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Ground and space based cloud-top wind velocities using CFHT/ESPaDOnS (Doppler velocimetry) and VEx/VIRTIS (cloud tracking) coordinated measurements

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We will present wind velocity results based in the measurements of the horizontal wind field at the cloud top level of the atmosphere of Venus, near 70 km altitude. Our aim is contribute to the characterisation of the zonal and meridional wind latitudinal profiles on hour and day-timescales. This will be done by tracking Doppler shift of solar and CO_2 lines over the dayside hemisphere in coordination with ESA's Venus Express orbiter. Our observations measured winds at cloud tops at latitudes 60°S-60°N, while Vex/VIRTIS privileged southern latitudes poleward of 45°S. This coordination effort intended to provide a combined monitoring of short-term changes of wind amplitude and directions with extensive spatial coverage. We present results based on inter comparison of ground-based Doppler velocimetry of cloud-top winds and cloud tracking measurements from the Venus Express spacecraft. Doppler wind velocimetry obtained with the 3.60 m Canada-France-Hawaii telescope (CFHT) and the Visible Spectrograph ESPaDOnS in April 2014 consisted of high-resolution spectra of Fraunhofer lines in the visible range (0.37-1.05 μm) to measure the wind velocity using the Doppler shift of solar radiation scattered by cloud top particles in the observer's direction. The complete optical spectrum was collected at a phase angle $\Phi = (76 \pm 0.3)°$, at a resolution of about 80000. Both ground-based and Venus Express measurements show considerable day-to-day variability revealing wave propagation and angular momentum transport in latitude which needs to be carefully assessed. ESPaDOnS and the sequential technique of visible Doppler velocimetry has proven a reference technique to measure instantaneous winds. These measurements are necessary to help validating Global Circulation Models (GCMs), to extend the temporal coverage of available datasets. The ground-based observations in the base of this project are critical in their complementarity with Venus Express, which was recently decommissioned. We compared our measurements with simultaneous observations using the Visible and Infrared Thermal Imaging Spectrometer (VIRTIS) instrument from the VEx orbiter. CFHT observations included various points of the dayside hemisphere, between +60°N and 60°S, by steps of 10°, and from sub-Earth longitude $[\phi - \phi_E] = 0°$ to -50° corresponding to 7:30a - 10:50a, while VIRTIS-M UV (0.38 μm) cloud tracking measurements extended on the dayside south hemisphere between 30 and 50°S and 9:05a - 10:50a. Our analysis technique allows an unambiguous characterisation of the zonal wind latitudinal, local time profile and its temporal variability. We will also present a latitudinal profile of the meridional wind in the mid-latitudes range, which will show for the first time meridional wind at both, southern and northern, hemispheres, from ground-based observations. We will present the results of our tracking on the short-timescale (daily) changes in the meridional profile of the zonal wind, confirm the detection of the meridional wind and constrain the extent of the Hadley cell, and constrain the presence of a sub-solar to anti-solar thermospheric component near the cloud top layers.