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Analysis of the origin of Martian tides using MGS aerobraking densities and a general circulation model

Y. **Moudden** (1) and J.M. Forbes (1)
(1) Colorado University (youssefmoudden@gmail.com)

MGS accelerometer measurements reveal large (10-25%) zonal variations in density at aerobraking altitudes that are well-captured by a Fourier decomposition or a least-squares fit comprised of waves 1-3. These variations were initially interpreted as stationary waves but were later demonstrated to be non-migrating tides that appear as stationary waves from Sun-synchronous orbit. The Global Mars Multiscale Model (GMMM) is found to reasonably replicate the observed density structures. Herein, the GMMM is used to perform a series of controlled numerical experiments that isolate the waves that are generated by longitudinal variations in topography, from those that are due to other processes such as zonal asymmetries in surface properties and nonlinear wave-wave interactions. Although the largest aerobraking density structures can be traced to specific topographic zonal wavenumber components, zonally-varying surface properties and nonlinear wave-wave interactions make important contributions for some waves. For instance, surface asymmetries in thermal inertia and albedo on their own account for diurnal standing (s = 0) and eastward-propagating (s = -1) density amplitudes of order 5-10%. Various examples are discussed wherein specific features of the observed density structures can be traced back to their excitation origins.