Addressing Interconnections Between the Built and Natural Environments Through Post-event Damage Surveys

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PROJECT GOAL

Characterize the interconnectedness of the built and natural environment within a given community and show how risk from tornadoes can be mitigated by improving our knowledge of these interconnections.

DETAILED DAMAGE SURVEYS

- Track debris from end point to source
- Categorize debris
- Record characteristics of individual trees near structures
- Assess the terrain

SURVEYS FOLLOWED FOUR TORNADO EVENTS

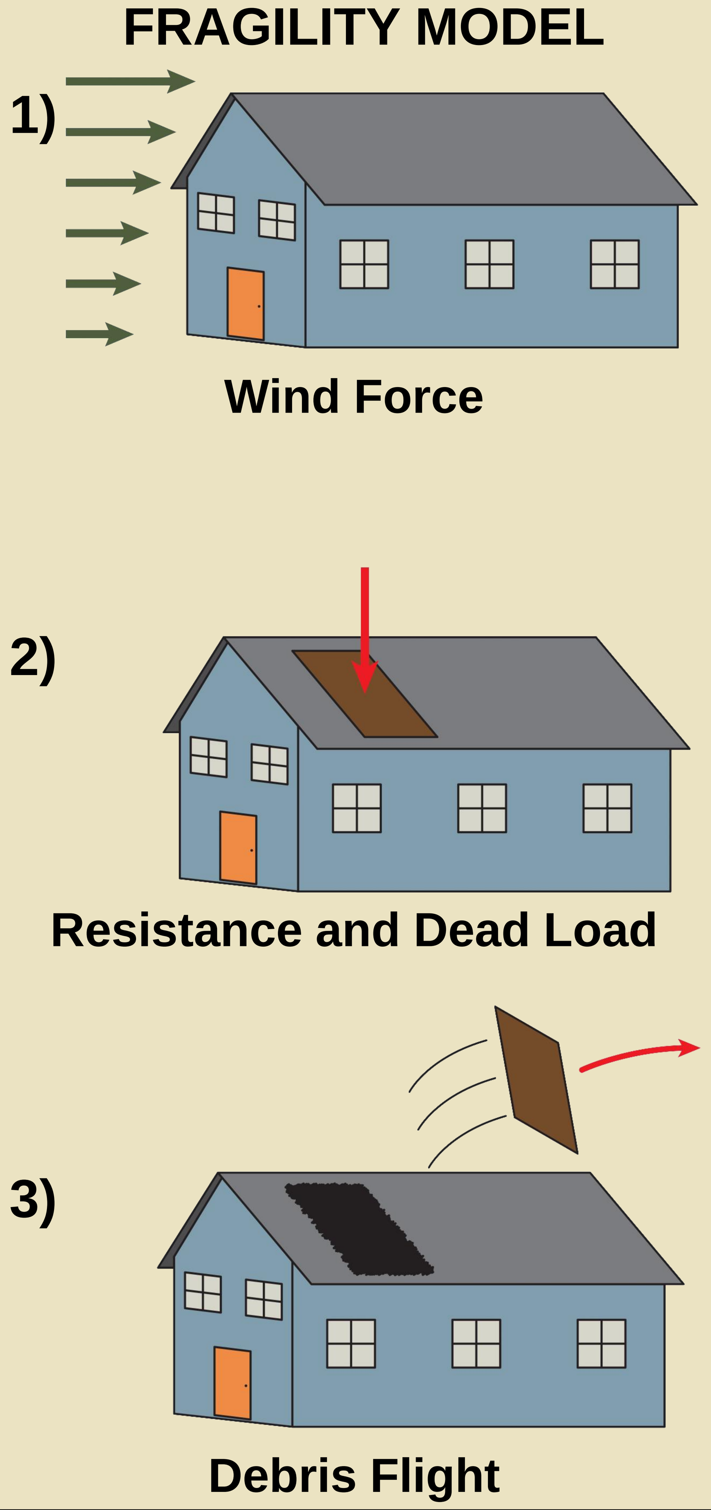
1) Nashville, GA, 22 January 2017 (NWS rated EF3)
2) Albany, GA, 22 January 2017 (NWS rated EF3)
3) Naplate, IL, 28 February 2017 (NWS rated EF3)
4) Jeffersonville, GA, 3 April 2017 (NWS rated EF1)


Students assist with a detailed damage survey in Albany, GA

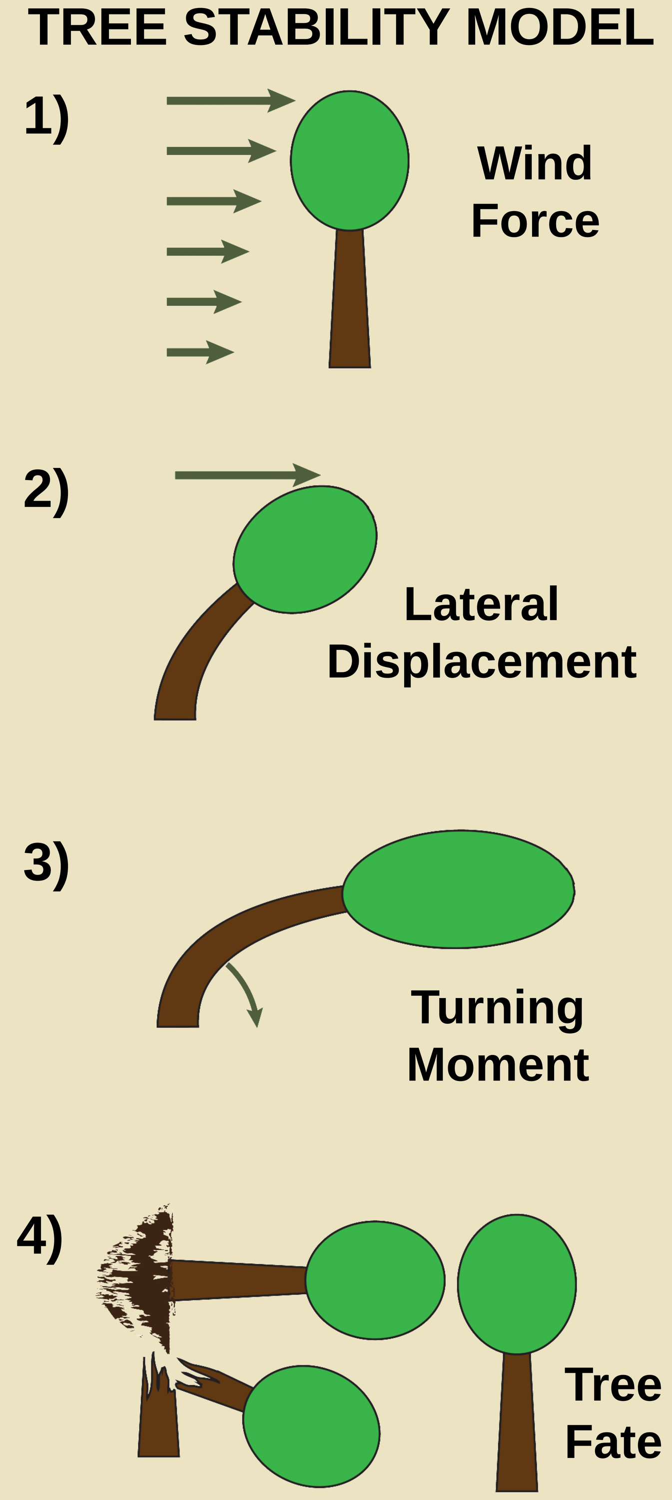
MODELING THE TORNADIC WIND FIELD

Debris and treefall patterns allow an estimation of the near-surface wind field using a Rankine vortex model coupled with both a tree stability model and an infrastructure fragility model that simulates debris flight.

FRAGILITY MODEL



TREE STABILITY MODEL

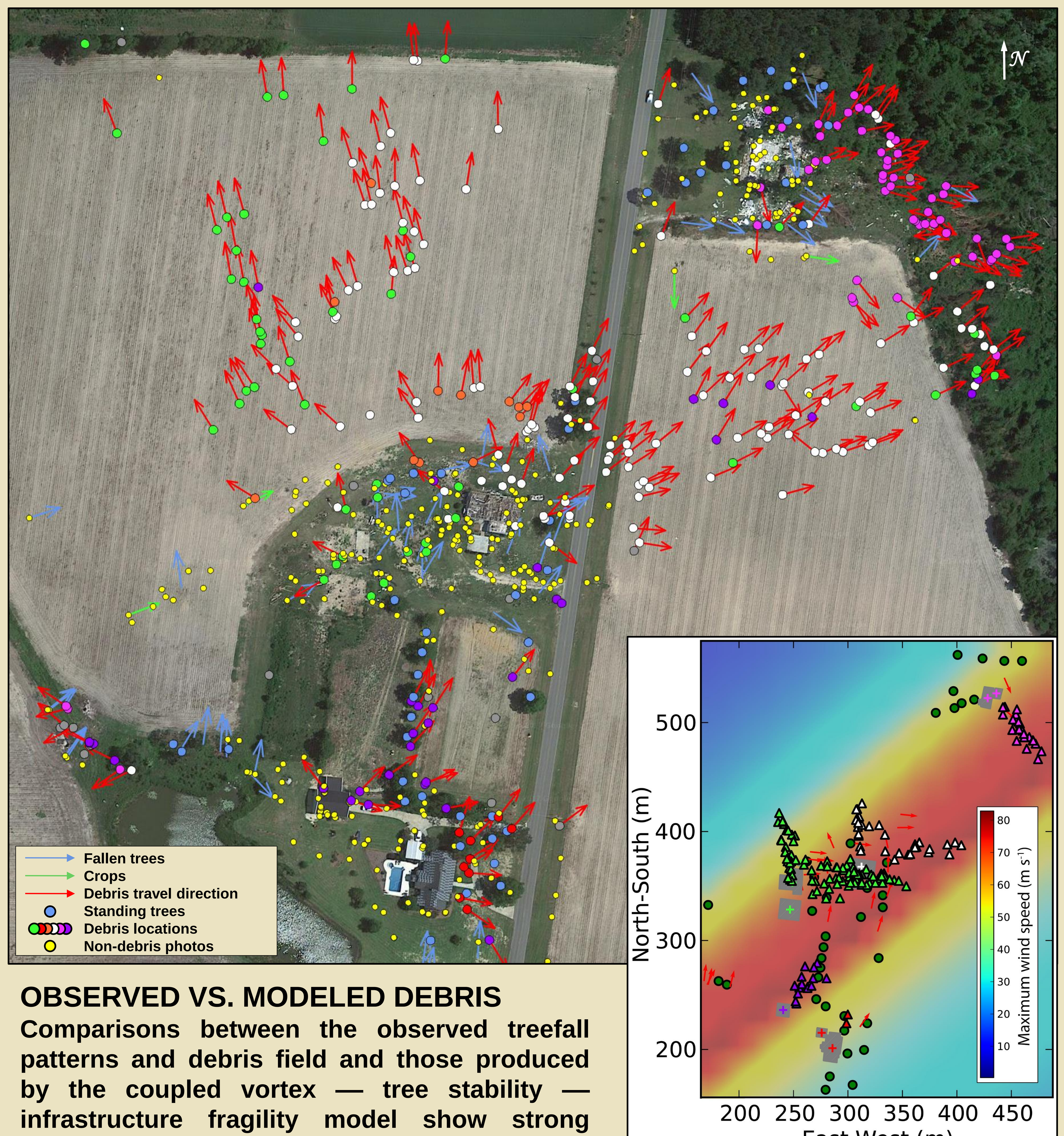


NASHVILLE, GA DAMAGE SURVEY

Damage to a 1.5-story residential structure, looking toward the west.

Geotagged debris photograph pointing west toward the source structure shown on the left.

Below: Debris and treefall patterns observed during the Nashville, GA damage survey. Large dots represent debris locations, colored by source structure; blue dots and arrows represent standing and fallen trees; red arrows indicate travel direction of debris from the source; green arrows indicate the fall direction of crops; and yellow dots indicate locations of non-debris photographs.



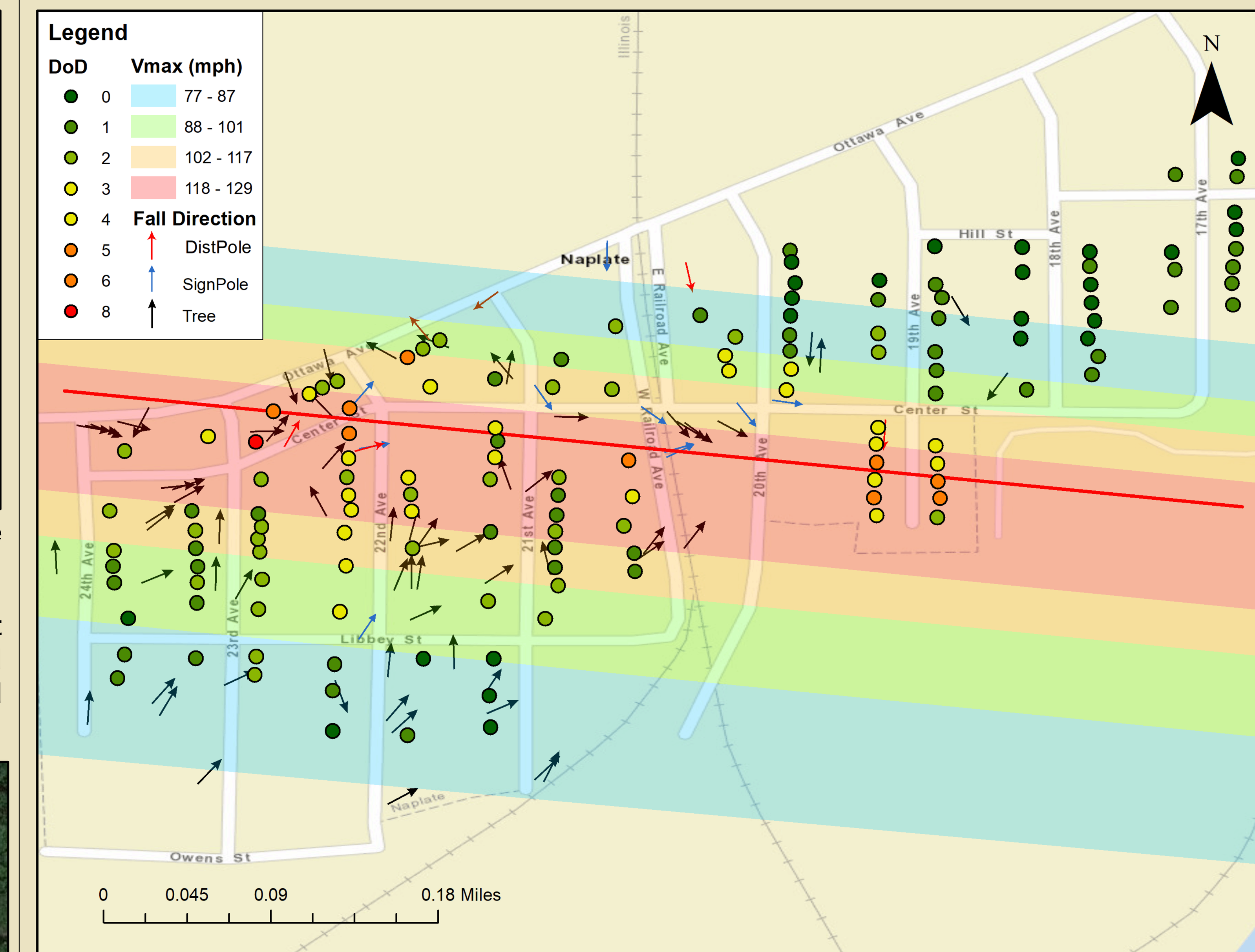
Modeled treefall and debris field corresponding with the damaged structures near Nashville, GA. Shading represents maximum wind speeds produced by the modeled vortex. Green dots are standing trees and red arrows represent fallen trees.

OBSERVED VS. MODELED DEBRIS

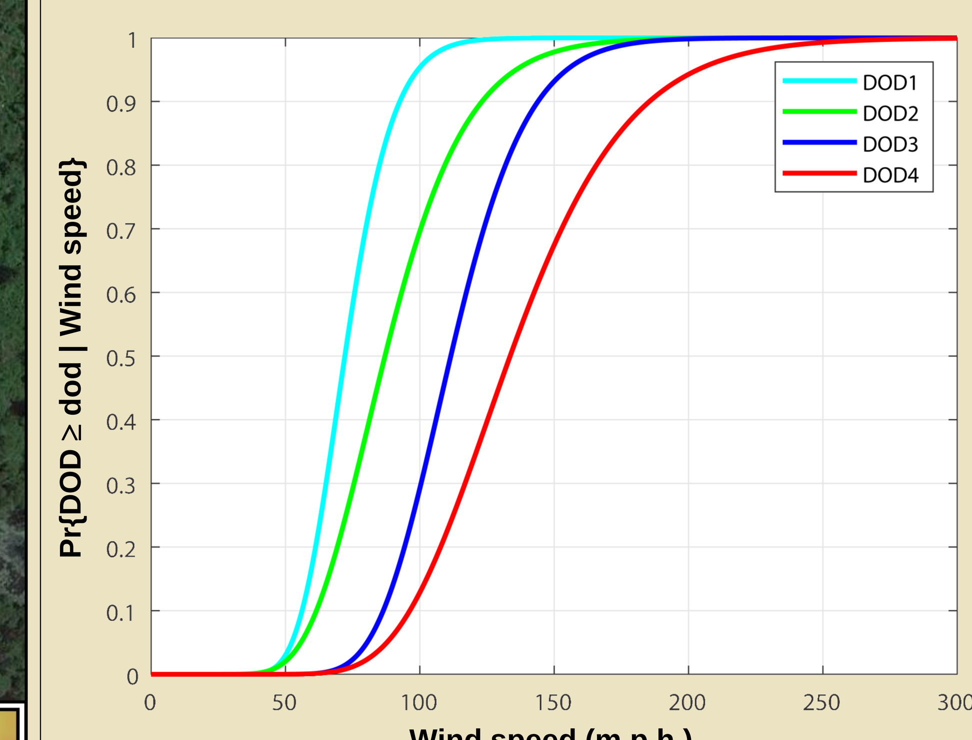
Comparisons between the observed treefall patterns and debris field and those produced by the coupled vortex — tree stability — infrastructure fragility model show strong similarities. The preliminary best fit produces a maximum wind speed of 83 m s^{-1} (EF4).

- 150 m core diameter
- 50 m s^{-1} maximum tangential velocity
- 30 m s^{-1} inward radial velocity
- 24.6 m s^{-1} forward velocity

NAPLATE, IL DAMAGE SURVEY



Above: Summary of the Naplate, IL damage survey showing damage to residential homes (FR12) via degree of damage on the Enhanced Fujita scale (colored dots) and downed trees (black arrows), street signs (blue arrows), and distribution poles (red arrows). The red line shows the center of the tornado and background colors represent wind speed estimates.

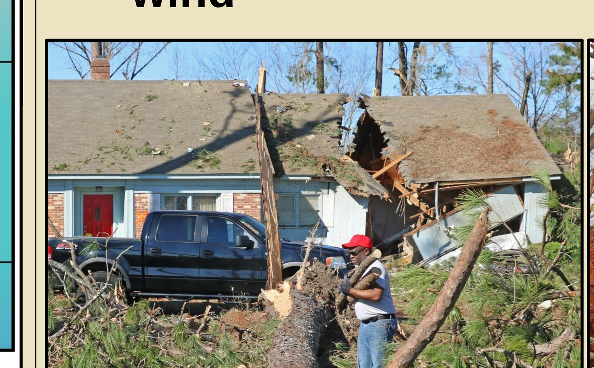


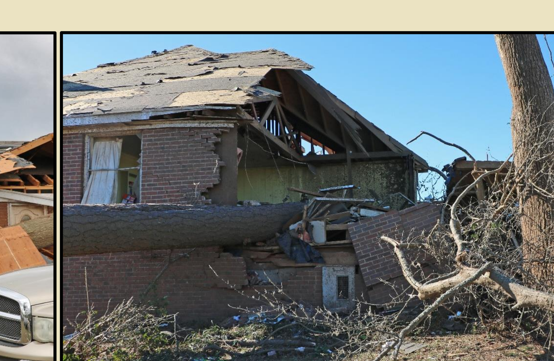
- Treefall patterns and damage to signs and poles help to identify tornado characteristics.
- Most severely-damaged houses appear to be near the center of the tornado.
- Two homes are responsible for the EF3 rating.

Above: Fragility curves based on the degree of damage (DOD) to residential construction on the EF scale and estimated wind speeds derived from the fall direction of trees. The abscissa gives the probability that an observed DOD equals or exceeds the DOD shown for each curve given a particular wind speed.

ALBANY, GA DAMAGE SURVEY

- Neighborhood within a mature loblolly pine forest
- Significant structural damage from treefall rather than directly from wind





Residential damage following the Albany, GA tornado highlights significant wind-induced tree damage coupled with minor direct wind damage.

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