

Current status and future prospects of the observations and modeling of Martian atmosphere

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CO₂ ice clouds and seasonal ice cap deposits in polar night

The seasonal CO₂ polar cap is formed from ice particles that have fallen from the atmosphere as well as those condensed directly on the surface. The possible occurrence of CO₂ snowfall in the winter polar regions have been observed, and previous simulation studies have indicated that the longitudinal irregularities of CO₂ ice clouds in the northern polar region seemed to be linked to local weather phenomena. Transient planetary waves are the prominent dynamical feature during northern winters in the martian atmosphere, and this study focuses on revealing the mechanism of how the dynamical influence of transient planetary waves affects the occurrences of CO₂ ice clouds, snowfalls and formations of seasonal CO₂ polar cap in high latitudes during northern winters.

The DRAMATIC (Dynamics, RAdiation, MAterial Transport and their mutual InterACtions) MGCM, which is used for this study, is based on a Japanese terrestrial model (CCSR/NIES/FRCGC MIROC) with a spectral solver for the three-dimensional primitive equations. A simple scheme representing the formation and transport of CO₂ ice clouds has been implemented into the MGCM. The simulation results showed that the CO₂ ice clouds are formed at altitudes of up to ~40 km in the northern polar region (northward of 70° N) during winter, which is consistent with the observations by the Mars Climate Sounder onboard Mars Reconnaissance Orbiter.

In addition, we found that the occurrence of the CO₂ ice clouds correlated to a large degree with the cold phases of transient planetary waves. Ice particles formed up to ~20 km can reach the surface in the form of snowfall in certain longitude regions (in 30° W–60° E), while in others these particles likely sublime in the lower warmer atmospheric layers.

Given the regular nature of such atmospheric waves on Mars, the results of this study suggest that the snowstorms may be predicted several weeks in advance. For missions to Mars aiming to explore these regions with rovers, such weather forecasts would offer the possibility of choosing a route that avoids heavy snow storms.

Other recent interesting topics

Topics of dust, water ice and circulations, such as rocket dust storms and katabatic jumps, revealed from recent observations and simulations are summarized.

Future prospects

Meteorological features of smaller scale (mesoscale) are becoming more and more important. We need more observations especially targeting the boundary layers, and simulation studies of the smaller scale features.