Online Summary

The 1 August 2013 Tornado in Jacksonville, FL

(Image Courtesy of http://arlington.firstcoastnews.com/news/news/119963-ef2-tornado-has-people-thinking-about-renters-rights)

University of Florida Wind Hazard Damage Assessment Team

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9 August 2013

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Wind Hazard Damage Assessment Team
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Executive Summary

Jacksonville, Florida, a city of 836,507 (in 364,678 homes), was hit by a tornado on August 1, 2013. Preliminary estimates by the National Weather Service placed its strength as EF-2. This area, (Duval County, FL) has been hit by 61 tornadoes over the past 64 years. The tornado touched down around 4:15pm and in 15 minutes, it tracked in northeasterly direction for approximately three miles through the Arlington Jacksonville area. The maximum damage swath of the tornado was mapped at about 135 yards. The majority of the damage consisted of fallen trees, minor damage to about twenty homes and flooding from the associated thunderstorm. One person sustained a minor injury.

This work is part of the research at the University of Florida to document tornado outbreaks as they occur. The study is done in parallel to our research seeking to understand and quantify the strength of tornado loads and their interaction with vulnerable wood-framed structures. It is our thesis, that engineering solutions are urgently needed and they will be found, to improve the tornado-resistance of houses. Stronger buildings can be built quite economically today that would mitigate structural damage and provide better life safety protection – it is up to communities and their leaders to decide whether they wish to pursue such resilient and sustainable approaches or whether to continue with the status quo. These solutions come at a price, yet to be determined, once engineers and scientists gain a better idea of the loads, and society determines what costs are acceptable to reduce the risks and minimize economic losses from tornadoes.

This report was prepared from online sources by University of Florida civil engineering students in Prof. David O. Prevatt's Research Group. It is part of their learning in forensic engineering and post-disaster damage investigation. Students were tasked to gather information from online sources and collate information on the tornado (from the National Weather Service, storm chaser Twitter feeds), injuries and fatalities (from media reports) and on structures (from the US Census Bureau and building code websites).

Please visit our website, http://windhazard.davidoprevatt.com, for additional information, and to download previous damage reports, survey results and for research on the interaction of tornadoes and residential infrastructure. A link to previous tornado damage surveys are also available on Dr. Prevatt's webpage, www.davidoprevatt.com, including the 2011 Tuscaloosa Tornado Damage Survey Report. A list of helpful references is included at the end of this report.

Your questions and comments on any aspects of our work are most welcome. Please direct your enquiries to NSF Graduate Research Fellow and PhD Graduate Student, Mr. David B. Roueche, who can be reached at david.roueche@ufl.edu.

About the Wind Hazard Damage Assessment Team

The Wind Hazard Damage Assessment Team was created through support from the NSF Award #1150975. Its mission is to train university students interested in building construction, engineering and architecture in the forensic engineering and techniques for post-hazard damage surveys and data collection. The team has surveyed damage after several Florida tornadoes and continuously monitors the prevalence of tornadoes worldwide. Ultimately the Team hopes to inspire upcoming engineers and building professionals in hopes to change the paradigm of widespread catastrophic damage to houses in tornadoes. Mr. Jeandona (JD) Doreste, is a civil engineering undergraduate student at UF and Webmaster of the Wind Hazard Damage Assessment Team site. JD is actively recruiting other UF students to join the team, and he can be reached at jdoreste1@ufl.edu.

PREDICTIONS

The Storm Prediction Center's initial expectations for tornado risk on August 1 were low across the country (Figure 1), and there was zero probability of tornado genesis in Florida. The greatest probability of tornado formation was in the central and northern regions of Nebraska.

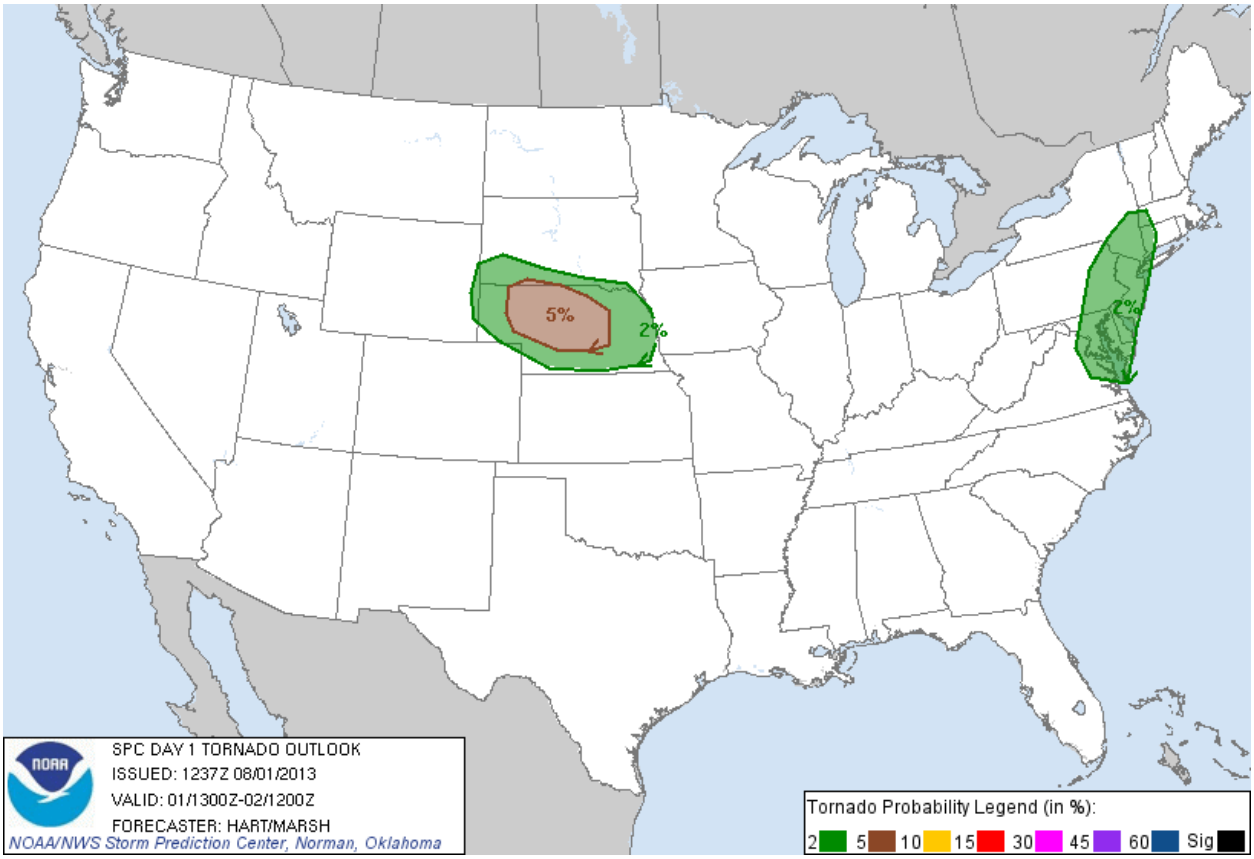

Figure 1: Tornado Probability for August 1, 2013 as Issued by NWS SPC at 12:40 PM UTC on same day (Source: http://www.spc.noaa.gov/products/outlook/archive/2013/day1probotlk_20130801_1300_torn.gif)

TWEETS

Storm chasers and local National Weather Service offices did not seem privy to the formation of a tornado in northern Florida. It was not until the storm began to unfold that posts/pictures of the transpiring events began to show up on Twitter.

TIMING OF TORNADO

The timeline of the tornado as it formed and impacted the city of Jacksonville, FL is given below. An illustration of the timing of the tornado impact using radar observations is shown in Figure 2.

4:15 PM – Multiple trees were blown down along with wind damage to a shed and fence near Monument Rd and McCornick Rd

4:20 PM – Tornado touched down near Monument Road and Derringer Road. The tornado briefly reach EF2 strength just south of Willowood Drive. A minor injury was reported in the Fort Caroline area

4:24 PM – Severe thunderstorm warning for eastern Duval County through 5:15 PM

4:30-5:30 PM – Flooding rainfall reports including knee-deep waters at Singleton's Seafood Restaurant near Mayport (estimated 3 inches in 30 minutes) were reported. Around 4.5 inches of storm total rainfall was measured in the Ashley Woods neighborhood near Craig Field.

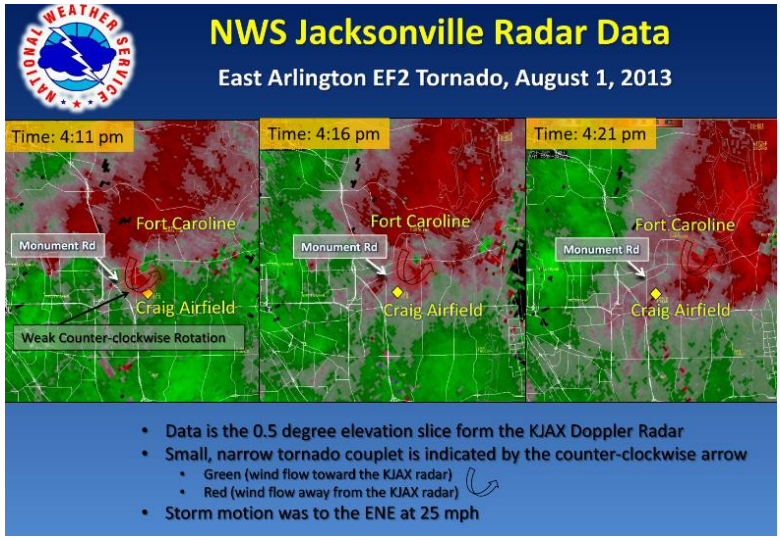

Figure 2: Radar Data for Jacksonville, FL

(Source: http://www.srh.noaa.gov/media/jax/vBriefing/Arlington_Tornado_Preliminary_Summary/index.htm)

HOUSING DEMOGRAPHICS IN JACKSONVILLE, FL

Jacksonville, Florida has a population of approximately 836,507 persons, living in 364,678 homes. (http://quickfacts.census.gov/qfd/states/12/1235000.html).

Approximately 80% of the homes in Jacksonville were built before 2000 (Figure 3). Many of the recent building code improvements were implemented after the impact of Hurricane Andrew in 1994, meaning that the majority of the homes in Jacksonville, FL were built prior to the implementation of the stronger building codes and are therefore particularly vulnerable to wind damage. The complete distribution of home ages is illustrated in Figure 3.

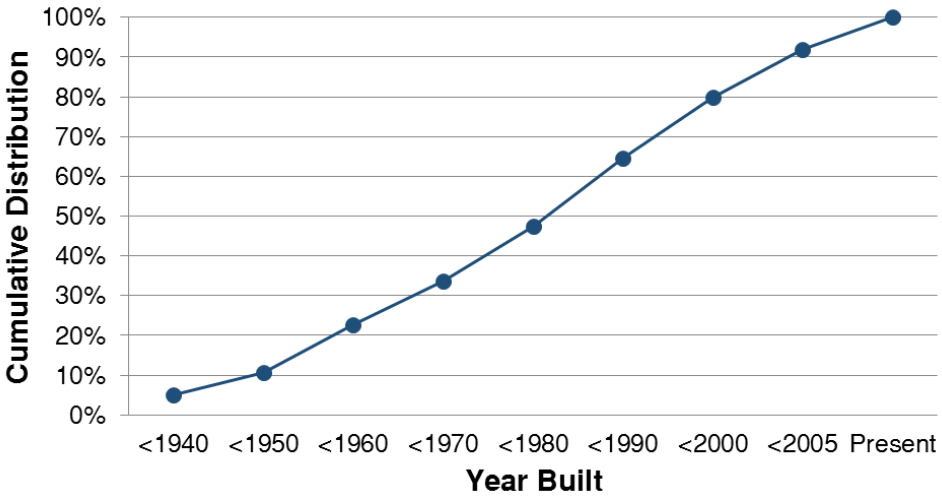

Figure 3: Distribution of Home Age in Jacksonville, Fl
(http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP04)

OBSERVED DAMAGES

The estimated tornado track as determined by the NWS Jacksonville survey team is shown below in Figure 4. The total length of the tornado was approximately 3 miles and at its widest point the damage path from the tornado was nearly 135 yards wide (NWS).

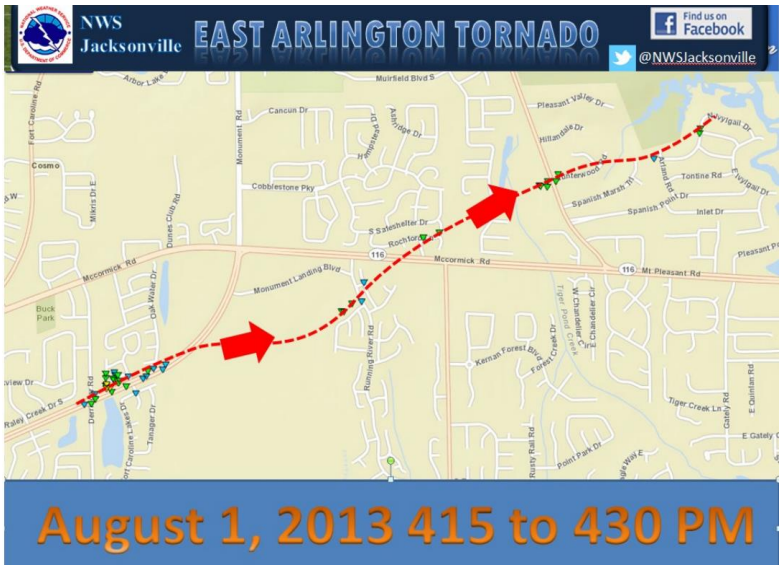

Figure 4: Estimated Tornado Track
(Source: http://www.srh.noaa.gov/media/jax/pdf/EF2Tornado_EastArlington_AUG2013.pdf)

The majority of the observed damage was snapped pine trees, which are classified as softwood trees in the EF-Scale Damage Indicators. Snapped trunks correspond to a Degree of Damage of 4 (Figure 5), which has an expected wind speed of 104 mph and therefore indicates a tornado intensity of EF-1 (86 – 110 mph).

DOD	Damage description	EXP	LB	UB
1	Small limbs broken (up to 1" diameter)	60	48	72
2	Large branches broken (1" – 3" diameter)	75	62	88
3	Trees uprooted	87	73	113
4	Trunks snapped	104	88	128
5	Trees debarked with only stubs of largest branches remaining	131	112	153

* DOD is degree of damage

Figure 5: Degrees of Damage for Softwood Trees, including Pine, from Enhanced Fujita Scale (2007),

Preliminary reports from the Jacksonville Sheriff's office and social media indicated minor to substantial damage to at least 15 structures. Some of the heaviest damage was observed at the Shadowood apartments on Willowood Drive. The majority of the damage to structures amounted to walls protruding outwards and sheathing loss (Figure 6), while the more substantial damage was caused by tree fall (Figure 7). Figure 8 shows a 2 X 4 that was launched into a home on Willowood Dr as a result of the strong winds.

For wood-framed wall, penetration by a 2x4 member typically occurs when the 2x4 s travelling at approximately 35 mph. Without knowing how far this object had flown it is not possible to estimate the wind speed, however, FEMA 361: *Design and Construction Guidance for Community Safe Rooms* suggests that objects lifted by the wind typically achieve velocities of 0.375 times the local gust wind speed with approximately 30 feet of travel distance. On that basis the wind speed estimate would be 93 mph, which is also in the range of EF-1 intensity.

Figure 6: Damage to the Shadowood apartments by Willowood Dr
(Courtesy of National Weather Service Jacksonville)

Using data available on Zillow.com, the homes that sustained damage on Derringer Rd near Monument Rd were built in the last three to six years. The apartment complex by Willow Dr and the homes between Monument Rd and Fort Caroline Lakes Dr N, also in the direct path of the tornado, were built in the mid 1970's and 80's.

Figure 7: Damage to homes by fallen tree in neighborhoods off of Monument Road, Jacksonville, FL
(http://www.firstcoastnews.com/topstories/article/322391/483/Roads-cleaned-homeowners-still-cleaning)

Figure 8: 2 x 4 imbedded in wall at the Shadowood apartments by Willowood Dr
(Courtesy of National Weather Service Jacksonville)

PREVIOUS TORNADO REPORTS IN DUVAL COUNTY, FL

Figure 9 maps all reported tornado touchdowns in Duval County, FL from 1950 to current from the Storm Prediction Center database. A total of 60 rated tornadoes were reported, with intensities varying from EF-0 to EF-2. The distribution of the intensities for Duval County is shown in Figure 10. As is typical in Florida, the majority of the reported tornadoes in Duval County are of the smaller, less intense variety. However, a significant number of tornadoes have occurred and the risk for tornado impacts in Duval County should be considered further.

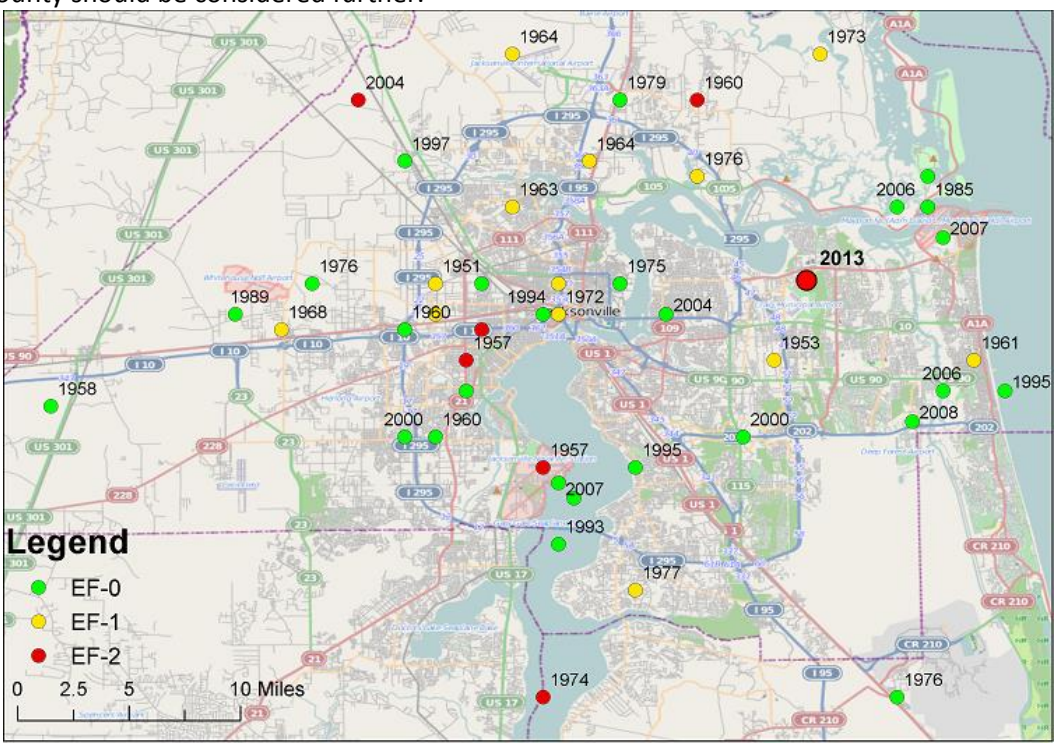

Figure 9: Map of tornado touchdown locations in Duval County, FL with year reported

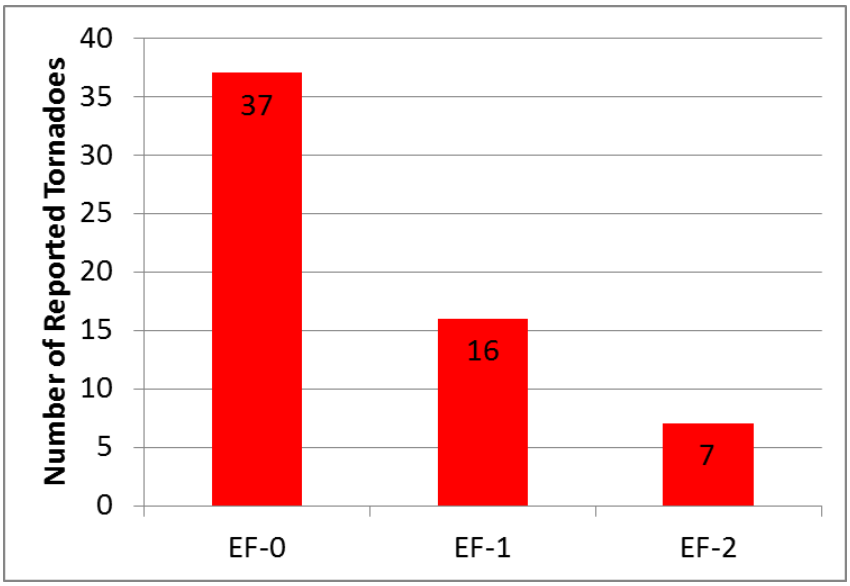

Figure 10: Distribution of tornado intensities in Duval County, FL from 1950 to current (http://www.spc.noaa.gov/wcm/#data)

Acknowledgements

The authors gratefully acknowledge the National Science Foundation for the financial support of this study under research grant 1150975. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

About the PI

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Useful References on Tornadoes and Their Effects on Wood-Framed Buildings and Other Structures

Peer-Reviewed Publications

Prevatt, D. O., Coulbourne, B., Graettinger, A., Pei, S., Gupta, R., and Grau, D. (2013). "Tornado of May 22, 2011 – Structural Damage Survey and Case for Tornado-Resilient Building Codes", 47 p. ASCE/Structural Engineering Institute, Reston, VA.

Prevatt, D. O., Roueche, D. B., et al. (2011c). "Building damage observations and EF classifications from the Tuscaloosa, AL and Joplin, MO tornadoes." *Proc., 2012 Structures Congress*, ASCE, Reston, VA, in press. Prevatt, D. O., van de Lindt, J. W., Graettinger, A., et al. (2011a). *Damage study and future direction for structural design following the Tuscaloosa tornado of 2011*. University of Florida, Gainesville.

Prevatt, David. O., van de Lindt, J.W., Back, E., Graettinger, A.J., Pei, S., Coulbourne, W., Gupta, R., James, D., Agdas, D.; (2012) Making the Case for Improved Structural Design: The Tornado Outbreaks of 2011, October 2012 ASCE's Leadership and Management in Engineering Journal

Prevatt, D.O., van de Lindt, J.W., Graettinger, A.,Coulbourne, B., Gupta, R., Pei, S., Hensen, S., Grau, D. (2011a) Damage Study and Future Direction for Structural Design Following the Tuscaloosa Tornado of 2011, University of Florida, Gainesville, FL (April 5, 2012).

Prevatt, D. O., van de Lindt, J. W., Gupta, R., and Coulbourne, B. (2011d). "Structural performance—Tuscaloosa tornado." *Structure Magazine*, July, 24–26.

Vo, T. D., Prevatt, D. O., Acomb, G. A., Schild, N. K., & Fischer, K. T. (2012, October). High speed wind uplift research on green roof assemblies. Conference paper presented at Cities alive: 10th annual green roof & wall conference, Chicago, IL. Retrieved from http://windhazard.davidoprevatt.com/wp-content/uploads/2012/12/SUBMISSION-5R-1-Vo-et-al.-High-speed-wind-uplift-research-on-green-roof-assemblies.pdf

Other Publications and Reports

Prevatt, D. O., Agdas, D., & Thompson, A. (2013). Tornado damage and impacts on nuclear facilities in the united states. Unpublished manuscript, Department of Civil and Coastal Engineering, University of Florida, Gainesville, Retrieved from http://windhazard.davidoprevatt.com/wp-content/uploads/2012/10/Prevatt-2013-US-Nuclear-Power-Plants-and-Tornadoes_dop.pdf

Prevatt, D. O., Doreste, J., & Egnew, A. (2013). Online summary damage from the 31 May 2013 tornado in El Reno, OK. Unpublished manuscript, Department of Civil and Coastal Engineering, University of Florida, Gainesville, Retrieved from http://windhazard.davidoprevatt.com/wp-content/uploads/2012/10/El-Reno-Tornado-31-May-2013-Summary-UNIV-FLORIDA.pdf

Prevatt, D. O., Kerr, A., Peng, X., Vo, T., & Doreste, J. (2012). Damage survey following the August 27th, 2012 tornado in Vero Beach, FL. Unpublished manuscript, Department of Civil and Coastal Engineering, University of Florida, Gainesville, Retrieved from http://windhazard.davidoprevatt.com/wp-content/uploads/2012/10/Damage-Survey-Vero-Beach-Tornado-Sept-7-2012-UNIV-FLORIDA.pdf

Prevatt, D. O., Roueche, D., Thompson, A., & Doreste, J. (2013). Online summary damage from the 20 May 2013 tornado in Moore, OK. Unpublished manuscript, Department of Civil and Coastal Engineering, University of Florida, Gainesville, Retrieved from http://windhazard.davidoprevatt.com/wp-content/uploads/2013/05/Moore-Tornado-20-May-2013-TORNADO-Summary-UNIV-FLORIDA.pdf

Prevatt, D. O., Roueche, D., Vo, T., Kerr, A., Thompson, A., Peng, X., & Egnew, A. (2013). Online/internet damage summary of the 15th May, 2013 North Texas tornado outbreak. Unpublished manuscript, Department of Civil and Coastal Engineering, University of Florida, Gainesville, Retrieved from http://windhazard.davidoprevatt.com/wp-content/uploads/2013/05/Summary-of-North-Texas-Tornado-Outbreak-on-May-15th_Final.pdf

Prevatt, D. O., Roueche, D., Kerr, A., & Peng, X. (2012). Summary of june 24, 2012 Lake Placid tornado. Unpublished manuscript, Department of Civil and Coastal Engineering, University of Florida, Gainesville, Retrieved from http://windhazard.davidoprevatt.com/wp-content/uploads/2012/10/June-24-Lake-Placid-Tornado-Damage-Survey.pdf
Engineering, Vol. 139, No. 2, February 1, 2013. ©ASCE, ISSN 0733-9445/2013/2-251–263.