

Dear Hyun Mee Kim,

Thank-you for the additional work that you and your co-author have undertaken to address my comments on the reviews of your manuscript. The extra experiment that you performed, ECOSS\_low is very helpful in confirming the usefulness of the self-sensitivity measure for selecting sites, and I think it would be good to refer to this experiment in your manuscript (see below). I noted in my previous correspondence that "I have a number of less important comments and suggestions but these are likely to be dependent on how the paper is revised based on the above questions, ...". I now include those suggestions where relevant. The list looks long but I think they can all be addressed with minor revisions. The page and line numbering is taken from the file 'acp-2019-241-author\_response-version3.pdf'.

P12, line 26: replace 'OSSE' with 'OSSEs'

P12, line 27 – P13, line 8: The IO and GA methods can both accommodate existing networks and I don't think the size of the region being examined needs to determine which network design method is useful. I think the comment you need to make is that the network design method needs to be appropriate to the inversion method being used. In methods where most of the computation effort can be independent of the network (e.g. through the simulation of response functions that can be sampled for any location), GA and IO methods are relatively inexpensive to run. For methods that require the full computation of the inversion for each network choice, GA and IO methods are not efficient. Please modify this paragraph.

P13, line 14: replace 'would' with 'could'

P15, line 7: replace 'suggested in' with 'based on'

P15, line 8: delete 'In addition,' and change 'from' to 'From'

P15, line 9: replace 'calculated' with 'sampled'

P15, line 11: insert 'a' before 'verification region'

P15, line 12: need to refer to Figure 1b, and minor changes i.e. 'number of ecoregions in the verification region is 40, of which 36 are Asian ecoregions (Fig. 1b) and 4 are ecoregions of Europe.'

P17, line 4: replace 'feasible' with 'possible'

P18, line 14: replace 'If there are' with 'Following Liu et al. (2009), we assume'

P19, line 22: You have added a comment in Section 4 about using alternative hypothetical observations, but I think it is also important to mention the issue here. Perhaps add 'One limitation, of this choice of hypothetical data, is that it uses the same spatial distribution of fluxes within an ecoregion as used in the inversion method, whereas in reality the within-region flux distribution could be different.'

P20, line 3: delete reference to model-data-mismatch (MDM) as this is not used elsewhere. Re-write as 'Observation error for the CO2 observations was set to 3 ppm, ...'

P20, line 22: add ', subject to a minimum spacing of 1000 km.' after 'randomly redistributed'

P20, line 28: Add an extra sentence '... observation network. Note that all additional sites are also subject to the 1000 km separation criterion. The 10 extra ...'

Section 3.1-3.4: Removing the PC and BIAS makes the paper clearer and easier to follow, but there were the places where this meant the text could be further improved (some suggestions below).

P23, line 14: Suggest delete the sentence 'Overall, REDIST ...' since the difference is mostly in summer and that is discussed in the following sentences.

P24, line 7: I don't think it is the uncertainties (always set to 3 ppm) that cause the larger summer RMSD, just that fluxes are larger in summer. Suggest 'The RMSDs of all three experiments are larger in summer, which may be caused by the larger surface carbon fluxes in this season as seen in the strong drawdown of CO<sub>2</sub> mole fractions shown in Fig. 2.'

P24, line 10-11, and p25 line 21, line 24: Suggest no decimal places needed on the maximum values.

P24, line 25: insert 'following' before 'experiments'.

P25, line 17-19: Suggest deleting the sentences 'However ...' and 'Specifically ...' as these repeat information presented elsewhere.

P27, line 18: add 'and deserts' after 'oceans'

P27, line 27: add 'in an ecoregion' after 'observations'

P27, line 27: add to end of paragraph 'Selected sites are listed in Table 4.'

P28, line 16 – P29, line 15. There is some repeated information in these paragraphs that could be reduced (e.g. most of the final paragraph of the section). Also now that you are showing the maximum and minimum RMSD from the add experiment, the apparently poorer performance of SS relative to ADD in summer and the better performance in winter is less obvious so a less detailed comment about this would be sufficient. It is worth noting that ECOSS gives smaller RMSD across the whole year. This would also be a good place to mention the extra experiment (ECOSS-low). I suggest replacing the sentence on line 22-24 with 'To confirm that the improvement is not just from including the ecoregion information, an additional test was performed using the same regions as ECOSS and the locations of lowest self-sensitivity in those regions. The resulting RMSD is similar to ADD and SS, confirming that both high self-sensitivity and ecoregion information is needed to give the improved results of ECOSS compared to randomly added observations sites.'

P30, line 4: Add 'Note that the 1000 km site separation criterion is still applied and this results in some different ecoregion selection between cases.'

P30, line 25: Suggest replace 'due to minor differences in the choice of observation sites' with 'since the two networks are quite similar'.

P31, line 8: Suggest adding after 'Asia', 'for the whole year; the distribution for summer is similar.' If this change is made, the sentence on p32, line 2-3 'The spatial RMSD ...' can be deleted.

P32, line 7: replace 'that region' with 'the Siberian region'

P32, line 25 onwards: Since Table 6 is now the only place that you present the correlation, I think it would be good to discuss it more explicitly, including that it is generally high due to the fixed flux distribution within ecoregions. In this paragraph you refer to lowest and highest skill score, but it might be clearer to differentiate PC and RMSD since for PC higher is better while for RMSD lower is better.

P34, line 6: It might be good to quote the RMSD values (as in Table 6) for these experiments to aid in the comparison with the earlier results.

P34, line 11-12: re-write sentence as 'in Siberian regions which lacked observation data in CNTL and showed high sensitivities in Fig. 6 and high RMSD in Fig.9a.' I think the remaining two sentences of this paragraph could be deleted as they appear to repeat information already provided.

P48, Table 3 caption: suggest adding '(see also Fig. 1b)' after 'verification domain'

P55, Fig 3 caption: suggest adding an extra sentence 'Note that cases (b-l) require a minimum 1000km spacing between sites.'

If you have any questions about these recommended edits, please don't hesitate to contact me by email.

Regards,

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