D–1.1 **Utilization of the NWS Damage Assessment Tool for Future Tornado Database Development and Application**

Bryan T. Smith

NOAA/NWS/NCEP/Storm Prediction Center, Norman, Oklahoma

1. Introduction

After the Enhanced Fujita (EF) Scale (WSEC 2006; Edwards et al. 2013) was implemented to assign wind-engineered intensity estimates to tornado damage in 2007, there was a need for a digital archive of tornado damage metadata. The Damage Assessment Toolkit (DAT; Camp et al. 2010) served this purpose. The National Weather Service (NWS) began this data collection in 2007 from a few select tornado events. This practice has been adopted by more NWS Forecast Offices in recent years. The EF Scale contains 28 Damage Indicators (DIs), with each associated with degrees of damage (DoDs) that indicate a range of possible wind speeds (WSEC 2006; Edwards 2013).

The Storm Prediction Center (SPC) is in the process of developing a more comprehensive tornado database by combining the existing SPC "ONETOR" tornado dataset—described in Schaefer and Edwards (1999)—with tornado damage survey information from the National Weather Service's DAT database (Fig. 1).

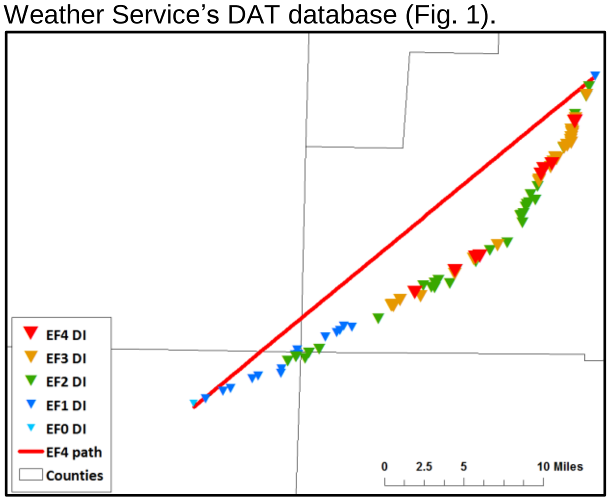

Figure 1. The 4/28/2014 Louisville, MS tornado path (ONETOR, red line; DIs from DAT, inverted triangles). The DI points are denoted by EF-scale rating (legend).

**Corresponding author address:* Bryan T. Smith, NOAA/NWS/NCEP/Storm Prediction Center, 120 David L. Boren Blvd., Suite 2300, Norman, OK 73072. Bryan.Smith@noaa.gov

This work describes the potential benefits of combining both datasets and introduces the concept of developing a probabilistic estimate of tornado damage intensity by using several objective input variables.

2. Data

All tornado data from the ONETOR and DAT datasets during the 2014–2015 period were organized and manually associated in a combined dataset. This procedure yielded a sample of 1149 tornadoes and 11826 DIs from a total of 2062 tornadoes from the 2-yr period. The number of DIs were disproportionate to the lower EF-scale magnitudes. The majority of DIs in the EF0–1 range were based on tree damage [58%; DIs 28 (hardwood trees) and 29 (softwood trees)]; whereas DIs associated with EF2–4 damage were overwhelmingly (82%) from man-made structures (i.e., homes, etc…).

3. Potential uses

a. SPC tornado database — the future

The association of the individual geocoded tornado DIs to the ONETOR database has potential to revolutionize data mining of tornado data and serve as a catalyst for beginning a new era in tornado database development. Geospatially associating this data to other meteorological information such as the SPC mesoanalysis data (Bothwell et al. 2002) using the SPC's environmental archive (Dean et al. 2006) is possible. Changing environmental conditions as represented by the SPC mesoanalysis data can be catalogued with a series of individual DAT points of a tornadic storm, which are likely different from the environmental data associated with the initial latitude/longitude pair for the ONETOR path (Fig. 2). Similarly, radar attribute information can be logged sequentially along the path of DIs by manually assigning rotational velocity [e.g., Smith et al. 2015, Thompson et al. 2017; (Fig. 3)]. The Lagrangian approach of following a thunderstorm through a 2-D environmental/radar-attribute space can provide information in a time series which can be explored for potential operational utility (Fig. 4).

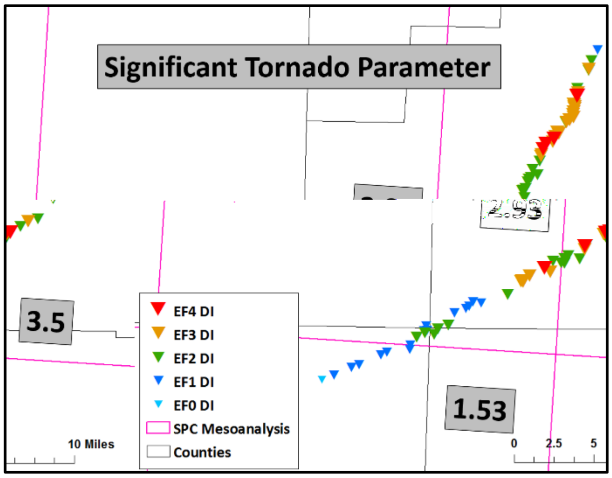

Figure 2. Similar to Fig. 1 except Significant Tornado Parameter values from the SPC Mesoanalysis (40km x 40km grid, pink squares) annotated in gray boxes.

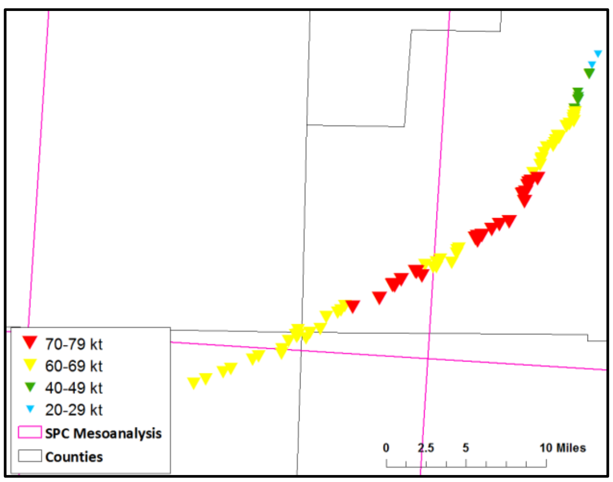

Figure 3. Similar to Fig. 2 except 0.5 degree rotational velocity binned values associated with the DIs (legend, lower left).

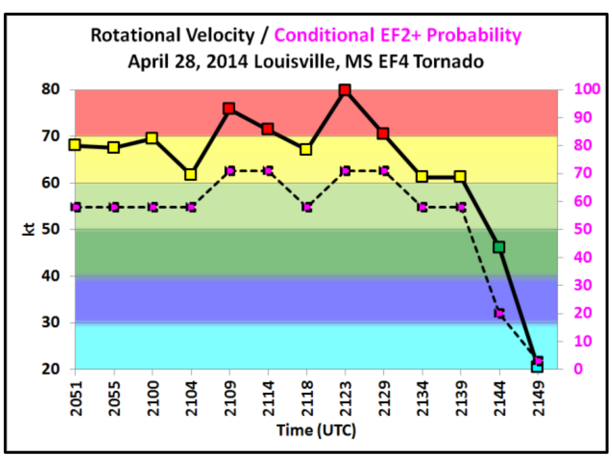

Figure 4. Time series [time (UTC), x-axis] of rotational velocity [thick black line; (kt) left vertical axis] and conditional EF2+ damage probabilities [dashed line; (percentage) right vertical axis] based on binned Significant Tornado Parameter values from Smith et al. (2015).

The establishment of a multi-year DI dataset can aid in exploratory investigations into the relationship between rotational velocity and damage indicator estimated wind speeds (Fig. 5).

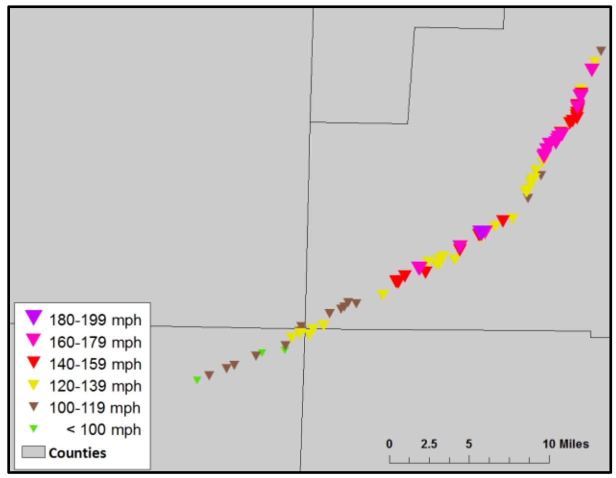

Figure 5. Similar to Fig. 1 except for estimated wind speeds associated with the DIs.

Additionally, nonmeteorological (e.g., geography) data using Geographic Information System (GIS) can offer additional spatial analysis to tornado damage rating information. Undoubtedly, population density (Fig. 6) and land use (Fig. 7) can influence both the meteorological assessment of tornado intensity and the societal impact of particular tornadoes. Quantification of these relationships more rigorously is now possible with these datasets through the development of a tornado damage climatology model. Future work will involve additional ONETOR–DAT database organization. This initial work, which provides a basis for future research, has already begun exploring the relationships amongst tornado data, the environment, and radar attributes. The SPC tornadic storm database is available for collaborative research, serving to enhance the interaction and communication between the research and operational communities in applied severe storms studies. The combined ONETOR–DAT dataset is available in text file format at the following SPC webpage (http://www.spc.noaa.gov/wcm). Potential users of this database include those in the insurance industry, emergency managers, and meteorologists.

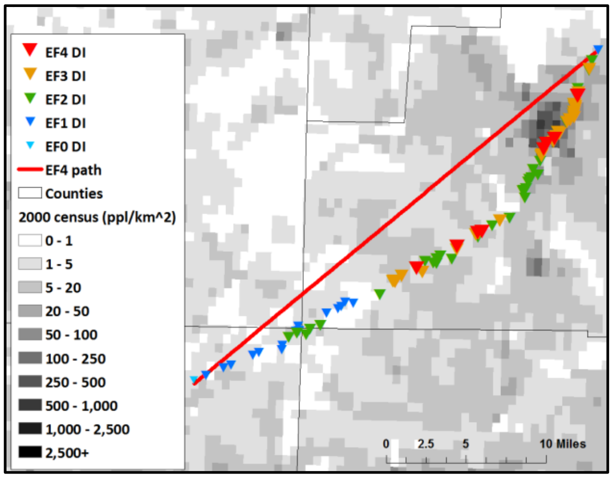

Figure 6. Similar to Fig. 1 except 2000 population density data (people/km^2) underlay.

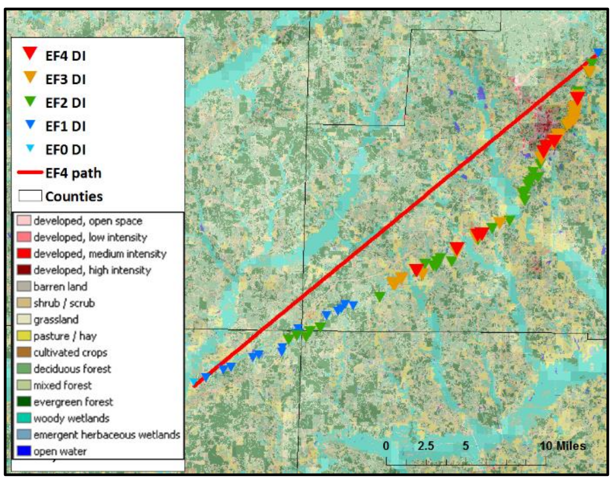

Figure 7. Similar to Fig. 6 except land use data underlay.

ACKNOWLEDGEMENTS

The author thanks Israel Jirak (SPC) for helping to clarify thoughts and for providing a thorough review of this manuscript. Parks Camp (Tallahassee NWS office) provided the DAT data.

REFERENCES

Bothwell, P. D., J. A. Hart, and R. L. Thompson, 2002: An integrated three-dimensional objective analysis scheme in use at the Storm Prediction Center. Preprints, *21st Conf. on Severe Local Storms*, San Antonio, TX, Amer. Meteor. Soc., J117–J120.

Camp, P. J., K. Stellman, and J. Settelmaier, 2010: Utilizing mobile devices for enhanced storm damage surveys. Preprints, *26th Conf. on IIPS*, Atlanta, GA, Amer. Meteor. Soc., 5B.4. [Available online at https://ams.confex.com/ams/90annual/techprogram/paper_161540.htm.]

Dean, A.R., R.S. Schneider, and J.T. Schaefer, 2006: Development of a comprehensive severe weather forecast verification system at the Storm Prediction Center. *Preprints*, 23nd Conf. Severe Local Storms, St. Louis MO.

Edwards, R., J. G. LaDue, J. T. Ferree, K. Scharfenberg, C. Maier, and W. L. Coulbourne, 2013: Tornado intensity estimation: Past, present, and future. *Bull. Amer. Meteor. Soc.*, **94**, 641–653, doi:https://doi.org/10.1175/BAMS-D-11-00006.1

Schaefer, J. T., and R. Edwards, 1999: The SPC tornado/severe thunderstorm database. Preprints, 11th Conf. on Applied Climatology, Dallas, TX, Amer. Meteor. Soc., 603–606.

Smith, B.T., R.L. Thompson, A.R. Dean, and P.T. Marsh, 2015: Diagnosing the Conditional Probability of Tornado Damage Rating Using Environmental and Radar Attributes. *Wea. Forecasting,* **30**, 914–932, https://doi.org/10.1175/WAF-D-14-00122.1

Thompson, R.L. and coauthors, 2017: Tornado Damage Rating Probabilities Derived from WSR-88D Data. *Wea. Forecasting,* **32**, 1509–1528, https://doi.org/10.1175/WAF-D-17-0004.1

WSEC, 2006: A recommendation for an enhanced Fujita scale (EF-scale). Wind Science and Engineering Center, Texas Tech University, Lubbock, Texas, 95 pp. [Available online at http://www.depts.ttu.edu/nwi/Pubs/EnhancedFujitaScale/EFScale.pdf.]