# A Comparison of Three Wind Speed Estimation Techniques Based on Tornado-Induced Treefall Patterns

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## GOAL

**Compare three published techniques that estimate wind speeds from tornadoes based on either discernible patterns of treefall or the severity of damage within forested areas.**

## TORNADO

**22 May 2011 Joplin, MO EF5**

## SUMMARY OF THE THREE METHODS

### GODFREY–PETERSON METHOD

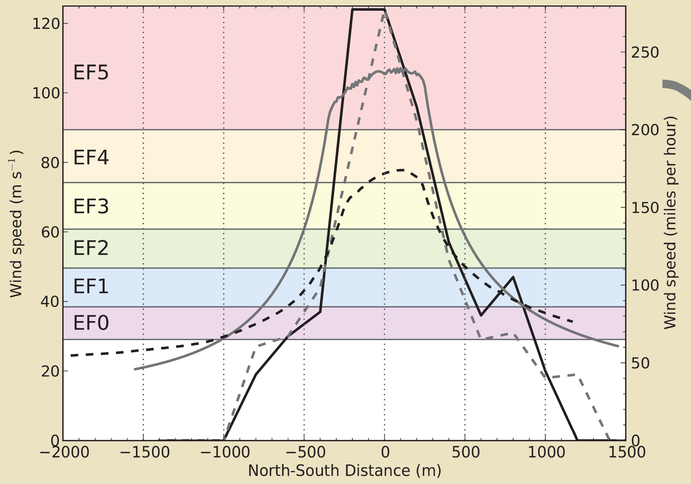
- **Requirements:**
  - **Aerial imagery**
  - **Tree species composition and size distribution**
- **Procedure:**
  1) **Coupled wind and tree resistance model determines a distribution of the percentage of trees that fall for a given wind speed.**
  2) **Assign most probable wind speed to small forest plots based on the percentage of fallen trees.**
- **Result: Maps of estimated EF-scale levels along an entire tornado track.**

### LOMBARDO METHOD

- **Requirements:**
  - **Aerial imagery or ground assessment**
- **Procedure:**
  1) **Select transects along tornado path**
  2) **Compare observed damage width, treefall direction, and extent of damage with those of a simulated pattern produced by an idealized vortex model along each transect**
  3) **Choose the combination of vortex parameters that produces a treefall pattern that best matches the observations along each transect**
- **Result: Reconstruction of the entire wind field of the tornado.**

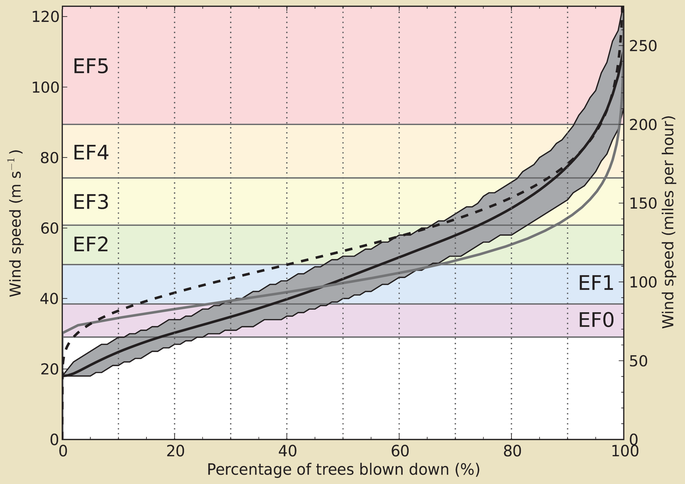
### KARSTENS METHOD

- **Requirements: Aerial imagery**
- **Procedure:**
  - **Digitize damaged trees via GIS**
  - **Compare observed treefall pattern in region of maximum damage with cross-sections of treefall patterns from an idealized vortex**
  - **Adjust modeled vortex parameters to find the best match.**
- **Result: Estimation of maximum wind speed across the damage path.**



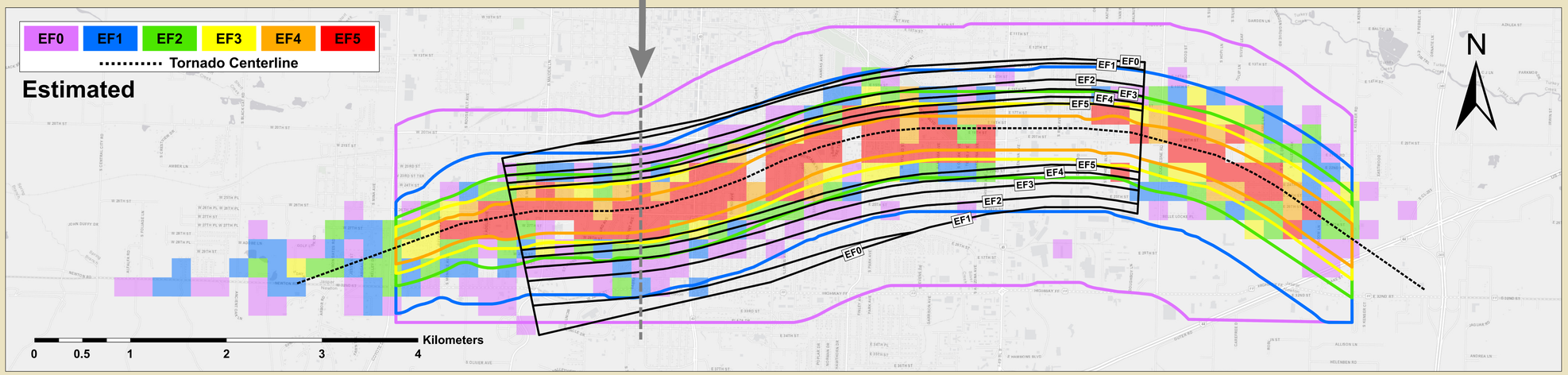

**Wind speed estimates along a north-to-south transect via the Godfrey–Peterson method at the longitude indicated by the gray dashed line in the figure below (solid black) and immediately to the east (gray dashed), the Lombardo method (black dashed), and the Karstens method (solid gray).**

**Read the extended abstract and references here:**



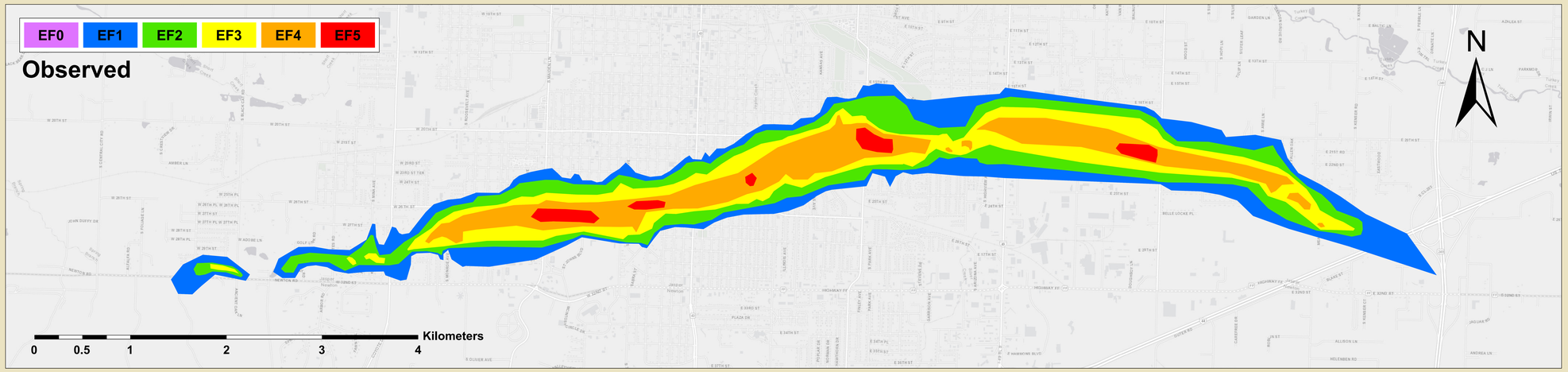

**Wind speed estimates via the Godfrey–Peterson method (solid black), the Lombardo method (dashed), and the Karstens method (gray) as a function of the percentage of trees blown down. The gray-shaded region denotes the 95% confidence interval based on the Godfrey–Peterson method.**

Transect




**ABOVE: Comparison of EF-scale ratings along the Joplin tornado track from the Godfrey–Peterson method (colored grid cells), the Lombardo method (colored contours), and the Karstens method (black contours with labels).**

**BELOW: Damage map developed from a detailed ground assessment of mostly traditional EF-scale damage indicators following the Joplin tornado. Adapted from Marshall et al. (2012).**




## CONCLUSIONS

- **Approaches differ in procedural aspects, data collection, and processing requirements, yet each method produces comparable results.**
- **General agreement supports the application of any one method with confidence, given individual circumstances and data availability.**