# **Geospatial Verification of Experimental Severe Weather Warnings**



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III. Traditional Verification of Experimental Tornado Warnings

Statistics



Warning

Duration

Average 51.20

> 32.71 37.81

> 32.93 44.98

# I. Introduction

Experimental severe weather warnings were issued by visiting NWS forecasters during the Experimental Warning Program (EWP) 2010 spring project at the Hazardous Weather Testbed (HWT) in Norman, OK.

The HWT is equipped with AWIPS workstations, "localizable" to any NWS forecas office in the CONUS.

Experimental grids are fed live into AWIPS.

Forecasters issued severe weather warnings aided by experimental Multiple-Radar Multiple Sensor (MRMS) severe weather applications.

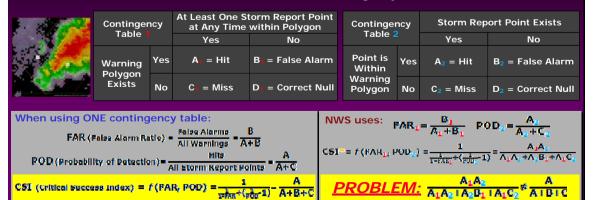
Operations occurred in real-time, and forecasters were blind to simultaneous official NWS warnings.

Using the 17 June 2010 Minnesota/North Dakota outbreak event, experimental Tornado Warnings were evaluated using a variety of verification techniques.

#### **II. Traditional Verification**

CSI (critical success index) = f (FAR, POD) =-

Includes elements calculated from two different contingency tables:



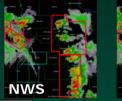
THAR + (ROD 1) A+B+( Other parameters calculated: Lead Time (initial and average) and Warning Area

	CWA		Scores			Lead Tin	ne (min)	Warning Area (sq. mi)		
			POD <sub>2</sub>	FAR <sub>1</sub>	CSI *	Mean	Initial	Total	Average	
	FGF	NWS	0.935	0.267	0.698	23.81	24.78	45698.53	1523.28	
		EWP	0.577	0.619	0.298	12.23	10.39	28759.51	684.75	
	MPX	NWS	0.840	0.462	0.488	17.52	16.76	12221.40	470.05	
t		EWP	0.960	0.634	0.360	20.27	20.80	16802.55	409.82	
	Total	NWS	0.894	0.357	0.597	21.23	21.49	57919.93	1034.28	
		EWP	0.734	0.627	0.329	15.53	14.66	45562.06	548.94	

Forecast offices: FGF (Grand Forks ND), MPX (Minneapolis MN)

• EWP warning areas were consistently smaller than NWS warning areas.

Lower scores with larger areas were most pronounced for the FGF area, so we divided the FGF area analysis into two sectors (MN, ND).





			Statistics									
Sect	Sector - FGF		Scores			ne (min)	Warnir (sq.	Warning Duratio n				
		POD <sub>2</sub>	FAR	CSI*	Mean	Initial	Total	Average	Average			
NWS	ND	0.900	0.267	0.678	16.50	19.06	11445	763	44.00			
	MN	0.962	0.286	0.695	29.66	29.35	33401	2385	58.79			

 Note that POD and lead time are improved for those warnings with greater average areas and durations

# IV. The Pitfalls of Traditional Verification

One ground truth point can verify a warning polygon of any size or duration!



Casting A Wider Net: Is this good service?

- By increasing the size and duration of a warning, polygon, one can increase the chances of getting a Hit and a large Lead Time.
- However, there is little penalty of a False Alarm it still gets counted as only ONE False Alarm!



#### V. Geospatial Verification Method One - Grid Points

Considers each 1 km<sup>2</sup> x 1 min grid point as a single event and data point in the contingency table:





POD, FAR, CSI are all derived from <u>the same</u> contingency table.

Correct Null (CN) conditions require  $\geq$  30 dBZ mean-filtered multi-radar Composite Reflectivity [can compute Heidke Skill Statistic (HSS)].

- Remaining grid points (non-events) are not used for scoring.
- Tornado reports are converted into a Tornado Observation grid:
- · Used radar data to interpolate tornado position every 1 minute
- "Splat" reports by 10 km (or any distance) with a Cressman distance weight

Hits and Misses are scored fuzzy from 0 to 1 using the Cressman weight:

- If obs grid point overlapping a warning grid:
- If obs grid point not overlapping warning grid:

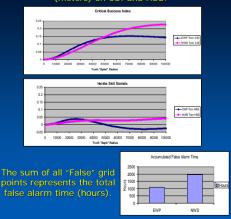
H (0,1) + F (0,1) = 1 M (0,1) + CN (0,1) = 1

Can't measure lead time using this method. Thus...method two (Truth Events).

### **VI. Grid Point Results**

FGF and MPX	POD	FAR	CSI	HSS
EWP	0.8422	0.9828	0.0171	0.0126
NWS	0.9434	0.9894	0.0106	0.0057
FGF Only	POD	FAR	CSI	HSS
EWP	0.7702	0.9841	0.0158	0.0027
NWS	0.9509	0.9916	0.0084	0.0009
MPX Only	POD	FAR	CSI	HSS
EWP	0.9829	0.9804	0.0196	0.0245
NWS	0.9275	0.9771	0.0229	0.0306
Forecast offices: FGF	Grand Forks	ND), MPX (N	Ainneapolis Ml	V)

The effect of varying truth "splat" radius (meters) on CSI and HSS.



#### VII. Geospatial Verification Method Two – Truth Events

Defined as a continuous time period that a specific grid point location is under a warning(s) and/or a tornado observation(s) and/or a 30 *dBZ echo*, *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" (>30 dBZ) throughout event
HIT: If grid point experiences a "hit condition" for at least 1 minute during event

 $t_{\text{eventBegins}} - t_{\text{eventEnds}}$ 

 $t_{\text{warningEnds}} - t_{\text{obsEnds}}$ 

 $t_{\rm obsBegins} - t_{\rm obsEnds}$ 

vt / wt

 $t_{\rm obsBegins} - t_{\rm warningBegins}$ 

 $t_{\text{warningEnds}} - t_{\text{warningBegins}}$ 

 $t_{\text{warnedObsEnds}} - t_{\text{warnedObsBegins}}$ 

[all events]

[HIT events only]

[HIT events only]

[HIT events only]

[HIT events only]

*IFALSE events onlv***1** 

*[HIT and FALSE onlv]* 

- EVENT TIME (*et*):
- LEAD TIME (*It*):
- DEPARTURE TIME (*dt*):
- FALSE ALARM TIME (*ft*):
- WARNING TIME (*wt*):
- VALID TIME (*vt*):
- VT PERCENTAGE (vtp):

	Transla	E	Desults
VIII.	Inuth	Event	Results

						Forecas	Forecast offices: FGF (Grand Forks ND), MPX (Minne				
					Averages						
FGF and MPX	POD	FAR	CSI	HSS	et	lt	dt	ft	wt	vt	vtp
EWP	0.7673	0.9088	0.0888	0.1054	22.4	17.0	15.1	29.7	37.2	8.5	0.229
NWS	0.9475	0.9074	0.0921	0.1086	31.3	29.0	31.1	43.8	56.7	7.9	0.140
FGF Only											
EWP	0.7092	0.9061	0.0905	0.0667	23.9	16.2	16.1	28.1	35.7	7.6	0.214
NWS	0.9612	0.9140	0.0857	0.0519	43.8	28.6	32.9	45.6	57.8	6.9	0.119
MPX Only											
EWP	0.9628	0.9147	0.0850	0.1322	21.0	19.0	12.7	33.4	40.5	10.8	0.267
NWS	0.9010	0.8745	0.1238	0.1973	20.5	30.4	24.5	34.5	51.0	11.7	0.230

# IX. Random Thoughts (but much more work to do!)

- The reduced average size and duration of EWP warnings led to improved FAR, FT, DT, and valid warning time percentage.
- Many of the EWP warnings were issued late, and missed some of the tornadoes, negatively affecting POD and LT
- This analysis will serve as the framework for rapid post-operations assessment of warning performance in the HWT starting in 2011.
- These procedures will also be used to assess:
- Verification of Severe Thunderstorm Warnings using gridded multi-radar hail information
- The impact of warning size and duration on warning service
- "Threats-In-Motion" where warning polygons move along with threats
- · Probabilistic information in warnings, and multiple warning thresholds

# IX. Acknowledgements

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