Modeling ionosphere response to Solar Proton Events in the whole atmosphere model EAGLE

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It is known that the main part of the solar proton energy is absorbed in the ionosphere D region, therefore the direct effect by Solar Proton Events (SPE) on the E and F region ionosoheric parameters is not strong. But chemical and thermodynamic processes which occur in the mesosphere and stratosphere during SPE can also generate additional perturbations in the ionosphere parameters. Such complex phenomena can be effectively investigated using self-consistent models of the atmosphere–ionosphere system. This study was performed with Entire Atmosphere global model (EAGLE). The EAGLE couples chemistry-climate Hamburg Model of the Neutral and Ionized Atmosphere (HAMMONIA) and Global Self-consistent Model Thermosphere, Ionosphere, Protonosphere (GSM TIP).
The solar proton fluxes and their ionization rates were calculated using the Atmospheric Ionization Module Osnabrück (AIMOS), which is used in the EAGLE. A set of numerical simulations for SPEs of January 2005 were performed. In the first model run only the characteristics of the proton flux were changed, and all other input parameters of the EAGLE model, including the parameters of the electron precipitations, corresponded to quiet geomagnetic conditions.
The following calculations took into account changes in electron fluxes and the geomagnetic condition during SPEs. It should be noted that the proton events on January 17 and 20, 2005 differed from each other by the parameters of the spectrum and the magnitude of the fluxes. Thus, the 17 January event was characterised by a large injection of solar particles peaking at the 10 MeV, and 20 January event had a peak at 100 MeV. The ionization rate maxima were located at an altitude of about 60 km and 40 km in the first and second cases, respectively. The results of model calculations demonstrated a weak increase in the critical frequency of the equatorial F2 layer (about 15%) after the SPE on January 17. Further analysis showed that an increase in foF2 is a consequence of an increase in the density of atomic oxygen due to a change in the thermospheric circulation. The 20 January proton event does not lead to any significant changes in the F2 region

of the ionosphere. Comparison of the model results with observational data shows a good qualitative agreement.

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