

Geosci. Model Dev. Discuss., referee comment RC1  
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## Comment on gmd-2021-1

Anonymous Referee #1

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Referee comment on "Decadal climate predictions with the Canadian Earth System Model version 5 (CanESM5)" by Reinel Sospedra-Alfonso et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-1-RC1>, 2021

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In this manuscript the authors are giving a comprehensive overview of the setup and prediction skill of CanESM5 experiments as part of CCCma's contribution to DCPD within CMIP6. The 40-member hindcast ensemble (initialized 1961-2019, 10 years) is initialized from dedicated assimilation runs, which incorporate atmospheric, oceanic and sea-ice re-analyses into the coupled model via nudging. Prediction skill is presented for upper ocean heat content, sea and air surface temperature, and primary production on land and in the ocean. The authors successfully show and use a way to break down prediction skill into a "predictable" and "unpredictable" fraction. With the help of a 40-member uninitialized experiment covering the same time period, prediction skill is also partitioned into an "initialized" and "uninitialized" component. These partitions greatly help in interpreting the capabilities of CanESM5! The authors also analyze the impact of ensemble size on prediction skill, which not only benefits the interpretation of CanESM5 results, but also helps in gauging results from other models and designing new experiments. Overall, I would like to thank the authors for tackling two of the most burning questions in decadal prediction at the same time: evaluation of predictable components, and evaluation of impact of ensemble size.

General comments:

This version of the manuscript appears already mature in terms of results and conclusions. However, I would like to take the chance to highlight some points, which upon improvement would lead to an even more concise publication.

1) The ensemble generation method is not clear. How are the "separate" assimilation runs (ch.3, p.4, l.25ff) kept separated over time, when they are nudged to the same re-analysis fields?

2) In my opinion, technical phrases could be used in an even more consistent manner, also in context what is used within the prediction community. I would like the authors to consider using only one phrase throughout the manuscript, including figure captions.

For the initialized experiments, these phrases have been used: "historical decadal forecasts" - "hindcasts" - "retrospective forecasts" - "forecasts".

For the uninitialized experiments, these phrases have been used: "historical" - "uninitialized" - "simulations". In particular the use of "simulations" for the uninitialized experiments seems to be suboptimal.

In context with the potentially predictable component, these phrases have been used: "noise-to-predictable variance ratio" - "noise-to-signal variance ratio"

3) On the use of "predictability" or "prediction skill". From my perspective it is important to thoroughly keep apart "actual predictability" of the real world ((un)initialized experiment vs. observational product) and "potential predictability" of the model world ((un)initialized experiment vs. own assimilation). For physical quantities, the authors assess actual predictability, for primary productivity they assess potential predictability. I would like to ask the authors to state the "potential" when discussing primary productivity. However, I wished the authors could include maps of actual predictability for primary productivity (1997-present) as well.

4) Several times, the authors state that CanESM5 could have "interactive" carbon or a "carbon cycle", but for the experiments presented here, the interactivity is not used (ch.2, p.4, l.18). I am okay with having the possible "interactivity" mentioned in the beginning, but I would like the authors to thoroughly check that the actual non-interactivity is properly referred to whenever the results are discussed.

5) Overall, there is a rather high content of abbreviations in the text. In particular, mathematical symbols are in parts heavily used, e.g.  $r_{XY}$ ,  $q_{e_i}$ . This sometimes renders the text more difficult to read, especially when in-text equations are used. Nevertheless, the text remains understandable, but perhaps the authors could check if some of the in-text equations could be made obsolete.

Specific comments:

Together with the general comments, a bunch of specific comments, which the authors may or may not consider, can be found in-text in the uploaded pdf.

Please also note the supplement to this comment:

<https://gmd.copernicus.org/preprints/gmd-2021-1/gmd-2021-1-RC1-supplement.pdf>