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) launched by an H-IIB rocket with the H-II Transfer Vehicle (HTV) in September 2009 and attached to the Japanese Experiment Module (JEM) on the International Space Station (ISS) demonstrated high-sensitivity submillimeter limb-emission sounding of atmospheric observations. Though the observation period is limited to about 6 months (October 12, 2009- April 21, 2010) owing to the failure of a critical component, 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.

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 four science objectives:
(MO.1) To investigate the 4-D space-time structure of the diurnal variations (atmospheric tides) in view of dynamics, chemistry, and electromagnetic processes
(MO.2) To unveil the vertical propagation of synoptic-to-planetary scale disturbances from the middle atmosphere (non-migrating tides and stratospheric sudden warming events) to the upper atmosphere
(MO.3) To understand atmospheric variations due to energy inputs from the magnetosphere (particle precipitation and magnetic storm)
(MO.4) To provide benchmarks for whole atmosphere models and climate models with detailed description of the background thermal structure and distribution of minor species

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-sensitivity 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. These outcomes including the atmospheric trace gas data will greatly contribute to improvement in reliability of chemistry climate models for future projection and accuracy of prediction models for space weather.

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

