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ANALYSIS OF TORNADO DEBRIS DURING THE APRIL 27, 2011 SUPER OUTBREAK AS DETERMINED USING SOCIAL MEDIA DATA

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1. INTRODUCTION

On 27 April 2011, a tornado outbreak of historic proportions ravaged Alabama and surrounding states. On that one day, more than 120 tornadoes, including four that were rated as a 5 on the Enhanced Fujita (EF) scale (NOAA 2012), caused 315 deaths (Storm Prediction Center 2012) and over 2400 injuries (NOAA 2012). Tornadoes during this "Super Outbreak" struck a number of populated areas, such as Tuscaloosa and Birmingham, AL, with devastating direct hits to smaller cities and towns such as Smithville, MS; Cullman, Hackleburg and Phil Campbell, AL; and Ringgold, GA (Figure 1).

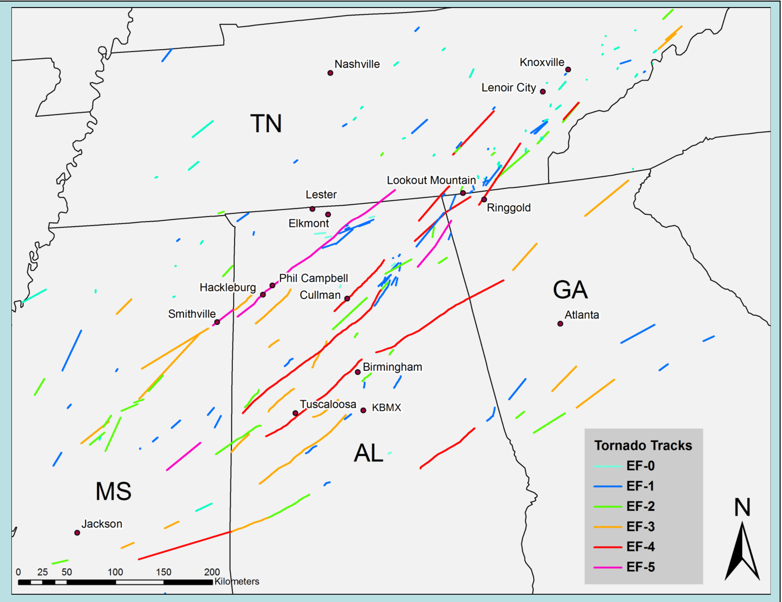

Figure 1. Tornado tracks across the Southeast U.S. on 27–28 April 2011 by EF scale.

The debris caused by this outbreak attracted public attention due to several items which took remarkable flights up and through the storms (Cross et al. 2011; Ortiz 2011). ***See more about this in Poster 154.*** Many items were identified by their owners and then returned to them, thanks to the power and reach of social media (Figure 2).

Figure 2. A five-foot-tall metal sign depicting the late Smithville, MS high-school band member Lee Frederick blew all the way to Russellville, AL (50 air miles; Ortiz 2011) on April 27, 2011.

In this poster, we primarily explain what we learned from analyzing the dataset.

2. DATA AND METHODOLOGY

Figure 3. Screen capture of Patty Bullion's "Pictures and Documents found after the April 27, 2011 Tornadoes" Facebook page.

We obtained information on the debris items by viewing the image and comments for each of the 1716 objects that were returned to their owners through the "Pictures and Documents found after the April 27, 2011 Tornadoes" Facebook page created by Patty Bullion of Lester, AL (Figure 3; Harmon 2011). After quality control, a total of **934 items** with reliable takeoff and landing points remained—**almost six times more than had ever been examined in a single study.** ***Please see Poster 154 for a more complete discussion of the data and methodology.*** The debris were classified into three groups based on weight after Anderson (1985; Figure 4) and Snow et al. (1995): **1) paper** (such as photographs or receipts), **2) light** (less than 0.45 kg or 1 pound), and **3) heavy** (greater than 0.45 kg).

To assess the potential paths that a paper or light object may have traveled, an online version of the **HYSPLIT Model** (Draxler and Rolph 2012; Rolph 2012) was used. We simulated debris trajectories using a point-source release and forward trajectory framework. Point-source releases were chosen for several locations that experienced catastrophic tornadic damage (e.g., Phil Campbell, AL). The forward trajectories were calculated from 12 km North American Mesoscale (NAM) model archived fields and specified for 27 April 2011 at times nearest the tornadic event by location (e.g., 2000 UTC, 2100 UTC). **Each trajectory was initialized at an altitude of 3 km, 4.5 km, and 6 km above ground level (AGL)**, consistent with the 5.5 km to 6.5 km peak heights for debris lofting estimated by Forbes (2012) for EF-4/5 tornadoes during this outbreak.

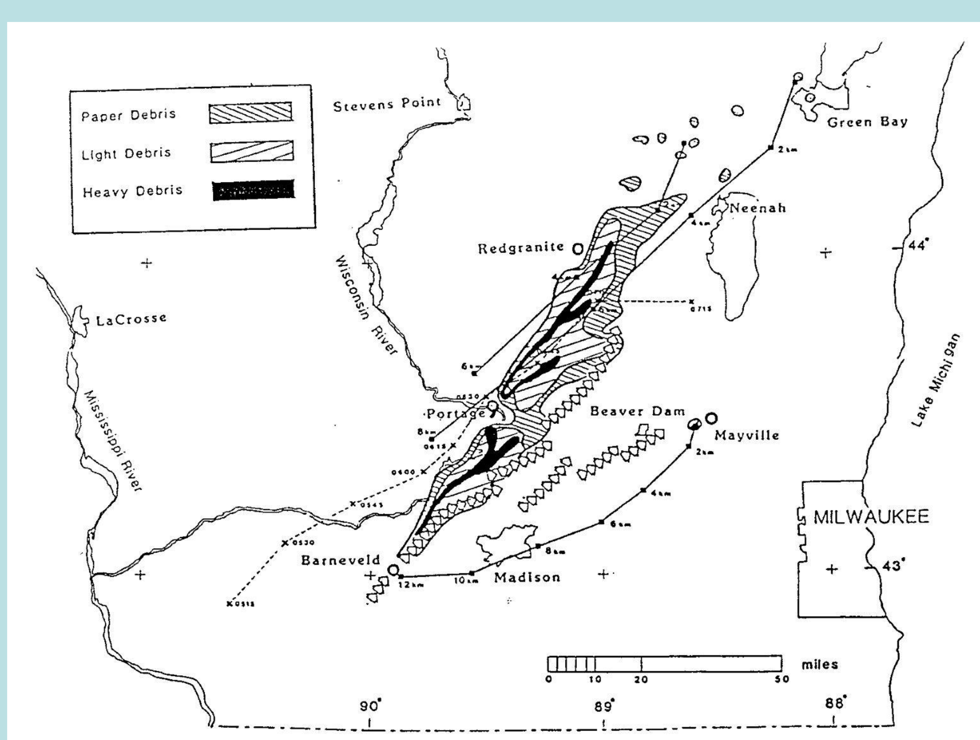

Figure 4. Debris fallout pattern from the Barneveld, Wisconsin, tornado, from Anderson's (1985) seminal research. Triangles are tornado tracks, the dashed line is the center of a complex of storms, and the solid lines are backward trajectories for a few debris items. We extended this methodology with more and more specific information on debris, and HYSPLIT trajectories.

3. RESULTS: DISTRIBUTION BY EF SCALE, TYPE AND DISTANCE

EF Scale	Heavy	Light	Paper	All Types
EF0	1	0	0	1
EF1	0	0	0	0
EF2	0	0	2	2
EF3	0	1	39	40
EF4	2	5	190	197
EF5	9	12	673	694
TOTAL	12	18	904	934

Table 1. The distribution of 934 reports of paper, light, and heavy debris as a function of EF scale.

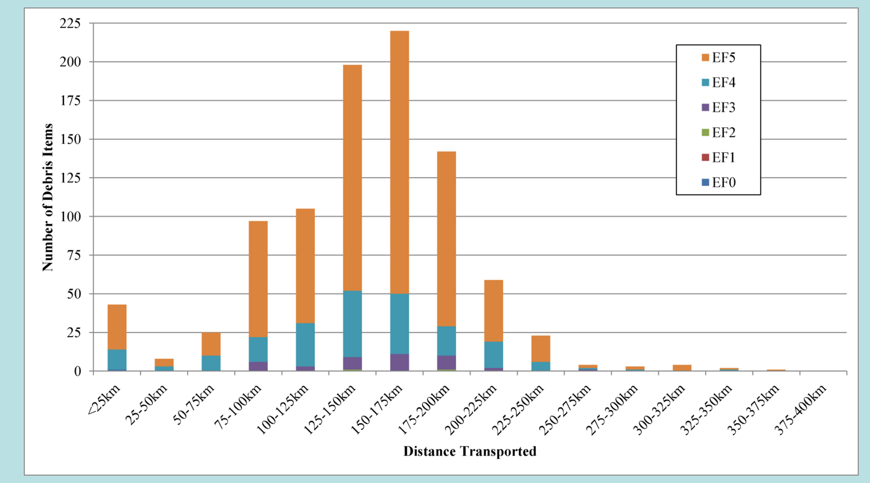

Figure 6. Plot of number of debris reports as a function of EF scale and distance for 27 April 2011.

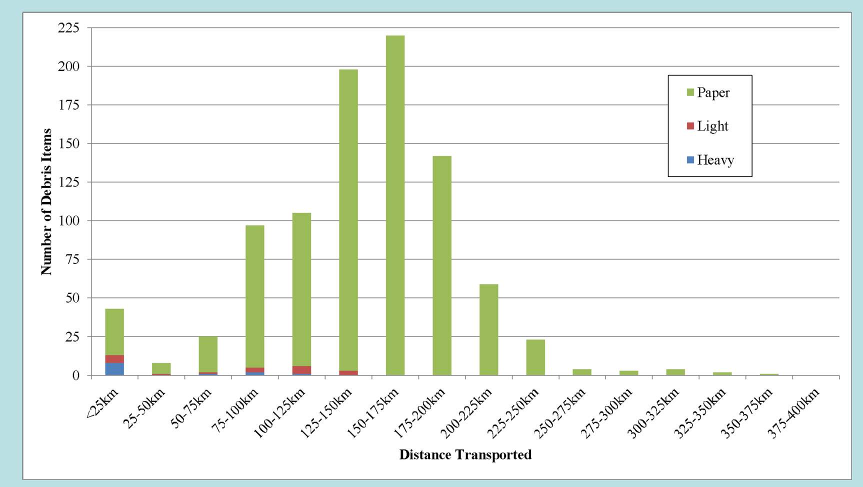

Figure 5. Plot of number of debris reports as a function of type and distance for 27 April 2011. Debris categorized as paper, light (weighing less .45 kg or one pound), and heavy (weighing more than .45 kg or one pound). Total number of reports plotted: 934. The furthest transported item traveled 353 km. No light or heavy items in the database were transported more than 144 km.

4. RESULTS: DISTRIBUTION BY TRAJECTORY LENGTH

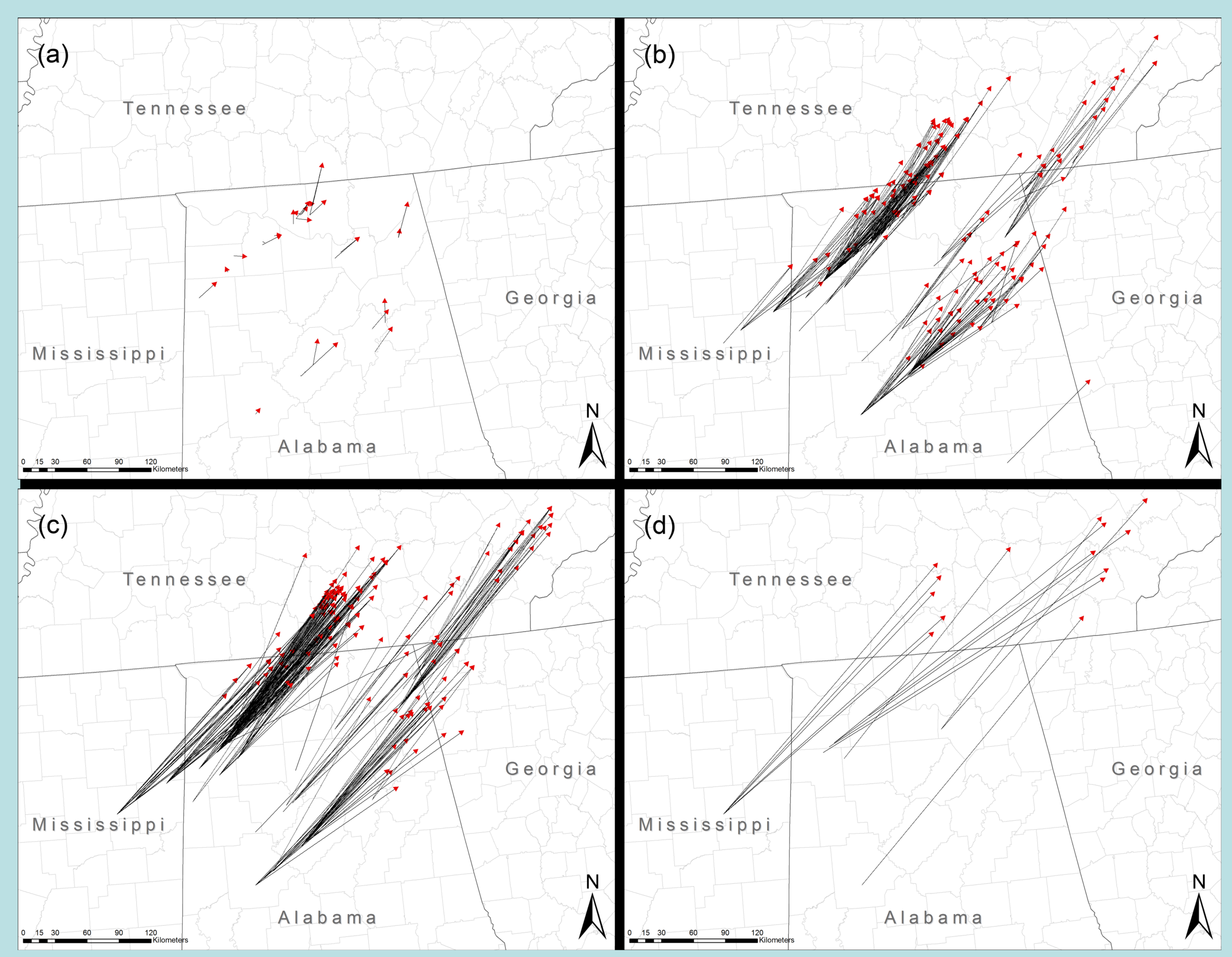

Figure 7. Tracks of debris objects that traveled a) < 50 km; b) 50 to 150 km; c) 150 to 250 km; d) >250km.

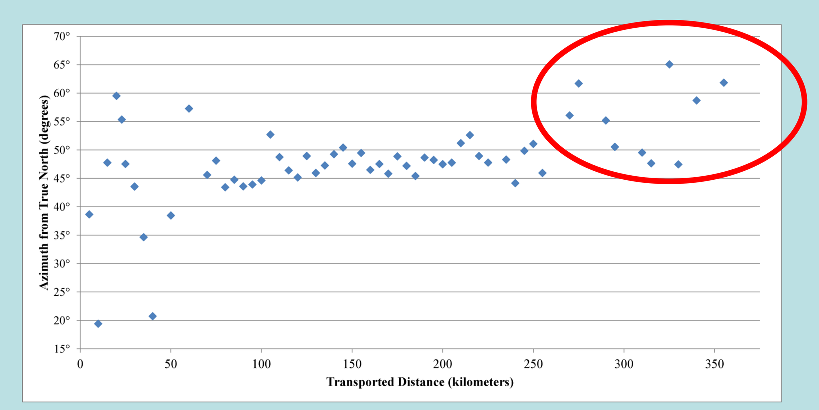

Figure 8. Average azimuth of debris trajectories for every 5 km indicating the general trend of greater azimuth angle with distance.

5. RESULTS: HYSPLIT TRAJECTORY MODELING

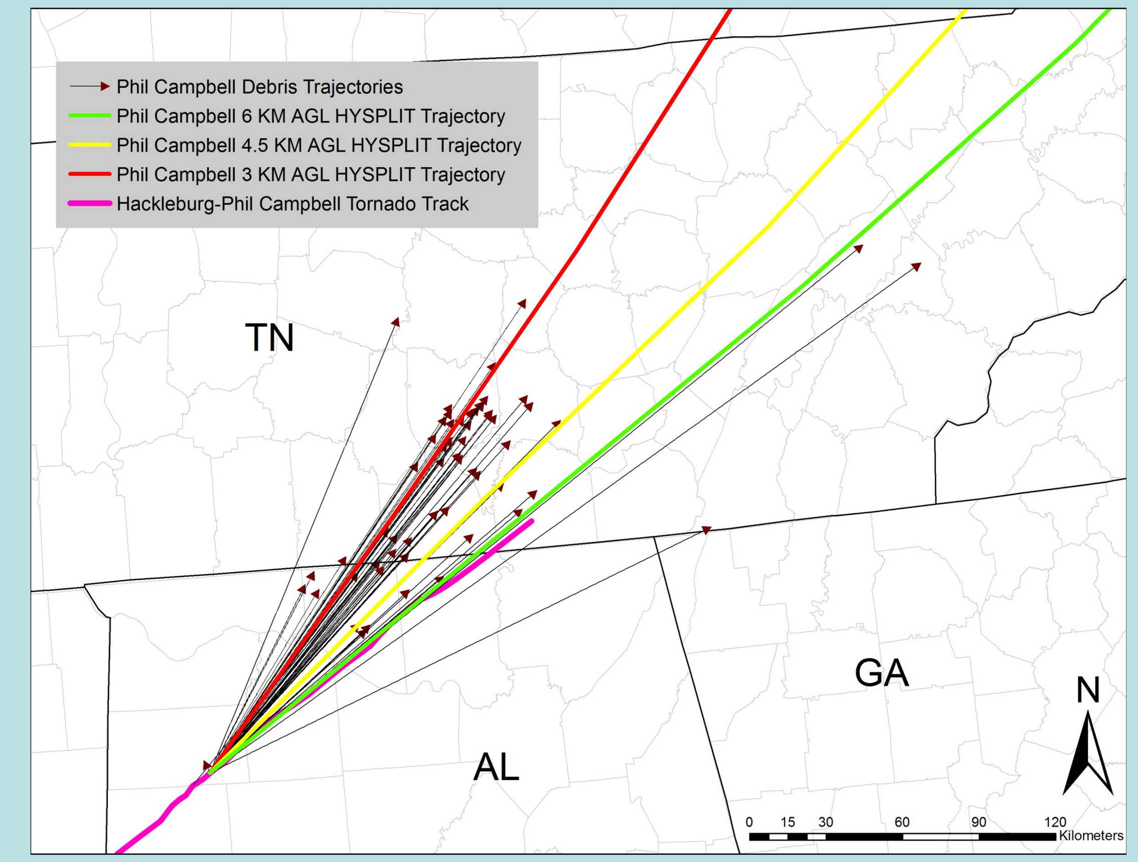

Figure 9. Trajectories of debris originating from Phil Campbell, AL with overlaid 3 km, 4.5 km, and 6 km AGL HYSPLIT trajectories initialized at 2000 UTC 27 April 2011. Calculated trajectories reach the edge of the figure domain at approximately 2300 UTC (3 km), 2300 UTC (4.5 km), and 0000 UTC 28 April 2011 (6 km).

6. CONCLUSIONS

- Two objects from Phil Campbell, AL were found in the vicinity of Knoxville, TN, topping the longest previously documented tornado debris trajectory of 335 km (Snow et al. 1995). **This study has determined a preliminary new world record for a tornado debris trajectory: 353 km (221 miles).**
- **Objects that traveled the longest distance** were found approximately **5° to the right of the average tornado track vector.**
- **Why the rightward tendency?** We think that this is due to the **longest-traveled objects** being the objects that **were lofted highest by the tornadic supercells.** Trajectories from HYSPLIT provided an excellent fit for the longest traveled objects for a release point altitude of 6 km, whereas HYSPLIT trajectories using a release point altitude of 3 km correlated well with observed debris trajectories for objects that traveled shorter distances (Figure 9). Our estimates of the altitude of debris lofting are also consistent with emerging radar analysis of this outbreak.
- **Social media information** can be used in **meteorological research**. ***See Poster 154 for a discussion of the pros and cons of this approach.***

7. REFERENCES

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Thanks to: Patty Bullion for her selfless work to reunite people with their lost objects; Lili Yin, Bryant Brough and Patrick Malone for data collection; and David Schultz, Tom Mote, Russ Schumacher and Marshall Shepherd for advice and comments on drafts. This work has been submitted to the *Bulletin of the American Meteorological Society*. **We dedicate this research to the victims and survivors of the April 2011 super outbreak.**

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