# Cloud tracking technique and Akatsuki's space-based observations in ultraviolet

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## Manual Cloud Tracking Method

- Analysis of imaging sequences that correlates and follows cloud patterns on Venus' atmosphere.
- Considering the two images , one taken of a certain cloud area with all of its features as well as another of the same area that is taken after the first image.
- Through practical means, one point is selected in each of the images which do correspond towards the same feature and a correlation vector is established ; through this vector, the time and the displacement are retrieved, therefore, the velocity of the wind at the selected point can be found.

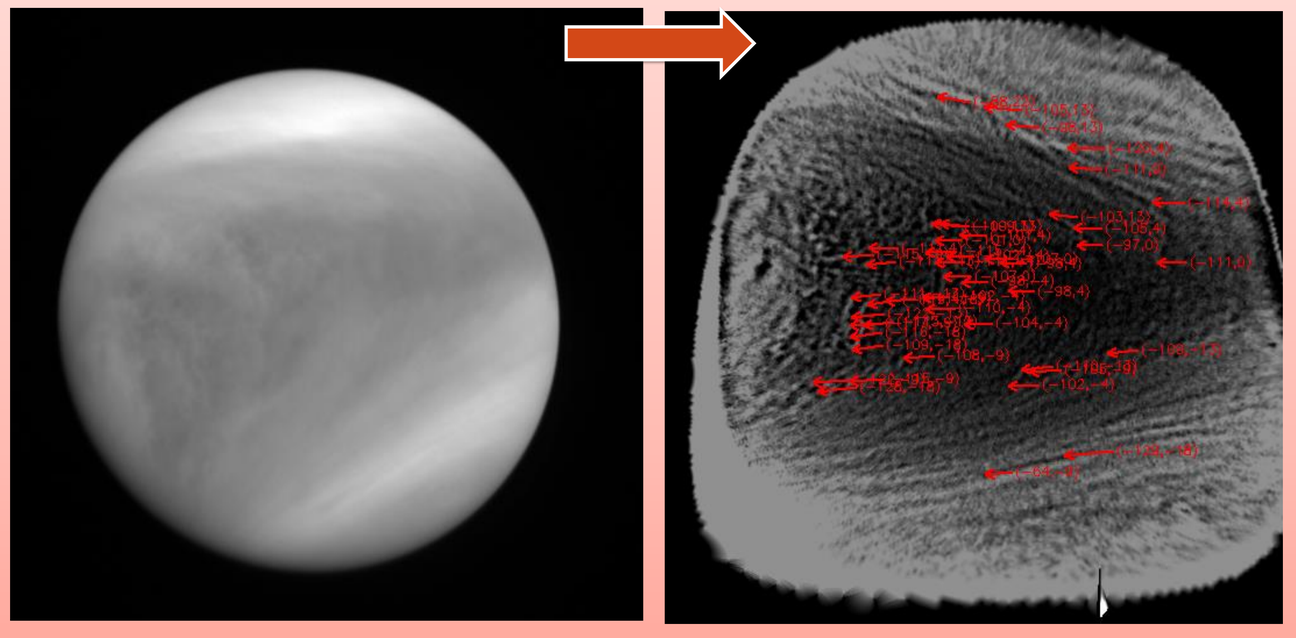

Fig 1: Examples of how a picture is processed and projected so that wind correlation vectors are traced after the manual cloud tracking process. Each tracer indicates the pair zonal wind velocity and meridional wind velocity in m/s. On the left side is a VCO/UVI image retrieved with the 283nm filter on 26-01-2017 and on the right side is the same image after the afforementioned method is applied.

## Results

- Observations with Akatsuki or Venus Climate Orbiter (VCO) spacecraft data with Ultraviolet Imager (UVI) imaging instrument.
- Navigated image processing with dedicated software, mainly contrast enhancement techniques are applied to spacecraft data for zonal wind velocities retrieval with manual cloud tracking method.
- A binning is performed for all velocity tracers in order to retrieve velocity zonal wind profilesfor each of the six observation days (26-01-2017 to 31-01-2017).

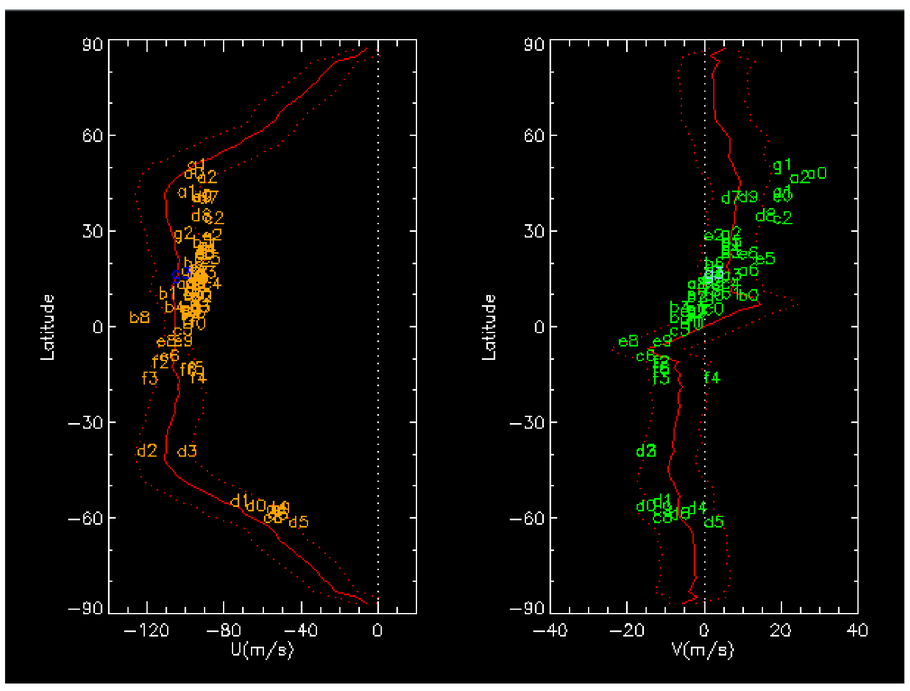


Fig 2: Example of correlation vectors information retrieveal in terms of position and wind velocities (zonal and meridional). Only the zonal wind velocities were considered for this work. The figure shows the zonal wind velocity (U) and the meridional wind velocity(V) against the planetocentric latitude of Venus.

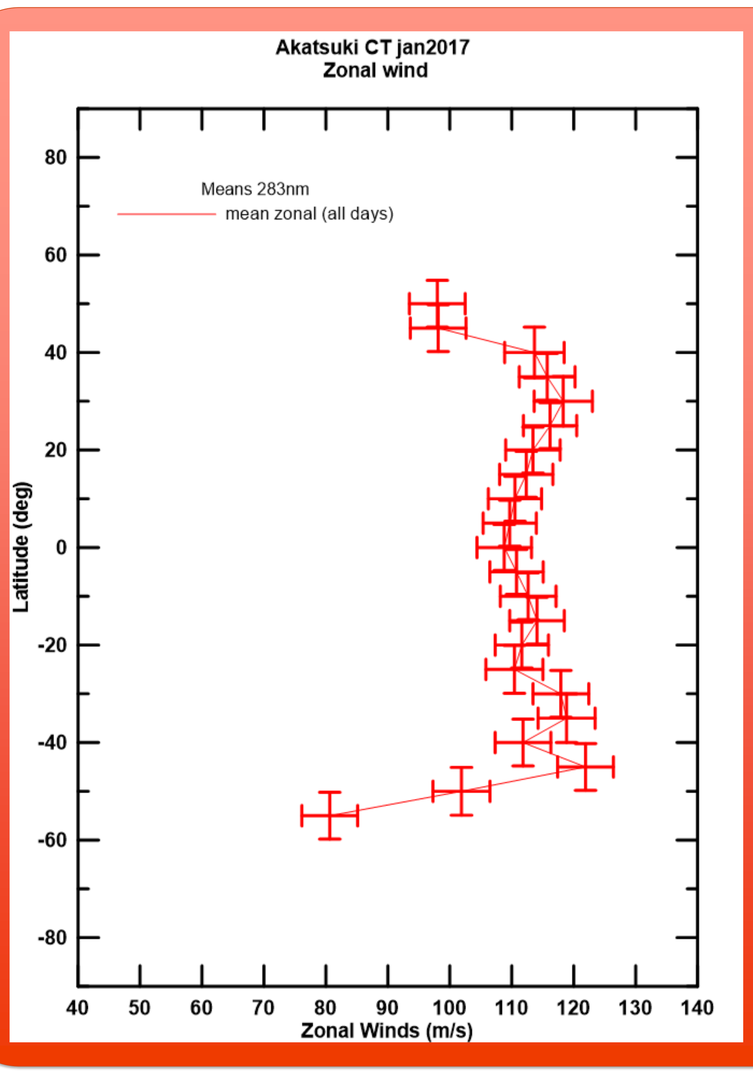


Fig 3: Mean Zonal wind profile (red) for all six observation days with the 283nm UVI filter where a steady wind velocity profile with a quick drop in velocity when reaching the poles can be observed. A 5 degree binning was used to obtain this profile.

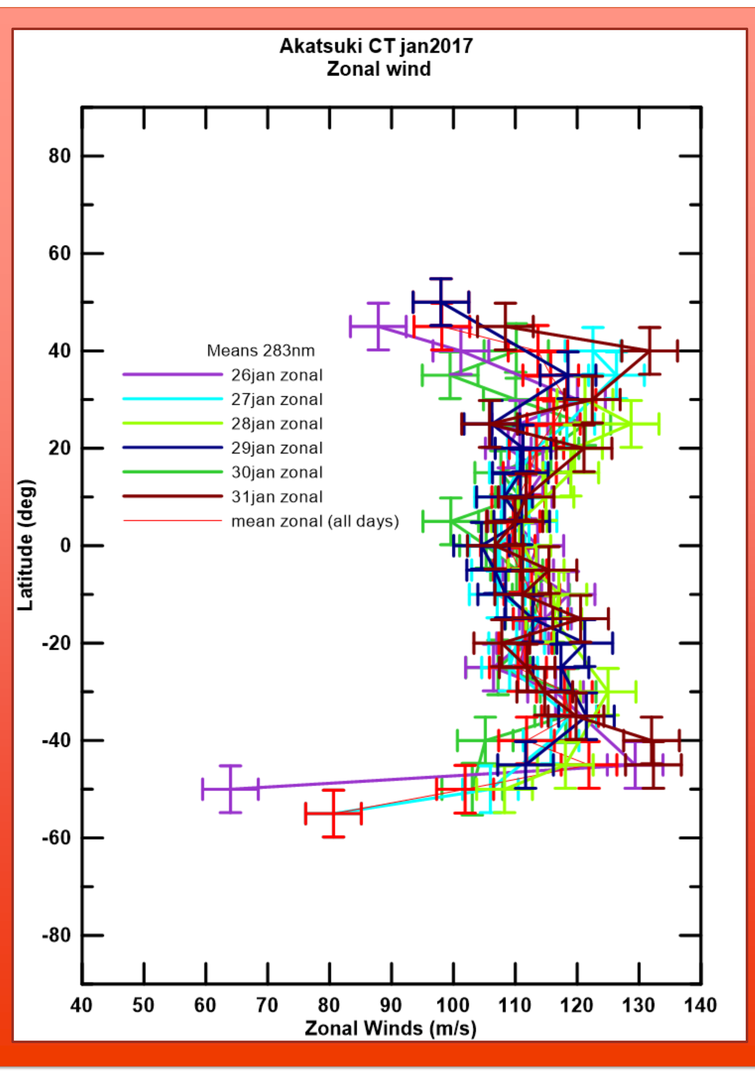


Fig 4: Zonal wind profile for each of the six observation days with the 283nm UVI filter where a steady wind velocity profile with a quick drop in velocity when reaching the poles can be observed for each day. A five degree binning was used to obtain these profiles.
Key:
26-01-2017 : purple
27-01-2017 : cyan
28-01-2017 : lime green
29-01-2017 : dark blue
30-01-2017 : dark green
31-01-2017 : brown

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### References

Sánchez-Lavega, A., et al. "Variable winds on Venus mapped in three dimensions", GEOPHYSICAL RESEARCH LETTERS, VOL. 35, 2008.

R. Hueso, J. Peralta, I. Garate-Lopez, T. V. Bandos, and A. Sanchez-Lavega. "Six years of Venus winds at the upper cloud level from UV, visible and near infrared observations from VIRTIS on Venus Express.", August 2015.