

Interactive comment on “A non-iterative linear retrieval for infrared high resolution limb sounders” by L. Millán and A. Dudhia

Anonymous Referee #1

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This paper describes a study on the application of a pure linear retrieval approach for the analysis of infrared limb-sounding observations. It is logically structured and all methods are clearly explained. Besides the obvious run-time aspect, it has been stated that one advantage of the method would be the strongly reduced noise error due to the large spectral region useable in contrast to conventional retrievals based on microwindows. It would be good to demonstrate this advantage e.g. by showing the noise errors in case of the MIPAS examples. Also, the trade-off between noise-error and other systematic errors should be mentioned, i.e. that increasing the spectral range may not lead to a significant improvement of the total error. Further, the agreement between the error estimation for the linear retrieval and the differences compared to the MORSE and/or MLS retrievals should be demonstrated. Specific comments are listed below.

P722:

The abstract is very general. It would be nice if any quantitative numbers could already be stated therein.

P724Eq1: The equation seems incomplete. Instead of $K_i^T S_y^{-1}(y - F(x_i))$ I would expect: $[K_i^T S_y^{-1}(y - F(x_i)) - \gamma^{-1}R(x_i - x_a)]$ Could you clarify?

P724Eq2: In case of optimal estimation (i.e. $\gamma^{-1}R = S_a^{-1}$) this would be the formulation for the total retrieval error, i.e. the smoothing error plus the retrieval noise error. However, in case of Twomey–Tikhonov this error makes no real sense since one has not a good estimate of the smoothing error part, which would need a realistic assumption on the atmospheric state covariance matrix. So one should rely on the retrieval noise error which is: $(K^T S_y^{-1}K + \gamma^{-1}R)^{-1}K^T S_y^{-1}K(K^T S_y^{-1}K + \gamma^{-1}R)^{-1}$

P725L15: Could you show the resulting vertical resolution from the averaging kernel matrix to get a feeling of how strong the retrieval is constrained by the regularization?

P726L10: The discussion of Fig. 4 is a bit weak. One should at least try to explain why the profiles oscillate much more than in Fig. 3. (Is there an issue with the regularization?)

P728L19 ‘practically at all altitudes’: But 20% are exceeded at some altitudes. Could you be more specific here.

P728L19 ‘less than 2% error margin at most of the altitudes’: Also here at 10% and 20% pressure increments, the error is larger 2% at many altitudes. Could your statement be made more exact.

P734L10 ‘from band A where most of the CO₂ lines occur’: Perhaps add a sentence why not band D, where also many CO₂-lines are.

P734L11 ‘This viewing mode was selected to apply the algorithm here described because it is in this mode where this algorithm has the more potential.’: Could you explain

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why?

P735Section7.2.1: Does the selection depend on height? Could you estimate the resulting errors due to the assumed limits of 0.9 and 1.1?

P737Section7.3: Is the selection made for MIPAS band A or B? Can you explain why the equatorial profile has been selected so rarely at low latitudes?

P738L21-24: The description of Fig. 16 does not fit well to the differences shown in Fig. 16.

P739L13 'lower than 0.01 hPa': Should this read 'lower than 0.1 hPa'?

P740L17: 'its results should improve once a more reasonable linearisation point climatology is used.' It would be good to demonstrate that this is the reason for the larger errors, e.g. by showing in Fig. 18 the difference between MORSE and the linearization points (or, better, results of the error estimation from chapter 6 applied to the actual case).

Technical:

P723L7: A more recent overview than 'Fischer, 2000' (instead of 'Fisher' as in the text) is 'H. Fischer et al., Atmos. Chem. Phys., Vol. 8, 2151-2188, 2008.'

P732Eq15 first term on right side: ' $\nu - \nu_0$ ' should read ' $v - v_0$ '. Also I doubt that the indices in the equation and below in the text should contain ν since this would imply 'wavenumber'.

P734L11 'This viewing mode was selected to apply the algorithm here described because it is in this mode where this algorithm has the more potential.': 'most' instead of 'more'

P740L21 'consider': Should read 'considered'

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