

Department of Applied and Computational Mathematics and Statistics Colloquium



Mihai Anitescu

Argonne National Laboratory

Weakly-Constrained 4D Var for Downscaling with Uncertainty using Data-Driven Surrogate Models

Data-driven models such as FourCastNet have emerged as a promising alternative to the traditional NWP models for forecasting. However, as the lead times, and, therefore, their forecast window, increase, these models show instability in that they tend to diverge from reality. In this work, when carrying out dynamic downscaling, we replace the computationally expensive PDE-based NWP models with FourCastNet in a "weak-constrained 4DVar framework" that accounts for the implied model errors. We demonstrate the efficacy of this approach for a hurricane-tracking problem; moreover, the 4DVar framework naturally allows the expression and quantification of uncertainty. We demonstrate, using ERA5 data, that our approach performs better than the ensemble Kalman filter (EnKF) and the unstabilized FourCastNet model, both in terms of forecast accuracy and forecast uncertainty. We discuss limitations of the current approach and possible improvements using scalable methods for statistical analysis involving generic covariance matrices.

Monday, March 31, 2025

3:45 – 4:45 PM

127 Hayes-Healy Center

Colloquium Tea – 3:15 PM in 101A Crowley Hall