MARS AEROBRAKING DATA AND ITS INTERPRETATION WITH APPLICATIONS TO FUTURE MARS MISSIONS

S. W. Bougher (1), G. M. Keating (2), P. G. Withers (3)

(1) U. of Michigan, (2) George Washington University, (3) Boston University

Recent Mars Global Surveyor (MGS) (1997-1999) and 2001 Mars Odyssey (Odyssey) (2001-2002) aerobraking exercises have provided a wealth of new measurements that contribute to the characterization of the Mars upper atmosphere structure (100-170 km) [e.g. Keating et al., 1998; Withers et al., 2003; Bougher et al., 2003]. The primary objectives for investigating the Martian upper atmosphere encompass both engineering and scientific purposes. For the former, it is essential to determine the short (diurnal and dust storm) and long term (seasonal and solar cycle) trends in the upper atmosphere climate. This information will be used to plan future aerobraking and descent exercises at the planet. Ultimately, it is important to determine the rates of escape of key species from the Martian upper atmosphere. Aerobraking data is limited in its spatial and temporal sampling, thereby serving only as the starting point for these detailed global studies of the Martian upper atmosphere.

Several key discoveries have been made during MGS and Odyssey aerobraking campaigns using Accelerometer measurements. It is confirmed that Mars upper atmosphere temperatures are the product of both solar cycle plus seasonal forcing. Zonal averaged latitudinal densities at constant heights are observed to decrease toward the winter polar night, as expected. However, a winter polar warming is observed during perihelion conditions near the Martian mesopause. No such warming is revealed in the opposite winter polar region during aphelion conditions. Longitude-fixed density features are observed during constant local time sampling; strong wavenumber 1-3 components are identified. Upward propagating non-migrating tides, linked to surface topographic features, are likely responsible. Finally, Mars dust storm impacts are felt at thermospheric heights within a few days of the onset of dust lofting. Thus, the Mars thermospheric structure and dynamics are typically driven by in-situ solar EUV/UV processes with significant modification by upward propagating tides and dust induced effects. Selected multi-dimensional model simulations will be presented to illustrate these key features of the Mars upper atmosphere.