

# FACETs:

- ① A New Watch/Warning Paradigm  
&
- ② Framework for Progress

Seeking Clarity & Coalescence  
in the Primordial Soup

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Deputy Chief  
Warning R & D Division  
(and Acting Deputy Director)  
NSSL

# DISCLAIMER!!!!

- The concepts presented herein are *under development and exploration* by the National Severe Storms Laboratory.
- They are NOT the accepted and adopted plans of the National Weather Service
  - *...although NWS is partnering in the exploration.*

# A Tornado Warning in 2013?

BULLETIN - EAS ACTIVATION REQUESTED  
TORNADO WARNING  
NATIONAL WEATHER SERVICE JACKSON MS  
1155 AM CST SUN FEB 21 2013

\*TORNADO WARNING FOR...

NORTHERN SUNFLOWER COUNTY IN NORTHWEST MISSISSIPPI  
TALLAHATCHIE COUNTY IN NORTHWEST MISSISSIPPI  
QUITMAN COUNTY IN NORTHWEST MISSISSIPPI

\* UNTIL 1 PM CST

\* AT 1155 AM CST...A TORNADO WAS REPORTED BY THE PUBLIC AND INDICATED BY RADAR 5 MILES NORTHEAST OF CLEVELAND...AND IS MOVING TOWARD THE NORTHEAST AT 55 MPH.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

IF THREATENING CONDITIONS ARE SIGHTED...BE PREPARED TO MOVE TO A PLACE OF SAFETY. TO REPORT A TORNADO OR OTHER SEVERE WEATHER...PLACE AN EMERGENCY CALL TO THE JACKSON MS NATIONAL WEATHER SERVICE OFFICE AT 601 939 5751...OR ASK THE NEAREST LAW ENFORCEMENT AGENCY TO RELAY YOUR REPORT TO THE NEAREST NATIONAL WEATHER SERVICE OFFICE.

Courtesy: Alan Gerard



# Nope!

BULLETIN - EAS ACTIVATION REQUESTED  
TORNADO WARNING  
NATIONAL WEATHER SERVICE JACKSON MS  
1155 AM CST SUN FEB 21 1971

40+ years ago!!



\*TORNADO WARNING FOR...

NORTHERN SUNFLOWER COUNTY IN NORTHWEST MISSISSIPPI  
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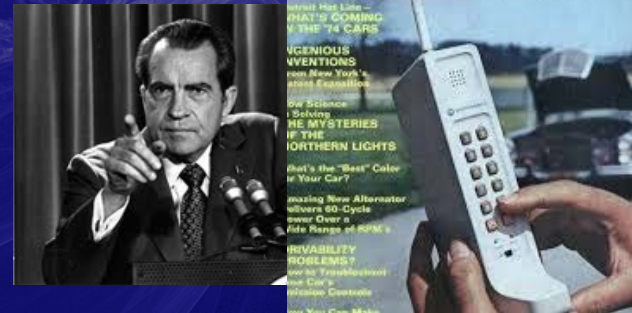
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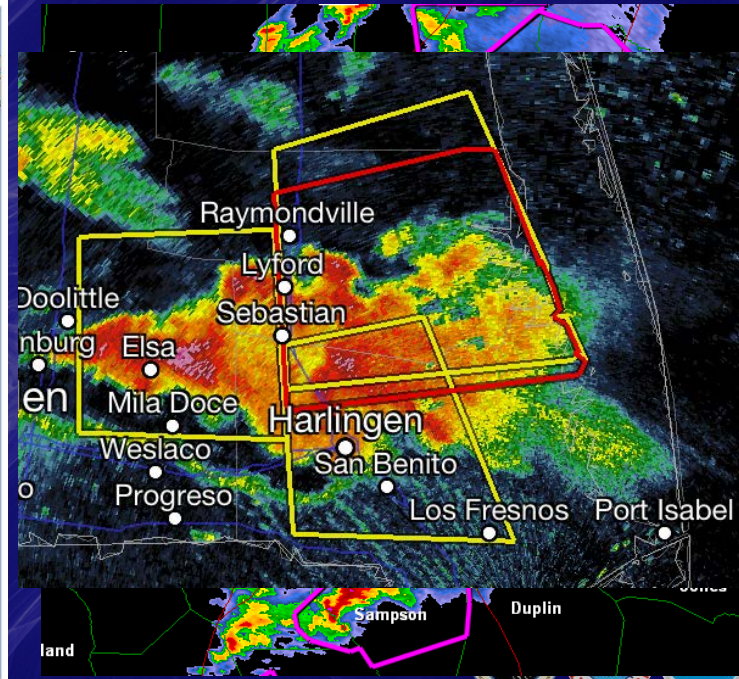
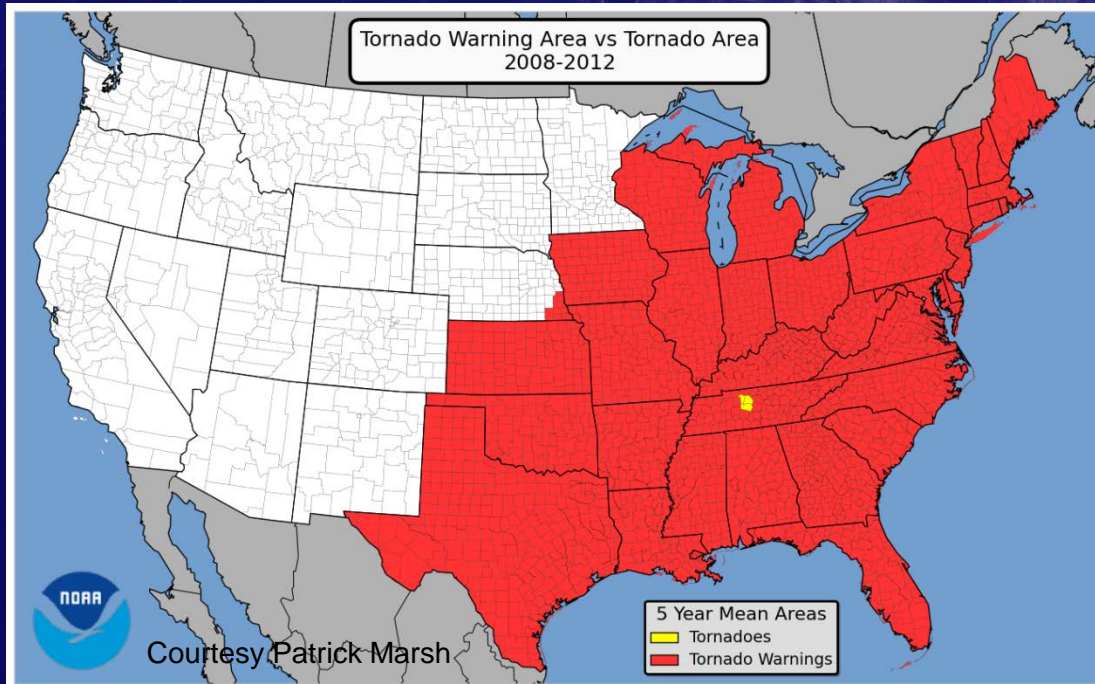
# Current Watch/Warning System “Challenges”

- Warning methodologies have changed little in over 40 years.
  - Except for “bullet format” and “storm-based” issuance.
- Society has changed...
  - Technology
  - Science
  - Social diversity
  - Lifestyles
  - Vulnerability

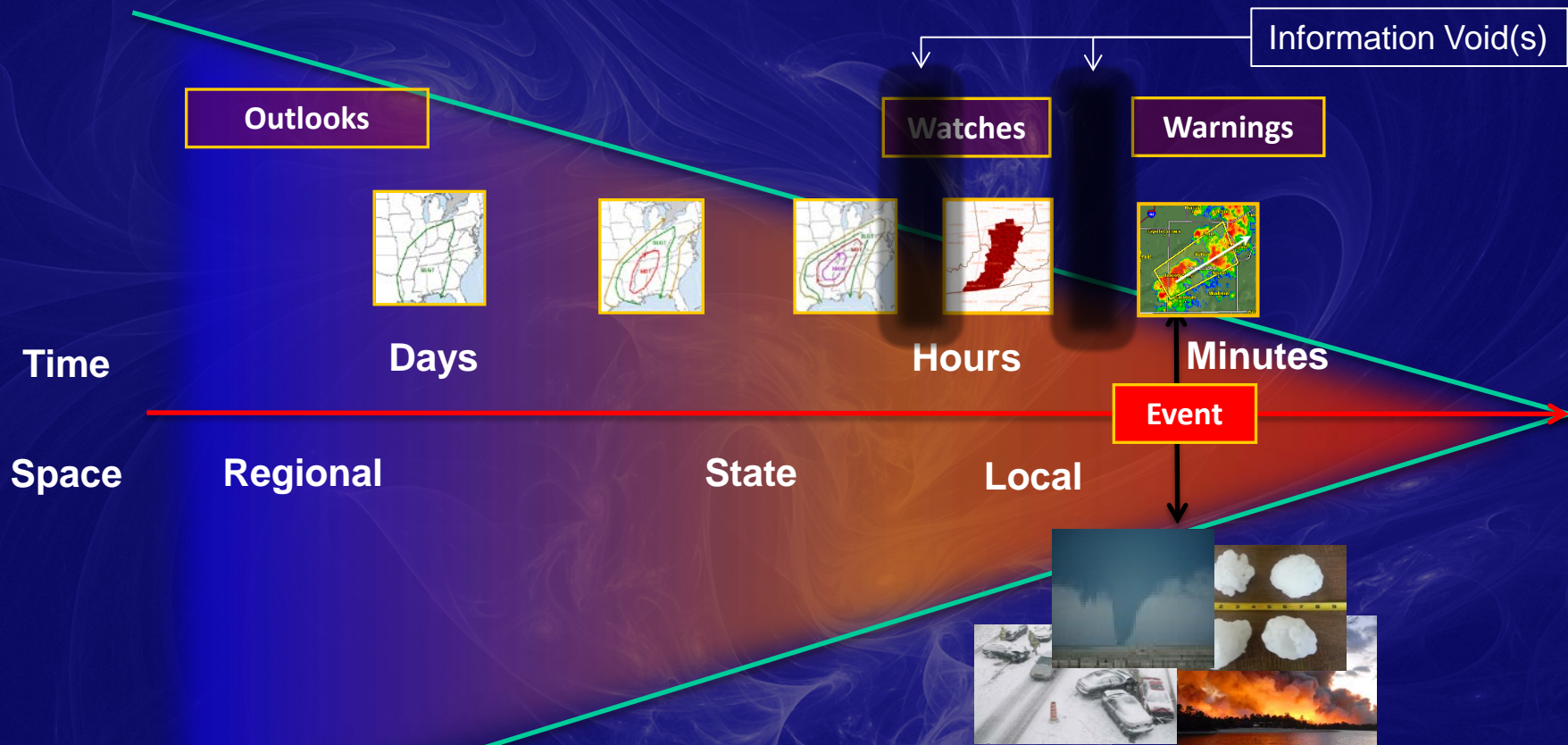


# Current Watch/Warning System “Challenges”

- Warning polygons are blunt instruments for communicating a dynamic, small-scale, multi-phenomenon threat.



# Current Watch/Warning System “Challenges”



- **Product-centric, deterministic (binary), and presumptuous.**
- **More information needed.**
- **More information available.**

Adapted from Dr. Heather Lazrus (NCAR)

# Seminal Question

## (Triggered by WRN)

- Should we continue addressing these challenges in an ad-hoc, piecemeal manner (i.e., tinker) ...

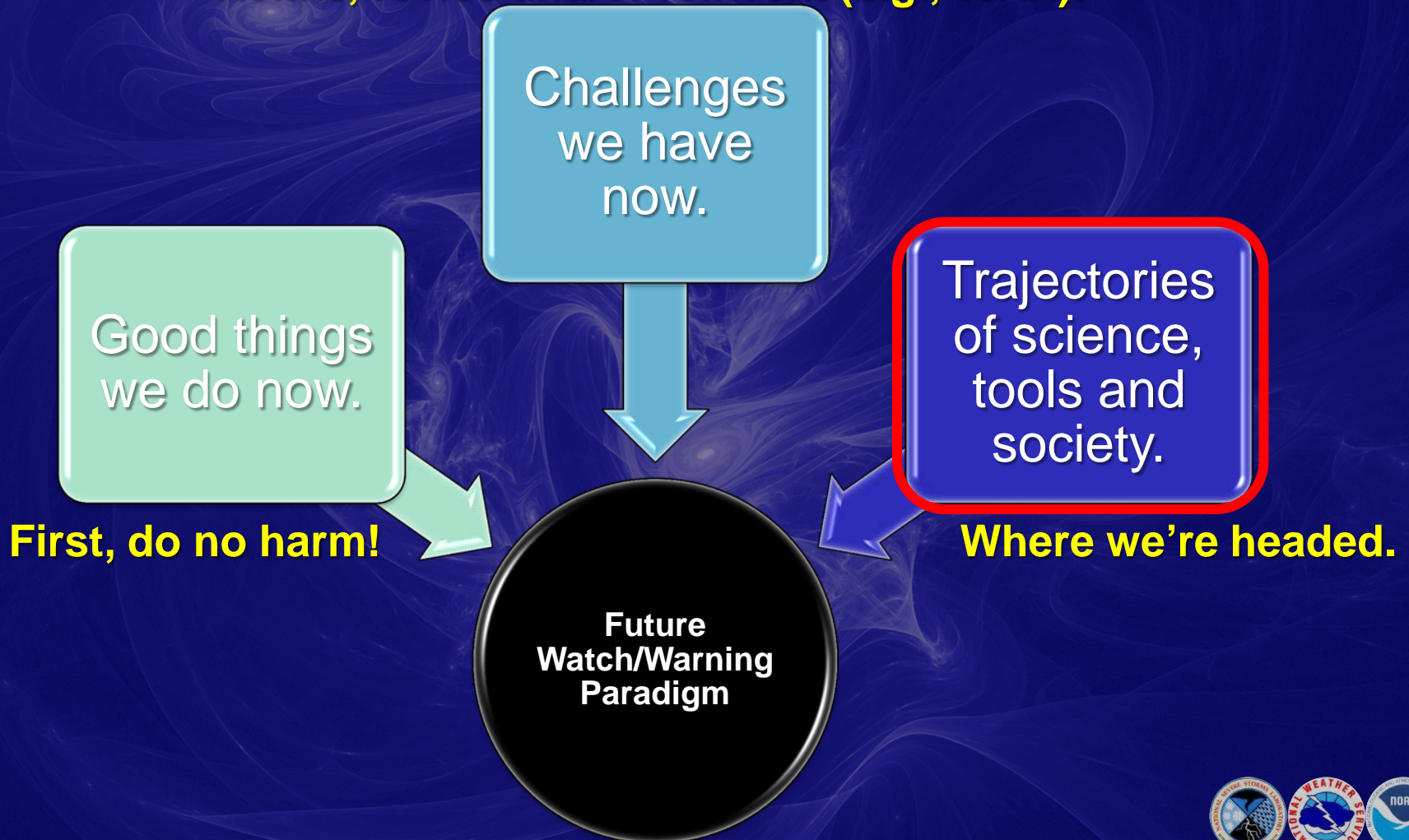
*...or develop a **new watch/warning paradigm** that addresses the challenges comprehensively (i.e., reinvent)?*

- Or, perhaps a little of both?



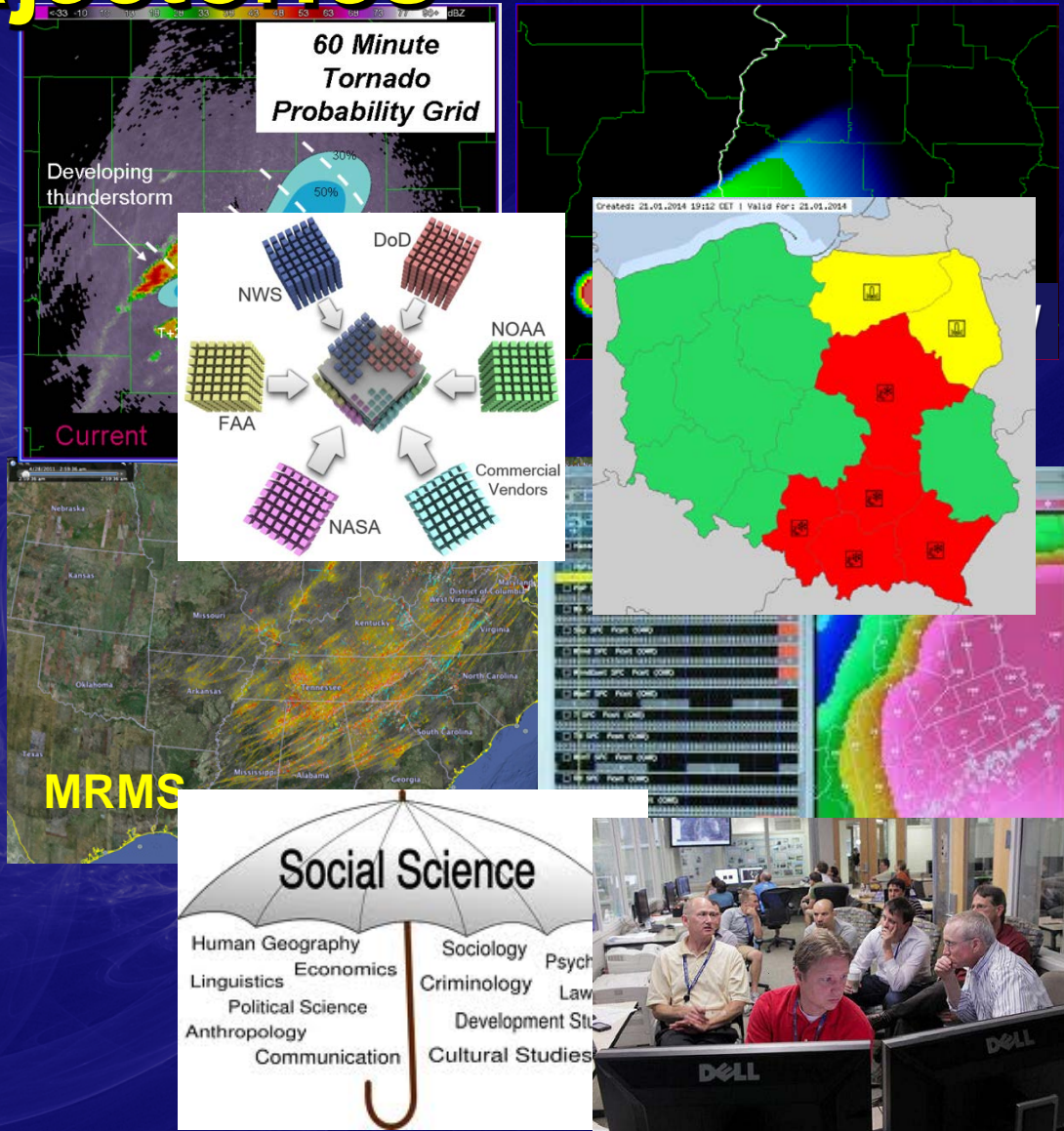
# Informing a Paradigm Shift

Refine, revise and/or reinvent (e.g., WRN).

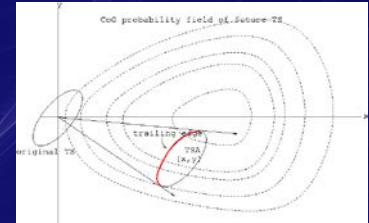
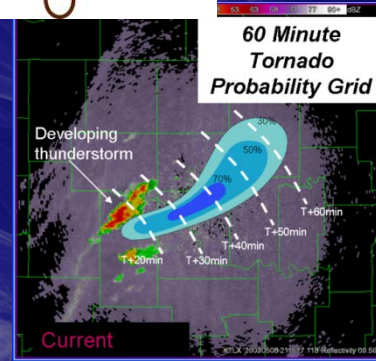
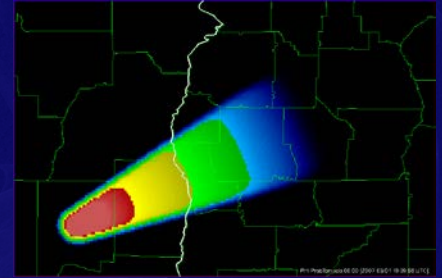
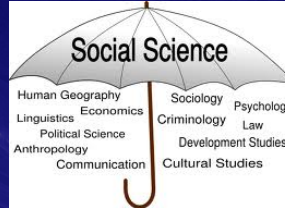
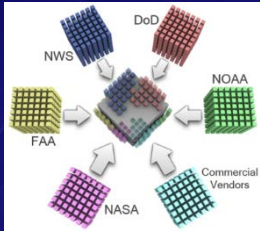


# Society, Science & Tech Trajectories

- Storm-scale models.
- The Grid!
  - *NWS already on it.*
    - But not severe ops.
- Social/Behavioral sciences.
- Alternatives to “Watch/Warning?”
- Exploration-friendly environment.
  - *Testbeds & Proving Grounds*



# The Primordial Soup



Winter Hazards Simplification



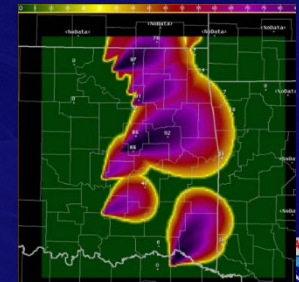
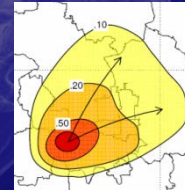
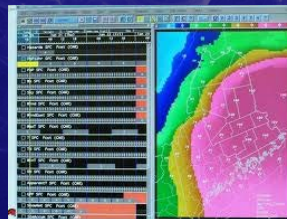
Confused by winter weather watches, warnings & advisories? Click here to help NWS simplify our products.



Mid-South Warning Improvement Project

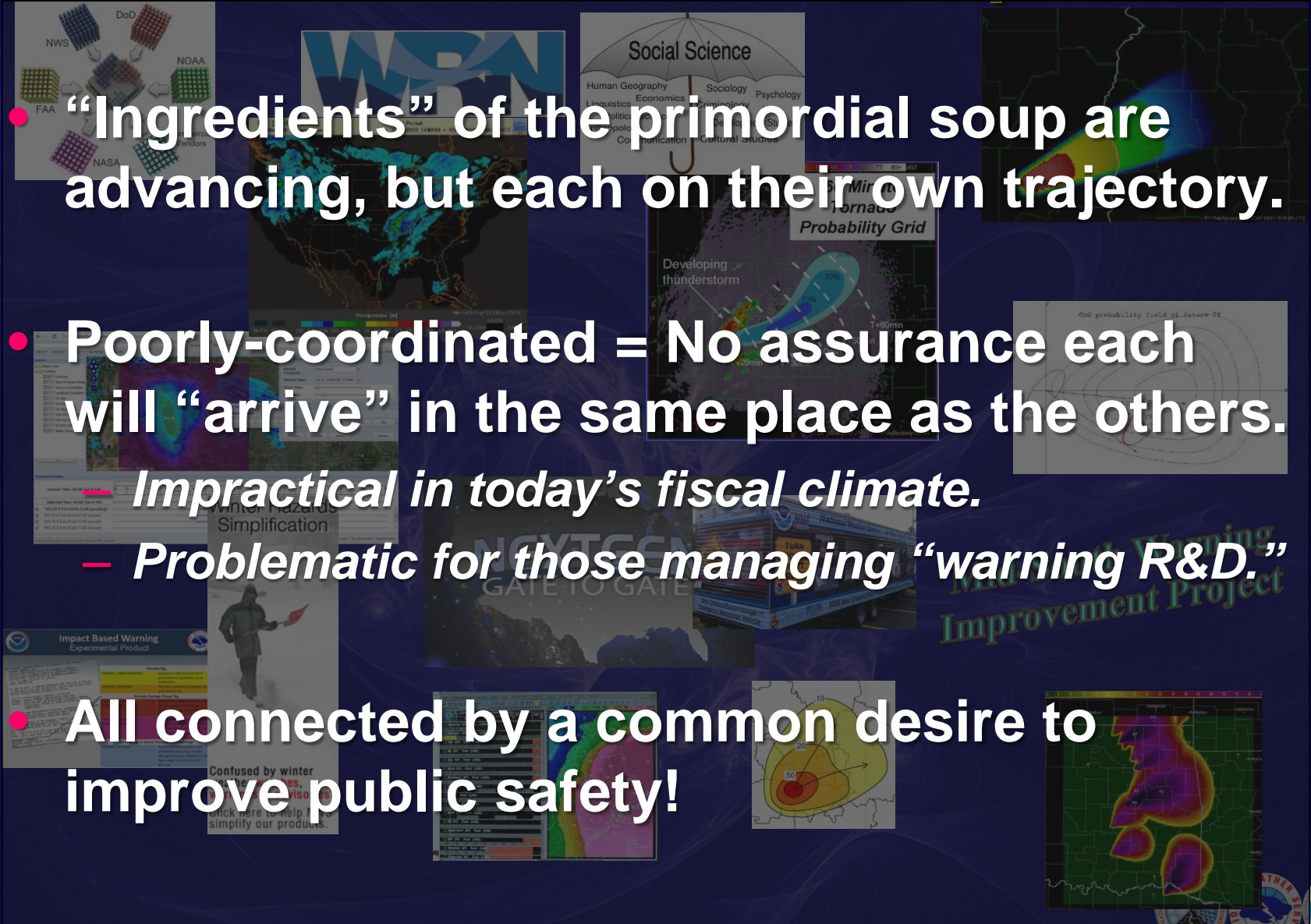
Impact Based Warning Experimental Product

Severity Key	Severity Key
Extreme	Extreme
Very High	Very High
High	High
Medium	Medium
Low	Low
Minor	Minor
Advisory	Advisory



# The Primordial Soup

- “Ingredients” of the primordial soup are advancing, but each on their own trajectory.
- Poorly-coordinated = No assurance each will “arrive” in the same place as the others.
  - Impractical in today’s fiscal climate.
  - Problematic for those managing “warning R&D.”
- All connected by a common desire to improve public safety!



# The Opportunity

- Given these challenges and trajectories, there is a need (and opportunity) to develop a **threat forecasting\*** paradigm that is...
  - *Modern*
  - *Effective*
  - *Scientifically robust*
  - *Holistic*
  - *Unifying*
  - *Enabling*

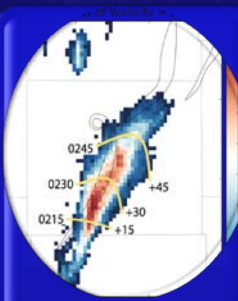
\*beyond watches & warnings



# Forecasting a Continuum of Environmental Threats



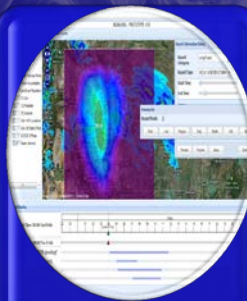
Grid-Based Probabilistic Threats



Observations & Guidance



The Forecaster



Threat Grid Tools



Useful Output



Effective Response



Verification Methods

Follows the flow of "The Warning Process"



# Facet #1: Grid-Based Probabilistic Threats

- The method or “nature” of watches and warnings.
  - *Now: Deterministic (binary), text-based messages created from polygons.*
  - *FACETs: Grid-based, probabilistic threats*



Grid-Based  
Probabilistic  
Threats

1

# Facet #1: Grid-Based Probabilistic Threats

**ACK!!!**

**Probabilities for the public?!**



**Grid-Based  
Probabilistic  
Threats**

**1**





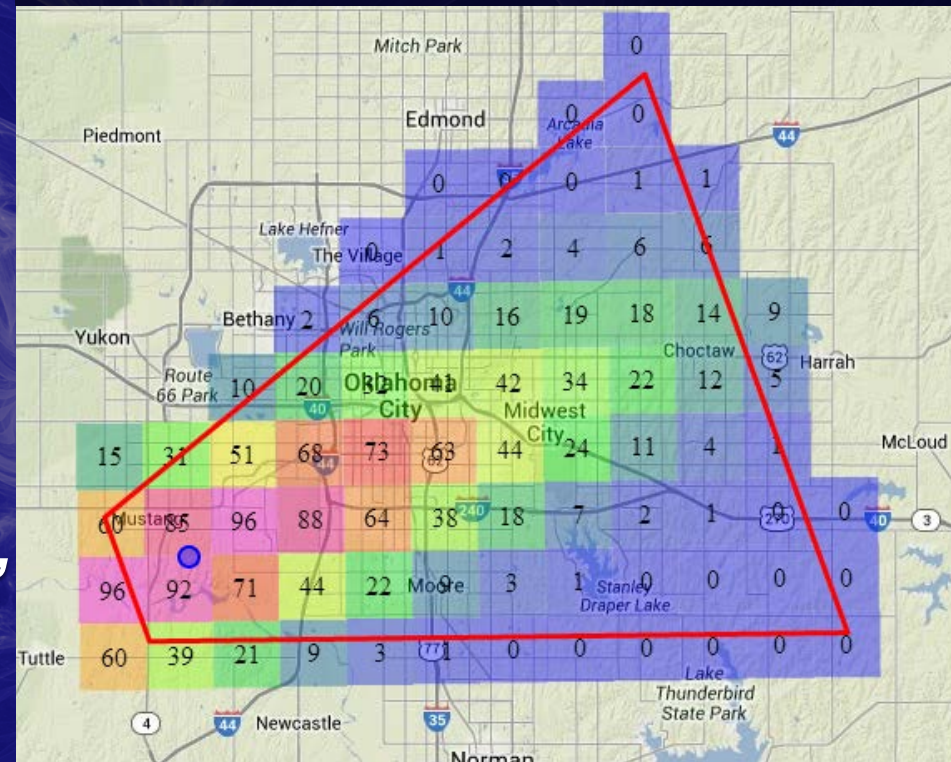
# Facet #1: Grid-Based Probabilistic Threats

- Probabilistic Hazard Information (PHI)
  - Forecasters convey threat probability on grids.
  - NOT (explicitly) watches or warnings, but...

## 30-Minute Threat: Tornado Probability

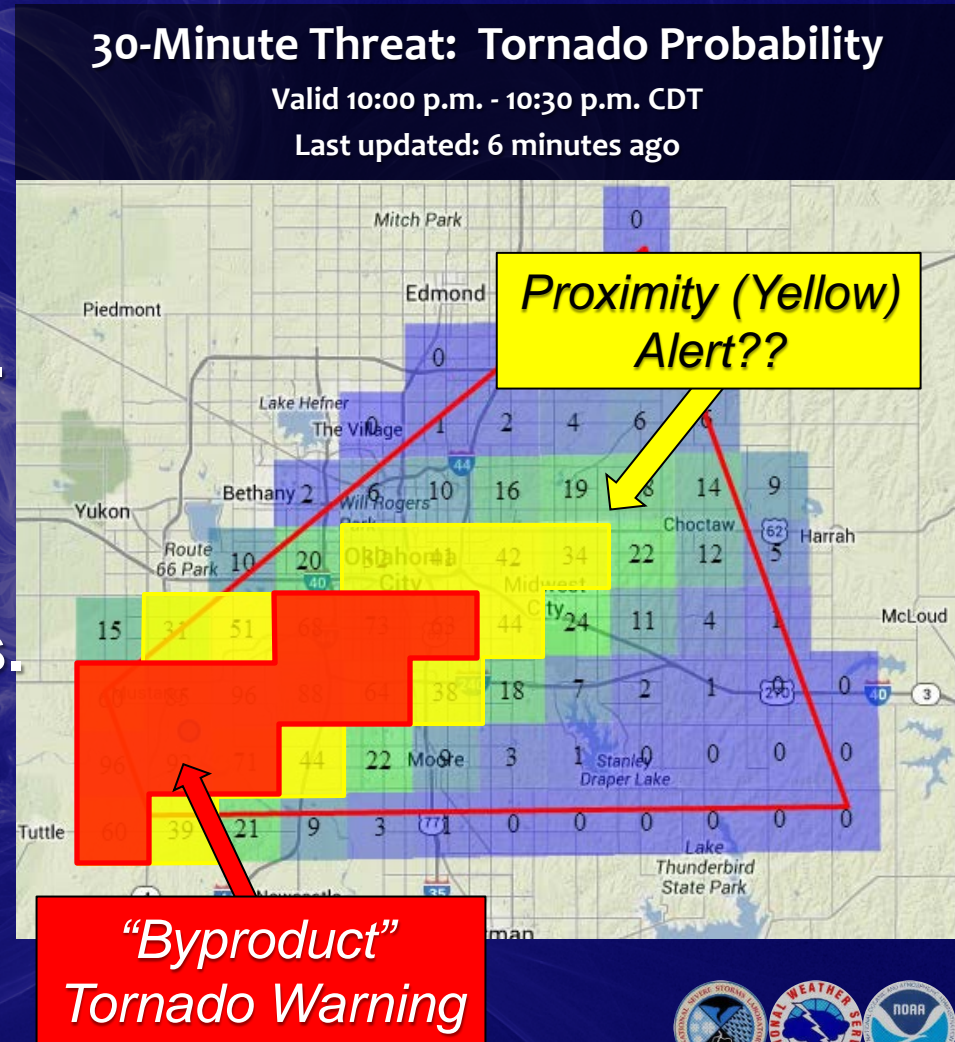
Valid 10:00 p.m. - 10:30 p.m. CDT

Last updated: 6 minutes ago



# Facet #1: Grid-Based Probabilistic Threats

- Legacy products (watches/warnings) result from pre-determined thresholds.
- Enables new products and messages.
- Not only severe storms.
  - Winter storms, fire weather, flooding, etc.



# The FACETs Continua

Temporal (Days to Seconds)



Day 8

Tornado Probability



Phenomenological  
(ALL threats)

Spatial



Also...

- Impacts (minor to catastrophic)
- Technologies (legacy to modern)
- Sophistication (simple to advanced)
- Products (Outlooks to warnings)

Created By: C. Karstens (C...)

0

20

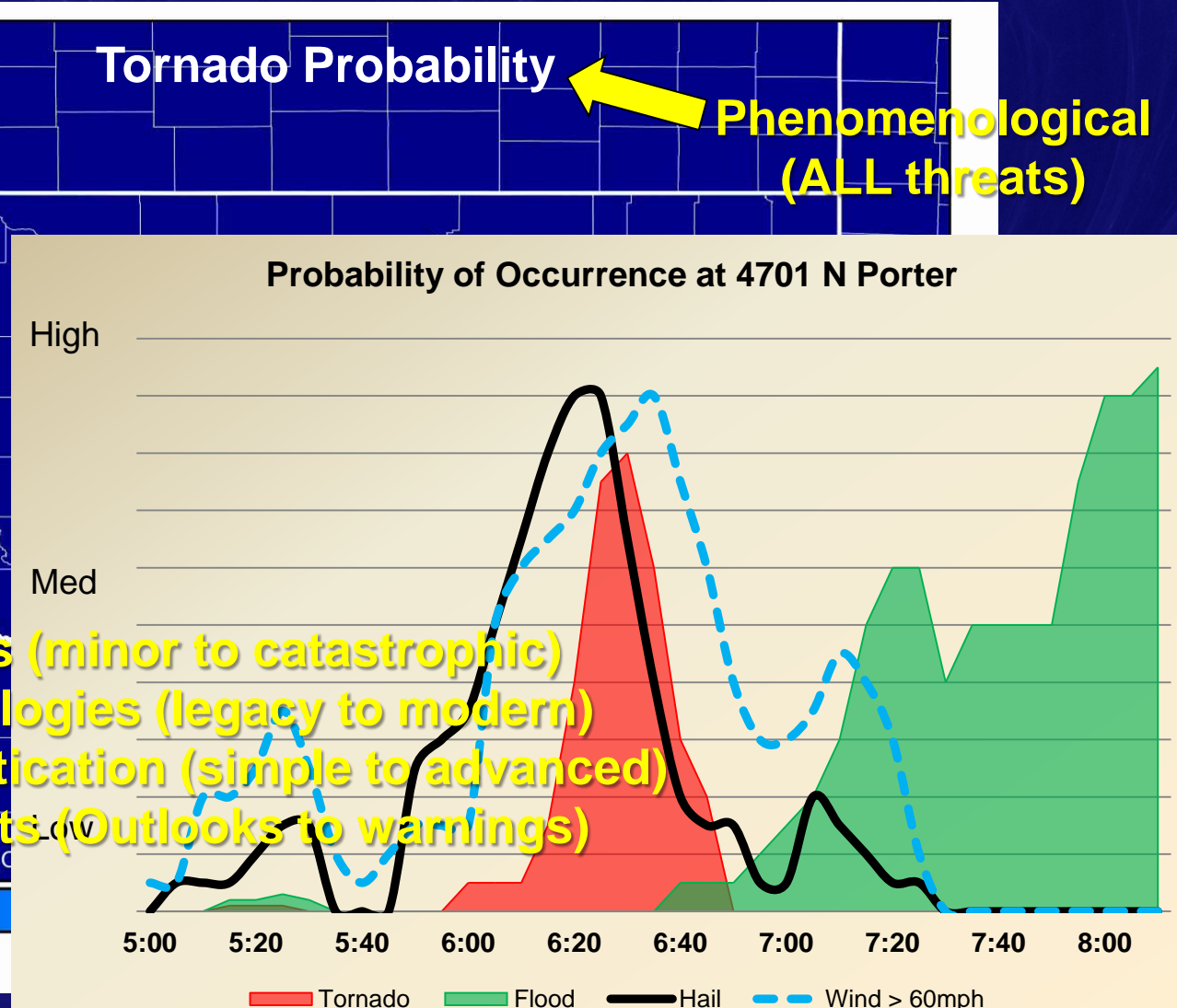
Probability of Occurrence at 4701 N Porter

High

Med

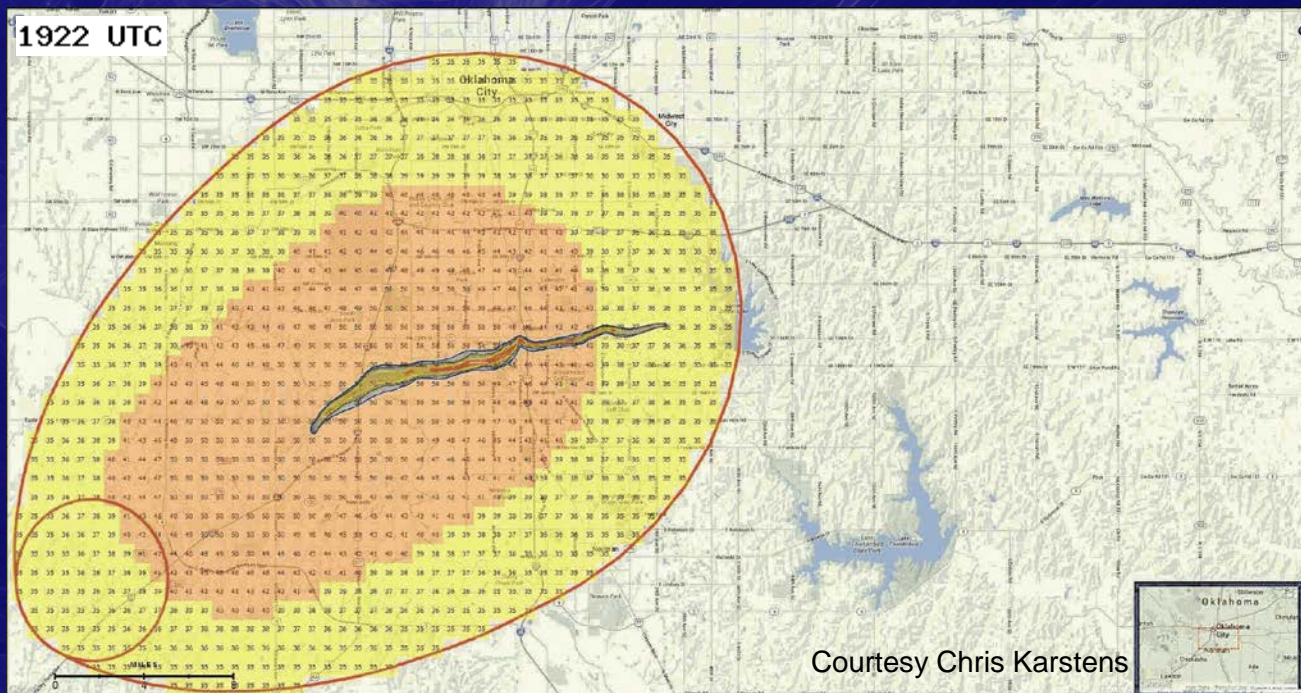
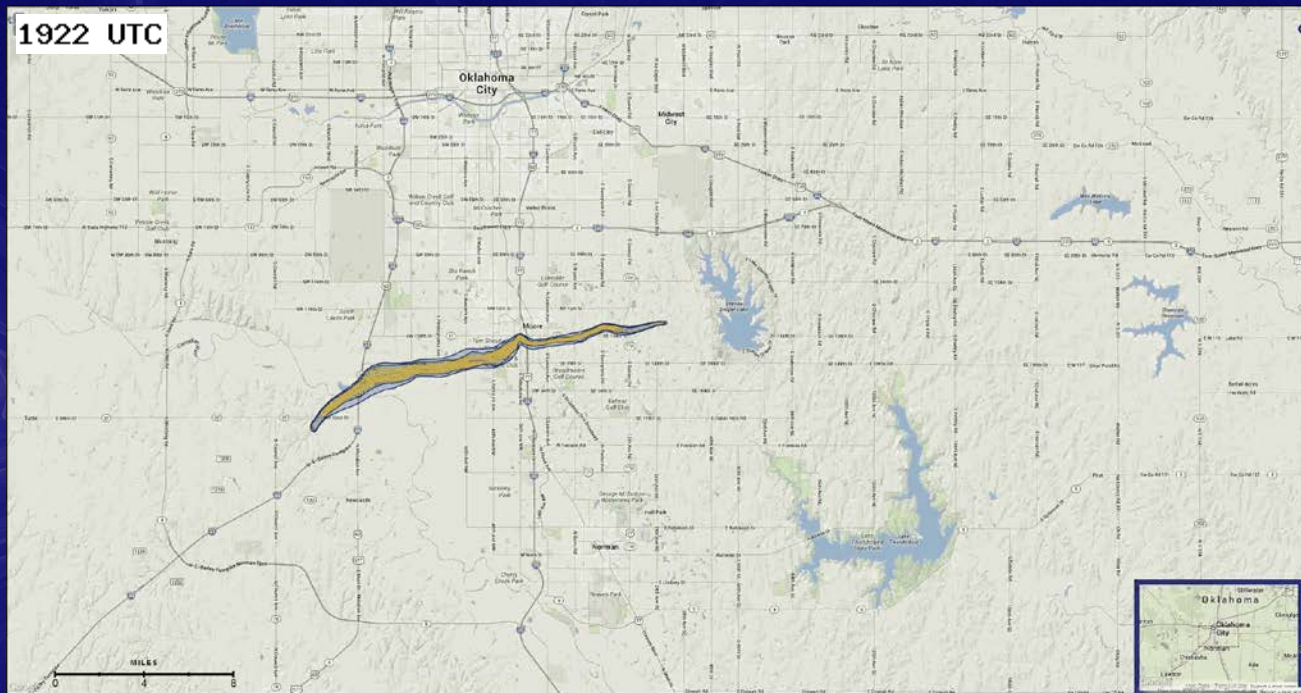
5:00 5:20 5:40 6:00 6:20 6:40 7:00 7:20 7:40 8:00

Tornado Flood Hail Wind > 60mph



# FACETs PHI\* Comparison: Newcastle/Moore Tornado

- Don't think “product-centric, deterministic warnings.”
- Think “continuous flow of relevant, actionable information.”



\*Probabilistic Hazard Information

Courtesy Chris Karstens

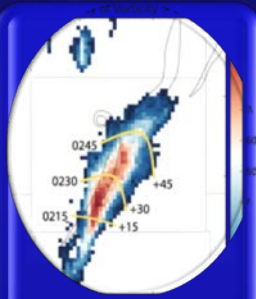
# Facet #2: Obs & Guidance

- What forecasters use to make decisions.
  - *Radar, satellites, models, observations, other forecasters, etc.*



**Grid-Based  
Probabilistic  
Threats**

**1**

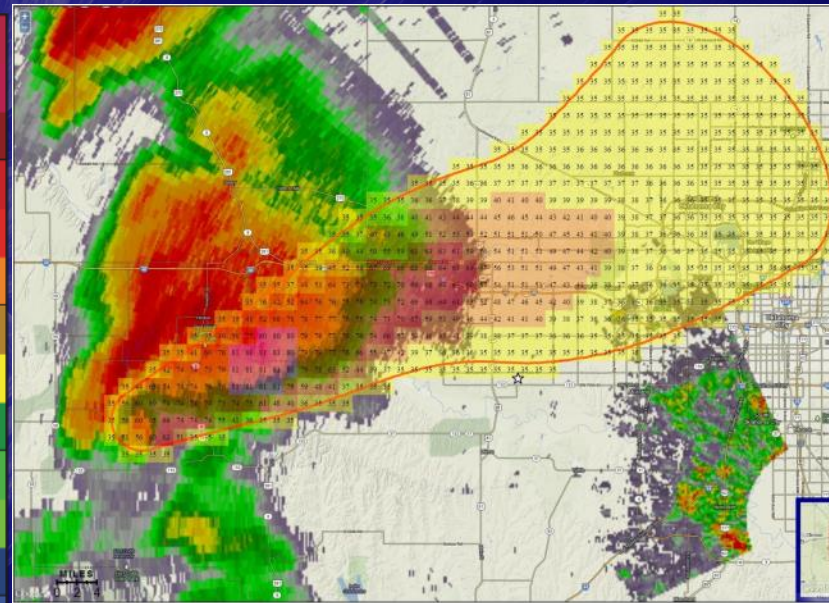
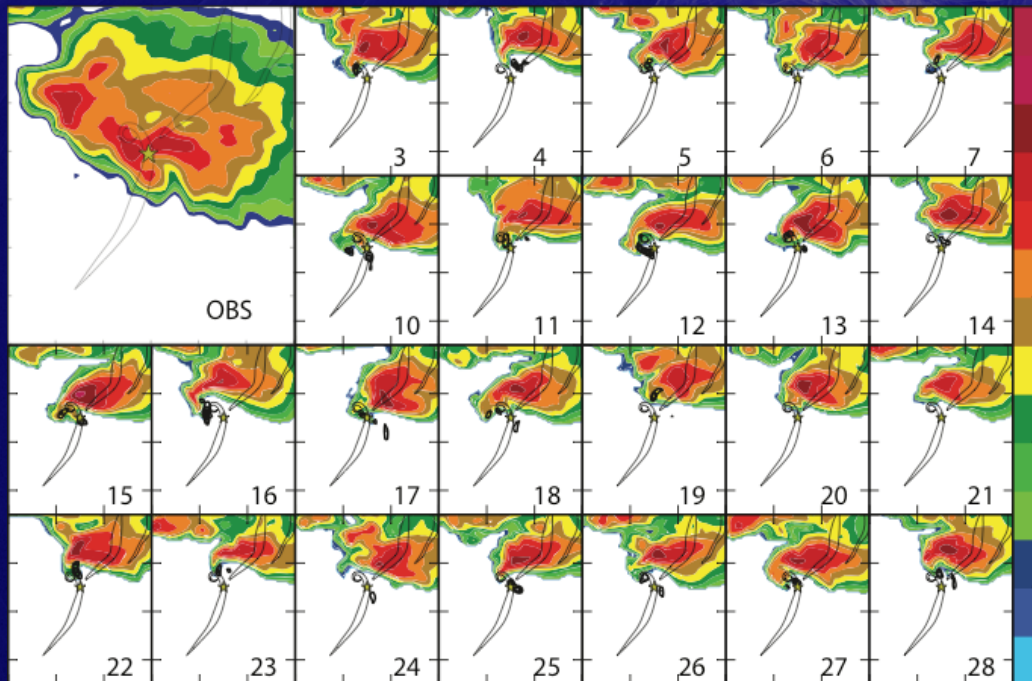


**Observations  
& Guidance**

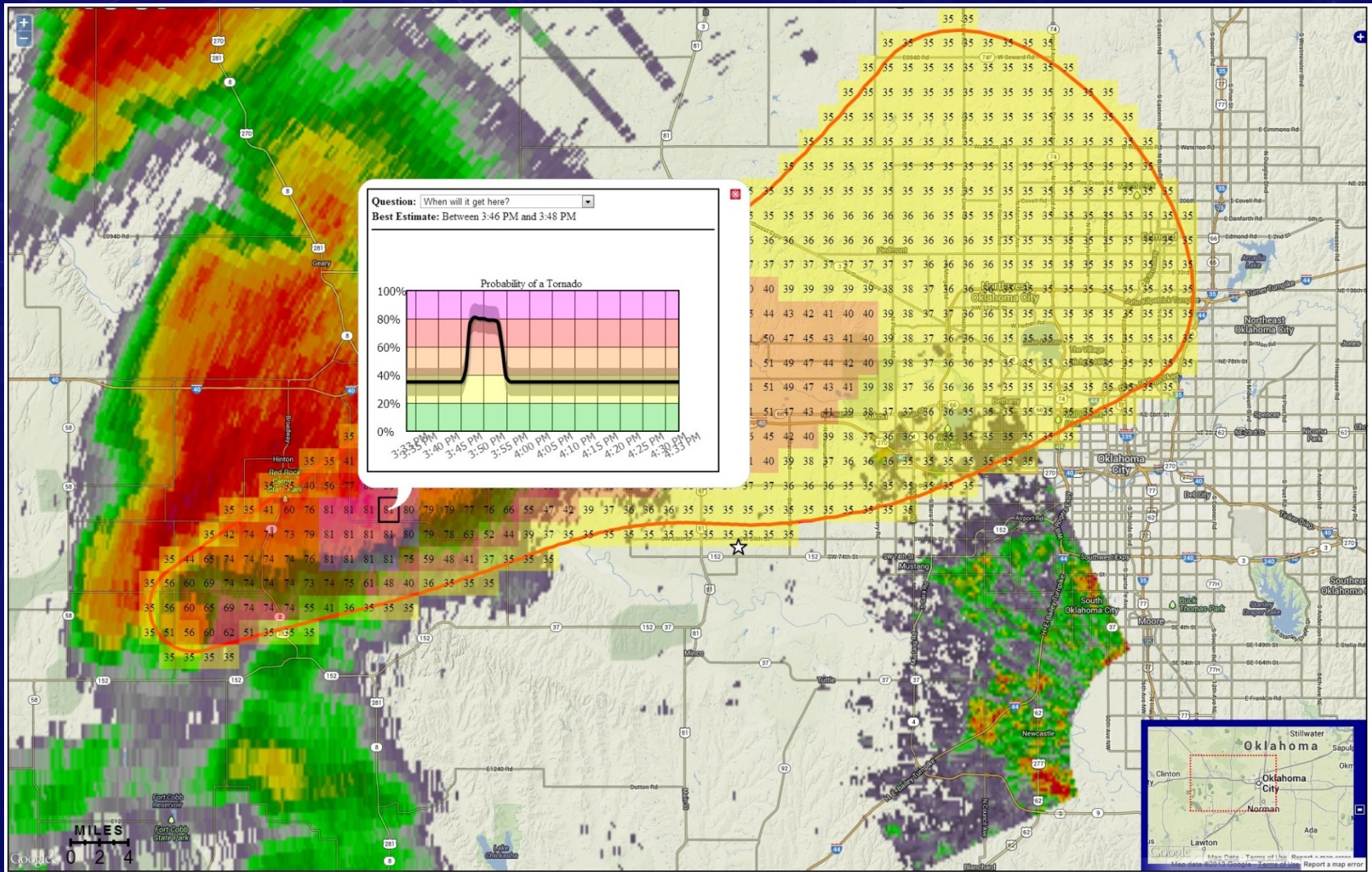
**2**

# Facet #2: Obs & Guidance

- Warn on Forecast
  - Storm-scale model output... then what?!
  - FACETs is the “**delivery mechanism**” for WoF-generated probabilistic output.



# MPAR + WoF + FACETS



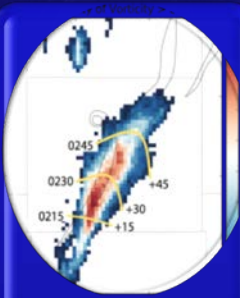
# Facet #3: The Forecaster

- The person making the watch/warning decisions.
  - *Knowledge, skills and abilities.*
  - *The human brain (wetware).*



Grid-Based  
Probabilistic  
Threats

1



Observations  
& Guidance

2



The  
Forecaster

3



# Facet #3: The Forecaster

- Forecasters over the grids!!
  - *As essential as ever to the ENTIRE warning process.*
- New paradigm = new training!
  - *Data management*
  - *Probabilistic threat information.*
  - *Uncertainty conveyance.*
  - *New guidance.*
  - *Best practices.*
  - *Tool use, etc.*



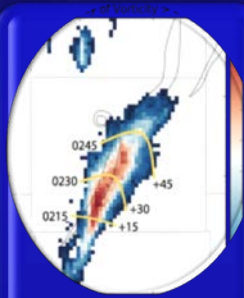
# Facet #4: Threat Grid Tools

- What forecasters use to create the hazard information.
  - *Hardware & software.*



Grid-Based  
Probabilistic  
Threats

1



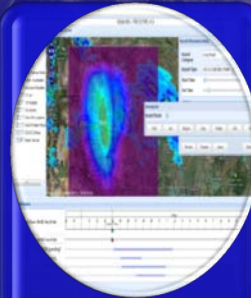
Observations  
& Guidance

2



The  
Forecaster

3



Threat Grid  
Tools

4

# Facet #4: Threat Grid Tools

**Prototype Probabilistic Hazard Information (PHI) Tool**

Product: Reflectivity | 7.9 | <-33 | -10 | 10 | 30 | 35 | 38 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 77 | 80° | dBZ

User: chris.karstens | Case: 20110524 - KTLX

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**Hazard Information**

Threat Probabilities | Background Probabilities | Display

Threat ID: 0  
 Threat(s): Tornado (EFD+) | Add Threat

Valid Start Time: 20:30:14 UTC

Forecast Time: +0 min.

Max Lead Time: 60 min.

Recommenders: <-Choose->

Initial Motion Vector: 244° @ 54 kts | Preview Grid

---

**Direction Uncertainty Evolution**

P(Tornado) 45°

Speed 34°

Speed (?) 23°

Direction 11°

Direction (?)

UNDO REDO

---

Warning Decision Discussion: Use For Speech ->

Recognized text will be copied here (or type manually).

Activate Threat

---

**Hazard Services Console**

Time: 2011-05-24 20:32:42 Z | Slider: 2011-05-24 20:30:14 Z

Event ID	Hazard Type	State	Start Time	End Time
0	TOR.W	Pending	24-May 20:30 Z	24-May 21:30 Z

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**Map Interface**

Map showing a threat grid over Oklahoma City and surrounding areas. The grid is color-coded by reflectivity (dBZ) from blue (low) to red (high). A red line indicates the threat path, and a red circle highlights a specific threat area at 20:30:14 UTC. The map includes a scale bar (0 to 12 miles) and an inset map of Oklahoma.

**Vertical Scale**

00.51  
00.90  
01.30  
01.80  
02.40  
03.10  
04.00  
05.10  
06.40  
08.00  
10.00  
12.50  
15.60  
19.50  
23.37  
28.20  
34.25  
42.80  
52.90

show  
Scales: 0, 1, 2, 3  
show  
Wof: show



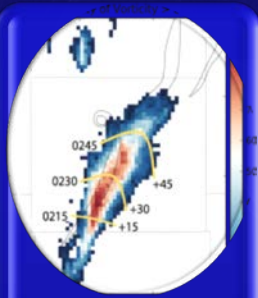
# Facet #5: Useful Output

- What the end user sees and hears.
  - *Graphical, textual, auditory, digital, etc.*



Grid-Based  
Probabilistic  
Threats

1



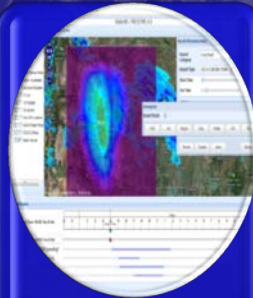
Observations  
& Guidance

2



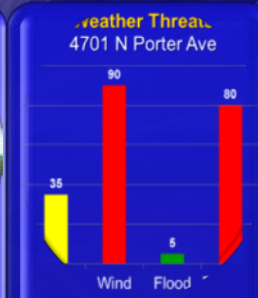
The  
Forecaster

3



Threat Grid  
Tools

4



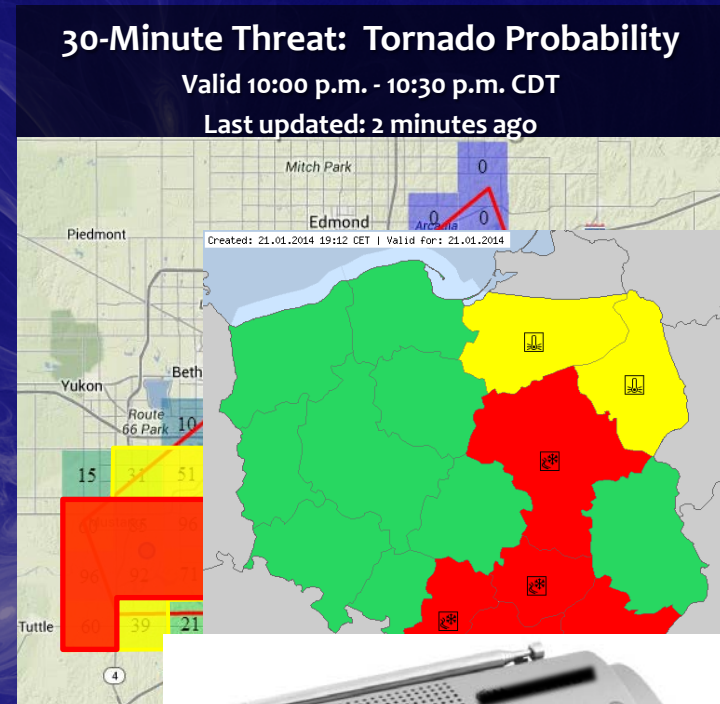
Useful  
Output

5

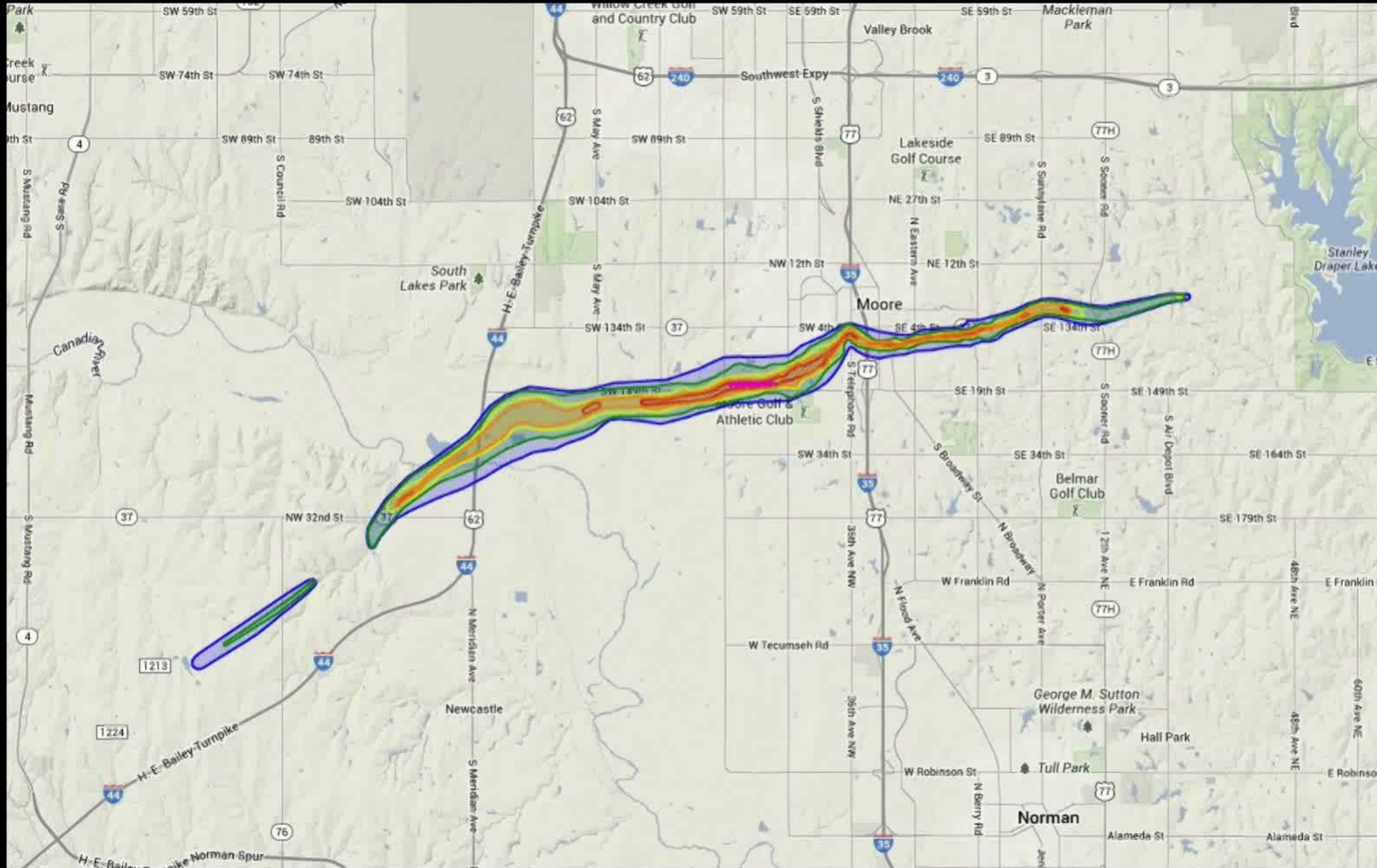


# Facet #5: Useful Output

- “GYRE” Messaging
  - *Green (No threat)*
  - *Yellow Alert for...*
    - Do not travel!
  - *Red Alert for...*
    - Take shelter now!
  - *Emergency Alert for...*
- After Canada & “Meteoalarm” in Europe.
- SocSci pointing this direction.



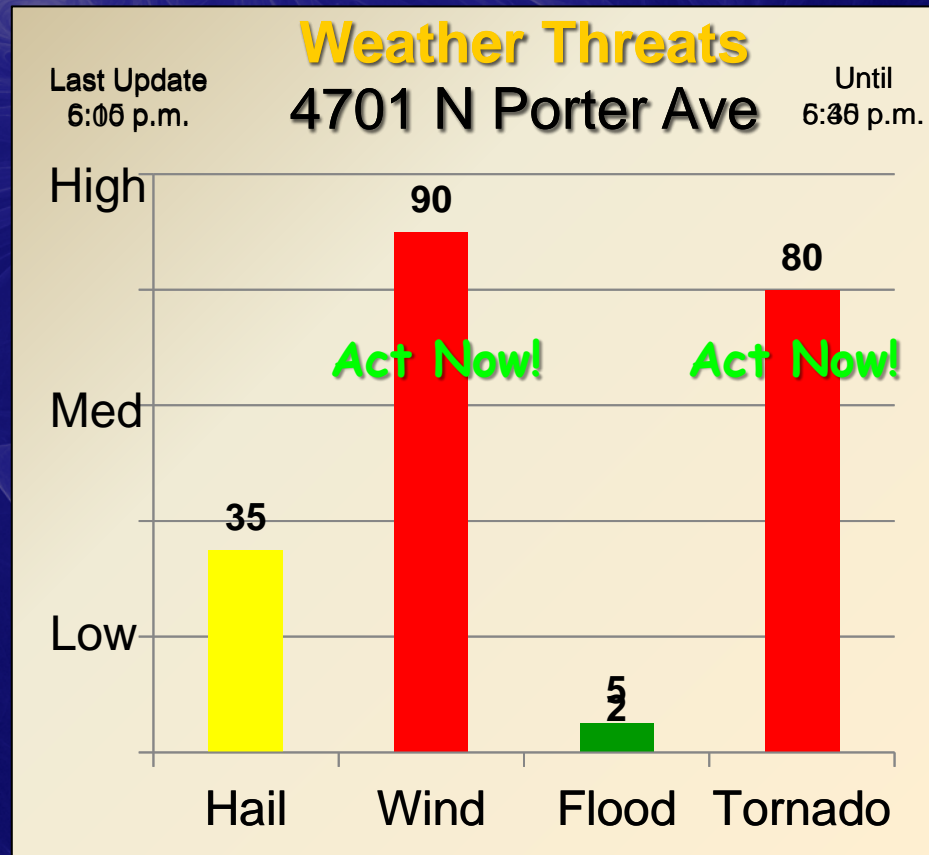
# Facet #5: Useful Output



Tornado  
Threat  
Meter



# Facet #5: Useful Output



*Phone App Example*





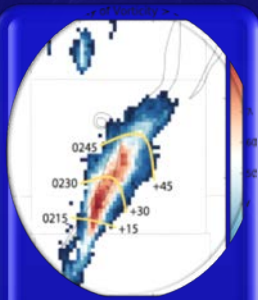
# Facet #6: Effective Response

- What the end user does.
  - *The science/human interface.*
  - *The most important facet.*
  - *Where social/behavioral sciences pay off.*



Grid-Based  
Probabilistic  
Threats

1



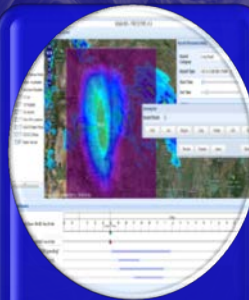
Observations  
& Guidance

2



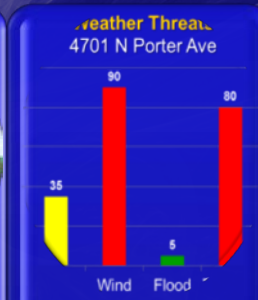
The  
Forecaster

3



Threat Grid  
Tools

4



Useful  
Output

5



Effective  
Response

6

# Facet #6: Effective Response

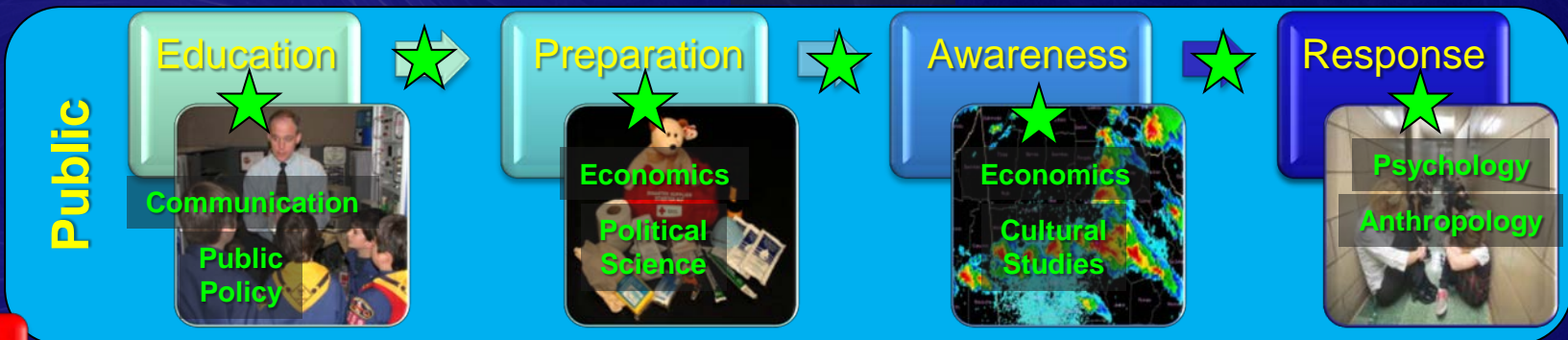
- “Learn how people respond to weather information & threats, accept that reality, and then build the system to work within that reality and still achieve the desired outcomes.”

*- Jeff Lazo, NCAR*

# Integrated Social, Behavioral & Physical Sciences

Sociology  
Psychology  
Economics  
Anthropology

Sociology  
Law



**The Impact**



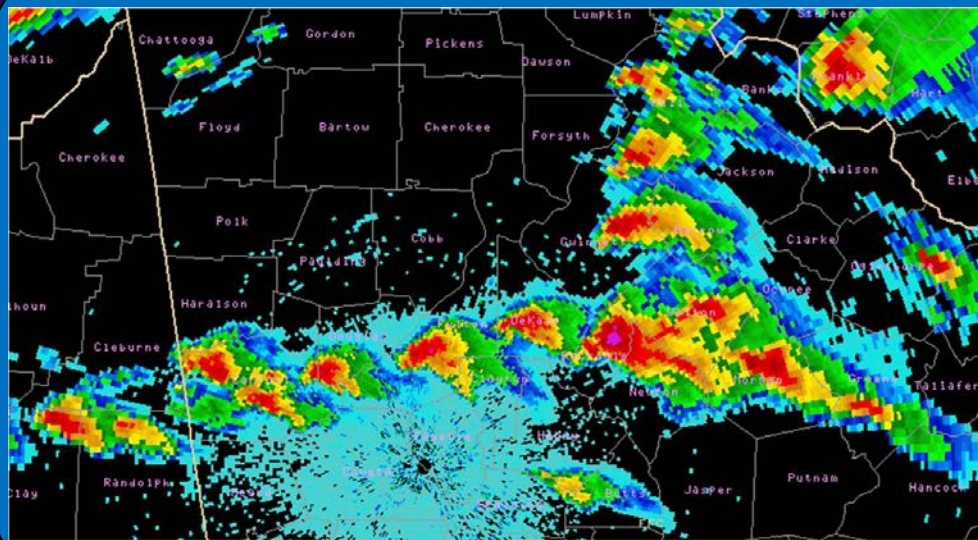
Human Geography  
Cultural Studies

## The FACETs Epoxy: Integrated Social, Behavioral and Physical Sciences

Linguistics



# Weather Hazards: Two Frames of Reference



**Us**

**Most research focused here.**

**“You”**

**More focus needed here.**

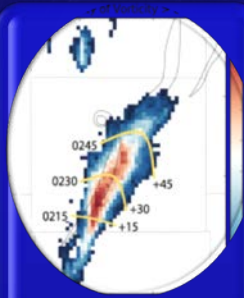
# Facet #7: Verification

- Evaluating system effectiveness.
  - *Measuring more than just forecast skill...*
  - *...measure the response, too!*



Grid-Based  
Probabilistic  
Threats

1



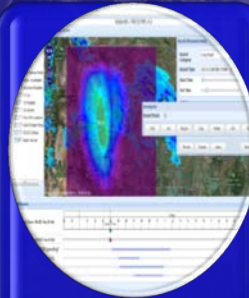
Observations  
& Guidance

2



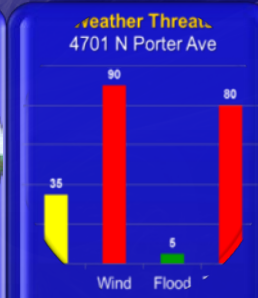
The  
Forecaster

3



Threat Grid  
Tools

4



Useful  
Output

5



Effective  
Response

6

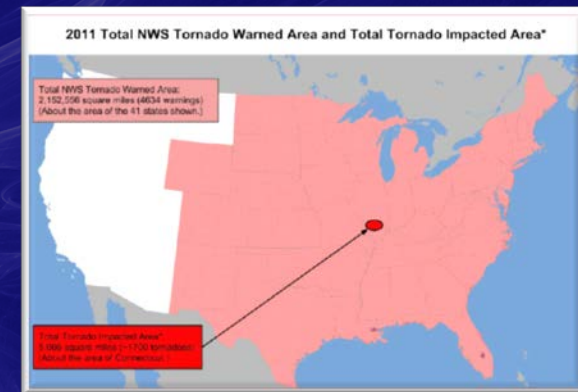
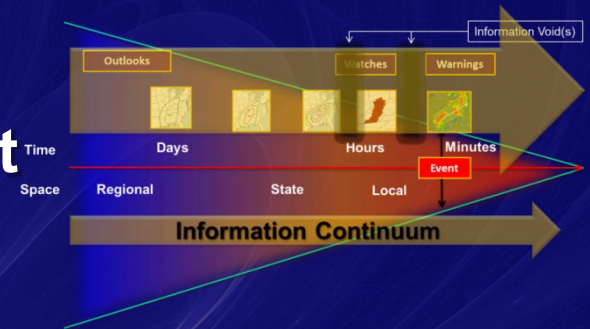


Verification  
Methods

7

# Expected FACETs Benefits

1. A fully-integrated information continuum of threat forecasts;
2. “False Alarm Area” reduced by at least 30%;
3. A WoF delivery mechanism.
4. WRN-identified issues addressed through reinvention vs. tinkering.
5. New private sector opportunities.
6. More useful, actionable, and recipient-specific information.



# In Summary...

- **FACETs is...**

- 1** ... *A new watch/warning paradigm (grid-based threats);*

- 2** ... *A framework intended to organize and guide reinvention efforts.*

- ... *A means of improving and enhancing NWS high-impact weather forecasting services.*

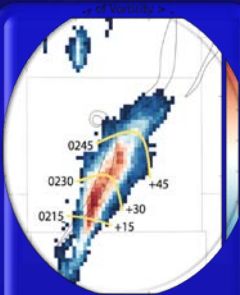


Lans P. Rothfus  
Warning R&D Division  
NOAA/OAR/NSSL

[lans.rothfusz@noaa.gov](mailto:lans.rothfusz@noaa.gov)  
678-665-7049



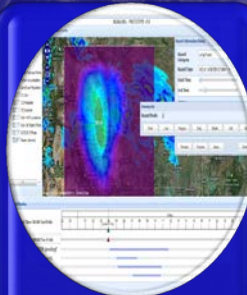
**Grid-Based  
Probabilistic  
Threats**



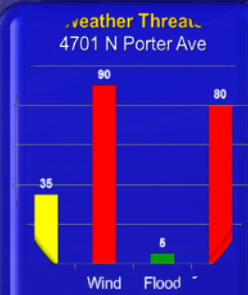
**Observations  
& Guidance**



**The  
Forecaster**



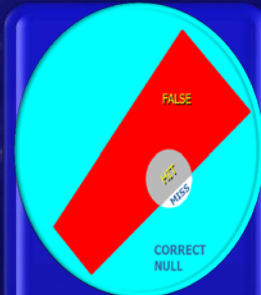
**Threat Grid  
Tools**



**Useful  
Output**



**Effective  
Response**



**Verification  
Methods**

