

# Research to Improve NOAA's Hurricane Forecast Guidance

Hurricane  
Matthew

Hurricane  
Nicole

**#NOAAHurricaneAware**



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**4 May 2017**

# Hurricane Matthew: Impacts

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North Carolina: 26 deaths

Florida: 12 deaths

South Carolina: 4 deaths



Haiti: 598 – 1,384+ deaths

# Tropical Cyclone Intensity

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- HWRF skill has improved over the past few seasons, but rapid change cases are still a problem
- Statistical models have difficulty forecasting rapid change
- Dynamical models can forecast rapid change, but not reliably (e.g., Matthew, Joaquin, Patricia)
- Consensus approach still shows best hope for modest improvements in forecast accuracy, but dramatic improvements still likely years away
- Large improvements requires increases in inner-core observations, higher resolution computer models, and better ways to get the new observations into the new models

**So how do we get there?**



# Keys to Success

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- **Science**

- Improve operational high-resolution coupled models (HWRF) – **particularly intensity changes**
- Improve understanding from combination of observations & high-resolution models

- **Information Technology**

- Develop research computing capacity to **accelerate** transition of research to operations

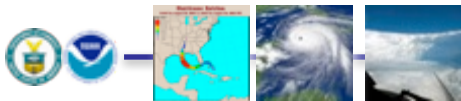
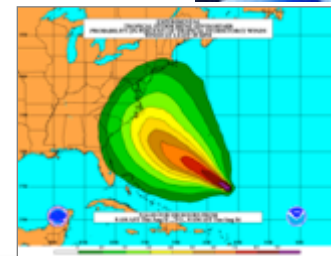
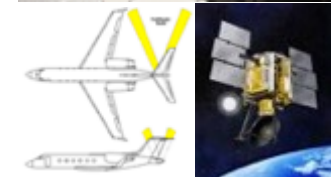
- **Observing Strategy**

- Improve use of existing and planned systems

- **Improve Forecaster Products**



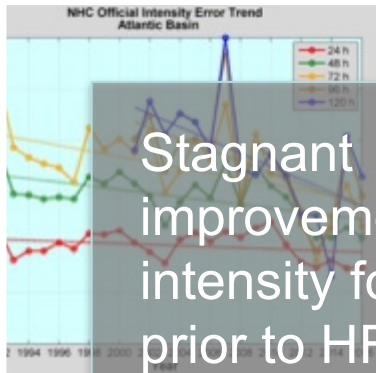
2014 HFIP Annual Workshop



# Current State of the Art

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## Operational Forecast Performance



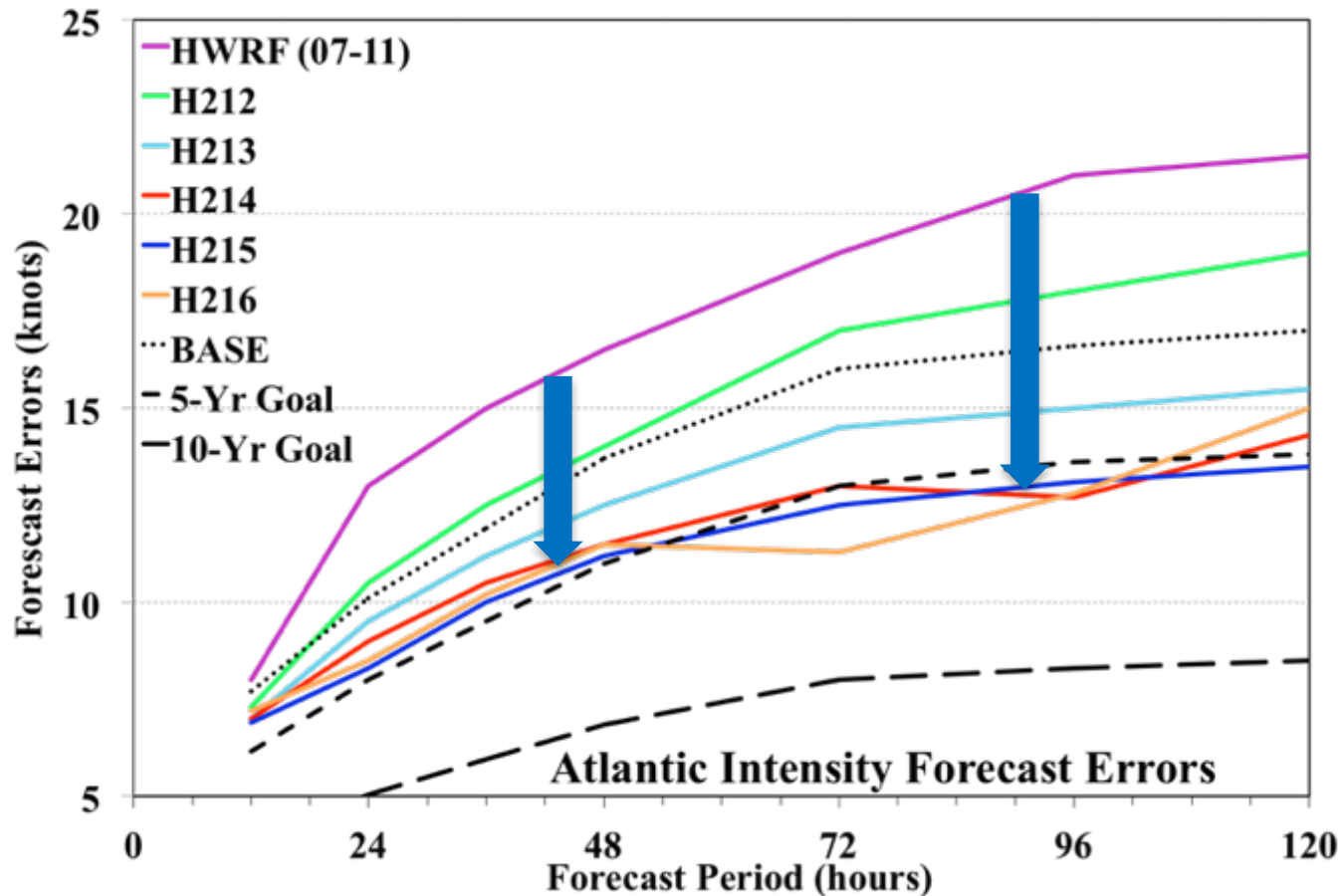
Stagnant improvement in intensity forecast prior to HFIP

- Since HFIP began in 2009, forecast error has decreased by 20-25% for 1-5 day forecasts.
- NOAA upgraded HWRF model resolution; now 2 km
- Dramatic improvements in HWRF since HFIP\*



# HWRF Improvements

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Under HFIP, the HWRF model has demonstrated a remarkable 15-20% improvement in hurricane intensity forecast accuracy each year since 2011



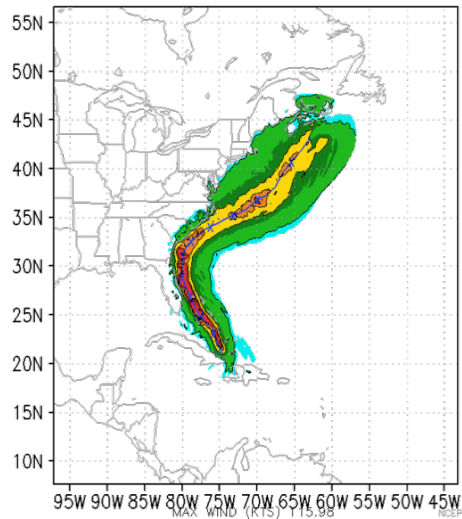
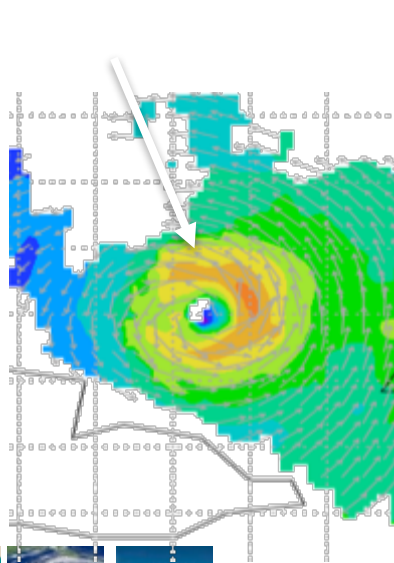
# HWRF Improvements: Assimilation of Aircraft Recon

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- NOAA P-3 transmitted Tail Doppler radar data in real-time for assimilation into HWRF

INIT 2016100512 Z for 126 h FCST VALID 2016101018 Z  
HWRF 10M MAX WIND(KTS) MATTHEW14L  
START POS (21.50 LAT, -74.90 LON) FINAL POS (43.20 LAT, -62.90 LON) X=12 h POS



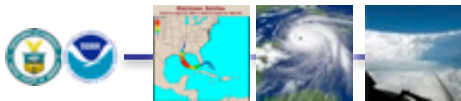
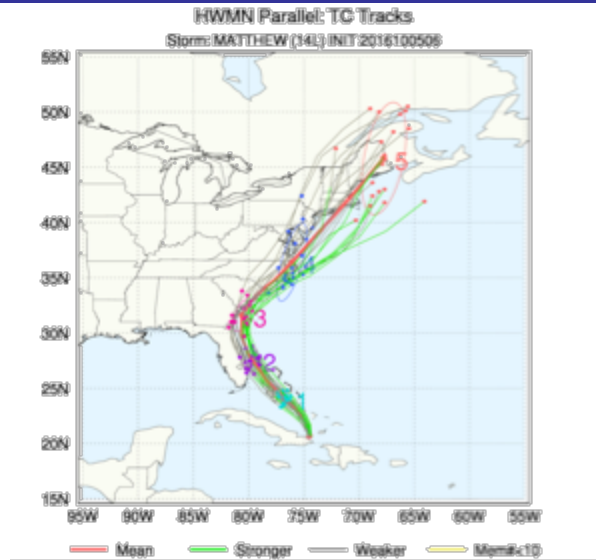
- Resulting forecast allowed NHC to target warnings where needed, without over-warning broader East Coast.

NOAA Hurricane Forecast Improvement Project

Meeting the Nation's Needs

# HWRF Improvements: Ensembles

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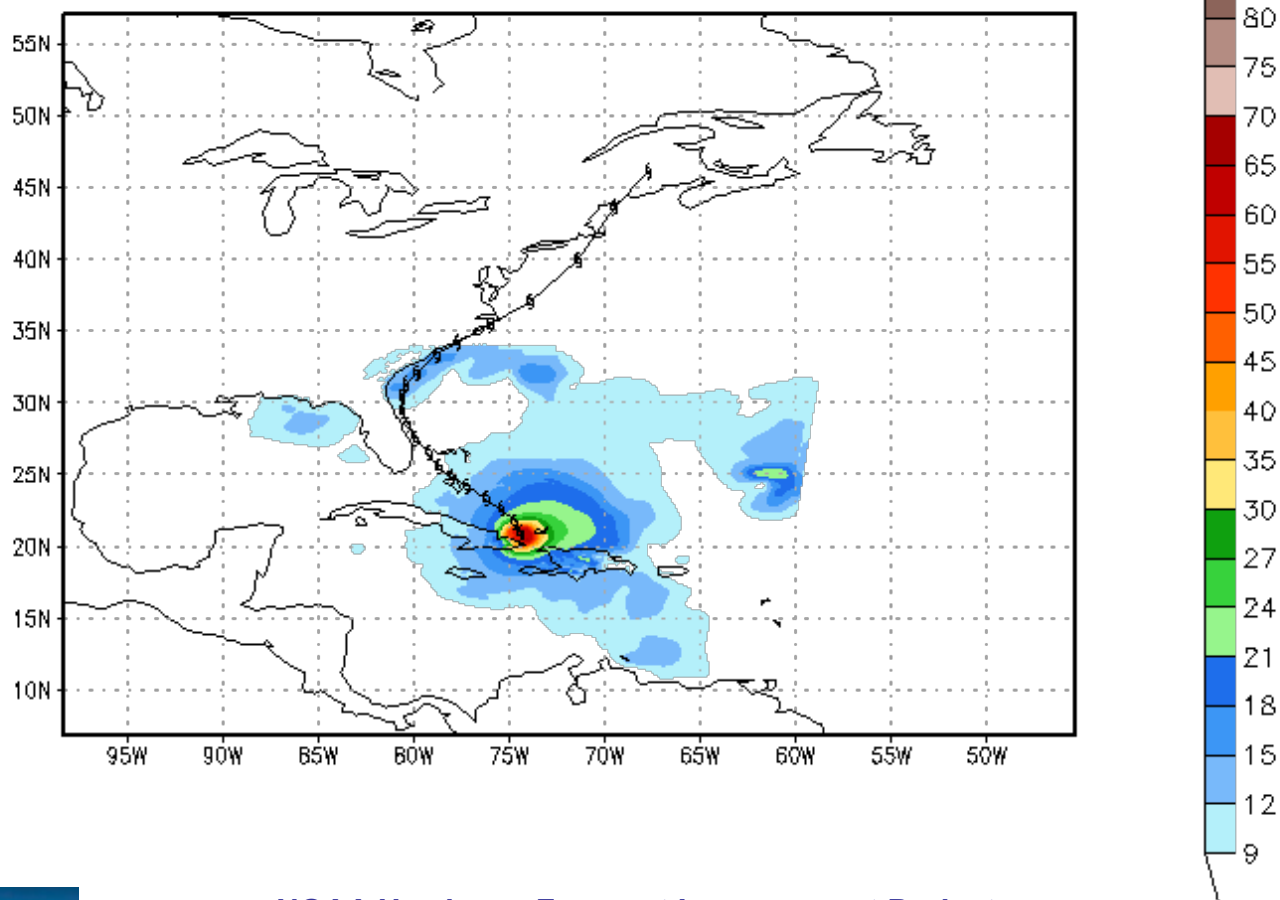




# HWRF Improvements: Ensembles

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Max 10m Wind(m/s) 2016100506-14I F001  
Min=0 Max=65.4972



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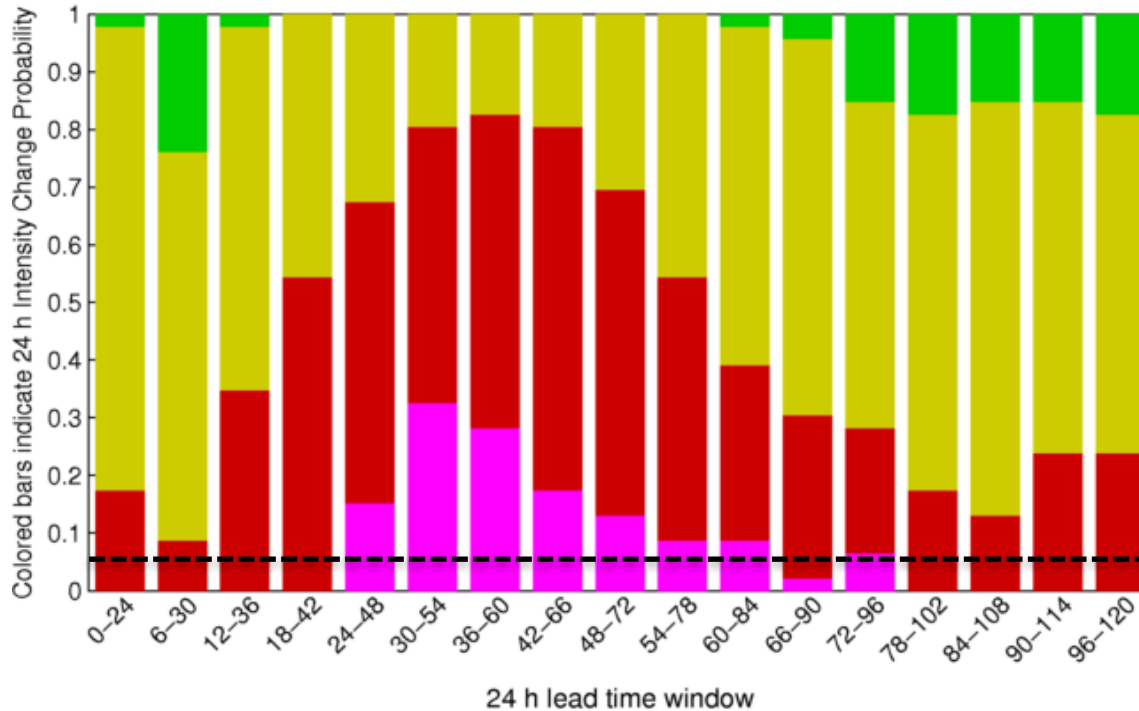
Meeting the Nation's Needs

# HWRF Improvements: Ensembles

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## COAMPS-TC / HWRF

HWRFACTCXGFDLEPS: TC = 07L2016, DTG = 2016082600



$\Delta I \geq 30$  kt (Rapid Intensification)

$10 \text{ kt} \leq \Delta I < 30 \text{ kt}$  (Moderate Intensification)

$-10 \text{ kt} < \Delta I < 10 \text{ kt}$  (Steady Intensity)

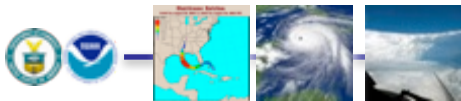
$-30 \text{ kt} < \Delta I \leq -10 \text{ kt}$  (Moderate Weakening)

$\Delta I \leq -30 \text{ kt}$  (Rapid Weakening)

TC already dissipated or dissipates during window

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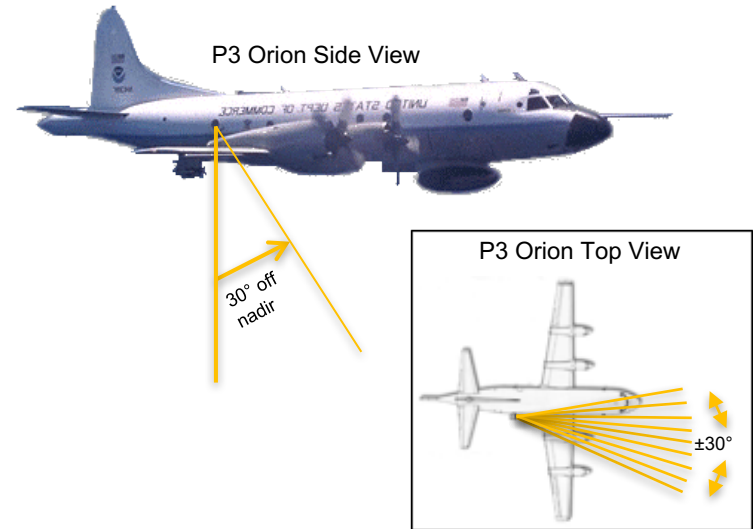


# HWRF Improvements: New Observations - 2017

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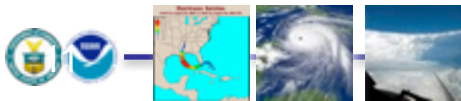
## Doppler Wind Lidar

- Compliments P-3 & G-IV Tail Doppler radar



## Coyote

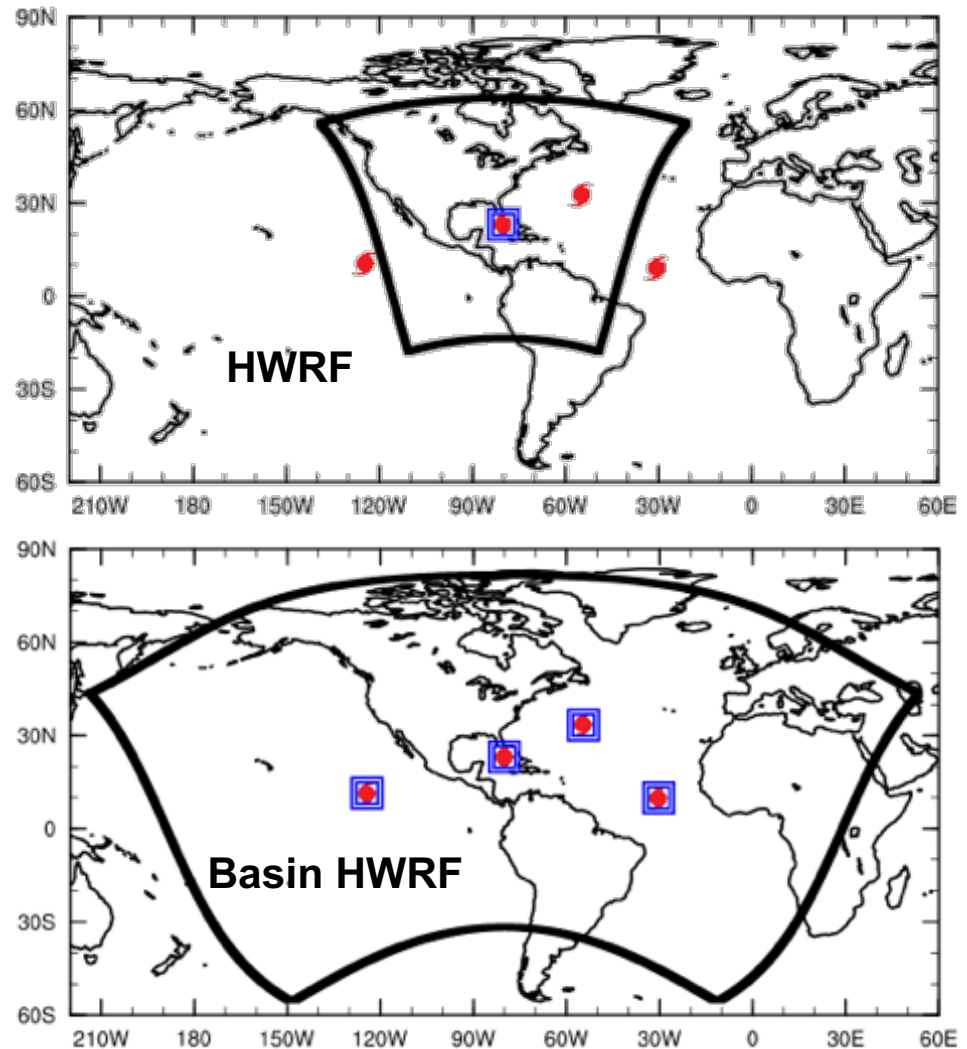
- Targets data gaps in hurricane boundary layer thermodynamics
- 5-6 Coyote in 2017
- Data sent to NHC



# Next steps – Basin HWRF

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- Keys to further improve hurricane predictions lie in modeling multi-scale interactions
- Requires Basin/Global domains with high resolution nests at 1-3 km horizontal resolution
- Research & development to advance next generation high resolution global model with nests



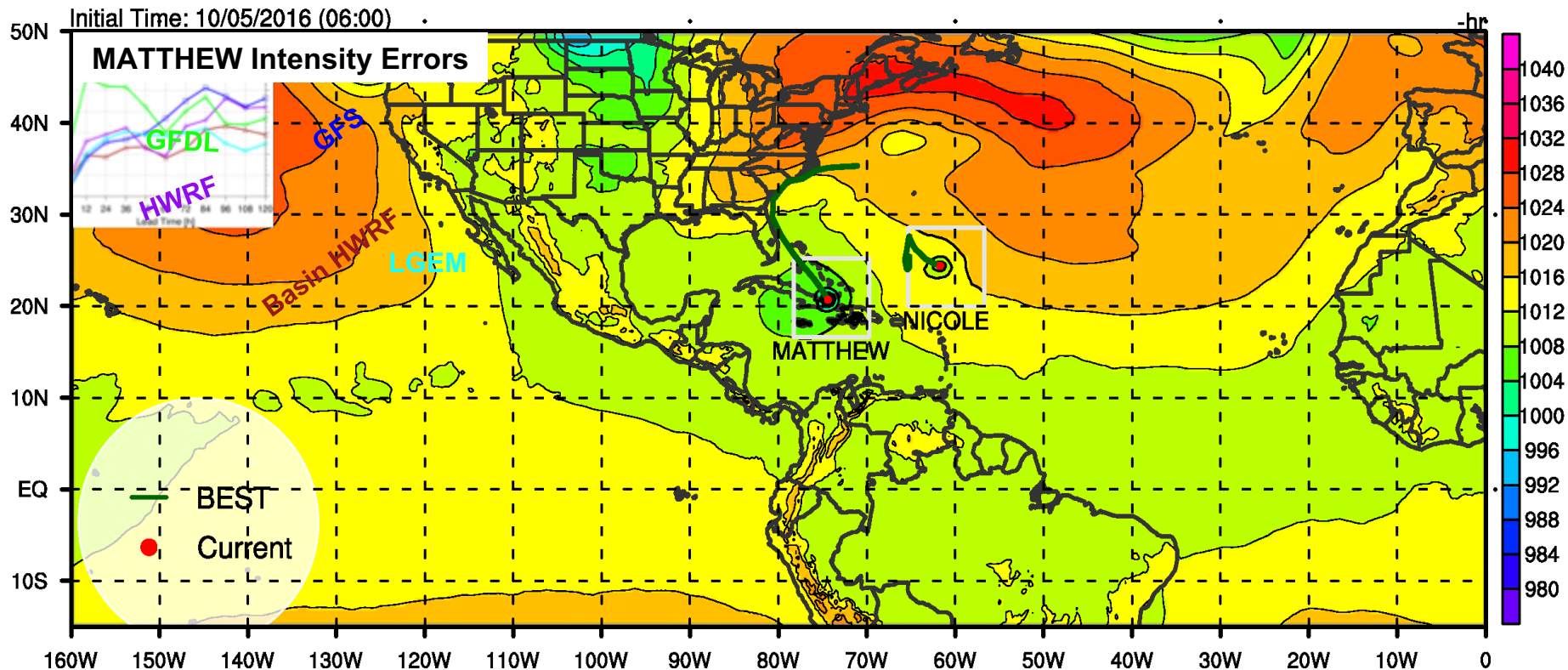
NOAA Hurricane Forecast Improvement Project

# Next steps – Basin HWRF

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## Matthew (14L) & Nicole (15L)

### Mean Sea Level Pressure [hPa] in Basin-Scale HWRF



# Research Challenges -

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## ***Priorities to be addressed by HFIP research & development community in FY17 are:***

- Reduce largest track and intensity errors
  - Improve initialization & physics impacting rapid intensity change
  - Improve vortex/shear interactions
- Extend/improve 7-day forecast skill
- Improve ensemble prediction & products



# Communicating in the field

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- Our blog

<http://noaahrd.wordpress.com>



follow us on  
**twitter**

- HRD Web page

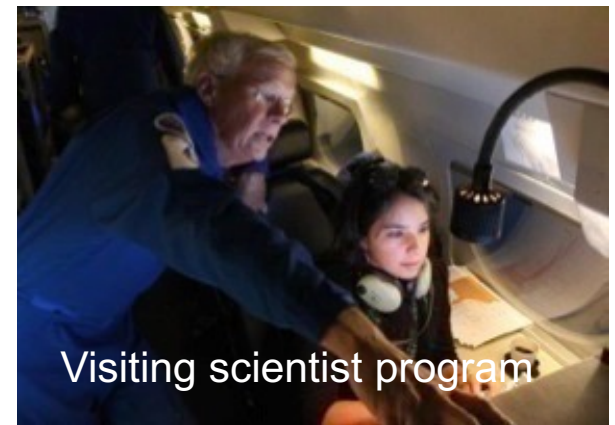
<http://www.aoml.noaa.gov/hrd>

- Facebook (5,844 followers)

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

- Twitter (20,830 followers)

[http://twitter.com/#!/HRD\\_AOML\\_NOAA](http://twitter.com/#!/HRD_AOML_NOAA)



Visiting scientist program

