Geophysical Research Abstracts
Vol. 14, EGU2012-4179, 2012
EGU General Assembly 2012

Diurnal variations of reactive chlorine and nitrogen oxides observed by MIPAS-B in the Arctic in January 2010 and March 2011

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Arctic winters 2009/2010 and 2010/2011 were characterized by strong vortices with extremely cold temperatures in the lower stratosphere above northern Scandinavia. Hence, the occurrence of widespread polar stratospheric clouds enabled a strong activation of chlorine compounds (ClO_x) which rapidly destroyed ozone when sunlight returned after winter solstice.

MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) balloon measurements obtained in northern Sweden on 24 January 2010 and 31 March 2011 inside the polar vortices have provided the first time diurnal variations of chlorine species over the whole altitude range in which chlorine is undergoing activation and deactivation. The first flight was carried out in very cold chlorine-activated air with widespread polar stratospheric clouds. The second one was performed at the end of the winter during the last phase of ClO_x deactivation. Around sunrise, several fast sequences of spectra (in time steps of about 10 min.) were measured to allow the retrieval of chlorine- and nitrogen-containing species which change quickly their concentration around the terminator between night and day. For this purpose the line of sight of the instrument was aligned perpendicular to the azimuth direction of the sun to allow for a symmetric illumination of the sounded air mass before and beyond the tangent point. Mixing ratios of species like ClO, NO_2, and N_2O_5 show significant changes under twilight conditions. Observations are compared and discussed with calculations performed with the 3-dimensional Chemistry Climate Model EMAC (ECHAM5/MESSy Atmospheric Chemistry).