Hazardous Weather Testbed

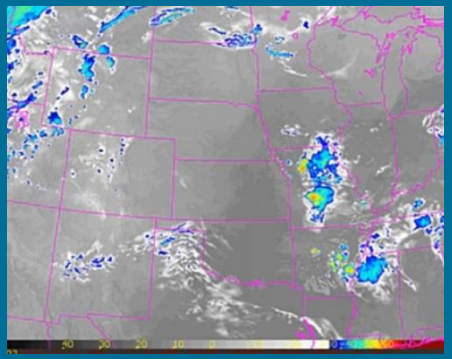
Results from the Experimental Warning Program in 2014

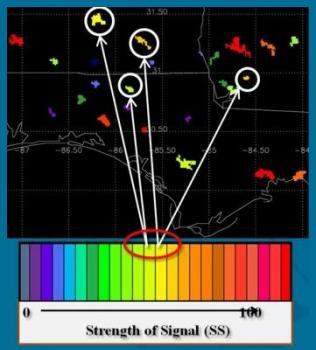
Gabe Garfield

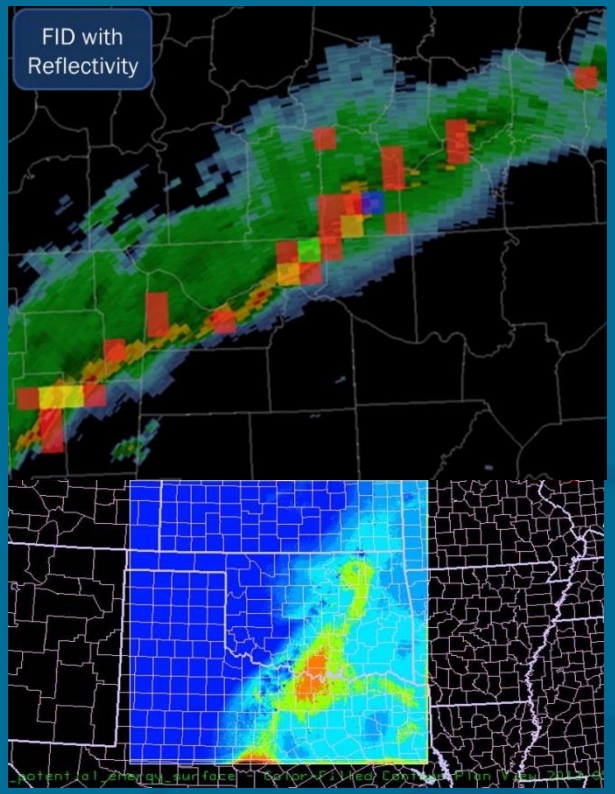
NOAA Hazardous Weather Testbed

CIMMS/NWS

Norman, OK







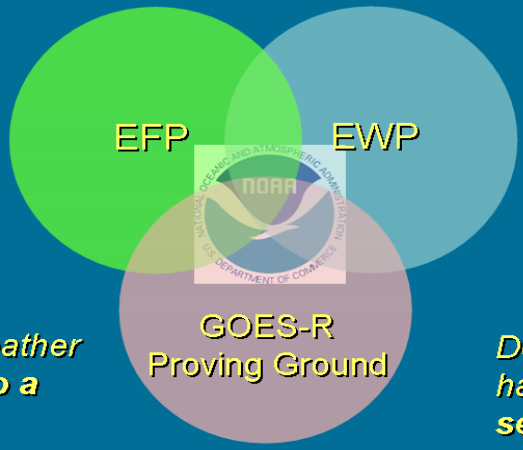
What is the HWT?

Not just a facility…

…but an organization:

Experimental Forecast Program

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

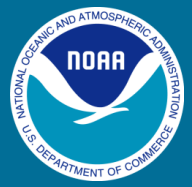


Experimental Warning Program

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

HWT Experimental Warning Program (EWP)

- Mission: Improve prediction of severe convective weather at the "warning scale" (0-2 hours).
- Norman has a large community of researchers, operational meteorologists, students, industry.
- But, we serve all National Weather Service WFOs and CWSUs nationwide.
- A vital component to the Research To Operations (R2O) process.



What is tested?

- New sensors:
  - Radar, satellite, lightning, etc.
- New Applications/Algorithms:
  - Multi-sensor integration (MRMS), GOES-R proxies, lightning jump, very short term models, etc.
- New Methodologies:
  - Best practices, new concepts, products, services
  - Social Science integration

EWP 2014

- MRMS Best Practices (April)
- Big Experiment (May / June)
- PHI Experiment (May / June)
- Hydro Experiment (July / August)
- ENTLN Experiment (July / August)

EWP 2014
By the Numbers

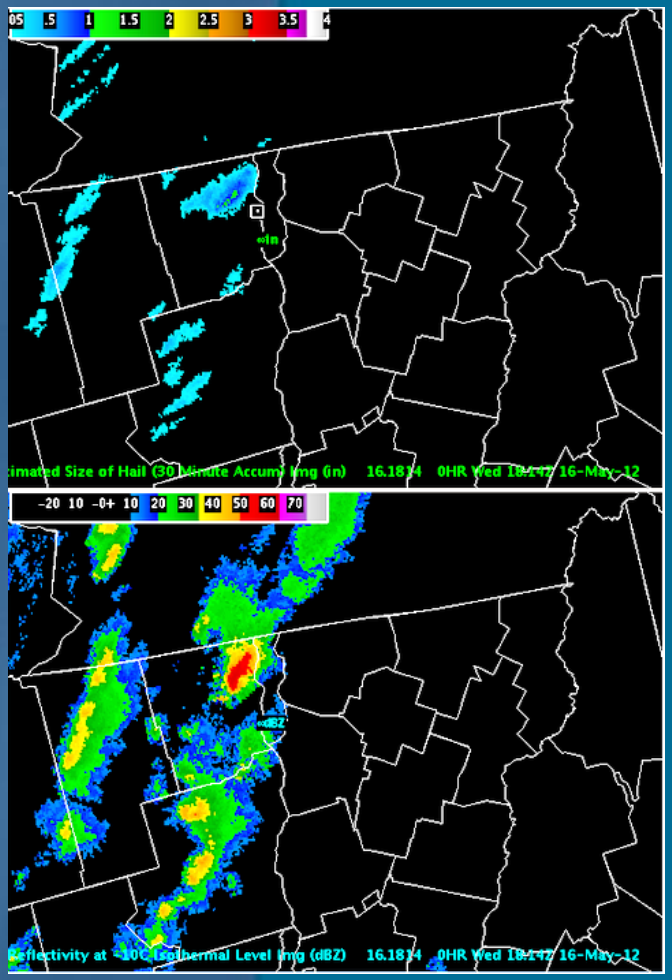
MRMS Best Practices	8 forecasters	(2 wks)
Big Experiment	16 forecasters*	(4 wks)
PHI Experiment	6 forecasters	(3 wks)
Hydro Experiment	8 forecasters	(4 wks)
ENTLN Experiment	18 forecasters	(6 wks)
TOTAL:	56 forecasters	(14 wks)

* 4 broadcasters participated

EWP 2013

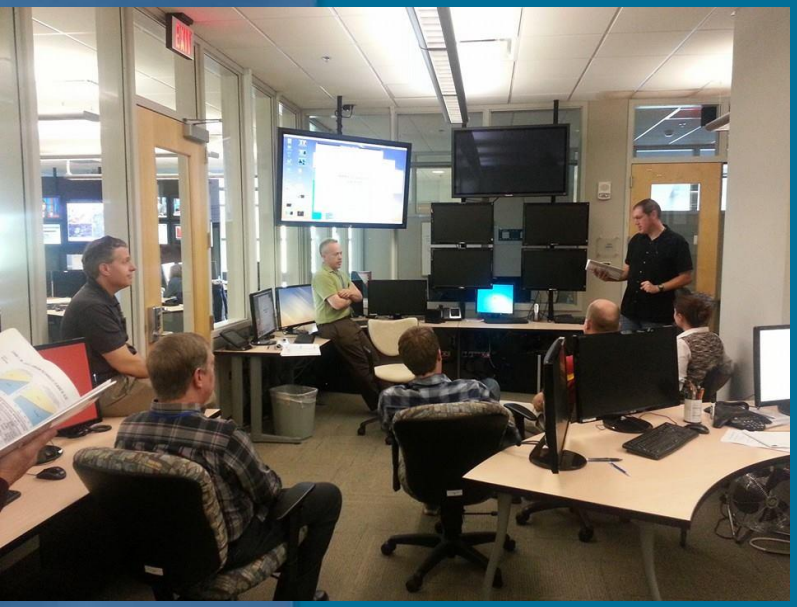
Big Experiment	6 forecasters	(3 weeks)
TOTAL:	18 forecasters	3 weeks

Multi-Radar Multi-Sensor (MRMS) Overview



- Tests in 2009, 2010, and 2013.
- Feedback helped secure MRMS's acceptance of an official operational system for the NWS
- MRMS Operational System at NCEP online by October 2014
- MRMS products will be displayable in AWIPS2 starting February 2015

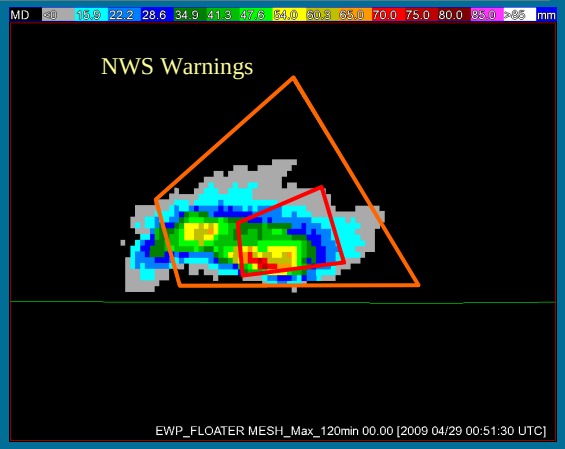
Multi-Radar Multi-Sensor Best Practices: Questions

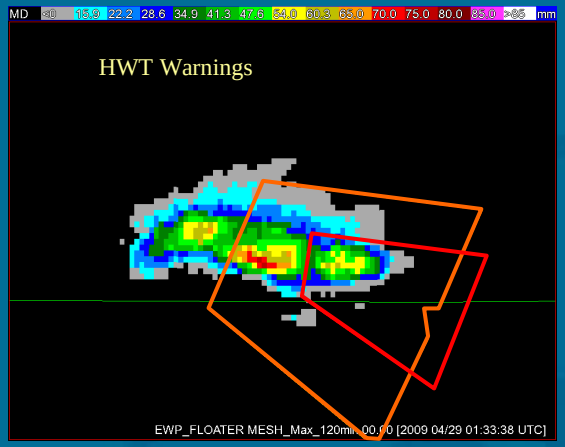


- What are the Best MRMS products for warnings?
- What are the optimal AWIPS2 procedures for hail, wind, and tornado?
- How does MRMS best integrate into traditional severe wx diagnosis?
- How does MRMS calibrate gainst traditional products?

MRMS BPE's "Secret" Hypotheses

- MRMS products improve warning decision making by:
  - Improving warning polygon alignment and precision (less false alarm area)
  - Speeding up storm diagnosis/triage
  - Improving lead time to first severe
  - Improving analysis in cones of silence





MRMS Best Practices Methodology

- Conducted controlled experiments with up to 6 archived severe weather cases
- Two groups of evaluators in two separate HWT rooms
  - Control group: no MRMS data
  - Experimental group: MRMS data

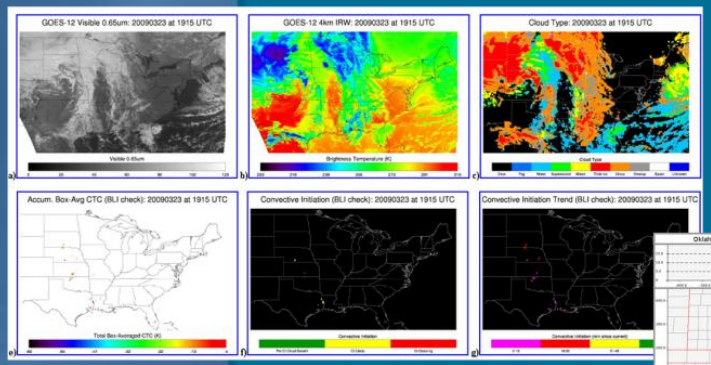
Early MRMS Results

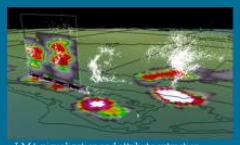
- Ranking storms much faster with MRMS
  - Control: 8 storms in 30 min
  - Experiment: 12.25 storms in 30 min
- Quick diagnosis of storms using MRMS
  - Donavon Technique, Case 1
    - Control: 48 s / storm
    - Experiment: 17 s / storm
  - Donavon Technique, Case 2
    - Control: 43 s / storm
    - Experiment: 23 s / storm

Big Spring Experiment

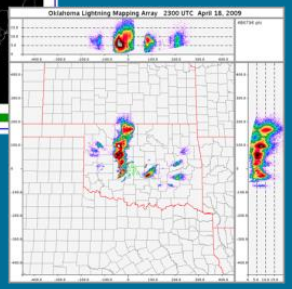
2014

GOES-R / PGLM

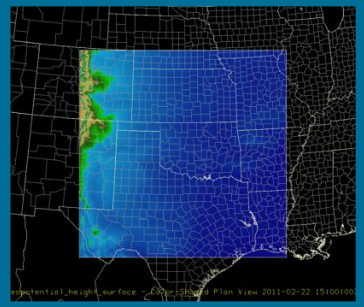


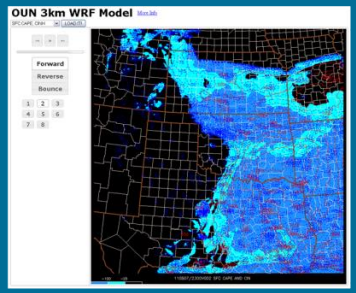


LMA visualization and attribute extraction

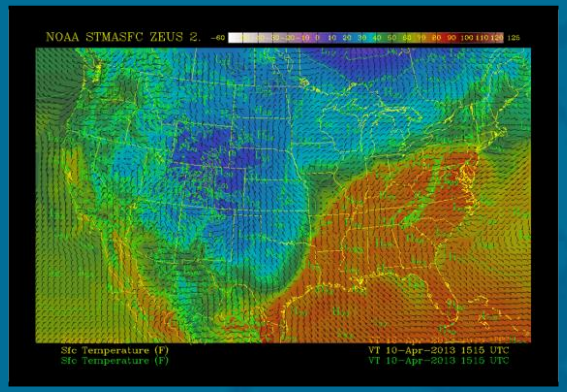


OUN WRF





LAPS Space and Time Multiscale Analysis System (STMAS)



New for Spring Experiment in 2014

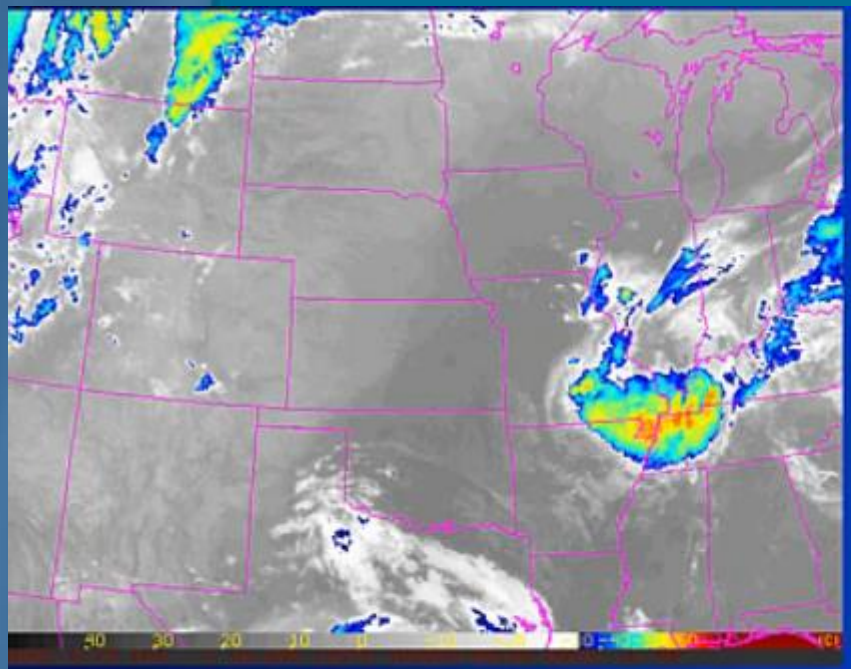
- Probability of Severe
  - Statistical model (for developing thunderstorms)
- Overshooting Top Detection
  - Satellite algorithm
- Variational LAPS model
  - On-demand, 1-km forecast
- Multi-field trending tool
  - Model output, satellite, radar
- GOES-R Rapid Scan
  - 1-min updates
  - 8-22 May 2014

EWP2014 Spring Experiment

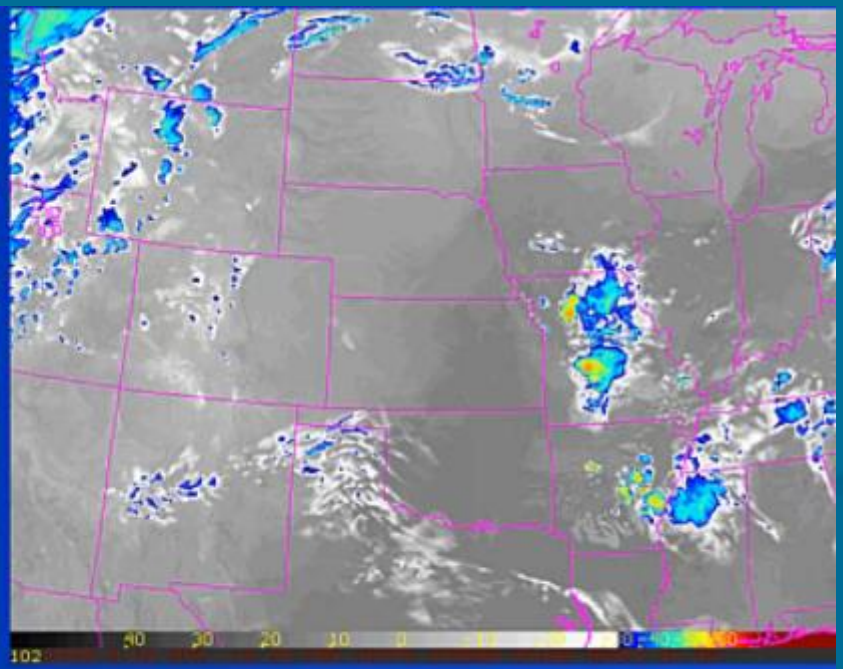
- 4 weeks (5 May, 12 May, 19 May, 2 June)
  - 4 forecasters per week
- Using AWIPS2 for the third year
- Want forecasters to think about how products are used in nowcast and warning decision making.
  1. Live blogging
  2. Mention experiment products in the warnings.

  Encourage forecasters to slip out of “comfort zones”

WRF Synthetic Cloud & Moisture Imagery



GOES-13 data from 16 March 2012 valid 09 to 21 UTC



Simulated Imagery based on a 9- to 21-hour foreca from the WRF-ARW

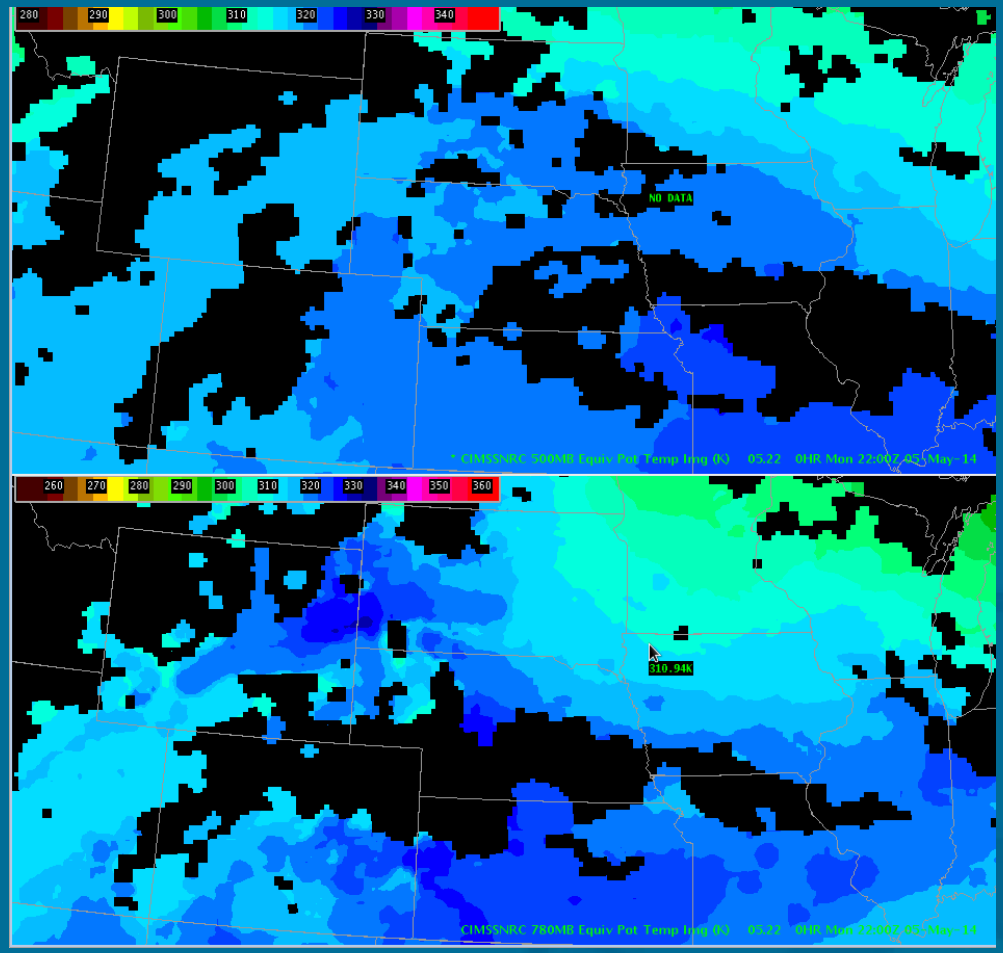
Big Spring Experiment

Synthetic Satellite Forecaster Evaluation

- If synthetic satellite agrees with observations, raises confidence (and vice versa).
- When on-track, predicted areas of storm development.

GOES-R Nearcast

Temperature / moisture fields advected by a trajectory model to forecast future state of atmosphere

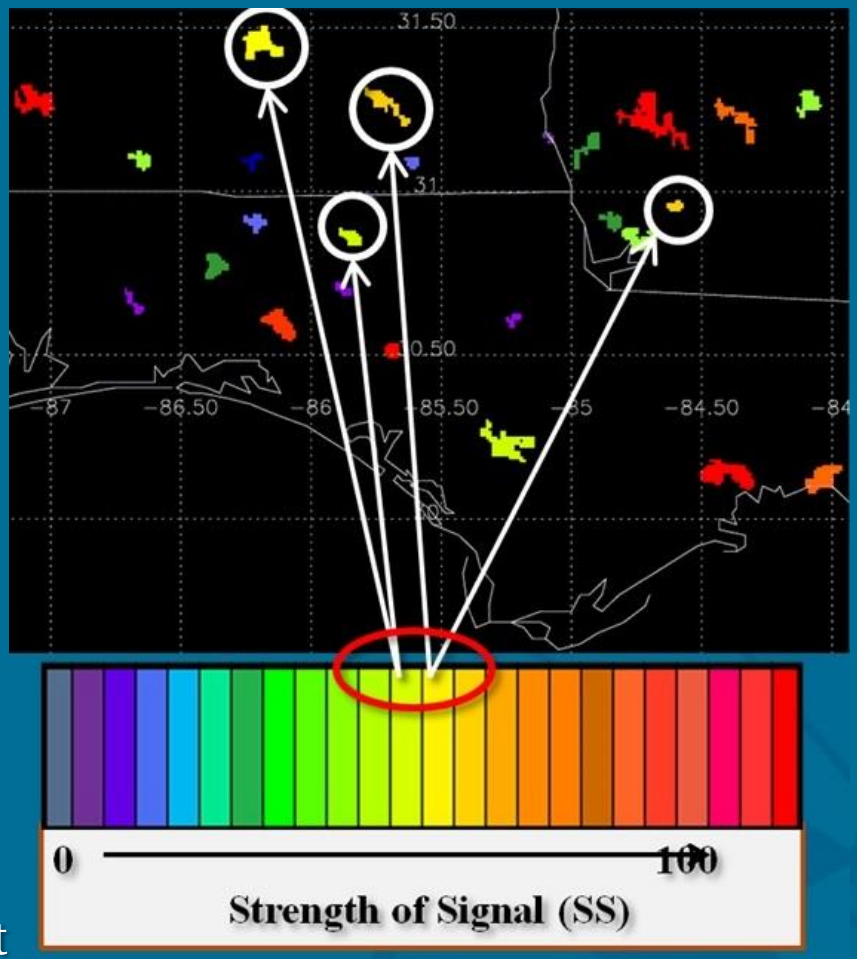


Big Spring Experiment

NearCast Forecaster Evaluation

- Predicted area of convective instability well
- Forecast area of convective initiation – usually on theta-e gradients
- Projections of gradient location were accurate

UAH Convective Initiation: "SATCAST"



Big Spring Experiment

UAH Convective Initiation Forecaster Evaluation

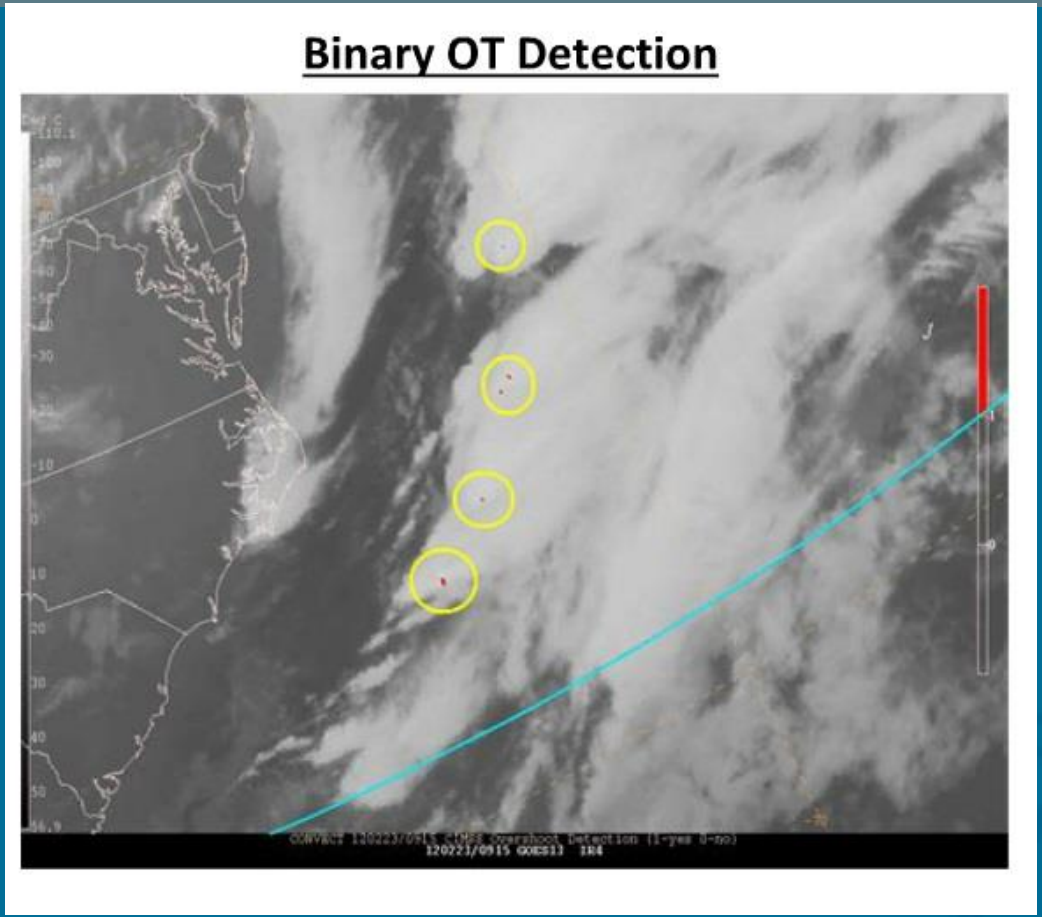
- Enhanced situational awareness
- Often indicated convective initiation before radar returns
- Considered close to ready for operations

UAH Convective Initiation Forecaster Evaluation

Drawbacks:

- Not as useful for nighttime operations when the algorithm switches to using IR
- Had to calibrate to every scenario
- Prone to false alarms

Overshooting Top Detection

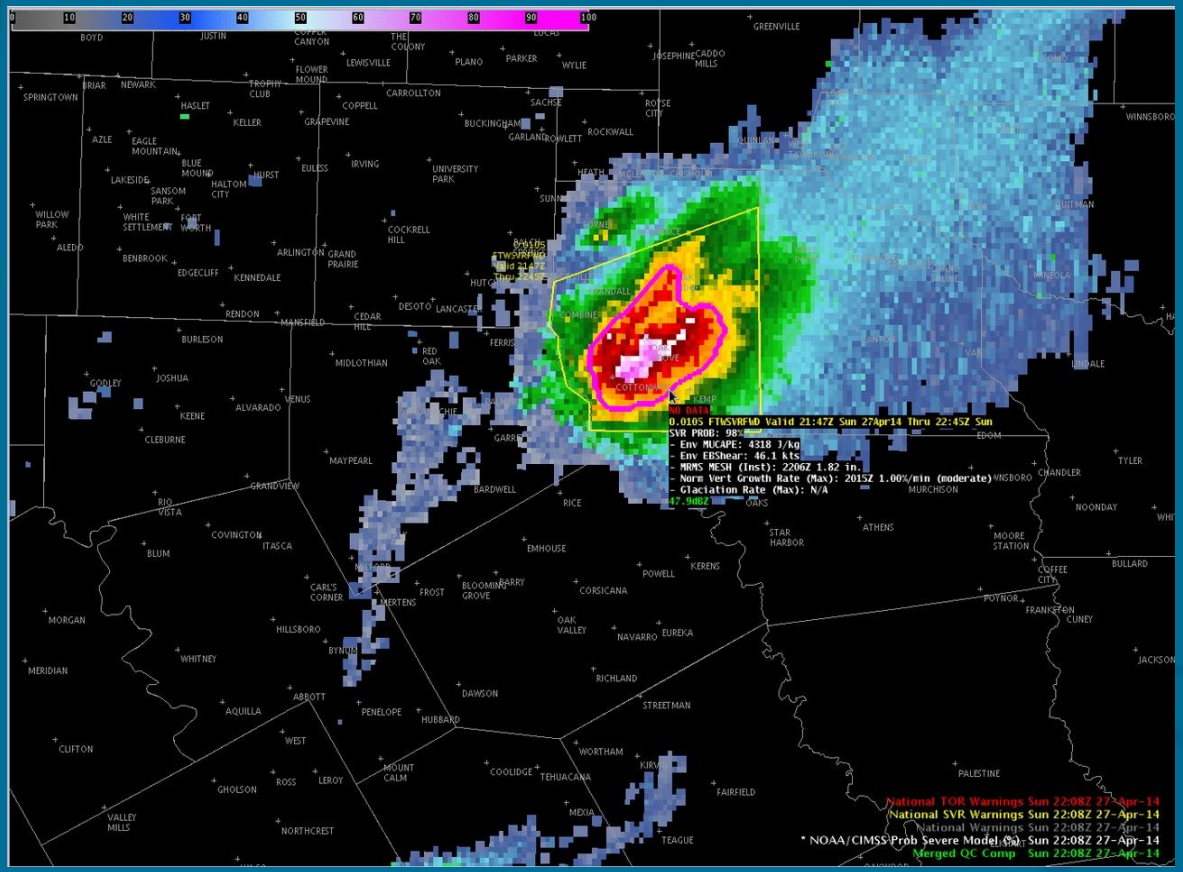


Big Spring Experiment

Overshooting Top Detection Forecaster Evaluation

- Enhanced situational awareness
- Beneficial for CWSUs, as well as broadcasters

Probability of Severe



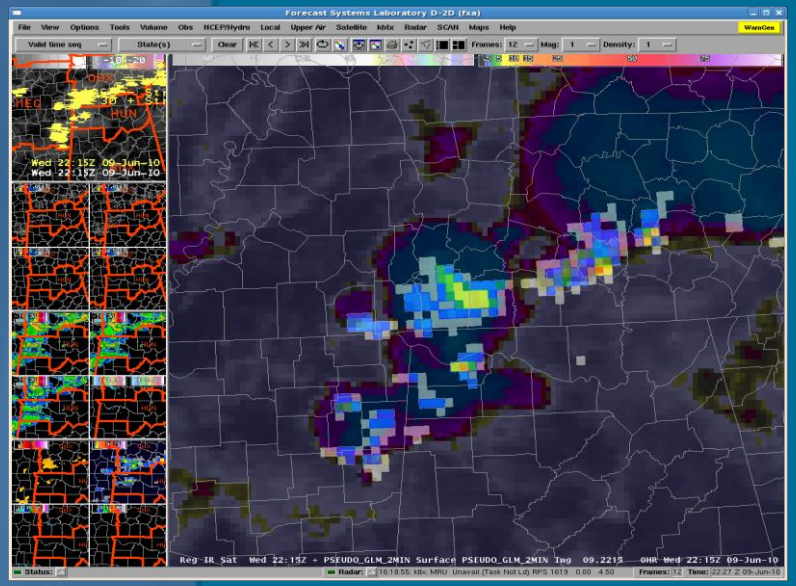
Big Spring Experiment

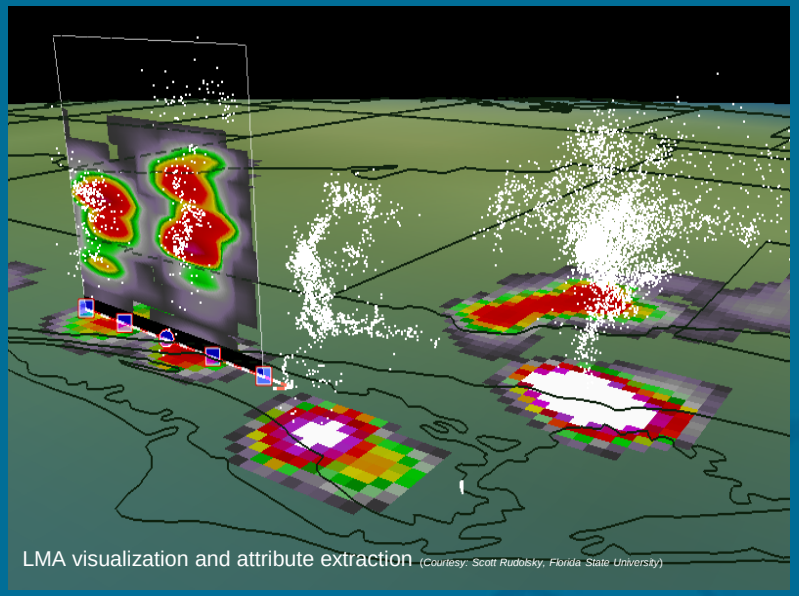
Probability of Severe Forecaster Evaluation

- Worked best for hail
- Trends were accurate
- Sampling tool gives view into why certain probs
- Struggles with mature cells
- Helpful in “tipping the scale” just after initiation
- Useful for broadcasters working by themselves

Pseudo-Geostationary Lightning Mapper (PGLM)

- Cloud-to-Ground + Intra-Cloud = **Total Lightning**




LMA visualization and attribute extraction *(Courtesy: Scott Rudolsky, Florida State University)*

Big Spring Experiment

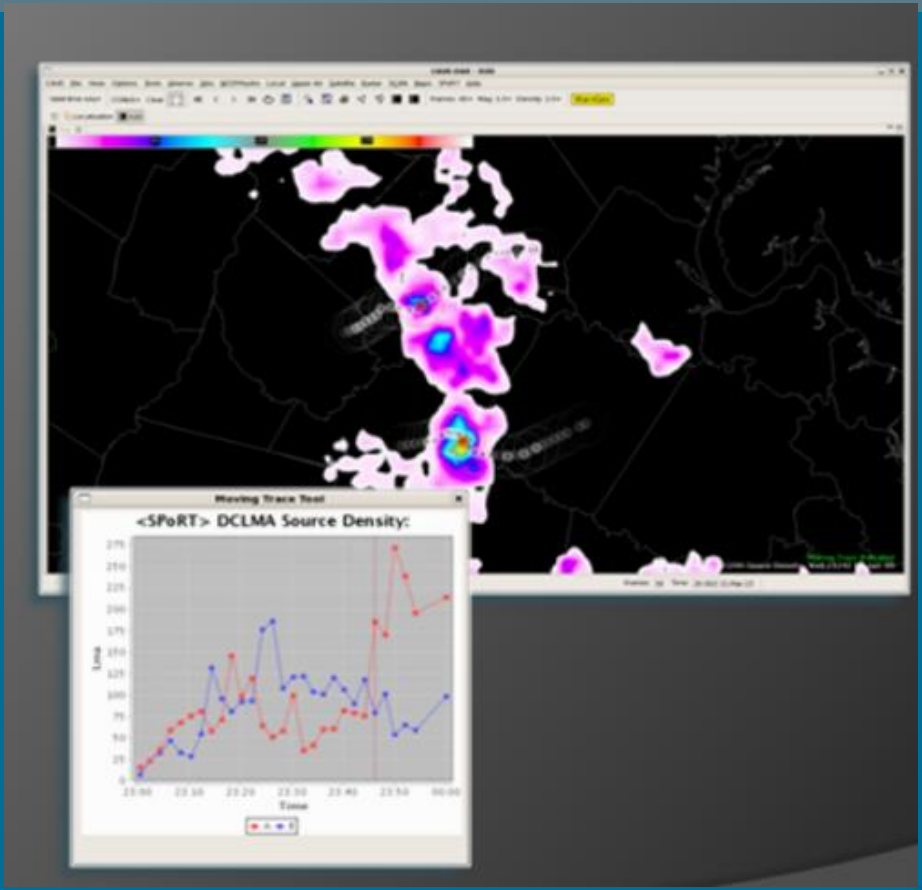
PGLM
Forecaster Evaluation

- Lightning jumps and flash density valuable for situational awareness
- Lightning jump detection highlights rapidly intensifying cells
- Lightning flashes and flash jump algorithms can indicate updraft health

PGLM
Forecaster Evalution

- Aviation perspective (CWSU) - Lightning products enhance nowcasting and help determine flight paths
- Broadcast perspective - All products useful for broadcast meteorologist working by themselves during severe weather operations

pGLM Multi-field Trending Tool for AWIPS2



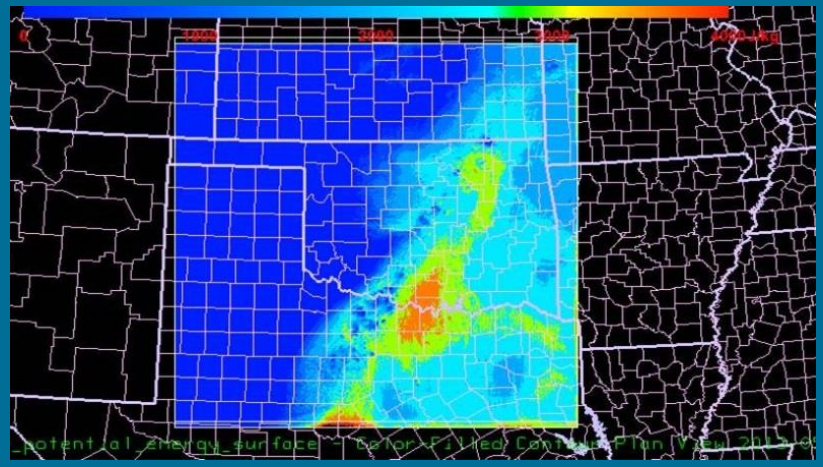
Big Spring Experiment

PGLM Trending Tool Forecaster Evaluation

- Prototype tool shows promise, but too much effort required for operations as of now

Variational LAPS (vLAPS)

- 3 models
  - 2 moveable, 1-km grids run hourly (out to 3 hrs)
  - One static, CONUS, 2.5-km grid run hourly
- Products
  - Composite Reflectivity
  - CAPE
  - Updraft Helicity
  - Storm Relative Helicity
  - Simulated IR Brightness Temp



Big Spring Experiment

vLAPS Forecaster Evaluation

- Helped to identify boundaries in CAPE field
- Theta-e from surface analysis is useful
- CAPE forecast accurate, generally
- High spatial resolution (1-km spacing) depicted smaller-scale features

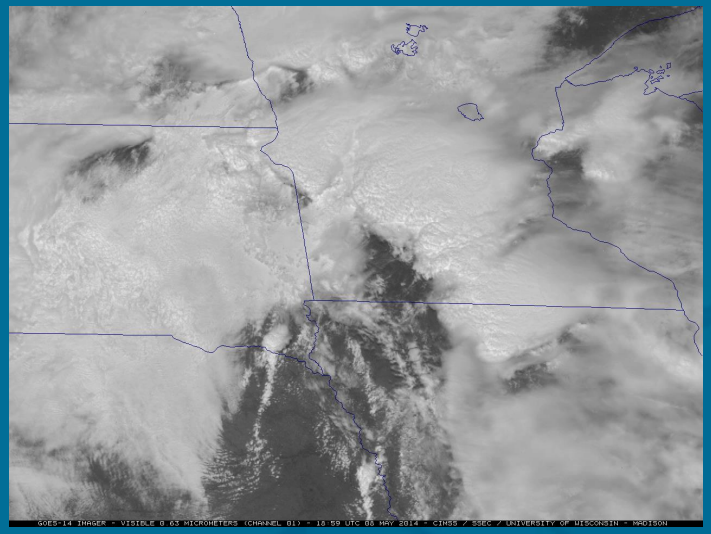
vLAPS Forecaster Evaluation

Drawbacks:

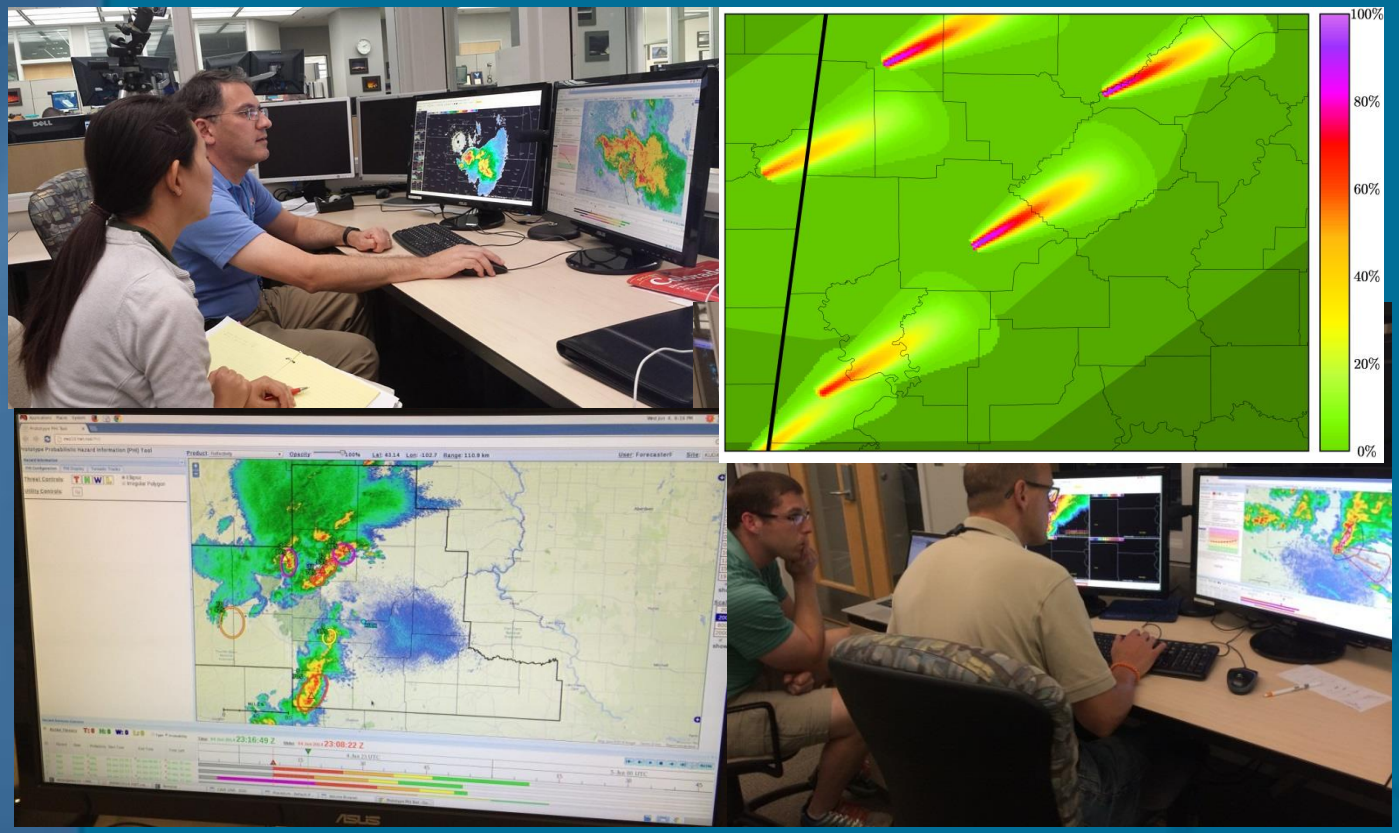
- Tended to overestimate composite Z
- Erroneous surface obs affected output
- Re-locatable domain wasn't big enough

Super Rapid Scan Satellite
5 – 22 May
Forecaster Evaluation

- Used to observe key storm-scale features
- Would not be able to identify without 1-min updates
- Enhanced situational awareness for convection
- Could also enhance detection of:
  - Fog advection/ dissipation
  - Lake-effect snow band



Probabilistic Hazards Information (PHI) Experiment



PHI
Early Results

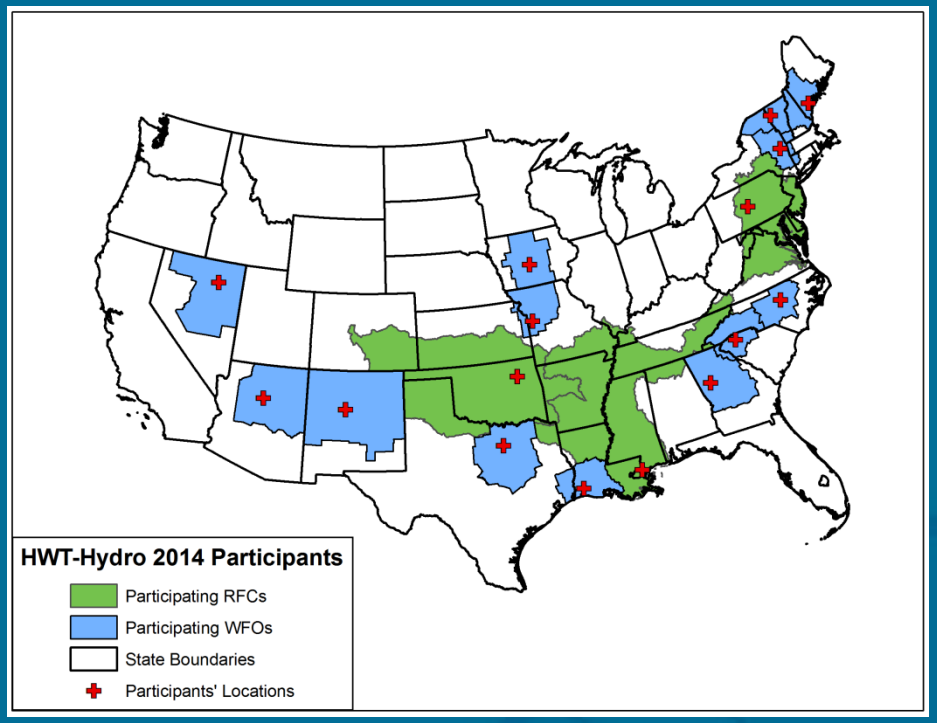
- "On-the-fence" decision points are reduced significantly.
  - Allows for low-probability hazard information to be communicated to the public.
  - Results in richer and more detailed information for more storms.
  - Workload is a non-issue when no more than ~4-5 hazards or storm is "well-behaved".
  - Need algorithms to provide first-guesses to offset workload, particularly for multi-mode events with complex evolution.
  - Focus for future testing/evaluation in HWT.

PHI
Early Results

- Different way of thinking
  - Forecasters are thinking more about the meteorology (i.e., structure/development of storms) of the event as compared to current warning system.
    - Enhanced situational awareness.
    - Implies sectorizing of forecasters into geographic regions as opposed to hazard type.
  - Old system – forecasters more concerned about “polygonology”.
  - Will be a need for training.

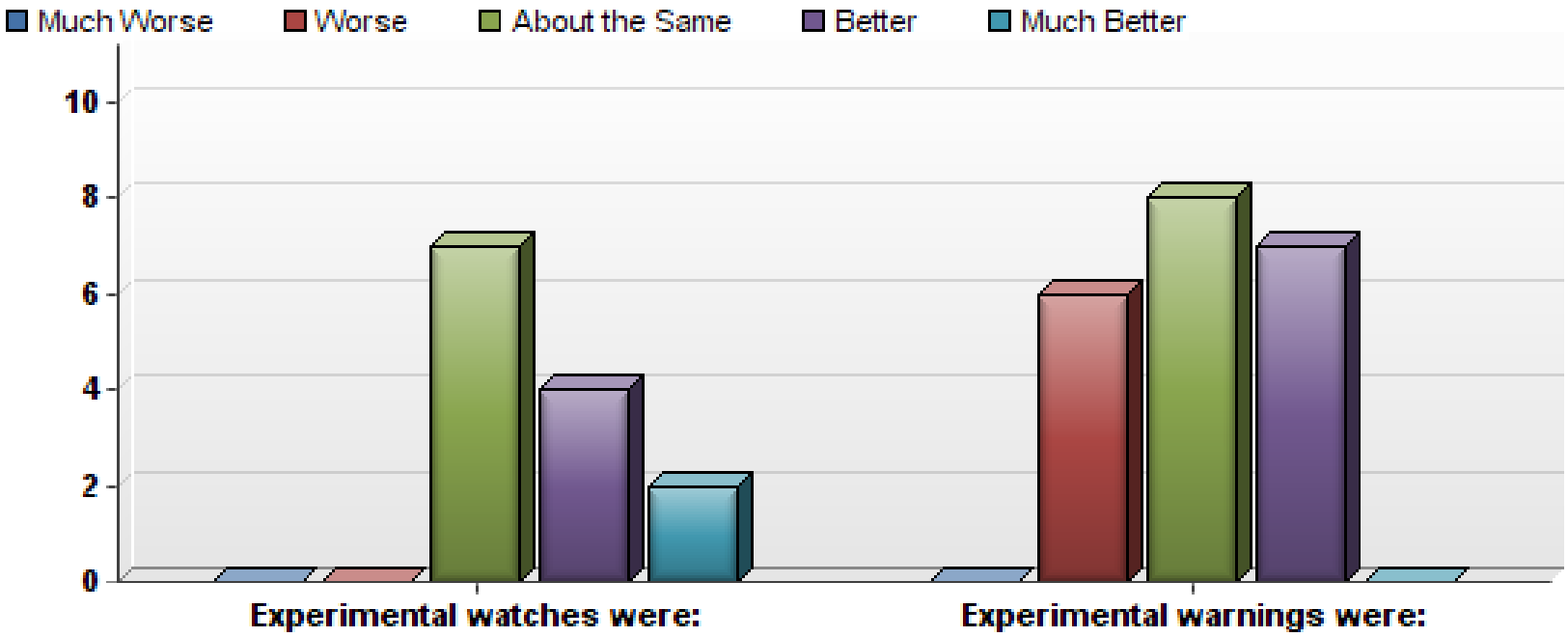
Hydrology Experiment

- Determine skill of tools
- Compare experimental watches with operational
- Determine feasibility of short-term flash flood watches
- Assess utility in communicating probability to public



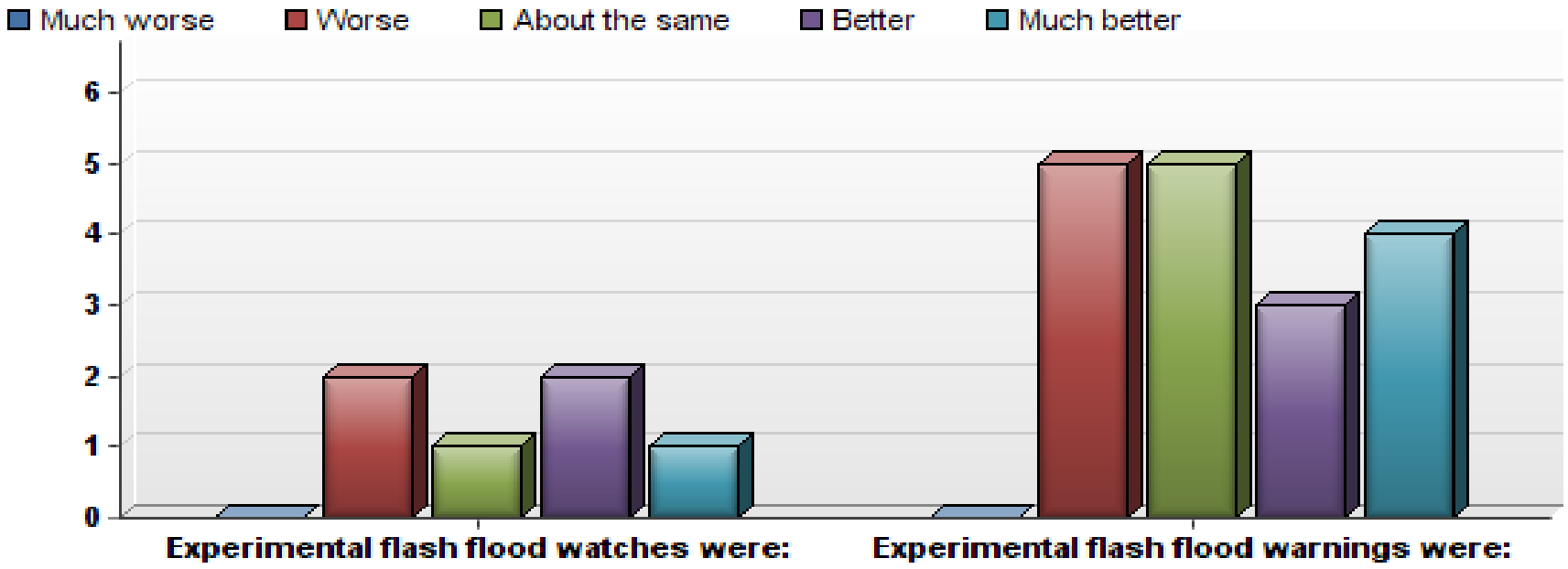
Hydrology Experiment

Flood Watches and Warnings

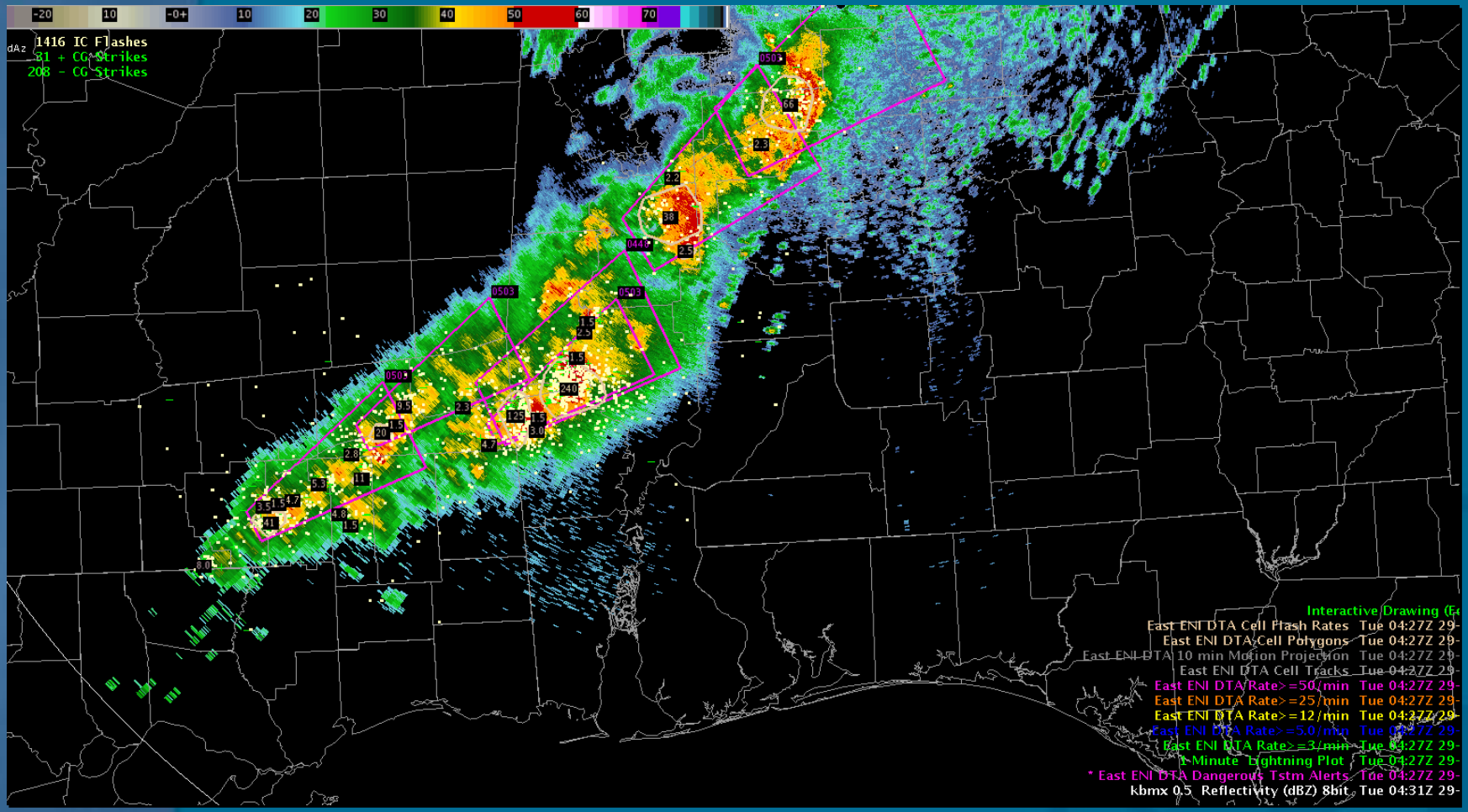


Hydrology Experiment

Flash Flood Watches and Warnings



Earth Networks Total Lightning Network (ENTLN) Experiment



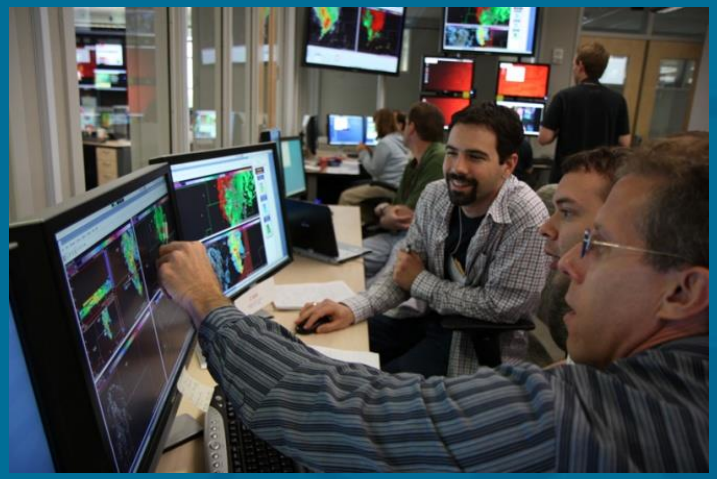
Questions?

MRMS Advantages

- Simple to use
  - Integration of multiple-radar and multiple-sensor information
- Gives greater lead time
  - Rapid-update capability (virtual volumes)
- Fills in gaps
  - Automatically fills in gaps left by other sensors

Daily Operations Procedure

- All 4 forecasters to start with mesoscale and nowcast operations
  - First, EFP briefing / collaboration meeting
  - Second, begin writing an area forecast discussion (on blog)
- As storms begin, move one forecaster to warnings
  - Warning forecaster (warnings, SVSs, some blogs)
  - Mesoscale / assistant warning forecaster (blogs)
- In case of a big event, may have all forecasters move to warnings (sectorize CWAs)
- May modify any of this on the fly as we settle into an optimal procedure.



EFP Collaboration

- EFP to prepare experimental probabilistic severe weather outlooks (tornado, wind, hail)
  - First 3-hour outlooks complete: 11 am CDT
    - 18-21, 21-00, 00-03 UTC
  - EFP map discussion: 100-130 pm CDT
  - Second 3-hour outlooks complete: 4 pm CDT
    - 21-00, 00-03 UTC
- If later shift, will arrange later collaboration with EFP (TBD)
- EFP outlooks will be available on AWIPS2 (and the Web)

CWA Selection "Triage"

- EFP experimental outlook and official SPC outlooks inform selection
  - LMA domains have highest priority (≥ SLGT)
  - OUN WRF and LAPS domains have next priority (≥ SLGT)
  - Greatest severe prob has next priority
- Ideally, will stick with one domain for entire shift
  - May all move to a new domain if severe weather dissipates or moves offshore

GOES-R Products

- WRF Synthetic Cloud and Moisture Imagery
- NearCast
- UAH Convective Initiation – “SatCast”
- Overshooting Top Detection
- Probability of Severe
- Total Lightning Detection / PGLM
- Lightning Jump Algorithm
- PGLM Multi-Field Trending Tool

Mesoscale Forecast Operations

- To inform later warning activities and to monitor during warning (“mesoscale desk”)
- Forecasters will issue afternoon/evening local severe wx discussion on blog.
- Provide hourly updates.

Nowcast Operations

- To monitor the 0-2 hour time frame before and during warning operations
- To determine location and timing of convective initiation and evolution
- Issue nowcasts via live blogging

Warning Operations

- Issuing experimental warnings using AWIPS2 WarnGen
- Include experimental product in warning description
- Students will provide real-time storm report information during ops.

Feedback

- Post-operations online survey for all products
- * Blog *
- Real-time discussions
- Debriefings (daily, weekly)

* Very important! *

Weekly Schedule

Monday Schedule

1205p	Convene to NSSL Dev Lab (NWC2820)
1210p	Welcome and Introductions
1215p	EWP2014 Orientation Briefing (Garfield)
1235p	Tales from the Testbed Orientation (VandenBoogart)
1245p	Break
100p	Convene in HWT Operations Area: EFP briefing to determine Monday CWAs AWIPS2 Familiarization, procedure loading Real-time nowcast/warning operations
???p	Dinner Break (time chosen based on wx)
700p	Fill out feedback survey; Day2 forecast prep
745p	Adjourn

Tue-Wed-Thu "Flex" Shift Schedule

- Determined at the end of the previous day's operations shift, based on expected timing of weather
  - Will be posted to EWP Blog; emailed to MICs
- Start time 11am, 12pm, 1pm, 2pm, or 3pm (12-8pm "default")
- Finish 8 hours later
- Dinner break time will be based on wx activity
- Tue-Wed (last 45 min of shift):
  - Forecasters fill out feedback surveys
  - Day 2 forecast to decide "flex" shift time
- Thu (last 90 min of shift):
  - 30-45 min: Forecasters fill out feedback surveys
  - 45-60 min: Prepare for TftT Webinar with WDTB facilitator.

Friday Schedule

900am	Convene in the WDTB Conference Room
900-950am	Webinar dry run (WDTB Conference Room)
950am	Move to the Dev Lab
1000am-1130am	Weekly debrief (Dev Lab)
1130am	Break to grab lunch, move to WDTB Conference Room
1200pm-1240pm	EWP2012 Weekly Webinar (WDTB Conference Room)
1240-100pm	Group photo
100pm	Operations End for the week

Weekly Webinars "Tales from the Testbed"

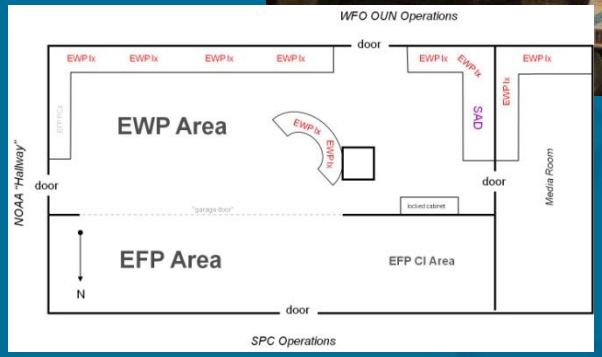
- A summary of that week's experience, presented by the NWS participants.
- Each Friday from 1200-1240 CDT from the NWC in Norman.
- The forecasters have 22 minutes to discuss their key takeaways that week.
- Weekly topics
  - To be determined
- Audience: WFO/CWSU peers, RHQ, NWHQ, funding agencies.
- Facilitated by WDTB (similar to dual-pol Storm of the Month").

Post-experiment Webinars to NWA and RITT in June (EFP and EWP).

EXTRA SLIDES

EWP Technology in the HWT

- NWS Advanced Weather Interactive Processing System 2 (AWIPS2):
  - Can emulate any forecast office nationwide
  - Displays experimental products
  - Issue experimental warnings
- Situational Awareness Display (SAD)
  - Television feeds
  - Streaming storm chaser dash cams



EWP Web Presence

- External (public)
  - http://hwt.nssl.noaa.gov/ewp
  - Content:
    - General Information about the EWP
    - Past experiment summaries
- Internal (private)
  - http://hwt.nssl.noaa.gov/ewp/internal/2014/
    - NOAA LDAP credentials required
  - Content:
    - The EWP Blog
    - Operations Plans
    - Training Materials
    - Schedules (Google Calendar)
    - Other useful links