New Warning Verification Techniques for FACETs

Performance on the 2007-2015 storm-based tornado warning database

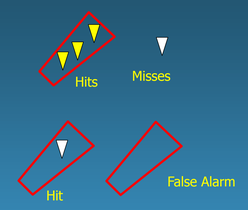
Gregory. J. Stumpf
CIMMS/NWS/MDL, Norman OK

Brandon R. Smith
CIMMS/NSSL, Norman OK

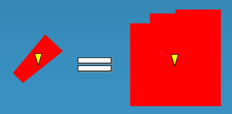
INTRODUCTION:

Severe Weather Polygon Warning Verification Today

- Report points used to verify warning polygon areas
  - Report points inside (outside) warning areas are HITs (MISSes)
  - Warning areas with (without) at least one report point is a HIT (FALSE ALARM)



- Very large warnings with only one report point is a HIT, but lots of False Alarm Area (FAA)



What are the benefits of gridded verification?

- Rewards precision in warnings
  - Counts against high false alarm area/time even in verified warnings
- Easier to score location-specific measures, such as lead time and departure times
- Can treat verified hazards as 2D areas — which they are!
- Reward for correct null forecasts
- Can be used to better address the relative goodness of innovative warning services concepts, such as **Probabilistic Hazard Information (PHI)**.

TWO METHODS OF GRIDDED VERIFICATION:

I. GRID POINT METHOD

- Treat the forecasts and observations on the same coordinate system, a geospatial grid.
  - Reconciles the area versus point issue

- Tornado reports are converted into a Tornado Observation grid:
  - "Splat" reports by 5 km (or any distance) to account for low precision of reports in space and time, as well as an "acceptable" distance "to be warned".
- Correct Null (CN) conditions are all locations outside the union of warning polygon areas and observation "splats".
- Considers each 1 km2 x 1 min grid point as a single event and data point in the contingency table:

Contingency Table		Grid point within range of tornado hazard at that time	
		Yes	No
Grid point is warned at that time	Yes	A = Hit	B = False Alarm
	No	C = Miss	D = Correct Null

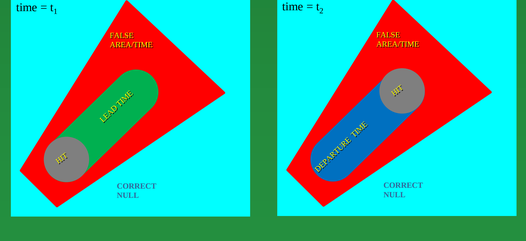
- Can't measure lead time using this method. Thus… Method II (Truth Events).

II. TRUTH EVENT METHOD

- Defined as a continuous time period that a specific grid point location is under a warning(s) and/or a tornado observation(s), *surrounded* by at least one minute of neither:
  - FALSE: If grid point remains in "false" condition throughout event
  - MISS: If grid point remains in "miss condition" throughout event
  - CORRECT NULL: If grid point remains in "CN condition" throughout event
  - HIT: If grid point experiences a "hit condition" for at least 1 minute during event

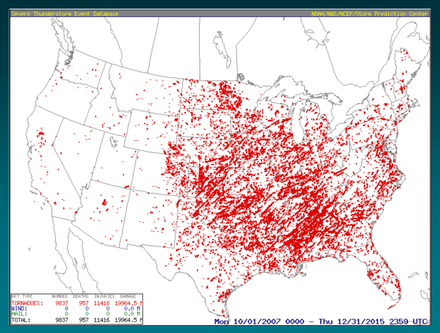
LEAD TIME (*lt*):	$t_{obsBegins} - t_{warningBegins}$	*[HIT events only]*
DEPARTURE TIME (*dt*):	$t_{warningEnds} - t_{obsEnds}$	*[HIT events only]*
FALSE ALARM TIME (*ft*):	$t_{obsBegins} - t_{obsEnds}$	*[FALSE events only]*

- Locations eventually impacted by a threat are not counted toward false alarm time, but instead as "lead time".
- Locations behind the threat are counted toward "departure time".



DATA SET:

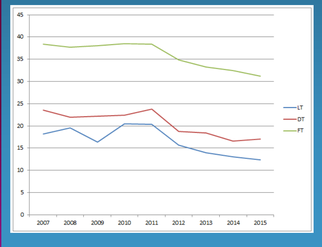
- All NWS Tornado Warnings from the storm-based (polygon) warning era from 1 Oct 2007 – 31 Dec 2015.
  - Forecast grids are produced at every minute.
  - Any warnings "continued" with a Severe Weather Statement (SVS) have their previous polygon replaced with the updated polygon.
- Tornado reports for the same period are in line segments for each county they cross.
  - Minute-by-minute tornado locations inferred by interpolating between start and end points/times of line segments.

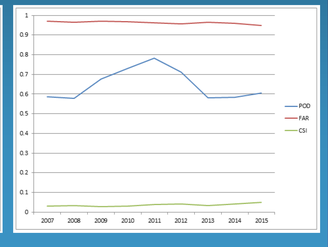


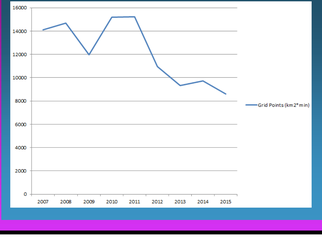
SOME RESULTS:

ANNUAL STATS (2007-2015):

- Lead Time (LT) has slowly declined over the period. But so has Departure Time (DT) and False Time (FT).
  - Unwarned events are not assigned a Lead Time.
- CSI slowly improves over time because FAR slightly decreases.
  - FAR is very high, owing to the large areas within warnings that are not affected by tornadoes.



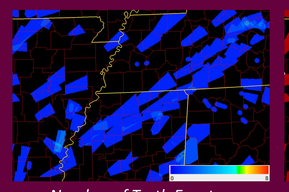




ANNUAL STATS (2007-2015):

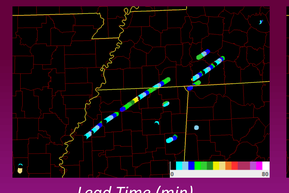
- Warning Area and Warning Time represented by number of 1 km^2 x 1 min HIT and FALSE grid points.
- Has declined over the period.
  - Most of the decline is in FALSE grid points (almost 60%).

Example:
2015 Mid-Mississippi Valley Maps
(23-25 December outbreak included)

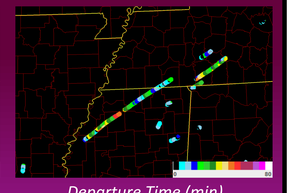


Number of Truth Events

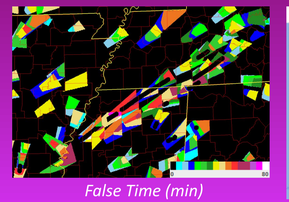
Score Grid (red=false; white=miss; grey=hit)



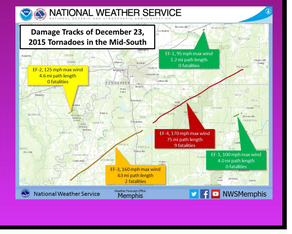
Lead Time (min)



Departure Time (min)

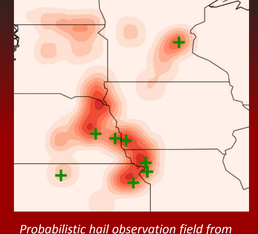


False Time (min)



NEXT…

- Compare to traditional NWS warning verification stats.
- Expand procedure to Severe Thunderstorm Warnings.
- Working with NOAA/ESRL/GSD to develop a probabilistic observation grid, combining MRMS MESH (hail estimate) with hail storm reports (see figure on the right).



Probabilistic hail observation field from blending radar data and hail reports (the green plus signs). From Wandishin et al.

BLOG: Experimental Warning Thoughts

http://tinyurl.com/exp-warn-thoughts

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