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NO_x production due to energetic particle precipitation in the MLT region - results from an ion-chemistry model

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The chemistry in the mesosphere/lower thermosphere (MLT) region is driven by forcing from solar radiation and energetic particles. The resulting ionisation, dissociation and excitation of the constituents lead to production of neutral reactive species such as NO_x (N, NO, NO_2) and HO_x (H, OH, HO_2), both directly from dissociation of neutrals and indirectly from subsequent ion-neutral reactions. As NO_x is long-lived during polar winter, it can be transported down to the stratosphere and contribute to catalytic ozone depletion.

To study the effective NO_x production rates during an ionisation event, runs with a one-dimensional state-of-the-art ion chemistry model (UBIC) are carried out and analysed. The model starts with a neutral atmosphere and uses direct ion and neutral production rates from Porter et al. (1976) and Rusch et al. (1981), adapted for the MLT region. Including raw ionisation rates from external sources such as AIMOS is possible. The ion-neutral reactions in the charged atmosphere are computed until equilibrium is reached, resulting in an effective production rate including impact of ion-neutral reactions.

The indirect NO_x production rate is found to depend on atmospheric parameters such as pressure, temperature and the abundance of NO_x, atomic oxygen and H_2O. For the MLT region, this leads to an increasing amount of NO_x per ionpair created with increasing altitude due to an increasing atomic oxygen VMR. Values of >1.8 NO_x per ionpair can be obtained.

The results are made available to a 3D Chemistry Transport Model using a database-approach and multilinear interpolation for readout. Efficiency of this approach and first results from a 3D CTM using the ion-chemistry results are discussed.