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Wave signature in the Venus cloud layer at 60 km observed by ground-based dayside infrared spectroscopy

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Abstract

We performed infrared spectroscopic measurements of the Venus' dayside to find out atmospheric wave structures at 60 km in the cloud layer by quantifying carbon dioxide absorption. The reflection altitude of 60 km is in between that of 70 km by the ultraviolet measurements and the absorbing altitude of 50 km by the infrared thermal emission measurements.

1. Introduction

In the Venus' atmosphere, waves of various scales seem to cause various kinds of meteorological phenomena. The generation mechanism of the super rotation may be explained by momentum transport of atmospheric waves. For example, the equatorial Kelvin wave [12] and/or the thermal tides [11]. Also it may be explained by pumping up of angular momentum by the meridional circulation [5], which may be driven by the Rossby waves [6].

To investigate atmospheric wave structures in the cloud region, most of studies have focused on the ultraviolet wavelengths to image atmospheric waves at 70 km [e.g. 3, 4]. Some studies have focused on the infrared wavelengths, and analyzed thermal emission from the nightside to image atmospheric waves at 50 km [e.g. 1]. We observe the dayside 1.7-μm reflected sunlight, and quantify carbon dioxide (CO_2) absorption. Since CO_2 is the main component of the Venus' atmosphere, CO_2 absorption is suitable to monitor the cloud altitude and atmospheric waves because the mixing ratio is constant at the cloud region. From the amount of CO_2 absorption and the Venus model atmosphere VIRA1985 [Venus International Reference Atmosphere, 10], the reflection altitude for the 1.7-μm radiation is estimated to be 60.3 km [7]. Since the scale height is 5.6 km at 60.3 km, we observe 5.6 km-thick layer above the reflection altitude. It is important to know wave phenomena at 60 km besides those at 70 km (dayside UV) and 50 km (nightside IR) to investigate atmospheric dynamics occurring in the cloud region.

2. Observation and Data analysis

We performed infrared spectroscopic measurements at the NASA Infrared Telescope Facility (IRTF, Mauna Kea, Hawaii) with the CSHELL spectrometer in May and November 2007, June 2009 and August 2010. The global maps of the clouds structure are derived by assuming rigid body rotations like the past studies [e.g. 1, 2]. The plot for differential rotation is produced by using wind speeds taken from [9] and [8] based on Venus Express data.

3. Summary and Conclusions

From the wave structure, we estimate the atmospheric rotation period as 5 days in May 2007 and 6 days in August 2010. The reflection altitude in August 2010 was found to be 1 km lower than that in May 2007. The change might be caused by the change of clouds' descent.

In this presentation, we will compare these results with those of Venus Express.

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