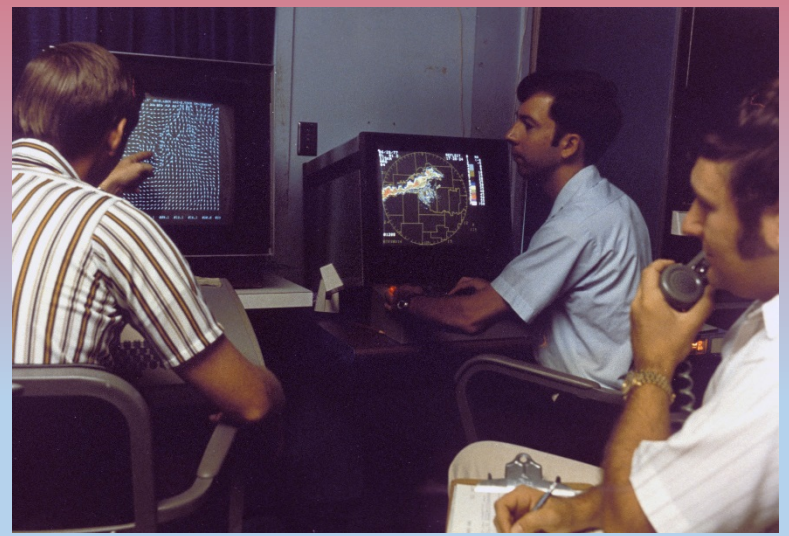
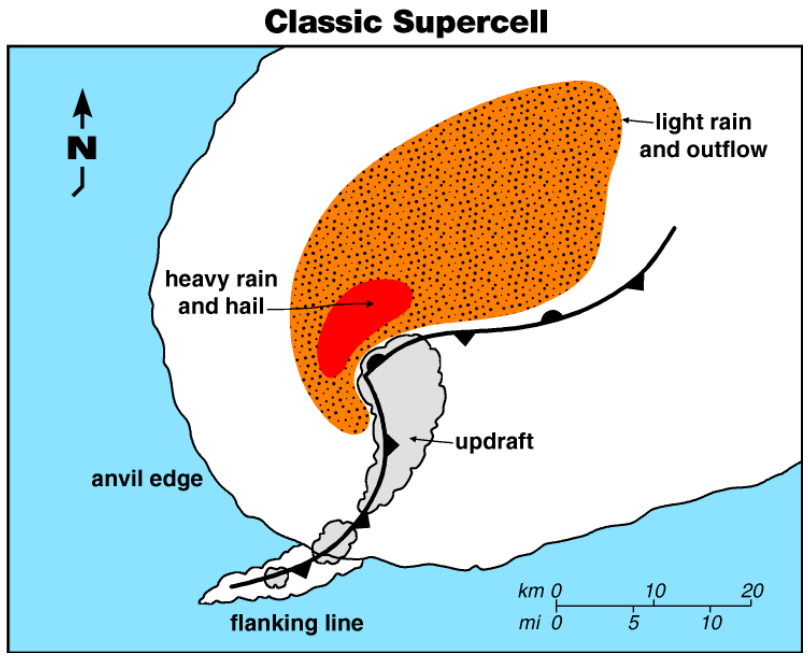
CIMMS Forecast and Warning Improvements

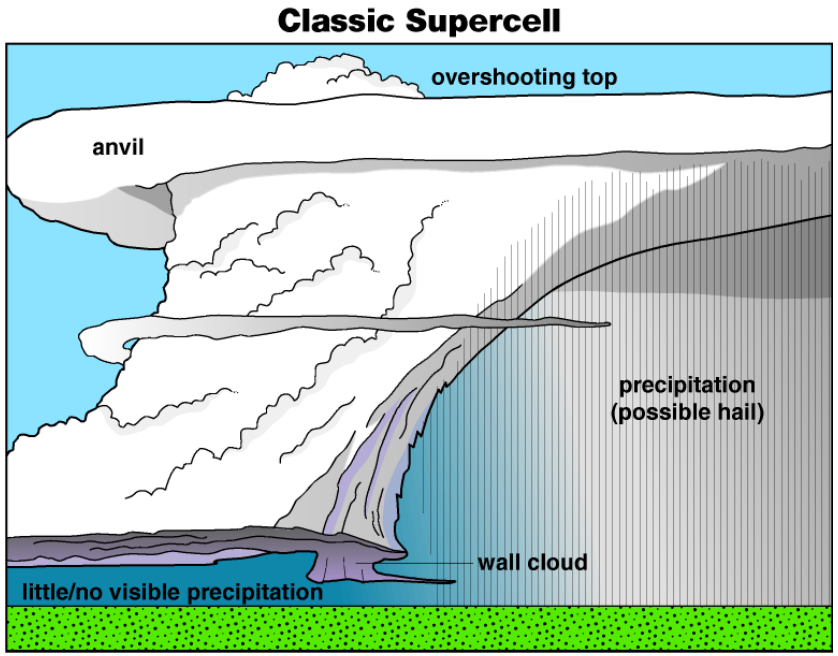


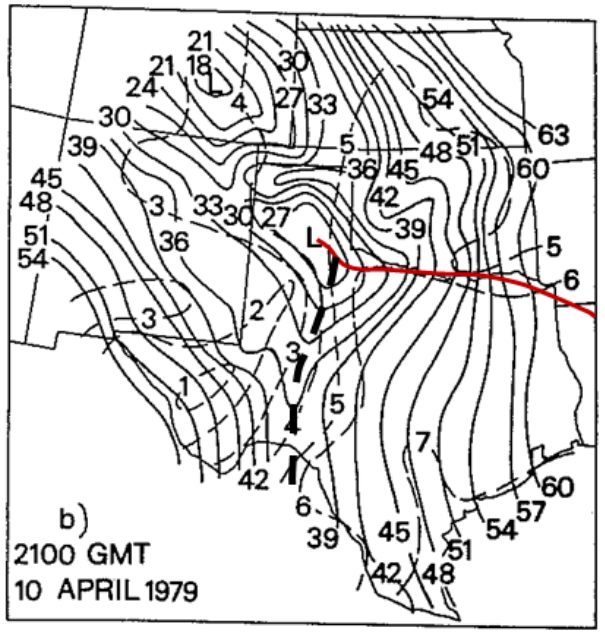
Don Burgess, CIMMS

Partners from CIMMS
Partners from NSSL
Partners from ROC

Early CIMMS (1980ish): Basics Being Developed

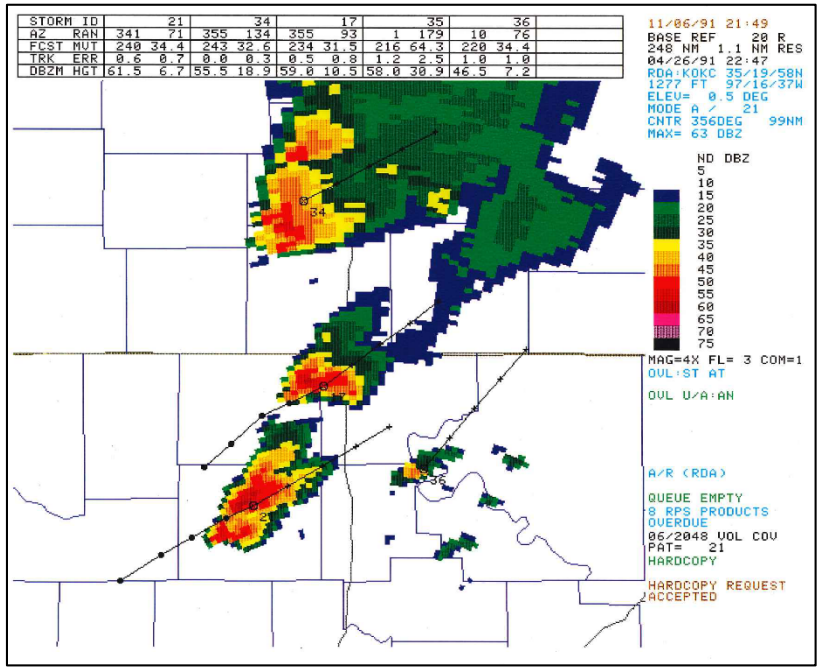




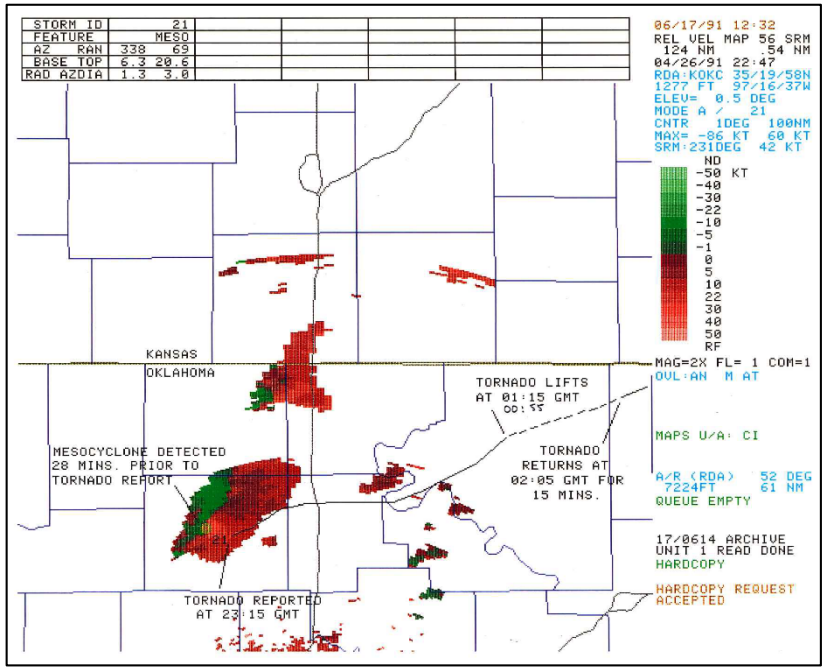


- Experimental Doppler Radar (NRO, CIM); Very Little Forecaster Radar Understanding: DOPLIGHT (1984-1987)
- Scientific Storm Intercept for Verification of Radar Signatures and Understanding Storm Structures
- Basic Understanding of Mesoscale and Near Storm Environments Were Aided by Field Programs

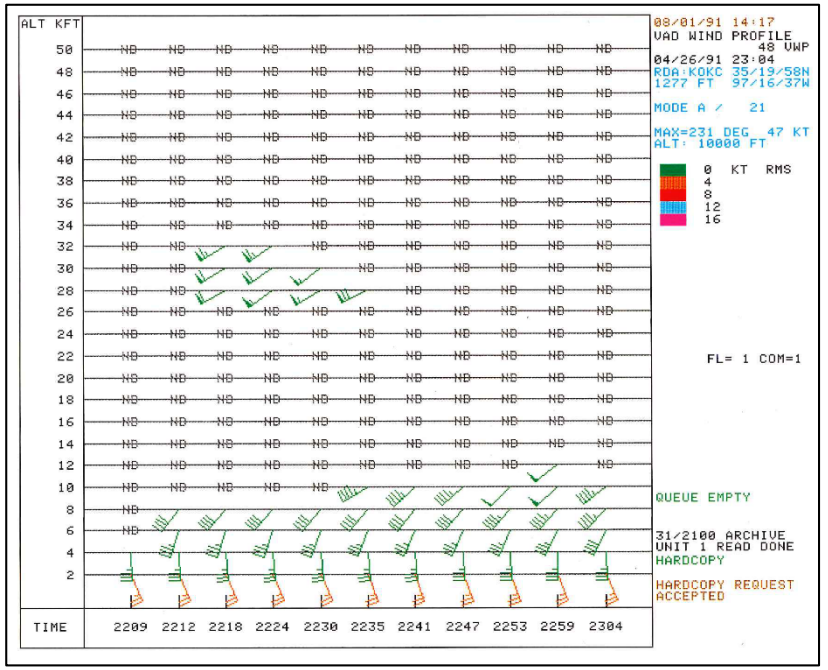
Initial WSR-88D Severe Storm Detection & Algorithms



KTLX-E Reflectivity & SCIT, April 26, 1991



KTLX-E Velocity & MESO, April 26, 1991



KTLX-E VWP, April 26, 1991

- Initial WSR-88D Display Products (not Level 2 resolution): Reflectivity, Velocity, Spectrum Width
- Initial Single-Radar WSR-88D Algorithms from CIMMS/NSSL/ROC:
  - SCIT: Storm Cell Identification & Tracking
  - HA: Hail Algorithm
  - VWP: VAD Wind Profile
  - MESO: Mesocyclone Algorithm
  - TVS: Tornadic Vortex Signature
  - VDA: Velocity Dealiasing Algorithm

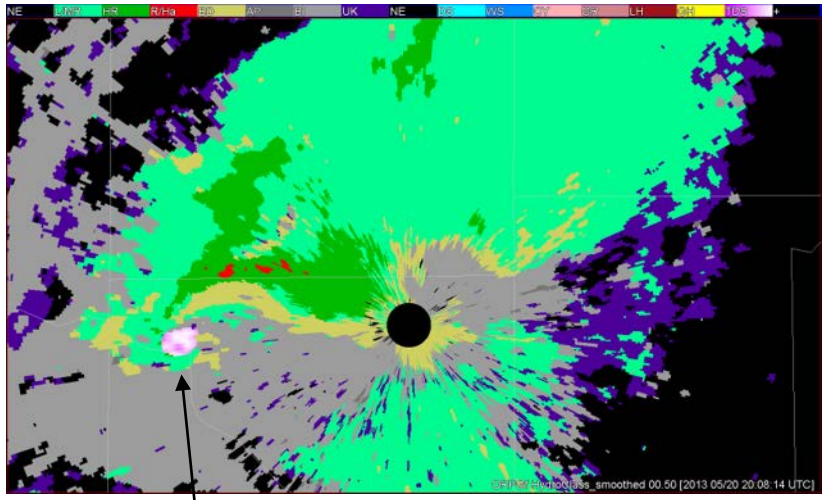
New/Improved Severe Storm Algorithms*: 1995-2018

- MDA Mesocyclone Detection Algorithm
- TDA Tornado Detection Algorithm
- HAD Hail Detection Algorithm
- NSE Near Storm Environment Algorithm
- GFDA Gust Front Detect Algorithm (FAA Only)
- MBDA Microburst Detection Algorithm (FAA only)
- DDPDA Damaging Downburst Prediction & Detection Algorithm
- BWER Bounded Weak Echo Region Algorithm
- VDDA Improved Velocity Dealiasing Algorithm
- MPDA Multi-PRF Dealiasing Algorithm
- RS Rapid Update - several algorithms using virtual volumes
- HSDA Hail Size Detection Algorithm
- TDS Tornado Debris Signature (Experimental)
- NMDA New MDA [*Posters by B. Smith et al & T. Smith et al*]
- NTDA New TDA [*Posters by B. Smith et al & T. Smith et al*]
- NHDA New HDA [*Posters by B. Smith et al & T. Smith et al*]

Added to Baseline
Not Added to Baseline
Dual-Polarization
Experimental

* Single-Radar Algorithms

HSDA with Large Hail (LH) and Giant Hail (GH)

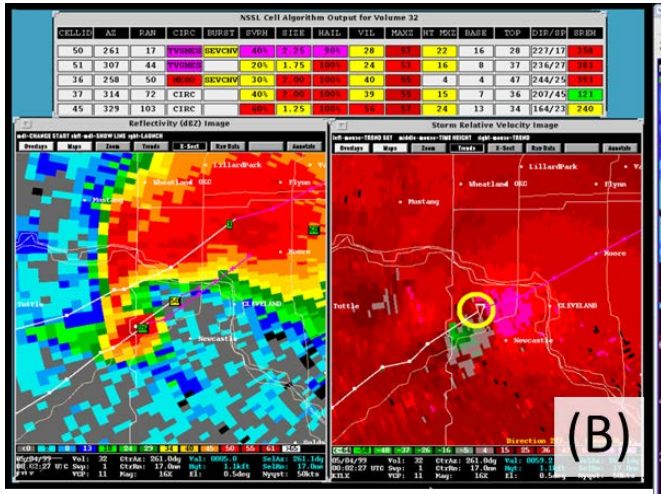


TDS with Shading for Confidence Intervals

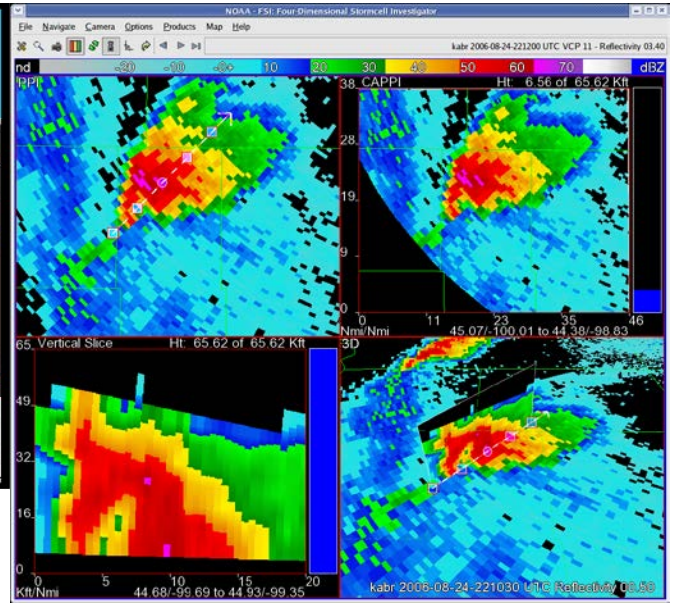
WSR-88D Data Display and Archive

- Data Display (Level 2 Data)
  - WSR-88D Algorithm Testing & Display System (WATADS)
  - Warning Decision Support System (WDSS)
  - WDSS –Integrated Information (WDSSII)
  - System for Convective Analysis & Nowcasting (SCAN)
  - Four-Dimensional Stormscale Investigator (FSI)

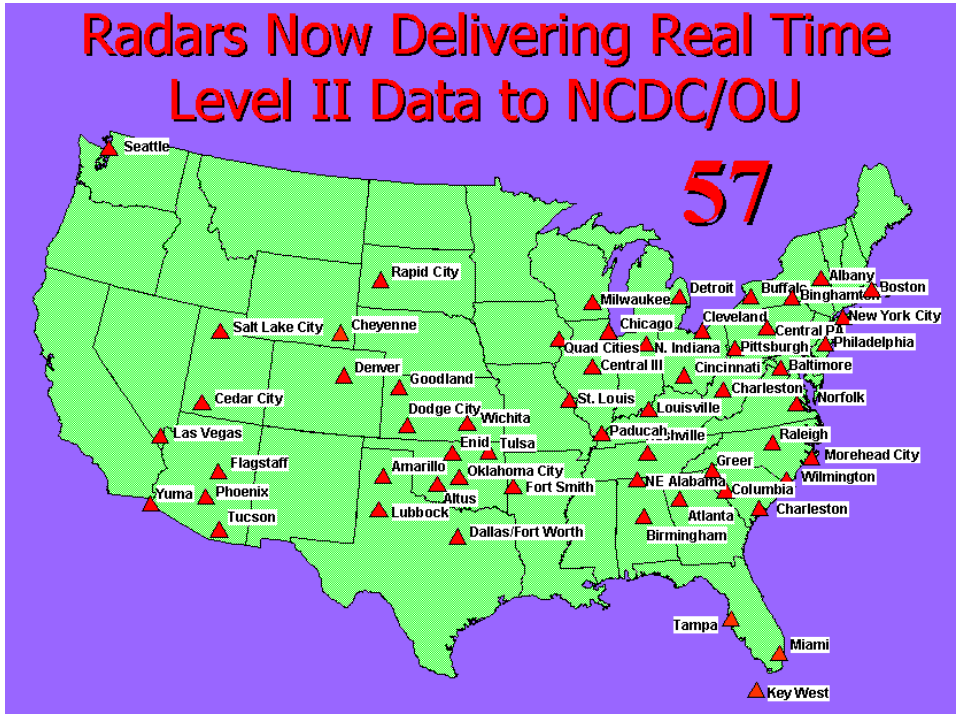
- Data Archive (Level 2 Data)
  - Collaborative Data Acquisition Field Test (CRAFT)
  - Radar Interface & Data Distribution (RIDDS)
  - Integrated Radar Data Services (IRADS)



WDSS Image: May 3, 1999

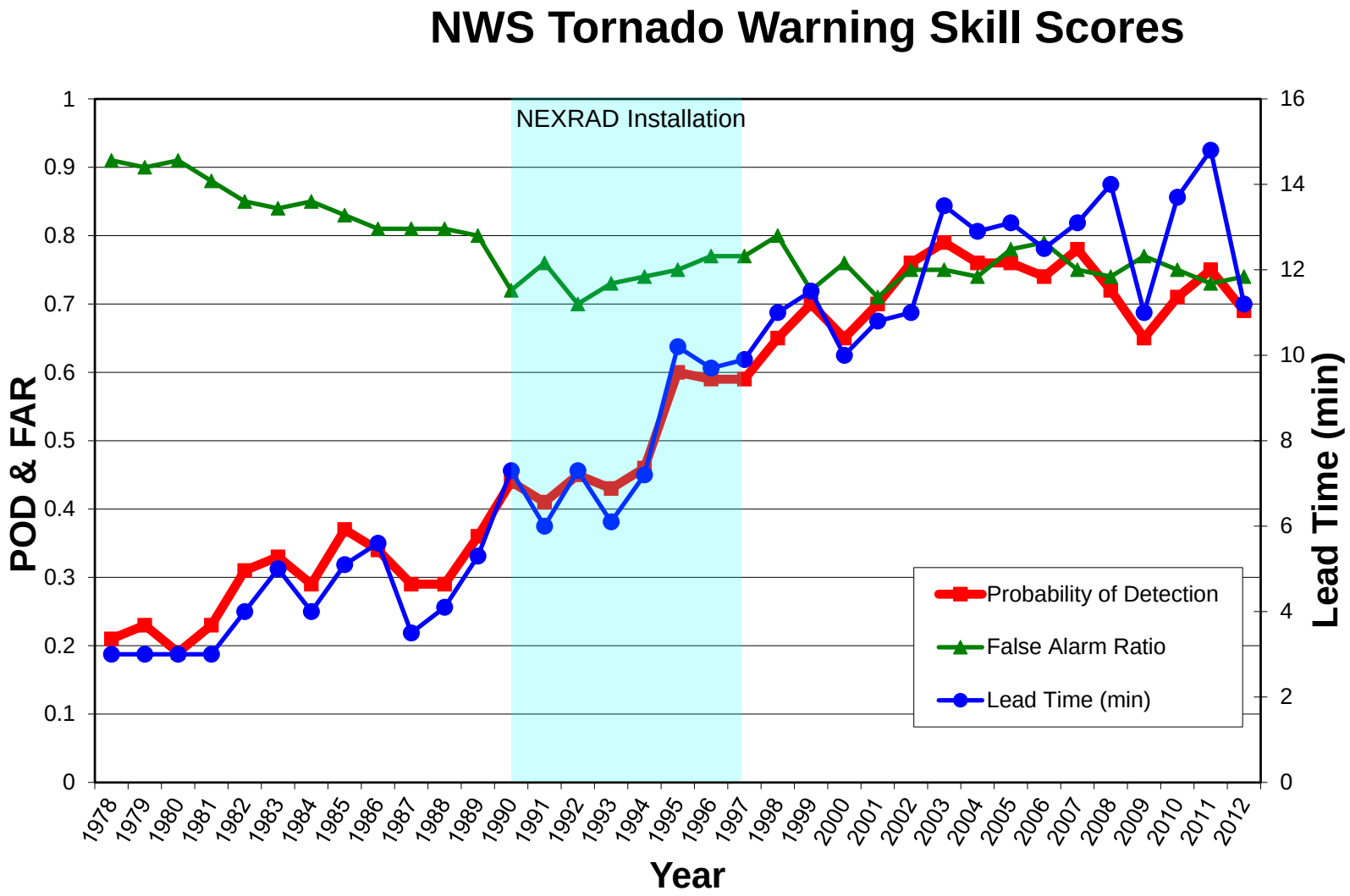


FSI Image: Reflectivity Analysis; From NWS AWIPS2 System



CRAFT Radars Sending Data to OU & NCDC in 2001; Project Lasted until 2004

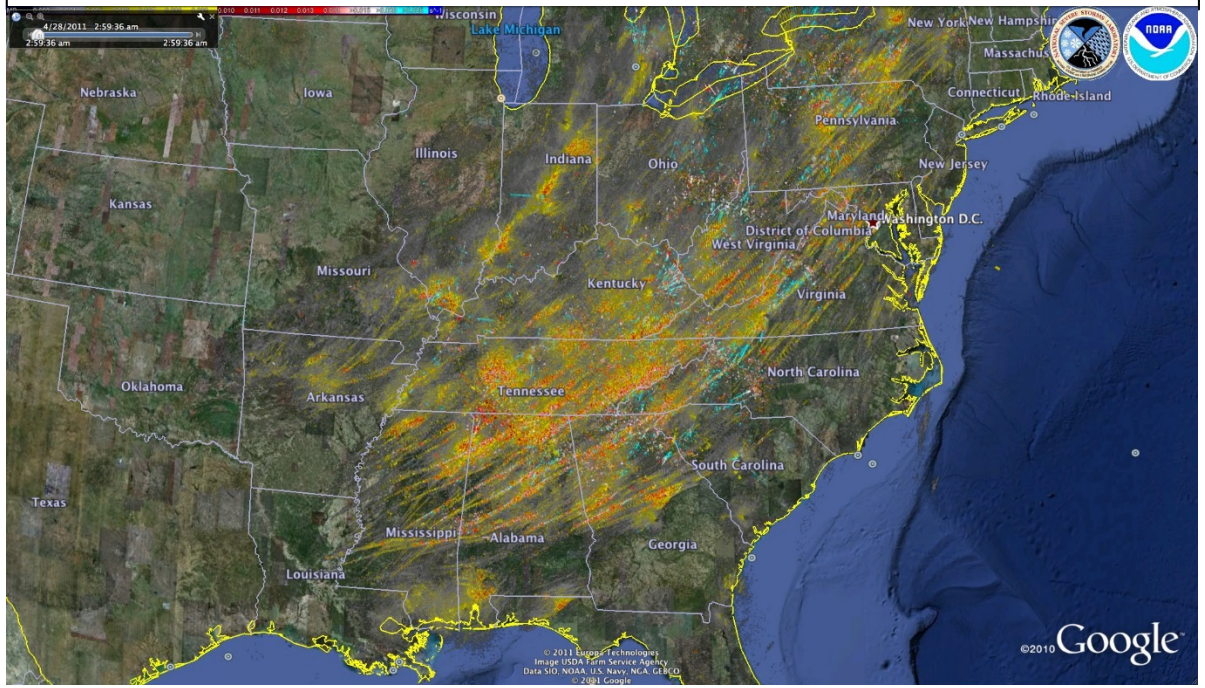
The Improvement in Tornado Warnings



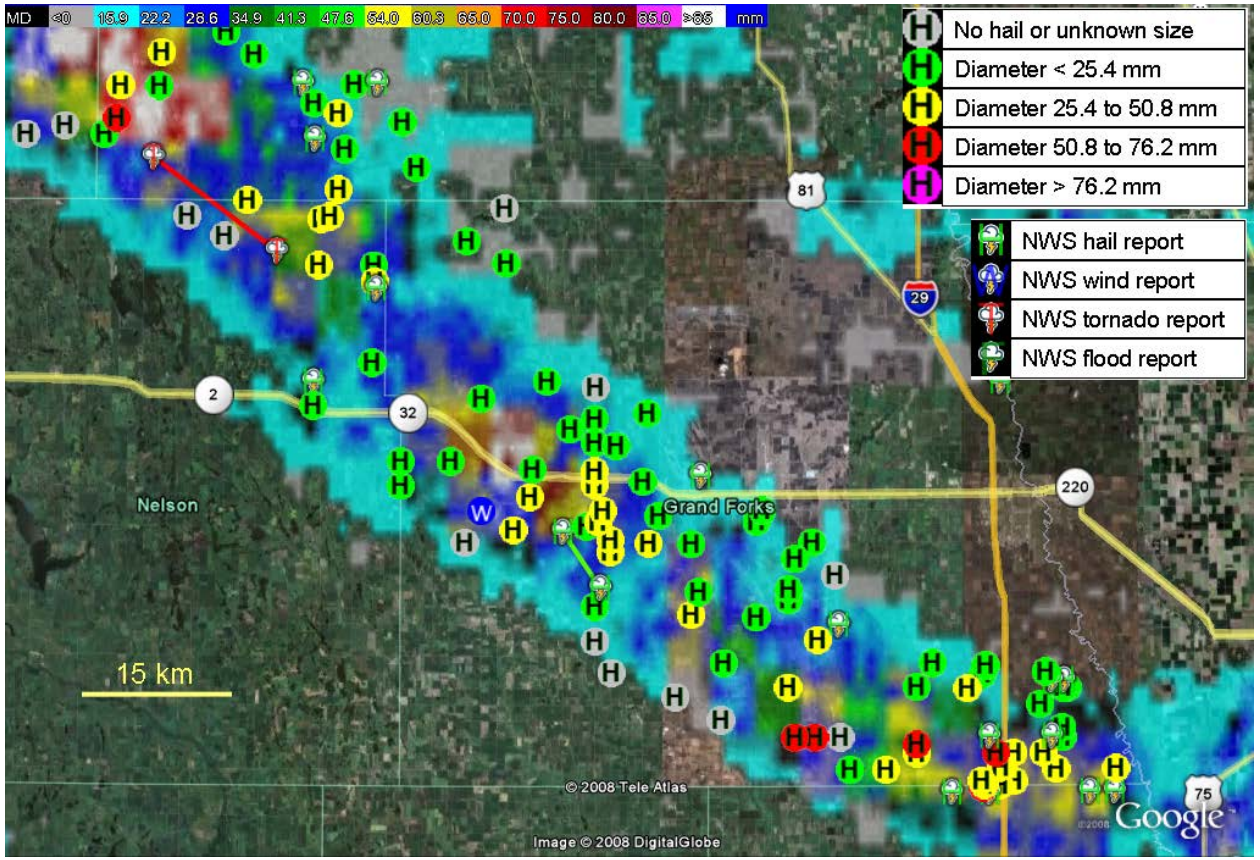
Department of Commerce Gold Medal (NSSL; and CIMMS) “for achieving scientific and technical breakthroughs leading to the continuous improvements in the national network of Doppler radars” (1997)

Multiple Radar/Multiple Sensor (MRMS) Severe Storm Applications

- Multi-Radar Multi-Sensor Applications Have Significant Advantages Over Single-Radar Applications
- First Called Quantitative Precipitation Estimation – Segregation Using Multiple Sensors (QPE-SUMMS)
- MRMS Combines QPE and Severe Storm Applications
  - Rotation Tracks (Shear Swaths)
  - Maximum Expected Size of Hail (MESH) Swaths
    - NSSL On Demand (Experimental)



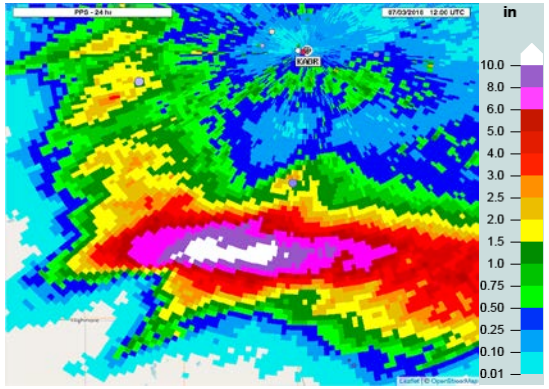
Rotation Tracks for April 27, 2011 Tornado Outbreak



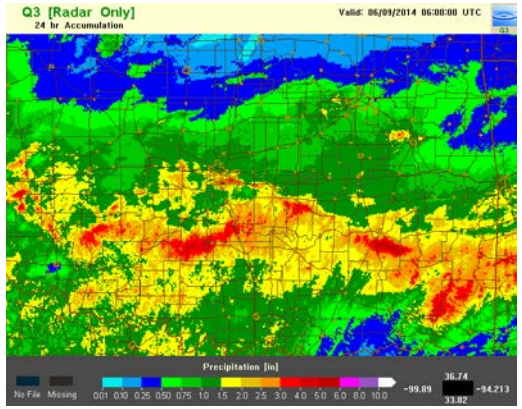
MESH Swath Overlaid with Hail Reports from the Severe Hazards Analysis & Verification Experiment (SHAVE). Note Correspondence between MESH Ouput and SHAVE Reports. Note also the Low Number of Hail Reports Received by the NWS Offices.

[*Poster by Ortega et al*]

Advances in WSR-88D Radar Quantitative Precip Estimation (QPE)



Single Radar



PPS (*Fulton et al. 1998*):
single radar, single-pol
single R(Z)/per radar; manually set

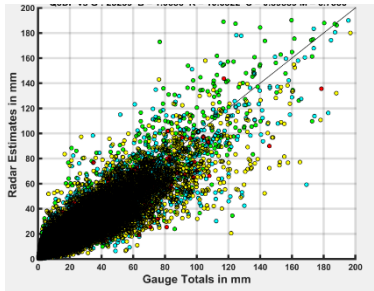
DPR (*Giangrande & Ryzhkov 2008*):
single radar, dual-pol
Hydrometeor classification
R(Z)/R(Z,Z_{DR})/R(K_{DP}) synthetic

1991 97 00 04 11 14 2019

CRAFT
(*Kelleher et al. 2007*)

Stage-II (*Baldwin & Mitchell 1996*):
multi-radar, single-pol
Inverse distance weighted (IDW) mosaicking
4km, hourly

MRMS-Q3RAD (*Zhang et al. 2016*):
Multi-radar, single-pol
dual-pol QC,
multi R(Z),
Precip classification
Bright band correction
Conditional IDW mosaicking
Canadian radar
1km, 2min



Multi-Radar Multi-Sensor (MRMS)

Z: reflectivity; Z_{DR}: differential reflectivity; K_{DP}: specific differential phase; A: specific attenuation

DOC Silver Medal for Operational MRMS (2015)

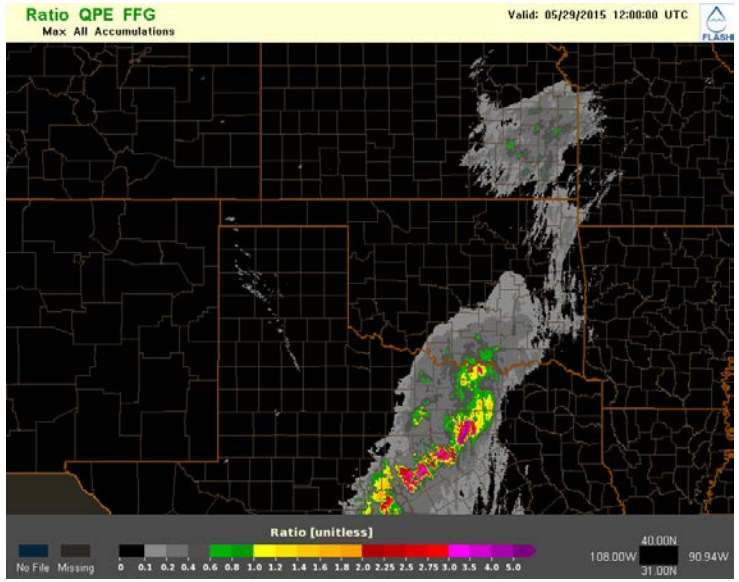
MRMS-Q3DP (Ryzhkov et al. 2014, *Zhang et al. 2017*):
Multi-radar, dual-pol
R(A)/R(K_{DP}) in rain and hail
Q3RAD in mixed and ice phase
Evaporation correction

Thanks to Jian Zhang; *Poster by S Martinatis, et al*

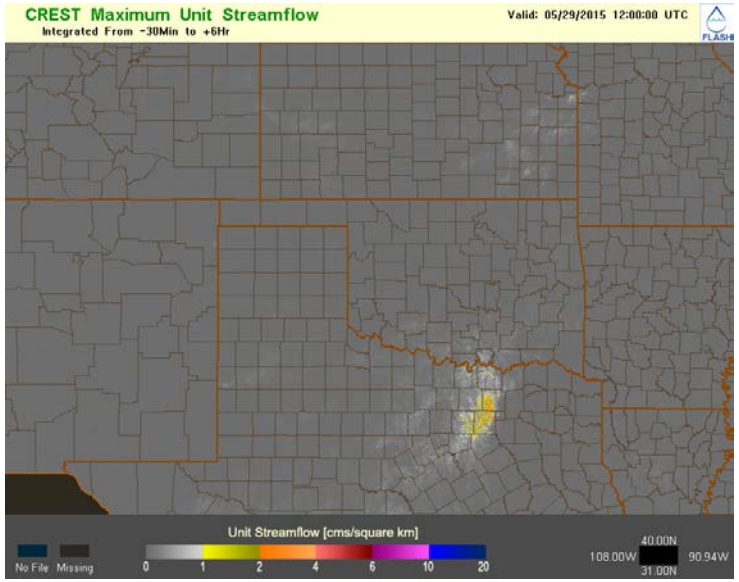
MRMS QPE and Flood Warnings

Flooded Locations and Simulated Hydrographs (FLASH) Project

FLASH uses rainfall observations from MRMS and a hydrologic model to introduce a new paradigm in flash flood prediction that produces outputs at 1-km 5-min resolution. It is now operational within the NWS.



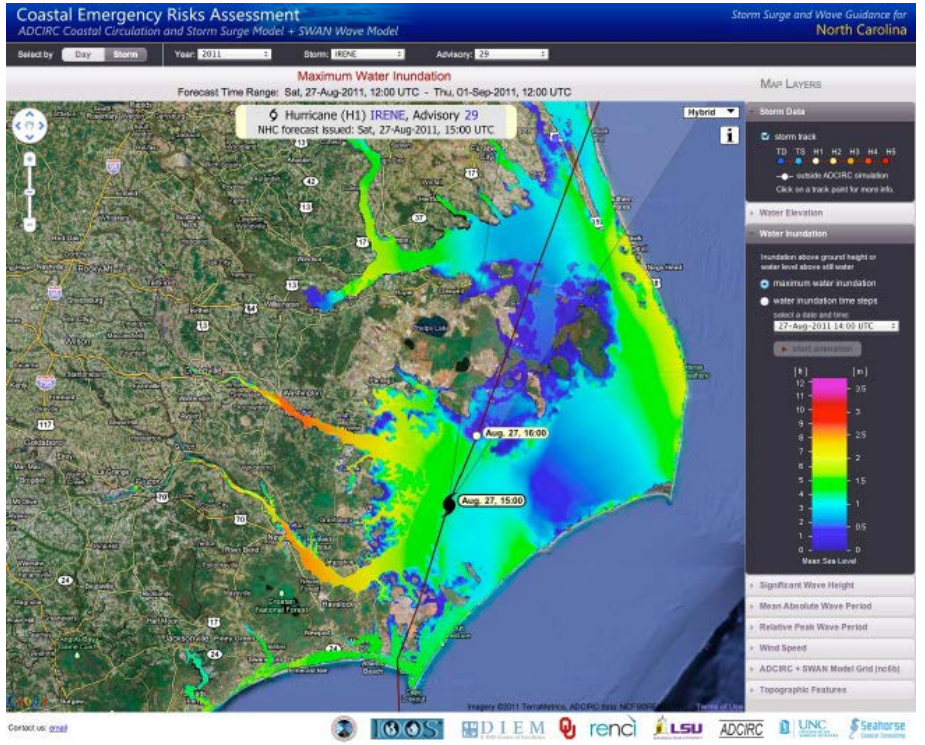
Ratio of QPE to Flash Flood Guidance for an event in North Texas on May 29, 2015



Maximum Unit Streamflow for an event in North Texas on May 29, 2015

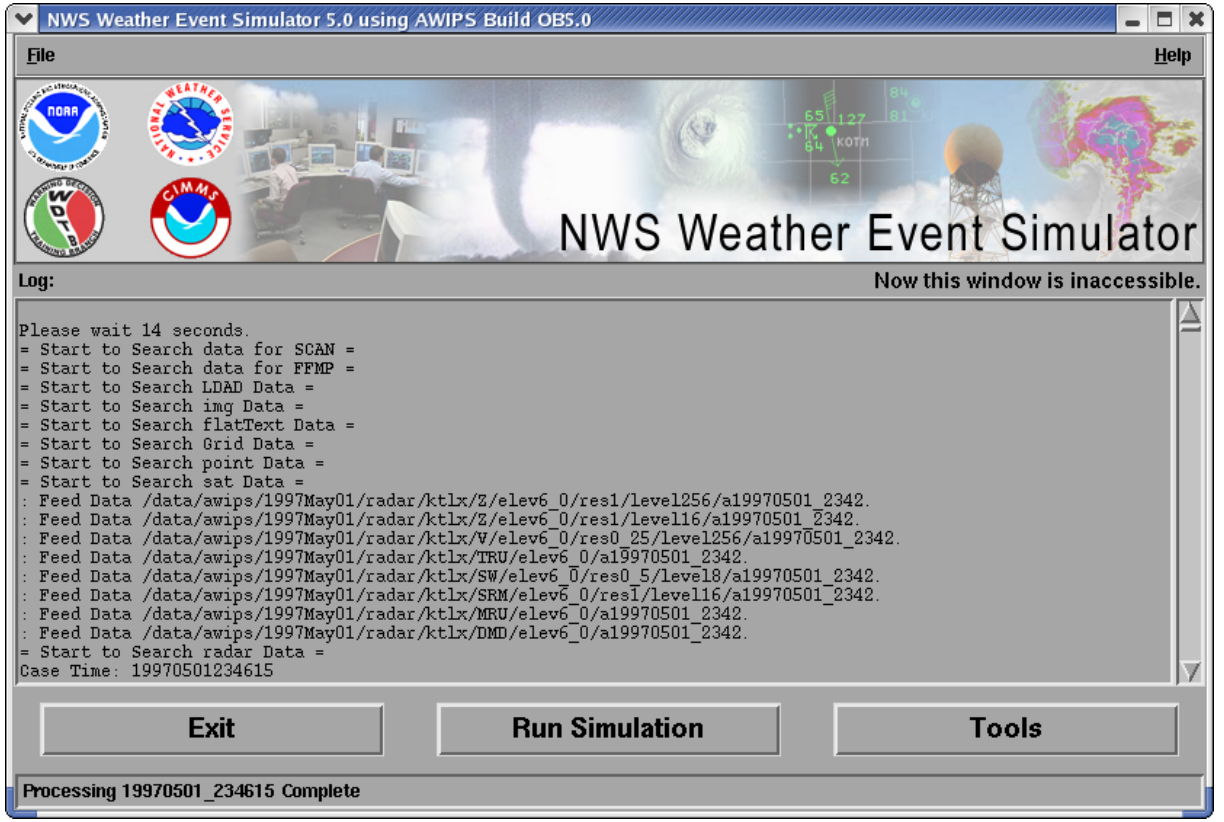
Coastal and Inland Flooding Observation and Warning (CI-FLOW)

CI-FLOW captures the complex interaction between MRMS rainfall, river flows, waves, tides and storm surge, and how they will impact ocean and river water levels



Forecast & Warning Improvement Success Tied to Training

- NWS Radar, Severe Storm and QPE/Flash Flood Training Done in Norman Since the 1990's by: OTB, FIRSTT, WDTB, WDTD
- Tornado Warning Guidance, Distance Learning Courses, Workshops, Weather Event Simulator (WES)

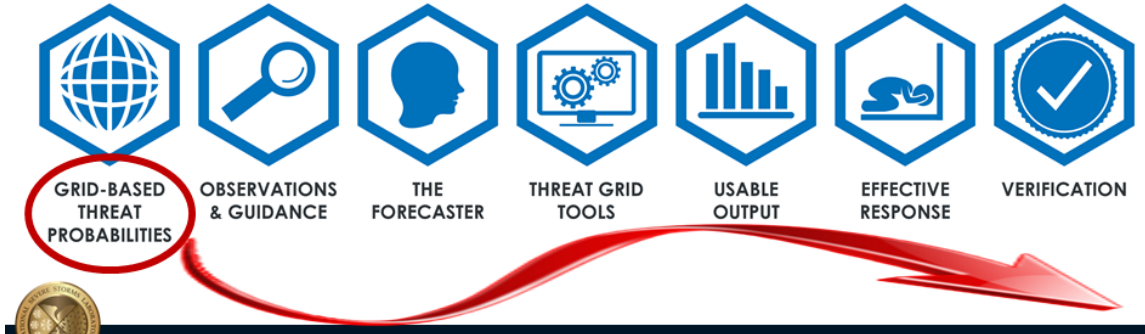


Thanks to B. Grant & A. Wood [*Posters by A. Wood et al & D. Morris et al]*

Forecasts & Warnings of the Future: FACETs

FACETs Is…

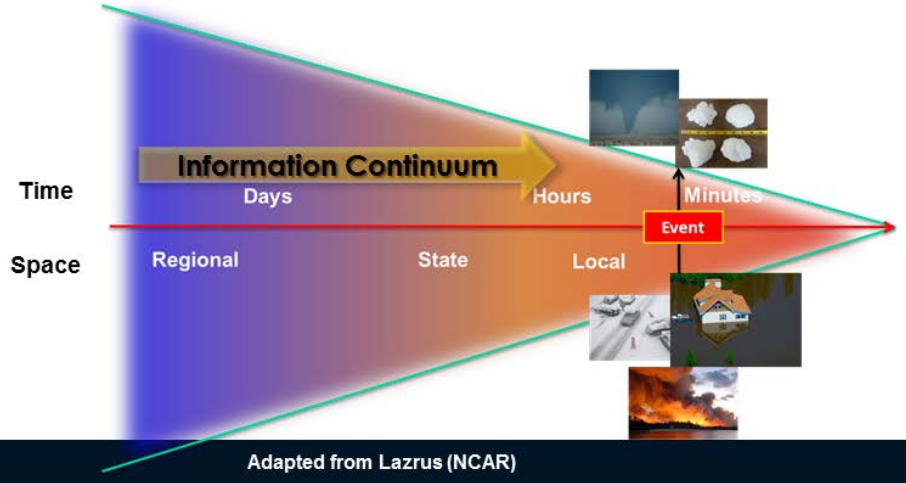
- Forecasting a Continuum of Environmental Threats
- A modernization of NOAA's current teletype-era, deterministic (binary), product-centric paradigm.
- Focused on entire forecast/warning process.



1

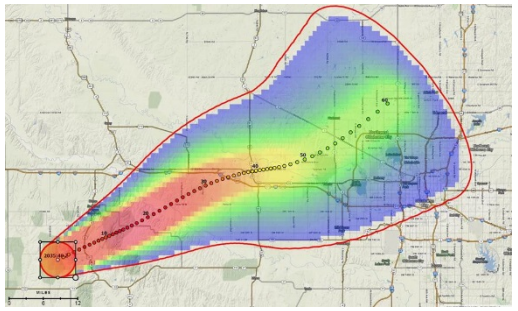
FACETs Is…

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



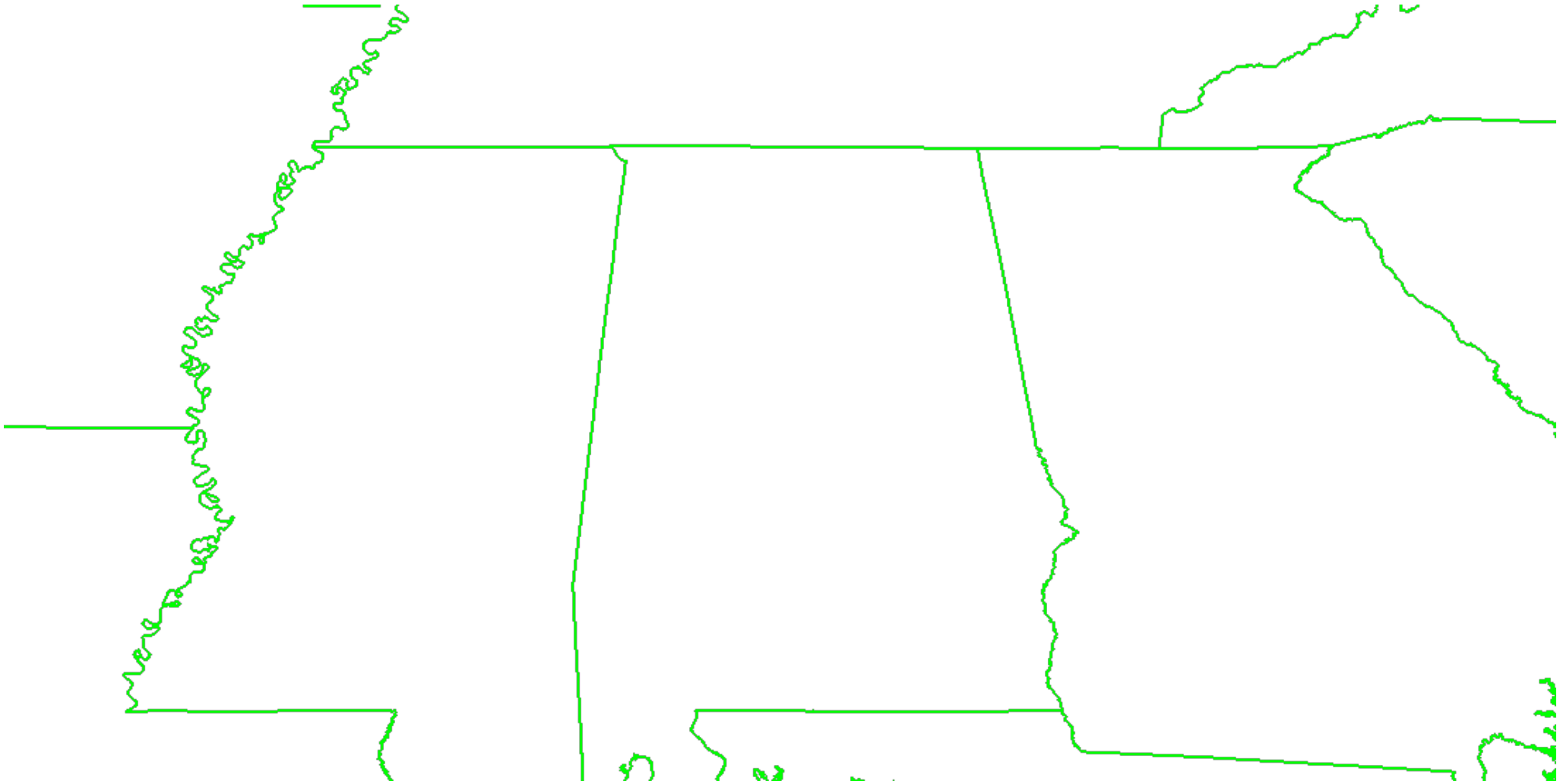
Adapted from Lazrus (NCAR)

2



Thanks to Alan Gerard [*Posters by K. Calhoun et al & G. Stumpf et al]*

How FACETs Might Look for an April 27, 2011-Type Event



Thanks to Greg Stumpf

QUESTIONS?