アンサンブルシミュレーションを用いた火星におけるダスト拡大地域の特定

Favorable regions for dust haze transport revealed by ensemble simulations

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Dust is the major source of the solar heating in the Martian atmosphere and then drives the circulation of dust itself. Dust events (dust storms, dust devils and dust haze) are disasters in the Mars atmosphere near the surface because they can generate strong winds and block sunlight almost completely. Statistics of dust events have been studied by analyzing atmospheric temperature, dust optical depth and visible images observed by successive orbiters, landers and rovers. Active areas of local dust storms, including curvilinear and textured storms have been identified observationally. The tendency of such small scale dust events should be affected by the large scale atmospheric conditions such as thermal or dynamical stabilities. Activity of regional dust storms has been investigated using the vast number of images observed by Mars Orbiter Camera onboard Mars Global Surveyor (MGS/MOC) and MARs Color Imager onboard Mars Reconnaissance Orbiter (MRO/MARCI). They tend to break out near the storm zones in the northern mid-latitudes and are probably very linked to baroclinic instability and the fronts. Although mechanisms of the growth, maintenance and decay of global dust storms have not been well investigated, most of global dust storms started in the southern spring to summer seasons as regional storms were merging with each other.
Questions about the mechanisms of dust storms and haze are as follow:
- Why does a dust storm/haze break out?
- Why does the dust storm/haze expand?
Mechanisms of initiation and maintenance of local dust storms will be understood and categorized into a few types in the near future by statistical studies. They can be also inferred from observations and theories of terrestrial dust storms. However, there are local dust storms also in the northern mid-latitudes. Why do not the local storms grow into regional dust storms? Why do not all regional dust storms merge with each other? Ogohara and Satomura (2011) found five favorable regions for expansion of local dust haze (FRs) and revealed what kind of the atmospheric phenomena controls the dust haze transport around such regions. However, it still remains unclear whether these five FRs are also favorable for dust haze transport climatologically because they performed just a single year calculation. Thus, we identify the climatologically robust FRs in this study by ensemble simulations. If such FRs were found, atmospheric phenomena characteristic of the FRs would govern the dust transport around there.
Each ensemble simulation is performed in the same manner as that by Ogohara and Satomura (2011). Although they could not separate injected dust from the background dust due to the model architecture, wee modify the model in this study so that I can treat the injected and background dust separately. The first spin-up run started from an isothermal (220 K) condition with constant surface pressure (6.4 hPa) and no wind over the entire planet. Fifty kinds of small disturbances are added to the temperature output data of the first spin-up run. The small disturbances of temperature at each sigma level are normal random numbers. The standard deviation of the distribution function is 0.01 times of the standard deviation of temperature at the sigma level of the first spin-up result. The second spin-up runs are

performed for 1 MY from L_s=180 independently using the 50 kinds of the output data of the first spin-up run with small disturbances as the initial data. After these spin-up runs, fifty global maps of dust haze expansion potential are made using the output data from the 50 kinds of the second spin-up runs as the initial data. The maps of dust haze expansion potential clearly show that there are a few robust FRs in the northern fall season. Also, it turns out that standard deviations of dust haze expansion are significantly higher in the northern high latitudes than in the low latitudes. The reasons why dust tends to expand around the robust FRs are the same as those explained by Ogohara and Satomura (2011). However, high ensemble standard deviation in dust haze expansion is clearly shown at the first time by this study. In the presentation, we will show when dust haze tends to spread extensively and when it does not.

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