A global view of small-scale perturbations in Mars' lower thermosphere derived from MAVEN/IUVS stellar occultation

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A global distribution of small-scale temperature and density perturbations in the Martian lower thermosphere (100-130 km) was inferred from the Mars Atmosphere EvolutioN (MAVEN) Imaging Ultraviolet Spectrograph (IUVS) stellar occultations for the first time. Two comprehensive Martian general circulation models (MGCMs), a gravity wave (GW) resolving MGCM and the Mars Planck Institute MGCM incorporating a state-of-the-art GW parameterization have been used to interpret the observations. The main results of this study are as follows:

(1) The observed perturbations demonstrate GW signatures with vertical wavelengths of 10-20 km and amplitudes of up to 7 % of the mean temperature (˜10 K) and 15-20 % of the mean density.

(2) The global distribution of the observed wave potential energy in the lower thermosphere possesses a distinct latitudinal structure. Larger values are found at middle- and high-latitudes (>30deg) and a weaker activity is inferred in low latitudes around the equator. This is contrary to the distribution of GW activity in the lower atmosphere, whose maximum is located in low latitudes.

(3) Our simulations with the two MGCMs demonstrate that the background winds play a major role in vertical propagation of GWs generated in the lower atmosphere. They can explain the latitudinal distribution of the observed GW activity in the lower thermosphere.

(4) The observed perturbations in the lower thermosphere are probably caused by GWs of tropospheric origin penetrated from below. More IUVS stellar occultation data will help to constrain GW parameterizations, validate Martian GCCMs, thus increasing perdictive skills of the latter.