Online Summary

Damage from the 31 May 2013 Tornado in El Reno, OK

(Image Courtesy of http://www.weather.com/news/tornado-central/storm-damage-friday-20130531)

University of Florida Wind Hazard Damage Assessment Team

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June 6, 2013

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Executive Summary

Just two weeks after a tornado caused extensive damage to Moore, OK, on 31 May 2013, El Reno, OK, was hit by another powerful tornado. El Reno is a little less than 30 miles to the north-west of Moore, and it has a population of 17,510 in 6,752 homes. The tornado tracked through mainly rural areas south of the town itself (south of Interstate 40). The unsettled weather spawned multiple vortices and several (nine) tornadoes in El Reno, Yukon, Mustang, near Moore, Del City, Watova and Oklahoma City. The most deadly was the El Reno. NWS reports a 16.2-mile curvilinear path of the tornado, and a maximum damage swath of 2.6 miles, making it the widest tornado on record. Building damage was relatively limited due to the rural track taken by this tornado. There were 20 confirmed fatalities, including the three storm chasers, Tim Samaras, his son, Paul and a videographer with his team. This was indeed a tragic loss to forecasting community.

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).

Researchers at the University of Florida and elsewhere will continue to document tornado outbreaks as they occur, and in parallel our research to understand and quantify the strength of tornado loads and their interaction with vulnerable wood-framed structures is continuing. It is our thesis, that engineering solutions can be found to improve the tornado-resistance of houses. These solutions come at a price, yet to be determined, once scientists have a better idea of the loads, and society determines what risks are acceptable. 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.

Please visit our website, for further information http://windhazard.davidoprevatt.com. Background information and our previous damage survey blogs can be found on Dr. Prevatt's webpage, www.davidoprevatt.com, including the 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.

PREDICTION OF WEATHER

Initial expectations for tornado risk on May 31st were very significant (Figure 1), with the Storm Prediction Center tornado outlook showing a 15% probability of tornado genesis in Central Oklahoma, Southern Kansas, and Southern Missouri.

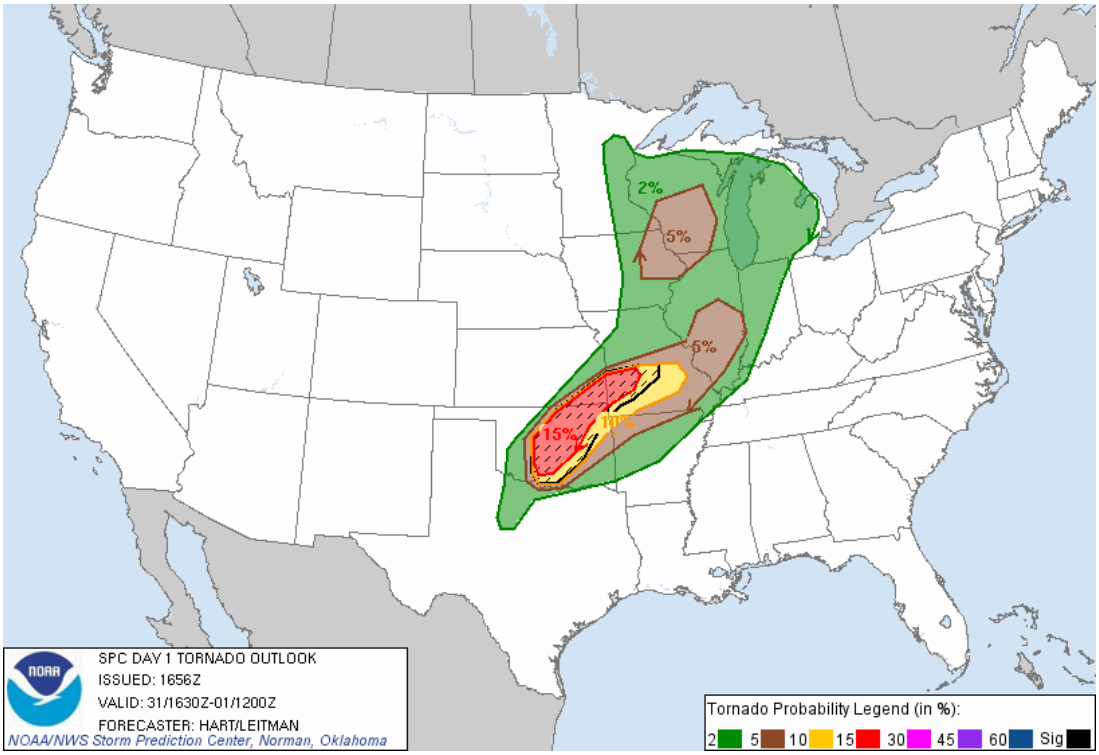


Figure 1: Tornado Probability for May 31, 2013 as Issued by NWS SPC at 17:00 PM UTC on Same Day (Source: http://www.spc.noaa.gov/products/outlook/archive/2013/day1otlk_20130531_1630.html)

TWEETS

Storm chasers were on high alert, expecting significant tornado outbreaks for Central Oklahoma, Southwest Missouri, and Southeast Kansas.

28storms.com @28storms 31 May
Tornado sirens are sounding in the Joplin, Missouri, area. Warning in effect #MOwx fb.me/29fTrJ0iN
Expand

28storms.com @28storms 31 May
Significant tornadoes possible today, with the greatest threat once again centered over Oklahoma... fb.me/1sTFEk1ab
Expand

TIMING OF TORNADO

The timeline of the tornado as it formed and impacted the city of El Reno, OK is given below. An illustration of the beginning and ending time of the tornado impact is shown in Figure 2.

5:37 PM - Tornado warning issued for storm along I-40 in Canadian County

5:57 PM - National Weather Service in Norman spots a dangerous rain-wrapped tornado two to three miles south of I-40 southwest of El Reno.

6:22 PM - Large violent tornado reported by the National Weather Service in Norman just east of Hwy 81, near El Reno moving straight east at 25 mph

6:25 PM - Tornado emergency declared by National Weather Service in Norman for El Reno

6:27 PM - Storm chasers say El Reno tornado's damage path is a mile wide

6:56 PM - National Weather Service declares tornado emergency for Will Rogers Airport, Wiley Post, Bethany, downtown Oklahoma City and north Moore

7: 09 PM - National Weather Service spotters see debris signature with tornado near Oklahoma City Fairgrounds

7:28 PM - National Weather Service detects a new tornado just east of Will Rogers Airport

7:38 PM - From KFOR: Small tornado touchdown reported near 19th Street and Telephone Road in Moore

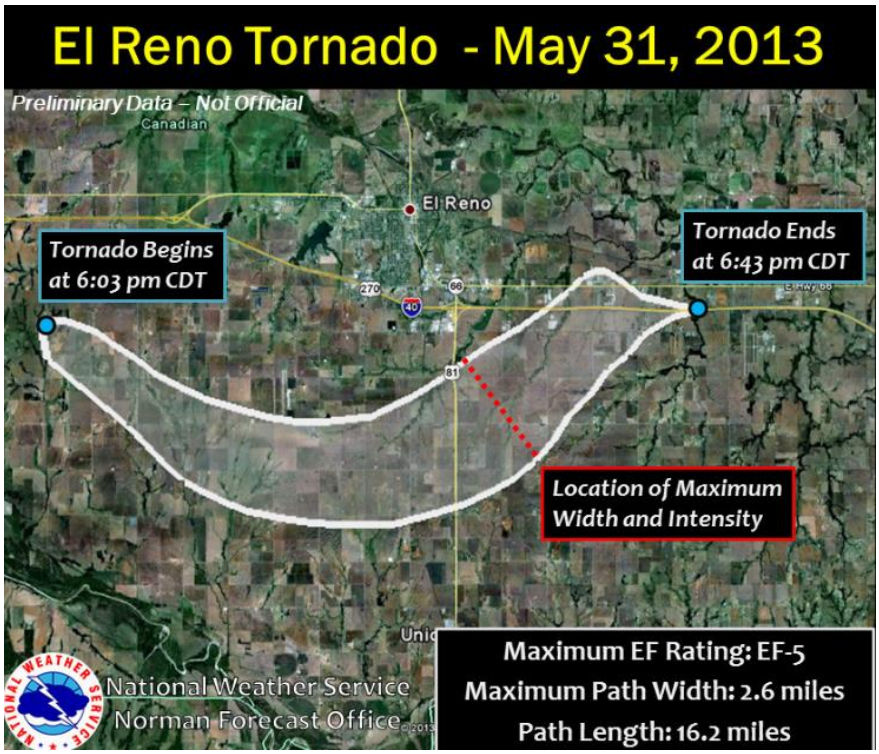


Figure 2: Timing of Tornado Impact to El Reno, OK
(http://www.tulsaworld.com/article.aspx/Fridays_El_Reno_tornado_upgraded_to_EF5_widest_on_record/20130605_11_A1_ULNSka613970)

Confirmed Tornado Strikes

The NWS survey teams confirmed that five tornadoes occurred in the 31 May 2013 tornado outbreak, the first occurring in Canadian County at 6:03 PM UTC and the last reported at 7:38 PM in Cleveland County. The estimated path of three of the tornadoes are illustrated in Figure 3, one began near El Reno and ended west of Yukon and then two in the South Oklahoma City area. The most dramatic damage seen was that of the tornado traveling in the vicinity of El Reno, OK. Preliminary damage assessments by the local NWS survey teams reported the storm to be an EF3, but after retrieving data from a mobile Doppler radar close to the tornado, this rating was upgraded to an EF5, with peak wind speeds of 295 mph.

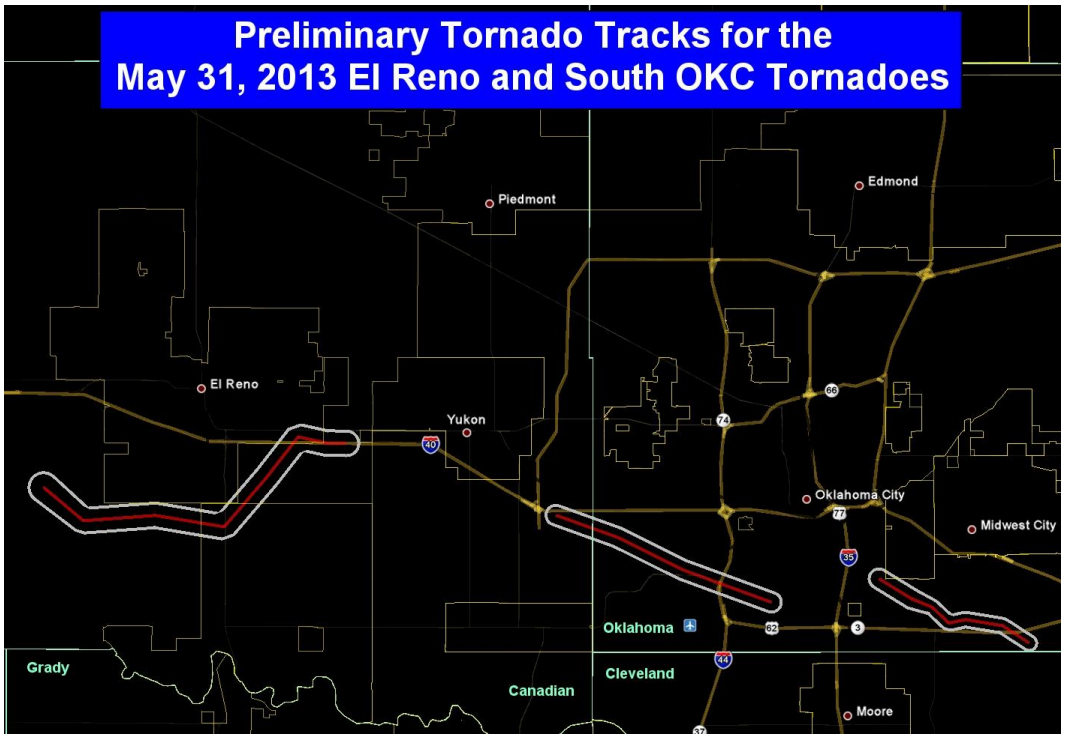


Figure 3: Preliminary Tornado Tracts of Three Independent tornadoes (Source: http://localtvkfor.files.wordpress.com/2013/06/tracks.jpg)

The maximum path width of the tornado was determined to be 2.6 miles and the approximate length was 16.2 miles, with the tornado appearing to be at its greatest intensity right before it reached any of the heavily populated regions of El Reno, OK. At this time, 20 fatalities and over 240 injuries are reported. Figure 4 displays a map where the first nine confirmed victims were found. A summary of the locations and other significant data concerning each confirmed tornadoes is given in Table 1. (http://www.tulsaworld.com/article.aspx/El_Reno_tornado_upgraded_to_EF5/20130604_100_0_TeNtoa585439 | http://kfor.com/2013/06/04/may-31-tornado-makes-history-largestef-5-on-record/ | http://www.weather.com/news/tornado-central/storm-damage-friday-20130531)

Table 1: Preliminary Tornado Survey Results

Location	Preliminary Rating	Begin Time	End Time	Path Length	Maximum Width
El Reno *(Southwest to Southeast of El Reno)*	EF-5	6:03 PM CDT	6:43 PM CDT	16.2	2.6 miles
Lightning Creek Park *(Lightning Creek Park to Straka Terrace and Western Avenue)*	EF-1	6:25 PM CDT	6:35 PM CDT	0.4 miles	250 yards
Southwest Oklahoma City/Will Rogers World Airport *(Fairfax Lane, northwest of SW 15th & Morgan Road Intersection to Intersection of SW 56th and Blackwelder Ave.)*	EF-1	6:51 PM CDT	7:23 PM CDT	10.4 miles	1.4 miles
Moore *(NW 5th St. to W Main St.)*	EF-0	7:50 PM CDT	7:55 PM CDT	0.5 miles	500 yards
Southeast Oklahoma City *(Creekwood Terrace to Keith Dr., east of Valley Brook)*	EF-0	7:33 PM CDT	7:40 PM CDT	0.4 miles	200 yards

(Source: http://www.srh.noaa.gov/oun/?n=events-20130531)

Figure 4: Map of Locations of first nine confirmed victims (Source: http://localtvkfor.files.wordpress.com/2013/06/may-31-tornado-death-map.jpg)

PREVIOUS TORNADOES IN EL RENO, OK

MAY 24 2011: At 3:50 PM CDT, the populated city of El Reno was struck by a devastating EF5 tornado that resulted in 9 deaths and 181 injuries. This 1760 yard wide tornado moved east-northeast through El Reno, creating a damage path more than 63 miles long, with peak winds greater than 210 mph. Similar to the May 31, 2013 tornado, wind speed measurements from a mobile Doppler radar were used to rate the tornado. The majority of the damaged buildings were one and two-story residential structures built on concrete slab foundations, several mobile homes were destroyed, and a few commercial buildings were badly battered. The May 24, 2011 and May 31, 2013 tornadoes are illustrate in Figure 5. (http://www.srh.noaa.gov/oun/?n=events-20110524-tornado-b2 | http://newsok.com/oklahoma-tornadoes-8-dead-60-injured/article/3570916)

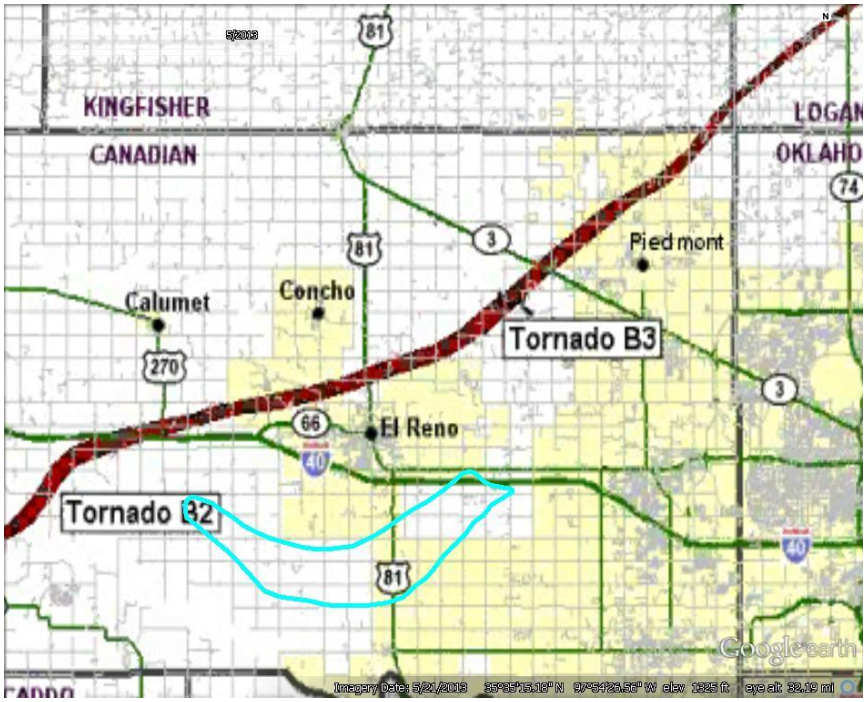


Figure 5: May24, 2011(Red) May 31, 2013 (Blue) El Reno Tornado Track

[The yellow, and grey areas illustrate the populated regions, graying being densely populated]

*(*http://www.srh.noaa.gov/images/oun/wxevents/20110524/maps/tornado-b2-b3-whole.jpg *)*

COMPARING MAY 20TH AND MAY 31ST OKLAHOMA TORNADOES

The evening of May 20th, 2013 Moore, OK was devastated by a 2 mile wide EF-5 tornado. It left a 17 mile damage path and resulted in 24 fatalities. Although detailed information concerning the El Reno tornado is not yet known, Moore was in the direct path of the tornado while the El Reno tornado followed a path that circumvented the city proper. (http://kfor.com/2013/06/04/may-31-tornado-makes-history-largest-ef-5-on-record/)

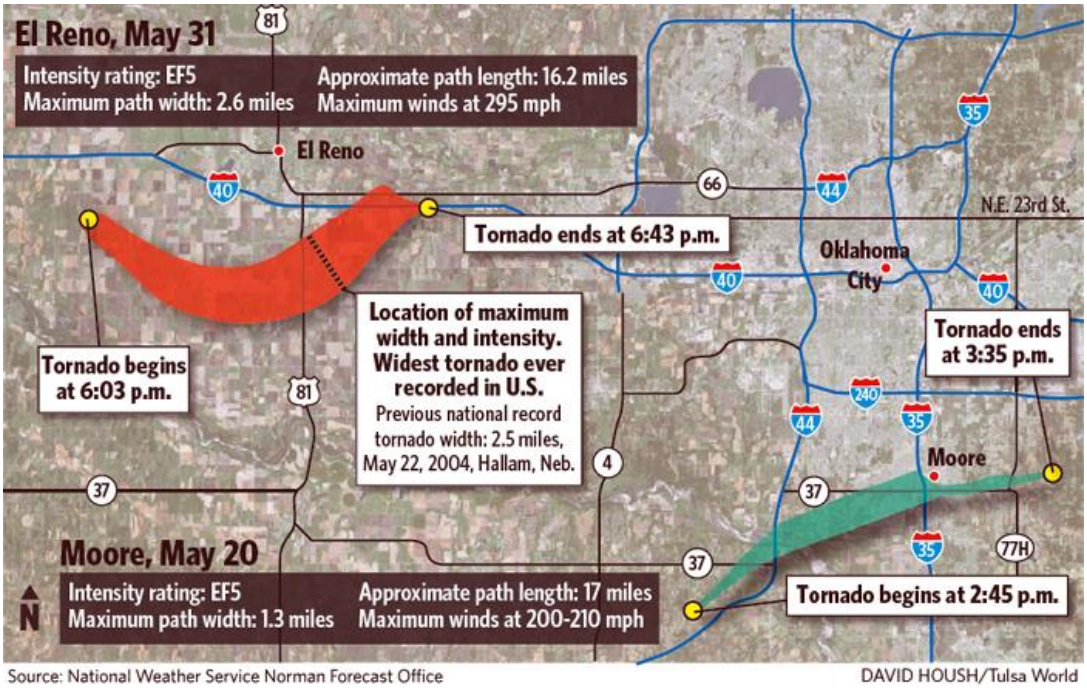


Figure 6: Comparing May 20th and May 31st Oklahoma Tornadoes (http://www.tulsaworld.com/article.aspx/Fridays_El_Reno_tornado_upgraded_to_EF5_widest_on_record/20130605_11_A1_ULNSka613970)

BUILDING CONSTRUCTION IN EL RENO, OK

El Reno, OK has a population of approximately 17,510 persons, living in 6,752 homes (http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk | http://quickfacts.census.gov/qfd/states/40/4023700.html)

95% of the homes in El Reno were built before 2000. The complete distribution of home ages is illustrated in Figure 7.

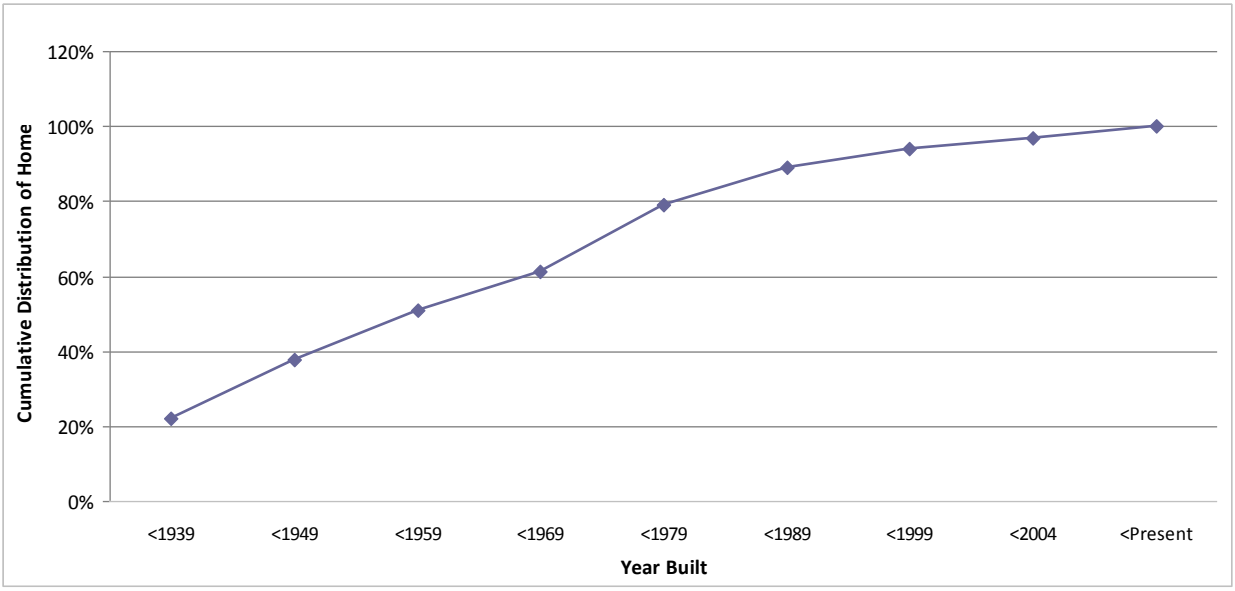
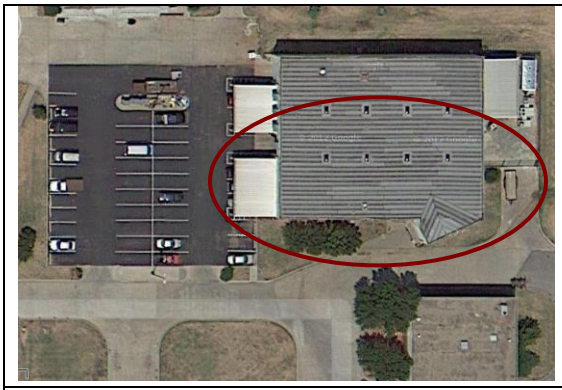


Figure 7: Distribution of Home Age in El Reno, OK
(http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP04)

Observed Damages

Although detailed information is not yet known, reports obtained from local news agencies and social media have indicated heavy damage to one technical training school, and a number of commercial buildings and residential buildings.

The Canadian Valley Voc Tech School's El Reno campus sustained heavy damage. The front of the main building and all other out buildings on the campus were severely damaged. Before and after photos of part of the campus are shown in Figures 8. It is not known at this time what the exact structural designs for this school was but it has been reported that those present at the time of the storm found shelter in the basement of one of the buildings on campus (Source: http://www.cvtech.edu/whats-new/cv-tech-works-dispel-wind-tower-blade-reports).



(a) Voc Tech School's Out Building (before)

(b) Voc Tech School's Out Building (after)

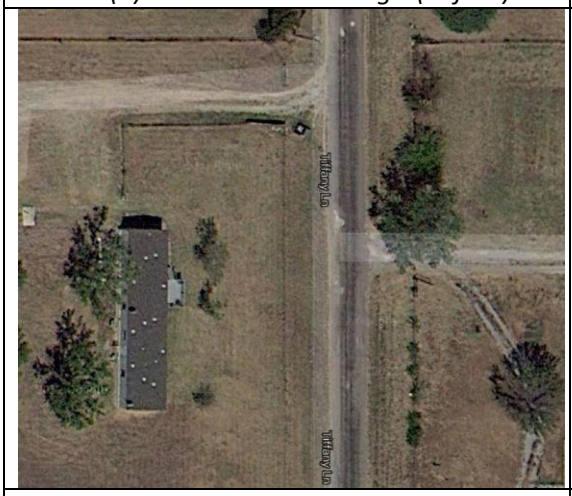
Figure 8: Before and after photos of damage to Canadian Valley Voc Tech School, El Reno Oklahoma
(Images Courtesy of Google maps & http://www.news9.com/story/22475572/news-9-pilot-jim-gardner-takes-aerial-look-of-tornado-damage-in-el-reno)

Damage to residential structures appears to be quite extensive, although no estimate as of yet has been given as to the number of homes damaged or destroyed. A neighborhood south of I-40 sustained heavy damage, as shown in Figure 9(b).

Using data available on Zillow.com, most of the homes within the damage path appear to have an average age of 30 years, years of construction ranging from 1935 to 2009.
Figure 9(d) shows a mobile home, built in 1978, moved about 100 feet off its foundation and what's left of it scattered over Tiffany Lane. It was located near the centerline of the estimated tornado path. From the photo it can be seen that this was a wood-frame home, but no information can be seen to indicate the quality of the wall-to-foundation and roof-to-wall connections. Note that while this home was completely swept off its foundation, homes in the background have damage varying from minor sheathing loss to being completely leveled.

(a) Residential Buildings (before)

(b) Residential Buildings (after)



(c) Aerial View of house built in 1978 (before)

(d) Aerial View of house built in 1978 (after)

Figure 9: Before and after photos of damage to Residential Structures between S Manning Rd and S Evens Rd

[(c) & (d) show extensive damage to a home at 4710 Tiffany Ln, El Reno, OK 73036]

(Images Courtesy of Google maps & http://www.news9.com/story/22475572/news-9-pilot-jim-gardner-takes-aerial-look-of-tornado-damage-in-el-reno)

CONCLUSIONS

Our group is concerned regarding the upgrading of the EF-rating from EF-3 to EF-5, with apparently no evidence of damage to support this on the ground. The reported use of mobile Doppler radar data on peak wind speeds is we believe an inappropriate use of the rating – as it does not provide wind speeds at the ground level where damage occurs. The guidelines for the Enhanced Fujita Scale states that, "The technology of portable Doppler radar should also be a part of the EF Scale process, either as a direct measurement, when available, or as a means of validating wind speeds estimated by the experts." However, as yet, the velocity profile of wind speeds in tornadoes cannot be predicted from tornado to tornado with any degree of certainty. (Source: http://www.depts.ttu.edu/nwi/Pubs/FScale/EFScale.pdf). We were also concerned that at least four motorists and four tornado storm chasers were among the fatalities in this storm. One weather crew also suffered injuries. It is important for us to acknowledge the unpredictable nature and strengths of these tornadoes and know that driving in a vehicle is not the safest place to be. Much has been made about the evening weather forecaster of a local TV station who advised listeners to leave their buildings, get into their cars and try to outrun the tornado. Such advice is incorrect as it places many more persons at risk of injury and death, as they were on 31 May 2013, stuck in bumper-to-bumper traffic on the south-bound lanes of Interstate I-35.

Acknowledgements

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About the PI

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