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Impact of the MELOS sub-millimeter sounder on Martian atmospheric science: Preparative experiments using a Martian GCM

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The MELOS Sub-millimeter (SMM) Sounder will bring new insights to the Martian atmospheric science through various observations which have never been achieved from the spacecrafts on the Martian orbit. First is the direct observation of wind velocity by measuring the Doppler shift of molecular lines. Up to now, no direct observations for the vertical distribution of wind velocity on Mars have been made, though there are a lot of observations for the vertical distribution of temperature. Recent ground-based microwave observations showed that the easterly wind velocity in the middle and upper atmosphere (above ~40 km height) is much faster than that we can expect from the thermal wind approximations. By mapping the detailed horizontal and vertical distributions of wind velocities, the SMM Sounder is expected to solve such a mystery in the middle atmosphere dynamics on Mars.
Second is the detailed observation of the horizontal, vertical and temporal variations of the water vapor distribution. In the previous Martian orbiter missions, only the horizontal distributions of water vapor column densities had been available for a long time. In 2009 SPICAM onboard Mars Express first observed the vertical distributions of water vapor from the Martian orbit by using the infrared occultation, but the local time coverage of the observation is limited. More global observations of the vertical distributions of water vapor are very significant, because the seasonal change of hygropause (cut-off height of water vapor) is an important key to investigate the meridional transport of water on Mars. The SMM Sounder is highly expected to detect the detailed vertical and seasonal changes of water vapor distributions.
The SMM Sounder will also observe the isotopic fractionation including HDO/H_2O (hereafter D/H ratio), and minor radical species such as O_3, $H_2O_2$and HO_2. The D/H ratio is an important key to investigate the age of water on Mars, the long-term change of climate, and the escape of atmosphere from the planet. The near-infrared ground-based observations have shown that the D/H ratio of water column on the dayside of Mars has a very large horizontal variability, from 2 to 8 times with respect to SMOW (standard mean terrestrial ocean value). But there is no data of the D/H ratio on the nightside, neither is its vertical change observed. Such information will be fully obtained by the SMM Sounder. The minor radical species are considered as catalysts to keep the CO_2abundance on Martian atmosphere, and thus their abundance should be measured.
All these planned observations above are expected to make more robust scientific significances in collaboration with the studies and data assimilations using a Martian General Circulation Model (MGCM). We are developing a DRAMATIC MGCM which examines the atmospheric Dynamics, RAdiation, MAterial Transport and their InteraCtions on Mars, based on a terrestrial GCM developed in CCSR/NIES/FRCGC. In this presentation we show the scientific performance of the SMM Sounder by simulating the observations from the MELOS orbit and the preparative studies using the DRAMATIC MGCM.

Keywords: Martian atmosphere, sub-millimeter sounder, general circulation model, remote sensing, water cycle, MELOS