

Interactive comment on “Regional CO₂ inversions with LUMIA, the Lund University Modular Inversion Algorithm, v1.0” by Guillaume Monteil and Marko Scholze

Anonymous Referee #1

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This paper describes a regional flux inversion framework that is designed to have modular functionality. The performance of the system was demonstrated with a series of Observing System simulation experiments and real data experiments. They showed that the flux inversion has improved monthly mean fluxes and fitting to the observations irrespective of experimental setup in the OSSEs, but the fitting to the observations get worse at some sites with real observations. In spite of the improved monthly mean fluxes, the annual total fluxes get worse with almost all experiments. The paper did not explore ways to improve annual total flux estimate. Though this is a modeling development study, I would recommend more discussions about how to improve the system and the advantage of the regional flux inversion compared to existing flux inversion

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system. Here are my detailed comments:

1. It is necessary to demonstrate that the regional flux inversion system developed here outperforms coarse global flux inversion. In this paper, TM5-4DVar is used as boundary conditions for regional flux inversions. I would recommend including discussions on the comparison between LUMIA and the TM5-4Dvar in both OSSE and real observation experiments.
2. The authors attributes the poor annual flux estimates to the larger adjustment to summer fluxes due to larger prior uncertainty. Since improving annual flux estimates is one of the major goals of regional flux inversions, I would recommend authors exploring ways to improve annual flux estimates, especially with OSSEs. In OSSEs, both true and prior fluxes are known, so specification of prior flux uncertainty can be based on the true prior flux errors. The percentage prior flux errors could be much larger during winter than during summer.
3. Validation of flux estimates from top-down flux inversion is a necessary step to assess the quality of the system. The framework described in this paper is lacking the flux validation component. A common method is to compare the posterior concentrations against independent CO₂ concentrations. With high resolution regional fluxes, is it possible to use other independent observations?
4. Please add computational cost of each component of the inversion system
5. Page 24, line 516, replace “than” with “as”
6. Page 26, Line 531, replace “im” with “in”.