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Atmospheric Measurement Techniques Discussions

Interactive comment on "Averaging kernel prediction from atmospheric and surface state parameters based on multiple regression with MOPITT CO and TES-OMI O_3 multispectral observations" *by* H. M. Worden et al.

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Please find the authors' replies to Referee #2 embedded below.

Anonymous Referee #2 Received and published: 13 May 2013

The paper "Averaging kernel prediction from atmospheric and surface state parameters based on multiple regression with MOPITT CO and TES-OMI O3 multispectral observations" by Worden et al. provides a method for rapid computation of state-dependent

averaging kernel (AK) estimates for Nadir sounding instruments. This method has been developed for its application to Observation System Simulation Experiments (OSSE) but could easily be employed to other applications such as climate model and instrument validation studies. The performance of this new method has been tested by means of a case study and improvements compared to the conventional use of a "mean AK" are clearly demonstrated. The paper is well written and structured and the methodology used is sound. This work is of high value for both atmospheric observation and climate modeling communities as it provides the basis for a computationally affordable way to consider state-dependent AKs in OSSEs and validation activities. I have only a few minor comments listed below:

Reply: We thank the referee for their encouraging comments.

minor specific comments: Introduction p 2753 l2: OSSE is only one (important) potential target for application of the proposed method. Others are climate model validation, instrument validation, etc. The interest of the scientific community in this important paper could be substantially broadened if the Introduction was less focussed on OSSE and other application were also discussed in more detail.

Reply: We appreciate the comment, however, we feel these other applications would need a separate evaluation of acceptable errors with respect to the true cases. For OSSE applications, which are likely to use average or representative AKs in current implementations, this approach represents a clear advantage. We also note that the title is not specific to OSSE applications and there is a reference in the introduction to a similar method used for climate model evaluation (Field et al., 2012).

p 2759 l1: "Aks are highly corrrelated". Do you mean that the AK columns are broad (i.e., highly correlated non-diagonal elements)?

Reply: This was also a comment of Referee #1. We were implying that the retrieved information is not independent (i.e., correlated) as indicated by the broad, overlapping AK rows. We will re-word this as follows: "However, the number of retrieval levels is

usually many more than the DFS of the retrieval, with highly correlated retrieval errors as demonstrated by the broad, overlapping rows of the AK."

p 2762 l2-3: I don't understand this sentence. The MR predictor contributions are always a linear combination to the MR fit (this is by definition the case in linear regression).

Reply: This was also a comment of Referee #1.We were referring to a linear combination in the contribution to the CO and O3 error metrics used to evaluate the performance of the predicted AKs, but we agree that this was not clear and also confusing given Eq. 5. As referee #1 suggested, we will delete the statement.

p 2764, Section 6: I agree that the metrics used here is more intuitive by using a single mean CO (O3) reference and a priori profile. On the other hand, the "true" CO (O3) profile might be correlated with the predictors (and hence predicted AKs) used in this study which would alter the statistics. Therefore, it would be important to check if the histograms in Figures 15-17 change when applying the AKs to the actual CO profiles corresponding to each observation (instead of the mean). It could also be interesting to look at maps (similar to Fig 1) for the CO differences introduced by the AK proxies at different pressure levels.

Reply: The reason for using common reference and a priori profiles in evaluating the predicted AKs with respect to a CONUS average was to remove the dependence of estimated error on the difference between test case retrievals and the a priori, e.g., if a test case (or "true") CO profile happens to be similar to the a priori, the estimated error could be small even if the predicted AK was a poor approximation. By selecting a single reference case that is sufficiently different from the a priori, we can isolate the contribution in error due only to the different AKs.

We also agree that maps of error due to the application of predicted AKs would be informative, and this will be produced for a future publication as we test the approach with model fields where we apply the "true" AK (from MOPITT, as a start) compared

with the AK predicted using the MR coefficients with input state parameters from the model.

technical comments: abstract, l26: I wouln't define CONUS in the abstract (it is not used there) but in the Introduction. As CONUS is (to my knowledge) not a commonly used acronym, it would be good to introduce it by "the continental United States (hereinafter referred to as CONUS)" Reply: Done.

Fig 17: It should be stated in the caption that it is the same as Fig 16 but with O3 error expressed in ppb (instead of %) Reply: Done.

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