FORECASTING GEOMAGNETIC ACTIVITY 3 HOURS IN ADVANCE FOR IONOSPHERIC APPLICATIONS

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Abstract

A forecasting magnetic activity three hours in advance is presented. This forecasted index is based on a suitable treatment of time-weighted accumulations of the three-hourly magnetic index Kp. The statistical analysis of impact of magnetic activity on the positive and negative disturbances of the F2 layer peak electron density NmF2 is made for 25 ionosondes in Europe and Russia during 1997 to 2000. It is shown that the response of positive and negative ionosphere disturbances to peak of magnetic activity Kpmax delays by 1 to 48h.

Introduction

Advanced models for forecasting of the ionosphere response to geomagnetic storm should take into account dependence of the ionospheric foF2 critical frequency on the past history of the magnetic activity (Fuller-Rowell et al., 2001; Muchtarov et al., 2001). We present here modification of the time-weighted accumulation of magnetic indices (Wrenn, 1987) in order to provide forecast of magnetic activity Kpm index 3h in advance to serve as predictor of ionospheric behaviour. To this end instantaneous geomagnetic indices are used only for the times *before* any given time, and the greatest weight is put on the maximum value for *n* preceding hours with ranking of kp values by decreasing order (De Franceschi et al., 2001; Gulyaeva et al., 2002). The elimination of the kp value for the current time of observation makes forecast of Kpm index 3h in advance. The series of Kpm based on kp indices for 12 preceding hours are produced for the total period of observations 1932 up-to-date. Permanent forecast of the Kpm indices is based of preliminary k-indices updated every 3 hours at Internet page of SEC, NOAA, Boulder, CO, USA.

The statistical analysis of impact of magnetic activity on the positive and negative disturbances of the F2 layer peak electron density NmF2 is made for 25 ionosondes in Europe and Russia. Since 1997, the ionospheric disturbed periods for selected ionosondes are permanently calculated by one of co-authors (TLG) for an Internet page of the Ionospheric Despatch Centre in Europe, IDCE, Warsaw. The total data set of the ionospheric disturbed periods consists of more than 10,000 events for 1997 to 2001 at 25 locations including 5000 negative DNmF2- events and 5700 positive DNmF2+ events. Relation between 3h kp (predicted Kpm indices) and DNmF2 events has been analysed in the present study. To make them comparable with hourly ionosonde observations, the 3-hour kp values were linearly interpolated to obtain its values at every hour.

First of all, the time lag (difference) between moment of observed peak of kp indices, Kpmax, during 48 hours preceding start of DNmF2, and the start-time of DNmF2 period has been calculated. The Kpmax is characteristic of intensity of magnetic storm, and the time lag is important parameter for forecasting a start of the ionospheric response to magnetic storm. It is shown that response of positive and negative ionosphere disturbances to peak of magnetic

activity Kpmax delays by 1 to 48 hours. Two peaks of occurrence of positive and negative ionospheric disturbed periods are found: (i) positive ionosphere disturbances reveal dominant values of Kpmax equal to 3 and 4 inducing positive disturbed periods; (ii) negative ionospheric disturbances are observed more frequently after Kpmax reached 4 or 5 thus more intense energy input from magnetosphere is a source of an ionospheric plasma depletion during the storm. There is certain amount of the positive disturbances (27%) and negative ionospheric disturbances (12.5%) occurred while Kpmax was less than 3 during 48 hours preceding start of the ionosphere disturbance. In such cases the ionosphere has been disturbed but the magnetic field was quiet.

However, for the strong magnetic disturbances specified as geomagnetic storm or sub-storm recent advances in modeling of the storm-time update of the ionosphere peak density based on history of the magnetic activity indices are rather promising. Proposed technique for forecasting the magnetic activity indices 3 hours in advance can be used in advanced procedures of the ionosphere forecasting.

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