Atmos. Meas. Tech. Discuss., 6, C1806–C1808, 2013
www.atmos-meas-tech-discuss.net/6/C1806/2013/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Remote sensing of atmospheric trace gas columns: an efficient approach for regularization and calculation of total column averaging kernels" *by* T. Borsdorff et al.

Anonymous Referee #1

Received and published: 26 July 2013

The authors present some considerations concerning scaling retrievals and the calculation of associated averaging kernels. The topic is carefully developed, but I have to admit that in my opinion the main conclusions can be derived in a much more straightforward manner without invoking the similarity between an L1 Tikhonov and the scaling approach. I believe that the resulting relations are already in common use in codes (and associated tools for the characterisation of retrieval results), e.g. for the analysis of ground-based spectra. It is appropriate that the authors stress the importance of (column) averaging kernels for ensuring a proper use of the data, e.g. for a comparison with a model. The practical investigation of the required vertical grid width performed

by the authors is an interesting and relevant contribution.

Because the authors claim that the algorithm is efficient and well-suited for operational analysis of satellite data, it would be desirable to include a comparison of the computational efforts required for (1) the simple scaling retrieval without generation of column averaging kernels (2) the proposed processing scheme: scaling retrieval including calculation of column averaging kernels (3) the constrained profile retrieval + generation of required diagnostics (averaging kernels). If the major computational effort is spent for the forward calculation and the generation of the required derivatives, I would not expect that the most flexible retrieval setup (3) would significantly increase the computational cost wrt approach (2). If the generation of altitude-resolved Jacobeans is considerable, an optimized approach (1) would be significantly more effective than (2) and (3), but would require additional consideration of providing a lookup table for the column averaging kernels as function of relevant parameters.

Minor comments / typos:

Abstract: "The proposed method is equivalent to Tikhonov reg of the first kind . . . ." This is only valid if the state vector is used as given in Eq. 30. If the state vector contains e.g. concentrations or mixing ratios the equivalence does not hold. Please state more precisely.

Page 5001: "this measurements" -> these measurements

Page 5002: "In a n ideal case, the column averaging kernel is constant . . ." Ideally, the column sensitivity should not only be constant, but unity at all altitudes.

Page 5002: "Despite its theoretical advantages, only a few retrieval algorithms use this approach. . ." – Not clear to me which aspects of the retrieval the authors refer to.

Page 5002: "[use of scaling retrieval within TCCON]... . But its main drawback is the lack of the corresponding column averaging kernel." – The main drawback of a scaling retrieval lies in the fact that the total column sensitivity shows larger deviation

from ideal behaviour than a profile retrieval. In general, a scaling retrieval provides a poorer reconstruction of the actual column, but it is numerically more efficient than a profile retrieval, especially if the column averaging kernel is not calculated for each individual retrieval. The calculation of the column averaging kernel requires calculation of altitude-resolved Jacobeans, which is expensive. For this reason, TCCON uses a set of reference kernels (as function of solar elevation). A similar approach might be feasible for operational analysis of satellite data (lookup tables containing column averaging kernels as function of relevant parameters, e.g. ground albedo, cloud top height and cloud fraction).

Page 5003: “insides” -> insights

Page 5004, Eq. 3: The first term in the cost function is incorrect (and would not be unit-free for a spectrum in radiance units). Please note: If you allow for a state vector which bears units (“the particular form of fk depends on the units of the state vector. . .”, page 5007), then the entries of the L matrix would bear units, too (whereas Eq. 4 suggests that the L-matrix is unit-free).

Page 5007, before Eq. 14: wrong symbol in the second equation

Page 5014: “faction” -> fraction

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 4999, 2013.