Temperature structure of Venus nightside with VIRTIS/Venus Express

Migliorini, A.[1], Grassi, D.[1], Lebonnois, S.[2], Montabone, L.[2,3], Drossart, P.[4], Piccioni, G.[1]

[1] INAF, via del Fosso del Cavaliere, 100, 00133, Rome, Italy
[2] Laboratoire de Meteorologie Dynamique, Jussieu, Box 99 75252 Paris, France
[3] AOPP, Dept. of Physics, University of Oxford, Parks Road, Oxford OX14PU, UK
[4] LESIA, 5, place Jules Janssen, 92195 Meudon, Paris, France

The Third Moscow Solar System Symposium - 8-12 October 2012

Visible and Infrared Thermal Imaging Spectrometer (VIRTIS)

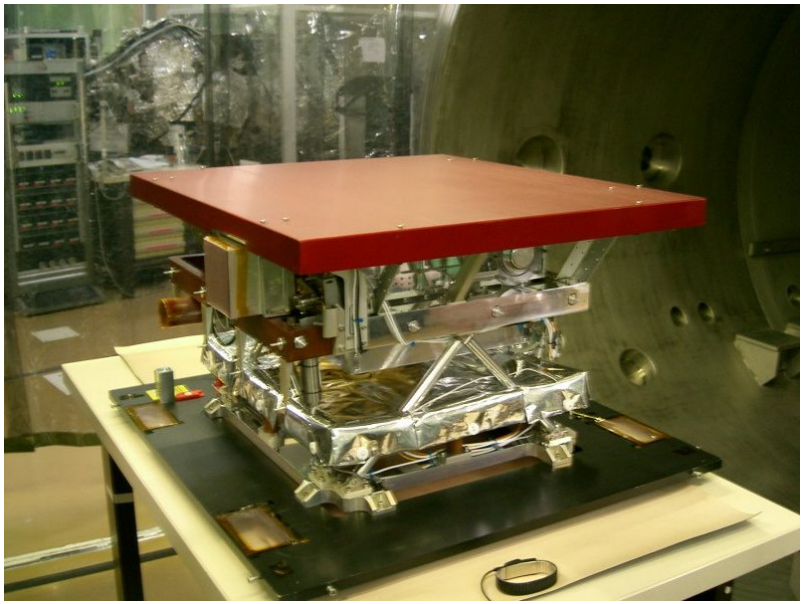
Mapping channel: M

Vis
spectral range: 0.25-1.0 μm
spectral sampling: 2 nm
spatial resolution: 0.25 mrad

IR
spectral range: 1-5 μm
spectral sampling: ~10 nm
spatial resolution: 0.25 mrad

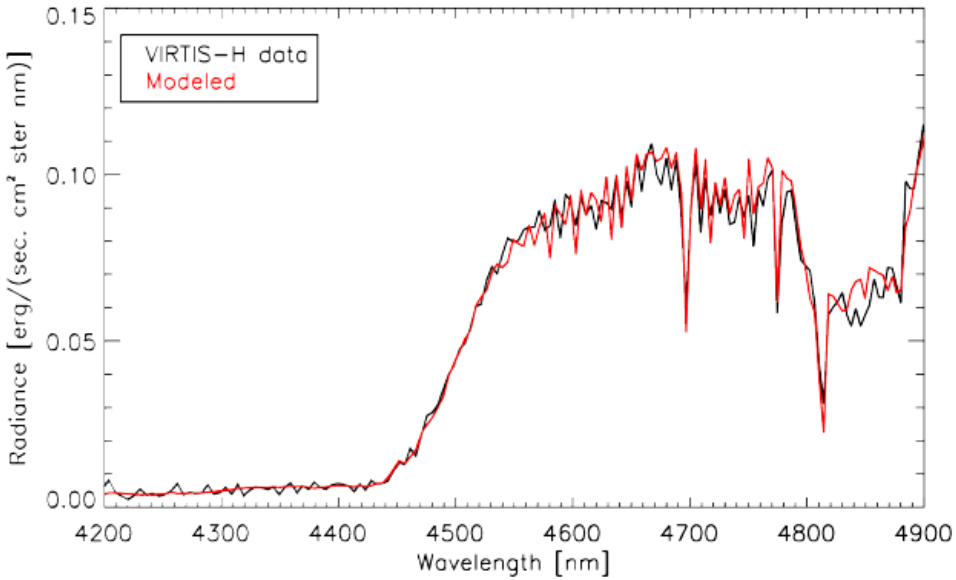
High resolution channel: H

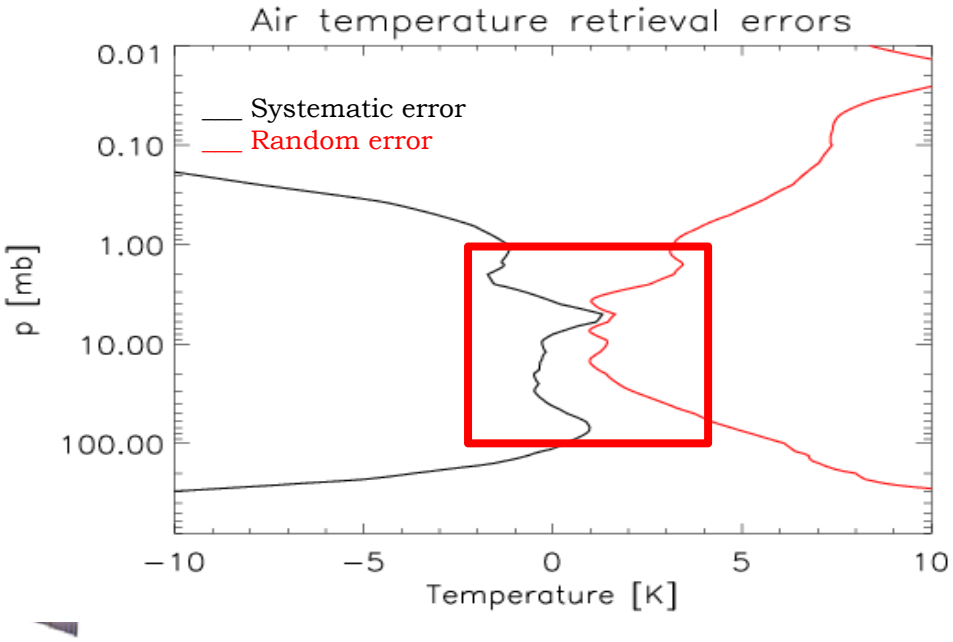
H
spectral range: 2-5 μm
spectral sampling: ~2 nm
spatial resolution: 1 mrad



Temperature retrieval method

The CO_2 band around 4.3 μm is used to investigate the atmospheric temperature in the night side of Venus, in the 100-1 mbar pressure range (approx 65-85 km), using a retrieval code based on the radiative transfer equation.





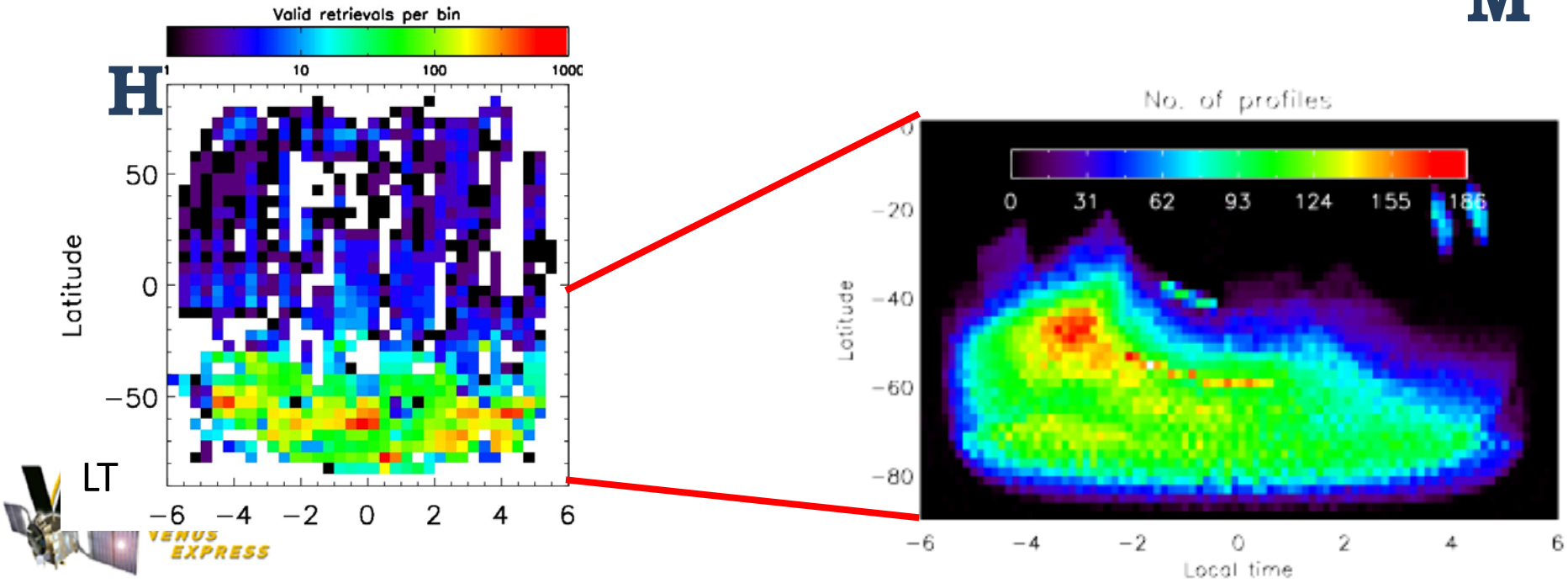
The total retrieval error on air temperature is within 4 K in the 1-100 mbar pressure range, as it is shown in the figure on the left.

Grassi et al., 2008

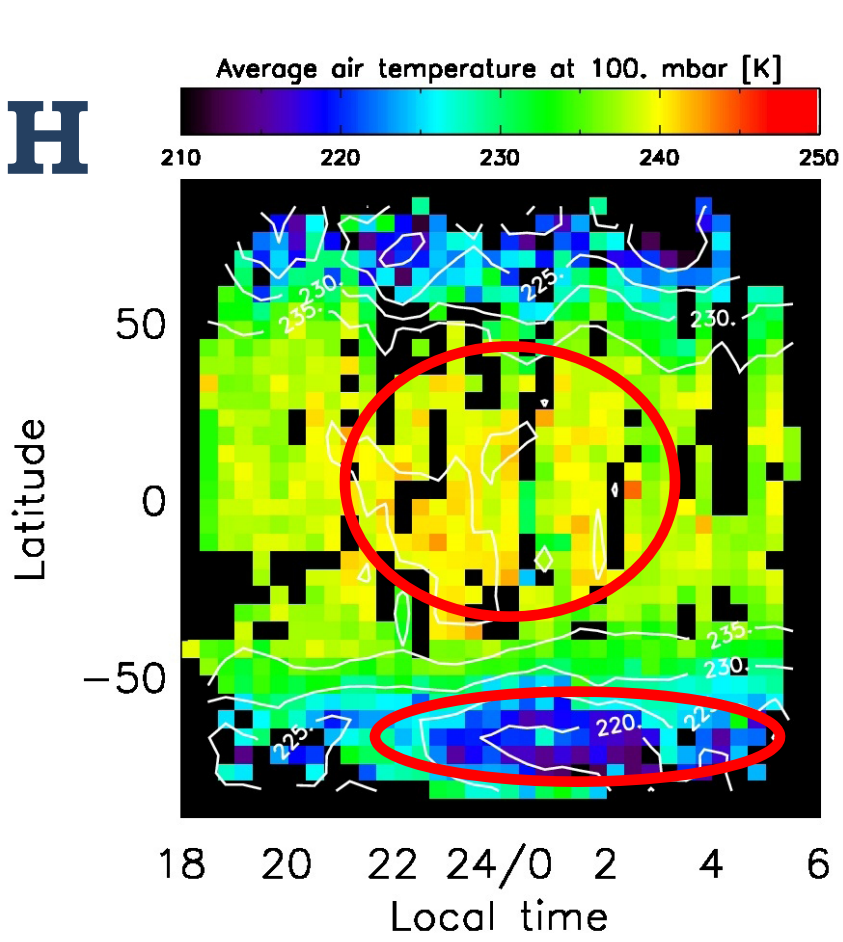
VIRTIS data and coverage

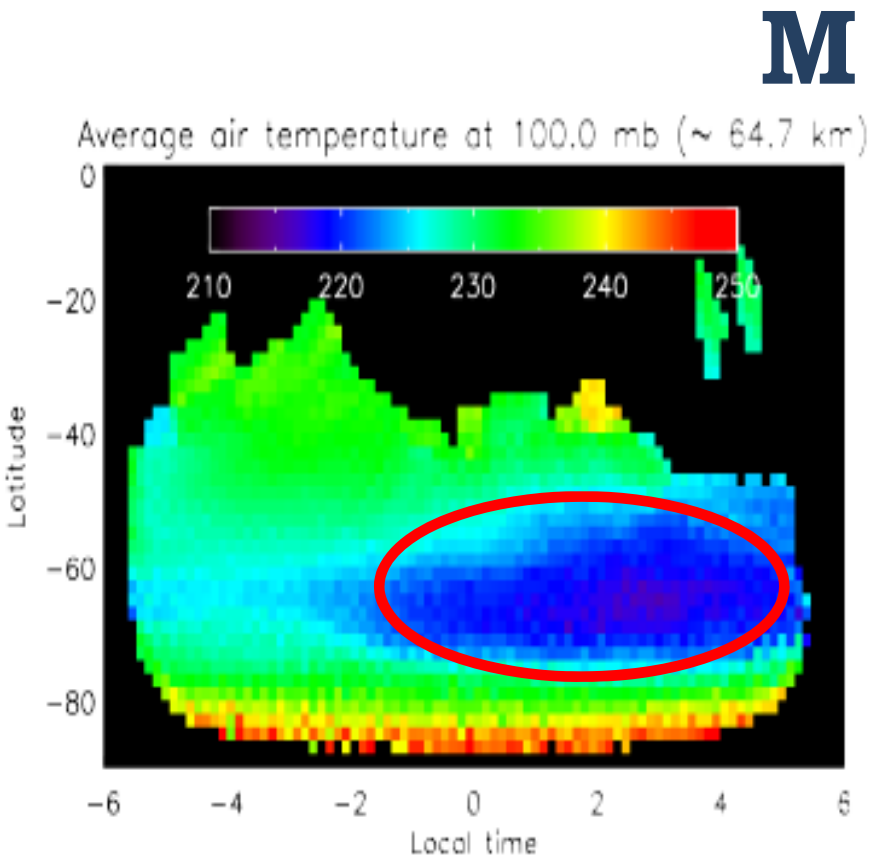
Data were selected both from the M and H channels of VIRTIS, the imaging spectrometer on board Venus Express.
After data filtering (we considered data with solar zenith angle lower than 95° and/or emergence angle greater than 30°), about **$1.48 \cdot 10^5$ individual retrievals** were included in the present analysis of the southern hemisphere with the M-channel, while about **$3 \cdot 10^4$ spectra** are used for the South and North hemisphere with the H-channel. Due to the orbit design, the southern hemisphere is better covered with the M-channel, as it is clear from the image below on the right.

M



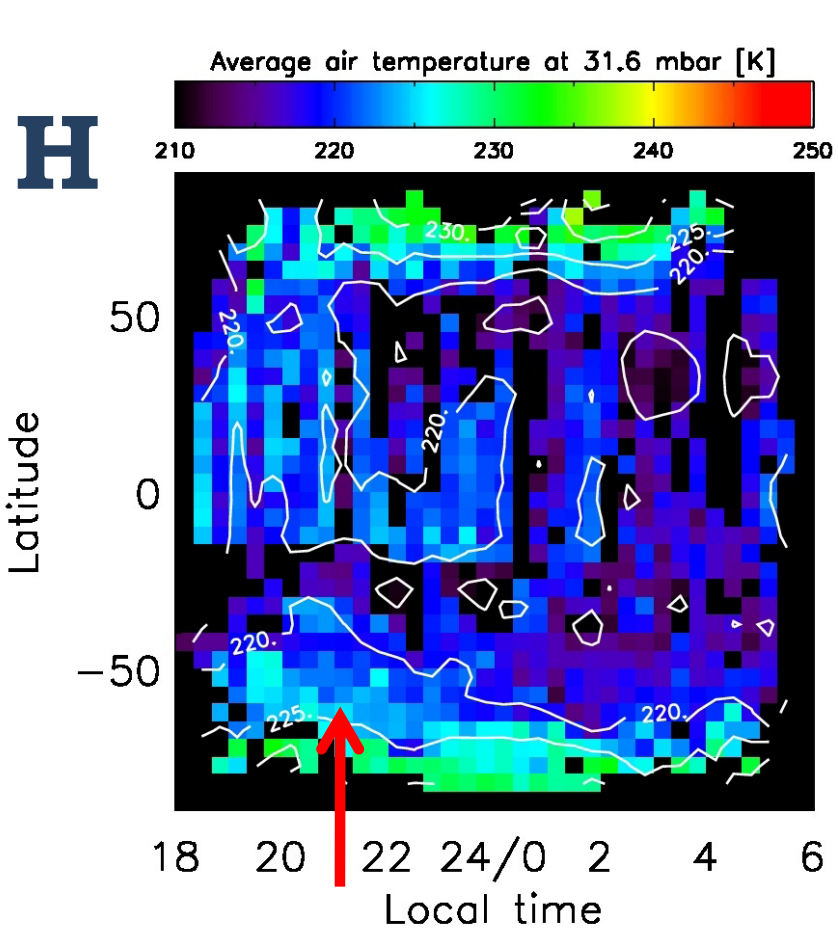
100 mbar (~65 km). The cold collar region is well evident at this pressure level. It is colder in the morning side, and also more pronounced on the southern hemisphere. An increase of temperature (about 240 K), observed in the antisolar point, is interpreted as an evidence of wavy activity.

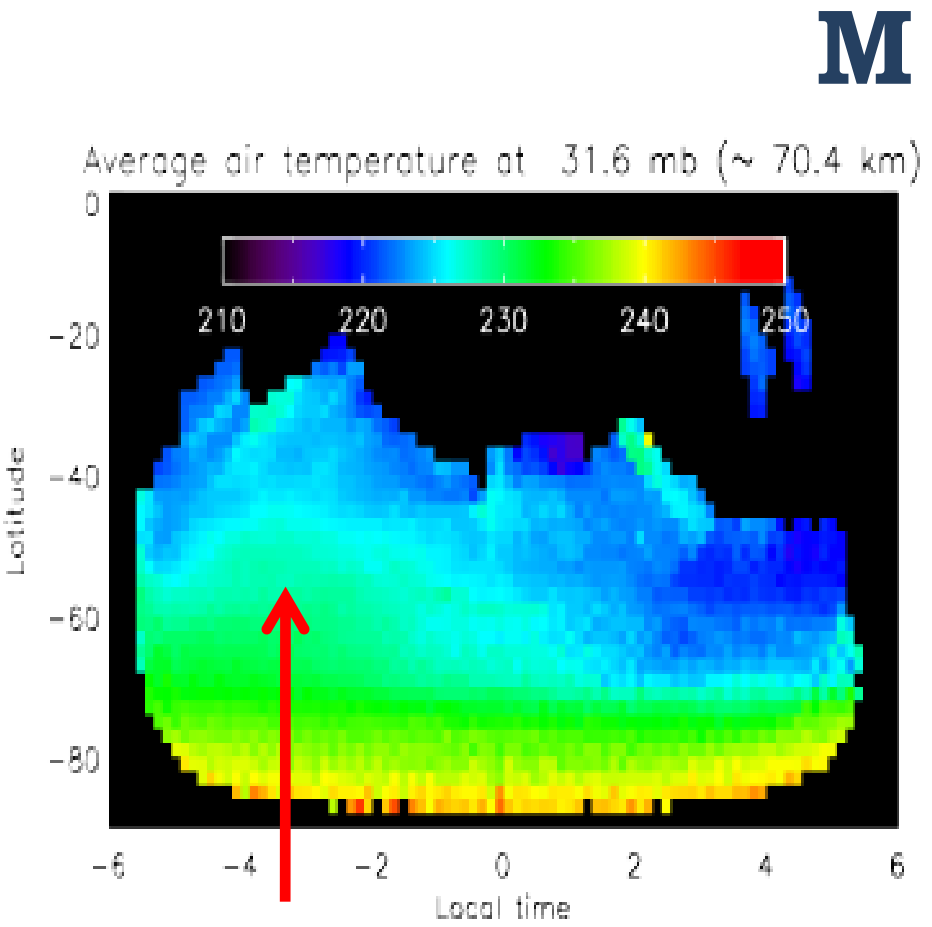




Migliorini et al., 2012

31.6 mbar (~70 km). At this level, the cold collar feature is no longer visible, although the morning side is still the coldest, and temperatures increase monotonically toward the pole. In the southern hemisphere, the 20-21 LT is the warmer time at most latitudes.

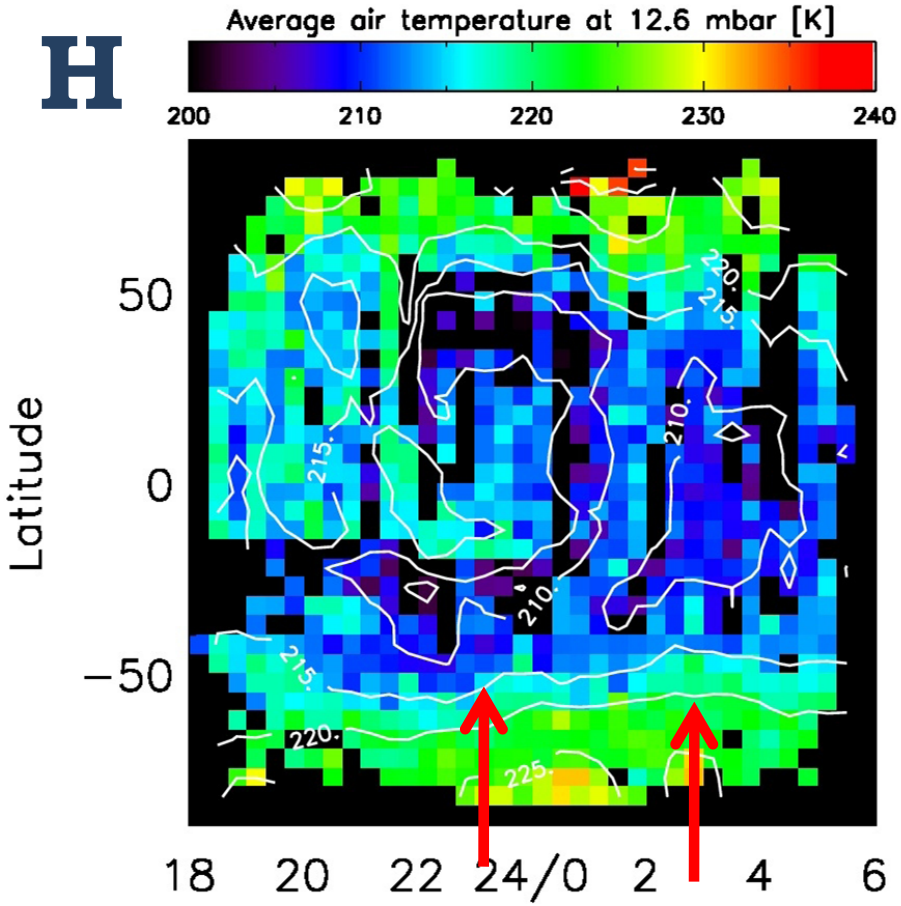




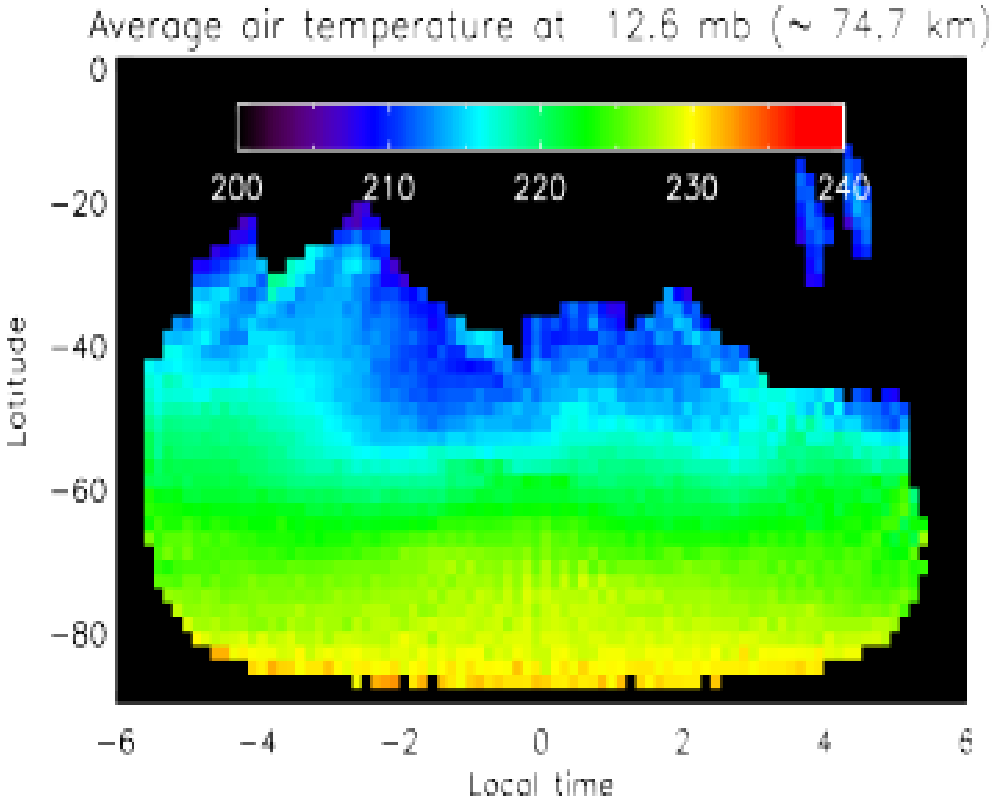
Migliorini et al., 2012

12.6 mbar (~75 km). Temperature features are less evident at this pressure level. Temperature increases towards the pole, quite monotonically. A second local maximum appears at about 3 LT, other than the those at about 20 and 23 LT.

H

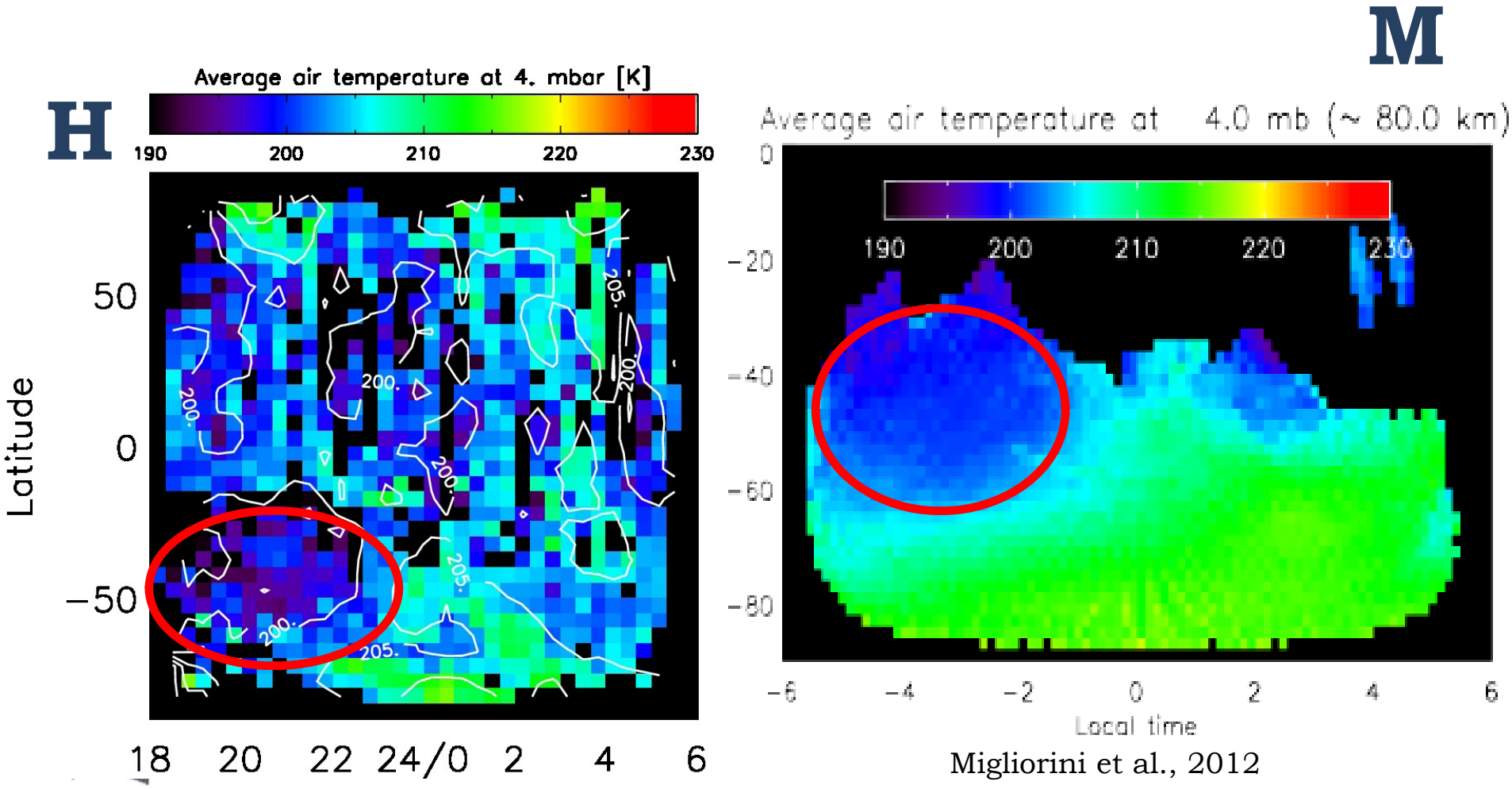


M



Migliorini et al., 2012

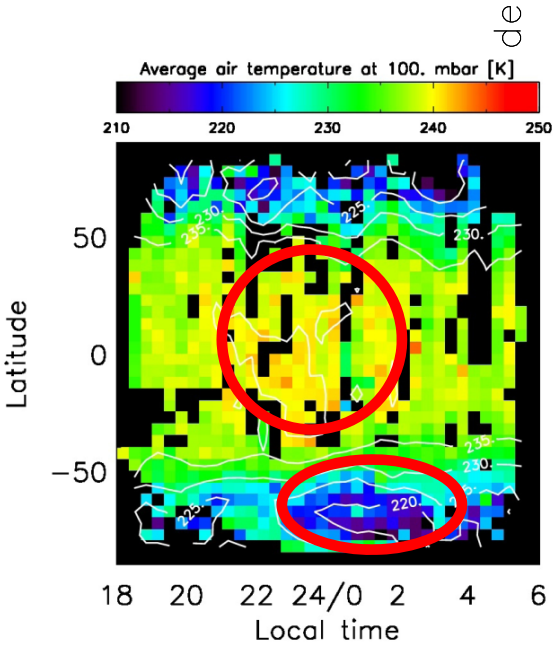
4.0 mbar (~80 km). The dawn side is warmer than the dusk one. A local maximum is observed close to midnight, while the mid latitude region at about 20-22 LT is the coldest region.

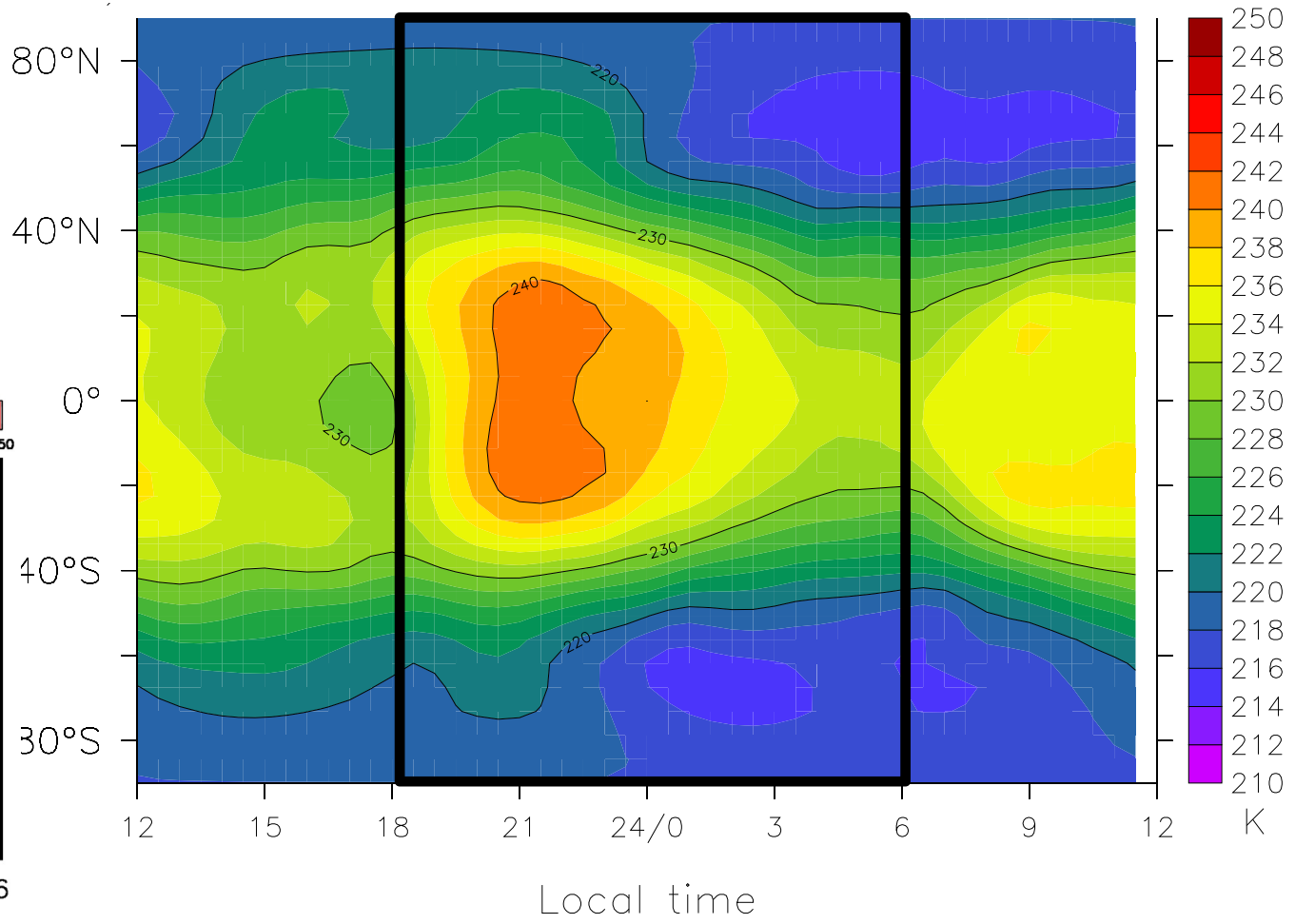


Migliorini et al., 2012

Comparison with LMD-GCM Model

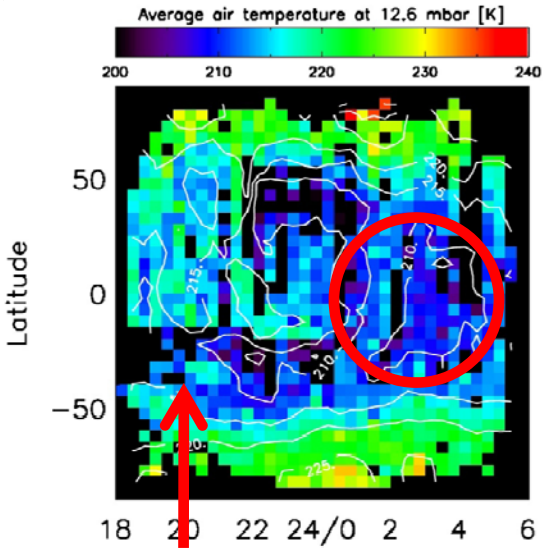
Map at 32 mbar
to be compared to
the VIRTIS map
at 100 mbar

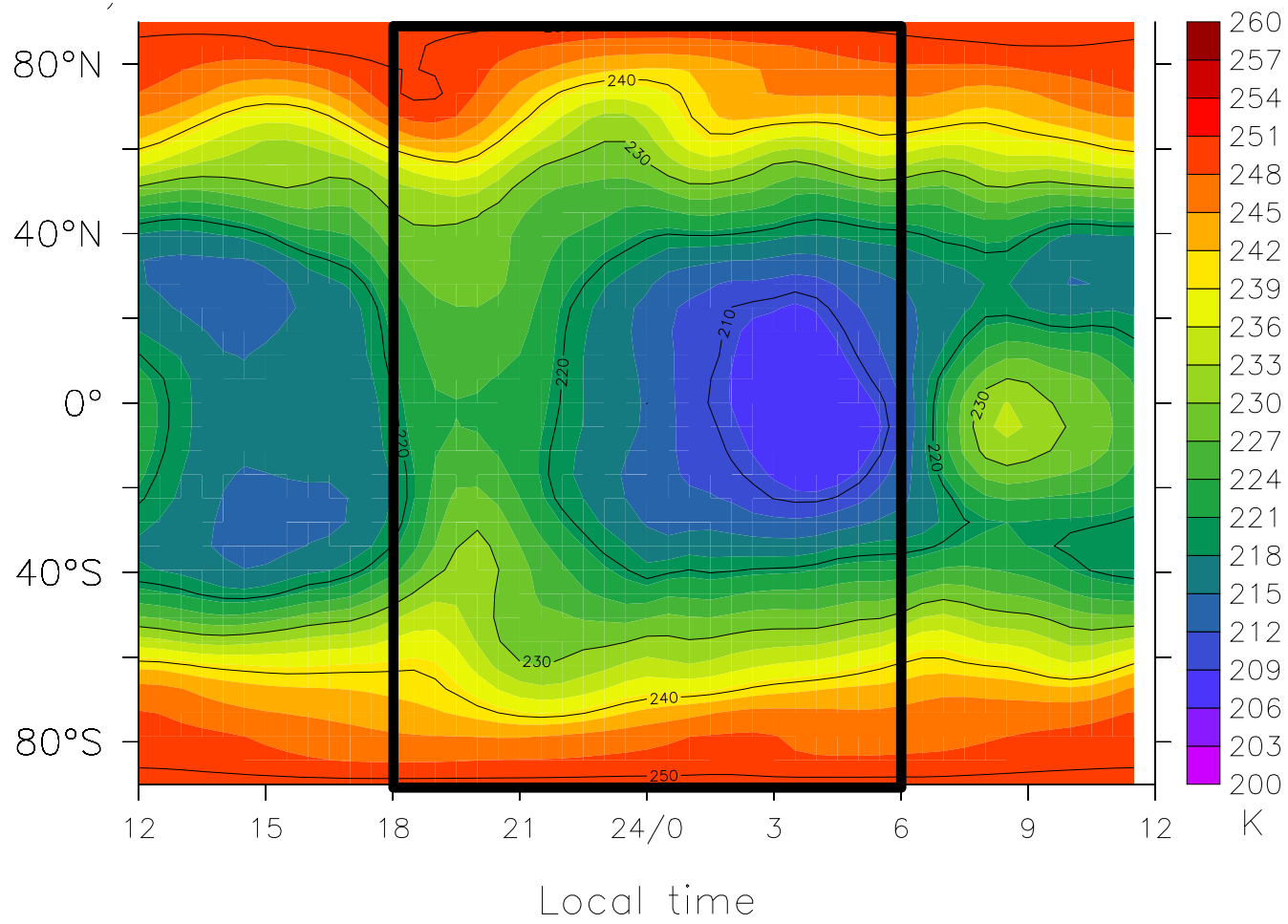




The map is located at the level of the cold polar minimum. The maximum in temperature (about 240 K) is observed at equatorial latitudes at about 21 h. The cold region (temp around 220 K) at mid-high lats is also present after midnight.

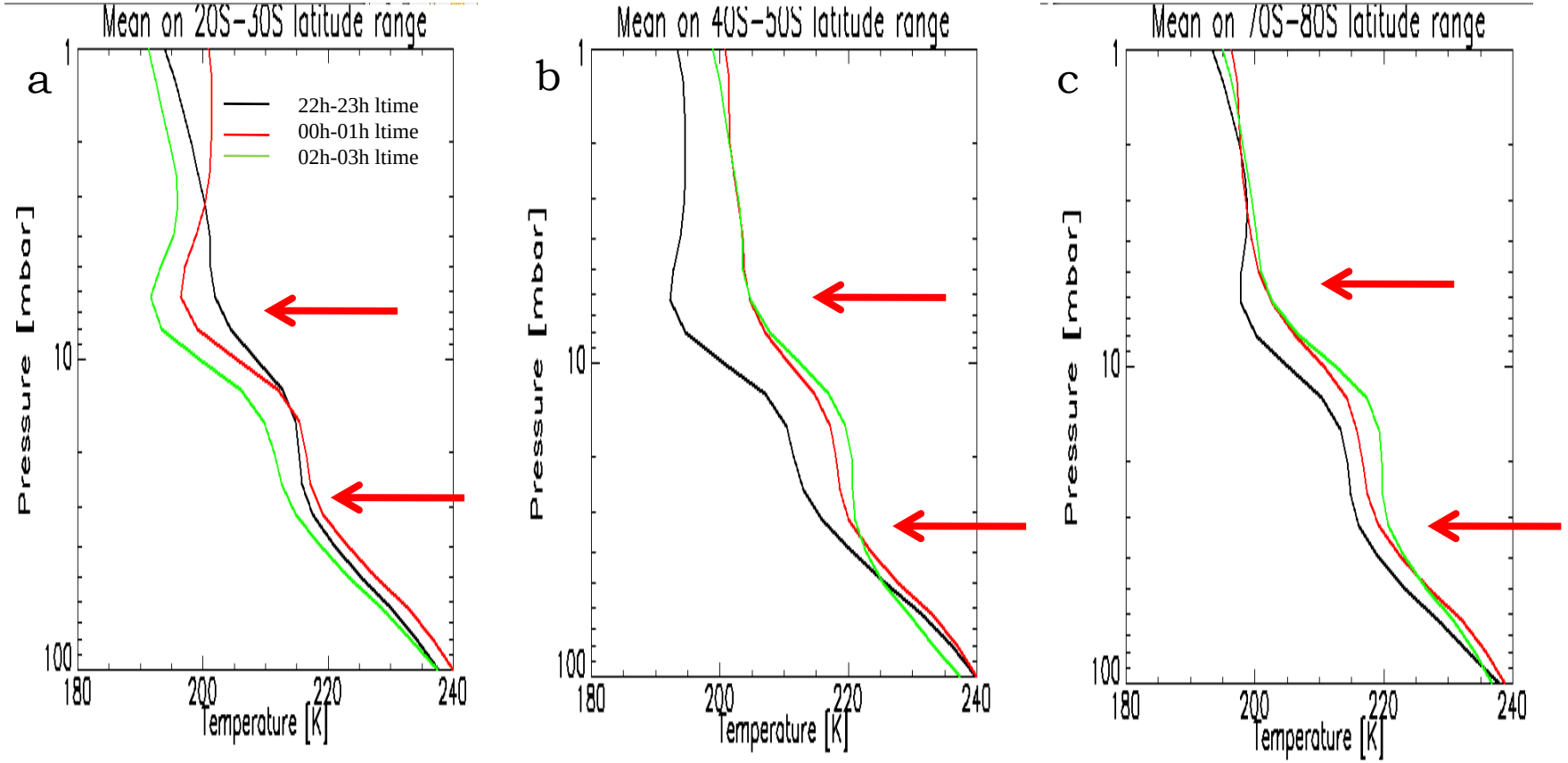
Map at 4 mbar to be compared to the VIRTIS map at 12 mbar.





The map correspond to the maximum of the polar warm region. A maximum in temperature is found at 20 h at mid-equatorial lats. The minimum is observed at the dawn side. Temperatures at poles are warmer than the local maximum at equator, as it is remarked in the observations by VIRTIS.

Vertical structure



a: Two regions with significant changes in the lapse rate are observed around 30 mbar and above 10 mbar. Differences of the profiles with respect to local time are observed. **b:** The same thermal inversion above 10 mbar is observed also at mid latitudes at all local times. Similarities between the profiles at midnight and 2 h local time are found. **c:** The same behavior is observed at high latitudes. The decrease in temperature is quite the same at the considered local time intervals.

Summary

1. Temperature is retrieved for the night side of Venus using VIRTIS on board Venus Express, on both hemispheres. A 3-D structure is derived from VIRTIS data.
2. Cold collar feature at about 65-70° is observed, showing a significant thermal inversion, as well as the asymmetry between the evening and the morning sides.
3. Minima at high lats are observed around 3 h, and a maximum at equatorial lats between 22 h and 24 h, in the map at 100 mbar.
4. The thermal features in the map at 100 mbar could be interpreted as the signature in VIRTIS data of the diurnal component of the thermal tide at the cold collar latitudes, while the semi-diurnal component is located at equatorial latitudes, according to the LMD Venus GCM model. Other tidal related features are clearly identified in the upper levels.