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A Multi-Fidelity Ensemble Kalman Filter with a machine learned surrogate model

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One of the disadvantages of oceanographic models is that they can be very computationally expensive. When combined with data assimilation, dynamical approaches such as the EnKF become expensive as they need a large number of ensemble members and thus model runs. In this work we investigate the use of a Multi-Fidelity Ensemble Kalman Filter (MF-EnKF), where the lower fidelity model is a machine learned surrogate model and the high fidelity model is the original full model. The idea behind this is to use an ensemble of a few but expensive full model runs, combined with an ensemble of many cheap but less accurate surrogate model runs. In this way we can reach similar or increased accuracy with less full model runs and thus less computational time. We investigate the performance by testing the approach on a simple atmospheric model, namely the Lorenz-96 model, and an oceanographic model, namely the Quasi-Geostrophic model. Results show that the MF-EnKF outperforms the EnKF for the same number of full model runs and that the MF-EnKF can reach similar or improved accuracy with less full model runs.