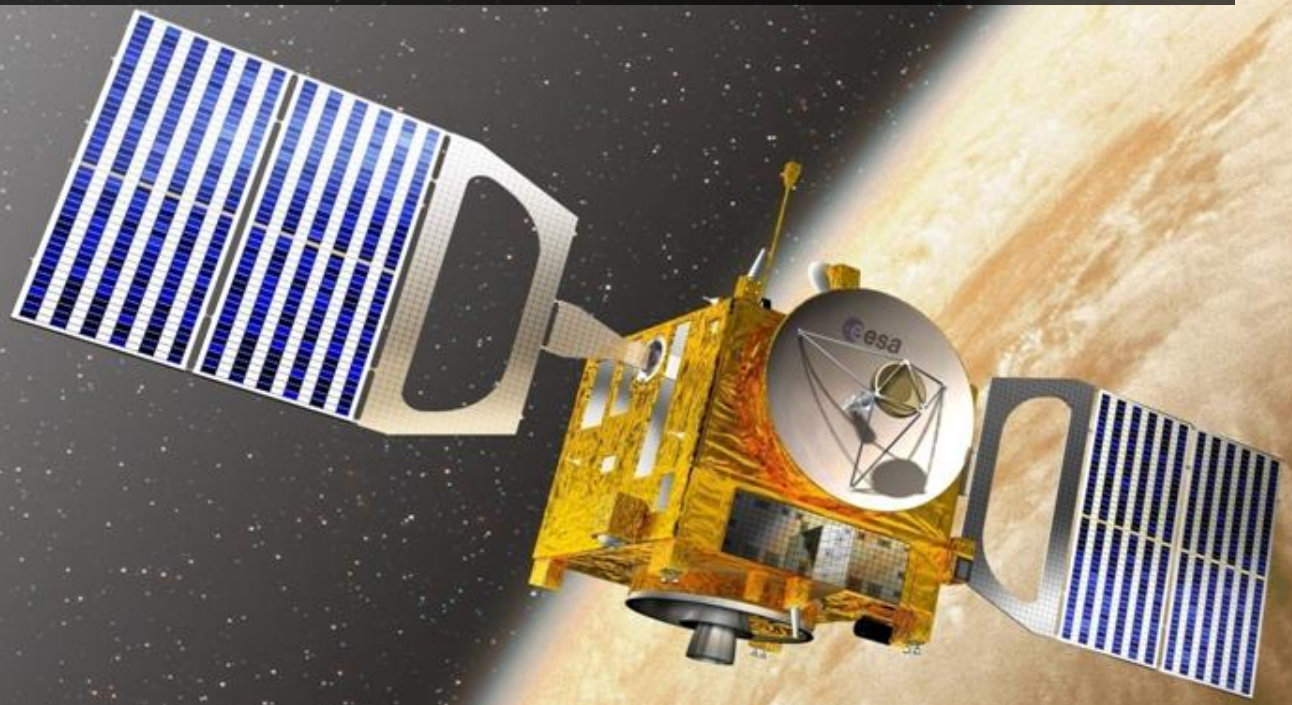
Venus Express

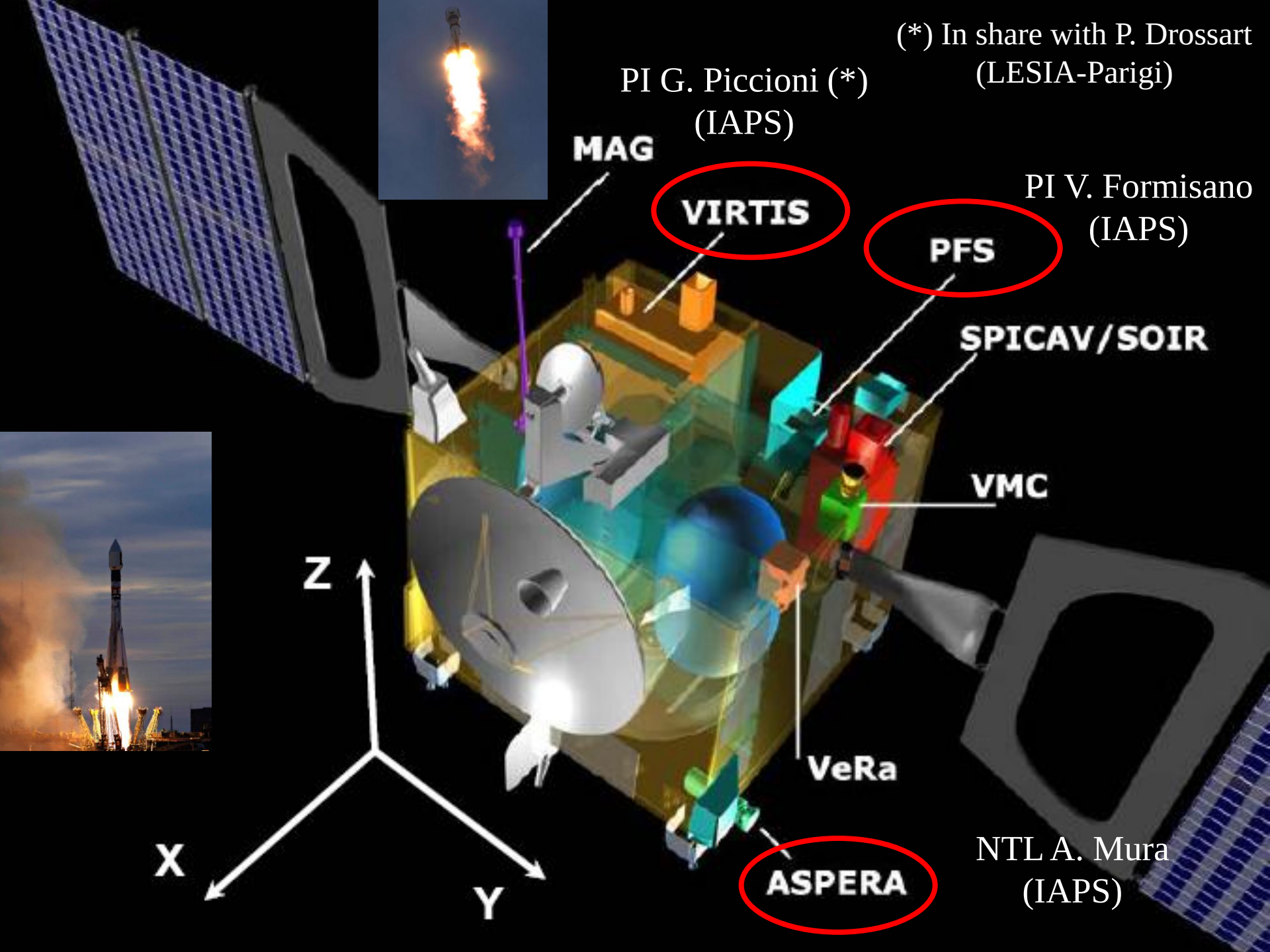


Giuseppe Piccioni

Istituto Nazionale di Astrofisica-IAPS, Roma

Venus Express

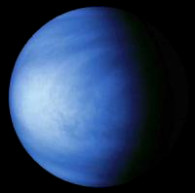
- Obiettivo: pianeta Venere
- Lancio: 9 Novembre 2005
- Inserimento in orbita : 11 Aprile 2006
- Inizio missione nominale: 4 Giugno 2006
- Attualmente in fase di missione estesa (fino alla fine del 2014 con ulteriore possibile estensione)

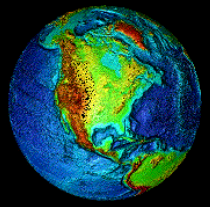

(*) In share with P. Drossart
(LESIA-Parigi)
PI G. Piccioni (*)
(IAPS)
MAG
VIRTIS
PFS
PI V. Formisano
(IAPS)
SPICAV/SOIR
VMC
Z
X
Y
VeRa
ASPERA
NTL A. Mura
(IAPS)

Venus Express durante l'integrazione a Torino

Terra-Venere: i gemelli diversi

Il pianeta più simile alla Terra





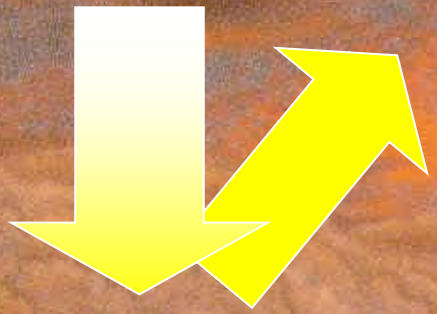
Parametri	Venere	Terra	Rapporto (Venere/Terra)
• Massa (10^{24} kg)	4.8685	5.9736	0.815
• Volume (10^{10} km^3)	92.843	108.321	0.857
• Raggio Equatoriale(km)	6051.8	6378.1	0.949
• Densita' media(kg/m^3)	5243	5515	0.951
• Gravita' superficie(eq.)(m/s^2)	8.87	9.80	0.905
• Albedo Visuale geometrico	0.65	0.367	1.77
• Irradianza solare(W/m^2)	2613.9	1367.6	1.911
• Temperatura efficace (K)	231.7	254.3	0.911

Parametri Orbitali

• Semiasse Maggiore (10^6 km)	108.21	149.60	0.723
• Periodo orbitale (giorni)	224.701	365.256	0.615
• Inclinazione Orbitale (deg)	3.39	0.00	-
• Eccentricita' Orbitale	0.0067	0.0167	0.401
• Periodo rotazione siderale(hrs)	-5832.5	23.9345	243.686

Effetto serra

Radiazione Solare



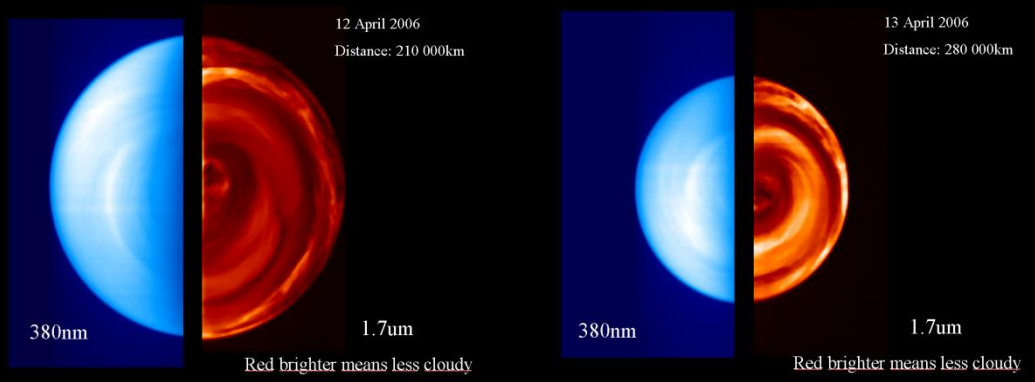
Emissione termica

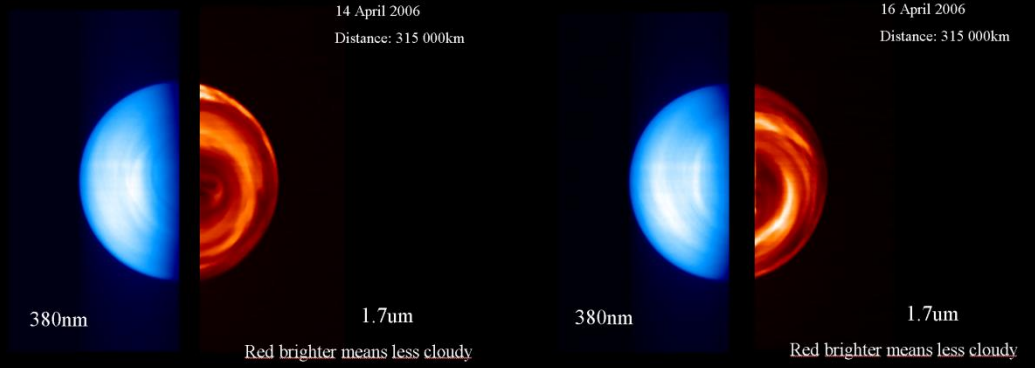
Temperatura di equilibrio

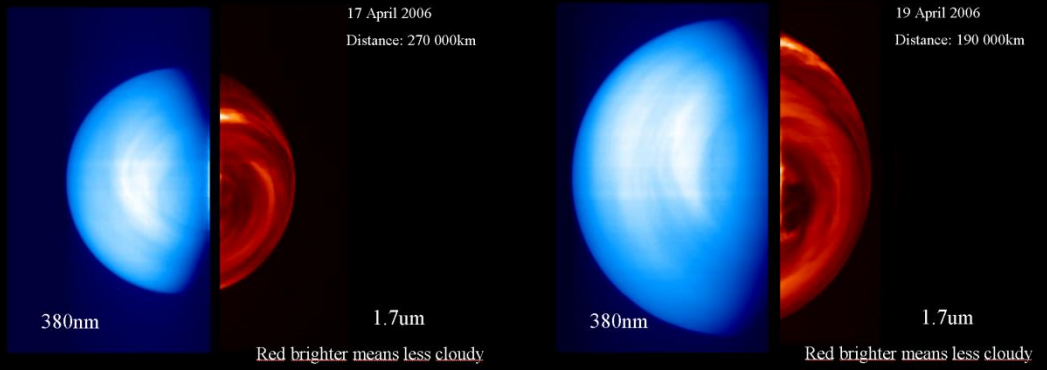
Corpo	Teq [° C]	T(superficie) [° C]
Luna	4	4
Terra	-10	15
Venere	-35	**464 !!**

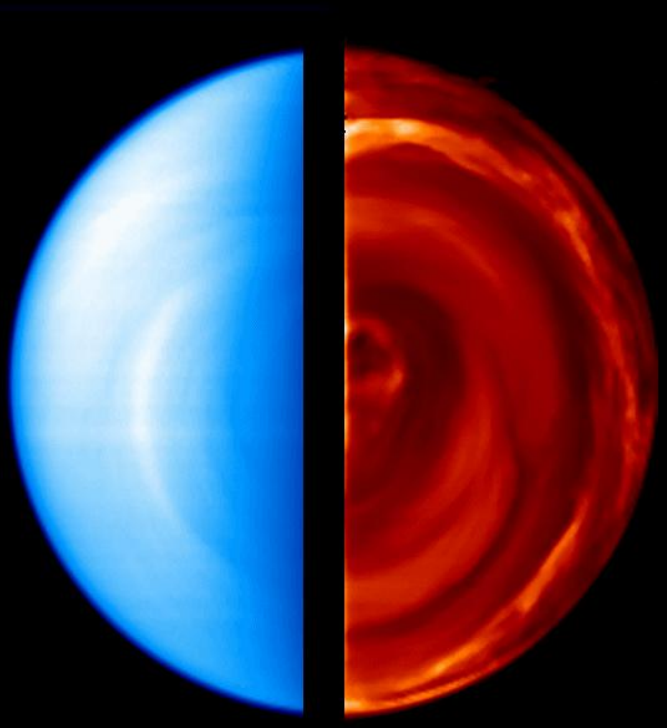
Potente effetto serra !

Immagini acquisite da VIRTIS durante l'inserimento in orbita



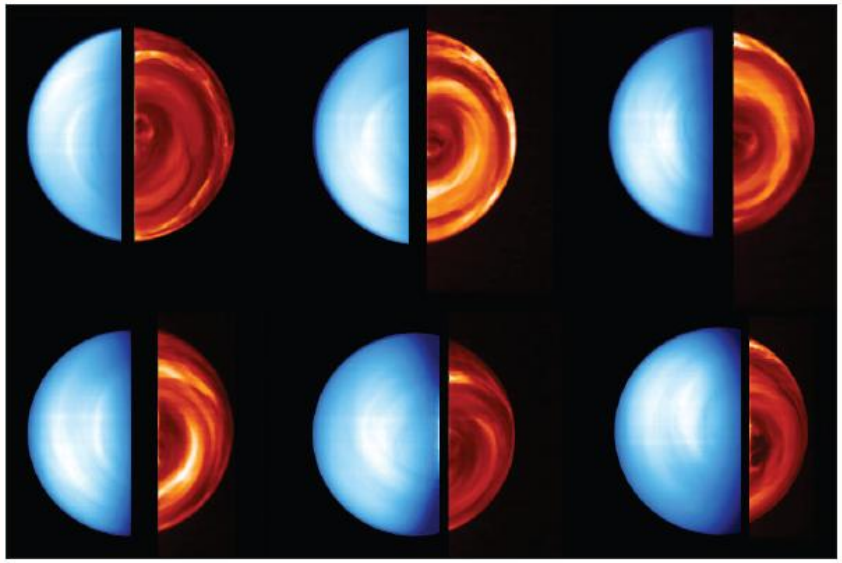






STILL THE FASTEST COMPUTER ON EARTH
IBM's BlueGene/L supercomputer grabs first place again in TOP500 list.
www.nature.com/news

TSP/AFP/GETTY



ESA/VIRTIS/INAF-IASF/OBS. DE PARIS-LESIA

SNAPSHOT

Venus by day and night

These orbs of blue and red are the planet Venus, as seen by the European spacecraft Venus Express during its cruise into orbit. The composite images are among the first data transmitted from the craft, wh be discu the Scie Commit (COSPA angry red swirls to the right are clouds deep in the venusian atmosphere on the planet's night side. They are seen by infrared light, the only type of radiation that makes it out through the dense near-infrared spectrometer (VIRTIS) on Venus Express between 12 and 19 April, from distances of between 190,000 and 315,000 kilometres while the spacecraft moved along a long ellipse around the planet. features like those seen in this image. But now the craft is in its final orbit, its suite of modern instruments is probing different aspects of the atmosphere's composition and dynamics in

16 July in Beijing.

The gauzy blue to the left is the planet's dayside, imaged with ultraviolet light; it is bright with reflected sunlight. Scientists aren't sure what causes the white stripes — maybe some kind of aerosol particle is absorbing the ultraviolet light, says Håkan Svedhem, Venus Express project scientist at the European Space Agency (ESA). The made of sulphuric acid. They float in an atmosphere that is mainly carbon dioxide, and are dragged into a spiralling pattern by fierce, westward winds that tear around the planet at hundreds of metres per second. Here, we view the planet from one end, with the clouds circling the south pole.

The sequence of images was captured by the ultraviolet/visible/ switched off during the craft's orbital manoeuvres, but since 4 June, data from its cameras, spectrometers and analysers have been streaming back to ESA's deep-space antenna at Cebreros, just outside Madrid, Spain. Earlier missions to Venus, by NASA's Mariner probes and the Soviet Union's Venera programme among others, have revealed atmospheric the data flooding in. They have two more weeks to do so before presenting their findings so far — on topics ranging from the hunt for surface volcanism to movies of the cloud tops — at a dedicated session in Beijing. "The COSPAR meeting will be the first time we've speculated about what we are seeing," says Svedhem. ■

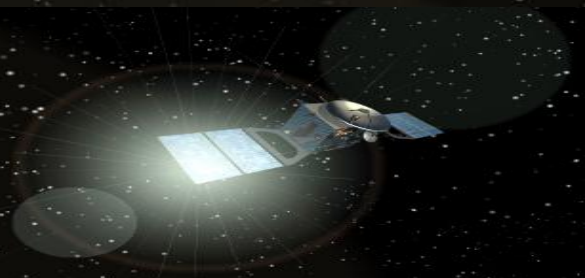
Jenny Hogan

News on Nature, July 2006

Venus by

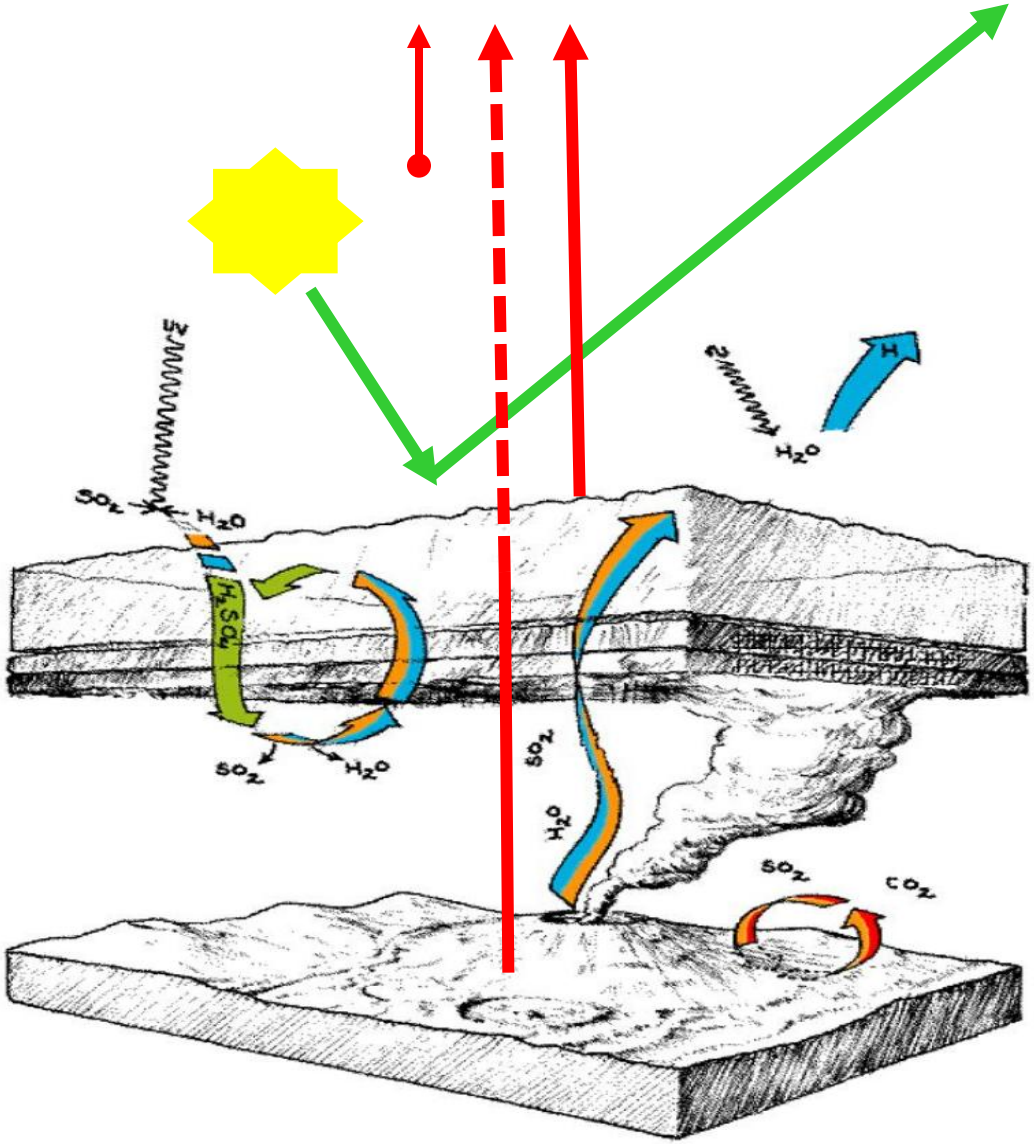
day and

night



Infrared Emission

Solar reflected light

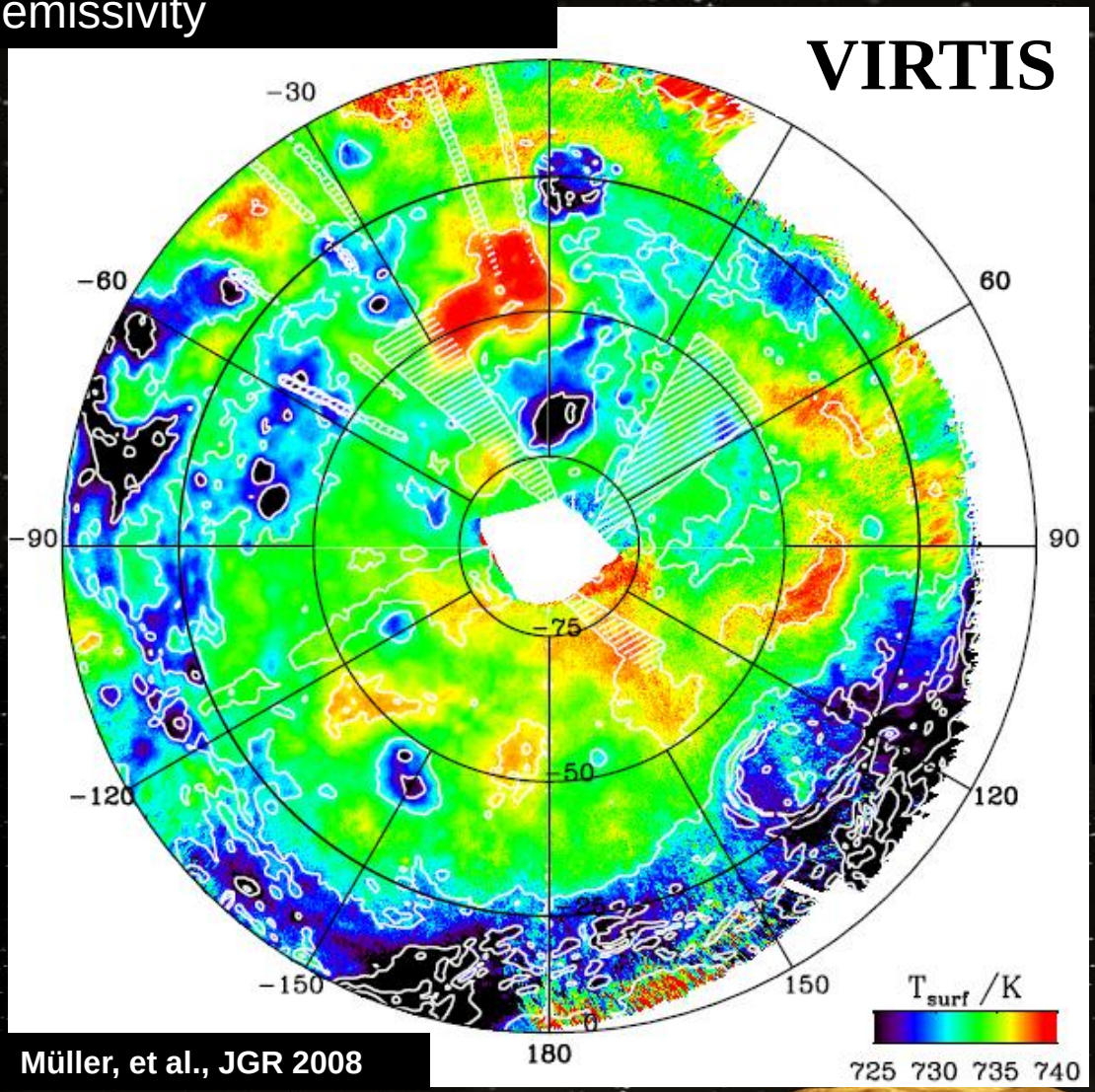


Mesospheric composition, dynamics, etc…

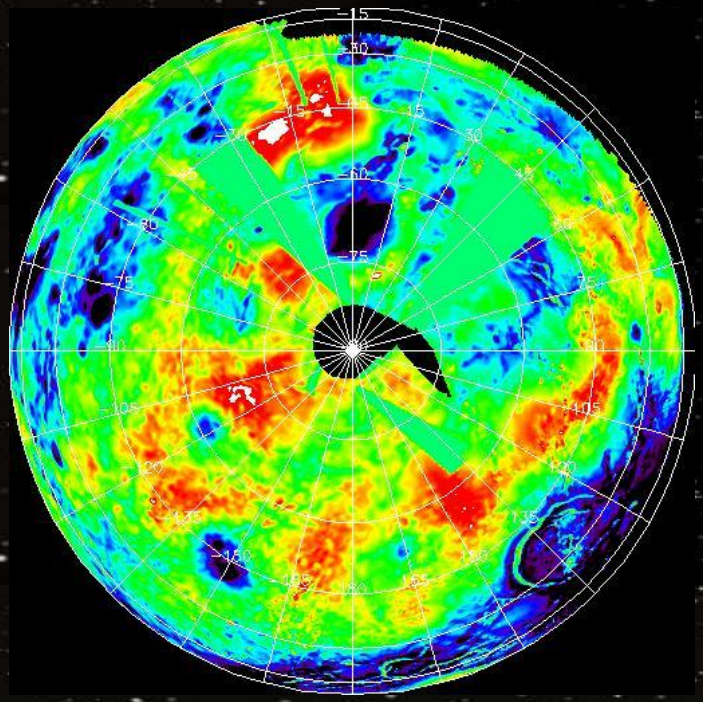
Surface, lower clouds composition, dynamics, temperature structure, airglows, etc…

Mapping the surface of Venus – Surface brightness temperature

... assuming constant emissivity



Müller, et al., JGR 2008



725 K — 745 K

Syntetic thermal map from Magellan data (GTDR)

Idunn Mons

Lat -46°

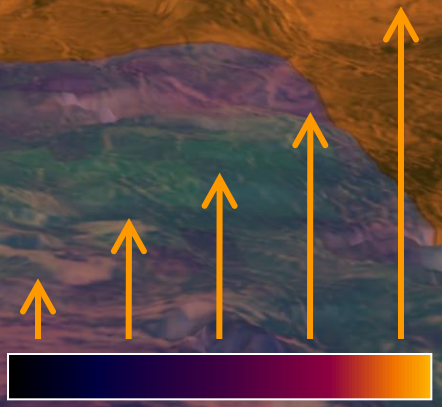
Long 214.5°

Radar image

VIRTIS image

Link movie

Thermal radiation

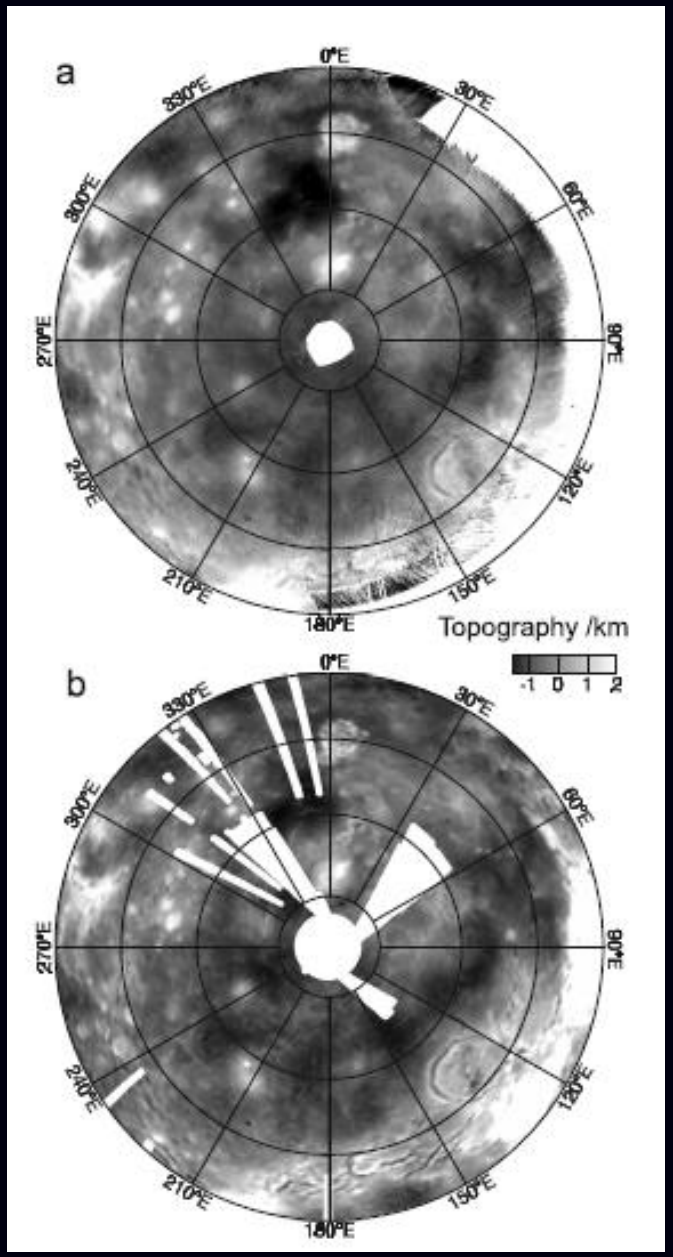


Emissivity

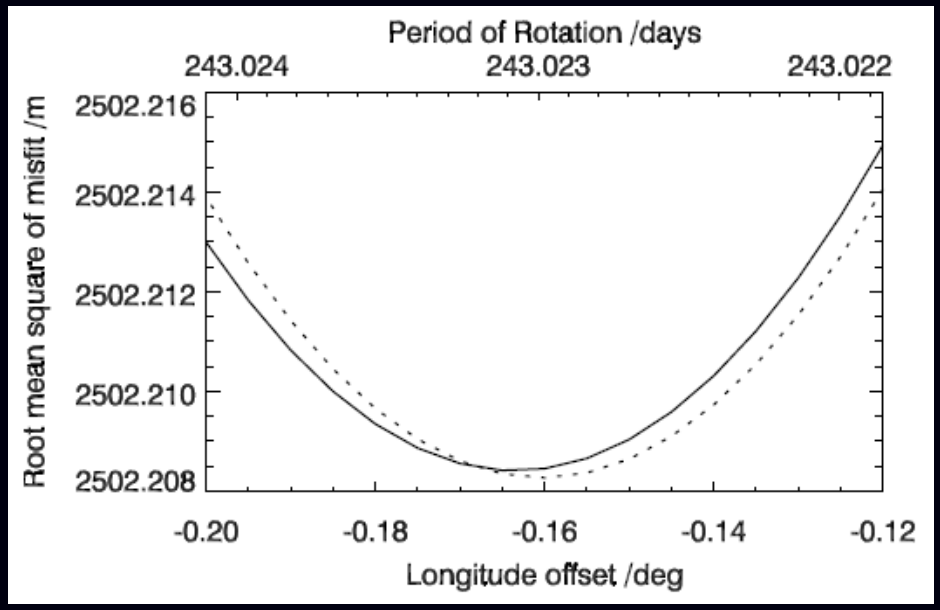
Weathering processes

time

"Fresh" lava, darker in IR, higher emissivity



VIRTIS derived altimetry



VIRTIS gives evidence to the orientation of Venus between 2006 and 2008; Magellan mission provided a global altimetry data set recorded between 1990 and 1992.

Magellan altimetry

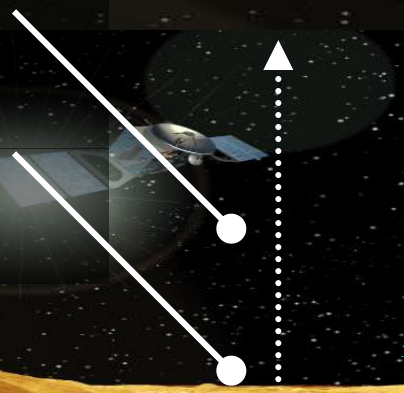
Comparison of the two data sets reveals a deviation in longitude indicating a rotation of the planet not fully described by the body fixed coordinate system

A revised period of rotation of Venus of **243.023 ± *0.001* *days*** is significantly different from the value of **243.0185 ± *0.0001*** recommended by IAU

Mueller et al.

“Typical” composition below the clouds

Molecule (ppmv)	Lat 0° - 20°		Lat 60°
CO (36km)	24±3	<	31±3
OCS (33km)	4±1	>	2.5±1
SO_2 (35km)	130±50	=	130±50
H_2O (35km)	31±2	=	31±2
H_2O (0-15km)	44±9	=	44±9

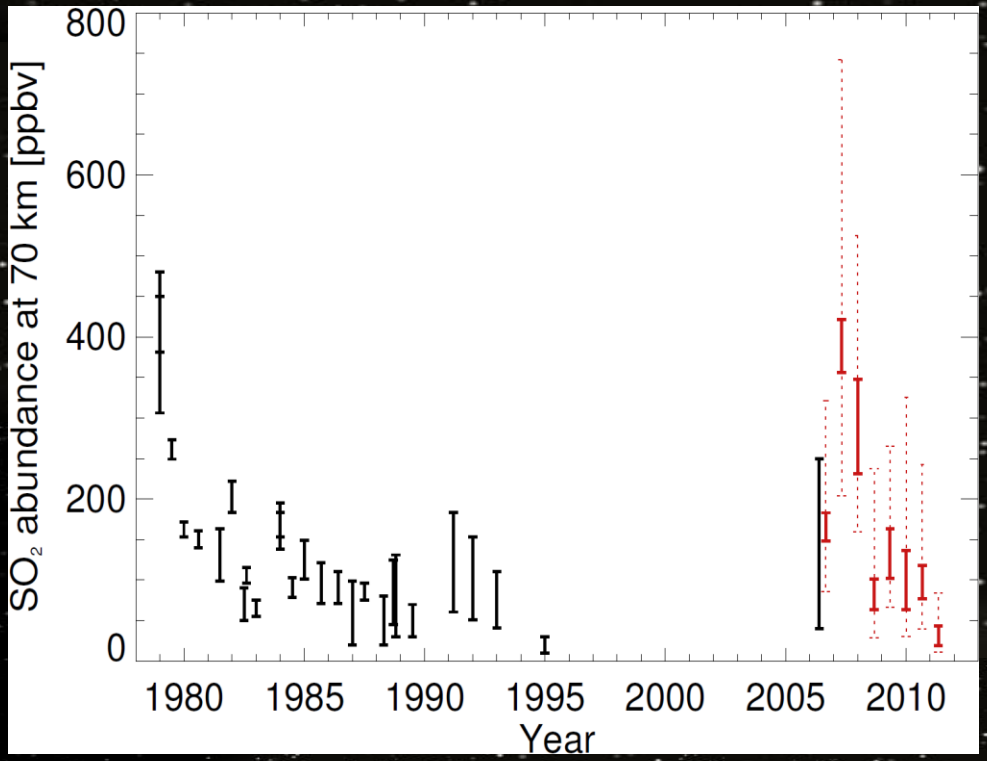


E. Marcq et al., JGR 2009

B. Bezard et al., JGR 2009

→

Mesospheric SO_2 changes

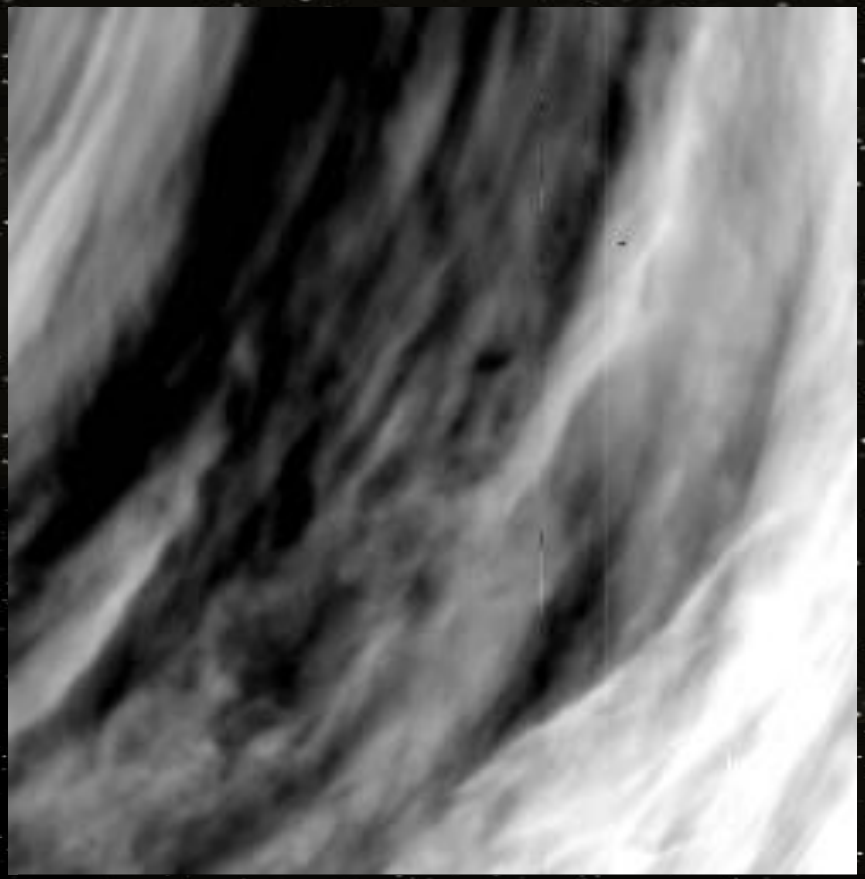


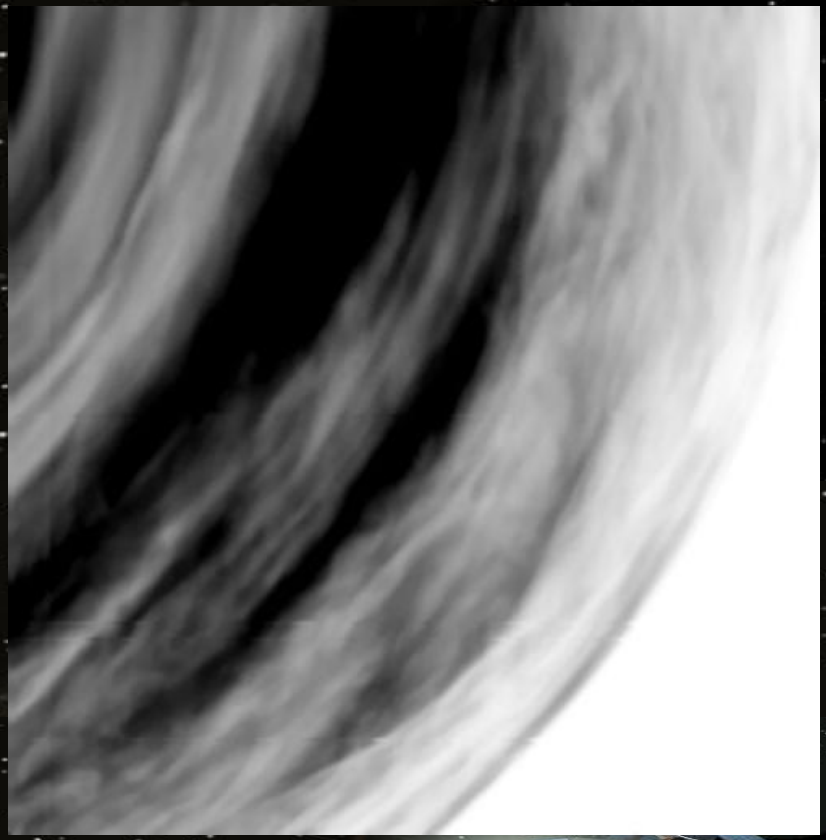
Venus Express shows episodic injection of SO_2 into mesosphere.

Is this connected with volcanic activity (like Pinatubo) ?

Or is it simply atmospheric variability ?

Superrotation and convective cells

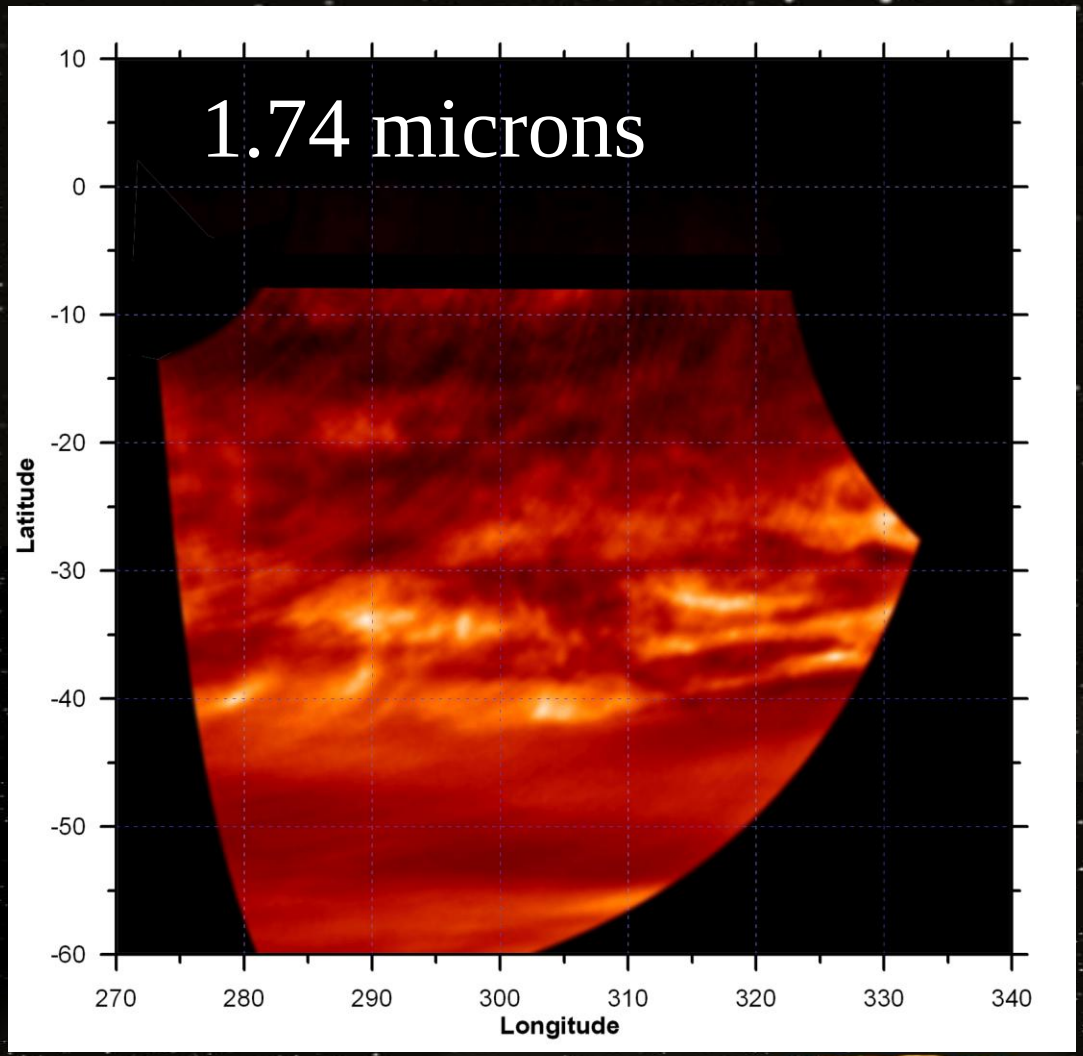




Orbit 157, Night side @ 1.7 μm

Slant distance from 65000 to 37000 km

The super-rotation: fast atmospheric motion in a slow rotating planet !

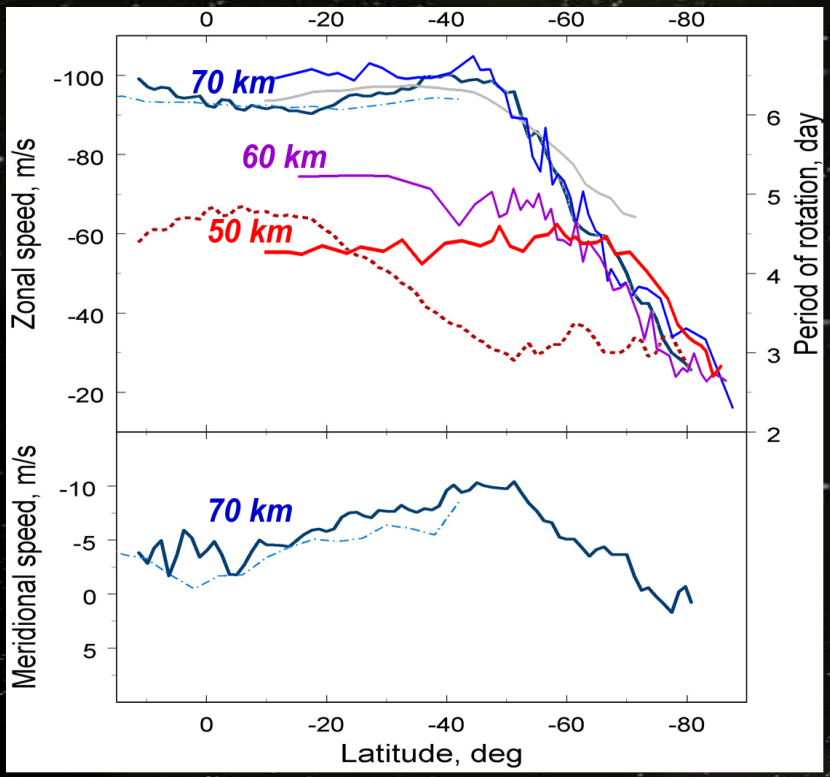


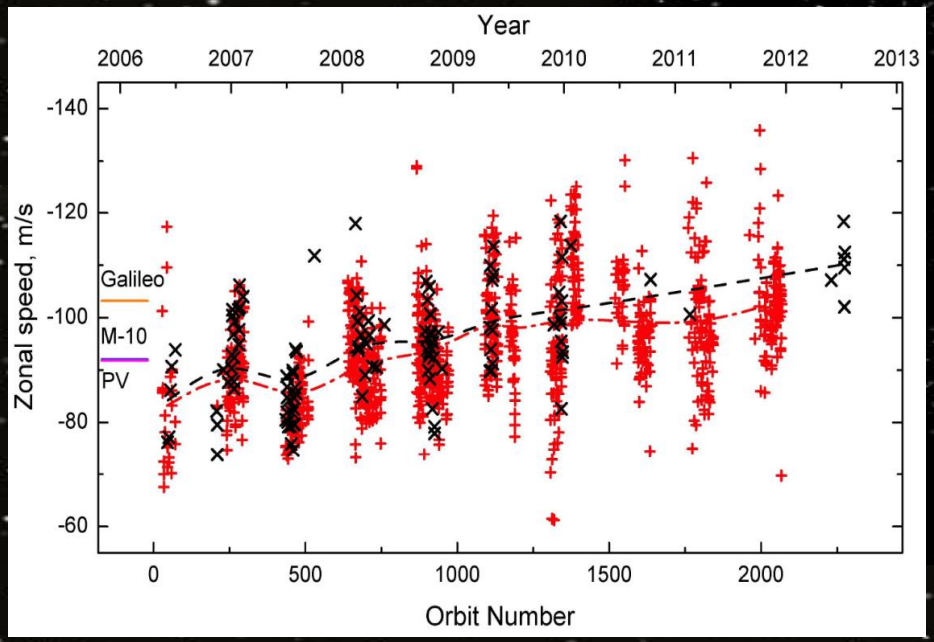
The atmosphere is up to **60 times** faster than the solid body rotation

Examples of wind measurements in the equatorial region:

200 km/h at 50km altitude

Changing winds at cloud level



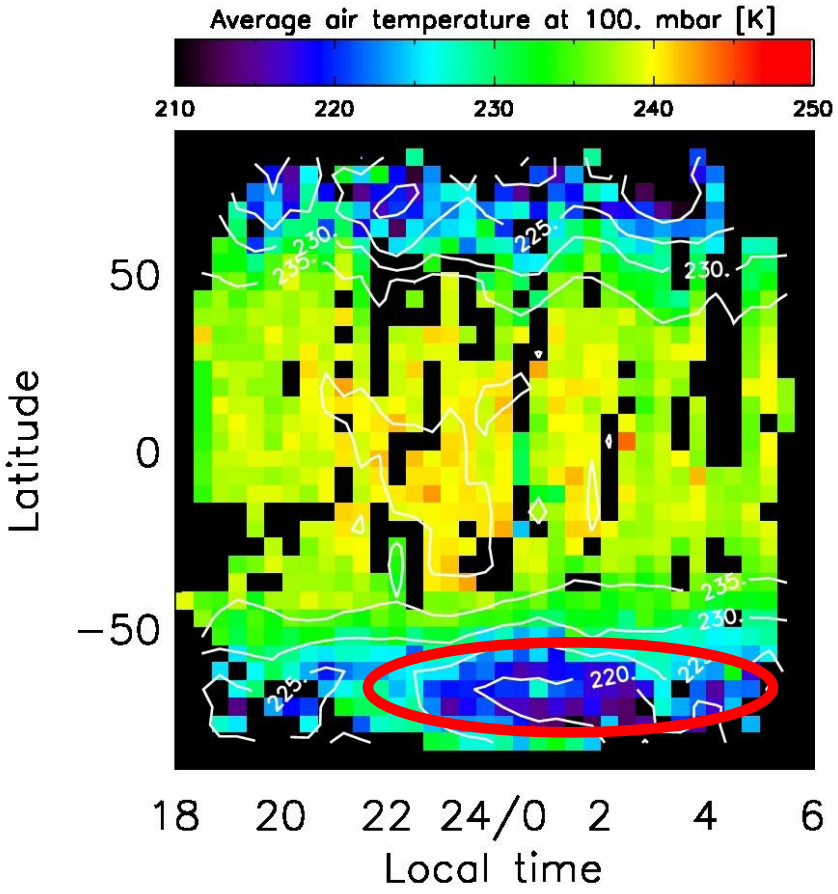


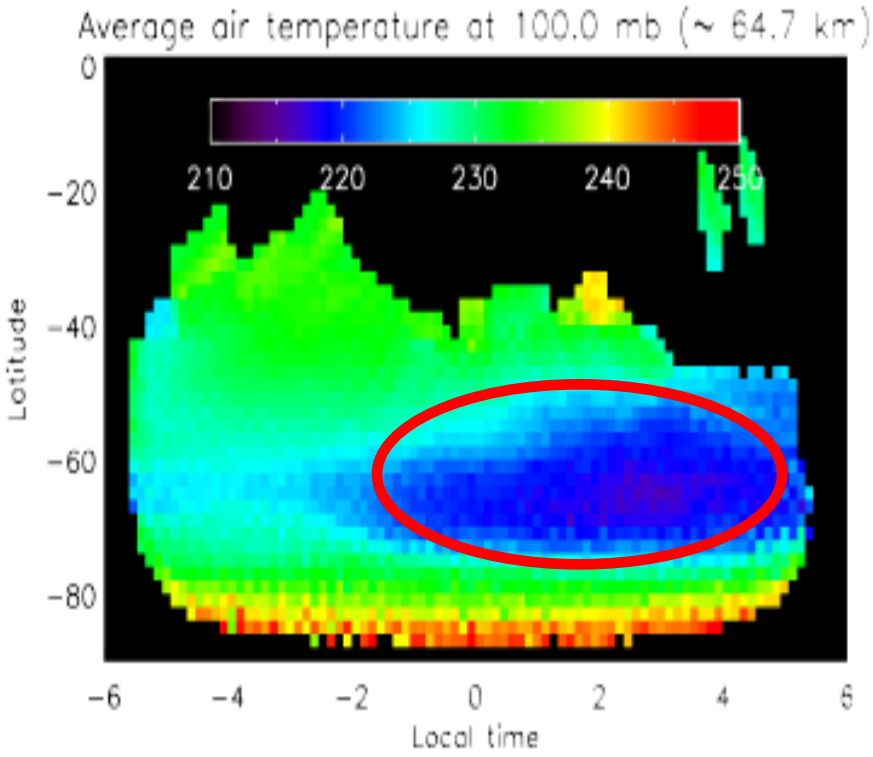
Venus Express provided the first ever 3-D determination of winds at different altitudes on Venus.

Now VEX reveals dramatic 30% increase in super-rotation rate over 6 years.

Khatuntsev et al., Sanches-Lavega et al.

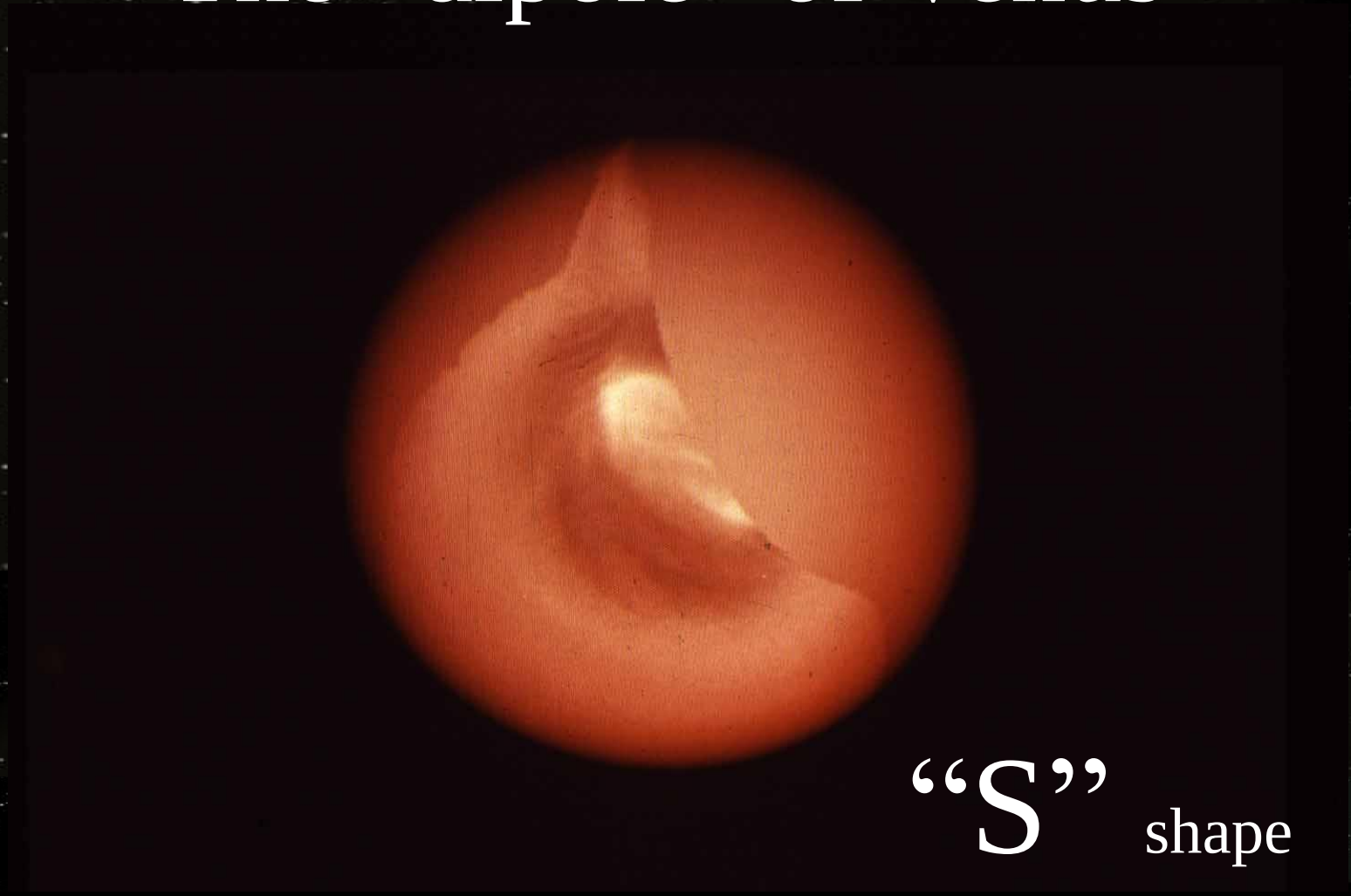
3-D Atmospheric thermal structure





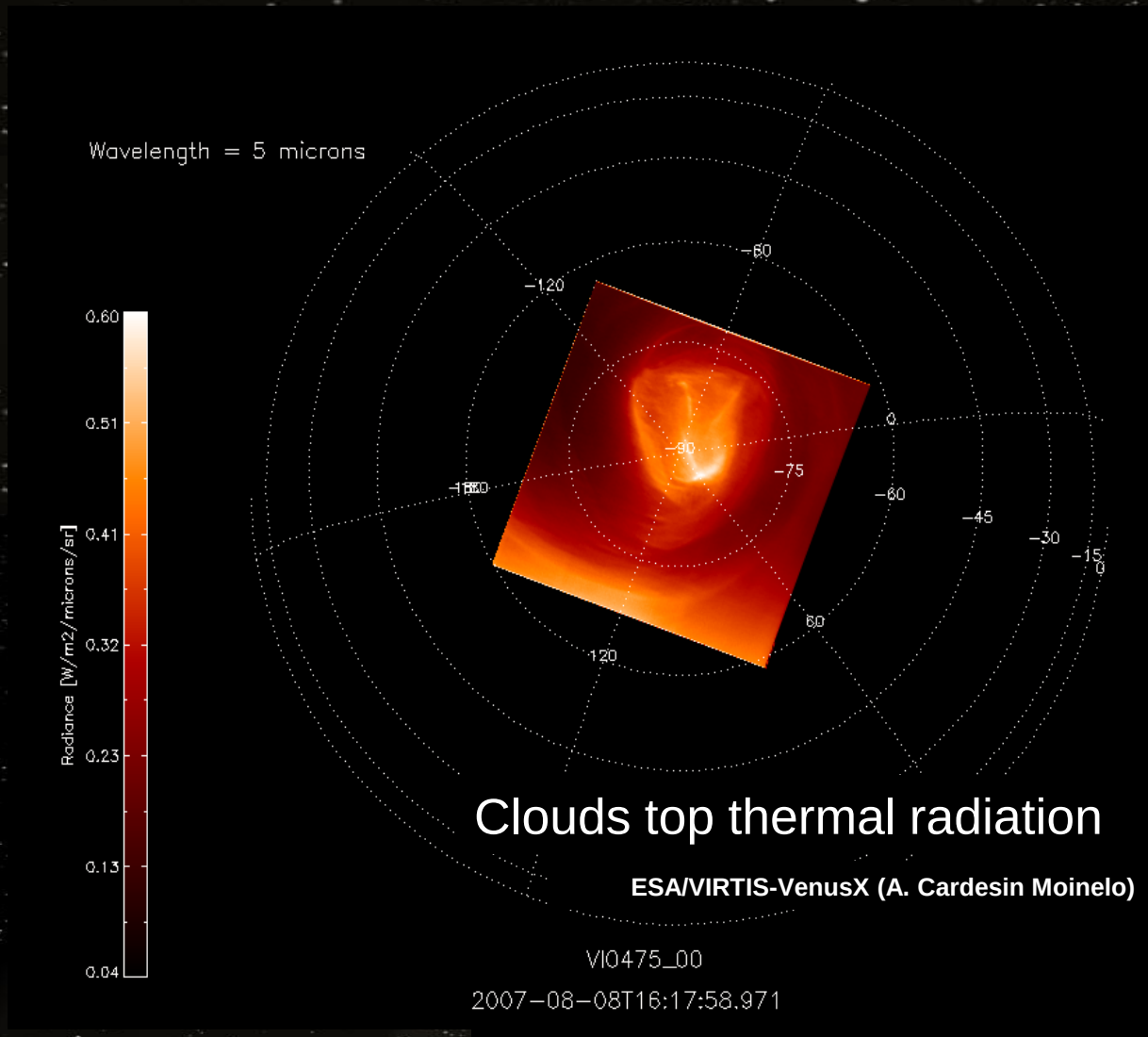
D. Grassi et al.,
A. Migliorini et al., 2012

The “dipole” of Venus



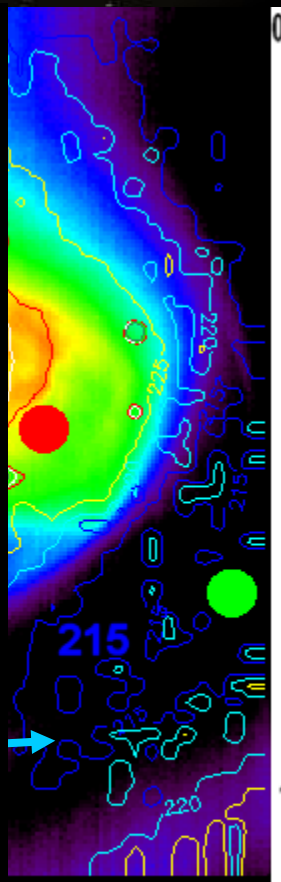
Observations from Pioneer Venus (1980). F. Taylor et al, JGR
North Polar Vortex at 15 microns

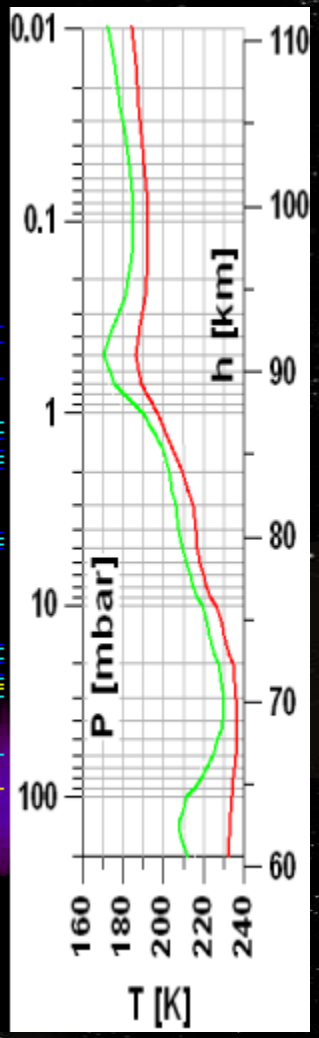
The thermal structure of the vortex



Clouds top thermal radiation

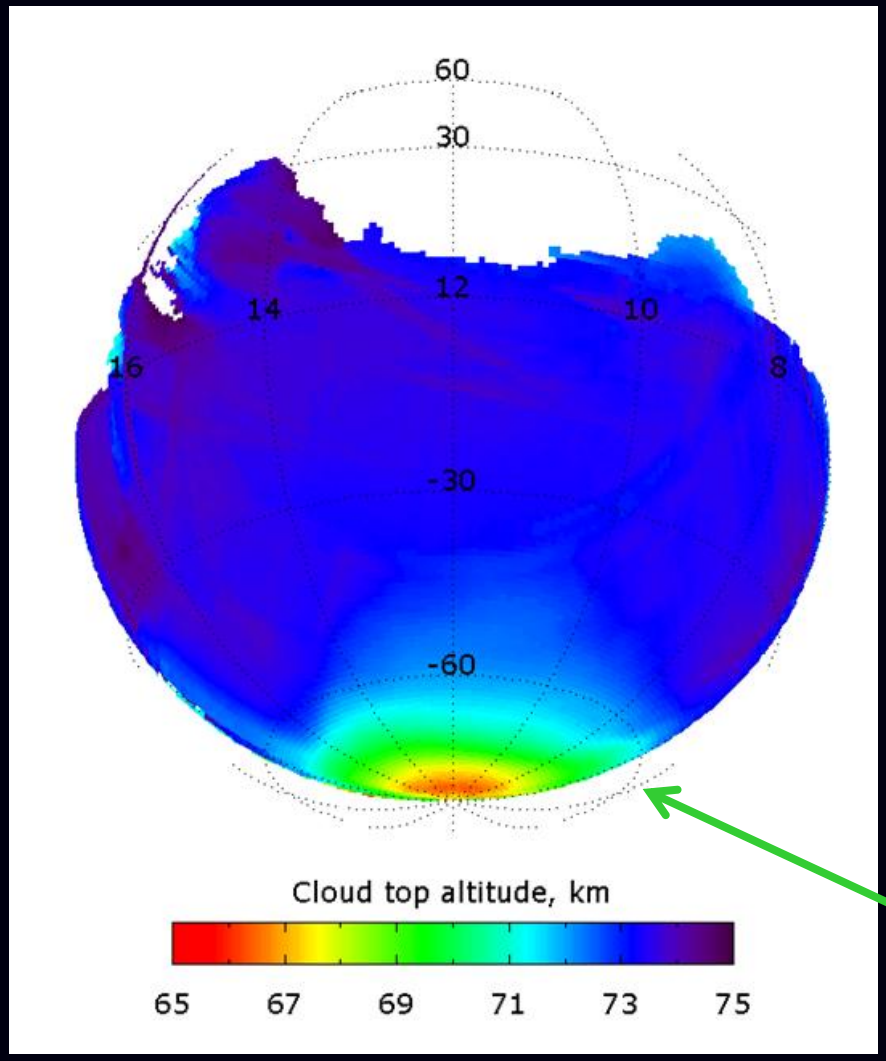
ESA/VIRTIS-VenusX (A. Cardesin Moinelo)





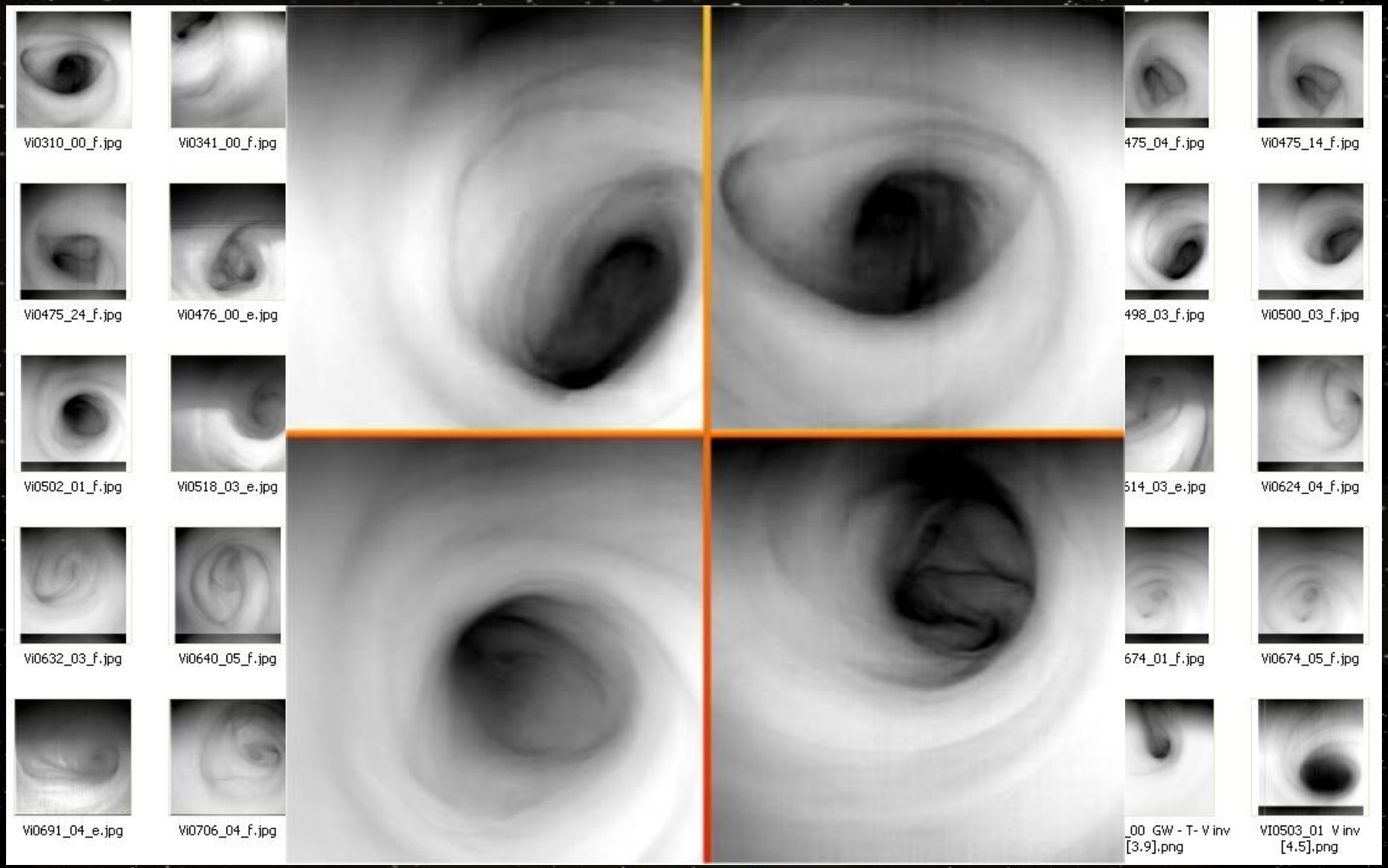
07

Clouds top altimetry



Large depression in the polar region

The many many faces of the vortex

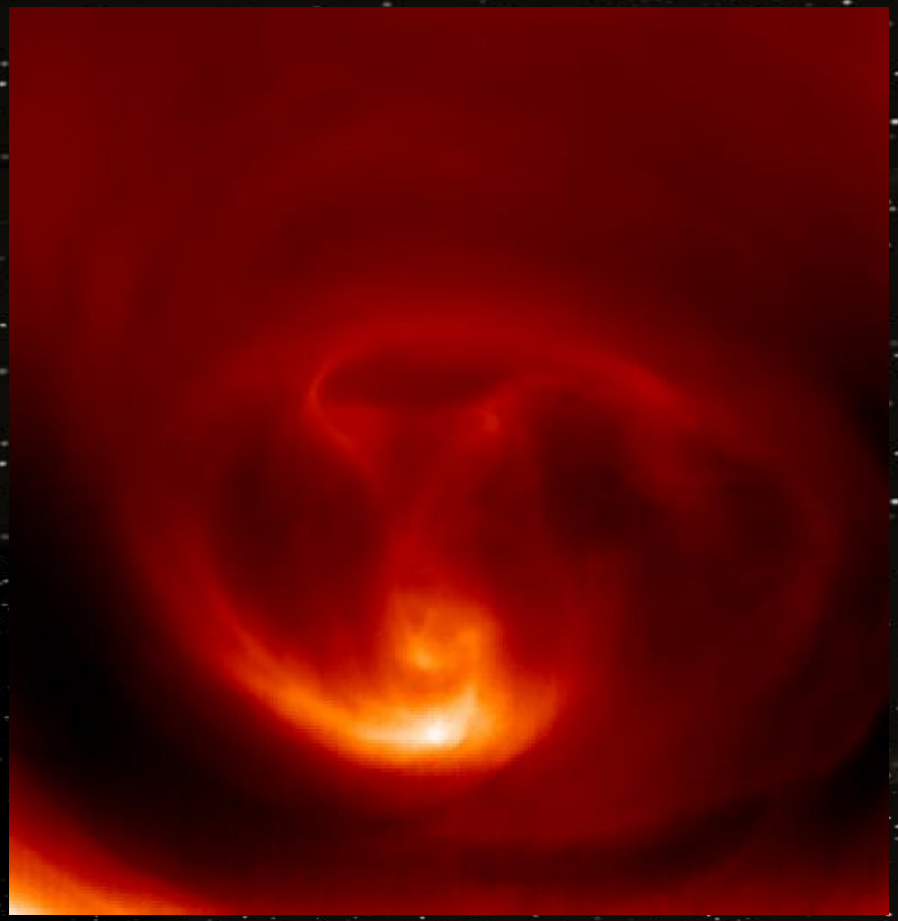


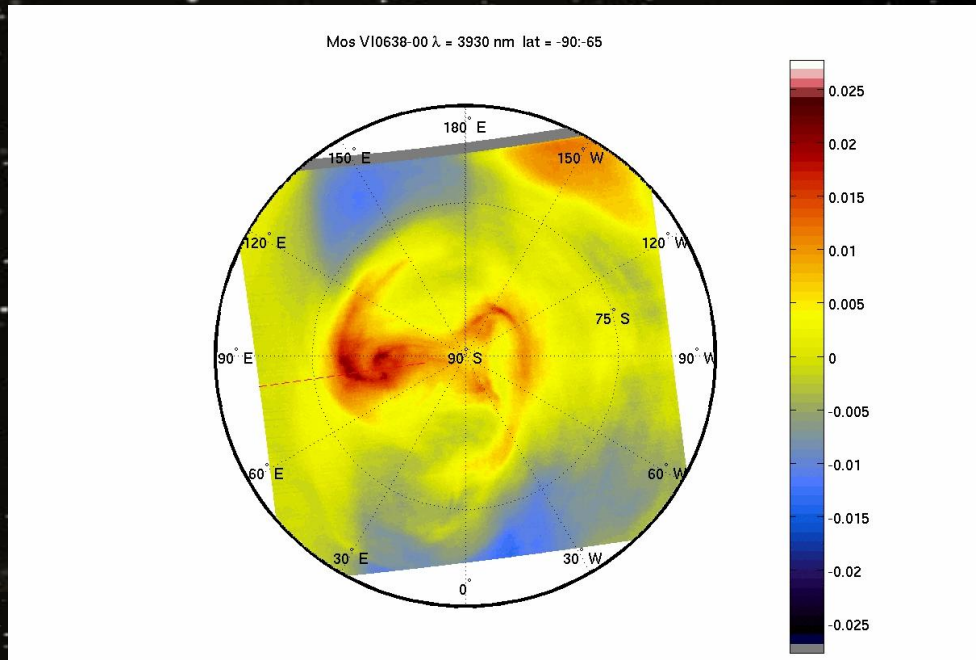
Astronomy Picture of the Day (2010 September 28) http://apod.nasa.gov/apod/ap100928.html

3-pole or 4-pole !!!

5.2 micron

(about 65 km)

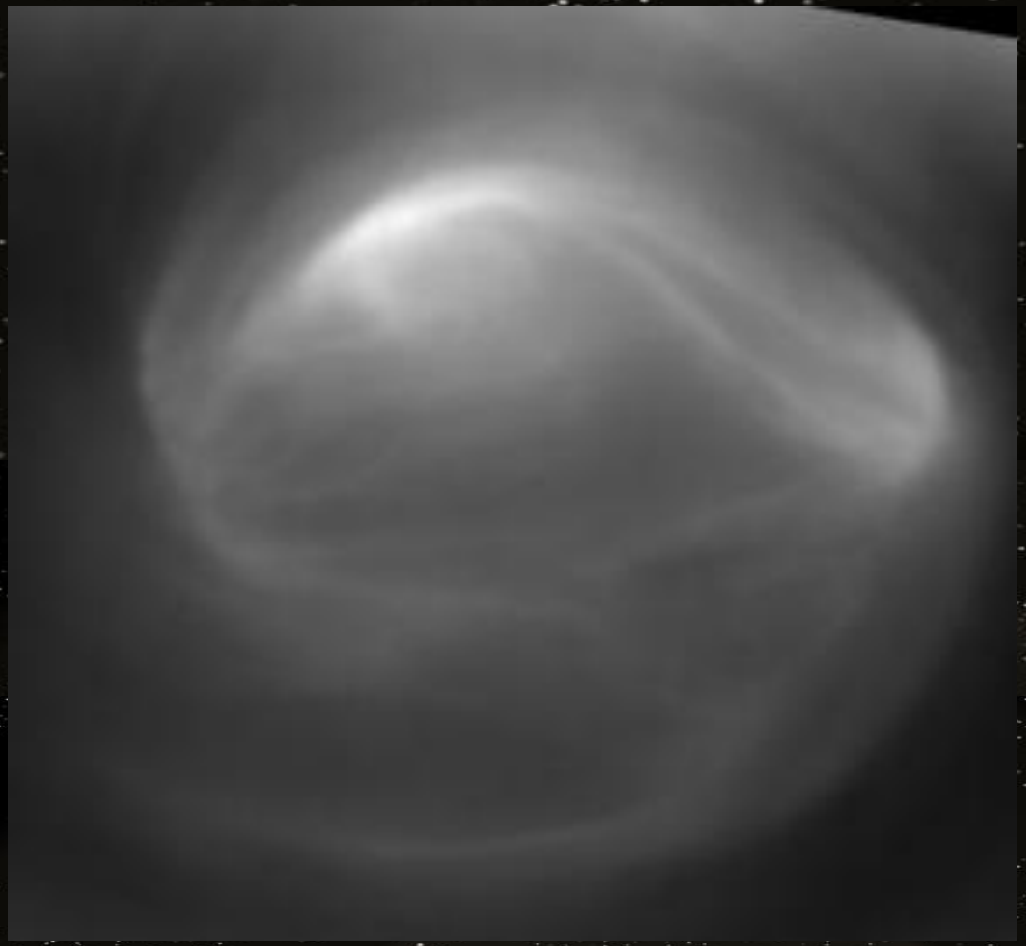


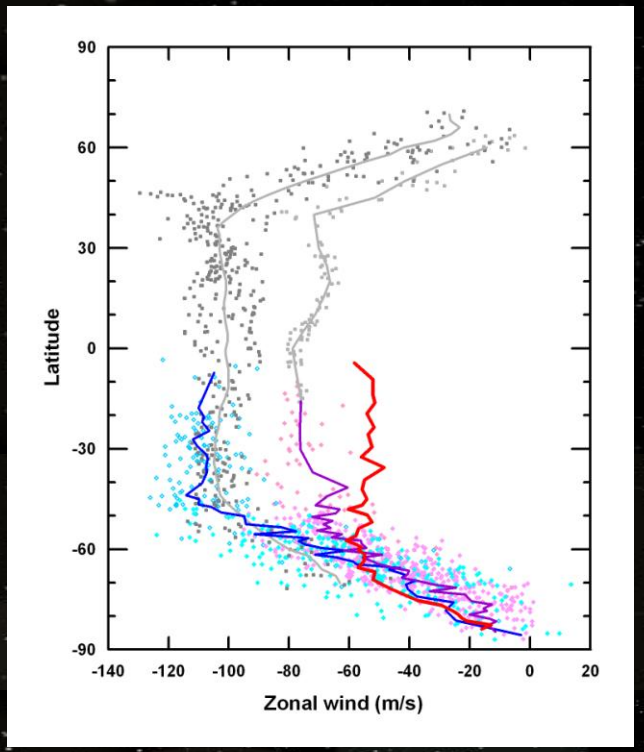


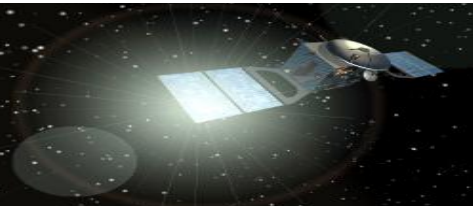
START_TIME = 2008-01-18T17:12:13.719

STOP_TIME = 2008-01-18T17:24:35.740

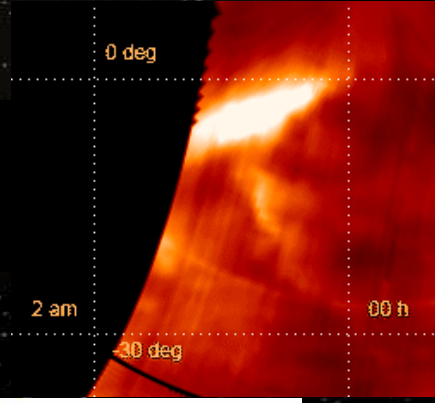
The unexpected complexity of the dynamics within the polar vortex



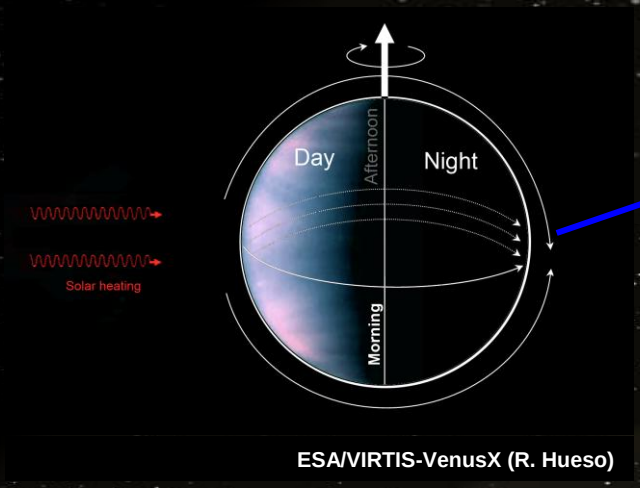




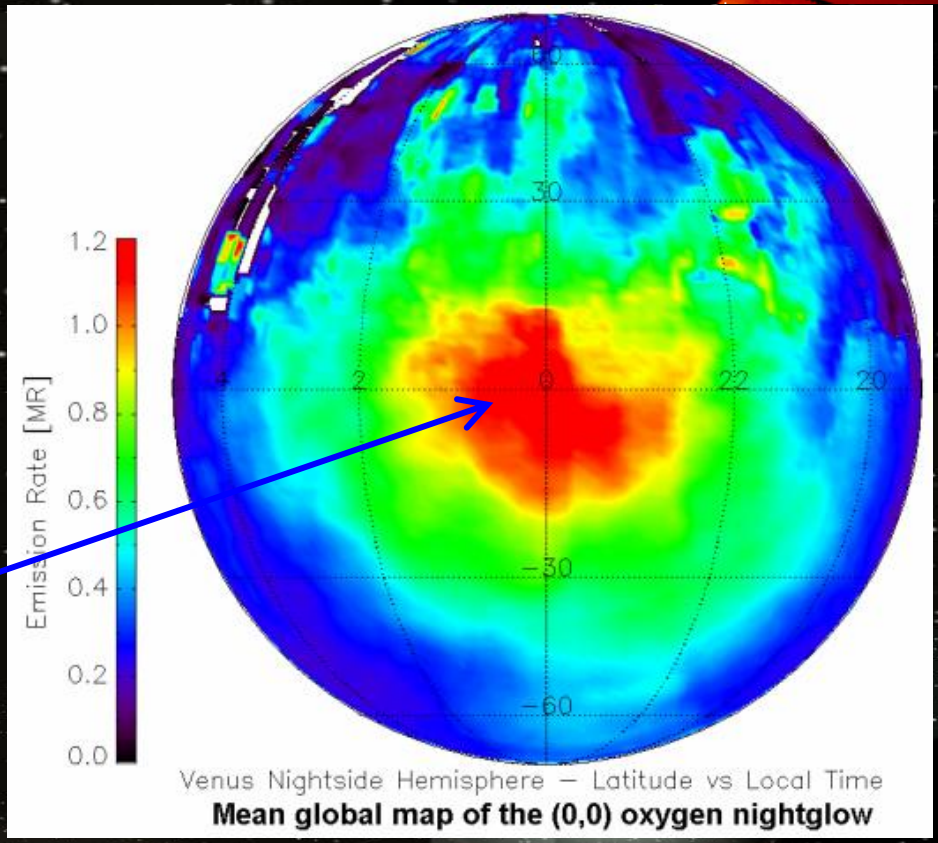
Global O_2 airglow averaged over 880 orbits (4 venusian years)



Peak emission is on the Anti-Solar point

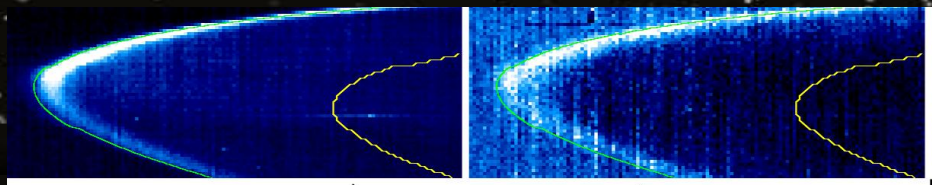


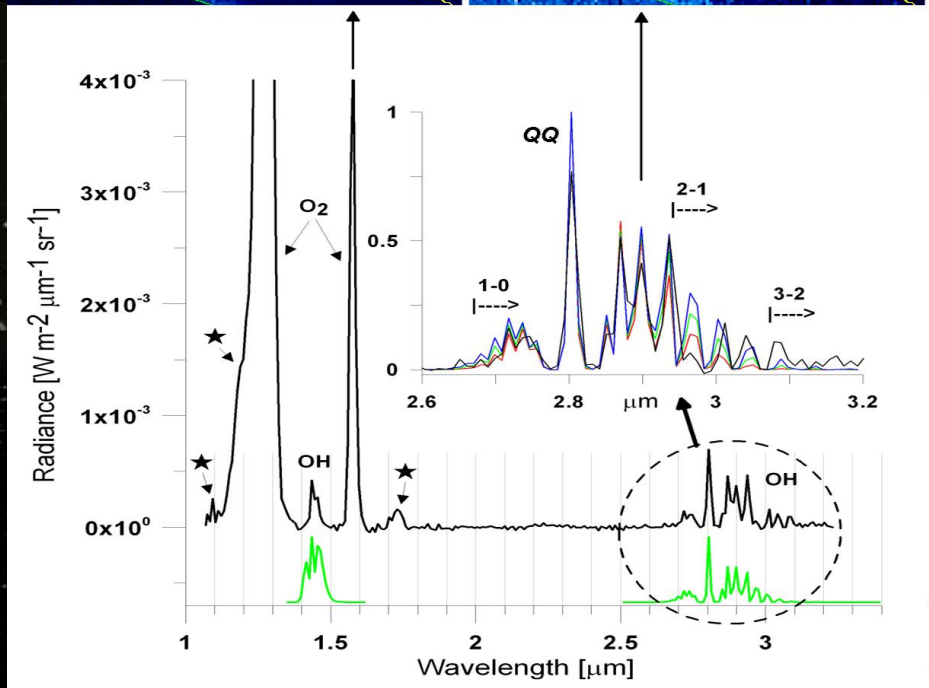
ESA/VIRTIS-VenusX (R. Hueso)

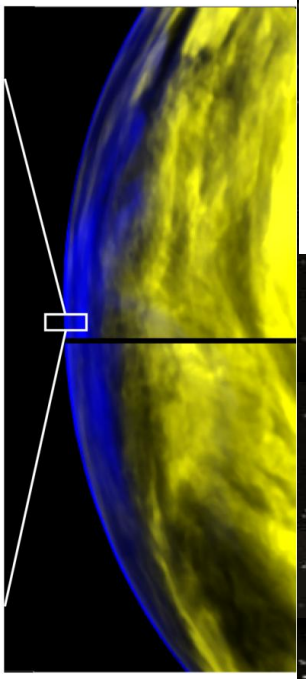


Piccioni G. et al., JGR 2009

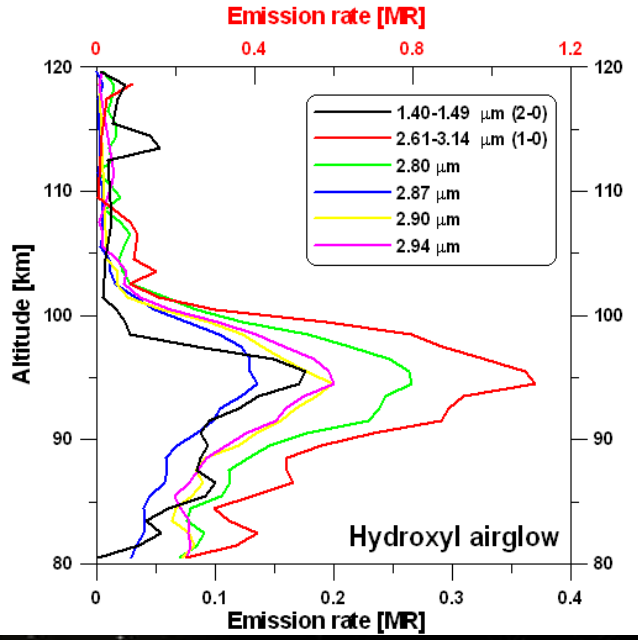
First detection of Hydroxyl







G. Piccioni et al., A&A 2008



Averaged spectra from 90 to 100 km

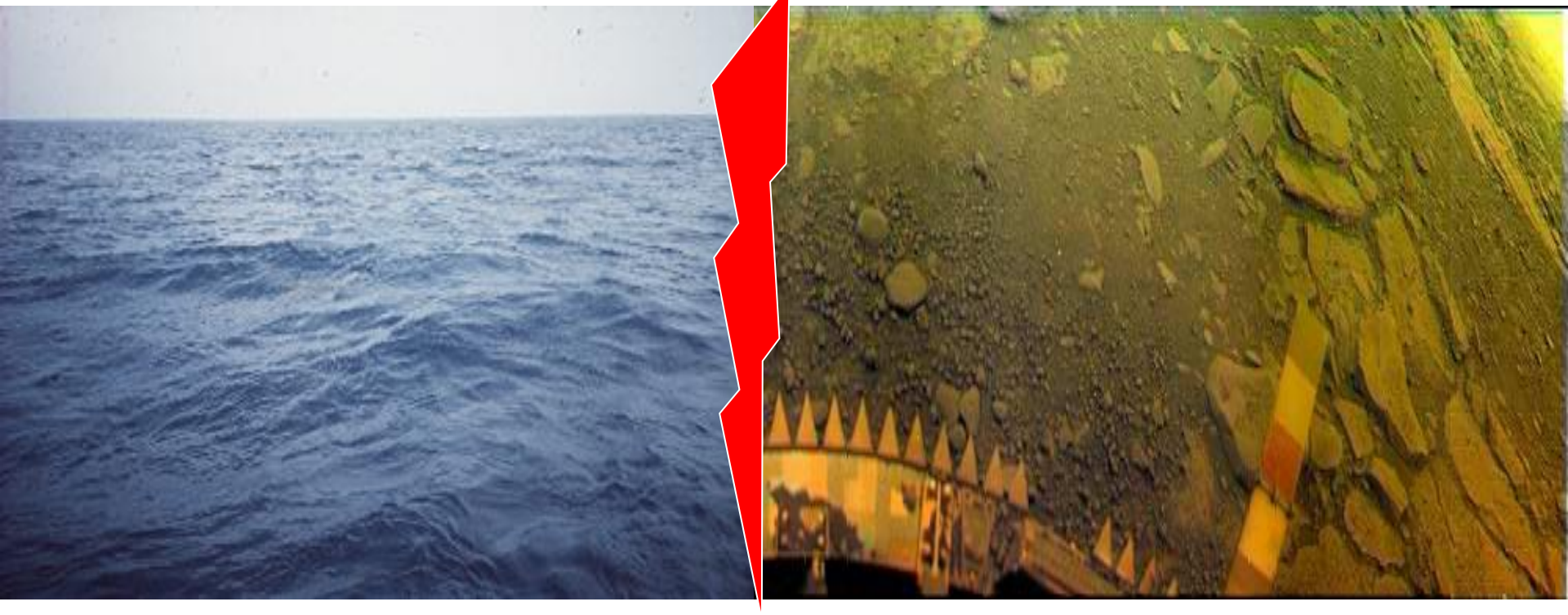
Green = syntetic spectrum

Black = measured

First indirect evidence of Ozone (later directly detected)

Effetto serra e perdita degli oceani di Venere

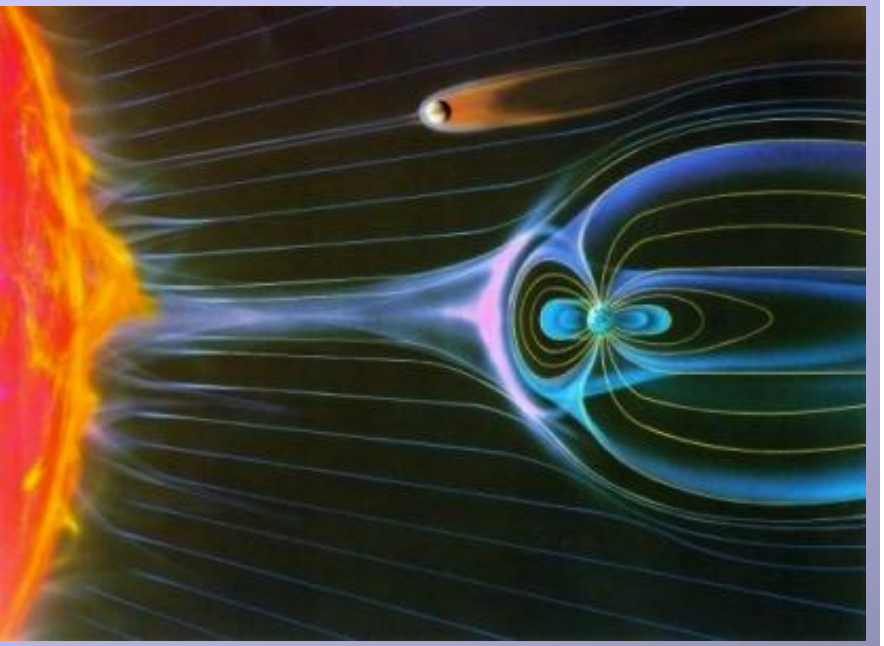
(Prima grande transizione, circa 4 miliardi di anni fa)



- Simile quantità d'acqua come la Terra all'origine
- Acqua odierna: H_2O_{VENERE} ~ 100,000 volte meno abbondante dell'H_2O_{TERRA}

Plasma environment and escape processes

Water: lost in space



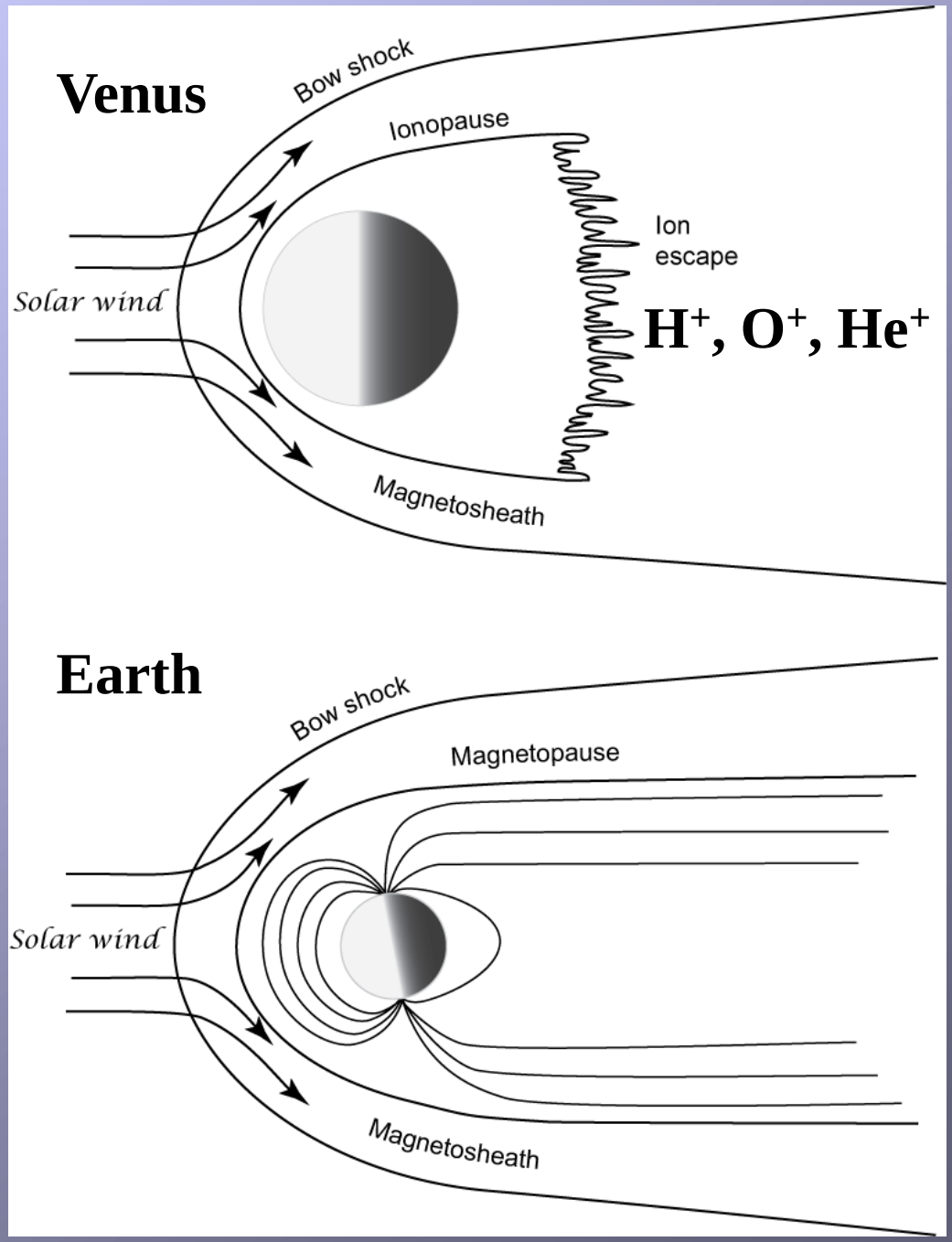
Escape rates during low solar activity:

QH^+ 7.1 10^{24} s^{-1}

QO^+ 2.7 10^{24} s^{-1}

QHe^+ 7.9 10^{22} s^{-1}

$QH^+ / QO^+ = 2.6$



Scientific impact of the mission to date

- More than 300 refereed articles, special issues of JGR (double), PSS (four issues), Nature (special section) and Icarus. An ISSI book is in print. A comprehensive reference book, Venus III, is being planned.
- A world wide revival in the interest in Venus. All major science conferences now include at least one session for Venus. As an example, the upcoming AGU meeting has 45 talks/posters on Venus.
- The community of ground based telescopic observers joined in a combined observation campaign 2007, which resulted in a special issue of PSS with 13 articles. Additional campaigns have taken place yearly since 2009.
- VEX members participated in proposals for NASA New Frontiers (SAGE) and Discovery (seven Venus proposals) programmes.