How Do Forecasters Utilize Output from a Convection-Permitting Ensemble Forecast System? Case Study of a High-Impact Precipitation Event

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Introduction
We are primarily motivated by two interrelated questions:
• How are ensembles best leveraged to result in improved weather forecasts across scales and forecast elements?
• How do forecasters’ utilization of ensemble guidance vary, and what impact does it have upon the forecast?

Background
Previous research has demonstrated that:
• Ensemble usage depends upon the type of forecasts being made: they are used more when ensemble output is matched to specific forecast requirements.
• Ensemble reliability, display methods, and perceived utility all influence how forecasters use ensemble guidance.

We evaluate how forecasters utilize convection-permitting ensemble guidance when a specific high-impact weather event – Tropical Storm Fay in 2008 (Figs. 1 and 2) – is forecast.

Forecasting Exercise
To evaluate how forecasters use ensembles, a forecasting exercise is conducted. All Fay guidance are shifted to the Houston/Galveston, TX area and presented as T.S. “Trixie.”
Forecasters create a 72-h QPF forecast using only deterministic operational guidance, then revise it after being presented with the ensemble forecast guidance in multiple forms.

After each phase of the exercise, surveys are conducted to document subjective forecast impressions related to the specific forecast scenario and how the ensemble was used.

Ensemble Performance and Forecast Verification
Initial and lateral boundary condition variability (Fig. 3a-h, i-p) influenced changes in QPF locations while physical parameterization variability influenced changes in QPF values. Ensemble forecasts reflect downscaled versions of the guidance from which they are initialized (Figs. 3 and 4).

The primary forecast challenge, therefore, is pinpointing the location and amount of maximum rainfall within a localized region. To that effect, the ensemble provides a skillful forecast relative to climatology (Fig. 5), but one that is underdispersive and biased (Fig. 6).

Forecasting exercise participants’ forecasts prior to viewing ensemble output are broadly similar (Fig. 7). There exist notable differences in how considering ensemble output resulted in changed forecasts (Figs. 8 and 9). In the aggregate, forecast skill improved after considering ensemble data. (Fig. 10).

Future Directions
There exist many R2O/C2R challenges regarding ensembles:
• What is the event-to-event, person-to-person, forecast-to-forecast variability in how forecasters use ensembles?
• How are ensembles best constructed, and how are element-specific data best mined from ensembles?
• How are the barriers to ensemble acceptance, perceived or real, best overcome – training, visualization, improved skill?
• How are ensembles best used in the forecast process?

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