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Gravity Waves in the Martian Atmosphere detected by the Radio Science Experiment MaRS on Mars Express

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Abstract

Gravity waves are an ubiquitous feature in all stably stratified planetary atmospheres. They are known to play a significant role in the energy and momentum budget of the Earth, and they are assumed to be of importance for the redistribution of energy and momentum throughout the Martian atmosphere.

1. The Radio Science Experiment MaRS on Mars Express

The Radio Science Experiment on Mars Express, MaRS, regularly sounds the Martian atmosphere and ionosphere by study of radio occultations seen from Earth: Derived radial profiles of neutral number density are interpreted as vertical profiles of temperature and pressure from the surface boundary layer up to ~50 km with a typical vertical resolution of only a few hundred metres [1].

The atmospheric profiles cover a wide range of latitudes and local times, enabling us to study atmospheric wave phenomena at different spatial scales in the mesosphere and troposphere [2].

2. Gravity Waves in the Martian Atmosphere

This high vertical resolution provides the unique opportunity to study small scale vertical wave structures in the Mars' lower atmosphere. These are manifest as fine scale temperature perturbations most probably caused by gravity, i.e. buoyancy, waves produced by the displacement of air masses flowing over elevated topographical features or other atmospheric sources such as convection in the surface boundary layer or wind shear.

The global distribution of gravity wave energy as seen throughout the extant MaRS data set is under study. This work provides further insight into local time dependencies, seasonal variations, and influences of topography.

Further studies of gravity waves with ray tracing models are underway to better understand the interaction of gravity waves with the background atmosphere, as well as the propagation and momentum flux deposition of the waves in the lower and middle atmosphere.

References

[1] Pätzold, M., et al. (2004), MaRS: Mars Express Orbiter Radio Science, ESA-SP1240.

[2] Tellmann, S., M. Pätzold, B. Häusler, D. P. Hinson, and G. L. Tyler (2013), The structure of Mars lower atmosphere from Mars Express Radio Science (MaRS) occultation measurements, J. Geophys. Res. Planets, 118, 306–320, doi:10.1002/jgre.20058.