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Winds from visible (513 nm) images obtained by the Venus Express Monitoring Camera

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Abstract

Long-term observations of Venus by the Venus monitoring camera (VMC) [4] onboard Venus Express in the visible range (513 nm) allowed to obtain information on circulation in the middle of Hadley cell. Here we present preliminary results of wind tracking of visible images obtained by VMC in the period 2007/07/01-2013/01/29. The mean zonal speed in middle latitudes (30-65ºS) is monotonously changing with latitude -76.5 to -61.5 m/s. In low latitudes (10-20ºS) zonal speed is about -82 m/s. Differences in the behavior of the meridional component in low and middle latitudes indicate that different cloud layers are observed in the visible range (513 nm). The mean horizontal flow demonstrates a dependence on local solar time. Moreover, the nature of diurnal variations is different for low and middle latitudes. Following Bertaux et al. [1] the mean horizontal flow in the middle of Hadley cell show a connection with the underlying topography.

1. Hadley cell from VMC observations

During ~9 years (from April 2006 through January 2015) Venus Monitoring Camera (VMC) [4] onboard the Venus Express orbiter has observed the upper cloud layer of Venus. The largest set of images was obtained in the UV (365 nm), visible (513 nm) and two infrared channels – 965 nm and 1010 nm. The UV dayside images were used to study the atmospheric circulation at the Venus cloud tops [2], [5]. Cloud features tracking in the IR images (965 nm) provided information about winds in the middle and lower cloud (49-57 km) [3]. Meridional speed for UV observations (cloud tops) has a negative sign, at the same time for IR observations the mean meridional speed in the middle cloud deck (55 km) has a positive sign (Figure 1). This result, together with the earlier measurements of the poleward flow at the cloud tops indicates the presence of a closed Hadley cell in the altitude range 55-67 km.

2. Winds in the middle of Hadley cell

Wind tracking of visible images (513 nm) obtained by VMC in the period 2007/07/01-2013/01/29 allowed us to investigate the circulation in the middle of Hadley cell. Mean zonal and meridional profiles of winds are presented at Figure 1 (green line).

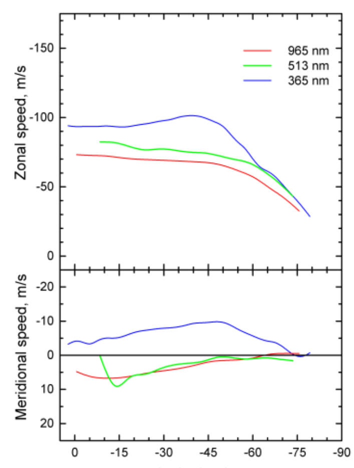

Figure 1: Mean zonal (top) and meridional (bottom) wind profiles. Blue correspond to UV (365 nm) [2], red – to IR (965 nm) [3] and green – to visible (513 nm).

In middle latitudes (30-65ºS) the zonal speed is monotonously changing from -76.5 to -61.5 m/s with South latitude increase. The meridional speed is also decreasing from 2.8 to 0.8 m/s and this parameter is systematically less than the meridional speed obtained from IR images. In low latitudes (10-20ºS) the zonal speed is dramatically higher (about -82 m/s) and looks like equatorial jet. The meridional component is also increasing from 0.4 m/s at -10ºS to 6 m/s at 20ºS with a maximum (~9 m/s) near -15ºS.

Thus, VMC is observing an overlying layer in low latitudes relative to the layer of middle latitudes.

In low latitudes the mean horizontal flow demonstrates diurnal variations. Both zonal and meridional components have afternoon maximum near -15ºS latitude. The zonal speed has a weak maximum near 13.5h, the meridional speed shows a strong peak at 14-15h (Figure 2).

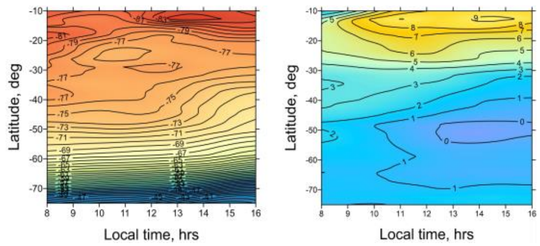

Figure 2: Diurnal variations of the mean zonal (left panel) and meridional (right panel) wind speed components obtained from visible (513 nm) images.

Figure 3 displays contour maps of mean zonal and meridional components derived from the VMC visible imaging. As in the case of the cloud top winds [1] and the case of middle cloud deck [3], we see similar evidence of the influence of Venus topography on the zonal and meridional speed. Obviously, Aphrodite Terra (60º-200ºE) significantly affects the circulation in the middle of Hadley cell.

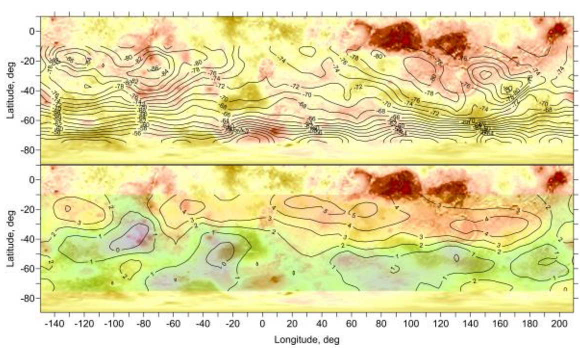

Figure 3: Venus geographic map with zonal (upper panel) and meridional (lower panel) speed contour maps.

3. Summary and Conclusions

1) VMC visible (513 nm) images of Venus dayside were used to derive atmospheric circulation in the middle of Hadley cell at altitudes 60-62 km.

2) In low latitudes the mean horizontal flow shows diurnal variations.

3) Zonal and meridional components of wind speed in the dayside Hadley cell show a connection with the underlying topography.

Acknowledgements

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