GCM simulations of the present and past water environment on Mars

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Though the current Mars is a dry planet, the ancient Mars is thought to have been a water-rich planet like the present Earth. There are many topographic evidences of past liquid water flow, which should be hints for the past climate on Mars. Most of the liquid water is thought to have escaped into space, but even on the present Mars, some water environments have been found as the permanent north polar cap, underground ice, and possibly salty liquid water.

On the present Mars, water vapor exists in the atmosphere with the mixing ratio of up to hundreds of ppmv from surface up to ~100 km altitude, and water ice clouds also exist in low-latitudes around aphelion (northern summer) with the infrared opacity of up to ~0.2 and winter polar regions. The north polar ice sheet is thought to be the main source of atmospheric water, as well as possibly the underground water. Also the detection and mapping of HDO/H2O ratio in the atmospheric water could be hints for the history and movement of water. Our Mars global climate model (MGCM), DRAMATIC, has simulated such water environment consistently with the available observations, and the detailed investigations are ongoing with high-resolution (horizontal resolution of ~67 km) simulations.

Moreover, we have simulated the paleoclimate on Mars using a MGCM for paleoclimate (PMGCM), with a dense CO2 atmosphere with the surface pressure of up to a few bars. Radiative effects of water vapor may contribute the warming, and the existence of liquid ocean and lakes contributes the supply of water in the atmosphere. Our PMGCM simulation with ocean/lakes estimated the distributions of fluvial and sediment discharges from the precipitation and snow accumulations, and showed the agreements with the observed valley networks with several exceptions.

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