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Small-scale temperature fluctuations in the Venus Atmosphere as seen by the VeRa Experiment on Venus Express

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Abstract

Atmospheric waves are present in the Venus atmosphere over a wide range of spatial scales and may well play a significant role in the energy budget of the planet. The Venus Express Radio-Science Experiment VeRa retrieves atmospheric profiles between 40 and 90 km altitude which show a high variability resulting from atmospheric waves and turbulence. Small-scale temperature fluctuations originating from internal gravity waves with vertical wavelengths of only a few kilometers are detectable in the VeRa profiles in the Venus mesosphere and troposphere.

1. The VeRa Experiment

The Venus Express Radio Science Experiment VeRa investigates the Venus neutral atmosphere and ionosphere using the spacecraft radio subsystem in a one-way radio link mode at two frequencies, X-band (8.4 GHz) and S-band (2.3 GHz).

An Ultra-Stable Oscillator (USO) provides a high quality onboard frequency reference source for the derivation of electron density profiles in the ionosphere and profiles of pressure, temperature and neutral number density of the neutral atmosphere [1,2]. Radial profiles of neutral number density are derived over the altitude range 40–90 km during the regularly recurring occultations. Assuming aerostatic equilibrium, these are then converted to vertical profiles of temperature and pressure [3].

2. Small-scale temperature variations

Gravity waves are a common feature in many planetary atmospheres. Several instruments have reported detection of gravity waves in the Venusian mesosphere or upper cloud region [4,5,6,7,8], but their role in maintaining the atmospheric superrotation is still unclear.

The high vertical resolution of the VeRa temperature profiles provides the unique opportunity to study small-scale vertical temperature fluctuations that are otherwise unobservable by any other remote sensing measurement technique. These studies provide the opportunity to improve our understanding of Venus's poorly constrained energy and momentum budgets.

Standard wave theory is used to analyze the observed wave structures with regard to their vertical and horizontal structure as a function of latitude and local time.

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