BRIEF REVIEW ON THE RESULTS OBTAINED WITH THE MGS AND MARS ODYSSEY 2001 ACCELEROMETER EXPERIMENTS

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The Mars Global Surveyor (MGS) z-axis accelerometer has obtained over 1600 vertical structures of thermospheric density, temperature, and pressure, ranging from 110 to 170 km, between Sept. 1997 and March 1999, compared to only three previous such vertical structures from Viking 1, 2, and Pathfinder (Tolson, et al., 1999). In November 1997, a regional dust storm in the Southern Hemisphere triggered an unexpectedly large thermospheric response at mid-northern latitudes, increasing the altitude of thermospheric pressure surfaces there by as much as 8 km and indicating a strong global thermospheric response to a regional dust storm (Keating, et al., 1998).

From analysis of the MGS accelerometer data, enormous planetary scale waves have been detected in the Martian thermosphere between 60°N and 60°S. Fourier analysis of the wave structure reveals high amplitude waves 2 and 3 which appear to remain at nearly constant longitude between ± 60° latitude when viewed near 3 PM (Keating, et al., 2001, Bougher, et al., 2001). However, measurements near 3 AM show evidence of essentially a phase reversal in wave 2 (Keating, et al., 2001). Taking into account the near sun-synchronous orbit it appears that these waves are principally non-migrating tides propagating to the east. Studies by Wilson et al. (Wilson, 2002) and Forbes et al. (Forbes, et al., 2002) indicate the wave 2 component is principally an eastward propagating diurnal wave 1 which rotates around Mars in the opposite sense of the sun once per day (basically the wave 1 Kelvin wave, which results from the interaction of tides and topography). Analysis of Thermal Emission Spectrometer (TES) MGS data near 30 km (Wilson, 2002) indicates a similar phase to this wave at 30 km (Wilson, 2002) and thus the wave appears to propagate up from below into the thermosphere. The observed wave 3 may be a combination of an eastward propagating, semi-diurnal wave 1 and the eastward propagating, diurnal wave 2 (basically the wave 2 Kelvin wave). Both the observed wave 2 and wave 3 maximize near the equator. These results give further evidence of coupling between the lower and upper atmosphere.

The Mars Odyssey 2001 (M01) Spacecraft was placed into orbit about Mars in September 2001. Aerobraking was performed from then until January 2002 to circularize the M01 orbit. The spacecraft carried triaxial accelerometers, which were used to safely perform aerobraking and to continue exploration of the detailed properties of the upper atmosphere, which had begun with the Mars Global Surveyor accelerometer measurements. The accelerometers were used to measure atmospheric density, and from the vertical structures measured on both inbound and outbound trajectories the scale height, temperature and pressure were determined. Altogether 600 vertical structures were obtained ranging from 95 km to above 170 km. Measurements were obtained for the first time near the North Pole and also the first measurements were obtained on the night-side in the Northern Hemisphere. Temperatures near 110 km were discovered to increase with latitude maximizing near the North winter pole, apparently due to dynamical heating (Keating, et al., 2002). This result is contrary to the MarsGram and MTGCM models used for Odyssey aerobraking, where model temperatures are predicted to minimize near the winter pole. For example, maximum temperatures near the North winter pole at 100 km were observed to be near 200 K while MTGCM temperatures were predicted to be near 100 K. However, a winter polar warming is predicted by the European Mars GCM (Forget, et al., 1999) at both the North and South Poles in local winter at high altitudes. The altitudinal variations and high latitude diurnal variations of temperature near the North Pole also appear to be in fair accord with the Forget et al. model. Apparently the upper atmosphere North polar winter warmings may result from adiabatic heating from the subsiding branch of the cross-equatorial meridional circulation from the Southern Hemisphere summer. The only measurements of the Southern Hemisphere winter polar upper atmospheric temperatures were obtained from accelerometers aboard the Mars Global Surveyor. These measurements do not show winter polar warmings, but minimum temperatures near the winter South Pole more in accord with radiative equilibrium, and more in accord with the MTGCM model. Apparently the summer-to-winter cell supplying dynamical heating to the North winter pole near perihelion is much stronger than the summer-to-winter cell supplying dynamical heating to the South winter pole near aphelion. The stronger dynamical heating during the North polar winter may result from being near perihelion where the closer sun and stronger dust activity may strengthen the meridional cell.

Figure 1 shows the complementary nature of the Mars Global Surveyor and Mars Odyssey 2001 accelerometer measurements and the measured global latitudinal/seasonal and diurnal variations in the Martian upper atmosphere at 130 km. The data points in green represent a 35 point running mean of the MGS Phase 1 data (fall/winter, Northern Hemisphere). The data points in blue represent MGS Phase 2 data (spring/summer Northern Hemisphere and fall/winter Southern Hemisphere). The data points in red represent the Odyssey 2001 data (fall/winter near North winter pole). Minimum densities at highest latitudes occur in winter near aphelion.

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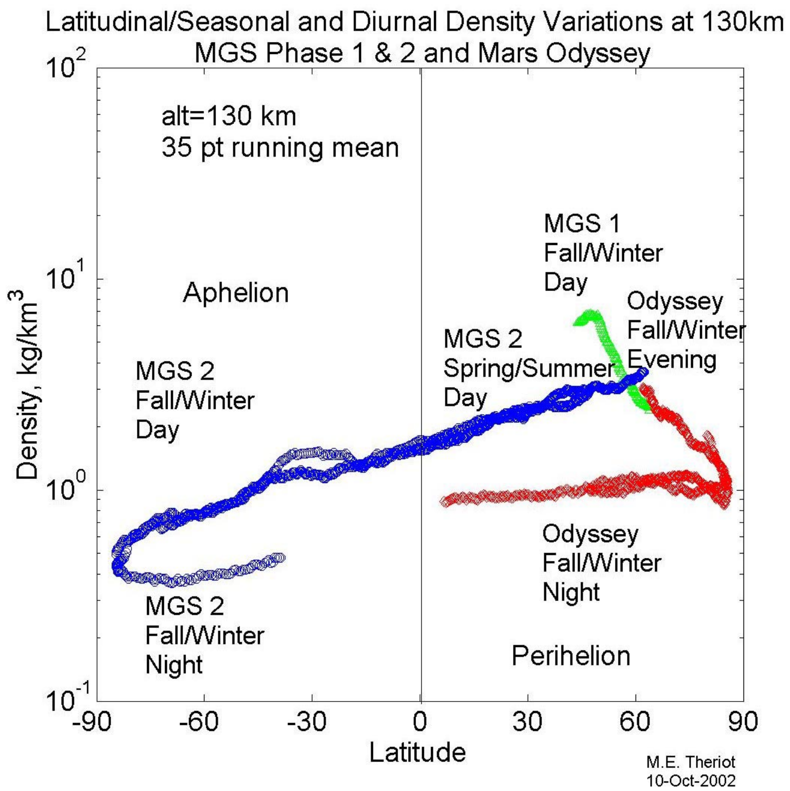

Figure 1