

Interactive comment on “AMOC fingerprints influence seasonal SST predictability in the North Atlantic” by Julianna C. Oliveira et al.

Anonymous Referee #2

Received and published: 2 November 2020

Review of "AMOC fingerprints influence seasonal SST predictability in the North Atlantic", by Oliveira et al.

General Comments:

This manuscript presents an analysis of the impact of the AMOC strength at 26N on the North Atlantic SST (based on Duchez et al., 2016) in the MPI-ESM-MR seasonal forecast system. First the authors evaluate the AMOC strength and fingerprints in an assimilation experiment ran with MPI-ESM-MR (used as initial conditions for the seasonal forecasts) and show similarities with the results of Duchez et al. (2016). The authors then compute the AMOC fingerprints for each season, which is the novelty of the paper, and investigate the impact of the atmospheric forcing (air-sea fluxes and Ekman-induced heat transport) on the SST variability which may be dominant on sea-

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sonal time-scales. The authors then evaluate and compare the skill of North Atlantic SST in the MPI-ESM-MR seasonal forecast system to determine whether considering strong and weak AMOC phases results in improved skill.

The quality of the writing is good overall but some sections are hard to follow the clarity should be improved (see detailed comments below). The analysis and results are interesting, and once the manuscript is improved (especially the discussion of the results) I believe it would be of interest to the seasonal prediction community. I therefore suggest this paper to be considered for publication after major revision.

Specific Comments:

1) I believe it would help the clarity of the manuscript if in each section of the paper it would be clearly stated which experiment is being analysed, as it took me some time to figure out if it was the assimilation experiment or the seasonal predictions. This should also be indicated in the figures, for example in the caption of figure 1, 'The AMOC in MPI-ESM-MR' is confusing as it does not refer to the experiment type. It would also help to motivate in the text why the experiment being used is suitable for the analysis. Since the first part of the paper considers only the assimilation experiment and it is constraint to observations, do you expect the conclusion to hold for the seasonal forecasts? The authors could consider computing the AMOC fingerprints with the seasonal forecasts.

2) The main concern I have with the paper is the interpretation of the seasonal SST skill results in terms of D16's mechanism for the strong and weak AMOC phases (section 3.3). I find the discussion insufficient to conclude whether the SST skill results are consistent D16's mechanism.

Comments by line:

Line 16: 'tropical seasonal SST anomalies' ->'Seasonal SST anomalies in the tropics'?

Line 21: Could explain briefly D16's mechanism to make the paper self sustained,

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having only to refer to D16 for specific details.

Line 21: 'links transition' -> 'links the transition'?

Lines 29-32: These sentences could be made clearer to make it easier to follow.

Lines 41-46: This paragraph could also be made clearer. The authors could explain what is meant by 'incorporating known physical mechanisms into their seasonal prediction analysis'. From the latter sentences I infer it means through the initial conditions? Perhaps the physical mechanisms could be briefly mentioned.

Line 47: The term 'potential predictability' could be briefly explained. Does it refer to the ability of the model to predict itself?

Line 49: Does 'initialised coupled simulations' refer to a set of hindcast (retrospective forecasts)? If so I would use this term to be more precise. The authors could briefly explain the evaluation technique in Borchert et al. (2018) to make the paper self sustained.

Line 71: This sentence should be written more precisely. 'full-field' initialisation refers to the initialisation method of the forecast system. While nudging refers to assimilation method used in the reconstruction where the initial conditions are taken from. The assimilation experiment is fully coupled right?

Line 98: Why is a linear trend removed?

Line 108: 'Model verification for AMOC' -> 'Verification of the AMOC in the assimilation experiment' or 'Verification of the AMOC in the reconstruction'?

Line 109: 'to' -> 'with', 'to' -> 'in'.

Lines 109-110: I don't think these sentences are necessary. As already mentioned I find the sentences unclear as the experiment analysed is not mentioned.

Table 1 is not discussed, so either comment on it or remove the table. What does

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'seasonal range' refer to? Should be defined.

Line 112: To compute the anomalies, why is the annual mean of each year removed rather than the annual climatology?

Lines 111-122: In this paragraph figures 1b,d and f are not referred in the text or discussed, so are they necessary? Also the figures are referred in the text with 'c.f.' when it is not necessary. The clarity of the paragraph could be improved. In lines 119-120 the 'seasonal range' is commented but no reference to table 1 is provided.

Figure 1: The labelling of the panels in the bottom right corner instead of in the top left may be slightly confusing, although a minor detail. Is AMOC-EKM (red line) necessary in the figure 1g?

Line 127: 'model' -> 'assimilation experiment'

Lines 125-142: The paragraph structure and the clarity of this section should be improved.

Lines 126-130 the authors describe the lagged correlation patterns between the AMOC and the SSTA as being the same for all lags. However, to me it seems that the pattern correlation evolves from lag 0 to month 7, as later described by the authors, which seems contradictory. I believe this should be clarified.

Line 145: Could reference Fig. 2 in this sentence.

Line 152: 'not shown', could show in the supplementary material.

Line 155: The first sentence seems unnecessary.

Lines 159-164: This paragraph seems a repetition of the previous paragraphs.

Lines 155-159: Related to a previous comment, a limitation with the definition of box 2 (Fig. 4) is that the positive correlation at later lags shifts towards the Eastern North Atlantic which is not included in the box. This indicates that the lag correlation patterns

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are not constant.

Line 166: delete 'here'.

Lines 166-175: It is not clear what period is being used, I suppose that the 30-year period?

Line 174: Why atmospheric drivers? Is this the only option? In fact, this seems inconsistent with the results shown in the next section (Fig. 7m).

Line 177: 'is response' -> 'is the response' or 'responds'

Lines 176-213: The clarity of this section could be improved and perhaps made shorter. I believe this section could also be improved by commenting on the implications of the results.

Line 218: 'The hindcasts' -> 'The hindcasts initialised in'.

Line 222: I assume that AUG and MAY refer to JJA and SON in fig. 8, if so this makes the text confusing, it would help to refer to the season like in fig. 8.

Line 229: 'The role of AMOC' -> 'The role of the AMOC'.

Line 231: What does 'separately' mean here? Is there any difference with the previous section?

Line 233: Does this mean that the startdates are divided into two sets, strong and weak AMOC?

Line 233 'Atlantic Meridional Variability (AMV)' -> 'Atlantic Multidecadal Variability (AMV)'?

Line 238: 'sub-' -> 'sub-tropical'

Line 242: 'we find higher hindcast skill for DJF...' this statement is not so clear to me. The magnitude of the skill in some regions seems higher, but the area of skill seems smaller.

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Lines 237-258: These paragraphs constitute some of the main results of the paper, but they seem insufficient to me and hard to follow. The interpretation of D16's physical mechanism in terms of skill does not seem very clear and I struggle to follow the interpretation of the results. Also, based on the AMOC seasonal fingerprints I would expect that D16's mechanism could perhaps explain the SST skill in spring and maybe in summer, but not autumn or winter.

Line 241: The statement: 'For strong AMOC phases, we find higher hindcast skill for DJF, JJA and MAM SSTAs over the subtropics in comparison to ACCs considering the full period', I am not certain about this statement. Comparing the skill maps it seems that the magnitude of the skill is greater in some regions but the areas with positive skill smaller. Perhaps computing maps of the difference of correlation (including the significance) could help the interpretation. Could the SST skill maps be affected by the smaller sample size when comparing the entire period and positive and negative AMOC composites?

Line 296: 'a more active ocean'? what does this refer to?

Interactive comment on Weather Clim. Dynam. Discuss., <https://doi.org/10.5194/wcd-2020-45>, 2020.

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