Building a robust hybrid model framework for the IFS

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Systematic model errors remain a fundamental challenge in numerical weather prediction, limiting the predictability horizon of current state-of-the-art systems. In this update, we present recent developments in constructing a hybrid model for the Integrated Forecasting System (IFS), which augments the physics-based model with a neural network-based statistical component for flow-dependent error correction.

Building on the framework of weak-constraint 4D-Var, we demonstrate the transition from offline pre-training to an online learning approach where the neural network parameters are included in the control vector. A key focus of this presentation is the development of a new batch learning algorithm leveraging the Ensemble of Data Assimilations (EDA) suite. We show that this batch learning approach significantly improves the efficiency of the training process and enhances the generalization of the neural network to out-of-training data during evaluation.

We illustrate the impact of the flow-dependent model error corrections on medium-range forecast performance, highlighting the superior predictive capability achieved through the improved online batch learning algorithm. We will conclude by outlining key challenges and future research directions.