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Multivariate analysis of Virtis/Venus-Express night side observations

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The Virtis-VEx spectral cubes obtained at Venus have been analyzed with Independent Component Analysis (ICA). The objectives of this study are to 1) separate various types of cloud signatures, 2) detect single events such as lightnings, 3) identify and filter instrumental effects in the data. The analyses have been run on night side observations of Venus with the low spectral resolution imaging channel (Virtis-M_IR). Typically 4 to 6 components are required to match the Venus IR spectral radiance.

Overall, the night side IR signal is dominated by emission from mid/high altitude clouds in the atmospheric windows and black body emission (up to 60% of the signal). Two other components are always present: from lower-mid clouds (carrying most variability in the 1.74 and 2.3 μm peaks), and deep atmosphere below the clouds (contrasted in the short wavelength peaks). In sessions covering the polar areas, the polar vortex and the dark collar surrounding it are described by components with specific ratios of the 1.74 and 2.3 μm peaks, indicating different particle sizes. In addition, the O_2 emission airglow always stands out separately.

Whenever scattering is moderate, the surface contribution to the signal is clearly detected on two components related to the 1.02 μm peak on one hand, and to the 1.10 and 1.17 μm on the other hand. Both are also associated to variations in the profile of the peak at 1.74 μm. The first one is responsive to high elevation areas, whereas the second one can detect variations from lower elevations.

Additional components concentrate information related to hot pixels and remaining

instrumental effects, such as a small stray light contribution in a part of the FOV, or spectral misregistration. Study of these components therefore allows to identify remaining calibration artifact at this level.

In successive observations, both the components and the fraction maps are consistent. This demonstrates the robustness of the method to random noise and small signal variations, and will allow to map individual components between various sessions, with potential application to cloud tracking.