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Water ice clouds on Mars: a study of partial cloudiness with a global climate model and MARCI data

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There is a large reservoir of water ice on Mars in the polar caps, that sublimates in summer and releases water vapor. Water is then advected in the atmospheric circulation that evolves seasonally. This vapor forms clouds, frost, and can also be adsorbed in the soil. In a global study of the water cycle, water ice clouds play a key part in the martian climate. There is a need to understand better their distribution and radiative effect.
The tool used in this study is the global climate model (GCM) of the Laboratoire de Météorologie Dynamique. It is made up of a core that computes fluid dynamics, and a physical part that gathers a number of parametrised processes. It includes tracers and the condensation and sublimation of water in the atmosphere and on the ground, allowing a study of the complete water cycle.
To improve the representation of water ice clouds in the model, a new parametrisation of partial cloudiness has been implemented and will be presented. Indeed, model cells are hundreds of kilometers wide, and it is quite unrealistic to suppose that cloud coverage is always uniform in them. Furthermore, the model was quite unstable since the implementation of the radiative effect of clouds, and partial cloudiness had the effect of reducing this instability.
In practice, a subgrid temperature distribution is supposed, and the temperature computed in the model is interpreted as its mean. The subgrid scale temperature distribution is simple, and its width is a free parameter. Using this distribution, the fraction of the grid cells under the water vapor condensation temperature is interpreted as the fraction of the cell in which clouds form (or cloud fraction). From these fractions at each height a total partial cloudiness (the clouds as seen from the orbit) is deduced. The radiative transfer is computed twice, for the clear area and for the cloudy one.
Observing the water cycle with this new parametrisation, some differences are seen with standard runs. These changes mainly affect the aphelion cloud belt and the polar hoods. Partial cloudiness is compared to higher resolution (one per one degree) runs in which cloudiness diagnostics are done. MARCI data of cloud opacity is also used to verify the predicted water ice cloud distribution and patchiness. The aim is to understand the causes of patchiness and to validate the choice of a subgrid scale temperature distribution. There are seasonal variations, recurring patterns near major topographical features.