High resolution simulation of the general circulation of the Martian atmosphere

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Recent observations of the Martian atmosphere have revealed that there are a number of local and regional scale dust storms which have the horizontal scale of 10-1000 km. These imply that, also in the Martian atmosphere, there are local to regional circulation structures which may be referred to as mesoscale disturbances which appear between the spatial ranges of vertical heat convection and baloclinic unstable waves, and that these local to regional disturbances play important roles on the dust lifting and its transfer. However, the grid size of the general circulation model (GCM) of the Martian atmosphere used in many studies (about 300 km) is not fine enough to resolve these disturbances explicitly. In this study, a GCM of the Earth's atmosphere, AFES, is adapted to Mars and a high resolution simulation of the Martian atmosphere is performed to examine the effect of the local to regional scale disturbances on the dust lifting and transfer processes. In the followings, we will present a brief explanation of the model now under developing for a high resolution simulation of the Martian atmosphere, and we will report some preliminary results obtained by a dust lifting experiment.

The model used in this study consists of the dynamical core of AFES, the semi-Lagrangian tracer transport scheme newly implemented in this study, and the physical processes introduced from the Mars GCM which has been developed by our group so far. AFES is based on CCSR/NIES AGCM 5.4.02, and is optimized to perform high resolution simulations on the Earth Simulator. As for the physcial processes, the radiative, the turbulent mixing, and the surface process are introduced from our Mars GCM. In addition, the dust lifting process and the gravitational sedimentation are newly implemented. The dust lifting process is the same as "threshold-sensitive surface stress lifting" parameterization proposed by Newman et al. [2002]. This parameterization is an GCM implementation of the process of dust lifting by the surface wind, whose characteristics is that dust is not ejected unless the surface friction velocity exceeds a certain threshold value. By the use of this GCM, a dust lifting experiment is performed with the resolution of T79L24, which is equivalent to about 90 km grid size. As a first step, dust is assumed to be radiatively inert in this experiment. Radiative heating due to dust is calculated separately from a zonally uniform distribution whose latitudinal profile is assumed referring to the observation by Thermal Emission Spectrometer (TES) onboard the Mars Global Surveyor (MGS).

The dust lifting experiment shows that the amount of surface frictional velocity becomes larger than the dust lifting threshold only in some limited areas, such as the northern slope of the Tharsis plateau and the northern edge of the Hellas basin. The large frictional velocity which results in dust lifting mainly occurs in daytime, and is cosidered to be caused by unstable condition due to daytime solar heating. However, dust lifting does not occur regularly every day; dust lifting is severly controlled by the situation of the atmospheric ciculation fields. We are going to proceed analyses of the results to identify whether the controlling circulation structure to be a local to regional disturbance.