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# CHEMICAL AND DYNAMICAL EFFECTS OF ENERGETIC PARTICLE PRECIPITATION THROUGH FORMATION OF STRATOSPHERIC NITRIC ACID BY A HYDRATED ION CLUSTER REACTION

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We aim to improve the modelling of energetic particle precipitation effects on the chemistry and dynamics of the middle atmosphere, and in particular the formation of high-altitude nitric acid (HNO3) polar enhancements. To this end, we have introduced a chemical pathway that produces HNO3 by conversion upon background hydrated water clusters H+(H2O)n in the National Center for Atmospheric Research (NCAR) Whole-Atmosphere Community Climate Model (WACCM) chemistry-climate model. The introduced chemical pathway alters the internal partitioning of NOy during winter months in both hemispheres, and ultimately triggers statistically significant changes in the climatological distributions of constituents including: i) a cold season production of HNO3 with a corresponding loss of N2O5, and ii) a cold season decrease in NOx/NOy-ratio and an increase of O3, in polar regions. We see an improved seasonal evolution of modelled HNO3 compared to satellite observations from Microwave Limb Sounder (MLS). Through O3 changes, both temperature and dynamics are affected, allowing for complex chemical-dynamical feedbacks beyond the cold season when the introduced pathway is active. Hence, we also find a NOx polar increase in spring-to-summer in the southern hemisphere, and in spring in the northern hemisphere. The springtime NOx increase arises from anomalously strong poleward transport associated with a weaker polar vortex. The model shows an intensification of the mean meridional circulation and a statistical significant weakening of the stratospheric jet down to the lower stratosphere, and we argue that it is caused by mid-latitude zonal asymmetries in O3 and short-wave heating. That the seasonal march of the stratospheric circulation is altered strongly highlights the importance of energetic particle precipitation and of NOx chemistry for the entire middle atmosphere.