ATMOSPHERIC RESULTS FROM THE MGS HORIZON SCIENCE EXPERIMENT.

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Introduction: The Horizon Science Experiment (HORSE) utilizes the Mars Horizon Sensor Assembly (MHSA) on the Mars Global Surveyor (MGS) orbiter to measure 15-μm band thermal emission from the Martian atmosphere. During the first two phases of aerobraking, from September 1997 to May 1998, and from September 1998 to March 1999, one of the four MGS quadrants was pointed well onto the planet consistently during the near-periapsis aerobraking passes, allowing the device to obtain data on the latitudinal variation of middle atmospheric temperature ($0.2-2.0$ mbar). Of particular interest during the first phase ($L_s = 182-300°$) were the effects of a prominent dust storm at $L_s = 224°$, and wavelike behavior in the strong temperature gradient near the north polar cap [1].

Southern Polar Vortex: The second phase of aerobraking extended from $L_s = 30-92°$. The periapsis shifted to the far south, allowing coverage of the southern polar winter vortex. During this phase the short orbital period allowed much faster longitudinal coverage, and maps of the MHSA data could be made each day. As in the north, a strong wavelike behavior was found in the high-latitude thermal gradient. Here, however, longitudinal (i.e., zonal) wavenumber one dominated, as opposed to two in the north during phase one aerobraking [1]. The latitude of steepest temperature gradient, y, seen by the MHSA during southern late autumn and early winter periods can be fit with the expression

$$y = \varphi_0 + a_1 \cos(\lambda + a_2) + a_3 \cos(2\lambda + a_4)$$

where λ corresponds to west longitude; φ_0 is the mean latitude (°); a_1 and a_3 are the amplitudes (°), and a_2 and a_4 are the phases (rad) of the first two harmonics. Values of the coefficients are listed in Table 1. Examination of annual simulations from the NASA Ames Mars general circulation model [2, 3] for southern autumn ($L_s = 75°$) shows a substantial north-south temperature gradient in southern middle and high latitudes that supports a strong westerly polar vortex aloft. Embedded in the southern polar vortex are significant longitudinal wavelike structures which produce significant zonal departures in the mean thermal and horizontal momentum fields through several scale heights (Figure 1a). The mean horizontal flow is not longitudinally uniform, particularly downstream of the Tharsis region and in the vicinity of the Hellas basin. Such north-south undulations in the mean westerly flow are manifestations of a large stationary (orographically forced) planetary wave (wavenumber 1 predominantly with wavenumbers 2 and 3 important below 0.1 mbar) excited in the southern polar vortex (Figure 1b).

L_s range	φ_0	a_1	a_2	a_3	a_4
74.1–75.5°	-58.7	4.4	4.2	-0.8	-11.0
76.4–77.7°	-59.4	4.7	3.8	0.8	-0.5
81.1–83.6°	-57.2	4.9	3.9	1.5	-39.0
91.6–92.5°	-56.7	-2.95	38.9	1.1	-0.3

Table 1: Coefficients for the latitude of steepest thermal gradient, y, observed by MHSA during the late stages of phase two aerobraking.

Mapping Phase: The MGS mapping phase began in March 1999. In this normal configuration, the MHSA samples data near the limb in four directions at once: fore and aft along the groundtrack, and on both sides of the track. This geometry provides greater local time coverage than does the Thermal Emission Spectrometer (TES). The off-track quadrants sample longitudes about ± 1 hour from the groundtrack (˜2 AM and PM). Thus, enhanced sampling of diurnal variations in temperature is available. This permits investigating thermal tidal characteristics of the atmosphere by analysis of the variations in atmospheric temperature as a function of local time. Thermal tidal amplitudes are dependent upon the thermal forcing of the atmosphere, which itself is strongly dependent upon both the magnitude of and spatial distribution of the suspended dust load. The 'curvature' in local time of these temperature variations can be diagnostic of diurnal and higher harmonic temperature variations which will be in part a manifestation of thermal tidal signatures. We are using analyses of numerical model results to characterize the magnitude of such temperature 'curvature' signals with diagnosed thermal tidal amplitudes. We will show preliminary results of this model analysis and initial attempts to apply this technique to recently acquired MGS MHSA mapping data.

References: [1] Martin T.Z. (1998) *Bull. Amer. Astron. Soc.,* **30,** 1020. [2] Haberle R.M. et al. (1993) *J. Geophys. Res.* **98,** 3093–3124. [3] Haberle R.M. et al. (1997) *J. Geophys. Res.* **102,** 13301–13311.

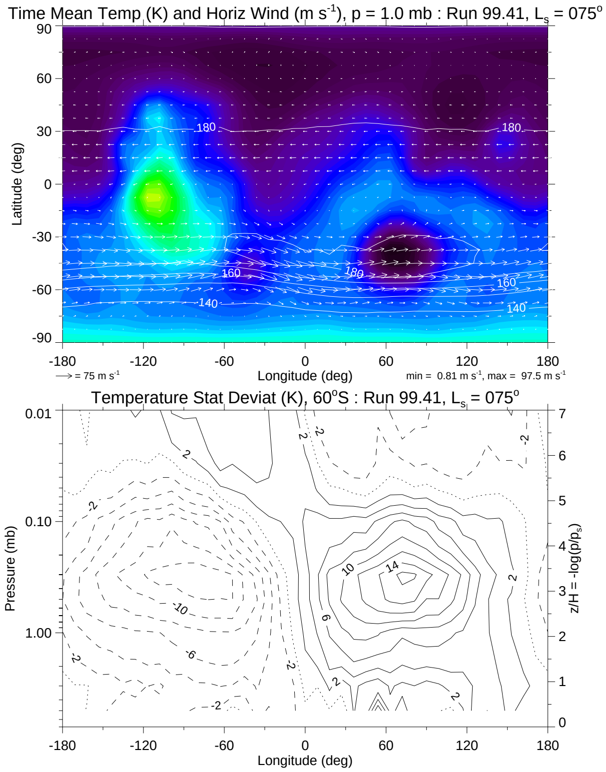

Figure 1: (a) A longitude-latitude cross section of the seasonal mean temperature (K) and horizontal wind (m/s) at p = 1.0 mbar as simulated by the NASA Ames Mars general circulation model for $L_s = 75°$. (b) A longitude-pressure cross section at 60°S of the stationary east-west (i.e., longitudinal) temperature deviation (K) from the seasonal mean. In panels (a) and (b) the contour intervals are 10 K and 2 K, respectively, and negative values in (b) are dashed.