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Challenges for the hybrid forecast models: representation of the systematic forecast error with machine learning

Machine learning (ML) is poised to play a key role in the next generation of forecast models for the Earth system. One specific approach of interest is hybrid modeling, where a ML model is trained to represent systematic (predictable) portion of the forecast error for traditional physics-based models. Then the ML model is used as an augmented tendency term in the traditional physics-based forecast equations. The simplest form of such methods can be designed by using average analysis increments as a tendency correction term in the forecast.

Based on our experience with this simplest type of hybrid model and based on the analysis of model biases across multiple operational centers, we identify key challenges and possible solutions for the development of more complex hybrid models. These challenges that we discuss in this presentation include:

1) Use of biased analysis as a source of ground truth for training of the ML models.
2) Short-term vs. long-term behavior of the model error.
3) Multi-scale nature of the forecast error.
4) Flow-dependence of the forecast error.
5) Interaction between model development, data assimilation, and machine learning.

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