# DUST LIFTING REPRESENTED IN A HIGH RESOLUTION MARS ATMOSPHERE GENERAL CIRCULATION MODEL.

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## Introduction

High resolution experiments of Martian atmosphere have continued to be performed by using a general circulation model (GCM). One of the purposes of high resolution experiments is to investigate the small and medium scale disturbances whose horizontal scales range from thermal convection to baroclinic waves. The other purpose of high resolution experiments is to have some insights into dust lifting processes on Mars, since the small and medium scale disturbances may have important roles on atmospheric dust lifting and transport. In this study, we focus on the properties of dust lifting in our high resolution experiments with special attention on the resolution dependence.

## Model description

The model used in this study consists of the dynamical core of AFES (*Ohfuchi et al.*, 2004), and the physical processes introduced from the Mars GCM which has been developed by our group so far (*Takahashi et al.*, 2003, 2004, 2006). The AFES is a spectral primitive equation model and is based on CCSR/NIES AGCM 5.4.02 (*Numaguti et al.*, 1997). The AFES was optimized to the Earth Simulator to conduct high resolution experiments of the Earth's atmosphere.

The introduced physical processes include the radiative, the turbulent mixing, and the surface processes. The radiation scheme considers absorption by $CO_2$ gas, and absorption and scattering by dust suspended in the atmosphere. The turbulent mixing is evaluated by using a simplified *Mellor and Yamada* (1982) level 2.5 scheme, in which the advection of eddy kinetic energy is neglected. In addition, the dust lifting process is implemented to diagnose the dust mass flux in the model. The dust lifting process is the same as one of "threshold-sensitive surface stress lifting" parameterizations used by *Newman et al.* (2002). This parameterization is a GCM implementation of the process of dust lifting by the surface stress, whose characteristics is that dust is lifted only when the surface friction velocity exceeds a certain threshold value.

The surface orographic height and albedo variation are based on the Mars Global Surveyor (MGS) observations (*Smith et al.*, 1999; *Christensen et al.*, 2001). The distribution of soil thermal inertia specified in the model is the same as that used by *Pollack et al.* (1990). But, in some experiments, uniform surface properties are used to investigate atmospheric disturbances that are not forced by variations of surface properties, orography, albedo and thermal inertia variations.

By the use of this GCM, we performed experiments at northern fall condition with horizontal resolutions of T79, T159, T319, and T639, and number of vertical layers of 96. Horizontal resolutions of T79, T159, T319, and T639 are equivalent to about 89, 44, 22, and 11 km grid size, respectively. In these experiments, the dust distribution used for radiative heating rate calculation is assumed to be uniform horizontally with dust optical depth of 0.2.

## Results

Figures 1 and 2 show distribution of low level relative vorticity and dust lifting flux represented in the T639 experiment. Many kinds of dust lifting events can be observed in the model. Some of those are associated to synoptic scale disturbances and others are caused by smaller scale disturbances, such as orography-related local circulation.

The properties of dust lifting represented in the experiments are analyzed in view of probability distribution functions with our attention on the resolution dependence (Figure 3). As is expected, in general, the high resolution experiment show higher surface stress than that in low resolution experiment, and the high surface stress tail is observed in the probability distribution functions. Such high surface stress tail is directly linked to dust lifting easily, and contribute to large dust lifting rate. However, resolution dependence may not be so simple as is shown in Figure 3. Some events with large amplitude waves may be responsible for such a dependence. The latitudinal dependence of such resolution dependences will also be discussed in the presentation.

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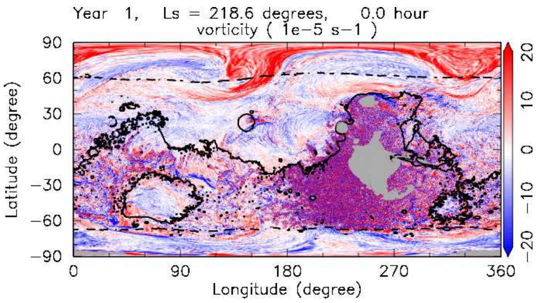


Figure 1: Distribution of vorticity at 4 hPa pressure leve by T639 experiment at northern fall ($L_s$ = 219°). Also shown are the areoid (solid line) and the location of polar cap edge (dashed line). Gray areas represent mountains at 4 hPa pressure level.

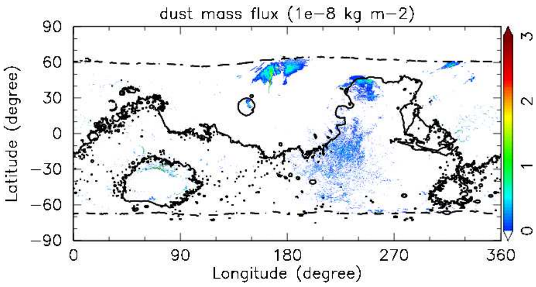


Figure 2: Same as Figure 1, but for dust lifting flux.

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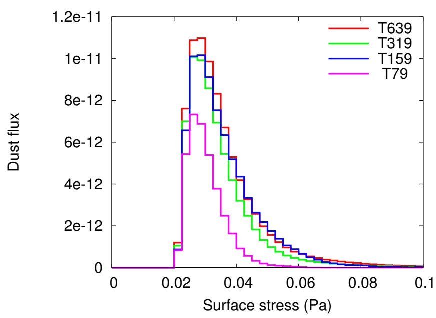


Figure 3: Probability distribution function of dust lifting flux as a function of surface stress.