Nightside atmospheric temperature fields from the VIRTIS-Venus Express data. A. Migliorini[1], D. Grassi[2], L. Montabone[3,4], S. Lebonnois[3], P. Drossart[5], G. Piccioni[1], and the VIRTIS-Venus Express Team, [1]IASF-INAF (Via del Fosso del Cavaliere, 100, 00133 Rome, Italy), [2]IFSI-INAF (Via del Fosso del Cavaliere, 100, 00133 Rome, Italy), [3]Laboratoire de Meteorologie Dynamique (Jussieu, Box 99 75252 Paris, France), [4]AOPP, Dept. of Physics, University of Oxford (Parks Road, Oxford OX14 PU, UK), [5]Obs. of Paris, LESIA (5, Place J. Janssen, 92190 Meudon, France).

Introduction: Atmospheric temperature structure is very important to constraint the status of a planetary atmosphere. Dynamical phenomena have clear counterparts in the temperature fields, while temperatures themselves drive a number of processes, like aerosol condensation and chemical stability of gaseous components, that affect the atmospheric energy budget. Infrared observations take advantage of the variability of CO_2 opacity with wavelength in order to retrieve, by inversion, the temperature profile from the gas thermal emission.

Thermal structure was investigated by several space probes in the early '80s [1, 2, 3], and more recently by using data acquired by the experiments on board Venus Express [4, 5]. The present work reports the investigation of the thermal structure of Venus as observed by VIRTIS on board the Venus Express spacecraft. The study is relevant for the nightside only, covering a latitude range from 80°S to 80°N.

Method: VIRTIS is a VIS-IR spectrometer on board Venus Express, composed by 2 channels: the first one called VIRTIS-M with imaging capabilities; the second one, called VIRTIS-H, without imaging capabilities but relatively higher resolving power. The detailed description of the instrument is reported in [6]. Radiance at 4.3 µm in the nightside spectrum of Venus was used to derive the atmospheric temperature of Venus. Using an invertion method, temperature was computed for 67 pressure levels, spanning from 1200 to 0.005 mbar, corresponding approximately to 50-105 km height. For the present investigation, we focus on the 100-4 mbar range, where the temperature is provided with an accuracy better than 4 K. Below or above this range, the uncertainty in the temperature retrieval increases, and hence these data were not taken into account.

Results: The cold collar feature at about 65-70° is observed at 100 mbar. This is the most remarkable feature at this pressure level, where the contrast is the highest. An asymmetry between the evening and morning sides, as reported in previous investigations, is here confirmed, dawn being colder than dusk. The thermal structure at 31 mbar (about 70 km height, not shown here) is quite featureless, though the asymmetric thermal behavior between the evening and morning terminators is still observed. At about 4 mbar (which corresponds to about 80 km height) the trend is reversed, the morning side being the warmer one.

Moreover, temperature seems to be not symmetric with local time.

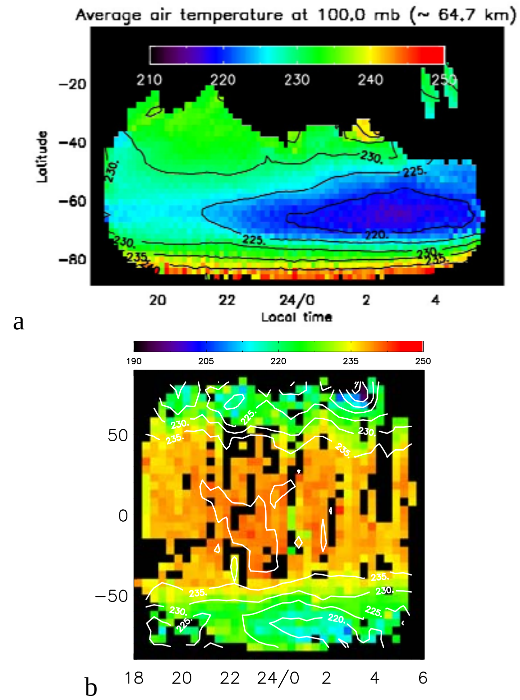

Figure 1: Thermal field at 100 mbar (about 65 km height) as retrieved with VIRTIS-M (a) in the Southern hemisphere, and with VIRTIS-H (b) in the latitude range from 80°S to 80°N. The better coverage in the Southern hemisphere allows to clearly observe the cold collar feature at about 60°S, colder after midnight. Despite the sparser sampling in the Northern hemisphere, the same feature is found here too.

The comparison with the LMD Venus GCM model [7, 8] shows a remarkable agreement, though an offset in pressure, corresponding to a shift in altitude of about 5 km, should be taken into account for direct comparison.

The model map at 31 mbar is shown in Figure 2, for a comparison with the VIRTIS maps at 100 mbar.

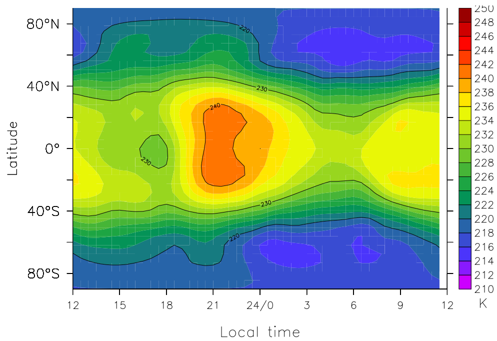

Figure 2. Map at 31 mbar, obtained with the LCD Venus GCM model. The cold collar feature is observed at about 60°, with a minimum in temperature at about 3 h LT. The maximum in temperature at equatorial latitudes (about 240 K) is an indication of the semi-diurnal thermal tides.

The maximum temperature is about 240 K, at the Equator around 22 h (Figure 2). The cold region below 220 K is also present, at mid- to-high latitudes, showing a minimum just before 3 h in the Southern hemisphere and slightly later in the Northern hemisphere. In the model, these minima at about 60° latitude in both hemispheres correspond to the signature of the diurnal component of the thermal tide. Conversely, the maximum temperature at the Equator around 22 h is created in the model by the semi-diurnal component of the thermal tide. Evidences of the thermal tides are also found on VIRTIS retrieved temperatures. The full discussion of the results is reported in [9].

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