OBSERVATIONS AND MODELING OF THERMAL STRUCTURE IN THE LOWER ATMOSPHERE AND THE UPWARD PROPAGATION OF TIDES INTO THE THERMOSPHERE. R. J. Wilson, and M. Kahre, NASA Ames Research Center, CA, USA (robert.j.wilson@nasa.gov).

Introduction: Thermal tides are the atmospheric response to diurnally varying thermal forcing resulting from radiative and convective heat transfer from the surface and from aerosol and gaseous heating within the atmosphere. Tides include sun-synchronous (migrating) waves driven in response to solar heating and additional non-migrating waves resulting from longitudinal variations in the distributions of topography, dust aerosol and water ice clouds. The systematic spatial mapping of temperature over 5 Mars years by the Mars Climate Sounder (MCS) has yielded a well-defined climatology of seasonally-varying temperature structures in the lower atmosphere, from 5 to ~80 km. Tide theory and Mars global circulation model (MGCM) simulations are a fruitful framework for relating temperature observations to thermal forcing by aerosol fields [1]. The analysis of density and temperature fields derived from MAVEN IUVS and NGIMS observations have revealed the presence of predominantly zonal wave 2 and 3 features at altitudes of 100-170 km that are almost certainly non-migrating tides propagating upward from the lower atmosphere [2,3]. In this presentation we will use the MCS climatology and MGCM simulations to relate the density variations seen by MAVEN with the seasonally varying tide activity in the lower atmosphere. Large amplitude perturbations in density are most sensitive to the tide components with the longest vertical wavelengths in temperature, which are well resoloved in MCS observations.

MCS Observations: Observations at 3am and 3pm local time allow for the construction of T_{avg}= (T_{3pm}-T_{3am})/2 and T_{diff}= (T_{3pm}-T_{3am})/2. The former field reflects the combined impact of stationary waves and semidiurnal tides, while the latter reflects the presense of diurnal tides. Apart from episodic global dust storms and the more regular occurrence of regional dust storms in the pre- and post-solstice seasons, there is a well-defined annual variation that reflects the seasonal cycle of insolation and the background variation in dust and water ice clouds. Figure 1 shows the latitude variation with season of the amplitude of the zonal wave 2 component of MCS temperature structure in the 60-75 km region of the atmosphere. The axisymmetric semidiurnal tide (S0) is particularly prominent at high latitudes (~75°N) during the L_s= 45-135° season (Figure 1a), while the diurnal wave 1 Kelvin wave (DE1) accounts for much of the structure in Figure 1b. The recent availability of additional local time observations acquired from cross-track limb viewing mode [4], in addition to the along track retrievals, has enabled a more complete characterization of diurnal temperature variability. In particular, the analysis of these multitrack observations has confirmed the presence of eastward propagating diurnal-period Kelvin waves and nonmigrating semidiurnal tides [*5*].

Modeling: Comparisons of the seasonally evolving latitude-height structure of the various tide modes derived from multitrack observations with MGCM simulations show encouraging agreement. There are also clear indications that many of the tide modes are sufficiently sensitive to aerosol forcing (including ice clouds) to be of diagnostic value in validation studies.

Conclusions: The very high degree of repeatability of atmospheric wave structure from year to year allows for the use of the MCS tide climatology to connect the temperature structure of the lower atmosphere to specific structures sampled by MAVEN at higher altitudes. The similarities between modeling and observations is reassuring, while the differences suggest that the tides may indicate sensitivity that can be exploited to improve aspects of the description of the zonal mean state of the winds and the distribution of thermal forcing. Ongoing modeling efforts will focus on extending simulations to higher altitudes.

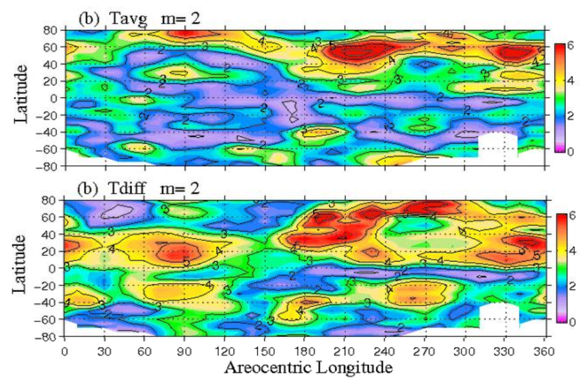

Figure 1. Seasonal evolution of the maximum amplitude of the zonal wave 2 component of the (a) T_{avg} and (b) T_{diff} fields within the layer bounded by 1 and 0.1 Pa (60-75 km).

References: [1] Moudden, Y., and J. Forbes, JGR, 113, (2008) [2] Lo et al., GRL, 42, (2015) [3] Liu et al., JGR, 122, (2017), [4] Kleinbohl A. et al., GRL, 40, (2013) [5] Wu, Z et al., JGR, 120, (2015).