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Relationship between planetary-scale waves and the background wind field at the cloud top of Venus

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In this study, we reveal temporal variation of the super-rotation of Venus atmosphere and spatial structures of planetary scale atmospheric waves at the cloud top level by deriving wind speeds and their variations at the cloud top from UV (365 nm) images taken by Venus Monitoring Camera (VMC) onboard Venus Express of European Space Agency. Because VMC has taken many cloud images covering from low to high latitudes of the southern hemisphere, well suited for derivation off wind speeds and their variations. We applied a proven cloud tracking method (reported at the 2008 Meeting) to these images and found that the equatorial zonal wind speed changes quasi-periodically, alternating "fast season" (over 100 m s^{-1}) and "slow season" (below 90 m s^{-1}) every ~100 earth days

From Fourier analysis of the wind speed and the cloud brightness variations, planetary-scale 5 day period variations were identified in the zonal and meridional wind speeds and the cloud brightness in the fast season of background zonal wind speeds. The phase speed of the 5-day period variations is slower than the background wind speed. The phase relationship between the zonal and meridional winds implies that the 5-day variation is a manifestation of a Rossby wave. These results are consistent with previous studies from Pioneer Venus observations (Del Genio and Rossow, 1990; Rossow et al., 1990). On the other hand, planetary-scale 4 day period variations were identified in zonal wind speeds and cloud brightness in the slow season. The phase speed of the 4-day period variations is faster than the background wind speed. These features are similar to those of the Kelvin wave-like perturbations observed in the previous study (Del Genio and Rossow, 1990).

According to the numerical results of Yamamoto and Takahashi, 1997, the Kelvin wave originating from the lower atmosphere can propagate vertically into the cloud top level and transport angular momentum vertically. On the other hand, the Rossby waves , which can be excited by the baroclinic instability in Venus atmosphere, transport angular momentum from the latitude where these are excited to the higher latitude, and dissipate this instability. The time variation of the super-rotation could be affected by these waves. In this study, we will evaluate the angular momentum transport by these waves based on the derived parameters from our analysis.

Keywords: Venus, super-rotation, Venus Express, Venus Monitoring Camera, atmospheric waves