EPSC Abstracts
Vol. 13, EPSC-DPS2019-131-1, 2019
EPSC-DPS Joint Meeting 2019
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EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Venus' atmosphere cloud tracked winds (283 and 385 nm): comparison with Doppler winds and GCM simulations

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Abstract

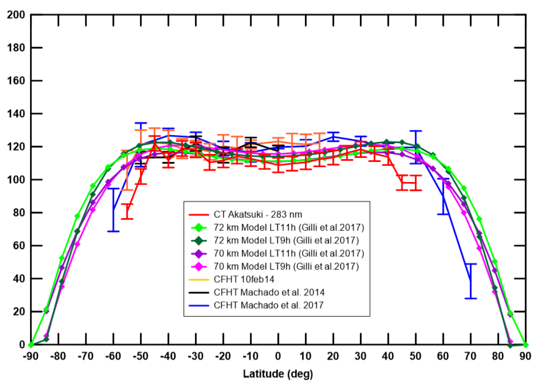

Figure 1: In this figure we compare UVI/AKATSUKI cloud tracked zonal wind results based on observations with the 283 nm filter, Doppler winds obtained with CFHT/ESPaDOnS and simulations with the 3D LMD GCM at altitudes from 70 to 72 km.

We present results of the meridional wind in both Venus' hemispheres and spatial and temporal variability of the zonal wind, based on coordinated observations at Venus cloud-tops based with two complementary techniques: Ground-based Doppler velocimetry (CFHT/ESPaDOnS, TNG/HARPS-N) and cloud-tracked winds using coordinated Akatsuki/UVI imaging at 283 and 385 nm. Cloud-tracked winds trace the true atmospheric motion also responsible for the Doppler-Fizeau shift of the solar radiation on the dayside by super-rotating moving cloud-tops with respect to both the Sun and the observer (Machado et al., 2014). Based on this complementarity, we performed coordinated campaigns in April 2014 (Machado et al., 2017), combining both Venus Express observations and ground-based Doppler wind measurements on the dayside of Venus' cloud tops at Canada-France-Hawaii telescope at a phase angle $\phi = (76 \pm 0.3)^{\circ}$, and with HARPS-N at TNG coordinated with Akatsuki's space probe observations in January 20017.

Akatsuki UVI (Horinouchi et al, 2018, Goncalves e al., 2019) and Venus Express cloud top wind measurements based on tracking using images taken with the VIRTIS instrument (Hueso et al., 2012, Sanchez-Lavega et al., 2008, Peralta et al., 2007) indicate nearly constant zonal winds in the Southern hemisphere between 0 and 55° S. The analysis and results show (1) additional confirmation of coherence, and complementarity, in the results provided by these techniques, on both spatial and temporal time scales of the two methods; (2) first-time estimation of the meridional component of the wind in other planet using the Doppler velocimetry technique, with evidence of a symmetrical, poleward meridional Hadley flow in both hemispheres; (3) spatial and temporal variability of the zonal flow with latitude and local time, with a significant increase of wind amplitude near morning terminator. We also present final results based on observations of Venus' bottom of the cloud deck, carried out with the Near Infrared Camera and Spectrograph (NICS) of the Telescopio Nazionale Galileo (TNG), in La Palma, on July 2012. We observed for periods of 2.5 hours starting just before dawn, for three consecutive nights. We acquired a set of images of the night side of Venus with the continuum K filter at 2.28 microns, which allows to monitor motions at the lower cloud level of the atmosphere of Venus, close to 48 km altitude. Our objective is to measure the horizontal wind field in order to characterise the latitudinal zonal wind profile, to study variability, to help constrain the effect of large scale planetary waves in the maintenance of superrotation, and to map the cloud distribution. We will present results of cloud tracked winds from ground-based TNG observations and winds retrieved from coordinated space-based VEx/VIRTIS observations.

The observational results from cloud tracked tech-

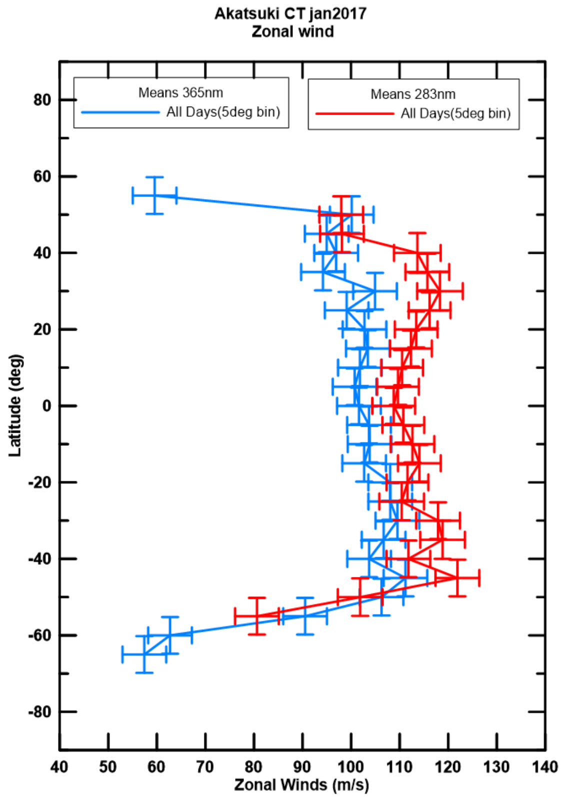

Figure 2: In this figure we present the latitudinal profile of the zonal wind (binned in five degrees) retrieved with cloud tracking techniques using Akatsuki's UVI observations in two different filters (283 and 385 nm). We can notice that the results from the two different filters show an average difference of about 10-15 ms^{-1}.

niques that were obtained at two different filters (283 and 385 nm) show clearly that they sound two different heights in the atmosphere, we will compare these results with the ground-to-thermosphere 3D model, developed at the Laboratoire de Meteorologie Dynamique in Paris (Gilli et al. 2017), at several pressure levels (and related heights). We will also present the comparison from this investigation with Doppler winds obtained from HARPS-N/TNG, ESPaDOnS/CFHT and UVES/VLT. Zonal wind predictions above 60 km, and at different levels of altitude, seem to be consistent with available measurements (Peralta et al. 2018, Machado et al. 2017, Goncalves et al. 2019).

Acknowledgements

We gratefully acknowledge the collaboration of the TNG staff at La Palma (Canary Islands, Spain) and CFHT helpful staff at Mauna Kea (Hawaii, USA). We thank the JAXA's AKATSUKI team for support with coordinated observations. We are grateful to ESA's VIRTIS/VENUS EXPRESS team for their availability and support to our coordinated observational campaign. We acknowledge support from the Portuguese Fundação Para a Ciência e a Tecnologia (ref. PD/BD/128019/2016 and ref. UID/FIS/04434/2013) through national funds and by FEDER through COMPETE2020 (ref. POCI-01-0145-FEDER-007672)

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