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Enormous cloud cover as seen by Akatsuki/IR2 on the night-side Venus disk

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Abstract

An improved (restored) data set of Venus night-side observations acquired by Akatsuki/IR2 is presented. An enormous cloud propagating faster than the background is found and its property (particle size and number density) is under study.

1. Introduction

Night-side observations in transparency windows of CO_2 atmosphere of Venus allow visualizing inhomogeneous clouds in ~50 to ~60 km altitudes. The IR2 camera on board Akatsuki captured such images at 1.735, 2.26, and 2.32 μm wavelengths [1]. In the IR2 night-side data, an enormous cloud of greater opacity and with very sharp edge in the front (western end) is seen repeatedly. This feature seems to encircle the planet with a period of ~4.5 days [2].

Although interesting, property of aerosols in this feature was not studied before due to difficulty of photometric measurements in IR2 night-side data. This difficulty comes from a combination of the intense day crescent and extended tail of IR2 point-spread function (PSF). In this paper, we restore the IR2 night-side data to a level suitable for photometry and analyze the enormous cloud feature with radiative transfer computations.

2. The data analysis

A good example sequence was acquired on 18 August 2016 (images were taken every 2 hours from 07:33 to 21:33). The IR2 PSF (believed to be caused by multiple reflection in the detector substrate) was modelled by [1]. We have developed a procedure to perform deconvolution of such data to pull the spread light back to the day crescent, effectively cleaning up the night-side (Vun, et al., in preparation). A subset (4 out of 8) of restored IR2 night-side images (2.26 μm) are shown in Figure 1.

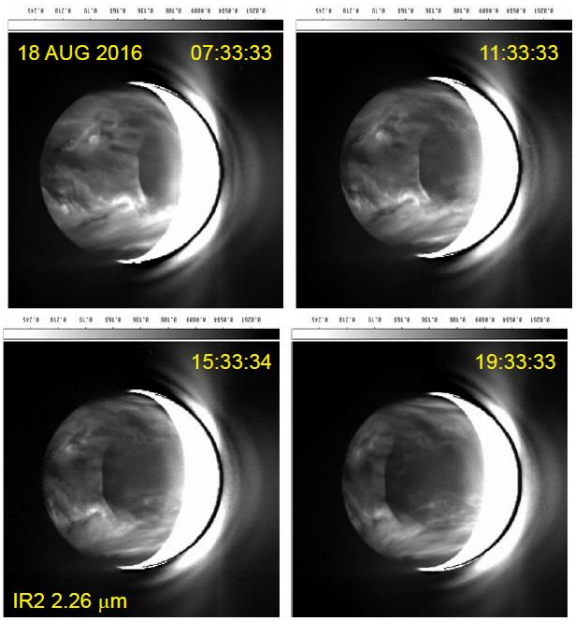

Figure 1: A sequence of IR2 2.26-μm night-side images (restored) with an enormous cloud feature.

In these images, Venus atmosphere rotates from right to left (~6-day rotation period at this altitude level). In the first image (07:33), the cloud feature appears from the sunset line and it nears the central meridian in the second image (11:33). All 8 images in the sequence were examined by constructing a movie. It reveals faster propagation of this cloud feature than the background, swallowing other cloud features.

Then, we plot the radiance along the equator (Figure 2) from the same 4 images as Figure 1. Black dots are the observed radiances, in which a sharp gap (indicated with arrow) due to this enormous cloud is obvious. Red and blue curves are the radiative-transfer computed radiance profiles with the nominal cloud model [3] in blue and a half of the nominal cloud opacity in red, respectively.

In the first image (07:33), all equatorial region seems to have slightly less cloud particles than the nominal cloud model [3]. This continues for background cloud region (higher pixel number than 100 in first 3 images and higher than 120 in the last image) but the enormous cloud feature seems to thicken (or darken in its brightness).

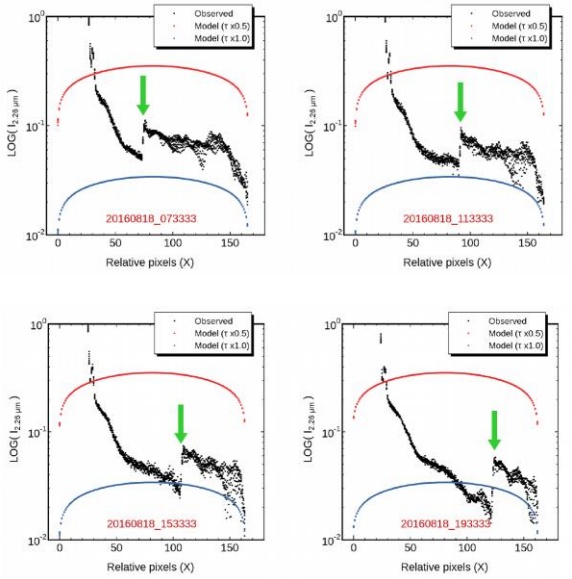

Figure 2: Radiance profiles along the equator. Note direction is opposite to that in Figure 1 so the day crescent is on the left (low pixel number).

However, we need to be cautious before saying conclusively that this thickening is real. The developed restoration process includes multiple steps and may introduce large uncertainties in resultant radiances. We will quantify uncertainties in each step to finalize our results.

It is noteworthy that similar features (if not the same) are also detected in the day-side images taken with the IR1 camera (0.90 μm wavelength, sensitive to cloud opacity ~55 km) [4]. Its behavior (opacity change) through the day time should be studied and be compared with these IR2 results. It would provide, for the first time, the change of clouds from day to night in the middle to lower cloud layer of Venus.

3. Conclusions

IR2 became un-operational in December 2016, due to malfunctioning of power-supply unit in the control electronics (IR-AE). The data acquired while IR2 was alive are, however, of high-quality and contain interesting (mysterious, often time) phenomena and await detailed analyses. The feature seen in this paper may or may not have an analogue on the earth but will certainly contribute to our understanding about the atmospheres of terrestrial planets.

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