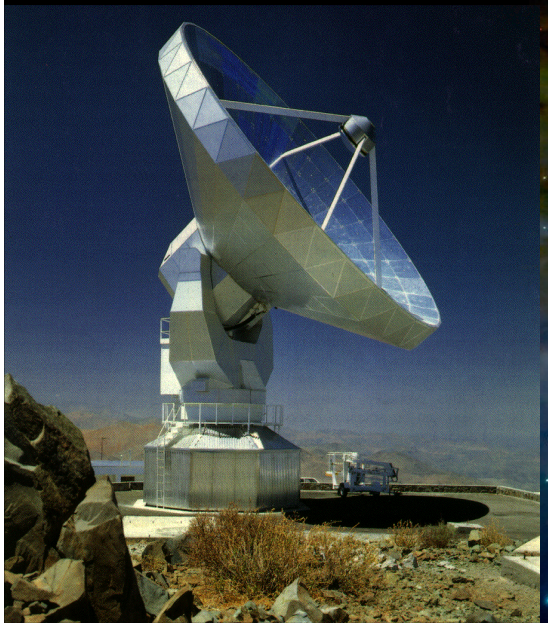
CAAUL: Origem e Evolução de Estrelas e Planetas

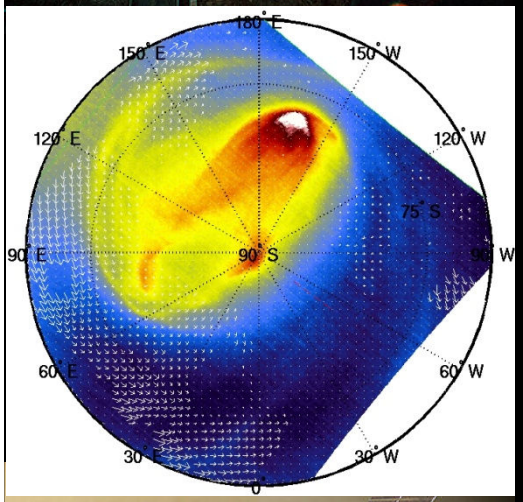
Atmosferas Planetárias

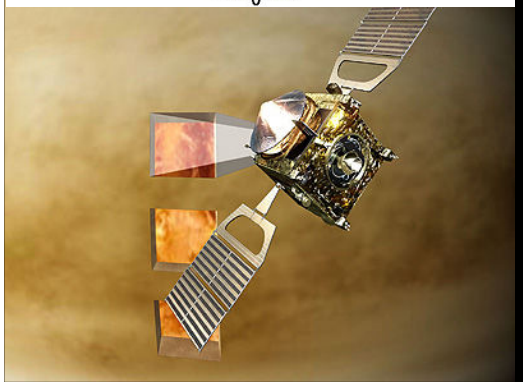


CAAUL

Linha de Origem e Evolução de Estrelas e Planetas

Planetary Atmospheres





- Observations and modelling of atmospheres of Venus and Titan
- Atmospheric dynamics characterization using remote sensing techniques
- Participation/collaboration in spatial missions Venus Express and Cassini-Huygens
- Ground-based Observations with high-resolution spectroscopy (VLT-Very Large Telescope)

Collaborations

Portugal:

- Univ. Évora

Spain:

- Instituto de Astrofisica de Andalucia (IAA), Granada
- Grupo de Ciencias Planetarias (GCP), Bilbao

European Spatial Agency:

- ESTEC European Space and Technology Centre, Noordwijk

France:

- Observatoire de Paris-Meudon, Paris
- Laboratoire de Météorologie Dynamique (LMD), Paris
- Univ. de Reims

Italy:

- Istituto di Astrofisica Spaziale e Fisica Cosmica (IASF), Roma

Germany:

- Max Planck Institute for Solar System Research (MPS), Lindau

Observing Time

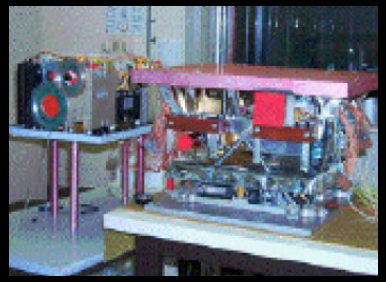
- ESO, Paranal, Chile: Very Large Telescope, UVES instrument

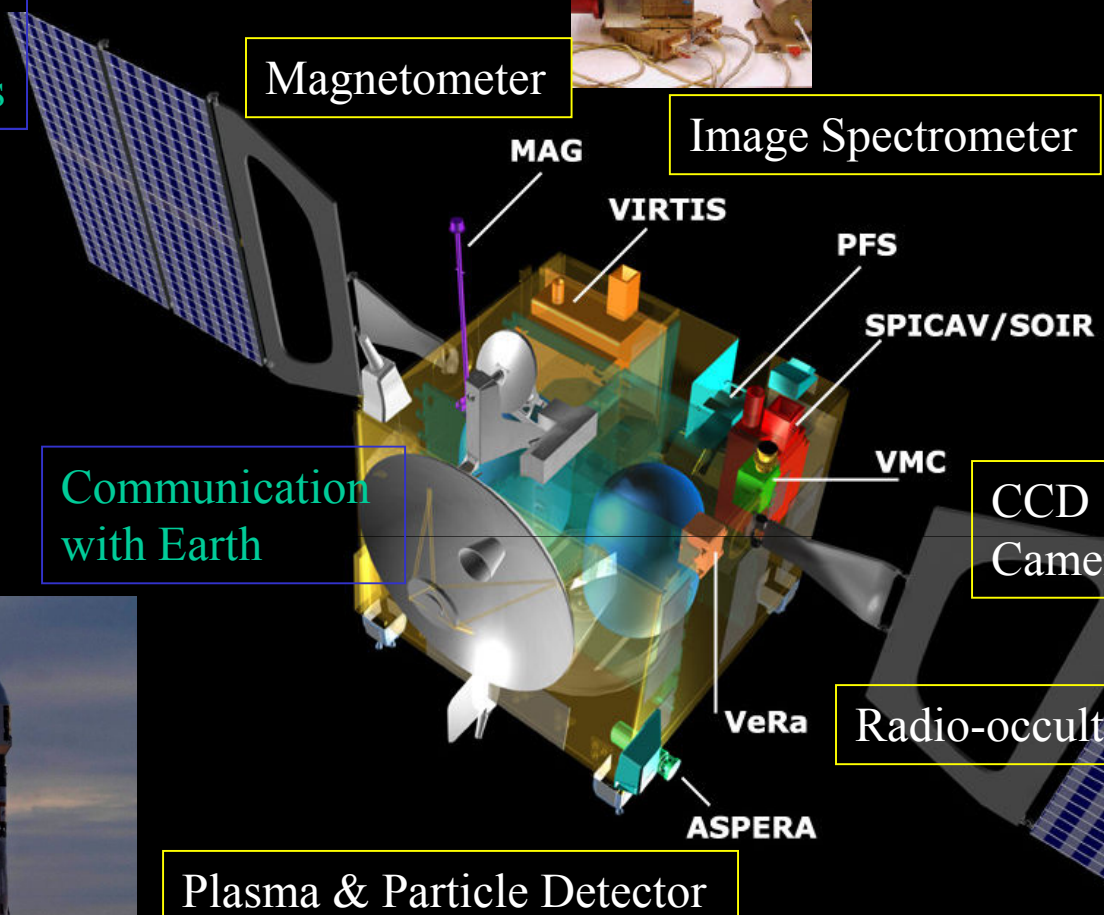
The Venus Express Mission

Solar Panels

Magnetometer

Image Spectrometer

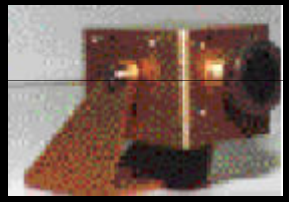


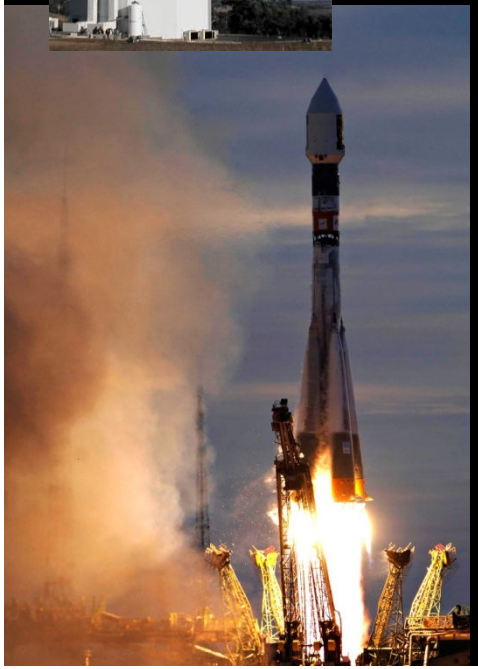


Solar and Stellar occultation experiment

Communication with Earth

CCD Camera



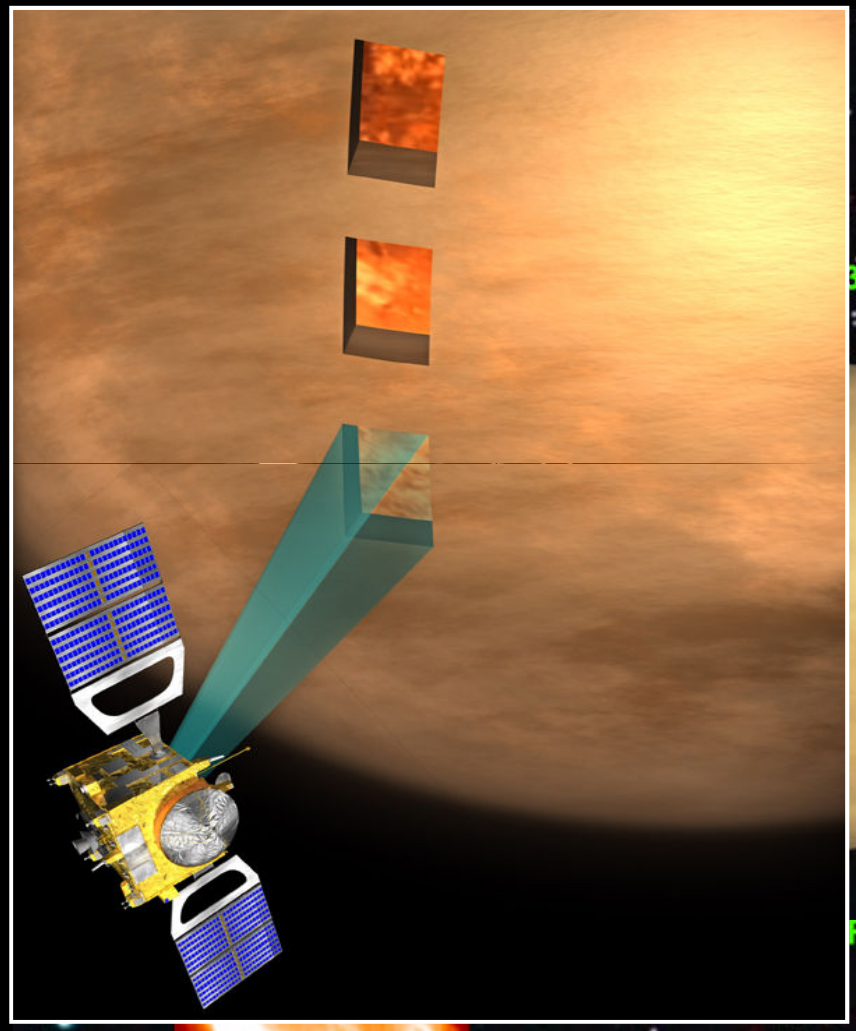


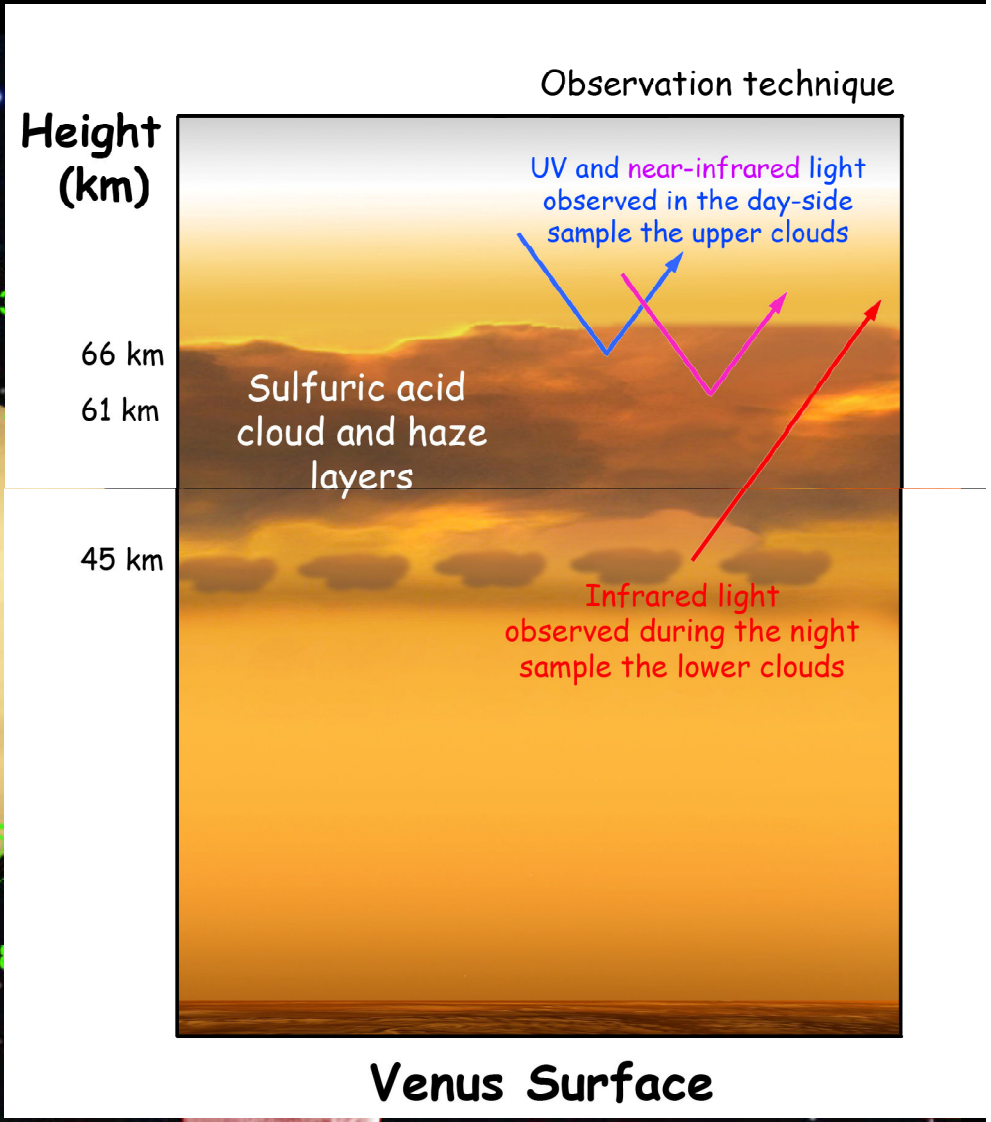
Radio-occultation Experiment

Plasma & Particle Detector

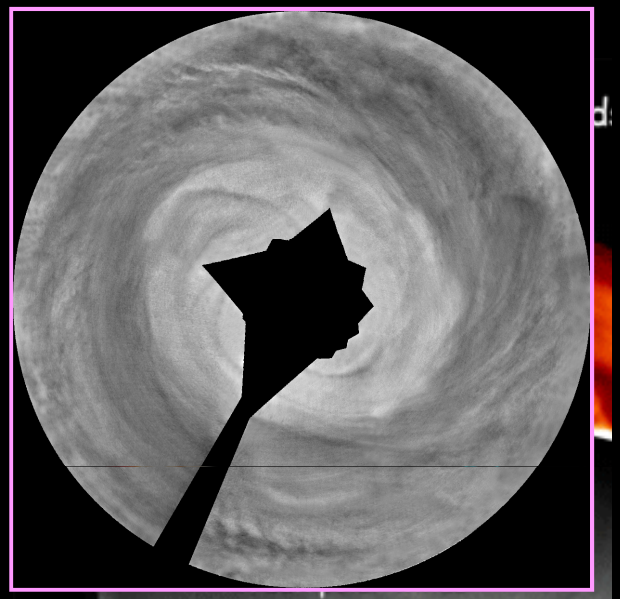
- **Orbit insertion in April 2006, mission extended to 2011**
- **Coordinated observations with Japanese mission Akatsuki after December 2010.**

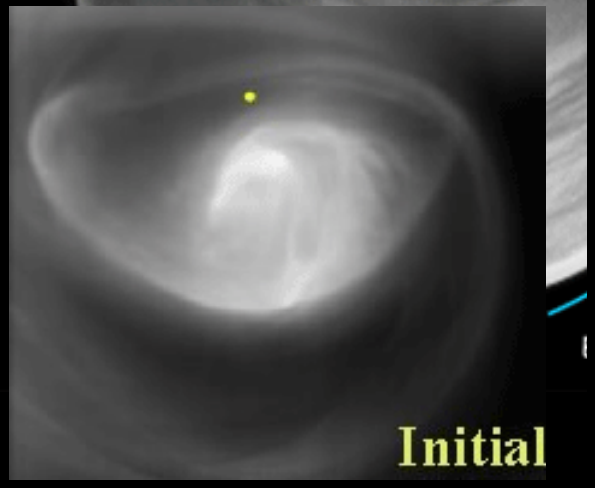
“Windows” for observing Venus

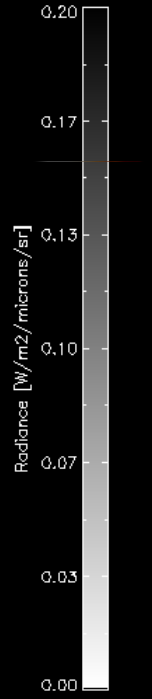


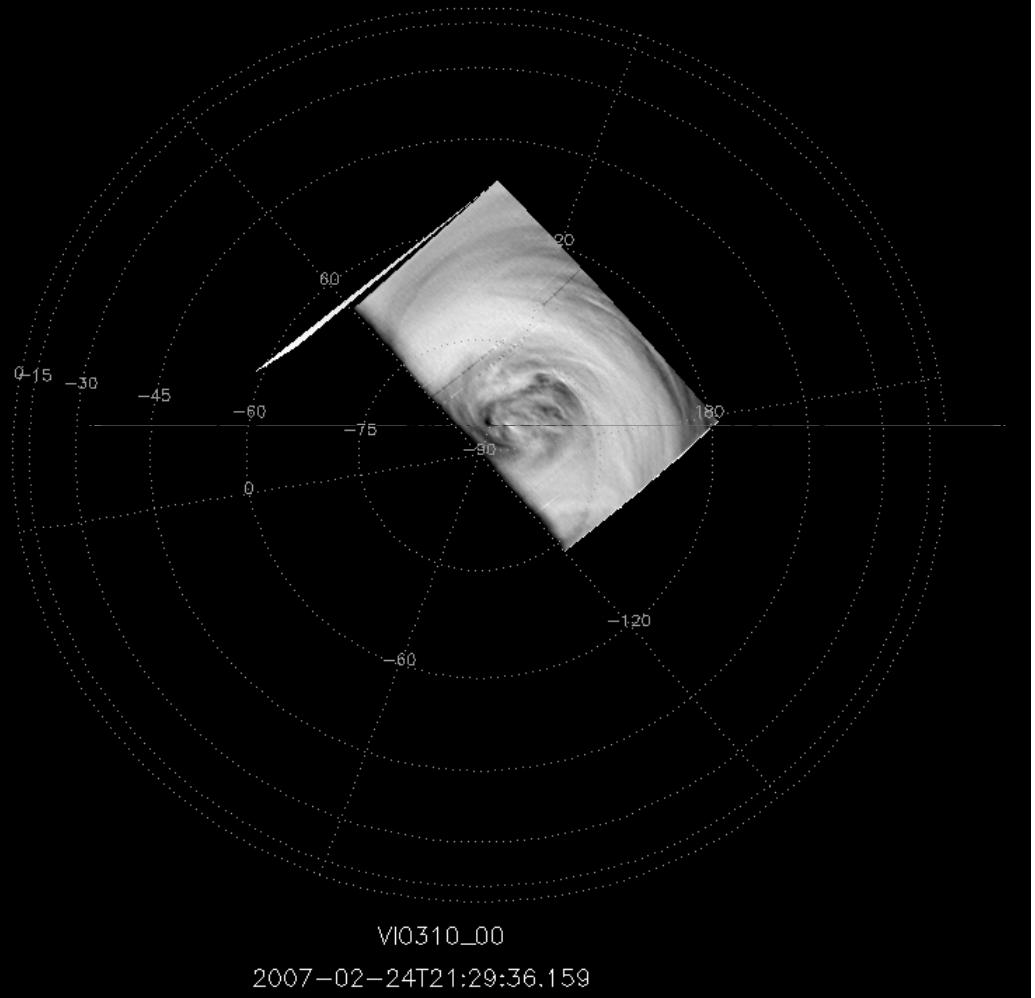


Atmospheric Dynamics in Venus

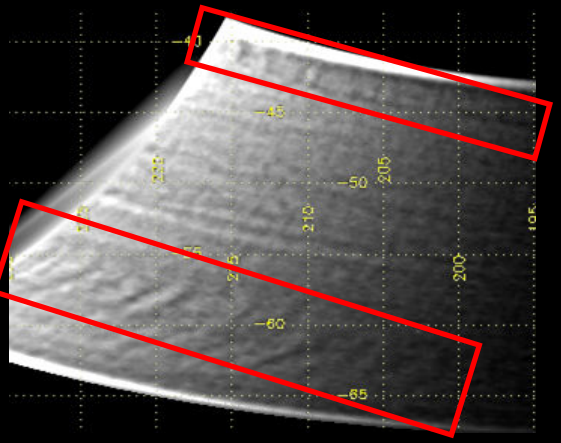


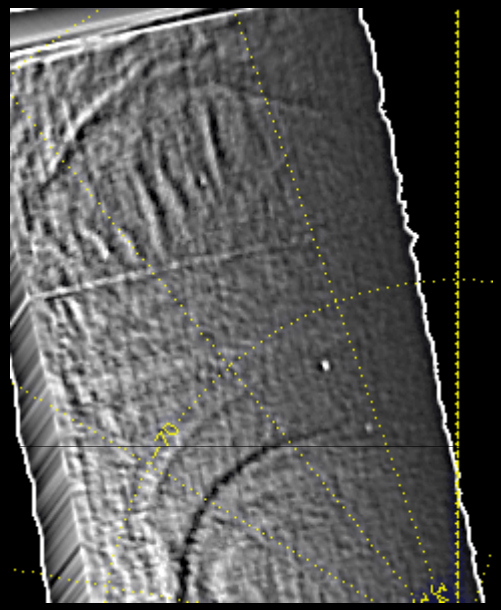


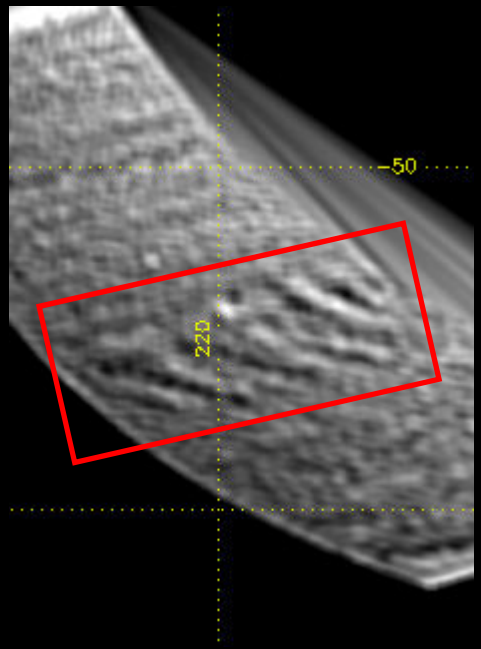


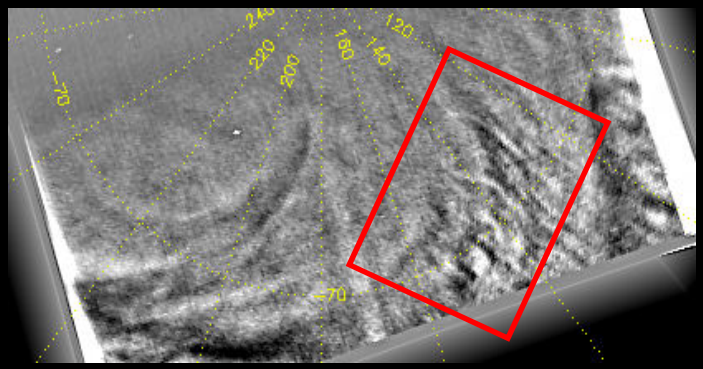


Venus: Gravity Waves

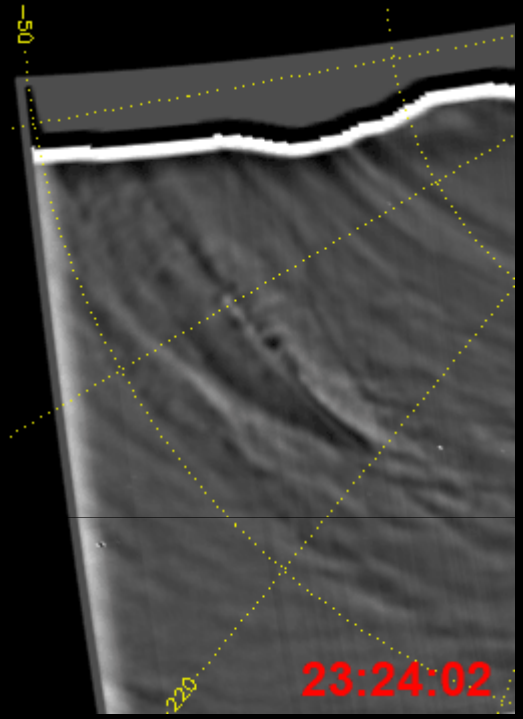


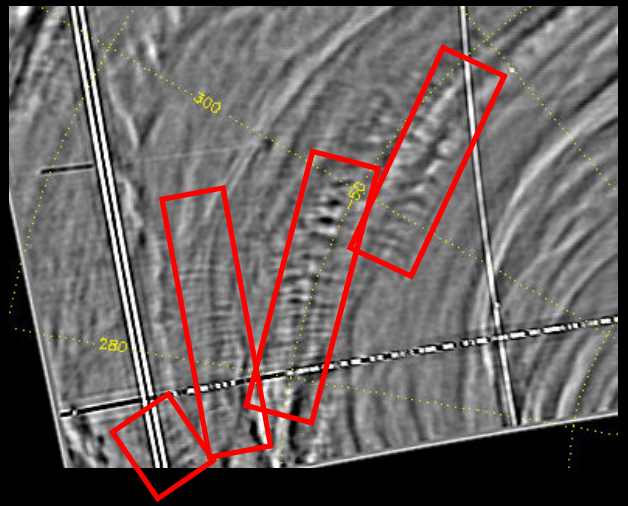


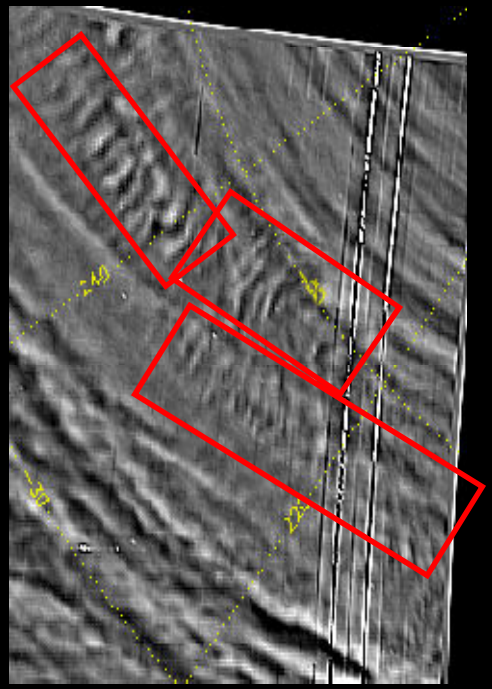


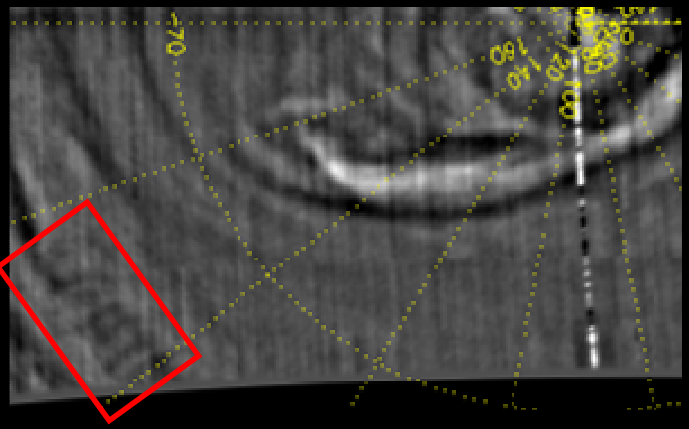


Venus: Gravity Waves





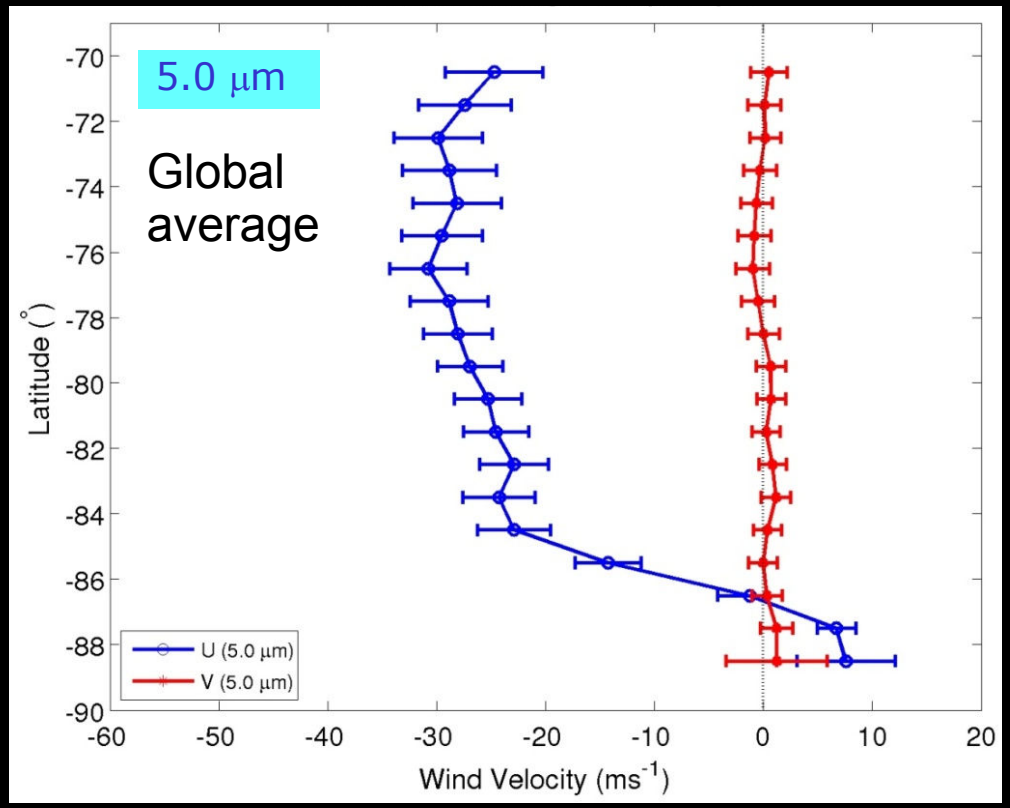


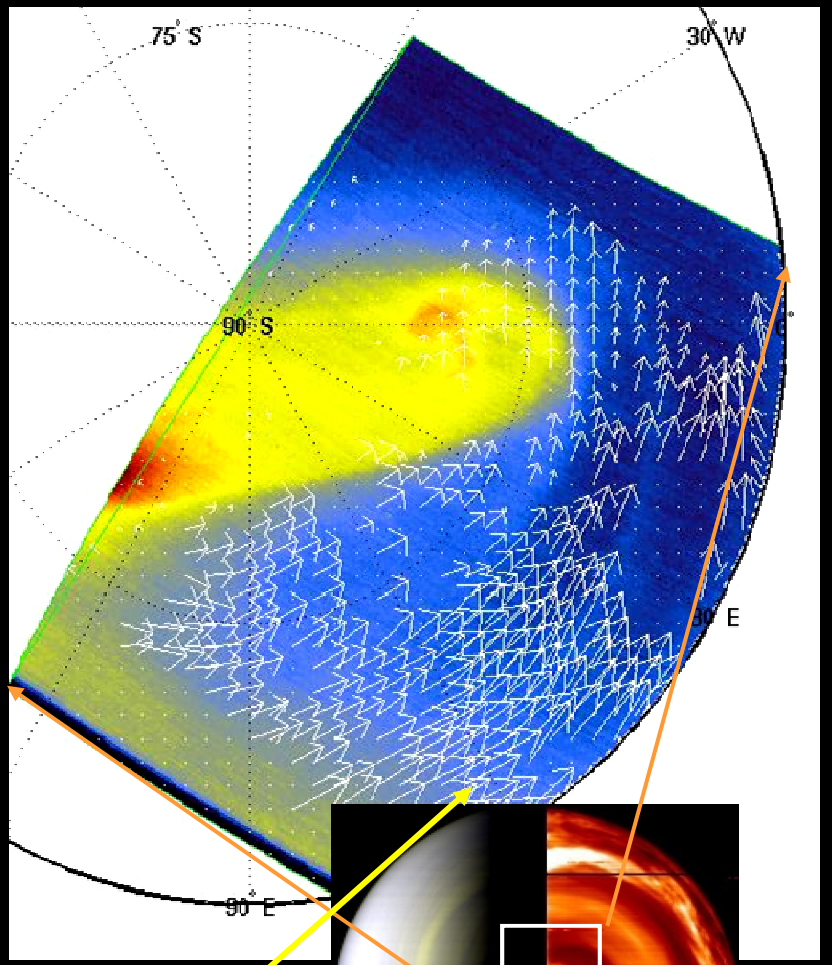


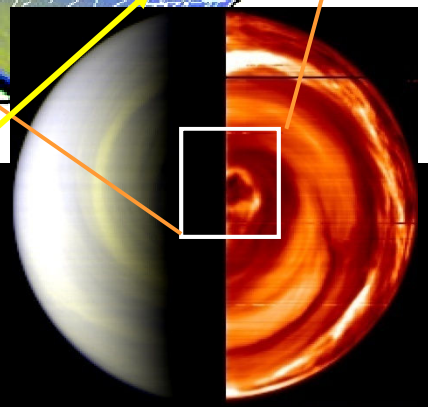
Venus Atmospheric Dynamics in the polar region

Images from VEX/VIRTIS:

- Determination of 2D circulation in the upper clouds (Cross-Correlation).







Windspeed vectors in an image of the nightside of Venus at 5.0 μm.

Alternative for Cloud Tracking: Phase Correlation

It's an Optical Flow technique:

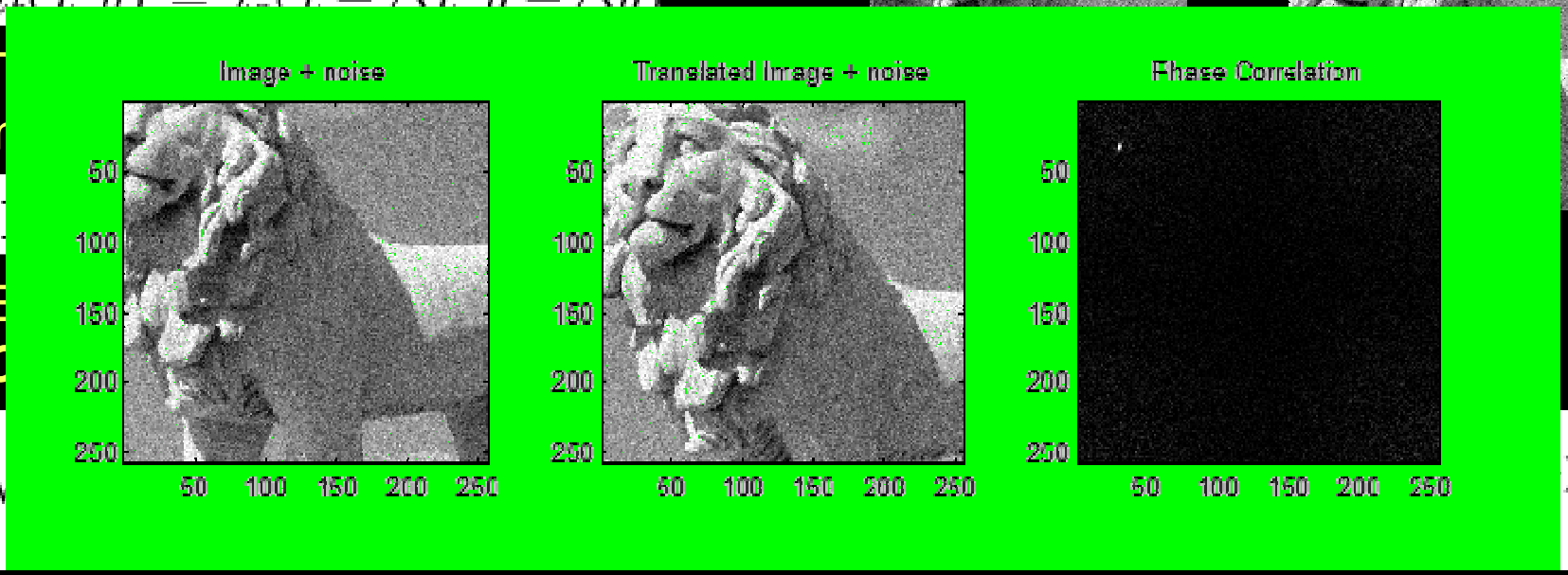
- We have 2 images i_a and i_b, being i_b a translated version of i_a.

$$i_b(x, y) \stackrel{\text{def}}{=} i_a(x - \Delta x, y - \Delta y)$$

- T
  i

- E
  C

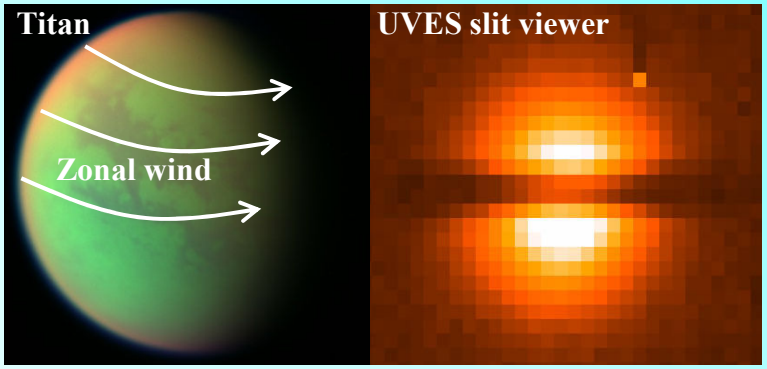
$$N$$

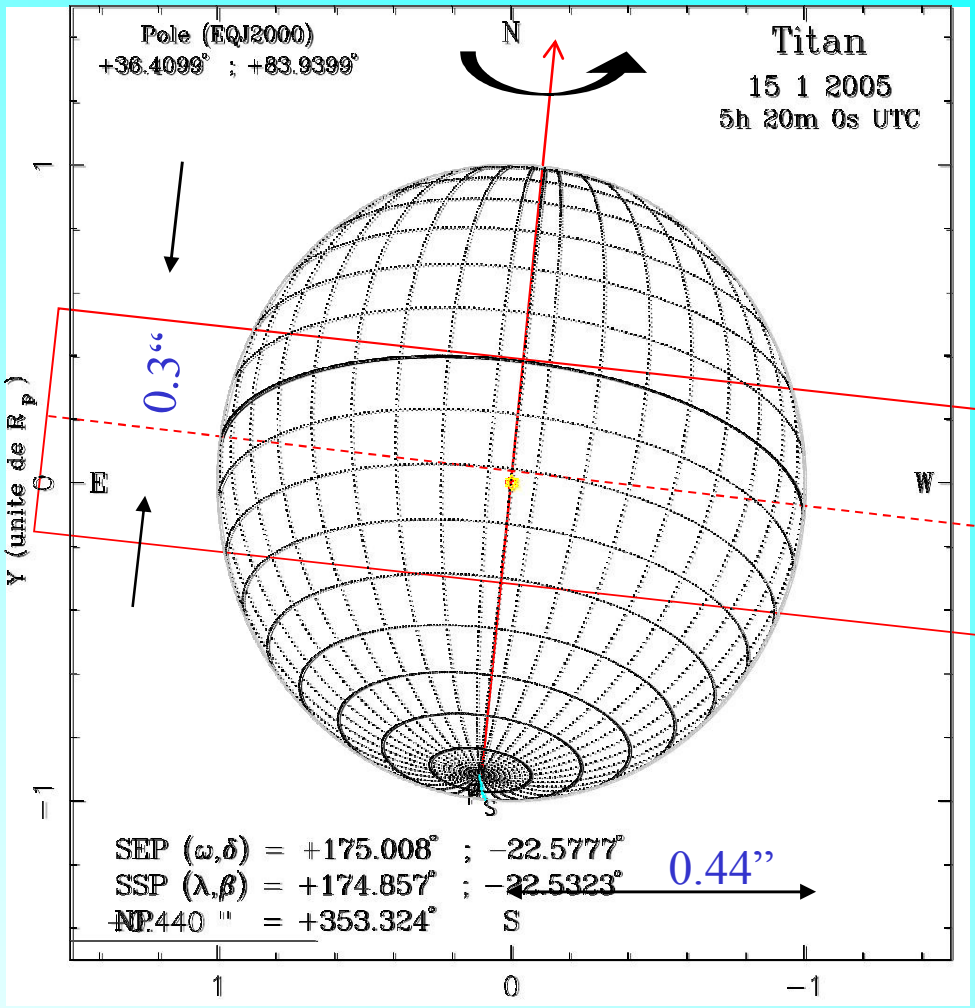


- And applying the Inverse FT to the NCS we obtain a Dirac Delta located in a position related to the translation:

$$PC = \delta(x - \Delta x, y - \Delta y)$$

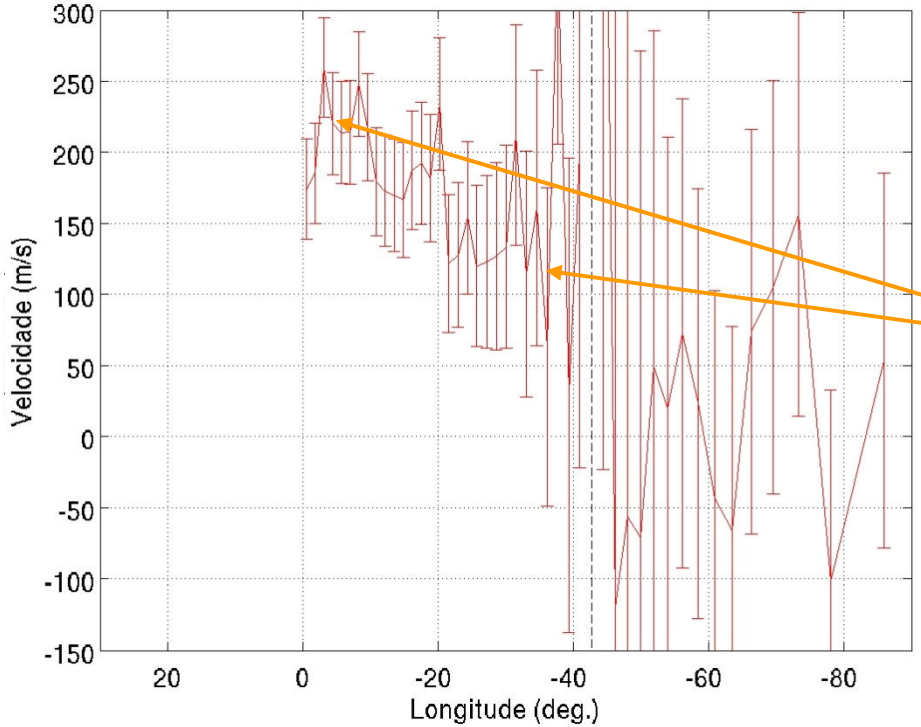
Doppler Velocimetry of winds in Titan



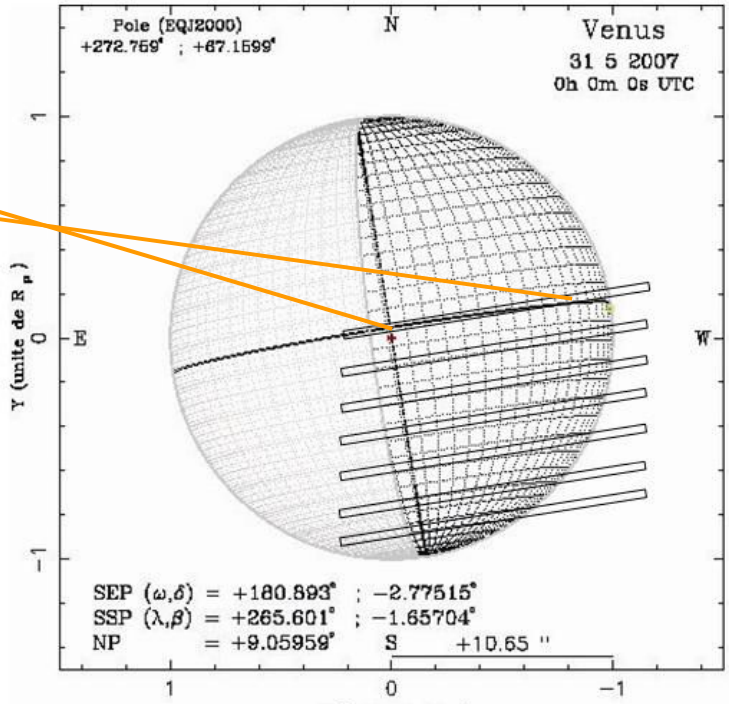


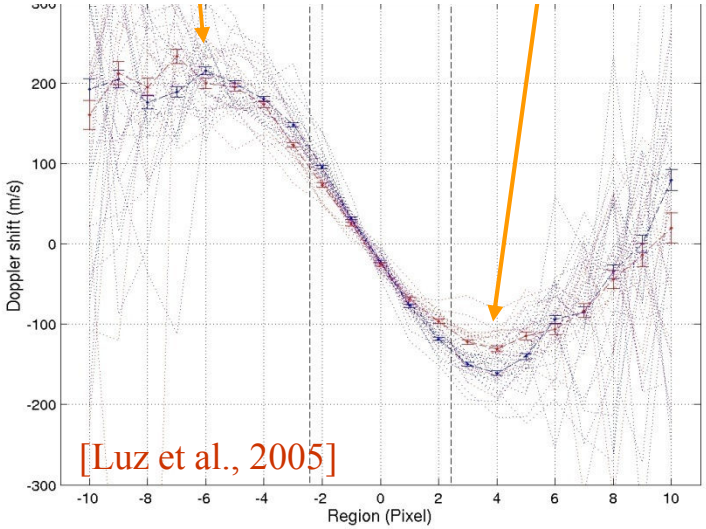
We applied the Doppler Velocimetry technique based on Fraunhofer lines for VIS solar radiation in high-resolution spectra (R~100 000). This allows to measure the windspeeds with high precision (several m/s). With Visible radiation we sense the atmospheric region with optical depth ~1 (250 km, stratosphere).

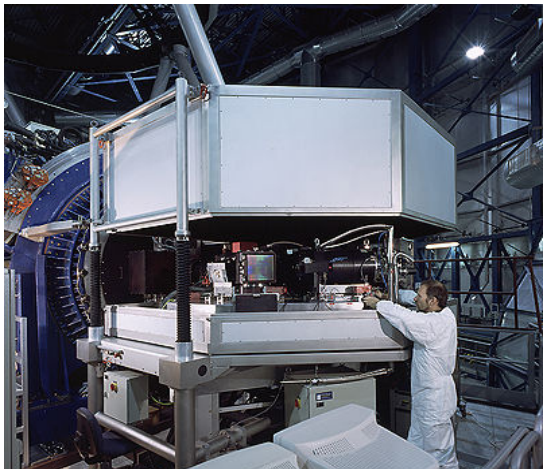
Wind measurements in Venus



Doppler Velocimetry technique also applied on Venus

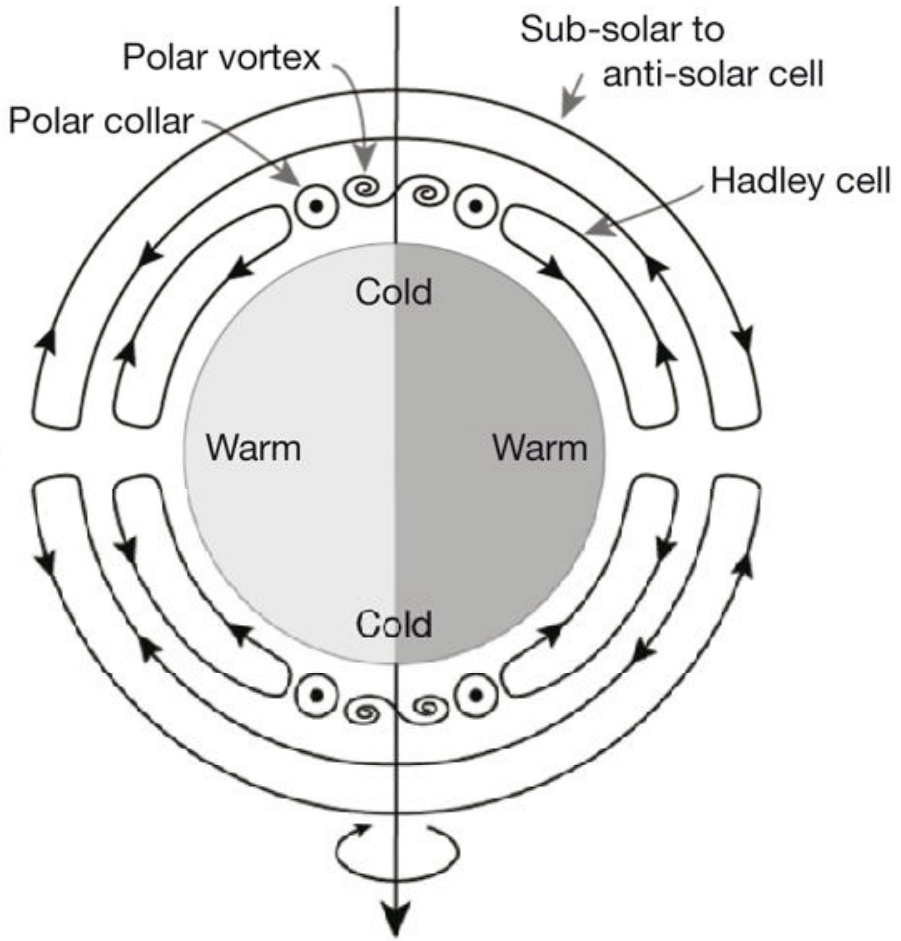






Characterization of atmospheric dynamics

- What's the atmospheric general circulation like?
- Which are the windspeeds?
- Variability and time scales?
- Which is the role played by the atmospheric waves?
- How characterize the morphology of the clouds and the polar vortex? (Venus)



FUTURE WORK:

- Use VMC images
- Develop an alternative cloud tracking technique: Opt.Flow
- Deep characterization of the polar vortex. Modelling.
- Extending the study of the gravity waves at all levels.

Venus: CO_2 Non-LTE Emissions

- Venus atmosphere can be considered to be in LTE
- As P decrease with Height, collisions are not able to compensate "changes" due to radiative transfer.
- In the upper atmosphere, NLTE rules.
- CO_2 4.3 μm fluorescence is originated at 80-150 km.
- Near 150,000 spectra from VIRTIS-H have been used.