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Middle atmospheric sciences using data from the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)

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The Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) aboard the Japanese Experiment Module (JEM) of the International Space Station (ISS) made atmospheric measurements of minor species in the stratosphere and mesosphere for about six months from October 2009 to April 2010. High-sensitivity measurements of SMILES had been performed by a receiver using superconductor-insulator-superconductor (SIS) mixers, cooled to 4.5 K by a compact mechanical cryocooler. Mission objectives are: i) Space demonstration of 4-K mechanical cooler and super-conductive mixer for the submillimeter limb-emission sounding in the frequency bands of 624.32- 627.32 GHz and 649.12- 650.32 GHz, and ii) global measurements with its high sensitivity for atmospheric minor constituents in the middle atmosphere (O3, HCl, ClO, HO2, HOCl, BrO, O3 isotopes, HNO3, CH3CN, etc), contributing to the atmospheric sciences. Thus global and vertical distributions of about ten atmospheric minor constituents related to the ozone chemistry are derived. See Kikuchi et al. (2010) in more detail about the SMILES mission.

In this talk, we will introduce an overview of the SMILES measurements and show some observational results in association with middle atmospheric chemistry and dynamics. To support the SMILES observational results, we also used outputs from nudged chemistry-climate models (MIROC3.2-CTM and SD-WACCM) in a complementary way. One of the most unique characteristics of the SMILES measurements is that the data from SMILES can be used to capture the diurnal variation of atmospheric minor constituents such as O3, ClO, HO2 and BrO, since the ISS took the non-sun-synchronous orbit. In particular we will give some detailed view on the global pattern of diurnal ozone variations throughout the stratosphere as reported by Sakazaki et al. (2013). These results demonstrate that the SMILES high sensitivity measurements are expected to provide further insights into atmospheric chemistry and dynamics.

References

Kikuchi, K., et al. (2010), Overview and early results of the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES), J. Geophys. Res., 115, D23306, doi:10.1029/2010JD014379.

Sakazaki, T., et al. (2013), Diurnal ozone variations in the stratosphere revealed in observations from the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) onboard the International Space Station (ISS), J. Geophys. Res., in press.

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