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The BISA GEM-Mars GCM

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GEM-Mars is a three-dimensional general circulation model of the Mars atmosphere extending from the surface to approximately 170 km based on the latest version of the GEM (Global Environmental Mesoscale) model, the operational data assimilation and weather forecasting system for Canada [Côté et al., 1998].

The dynamical core is an implicit two-time-level semi-Lagrangian scheme on an Arakawa C-grid with a terrain-following, log-hydrostatic-pressure vertical coordinate discretized on a Charney-Phillips grid. The model has both a hydrostatic and non-hydrostatic formulation, providing a single platform for simulations on a variety of horizontal scales. The model code is fully parallelized using OMP and MPI.

The GCM includes the relevant physical processes such as CO_2 condensation, planetary boundary layer mixing, gravity wave drag and surface parameterizations. A simple water cycle, basic gas-phase chemistry and passive tracers are also included in the model. Because of the vertical extent of the model, UV heating, non-LTE effects and molecular diffusion are also included.

Dust is prescribed using the MGS scenario for total opacities and a Conrath profile shape. In the dust radiative transfer code, dust optical properties are based on the Wolff et al [2006, 2009] data. Temperatures in the lower and middle atmosphere have been evaluated using TES [Smith, 2004] and MCS [Kleinbohl et al. 2009] data. Winds and atmospheric circulation (mass stream functions) have been compared with the literature and show a good correspondence to other Mars GCMs. In parallel, active lifting and settling of size-distributed dust has also been implemented.

The soil model has been improved to better match surface and near-surface temperatures from the Viking Landers, Phoenix [Davy et al. 2010], and TES. Near-surface winds and friction velocities have been compared with the literature and show reasonable performance.
Condensation of CO_2 in surface ice has been validated using CO_2 ice mass data from HEND [Litvak et al. 2004] and GRS [Kelly et al. 2006]. The effect of the polar cap formation on the pressure cycle is found to be in very good agreement with the Viking Landers and Phoenix [Taylor et al. 2010] data.

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