

## ***Interactive comment on “Measurement of the Arctic UTLS composition in presence of clouds using millimetre-wave heterodyne spectroscopy” by E. Castelli et al.***

**Anonymous Referee #1**

Received and published: 16 May 2013

The paper describes airborne remote sensing measurements of the UTLS region performed with the millimetre limb-sounder MARSCHALS near Kiruna in March 2010. Compared to a previous campaign, the instrument performance has been improved and data from three channels, including additional trace gases are retrieved. Thus, a significant advancement of the system is described which is worth being published. However, some statements in the presentation of the results are rather qualitative and, therefore, require revision before publication. Further, to demonstrate the improvements, spectral fits should be shown from all three bands. A proper data analysis requires also an estimation of the total error budget including a mapping of other in-

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strumental uncertainties apart from the instrumental noise only. At last, the retrieval of extremely low CO values seems rather vague due to some apparent systematic spectral residuum at the position of the CO line. This should be discussed in more detail.

Specific comments:

P3130,L21: ‘The performance of the retrieval are demonstrated from the results of data processing of MARSCHALS, deployed in the 2010 Arctic campaign with the M-55 Geophysica as an airborne simulator of the millimetre-wave limb-sounder proposed for the ESA Earth Explorer 7 candidate Core Mission PREMIER (PRocess Exploration through Measurements of Infrared and millimetre-wave Emitted Radiation).’

This sentence of the abstract is not very clear and does not really fit to the preceding text. It should be improved. Further, throughout the paper references to PREMIER should be updated with respect to the results of the selection process for EE7.

P3134L6: ‘The limb of the atmosphere is sampled through an open aperture in the starboard side of the Geophysica aircraft at angles equivalent to 1 km tangent point steps. A single scan of 28 measurements starts just below ground level and reaches up to just above platform altitude and includes an additional space view at 20 above horizontal.

This is somehow contradictory to what is shown further below in the manuscript where the tangent point sampling seems not to be uniform. Could you clarify this in the text? Further, could you specify the FOV width and how it relates to the tangent point sampling?

P3144L4: ‘Each MARSCHALS scan was analysed individually, retrieving four scalar instrumental parameters (gain, offset, pointing bias angle and frequency shift) along with vertical 5 distributions of temperature, water, ozone, nitric acid, nitrous oxide, carbon monoxide and extinction coefficient.’

How strong is the dependence between offset, gain on the one side and extinction

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coefficient on the other? Can these quantities well be distinguished by the retrieval. Which constraint has been used for the continuum profile retrieval?

P3144L5: How have the profiles above the highest grid point been handled? (e.g. scaled with the highest point)

P3146L10: In addition to the chi-square I strongly recommend to show examples of spectral fits with residuals for all three bands, on the one hand for a case with good  $\chi^2$  and on the other for those with larger  $\chi^2$ . I think this would be needed to show the quality of the observations and to judge whether other instrumental effects, like channeling might be present.

Chapter 4.3: Only instrumental noise errors are shown. However, I miss an estimation of the total instrumental error budget taking into account the uncertainties due to instrument characterization (e.g. FOV knowledge, calibration, instrumental line shape, baseline effects, pointing uncertainty/stability) At least for single profiles it would be interesting to see how those uncertainties relate to the noise error.

P3148L21: '(not shown) show a very good agreement'

What means 'very good' here? This should be more quantitative (either as a Figure or quote some numbers).

Fig 7: Could you draw in the flight altitude?

P3149L23: 'HNO<sub>3</sub> data have been compared to MLS/Aura, MIPAS-STR and with MIPAS/ENVISAT data with good results.'

Please show a figure or at least give more quantitative measures (e.g. % difference at different altitudes).

Fig9: This figure is not clear. How do the right and the left panel correspond to each other? (x-axis).

P3150L14: 'The obtained results can be considered a proof of the robust analysis

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performed on MARSCHALS data of the PREMIER-Ex flight from Kiruna'

Looking at Fig10a, I would question this robustness. Do you have arguments that any of the structures present in the N<sub>2</sub>O distribution are real?

Fig13a: How are negative retrieval results handled? Are those just set to zero as the figure indicates?

Fig13c: There is an obvious negative residuum just left of the CO-line? What can be the reason? If it would be an instrumental artefact, it could very well be the reason for the very low CO-values. Does it appear in each fit residuum? Further, the instrumental noise values (which I assume to be 1-sigma values) indicated by the green lines seem to be rather high compared to the residuum.

P3152L25: Is the radius a constant value or e.g. the median of some particle distribution (in that case the width should also be reported)?

P3152L27: Could you also report the value of the number density used?

Technical

P3132L13: 'To overcome this, as part of the seventh call for Earth Explorer Core missions currently under evaluation in the frame of the European Space Agency (ESA)'s Living Planet Programme, one of the three mission candidates selected to enter Phase-A feasibility study is the mission "Process Exploration through Measurement of Infrared and Millimetre-wave Emitted Radiation" (PREMIER)'

Since the evaluation has taken place, this sentence should be updated.

P3132L28: 'Respective infra-red instruments to demonstrate the IRLS capabilities are already existing, e.g. Michelson Interferometer for Passive Atmospheric Sounding – STRatospheric aircraft (MIPAS-STR), Gimballed Limb Observer for Radiance Imaging of the Atmosphere, AirBorne version (GLORIA-AB)'

Could you give references for those instruments?

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P3148L22: 'hydropause'

Correct to 'hygropause'

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Interactive comment on Atmos. Meas. Tech. Discuss., 6, 3129, 2013.

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