



Submillimeter-wave limb sounder, SMILES-2, for observation of the stratosphere, mesosphere, and lower thermosphere

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1 Extended Abstract

Spaceborne submillimeter-wave limb sounder is a unique instrument that has capability to observe wind and temperature in very wide range of atmospheric layer, that is the stratosphere, mesosphere, and lower thermosphere, with a single measurement technique. The vertically seamless observation of atmosphere is desirable for studying coupling between the upper and lower atmospheres. The mesosphere and lower thermosphere are the most interesting atmospheric region in terms of vertical energy connection. This region gets large energy from solar radiation and energetic particles from space, while the region is affected by gravity waves and tides from the lower atmosphere.

We are proposing a new satellite mission of submillimeter-wave limb sounder, which has very low noise superconducting receivers. Our proposing mission will provide good precision and vertical resolution in measurements of the stratospheric, mesospheric, and lower thermospheric temperature and wind. The specification of temperature measurement will be a precision of 1 K with a vertical resolution of 2 km. The precision of wind measurement will be 2 m/s with 2 km vertical resolution in an altitude range between 40 and 90 km, and 10 m/s with 10 km resolution between 90 and 150 km [1]. Moreover, the mission will measure a variety of chemical species, including O-atom, OH, O₂, H₂O, CO, NO, O₃, N₂O, and many halogenated compounds such as ClO and BrO [2].

The mission instrument will consist of 1-m class aperture antenna, superconducting submillimeter-wave receivers, microwave spectrometers, and ancillary instruments. The frequency bands of submillimeter-wave receivers are selected by simulation studies to cover the important absorption lines in a frequency range of 485 GHz and 2.06 THz. The estimated measurement noise by the simulation study shows that superconducting receiver, which has roughly one order lower noise than semiconductor receiver, is the only instrument that can satisfy the above mentioned specification of wind measurement, which are required for studying the atmospheric vertical variations. The cooling system for superconducting devices of the receivers uses a heritage of the successful submillimeter-wave limb sounding mission, JEM/SMILES, which was deployed on the international space station from 2009 to 2010. To observe horizontal direction of wind, the mission will have two antennas seeing two directions, ahead and behind aslant, and observe the atmosphere twice from different directions.

The mission, named SMILES-2, will be designed to be accommodated to the JAXA small-size satellite, whose weight can be around 700 kg. The satellite orbit is currently assumed to be a height of 550 km and an inclination of 66°. The conceptual design of the mission is now studied by SMILES-2 working group. If the proposal is selected by JAXA/ISAS, the mission may be launched in 2023 or later.

References

- [1] P. Baron, *et al.*, “Measurement of stratospheric and mesospheric winds with a submillimeter wave limb sounder: results from JEM/SMILES and simulation study for SMILES-2,” *Proc. SPIE*, **9639**, October 2015, pp. 96390N-96390N-20, doi: 10.1117/12.2194741.
- [2] M. Suzuki, *et al.*, “Sensitivity study of SMILES-2 for chemical species,” *Proc. SPIE*, **9639**, October 2015, pp. 96390M-96390M-15, doi: 10.1117/12.2194832.