MARTIAN B STORM GENESIS AND EVOLUTION: INITIAL ANALYSIS OF THERMAL DATASETS.

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Introduction: Dust lifting on Mars likely occurs primarily as a result of the exchange of momentum between the atmosphere and the surface via saltation. During saltation, sand-sized particles are mobilized but do not enter into suspension. When these larger particles fall back to the surface, kinetic energy is transferred to smaller dust particles which are then lofted into suspension in the atmosphere. Depending on the altitude to which dust is lofted, it can have a significant effect on atmospheric temperatures. As a strong absorber and emitter in the infrared, dust can influence atmospheric heating and modify the global circulation and weather on Mars [1,2].

Although dust is present in Mars' atmosphere throughout the year, the atmosphere is generally dustier during the second half of the year when Mars is near perihelion. Observations reveal that episodic global-scale dust storms and fairly regular regional-scale dust storms are superimposed on a well-defined and highly repeatable seasonal cycle of dust opacity and associated mid-level atmospheric temperature responses. Kass et al. (2016) used 50 Pa temperature observations from MRO/MCS to identify three highly repeatable time periods during which regional dust storms occur, and designated them the "A", "B" and "C" storms. While "A" and "C" storms have been studied a fair amount to-date, "B" storms have not yet been investigated in detail.

This study explores the generation and evolution of the annually recurring regional dust storm known as the "B" storm, which was identified and categorized by Kass et al. (2016) based on 25 km (50 Pa) temperature observations. The B storm is a southern-hemisphere (SH) phenomenon that originates at the cap edge just after perihelion and which reaches peak intensity during the SH summer solstice, Ls 270. It may originate from the cap edge storms that spawn near the edge of the seasonal CO_2 cap during retreat, but the mechanisms for B storm genesis have yet to be determined definitively [1].

Methods: We will use observational data sets and a global climate model (GCM) to investigate "B" regional storms. The data analysis component will include the analysis of imagery from MGS/MOC and MRO/MARCI, and spectroscopic data sets of dust and temperatures from MGS/TES and MRO/MCS with the goal of fully characterizing the behavior of these storms.

Both MGS and TES provide data well-suited for temperature analysis at 25 km. MCS measures atmospheric temperature, dust extinction, and water ice extinction at 5 km intervals from the surface to about 80 km. TES measured atmospheric temperatures, column dust and water ice opacities, and column water vapor abundances. Measurements made by TES extended from the surface to about 40 km [1].

At the 50 Pa (25 km) level, local dust events usually confined to shallower depths are effectively filtered out of the analysis leaving the regional dust events identifiable by their temperature signatures [1]. Our preliminary analysis makes use of the fact that the brightness temperature at 15 microns (T15 temperature) is a close approximation to observed temperature at 25 km. We first reproduce the zonal mean 50 Pa level temperature plots for MY 29-32 to establish a baseline for our procedures moving forward [1]. Expanding on Kass et al. (2016), we include recent MCS data from MY 33 and 34 as well.

Preliminary Analysis: The daytime (3PM) T15 temperatures in Figure 1 indicate: in MY 29, a strong A storm at Ls 240, a B storm at high southern latitudes just after Ls 270, and a C storm at Ls 320; in MY 30, a B storm at Ls 270; in MY 31 & MY 32, a B storm just before Ls 270; in MY 33, a B storm at Ls 270; and in MY 34, a strong A storm in the northern hemisphere at Ls 210, and a B storm around Ls 270 although there is a data gap. For the B storms, each is indicative of lofted dust and resultant warming.

The daytime temperature structure illustrates that the B storm occurs annually around Ls 270 and is confined to high southern latitudes. It reaches its peak intensity around SH summer solstice, Ls 270, consistently for all six MY assessed.

Since direct solar heating is absent overnight, the nighttime T15 temperatures (Figure 2) are often useful for differentiating the heat signature of direct solar heating from the dynamical response to that heating. However, in the southern polar latitudes at perihelion the sun does not set and direct solar heating remains present throughout the night. Importantly for our study, dust lofted in the B storm experiences this direct heating day and night for the entirety of its lifetime.

The B storm expands as far north as -60 latitude and decays in latitudinal extent more gradually than it grows. This feature is less obvious in the nighttime (3AM) T15 temperatures (Figure 2).

The temperature signal is stronger at night for MY 30-33. The warm pool is larger in area relative to the background at night in these four cases. This more uniform warming masks the "tail" feature somewhat, such that it is barely noticeable during these years.

Unfortunately, gaps in MCS data in MY 29 and 34 prevent confirmation of the tail feature during those years, however, the B storm temperature signature follows a very different pattern than that described for MY 30-33. MY 29 and 34 appear to show smaller centers of warming at night and larger centers of warming during the day. This is in opposition to that previously described for MY 30-33.

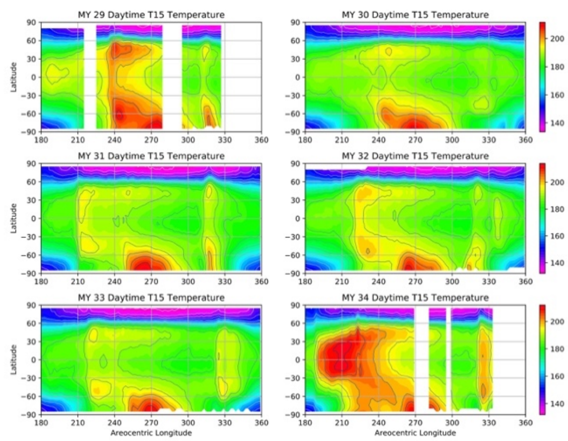

Figure 1. 3PM zonally averaged T15 temperatures at 50 Pa between Ls 180-360 for Mars Years 29 through 34.

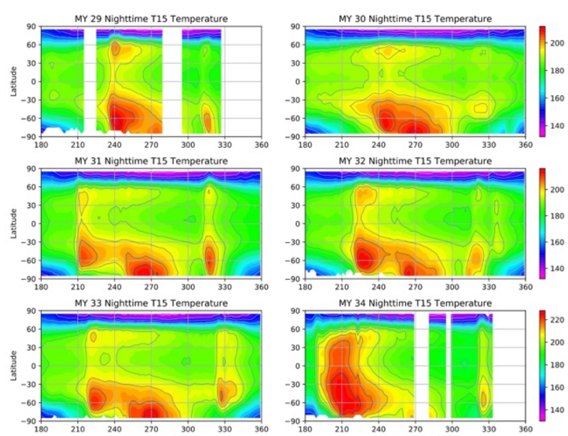

Figure 2. Same as Figure 1 but for 3AM.

Conclusions and Future Work: We will continue investigating the heat signatures of B storms by looking at the total column heating as recorded by TES. We will also look at lower altitudes for patterns that may describe the relationship between B storms and the cap edge storms that develop while the seasonal cap is retreating. In the future, we will use GCM simulations to determine the atmospheric and thermodynamic conditions associated with these storms.

References: [1] Kass D. M., Kleinbohl A., McCleese D. J., Schofield J. T. and Smith M. D. (2016) *Geophs. Res. Letters, 43,* 6111–6118. [2] Wang, H. and Richardson, M. I. (2015). *Icarus, 251*, 112-127. [3] Heavens N. G. et al. (2011). *J. Geophys. Res., 116.*