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CO2 Snowfalls Affected by the Baroclinic Waves in the Winter Polar Atmosphere of Mars

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Using a Mars general circulation model (MGCM), we have simulated the formation of CO_2 ice clouds in the winter polar atmosphere of Mars, and showed that the occurrences of ice clouds and deposition rates on the surface are closely linked to traveling planetary waves. Given the regular and periodic nature of such waves, this study may suggest a basis for reliable forecasts of CO_2 snow storms.

The seasonal CO_2 polar cap appears to be formed from ice particles that have fallen from the atmosphere as well as those condensed directly on the surface. The possible occurrence of CO_2 snowfall in the winter polar regions have been observed, and preceding simulation studies have indicated that the longitudinal irregularities of CO_2 ice clouds in the northern polar region seemed to be linked to local weather phenomena. Especially transient planetary waves are the prominent feature during northern winters in martian atmosphere, and this study put an emphasis on revealing the mechanism how the dynamical influence of transient planetary waves affect the occurrence of CO_2 ice clouds, snowfalls and formations of seasonal CO_2 polar cap in high latitudes during northern winters.

We have implemented a simple scheme representing the formation and transport of CO_2 ice clouds into our MGCM, and investigated snowfall in high latitudes during northern winters. Our simulation showed that clouds were formed at altitudes of up to ˜40 km in the north of 70 N, and their occurrence correlated to a large degree with the cold phases of transient planetary waves. Most ice particles formed above 10 km did not reach the surface in the form of snowfall, and it was likely that these particles sublimate in the lower warmer atmospheric layers. Deposition rates on the surface was shown to strongly depend on the transient planetary waves below ˜10 km, as 90% of the seasonal ice cap was created by CO_2 snow while the remaining 10% were attributed to direct condensation on the surface.

Keywords: Mars, atmospheric dynamics, general circulation model, CO2 ice clouds, polar ice cap