MODELLING THE MARTIAN ATMOSPHERE USING THE GEM-MARS GCM.

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Introduction:

The GEM-Mars model is a three-dimensional global climate model (GCM) for the Martian atmosphere. The dynamical core is based on the GEM (Global Environmental Multiscale) operational weather forecast model for Canada (Côté et al., 1998). The model was originally adapted to include on-line tropospheric chemistry for air quality studies (Kaminski, Neary et al., 2008). It was then modified for Mars (Moudden and McConnell, 2005 and 2007) and further developed to include a water cycle with a 14-layer regolith slab and bulk ice clouds (Akingunola, 2008).

Calculations include absorption and scattering of radiation by seasonally and latitudinally varying dust in the atmosphere. Carbon dioxide condensation and sublimation are also included. The current chemical scheme is comprised of 12 species, 15 photolysis reactions and 31 chemical reactions (García-Muñoz et al., 2005) as opposed to the chemical scheme of Moudden and McConnell (2007).

The GEM-Mars Model:

The dynamical core of GEM-Mars uses a semi-implicit semi-lagrangian advection scheme on a Arakawa C grid. In the vertical, there are 102 hybrid vertical levels which are terrain-following at the surface and gradually transform to pressure levels with the top at ~140 km. The horizontal resolution used for this study is 4°x4° and the timestep used for both the dynamics and chemistry is 1849 seconds.

The radiation scheme includes absorption and scattering by seasonally and latitudinally varying dust in the atmosphere (MGS-TES standard scenario) as well as non-LTE effects above ~80 km (López-Valverde and López-Puertas, 1994).

The gas-phase chemical scheme includes O_3, O_2, $O(^1D)$, O, CO, H, H_2, OH, HO_2, H_2O, H_2O_2, and O_2 $(a^1\Delta g)$. Several passive tracers are also in place. Input variables consist of MGS-TES derived surface albedo and thermal inertia and MGS-MOLA topography. Meteorological and chemical fields are initialized from previous runs with several years of spin-up. The chemical fields are transported through advection, eddy diffusion and molecular diffusion.

Model Results:

Model results are compared to selected observational datasets for meteorology and chemistry. GEM-Mars is also used to investigate the possible emission rates and lifetime of methane in the Martian atmosphere, which is observed by Formisano et al., 2004, Krasnopolsky et al., 2004 and Mumma et al., 2009.

Comparison with MGS-TES shows that GEM-Mars is able to reproduce the main features of the Martian atmosphere. Model results show that the general circulation, water cycle and ozone columns behave as expected.

Figure 1 is a comparison of zonal mean temperatures at $L_s=0$. The pattern and magnitude show a reasonable agreement. Other seasons (not shown here) also compare well.

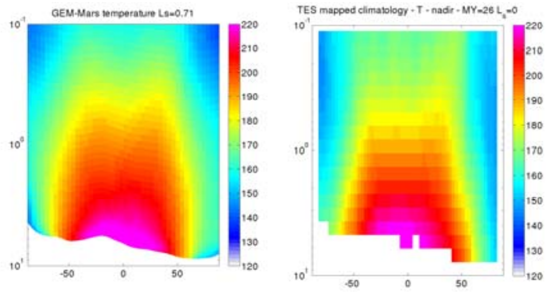

Figure 1 Left: GEM-Mars temperature at L_s=0.71, Right: MGS-TES temperature at L_s=0 (data courtesy of M. Smith).

The zonal mean wind fields from GEM-Mars are given in Figure 2. Again, the main features and magnitudes are reproduced and compare well with those published in Smith et al., 2001, for example.

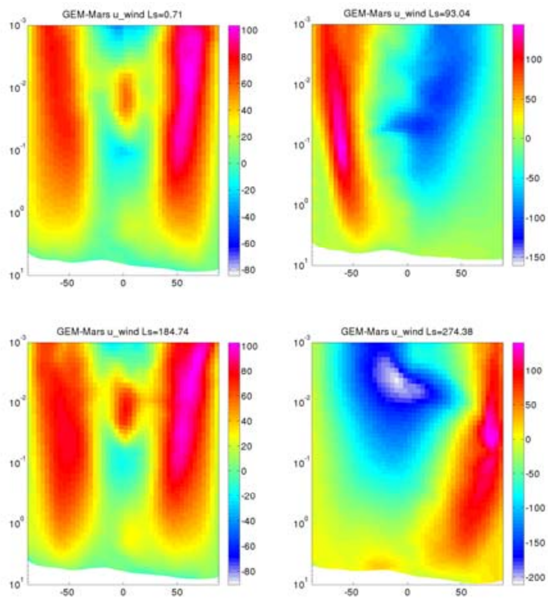

Figure 2 Zonal wind fields from GEM-Mars. Top

left: L_s=0.71, Top right: L_s=93.04, Bottom left: L_s=184.74, Bottom right: L_s=274.38.

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