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NOAA Hurricane Research

Hurricane
Irma

Hurricane
Jose

F. Marks

NOAA HFIP Research Lead

NOAA/AOML Hurricane Research Division

Outline:

- Hurricane Research
 - Mission
 - Vision
 - Who?
 - How?
 - What?
 - Track
 - Intensity
 - Structure
 - Impacts
 - What's Next?

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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

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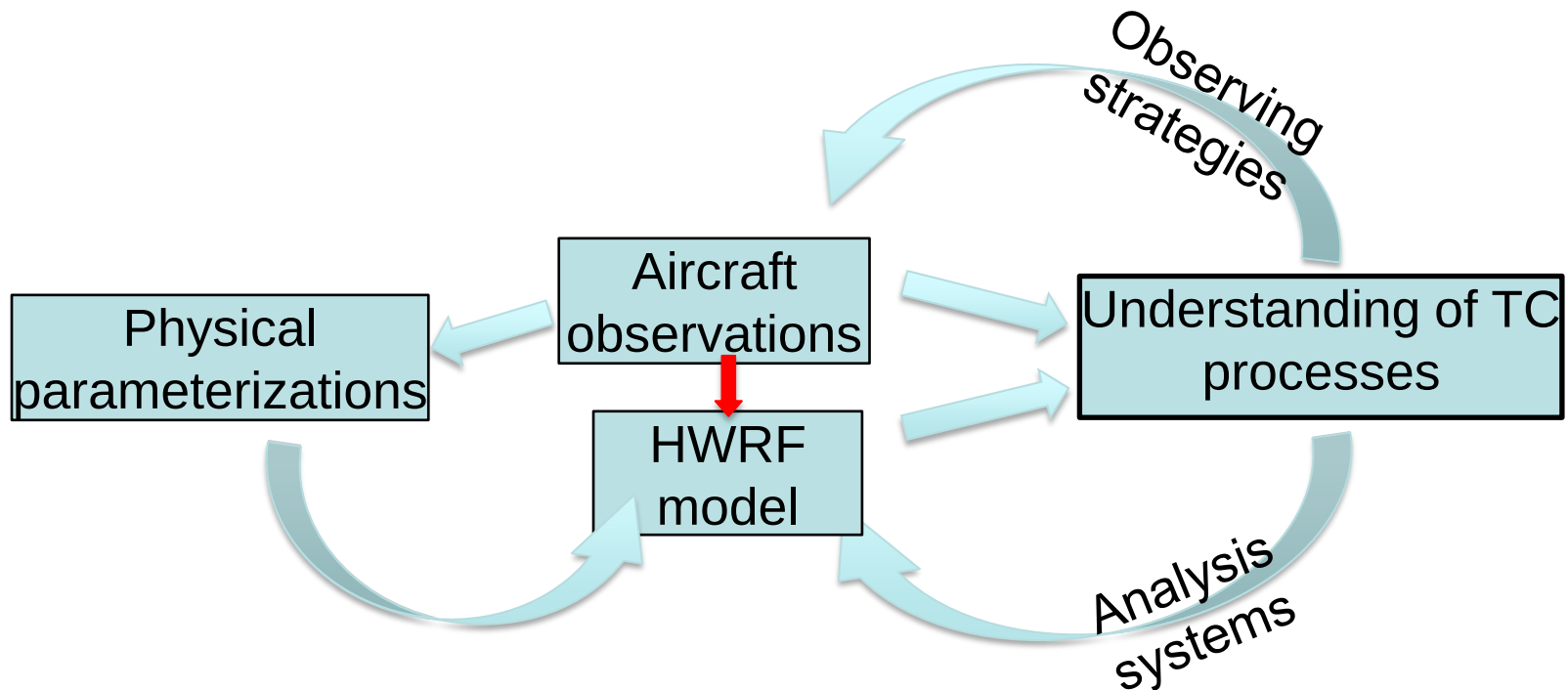
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Vision:



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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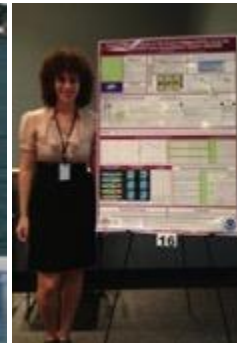
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Who?

Staff includes 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**).



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NOAA HURRICANE FORECAST IMPROVEMENT PROJECT

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

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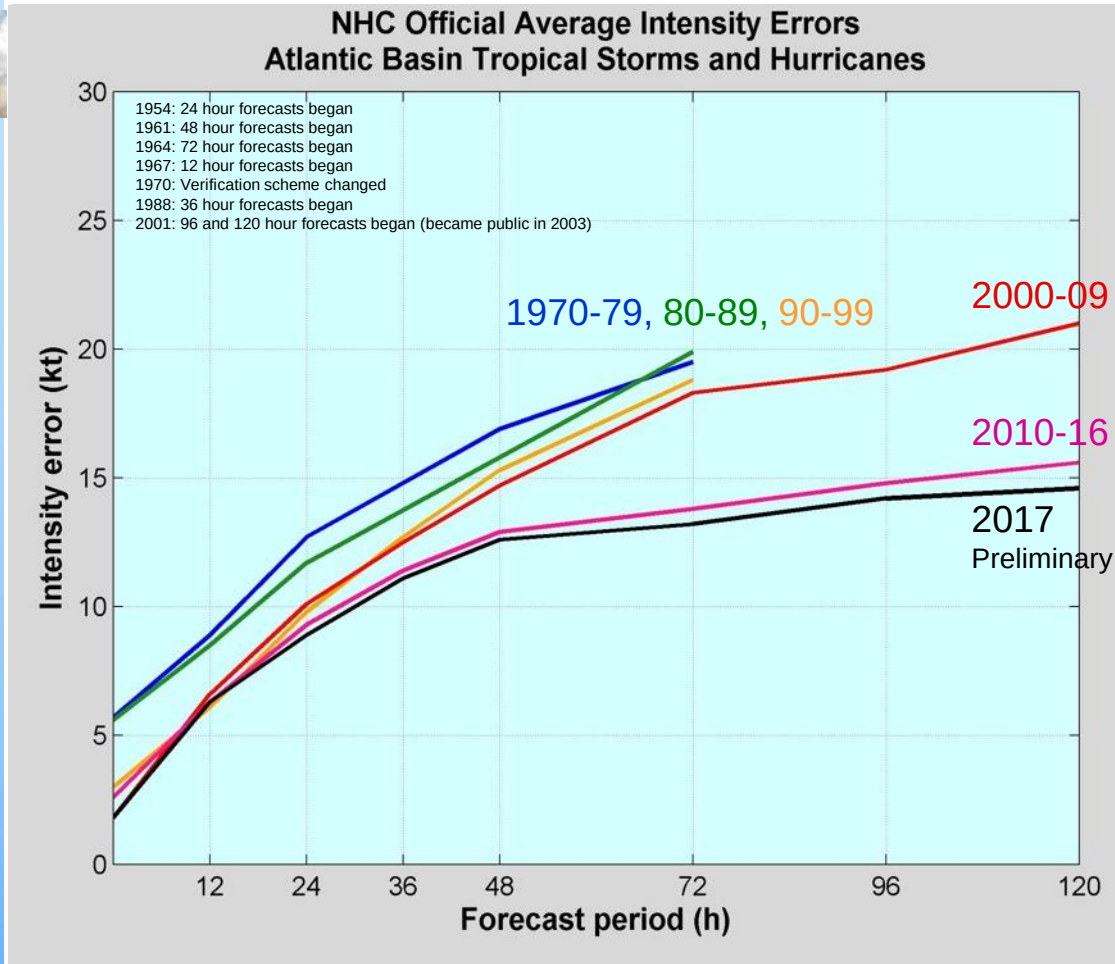
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Operational Forecast Performance



- 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



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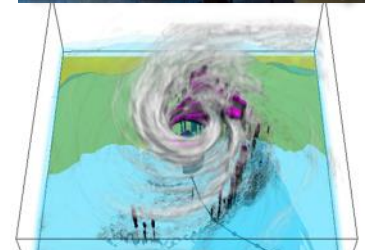


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How to get there?

- Science
 - Improved understanding from combination of observations & models
 - High resolution coupled models – especially 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





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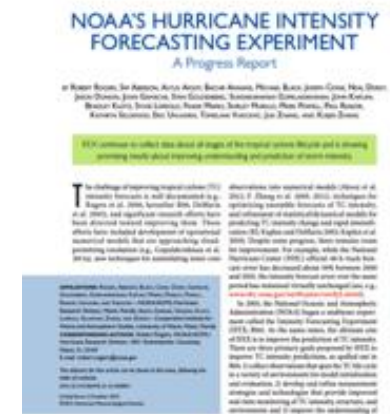
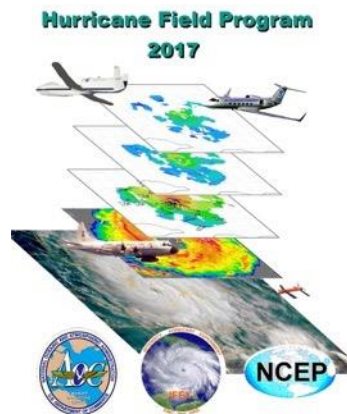
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HOW?:

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



<http://www.aoml.noaa.gov/hrd/HFP2017/index.html>

Gall et al., BAMS, 2013

Rogers et al., BAMS, 2013



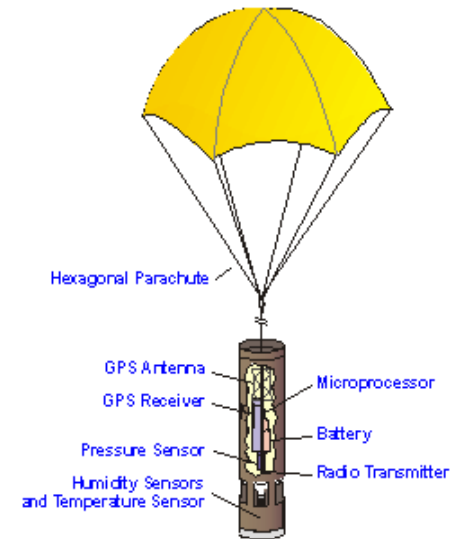
WHAT?:

Current TC research: Track:

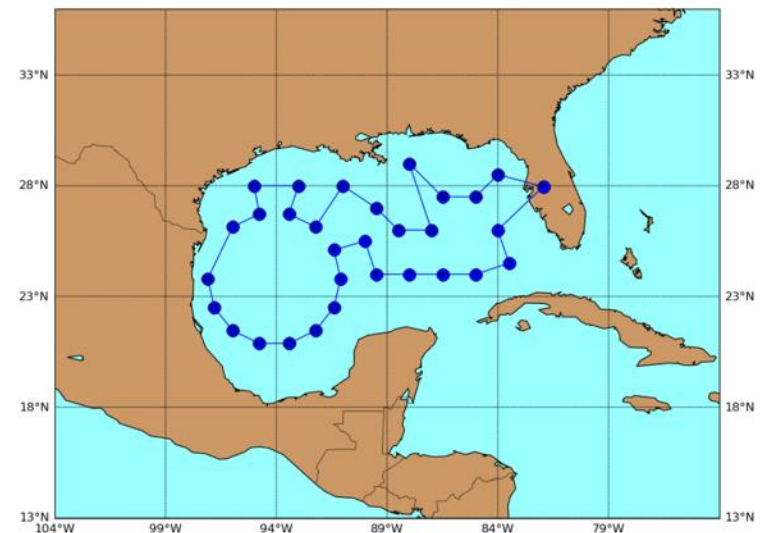
- Synoptic-surveillance using dropsondes.



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



NOAA G-IV Flight Track Drop Locations for HARVEY (AL092017)
On 2017082412 the storm was centered at 23.8N ; -94.1





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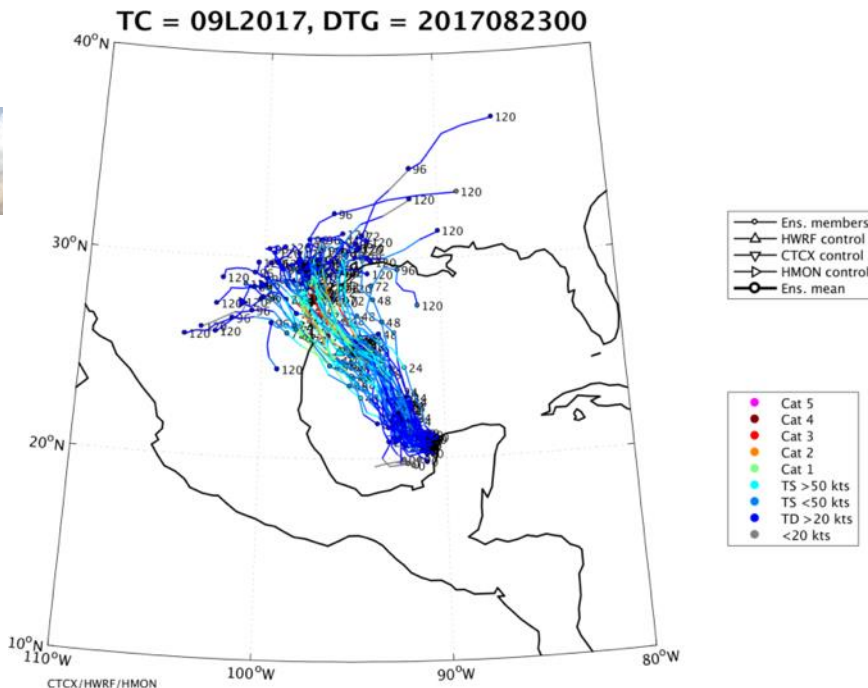


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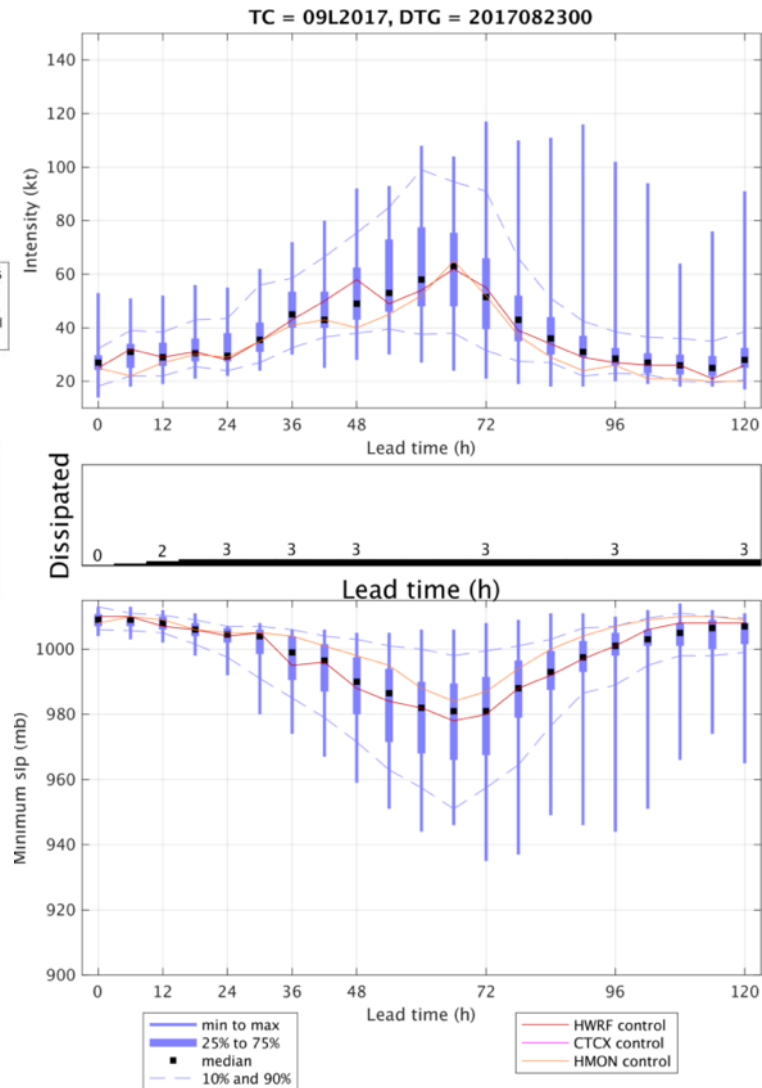
Track (continued):

- 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

Harvey (10L) 2017 real-time





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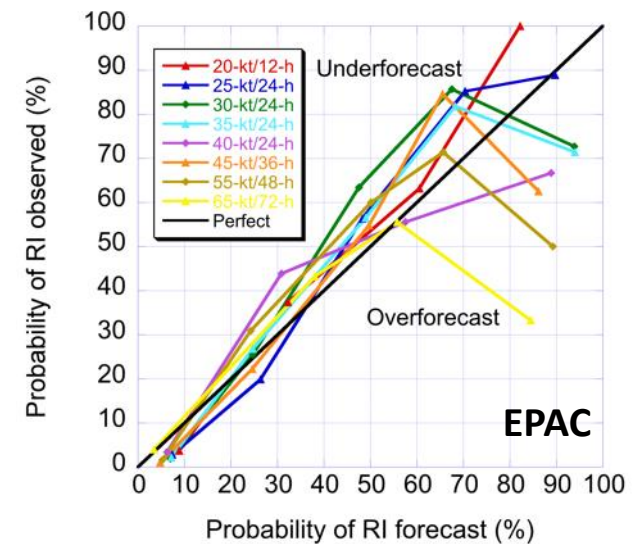
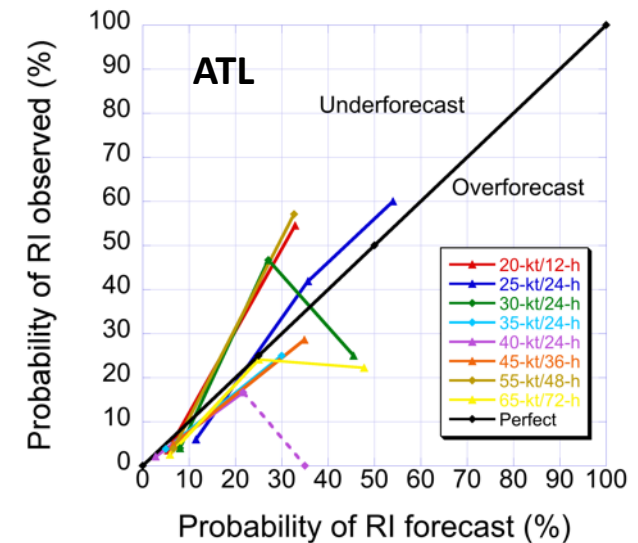
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Intensity:

• 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





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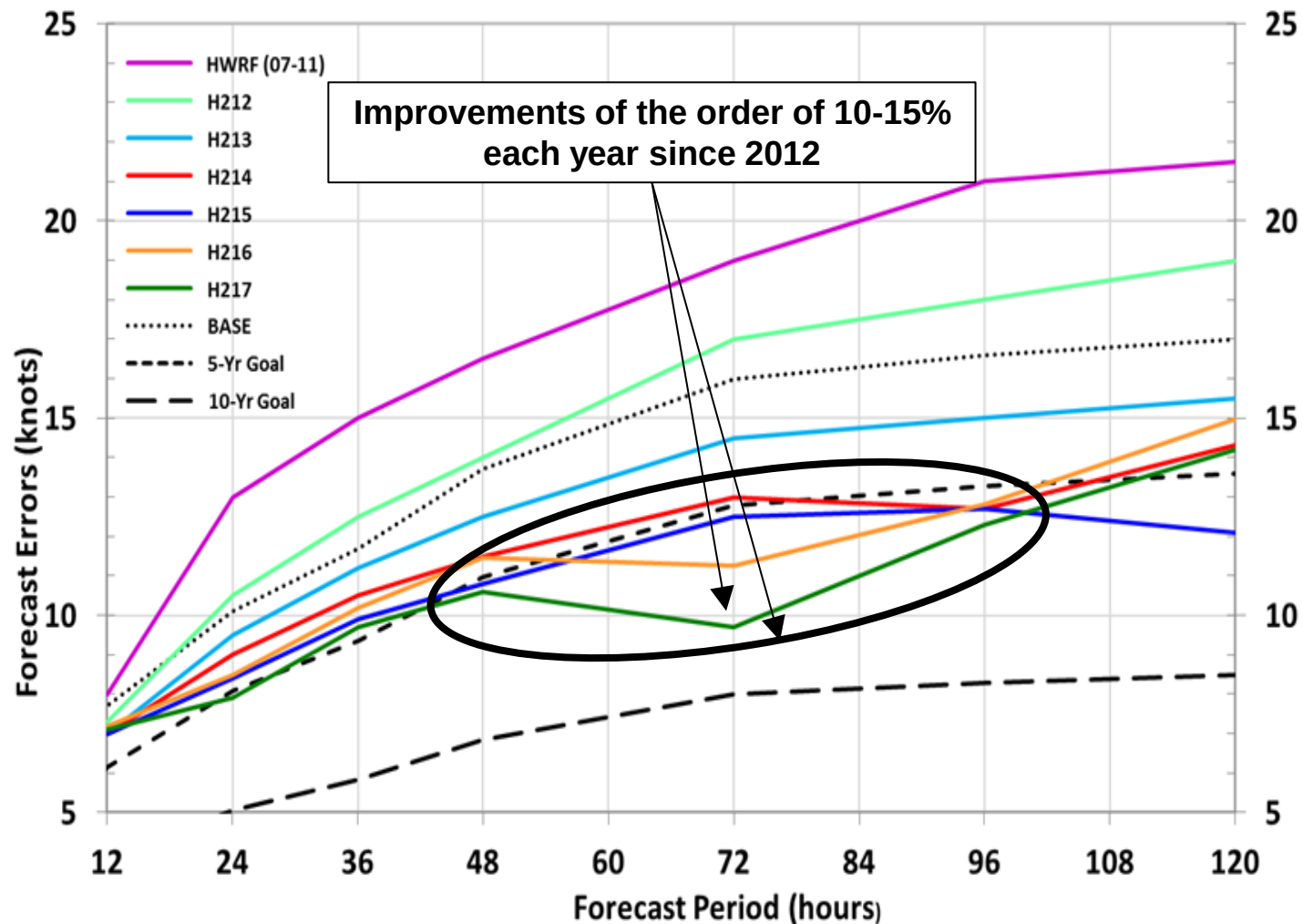
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Intensity (continued):

- 3-D modeling of TC

HWRF:



7 years of continuous improvements in intensity forecasts



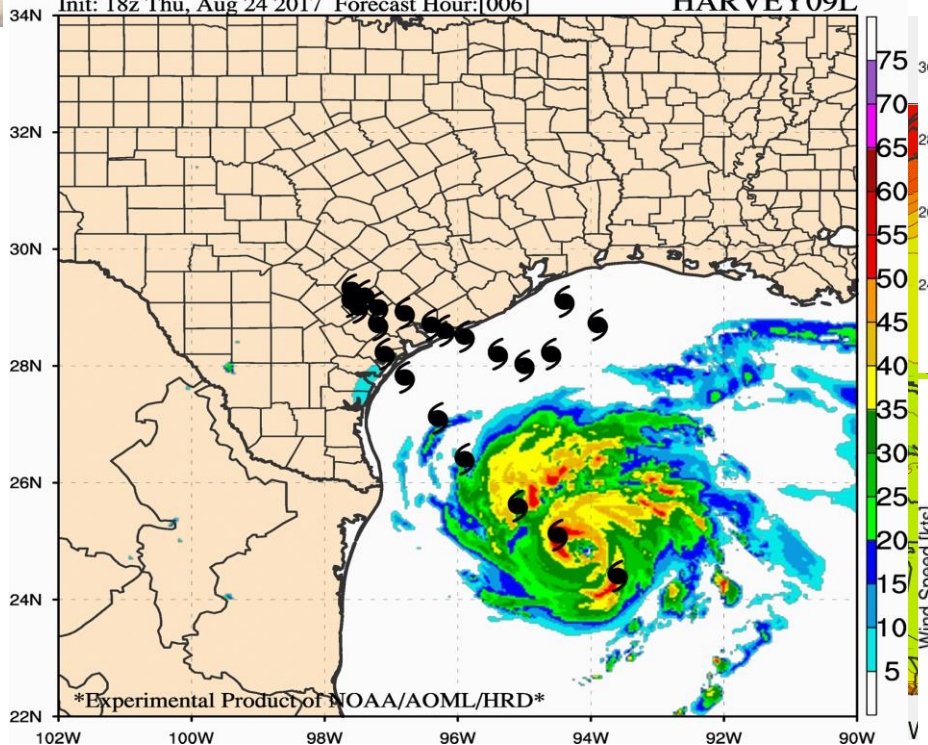
Intensity (continued):

HWRF: Global to local

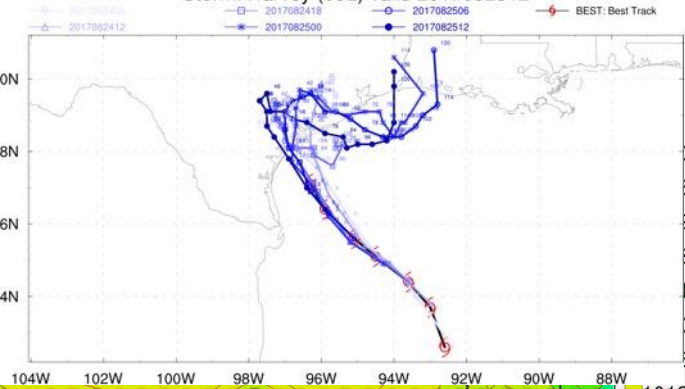
Experimental Basin-HWRF simulations

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

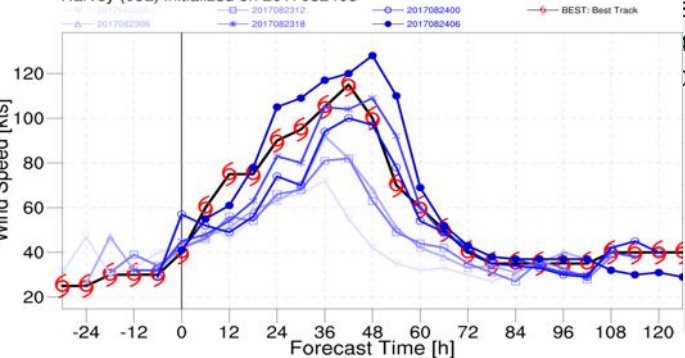
**2017 Basin-Scale HWRF
Modeled Radar Reflectivity [dBz]**
Init: 18z Thu, Aug 24 2017 Forecast Hour:[006] HARVEY09L



2017 Basin-Scale HWRF Track Trend
Storm: Harvey (09L) valid 2017082512



HB17 Late Intensity Trend
Harvey (09L) initialized on 2017082406



Harvey (11L)

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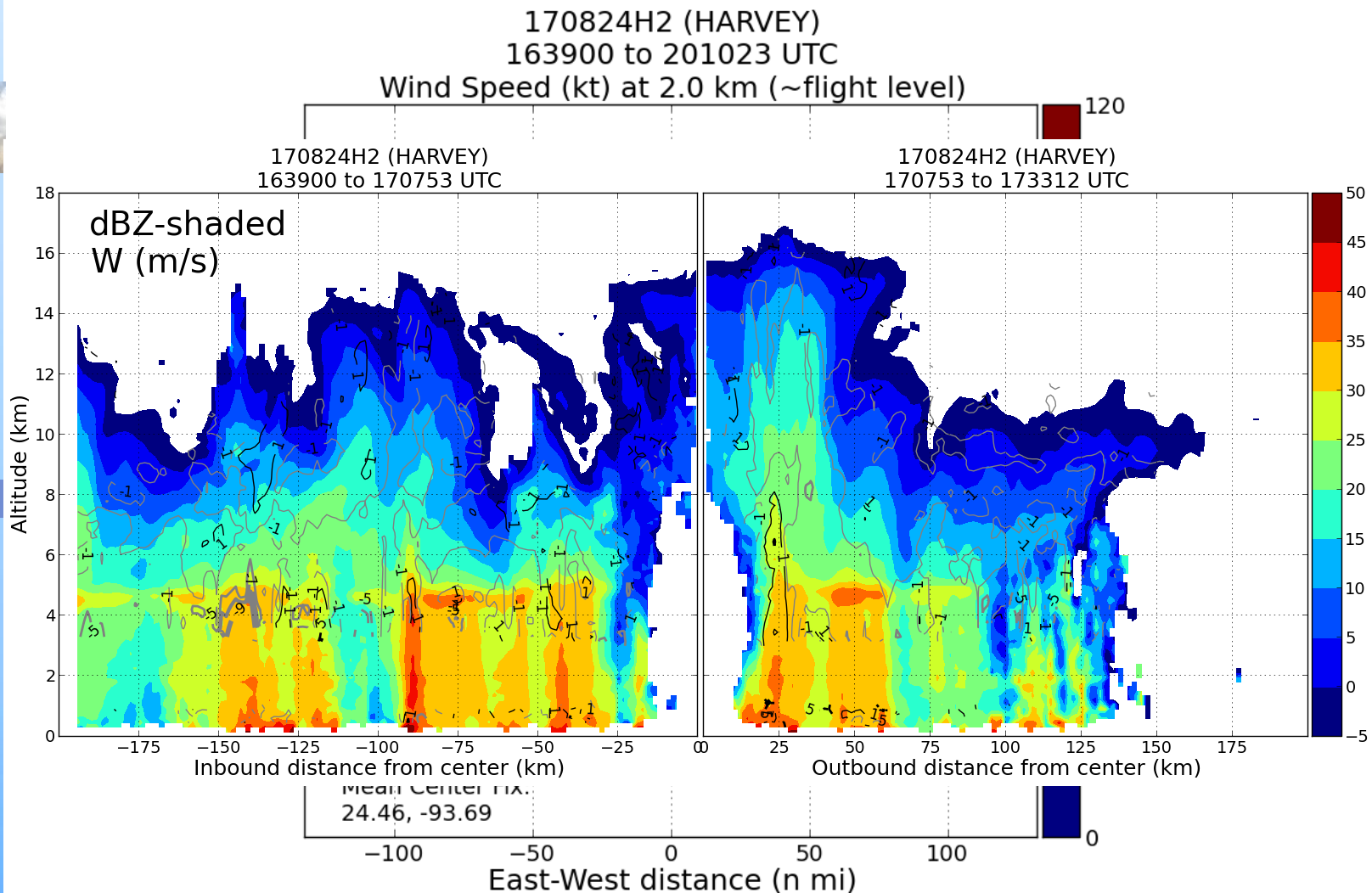
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Intensity (continued):

- Real-time Situation Awareness from TDR



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

http://www.aoml.noaa.gov/hrd/Storm_pages/harvey2017/radar.html



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Intensity (continued):

Better HWRF Initialization – aircraft data & TDR

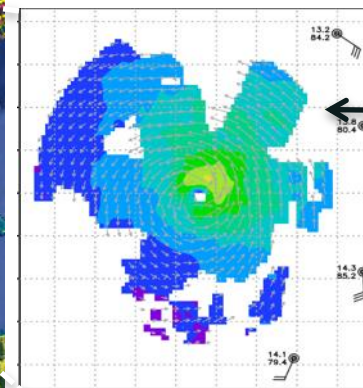
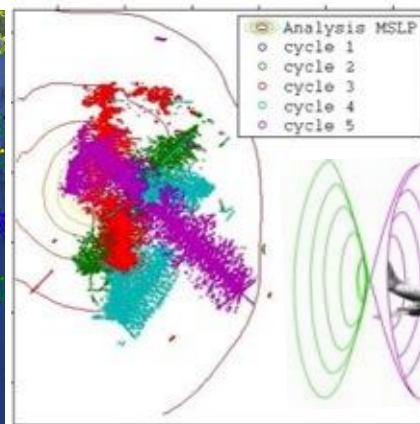
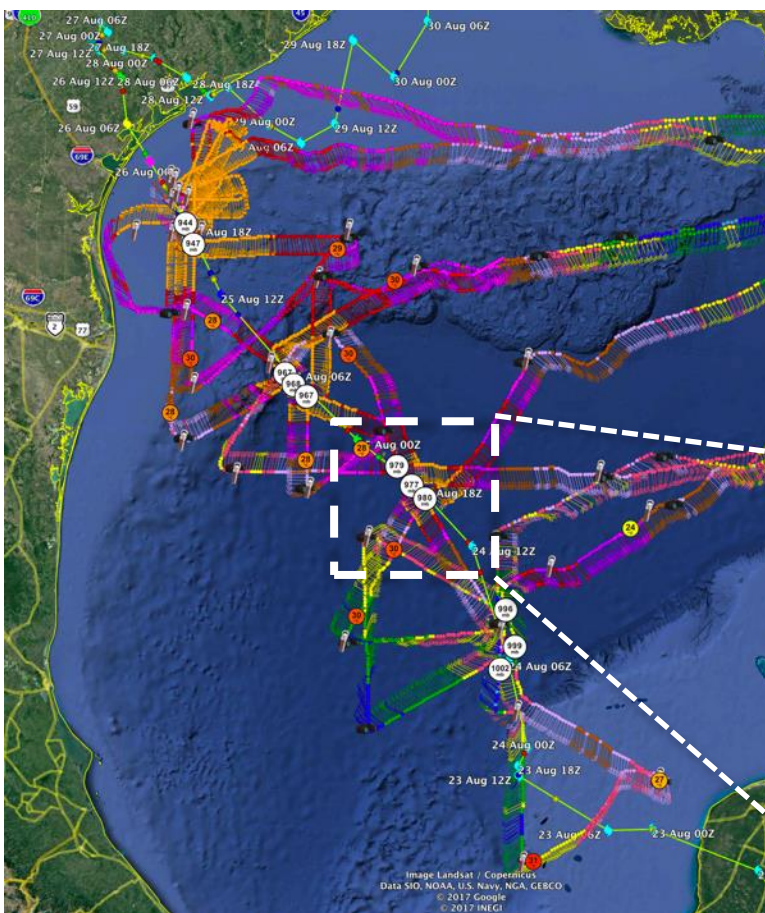
Synergy of high resolution forecast and airborne observations

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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 Harvey (2017)



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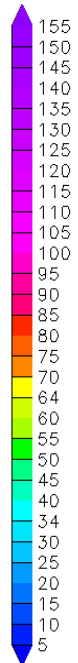
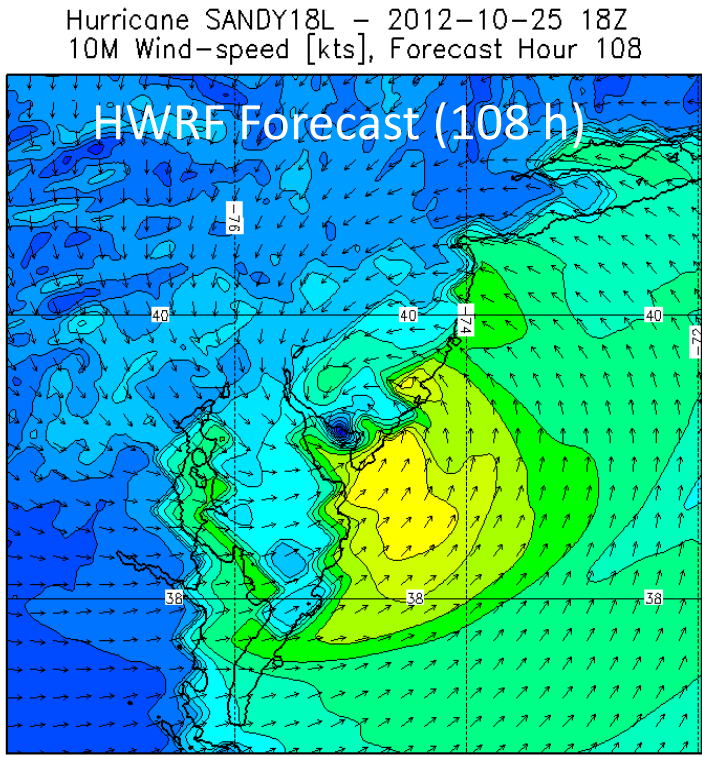
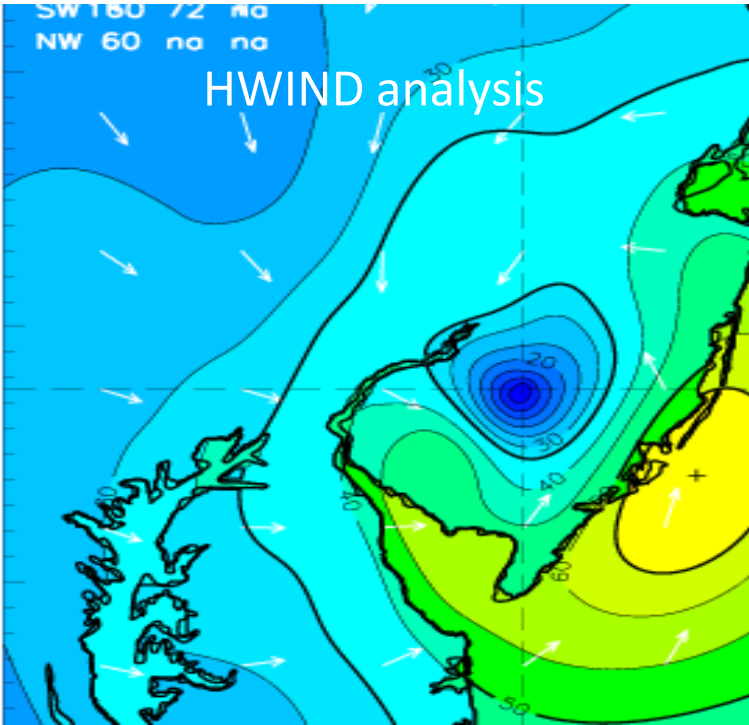
Structure:

- Evaluation of Model structure

Data Coverage

H*Wind 10m winds

HWRF 10m winds





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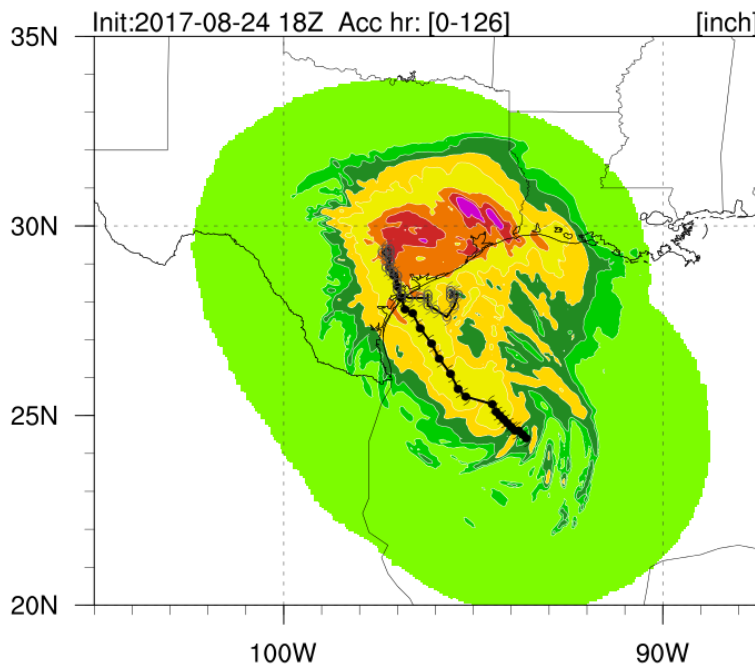


Impacts: Rainfall

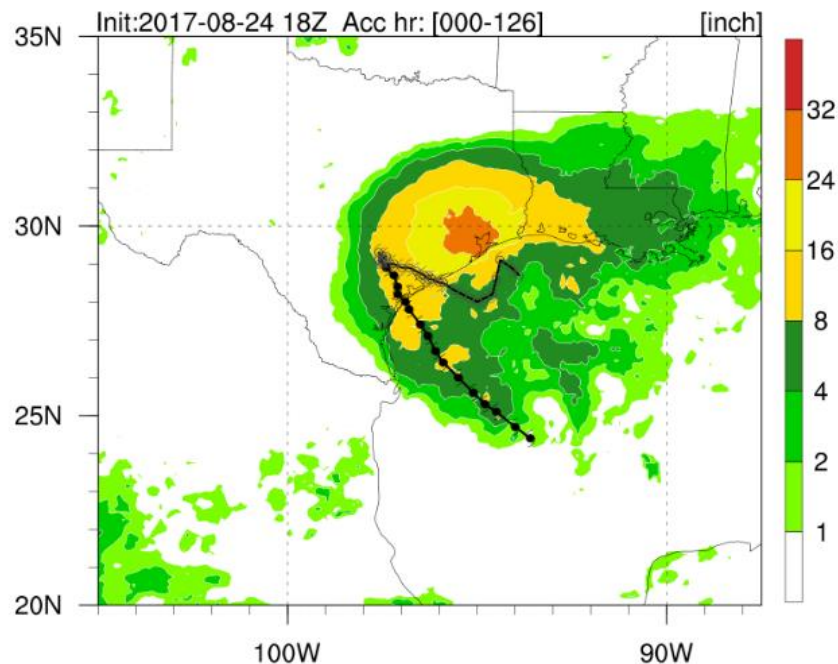
Model

IMERG Final

Hurricane Harvey- Rain Swath (HB17)



Hurricane Harvey- Rain Swath (IMERG F)



Hurricane Harvey (2017)

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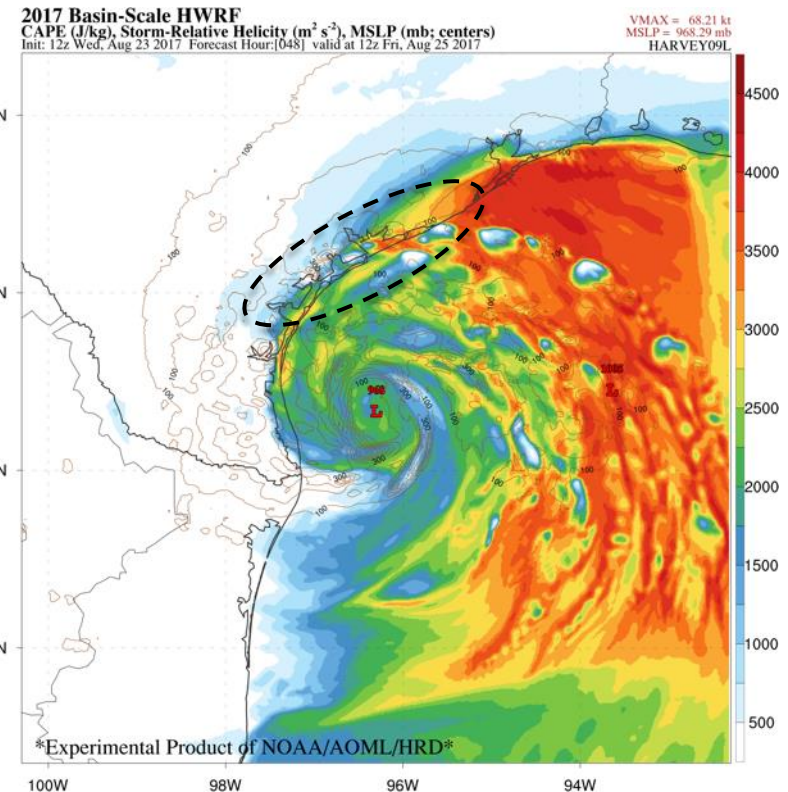
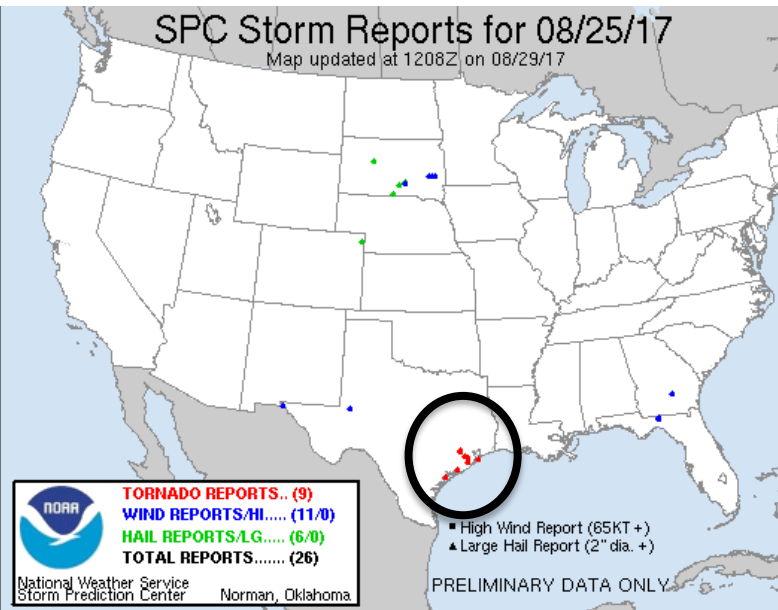
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Impacts: Tornadoes

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 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)

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Questions?

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- Our blog

<http://noaahrd.wordpress.com>



follow us on
twitter

- HRD Web page

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

- Facebook (5,420 likes)

<http://www.facebook.com/noaahrd>

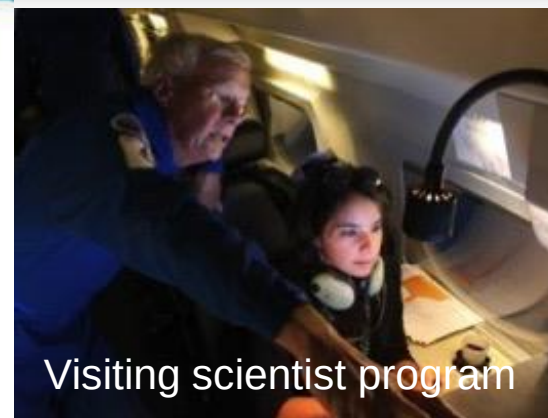
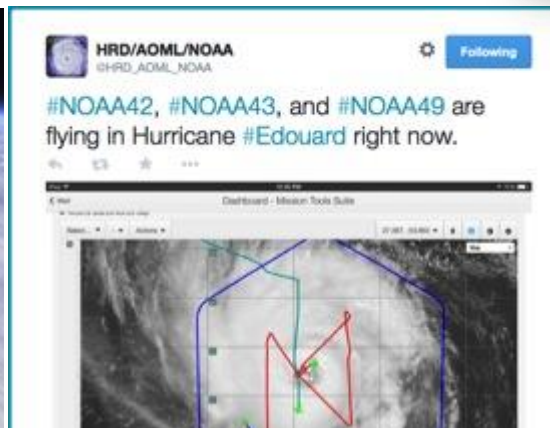
- Twitter (30,200 followers)

http://twitter.com/#!/HRD_AOML_NOAA



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Visiting scientist program

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