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Thermal tides on Mars: Comparing Mars Global Surveyor refractivity data with the Mars Climate Database

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Radio occultation measurements of atmospheric refractivity with Mars Global Surveyor (MGS) cover the same surface to 250 km altitude range as the recently extended Mars Global Climate Model (MGCM) from the Labroratoire de Meteorologie Dynamique-CNRS in Paris (LMD). In this work, we analyze and compare profiles of atmospheric refractivity from MGS with profiles of neutral density from the Mars Climate Database (MCD) version 4.0, a database of atmospheric statistics compiled from the MGCM and developed by LMD and the department of Atmospheric, Oceanic and Planetary Physics (Oxford) in collaboration with the Instituto de Astrofísica de Andalucía (Granada). Comparing results from the MGS refractivity observations with results from the MCD under similar conditions contributes to our understanding of observed phenomena as well as helps to test and validate the numerical simulation.

Our recently published approach for analyzing the MGS refractivity profiles uses basic wave decomposition techniques with weighted-least squares to generate amplitudes and phases for observed zonal wave numbers over the entire altitude range. These fitted amplitudes and phases allow us to study atmospheric structure and dynamics, such as thermal tides near the electron density peak ($\sim$130 km) and stationary Rossby waves in the neutral atmosphere (0–50 km) as well as the transition region between the neutral atmosphere and ionosphere (60–80 km). For example, our initial results with a small subset of the MGS refractivity data show distinctive structure from 80–200 km which appears to be caused by an eastward-propagating semidiurnal tide with zonal wave number 1.

We further characterize this tidal component using a larger set of MGS refractivity

profiles during spring and summer in northern hemisphere. The MGS data set extends coverage in latitude (65–85^{o}N), season ($L_{\rm S}$=70–170 in MY 25), and local time ($t_{\rm LST}$ $\sim$3–9 hours). We compare the MGS refractivity results to the neutral density simulation represented in the MCD and investigate the degree to which the MCD simulates the behavior of this observed tidal component.