Atmos. Meas. Tech. Discuss., 6, C608–C611, 2013
www.atmos-meas-tech-discuss.net/6/C608/2013/


Atmospheric
Measurement
Techniques
Discussions

# *Interactive comment on* "Ten years of MIPAS measurements with ESA Level 2 processor V6 – Part I: retrieval algorithm and diagnostics of the products" *by* P. Raspollini et al.

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Received and published: 15 April 2013

We thank referee #1 for taking the time to review our paper and for the comments that we feel have helped to improve the paper. Our answers are reported after each referee's comment.

>General comments: It was a pleasure to read this article. It is well written and all aspects described in a clear and concise way. However, some sentences appear to be quite complex and long and splitting them upp to shorter sentences could improve their understandability. (e.g. p 465, l 17 to 21, and others) There are a few paragraphs with one sentence only, which could be embedded to adjacent paragraphs.



All the paper will be re-read and modified according to your suggestion.

>Specific Comments:

>Page 472 Line 117: You say that Di is a diagonal matrix with diagonal elements equal to those of KiTSy-1Ki. Does this approach provide any advantage compared to the common use of the unit matrix I ?

The Levenberg approach provides a damping proportional to the quantity alpha*I, where I is the unit matrix, while the Marquardt approach provides a damping scaled with the magnitude of the diagonal terms of the Hessian matrix of the cost function. The Levenberg approach guarantees that for a sufficiently large damping parameter the Gauss-Newton method approaches the direction opposite to the gradient, thus finding a descent direction. This is not guaranteed in the Marquardt approach. The Marquardt approach is preferable when, as in our case, the state vector includes inhomogeneous terms (VMR, continuum, offset), which have very different numerical values. This method allows to have a damping independent from the retrieval error. Furthermore, the scaled correction permits to maintain the influence of the smallest diagonal elements of the Hessian (contributing with large elements in the inverse), so that generally the convergence of the Marquardt approach is faster.

A sentence will be added in the revised paper to explain this.

>Page 477: You present the a posteriori application of the Tikhonov-regularization with a weak constraint. Does this approach provide the possibility for a direct assessment of the smoothing and related errors? Did you assess these errors?

The smoothing error depends on the Averaging Kernels (AK) of the retrieved profile, and on the Covariance Matrix (CM) of the real ensemble of atmospheric states about the mean state. In our case the AK of the retrieved profile is the result of two types of regularization applied to the retrieved profile, the Levenberg Marquardt regularization applied during the iterations, and the Tikhonov regularization applied a posteriori with

a self adapting constraint based on the Error Consistency method.

In the Error Consistency method the difference between the regularized and the unregularized profiles is on average equal to the random error of the regularized profile. Therefore we know that the smoothing error of this regularization is comparable with the random error of the regularized profile.

However, for computing the total smoothing error of the retrieved profile we have to take into account also the impact of the Levenberg-Marquardt regularization performed during the iterations. The total smoothing error has not been assessed, since it strongly depend on an accurate knowledge of the CM of the real ensemble of atmospheric states about the mean state. Since the AK is provided for each scan, the retrieval can be considered as a smoothed estimate of the atmospheric state.

>Page 482, Line 16 ff: To which extend does the removal of the 10-10 ppmv requirement for the last iteration reduce the influence of a possible positive bias, which might have been introduced during the earlier iterations, assuming the last iterations step is comparatively small?

In case of a pure Gauss iteration, i.e. with Marquardt parameter equal to 0, in the linear approximation the result of each iteration does not depend on the result of the previous iteration. If Marquardt parameter is significantly different from 0, this is not the case, since the Levenberg-Marquardt approach implies a reduction of the retrieval step-length with respect to the Gauss-Newton step. In our case, in general very few profiles terminate with a relatively large value of the Marquardt parameter and, as a consequence, the contribution of the previous iteration is on average quite small.

>Page 483: The estimates of the uncertainty of the tangent altitude is unclear. It is difficult to relate the uncertainties of up to 1.5 km (as stated in line 4) to a mean bias of 80 m (line 14).

The 1.5 km error on the knowledge of the tangent altitude represents a peak value that



has to be compared with the standard deviation of the correction which was found to be equal to 310 m. In the text we will delete the quotation of the mean bias that can be misleading.

>Minor/Technical Comments: Page 463, Line 19: "...measurements, this made ill-conditioned the retrieval formalism of the MIPAS operational processor." This sounds strange.

The word 'formalism' will be replaced by the word 'problem'.

>Page 469, Line 19 - 20: Citations should be in brackets or embedded in the sentence

ok

>Page 480, Line 22 ff: This sentence is quite long and difficult to understand. Is it correct that the results of one retrieval are used as input for the subsequent species? If yes, then the statement in the sentence before is slightly confusing as the species being retrieved individually might be considered to be a retrieval independent from the previous species, which is not the case.

The retrieved profiles in the previous steps of the retrieval chain are used as assumed profiles of the interfering species in each subsequent retrieval. As a consequence, each retrieval of the chain is not independent from the others, even if the retrieval of each species is performed individually. In the text the work 'individually' will be replaced by the word 'sequentially'.

>Page 482, Line 20: Join this sentence with the previous paragraph.

ok

>Page 484, Line 15: "percent noise error" should be replaced by "relative noise error"

ok

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Interactive comment on Atmos. Meas. Tech. Discuss., 6, 461, 2013.