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Atmospheric Measurement Techniques Discussions

Interactive comment on "The application of mean averaging kernels to mean trace gas distributions" *by* Thomas von Clarmann and Norbert Glatthor

Anonymous Referee #2

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This manuscript discusses an important and often ignored issue involving the application of averaging kernels to mean profiles. A solution to the problem is presented where the covariance between the averaging kernel and the atmospheric state is calculated. Examples are shown applying the method to MIPAS, and recommendations are given to data producers of monthly zonal mean data.

The manuscript is well written and suitable for publication in AMT after a few comments are taken into account.

General Comments

The discussion and conclusion (including the recommendations) of the paper focuses on the ideal case where the data producer actually calculates (and stores) an averaging kernel for each individual profile. It is somewhat common to only produce representative averaging kernels and perhaps use them as a metric for retrieval performance in a validation/retrieval paper or data quality document. Would a possible recommendation of this work be that a few of these covariance terms should be calculated and included as an assessment of the data quality?

Related to the above point, I have to wonder, is the covariance profile useful beyond a correction when applying the mean averaging kernel? My (perhaps wrong) interpretation is that when the covariance profile is 0, the mean of the retrieved profile is a smoothed version of the true mean atmospheric state. I suppose what I am asking is that if the covariance profile is not 0, is it wrong to interpret the retrieved mean as a smoothed version of the true atmospheric mean? If so, I would like to see a discussion of this included in the manuscript.

Minor Comments

p.1 l.9: ". . . on a given altitude grid . . . "
Here and throughout this section it is written that altitude is the vertical coordinate, however all of the arguments should equally apply to any vertical coordinate.

p.2 l.18: "For a constrained retrieval of the type"
The way this is presented the reader may assume that what follows only applies to

retrievals applying a (possibly iterative) form of eq. 1, when the concepts here are more general.

p.2 l.29: eq. 4
Somewhere here I would like to see a brief mention that $x_{original}$ needs to be converted to the same grid and representation (vmr/number density and altitude/pressure) as the retrieval.

p.3 l.5: "Calculation of zonal averages over L profiles . . . "
Why restrict to zonal?

p.3 l.12: "For a retrieval with $x_a = 0$ . . . "
This is a nitpick and I don't necessarily think it should be changed, but the same would be true with x_a=constant and a Tiknonov regularized retrieval. I guess the general condition would be if x_a is in the null space of R.

p.3 l.22: "For a retrieval where an individual prior x_a is used for each profile . . . "
I suppose this assumes that the prior used is a good representation of the true atmospheric state/variability.

p.3 l.15: "cov(A, x) and be approximated by cov$(A, \hat{x})$"
I have a hard time intuitively understanding the implications of this approximation. I think that there are two things going on here, the first is the switch from the true state to the smoothed state, which I don't expect to have a large effect. But since the intention is to use this to compare two measurements, are we also assuming that both instruments have approximately equal sampling within whatever bin is being averaged?

p.4 l.8: "For retrievals performed in the log-space, all this becomes slightly more complicated . . . "
It is fine to ignore the issues with log retrievals, since, as stated, averaging may have its own issues, but I have to wonder is this not a more general representation issue? Presumably if our goal was to compare a high resolution and a low resolution retrieval that both operated in log space, it would be possible using this framework if the averaging was done in log space.

p.4 l.10: eq. 12
Perhaps related to above, but this equation is hard to interpret when the x's do not represent the same thing (some are in linear space some are logarithmic). Or maybe all the x's are intended to be in linear space and the logarithm being applied to $x_{original}$ is missing?

p.7 l.12: "The covariance effects can exceed 10% and thus need to be considered when mean profiles are used for quantitative analysis and mean averaging kernels are applied."
This statement had me wondering about the implications of this effect beyond comparisons of two measurements. Say a data user is using zonally averaged MIPAS HCN data, but not actually applying any mean averaging kernel. Would having knowledge of the magnitude of this covariance term guide them in their analysis, similar to the way having a measure of vertical resolution from the averaging kernel would?

Technical Comments

p.4 l.18: eq. 13
Equation has extra equal signs.

p.7 l.3: “consistes”
consistes → consists

p.7 l.17: “we recommed”
recommed → recommend

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