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Derivation of two-dimensional wind velocity distribution in south polar vortex of Venus from VEX/VMC

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Vortical structures called "polar vortices" exist on the poles of Venus. Polar vortices also exist on other planets in the solar system such as Earth, while the vortices of Earth are low-temperature regions, the temperature structures of the vortices of Venus observed in infrared region are characterized by high-temperature regions called "polar dipoles" on the poles, and low-temperature regions called "polar collars" or "cold collars" surround the dipoles.

The vortices on Venus are unique in their dipole- or oval-like shaped high-temperature regions and significant longitudinal non-uniformity. These dipoles rotate with periods of 2.5 to 3 days, which are extremely faster than rotation period of solid planet (243 days). It is known to blow a zonal wind called "super-rotation" at mid- and low-latitude areas with a period of 4 days at equator. Its period at latitude of 70 degrees is about 3 days, which is consistent with the period at the edges of the vortices [Markiewicz et al., 2007]. This suggests that the rotations of the dipoles and the super-rotation are successive. On the other hand, the collars do not rotate quickly as dipole and the lowest temperature region is at dawnside. This means that the structure of the dipoles is wavenumber 2 and the collar is 1, in addition, the dipoles vary considerably in shape, from single mode to mode 3, or even more complex shapes [Piccioni et al., 2010].

Pioneer Venus Orbiter (PVO) in 1978 and Galileo in 1990 observed the vortex, but they observed only north, and for short periods. Venus Express (VEX) which injected into Venus orbit in 2006 observed south vortex for the first time, and continues to obtain data until now. VEX mounts instruments named Venus Monitoring Camera (VMC) and Visible and Infrared Thermal Imaging Spectrometer (VIRTIS). VIRTIS observed wide range at near-infrared regions, at which we can observe the well-marked structures of dipoles and collars. This is thermal emission from the cloud top, which reflects the distribution of temperature. Meanwhile, UV channel of VMC is at 365nm, at which distinct features are observed, and believed to reflect the distribution of unknown UV absorbers at about up to 70km altitude which represent above the cloud layer. We can see features also on the pole at this channel, but the dipole and collar are unclear.

The study aims to derive two-dimensional wind velocity distribution in the south vortex by analyzing VMC data at 365nm by cloud tracking method. Markiewicz et al. [2007] and Moissl et al. [2009] derived the distribution by using VMC data, and Sanchez-Lavega et al. [2008] did it by using VIRTIS data. These researches, however, derive latitude distribution of zonal-mean wind velocities, and average the velocities latitudinally with some degrees width . Therefore, it is not suitable for studying the structure of the dipole which has notable longitude non-uniformity, and we cannot discuss about the fine latitudinal structures. We still do not know that longitude non-uniformity like dipoles and collars at infrared regions is also observed on the motion of the unknown UV absorber at the polar region. Thus, we require to derive two-dimensional wind velocities with higher resolution than previous studies to confirm the non-uniformity.

Furthermore, the cloud trackings on previous studies use the manual tracking method which identifies similar features by visual check, but this method has limitations of objectivity and throughput. We will apply the cross correlation method developed to derive the latitudinal wind velocity distribution at mid- and low-latitude [Kouyama et al., 2009] to high-latitude region, and consider the possibility of automatic wind velocities derivation with objective criteria. There are proper difficulties at high latitude that the clouds do not go straight but rotate, low contrast and streak features of clouds. Therefore, we need to resolve these problems to derive wind velocity distribution of the vortex.

Keywords: Polar vortex, Venus, wind velocity distribution, Venus Express, VMC, Venus Monitoring Camera