

Current Status of Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)

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<http://smiles.tksk.jaxa.jp/> (website in JAXA)

1. Introduction

The Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) was designed to be aboard the Japanese Experiment Module (JEM) on the International Space Station (ISS) as a collaboration project of Japan Aerospace Exploration Agency (JAXA) and National Institute of Information and Communications Technology (NICT). Mission Objectives are: i) Space demonstration of super-conductive mixer and 4-K mechanical cooler 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 observations of atmospheric minor constituents in the stratosphere (O_3 , HCl, ClO, HO_2 , HOCl, BrO, O_3 isotopes, HNO_3 , CH_3CN , etc), contributing to the atmospheric sciences.



2. SMILES Instrument

Figure 1 shows a block-diagram of SMILES payload. SMILES is equipped with a heterodyne superconductor-insulator-superconductor (SIS) receiver to be operated at 4.3 K in the 625/650 GHz band as a limb-emission sounding radiometer. SMILES has a mechanically scanning elliptical offset-Cassegrain antenna with diameters of 40 cm x 20 cm to achieve an altitude resolution of about 3 km at the tangential altitude ranging from the upper troposphere (10 km) to the lower mesosphere (60 km) from the orbit of the ISS (altitude of 280–400 km).

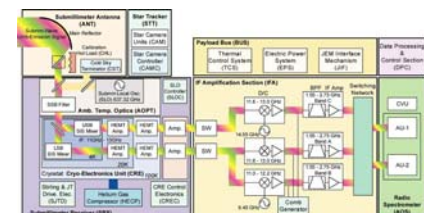


Figure 1 Block diagram of JEM/SMILES payload

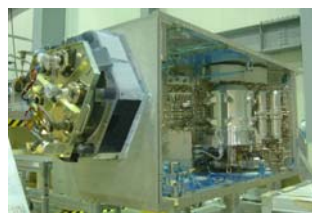


Figure 2 SMILES from the backside

Figure 2 shows a view of the SMILES payload from the backside. The envelope of the SMILES payload mainframe structure has a dimension of 1.85 m x 1 m x 0.8 m. The total mass of the payload is less than 500 kg. The electrical power consumption of the payload is less than 900 W for normal operation.

3. SMILES observation

The ISS has a 51.6° inclined orbit with 93 minutes period. In order to measure high-latitude regions, the antenna beam is tilted 45° left from the direction of orbital motion, enabling SMILES to observe latitudes from 38°S to 65°N. Figure 3 shows an example of one day SMILES global coverage with O_3 amounts at 28 km on October 12

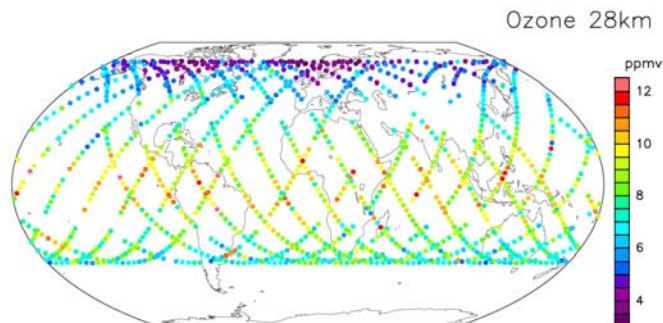


Figure 3 One day global O_3 distribution observed by SMILES on October 12

4. Scientific targets of SMILES

Not only in the polar latitudes, but also in the mid- and lower latitudes, ozone depletion is critical whole the globe. Recovery of the ozone hole over the Antarctica is estimated around 2060–2070, but there is very big uncertainty in association with the Cl and Br chemistries (WMO, 2006). Since the SMILES mission is distinguished as that focusing on the detailed halogen chemistry related to ozone destruction, we will mostly aim at the following scientific targets.

- ▶ Bromine budget
- ▶ Inorganic chlorine chemistry

5. Initial results of the SMILES L1B data

Figure 4 shows example of the Level 1B data. Tsys is less than 400 K and frequency calibration is less than 100 kHz. As many as around 1400 profiles per day have been observed but about 100 profiles are interfered by the ISS solar paddle.

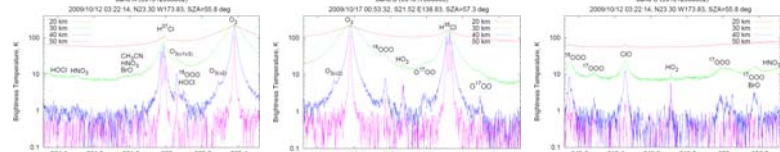


Figure 4 SMILES L1B data (calibrated)

6. Initial results of the SMILES L2 data

Figures 5 and 6 show retrieval results derived by the latest version of the Level 2 (L2) data processing system at ISAS/JAXA. A priori profiles of O_3 , HCl, HNO_3 , ClO and HO_2 , BrO are based on AURA/MLS observations and CCSR/NIES, respectively.

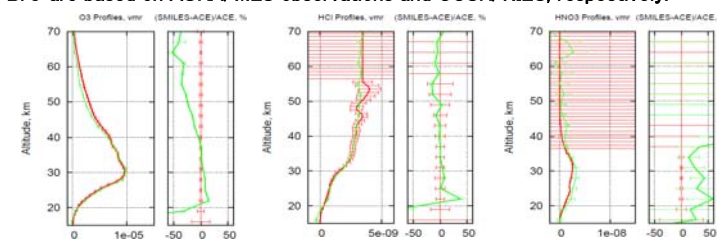


Figure 5 Vertical profiles and differenced for SMILES (green) and ACE/FTS v2.2 (red)

The vertical profiles in Figure 5 are comparisons of matched profiles (within 5° latitude, longitude, and on the same day) from SMILES and ACE/FTS v2.2 to determine average biases and related statistics between these two data sets (more detail in Mitsuda et al. A21C-0171 poster).

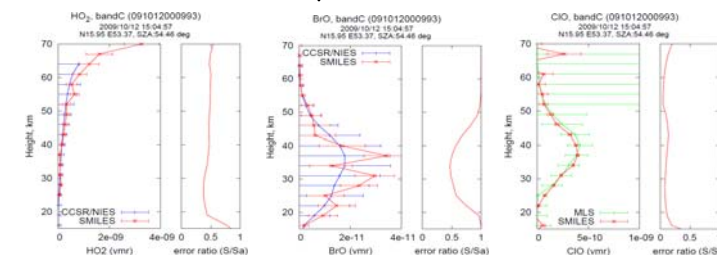


Figure 6 Vertical profiles of the SMILES standard products and the error ratios

Figure 7 shows latitude-height sections of the zonal mean O_3 distribution on October 12 from SMILES (left) and MLS (right). General features are well captured, and two peaks in the subtropics are replicated in both of the observations, which may be related to the meridional circulation in the equatorial latitudes of the stratosphere.

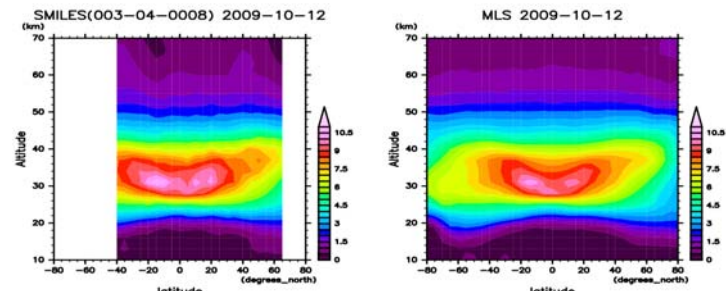


Figure 7 Contour plot of zonally averaged SMILES and MLS v2.2 O_3 profiles

The SMILES L2 products will be ready quite soon for validation studies.

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REFERENCE

- 1) JEM/SMILES missionplan, Version2.1.
Available: http://smiles.tksk.jaxa.jp/document/SMILES_MP_ver2.1.1.pdf
- 2) Takahashi C., Ochiai S. and Suzuki M., 2010, JQSRT, 111, 160–173