Solar particle precipitation into the Earth's atmosphere

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It has been recognized since the 1960s that precipitation of energetic particles originating from the Sun or from the terrestrial radiation belts into the Earth's atmosphere can disturb the chemical composition especially of the middle (~15 –100 km) and upper (> 100 km) atmosphere. Primary processes are collision reactions between the precipitating primary and secondary particles and the most abundant constituents, N_2 and O_2. Dissociation, dissociative ionisation and ionisation releases N, O, N^+, O^+, N_2^+ and O_2^+; subsequent neutral and ion-chemistry reactions lead to the formation of nitrogen radicals (NOx = N, NO, NO_2) and hydrogen radicals (HOx = H, OH, HO_2). Both HOx and NOx species contribute to catalytic ozone loss in the middle atmosphere; as ozone is the key component of radiative heating and cooling in this atmospheric region, atmospheric temperatures and dynamics can be affected as well.

A number of observations as well as model studies show an impact of large solar coronal mass ejections and auroral activity on the chemical composition of the middle atmosphere; in recent years, evidence has also been obtained for a response of atmospheric dynamics from the lower thermosphere down to the Earth's surface, probably due to a complex feedback between radiative heating rate changes, the mean circulation, and wave propagation and breaking (a summary of observations and model studies is given, e.g., in Sinnhuber et al., 2012).

In this presentation, the link between solar and geomagnetic activity and atmospheric composition and dynamics will be shown from the fundamental primary processes to the complex feedback mechanism between atmospheric composition changes and dynamical disturbances down to the surface.

References

[1] M. Sinnhuber, N. Wieters, H. Nieder, Energetic particle precipitation and the chemistry of the mesosphere / lower thermosphere, in: Crucial processes acting in the Mesosphere / lower Thermosphere, Surveys in Geophysics, doi: 10.1007/s10712-012-9201-3, 2012