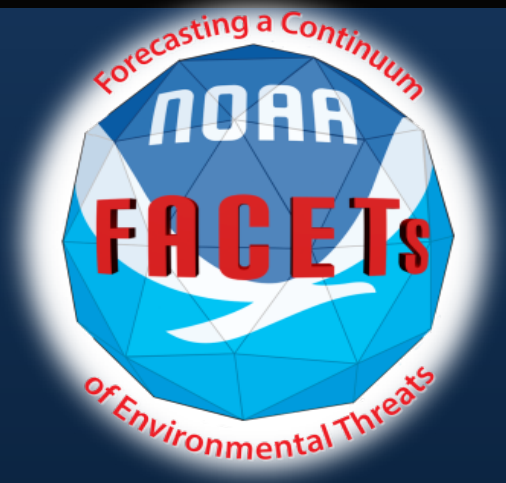
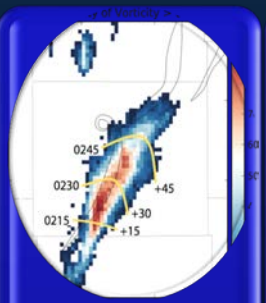
Forecasting a Continuum of Environmental Threats (FACETs)

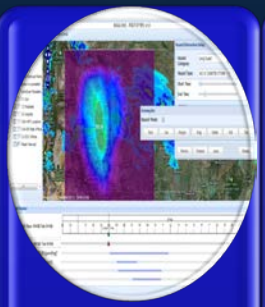


The Method of Warnings



Observations & Guidance

The Forecaster



Threat Grid Tools

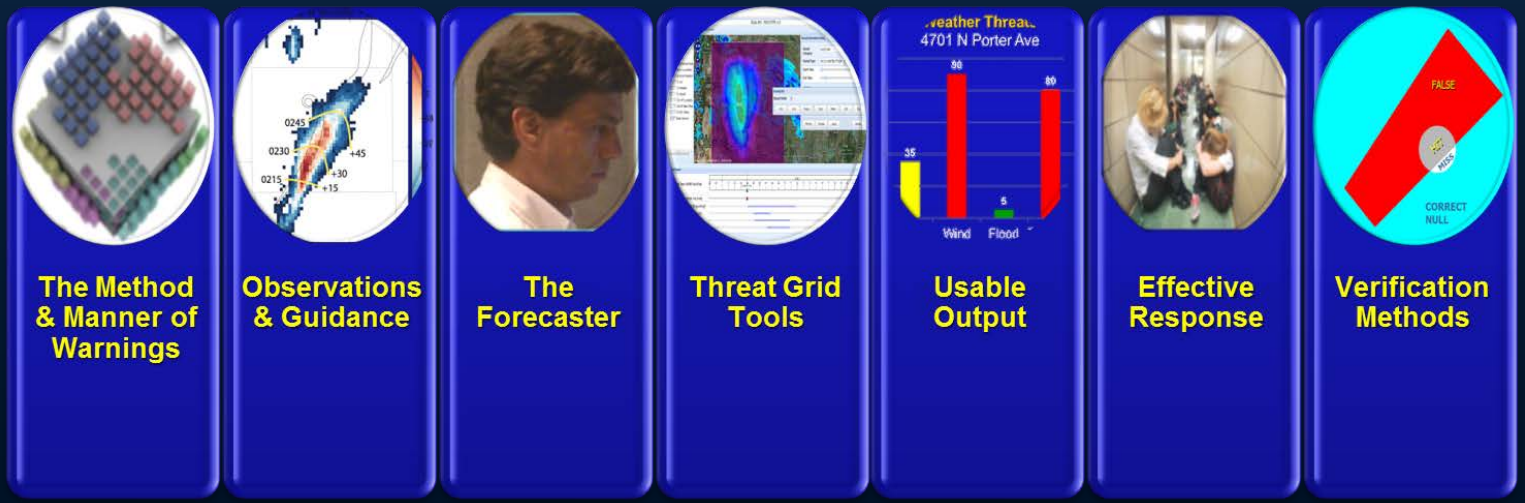
Useable Output

Effective Response

Verification Methods

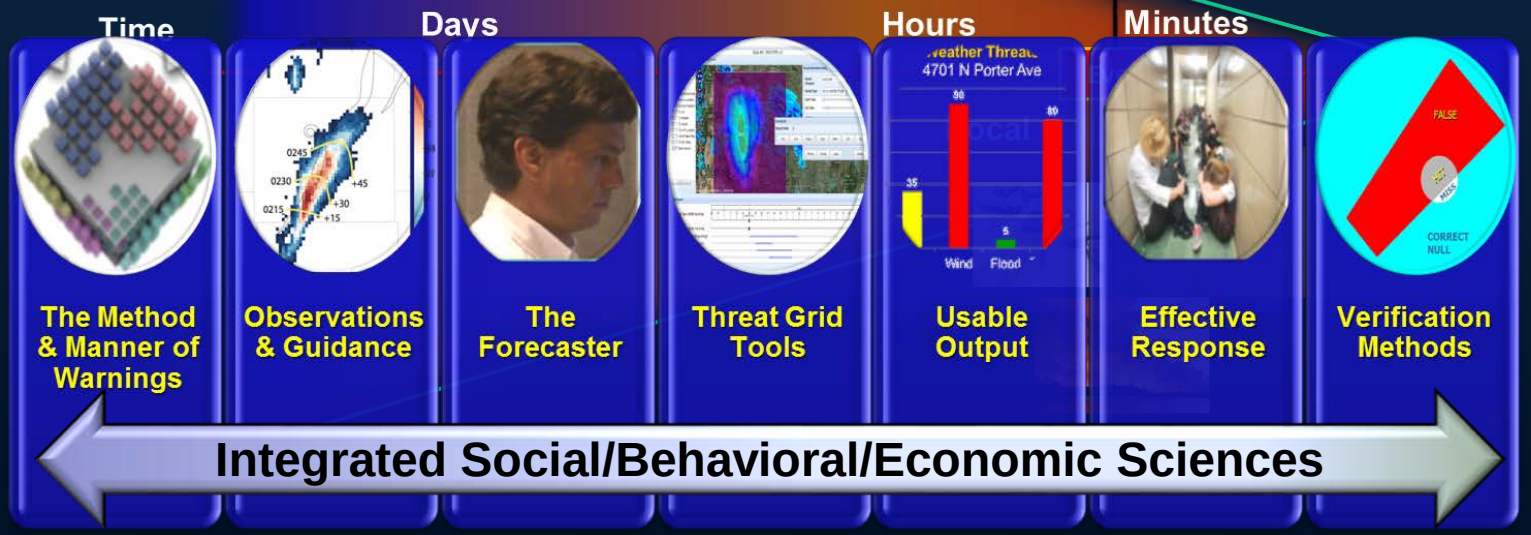
FACETs is…

- A proposed modernization of the NWS's >40-year old, deterministic, product-centric, WWA paradigm.
- A product of NOAA's Weather Ready Nation and a means of achieving WRN goals.
- An organizing framework for R2O.



FACETs is…

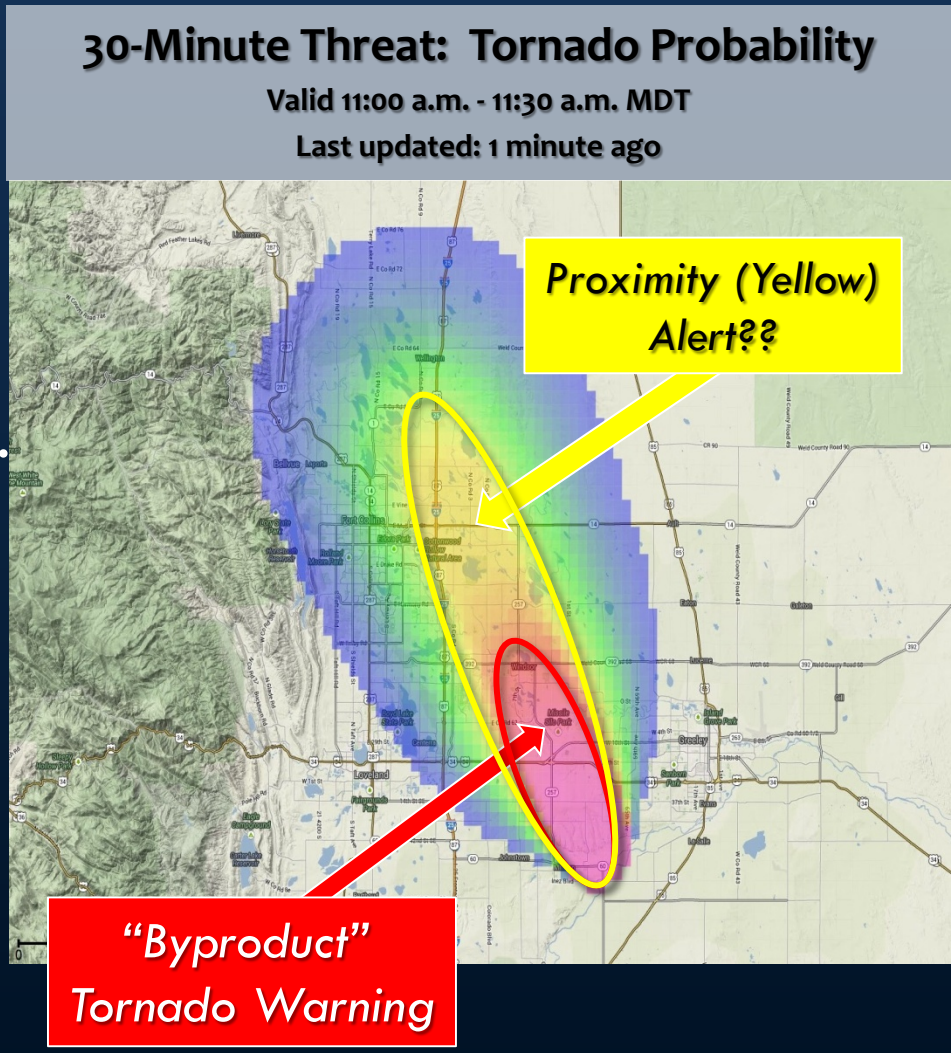
- A science-driven paradigm delivering a continuous stream of high-res, probabilistic hazard information (PHI) extending from days to within minutes of event.
- Optimized for user-specific decision-making through comprehensive integration of soc vioral sciences.



Future of Severe Weather Services: Changing the Starting Point

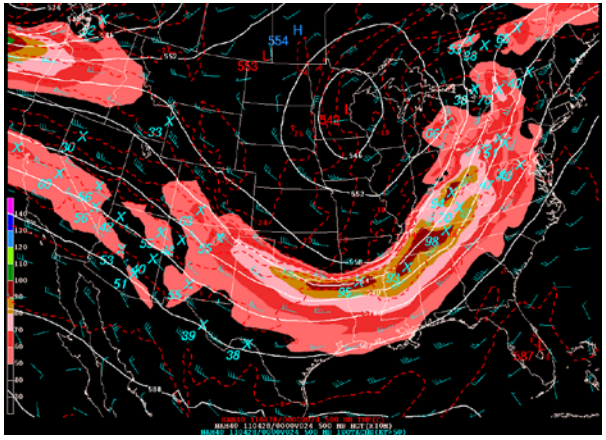
Moving from "binary" polygon watches/warnings to Probabilistic Hazard Information (PHI)

- Grid-based threat probabilities.
  - Legacy warnings/watches "fall out."
  - New messages possible.
- Not only for tornadoes.
  - Winter weather, hail, lightning, flooding, etc.

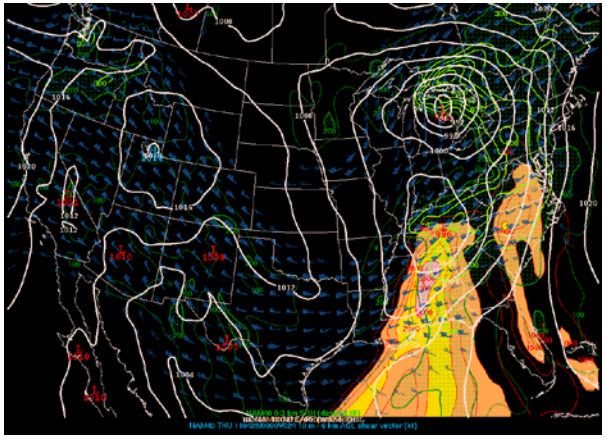


Use of NWP Model Guidance in Operational Severe Storm Forecasting

- Prediction of Severe Storm Phenomena
  - Tornadoes, large hail and severe wind are not explicitly resolved by traditional models (NAM, GFS, RAP)
  - Severe weather forecasts historically based on environment and precipitation fields
    - Pattern, CAPE, shear, precipitation, sounding examination
    - These represent pre-convective and near-storm environments



500 mb Height, Temp, Isotachs



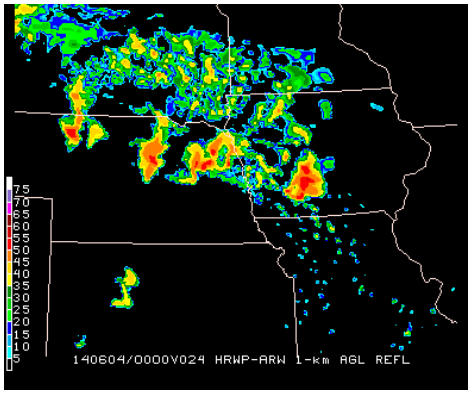
PMSL, CAPE, 6 km Shear, 3 km SRH

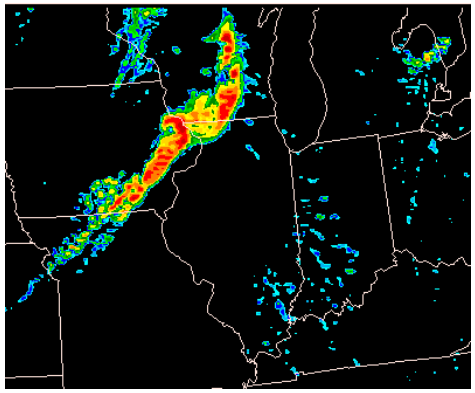
NSHARP Skew-T Sounding Analysis

Use of NWP Model Guidance in Operational Severe Storm Forecasting

- Prediction of Severe Storm Phenomena
  - Tornadoes, large hail and severe wind are not explicitly resolved by traditional models (NAM, GFS, RAP)
  - Severe weather forecasts historically based on environment and precipitation fields
    - CAPE, Shear, precipitation, sounding examination
    - These represent pre-convective and near-storm environments
  - Over the last decade, explicit storm attribute fields have been extracted from convection-allowing models (CAMs)
    - Provide information about convective mode, intensity, structure & evolution

Simulated Reflectivity: Discrete Cells

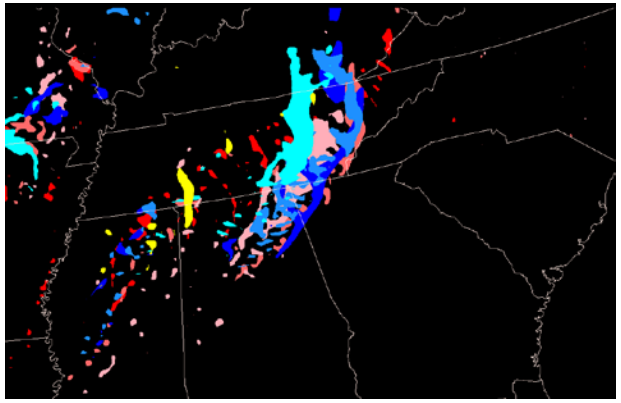




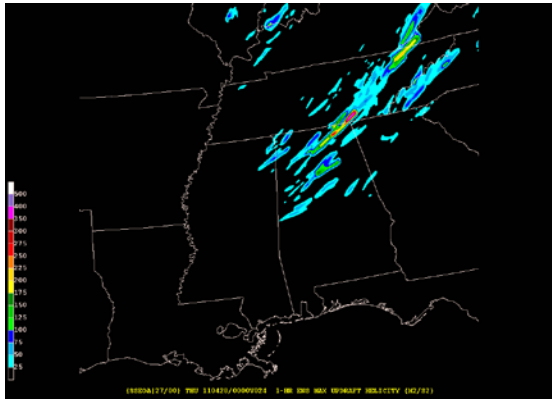
Simulated Reflectivity: Quasi-Linear Structure

Convection-Allowing Ensemble Systems

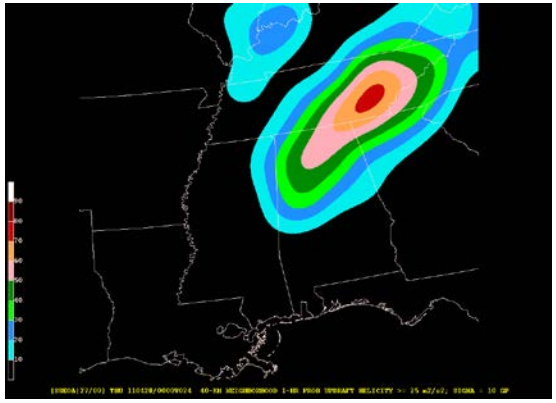
- Convective storm prediction is inherently probabilistic
- Ensemble approaches provide a range of possibilities and information about likelihood of occurrence
- SPC Storm-Scale Ensemble of Opportunity (2011)
  - Requires grids from all members for post-processing
- Post-processing techniques
  - Hourly Maximum Fields; Neighborhood Probabilities



Spaghetti: Simulated Reflectivity >40 dBZ



Hourly Max from any Member: UH



Neighborhood Prob: UH>25 m2/s2

Post-Processing Data Requirements for Convective Storm Analysis & Prediction

- **Consistent derived environment (CAPE, etc.) and explicit storm attribute computations across platforms (obs, NWP)**
- **Environmental & Pattern Data**
  - SREF/GEFS (hourly output) and HREF Data (15 min output)
  - 2-D grid of pattern/environmental fields
  - Full vertical resolution point soundings
  - Environment examples:
    - CAPE/CIN (SB, ML, MU parcels); layer specific (e.g., 0-3 km, -10C to -30C)
    - Bulk Shear (0-1 km, 0-3 km, 0-6 km, effective layer)
    - SRH (0-1 km, 0-3 km, effective layer)
    - SCP, STP composite parameters
  - Reforecast/Retrospective Data
    - Minimum one year per ensemble member for one cycle (00Z, 12Z...)

Post-Processing Data Requirements for Convective Storm Analysis & Prediction

- HREF Data – Storm Attribute Fields (@Full Horiz. Resolution)
  - 3-D grid of simulated reflectivity (15 min output)
  - 2-D storm attributes (15 min output)
  - Object ID and tracking
    - Open feature vector formats (e.g., JSON, GeoJSON)
    - Value is saving feature-time information
  - Examples of Hourly Maximum Fields (HMFs – hourly output)
    - Reflectivity (1 km AGL, composite)
    - Maximum Updrafts/Downdrafts in lowest 400 mb
    - Updraft Helicity (low- and mid-level)
    - 10-m Wind
    - Severe Hail, Severe Wind, Tornado, and Lightning Diagnostics
  - As CAM and CAM Ensemble data extraction and development of new diagnostics progresses, unified post should be designed to easily add new guidance fields

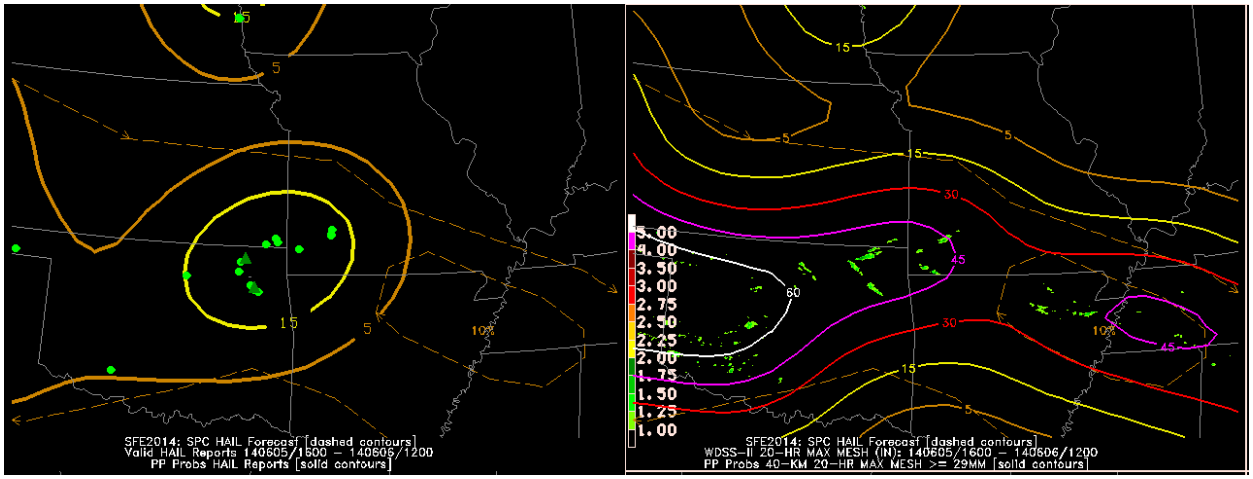
Post-Processing Data Requirements for Convective Storm Analysis & Prediction

- **Storm Attribute Fields/Objects**
  - WoF and next-generation HREF Output
  - 4-D storm object attributes (5 min output)
    - Explore object identification and tracking algorithms
      - Potentially reduce output volume
    - Data fusion – machine learning to combine real-time storms and analyses
      - Combine observed storm attributes (MYRORSS) with NWP
  - Exploit “in-the-model” computation of variables/diagnostics rather than post-processing
    - For very-fine scale variability in convective phenomena
      - Tornadoes, hail, damaging wind, and lightning
    - Captures fine temporal resolution evolution reducing I/O requirements
- HREF reforecast/retrospective data
  - Minimum of 12 total months of active severe weather periods
  - Should encompass multiple seasons/possibly multiple years

Post-Processing Data Requirements for Convective Storm Analysis & Prediction

- Calibrated Probabilistic Guidance Development
  - Large dependency on observed severe storm data base for “truth”
  - Database contains many strengths/limitations (some non-meteorological)
  - Will need to explore blended event databases that include:
    - Local Storm Reports/Storm Data
    - Remotely Sensed Severe Weather Occurrence (e.g., MRMS)
    - Lightning Data
    - Rapidly Updated Analysis (RUA - diagnosis of storms & environment)

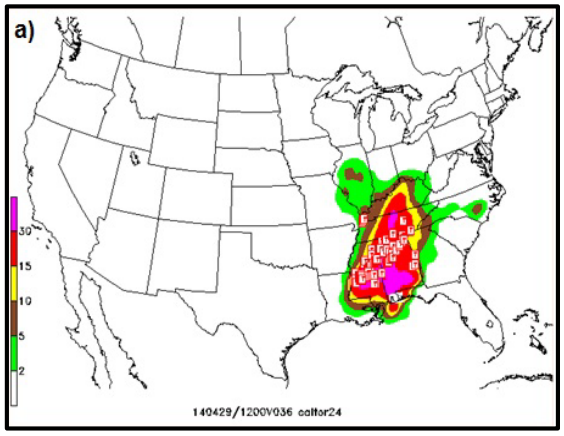
Hail Reports from LSRs (Green Dots) and Practically Perfect Hindcast Probability



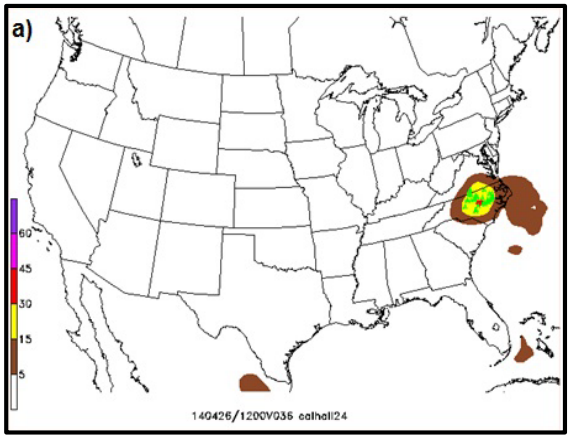
Hail Tracks from MRMS-MESH and Practically Perfect Hindcast Probability

Post-Processing Data Requirements for Convective Storm Analysis & Prediction

- Specialized Calibrated Probabilistic Guidance Development
  - At SPC focused on severe and fire weather missions
    - Extraction of specialized fields/creation & testing of new diagnostics
    - Center-led post-processing of SREF, CAM & CAM ensemble guidance for SPC and NWS operations
      - partnership that builds upon decades-long SPC experience for specialized guidance
    - Calibrated probabilistic guidance for Lightning, Lightning Density, Total Severe, Individual Severe Hazards
    - Dissemination of specialized guidance throughout NWS and enterprise
    - Probabilistic impact forecasts to support consistent science-based IDSS



24-h Calibrated Tornado Probability 28 Apr 2014



24-h Calibrated Hail Probability 27 May 2014