Structures of planetary-scale waves at Venusian cloud top revealed by an cloud-tracking method tolerant to streaky features

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Ultraviolet (UV) images of Venus show various features of clouds due to inhomogeneously distributed UV absorbers in the cloud layer (Nara et al., 2019). Cloud tracking has been widely used to derive atmospheric motion. As for Venus atmosphere, long term variations of super-rotation (Kouyama et al., 2013), properties of atmospheric waves (e.g. Kouyama et al., 2015; Limaye, 1988), and a relationship between the cloud morphology and wind velocities (Del genio & Rossow, 1990) have been studied.

The atmosphere in the high latitudes of Venus are considered to be unstable due to the strong latitudinal shear of the mean zonal wind associated with mid-latitude jets. A momentum transport caused by such regions is essential to understand the mechanism of super-rotation. However, the discussions of these studies are limited to low latitudes due to the difficulty in cloud tracking in high latitudes, where streak features are predominant. Because the displacement of such streaks along the streak direction cannot be identified, uncertainties in estimated cloud motion vectors become large (Ikegawa & Horinouchi, 2016).

To solve this problem, we developed a method to increase the accuracy of cloud tracking by eliminating streaks from the images. The algorithm finds the orientation of streaks in an image making use of the nature that the brightness gradient takes a minimum along streaks, and then remove the streaks by differentiating the image along the estimated orientation.

Using UV (365 nm) images obtained by UVI on Akatsuki, we deduced velocity fields with cloud tracking proposed in this study. Spectral analysis of the time series detected significant periodicity associated with planetary-scale waves even in high latitudes. We present horizontal structures of the planetary-scale waves and associated momentum transports.