DOC / NOAA / OAR
National Severe Storms Laboratory
2021 NSSL Science Review

Collaborative Research Environments




Collaborative Research Environments enable...

Dynamic interactions between researchers and practitioners that support a true iterative R&D environment

Various Efforts

- Lead and operate NOAA's Hazardous Weather Testbed (in partnership with NWS)
- Strong partnerships and relationships with other NOAA testbeds (AWC, HMT, OPG)
- Collaborative relationships with NWS at **all** levels of the organization (NWSH, regions, field offices)

NOAA's Hazardous Weather Testbed

Experimental Warning Program

Detection/prediction of hazardous weather events ***up to several hours in advance***

Warning Research

Forecasting Research

Satellite-based Research

Experimental Forecast Program

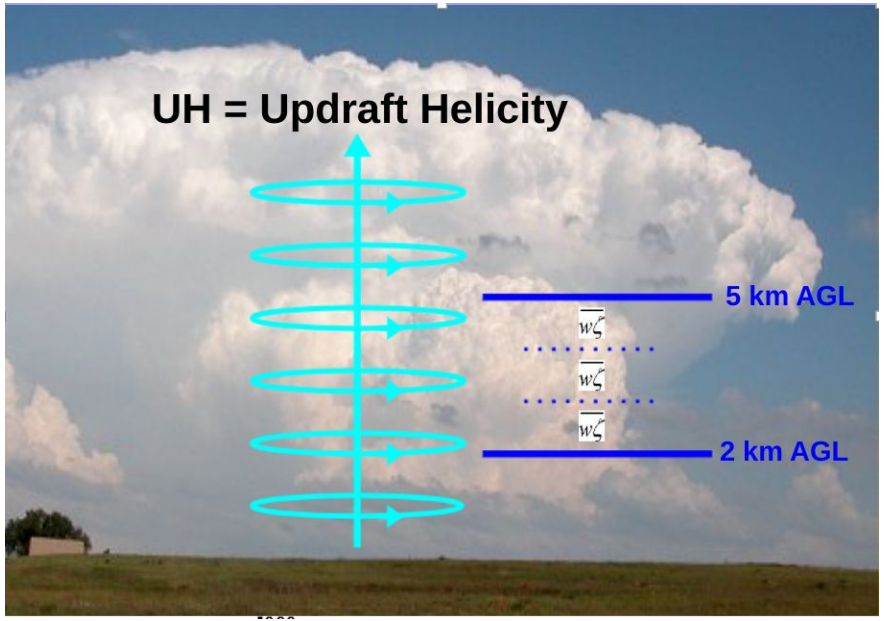
Prediction of hazardous weather events from ***a few hours to a week in advance***

Broader HWT Influence

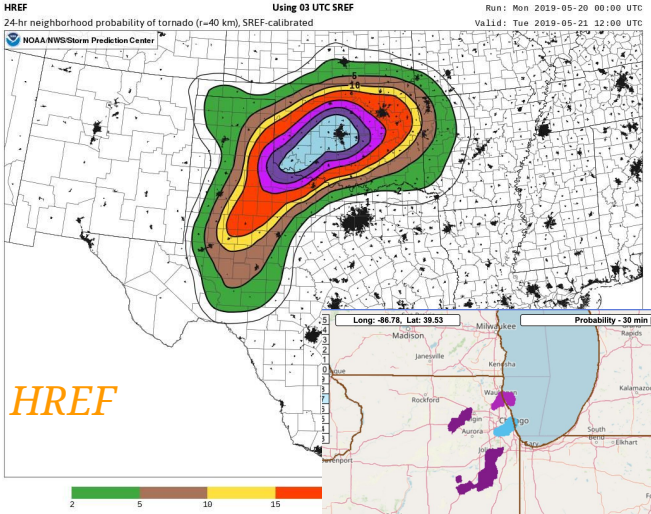
- New hurricane testbed at NHC being modeled after HWT experiments involving end users
- GSL consulting with HWT for development of new fire weather testbed
- Work with OPG on virtual testing and collaboration

How do we judge success?

- R2O Successes
- Successful testbed evaluations (not always leading to R2O success)
- And especially, **knowledge transfer**



Impacts and successes...



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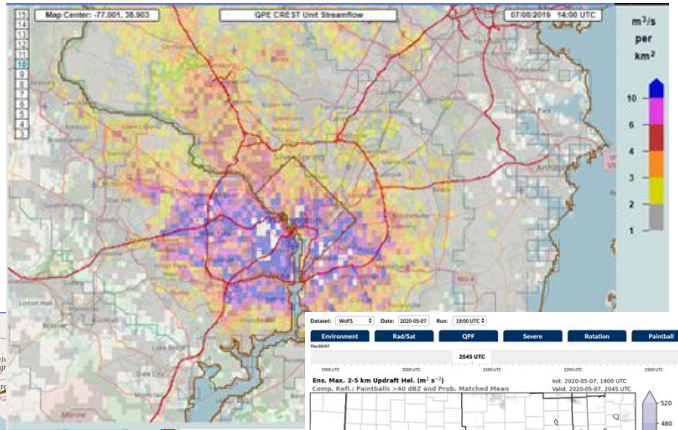
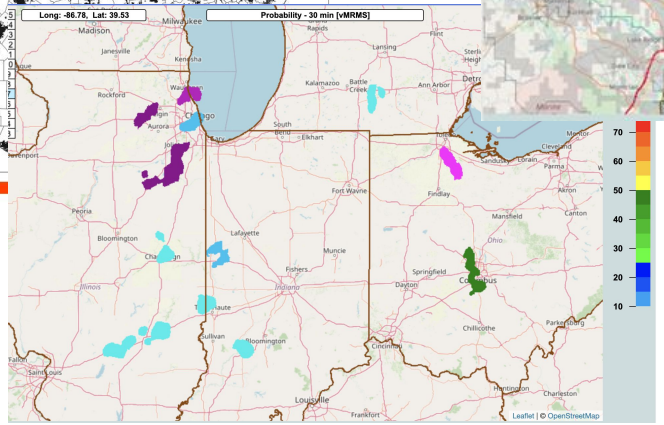
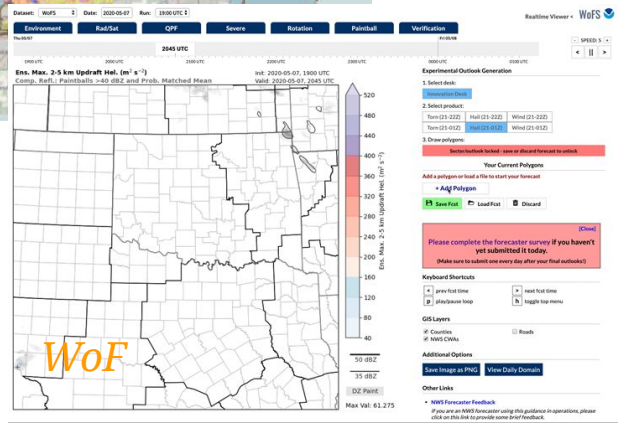


FLASH



ProbCGLightning



WoF

Multiple Collaborative Environments

Year-round Partnerships
Heather Reeves

Experimental Warning Program
Kodi Berry

Experimental Forecast Program
Adam Clark

Naturalistic Environments
Katie Wilson

Collaborative Research Environments

Year-round Partnerships

Heather Reeves, PhD; CIWRO Research Scientist; WRDD




Flooding from Ida kills dozens of people in four states

-NY Times, 2 Sept 2021

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Hail cracks windshield of United Airlines plane, forcing emergency landing at O'Hare

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At least 6 dead in 133-car pileup in Fort Worth after freezing rain

-Dallas News, 11 Feb 2021

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-Dallas News, 11 Feb 2021

New wildfire prompts evacuations in northern California

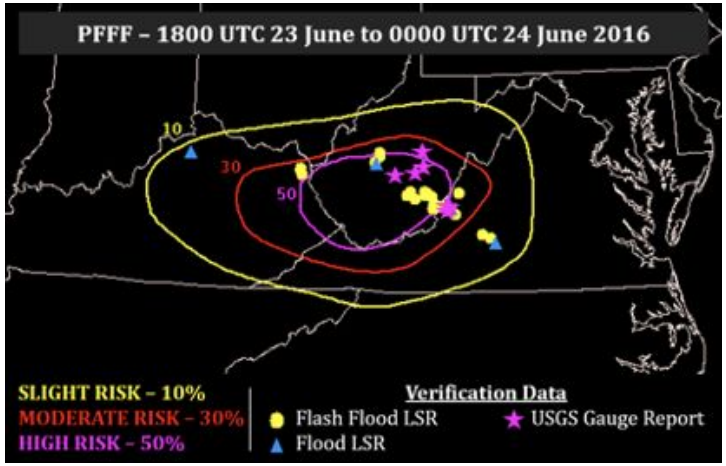
-AP, 23 Sept 2021


NATIONAL WEATHER SERVICE
WARNING DECISION TRAINING DIVISION
WDTD
AWC
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
AVIATION WEATHER CENTER
DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA
NATIONAL SEVERE STORMS LABORATORY
U.S. DEPARTMENT of COMMERCE
NATIONAL OCEANIC and ATMOSPHERIC ADMINISTRATION
FEDERAL AVIATION ADMINISTRATION
DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA
EM
bts
opg
NOAA
Storm Prediction Center
Norman, Oklahoma

WPC Partnership: Flash flooding (FFaIR experiment)

At least 26 dead as historic floods sweep WV

-USAtoday, 25 June 2016



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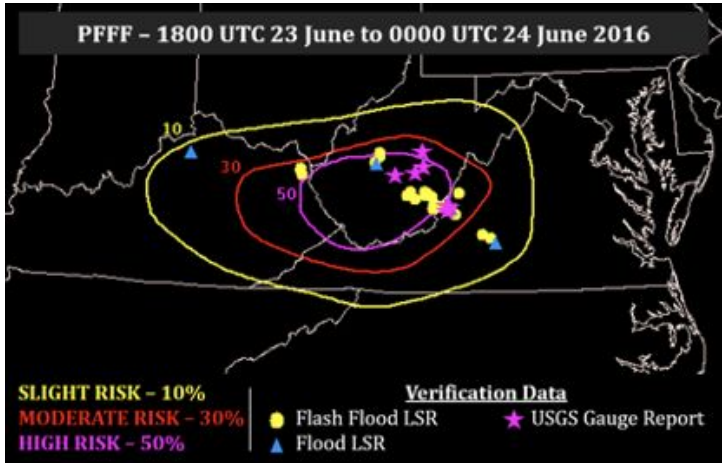
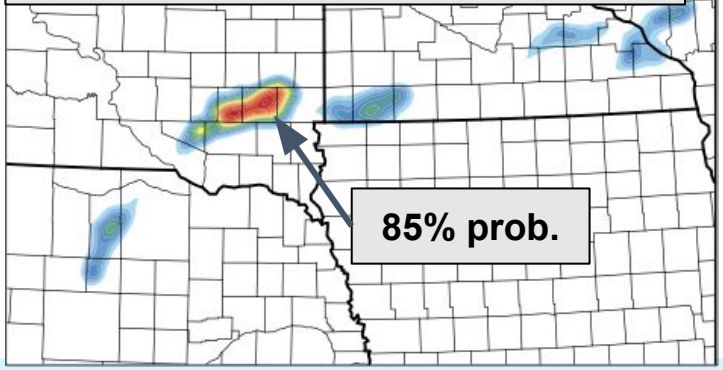
-USA Today, 25 June 2006



Probability of exceeding 5-year ARI



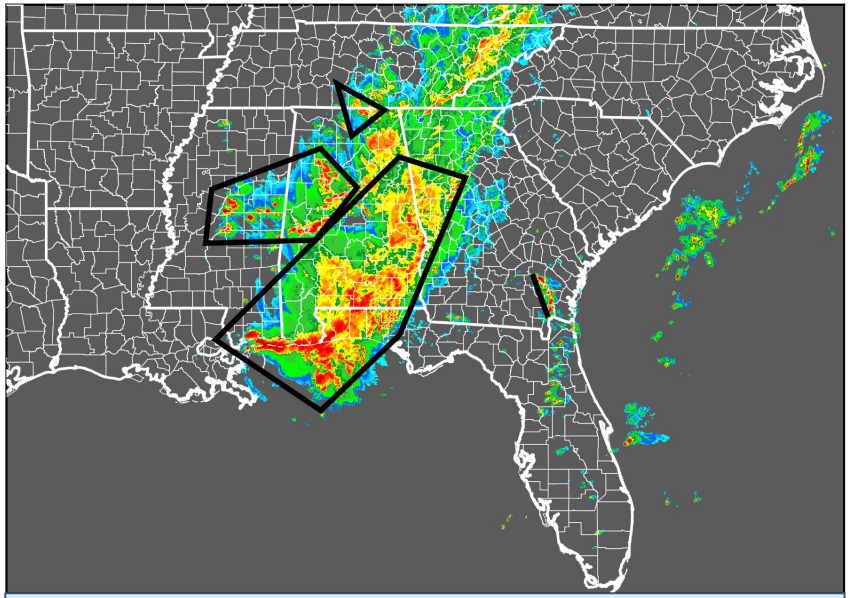
Heavy rainfall hits southwest South Dakota

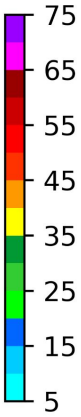
-Argus, 13 July 2018

More info on WoF coming in session on **Forecast/Warning Tools and Techniques

Aviation Weather Center Partnership

Manually-generated C-SIGS





CONVECTIVE SIGMET 71E
VALID UNTIL 2255Z
FL GA AND CSTL WTRS
FROM 50SSW SAV-20NE CRG-30SW CRG-50SSW SAV
AREA SEV TS MOV FROM 26035KT. TOPS TO FL320.
TORNADOES POSS.

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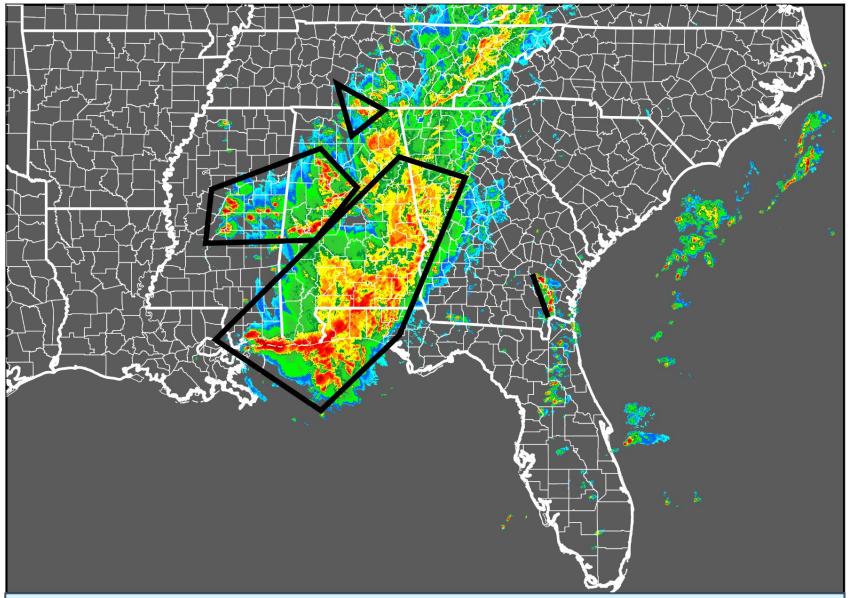

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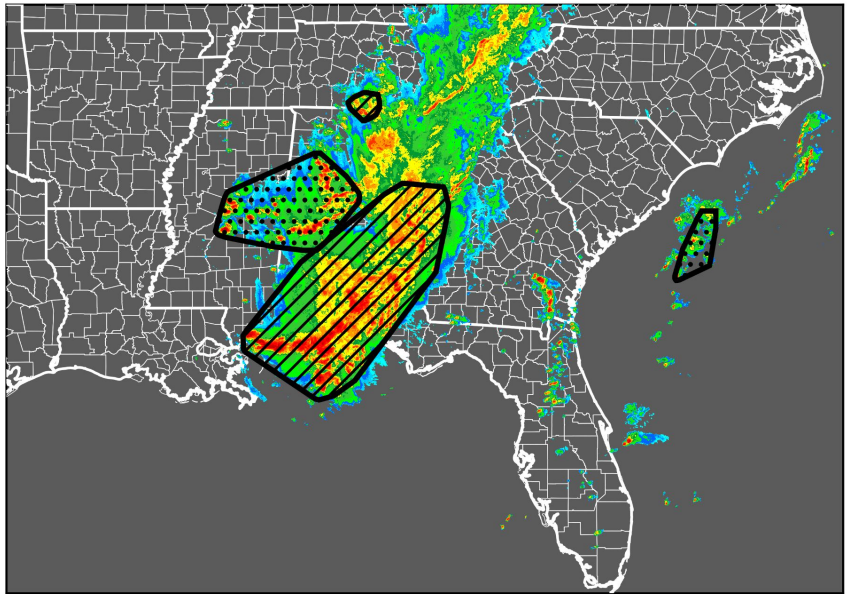
Automated, graded C-SIGS

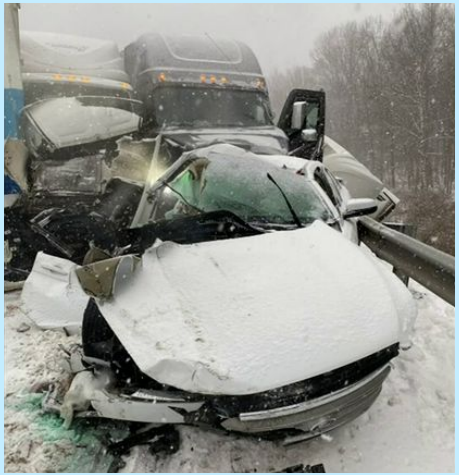


0-25% coverage
25-40% coverage
40-74% coverage
74%+ coverage

WPC partnership: Winter-Weather Experiment

Two dead in 66-vehicle crash on I-80

-ABC, 17 Dec 2020



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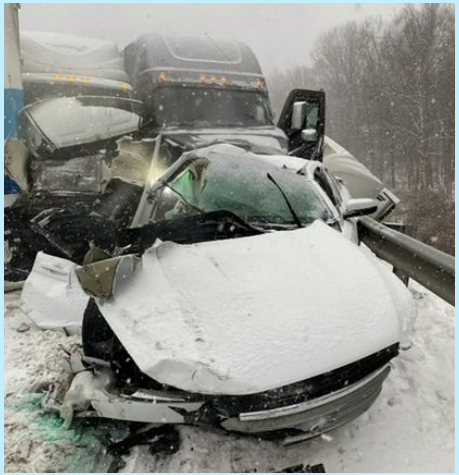

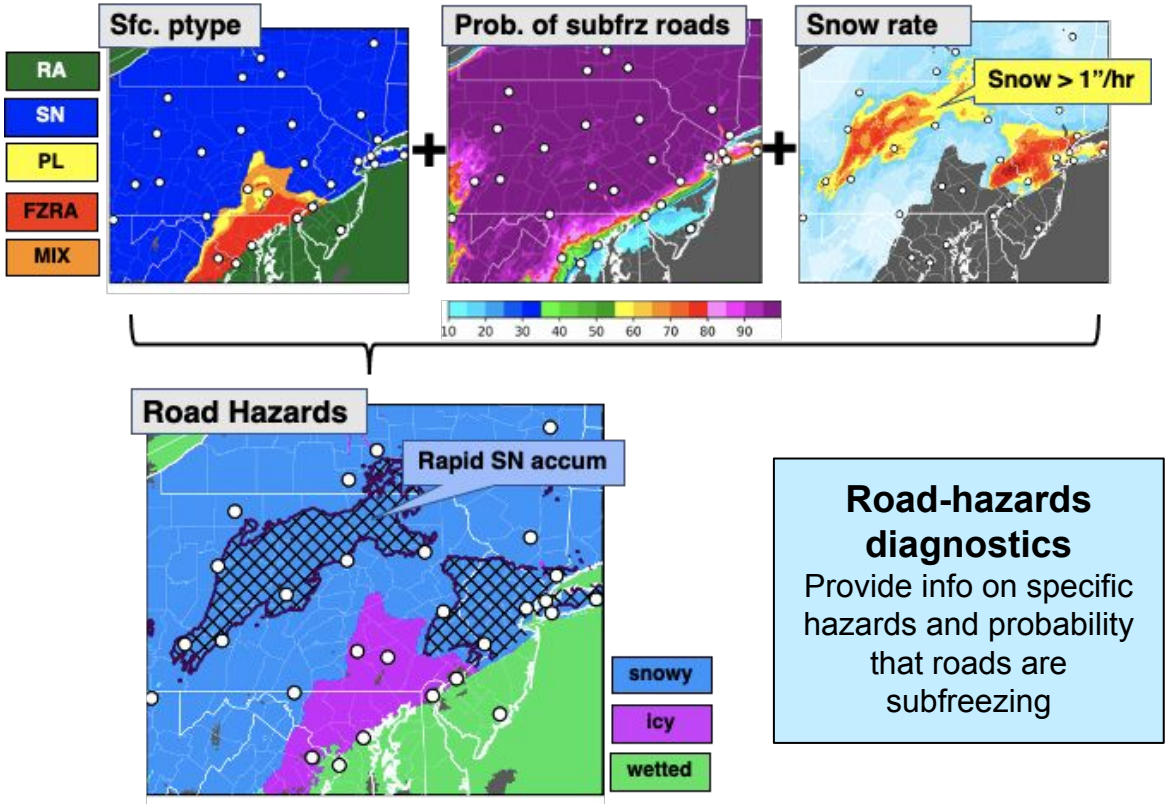

Road-hazards diagnostics

Provide info on specific hazards and probability that roads are subfreezing

Future work

Partnership with HMT to develop guidance for flash floods and debris flows for burn scars.

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Partnership with NWS to evaluate messaging of road threats during winter weather

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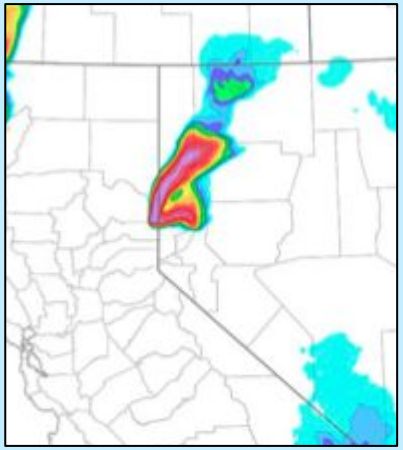
Partnership with GSL in new testbed to evaluate forecasting tools for wildfires



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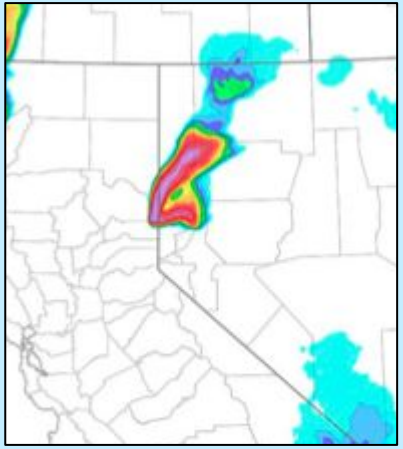
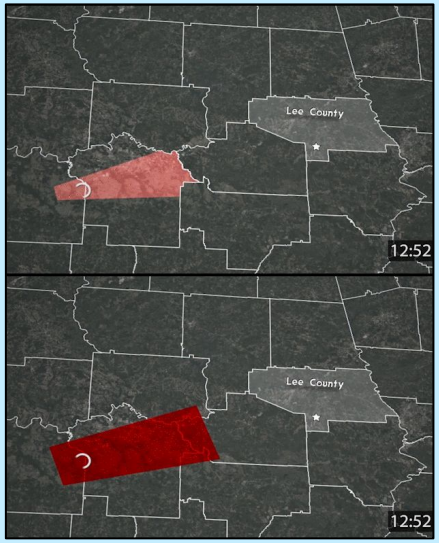




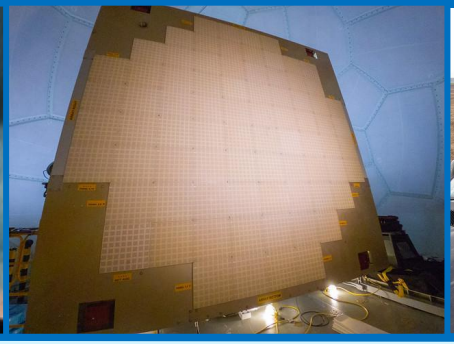
Partnership with OPG to evaluate Threats-in-Motion

Collaborative Research Environments

Experimental Forecast Program of the Hazardous Weather Testbed (HWT)

Adam Clark, PhD; NSSL Research Meteorologist; FRDD






NOAA HWT Spring Forecasting Experiments

What is it?

★ 5-week severe weather forecasting and evaluation experiment led by NSSL & SPC.

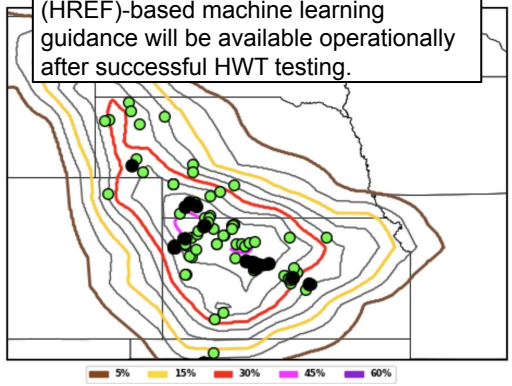
★ **Main goals – Accelerate research to operations (R2O) through:**

(1) Testing new severe weather prediction tools and forecasting methods,

(2) Studying how end-users apply severe weather guidance, &

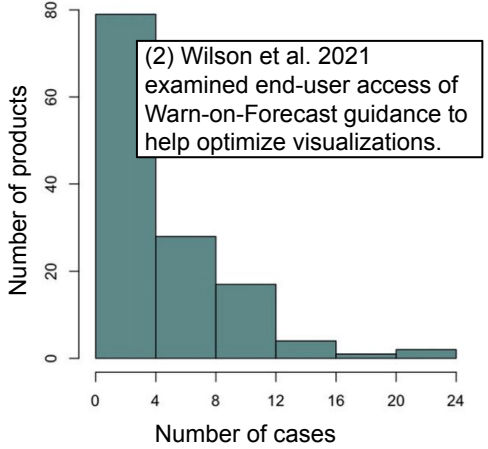
(3) Facilitating experiments for optimizing convection-allowing model (CAM) ensemble design to inform the Unified Forecast System (UFS).

(1) High-Resolution Ensemble Forecast (HREF)-based machine learning guidance will be available operationally after successful HWT testing.

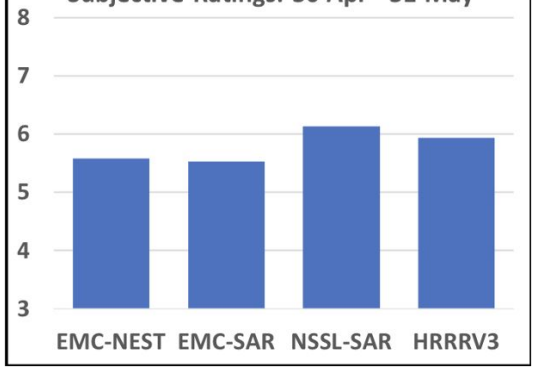


ML-based probability of severe hail.

(2) Wilson et al. 2021 examined end-user access of Warn-on-Forecast guidance to help optimize visualizations.



(3) HWT evaluations of the Finite Volume Cubed Sphere Model (FV3) have helped pave the way for operational implementation.



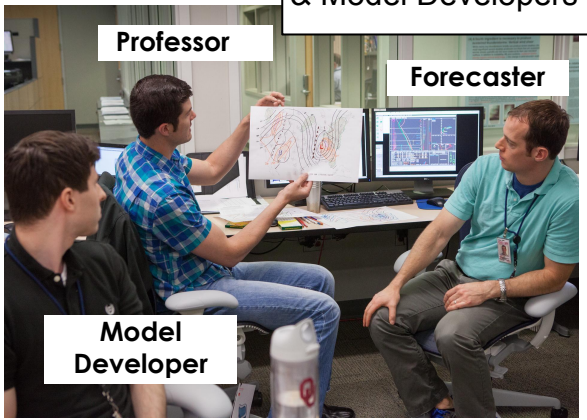
NOAA HWT Spring Forecasting Experiments

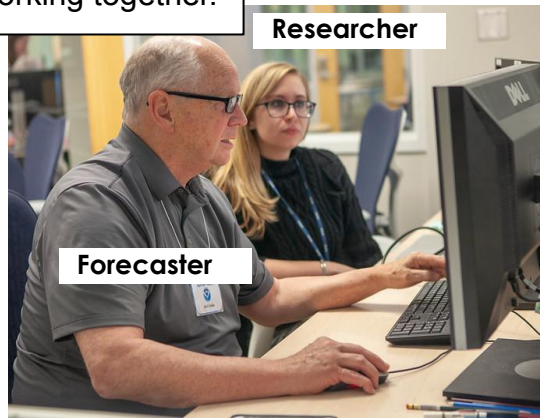
Keys to success

- ★ Sense of realism & operational urgency
- ★ Diverse participant backgrounds
- ★ R2O↔O2R pathways
- ★ Enabling quality science: 116 peer-reviewed pubs since 2016.
- ★ World-class, interactive web visualization and drawing tools

Web-based drawing tools helped facilitate remote participation during COVID.

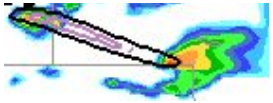
Researchers, Professors, Forecasters, & Model Developers working together.





Selected HWT Milestones: 2003-present

2003-05: First large-domain, "storm scale" models tested in the HWT. Major turning point in use of model data.



2006: NSSL-WRF real-time modeling framework established at NSSL.

2007-10: First real-time, large-domain CAM ensembles tested in the HWT (NOAA-funded project led by OU's Center for Analysis and Prediction of Storms).

2012-16: Storm Scale Ensemble of Opportunity developed and tested in HWT, the precursor to HREF.

2014: High-resolution Rapid Refresh Model (HRRR) becomes operational.

2016: Community Leveraged Unified Ensemble (CLUE) framework established for HWT, facilitating multi-agency collaborations on optimizing CAM ensemble configurations.

2016-18: First real-time Warn-on-Forecast prediction used by HWT forecasters.

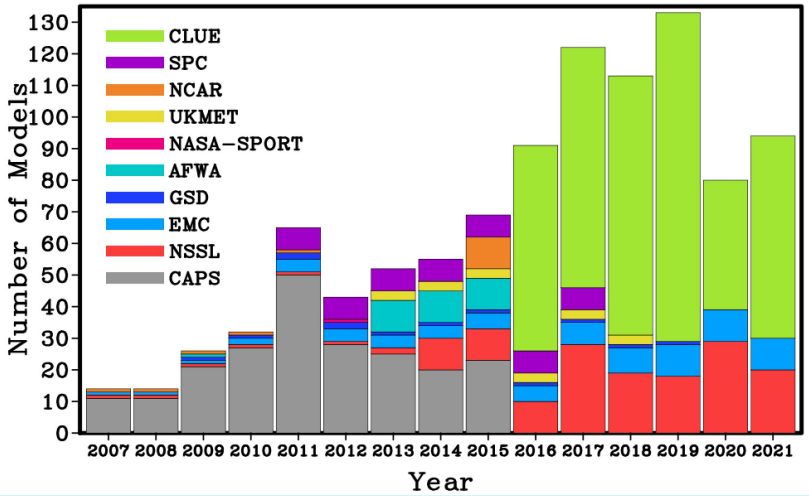
2017: Implementation of 1st operational CAM ensemble, HREF, at NCEP. ***HREF web-viewer is primary means by which NWS examines the model data.***

2021: Real-time, large-domain, 1-km predictions implemented in NSSL-WRF framework.

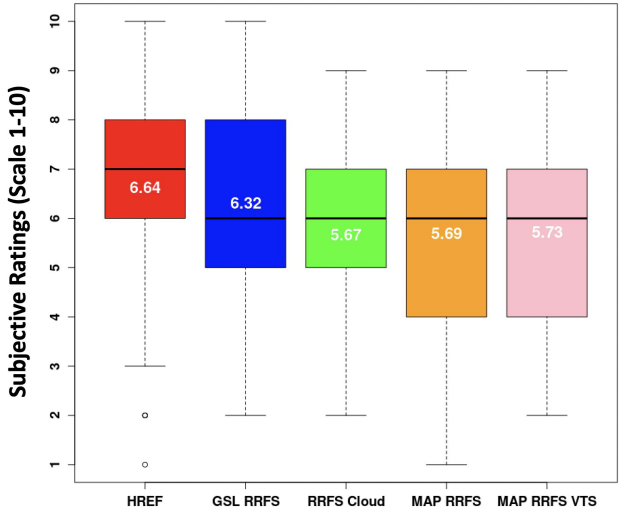
The Community Leveraged Unified Ensemble (CLUE)

- ★ *Inspired by the international UCAR (University Corporation for Atmospheric Research) Model Advisory Committee to provide* ***evidence-based decision making*** *for design of a future operational convection-allowing ensemble.*
- ★ **GOAL:** Design HWT experiments to provide more controlled datasets that can be better utilized to inform configuration of near-future operational systems [e.g., Rapid Refresh Forecast System (RRFS)].
- ★ Contributors agree on a set of model specifications & post-processing methods & data format. In SFE 2021, six agencies contributed 14 unique sets of model data for various experiments.

Models contributed to HWT since 2007

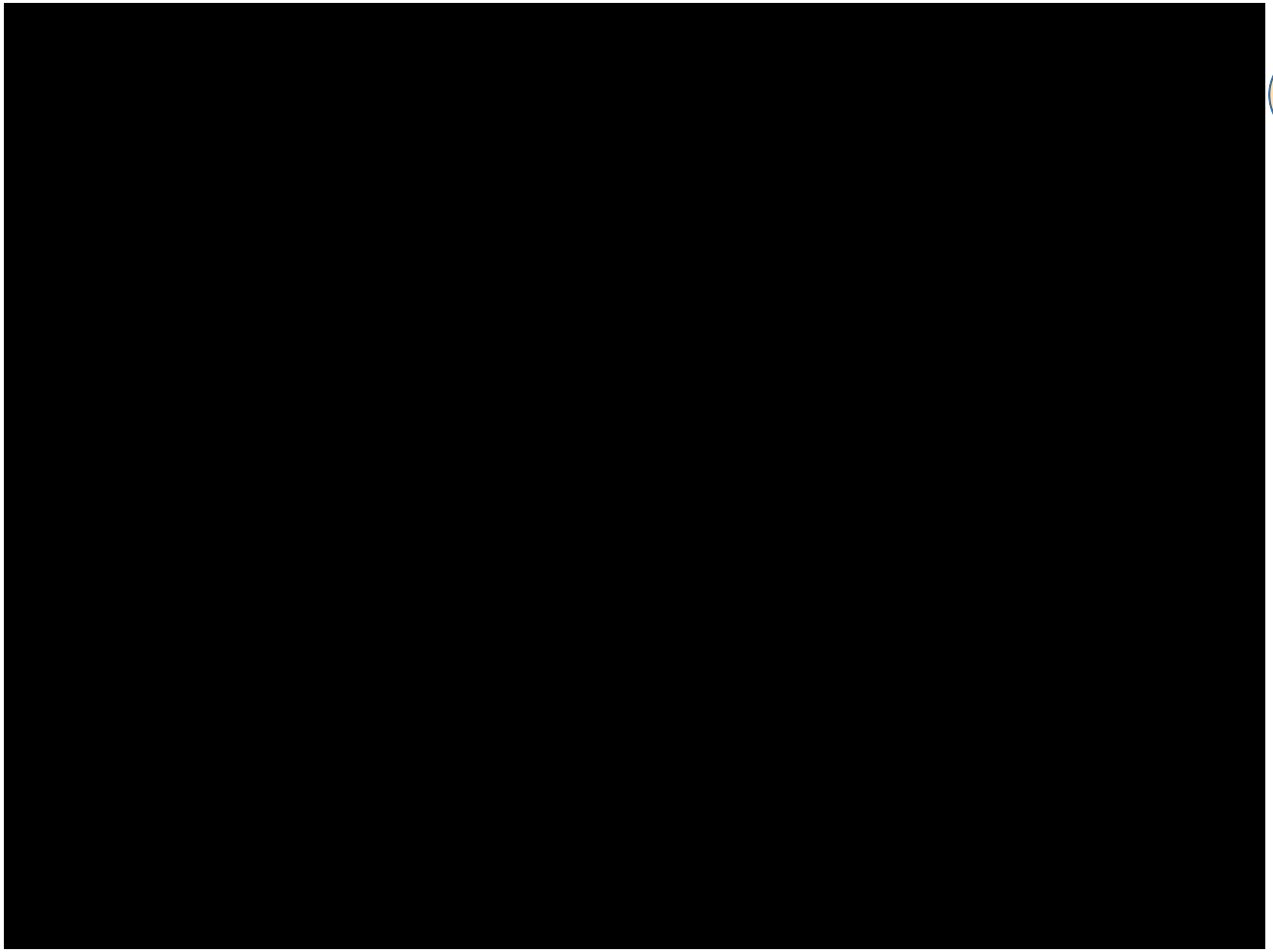


Example of 2021 CLUE results

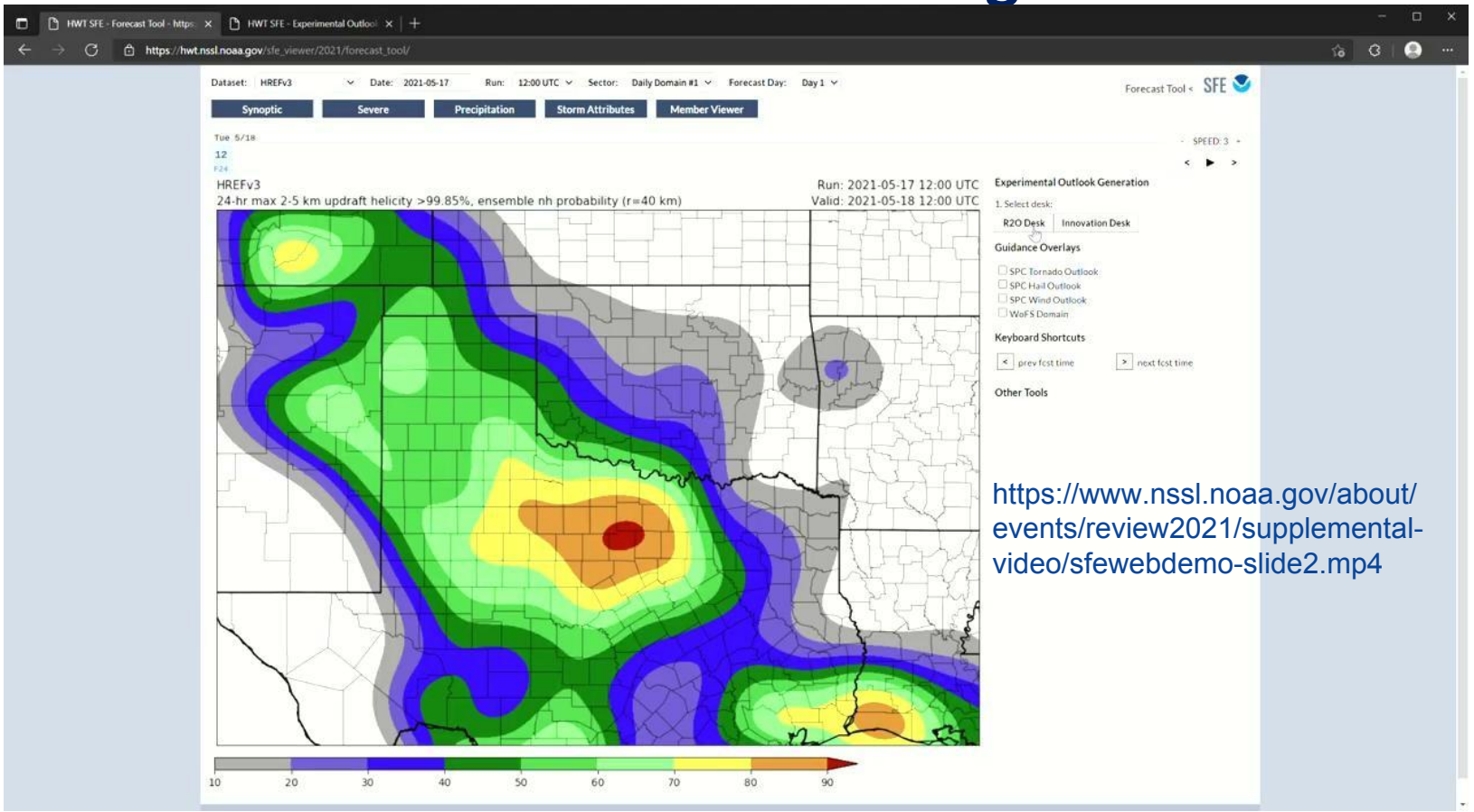


SFE Model Comparison Web-viewer

https://www.nssl.noaa.gov/about/events/review2021/supplemental-video/sfewebdemo-slide1.mp4



SFE Interactive Drawing Tools



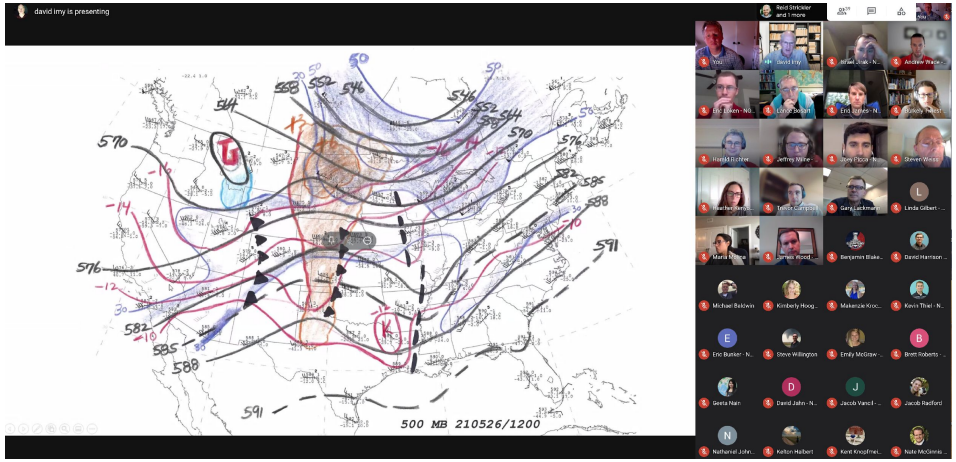
https://www.nssl.noaa.gov/about/events/review2021/supplemental-video/sfewebdemo-slide2.mp4

Collaborations

- **NOAA funding programs:** Joint Technology Transfer Initiative (JTTI), Unified Forecast System R2O project, R2O Initiative, Weather Testbeds, etc. (https://wpo.noaa.gov/Funding/Funded-Projects).
  - Since 2015, we've integrated *over 30 funded projects* into SFEs.
  - Regular collaborators include: U. of Oklahoma, NCAR, Iowa State, Texas Tech, Colorado State
- **NOAA Environmental Modeling Center:** Testing model upgrades, Rapid Refresh Forecast System prototypes, and new mesoscale analysis systems.
- **OAR Laboratories:** Global Systems Laboratory and Geophysical Fluid Dynamics Laboratory
- **Participants:** NWS Weather Forecast Offices & National Forecasting Centers, graduate students, professors, private sector, government researchers/modelers, etc.
- **United Kingdom Meteorology Office:** Sharing model data and UK Met forecasters participate. Collaborations on forecast verification, ensemble configuration, and most recently a multi-agency experiment to explore impact of driving model vs. initial condition.
- **Inspiration for other testbeds:** Australia Bureau of Meteorology (BOM), European Severe Storms Laboratory (ESSL), Weather Prediction Center, Aviation Weather Center.

Future Work

- ★ Don’t forget our roots! Interaction with SPC at grass roots levels on topics of mutual interest.
- ★ Continue to test Warn-on-Forecast and expand user engagement. This will be critical as we transition to Unified Forecast System framework and prepare for operational implementation.
- ★ Lead development and testing of the Rapid Refresh Forecasting System (RRFS), that will subsume several regional modeling systems in NCEP’s production suite.
- ★ Continue to find ways to innovate and expand engagement in a post-COVID workspace, including facilitating virtual, in-person, and hybrid experiments.



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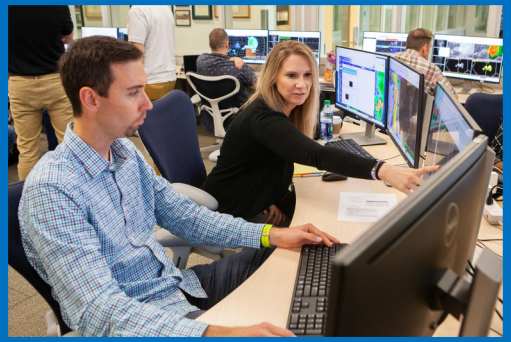
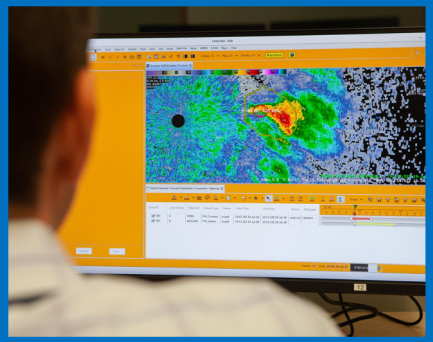
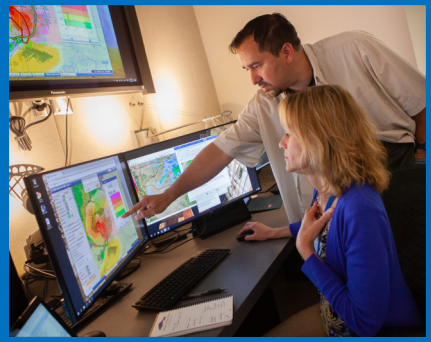
Experimental Warning Program of the Hazardous Weather Testbed

Kodi Berry, PhD; NSSL Research Meteorologist; WRDD



Hazardous Weather Testbed
Experimental Warning Program

Algorithm Developers

Researchers

Trainers & Human Factors Experts

Forecaster/ Broadcaster

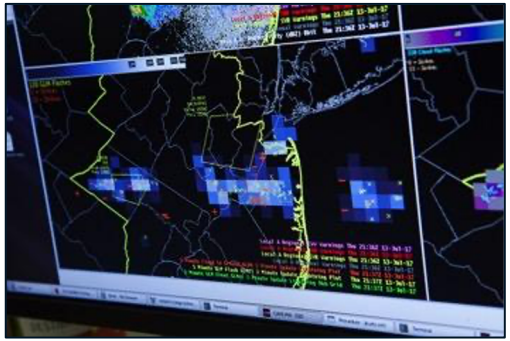
The goal of the EWP is to accelerate the transition of new meteorological insights and technologies into advances in warning for severe weather events.

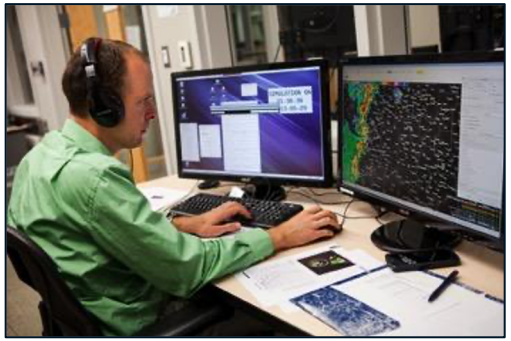
EWP Experiments

1. Assess the operational utility of new scientific concepts and technologies,
2. Provide direct feedback from forecasters to developers on the strengths and limitations of their concepts,
3. Offer insights to better meet the needs of operational forecasters,
4. Transfer knowledge of research concepts and ideas to the operational environment

EWP Experiments

- Last 3-5 weeks
- 2-4 NWS forecasters come to Norman, OK each week
- Forecasters, researchers, & academics side-by-side
- Real-time weather: makes it easier for researchers to understand operational challenges





EWP Experiments

- Projects and testing are tailored to research goals
  - **Exploratory**: provide insight on how a user might interact with or communicate new technologies or data.
  - **Experimental:** follow a specific outline of repeatable hypothesis testing. Thorough examination of how a new capabilities impact the operational environment.
- 283 forecasters, 93 emergency managers, 58 broadcast meteorologists participated since 2015
- More than 25 formal publications since 2015 covering different experiments and many more conference publications and technical reports.

The Experimental Warning Program of NOAA's Hazardous Weather Testbed

Full access

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Kristin M. Calhoun[1], Kodi L. Berry[1], Darrel M. Kingfield[2], Tiffany Meyer[3], Makenzie J. Krocak[4,5], Travis M. Smith[1,4], Greg Stumpf[6,7], and Alan Gerard[1]

[1 1] NOAA/OAR/National Severe Storms Laboratory, Norman, Oklahoma | [2 2] NOAA/Global Systems Laboratory, Boulder, Colorado | [3 3] UCAR/Unidata, Boulder, Colorado | [4 4] Cooperative Institute for Mesoscale Meteorological Studies, University of Oklahoma, Norman, Oklahoma | [5 5] Center for Risk and Crisis Management, University of Oklahoma, Norman, Oklahoma | [6 6] Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado | [7 7] NOAA/NWS/Meteorological Development Laboratory, Silver Spring, Maryland

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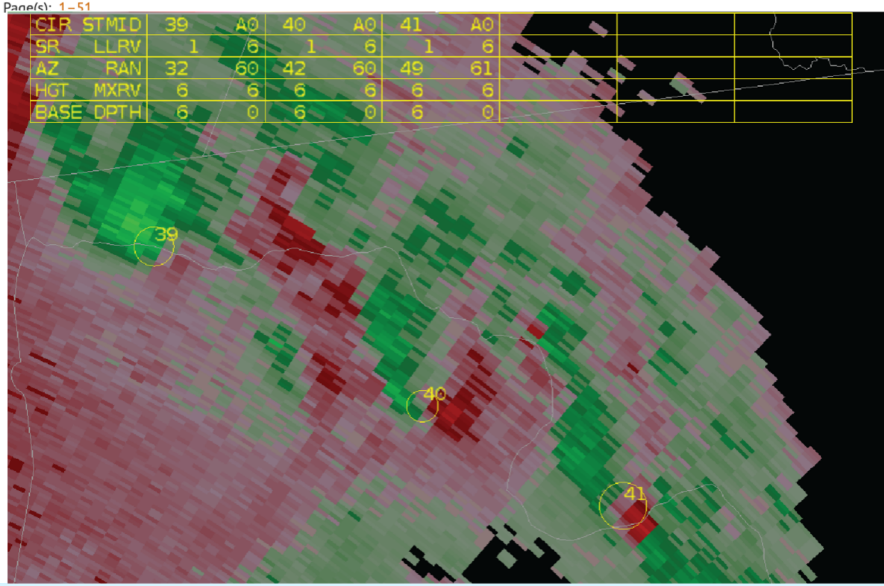

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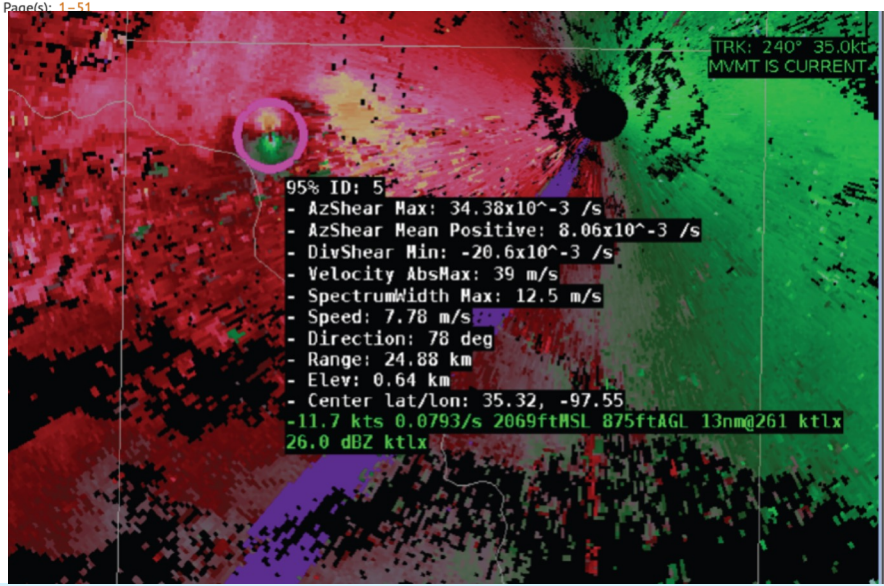
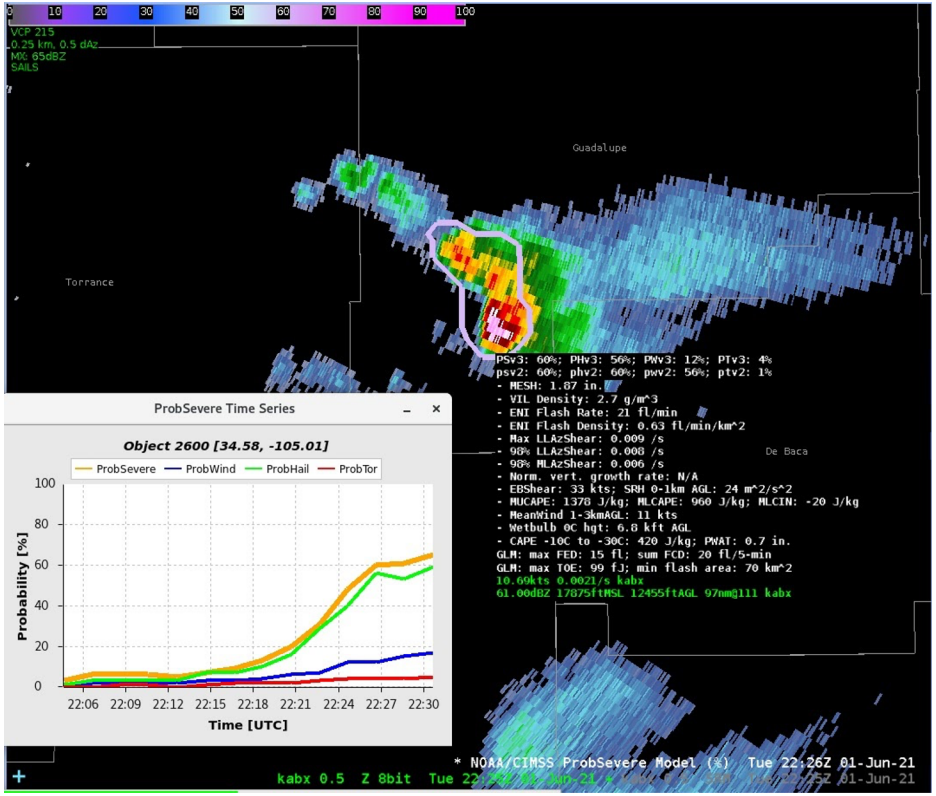


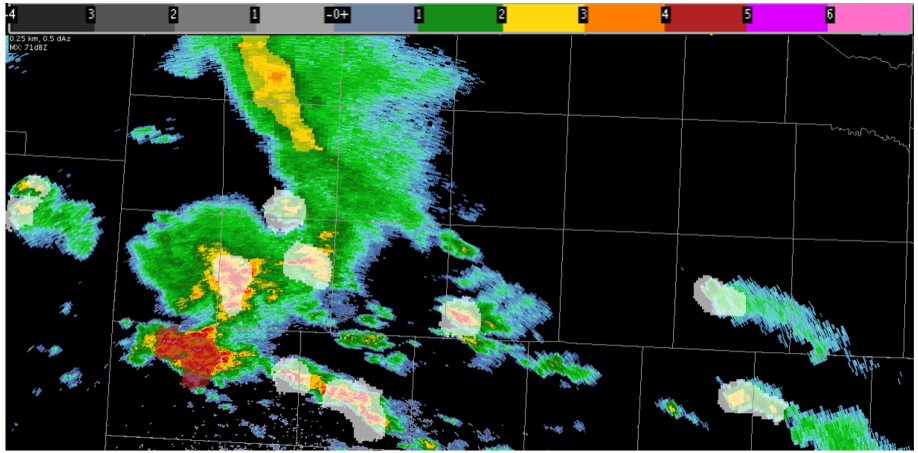
Satellite Convective Applications Experiment

- 2015-2016: Feedback from the forecasters helped to determine which products would be integrated into the GOES-R dissemination after launch
- 2017-2018: Experiments shifted to validating algorithms and testing new data (e.g., Geostationary Lightning Mapper)
- 2019-Present: EWP continues to provide NESDIS GOES and JPSS programs an opportunity each spring to conduct demonstrations of current and future products and provide recommendations for operations.



EWP: R2O and O2R

- NWS forecaster participation in EWP experiments results in direct transition of knowledge from research to operations.
- Lightning Jump Algorithm changed from a 2-standard deviations (sigma) product to gridded jump (and dive) due to forecaster feedback.



When your radar coverage is above 10kft.

DFWStormChasers @DFWStormChasers · 16h

satellite indicated svr in Montana.

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MTC057-300000-
/O.CON.KTFX.SV.W.0053.000000T0000Z-210730T0000Z/
Madison MT-
538 PM MDT Thu Jul 29 2021

...A SEVERE THUNDERSTORM WARNING REMAINS IN EFFECT UNTIL 600 PM MDT
FOR CENTRAL MADISON COUNTY...

At 537 PM MDT, a severe thunderstorm was located near Virginia City,
moving east at 20 mph.

HAZARD...60 mph wind gusts.

SOURCE...Satellite indicated.

IMPACT...Expect damage to roofs, siding, and trees.

Locations impacted include...
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1 1 19

Rob Hart
@rqhart

Replying to @cschultzwx

It was me...Significant flare-up in satellite with a lightning jump, and nearby obs measuring 50 mph made me pull the trigger.

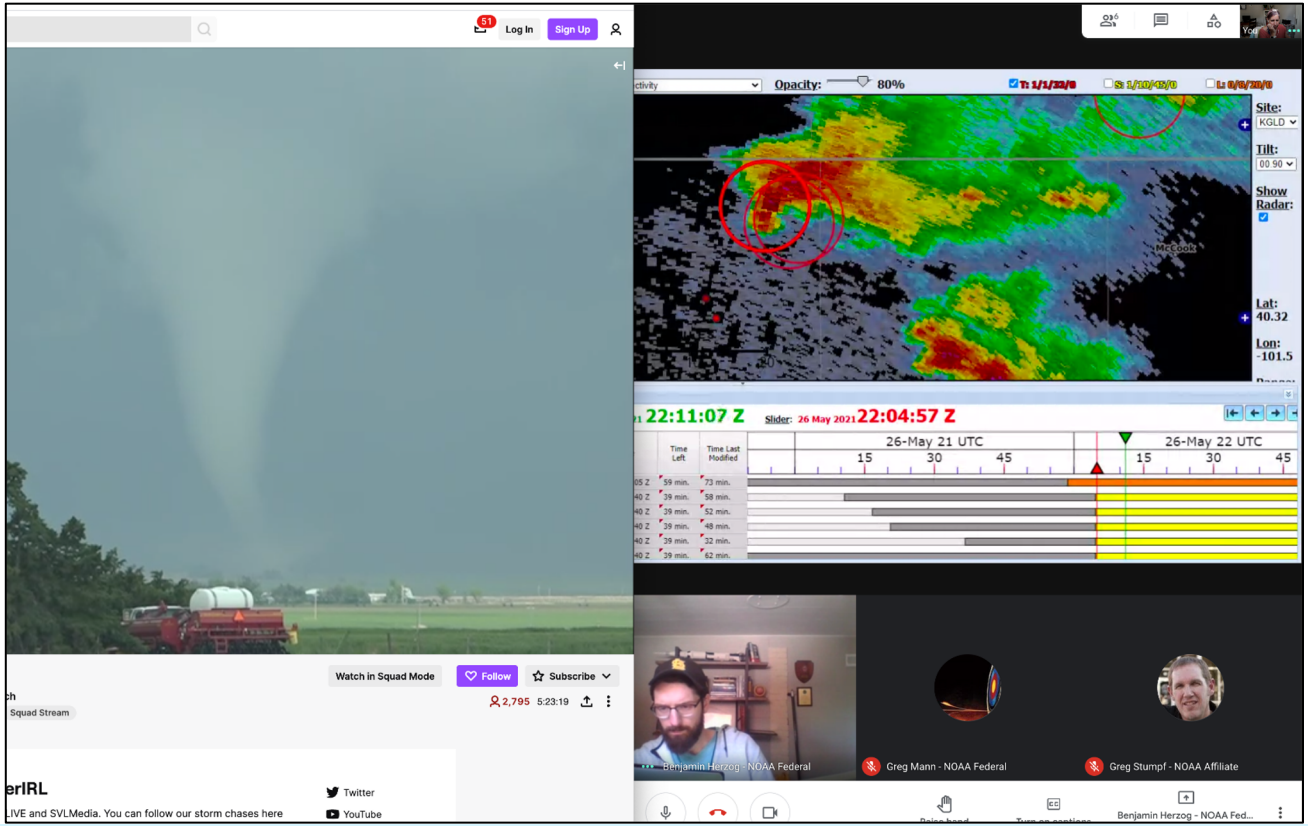
11:28 PM · Jul 29, 2021 · Twitter for iPhone

Rob Hart @rqhart · 12h

They do! I was using some GLM lightning procedures today that I made as a result of the HWT.

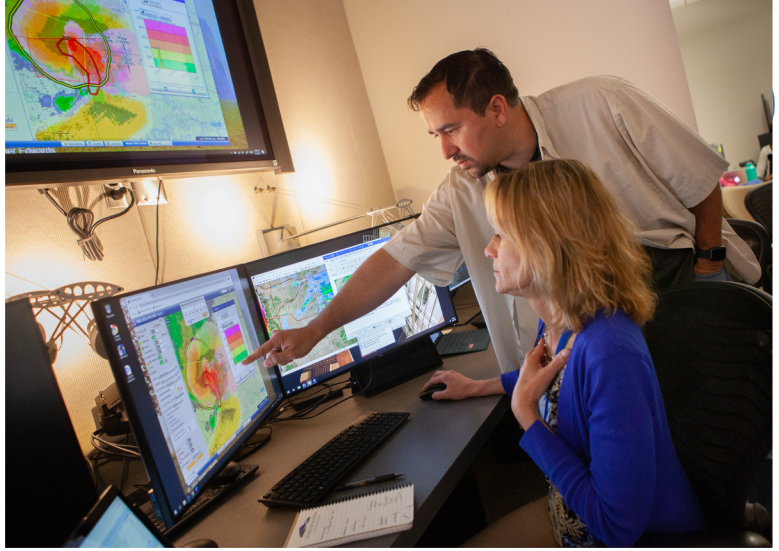
COVID-era and the transition to a virtual environment

- Tools and data (terabytes of data!!!) all transitioned to the cloud (including NWS AWIPS capabilities to issue warnings)
- Used collaborative tools like Google Meet and Jamboard to continue testing and evaluation remotely



Future Work in the HWT

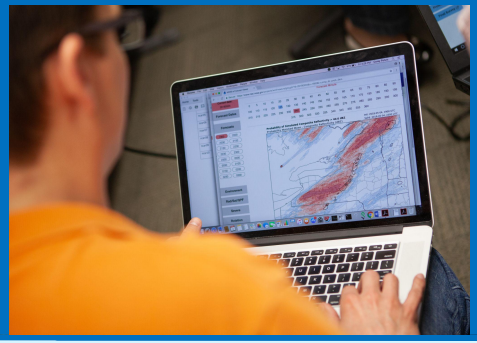
- Leverage lessons learned during virtual experiments and develop hybrid experiments both in-person and in the cloud
- Design experiments for FACETs that blend Experimental Forecast and Warning Programs to bridge across time scales and reference classes



Collaborative Research Environments

Research in the Naturalistic Environment

Katie Wilson, PhD; CIWRO Research Scientist; FRDD

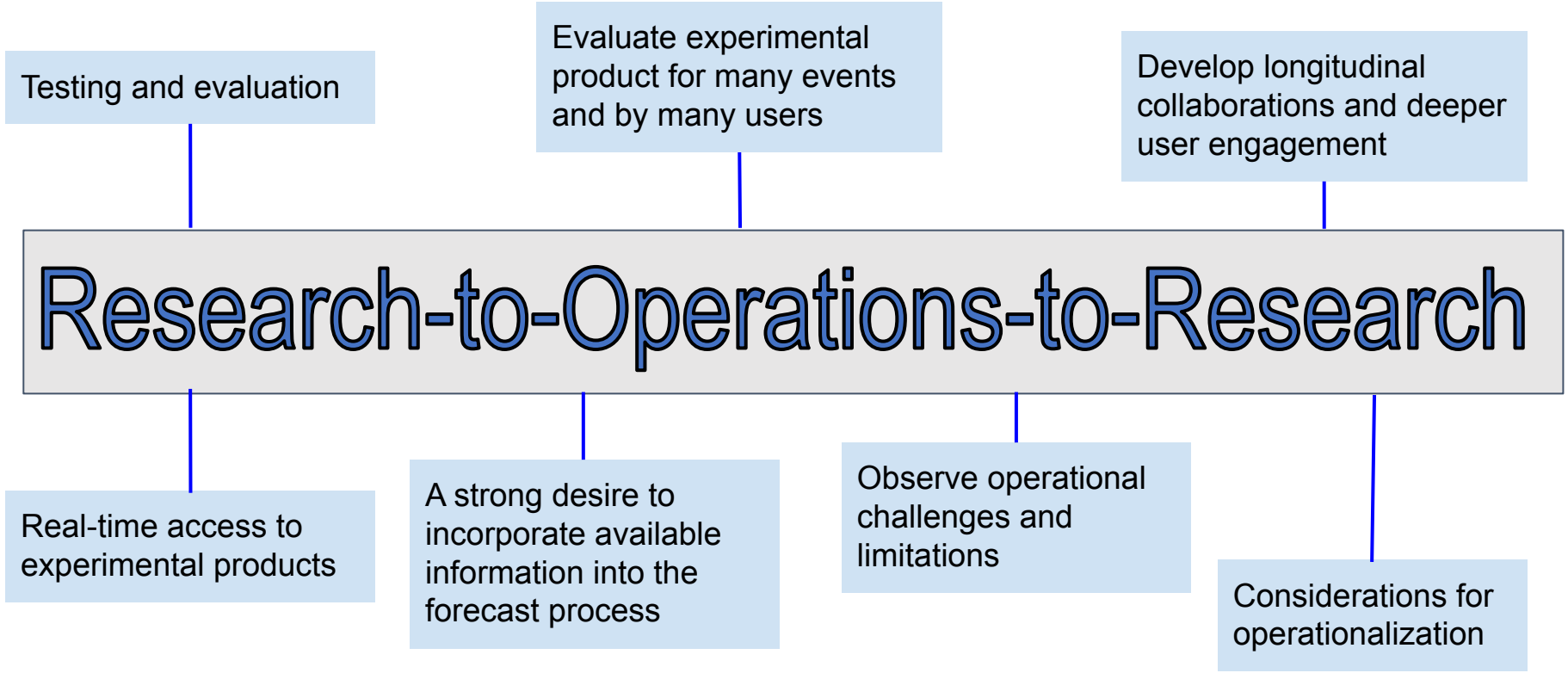



What is Research in the Naturalistic Environment?

- Conducting research on the operational floor
- Test and evaluate tools within the full forecast process
- Provides ecological validity and therefore external validity to controlled experiments

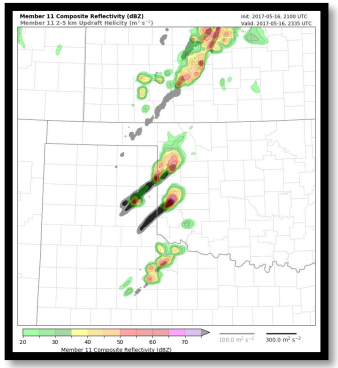
Live shot of the Norman Weather Forecast Office

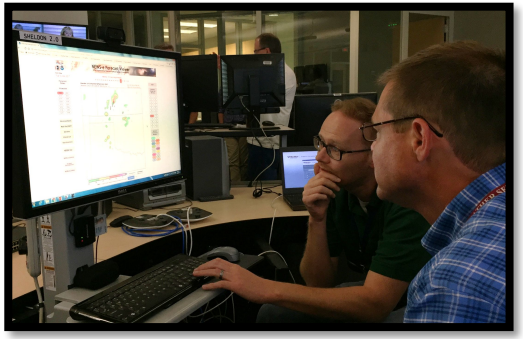
Why is Research in the Naturalistic Environment Important?



An Example: Warn-on-Forecast in Operations

- Co-location of NSSL/OU CIWRO with the Norman Forecast Office
- Warn-on-Forecast guidance is available during the real-time run season
- Impromptu science support during weather events
- Learning *together* about the real-time applications of Warn-on-Forecast guidance



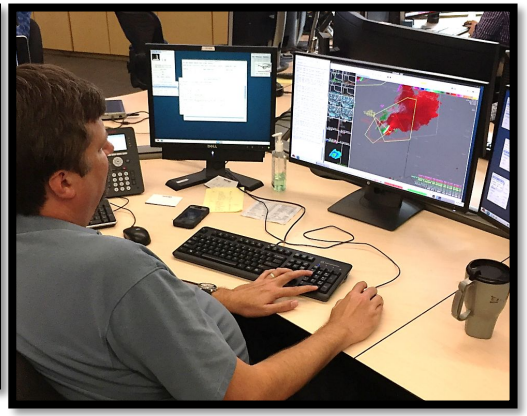


...SIGNIFICANT WEATHER ADVISORY FOR northwestern Harmon... southwestern Roger Mills...western Beckham and northwestern Greer Counties Until 545 PM CDT...

Storms capable of producing tornadoes were located in the Texas panhandle. One storm was located southwest of Wheeler and the other located northwest of Wellington at 515 pm. The storms were moving northeast at 35 MPH. These storms will move into western Oklahoma before 6 PM. Severe weather is likely with these storms as they move into Oklahoma and there is a high probability that tornado warnings will be issued.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

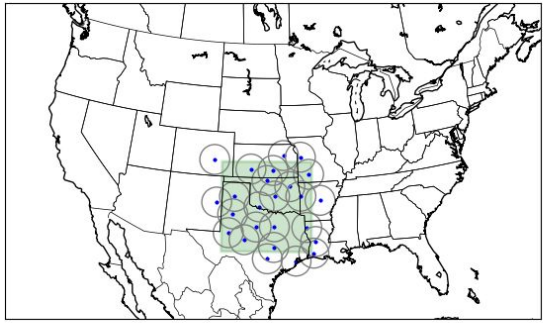
Monitor the situation closely. Be ready to act quickly if a warning is issued or if storms threaten you.



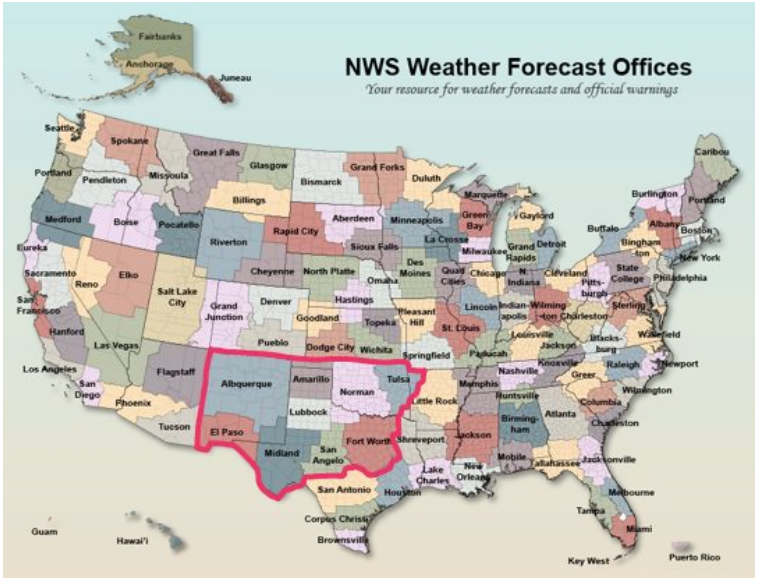
Images courtesy of WFO Norman

Growing Real-time Collaborations

- 2020 & 2021
- 9 southern region NWS forecast offices
- Union-approved working group
- Formalize R2O2R efforts



Example of the Warn-on-Forecast Domain of the Day



The Southern Region WoF Working Group

Virtual Activities to Support Real-time Collaborations

- Webinars, training & best practices
- Case study preparation

- Google Meet
- Scientist & forecaster interactions
- Document uses and applications

- Post-event briefings
- Workflow examples
- Product and interface feedback
- Formal surveys

Future Plans for Naturalistic Research

1. Further develop training on for experimental forecast guidance
2. Expand collaborations to other NWS regions
3. Connect engagement with national centers and local offices