Atmos. Meas. Tech. Discuss., 3, C1443–C1446, 2010
www.atmos-meas-tech-discuss.net/3/C1443/2010/

Atmospheric Measurement Techniques Discussions

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

Anonymous Referee #1

Received and published: 13 September 2010

General comments

This paper reports the first attempt of 3D tomography of the atmosphere carried out on simulated spectroscopic measurements. Aircraft-based measurements of the GLORIA spectrometer are simulated and analyzed (using several approximations) for the case study of a realistic ozone anomaly occurred in the UTLS. The authors extend to 3D a consolidated retrieval algorithm, the challenge being the handling of the huge dimensions that arise in a 3D tomography even for a limited atmospheric parcel. As it is the paper represents an academic study that, besides its remarkable results, highlights critical issues (see comments below) that need to be solved for practical applications. All things considered, the content of the paper is innovative and clearly presented so

that, in my opinion, it deserves publication on AMT. However I pose the following substantial considerations as a matter of discussion:

- Authors start from the assumption that "the inversion of F presents a non-linear, ill-posed, and in many cases both under and over-constrained inversion problem", therefore they adopt a retrieval scheme that makes use of a-priori knowledge about the atmospheric state. With this approach the strategy is to oversample the atmospheric field of the geophysical target with an exceeding number of retrieval parameters, regularize and, a-posteriori, evaluate the entity of the oversampling by calculating the actual spatial resolution of the retrieval products. This approach is suitable (and operational) for 1D retrievals where the dimensions of the problem are relatively small. Considering the large amount of information merged by the GLORIA measurements it is not obvious (and in my opinion should be verified) that 3D tomography results in a singular inversion problem without a-priori knowledge. The authors themselves verify (at P. 3012 L. 14) "a negligible influence of a priori information" and the literature reports 2D retrievals that don't need a-priori or simply adopt a Levemberg-Marquardt scheme. The possibility to avoid a-priori would simplify the retrieval algebra, reduce the demand of computing resources, and allow to drop some approximations. On the other hand (also considering the envisaged satellite application of GLORIA) it would lead closer to an operational retrieval where atmospheric anomalies are not predictable and the routinely used retrieval grid must be defined a-priori on the basis of only the trade-off between spatial resolution and retrieval precision.

- In my opinion Sect. 4.5 is superfluous. It is consolidated that 2D perform better than 1D retrieval schemes: it is then straightforward the superiority of 3D w.r.t. 1D. On the other hand the discussion in Sect. 4.5 is rather convoluted.

Specific comments

P 2996, L 6 and L 11, "high (spectral) resolution": looking at the average performance of existing aircraft and space-borne atmospheric spectrometers I would not define "high"

the spectral resolution of GLORIA even in the chemistry mode.

P 2996, L 10: the adjective “fast” is inappropriate in the absence of terms of reference for 3D algorithms.

Sect. 3.1: If I properly understand the Jacobian matrix is calculated numerically but, despite the fast forward model, “about 90 percent of the computation time is used for calculating the Jacobian matrix”. Did the authors consider the analytical approach for the calculation of derivatives? It should be much faster.

Sect. 4.1 P 3011: It is not specified whether the analyzed observations are generated using RFM or the retrieval forward model. In the second case the retrieval test carried out without instrument noise (sect. 4.2 see next point) provides a measure of the approximations introduced by the internal forward model plus those due to the retrieval scheme (e.g. smoothing error). Please specify.

P 3011, L 18: Since the Jacobian matrix has been calculated twice, I infer that convergence required two iterations. Could the authors explicit the number of iterations required by their test case?

Sect. 4.2, P 3012, L 8: In real analyses the influence of noise on the retrieval results is usually provided by the estimated standard deviation of the retrieved values. It is not clear if, in operational retrievals, the authors propose to deliver samples of the random errors as discussed in Sect. 3.4.

Technical corrections

P 2997, L 23: “relative” or “relatively” ?

P 2998, L 10: the acronym MIPAS should be developed here instead of P 3018, L10.

P 3005, L 4: Probably Equation (4)” is more appropriate than “(4)” at the beginning of a paragraph.

P 3006 Eq. (9): I cannot find a definition for Gepsilon.

P 3006, L 17: “too large” instead of “to large”.

P 3007, L 2: This equation should be numbered as (10) while Eq. (10) should be shifted to (11).

P 3008, L 17: “hand” instead of “hands”.

P 3010, L 1: “not to require” instead of “to not require” ?

P 3016, L 1: “could possibly be optimized” instead of “could possibly optimized”.

P 3016, L 25 and Fig. 13: I cannot identify “a broad black circle” in Fig. 13.

P 3018, L 23: “LIMB” should be “limb” because it is not an acronym.

P 3019, L 2: I don’t see the need of “(a subset of)” in this period.

P 3023, L 4: “the its” delete one of the two.

P 3023, L 5: expand “r.h.s.”.

Table 1 caption: “principal” instead of “principle”.

Table 1: “(15 km observer altitude)” placed in this header seem to indicate that the entries of the table refer to this altitude which (I believe) is not the case.

Table 1: The entry “vertical FOV” is a redundant information.

Fig. 2: Please include in the caption the information that this simulation is for the dynamics mode of observation.

Fig. 17 caption: “in case” instead of “ion case”.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 2995, 2010.