





Hurricane Forecast Improvement Project Overview: 2018 HFIP Annual Meeting

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NOAA Hurricane Forecast Improvement Project

Meeting the Nation's Needs



HFIP Vision/Goals (2009-2018)



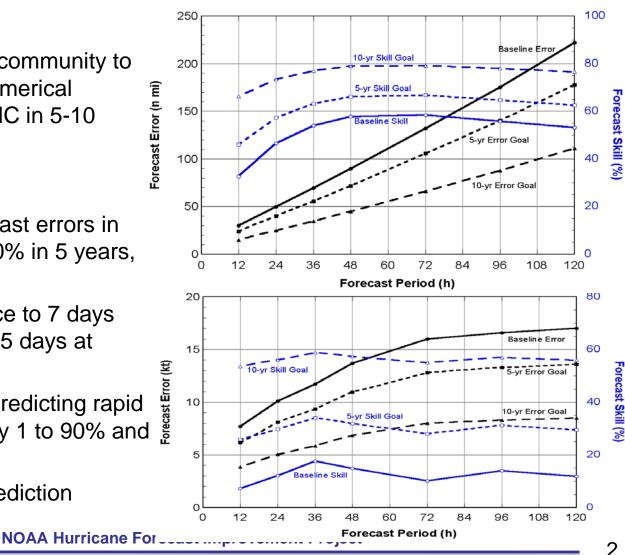
• Vision

 Organize the hurricane community to dramatically improve numerical forecast guidance to NHC in 5-10 years

Goals

- Reduce numerical forecast errors in track and intensity by 20% in 5 years, 50% in 10 years
- Extend forecast guidance to 7 days with skill comparable to 5 days at project inception
- project inception
 Increase probability of predicting rapid intensification (RI) at day 1 to 90% and 60% at day 5
- Improve storm surge prediction





Meeting the Nation's Needs



Keys to 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.

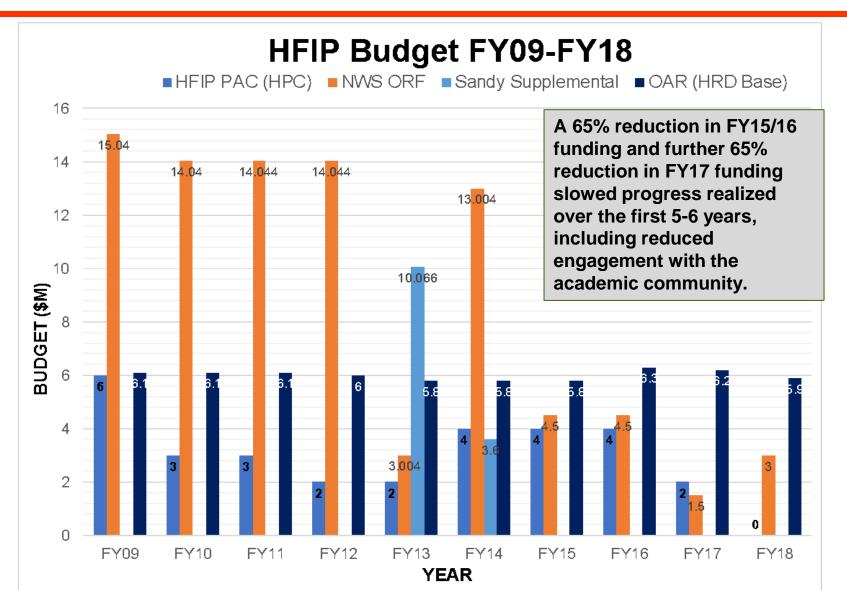
- Partnerships: NOAA research working closely with operations (NWS/NCEP, DOD/JTWC), Federal & academic partners (NASA, NSF, ONR, NRL, NCAR), & international collaborations
- **Outreach and community participation**
 - Developed and facilitated next generation of TC researchers for NOAA
- HFIP R&D computing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





Appropriation History (2009-2018)







Highlights for 2018



- Operational HWRF was best individual intensity forecast in the ATL
 - HWRF was best individual model for RI cases
 - Storm size errors and bias were reduced for both basins
- Improved Data Assimilation system in HWRF
 - Admit new data sets (GOES-16 AMV's, NOAA-20, SFMR, Dropsonde drifts, TDR from G-IV)
- Improvements in numerical guidance continuing to appear in NHC official forecast
- Initial results of HWRF model driven by new FV3GFS data run during the realtime season
 - Oper HWRF outperforms FV3-HWRF with continued development is ongoing to address the degradations
- HWRF v4.0 public release includes the capability to test HWRF using FV3GFS BC/ICs

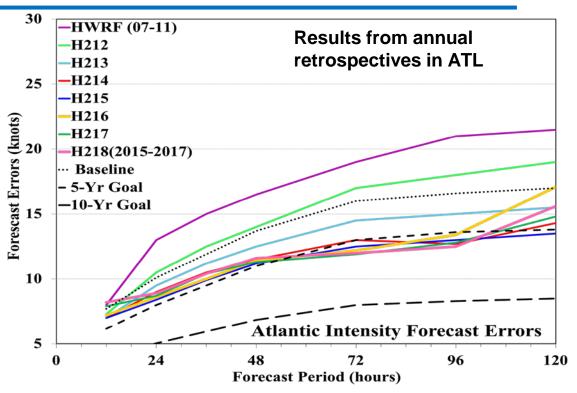




HWRF: Hurricane Weather Research and Forecast System



- 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
 - o SFMR, dropsonde drifts
 - o G-IV TDR
 - $\circ~$ GOES-16 AMV's and NOAA-20 data sets

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Real-time Reservation Projects run during the 2018 Season

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



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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	а	\$221,400	
Using Dynamically-Based Probabilistic Forecast Systems to Improve the NHC		Schumacher,			
Wind Speed Speed Products	CSU-CIRA	Andrea	d,c	\$200,004	
<u>RI changes: improving sub-grid scale</u> <u>model parameterization and</u>					
microphysical-dynamical interaction	FIU	Zhu, Ping	b	\$296,701	
New Frameworks for Predicting Extreme Rapid Intensification	MIT	Emanuel	b	\$339,571	a: Data Assimilation
Enabling Cloud Condensate Cyling for All-Sky Radiance Assimilation in HWRF	CSU-CIRA	Wu, Ting-Chi	a,b	\$238,017	b: Prediction: Intensity/Track
Evaluating initial condition perturbation					c: Ensemble Development
methods in the HWRF ensemble BANS = president system	SUNY Albany	Torn, Ryan	c,d	\$292,483	d: Post-Processin



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





Revised HFIP Goals aligned with the Weather Act



- Reduce forecast guidance errors, including during RI, by 50% from 2017
- 2. Produce 7-day forecast guidance as good as the 2017 5day 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





Key Strategies:



- 1. Advance an operational Hurricane Analysis and Forecast System (HAFS)
- 2. Improve probabilistic guidance
- 3. Enhance communication of risk and uncertainty
- 4. Support dedicated high performance computing allocation
- 5. R2O Enhancement
- 6. Broaden expertise and expand interaction with external community



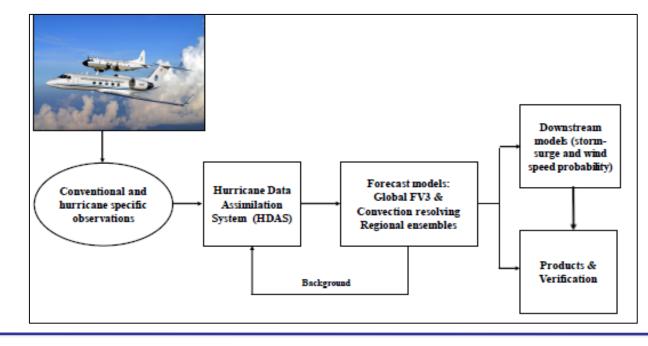






1. Advance operational hurricane analysis and forecast system (HAFS)

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







HAFS Yearly Milestones



- HAFS v0.0 is HWRF
- Prototype HAFS v0.A: 3km single domain FV3 (3km) centered over the NATL basin -- Year 1
- Prototype HAFS v0.B: Global FV3 (13 km) with a static nest (3 Km) centered over the NATL basin -- Year 1
- HAFS v0.1: Single storm configuration over the NATL basin with HWRF physics, VI, DA and coupling to ocean -- Year 2
- HAFS v0.2: Fully coupled configuration with inner-core DA and multiple moving nests -- Year 3





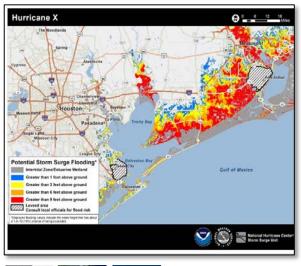
Key Strategies: Guidance & Products



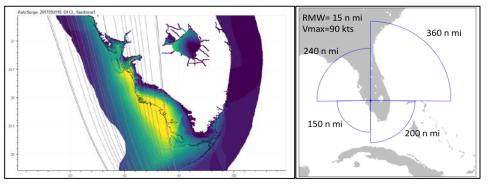
2. Improve probabilistic guidance

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

Potential Storm Surge Flooding Map



Planned improvements to P-Surge to Improve the 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	(ТВ)						
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

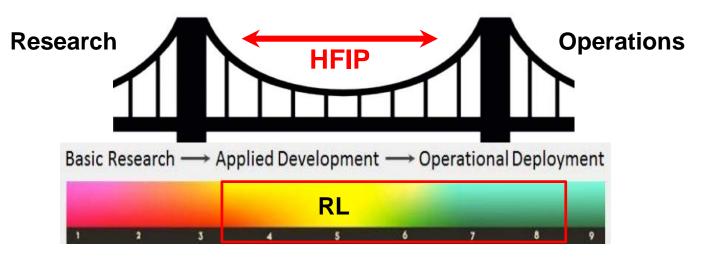






5. Research to Operations (R20) Enhancements

- 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, HWT, HMT, DTC, JCSDA)





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Key Strategies: Outreach to 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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	c Grants Notice c NOAA-WVS-NWSPO-2018-2005325		Synopsis 3
	 NOAA-MVS-NVSPO-2018-2005325 Round 3 of Research to Operations Initiative: NGGPS 	Posted Date: Last Updated Date:	Nov 08, 2017
renang opportunity title	 Round 3 of Research to Operations Initiative, NGGPS and HEIP 	Cast Updated Date: Original Closing Date for Applications:	
Opportunity Category		Current Closing Date for Applications:	
Opportunity Category Explanation		Archive Date:	
	r: Cooperative Agreement	Estimated Total Program Funding:	\$3,500,000
Category of Funding Activity	Natural Resources	Award Ceiling:	\$200,000
	Science and Technology and other Research and Development	Award Floor:	\$100,000
Category Explanation	E.		
Expected Number of Awards	r. 20		
	k 11.468 – Applied Meteorological Research		
Cost Sharing or Matching Requirement	t No		
Eligibility			
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	oble applicants are institutions of higher education profit		darativ fundad a durational institutions such as the
	stgraduate School. This restriction is needed because the		
Additional Information			
Agency Name: Departs	ment of Commerce		
Description: This pro	ogram announcement is for projects to be conducted for a applicants are institutions of higher education and federa	two-year period with an anticipated start di	ate of September 1, 2018 unless otherwise directed
Resear	ch to Operations (R2O) initiative is to expand and accelerate the accuracy of weather forecasts. This will be achieved	ate critical weather forecasting research to e	operations to address growing service demands an
models	and inclusion of the coupling among atmosphere, ocean	, land surface and ice system components.	(2) improved data assimilation techniques; (3) nes
tools an	Il prediction capabilities; (4) improved hurricane and tripic id techniques; and (7) improved software architecture and	system engineering The R2O Initiative is s	soliciting proposals for projects involving applied sci
Inibative	ng and/or data assimilation that support development of the e is also soliciting proposals for the Hurricane Forecast In	norovement Project (HFIP) initiative to enga	ge and coordinate humcane research required to in
proposi	onal humcane forecasts and meet societal requirements als. This notice also describes opportunities and applicat	ion procedures to demonstrate capabilities	that have the potential to be incorporated into open
NWS ni objectiv	umerical weather prediction (NWP) analyses and forecast es.	is. The R2O initiative addresses NOAA's We	rather Ready Nation (WRN) strategic goal and supp
Link to Additional Information:			
Grantor Contact Information: If you ha	ave difficulty accessing the full announcement electronical	Ry please contact	
Christe	pher Hedge 301-427-9242 1325 East West Highway, Silve	er Spring, MD 20910-3283	
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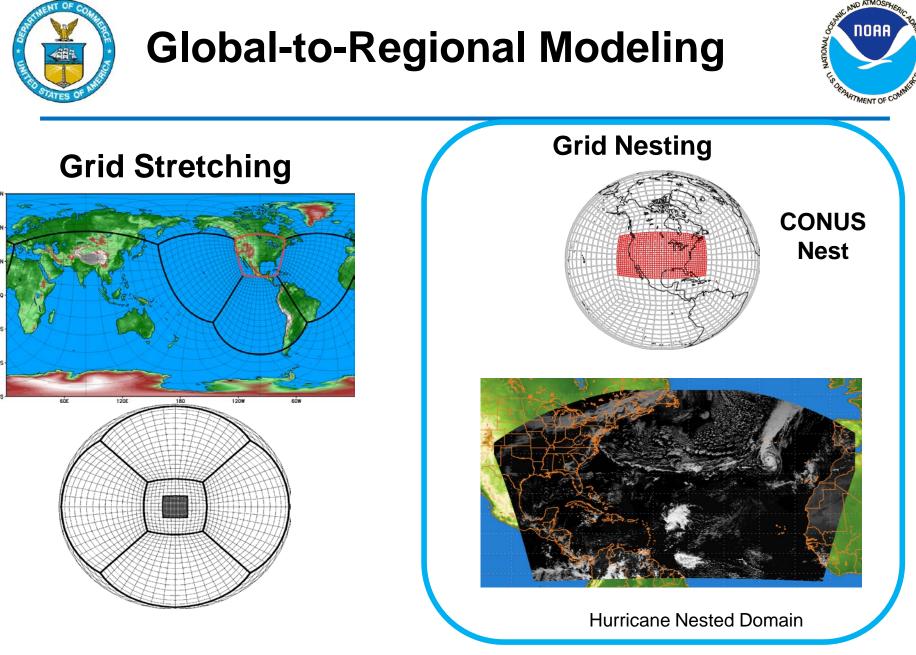






Questions and Discussion







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Nested 3-km FvGFS for Hurricane Harvey

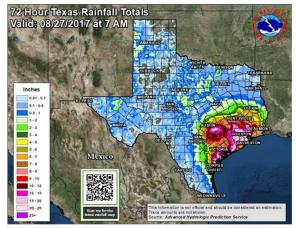


Model configuration of nested 3-km FvGFS

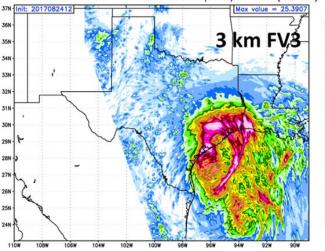
- FV3 dynamical core with GFS physics (fvGFS)
- 13-km global, 3-km nest (2-way interaction) covering the entire Atlantic
- GFDL 6-class microphysics
- Scale-aware SAS convective scheme
- 63 vertical levels

Nested fvGFS captured the double max structure with the core near Corpus Christi and the band training into Houston

OBSERVED 72h PRECIPITATION TOTALS



3-km fvGFS 1-72 hr accumulated precipitation (inches)





NOAA Hurricane Forecast Improvement Project

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