EGUsphere, referee comment RC3
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Comment on egusphere-2022-928

Anonymous Referee #3

Referee comment on "Toward a multivariate formulation of the parametric Kalman filter assimilation: application to a simplified chemical transport model" by Antoine Perrot et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-928-RC3, 2022

The manuscript describes an application of "parametric" Kalman Filter to data assimilation for chemical modeling. I believe it can be significantly shortened by providing just one example of the application of PKF.

The assimilation method relies on evolving covariance error statistics based on prognostic equations rather than obtaining them from ensemble of states as in more traditional ensemble KFs. Increased complexity of forecast model equations corresponds to the increased complexity of equations for error covariances and increased number of simplifying, maybe arbitrary assumptions.

Chemical model forecasts do not depend on chemical parameterizations alone but also on evolving physical state (meteorology). Therefore, it is difficult to imagine how a proposed system of modeling error covariances using chemical parameterizations alone can favorably compare with a traditional system that relies on an ensemble of simulations forming a basis to obtain estimates of error covariances of species. I don't believe that a proposed system of assimilation using PKF will be successful in application to real-world data assimilation for air quality such as with model MOCAGE that the authors mention. It would be valuable if a positive result can be demonstrated. Otherwise, the proposed application of "parametric" KF is just a curiosity that can be described in a significantly reduced manuscript.

I believe that the manuscript should be much revised and its publication subject to a demonstration that the application of PKF in a realistic DA scenario provides benefits that are comparable to those using a traditional EnKF approach.