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Interactive comment on "An update of IPCC climate reference regions for subcontinental analysis of climate model data: Definition and aggregated datasets" *by* Maialen Iturbide et al.

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This dataset, and therefore manuscript, is clearly an important contribution to the field. I appreciate the openness of the process this time around to define the regions, and that this allows the community a chance to comment on the choice of them. Previously the regional definitions have been either mandated from the top-down or decided by individual researchers for their own purposes. Having said that I feel that the manuscript would benefit from some revisions before it can be published.

This manuscript has multiple different aims. I interpret these as:

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1. Justifying any changes in the pre-existing regions
2. Analysing the homogeneity of the regions (this is explicitly stated in the abstract)
3. Providing detailed information to allow researchers to apply the regions themselves
4. Presenting 2 codes to permit regional analyses to be performed
5. Describing a dataset of precomputed time series from the CMIP5 (and CMIP6) simulations

This is an ambitious, but really useful, set of goals. Unfortunately, I find some of the presentation in the manuscript is sub-optimal for these aims. There are some questions that arose from my reading of the manuscript and I have some suggestions that would strengthen the manuscript. I've decided to separate my comments into ones relating to the regions themselves, and ones relating the manuscript. For the purpose of peer-review I feel that only the manuscript comments must be addressed. I do not really mind whether the authors alter the regions in light my comments – rather that they justify the choices they have made.

I would also like to mention that I have forked their repository and started to look at the python code. I work mainly in NCL myself, and have added an equivalent function I've written to compute the area-statistics for the AR5 regions into my version. When this manuscript is revised, I should be able to update the definitions in this function as a contribution to the effort.

1 Comments about the manuscript

I often found the justifications for the sub-divisions to be criticisms of the earlier regions, rather than providing an argument for the new choices. For example, in Africa (P5, L12-

20) you convincingly demonstrate that the AR5 regions have failings. But there is no acknowledgment the new boundary is different in the Central/Northern compared to the Southern region, let alone justification for it.

I was surprised by the fact the manuscript only uses the (somewhat arbitrary) interpolated grids for any discussion about whether there are sufficient grid boxes in the regions. This use was exemplified by Fig. 3, whose findings are strongly reliant on the presumed 1° or 2° grid resolution. This component of the manuscript would be much more convincing if you used actual GCM grids. [I believe that an easy way to compute this would be to apply the region masks to the areacella variable. You could then back out the number of grid boxes by dividing the sum of areacella by the mean of areacella.]

It was unclear to me from either the manuscript, or the provided codes, whether interpolation onto a common grid is/was performed in the computation of the regional averages. Whilst I accept the necessity of using a common grid for any ensemble averaging - such as in Fig 2(d,e) – it would appear to introduce unnecessary computation in determining an area mean, and may even introduce errors in computing higher order statistics.

I did not notice any analysis of the homogeneity of the new regions in the manuscript. You discuss Fig. 2 as if it presents such analysis. But this figure solely presents some key spatial fields and requires the reader to make their own qualitative assessment about the homogeneity. I suspect the box and whiskers in Fig. 5 conventionally presents the spread with time of the monthly values. Therefore, it does not demonstrate that all the grid points within a region have a homogeneous climate. Rather Fig 5 shows that the area averages of the regions follow different structures, which does not allow a reader to identify where 3 different rainfall regimes exist, but are being shoehorned into 2 boxes. (I note that Fig. 5 may instead use the box and whiskers to measure the spatial variance in the climatological monthly rainfall over the region, but this not mentioned in the caption – nor would it be necessary if an alternate method of demonstrating the homogeneity is used).

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Please be careful about using the term (inter)annual variability (e.g. P5, L15). This phrase relates to things like the North Atlantic Oscillation and El Niño. You are using it to discuss the climatological seasonal cycle.

In light of my own efforts to apply the AR5 regions in NCL, can you please explicitly mention that the regions are defined by straight lines on a projected plane – rather than great circles over a sphere.

Can you please be more explicit about your treatment of coastal ocean? P6, L1 and the caption in Fig. 1 suggest that the terrestrial regions are only defined over land (as was the case in AR5). This brings up 2 questions

- Clearly the new terrestrial regions avoid the open ocean by definition, but this still means that the coastal grid boxes are not included in any region. How much of the Earth's surface is not included in any region at all?
- Some of the old regions were defined as both land and sea regions (for example the aptly named SEA), with the Caribbean region combining both. The manuscript needs to both explicitly state, and justify why, you eschewed such an option in these updated regions?

Your discussion around Fig. 3 (P4, L20) suggests that 20 gridboxes is sufficient, but less than that should be treated with caution. What is the impact of the variations in resolution of the CMIP6 models on the fidelity the 4 small regions highlighted? I note that for example the GISS-E2-1-G model has a resolution of 2°x2.5° - so clearly falls into the 'treat with caution' category. Perhaps you could advise readers on an approach to acknowledge this uncertainty.

I was surprised by your choice of which regions to illustrate in Fig. 6. You may want to consider highlighting some of the new regions that you've defined in this manuscript – perhaps even in comparison to an old one.

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I appreciate that you've provided scripts to use these regions in both python and R. Would you be able to comment on the scripts' performance? For example, does the region extraction take a long time? Is the R approach faster than the Python?

2 Comments about the actual regions

1. I can see a lot merit in the criticisms from both Jason Evans and Michael Grose about the new Central Australian region. I have little preference as to which version you pick – but their comments highlight the issues inherent in writing a manuscript that argues against the old regions - rather than arguing for the new ones.
2. I found your new sub-divisions for South America puzzling.
   (a) You provide little justification for division between NSA and SAM. The only differences visible in the variables shown in figure 2 occur in the Koppen-Geiger classification. Yet other regions, most notably CAF, happily combine these classes.
   (b) I was unsure that the subdivision of Southern South America provides an improvement. The new SWS region mashes together both the Atacama desert and the Mediterranean climate – a distinction which is made in N. Africa & Europe, Australia and North America.
   (c) The creation of SSA – a region focussed on Patagonia – seems reasonable. But it was unclear why 47°S was taken as a dividing boundary. Given the small size of the region (as you warn readers about in Fig. 3), why did you pick that latitude as its boundary? Politically, the Argentinian Province of Chubut provides two convenient alternate latitudes, given that it straddles 42-46°S. I would leave it to the authors to assess whether Chubut is sufficiently Patagonian for inclusion into the region or not.

3. What about Madagascar? Inspecting the variables shown in Fig 2a-c and the fact that it's not contiguous, I wonder if it should really be considered as part of the South East Africa. It is certainly a larger landmass that New Zealand.

4. Will ensemble-wide relationships between the North Atlantic Ocean warming and the AMOC be confounded because both the Labrador and Norwegian Seas are not incorporated into the region?

5. Is the New Zealand region adequately resolved as a land-only region across all CMIP6 model resolutions?

6. Why do the Russian Arctic and Far East regions stop at 180°? Why does NWA exclude the Alaskan Peninsula (defining a latitude lower that 60°N may not be unsuitable)? The peninsula and Russian area around the Bering Strait are the only examples of continental land masses that is incorporated into ocean regions.

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