Forecast Challenges of the 2017 Hurricane Season and NHC Priorities for 2018

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Outline

• Forecast Challenges
  • Genesis
  • Rapid Intensification
  • Structural Changes

• Model Performance
  • HMON, HWRF, COAMPS-TC

• NHC Modeling Priorities for 2018
GFS Genesis Problems

- 2017 GFS had issues with under-predicting genesis at longer time ranges in both basins
  - Atlantic: GFS hit 3 of 16 genesis events at 120 h (19%)
  - East Pacific: GFS hit 7 of 18 genesis events at 120 h (39%)
- GFS forecast only half of Atlantic TC formations 48 h in advance
- East Pacific better in the short range – GFS hit 13 out of 18 events at 48 h (72%)
Atlantic GFS Genesis Forecasts

• 2-day GFS genesis forecasts had a lot of noise – low probabilities had an under-forecast bias; sample quite small at 40% and above
• 5-day results smoother, but persistent 10-20% under-forecast bias for most probabilities

2-day “High” Forecasts
GFS: 15
NHC: 45

5-day “High” Forecasts
GFS: 16
NHC: 89

Preliminary results courtesy of Dan Halperin
East Pacific GFS Genesis Forecasts

2-day GFS genesis forecasts generally OK, but a big low bias around 30%
5-day results terrible – huge under-forecasts at low to medium probability ranges!

Preliminary results courtesy of Dan Halperin

2-day “High” Forecasts
GFS: 43
NHC: 52

5-day “High” Forecasts
GFS: 59
NHC: 111
Some signal early (4-5 days), but signal weakened inside of 60 hours until genesis.
GFS Genesis Example – Maria

Weak/No signal until 42 h prior to genesis

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Little/No Signal Prior to Genesis

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GFS Genesis Example – Lee (Genesis #2)

GOES-13 Visible Imagery – 1815 UTC 22 September 2017
Rapid Intensification

• Rapid intensification was more frequent than average in the Atlantic in 2017
  • 24 h: 39 observed RI cases (≥ 30 kt) out of 312 total (9.6%)
    • HWRF: 6 correct, 1 false alarm
    • LGEM: 2 correct
    • NHC: 6 correct, 1 false alarm
  • 48 h: 24 observed RI cases (≥ 55 kt) out of 253 total (9.5%)
    • HWRF: 2 correct, 3 false alarms
  • 72 h: 13 observed RI cases (≥ 65 kt) out of 208 total (6.3%)
    • HWRF: 4 correct, 5 false alarms
    • NHC: 1 correct
2017 Atlantic OFCL Errors

**NHC Official vs. CLIPER5 Forecasts**
Atlantic Basin

**NHC Official vs. Decay-SHIFOR Forecasts**
Atlantic Basin

Track

Intensity
Rapid Intensification – Harvey

- Intensity guidance from first forecast when Harvey regenerated in the Gulf of Mexico (12Z 23 August 2017)
- Actual intensity increased 30 kt in 24 h and 65 kt in 48 h
- No guidance showed Harvey reaching hurricane intensity before landfall
  - Landfall intensity 115 kt (cat 4)
Rapid Intensification – Harvey

- HWRF consistently underestimated the development rate of Harvey in the Gulf, even once rapid intensification began.

- 24-h bias for HWFI in Harvey through landfall was -17.5 kt (8 cycles) and -34.5 kt at 48 h (4 cycles)
For Irma’s first RI instance, intensity guidance showed about 5-25 kt of strengthening, but storm intensified by 40 kt (12Z cycle on 8/30)
Rapid Intensification – Irma

- Irma’s second round of RI to category 5 intensity was very poorly predicted by all guidance, even within 6 h of RI event beginning (00Z cycle on 9/5)
For first Maria forecast, HMON and COAMPS-TC captured initial 24-h of strengthening, but no guidance had second round of RI to Cat 4/5 range.
Rapid Intensification – Maria

• Just prior to second RI instance, guidance showed at most 25-30 kt of strengthening in 24 h, when 40 kt of intensification occurred in just 12 h
Long Duration Cat 5 – Irma

- HWRFI continually weakened Irma once it became a cat 5
Long Duration Cat 5 – Irma

- HMON did a better job keeping Irma at Cat 5 intensity, but kept intensity too high (likely due to track that didn’t interact with Cuba)
Maria – Structural Changes

Maria RMW vs. Intensity

PR Landfall

SSMIS Image at 0811 UTC 20 Sep. 2017
SSMIS Image at 2227 UTC 19 Sep. 2017
GPM Image at 0151 UTC 20 Sep. 2017
Model Performance
HMON – Atlantic Track

- HMON track errors were 10-30% larger than HWRF through day 4
- HMON was not included in the TVCN multi-model track consensus in 2017, but it would have degraded it by up to 7% (at 72 h)
HMON – Atlantic Intensity

- HMON intensity errors were 5-20% larger than HWRF
- HMON was not included in the IVCN multi-model intensity consensus in 2017, but it would have improved it slightly (1-3%) at most lead times
HMON Intensity Bias

- For 2017 HMON had a very large low bias for systems that were < 50 kt at the initial time.
- Slight high bias for systems initially at hurricane intensity.
• For 2017 HWRF had a large low bias for systems that were < 50 kt at the initial time

• 2-4 kt low bias through 72 h for systems that were hurricanes at the initial time, with small high bias at 96 and 120 h
COAMPS-TC – Atlantic Track

- COAMPS-TC track errors were 6–12% larger than HWRF at most lead times
- COAMPS-TC slightly degraded the TVCN multi-model track consensus through 96 h and slightly improved it at 120 h
COAMPS-TC – Atlantic Intensity

- COAMPS-TC intensity errors were 10–20% larger than HWRF through 72 h, but 5–10% smaller at days 4–5
- Removing COAMPS-TC from IVCN would degrade the consensus by up to 8%
GFS Intensity Bias

- For 2017 interpolated GFS intensity (GFSI/AVNI) had an increasing low bias through 96 h.
- Becomes a high bias by 120 h when interpolator phase out ends.
For U.S. landfalling hurricanes, the GFS had larger errors than ECMWF for Harvey and Irma, but the GFS had lower errors than ECMWF in Maria.
NHC Modeling Priorities for 2018

• Continue to improve HWRF, especially for RI cases
• Improve HMON so it can contribute positively to the consensus aids
  – Address significant weak bias for weaker storms
• Work towards a less under-dispersive ensemble system
• Improve GFS genesis forecasts
• Address low bias in GFS intensity forecasts
• Develop methods to assimilate GOES-16 and JPSS data
• Begin work toward extending TC intensity guidance out to 7 days