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Interactive comment on "Ensemble initialization of the oceanic component of a coupled model through bred vectors at seasonal-to-interannual time scales" *by* J. Baehr and R. Piontek

Anonymous Referee #1

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1   General comments

This paper presents a bred vector method for ocean model initialization relevant for seasonal-to-interannual coupled model predictions. The main novelty of the method compared to previous work is to extend the breeding to the entire water column of the ocean model, and focus on the transition time scale around one year lead time. The authors start by describing the model framework and discuss the choices made in their implementation of bred vectors in the MPIOM oceanic component. They then present an analysis in a perfect model framework to compare bred vector perturbations to a more traditional lagged initialization method. This manuscript is well-written, clearly

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organized and concise. I found the bred vector method description particularly clear. The authors made the effort of showing results for different lead times and different ocean variables. The Talagrand diagram figures over different ocean regions are a nice and synthetic way to present results.

The authors are well aware of the main limitations to their current study and discuss these in the paper. In the bred vector implementation section, the validation of the choices for the implementation is rather short, in the sense that some sensitivity tests were run, results are discussed but not necessarily shown. This could be done for instance in supplementary material for readers interested in specifics of the method. Another thing I would have expected to see in the article was an evaluation of the significance of the results presented. The scientific conclusions drawn from the study are valid in the framework described in the paper, and this study will greatly benefit from being adapted to initialized interannual integrations to see if conclusions hold. Follow-up papers on this work will be very interesting for the seasonal-to-decadal climate modelling community.

More specific comments/questions for the authors follow.

2 Specific comments

2.1 Introduction

p5191, l. 10: "Different techniques have been tested to initialize and perturb the ocean's surface": Instead of citing a bulk of papers, could you maybe list a few of these techniques and the relevant papers for each? Is there a review paper you could cite on these initialization techniques?

p5192 l. 19: "At the expense of being limited to perfect model measures to quantify the

ensemble spread": I am actually more concerned about the quantification of the model error than the ensemble spread when dealing with perfect model simulations. What exactly do you mean by this?

2.2   Bred vector implementation

I really liked the description section which describes thoroughly the bred vectors method.

p5195, l. 3: "The breeding cycle itself consists in the last four steps" : For the sake of clarity it could be a good idea to use numbers instead of hyphens, and then say "steps n to n+3"...

In the implementation section (3.2), the choices for several settings of the method are discussed. However, even if an assessment of the method as described here is made in the beginning of the results section 3.3 to justify that these choices are valid, it would be most interesting for readers who intend to reproduce these results in other ocean models to have more details on the tests that were made, by means of supplementary material for instance.

p5196, l. 26: Did you try other normalizations for the bred vectors? Did you test other values for the normalization instead of 10 percent before coming to the conclusion that this was the most appropriate choice?

In the results section, figure 1 is difficult to interpret given that there is no color bar. Do the colors correspond to the same values in all four figures shown?

p5198, paragraph lines 16-22: "Neither choice fundamentally changes the regression maps (Fig. 1) [. . .] are analyzed." From the formulation of the sentence, I would expect to see these results in the figure somewhere. I would remove the "(Fig. 1)" if you don't intend to show this, or change the sentence.

2.3 Ensemble generation

p 5199, l.13: "All quantities presented in this section are averaged over the ten ensemble members": this statement is confusing, since you are mostly looking at ensemble spread (as in the Talagrand diagrams).

l.22: The description of how the Talagrand diagram is calculated could be more clear; what do you mean by "the ensemble is sorted according to a predicted value"? Furthermore, in the figures, you present Talagrand diagrams for rather large regions/boxes. It could be useful to mention in the text how you pool the data together in your analysis (described briefly in the caption for figure 4).

l.27: "The spread-error ratio is then the ratio of this spread and the difference": do you mean root mean square difference?

p5200, l.1: "A perfect ensemble would result in a spread-error ratio of 1." Could you be a little more precise about what you mean by "perfect" in this sentence?

In the results section, some figures are discussed quite briefly, leaving the reader to make his own interpretations as to whether the bred vectors initial perturbation method is indeed better than the lagged initialization. As mentioned earlier, and although this is sometimes a complicated task, results would highly benefit from significance assessments.

I find figure 4 and the other Talagrand diagram box figures very interesting, both in terms of content and in terms of ways of presenting synthetic experiment results. However, more information should be given on the shading used to indicate which ensemble is closer to a flat distribution. How was this calculated? Which threshold was chosen to discriminate between categories?

The figures showing the spread-error ratios (fig. 5, 6c and d) would benefit from a clearer separation in the colors used. The changes between both methods are some-

times quite small and they are difficult to see when values remain in the blue-green color range.

More specific comments on this section follow:

- p5200, l.8: the sentence must have been cut, and makes no sense as it is now.

- p5200, l.15: Is the 0.05 spread-error difference significant?

- p5201, l.2: The description of the differences between figures 5a and 5b lacks more detail, more quantitative information. Furthermore, although Talagrand diagram results shown previously give some idea that the improvements noted in 5b are mainly due to increasing the ensemble spread, it could be worth discussing the impact of error alongside the spread-error analysis shown here.

- I am curious about what is happening in the bred vector initialization experiments around Japan. The spread-error ratio in figures 5b and 5d over this area is much higher than in the lagged initialization case, although judging from the Talagrand diagrams in figure 4 there is no clear difference for this region when compared to other boxes. Did you have a further look at this? How does the error over the region grow? Can this be related directly to the bred vector perturbations?

2.4   Discussion

I very much appreciated this section as it underlines the fact that the present study is preliminary and details how it can be extended and applied to a more operational framework. In the case of initializing coupled ocean-atmosphere bred vectors, would you expect the optimal breeding cycle time to change much with respect to an ocean-only breeding method?

3 Technical comments

You make an extensive use of "e.g.", which sometimes is not adapted to the construction of the sentence (see for example p 5193, l. 19).

p 5193, l. 21: "uninitialized freely model": a word must be missing here...

Figure 1: the color bar is missing; there seems to be a white dot on figure 1c, is this due to highly negative values?

Figure 2: Since the values are quite similar in both experiments, I would suggest using the same color bar and scale so that the unperturbed and bred experiments can be compared more easily.

p 5199, l. 21: (ii) is missing in the enumeration of the measures.

p 5203, l. 18: used IN/BY Yang et al. (missing word)

In the references section, some capital letters are missing (for instance, "north atlantic" p5206 l.10) in several article references.

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