**Atmospheric
Measurement
Techniques
Discussions**

Interactive comment on "Two-dimensional performance of MIPAS observation modes in the upper-troposphere/lower-stratosphere" *by* M. Carlotti et al.
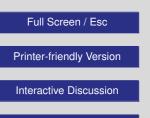
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In their discussion paper the authors postulate that covariance matrices and averaging kernels of Levenberg-Marquardt retrievals include a λI term. This is not correct, the λI term should be deleted. Further, Eq. (2) of the discussion paper holds only for $R = S_a^{-1}$, i.e. a climatological covariance matrix; this expression is not valid for other regularization matrices. Eq. (2) of the discussion paper thus should read:

$$V_{\Delta x} = (K^T S_n^{-1} K + R)^{-1} K^T S_n^{-1} K (K^T S_n^{-1} K + R)^{-1} \tag{1}$$

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Equation (3) of the discussion paper should be replaced by

$$A = (K^T S_n^{-1} K + R)^{-1} K^T S_n^{-1} K, \tag{2}$$

i.e. the term λI should be deleted. In the Rodgers book the form of the averaging kernel (for Levenberg-Marquardt retrievals) as postulated by the authors is not presented, thus the reference is misleading and inappropriate. The correct averaging kernels are inferred as follows: We reorganize Eq. (1) of the discussion paper:

$$(K^T S_n^{-1} K + R + \lambda I)(x_{i+1} - x_i) = \left[K^T S_n^{-1} n + R(x_a - x_i) \right] \tag{3}$$

Convergence means that $x_{i+1} - x_i \to 0$, hence (with $n = y - f(x)$)

$$K^T S_y^{-1}(y - f(x_i)) \to -R(x_a - x_i). \tag{4}$$

We see that x of a converged retrieval depends only on the measurement y, the forward model f, the Jacobian matrix K, the regularization R and x_a (if any), but not on the Levenberg-Marquardt term λI, regardless how large this is in the final iteration. Thus, also the covariance matrix and the averaging kernels cannot depend on the Levenberg-Marquardt term. For further details see my comments to the Ceccherini and Ridolfi paper referenced below.

The authors may argue that the iteration is stopped prior to reaching convergence and that the above does not apply. In this case, however, the expressions in the discussion paper for averaging kernel and covariance matrix are still incorrect and the formalism proposed by Ceccherini and Ridolfi, ACP, 10, 3131-3139, 2010, has to be applied, which leads to different averaging kernels and covariance matrices than those postulated in the discussion paper. In this case, however, the value of a non-converged solution must be questioned.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 2861, 2010.

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