**Ionospheric responses to isolated and strong geomagnetic events identified by AE-index: statistical analysis and modeling**

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The paper presents comparison of ionospheric responses to isolated and strong geomagnetic events identified by the AE-index (AE-storms) using statistical analysis and modeling. The statistical analysis includes identification of isolated and strong geomagnetic events based on the AE-index and calculation of the “reference” ionospheric response. The “reference” response is the dynamics of the average ionospheric disturbance obtained by the superimposed epoch method with key moments corresponding to the AE maximum for winter, spring, summer and autumn AE-storms. As an ionospheric characteristic, we used the regional electron content (REC), which is the average value of the total electron content (TEC) over all longitudes for the selected latitudinal zone. The ionospheric disturbance is relative (percentage) deviation of the observed values from the 27-day running average REC. To perform model calculations based on the Global Self-Consistent Model of the Thermosphere, Ionosphere and Protonosphere (GSM TIP), we used “reference” AE-storms, as control parameters, obtained by averaging the variation of the AE- and AL-indices using the superimposed epoch method with key moments corresponding to the maximum of the AE-index.

The comparative analysis of the “reference” responses to strong and isolated AE-storms revealed the following patterns. The response to strong storms is generally more negative: (a) with the exception of one case, the response to strong storms has negative phase; (b) in a number of cases, the response lacks a positive phase, which is present in the responses to isolated storms; and (c) in most cases, the amplitude of the negative response increases. As a rule, the amplitudes of positive responses (when they are present) are close for both types of AE-storms, with the exception of the high-latitude zone of the Southern Hemisphere. In some cases, the amplitudes of both positive and negative responses to strong and isolated AE-storms are close to each other.

Comparison of model calculations with observations showed that the best agreement is observed for high-latitude zones of both hemispheres, where GSM TIP demonstrates qualitative agreement with observations with some quantitative differences. For mid-latitude zones of both hemispheres and the equatorial zone, GSM TIP does not reproduce (or reproduces with a noticeable underestimation) the positive phase of the observed ionospheric response. In the case of a negative phase, GSM TIP agrees well with observations in a number of cases. In general, GSM TIP reproduces an increase in the negative phase of the ionospheric response during the transition from isolated AE storms to strong AE storms.

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