Research to Improve NOAA’s Hurricane Forecast Guidance

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Hurricane Matthew: Impacts

North Carolina: 26 deaths

Florida: 12 deaths

South Carolina: 4 deaths

Haiti: 598 – 1,384+ deaths

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Tropical Cyclone Intensity

• HWRF skill has improved over the past few seasons, but rapid change cases are still a problem
• Statistical models have difficulty forecasting rapid change
• Dynamical models can forecast rapid change, but not reliably (e.g., Matthew, Joaquin, Patricia)
• Consensus approach still shows best hope for modest improvements in forecast accuracy, but dramatic improvements still likely years away
• Large improvements requires increases in inner-core observations, higher resolution computer models, and better ways to get the new observations into the new models

So how do we get there?
Keys to Success
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- **Science**
  - Improve operational high-resolution coupled models (HWRF) – *particularly intensity changes*
  - Improve understanding from combination of observations & high-resolution models

- **Information Technology**
  - Develop research computing capacity to *accelerate* transition of research to operations

- **Observing Strategy**
  - Improve use of existing and planned systems

- **Improve Forecaster Products**
Current State of the Art

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Operational Forecast Performance

- Since HFIP began in 2009, forecast error has decreased by 20-25% for 1-5 day forecasts.
- NOAA upgraded HWRF model resolution; now 2 km
- Dramatic improvements in HWRF since HFIP*

Stagnant improvement in intensity forecast prior to HFIP
Under HFIP, the HWRF model has demonstrated a remarkable 15-20% improvement in hurricane intensity forecast accuracy each year since 2011.
HWRF Improvements: Assimilation of Aircraft Recon

- NOAA P-3 transmitted Tail Doppler radar data in real-time for assimilation into HWRF
- Resulting forecast allowed NHC to target warnings where needed, without overwarning broader East Coast.
HWRF Improvements: Ensembles

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HWRF Improvements: Ensembles

Max 10m Wind (m/s) 2016100506-141 F001
Min=0 Max=65.4972
**HWRF Improvements: Ensembles**

**COAMPS-TC / HWRF**

HWRFCTCXGFDEPS: TC = 07L2016, DTG = 2016082600

Colored bars indicate 24 h intensity change probability

- $\Delta I \geq 30$ kt (Rapid Intensification)
- $10 \text{ kt} \leq \Delta I < 30$ kt (Moderate Intensification)
- $-10 \text{ kt} < \Delta I < 10$ kt (Steady Intensity)
- $-30 \text{ kt} < \Delta I \leq -10$ kt (Moderate Weakening)
- $\Delta I \leq -30$ kt (Rapid Weakening)

TC already dissipated or dissipates during window

NOAA Hurricane Forecast Improvement Project

Meeting the Nation’s Needs
HWRF Improvements: New Observations - 2017

Doppler Wind Lidar
• Compliments P-3 & G-IV Tail Doppler radar

Coyote
• Targets data gaps in hurricane boundary layer thermodynamics
• 5-6 Coyote in 2017
• Data sent to NHC

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Next steps – Basin HWRF #NOAAHurricaneAware

- Keys to further improve hurricane predictions lie in modeling multi-scale interactions

- Requires Basin/Global domains with high resolution nests at 1-3 km horizontal resolution

- Research & development to advance next generation high resolution global model with nests

http://storm.aoml.noaa.gov/hwrfxprojects_test/model.html?projectName=BASIN
Next steps — Basin HWRF
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Matthew (14L) & Nicole (15L)

Mean Sea Level Pressure [hPa] in Basin-Scale HWRF

Initial Time: 10/05/2016 (06:00)

MATTHEW Intensity Errors

MATTHEW & NICOLE

NOAA Hurricane Forecast Improvement Project
Meeting the Nation’s Needs
Priorities to be addressed by HFIP research & development community in FY17 are:

- Reduce largest track and intensity errors
- Improve initialization & physics impacting rapid intensity change
- Improve vortex/shear interactions
- Extend/improve 7-day forecast skill
- Improve ensemble prediction & products
Communicating in the field
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- Our blog
  http://noahrd.wordpress.com
- HRD Web page
  http://www.aoml.noaa.gov/hrd
- Facebook (5,844 followers)
  http://www.facebook.com/noahrd
- Twitter (20,830 followers)
  http://twitter.com/#!/HRD_AOML_NOAA

Visiting scientist program

#NOAA42, #NOAA43, and #NOAA49 are flying in Hurricane #Edouard right now.