

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

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It is widely recognized that the vertical coupling processes of the Earth's atmosphere are significant, and the atmosphere should not be investigated only in the limited altitude range, such as the troposphere, the stratosphere, the mesosphere, the thermosphere and the ionosphere, but be treated as a whole. This "whole atmosphere" concept helps to understand the physical processes of atmospheric phenomena in which the vertical coupling is essential. The SMILES-2 mission, a candidate mission of the ISAS small-scale satellite series, will elucidate the Earth's whole atmosphere above the tropopause by the observation of the wind, the temperature and the trace gases from 10km to 150km altitude using the superconducting submillimeter-wave limb-emission sounder (SMILES). The goal of the SMILES-2 mission is to obtain a complete understanding of the dynamics, chemistry and energy balance of the atmosphere that contribute to the coupling between different atmospheric layers above the tropopause. Its four scientific objectives are as follows: (1: "Diurnal variation of the whole atmosphere") To investigate the 4-D space-time structure of the diurnal variations (atmospheric tides) in view of dynamics, chemistry, and electromagnetic processes, (2: "Upward coupling") 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, (3: "Downward coupling") To understand atmospheric variations due to energy inputs from the magnetosphere (particle precipitation and magnetic storm), (4: "Models & Applications") To provide benchmarks for whole atmosphere models and climate models with detailed description of the background thermal structure and distribution of minor species. The SMILES instrument uses the heritage technology of the SMILES on the international space station (ISS) from 2009 to 2010. It demonstrated a 4 K mechanical cooler for high-sensitivity submillimeter limb-emission sounding of atmospheric observations. Following the success of the SMILES on ISS, the SMILES-2 satellite mission was proposed to observe temperature and wind fields, and distributions of atmospheric trace gases from the middle atmosphere to the upper atmosphere for five years from 2024 with two sub-payload instruments.

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