6 -1	3 +3	2 0	14 0	4 0	0 0
31		1 0		4 0	5 0		13 -1		0 0

1943	Jan 43	Feb 43	Mar 43	Apr 43	May 43	Jun 43	Jul 43	Aug 43	Sep
1	1 +4	3 0	3 +1	8 -1	17 -2	4 0	1 0	10 0	14 -2
2	3 -1	3 -1	9 +1	7 +1	11 +1	3 0	2 0	12 -2	13 -1
3	4 +1	6 -1	5 +1	14 -1	6 +1	2 -1	8 0	12 -1	16 -2
4	13 +1	8 -1	11 +1	11 -1	5 -1	1 0	11 +3	12 0	12 -1
5	10 -1	7 0	9 0	12 0	5 -1	3 0	15 0	10 0	11 -2
6	6 -2	7 -1	4 0	12 0	2 0	6 +1	15 -1	8 0	6 -2
7	1 0	2 +1	3 +1	10 -1	3 -2	7 0	9 -1	10 0	4 -2
8	2 +2	3 +1	5 -1	4 -1	0 0	12 +1	11 0	18 -1	12 -1
9	5 -3	3 0	4 -1	1 +1	1 0	11 0	13 0	16 -5	14 -2
10	3 0	1 +1	2 0	12 +1	2 +1	10 0	11 0	5 -2	13 -2
11	1 +1	5 -1	8 +2	14 -1	4 +2	7 0	10 +1	3 -1	12 -3
12	3 0	2 +1	11 0	2 0	7 -1	7 +1	9 0	5 0	10 -1
13	1 0	7 +1	1 -1	1 0	9 +1	11 -1	9 -1	16 0	12 -2
14	0 0	2 0	5 -2	1 -1	7 -1	8 0	1 0	12 0	11 -1
15	0 +1	2 0	1 -1	4 +1	12 -1	1 0	4 +1	10 -1	8 -2
16	2 +3	1 +3	12 +1	8 -2	7 +1	1 0	6 -2	12 0	6 -1
17	12 +1	15 +1	6 0	4 -2	12 -1	0 +1	6 0	12 -2	6 -2
18	5 +1	8 -3	3 0	3 -1	14 -1	1 0	10 +1	14 0	5 -1
19	3 0	5 -1	6 +2	2 -1	10 0	7 +1	8 0	13 +1	7 -3
20	14 +2	2 +1	12 +1	5 0	2 0	11 +1	4 0	14 -1	4 -1
21	12 +1	1 +1	5 0	11 -1	1 +1	11 0	8 -1	10 -3	11 -1
22	12 +1	1 +1	9 +3	4 -1	1 -1	11 -1	8 -1	2 0	11 -2
23	5 0	4 +1	13 -1	0 +1	5 +1	11 +1	3 -1	6 -2	7 -3
24	6 -3	4 +1	5 0	0 0	13 -2	11 0	1 +1	11 -2	3 -1
25	2 -1	7 +4	2 0	8 0	11 0	8 0	1 0	10 -3	7 0
26	9 -1	11 +2	2 +1	14 -1	4 +1	2 0	4 0	10 -2	14 -1
27	4 +1	6 0	2 0	4 +1	8 +1	4 +1	5 -1	2 0	14 0
28	5 +1	1 +1	1 +1	3 +1	12 0	10 +2	2 0	15 -1	15 0
29	2 0		14 +1	7 -1	6 +1	3 0	1 +1	14 0	17 -1
30	4 -1		12 +1	10 +1	4 -1	1 -1	11 0	18 0	17 +1
31	2 0		10 -1		2 0		8 0	20 0	

1943	Oct 43	Nov 43	Dec	1944 Jan 44	Feb 44	Mar 44	Apr 44	May 44	Jun
1	15 -1	12 0	4 +1	10 +1	1 +1	2 0	7 +1	14 +3	2 +1
2	15 0	3 -1	10 -1	3 0	3 0	5 +1	18 +2	12 -1	2 0
3	15 0	1 +1	12 -1	1 0	1 0	1 0	11 -1	5 -1	1 0
4	11 -1	1 0	10 0	3 -1	4 +1	12 +1	12 -1	10 +1	3 +2
5	5 -1	7 -1	9 -3	8 -1	2 +1	5 +1	12 0	9 0	3 +2
6	2 0	13 0	0 +1	2 +2	1 +1	11 +1	12 0	10 0	1 +1
7	9 0	9 -2	1 +1	2 0	14 +3	13 +1	11 -2	8 +1	1 +1
8	13 -1	7 -1	2 +1	2 +1	13 0	11 -1	9 -1	6 -2	1 -1
9	15 0	6 -2	5 -2	3 0	10 +2	13 -1	5 +3	1 +1	2 +1
10	10 0	5 0	4 0	8 +1	10 +1	14 +2	12 -2	1 0	2 0
11	7 -1	1 0	1 0	13 +1	10 0	8 +1	7 -1	2 -1	2 +2
12	7 -2	1 +1	1 0	12 0	9 -3	12 0	5 0	2 0	0 0
13	3 -1	1 +1	2 0	13 +1	8 0	9 0	0 0	0 +1	2 +1
14	1 +1	2 0	4 +3	13 +2	16 0	7 +1	0 0	1 0	5 +1
15	0 +1	1 +1	3 +1	12 +1	11 0	3 -1	6 +1	2 0	9 +2
16	2 0	8 -1	14 +2	12 0	5 -2	4 -1	14 +1	0 0	8 -1
17	7 -2	0 +1	14 -1	11 -1	2 0	0 0	5 -1	1 0	3 +1
18	4 -1	4 +1	11 -1	10 -1	1 0	8 +3	3 0	1 0	2 0
19	5 -2	17 +1	15 0	8 -1	1 0	13 0	1 0	1 0	2 +1
20	8 0	15 0	13 0	6 -1	9 +1	4 0	2 -1	0 +1	6 0
21	4 -1	14 +1	11 -1	3 -1	5 -1	3 +2	2 0	1 0	9 0
22	11 -1	12 -1	10 -1	3 0	2 0	7 0	0 0	1 0	11 0
23	6 -1	15 0	8 -1	3 0	2 0	5 +1	0 0	2 +2	8 +1
24	15 0	14 +1	4 0	3 0	1 +1	0 +1	8 -3	7 -1	2 +1
25	14 -1	15 +1	7 -2	2 +1	1 0	5 +3	4 0	3 +1	1 +1
26	16 +1	15 0	9 0	5 +3	1 0	14 +1	5 -1	3 +1	9 +1
27	13 0	15 -1	3 0	7 0	1 0	17 +1	7 -1	5 0	6 -1
28	15 -2	12 -2	1 0	5 -1	2 0	6 +3	6 0	2 +3	2 0
29	14 0	12 -1	5 -1	3 -1	4 0	12 -2	5 +1	12 0	5 +1
30	13 -1	4 -1	2 +1	1 0		9 -1	11 -2	6 +2	3 0
31	14 -1		8 0	3 +1		5 +1		5 +2	

1944	Jul 44	Aug 44	Sep 44	Oct 44	Nov 44	Dec	1945 Jan 45	Feb 45	Mar
1	2 0	3 +1	7 -1	11 +1	1 0	4 +1	6 +1	2 -1	2 -1
2	3 -1	8 +3	12 0	3 +1	1 0	8 +3	6 -2	6 +2	2 +1
3	2 +2	15 +1	5 0	10 0	3 +1	6 -1	5 +1	4 -2	6 -1
4	2 +1	3 -1	4 +1	4 0	7 +1	3 -1	5 +2	2 -1	2 -1
5	2 0	3 +1	3 +1	2 -1	12 +2	3 +1	2 0	9 0	10 +2
6	2 +1	4 -1	2 0	6 +3	8 0	3 0	3 -1	7 0	9 +1
7	4 +1	2 0	3 0	3 0	2 0	0 0	2 0	3 0	5 -1
8	1 +1	3 +2	5 +1	0 0	2 0	1 0	1 0	9 -1	11 0
9	6 +2	2 0	3 -1	1 0	4 -1	3 -1	6 +2	8 0	3 +1
10	3 +2	5 +1	3 0	3 +2	5 +4	1 0	12 0	4 0	2 0
11	2 -1	6 -1	4 0	13 +1	1 0	1 0	0 0	6 -1	14 0
12	1 +1	6 0	5 0	5 0	1 -1	1 0	2 +1	4 -2	16 +1
13	2 +1	3 0	3 +1	6 -1	0 0	9 +3	4 0	0 0	6 -3
14	3 +1	2 +1	6 -1	12 +3	1 +1	10 -2	1 0	2 +2	7 -1
15	5 +1	2 0	1 0	14 0	0 0	4 +4	14 +3	11 +1	17 0
16	4 +2	2 +1	2 -2	6 -2	1 0	18 +1	8 -2	11 0	11 0
17	4 0	2 +1	1 +1	6 -2	0 +1	17 +2	8 +1	7 +1	5 0
18	2 +2	10 +3	5 -1	5 -1	4 -1	10 +2	3 0	4 -2	6 -1
19	4 +3	4 +1	0 +1	1 0	4 0	4 -1	6 -1	2 -1	2 -1
20	6 +2	2 0	4 +3	2 +1	10 +2	4 0	6 -2	1 0	11 0
21	4 +2	1 0	10 -1	2 -1	0 +1	6 -2	2 +1	0 0	5 0
22	3 +1	2 +1	5 +1	2 -1	0 +2	4 +1	1 -1	3 +1	1 -1
23	2 -1	5 +3	7 +1	8 +2	1 0	2 0	1 -1	3 +2	1 -1
24	0 0	7 +2	12 0	10 0	0 +1	0 +1	0 0	3 0	4 +2
25	1 -1	1 -1	6 0	4 +1	0 +1	1 -1	0 0	8 -1	6 0
26	1 +1	2 +1	7 -1	8 -2	3 0	4 +2	4 +2	11 +1	16 0
27	1 +1	3 0	8 0	4 0	0 +1	14 +2	2 0	9 +1	12 -1
28	1 +1	10 +2	3 0	4 -2	0 +2	8 +1	7 +4	4 +1	16 +1
29	2 +2	2 0	4 -1	1 +1	1 0	6 +2	16 0		8 -1
30	2 +1	5 -1	13 +2	2 -1	3 +1	10 -1	8 -1		1 0
31	3 +1	9 +2		7 -1		4 0	1 0		1 0

1945	Apr 45	May 45	Jun 45	Jul 45	Aug 45	Sep 45	Oct 45	Nov 45	Dec
1	16 0	6 -1	1 -1	15 -1	2 +1	2 0	4 0	1 -1	0 0
2	9 -2	7 -2	1 -1	6 0	10 0	3 0	3 -1	0 +1	2 0
3	1 0	8 -3	1 0	3 0	3 -1	1 0	0 0	1 0	0 0
4	3 +2	3 -1	1 0	8 +2	2 0	10 0	0 0	3 +1	0 0
5	10 -1	3 -2	2 0	9 -1	4 +2	4 -1	5 +2	5 0	2 +2
6	11 0	3 -1	11 +1	12 0	4 0	3 -1	1 +1	0 0	6 +2
7	10 -2	1 0	8 0	5 +1	3 +1	2 0	5 +2	1 0	4 0
8	9 -1	2 -1	10 0	8 -2	2 +1	2 +2	5 +1	6 +3	8 -1
9	0 0	6 +2	6 +1	3 -1	1 0	2 0	3 -1	15 +1	7 -1
10	1 0	6 +2	7 0	1 +1	0 +1	1 0	0 0	7 -3	3 -3
11	13 +2	11 0	5 0	1 0	2 +1	7 +1	0 0	10 0	1 -1
12	13 0	8 -2	2 0	2 -1	2 0	8 -1	13 +2	10 -1	1 0
13	8 -2	5 -1	2 0	1 0	6 +2	5 0	7 -2	5 +1	10 +3
14	11 -2	5 0	1 0	1 0	9 +1	1 -1	6 0	3 0	18 0
15	8 -2	1 -1	1 0	1 -1	5 +1	1 -1	3 +1	5 0	6 -1
16	2 0	4 -2	1 0	5 +1	3 +2	3 0	8 +2	8 +1	2 0
17	1 0	3 0	4 0	8 +2	2 0	14 +2	5 +1	5 -1	8 0
18	2 -1	6 +1	2 0	4 0	0 0	15 +1	4 -2	1 -1	2 -1
19	6 0	5 -1	2 -1	4 -1	0 0	7 0	6 +1	0 +1	9 +2
20	8 -2	4 0	3 0	1 -1	0 0	5 -1	5 0	1 -1	12 0
21	1 0	4 0	1 0	1 0	4 0	4 0	2 0	1 +1	11 -4
22	4 +1	2 -1	0 +1	1 0	5 +5	2 -1	4 +1	1 0	0 0
23	8 -2	4 -1	1 0	8 +1	6 +1	0 0	1 0	1 +1	7 +2
24	9 -1	5 -1	1 -1	4 +1	1 0	0 0	16 +2	0 0	9 +1
25	4 -2	9 -3	3 -1	1 0	0 +1	3 +2	15 0	2 -1	11 +3
26	0 0	3 0	1 -1	2 -1	1 0	3 -1	1 0	0 0	12 -1
27	1 0	4 0	7 -1	0 +1	4 0	7 -2	8 +2	0 +1	12 0
28	0 0	3 -1	2 +1	7 0	13 +2	3 -1	14 -1	1 0	12 -2
29	2 +1	5 -1	1 -1	5 0	3 +1	2 +1	5 0	6 0	7 -2
30	7 0	9 -1	7 +1	9 -2	1 0	9 -1	3 0	1 0	3 -1
31		5 -1		1 +2	1 +1		1 0		4 -1

1946	Jan 46	Feb 46	Mar 46	Apr 46	May 46	Jun 46	Jul 46	Aug 46	Sep
1	6 +2	1 -1	12 -1	10 -2	4 -1	3 -1	1 0	3 -1	2 -1
2	4 +3	5 -1	9 -2	11 -2	5 -2	3 -2	5 -3	2 -1	5 -2
3	17 +2	6 +1	2 0	4 -1	3 -1	0 0	9 -1	2 -1	4 0
4	16 0	6 +1	12 -2	3 -1	5 -1	3 0	2 -1	1 -1	9 -1
5	6 -2	8 -2	12 -2	5 -1	5 -1	5 0	1 0	2 0	7 -1
6	7 0	8 -3	9 -2	5 -2	15 -2	7 0	2 -1	4 -2	3 0
7	3 +4	19 +1	5 0	8 -3	14 0	15 -1	14 -1	11 -1	10 -1
8	2 0	19 +1	2 0	5 -1	14 -2	13 -1	9 +1	3 +1	6 -1
9	1 0	9 -3	7 +3	14 -2	16 -4	10 -1	10 +1	2 0	7 +2
10	2 +1	10 -3	17 0	5 -2	9 -1	4 0	6 -2	3 -1	10 -3
11	11 -1	4 -2	13 -1	2 -1	15 -1	7 -2	8 -4	12 0	6 -1
12	5 -1	5 0	1 -1	8 -1	5 -3	12 -1	3 -2	8 -1	7 -2
13	1 0	8 -2	2 -1	11 0	5 -3	9 -2	2 -1	4 0	4 -2
14	1 -1	13 -1	2 0	12 -1	2 -1	5 -2	10 -1	16 -2	4 -2
15	1 +1	10 -2	5 +2	17 -1	2 -1	4 -1	6 -1	11 -2	3 -2
16	4 -1	4 -1	1 +1	5 -2	4 -2	10 -1	8 0	11 -1	13 +1
17	6 +1	4 -2	11 0	3 -2	8 -2	12 -2	7 -1	11 -1	13 -1
18	7 +1	3 0	4 0	4 -2	8 -2	10 -2	14 0	2 0	19 +1
19	6 -1	12 +1	2 +1	2 -1	1 0	14 -2	12 -1	4 -1	17 -1
20	1 0	11 +1	7 -1	2 -1	6 +2	7 -3	2 0	2 0	8 -3
21	0 +2	16 -1	7 -2	1 -1	13 -1	9 -2	6 -1	1 -1	11 0
22	7 -1	10 -1	12 +1	9 0	16 -1	7 -2	7 -1	0 0	21 0
23	9 0	11 0	11 0	19 0	14 -1	2 0	10 -1	1 -1	20 -1
24	13 +1	6 +1	19 0	19 0	11 -1	2 -1	2 -1	3 0	11 -3
25	7 +1	7 -2	21 0	6 0	9 -2	6 -1	10 -3	3 -1	2 -1
26	10 -1	4 -2	16 -1	5 -2	5 -1	7 -2	17 0	1 0	3 -2
27	2 0	0 0	13 -2	4 -1	2 -1	10 -2	20 -1	3 -1	14 0
28	1 +1	1 0	22 0	7 -2	5 -2	8 0	10 -1	2 -1	18 -1
29	4 -1		14 -1	6 -2	4 -1	15 0	17 -2	1 -1	14 -1
30	3 -1		3 -1	2 -1	3 0	3 0	13 -1	3 +1	14 -2
31	3 0		8 -1		9 -3		4 -2	16 -2	

1946	Oct 46	Nov 46	Dec 1947	Jan 47	Feb 47	Mar 47	Apr 47	May 47	Jun
1	11 -2	12 -1	3 -1	3 0	5 -1	3 -1	5 -2	8 -1	12 -1
2	7 -2	5 -1	5 -2	6 +3	1 0	18 +1	5 -1	1 -1	2 -1
3	8 -4	2 -2	6 -3	8 +2	4 0	19 +1	8 -1	2 0	5 -1
4	7 -3	3 -1	3 -1	11 +1	8 -2	18 -2	11 -1	2 0	3 0
5	9 -1	8 +1	7 0	12 0	2 0	6 -1	6 -1	5 -2	13 0
6	9 0	11 +1	4 -1	11 -2	6 -1	3 -1	10 -2	4 0	7 -1
7	8 -2	5 -2	7 -1	6 -1	5 +3	10 -1	5 -1	2 0	10 -2
8	1 +1	2 0	5 -2	4 -2	12 +1	18 0	9 -1	0 +1	11 -2
9	13 -1	6 -2	2 -1	0 0	11 0	15 -1	13 -1	0 0	9 -1
10	8 -3	7 0	7 0	0 0	8 +1	3 +1	6 -1	2 -1	6 -1
11	5 -2	10 -3	8 +2	0 0	3 0	3 0	8 -3	4 0	4 -1
12	7 -4	10 -3	9 -1	0 0	2 0	10 0	7 -1	7 -1	4 -1
13	3 -2	4 -2	5 -2	0 +1	2 -2	9 0	6 -1	10 -2	11 0
14	3 -2	2 -1	0 0	1 0	1 -1	12 -1	7 0	11 0	17 -1
15	3 -1	9 +1	0 0	2 +1	1 -1	14 +1	9 -4	13 -1	8 0
16	4 0	10 -3	2 0	14 +1	15 +1	10 -1	8 -2	14 -1	3 +1
17	1 0	3 -1	5 0	8 0	14 0	12 -2	19 -1	8 -2	14 +1
18	1 0	3 -1	3 0	5 +1	7 -1	8 -1	16 -1	9 -2	7 0
19	4 0	10 -1	12 +1	5 0	12 -1	6 0	12 -2	6 -1	8 -2
20	12 -2	9 -1	2 -1	2 +1	6 0	8 -3	13 -1	3 0	4 -1
21	3 +1	12 +1	7 +1	3 -1	1 -1	5 -1	4 -1	4 -1	4 -1
22	2 0	9 -2	7 0	3 +1	1 +1	11 -2	0 0	5 +1	8 -1
23	4 -2	5 -2	5 -1	2 0	0 0	13 0	1 -1	12 0	9 -2
24	3 -1	12 0	2 -1	11 0	4 0	13 -3	0 0	16 0	6 -1
25	5 -2	10 +2	6 +2	17 -1	6 +1	7 -1	6 0	7 0	11 -2
26	13 -1	5 -1	7 0	12 0	8 -2	12 -1	8 -3	11 -1	10 -2
27	16 -1	0 0	8 -1	9 +1	3 -1	12 0	8 -2	8 -1	3 +1
28	6 0	1 -1	5 -2	6 0	3 +1	18 -3	7 -3	10 -1	5 -1
29	6 -1	0 0	3 -1	6 -2		9 0	6 0	11 -1	2 -1
30	2 -1	1 0	0 0	3 +1		14 -3	7 -2	2 0	6 -1
31	9 +1		2 -1	3 -1		11 -2		9 0	

1947	Jul	47 Aug	47 Sep	47 Oct	47 Nov	47 Dec	1948 Jan	48 Feb	48 Mar
1	6 -1	10 -1	6 -1	14 -1	6 -1	7 0	7 +2	1 +1	15 -1
2	9 -2	8 -1	5 0	17 -2	4 -1	4 +2	10 +2	7 +1	13 0
3	4 -1	5 -1	18 0	15 -2	2 0	1 0	15 +1	13 +2	12 -2
4	1 0	5 +1	14 -2	5 -2	5 +1	5 +2	1 0	8 +1	5 -1
5	1 0	3 -1	10 -1	3 -1	1 0	8 -1	4 +2	9 0	5 0
6	4 +1	7 -1	11 +1	5 -1	0 0	13 0	7 -1	5 +2	8 0
7	5 -1	4 -1	15 -1	9 0	1 +1	7 +1	9 +1	5 +1	4 +1
8	7 -2	4 -2	10 -1	7 -1	9 0	5 -1	11 +1	5 +1	3 +2
9	5 0	3 -1	3 -1	16 0	17 0	11 0	9 0	1 0	5 0
10	7 -1	4 -1	1 0	17 -2	16 -1	7 -2	6 -1	6 0	5 +2
11	6 0	6 +1	9 +1	15 -2	16 0	9 -2	6 -2	4 -1	4 +4
12	5 0	12 0	9 0	15 -1	11 -3	10 +1	5 +2	4 0	11 0
13	6 0	12 -1	16 -2	12 0	8 -2	10 -1	2 0	6 +1	14 0
14	3 0	7 +1	17 -2	15 -2	6 -1	8 -2	1 0	6 +1	15 -1
15	4 -1	16 +1	17 -3	15 -1	8 -2	7 -1	2 +2	12 +2	19 0
16	2 +2	16 0	11 -3	11 -1	8 -3	2 -1	3 -1	12 0	5 +2
17	17 -1	17 -3	16 -1	9 -2	3 0	2 -1	12 +2	9 0	7 0
18	17 -1	17 -3	15 -2	9 -2	5 -1	4 -1	7 0	10 +1	3 -1
19	12 -1	16 -3	12 -1	13 -2	10 -2	5 -1	7 +1	8 0	5 -1
20	13 -1	15 -2	11 -3	11 -2	4 0	2 -1	8 +2	2 -1	6 +1
21	7 -2	15 -3	11 -3	8 -1	5 0	0 0	9 0	0 0	7 0
22	9 -3	18 0	13 -1	6 -3	3 0	3 +2	7 0	2 0	5 0
23	11 -2	16 -2	15 -2	9 -3	5 -1	7 +2	4 -2	12 +1	1 +1
24	7 -2	11 -1	18 -1	7 -1	7 +3	3 +2	1 0	9 +2	1 0
25	10 -2	12 -2	19 -2	3 0	5 -1	2 0	2 -1	2 0	1 0
26	10 -2	7 -2	8 -1	1 0	2 0	6 0	1 -1	1 +2	5 +3
27	10 -3	7 -2	7 -1	1 0	4 0	8 -1	4 +1	7 +1	6 0
28	4 -1	6 -2	6 -1	1 -1	3 0	5 -1	2 +1	9 0	3 0
29	6 -1	8 -1	5 0	1 0	7 -1	7 +2	9 +1	9 0	2 0
30	2 -1	4 -2	6 +1	2 0	3 +3	1 +1	8 0		7 +1
31	3 +2	8 -1		5 0		0 0	5 0		6 +3

1948	Apr	48 May	48 Jun	48 Jul	48 Aug	48 Sep	48 Oct	48 Nov	48 Dec
1	11 -1	6 -2	13 +1	4 +2	7 +1	14 -2	15 0	9 +2	1 -1
2	9 -2	12 -1	5 0	3 0	7 +2	12 -1	15 -1	16 +1	4 +1
3	8 -1	10 0	3 0	5 0	5 0	8 -1	12 -1	10 -1	5 -3
4	4 -1	8 +1	2 0	11 -1	10 +1	12 -3	9 +1	1 0	2 +2
5	2 -1	4 0	4 +1	8 0	3 +1	4 -1	9 -2	2 0	3 0
6	12 +1	10 -3	3 0	6 +1	4 +2	3 0	1 0	3 +1	11 +3
7	7 +2	14 -1	5 +1	4 +2	9 +1	8 -1	3 +2	7 -1	10 +1
8	1 0	8 -2	5 0	6 0	20 0	5 -1	3 0	9 0	5 +2
9	1 +2	13 0	5 +1	4 -1	16 +1	5 +1	1 0	8 0	4 -1
10	4 +1	10 -2	3 0	6 +2	18 0	5 0	12 0	4 -1	4 +3
11	3 -1	8 -1	3 +1	3 +1	12 +1	7 +1	10 -1	3 0	8 +1
12	7 0	7 -1	4 0	4 0	13 -2	10 +1	8 -1	1 0	1 -1
13	7 0	9 +1	7 -1	4 0	7 -1	4 +1	7 0	4 +1	8 +1
14	9 +1	5 -1	1 +2	9 +1	6 -1	4 0	14 +1	3 0	12 -1
15	8 0	15 -1	0 +1	4 +1	4 -1	9 +1	16 -1	7 +2	6 0
16	3 -1	18 -1	0 0	7 +1	1 0	11 0	4 -1	8 -1	9 +1
17	3 0	5 +1	6 +1	7 -1	2 +1	5 0	14 -1	11 -1	4 0
18	4 0	5 0	7 +3	2 +1	2 0	5 +2	18 0	11 0	4 0
19	2 0	2 0	9 +1	1 0	5 +4	5 0	19 -1	11 -1	5 -2
20	7 +1	3 0	7 +1	2 +1	13 +1	3 +1	11 -1	16 0	4 +1
21	11 +2	15 0	11 0	6 +1	9 0	4 +2	17 0	13 -1	12 +1
22	16 -1	12 -1	9 -1	3 -1	5 +1	9 +1	14 -1	11 0	7 -1
23	4 -1	9 -1	3 +1	2 +1	9 0	10 0	13 0	9 -2	3 +3
24	6 +1	9 0	3 +2	2 -1	5 +1	11 +1	13 -1	11 0	10 0
25	8 -1	7 0	6 +2	3 0	3 +1	13 -1	9 0	11 +1	13 +2
26	8 0	4 -1	11 -1	6 0	1 -1	11 -1	11 -1	8 +2	8 +1
27	7 -1	4 0	6 -1	3 0	1 +2	2 -1	13 0	7 -1	6 -1
28	5 0	2 +1	1 +1	5 +2	6 +1	0 0	6 -1	7 -1	2 -1
29	10 0	12 -2	1 0	10 +1	12 0	12 0	5 0	3 -2	5 +1
30	5 0	8 0	2 +2	9 +1	11 -1	10 0	3 0	1 -1	11 +3
31		5 +1		12 0	6 -1		7 -1		13 0

1949	Jan	49 Feb	49 Mar	49 Apr	49 May	49 Jun	49 Jul	49 Aug	49 Sep
1	8 -1	1 +1	9 +3	2 +1	1 +1	7 0	2 +1	2 +1	10 0
2	15 -2	2 -1	12 -1	3 -1	6 -1	6 -1	1 -1	10 +3	11 0
3	2 -1	7 +5	11 -1	5 0	12 0	6 0	1 +2	17 -1	14 +1
4	1 0	13 -1	5 0	3 -1	13 0	17 0	1 0	17 0	8 0
5	1 -1	4 0	7 -2	3 -1	10 -1	17 -1	1 +1	10 +1	6 -1
6	5 +2	11 +2	1 -1	2 -1	9 -1	12 0	1 0	5 +2	5 -3
7	9 -2	11 -1	3 -2	13 +2	5 -1	7 +1	6 0	7 +1	3 0
8	6 +2	1 0	4 -1	18 0	6 0	3 -1	5 +1	13 0	7 +1
9	9 +1	1 0	11 +1	5 +1	9 0	4 +1	5 +1	6 +1	4 0
10	9 0	3 0	1 0	13 -2	6 0	1 0	1 0	6 0	1 0
11	8 0	10 +1	1 -1	13 -1	9 +1	2 0	2 0	1 0	6 -2
12	9 +1	9 -3	5 +1	12 +2	20 0	14 -1	6 +2	1 0	12 0
13	9 -2	9 -2	11 0	12 -1	17 -1	11 -1	8 +3	4 +1	8 -2
14	3 -1	7 -1	14 0	10 -1	10 -1	3 +1	2 +3	13 -1	9 +1
15	2 0	7 +1	11 -1	6 0	4 -1	7 +1	0 +1	12 0	6 -1
16	5 -1	5 -1	14 +1	8 -1	9 -1	4 0	10 +1	4 +1	7 -2
17	3 +2	12 +2	14 0	7 -1	4 +1	5 +1	7 +1	8 0	3 0
18	10 0	11 -1	14 -2	3 +1	1 -1	8 0	7 +2	7 0	1 +1
19	10 -1	4 -2	6 -1	3 0	2 +1	5 -1	9 0	6 0	0 0
20	4 -2	4 +3	7 0	2 -1	1 0	3 -1	3 +1	6 -1	0 0
21	6 0	11 +2	11 +1	2 -1	4 +1	2 0	2 +1	4 0	0 +1
22	8 -4	15 0	18 0	2 0	4 +2	6 +1	7 0	3 -1	3 0
23	6 +1	6 +2	15 -1	3 +1	5 -1	2 -1	9 0	1 -1	2 -1
24	14 +1	12 -1	4 -1	4 +1	4 -1	4 -1	5 +1	0 0	8 +2
25	20 0	2 -1	6 -1	3 0	5 0	8 0	6 0	0 0	13 0
26	19 0	4 +1	9 -2	4 -1	3 +1	5 0	2 +1	2 -1	10 0
27	10 -2	10 -1	1 -1	8 -1	3 +1	5 -2	1 0	6 0	12 -1
28	4 -1	3 0	9 -1	3 0	3 -1	5 -1	1 0	4 -2	7 0
29	4 -1		9 -2	9 0	1 -1	9 -2	2 +3	4 +1	3 0
30	1 -1		6 -2	2 -1	14 +1	4 0	3 0	5 0	9 +1
31	3 0		1 -1		13 0		3 +1	4 0	

1949	Oct	49 Nov	49 Dec	1950 Ja	Fe	Mr	Ap	My	Je	Jl	Au	Se	Oc	No	De	1951 Ja	Fe
1	5 +1	13 +2	6 -1	4	4	6	15	3	9	7	10	2	17	16	3	7	12
2	5 -1	13 +1	2 -1	4	12	5	14	11	10	3	10	2	18	9	6	10	3
3	1 0	11 -2	6 +1	3	11	4	13	15	9	9	11	16	16	6	4	9	2
4	10 +2	5 0	8 +1	5	10	3	13	11	4	13	5	15	16	15	2	3	6
5	9 0	10 0	6 0	3	5	3	16	11	4	9	3	17	14	7	4	6	10
6	11 0	5 +1	6 0	6	5	8	13	6	14	6	6	15	12	2	9	2	14
7	17 0	2 -1	1 -1	6	8	11	10	6	2	6	15	10	13	0	6	2	6
8	14 +1	0 0	2 0	1	7	2	4	2	4	3	18	15	7	4	7	5	11
9	10 -1	4 +1	12 -1	6	7	4	5	0	12	7	14	9	6	2	5	3	12
10	5 0	8 +1	2 +1	5	1	2	5	4	10	5	15	11	2	14	5	7	12
11	10 0	12 0	1 -1	5	2	1	4	8	4	13	13	11	2	9	1	10	12
12	4 +1	9 +1	0 0	3	3	2	10	2	4	15	13	6	8	12	11	10	14
13	8 +1	6 0	1 -1	5	1	2	6	9	1	12	7	8	6	11	14	9	11
14	18 +1	7 +1	8 +2	10	3	6	2	9	2	6	11	1	15	6	14	9	7
15	20 0	5 +2	4 +1	6	4	11	10	11	1	6	7	1	12	1	7	10	2
16	17 0	7 -1	5 0	6	2	4	5	7	3	5	2	10	15	3	6	10	1
17	9 -1	1 0	2 0	2	1	3	6	3	8	3	1	11	12	8	4	6	2
18	4 0	5 +2	1 0	3	1	3	9	2	4	2	8	12	8	7	7	3	7
19	9 -1	14 +2	2 +2	7	3	18	12	2	2	2	19	12	2	2	7	8	7
20	6 0	15 -2	6 0	11	18	5	12	4	2	3	19	14	3	2	7	5	3
21	6 -1	9 +1	5 +3	10	18	12	1	4	4	5	10	5	1	2	3	10	6
22	9 +1	2 +2	4 +1	6	12	11	2	10	6	6	3	1	6	11	13	16	15
23	9 +1	4 +2	5 +3	3	16	3	9	13	11	0	4	12	9	4	14	11	17
24	10 -2	3 0	8 0	15	15	12	13	7	15	13	2	15	5	7	14	6	14
25	3 -1	1 0	4 +1	12	9	7	5	6	10	14	2	14	3	16	13	4	10
26	3 +1	1 +1	2 0	7	0	4	2	8	5	2	0	9	3	17	13	7	9
27	14 +1	7 +1	3 0	8	2	14	2	16	2	5	3	6	1	15	10	10	16
28	13 -1	2 -1	5 +1	7	7	6	7	17	2	5	10	3	18	15	7	10	16
29	8 -1	13 0	4 +1	2		8	9	11	14	5	11	1	17	11	4	8	
30	4 -1	14 +1	7 +2	9		4	13	9	14	6	9	7	16	8	4	9	
31	6 -2		9 +2	2		10		3		7	4		16		2	16	

Table 3a. Monthly and annual averages of Cp, multiplied by 100.

	Ja	Fe	Mr	Ap	My	Je	Jl	Au	Se	Oc	No	De	Year
1932	..	..	..	..	..	..	..	50	57	49	40	43	48
1933	50	49	57	64	51	40	35	43	..	..	..	..	
1940	71	62	80	65	60	63	56	54	63	64	73	72	65
1941	68	84	103	68	54	52	62	62	78	51	66	49	66
1942	45	56	90	71	38	38	61	61	76	87	70	52	62
1943	49	45	63	65	65	62	69	110	104	93	80	65	73
1944	61	52	77	67	43	38	26	43	51	53	25	54	49
1945	46	51	70	59	48	32	44	32	43	49	33	61	47
1946	54	79	91	71	76	74	80	48	95	62	62	47	70
1947	56	54	106	77	66	74	69	96	111	89	61	54	76
1948	59	66	67	64	84	48	52	75	74	100	75	65	69
1949	72	70	81	61	69	64	38	61	63	89	69	44	65
1950	59	67	63	82	74	64	66	85	91	96	81	73	76
1951	78	92	..	..	..	..	..	..	..	..	..	..	..
Average for 1932/33 and 1940 to 1950													
	58	61	79	68	61	54	55	62	76	74	61	57	64

Table 3b. Monthly and annual averages of the differences (Ci – Cp), multiplied by 100.

	Ja	Fe	Mr	Ap	My	Je	Jl	Au	Se	Oc	No	De	Year
1932	..	..	..	..	..	..	..	+17	+16	+24	+18	+24	+17
1933	+15	+16	+14	+12	+11	+15	+19	+17	..	..	..	..	
1940	+11	+ 6	+ 1	+ 5	+ 9	+ 9	+ 7	+10	+ 7	+ 8	+11	+ 7	+ 8
1941	+ 4	– 3	– 2	– 3	+ 4	+11	+ 4	+ 4	+ 2	+ 7	+ 7	+ 9	+ 4
1942	+ 7	+ 6	– 2	+ 1	+ 2	+10	+ 5	+ 5	– 3	0	+ 1	+ 4	+ 3
1943	+ 3	+ 5	+ 3	– 3	0	+ 2	0	– 9	–14	– 6	– 1	– 1	– 2
1944	+ 1	+ 2	+ 6	– 3	+ 4	+ 6	+ 9	+ 7	+ 1	+ 1	+ 6	+ 6	+ 4
1945	+ 2	0	– 1	– 4	– 7	– 1	0	+ 7	– 1	+ 4	+ 1	– 1	0
1946	+ 2	– 8	– 6	–12	–13	–11	–11	– 7	–11	–12	– 8	– 5	– 9
1947	+ 1	– 2	– 8	–14	– 5	– 8	– 9	–11	–11	–11	– 4	0	– 7
1948	+ 4	+ 4	+ 4	0	– 6	+ 6	+ 4	+ 4	– 1	– 3	– 1	+ 4	+ 2
1949	– 4	+ 1	– 6	– 2	– 1	– 3	+ 9	+ 1	– 2	0	+ 5	+ 5	0
Average for the ten years 1940 to 1949													
	+ 3	+ 1	– 1	– 4	– 1	+ 2	+ 2	+ 1	– 3	– 1	+ 2	+ 3	0

Table 3 lists 3 days with Cp = 2.2, 7 with 2.1, and 7 with 2.0 If, in addition to the days beginning at midnight Universal Time, intervals of 24 hours with other limits are admitted, higher values than 2.2 have occurred, e.g. the 24 hours beginning 1940 March 24, 12.00 U.T., would get Cp = 2.3, and the 24 hours beginning 1941 Sept. 18, 9.00 U.T., would get Cp = 2.4.

It should not be forgotten that the characterization of an interval of 24 hours by a single figure for the whole earth has its limitations and requires a compromise, especially if the day is partly quiet, partly disturbed. It is therefore recommended to use as much as possible the indices for three-hour-intervals, for a local measure of activity, the K-index provided by the nearest observatory, or for the Earth as a whole, the planetary Kp-index. But there is a demand for an objective measure of activity for a whole day and for the whole earth, and this shall be met by Cp. – If a local daily measure of activity is desired, a figure Ck will be suggested in Note 3.

The method used to introduce Cp, namely, assimilating of frequency distributions by ranking, has been applied before in the standardization of K [2]. See also Note 1 for a transitory stage (daily indices B and Bp) now given up. In Note 2, typical Kp-values leading to various figures Cp are tabulated.

The monthly and annual averages given in Tables 3a and 3b will be referred to in Note 5.

5. General relation between Ci and Cp. Tables 4 and 5 contain practically the same information in different arrangement. The correlation-coefficient between Ci and Cp is +o.962.

Table 4. Correlation-Table Ci..Cp for the 3653 days, 1940-49.

Tp \ Ti =	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Sum
0	90	46	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	141
1	72	203	96	9	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	383
2	3	80	152	82	25	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	348
3	1	12	87	123	77	26	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	331
4	.	.	28	76	87	74	26	10	4	.	1	.	.	.	.	.	.	.	.	.	.	306
5	.	.	7	29	79	84	62	39	15	3	1	.	.	.	.	.	.	.	.	.	.	319
6	.	.	.	4	27	64	67	45	32	8	.	.	.	.	.	.	.	.	.	.	.	247
7	.	.	.	1	6	29	54	49	60	23	8	3	1	.	.	.	.	.	.	.	.	234
8	.	.	.	.	3	12	28	50	49	44	24	6	.	.	.	.	.	.	.	.	.	216
9	.	.	.	.	.	1	9	28	32	50	54	21	8	.	.	.	.	.	.	.	.	203
10	.	.	.	.	.	.	.	11	20	41	45	26	20	3	.	.	.	.	.	.	.	166
11	.	.	.	.	.	.	.	1	5	17	46	54	30	10	6	.	1	.	.	.	.	170
12	.	.	.	.	.	.	.	.	.	2	17	46	59	32	7	4	.	.	.	.	.	167
13	.	.	.	.	.	.	.	.	.	.	1	6	35	29	16	18	1	.	.	.	.	106
14	.	.	.	.	.	.	.	.	.	.	.	1	9	28	22	21	9	6	.	.	.	96
15	.	.	.	.	.	.	.	.	.	.	.	.	1	11	22	20	15	3	1	.	.	73
16	.	.	.	.	.	.	.	.	.	.	.	1	1	1	6	12	13	10	1	.	.	45
17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	5	11	11	9	2	.	41
18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	5	13	4	1	26
19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	8	6	18
20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	17
Sums	166	341	375	324	306	295	252	234	217	188	197	164	164	114	82	81	52	36	27	16	22	3653

For the 3653 daily values of Ci, Cp, and (Ci - Cp),

	Ci	Cp	(Ci - Cp)
the arithmetic means are	o.646	o.643	+ o.003;
the standard deviations are	o.462	o.458	o.126.

The last two columns of Table 5 show that the scattering of (Ci - Cp) is lowest at the two ends of the scale; but at no level the standard deviation of (Ci - Cp) exceeds o.15.

The linear equations of regression according to least squares adjustments, are,

Ci = o.970 Cp + o.021 + Ri   Cp = o.954 Ci + o.028 + Rp

the standard deviations of the residuals are, for Ri, o.126 and, for Rp, o.125; the residuals of the equations Ci = Cp + R, with R = Ci-Cp, have the standard deviation o.126, practically not higher than those for the least - square residuals, Ri and Rp.

Table 5. Frequencies of the excess Ei = 10 (Ci - Cp), for fixed values of Cp, for the 3653 days, 1940-49.

Cp=	Ei = -5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	Sum	(Ci - Cp) Average	Stand. dev.
0.0	.	.	.	.	.	90	46	5	.	.	.	.	141	+0.04	0.07
0.1	.	.	.	.	72	203	96	9	2	1	.	.	383	+0.01	0.08
0.2	.	.	.	3	80	152	82	25	4	2	.	.	348	+0.02	0.10
0.3	.	.	1	12	87	123	77	26	4	1	.	.	331	+0.01	0.11
0.4	.	.		28	76	87	74	26	10	4	.	1	306	+0.02	0.13
0.5	.	.	7	29	79	84	62	39	15	3	1	.	319	+0.01	0.15
0.6	.	.	4	27	64	67	45	32	8	.	.	.	247	0.00	0.14
0.7	.	1	6	29	54	49	60	23	8	3	1	.	234	+0.01	0.15
0.8	.	3	12	28	50	49	44	24	6	.	.	.	216	-0.02	0.15
0.9	.	1	9	28	32	50	54	21	8	.	.	.	203	0.00	0.15
1.0	.	.	11	20	41	45	26	20	3	.	.	.	166	-0.02	0.15
1.1	.	1	5	17	46	54	30	10	6	.	1	.	170	-0.02	0.14
1.2	.	.	2	17	46	59	32	7	4	.	.	.	167	-0.02	0.12
1.3	.	.	1	6	35	29	16	18	1	.	.	.	106	0.00	0.12
1.4	.	.	1	9	28	22	21	9	6	.	.	.	96	+0.01	0.14
1.5	.	.	1	11	22	20	15	3	1	.	.	.	73	-0.03	0.12
1.6	1	1	1	6	12	13	10	1	.	.	.	.	45	-0.05	0.14
1.7	.	.	3	5	11	11	9	2	.	.	.	.	41	-0.04	0.13
1.8	.	.	1	2	5	13	4	1	.	.	.	.	26	-0.02	0.11
1.9	.	.	.	1	3	8	6	.	.	.	.	.	18	+0.01	0.08
2.0	.	.	.	.	2	15	.	.	.	.	.	.	17	-0.01	0.03
	1	7	65	278	845	1243	809	301	86	14	3	1	3653		

The last line of Table 5 shows that the differences (Ci - Cp) are, on 4 out 5 days, not higher than 0.1, more exactly

(Ci - Cp) = 0.0 for 1243 days, or 34 per cent of all days,
= -0.1 or +0.1   1654   45 ,
= -0.2 or +0.2   579   16 ;
= -0.3 or +0.3   151   4 .

The remaining 26 days (about 7 out of 1000 days) are listed in Table 6.

Table 6. Days with (Ci - Cp) numerically greater than 0.3, from the years 1940-49.

Date	Ti	Tp	Kp-indices
Ci - Cp = + 0.6			
41 Je 9	10	4	0+1-1+4- 3-1+2-2+
Ci - Cp = + 0.5			
40 No 12	16	11	2+0+2+5- 3+3+4o5+
49 Fe 3	12	7	2o0+1+1+ 2+2-4o5-
45 Au 22	10	5	0o1-1+1o 1+4-4o3-
Ci - Cp = + 0.4			
42 Ja 2	11	7	1o2o3-2o 3+3+4-3-
43 Fe 25	11	7	1-2o0+1+ 1+3o4o4o
45 Ja 28	11	7	2+1+1-0+ 1+2+4+5-
41 De 13	9	5	1+1o2o2- 3-3o3o2o
44 No 10	9	5	0+0+2o2+ 3o4o3o0o
48 Au 19	9	5	1o0+0+0+ 0+2-4o4+
40 Je 22	8	4	0+1o0+3+ 3+2o1+2+
40 No 20	8	4	0+0+1+1o 1+2+2o4+
44 De 15	8	4	1-1-2-1+ 1-1-3o4o
Ci - Cp = + 0.4 (contd)			
48 Mr 11	8	4	1o1o0+0+ 1+0+0+5-
46 Ja 7	7	3	0+1+1-1o 2o2o3o2o
40 Je 29	6	2	0+1+1-0+ 1+1o3o2-
42 Je 23	6	2	1-1-1+1+ 2o2o2o2o
43 Ja 1	5	1	0o0o0o0+ 0o1+3-3o
Ci - Cp = - 0.4			
46 My 9	12	16	4+5-5-4+ 6o6-6-5-
45 De 21	7	11	5o6-3+3o 2o1o1o1+
47 Ap 15	5	9	4o4o3-3o 3+3o2+3-
46 Jl 11	4	8	3+3+2+2+ 3-3o4-2o
46 Oc 3	4	8	3o4o4-1+ 3-3+1-1-
49 Ja 22	4	8	3o3+4+3o 3-2-1+1o
46 Oc 12	3	7	3+4-4o1- 1-1o1o3-
Ci - Cp = - 0.5			
43 Au 9	11	16	8-6+4+3- 3o3o2+4o

Table 7. Selected days differently characterized by Ci and Cp.
(Ti = 10 Ci, Tp = 10 Cp).

Pairs of days with equal Ci, different Cp				Pairs of days with different Ci, equal Cp			
Date	Ti	Tp	Kp-indices	Date	Ti	Tp	Kp-indices
44 No 28	2	0	0+0o0o0+ 0o1-2o1+	40 Je 29	6	2	0+1+1-0+ 1+1o3o2-
43 Ja 9	2	5	3o3-3+3+ 1-1+1-1o	46 No 3	0	2	2+1+3-0+ 1o1-0+1+
43 Ja 1	5	1	0o0o0o0+ 0o1+3-3o	41 Je 9	10	4	0+1-1+4- 3-1+2-2+
47 Ap 15	5	9	4o4o3-3o 3+3o2+3-	44 Oc 28	2	4	2-3-3-2- 2o1+2+2-
46 Ja 7	7	3	0+1+1-1o 2o2o3o2o	49 Fe 3	12	7	2o0+1+1+ 2+2-4o5-
45 De 21	7	11	5o6-3+3o 2o1o1o1+	46 Oc 12	3	7	3+4-4o1- 1-1o1o3-
41 Je 9	10	4	0+1-1+4- 3-1+2-2+	42 No 23	12	9	2o2-2-2- 3o4o3o5+
47 Mr 24	10	13	5-6o5+3- 2+3-3-2+	42 Oc 7	6	9	4+3+3+2- 3+3o1+2+
49 Fe 3	12	7	2o0+1+1+ 2+2-4o5-	40 No 12	16	11	2+0+2+5- 3+3+4o5+
46 My 9	12	16	4+5-5-4+ 6o6-6-5-	45 De 21	7	11	5o6-3+3o 2o1o1o1+
40 No 12	16	11	2+0+2+5- 3+3+4o5+	45 Oc 24	18	16	4-4-4+6- 6o5+6o5+
47 Mr 4	16	18	7+7o7+7- 4o3+5o3o	43 Au 9	11	16	8-6+4+3- 3o3o2+4o
44 Ap 2	20	18	4+5o8o8+ 6o4o5o4o				
46 Jl 27	19	20	9-9-9o7- 5+4-4-2+	←This day underrated by Ci			
All days with Ci = o.0, Cp = o.2 or o.3				All days with Ci = o.2, Cp = o.0			
44 Se 16	0	2	0+2o2-1- 1+2o1-1-	40 Ja 26	2	0	0+0o0o0+ 0+1-1+2-
46 No 3	0	2	2+1+3-0+ 1o1-0+1+	41 No 15	2	0	1-0o0+1- 1-1-1o1o
47 Fe 13	0	2	1o1+2-2- 2+1o1o0+	44 No 22	2	0	0+0o0o0+ 0+2o1o1o
45 De 10	0	3	2-3o1+2- 1+1o0+0+	44 No 28	2	0	0+0o0o0+ 0o1-2o1+
				46 Ja 21	2	0	0o0o0o0o 1-1o1+2+
All days with Ci = o.3, Cp = o.6 or o.7				All days with Ci = o.6 or o.7, Cp = o.3			
43 Ja 24	3	6	3+3-2-3o 2+2-2+2o	41 Oc 10	6	3	0+1-1o1- 1+2o3+2+
45 Mr 13	3	6	4-2o2o3+ 3o1+1o1-	42 Au 30	6	3	1-1o1o1+ 2-2+3+1o
46 De 3	3	6	4+3o2+3- 1+1+1o0+	46 Ja 7	7	3	0o1+1-1o 2o2o3o2o
47 Oc 22	3	6	3o4-3o2+ 3-1+1o2-	47 No 30	6	3	1o1+2-2o 1-2-3-3-
46 Oc 12	3	7	3+4-4o1- 1-1o1o3-	48 De 23	6	3	2o0+2o1+ 2-1o3-3-

6. **Discussion of days with large differences (Ci - Cp).** Table 7 is arranged to exhibit the essential reasons for the differences between Ci and Cp.

The comparison with the 8 values of Kp for each day in Table 7 shows that, in general, Ci is higher than Cp for such Greenwich days which are disturbed in the noon or evening hours, while Ci is lower for Cp if the main disturbance is restricted to the first three-hour-intervals (Eighths) of the Greenwich day, up to about 09 Universal Time. The reason seems clear: For the great number of European observatories the level of activity is generally low in the early morning hours, and high in the evening. This well-known daily variation of activity, numerically expressed in the Conversion-Tables K into Ks (IATME Bull. 12b), leads to an "European bias" in C, which is reflected in Ci (see also Note 4).

7. Systematic changes of (Ci - Cp). An inspection of the excess-values Ei = 10 (Ci - Cp) in Table 3 shows that there are significant changes in Ei from year to year. Thus, plus-signs prevail in 1932/33 and in 1940, and minus-signs prevail in 1946. For a closer study, it must be taken into account that Ei may depend systematically on Cp; in order to make the groups of days large enough in each sub-division, five levels of activity were kept separate, namely 10 Cp = Tp =(0, 1,or 2); (3, 4, 5);(6, 7, 8);(9, 10, 11, 12);(13 to 20). The frequencies of Ei = 10 (Ci - Cp) in each group were counted for each quarter year. As a sample the complete table for one level of activity (Cp = o.9 to 1.2) is reproduced here in Table 8. The shift in the frequencies from the Polar Year 1932/33 over 1940 to 1946/47 is quite obvious.

Table 8. Frequencies of the excess Ei = 10 (Ci - Cp) for all days with Cp = o.9 to 1.2, for quarters (JFM = Jan. Febr.March, etc.) and years, Polar Year 1932/33, and years 1940-49.

Ei=	-3	-2	-1	0	+1	+2	+3	+4	+5	Sum
32/33 JFM	.	.	.	2	3	6	3	.	2	16
AMJ	.	.	.	4	8	3	5	.	.	20
JAS	.	.	.	1	2	2	5	3	.	13
OND	.	.	.	.	2	.	6	.	2	10
Year	.	.	.	7	15	11	19	3	4	59
40JFM	.	.	2	7	2	5	2	.	.	18
AMJ	.	.	1	5	4	3	.	.	.	13
JAS	.	.	1	5	7	2	.	.	.	15
OND	.	.	.	7	6	6	2	.	1	22
Year	.	.	4	24	19	16	4	.	1	68
41JFM	.	2	8	7	7	2	.	.	.	26
AMJ	1	2	1	6	5	3	.	.	.	18
JAS	.	1	1	6	6	5	.	.	.	19
OND	.	1	4	3	2	1	.	.	.	11
Year	1	6	14	22	20	11	.	.	.	74
42JFM	.	2	.	10	4	3	1	.	.	20
AMJ	.	.	3	5	5	1	1	.	.	15
JAS	.	.	6	9	5	2	2	.	.	24
OND	1	.	5	6	3	.	2	.	.	17
Year	1	2	14	30	17	6	6	.	.	76
43JFM	.	.	3	2	8	1	1	.	.	15
AMJ	.	.	7	9	7	1	.	.	.	24
JAS	3	7	9	10	2	.	1	.	.	32
OND	1	2	9	5	.	.	.	.	.	17
Year	4	9	28	26	17	2	2	.	.	88
44JFM	1	1	4	6	6	1	.	.	.	19
AMJ	.	3	4	7	2	1	.	.	.	17
JAS	.	.	1	2	.	2	1	.	.	6
OND	.	1	1	2	1	3	2	.	.	10
Year	1	5	10	17	9	7	3	.	.	52

Ei=	-4	-3	-2	-1	0	+1	+2	+3	Sum
45JFM	.	.	.	2	6	4	1	.	13
AMJ	.	1	3	4	3	1	.	.	12
JAS	.	.	1	2	3	1	.	.	7
OND	1	.	1	2	3	1	1	2	11
Year	1	1	5	10	15	7	2	2	43
46JFM	.	2	5	4	4	3	.	.	18
AMJ	.	1	8	6	2	.	.	.	17
JAS	.	3	1	10	2	2	.	.	18
OND	.	3	3	5	2	5	1	.	19
Year	.	9	17	25	10	10	1	.	72
47JFM	.	.	4	5	8	3	.	.	20
AMJ	1	.	9	7	4	.	.	.	21
JAS	.	5	5	7	2	2	.	.	21
OND	.	2	5	2	4	1	.	.	14
Year	1	7	23	21	18	6	.	.	76
48JFM	.	.	1	.	8	5	4	.	18
AMJ	.	1	3	6	4	4	1	.	19
JAS	.	1	.	4	8	10	.	.	23
OND	.	.	2	8	7	5	1	2	25
Year	.	2	6	18	27	24	6	2	85
49JFM	.	1	6	9	3	5	3	1	28
AMJ	.	.	1	7	4	1	1	.	14
JAS	.	.	.	1	7	4	.	1	13
OND	.	.	2	4	5	3	3	.	17
Year	.	1	9	21	19	13	7	2	72

All years 1940 - 1949.

Ei=	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	Sum
	2	27	82	165	208	142	58	21	.	1	706

The average differences (Ci - Cp) for the 5 levels of activity are given in Table 9. Main result: Compared with Cp, the average Ci was, in 1932/33, too high by 0.07 to 0.26 units; in 1940, too high by 0.06 to 0.09 units, and, in 1946 and 1947, too low, as much as 0.11 units of Ci or Cp. One may say that Cp = 1.0 was expressed, in 1932/33, by Ci = 1.2; in 1940, by Ci = 1.1; in 1947, by Ci = 0.9.

Table 9.

Average differences (Ci - Cp), expressed in one hundredth unit of Ci or Cp, for years and quarter years (JFM = January, February, March, etc.) for the five levels of activity:

Level:	Years											Seasons				All
Cp =	32/33	40	41	42	43	44	45	46	47	48	49	JFM	AMJ	JAS	OND	
0.0 to 0.2	+ 7	+6	+5	+3	+4	+ 4	0	- 4	- 1	+2	0	+ 2	+ 1	+ 2	+ 2	+ 2
0.3 to 0.5	+22	+8	+5	+2	-2	+ 5	0	-10	- 3	+4	+2	+ 1	0	+ 2	+ 2	+ 1
0.6 to 0.8	+25	+8	+4	+5	-6	+ 2	-1	- 9	- 8	+2	+1	+ 1	- 1	0	- 1	0
0.9 to 1.2	+21	+9	+2	+3	-4	+ 2	-2	-10	-11	+1	-1	+ 1	- 4	- 2	0	- 1
1.3 to 2.0	+26	+6	+2	+1	-4	+12	+8	- 7	-11	-2	0	+ 2	- 4	- 6	+ 1	- 1

The seasons (Table 9) have little systematic influence (less than 0.1 unit) on the average (Ci - Cp), apart from somewhat smaller values for the higher levels of Ci in northern summer. The monthly averages for (Ci - Cp), in the bottom line of Table 3b, are insignificant, not above a few hundredths of a unit of C. They show a trace of the wellknown semi-annual wave in magnetic activity - so clearly expressed in the bottom-lines of Tables 3a and 18 -, with a reversed sign in (Ci - Cp), in keeping with the tendency of Ci to shift its standard opposite to the general level of activity.

Shifts in the standard of Ci are important enough to be demonstrated by two more examples. Table 10 shows the number of days with Cp = 0.9, as distributed according to Ci, for four years. Ci, in 1932/33 compared with 1947, was rated too high by more than 0.3 units. In 1949, no appreciable systematic difference appears between the levels Cp = 0.9 and Ci = 0.9.

Table 10.

Frequencies of Ci on days with Cp = 0.9 in selected years.

Year	n =	Ci = 0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	Average Ci
1932/33	15	.	.	.	.	1	3	3	7	.	1	1.13
1940	26	.	.	.	1	5	11	8	1	.	.	1.02
1947	19	1	2	6	2	6	2	.	.	.	.	0.78
1949	29	.	1	6	5	6	8	2	1	.	.	0.88

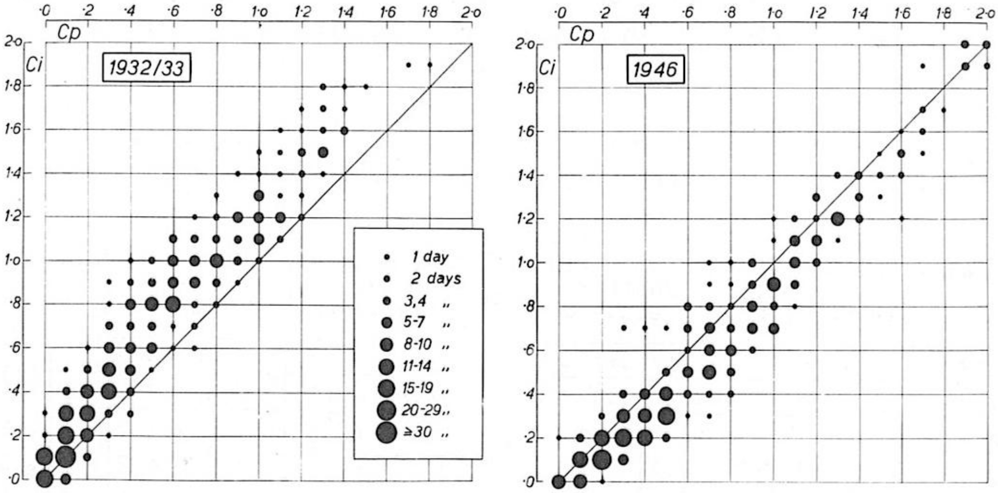

Fig. 1 shows the two correlations between Ci, Cp for the 396 days of the Second International Polar Year 1932/33, and for the 365 days of the year 1946. The number of days for each combination (Ci,Cp) (e.g., in 1932/33, 18 days with Ci = Cp = o.0, 38 days with Ci = Cp = o.1, 17 days with Ci = o.1, Cp = o.0 etc.) is indicated by symbols, and the reference-line Ci = Cp is drawn. In 1932/33, most symbols lie above the line Ci = Cp (i.e., Ci was too high), in 1946, most symbols lie below the line (i.e., Ci was too low).

It should be added that such large shifts of (Ci - Cp) are certainly not due to Cp. Whoever has worked with K-indices for non-tropical observatories will agree that any uncertainty remaining in Kp, as the basis of Cp, is restricted to the lowest levels, Oo, O+ or 1-, say; such an extreme shift at the level Cp = o.9 from Ci = 1.4 (for 1933 Jan.22) to Ci = o.5 (for 1947 April 15) could never have occurred in Cp, since Cp = 1.4 (see Table 13) corresponds to Kp = 5-, while Cp = o.5 corresponds to Kp = 2+, two levels of K which are much too far apart to merge in the average for 88 indices (11 observatories, 8 intervals).

Systematic shifts in (Ci - Cp) tend to blur the correlation (Ci, Cp). This is easily seen from Fig.1: Superposition of the two diagrams for 1932/33 and for 1946 would give a much wider scattering. Numerical data follow:

	1932/33	1946	1932/33 +1946
Number of days	396	365	761
Average Ci	o.65	o.61	o.63
Average Cp	o.48	o.70	o.59
Average (Ci - Cp)	+o.17	-o.09	+o.04
Standard deviation of Ci	o.49	o.49	o.49
Standard deviation of Cp	o.41	o.48	o.45
Standard deviation of (Ci - Cp)	o.15	o.12	o.19
Correlation-Coefficient r(Ci,Cp)	+o.96	+o.97	+o.92

8. Causes for shifts in the standard of Ci: Two main causes are obviously possible: Every change in the membership of the C-observatories-addition of new stations as well as termination of old stations-may alter the average Ci in as much as the standards of the individual C at these observatories differ.

If the C's for three observatories furnishing many twos like Tr, Lo, RS were replaced by the C's of three stations furnishing many zeros like He, Ch, Am, the average Ci for 1949 would already be depressed by o.1 unit. This would occur even if all other stations kept their individual standards faithfully during their collaboration.

The other cause for shifts in Ci might be a change in the standard of C at individual stations, either gradual in the course of the years, or abrupt with a change in the observer or in the scaling practice.

Table 11. Average characters C, for days with Cp = o.5 and for days with Cp = o.9, given by 11 observatories designated A to L, in 5 selected years.

n = number of days with Cp = o.5 or o.9.

Year	n	A	B	C	D	E	F	G	H	J	K	L
						Cp = o.5						
1932/33	27	o.8	o.5	o.4	o.6	o.3	o.1	1.0	o.6	1.0	1.3	1.0
1940	28	o.0	o.0	o.2	o.0	o.3	o.1	o.6	o.1	o.4	1.5	1.0
1943	24	o.0	o.1	o.0	o.0	o.1	o.0	o.4	o.2	o.5	1.3	1.0
1946	34	o.0	o.0	o.0	o.0	o.1	o.0	o.4	o.0	o.6	1.1	1.0
1949	32	o.0	o.2	o.0	o.0	o.0	o.0	o.5	o.1	o.8	1.4	1.0
						Cp = o.9						
1932/33	15	1.0	o.9	o.9	1.0	o.7	o.5	1.7	1.0	1.2	1.9	1.0
1940	26	o.5	o.8	o.8	o.7	1.0	o.5	1.3	o.5	o.9	1.9	1.0
1943	12	o.2	o.7	o.3	o.5	o.8	o.2	1.2	o.7	1.1	1.8	1.0
1946	20	o.0	o.0	o.0	o.2	o.6	o.1	1.2	o.6	1.0	1.7	1.0
1949	18	o.1	o.6	o.0	o.6	o.4	o.0	1.1	o.4	1.0	1.9	1.0

Such shifts of stations-standards of C have occurred in a surprising number of cases. A typical sample, from more extended studies, is shown in Table 11: For eleven stations - whose names are replaced by letters A to L since no inducement for further enquiries is intended -, and for 5 years, the characters C for all days with Cp = o.5 were averaged for each station, and the same was done for all days with Cp = o.9. An inspection of Table 11 - with the shocking changes in station-standards by as much as one whole unit of C - will demonstrate how precarious the basis of Ci actually is.

G. van Dijk finished a detailed discussion [9] on the activity in the year 1930 - resumed recently by H.H.Howe [5] - by the conclusion"...that the standard of characterisation was stable in the investigated period 1921 to 1934, so that Ci can be used as a measure of magnetic activity, not only for intervals of weeks and months, but also for intervals of years."

The evidence given in our §§ 6 to 8 is, however, rather convincing in tracing quite definite changes in the standard of Ci during the years 1932 to 1949, which discredit monthly and annual means of Ci (See also Note 5).

9. Statistical aspects of Ci. It is of interest to recall the conception of the international character figure Ci as envisaged in 1905 by Adolf Schmidt [4]. He vigorously rejected all proposals to make any numerical prescriptions for the method of assigning the characters C = 0, 1, 2; on the contrary, that method was left entirely left at the discretion of the directors of each observatory. It is true that G. van Dijk [9], who was in charge of the derivation of Ci up to 1939, occasionally wrote letters to such observatories whose standards of C differed too much from that of most observatories; but otherwise, Schmidt's principle of estimating C ad libitum has been adhered to until to-day.

Schmidt's attitude was due to his belief (now refuted by the K-index) that objective numerical measures of activity, applicable to all observatories, could not be provided without an unjustified amount of labor. He realized, of course, the psychological reasons for dangerous shifts of standards, but, fortunately, the consequences of that arbitrariness have been less disastrous than they might have been. In fact: those evil spirits which have so often played havoc among geophysical statistics, have, in the past, had mercy on geomagneticians, in providing them with a good series of Ci whose defects (§§ 6 - 8) are small compared with its merits.

How miraculous this result is, has been shown by Table 11. Another aspect is given by some simple considerations: Assigning characters C = 0, 1, or 2 for a year (say, 1949) at a single station is equivalent to "ranking" the daily magnetograms in the order of their activity, and to choose two limits, an upper one for C = 0, and a lower one for C = 2, much as described by H.H.Howe [5]. Imagine now, that <u>all</u> observatories would agree to choose those limits so that everywhere, the days in 1949 with C = 0, 1 and 2 in 1949 should number (say) 100 : 200 : 65. Because of the high correlation of magnetic activity at different stations, the ranks given to each day would not differ much from station to station. The majority of days would then be classified alike at all stations, so that, in the average for all stations, 80 days (say) would have Ci = 0.0, 150 days Ci = 1.0, and 50 days Ci = 2.0, and only the remaining 85 days (say) would have intermediate values of Ci. This, of course, would be highly indesirable, because Ci would then fail to distinguish neither the really quiet days nor the days with great storms.

Fortunately (!), the observatories disagree heartly in the percentages of C = 0 or 2: for instance, in 1949, the number of days

with	C = 0	1	2	
was for Lovö	30	139	196	days, average C = 1.45
for Abinger	36	299	30	days, average C = 0.98
for Honolulu	337	24	4	days, average C = 0.09

These great differences in "sensitivity" of the observatories cause that customary fine gradation in Ci, as shown, e.g., in the frequencies of Table 4 (See also Table 17).

A few possible modes how the Ci-scheme might have worked will be demonstrated for the year 1949: Three groups, of 10 observatories each, were selected, with many twos (sanguine), with many ones (equable) and with many zeros (impassive). The observatories, and the average percentages of the number of characters C = 0, 1, 2 assigned in 1949 by each group, are:

Sanguine group:	Tr So Lo RS Me Wi Ma Ag Eb Ks,	0:1:2 = 20:49:31.
Equable group:	Co Le Es Sw Ab CF Na Tl Ka Pi,	0:1:2 = 31:60: 9.
Impassive group:	Ni Ch ZS SJ Ho Hu El Ap Wa Am,	0:1:2 = 76:22: 2.

The average characters of the year 1949 for the three groups are 1.11, 0.78, and 0.26 (see also Note 5, Table 17).

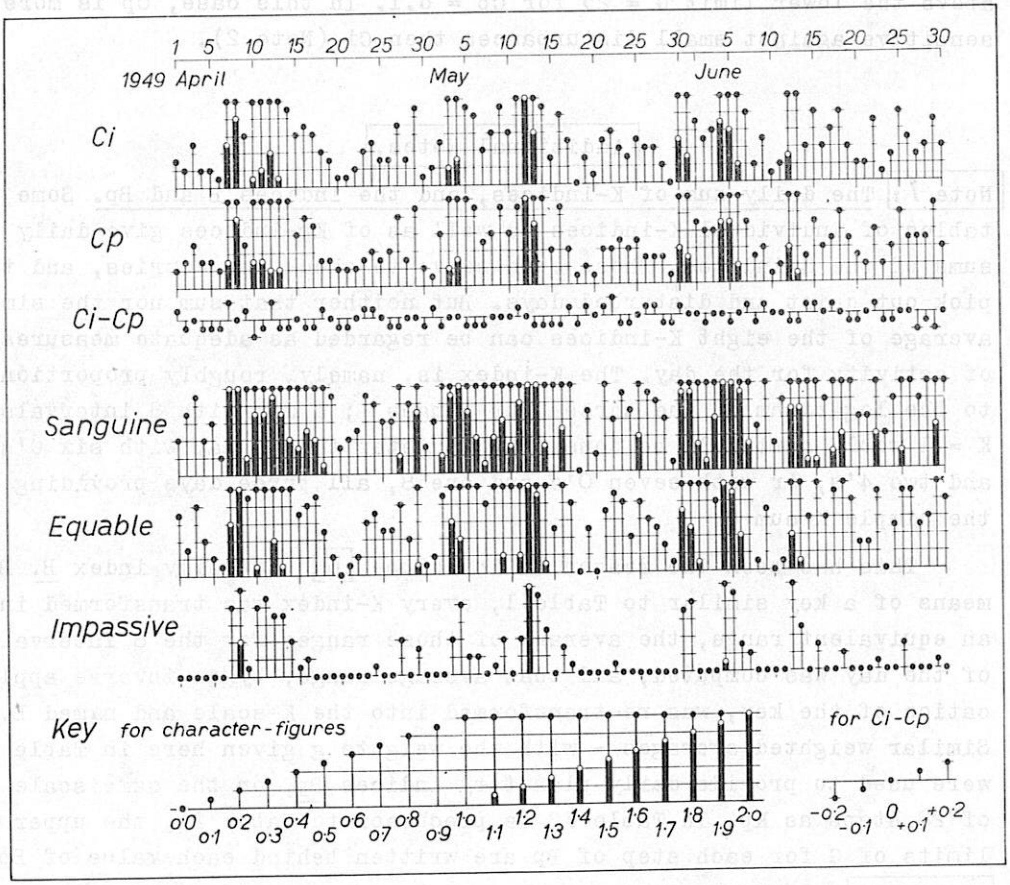

Fig.2. Various kinds of daily magnetic character-figures, 1949 April 1 to June 30. Ci = International, Cp = planetary; and average daily characters for three groups of ten observatories each, preferring C = 2 (sanguine), C = 1 (equable), or C = 0 (impassive).

Fig. 2 shows the agreement between Ci and Cp just as clearly as their good gradation. The average characters for the three sensitivity-groups show the features to be expected; of the 91 days, the following numbers had

Character figure =	o.0 to o.2	o.8 to 1.2	1.8 to 2.0	o.3 to o.7, or 1.3 to 1.7
for Ci	18	18	2	53
for Cp	15	18	2	56
for "Sanguine" group	4	30	13	44
for "Equable" group	15	37	5	36
for "Impassive" group	65	9	1	16

There is an analogy to photographic emulsions : The picture of the changes of magnetic activity from day to day as given by Ci or Cp, has excellent half-tones as well as good contrasts ; the sanguine group is somewhat "over-exposed", the impassive group "under-exposed", while the equable group gives a "grey" picture.

All three sensitivity-groups agree, with Ci and Cp, on 2.0 for 1949 May 12, and, with Ci, on o.0 for 1949 May 18. For the latter day, Cp = o.1, because the 8 Kp-indices 0+1-1-1o 1-1-1+1+ lead to G = 28, above the lower limit G = 23 for Cp = o.1. In this case, Cp is more sensitive against small disturbances then Ci (Note 2).

Additional Notes.

Note 1: The daily sum of K-indices, and the indices B and Bp. Some tables of individual K-indices as well as of Kp-indices give daily sums of the 8 indices. Those sums serve to check the entries, and to pick out quiet and disturbed days. But neither that sum nor the simple average of the eight K-indices can be regarded as adequate measures of activity for the day. The K-index is, namely, roughly proportional to the logarithm of the three-hour-ranges ; a day with 8 intervals K = 1 would certainly be considered quieter than a day with six 0's and two 4's, or with seven 0's and one 8, all three days providing the simple K-sum 8.

This has been the reason to introduce [6] the daily index B. By means of a key similar to Table 1, every K-index was transformed into an equivalent range, the average of those ranges for the 8 intervals of the day was computed, and that average range, by an inverse application of the key, was re-transformed into the K-scale and named B. Similar weighted averages - with the weights g given here in Table 1 - were used to provide daily planetary indices Bp, on the same scale of 28 steps as Kp. In Table 12 (a precursor to Table 2), the upper limits of G for each step of Bp are written behind each value of Bp.

Table 12. Upper limits of daily sums G of g for daily indices Bp.

Bp	G	Bp	G	Bp	G	Bp	G	Bp	G
		2-	52	4-	196	6-	588	8-	1544
0o	8	2o	64	4o	240	6o	692	8o	1772
0+	19	2+	84	4+	288	6+	820	8+	2144
1-	28	3-	108	5-	344	7-	972	9-	2800
1o	36	3o	132	5o	412	7o	1144	9o	..
1+	44	3+	160	5+	492	7+	1332		

These Bp-indices were given for 1932/33 (IATME Bull. 12c). They were also computed for all days of 1940 - 1949 and used in the assimilation of the Cp-scale to the frequency-distribution of Ci.

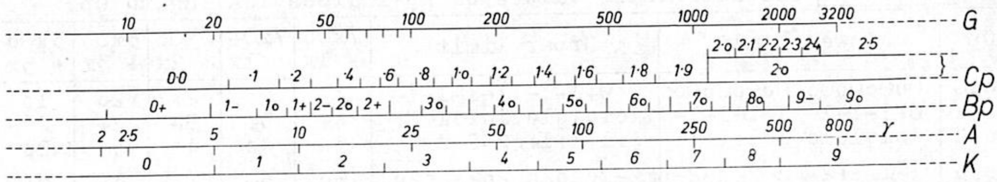

Figure 3. Comparison of scales.

The 28 steps of Bp gave, at the lower and upper ends of the scale, a somewhat more detailed classification than the 21 steps of Ci (see Fig.3). In 1932/33 and 1940-49, the lowest level Bp = Oo was reached on 8 days only:

1933 Febr. 17; 1940 March 15, March 18, Dec. 8; 1944 Nov. 13;
1945 Jan. 24, Oct. 11, Dec. 4.

All these days have Cp = o.O (of course) as well as Ci = o.O, except 1940 March 15 with Ci = o.1.

On the other end of the scale, Bp = 7+, which has nearly the same lower limit in G as Cp = 2.O, occurred, in the 10 years 1940-1949, on 12 days, Bp = 8- on 4 days, Bp = 8o on 4 days, and Bp = 8+ was reached on two days, 1941 July 5 and Sept. 18. All these are the usual Greenwich days. For the 24 hours beginning 1940 March 24 at noon, Universal Time, Bp = 9-; and for the 24 hours beginning 1941 Sept.18, 9.00 U.T., Bp = 9o. This shows that the whole range of Bp may occur, (in the case of 1940 March 18 and March 24 the extremes Oo and 9o occurred a few days apart!) and, therefore, the extension of the Cp-scale beyond 2.O has been recommended.

|| B and Bp have now been given up in favor of Ck (Note 3) and Cp.||

Note 2. Specimen for Cp. The definition of Cp as given by Tables 1 and 2 is illustrated by Table 13. The first two columns give 8 Kp-indices which are nearly equal, and for which the sum of the weights g leads to the lower and upper limits of G for Cp according to Table2 (The order of the eight Kp-indices - here arranged increasing - is, of course, irrelevant for Cp). The last 5 columns give various combinations of low and high Kp-indices.

It is perhaps surprising that a day with Cp = o.O may have seven intervals with Kp = Oo and one interval with Kp = 4- (a disturbance beginning in the late evening). Since Kp = Oo is quite rare, such extreme combinations will hardly ever occur. It would have been easy to introduce additional restrictions in the definition of Cp, for instance, to say that Cp = o.O should have no Kp beyond 2-, say. But such complications-beyond the limits of G set in Table 2-appear rather unnecessary, because the characterization of a day with intervals unequally disturbed requires a compromise in any case. Moreover, Cp shall continue the standard of Ci, and the reader is asked to refer to the diagram in IATME Bull.No.12b, pp. 109-110, which demonstrates the great variety of combinations of eight Kp-indices which, in the past, have occurred on days characterized by identical values for Ci.

Continued absolutely quiet conditions on the whole Earth for more than a few hours are so rare, that even Cp = o.O does not exclude the occurrence of small disturbances at some polar stations beyond the limits set for K = O; even the quietest day of 1932/33, namely, 1933 Febr. 17, with Kp = 0o0o0o0+ 0o0o0+0o (see IATME Bull.No. 12d, p. 23) brought, at Fort Rae [7], passing disturbances with hourly ranges in H and Z up to 60 γ, and 5 local K-indices 2.

Table 13. Characteristic values of Kp-indices leading to Cp.

Cp	Lower limit	Upper limit	7x0o + 1x	7x0+ + 1x	6x0o + 2x	5x0o + 3x	3x0o + 5x
0.0	0o0o0o0o 0o0o0o0o	0+0+1-1- 1-1-1-1-	4-	2o	2+	2o	1o
0.1	0+1-1-1- 1-1-1-1-	1o1o1o1o 1o1o1+1+	4+	3+	3o	2+	2-
0.2	1o1o1o1o 1o1+1+1+	1+1+1+1+ 2-2-2-2-	5-	4o	4-	3-	2o
0.3	1+1+1+2- 2-2-2-2-	2-2o2o2o 2o2o2o2o	5o	5-	4o	3+	2+
0.4	2o2o2o2o 2o2o2o2o	2o2o2o2+ 2+2+2+2+	5+	5o	4+	4-	3-
0.5	2o2o2+2+ 2+2+2+2+	2+2+2+2+ 2+2+3-3-	6-	5+	5-	4-	3o
0.6	2+2+2+2+ 2+3-3-3-	2+2+3-3- 3-3-3-3-	6o	6-	5-	4o	3+
0.7	2+3-3-3- 3-3-3-3-	3-3-3-3- 3-3-3o3o	6+	6o	5o	4+	3+
0.8	3-3-3-3- 3-3o3o3o	3o3o3o3o 3o3o3o3o	7-	6+	5+	5-	4-
0.9	3o3o3o3o 3o3o3o3+	3o3o3+3+ 3+3+3+3+	7o	7-	6-	5-	4o
1.0	3o3+3+3+ 3+3+3+3+	3+3+3+4- 4-4-4-4-	7+	7o	6o	5o	4+
1.1	3+3+4-4- 4-4-4-4-	4-4-4-4- 4-4-4o4o	8-	7+	6+	5+	4+
1.2	4-4-4-4- 4-4o4o4o	4o4o4o4o 4o4o4+4+	8o	8o	7-	6-	5-
1.3	4o4o4o4o 4o4+4+4+	4+4+4+4+ 4+4+5-5-	8+	8+	7o	6o	5o
1.4	4+4+4+4+ 4+5-5-5-	5-5-5-5- 5-5-5-5-	9-	9-	7+	6+	5+
1.5	5-5-5-5- 5-5-5-5o	5-5o5o5o 5o5o5o5o	9-	9-	8-	7-	6-
1.6	5o5o5o5o 5o5o5o5o	5+5+5+5+ 5+5+5+5+	9o	9o	8o	7o	6o
1.7	5+5+5+5+ 5+5+5+6-	6-6-6-6- 6-6-6-6o	..	..	8+	8-	7-
1.8	6-6-6-6- 6-6-6o6o	6o6o6+6+ 6+6+6+6+	..	..	9-	8+	7o
1.9	6o6+6+6+ 6+6+6+6+	7o7o7o7o 7o7o7+7+	..	..	9o	9-	8o
2.0	7o7o7o7o 7o7+7+7+	7+7+8-8- 8-8-8-8-	..	..	..	9o	8+
2.1	7+8+8+8- 8-8-8-8-	8o8o8o8o 8o8+8+8+	..	..	..	..	9-
2.2	8o8o8o8o 8o8o8+8+	8o8o8o8o 8+8+8+8+	..	..	..	..	..
2.3	8o8o8o8+ 8+8+8+8+	8+9-9-9- 9-9-9-9-	..	..	..	..	9o
2.4	9-9-9-9- 9-9-9-9-	9-9-9-9- 9-9o9o9o	..	..	..	..	..
2.5	9-9-9-9- 9o9o9o9o	9o9o9o9o 9o9o9o9o	..	..	..	..	..

Note 3. Local daily character-figures Ck and Cs. Every observatory that scales K-indices may, if it wants to do so, derive a local daily character-figure Ck by a process similar to that by which Cp is derived from Kp. The following weights are proposed:

Table 14. Weights k to be assigned to K-indices to derive Ck.

K =	0	1	2	3	4	5	6	7	8	9
k =	0	3	7	15	27	48	80	140	240	400

The sum of the 8 values of k for the day is used as G in the key given in Table 2, and the result is called Ck.

Example (Cheltenham): 1949 June 5. K-indices 3545 4455. Sum of weights k, according to Table 14, 15 + 3 x 27 + 4 x 48 = 288, from Table 2, therefore, Ck = 1.4.

Observatories for which conversion-tables (to convert K-indices into standardized Ks-indices) are available (IATME Bull.No. 12b, pp. 99-101), may also derive from Ks, via Tables 1 and 2, a standardized character-figure Cs to approximate Cp.

Table 15. Daily character-figures, April to June 1949, world-wide Ci and Cp, and local Cs and Ck for Wingst and Cheltenham, indicated by their tenfold values Ti, Tp, Ts, Tk.
(As a local daily measure of activity, Ck, derived from local K-indices, is recommended).

	April 1949						May 1949						June 1949					
	Ti	Tp	Ts Wn	Ts Ch	Tk Wn	Tk Ch	Ti	Tp	Ts Wn	Ts Ch	Tk Wn	Tk Ch	Ti	Tp	Ts Wn	Ts Ch	Tk Wn	Tk Ch
1	3	2	3	4	3	3	2	1	1	0	2	0	7	7	8	8	7	8
2	2	3	5	1	4	1	5	6	6	6	6	5	5	6	6	6	6	6
3	5	5	6	6	5	4	12	12	12	9	10	8	6	6	5	6	5	6
4	2	3	2	3	2	2	13	13	14	12	12	12	17	17	17	17	15	15
5	2	3	5	4	4	3	9	10	11	7	10	6	16	17	16	16	14	14
6	1	2	3	2	2	1	8	9	10	8	10	8	12	12	13	13	12	11
7	15	13	12	14	11	11	4	5	5	4	5	4	8	7	8	6	8	7
8	18	18	18	18	16	16	6	6	10	4	10	4	2	3	3	3	3	3
9	6	5	5	5	4	4	9	9	9	9	9	8	5	4	7	4	7	4
10	11	13	12	14	12	12	6	6	8	6	8	6	1	1	1	1	1	0
11	12	13	14	13	12	11	10	9	7	8	7	8	2	2	2	1	2	4
12	14	12	11	13	10	11	20	20	20	20	19	20	13	14	14	13	12	11
13	11	12	13	11	11	10	16	17	17	17	14	15	10	11	11	10	10	9
14	9	10	7	11	6	10	9	10	11	9	10	8	4	3	4	3	4	3
15	6	6	9	6	8	5	3	4	5	5	5	5	8	7	9	9	9	8
16	7	8	10	9	10	8	8	9	8	9	7	9	4	4	7	5	7	5
17	6	7	8	7	7	6	5	4	5	4	4	4	6	5	5	8	4	7
18	4	3	5	4	5	4	0	1	1	1	1	1	8	8	10	8	10	9
19	3	3	2	3	2	2	3	2	4	3	4	2	4	5	8	5	7	5
20	1	2	2	2	2	1	1	1	2	1	2	1	2	3	3	2	4	3
21	1	2	2	4	1	3	5	4	5	5	5	4	2	2	3	2	4	2
22	2	2	2	2	2	1	6	4	6	5	7	5	7	6	6	9	6	7
23	4	3	4	2	3	1	4	5	7	5	7	5	1	2	4	0	4	0
24	5	4	5	5	5	4	3	4	4	2	4	2	3	4	4	4	5	4
25	3	3	5	3	4	2	5	5	6	3	6	2	8	8	10	7	9	7
26	3	4	5	5	4	4	4	3	5	2	5	1	5	5	6	4	7	4
27	7	8	9	7	7	6	4	3	5	2	5	2	3	5	5	6	5	6
28	3	3	4	4	4	3	2	3	2	2	3	2	4	5	4	7	4	6
29	9	9	9	5	9	3	0	1	0	0	0	0	7	9	10	8	9	7
30	1	2	2	1	1	1	15	14	16	14	13	11	4	4	5	4	6	4
31							13	13	13	13	12	12						

In Table 15, the ten-fold values Ts and Tk of Cs and Ck, for Wingst and Cheltenham, are compared with Ti = 10 Ci and Tp = 10 Cp. It appears that the approximation to Cp is not much improved by the use of the standardized Ks-indices instead of the original K-indices [2]. Therefore, the use of the simple Ck may be recommended.

For any individual observatory, the weights k given in Table 14 could be further adjusted to improve the similarity of Ck and Cp; it would also be possible to shorten the process (K to Ks to g to G to Cs) by introducing, for every season, separate conversion-keys (K to g) for each of the eight three-hour-intervals. But it is doubtful whether the result of such refinement would pay the effort.

The way from the K-indices to Cp proposed in this paper (§ 4) goes via Kp. Another possibility - namely (K to Ck to Cp) - is ruled out as it would be open to some of the objections (§ 9) to the Ci-scheme.

Note 4. Local bias in C and Ci. The daily variation in the target-sectors of solar particle radiation P (see the discussion in [8]) makes the North-European observatories (e.g. Tromsö, Sodankylä, Dombås, Rude Skov, Wingst, in longitudes 9^o to 29^oE) alternate in sensitivity to P, so-to-say, with the North-West American observatories (e.g. College, Meanook, Sitka, in longitudes 113^o to 148^oW):

The intervals	06 to 09 GMT	and	18 to 21 GMT
are in N-Europe	quietest		most disturbed
in NW-America	most disturbed		quietest.

Consider two Greenwich days, D1, most disturbed between 06 to 09 GMT, and D2 most disturbed between 18 to 21 GMT: Comparing D1 with D2, Europe will have a bias to regard D2 relatively more active, and West-America will have a similar bias towards D1. This would show in Ck and presumably in C too. Since so many observatories furnishing C-characters are in Europe, this bias may also be expected in Ci: and in fact, apart from the shift in (Ci - Cp) from year to year, the days with positive (Ci - Cp) are, in general, more disturbed in the evening, while those with negative (Ci - Cp) are more disturbed in the morning of the Greenwich day. This has been pointed out in § 6; two more groups of days (Table 16) with large differences (Ci - Cp) will now be discussed by means of local K-indices and character-figures Ck (Note 3).

Table 16. K-indices and local Ck-figures for selected days at European and at NW-American observatories.

	1933 Jan.22 Ci=1.4 Cp=o.9	1947 April 15 Ci=o.5 Cp=o.9		1949 Febr.3 Ci=1.2 Cp=o.7	1949 Febr.4 Ci=1.2 Cp=1.3	1949 Jan.22 Ci=o.4 Cp=o.8
Kp	1331 3444 --0+ -000	4433 3323 00-0 +0+-	Kp	2011 2245 0+++ +-0-	6654 3211 +--- +-00	3343 3211 0++0 --+0
			European group			
Do	0131 2575	4313 3313	Tr	1000 1155	4633 3200	4332 3223
RS	0121 2445	4322 3223	So	1001 2166	6533 3100	3222 3122
Wn	1231 2545	4322 3323	RS	1011 2154	6432 2100	3333 2111
Ck=	1.1	o.8		o.9	1.0	o.6
			NW-American group			
Co	1232 4433	3444 3322	Co	1000 2133	4555 4311	2264 4200
Me	0341 2333	3444 3222	Me	1011 1223	6765 5211	2254 4111
Si	0332 3433	2434 2211	Si	1011 1133	6656 5201	2253 3200
Ck=	o.6	o.9		o.2	1.5	o.9

The first pair of days in Table 16 are the extreme cases of Table 10: Both have Cp = o.9, but 1933 January 22 has Ci = 1.4, and 1947 April 15 has Ci = o.5. The second group are the days with the greatest differences (Ci - Cp) in 1949, namely 1949 Febr.3 (Ci = 1.2, Cp = o.7) and Jan.22 (Ci = o.4, Cp = o.8). The K-indices for Febr. 4 (Ci = 1.2, Cp = 1.3) are given too, because it is quite characteristic to see, in the disturbance extending through the three-hour-intervals 1949 Febr.3, 18.00 GMT to Febr.4, 15.00 GMT, how the local European bias raises the two K-indices 18.00 to 24.00, while the American bias raises the three K-indices, 6.00 to 15.00. Ci is 1.2 for both days, 1949 Febr.3 and 4, obviously as a result of the "European bias" emphasizing the evening disturbance of Febr.3 against the forenoon disturbance of Febr.4. Both Febr.4 and Jan.22 (with Cp = o.4) appear in Ci grossly underrated against Febr.3, from the standpoint of the American observatories.

Note 5. Characterization of months and years. The difficulty to characterize, by a single figure, a whole day, with different levels of magnetic activity, is even more pronounced in the case of whole months, years etc. In recent discussions ([5] and [8]), it has been proposed to consider frequencies of Kp-indices.

Table 17. Average characters for months and year, 1949, for twelve typical observatories, and frequencies of characters for 1949.

	Tr	Lo	RS	Ni	Ch	Ho	Am	Co	Le	Es	Ab	Tl	Mean Ci	Mean Cp
Ja	1.1	1.5	1.5	0.6	0.1	0.1	0.3	0.7	0.7	0.8	1.0	1.0	0.68	0.72
Fe	1.1	1.5	1.3	0.6	0.2	0.0	0.3	0.5	0.7	0.7	0.9	1.0	0.71	0.70
Mr	1.2	1.5	1.4	0.5	0.3	0.1	0.3	0.5	0.7	0.8	1.0	1.1	0.75	0.81
Ap	1.1	1.4	1.3	0.3	0.1	0.0	0.2	0.4	0.6	0.6	1.1	0.9	0.59	0.61
My	1.3	1.5	1.5	0.4	0.2	0.1	0.2	0.6	0.7	0.7	1.0	1.1	0.68	0.69
Je	1.5	1.5	1.4	0.3	0.1	0.0	0.2	0.7	0.7	0.8	1.0	1.0	0.61	0.64
Jl	1.0	1.3	1.2	0.4	0.0	0.0	0.0	0.5	0.5	0.6	0.8	0.7	0.47	0.38
Au	1.3	1.5	1.4	0.3	0.2	0.1	0.2	0.8	0.8	0.8	0.9	1.0	0.62	0.61
Se	1.3	1.3	1.2	0.5	0.1	0.1	0.2	0.6	0.7	0.6	0.9	0.8	0.61	0.63
Oc	1.6	1.7	1.6	0.7	0.3	0.3	0.4	1.0	1.0	1.1	1.2	1.2	0.89	0.89
No	1.3	1.5	1.5	0.6	0.2	0.2	0.3	0.8	0.8	0.9	1.0	1.0	0.74	0.69
De	0.8	1.2	1.0	0.3	0.0	0.0	0.1	0.5	0.7	0.6	1.0	0.8	0.49	0.44
Year	1.2	1.5	1.4	0.5	0.1	0.1	0.2	0.6	0.7	0.7	1.0	1.0	0.65	0.67
Number of days in 1949 with C = 0, 1, or 2														
C=														
0	67	30	37	202	317	337	292	148	124	118	90	77		
1	147	139	163	159	45	24	67	203	222	224	229	228		
2	151	196	165	4	3	4	6	14	19	23	46	60		

In order to demonstrate the inedaquecy of monthly averages of Ci, Table 17 gives averages characters for twelve typical stations, for the months and the year 1949.

The monthly averages of Ci vary so little, that the shifts in the standard of Ci (§ 7) distort the impression of the activity level given by the average Ci. For instance, the average character-figures are

	Ci=	Cp=		Ci=	Cp=
for December 1932	0.67	0.44	for the 13 months 1932/33	0.65	0.48
for June 1946	0.63	0.74	for the year 1946	0.61	0.70

Of course, the average Cp is a more reliable indication of the relative level of activity. But despite of their uncorrupted standard, the monthly averages of Cp are disappointing because they give a too colourless picture: Low averages of Cp can, it is true, be relied upon as indicating a quiet month, but medium or high monthly averages may be misleading. The most blatant case is that of March 1940, with the average Cp = 0.80, Ci = 0.81. That month brought, up to the 23rd, 8 days with Cp = 0.0 or 0.1, but in the last 9 days, there were three days of intense storm with Cp = 2.1. The average Cp for the first 23 days is 0.40, for the last 9 days , 1.74. If we look for a month with a similar average Cp, we find April 1950, in which the most disturbed day had Cp = 1.6 only, and no Kp higher than 7-. In the month with the highest monthly average of Cp, September 1947 with Cp = 1.11, no day reached the level Cp = 2.0.

Similar remarks have sometimes been made to discredit the K-indices: Hourly ranges, plotted in gammas, give, to the unexperienced eye, a much more pronounced picture of the changes in activity than K-indices. Indeed, a change of K from 6 to 9 means, of course, a much bigger numerical increase in the ranges than that from K = 1 to K = 4 (see Table 14). It should, however, be remembered that the K-index is approximately a logarithm of a range. Likewise, Ci or Cp are somewhat conservative in their scale; the picture of a great magnetic storm connected, to the geomagnetician, with Ci = 2.0, is a result of training and experience rather than the impression made by that modest figure. It would have been easy, of course, - though uneconomical - to devise more impressive scales, with graphs consuming more paper than the current note-script for K, Kp or Cp.

Now, in spite of all arguments that speak in favor of characterizing months etc. by frequencies of Kp, there will probably always be a demand for monthly measures of activity expressed by not more than one figure, and magneticians should try their best in that direction. As demonstrated above, the average Cp is not good; it fails to express the great difference of the two model months, A and B, discussed in [9], which have different numbers of very quiet days (Cp = o.O), moderately disturbed days (Cp = 1.0), and storm days (Cp = 2.0), namely,

A with 5 days o.O, 25 days 1.0, no day 2.0,
B with 15 days o.O, 5 days 1.0, 10 days 2.0,

but the same average Cp = o.83.

A compromise seems possible by using the conception of the average amplitude, introduced in one of the first K-papers [6], in the following form: Every Kp-index is replaced by its weight g, according to Table 1. The average of the g is computed and doubled. That gives the average amplitude Ap, in gammas, for a standard observatory. This computation may be abridged by using the monthly frequency-tables of Kp - such as those given in IATME Bull. No. 12c, pp. 131-133. Local measures may be computed from the K-indices, using the weights k from Table 14.

Table 18 of average amplitudes Ap has been computed for the 147 months for which Kp-indices are available. It will not be discussed here, except to say that Ap proves to be superior to Cp in ranging the two months March 1940 and April 1950 mentioned above, with nearly equal average Cp, more reasonably: March 1940 gets the highest value of Ap for the whole series, 73 γ, while April 1950 gets 37 γ only. Ap agrees with Cp at the lowest levels of activity: The months of July and November, 1944, with the lowest average Cp = o.26 and o.25, get also the lowest average Ap = 11 and 12 γ. - With the u-measure, Ap shares the emphasis on the most intense disturbances.

Table 18. Average amplitudes Ap for months and years. Unit γ.

	Ja	Fe	Mr	Ap	My	Je	Jl	Au	Se	Oc	No	De	Year
1932	..	..	..	..	..	..	..	23	24	20	17	18	21
1933	19	23	25	25	23	17	15	18	..	..	..	..	
1940	30	25	73	35	27	33	24	21	28	28	32	29	32
1941	28	36	66	30	21	22	39	33	53	23	32	23	34
1942	18	23	45	34	16	16	25	26	34	45	29	21	28
1943	21	19	26	28	29	25	29	62	51	47	40	28	34
1944	25	24	35	30	19	16	11	18	20	22	12	27	22
1945	20	22	34	26	18	14	19	14	19	22	15	26	21
1946	25	44	67	40	35	32	44	23	69	26	25	18	37
1947	25	23	64	35	28	32	32	51	64	46	28	21	37
1948	24	25	35	26	38	20	20	40	30	54	32	26	31
1949	41	29	38	28	37	28	15	28	26	51	31	17	31
1950	24	35	29	37	33	28	28	49	45	56	41	32	36
1951	32	43	..	..	..	..	..	..	..	..	..	..	..
	Average for the years 1932/33 and 1940 to 1950												
	25	27	45	31	27	24	25	31	39	37	28	24	30

References.

[1] Trans.Oslo 1948 Meeting. IATME Bull.No. 13, pp.22 f. and pp. 339-341. Washington 1950.

[2] Bartels, J.: "The standardized index, Ks, and the planetary index Kp." IATME Bull.No. 12b, 97-112 Washington 1949.

[3] See quarterly tables in Journ.Geophys.Res., beginning Vol.54, 295-299, Washington 1949; monthly in "Ionospheric Data", issued by Central Radio Propagation Lab.Washington (F-series). Numerical Tables and 27-day recurrence diagrams in the IATME Bull.No.12b (for 1945 to 1948), 12c (for 1940 to 1944, and 1949), 12d (Aug. 1932 to August 1933). Complete 27-day diagrams in Abhandl.Akad. Wiss.Göttingen, Math.Phys.Kl., Sonderheft, 1951, pp. 12-29.

[4] Schmidt, Ad. "Die internationalen erdmagnetischen Charakterzahlen" Meteorol.Ztschr. 33,481-492 (1916). See also the abstracts from the reports on the conferences at Innsbruck, Terr.Magn. 10, 197. (1905); and at Berlin : Terr.Magn. 15, 187-187 (1910).

[5] Howe, H.H., Journ.Geophys.Res.55, 153-157 (1950); with remarks by J.Bartels, l.c., 158-160.

[6] Bartels, J., N.H.Heck and H.F.Johnston, Terr.Magn. 44, 411 f.(1939).

[7] Stagg, J.M., British Polar Year Expedition Fort Rae, N.W.Canada, 1932-33, Vol. II, London, Roy.Soc., 1937.

[8] Bartels, J., Journ. Geophys.Research 55, 427-435 (1950)

[9] Dijk, G. van, "Measures of terrestrial-magnetic activity". with remarks by J.Bartels. Terr.Magn. 40, 371-382 (1935). Some of the arguments are reprinted in Chapman-Bartels, Geomagnetism, Vol.1, pp. 393f.

Main conclusion: The daily planetary character-figure Cp, based exclusively on Kp-indices, appears to meet the requirements of the IATME for an adequate and homogeneous continuation of the series of daily international magnetic character-figures Ci.

Geophysikalisches Institut
Universität Göttingen,
8 April 1951