Forecaster Tornado Warning Decision Processes in PARISE 2012

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Experiment Design and Execution
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Understanding NWS Verification
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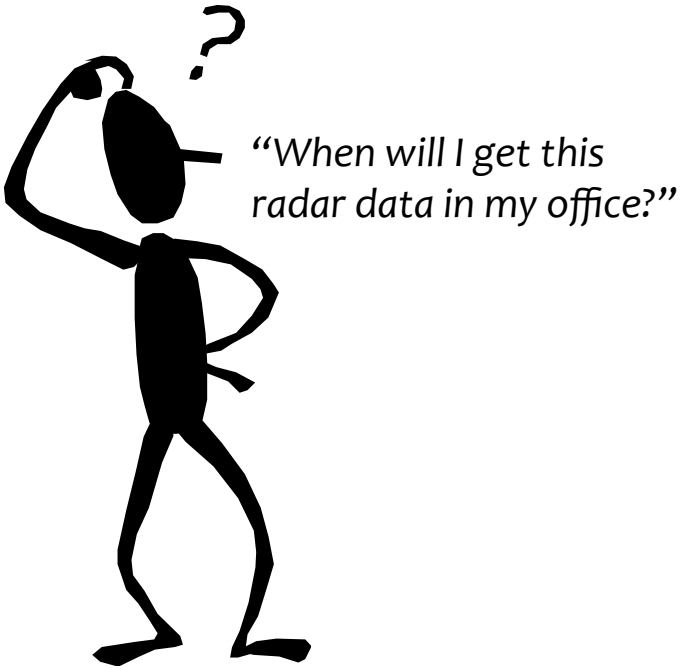
PARISE 2012 Motivation

2010 PARISE findings suggest faster, adaptive radar scanning can:

1) **Improve NWS forecaster ability to warn public of EF0/EF1 tornadoes**
2) **Increase tornado lead time: Average 12 min vs 0.76 min**
3) **Increase time available for public response**



"When will I get this radar data in my office?"

NWS Forecaster

More direct data collection methods?
Are these results repeatable?
What about null cases?

Scientist

2012 PARISE

Objective

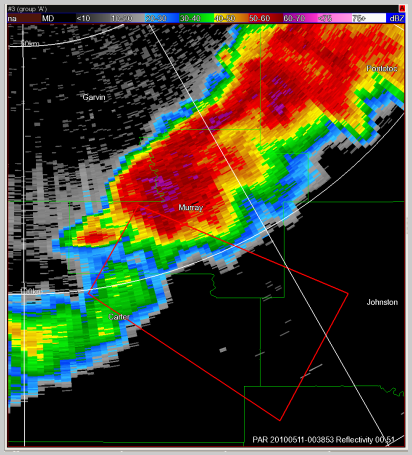
Test whether rapid, adaptively scanned radar data aids forecaster ability to make warning decisions during tough, potentially tornadic cases

- 12 NWS Forecasters working individually
  - 2 per week over 6 weeks (June – Aug)
- 4 supercell events
  - 2 tornadic, 2 non-tornadic

Data Collection

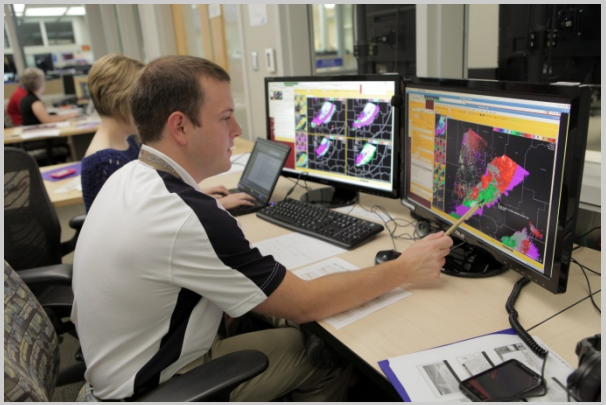
Work the Event

Video and screen recordings



Warnings issued

Case Walk Through (Hoffman, 2005)



Forecaster recalls thoughts & actions

Case Walk Through

* Cognitive task analysis
* Protocols for CTA (Hoffman, 2005)

* Three Sweeps
  - Sweep 1: Forecaster talks through their actions
  - Sweep 2: Corrections and additions, identify decision points
  - Sweep 3: Conceptual diagram and probing questions

* Tool provides rich qualitative data regarding the warning decision processes of forecasters

Situational Awareness

"The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future."

Endsley, 1995

Situational Awareness

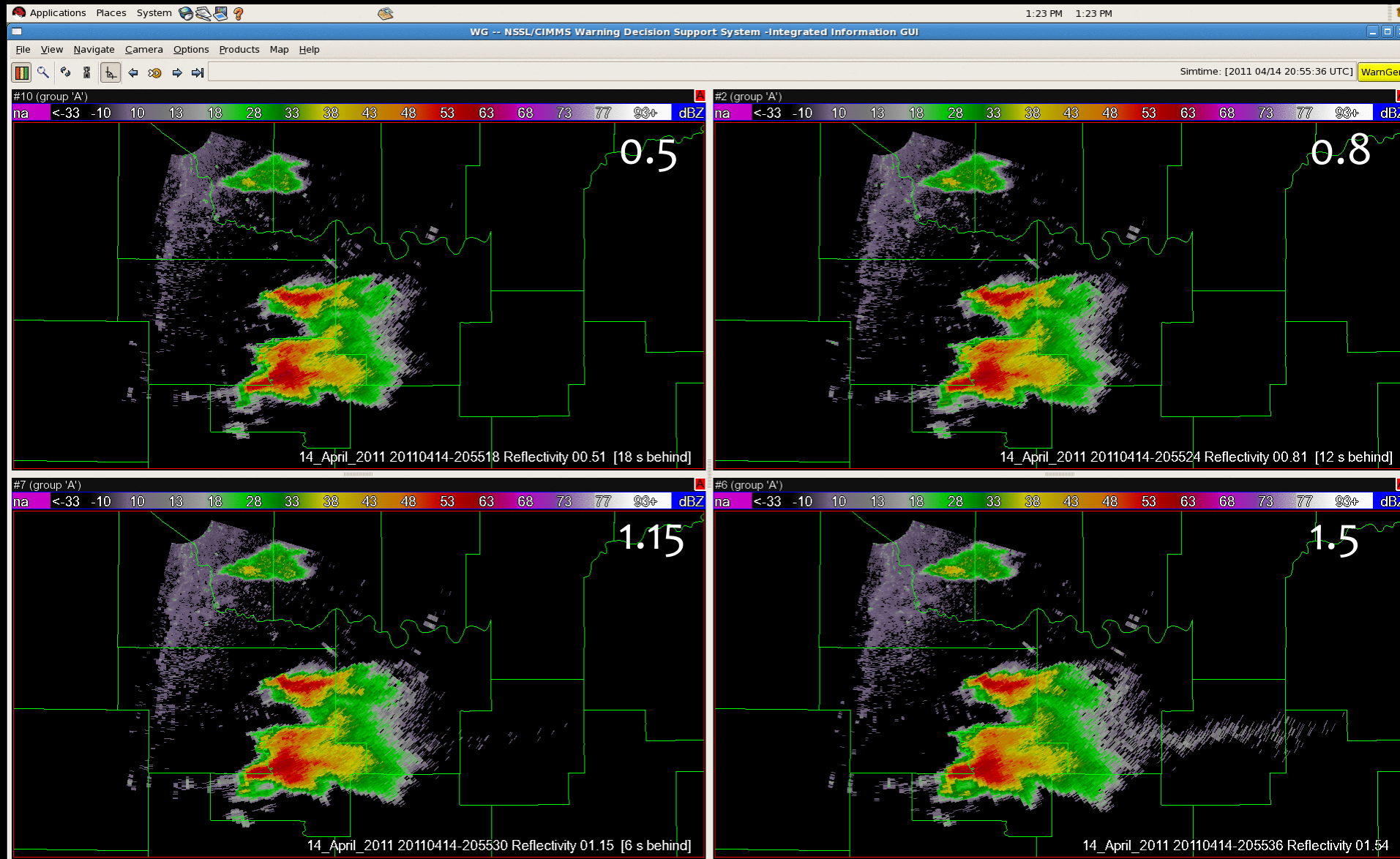
Level 1
Perception

Level 2
Comprehension

Level 3
Projection

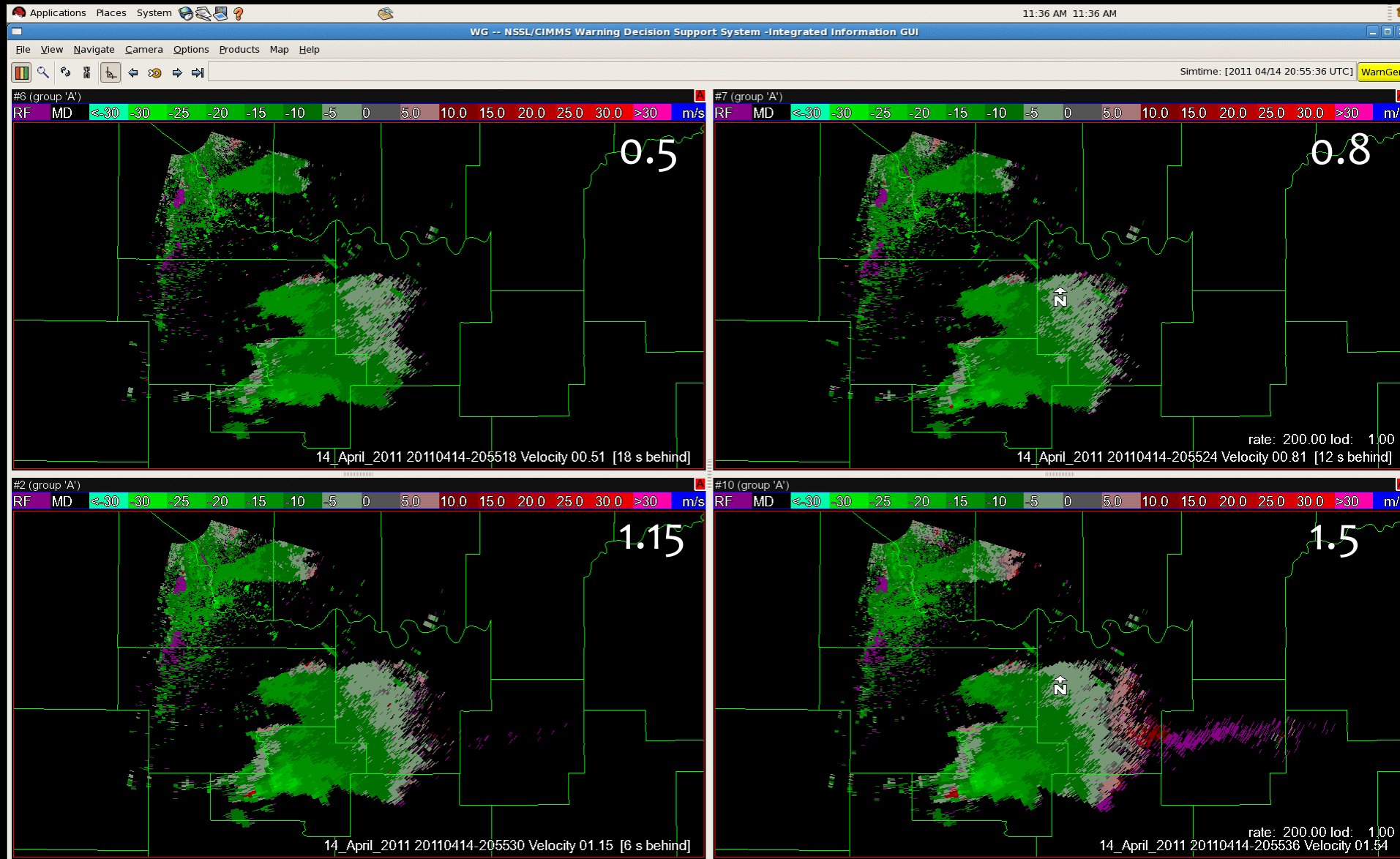
Null Case

2055 – 2120 UTC 14 May 2011



Null Case

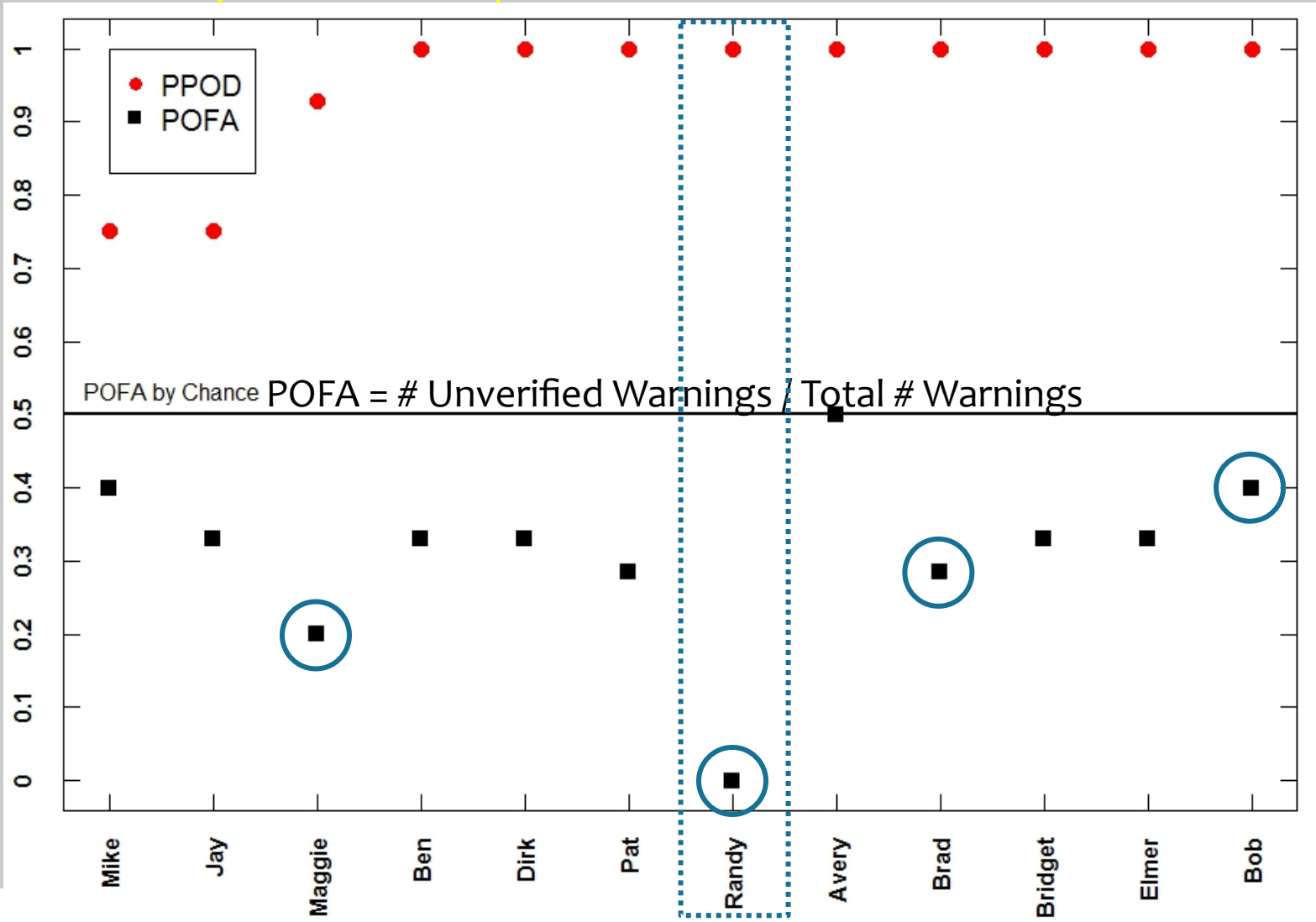
2055 – 2120 UTC 14 May 2011



PARISE 2012 Results

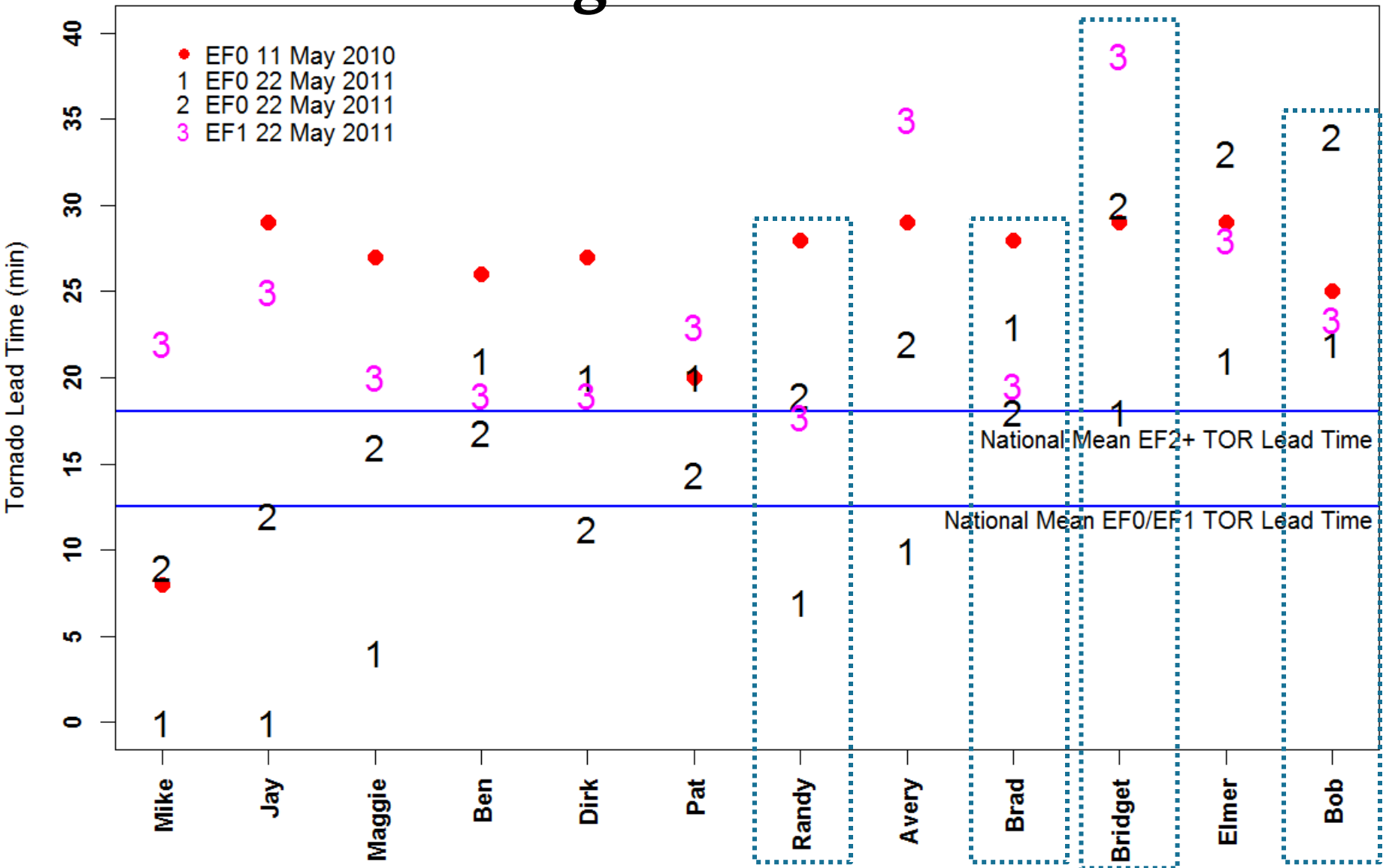
Probability of Detection / Prob. of False Alarm

PPOD = sum(% Event Warned)/Total # Events



PARISE 2012 Results: Tornado Lead Time

21 min Average Tornado Lead Time



Randy Gains SA at Start of Null Case

Time (UTC)	Situational Awareness	Judgments, Projections, & Decisions
2055	➢ No severe weather threats of immediate concern	Have left- and right-moving supercells
2057	➢ Pronounced BWER & Midlevel Mesocyclone	Left mover unlikely to produce a tornado
2059	➢ Inbound velocity is decreasing in intensity	Focus attention on right mover and continue to monitor for tornado development

2100

SA Leads to heightened concern for tornadogenesis

Time (UTC)	Situational Awareness	Judgments, Projections, & Decisions
2101	➢ Inflow weakest its been	
2102	➢ Onset of RFD	Judges midlevel meso is intensifying
2103	➢ Inflow increasing above 0.5	
2104	➢ 1.1 to 3.0 Dramatic increase in inbounds & outbounds ➢ Delta V (3 deg) ~100 kt	2106 → Projects meso may descend to the ground
2105	➢ 0.5/0.8 Inbounds increasing; are up to 60 kt	Decides to monitor low-levels for meso development

Decides a Tornado Warning *May Be* Needed

Time (UTC)	Situational Awareness	Judgments, Projections, & Decisions
2106	➢ Inflow strongest its been ➢ 0.5 Vel. couplet forming to west of inflow	
2108	➢ Inflow weakens a bit ➢ 0.5 couplet intensifies ➢ Midlevel rotation weakens	
2109	➢ 1.1/1.5 G2G couplet forms	2109 → Decides to prepare to issue warning. Draws polygon. Monitors next scan to see if G2G couplet develops at lowest 2 tilts

Decides Not to Issue Tornado Warning

Time (UTC)	Situational Awareness	Judgments, Projections, & Decisions
2110	➢ G2G Couplet did not descend to 0.5/0.8 ➢ Midlevel G2G couplet has not organized; appears slightly weaker	2110 → Decides to hold off on tornado warning. Continues monitoring storm
2111	➢ Midlevel G2G couplet has weakened further ➢ Another surge in inflow strength	

Maggie, Brad, and Bob also Decide Not to Issue Tornado Warning

Bob

- RFD did not bring the strong midlevel meso down around to the lowest tilt

Randy & Maggie

- G2G Couplet did not descend to 0.5/0.8

Brad

- Never gained SA that triggered concern to warn

Dirk's decision process similar but decides to warn near end of case

Time (UTC)	Situational Awareness		Judgments, Projections, & Decisions
2111 -- 2115	➢ Velocity data showed increasing LL rotation, but thinks it may be velocity aliasing issue	2115	Judges positioning of the couplet relative to the reflectivity signature doesn't fit his conceptual model
2115--2118	➢ Strengthening in meso is maintained at 1.5 deg ➢ Storm is headed toward town of Sulphur ➢ Mesocyclone continues to descend: now seen down to 1 deg.	2118	Strengthening LL meso, combined with hook suggests that tornadogenesis may be underway Decides to issue a tornado warning

Another 7 also Decided to Warn on Right Mover

Situational Awareness

- Extremely well organized supercell
  - tremendous updraft and midlevel mesocyclone.
- Mesocyclone began descending into the lower elevation tilts, increasing risk for tornadogenesis.
- Tightening at 0.5
- Noticed the filling / collapse of BWER at all middle tilts along with collocated tightening of circ
- Circ at lowest tilt was getting tight and persisting

Time of Warning Decisions

2058 → Pat

2102 → Elmer

2103 → Bridget & Jay

2105 → Ben

2106 → Avery

2108 → Mike

Conclusions

Forecasters gained min-by-min SA and short-duration trends in SA from PAR data that impacted their decision process

Differences in conceptual model pivot points and SA determined whether a forecaster decided to warn or not to warn

Decide to Warn

- Strengthening of midlevel circulation and its apparent descent indicates possible tornadogenesis
- Tightening of circulation at lowest tilt (one forecaster interpreted persistence)

Decide not to Warn

- RFD did not bring the strong midlevel meso down around to the lowest tilt
- G2G Couplet did not descend to 0.5/0.8
- Never gained SA that triggered concern to warn