Review of ESSD-2023-166:

Indicators of Global Climate Change 2022: Annual update of large scale indicators of the state of the climate system and the human influence, by P. Forster et al.

Review by G. Janssens-Maenhout, 9/5/2023

General comment

In line with IPCC's values to provide unbiased, traceable and transparent information and conform with the FAIR principles for sharing data, this paper documents important indicators for closely monitoring the climate change that can be attributed to human activities. While the IPCC AR (FAR until AR6) were giving similar information at relative large timesteps of 5+ years, the ESSD paper series will now continue to give for these indicators such information on an annual basis. The period covered are 10 years, 2013-2022, while AR6 covered 2010-2019. Given the acceleration in climate change and urgency for stepping up climate actions, this is most appreciated. The dataset is fully available on zenodo, authored by 13 coauthors of the ESSD paper.

However, it would have been useful to just extend the period with 3 yr before and 3 yr after the AR6 period, covering 2007-2022 for two reasons: (i) the average over the 10 yr 2010-2019 can be confronted with averages over a symmetrically extended period, (ii) 2008 saw a dip in emissions due to financial crisis and 2020 due to COVID. In the aftermath of the financial crisis, we saw a stabilising of the emissions, (Cfr. https://www.pbl.nl/en/publications/trends-in-global-co2-emissions-2013-report) but this seemed only a temporarily slow down. How can we be sure about a definite stabilising in the aftermath of COVID? It would be interesting to compare the shocks of 2008 and of 2020 and their impact on the successive years 2008-2010 en 2020-2022.

The indicators cover emissions (GHG as well as SLCF), GHG concentration, radiative forcing, surface temperature change, Earth energy imbalance, warming attributed to human activities, carbon budget and global temperature extremes. Unfortunately, indicators related to the water cycle (closely interacting with the carbon cycle) are not part of the set of indicators. While surface temperature change is a prime indicator (Fig.8 being one of the most important figures), other indicators such as soil moisture and water availability might have more direct impact on humans and nature. (Similarly, the addition of the global temperature extremes is much valued.)

Specific remarks:

Lines 78, 1234: Stabilising emission trend might be risky to claim. A slowing down of the increase might be a more prudent and correct claim.

Lines 66, 149: Emissions: please specify that these are emissions of GHGs and SLCF.

Line 200: FFI = fossil fuel and industry. It is then further explained that industrial process emissions are meant. It might be useful and clarifying to say that e.g. biomass and biofuel used in industry is not included.

Line 201: Not only deforestation but also forest degradation might be added.

Line 204: F-gases are also emitted by military activities (in the past 20% shares have been estimated). It might be clarifying to mention that these are excluded?

Line 220: there are other global inventories worth mentioning here:

- Carbon monitor https://www.nature.com/articles/s43017-023-00406-z
- TNO CAMS CO2 global emissions inventory https://coco2-project.eu/data-portal

Line 232 and line 260: the uncertainty of CO2-LULUCF is not consistent: +/- 2.6 versus +/- 2.8. Please clarify

Line 286: CH4: recent progress has been made: please take up insights from E. Nisbet et al., 2023 (DOI: 10.22541/essoar.167689502.25042797/v1) and from Z. Zhang et al., 2023 (https://www.nature.com/articles/s41558-023-01629-0)

Line 282: not only an adjustment. It seems to me that also the uncertainty got significantly reduced (from 6.6 to 5.7 Gt CO2e). Please clarify if this is also due to improvements of the LULUCF emission estimates.

Line 300: Table 1: surprisingly the projection for 2022 has the same uncertainty as the calculated value for 2021. Is the extra uncertainty for the projection so small?

Line 338: another source of SLCF emissions is Crippa et al. ESSD (2018)

Line 355: Although CEDS gives estimates for 1750, it covers also 1970. The methodology to calculate the emission estimate for 2019 is much more similar to the values in 1970 than in 1750. Why not selecting also 1970 as like for CO2e instead of 1750?

Line 400: Also here an extra column with the value for 1970 could be useful.

Line 523: when changing the dataset from IEA to IATA, is there a jump? Can this be assessed with the IATA data backwards before 2020?

Line 615, Table 4: I do not understand a trend here for the aerosol cloud interactions? Any comment on these three values?

Line 810, states to assume “recent” linear trends. I can understand that the latest increment can be linearly assessed, but is the entire trend also linearly assessed (given the multivariate linear regression method in line 850)?

Line 1025: the global surface temperature is “close” to linearly proportional to the cumulative global CO2 (not CO2e?) emissions. The causal relationship between the global surface temperature and the cumulative emissions, can be assessed with the response on a significant change. Can this be done for the change of CO2 in 2020?

Line – Table 8: It is difficult to “interpret” the different levels of likehood to limit the global warming, I would have thought that we’ll can consume our 3 yr margin (150 GtCO2e), for inducing > 1,5 deg C with 67% likelihood, but in the conclusions in Table 10, it is claimed that we exhausted already our margin and have already now a chance of 1 in 3 to exceed the 1,5 degC. How do the two Tables link?