DIURNAL VARIATIONS OF DUST FROM MARS CLIMATE SOUNDER OBSERVATIONS DURING THE GLOBAL DUST EVENT IN MARS YEAR 34. A. Kleinböhl[1], A. Spiga[2], D. M. Kass[1], J. H. Shirley[1], E. Millour[2], L. Montabone[3], F. Forget[2], [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, [2]Sorbonne Université and Laboratoire de Météorologie Dynamique, Paris, France, [3]Space Science Institute, Boulder, CO (Armin.Kleinboehl@jpl.nasa.gov).

Introduction: Global, or planet-encircling, dust events are the probably the most distinctive feature of the martian atmosphere. They can lift dust well into the middle atmosphere, enshroud the planet with dust for months, and have a profound effect on atmospheric temperatures and the overall circulation. The recent global dust event (GDE) on Mars provides a unique opportunity to gain insight into the behavior of these large-scale dust events as it was observed from the surface by the Curiosity rover [1] as well as from Mars orbit by several orbiters. Initial signatures of the MY34 GDE were observed on June 2, 2018 (L_s=186°). It peaked around July 7, 2018 (L_s=207°) and then decayed over several months, with background dust conditions reached in the second half of October 2018 (L_s=270°-280°).

Previous orbital observations of GDEs on Mars typically yield dust column optical depth measurements that are usually only available on the dayside of the planet [2,3]. The Mars Climate Sounder (MCS) [4] onboard Mars Reconnaissance Orbiter (MRO) was observing the martian atmosphere nearly continuously over the duration of the GDE. MCS dust profiles are available on both the dayside and nightside part of the orbit, allowing the study of diurnal variations of dust. In addition, the MCS observations included frequent sideways scans [5] to extend the range of local times observed during the event. Here we show dust profiles measured during the GDE and evaluate variations in the observed dust distribution with local time. We compare the measured dust distributions with results from the LMD General Circulation Model (GCM) in order to isolate mechanisms for the observed variability.

MCS Instrument and Retrievals: The Mars Climate Sounder [4] is a mid- and far infrared thermal emission radiometer on board the Mars Reconnaissance Orbiter. It measures radiances in limb and on-planet viewing geometries. From these radiance measurements, profiles of atmospheric temperature, dust, and water ice are retrieved from the surface to ~80 km altitude with a vertical resolution of ~5 km [6-8]. Temperature measurements exploit the atmospheric emission of the 15 µm CO_2 band. Dust and water ice extinction retrievals are centered on major absorption bands at 22 µm and 12 µm, respectively. Dust retrievals during the GDE use the MCS far IR channel B1 at 32 µm in addition to the 22 µm band. Because the extinction efficiency at 32 µm is only about half of the value at 22 µm, the use of B1 detectors extends the retrievable altitude range in dusty conditions typically by 1-1.5 scale heights [9].

Results: For this analysis we consider zonal averages of temperature and dust profiles that were binned separately for day and night in seasonal steps of 5° L_s. Figure 1 shows the results of this analysis for the L_s-

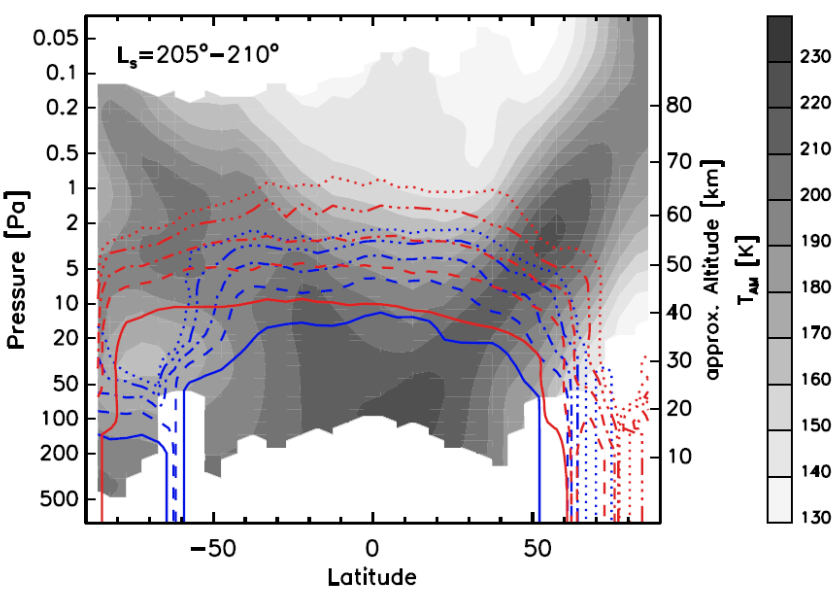

Figure 1: Temperature and dust extinction as observed by MCS during the peak of the MY34 global dust event. Data has been zonally averaged in bins of five degrees latitude. Gray shades show the temperature structure from the nighttime part of the orbit. Colored contours show isolines of dust extinction at 463 cm^{-1} for daytime (red) and nighttime (blue) measurements. Contour levels correspond to 10^{-3} km^{-1} (solid), $3x10^{-4}$ km^{-1} (dashed), 10^{-4} km^{-1} (dash-dotted), $3x10^{-5}$ km^{-1} (dash-multidotted), and 10^{-5} km^{-1}(dotted).

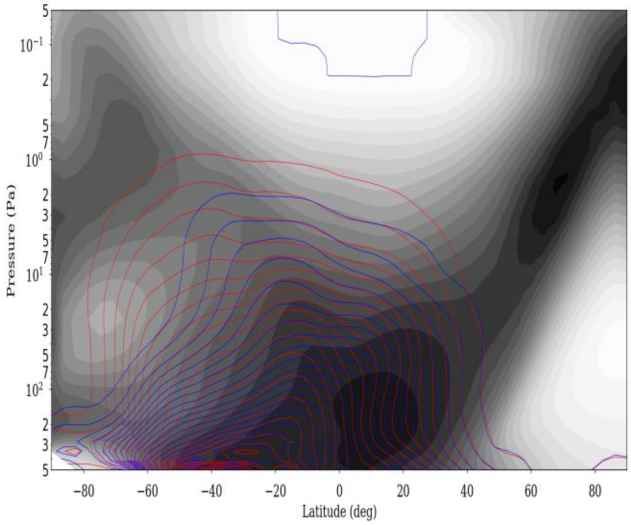

Figure 2: Zonally averaged temperatures and dust distributions simulated by the LMD GCM for the same time period as in Fig. 1. Gray shades show nighttime temperatures. Colored lines show dust mixing ratios at daytime (red) and nighttime (blue).

range of 205°-210°, corresponding to the peak phase of the GDE. Grey shades show nighttime atmospheric temperatures that reach maximum values of 220-230 K in the lower atmosphere of the equatorial region and in the downwelling branch of the overturning atmospheric circulation in the northern middle atmosphere. The polar vortex is well established in the northern high latitudes, with temperatures close to the CO_2 frost point and very low dust amounts.

At virtually all other latitudes significant amounts of dust are found. Dust extinction profiles at mid- and low latitudes often tend to approximately follow the decrease of atmospheric density with altitude up to a certain altitude, above which the decrease steepens significantly. This level is found at much lower pressures during the day than at night. The level of 10^{-5} km^{-1} dust extinction is found around 2 Pa or higher at night, while during the day this level moves to about 1 Pa. This corresponds to an altitude difference of roughly 10 km. The fact that levels of constant extinction do not only change altitude but also pressure levels suggests that this change is not simply related to the expansion of the atmosphere due to heating on the dayside. Rather, tidal effects and processes of active lofting during the day and sedimentation during the night are likely to be involved in the formation of this day/night difference.

In the southern polar regions differences between day and night are even more striking than at mid- and low latitudes. While daytime extinctions decrease only slowly towards the south pole, nighttime extinctions decrease significantly poleward of about 50°S. At polar latitudes, the level of 10^{-5} km^{-1} dust extinction is found at 50-60 km altitude during the day but only around 20-30 km altitude at night, corresponding to a ~30 km altitude difference between day and night. It is unlikely that this large difference is caused by an active lofting mechanism. We suggest that the area of low dust in the southern polar region is a remnant of the southern polar vortex that is still dynamically confined and separated from the rest of the atmosphere. This interpretation is supported by a cold pole in the nighttime temperature structure that is roughly co-located with the minimum in dust extinction. We propose that dynamical effects on the dusty dayside push this vortex remnant toward the nightside.

Dust distributions and their diurnal variations observed by MCS are compared with simulations of the LMD GCM (Figure 2). Initial analyses suggest that both the behavior at mid- and low latitudes as well as the behavior in the south polar region are qualitatively represented by the model. Deeper insights into the mechanisms controlling the diurnal changes in the dust distributions will be gained from the GCM simulations and presented at the conference.

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