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3D Modeling of the Martian Water Cycle with MAOAM-GCM

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Abstract

The study of seasonal migration of atmospheric water on Mars has played a significant role in the planning of recent space missions. The upcoming Herschel observations are expected to bring a major contribution to the study of the Martian atmosphere and its climate evolution, by monitoring changes in water abundance and distribution. The Martian water cycle has been successfully modeled in several general circulation models (MGCMs), but there still exist considerable discrepancies between the simulations and observations[1]. Less is known about the distribution of water vapor during dust storms since its measurements are difficult when the amount of airborne aerosol is high.

In this work, we investigate water cycle simulations with a recent version of our MGCM. The earlier version of dynamical general circulation model has been described in detail by Hartogh, et al[2], and Medvedev and Hartogh[3]. The current model is based on a new spectral solver for the three-dimensional primitive equations of the hydrodynamics in hyprid coordinates[4], and incorporates a self-consistent water cycle. The model employs a number of parameterizations for the microphysical processes[5], taken into account advective and diffusive transport of two dynamical tracers of water vapor and ice, and all relevant processes such as condensation, cloud formation, sedimentation, sublimation, and surface deposition. The water vapor-ice distribution relies on a saturation condition that controls the transfer of molecules between solid and gas states. Water vapor is continuously generated by sublimation and removed by condensation. The vapor transport is affected by eddy diffusion in the boundary layer and by molecular diffusion in the thermosphere. The total prescribed dust amount [6] varies with season and latitude and allows for the representation of dust storms which are known to erupt near the perihelion. We investigate the response of the model during major dust storms and show how high dust contents of the atmosphere affects the water vapor amount and ice accumulations.

The present simulations are focused on the validation of the scheme and study of the factors which control the water abundance in the martian atmosphere.

References

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