A Comparison of Tropical Storm (TS) and Non-TS Gust factors for Assessing Peak Wind Probabilities at the Eastern Range

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Overview

- Motivation and Goals
- Data sets
- Gust factor (GF) definition
- Data preparation
- Comparison results
- Conclusion
Motivation and Goals

• Motivation:
  – Peak winds important for space operations, difficult to forecast
  – Model for TS peak winds developed by Merceret (2009)
  – AMU task: create non-TS peak wind climatologies/probabilities

• Goals:
  – Compare TS to extratropical (non-TS) GF over same range of wind speeds and heights
  – Determine if TS model can be adapted to non-TS environment
Data: Towers

- Prop/vane anemometers
- Sensors on opposite sides of each tower
- Automated and manual QC
- **Same** towers, **Same** sensors, **Same** site: eliminates location and instrument differences

### Wind Tower Sensor Heights

<table>
<thead>
<tr>
<th>Tower #</th>
<th>#2</th>
<th>#6</th>
<th>#110</th>
<th>#313</th>
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<tbody>
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<td>✓</td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td>145 ft</td>
<td>✓</td>
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<tr>
<td>162 ft</td>
<td>✓</td>
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<tr>
<td>204 ft</td>
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<tr>
<td>295 ft</td>
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<tr>
<td>394 ft</td>
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<td></td>
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<tr>
<td>492 ft</td>
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</table>
Data: Stratifications

• TS data set:
  – Hurricanes Frances and Jeanne (September 2004)
    • Towers 2, 110, and 313
    • Empirical models for GF $\mu$ and $\sigma$ as function of speed and height
  – Validated with Hurricane Wilma data (October 2005)

• Non-TS data set
  – Cool-season (October – April) 1995 – 2007
  – Towers used for launch decisions
  – Stratifications for TS comparison study:
    • NE wind sector (0° to 60°)
    • Daytime data
    • Mean speeds $\geq$ 15 kt
How Gust Factor is Determined

Mean: 22.5   Peak: 25.9   GF: 1.15

Wind Speed (Kt) vs. Time (sec) graph

- 1 Sec Wind
- Mean Wind
- Peaks

GF: Gust Factor
Comparison: Mean GF

- Non-TS GF < TS GF at same height and wind speed
- Consistent with most previous results

<table>
<thead>
<tr>
<th>Tower</th>
<th>Speed Bin (kt)</th>
<th>54 ft</th>
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GF Change with Height/Speed

• Height
  – Non-TS GF change with height same form as TS: $aH^b$
  – Non-TS $R^2 = 0.9998$
  – No such comparison found in literature

• Speed
  – TS GF decrease with increasing mean speed
  – Non-TS GF show no consistent variation
    • Limited speed range
    • Lower speeds

<table>
<thead>
<tr>
<th>Source</th>
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<th>$b$</th>
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GF Standard Deviation

- TS GF $\sigma$ decreased monotonically with height/speed
- Non-TS $\sigma$ showed no consistent variation with height or wind speed
- Ratios of non-TS to TS $\sigma$ ranged from about 0.7 to 1.3 with no consistent height/speed patterns
Conclusions

- Use of same sensors/location reduce sources of comparison variance
- Non-TS GF < TS GF
- Result consistent with most studies in the literature
- Non-TS GF decrease with height similar to TS GF
- Unable to model the probability of exceeding specified peak speeds for non-TS due to inconsistent GF $\sigma$ patterns