REVIEW

Manuscript: ESD-2020-66

Title: Assessment of a full-field initialised decadal climate prediction system with the CMIP6 version of EC-Earth

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General Comments

This study presents an assessment of the last BSC decadal hindcasts, run with the CMIP6 version of EC-Earth and contributing to DCPP-A. The manuscript is very well written. The study takes into account and discusses relevant aspects from the most recent literature in the field of decadal predictions. The analysis uses a variety of commonly used diagnostics and also goes in some depth into understanding (in the context of this model) the role of full-value initialization with the associated initialization shock and model drift occurring in a key area of deep-water formation in the North Atlantic. The Reviewer suggests this manuscript for publication after some minor amendments. The latter are mainly textual but include also the resizing of some figure panels and considering taking a look at surface wind biases (possibly to be shown as supplemental material).

Specific Comments

1. Line 5: It would be helpful to be admitted / clarified that the realistic initialization contains part of the externally forced trends as, for example, the oceans get warmer with global warming. Yes, there are also aerosols and CO_2 which modify radiation and clouds during the simulations, but the warming signal is also contained in the initialized ocean state (progressively warmer).

2. Line 6: “gets” → is

3. Line 13: “in the surface” → at the surface..... the subsurface layer,

4. Line 47-50: On this point, there is also another recent study using DCPP-A (Athanasiadis et al., 2020) that shows comparable (even higher) skill for the NAO using CESM-DPLE.

5. Line 61: “is initialisation” → is the realistic initialisation of the ocean state *(or of the Earth system, if the authors prefer).*

6. Line 65: “especially in” → especially in the deep ocean and before modern instruments (such as ARGO floats) were introduced.

7. Line 66: What is the meaning of the word “exclusively” in this sentence? Initial states are built from observations.

8. Line 95: “that take” → which take

9. Line 115: “10 member” → 10-member

10. Line 154: Has the word “cmorisation” been defined earlier? Perhaps it would be best to keep the “CMOR” part in capital letters.

11. Line 155: “data was...” → data were systematically checked for their quality with...

12. Line 174: I expect that the drift cannot affect equally all predictions (initialized in different years with different states, closer to or further from the model climatology). The drift is defined as the average tendency over many years, is not that so?

13. Line 199: “persisting it” → making it persist

14. Line 219: “Equator-60” → Equator−60 (not hyphen but en dash).

15. Line 248: What do you mean by “phases”? The Reviewer guesses what the authors might mean. Please take into account the common use of “phase” as a verb (https://www.merriam-webster.com/dictionary/phase) and expand this sentence accordingly.

16. Line 249: “equivalent” → comparable / similar

17. Line 259: “influence of” → influence of the unpredictable part of

18. Line 261: Here and elsewhere (where a similar expression is used as an adjective) use “low-frequency”.

19. Line 295: “is for the some” → is for some

20. Line 319: “5f” is a reference to “Fig. 5f”? Please follow the instructions for authors of this journal – in any case, all references to figures should follow a standard way (same throughout the text).

21. Line 344: “ranges(Figure” (add space)

22. Line 351: “to aid” → so as to aid

23. Line 356: “feature” → behaviour / relationship

24. Line 359: “evolve” → evolves (singular)

25. Line 363: Why should that be? Same model => same attractor.

26. Line 389: The Reviewer questions the idea that PRED can reach (or come in the neighborhood of) the model's AMOC attractor in just 10 years.

27. Line 392: But could not it be that a surface-wind bias (likely associated with a bias in Greenland blocking frequency) favors the formation of sea ice in the Lab. sea, which subsequently blocks heat and moisture surface fluxes? If the authors agree that this is a plausible explanation, at least in part, the Reviewer would suggest to take a look at surface wind biases in that area.

28. Line 414: What does “their” refer to?

29. Line 421: Here and elsewhere, please make “3” a superscript (exponent). Also, add some small spaces between values/numbers and units.

30. Line 428: “simulation” → simulations

31. Line 486: “varibility” → variability

32. Line 491: Speaking of an “effect”, is this positive, or negative? What kind of effect?

33. Line 498: Speaking of different members exhibiting different mean states, it is likely that the AMOC has a degree of non-stationarity and not necessarily a uni-modal distribution. If that is so, then the multi-member time average may not correspond to any real attractor (preferred state).

34. Line 501: “brings the predictions apart from” → carries the predictions away from

35. Line 517: “prone” → likely
    A method is prone to errors, instead, the errors themselves are not “prone” to occur.

FIGURE 2: In the caption please change the sentence referring to the hatching – what are significant are the ACC values, not the areas themselves. Also write: “Points with missing values...” as the masking is applied to an area.
From a scientific view point: the lack of predictive skill in the subpolar gyre (south of Greenland) is an indication of likely poor NAO skill (see Athanasiadis et al., 2020). Have the authors assessed the NAO skill for this set of hindcasts? If the NAO skill is indeed poor, perhaps it would be fair and worth mentioning this possible connection.

FIGURE 5: This, but also other figures, should be expanded so as to best use the available space. The overall figure width should, however, remain a bit narrower than the width of the main text (plenty of space until there).
From a scientific view point: Why does HIST ensemble mean exhibit such a weak ENSO variability, in

contrast to PRED, for the 1st year of the predictions? Arguably, because ENSO events are mainly out of phase across the HIST ensemble (as expected). The authors may want to mention this rather trivial explanation.

FIGURE 11: “Scatterplot diagram” → Scatter plot.