Verification of Tornado Intensity Added to NWS Preliminary Tornado Damage Paths

Bobby Saba[1,2], Christopher Karstens[3], Bryan Smith[3], Rich Thompson[3], Patrick Marsh[3], Dough Speheger[4], James LaDue[5]

1. Class of 2020 NOAA Hollings Scholar 2. Department of Atmospheric Sciences, Northern Vermont University – Lyndon – Lyndonville, VT 3.

NOAA/NWS/SPC – Norman, OK 4. NWS Forecast Office – Norman, OK 5. NWS Warning Decision Training Division – Norman, OK

[1]Corresponding Email: rxs07280@nvu.vsc.edu

Motivation

In the immediate wake of a tornado, it is unknown which areas sustained the most extreme damage. While damage surveys estimate tornadic strength at individual damage indicators, emergency managers need to know which areas need the quickest response to direct necessary resources.

Model

The model used for this analysis depicts tornadic wind speeds spatially from consecutive rotational velocity signatures. It adds intensity thresholds to already operational National Weather Service (NWS) track polygons (Figure 1). Output wind speeds are derived from Storm Prediction Center mesoanalysis data, radar data, analytical vortex model data, and 1km population. Case output (Figure 2) consists of 101 tracks representing each percentile of wind speeds or probabilities. Smoothing using incremental radius of influence (ROI) values was performed to optimize skill for informing user-defined value propositions.

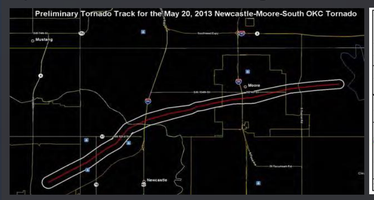


Figure 1: Preliminary NWS track polygon.

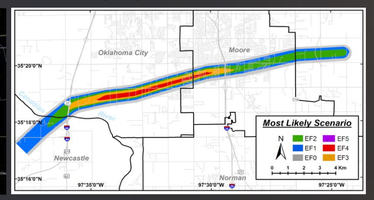


Figure 2: Example percentile model output.

Forecast Verification Metrics

Using the 2x2 contingency table (Figure 3), raw skill scores can be computed to assess model performance. False alarm rate, success rate, probability of detection, and critical success index were used in this analysis. Secondary metrics such as error score and ROC score were computed from these raw values.

$$FAR = \frac{B}{A+B} \qquad POD = \frac{A}{A+C}$$

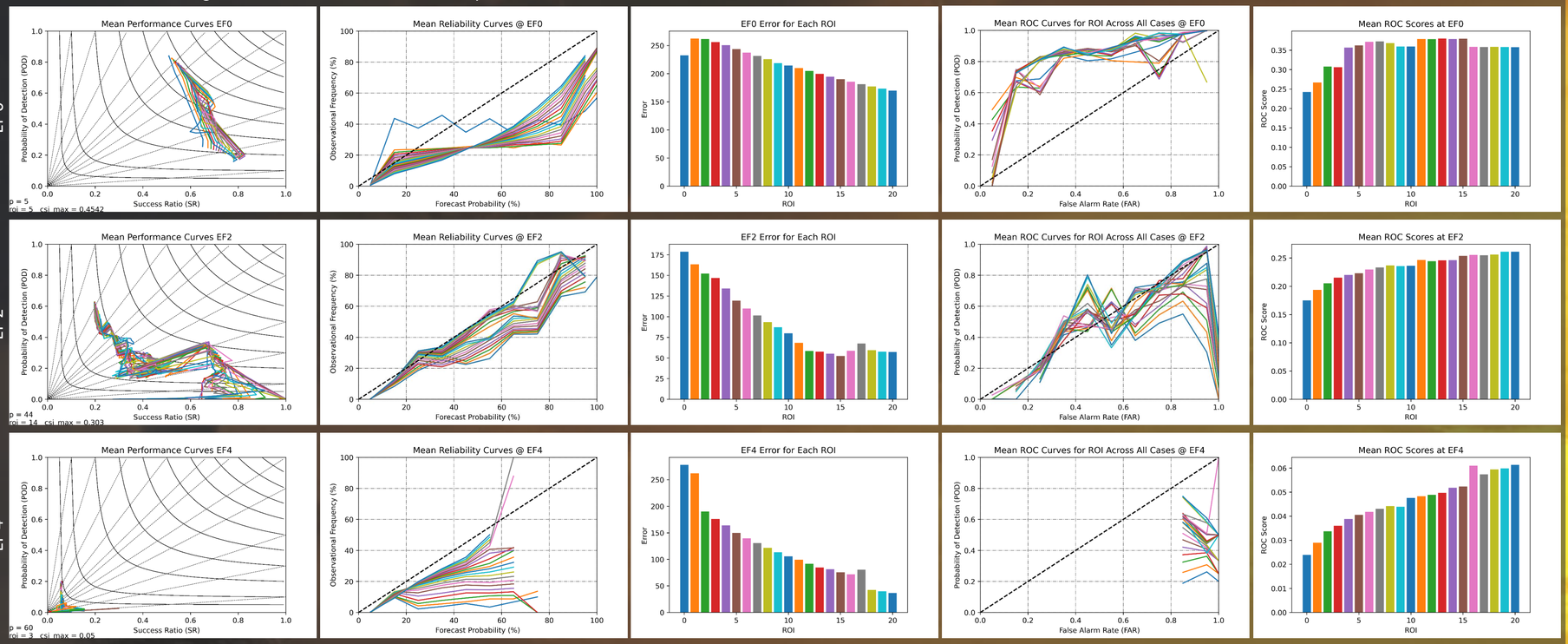
$$CSI = \frac{A}{A+B+C} \qquad error = \sum_{n}^{0} |x - y|$$

$$SR = 1 - FAR$$

2x2 Contingency Table		Event Observed	
		Yes	No
Event Forecast	Yes	A	B
	No	C	D

Figure 3: 2x2 Forecast Contingency Table (from Roebber (2009)).

Results



Summary/Conclusions

The data above imply the following settings for user-defined value propositions:

Best Case Scenario: low percentile/high ROI

Worst Case Scenario: high percentile/low ROI

Most Likely Scenario: middle percentile/mid-high ROI

In higher intensity storms, spatial accuracy diminishes. However, in these events, the model can accurately forecast those higher intensity winds.

Future Work

Expanding the dataset to over 20 cases is critical to addressing any issues with model code. Adding smoothing to observation data will assist in creating a practically perfect dataset. Implementation into the NWS forecast offices would aid in tornado forecasting, and it would provide immediate knowledge of potential tornado intensity.

Acknowledgments

I would like to extend a thank you to my mentor, Dr. Chris Karstens, and all associated co-mentors. Their leadership and guidance made this project engaging and enjoyable given the remote setting. Their willingness to share their workforce experiences allowed me to explore new career paths which I look forward to pursuing following graduation. I would also like to thank the NOAA Ernest F. Hollings Scholarship Program as the funding sponsor for this work.

References

Roebber, P. J., 2009: Visualizing multiple measures of Forecast Quality. *Weather and Forecasting*, **24**, 601–608, doi:10.1175/2008waf2222159.1.

National Weather Service

Northern Vermont University

Storm Prediction Center
Norman, Oklahoma