Outline:

- Hurricane Research
  - Mission
  - Vision
  - Who?
  - How?
  - What?
    - Track
    - Intensity
    - Structure
    - Impacts
- What in 2016?
  - IFEX2015
  - IFEX2016
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/](http://www.aoml.noaa.gov/hrd/)

NOAA’s hurricane research focus for >50 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 38 employees: 20 federal & 21 contract

- 21 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 (NCGPS).
Goals

• **Improve** Forecast Accuracy
  - Hurricane impact areas (track) – 50% in 10 years
  - Severity (intensity) – 50% in 10 years
  - Rapid intensity change detection
  - Storm surge forecast improvements

• **Extend** forecast reliability out to 7 days

• **Quantify, bound and reduce** forecast uncertainty to enable risk management decisions
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 spanning TC life cycle for model initialization and evaluation
- Develop and refine 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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http://www.aoml.noaa.gov/hrd/HFP2014/IFEX.html

Rogers et al., BAMS, 2006
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

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:**

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

**HWRF: Global to local**

Experimental Basin-HWRF simulations

(http://storm.aoml.noaa.gov/hwrfxprojects/?projectName=BASIN)

![Geopotential Height [gpm]](image)

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Intensity (continued):

- Airborne Doppler radar studies

Airborne Doppler-analyzed wind field Hurricane Katrina, 28 September 2005

Intensity (continued):
Assimilation of data into numerical models

Synergy of high resolution forecast and airborne observations

Hurricane Sandy (2012)

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

HWRF Forecast (108 h)
Impacts:

Rainfall

Stage IV rain accumulation (144 h)

HWRF rain accumulation (120 h)

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Hurricane Isaac (2012)
What in 2015 & 2016?:

• **IFEX 2015**
  - NOAA aircraft flew **30 P3 and 15 G-IV missions**
  - Highlights include Hurricanes Danny, Erika, Joaquin, & Kate (ATL), Patricia (EPAC), & Oho (CPAC)
  - 4 **NOAA SHOUT Global Hawk** missions and 3 ONR WB-57 missions.
  - For details see: [http://noaahrd.wordpress.com/category/ifex-discussion](http://noaahrd.wordpress.com/category/ifex-discussion)

• **IFEX 2016**
  – 2 WP-3D, G-IV – 250 flight hours (1 June-30 Nov.)
  – Crews available 2/day missions starting July
  – Interact with SHOUT during their field campaign

• **HFIP real-time model demonstration**
IFEX 2015:
Improved Models & Data: Erika

- 5 P-3 missions from 25-28 August 2015 at 12 h Doppler sampling (HEDAS/GSI) & 1 G-IV mission
- Doppler data transmitted in real-time for assimilation into HWRF
- Sampled Erika as a tropical storm

Gamache, Reasor, Gopal (AOML/HRD), Tallapragada, Tong (EMC)
IFEX 2015:
Develop & refine observing technologies:

- G-IV flight tracks in Hurricane Joaquin 29 & 30 September 2015
- G-IV Doppler analysis at 1-km altitude

- G-IV Doppler provides enhanced coverage at higher altitude
- G-IV flown further from center to sample environment and supplement P-3
**IFEX 2015:**
Develop & refine observing technologies:

**Doppler Wind Lidar (DWL)**
- Compliments P-3 & G-IV Tail Doppler radar
- 9 flights into Tropical Storms Danny and Erika
  - 7 flights collected data
  - Elevation angle range of -110° to +110°
  - Azimuth angle range +/- 30°
  - Preset scanning modes: conical sweeps, etc.
- Access DWL computer via laptop

*F. Marks*
2/29/2016
Slide 20
What in 2016?:

- **SHOUT**

  - **GOAL:** Test prototype UAS concept of operations that could mitigate the risk of diminished high impact weather warnings in case of polar-orbiting satellite observing gaps

- **Global Hawk**
  - Flight level: ~55-60,000 ft
  - Duration: ~24 h
  - Range: 11,000 nm
  - Payload: 1500+ lbs
  - Deployment site: NASA Wallops Flight Facility, VA
  - 5 week deployment (late August through September)
  - Instrumentation: AVAPS, HAMSR, & HIWRAP
Communicating in the field

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

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

• Facebook (3,475 likes)
  http://www.facebook.com/noaahrd

• Twitter (12,950 followers)
  http://twitter.com/#!/HRD_AOML_NOAA

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