NOAA Hurricane Research

Outline:
- Hurricane Research
  - Mission
  - Vision
  - Who?
  - How?
  - What?
  - Track
  - Intensity
  - Structure
  - Impacts
  - What’s Next?

Hurricane Matthew

Hurricane Nicole

F. Marks
NOAA HFIP Research Lead
NOAA/AOML Hurricane Research Division

F. Marks
2/27/2017
Mission:

Advance understanding and prediction of TCs through observations, numerical models, and theory, with emphasis on processes within inner part of storm.

HRD research supports NOAA's Strategic Plan:

- Advance understanding and prediction of changes in the environment through world class science and observations
- Improve preparedness, response, and recovery from weather and water events by building a Weather-Ready Nation

http://www.aoml.noaa.gov/hrd/

NOAA’s hurricane research focus for >60 years
Vision:

HRD is uniquely positioned to advance understanding of TC processes in close cooperation with efforts to improve observing strategies and numerical prediction.
Who?

Staff includes 44 employees: 21 federal & 24 contract

- 23 research scientists
  - 4 post-docs
- 16 support personnel
- 2-3 summer students

- HRD scientists collaborates locally with scientists in other AOML divisions, CIMAS, UM/RSMAS, and FIU
- HRD coordinates its research with OAR laboratories (ESRL, GFDL, ARL, NSSL), AOC, NESDIS, NWS (EMC, NHC, & WFOs), and Testbeds (JHT, DTC, JCSDA, & OSSE).

- Funded Priorities: NOAA Hurricane Forecast Improvement Project (HFIP), Quantitative Observing System Assessment Project (QOSAP), & Next Generation Global Prediction System (NGGPS).
Vision

• Organize hurricane community to dramatically improve numerical forecast guidance to NHC in 5-10 years

Goals

• Improve forecast accuracy for track & intensity by 20% in 5 years, 50% in 10 years
• Extend forecast guidance to 7 days with skill comparable to current 5 day forecasts
• Increase probability of predicting Rapid Intensity Change (RI/RW)
Current State of the Art

Operational Forecast Performance

- Since HFIP began in 2008, forecast error has decreased by 20-25% for 1-5 day forecasts.
- NOAA upgraded HWRF model resolution; now 2 km
- Remarkable improvements in HWRF since HFIP.
How to get there?

- **Science**
  - Improved understanding from combination of observations & models
  - High resolution coupled models – especially intensity changes
  - Techniques to understand, reduce & communicate uncertainty

- **Information Technology**
  - Increased computing power
  - IT infrastructure for inter-agency data exchange

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

- **Improved Forecaster Products**
HOW?:

NOAA Intensity Forecast Experiment (IFEX)

Partnership to improve TC intensity/structure forecasts

- Collect observations over TC life cycle for model initialization and evaluation
- Develop measurement technologies to provide improved real-time monitoring of TC intensity, structure, and environment
- Improve understanding of physical processes important in intensity change

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Gall et al., BAMS, 2013
Rogers et al., BAMS, 2013
WHAT?:

Current TC research:

Track:

- Synoptic-surveillance using dropsondes.

- Analytical & numerical studies.
- Ensemble track forecasting & targeted observations.

http://www.aoml.noaa.gov/hrd/data_sub/assesment.html
**Track (continued):**
- Ensembles: Single & Multi-model

- **HWRF EPS** (27/9/3 km, 42 levels) – 20 members
- **GFDL EPS** (55/18/6 km, 42 levels) – 10 members
- **COAMPS-TC EPS** (27/9/3 km, 40 levels) – 10 members

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[Graphs and charts showing track, intensity, and other data for Hurricane Hermine (09L) 2016 real-time predictions.](http://www.emc.ncep.noaa.gov/gc_wmb/vxt/)
Intensity:

• Statistical Models
  – Since 1997, D-SHIPS most skillful intensity guidance to NHC/TPC.
  – Incorporates wind field decay after landfall.
  – Incorporates inner-core SST impact with 6-8% increase in forecast skill.
  – Developed Rapid intensification index (RII) that average 5% & 30% improvement for ATL & EPAC (EPAC easier than ATL).
    - RII POD higher than any dynamical model & OFCL in both ATL and EPAC, while FAR comparable

Kaplan et al (2009)
Intensity (continued):

• 3-D modeling of TC

HWRF:

![Graph showing improvements in intensity forecasts](image)

**Improvements of the order of 10-15% each year since 2012**

6 years of continuous improvements in intensity forecasts
Intensity (continued):

HWRF: Global to local

Experimental Basin-HWRF simulations
(http://storm.aoml.noaa.gov/basin/?projectName=BASIN)

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

Matthew (14L) & Nicole (15L)
**Intensity** (continued):

- Real-time Situation Awareness from TDR

Airborne Doppler-analyzed wind field Hurricane Matthew, 6 October 2016

**Intensity** (continued):

Better HWRF Initialization – aircraft data & TDR

Synergy of high resolution forecast and airborne observations

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F. Zhang (PSU), Aberson, Aksoy, Gamache, Gopal (AOML/HRD)
Structure:

- Evaluation of Model structure

Data Coverage

**H*Wind 10m winds**

**HWRF 10m winds**

Hurricane SANDY18L – 2012-10-25 18Z
10M Wind-speed [kts], Forecast Hour 108

HWIND analysis
Impacts:

Rainfall

Gage rain accumulation (144 h)

HWRF rain accumulation (126 h)

Rainfall:
- Hurricane Matthew (2016)
- Gage rain accumulation (144 h)
- HWRF rain accumulation (126 h)

Maximum: 18.95" Evergreen 3.3 NE, NC

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What’s Next?

Operational Impact
• Demonstrate Basin-HWRF during hurricane season
• Demonstrate impact of aircraft data & Doppler Radar (TDR)
• Demonstrate multi- & single-model ensembles for Intensity

Research & Development
• Develop fully cycled HWRF GSI-hybrid DA - Focus on high-resolution domains
• Improve use of satellite data in TC DA
• Improve use of inner core observations in operations, TDR, UAS, DWL, etc.
• Improve HWRF physics using aircraft observations (IFEX)
• Develop global physics for high resolution (NGGPS)

Technical Advancements
• Transition HWRF to HMON and eventually FVGFS (NGGPS)
Questions?

- Our blog
  http://noaahrd.wordpress.com

- HRD Web page
  http://www.aoml.noaa.gov/hrd

- Facebook (5,420 likes)
  http://www.facebook.com/noaahrd

- Twitter (20,500 followers)
  http://twitter.com/#!/HRD_AOML_NOAA