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Variability of the cloud-top altitude deduced from radio occultation experiments and thermal mapping obtained by LIR onboard Akatsuki

T. Fukuhara (1), H. Ando (2), T. Imamura (3), M. Takagi (2), M. Taguchi (1), and LIR/RS project team
(1) Rikkyo University, Japan, (2) Kyoto Sangyo University, Japan, (3) The University of Tokyo, Japan

Abstract

The thermal infrared images acquired by LIR onboard Akatsuki have been compared with result of the radio occultation experiments which have been synchronously acquired with LIR. We have derived variability of the cloud-top altitude from the comparison. The result shows that the cloud-top altitude has been mostly ~67 km in the southern low latitude. Whereas, the altitude seems slightly increased with the mid latitude. Previous observations by Vera, VIRTIS, and VMC onboard Venus express indicated the altitude was stable in the latitude. The aspect seen in the result by the collaboration may represent a feature which is independent from the results previously observed. We are carefully considering the result obtained by our observation.

1. Introduction

Venus climate orbiter called Akatsuki which failed to be inserted into Venus orbit in 2010 has been successfully re-orbited on December 2015 [1], and instruments onboard the spacecraft has finally started observation of Venus. The longwave infrared camera (LIR) detects thermal emission with wavelengths of 8 - 12 μm from Venus disk regardless of day or night side, and represents horizontal distribution of the brightness temperature at the cloud top [2]. LIR has continuously archived more than eight thousands images without serious fault for two Venusian years. Meanwhile, the radio occultation experiment termed Radio Science (RS) retrieves the atmospheric pressure, the temperature, the sulfuric acid vapor mixing ratio, and the electron density [3]. Akatsuki RS mainly probes the low and middle latitude regions with the near-equatorial orbit in contrast to the previous radio occultation experiments using polar orbiters. It obtained 19 vertical profiles of the Venusian atmosphere by April 2017. Temperature profiles were successfully obtained at altitude of 38 - 85 km and show distinct atmospheric structures depending on the altitude.

The cloud-top altitude observed by LIR would be roughly ~65 km in accordance with the contribution function of Venus atmosphere under situation of typical cloud distribution [4]. However, it is difficult to retrieve precisely the variability of cloud-top altitude except for the comparing with the vertical temperature profile synchronously observed. LIR images have been synchronously acquired with most of RS observations as a basic strategy for Akatsuki observation. We could successfully acquire 6 data sets in which LIR and RS observations have observed completely same region.

2. Image data processing

LIR image included background variance depending on baffle temperature at observation; it brings an image brighter than our expectation. Hence, it has been canceled firstly by using deepspace images which have been acquired on orbit with different baffle temperature. Furthermore, limb-darkening effect which is generally seen in the thermal infrared images has been eliminated from the image by the approach previously developed [5]. Absolute brightness temperature of the cloud-top on Venus could be finally deduced from LIR observation.

3. Result and Discussion

The temperature of the region synchronously observed with RS has been compared with the vertical temperature profile retrieved by RS to

deduce the altitude LIR observed. The data set covers latitude of 7°S - 35°S with local time of ~5:00 except for one which has been observed at 50°N degrees with local time of ~19:00. The emission angle at the time of observation is mostly ~15 degrees in southern hemisphere. The cloud-top altitude has indicated mostly ~67 km in the southern area. Whereas, the altitude seems slightly increased with the mid latitude. In contrast, previous observations by Vera, VIRTIS, and VMC onboard Venus express (VEX) indicated the altitude was stable in the latitude [e.g., 6, 7]. The aspect seen in the result by the collaboration may represent a feature which is independent from the results observed by VEX. We are carefully considering the result obtained by our observation.

References

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