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Characterising Atmospheric Gravity Waves on Venus's lower and upper cloud banks using Venus Express VIRTIS and VMC data.

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Abstract

On this talk, we will report on the detection and characterisation of atmospheric gravity waves on the lower and upper cloud deck of Venus using images from the Venus Monitoring Camera (VMC) and the Visible Infrared Thermal Imaging Spectrometer (VIRTIS). This work is intented to follow-up on the reports by Peralta,J.,et al.(2008)[10] and Piccilli,A.,et al.(2014)[11] going through the complete VIRTIS and VMC data sets to fully characterise gravity waves observed during the Venus Express mission. Images were navigated and processed for optimal detection of wave features and accurate characterisation of wave properties such as horizontal wavelength, packet length and width, orientation and where possible phase velocity of wave packet.

1. Introduction

An atmospheric gravity wave is an oscillatory disturbance on an atmospheric layer in which buoyancy acts as the restoring force. It can only exist in a stably stratified atmosphere, that is, a fluid in which density varies mostly vertically (Holton,2004)[4]. Gravity waves manifest themselves as regular cloud structures or quasi-periodic disturbances on atmospheric temperature profiles (Piccialli,A.,et al.(2014))[11]. Though their origin is not clear, possible theories include Kelvin Helmholtz instability, surface topography and convective instability below the upper cloud (Peralta,J.,et al.(2008), Piccialli,A.,et al.(2014))[10, 11]. Reports of observations of features interpreted as gravity waves are frequent on Earth's atmosphere (Sanchez-Lavega,A., 2011)[12], on the atmosphere of Mars (*Määtänen*,A.,et al.(2010), McConnochie,T.,et al.(2010))[6, 9], on Jupiter's temperature profile (Young,L.,et al.(2005))[14] and at cloud level (Arregi, J.,et al.(2005))[1]. On Venus' atmosphere, gravity waves have been detected both on temperature profiles acquired by the Pioneer Venus Probes (Counselman, C.,et al.(1980),Seiff,A.,et al.(1980))[2, 13] and visually on the base (44-48 km altitude) and upper (62-70 km) cloud deck with ultraviolet, visible and infrared observations with VIRTIS (Peralta,J.,et al.(2008))[10] and VMC (Machado,P.,et al.(2017), Markiewicz,W.,et al.(2007), Piccialli,A.,et al.(2014))[7, 8, 11, **?**], both onboard Venus Express. Atmospheric gravity waves are very important since they can transport energy and momentum by propagating both vertically and horizontally within the atmosphere (Holton,2004)[4] and could play a key role in the maintenance of the atmospheric circulation on Venus.

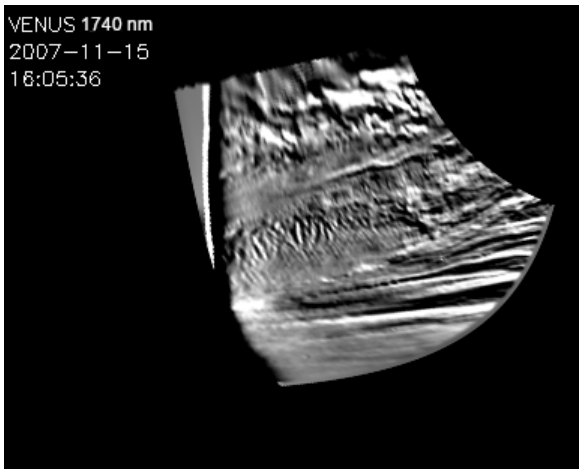

Figure 1: An atmospheric gravity wave as observed by VIRTIS-M at 1740 nm. The image is processed for increased contrast and cyllindrically projected.

2. Method, Results and Conclusions

We detected atmospheric gravity waves on the upper cloud deck ($\approx$ $68km$ altitude) with both VMC/VEx and VIRTIS/VEx at near-UV and visibile wavelengths and on the lower cloud deck ($\approx$ $48km$ altitude) with VIRTIS/VEx at infrared wavelengths. Using the PSA archive from ESA, we used VIRTIS and VMC data following the works in Peralta,J.,et al.(2008)[10] and Piccialli,A.,et al.(2014)[11] respectively. Gravity waves were detected as quasi-periodic contrasting bands on the observed layer of the atmosphere. Images were navigated and processed for both detection and further characterisation purposes.

Taking advantage of the high navigation precision provided by SPICE data and state-of-art planetary science tools such as PLIA (Hueso,R., et al.(2010))[5] and other software that has been used to measure winds on the cloud tops of Venus (Goncalves,R.,et al.(Submitted,2019))[3], we characterised several properties of detected wave-packets including horizontal wavelength, orientation, packet length and width. Some wave-packets were detected on several related images and were suitable for phase velocity measurements.

We present some first results of this study which expand upon Peralta,J.,et al.(2008)[10] and Piccialli,A.,et al.(2014)[11] with further characterised packets which could help in explaining the origin of such waves on the atmosphere of Venus and constrain models.

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