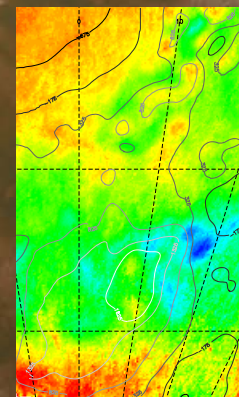
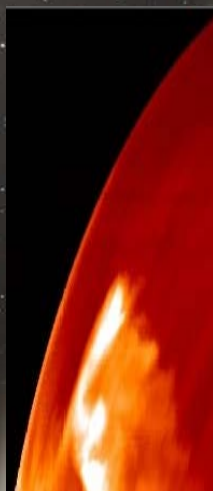
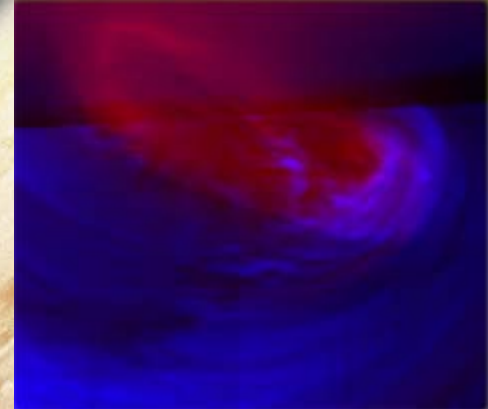




VIRTIS-Venus Express

G. Piccioni, P. Drossart and the
VIRTIS-VenusX Team



Scientific Team Members by Countries

	I ⁽¹⁾ (PI)	F ⁽²⁾ (PI)	PO	ES	RU	NL	US	D	UK	P	Total
Total	14	10	1	2	2	1	2	5	2	1	40

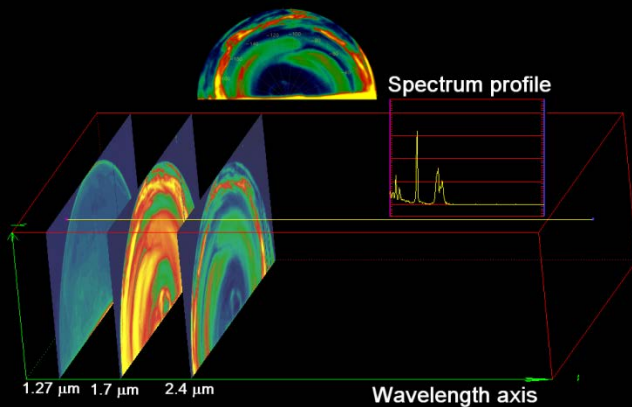
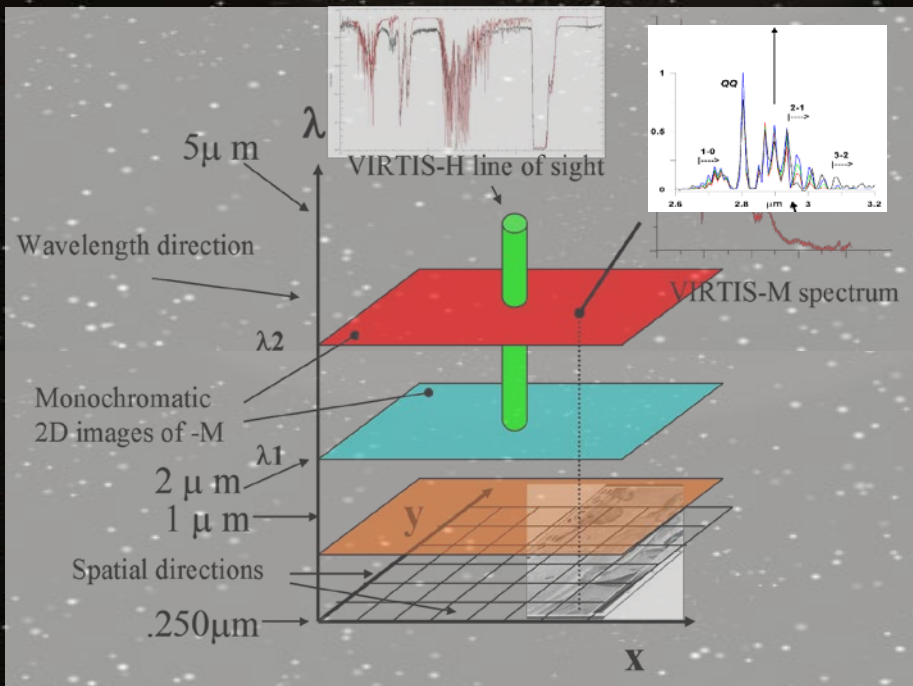
(1) G. Piccioni, IAPS-INAF Rome, Italy

(2) P. Drossart, LESIA Observatoire de Paris, France

In the course of the mission, more than 20 young scientists have got their PhD, contributing significantly in the progress of Venus Science (and not only).

VIRTIS output

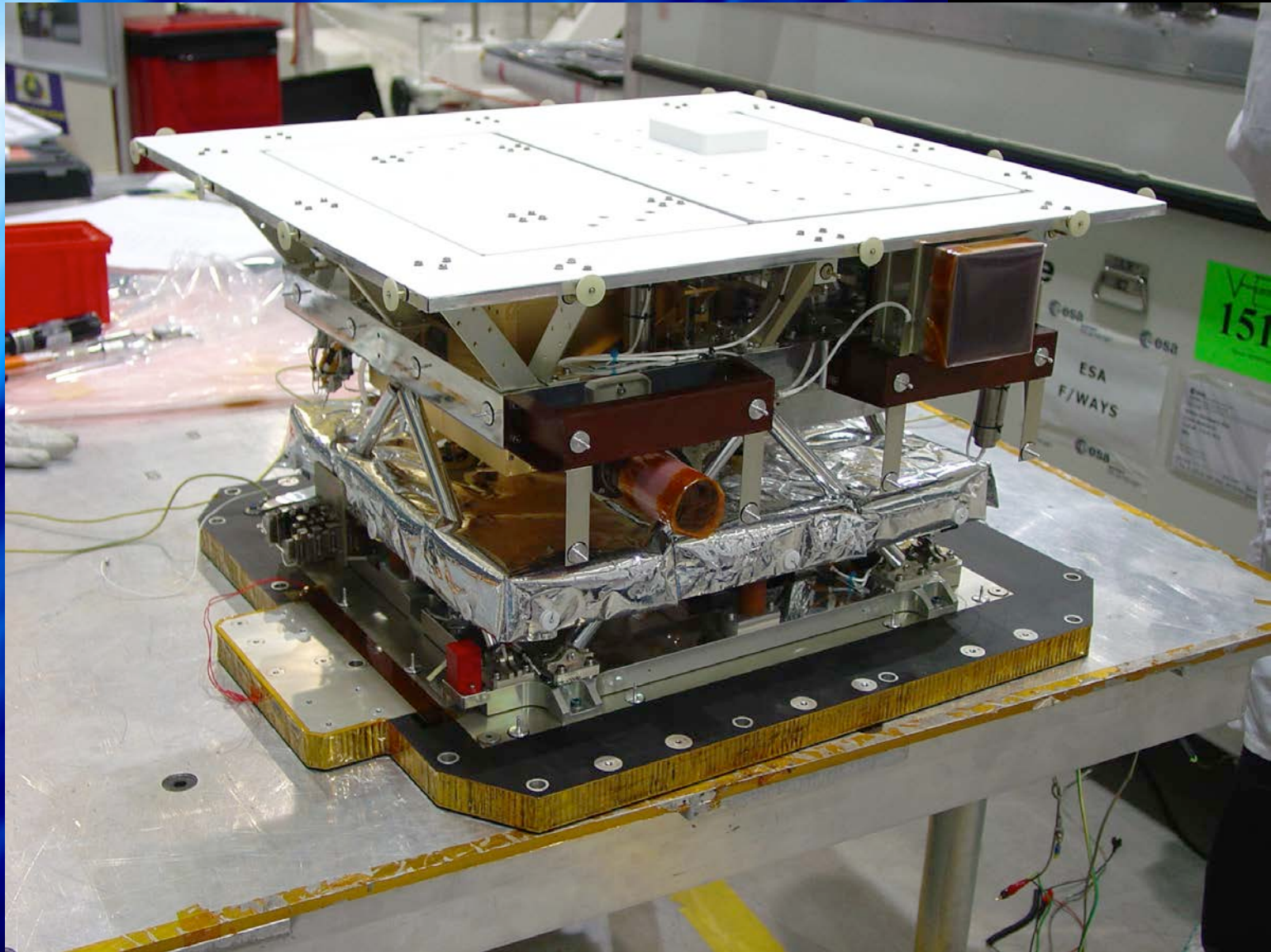
The output from VIRTIS-M can be considered to be a large set of stacked monochromatic two-dimensional images in the range between 0.27 to 5.2 μm , at moderate spectral resolution. The field of view of VIRTIS-H centered in the middle of the -M image provides IR spectra at high spectral resolution in this small portion of the frame.



Credits: ESA/VIRTIS-VenusX

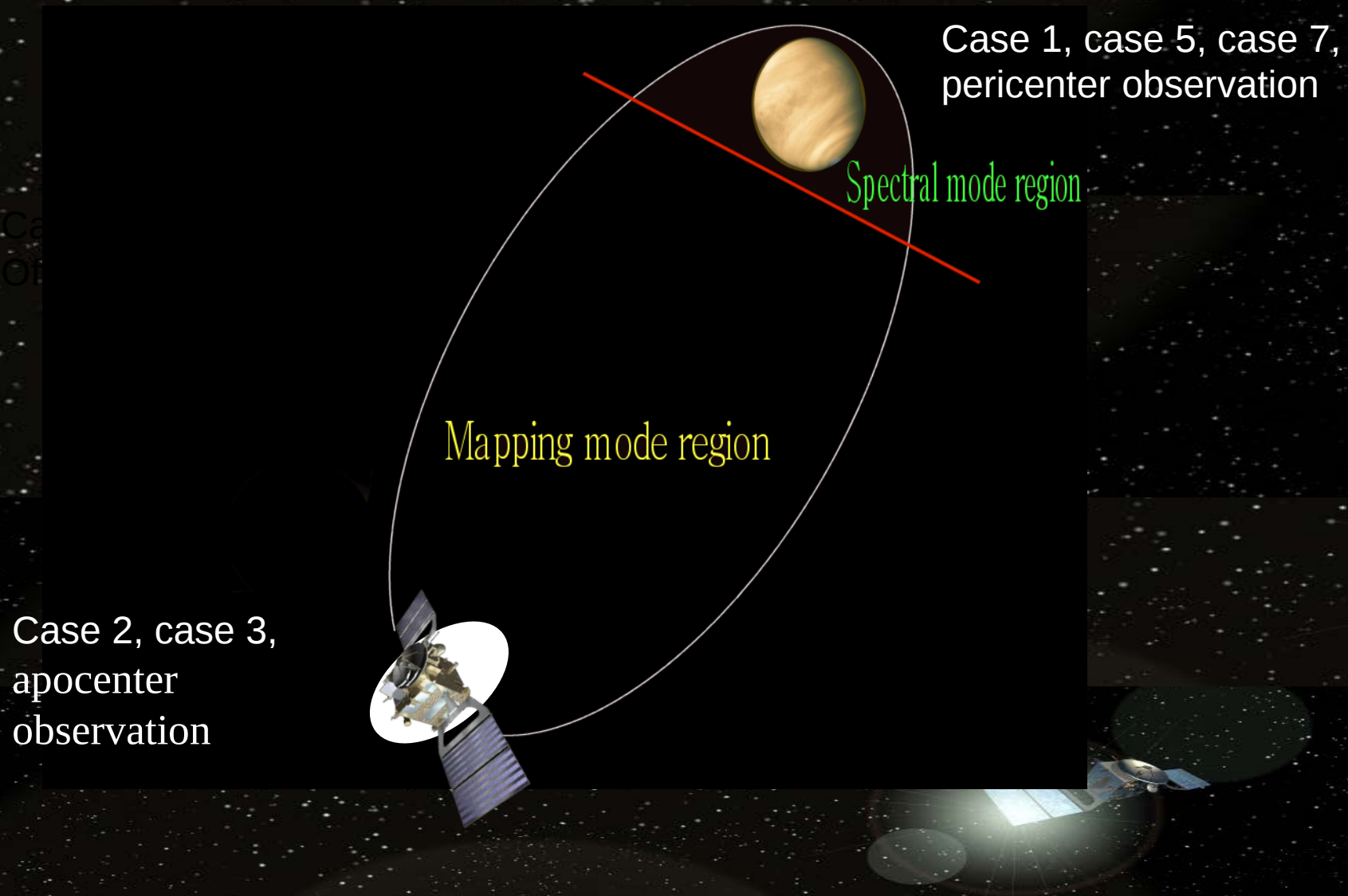
Parameter	VIRTIS-M		VIRTIS-H
	Visible	Infrared	
Spectral Range [μm]	0.27 - 1.1	1.05 - 5.19	1.88 - 5.03
Spectral sampling [nm]	1.9	9.8	0.6
FOV [mrad]	64 x 64		0.58 x 1.75
IFOV [mrad]	0.25 x 0.25		N/A

VIRTIS during the integration in Turin (2004)

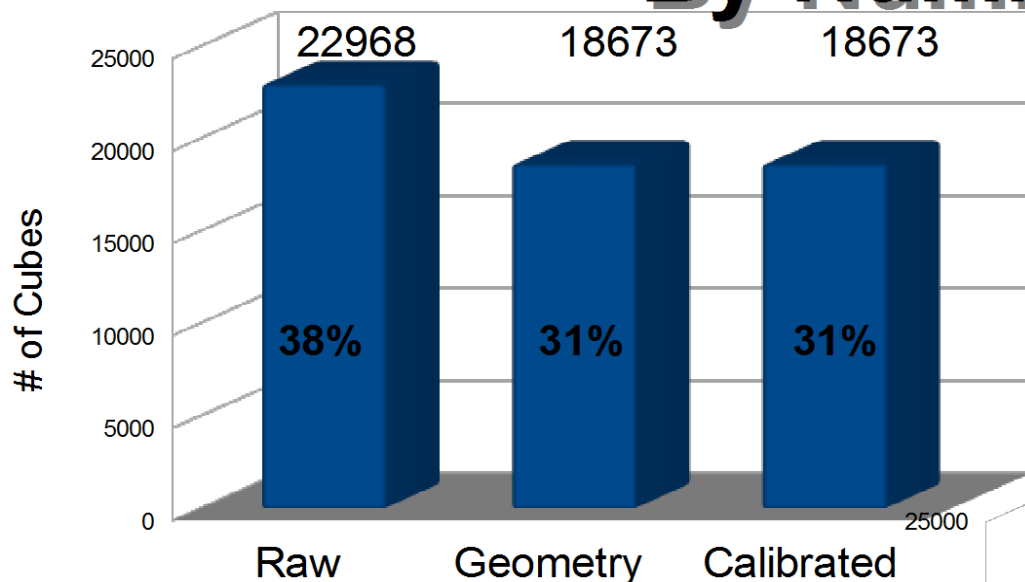




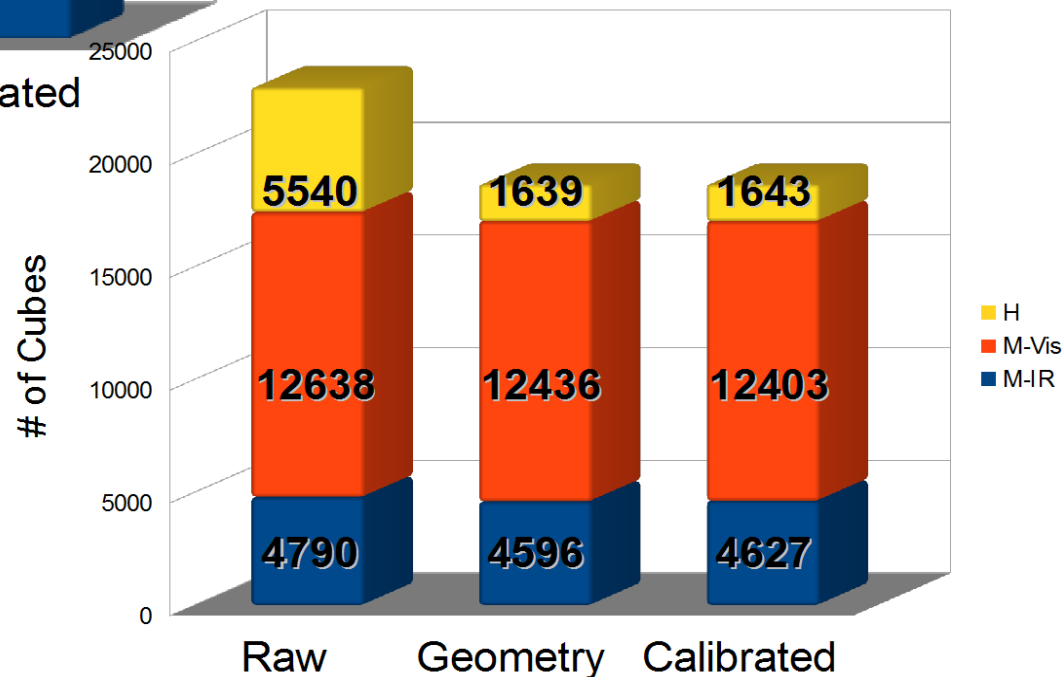
Orbit and observation strategy



VIRTIS-VeX Data Production By Numbers



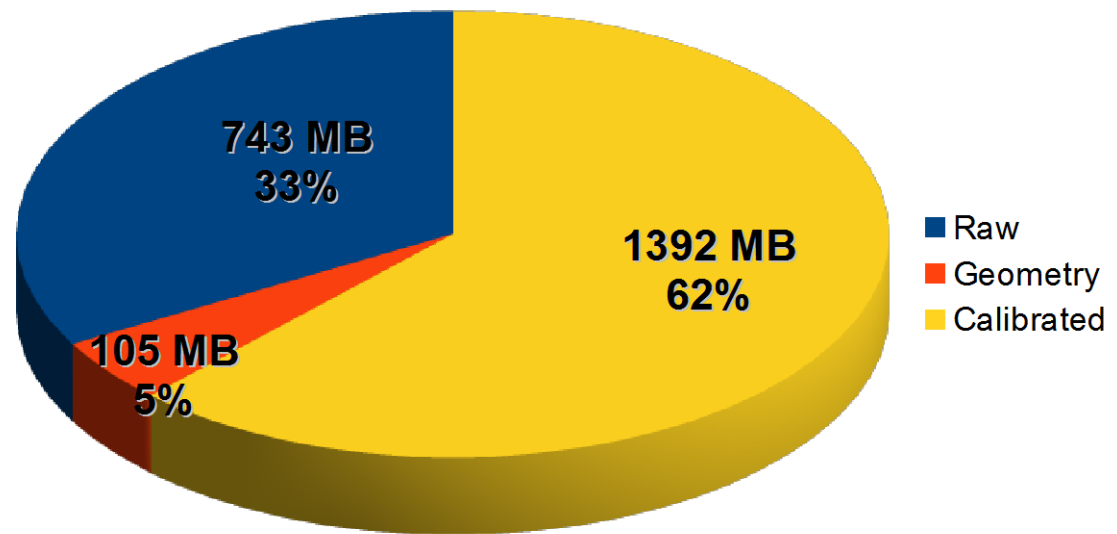
Total file number: 60312



From R. Politi

VIRTIS-VeX Data Production By Size

Total Data Archive Size: 2,2 TB

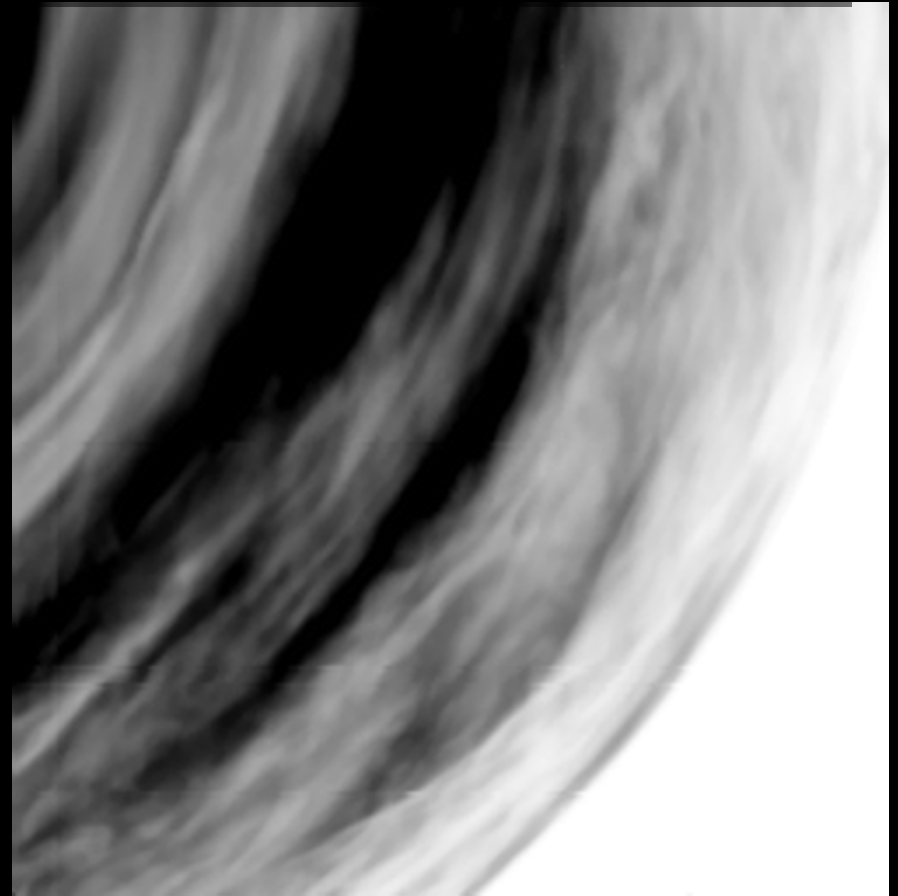


From R. Poli

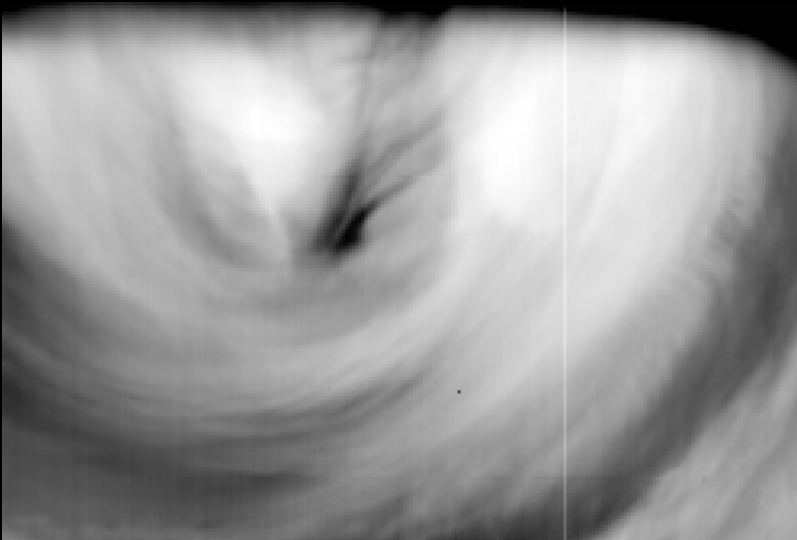
Morphology and clouds tracking for wind measurements

Orbit 157, Night side @ $1.7 \mu\text{m}$

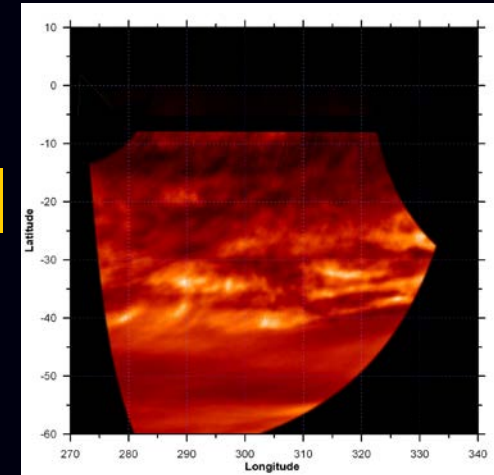
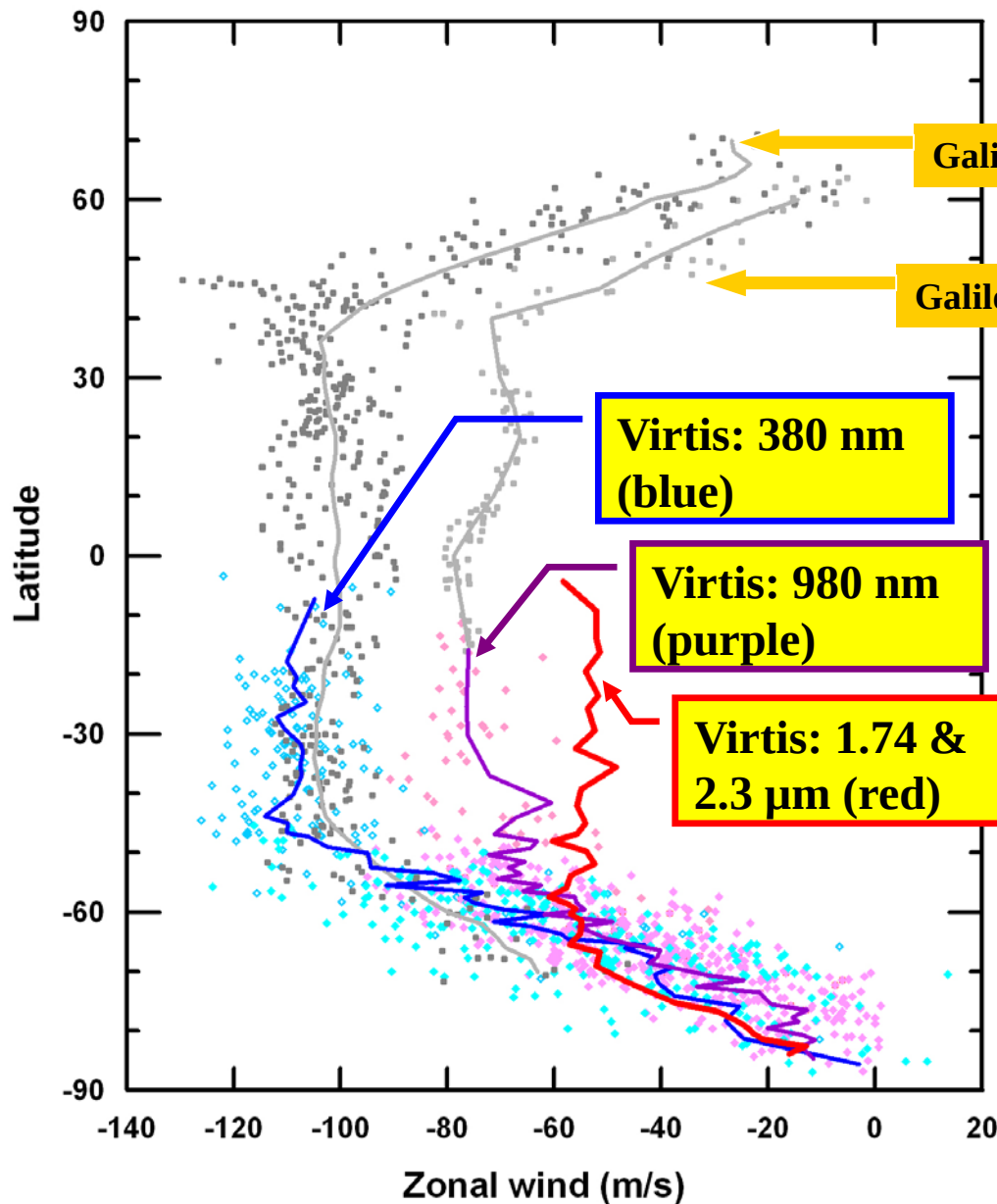
Slant distance from 65000 to 37000 km



Orbit 314, Night side @ $1.7 \mu\text{m}$, February 28 2007, Slant distance 60000 km



Zonal Wind Profiles: Galileo – VIRTIS-VEX



3-D clouds
tracking wind
profile:

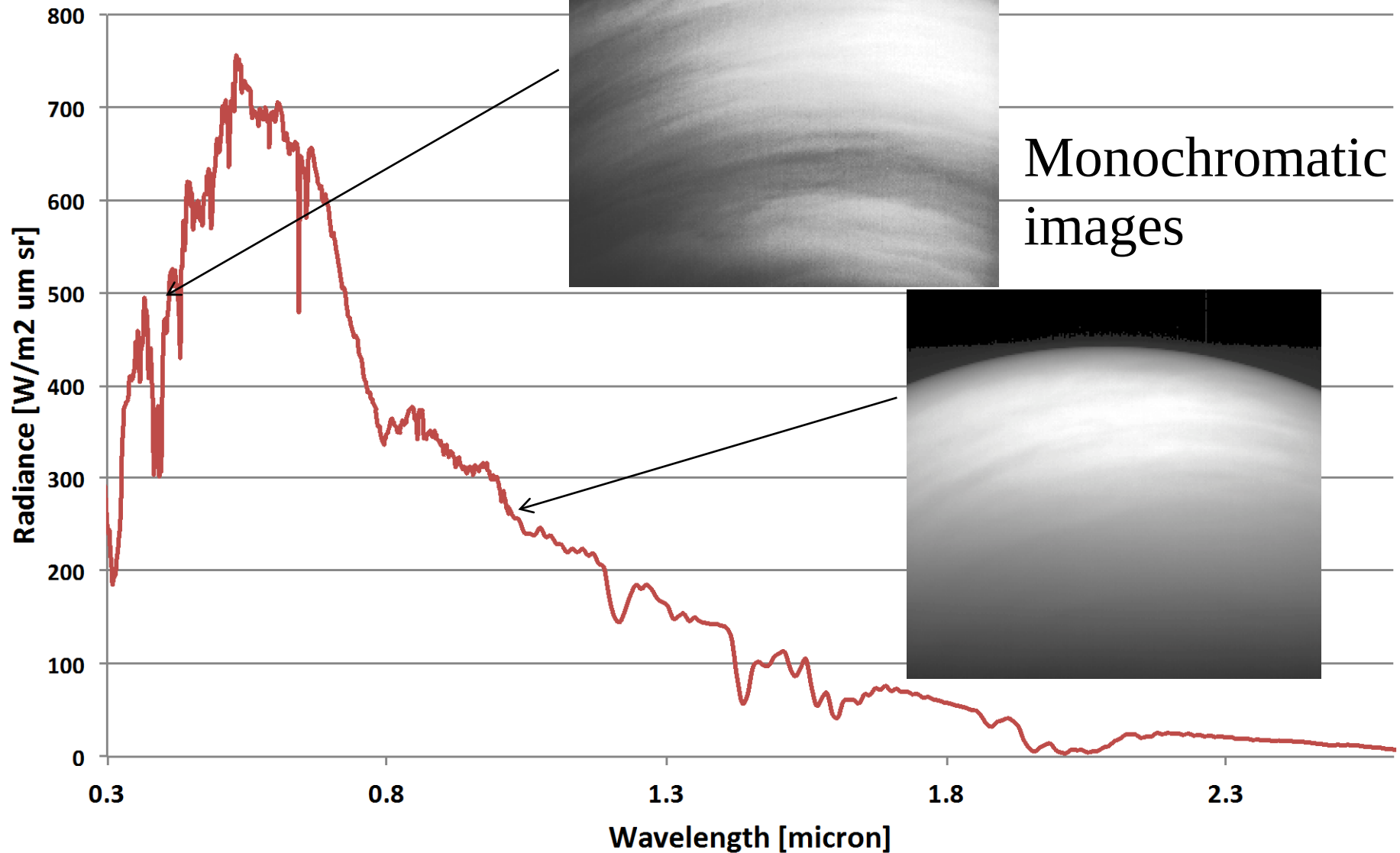
red = 47 km

purple = 61 km

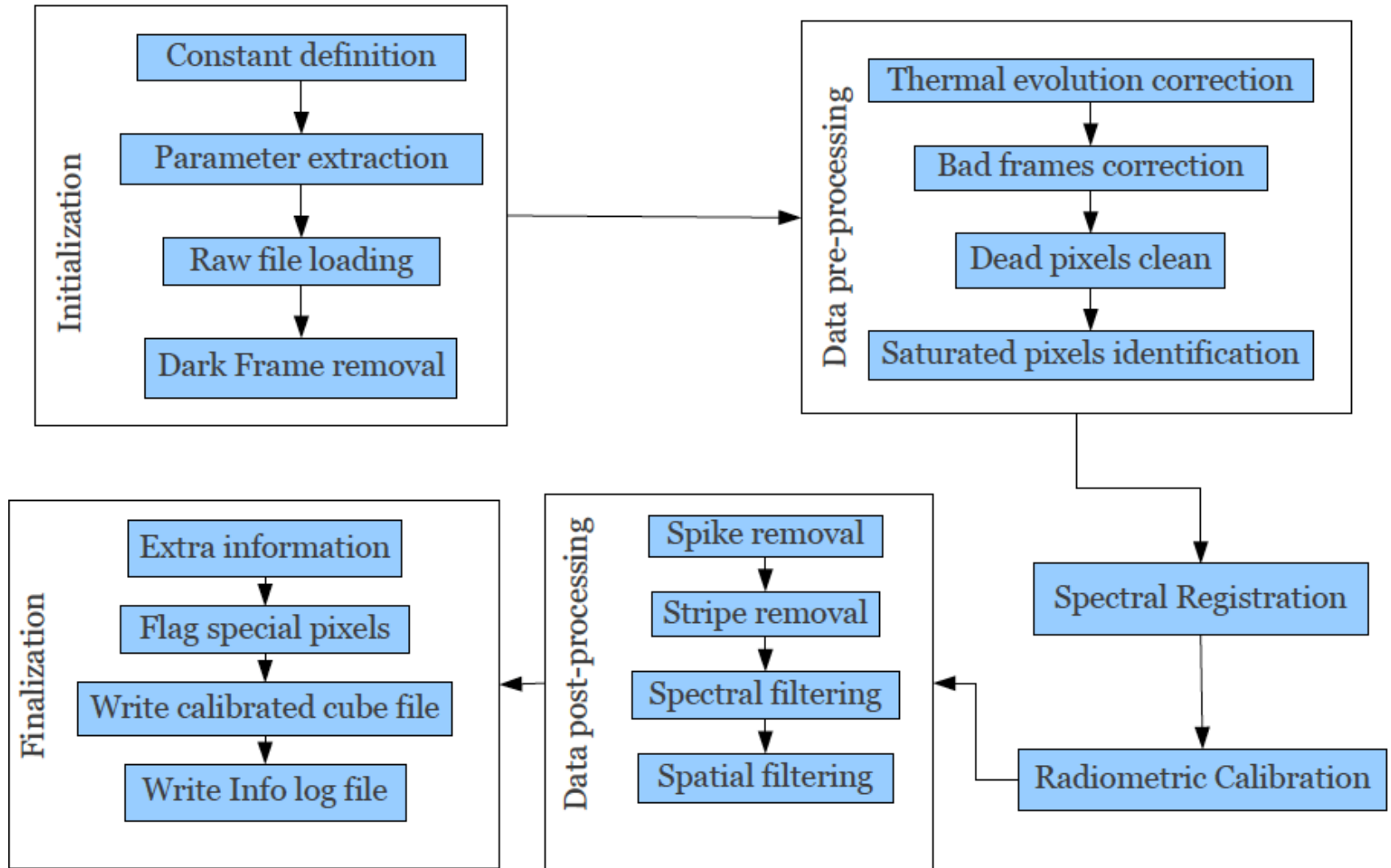
blue = 68 km

A. Sanchez Lavega et al., GRL 2008

A sample of a spectrum (not full) of the Venus day side



VIRTIS-M Calibration



R. Politi

The VIRTIS calibrated data delivered to PSA (ESA) have the latest version (the same as for the team)

Data and tutorials are freely available here:

<http://www.rssd.esa.int/PSA>

(→ Venus Express)

Some example of VIRTIS-M data and results

(Although you can see a large set of
examples in this workshop)

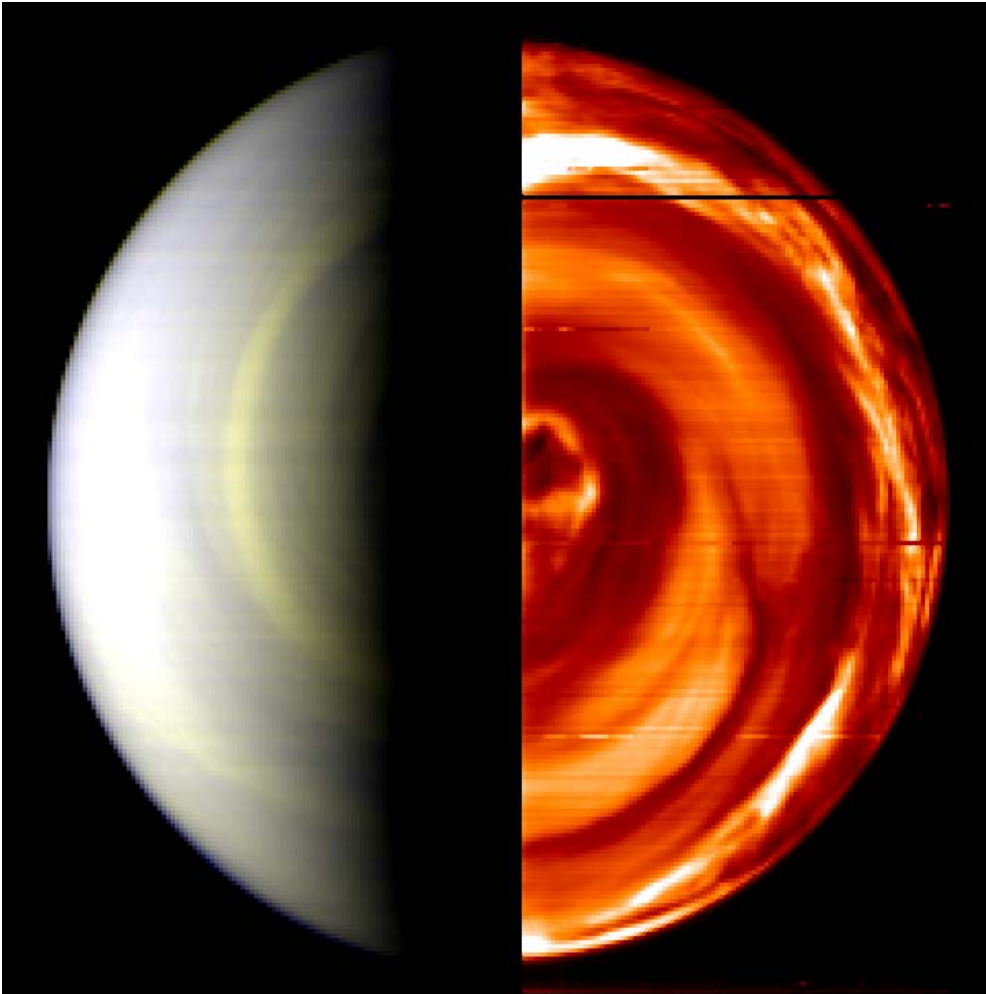


Nadir geometry

Case 1, case 2, case 3 observations



First VIRTIS Venus image **one day**
after the Venus Orbit Insertion
See www.esa.int, April 13 2006



On the left is a VIRTIS-M visible false colour image of the day side using a combination from wavelength in the Blue @380nm and red at 650nm.

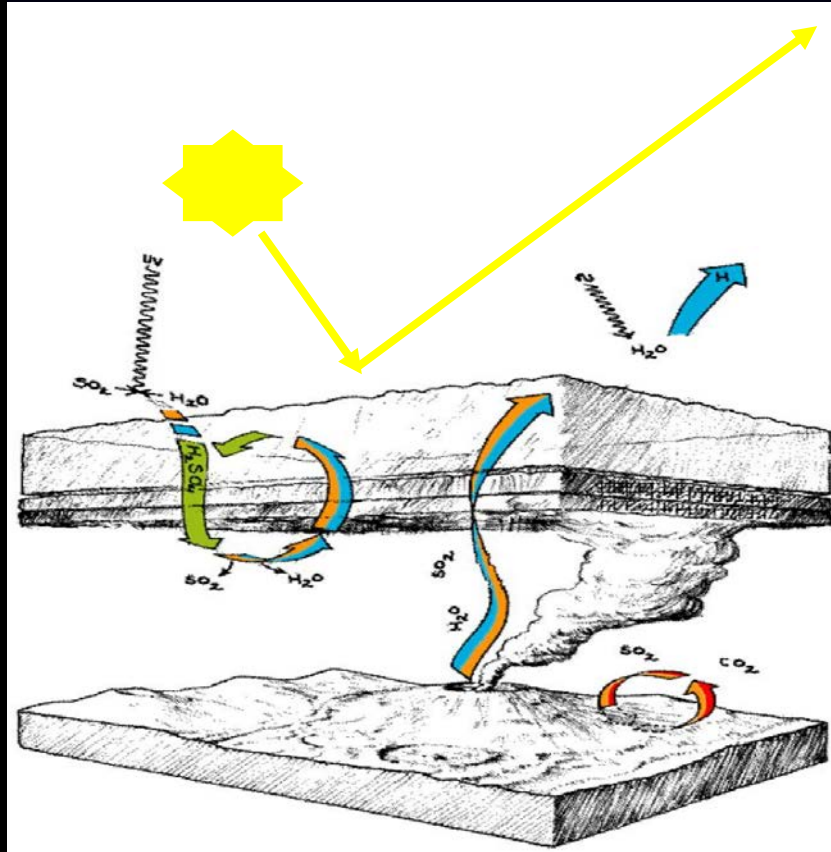
The spiral features are due to scattered light from the cloud top particles.

On the right is an image from VIRTIS-M infrared, night side, @1.7 μ m the radiance comes from the deep atmosphere, below the clouds.

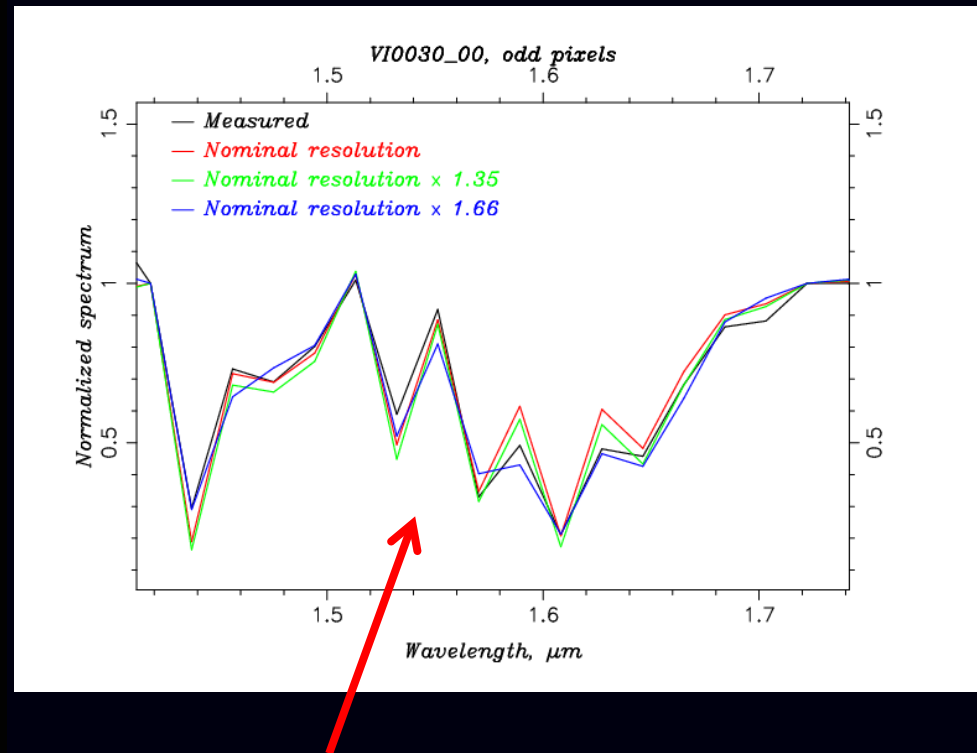
Red means less cloudy zone.

South pole is in the center.

Altimetry of the clouds top (day side)

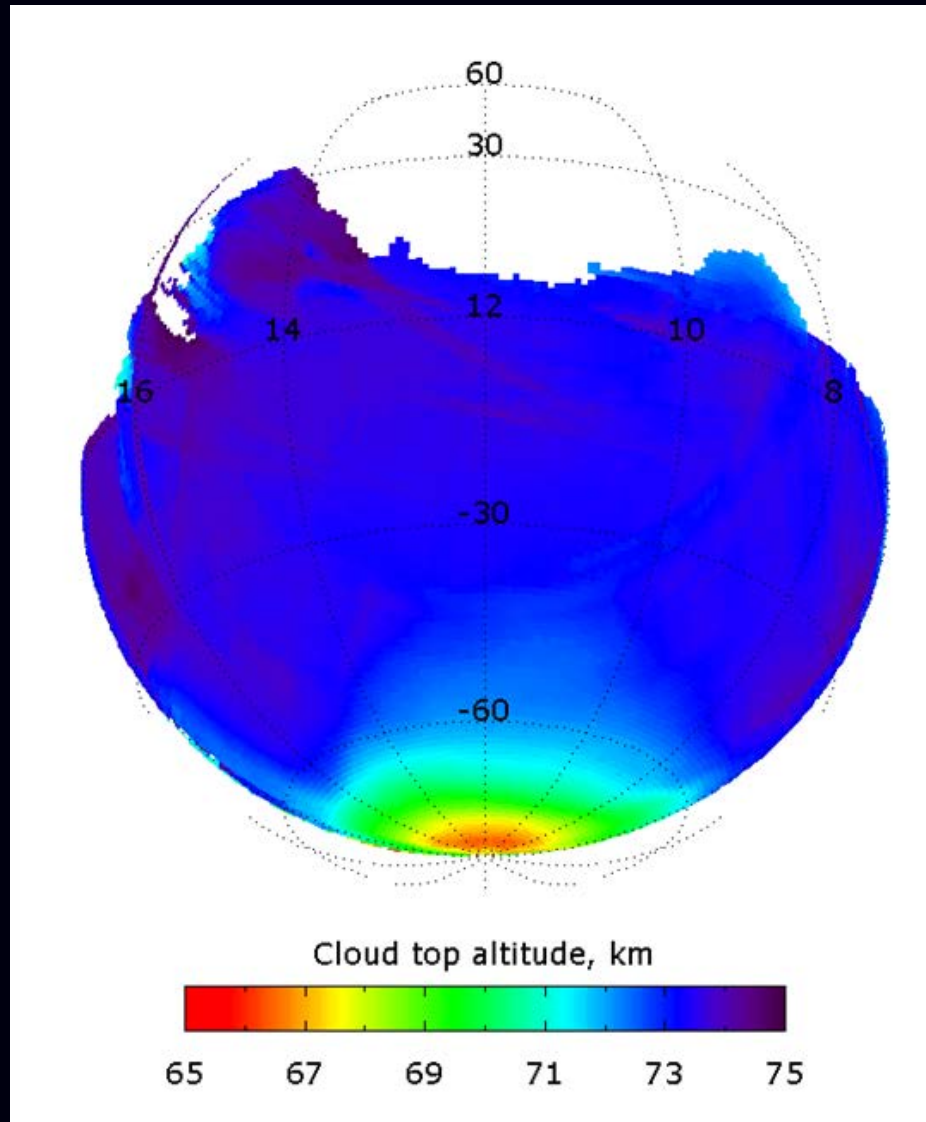


Bands used for the
altitude retrieval



Altimetry

Clouds altimetry from the CO₂ absorption (day side)



Large
depression
in the polar
region

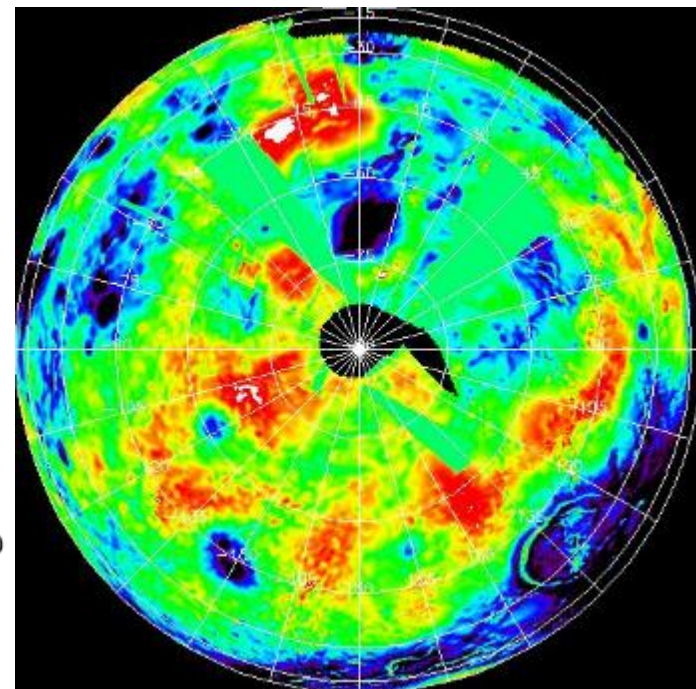
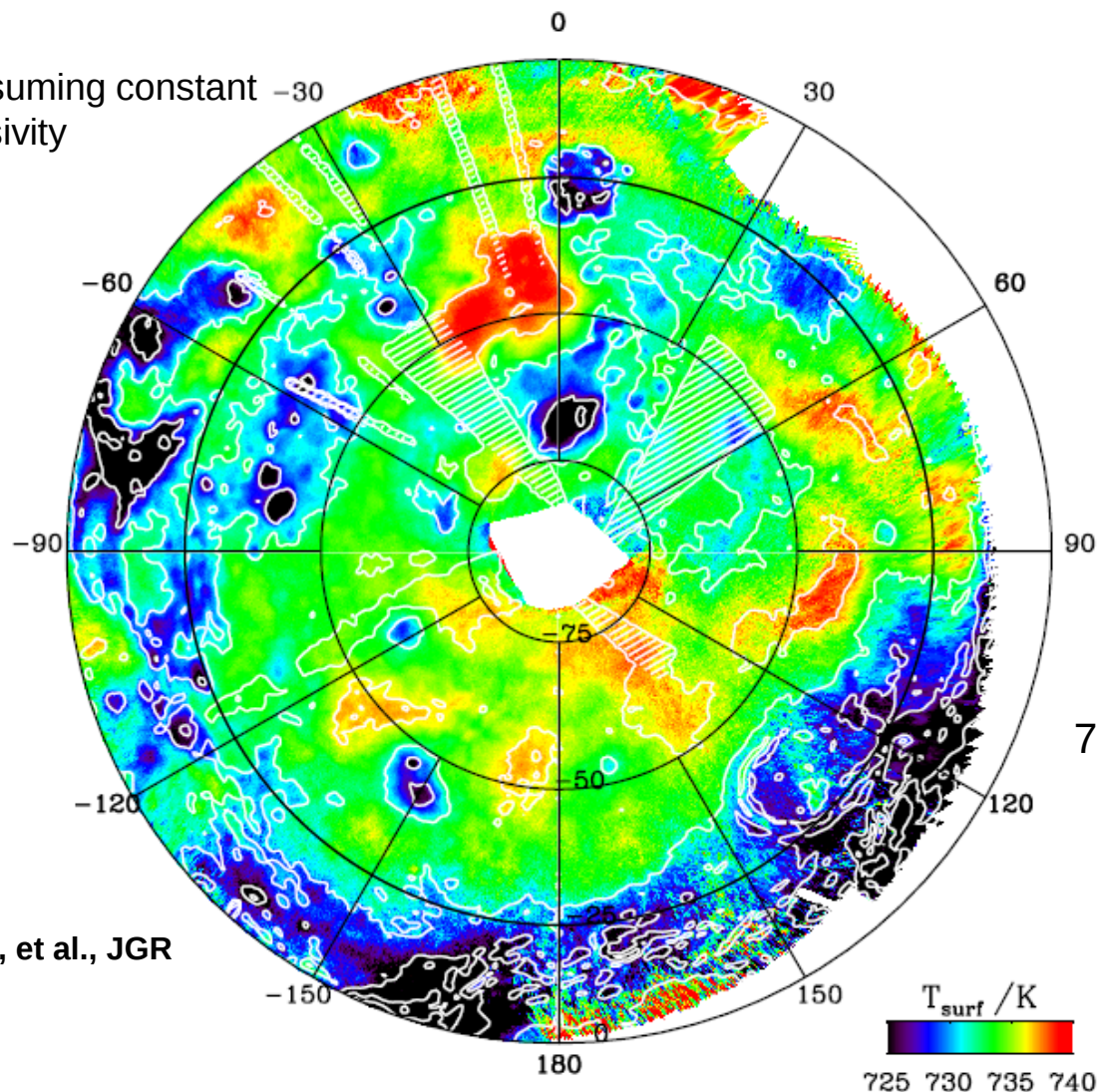
N. Ignatiev et al., JGR 2009

Surface

(from the atmospheric windows)

Mapping the surface of Venus – Surface brightness temperature

... assuming constant –30
emissivity



725 K 745 K

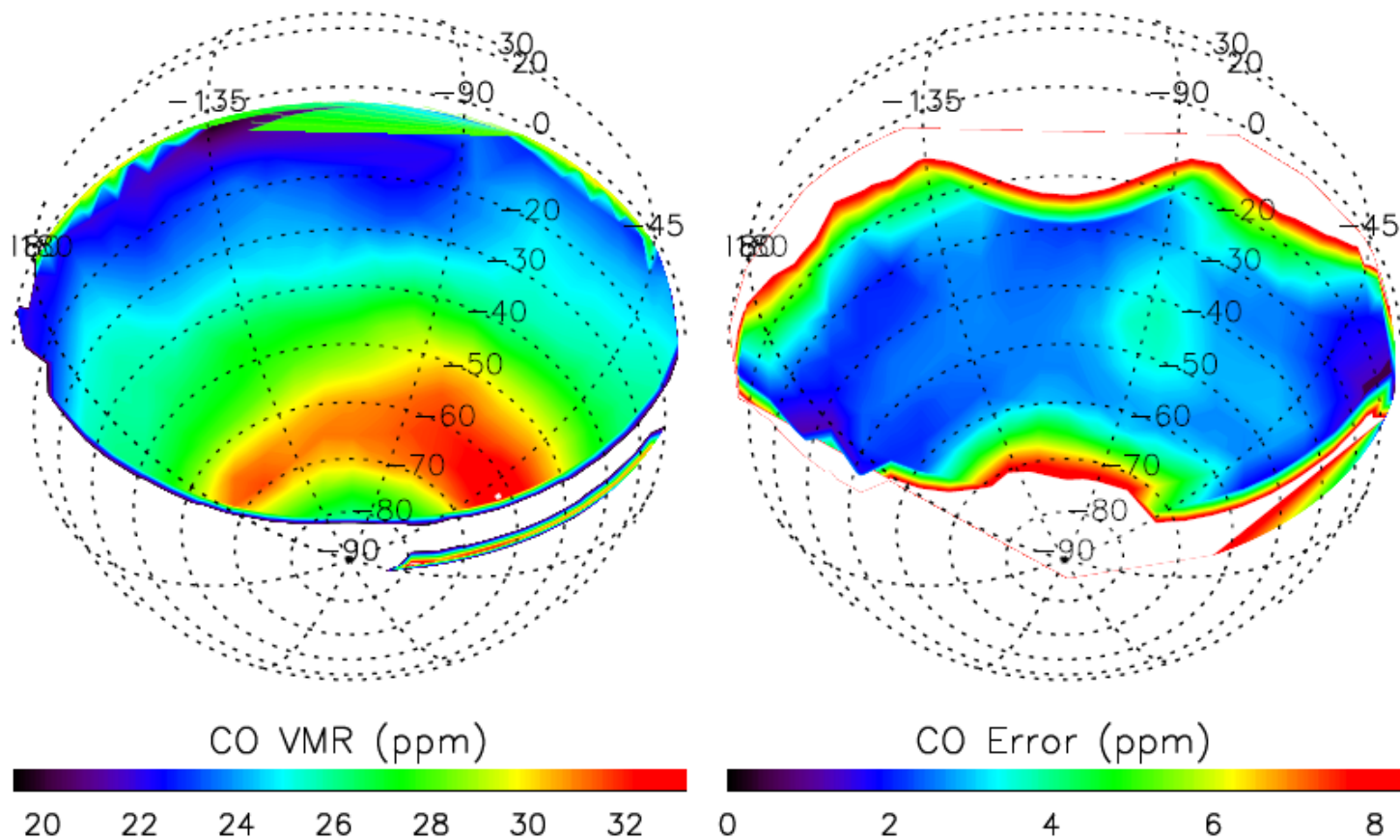
**Syntetic thermal map
from Magellan data
(GTDR)**

VIRTIS

Lower atmosphere

(Composition measurements from thermal emission on the night side)

CO distribution from VIRTIS-M

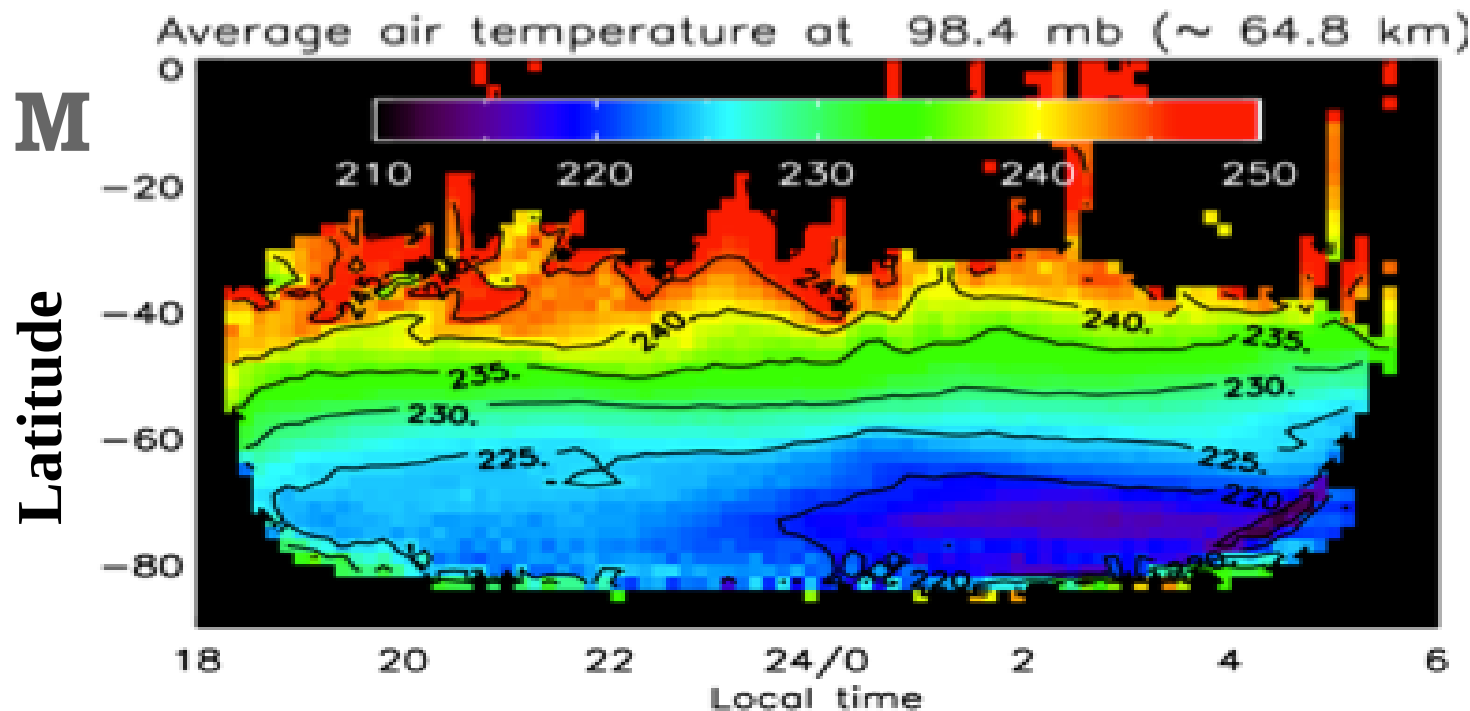


C. Tsang et al., 2009

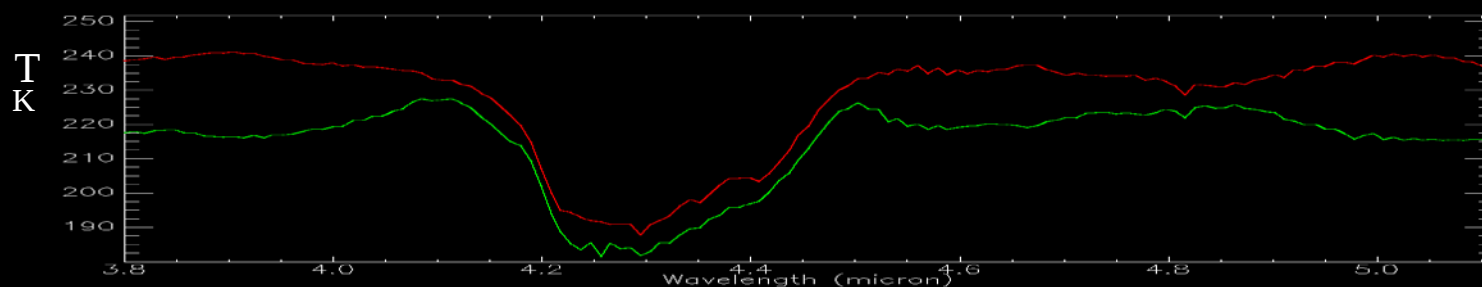
thermal structure

(from the CO₂ lines)

Map at 100 mbar (~65 km)



from D. Grassi

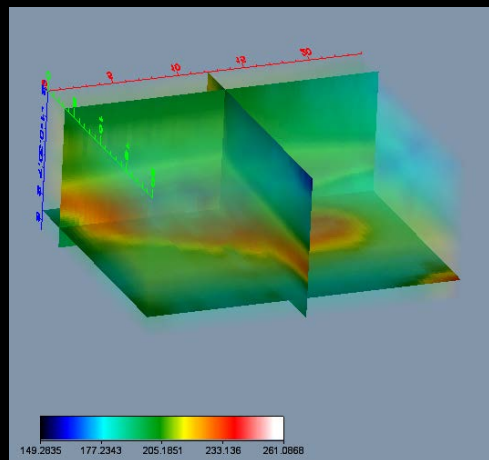


The cold collar region is well evident at this pressure level. It is colder in the morning side, and also more pronounced on the southern hemisphere. An increase of temperature is observed in the antisolar point, interpreted as an evidence of waves activity (diurnal).

polar vortex

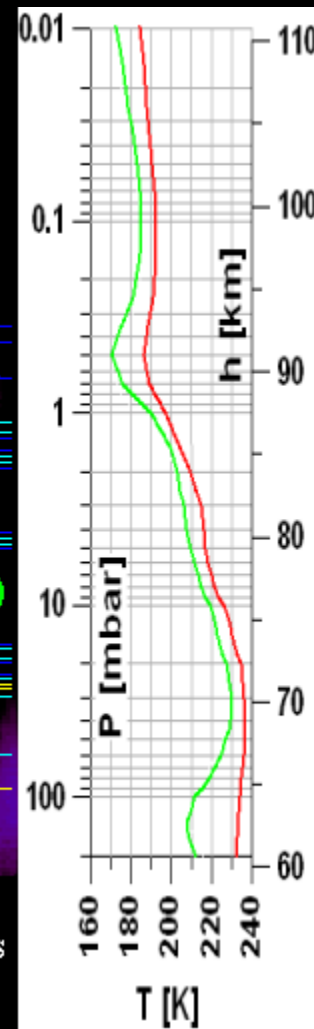
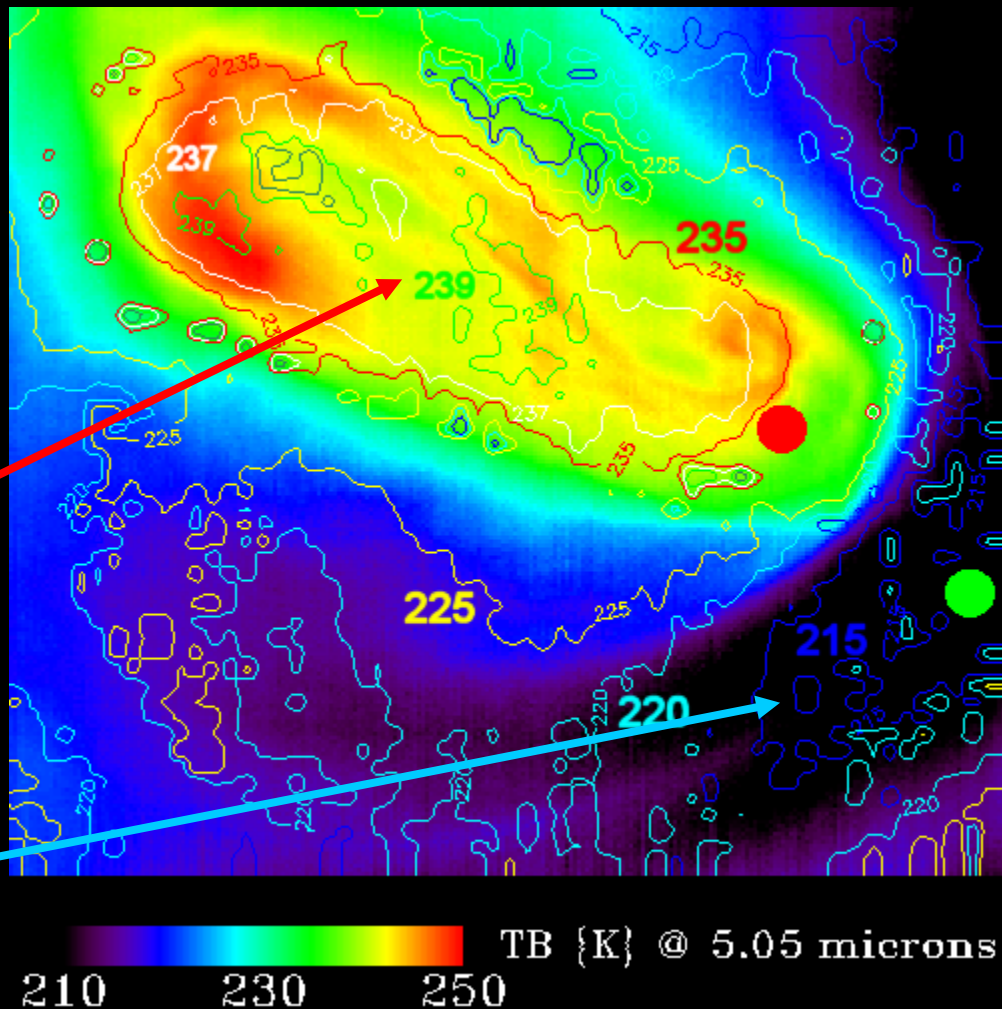
(structure and dynamics)

The structure: vortex case



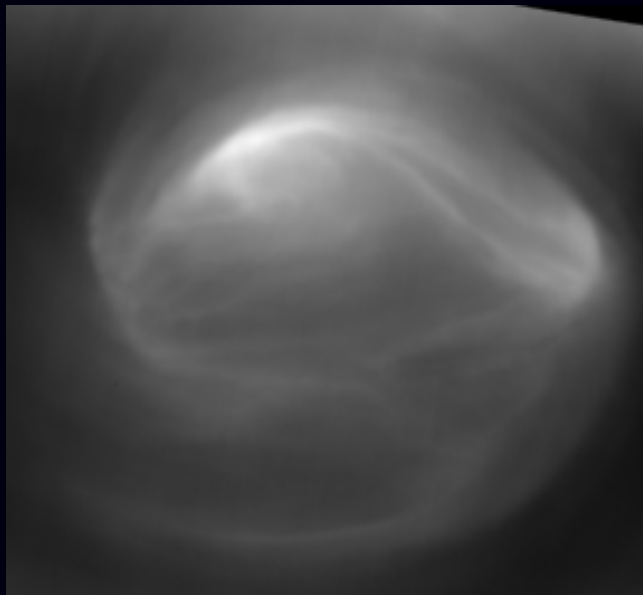
“High” temperature region is within the vortex

“Low” temperature region is just outside, surrounding the vortex



G. Piccioni et al., Nature 29 November 2007

Vortex altimetry and morphology

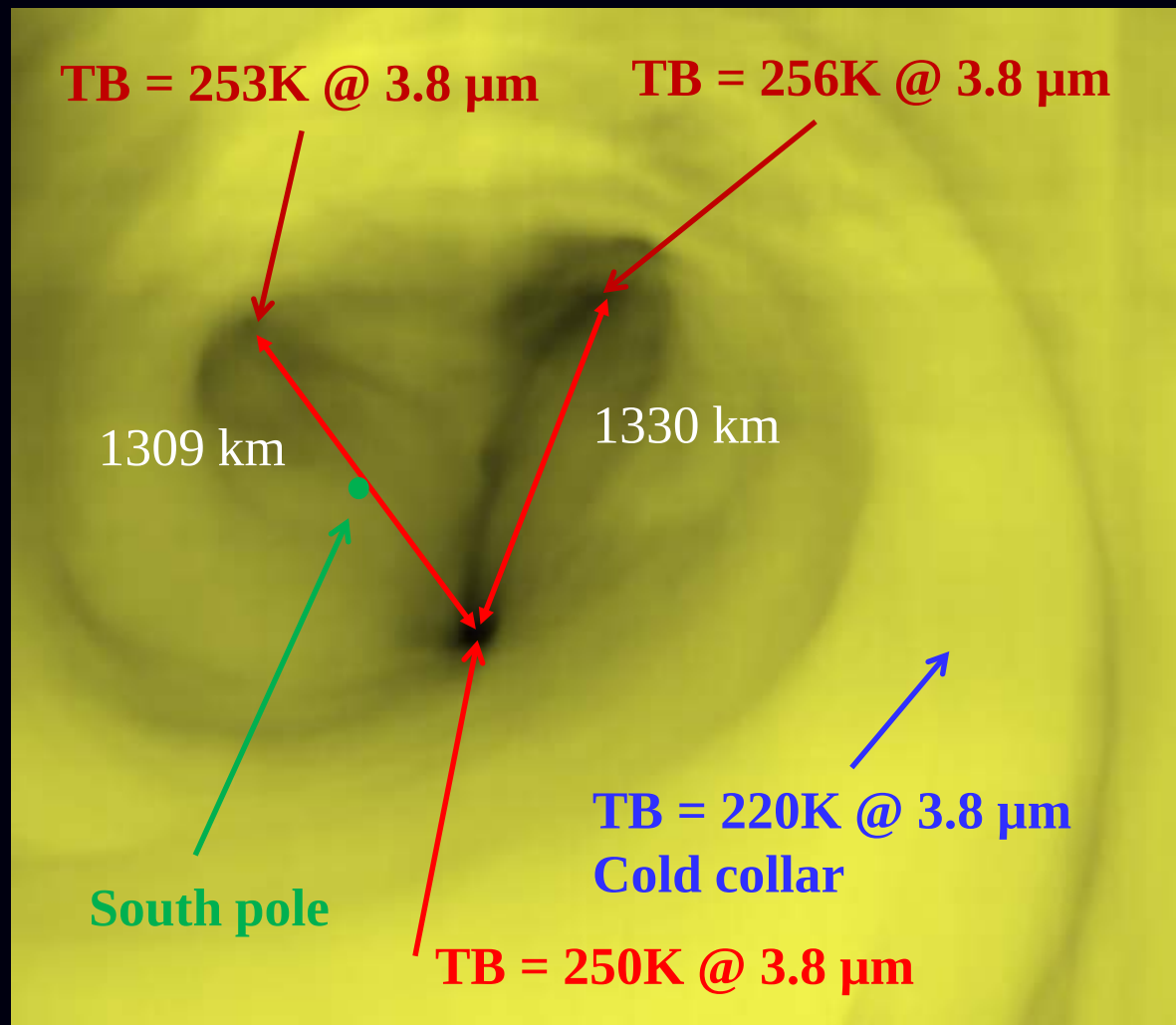


Orbit 614 session 03

Image @ 3.8 μm

Probed altitude is on the
clouds top (about 65km)

“center” of vortex is
offset wrt south pole

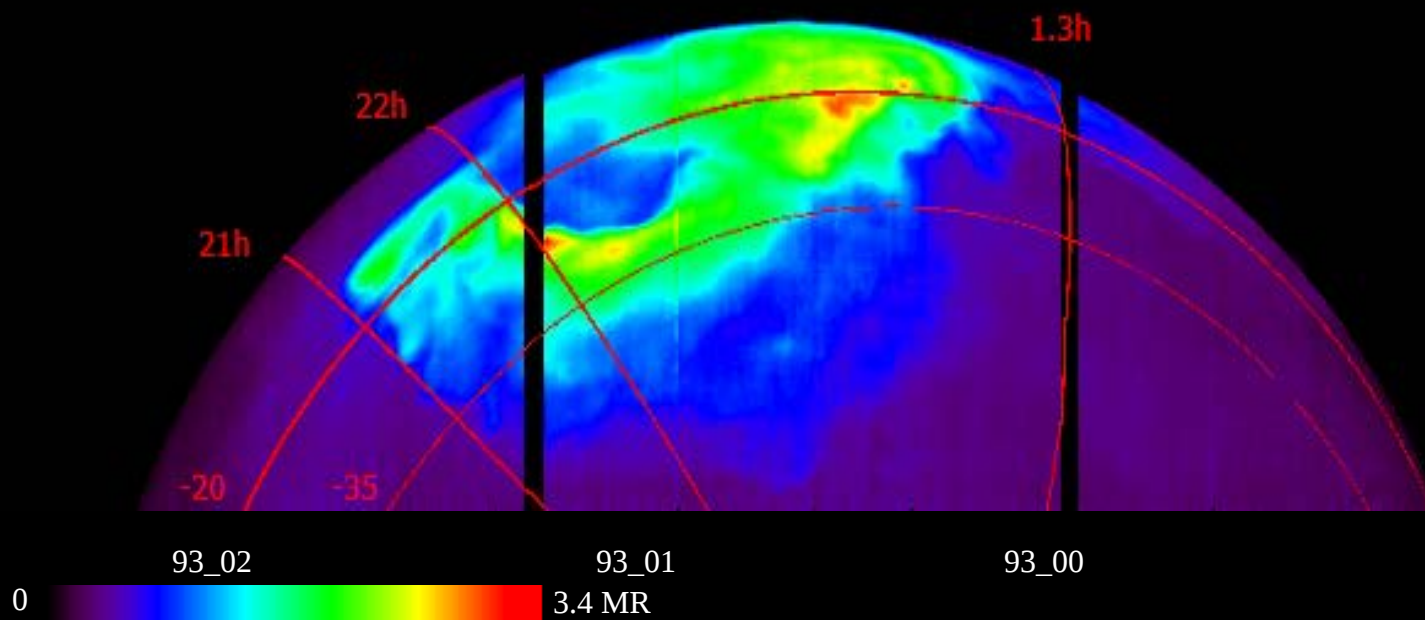


Nightglow

(NLTE emissions in the upper atmosphere)

O₂ emission

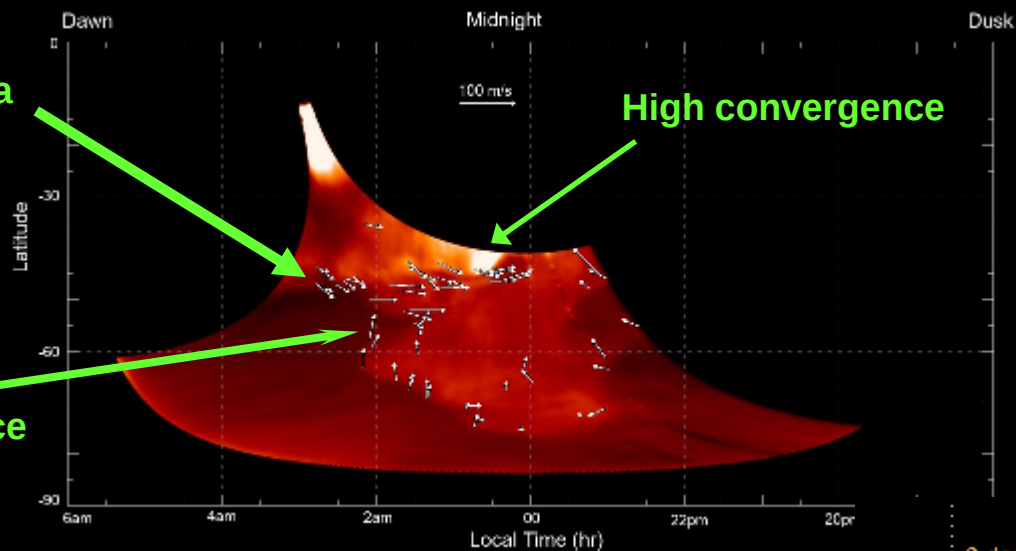
Orbit 93



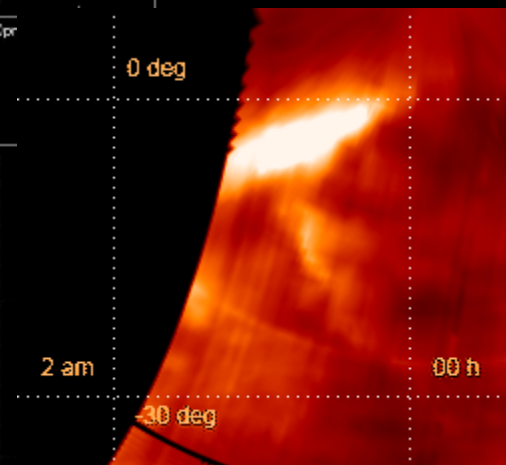
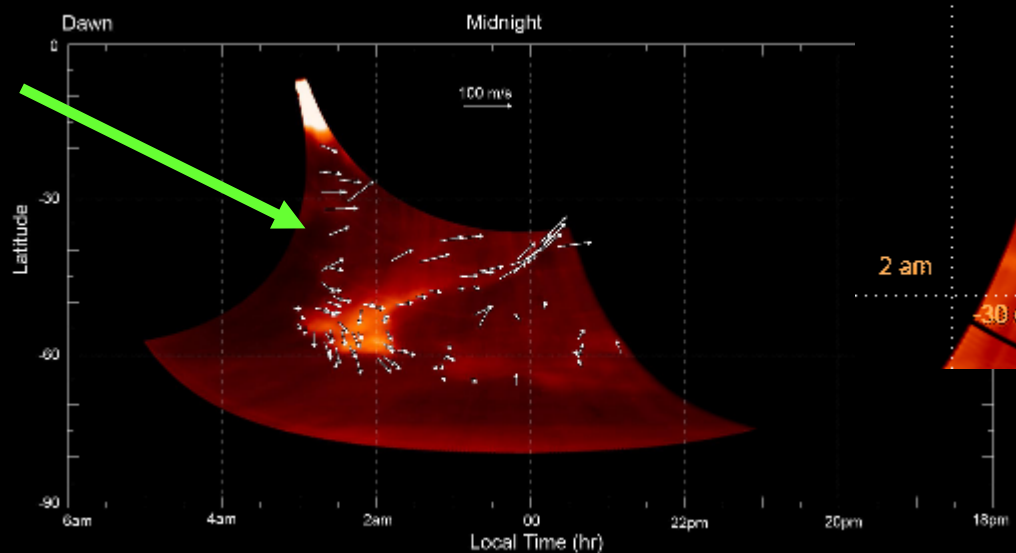
Oxygen nightglow corrected for thermal emission and clouds backscattering

The apparent jet is a common feature over a few orbits

Small convergence



The apparent jet is a common feature over a few orbits

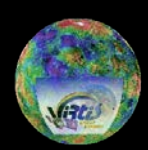


P. Drossart et al., Nature 2007



Limb geometry

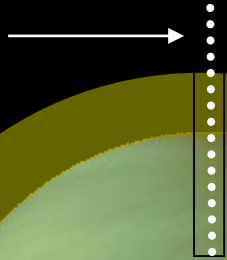
Case 5, case 7 observations



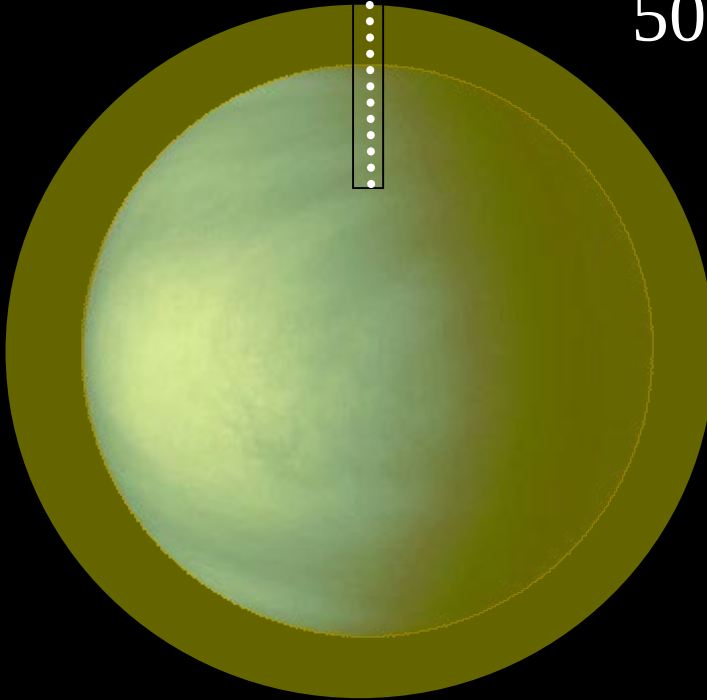
Typical limb geometry

VIRTIS-M slit

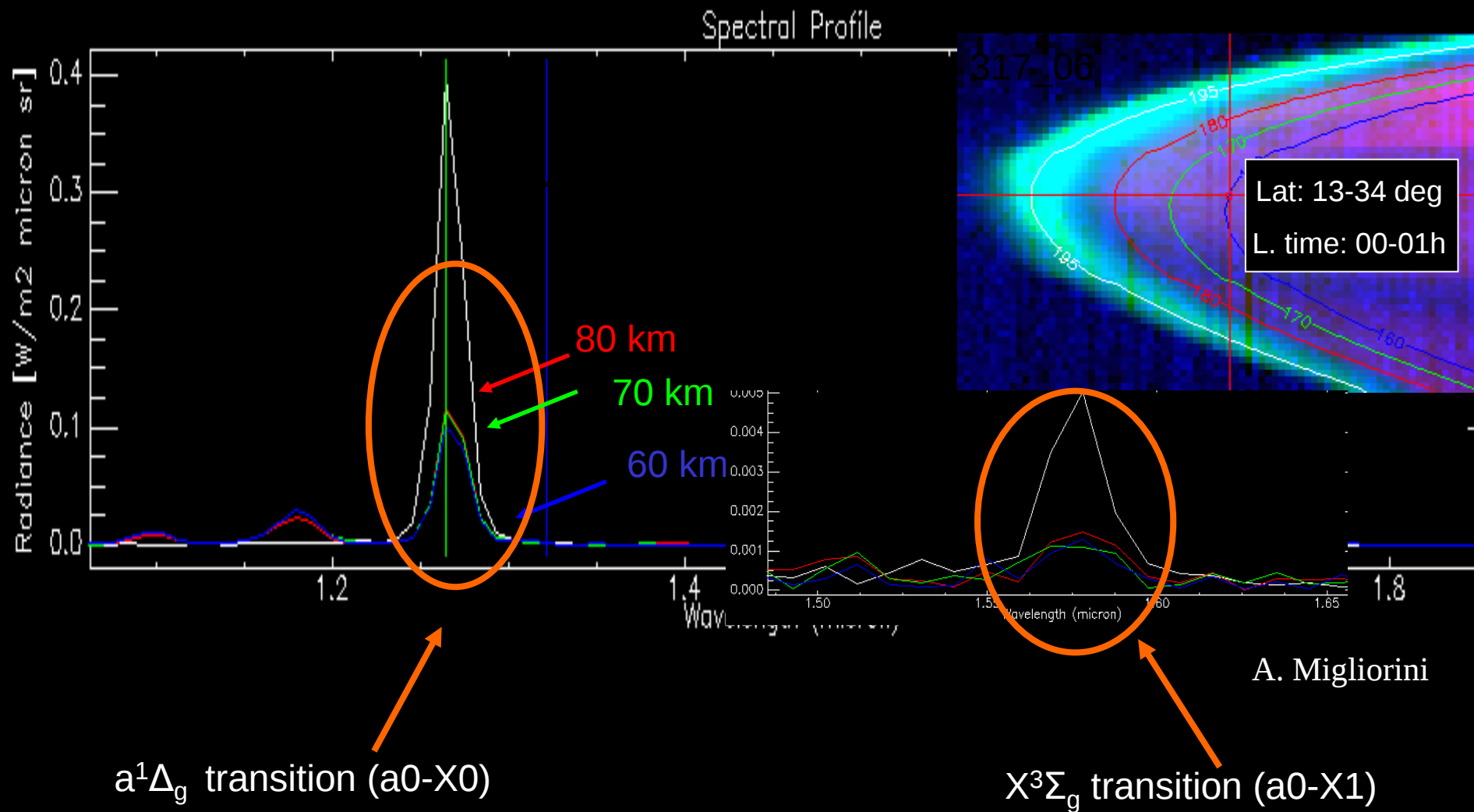
// Y axis of SPC



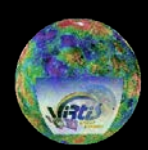
**vertical coverage: 320 km @
5000km slant distance**



Venus night-side spectrum at different altitudes (“tangential” limb)



Atmospheric view in limb geometry. Mean distance from the planet of about 12000 km. Spatial resolution better than 2 km.



"Normal" limb Pointings

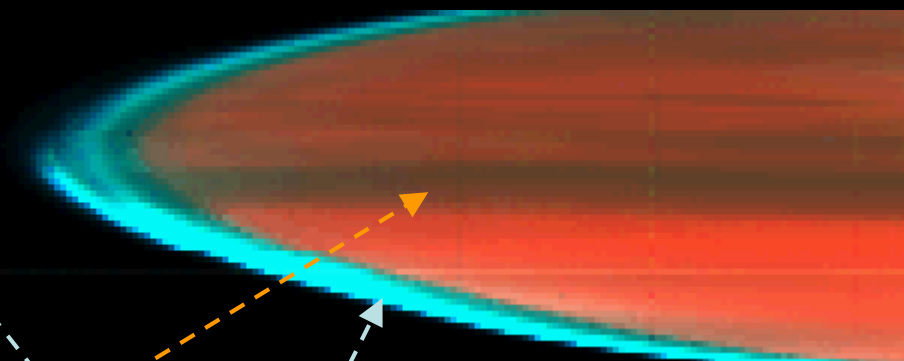


Inertial limb nightside

Tangential limb nightside



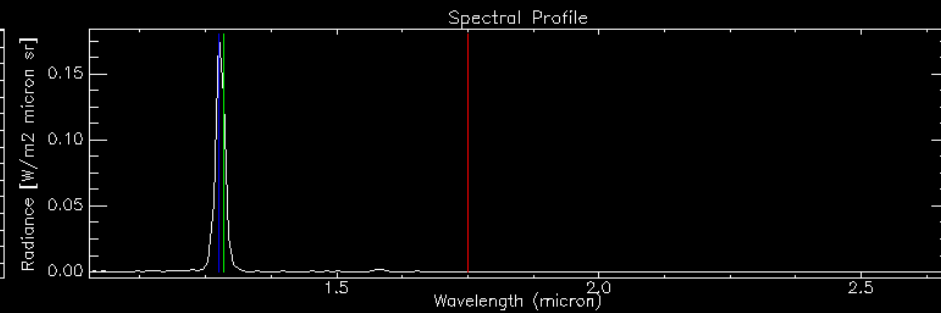
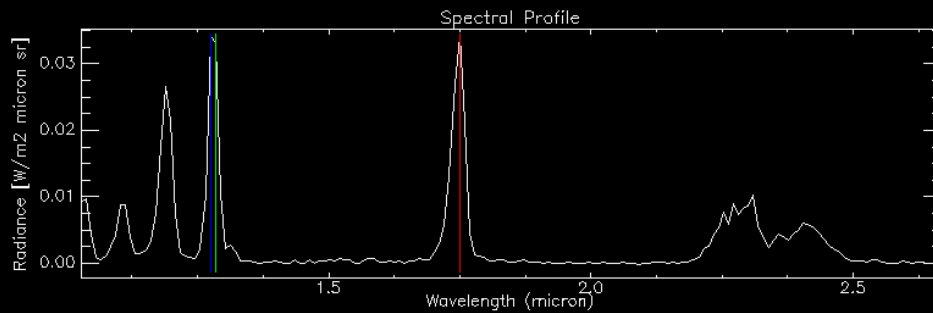
VI0102_15



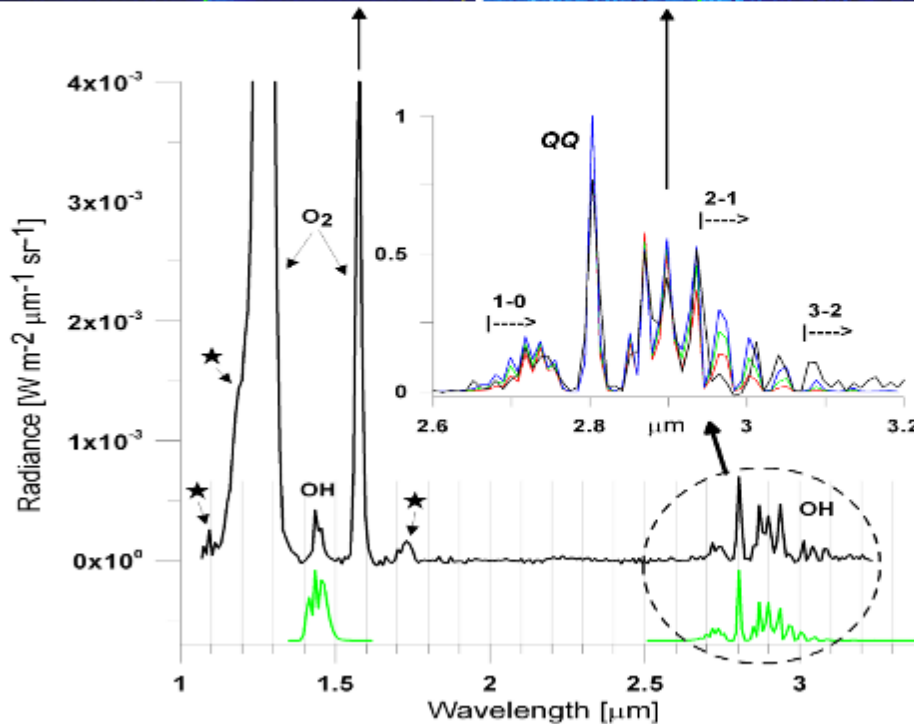
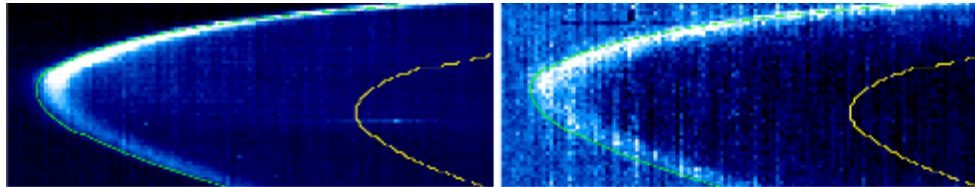
VI0321_04

Nightside cloud spectral profile

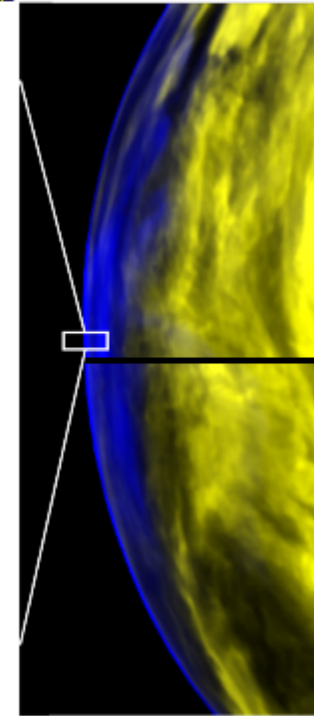
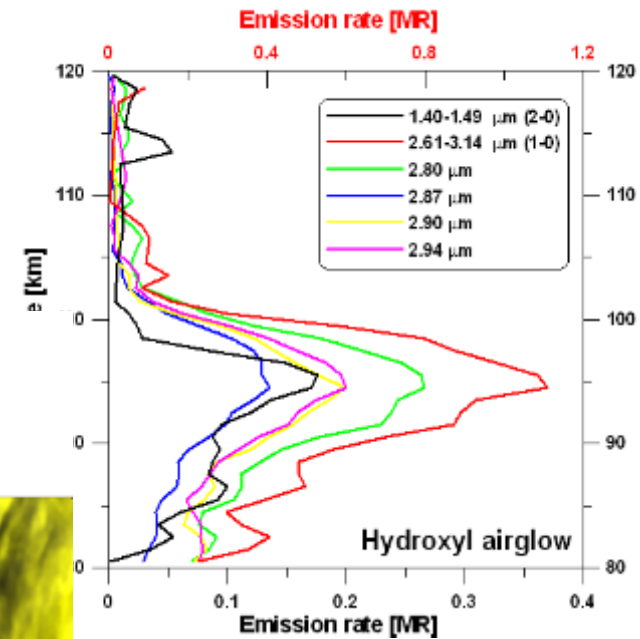
Nightside airglow emission at limb



Hydroxyl nightglow



G. Piccioni et al., A&A 2008

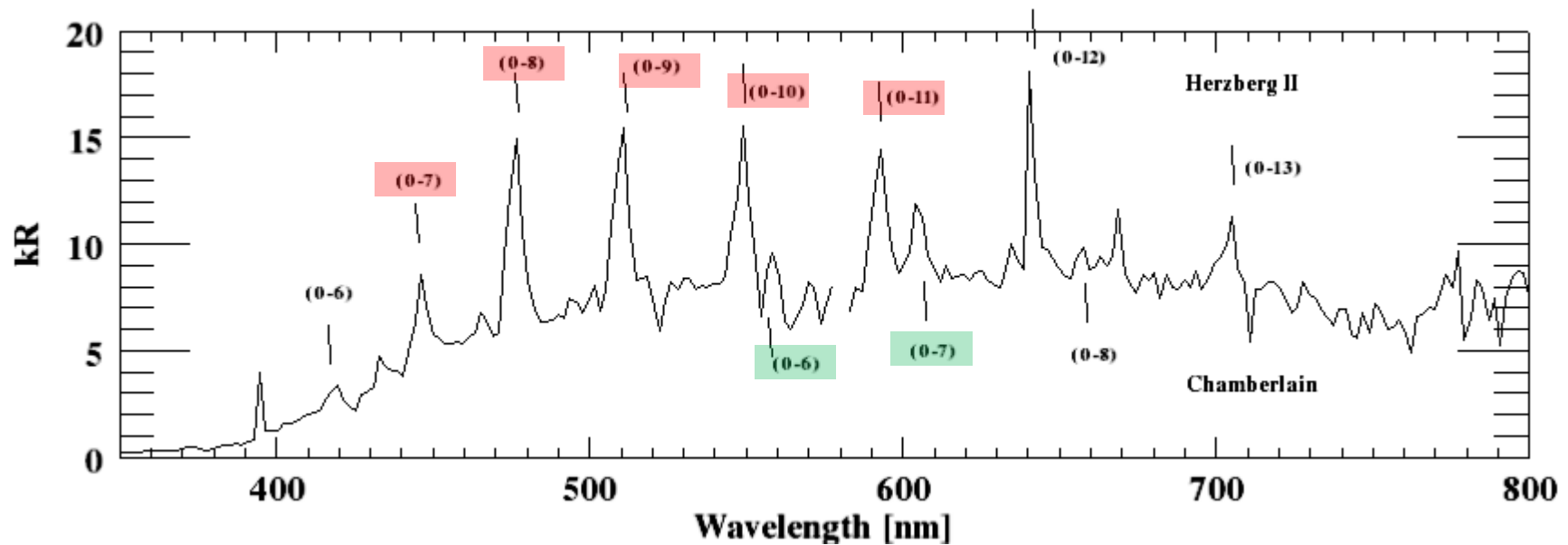


Averaged spectra
from 90 to
100 km

Green = syntetic
spectrum

Black = measured

O₂ nightglow in the visible



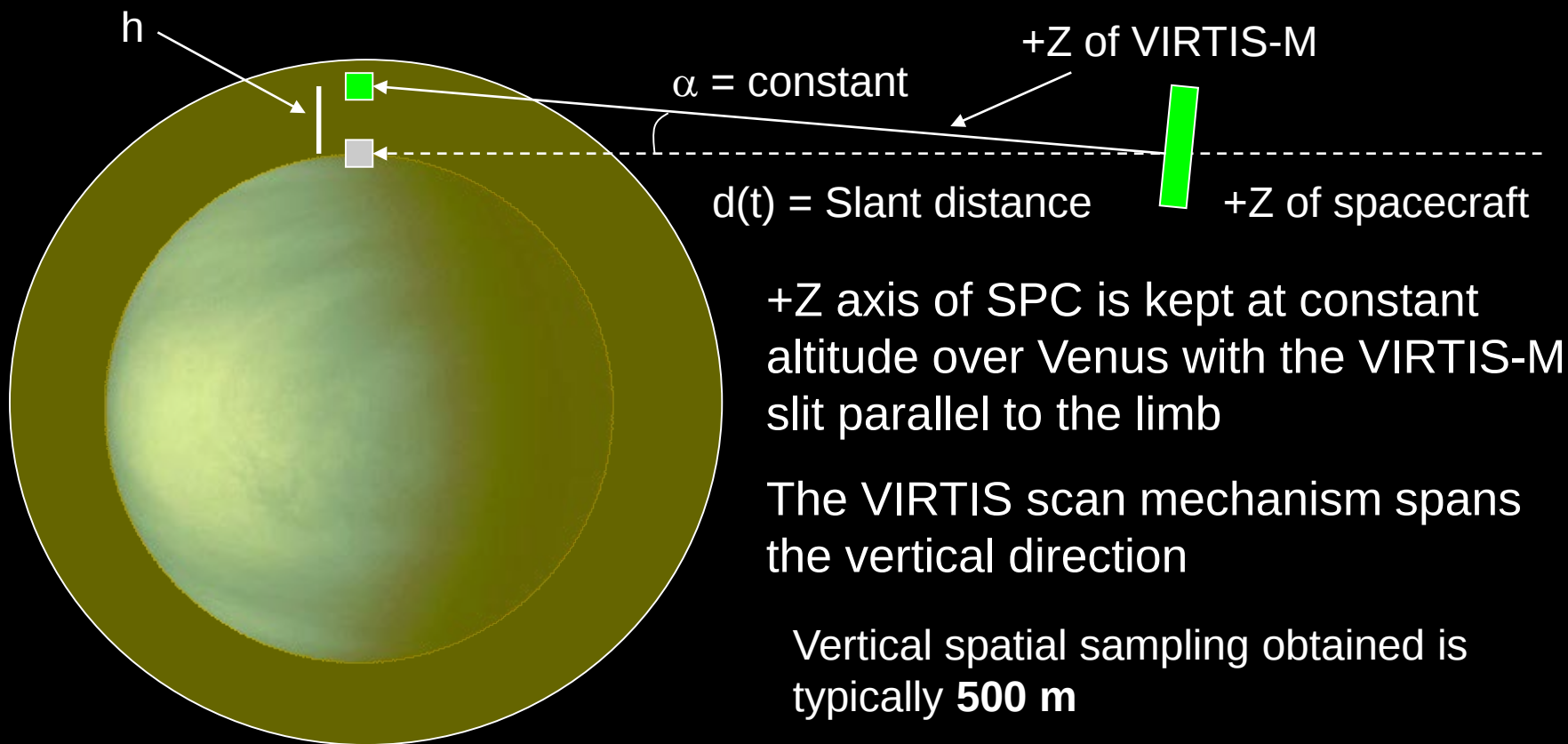
Mean spectrum, obtained by averaging about 8700 spectra, selected in the 90-100 km altitude range in the images acquired from March 2010 to February 2011. From the spectrum, it is clear that 8 Herzberg II bands are detected. In addition, 3 Chamberlain bands are observed. For the HII and Chamberlain bands highlighted with the coloured boxes we investigated altitude and intensity properties.

Migliorini et al., Icarus



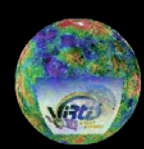
Limb tracking

Limb tracking geometry



Range 80-130 km night side

Range 70-230 km day side



Limb tracking mode (altitude of tracking is 0 km)



$T_{exp} = 8 \text{ sec}$

Session: VI0715_02

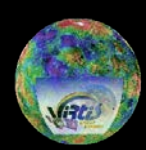
Spatial resolution: 0.5 km/px

$R=1.27 \text{ }\mu\text{m}$, $G=1.25 \text{ }\mu\text{m}$, $B=1.26 \text{ }\mu\text{m}$

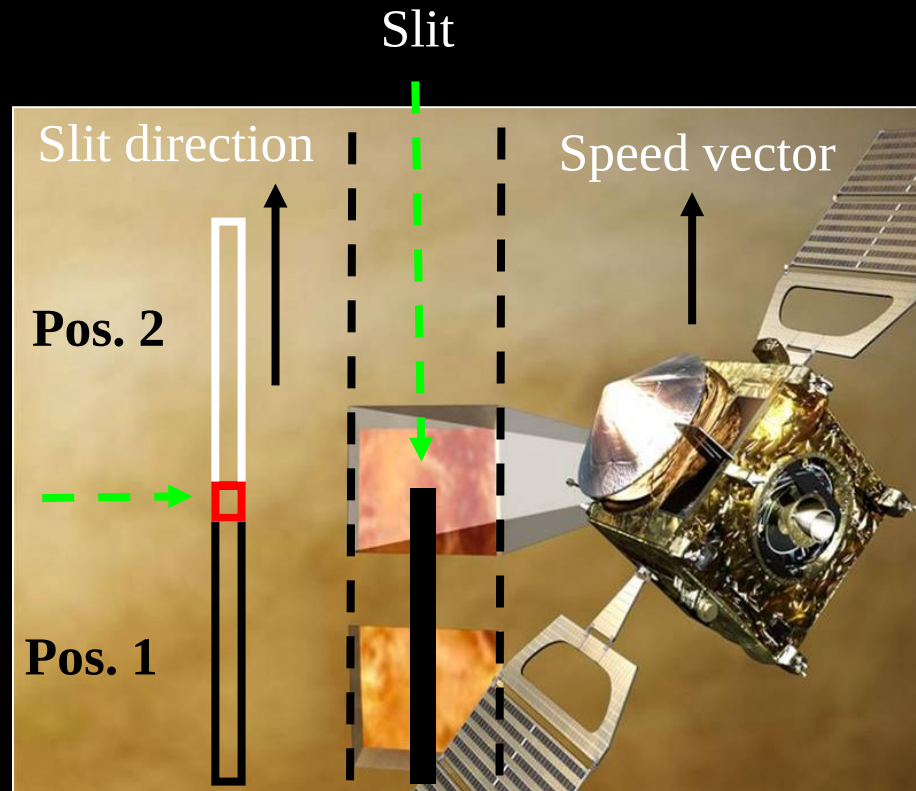


Special limb mode

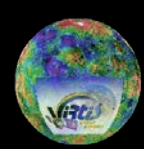
(executed only 2 times for calibration)



Calibration custom observation (orbit 274)



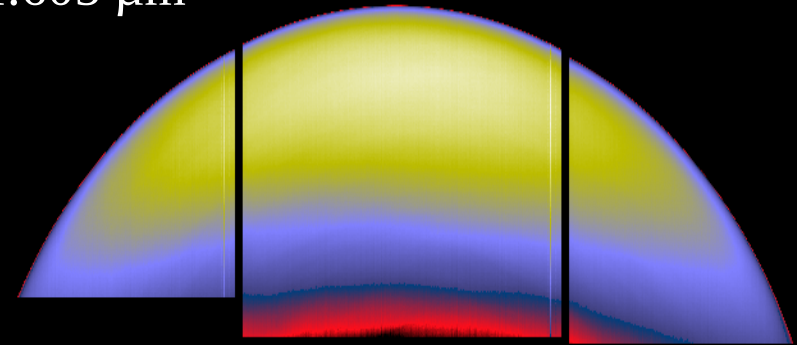
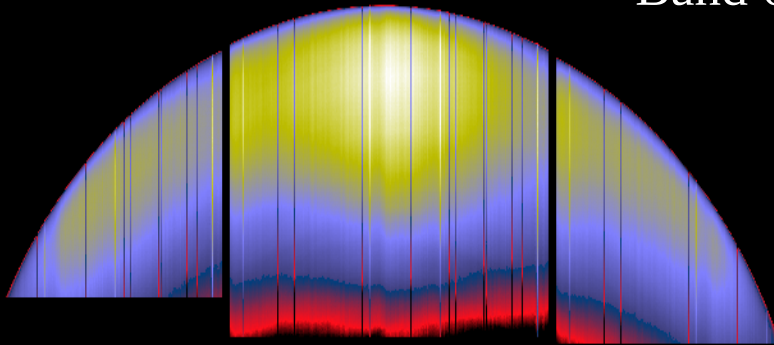
The samples (along the slit) see the same scenario (assuming no significant temporal variation)



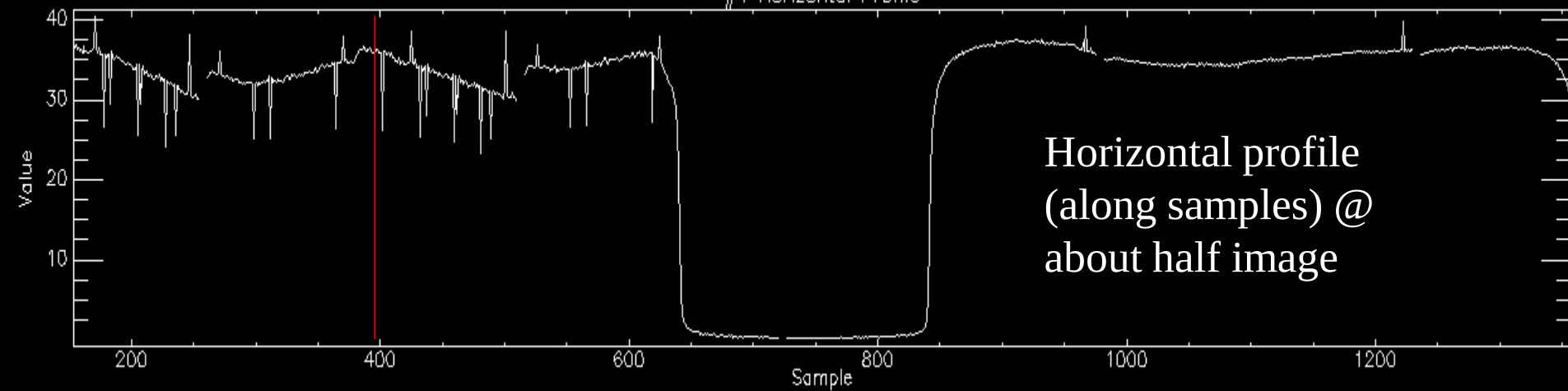
Uncorrected ITF

Corrected ITF

Band 63 @ 1.605 μm



#4 Horizontal Profile



“True” colors image of Venus acquired by VIRTIS, Aprile 19 2006





End of VIRTIS-M part

April 4-8 2016

G. Piccioni et al. @ Venus Conference 2016 - Oxford