

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2021-294

Anonymous Referee #2

Referee comment on "Extreme events representation in CMCC-CM2 standard and high-resolution general circulation models" by Enrico Scoccimarro et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-294-RC2>, 2021

This study evaluates the impact of increasing the horizontal resolution on extremes in near surface temperature and precipitation in the CMCC-GCM model. The analysis is performed on two simulations performed following the HighResMIP protocol. The study is interesting, but would benefit from providing additional context and background as well as additional analysis.

Major comments

1. The introduction does not provide sufficient context to the study. In particular, the authors should expand it to include a discussion on prior studies which have looked at the impact of resolution on the ability of GCMs in simulating extreme events.
2. While I agree with using two products to evaluate the model's precipitation, I would have to disagree with the use of ERA5 for that purpose. Precipitation is not assimilated in reanalyses and is thus a product of the model used to create it. Although ERA is a superior product to its predecessor, there are many known issues with ERA5 precipitation. See for example:

Rivoire, P., Martius, O., & Naveau, P. (2021). A comparison of moderate and extreme ERA-5 daily precipitation with two observational data sets. *Earth and Space Science*, 8, e2020EA001633. <https://doi.org/10.1029/2020EA001633>

Hu, G., Franzke, C. L. E. (2020). Evaluation of daily precipitation extremes in reanalysis and gridded observation based data sets over Germany. *Geophysical Research Letters*, 47, e2020GL089624. <https://doi.org/10.1029/2020GL089624>

Crossett et al. (2020) Evaluation of Daily Precipitation from the ERA5 Global Reanalysis against GHCN Observations in the Northeastern United States. *Climate*, 8, 148; doi:10.3390/cli8120148

It would thus be better to use another observational product to evaluate the model.

3. I am not sure that daily mean 2m temperature is the best variable to evaluate extreme temperatures in the model. Why not use tasmin and tasmax? And Figure 3 could be sent to the supplementary material as it is hardly discussed.

4. The color schemes used to present the data makes it difficult to understand the results. For one, it saturates very quickly. For example, on Fig. 1, it is nearly impossible to distinguish values between -6 and -20 (when it is printed on paper). And also, there are similar colors on both sides of the 0 point (e.g. green on Fig 3.). It made reading through the precipitation subsection particularly difficult, as I couldn't get a good sense of the size of the biases that were being shown. My suggestion would be to refer to the IPCC visual style guide:

<https://www.ipcc.ch/site/assets/uploads/2019/04/IPCC-visual-style-guide.pdf>

5. I think the manuscript would benefit from an attempt at explaining some of the results that are presented. The authors described the convection scheme in Section 2.1, because "it is worthwhile to mention for our discussion on precipitation biases", but the convection scheme is never referred to when the results are presented. Does it explain the differences between results obtained with 6-hourly data and daily mean? And if so, how?

Could dry biases in the model play a role in the extreme of near surface temperature? Was the impact of resolution on extreme temperature and precipitation evaluated by other groups using the CAM model? Are the results consistent with those found here?

Furthermore, Vanière et al. (2019) has shown a significant impact of resolution on precipitation over mountainous areas in HighResMIP models. Are the results presented here consistent with that study and others that have looked into this issue previously?

Given that this is a single model study, it is difficult to evaluate if the results are model dependent. Expanding the discussion would help in that regard.

Vanière et al. (2019) Multi-model evaluation of the sensitivity of the global energy budget and hydrological cycle to resolution. *Climate Dynamics*, 52, 6817–6846

Minor comments

CMCC-CM2-HR and CMCC-CM2-VHR might be the name of the models, but it is strange to refer to a model with a resolution of 1 deg (for the atmospheric component) as high resolution. It might be easier for the reader to simply refer to the two configurations as standard resolution (1 deg) and high resolution (0.25 deg). To be clear, I am not suggesting changing the name of the models, but simply to use the terms standard resolution and high resolution (or something along those lines) when referring to MCC-CM2-HR and MCC-CM2-VHR.

The authors should mention the name of the experiment from which the data are taken.

Vanière et al. (2019) noted different responses in terms of the impact of resolution on precipitation between grid point and spectral models. As such, the type of atmospheric model should be highlighted and the authors should mention whether their results are consistent with that prior study.

p.1, line 26: "A climate variation can have an impact on human activities...". I am not sure what the authors mean by "climate variations: in this context, but this phrasing is a bit odd. I would suggest rewriting.

p. 1, line 27: "Extreme climate events are involved in the vast majority of the most severe episodes." The most severe episodes of what?

p. 2, line 32: "was designed to understand the role of the horizontal resolution."

The role of horizontal resolution on what?

p.2, line 33: "based on two versions of the GCM"

p. 2, line 34: " differing only **in their** atmospheric horizontal resolution"

p.2 line 41: "However, such analyses has employed rather low frequency data..."

I am not sure what analyses the authors are referring to (or what they mean by low and high frequency), but many studies have used daily or sub-daily data to look at extremes in climate models. See for example:

Wehner M, Lee J, Risser M, Ullrich P, Gleckler P, Collins WD. 2021 Evaluation of extreme sub-daily precipitation in high-resolution global climate model simulations. Phil.Trans.R.Soc.A379: 20190545. <https://doi.org/10.1098/rsta.2019.0545>

Wehner MF et al. 2014. The effect of horizontal resolution on simulation quality in the Community Atmospheric Model, CAM5.1. J. Adv. Model. Earth Syst. 6, 980–997. doi:10.1002/2013MS000276.

And references therein.

p.2 line 62: "The two models object of this study.. ¼ degree in VHR."

I would recommend moving this sentence to the previous paragraph when the authors discuss the atmospheric component of the model.

p.4, line 115: "Also, the positive HR DJF bias over eastern Europe is more than halved in VHR". To me, it seems like it disappears, but it might be due to the colorbar.

p.4, line 118: "The positive extreme temperature bias between 30N and 60N shown by the HR model during JJA is partially reduced in VHR." This seems to happen mostly over Europe and Asia, not so much North America.

p.4, line 119: "the 5 to 7C positive JJA bias over the western coast of South America in HR results haved in HR". That might be the case, but it is really hard to see in the figure. Also, some words seem to be missing in that sentence.

p.5, line 129: "the model extreme precipitation **is compared** to..."

p.5, lines 155-164. I have to confess I didn't quite understand that explanation.

p.6, line 188: Replace PRIMAVERA by HighResMIP