



NOAA Hurricane Research

Outline:

- Hurricane Research
 - Mission
 - Vision
 - Who?
 - How?
 - What?
 - Track
 - Intensity
 - Structure
 - Impacts
- What in 2016?
 - IFEX2015
 - IFEX2016

Hurricane
Joaquin

F. Marks

NOAA HFIP Research Lead

NOAA/AOML Hurricane Research Division

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Slide 2

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 >50 years



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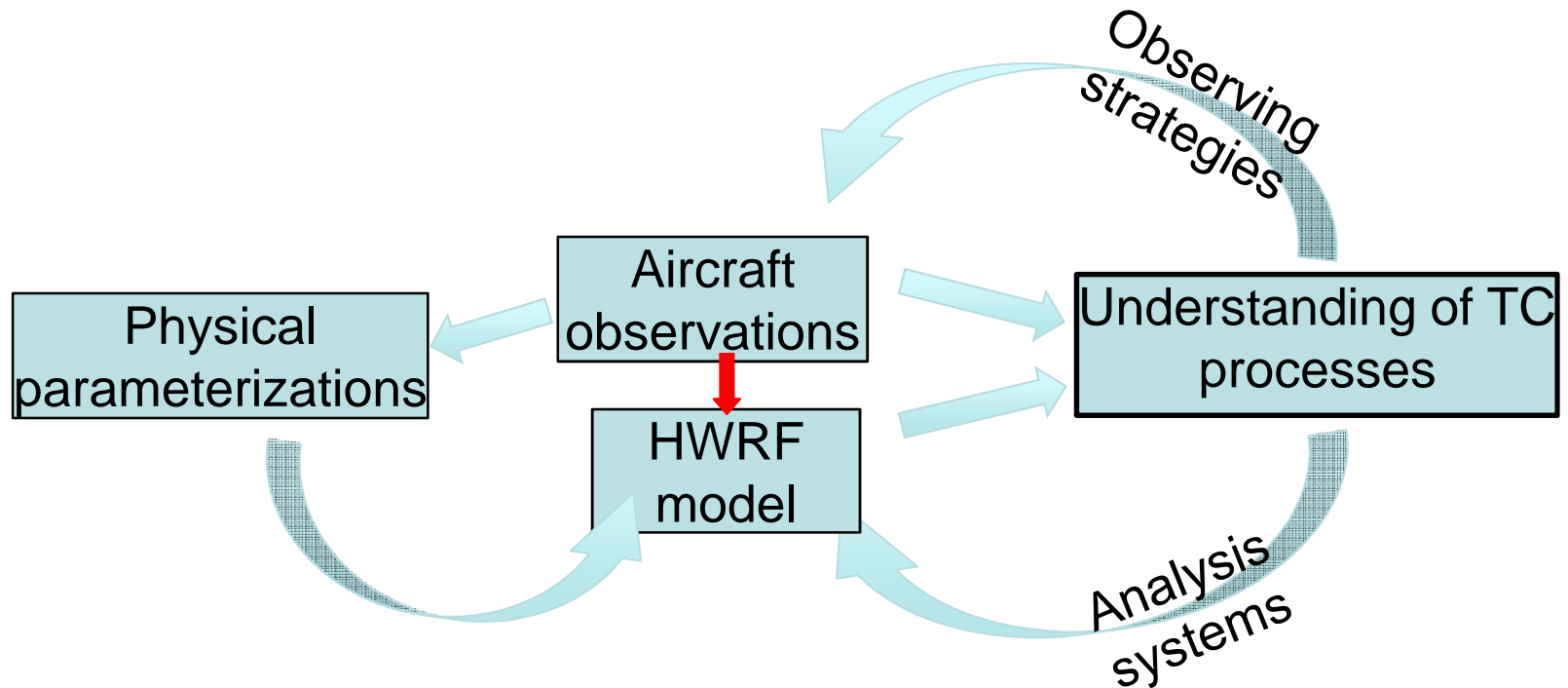
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Vision:



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



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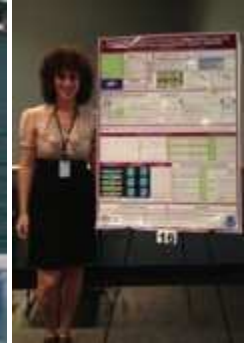
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Who?

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 (**NGGPS**).



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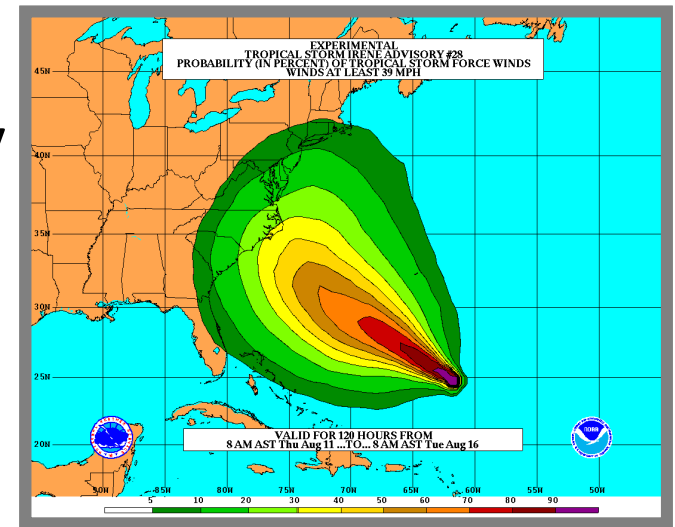
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Goals

- **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





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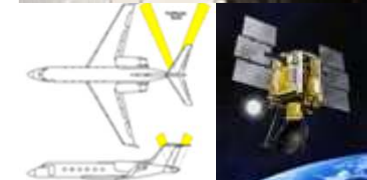
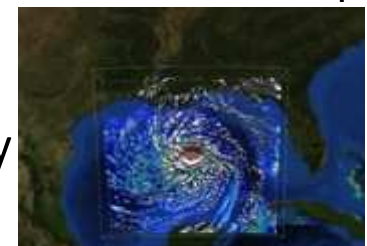
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How to get there?

- 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





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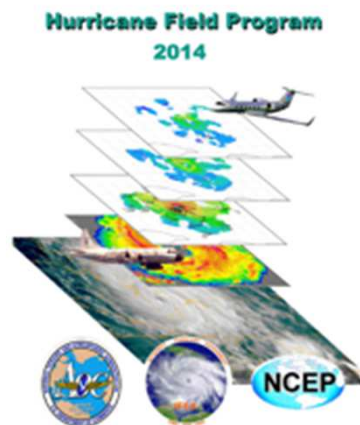
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HOW?:

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



Rogers et al., BAMS, 2006



Rogers et al., BAMS, 2013

<http://www.aoml.noaa.gov/hrd/HFP2014/IFEX.html>



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WHAT?:

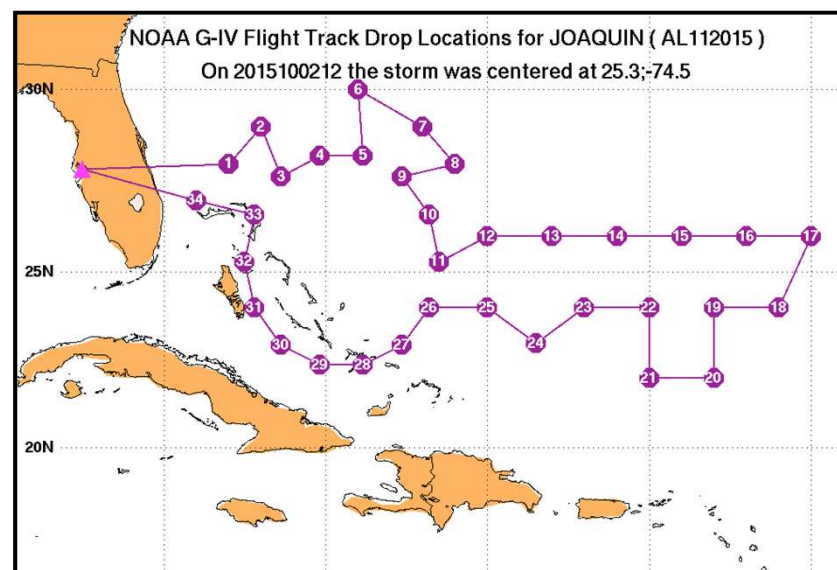
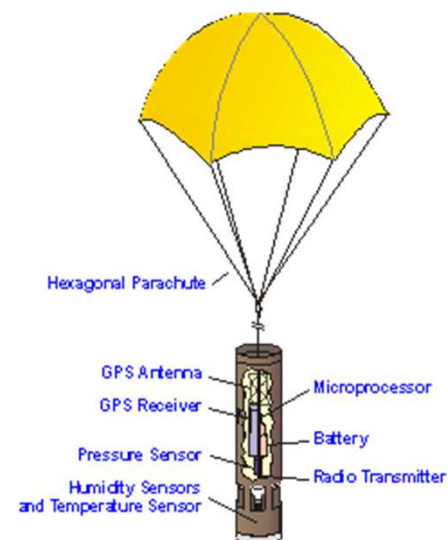
Current TC research:

Track:

- Synoptic-surveillance using dropsondes.



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



http://www.aoml.noaa.gov/hrd/data_sub/assesment.html



Outline:

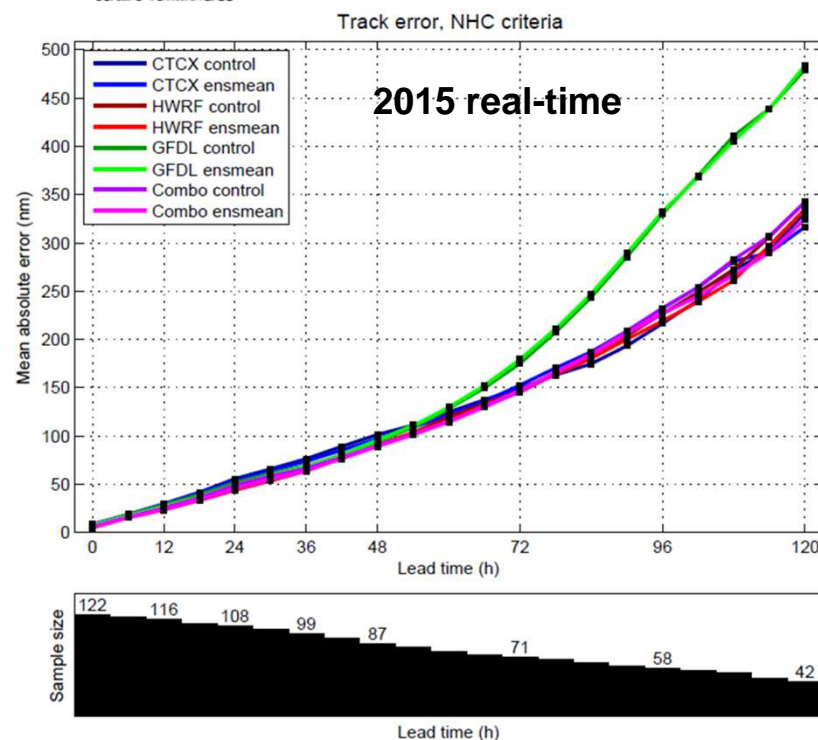
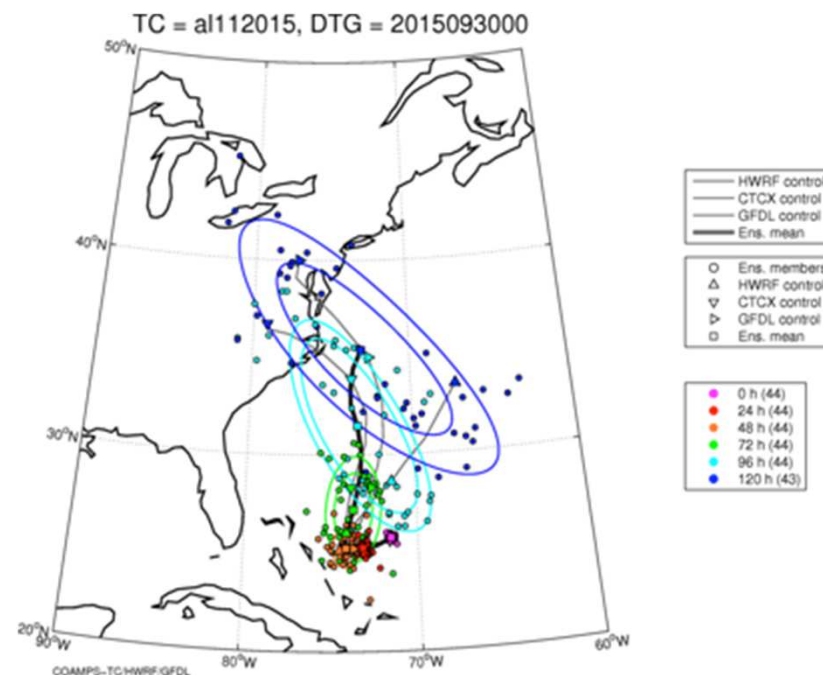
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Track (continued):

- 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/



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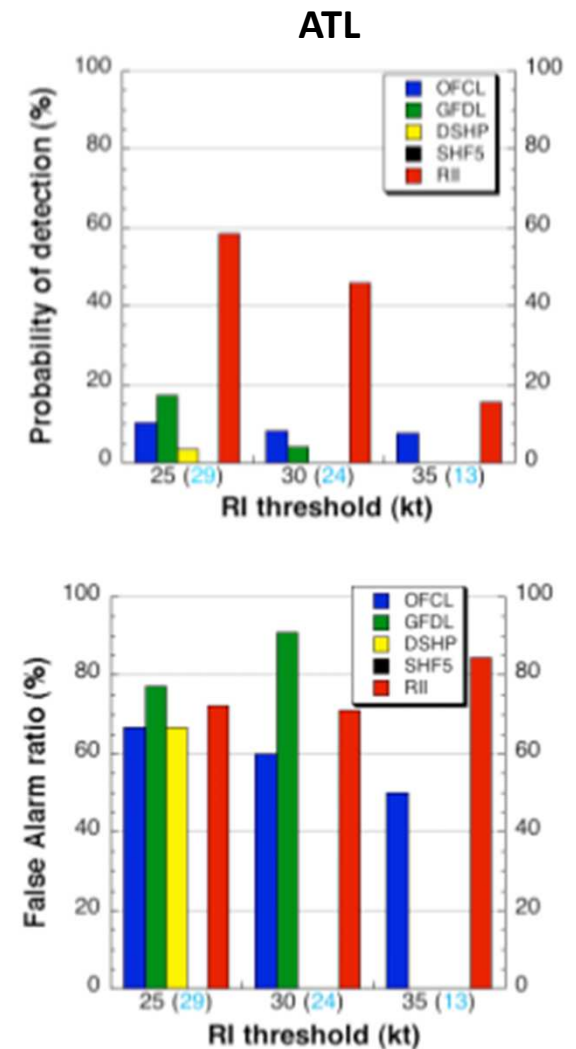
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Intensity:

• 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)





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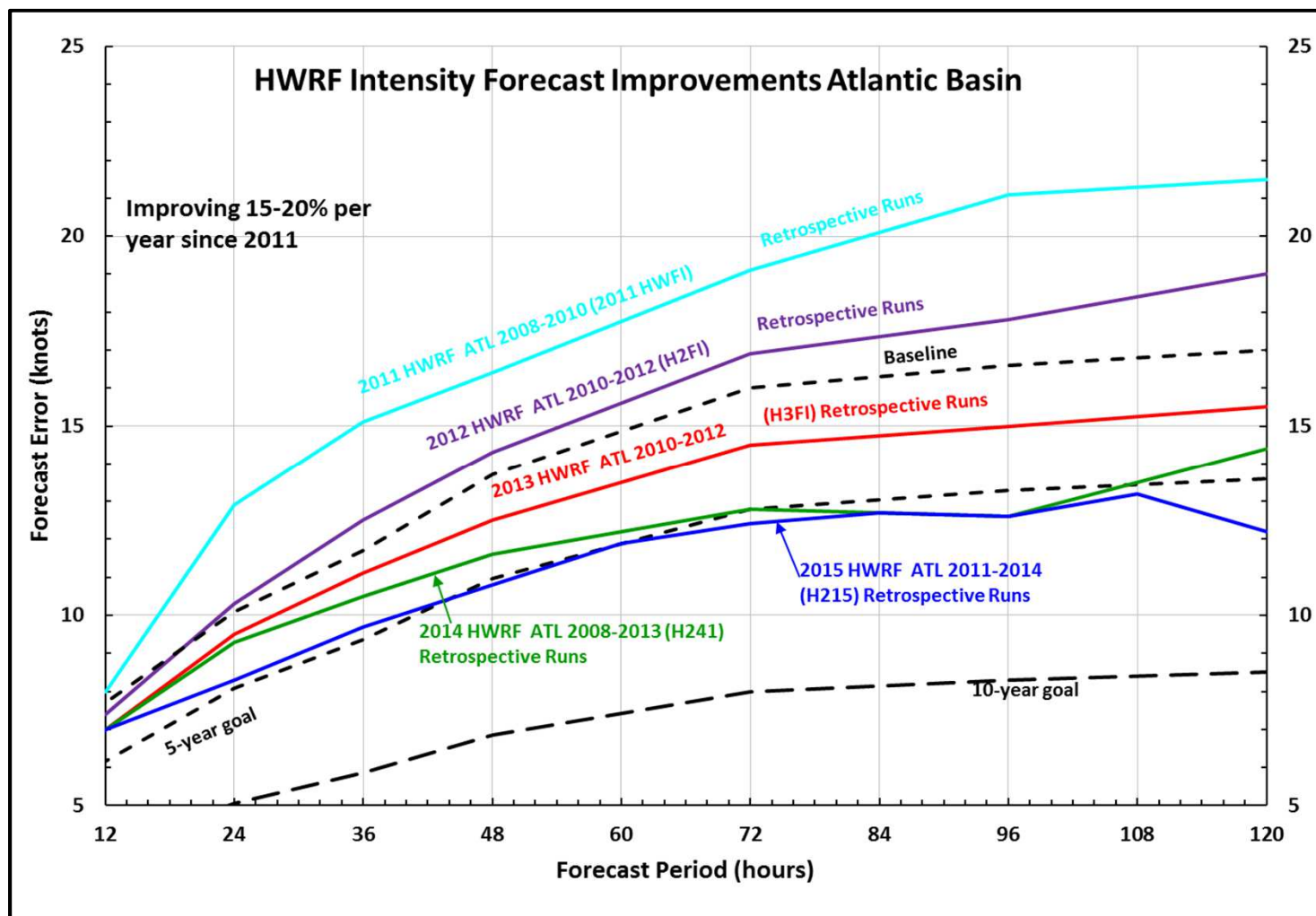
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Intensity (continued):

- 3-D modeling of TC

HWRF:



4 years of continuous improvements in intensity forecasts



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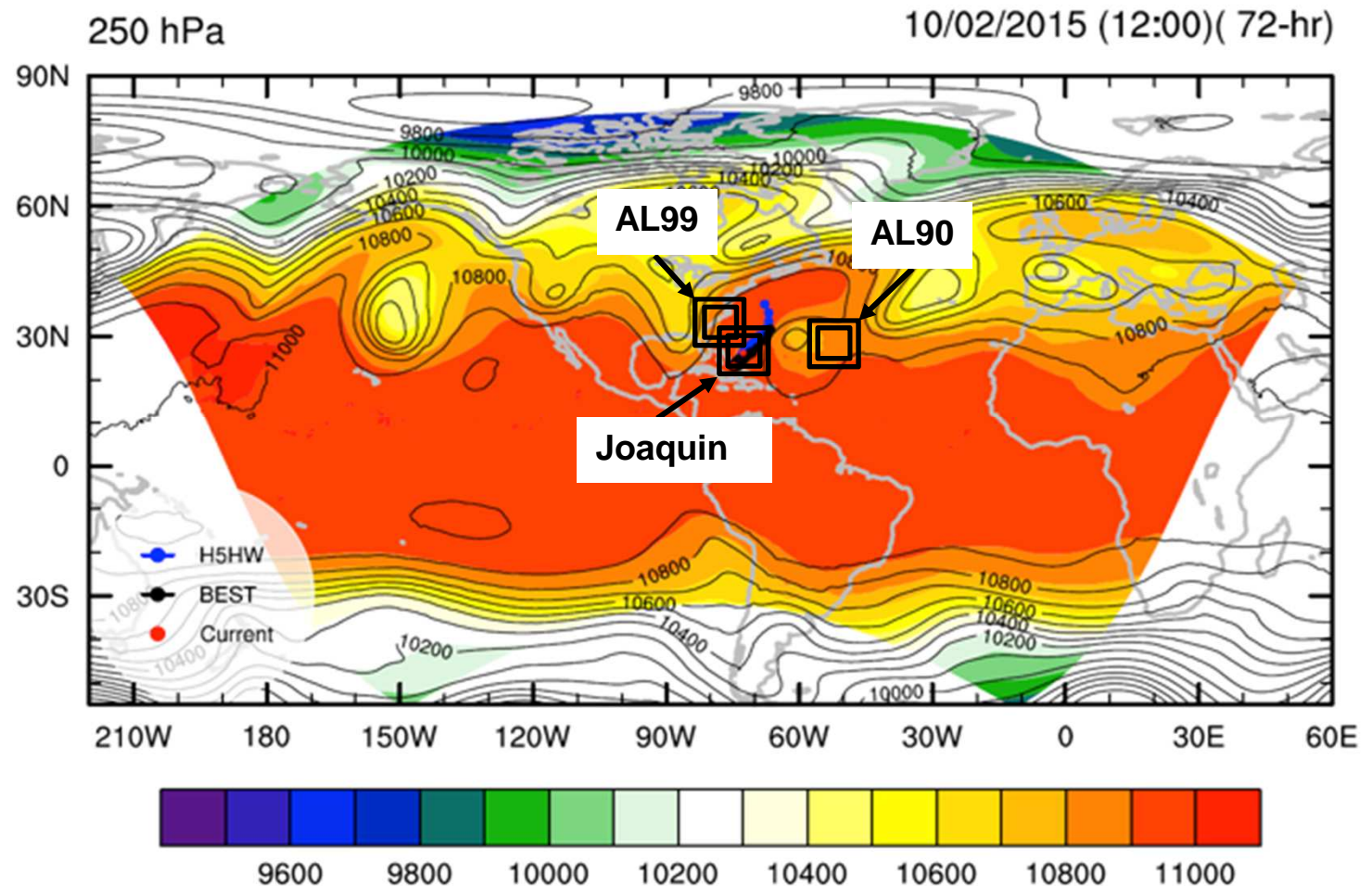
Intensity (continued):

HWRF: Global to local

Experimental Basin-HWRF simulations

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

Geopotential Height [gpm]





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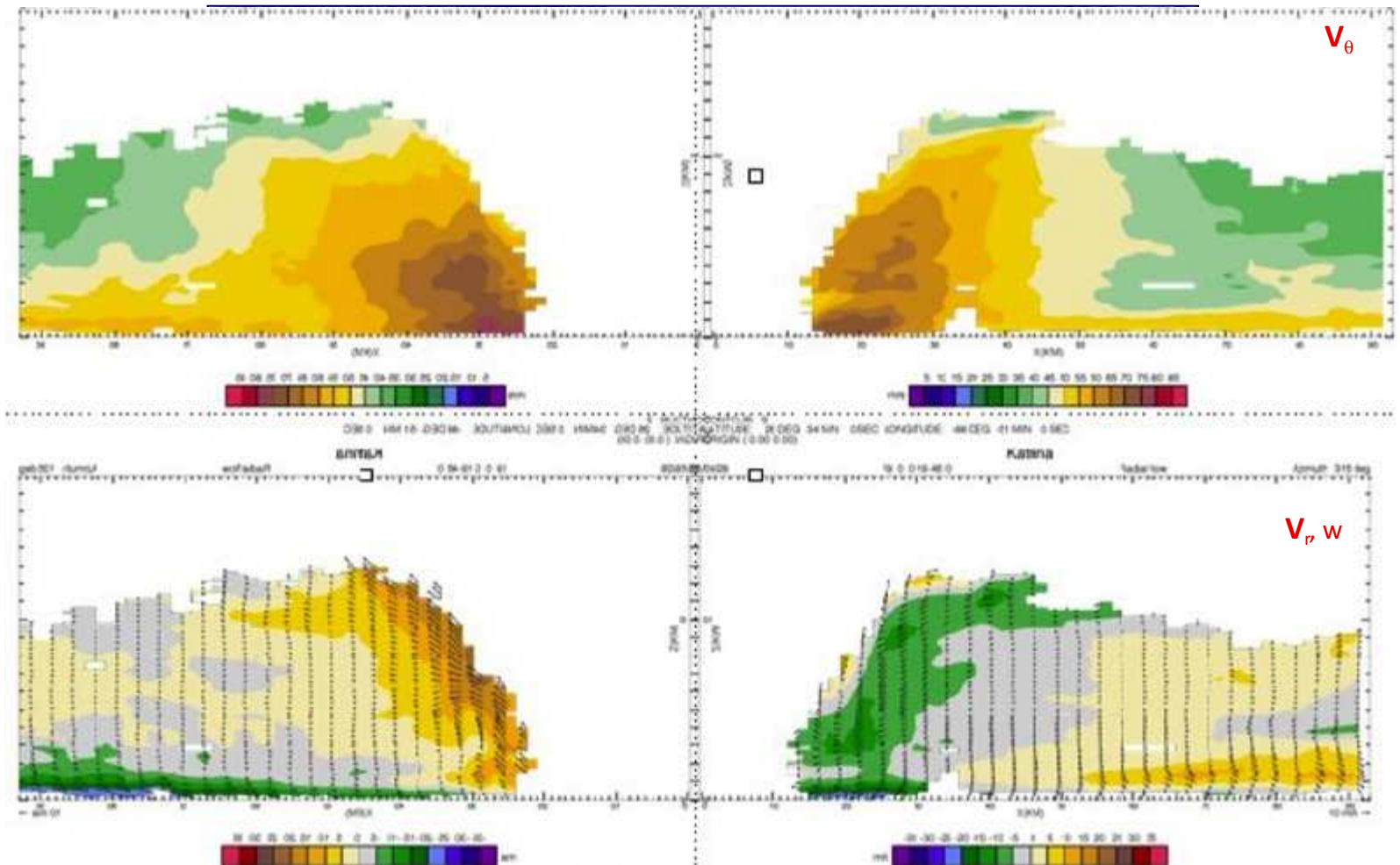
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Intensity (continued):

- Airborne Doppler radar studies



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

http://www.aoml.noaa.gov/hrd/Storm_pages/katrina2005/radar.html



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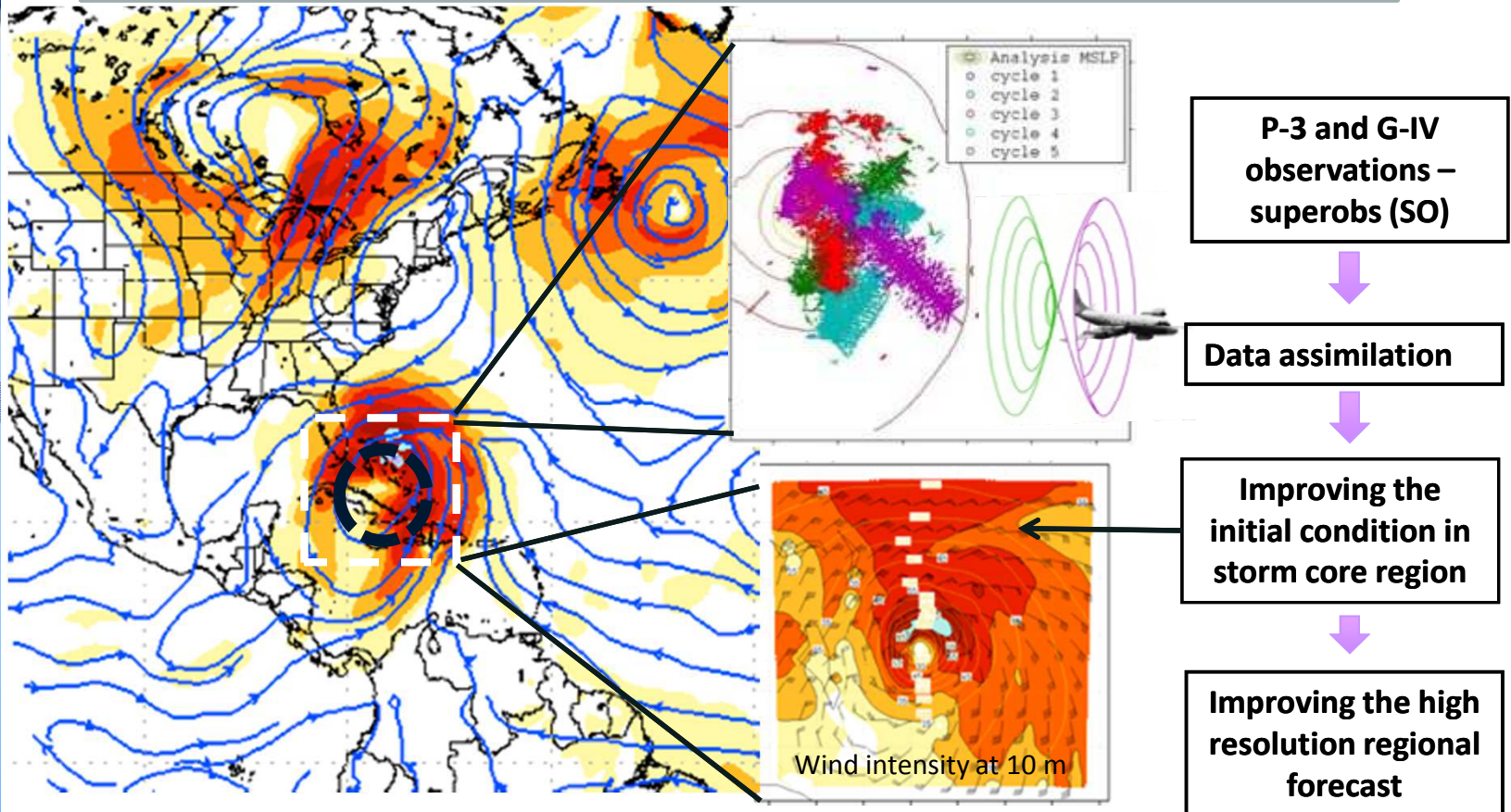
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Intensity (continued):

Assimilation of data into numerical models

Synergy of high resolution forecast and airborne observations



Hurricane Sandy (2012)



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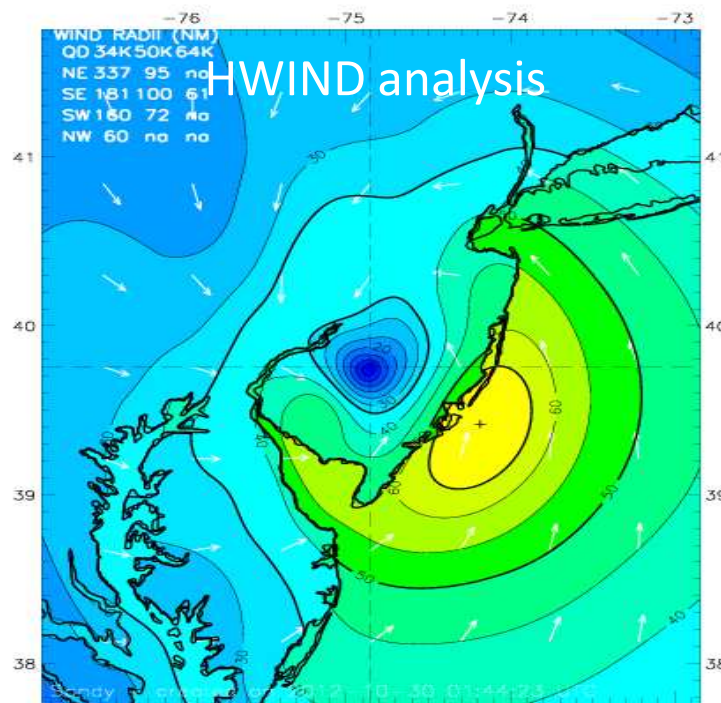
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Structure:

- Evaluation of Model structure

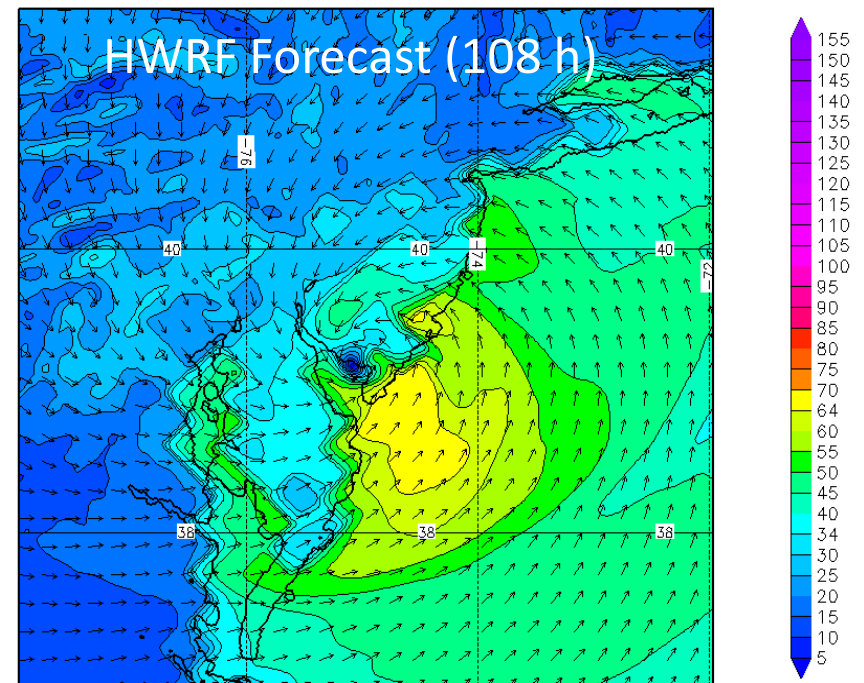
Data Coverage

H*Wind 10m winds



HWRF 10m winds

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





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Impacts: Rainfall

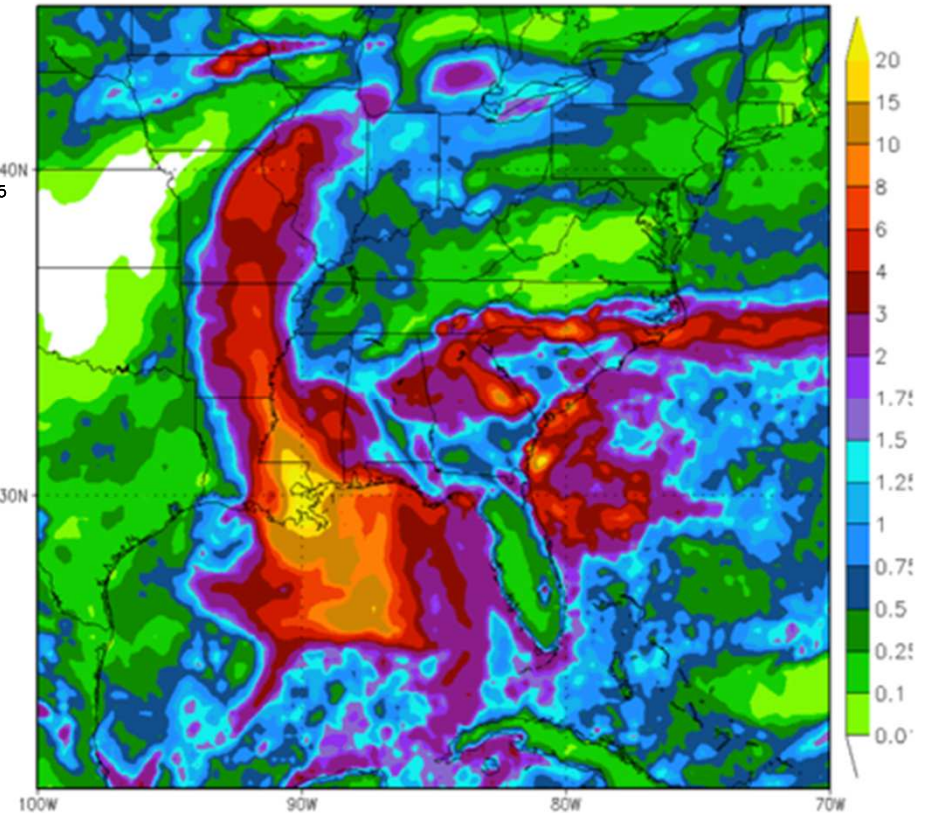
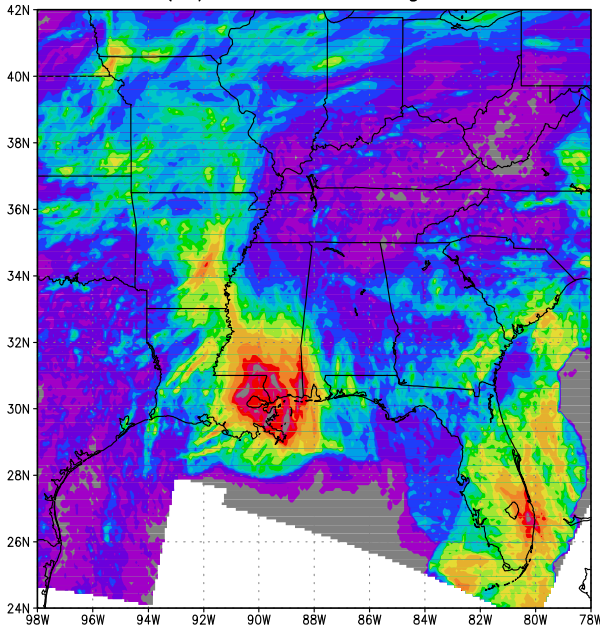
Stage IV rain accumulation (144 h)

HWRF rain accumulation (120 h)

Hurricane ISAAC09L - 2012-08-27 12Z
Total Rain Swath [mm], 0-to-126 hours

Outline: Accumulated Rain (in) 00UTC 25 Aug-23UTC 31 Aug 2012

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Hurricane Isaac (2012)

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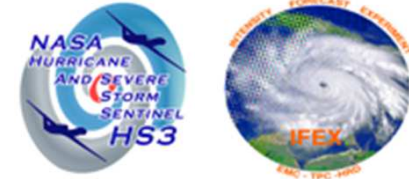
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What in 2015 & 2016?:



• 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>

• 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



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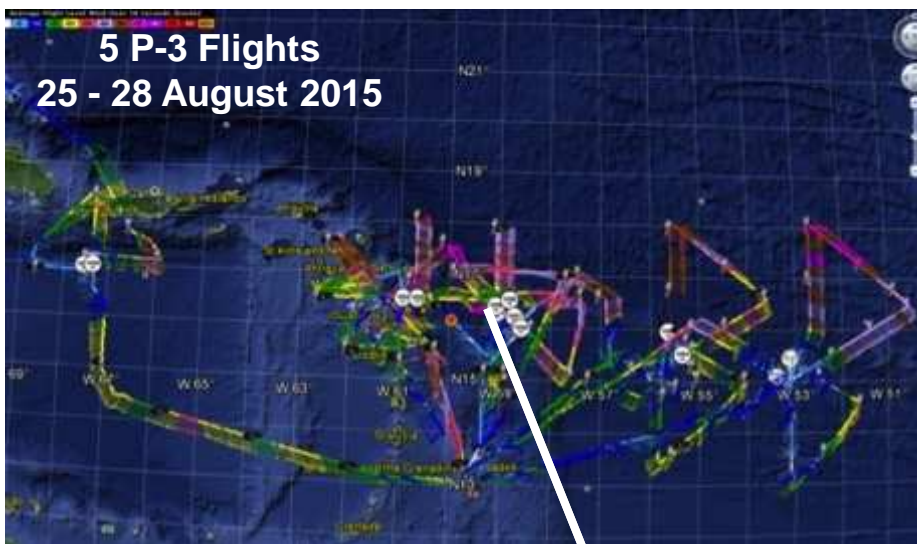
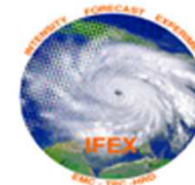
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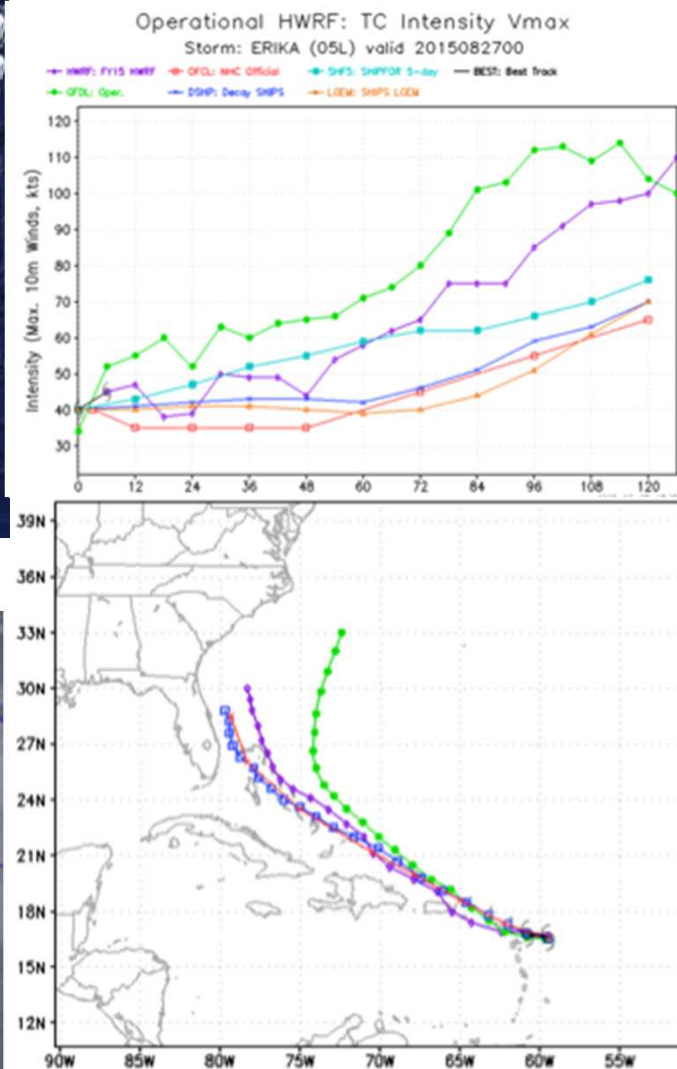
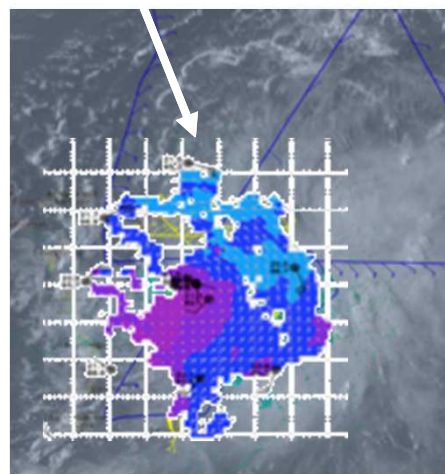
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IFEX 2015:

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

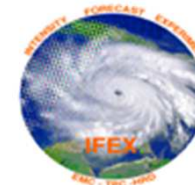


Gamache, Reasor, Gopal (AOML/HRD), Tallapragada, Tong (EMC)



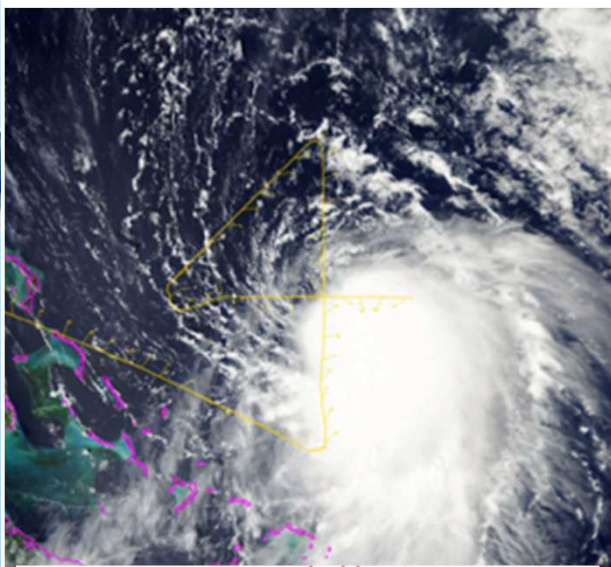
IFEX 2015:

Develop & refine observing technologies:

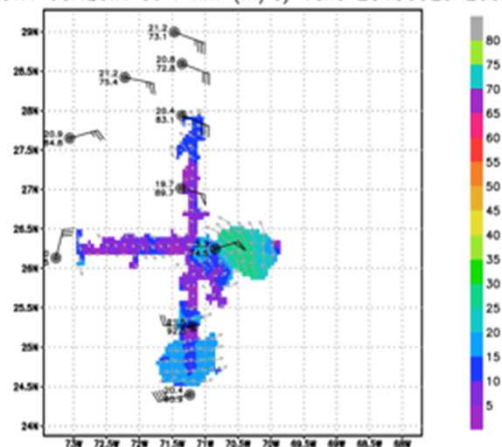


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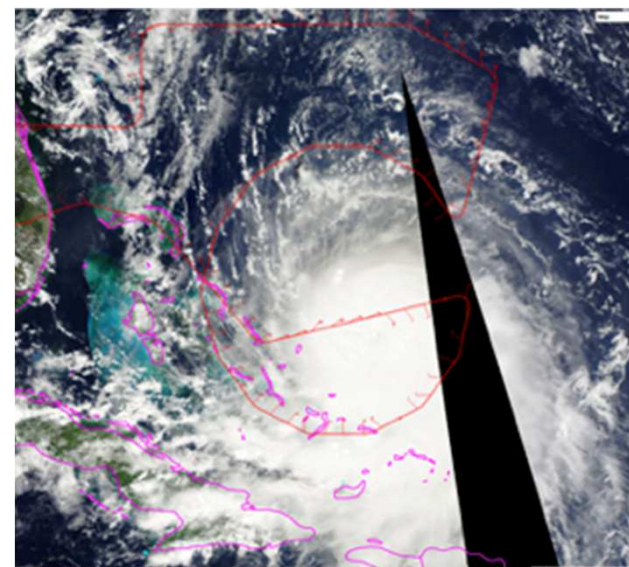
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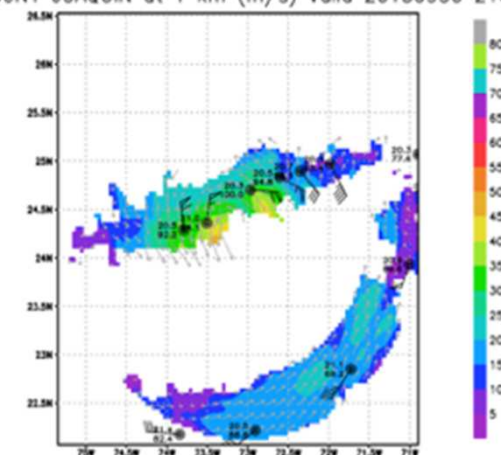
150929N1 JOAQUIN at 1 km (m/s) Valid 20150929 2004Z



- G-IV flight tracks in Hurricane Joaquin 29 & 30 September 2015



150930N1 JOAQUIN at 1 km (m/s) Valid 20150930 2100Z



- 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

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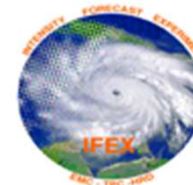
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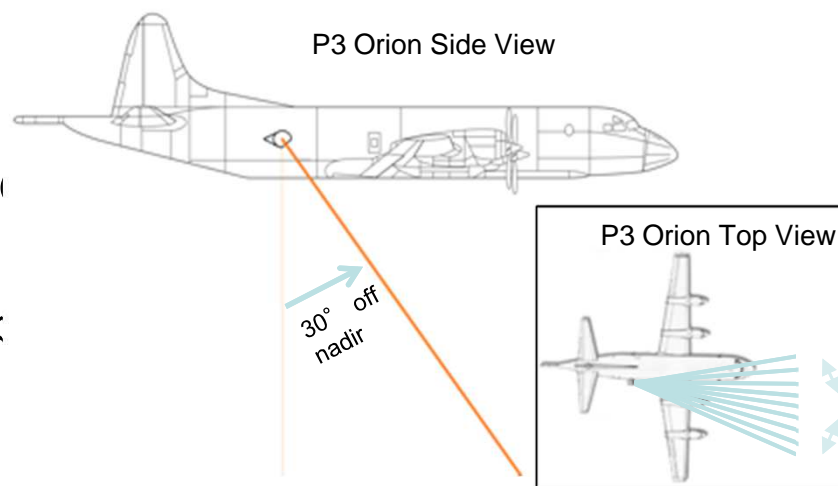
IFEX 2015:

Develop & refine observing technologies:



Doppler Wind Lidar (DWL)

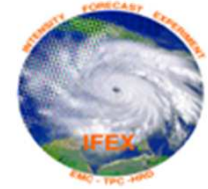
- Compliments P-3 & G-IV Tail Doppler radar
- 9 flights into Tropical Storms Danny and Erika
 - 7 flights collected data
- Elevation angle range of -110° to $+110^{\circ}$
- Azimuth angle range $\pm 30^{\circ}$
- Preset scanning modes: conic sweeps, etc.
- Access DWL computer via laptop





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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





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Communicating in the field

- Our blog

<http://noaahrd.wordpress.com>



follow us on
twitter

- 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

