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Dynamical Processes of Dust Lifting in the northern Mid-latitude region of Mars during the Storm Season

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Abstract

By numerical simulation with the general circulation model for Mars, the dynamical processes of Martian dust storms in the northern mid-latitude region during the storm season have been studied.

1. Introduction

Previous observations [1] show that the regular annual activity of Martian dust storms is more active at northern mid-latitude region during the second half of the Martian year, especially concentrated in two episodic periods (Ls = 220° - 260° and Ls = 310° - 340°). They have been suggested to be dominated by the transient mid-latitude waves with the zonal wave number of 1~3, and the period of 2~7 sols [2][3]. However, due to the limited temporal resolution of the satellite observations and the prescribed dust content applied in most GCM simulations, the processes with a period less than 2 sols and result in the dust lifting may have been missed. In this study, these two issues as well as the asymmetric terrain effect would be focused.

2. Numerical Experiments

The basic configuration of the simulations is generally similar to that used in [4]. The model includes an active dust scheme and a dust devil scheme similar to those used in [5]Newman and Richardson (2015). Then the suspended dusts may change the atmospheric radiation and so the circulations. The simulation in the second year is considered as the control simulation 'CTRL' and the results are dumped out every 2hrs.

In order to test the terrain effect, the asymmetric terrains north than 15 ºN have been smoothed as a sensitive experiment named 'RmTerrain'.

3. Figures

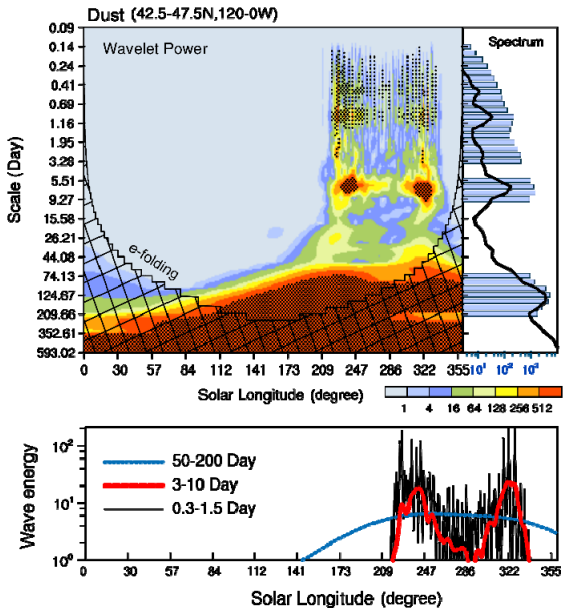

Figure 1: Wavelet analysis on the time series of simulated dust mixing ratio near surface averaged in the mid-latitude region near Alba Patera (42.5º - 47.5º N and 120º - 0º W). The shading depicts the spectrum power (significant region is dotted and the mesh marks where it is above the e-folding line), and the time-averaged spectrum is shown in the upper right (curve is the total energy profile and bars are the effective energy). The bottom subplot shows the time series of wave energy of the interested wave bands.

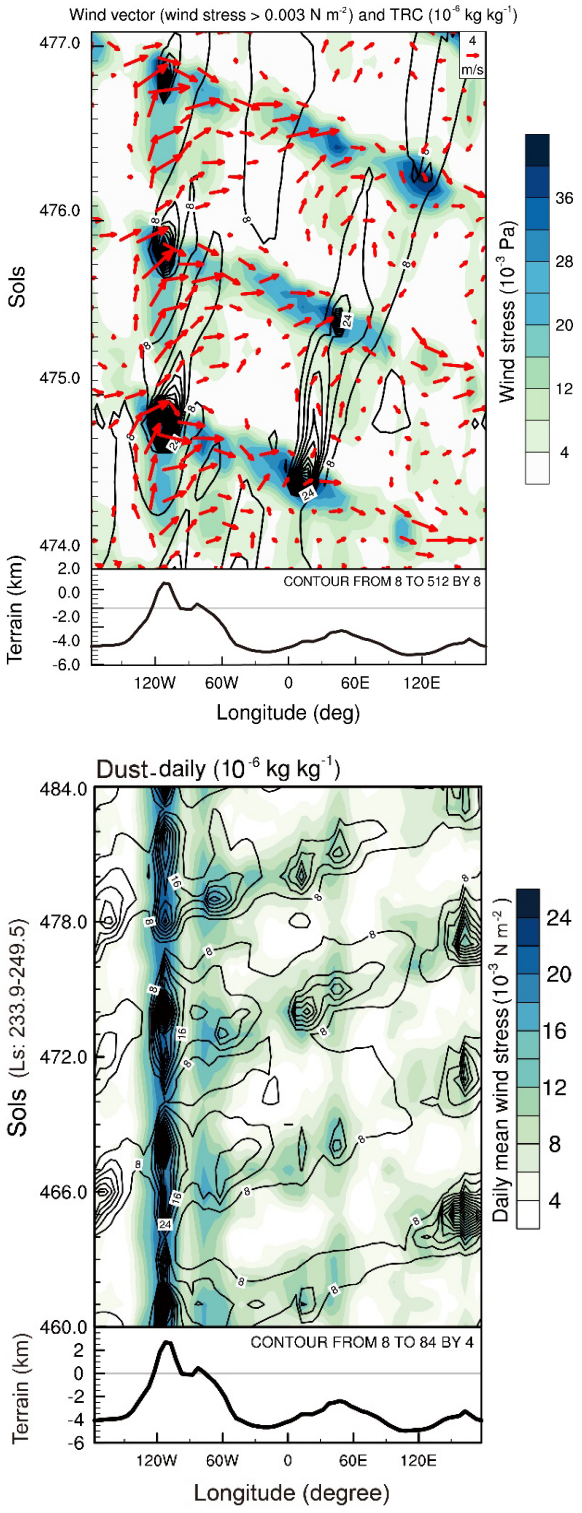

Figure 2: Hovmöller diagram of surface dust mixing ratio (contours, 10^{-6} kg kg^{-1}) and wind stress (shading, 10^{-3} N m^{-2}) averaged between 42.5º and 47.5ºN

during (a) sols 474.0 - 477.0 and (b) sols 460.2 - 484.2 (Ls = 233.9º - 249.5º). (a) also shows surface winds (red vectors) when wind stress is significant (> 0.003 N m-2), and in (b) the variables are daily mean. The corresponding profile of terrain (km) in the region is shown in the bottom. Summary and Conclusions

- The Martian dust storm activities can be well interpreted by the GCM model MarsWRF, especially the dust source region and the double-peak episodes.
- Three distinct periods of dust lifting activities can be identified: semi-diurnal to diurnal (0.5-1.5 sols), synoptic (3-7 sols) and seasonal (50-200 sols).
- Dust lifting is dominated by the diurnal thermal tide near three high terrains. Then the suspended dust are advected downstream by the baroclinic waves.
- The asymmetric high terrains have a pivotal role in triggering the dust, but have little effects on baroclinic waves.

Acknowledgements

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