

Diving into the Forecast with Ensemble Clustering and Sensitivity Analysis: Insights from the 2024 FFaIR Experiment and Applications to Winter Weather & Atmospheric Rivers

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Ensemble clustering is a powerful post-processing method that condenses ensemble forecasts down to their prevalent scenarios, acting as a helpful tool to visualize and message forecast uncertainty. Originally developed for nor'easters, this approach has advanced through the R2O pipeline, becoming more operational at WPC and a centerpiece of the Dynamic Ensemble-based Scenarios for IDSS (DESI) platform.

In the 2024 Hydrometeorology Testbed Flash Flood and Intense Rainfall (FFaIR) experiment, we applied clustering to a 28-member time-lagged Rapid Refresh Forecast System ensemble (RRFSe). Clusters for 6-hour QPF fields outperformed the full ensemble in 83.7% of participant evaluations, highlighting the method's utility for forecasting extreme rainfall. Importantly, clustering captured diverse initialization times, showcasing the value of time-lagged ensembles in increasing forecast spread.

To further understand sources of forecast uncertainty, we also developed an ensemble sensitivity analysis (ESA) application to identify early atmospheric differences driving scenario outcomes. This talk will highlight operational applications of clustering and ESA, results from the FFaIR experiment, their utility in winter weather and AR prediction, and future directions for these techniques.