

Middle atmospheric chemistry and dynamics: results from the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)

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The Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) was developed to be aboard the Japanese Experiment Module (JEM) on the International Space Station. SMILES was successfully launched by the H-IIB rocket with the H-II Transfer Vehicle on September 11, 2009, was attached to JEM on September 25, and started atmospheric observations on October 12. Unfortunately, SMILES observations have been suspended since April 21, 2010 due to the failure of a critical component in the submillimeter local oscillator. However, high-sensitivity measurements of minor species had been performed by a receiver using superconductor-insulator-superconductor (SIS) mixers, cooled to 4.5 K by a compact mechanical cryocooler. Thus global and vertical distributions of about ten atmospheric minor constituents related to the ozone chemistry are derived. The mission objectives are as follows: i) To demonstrate a 4-K mechanical cooler and superconducting mixers in the environment of outer space for submillimeter limb-emission sounding and ii) To measure atmospheric minor constituents in the middle atmosphere globally in order to gain a better understanding of factors and processes controlling the stratospheric ozone amounts and those related to climate change. Since the ISS has a circular orbit with an inclination angle of 51.6 degrees, no observations in the polar latitude are available. To measure northern high-latitude regions the antenna beam is tilted 45 degrees left from the direction of orbital motion, enabling SMILES to observe latitudes from 38°S to 65°N. Another important aspect of the SMILES observation is that SMILES can measure the atmosphere at different local times because of the non-sun-synchronous ISS orbit. Measurements of diurnal variation of the atmospheric minor species are expected to provide further insights into the atmospheric science. The SMILES measurements have been processed to provide unique observational results in association with middle atmospheric chemistry and dynamics, thus these results demonstrate SMILES abilities to observe the atmospheric minor constituents in the middle atmosphere.

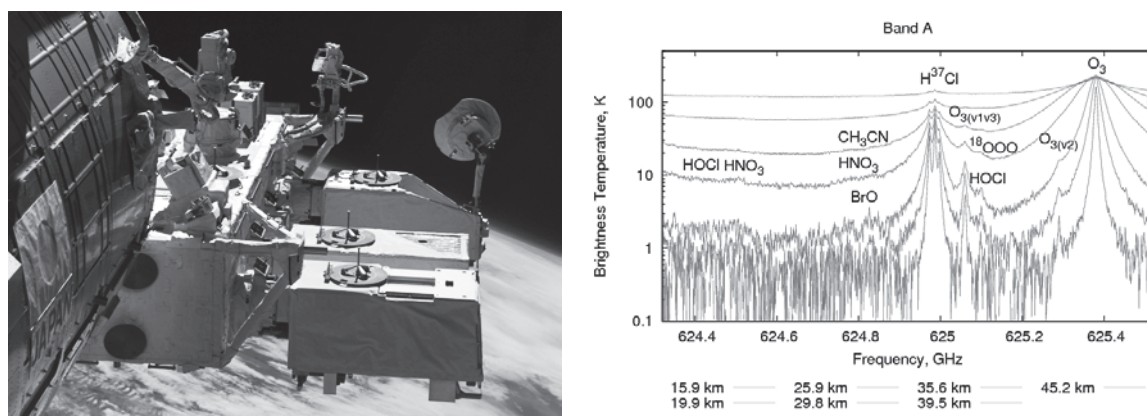


Figure 1. (left) The SMILES instrument (second from the front) attached to the Japanese Exposed Facility on the International Space Station. (right) Observed spectra at several altitudes for Band A measured at 03:22:14 UT on October 12, 2009 at 23.30°N and 173.83°E.

References

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