

# Hazard Services – Probabilistic Hazard Information (HS-PHI)

## Three Years of Experiments at the NOAA Hazardous Weather Testbed (2016-2018)

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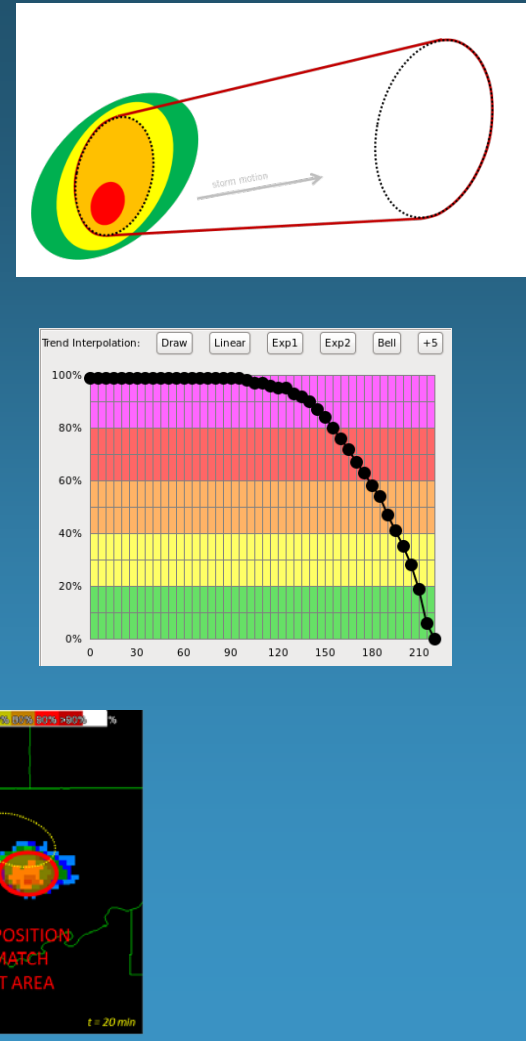
### FROM RESEARCH TO OPERATIONS:

#### BACKGROUND

- Forecasting A Continuum of Environmental Threats
  - A next-generation severe weather watch and warning framework that is modern, flexible, and designed to communicate clear and simple hazardous weather information to serve the public.
- Probabilistic Hazard Information (PHI)
  - Continuously-updating probabilistic hazard grids.
  - PHI can be used to provide custom user-specific products that can be tailored to adapt to a variety of needs – for example, providing longer lead times, at lower confidence, for more vulnerable populations with a lower tolerance for risk.

#### Warnings versus PHI

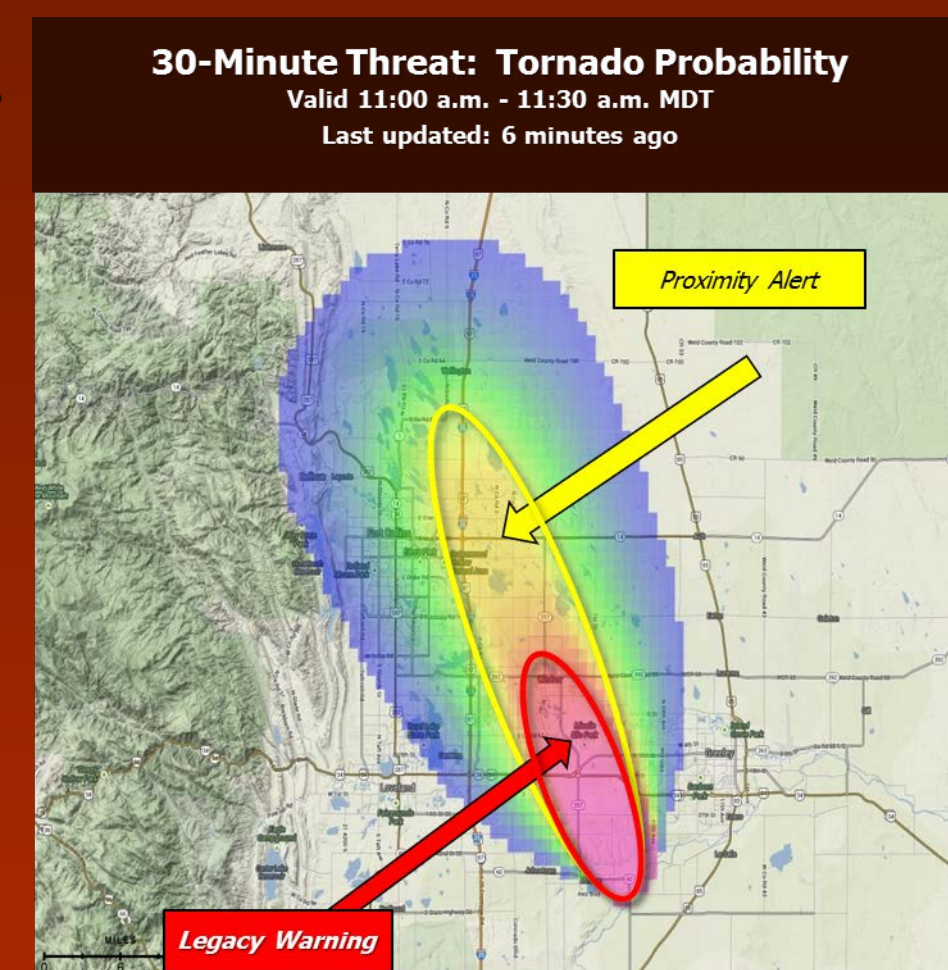
- Track areas, not points or lines.
- Uses motion uncertainty (swath width)
- Addition of probabilistic trend, with limit of predictability (0% or background prob)
  - Durations can exceed typical warning durations for long-tracked events
- Define and edit object attributes – WE DON'T EDIT GRIDS
  - Threat area location at time=0, motion vector, motion uncertainty, duration, forecast probability trend
- Nudging objects
  - Replaces SVS process
  - Threats-In-Motion (TIM)



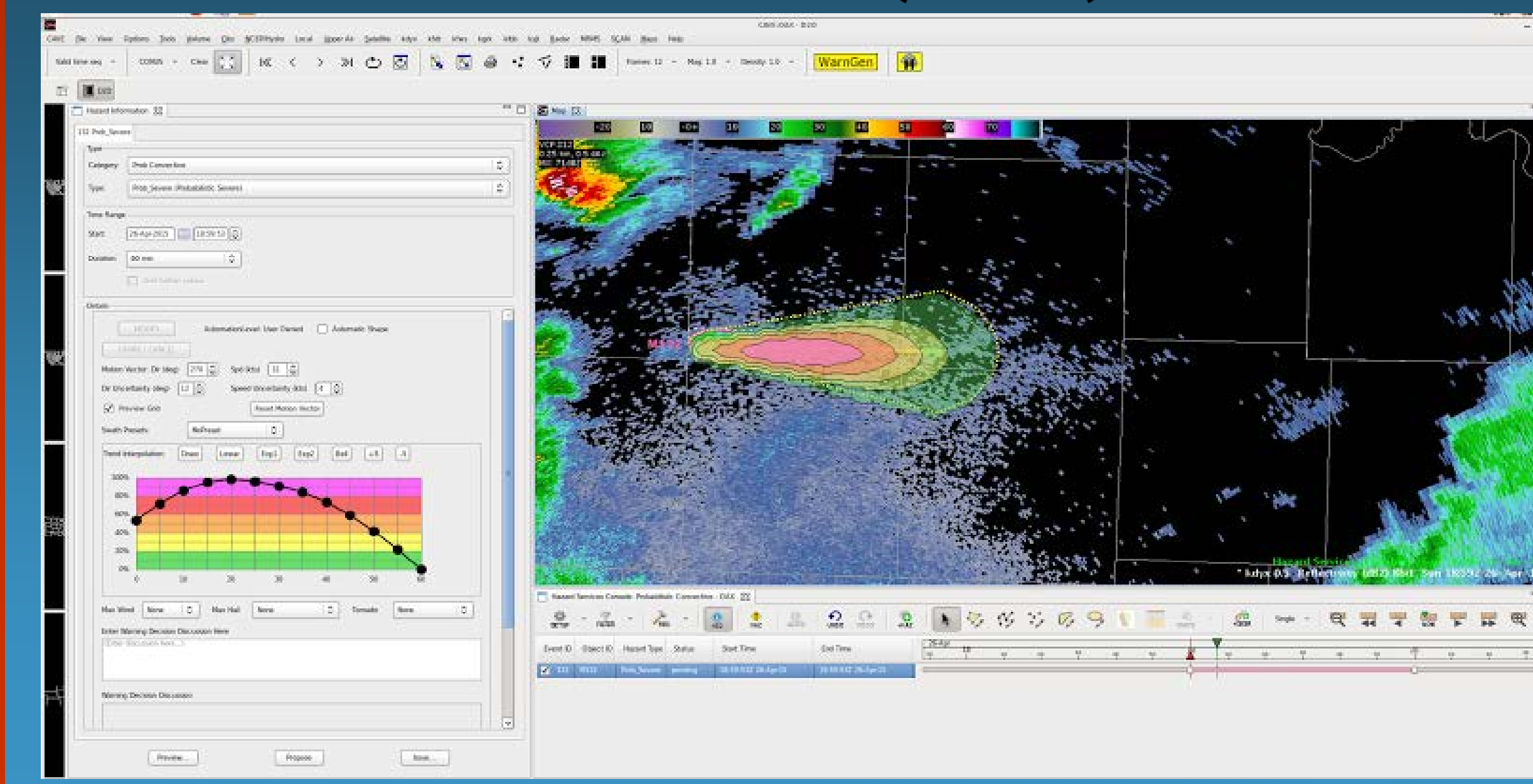
#### Adaptive warnings from PHI

##### Evolution from product-centric to information-centric paradigm:

- Probabilistic Hazard Information (PHI): forecasters convey threat probability on grids using a new threat management tool.
- Legacy products (warnings/watches) result from pre-determined thresholds (probability and/or time of arrival) applied to binary decision-making.
- Opens the door for new products and services – such as low-probability longer lead time warnings for high risk users who have greater tolerance to high false alarm ratios.

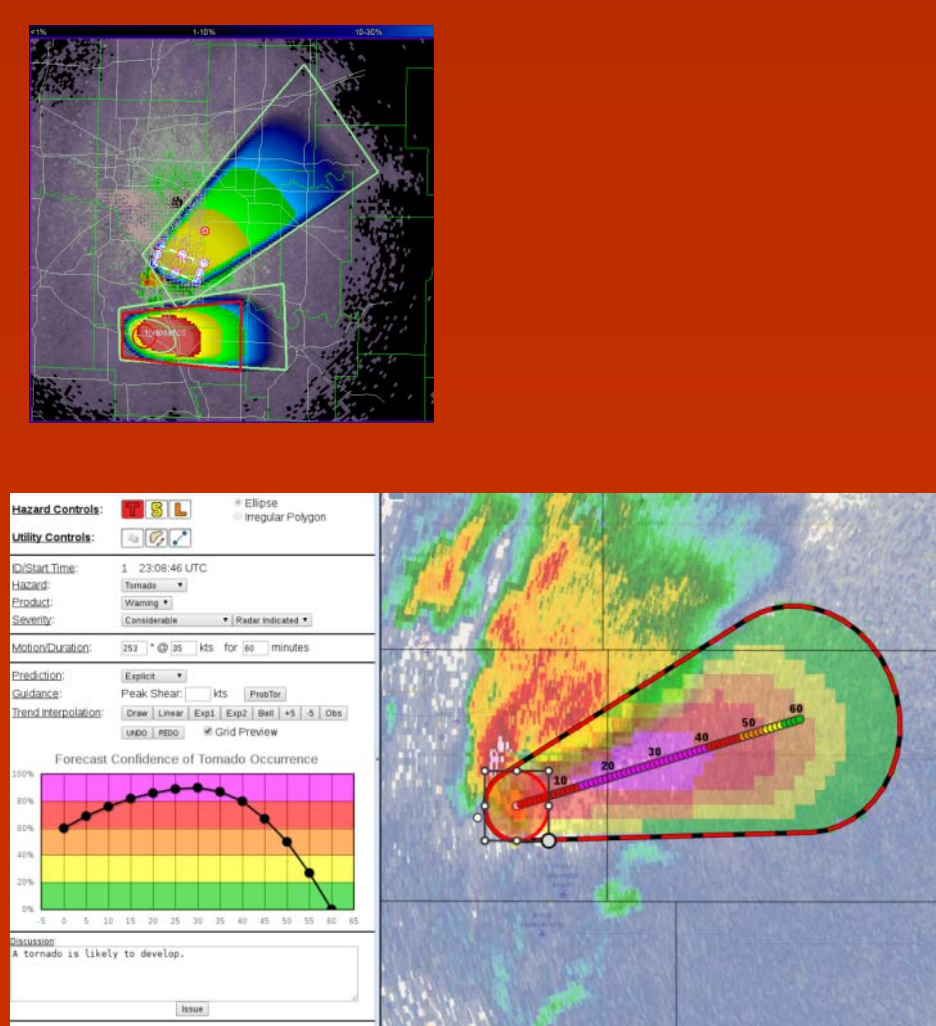


#### AWIPS2 HAZARD SERVICES – PROBABILISTIC HAZARD INFORMATION (HS-PHI)



#### History of PHI in the HWT

- First NSSL PHI prototype tests using Warning Decision Support System II (WDSSII), tested in 2007, 2008.
- Second modern NSSL PHI Prototype using a web browser-based design, tested in 2014, 2015, 2016, 2017.
  - Look and feel based on AWIPS2 Hazard Services
  - Integrated user component with Emergency Managers and TV broadcasters using the Enhanced Data Display (EDD) to display custom products derived from PHI
- USWRP Grant: Developed initial capability in AWIPS2 experimental Hazard Services – PHI (HS-PHI) using PHI Prototype as a guide, tested in 2016-2018.



### NOAA HAZARDOUS WEATHER TESTBED:

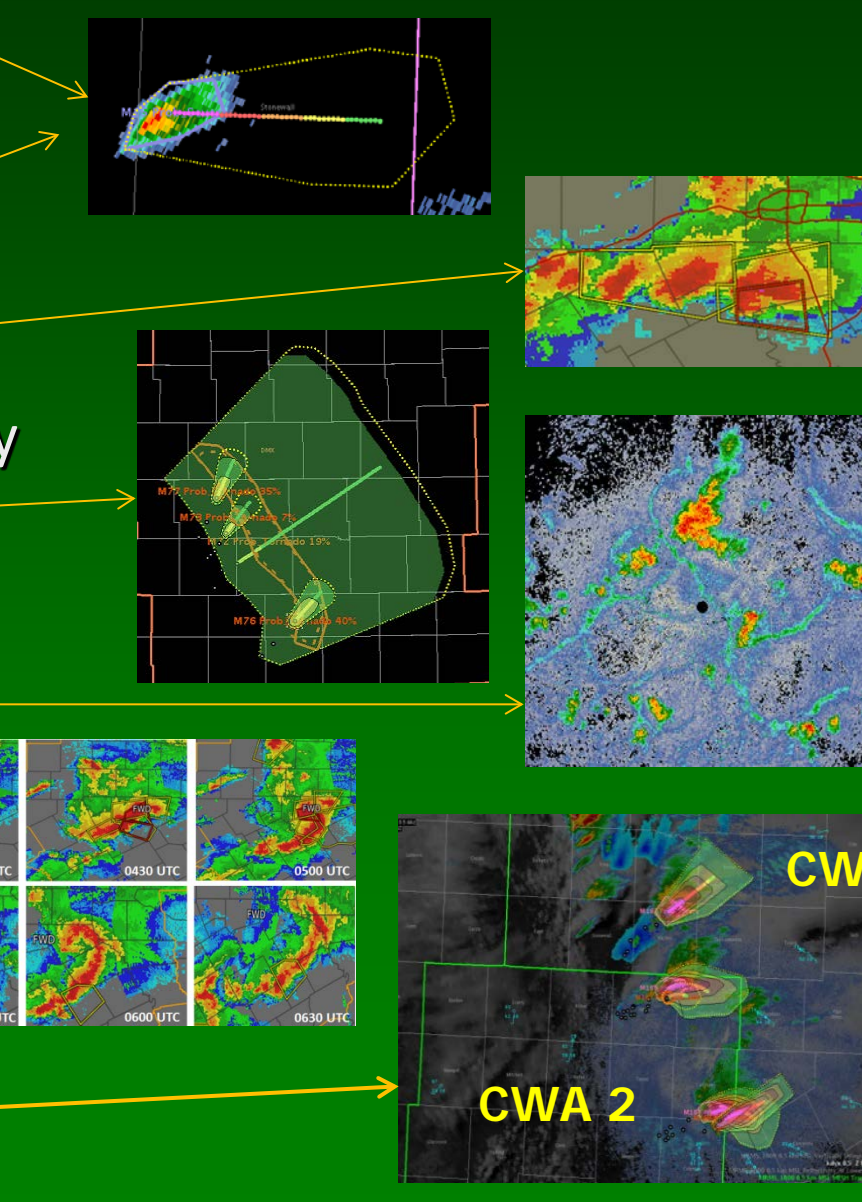
#### HS-PHI HWT Experiment Objectives:

- **Technology:** Evaluate HS-PHI components and performance so that the software can be improved before operational implementation.
- **Human Factors:** Measure forecaster workload using HS-PHI, including ease of use and graphical design.
- **Methodology:** Assess how forecasters adopt and evolve their current warning methodology into the HS-PHI environment, including evaluating the human-machine mix with automated ProbSevere guidance.
- **Conceptology:** Collect and analyze data on forecasters' thoughts on the paradigm change from deterministic warning products to probabilistic hazard information.



#### DISPLACED REAL-TIME SCENARIOS

- Isolated marginally severe storm
  - Provide forecasters with basic concepts of PHI
- Developing supercell
  - For continued practice with PHI and object nudging.
- Merging/splitting supercells
  - Dealing with many events in very close proximity
- Quasi-Linear Convective System Tornadoes
  - Multiple-scale PHI
- Low-Shear Summer Southeast Microbursts
  - Random slow motion
- Upscale growth to squall line
  - Merging objects to larger objects
- Mature supercells
  - To study issues with cross-forecast area **collaboration**



#### 2016-2018 Operations Weeks:

- Three weeks per year (Mar-Apr).
- 2 forecasters per week.
- 18 WFO forecasters have participated from 5 of the 6 NWS regions.

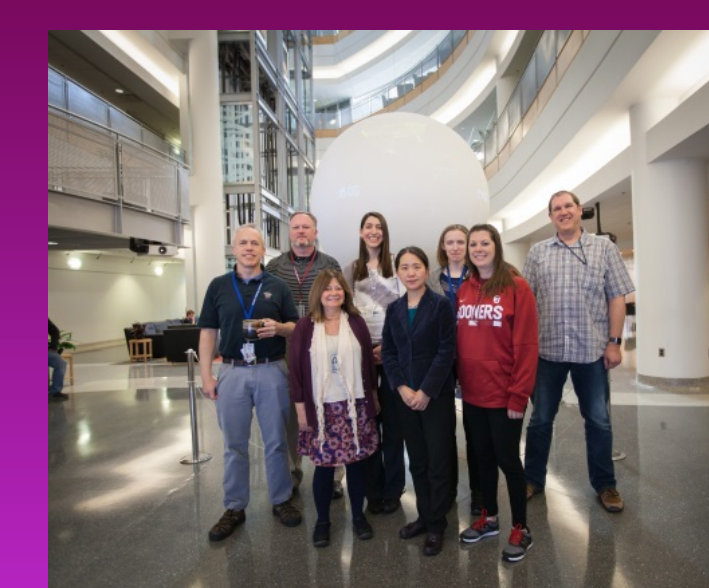
DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
Forecasters: [List of names]	Forecasters: [List of names]	Forecasters: [List of names]	Forecasters: [List of names]	Forecasters: [List of names]
Products: [List of products]	Products: [List of products]	Products: [List of products]	Products: [List of products]	Products: [List of products]
Scenarios: [List of scenarios]	Scenarios: [List of scenarios]	Scenarios: [List of scenarios]	Scenarios: [List of scenarios]	Scenarios: [List of scenarios]

#### Human Factors Data Collection:

- Pre-operations survey
  - Internal probability thresholds, ProbSevere use, WFO warning team composition, forecasters' ideas for warning improvement
- Live video of forecasters, desktops, and group discussions
- Discussions during events with meteorologists, developers, trainers, and human factors scientists
- Post-event survey/discussion (60 minutes each)
  - NASA Task Load Index (TLX) Mental Workload Survey
    - Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, Frustration
  - Confidence Survey
- End-of-Week Discussion (Friday)
  - Post-Study Usability Survey
  - Long Interview touching on the four main objectives

### FINDINGS and FUTURE WORK:

- How will we effectively extract legacy warnings from a continuously-updating probabilistic grid?
  - Probability thresholds?
  - Time-of-arrival thresholds?
  - Forecaster decision points?
- It will be a challenge to blend probabilities at the storm scale with those from the SPC outlook scale, since they exist from different reference classes.
- Cross-WFO collaboration and object handoff will require significant analysis of inter- and intra-office culture.
- **Poster 117 (Nietfeld et al.) has more information.**



#### MOVING FORWARD:

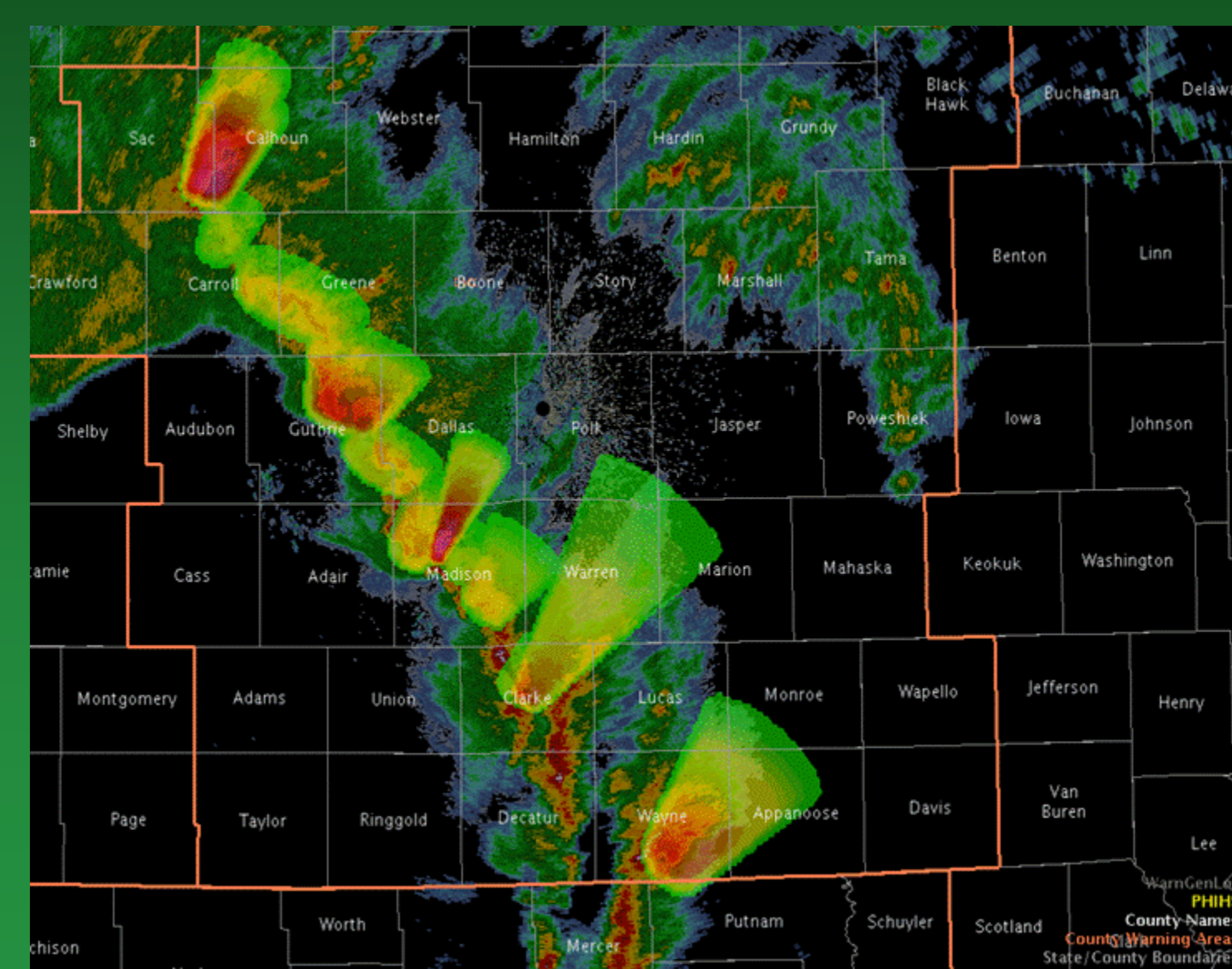
- We have been granted additional funds via JTIT to begin the incorporation of new functionality:
  - Intermediate "Threats-In-Motion" warnings (without PHI)
  - Legacy warning product generation
  - Lightning PHI
- Another JTIT grant for Cross-WFO Collaboration funded for 2019-2020:
  - Field surveys.
  - Additional collaboration tools.
  - HWT experiment.
- Addition of new functionality informed by PHI Prototype during 2016-2017 tests)
- Addition of new science as developed in companion JTIT proposals:
  - New probabilistic plume model
  - New storm object ID and tracking model
  - Improved probabilistic guidance
- HWT spring experiments to include users (EMs, etc.)
- Testing at Operations Proving Ground and some WFOs
- Policy and paradigm shift to make FACET's operational

#### Cross Organizational Team

- **NWS Meteorological Development Laboratory** -- Experimental Design coordinator, Product Owner, writing Functional Tests and prioritizing tasks. Conduit between PHI Prototype and PHI into Hazard Services / AWIPS / Operations. PHI visionary.
- **ESRL/Global Systems Division** -- Software design and development, integration with AWIPS, Hazard Services concepts, and VLab.
- **NWS Forecasters** -- Trying new paradigm, input from operation perspective, feedback on improving software, concepts, and process, O2R
- **National Severe Storms Laboratory** -- FACET's concept and collaborations, IT support, Hazardous Weather Testbed facility, overall management of the grant / funding, future funding
- **NWS Warning Decision Training Division**-- Development of the Training including future operational use and best practices
- **University of Akron** -- Human Factors

#### Software Development Process

- The 2015 version of NSSL PHI Prototype is our current benchmark.
- New systematic software releases and virtual functional testing resulted in better progress and improved stability each subsequent year.
- Recent new functionality added:
  - Convective Recommender
    - Processes ProbSevere detections into Hazard Services – PHI objects.
  - Levels of Automation
    - Forecasters can create manual objects.
    - Forecasters can assume partial or full control of automated objects, and relinquish control back to automation one attribute at a time.
  - New object drawing tools: ellipses, rotation, resizing
  - Buffering of commands for quicker responsiveness
  - Ownership of hazard objects and locking (first step in collaboration tools)
  - Better drawing colors to enhance visibility of objects on radar data



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