Long-term variations of the structures of planetary-scale waves observed in Akatsuki LIR images

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Venus is a planet with a very long rotation period, but it has a very fast cruising wind that can reach 100 m/s at an altitude of 70 km (Schubert et al. 1980). This wind is called superrotation. Superrotation is predicted to be maintained by momentum transport by non-axisymmetric vortices (Gierasch, 1975; Rossow and Williams, 1979; Del Genio and Rossow, 1990), and Venusian general circulation models suggest that such a latitudinal momentum transport occurs (e.g., Yamamoto and Takahashi, 2003). In this study, we focus on the possible contribution of planetary-scale waves and aim to clarify the structure of planetary-scale waves on Venus from Akatsuki' s observations. The existence of planetary-scale waves with a wavenumber of 1, such as Kelvin waves with a period of ~4 days and Rossby waves with a period of ~5 days, has been confirmed so far by previous Venus missions (Del Genio and Rossow, 1990; Kouyama et al., 2015; Imai et al., 2019; Kajiwara et al., 2021). The amplitudes of these planetary-scale waves vary over time scales of several months, as revealed by an analysis of cloud-tracked winds obtained by the Ultraviolet Imager onboard Akatsuki (Imai et al., 2019). Observations by Akatsuki's Longwave Infrared Camera (LIR) have also revealed that waves with different periods appear simultaneously at high latitudes (Kajiwara et al., 2021). However, the long-term evolution of these planetary-scale waves and the structure of their vertical propagation have not been revealed from observations until now. In this study, we improved the method of Kajiwara et al. (2021) and used the LIR data to detect planetary-scale waves from brightness temperature changes. We compared the results for different periods and tried to clarify the vertical structures of planetary-scale waves by using the fact that the observation altitude depends on the emission angle. The amplitude of the planetary-scale waves differs depending on the time of data acquisition and the altitude of the observation, which depends on the angle of incidence used in the analysis, and may be related to the variation of the background wind speed.

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