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Discussions

Interactive comment on "Technical Note: Temporal change in averaging kernels as a source of uncertainty in trend estimates of carbon monoxide retrieved from MOPITT" *by* J. Yoon et al.

Anonymous Referee #2

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The paper by Yoon et al. points out that trends and temporal variability observed in remote sensing data may in general exhibit a contribution from temporal change of the averaging kernels beside contributions from variability of the targeted true state and the a priori state. They illustrate the finding by assessing the trend in carbon monoxide (CO) concentrations at surface-level retrieved from MOPITT measurements. A sensitivity study indicates that averaging kernel driven variability could be a significant contribution.

The study is of interest to the reader community of ACP. The methods appear appropriate and the paper is well written. Therefore, I recommend publication after considering

the following comments.

- The example chosen to illustrate the effect seems rather malign to me. If I understand correctly, the state vector x contains a vertical CO profile with N layers (N=10?, Fig. 3). The corresponding averaging kernel matrix is an (N x N) matrix. What is called "CO at the surface" is the lowest layer of the profile with the Nth row of the averaging kernel matrix being the relevant smoothing operator (eg. illustrated in Fig.3). Is this correct or do you refer to >800 hPa as the surface layer? Figure 3 indicates that the degrees-of-freedom-for-signal (DFS) for this quantity are probably well below 1. This makes the second term - the contribution from the real trend - on the right-hand-side of equation (4) small. How would the temporal change of averaging kernels affect a better constraint quantity such as total column CO or "boundary layer CO" (eg. averaged between surface and 800 hPa)?

- Do you detect a correlation between DFS and CO trend for real data and/or the sensitivity study in Fig. 5?

- Typically, optimal estimation retrievals provide the sum of smoothing and noise error as the a posteriori error estimate. Temporal change of the averaging kernels should induce temporal change of the smoothing error. Could this be used to detect the effect or even to take it into account for trend estimates?

- I agree with the other review that the description of the sensitivity study (p20326,l5; Fig. 5) to estimate the magnitude of the averaging kernel effect should be revised and more detail should be provided. Partially, the section is hard to understand because the algebra is presented in full vector format, while the example only uses a single component of the state vector. In particular, I do not exactly understand how dA/dt is calculated. Is this the change in matrix elements determined from spatially ($1° \times 1°$?) and temporally (1 month?) averaged AKs (similar to equation (1))?

- p20323,l4: I do not understand what $\tilde{y}^m$ is. Please clarify the text.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 20319, 2013.

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