RC5 Damon Mathews

Overall, this paper continues to improve and the authors are to be congratulated for this sustained and important effort. I have only a couple of minor comments (mostly since I did not have time to more thoroughly review the entire manuscript).

1) Cumulative emissions since 1850:

On p9 the cumulative emissions since 1850 are described as aligning with the IPCC AR6 pre-industrial period, but this is not correct, since technically the pre-industrial reference period for global temperature is the 1850-1900 average (not 1850 specifically). So to align precisely with this, the cumulative emissions should be reported similarly. A quick option would to report cumulative emissions since 1975 (the midpoint of the pre-industrial period). Better however (if we want to be exactly precise) the total since the 1850-1900 reference period could be calculated as (cumulative total since 1850) - (average of cumulative emissions since 1850 for each year from 1850 to 1900). Providing this number would also be helpful for estimating the TCRE and remaining carbon budget based on historical observations, since these are the cumulative emissions that are associated with warming since the pre-industrial period, whereas cumulative emissions since 1850 would be associated with warming since some period entered on the year 1850.

Not clear which sentence the reviewer refers to as there is no mention of IPCC on page 9. Maybe the reviewer meant page 7 where we wrote: "Finally, it provides cumulative emissions from fossil fuels and land-use change since the year 1750, the pre-industrial period; and since the year 1850, the reference year for historical simulations in IPCC AR6 (Eyring et al., 2016).". This sentence is correct, the historical simulations from CMIP6 did start in 1850. This has nothing to do with the 1850-1900 reference for temperature.

2) National land-use CO2 emissions

The text and figures speak to national-level estimates of CO2 emissions from LULCC — this is a great addition to the carbon budget, and would be important to include if possible in the national emissions datafile that is produced. At the moment, the list of data products in this file (National_Carbon_Emissions_2022v0.1.xlsx) only include national FF emissions. Can you add a sheet to this file that gives the accompanying national land-use CO2 emissions?

Excellent suggestion. Consider it done !

3) Atmospheric CO2 growth rate

I have been asked many times by media why CO2 concentrations continued to grow in 2020 despite decreased CO2 emissions ... of course the answer is obvious, but nevertheless remains a question that many people ask. Might be helpful to address this specifically in the executive summary, as well as elsewhere is the manuscript -- for example, can the drop in atmospheric growth rate in 2020 be attributed to the drop in emissions? Maybe not (given other contributing factors) but in theory, all else being equal, the atmospheric growth rate should be roughly proportional to emissions, which could be highlighted for public communication purposes.

We sympathise with the reviewer, this is one of the many common misunderstandings about the carbon cycle. There are (at least) two issues here. First issue is a confusion between

change in emissions and change in concentrations. An emission decrease of X% would translate into an atmospheric CO2 growth rate decrease of X% (everything else being equal), NOT into an atmospheric CO2 decrease of X%. Second issue is the natural year to year variability of the land carbon cycle which is significantly larger than any past changes in annual emissions. Even the 2020 decrease of 5.4% (about 0.5GtC) is smaller than the natural year to year swings in the land carbon sink (see Figure 4 panels b and d).

On the first issue, we feel there is not much we can do. The whole paper (ex figures 2, 3, 4, 14, Table 6, and related text) makes it clear that the global carbon budget is defined as: atmospheric CO2 ***growth rate*** *= sources minus sinks (equation 1). On the more specific second issue (can we detect a change in emissions?), we changed the last sentence of the executive summary to make it clearer: " Year to year variability in the land sink is about 1 GtC yr-1 and dominates the year-to-year changes in the global atmospheric CO2 concentration, implying that small annual changes in anthropogenic emissions (such as the fossil fuel emission decrease in 2020) are hard to detect in the atmospheric CO2 observations."*