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Modelling of long term impacts of Solar Proton Events on the Earth's middle atmosphere

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During a Solar Proton Event (SPE) the flux of highly energetic charged particles from the sun is greatly increased. When these particles (mainly protons, αs and electrons) reach the Earth they are deflected by the terrestrial magnetic field. Due to its dipole-topography the geomagnetic field guides the solar particles into the polar regions where they can enter the atmosphere. There interactions with air molecules lead to the formation of reactive NO_x, HO_x and O_x radicals. The resulting disturbances of the middle atmosphere's chemistry are known to influence the stratospheric ozone particularly in the polar regions. In order to assess the impacts of SPEs on the Earth's atmosphere over time periods of several hundred years 2D-atmospheric chemistry and transport simulations have been performed, neglecting the influence of electrons. The proton and α fluxes applied to the model are derived from present day distributions of event sizes and frequencies combined with McCracken's data of nitrate ice-core depositions reaching back 400 years in the past. Monte-Carlo simulations of energetic proton interactions with air molecules are used to yield ion pair production rates in the atmosphere. These rates finally prescribe the production of molecule radicals in the neutral chemistry model. The simulations show for the first time the atmospheric response to a realistic series of SPEs over long time periods.