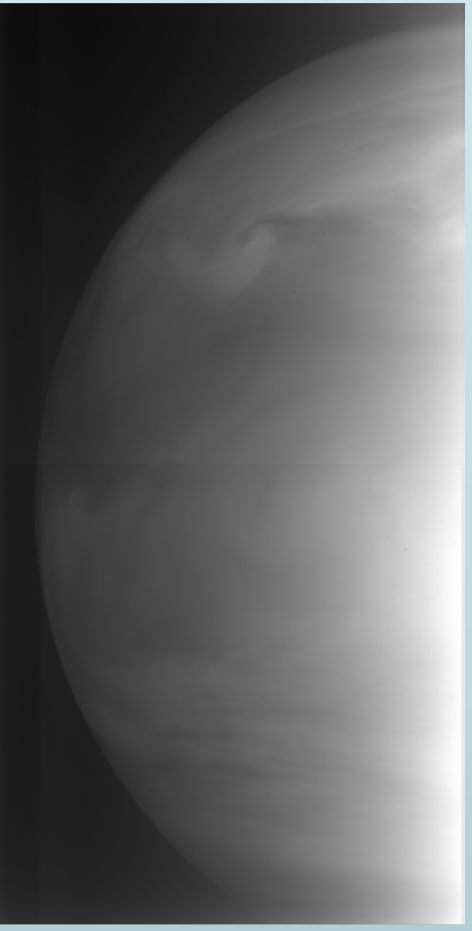
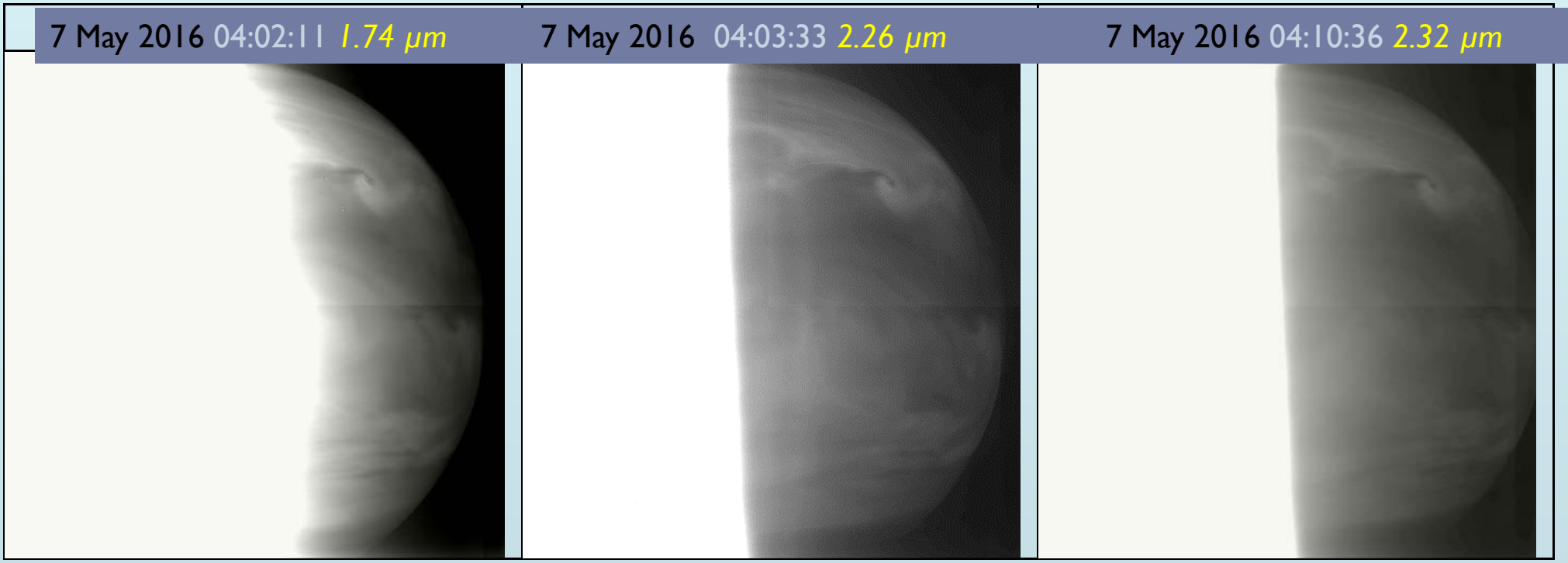
MESOSCALE VORTEX CIRCULATIONS ON VENUS
OBSERVED IN AKATSUKI IR2 IMAGES

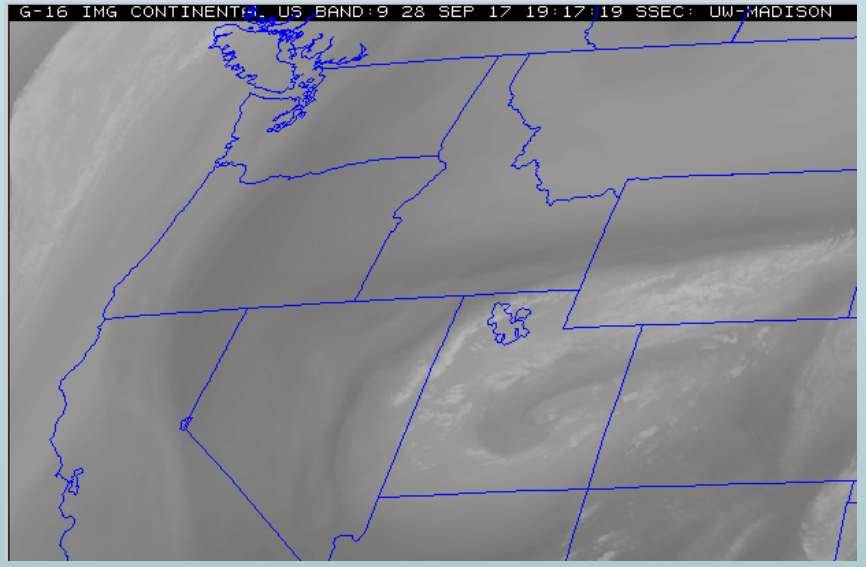


S.S. Limaye[1], T. Satoh[2], J. Peralta[2], T. Horinouchi[3], T. Imamura

8th Moscow Solar System Symposium, Space Research Institute, Moscow, Russia
9-13 October 2017

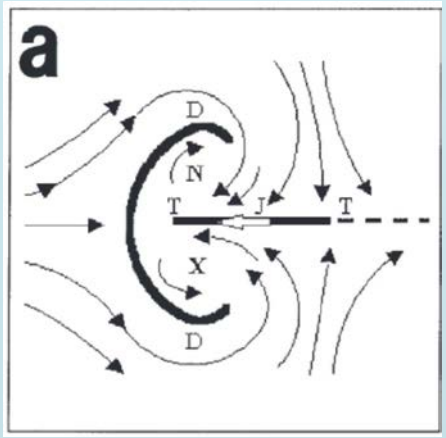


A similar "mushroom" feature, but more developed, was seen two orbits earlier at the same latitude, suggesting that it may be the same feature evolving and migrating mostly in longitude. Such features have been shown to be pairs of cyclonic and anti-cyclonic circulations



Similar vortex pair features are routinely seen in water vapor images of Earth obtained from weather satellites

Circulation aspects of the mushroom feature on Earth



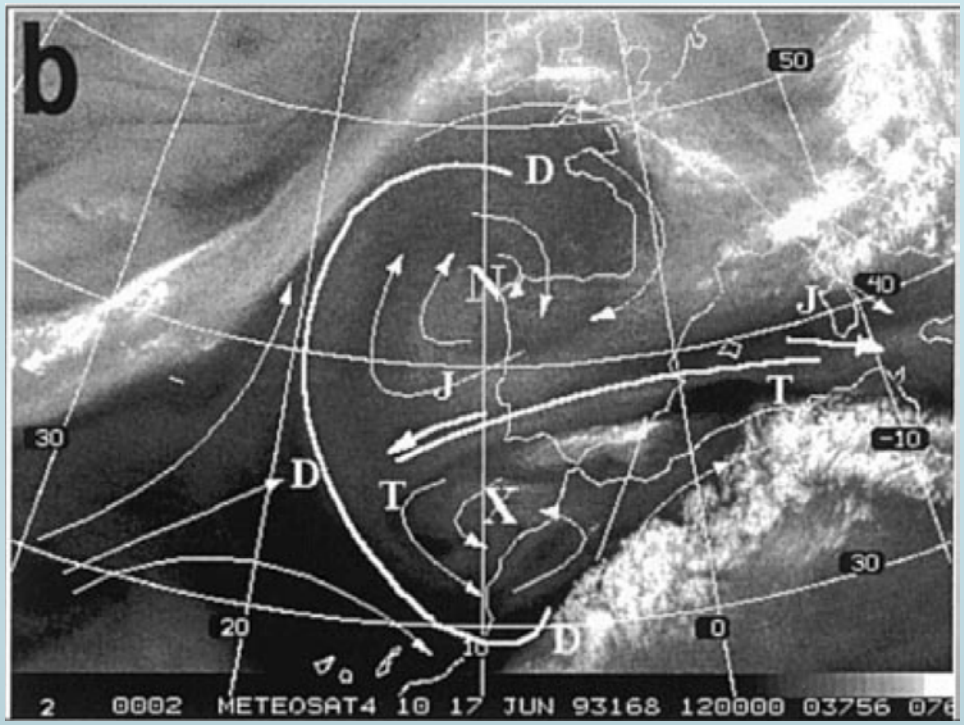
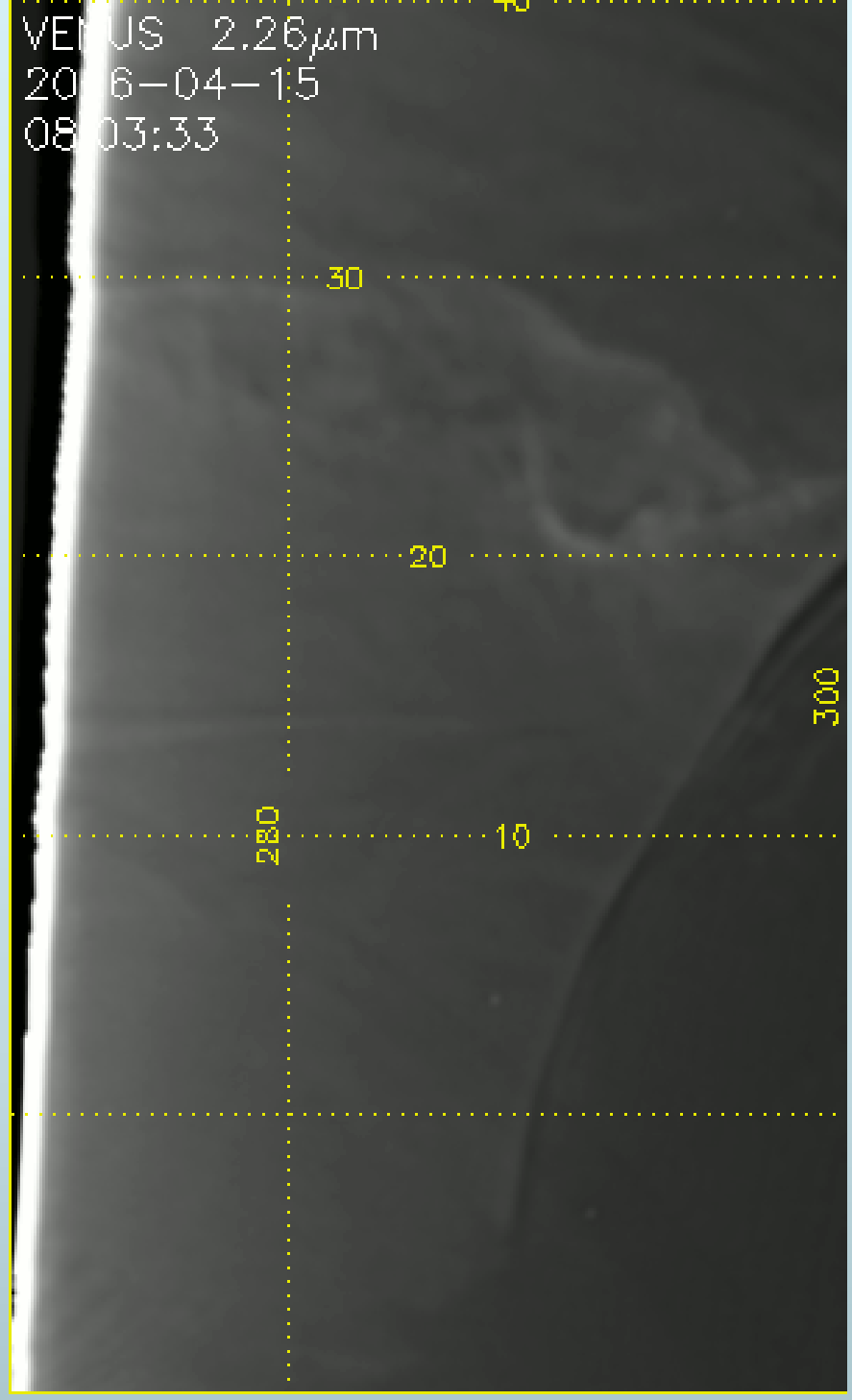


Figure 1, . (a) Idealized mushroom-like system as seen in WV imagery for an easterly flow. The two thick lines represent the deformation axes. DD represents the leading deformation zone, TT is the trailing deformation zone, X and N mark the negative and positive vorticity centers, respectively, and J indicates the local jet stream circulation. Thin solid lines are the streamlines of the relative motion of the flow. (b) METEO SAT WV imagery at 1200 UTC on 17 June 1993 showing a mushroom-like pattern close to the Iberian peninsula. A sketch of the main kinematic features, derived from a satellite imagery sequence, has been drawn.

"The mushroom configuration in water vapor imagery and operational applications", Martin et al., Meteorol. Appl. 6, 143–154 (1999)



300° 290° 280°

Are these circulations triggered by topography?

The vertical shear of the horizontal wind can lead to transformation of vorticity through forced vertical motion over elevated features on the surface.

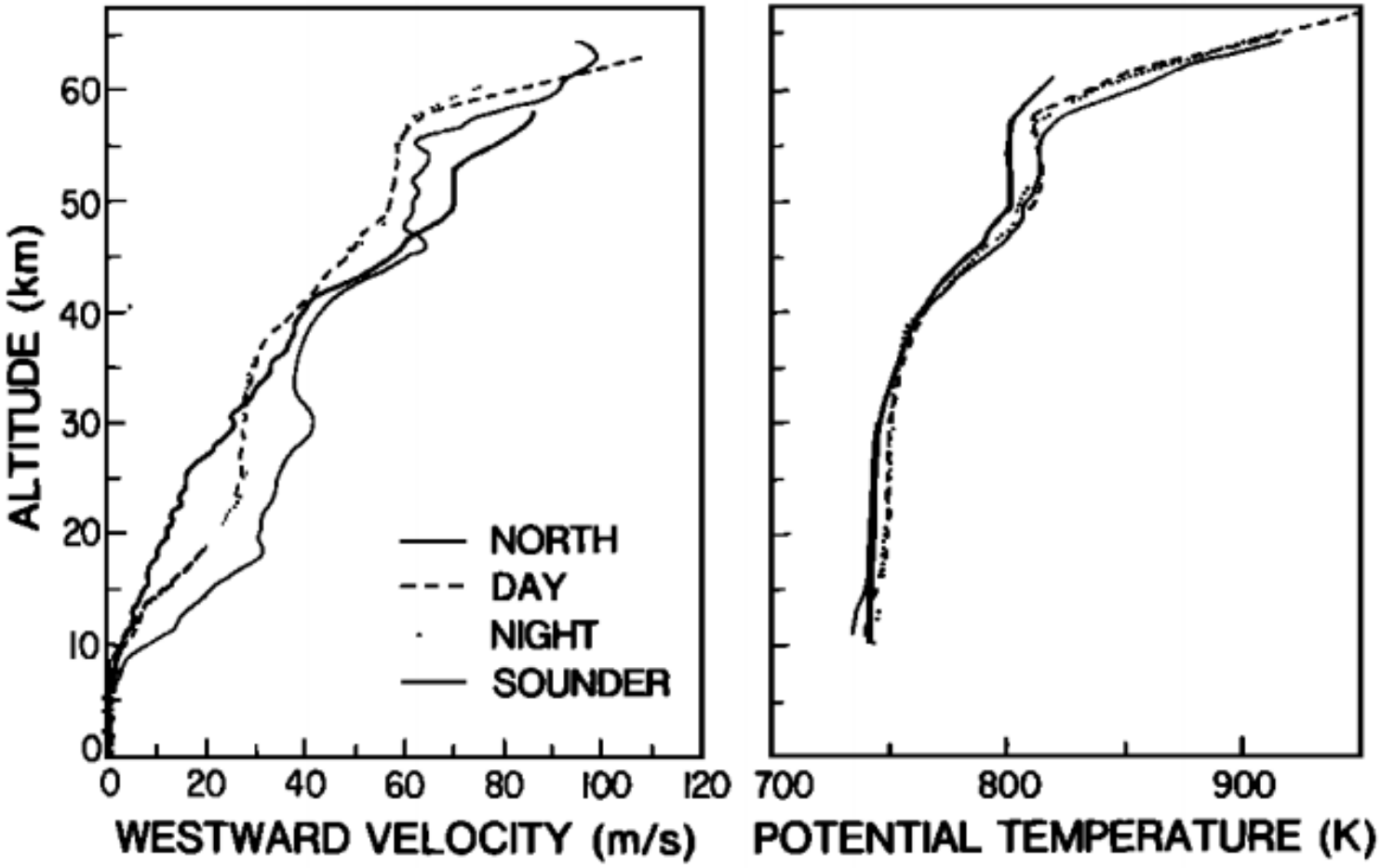
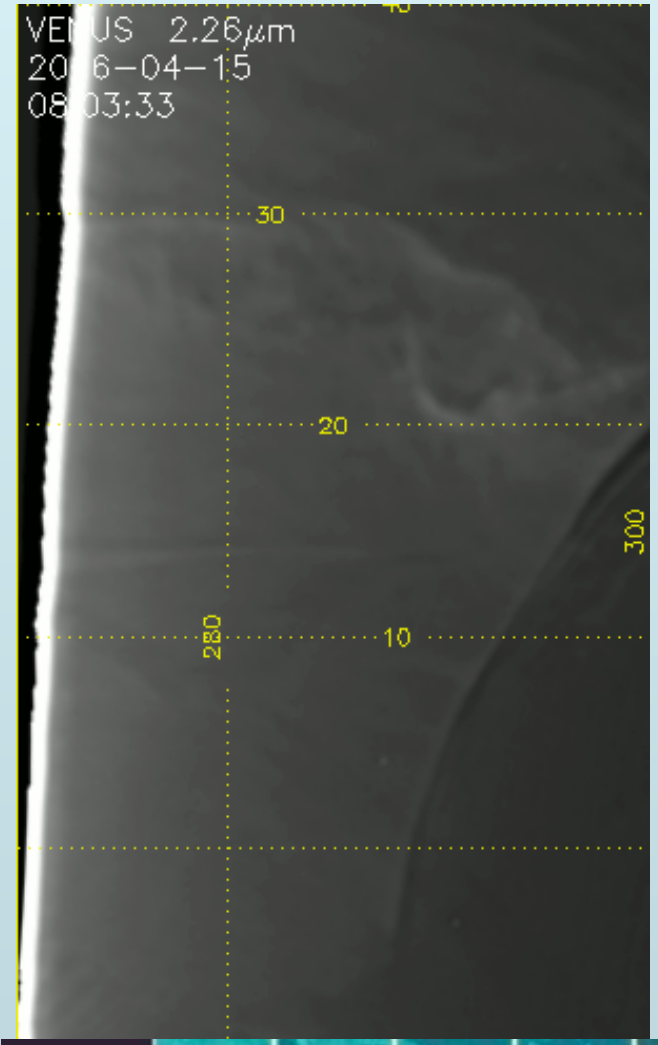
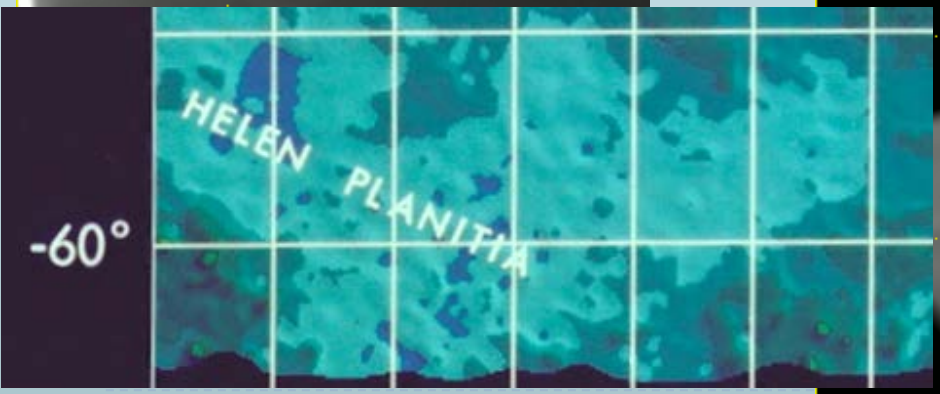
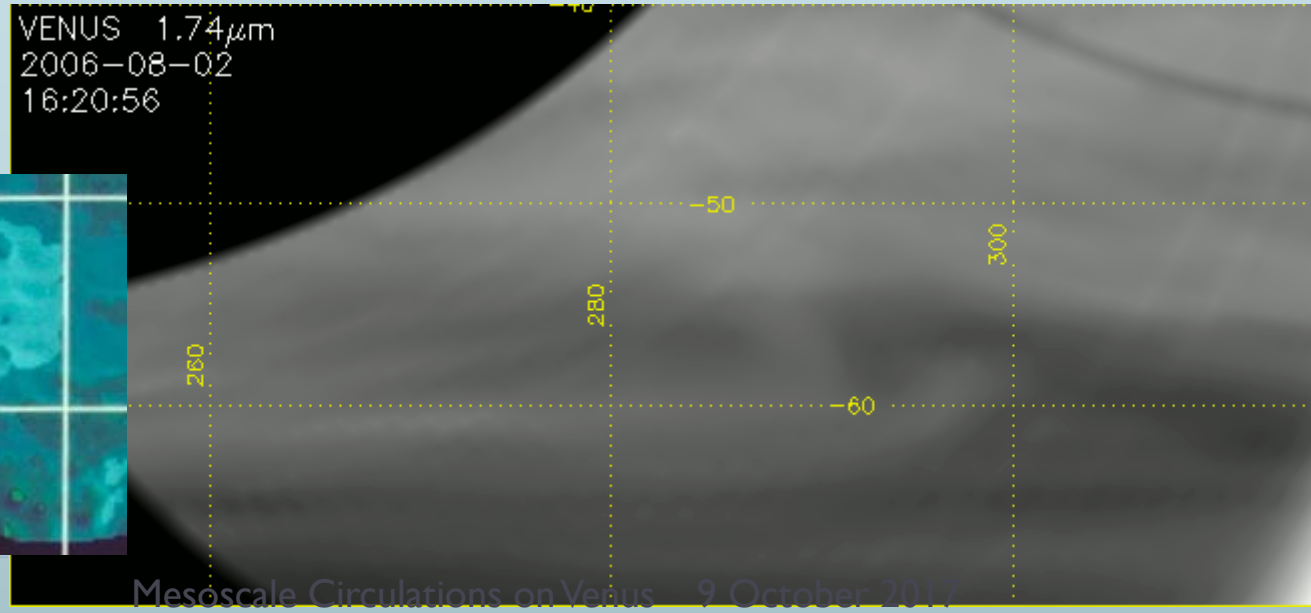


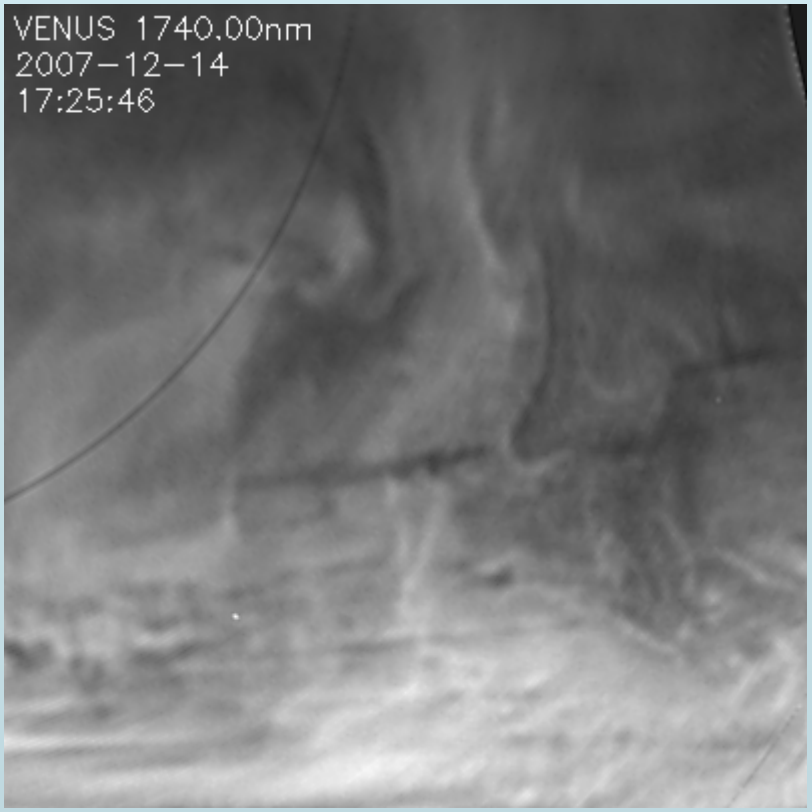
Fig. 4. Zonal wind velocity and potential temperature profiles. The wind velocities are derived from the Pioneer Venus DLBI and Doppler tracking data. Potential temperatures are derived from temperature measurements by the probes, assuming an atmosphere of 96.5% CO_2 and 3.5% N_2. In the potential temperature representation, adiabats are vertical lines, positive slopes indicate statically stable subadiabatic regions, and negative slopes indicate unstable superadiabatic regions.

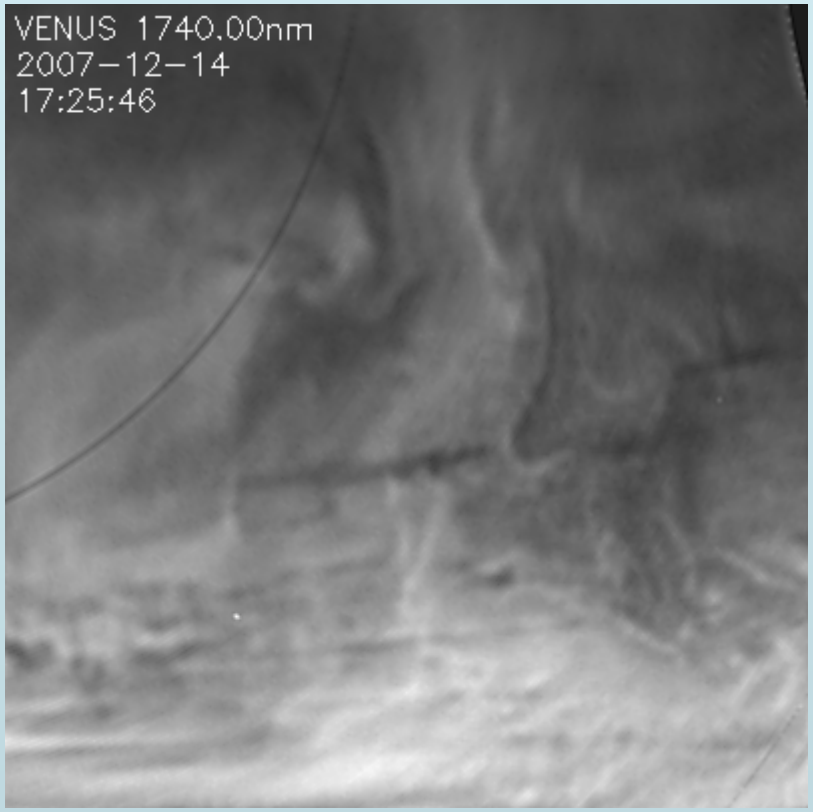


Similar features in VIRTIS Data









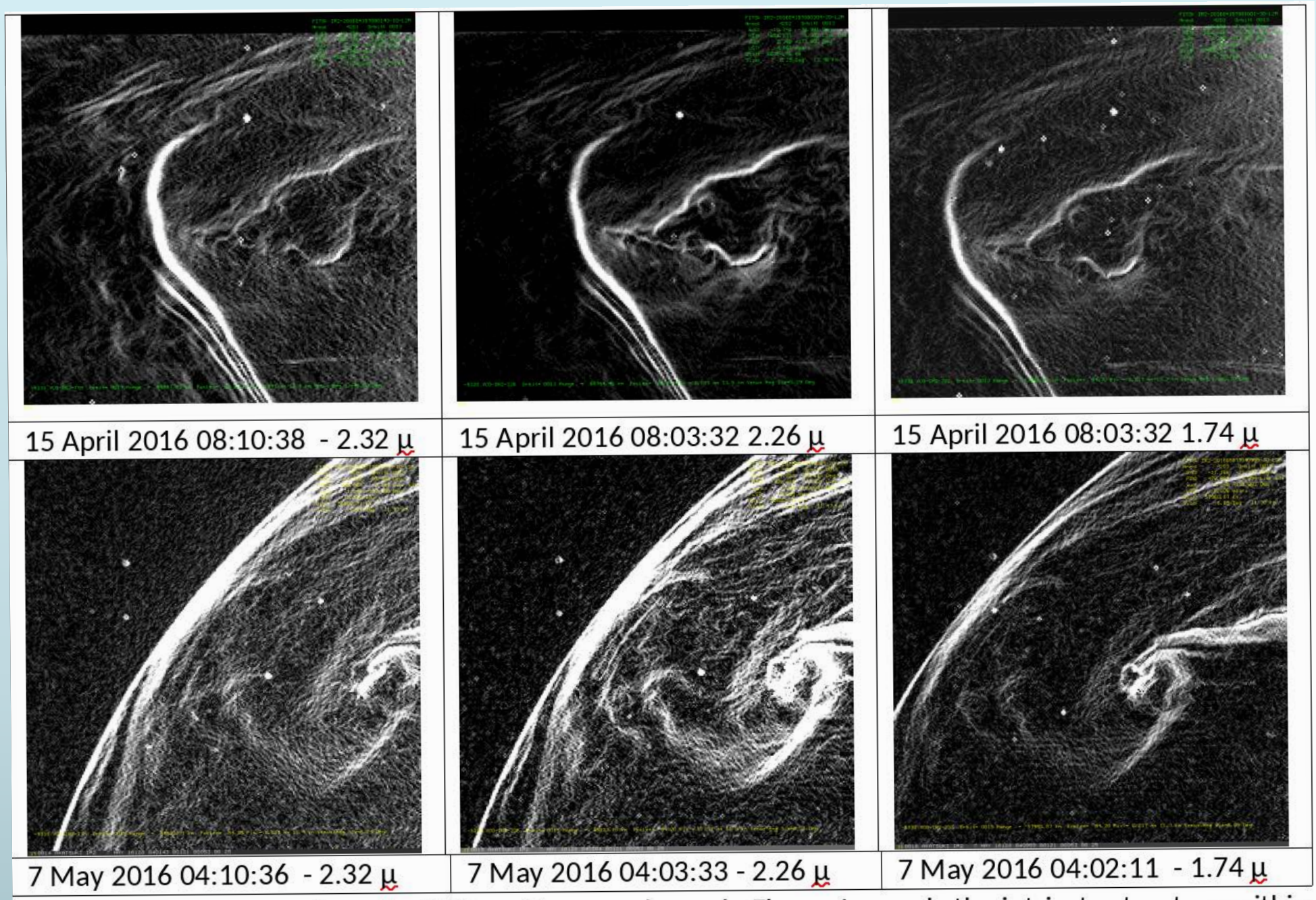
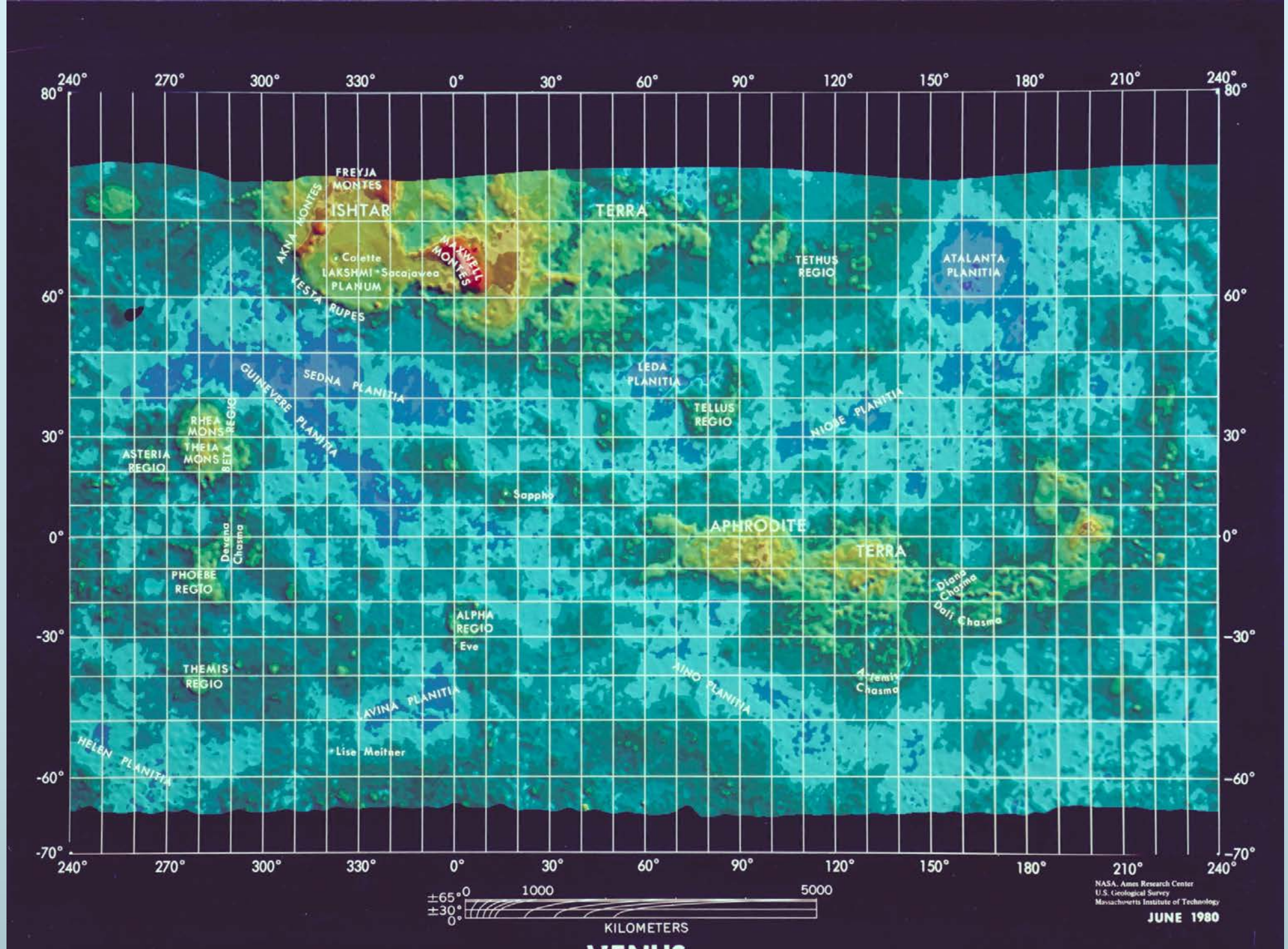
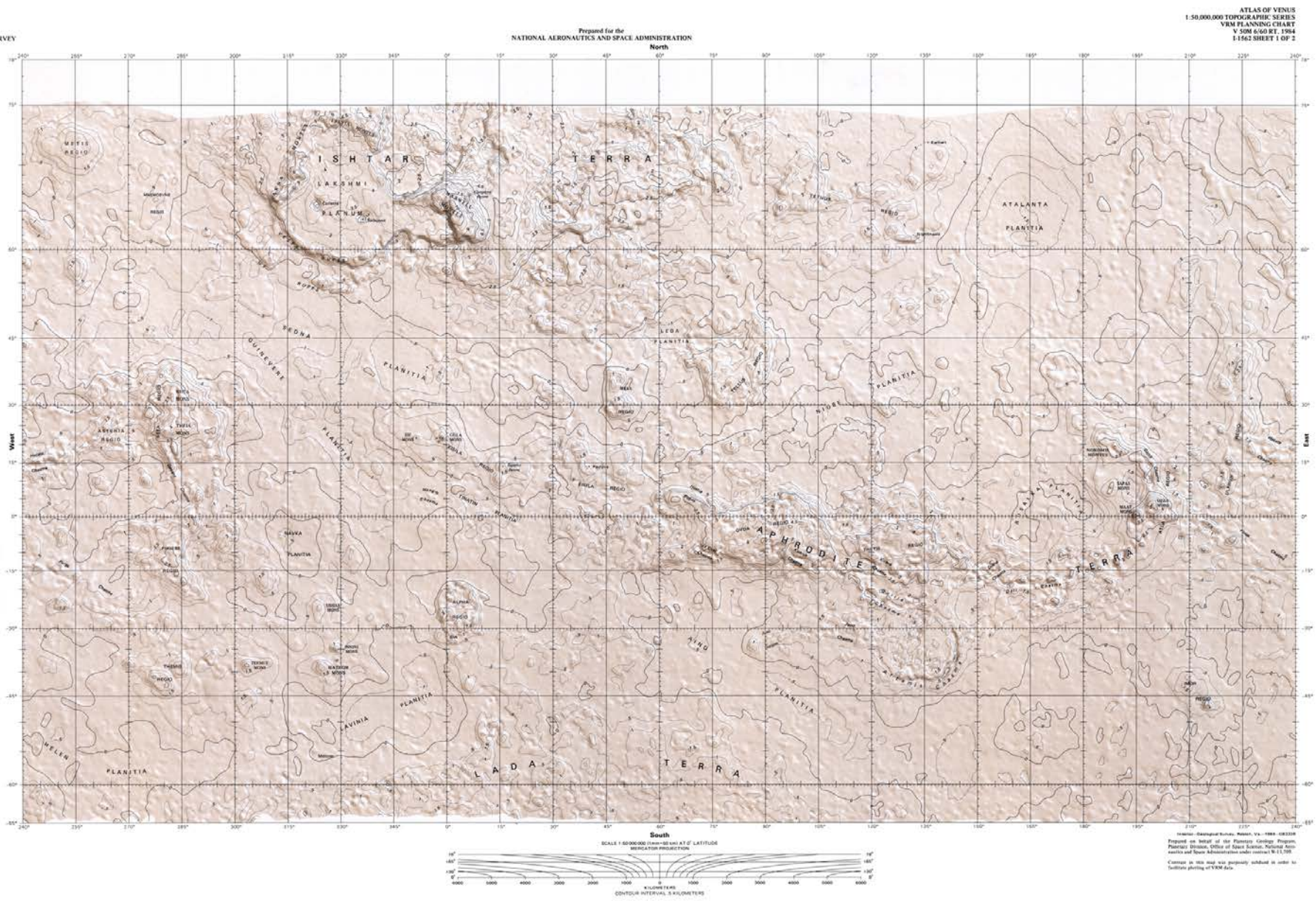
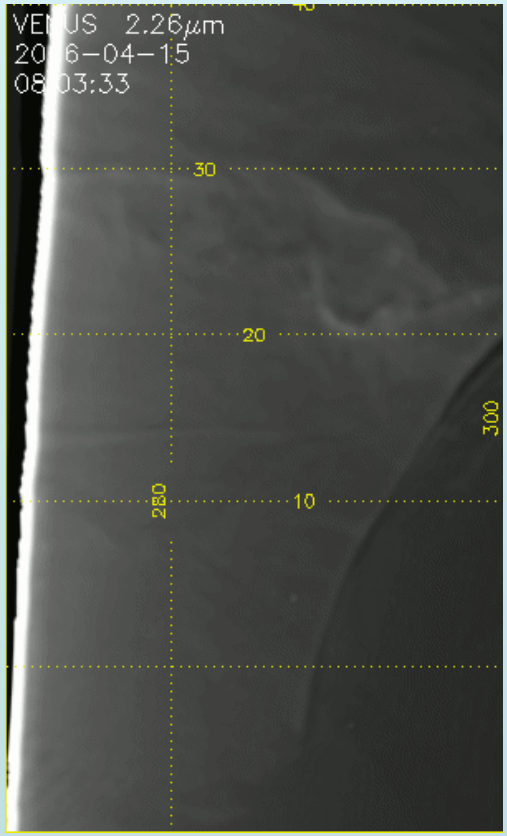


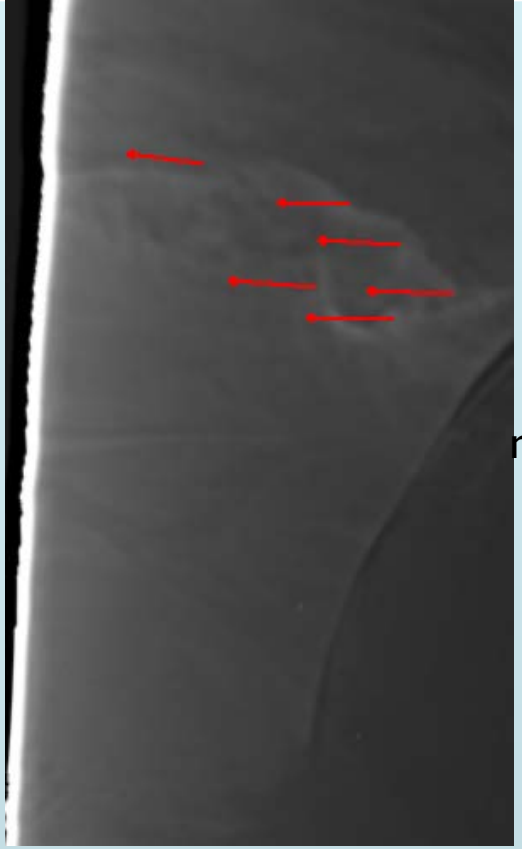
Figure 4. A sequence of gradient filtered images shown in Figure 1 reveals the intricate structure within and around the mushroom feature.



VENUS

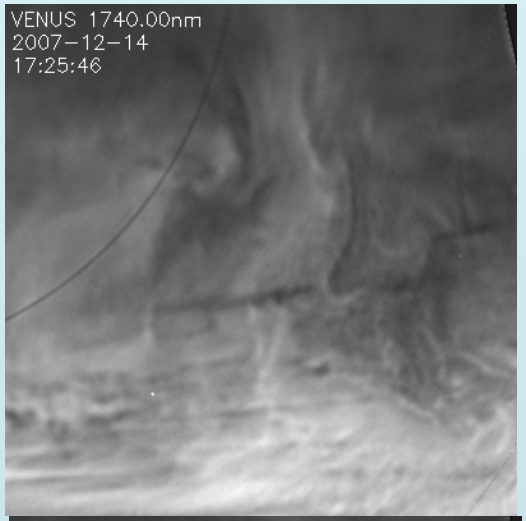


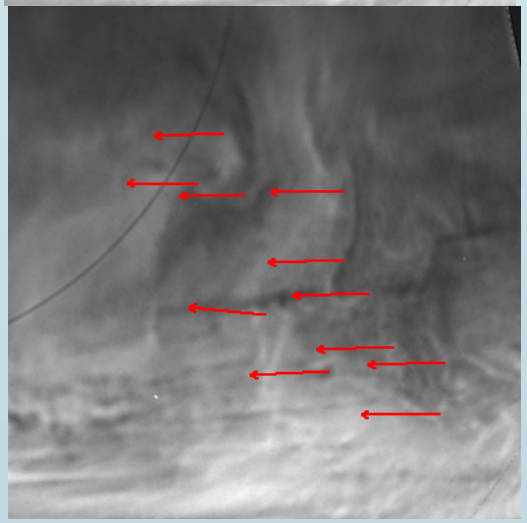


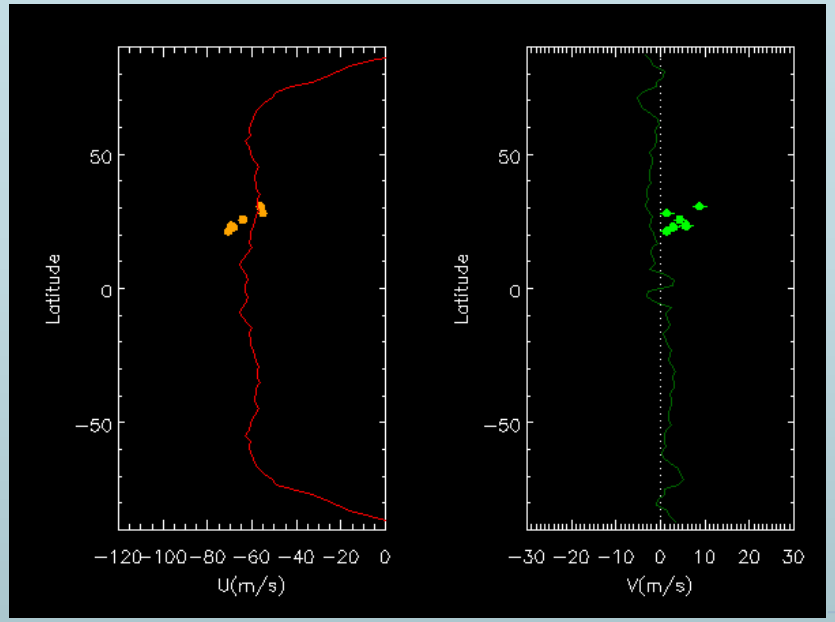


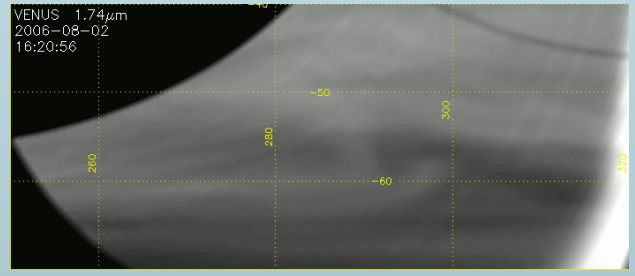
Good temporal and coverage is not available at high resolution to measure rotational motions.

Only zonal displacement is measureable due to low resolution









Puzzles

- Some questions to ponder:
  - Is there any difference in radiances of the cyclonic and anti-cyclonic features?
  - What makes them detectable?
  - What is the sharp boundary seen in the April 15 discovery frame?

Summary

•This is the first instance of meso-scale circulations on Venus in low and mid latitude regions, as only in the “eye” of the hemispheric vortex have meso-scale features arising out of dynamical instability have been observed

•The morphology indicates strong meridional flows and opposite to the ambient zonal flows.

•The vortex pair are often found in stratospheric extrusion events on Earth (cold dry air fingers sinking fast) which run into “blocking” high pressure regions causing the flows to bifurcate and form a vortex pair with opposite vorticities

•The same location suggests that local topography could induce such flows by creating a blocking feature over mountain tops.

•No time sequences are available on those two orbits, only three IR 2 filter images, so measuring cloud motions is not very feasible
•IR2 images show many amazing and perplexing non zonal flows

•Earth vortex pairs are short lived – only about a day or less, but the Venus vortex pairs may last longer?