Interactive comment on “Towards a 3-D tomographic retrieval for the Air-borne Limb-imager GLORIA” by J. Ungermann et al.

Anonymous Referee #2

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This is a nice solid paper introducing the next advance in retrievals of atmospheric composition fields from limb remote sounding observations. While it is a natural and unsurprising extension of previous work, it has, in this paper, been very well introduced, explained and demonstrated. I am happy to recommend this paper for publication, pending the clarification of a few points described below.

The standard of writing is very good and the figures are particularly clear and nicely composed. The number of equations has been commendably kept to a reasonably small level, and while some background is given, the author manages to avoid a whole-sale revisit of well-established material (e.g., from Rodgers’ book).

My only major concern with the work is the issue of temporal variations in the underlying fields. Aircraft observations can take several hours to be completed, and UT/LS composition fields can evolve significantly during this time (particularly, for example, during strong convection). For an introductory study such as this, it is perfectly reasonable to set aside this issue, but its existence should at least be acknowledged and your choice to ignore it for the moment stated explicitly.

Ultimately, I think one would probably have to invoke some kind of assimilation system to handle that issue ‘correctly’. I recognize this is an oft-discussed topic. Some have said that assimilation should be all one needs these days, and that stand-alone retrievals should become a thing of the past. I’m generally not all that persuaded by such arguments, particularly for limb observations. However, assimilation would be a nice way to handle the temporal variation issue in this case (but it would place you at the mercy of model accuracy).

My minor comments follow.

— Abstract

Line 8: ‘The 45 (deg) to 135 (deg)’ is not clearly stated, I presume 0 (deg) is the flight direction. Also (though less important) is it clockwise or anticlockwise from the aircraft (viewed from above or below)?

— Page 2996

Line 25: If you’re going to state that ‘the processes involved are among the least understood of the atmosphere’, following that up by citing a 15-year-old review paper is not a good idea! Since Holton wrote that paper there have been at least 3 satellite missions including limb sensors specifically targeting this region, plus countless airborne field campaigns, not to mention many many modeling studies. Surely those have answered many of the questions Holton identifies? What are the next decade’s questions in this area? You’ll need stronger language than this to get GLORIA funded and flown. It would help to update this material.
Line 1: This cascade is interesting perhaps, but why do we care? Why do we need to fill the observational gap? How will it improve our knowledge of things like radiative forcing etc.? Have people shown that it is this gap that makes our models wrong? It's not essential to include this kind of motivation detail in a paper like this, but it is nice to do so.

Line 8: 'an altitude' -> 'a tangent altitude'?

Lines 8-9: It would be helpful to also give these angles in terms of distances at the tangent point. I imagine it varies with altitude a little, so just giving typical values would be fine.

Lines 12-14: Just curious - some instruments look forward / backwards. It might be nice to discuss the relative merits of side viewing (apart from the mundane issues of shielding your optics from debris). Is the side-viewing geometry more favorable for these kind of tomographic observations? Your figures seem to make the case that it is - it would seem harder to do this kind of multi-vantage point viewing in a forwards/backwards geometry.

Line 23: 'GLORIA allows *us* to implement'

Line 25: 'Gladly' -> 'Fortuitously'

Line 27: '... by this *simplification*.'
Within 5 percent? It's hard to tell that from the figures - the continuous color scale makes it hard for the reader to interpret quantitatively. We'll take your word for it of course, but you might want to consider a more discrete color scale (~5 reds, grey, ~5 blues)? This goes for all your plots.

It would be good to be more quantitative here - what does our 5% become?

This sentence is a bit unclear, please give more details.

'Three problems you could have - an ellipsoidal volume that was not aligned with any useful axes (vertical, along/across track) would be another (perverse I admit) example.'

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'future studies' -> 'the studies described in this paper'.

'In effect' -> 'In summary', and insert 'clearly' between 'is' and 'an'.

'Exemplary' -> 'For example'

'One seems' in this context is slightly ambiguous. I suggest 'We seem'.

'exemplary' -> ', as an example,'

Why is 'LIMB' capitalized here?

I would avoid 'first guess' here, as it may lead to confusion - people may think you change the value each iteration. 'reasonable value'.

I'd delete the comma after 'efficient'

'... but “instead” to reduce ...'

'Depicted' -> 'Figure 17 shows...'

The caption here has material that feels like it belongs in the main body of the document.

These captions, on the other hand, are too short. At least say 'as for figure 5 but for vertical resolution' or something.

All the points have black rings around them. If there is one that is broader than the others, I can't spot it. Please make this clearer somehow.

Last sentence of the caption is unclear - what are we supposed to look at? Give us the altitude/distance of the region you're talking about. Is it everything from 400-800km, 4-16km or are there particular layers of interest?