MAVEN/NGIMS observations and full-particle DSMC modeling of gravity waves in the Martian upper thermosphere

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Global distribution and parameter dependences of gravity wave activity in the Martian upper thermosphere have been analyzed using density profiles obtained by the Neutral Gas Ion Mass Spectrometer (NGIMS) onboard the MAVEN spacecraft. The average amplitude of gravity waves around the Martian exobase is ~10% on the dayside and ~20% on the nightside, which is about two and ten times larger than those on Venus and in the low latitude region of Earth, respectively. The amplitudes are inversely proportional to the background atmospheric temperature, suggesting saturation due to convective instability in the Martian upper thermosphere. After removing the dependence on the background temperature, dependences of the average amplitude on the geographic latitude and longitude and solar wind parameters are found to be not larger than a few percent. These results suggest that the amplitudes of gravity waves are mainly determined by convective breaking/saturation in the upper thermosphere on Mars, unlike those on Venus and Earth. We have also performed numerical simulations of propagation, saturation, and dissipation processes of gravity waves in the Martian upper thermosphere using a full-particle Direct Simulation Monte-Carlo (DSMC) model. The modeling results are compared to the NGIMS observations with a particular emphasis on the vertical profiles of the wave amplitudes and their day-night variations to constrain the vertical and horizontal wavelengths of the observed waves.

Keywords: Gravity waves, Upper thermosphere, Mars

