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Intensity of the auroral electrojets during a recovery phase of magnetic storm

R.N. Boroyev

Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy, Siberian Branch, Russian Academy of Sciences, 31 Lenina Ave, Yakutsk 677007, Russia

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Abstract

In this work, the effect of solar wind velocity on the development of magnetospheric and ionospheric disturbances is studied. It is shown that at high velocity of the solar wind during a recovery phase of magnetic storm the strong auroral activity characterized by the AE index is observed. In some cases during a recovery phase of magnetic storm the value of AE index is practically comparable with the value of AE index observed during the main phase of magnetic storm. When comparing time intervals of two magnetic storms during which the values of solar wind electric fields are approximately equal to each other, it is found that auroral electrojet intensity is stronger in that storm in which the solar wind velocity is higher.

Keywords: Solar wind velocity; Magnetic storm; IMF Bz; Electric field; Auroral electrojet; Geomagnetic index

1. Introduction

A study of reasons of the generation and peculiarities of development of magnetospheric and ionospheric disturbances (a magnetic storm, a substorm, geomagnetic pulsations, etc.) and their forecasting are the key problems of solar-terrestrial physics. It is known that the intensity of magnetospheric and ionospheric disturbances depends on the solar wind (SW) velocity and the southward component of the interplanetary magnetic field (IMF Bz). During southward IMF, there occurs a direct transmission of energy of the solar wind into the Earth's magnetosphere. The correlation analysis between parameters of the solar wind, interplanetary magnetic field and geomagnetic indices determining the intensity of magnetospheric and ionospheric disturbances, was carried out in many studies (Russell et al., 1974; Akasofu et al., 1985; Gonzalez et al., 1999; Borovsky and Funsten, 2003; Plotnikov and Barkova, 2007; Yermolaev et al., 2005, and therein). In those works, it was determined that velocity, density of the solar wind, components of the IMF had a strong impact on the development of magnetospheric and ionospheric disturbances. It was shown that the main contribution into development of disturbances made a southward IMF Bz whose efficiency was connected with the action of solar wind electric field ($E = V \times Bz$) (Burton et al., 1975; Gonzalez et al., 1994). A value of solar wind electric field is mainly determined by the value of southern IMF Bz. It is connected with the fact that during magnetospheric and ionospheric disturbances the value of southern IMF Bz, unlike the SW velocity can be increased by a factor of tens. Besides, as it was shown in some papers the correlation coefficients between the geomagnetic indices and the solar wind electric field, and the IMF Bz practically coincide. Unlike the IMF Bz, the connection between Dst and SW velocity (Vsw) is ambiguous. Thus, for the ranges of Dst indices from −50 nT up to −180 nT the Vsw does

E-mail address: boroyev@ikfia.sbras.ru

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not have an effect on Dst (Kane, 2010). For a wider interval of Dst index (from −50 nT up to −500 nT) the correlation factor between Dst and Vsw is equal to $r \approx 0.5$. Thus, it is not quite clear, what contribution into the development of magnetospheric and ionospheric disturbances is due to Vsw.

The aim of this work is to study the influence of SW velocity on the auroral electrojet intensity.

2. Experimental data and results

For the analysis, the daily average data of parameters of the solar wind and IMF (http://www.omniweb.com/) have been used. The geomagnetic activity has been estimated by the AE and Dst indices. The high-latitudinal index (AE) determines the intensity of auroral current and is an indicator of substorm activity (Davis and Sugiura, 1966). The low-latitudinal index (Dst) is used for the estimation of intensity of a ring current during magnetic storms, and is a standard of geoefficiency of the interplanetary disturbances (Sugiura, 1964; Burton et al., 1975). The values of geomagnetic activity indices (AE and Dst) have been taken from the following website http://swdcwww.kugi.kyoto-u.ac.jp/index.html. For the 1996–2013 period 10 magnetic storms have been considered. The minimum value of Dst index (Dst (min)) in the considered magnetic storms has varied from −50 nT up to −200 nT.

Fig. 1 presents the hourly variations of SW parameters (the electric field – Ey, pressure – P, velocity – Vsw) and indices of geomagnetic activity (Dst and AE) for the February 9–13, 2004 period. As is seen from Fig. 1 on February 11, 2004 near to the minimum value of Dst index (Dst(min) = −93 nT) great values of the AE index (AEmax = 994 nT)

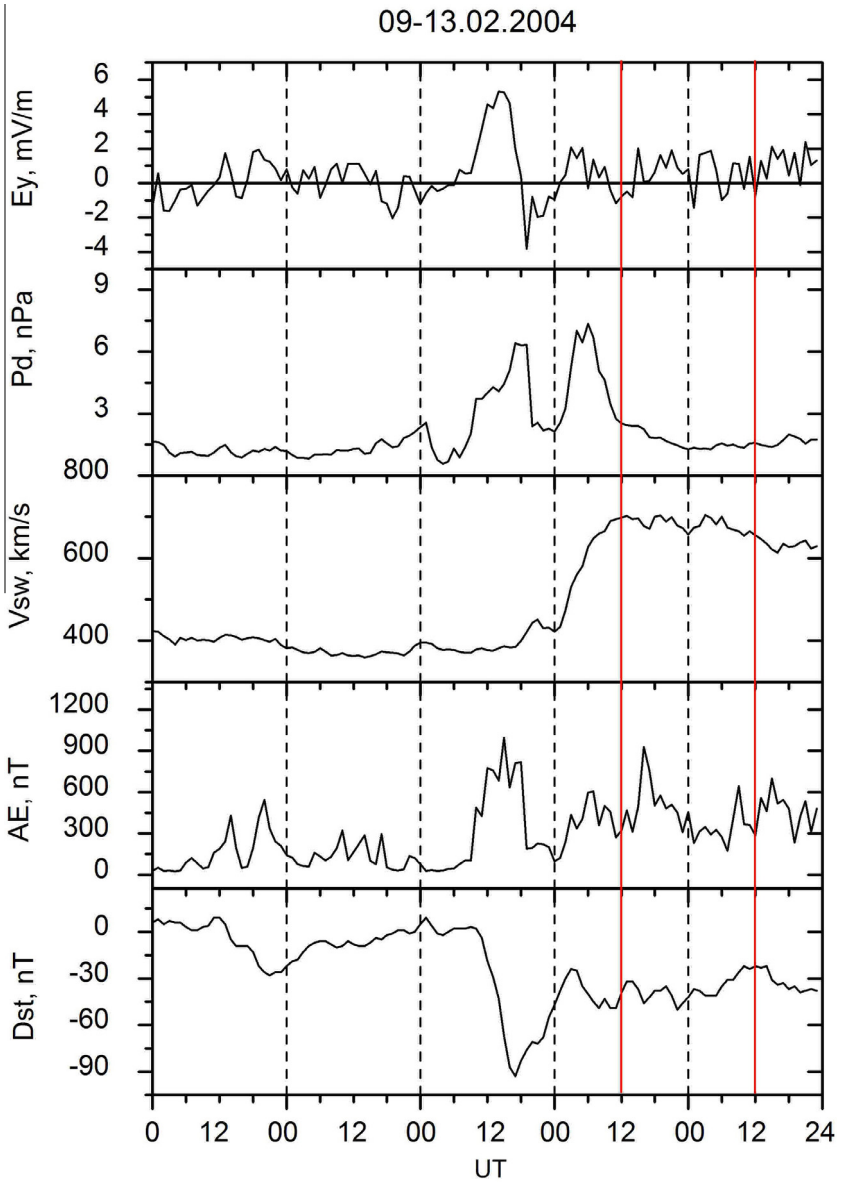

Fig. 1. Variations of SW parameters and indices of geomagnetic activity for the February 9–13, 2004 period.