

Interactive comment on “Airborne limb-imaging measurements of temperature, HNO₃, O₃, ClONO₂, H₂O and CFC-12 during the Arctic winter 2015/16: characterization, in-situ validation and comparison to Aura/MLS” by Sören Johansson et al.

Anonymous Referee #1

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The manuscript reports the results of high spectral resolution atmospheric emission measurements of UTLS temperature and composition (HNO₃, O₃, ClONO₂, H₂O and CFC-12) conducted by the limb-imaging Fourier transform infrared spectrometer GLORIA on board the HALO research aircraft during the Arctic winter 2015/16. A clear overview is presented of the substantial amount of data acquired by GLORIA in the 15 flights of the PGS campaign, with a focus on the analysis of a single flight supported by detailed insight into the retrieval process and systematic and noise error

estimate. Validation of GLORIA temperature and trace gases retrieved profiles is performed against correlative data by the HALO in-situ payload and comparison with the Aura/MLS space-borne observations. Along with an appendix showing plots of results from the other flights, the paper includes an extensive list of bibliographic references and information for access to the discussed data sets from GLORIA, from the HALO in-situ payload, from Aura/MLS and ECMWF analysis, in line with the declared purpose to serve as a baseline for scientific studies using GLORIA measurements.

GENERAL COMMENTS The paper is well written and properly organized and its contents fit the scope of the AMTD/AMT journal. The material presented by the authors is sufficiently informative and significant new results are pointed out in specific sections of the paper and consistently highlighted in the conclusions. The relevance of improvements in the quality of the retrieval products and in the extended coverage of atmospheric targets resulting in the retrieval products from instrument upgrading with respect to measurement performance described in previous publications cited in the references is unquestionable. The need for accurate high vertical resolution measurements of critical regions of the Earth's atmosphere such as the Upper Troposphere and Lower Stratosphere is made explicit in the article and that need, which can be achieved only by limb-sounding instruments, has become even stronger due the warning for the risk of the limb-gap in spaceborne observations. I recommend the paper for publication after technical corrections and minor changes.

TECHNICAL CORRECTIONS The statement "Space-borne measurements provide global coverage" (pag. 2, line 9) is not necessarily true. Geostationary satellites do not provide global coverage. I suggest the following modification: "Space-borne measurements can provide global coverage"

The detailed description of the results from a single flight from the PGS campaign was performed by selecting flight PGS-19. Is that the result of a purely random choice or of a selection based on pre-established criteria? A short statement providing this information to the reader might be of help.

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The term “combination” (suggesting a synergistic use of data) referred to the link established between GLORIA and MLS data does not appear the most appropriate. The extent to which the two datasets were jointly used to build the results reported in the manuscript appears to be rather limited. The term “comparison” might still be more appropriate to represent the actual exercise conducted using both data sets. I leave to the authors to decide on this point.

If available from the diagnostics of GLORIA measurements during the PGS campaign (or the PGS-19 flight): which is the typical amount of bad pixels filtered out (per row or per image)? Is that affecting the quality of the measurements in a significant manner with margins for future improvements?

In the statement “Another important quantity for a retrieval is the degrees of freedom” (pag.9, line 26), the correct expression to use is “the number of degrees of freedom”.

The statement “. . . since the diagonal element of each averaging kernel row is a measure . . . retrieval results” (pag. 9, line 27) shall be formulated in a different manner, to avoid using the expression “diagonalelement of a row”.

MINOR CHANGES I recommend the authors to revise the use of commas throughout the manuscript. An extensive (but not exhaustive) list of this kind of modifications is included among the minor changes here below.

Pag 1, line 15 – insert comma after “Additionally” Pag 2, line 29 – change “gases” to “gas” Pag. 3, line 3 – change “de-/activation” to “de-activation” (here and elsewhere in the paper for both de-/activation and de-/nitrification) Pag. 3, line 6 – insert comma after “purpose” Pag. 3, line 24 – insert comma after “In this paper” and after “In this measurement”. Pag. 5, line1 – insert comma after “system” Pag. 5, line27 – change “auto-co-variance Function analysis” to “auto-covariance function analysis” Pag. 6, line23 – insert comma after “model” Pag. 6, line 30 – use the same spelling for a priori here (“a priori”) and at pag. 7, line 3 (“a-priori”) Pag. 7, line14 – insert comma after “purpose” Pag. 7, line17 – insert comma after “work” Pag. 7, line21 – insert comma

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after “step” Pag. 7, line22 – insert comma after “retrieval” Pag. 8, line3 – insert comma after “H2O” Pag. 9, line 4 – change “:” to “.” Pag. 9, line6 – insert comma after “method” Pag. 9, line 14 – insert comma after “Here” Pag. 11, line 5 – change “For this reason no comparisons . . . are shown” to “For this reason, no comparison . . . is shown”. Pag. 11, line 9 - insert comma after “track” Pag. 11, line 24 - insert comma after “Fig. 4” Pag. 11, line 26 - insert comma after “HNO3” Pag. 14, line 28 - insert comma after “reason” Pag. 15, line 6 - insert comma after “temperature” Pag. 15, line 11 - Include the statement “which is closest . . . better than 2 km” between two commas. Pag. 16, line 1 - change “flight PGS19 are presented in Fig. 7” to “Flight PGS19 is presented in Fig. 7” Pag. 18, line 7 – insert comma after “(Clarmann et al., 1993; Oelhaf et al., 1994; Roche et al., 1994)” Pag. 20, line 10 – insert comma after “(way points "A" to "B)”. Pag. 22, line 4 – remove “recent” after “we discuss” Pag. 23, line 10 – insert comma after “atmospheric variability”.

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