

Variability mechanism of zonal wind velocity in the cloud top altitude of Venus obtained by the long-term AKATSUKI ultraviolet imager data

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A preceding analytic study using the ultraviolet cloud images by AKATSUKI showed that the mean zonal wind velocity around the cloud top of Venus had a long-term variability with a period of a few hundred days (Horinouchi et al. 2018). Furthermore, the meridional profile of the zonal wind velocity became asymmetric in a certain period with the velocity in the northern hemisphere slower than in the southern hemisphere. However, the mechanisms which produce the long-term variability and the asymmetry of the wind velocity structure are unknown, and investigating them should be important for understanding the planetary atmospheric dynamics not limited to Venus. In this study, we extended the period of the preceding analytic study by Horinouchi et al. (2018) (1 year and 4 month) to 3 years, from December 2015 to December 2018, and investigated the long-term variability of mean zonal wind velocity in more detail, as well as the period(s) and factor(s) which show the hemispheric asymmetry of it.

We used the wind vector dataset obtained by the cloud tracking with the ultraviolet imager onboard the AKATSUKI spacecraft. At first, as well as Horinouchi et al. (2018), we investigated the temporal variability of mean zonal wind velocity with respect to local time and the analysis period. We used the 5-day-averaged wind velocity, and divided them into three parts: 20°N - 35°N, 20°N - 20°S, and 20°S - 35°S. Next, we analyzed the meridional profiles of mean zonal wind velocity for 5 periods divided in every 7 months, using the 10-days-averaged wind velocity to remove the short-term variabilities by planetary-scale waves (Kouyama et al. 2013). In addition, we investigated meridional profiles of 1-month-averaged zonal wind velocity to identify the periods of hemispheric asymmetry.

Our results showed that the mean zonal wind velocity during the analyzed period of 3 years had a variability with a period of approximately 7 months in both 283nm and 365nm wavelengths and all latitudes. Thus, it is identified that the long-term variability indicated in Horinouchi et al. (2018) continued in the whole analysis period in this study. The meridional profiles of 7-month-averaged zonal wind velocity in the divided 5 periods indicated that the asymmetry appeared only between October 2016 and April 2017 at 365 nm even in the whole analysis period of 3 years in this study. In the asymmetry period, the wind velocity at 40°N was approximately 12 m s^{-1} slower than at 40°S. The meridional profiles of 1-month-averaged zonal wind velocity showed that the asymmetry appeared only for two months in December 2016 and January 2017, with the wind velocities at 40°N of approximately 13 m s^{-1} and 21 m s^{-1} slower than at 40°S, respectively.

To investigate the mechanism of the appeared asymmetry, we derived meridional profiles for three local time periods (8-10, 11-13, and 14-16) and a latitude-longitude cross section of zonal wind velocity averaged in between October 2016 and April 2017 when the asymmetry was observed, and checked the relationship among the zonal wind velocity, local time, and topography. As a result, the slow zonal wind velocity corresponded to the afternoon in local time when many topographic waves have been observed (Kouyama et al. 2017), and the region of slow zonal wind velocity coincided with the downstream side of mountainous terrain, including Mt. Maxwell which is the highest mountain on Venus at around 60°N. Therefore, it is indicated that the mountain waves generated by those topographic features possibly slowed wind velocity in the northern hemisphere.

Reference

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Keywords: Venus, Akatsuki, Planetary atmosphere, Cloud motion vector