Characterization of the atmospheric dynamics of Venus with ground-based Doppler velocimetry

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The objective of this work is to help constrain the atmospheric dynamics of Venus, in coordination with the effort under way with the European Space Agency's Venus Express mission (VEx) and with the forthcoming Japanese mission Akatsuki, due to arrive in December 2010. Major objectives are:

1. to complement in-situ observations made by space missions (which use cloud tracking techniques or infer winds indirectly) with direct measurements;

2. to measure the latitudinal profile of the zonal winds in the cloud layer, mesosphere and in the thermosphere of Venus and to search for wave motions through ground-based spectroscopic observations, using Doppler techniques;

3. to better understand the nature of the processes governing super-rotation in the atmosphere of Venus, in particular waves and wave-mean-flow interactions, as well as the latitudinal extent of the cyclostrophic balance approximation at cloud top level.

Cloud-top winds were measured from Doppler velocimetry, a technique which has been used previously to measure Titan's winds from the Doppler shifts of the backscattered solar Fraunhofer spectrum (Luz et al. 2005, Icarus 179, 497 ; 2006, J. Geophys. Res. 111, E08S90), and the winds of Venus from Doppler shifts of CO_2 absorption lines (Widemann et al. 2007, Plan. Sp. Sci. 55, 1741 ; 2008, Plan. Sp. Sci. 56, 1320). The spatially-resolved velocity changes on the source are measured using the optimal weight of intensity variations along the spectra to perform absolute accelerometry, with respect to a reference spectrum (see e.g. Civeit et al., 2005, A&A 431, 1157 ; Gaulme et al., 2008, Plan. Sp. Sci. 56, 1335 ; Gabsi et al., 2008, Plan. Sp. Sci. 56, 1454).

The UVES instrument achieves both high spectral resolving power (R ~ 100000) and high spatial resolution. Observations were made at a central wavelength of 580 nm with the UVES red arm and at 437 and 860 nm in dichroic mode, using both the blue and red arms. The narrow slit width of 0.3 arcsec, combined with the large angular size of the planet, allow a direct determination of the latitudinal (slit perpendicular to equator) or longitudinal (slit parallel to equator) variation of the zonal winds in both the northern and southern hemispheres. We will discuss the results and the intercomparison between ground-based observations and VIRTIS/VEx and VMC/VEx wind measurements (Sánchez-Lavega et al. 2008, GRL 35, L13204 ; Moissl et al., 2009, JGR 114, E0031).