NEW RESULTS FROM MARS GLOBAL SURVEYOR ACCELEROMETER.

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1 Introduction

Continuing analysis of the Mars Global Surveyor (MGS) Accelerometer [Keating et al., 1998] data is providing new insight into the behaviour of the martian upper atmosphere.

Measurements from the accelerometer aboard Mars Global Surveyor (MGS) have yielded over 1600 vertical structures of martian thermospheric density and derived temperature and pressure, as compared to only 3 previous *in situ* profiles [Keating et al., 1998; Keating et al.; 1999, Bougher and Keating, 1999]. Spanning an altitude range of 100–170 km, these data have been obtained during two aerobraking phases: (1) 7 months spanning northern autumn and winter on Mars (L_s = 180^o to 300^o, during the martian dust storm season), from September 1997 to March 1998, and (2) 5 months spanning northern spring and summer on Mars (L_s = 30^o to 95^o during aphelion), from September 1998 to February 1999.

2 Changes in longitudinal structure with latitude

Longitudinal structure has been seen in the martian upper atmosphere during both Phase 1 and 2 of MGS aerobraking [Withers et al., 1999]. Variations in density by a factor of two over 45^o of longitude are commonplace. Longitudinal structure has been seen at every season (northern autumn, winter, spring, and summer), every latitude (60^o N to the south pole), and every local solar time (midafternoon and late night) at which measurements have been made at essentially fixed latitude and local solar time. Indeed, it appears to be ubiquitous.

Changes in the longitudinal structure with latitude can be easily seen during Phase 2, when periapsis precessed southward from 60^o N to the south pole at aphelion, a time of very slow seasonal change, with only a two hour change in local solar time. The longitudinal structure at a given latitude is characterised by a harmonic fit to all data within a 10^o latitude range. This harmonic fit is then normalised by its mean to remove the effects on the longitudinal structure of different mean densities at different latitudes. A series of fits centred on different latitudes is then merged in a contour plot to produce Figure 1.

Are high densities seen over high topography? Comparison with topography at mid northern latitudes shows no major density peak over Alba Patera, but a major density peak to the north of the Arabia highlands [Smith et al., 1999]. The density peak to the north of the Arabia highlands persists to the south, over the highlands and even over the eastern half of the low-lying Hellas basin. The western half of Hellas lies beneath a trough in density. There is not a good correlation between density and topography, which argues against a stationary wave model for generating the longitudinal structure.

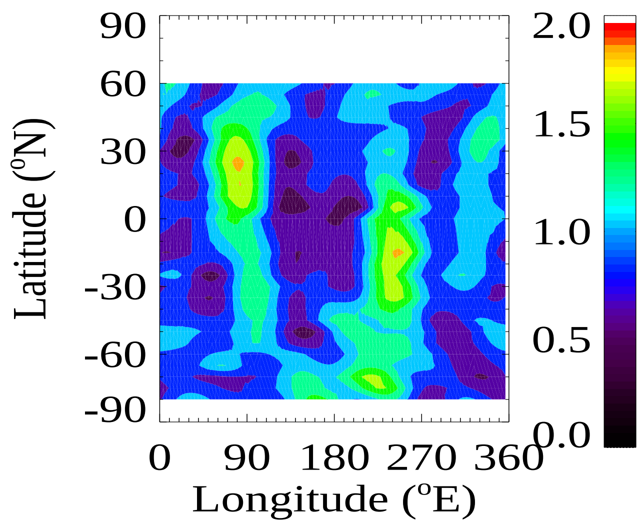

Figure 1: Ratio of fitted density to mean fitted density at same latitude for outbound densities at 130 km during Phase 2.

3 Changes in longitudinal structure with local solar time

Changes in the longitudinal structure with local solar time can be easily seen at the end of Phase 2, when periapsis crossed the terminator close to the south pole. Densities south of 40^o S were measured at approximately 3 p. m. and 2 a. m. local solar times, with only a few weeks separating the measurements at different local solar times. The daytime and nighttime longitudinal structures are completely different, as shown in Figure 2. Daytime densities are large and rarely have longitudinal structure significant above the 1 σ level, whereas nighttime densities are smaller and have a very pronounced longitudinal structure, with variations of a factor of 4 occurring over about 45^o of longitude. It is not possible for *both* the daytime and nighttime longitudinal structures to correlate with topography, as should occur in the stationary wave model, and no change with local solar time is predicted by this model. The observed changes with local solar time argue persuasively against the stationary wave model.

4 Day to day variability in martian upper atmosphere

Occasionally the orbit of MGS was such that repeat coverage was obtained at a given latitude, longitude, and local solar time at intervals of one martian day for a period of a few martian days. Usually density measurements were reasonably

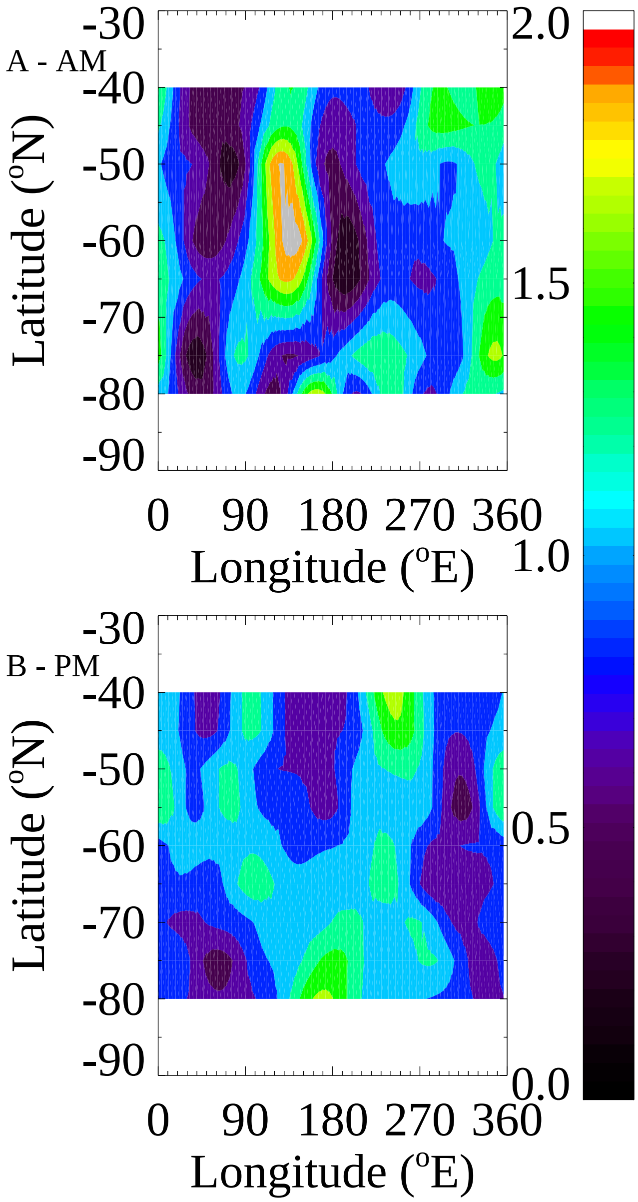

Figure 2: As Figure 1, but with inbound densities. (a) Local solar time approximately 2 a. m. (b) Local solar time approximately 3 p. m.

consistent from one measurement to the next. However in at least one instance (around mid-November 1998) upper atmosphere densities more than doubled in one martian day then returned to close to their initial values. This was observed at 330^o E at both 20^o and 40^o N. Such an event is believed to be too short-lived to be a dust storm.

5 Conclusions

The ubiquity, stability, and large amplitude of the longitudinal structure make it an important atmospheric phenomenon that must be successfully explained in any model claiming to describe the martian atmosphere.

Regular variations in the atmosphere with longitude at fixed latitude and local solar time require a forcing which also varies in longitude. Such a forcing must come from the surface or interior of the planet and the resulting wave(s) must propagate through the lower atmosphere. Hence the observed longitudinal structure will contain information on both the forcing and the properties of the lower atmosphere through which the wave(s) propagated. It contains information about the state of the lower martian atmosphere which, if it can be understood, will enable aerobraking data to reveal details about all altitude regions of the atmosphere, not just the upper atmosphere.

6 Acknowledgments

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7 References

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