Test and Evaluation of Rapid Post-Processing and Information Extraction From Large Convection Allowing Ensembles Applied to 0-3hr Tornado Outlooks

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Reminder - R2O: Where do we fit?

Addresses NOAA objective:

"…post-processing tools and techniques to provide effective decision support for high-impact weather."

Addresses high priority topic 4:

"…daily severe weather prediction using rapidly updating ensemble radar data assimilation and forecasts while minimizing data latency via post processing strategies for information extraction."

Reminder: Post-processing Strategy

- The proposed post-processing paradigm will consist of five steps:
  1. Rapid ID of predefined but broad objects for the purposes of filtering and data reduction,
  2. Transmitting reduced data sets while retaining information (why send zeros!)
  3. Reception and regridding data (adaptable)
  4. Generation of predefined probabilities (static probabilities – broad applicability)
  5. Generation of user-defined probabilities (on-the-fly post processing for INSIGHT in Scientific forecasting)

Reminder: Purpose

- Match the needs of forecasters with tools, data, and information that can help them make better judgments/decisions.
- Smaller, faster, agile data in a time-pressure environment

Accomplishments

- Through interviews of NWS forecasters learned that CAM trust is low b/c of low familiarity and un-calibrated expectations
- Developed & tested our post-processing approach to meet situational awareness needs
- Minimized data while providing a similar amount of *information* (20***kb*** vs 18**MB**)
- Implemented system in real-time during HWT 2016 PHI experiment with minimum latency (~4 minutes) for this task

Year 1: what have we done

I. Forecaster interviews on the use of model/ensemble forecasts for short term prediction of severe weather

II. Planning, testing, development, and implementation of our post-processing into the 2016 HWT Probabilistic Hazard Information (PHI) tool experiment

I. WFO and NCEP center Interviews

- NWS Forecasters (7 WFOs and a National Center)
- Purpose - to understand forecasters:
  - Current use of 0-3h model guidance &
  - Openings: Challenges, opportunities, needs, pitfalls
- Prelim findings:
  - All about now; All about observations; ingredients based approaches relied on heavily
  - Mixed familiarity with hi-res models
  - For all: unsure when/how much to trust for 0-3h
  - Expectations are un-calibrated
  - Work processes have not incorporated models yet

Results: Openings for hi-res models

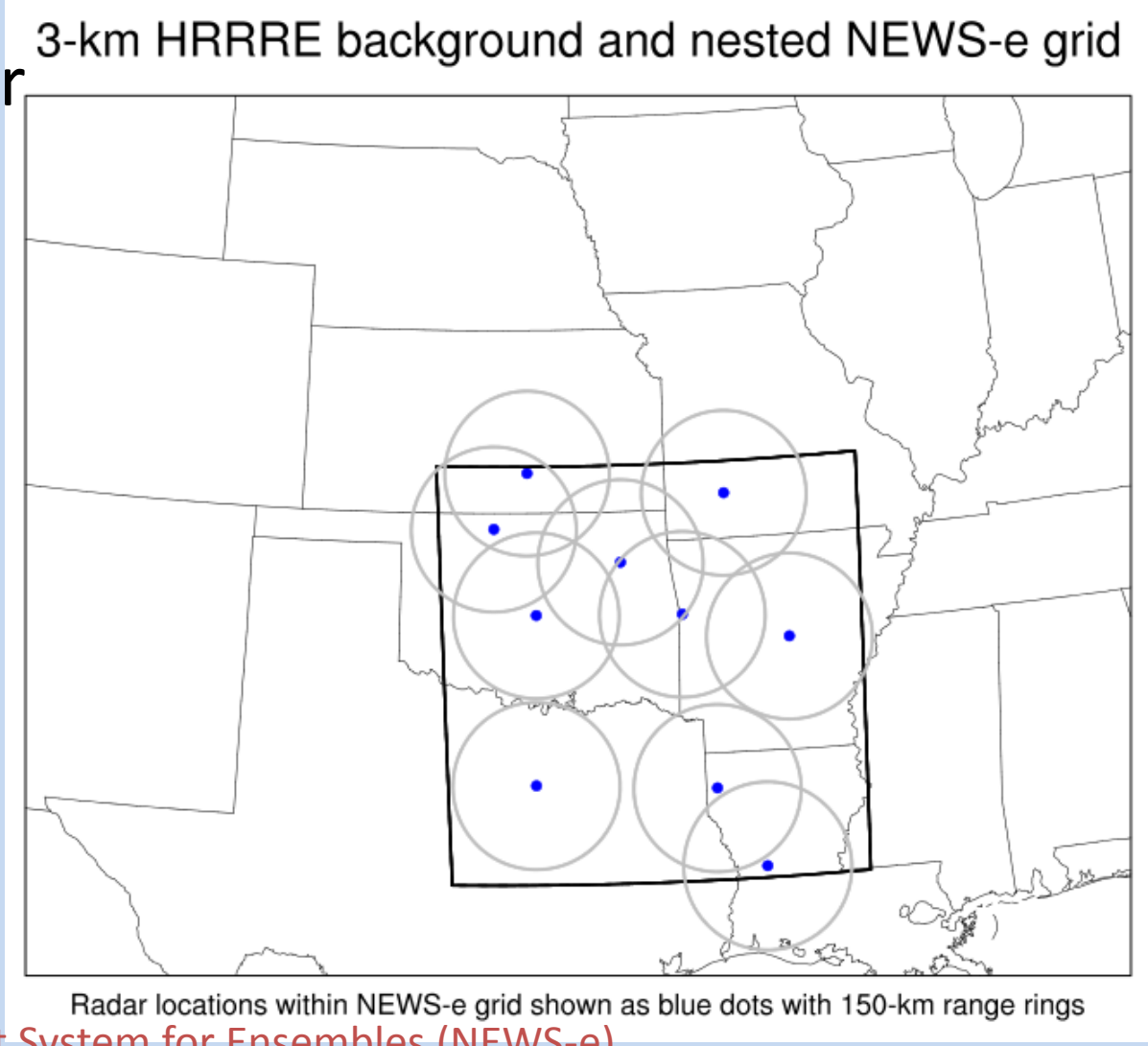
- Forecast **value** not equivalent to **quality**
  - We should want to equip forecasters with techniques to anticipate _____!
  - E.g. that the model produces supercells is important & useful
- Forecasters want lots of data up-front to learn new tools → TRUST
  - Need to know strengths and weaknesses but:

    When/how/why does it work vs not work?

    Expectations to work on all events*
- WDTD Training on "algorithms"
  - Use them first for triaging
  - Cannot be used at face value, need to know strengths and weaknesses

II. Post-processing in HWT PHI 2016

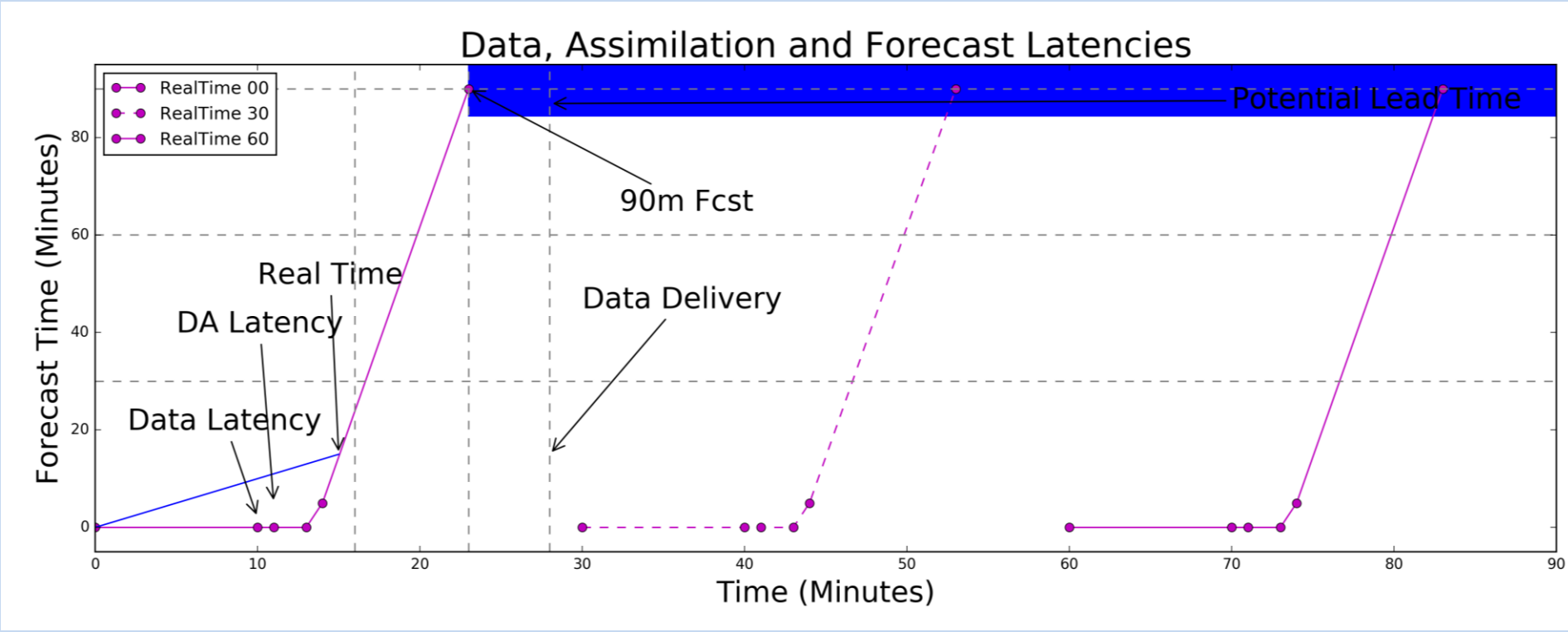
- NEWS-e 18 member mixed physics ensemble init by HRRR-E*
- Cycled radar data assimilation (15m)
- Forecasts out 90m every 30m (00 and 30 past the hour, 19-03 UTC)



NSSL Experimental Warn on forecast System for Ensembles (NEWS-e)

*HRRR-E run by GSD as part of the Warn on Forecast initiative

NEWS-e during HWT 2016: Each Run



Have minutes to post-process and deliver to stay relevant

Hazardous Weather Testbed Probabilistic Hazard Information 2016

Goals:

- Present NEWS-e information as close to base data.
  1. See all the UH and vorticity tracks
  2. Ensemble is under-dispersive: tracks lie on top of one another, so make probability "grids"
  3. Probability grids aren't just number of members b/c of ***TIME*** (members & time conflated);
     - not appropriate to use Gaussian smoothing/neighborhoods
  4. Side benefit: by worrying more about the time dimension we got to adaptive pseudo-probability (frequency)

HWT PHI 2016

Challenge:

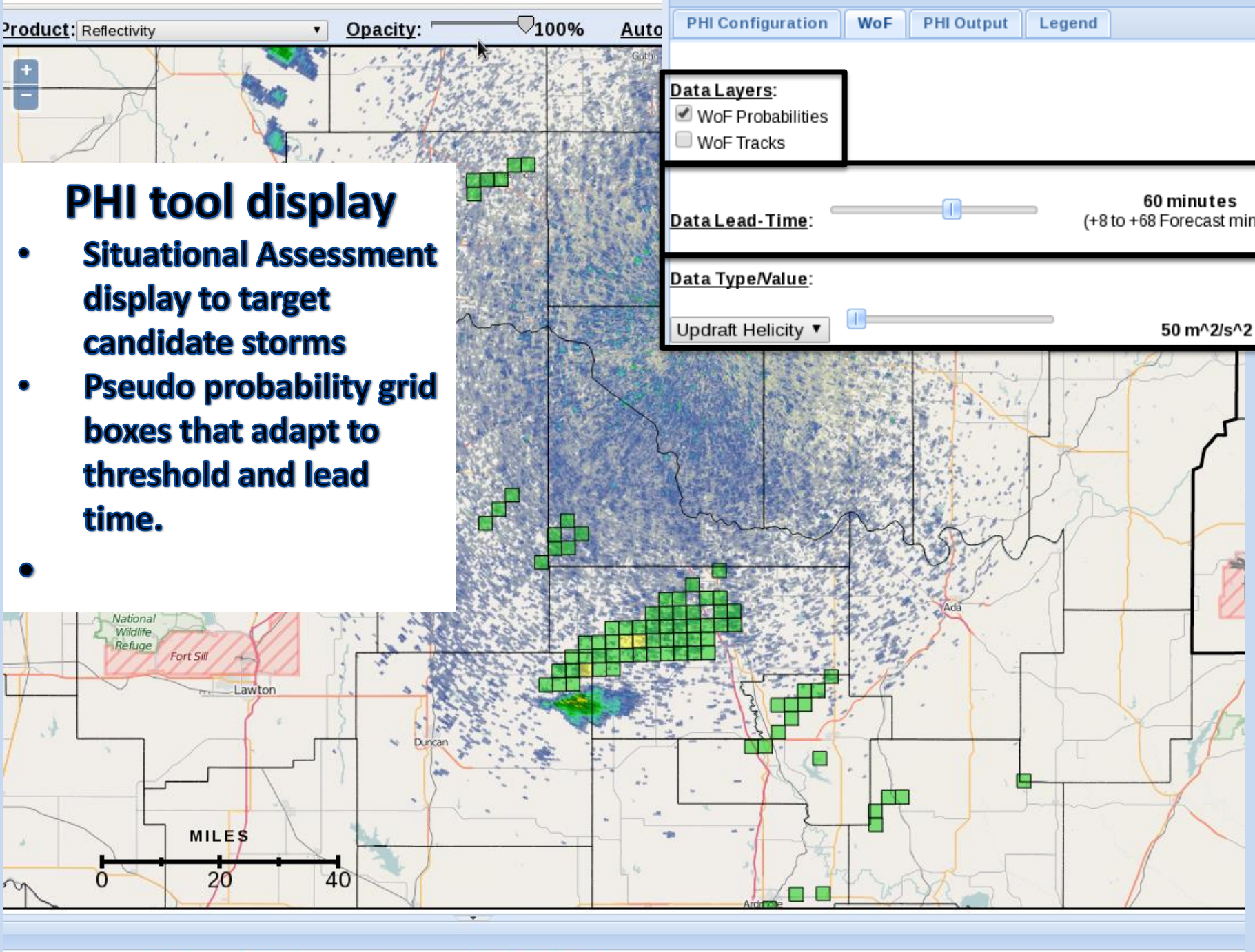
- Gain insight for using NEWS-e in warning ops.
  1. Match tracks to individual storms (observed & simulated)
  2. Interest in data queries?
  3. Look for ways to add value to a “radar first” storm interrogation
     - Want to help anticipate near term changes or development

HWT PHI 2016

Challenge:

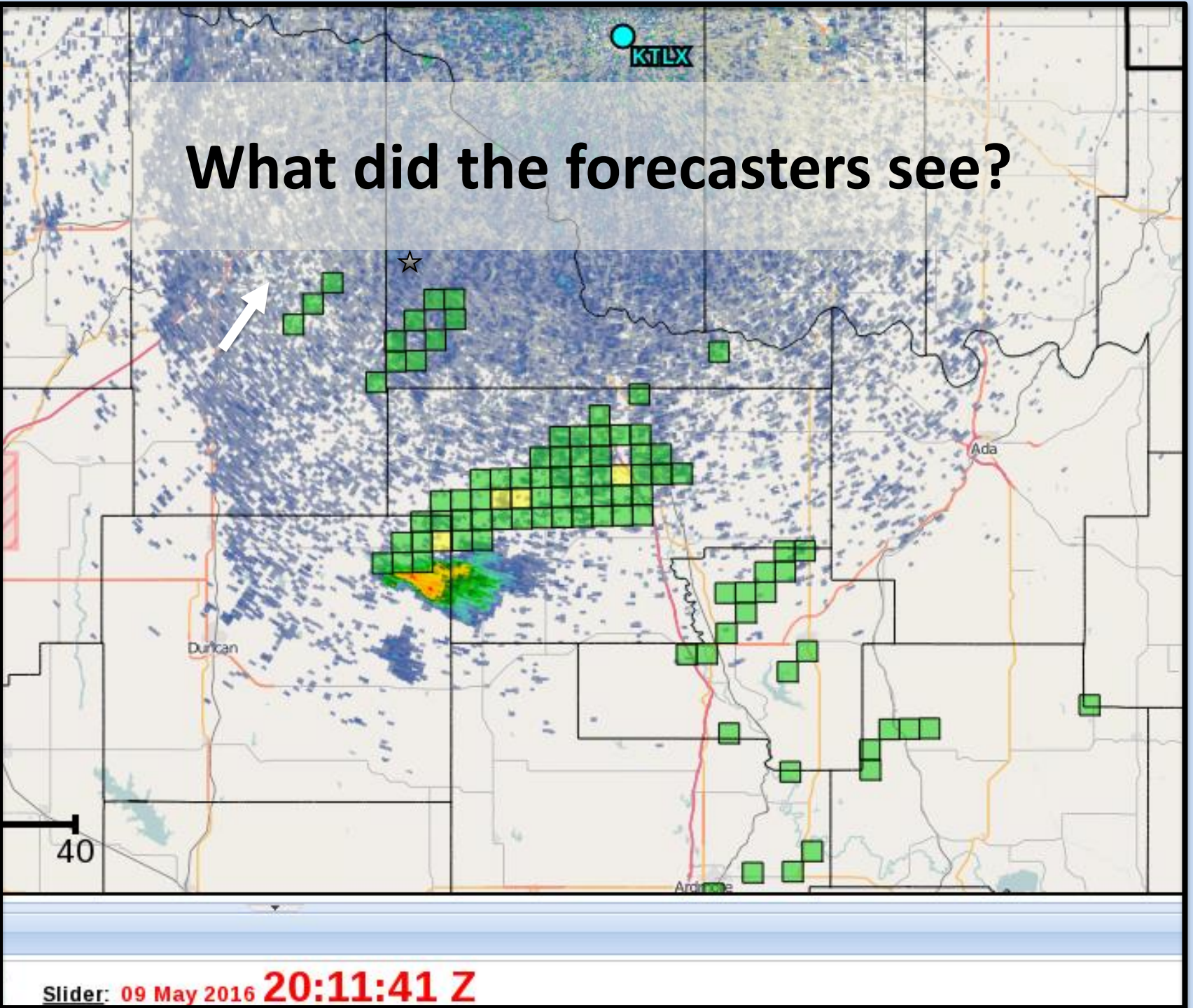
- Can we apply this data at relevant scales?
  1. Down to the 5-minute output time
  2. Down toward the scale of radar features
     - At super-res, 1 model grid box = ~144 radar pixels
  3. Update frequency for new model forecasts

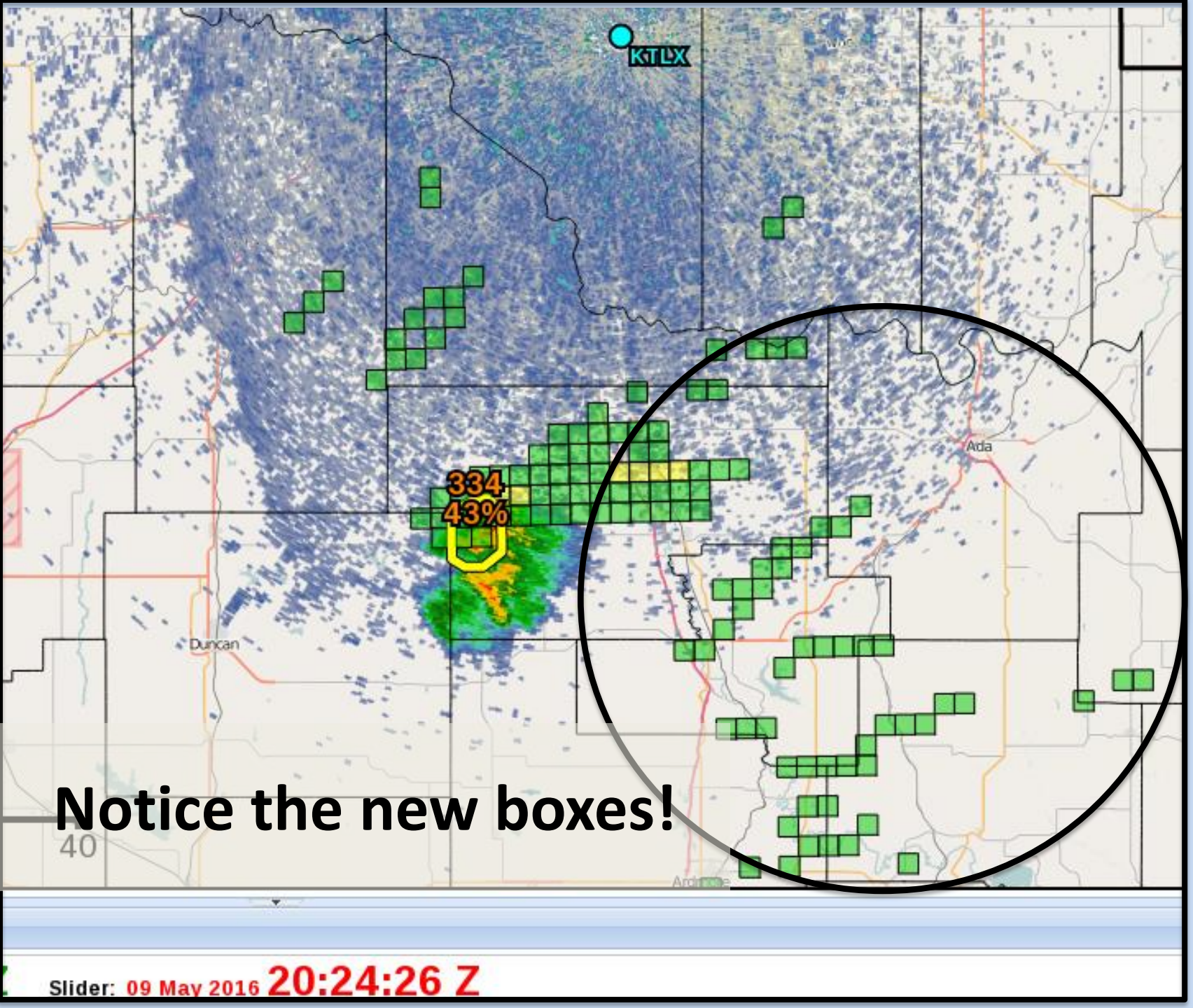
So what does this display look like?

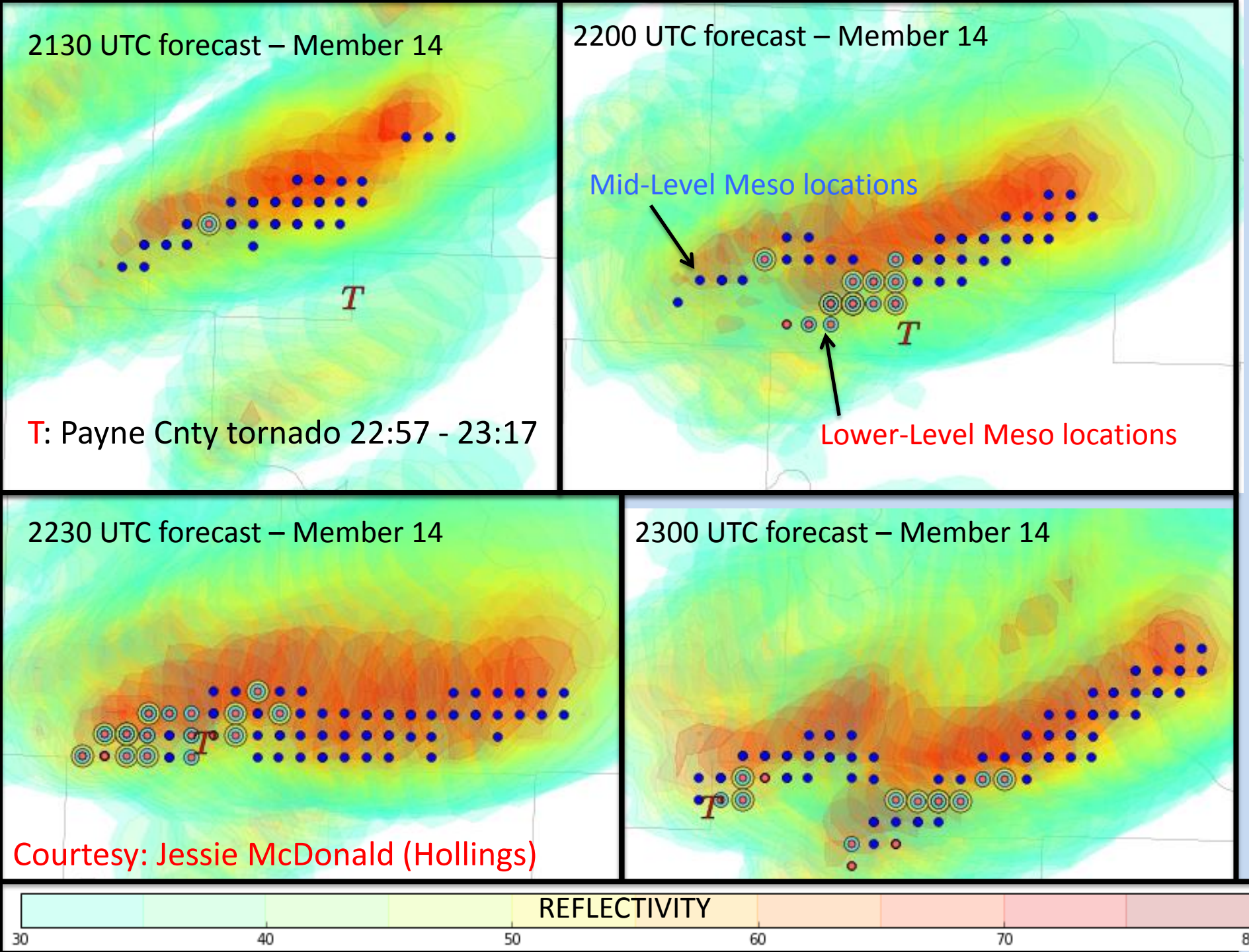


PHI tool display

- Situational Assessment display to target candidate storms
- Pseudo probability grid boxes that adapt to threshold and lead time.
-


KTLX
What did the forecasters see?
Ada
Duncan
40
Slider: 09 May 2016 20:11:41 Z


KTLX
334
43%
Duncan
Ada
Notice the new boxes!
40
Slider: 09 May 2016 20:24:26 Z


2130 UTC forecast – Member 14
T
T: Payne Cnty tornado 22:57 - 23:17
2200 UTC forecast – Member 14
Mid-Level Meso locations
T
Lower-Level Meso locations
2230 UTC forecast – Member 14
T
Courtesy: Jessie McDonald (Hollings)
2300 UTC forecast – Member 14
T
REFLECTIVITY
30
40
50
60
70
80

R -> O
Data Collection

- Each day: displaced (limited operational data) and real-time weather (operational data)
- 3 week experiment: 12 operating days
  - 9 being “operational” and
  - 3 for learning and testing w/ new participants.
- 9 forecasters, 3 per week

Description	Good	Code fail	Domain N/A	Compute down	Data failure	Total
Week 1	1	3				4
Week 2	2			1 (JET)	1	4
Week 3	3		2			4

Preliminary HWT observations

- NWS Training warns the forecasters about "algorithms":
  - "Cannot algorithm EVERYTHING"
    - Cannot anticipate every possible scenario
- Forecasters:
  - Used the guidance for identifying hot spots
    - Not expecting answers/accuracy, inferring usefulness*
    - Confidence in warning decisions (warn & not to warn) because

      "right now we have no tornado guidance"
  - Accuracy
    - In situational awareness paradigm – not a real problem. Can revert to radar for final human data assimilation
    - Can easily discount spurious convection when not on radar – "always have conflicting information"
    - Expectations: Still want accuracy, reliability, calibration on range of events/event types

Summary

- Variables like UH and 3d vorticity already available in some models (transition to operational use)
- Techniques result in data reduction with minimal latency (will work to improve and refine this & add variables/displays)
- Mixed method of social and physical science is working well
  - Interviews and experiment paired well to tackle the post-processing problem from the perspective of the forecasters (and their challenges)
- Cross pollination with VORTEX SE (D. LaDue)
  - Used VORTEX-SE case study in experiment
  - VORTEX-SE steering committee is using our interview data

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