Precipitation Forecasting and Verification Tools for the WPC to Probabilistically Quantify Excessive Rainfall Nationwide

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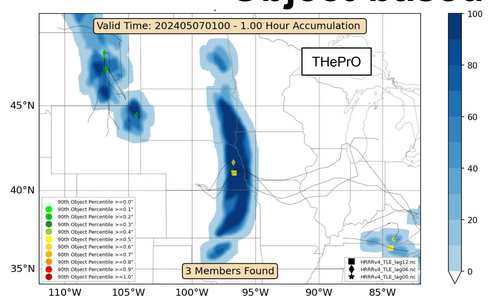
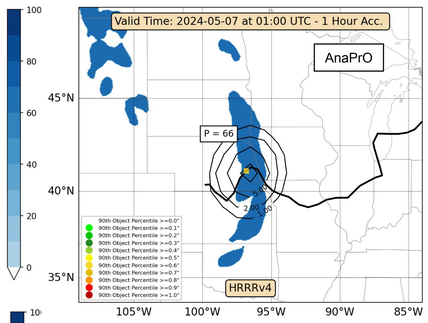
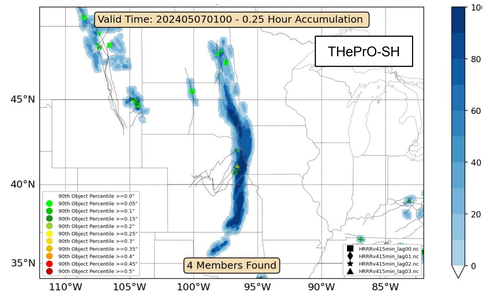
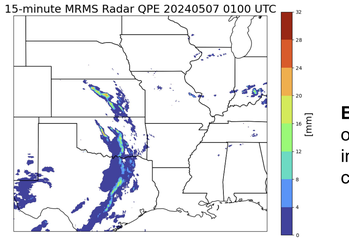
Object-based Verification









GOAL: Use of METPlus Mode Time Domain (MTD) to identify heavy precipitation objects on a hourly (THePrO) and subhourly (THePrO-SH) scales using the HRRR time-lagged ensemble.

- Probabilistically quantify regions of excessive precipitation exceeding particular thresholds.
- Use archived observations to construct analog forecast that provide displacement information for real-time objects through linkage to retrospective modeled objects and their corresponding observations (AnaPrO).
- Implement machine learning algorithms to cluster objects that share similar atmospheric characteristics to gather more appropriate historical data and inform the probabilistic products.
- Verification metrics to be computed using the Multi-Radar Multi-Sensor (MRMS) radar quantitative precipitation estimation (QPE).
- Development of new webpage to display these tools with the capability to investigate the data through an enhanced user interface.

Bonus: Transition development code to operational-like computing environment. This includes rewriting code to more easily accept changes with further development plans.

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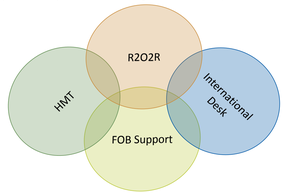
WPC DTB Vision Statement

To become a preeminent catalyst for transformative weather prediction capabilities through collaborative research and development. We envision a seamless integration of cutting-edge science into operational forecasting, ultimately enhancing forecast accuracy, timeliness, and usability for the betterment of society.

Overview of Projects

The DTB team develops and maintains a broad scope of projects and products, all aimed to advance the state of forecasting and the state of atmospheric science. Most employees at DTB carry a variety of skills and wear many different hats. Generally, the projects developed and maintained here fall into one (or more) of four categories and span a wide range of operational readiness levels.



Satellite Data Infusion for Heavy Precipitation

The main objective for the Satellite Data Infusion for Heavy Precipitation project is to develop and prototype an ML technique to enhance the probabilistic quantitative precipitation forecast (PQPF) at hourly and 6hr forecast time periods out to 24 hours.

- **Data** - Our model predictors consist of moisture, thermodynamic, and mass variables at multiple levels in the atmosphere from the High Resolution Rapid Refresh (HRRR) hourly forecast model. These inputs are mapped to the Multi-Radar/Multi-Sensor System (MRMS) observational dataset. Currently we limited our time to the month of June 2021, but will expand as we develop.
- **ML Architecture** - We are using the U-Net Convolutional Neural Network (CNN) architecture [Figure 1] originally developed by Ronneberger et al. in 2015. This architecture differs from other CNNs by using upsampling layers to replace pooling operator.
- **Verification** - This still needs to be included in the project, but we are planning on including several measures to verify skill (eg. Briar Skill Score) and reliability.
- **Preliminary Results** - Probabilities are much lower than expected, but does a reasonably well job at capturing spatial features.

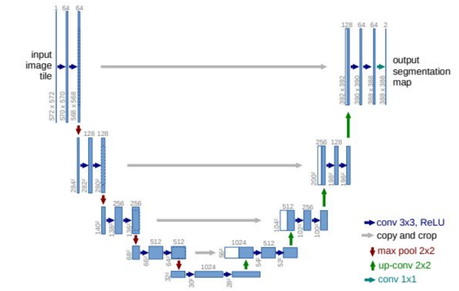


Figure 1. An illustration from Ronneberger et al. 2015 of the U-Net architecture.

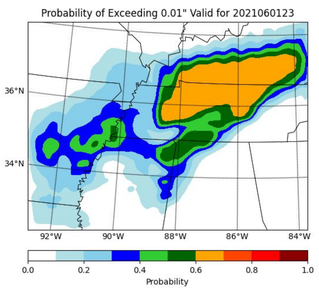


Figure 2. Probability of hourly precipitation accumulations exceeding 0.01” valid for June 01, 2021 at 23 UTC

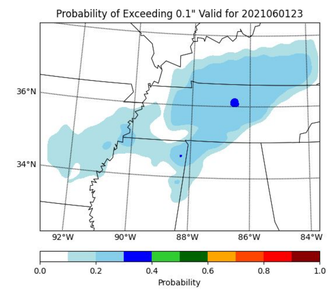


Figure 3. Probability of hourly precipitation accumulations exceeding 0.1” valid for June 01, 2021 at 23 UTC

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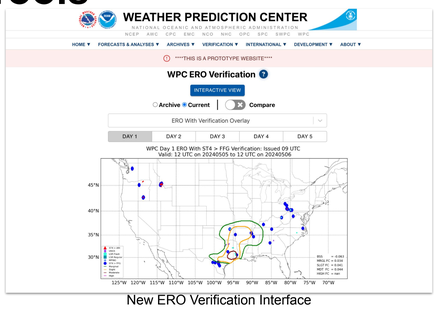
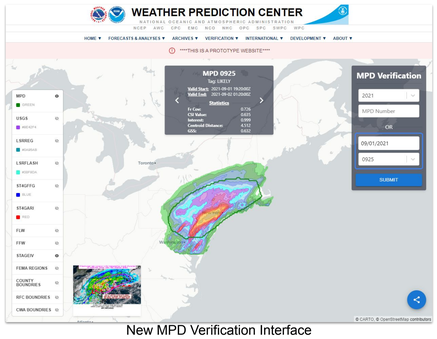
Web Development for Verification Tools

New web-based interfaces have been developed to facilitate inspection of verification information for both the Excessive Rainfall Outlook (ERO) and Mesoscale Precipitation Discussion (MPD) products.

- **ERO Verification Web Page**:
  - **URL**: https://origin.wpc.ncep.noaa.gov/aking/ERO-verification-multi/
  - Two different ways to inspect data:
    - Static image browser (plot view)
    - Interactive map (interactive view)
  - Comparison mode to enable easy side-by-side comparisons
  - Toggle to switch between current and archived data
- **MPD Verification Web Page Features:**
  - **URL**: https://origin.wpc.ncep.noaa.gov/aking/mpd-verif/
  - Interactive map on which a multitude of different overlays can be added (i.e. UFVS components, warnings, StageIV data, etc)
  - The ability to share a specific map view using a generated link
  - Forward/backward buttons to quickly flip through MPDs
  - Expandable MPD graphic for comparison



New ERO Verification Interface



New MPD Verification Interface

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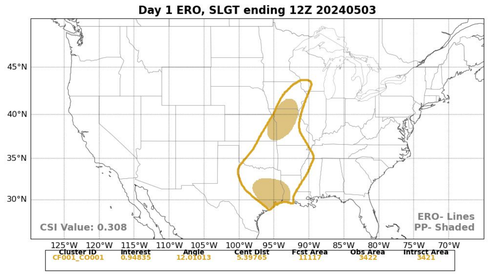
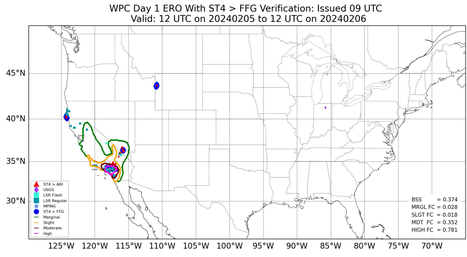
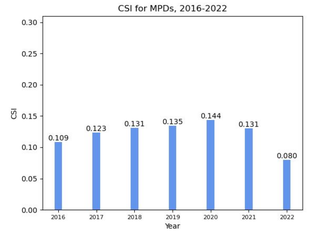
Excessive Rainfall Outlook and Mesoscale Precipitation Discussion Verification

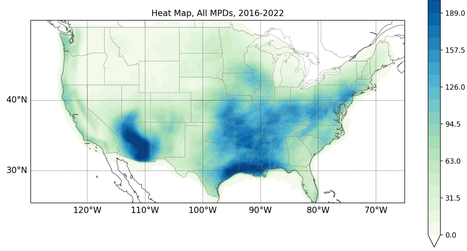


ERO:
- Grid- and object-based verification of the ERO product running in real time.
- Calibration of the product with the probability of observations occurring within the area of concern.





MPD:
- Object-based verification of MPDs running in real time.
- Determine performance of the product in different regions, seasons, years, and for various event types (TC, AR, monsoon, etc.).



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