Atmos. Meas. Tech. Discuss., 7, C924–C926, 2014
www.atmos-meas-tech-discuss.net/7/C924/2014/

Atmospheric Measurement Techniques
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Discussions

AMTD

7, C924–C926, 2014

Interactive Comment

Interactive comment on "Smoothing error pitfalls" *by* T. von Clarmann

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Received and published: 14 May 2014

The paper presents a detailed discussion of a subject which is important to the interpretation of remote sensing measurements, but is not well understood in the community. The subject of smoothing error has by-and-large been approached correctly by investigators responsible for retrievals from remote measurements, but its implications and limitations are often not understood by data users.

The current paper will help alleviate this shortcoming. It also presents a quantitative aspect of the subject for the first time, namely its relation to error propagation. The paper is generally well reasoned and well written, with a few exceptions already discussed by other reviewers. I feel it makes an important contribution and should be published with minor changes. One recommendation made by others which I support is to include a few specific examples. They needn't be lengthy. A sentence or two and a reference could specify how a particular experiment dealt with the smoothing error issue.

Both the concepts of smoothing error and averaging kernels are intended to cope with the limited information inherent in remote measurements. The following discussion is relevant to the author's recommendations regarding their use.

The concept of 'null space' error was first introduced in Rodgers, 1990. (It was subsequently renamed 'smoothing error' after A. O'Neil pointed out that 'null space' was not strictly correct.) Clive and I discussed that paper when it was in draft form, and we both recognized smoothing error as a problematic (but unavoidable) concept. However the principal difficulty we saw with it was its dependence on the covariance matrix of variability of the true atmospheric state, which is poorly known at best. To the best of my knowledge, the paper being reviewed is the first to recognize the difficulty with Gaussian error propagation applied to smoothing error.

It emerged from those early discussions that one could eliminate smoothing error from the comparison of atmospheric profiles from different sources (measurements or models) if the vertical resolution of one profile was much finer than the other. The smoothing error is removed by smoothing the high resolution profile with the low resolution averaging kernels. As far as I know, this was used first in Connor et al 1994, who called the result the 'convolved profile.' This approach also removes the a priori profile, used by the low resolution measurement, from the comparison.

Comparing profiles with comparable vertical resolution is more difficult. It was a focus of work around the end of the century and eventually led to Rodgers & Connor, 2003. Here again, as the author of the current paper points out, smoothing can be eliminated as a source of difference between measured profiles, by application of the measurement averaging kernels.

My own approach to the problem is given in Connor et al, 2008, for the OCO mission. It is to provide an estimate of smoothing error as a qualitative guide for the data user, and also to provide the a priori profiles and the averaging kernels. In addition, I have recommended the use of Rodgers & Connor (2003) in quantitative profile comparisons. Thus, I wholeheartedly agree with the author's recommendation for the provision and use of the averaging kernels, and urge him to accept smoothing error as a simpler, if less precise, aide to understanding.

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Interactive comment on Atmos. Meas. Tech. Discuss., 7, 3301, 2014.