Semiannual Variation in The Number Of Energetic Electron Precipitation Events Recorded in The Polar Atmosphere

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Abstract

The analysis of the monthly numbers of Electron Precipitation Events (EPEs) recorded at Olenya station (Murmansk region) during 1970-1987, shows the semiannual variation with two maxima centered on April and September. We analyse the interplanetary plasma and geomagnetic indices data sets associated with the EPEs recorded. The possible relationship of this variation and Russel-McPherron, Equinoctial and Axial effects is discussed.

1. Introduction

Numerous Electron Precipitation Events (EPEs) were recorded in the polar atmosphere at Olenya station (Murmansk region, 68.57N and 33.03E, geomagnetic cuttoff rigidity $R_c \sim 0.6$ GV, L=5.6, invariant latitude 65 degrees) during 1957-2002. The long-term cosmic ray balloon experiment as well as the method of electron precipitation events evaluation is described in details in [1-9]. The EPEs in the atmosphere are produced by precipitation of energetic electrons with energy from few hundreds keV up to few MeV. The main characteristics of these EPEs and their occurrence rate in relation to solar activity cycle were presented in [5-9]. The goal of this short paper is to present the experimental evidence for the existence of seasonal (semiannual) variation in the EPE occurrence rate.

2. Experimental data

We choose the observations at Olenya during the period from 1970 up to 1987. During this time the ballooning was rather often (practically everyday and often two or more flights per day) and 240 electron precipitation events were recorded. We evaluated a distribution of EPEs over a year as the monthly occurrence rates of EPEs relative to the total number of EPEs recorded in the atmosphere (240). This distribution is shown in Figure 1. There are two peaks in the EPEs occurrence rate: the first is very distinct in April and the second one is rather extended covering August-October period.

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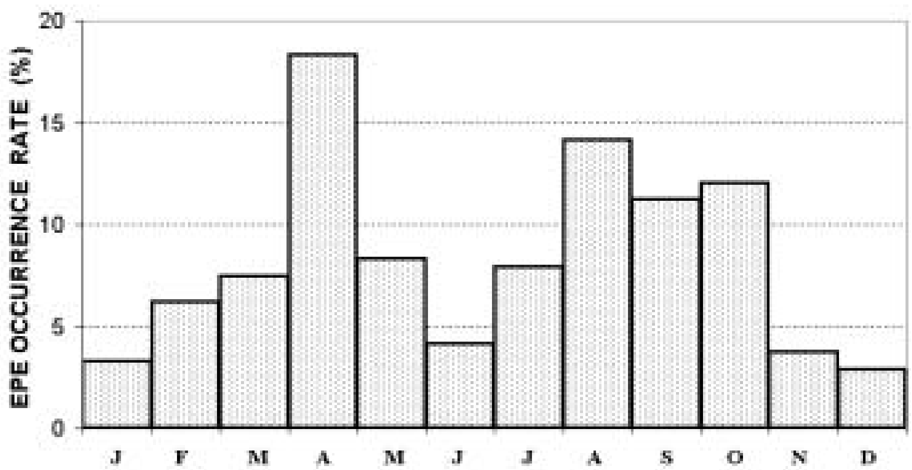

Fig. 1. The monthly occurrence rate (in % per month) of the electron precipitation events observed in the atmosphere at Olenya during 1970-1987. Total number of EPEs is 240.

The existence of semiannual (dual peaks) variation in the various manifestations of geomagnetic activity and geomagnetic indices is well-known during more than 150 years. To explain this variation, the various physical effects, including the Russel-McPherron, equinoctial, axial effects were proposed in the past [e.g. 10-12]. The changes of solar wind parameters, interplanetary magnetic field (IMF), inclination of the Earth's magnetic dipole relative to IMF are the main factors of the seasonal variation origin. In Table 1 the dates of maximum geomagnetic activity related to the menthioned above effects are listed. Also, the periods

Table 1. Dates corresponding to maximum geomagnetic activity in relation to the known effects and maximum EPE occurrence during a year.

Effect	Spring	Fall
Russel-McPherron	April, 5	October, 5
Equinoctial	March, 21	September, 23
Axial	March, 5	September, 6
EPEs in the atmosphere	April, 1-10	August, 20-31
		September, 20-30
		October, 20-31

of maximum occurrence rate of EPEs in the atmosphere are presented. We note, that the first maximum of EPE occurrence (see Fig.1) is in accordance with the period of maximum geomagnetic activity expected from the Russel-McPherron effect.

The second peak of EPEs occurrence is extended and, probably, due to superposition of the menthioned effects.

3. Discussion

The careful analysis of the origin of the seasonal effect in the EPE occurrence is out the scope of this short paper. Nevertheless, we have analyzed the geomagnetic indices (AE, Dst, SSC data) and solar wind parameters (solar wind speed V, interplanetary magnetic field B, and its B_z - component). First, we found that only 13 % of EPEs occurred at the day of Sudden Storm Commencements (SSC) registration. Then we apply superposed epoch analysis to the SSC and EPEs data bases. For that we choose the day of EPEs registration as a zero-day and examine the daily SSC occurrence rate for 11 days before and 11 days after the EPE recorded. The result of superposition of 240 events is presented in Figure 2. It is clearly seen that majority of electron precipitation was recorded $\sim$ 2 days after the geomagnetic storm commencements (SSC). It is in accordance with the model suggesting the strong electron acceleration in the magnetosphere one-two days after the SSC [13, 14]. Using this fact, for each month we have

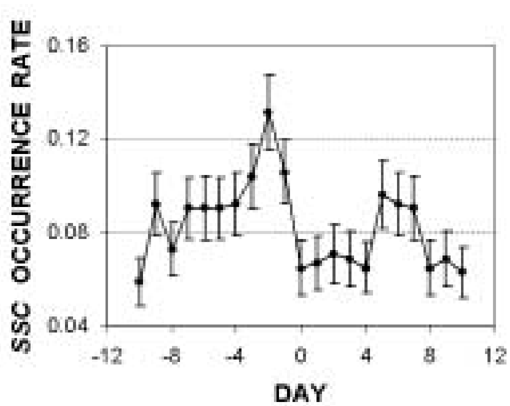

Fig. 2. The Sudden Storm Commencements (SSC) daily occurrence rate relative to the day of the electron precipitation events observations in the atmosphere. The method of superimposed epochs is used to calculate the SSC occurrence rate during 11 days before and 11 days after the EPE observation.

evaluated the mean values of the AE, Dst -indices, as well as the mean values of V, B and B_z corresponding to the day of EPE observations and 1, 2 days before the EPE. We found that there is no seasonal variation in the menthioned above parameters. But, we note that during the day of EPE observation, the level of AE and -Dst indices is 1.5-2 times higher in comparison with that for two days before the EPE.

4. Results

The analysis of the monthly numbers of Electron Precipitation Events (EPEs) recorded at Olenya station (Murmansk region) during 1970 - 1987, shows the semiannual variation with two maxima. The first is in April and the second one, is rather extended covering August-October period. We believe, that the first peak is in accordance with the expectation of Russel-McPherron effect. A second peak is complex and probably due to the superposition of axial, equinoctial and Russel-McPherron effects.

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