Data Assimilation & Machine Learning
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Assimilating real Earth system observations with machine learning models

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Abstract

There has been a recent surge in development of accurate global atmospheric model emulators, including full ML model emulators (FourCastNet, PanguWeather, GraphCast, GenCast) and hybrid models (NeuralGCM). Evaluation of these models has mainly been focused on forecasts, mostly with 1-10 day lead times. However, forecasts rely on accurate initial conditions that, in the context of operational weather prediction, generally come from a cycled data assimilation system. While there have been a few DA studies that utilize emulators, these studies have focused on synthetic observation experiments. Here we present what is, to our knowledge, the first study of a cycling DA system using ML models to assimilate real observations. A reduced observation network consisting of only surface pressure observations is assimilated into several popular pure and hybrid ML models, including NeuralGCM and PanguWeather, using an ensemble Kalman filter. This experiment design provides an informative test case since the performance of the DA system relies on accurately capturing ensemble covariances to update unobserved state variables, where the observed variables are not part of the loss function used in the optimization process. NeuralGCM is a natural model to test in this context since it includes a publicly-available stochastic model that may be more appropriate for an ensemble DA system. Results will be presented from experiments that cycle with models including NeuralGCM, and compared to those from experiments that cycle with a coarse-resolution version of a purely physical model, NOAA's operational Global Forecast System. Preliminary conclusions and lessons learned will be discussed.

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