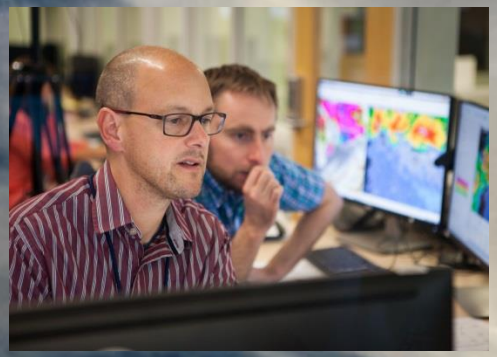
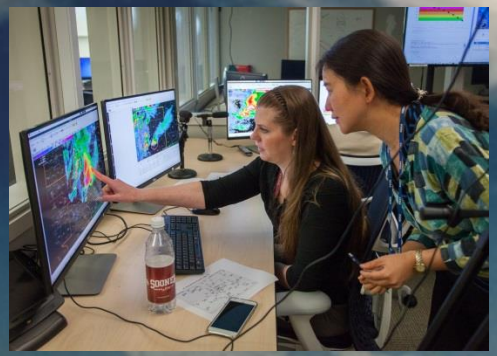
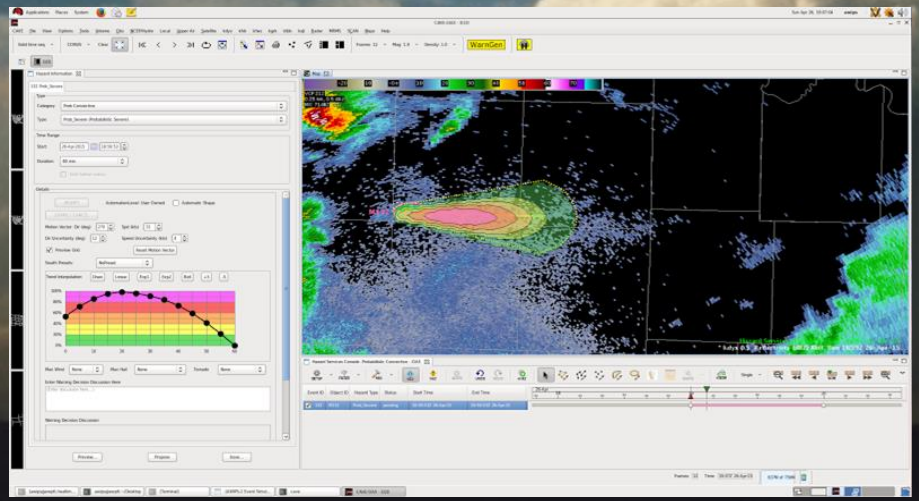






Hazard Services-Probabilistic Hazard Information (HS-PHI)

VLAB FORUM (SEPTEMBER 2017)

Greg Stumpf
CIMMS / NWS-MDL, Norman, OK
Tracy L. Hansen
ESRL / GSD, Boulder, CO

With: Alyssa Bates, Chris Golden, Yujun Guo, Joe James, Jim LaDue, Chen Ling, Kevin Manross, Tiffany Meyer

Outline

- Background
- USWRP Grant
- Team Composition
- Development Process
- Hazardous Weather Testbed Experiment
- Preliminary Findings
- Looking ahead

BACKGROUND: FACETs and PHI

- 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)
  - Rapidly-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.

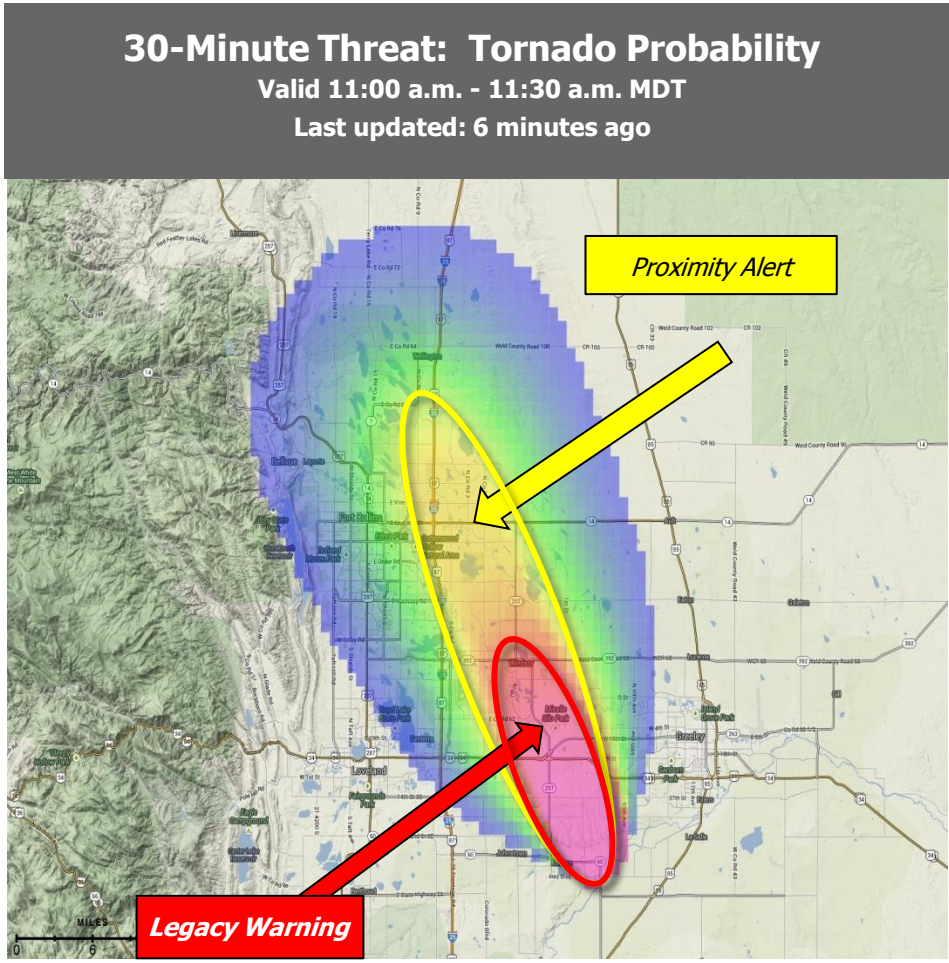
Adaptive warnings from PHI

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 applied to binary decision-making.

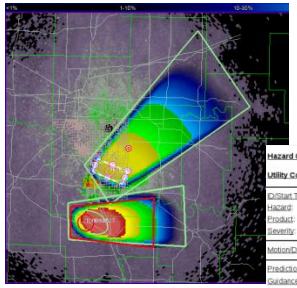
Opens the door for new products and services – such as low-probability longer lead time warnings for high risk users who have greater tolerance to high false alarm ratios.



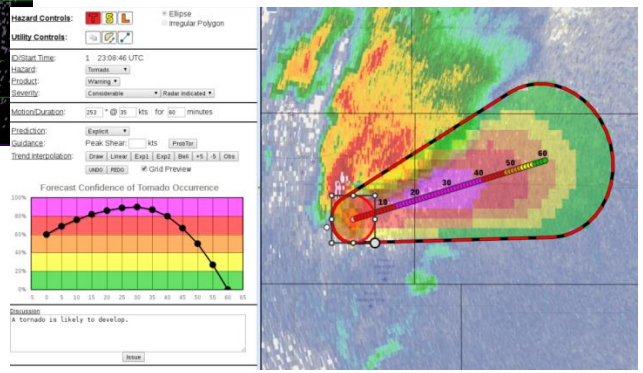
PHI Evaluation History in the Hazardous Weather Testbed (HWT)

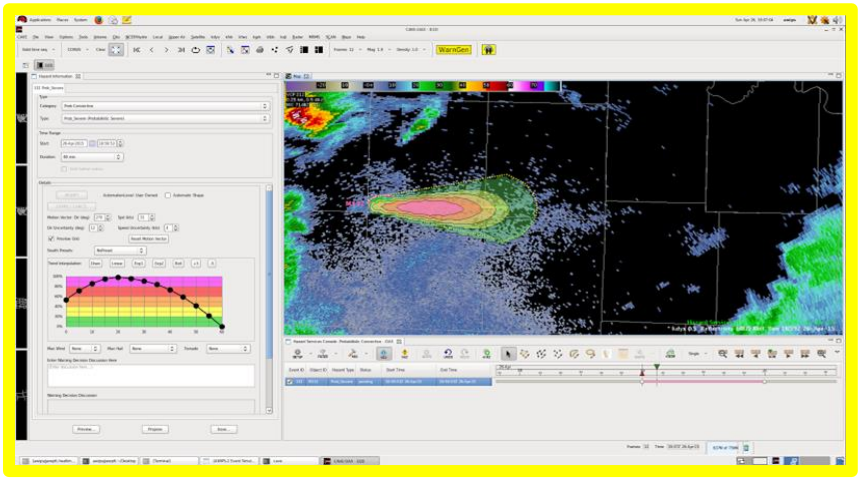
PHI Tool Evolution:

- 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.
  - 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.



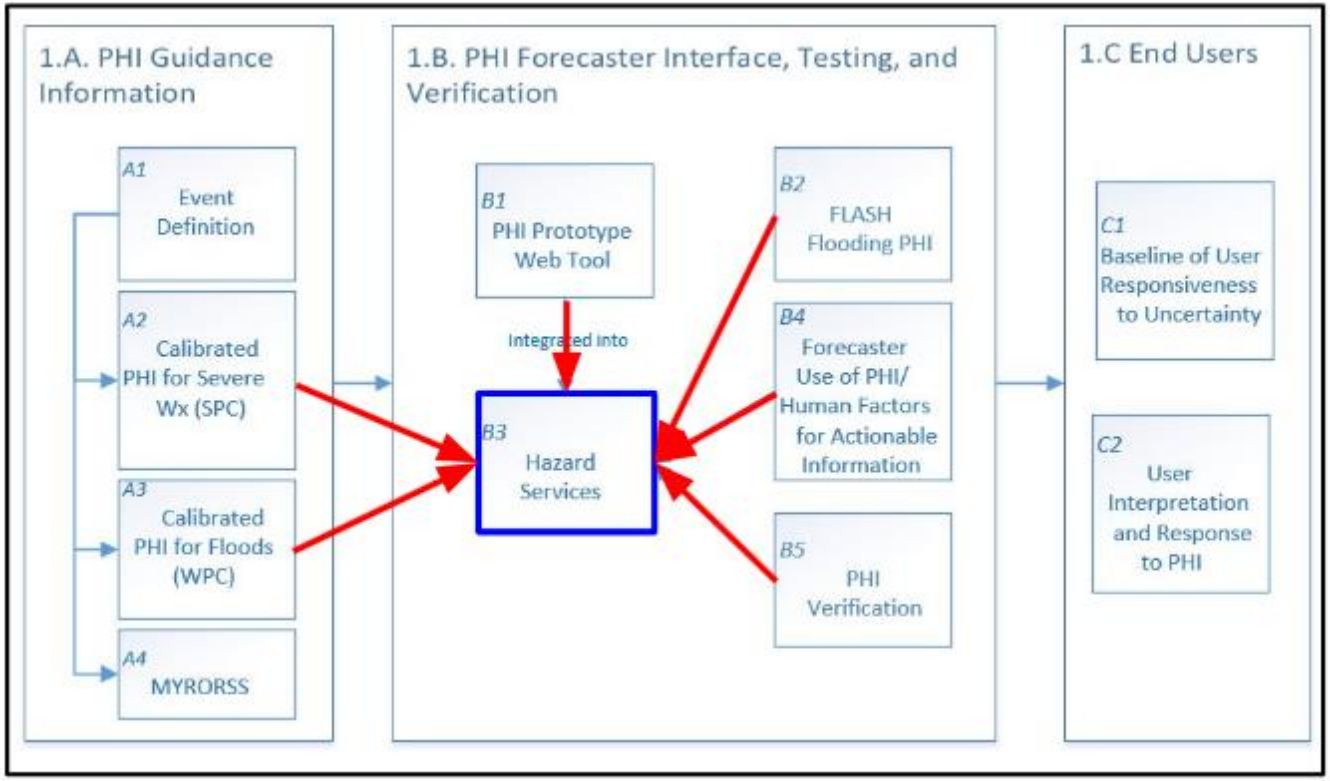


- **USWRP Grant:** Developed initial capability in AWIPS2 experimental Hazard Services – PHI (HS-PHI) using PHI Prototype as a guide, first tested in 2016.

USWRP Grant:
Probability Of What? (POW)

RL6 by end of Year 3 (1 June 2018)

Operational readiness will follow



Cross-Organizational Team

- **MDL** -- Experimental Design coordinator, Product Owner writing Functional Tests and prioritizing tasks. Conduit between PHI Prototype and PHI into Hazard Services / AWIPS / Operations. PHI visionary.
- **GSD** -- Software design and development, integration with AWIPS, Hazard Services concepts, and VLab.
- **Forecasters** -- Trying new paradigm, input from operation perspective, feedback on improving software, concepts, and process, O2R
- **NSSL** -- FACETs concept and collaborations, IT support, Hazardous Weather Testbed facility, overall management of the grant / funding, future funding
- **WDTD** -- Development of the Training including future operational use and best practices
- **University of Akron** -- Human Factors

Year 2 Process (2016-2017)

- **Throughout:**
  - Weekly Design and Planning meetings with entire team
  - Development and Testing at GSD
  - Use of Virtual Lab Development Services
- **May**: Set up single machine Test Environment at GSD
- **Sept**: Set up dual machine Test Environment at GSD

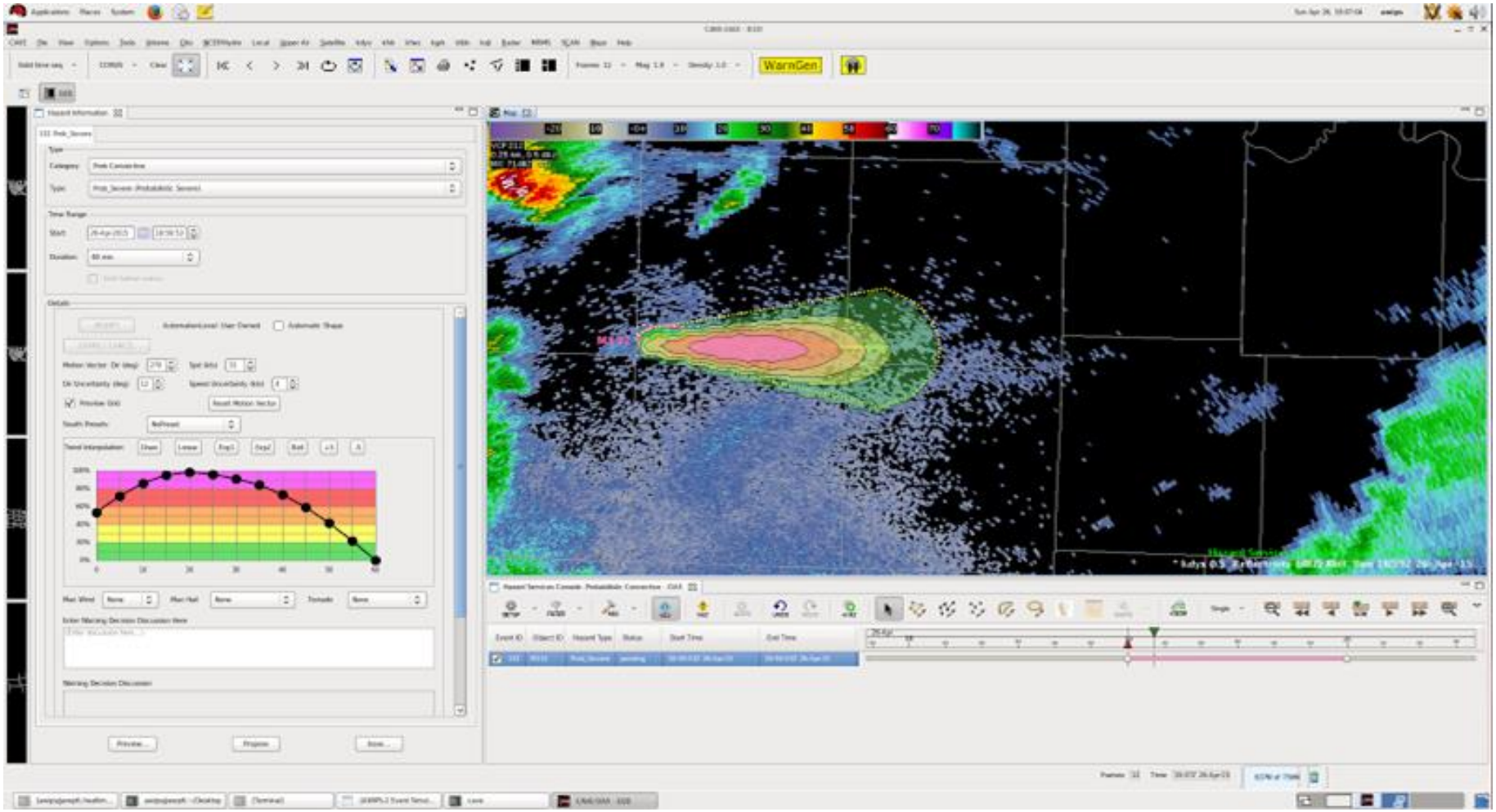
Major shift in Team dynamics and progress:

- **Oct-Feb**: Coding and Testing against Detailed Functional Tests using WebEx so developers could watch HWT in action
- **Mar-April**: HWT with continued improvements in off weeks

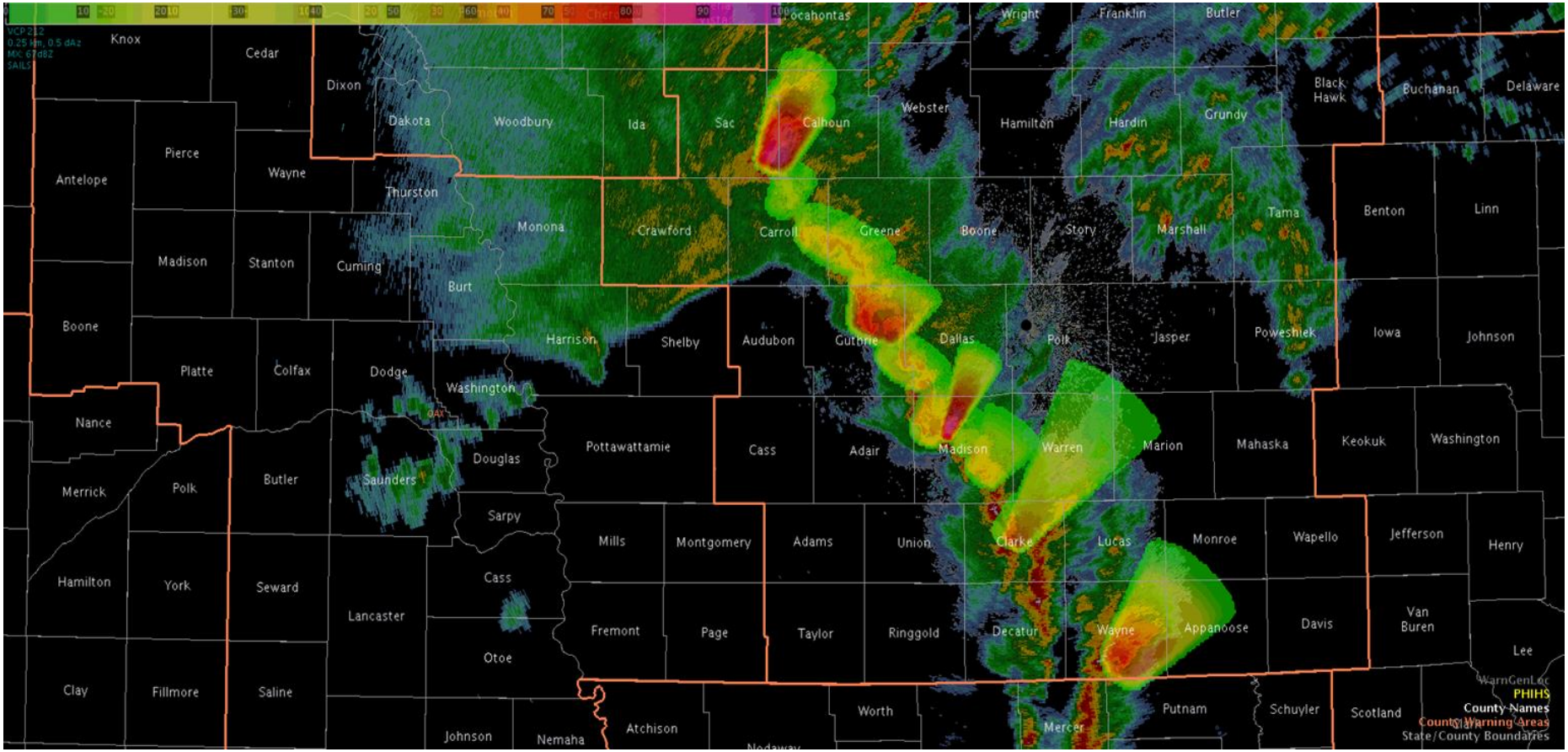
HS-PHI software developments in Year 2

- The 2015 version of NSSL PHI Prototype was the Year 2 benchmark.
- New functionality added for Year 2:
  - Convective Recommender
    - Processes ProbSevere detections into Hazard Services – PHI objects.
  - Workflow for editing objects including adjusting of the motion vector
  - Levels of Automation
    - Forecasters can create manual objects.
    - Forecasters can assume partial or full control of automated objects.
  - New object drawing tools: ellipses, rotation, resizing
  - Ending objects
  - PHI output grids
  - Warning Decision Discussion (timestamped entries)

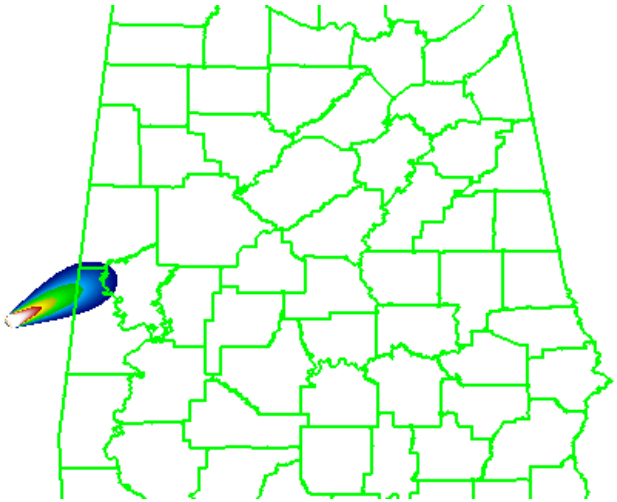
PHI in AWIPS2/Hazard Services (HS-PHI)



PHI Output Grids in AWIPS2



HS-PHI HWT Experiment Objectives



"Threats-In-Motion (TIM)"

Technology: Evaluate HS-PHI components and performance so that the software can be improved before operational implementation.

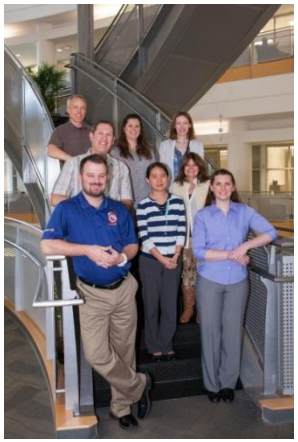
Human Factors: Measure forecaster workload using HS-PHI, including ease of use and graphical design.

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.

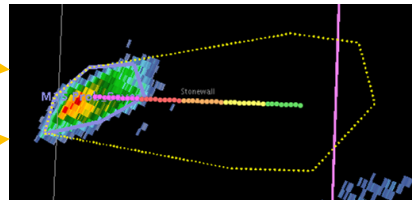
HS-PHI 2017 HWT Experiment

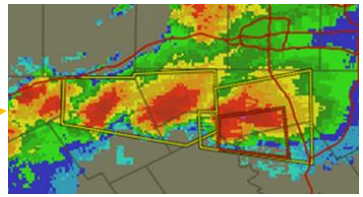
- Training materials hosted by Virtual Lab Collaboration Services
- 2017 Operations Weeks:
  - Shakedown: 20 – 24 Feb (1 forecaster)
  - Week 1: 20 - 24 Mar (2 forecasters)
  - Week 2: 3 – 7 Apr (2 forecasters)
  - Week 3: 17 – 21 Apr (2 forecasters)

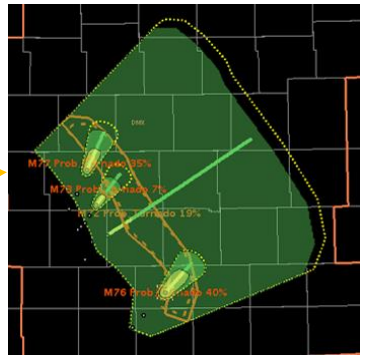


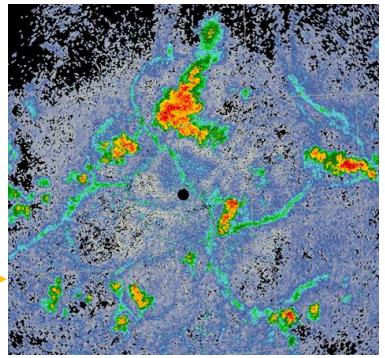
2017 Displaced Real-Time Scenarios

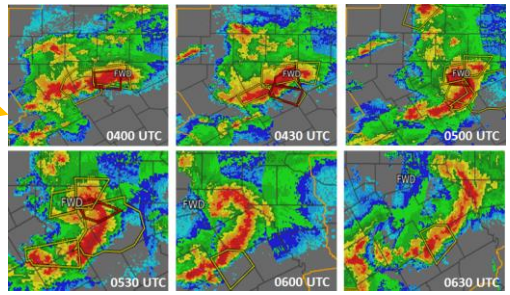
- Isolated marginally severe storm
  - Provide forecasters with basic concepts of PHI
- Developing supercell
  - For continued practice with PHI and object nudging.
- Merging/splitting supercells
  - Dealing with many events in very close proximity
- Quasi-Linear Convective System Tornadoes
  - Multiple-scale 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**

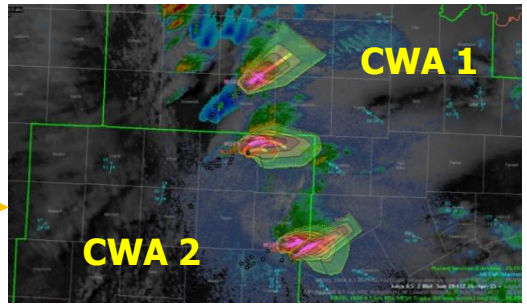








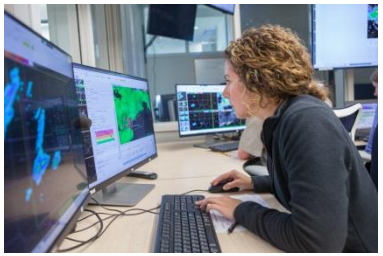




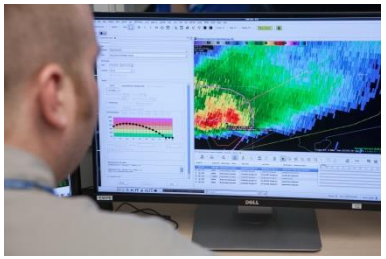
Human Factors Data Collection

- 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
    - Technology, Human Factors, Methodology, Conceptology

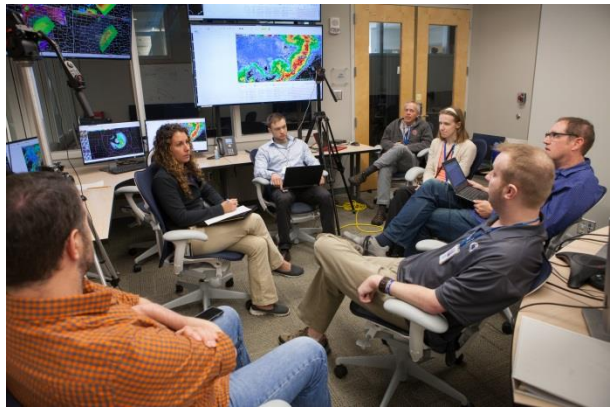
Forecaster contributions



- Visiting forecasters provided suggestions to improve the software.



- These suggestions are triaged to determine if they can be:
  - Incorporated into HS-PHI directly
  - Incorporated into both the PHI Prototype and HS-PHI
  - Require proof-of-concept testing in the PHI Prototype first.



- Forecasters helping to formulate operational best practices – WDTD integration.

Year 2 Preliminary Findings

- New systematic software releases and virtual functional testing resulted in better progress and more stable platform than in Year 1.
  - Forecasters completed all required scenarios without major software interruptions.
- Cross-WFO collaboration and object handoff will require significant analysis
  - OAR Office of Weather and Air Quality (OWAQ) HWT Proposal not accepted – will pursue other means of funding.
- Software performance issues continue to impact the forecaster experience and need to be addressed.

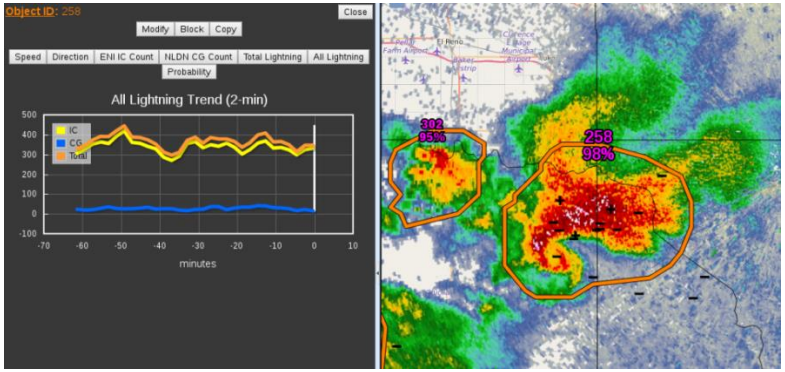
Year 3 Development – Finish 2015 Prototype Capabilities

- Address performance issues and stability
  - Hazard Services Registry implementation results in slow-downs
    - Need to incorporate the latest improvements
    - If necessary, explore alternative solutions
  - Buffering of commands for quicker responsiveness
    - PHI requires intense user interaction with hazard objects which warrants performance analysis and optimization
  - More robust error handling

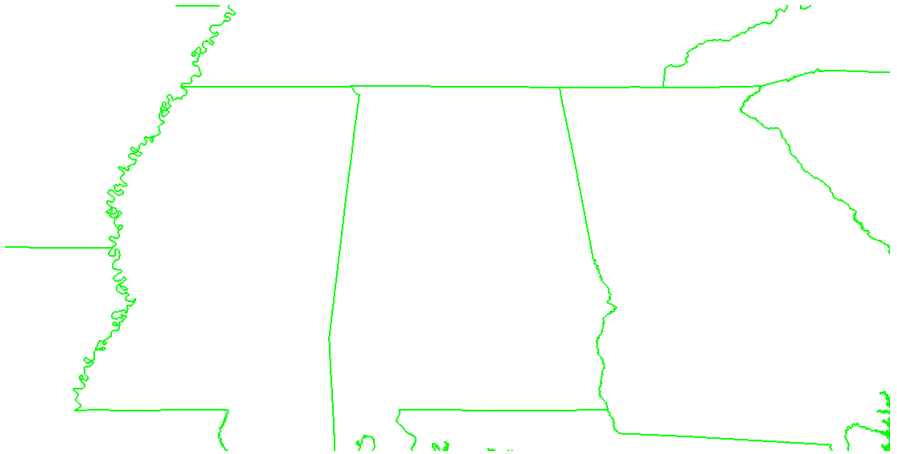
- Continue to refine functionality
  - Ownership of hazard objects and locking
  - Redraw polygon
  - Respond to user interface suggestions from forecasters

Year 3 Development – New Functionality

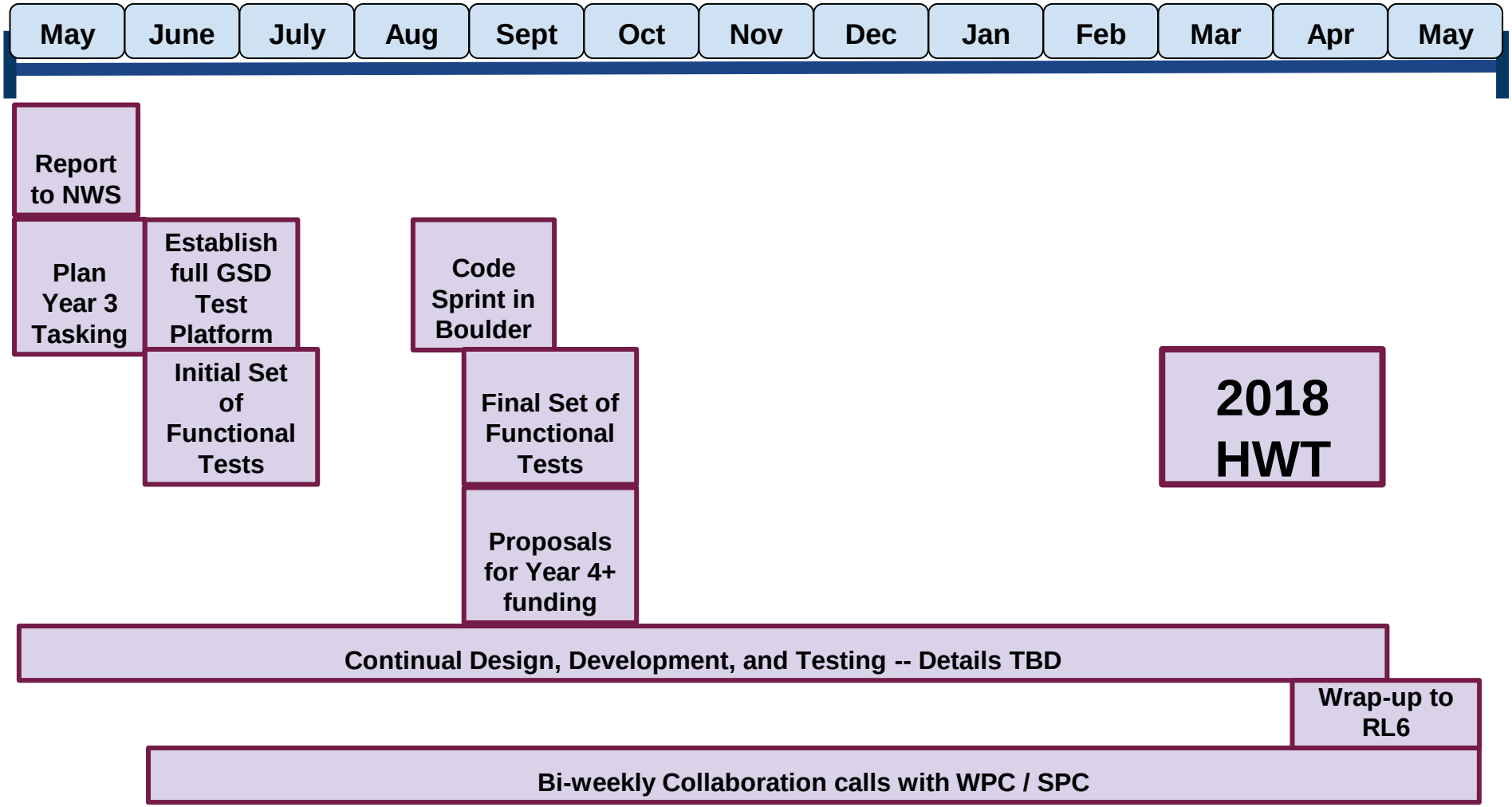
- Begin development of new functionality, including new items IDed by HS-PHI HWT tests, and those vetted by the PHI Prototype in 2016-2017.



- Candidates at the top of the list are:
  - Lightning PHI
  - Warning product output (with VTEC, etc.)
  - Deterministic Threats-In-Motion (TIM) polygons
  - Storm Longevity



Year 3 Timeline



Path to operations after the USWRP: Year 4+

- JTTI Proposal pending (software to RL7)
  - Complete development of 2016-2017 Prototype functionality
  - HWT spring experiments to include users (EMs, etc.)
  - Addition of new science as developed in companion JTTI proposal:
    - New plume model
    - New storm object ID and tracking model
    - Improved probabilistic guidance
    - New products informed by PHI Prototype
- Policy and paradigm shift to make FACETs operational