R009-P27
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火星全球気候モデル DRAMATIC MGCM の現状：マルチスケールモデリングとデータ同化に向けて

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The current state of DRAMATIC MGCM: Towards the multi-scale modeling and data assimilation

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The DRAMATIC (Dynamics, RAdiation, MAterial Transport and their mutual InteraCtions) MGCM (Mars Global Climate Model) has been developed on the dynamical core of MIROC (Model for Interdisciplinary Research On Climate) spectral solver for the terrestrial climate modeling, and used for the investigations of atmospheric dynamics (baroclinic waves, semi-annual oscillation, winter polar warming induced by a global dust storm, etc.) and material transport (CO_2, water, and dust cycles) on Mars, as well as the collaborations with observations.

Now we have updated the dynamical and physical schemes of the MGCM. Now the MGCM is based on MIROC6 [Tatebe et al., 2019] and the definition of vertical layers has been updated to the hybrid sigma-pressure coordinate. Also, we have implemented the dust cycle with 6 particle mode radii (0.0625, 0.125, 0.25, 0.5, 1, and 2 μ m), in whch dust is injected from surface along with 3-dimensional (latitude, longitude, and time) dust scenarios for past observations [Montabone et al., 2015, 2020] and part of the dust particles works as nuclei of water ice clouds. The formation of water ice clouds is based on Montmessin et al. [2004], and the radiative effects of water ice clouds, CO_2 ice clouds, and water vapor have been newly implemented.

In the current simulations with horizontal resolution of T21 (~5.6 degrees or ~333km), we have reproduced the zonal-mean temperature fields and water ice distributions consistently with MRO-MCS observations [McCleese et al., 2010] as well as their diurnal changes (note that MRO-MCS has observed them for local times of 3PM and 3AM). Now we are starting the simulation with higher horizontal resolution of T106 (~1.1 degrees or ~333km) for the reproduction of the generation and propagation of gravity waves as our simulations with the previous version of MGCM [Kuroda et al., 2015, 2015, 2019, 2020].

In addition, we are developing a regional mesoscale model using the SCALE (Scalable Computing for Advanced Library and Environment) 3-dimensional fully compressible non-hydrostatic dynamical core [Nishizawa et al., 2015] and common physical schemes with DRAMATIC MGCM. We have made test simulations with the horizontal resolution of down to 1 km in Acidalia Planitia. Moreover, we are planning the data assimilation using available observational datasets, such as MRO-MCS, using the LETKF (Local Ensemble Transform Kalman Filter) method based on our experiences for Venus atmosphere [Sugimoto et al., 2017; Fujisawa et al., 2022]. The reanalysis data being produced will be used as boundary conditions of the regional mesoscale model for the reproductions of past multi-scale meteorology on Mars to investigate the mechanisms of the occurrences and expansions of dust storms which have been observed.

Our multi-scale simulation and data assimilation aim to collaborate with the future Mars missions, such as MMX (Martian Moons eXploration) [Kuramoto et al., 2022; Ogohara et al., 2022] which is launching in 2026, towards the realization of weather forecasting on Mars for the era of human activities on Mars.