SIMULATIONS OF THE MARTIAN SEASONAL DUST CYCLE WITH A GENERAL GIRCULATION MODEL.

F. Forget, F. Hourdin, C. Hourdin and O. Talagrand. (Laboratoire de Météorologie Dynamique, Université Paris 6, BP 99, 75252 Paris cedex 05, France. E-mail : forget@lmd.jussieu.fr)

Introduction: To improve our understanding of the atmospheric dust cycle, key to the Mars climate, we have developed an interactive dust transport model within our 3D General Circulation Model (GCM) of the Martian atmosphere [1]. This dust cycle model accounts for the lifting of the dust by near surface winds and dust devils, the vertical mixing in the turbulent boundary layer and by atmospheric convection, the advection by the general circulation, gravitational sedimentation and even a possible ``scavenging" by CO2 clouds in the polar regions. The transported dust is radiatively active. Multiple particle sizes are simultaneously taken into account.

Such a complete model helps us to better understand the numerous aspect of the dust cycle which remains poorly understood and provides a powerful tool to interpret the observations.

Dust lifting: A key issue is the lifting of the dust by the atmosphere, a process which remains poorly understood. For instance, we do not know what generate the southern summer planetary scale dust storms which characterizes the seasonal cycle and the interannual variability of the Martian climate. Do they results from large scale wind processes like for the major desert dust storms on Earth, or from intense dust devils activity ? This last process has been parameterized in the model based on the theoretical work of Renno et al [2] which was used to determine a dust devil activity from the depth of the convective boundary layer and the surface-atmosphere heat flux. The modeled activity appears to be in very good agreement with the available observations of the dust devils diurnal behavior and geographical location. In addition, the simulated dust devils exhibit a strong seasonal cycle with a maximum amount of dust lifted during southern spring and summer around perihelion, when the actual atmosphere is indeed known to be more dust laden than during the other half of the year.

Lifting may also be due to the general circulation which is directly predicted by the model. The GCM winds can be used to simulate dust lifting based on the available theories developped for Earth and Mars on the basis of theoretical considerations and wind tunnel simulations [3]. Extreme surface winds able to lift dust are predicted when the general circulation combines with slope effects. Although the behavior of these winds is found to be very model dependent, careful modeling clearly indicates that large scale winds are more efficient to lift dust during southern spring and summer, especially when the atmosphere is dust laden.

Overall, these studies suggest that dust devils may provide a continuous source of background dust, with a maximum activity around southern summer solstice, and that at these seasons the enhanced background dust may be able to trigger the general circulation enough to generate large-scale dust storms as observed on Mars during this period of the year. This global scenario can be modeled with the GCM-dust cycle model. Results from several annual simulations, and the comparison of the resulting dust cycle with the available observations will be presented.

Dust distribution and transport: Within this context, the model has also been used to study the spatial distribution of the dust and the variation of its size distribution. Before MGS, not much observations were available to validate such a simulations. Nevertheless, it has been possible to very well reproduce the latitudinal and seasonal variations of the altitude of the top of the dust layer as observed by limb imaging aboard Mariner 9 and Viking, and the vertical variations of the dust particle size deduced from Phobos 2 observations.

References:

[1] Forget et al. (1999) *JGR-planet*, in press, [2] Renno et al. (1998), *JAS 55*, 3244-3252 [3] Marticorena B. and Bergametti G. (1995), *JGR 100*,16415-16430.