Title	<Recent research activities>A proposal for satellite observation of the whole atmosphere - superconducting submillimeter-wave limb-emission sounder (SMILES-2)
Author(s)	Shiotani, Masato
Citation	Sustainable humanosphere : bulletin of Research Institute for Sustainable Humanosphere Kyoto University (2019), 15: 10-10
Issue Date	2019-09-30
URL	http://hdl.handle.net/2433/245074
Right	
Type	Departmental Bulletin Paper
Textversion	publisher

RECENT RESEARCH ACTIVITIES

A proposal for satellite observation of the whole atmosphere – superconducting submillimeter-wave limb-emission sounder (SMILES-2)

(Laboratory of Atmospheric Environmental Information Analysis, RISH, Kyoto University)

Masato Shiotani

Background

In the middle atmosphere the ozone layer shielding harmful ultraviolet radiation enables life on Earth. In the upper atmosphere high energy radiation with shorter wavelength such as X-ray and extreme ultraviolet is absorbed to produce plasma particles. It is recognized that the middle and upper atmosphere is susceptible to anthropogenic perturbations, such as the release of chlorofluorocarbons resulting in ozone destruction and the increase in greenhouse gases bringing about cooling there. The middle and upper atmosphere is also known to be sensitive to variability in solar activities such as explosions on Sun's surface (e.g. flare), 27-day solar rotation, and the 11-year solar cycle.

The region around the mesopause, including the upper mesosphere and the lower thermosphere (MLT), is an important transition layer where atmospheric characteristics change in terms of both physics and chemistry. The thermal and dynamical structure in the middle atmosphere, mostly determined by a radiative balance with time scale longer than a day, is characterized by the background states varying with a seasonal time scale and the disturbances with periodicities over 24 hours. In contrast, in the upper atmosphere temperature variations show a distinctive diurnal cycle mostly driven by changing solar radiation due to the earth's rotation. The diurnal variations in the upper atmosphere are highly affected by atmospheric waves propagating from the middle atmosphere and by electromagnetic energy inputs from the magnetosphere. However, the lacking of global observations in the MLT region seriously hinders us from investigating the underlying coupling processes between the lower and upper atmosphere.

Mission objectives

On the basis of the heritage of the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) on the International Space Station, we propose a satellite mission "SMILES-2" to observe temperature and wind fields, and distributions of atmospheric trace gases for the full diurnal cycle from the middle atmosphere to the upper atmosphere. SMILES-2 observations will enable us to obtain global information with unprecedented accuracy on the whole atmosphere including the MLT where observation data have been lacking. We set the following four science objectives for the SMILES-2 mission: (1) To investigate the 4-D space-time structure of the diurnal variations (atmospheric tides) in view of dynamics, chemistry, and electromagnetic processes; (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; (3) To understand atmospheric variations due to energy inputs from the magnetosphere (particle precipitation and magnetic storm); (4) To provide benchmarks for whole atmosphere models and climate models with detailed description of the background thermal structure and distribution of minor species.

From those views we will be able to grasp the upward and downward coupling processes in the 4-D dynamical structure of diurnal variations which are one of the most essential characteristics in the earth's atmosphere. These outcomes including the atmospheric trace gas data will greatly contribute to improve the reliability of chemistry climate models for future projection and the accuracy of prediction models for space weather.

Acknowledgements