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A chaotic permanent vortex in Venus southern pole

I. Garate-Lopez[1], R. Hueso[1], and A. Sánchez-Lavega[1]

[1] Escuela Técnica Superior de Ingeniería, Universidad del País Vasco, Bilbao, Spain

Abstract

Polar vortices are common in the atmospheres of rapidly rotating planets. On Earth and Mars they are tight to the surface and their existence follows the seasonal insolation cycle. Venus is a slowly rotating planet but it is also known to have vortices at both poles at the edge of a superrotating atmosphere (Piccioni, G., et al. 2007, Nature, 450, 637). From the study of cloud motions at two altitude levels using images from the VIRTIS instrument onboard Venus Express, we show that the south polar vortex is a permanent and dynamically chaotic feature. The center of rotation of the vortex at these two levels (about 42 km and 64 km above the surface), rarely coincide and both centers wander erratically in direction with speeds of up to 16 $\mathrm{m\,s^{-1}}$ around the pole. The cloud morphology and vorticity patches are uncorrelated and change continuously. At the upper level the streamlines show closed patterns half of the times but there are cases with clear convergence (mass inflow) and divergence (mass outflow) implying vertical velocities of up to 0.2 $\mathrm{m\,s^{-1}}$. Contrarily to Earths polar vortices, the south polar vortex in Venus is a long-lived unstable feature related to strong vertical and meridional wind shears in the upper cloud and to the vertical static instability in the mid- and lower clouds that is kept at the polar latitudes by a surrounding cold collar.

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