Pc1 geomagnetic pulsation behavior depending on the solar activity

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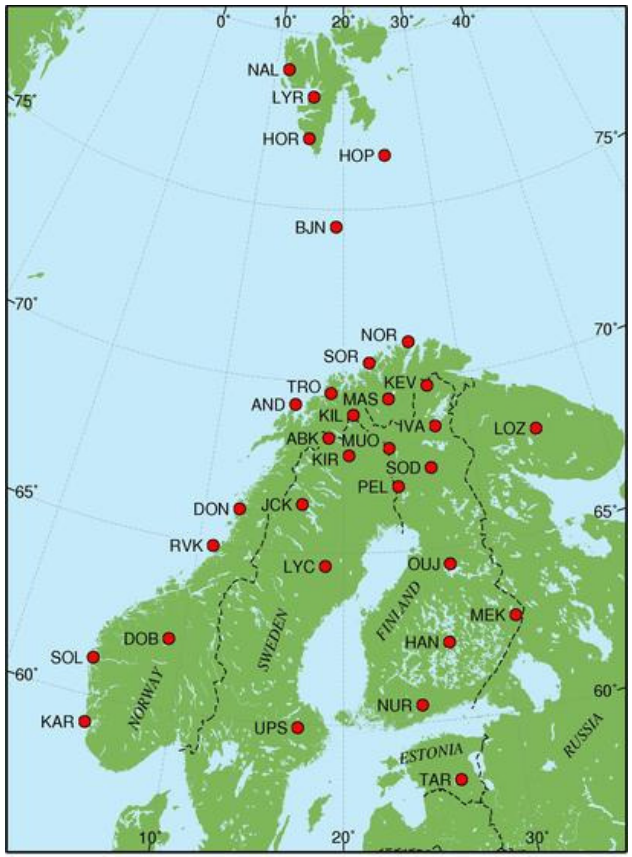
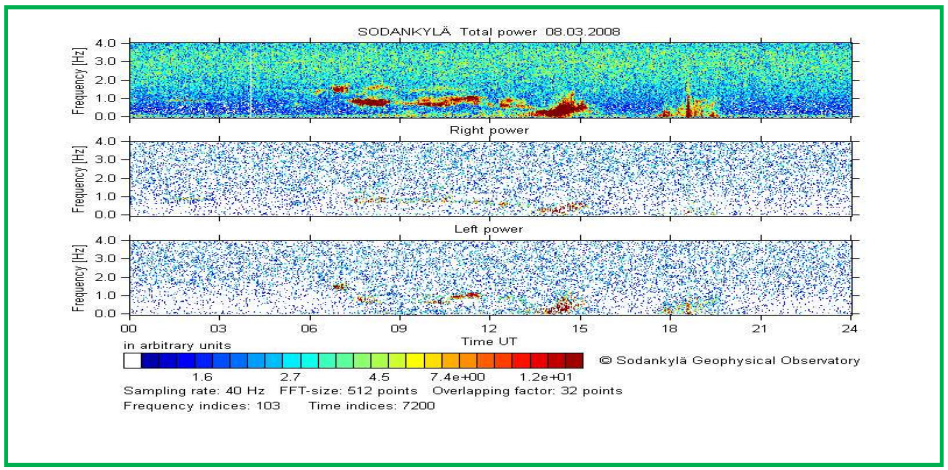




Abstract

- **The latitude feature of Pc1 geomagnetic pulsations was studied on the base of the Scandinavian magnetometer chain near the maximum and minimum of the 24-th solar activity cycle** (http://sgo.fi/Data/Pulsation/pulArchive.php)**.**
- **In the minimum (2008) there were about 30 magnetic storms, but in 2009 - only 5. The number of the hours with Pc1 was ~100 in 2008 and only ~20 in 2009. Generally, during the solar minimum, the shape of the Pc1 dynamic spectra was simple and the wave duration < 3-5 hours. However, during the declining (2006) and increasing (2010) solar activity stage, the spectral structure of Pc1 became more complicated and the wave duration increased up to 10-12 hours.**
- **We compared the total, right-hand and left-hand polarized Pc1 pulsations at two latitude spaced stations: SOD (Φ=63.8^o, L~5.3) and NUR (Φ=56.6^o, L~3.5) and found that in 2003 (near solar maximum), the Pc1 pulsations were stronger at NUR generally with left-hand polarization. However, in 2008-2009, the Pc1 events were stronger at SOD with left-hand polarization too (so, in vicinity of the wave exit point from the ionosphere too).**
- **Our finding supports the idea that the area of Pc1 wave generation could be related to the vicinity of the plasmapause.**

2008

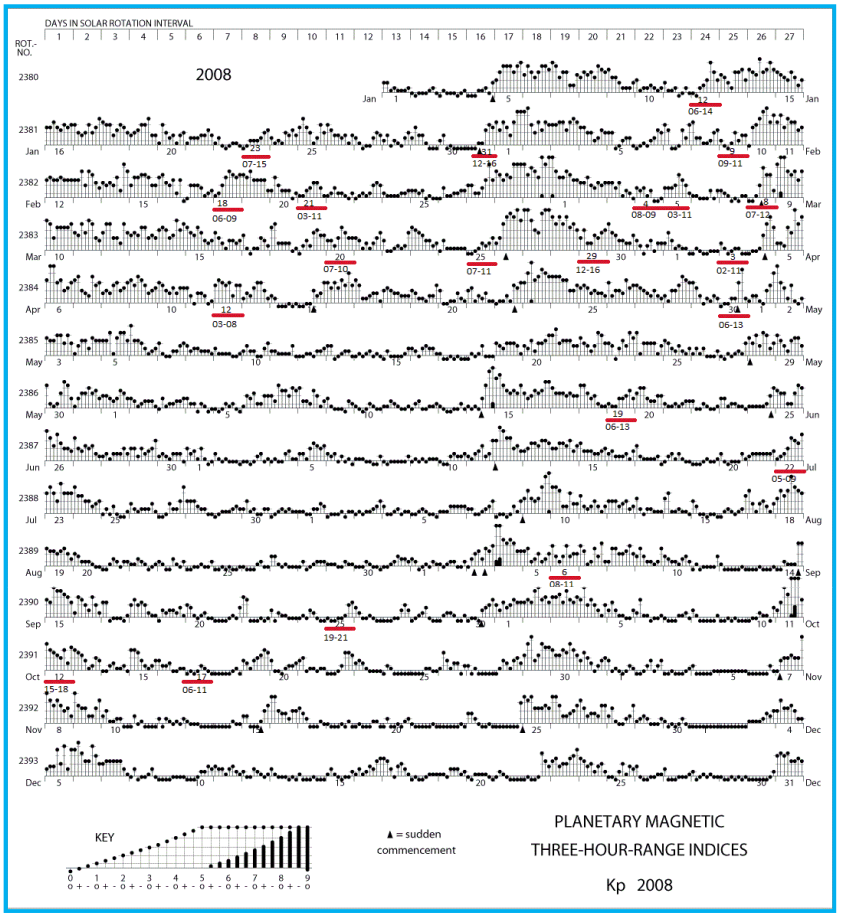


Fig.1a

2009

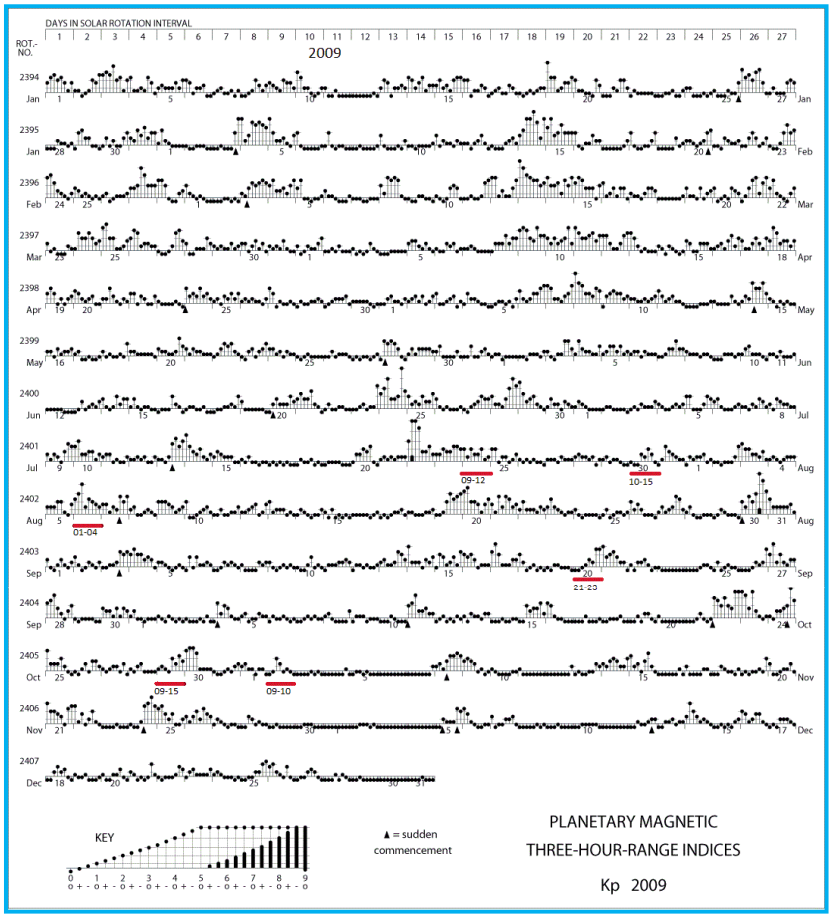


Fig.1b

The geomagnetic activity and long-lasting Pc1 occurrence (red bars) in 2008 and 2009

It is seen, that in 2008 there were observed much more number of long-lasting Pc1 events than that in 2009. Most of Pc1 events were associated with magnetic storms and magnetic disturbances development.

It is well known, that the Pc1 occurrence maximum is observed in the declining phase of the solar activity. Really, in the declining phase of the 23-th cycle of the solar activity (2006), the number of the hours with long-lasting Pc1 series was rather high ~270.
In 2008, the number of the hours with long-lasting Pc1 series was ~100 and in 2009 it was only ~20. It corresponds to the relationship of long-lasting Pc1 generation with magnetic storms development.

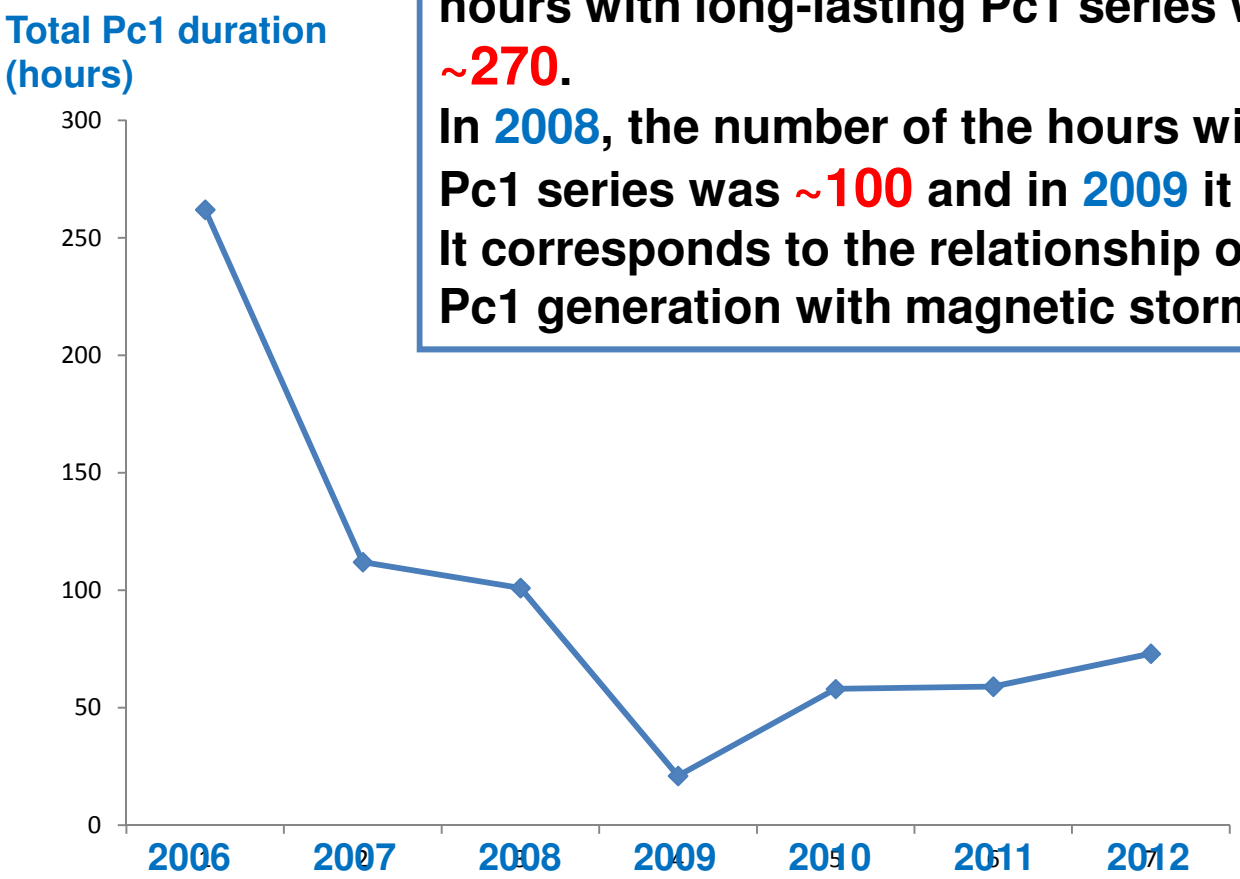


Fig.2. The total yearly Pc1 duration in the solar activity minimum

During the declining phase of the solar activity (2006) , the spectral structure of Pc1 sometimes was complicated.

As a rule, during the solar activity minimum, the shape of the frequency-temporal Pc1 spectra looked like a very monochromatic emission of not more 3-5 hours duration.

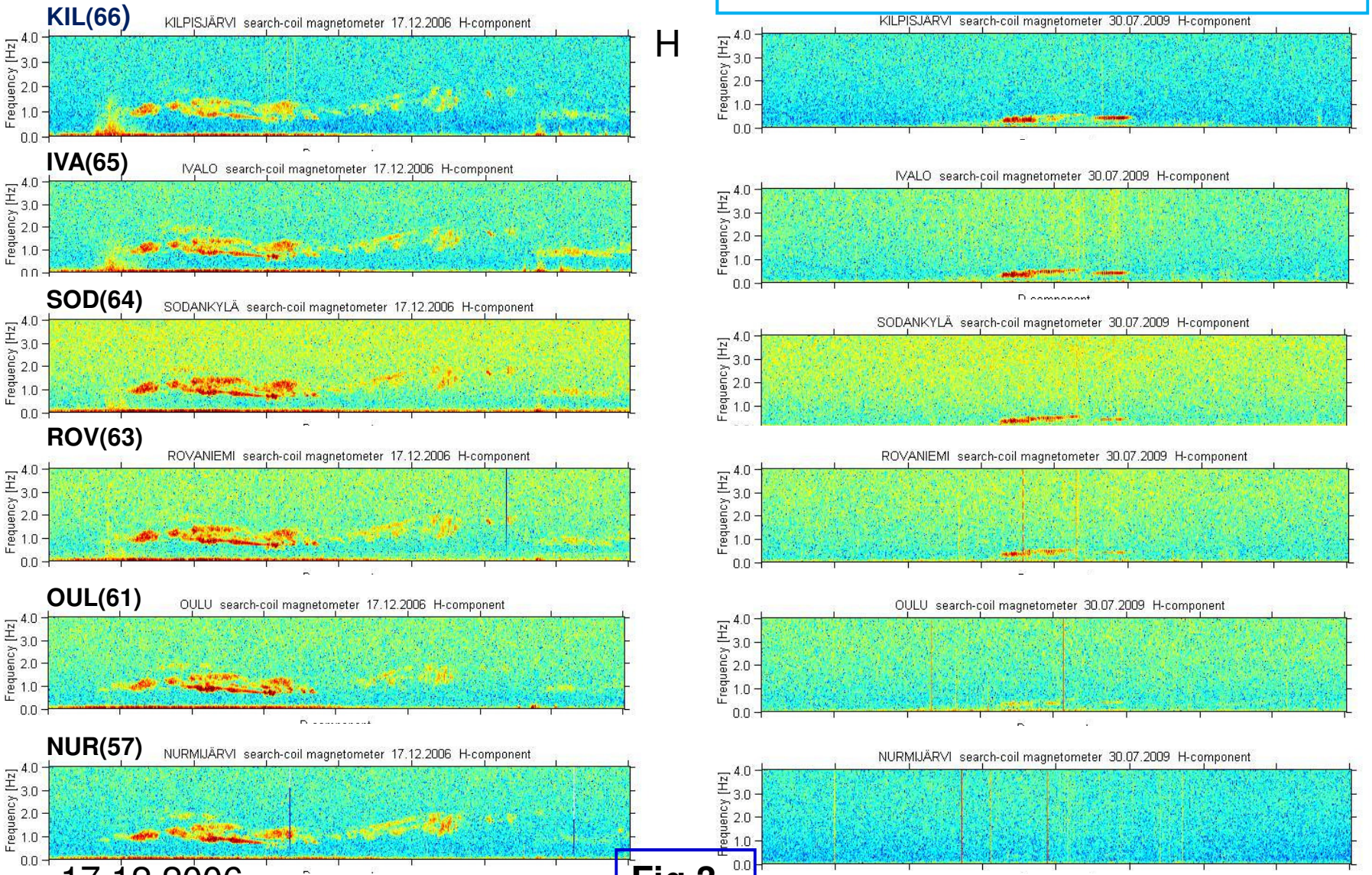
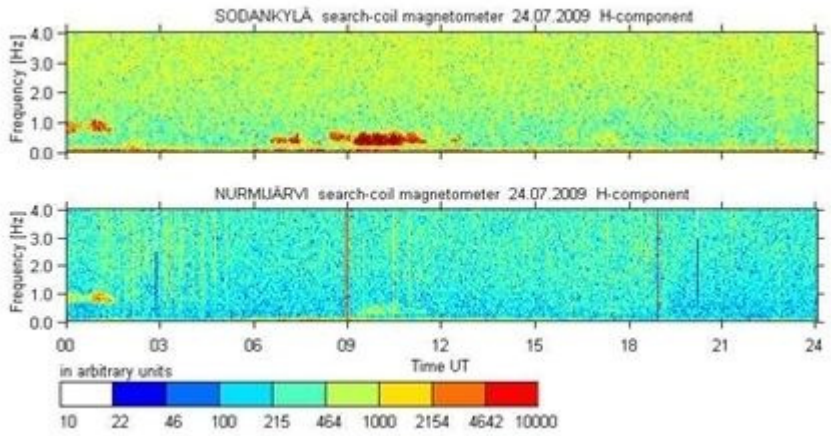


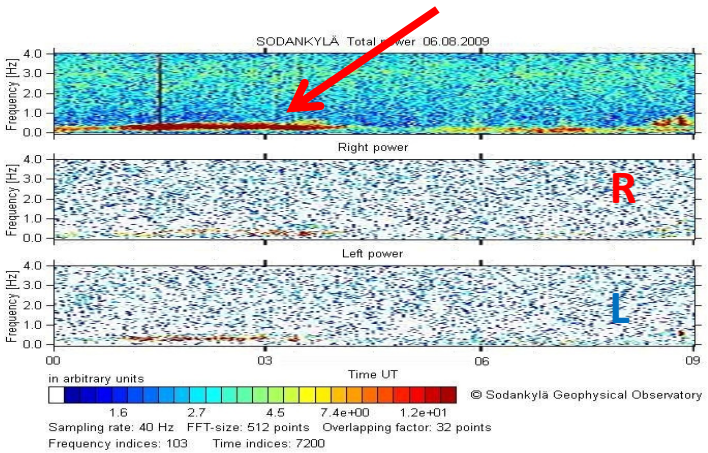
Fig.3

During the solar minimum (2008, 2009), the Pc1 pulsations are typically observed in the beginning of geomagnetic activity increasing after magnetically quiet (Kp ~ 0-1) periods, and the pulsations were stronger in SOD (L~5.3) than in NUR (L~3.6).

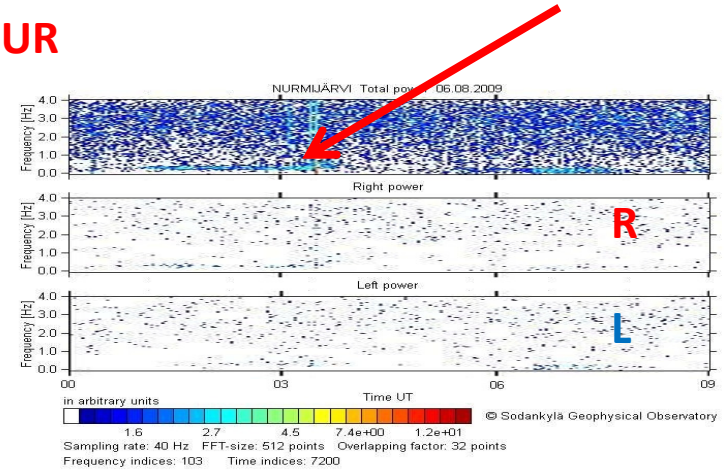
24.07.2009



SOD **06.08.2009**



NUR



The plasmapause location can be estimated as (Lpp=5.5-0.46 Kp_{max}), where Kp_{max} - maximal value of Kp for previous 24 hours. Kp was ~2, thus, the plasmapause could located at L~5.0-5.5. The same result gives the model www.spaceweather.eu (See Fig. 5).

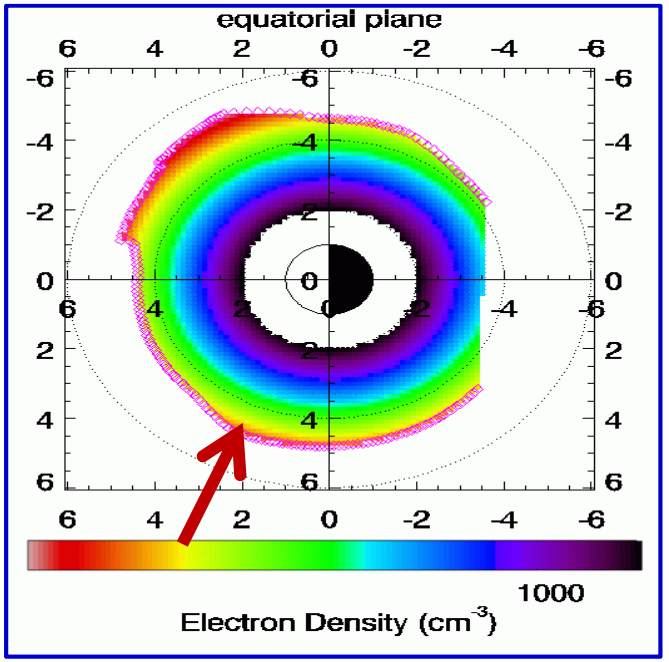


Fig. 5

20.11.2003

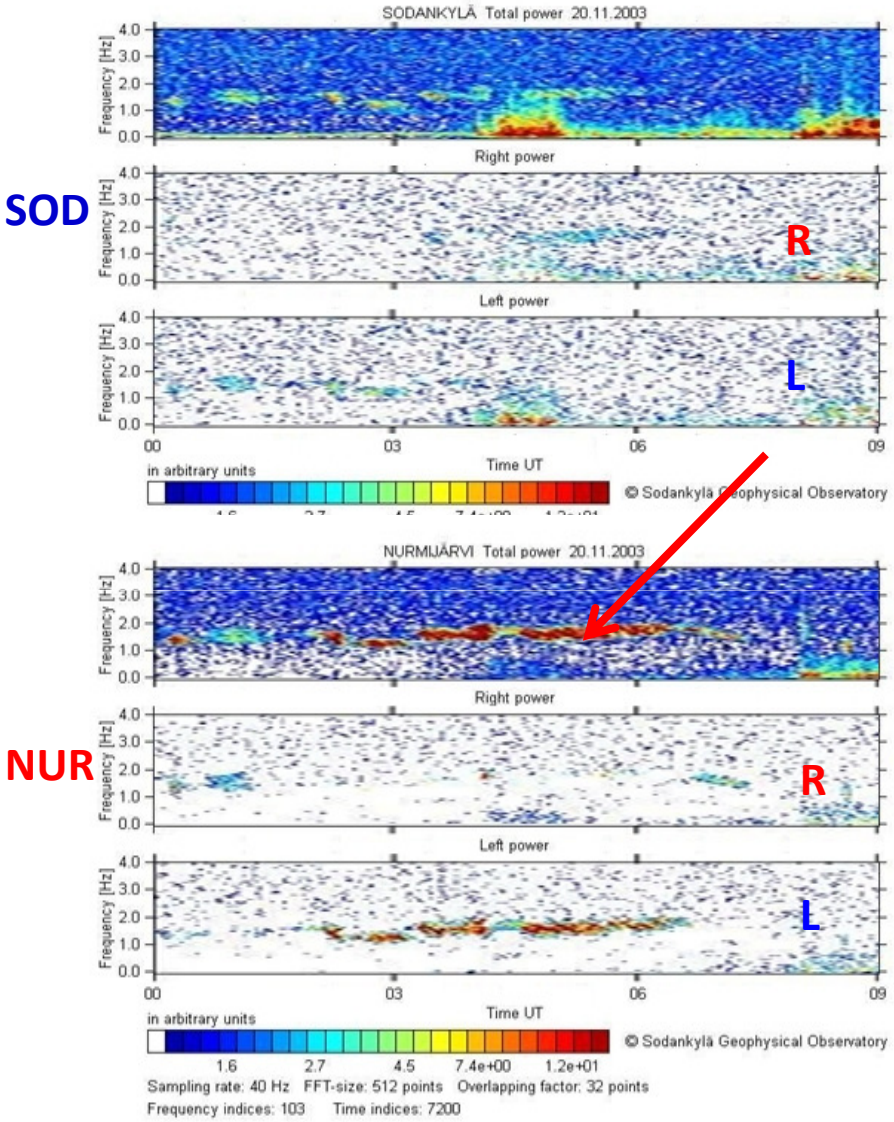


Fig. 6

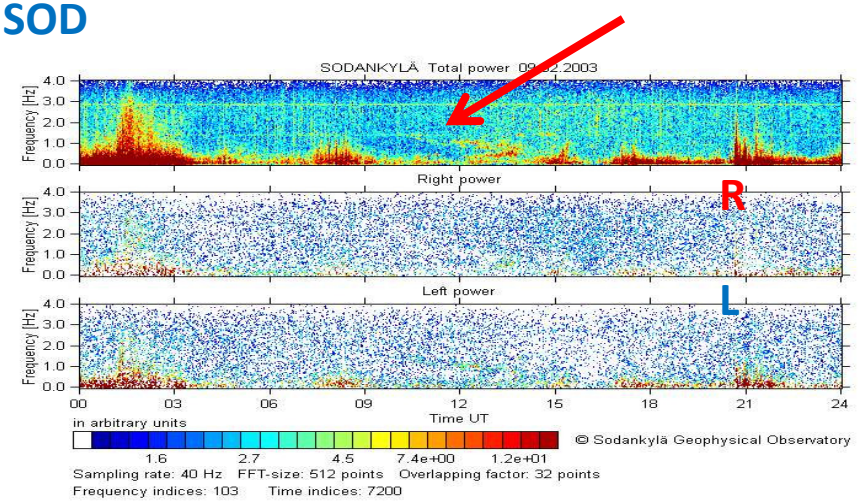
During the solar maximum (e.g. 2003) geomagnetic pulsations Pc1 were observed, generally, at the declining stage of magnetic activity after strong magnetic disturbances.
The pulsations are typically seen during the recovery phase of magnetic storms.

Under these condituions, the Pc1 waves were stronger in lower latitudes, e.g. at NUR (L~3.6) than at SOD (L~5.3). The examples are presented in Fig. 6 and 7.

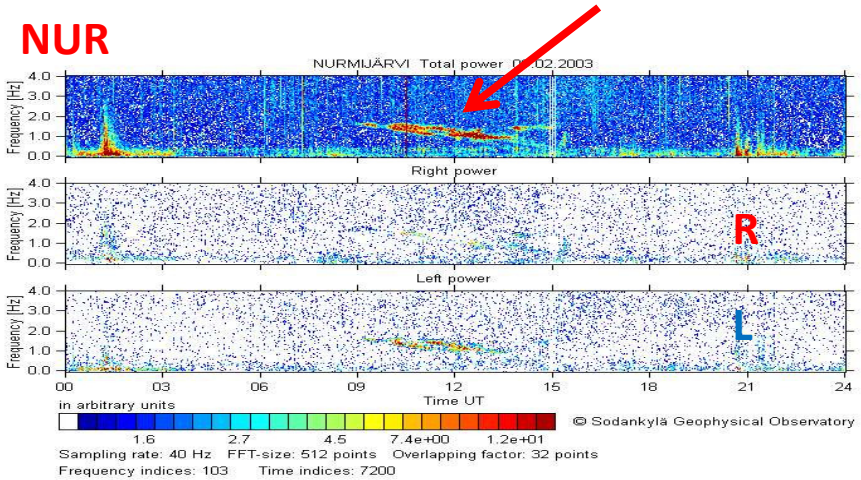
The wave polarization was mainly left-handed (L) at NUR. However, at SOD Sometimes, the Pc1 waves showed also the right-hand (R) polarization.

09.02.2003

SOD



NUR



The estimated plasmapause location was L~3.5-4.0. The same results gives by using the model www.spaceweather.eu.

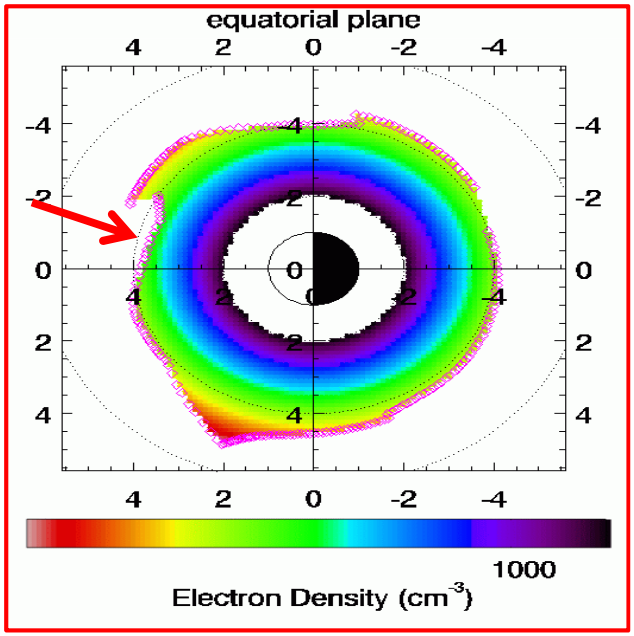


Fig. 7

DISCUSSION

- **The Pc1 pulsations propagate in the magnetosphere along geomagnetic field lines down to the ionosphere as left-hand polarized electromagnetic (Alfven) waves. Mapping through the ionosphere, these waves are seen on the ground near their footprint as the left polarized mode. Also the maximum of geomagnetic pulsation intensity is located in this region. Thus, the left-hand polarization of ground-based Pc1 indicates the station location in vicinity of their source footprint.**

- **Right-hand polarized Pc1 waves on the ground could be related to the capture of Alfven waves into the ionospheric waveguide [e.g., Manchester, 1966; Greifinger and Greifinger, 1968] and their convert into the fast magnetosonic ones resulting the wave polarization change from the left-handed into the right-handed .**

- **Another reason of right-hand polarized Pc1 wave appearance could be the availability of the *heavy ions* (mainly He^+ and O^+) in the magnetospheric plasma, leading to the emergence of so called the tunnel effect and the wave polarization reverse as it was observed, for example, on GEOS spacecraft [e.g. Perraut et al., 1984, Mikhailova, 2011] .**

SUMMERY

The ground-based Pc1 pulsations (pearls) behavior is controlled by the solar activity level.

In the minimum of the solar activity (2008-2009), the shape of the Pc1 dynamic spectra was simple. However, during the declining (2006) and increasing (2010) solar activity stage, the spectral structure of Pc1 became more complicated and the wave duration increases.

During the solar minimum, the Pc1 events were stronger at higher latitudes, e.g. at SOD ($\Phi=63.8^{o}$, L~5.3) than at NUR ($\Phi=56.6^{o}$, L~3.5). It was inverse during the solar maximum. We interpret that as the Pc1 generation in vicinity of the plasmapause which location change with solar activity variation.

The wave polarizations study can give us some additional information about the possible plasmapause location and its temporal dynamics.

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