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Convectively-generated gravity waves on Mars and their influence on the upper atmosphere

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Gravity waves in the Martian atmosphere have been identified through various observations. The sources of the waves are still unclear, although topographically-generated gravity waves have been studied using regional models and incorporated into Mars GCMs with parameterizations. Here we investigate convective generation of gravity waves on Mars using a two-dimensional regional model based on the non-hydrostatic meteorological model CReSS. The heating source of the convection model is considered a horizontally-uniform heating of the atmosphere near the surface by sunlight and a localized heating caused by absorption of sunlight by dust clouds. The results show that tntense convection is generated as a result of a thin atmosphere, leading to generation of short-period, large-phase velocity (both in horizontal and vertical) waves. Such waves can reach high altitudes without serious dissipation; the horizontal wavelengths and the amplitudes of the gravity waves reproduced in the lower thermosphere are consistent with the density fluctuations measured during aerobraking experiments. The waves attain saturation amplitudes above ˜80 km altitude.

We further investigated the properties of vertical propagation and dissipation in the thermosphere using linear wave solutions based on the wave parameters observed in the convection experiment. Gravity waves reaching the thermosphere are damped by molecular diffusion and heat the atmosphere. The vertical profile of the heating rate shows two maxima: the lower one is located near the altitude where the amplitude peaks, and is generated by the sensible heat flux divergence, and the upper one is generated by the viscous dissipation of kinetic energy. These heating rates are comparable to other dominant processes such as EUV heating.

Keywords: Mars, gravity wave, convection