Geophysical Research Abstracts
Vol. 15, EGU2013-7150-1, 2013
EGU General Assembly 2013

Rotational temperatures derived from CO_2 bands using the SOIR instrument on board Venus Express: Comparison with hydrostatic temperature profiles

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The SOIR instrument performs solar occultation measurements in the IR region (2.2 - 4.3 μm) at a resolution of 0.12 cm^{-1}, the highest of all instruments on board Venus Express. It combines an echelle spectrometer and an AOTF (Acousto-Optical Tunable Filter) for the order selection. [1]

The wavelength range probed by SOIR allows a detailed chemical inventory of the Venus atmosphere at the terminator in the upper mesosphere and lower thermosphere (70 to 170 km) with an emphasis on vertical distribution of the gases. In particular, measurements of CO_2 density vertical profiles have been routinely performed. From these density measurements, kinetic temperature profiles are derived using the hydrostatic equilibrium. A permanent cold layer is observed at the mesopause ($\approx$ 120 km). [2]

A different and independent method is developed here, making use of the information obtained from the rotational structure of the CO_2 bands to derive rotational temperature profiles. The rotational temperature profiles are compared to the hydrostatic temperature profiles, and they confirm the presence of the cold layer at the mesopause. Also, the non-local thermodynamical equilibrium hypotheses are tested to know whether the differences between these temperature profiles at high altitude (above 140 km) can be explained.

[1] In flight performances of the SOIR instrument on board Venus Express, A. Mahieux, V. Wilquet, A.C. Vandaele, E. Neefs, S. Berkenbosch, R. Clairquin, D. Fussen, N. Mateshvili, D. Nevejans, B. Ristic, A. Fedorova, O. Korablev, E. Villard, F. Montmessin, J.L. Bertaux, Applied Optics, Vol. 47, No. 13, 2008

[2] Densities and temperatures in the Venus mesosphere and lower thermosphere retrieved from SOIR on board Venus Express; CO_2 densities and temperatures, A. Mahieux, A.C. Vandaele, S. Robert, V. Wilquet, R. Drummond, F. Montmessin and J.L. Bertaux, Journal of Geophysical Research, Vol. 117, E07001, doi:10.1029/2012JE004058, 2012