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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Technical note: A high-resolution inverse modelling technique for estimating surface CO_2 fluxes based on the NIES-TM – FLEXPART coupled transport model and its adjoint" *by* Shamil Maksyutov et al.

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A short comment by S. Maksyutov (first author) in reply to Anonymous referee #1 comment posted June 29, 2020

The review comment states: "The paper is a technical note, reporting on minor improvements in the setup already described in Belikov et al., 2016. The improvements seem to be exclusively technical (some improvements in the memory management, and the use of a different tool to derive the adjoint code, which would fit better in GMD

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than in ACP). Furthermore there is not demonstration that it achieves any better results of performance compared to that setup or to comparable inverse models."

Author's reply: There is some misunderstanding about developments made since the mentioned paper. It should be noted that in a paper by Belikov et al., (2016), there was no attempt to do the inversion, instead, it focused on development of forward coupled model (at lower resolution of 1 degree), its adjoint, the adjoint accuracy and performance.

In this study, (1) the Lagrangian model resolution was increased to 0.1 degree, and necessary prior fluxes were developed; (2) Flux covariance operator was developed specifically to handle the challenges of operation at high spatial resolution; (3) Iterative optimization technique was implemented and multiple (time consuming) inversion trials were performed before achieving reported results.

The review comment: "In fact, the only results presented are a series of model-data mismatches, which do not demonstrate much, beyond the fact that the model is indeed able to improve the fit to observations (the contrary would be very worrying!). "

Author's reply: Still, do demonstrate that the technical development is valid, and the inverse model does work, showing the fit to the observations is desirable.

The review comment: "Finally, I don't think that the setup is adequate for what it aims to achieve (it makes no sense to optimize fluxes at a 0.1° resolution with covariance lengths of 500 km)."

Author's reply: Using the same resolution in inversion as in transport is achieved in our case with a minor additional computational cost (due to efficient covariance operator). The covariance scale is a tunable parameter, it can be set according to information content available in the observations. Many inverse modeling studies (eg Chevallier et al, 2010) do not assume the current observing network provides enough information to constrain the land biosphere fluxes globally at a higher resolution than 500 km. It

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is mentioned (Chevallier et al, 2010) that with shorter covariance scales the model may take more iterations to converge. Accordingly, the transport model resolution is often higher here than the effective resolution of the inverse model. The rationale for using higher resolution inversion in comparison to lower resolution, such as using large regions, is to reduce aggregation error (Kaminsky et al., 2001).

References:

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