

# Trip Report - Amory, MS Tornado Damage Survey



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**May 2023**



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Geospatial Science and Human Security Division

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## 1. INTRODUCTION

On March 24<sup>th</sup>, 2023 a series of tornadoes swept through the South. The State of Mississippi was hit particularly hard, with several powerful tornadoes striking the state. The town of Amory, located approximately 23 miles southeast of Tupelo, experienced considerable devastation after an EF-3 tornado passed through the area.

An ORNL team supporting DOE’s CESER AOI-2 and ESF-12 emergency response projects traveled to Amory from March 29<sup>th</sup> to 31<sup>st</sup> to collect data using a variety of drone-based camera systems.

The ESF-12 effort at ORNL is tasked with developing a rapidly deployable, self-sufficient kit for mapping post-disaster electrical infrastructure damage “at the edge”. The kit will include aircraft and all associated support equipment needed for a team to operate and process data effectively in the field. The current focus of the project is an evaluation of an AgEagle eBee X and a Wingtra WingtraOne GenII to determine which aircraft is better suited to ESF-12 disaster deployment engagements. Variables such as portability, flight time, repairability/maintainability, and image quality are under consideration.



Figure 1. eBee X (<https://ageagle.com/wp-content/uploads/2022/06/ebee-x.png>)

*Note: An eBee TAC was flown for the Amory deployment due to a delay in delivery of the eBee X purchased for ESF-12. The aircraft have virtually identical photographic performance and flight characteristics.*



Figure 2. WingtraOne GenII

Each aircraft was used to collect high resolution aerial imagery. Imagery was then processed with Pix4D React and pushed to network storage using MAPSTER, an ORNL software that enables rapid map data availability and dissemination via a user-friendly web interface.

The second effort supported was AOI-2. The goal of the AOI-2 project is to create a drone-based machine learning system capable of automatically detecting damaged electrical power infrastructure. Imagery is collected by a camera and processed in real time on the aircraft to determine location and confidence that an electrical asset (such as a utility pole) is damaged. Once processing is completed, data are pushed to ORNL's MavNET server over a cellular link, and thence to EAGLE-I. At its current stage of development, the aircraft used is a custom-built technology demonstration quadcopter, "Cornelia".



*Figure 3. "Cornelia" technology demonstrator*

The tornado event in Amory created an opportunity to field test both emerging capabilities in an operationally relevant environment.

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## 2. LOCATIONS

The team operated from 6 discrete launch and recovery areas within the damaged portion of Amory:

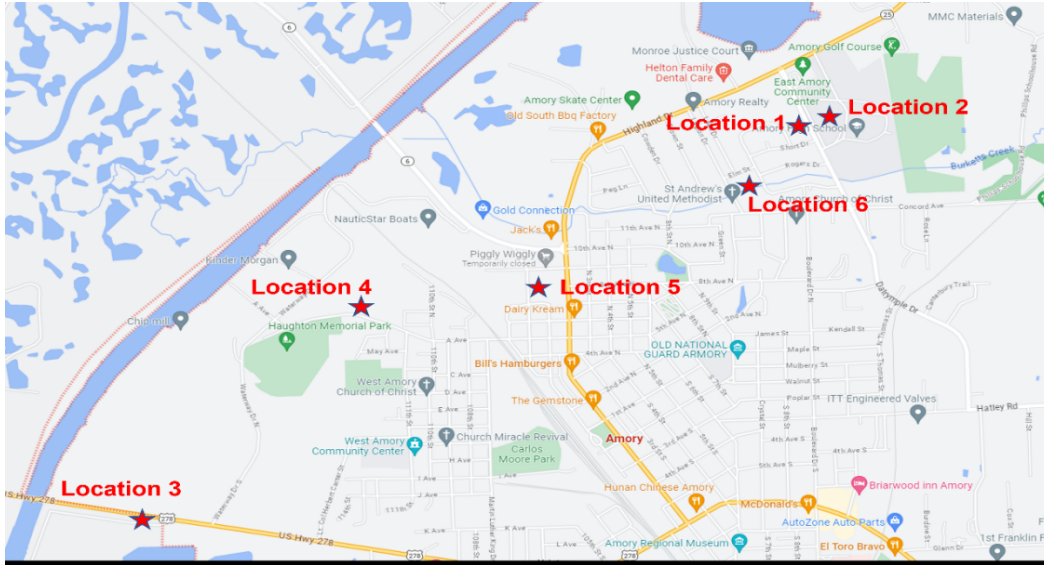


Figure 4. Overview of launch and recovery locations

These locations followed the approximate southwest to northeast track of the storm damage. Additional damage was present outside the city limits, but those areas were not surveyed on this field deployment due to time constraints.

### 2.1 LOCATION 1 – 29 MARCH 2023

This location was situated in the parking lot of the North Boulevard Christian Church at 1201 North Boulevard. (Red star denotes the approximate location of the team)



Figure 5. Location 1: Pre-storm (left), post-storm (right)



A flight of the Cornelia AOI-2 system was conducted, with a total flight time of approximately 20 minutes. Flights covered utility lines along North Boulevard, as well as feeder lines powering a residential area on Highland Circle.

The entire field set up was assembled, including the Starlink internet system and portable generator. Setup took approximately 20 minutes, tear-down about 10.



*Figure 6. Location 1 field setup*



*Figure 7. Preparing "Cornelia" quadcopter for flight*



*Figure 8. "Cornelia" prior to launch*

## **2.2 LOCATION 2 – 29 MARCH 2023**

Site 2 was located on the loop road around Amory High School, near the baseball field.



*Figure 9. Location 2: pre-storm (left), post-storm (right)*

A series of two flights with the AgEagle eBee TAC were conducted. These covered the northeast portion of Amory, from approximately the National Guard Armory on Highway 25 to Legion Drive in the southwest. For this location only a folding table and eBee equipment were set up, as battery power was sufficient.

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*Figure 10. Damaged ball field at Location 2*



*Figure 11. Preparing to launch the eBee at Location 2*

The sports complex supporting Amory High School was badly damaged. The school itself survived mostly intact.

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### 2.3 LOCATION 3 – 30 MARCH 2023

Location 3 was a gravel side road in a rural area just off Highway 278, near the Tombigbee Waterway overpass. (Approximate coordinates 33.980067° N, -88.512845° W)



*Figure 12. Location 3: pre-storm (left), post-storm (right)*



*Figure 13. Location 4 launch and recovery area*

One Wingtra flight was conducted, as well as a series of two flights with Cornelia to observe damaged utility poles along the Highway 278 right-of-way.

Imagery from this area exhibited many downed trees in the parcel to the south of Highway 278, but little other damaged infrastructure.

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## 2.4 LOCATION 4 – 30 MARCH 2023

The 4<sup>th</sup> location was the parking lot of the Amory Early Learning Academy, located at 1212 Cemetery Rd.



*Figure 14. Location 4: pre-storm (left), post-storm (right)*



*Figure 15. Field setup and leaning utility poles at Location 4*

Two eBee flights were used to cover the Cemetery Road area and the western outskirts of Amory. Cornelia was flown over utility poles (both damaged and undamaged/already repaired) along Cemetery Road.

## 2.5 LOCATION 5 – 30 MARCH 2023

This launch and recovery area was near a warehouse/shop type building off 103<sup>rd</sup> St North, just south of the Dollar General and Piggly Wiggly shopping center.



*Figure 16. Location 5: pre-storm (left), post-storm (right)*

A single Wingtra mission was flown. This flight covered the area of town from the railroad tracks in the southwest to Meadowbrook Circle in the northeast.

## 2.6 LOCATION 6 – 30 MARCH 2023

The final test location was situated in the driveway of the VFW hall (off Legion Drive), across the street from St. Andrew's Methodist.



*Figure 17. Location 6: pre-storm (left), post-storm (right)*

One Wingtra mission was flown to cover the central part of Amory and connect the swath of imagery from previous flights.

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### 3. CONCLUSIONS

The purpose of the Amory field deployment was two-fold: collect imagery for analysis and machine learning algorithm development, and to test the field deployment kit in an operationally relevant area. Both missions were accomplished.

Approximately 10,000 images were collected. These images resulted in a map coverage of roughly 1,100 acres in and around Amory. Flight data from the Cornelia platform will be used by ORNL data scientists to enhance machine learning algorithms for detection of damaged utility infrastructure.

The team tested two candidate aircraft for ESF-12: the AgEagle eBee and Wingtra WingraOne. The eBee is made of a resilient foam body with detachable wings but must be launched by hand from an area (at minimum) the size of a t-ball field. The Wingtra permits vertical takeoff and landing but does not have detachable wings (doesn't break down to fit in a small case) and requires an additional post-flight processing step prior to creating an orthomosaic map from collected imagery. Both aircraft performed well, with no issues.

Deployments offer a unique opportunity to test all components of a disaster response kit. The various locations and setup situations illustrated a range of possible operating environments that could potentially be experienced in the field. A team deployed in a disaster afflicted area will encounter difficulties not seen in the lab. The team must be self-sufficient without outside support. All equipment, spare parts, fuel, tools, and utilities must be staged and 'packed in' by the team. Personnel needs such as hygiene, food, water, first aid, insect repellent, backup communications systems, etc must be considered and accounted for.

Care must also be given to robust work control and safety measures. Field deployments are undertaken with carefully planned safety documentation, however the situation in the field is dynamic and operators must be able to act in a safe, legal, and ethical manner throughout a range of unexpected circumstances.

No issues were encountered that would necessitate major changes to the deployment paradigm as planned for future ESF-12 UAS support work. The availability of sufficient electrical power is perhaps the most challenging aspect of field work to take into consideration. Many vehicles do not come with DC-AC inverters of substantial enough power output to charge batteries and run the satellite-based internet hardware simultaneously. This was mitigated by bringing a gasoline powered generator along- however a generator comes with a unique set of safety considerations and may not be practical for all deployments.

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