

## ***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 #2**

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Referee Report on

E. Castelli et al., Measurement of the Arctic UTLS composition in presence of clouds using millimetre-wave heterodyne spectroscopy

### GENERAL COMMENTS

The manuscript gives a detailed report of the 2010 arctic measurement campaign of the MARSCHALS limb sounding instrument aboard the Geophysica. A description of the instrument including recent enhancements, the rationale and objectives of the

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campaign, and retrieval issues are provided to prepare for an extensive presentation of the results in sections 4.3, 5, and 6. The retrieved temperature and concentration profiles are shown along with some retrieval diagnostics and comparisons with appropriate satellite measurements. Unfortunately detailed comparisons with MIPAS-STR data are deferred to a forthcoming paper.

In general the paper is well written and recommended for publication in AMT after minor revision (improved organization, some open questions, and numerous technical things).

### SPECIFIC COMMENTS

Title: Only a small part of the paper actually deals with clouds (one of seven sections, or 2 of 25 text pages). And according to section 6 only one scan (51) is contaminated by clouds (see remark to p.3152 / line 12). Thus, having "clouds" in the title might be misleading. Actually there are some other terms (e.g. limb, airborne, ...) that could be (more) useful for AMT readers to pick up the paper from the journal's table of contents. Moreover temperature was retrieved as well (but this is possibly regarded as a side-product).

Abstract: p. 3130/line 16 It is not quite clear what the information given in parentheses really means.

p. 3130/line 21 There is some redundancy / repetition in the last sentence compared to information already given.

Structure of the paper: Some (sub-)section titles are misleading, e.g. subsection 4.3 presents only instrument and general diagnostics, and the geophysical results are given in section 5 that is therefore more than just a discussion. Using section 4 only for a presentation of retrieval code and strategy and section 5 for a presentation (and discussion) of results (instrument, diagnostics, geophysical and even clouds) might be more logical. In other words, some thought of a better organization of the paper

might be appropriate. I do not want to enforce the IMRAD (4 or 5 sections: Introduction, Methods, Results and Discussion (and possibly summary/conclusions), see <https://en.wikipedia.org/wiki/IMRAD>) format here, but 7 sections is a lot!

3133/26 The structure of the paper as described here is not in sync with the actual structure (e.g., conclusions now in sect. 7) ==> Update!

3140/14 Did you look for overpasses of A-train satellites in general or only for AURA-MLS? Later on its mostly MLS, MODIS and CALIPSO in section 6 only.

3140/19 So strictly speaking there was no A-train overpass?

3141/05 Are these legs identical to the legs mentioned in the previous paragraph (3140/22)?

3141/07 So the second leg is also a mix (inside+outside)? And what means "mixed air" for the third leg?

3141/17 I guess the sequence is CBD CBDCBD... and not 19\*B, then 18\*B, then 19\*D (Maybe this can be rephrased slightly, during the first read I was a bit unsure)

3142/02 Are these scans shown in Fig. 2b?

3142/14 "... Levenberg-Marquardt algorithm ... to reduce the stepwidth ..." LM does not simply reduce the step width but also considers the step direction.

3142/21 Forward model description Presumably a line-by-line code. It would be useful to have some information on line data (HITRAN|GEISA|JPL), line shape, (CKD|Liebe|...) continuum, etc. (Actually this information is also missing in the MARC JQSRT paper)

3143/11 reduced chi squared: Final chi squared (i.e. after convergence)? Later on some numerical values are given, so it would be useful to provide the exact definition, i.e. is it simply the sum of squared residuals or does it include some extra factors (noise level, number/length of measurement vector, ...). Similarly, precise definition of

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the information content could be useful for completeness.

3144/14 Are there any other interfering gases to be considered?

3145/19 The subsection title suggests that ALL results are discussed here. But actually only instrument and general diagnostics are presented here.

3146/12 Any reasons for the different chi squared values in the third leg?

3147/07 Vertical resolution: How reliable is the FWHM estimate in view of the retrieval grid point spacing as large as 4km

3148.26 What defines "best performance" and "worse/worst performance"? The information content is always high!

3148.24 "O3 can be retrieved ... from the three bands" Are the results shown here from concurrent multi-band retrievals and/or did you perform any single band analysis? If yes, what about O3(band B) vs O3(band C) ... vs O3(B+C+D)?

3151/17 "... without including CO ..." According to Fig. 13 CO is included in the forward model/radiative transfer (at low or IG2 values), but not fitted.

3152/12 "In one case only, for scan number 51, ..." Why only scan 51? What about the other outliers in Fig 3a?

3154/23 "The quality of the retrieval products obtained from MARSCHALS ... is relevant ... IRLS of PREMIER." Why is the present MARSCHALS retrieval relevant for the future (proposed/failed/...) IRLS-PREMIER? The lessons learned from the MARSCHALS analysis, or from the synergetic MARSCHALS + MIPAS-STR retrievals? As a guide for future IRLS + STREAMR retrievals?

p. 3161, Table 1. There is a slight asymmetry in the signal and image bands of band B (317.46-294.00 vs. 341.00-317.46)

TECHNICAL CORRECTIONS

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Remark: there is a mix of lower and upper case nouns throughout the paper, e.g. "Northern polar" vs. "northern Polar" or "level 1" vs. "Level 2". This is also true for the table entries, e.g. the first column in Table 1.

3130/07 "PREMIER": move acronym definition up from end of abstract to first occurrence

3130/14 "... vertical profiles of CO and N<sub>2</sub> ..." for consistency with the previous sentence use names (carbon monoxide) here.

3130/18 "information ... extracted from the retrievals" → "information ... extracted from the data/observations/..."

3131/08 "Tropopause height" → "tropopause height"

3131/22 "Northern polar vortex" → " northern polar vortex" (compare 3140/05)

3133/23 rephrase to avoid the double "code"

3133/24 use math italic for "T" (temperature)

3134/22 rephrase sentence to avoid the double "antenna control loop" at the start and end

3135/01 genitive: "... the bands' frequency range ..."

3135/05 no genitive: "... its ..."

3135/06 there are two "upgrades" in the subsection title, rephrase?

3136/08 3136/17 3137/01 three almost identical sentences, ideally rephrase?

3136/24-26 double "... has now been replaced with ..."! rephrase?

3137/06 "a number of software modifications has ..."

3137/22 3138/23 "lab" → "laboratory"

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3138/15 "... this repeated test is ..." or "... these repeated tests are ..."

3139/22 "... 1.5 GHz, channel spacing ..." comma? or simply "and"?

3140/05 "northern Polar region" → " northern polar region" (compare 3131/22)

3140/11 "... above Scandinavia ..."

3140/16 rephrase to avoid the double "model"

3141/18 "level 1" vs. 3141/20 "Level 2"

3142/10 "... retrieval of ... spectra" → "... analysis of ... the spectra" or something similar (its the atmospheric state to be retrieved from the spectra)

3142/14 "step width"

3143/02 new paragraph?

3143/09 plural "parameters"

3143/22 "during the PrEx1 campaign"

3143/25 swap "... the presence of all three bands for the first time ..."

3144/22 "find a better retrieval strategy" or "find the best retrieval strategy" ?

3145/03 "(along to the other targets)" → "(with the other targets)"

3145/22 "... for all vertically resolved targets." (delete "the")

3146/10 plural "The values ... are reported"

3146/12 "a part" → "apart"

3146/10 plural "The values .... are reported ..."

3146/19 plural "scans"

3147/19 no comma after the parentheses

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3148/18 "a part" → "apart" no comma "... flight that justifies ..."  
3148/26 "... even if the best performances ..." → "... although the best performances ..."  
3149.01 "the worst ones" ?  
3149.04 "but also due to ..."  
3149.12 plural "profiles"  
3149.14 significant  
3149.19 delete the first "and" in this listing  
3149.22 find → found  
3149.24 The "HNO<sub>3</sub> data have been compared ..." sentence starts a new topic, so it seems to be more appropriate to start the paragraph here, not after this sentence.  
3150/08 "a weak constraint on"  
3150/13 "... with respect to / compared to / relative to ..." "other instrument"  
3151/03 3151/15 Quite a long paragraph! Maybe split for new paragraphs here.  
3151/06 "... one of the bands ..."  
3152/05 no comma after the parentheses  
3152/03 Two very long paragraphs in this section. Two improve readability please consider further splits.  
3152/06 The cross section unit cm<sup>2</sup> better fits in the figure caption  
3152/26 "... of the external ..."  
3153/27 "... one sequence ..." scan?

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3154/01 Another long paragraph. Splitting in some paragraphs could help. A mix of present and past tense. Make it consistently.  
3154/15 swap: "... was applied for the first time ..."  
3154/22 "onboard the ... satellite" (or spacecraft or ...)  
p. 3166, Fig. 2: axis labels missing (lat/lon)  
p. 3167, Fig. 3b: To make an assessment of the DOF easier please provide the length of the state vector  
The axis labels of the contour plots are relatively small. Ensure appropriate size for the final paper.

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