Upper-atmospheric NO_x production by energetic particle precipitation: A mechanism for sun-earth coupling?

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Odd nitrogen (NO_x = NO + NO_2) is produced in the polar upper atmosphere by energetic particle precipitation: aurora, relativistic electrons and solar protons. Increasing evidence from instruments such as Envisat/GOMOS, EOS-Aura/MLS and VLF receivers show that downward transport of NOx takes place in the winter polar vortex and affects the chemistry of the stratosphere, especially ozone. This is therefore a mechanism that indirectly couples solar activity to possible long-term variations in Earth's atmosphere, because of the importance of ozone for the thermal balance of the atmosphere.

In this poster a review of current observations and theoretical studies with the Sodankylä Ion-neutral Chemistry (SIC) model is given, as presented in Turunen et al. (JASTP, in press, 2009), Seppälä (2007) and Seppälä et al. (2008). Large SPEs are found to produce higher initial NOx concentrations than long-lived REP events, which themselves produce higher initial NOx levels than auroral electron precipitation. Only REP microburst events were found to be insignificant in terms of generating NOx. We show that the Envisat/GOMOS observations from the Arctic winter of 2003~2004 are consistent with NOx generation by a combination of SPE, auroral precipitation, and long-lived REP events.

References:

A. Seppälä, Observations of production and transport of NOx formed by energetic particle precipitation in the polar night atmosphere, Ph. D. thesis, Finnish Meteorological Institute, Helsinki, 2007

A. Seppälä et al: The Effects of Hard Spectra Solar Proton Events on the Middle Atmosphere, J. Geophys. Res., 2008