Vortex pairs reveal meso scale flows on Venus

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The prevalence of cyclostrophically balanced flow and the trajectories of VeGa 1 and VeGa 2 balloons practically along latitude parallels had created the impression that in the mid cloud layer the meridional components of wind were weaker than the zonal components on regional scales. The night side images taken from JAXA's Akatsuki orbiter (Nakamura et al., 2016) reveal that meso-scale circulations exist on Venus which indicates significant deviations from cyclostrophic balance locally.

A vortex pair ("mushroom" feature) consisting of a cyclone and anti-cyclone, was first observed in nightside images from the IR2 camera (Satoh et al., 2016) on Akatsuki orbiter on April 15, 2016 at 1.74, 2.26 and 2.32 μwavelengths in the northern hemisphere. A sequence of three images about two hours apart reveals the vortex circulation. Such vortex pairs were first detected on Earth when water vapor images became available from geosynchronous weather satellites. The detection of such pairs on Venus raises questions about the forcing mechanisms for the formation on the slowly rotating planet with only the fast zonal winds providing vorticity generation.

The location at which the cyclonic and anticyclonic circulations separate from the ambient flow (indicated by the "stem") is about 25°N and 300° E longitude, near Beta Regio, and it is tempting to suggest that the feature is created due to topographic influence, similar to the observation of a large gravity wave also observed in the thermal infrared image of Venus from Akatsuki (Fukuhara et al., 2017). The geometry suggests that the current which creates them comes from a higher latitude, veering sharply from an initial near zonal direction towards the equator.

Images taken after two orbits of Akatsuki also show a similar feature, but more mature feature at the same latitude but at a slightly westward longitude. We can only wonder if it is the same feature that developed over about three weeks or a new one as there are no intervening observations. If it is the same feature, then one difference between the Earth and Venus is clear –on Earth the vortex pairs evolve over a matter of hours, much shorter than 21 days indicating different flow regimes on the two planets. If it is a different feature, then the question is why are such features observed so infrequently? Perhaps the answer lies in some active processes at the surface.

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