



NWS Storm Prediction Center

Current SPC Ensemble Use & Future Needs

Dr. Russell S. Schneider

Director, NOAA-NWS Storm Prediction Center

22 August 2023

9th NOAA Ensemble Users Workshop



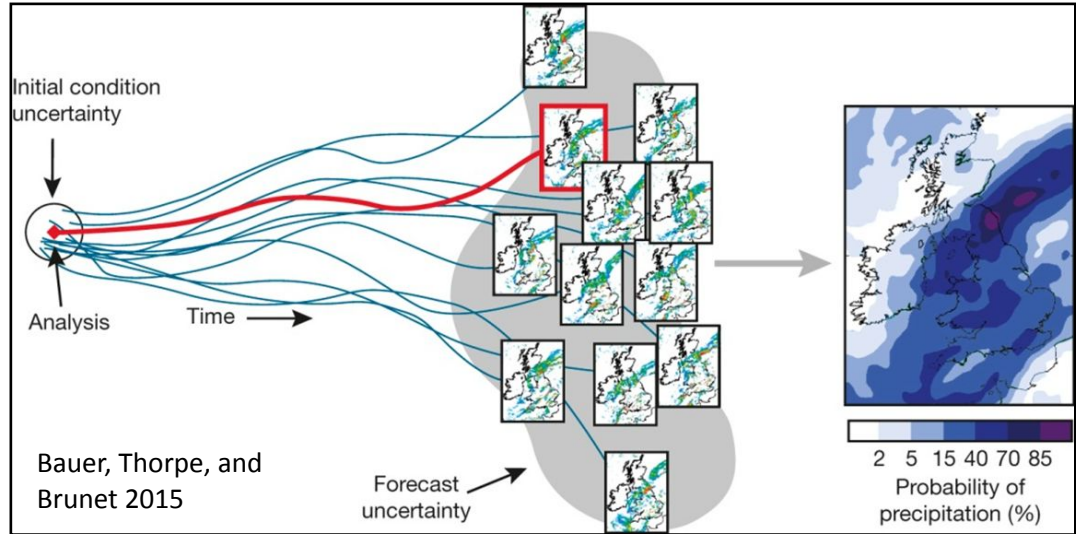
NOAA NWS Storm Prediction Center

- Forecast tornadoes, thunderstorms, and wildfires nationwide
- Forecast information from 8 days to a few minutes in advance
- World class team engaged with the research community
- Partner with over 120 local National Weather Service offices



Inherently Chaotic and thus Probabilistic

“Chaos: When the present determines the future, but the approximate present does not approximately determine the future.” - Edward Lorenz



130 JOURNAL OF THE ATMOSPHERIC SCIENCES VOLUME 20

Edward N. Lorenz

Deterministic Nonperiodic Flow¹

EDWARD N. LORENZ
Massachusetts Institute of Technology
(Manuscript received 18 November 1962, in revised form 7 January 1963)

ABSTRACT

Finite systems of deterministic ordinary nonlinear differential equations may be designed to represent forced dissipative hydrodynamic flow. Solutions of these equations can be identified with trajectories in phase space. For those systems with bounded solutions, it is found that nonperiodic solutions are ordinarily unstable with respect to small modifications, so that slightly differing initial states can evolve into considerably different states. Systems with bounded solutions are shown to possess bounded numerical solutions.

18 April 1994

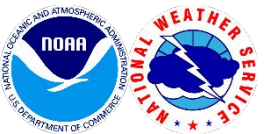
Dr. Steven Tracton
National Meteorological Center
World Weather Building-Room 604
5200 Auth Road
Camp Springs, MD 20746 W/NMC51

Dear Steve, *Rm 604*

Harold E. Brooks
Harold E. Brooks
Meteorologist

David J. Stensrud
David J. Stensrud
Meteorologist

We would like to invite you or a colleague to attend an informal workshop on Short-Range Ensemble Forecasting (SREF), sponsored by the National Meteorological Center (NMC) and the National Severe Storms Laboratory, to be held 25-27 July 1994 at the NMC in Camp Springs, Maryland.



NMC Short Range Ensemble Workshop (July 1994): SAMEX | SREF | Clustered Scenarios



NOAA Hazardous Weather Testbed



Experimental
Forecast
Program

*Analysis & Prediction of
hazardous weather events
from a few hours to a week in advance*

Focus for Agile Collaborative Innovation

1998 – 2000: **Probabilistic SPC Product Suite**

2000 – 2003: **Short Range Ensemble (SREF) Development & Post Processing**

2003 – present: UFS **CAM** Development, Visualization & Information
Extraction

2007 – present: UFS **CAM-Ensemble Development, Visualization,
Information Extraction & Post Processing**

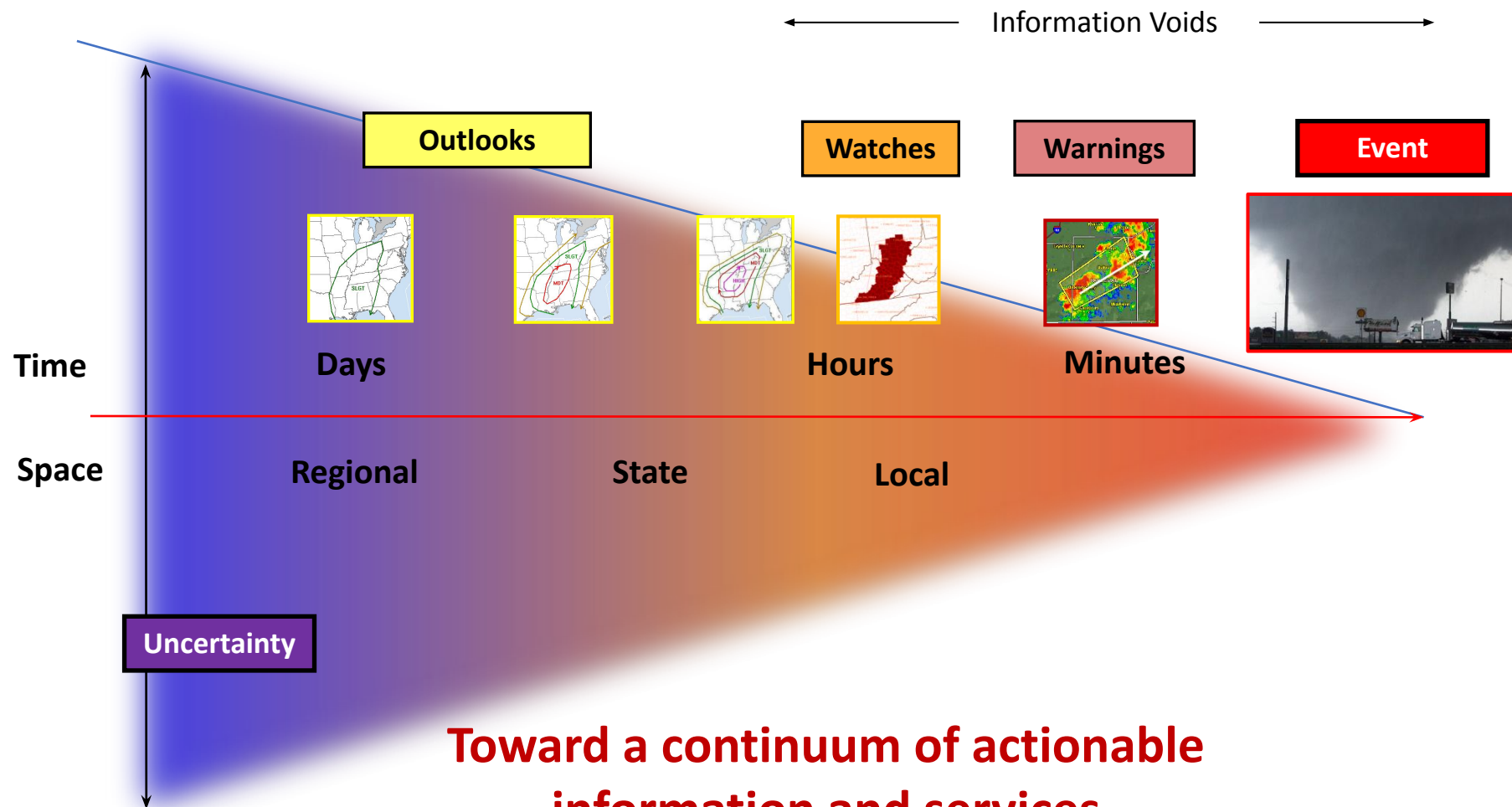
2019 – present: UFS Storm scale DA enabled **environment & storm analyses**

2019 – present: UFS CAM-ensemble information for **intensity forecasts**

- Exploit emerging virtual experiment capability & cloud-enabled capacities
- Fuse Forecast and Warning Experiments

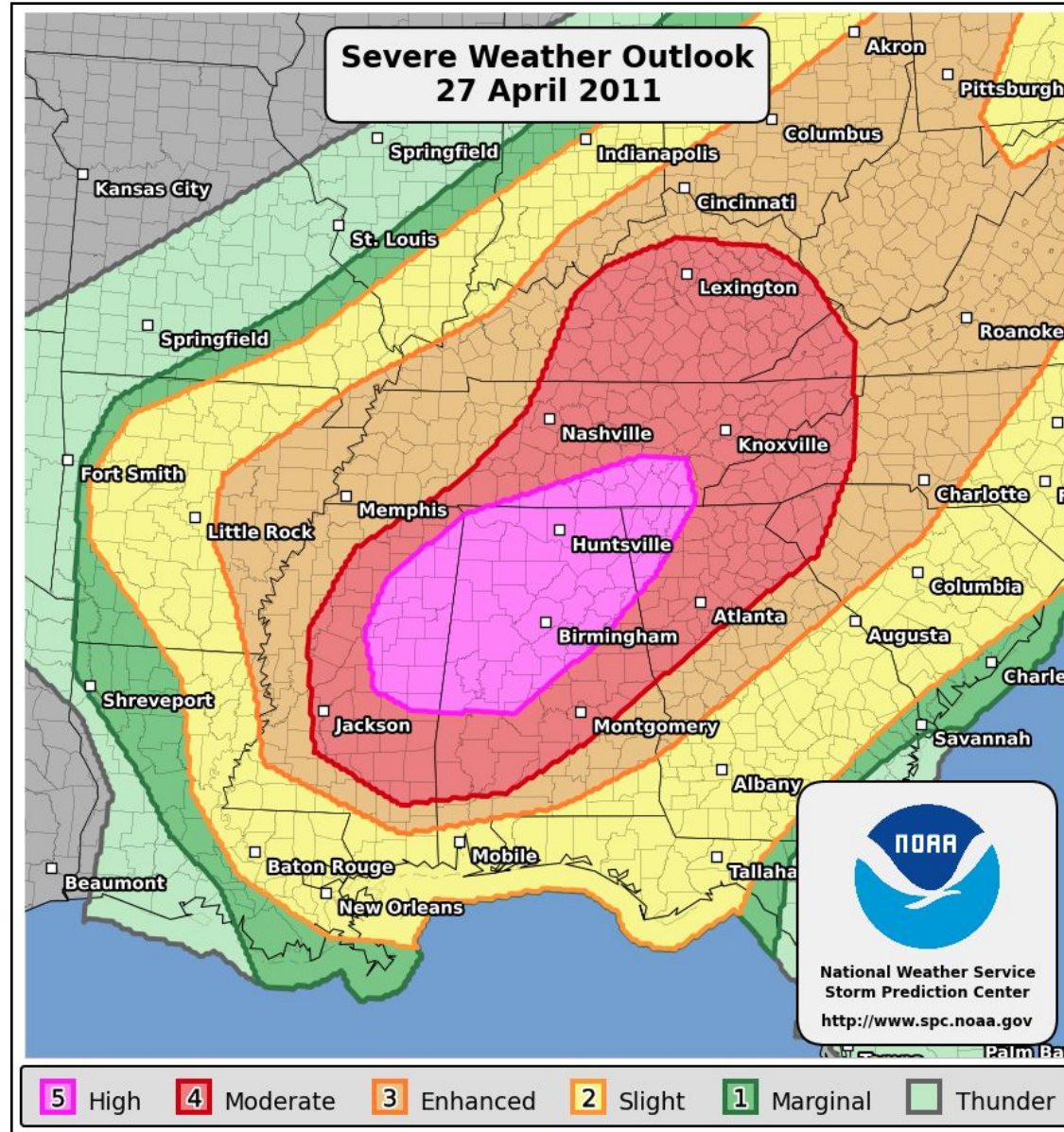
Sustained Strategic Focus

A Probabilistic Forecast & Warning Information Continuum



Toward a continuum of actionable information and services
optimal for the pace and nuance of emergency decision making

[Probabilistic] Public Severe Weather Outlooks



HREF: Extracted UH tracks

Storm Prediction Center

Date: 2021-03-25 Run: 12:00 UTC Sector: CONUS

SPC HREF Ensemble Viewer

SPC Guidance Synoptic Severe Winter Fire Precipitation Storm Attributes Member Viewer Links

Fri 03/26 1200 UTC F24 F48

HREF NP[2-5 km UH>75] Run: Thu 2021-03-25 12:00 UTC
 24-hr max 2-5 km UH >75 m²/s², ensemble paintball Valid: Fri 2021-03-26 12:00 UTC

NOAA/NWS/Storm Prediction Center

Product Overlays [Drag to rearrange order]

- 24-hr max 2-5 km UH, nh prob >75 m²/s² (r=40 km)

Product Underlays [Drag to rearrange order]

- 24-hr max 2-5 km UH >75 m²/s² (HRRR)
- 24-hr max 2-5 km UH >75 m²/s² (HRW NSSL)
- 24-hr max 2-5 km UH >75 m²/s² (HRW ARW)
- 24-hr max 2-5 km UH >75 m²/s² (HRW NMMB)
- 24-hr max 2-5 km UH >75 m²/s² (NAM Nest)
- 24-hr max 2-5 km UH >75 m²/s² (HRRR -6h)
- 24-hr max 2-5 km UH >75 m²/s² (HRW NSSL -12h)
- 24-hr max 2-5 km UH >75 m²/s² (HRW ARW -12h)
- 24-hr max 2-5 km UH >75 m²/s² (HRW NMMB -12h)
- 24-hr max 2-5 km UH >75 m²/s² (NAM Nest -12h)

Other Overlays

GIS SPC Outlooks Verification

Keyboard Shortcuts

- < prev fcst time > next fcst time
- p play/pause loop b last run (hold down)
- h toggle top menu

More Information

- HREFV2 is an operational version of SSEO ?
- Neighborhood probability details ?
- HREF members
- HREF/SREF Calibrated Guidance FAQ
- Site update history

Legend:

- HRRR -6h
- HRW NSSL -12h
- HRW ARW -12h
- HRW NMMB -12h
- NAM Nest -12h
- HRRR
- HRW NSSL
- HRW ARW
- HRW NMMB
- NAM Nest

Storm Prediction Center

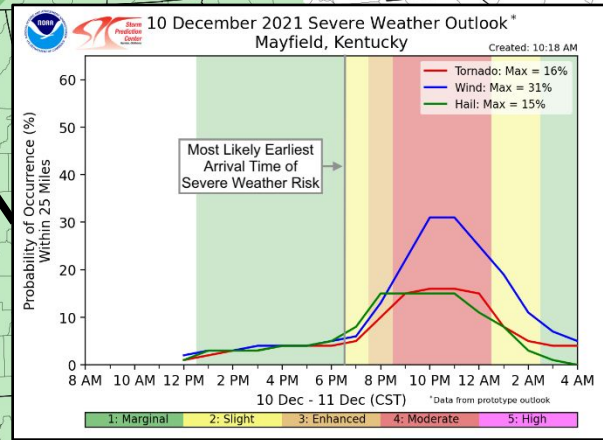
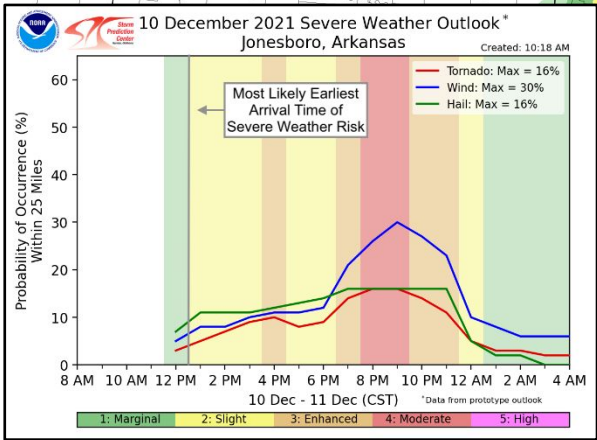
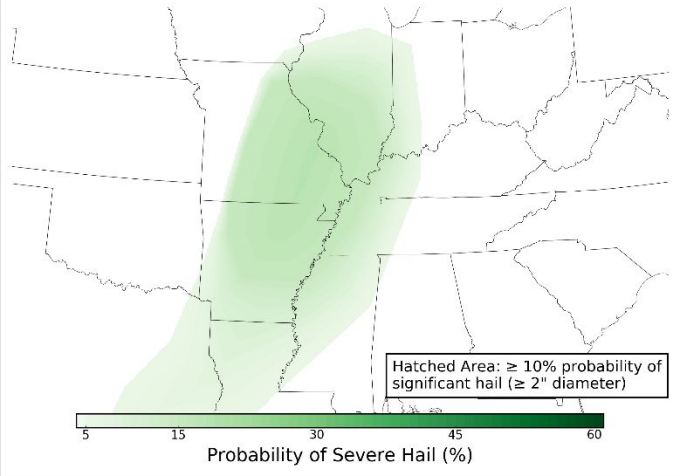
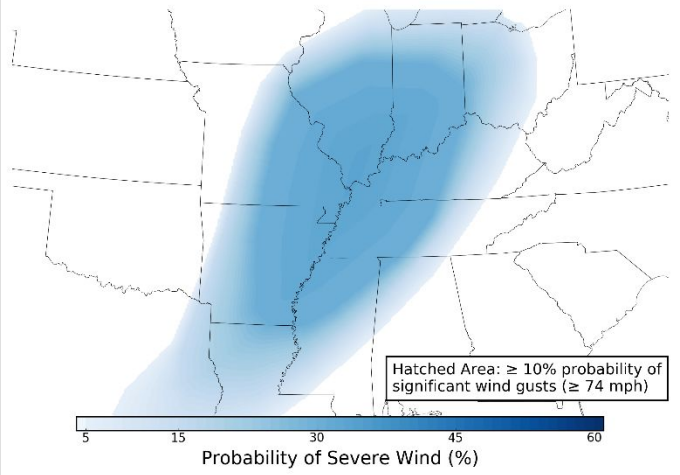
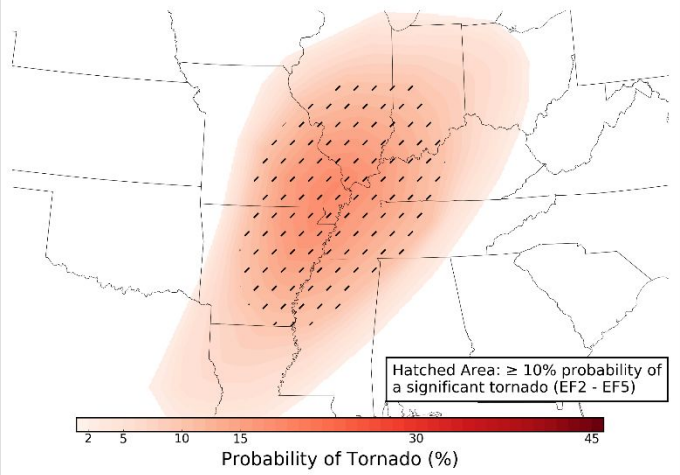
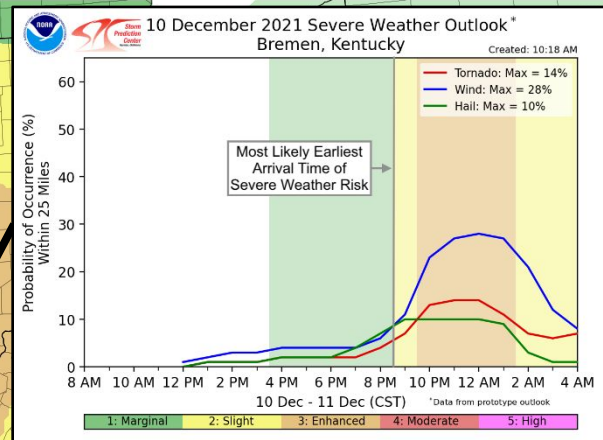
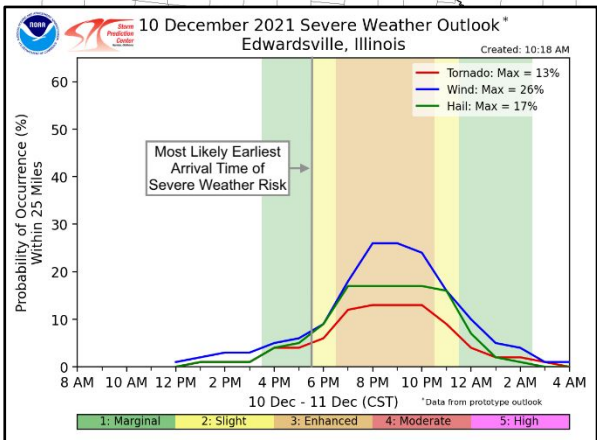
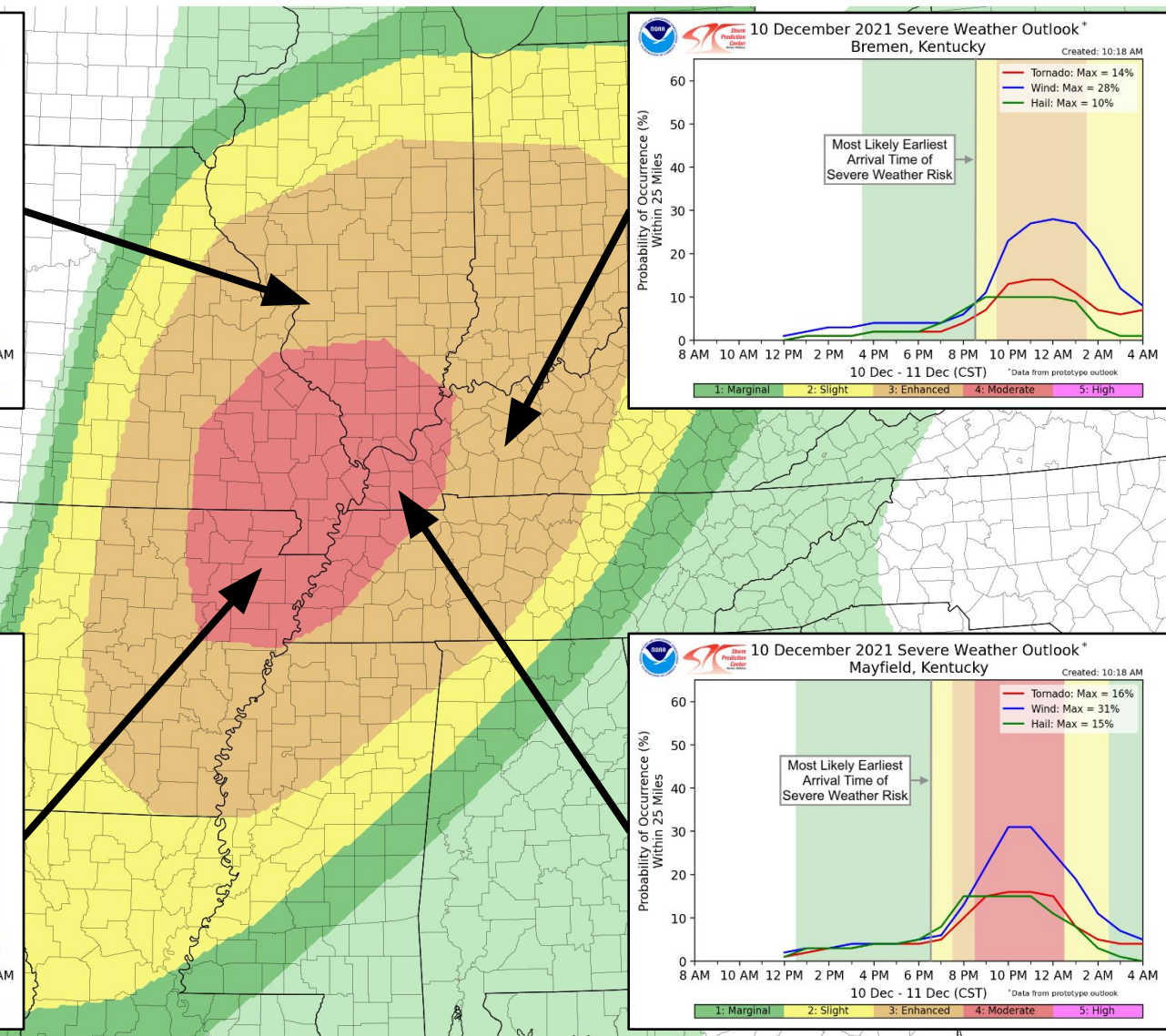


Led by: Israel Jirak | model UH (hourly) history variable – HWT SFE 2005



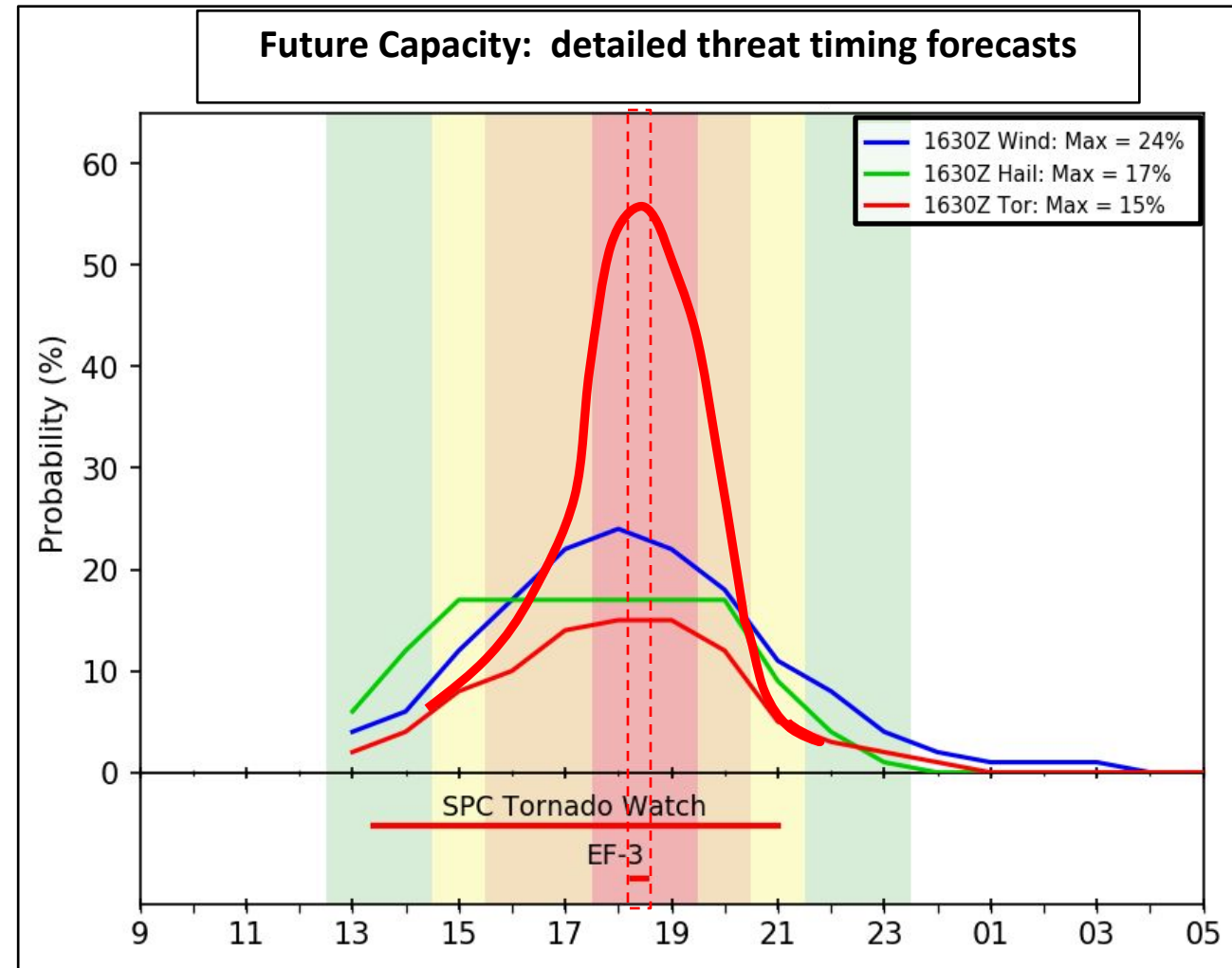
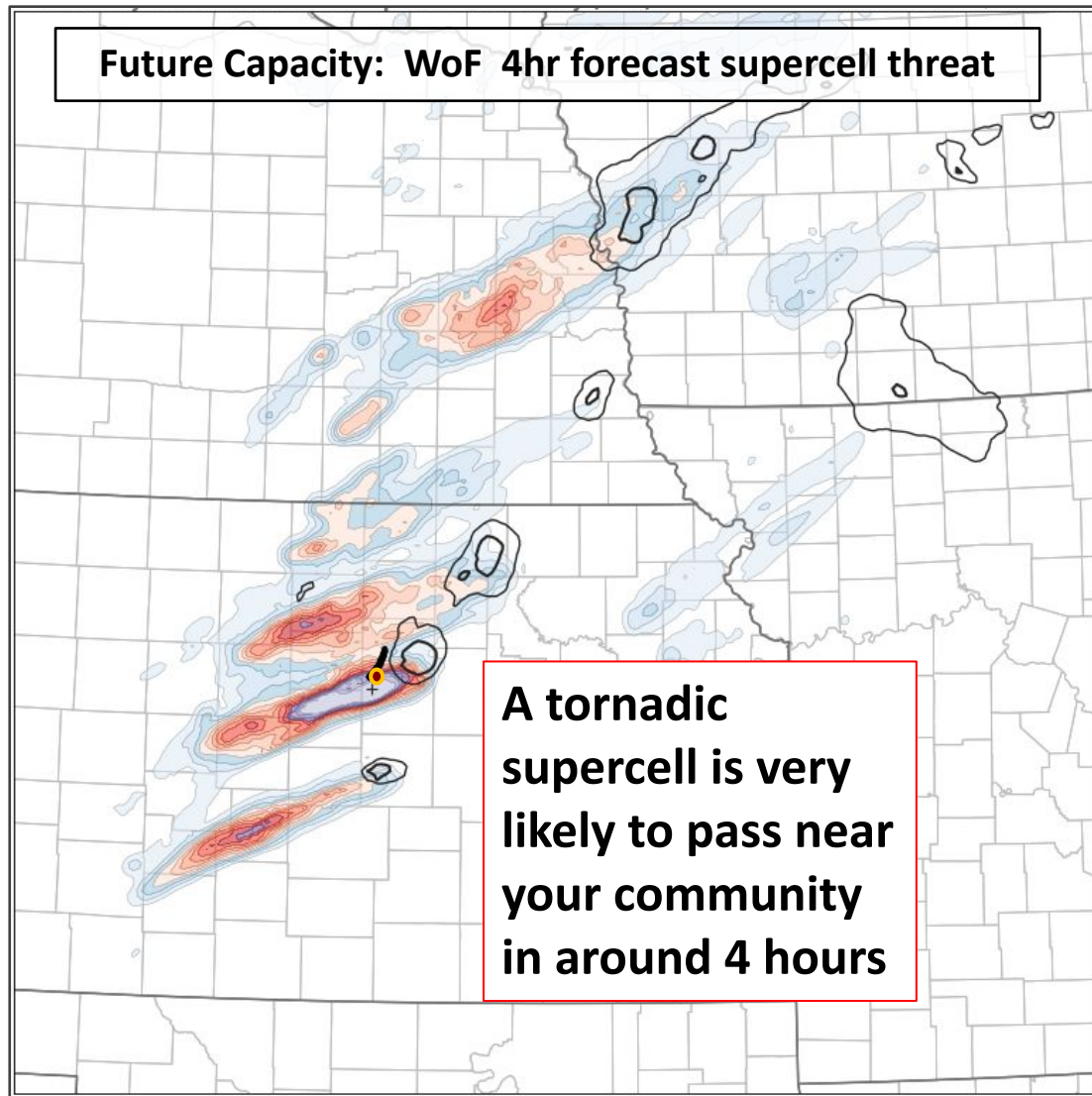
HREF | HRRR | RRFS Severe Threats Timing Forecasts for EM & public

10 December 2021



Thunderstorm 1: Marginal 2: Slight 3: Enhanced 4: Moderate 5: High

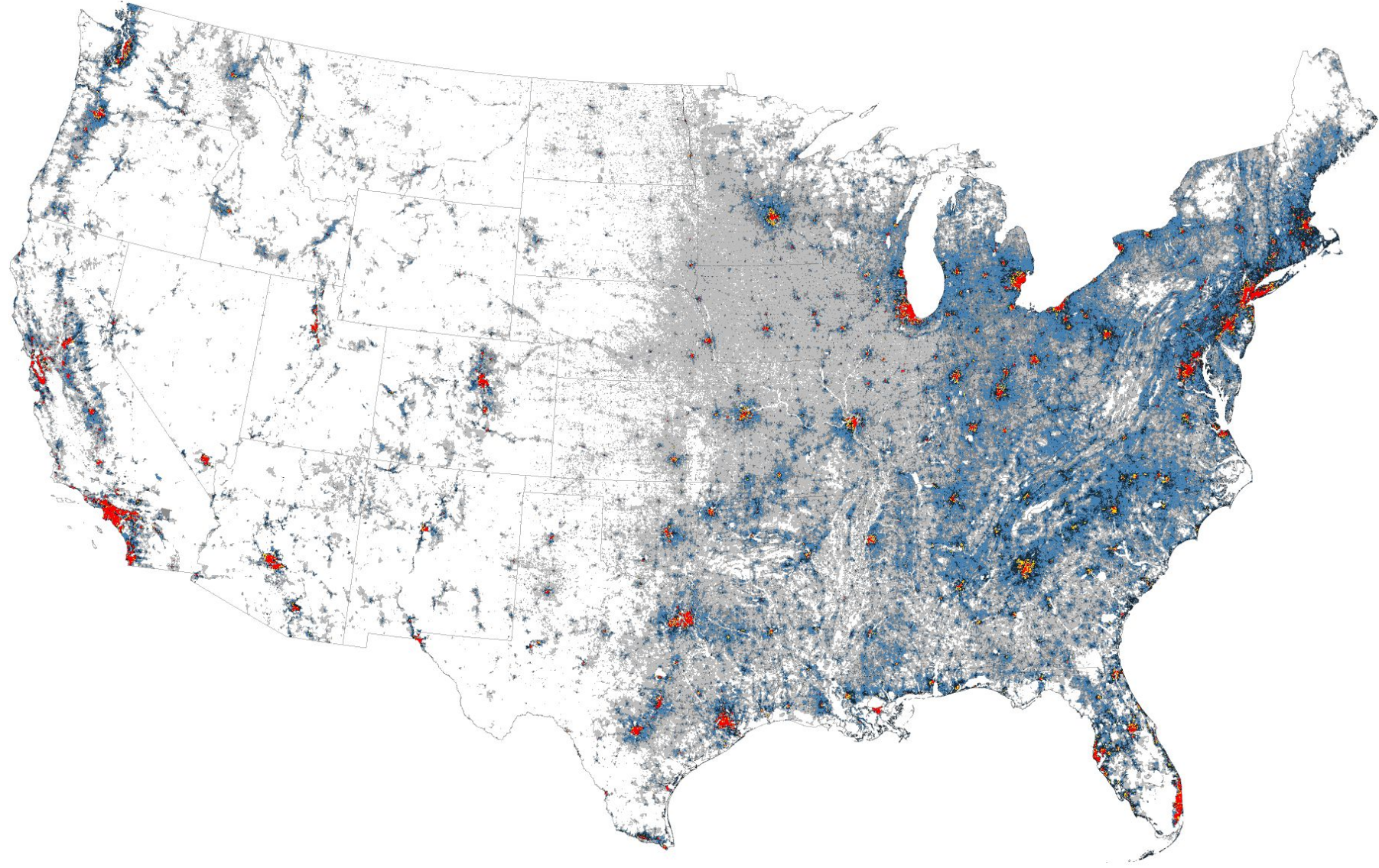
WoF High Resolution Severe Weather Outlooks



Challenges

- Focus on **optimal NWP ensemble composition**, configurations, and perturbation strategies
 - Better support the **diversity of societal challenges at all projection times**
 - **NWP as a tool** for supporting individual service needs **for society**
- Improved **information extraction during integration** particularly at fine spatial and temporal scales
 - better understand model behavior and better support societal decisions through post processing including as AI/ML inputs
 - Supports effective member clusters aligned with societal outcomes for more meaningful scenarios & their probability of occurrence
- **Improve** unique service, time & space scale, and social relevance of **verification metrics & value estimation**
- Increase **organic (agile) collaboration** throughout RL

FEMA & EM Partnerships: Impact Forecasts

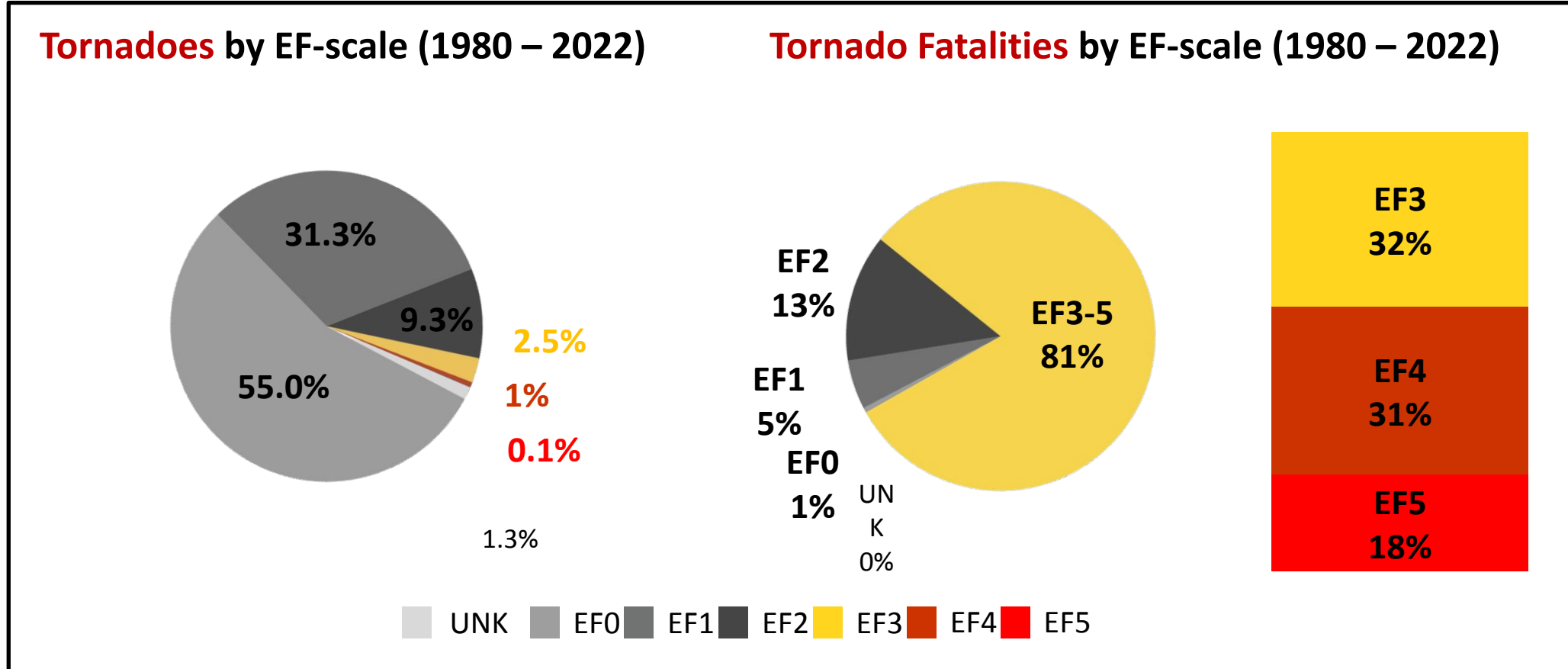


Led by: Patrick Marsh (SPC), Joey Picca (OU-CIMMS) and Somer Erickson (FEMA)

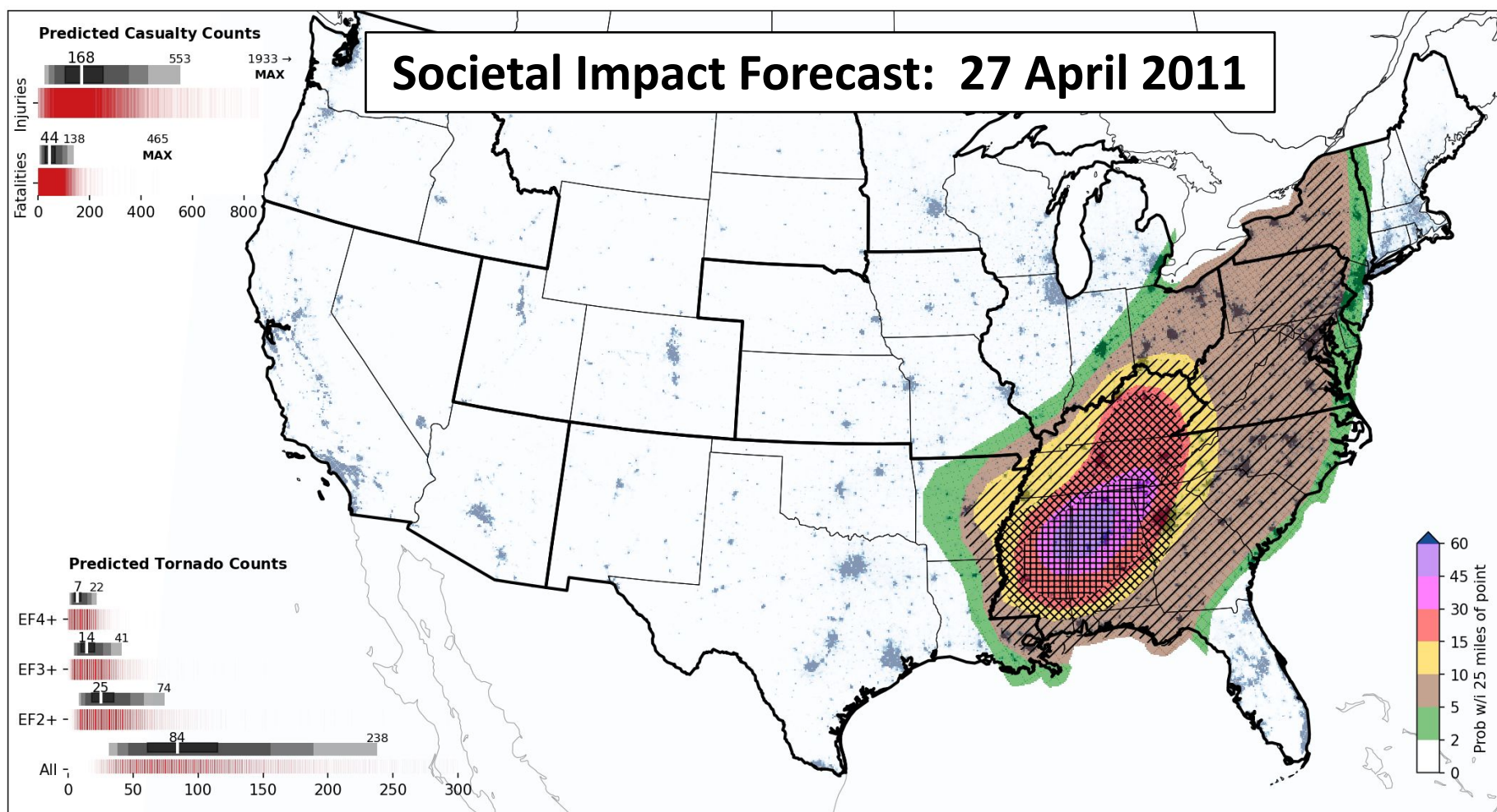


Quantitative IDSS – qIDSS: Societal Impact Forecasts

Fatalities & damage by EF-scale

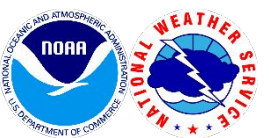
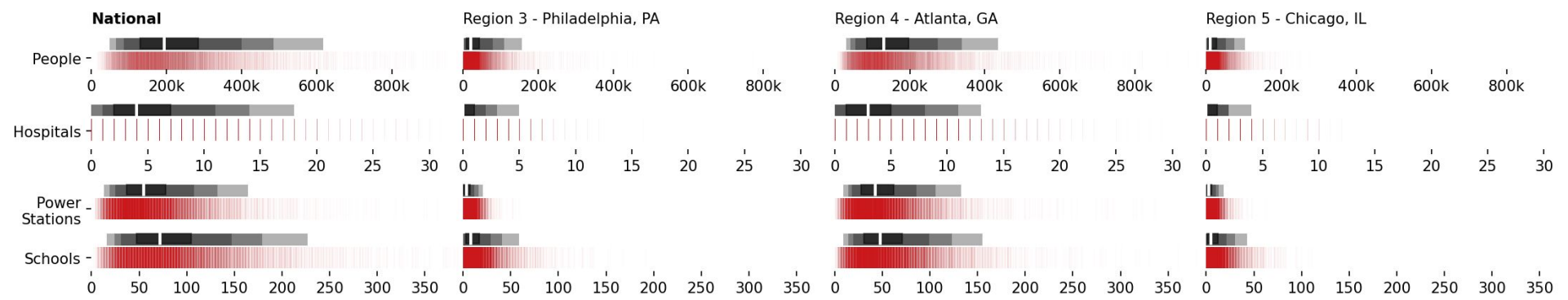


Need improved quantitative forecasts of **intensity** & sub-grid scale coverage

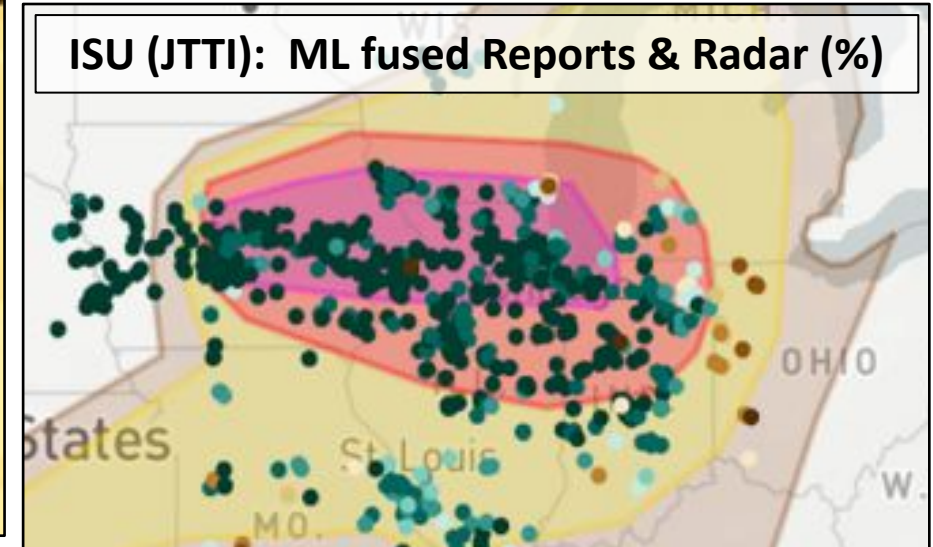
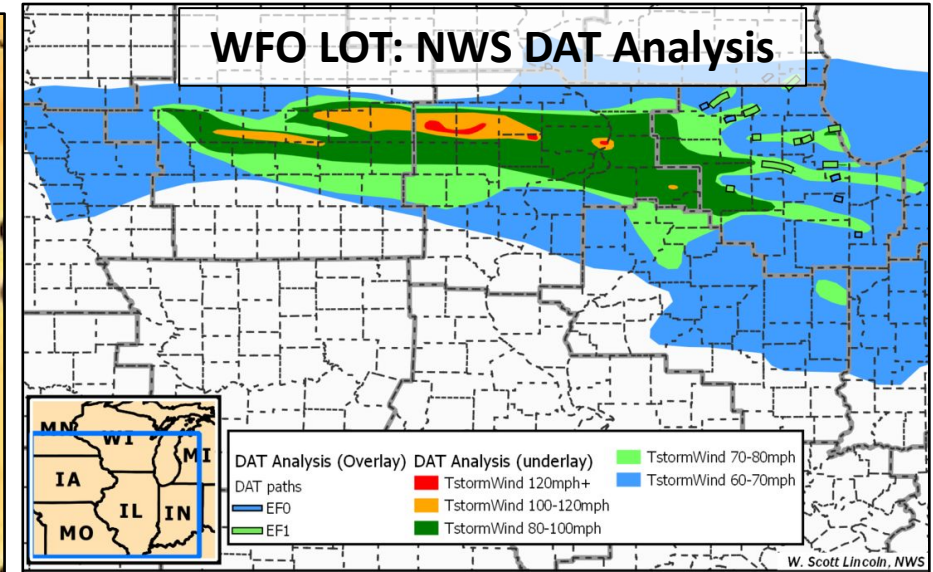
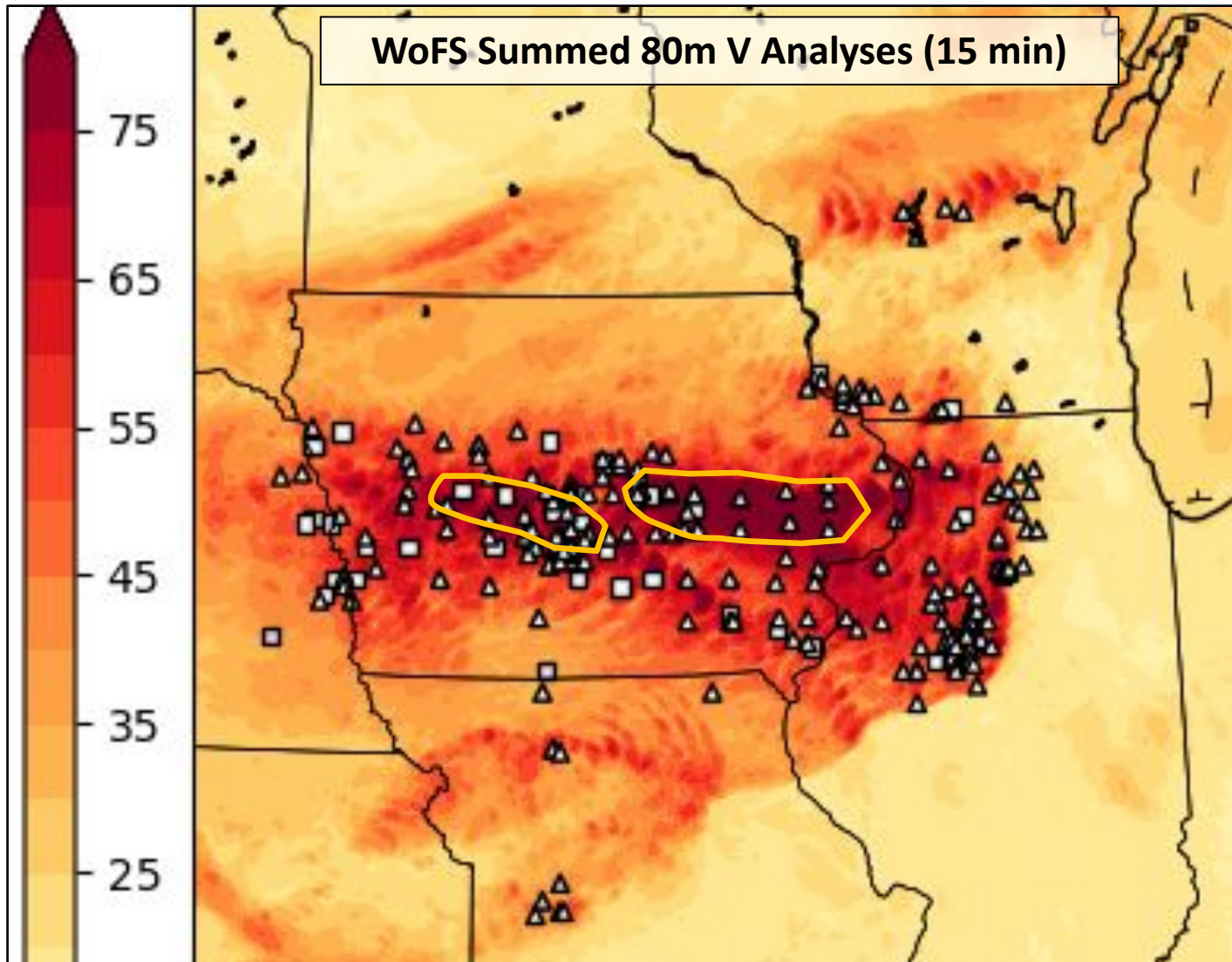


Potential Societal Impacts

Recurrence Rate: **1 per 40 yr**



Severe Wind Verification: NWP (Radar DA) Analyses as Truth

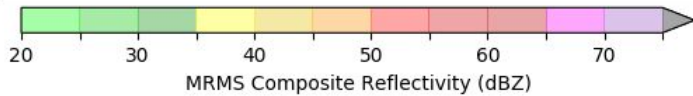
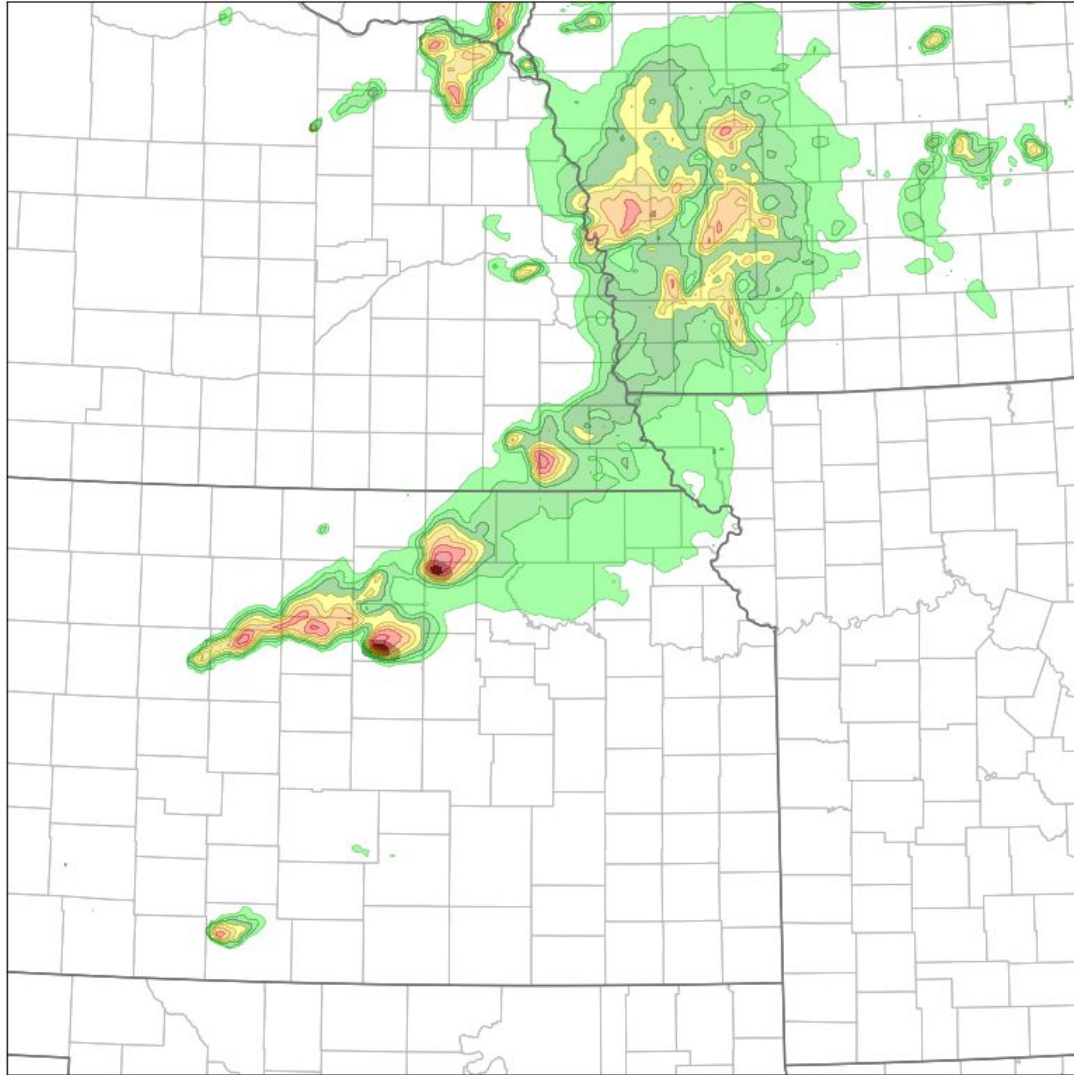


Need improved quantitative forecasts of **intensity & sub-grid scale coverage**

Next Generation: 3D RTMA (WoFS) Stormscale Analysis

MRMS Composite Reflectivity (dBZ)
MRMS 0-2 km Azimuthal Wind Shear (s^{-1})

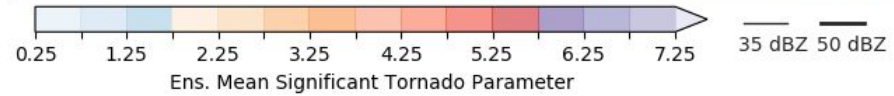
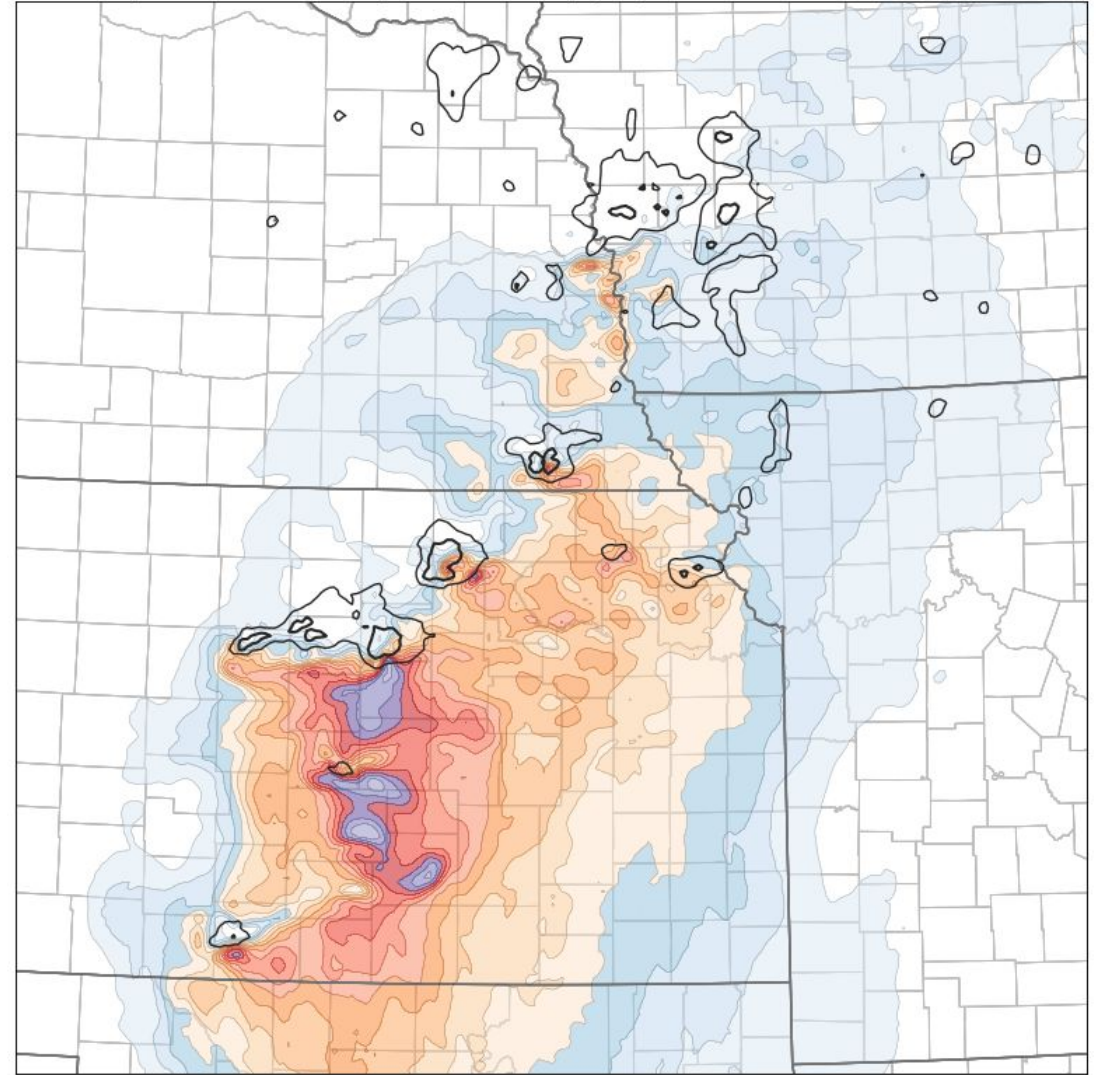
Init: 2018-05-02, 0100 UTC
Valid: 2018-05-03, 0100 UTC



0.005 $m^2 s^{-2}$ 0.008 $m^2 s^{-2}$

Ens. Mean Significant Tornado Parameter
Probability Matched Mean - Composite Reflectivity (dBZ)

Init: 2018-05-02, 0100 UTC
Valid: 2018-05-02, 0100 UTC



Led by: Israel Jirak, Patrick Marsh, NSSL, and GSL

Challenges

- **Fine-scale ($\leq 3\text{km}$), rapidly updating (3-15 min) DA & analysis system**
- capture trends of the **environment & individual storm** characteristics
 - including storm-scale re-analysis datasets for development
 - Low latency for real time situational awareness & decisions
 - Separate final analysis with extended data cut off
- integrate diverse storm-scale observing systems (esp. robust **radar DA**)
- **optimized for analysis quality** (fit to observations) - not only forecast IC
- **objective estimate of truth** (final analysis) supports verification & AI/ML development



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