Cloud tracked winds at the lower cloud level using Venus’ night side observations at 2.28 µm with TNG/NICS

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Ground-based Cloud Tracking: method and data reduction

By continuous monitoring of the horizontal cloud structure at 2.28 µm (NICS Kcont filter), it is possible to determine wind velocities using the technique of cloud tracking. We acquired a series of short exposures of the Venus disk. The best 10% of images have been selected, registered to a common coordinate system and co-added to compose a first image (A). Another series were taken at a later time, forming a second image (B). Cloud displacements in the nightside of Venus, between images A and B, can be computed using both an automated technique [3] and a manual one [5]. We used a semi-automatic method, based on a phase correlation method between images (Peiris, personal communication) that increases the precision of the match between the observed cloud features (on image A) and its new location in image B.

Figure above: From left to right, a Continuum K, image, a Brackett-gamma image, and the result of subtracting a scaled Brackett-gamma image from the one taken in Continuum-K. On these images the dark regions are clouds, the bright regions are optically thinner areas between the clouds that allow thermal emission from the lower atmosphere to escape, and the outlined crescent is the central disk of the planet.

Space-based Cloud Tracking

This observing strategy was similar to the one used previously by Young et al. [9] and Taverner et al. [8] at IRTF. The Venus apparent diameter at observational dates was greater than 32” allowing a high spatial precision. The 113” pixel scale of the NICS narrow field camera allowed to resolve pixel displacements. The absolute spatial resolution on the disk was 100 km/px at disk center, and the (0.8–1”) seeing-limited resolution was 400 km. By visualising the best images and cross-correlating regions of clouds the effective resolution was significantly better than the seeing-limited resolution. In order to correct for scattered light from the (unfiltered) day side crescent into the nightside, a set of observations with the Brγ filter were performed. Cloud features are invisible at this wavelength due to the high optical depth of the gaseous CO2/CO system, and this technique allows for a good correction of scattered light [8].

Conclusions and Prospects

The cloud tracked winds based on VIRTIS-M are consistent with previous results. The preliminary comparison with the ground-based cloud tracked winds (TNG/NICS) and the coordinated space-based (Vex/VIRTIS) show some consistency, despite the systematic higher zonal wind velocities from the ground-based observations. VMC/Vex cloud-tracked winds are still under ongoing work. In this work we used an improved cloud tracking method based on a phase correlation between images.

We will improve the navigation of the ground-based images in order to optimise the cloud features’ shifts determination between images A and B, which will increase the precision of the retrieved wind velocities (ongoing work).

References