The Martian Upper Atmosphere as Revealed by Mars Global Surveyor's Aerobraking

Paul Withers and Steve Bougher, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, *withers@lpl.arizona.edu*

Mars Global Surveyor observed large and unexpected variations in upper atmospheric density with longitude. A stationary wave fit to these variations changed in both amplitudes and phases with latitude and did not correlate precisely with topography.

Mars Global Surveyor (MGS) has completed aerobraking. During phase 2 of aerobraking (September 1998 - February 1999) the elliptical, near polar orbit penetrated the atmosphere for ~10° either side of periapsis. Periapsis precessed from $\sim 60° N$ to the south pole and back to $\sim 60° S$, sampling all longitudes. The local solar time range of periapsis was more restricted, being ~1500 until periapsis neared the south pole when it quickly changed, through midnight, to ~0200 as periapsis crossed the terminator. Periapsis altitude was $\sim 110 \pm 10$ km. During this period Mars was passing through aphelion and the season was northern spring.

An accelerometer (ACC) onboard MGS allowed the derivation of density, density scale height and temperature at periapsis and 130 km (both inbound and outbound). This data, intended for mission support, is also a valuable scientific resource. Future processing by the instrument team will generate vertical profiles of the three above-mentioned parameters for each orbit.

Predictions of the density, density scale height and temperature of the martian upper atmosphere during aerobraking were made by the Mars Thermosphere Global Circulation Model (MTGCM) for mission support. These predictions failed to completely capture some aspects of the martian upper atmosphere as measured by MGS.

1) A vertical offset of a few kilometres between model and actual upper atmosphere heights must be included to force a reasonable fit to the averaged behaviour of the upper atmosphere. This offest is set according to ACC measurements of the height of a reference pressure level. It is thought that this offset is due to poor knowledge of the vertical dust distribution, small problems in the radiative transfer model and incomplete coupling between the lower boundary of the MTGCM and the upper boundary of a lower atmosphere global circulation model.

2) MGS observed startling variations in density by about a factor of three with longitude. The variations were reasonably well fit by a stationary wave model with waves having 1 to 4 cycles over 360° of longitude. MTGCM did not predict any variation in atmospheric properties with longitude. No such variation is observed on Venus or the Earth. The amplitudes and phases of the waves changed as periapsis precessed southward but did not correlate precisely with topography. Topography is presently thought to be the forcing mechanism for the waves.