GPS radio occultation measurement for SMILES-2

*Makoto Suzuki[1], Philippe Baron[2], Satoshi Ochiai[2], Naohiro Manago[3], Josaphat Tetuko Sri Sumantyo[3], JANN-YENQ Liu[4], Akinori Saito[5], Huixin Liu[6], Masato Shiotani[7]

1. Institute for Space and Astronautical Sciences, Japan Aerospace Exploration Agency, 2. National Institute of Information and Communications Technology, 3. Center for Environmental Remote Sensing, Chiba University, 4. Center for Astronautical Space and Engineering, National Central University , 5. Kyoto University, 6. Dept. of Earth and Planetary Science Faculty of Science Kyushu University, 7. RISH, Kyoto University

SMILES-2 (Shiotani et al IGARSS 2019, Ochiai et al IGARSS 2019) is a proposal submitted to JAXA/ISAS small satellite program (Feb. 2020), which is now under selection to go to Pre-Phase A1b and, if selected, it launch will be latter half of 2020s. SMILES-2 will have 3 instruments; (1) submm and THz limb sounder, (2) GPS Radio Occultation (RO) for temperature and density, and (3) Langmuir probe for in situ Electron density and temperature. This paper discuss the combined measurement of submm-THz and GPS RO.

Two submm bands are (i) 619.1-627.1, 649.05-657.05 GHz double side bands (DSB) with 638.075 GHz Local oscillator (LO), and (ii) 750.0-756.0, 771.0-777.0 GHz DSB with 763.5 GHz LO, both with 1.0 MHz sampling interval. The 638 GHz band is a band width extended one from ISS/JEM/SMILES frequency coverage, and the 763.5 GHz band is designated to measure O2 and H2O well suited for temperature and wind speed retrieval. Terahertz (THz) band is aiming to measure O-atom (O-atom density, temperature, and wind speed), and OH. Suzuki et al have shown sensitivity for chemical species (Suzuki et al IGARSS 2019), and Baron et al have shown sensitivity for temperature and wind speed (Baron et al, AMT 2020).

GPS RO is established measurement technique of temperature-density-altitude profile (0-40 km) and electron density profile (upper atmosphere; 90 km - Satellite altitude). If SMILES-2 spacecraft has two RO antenna forward and backward, we can expect 5-6 times/day coincidence (i.e. <100 km in azimuth direction at tangent points) of submm-THz and GPS-RO measurements. The THz observation of SMILES-2 (2.0 THz for O-atom) can provide dataset of temperature, O-atom density, wind speed of neutral atmosphere (<150 km), so we can investigate the interaction from electron density at the coincident condition.

GPS RO meteorological dataset (0-40 km) is also crucial for improving spectroscopic parameters (gamma-air and n-air), since those spectroscopic parameter will have 5%-20% uncertainty without careful laboratory measurements . It will affect to all retrieval of chemical species with same magnitude (5%-20%). So, we propose to make spectroscopic studies based upon SMILES-2 dataset (submm-THz L1B data with GPS RO temperature profile). The GPS RO dataset is the only dataset which has comparable temperature precision of SMILES-2, and the accuracy (systematic difference from true value) is much better than the SMILES-2 dataset.
GPS RO instrument can be developed easily based upon JAXA GPSR system standard for most JAXA earth orbiting satellites, and it was a plan in the 2018 SMILES-2 proposal. We have chosen the one from Taiwan Central University because of its strong scientific ad engineering heritage from COSMIC-1/2 programs.

Keywords: submm, limb souding, GPS radio occultation, electron density profile, temperature profile

