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Interactive comment on "Potential of European $^{14}CO_2$ observation network to estimate the fossil fuel CO_2 emissions via atmospheric inversions" *by* Yilong Wang et al.

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General Comments

This paper lays out the potential for current and future $^{14}CO_2$ observations to improve estimates of fossil fuel emissions in Europe. It uses two types of Observing System Simulation Experiments (OSSEs) based on either the theoretical uncertainty reduction

for a well-tuned case or a more realistic case where prior uncertainties do not match differences between prior and truth. It also uses several versions of an observing network ranging from the current network to a saturated case where every grid cell in the target domain is sampled. Results are not very surprising with the current network offering useful information at the conjunction of dense networks and high emissions (and concomitant uncertainties) with the case improving as networks become more dense. results are, however, sensitive to the proper tuning of prior covariances; a salutary result the authors are right to emphasise. The paper addresses an important problem with reasonable if not state-of-the-art tools, is clearly written and within scope.

I have two concerns about the paper, one general and one specific. the authors note the dependence of their results on the resolution of their transport model ($3.75 \times 2.5^\circ$) but I think should do more to evaluate this. It is unlikely that anyone would use this resolution for an inversion of fossil fuel emissions targeting Europe and the guidance on network density is hard to generalise. The authors can help a little here since their group has access to higher resolution models. How much do the representation and aggregation errors change with increasing model resolution. Representation error probably decreases while aggregation error increases but how much? Increased resolution makes gaps in the network inevitable, what effect will they have? this could be tested by a couple of systematic thinning experiments on the saturated network case here.

My other concern is for this saturated case. As I understand it, each grid cell is oversampled with two measurements. If this is the case and the transport Jacobians for the two measurements are the same then I think the two measurements can be combined into a single measurement by summing their information content. There should also be strong correlation between the two measurements in the same grid cell, accounting for large-scale errors in the transport model. In particular, I think that the relationship between the aggregation and representation errors for the two types of site is complex, interesting and perhaps important. It is quite possible that using both types of site

reduces the sampling inhomogeneity necessary for aggregation errors (Trampert and Snieder, 1996; Kaminski et al., 2001).

References

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