

Effects of January 2005 SPEs on the chemistry of the polar atmosphere

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Intense ionization in the upper stratosphere/mesosphere of the polar regions, caused by two intense Solar Proton Events (SPEs) that occurred in January 2005, led to important changes in the atmospheric chemistry. Aura Microwave Limb Sounder (MLS) and ENVISAT Michelson Interferometer for Passive Atmospheric Sounder (MIPAS) recorded these variations mainly in the northern polar regions. SPE-induced HO_x (OH, HO₂) production led to mesospheric ozone depletion and changes in chlorine species (e.g., HCl, HOCl, ClO). Furthermore, evidence of SPE-induced ClONO₂ changes demonstrates that a significant interplay between NO_x and ClO_x is present also under SPE conditions.

MLS and MIPAS data are compared with the National Center for Atmospheric Research Whole Atmosphere Community Climate Model (WACCM4) results. WACCM4 generally reproduces the SPE-induced variability in the examined species, nevertheless some small discrepancies between observed data and model predictions (e.g., for stratospheric HCl) still remain.

Finally, comparing SPE-induced changes and year-to-year variability for upper stratospheric chlorine species, we show that chlorine variations attributed to intense SPEs are comparable in magnitude to the chlorine variability that is observed after sudden stratospheric warmings.

Keywords: Solar Proton Events (SPEs), atmospheric chemistry, polar regions, middle atmosphere