Ninth Workshop
Solar Influences on the Magnetosphere, Ionosphere and Atmosphere
Sunny Beach, Bulgaria, May 30 - June 3, 2017

On the possibility to predict the future sunspot maximum

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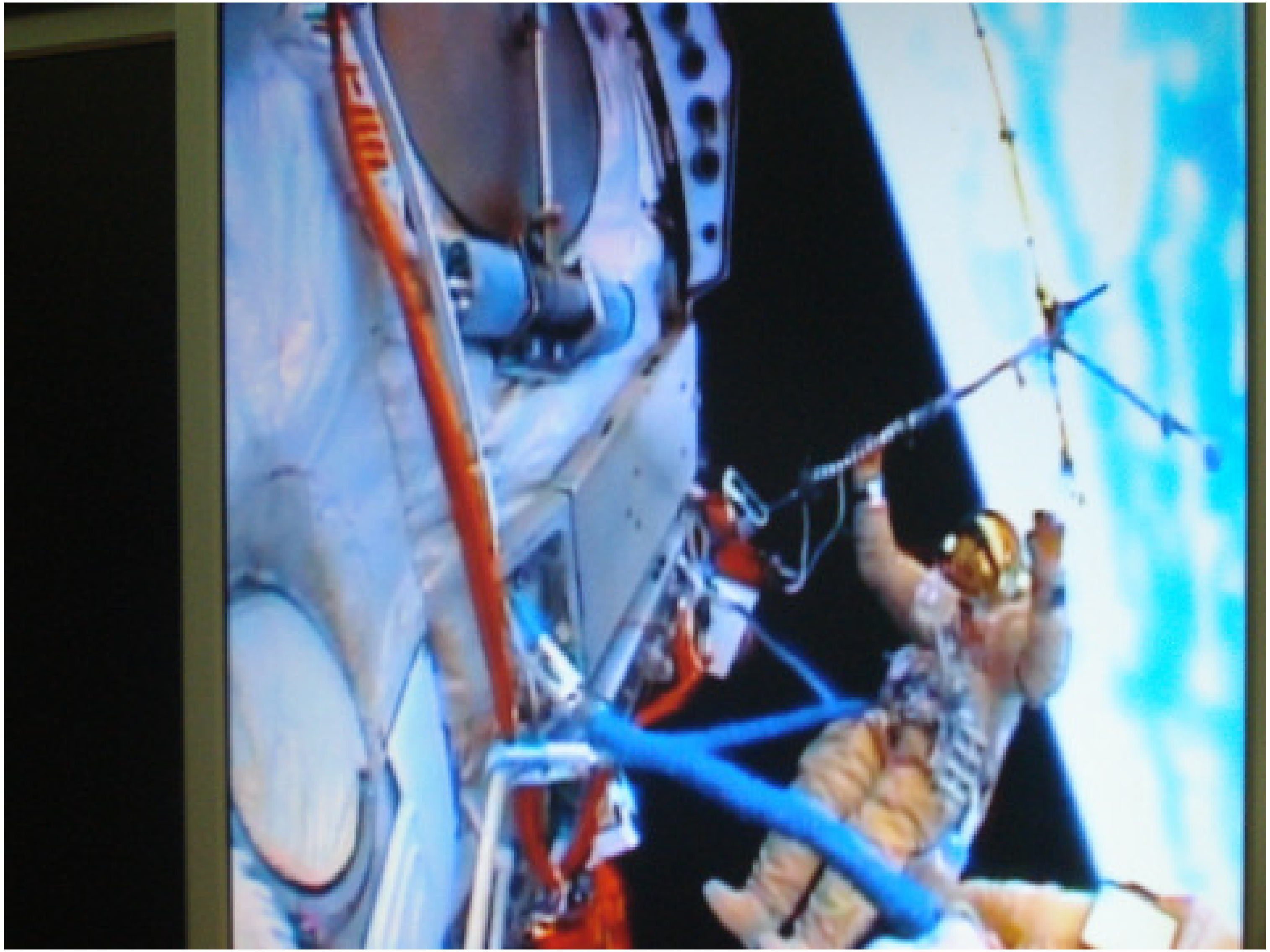
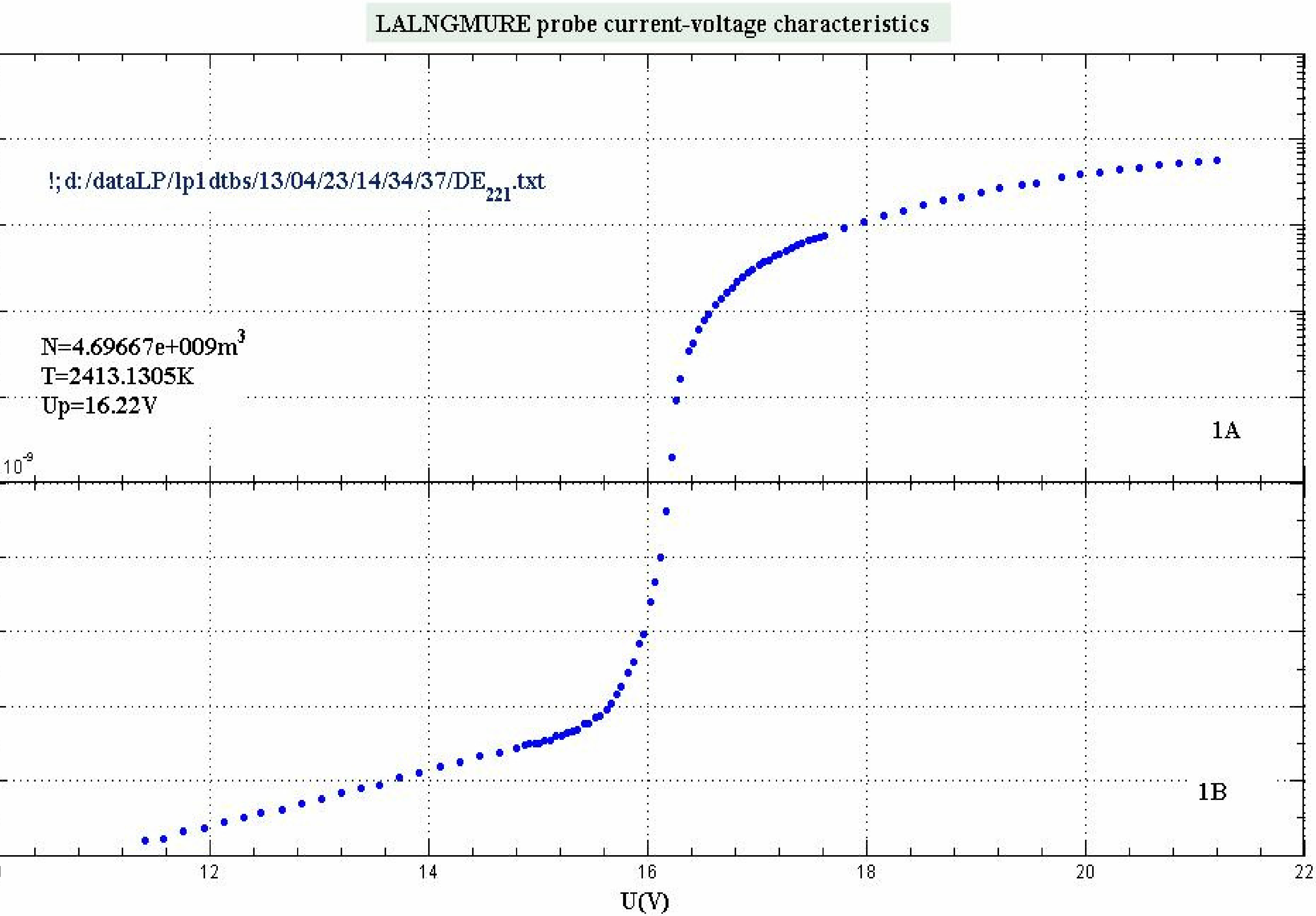
Space probe instruments





1B	
11.4	4.81e-009
11.57	4.78e-009
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11.94	4.63e-009
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12.65	4.39e-009
12.83	4.3e-009
13.02	4.24e-009
13.2	4.16e-009
13.38	4.11e-009
13.55	4.05e-009
13.73	3.96e-009
13.91	3.89e-009
14.1	3.81e-009
14.28	3.76e-009
14.46	3.66e-009
14.64	3.63e-009
14.8	3.56e-009
14.87	3.53e-009
14.91	3.51e-009
14.97	3.51e-009
15.01	3.5e-009
15.06	3.46e-009
15.11	3.46e-009
15.16	3.4e-009
15.21	3.4e-009
15.27	3.35e-009
15.31	3.34e-009
15.36	3.31e-009
15.42	3.24e-009
15.46	3.23e-009
15.52	3.16e-009
15.56	3.13e-009
15.62	3.04e-009
15.66	2.96e-009
15.72	2.84e-009
15.76	2.73e-009
15.82	2.56e-009
15.87	2.41e-009
15.92	2.16e-009
15.96	2.03e-009
16.02	1.61e-009
16.06	1.34e-009

1A	
16.22	-1.95e-
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16.3	-1.62e-
16.37	-3.34e-
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16.56	-9.24e-
16.62	-1.17e-
16.67	-1.4e-
16.72	-1.62e-
16.77	-1.88e-
16.82	-2.18e-
16.86	-2.42e-
16.92	-2.79e-
16.96	-3.05e-
17.02	-3.45e-
17.06	-3.73e-
17.11	-3.96e-
17.16	-4.4e-
17.2	-4.67e-
17.27	-5.08e-
17.32	-5.5e-
17.37	-5.79e-
17.41	-6.1e-
17.47	-6.54e-
17.52	-6.88e-
17.57	-7.33e-
17.62	-7.67e-
17.79	-9.18e-
17.97	-1.08e-
18.16	-1.26e-
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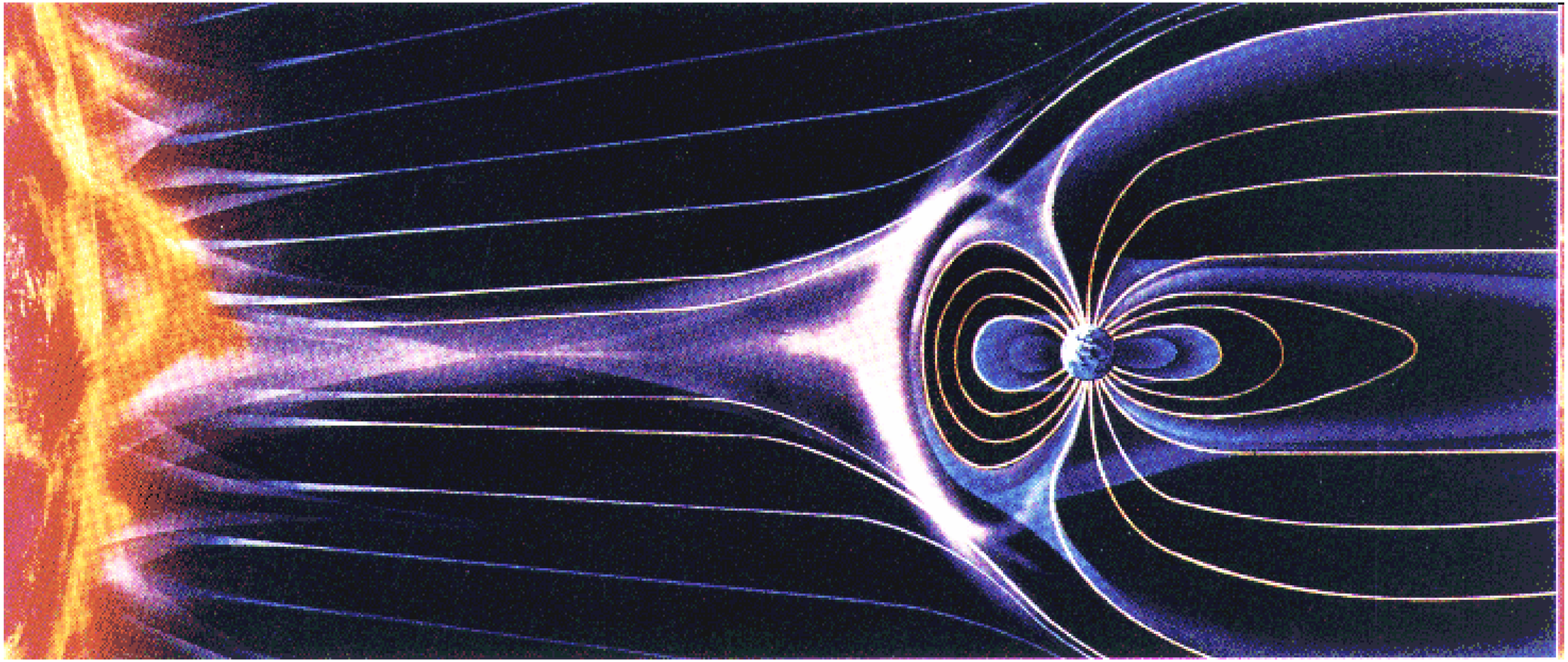
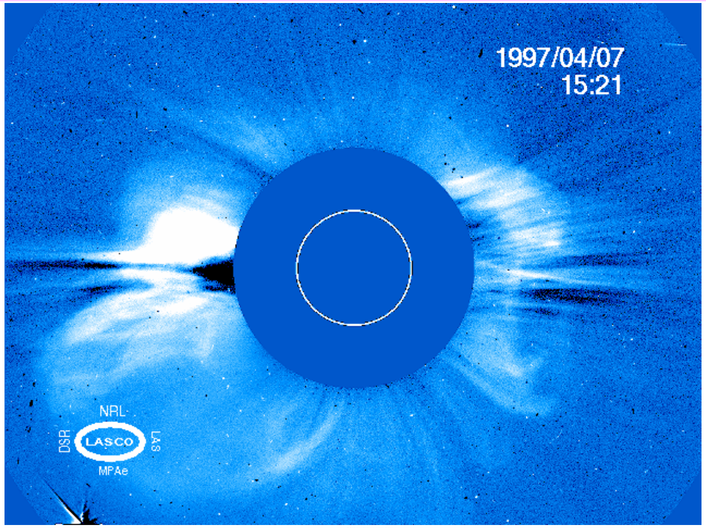
19.22	-2.67e-
19.42	-2.96e-
19.55	-3.12e-
19.78	-3.68e-
19.95	-3.89e-
20.13	-4.1e-
20.31	-4.39e-
20.5	-4.66e-

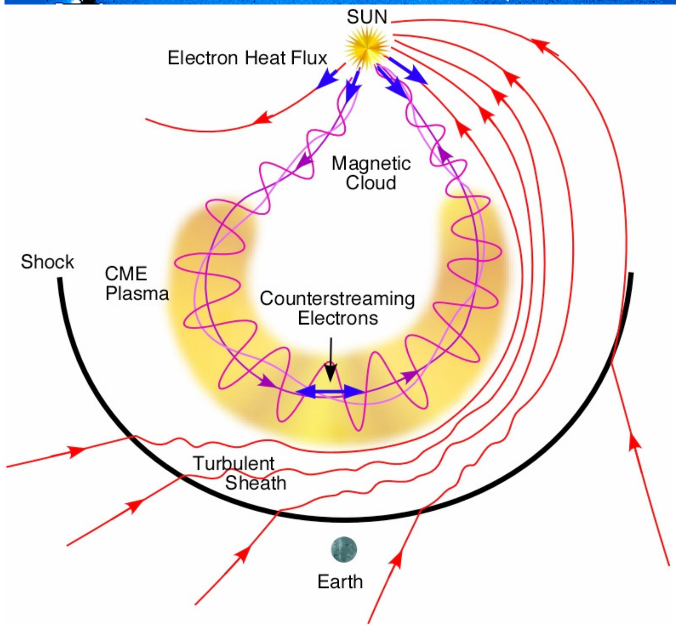
The Earth as a space probe



Geomagnetic activity - disturbance of the Earth's magnetosphere caused by a solar wind shock wave and/or cloud of magnetic field that interacts with the Earth's magnetic field.

Solar drivers of the geomagnetic disturbances: (1) coronal mass ejections





A coronal mass ejection (CME) are large eruption of magnetized plasma from the Sun 's outer atmosphere, or corona, that propagates outward into interplanetary space

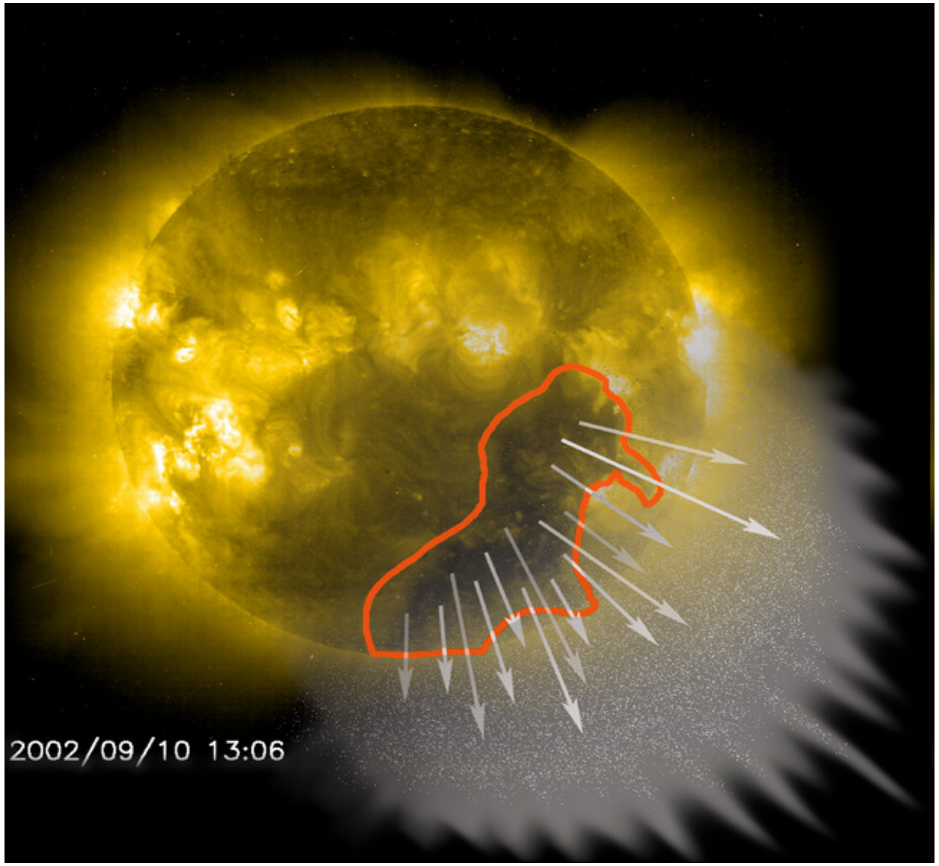
- CME interact with Earth's magnetic field
- CME cause the strongest geomagnetic storms
- During periods of more sunspots there are more solar flares and CME

Solar drivers of the geomagnetic disturbances: (2) high speed solar wind stream

source: unipolar open magnetic field areas - coronal holes

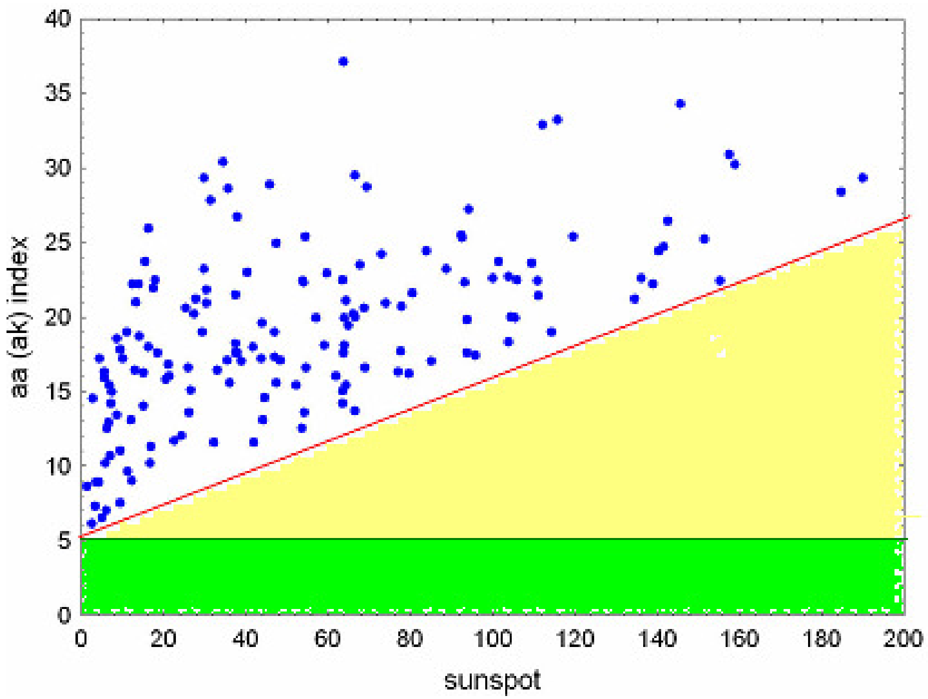
HSS frequently impinging on the Earth's magnetosphere causing recurrent geomagnetic storm activity

HSS maximum is during the descending phase of solar activity cycle



Manifestation of the solar poloidal field

3 components of the geomagnetic activity

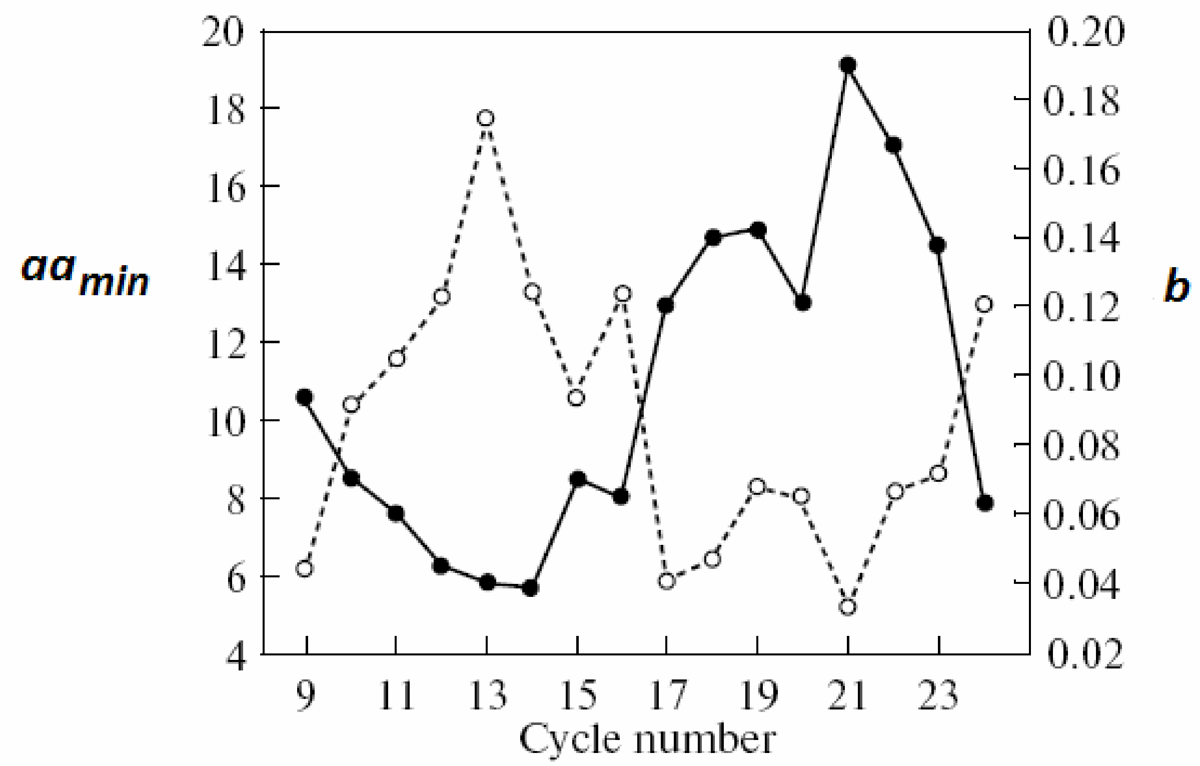


$$aa = aa_{min} + aa_T + aa_p$$

$$aa_T = b*R$$

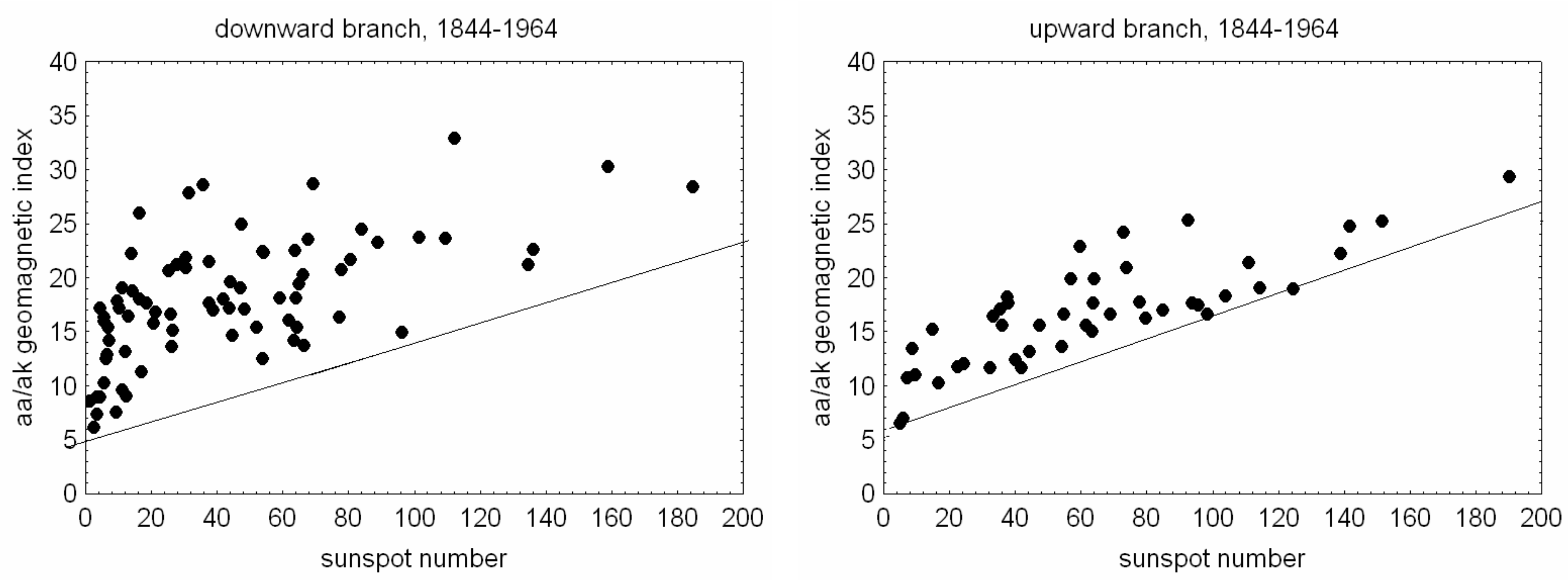
- aa_{min} - the floor below which geomagnetic activity cannot fall even in the absence of sunspot
- aa_T**=b*R** – geomagnetic activity caused by sunspot-related solar activity
- b – measure of the sensitivity of the geomagnetic activity to increasing number of sunspots.
- aa_p – geomagnetic activity caused by non sunspot-related solar activity

Variations of the coefficients aa_{min} and b in sunspot cycles

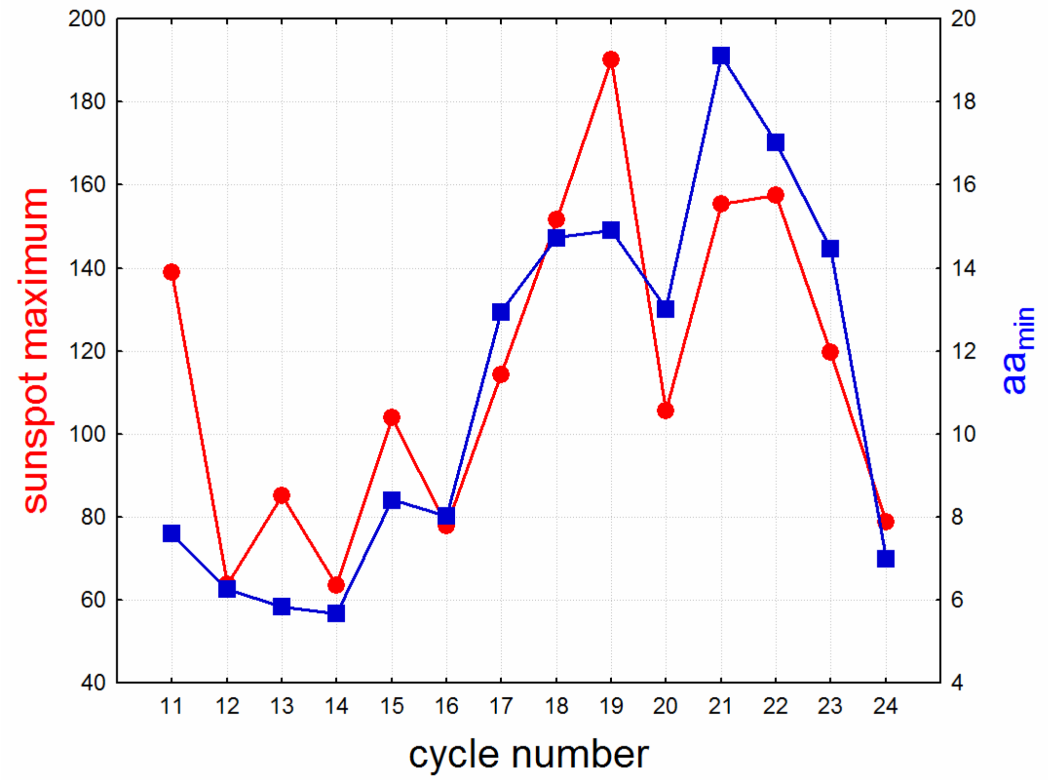


aa_{min} decreased from the minimum of cycle 9 to the minimum of cycle 14, increased until the minimum of cycle 21, and has been decreasing since then

Can we determine the maximum of the **sunspot number** by *aa_min*



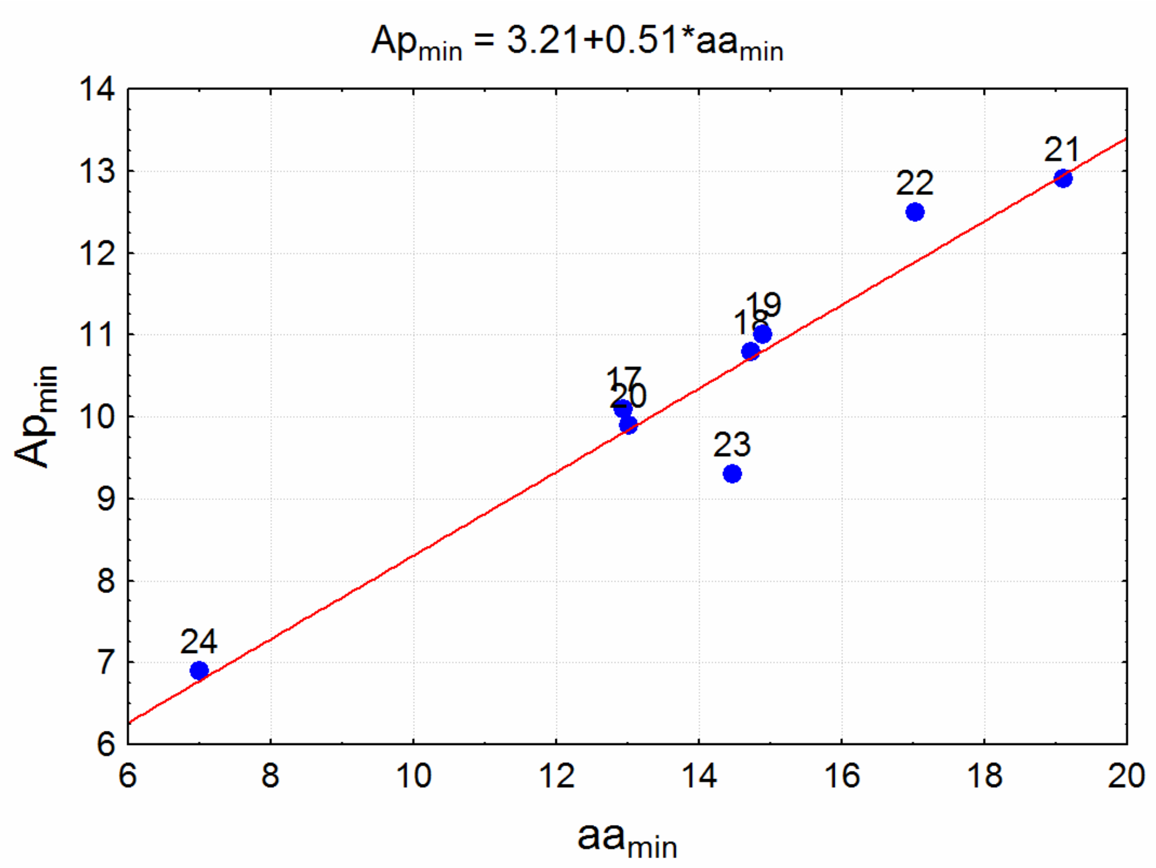
Relationship between *aa_{min}* and sunspot number at maximum



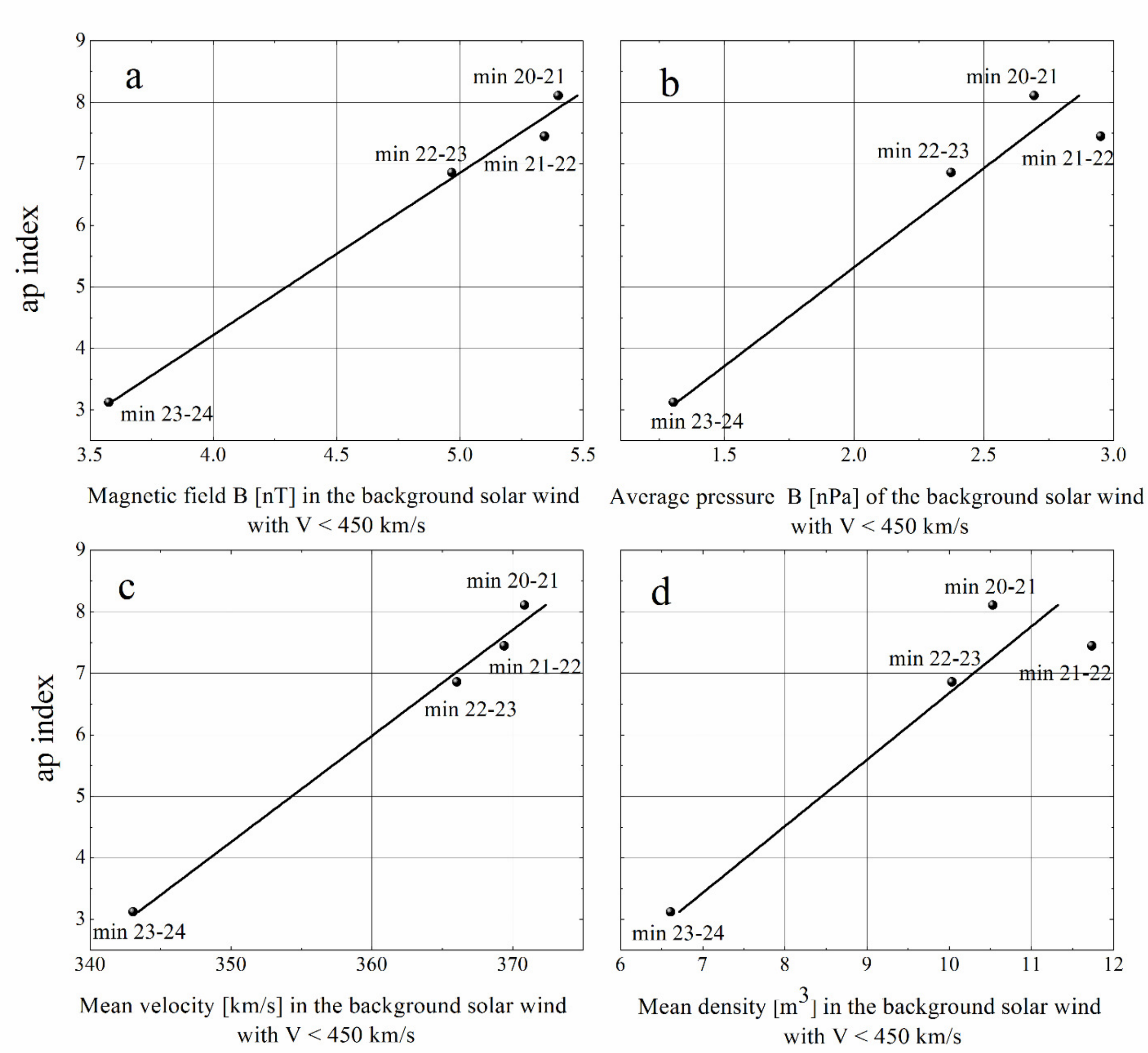
- Sunspot maximum correlates with the geomagnetic activity floor in the same cycle.

- **⇒ Characteristics of the cycle can b determined even at the beginning o the cycle**

Relationship between aa_{min} and A_p at the beginning of the cycle



- We consider the average values of Ap at the beginning of the cycle.
- It can be seen that there is a quasi-linear dependence between Ap and aa_{min}.
- ⇒ We can use Ap as a precursor of the next solar maximum



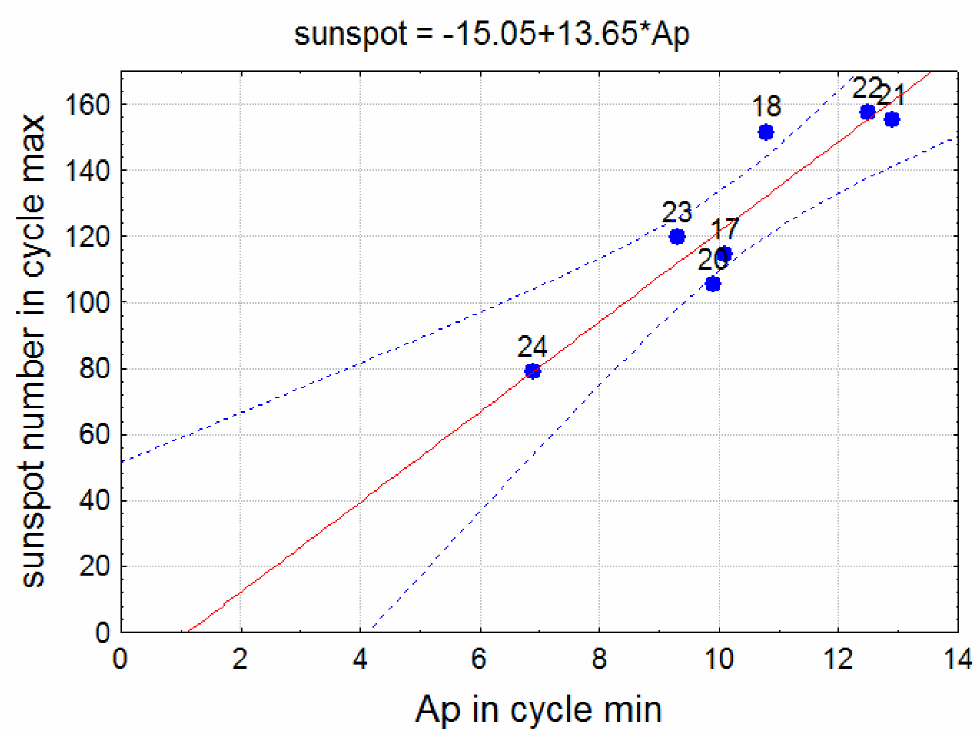
As we have already shown, Ap during the solar minimum depends on the parameters of the slow solar wind.

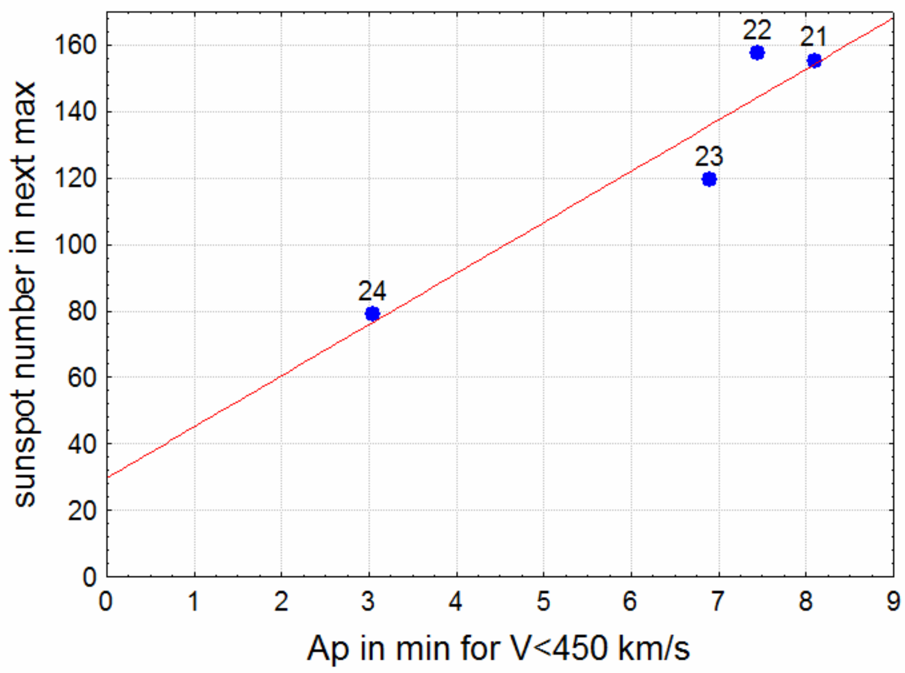
Changes in the parameters of the slow solar wind, which affects the Earth's magnetosphere, lead to changes in the geomagnetic activity.

$\Rightarrow$ Changes in the average Ap-index at the sunspot minimum reflect the changes in the characteristics of the slow solar wind.

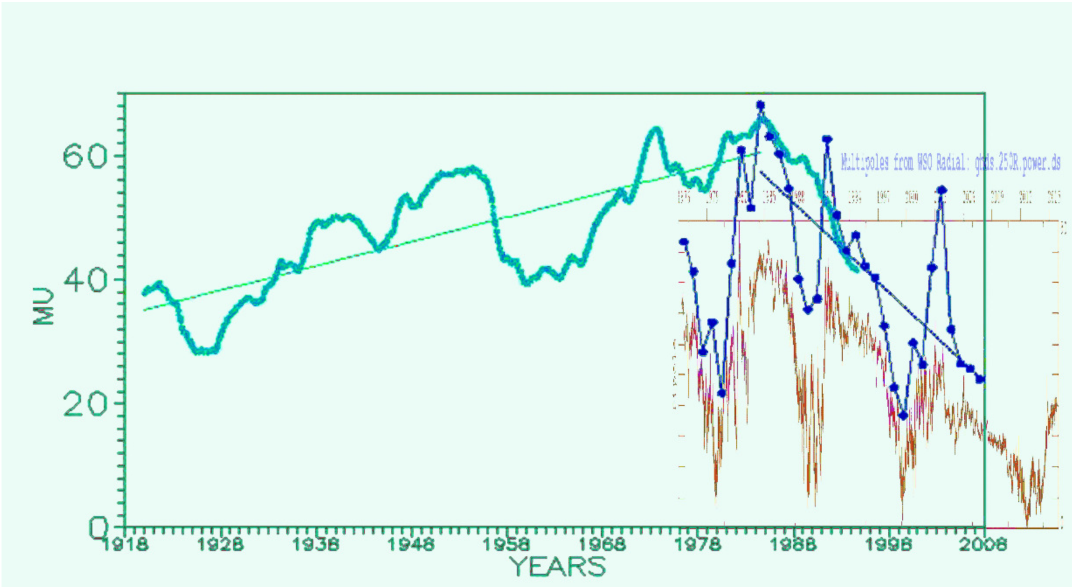
$\Rightarrow$ The characteristics of the slow solar wind at the minimum determine the intensity of the next cycle.

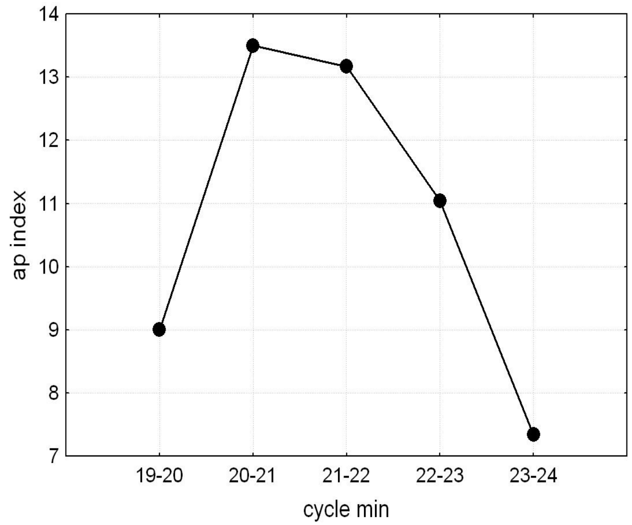
Relationship between the sunspots maximum and Ap at the previous minimum





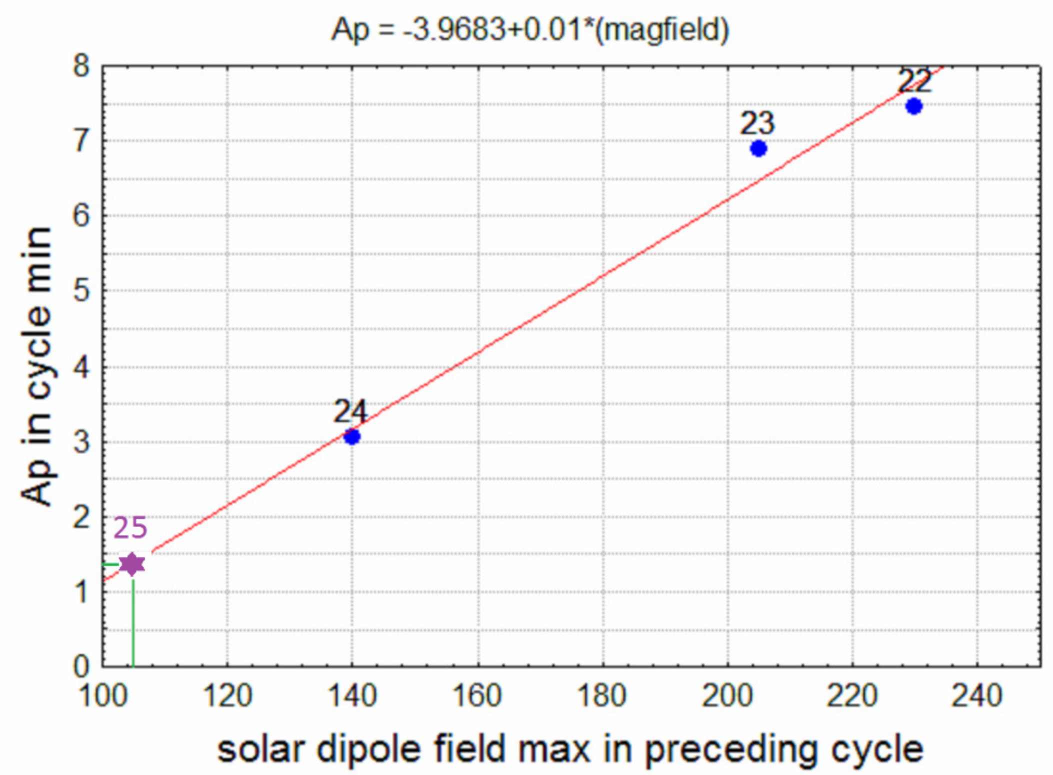
Can we determine Ap index at the minimum?





The decrease in the average Ap index at the minimum of the cycle 22, is associated with a decrease in the dipole field of the Sun.

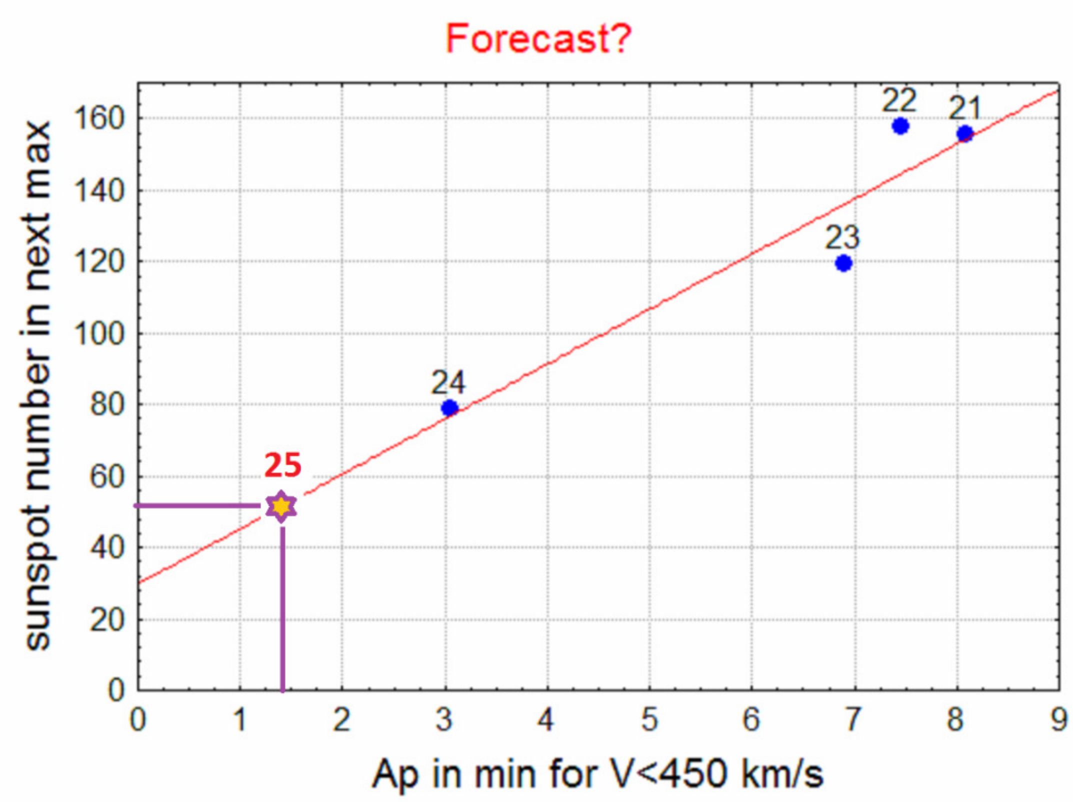
The relationship between the dipole field of the Sun and the Ap-index in the next minimum



The expected value in the next minimum

Ap=1,35

Forecast



Relationship between the average Ap index at the beginning of the cycle, when the Earth is not influenced by coronal mass ejections and fast solar wind, and the number of sunspots at the next maximum

The expected number of sunspots is about 50-55 !?


MDI Intensitygram: 2000.07.19_11:12
Thank you for attention
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