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On the Utility of Data Assimilation for Extremes in a Conceptual Atmospheric Model

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An important research question is whether current data assimilation (DA) schemes can reproduce extreme events in analysis fields and how skillful they are in forecasting them. Here, we examine the utility of two widely used DA methods, the Ensemble Kalman Filter (EnKF) and the four-dimensional variational method (4DVar), for the estimation and prediction of extremes in a conceptual model of the atmosphere. We evaluate the DA performance by first examining whether the analysis captures the extreme value statistics of the control simulation. Second, we examine whether the forecasts generated from the analyses can well predict the extremes occurring in the verifying control simulation. Our results indicate that the two DA methods are beneficial for the prediction of extreme events, especially when compared with a rudimentary DA scheme which just imputes observations where they are available. Our results reveal that the EnKF is more accurate than the 4DVar in estimating the extreme, while the 4DVar produces better deterministic forecasts of extremes. However, we can take advantage of the EnKF and convert ensemble forecasts into probabilistic forecasts, which improve over the deterministic forecasts. Therefore, our results suggest the use of the EnKF for DA for extremes.