NOAA's Hurricane Forecast Improvement Project: Framework for Addressing 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

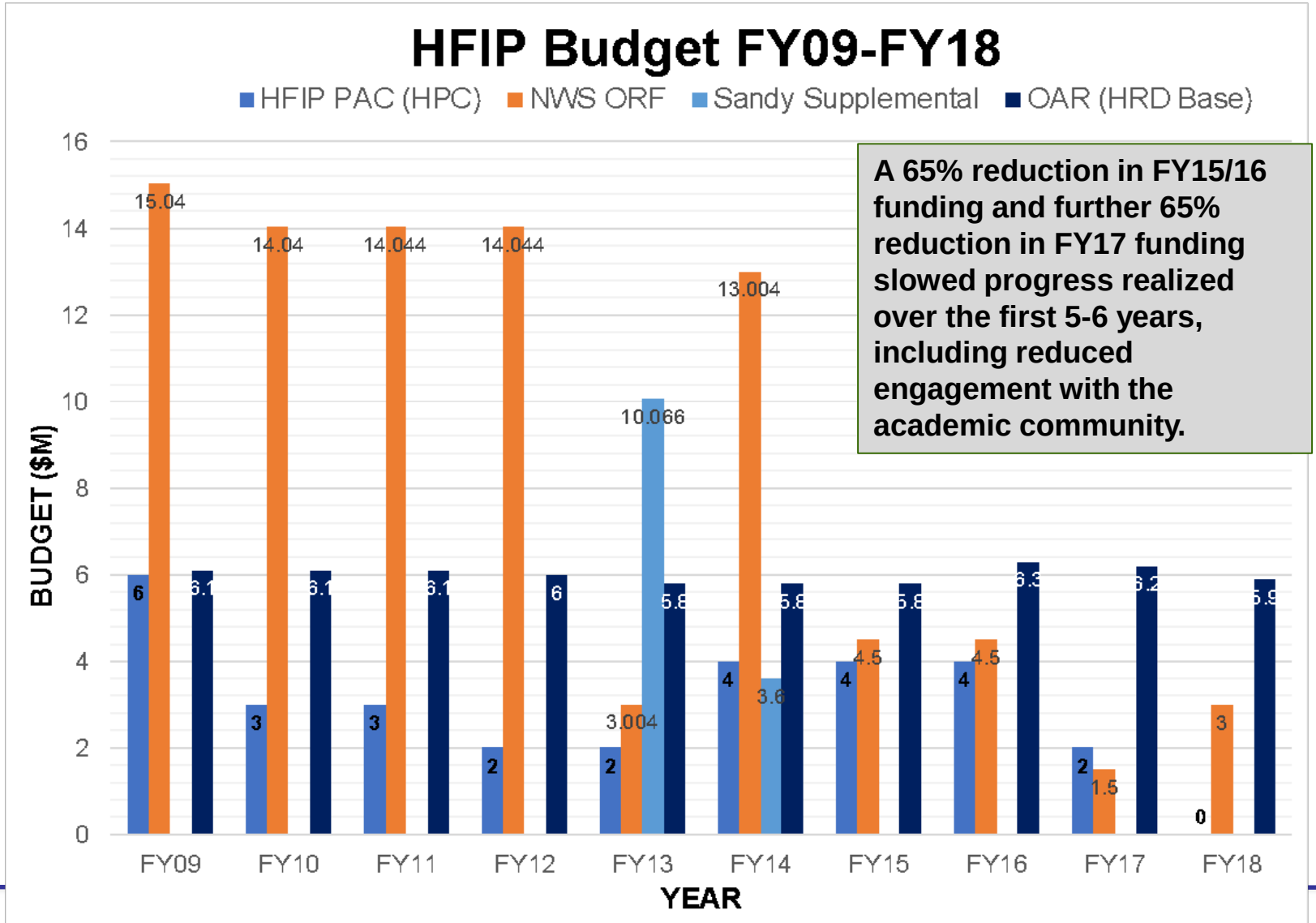
Goals

- 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

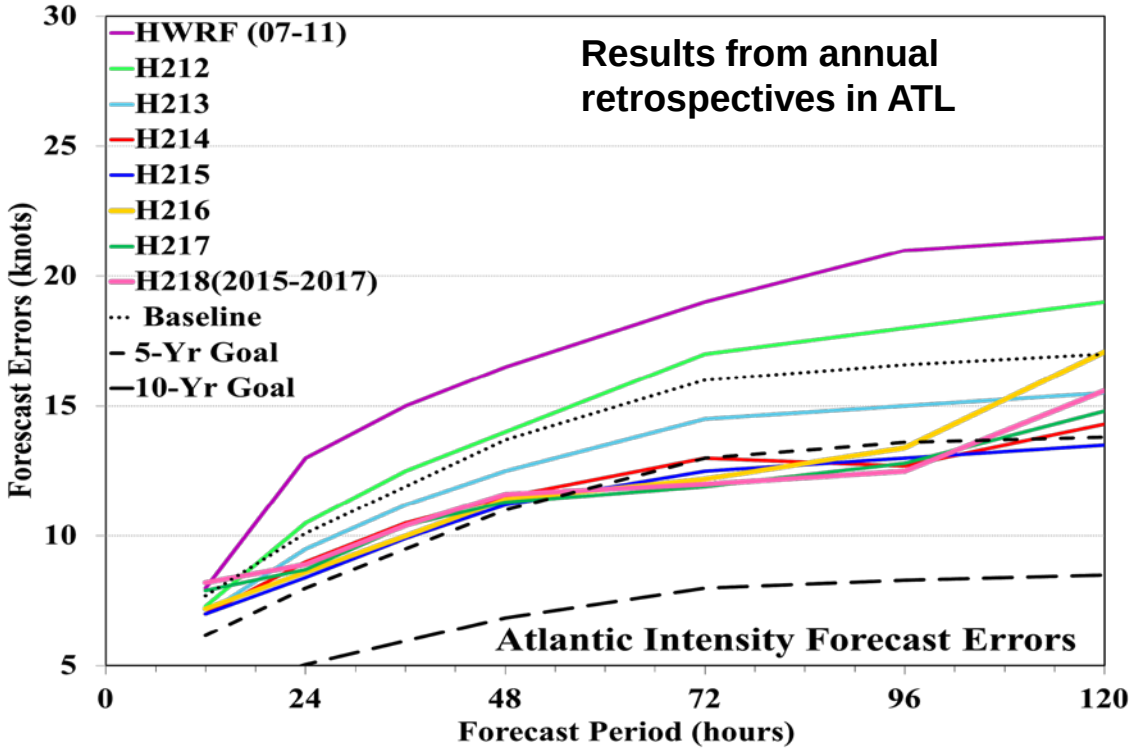
HFIP achieved ~20% decrease in average hurricane track and intensity forecast errors, reaching the 5-yr goals, and for track very close to the 10-yr goal.

Appropriation History
(2009-2018)



HWRF: Hurricane Weather Research and Forecast System

- HWRF continuously improved in the past seven years through support from HFIP
- Successful community modeling approach for accelerated transition of research to operations
- New in 2018 for operational HWRF:
  - Increase horizontal resolution to 13.5/4.5/1.5 kms
  - Updates to RRTMG radiation scheme
  - Unified HWRF/HMON coupler



  - New datasets for assimilation in the hurricane inner core and environment
    - SFMR, dropsonde drifts
    - G-IV TDR
    - GOES-16 AMV's and NOAA-20 data sets

Real-time Reservation Projects run during the 2018 Season

Real-time Reservation Project	User Name	Organization
HWRF driven by FV3GFS Parallel Experiment	Avichal Mehra (base project PI), Biju-Thomas (RT PI), Bin Liu (Tech.Lead)	EMC
HWRF Ensemble: rthwrf-EPS	Avichal Mehra (Base PI), Zhan Zhang (RT PI), Weiguo Wang (Tech.Lead)	EMC
3-km nested hfvGFS (Atlantic)	Shian-Jiann Lin (Base PI), Andrew Hazelton (RT PI), Matt Morin (Tech.Lead)	GFDL
Real-time Basin-Scale HWRF (w/ cycled data assimilation)	Ghassan Alaka, Jr. (Base and RT PI) Jonathan Poterjoy, Xuejin Zhang, and Gopalakrishnan Sundararaman	AOML/HRD
HMON Ensemble real-time experiment: hwrfv3	Avichal Mehra (Base-PI) , Weiguo Wang (RT-PI), Lin Zhu (Tech. Lead)	EMC
FV3GFS, C768 with data assimilation (DA) cycle	Georg Grell (Base and RT PI), Judy Henderson (Tech.Lead)	ESRL, GSD
Real-Time Analog Ensemble: hwrf-anen	William E. Lewis (Base and RT PI), Chris Rozoff (New role or Tech.Lead)	UWI.edu

2018 HFIP FFO University Awarded Grants

Project Title (Linked)	Submitting Organization	Principal Investigator	Priority Area(s) - see below	Total $
Advanced DA Techniques for Satellite-Derived Atmos. Motion Vectors from GOES 16/17 in the HWRF	WI-CIMMS	**Lim, Agnes**	a	$221,400
Using Dynamically-Based Probabilistic Forecast Systems to Improve the NHC Wind Speed Speed Products	CSU-CIRA	**Schumacher, Andrea**	d,c	$200,004
RI changes: improving sub-grid scale model parameterization and microphysical-dynamical interaction	FIU	**Zhu, Ping**	b	$296,701

a: Data Assimilation
b: Prediction: Intensity/Track
c: Ensemble Development
d: Post-Processing

Priorities for the Next Phase of HFIP

- Evolution of HAFS - FV3 based hurricane application
- Reduce largest track and intensity errors
  - Target RI cases; improve initialization & physics impacting rapid intensity change
- Focus on improvements of model physics (scale aware)
- Continued focus on high-resolution ensembles and data assimilation (satellite data)
- Improve ensemble prediction & products
- Extend/improve guidance out to 7 days
- Provide improved products and tools to the forecasters

Weather Act Sec.104: HFIP

Develop an updated plan, detailing the specific research, development, and technology transfer activities necessary to sustain HFIP and achieve the 3 focus areas in **Section 104 of the Weather Research and Forecasting Innovation Act**:

1. improving the prediction of rapid intensification and track of hurricanes
2. improving the forecast and communication of storm surges from hurricanes
3. incorporating risk communication research to create more effective watch and warning products

The plan will detail long-term HFIP goals, priorities, and approaches.

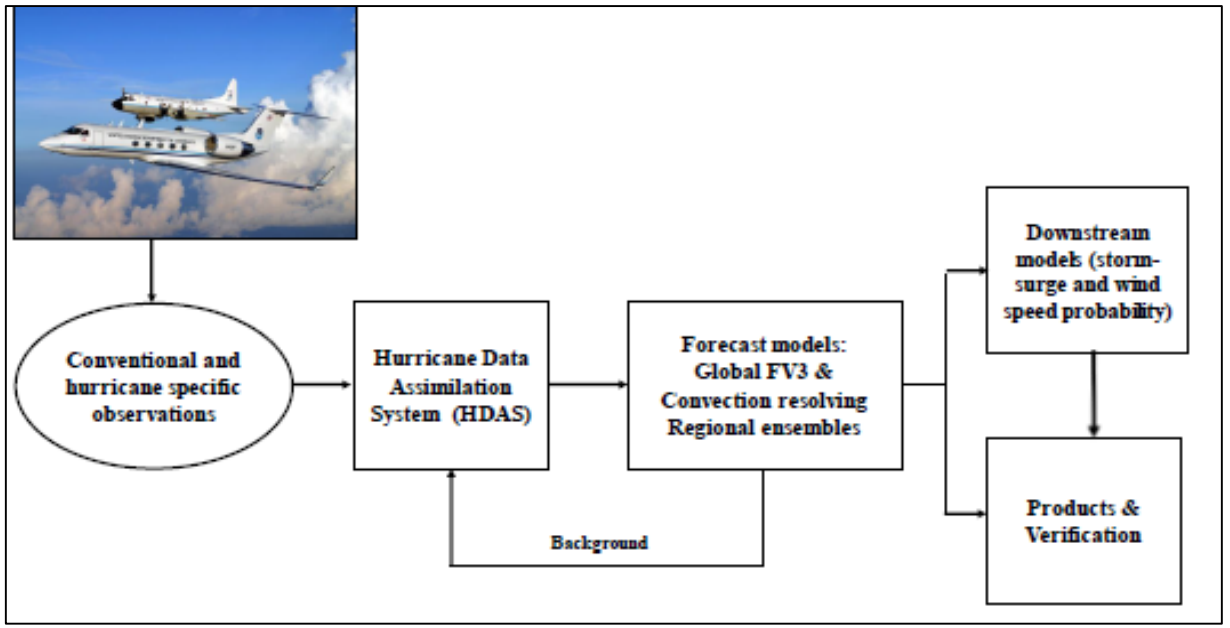
HFIP Goals aligned with the Weather Act

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

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

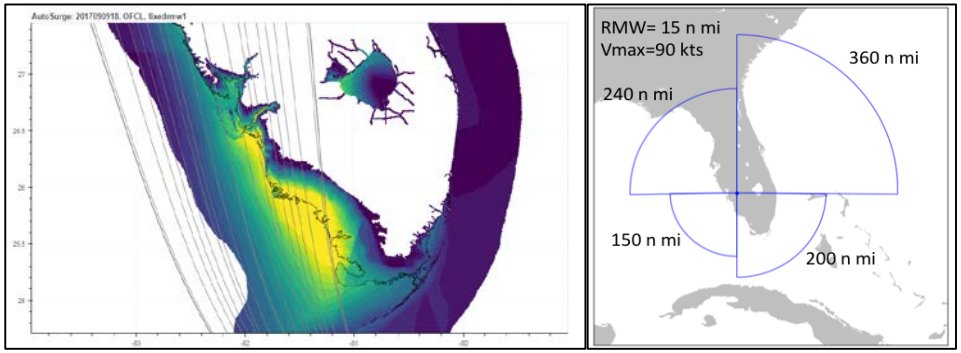


Key Strategies: Guidance & Products

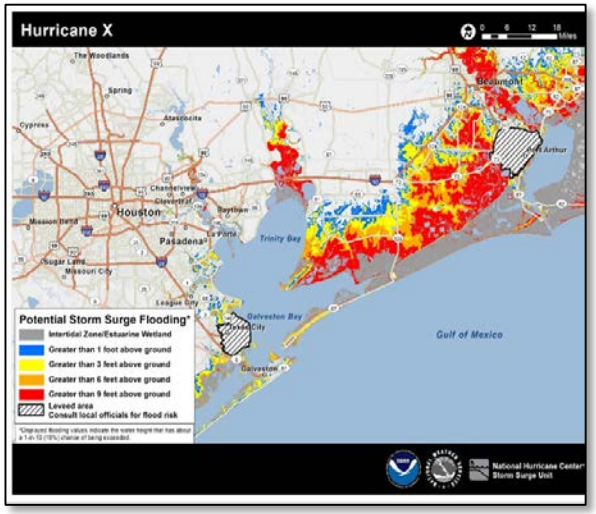
2. Improve probabilistic guidance

- 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

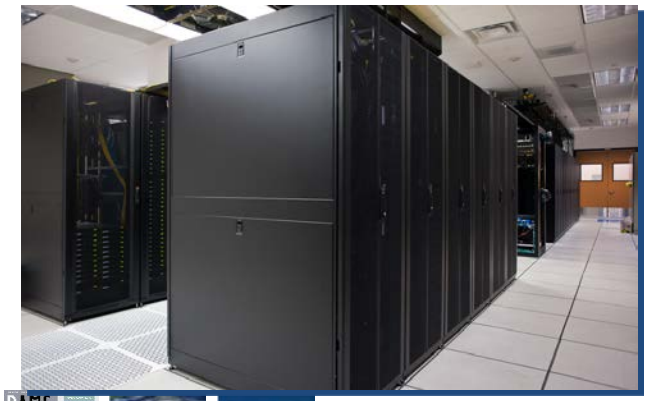
- Evaluate TC products for effective communication of risk
- Determine operationally viable ideas from NWS partners and stakeholders
- Iterate between social and behavioral sciences and operational community to develop and/or enhance new and/or current TC products

Key Strategies: HPC

4. Support Dedicated HPC Allocation

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

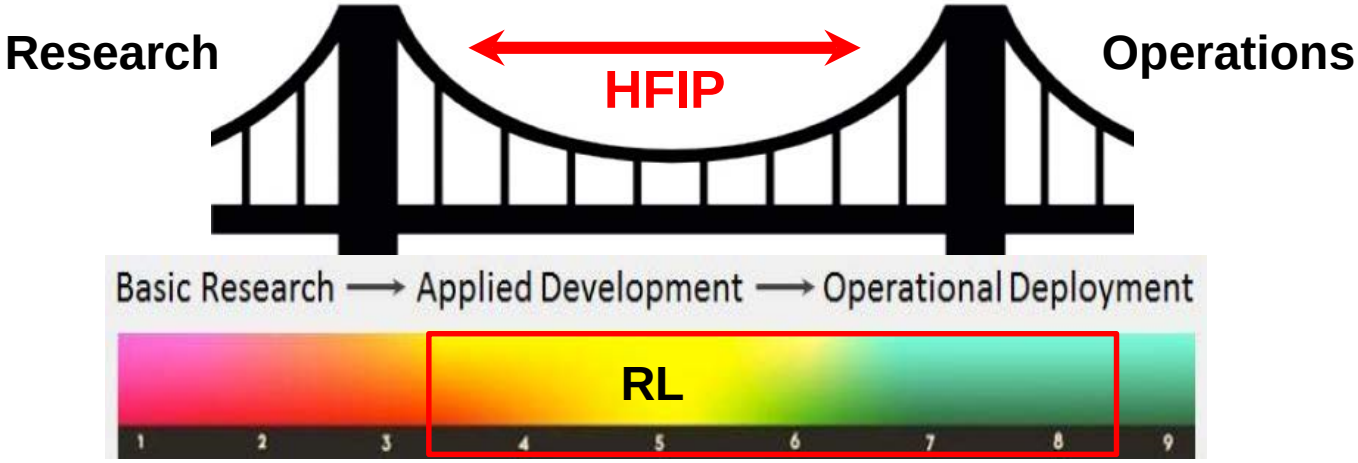
Compute	(core h/ month)	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023
Hurricane	Prediction (R&D)	**41.6M**	**57.2M**	**72.8M**	**88.4M**	**104.0M**	**119.6M**
Hurricane	Operations (NCEP)	1.54M	1.85M	2.21M	2.66M	3.20M	3.84M
Storm surge	NHC/SLOSH/ SWAN	4.8M	6.6M	8.4M	10.2M	12.0M	13.8M
	MDL	0.36M	1.58M	2.02M	3.32M	6.85M	7.09M
	NOS		0.45M	0.45M	0.55M	0.55M	0.71M
Disk	**(TB)**						
Hurricane	Prediction	**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

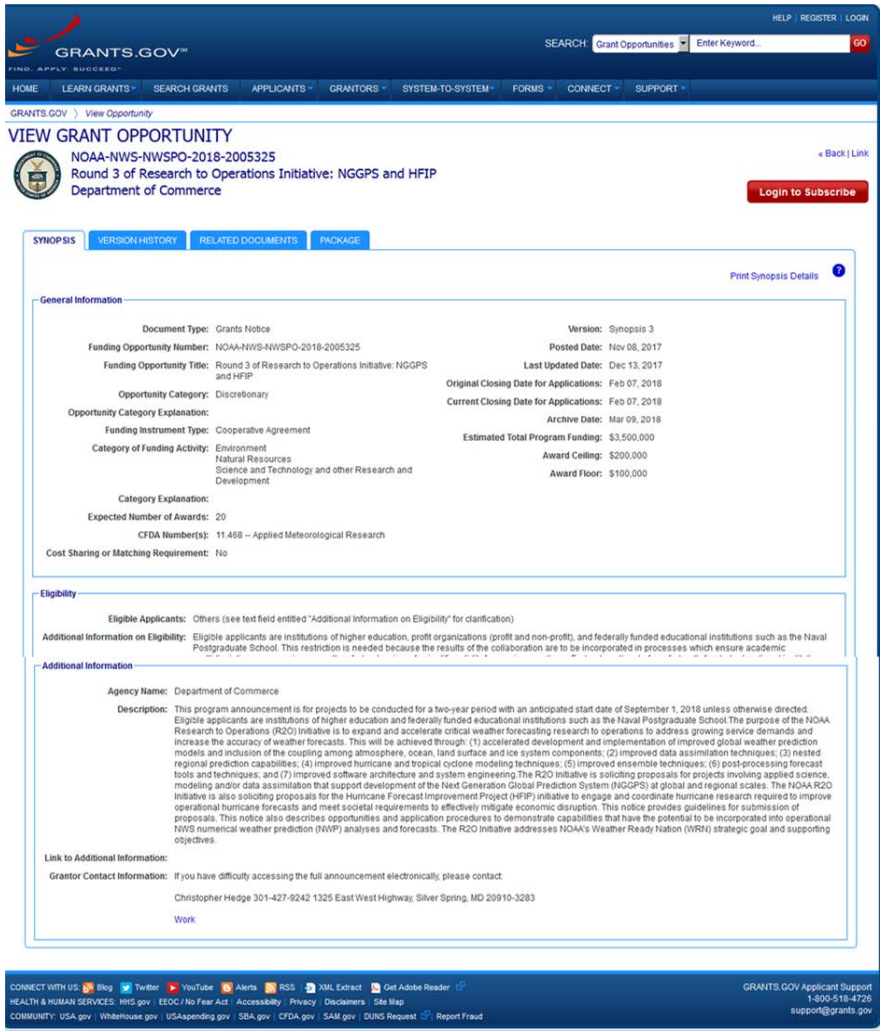
- Accelerate R2O using NOAA Testbeds by following NOAA's best practices for promoting readiness levels
- Develop a process to prioritize research targeted for operational improvements



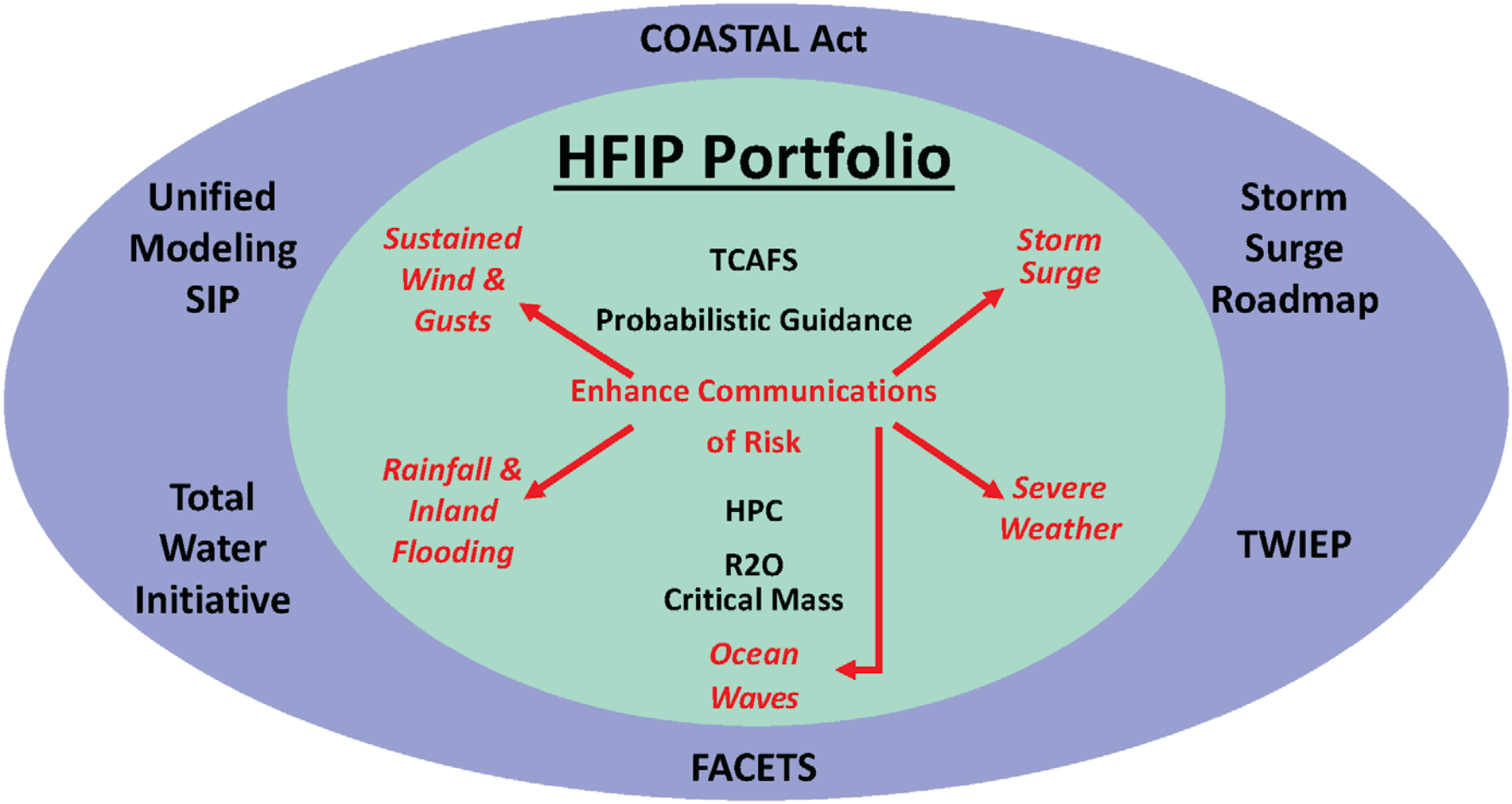
Key Strategies: Outreach to Community

6. Broaden expertise & expand interaction with external community

- Re-invigorate 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)



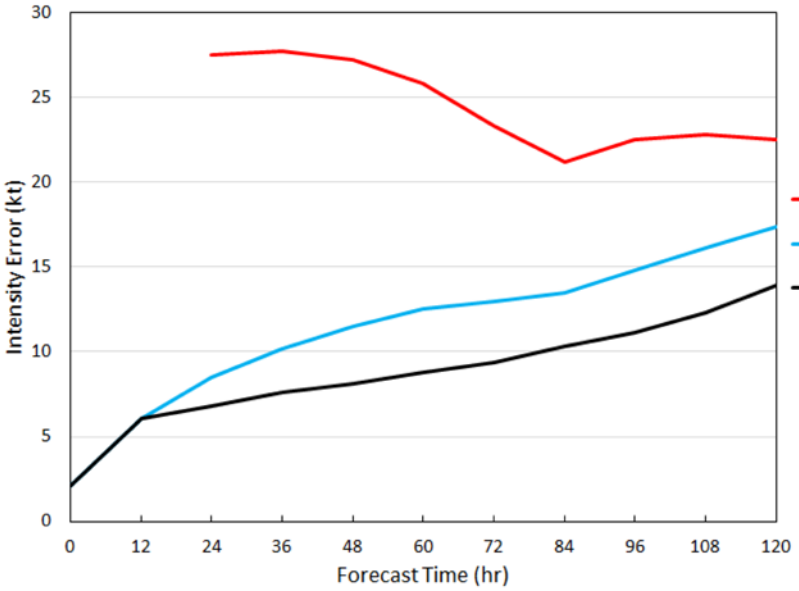
Connections



Questions?

Rapid Intensification Goal

3-yr IVCN Intensity Error



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

- Reduce all and RI intensity error by 50%

Intensity Error Baseline and Goal