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Nonlinear Processes in Geophysics
Discussions
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Interactive comment on "On the localization in strongly coupled ensemble data assimilation using a two-scale Lorenz model" *by* Zheqi Shen et al.

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According to the comments, we have a major revision of this manuscript, and we also hired a professional service to edit the English. We have point-to-point responses of the reviewers' comments as follow:

The paper discusses localization in strongly coupled data assimilation systems. The authors use a two-scale Lorenz model to develop their technique and prove their idea through twin-experiments. 1- In general, the paper is not well-written. The grammar and the structure of the sentences is quite weak. There are a lot of language mistakes that I can't even list here, for brevity. If this to be reviewed and submitted again, I

strongly encourage editing the manuscript by a native speaker

RESPONSES: We are sorry that the reviewer was not happy with our English. As non-native speakers, we are aware of our weakness. Thus, we have hired a professional service, American Journal Experts (AJE), to edit the English of this manuscript prior to submission, including the grammar, punctuation and spelling. We have attached the certificate at the end of this document. Moreover, we have submitted this reviewer comment to AJE, and they have performed an additional revision to ensure that the English of this manuscript is of high quality. We hope that this reviewer now finds the English in the revised version to be satisfactory.

2- Furthermore, around 80 % of the paper is based only on academic information that the community is aware of, with little to no novelty. The only new idea is found in Section 3.3 where the authors propose a cross-domain localization strategy for SCDA. However, even that seems to be model specific and may not be generalized for realistic atmospheric applications in my opinion.

RESPONSES: Usually, a new idea or method is developed based on previous work and existing methods. In this manuscript, we developed a new localization method for a strongly nonlinear coupling system using EAKF. It is typical to present an introduction to EAKF, an introduction to the model used, and some discussion of the possible concerns and problems for the current localization methods, which, according to this reviewer, may be considered academic information that the community is already aware of. However, we think this overview is necessary to not only provide a friendly presentation to the readers but also maintain scientific rigor. This approach is common in many scientific papers.

We did not count the frequency of these components in this manuscript, but we believe 80 % is slightly exaggerated. However, we think it is not important. This manuscript developed a new method for strongly coupled ensemble data assimilation, as the reviewer described. The use of SCDA systems is very new and highly challenging. New ideas and methods used for the development of SCDA systems are difficult to implement; this difficulty may be one of the main reasons why few researchers are working on data assimilation, especially SCDA, compared with the many researchers working on data analysis. We should encourage young scientists to work in such a challenging field. More importantly, we think the new method is original and novel, thereby making this manuscript sufficiently innovative and deserving of publication.

We agree with this reviewer that the developed method and its performance may be model-dependent. However, this is not a reason to reject the publication of this work since the model-dependence occurs not only for this work but also for many other published works. This is especially true in the development of data assimilation methods, which always use a simple Lorenz model to test and develop a new method at the first step. We can find many assimilation papers published in reputable journals that only use a Lorenz model to develop new ideas or methods. Thus, the Lorenz model is also called a "test bed" in the field of data assimilation method development, and its use has been widely published in the literature. Therefore, it is unfair if this work is rejected due to our use of a Lorenz model.

3- The assessment of the results is poor. I wasn't sure if the authors are reporting forecast or analysis errors. Also, the RMSE on its own is often not a very good metric to assess a new assimilation/localization strategy. I wanted to see how the authors choice of equations 10 and 11 affect the ensemble spread evolution.

RESPONSES: Thank you for this comment. Sorry for the confusion. We present both the forecast and analysis errors in the manuscript, as described in Section 2.2 (Page 4, line 28), which this reviewer may not have noticed.

For the revised manuscript, we reran the experiments with some new feature of EAKF and assessed the results using different metrics, as listed below.

1. We use the adaptive inflation scheme developed by Anderson (2009) in the EAKF.

   The adaptive inflation method uses different inflation parameters for different state elements, and the parameters are updated according to the observation and localization factor as a function of time. By using this method in the experiment, we can exclude the influence of the inflation on the results. The comparison result can be attributed to the localization method, which reinforces the conclusions.

2. To assess the performance of the CDA methods on each model, we still use the mean of the scaled RMSE (MS-RMSE) and the "coefficient of efficiency" (CE), as described in the submission. In addition, to better assess the result, as this reviewer mentioned, we will also compute the ensemble spreads in each of the forecast and analysis steps of the experiment. The root-mean-squared spread is scaled by the long-term STD, and the mean of the scaled RMSS (MS-RMSS) is used to further evaluate the result of each CDA method, as shown in Figures 6 - 9 in the revised manuscript. The spread is a good measure of the uncertainty, and we think it will emphasize our conclusions.

Thank you for the suggestion.

4- Related to point 2, I suggest the authors test their method in a large model assimilating real data. This at least will improve the quality of the manuscript given the lack to any theoretical developments.

RESPONSES: Thank you for this suggestion. We will attempt to implement this method in a real model in the next step. However, it is beyond the scope of this manuscript, as argued above. Moreover, assimilating real data in a large coupled model is very time consuming and challenging. We also desire for the method to be published soon, which we believe will benefit and promote the study of the SCDA method.

5- Sections 2.3 and 3.1 can be removed or summarized. The EAKF equations can be referenced and the same goes for Gaspari-Cohn function and localization in general.

RESPONSES: Thank you for this comment. Section 2.3 briefly introduces the EAKF method as a convenience to readers who have little knowledge about EAKF and for the efficient discussion of the new method, which we believe to be reader friendly. Thus, we modified this section but still kept it in the revised version. In the revised manuscript, we also included the adaptive inflation method used in the experiments. As suggested, we only provided a reference (Anderson 2009) and did not discuss it.

This work addresses localization. Thus, we think the discussion of the localization in a general framework is essential, as it provides the necessary background for the development of the new method and further discussion.

Additionally, we think that the equation on the GC function should remain in Section 3.1. It is frequently referred in Section 3.2 and Section 3.3, which both discuss some important issues about the GC function and its applications.

Please also note the supplement to this comment:
https://www.nonlin-processes-geophys-discuss.net/npg-2018-50/npg-2018-50-AC1-supplement.pdf

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Interactive comment on Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2018-50, 2018.

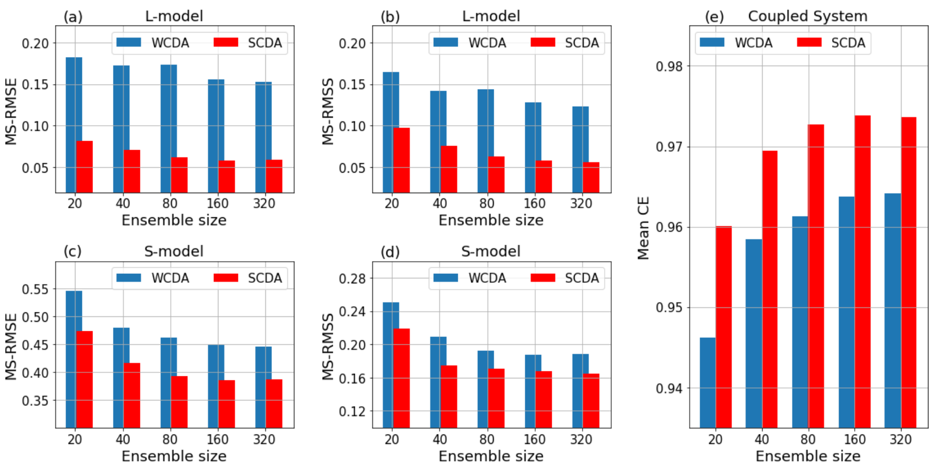

Fig. 1. figure6: The MS-RMSE of L-model (a) and S-model (c), the MS-RMSS of L-model (b) and S-model (d), and the mean CE of the coupled system (e) against different ensemble sizes with WCDA and SCDA.

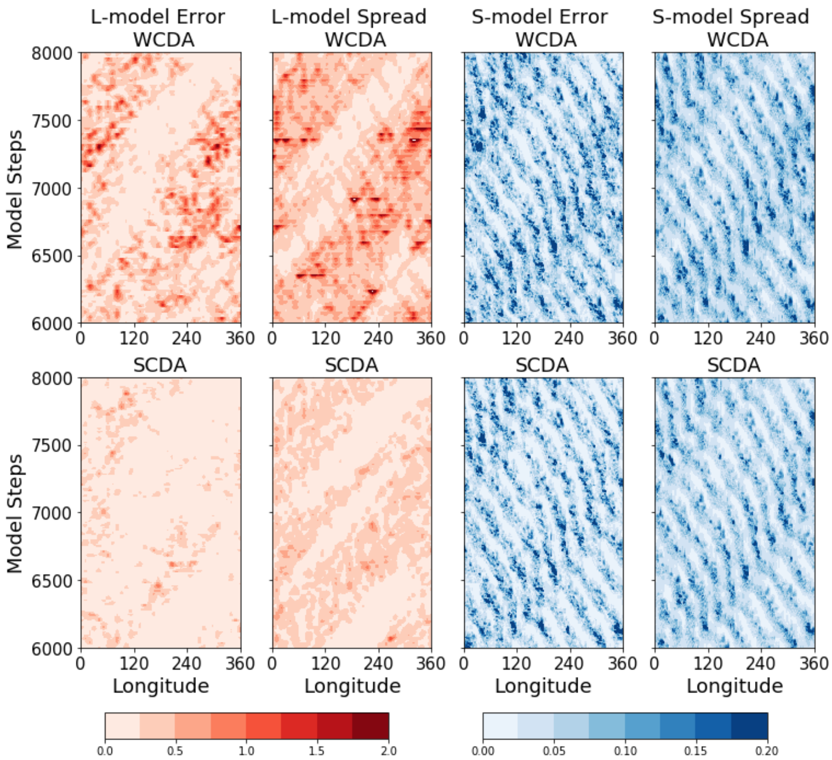

Fig. 2. figure7: The absolute analysis errors and ensemble spreads of the L-model using SCDA and WCDA (left) and of the S-model using SCDA and WCDA (right).

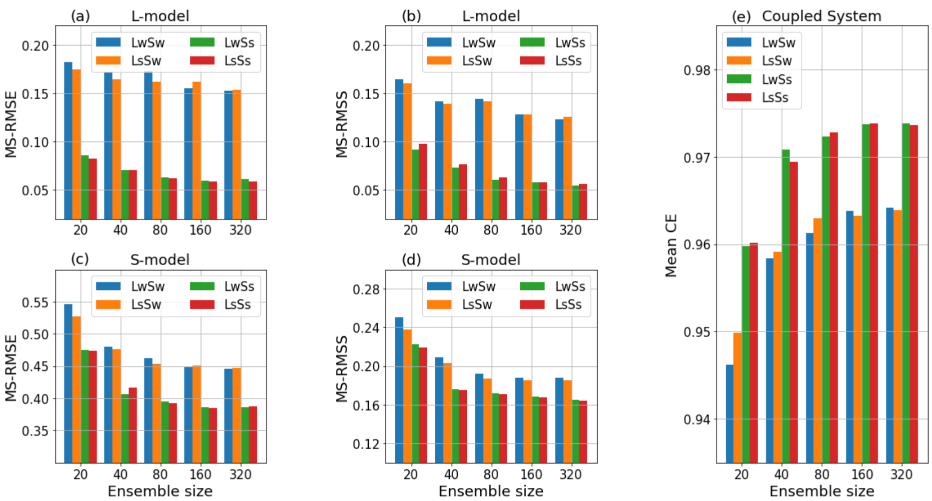

Fig. 3. figure8: The MS-RMSE of the L-model (a) and S-model (c), the MS-RMSS of the L-model (b) and S-model (d), and the mean CE of the coupled system (e) against different ensemble sizes and different CDA

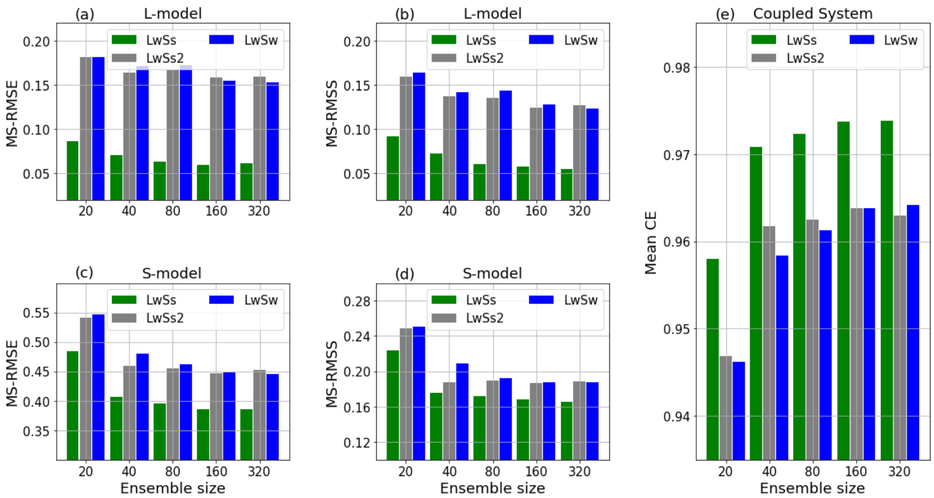

Fig. 4. figure9: The MS-RMSE of the L-model (a) and S-model (c), the MS-RMSS of the L-model (b) and S-model (d), and the mean CE of the coupled system (e) with different SCDA formula