

Interactive comment on “Impact of Optimal Observational Time Window on Coupled Data Assimilation: Simulation with a Simple Climate Model” by Yuxin Zhao et al.

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General comments

The article presents results relevant to coupled data assimilation for systems, such as the ocean-atmosphere system, in which there is a large dissimilarity between the timescales that characterise each one of the subsystems (called media in the paper referring to the atmosphere and ocean). In particular, the study focuses on the impact of changing the length of the observational time window (OTW) for each of medium and present arguments linking the optimal OTW to the characteristic variability time scale in each coupled medium. The results are significant and the presentation is mostly clear and concise. However, the paper would benefit from proof-reading focusing on English

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language aspects that would make it even clearer. I have included some comments referring to this point, but I did not try to compile an exhaustive list.

Specific comments

1 It would be useful to have more background information on the CDA strategy studied in the paper. In particular I was wondering why the observational data should be assumed at the assimilation time when 4D Var would avoid that problem. It was only in Section 4 that 4D Var was mentioned as an alternative.

2 P2, L20-22: The two questions posed are circular in the sense that the answer to the first would depend on the effects of varying the OTW on the quality of CDA and the answer to the second depends on the existence of an optimal OTW. I would suggest the following rearrangement: '1) What is the impact of varying OTWs for each coupled component within the coupled model framework on the quality of CDF for climate estimation and prediction initialisation? 2) Based on this impact, Is there an optimal OTW so that assimilation fitting has maximum observational information, but minimum variability distortion?' The point is subtle, but it might be worth doing for clarity.

3 Equation (1): Should there be a dot over eta? Is the dot over C6 correct?

4 It is not necessary to describe the Runge-Kutta method in Section 2.1.

5 P5, L3: What is 'localization and imbalance'?

6 P5, L26: Please define Y_k , or is it the same as $Y_{\{k,t\}}$.

7 P7, L3-5: Move this paragraph to the end of section 2.2. I was actually wondering whether twenty cases were sufficient to compute statistics.

8 P7, L30: How are model years defined?

9 P8, L9-11: What do you mean by the strong nonlinearity and smoothness of the Runge-Kutta method? Can you elaborate on this point? Perhaps a different method

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would be more appropriate to obtain the solution of system (1).

10 P8, L22: It is not clear why the spread should be small. Please explain this point.

11 P8, L28: What is 'convexity with respect to OCN-OTWs'?

12 P11, L1: Which one is the curve of $X2$ -RMSE in the OCN-OTW space? The figure (Fig. 9b) only shows one set of lines as a function of OCN-OTW and it corresponds to omega-RMSE.

13 P11, L12-17: The information in these lines is a repetition from the previous paragraphs. They can be deleted.

14 P12, L3-8: The discussion about the influence of the coupling term in the optimal OTWs is interesting, but it is hard to see what the implications for the real world or for a realistic CDA system are. Please, also discuss these points.

15 Figure 5: What does the blue shading under the lower bound mean?

16 Figure 10c is not discussed and therefore could be dismissed.

17 Figures 11a and specially Fig. 11b, which only shows a horizontal line, are not needed as they can be simply described in the text.

Technical corrections:

P1, L21-23: Some of the main results are given in these lines. However, the sentence is written in a very confusing style. I would encourage the authors to rewrite it to make the abstract, and the paper, more accessible.

P1, L30: Delete 'the' between 'by' and 'coupled'.

P1, L32: Add 'to sub-grid processes' after 'approximation'.

P2, L11: Delete 'in each medium here' and add 'for each medium' after '(OTW)'.

P2, L20: Delete 'exist' between 'not' and 'an' and add 'exists' after 'OTW'.

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P2, L21: Expand 'What's' to 'What is'.

P2, L24: Change 'identify' to 'identifies'. Also, the end of the sentence, after 'medium' is not clear. Please, rewrite.

P3, L25: Change 'frequent' to 'frequency'.

P4, L7: Delete 'Namely'.

P4, L8: Define TU.

P4, L12: I think the sentence is incomplete. What does 'C2' does in contrast?

P4, L16-17: As it is written, the sentence starting with 'Where' and ending with 'scale' makes no sense. Please, rewrite.

P4, L21: Do you mean 'In summary' rather than 'Summarily'?

P4, L24: The method's name is Runge-Kutta not Runger-Kutta. Since it is not used in the text the acronym RK4 is not necessary.

P4, L25: Change notation as 'k0-k3' looks like 'k0 minus k3'.

P5, L6: Either change 'In the words of Zhang (2011a)' to 'Following Zhang (2011a)' or clearly indicate the quote from that paper using quotation marks.

P5, L14: The sentence does not make sense. Please rewrite.

P6, L15: Change 'including' to 'included'.

P6, L19 and L20: Change 'integrates' to 'is integrated' P6, L24: Delete 'etc.' or perhaps change it to 'and other parameters'. P7, L4: Change 'will obtain' to 'was obtained'. P7, L11: Omega and w are two different letters. P7, L28: The sentence is incomplete. Figure 3 presents the power spectrum of what? P8, L23: Change 'keeps' to 'is kept'. P9, L26 and L27: Change 'including' to 'included'. P10, L15: Delete 'gained'. P10, L11: I think where it says 'only limits' should say 'is limited'. Caption to Fig. 9: Change 'panels' to 'panel'. Figure 10: The value of C1 in the legend is constant and therefore

it is not needed there.

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