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:

Understanding & prediction of TCs

Models (HWRF, HAFS)

Analysis systems (DA)

Observing strategies (e.g., OSE/OSSE)

Evaluation (e.g., parameterizations)

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

F. Marks
4/29/2019

Vision:
Understanding & prediction of TCs

Models (HWRF, HAFS)

Analysis systems (DA)

Observing strategies (e.g., OSE/OSSE)

Evaluation (e.g., parameterizations)

HWRF forecast for IRMA (11L) at 2017090812

Most Likely Arrival Time of Tropical-Storm-Force Winds

OSE/OSSE

Parameterizations
Who?

Staff includes 49 employees: 22 federal & 27 contract

- 28 research scientists
  - 2 post-docs
- 21 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, & EPIC).

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

NHC Official Average Intensity Errors
Atlantic Basin Tropical Storms and Hurricanes

- Since HFIP began in 2008, forecast error has decreased by 20-25% for 1-5 day forecasts.
- NOAA upgraded HWRF model resolution; now 1.5 km
- Remarkable improvements in HWRF since HFIP

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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/assesment.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-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:**

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**Intensity Skill vs. OCD5**

- **HFIP 10-yr**
- **HFIP 5-yr**
- **HFIP baseline**

*NOAA/AOML/HRD*
**Intensity (continued):**

**HWRF: Global to local**

Experimental Basin-HWRF simulations

(https://storm.aoml.noaa.gov/basin/?projectName=BASIN)

*Experimental Product of NOAA/AOML/HRD*
**Intensity** (continued):

- Real-time Situation Awareness from TDR

Airborne Doppler-analyzed wind field Hurricane Irma, 5 September 2017

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

Synergy of high resolution forecast and airborne observations

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

Hurricane Michael (2018)
Structure:
• Evaluation of Model structure

**Structure:**

- Evaluation of Model structure

**Data Coverage**

- HWRF 10m winds

**HWRF Forecast (108 h)**

**Data Coverage**

- H*Wind 10m winds

**HWRF 10m winds**

**Hurricane SANDY18L**

- 2012–10–25 18Z
- 10M Wind–speed [kts], Forecast Hour 108
Impacts:
Rainfall

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

Hurricane Harvey- Rain Swath (Stage IV)
Acc: 2017082418-2017083000(126hr) [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

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What’s Next?

Operational Impact
• Demonstrate Basin-HWRF during hurricane season
• Demonstrate impact of aircraft data & Doppler Radar (TDR)
• Demonstrate ensembles for probabilistic hazard guidance

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 (6,940 likes)
  http://www.facebook.com/noaahrd

• Twitter (34,700 followers)
  http://twitter.com/#!/HRD_AOML_NOAA