

Interactive comment on “Measurement of the water vapour vertical profile and of the Earth’s outgoing far infrared flux” by L. Palchetti et al.

L. Palchetti et al.

Received and published: 26 March 2008

1. REVIEWER COMMENT

The paper presents an analysis of far-IR atmospheric emission measurements made with a balloon-borne Fourier transform spectrometer. The authors use these measurements to infer atmospheric state in the troposphere (profiles of T and H₂O VMR and surface BT). These profiles are used for the calculation of the outgoing radiation flux. A comparison with correlated ECMWF analysis shows that temperature profiles are in good agreement, while significant departure are observed for water vapor. The discrepancy in the water vapor profiles reflect in a significant departure of the computed radiation flux. The authors conclude that the usage of spectrally resolved wideband measurements is adequate for a better characterization of the Earth outgoing radiation flux. The measurements analyzed in this paper are of extreme interest for atmospheric

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studies. The main interest resides in the spectral region studied, ranging from 100 to 1400 cm^{-1} . In this spectral interval few atmospheric measurements have been made and spectroscopic uncertainties still exist in the water vapor line parameters and continuum models. The authors have the merit of pointing out the need to better characterize the far-IR region. In fact the radiative cooling associated with water vapor emission in this spectral region is still a source of systematic uncertainties in the climate models. Owing to the originality of the measurements and the relevance of the considered topic this paper meets the standard for publication on ACP. However the paper could be significantly improved by extending the discussion on the results and by reviewing the English. Therefore I recommend to consider the comments listed below before resubmitting.

REPLY

The Reviewer has well identified the key points of the paper. We plan to extend the discussion on the results (see reply to comment 3) and to revise the English.

2. REVIEWER COMMENT

Specific comments Many questions that arise during the data analysis are not fully explained or sufficiently discussed. I collect some example below. Page 17747, line 1; 'Voigt profile...'; the usage of the Van Vleck-Weisskopf model for the water vapor line-shape is not explained, a sentence should be added here to justify the adopted model.

REPLY

The following sentence will be added in the revised text:

"The latter function is a rigorous model of the collisional broadening effect. This model is important at low frequencies where the Lorentz approximation, that the half width is much smaller than the central frequency of the line, does not apply. Therefore the Van Vleck-Weisskopf correction is not necessary for most of the fitted spectrum, but given

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its small computational cost, it was used at all frequencies.”

3. REVIEWER COMMENT:

Page 17749, line 26; 'The differences for...'; here a discussion should be made, why you see these discrepancies in the water vapor profiles? The authors should discuss more in-depth their results and propose an explanation; is it due to thin cirrus clouds, to a problem in the ECMWF data, or to uncertainties in the water vapor continuum?

REPLY

We agree that the observed discrepancy in the water vapour profile above 11 km must be discussed. A comment will be added about the effect of cirrus clouds and water vapour spectroscopy (line parameters and continuum) in our measurements. The following sentence will be added at pag. 17750:

”In the case of the water vapour profile different considerations apply at different altitudes. In the lower atmosphere (at 11 km and below) consistent results are observed and the few large differences can be explained by the smoothing error. Indeed for water vapour, because of its large vertical variations, the smoothing error is expected to have more pronounced effects than for temperature. On the other hand, a large disagreement is observed at 13 km. In order to explain this disagreement, the effect of cirrus clouds, water vapour continuum and spectroscopic errors have been investigated.

When cirrus clouds are included in our atmospheric model, the retrieved column of ice particles turned out to have an average value throughout the flight of about $1 \mu\text{g}/\text{cm}^2$ with an r.m.s. of $16 \mu\text{g}/\text{cm}^2$. No detectable change was observed in the retrieved water vapour and temperature profiles when cirrus clouds are fitted. Therefore, the error introduced by the assumption of no cirrus clouds is negligible.

A stringent validation is lacking for the water vapour continuum absorption model, however the Jacobian calculations indicate that this quantity does mainly influence the retrieval of water vapour below 7 km where smaller discrepancies are observed. The

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retrieved value at 13 km directly depends on the spectroscopy of water vapour; however the spectroscopy cannot account for a difference as large as the one observed. Also considering that the chi-square test provided values that varied between 0.9 and 1.5, we conclude that no evidence can be found in our measurements for a significant unaccounted systematic error that can explain the discrepancy observed at 13 km. This suggests the possibility of an over estimate of water vapour in ECMWF model at high altitudes.”

4. REVIEWER COMMENT

Page 17750, line 11; 'isolated exceptions...': a discussion should be made at this point, why you have these isolated peaks in your residuals? An explanation should be proposed to the reader, e.g: around 590cm⁻¹ there is a strong N₂O band and maybe something is missing in modeling N₂O emission.

REPLY

This is correct. The isolated peak is due to N₂O which is not fitted in the retrieval. We assumed that its concentration is equal to the climatological values. The following sentence will be added in the revised text:

”The isolated exceptions of the peaks at around 460 cm⁻¹ and 590 cm⁻¹ are due to the non-fitted concentrations of, respectively, HNO₃ and N₂O which were assumed to be equal to the climatological value.”

5. REVIEWER COMMENT:

Technical Corrections

Page 17743, line 3; The sentence 'Even if its main...' is too long and should be rephrased

Page 17744, line 14; ?contest?; change to ?context?

Page 17745, line 11;?(European-Commission,2000..?; who is the author of this refer-

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ence?

Page 17746, line 15; ?the software devoted?; change to ?the software used for the?

Page 17746, line 16; ?The main features...?; rephrase this sentence

Page 17747, line 27; ?exported by the program?; change to ?provided by the...?

Page 17748, line 5; ?found a drier atmosphere?; change to ?drier atmosphere with respect to ECMWF?

Page 17748, line 14; ?The degree of freedom..?; the sentence is too long and should be rephrased

Page 17748, line 18; ?rotovibrational?; change to ?ro-vibrational?

Page 17748, line 26; ?The second effect...?; the initial sentence is too far away for the reader, I propose to restart by specifying which effect you are talking about, e.g.: ?The calibration uncertainty...?

Page 17749, line 1; ?An in-deep...?; change to ?An in-depth...?

Page 17749, line 1; ?errore?; change to ?error?

Page 17749, line 27; ?in particularly?; change to ?in particular?

Page 17750, line 2; ?less that?; change to ?less than?

Page 17751, line 4; ?for the best...?; change to ?in the best...?

Page 17751, line 11; ?an horizontal?; change to ?a horizontal?

Page 17751, Eq 1; The dependency of FOLR is missing in the equation

Page 17751; ?J2 are the jacobian matrix?; change to ?J2 are the jacobian matrix defined as:?

Page 17752, line 16; ?calculated for?; change to ?calculated from?

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Page 17752, line 19; ?are less that?; change to ?are less than?

Page 17752, line 23; ?calculated for?; change to ?calculated from?

Page 17752, line 28; ?larger for the...?; larger than what? Please specify

Page 17753, line 8; ?The instrument performed..?; rephrase the sentence

Page 17753, line 15; ?differs of about?; change to ?differs by about?

Page 17753, line 16; ?The difference allows...?; rephrase the sentence

REPLY

All these corrections will be performed in the revised text. As far as Eq. 1 is concerned, F_{OLR} was intended to indicate the OLR flux and not a function. If this is misleading we propose to remove the first term of the equation and to show only the expression.

6. REVIEWER COMMENT

Reference; Bianchini et al., 2006; the reference is incomplete Reference; European Commission, 2000; the reference is incomplete Reference; Remedios et al., 1999; the reference is incomplete.

REPLY

The following information will be added:

- Bianchini, G., Palchetti, L., and Carli, B., A wide-band nadir-sounding spectroradiometer for the characterization of the Earth's outgoing long-wave radiation, Proceedings of SPIE, Systems and Next-generation Satellites XII 6361, R. Meynart, S.P. Neeck, H.Shimoda, Eds., 63610A, 2006.

- Remedios, J.J., Extreme atmospheric constituent profiles for MIPAS, Proceedings of the European Symposium on Atmospheric Measurements from Space, ESTEC, Netherlands, 20-22 January, 779-783, 1999.

- Rizzi R., et al., REFIR Radiation Explorer in the Far InfraRed, Tech. Rep. Final ENV4-CT6-0344, European Commission, Brussels, Belgium, 2000.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 17741, 2007.

ACPD

7, S9696–S9702, 2008

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