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Resolution dependence of dust mass flux simulated by Mars general circulation model: seasonal variation

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There are always dust suspended in the Martian atmosphere, and its radiative heating and cooling have significant impact on the thermal budget of the atmosphere. On the one hand, it is well known that the dust storms with various sizes occur on Mars, and those cause variations of temperature and wind on a various temporal and spatial scales. However, the lifting process of dust suspended in the atmosphere and the generation processes of dust storms have not been understood fully. Numerical experiments with a high resolution model would provide new insights into those processes, because a previous study pointed out that small and medium scale disturbances with a horizontal scales less than a few hundreds of kilometers would contribute to the dust lifting. Based on these ideas, we have been investigating the structures of small and medium scale disturbances in the Martian atmosphere by using a Mars general circulation model with several horizontal resolutions ranging from 89 to 22 km. In this presentation, the results of experiments at northern summer condition are presented and are compared with those at northern fall condition presented earlier.

The model used in this study consists of the dynamical core of AFES, 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 physical 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 implemented. The dust lifting process is the same as one of "threshold-sensitive surface stress lifting" parameterizations 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, we performed simulations at northern fall season with resolutions of T79L96, and T319L96, which are equivalent to about 89 and 22 km grid size, respectively, and with 96 vertical layers.

The preliminary results of simulations with several horizontal resolutions at northern summer show that the global mean dust lifting amounts does not change very much with increasing horizontal resolution. This resolution dependence is different from that at northern fall presented earlier. It was shown that the dust lifting amount increases with increasing horizontal resolution at northern fall, mainly because the better-resolved slope wind around the Valles Marineris region causes large dust lifting in the high resolution simulation. In the presentation, the dust lifting mechanism at northern summer and the mechanism of the seasonal variation of resolution dependence of dust lifting will be discussed.