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Interactive comment on "EnKF and 4D-Var Data Assimilation with a Chemistry Transport Model" *by* S. Skachko et al.

Anonymous Referee #3

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Review of EnKF and 4D-Var Data Assimilation with a Chemistry Transport Model by S. Skachko et al.

This study compares EnKF and 4D-Var data assimilation methods applied to a chemistry transport model. The purpose is to compare relative merits of the two methods on long time (short windows) atmospheric chemistry data assimilation with prescribed flow fields.

Major comments:

1 EnKF Experimental setup: Page 6: "the model error term is added to observed species only." What is the rationale for this? The same L operator seems to be used both for 4D-Var and EnKF, but at lest in the definition of \eta in (7), and (1) or (2), L lives in different spaces.

2 The authors claim that the same error covariances are used in both cases [page 14: "the same correlation model for all prescribed error correlations (i.e. the background error for 4D-Var, initial error and model error for EnKF)"]; however, on page 8 around line 10, they seem to indicate different localization operators that come in to build B. This should be clarified.

3 Cross species localization: In Section 5 the authors discuss the effects of inter-species localization. It is unclear to me what is done here. Is ENFK-CC the same as EnKF except that in EnKF-CC the O3 and NO2 are localized? If that is the case, then this is problematic because one cannot choose to localize some species and not localize the others because it introduces transients that may lead to spurious bias oscillations. This should be clarified as well.

Minor comment:

Page 4 line 2: "cross-covariance between species are taken into account automatically using the 4D-Var adjoint mode" is not clear to me. How is this achieved?

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