EPSC Abstracts
Vol. 8, EPSC2013-206-2, 2013
European Planetary Science Congress 2013

Dust lifting in GEM-Mars using a roughness length map

Frank Daerden (1), Lori Neary (1), Jim Whiteway (2), and Eric Hébrard (3)
(1) Belgian Institute for Space Aeronomy, Brussels, Belgium (2) Department of Earth and Space Science and Engineering, York University, Toronto, Canada (3) Laboratoire d'Astrophysique de Bordeaux, Floirac, France. (F.Daerden@aeronomie.be)

Abstract

Lifting of size distributed dust due to surface wind stress and dust devils has been implemented in the GEM-Mars 3D-GCM. It turned out that a detailed surface roughness length map was necessary to bring the simulated dust opacities in accordance with observations.

1. The GEM-Mars GCM

The GEM-Mars GCM is a derived version from the GM3 GCM [1, 5] based on GEM version 3.3.0 and now 4.2.0 [3]. It is a 3D grid point model from the surface up to ~150 km with semi-lagrangian, semi-implicit advection scheme. The horizontal resolution applied in the present study is 4°x4°. GEM-Mars includes CO_2 condensation and a surface pressure cycle, a multi-layered soil model for heat conduction including a subsurface ice table, a surface parameterization (based on Monin-Obhukov similarity theory), a turbulent diffusion parameterization for the PBL, a gravity wave drag parameterization, eddy and molecular diffusion, a water cycle including clouds and surface ice, and online atmospheric chemistry.

2. Dust lifting

Size distributed dust (3 bins for the moment) is lifted when the surface wind stress exceeds a threshold value. Dust can also be lifted in dust devils which are parameterized by a dust flux which is proportional to the sensible heat flux and the boundary layer height. For the wind lifting, the threshold for surface wind stress is 0.0225 Nm as in [4]. Other lifting parameters have been chosen to reproduce the observational data. The dust source is for the moment assumed to be inexhaustible.

3. Roughness length

Using a uniform value for the aerodynamical surface roughness length as is done in many studies did not provide satisfactory results in our GCM. Specifically regions of high topographic gradients provided excessive surface drag velocities and hence wind stresses. Although regions such as volcano slopes can be expected to be only a minor source of dust, in the current implementation in the model (i.e. unlimited dust source) the strong slope winds lead to excessive dust production.

One way to solve this problem would be to modulate the dust lifting flux with dust availability on the surface, which would be the result from another dedicated study or taken from other GCM studies.

In the present study we decided to work on the roughness length to improve the dust lifting. The detailed roughness length map of [3] shows often much smaller roughness lengths over areas where we produced excessive dust. Therefore this map was implemented in the model instead of using a uniform value. The simulation of dust lifting improved considerably after doing this. It turned also out that the precise interpolation of the map, which is noisy at the smallest length scales, to the GCM resolution is an important aspect and needs to be done with care.

We will compare simulated dust opacities to various datasets.

4. Next steps

More studies will be done on interpolating the roughness length map to the GCM resolution. Finally we will make the dust radiatively active and hence feedback into the radiative transfer and abandon the prescribed dust climatology.

References

[1] Akingunola, A., PhD Thesis, York University, 2008.
[2] Côté, J. et al (1998), Mon. Wea. Rev. 126, 1373-1395.
[3] Hébrard, E. et al (2012), J. Geophys. Res., 117, E04008.
[4] Kahre, M.A. et al (2006), J. Geophys. Res., 111, E06008.
[5] Moudden Y. and J. C. McConnell (2005), J. Geophys. Res., 110, E04001.