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SOME PROPERTIES OF THE IPDP TYPE MAGNETIC PULSATIONS

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Abstract. Two-year data of the Finnish ground-based search coil magnetometer network were used to display some statistical properties of geomagnetic pulsations of the Pc1 range called Intervals of Pulsations of Diminishing Periods (IPDP). Some 80% of IPDP events were observed at 15-21 MLT. In agreement with earlier findings we showed that the IPDP events at lower latitude stations tend to appear at later MLTs. For the first time we showed that the IPDP end frequency tends to increase with MLT. The IPDP end frequencies are always below of the equatorial He+ gyrofrequency.

Introduction

Intervals of Pulsations of Diminishing Periods (IPDP) are a type of geomagnetic pulsations in the Pc1-2 range. Comprehensive descriptions of the IPDP morphology and hypotheses of the IPDP generation can be found in a review by Kangas et al. (1998) (see, also references therein). Although the investigation of IPDP has a rather long history (e.g., Troitskaya and Melnikova, 1959; Troitskaya, 1961; Heacock, 1967; Fukunishi, 1969; Gendrin, 1970; Kiselev and Raspopov, 1971), there is no clear understanding of specific features of these pulsations, including the formation of their dynamic spectra characterized by the frequency increase with time. Evidently, there is a need in more detailed analysis of the IPDP properties. A powerful tool for investigation of the geomagnetic phenomena is the use of meridional chains of ground stations. At the same time there are only few studies dealing with the IPDP investigations on the basis of such networks (e.g., Lukkari et al., 1977; Maltseva et al., 1981). Statistical results on the latitudinal dependence of the IPDP properties on the same meridian were obtained with observations only at two stations situated in the auroral zone and at mid- latitudes (e.g., Soraas et al., 1980; Pikkarainen et al., 1983).

The Finnish search coil magnetometer chain is the most suitable one for investigation of the IPDP properties. Indeed, the magnetometers have appropriate frequency characteristics, permanently operate for many years, and situated at latitudes where the IPDP source footprint is more often observed (see, a companion paper by Yahnin et al., this issue). In this paper the data from the Finnish network are used for investigation of some spatial characteristics of the IPDP parameters.

Data

The ground observations of geomagnetic pulsations were performed by the Finnish network of search coil magnetometers located at CGLat = 56.9-65.1º, MLT = UT + 2. The list of ground stations registering the magnetic pulsations and used in this study is presented in Table 1. The magnetometers of the Finnish chain have a linear frequency response of 1.4 V/(nT*Hz) with an instrumental noise figure of ~1 $pT/Hz^{1/2}$ at 1 Hz. The magnetometers of the Finnish network are identical and intercalibrated, so they can be used for comparison of intensity of the pulsations at stations along the meridian.

Data for years 2004 and 2005 were used for this study. The data from three stations IVA, OUL and NUR (representing, respectively, poleward, middle, and equatorward parts of the magnetometer chain) were searched to reveal IPDP events observed at least at one station. In all, 153 events were found (74 events in 2004 and 79 events in 2005). For all events the IPDP beginning and ending times were determined as well as the end frequency. As an example, two IPDP events observed on 4 June 2005 at ~17-18 and 19-20 UT are shown in Fig. 1.

Table 1

Station	Station abbreviation	Geographic coordinates		Corrected Geomagnetic coordinates		L value
		Latitude	Longitude	Latitude	Longitude	
Kilpisjarvi	KIL	69.0	20.9	65.9	104.2	6.1
Ivalo	IVA	68.6	27.3	65.1	108.9	5.7
Sodankyla	SOD	67.4	26.4	64.0	107.4	5.3
Rovaniemi	ROV	66.8	25.9	63.6	106.6	5.1
Oulu	OUL	65.1	2.9	61.7	105.6	4.5
Nurmijarvi	NUR	60.5	24.6	56.9	102.4	3.4

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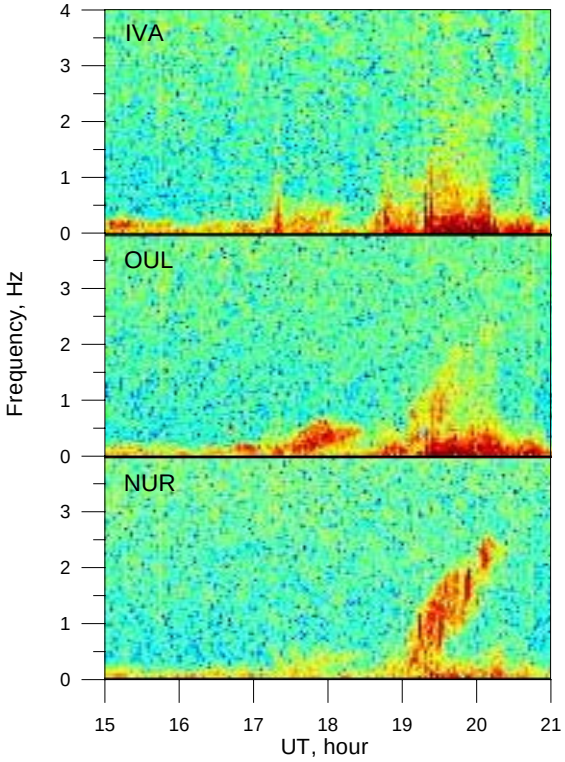

Fig. 1

Statistical properties of IPDP

All the IPDP events were found within 12-23 MLT (some 80% of events were within 15-21 MLT). 63 of 153 events were observed at only one station (22, 20 and 21in IVA, OUL, and NUR, respectively). Note, that observation of the signal only at one station suggests the close location of the IPDP ionospheric source. 25 events were observed simultaneously at all three stations. Other IPDP were observed simultaneously at two neighboring stations: at IVA and OUL (30 events) or OUL and NUR (35 events). The number of events registered in IVA, OUL, and NUR was 76, 110, and 81, respectively.

In the upper panel of Fig. 2 the occurrence of IPDP events relatively to MLT for each of three stations is shown. The medians (shown by shading) of distributions fall at 16, 17, and 18 MLT for IVA, OUL, and NUR, respectively. Thus, the station at lower latitude observes IPDP at later MLT. We also considered the dependence of the IPDP end frequency on MLT. The dependencies of the average (over an hour of MLT) values of the end frequency for each of the three stations are presented in middle panel of Fig. 2. The end frequency increases with MLT at every station. This Figure shows that at any MLT the averaged end frequency depends on latitude. The higher the latitude of a station the lower is the averaged IPDP end frequency. The dependence on latitude is also seen in the bottom of Fig. 2 where the end frequencies are plotted for those 63 IPDP events, which were observed only at one of the three

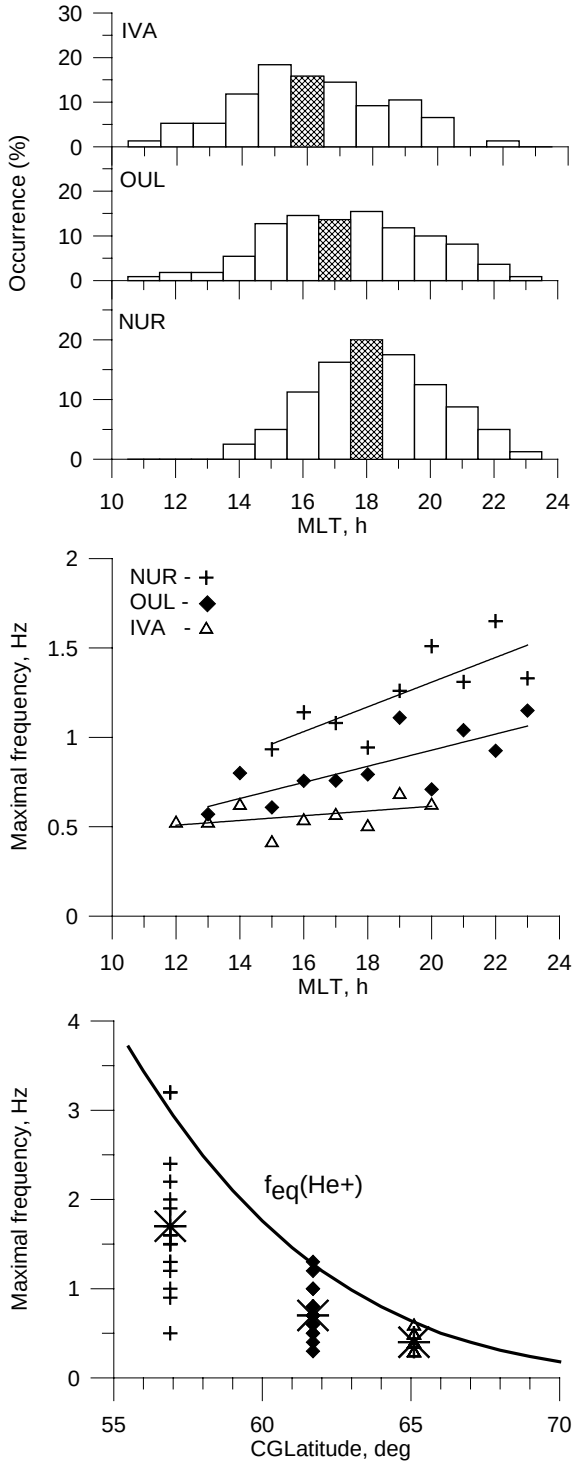

Fig. 2

stations. In this Figure the equatorial He+ gyrofrequency (in the dipole magnetic field) is also shown. Almost all observed end frequencies are below the He+ gyrofrequency. Asterisks mark median values of the end frequencies. Both dependences of the IPDP frequency on latitude and the He+ frequency are consistent with the suggestion that IPDP represent the ion-cyclotron waves.

Discussion

Some results presented here are in accord with those reveled in previous IPDP studies. Thus, Soraas et al. (1980) considered IPDP observations at auroral zone station Lovozero (L=5.1) and mid-latitudinal station Borok (L=2.8). They found that the pulsations in Borok are often seen at later MLTs compared with those in Lovozero. Our result presented in Fig, 2 confirms their finding.

Pikkarainen et al. (1983) used the data from the same stations as well as Syowa Base station in Antarctica (L=8) to compare the end frequencies of IPDP with He+ gyrofrequency in the equatorial plane. They concluded that the IPDP end frequencies are typically less that the He+ gyrofrequency at corresponding L-shell. Their Fig. 5, however, shows that maximal end frequencies at higher latitudes are above the He+ gyrofrequency, while at Borok the maximal end frequency is well below it. This is, likely, due to the fact that each station could register the signals from remote sources located at latitudes, which are higher than latitude of Borok and lower than latitude of Lovozero and Syowa. (The results of the companion paper by Yahnin et al. (this issue) do suggest such location of the IPDP sources.) In our approach, however, we should note that the end frequency is determined for the sources located close to the observing ground station. Evidently, this is why we did not observe, practically, the end frequencies above the He+ gyrofrequency.

To our knowledge, the growth of the IPDP end frequency with MLT at any latitude is found for the first time. This fact along with the dependence of the IPDP occurrence on MLT means that the IPDP source region statistically locates at higher (lower) latitudes at earlier (later) MLTs. Similar conclusion was achieved by Yahnin et al. (this issue) on the basis of consideration of proton aurora related to IPDP. As they showed, the ionospheric projection of the magnetospheric region where the IPDP related ion-cyclotron instability develops IPDP also located at higher (lower) latitudes at earlier (later) MLTs.

Conclusion

Present study confirms some earlier result on statistical characteristics of IPDP. In particular, the dependence of the IPDP occurrence on MLT is demonstrated. New information is also revealed. The IPDP end frequency is found to be lower (higher) at earlier (later) MLT at any latitude. We concluded that these IPDP properties are consistent with the IPDP source statistically located at higher (lower) latitudes at earlier (later) MLTs.

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