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Middle atmospheric ion chemistry during energetic particle events, and impacts on the neutral chemistry

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It is well established that solar proton events (SPEs) are sources of distinct chemical disturbances in the Earth's polar atmosphere. While the observed SPE caused production of NOx, and the subsequent destruction of ozone can be reproduces quite well by atmospheric models using basic parametrizations for NOx and HOx release as a function of the particle impact ionisation rate, there are significant differences between measurements and model predictions concerning several other chemical compounds. For instance, during the October 2003 SPE, measurements of a number of species were obtained from the MIPAS instrument on-board the ENVISAT satellite. These measurements show significant enhancements of HNO_3 and N_2O_5 as well as an increase of several chlorine species, i.e., ClO, HOCl and $ClONO_2$. Atmospheric models cannot reproduce these chemical effects if only production of NOx and HOx is considered.

The impact of positive and negative ion chemistry on the neutral composition of the middle atmosphere is investigated combining model results from the University of Bremen Ion Chemistry model UBIC with different neutral stratosphere-mesosphere models, particularly the new Bremen three-dimensional Chemistry and Transport model of the middle atmosphere. Focus of the investigation will be the impact of negative ion chemistry on the activation of chlorine radicals, and on the partitioning of NOy species.

Model results will be compared to measurement data of different satellite instruments (HALOE, MIPAS, MLS) for several large SPEs (e.g., the July 2000, Oct/Nov 2003, and January 2005 events) to show that the observed chlorine activation and the increase of HNO_3 can be reproduced much better if full negative ion chemistry is considered additionally to the NOx and HOx production.