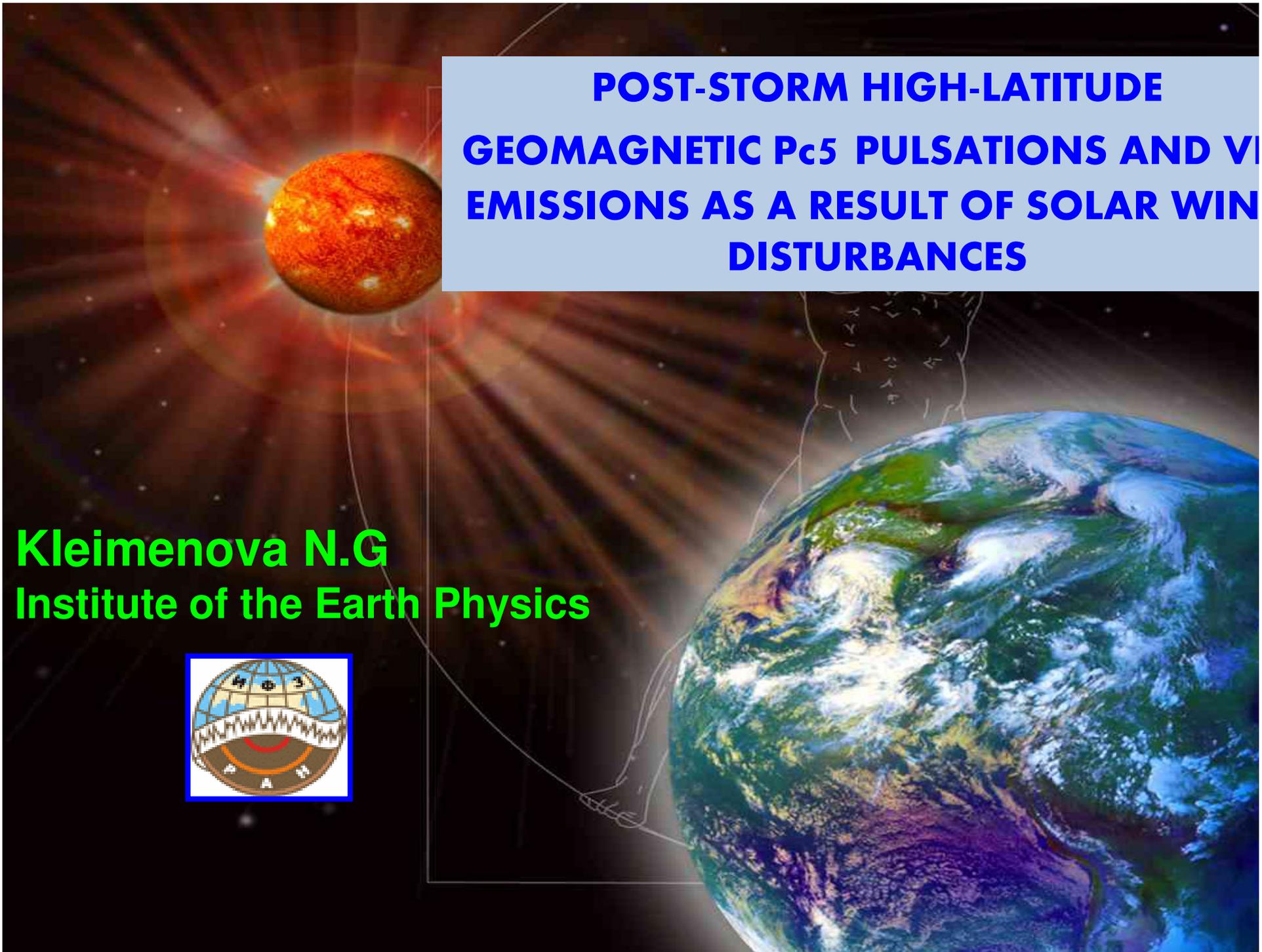


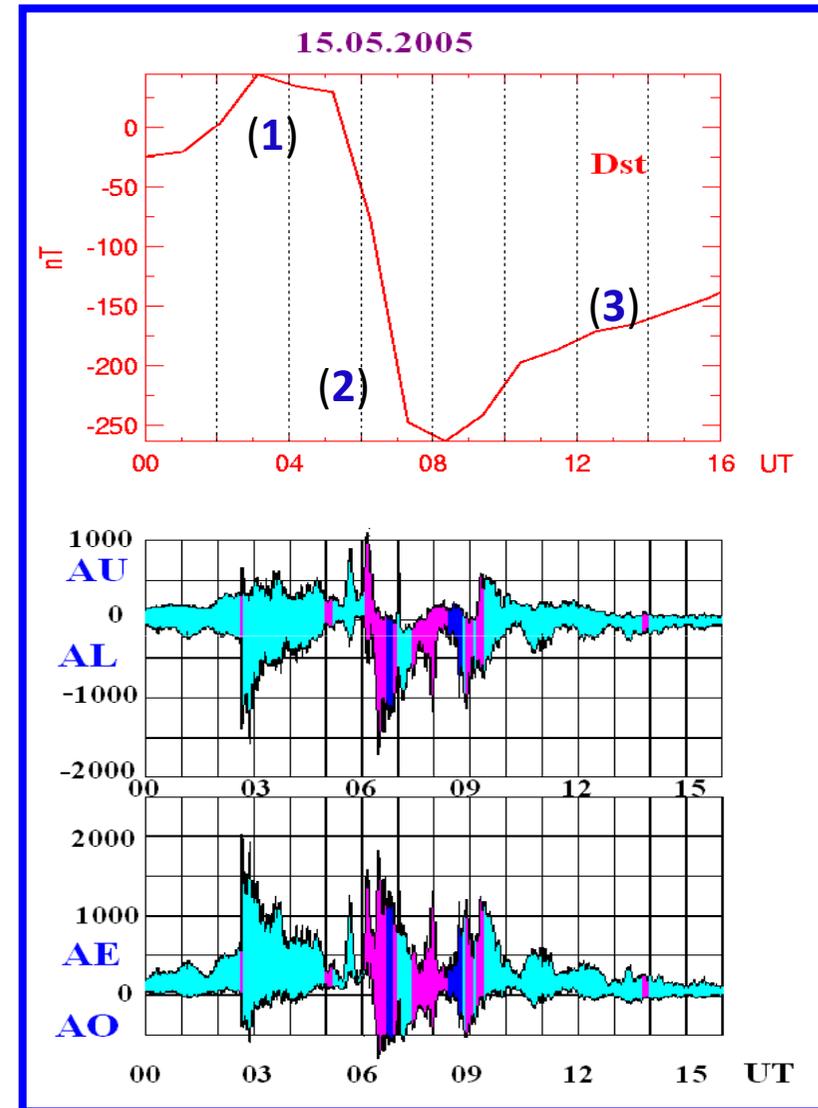
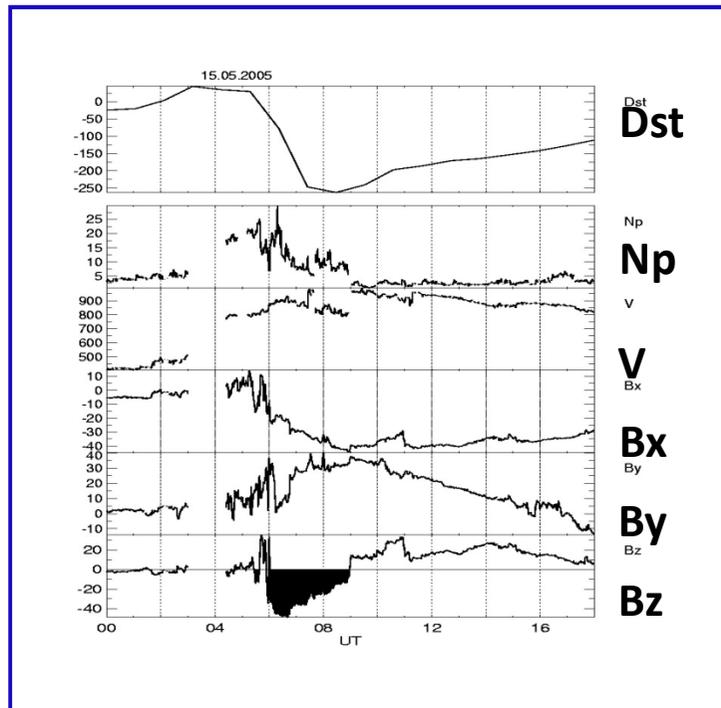
**POST-STORM HIGH-LATITUDE
GEOMAGNETIC Pc5 PULSATIONS AND VLF
EMISSIONS AS A RESULT OF SOLAR WIND
DISTURBANCES**

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Institute of the Earth Physics



Magnetic storms are a typical manifestation of solar–terrestrial interactions. Magnetic storm consists of (1) initial, (2) main and (3) recovery phases.

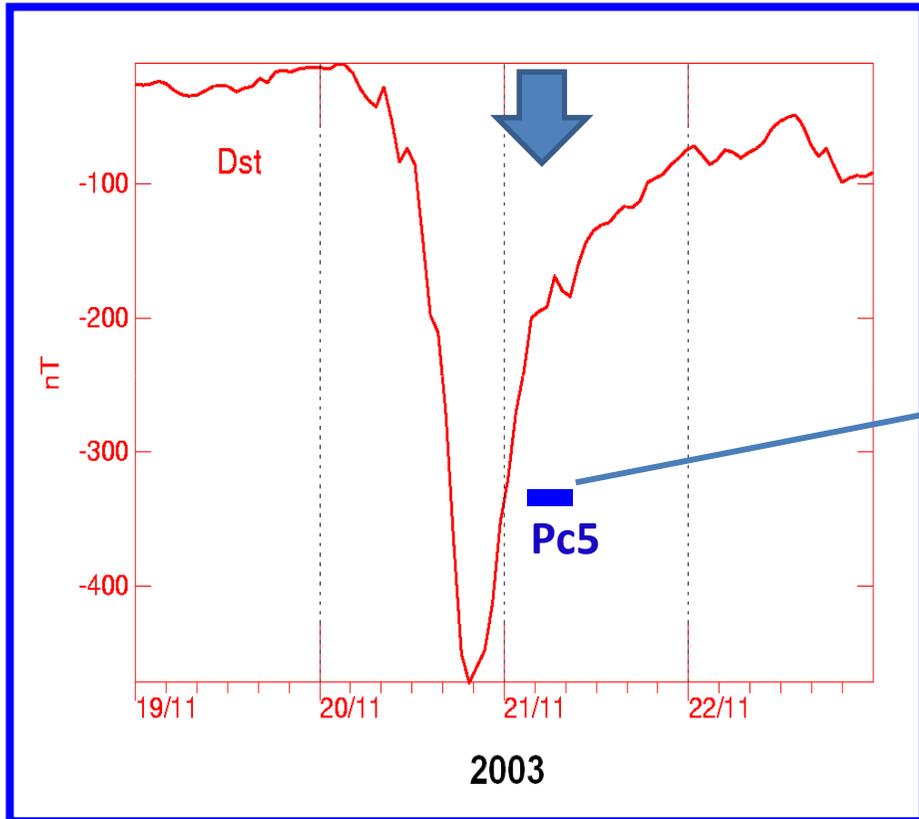
In **the recovery** storm phase, the Interplanetary Magnetic Field (IMF) turns to the positive values (northward direction), the solar wind energy input stops and geomagnetic activity drops.



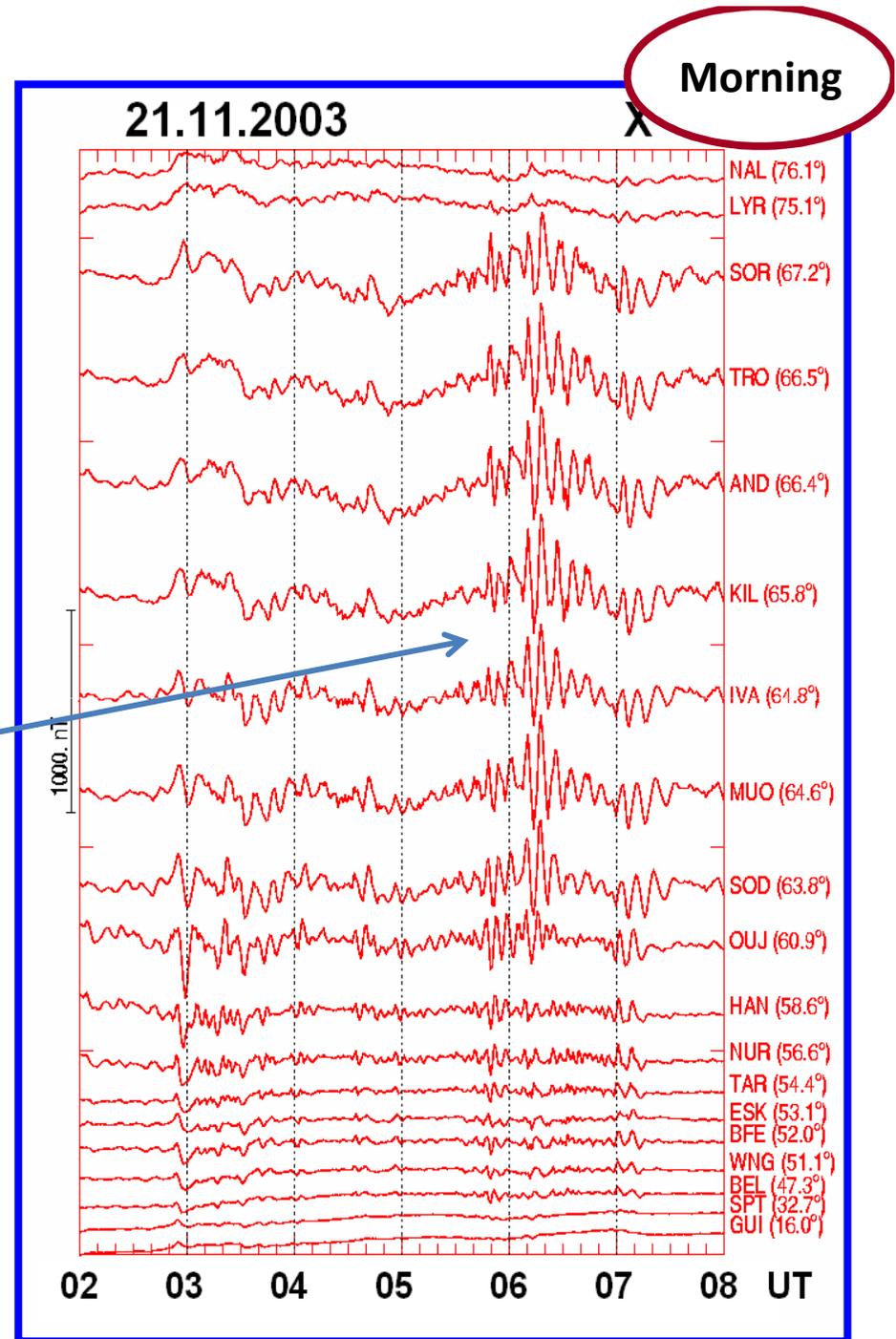
In the recovery phase, post-storm effects occur as magnetospheric auto-oscillations.

Geomagnetic pulsations Pc5

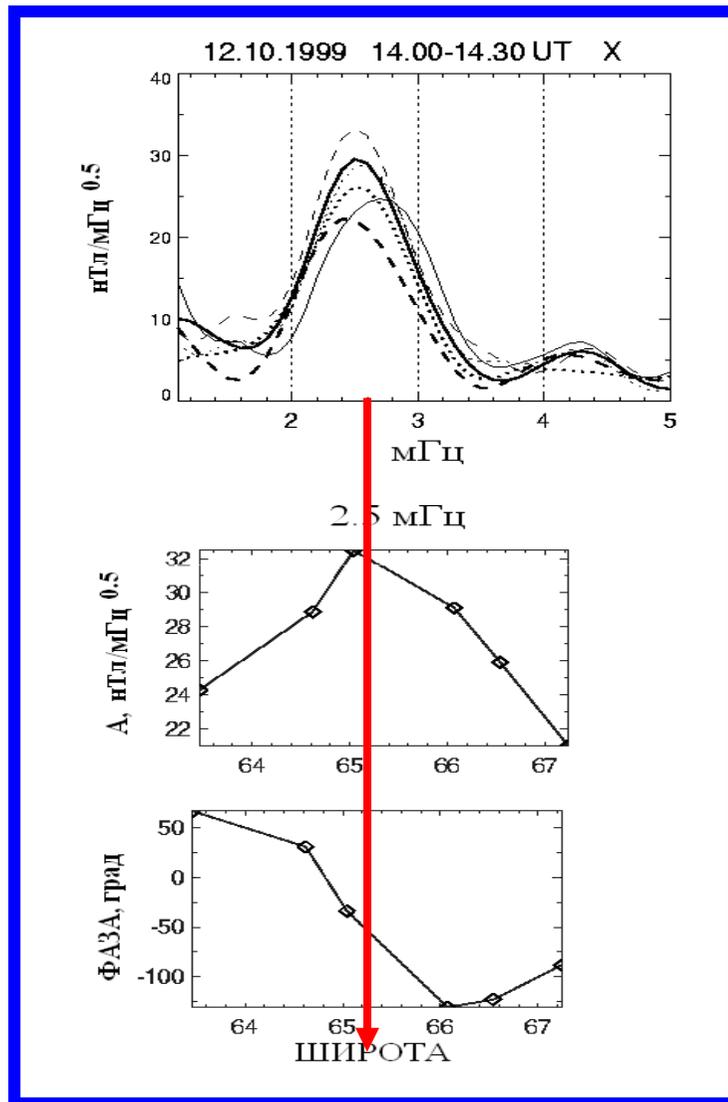
Early recovery storm phase



Geomagnetic pulsations with periods of few minutes (**Pc5**) are typical for magnetic storm recovery phase

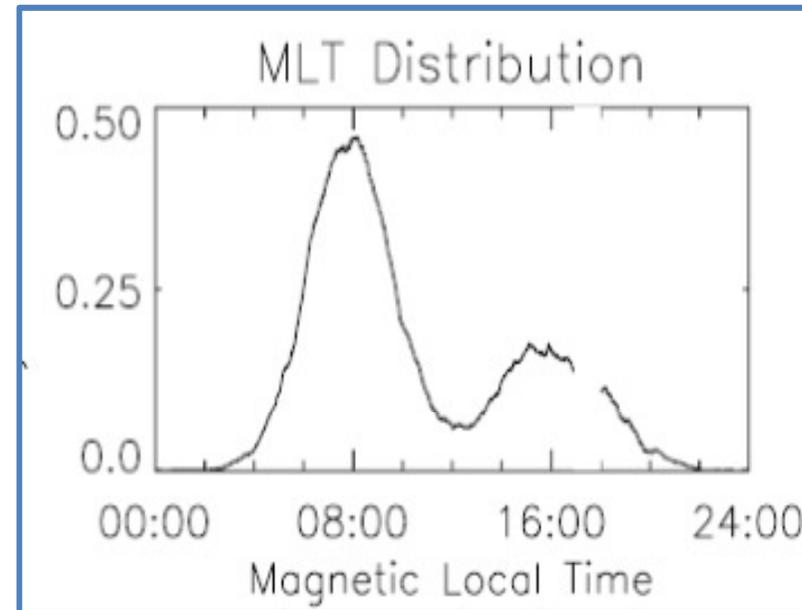
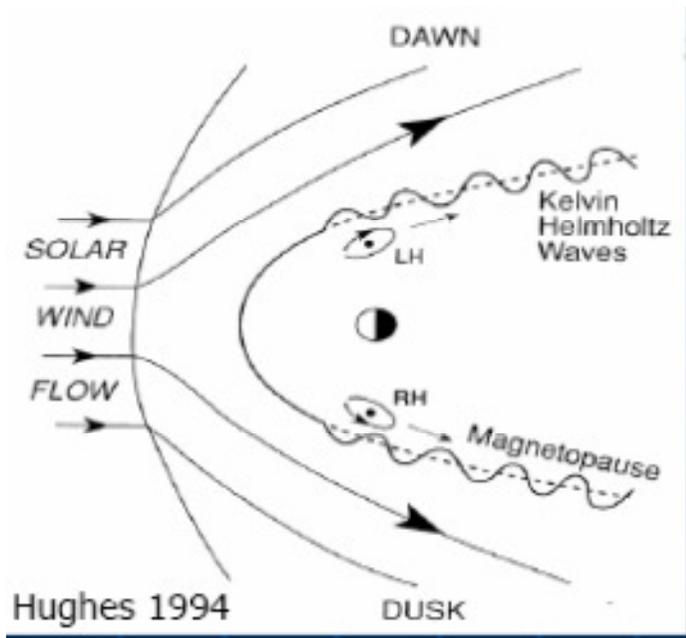


Field Line Resonance



- *The resonant frequency of a field line is determined by its length, magnetic field strength and the equatorial plasma density. The wave resonant frequency decreases with L-shell increasing.*
- *There is an amplitude local peak and phase reversal across the resonant latitude.*
- *The most likely source for Pc5 pulsations is Kelvin-Helmholtz (KHI) instabilities at the magnetopause generating compressional mode waves that propagate through the magnetosphere and couple to Field Line Resonances (FLR).*

The main behavior of Pc5 geomagnetic pulsation can be explained in the terms of field line resonance (FLR)



Geomagnetic pulsations

Day (Pc)

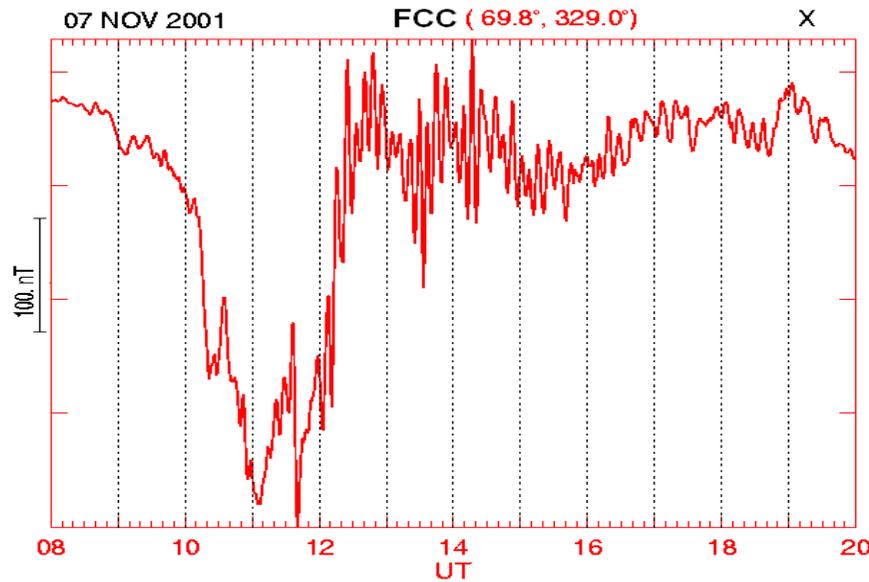
- T= 0.2-5.0 s (Pc 1)
- T= 10 - 45 s (Pc 2-3)
- T= 45 - 150 s (Pc 4)
- T= 3-10 min (Pc 5)

Night (Pi)

- T = 1- 40 s (Pi1)
- T= 40-120 s (Pi2)
- T > 2-3 min (Pi3)

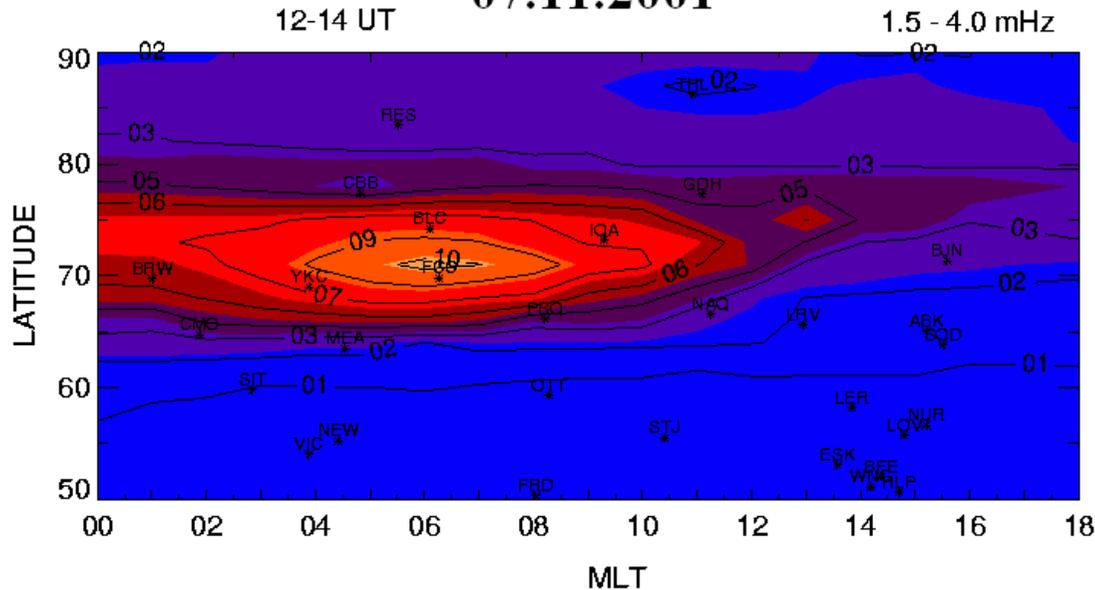
07.11.2001

Typical Pc5 pulsations

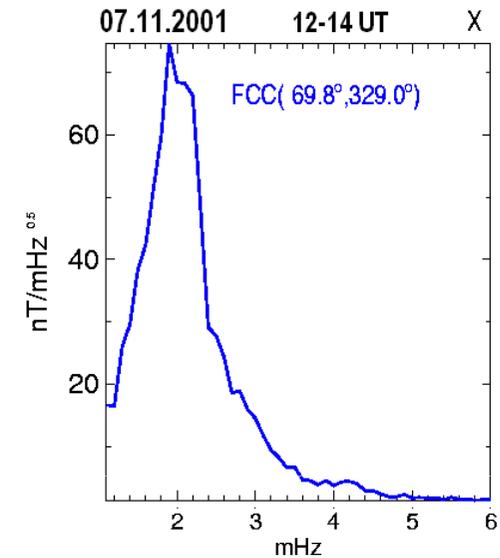


Typical Pc5 global distribution

07.11.2001



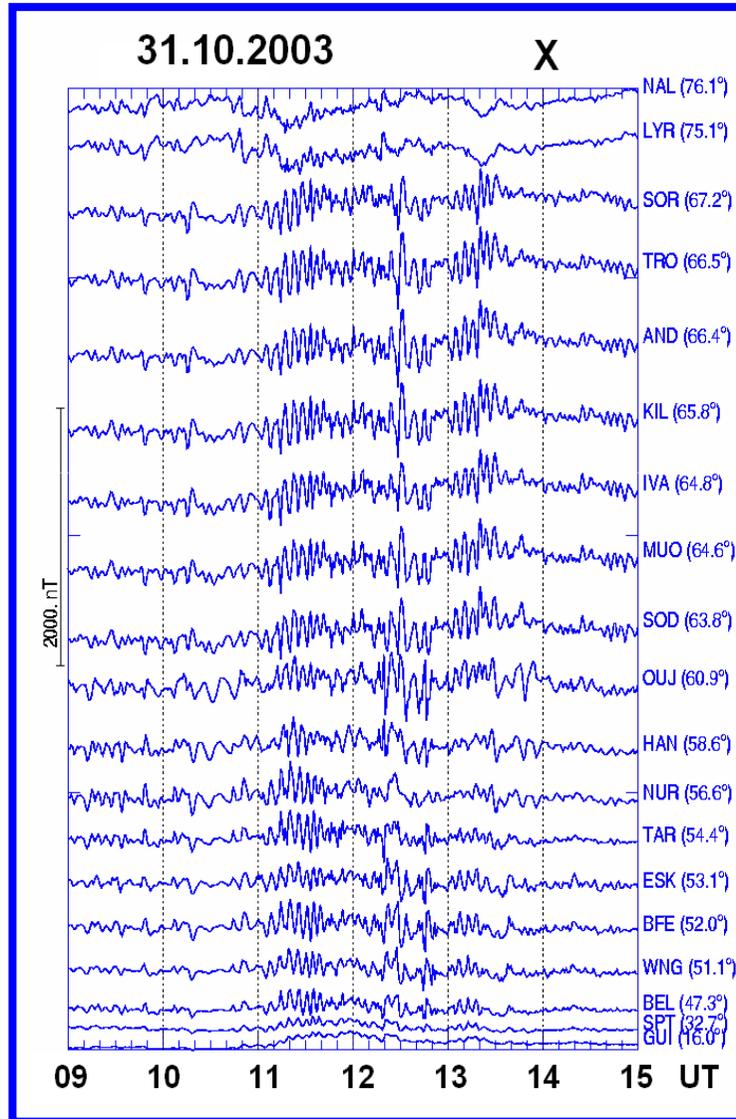
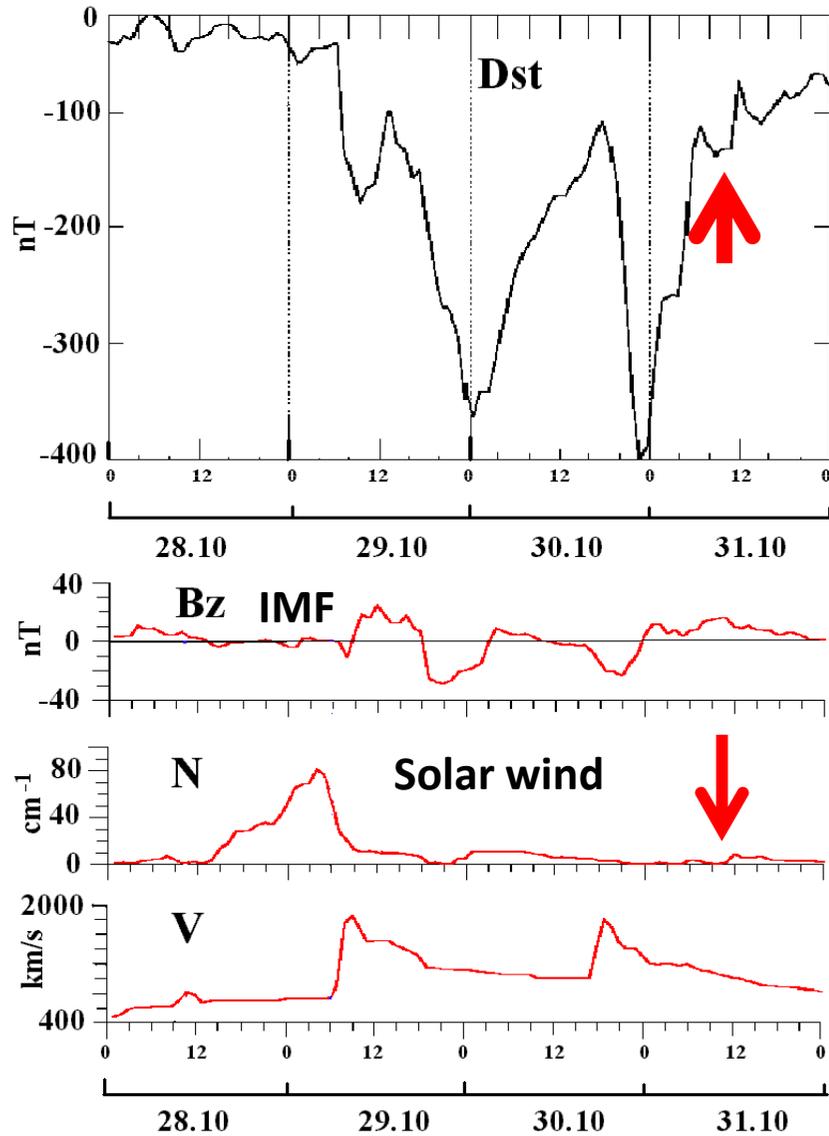
Typical Pc5 specter



Typical Pc5 pulsations are attributed to the field line resonances driven by magnetopause shear-flow instability, developing preferentially on the dawn flank.

After very strong magnetic storms, the Pc5 pulsations can be excited in global latitude scale

28 -31 October 2003



16.07.2000

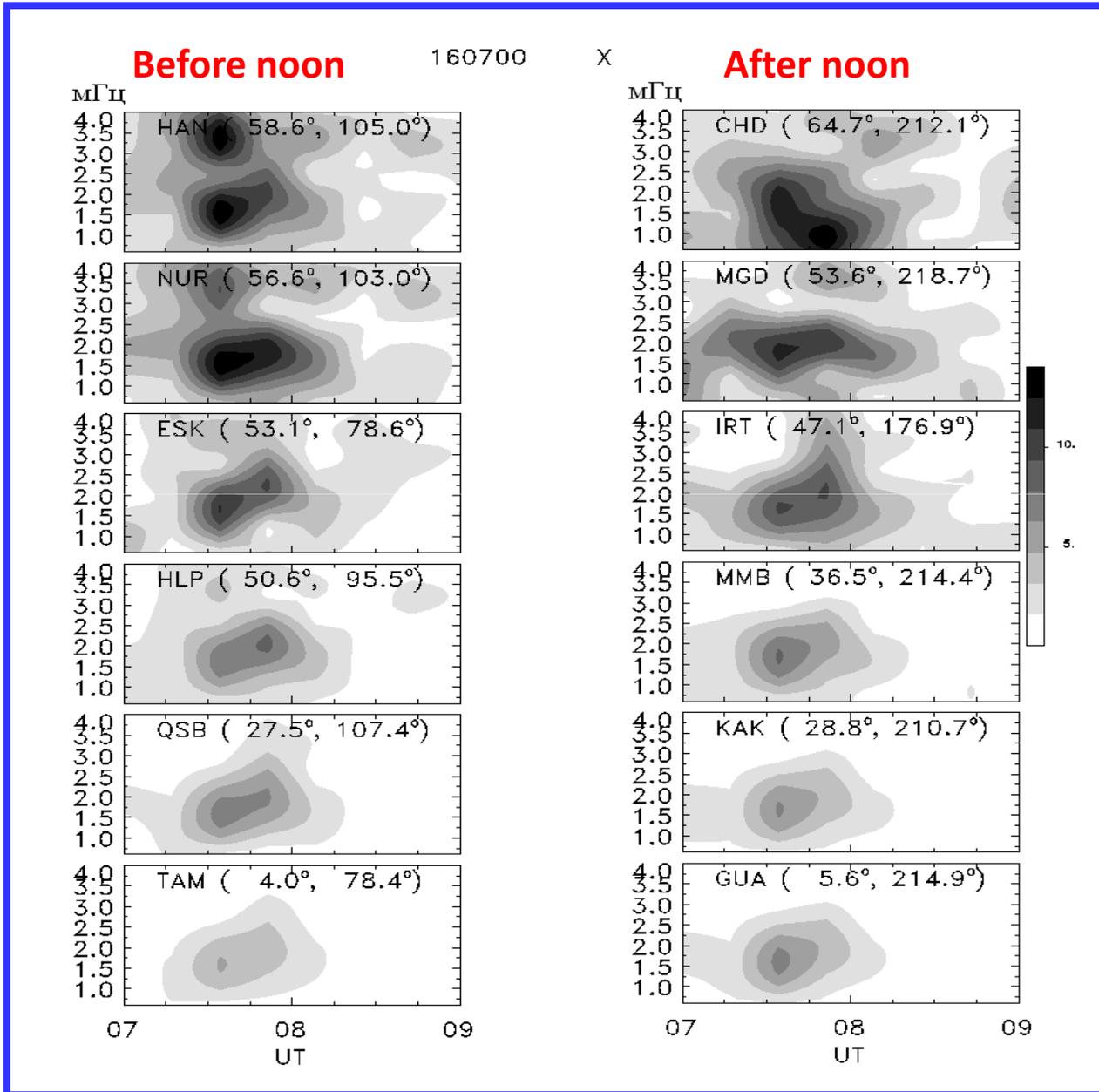
Global Pc5 pulsations

Bastille storm

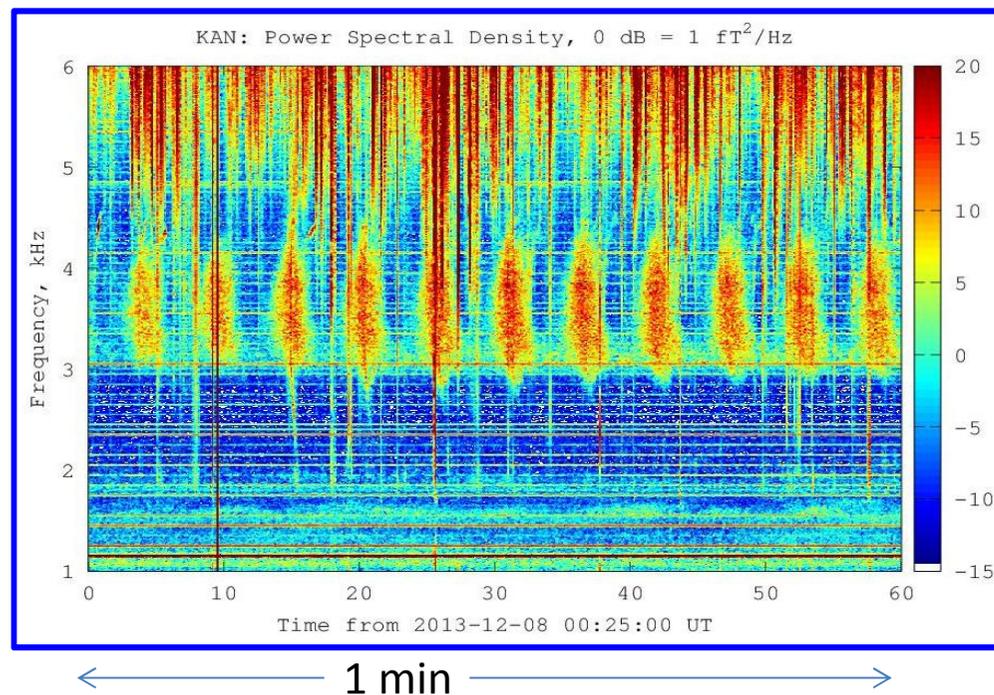
Storm recovery phase

V_{sw} ~900 km/s
B_z IMF ~ +30 nT

Deep penetration of Pc5 geomagnetic pulsations up to equatorial latitudes.



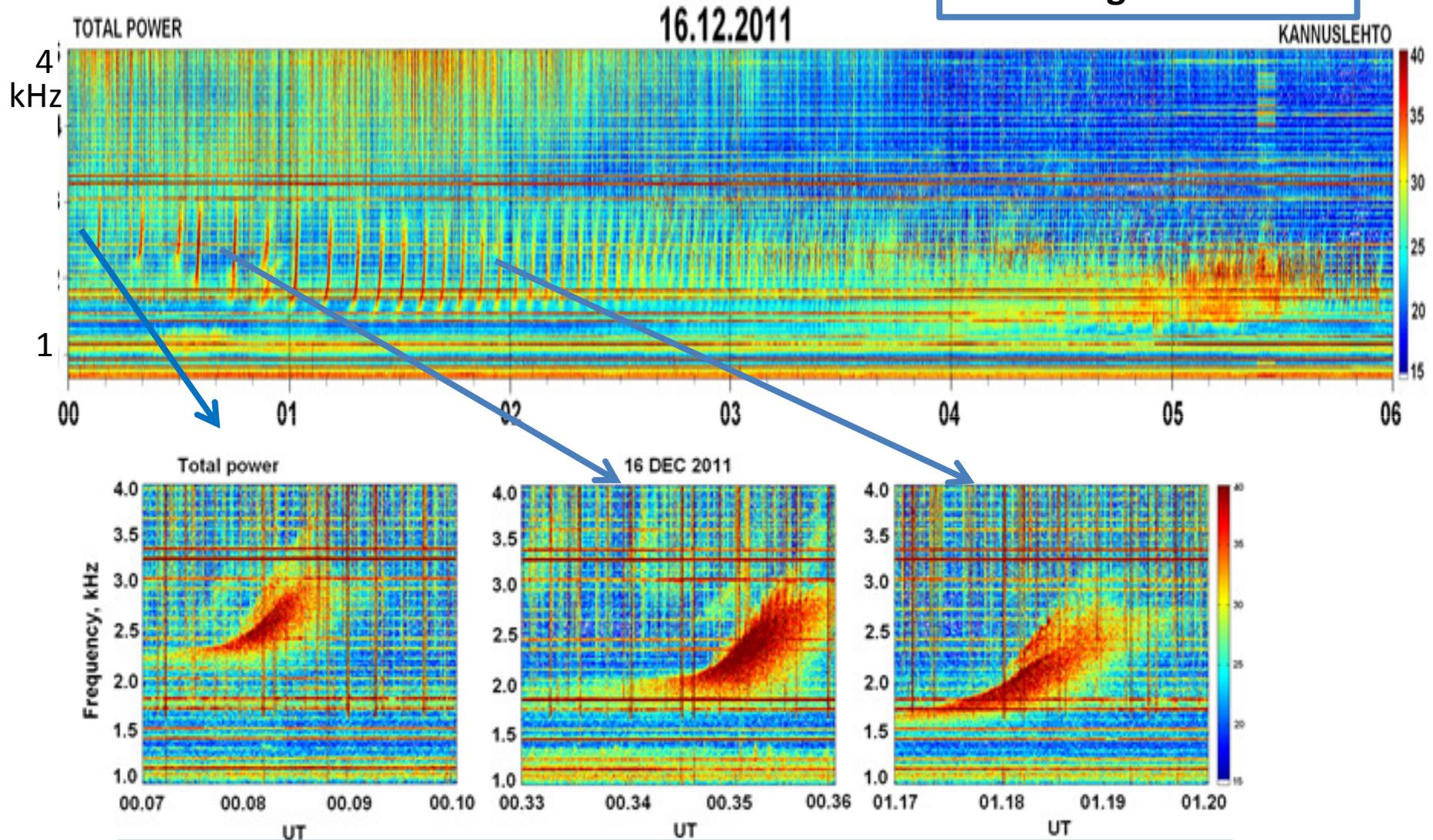
The auto-oscillations in the relaxed magnetospheric plasma maser can be observed in the higher frequency band as well (the frequency is about 6 order higher than resonant Pc5 pulsations). It is a special regime of the electron-cyclotron instability at several kHz (Very Low Frequency - VLF) emissions, known as quasi-periodic VLF waves.



An example of typical quasi-periodic VLF waves spectrogram

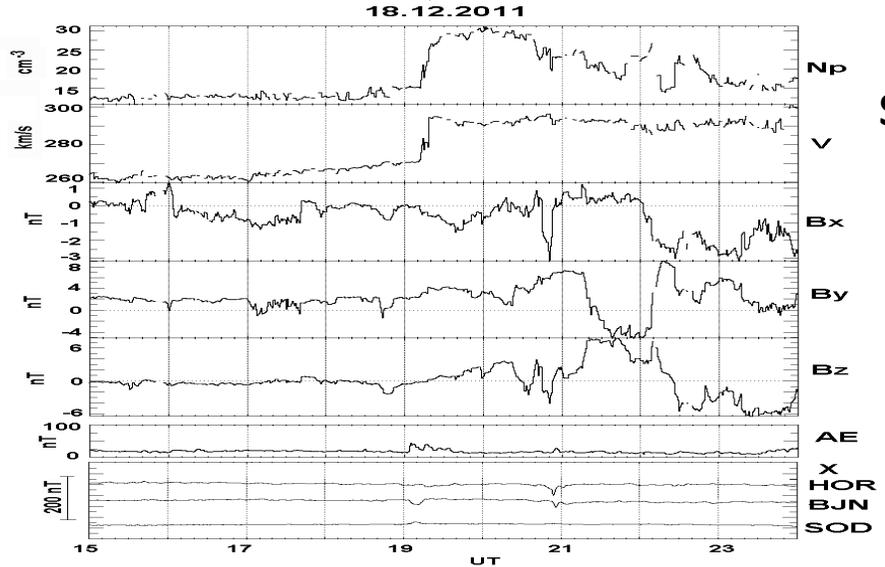
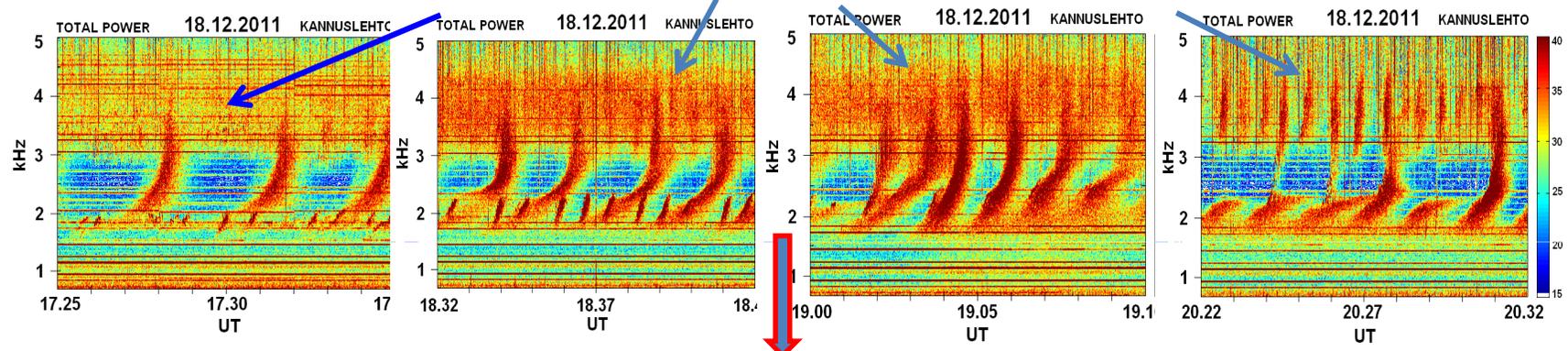
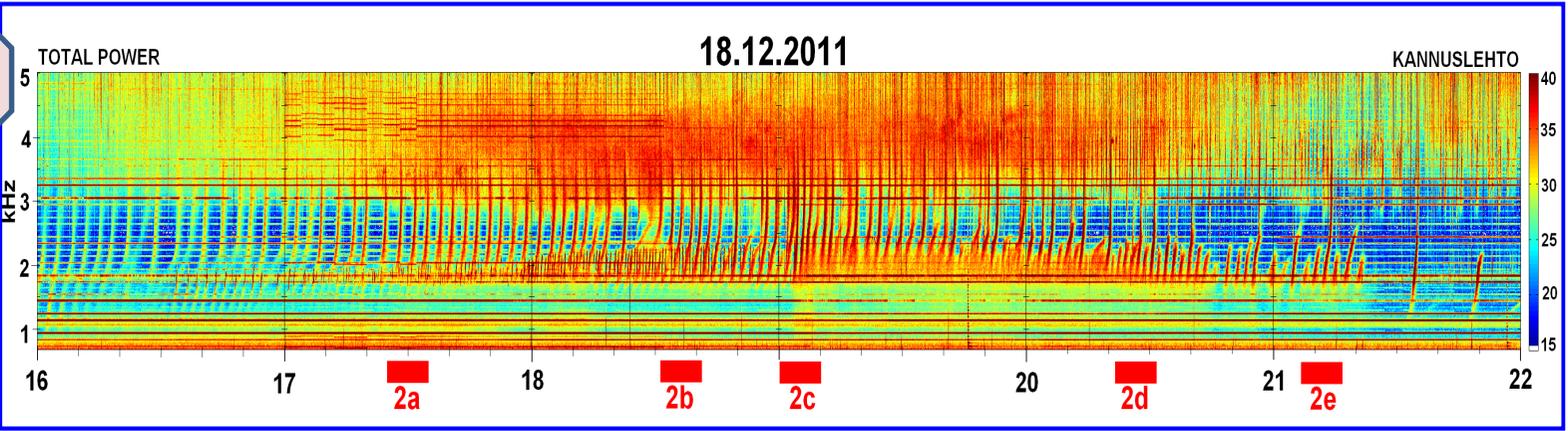
1

Late recovery phase of small magnetic storm



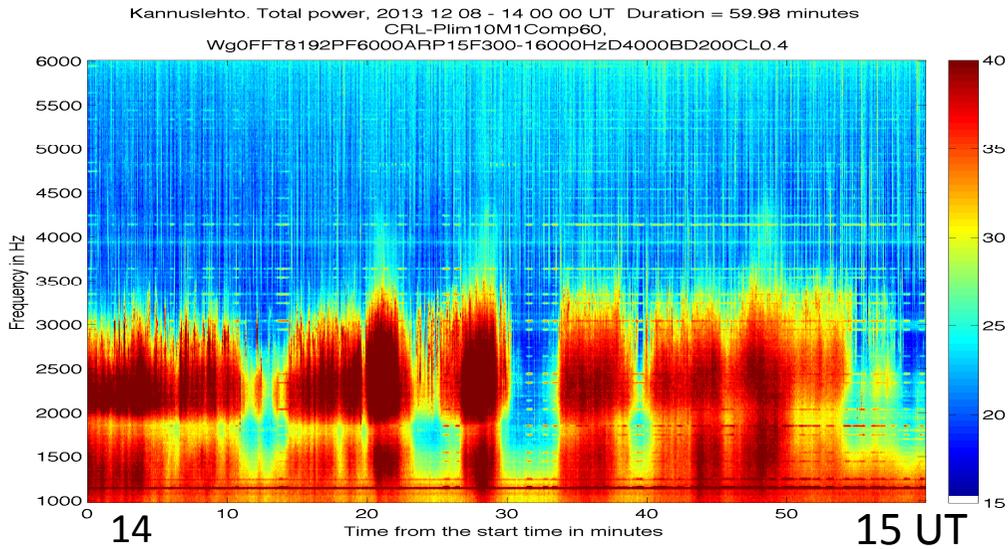
The low frequency wave limit decreased with time, thus the wave source is shifting to higher latitudes (bigger L-values).

2

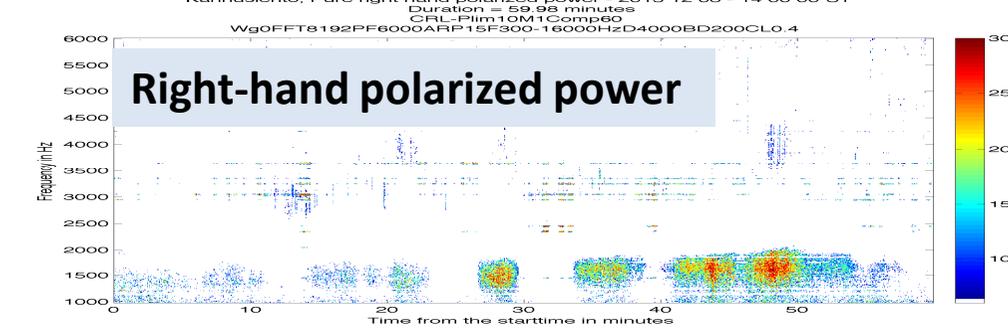
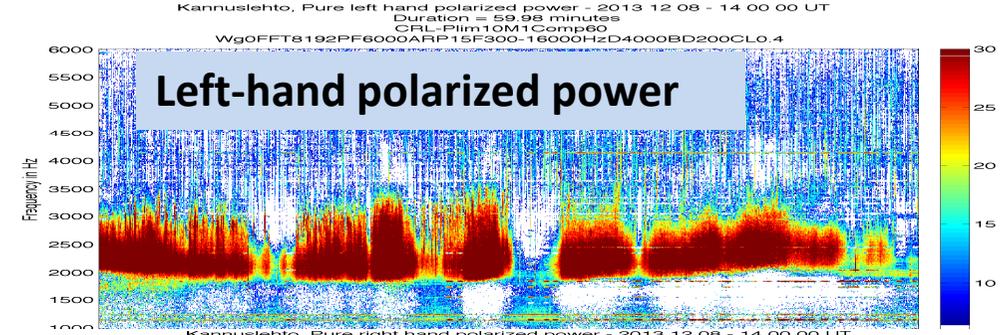


Soar wind and IMF data

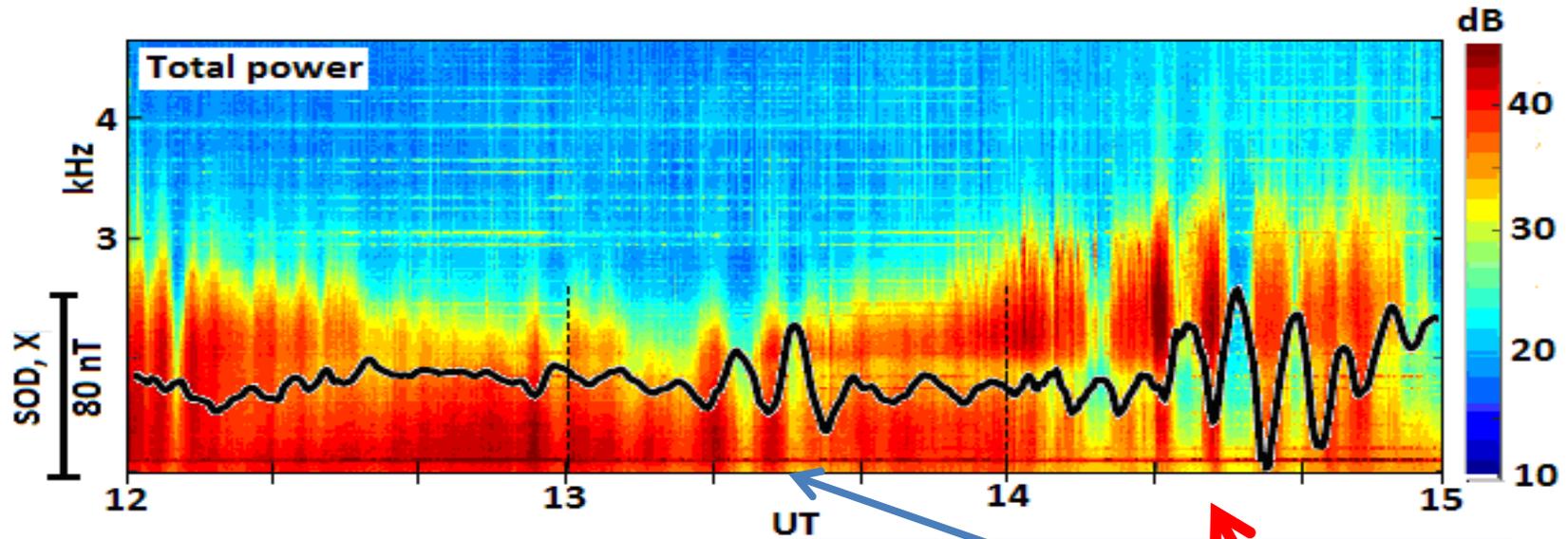
A jump of solar wind density and velocity changed the VLF dynamic spectra



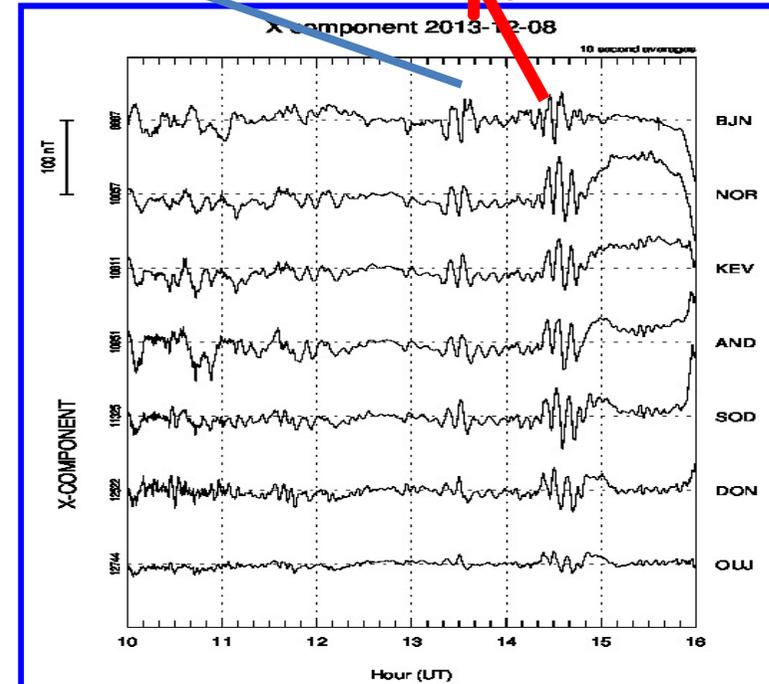
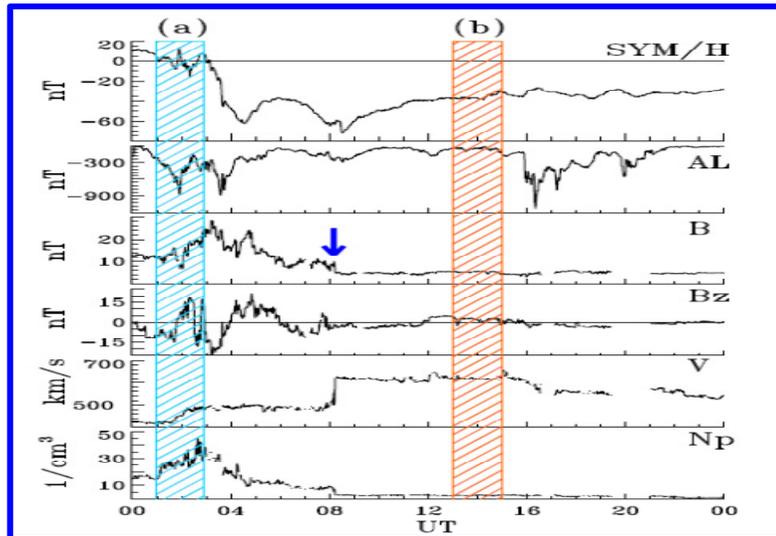
**“Mushrooms”- like
 VLF (1-4 kHz) emissions
 in the magnetic storm
 recovery phase**



08.12.2013

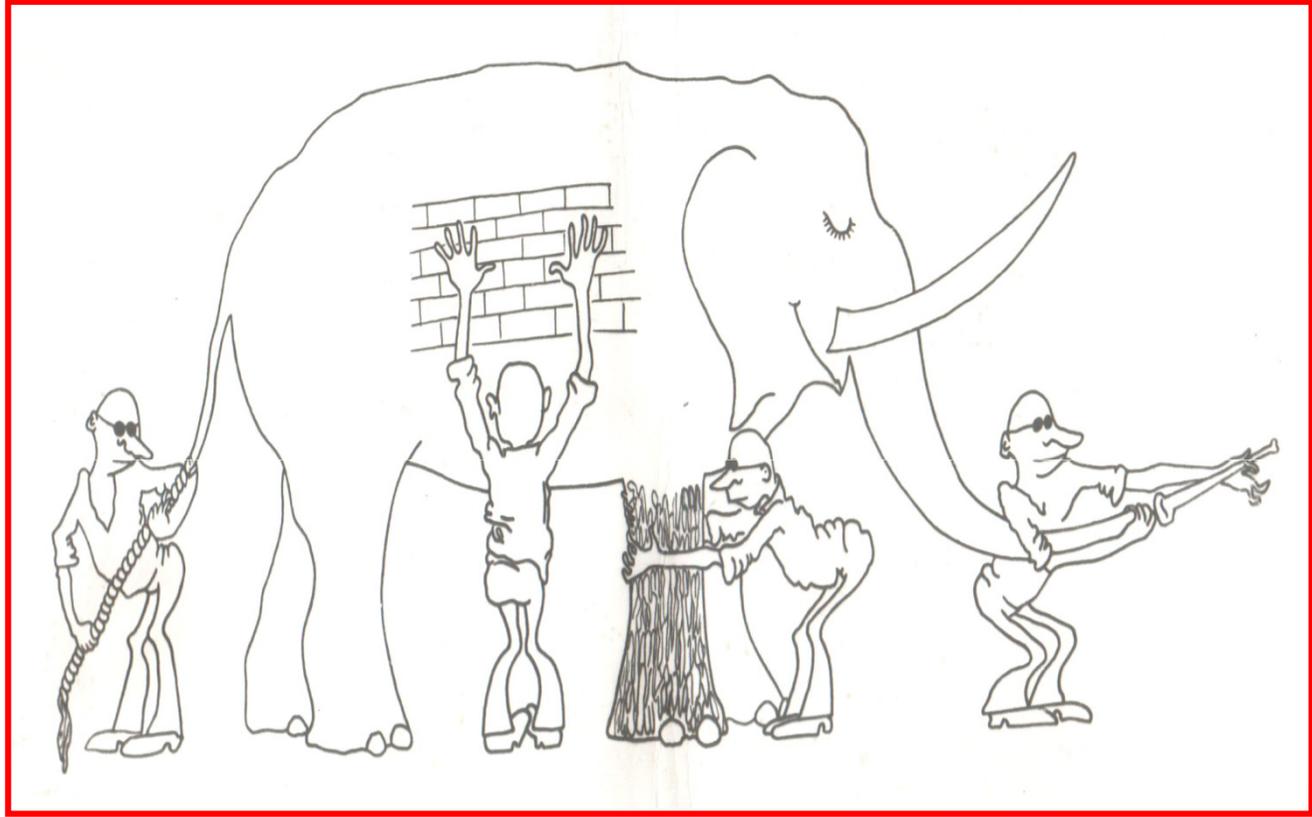


The Pc5 geomagnetic pulsations modulate the grow rate of VF hiss (“mushrooms” repetition).



CONCLUSION

- The wave of different frequency scale play an important role in the magnetosphere energy transform, spatially, in the magnetic storm recovery phase .
- The typical magnetosphere relaxing waves in the storm recovery phase can be the **geomagnetic Pc5 pulsations** at several minutes period with quasi-monochromatic structure. The main source of these Pc5 pulsations can be the magnetic field line resonance (FLR).
- .
- The auto-oscillations in the relaxed magnetospheric plasma maser can be observed also as the special regime of the electron-cyclotron instability **at several kHz (Very Low Frequency - VLF)** emissions, known as quasi-periodic VLF waves.
- The trigger of both waves generation onset is related to a sudden appearance of some inhomogeneity in the solar wind or IMF.





THANK

YOU

FOR COMING