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Interactive comment on “Level 2 processing for the imaging Fourier transform spectrometer GLORIA: derivation and validation of temperature and trace gas volume mixing ratios from calibrated dynamics mode spectra” by J. Ungermann et al.

Anonymous Referee #2

Received and published: 3 February 2015

General Comments

This paper describes a 1-D retrieval method for measurements taken by the GLORIA infrared limb-imager during two validation campaigns in 2012. GLORIA is a novel instrument; the data processing for it is in its infancy and not much has previously been published about it. The authors are well known in their specialist field of work. They are affiliated to the institutes that have developed, built and deployed the GLORIA instrument, the data processing of which is the subject of this work. They also have

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a proven track record of publishing atmospheric measurement from remote sensing instruments, as well as theoretical work on retrieval methods. The authors' consortium is therefore well placed to have conducted this work.

I expect a publication of a retrieval scheme to contain a theoretical description of the algorithm used, as well as an encyclopaedia of input parameters (measurement data and errors/problems therewith, prior information, approximations used and their impact on the result, correlations, etc.). There must also be a comprehensive section on the validation of the results, wherever possible. The manuscript as such addresses all these topics, with the exception of the issues raised in the section "Specific Comments". If these are addressed satisfactorily, I recommend the manuscript to be published in AMT.

Specific Comments

Page 12040, line 27: The difference between dynamics and chemistry mode could be explained in more detail: I.e. what is the extent of changes to the spectral and spatial resolutions from one mode to the other? Also, how are the different modes implemented at instrument level? The details of this presumably affect the data processing.

Page 12041, line 19: "the used configuration for the GLORIA data processing". Is there a version number to help identify this "used" configuration in future references? If not I think there should be one.

Page 12043, line 17: It is said that Table 1 describes what the optical properties of the aerosol extinction coefficients are, i.e. it would be interesting to know what the prior information for aerosol retrieval was. However the table just lists an aerosol index, which I presume is a placeholder for an unspecified set of aerosol parameters?

Page 12068, Table 2: The vertical correlations lengths seem quite large. What provision has been taken to ensure that the 5km correlation length for water vapour doesn't affect the retrieved Tropopause altitude?

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Page 12048, lines 8ff: An error estimate for the fast forward models is given by comparing the band model with the more accurate monochromatic model, and then both of the fast models with the more detailed RFM. However, the RFM explicitly uses the same ray tracing, so how are errors from the ray tracing estimated? This is exuberated by the fact that the band model is used as a priori for the monochromatic forward model in the retrieval.

Page 12049, line 20: “The characterisation of actual noise figures is still in progress”. The measurement noise figure is of central importance to the retrieval algorithm. It’s reasonable to expect that uncertainties in its knowledge will have a major impact on the results. The authors claim that they have evidence that the estimates they are using are accurate enough. It would strengthen their case if they could quantify this statement.

Page 12055, line 12: The correlation of O₃ with HNO₃ and anti-correlation with H₂O reflects the distinction between stratospheric air (dry, O₃ rich) vs. tropospheric air. This is worth pointing out in the text since it’s an important self-validation of the retrieval! In fact, the actual discussion of the scientific findings is quite marginal - a mere couple of lines. Surely this could be extended.

Page 12058, line 9: “It is expected that the vertical resolution of temperature can be further improved when the instrument artefacts around the CO₂ Q-branch have been resolved”. This, together with the statements that not all of the campaign spectra have been processed and that the Level1 processing hasn’t reached a final version, is the main issue I have with the current manuscript. For a work that aims to become the canonical reference for future scientific publications of GLORIA campaign data, I would have expected it to be based on the comprehensive set of measurement data. Conclusions generally stand on wobbly ground if the input data lacks the seal of approval. At the very least I would like to see a solid case being made to corroborate that whatever instrumental effects are possibly to be identified from i.e. the CO₂ Q-branch – or from any of the missing scans for that matter – will not require significant alterations to the

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retrieval processor as it is described in this work.

Page 12074, Figure 4 (and similarly Figure 5): There is a periodic structure (oscillations) at the top altitudes of the error profiles for offset and spectroscopic parameters for CO₂. I wonder what the reason for this is? It's striking for O₃ and HNO₃, not so for Temperature and H₂O (probably masked by the different scales).

Technical Corrections

Header: The secondary affiliation mark for author T. Guggenmoser for his current position at ESETC (*) is barely legible. Given that an affiliation entry for ESTEC already exists (3) why not just re-use the latter.

Page 12039, line 1: Could explain what the word “gimballed” means. It's instrumental to the instrument concept, yet it's quite an exotic term and as such not universally understood.

Page 12039, line 5: Is HALO an acronym or a proper name? If it's the former please expand.

Page 12039, line 9: What are the different modes of operation, and how is dynamics mode different from chemistry mode?

Page 12039, line 15: What is FAIRO?

Page 12039, line 19: “fraction” should be “extent”.

Page 12041, line 1: “ESa Sounder Campaign (ESSENCE”); Inconsistent capitalisation; write as either ESSenCe, or ESA Sounder Campaign.

Page 12042, line 7: “0.625” should be “0.625 cm-1”

Page 12042, line 9: “which corresponds to a vertical sampling of ≈ 140 m 5 km at the limb below the instrument”. This is a bit confusing. Does it mean “... a vertical sampling of ≈ 140 m at a tangent point 5 km below flight altitude.”

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Page 12042, lines 20 and 22: Expansion of acronyms JURASIC and JUTIL: Again inconsistent capitalisation. Would be nice to do it consistently throughout, i.e. “JUelich RApid Spectral Simulation Code” as was done for the first acronym in the manuscript.

Page 12046, line 29: “Meaningfully” should read “significantly”.

Page 12049, line 8: “Thereby” should be “Where” or “Whereby”.

Page 12049, line 10: “with” should probably read “and”, with no final stop in equation 3.

Page 12059, line 25: “q_log” is later called “q_H2O” in the next formula. This is slightly confusing. How about the following notation “q^H2O_log” and “q^H2O_vmr”, or using italic variables for log-space and roman variables for vmr-space?

Page 12051, line 15: Rephrase “Of these, only a small subset has been currently processed consisting of several thousand profiles” to “Of these, only a small subset of several thousand profiles have currently been processed.”

Page 12052, line 26: “on board HALO” should read “aboard HALO” or “on board of HALO”.

Page 12054, line 26; Page 12055, line 3; Page 12056, line 6 and 12, Page 12057, line 1: “in the order of” should read “on the order of”. “in the same order” denotes a sorting criterion, “on the order” attributes similar magnitude (and “roughly on the order of” on Page 12055 is in fact a pleonasm).

Page 12073, Figure 3. The caption to Figure 3 could be improved. What are the red vertical lines? Half of the time these seem to correlate with singularities in the residuals; what is the reason for the latter? Also, the text mentions a instrumental effect at the CO2 line at 792cm-1. I can’t recognise this in the figure, and the residuals are within their boundaries, which would imply that the effect is present in the simulations too?

Page 12075, Figure 5 and Page 12076, Figure 6: Sub-panels (a) – (c) not attributed in

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caption.

Page 12078, Figure 8; Page 12079, Figure 9; Page 12080, Figure 10: Sub-panels not (a), (b) not attributed in caption.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 12037, 2014.

AMTD

7, C4827–C4832, 2015

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