Mars Climate Database version 5

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Abstract

The Mars Climate Database (MCD) is a database of meteorological fields derived from General Circulation Model (GCM) numerical simulations [2,4] of the Martian atmosphere and validated using available observational data. The MCD includes complementary post-processing schemes such as high spatial resolution interpolation of environmental data and means of reconstructing the variability thereof.

The GCM is developed at LMD (Laboratoire de Météorologie Dynamique, Paris, France) in collaboration with several teams in Europe: LATMOS (Laboratoire Atmosphères, Milieux, Observations Spatiales, Paris, France), the Open University (UK), the Oxford University (UK) and the Instituto de Astrofisica de Andalucia (Spain) with support from the European Space Agency (ESA) and the Centre National d'Etudes Spatiales (CNES).

The MCD is freely distributed and intended to be useful and used in the framework of engineering applications as well as in the context of scientific studies which require accurate knowledge of the state of the Martian atmosphere.

The Mars Climate Database (MCD) has over the years been distributed to more than 150 teams around the world. With the many improvements implemented in the GCM over the last few years, a new series of reference simulations have been run and compiled in a new version (version 5) of the Mars Climate Database, released in the first half of 2012.

1. Recent improvements in the LMD GCM

For more than twenty years, our teams have joined forces to develop the most realistic GCM to accurately model the martian atmosphere and climate. It has now matured to the point of being a “Mars System Model” capable of simulating the CO2 cycle, the dust cycle, the water cycle, the release and transport of radon, water isotopes cycle, the martian thermosphere and ionosphere, etc.

Ongoing efforts have been made to improve our GCM and key recent improvements over the last few years include:

- Updated schemes for the upper atmosphere: an improved computation of thermal cooling rates, a better treatment of radiative transfer in the 15-um bands, an enhanced solar heating rate model and an improved molecular diffusion scheme have been implemented [3].
- Use of improved dust radiative properties derived by [10].
- Improved representation of dust vertical distribution and particle size [5].
- Taking the radiative effect of water ice clouds into effect [6] and including the scavenging of dust particles due to the sedimentation of ice particles within clouds [9].
- Implementation of a new parametrization of near surface convection, based on a mass flux parametrization of vertical transport [1]. This strongly improves the near surface daytime thermal structure, allows to better simulate the transport and mixing by convection, and affects the strength of the Hadley circulation.

2. The Mars Climate Database

The previous version of the Mars Climate Database, MCD version 4.3, was released in May 2008 and has since been distributed to over 150 teams around the world. Current applications include entry descent and landing (EDL) studies for future missions (ExoMars, MSL), investigations of some specific Martian issues (via coupling of the MCD with homemade codes), analysis of observations (Earth-based as well as with various instruments onboard Mars Express and Mars Reconnaissance Orbiter), etc.

We have recently compiled outputs from the latest version of our GCM to build MCD version 5, released in the end of June 2012.

2.1 Overview of MCD v5 contents

As in previous versions of the Mars Climate Database [7], MCD version 5 provides:

- Climatologies over a series of dust scenarios: standard year, cold (ie: low dust), warm (ie: dusty atmosphere) and dust storm, all topped by various cases of Extreme UV solar inputs (low, mean or maximum). These scenarios differ from those of previous versions of the MCD as they have been derived from home-made, instrument-derived (TES, THEMIS, MCS, MERs), dust climatology of the last 7 Martian years [8].
- Mean values and statistics of main meteorological variables (atmospheric temperature, density, pressure and winds), as well as surface pressure and temperature, CO2 ice cover, thermal and solar radiative fluxes, dust column opacity and mixing ratio, [H20] vapour and ice columns, concentrations of many species: [CO], [O2], [O], [N2], [H2], [O3], ...
- A high resolution mode which combines high resolution (32 pixel/degree) MOLA topography records and Viking Lander 1 pressure records with raw lower resolution GCM results to yield, within the restriction of the procedure, high resolution values of atmospheric variables.
- The possibility to reconstruct realistic conditions by combining the provided climatology with additional large scale and small scale perturbations schemes.

2.2 Obtaining MCD v5

The MCD is freely distributed and intended to be useful and used in the framework of engineering applications as well as in the context of scientific studies which require accurate knowledge of the state of the Martian atmosphere.

The MCD may be accessed either online (in a somewhat simplified form) via an interactive server available at http://www-mars.lmd.jussieu.fr (useful for moderate needs), or from the full DVD-ROM version which includes advanced access and post-processing software (contact millour@lmd.jussieu.fr and/or forget@lmd.jussieu.fr to obtain a free copy).

References

[1] Colaitis et al., in preparation, 2012.

[2] Forget et al., Improved General Circulation Models of the Martian Atmosphere from the Surface to Above 80 km, JGR, Vol 104, 1999.

[3] Gonzalez-Galindo et al., A Ground-to-Exosphere Martian General Circulation Model: 1. Seasonal, Diurnal, and Solar Cycle Variation of Thermospheric Temperatures, JGR, Vol 114, 2009.

[4] Lewis et al., A Climate Database for Mars, JGR, Vol 104, 1999.

[5] Madeleine et al., Revisiting the Radiative Impact of Dust on Mars using the LMD Global Climate Model, JGR, Vol 116, 2011.

[6] Madeleine et al., in preparation, 2012.

[7] Millour et al., An Improved Mars Climate Database, Fourth International Workshop on the Mars Atmosphere: Modelling and Observations, 8-11 February 2011, Paris, France, 2011.

[8] Montabone et al., European Planetary Science Congress, 23-28 September 2012, Madrid, Spain, 2012.

[9] Navarro et al., in preparation, 2012.

[10] Wolff et al., Wavelength Dependence of Dust Aerosol Single Scattering Albedo as Observed by the Compact Reconnaissance Imaging Spectrometer, JGR, Vol 114, 2009.