Short-term and Long-term temperature variations in upper cloud layer of Venus obtained from 10 Venusian-year operation of Akatsuki/LIR

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In recent years, long-term variations (more than 10 Venusian years) in zonal wind speed and UV albedo at the cloud top level have been revealed from combination of Venus Express and Akatsuki observations (Khatuntsev et al., 2013; Lee et al., 2019). The magnitude of variation in zonal wind speed reached ~30 m s^{-1}, 30 percent of the super-rotation of Venusian atmosphere. On the other hand, it has known that both UV albedo and wind speed also show short-term variations (e.g. 4-day and 5-day variations) which should reflect existence of planetary scale waves at the cloud level of Venus, which can accelerate and/or decelerate the super-rotation due to vertical transportation of atmospheric momentum through their propagation. From the expectation in Lee et al (2019) for the long-term variation, and from the characteristics of planetary scale waves, atmospheric temperature should vary with such variations. Therefore, temperature observation is one of key elements to advance understanding about the variations. The dataset obtained by the longwave infrared camera (LIR) onboard Akatsuki is a quite suitable and unique dataset for this purpose, because LIR has observed brightness temperature at the cloud level for ~10 Venusian years almost continuously and its observation interval (one or two hours) is sufficiently frequent for resolving the 4-day and 5-day waves.

In this study, we first focused on brightness temperature measured at a disk center of Venus in each LIR image, where we can ignore the apparent temperature variation due to the emission angle effect (Kouyama et al., 2019; Akiba et al., 2021). By analyzing LIR images from 2019 October to 2021 December, when LIR had shown stable performance, we found a long-term variation with a time scale of almost 10-Venusian years. The time scale is similar to those for UV albedo and zonal wind speed (Lee et al., 2019), and the peak timing of the temperature variation seemed to correlate with that of the zonal wind speed obtained by cloud tracking with ultraviolet images (cf. Horinouchi et al., 2018). The relationship is consistent with the expectation of Lee et al. (2019).

Then, we applied a periodical analysis with a sliding window of 20 days following to Imai et al (2019), and we confirmed that various short-term variations with periods of 4 ~ 6 days appeared and disappeared in the 10 Venusian years. One example of the enhancement and dissipation were confirmed in wind speed (Imai et al., 2019). The LIR result may provide more examples of the wave activity.

In the presentation, we will show the above results obtained from LIR’ s long-term observation and discuss relationship between the variations seen in brightness temperature from LIR images and those in UV albedo and zonal wind speed.

Keywords: Venus, Akatsuki, LIR, Planetary-scale waves