# Diagnostic experiments of lifted dust flux at the surface with Mars GCM: Consideration of the effects of topography

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The Martian dust influences atmospheric thermal structure (e.g. Liu et al., 2003). Some research groups have made efforts simulating the Martian dust cycle with general circulation models (e.g. Newman et al., 2002, Basu et al., 2004, Kahre et al., 2006). We also implemented two dust lifting schemes into DCPAM (Takahashi et al., 2014) which is a general circulation model developed by our group: One is the lifting scheme with model resolved wind stress, and the other is the scheme with model unresolved vortices such as dust devils. And, we performed diagnostic experiments of the lifted dust flux with these schemes (Ogihara et al., 2014). Characteristics of the lifted dust flux of this result are roughly consistent with those of previous studies. But, because the behavior of dust lifting schemes is complex due to topography, we could not completely understand how the lifted dust flux distribution is decided. In order to understand effects of topography on the behavior of the dust devil lifting scheme, in the work we perform two diagnostic experiments of dust lifting with the flat topography and zonal mean topography. And, we compare the results of the experiment used the flat topography with those of used the zonal mean topography.

The model utilized is DCPAM. DCPAM adopts three dimensions primitive equations. The radiative scheme by Takahashi et al.(2003, 2006) is used. This includes the radiative effects of gaseous $CO_2$ and dust. And, dust distribution is spatially and temporally fixed. The turbulent process is expressed by using vertical diffusivity based on Mellor and Yamada (1982). The surface process is expressed based on Beljaars and Holtslag (1991), Beljarrs (1994). We employ a dust devil lifting scheme used by Newman et al. (2002). This scheme calculates the lifted dust flux intensity with the surface sensible heat flux and the thermodynamic efficiency, which depends on the depth of the convective layer. The horizontal discretization is the spectral method, and the truncation wavenumber is 21. The vertical discretization is the finite difference method, and the number of levels is 36. We integrate 4 Mars years, and use the last 1 Mars year for analysis. We investigate about two regions: latitude 25N degree and 25S degree. And, we focus on the season during the spring and summer in each hemisphere, when dust is intensely lifted. We perform two diagnostic experiments of the lifted dust flux with fixed a surface distribution of thermal inertia and albedo. One is the experiment with flat topography (Case F) and the other is with zonal mean topography (Case Z).

First, results for regions around 25N degree are as follows. The zonal mean lifted dust flux of Case Z is smaller than that of Case F. Thermal budget analyses show that the heating the upper layer due to the convective adjustment of Case Z is less effective and meridional circulation is weaker as compared to Case F. So, the lower atmosphere of Case Z is more stable than that of Case F and the surface sensible heat flux of Case Z is less intensive than that of Case F. Therefore in Case Z the dust devil lifting is less active than that in Case F.

Second, results for regions around 25S degree are as follows. The zonal mean lifted dust flux of Case Z is greater than that of Case F. Thermal budget analyses show that the heating the upper layer due to the convective adjustment of Case Z is more effective and meridional circulation is more intensive as compared to Case F. So, the lower atmosphere of Case Z is more unstable than that of Case F and the depth of the convective layer of Case Z is larger than that of Case F. Therefore in Case Z the dust devil lifting is more active than that in Case F.

 

These results indicate that if the convective adjustment heats the upper layer and meridional circulation enhances, the dust devil lifting intensify.
In the future, we will investigate what does observed topography effect on the dust devil lifting.

Keywords: Mars, Dust, General Circulation Model, Dust Devil, Dust lifting