

Analysis of Arctic stratospheric minor gases related to ozone depletion by coupled use of JEM/SMILES and ACE-FTS

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The Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) is a sensor equipped in the Japanese Experiment Module "KIBO" on board the International Space Station (ISS), which has unprecedented high sensitivity with superconducting technology. SMILES had observed atmospheric minor constituents which included ClO which was not able to be observed by high sensitivity until now in the stratosphere and mesosphere from October 12, 2009 to April 21, 2010 with more than ten times the precision of other existing sensors. The Atmospheric Chemistry Experiment - Fourier Transform Spectrometer (ACE-FTS), which is on board SCISAT-1, has been observing atmospheric minor constituents in the upper troposphere and stratosphere from March 11, 2004 by solar occultation technique. We have analyzed SMILES Level 2 (L2) research products and ACE-FTS to discuss the relationship between temperature and stratospheric minor gases related to ozone depletion and time variation of Cl Partitioning in the Arctic winter of 2009/2010.

Analysis of the SMILES L2r ClO profile and the ACE-FTS HCl, NO_y, ClONO₂ and N₂O profiles from 50 to 65N showed that differences in ClO, HCl and ClONO₂ concentrations between inner polar vortex and outer polar vortex was the largest from 18 to 28 km in January and February 2010. We calculated ice frost point (T_{ice}) at each measurement location. In the region where a temperature was lower than the calculated T_{ice} plus 15 K, concentrations of HCl, ClONO₂ and NO_y dramatically decreased; decrease in the concentrations was the largest at equivalent latitudes higher than 70. It is suggested that the decrease in HCl, ClONO₂ and NO_y was caused by PSC formation and heterogeneous reaction on the surface. We analyzed correlations between N₂O and other minor constituents. A compact correlation between them was seen in November 2009. On the other hand, the correlation in January and February had a different characteristic. This suggests that changes in concentrations of these minor constituents was caused by chemical factors, not by dynamical factors. We analyzed a time-series of Cl Partitioning by using ClO and HOCl observed by SMILES and HCl and ClONO₂ observed by ACE-FTS in inner polar vortex in 2009/2010. The concentrations did not change in November 2009. In the beginning of January 2010, the concentrations of HCl and ClONO₂ decreased. In the middle of January, the concentration of ClO dramatically increased. In the end of January, the concentration of ClO dramatically decreased and the concentrations of HCl and ClONO₂ increased. In February and March, the concentration of ClONO₂ was higher than that in November 2009. In the presentation, we show more detailed analysis of Cl Partitioning in 2009/2010 observed by SMILES and ACE-FTS.

Keywords: stratospheric minor gases, ozone depletion, remote sensing