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Tidal effects on the zonal mean structure of Mars' lower thermosphere

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The Global Mars Multiscale Model (GMMM) is a general circulation model of Mars' atmosphere extending to about 170 km. The GMMM is found to reasonably replicate the zonal density structures near Ls = 90 and between -70 and +80 deg latitude and 110-130 km altitude observed by the MGS accelerometer, and that are attributable to non-migrating tides. The importance of both migrating (sun-synchronous) and non-migrating tides to the dynamics of Mars' atmosphere is well known. However, the effects of tidal dissipation (primarily through radiative damping and molecular dissipation) on the structure and dynamics of the zonal mean atmosphere have not yet been well delineated. Here we use the GMMM to perform controlled experiments to reveal these effects, which are quite substantial. For instance, migrating (westward-propagating) tides enhance the summer-to-winter Hadley-like circulation that extends into the lower thermosphere, and produces temperature increases of ˜20K due to subsidence heating between 100-140 km in the high-latitude winter hemisphere, while the predominantly eastward-propagating non-migrating tides at these levels oppose this effect. Dissipation of non-migrating tides produces zonal mean eastward winds of order 10-70 m/sec (maximizing near 120 km) between 60 and 140 km at low to middle latitudes, while addition of the migrating tidal effects produce westward mean winds that tend to negate this effect, and in fact reverse the zonal mean winds to -20 to -40 m/sec above 130 km over the equator and between 80 and 140 km above 30 deg latitude in the winter hemisphere.