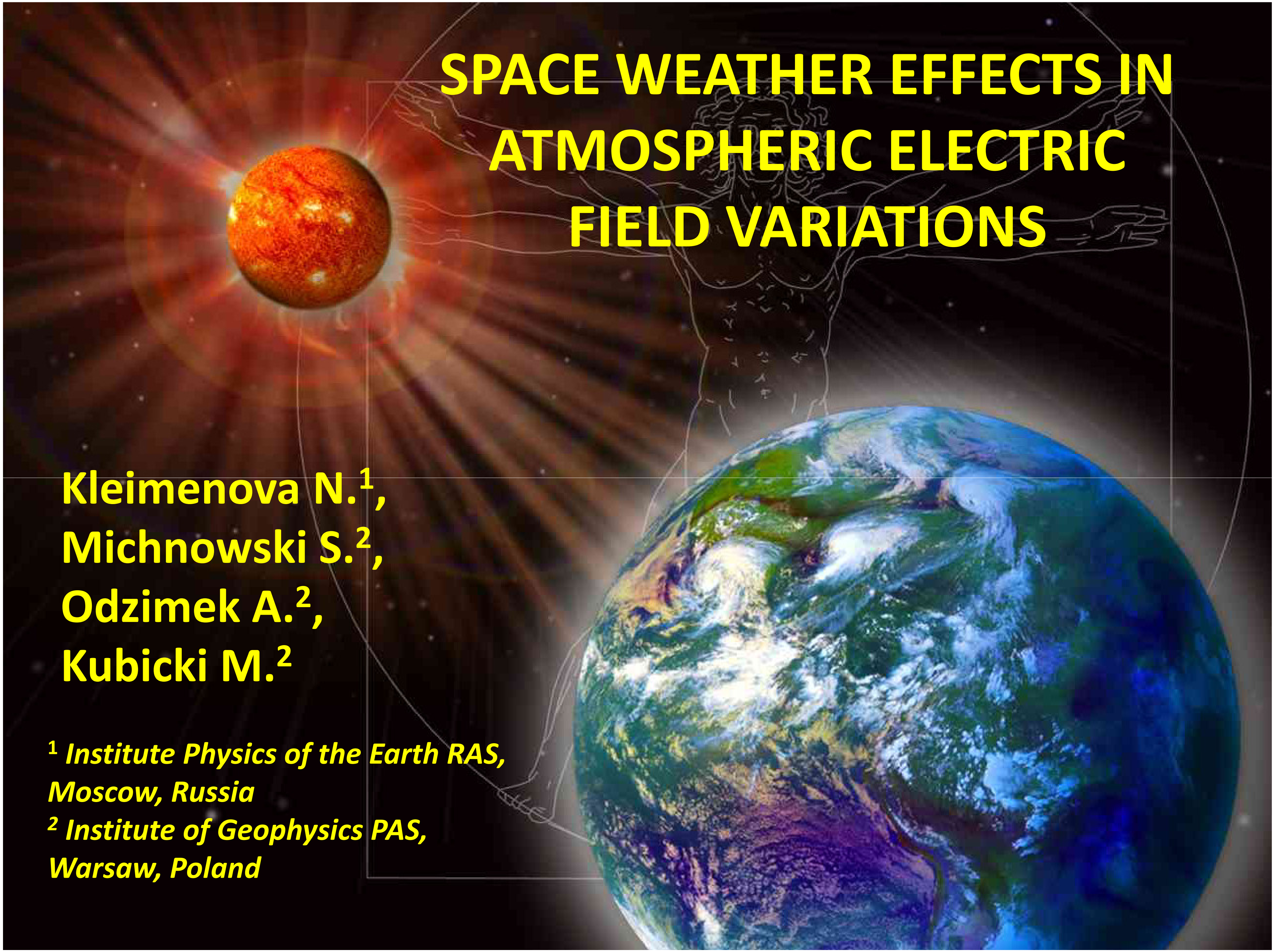

SPACE WEATHER EFFECTS IN ATMOSPHERIC ELECTRIC FIELD VARIATIONS

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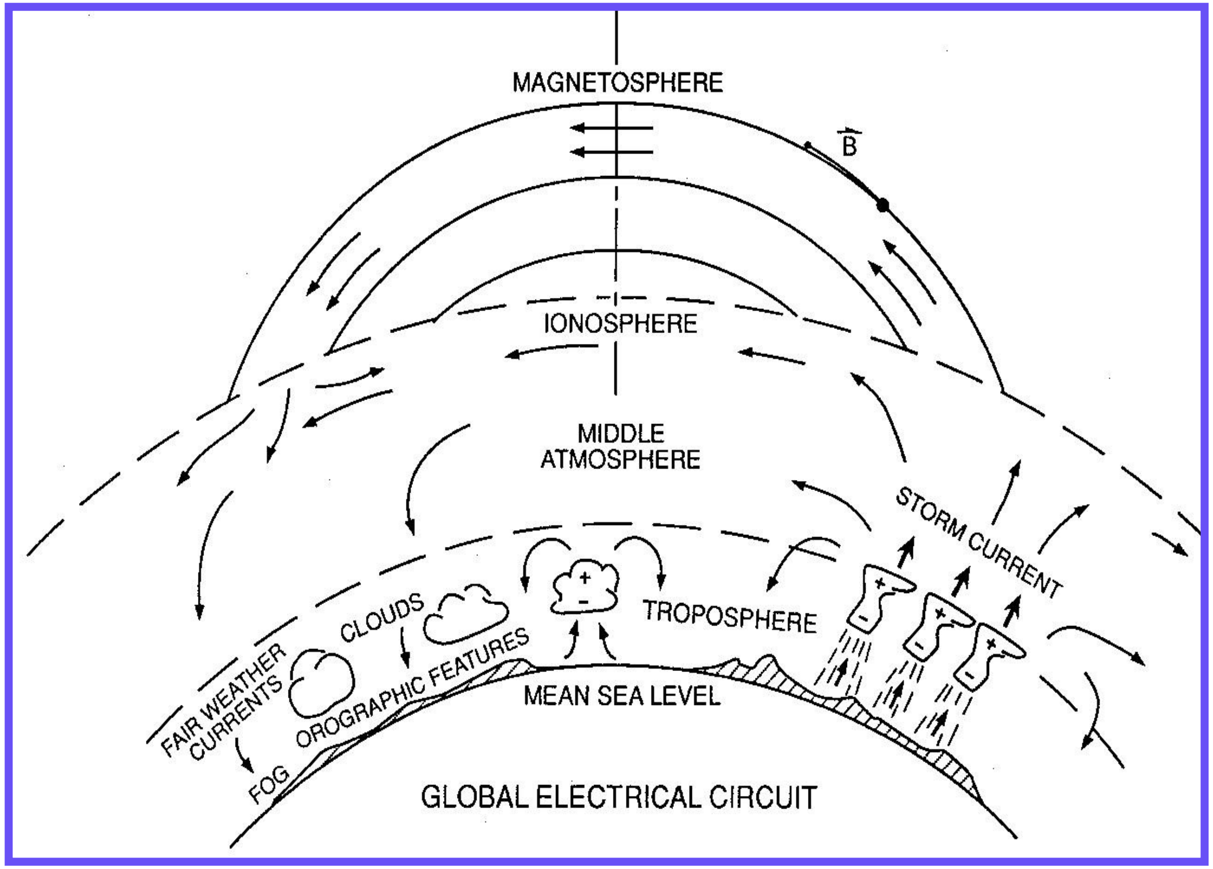
Atmospheric electricity

The global electric circuit

The global electric circuit is controlled by the global thunderstorm activity. Thunderstorm activity draws current upward from the ground. The ionosphere disperses the current globally, and it leaks back to the surface.



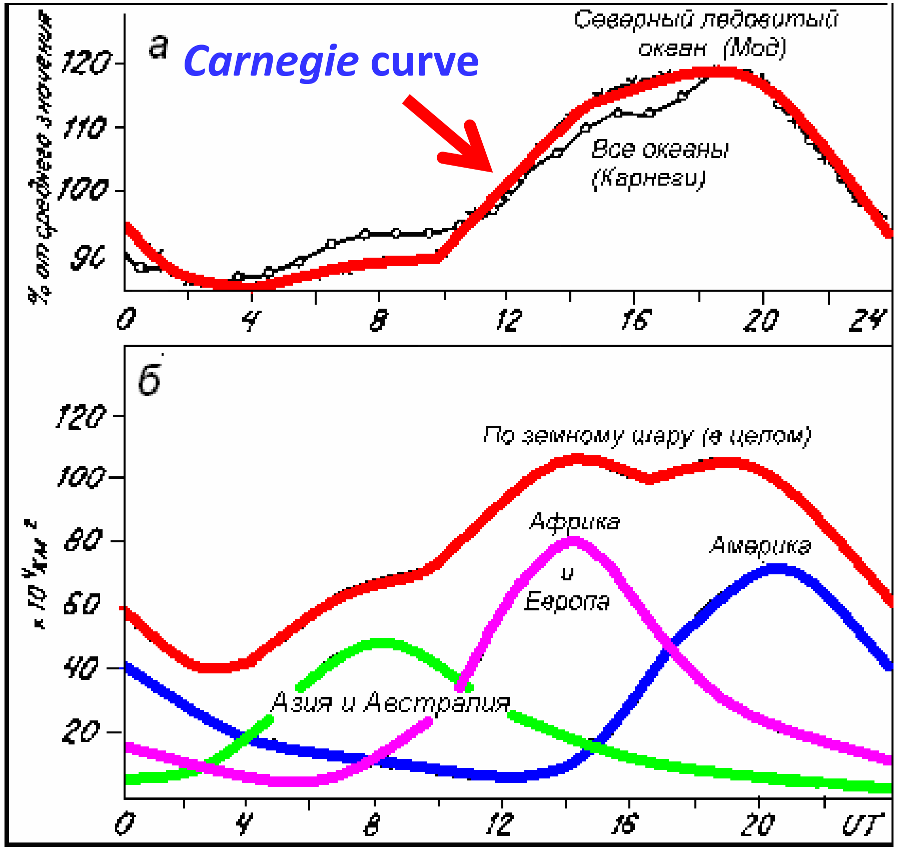
The global electric circuit

- The vertical atmospheric electric field (Ez), averaging ~100 V/m at ground level, represents the state of the global atmospheric electric circuit, which is controlled mainly by the world thunderstorm and shower clouds activity.

- The global atmospheric electric circuit is closed through the high-latitude ionosphere; therefore, the state and variations in the atmospheric electric field can be highly affected by magnetospheric and ionospheric disturbances.

- The Ez behavior is much more variable and complicated in high latitude zones than in the middle and low ones.

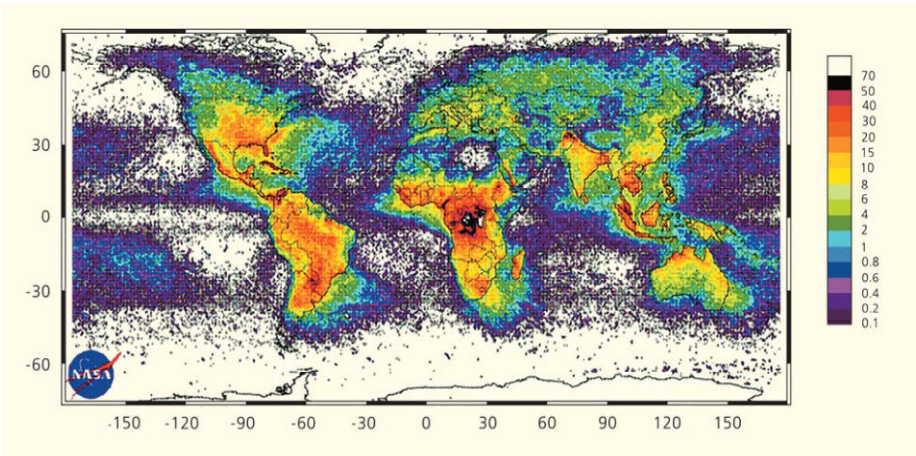
- To avoid meteorological influences we used Ez data, obtained only under so called "fair weather" conditions, which request the absence of a rain, snow, fog, lower clouds, and wind velocity more 6 m/c-



The wooden geomagnetic vessel *Carnegie*, operated in 1909 - 1929, made series of the atmospheric electric field measurements around the world's oceans.

It was found the daily Ez variations are simultaneous in UT at all different points.

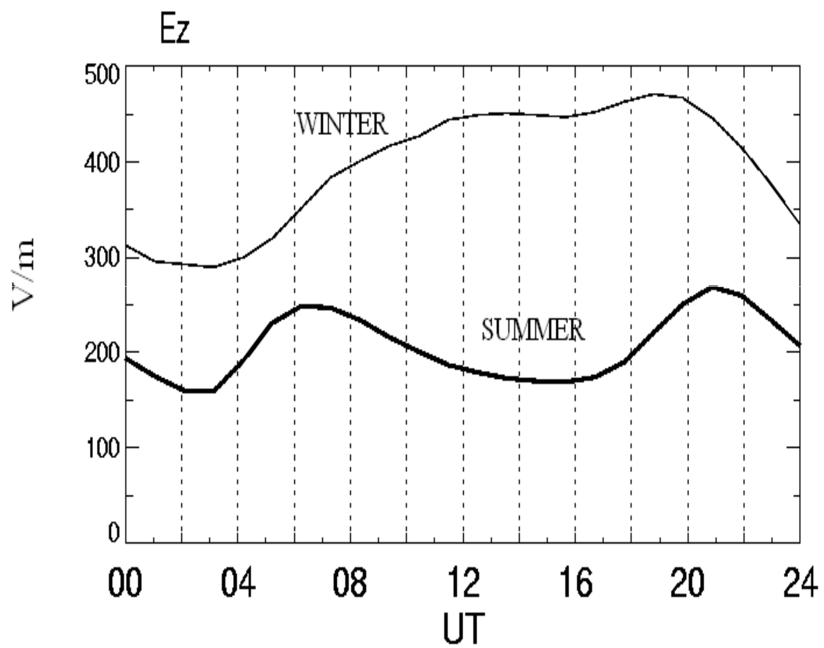
This variation is known as the *Carnegie* curve.



The Ez daily variations could be interpreted as summing the diurnal variations in global thunderstorm activity area of America, Africa and Asia+ Australia .

MIDDLE LATITUDE STUDY

The polish S. Kalinovski Geophysical Observatory Swider
Geographical **ϕ=52º07\`N, $\lambda$=21º15\`E**
Geomagnetic **Φ=47.8º, Λ=96.8º**

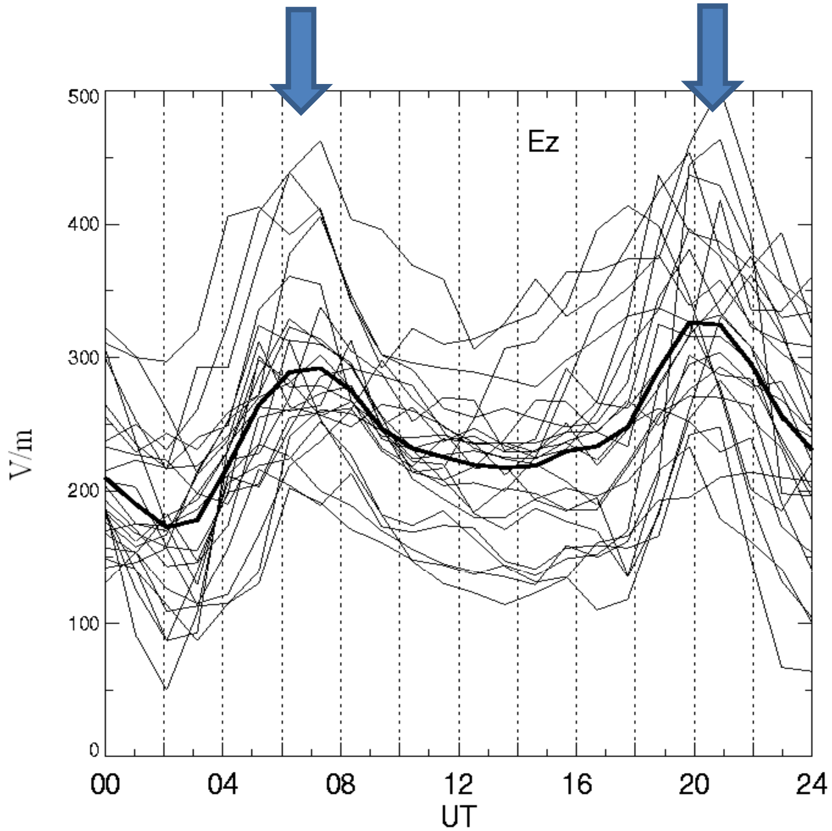


The diurnal Ez intensity variations in winter and summer in the middle latitudes.

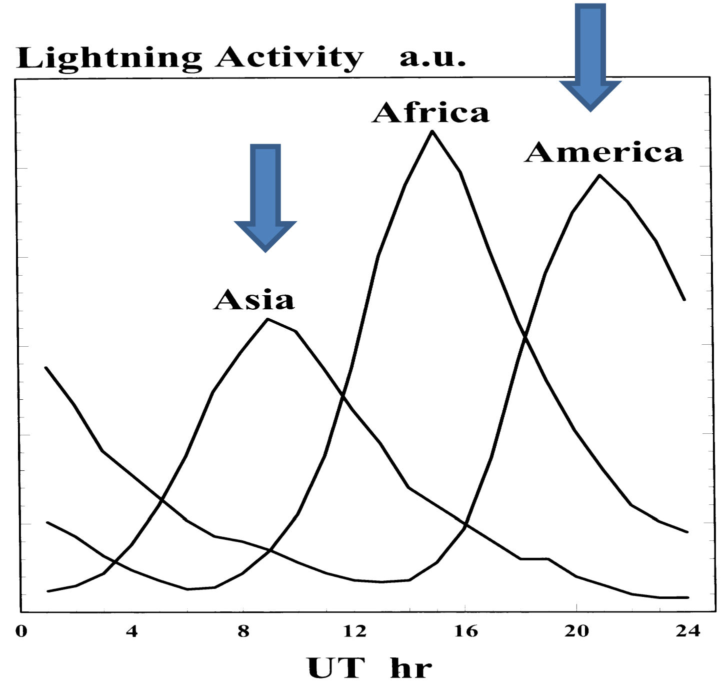
The statistical study of more than 30 year data (without the separation of the magnetically quiet and disturbed periods) demonstrated that the winter Ez values are much higher than the summer ones.

That could be a result of the space weather influence.

The Ez diurnal variations under magnetically quiet periods



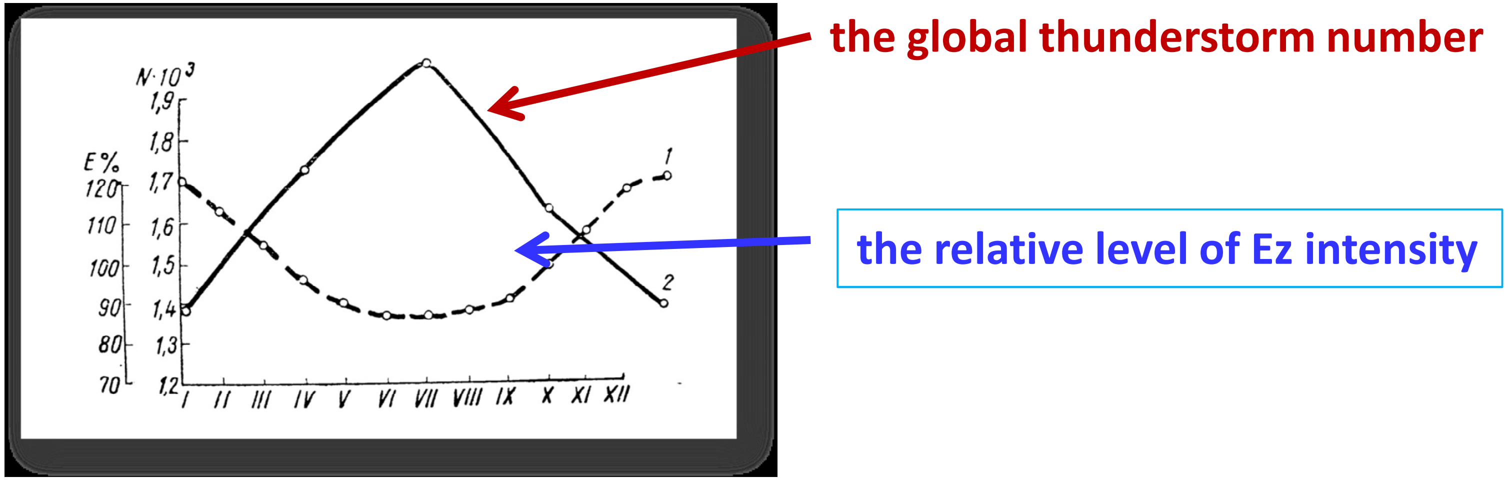
(Kp≤2), solid line – averaged quiet day data



Daily variations of the global thunderstorm activity

Despite of a strong day-to-day variability of Ez amplitudes the common tendency is seen. There were two enhancements roughly matched the "Carnegie curve": the maxima correspond to the Asian and American thunderstorm activity centers.

- The diurnal Ez intensity variations are controlled by the global thunderstorm activity.
- But the paradox is that the averaged mid-latitude level of the Ez intensity anti-correlates with the global thunderstorm number.



The number of thunderstorm anti-correlates with the solar activity (Wp)

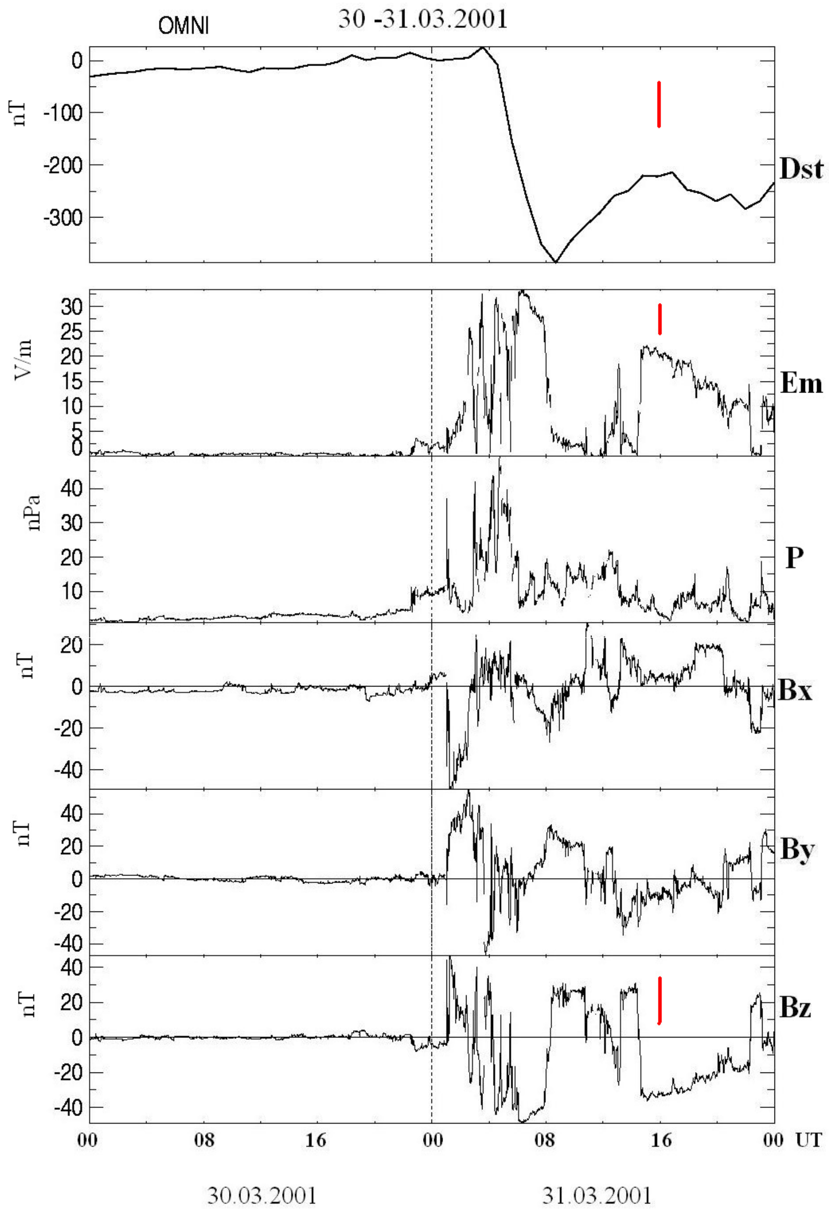
	1956	1964	1968	1976	1979	1987	1990	1998
Wp	142.6	27.6	91.4	36.5	114.0	41.3	118.9	28.6
N	340	218	341	270	349	184	231	147
N/W	2.38	7.89	3.73	7.39	3.06	4.45	1.95	5.13

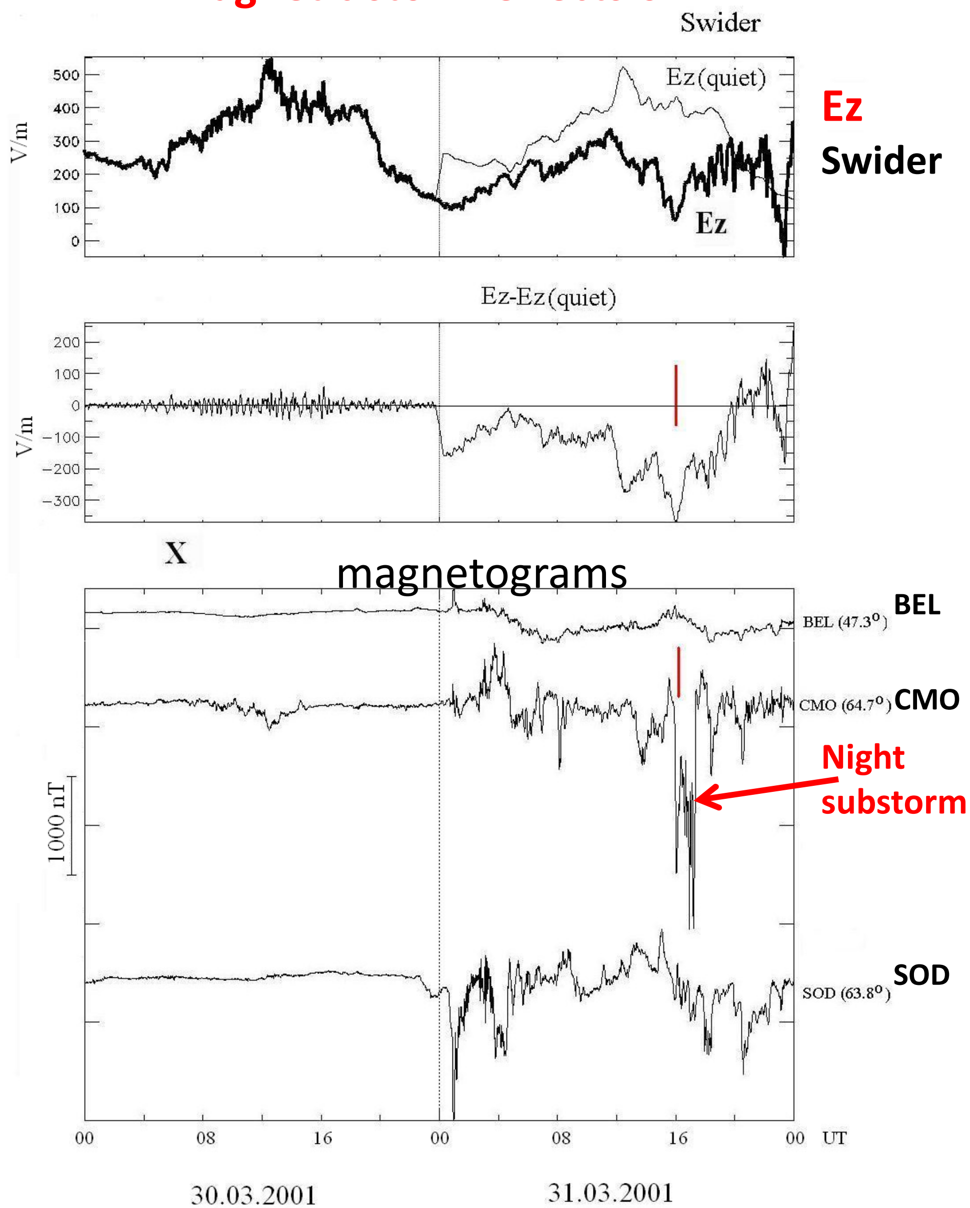
Altay (Siberia) according to Dmitriev et al., 2002

Space weather conditions

30 - 31.03.2001

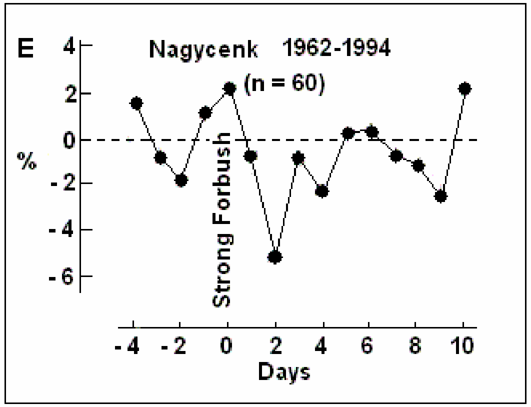
Magnetic storm effects on Ez

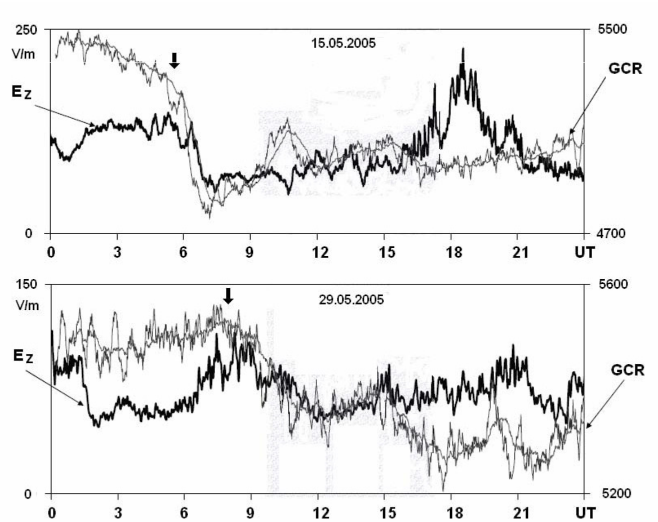


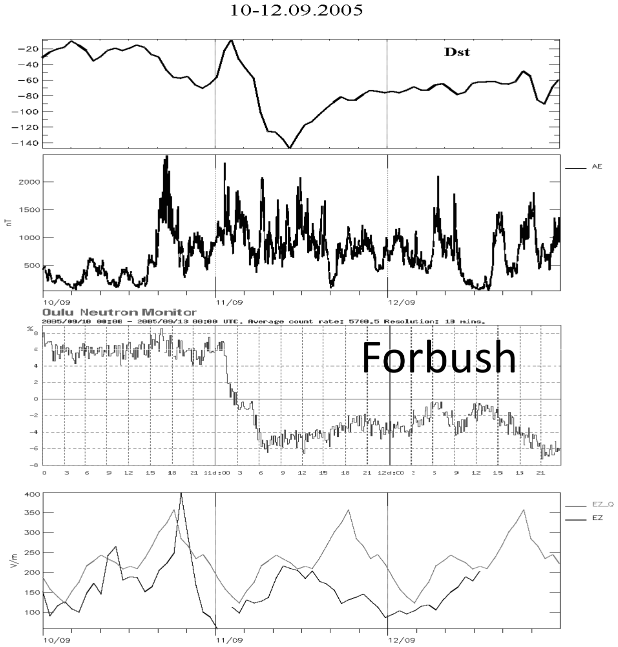


The daytime Ez decreasing associated with night-side substorms was typical for all 14 analyzed magnetic storms

The Forbush decrease influence to the Ez changes

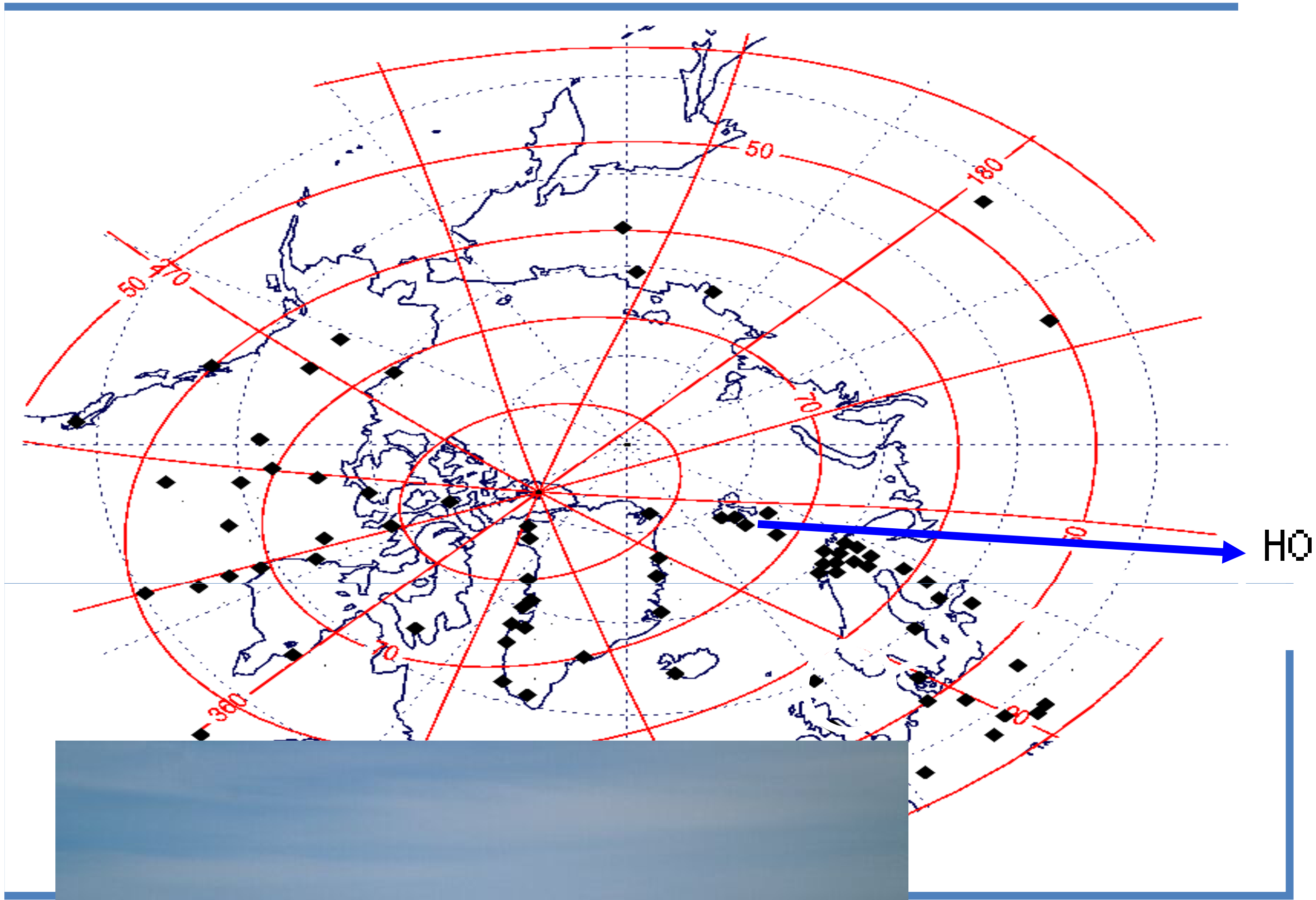






The strong Ez depletion in the days of Forbush decrease development is seen.

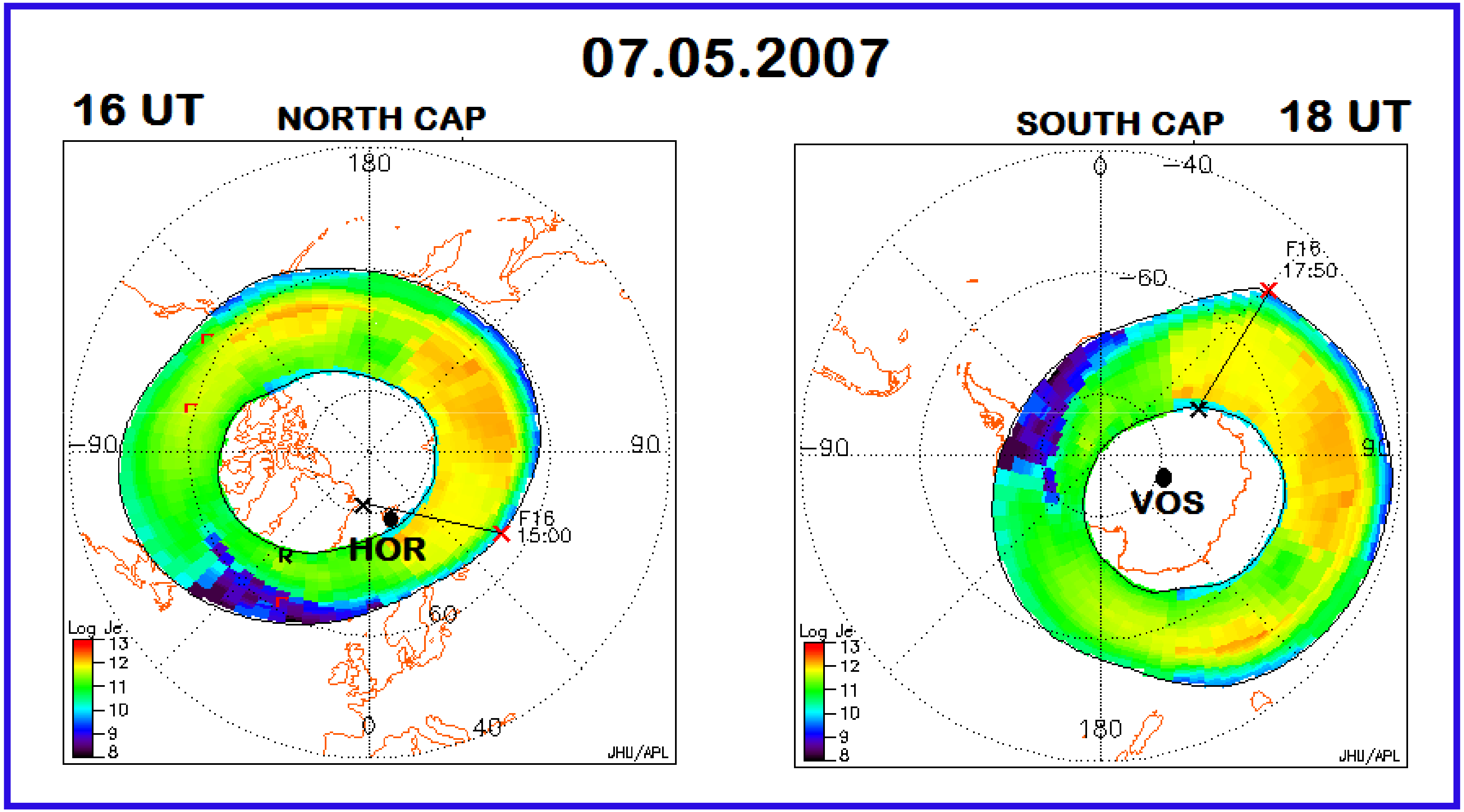
Polar cap latitudes



HORNSUND

GEOGRAPH. 77.00° 15.60°

GEOMAGNET. 74.02° 110.48°


07.05.2007
16 UT
NORTH CAP
180
-90
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60
40
0
F16
15:00
HOR
Log Je
13
12
11
10
9
8
JHU/APL
SOUTH CAP
18 UT
0
-40
-60
-90
90
180
F16
17:50
VOS
Log Je
13
12
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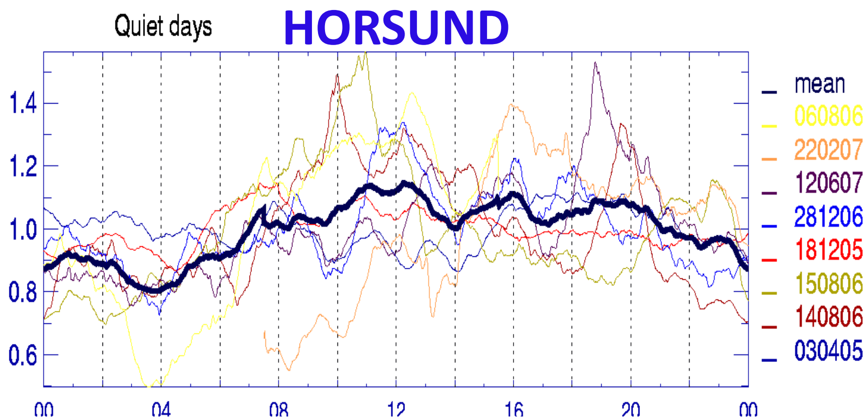
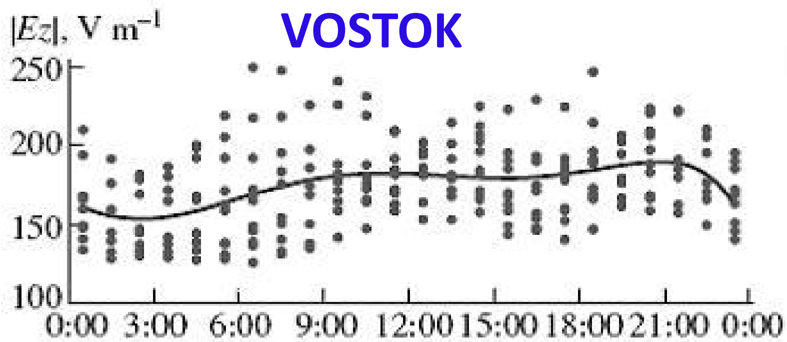
8
JHU/APL

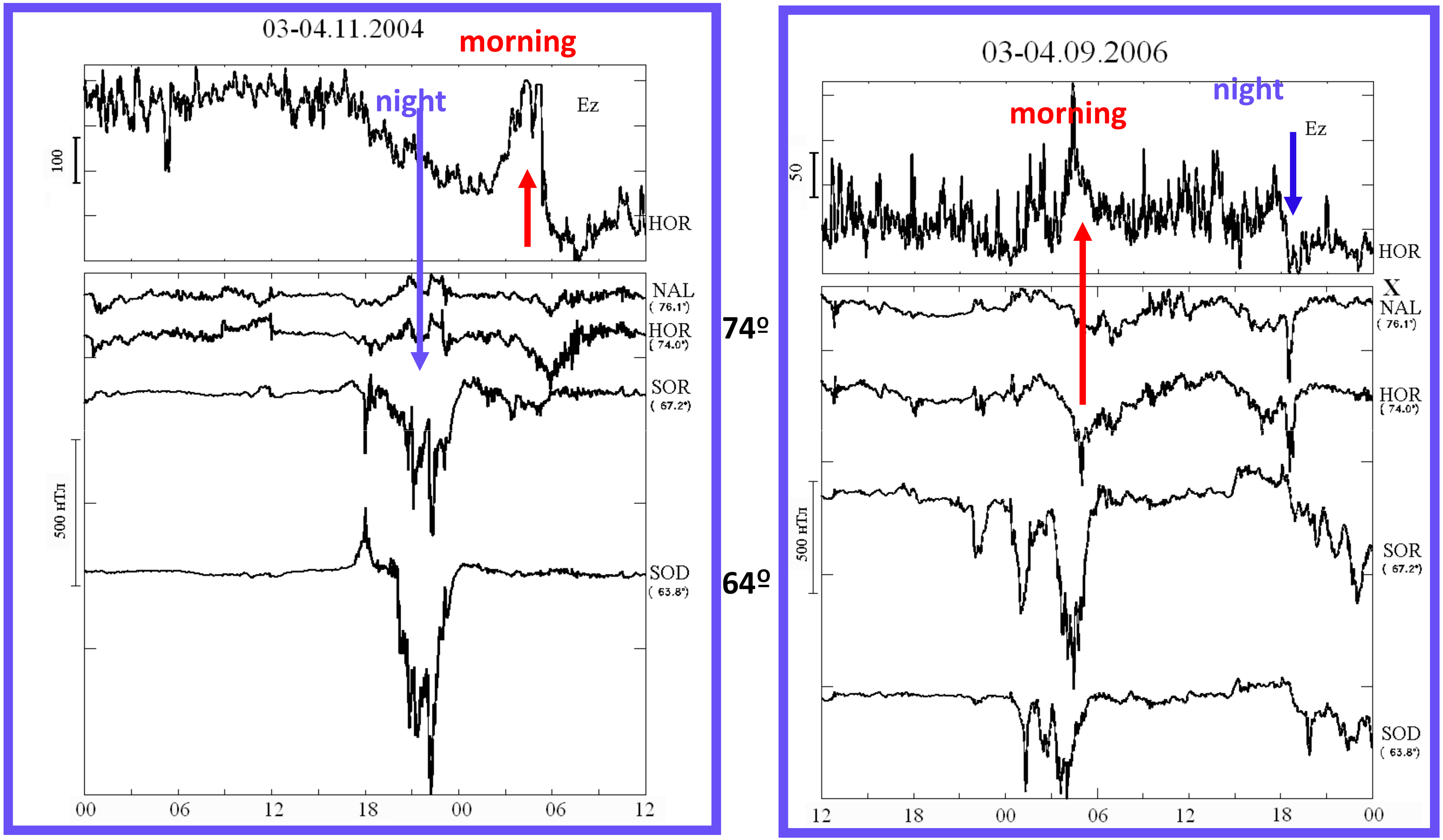
Ez diurnal variations at high latitudes





Contrary to middle and low latitudes under quiet geomagnetic conditions, in polar atmospheric electricity (Ez) there are **no well-defined diurnal variations.** **Thus, in the polar areas, the thunderstorm influence is not so strong as in the middle latitudes.**

Substorm effects in Ez at polar latitudes (obs. Hornsund)

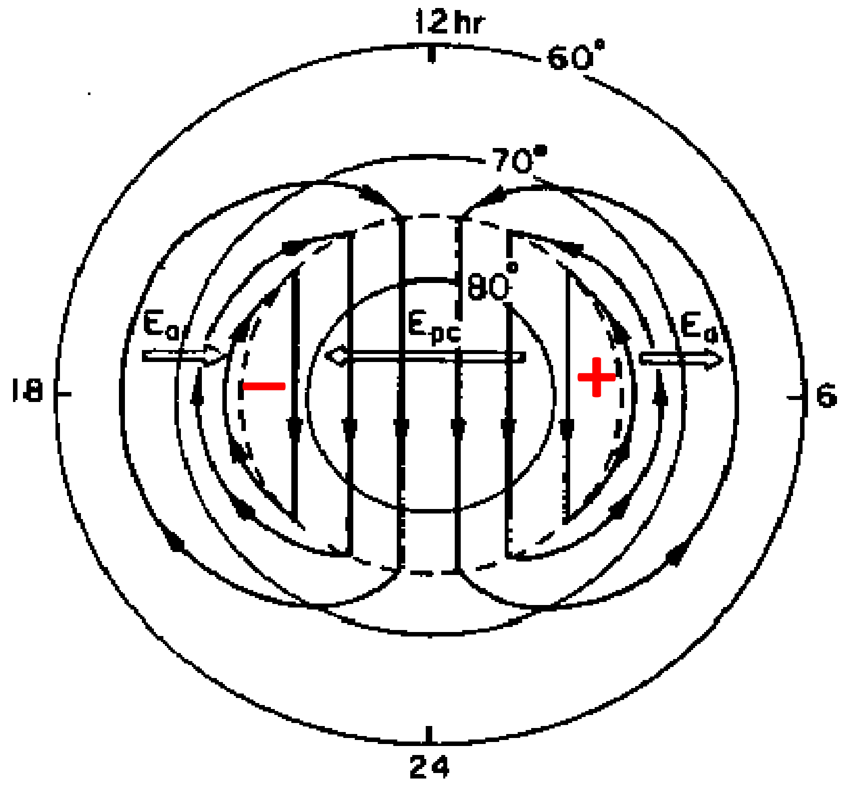


Two examples of a negative Ez deviation during the night substorms and a positive Ez deviation during the morning substorms

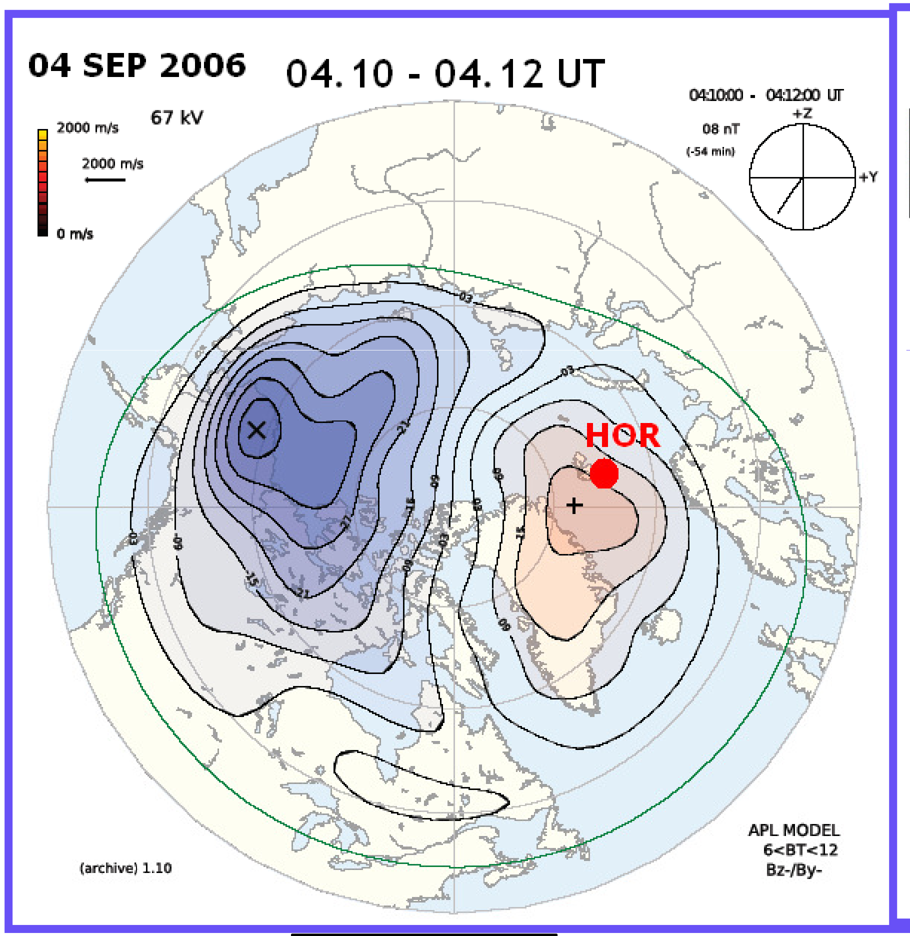
In the polar regions, the interaction of the solar wind and the Earth's magnetic field leads to the polar convection driven by the horizontal electric fields from dawn-to-dusk across the polar cap and can produce significant vertical electric fields at ground level.

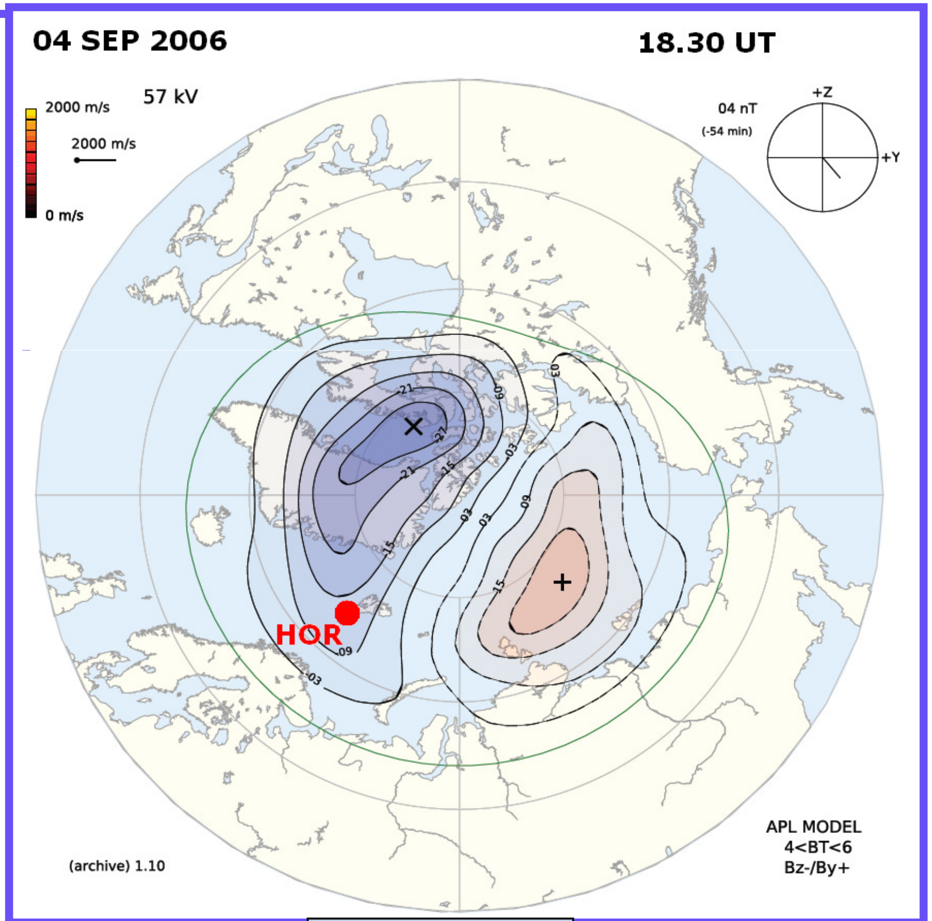
[*Park,* 1976].

In the polar regions, the interaction of the solar wind and the Earth's magnetic field causes the two-cell convection patterns in the polar ionosphere.



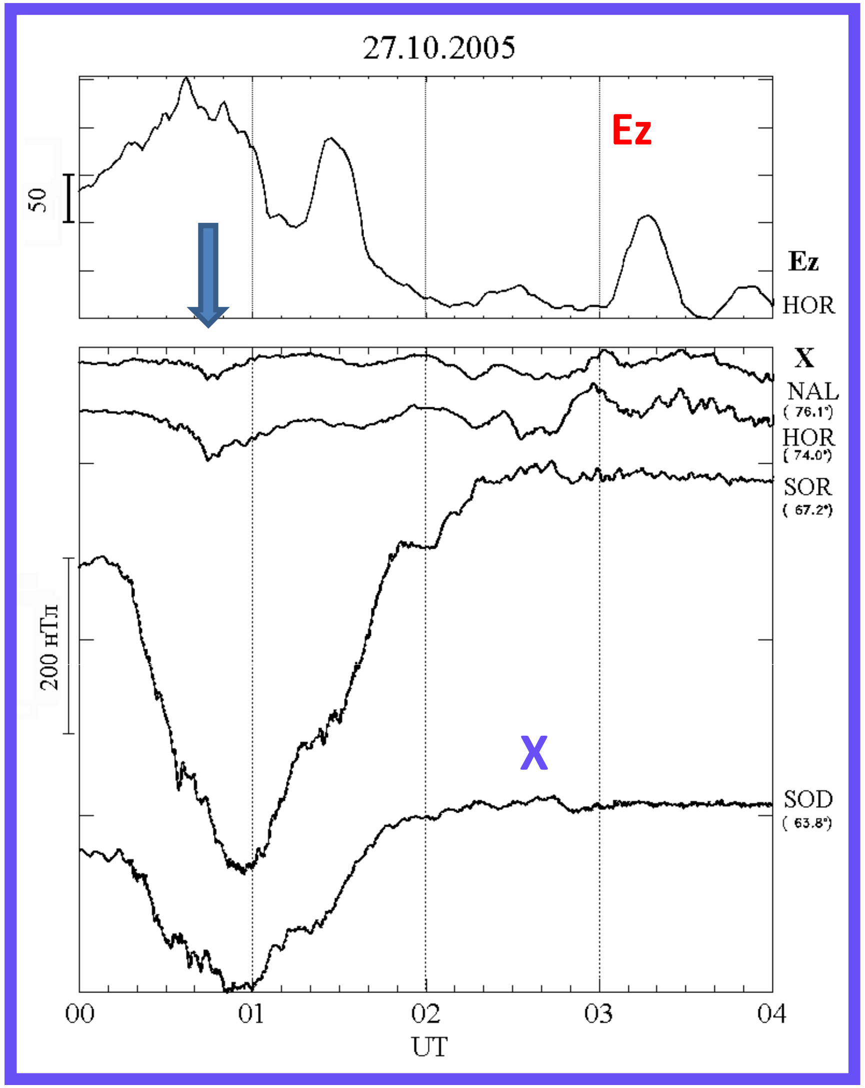
Global structure of high latitude plasma convection during the considered substorms at Scandinavian meridian according to the SUPERDARN data

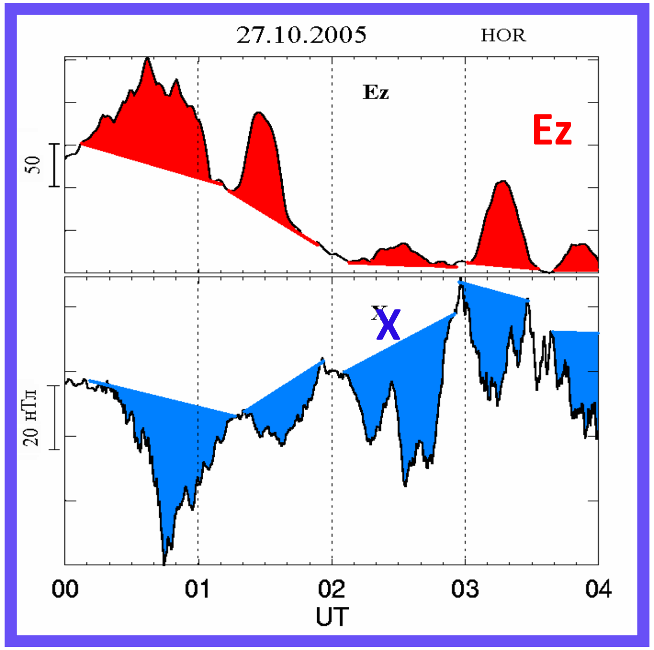




morning

evening


27.10.2005
Ez
50
Ez
HOR
X
NAL
(76.1°)
HOR
(74.0°)
SOR
(67.2°)
200 нТл
X
SOD
(63.8°)
00
01
02
03
04
UT


27.10.2005
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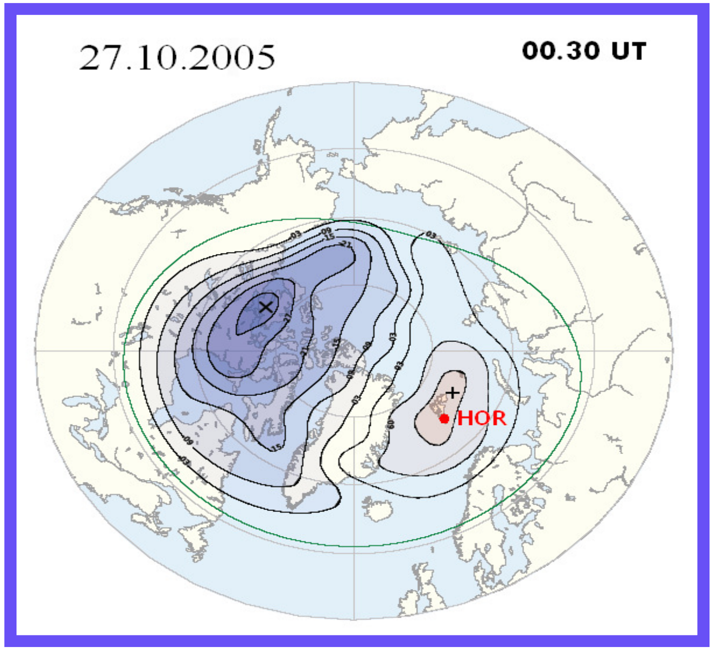
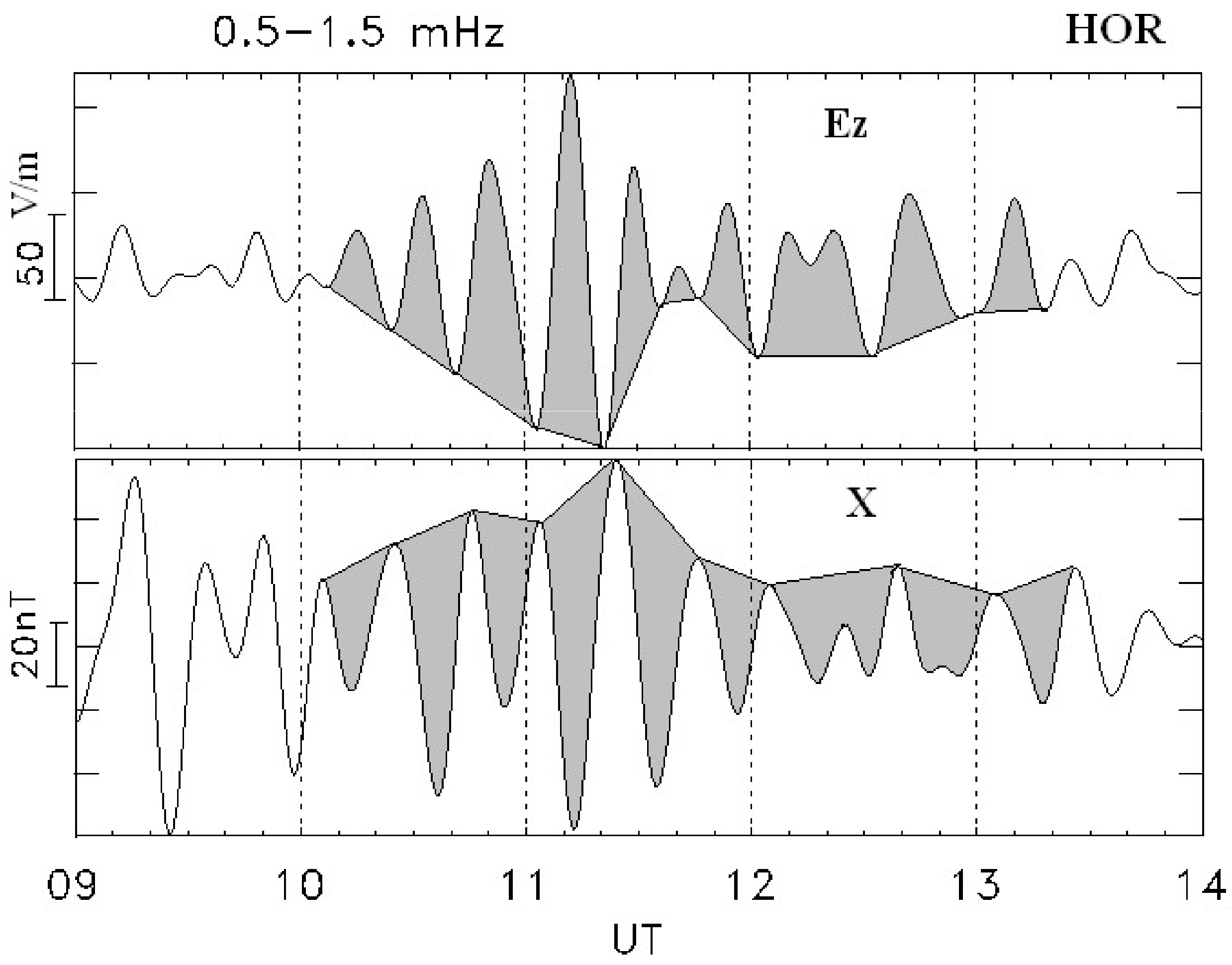
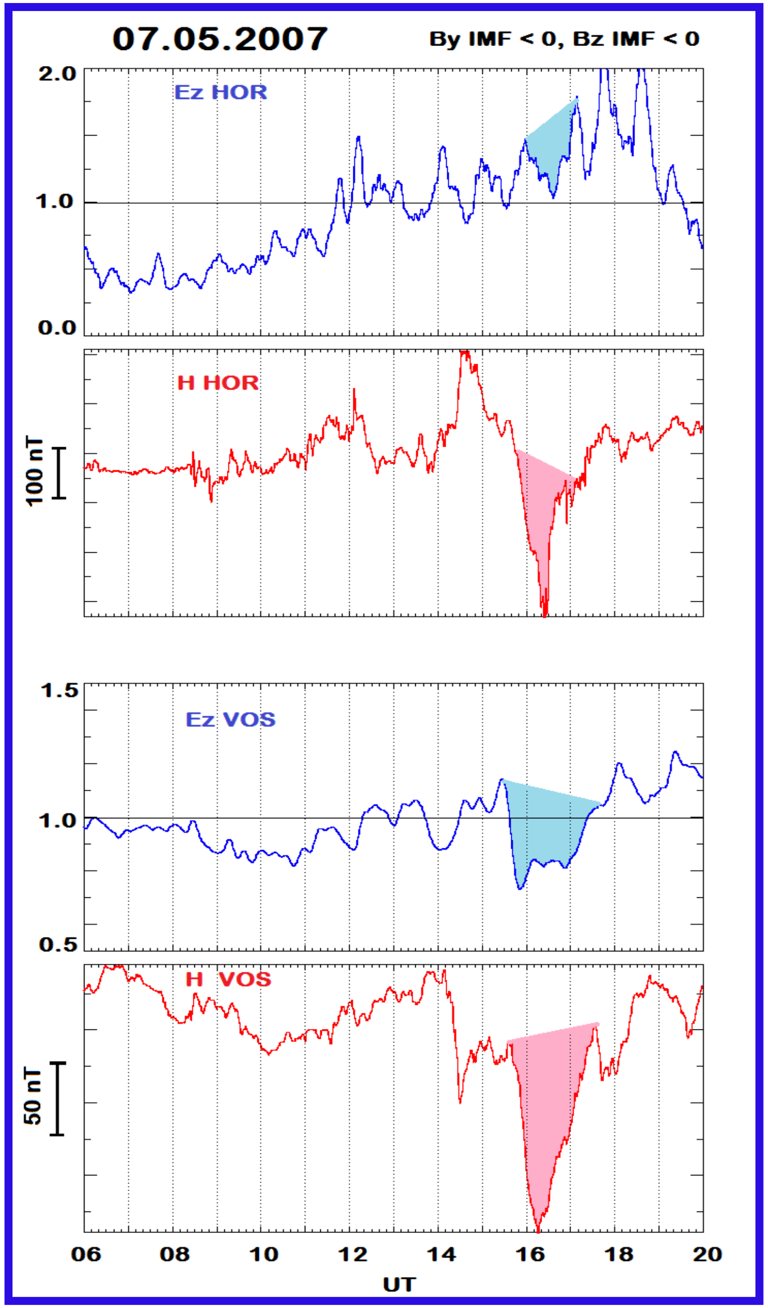
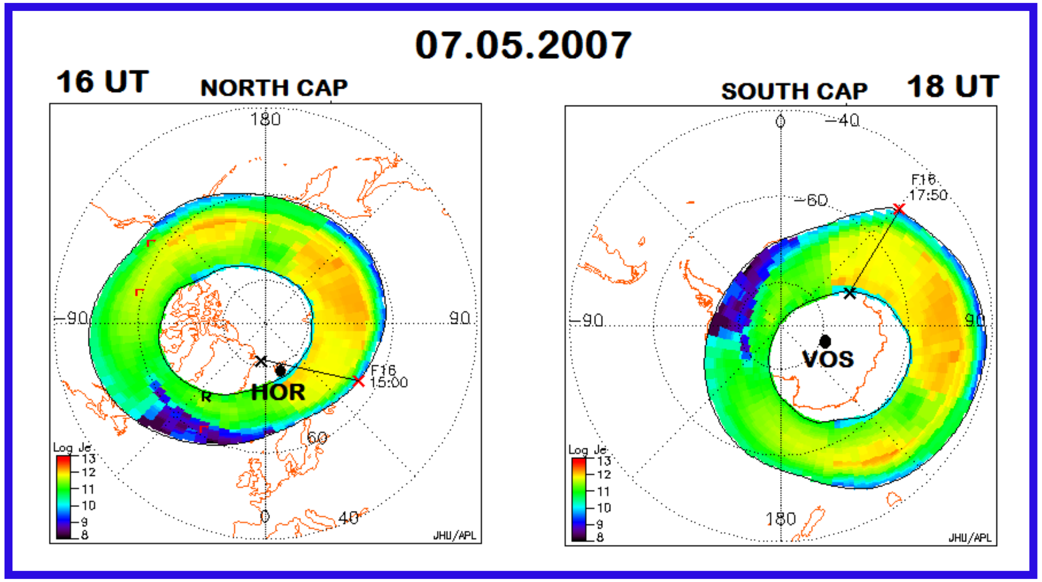
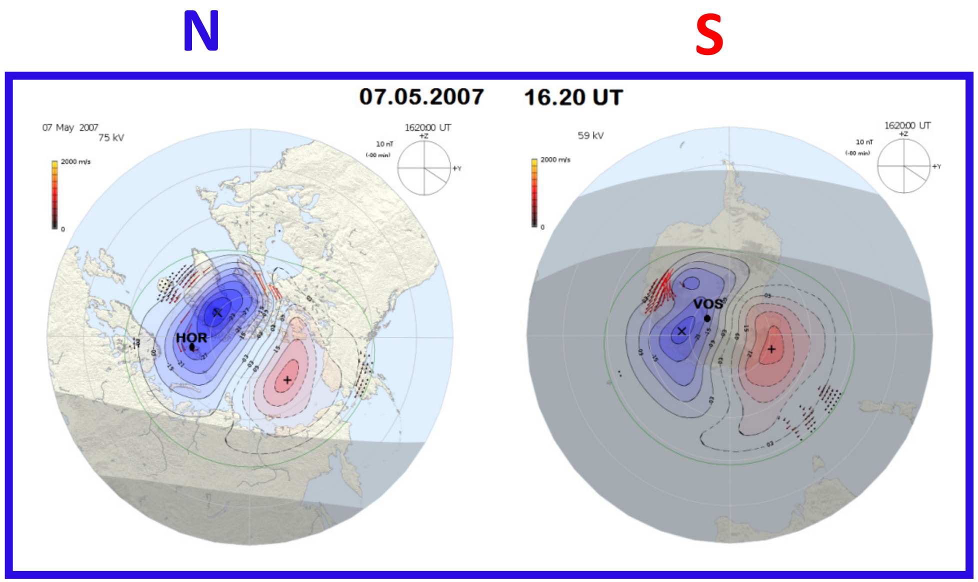

27.10.2005
00.30 UT
HOR

The anti-correlation between the pulsations in the vertical electric (Ez) and horizontal magnetic field



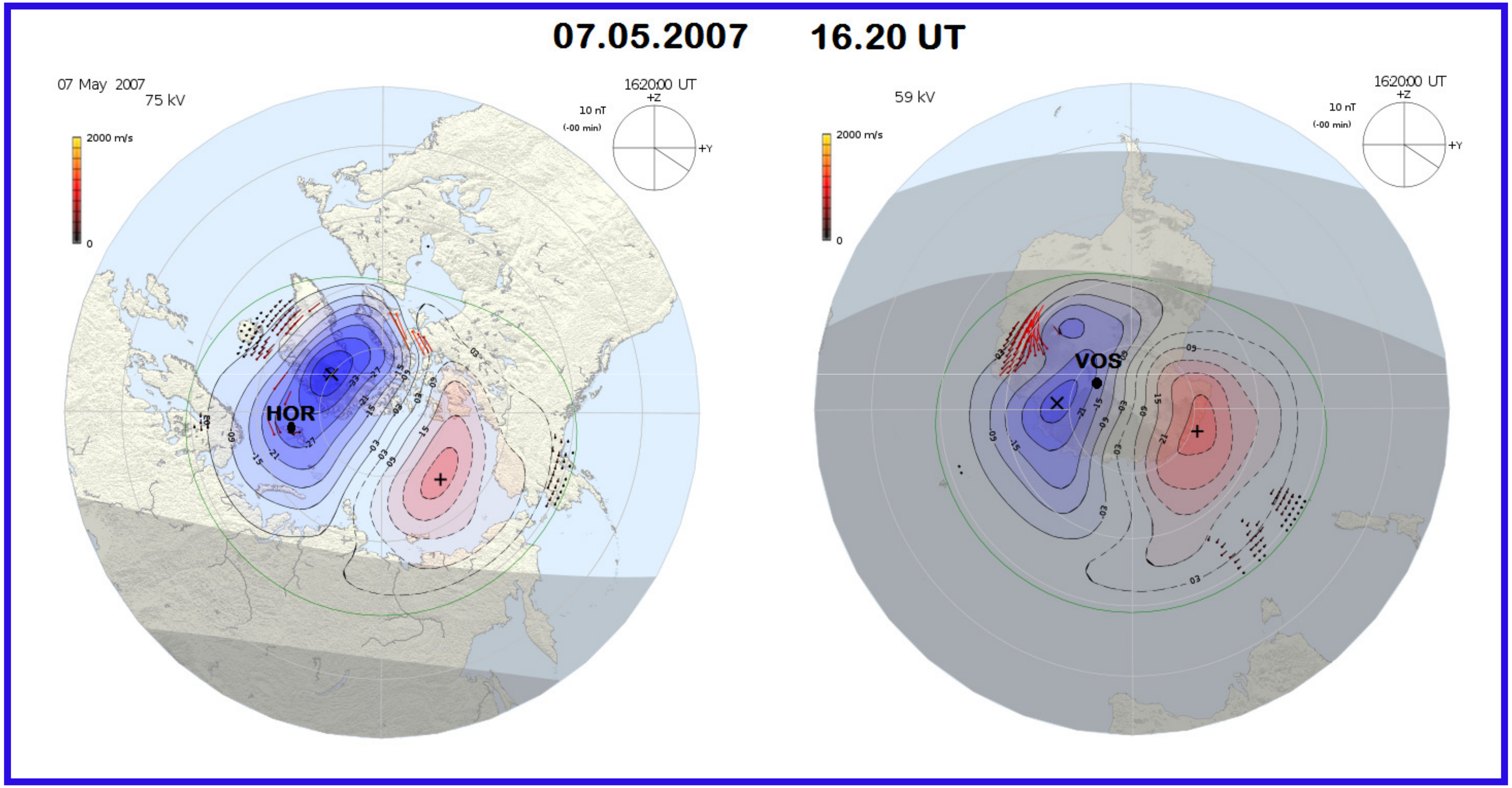






By IMF<0, Bz IMF<0

N   S


07.05.2007
16.20 UT
07 May 2007
75 kV
2000 m/s
0
1620:00 UT
10 nT
(-00 min)
+Z
+Y
HOR
59 kV
VOS

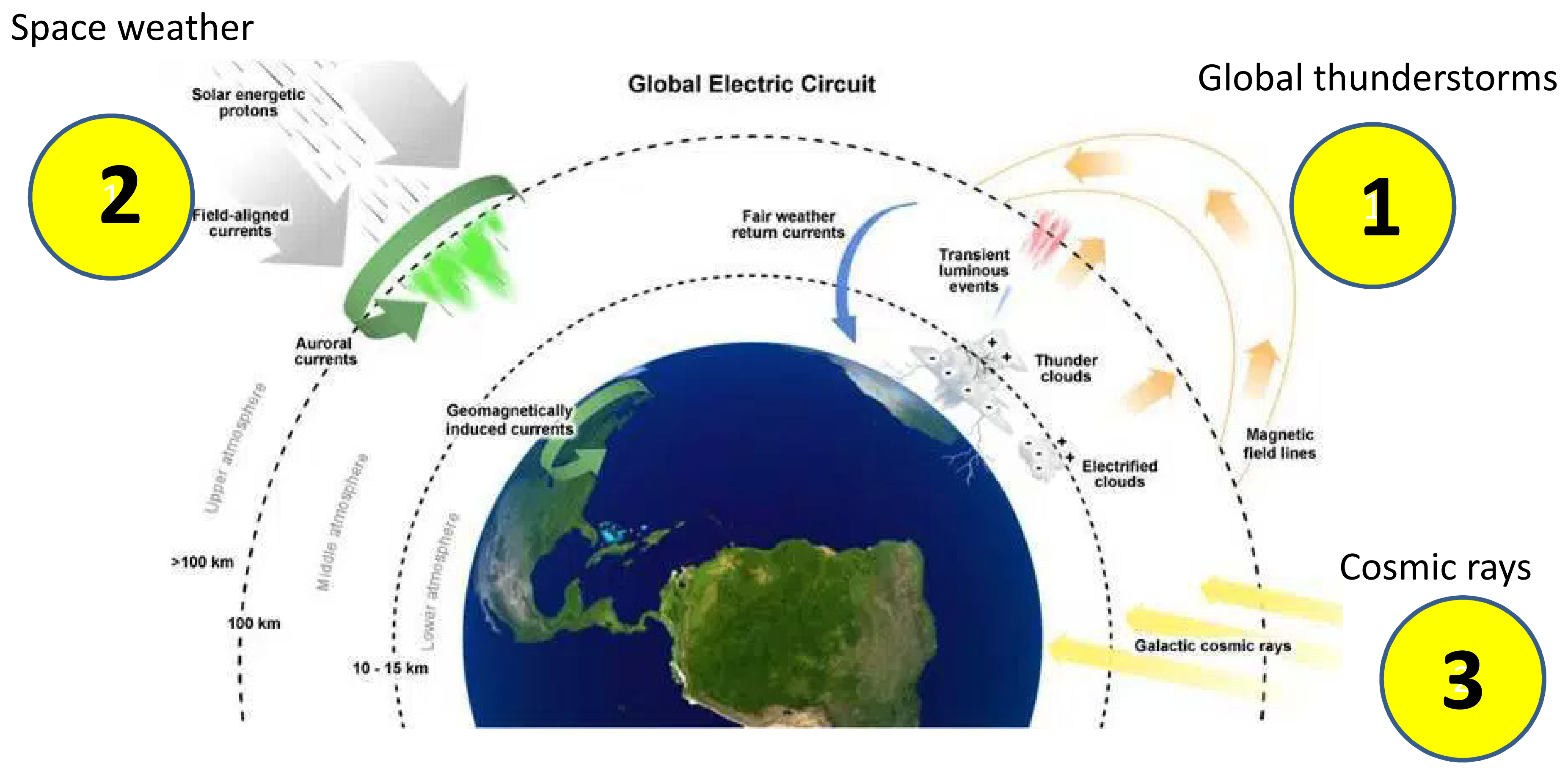
17 LT   **23 LT**

Summary

- **1. The global atmospheric electric circuit state is controlled not only by the world thunderstorm activity but by magnetosphere-ionosphere disturbances as well.**

- **2. The effect of the magnetic storm main phase was established in the mid-latitude atmospheric electricity. The strong daytime Ez negative anomalies were found in association with night-side magnetosphere substorm onsets under any local magnetic activity.**

- **3. The substorm related Ez effects were observed at high-latitudes as well. Polar Ez variations related to substorms were "positive" in the local morning and "negative" in the local evening. We speculate that the sign of Ez excursion depends on the station location relative to the position of the positive or negative center of the polar ionosphere plasma convection.**



The main sources of the atmospheric electricity

- **The final question remains still open:**
- ***That is the physical mechanism of the space weather influence on the atmospheric electric field disturbances near ground?***
- **The understanding of this influence physics could provide to establish one more channel for interaction in the solar wind – magnetosphere – ionosphere –atmosphere system**


Thank you for coming!