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DUST-RELATED INTERANNUAL AND INTRASEASONAL VARIABILITY OF MARTIAN CLIMATE USING DATA ASSIMILATION

T. Ruan (ruan@atm.ox.ac.uk)**, L. Montabone, D. P. Mulholland, P. L. Read,** *Department of Physics, University of Oxford, Oxford, UK,* **S. R. Lewis,** *Department of Physics & Astronomy, The Open University, UK.*

Introduction:

Data assimilation has been applied in several studies [Montabone et al., 2005; Lewis et al., 2005; Montabone et al., 2006a; Montabone et al., 2006b; Lewis et al., 2007; Wilson et al., 2008; Rogberg et al. 2010] as an effective tool with which to analyze spacecraft observations and phenomena (e.g., atmospheric tides, transient wave behavior, effects of clouds in the tropics, weather predictability, etc.) in the Martian atmosphere. A data assimilation scheme combined with a Martian Global Circulation Model (GCM) is able to provide a complete, balanced, four-dimensional solution consistent with observations. The GCM we use [Forget et al., 1999] combines a spectral dynamical solver and a tracer transport scheme developed in UK and Laboratoire de Météorologie Dynamique (LMD; Paris, France) physics package developed in collaboration with Oxford, The Open University and Instituto de Astrofisica de Andalucia (Granada, Spain).

Here, we describe and discuss dust-related interannual and intraseasonal variability of the Martian climate. The results shown in this study come from a reanalysis using the Martian GCM with data assimilation scheme which assimilates Mars Global Surveyor/Thermal Emission Spectrometer (MGS/TES) retrievals of temperature and column dust opacity. The detailed model setup was described by Montabone et al. [2006a], and the data assimilation scheme employed in this study was introduced in the work of Lewis et al. [2007].

Zonal-Mean Diagnostics:

Figure 1 shows the zonal-mean, daily-averaged zonal wind at the equator in the MGS/TES reanalysis. The zonal wind is averaged in the latitude band [-10, 10] degrees. In the Figure, pressure and pseudo-altitude values are simply calculated from the model terrain-following vertical coordinate using a reference pressure of 6.1mb and a scale height of 10.8 km. MY 25 is the Martian year when the 2001 planet-encircling dust storm occurred. This event had a significant impact also on the equatorial zonal wind, as can be clearly seen in the Figure, where the low-altitude westerly (usually around 15 km altitude) was strongly reinforced and extended in altitude. The results from the reanalysis of zonal-mean wind presented here also indicate clear semi-annual oscillations below 0.1mb among all 3 assimilated Martian years, similar to the phenomenon found in the work of Kuroda et al.[2008] using a free-running GCM. Between 0.01mb and 0.75mb, there is a significant zonal-mean wind speed increase from Ls = 240° to Ls = 345° in each year. Below 1mb to near-

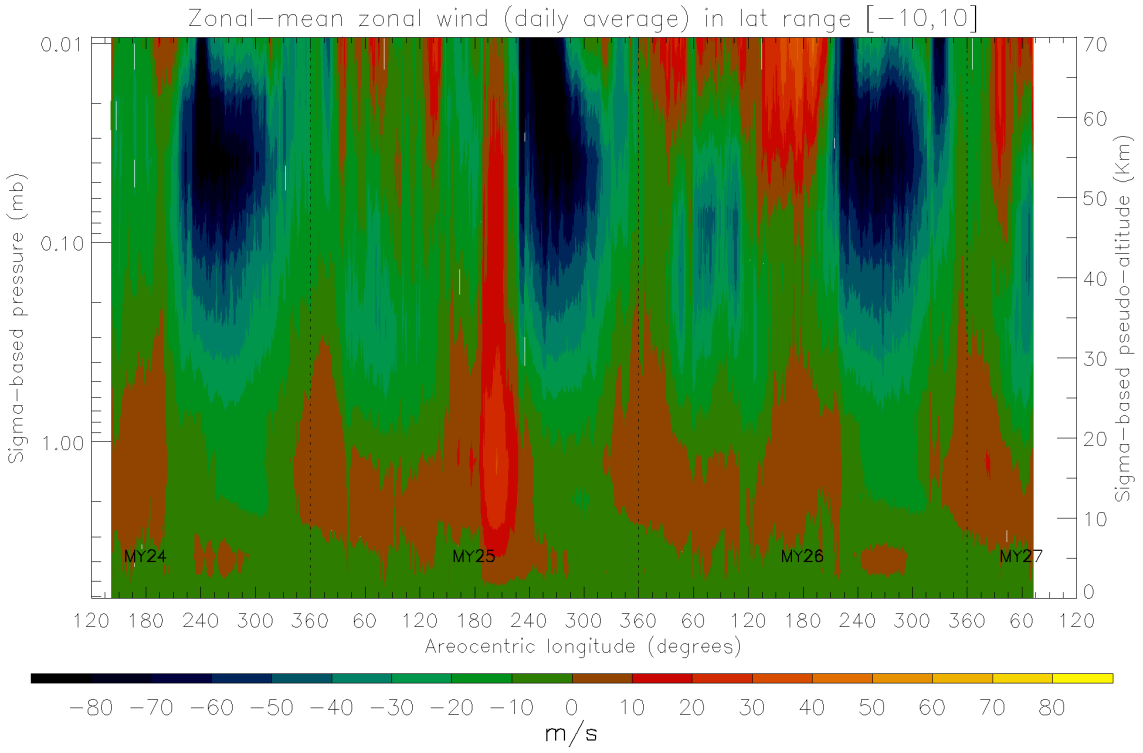

Figure 1, zonal-mean of daily-averaged zonal wind at the equator in the MGS/TES reanalysis

surface levels, a clear reversal of zonal-mean wind can be noticed, but with similar magnitude.

Figure 2 shows the time series of the zonal-mean zonal wind in the latitude band [-10, 10] degrees at 0.75 mb (corresponding to a pseudo-altitude of 22.5 km). The time series is extracted from the MGS/TES reanalysis dataset. Zonal wind values are daily averaged. The semi-annual oscillation is clearly shown in the Figure, as well as the effect of the 2001 planet-encircling dust storm. It is worth mentioning that the amplitude of the semi-annual oscillation is smaller in our reanalysis than in the study with a free-running GCM by Kuroda et al. [2008], which used a prescribed dust scenario.

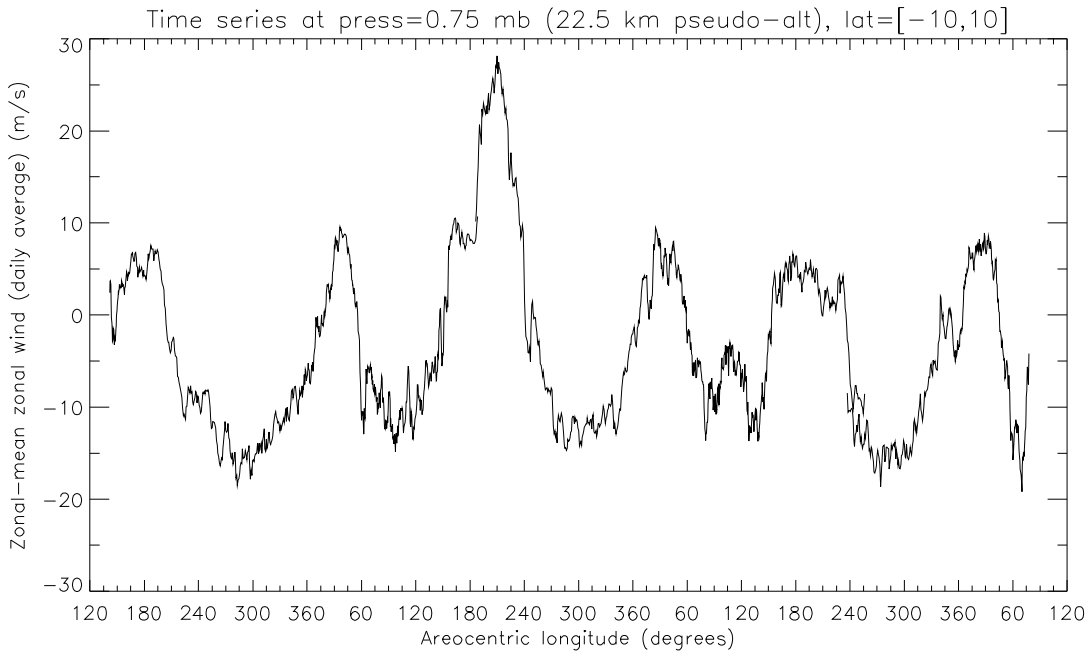

Figure 2, time series of the zonal-mean zonal wind in the latitude band [-10, 10] degrees at 0.75mb (corresponding to a pseudo-altitude of 22.5 km)

Summary and Future Plans:

In this study we investigate the variability of zonal-mean wind, dust and so on in the Martian climate, based on a Martian GCM with data assimilation. Particularly, semi-annual oscillation similar to previous study by Kuroda et al. [2008] is seen in our model simulation results. However, data assimilation has been conducted so far without advecting the assimilated dust field mainly because TES did not provide information about the dust distribution in the vertical direction. Therefore, this preliminary study without transporting dust is not yet able to investigate the dust lifting resulting from surface wind stress. A more sophisticated data assimilation scheme combined with dust transport will be introduced in future work, since newly-available Mars Climate Sounder (MCS) data has relatively detailed information in the vertical direction compared to TES data. It will be possible to assimilate the dust opacity vertical profiles to obtain a better reanalysis global datasets. The Analysis Correction Scheme, used in our Martian data assimilation, will be applied to the observed dust opacities. Corrected opacities will be opportunely converted to dust mixing ratios, and further used to reconstruct the dust transport and diagnose the degree to which it is predicted in the model. Those outcomes will be useful information for improving the dust lifting schemes. Given that the temperatures and winds are basically correct in the reanalysis, the correction of the dust field becomes solely a test of the accuracy of lifting parameterization, as well as the assumptions about surface dust availability.

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