



# Update on NOAA's Hurricane Forecast Improvement Project: Proposed Framework for Addressing Section 104 of the Weather Research Forecasting Innovation Act of 2017

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# HFIP Vision/Goals (2009-2018)



## 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)
- **Improve** storm surge prediction





# HFIP Success

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**HFIP achieved ~20% decrease in average hurricane track and intensity forecast errors, reaching the 5-yr goals, and for track very close to the 10-yr goal.**





# Keys to Success

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- **Partnerships:** NOAA research working closely with operations (NWS/NCEP, DOD/JTWC), Federal & academic partners (NASA, NSF, ONR, NRL, NCAR), & international collaborations
- **Diversity:** Manpower to evaluate model performance with hurricane datasets
- **Outreach and community participation**
  - Developed and facilitated next generation of TC researchers for NOAA
- **HFIP R&D computing**
- **Integrated use & support of testbeds (DTC & JCSDA)**





# Highlights for 2017

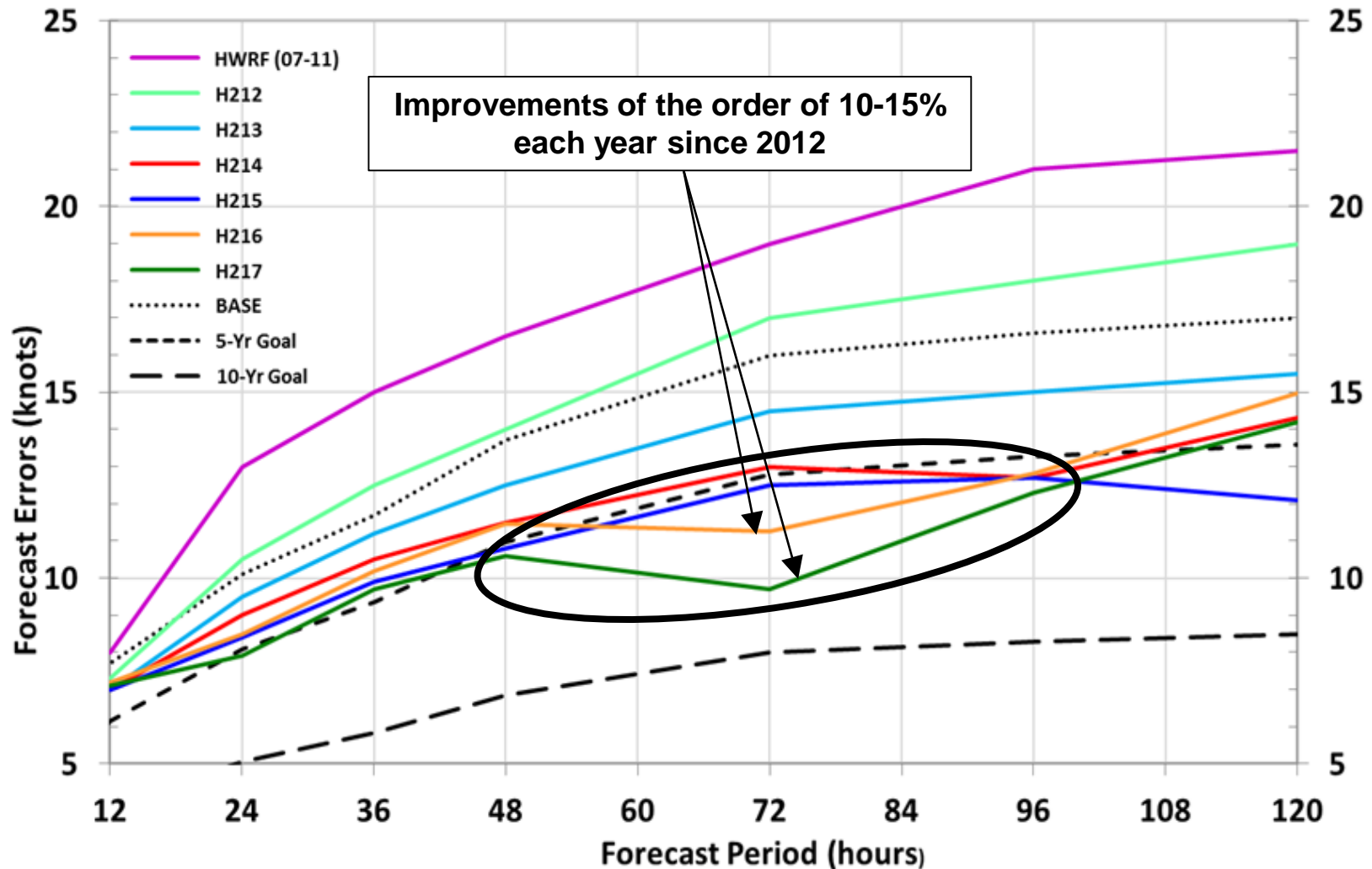
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- Operational HWRF best ATL intensity forecast model
- New products and tools at NHC ready for Operations
- HMON replaced legacy GFDL hurricane model
- Basin-scale HWRF demonstrated track skill over operational HWRF
- fvGFS demonstrated better intensity guidance than any global model
- Ran experimental multi-model regional ensemble (HWRF/HMON/COAMPS)
- Improvements to HFIP Corrected Consensus Approach (HCCA) model





# 2017 HWRF: ATL Intensity Forecast Trend Improvement





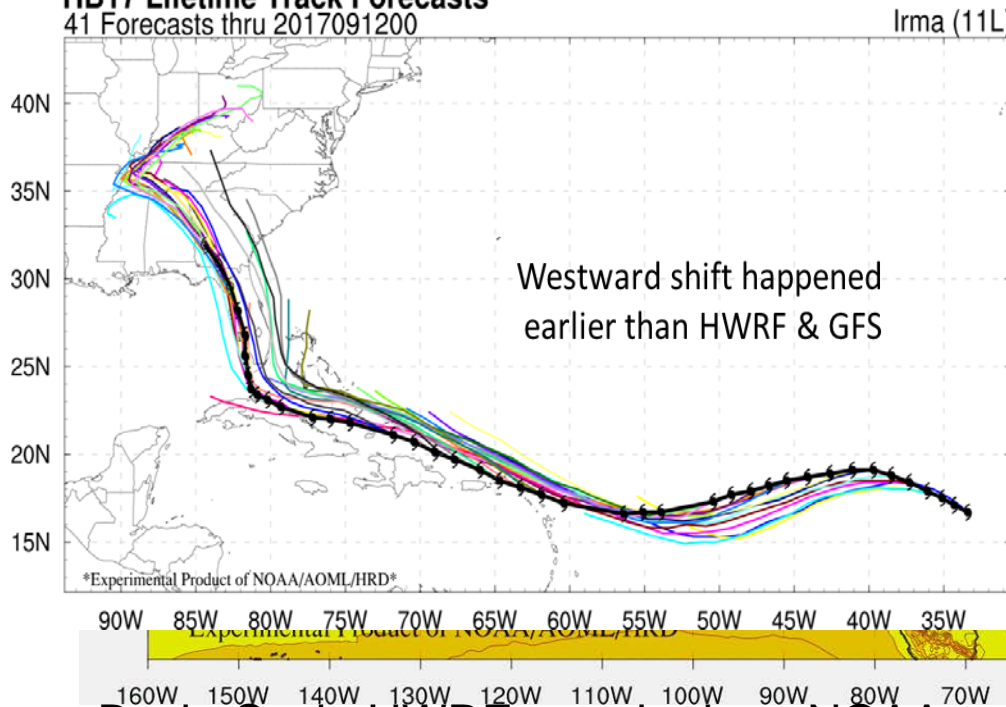


# Stream 2: HWRF-B - Hurricane Irma Predictions



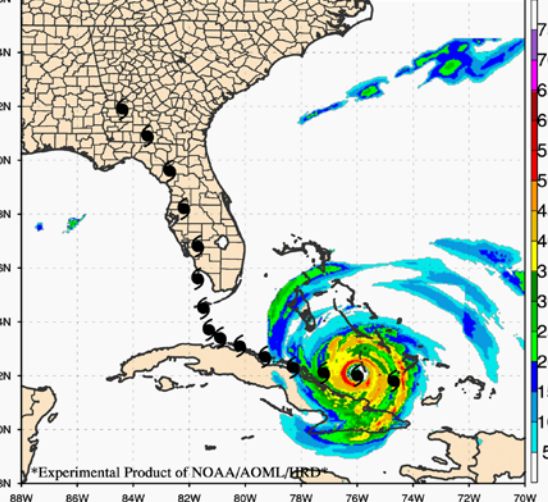
## HB17 Lifetime Track Forecasts

41 Forecasts thru 2017091200



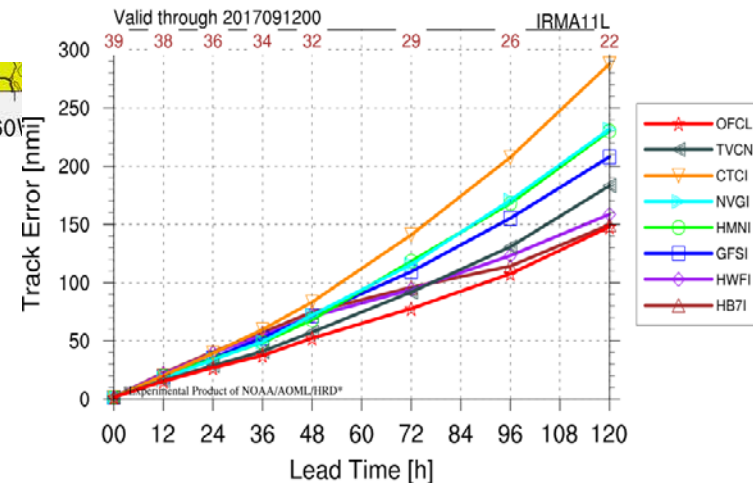
## 2017 Basin-Scale HWRF Modeled Radar Reflectivity [dBz]

Init: 12z Fri, Sep 08 2017 Forecast Hour: [006]



## EARLY TRACK ERROR

Valid through 2017091200

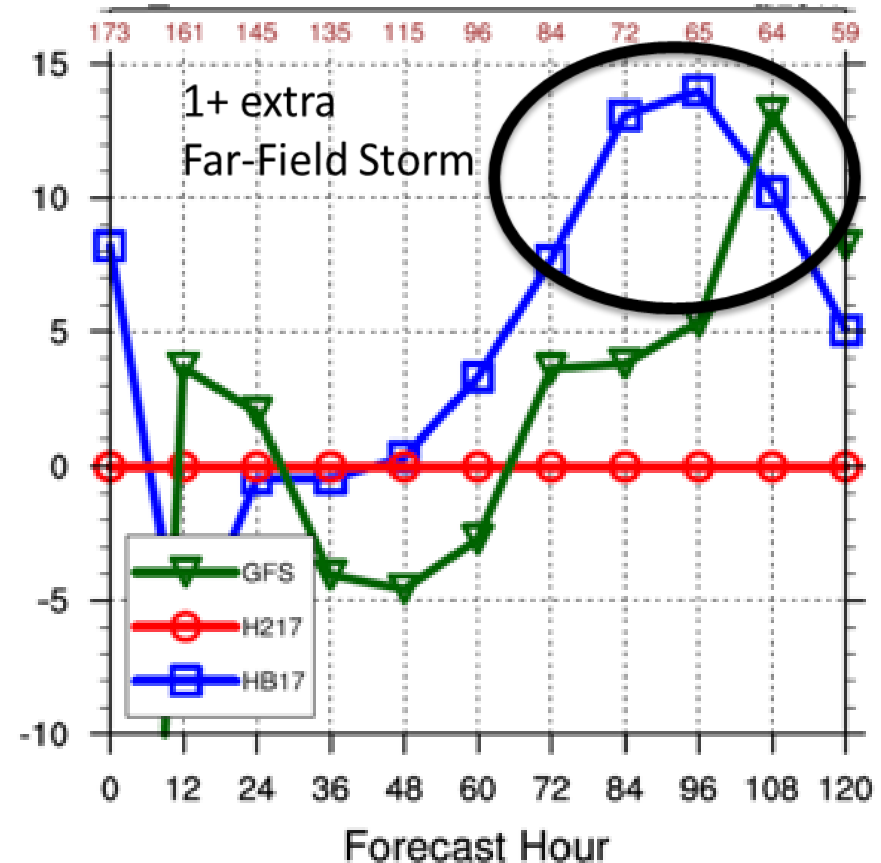
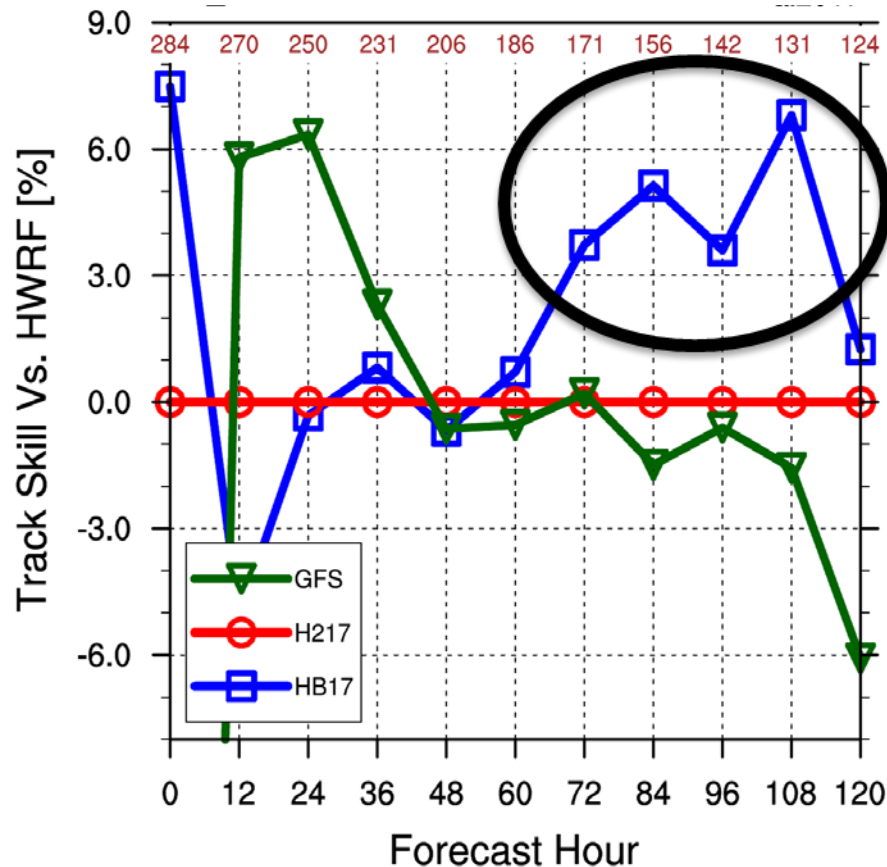


- Basin-Scale HWRF was the best NOAA model for Irma track forecasts at Days 4-5.
- Rainband structure accurately predicted along FL east coast.
- RECON data was successfully assimilated.





# Stream 2: HWRF-B – 2017 ATL Track Skill





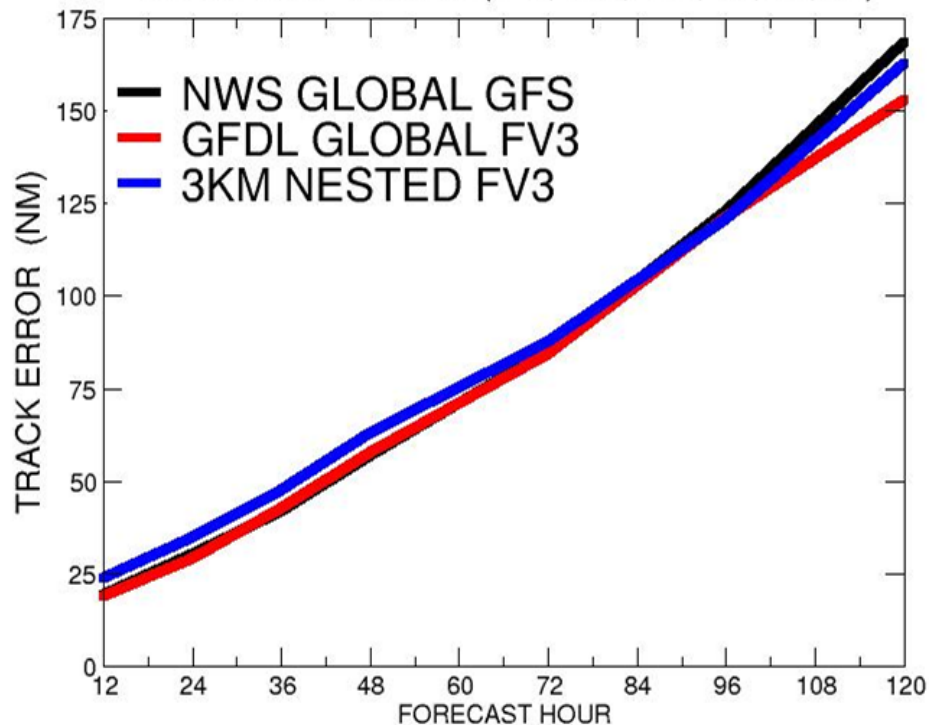


# Stream 2: 2017 ATL fvGFS Performance



## 2017 ATLANTIC SEASON

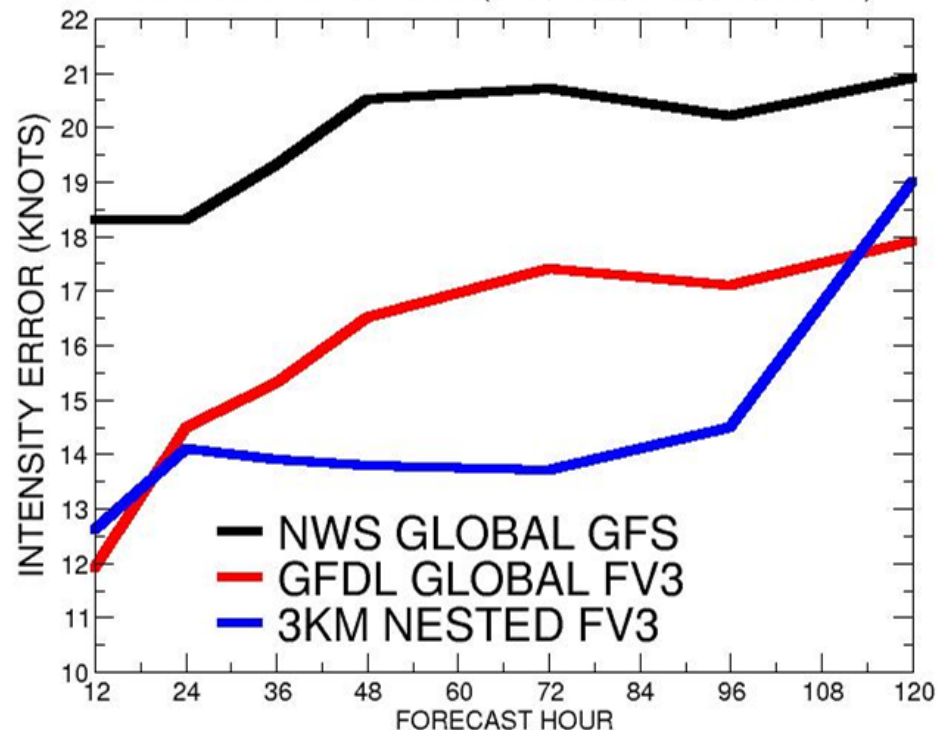
NUMBER OF CASES: (140, 133, 122, 95, 82, 68)



- 9% track degradation with introduction of 3km nest

## 2017 ATLANTIC SEASON

NUMBER OF CASES: (140, 133, 122, 95, 82, 68)

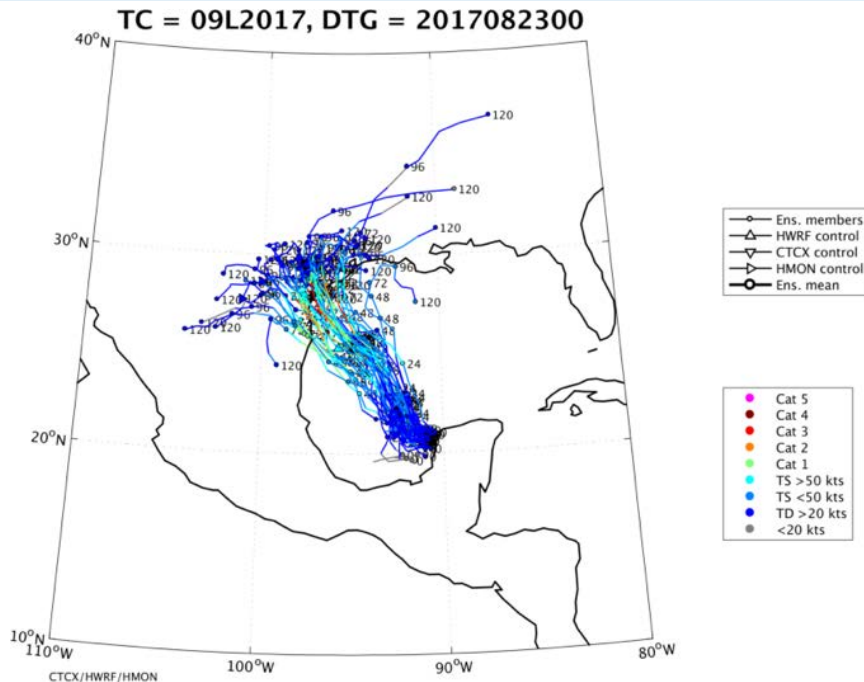


- 15% reduced intensity errors 1-4 days
- Degraded performance day 5 (lack of ocean coupling ???)

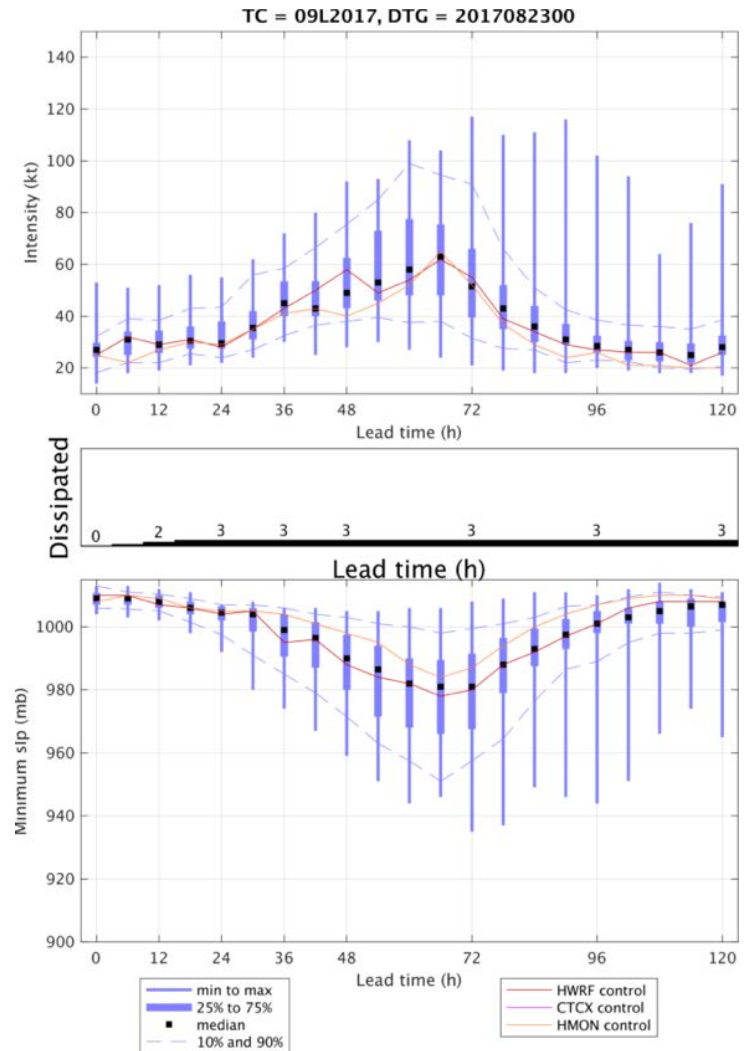




# Stream 2: HFIP Regional Multi-model Ensembles



- 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





# NHC Modeling Priorities for 2018



- Continue to improve HWRF, especially for RI cases
- Improve HMON so it can contribute positively to the consensus aids
  - Address significant weak bias for weaker storms
- Work towards a less under-dispersive ensemble system
- Improve GFS genesis forecasts
- Address low bias in GFS intensity forecasts
- Develop methods to assimilate GOES-16 and JPSS data
- Provide skillful TC track and intensity guidance out to 7 days





# Going Forward

- Improve forecast confidence to enhance public response
  - Reduce largest track and intensity errors
  - Improve **vortex/shear** interactions
  - Improve initialization & physics impacting **RI**
- Maintain focus on forecast accuracy (track and intensity) to improve overall forecast performance
- Reduce uncertainty
  - Improve ensemble prediction products
- Improved forecasts for landfalling storms and increased emphasis on **storm surge**
- Bring hurricane forecast modeling into UFS





# **Proposed new goals, objectives, and strategies in response to Section 104 of the Weather Act**





# Weather Act Sec. 104: Hurricane Forecast Improvement Program



- The Under Secretary, in collaboration with the United States weather industry and such academic entities as the Administrator considers appropriate, **shall maintain a project to improve hurricane forecasting.**
- The goal of the project shall be to **develop and extend accurate hurricane forecasts and warnings** in order to reduce loss of life, injury, and damage to the economy

## HFIP Science and R2O Challenges:

- Reduce **track** and **intensity** errors
- Improve initialization and physics impacting **RI**
- Extend forecast guidance to **7 days**
- Improve model guidance of **pre-formation**
- Improve forecast and communication of **storm surge**
- Incorporate **risk communication** into product suite







# Revised HFIP Goals aligned with the Weather Act



1. Reduce forecast guidance errors, **including during RI**, by 50% from 2017
2. Produce 7-day forecast guidance as good as the 2017 5-day forecast guidance
3. **Improve guidance on pre-formation disturbances, including genesis timing, and track and intensity forecasts, by 20% from 2017**
4. **Improve hazard guidance and risk communication, based on social and behavioral science**, to modernize the TC product suite (products, information, and services) for actionable lead-times for storm surge **and all other threats**

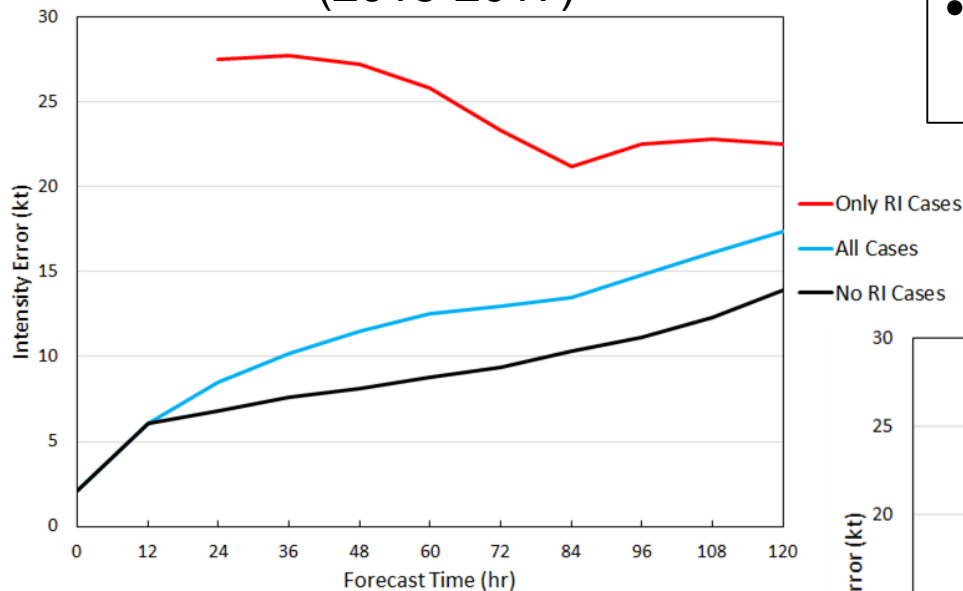




# Rapid Intensification Goal

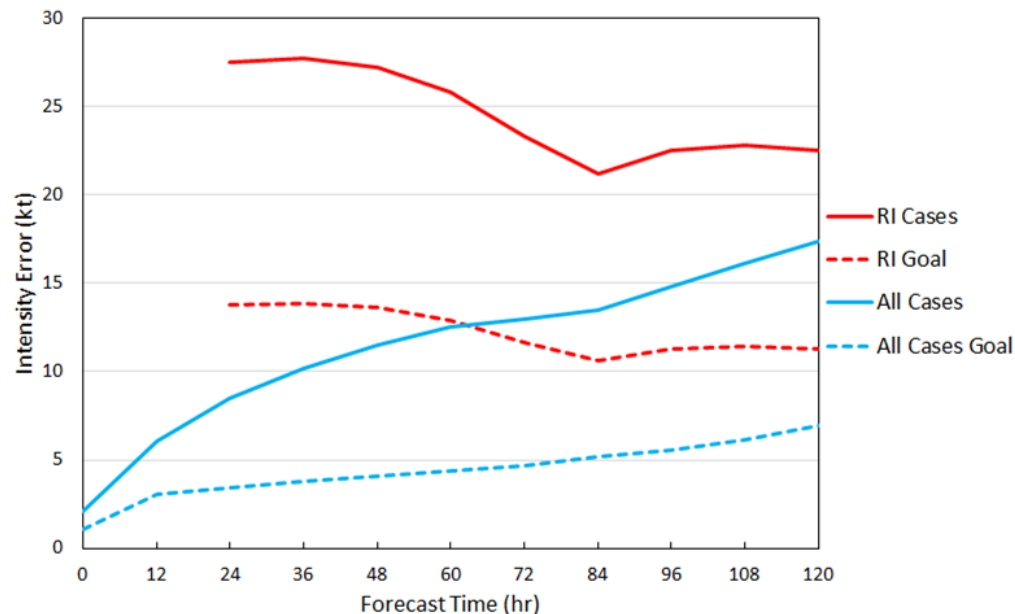


## 3-yr IVCN Intensity Error (2015-2017)



- Metrics based on 3-yr (2015-2017) average IVCN error

## Intensity Error Baseline and Goal



- Reduce all and RI intensity error by 50%



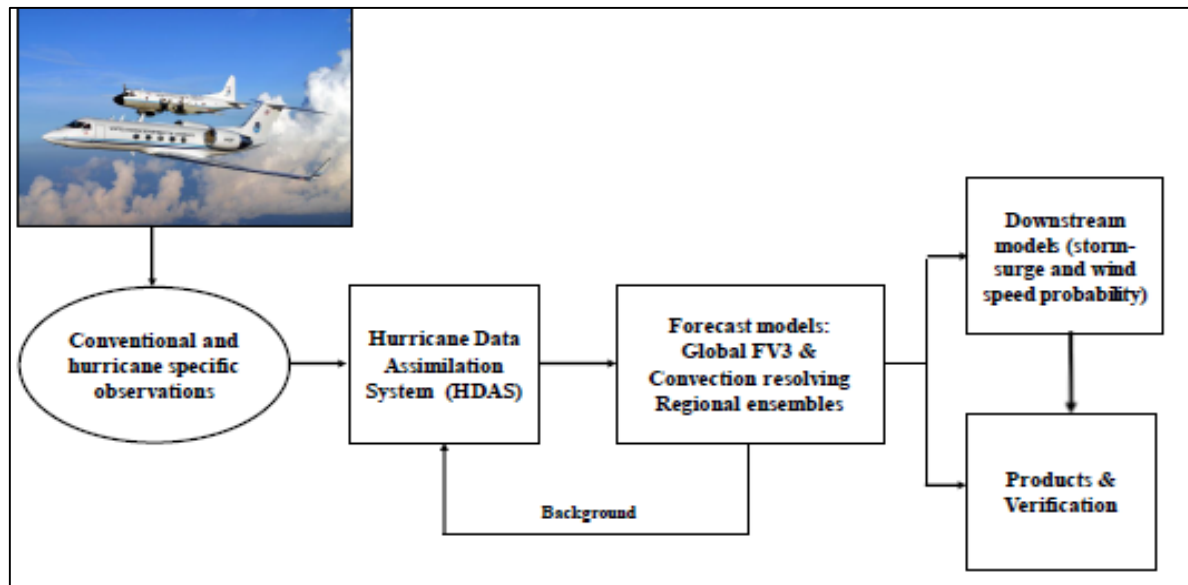


# Key Strategies: HAFS



## 1. Advance operational hurricane analysis and forecast system (HAFS)

- R&D for HAFS to advance deterministic and ensemble prediction capabilities
- R&D for fusion of modeling, data assimilation and observations to produce an analysis of record
- R&D for ensemble post-processing to extract guidance and uncertainty information





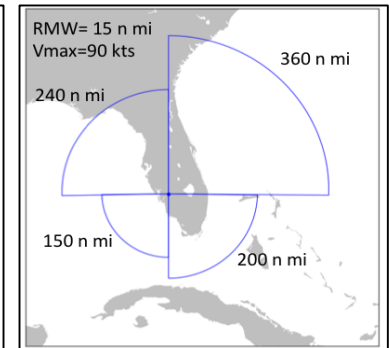
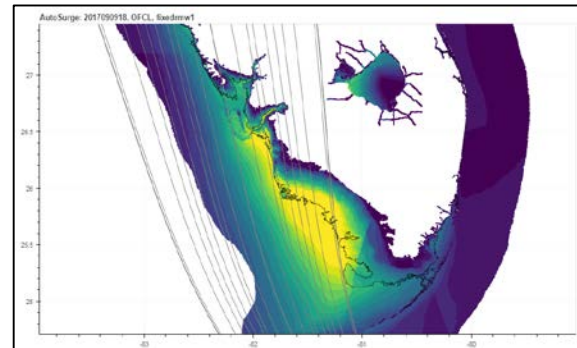
# Key Strategies: Guidance & Products



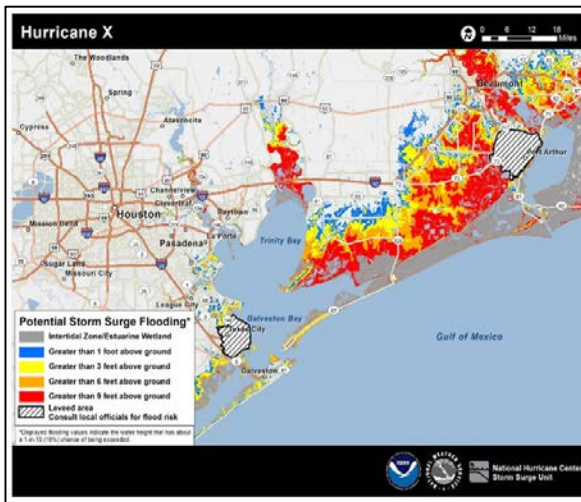
## 2. Improve probabilistic guidance

- Calibrate guidance with HAFS
- Incorporate dynamically-based uncertainty into hazard models and products
- R&D for hazard-specific products from HAFS

### Planned improvements to P-Surge to Improve the Potential Storm Surge Flooding Map



### Potential Storm Surge Flooding Map



## 3. Enhance communication of risk and uncertainty

- Evaluate TC products for the effective communication of risk
- Modernize TC products as informed by social and behavioral science





# Key Strategies: HPC

## 4. Increase HPC Capacity

- NOAA R&D and operational computing to support HAFS development
- Sustain modeling and software engineering expertise
- Match with technological innovations



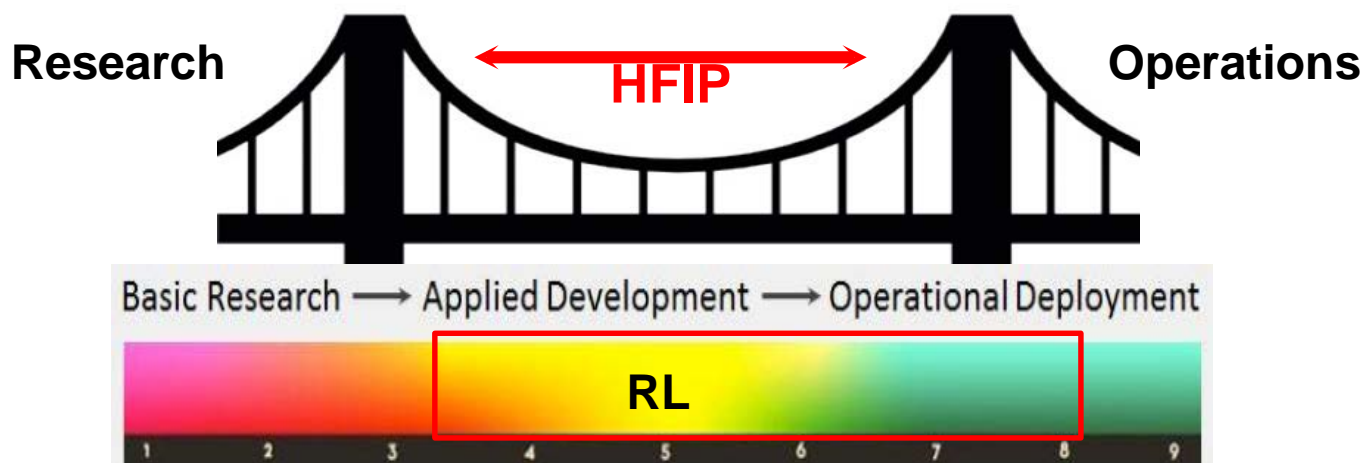
Compute	(core hr/ month)	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023
Hurricane	Prediction (R&D)	41.6M	57.2M	72.8M	88.4M	104.0M	119.6M
Hurricane	Operations (NCEP)	1.54M	1.85M	2.21M	2.66M	3.20M	3.84M
Storm surge	NHC/SLOSH /SWAN	4.8M	6.6M	8.4M	10.2M	12.0M	13.8M
	MDL	0.36M	1.58M	2.02M	3.32M	6.85M	7.09M
	NOS		0.45M	0.45M	0.55M	0.55M	0.71M
Disk	(TB)						
Hurricane	Prediction (R&D)	6,040	8,280	10,520	12,760	15,000	17,500
Hurricane	Operations (NCEP)	800	960	1152	1383	1660	1990
Storm surge	NHC/SLOSH /SWAN	80	110	140	170	200	230
	MDL	32	44	56	68	80	92
	NOS	6	88	91	101	104	140



# Key Strategies: R2O

## 5. Research to Operations (R2O) Enhancements

- Accelerate transition to operations by following NOAA's best practices for promoting readiness levels (RLs)
- Develop a process to prioritize research targeted for operational improvements
- More integrated use & support of Testbeds (JHT, DTC, JCSDA)







# Key Strategies: External Community



## 6. Broaden expertise and expand interaction with external community

- Re-invigorate the grants program
- Maintain a visiting scientist program at research and operational centers
- Advisory committees, community workshops
- Collaborate/coordinate with social and behavioral sciences
- Outreach to America's Weather Industry (AWI)

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NOAA-NWS-NWSP0-2018-2005325  
Round 3 of Research to Operations Initiative: NGGPS and HFIP  
Department of Commerce

**SYNOPSIS** | VERSION HISTORY | RELATED DOCUMENTS | PACKAGE

**General Information**

Document Type: Grants Notice	Version: Synopsis 3
Funding Opportunity Number: NOAA-NWS-NWSP0-2018-2005325	Posted Date: Nov 08, 2017
Funding Opportunity Title: Round 3 of Research to Operations Initiative: NGGPS and HFIP	Last Updated Date: Dec 13, 2017
Opportunity Category: Discretionary	Original Closing Date for Applications: Feb 07, 2018
Opportunity Category Explanation: Cooperative Agreement	Current Closing Date for Applications: Feb 07, 2018
Funding Instrument Type: Environment	Archive Date: Mar 09, 2018
Category of Funding Activity: Natural Resources	Estimated Total Program Funding: \$3,500,000
Category Explanation: Science and Technology and other Research and Development	Award Ceiling: \$200,000
Expected Number of Awards: 20	Award Floor: \$100,000
CFDA Number(s): 11.458 -- Applied Meteorological Research	
Cost Sharing or Matching Requirement: No	

**Eligibility**

Eligible Applicants: Others (see text field entitled "Additional Information on Eligibility" for clarification)

**Additional Information on Eligibility:** Eligible applicants are institutions of higher education, profit organizations (profit and non-profit), and federally funded educational institutions such as the Naval Postgraduate School. This restriction is needed because the results of the collaboration are to be incorporated in processes which ensure academic integrity.

**Additional Information**

Agency Name: Department of Commerce

Description: This program announcement is for projects to be conducted for a two-year period with an anticipated start date of September 1, 2018 unless otherwise directed. Eligible applicants are institutions of higher education and federally funded educational institutions such as the Naval Postgraduate School. The purpose of the NOAA Research to Operations (R2O) Initiative is to expand and accelerate critical weather forecasting research to operations to address growing service demands and increase the accuracy of weather forecasts. This will be achieved through: (1) accelerated development and implementation of improved global weather prediction models and inclusion of the coupling among atmosphere, ocean, land surface and ice system components; (2) improved data assimilation techniques; (3) nested regional prediction capabilities; (4) improved hurricane and tropical cyclone modeling techniques; (5) improved ensemble techniques; (6) post-processing forecast tools and techniques; and (7) improved software architecture and system engineering. The R2O Initiative is soliciting proposals for projects involving applied science, modeling and/or data assimilation that support development of the Next Generation Global Prediction System (NGGPS) at global and regional scales. The NOAA R2O Initiative is also soliciting proposals for the Hurricane Forecast Improvement Project (HFIP) initiative to engage and coordinate hurricane research required to improve operational hurricane forecasts and meet societal requirements to effectively mitigate economic disruption. This notice provides guidelines for submission of proposals. This notice also describes opportunities and application procedures to demonstrate capabilities that have the potential to be incorporated into operational NWS numerical weather prediction (NWP) analyses and forecasts. The R2O Initiative addresses NOAA's Weather Ready Nation (WRN) strategic goal and supporting objectives.

**Link to Additional Information:**

Grantor Contact Information: If you have difficulty accessing the full announcement electronically, please contact:  
Christopher Hedge 301-427-9242 1325 East West Highway, Silver Spring, MD 20910-3283

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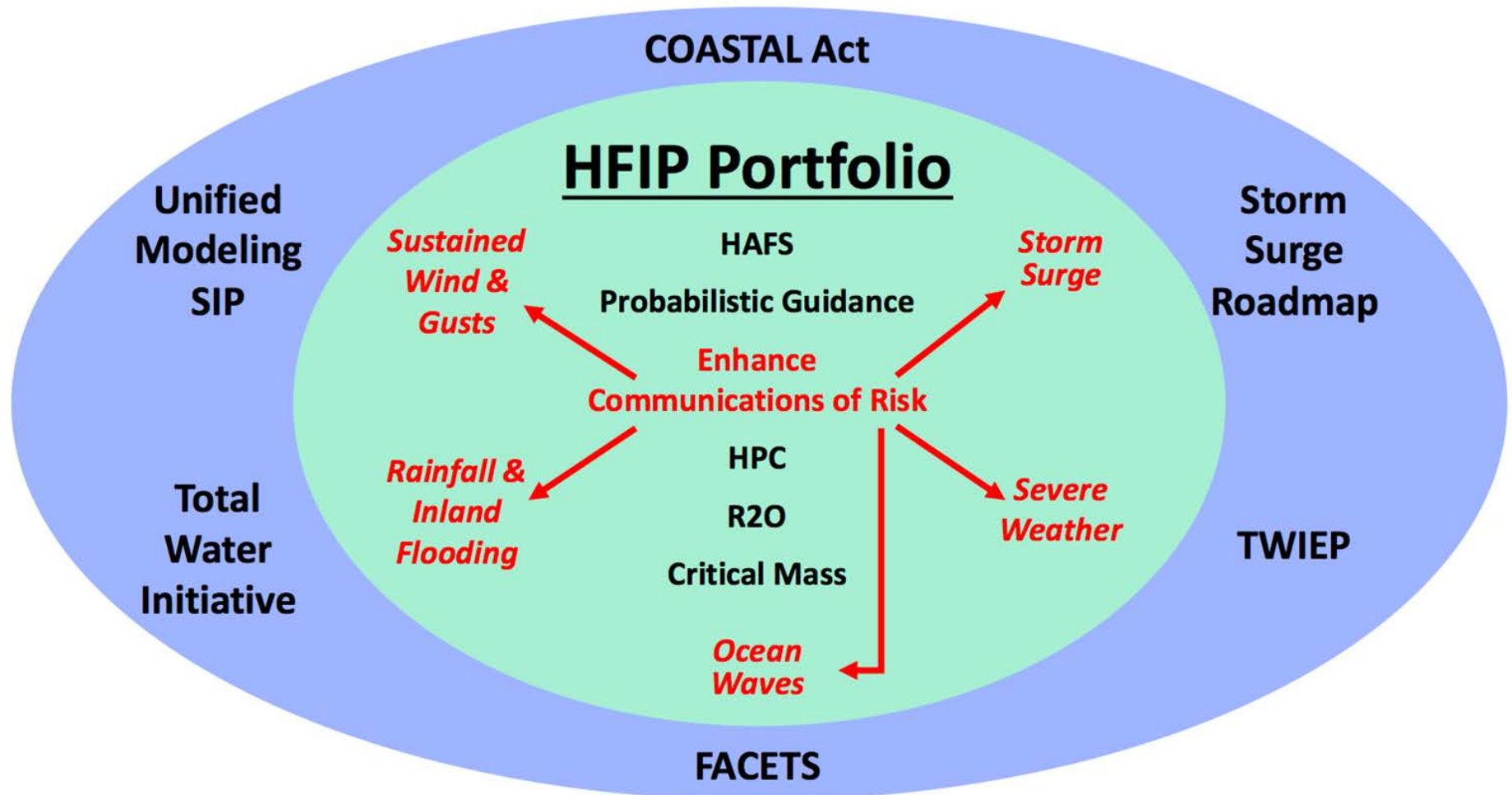
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# Connections





# Who, What, & When?

## Strategic Writing Team

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Morris Bender (OAR/GFDL)	Tim Marchok (OAR/GFDL)	Alan Gerard (OAR/NSSL)
Pablo Santos (NWS/Miami)	James Nelson (NWS/WPC)	Cody Fritz (NWS/NHC)
Ed Mifflin (NWS/STI)	<i>Nicole Kurkowski (NWS/STI)</i>	<i>Frank Marks (OAR/AOML)</i>
Nysheema Lett (NWS/STI) Exec Sec		

- Update [original HFIP plan \(July 18, 2008\)](#), incorporating recommended short- and long-term programmatic HFIP goals into the HFIP strategic plan, outlining specific steps for achieving model advancements and improvements in predictive capabilities.
- Organize goals by 3 Weather Act focus areas.





# Questions and Discussion

