

Interactive comment on “Assessing filtering of mountaintop CO₂ mixing ratios for application to inverse models of biosphere-atmosphere carbon exchange” by B.-G. J. Brooks et al.

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Received and published: 9 November 2011

We are grateful to Reviewer 1 for their feedback and provide some responses here. We agree that there are other papers on regional inversions that can and will be mentioned and discussed in this manuscript (e.g., Gourjji et al., 2012, Wu et al., 2011).

Whether or not a coarse-grid global model is practical for simulations over complex terrain. One of our primary interests in this work is to improve simulated carbon exchange over the RACCOON domain (~10-degrees of longitude)– a large area but of very complex topography that has a very smooth representation in CarbonTracker.

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Although much fine detail is averaged over one advantage is that simulations can be conducted rapidly over the entire domain as well as compared in the context of other regions. Global inversion models do have their disadvantages, but one of our objectives is to attempt to ameliorate these by handing the models data that are representative on the the scales they operate. These kinds of models are probably the most in need of a filtering protocol appropriate to their resolution. It could be argued conversely that a high resolution regional model would benefit less from screening observations due to its improved representation of topographic heterogeneity and wind variability.

Synoptic variability and the 1 ppm hourly standard deviation criteria. Synoptic changes in CO₂ can often be on the order of several ppm and even more than 10 ppm is not unusual. Despite short lived fluctuations in wind these measurements occurring near fronts are relevant and should not necessarily be filtered on that basis alone. As we showed in the paper the statistical filters (SV, SVLG, SVLR), which all have a 1 ppm hourly standard deviation limits, fortunately did not reject these measurements. The 1 ppm standard deviation criteria is a method to flag and reject data points on the basis of excessive short term variability due either to measurement error from the instrument and/or excessive changes in CO₂ resulting from transient local events that bring strong changes in CO₂. Variance is determined from the hourly average of ~3-minutes IRGA measurements.

Filter's based on coarsely gridded global inversion models. CarbonTracker's nested model grid includes 3 levels from 3° × 2° to 1° × 1°. Over relatively homogeneous areas (i.e., oceans) atmospheric transport is limited to 3° × 2°. Over the North American domain transport is downscaled to 1° × 1°. Given this one might expect that a filter relying on a model with generalized 1° × 1° wind fields will be under-representative of the total variability actually observed, as was commented in the review. However,

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since we use only the maximum and minimum lapse rate limits about nine-tenths of the total RACCOON measurements are retained through lapse rate filtering. This is very similar to the proportions of retained observations from the two other statistical filters SV, and SVLG. So it does not seem to be the case that the model-specific lapse rate filter when using CT is being overly selective as we might expect. A large majority of the data would be passed to the inversion model and would be evaluated by the internal filters during assimilation.

Model-data-mismatch as an evaluation criteria for filters. A filter that results in a smaller model-data-mismatch may not necessarily indicate better filter performance. Assimilated CO₂ observations can push the posteriors differently depending on how different they are and on which side they fall relative to the priors. Hypothetically, subset A which is less selective could contain more observations that are a bit closer to the model priors resulting less rejection by the internal filter and smaller model-data-mismatch. Subset B on the other hand, might be more selective resulting in fewer assimilated observations, less “nudging” of the priors, and larger model data mismatch even though the observations that subset B passed to the inversion model were more representative of the model resolution. Due to the aforementioned issues we agree that MDM can be of use in filter analysis, but that it might be best treated separately and in depth with consideration paid to the nature of the assimilation protocol, because it has a strong impact on mismatch. As suggested in the response to Review #2 an error analysis of the sensitivity of the lapse rate filter to lapse rate uncertainty could be more revealing as an evaluation method on the representativeness of that filter for that model in particular.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 25327, 2011.

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