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Doppler-shift measurements in the 12CO (1-0) line of Venus: a study of the dynamics at the Venusian mesosphere

Hideo Sagawa[1]; Yoshimi Kitamura[2]; Masato Nakamura[1]

[1] ISAS/JAXA; [2] JAXA

Two different mechanisms govern the global dynamics in Venus: At the lower atmosphere (inside and below the cloud layer), the retrograde zonal (RZ) flow is predominant, and its velocity increases with altitude reaching up to 100 m/s at the altitude of approximately 70 km (e.g., Schubert, 1983). On the other hand, at the upper atmosphere (altitudes of above 100 km), the gases are driven with a strong flow from the dayside to the nightside due to a large day-to-night temperature gradient. This flow is generally called subsolar-to-antisolar (SSAS) flow. It is considered that this flow is a predominantly axisymmetric and has a maximum velocity when it crosses the terminator, converging around the antisolar point (Bougher et al., 1986). In the intermediate region, i.e., mesosphere there may be a vertical extension of the RZ flow from the lower altitude that causes a drag effect of the converge point of the SSAS flow (Mayr et al., 1980). This study aims to understand the contribution of the RZ flow on the mesospheric dynamics by conducting disk-resolved mapping of the wind field at the various local time of Venus.

The spatial variation in the Doppler shift of the line-center frequency of the ^{12}CO (1-0) absorption line (115.271204 GHz) was obtained in order to visualize the line-of-sight wind velocity at the altitude of 95-105 km. The spatially-resolved observations were conducted with using the Nobeyama millimeter array in 2004-2006. By using the high dispersion spectro-correlator, the spectra were obtained in the frequency resolution of 31.25 kHz which corresponds to a resolution of 80 m/s at the observed wavelength.

All the measurements at the various Venusian phase angles demonstrated a global wind that was driven from the dayside to the nightside. Furthermore, the development in the spatial resolutions (approximately 1000 km) enabled us to detect an inhomogeneous wind distribution that could not be explained by the combination of the SSAS and RZ flows such as a north-south asymmetry. During our observations, the local wind velocity at the antisolar point varied from more than 150 m/s to less than 40 m/s. By considering that the theoretical wind of the SSAS flow reduces its velocity to zero at the antisolar point, these velocities are likely represent the RZ flow that has originated the super-rotation at the cloud level. These results imply that the dynamics at the mesosphere shows spatial and temporal variations that may be related to the fluctuation in the super-rotation at the cloud level.