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Influence of solar-related effects and topography on the cloud top circulation above Aphrodite Terra from VMC/Venus Express wind fields

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Abstract

A set of UV (365 nm) images obtained by the Venus Monitoring Camera [3] onboard ESA's Venus Express orbiter from 2006 to 2013 was used to study the circulation of the mesosphere. It was found that the surface topography influences on the behavior of the horizontal flow above Aphrodite Terra to at least 30°S. A maximum deceleration of the mean zonal flow is observed at noon above Ovda Regio (the highest region of Aphrodite Terra). We attributed the observed wind deceleration to interaction of the gravity (mountain) waves generated by Aphrodite Terra with the atmospheric circulation. The mean zonal and meridional flows at cloud top level in the equatorial region are perturbed by a solar tide at 13-14 h.

1. Introduction

The dependence of the zonal wind speed on the longitude was found over Aphrodite Terra in the latitude band 0-30°S using a data set collected over a long local time interval (09-15 hour LT) in [1]. More than 44,000 wind vectors were derived by digital cloud tracking [2, 4] in the latitude band 0-30ºS from the VMC UV images acquired in 262 orbits in 2006 - 2013. The big data set allowed a detailed investigation of the mean wind field at the cloud top level as a function of longitude, latitude and local time.

2. Results

The data were grouped in 1 hour local solar time bins (Figure 1). The plots show the evolution of the zonal wind field with local time. The most pronounced feature is the area of reduced wind speed above and downstream of Aphrodite Terra with velocities of -84±2 m/s which shape changes with local time.

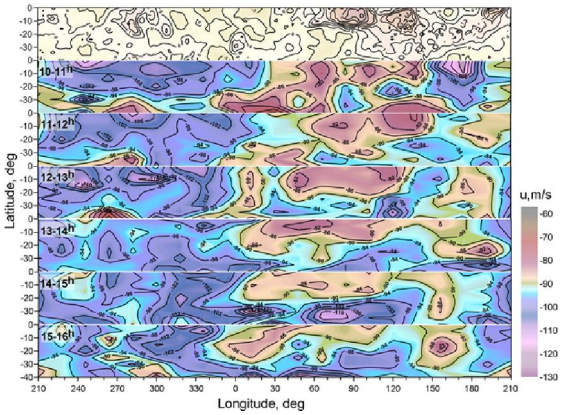

Figure 1: Spatial distribution of the average zonal wind speed at the cloud top plotted for 1-hour local time intervals. The local time is the same for all points in the wind maps; it is indicated in the upper left corner of each panel. Topographic maps from NASA Magellan mission are presented in the upper panel.

A study of the positions of the slowest wind in the latitude band 10±5ºS above Aphrodite Terra as a function of longitude shows that the wind velocity minimum (in module) is reached above Ovda Regio (the highest region, 90±5º E) at noon local time (Figure 2).

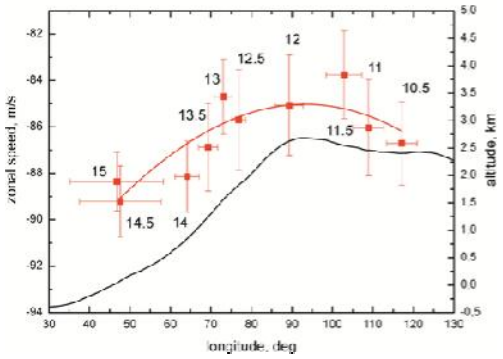

Figure 2: Positions of the minimum of the mean zonal speed for different local time bins (red squares) above Aphrodite Terra as function of longitude. The error bars correspond to confidence intervals (3*SEM, where SEM is standard error of the mean) or 99.7% confidence levels. The black line shows the mean surface topography at 10±5ºS.

The horizontal flow at the cloud top level in the equatorial region is perturbed at 13-14 h (Figure 3). The perturbation of both zonal and meridional wind components may be explained by the solar tide. For zonal component this effect is better seen in low land regions where the orographic deceleration effect is absent.

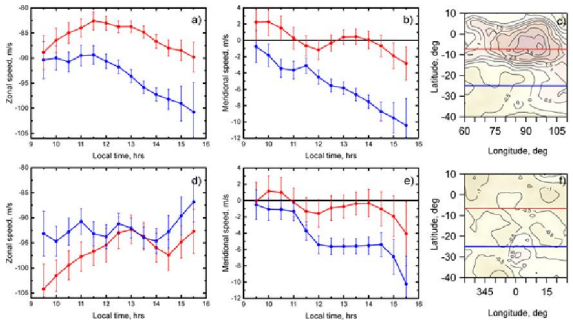

Figure 3: Mean local time profiles of the zonal (a, d) and meridional (b, e) speeds for two 10º latitudinal bands centered at 7º (red) and 25ºS (blue) for highland Ovda Regio (60-110ºE) (c) and the lowland region (335º-25ºE) (f). The data were averaged over 1 hour with a shift of 0.5 hour. The error bars correspond to 3*SEM.

3. Summary and Conclusions

It was found from tracking of the cloud features in the VMC/Venus Express UV images that the zonal wind at the cloud top decelerates above Aphrodite Terra. It was also found that the influence of topography on the cloud top winds depends on local solar time. We tentatively attributed the observed wind deceleration to interaction of the gravity (mountain) waves generated by Aphrodite Terra with the atmospheric circulation. The perturbation of both zonal and meridional wind components was observed in the equatorial region around 13-14 h and may be explained by a solar tide.

Acknowledgements

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