Interactive comment on "Optimal Precursors Identification for North Atlantic Oscillation using CESM and CNOP Method" *by* Bin Mu et al.

Bin Mu et al.

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Dear reviewer:

We are very grateful for your comments about our manuscript. On behalf of my co-authors, we thank you very much for giving us an opportunity to revise our manuscript. Based on your comments, we have made the following modifications to this manuscript:

1. Comment:

In this work, the authors studied two cases of different initial conditions. I would suggest the authors to provide more background information about the two cases.

Response:

Thank you for your suggestion. The second case was added according to the previous reviewer in order to prove that the CNOP method is effective for different initial conditions. Our experiment is based on the model data and starts simulation from the 53rd winter of the model year (0053-11-01). We select two cases that would not develop into the strong NAO event after 15 days (since the e-folding time scale of the NAO event is two weeks) to observe the NAOI variation after superimposing perturbations. Case 1 is from 0053-01-11 to 0053-01-26, while Case 2 is from 0053-01-15 to 0053-01-30. The reference states of Case1 and Case 2 have the opposite phases, with the NAOI of 0.82 and -1.09. From Figure 9 we can see that the corresponding events can be triggered by CNOP_PO and CNOP_NE, with the NAOI of 3.06 and -3.09 for Case 1 and 2.22 and -2.58 for Case 2. It is indicated that the CNOPs searched by our method can cause the maximum uncertainty under various initial conditions.

Modification:

We add some descriptions of these two cases, especially for why choosing these two cases to simulation the NAO. (See M1)

2. Comment:

The authors explained the Parallelelization methods in section 3.3 in great detail, and also presented the corresponding results in section 4.6 with three figures and one table. The contents are good and informative, but since the title of the work has been changed, probably the authors could consider shortening this part, or move some of the contents to supplementary materials?

Response:

The performance enhancement of the algorithm and numerical model is an innovation point of our research, but it may indeed take up too much space to introduce the parallelization technique. We merged three subsections in Section 'Parallelization' and shorten the contents, in particular for the related works about GPU acceleration.

Modification:

See M2

3. Comment:

In the Abstract, line 10, what is the last stage of the prediction period? Clearer information should be provided here.

Response:

The last stage refers to the period from Day 7 or Day 9 to Day 15. From Figure 8, it can be seen that there has not been much change in NAOI when the perturbations just superposing on the basic state. The curves of perturbations (CNOPs, Breds, and Randoms) start to evolve in different directions on Day 7 (Case 1) or Day 9 (Case 2). It proves that the nonlinear process begins to take effect in the last few days. To make the sentence more clear, we replace the "last stage" with more detailed information here.

Modification:

See M3

4. Comment:

On page 3, in line 9, "run" should be "running".

Response:

Sorry for the incorrect writing. We have modified this word.

Modification:

See M4

5. Comment:

On page 3, in line 13, a reference is need here in the end of this sentence.

Response:

Thank you for pointing this out. We have cited a representative work at the end of this sentence.

Modification:

See M5

6. Comment:

On page 18, in line 19, what is the 25th layer? What is the constrained condition T'2 <= 100? More detailed information is needed here. For instance, it is better to point out clearly the height of the considered layer, instead of simply using the 25th layer.

Response:

CESM uses the hybrid level at midpoints (1000 * (A + B)) to express the levels of layers. Assume that hybrid level definitions is: $p = a * p0 + b * ps$, the midpoints level is $p(k) = hyam(k) * ps0 + hybm(k) * ps$. The 25th layer corresponds to the level of 7.389, and it may easy to understand or follow to mark it "25th layer". Relevant information has been added.

We're very sorry that there are some mistakes in the constrained condition. The constrained condition should be $1/D \int_{D} \int_0^1 T^2 d\sigma dD <= 100$ (The summation of the temperature square in the grid of north of 60N should no more than 100).

Modification:

see M6

We appreciate editors and reviewers' warm work earnestly and hope the correction will meet with approval. Once again, thank you very much for your comments and suggestions. If you have any questions, please contact us without hesitation.

Best regards,

Jing Li

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