

Geosci. Model Dev. Discuss., referee comment RC5  
<https://doi.org/10.5194/gmd-2022-57-RC5>, 2022  
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## **Comment on gmd-2022-57**

Anonymous Referee #5

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Referee comment on "Downscaling multi-model climate projection ensembles with deep learning (DeepESD): contribution to CORDEX EUR-44" by Jorge Baño-Medina et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-57-RC5>, 2022

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Review of GMD-2022-57

Downscaling Multi-Model Climate Projection Ensembles with Deep Learning (DeepESD):  
Contribution to CORDEX EUR-44

By Baño-Medina et al.

In this study, the authors develop a downscaling method for climate variables based on the perfect prognosis approach using convolution neural networks (CNN) and evaluate how it extrapolates to unseen climatic states as projected by multi-model Earth system models. They focus on temperature and precipitation as well as on the European domain. The authors compare the output of their method to regional high-resolved climate model output and show that the CNN-approach reduces biases for the historical period and extrapolates to future climate change conditions in a plausible way.

The downscaling approach is very interesting and useful, especially the evaluation of its extrapolating skill to a different system state. Overall, the manuscript is well written. I have a few general comments and a short list of specific comments. Thus, I recommend minor revisions before publication.

- Could you make flowchart of your workflow and include as a figure in the methods

section? It is a bit hard to follow your exact procedure.

- Isn't the comparison to observations between unconstrained mechanistic models (i.e. GCMs) and CNNs trained on observations "unfair"? If you did some nudging procedure with GCMs you would also end up with model output better fitting observations. For the CNN training, did you split the observational data into train (validation) and test set (only train on 20 years and show performance for 10 years)? Again, a flowchart would help to understand what you did. If you show the performance of DeepESD for the test set and compare that to GCM output, it'd be "more fair", but still, just by design we would expect that the CNN reproduces observations better than GCMs.
- You show that the CNN learns the "necessary" dynamics based on predictors of the historical period and extrapolates reasonable well using predictors from GCM output for projections. That is a very interesting point. I wonder if this simple bias correction for GCMs really does the trick, as the models considerably diverge over the climatic time-scales and very model specific regional biases emerge. Can you comment on whether other bias-correcting measures were tested? Overall, there is certainly a long list of potential further evaluation and testing steps that could be undertaken, but maybe it is enough for this model description paper.

Specific Comments:

L5: What is DeepESD standing for? Please introduce acronym before first usage.

LL33-34: The "perfect prognosis" approach is based on the assumption that GCMs don't have systematic biases with respect to the observations that were used for training, right? Maybe you should include a short sentence here that addresses this aspect.

L55: I recommend to use another more static hosting platform for your code, e.g. Zenodo (<https://zenodo.org/>).

L60: Why did you use ERA-Interim reanalysis? It is outdated for quite some time now.

L62: I don't understand your use of dashes (—) in the manuscript. Please check whether they make sense throughout the manuscript.

LL62-65: What about adding high-resolution orography description as static predictor?

L85: Why did you analyze both and can you provide the reason why you settled with the deterministic one?

L88: Please stick to the tenses (in this paragraph you mix present and past tense), i.e. do not switch between present and past tense when describing your results or methods. I recommend that you always use present tense when talking about your study, i.e. when describing your methods, your results etc., and use past tense when referring to already published studies.

L137: "contribute to increasing"

Figure 1: Add unit at lower right colorbar. Also, it'd be useful if you could include letter characters as pointers to subplots, e.g. a,b,c,d. This comment applies for all Figures.

Figure 4: Please be more specific about the numbers in the plots. Please provide more detailed information in the caption.

Figure 5: The mid-column misses a time axis. DeepESD is not "yellow" but "green", no?