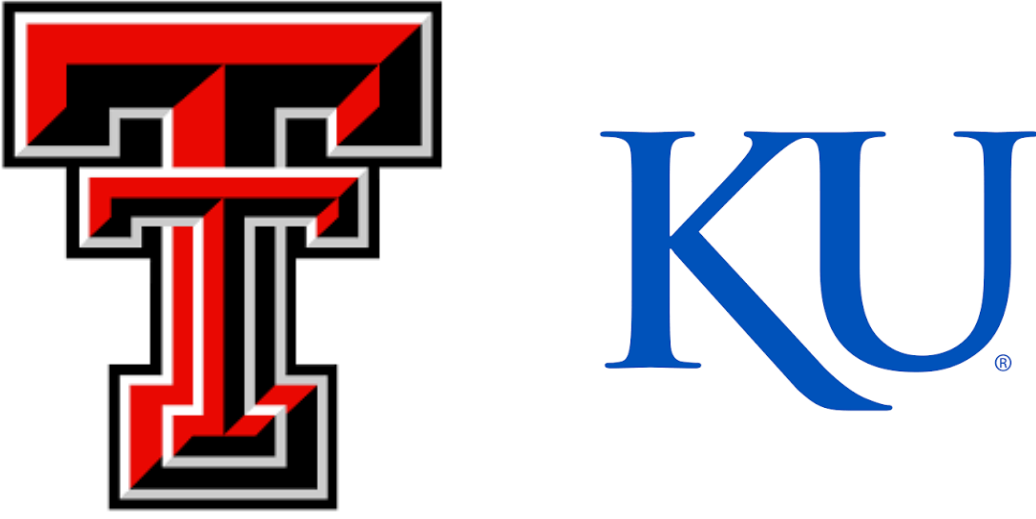


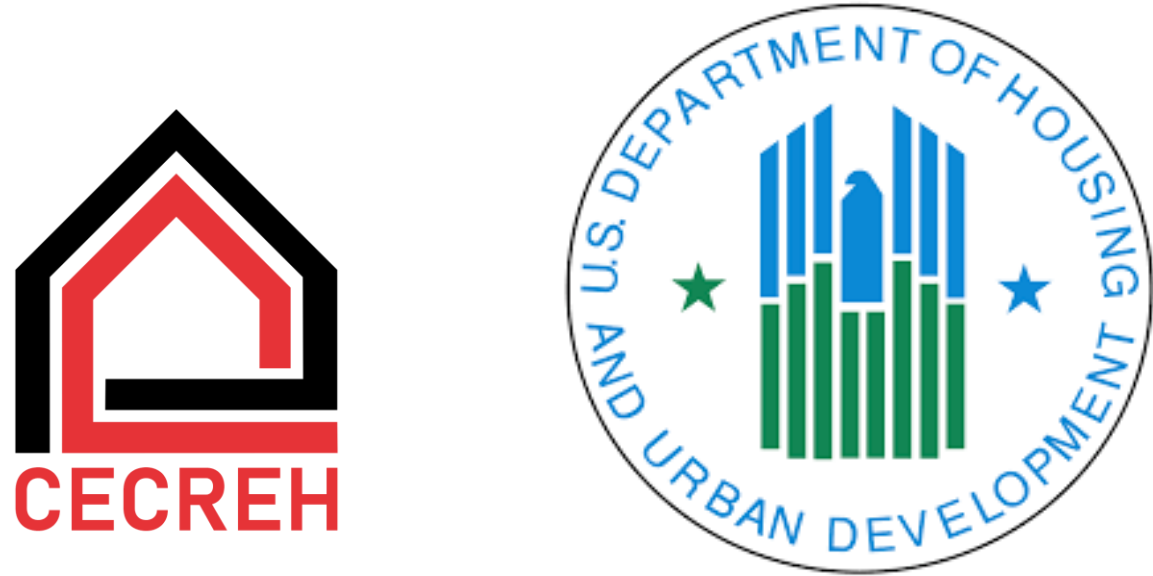
Installation-Sensitive Empirical Fragility Assessment of Manufactured Housing under Hurricane Wind Hazards in Florida



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WHY THIS STUDY?

Manufactured home hurricane vulnerability is influenced by more than wind intensity alone. Construction era, installation quality, anchorage condition, retrofit status, deterioration, and accessory structures can substantially affect observed damage.

RESEARCH QUESTION

How does hurricane-wind vulnerability differ between 1994–2007 and post-2008 manufactured homes in Florida?

- 1994**
HUD Wind-Resistance Revision
- 1994–2007**
Post-HUD Wind Era
- 2008**
Federal Installation Standards
- Post-2008**
Modern Installation Era

NOAA
Wind Exposure

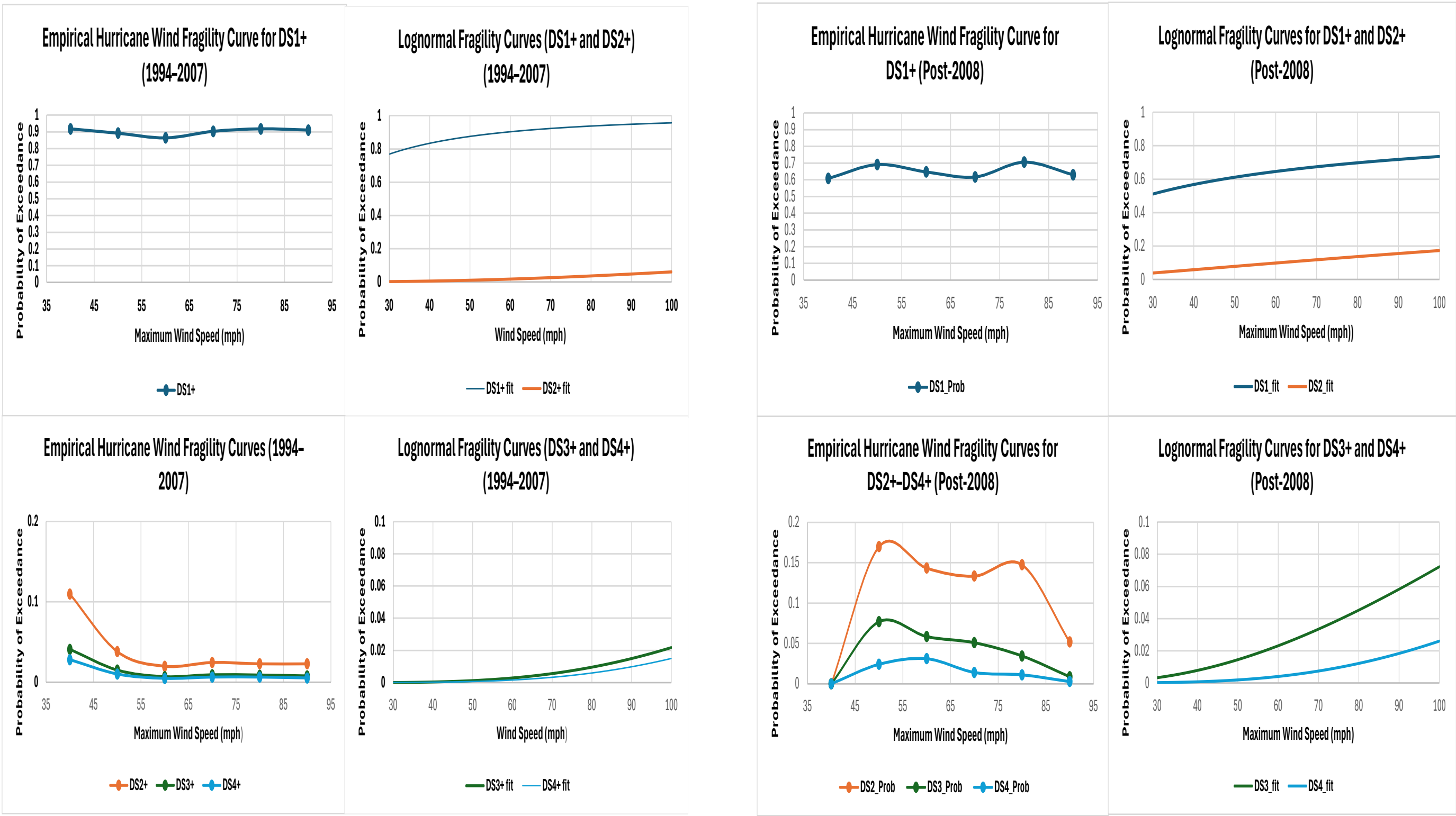
FEMA
Damage Observations

Florida DOR
Year Built / Construction Era

Post-Event Reports
Engineering Interpretation

INTEGRATED DATA

ERA-BASED FRAGILITY RESULTS



Damage state	1994–2007	Post-2008
DS1+	88.63%	64.55%
DS2+	2.98%	14.21%
DS3+	1.12%	5.67%
DS4+	0.77%	2.50%

Aggregate exceedance rates; differences in wind exposure should be considered when comparing eras.

DS1+ EXCEEDANCE, 1994–2007 vs POST-2008

88.63% → 64.55%

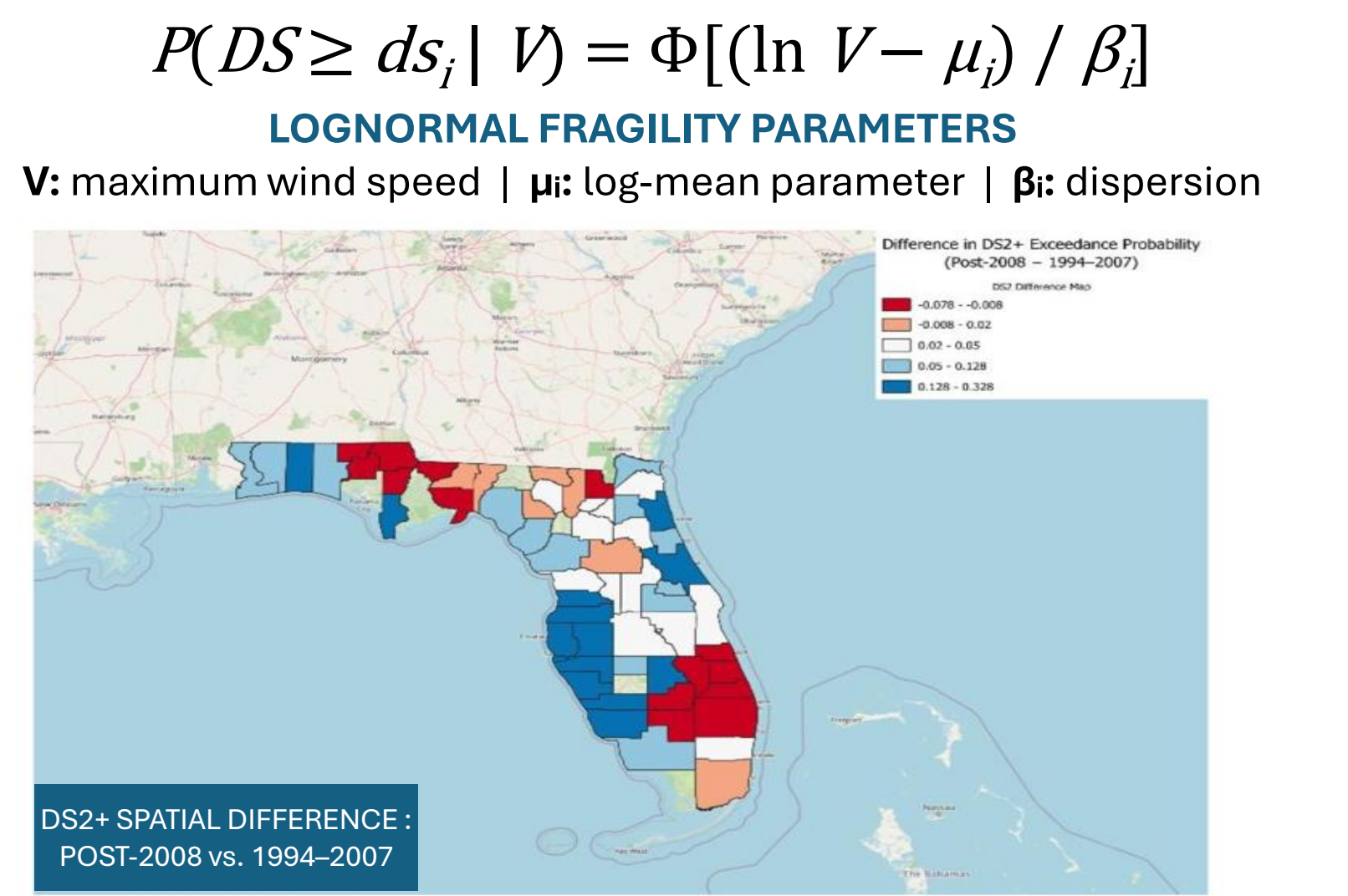
Post-2008 homes were far less likely to sustain any recorded damage

Post-2008 homes exhibited lower DS1+ vulnerability after accounting for wind speed, supporting improved resistance to lower-level wind-related damage. The higher DS2+–DS4+ values likely reflect the loss-based nature of FEMA proxy damage classifications, which can capture accessory-structure, roof/envelope, and repair-cost-related damage, together with event-specific exposure and data-aggregation effects, rather than weaker primary structural performance.

METHODS

- FEMA + NOAA + FLORIDA DOR
- DATA SCREENING & INTEGRATION
- CONSTRUCTION-ERA CLASSIFICATION
1994–2007 | POST-2008
- FEMA-DERIVED PROXY DAMAGE STATES
- 10-mph WIND-SPEED BINS
- EMPIRICAL EXCEEDANCE PROBABILITIES
- LOGNORMAL FRAGILITY FITTING
- ERA-BASED COMPARISON

FEMA-derived damage states are proxy measures of population-level vulnerability, not direct building-level structural-failure classifications.



01 — ERA MATTERS

Construction era and associated installation practices influence hurricane-wind vulnerability.

02 — IMPROVED LOWER-LEVEL PERFORMANCE

Post-2008 homes showed lower DS1+ vulnerability, while field evidence generally indicates improved foundation stability.

03 — ACCESSORIES REMAIN A WEAK LINK

Carports, roof-over systems, screened rooms, and attachments can substantially escalate damage.

04 — MITIGATION MUST BE SYSTEM-LEVEL

Anchorage maintenance, retrofit systems, improved accessory connections, and self-supported carport designs remain important mitigation priorities.

SELECTED REFERENCES

FEMA (2009). *Protecting Manufactured Homes from Floods and Other Hazards*, FEMA P-85.

HUD (2025). *Model Manufactured Home Installation Standards*, 24 CFR Part 3285.

Sutley et al. (2020). *Performance of Manufactured Housing during Hurricanes Irma and Michael*.

Marquez et al. (2026). *Performance of Manufactured Home Anchorage Systems after Hurricane Michael*.

LIMITATIONS & CAVEATS

- Accessory failures
- Roof / envelope damage
- Proxy / reporting effects
- Sparse severe-damage observations



Interior damage typical of FEMA-assessed DS2+ homes.

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