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Comment on essd-2021-235

Anonymous Referee #2

Referee comment on "Comparing national greenhouse gas budgets reported in UNFCCC inventories against atmospheric inversions" by Zhu Deng et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2021-235-RC2, 2021

I find this manuscript to be a fundamental milestone in addressing a key need in developing independent methods for monitoring country reporting of GHG emissions to the UNFCCC. The possibility to use inversion model results as an independent, science-based tool for monitoring has been long put forward by the IPCC, so much so that teh refined 2019 guidelines dedicated new sections to it. A few countries in Europe have even begun including early systems in their national GHG inventory (NGHGI) processes.

Having said that, in fact becasue of it, my opinion is that this manuscript, while offering a view into what is possible currenlty with available data and model capabiliies, needs to be equally fully transparent about the underlying uncertainties and limitations. I have made many comments throughuot the manuscript that point to these needs, with recommendations to the authors to address each of them.

More in general, the authors need to be transparent about the follwoing issues:

1. While comparisons with NGHGI data appear to be remarkably positive in the sense of demonstrating the power of inversion modeling, I was left with the doubt that at least some of this agreement is built in and a consequence of significant calibration. For one, the inversions are driven by primers, typically global model data which in turn are often derived from the NGHGIs data --or are constricted in a similar fashion. The reader should be informed of the degree of depence between one (the primer, consistent with and oftern adjusted to reproduce NGHGI) and the other (the results, compared to NGHGI).

2. Even when the independence of model and observation are sufficiently demonstrated, the reader is still poorly informed on the degree of uncertainty upon which the inversion modeling depends upon and the implications for result interpretation. Uncertainty in input primer data; uncertainty in land cover maps used to derive land fluxes; uncertainty in

lateral flows used to modify apparent inversoin signals; among several others.

3. The reader is not sufficiently informed of the mapping that was used to ''read'' the UNFCCC country data used for assessing the good ness of the inversions. As the authors state, Annex I data are pretty straightforward. But the same is not true for GHG data from NAI countries. How were in practice LULUCF, forest land and other type land data read and mapped into categories that are instead used by the inversion models? Such information should at least appear in the SI, but it's not there.

4. Which were the global datasets used as primers? THis is also not clear. For LULUCF, it's unclear whether FAOSTAT was used, as a complement to country data or not.

5. Considering the above, I found that the authors tended to discuss discrepancies between inversion model results and NGHGI by consistently assuming that the models were right and the NGHGI wrong. Although some of the theoretical reasoning may at times be correct, the underlyin guncertainty in both sources would in my opinion advice for greater caution in drawing such assumptions--- in general it does not seem that any definitive direction can be deduced from the available data.

6. Considering the importance that is being placed--rightfully--on the use of inversion modeling as an additional, independent and very much perfectable instrument in coming years for monitoring the quality of NGHGI data, I would have expected a more detailed and nuanced discussions where current limitations (ie uncertainties but not only--issues of land use definitions are also very important to the usability of such methods) lie, and what a honest assessment of the performance of the current exercise suggests for the future: where are the most important areas for improvement and what can be done to improve the system. For instance, is the currently uncertainty sufficient for use in monitoring GHG mitigation actions? If the inversion models have a given uncertainty range attached to them currently, what is then the minimum range of monitoring that they could permit? IN practice, can a system that carries uncertainties of 50% and above be able to monitor changes in NGHGI inventories (needed to demonstrate mitigation actions) of 10-30% over the next decade?

For all the above reasons, I strongly feel that this manuscript should be published in ESSD, but only after major revisions that address my points.

Please also note the supplement to this comment:
https://essd.copernicus.org/preprints/essd-2021-235/essd-2021-235-RC2-supplement.pdf