

Improving Reanalyses using Physically Based Stochastic Parameterizations

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Abstract

Reanalysis datasets are a crucial part of climate research, offering consistent sets of climate fields for use in the monitoring, simulation and prediction of climate variability. The quality of reanalysis fields depends strongly on the quality of background “first guess” fields and the proper specification of their expected errors relative to observational errors. Many modern Kalman filter based reanalysis systems use an ensemble of short-range forecasts as first guess fields and their spread to specify their expected errors. In principle, such systems have a superior flexibility to make these specifications state-dependent, i.e. “to go with the flow”, in a physically consistent manner. In practice, however, much of this potential advantage is lost because the spread of the forecast ensemble is often unrealistically low, necessitating an artificial covariance inflation to produce reasonable results. To what extent such misspecifications of the error covariances compromise the quality of existing reanalysis datasets is completely unclear at present.

In this presentation, we will explore the potential impact on reanalyses of including physically based stochastic parameterizations (SPs) of atmospheric convection and other physical processes in the forecast model used for generating the first-guess fields. Proper inclusion of the SPs should substantially reduce the need for the artificial inflation of first-guess error covariances and lead to an improved relative weighting of the observations and first guesses in the reanalysis algorithm. We will discuss strategies of how the development of such SPs could be guided not only by physical considerations but also by assessing to what extent they lead to better probabilistic weather predictions and better representations of climate variability in long climate runs of the same forecast model.