



FACETs: A Next-Gen Forecasting Paradigm for High-Impact Weather

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October 24, 2015

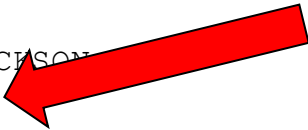




Anything Wrong with This Warning?

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

40+ years ago!!



- *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.

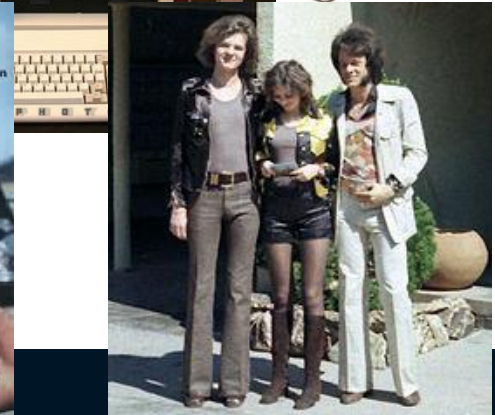
PRECAUTIONARY/PREPAREDNESS ACTIONS...

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.

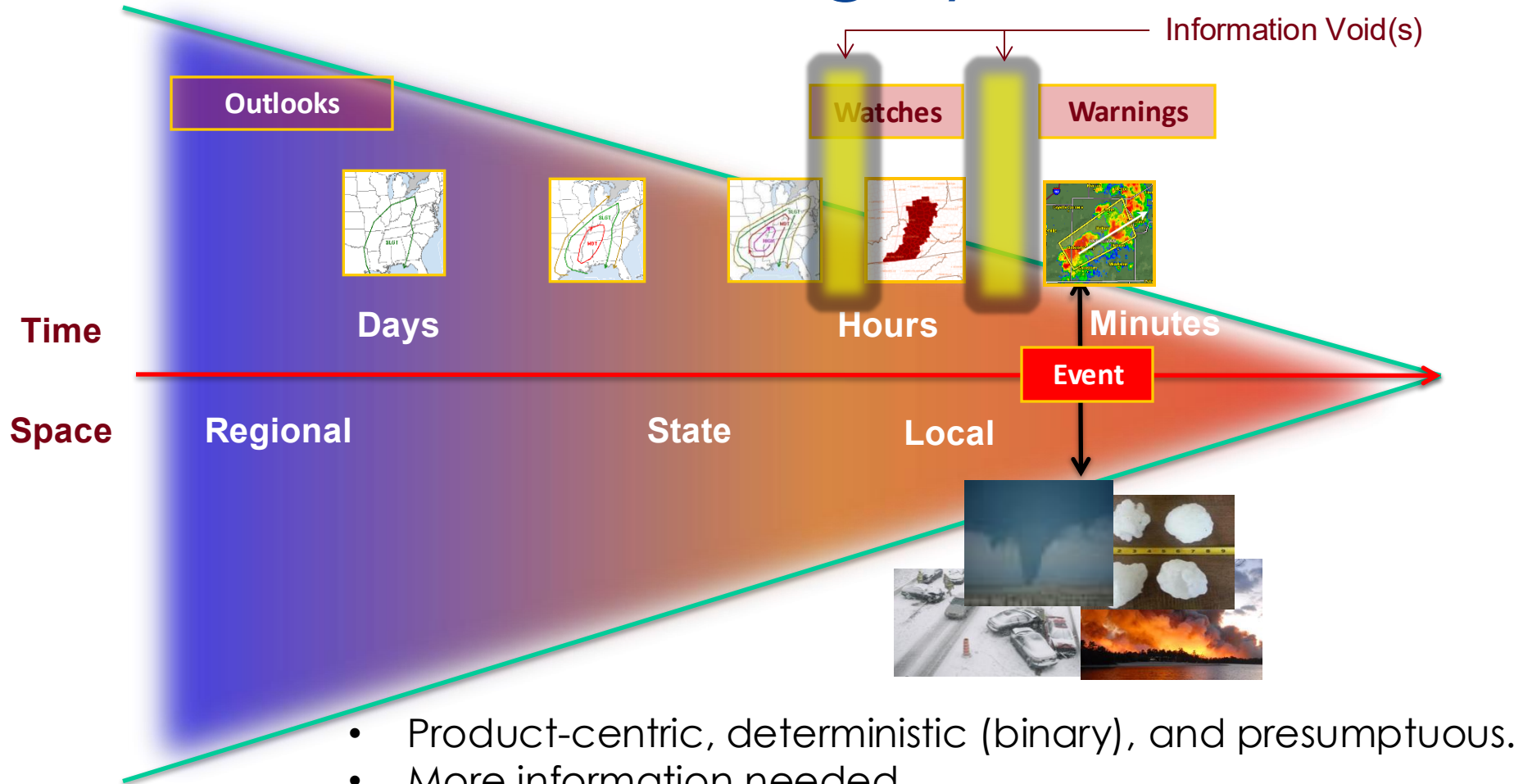


The Current Warning System

- Warning methodologies have changed little in over 40 years.
- What HAS changed in the past 40 years?
 - Technology
 - Science
 - Social diversity
 - Lifestyles
 - Vulnerability



The Current Warning System

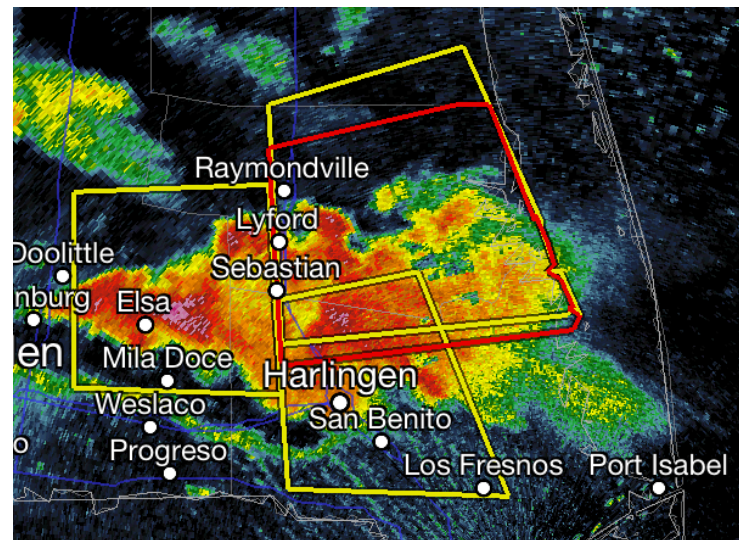
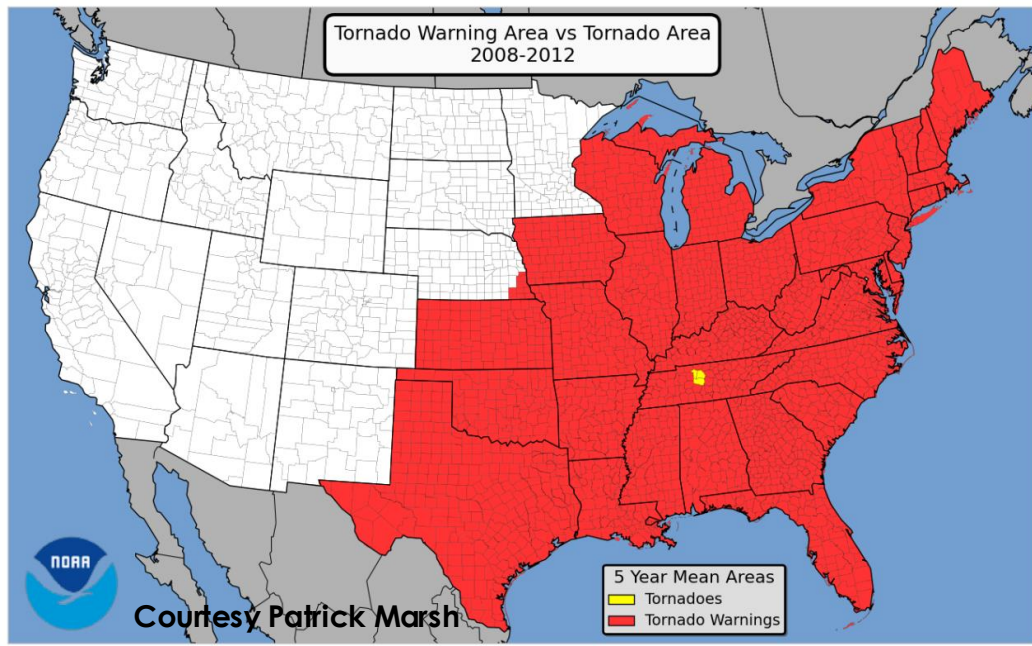


- Product-centric, deterministic (binary), and presumptuous.
- More information needed.
- More information available.



The Current Warning System

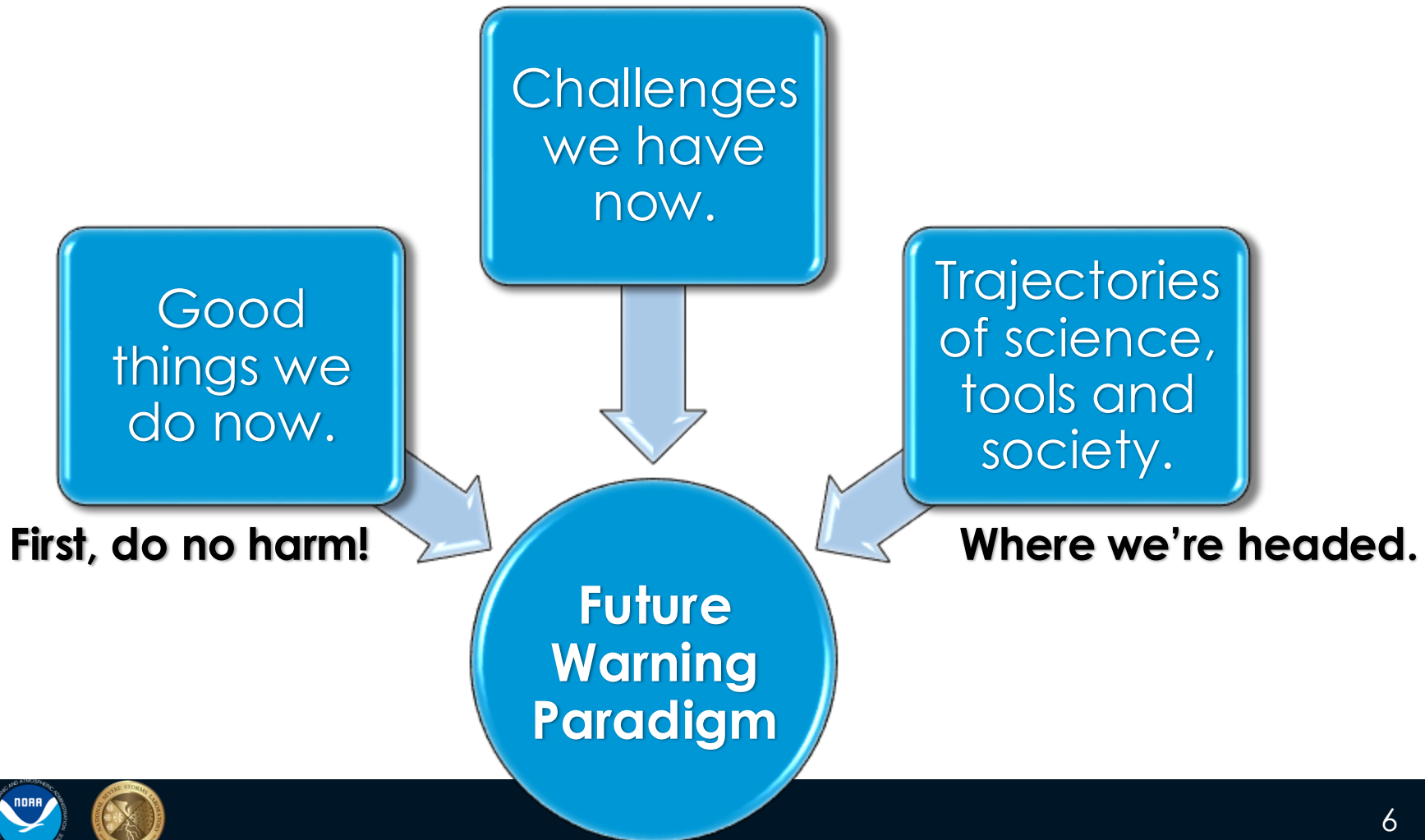
- Warning polygons are messy!
- Inherently “binary” (on/off; in/out)
- Large false alarm area.





Informing a Paradigm Shift

Refine, revise and/or reinvent.





FACETs Video

- [Video](#)



FACETs Is...

- Forecasting a Continuum of Environmental Threats
- A **modernization** of NOAA's current teletype-era, deterministic (binary), product-centric paradigm.
- Focused on entire forecast/warning process.



GRID-BASED
THREAT
PROBABILITIES



OBSERVATIONS
& GUIDANCE



THE
FORECASTER



THREAT GRID
TOOLS



USABLE
OUTPUT



EFFECTIVE
RESPONSE

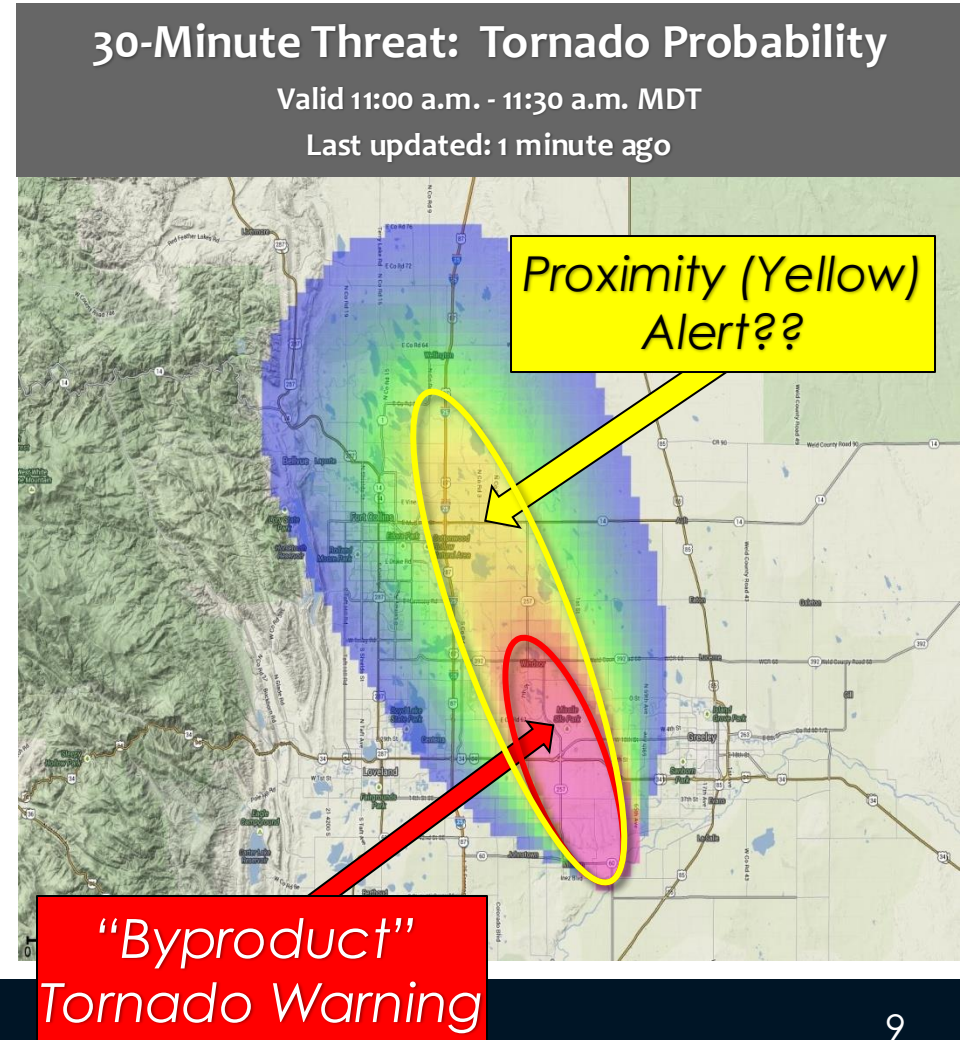


VERIFICATION



Facet #1: Changing the Starting Point

- Move from “binary” polygons to **Probabilistic Hazard Information (PHI)**
 - Grid-based threat probabilities.
 - Legacy warnings “fall out.”
 - New messages possible.
 - Not only for tornadoes.
 - Tropical, winter, hail, lightning, flooding, aviation, etc.

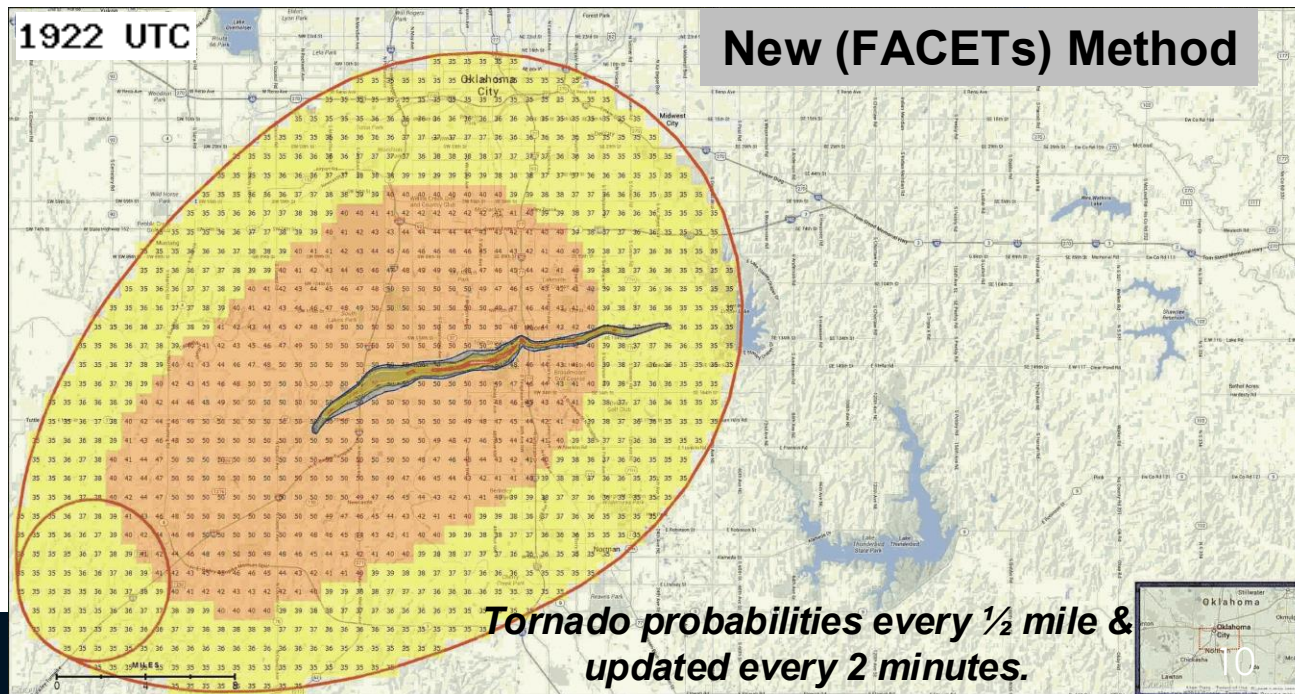
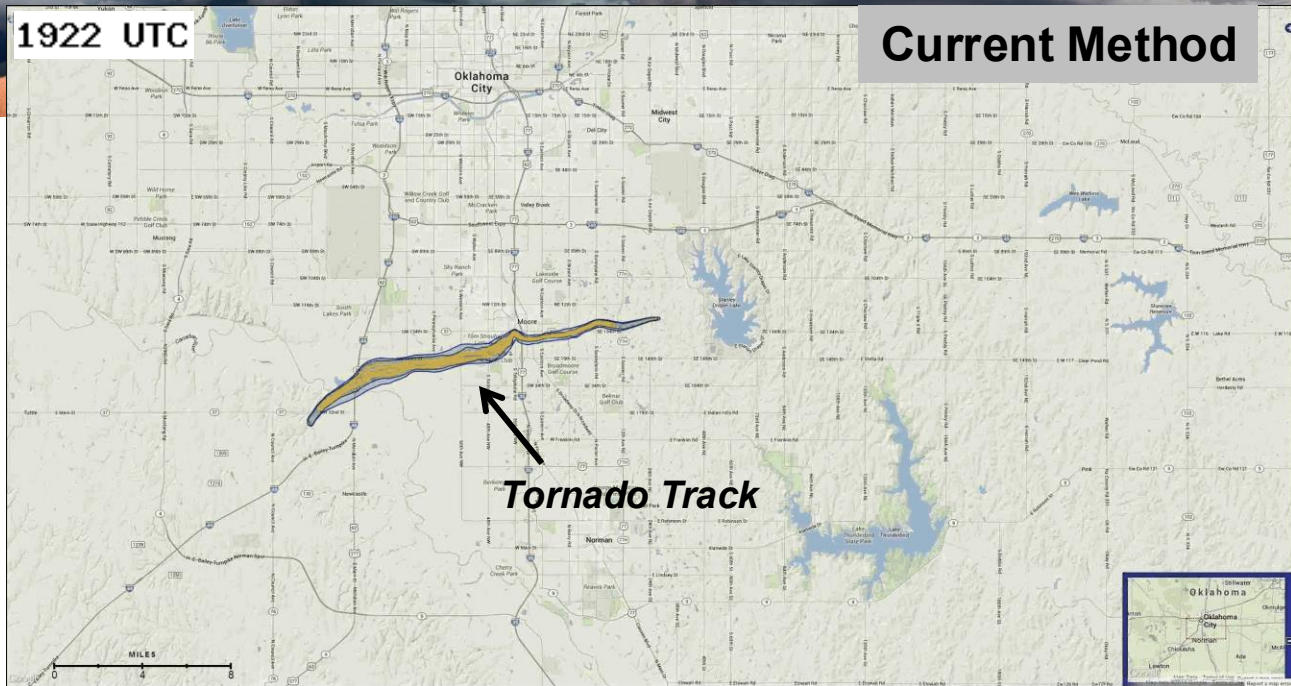


FACETs PHI* Comparison: 20 May 2013

Don't think "large, binary warning products."

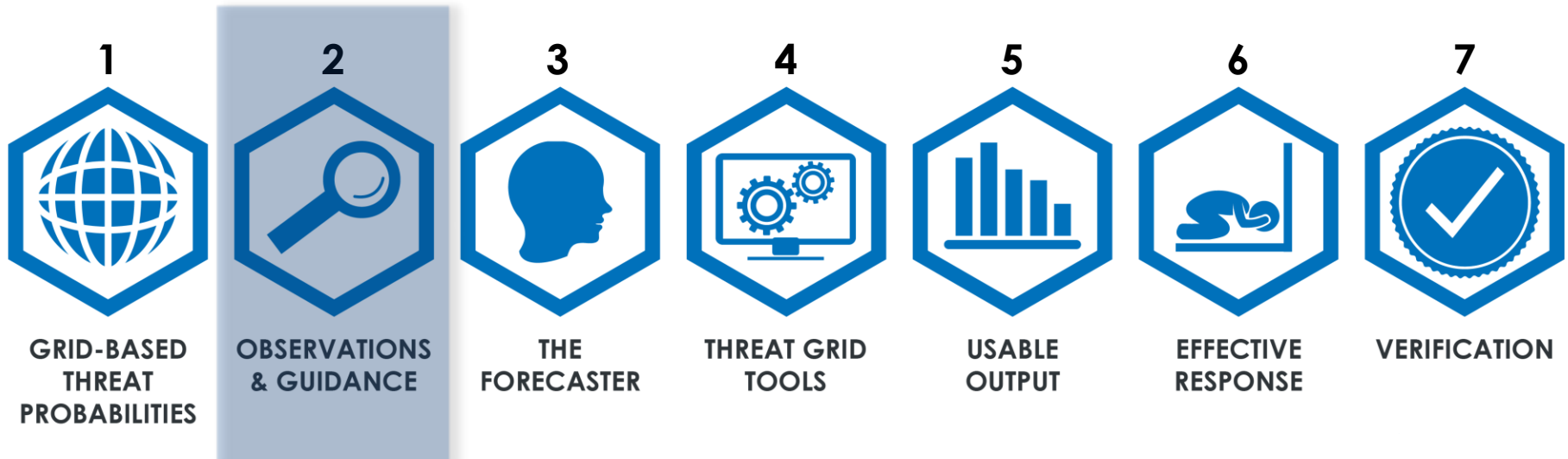
Think "continuous flow of relevant, actionable information for each neighborhood."

*Probabilistic Hazard Information



Facet #2: Obs & Guidance

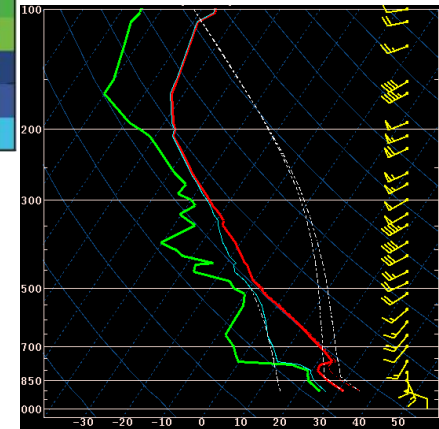
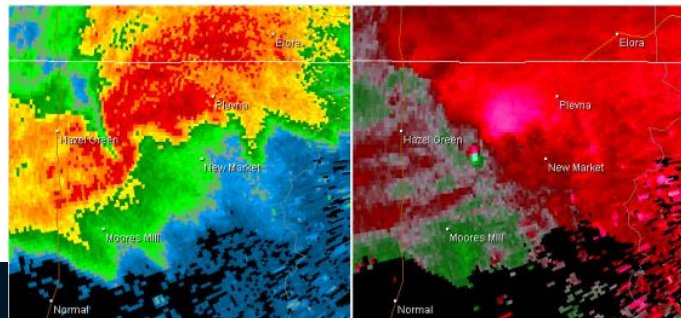
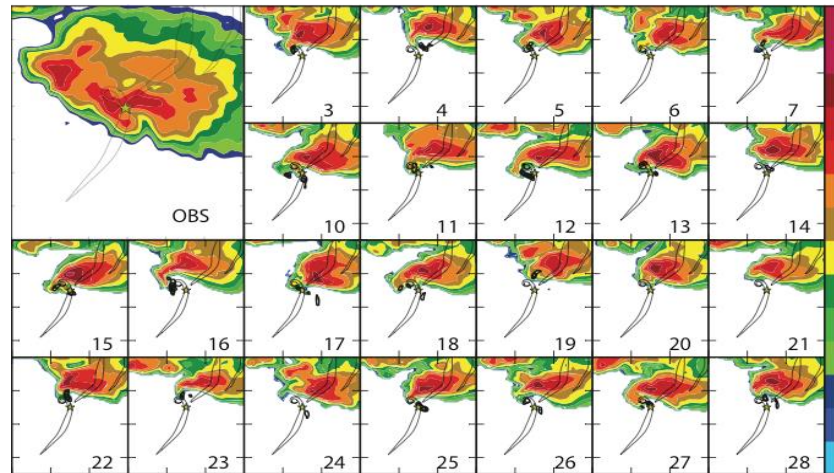
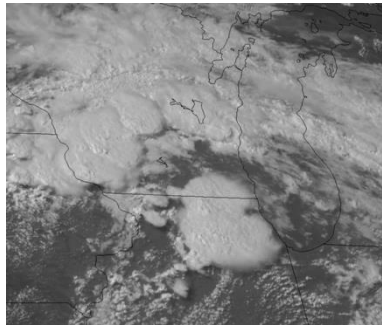
- What forecasters use to make decisions.
 - Radar, satellites, models, observations, other forecasters, etc.





Facet #2: Obs & Guidance

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





FACETs Is...

- The “**delivery mechanism**” for emerging convective class models and tools - and their resulting probabilistic guidance...
- Warn on Forecast
- Pro-FLASH
- Multi-Year Reanalysis of Remotely-Sensed Storms (MYRORSS)

BULLETIN - EAST
TORNADO WARNING
NATIONAL WEATHER SERVICE
1155 AM CST SUN

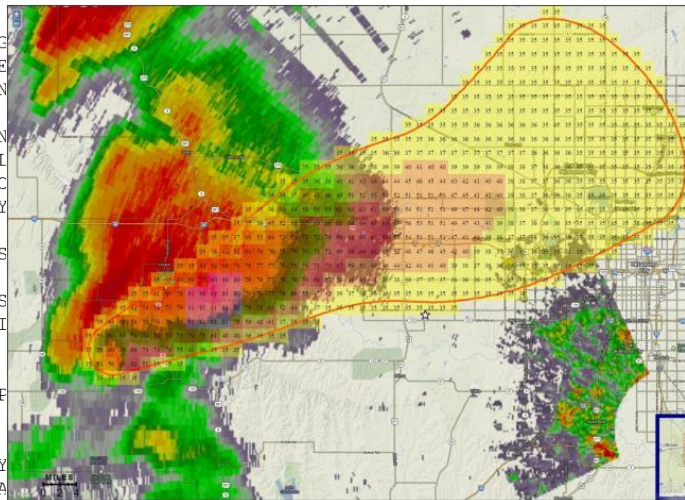
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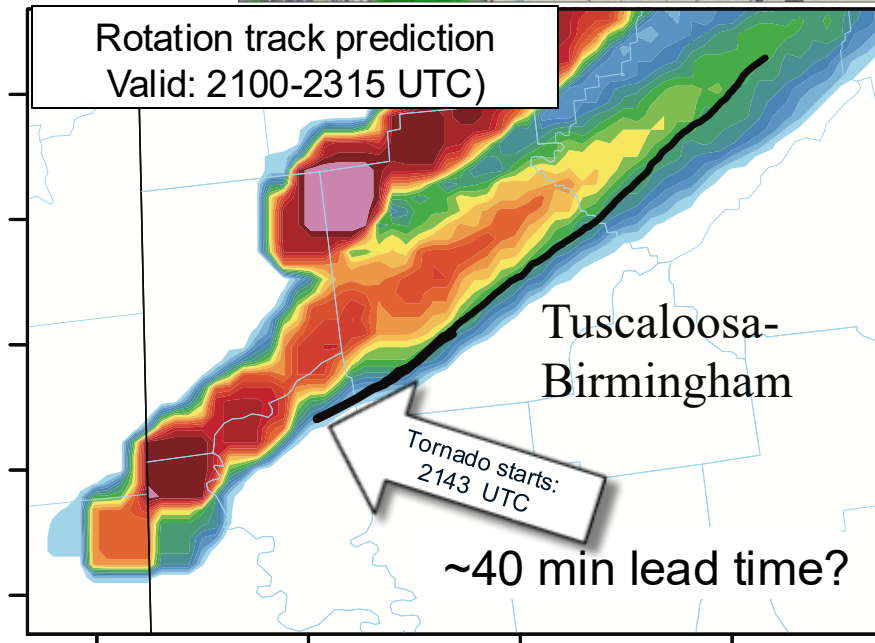
* AT 1155 AM CST
BY RADAR 5 MILES
NORTHEAST AT

PRECAUTIONARY/E

IF THREATENING
PLACE OF SAFETY
AN EMERGENCY CA



Rotation track prediction
Valid: 2100-2315 UTC

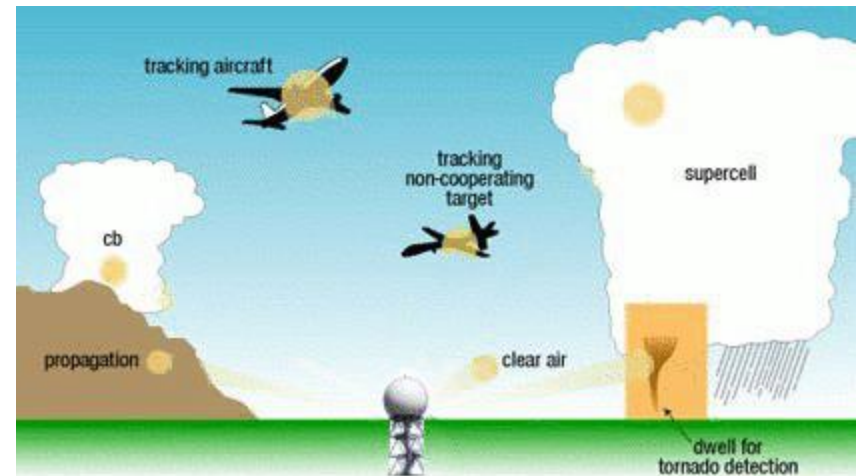


Multi-Function Phased Array Radar (MPAR)

Conventional scanning

NEXRAD

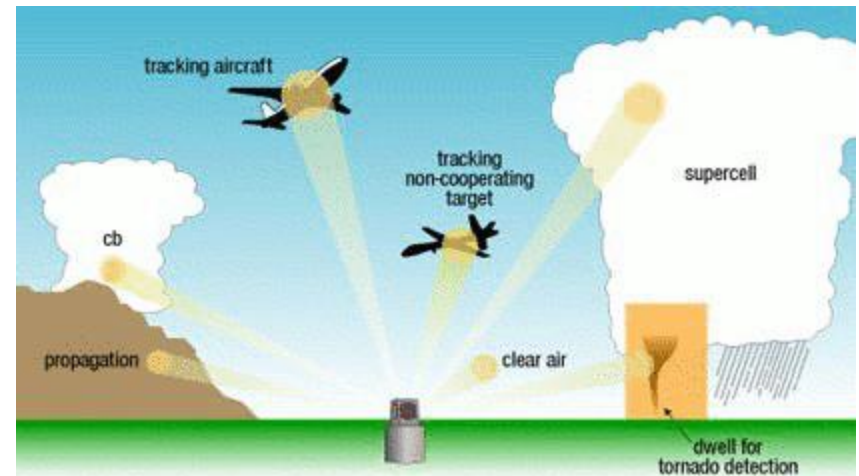
Sequential scanning only
(including "clear" air)



Electronic Adaptive scanning

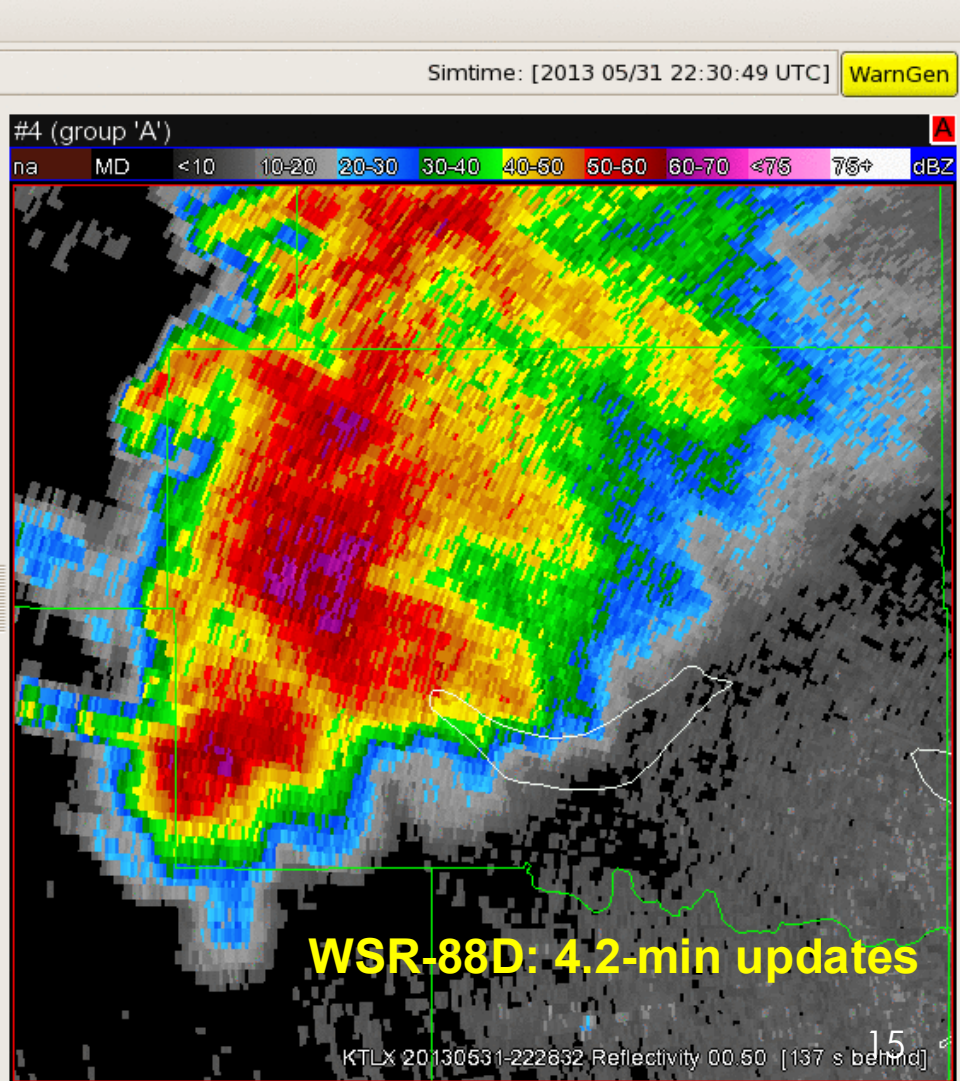
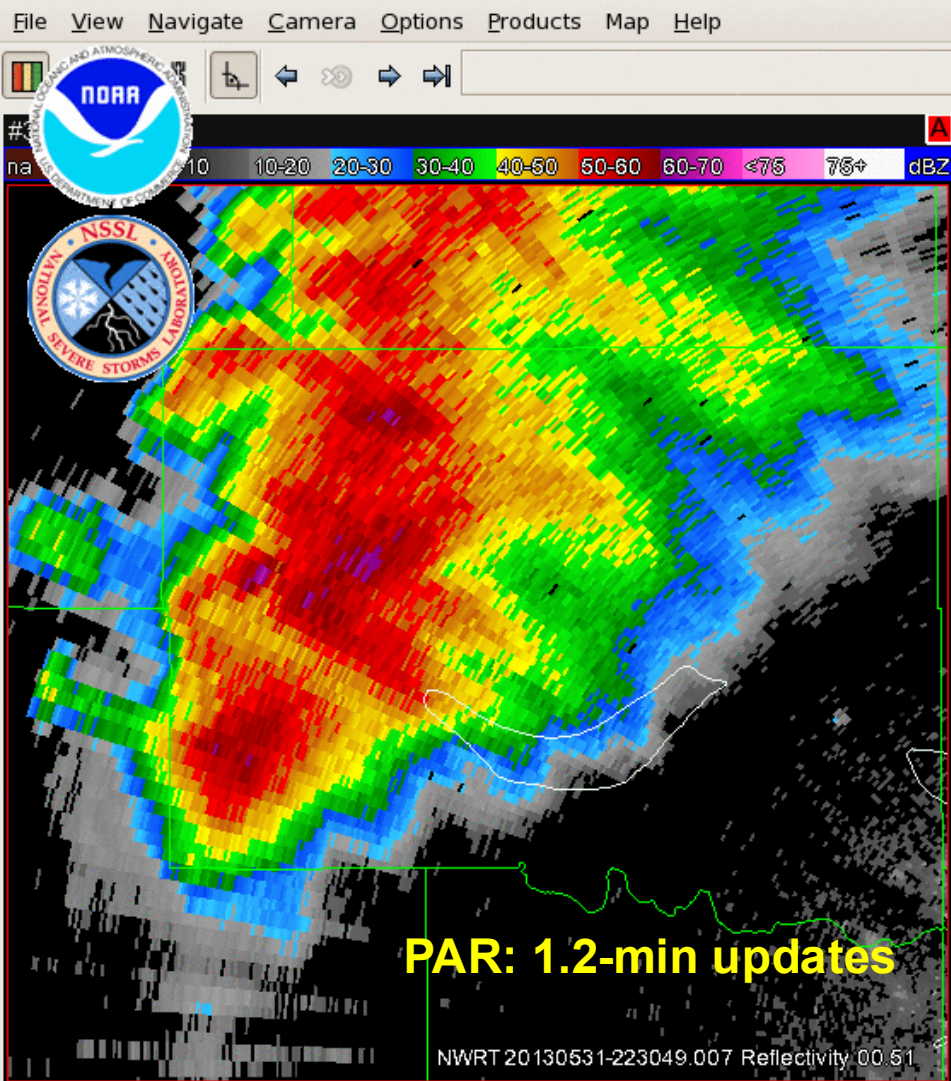
Phased Array Radar

Concentrates radar
only on areas of concern

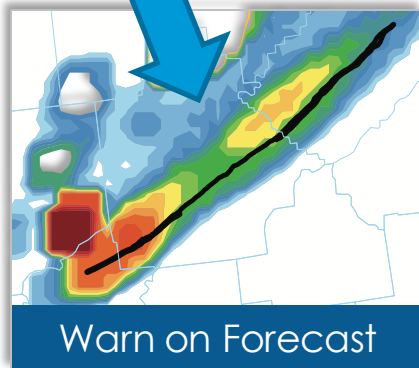




Phased Array Radar (PAR)



NSSL Interconnections



- Rapid radar updates (e.g., MPAR) improve Warn-on-Forecast ensemble performance (which then improves FACETs effectiveness).



GRID-BASED
THREAT
PROBABILITIES



OBSERVATIONS
& GUIDANCE



THE
FORECASTER



THREAT GRID
TOOLS



USABLE
OUTPUT



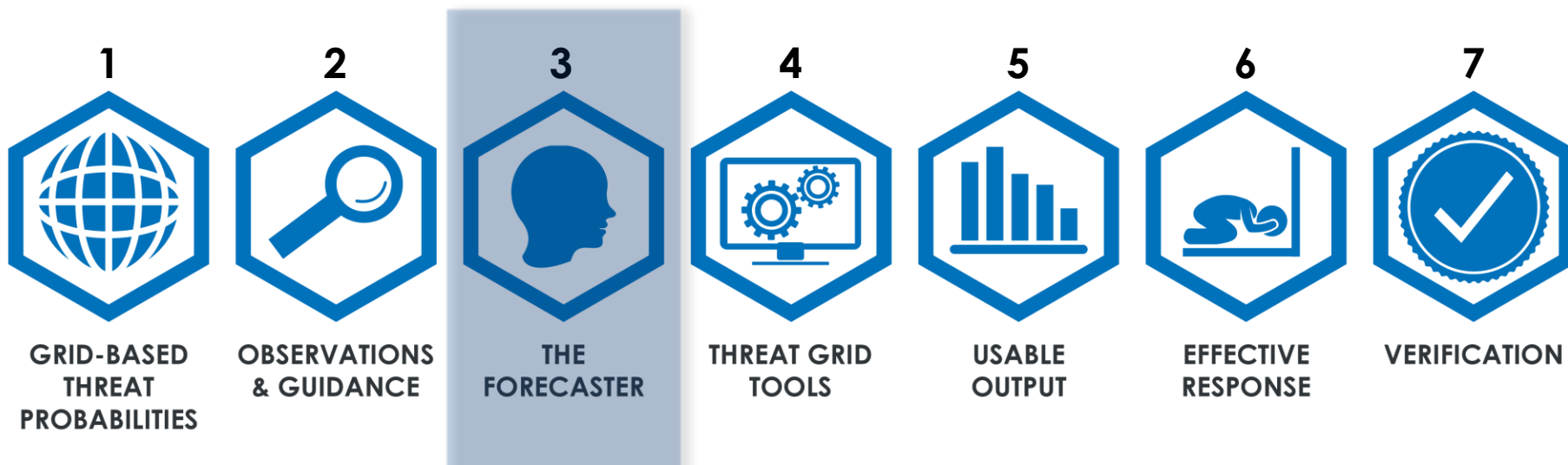
EFFECTIVE
RESPONSE



VERIFICATION

Facet #3: The Forecaster

- The person making the watch/warning decisions.
 - Knowledge, skills and abilities.
 - Human factors insights being applied in HWT.





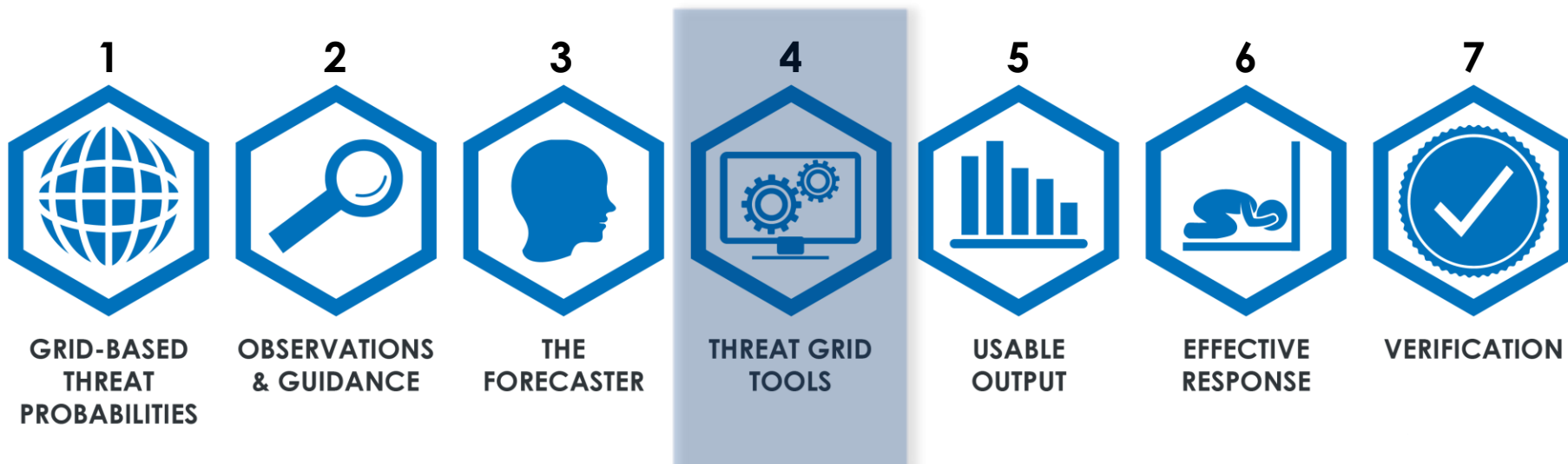
Facet #3: The Forecaster

- Forecasters over (and in) the grids!!
 - They are essential to the warning process.
- New paradigm = new training!
 - Probabilistic threat information.
 - Uncertainty conveyance.
 - Use of guidance.
 - Best practices.
- For maximum effectiveness of FACETs, NWS must have renewed training efforts.



Facet #4: Threat Grid Tools

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



Facet #4: Threat Grid Tools

Prototype Probabilistic Hazard Information (PHI) Tool

Hazard Information

Threat Probabilities Background Probabilities Display

Threat ID: 0
 Threat(s): Tornado (EF0+) 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 (?) 0°

Warning Decision Discussion: Use For Speech ->
 Recognized text will be copied here (or type manually).

Activate Threat

Product: Reflectivity

User: chris.karstens **Case:** 20110524 - KTLX

Tilt: 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

Scale: 0, 1, 2, 3

Hazard Services Console

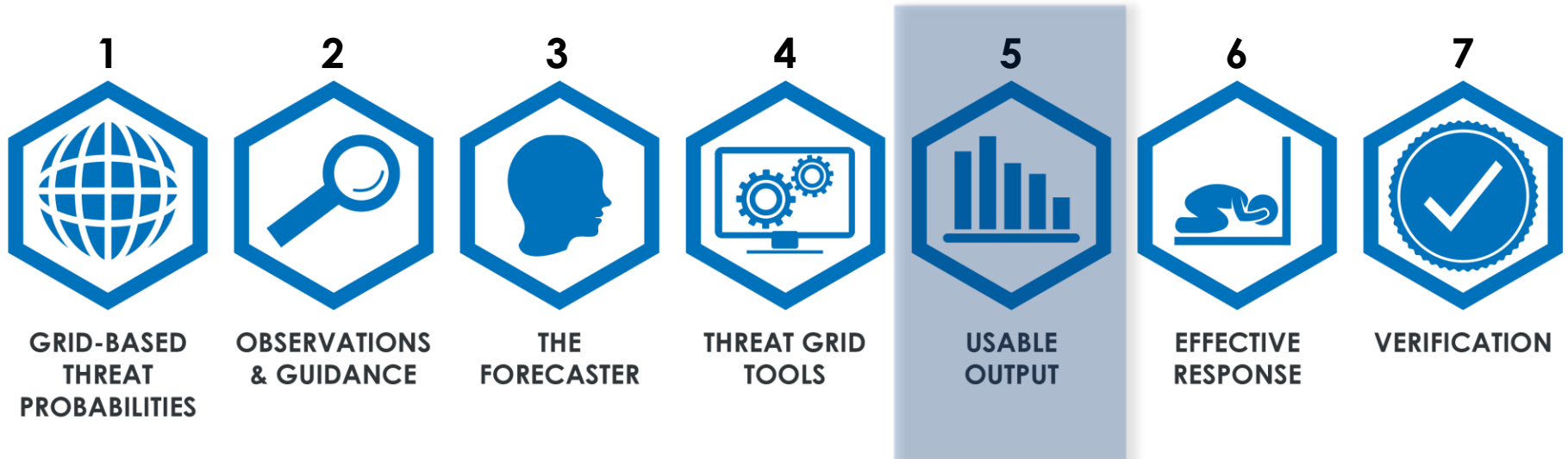
Time: 2011-05-24 20:32:42 Z **Slider:** 2011-05-24 20:30:14 Z

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

Timeline: 24-May 20 UTC, 45, 15, 24-May 21 UTC, 30, 45, 15

Facet #5: Usable Output

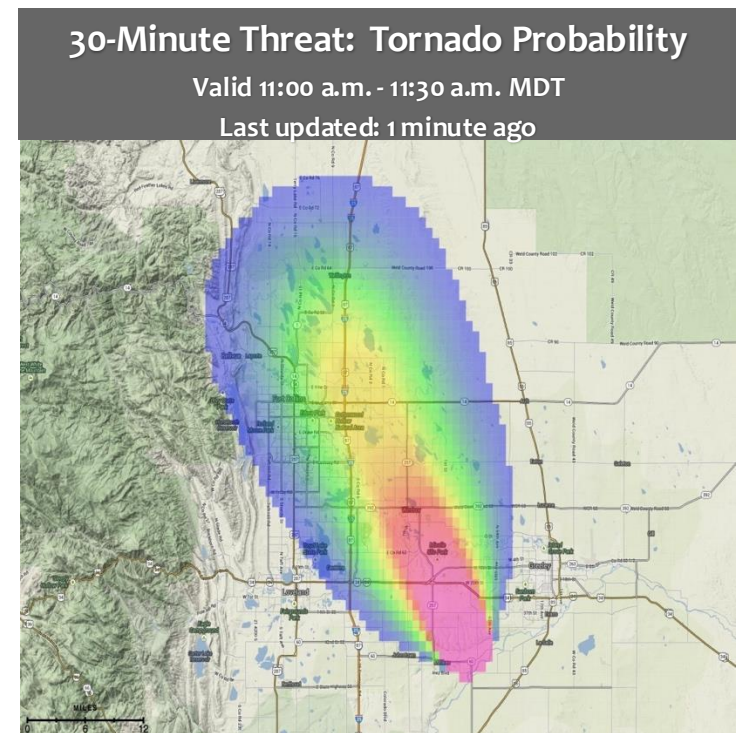
- What the end user sees and hears.
 - Graphical, textual, auditory, digital, etc.





Facet #5: Usable Output

- Legacy watches & warnings, **yes**.
 - Smaller, phenomenon-specific areas.
 - User-specifiable thresholds.
 - Longer (non-warning) lead time.
 - New opportunities for private sector.
- Impact-focused, with new information.
 - Urgency, confidence, range of possibilities, etc.





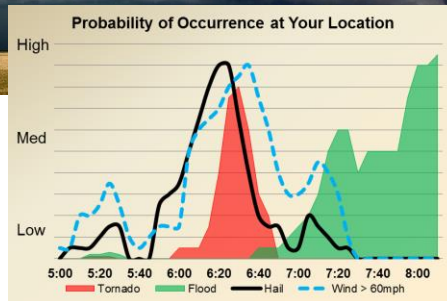
Facet #5: Usable Output

- Better DSS through better (and easier) impact communication.
 - Based on weather threat forecast, a GIS-based, “**impact translator tool**” could communicate the site-specific impact.
 - Forecast: “Wind gusts to 60 mph”
 - Impact: “Numerous trees and branches will fall. Roofing material will be peeled back. Mobile homes will be rolled.”



FACETs is...

Multimedia, multi-point enabling.



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1155 AM CST SUN FEB 21 2013

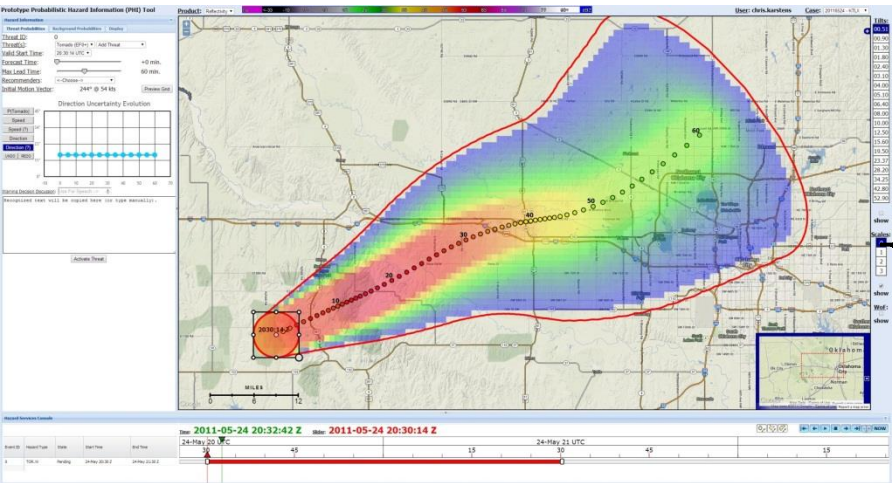
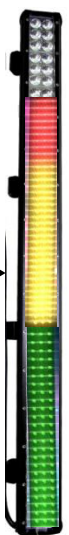
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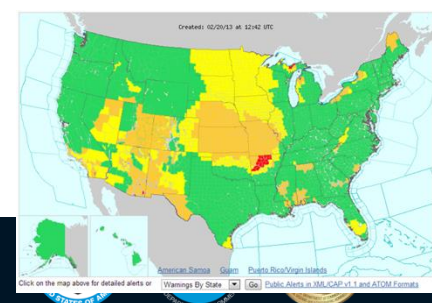
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Wind Grid

Hail Grid

Tornado Grid



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
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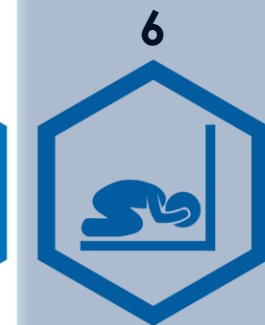
THE
FORECASTER



THREAT GRID
TOOLS



USABLE
OUTPUT



EFFECTIVE
RESPONSE



VERIFICATION

Integrated Social, Behavioral & Physical Sciences



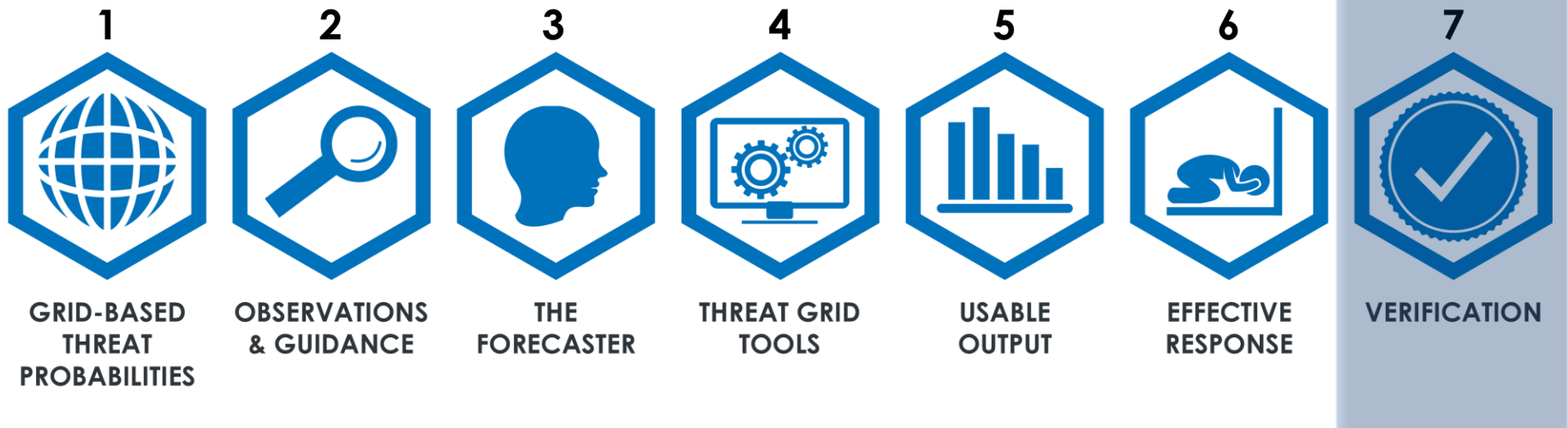
The Impact

The FACETs Epoxy: Integrated Social, Behavioral and Physical Sciences



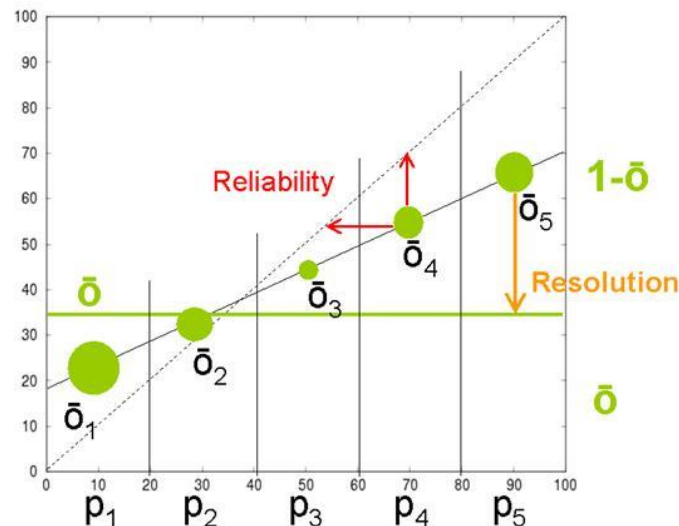
Facet #7: Verification

- Evaluating system effectiveness.
 - Measuring more than just forecast skill...
 - ...measure the response, too!
- Used to improve the system (O2R).



Facet #7: Verification

- Forecasts and observations on the same coordinate system: A **geospatial grid**.
- Statistically-valid and scientifically-robust results suitable for system improvement & research.
 - Reliability } **Brier Score**
 - Resolution }
- New metrics possible...
 - False alarm time & area.
 - Site-specific lead time, etc.



From ECMWF and Allan Murphy

FACETs Is...

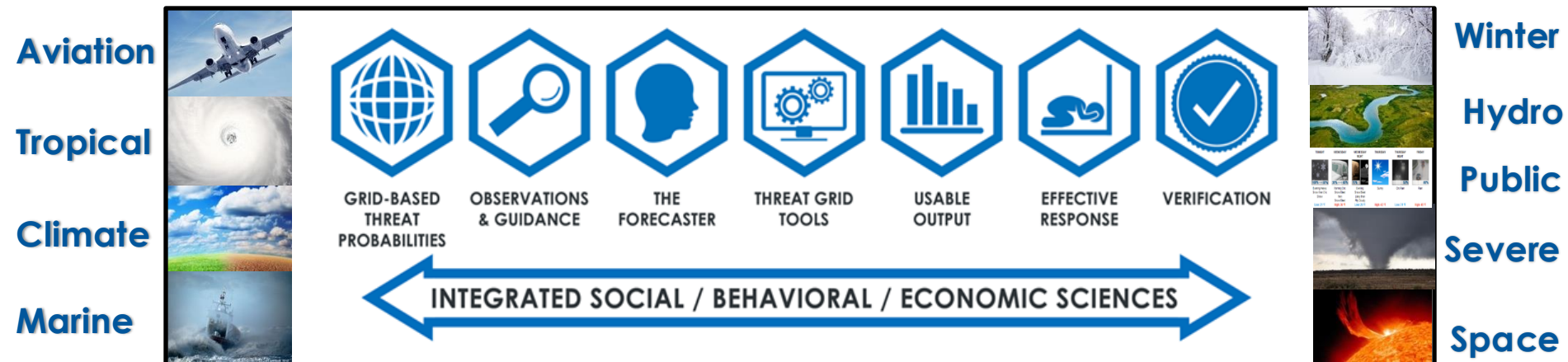
- Optimized for user-specific decision-making through comprehensive **integration of social/behavioral/economic sciences**.
- A **framework** to focus R&D activities.





Over the Horizon

- FACETs concepts applied in all high-impact weather threat areas.
- Currently coordinating with NWS on this.

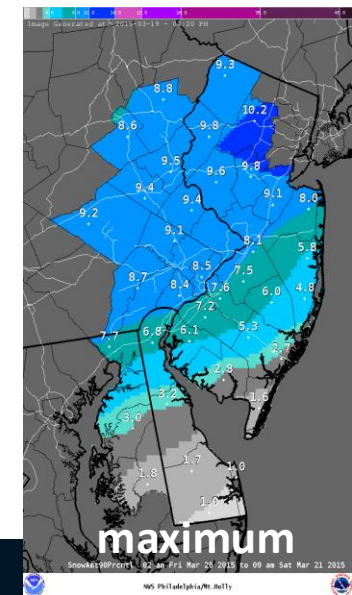
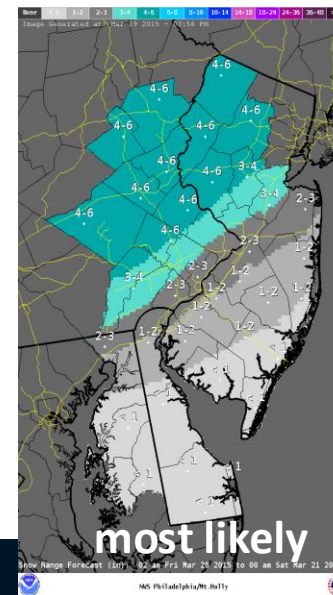
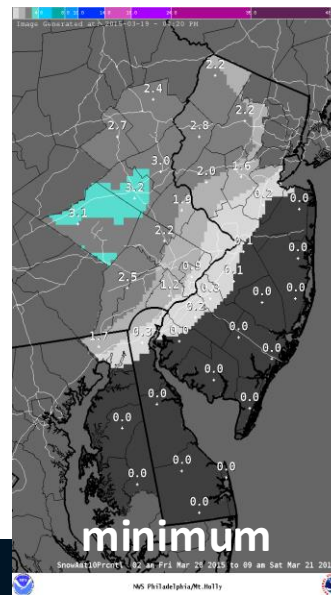


Probabilistic Snowfall Experiment

- WFOs Boston, New York City, Philadelphia and Baltimore/Washington DC produced experimental probabilistic storm total snowfall forecasts.
- **Purpose: To communicate forecast uncertainty and reasonable worst and best case scenarios.**

Overall objective verification and customers surveys indicate a **successful experiment.**

Expanding in FY16.



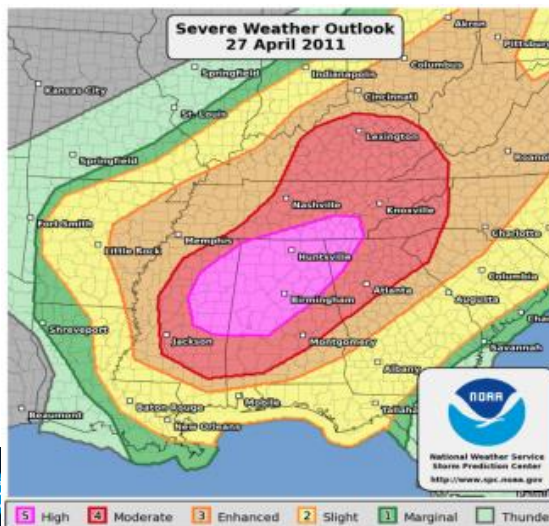
Probabilities Trigger Warnings

Storm Surge Warning

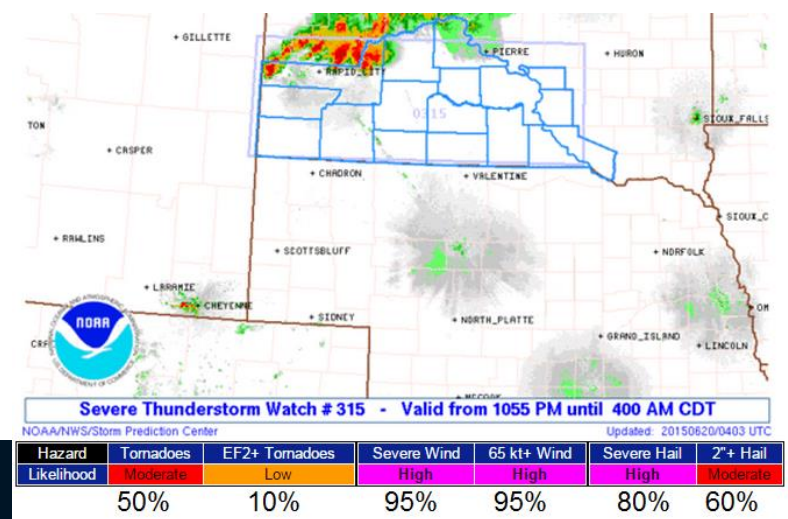
10% chance of exceeding 3 ft inundation.

Convective Outlook and Watches

Defined by probabilities.



Day 2 Outlook Probability	Combined TOR, WIND, HAIL
5%	MRGL
15%	SLGT
15% with Significant Severe	SLGT
30%	ENH
30% with Significant Severe	ENH
45%	ENH
45% with Significant Severe	MDT
60%	MDT
60% with Significant Severe	HIGH



Notional Maturity Assessment

Facet	Severe	Winter	Tropical	Hydro	Marine	Climate	Fire	Public
Method & Manner	Yellow	Orange	Orange	Orange	Red	Green	Orange	Orange
Obs & Guidance	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Yellow
The Forecaster	Orange	Orange	Yellow	Orange	Orange	Green	Orange	Orange
Tools	Orange	Red	Yellow	Yellow	Red	Yellow	Red	Red
Usable Output	Yellow	Red	Yellow	Red	Red	Red	Red	Red
Effective Response	Red	Red	Red	Red	Red	Red	Red	Red
Verification	Yellow	Yellow	Yellow	Yellow	Orange	Yellow	Red	Red

Very poor

Poor

Marginal

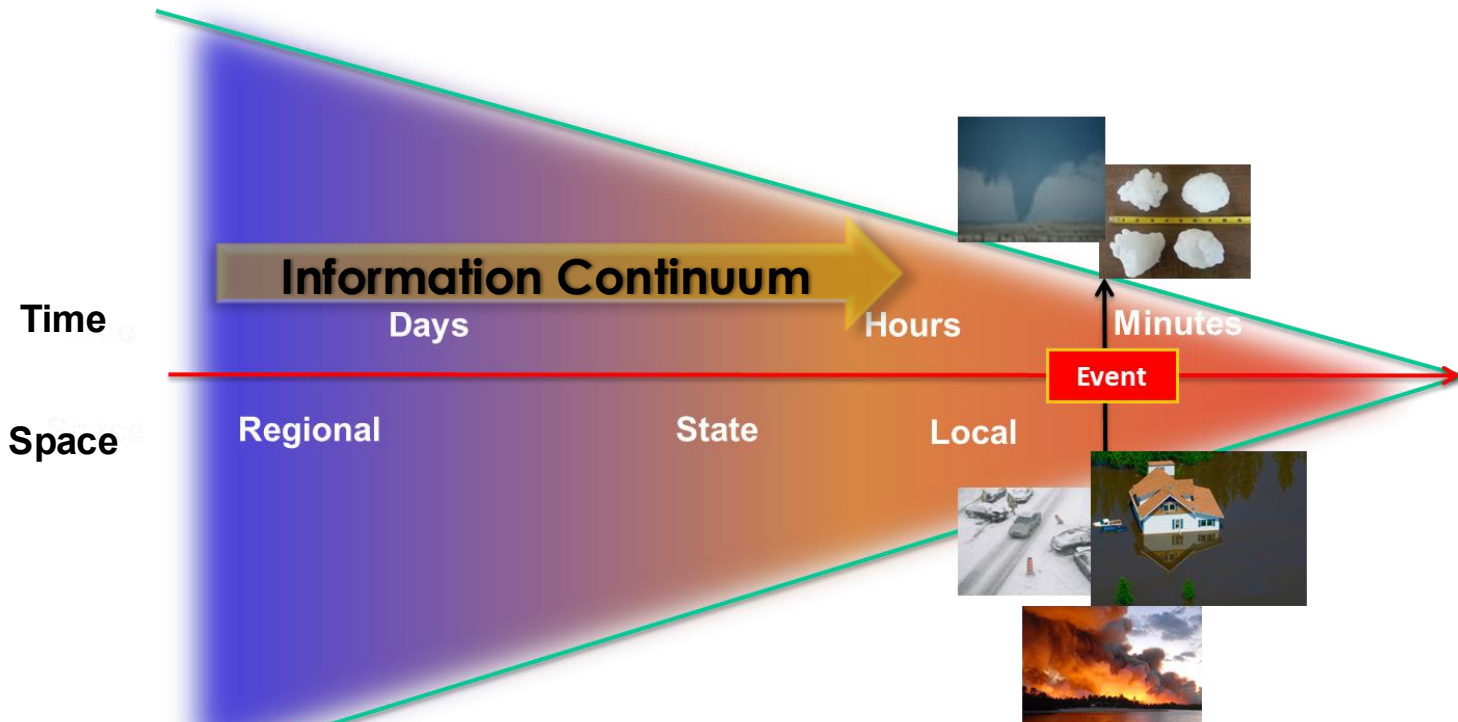
Good





FACETs Is...

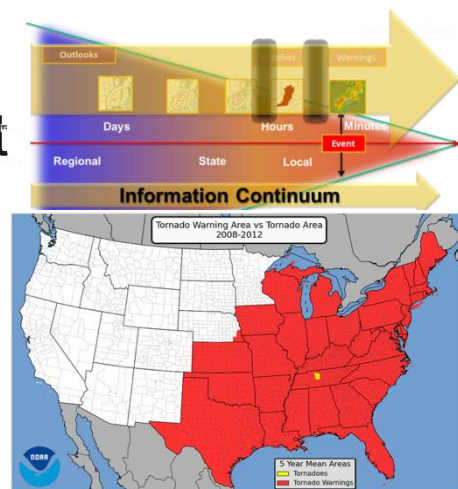
- A continuous stream of calibrated, high-res, **probabilistic hazard information** (PHI) extending from days to within minutes of event - **for all Environmental Threats**.



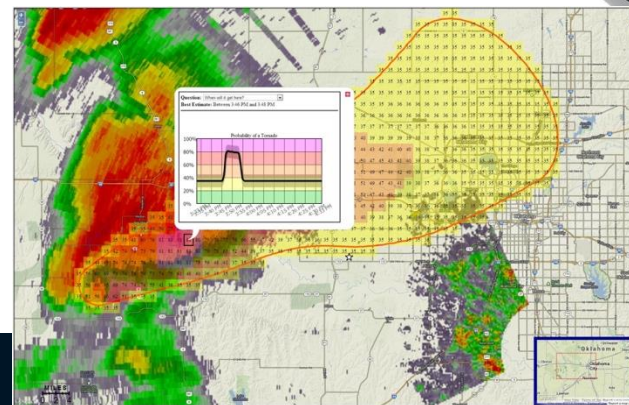


Expected Benefits

- A fully-integrated continuum of weather threat information;
- Reduction in size of “warned” areas;
- Considerable new opportunities for America’s Weather Industry;
- More useful, actionable, and recipient-specific information.
- A more Weather-Ready Nation.

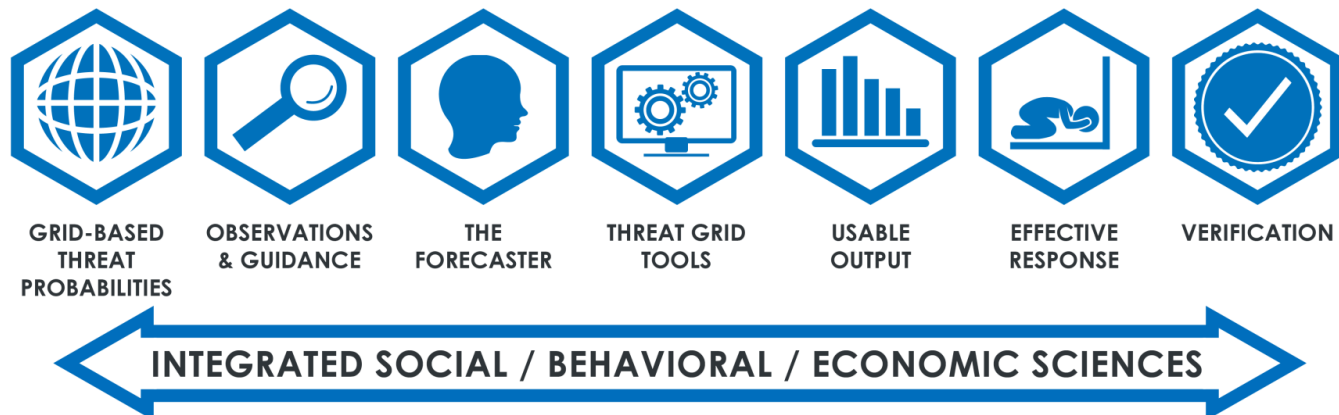


WRN



Summary

- **FACETs**: An over-arching **vision and strategy to modernize** NOAA's hazardous weather forecasting paradigm.
 - A “master plan” exists – much work (and science) to do!
 - For all environmental hazards.
 - Considerable benefits to society expected.
 - A game-changer.





Thank You!

Lans Rothfusz

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