Effect of relativistic electron precipitation on neutral atmospheric composition

E. Turunen, Th. Ulich, C.-F. Enell, A. Kero
Sodankyla Geophysical Observatory, Sodankyla, Finland

P. T. Verronen, A. Seppälä
Finnish Meteorological Institute, Earth Observation, Helsinki, Finland

Several recent theoretical investigations have contributed to quantification of local neutral chemistry variations in the mesosphere-lower thermosphere region due to high energy particle precipitation during solar proton events. Significant momentary production of odd nitrogen through dissociation, ionisation and subsequent ion-chemical processes is also confirmed experimentally. Less attention has been paid to detailed quantifications of the chemical forcing by high energy electron precipitation. Recent theoretical results from the Sodankyla Ion-Chemistry Model show how nitric oxide is produced and sustained in the high-latitude ionosphere in response to energetic auroral electron precipitation. Dramatic local increases in nitric oxide above background levels seem to persist into the dayside after auroral activity, and the persistence of nitric oxide leads to elevated electron densities long after the activity has subsided.

In this paper we estimate theoretically the effects on nitric oxide concentration during relativistic electron precipitation events. We use the Sodankyla Ion Chemistry model, which is a 1-dimensional time-dependent model of the lower ionosphere. It solves for concentrations of 36 positive ions, 27 negative ions, and 14 neutral species. The altitude range is from 30 to 120 km, with 1 km resolution. The model includes several hundred chemical reactions, photoionisation/dissociation of N2, O2, O2(1Dg), O, NO, NO2, O3, and H2O, as well as vertical transport in the form of eddy and molecular diffusion.