Cloud morphology and wind measurements by the Akatsuki 1 μm camera

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Abstract

Remote wind measurements on Venus have been conducted mainly in the UV region, where the presence of an unknown absorber allows the tracking of clouds. On the contrary, cloud tracking with images in near-infrared (NIR) wavelengths (which allow to sense a deeper level than UV images) is difficult due to the faint contrast of just a few percent. Here we present the analysis of 900-nm images of Venus's dayside clouds, taken by the IR1 camera onboard JAXA's Akatsuki mission. A comparison with UV images is also undertaken to gather information about acceleration processes and different contrast-forming heights. Considerable hemispherical asymmetries and sharp changes are sometimes observed in albedo at this infrared wavelength. This may indicate that 900-nm contrasts is partly formed by an unexpected unknown absorber. The zonal and meridional wind profiles found are similar to those of previous NIR measurements but displaying faster zonal winds at the equator, suggesting that equatorial jets are also apparent on the middle clouds of the dayside. The winds during the Akatsuki missions were also combined with measurements from amateur observations and during the Venus Express mission, revealing that the zonal winds seem to steadily increase along 10 years.

Akatsuki IR1 camera 900 nm
dayside imaging set up:
little gas nor cloud absorption

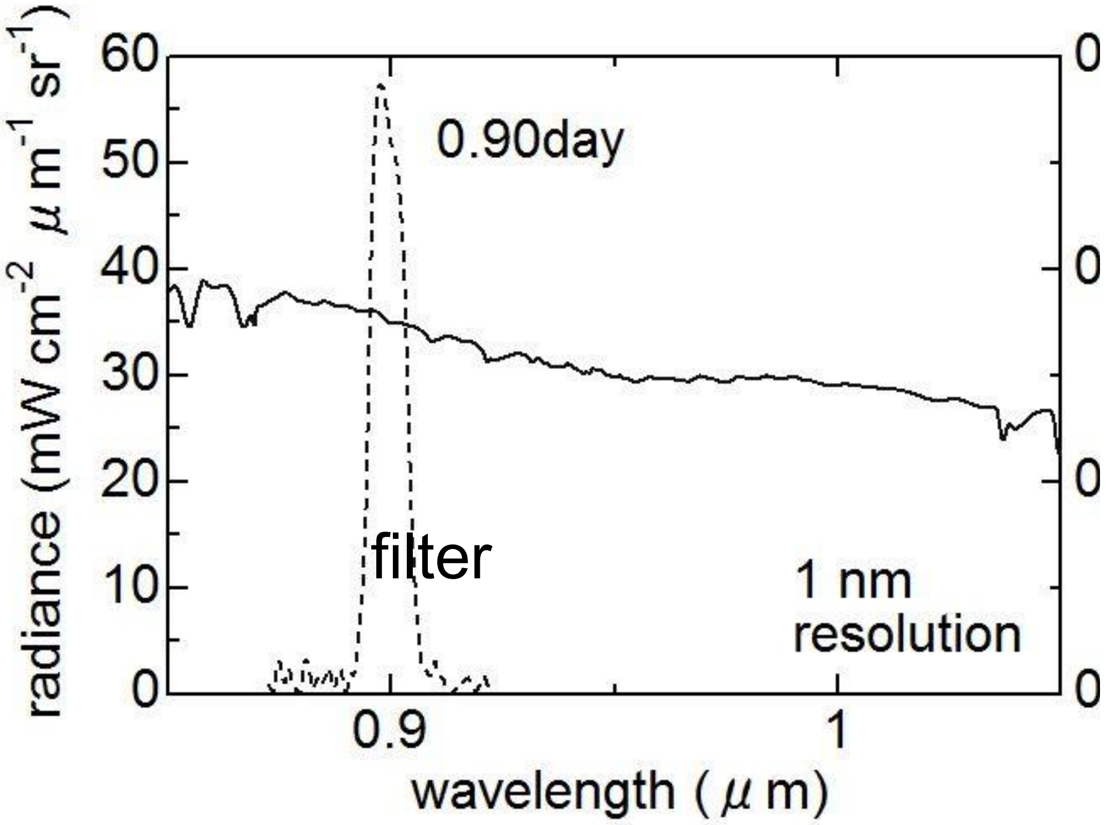
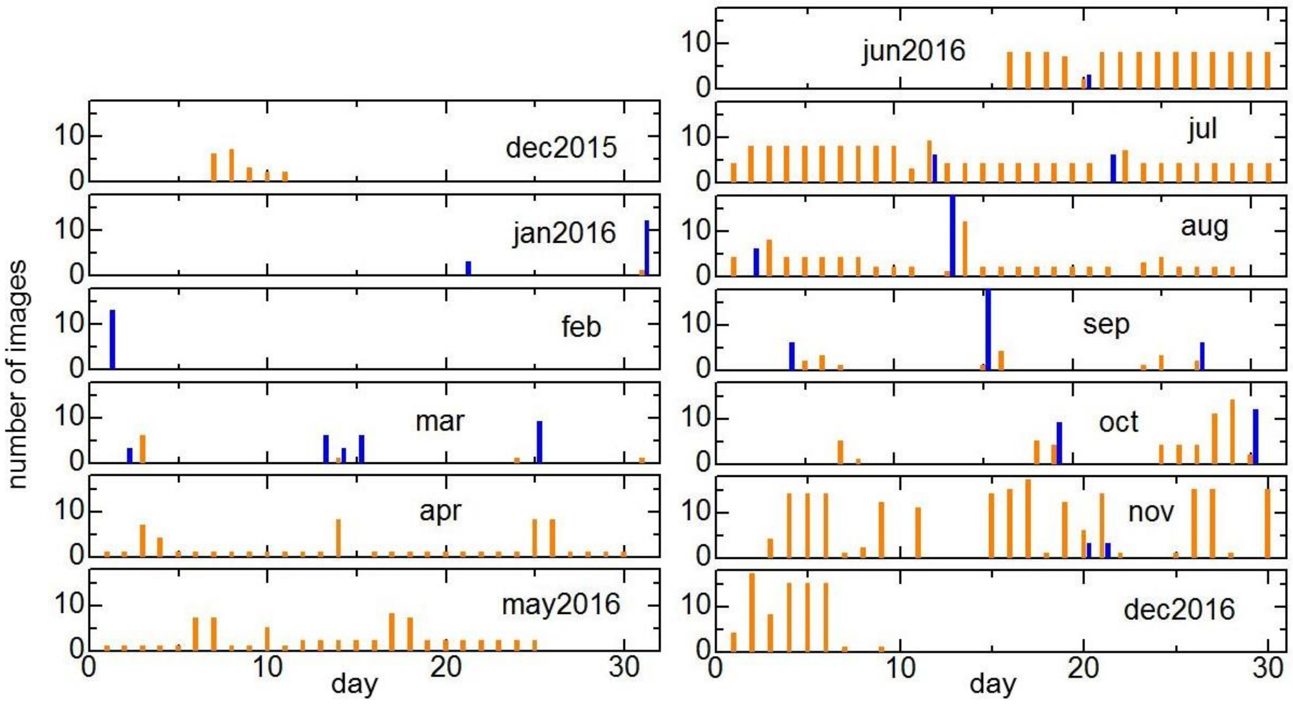
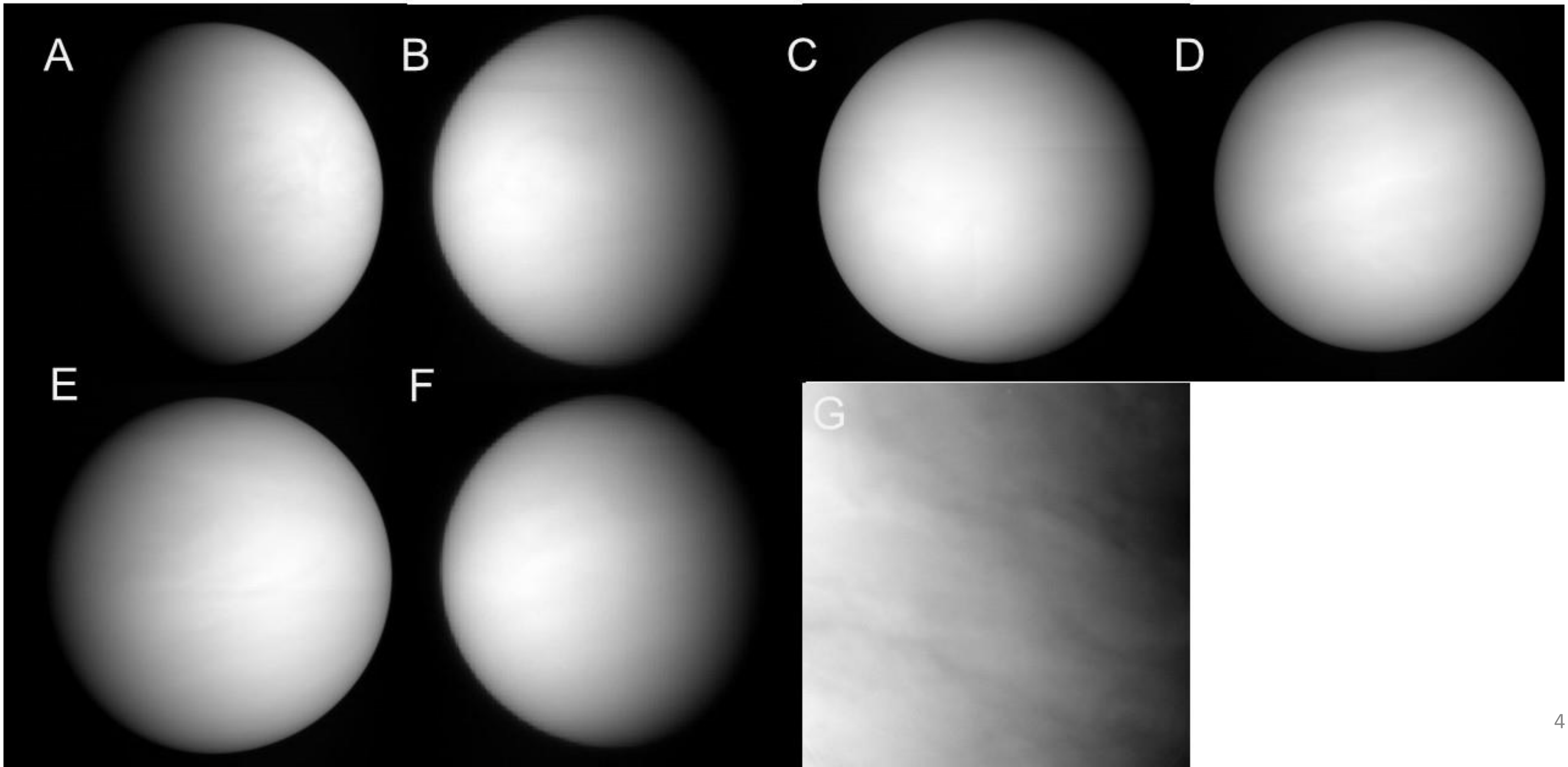


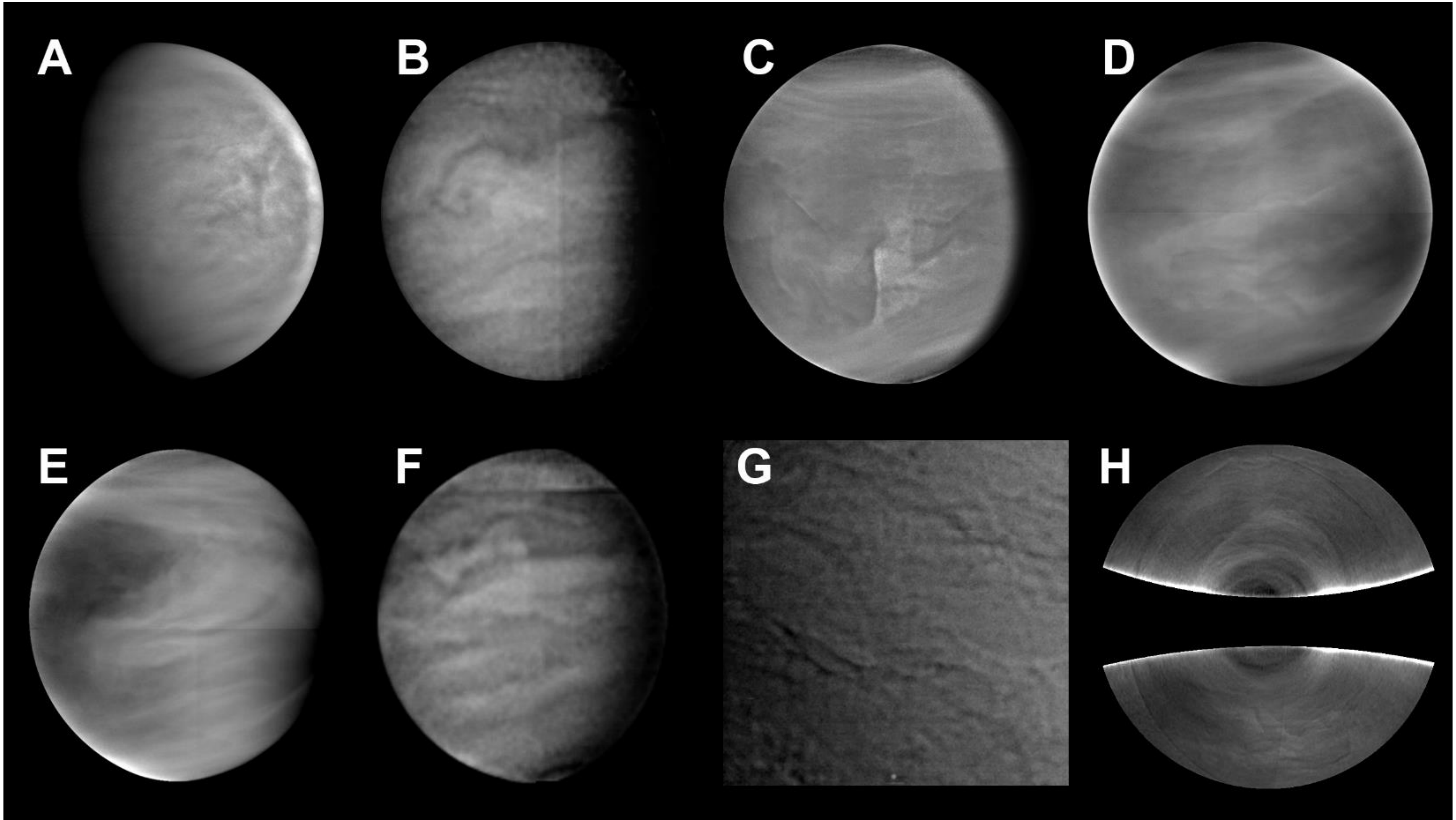
Image acquisition status:
day (red) and night (blue)
many day images but less
at night



Raw 900 nm day images: Sharp structure (discontinuity) may be noticed but with 3% contrast (ABC); smooth example (D); Darker N-hemisphere by 5% (EF); Close up (G: 1800km x 1800km)



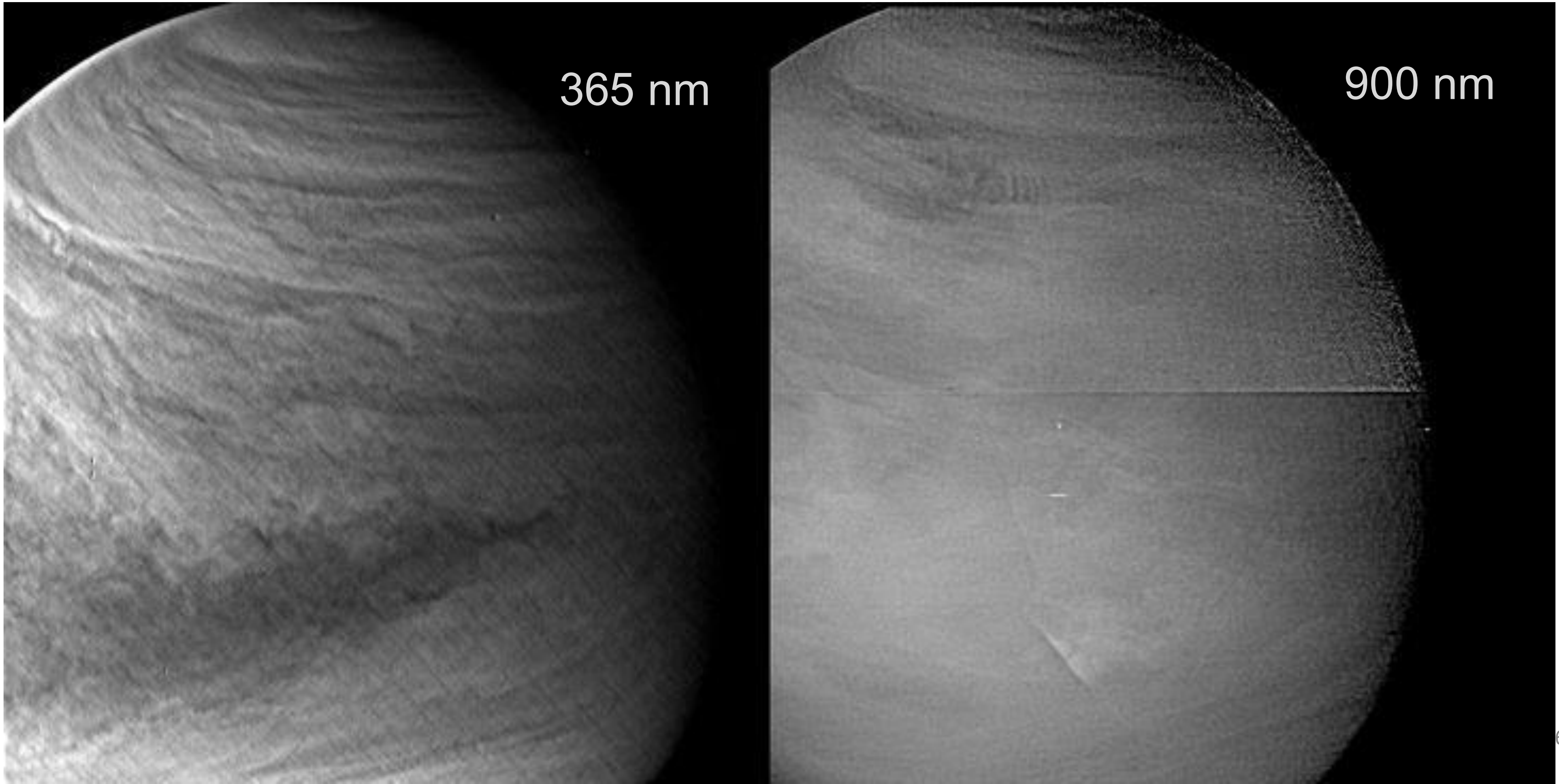
Contrast enhanced 900 nm day images: Sharp structure (discontinuity: ABC); smooth example(D); Darker N-hemisphere (EF); close up (G : 1800km x 1800km) Such sharp structures are not seen in UV images.



Little similarity with UV: Simultaneous UVI 365 nm and IR1 900 nm images:
Y shape in UV is not seen in IR, and sharp structure in IR is not seen in UV

UVI 20161120 151316

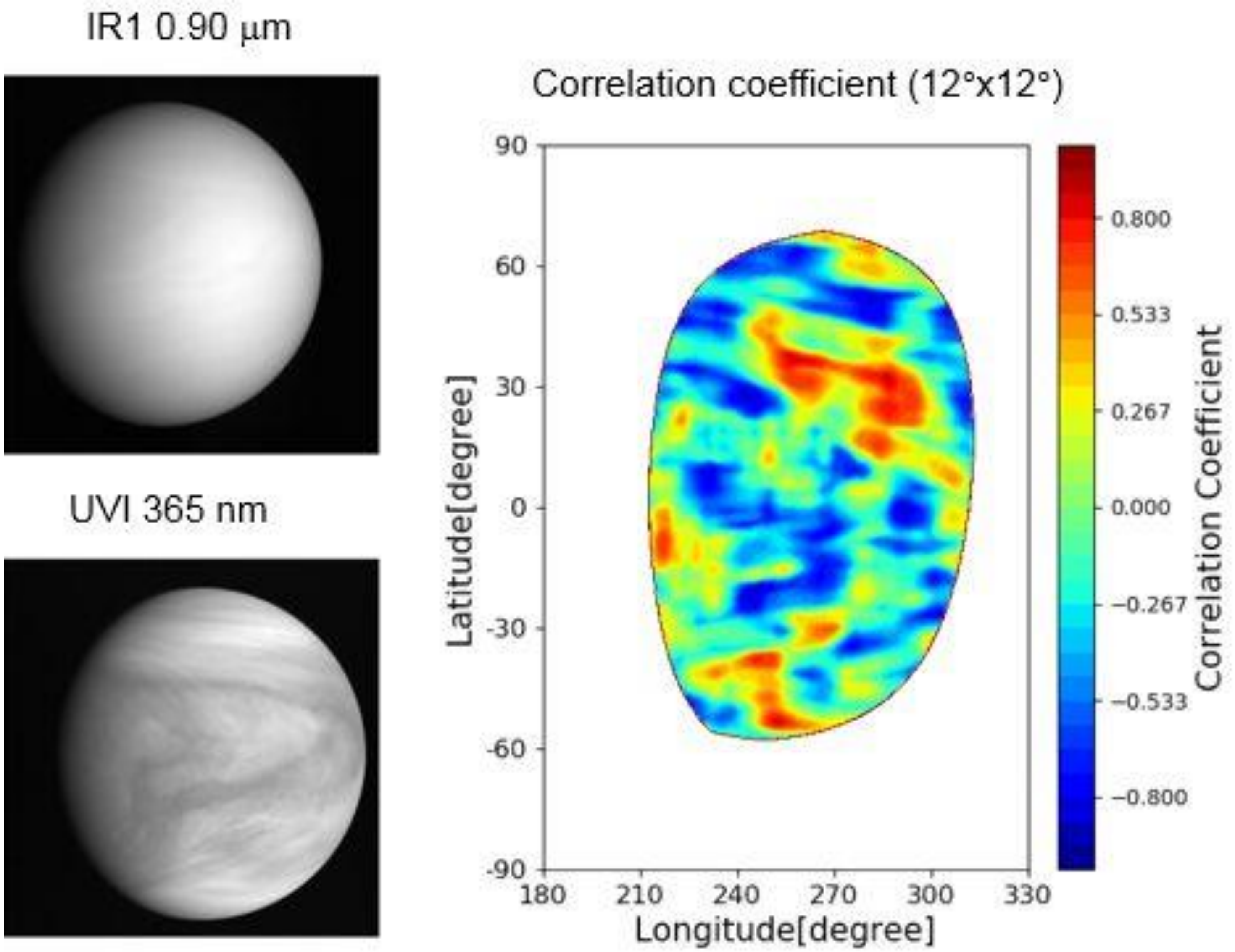
IR1 20161120 150552



Little correlation with UV

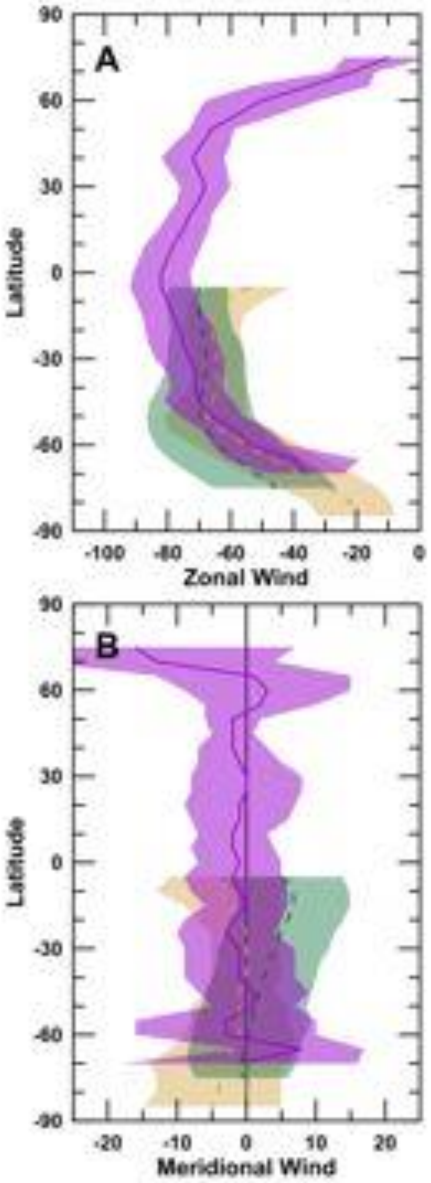
IR1 900 nm and UVI 365 nm images taken 15 minutes apart and their correlation (after Narita & Imamura)

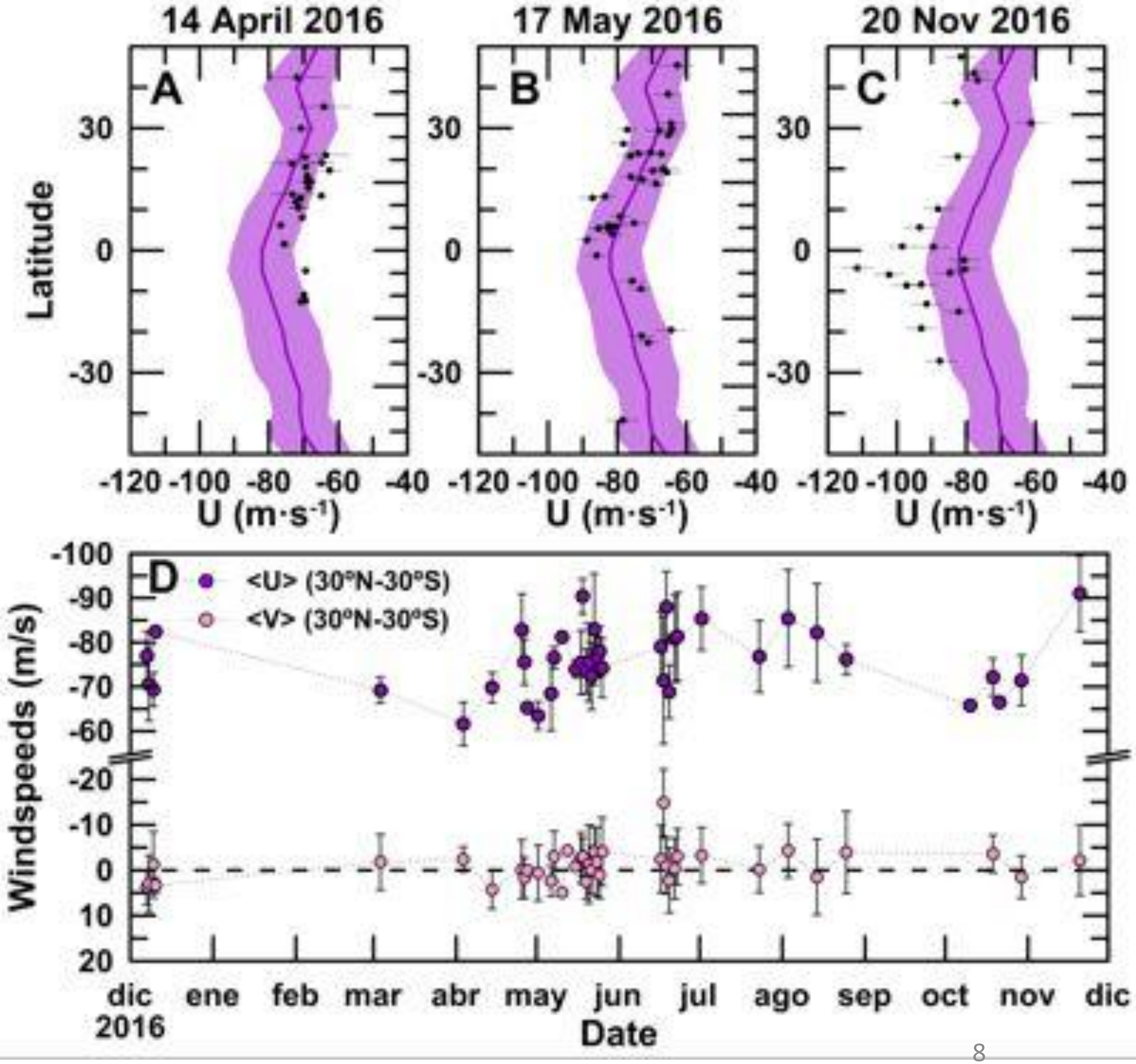
Little correlation indicates different contrast forming process



Winds from 900 nm day images: Zonal wind speed 75 m/s at low latitudes and little meridional wind

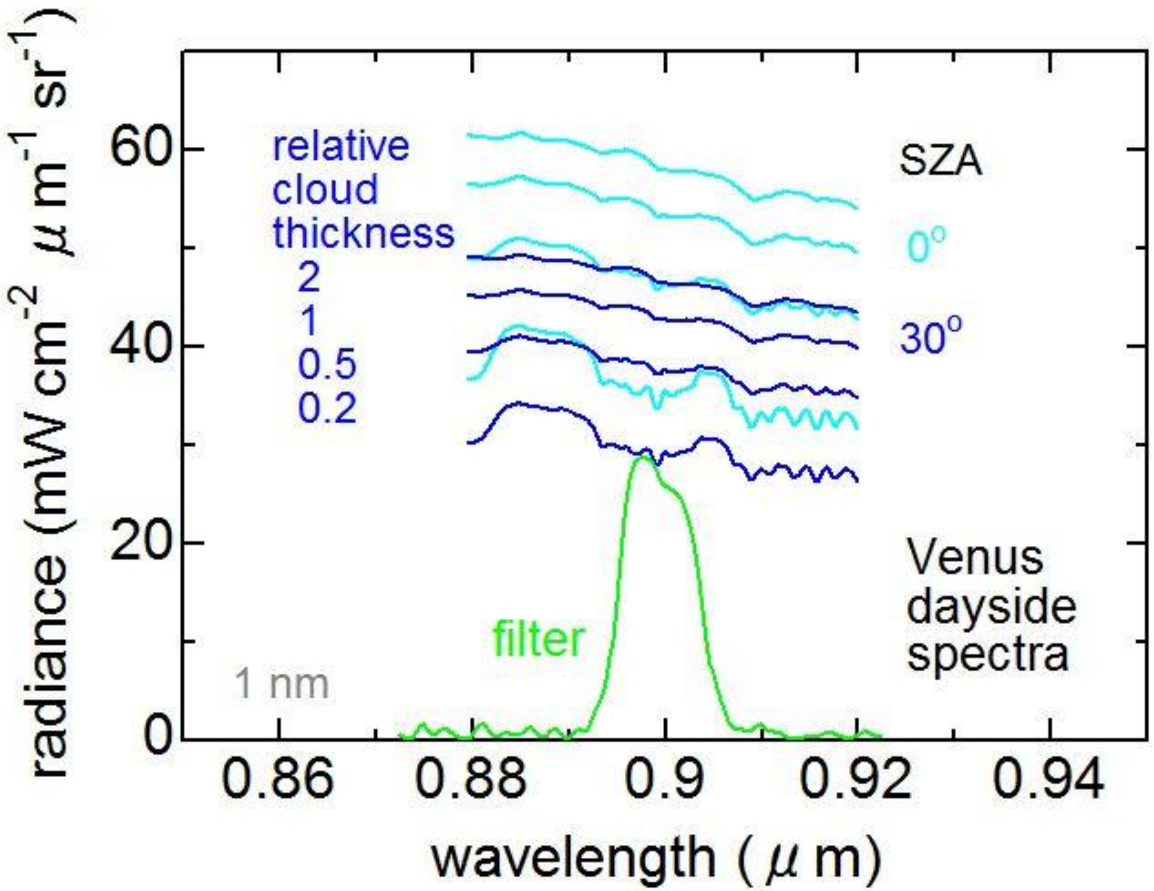
Zonal speed 75 m/s slower than the UV speed 100 m/s also indicates different contrast forming process

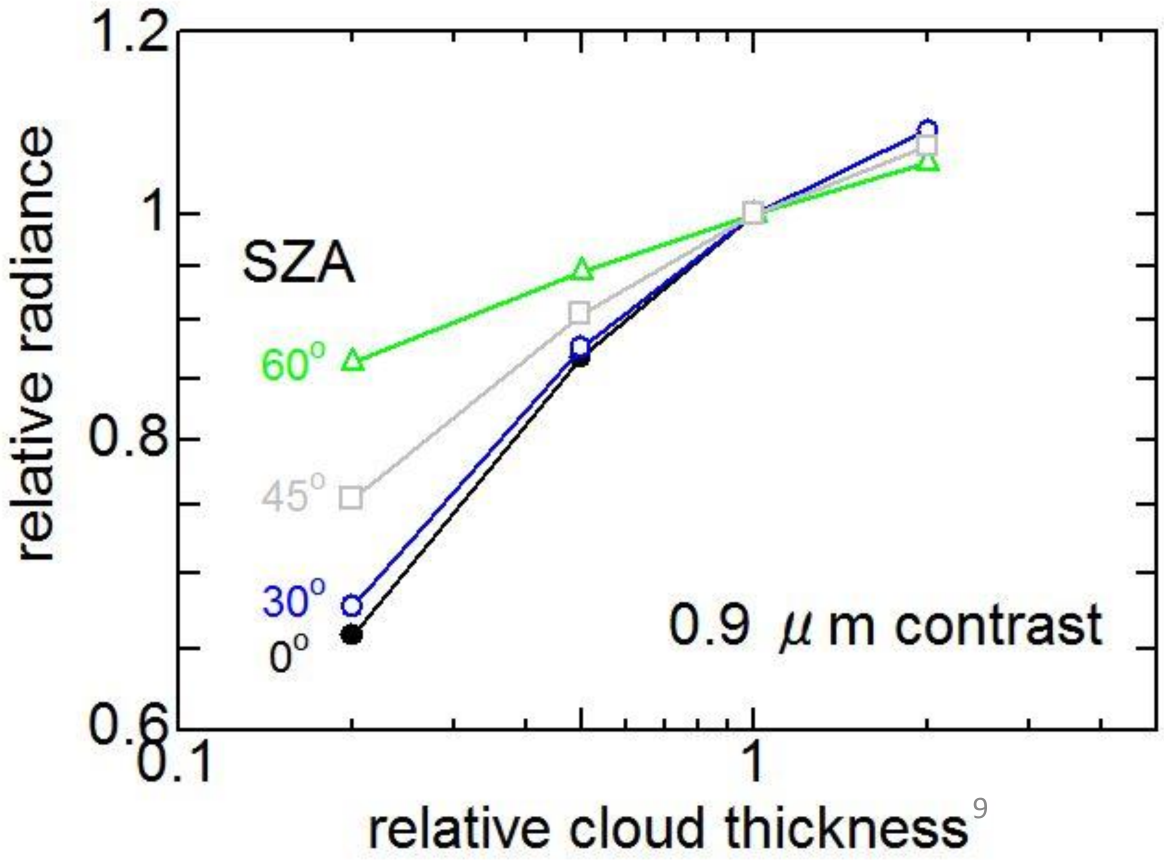




Contrast source?

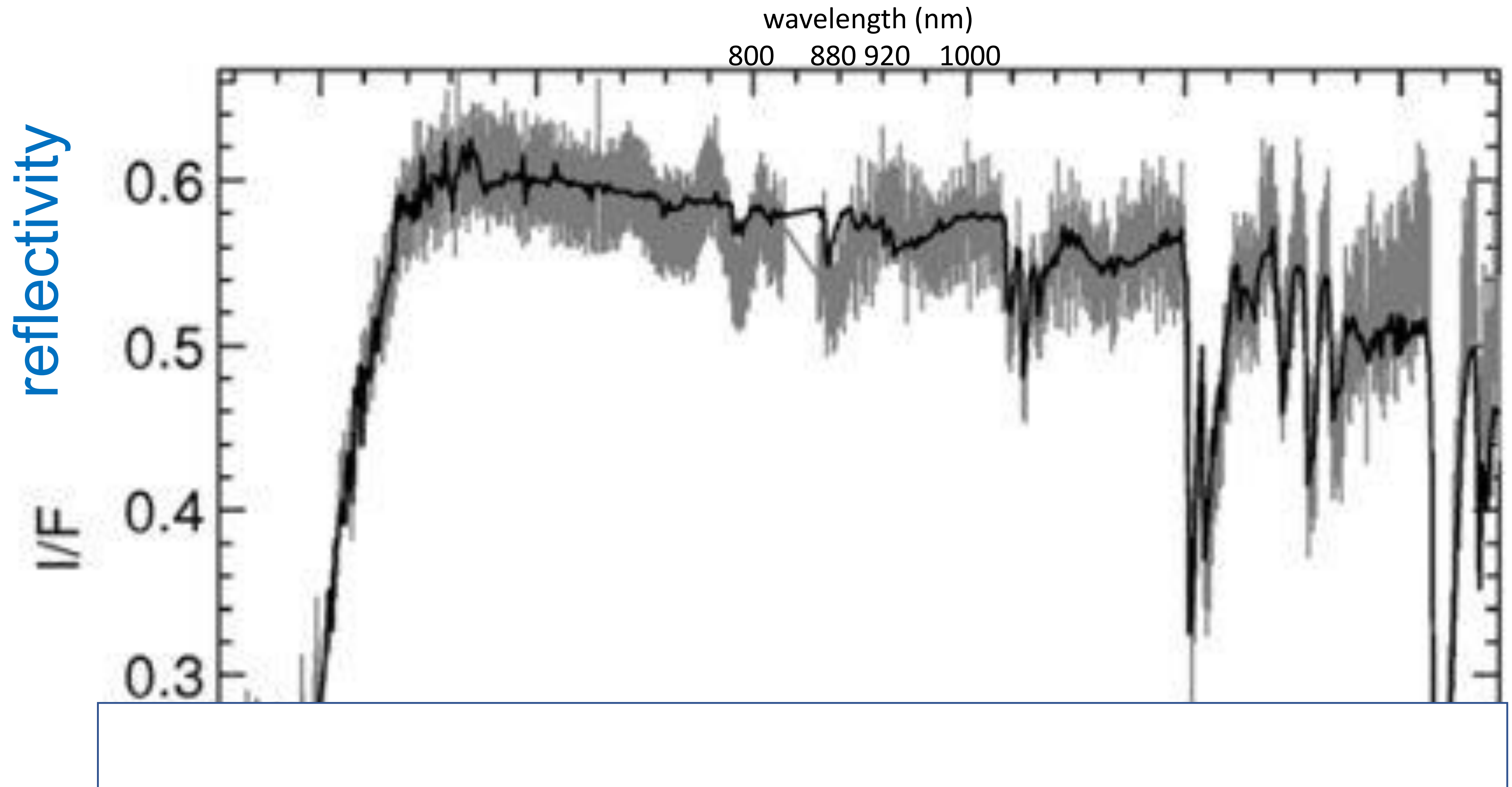
Calculated day spectra: local contrast comes from non-uniform cloud thickness, and global contrast from SZA. Sharp structure of 3% contrast (discontinuity) may be due to 20% change in cloud thickness; 5% darker hemisphere due to 30% change; Such change (+/-30%) in cloud thickness is common in the descending probe data.



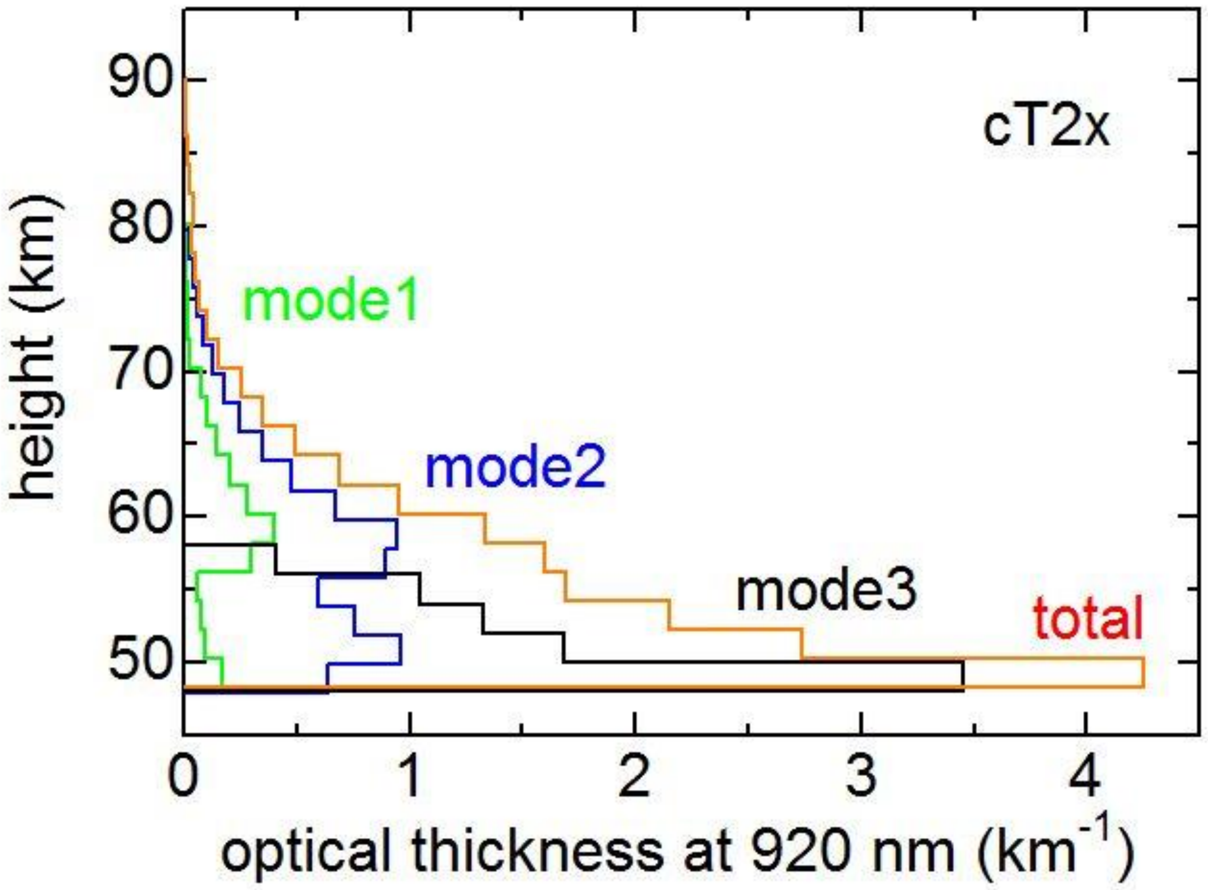


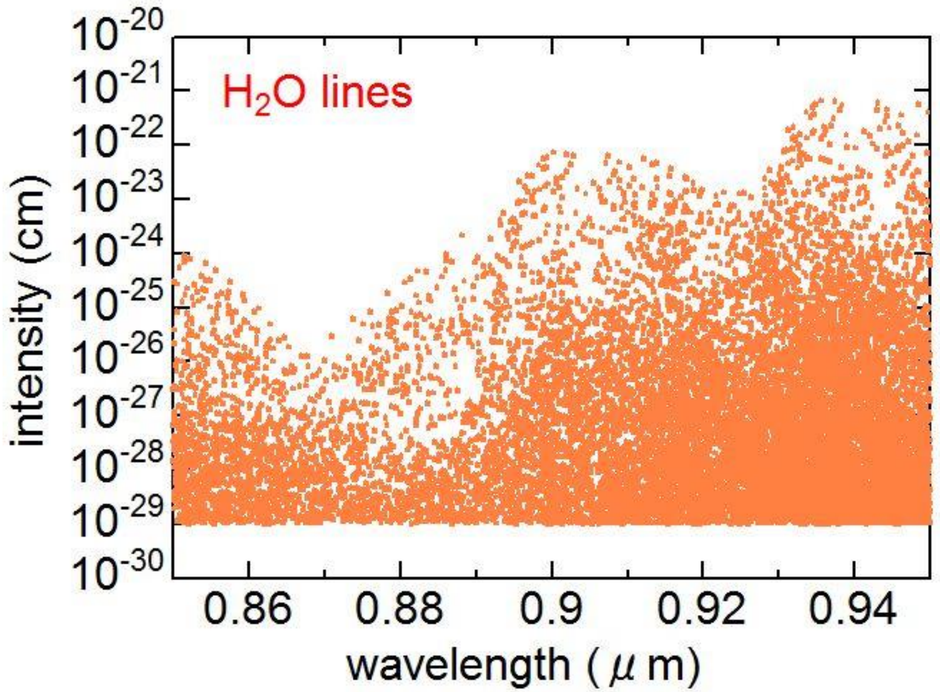
MASCS/MESSENGER Venus spectrum (Perez-Hoyos et al.,2018)

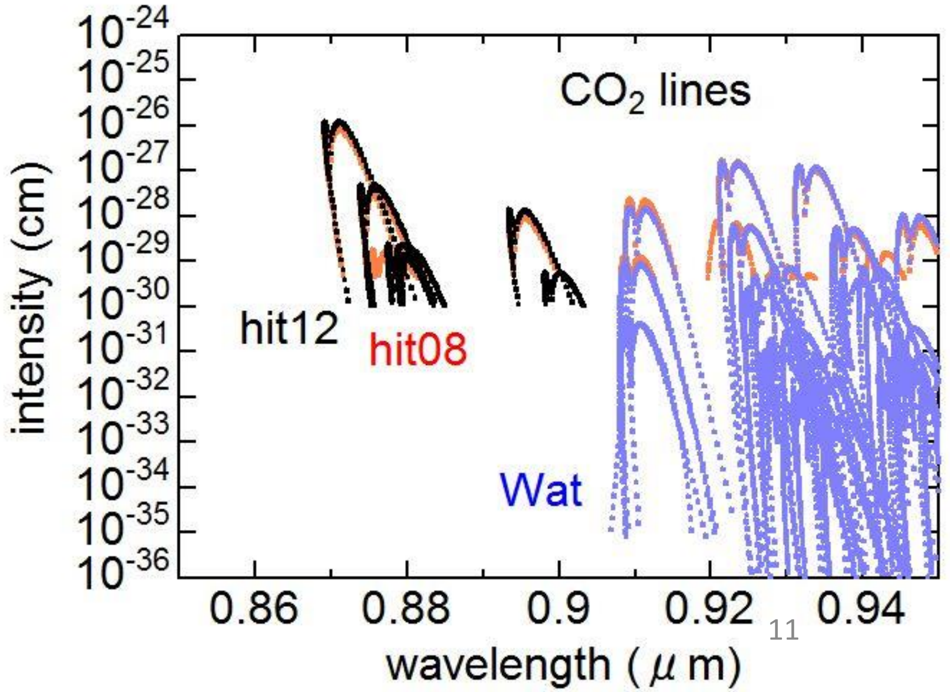
shows absorptions at 870 and 930 nm, but they are outside the IR1 pass band 895-905 nm indicating little contribution in IR1 contrast.



The cloud model: cT2x (Takagi & Iwagami 2011)
based on Venera and PV descending probes
(total thickness 34)







Summary

1. Sharp structures (discontinuities) often appear. They are not seen in UV images (Y-shape is not seen in 900 nm images) indicating different contrast forming process.

2. The zonal wind speed 75 m/s found in 900 nm images is slower than the UV speed of 100 m/s probably due to lower 900 nm contrast forming height (at 51-55 km: Iwagami et al 2018) instead of 70 km for UV.

3. The contrast source mostly seems to be inhomogeneity in cloud thickness, but additional absorber may work at 900 nm.

4. However, the reason for different contrast forming mechanisms is unknown.