Amateur observations of a planetary-scale wave in the middle clouds of Venus

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Abstract

We present preliminary results from the identification and evolution of a planet-scale atmospheric wave - a Cloud Discontinuity (CD), occurred in the middle clouds of Venus during March/April 2020. It was observed mainly as a long vertical dark streak on the dayside hemisphere of Venus in amateur near-infrared images (NIR). This work uses only the the first data that were reported in ALPO-Japan obtained with small telescopes mainly from Greece and Ukraine. Amateur observations must continue in support of professional earth-based and spacecraft observations.

1. Introduction

Imaging Venus in the NIR spectrum (~750-1000nm) reveals the morphology and dynamics of the dayside middle clouds (50.5–56.5 km from the surface). The top clouds of Venus (56.5–70 km from the surface), observed in UV, are too fast with velocities 60 times faster than the planet, a phenomenon known as superrotation. Below the middle clouds of Venus the lower clouds exist (47.5–50.5 km). Lower-middle and upper clouds comprise the main cloud deck in the atmosphere of Venus. The middle clouds move slower than the upper layer and are less studied [1]. During March 2020 Kardasis (MK) detected and followed the evolution of a planet scale atmospheric wave, a Cloud Discontinuity (CD, Cloud Discontinuity is a term referred as such in [1]). It was observed mainly as a long vertical dark streak on the dayside hemisphere of Venus (Image 1). This kind of CD's are cloud patterns identified for the first time by the Japanese space mission AKATSUKI characterized by sharp albedo change [1, Figure 1c].

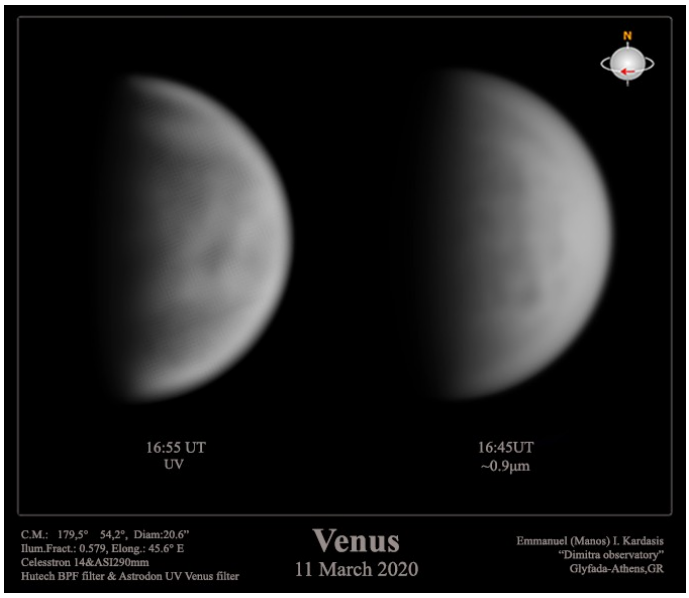

Image 1: *The first image of the March Cloud Discontinuity. It can be seen as dark vertical streak in the centre of the illuminated disc in the right image (Manos Kardasis 11/3/2020 16:45UT, 355mm SCT,ZWO 290MM, Right image 884-900 nm & left image UVenus filter, Glyfada-Athens ,Greece)*

2. Methodology

This preliminary analysis is based on measurements on the first available dayside images, 3 by Kardasis and 2 by Naryzhniy (YN), made in 5-day steps (the period needed for the same feature of middle atmosphere to be visible again) from 11 March to 31 March 2020. Gradualy more amateur uploded confirmation images on the ALPO-Japan website [2]. MK images were acquired from Glyfada-Athens (Greece) using a 355mm telescope and a Hutech884-900nm filter. YN images were acquired from Kiev (Ukraine) using a 400mm, telescope and IR-glass IKS-6, >950nm filter. Both used a ZWO 290MM camera. At that epoch (~21/3/2020) Venus presented solar elongation of 46°East, 23 arcsec in diameter, and 52% of illuminated disk. The amateur technique [3] is based on the "lucky imaging" technique combined with special processing to increase contrast . WinJupos [4], was used for feature measurements and analysis.

3. Discovery and Evolution

On the 11th of March MK captured a long dark vertical feature (followed by a brighter streak), suspected to be a CD. He confirmed that it still existed 10 days later when the specific longitude was again observable. An alert was send to worldwide observers. Previous observations presented not obvious signs of the event. The CD was observed until April 25th.

4. Measurements

The CD spanned between ~30° S and ~30° N, with a total length ranging from ~4500-6500km and 350-700km width . The dark streak is always followed by a bright one. The CD drifted compared to surface longitude as can be seen in image 2 (~ -69 °/d in system 1). Speed measurements made between pair of images (11/3&16/3,16/3&21/3,21/3&26/3) separated by 5-day period produce a very small error on average. The measurements were averaged in latitude bins of 10° in three bands as presented on table 1:

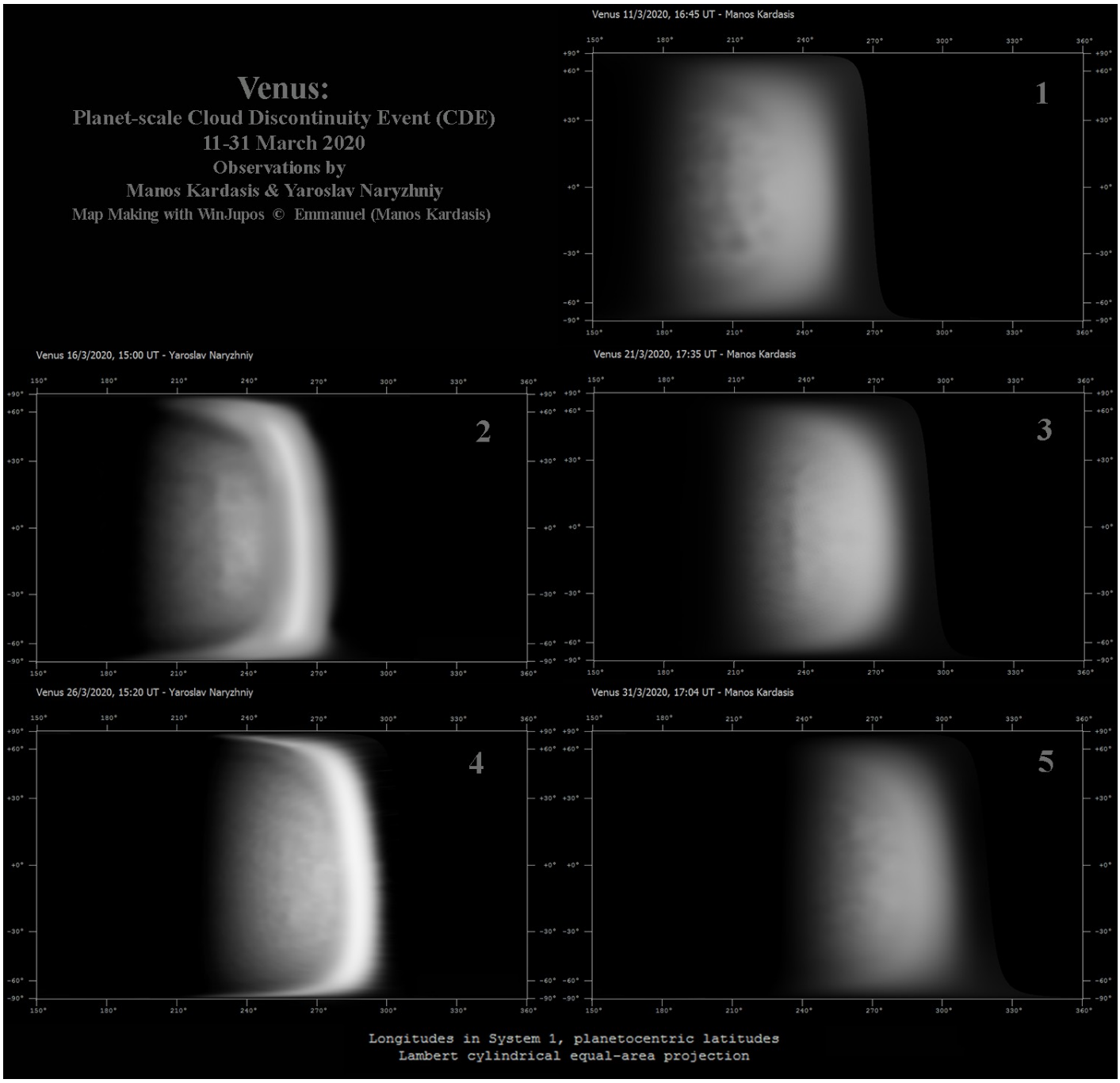

Image 2: *The Evolution of the planet scale Cloud Discontinuity between 11-31 March 2020 from observations of Manos Kardasis (355mm SCT,ZWO 290MM, Glyfada-Athens ,Greece) and Yaroslav Naryzhniy (400mm Dall-Kirkham,ZWO 290MM, Kiev ,Ukraine)*

Measurements Latitude	TOTAL Meas.No.	Average Latitude	TOTAL zonal speed (m/s)	Error ± (m/s)
20° N - 30° N	7	+22,3°	**77,88**	0,54
10° N - 20° N	12	+12,3°	**82,55**	0,23
5° S - 5° N	18	+0,0°	**84,44**	0,06
10° S - 20° S	13	-12,5°	**82,54**	0,51
20° S - 30° S	19	-25,8°	**76,89**	0,29
TOTAL	69		**80,86**	**0,33**

Table 2. *Average CDE zonal speed measurements in different latitude bands from Table 1.The zonal speed increases as we reach the equator.*

The speed between the three pairs of images is about the same and CDE seems to move with the same speed during March. The speed gradually peaks at the equator By comparing these speeds with Figure 4A of reference [1] we can see that in general the speed is higher than the average zonal speed of middle clouds in similar latitudes. Examined observations shows no direct relation between features in UV and NIR data. This is evident in the sharp edges of the CDE, present in NIR data, which are absent in UV data.

Conclusions

In this work, the detection and evolution of planet-scale atmospheric wave (a Cloud Discontinuity) in Venus is presented for the first time from amateur data. It was obvious in NIR images as a dark vertical streak followed by a bright streak. It was placed between 30°N- 30°S with an average size of ~5500X500km. The phenomenon was first captured by the MK on 11/3/2020 and it was observed on March 2020 as an almost vertical streak. UV and NIR data have no direct relation. Mean zonal speed gradually increases from mid-latitudes to the equator where it peaks, reaching 84,44 ±0,06 m/s.

A professional paper lead by JP on similar phenomena was recently published [5]. It is critical that amateur observations will continue in order to support future spacecraft fly-bys and the AKATSUKI mission. An ongoing analysis of the examined phenomenon that uses data from many amateurs and the AKATSUKI mission will be published soon.

Acknowledgements

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