Reporter review: A38/A40 :

Geomagnetic Observations under a Quiet Sun: the 50th Anniversary of the "International Year of the Quiet Sun"

Use of Indices and Recovered Analogue Records in Geophysical Data Analysis

M. Nose, B. Veenadhari, S. Ueno, H. McCreadie & A. Chambodut

8 Talks (4 invited) + 11 Posters

Long-term solar variations

- *K. Kusano & D. Syukuya*, Hemispheric asymmetry of solar cycle activity
- *N. Gopalswamy*, Long-term variation of coronal mass ejection activity and its space weather
- *B. Tsurutani et al.*, The solar and interplanetary causes of the recent minimum in geomagnetic activity (MGA23) explained

Long-term interplanetary/magnetospheric/atmospheric variations estimated from geomagnetic field variations

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K. Kusano & D. Syukuya,
Hemispheric Asymmetry of Solar Cycle Activities

Svalgaad & Kamide 2013

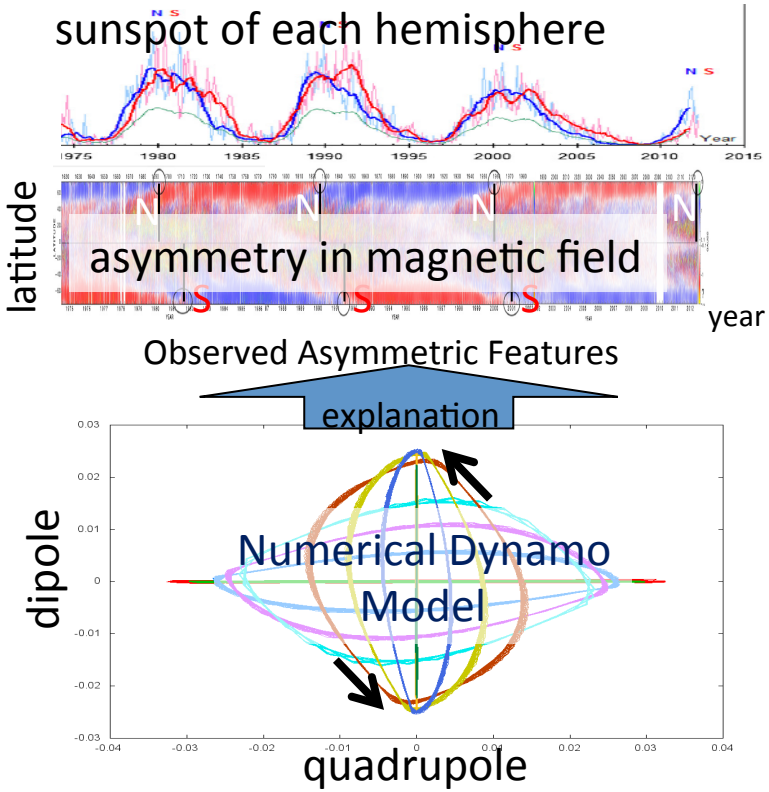
Long-term solar variations

Objectives: To reveal the mechanism underlying the asymmetry of the solar cycle activities between N-S hemisphere.

Method: Numerical simulation

Results: flux transport dynamo model well explains the asymmetric feature, even if the flow in convection zone is totally symmetric (-> the solar cycle may form attractors in which the two magnetic components of different symmetry oscillate with the phase gap of $\pi/2$)

the hemispheric asymmetry is an inherent nature of solar cycle.



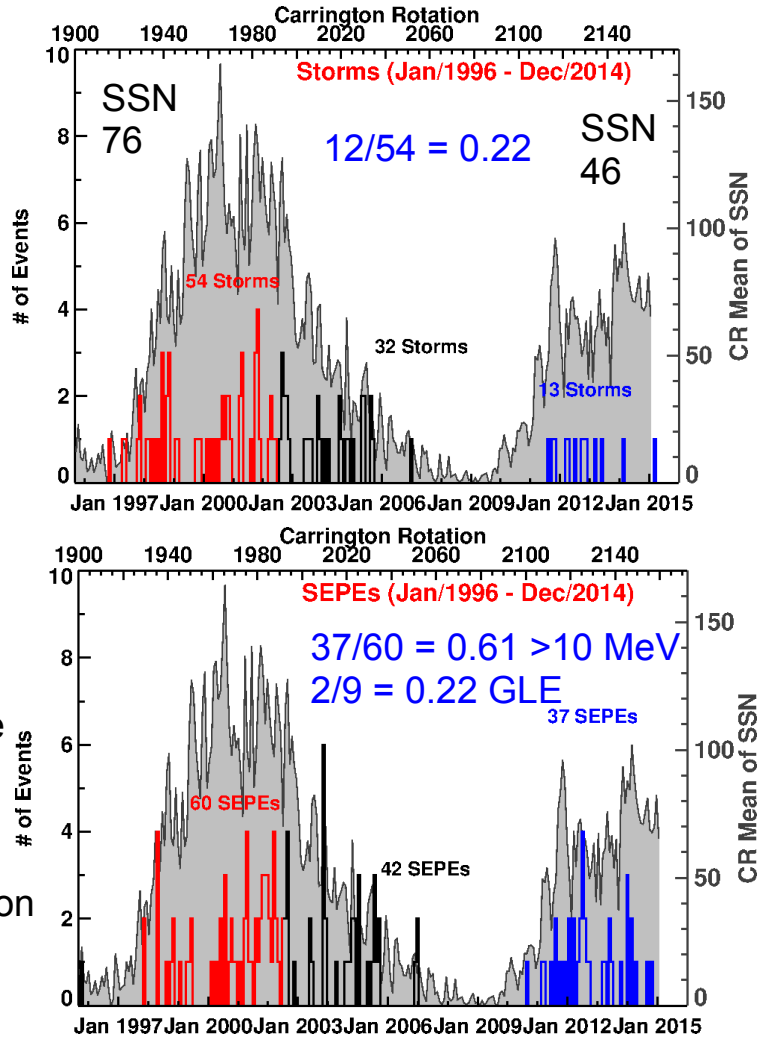
N. Gopalswamy,
Long-term variation of coronal mass ejection activity and its space weather consequences

- Space Weather Events in Solar Cycles 23 & 24
- First 73 months of the two cycles compared

Long-term solar variations

- Average sunspot number (SSN) dropped by 40% (76 to 46)
- # of major storms (Dst <-100 nT) dropped by 78% (54 to 12)
- # of large SEP events (>10 MeV) dropped by 40% (60 to 37)
- # of ground level enhancement (GLE) in SEP events (>700 MeV) dropped by 78% (9 to 2)
- # of fast and wide CME rate dropped by 25% (3.6/mo to 2.7/mo)
- Drop in neither SSN nor CME rate consistent with the decrease in major storms or high-energy SEP events (GLE events)
- The difference can be attributed to the decreased total pressure and Heliospheric magnetic field in cycle 24 leading to the anomalous expansion of CMEs:
  - Expanded CME → weak Bz → weak storms
  - Weak Heliospheric B → low efficiency of shock acceleration → less number of high-energy SEP events (GLE events)

Gopalswamy *et al.* 2014 GRL

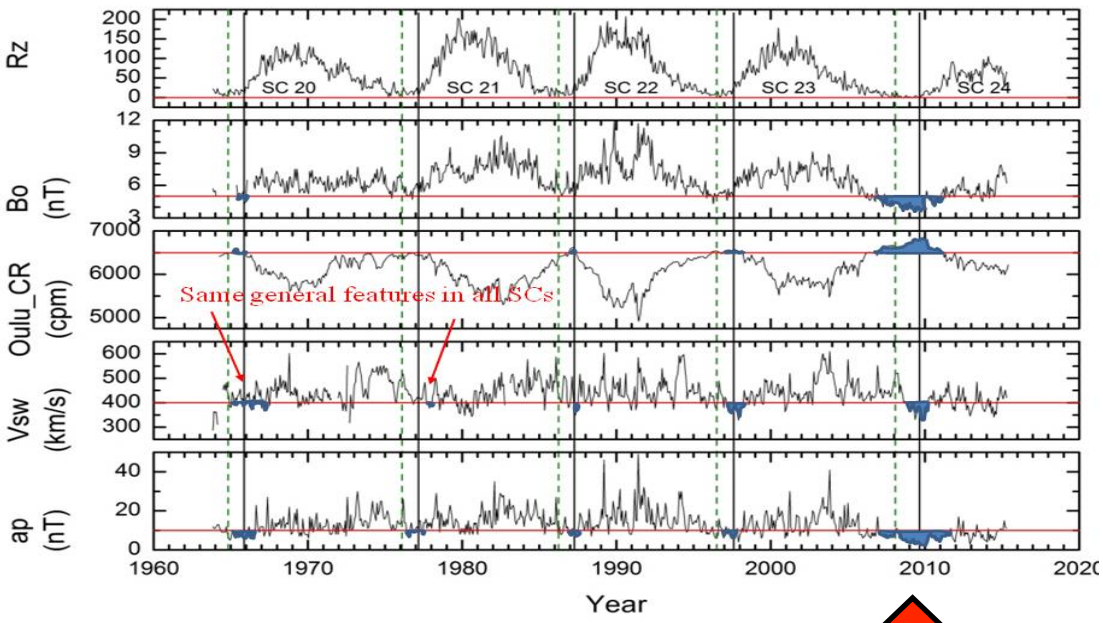


B.T. Tsurutani, E. Echer, R. Hajra, W.D. Gonzalez, A.J. Mannucci, O.P. Verkhoglyadova, A.J. Mannucci, M.G. Mlynczak & L.A. Hunt

The Solar and Interplanetary Causes of Geomagnetic Activity During Solar Minimum

Long-term solar variations

- The combination of: 1) low solar and IMFs, 2) low V_{sw}, 3) low IMF B_{south} variances (Alfvénic fluctuations) are the causes for the all-time minimum in geomagnetic activity in 2009.
- The causes of 2) and 3) are the lack of equatorial coronal holes and the presence of midlatitude coronal holes.
- It was also found that 4) there was a minimum in occurrence of CMEs and 5) the speeds were minimum near sunspot minimum (2008).



It is possible that during the Maunder Minimum, the fields were lower still with even lower solar wind speeds and even lower CME speeds.

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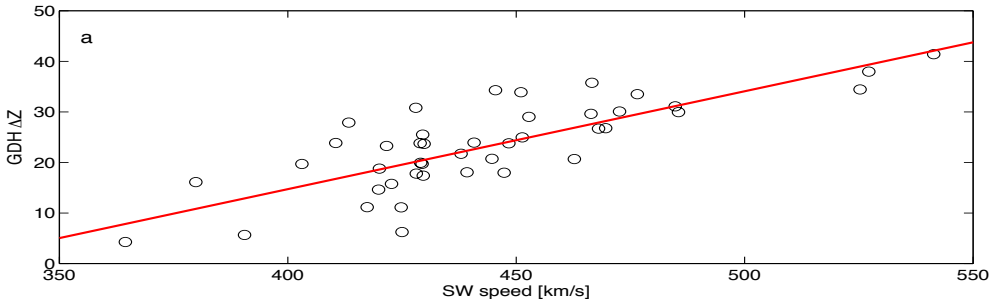
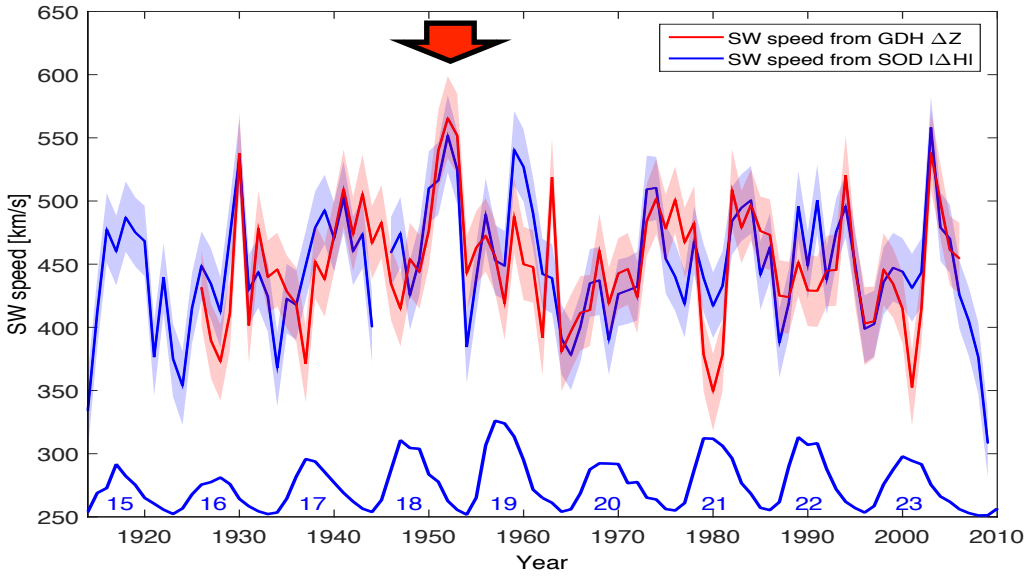
Long-term variations…

K. Mursula, R. Lukianova & L. Holappa
Occurrence of high-speed solar wind streams over the Grand Modern Maximum

- There is a high correlation between the annual averages of the solar wind speed and GDH ΔZ, where ΔZ=Z(disturbed)–Z(quiet).
- We find that the occurrence of high speed streams maximized during the declining phase of the solar cycle 18, indicating excessively strong polar fields during the minimum between SC 18 and SC 19.
- This gives direct support for validity of the solar dynamo theory [Babcock, 1961] during the most active period of solar magnetism.



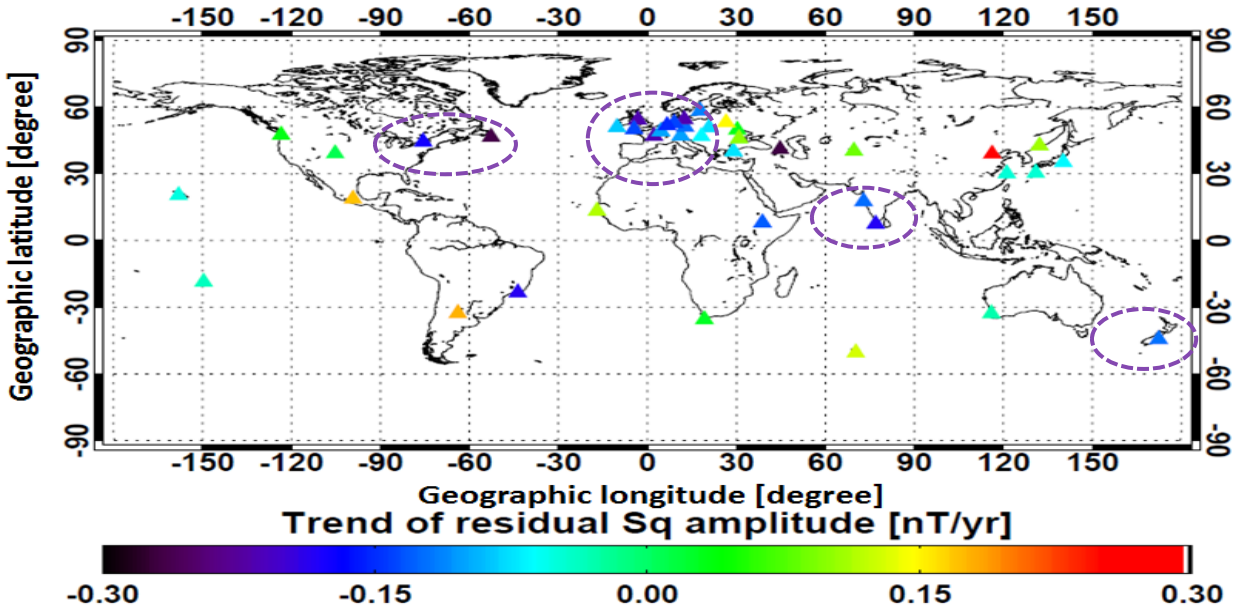


A. Shinbori, Y. Koyama, M. Nose, T. Hori, Y. Otsuka, and A. Yatagai
Long-term variation in the upper atmosphere as seen in the geomagnetic solar quiet daily variation

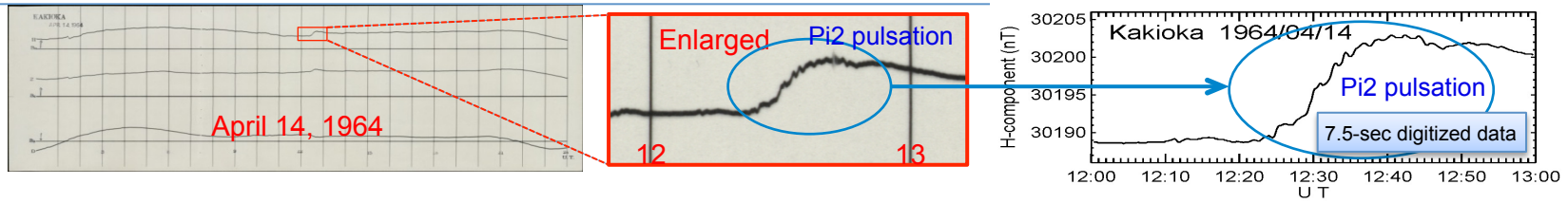
- Long-term variations of the Sq amplitude have been investigated by using geomagnetic field data from 69 observatories for 1947-2013.
- The Sq amplitude after removing contribution from the solar activity (F10.7), that is, the residual Sq amplitude, shows negative rate of change over a wide region (Europe, India, the eastern part of Canada, and New Zealand).

Long-term variations…

- This result showed that the increasing trend in the Sq amplitude reported by Elias et al. [2010] is not applicable to all the observation points



M. Nosé, K. Yamamoto, N. Mashiko & S. Nagamachi
Estimation of magnetospheric plasma ion composition for 1956-1975 by using high-time resolution geomagnetic field data created from analog magnetograms

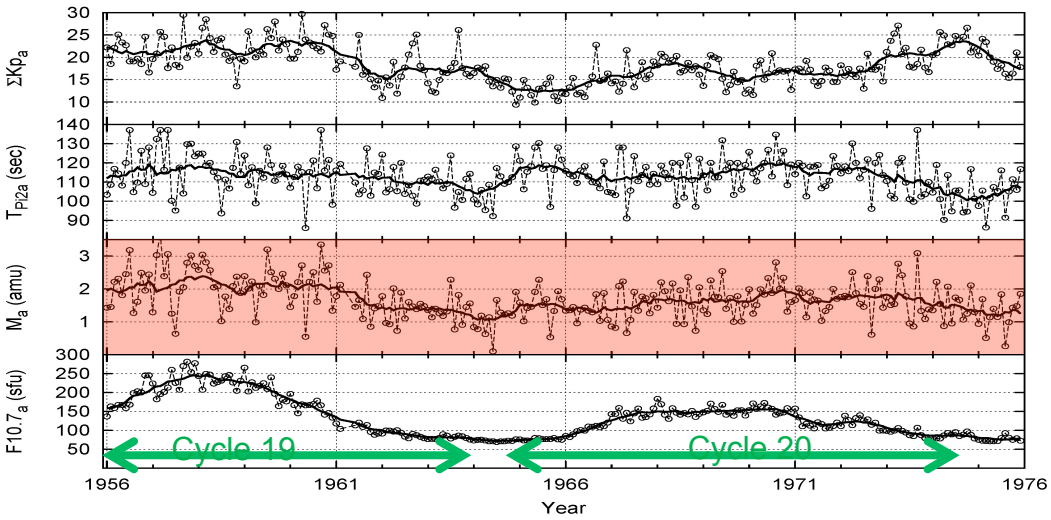


Long-term variations…

- 7.5-sec digitized data have been created from analog magnetograms for 1956-1975.
- Pi2 pulsations can be identified from the 7.5-sec digitized data.
- Substituting the observed period of Pi2 pulsations and Σ Kp into the empirical equation, we can estimate the plasma ion mass (M) before 1975.
- It is found that M shows long-term variations between 1.1 amu and 2.4 amu during the solar cycle 19 and 20.
- The digitized data created from analog magnetograms give an important clue to know the space environment in old days.

Empirical Equation

$$T_{Pi2}\ [sec] = -1.34(\pm0.05)\cdot \Sigma Kp + 17.65(\pm0.80)\cdot M\ [amu] + 108.68(\pm0.94)$$



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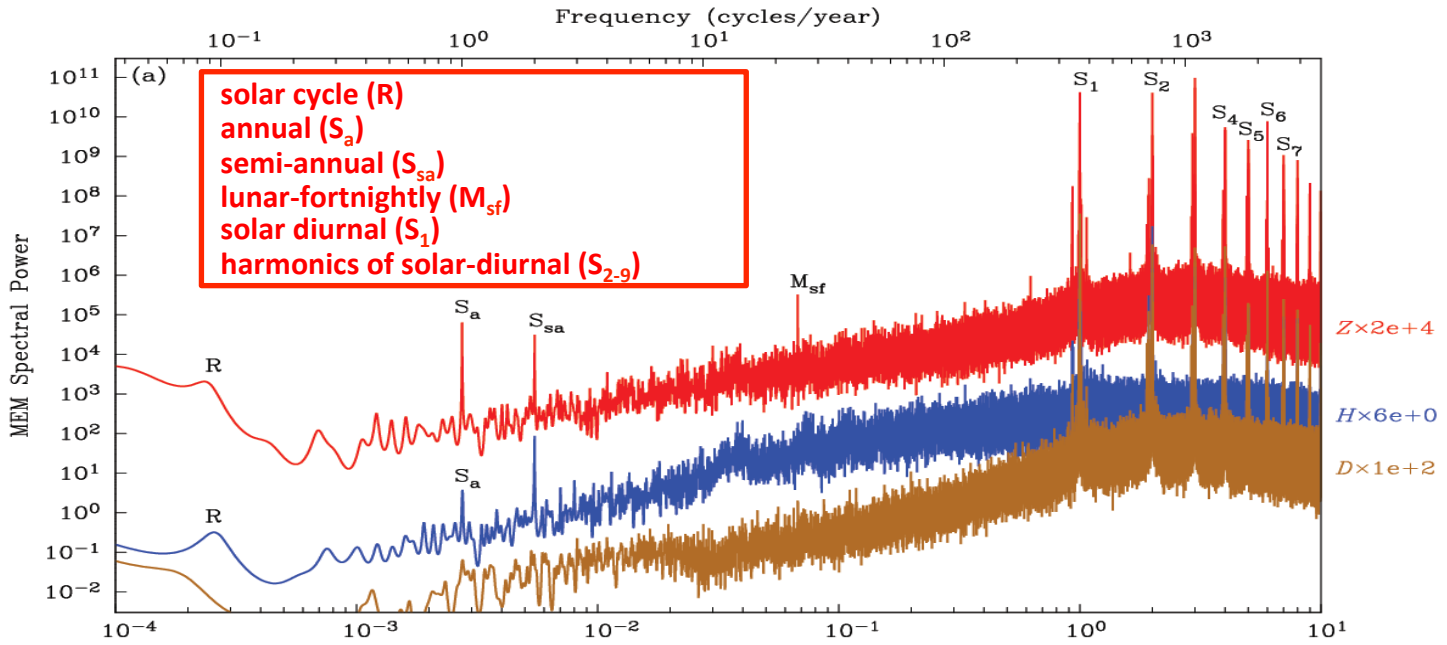
J. J. Love & E. J. Rigler,
The magnetic tides of Honolulu

- Nearly 100 years of hourly magnetic data from Honolulu magnetic observatory
- Panoramic view of spectrum clearly shows different modes of geomagnetic variations.



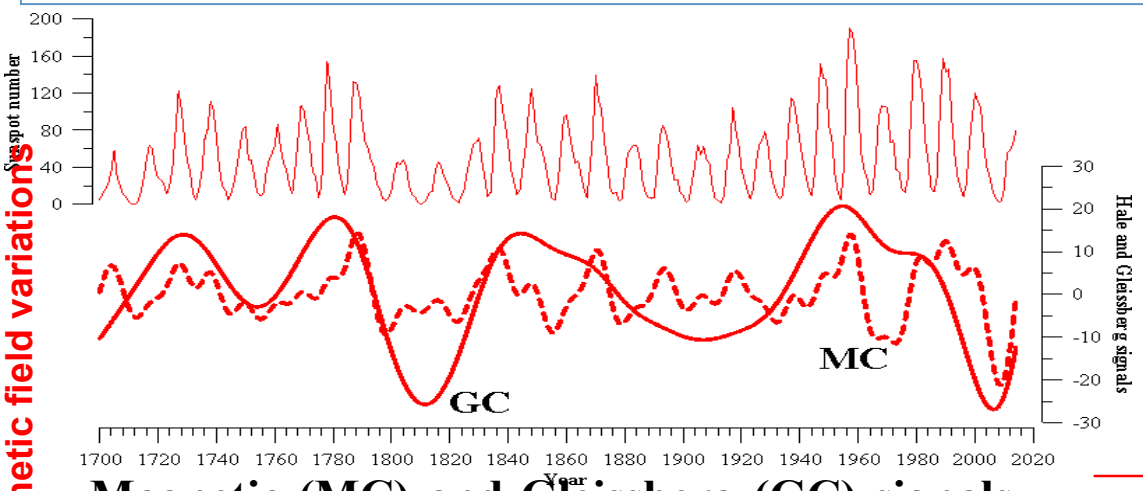
- Hyperfine view of spectrum shows solar cycle modulations of solar-diurnal and other known tidal constituents (Rs).

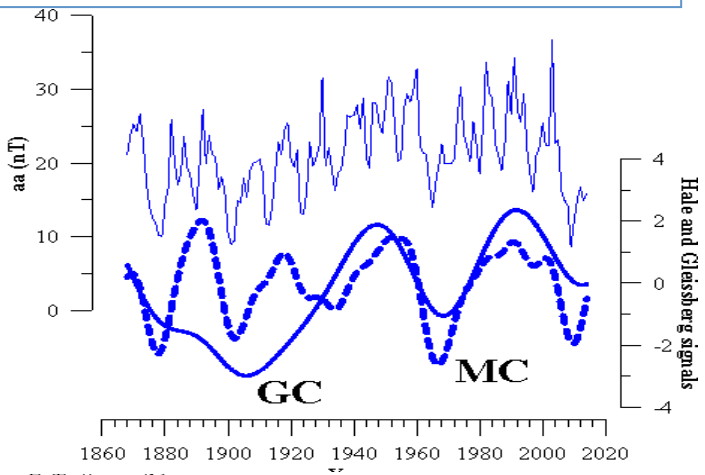
Long-term geomagnetic field variations

C. Demetrescu & V. Dobrica

The Quiet Sun of 1964-65 and the following solar cycle 20, an expression of long-term evolution of solar activity

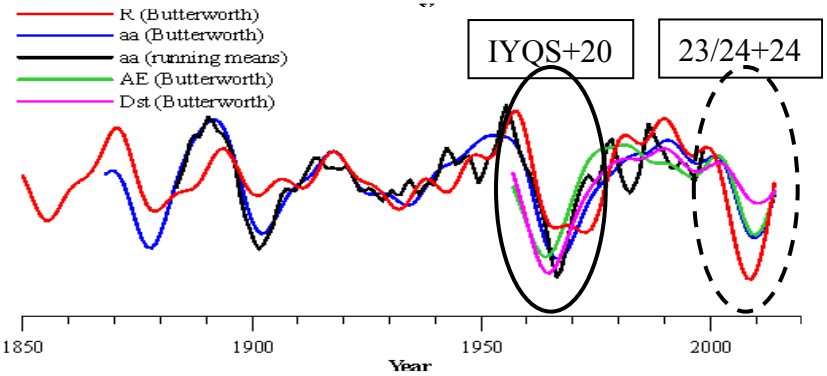
Long-term geomagnetic field variations





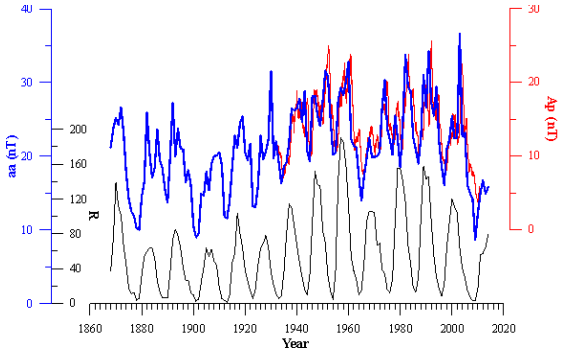
Magnetic (MC) and Gleissberg (GC) signals in R and aa

superposed minima in MC and GC signals for both IYQS + next cycle 20 and the last deep minimum 23/24 + next cycle 24



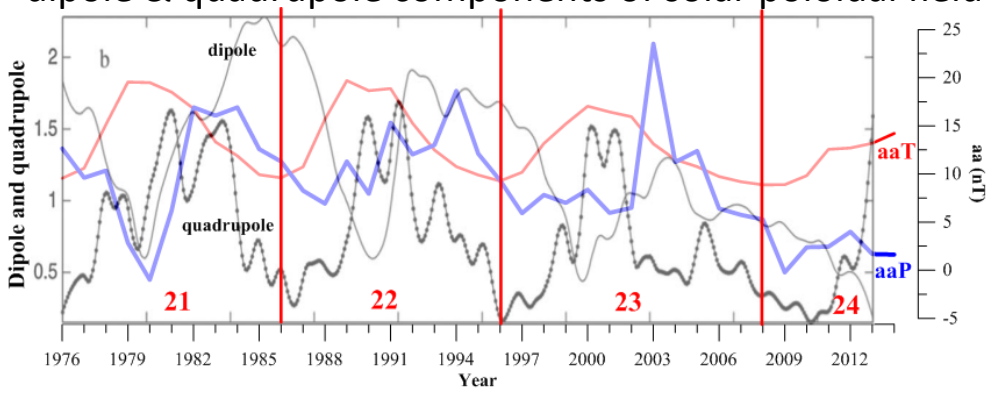
V. Dobrica & C. Demetrescu ,
Long-term evolution of geomagnetic activity: An analysis of its solar and magnetospheric sources

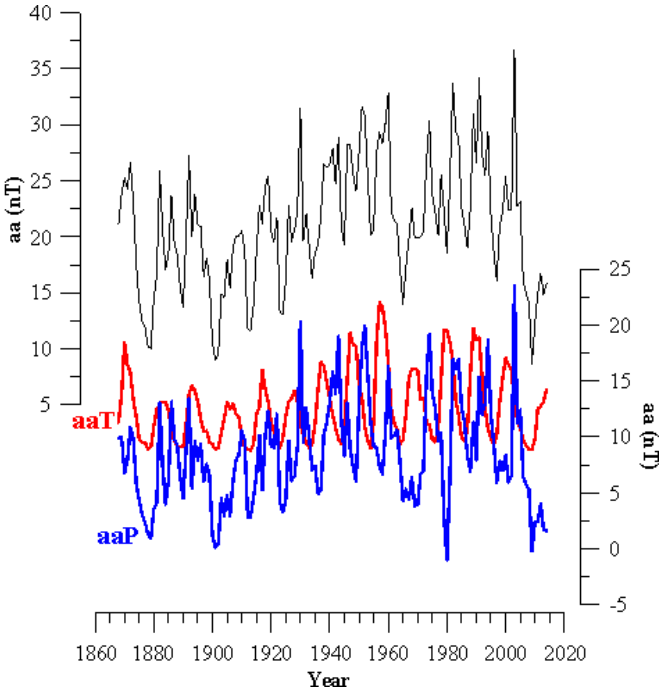
Long-term geomagnetic field variations



non-sunspot-related geomagnetic activity (aaP)

dipole & quadrupole components of solar poloidal field





sunspot (aaT) &
non-sunspot-related (aaP)

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New International Service of Geomagnetic Indices' web site

http://isgi.unistra.fr

IAGA Endorsed Geomagnetic Indices

PC

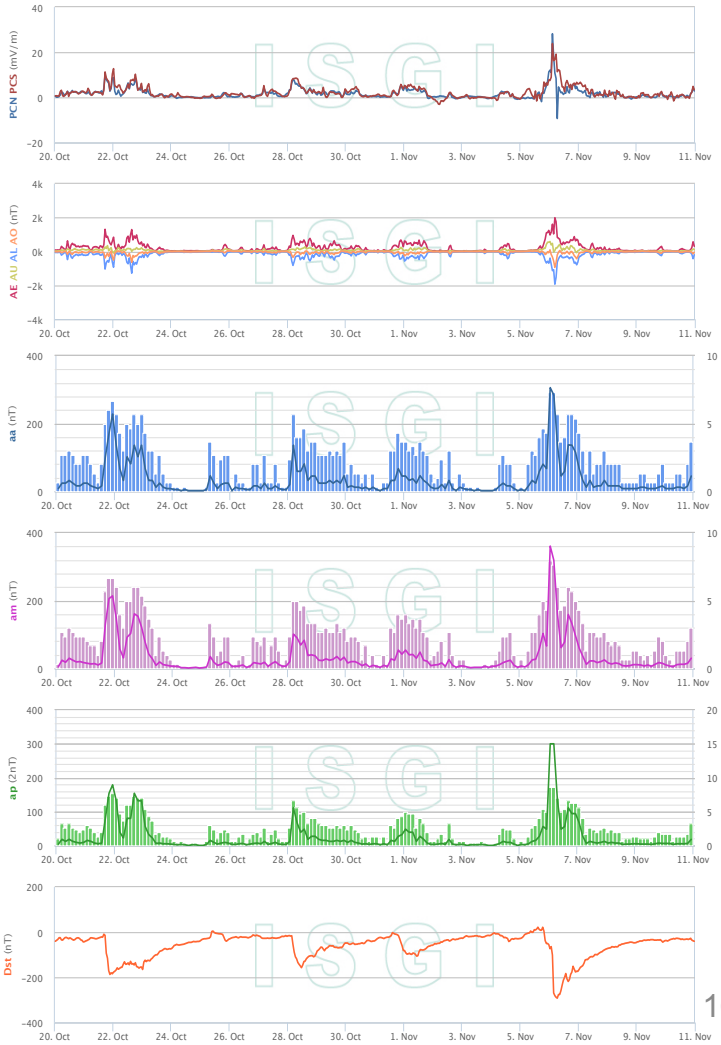
AE

aa

am

Kp

Dst



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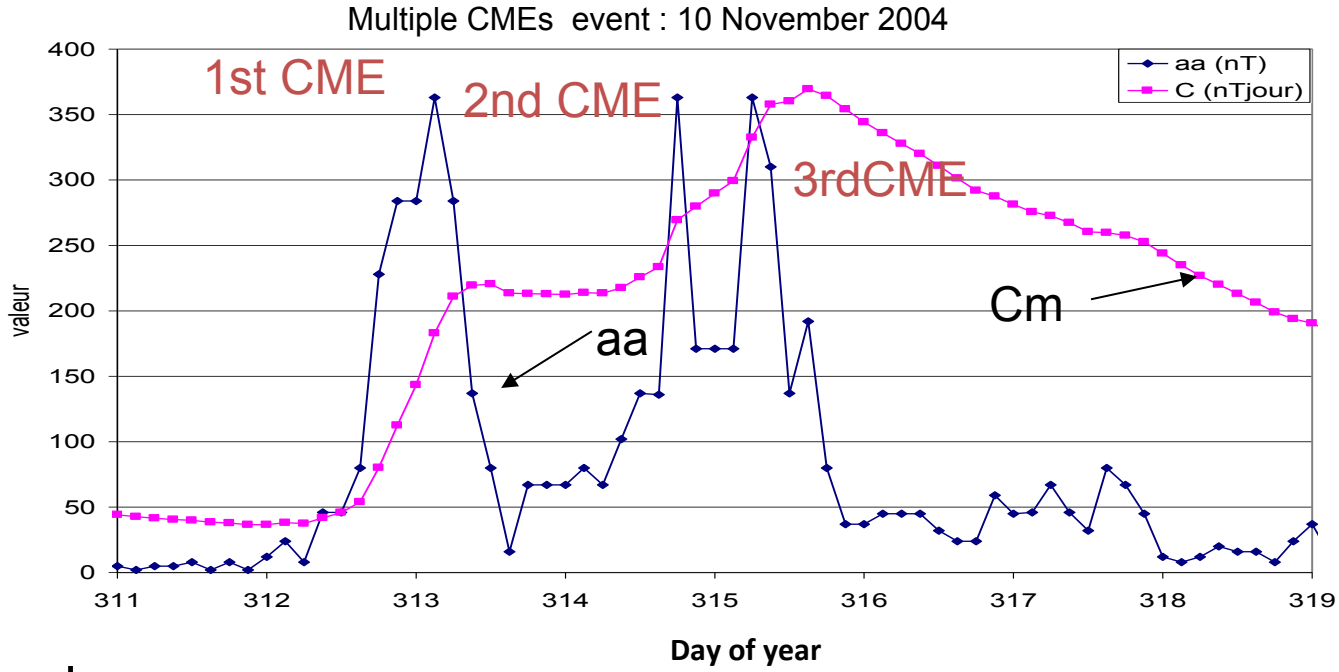

$$Cm(t) = \frac{1}{\tau}\int_0 Am(t-t')\exp^{-t'/\tau}dt'$$

Cm allows finding multiple events, studying the energy entry inside the magnetosphere and bring new information about radiation belts fluxes.

Geomagnetic Indices: définition and use

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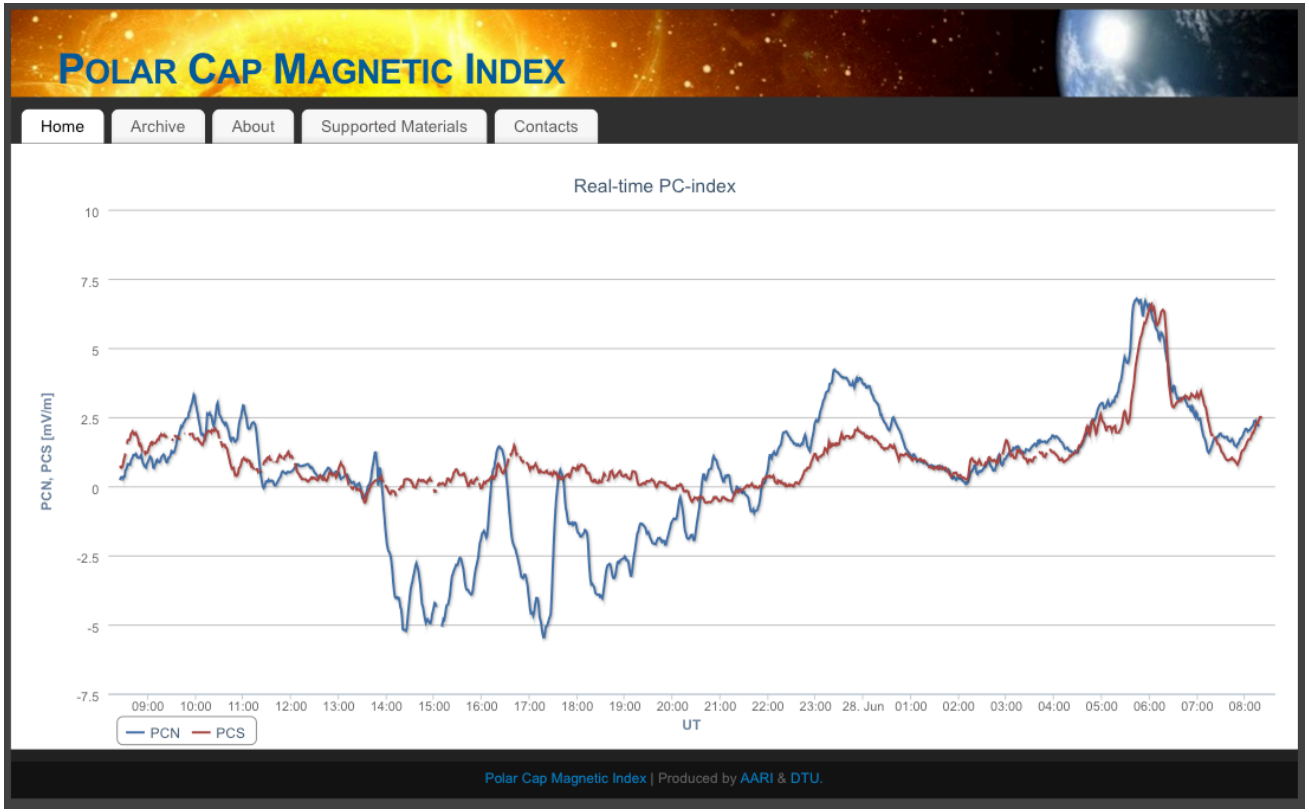
PC index as a new ground-based means for exploration of short-term changes in space weather and magnetosphere state



http://pc-index.org/

A. Chambodut, A. Marchaudon, C. Lathuillère & M. Menvielle, New geomagnetic indices α with 15 minutes time resolution

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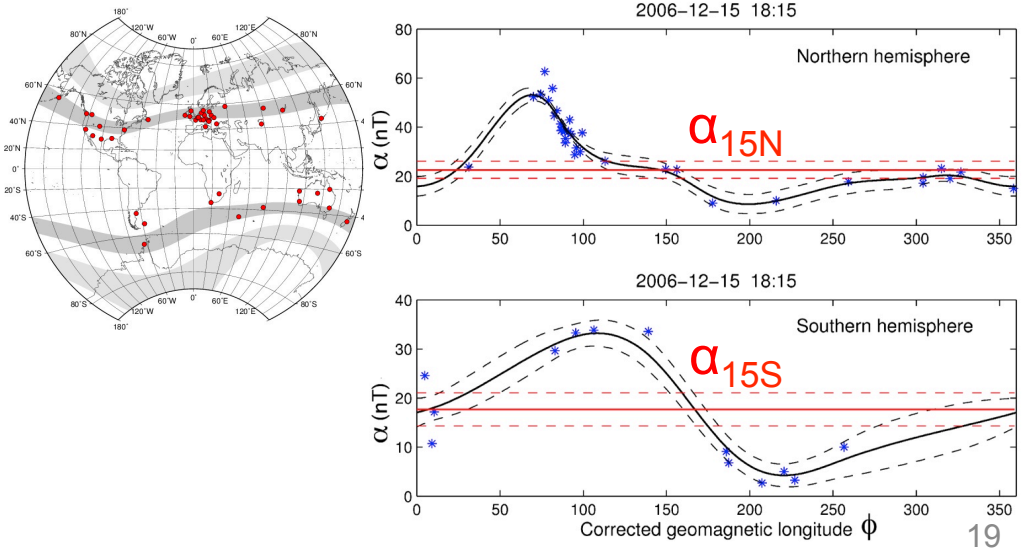
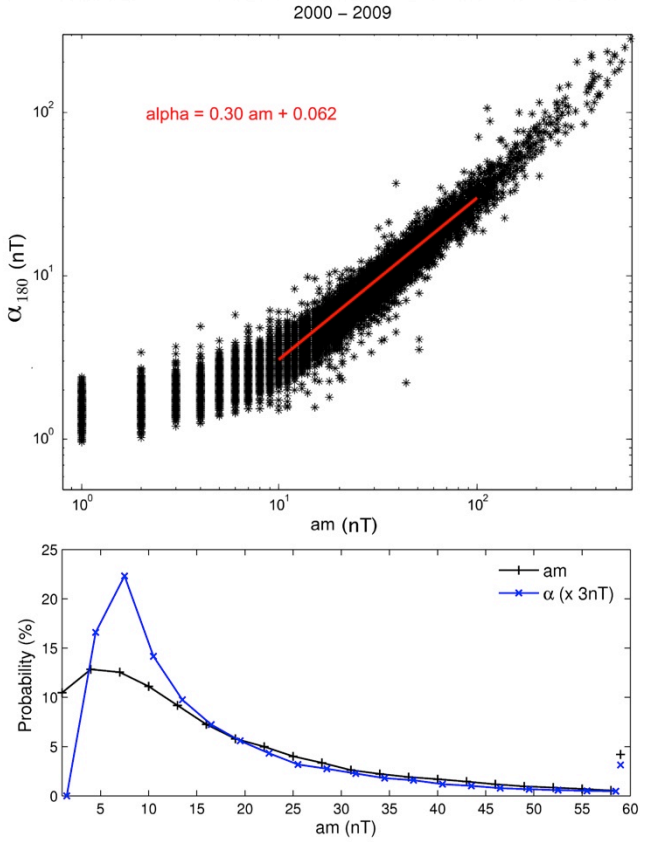


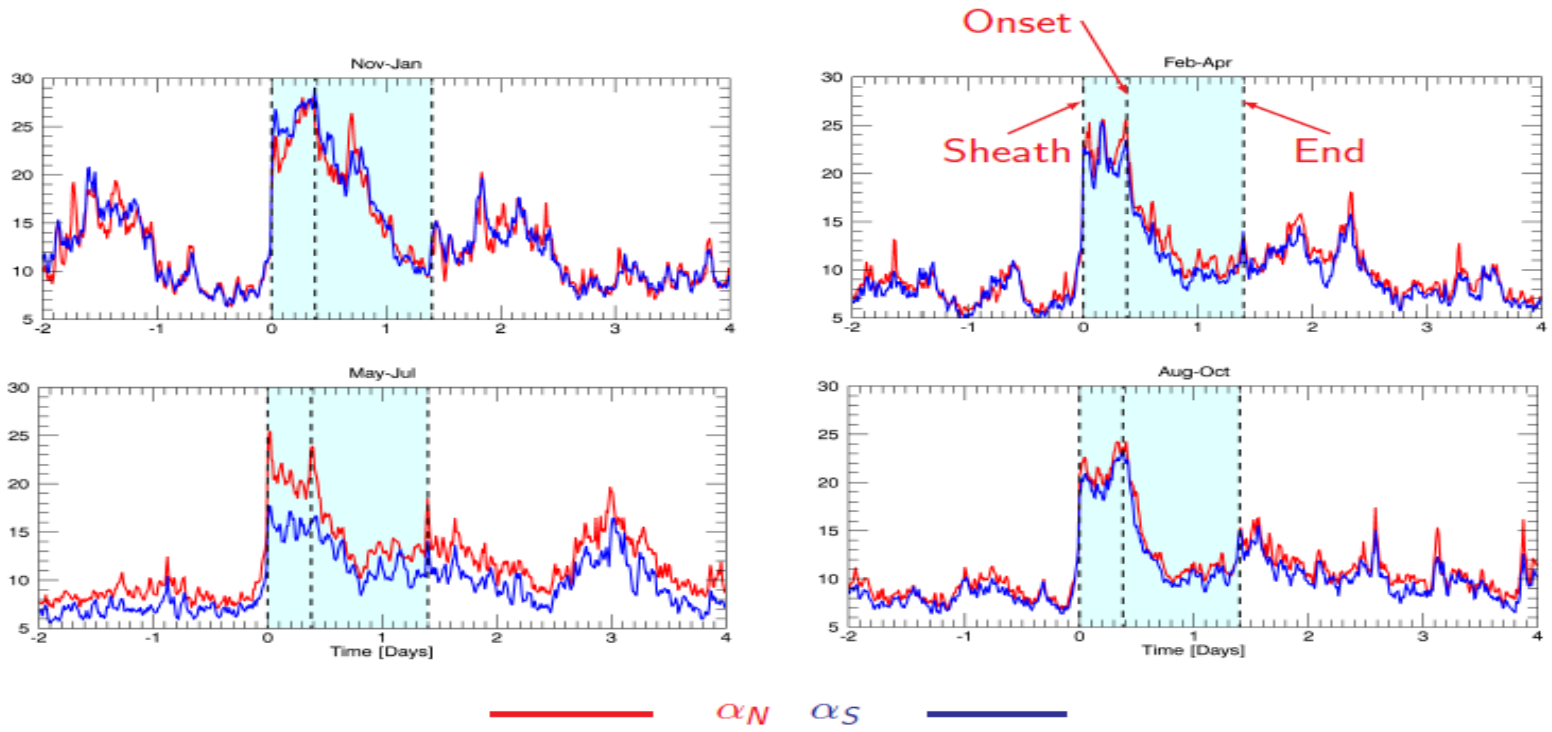


- planetary and hemispheric indices
- subauroral indices
- calculated with an adaptive network of stations (always take the denser one)
- continuous and homogeneous serie since 1996
- resolution 15 minutes
  - still need to investigate in details the longitudinal variations

Geomagnetic Indices: definition and use

R. Benacquista, S. Rochel Grimald, D. Boscher, A. Marchaudon, A. Chambodut, G. Rolland
Magnetic activity during substorms expressed with the new global magnetic index α

Thanks to a higher resolution (15 min), the new indices α provide an opportunity to better understand magnetic substorms



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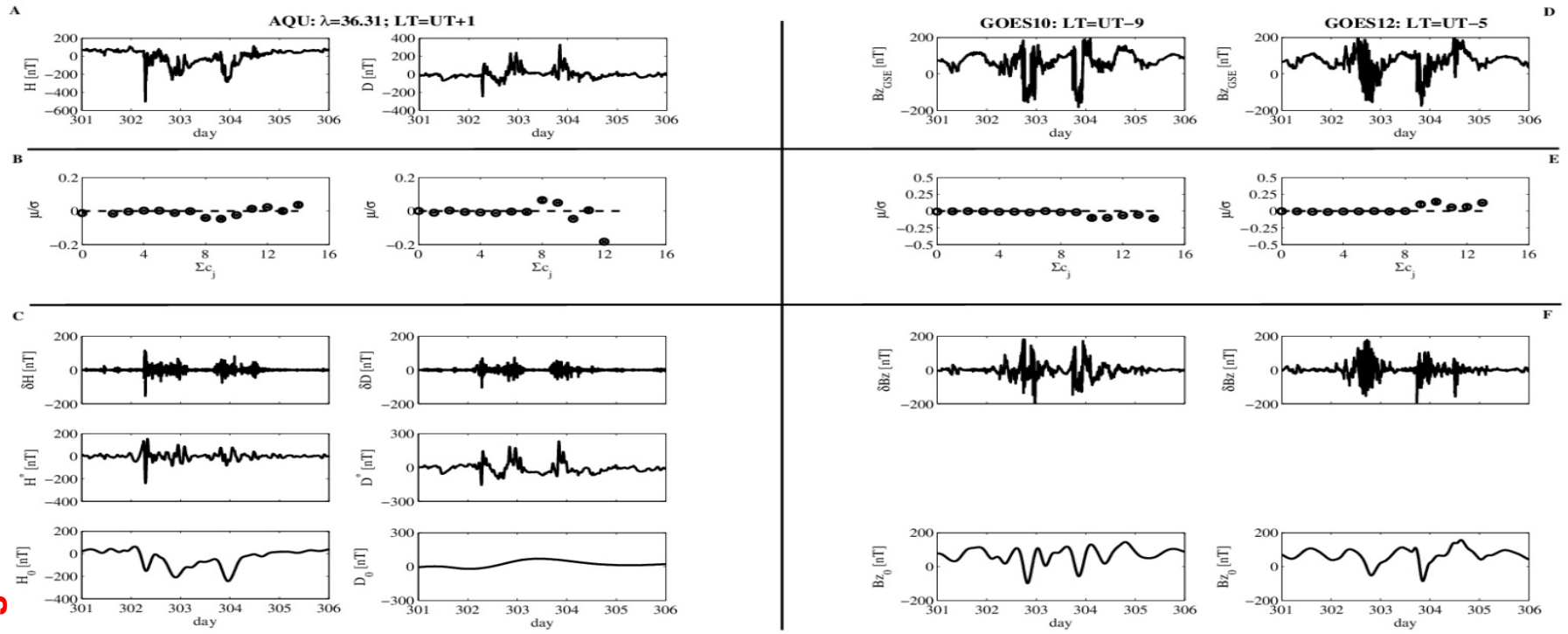
The modulated baseline and anomalies of geomagnetic field during geomagnetic storms



ground

satellite

Geomagnetic Indices: definition and use

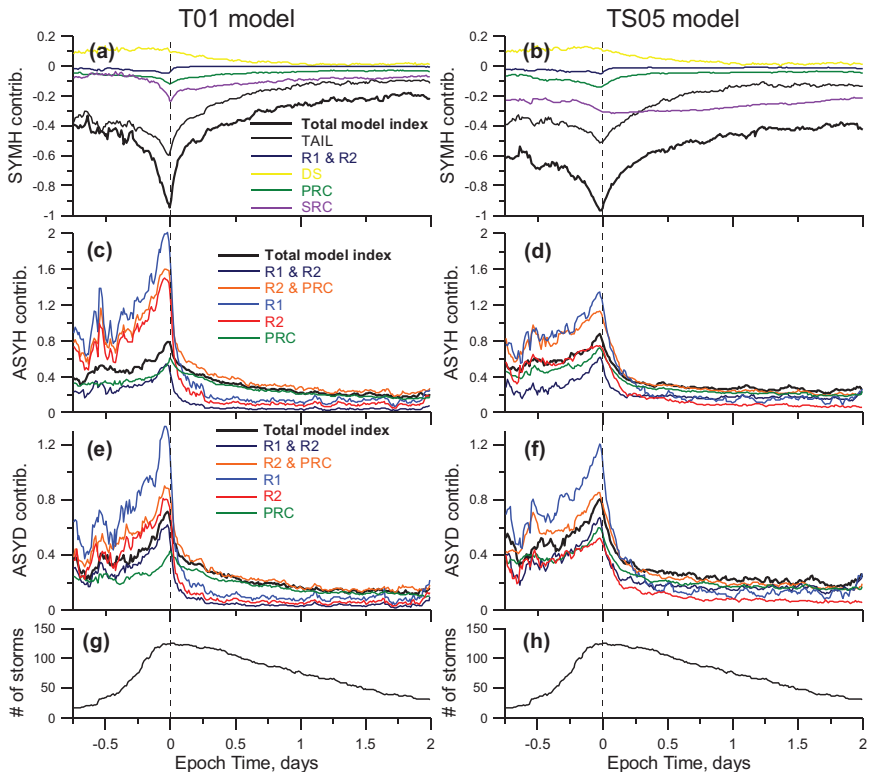
R. Ilie, N. Ganushkina, S. Dubyagin & M. Liemohn
Dynamics of magnetospheric currents systems revealed using modeling and ground based observations

Empirical models which include the field-aligned currents and dawn-dusk asymmetry were used:

1. T01 [*Tsyganenko*, 2002a, b]
2. TS05 [*Tsyganenko and Sitnov*, 2005]

Cross-tail current gives the dominant contribution to the SYM-H index during storm main phase (model R2 FAC, PRC, and cross-tail current systems are not spatially demarcated and overlap in the vicinity of geostationary orbit).

Only current systems which close via the ionosphere give a significant contribution to the ASY-H and ASY-D indices. These systems are the PRC and R1 and R2 FACs.



Superposed Epoch Analysis: all storms 1995-2004

8 Talks (4 invited) + 11 Posters

Long-term solar variations

- *K. Kusano & D. Syukuya*, Hemispheric asymmetry of solar cycle activity
- *N. Gopalswamy*, Long-term variation of coronal mass ejection activity and its space weather
- *B. Tsurutani et al.*, The solar and interplanetary causes of the recent minimum in geomagnetic activity (MGA23) explained

Long-term interplanetary/magnetospheric/atmospheric variations estimated from geomagnetic field variations

- *K. Mursula et al.,* Occurrence of high-speed solar wind streams over the Grand Modern Maximum
- *A. Shinbori et al.,* Long-term variation in the upper atmosphere as seen in the geomagnetic solar quiet daily variation
- *M. Nose et al.*, Estimation of magnetospheric plasma ion composition for 1956-1975 by using high-time resolution geomagnetic field data created from analog magnetograms

Long-term geomagnetic field variations

- *J. J. Love & E. J. Rigler*, Geomagnetic tides of Honolulu
- *C. Demetrescu, & V. Dobrica*, The Quiet Sun of 1964-65 and the following solar cycle 20: expression of long-term evolution of solar activity
- *V. Dobrica & C. Demetrescu* , Long-term evolution of geomagnetic activity. An analysis of its solar and magnetospheric sources
- *X. Zhao et al.,* The Study of Sq equivalent current during the solar cycle

Geomagnetic Indices: definition and use

- *A. Chambodut et al.*, New international service of geomagnetic indices' web site
- *L. Billingham & G. Kelly*, An application of machine learning to geomagnetic index prediction: Aiding human space weather forecasting
- *D. Boscher & S. Rochel*, A new vision of the magnetic indices for the Sun-Earth connection
- *O. Toshichev & J. Matzka,* PC index as a new ground-based means for exploration of short-term changes in space weather and magnetosphere state
- *A. Chambodut et al.* , New geomagnetic indices α with 15 minutes time resolution
  Subauroral magnetic activity during magnetic quiet periods as described using 15-minutes α magnetic index
- *R. Benaquista et al.*, Magnetic activity during substorms expressed with the new global magnetic index α
- *M. Piersanti et al.*, The modulated baseline and anomalies of geomagnetic field during geomagnetic storms.
- *R. Ilie et al.,* Dynamics of magnetospheric currents systems revealed using modeling and ground based observations