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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 #3

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General comments:

This study applies an EnKF to the tracer transport model BASCOE and compares the EnKF with an existing 4D-Var. The EnKF and 4D-Var systems are calibrated carefully, and the settings such as 4D-Var iteration number and EnKF ensemble size are chosen carefully to make the comparison as fair as possible. Limitations exist such as the different treatment of model error in EnKF and 4D-Var, but those limitations are clearly stated with reasonable discussions. The paper is generally well written and provides useful information. I have a major comment about correlations of time series in statistical inference, but once this point is cleared, the paper would be a useful contribution and worth publication. I also list several minor comments as below, which may be

useful to improve the paper. Overall, I would recommend minor revision.

Major comments:

1. The overall conclusion from this paper on the comparison between 4D-Var and EnKF suggests no significant difference between the two data assimilation methods. However, Fig. 5 shows 4D-Var outperforms EnKF only very slightly but quite consistently. If the statistical hypothesis testing (or statistical inference) considers the correlations in time series, statistical significance may be obtained to support 4D-Var's advantage. However, it appears that the paper does not consider correlations in statistical inference, this does not seem a wise choice to make the comparison of time series. I would suggest performing statistical inference with correlations considered, that may lead to different conclusion.

Minor comments:

1. P.340, L.2, "The" -> "An"

2. Eq. (18), the notations of rho and the Schur product do not look precise, need revisions. Eq. (17) assumes that rho has the same shape as the B matrix, and that the open circle operator indicates the element-wise product. Eq. (18) uses the same rho and open circle operator but applied to HBH, that has the matrix shape of the R matrix, not B. The same applies to Eq. (19). Also, Eq. (18) is an approximation, should not use the equal sign.

3. P.352, L.13, zeta in Eq. (4) is not an analysis increment, but control variables.

4. P.352, L.24, "mathematical" -> "statistical" ?

5. P.372, Fig. 2, the values of alpha and r in figure caption are not consistent with legend and main text.

6. P.357, L.11, I do not understand why 48 analyses. Does this mean EnKF analysis is computed 48 times during the 24-h period? It is necessary to clarify what "48" means.