Solar modulation of minor compounds in the polar winter middle atmosphere

A. Damiani[1], M. Laurenza[2] , P. Diego[2], M. Storini[2]
[1]*Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan*
[2]*Institute for Space Astrophysics and Planetology, INAF, Roma, Italy*

Energetic particle precipitation (EPP) refers to highly energetic protons and electrons accelerated through different processes. They can enter the polar middle atmosphere, ionize and dissociate atmospheric constituents and produce enhancements in HOx and NOx. Since in the absence of solar radiation NOx is chemically long-lived, the NOx-related effects can persist from weeks to months depending on the solar illumination. Recent observations have shown that during winter NOx can be transported downwards inside the polar vortex by the residual circulation and influence the stratospheric O3. Although EPP-induced NOx is a consistent source of nitrogen oxides at high latitudes, it is usually not included into climate models. The EPP-NOx parameterization based on geomagnetic indices and HALOE/UARS NOx data has been shown to be a useful proxy but limitations in both the orbit and the acquisition geometry of this satellite sensor could influence the reliability of the results. Recent satellite sensors are able to measure the NOx and other NOy compounds also under nighttime conditions (e.g. MIPAS/Envisat, MLS/Aura), and they provide better estimates of the EPP-NOy production, despite their somewhat shorter time series.

On the other hand, EPP-induced variations in the VMRs of minor compounds such as H2O and CO, which are routinely adopted as atmospheric tracers, are limited. Nevertheless, they can be affected by the ultraviolet spectral irradiance variability during the solar cycle. Therefore, their VMRs are expected to present a solar cycle modulation in the mesosphere-lower thermosphere region which could be carried down to the lower altitudes.

In the present study we report observational evidences of the EPP-induced NOy variability as recorded by different satellites and their dependence on the geomagnetic activity at different time scales and altitudes. Moreover, we show that the tracers used to highlight the NOy descent present a solar modulation even in the upper atmosphere. Periods of overlaps among different datasets will be carefully examined trying to extend the resulting time series.