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# Comment on wcd-2022-46

Anonymous Referee #1

Referee comment on "Can low-resolution CMIP6 ScenarioMIP models provide insight into future European post-tropical-cyclone risk?" by Elliott Michael Sainsbury et al., Weather Clim. Dynam. Discuss., https://doi.org/10.5194/wcd-2022-46-RC1, 2022

Review of "Can low-resolution CMIP6 ScenarioMIP models provide insight into future European Post-Tropical Cyclone risk?" by Sainsbury et al.

In this article the authors investigate the change in PTCs affecting Europe due to global warming in coarse resolution CMIP6 models. Because TC are intense small-scale systems the analyses of TCs and PTCs is usually done with the highest resolution models available. The authors of this article take the courage step to analyse TCs and the subsequent PTCs in present coarse CMIP6 ScenarioMIP runs.

Although courageous this choice is defendable because apart from being small scale and intense, TCs are characterized by their different structure such as warm core and can be identified in low resolution models although with smaller intensity and larger structure as already shown by Haarsma et al 1993.

The authors provide a thorough analysis of the change in PTCs affecting Europe and the different factors that play a role in this change, like change changes in TC genesis, recurvature and reintensification. For the first time the authors provide an analysis of the complete PTC life cycle and the changes due to global warming in climate models. This analyses is compared with HURDAT2 observations and ERA5 reanalyses highlighting that the CMIP6 ScenarioMIP models are able to capture the main processes that govern the evolution of TCs to PTCs. However, from these analyses it is also clear that the climate models still show large biases, which are not only due to the low resolution.

The strong point of this article is that it separates the different phases in the evolution of PTCs affecting Europe starting with the genesis of TCs in the Atlantic and investigates the different processes that play a dominant role in those phases and how these are affected by global warming, which has not been done before. I consider therefore this as an important paper, also for future studies with larger ensembles and higher resolution, for

which this analysis can be repeated or serve as a guideline.

The scientific question how global warming will affect future European PTC risk is far from being answered. However, this study disentangles this question into other underlying relevant questions and provides useful analyses and preliminary answers.

The article is well written, and the analyses are done thoroughly. I recommend publication. I have only a few minor comments that I will discuss below.

1) The authors select only five models from the large CMIP6 set, based on a criterium outlined in the supplemental material. Five models is a rather small number for any statistical robust conclusions. The selection criterion is based on a TC frequency being equal or larger than observed hurricane frequency. No motivation for this selection criterium is given. I am wondering if a weaker criterium providing a larger ensemble would give similar results and give more statistical robustness. Please provide arguments for this criterium choice.
2) Two of the models that are analysed (CNRM and HadGEM) have resolutions comparable to the HighResMIP resolution (~50 km atmosphere, 0.25° ocean). These two models are also analysed in Baker et al. 2022. So, the sentence at line 74-76 is not correct. HighResMIP models had a somewhat different protocol than ScenarioMIP (i.e. aersol forcing, land surface scheme). Also period and spin-up are differently. I assume that CNRM and HadGEM are based on the HighResMIP models and modified and used for the ScenarioMIP. Please explain.
3) Line 152-153 something went wrong in explaining the region of WEST. Later the regions are shown for instance in Fig. 7. May be mention that the figures are shown in the forthcoming plots?
4) A notable difference in Fig.1 is the genesis over west Africa simulated by ERA5 and the models, but not seen in HURDAT2. Is this spurious or are no observations available over Africa for HURDAT2? Please explain or discuss this.
5) Line 232-233. To me this is no surprise as coarse resolution models tends to increase the size of TCs and reduce the pressure gradient. May be include this argument here?
6) Line 285. Maybe you can mention the numbers of Sainsbury et al 2020 here?
7) Line 463-464. Here and in the supplemental material section 7 the effect of ensemble size is investigated. However, the ensemble spread is not discussed. That the ensemble size does not affect the basic results is reassuring, but I assume that there is considerable spread in TCs and also how much of those TCs recurve and translate into PTCs between individual ensemble members.

An interesting result of this study is the important role of vertical wind shear for the development of PTCs. The important role of wind shear associated with El-Nino's for genesis and development of TCs is well known. This study also shows the large biases in wind shear in CMIP6 models. To this I want to add that recent studies also show that there is a mismatch during recent decades between the observed evolution of El-Nino and simulated by CMIP6 models (Seager et al. 2019). This will have an impact on vertical windshear over the North Atlantic and the genesis TCs and as a consequence also the PCT risk for Europe.

Haarsma, R. J., Mitchell, J. F., & Senior, C. A. (1993). Tropical disturbances in a GCM. Climate Dynamics, 8(5), 247-257.

Seager, R., M. Cane, N. Henderson, D. E. Lee, R. Abernathey and H. Zhang (2019). 'Strengthening tropical Pacific zonal sea surface temperature gradient consistent with rising greenhouse gases'. In: Nature Climate Change 9.7, pp. 517–522. doi: 10.1038/s41558-019-0505-x.