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Stability and variability of Venusian cloud top altitude from the complete set of dayside images taken by Akatsuki IR2

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Venus is completely shrouded by optically thick clouds of sulfuric acid that are located between ~47 and 70 km. The clouds play significant roles in the chemistry, dynamics, and energy balance of the atmosphere. The cloud tops have been investigated through imaging, spectroscopy, and polarimetry in a broad range of wavelengths, from UV to mid-infrared, as well as in-situ measurements. For example, Ignatiev et al. (2009) studied the cloud top altitude from the depth of CO_2 absorption band at 1.6 micron acquired by VIRTIS onboard Venus Express. They found that the cloud tops decreased poleward of 50 deg and this depression coincided with the eye of the polar vortex.

Sato et al. (2020) described the dayside cloud top structure of Venus as retrieved from 93 images acquired at a wide variety of solar phase angles (0-120 deg) using the 2.02-micron channel of the 2-micron camera (IR2) onboard the Venus orbiter, Akatsuki, from April 4 to May 25, 2016. Since the 2.02-micron channel is located in a CO_2 absorption band, the sunlight reflected from Venus allowed us to determine the cloud top altitude corresponding to a unit aerosol optical depth at 2.02 micron. First, the observed solar phase angle dependence and the center-to-limb variation of the reflected sunlight in the region equatorward of 30 deg were used to construct a spatially averaged cloud top structure characterized by cloud top altitude z_c, Mode 2 modal radius $r_{g,2}$, and cloud scale height H, which were 70.4 km, 1.06 micron, and 5.3 km, respectively (Hereafter, this retrieval process is referred to as Step I). Second, cloud top altitudes at individual locations were retrieved on a pixel-by-pixel basis with an assumption that $r_{g,2}$ and H were uniform for the entire planet (Step II). The latitudinal structure of the cloud top altitude was symmetric with respect to the equator. The average cloud top altitude was 70.5 km in the equatorial region and showed a gradual decrease of ~2 km by the 45 deg latitude. It rapidly dropped at latitudes of 50-60 deg and reached 61 km in latitudes of 70-75 deg. The average cloud top altitude in the region equatorward of 30 deg showed negligible local time dependence, with changes up to 1 km at most.

In this study, we applied the method described above to the complete set of 2.02-micron images (a total of 374 images taken from December 11, 2015, to October 29, 2016) to better understand the latitudinal, local time, and temporal variations in cloud top altitude of Venus. After the publication of Sato et al. (2020), parameters to represent the sensitivity of radiance to the detector temperature was revised and a method for identifying saturated pixels of IR2 image was updated. In addition, the spectroscopic line parameters used for radiative transfer model were also replaced by the latest HITRAN2020 database. In the retrieval process, the complete set of 2.02-micron images was grouped into a few subsets allocated on the basis of the solar phase angle dependence. Then, Step I was applied to each subset. The cloud top structure derived from a subset including the images used in Sato et al. (2020) was found to be robust to these updates. In this presentation, we present initial results of this follow-up analysis regarding the cloud top altitude of Venus using IR2 images.