NOAA HURRICANE FORECAST IMPROVEMENT PROJECT

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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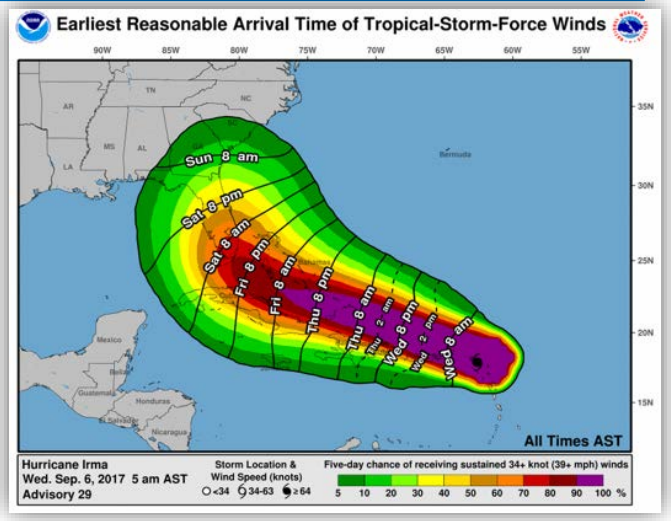
HFIP Vision/Goals (2009-2018)

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

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.

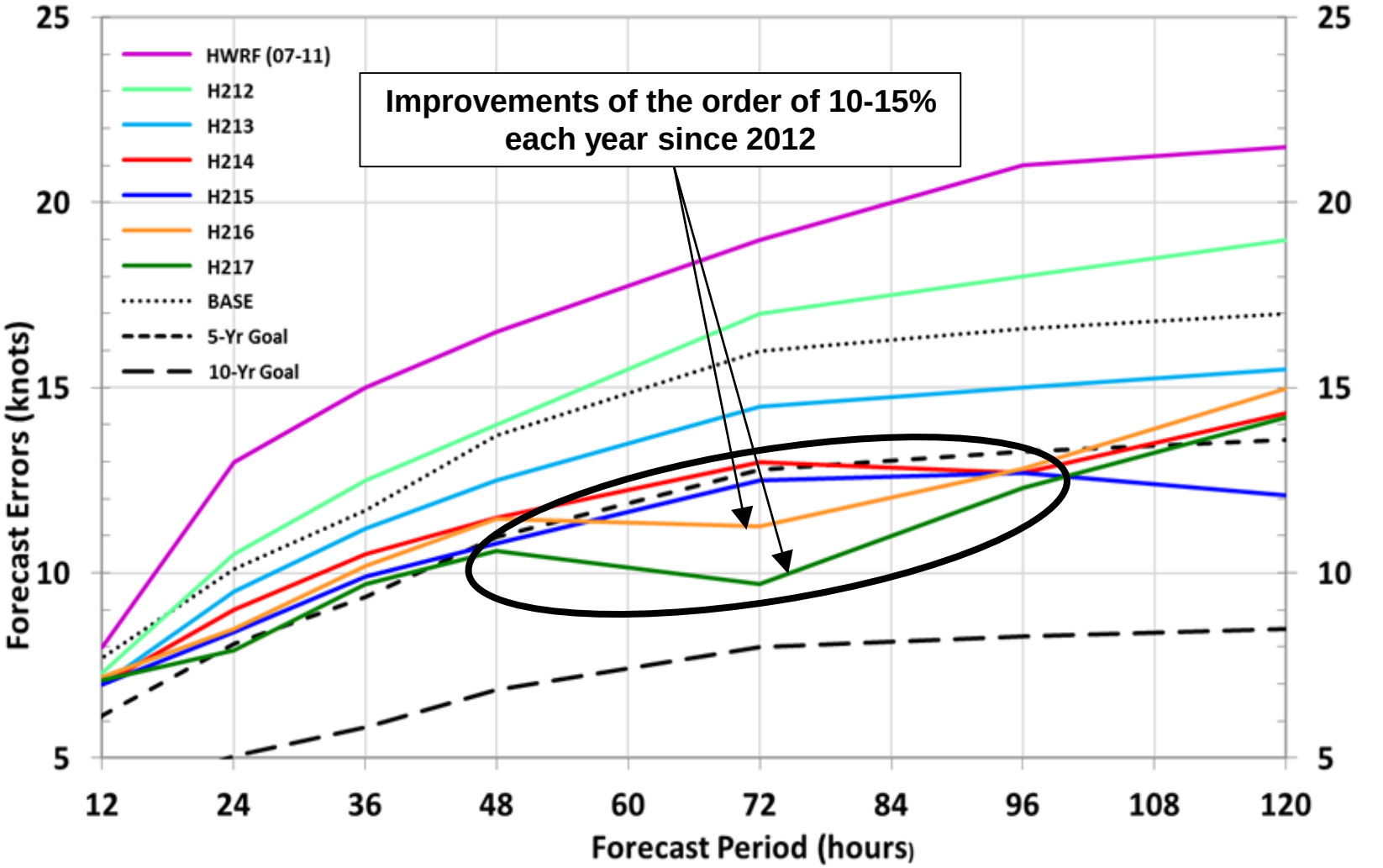
Keys to Success

- **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)

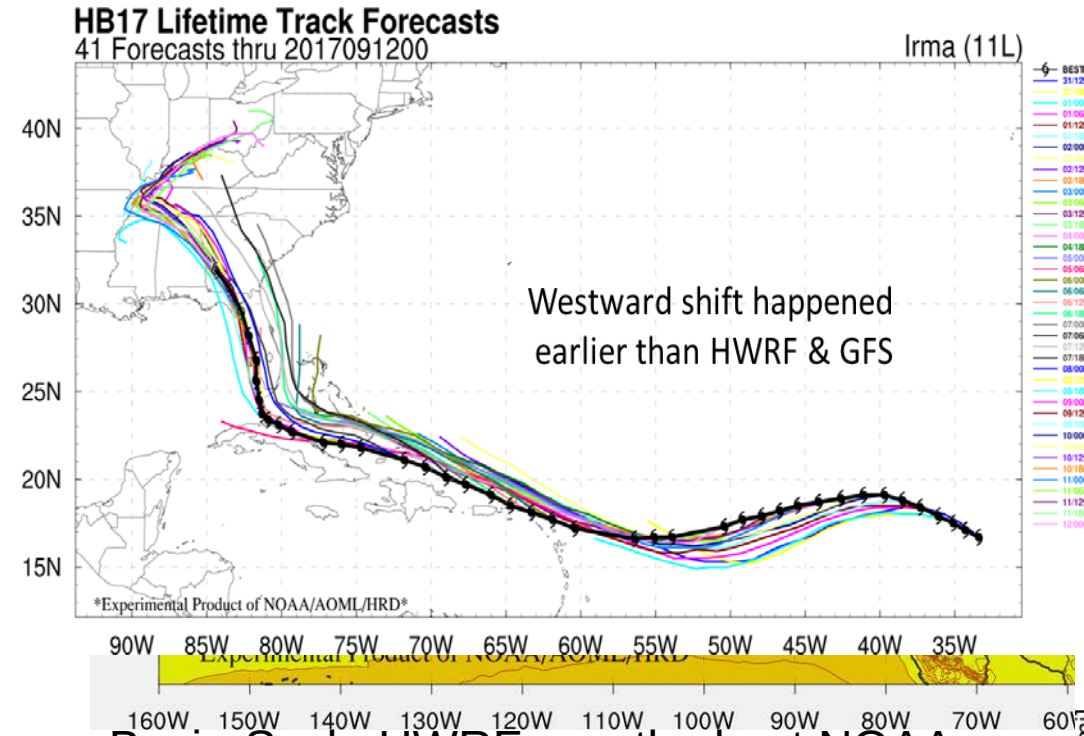
Highlights for 2017

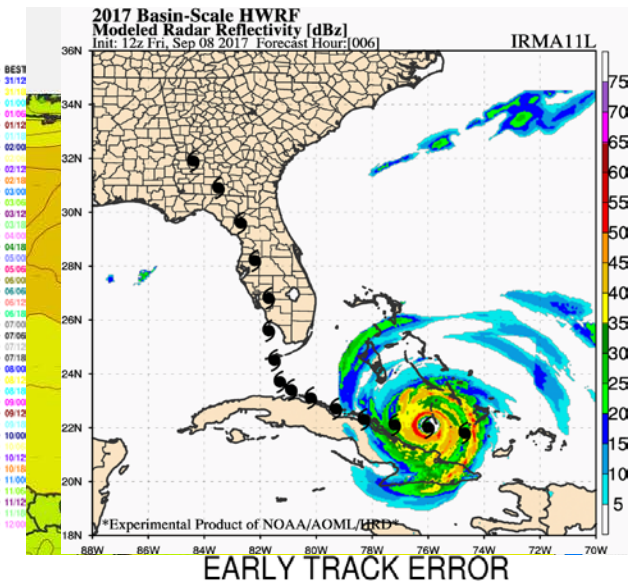
- Operational HWRF best ATL intensity forecast model
- New products and tools at NHC ready for Operations
- HMON replaced legacy GFDL hurricane model
- Basin-scale HWRF demonstrated track skill over operational HWRF
- fvGFS demonstrated better intensity guidance than any global model
- Ran experimental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

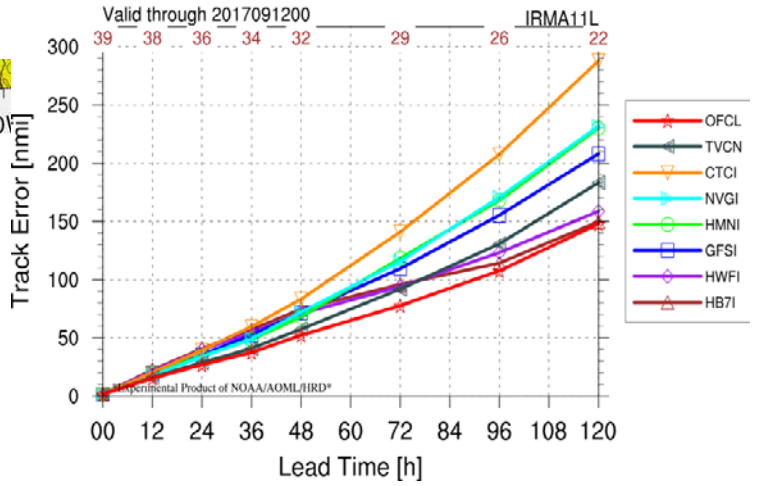
2017 HWRF: ATL Intensity Forecast Trend Improvement



Stream 2: HWRF-B - Hurricane Irma Predictions

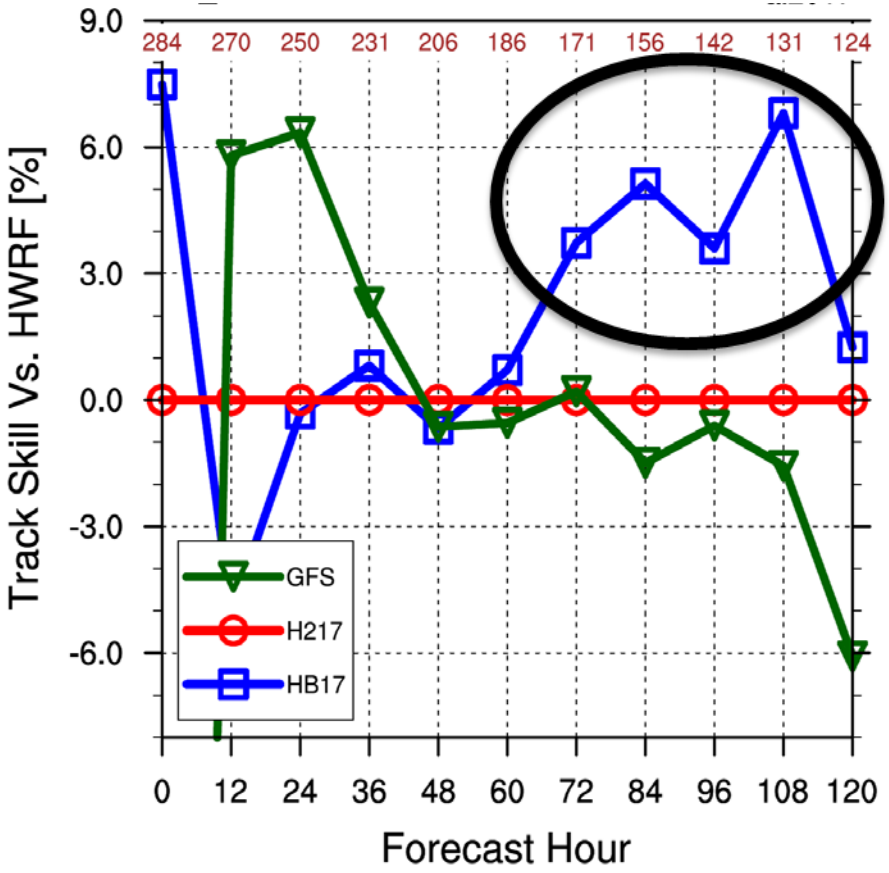


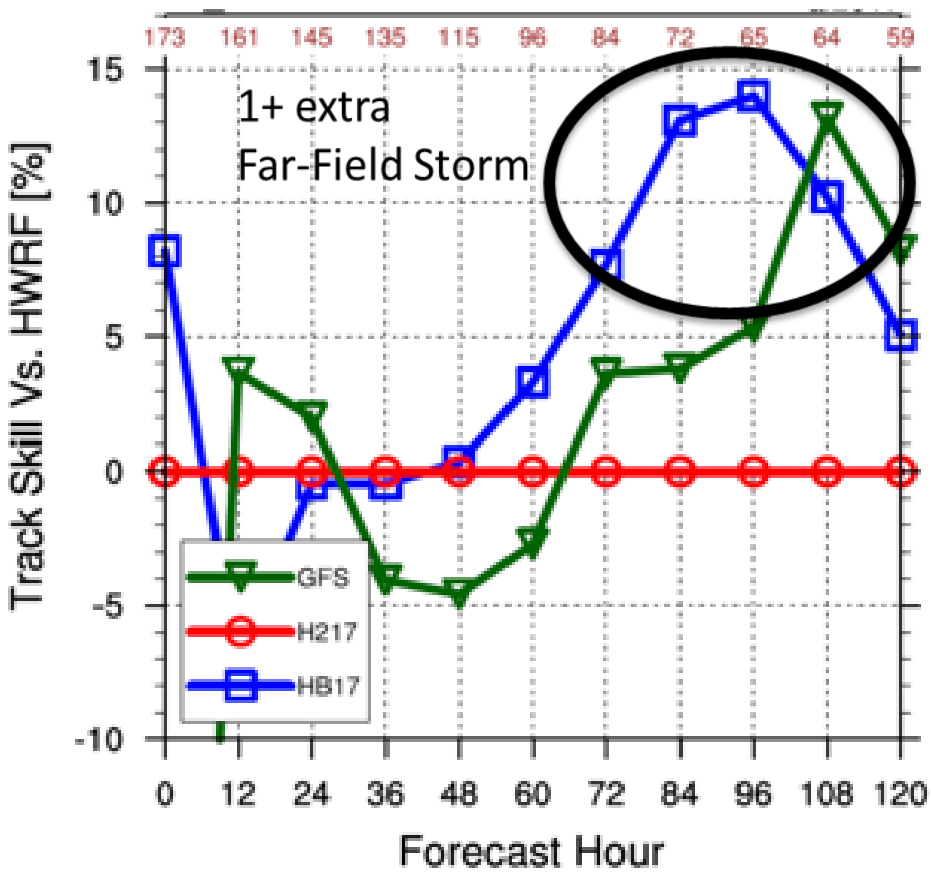




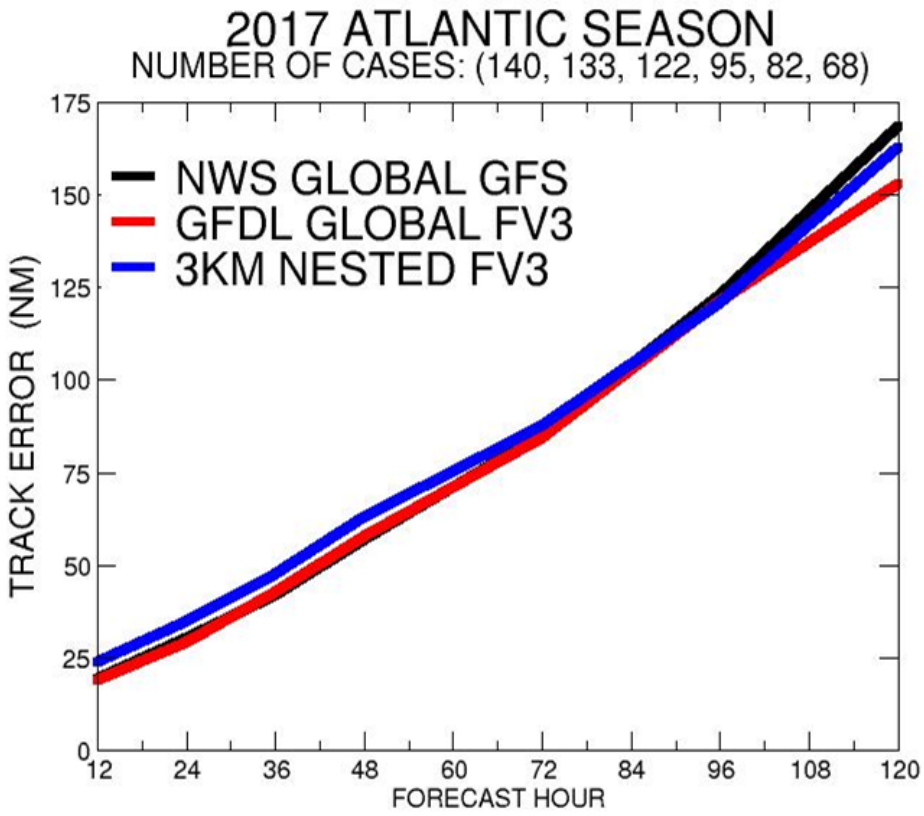
- Basin-Scale HWRF was the best NOAA model for Irma track forecasts at Days 4-5.
- Rainband structure accurately predicted along FL east coast.
- RECON data was successfully assimilated.

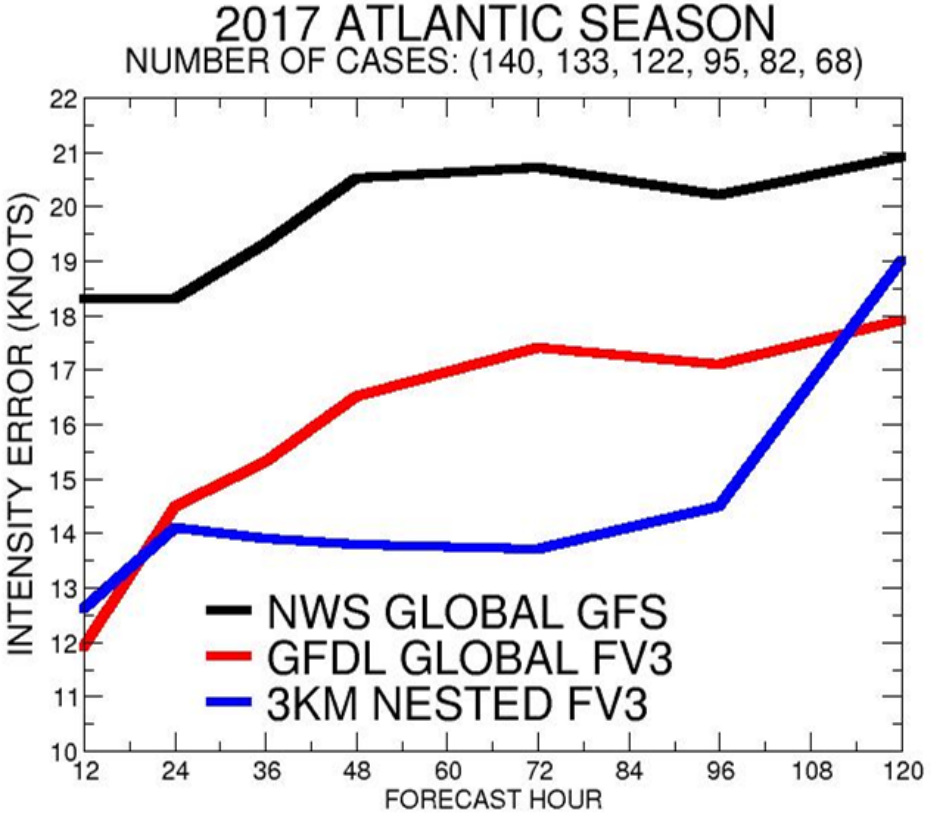
Stream 2: HWRF-B – 2017 ATL Track Skill





Stream 2: 2017 ATL fvGFS Performance

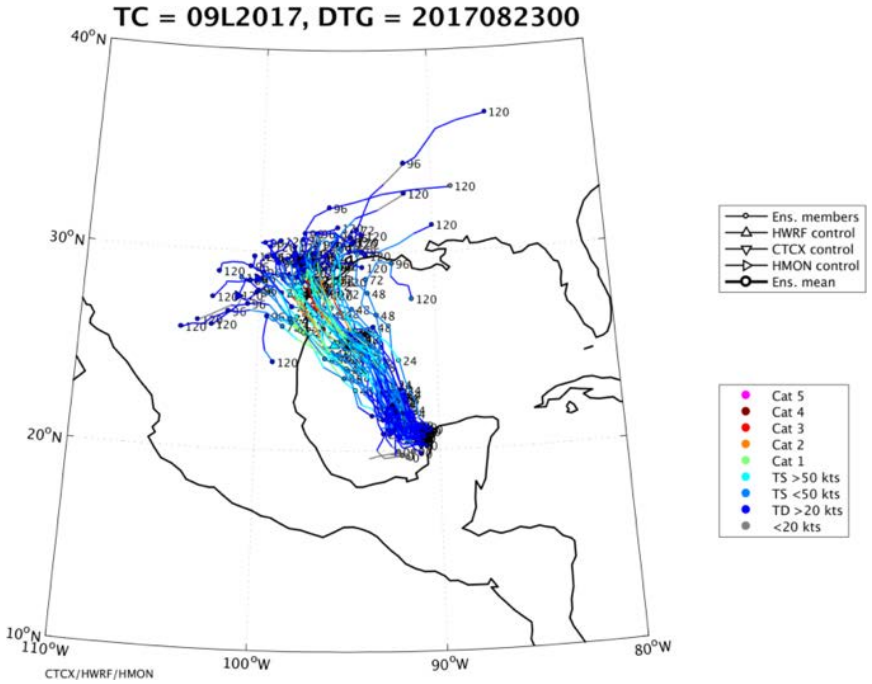


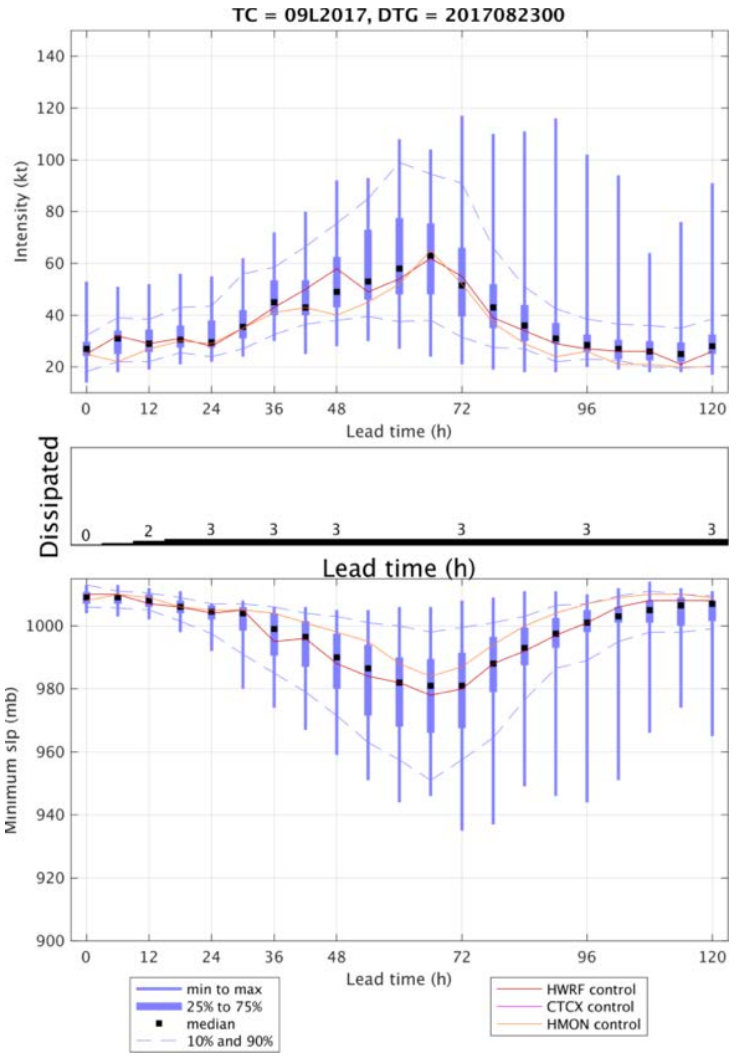


- 9% track degradation with introduction of 3km nest

- 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:

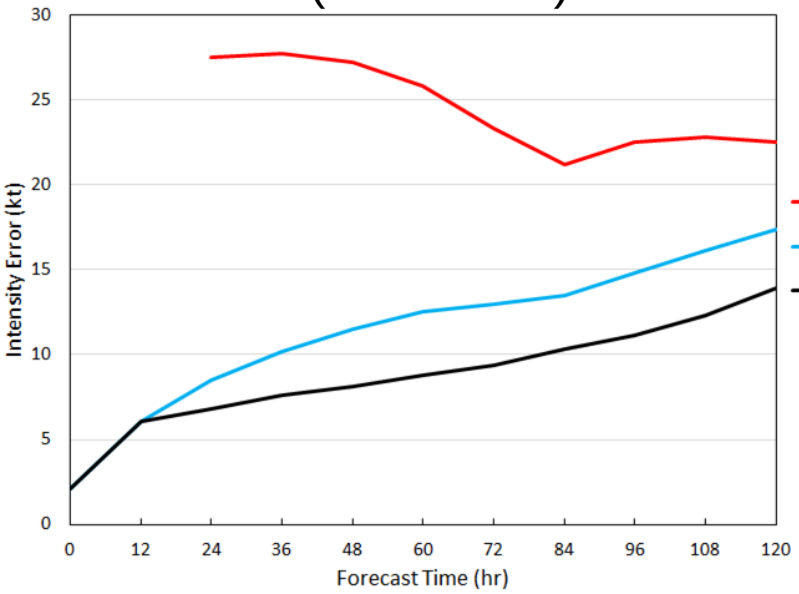
- Reduce **track** and **intensity** errors
- Improve initialization and physics impacting **RI**
- Extend forecast guidance to **7 days**
- Improve model guidance of **pre-formation**
- Improve forecast and communication of **storm surge**
- Incorporate **risk communication** into product suite

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

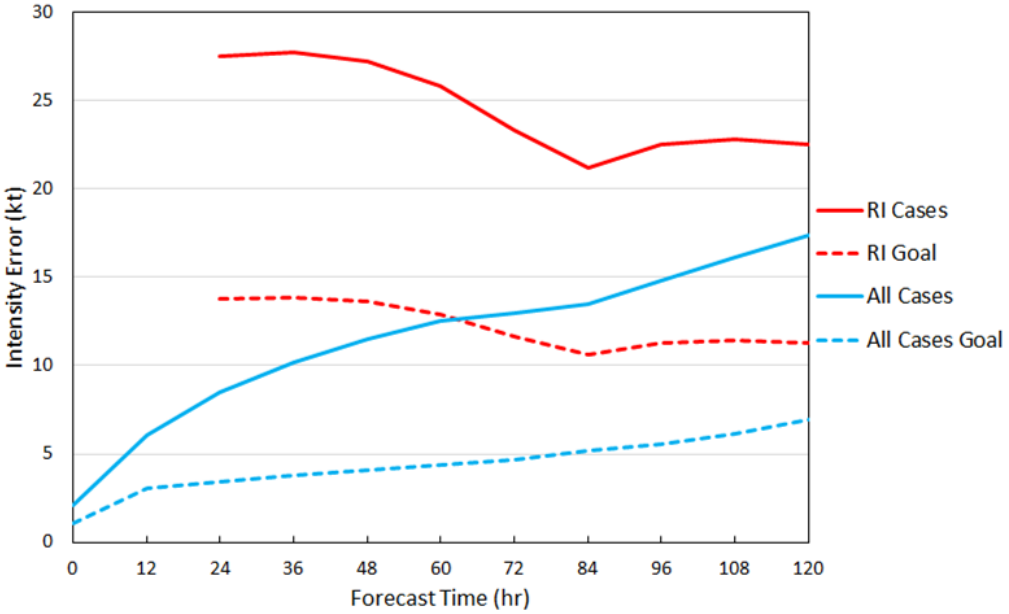
Rapid Intensification Goal

3-yr IVCN Intensity Error (2015-2017)



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

Intensity Error Baseline and Goal

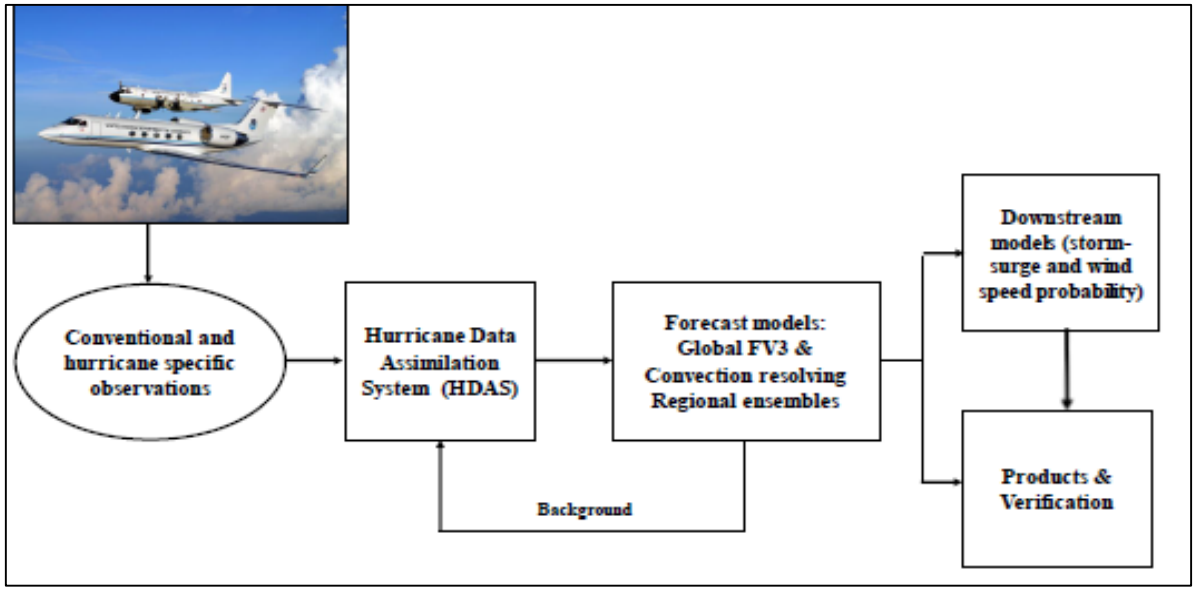


- Reduce all and RI intensity error by 50%

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

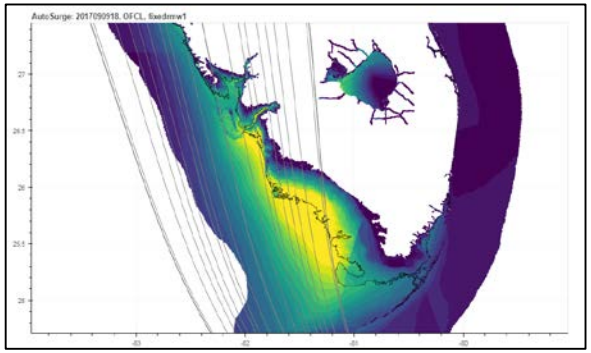


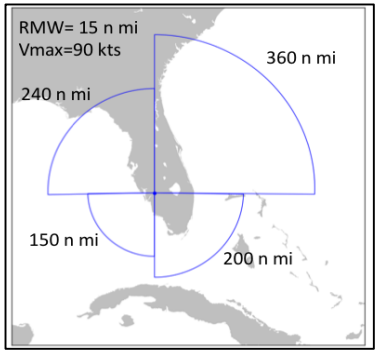
Key Strategies: Guidance & Products

2. Improve probabilistic guidance

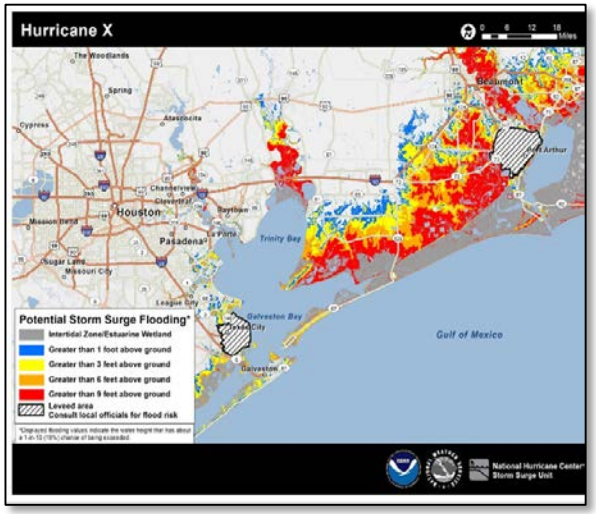
- Calibrate guidance with HAFS
- Incorporate dynamically-based uncertainty into hazard models and products
- R&D for hazard-specific products from HAFS

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

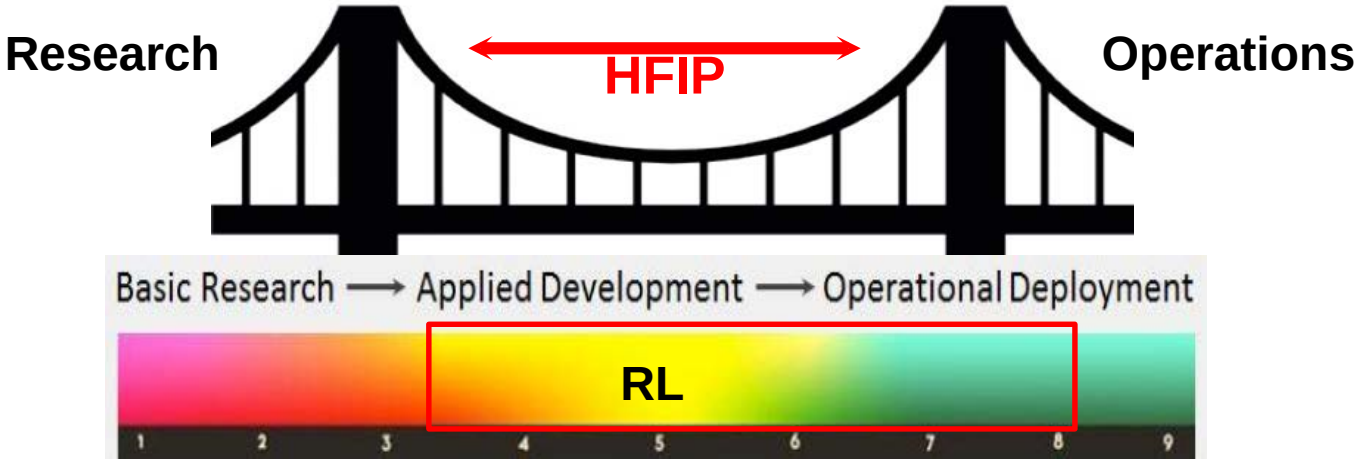
- NOAA R&D and operational computing to support HAFS development
- Sustain modeling and software engineering expertise
- Match with technological innovations

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 (R20) Enhancements

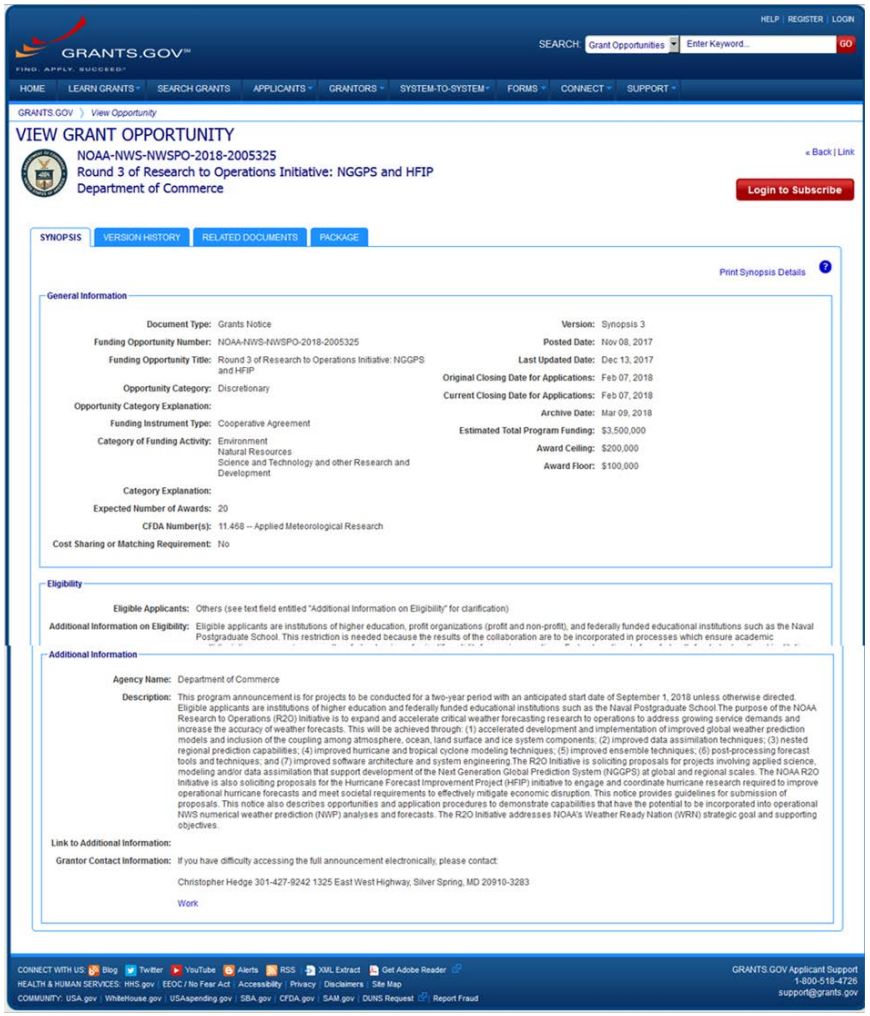
- Accelerate transition to operations by following NOAA's best practices for promoting readiness levels (RLs)
- Develop a process to prioritize research targeted for operational improvements
- More integrated use & support of Testbeds (JHT, DTC, JCSDA)



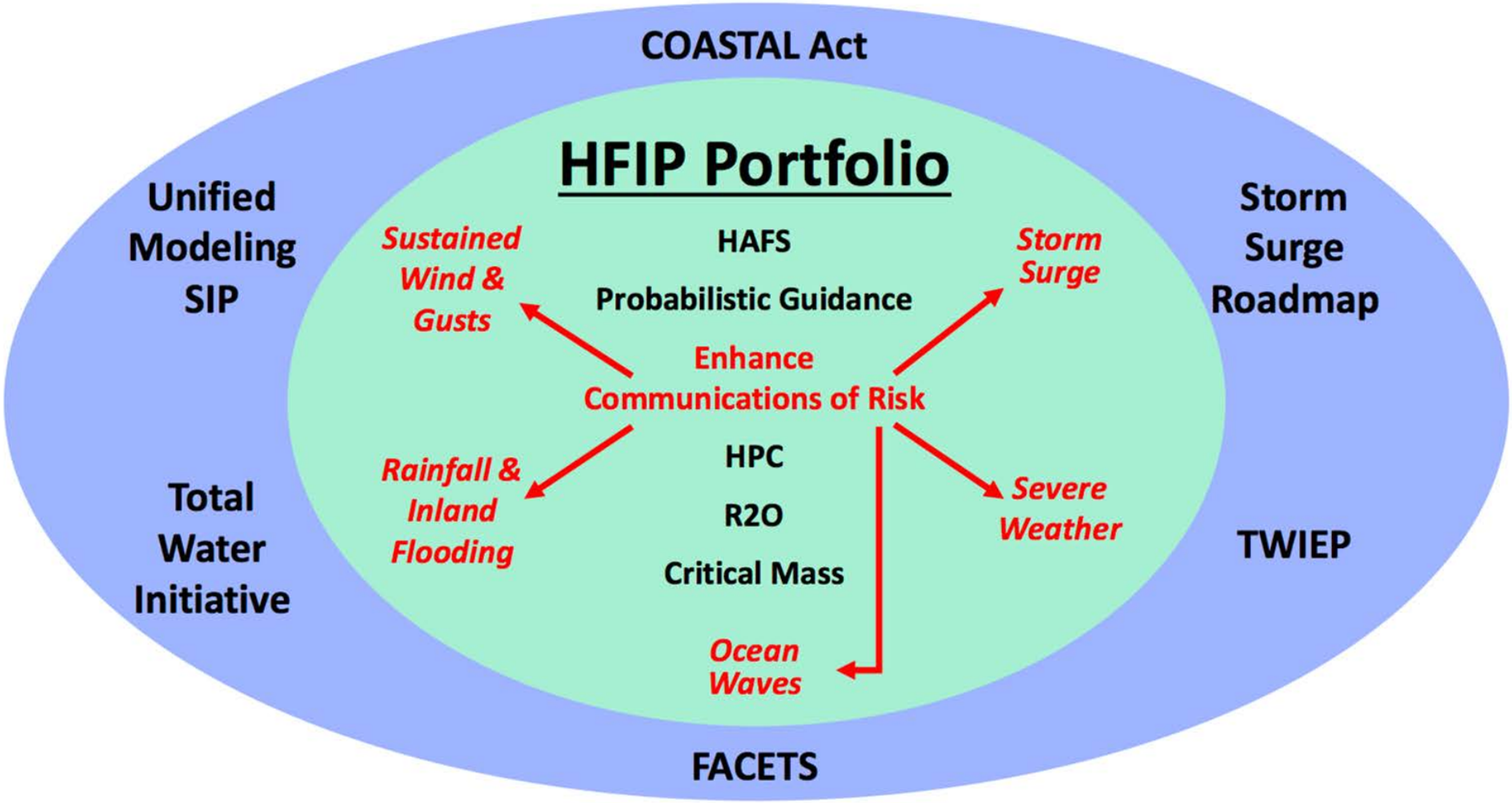
Key Strategies: External Community

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)



Connections



Who, What, & When?

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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