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Interactive comment on "A biogenic CO_2 flux adjustment scheme for the mitigation of large-scale biases in global atmospheric CO_2 analyses and forecasts" *by* A. Agustí-Panareda et al.

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This paper presents an enhancement to the CO2 assimilation system used within the Copernicus tracer assimilation system at ECMWF. The enhancement is certainly useful and potentially quite important but it comes with its own problems. I believe these need to be discussed in the manuscript and addressed in how the new product is made available.

The enhancement addresses the problem of large-scale biases in the fluxes which underlie the prior concentrations used in the assimilation. These biases are a serious

matter since they mean that the probability densities assumed in the assimilation system (centered on the true value) don't, in fact, hold. So this is a potentially valuable improvement.

The problem arises when we consider what the generated CO2 fields are used for. Although there is probably some benefit for improved retrievals of temperature and moisture by improving the CO2 field the overwhelming use for the assimilated CO2 products is in estimating surface fluxes. the statistical apparatus is identical to the assimilation of the CO2 fields and the same restrictions apply. Among them is a firm prohibition on reusing information and the requirement that observations and prior are independent. Both of these are potentially violated in any downstream use of the BFAS product. Let's deal with these two problems in turn.

The assimilated CO2 field now includes information from a prior informed by a previous flux inversion. This inversion presumably used measurements from the in situ network, aircraft and/or TCCON. We can't tell which without a detailed examination of the papers that underlie that inversion. We need to know because, if we're going to use the BFAS product to drive a future inversion, we need to exclude those measurements. One might argue that the periods don't overlap but the evidence of the paper shows that the model-data mismatch is so strongly correlated from year to year (consistent seasonal errors in the pre-BFAS version) that this doesn't avoid the problem.

The second problem, of the prior estimate for a flux inversion being partially reflected in the data we use is not new with BFAS. It exists in the original Copernicus products too. I'm unsure whether the mixing data and model information in the prior CO2 field makes this problem worse but it seems like it should.

Finally there is the question of the uncertainty of the BFAS CO2 field. There are two countervaling effects in play. First the bias correction of the prior has reduced residuals in the generated CO2 field so that uncertainties (which are the statistics of the difference between estimated and true values) seem to have reduced. On the other hand an

extra process has been added to the assimilation with a new set of parameters to scale prior fluxes. These will have their own uncertainty and should (since the posterior CO2 field is sensitive to its prior) increase posterior uncertainty. Which of these wins out? I am always a little wary of criticizing a paper for things it did not do since no piece of research is complete. However it's an important general rule that products that are to be used as inputs to statistical procedures such as flux inversions need to specify their uncertainty as well as their mean.

I believe this paper is a potentially valuable contribution and look forward to the authors' revision. If the authors accept my first point about the mixing of data into their CO2 field then they also need to find a way of detailing which data was used to generate the flux fields that underlie BFAS.

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