RC4 Hélène Peiro

Thank you for the opportunity I was offered to be reviewer and I would also like to thank the authors for this excellent study. This latest version of the global carbon budget study is a useful and comprehensive work for the carbon community. Please find below a few comments.

Thank you.

ln.333. How the added decomposition of ELUC into its main component improve or change the Global Carbon Budget?

It doesn't change the Global Carbon Budget in the sense that ELUC is still the net flux seen by the atmosphere and used in our global budget (see equation 1 in the Introduction). However, the new decomposition of ELUC allows us to better distinguish sources due to direct deforestation or to organic soil carbon loss (in peatlands) from. sinks on forest land such as through afforestation/reforestation.

ln.353. It should be BP energy company.

Done

ln.401-403. these sentences could be rearrange and rewrote in one sentence. The information seem redundant.

Not clear what information was redundant, but we slightly rephrased to shorten the sentence.

Ln.403. 3 independent datasets for peat drainage are included. It is not well clear which are the corresponding datasets in the section 2.2.1

These are described in the appendix, section C.2.1 (which is referenced at the end of Sec. 2.2 for further details), but we also added the reference here.

ln.539. A fourth simulation has been added in this 2022 paper compared to the 2021 paper. It is not clear what the added simulation brings to the study in comparison to the previous one.

As explained in the text, the 4th simulation (sim D) is used to compare the change in anthropogenic carbon inventory in the interior ocean (sim A minus sim D) to the observational estimate of Gruber et al. (2019). See also section 3.5.5 on models evaluation.

ln.617. CMS-Flux is assimilating both GOSAT and OCO-2 simultaneously. Even if these sensors have similar spectral bands, their calibration are not perform in similar ways which could bring non- negligeable biases in the inversion result. It would, hence, be interesting to know (useful for the inversion results of this manuscript) how the biases resulted from the joint GOSAT and OCO-2 assimilation was considered in the CMS-Flux inversion.

CMS-Flux indeed assimilates GOSAT for the period of 2010-2014, and OCO-2 for the time period of 2015-2021. But they are not assimilated simultaneously. When compared to independent observations, there is no obvious differences in performance during the GOSAT time period and OCO-2 time period (Figure 9 in Liu et al., 2021 and Figure B4 in this manuscript), which indicates that there is no obvious bias between GOSAT and OCO-2, at least at larger scale. Furthermore, both GOSAT and OCO-2 retrievals used in CMS-Flux were generated using the same retrieval ACOS retrieval algorithm and validated against the same TCCON observing network. When validating against TCCON observations, both GOSAT and OCO-2 retrievals have mean bias ~0.1-0.2 ppm, and RMS ~1.0ppm (Figure 8 in Tayler et al., 2022.

Section 3.1.1 Even though the values have been updated, the text is similar to the 2021 paper. It would have been interested, for instance, to add further information comparing the 1850-2021 (including the post-covid lock-down) and 1850-2020 (including the covid lock-down) periods. Some of the difference between 2021 and 2020 are mentioned in section 3.1.3 but this could be mentioned in section 3.1.1 as well.

Section 3.1.1 is about the full historical period (starting from 1850), not about specific years. We have a dedicated section 3.1.3 on the year 2021.

Ln 672, in comparison to the 1850-2020 period, the 1850-2021 one has only a decrease of 1% from natural gas but the contribution of the other sources have not changed. Do you know if the reduction in natural gas emission is coming from a specific region or not?

This 1% changes is due to rounding errors and minor revisions in the annual estimates of fossil fuel components, it is not due to the addition of one year.

ln.679. need to remove a parenthesis after Hoesly et al., 2018.

Done, thank you

ln.773. You mention "these changes [...] lead to higher net emissions in Brazil in the last decades compared to last year's GCB" . It would be useful here to add some carbon emission values. How much carbon emission are you talking about?

We have now added the values of GCB2021 in comparison to GCB2022.

ln.777. You mention that the increase in deforestation over Brazil and the associated carbon emission is not well capture. Do you have an estimation of how much carbon emission from the deforestation in Brazil is missing in your estimation? For future GCB, do you consider additional measurements (i.e. chlorophyll fluorescence or vegetation canopy from spaceborne platforms) to help better address and monitor deforestation related to the global carbon budget?

On the first question: We cannot quantify differences to the cited Silva Junior et al study, since that study and the land use forcing underlying the GCB simulations consider different types of land use/cover changes. We therefore removed this sentence. On the second question: We re-entered information from last year's budget where we discussed that a comparison against Earth observation data is not directly possible.

ln.1049-1050. Why not using an other dataset independent from the data products?

Fair point. We may add comparison to pCO2 calculated from GLODAP DIC and Alkalinity, for example, as in Gregor et al., 2019 (https://doi.org/10.5194/gmd-12-5113-2019) in the future. However, the data products are all fairly close to each other, independent of the evaluation data set used, and not much information would be added by adding other datasets. SOCAT is the data set which has by far the largest number of observations and is thus the evaluation dataset of choice for the GOBMs. We thus prefer to use SOCAT in order to compare GOBMs and data-products in one figure.

ln.1242. I could not find Section 2.7.4.

Sorry, it should read Appendix D4. Corrected now.

ln.1345. CO2 should be CO_2

Done, thank you