Geophysical Research Abstracts
Vol. 20, EGU2018-11018, 2018
EGU General Assembly 2018

Temporal evolution of chlorine and related species observed with Aura/MLS, Envisat/MIPAS, and ground-based FTIR at Syowa Station, Antarctica during late winter and spring in 2007 and 2011

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We analyzed temporal variation of ClO, $ClONO_2$, HCl, HNO_3, and O_3 measured by satellite sensors Aura/MLS, Envisat/MIPAS, and ground-based Fourier-Transform infrared spectrometer (FTIR) installed at Syowa Station, Antarctica (69.0S, 39.6E) from March to December, 2007 and September to November, 2011. Vertical profiles of O_3, HNO_3, and HCl and vertical column of $ClONO_2$ were retrieved from solar spectra taken with a ground-based FTIR. We analyzed temporal variation of these species at 18 and 22 km over Syowa Station. In early July, polar stratospheric clouds (PSCs) started to be formed over Syowa Station. With the return of sunlight at Syowa Station in early July, $ClONO_2$ and HCl showed depleted values while ClO showed enhanced values. At two altitudes (18 and 22 km), when ClO concentrations started to decline in early September, HCl started to increase rapidly, while the increase in $ClONO_2$ was gradual. The Cly partitioning between HCl, $ClONO_2$, and ClO showed difference at different altitudes. At the altitudes of 18 km, where ozone was almost depleted, ClO and HNO_3 amounts are low, so conversion to HCl was favored rather than $ClONO_2$. Whereas, at 22 km, sufficient ozone still remained, at an amount that $ClONO_2$ formation from ClO and NO_y species continued to occur at this altitude. In early winter, HCl depletion continued even when the counterpart of the heterogeneous reaction ($ClONO_2$) disappeared. Possible cause of this depletion could be attributed by the mixing of voltex edge air where NO_x is formed by photochemical reaction, and resulting $ClONO_2$ production, and gradual heterogeneous reaction with HCl.