NOAA Hurricane Research

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

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

Hurricane Irma

Hurricane Jose

F. Marks
2/26/2018
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
  - 3 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 rapid intensity change
  • Research 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/assessment.html
Track (continued):

- Ensembles: Single & Multi-model

- HWRF EPS (27/9/3 km, 42 levels) – 20 members
- HMON EPS (18/6/2 km, 42 levels) – 10 members
- COAMPS-TC EPS (27/9/3 km, 40 levels) – 10 members

http://www.emc.ncep.noaa.gov/gc_wmb/vxt/
Intensity:

- **Statistical-Dynamical Models**
  - Since 1997, D-SHIIPS 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:

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

7 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)

Harvey (11L)
Intensity (continued):

- Real-time Situation Awareness from TDR

Airborne Doppler-analyzed wind field Hurricane Harvey, 24 August 2017

**Intensity (continued):**
Better HWRF Initialization – aircraft data & TDR

Synergy of high resolution forecast and airborne observations

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Hurricane Harvey (2017)

- P-3 and G-IV observations – superobs (SO)
- Data assimilation
- Improving the initial condition in storm core region
- Improving the high resolution regional forecast
Structure:

- Evaluation of Model structure

Data Coverage

**HWRF 10m winds**

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

**HWRF Forecast (108 h)**

**H*Wind 10m winds**

HWIND analysis
Impacts:
Rainfall

Hurricane Harvey - Rain Swath (HB17)
Init: 2017-08-24 18Z  Acc hr: [0-126] [inch]

Hurricane Harvey - Rain Swath (IMERG F)
Init: 2017-08-24 18Z  Acc hr: [000-126] [inch]

Hurricane Harvey (2017)
Impacts: Tornadoes

Hurricane Harvey (2017)

- HWRF-B can provide useful guidance on TC-induced tornadoes
- HWRF-B predicts high CAPE and helicity along the TX coast, especially from Matagorda Bay to Galveston Bay
- Matches up well with SPC Storm Reports
What’s Next?

Operational Impact
• Demonstrate Basin-HWRF during hurricane season
• Demonstrate impact of aircraft data & Doppler Radar (TDR)
• Demonstrate multi-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 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 (30,200 followers)
  http://twitter.com/#!/HRD_AOML_NOAA