EPSC Abstracts
Vol. 11, EPSC2017-404, 2017
European Planetary Science Congress 2017

Nightside temperature measurements at 95 km from OH nightglow in the Venus atmosphere

A. Migliorini (1), M. Snels (2), J.-C. Gérard (3), L. Soret (3), G. Piccioni (1) and P. Drossart (4)

(1) IAPS-INAF, Rome, Italy, (2) ISAC-CNR, Rome, Italy, (3) LPAP, Université de Liége, Belgium, (4) LESIA, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universités, UPMC Univ. Paris 06, Univ. Paris-Diderot, Sorbonne Paris Cité, 5 place Jules Janssen, 92195 Meudon, France

Corresponding author: Alessandra.Migliorini@iaps.inaf.it

Abstract

In the present work, temperature estimations at an altitude of about 95 km on the night side of Venus are provided. They are derived from hydroxyl nightglow emissions, observed in the infrared spectral range at 2.7-3.5 μm, using the Visible and Infrared Thermal Imaging Spectrometer on board Venus Express.

1. Introduction

The Venus atmospheric region from 90-100 km is dominated by a permanent warm layer, according to stellar occultation measurements with the SPICAV instrument on board Venus Express (Bertaux et al., 2007; Piccialli et al., 2015). The same is partly reproduced by the VTGCM model (Bougher et al., 2015). However, the atmospheric temperature in the upper mesosphere of Venus is still uncertain, showing a very high variability, and values from 170 K (Krasnopolsky 2010) to 250 K (Bertaux et al., 2007; Piccialli et al., 2015), obtained from ground- and space-based observations.

Independent measurements of the atmospheric temperature at about 95 km, obtained by taking advantage of the hydroxyl nightglow observations, are presented in this work. The retrieved temperature is on average on the order of 176 ± 5 K, which is in good agreement with previous space observations, and temperature measurements obtained by taking advantage of the high resolution ground-based observations of $O_2(^1\Delta_g)$ nightglow emissions.

2. Method

Infrared spectral images, acquired with the Visible and Infrared Thermal Imaging Spectrometer (VIRTIS) on board Venus Express, are analysed in this framework. The idea is to use the hydroxyl complex structure observed in the Venus nightside in the spectral range 2.7-3.5 μm, where bands from the $\Delta v=1$ sequence are clearly identified (Piccioni et al., 2009; Migliorini et al., 2011; Soret et al., 2012), to derive the atmospheric temperature, provided that the atmosphere is in Local Thermodynamic Equilibrium (LTE). In the Venus case, this condition has been demonstrated to be valid for the rotational energy levels. Hence the intensity distribution of the rotational levels can be used to estimate the local atmospheric temperature.
The band structure of the $\Delta v=1$ OH transitions is simulated with the PGOPHER code (pgopher.chm.bris.ac.uk) for different rotational temperatures (130-250 K). The simulations are then compared to the VIRTIS spectra, obtained as the average of data collected in the altitude range 90-100 km, observed in limb mode. The atmospheric temperature is finally the one that minimizes the difference between the synthetic and the observed spectrum.

3. Results

Figure 1 shows an example of best fit, for the VIRTIS image 317-06 (2007-03-04). The best fit is achieved for a rotational temperature of 172.6 ±5 K.

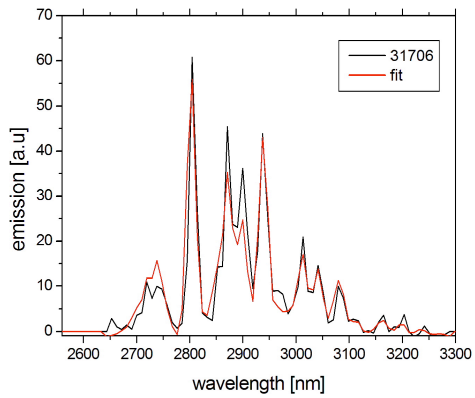

Figure 1. VIRTIS spectrum (in black) compared to the simulated spectrum (in red). The best fit is obtained for a rotational temperature of 172.6 ± 5 K.

VIRTIS measurements cover the latitude range from equator to about 70° N, and the local time interval 19 h – 5 h in the night.

Variability with respect to the latitude is investigated, while no important variations with respect to the local time are observed.

The obtained results are in good agreement with the previous measurements, as observed in Figure 2.

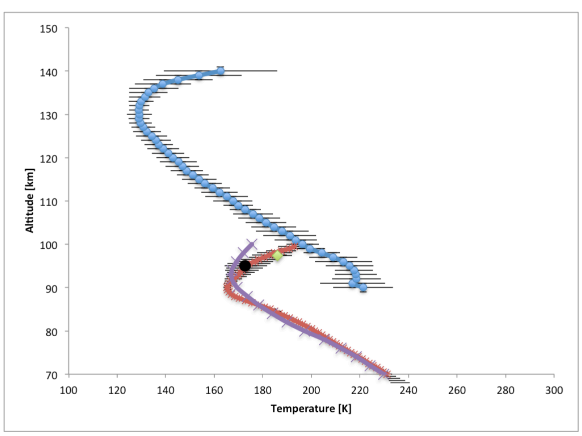

Figure 2. Comparison between mean value in this work (in black) and previous Venus Express and ground-based temperature measurements. In blue, Venus Express/SPICAV thermal profile; in red Venus Express/VeRa profile; VIRA profile is in violet; in green ground-based temperature estimate using $O_2(^1\Delta_g)$ nightglow emissions at 97.4 ± 2.5 km (Gérard et al., 2017).

4. Summary and Conclusions

Hydroxyl nightglow emissions are used to investigate the atmospheric temperature in the Venus upper mesosphere. The temperature estimation is on average equal to 176 ± 5 K, from the VIRTIS data analyzed in this framework.

The applied method is an effective alternative to derive temperatures at an altitude not well investigated with other remote sensing or occultation measurements obtained with the instruments on board Venus Express. In this way, the present work contributes with independent data to the temperatures estimation of the upper mesosphere – lower thermosphere of Venus, providing new constraints on the aeronomy of Venus

Acknowledgements

The authors wish to thank ESA, ASI, CNES and the other national space agencies, which supported the Venus Express mission. This work was funded by ASI (grant n. ASI-INAF I/050/10/2). JCG and LS acknowledge support from the PRODEX program managed by the European Space Agency with the help of the Belgian Federal Science Policy Office (BELSPO).

References

[1] Bertaux et al., 2007, Nature, 187, 247-259.
[2] Bougher et al., 2015, Planet. Space Sci, 113-114, 336-346.
[3] Gérard et al., 2017, submitted to Icarus.
[3] Krasnopolsky, 2010, Icarus, 207, 17-27.
[4] Migliorini et al., 2011, Planet. Space Sci., 59, 974-980.
[5] Piccialli et al., Planet. Space Sci., 113-114, 321-335.
[6] Piccioni et al., 2009, A&A, 483, L29-L33.
[7] Soret et al., 2012, Planet. Space Sci., 73, 387-396.
[8] Tellmann et al., 2009, J. Geophys. Res., 114, E00B36.