Satellite Observation of the Whole Atmosphere - Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES-2)

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The Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) was developed for deployment in the Japanese Experiment Module (JEM) on the International Space Station (ISS). SMILES conducted atmospheric observations for approximately six months, from October 2009 to April 2010, to measure concentrations of minor species in the stratosphere and mesosphere. Outstanding results have been achieved such as an identification of diurnal cycle of the stratospheric ozone, which had not been examined yet because of poor data quality in the previous satellite measurements. In addition, by comparing SMILES data with existing observation data and results from the chemistry climate models, it has been recognized that we need a reference data for temperature, wind, and minor species with high precision to constrain the models. After the launch there has been discussions about the possibility to derive wind information from the Doppler shift of observed lines, and the necessity to have temperature information from adequate line selection. Thus, we now recognize the potential of high-sensitivity observations about temperature and wind fields up to 150 km to cover the uncharted territory, the mesosphere and the lower thermosphere (MLT).

Based on the SMILES heritage, we propose a satellite mission to observe temperature and wind fields, and distributions of atmospheric minor species for the full diurnal cycle from the middle atmosphere (stratosphere and mesosphere) to the upper atmosphere (thermosphere and ionosphere) for a period of five years. SMILES-2 observations will enable us to obtain global information with unprecedented accuracy on the whole atmosphere including upper mesosphere and lower thermosphere where observation data have been lacking.

This mission has three specific science objectives.
(MO.1) To investigate the effects of lower atmosphere on the MLT via upward propagating atmospheric waves such as atmospheric tides
(MO.2) To understand atmospheric variations due to energy inputs from the magnetosphere (particle precipitation and magnetic storm)
(MO.3) To understand the solar-terrestrial system by providing benchmarks for whole atmosphere models

Using observation data from the middle atmosphere to the upper atmosphere as a whole, we will be able to grasp the 4-D dynamical structure of diurnal variations (atmospheric tides) which are one of the most essential variabilities in the earth's atmosphere. For understanding climate change in view of chemical processes affecting the ozone layer, we will be able to utilize high-sensibility measurements of the atmospheric minor species in a quantitative manner. In the upper atmosphere, a transition layer between the atmosphere and the outer space, we will be able to clarify a role of energy inputs from the magnetosphere from the temperature and wind observations. The observation data will provide unprecedented benchmark data to comprehensive whole-atmosphere simulation models whose development is necessary for accurate seasonal weather forecasts, future climate projections, and space weather forecasts.

Keywords: middle atmosphere, upper atmosphere, satellite observations, temperature, wind

