Innovative Tools and Testbed Initiatives from CIRES at the Weather Prediction Center to Advance Weather Forecast Operations

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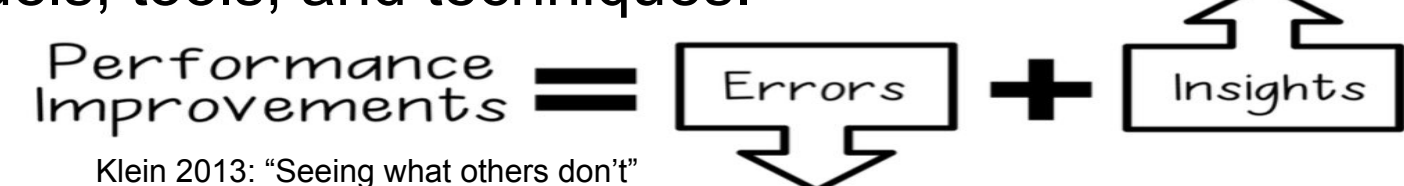## HydroMeteorology Testbed (HMT)

Who we are

We are Scientists who bridge the gaps between research & operations, to improve forecasts of precipitation extremes, in a human centered way. We generate discussion through Experiments, Seminars, Training, and Focus Groups. We use subjective and objective methods to evaluate and verify NWP models, tools, and techniques.

HMT is a:
- Naturalistic decision-making environment
- Physical & virtual space
- Insight-generating collaboration
- Sits at the intersection between Research and Operations

Performance Improvements = Errors + Insights

Klein 2013: "Seeing what others don't"

We host immersive experiments:
- Flash Flood & Intense Rainfall (Summer)
- Winter Weather Experiments (Winter)
- Atmospheric River Experiment (NEW!)

What we aspire to:
- Improve forecasters' expertise via a robust ecosystem of tools and knowledge
- Generate non-traditional insight on challenges of Forecasting & Impact-based Decision Support Services
- Improve the state of the science with real-world testing & evaluation
- Be People (not technology) Centered

**Activities We Conduct and Projects We Support**
- Forecast Exercises focused on *Extremes*
- Models & Ensembles: RRFS, NBM, HRRR, HREF
- AI/ML: ERO 1st guess, snow, precip
- *Probabilistic* Forecasting Techniques
- Subjective and Objective *Verification*
- *Websites* to view data in a variety of ways

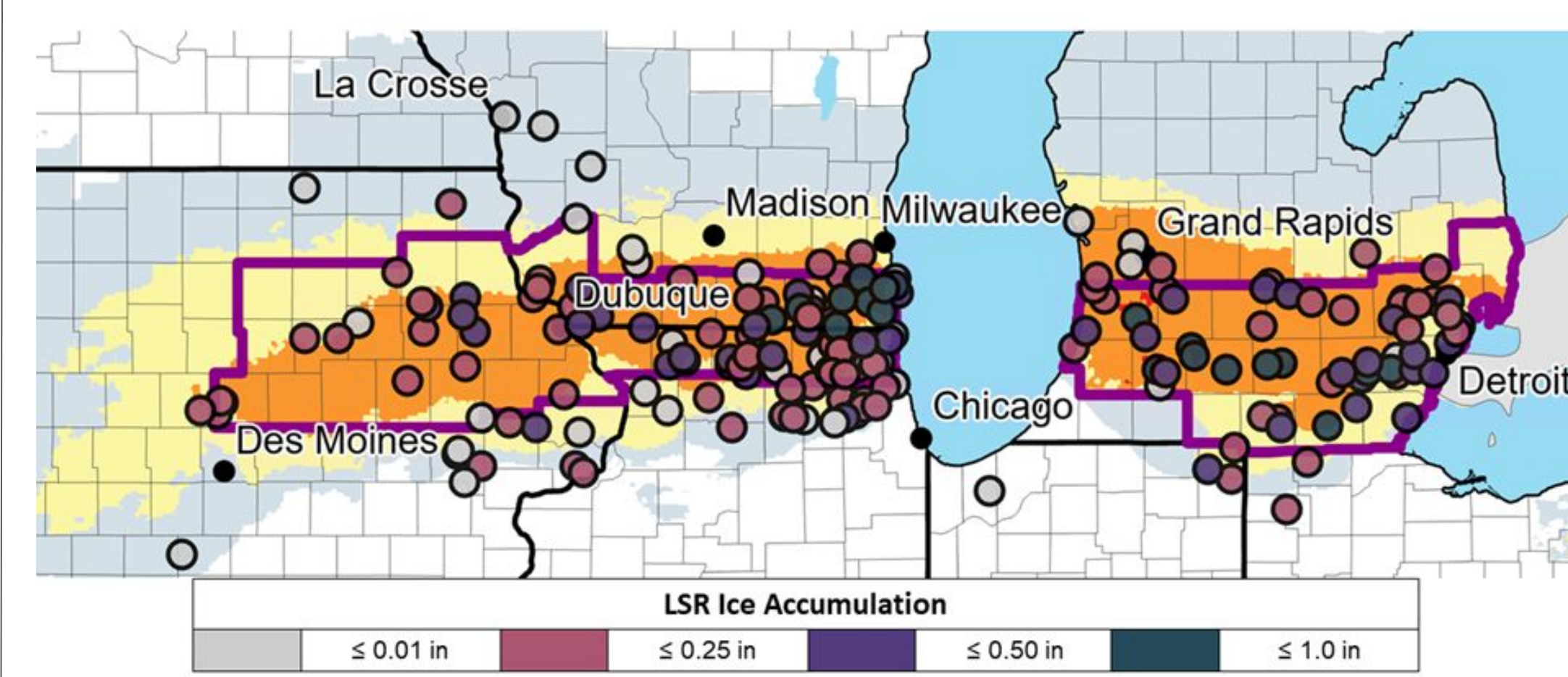| Our People:		
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Experimental Sounding Viewer

Interactive Website for Summarizing Model Forecasts: shown is hourly precipitation

Examples of Verification of Forecast Activities for WWE and FFaIR

Left: MSTP verification ice accumulations using FRAM.

Right: MRTP verification for extreme rainfall using MRMS-GC QPE.

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.
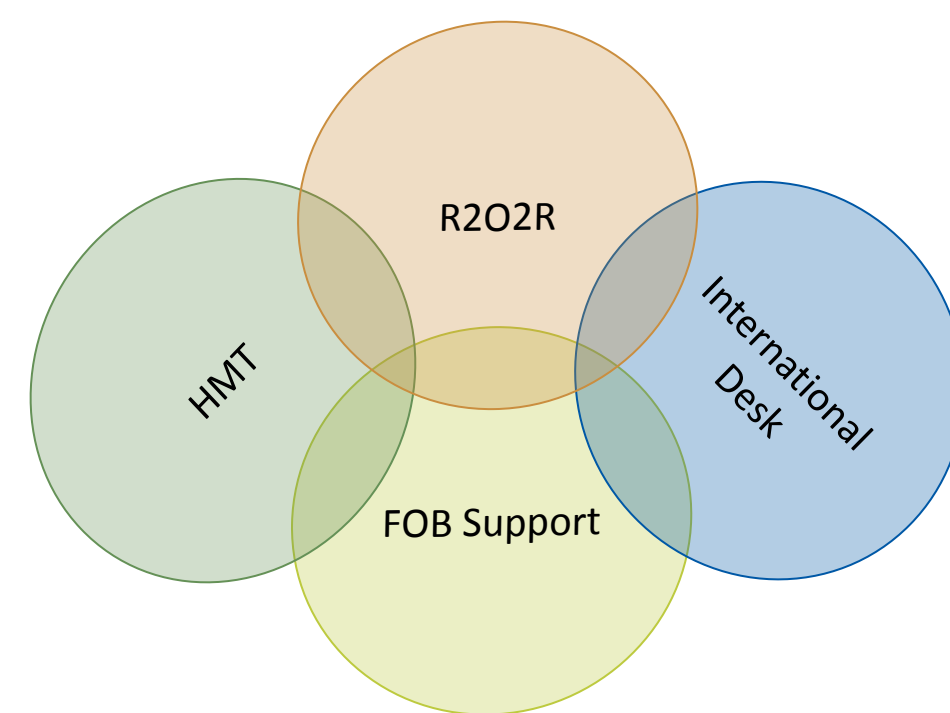
Winter Storm Severity Index (WSSI)

The Winter Storm Severity Index (WSSI) combines official NWS forecast data with climatological and non-meteorological information using geographical information system (GIS) software to spatially depict the severity of potential societal impacts. It is an impact-based decision support tool designed to help forecasters, stakeholders, and the general public maintain situational awareness of forecasted winter impacts. There is currently a "suite" of WSSI products at various stages of development:

- Deterministic **WSSI** – Operational
- Probabilistic WSSI (**WSSI-P**) – Operational
- Hourly WSSI (**WSSI-HI**) – Prototype
- WSSI for Alaska (**WSSI-AK**) – In Development

Verifying impact-based products is difficult. For the WSSI, subjective verification includes comparing output against issued NWS Warnings and Advisories, Local Storm Reports (LSRs), and crowdsourced mPING reports.
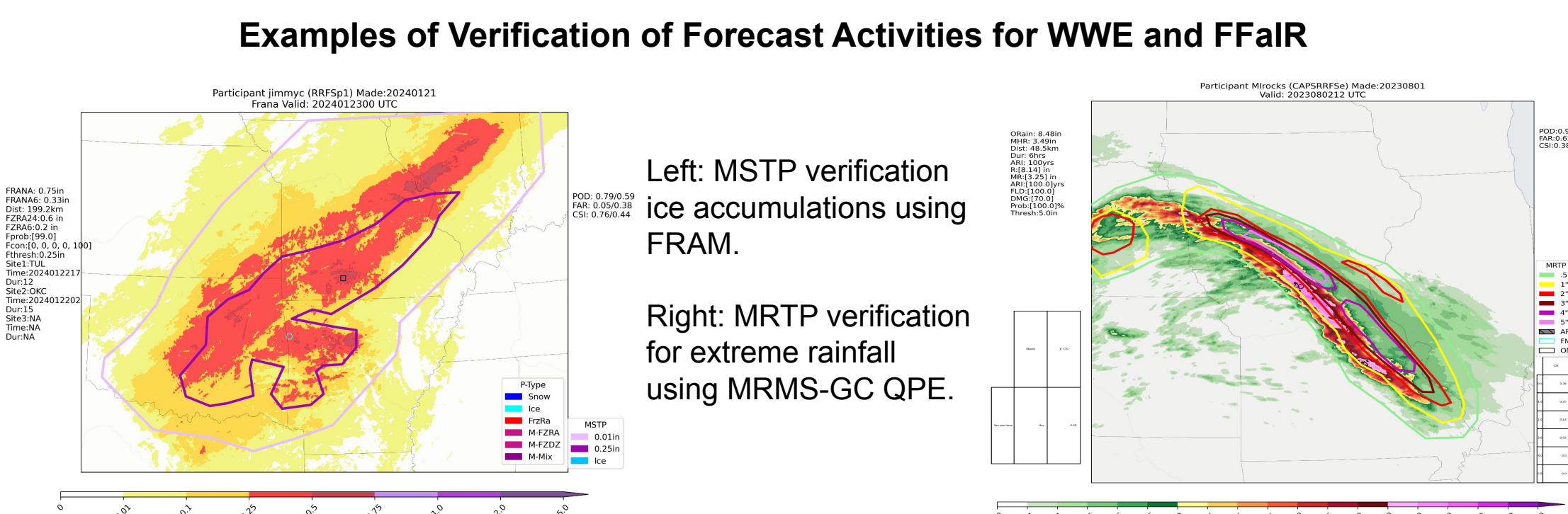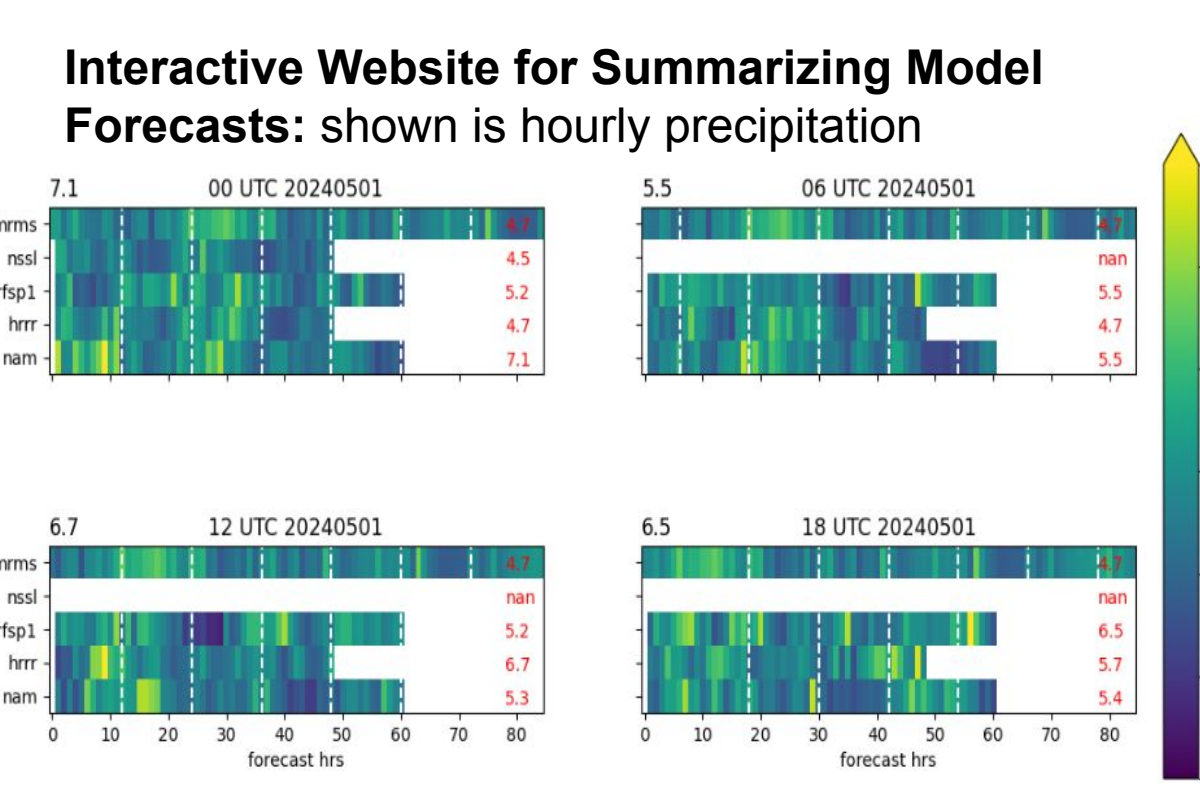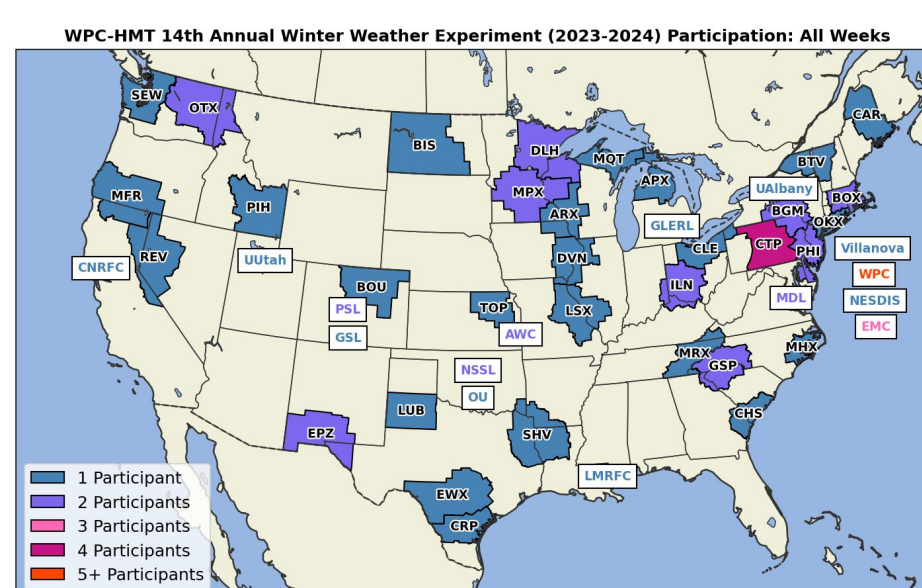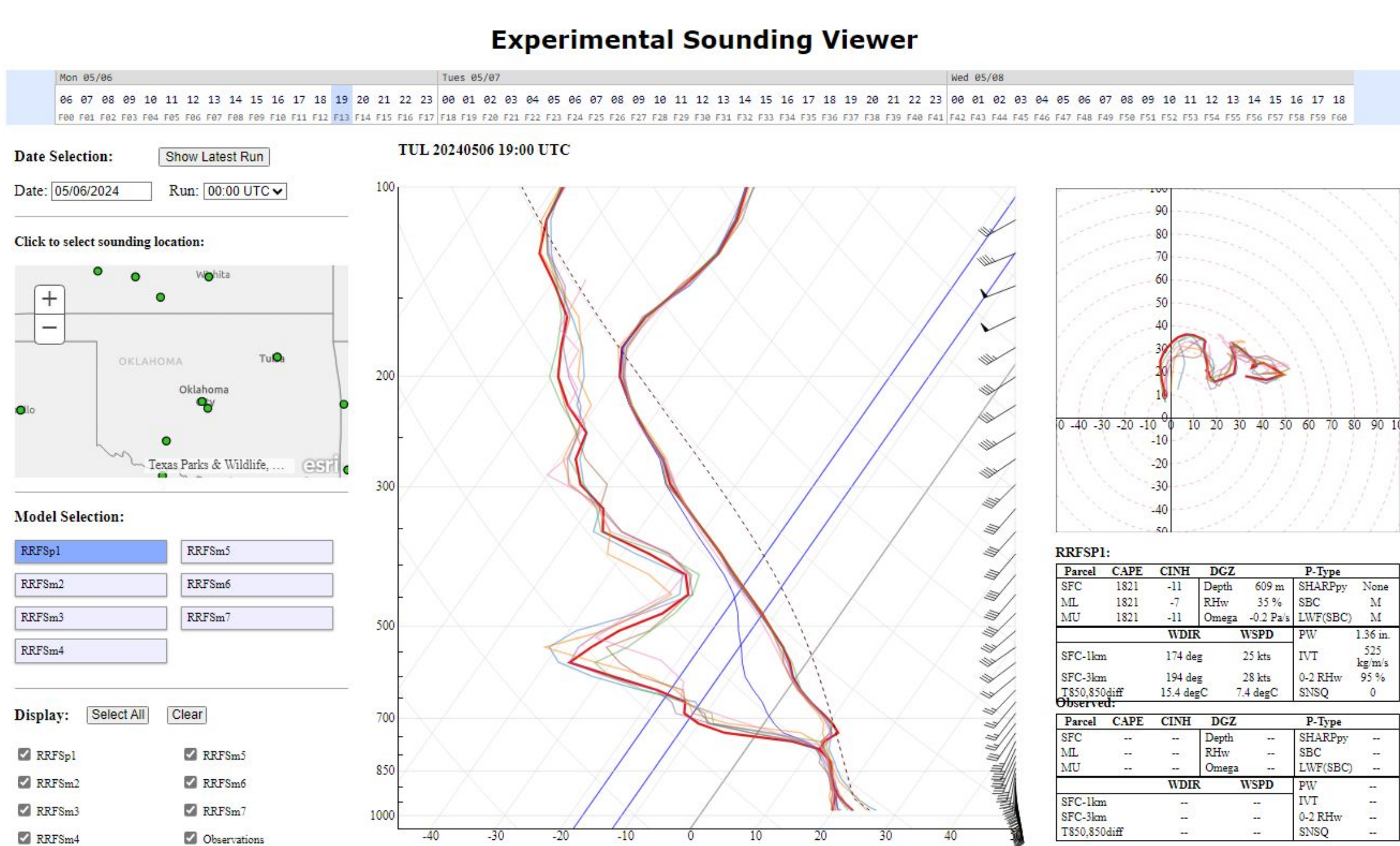

Figure 1: 3-day WSSI forecasted ice accumulation impacts ending at 1200 UTC 25 February 2023 (shaded; as in Figure 4c), with all NWS Ice Storm Warnings (purple outlines) and freezing rain accumulation local storm reports (color-coded circles according to ice accumulation in inches) valid within that time frame. Ice accumulations are taken as-is from the report, and not adjusted for radial or flat accumulations.

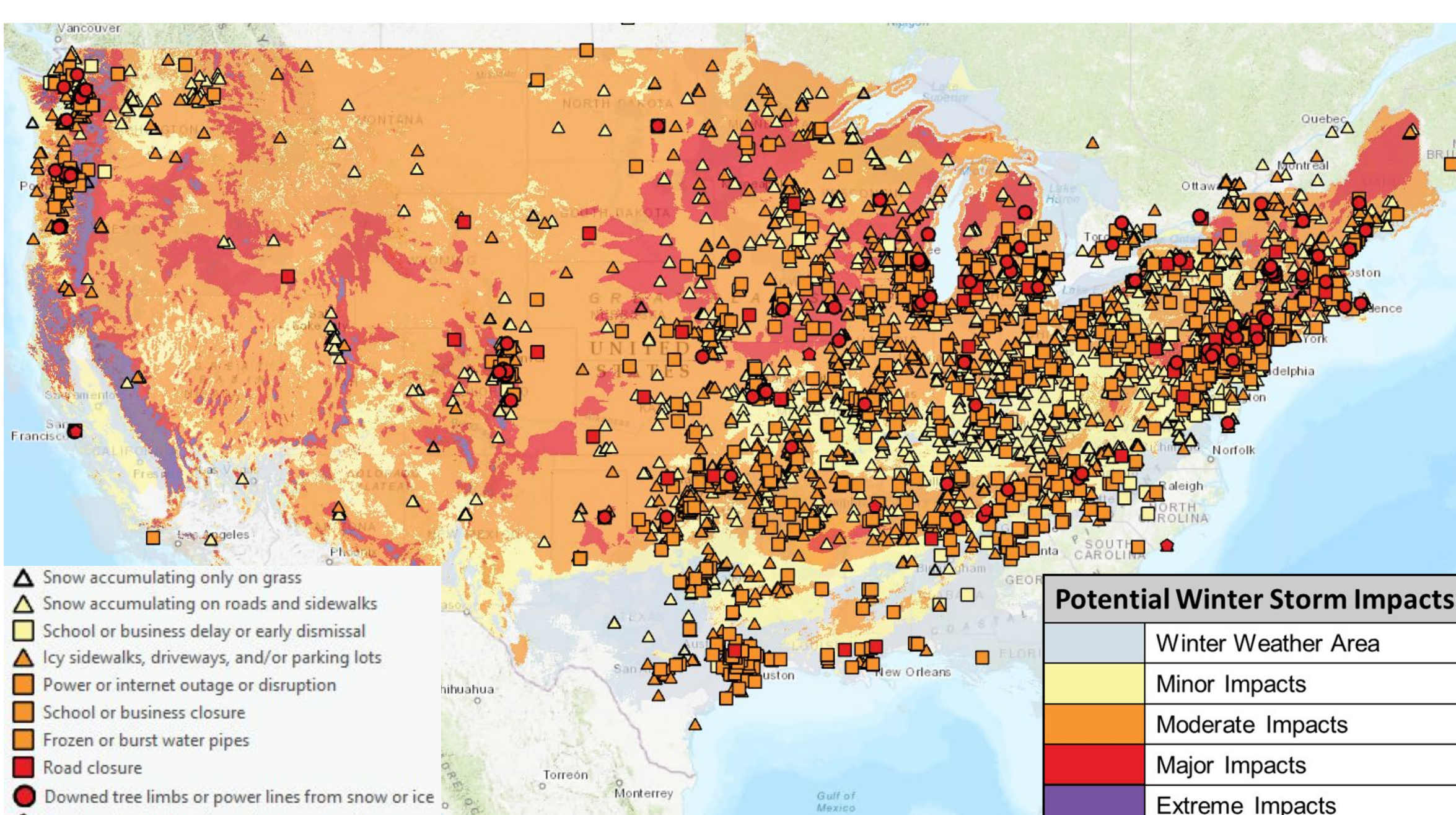**Contact:** Dana Tobin: dana.tobin@noaa.gov

Figure 2: November 2023 - March 2024 maximum overall Days 1-3 WSSI output (colored shading according to the bottom right legend) with mPING reports of Winter Weather Impacts, colored by corresponding impact severity level from the bottom left legend.

Ensemble Clusters & Sensitivity Analysis

The **"What"**

The Ensemble Clustering Tool distills large forecast datasets down to their prevalent scenarios
- Summarizes an ensemble forecast dataset without nuance amongst the membership or overwhelming the forecaster with too many options

Clustering tool widely-used across NWS to identify main modes in the forecast, either through WPC pages or the DESI platform
- Forecasters still desire more information about which features in the ensemble lead to different clusters - *what are the forecast scenarios sensitive to?*

The **"Why"**

**Ensemble Sensitivity Analysis reveals which early forecast features are most relevant to a chosen high-impact event!**

Clustering with GSL's DESI

WPC and GSL collaboration! Much more powerful and interactive way to visualize the clusters!

WPC Cluster Example

(Cluster Differences from Full Ensemble Mean shown by color-filled contours)
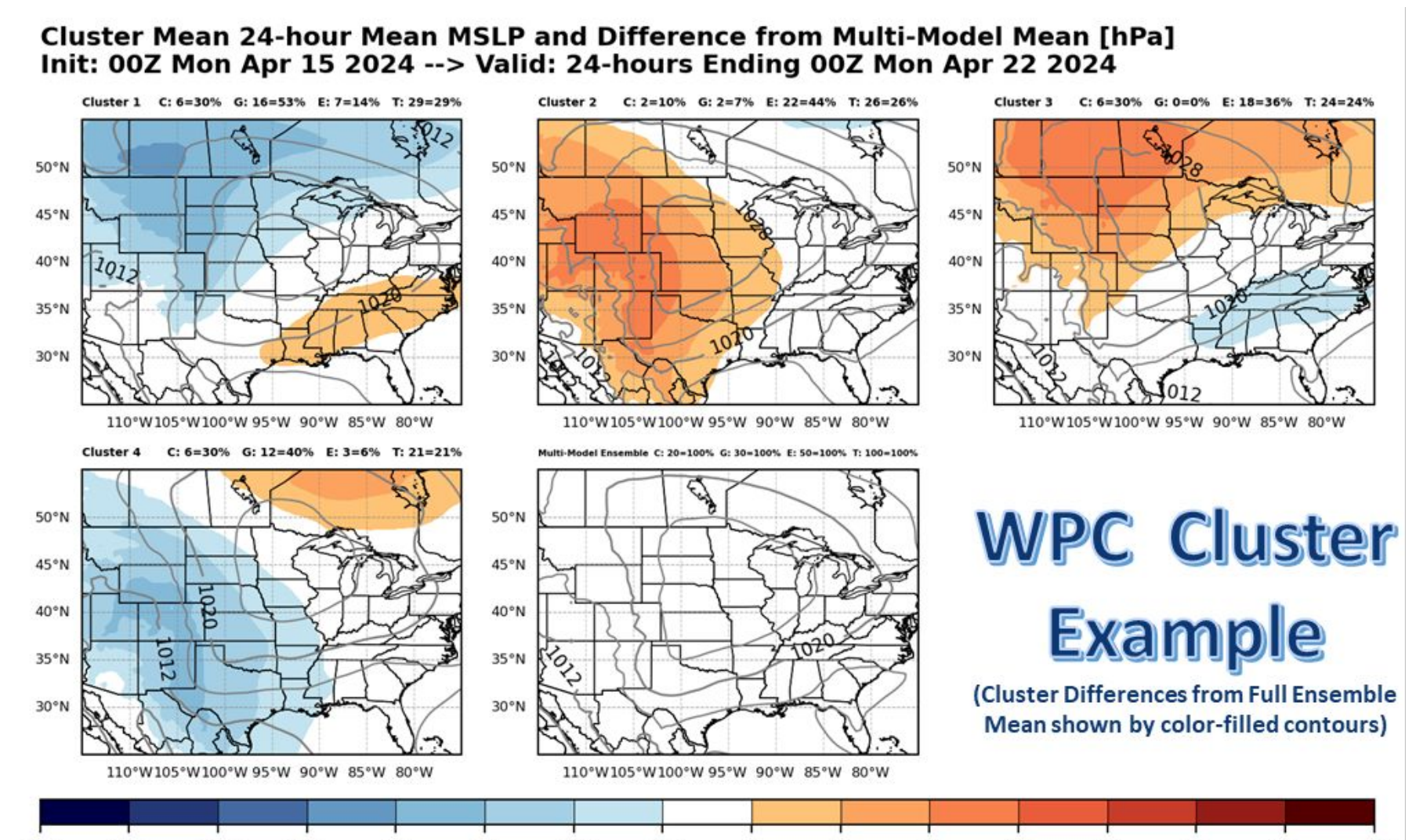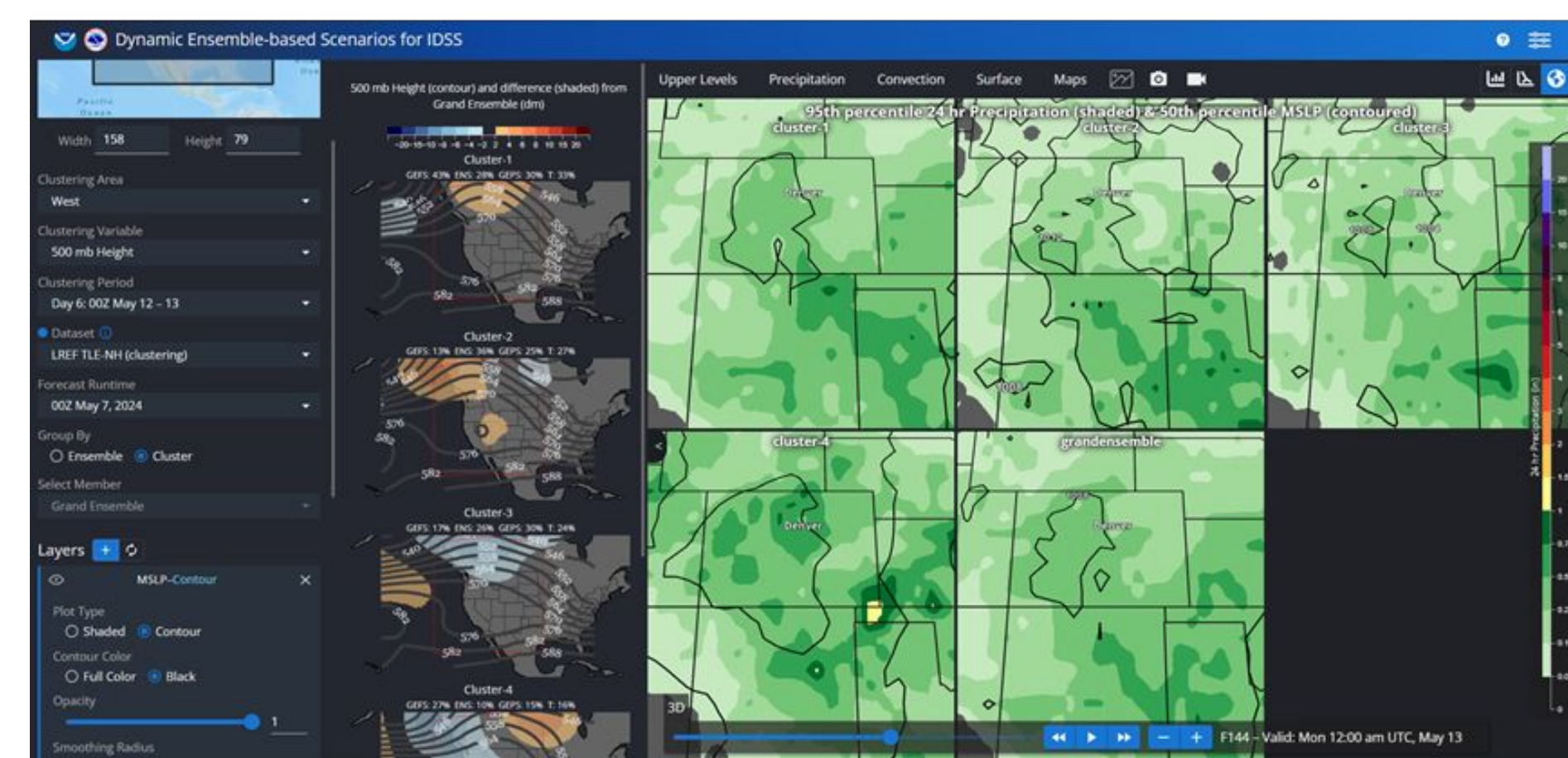
Ensemble Sensitivity Analysis (The "Why")

Allows a forecaster to interrogate early forecast features most relevant to the realization of each forecast scenario! Which features in the flow does the forecast "care" most about?

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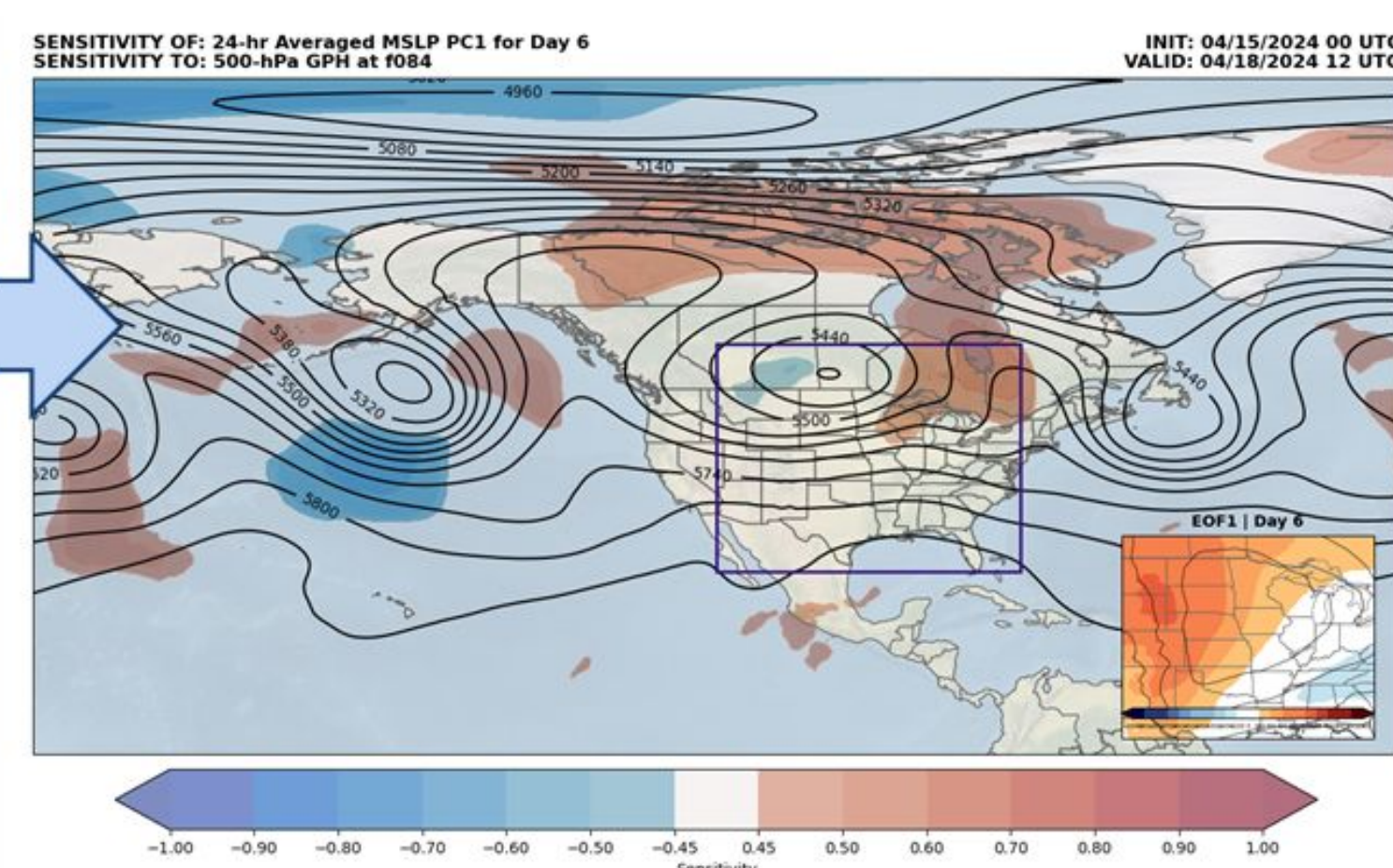
Urban Rain Rate Dashboard
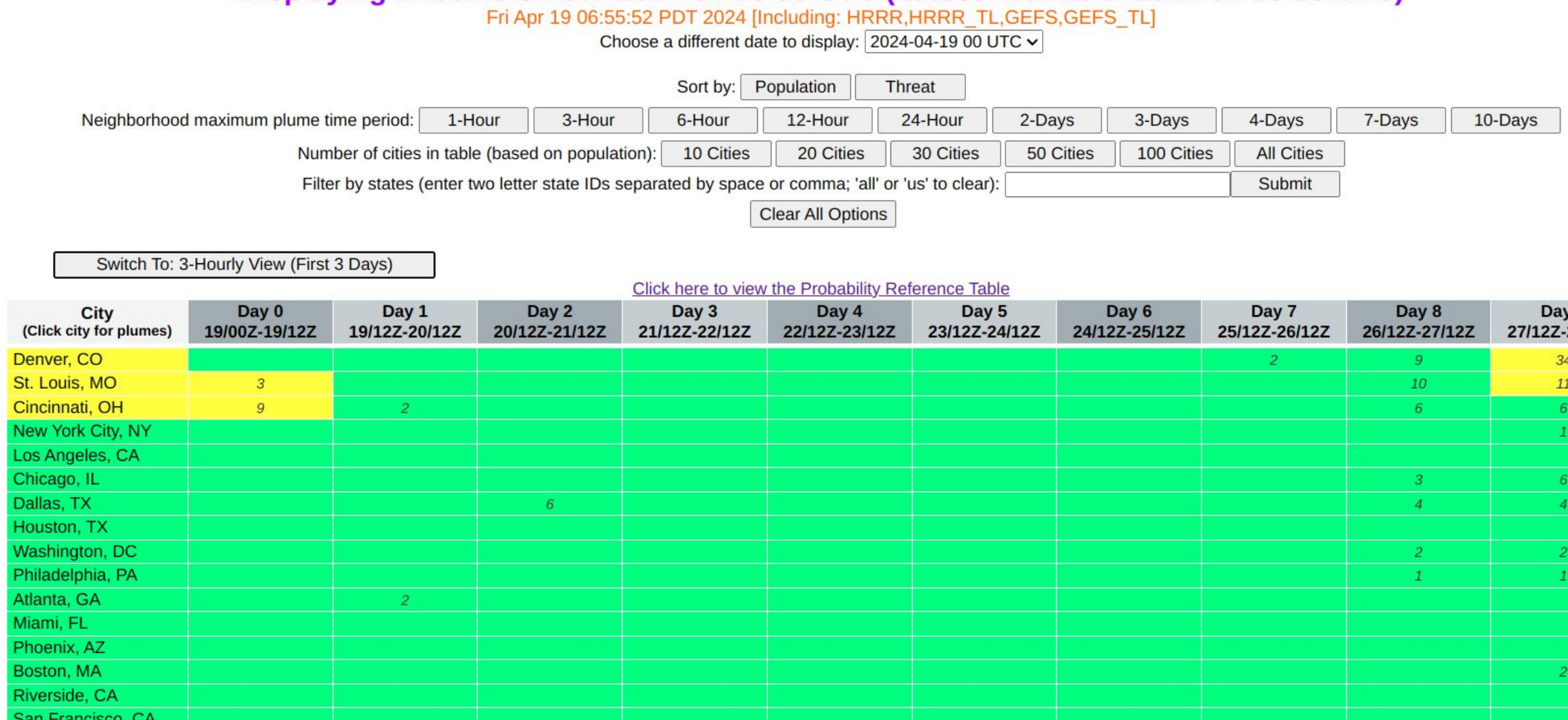
Goal: Provide guidance to city water managers for potential urban flash flooding events.

- Use ensembles and a neighborhood approach to account for uncertainty.
- Additional images available to show the layers of data that produce the dashboard color and number.
- Collaboration with Nurture Nature Center for social science development.
- Beginning verification

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