

Mars water ice and carbon dioxide seasonal polar caps : GCM modeling and comparison with Mars Express Omega observations. F. Forget^{1,3}, B. Levrard², F. Montmessin³, B. Schmitt⁴, S. Doute⁴, Y. Langevin⁵, J. P. Bibring⁵. ¹LMD, IPSL (Universite Paris 6, BP99, 75252 Paris Cedex 05 France; forget@lmd.jussieu.fr), ²Laboratoire des Sciences de la Terre, UCBL1/ENS Lyon, France, ³NASA Ames Research Center, USA, ⁴Laboratoire de Planétologie de Grenoble, Grenoble, France, ⁵IAS, Orsay, France.

Introduction: To better understand the behavior of the Mars CO₂ ice seasonal polar caps, and in particular interpret the the Mars Express Omega observations of the recession of the northern seasonal cap, we present some simulations of the Martian Climate/CO₂ cycle/water cycle as modeled by the Laboratoire de Météorologie Dynamique (LMD) global climate model.

The model: the climate model is based on the LMD General Circulation model (Forget et al. JGR, 1999). It includes a complete water cycle parametrisation that take into account sublimation, condensation, cloud formation and transport of water vapor and water ice (Montmessin et al., JGR, 2005) and that have been validated through comparisons with the MGS TES dataset. The CO₂ cycle is also represented (Forget et al. Icarus, 1998) with some representation of the CO₂ ice clouds. A recent improvement is the habilty to take into account the CO₂ gas depletion in the polar night (and enrichment over the subliming cap). For this purpose, an exact mathematical representation of the gaz motion in GCM "sigma" coordinates has been written, and a parameterisation of the vertical mixing due to non-condensable gaz buoyancy has been included.

At the LPSC conference, we also plan to present results from a version of the model that includes a detailed representation of the stratification of the 3 components seasonal deposits (CO₂ ice, water ice, dust) in order to better represent the composition of the first millimeters that are sensed by Omega and other instruments in orbit. Below we present preliminary results obtained with the baseline version of our model.

Preliminary results: The Omega observations provides an unprecedent view of the water ice components of the seasonal polar caps (Schmitt et al., this issue). Although most of the mass of the caps is CO₂ ice, these observations indicate that water ice tends to recondense on CO₂ ice in spring and be left behind, forming a water ice bright cap surrounding the main CO₂ ice cap. Figures 1-4 show some GCM prediction of this water ice frost layer. More detailed comparison with the Omega observations will be presented at the conference.

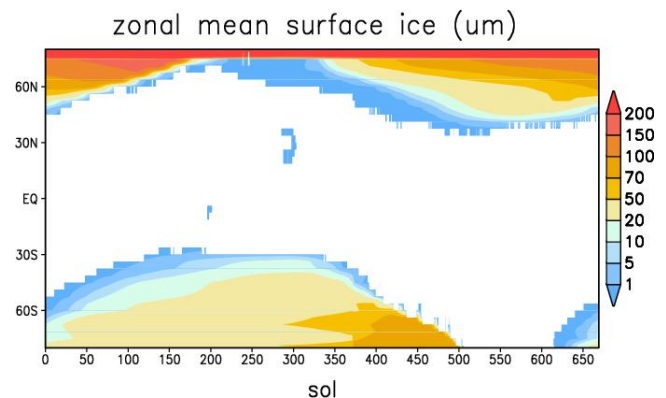


Figure 1 : Zonal mean surface ice layer thickness (micrometers) as predicted by the GCM as a function of time (sol since Ls=0°; Sol 192 and sol 515 are N. summer and winter solstice, respectively). In most location, the ice is covered or mixed with much larger amount of CO₂ ice, but water ice can appear at the edge of the CO₂ cap or when the cap is receding (see below)

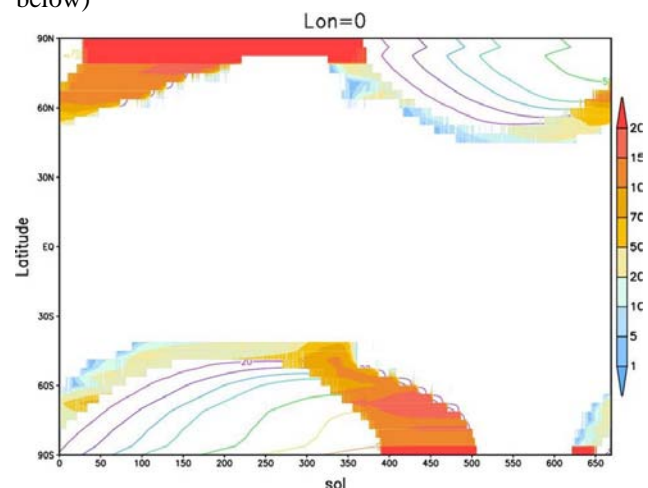


Figure 2: A model based representation of the apparent surface water ice at the surface at longitude 0°E. The contours represent the CO₂ ice thickness (kg/m²). Color shaded is the surface water frost thickness (micrometers), but only shown where no CO₂ ice is present or if CO₂ ice is subliming (possibly leaving a water ice rich apparent surface layer). This is where Omega is expected to detect it

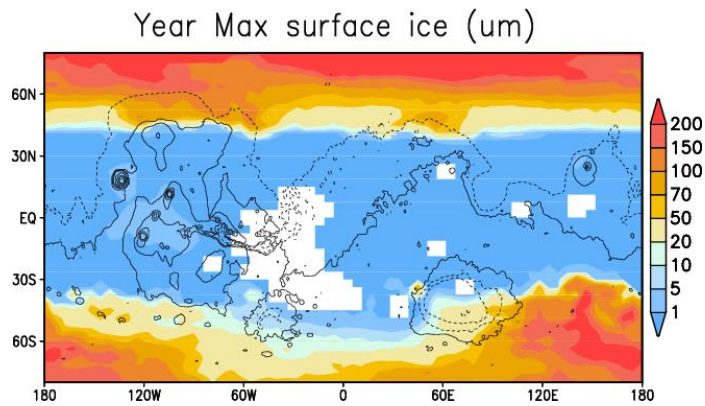


Figure 3: Maximum surface ice thickness (micrometers) predicted by the GCM

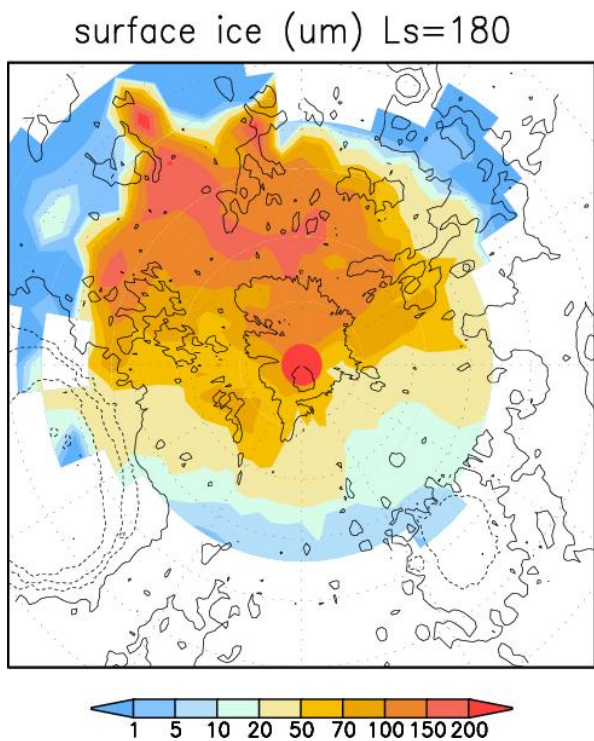


Figure 4. A polar projection of the water ice surface layer (in micrometers) predicted at Ls=180 (fall equinox). The black contour illustrate the underlying topography. Because of the asymmetric transport into the polar regions due atmospheric stationary waves triggered by the topography, the water frost cap is highly asymmetric, with mostly ice in the “cryptic region”. Could water ice affect the seasonal cap microphysics and explain the location of the cryptic region? The link between water ice and microphysics remains unclear to us. Nevertheless It will be very interesting to see if such an asymmetry is detected by Omega when the southern spring cap will be observed.