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The Mars Climate Database (MCD version 5.2)

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Abstract

The Mars Climate Database (MCD) is a database of meteorological fields derived from General Circulation Model (GCM) numerical simulations 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. We have just completed (March 2015) the generation of a new version of the MCD, MCD version 5.2.

1. Introduction

The GCM that is used to create the MCD data is developed at Laboratoire de Météorologie Dynamique du CNRS (Paris, France) [1-3] in collaboration with 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. Over the years, various versions of the MCD have been released and handed to more than 150 teams around the world. Current applications include entry descent and landing (EDL) studies for future missions (Insight, ExoMars), 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),...

The MCD is freely available upon request (simply contact millour@lmd.jussieu.fr or forget@lmd.jussieu.fr); a simplified web interface for quick browsing at MCD outputs is available on http://www-mars.lmd.jussieu.fr .

2. Overview of MCD contents

The MCD provides mean values and statistics of the main meteorological variables (atmospheric temperature, density, pressure and winds) as well as atmospheric composition (including dust and water vapor and ice content), as the GCM from which the datasets are obtained includes water cycle [4,5], chemistry [6], and ionosphere [7,8] models.

The database extends up to and including the ther-mosphere [9,10] (~350km). Since the influence of Ex-treme Ultra Violet (EUV) input from the sun is signifi-cant in the latter, 3 EUV scenarios (solar minimum, average and maximum inputs) account for the impact of the various states of the solar cycle. MCD provides mean values and statistics of the main meteorological variables (atmospheric temperature, density, pressure and winds) as well as atmospheric composition (including dust and water vapor and ice content), as the GCM from which the datasets are obtained includes water cycle [4,5], chemistry [6], and ionosphere [7,8] models.

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As the main driver of the Martian climate is the dust loading of the atmosphere, the MCD provides climatologies over a series of **dust scenarios** : **standard year** (a.k.a. **climatology**) , **cold** (i.e: low dust), **warm** (i.e: dusty atmosphere) and **dust storm**, These are derived from home-made, instrument-derived (TES, THEMIS, MCS, MERs), dust climatology of the last 8 Martian years [11]. In addition, we also provide additional "add-on" scenarios which focus on individual Martian Years (MY 24 to 31) for users more interested in specific climatologies than the MCD baseline scenarios designed to bracket reality.

The MCD provides users with:

- 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 concentrations, along with concentrations of many species: [CO], [O2], [O], [N2], [Ar], [H2], [O3], [H] ..., as well as electrons mixing ratios.
- Dust mass mixing ratio, along with estimated dust effective radius and dust deposition rate on the surface are also provided
- Following the recent improvements on the parametrization of physical processes in the Planetary Boundary Layer (PBL) [12], many related fundamental quantities such as PBL height, minimum and maximum vertical convective winds in the PBL, surface wind stress and sensible heat flux,... are available.
- 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 (derived from Empirical Orthogonal Functions extracted from the GCM runs) and small scale perturbations (gravity waves) schemes.

3. Validation of MCD version 5.2

At EPSC, we will show and discuss how MCDv5.2 compares with available measurements (as illustrated in Figure 1) from many available sources (e.g. landers and rovers, instruments onboard past and present orbiters).

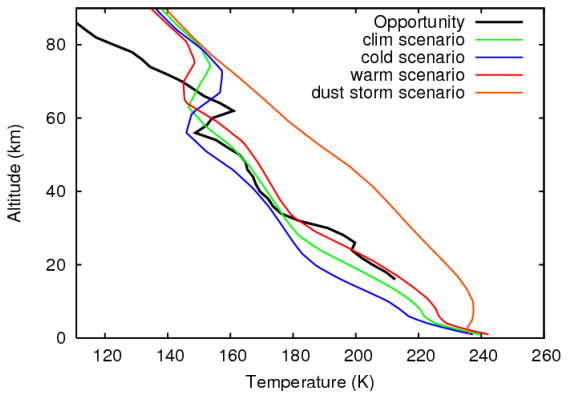

Figure 1: Illustration of the way the MCD dust scenarios bracket reality, in the present case with a comparison to the temperature profile (retrieved by P. Withers) from Opportunity entry, which occurred during a local dust storm.

References

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