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Small Scale Wave Structures in the Martian Atmosphere as seen 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 assumed to play a significant role in the energy budget of a planet and the redistribution of energy and momentum throughout the atmosphere.

1. The MaRS Experiment

The Radio Science Experiment MaRS on Mars Express is sounding the Martian atmosphere and ionosphere using the spacecraft radio subsystem [1].

Radial profiles of neutral number density are used to derive vertical profiles of temperature and pressure from the surface boundary layer up to ~50 km with a vertical resolution of only a few hundred metres.

The high vertical resolution of the MaRS temperature profiles provides the unique opportunity to study small scale vertical wave structures in the Martian lower atmosphere between the surface and about 40 km. These small scale temperature perturbations are most probably caused by gravity waves (buoyancy waves) produced by the displacement of air masses flowing over elevated topographical features or other atmospheric sources like convection or wind shear.

2. Gravity Wave Structures

Gravity waves are known to play a significant role in the energy and momentum budget of the Earth [e.g. 2,3,4].

Important effects are also predicted for Mars [5,6] but observations are still sparse. The small scale temperature perturbations with wavelengths smaller than 10 kilometres are extracted by low pass filtering of the MaRS temperature profile and subtracting the low pass filtered profile from the original measurement.

A widely used parameter for the evaluation of gravity wave activity in atmospheric science is the wave potential energy per unit mass [4,7]:

$$E_p = \frac{1}{2}\left(\frac{g}{N}\right)^2 \left(\frac{T'}{\overline{T}_0}\right)^2 \qquad (1)$$

where g is the gravity acceleration, N the Brunt-Väisälä frequency, T' denotes the temperature perturbation and the low pass filtered temperature profile is given by T_0.

The global distribution of gravity wave energy will be examined using the entire data set of MaRS available at that time. Comparisons with other independent measurements and model predictions will be shown.

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