# The circulation structure in the Martian atmospheric boundary layer obtained by high resolution LES

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## 1. Introduction

Dust in the Martian atmosphere has a great influence on the temperature structure of the atmosphere (Montabone et al., 2005). Dust is lifted from the ground by the wind in the atmospheric boundary layer. In many studies using atmospheric general circulation models (GCMs), dust lifting by the subgrid scale wind is parameterized. Validity of parameterization schemes has been examined through comparisons of distributions of dust optical depth and temperature obtained by calculations with observational results.

More direct validation dust lifting parameterization comparing with the microstructure of wind fields in the atmospheric boundary layer is desirable, but has not been conducted. Instead, examinations with the results of large eddy simulations (LESs) have been performed. Fenton and Michaels (2010) conducted LESs whose horizontal resolution was 100 m. They used initial states with various horizontal wind distributions. Their results suggest that certain initial wind distributions cause dust lifting. However, effects of phenomena such as the dust devils with horizontal scale of dozens of meters could not be represented because of coarse resolution. Nishizawa et al. (2016) conducted LESs where several different grid spacing ranging from 100m to 5m were employed to examine resolution dependence. The isotropic grid spacing of 5 m is the highest resolution among Martian LESs performed so far. The initial state is a horizontally uniform rest atmosphere. They examined vorticity and vertical wind at altitude of 62.5 m. The vertical wind has cellular structures whose boundaries are composed of narrow regions with strong upward winds. With the higher resolution, the intensity of vorticity becomes stronger and radius of vorticity becomes smaller. In the previous studies described above, the circulation field near surface has not been examined, although the circulation field is related to dust lifting.

Our aim is to understand the relationship between the circulation structure and the surface stress. In this presentation, we show the results of analysis focusing on the lowest level of the model (z = 2.5 m).

## 2. Data

We use the data calculated by Nishizawa et al. (2016) which utilized SCALE - LES ver. 3 developed by RIKEN / AICS. The values of model parameters are those of Mars. The model domain is 19.2 km ×19.2 km ×21 km. Five experiments with the resolutions ranging from 100 m to 5 m were analyzed. The heating rate and the surface temperature are given externally from one-dimensional simulation by Odaka et al. (2001). Horizontally periodic boundary conditions are adopted. Except for the 5 m resolution run, the vertical temperature profile of initial state is obtained from Odaka et al. (2001) and tiny random perturbations are added. For the 5 m resolution run, integration is performed for 1 hour from the result at 14:00 (local time) obtained by the 10 m resolution run. In this study, we use the data at 14:30 obtained with the 5 m resolution run. Surface stress is calculated using the same scheme as Nishizawa et al. (2016).

## 3. Results

In order to compare the surface stress distributions with the circulation structures, we examine the wind velocity distributions at the lowest level of the model. To estimate the frequency of dust lifting, we investigate the histogram of intensity for the surface stress. In this presentation, we will show these results in detail. We are now proceeding analyses of the data at the time other than 14:30 and other resolutions. With considering the results, we will obtain an understanding on the relationship between surface stress field and circulation field.

Keywords: Mars, Atmospheric Boundary Layer, High Resolution Large Eddy Simulation, Dry Convection, Surface Stress, Dust Lifting

 