EXTENDED ABSTRACT

Mars Global Reference Atmospheric Model (Mars-GRAM 2001) is an engineering-level Mars atmosphere model widely used for many Mars mission applications (Justus and Johnson, 2001; Justus et al., 2002a). From 0-80 km, it is based on NASA Ames Mars General Circulation Model (MGCM; Haberle et al., 1993), while above 80 km it is based on Mars Thermospheric General Circulation Model (Bougher et al., 1990). Mars-GRAM 2001 and MGCM use surface topography from Mars Global Surveyor Mars Orbiting Laser Altimeter (MOLA; Smith and Zuber, 1998).

Validation studies (Justus et al., 2002b,c) are described comparing Mars-GRAM with Mars Global Surveyor Radio Science (RS; Hinson et al., 1999) and Thermal Emission Spectrometer (TES; Smith et al., 2001) data. RS data from 2480 profiles were used, covering latitudes 75° S to 72° N, surface to ~40 km, for seasons ranging from areocentric longitude of Sun (Ls) = 70-160° and 265-310°. RS data spanned a range of local times, mostly 0-9 hours and 18-24 hours. For interests in aerocapture and precision landing, comparisons concentrated on atmospheric density. Figure 1 shows that, at a fixed height of 20 km, RS density varied by about a factor of 2.5 over ranges of latitudes and Ls values observed. Evaluated at matching positions and times, Figure 2 shows average RS/Mars-GRAM density ratios were generally ±0.05, except at heights above ~25 km and latitudes above ~50° N. Average standard deviation of RS/Mars-GRAM density ratio was 6%.

TES data were used covering surface to ~40 km, over more than a full Mars year (February, 1999 – June, 2001, just before start of a Mars global dust storm). Depending on season, TES data covered latitudes 85° S to 85° N. Most TES data were concentrated near local times 2 hours and 14 hours. Observed average TES/Mars-GRAM density ratios were generally ±0.05, except at high altitudes (15-30 km, depending on season) and high latitudes (> 45° N), or at most latitudes in the southern hemisphere at Ls ~ 90 and 180°. Compared to TES averages for a given latitude and season, Figures 3-5 show that TES data had average density standard deviation about the mean of ~2.5% for all data, or ~1-4%, depending on time of day and dust optical depth. Average standard deviation of TES/Mars-GRAM density ratio was 8.9% for local time 2 hours and 7.1% for local time 14 hours. Thus standard deviation of observed TES/Mars-GRAM density ratio, evaluated at matching positions and times, is about three times the standard deviation of TES data about the TES mean value at a given position and season.

Figure 1 – Comparison of density at 20 km altitude from Mars Global Surveyor Radio Science observations and Mars-GRAM 2001 model.

Figure 2 - Height-latitude cross section of average observed density ratio (Radio-Science/Mars-GRAM 2001) for all Ls and times of day.
issues for accidental break-up and burn-up scenarios. For lander missions, applications include analysis for entry, descent and landing (EDL), guidance and control analysis for precision landing, and (with the new near-surface environment features) systems design and analysis for lander operations.

ACKNOWLEDGMENTS

The authors gratefully acknowledge support from the Mars Data Analysis Program (MDAP), Dr. Joseph Boyce, NASA Headquarters, MDAP Discipline Scientist. We also thank Dr. John Pearl and other members of the Mars Global Surveyor Thermal Emission Spectrometer team for providing their data in a timely and useful form.

REFERENCES


