

## Review 2021-386, global carbon budget

Thank you opportunity to review global carbon budget. I conclude authors have submitted (another) excellent product. Comprehensive and careful compilations and analysis, great graphics, excellent presentation (other ESSD papers should emulate Tables 1, 2 and 3), easy-to-access and easy-to-use spreadsheet. Thanks to authors and thanks to ESSD.

I make a few comments about confusing organization and also (mindful of admonition from editor to find ways to shorten) a few suggestions on ways to shorten. Overall, I enthusiastically recommend publication.

- 1) Abstract, exec summary, introduction, etc. I suppose authors might intend abstract and introduction for other scientific users, as for many ESSD papers, with executive summary for non-experts? Reader now confronts abstract of three paragraphs, with middle paragraph devoted entirely to numbers, then executive summary organized as highlight sentences followed by explanatory numbers. To this reader, all this text seems highly (carefully?) technical, backed by best numbers. If so, then I do not understand purpose for exec summary. If authors want exec summary included in a reviewed document, they should eliminate as much redundancy as possible? Summary highlight sentences should go in conclusions? Or into abstract, in place of quantitative paragraph? Or, they could make exec summary as a separate document, used on GCP website? In present formats, I do not understand purpose of exec summary.
- 2) Page 5 Lines 15, 16 - "patterns reflect the stringency of the COVID-19 confinement levels": Which patterns? 5% drop in 2020? 5% rebound in 2021. Combined drop-then-rebound pattern? Country-to-country comparisons? Authors raise confusion with this statement.
- 3) Page 5 Lines 17 to 19 - 23 countries achieved significant reduced emissions over past decade but these countries do not represent the big emitters? But sources remain national reports which can be 'cooked' according to country preference? Here the authors seem to intend to write for a non-expert reader but they somewhat fail to make their point?
- 4) Page 5 lines 20 to 30 - more confusion here? All LULUC refers to managed land? Emissions only changed due to changes in management? Decrease (significant?, not significant?) over prior decades not well documented here?
- 5) Page 5 line 29 - "the (rising) importance of degradation": Degradation here means land previously used as cropland or grazing land now abandoned? Or, burned? Not clear what the authors intend here?
- 6) Page 6 lines 6 to 10: important statement, has gotten or will get much attention, but seems somewhat of a diversion for GCB? Also, line 13 refers to "net zero". Do authors adopt political conventions of assuming unproven unrealistic CO<sub>2</sub> removals, or do they mean quantitatively-rigorous zero emissions? Need more careful language here, to avoid misinterpretations?
- 7) Page 6 line 21; global reduction of 0.18 ppm? Really? Hard to find any evidence for such reduction on e.g. CO<sub>2</sub> Earth (NOAA)? Ironically, 0.18 change here equals exactly the calibration change (likewise 0.18 ppm) outlined on page 16. Circumstance?
- 8) Page 6 lines 22 to 29: A statement about real change in ocean uptake or about current deficiencies in ocean observations? Both? Can one conclude the former while acknowledging the latter?
- 9) Page 7 lines 5 to 7: Important statement here but redundant with text above?

At this point, before conventional Introduction, reader has encountered exec summary containing / highlighting seven important points. Authors have conveyed mixed message. If abstract and introduction, followed by methods, results, and discussion/conclusion, proceed in well-written sequence as expected for ESSD product, with exec summary added to provide a short-cut for readers who do not want, or lack time, to read entire manuscript, good. But language of exec summary remains too similar to normal technical text, so that it does not

appear friendly to non-experts? In attempting to extract, authors have too many times added confusion. Get someone else, outside of this group, to write an exec summary? Make it a separate product from this complete description manuscript? I think I understand intent, and I applaud effort for this product, but outcome not as clear or distinct as authors might have liked. Making it a separate product would save approx 3 pages here?

Page 8 line 4: reader sees 412 ppm here but just a few lines (page 6 line 17) earlier saw 414.7, almost 415 ppm. Need to make clearer distinction between final QC'd value for 2020 (here) and first projections (earlier)?

Page 8 line 25, 26 - "to quantify the permissible emissions for a given climate stabilization target": But, 'permissible' emissions involve a morass of social assumptions and choices, as evidenced by massive literature around SSPs. Can this group really quantify future emissions as a function of a biogeochemical carbon cycle separate from vague social choices? I understand desire to see this product take a greater impact on social change but I worry slightly that authors 'bend' their otherwise-excellent quantitatively-rigorous product toward highly-uncertain future estimates.

Page 13 line 15 - "all other countries combined"- a bit vague, somewhat awkward, allows reader confusion?

Page 16 lines 16, 17: these represent impacts of calibration corrections, not actual emissions reductions! Authors know exactly what they intend but they here open the door slightly to reader misinterpretation.

Page 17 line 9 - "0.17 GtC yr<sup>-1</sup> for 1980-2020": This number is essentially identical to the decrease authors have reported due to Covid-19?

Page 23 line 10: same 30+ aircraft CO<sub>2</sub> measurement projects as listed in prior versions? If so (I have only done a perfunctory comparison), these could be cited rather than re-reported? Save another formatted page or two?

Page 24 line 10, Fossil fuel emissions: In all these results sections, authors report based on historical (1850-2020), recent (1960-2020), final (2020) and projection (2021). Not until partitioning discussion at section 3.7 (top of page 40) does reader again encounter decadal results. But, at least through exec summary and introduction, authors have presented decadal outcomes and trends as of primary interest. Reader needs to know beforehand that decadal trends relate only (primarily) to component exchanges and regional or country-specific assessments?

Page 43 line 23: extra or misplaced comma here?

Page 44 line 16: FACE experiments?

BIM discussion starting from page 45 line 22 = excellent!

Page 47 line 24 'Tracking progress': Again a small voice of caution. After pages, table and charts of highest quality with itemized uncertainties and extensive validation, authors next turn to a purely political agreement from Paris. If the information here seems or proves relevant to that agreement, good. But readers can get the sense that Paris agreement contains hard QC'd targets, which it emphatically does not. Authors use their hard (and, hard-won) numbers to show progress toward a soft target?

All these discussion rely entirely on national reports which - unfortunately - we must regard as estimates at best or as manipulated at worst. Uncertainty discussion (e.g on page 50) focuses on sectors, definition boundaries, activity factors etc. but seems nowhere to acknowledge deliberate mis-reporting? Here, however, authors take readers through a logical, orderly, quantitative assessment (e.g. through pages 48, 49 etc.) Meanwhile, as reported earlier in manuscript and as reported hourly, daily, monthly, annually etc. by NOAA, atmospheric CO2 concentrations rise consistently and relentlessly. Nothing I write will seem unfamiliar to these authors, but their products seems to divide here: the reality of atmospheric concentrations on the one hand vs these hopeful projections about remaining emissions on the other. Annual GCB must acknowledge and report latest data relevant to both views, but in a way that leaves readers/users clear about what represents hard data and what represents political and politically-motivated targets? I don't know what to suggest as clear separation or resolution but present format seems to give equal credence to both aspects. Perhaps make clearer somehow (as in your uncertainty sections) where you rely on measured concentrations and where on national reports? If national reports referenced to actual concentrations? Great! But national reports with the same apparent credibility as measurements? Cautious.

Page 49, lines 15 to 17: Confused again. a) Net zero here means quantitative zero net emissions, not politically expedient net zero based on future imagined reductions? b) If apparent 0.5 GtC reductions due to Covid-19 in 2020 were NOT matched by equivalent reductions in atmospheric CO2, then how can we advocate similar or continued emissions reductions of that magnitude? I do not dispute goals or policy, but data shown here suggest that 2020 Efos changes had minor to zero quantifiable impact on global atmospheric CO2?

Page 51 line 8 - NGHGI?: One suspects 'National GreenHouse Gas Inventories' but the acronym needs accurate definition.

For the most part, consider this list of comments as suggestions only. One reader encountering this product from a personal viewpoint. A few typos you will want to fix but otherwise not much that requires definite change.