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The Mars Climate Database (Version 6.1)

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Introduction:

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.

The GCM that is used to create the MCD data, now known as the Mars Planetary Climate Model (Mars PCM) is developed at Laboratoire de Météorologie Dynamique du CNRS (Paris, France) [1] in collaboration with LATMOS (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 latest version of the MCD, version 5.3 [2], was released in July 2017, and at the time of writing of this abstract we are working on MCDv6.1 [3], which we will release in June 2022. This new version will benefit from all the recent developments and improvements in the Mars PCM's physics package.

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 400 teams around the world.

Current applications include entry descent and landing (EDL) studies for future missions, 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, Mars Reconnaissance Orbiter, Maven, Trace Gas Orbiter, Hope),...

The MCD is freely available upon request via an online form on the dedicated website: http://www-mars.lmd.jussieu.fr which moreover includes a convenient web interface for quick looks.

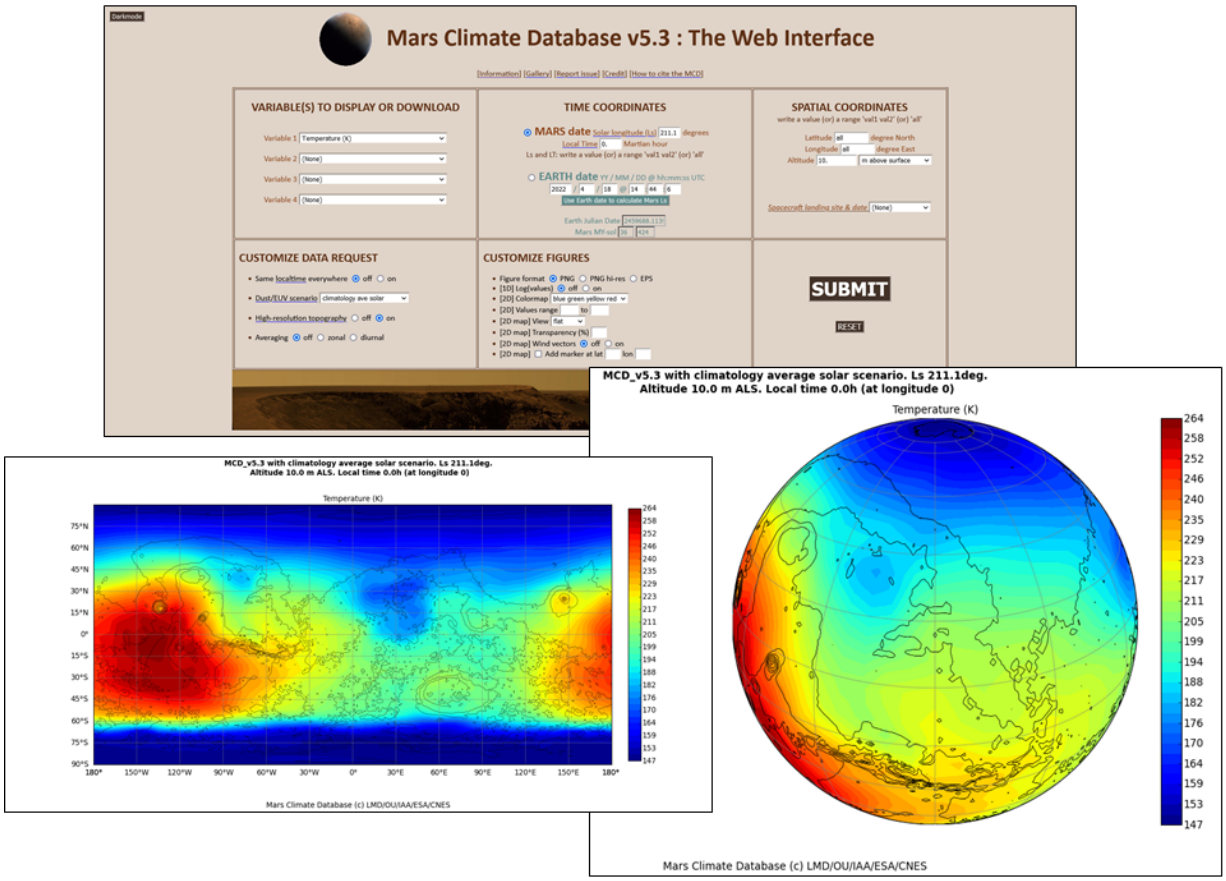

Figure 1: Illustrative example of the online Mars Climate Database web interface and its plotting capabilities.

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, chemistry, and ionosphere models. The database extends up to and including the thermosphere (~350km). Since the influence of Extreme Ultra Violet (EUV) input from the sun is significant in the latter, 3 EUV scenarios (solar minimum, average and maximum inputs) account for the impact of the various states of the solar cycle.

As the main driver of the Martian climate is the dust loading of the atmosphere, the MCD provides climatologies over a series of synthetic 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 12 Martian years. In addition, we also provide additional "add-on" scenarios which focus on individual Martian Years (from MY 24 to MY 35) for users more interested in more specific climatologies than the MCD baseline scenarios.

In practice 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] vapor and ice concentrations, along with concentrations of many species: [CO], [O2], [O], [N2], [Ar], [H2], [O3], [H] ..., as well as electrons mixing ratios. Column densities of these species are also given.
- Physical processes in the Planetary Boundary Layer (PBL), such as PBL height, minimum and maximum vertical convective winds in the PBL, surface wind stress and sensible heat flux.
- 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).
- Dust mass mixing ratio, along with estimated dust effective radius and dust deposition rate on the surface are provided.
- A high resolution mode which combines high resolution (32 pixel/degree) MOLA topography records and Insight pressure records with raw lower resolution GCM results to yield, within the restriction of the procedure, high resolution values of atmospheric variables (pressure, but also temperature and winds via dedicated schemes).

Validation of MCDv6.1:

At EPSC2022 we will present validation campaigns between the MCDv6.1 and multiple measurements such as:

- Surface temperatures, atmospheric temperatures and water vapor from TES/MGS.
- Atmospheric temperatures, water ice and airborne dust from MCS/MRO.
- Atmospheric temperatures from MGS and MEx radio occultations
- Atmospheric temperatures from TIRVIM/ACS/TGO
- Surface pressures recorded by Viking Landers, Phoenix, Curiosity and Insight
- And hopefully much more...

References:

[1] Forget et al. (2022), "Challenges in Mars Climate Modelling with the LMD Mars Global Climate Model, Now Called the Mars « Planetary Climate Model »(PCM) ", The 7th International Workshop on the Mars Atmosphere : Modelling and Observations, 14-17 June 2022, Paris, France.

[2] Millour et al. (2018), "The Mars Climate Database (version 5.3) ", From Mars Express to ExoMars Scienfic Workshop, 22-28 February 2018, ESAC Madrid, Spain.

[3] Millour et al. (2022), "The Mars Climate Database, Version 6.1 ", The 7th International Workshop on the Mars Atmosphere : Modelling and Observations, 14-17 June 2022, Paris, France.

MCD Team: So many over the years...