Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PPS05-15 Room:A03 Time:May 28 12:15-12:30

Assessment of Mars surface environment for a exploration program: application of CReSS to Martian atmosphere

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A Mars surface exploration program is now planned by space engineering and planetary science communities in Japan. To support designing the landing module and observation instruments and ensure safety mission operation, evaluation of plausible range of meteorological conditions at proposed landing site is required. For mesoscale assessment of Mars surface environment, we are now trying to apply ”Cloud Resolving Storm Simulator (CReSS)” (Tsuboki and Sakakibara, 2002) to Martian atmosphere.

CReSS is a numerical model based on quasi-compressible system (Klemp and Wilhelmson, 1978). To apply CReSS to Martian atmosphere, radiative transfer scheme (Takahashi et al., 2006) used by planetary atmospheric general circulation model DCPAM (Takahashi et al. 2012) is introduced. The surface topography, albedo, and thermal inertia are adopted from Mars Global Surveyor observation data. The terrestrial calendar included in CReSS, which defines the length of year, month, hour, and minute, is modified to be suitable for Mars' rotation and orbital period.

To examine the model performance, we perform some idealized numerical experiments without the surface topography and effects of large-scale circulation. At first, we perform comparing experiments to the result of one-dimensional radiative-convective calculations (DCPAM-1D) with almost same experimental setting, and find that the simulated diurnal variations of surface temperature and heat budget at the surface are consistent with those of DCPAM-1D. Next, we perform experiments with solar radiative condition at the landing sites of NASA's rover, Spirit and Opportunity. We find that the simulated vertical temperature profiles near the surface in daytime are consistent with the data of NASA's rover if using mixing length of sub-grid scale turbulence parameterization given by Deardorff et al. (1980) which is commonly adopted in previous studies (e.g. Spiga et al., 2010). Following the idealistic experiments mentioned above, we begin to perform more realistic numerical experiments at proposed landing sites. In the experiments, the surface topography and effects of large-scale circulation are considered. In order to consider the effects of large-scale circulation, simulation data of DCPAM is used as initial and boundary conditions.

In this presentation, we show outline of our numerical model and some results of numerical experiments.

Keywords: Martian atmosphere, planetary exploration, numerical modeling, cloud resolution model