High-frequency Tropical Cyclone Forecasts: Intensity

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Thanks to: Vijay Tallapragada, Sam Trahan, Ryan Torn, William Lewis, and Yi Jin
Outline

• Comparison of observed and modeled intensity
• Samples and Statistics for Participating Models:
  – H212 (planned 2012 HWRF)
  – HWF3 (2011 HFIP HWRF)
  – AHW4
  – UWN8
  – COAMPS-TC (not shown)
• Conclusions and future work
NHC Best Track

• Best track values are intended to be “representative” values over a 6h interval
  – Not instantaneous

• Intensity determined from variety of sources
  – Flight level winds and SFMR
  – Dvorak Estimates
  – Land and buoy observations
Reality vs model

- At 10,000 ft, SFMR has a 50% power footprint with a diameter of 1.3km, (1% power = 2.8km)
- 10-s averages from SFMR are used to determine intensity operationally
  - Resulting footprint is smaller than the gridspacing of some models

Figure 7 from Uhlhorn and Nolan 2012
High Frequency (HTCF) Output

• Simple tracker run at every time step (nearly)
  – Maximum wind in inner-most domain
  – Minimum pressure in inner-most domain
  – Location of maximum wind, minimum pressure, and nest center

• 5 Cases Examined
  – Emily 05L 2011080200
  – Irene 09L 2011082400
  – Katia 12L 2011090500
  – Maria 14L 2011091200
  – Rina 18L 2011102400
H212

- 3km horizontal gridspacing
- Instantaneous ATCF intensity
H212 Spectral Analysis

iFilter 3.0: INPUT: Signal  x=time

POWER SPECTRA: BLUE = Input signal  RED = Filter

x=Frequency (e.g. cycles/day)

×10^9
H212 Stats

- Intensity fluctuations occur primarily on a timescale of 3-8 hours
  - Longer than convective timescale (in reality)
- Instantaneous value is typically within 5 kts of the 6-hr mean, but difference can be as large as 10+ kts.

Difference: HTCF-6-hr running mean

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<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td>2.0</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>2.7</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>12.0</td>
</tr>
</tbody>
</table>
HWF3

- 3km horizontal gridspacing
- Instantaneous ATCF intensity
HWF3 Spectral Analysis
HWF3 Stats

- Like H212, intensity fluctuations occur primarily on a timescale of 3-8 hours
- Fluctuations are larger than H212
- Intensity is typically within 6 kts of the 6hr running mean, but can deviate by as much as 18kts (a full S.S. category)

Difference: HTCF-6-hr running mean

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Average</td>
<td>2.1</td>
</tr>
<tr>
<td>SD</td>
<td>2.9</td>
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<tr>
<td>Maximum</td>
<td>18.0</td>
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</table>
AHW4

- 4km horizontal gridspacing
- Instantaneous, 12-km spatially averaged ATCF intensity
AHW4 Spectral Analysis

iFilter 3.0: INPUT: Signal  x=time

POWER SPECTRA: BLUE = Input signal  RED = Filter

x=Frequency (e.g. cycles/day)
AHW4 Stats

- Like H212 and HWF3, intensity fluctuations occur primarily on a timescale of 3-8 hours
  - Larger contribution at higher frequencies
- Intensity is commonly within 6 kts of the running mean, however fluctuations as large as 14 kts were observed.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
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<tbody>
<tr>
<td>Average</td>
<td>2.3</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>3.0</td>
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<tr>
<td>Maximum</td>
<td>14.0</td>
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</tbody>
</table>
UWN8

- 8km horizontal gridspacing
- 6 hour (+/- 3 hr) running mean ATCF intensity
UWN8 Spectral Analysis

iFilter 3.0: INPUT: Signal  \( x = \text{time} \)

POWER SPECTRA: BLUE = Input signal  RED = Filter

\( \times 10^7 \)

\( x = \text{Frequency (e.g. cycles/day)} \)
UWN8 Stats

- Intensity fluctuations occur almost entirely on a timescale of 3-8 hours
  - May be a function of gridspacing
- UWN8 has the smoothest intensity, and has the smallest difference between instantaneous intensity and the running mean

### Difference: HTCF-6-hr running mean

<table>
<thead>
<tr>
<th>Average</th>
<th>1.8</th>
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<tbody>
<tr>
<td>Standard Deviation</td>
<td>2.4</td>
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<tr>
<td>Maximum</td>
<td>10.6</td>
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</tbody>
</table>
Conclusions

• ATCF output is not necessarily representative of what the model is predicting, or how NHC “observes” intensity
  – Methods such as spatial averaging may offset with the inherent under-sampling of real storms
  – How the tracker determines intensity has implications on model development and verification

• Variability of intensity is fairly consistent among models
  – HWF3 has the most variability
  – UWN8 has the least variability

• Fluctuations at timescales less than one hour appear to contribute very little to the variability of intensity
  – 15 minute output should be sufficient to resolve nearly all intensity fluctuations for operational applications (4*ΔT = 1 hr)
Next Steps

• Complete intensity analysis
• Inter-model structure comparisons
• Determine best way to display and share HTCF information
  – New HFIP products webpage
Additional Experiments