Geoscientific
Model Development
Discussions

Interactive comment on "**Comparison of the ensemble Kalman filter and 4D-Var assimilation methods using a stratospheric tracer transport model**" *by* **S. Skachko et al.**

Anonymous Referee #2

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This manuscript presents a well documented comparison between 4D-Var and EnKF data assimilation strategies applied to a state estimation problem that models strato-spheric tracer transport. I have several comments that are related to the description of experiments and various statements regarding fair comparison and conclusions.

Major comments:

1. The following argument:

"Since the biases are markedly similar, they have most probably the same causes: these can be deficiencies in the model and in the observation dataset, but not in the assimilation algorithm nor in the error calibration."

can be specious because similar biases is not sufficient to prove that the assimilation and error calibration are correct. I suggest removing the last part after "but".

2. Please explain the experimental setup [preferably between 3 and 3.1] for the two strategies. Is EnKF restarted? Is 4D-Var started from the previous forecast? Also please provide more details about the model and observations; how sparse are the observations? Some details are provided in Sec. 2.1

3. Consider analyzing the the 4D-Var and EnKF solutions against each other. OmF is an indicator of how far are they from the observations, but if the two are indeed close than that would be an interesting conclusion.

4. Similar conclusions as expressed in argument 1. above may be obtained if the assimilation is constrained by data. Details in point 2. may clarify this item; how-ever, leaving out observations may truly elucidate this point. Moreover, leaving out observations may also be used in a cross-validation experiment and will enhance any conclusions from 2.

5. The calibration of the observation error covariance in EnKF and 4D-Var can have Bayesian interpretation. In this case, r is a stationary random variable with it's own uninformative prior or a hyperparameter. This variable is calibrated first, and its max-imum likelihood value is used. This means that the error model for the observations is assumed to be additive and the actual errors to be unknown and part of the inverse problem and it should be stated as such.

6. EnKF and 4D-Var use different statistical assumptions. The most problematic in this comparison is the model error, and therefore are directly comparable unless there is no model error. This does not invalidate the conlusions of this study; however, the conclusions can be overstated. In particular, the use of the same r in both strategies may be inadequate.

7. The posterior covariance of EnKF - readily available - is not used to assess its

correct forecast. This is just a suggestion, but I realize the challenge in processing such datasets.

9. The covariance tuning for EnKF may become unstable based on the results presented herein. How would it be affected if the assimilation would have been started on September 1st where there is a distinctive growth in the chi factor?

Graphics comments: Suggest using Julian date (or day of year) in on the x axis in Fig. 2, 5, 6.

Typographical errors: P 352, L 23: missing "to be"

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