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Interactive comment on "Global emissions pathways under different socioeconomic scenarios for use in CMIP6: a dataset of harmonized emissions trajectories through the end of the century" *by* Matthew J. Gidden et al.

Anonymous Referee #1

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General Comments

This is a very well written paper. It presents nine newly harmonized and downscaled scenarios for CMIP6 activities that complement scenarios used in CMIP5. The reasoning for the inclusion of the new scenarios are well founded and the analysis is thorough and well organized and presented. The figures complement and are illustrative of the points raised in the text. The harmonization is the result of the application of a methodology using a software package named aneris, which is explained elsewhere in previously published articles. As such, the validity of the harmonization method and

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a case study of it have already been subject to peer review.

However, in my opinion, a few points should be addressed before the paper is ready for publication.

One general caveat for acceptance for publication (which led to my "major revisions" request) has to do with the reproducibility of the experiment. On the one hand, the fact that aneris is provided as an open source software package available for download, goes a long way toward reproducibility. However, I was not able to find anywhere in the manuscript a clear link to the data used as input for aneris to perform the harmonization and downscaling. Are these scenarios the same that are available in the public SSP or CMIP database? If so, it should be clearly stated and a link provided. If not, then all the data necessary to replicate the experiment should be made available somewhere and a link provided to it. In my opinion this is required for acceptance of the manuscript for publication.

Additionally, the reference list includes mostly papers authored by the authors themselves. A broader literature review is recommended.

Specific Comments

This article presents a broader application of the harmonization method described in previous publications, but also adds a downscaling process to the scenarios. This downscaling process is partly explained here but the reader is referred to external documentation for further information. In particular, the article Feng (2018) is not yet published, so it is not possible to fully evaluate the validity of the methodology used or of the results obtained. The authors do provide a summary of Feng (2018) in the appendices, but see below for a request for clarification about that.

2.1.3 Region-to-Country Downscaling

Some questions about region-to-country downscaling emerge, particularly about assumptions made. For instance, the use of a linear downscaling method “means that

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the fraction of regional emissions in each country stays constant over time" (page 9 line 30). This seems an oversimplification for sectors that may represent a large share of emissions in many countries today (mostly developing countries). However, this may not be true in the future, especially as countries develop and energy use increases. Thus, holding the share of LUC emissions constant over time overestimates their contribution to total emissions, and downplays the potential contribution of energy use in these countries. More importantly, it downplays any mitigation efforts potentially implemented by such countries. Is it reasonable to assume that in SSP1 the shares of Agricultural Waste Burning emissions will remain constant? Why?

This assumption is made without any justification or analysis of its validity and potential impacts on results. The reader is referred to the "downscaling wiki", an online documentation site, but very little explanation is to be found there as well.

Additionally, this linear method may well have different impacts on different GHG species. Aerosols in particular, especially as these are the only species for which the downscaling results are presented in Section 3.4. Surely, agricultural waste burning has an impact on aerosol formation so that the choice of downscaling method in the first step (region to country) is fundamentally important.

Wouldn't it be more appropriate to also use some form of convergence as is done for other sectors? It seems to me this assumption of constant shares for LUC emissions should be fully justified or, preferably, be the subject of sensitivity analysis of some form. This should be further explored, explained and justified. In my view, it should have its own section in the supplementary information. Understandably, there is high uncertainty with these categories of emissions, but that is only more reason to explicitly address it. Also, it would be useful to have a comment by the authors about how this assumption might impact results of the CMIP6 activities using these scenarios as input.

Appendix C: Emissions Gridding

Page 30, line 5: "For each aggregate sector the spatial pattern of emissions within

a country, therefore, does not change over time in the future scenarios, although the spatial pattern of total emissions will change due to changes in the sectoral distribution of emissions."

This sentence is important and should be better formulated. I am having difficulty understanding what stays constant and what changes over time. Maybe the crux of the problem is what is meant by the word “total emissions”. Is meant as “global emissions”, as contrast with “emissions within a country”?

In my opinion, this section should be expanded to include the points I raised above in my previous comment on Section 2.3.1.

Technical Corrections Page 2, line 32: “where” should be “were” Page 21 line 13: there is no Section 2.4

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