

## ***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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### *Specific comments*

*Between lines 10 – 15, page 7. The authors mentioned that  $P_{xx}$  is a diagonal-constant matrix. Does this mean that the off-diagonal elements in  $P_{xx}$  are all zero? If so, it seems to me that very “strong” localization is applied in the EAKF. To see this, let’s use notations similar to those in Eq. (7) of the manuscript, but here I dropped the index  $n$  of ensemble members. Without loss of generality, and regardless of which type of EnKF*

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is used, in general one would have the following update formula

$$\Delta x_m = \sum_{s=1}^S P_{m,s} K_{m,s} \Delta y_s$$

For the authors' specific problem in consideration, one has  $M = S$ . So " $P_{xx}$  is a diagonal-constant matrix" means that  $P_{m,s} = 0$  if  $m \neq s$ , or in other words, the model variable  $x_m$  is only updated using the observation at the same location as  $x_m$ . In reality, it may be possible that observations at nearby locations also contain certain information of  $x_m$ , so a "weaker" localization scheme may be useful. Although, I do see that, in this case, adding more observations in the update scheme may make localization much more complicated. My suggestion here is thus to clarify the situation, and discuss the implication when  $P_{xx}$  (likewise,  $P_{zz}$ ) is chosen to be a diagonal matrix. (No action required for the side remark in the sequel) In general, it should be desirable to make the localization scheme more general and more flexible. For this purpose, the authors may wish to have a look at the idea behind the recently proposed correlation based adaptive localization.

**RESPONSES:** We apologize for using the term "diagonal-constant matrix". In the revised version, we indicate that  $P_{xx}$  is a  $K * K$  Toeplitz matrix, which means that each diagonal of  $P_{xx}$  has the same value, e.g., the main diagonal has the value  $\rho(0, c)$  and the  $k$ -th diagonal has  $\rho(k, c)$ . Therefore, the off-diagonal elements are non-zero unless the distance exceeds a cut-off radius of  $2 * c$ . Again, we apologize for the misleading statements, and thank you very much for the suggestions.

*Technical corrections (minor issues)*

1. Line 22, page 6. In "...inversely proportional to the distances...", "proportional" does not sound accurate.

**RESPONSES:** Thank you for pointing this out; we changed the statement to "The value of the localization function decreases when the location of the state element moves

away from the observation site.”

2. *First line, page 7. In “...the prior ensemble member”, consider adding “n-th” before “prior”.*

**RESPONSES:** This has been added. Thank you for the suggestion.

3. *Page 7 mentions “correlation covariance” in a few places. I guess it should be “cross covariance” instead.*

**RESPONSES:** We have changed this term to “covariance matrix”.

4. *First line, page 8. In “could beyond...”, add “be” before “beyond”.*

**RESPONSES:** This has been added. Thank you for the suggestion.

5. *Line 21, page 9. Double check the notation  $\rho_z z$*

**RESPONSES:** This is a typo. Thank you for pointing out this error. It has been corrected.

6. In Eq. (10), define the operator before using it. It does not seem to be a standard tensor product (between two vectors).

**RESPONSES:** We changed the notations in Eq. (10) and (11) and defined the Kronecker product in the first line of page 10.

7. *Last line of Section 3, page 10. In “...L-variable has equal effect...”, it seems “has” should be “have”.*

**RESPONSES:** Thank you for pointing out this error. It has been corrected.

8. *In the definition of CE (page 10), why  $x_{true}$  should be squared in the denominator.*

**RESPONSES:** This is a typo. Thank you for pointing out this error. It has been corrected.

*Line 12, page 11. In “It is possible that the smaller MS-RMSE with SCDA in figure 7b*

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*is due to ...”, it seems to me “figure 7b” should be “figure 6b” instead. Similarly, Line 20, in “whose results are shown in Figure 9d–f”, maybe “Figure 9d–f” should be “Figure 8d–f”.*

**RESPONSES:** Thank you for pointing out this error. It has been corrected. Additionally, we have rerun the experiments according to the suggestion of another reviewer, and some of the figures are reproduced.

*Line 13, page 12. In “when  $N \leq 320$ ”, should “ $\leq$ ” should be “ $=$ ” instead?*

**RESPONSES:** In the revised manuscript, we compare the CDA scheme 3 with an alternative localization method to show the impact of Eq. (10) on the SCDA of the S-observations. Therefore, the whole paragraph has been rewritten.

*9. Line 24, page 12. In “...limited ensemble size”, add “a” before “limited”. Line 25, add “of” after “the presence”.*

**RESPONSES:** This has been added. Thank you for the suggestion.

*10. Lines 5 – 6, page 13. Replace “factors” by “factor”, and change “a update” to “an update”.*

**RESPONSES:** We have changed this phrasing. Thank you for the suggestion.

We have hired native English-speaking editors to improve the English and hope that this strategy can eliminate those errors. Thank you for your help.

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

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