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Energetic particles and their influence on the atmosphere of the Earth: 3D model simulations and comparison with MIPAS data

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Solar high energetic particles (protons mostly), which reach polar regions of the Earth after Solar Proton Events (SPEs) initiate inonization of the atmosphere below 100 km. Such kind of forcing leads to strong enhancement of electron density (and other ions) in D-region of the ionoshere, nd also, via ion-neutral chemical reactions, to the disturbances in chemical composition (first of all, to additional NOx and HOx production). Theoretical analysis (Porter et al., 1976; Solomon et al., 1981) showed, that each pair of ions, which are created by solar protons in the atmosphere gives one molecular of NOx and two molecular of HOx. Than this additional molecular amount leads to the intensification of chemical catalitical cycles of ozone destruction.
Global 3D numerical models haven been used to investigate the influence of SPEs on chemical composition, temperature and circulation of the atmosphere. In order to calculate the ionization rates produced by solar protons satellite data (GOES) of corresponding proton fluxes in different canals of energy were used. It was shown by simulations, that ozone was strongly destroyed by SPEs in the polar stratosphere and mesosphere, and it leads to the changes in temperature and circulation. It was found also, that these changes penetrate to the lower latitudes and may has a long-term consequences. The comparison between photochemical simulation for SPE of October-November 2003 and satellite observations (MIPAS instrument on board of ENVISAT) showed rather good agreement including ozone depletion, increased NOy and HOx compounds in the mesosphere and higher stratosphere.