Atmos. Chem. Phys. Discuss., 8, S10221–S10223, 2009
www.atmos-chem-phys-discuss.net/8/S10221/2009/

Atmospheric Chemistry and Physics Discussions

ACPD

8, S10221–S10223, 2009

Interactive Comment

Interactive comment on "A self-adapting and altitude-dependent regularization method for atmospheric profile retrievals" *by* M. Ridolfi and L. Sgheri

M. Ridolfi and L. Sgheri

Received and published: 6 January 2009

We warmly thank S. Kulawik for her comment. We are very sorry for not being able to find earlier S. Kulawik's relevant papers cited in the comment. Certainly we will amend our final paper to include references to these papers.

Regarding the specific questions (reported hereafter in *italic* for convenience):

How much the parameters w_e and w_r must be tuned for different species or atmospheric conditions to obtain optimal retrievals?

The three terms of Eq.(7), including their normalization factors, are defined in such a way that the parameters w_e and w_r have a precise physical meaning (see page 18014, lines 1-4 and 18-20) independent of the actual atmosphere encountered and of the particular profile considered. The value of w_e and w_r determines the tradeoff between the χ^2 increase and error decrease, taking into account also the vertical resolution. Accordingly, in the practice we found that fine and species-dependent tuning of these parameters is not rewarded by the retrieval. In the revised paper we will include a statement clarifying this point (perhaps after line 7 of page 18015).

Is my understanding correct that the results were validated using a single simulated retrieval, and one orbit of real MIPAS data? I would be interested in seeing results (retrieved vs. true) for an orbit of simulated data.

Yes your understanding is correct. In the first version of the paper we used this approach for conciseness reasons and because, once the self-consistency of the method is proven, no strange behaviours can be expected from simulations. However you are right that the characterization of the statistics of the results from a full simulated orbit would be useful. Considering that also the reviewer #1 is in favour of extending the analysis to a full orbit of synthetic data, we will include this analysis in the revised paper.

One of the challenges of TES water is the drop-off in sensitivity for pressures less than about 100 hPa to essentially zero. Does the form of Equation 7 allow for markedly different sensitivities at different altitudes? In other words, does the constraint tend towards a 0th derivative Tikhonov in altitude regions of zero sensitivity?

We represent the $\mathbf{\Lambda}$-profile using up to $n-i$ ($i=1,2$) grid points, therefore the strength of the regularization can rapidly change as a function of altitude, also by orders of magnitude (see e.g. panels (d) of Figures 1 and 5). In the case of TES retrievals we expect the VS method to provide a very strong regularization for pressures less than 100 hPa. For strong regularization the profile is constrained to be a line (if $\mathbf{L}_2$ is used) or a vertical line (if $\mathbf{L}_1$ is used). In case of MIPAS retrievals we found the best results using $\mathbf{L}_2$, however in our program we can select between the $\mathbf{L}_1$ and $\mathbf{L}_2$ operators.

ACPD
8, S10221–S10223, 2009

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

Was there a unique solution for Lambda (the constraint strength) at each altitude level? We set the constraint strength to a 2nd order polynomial as a function of altitude to reduce the number of parameters to solve for, otherwise the solution was unstable.

In the formulation of Eq.(2) we may speak of a vertical profile of $\mathbf{\Lambda}$ (in the sense that each element of the diagonal matrix $\mathbf{\Lambda}$ is multiplied by some discrete derivative of the profile at some altitude). Of course, even after the decision to pick up a single second derivative penalization term, we were left with $n-2$ values to determine, where n is up to 27. Our solution was to use a first order spline with $p \leq n-2$ nodes corresponding to fixed altitudes in the range of the profile retrieval. One advantage of the spline formulation is that a change in a coefficient produces only a localized change in the $\mathbf{\Lambda}$-profile. Even with $p = n-2$ the minimization of the TF shows no instabilities, in the sense that the achieved $\mathbf{\Lambda}$-profile is not sensitive to the starting point of the minimization. The value of p may be lowered down to 9 with no substantial change in the shape of the $\mathbf{\Lambda}$-profile. The minimization of the target function with 9 variables is still a not negligible task, and in fact we still have a 5-12% computing time increase in the inversion. We could not avoid using a stochastic method such as simulated annealing for the minimization of the TF. As stated in the paper (Section 2.2), analytical methods fail because the TF shows several local relative minima and this type of minimization methods are easily trapped into local minima.

If S. Kulawik is also interested, we would be pleased to test our VS method on TES retrievals, we shall be in contact by e_mail to check this possibility.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 18007, 2008.

ACPD

8, S10221–S10223, 2009

Interactive Comment