3D GCM-IONOSPHERE MODEL TO DESCRIBE THE MARTIAN IONOSPHERIC DYNAMICS

J-Y. Chaufray, F. Forget, *Laboratoire de Météorologie Dynamique, CNRS, France (jyclmd@lmd.fr)*, **F. Gonzales-Galindo, M.A. Lopez-Valderde,** *Instituto de astrofisica de Andalucia, CSIS, Granada, SPAIN*, **F. Leblanc**, *LATMOS, CNRS, Université Saint-Quentin en Yvelines, Université Pierre et Marie Curie.*, **P-L. Blelly**, CESR, Toulouse, France, **O. Witasse**, ESA-ESTEC, Noordwijk, Netherlands.

Introduction:

Recent observations and simulations showed the importance of the upper atmosphere/ionosphere in the escape processes at Mars (Lundin et al. 2008). The solar wind interacts with the Martian ionosphere leading to an ionospheric outflow into the Martian induced magnetosphere. One of the goals of the Heliosares project is to simulate this ionospheric outflow, by coupling a GCM-Ionospheric model, an exospheric model and a Mars-Solar wind interaction model for different solar conditions. In this presentation, we will present the 3D dynamical ionospheric core implemented in the Martian GCM model developed at LMD (Forget et al. 1999, Gonzales-Galindo et al. 2009). This core solves the ions and electrons dynamics equations (5 moments) including the interaction with the neutral atmosphere. The grid for discretization of the plasma dynamics is similar to the neutral grid with a shifted grid between scalars and wind velocity / electric field components (Fig.1).

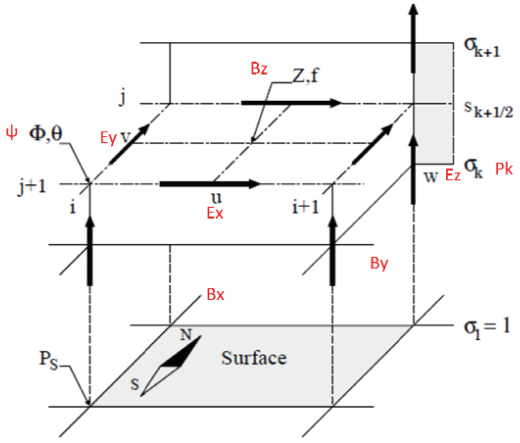

Fig. 1: Spatial grids for ions and neutral variables in the GCM-Ionosphere code.

The continuity equation is solved using a finite volume sheme based on a Van-Leer method (Hourdin and Armengaud 1998) while the dynamics and the energy equations are solved using finite difference scheme. To fulfill the CFL condition, the time step of ion dynamics (~ 50 ms) is reduced compared to neutral time step. As shown from first preliminary tests, the neutral collisions are dominant at pressure level ~ 10^{-6} Pa and control the ion velocity and temperature while at pressure levels ~ 10^{-8} Pa, the diffusion becomes important (Fig. 2). Mathematical and numerical models, as well as first validation tests and results without magnetic field will be presented.

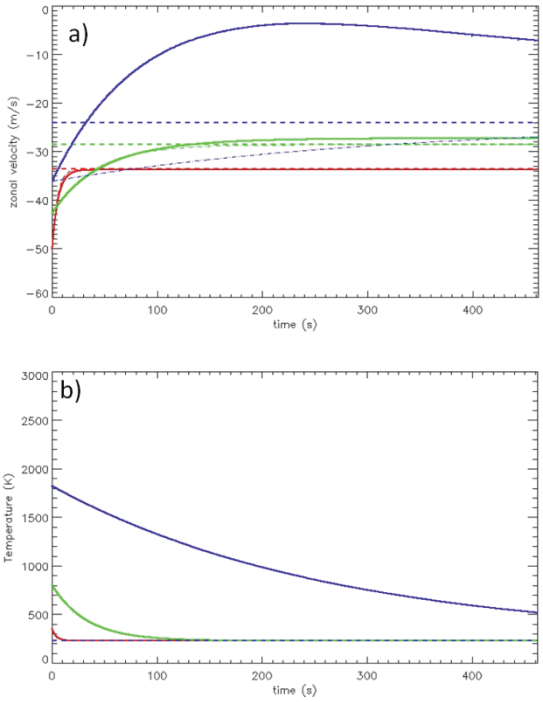

Fig. 2: Evolution of the ionospheric plasma zonal velocity (2a) and temperature (2b) during 1 neutral time step at three different atmospheric pressure levels (P ~ 10^{-6} Pa in red, 10^{-7} Pa in green and 10^{-8} Pa in blue) at a given latitude/longitude position. Solid line represents the plasma parameters while dashed line represents the neutral parameters. The dot-dashed line on Fig. 2a corresponds to exponential variations neglecting all forces except the neutral collisions in the movement equation. For temperature evolution, the neutral collisions term is the only diabatic term included in this first test.

References:

F. Forget et al. 1999, JGR, 104, 24,155-24,175
F. Gonzales-Galindo et al., 2009, JGR, 114, E04001
F. Hourdin and A. Armengaud, 1998, MWR, 127,822
R. Lundin et al., 2008, GRL, 135, L18203