Plans for Jet (HPC) and Research to Operations

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HFIP Annual Meeting, November 7, 2018

Keys to Success

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

NOAA R&DHPC Dedicated to Hurricanes (Jet Machine in Boulder)

	Install Date	Total Cores	Performance (Tflops)	Storage (TB)
Phase 1 (Njet)	Aug 2009	3184	35.6	350
Phase 2 (Tjet)	Aug 2010	10600	113.0	416
Phase 3 (Ujet)	Oct 2011	16648	182.0	1166
Phase 4 (Sjet)	Aug 2012	22088	272.0	1613
Phase 5 (Vjet)	Aug 2014	24456	340.26	3261
Phase 6 (Xjet)	Oct 2015	32520	576	3773
Phase 7 (Xjet+) expansion	Aug 2016	45388	820	4400

Dedicated to hurricane research, community engagement and advanced R2O demonstration (including real-time experiments)

2018 Jet Upgrades

Jan: New lfs1 in production
Aug: Compute cold air isolation completed for all Jet systems
Nov: Infiniband backbone (disk to compute bandwidth) upgrade
Dec: Ethernet management/provisioning network upgrade
Dec: HW to support SW stack expansion
Dec: lfs1 upgrade: +1PB and flash tiers for small file performance improvement
Dec: kJet

2019 Jet Upgrades

2019: Pre-real-time season Jet upgrades

Batch Scheduler: SLURM replacing MOAB, ~March 2019

CentOS 7.x OS upgrade and SW stack refresh

2019: Potential Pre-real-time season Jet upgrades

ARM (Allinea) Forge and Reports for debugging and profiling

Compute System Provisioning and Management SW

Scheduler Changes

SLURM batch system scheduler

- Transition from MOAB to SLURM is being extended until late next quarter.
- Details and new schedule are TBD.
- Currently Selene and a 238 node uJet partition is available for SLURM testing for select testers.

Compute Changes to Jet

2018 Jet Compute configuration changes

Nov: uJet partial decommissioning (334 node, 4008 core, HFIP allocation reduced by ~12%)

Dec: kJet available (360 node, 14,400 core, HFIP allocation is TBD)

Jet Core Allocations

Sept'18: Core Allocation

Cores	tJet	uJet	sJet	vJet	xJet	kJet	Total Cores
HFIP	5,976	7,080	5,440	2,368	15,456	0	36,320
Others	3,120	0	0	2,240	4,128	0	9,488
Total	9,096	7,080	5,440	4,608	19,584	0	**45,808**

Dec'18: Post kJet(TO-5) Core Allocation

Cores	tJet	uJet	sJet	vJet	xJet	kJet[1]	Total Cores
HFIP	5,976	2,856	5,440	2,368	15,456	0	32,096
Others	3,120	0	0	2,240	4,128	14,400	23,888
Total	9,096	2,856	5,440	4,608	19,584	14,400	**55,984**

[1]Final kJet Allocation is TBD by Allocation Committee

Jet File Systems

Jet File Systems Dec'18

	lfs3[1]	lfs1	Total
Install Date	2014	2018	
Capacity (PB)	3.10	3.42	6.52
Quotable (PB)	2.48	2.74	5.22
Others Quota (PB)	0.92	1.48	2.40
HFIP Quota (PB)	1.56	1.26	2.82

[1]lfs3 will likely have to be replaced by Aug 2020

2018 Real-time Reservations Summary

- Application process completed on schedule but there were several scaling, timing, and workflow issues which had to be resolved.
  - 6 projects with 29 reservations authorized (16,774,000 cr-hrs/mo)
  - 16 reservation adjustments required after July 3rd
- The MOAB reservation batch system ran without incident
- 15 help tickets for system and allocation issues
- **Major Issues:**
  - Unreleased/unused Reservations
    - Multiple storms in one reservation
    - Unused reservations not released
  - 1 project reported slow performance on lfs1 in the last week of Oct
  - 1 project experienced variable job performance due to overloading a single lfs1 server

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

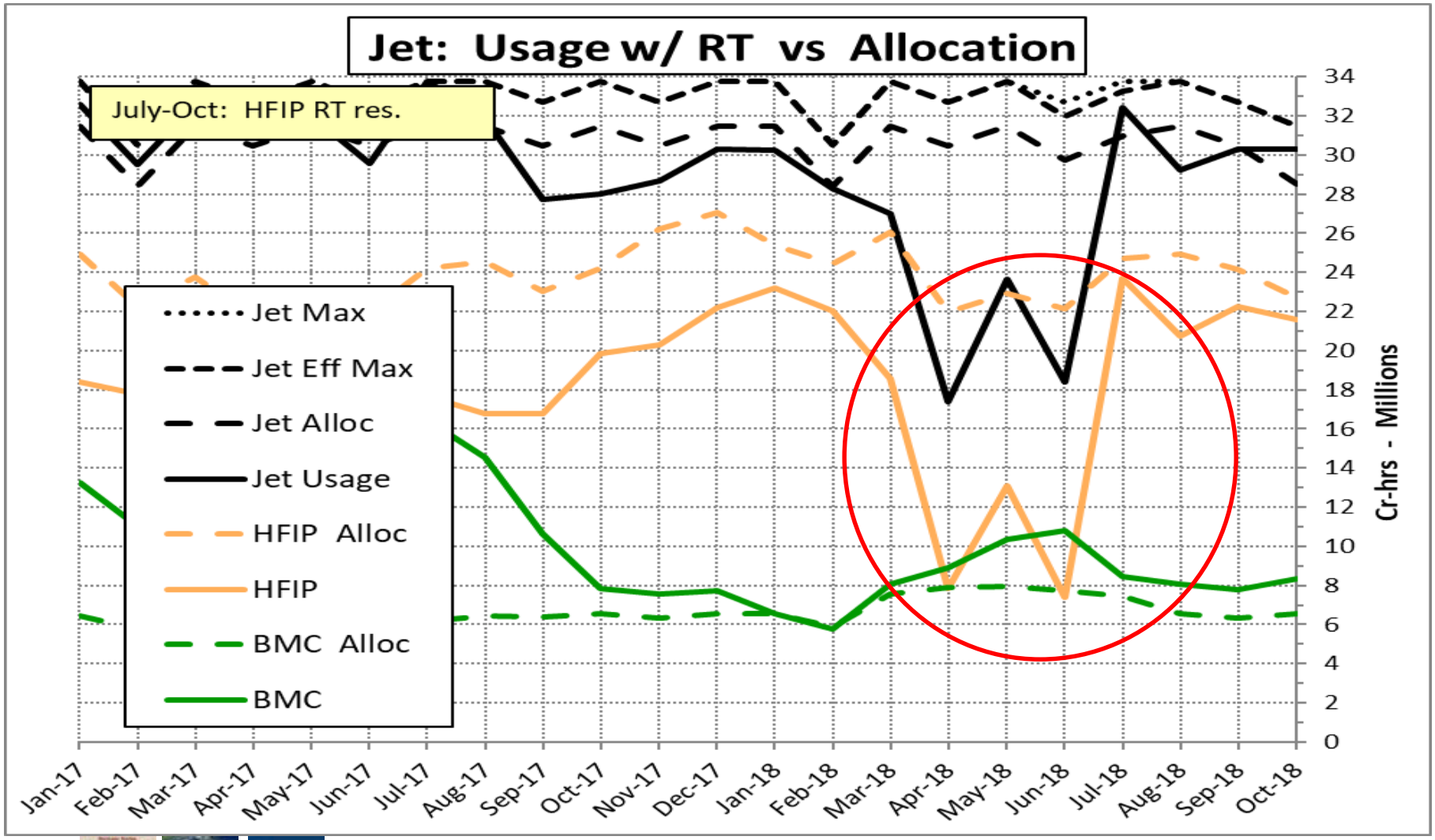
2019 Real-time Reservations Recommendations

- Improve scaling, timing, and workflow data supplied with applications
- Improve reservation structure for multi-storm workflow
- Improve release of unused reservations
- For large data writes “Stripe” data to prevent unstable disk performance

2019 Jet Reservations Tasks/Issues

- Reservations with SLURM (release/recreation, testing)
- Develop reservation utilization charts
- Jet SW upgrades: OS upgrade. SW stack upgrades and consistency with Theia.

Jet Usage Statistics



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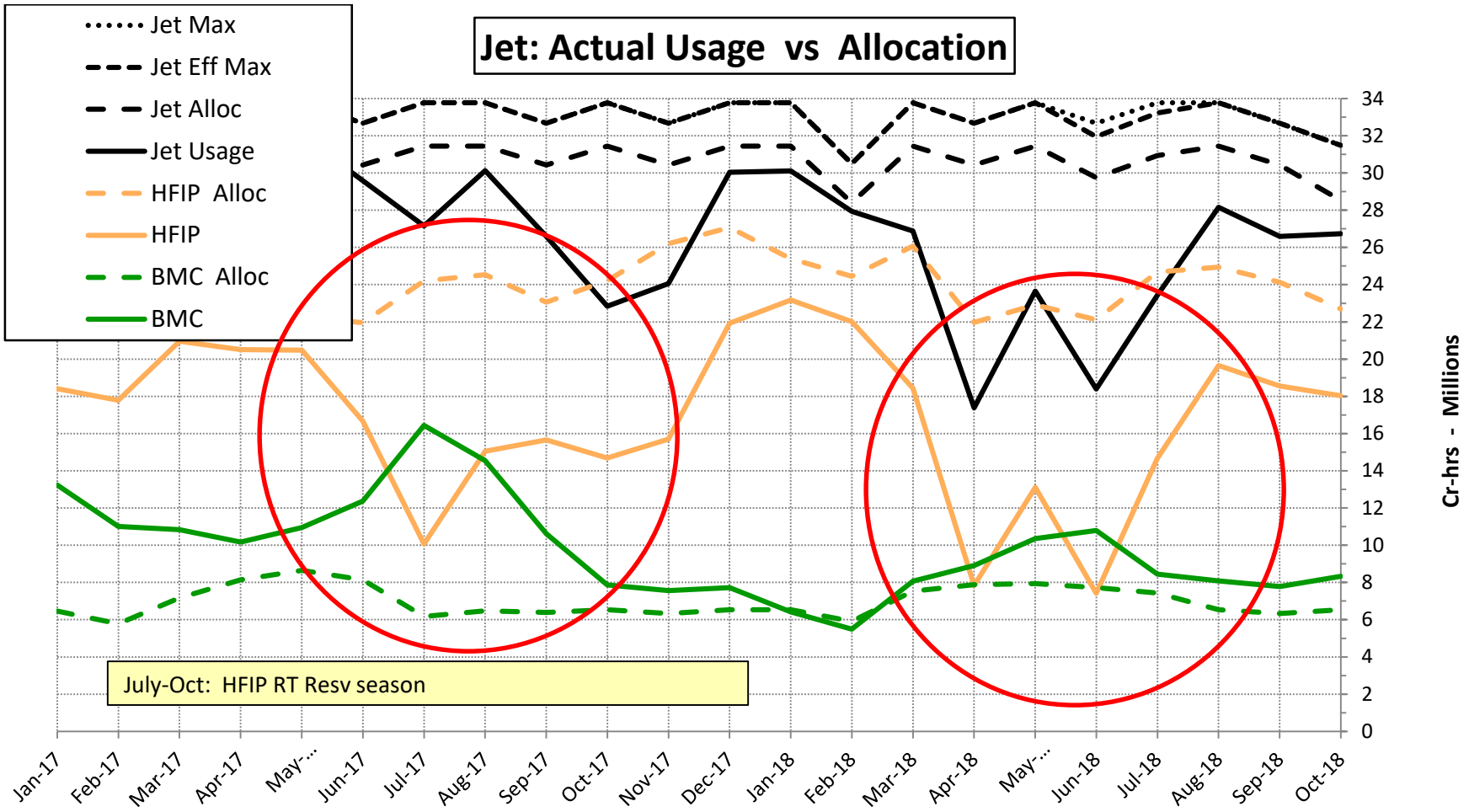


Major Projects and Current Allocations

hwrfv3	5.5 M hrs
hybda	1 M hrs
hur-aoml	4 M hrs
hfv3gfs	8.2 M hrs
dtc-hurr	0.4 M hrs
hfip-gfdl	0.5 M hrs
hfip-hda	0.5 M hrs
swash	0.5 M hrs

Total available HFIP allocations: 21.6 M hrs per month
(reduced from 24.5 M hrs due to ujet reconfiguration for kjet)

Federal Funding Opportunities

2 companion Federal Funding Opportunities (FFO)

- First FFO is two separate competitions: **HFIP** and NGGPS
  - HFIP: Collaborative projects with EMC or NHC researchers
  - NGGPS: Collaborative projects with EMC or CPC researchers, including S2S projects
- Estimated funds available: **$1M for HFIP**, $2.5M for NGGPS
- 2-year projects, maximum funding $200K/year
- Project start date: September 1, 2018

HFIP Funded Projects (2018-2020)

Advanced DA Techniques for Satellite-Derived Atmospheric Motion Vectors from GOES 16/17 in the HWRF	Agnes Lim, U. Wisconsin
Using Dynamically-Based Probabilistic Forecast Systems to Improve the NHC Wind Speed Products	Andrea Schumacher, CSU
Rapid Intensification Changes: Improving Sub-Grid Scale Model Parameterization and Microphysical-Dynamical Interaction	Ping Zhu, FIU
New Frameworks for Predicting Extreme Rapid Intensification	Kerry Emanuel, MIT
Enabling Cloud Condensate Cycling for All-Sky Radiance Assimilation in HWRF	Ting-Chi Wu, CSU
Evaluating Initial Condition Perturbation Methods in the HWRF Ensemble Prediction System	Ryan Torn, SUNY Albany

NGGPS Funded Projects (2018-2020)

Convection Permitting Global Prediction: Evaluation for Operational Application in NOAA	Cliff Mass, U. Washington
Improving Weeks 3-4 Weather Prediction through a Global CAM Version of the NOAA Unified Coupled Modeling Framework	Jim Kinter, GMU
Improving Cloud Processes in the NCEP Global Models	Steve Krueger, U. Utah
Using Process-Oriented Diagnostics with Feature-Based Verification Software to Improve Models	Brian Colle, SUNY Albany
Advancing 4D-Variational Ocean Data Assimilation Capabilities at NCEP	Steve Penny, UMD
Sub-grid Cloud Overlap Radiation Enhancements for Global Weather Predictions	Mike Iacono, AER
The Unified Gravity Wave Physics in the Vertically Extended Atmospheric Models of NGGPS: Resolution-Aware Coupling and Verification with FV3	Valery Yudin, U. Colorado

NGGPS Funded Projects (2018-2020)

Continued Assimilation and Enhancement of the Blended High-Resolution Snow Depth Analysis into NWP Models for Global and Regional Applications	Cezar Kongoli, UMD
Development and Application of Microphysics Specific and Distribution Consistent Microwave Radiance Forward Models for the FV3 Model Under the JEDI Framework	Fuqing Zhang, PSU
The Impact of Ocean Resolution in the UFS on the Subseasonal Forecast of Extreme Hydrological Events	Christina Stan, GMU
Use of Satellite Data to Evaluate Connections Between the Radiation, Cumulus Convection, and Microphysics Parameterization Schemes and their Scale Sensitivity for FV3-GFS	Shaowu Bao, Coastal Carolina University
Scale-Dependent Covariance Localization for the FV3-GDAS 4DEnVar Data Assimilation System to Improve Global and Hurricane Predictions	Xuguang Wang, U. Oklahoma

Key Strategies

4. Increase HPC Capacity

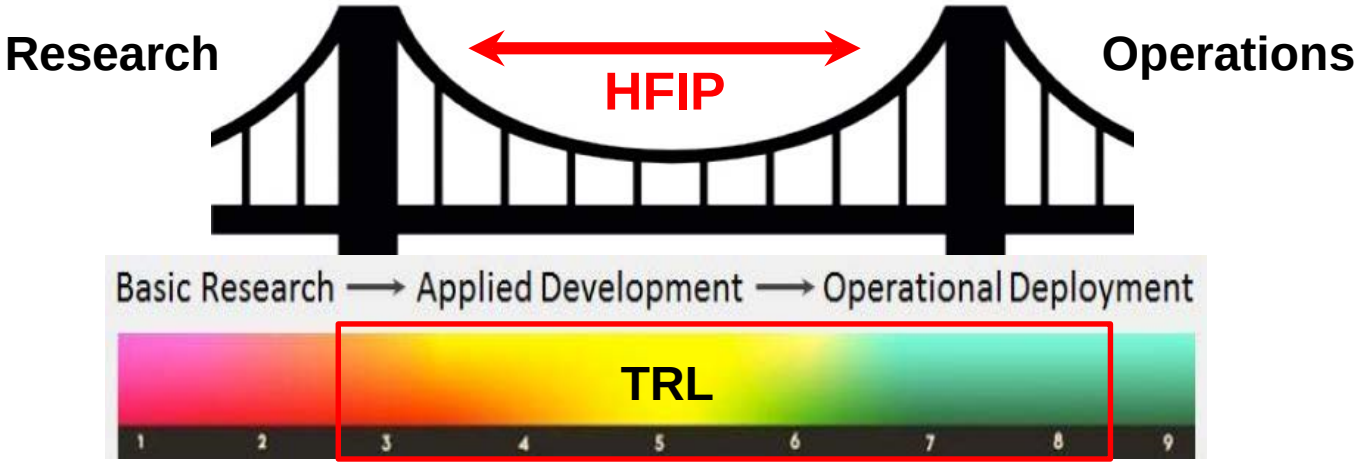
- NOAA R&D and operational computing to support HAFS development
- Sustain modeling and software engineering expertise
- Match with technological innovations

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	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

5. Research to Operations (R20) Enhancements

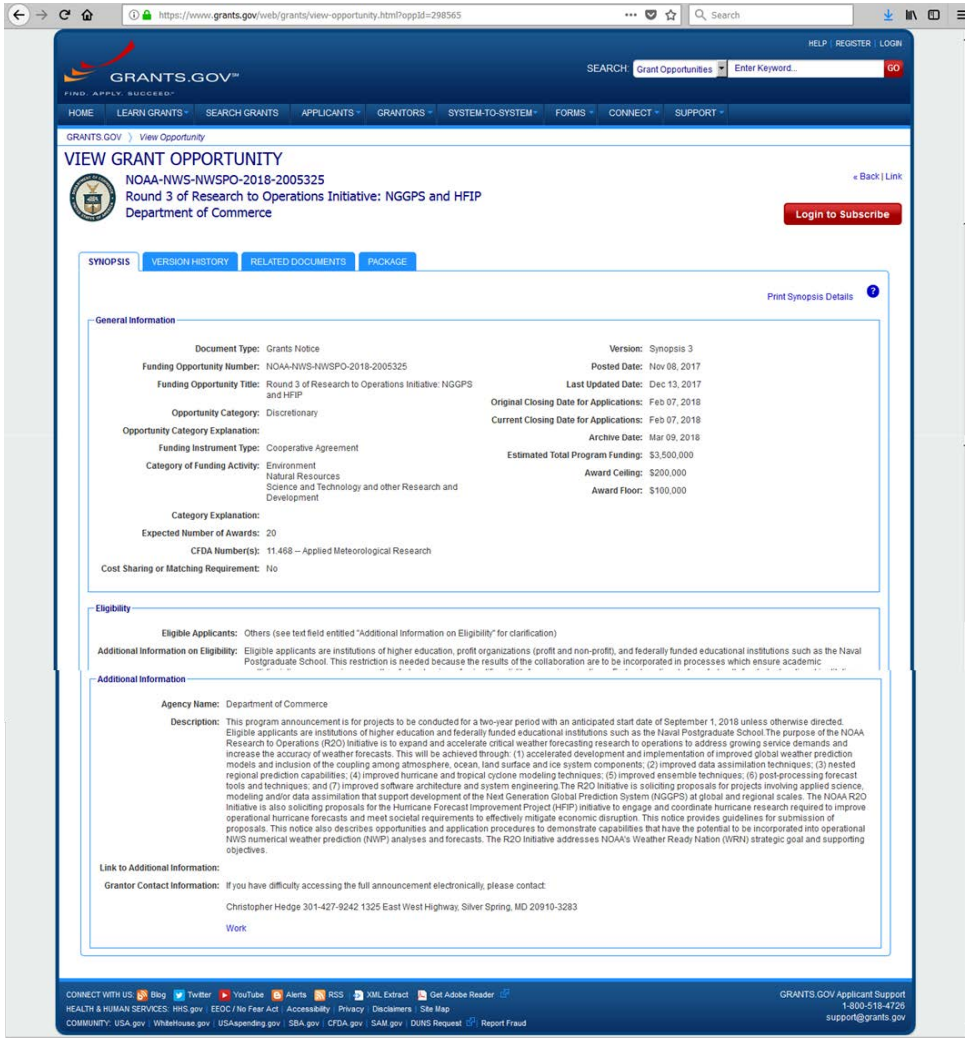
- Accelerate transition to operations by following NOAA's best practices for promoting technical readiness levels (TRLs)
- Develop a process to prioritize research targeted for operational improvements
- More integrated use & support of Testbeds (JHT, DTC, JCSDA)



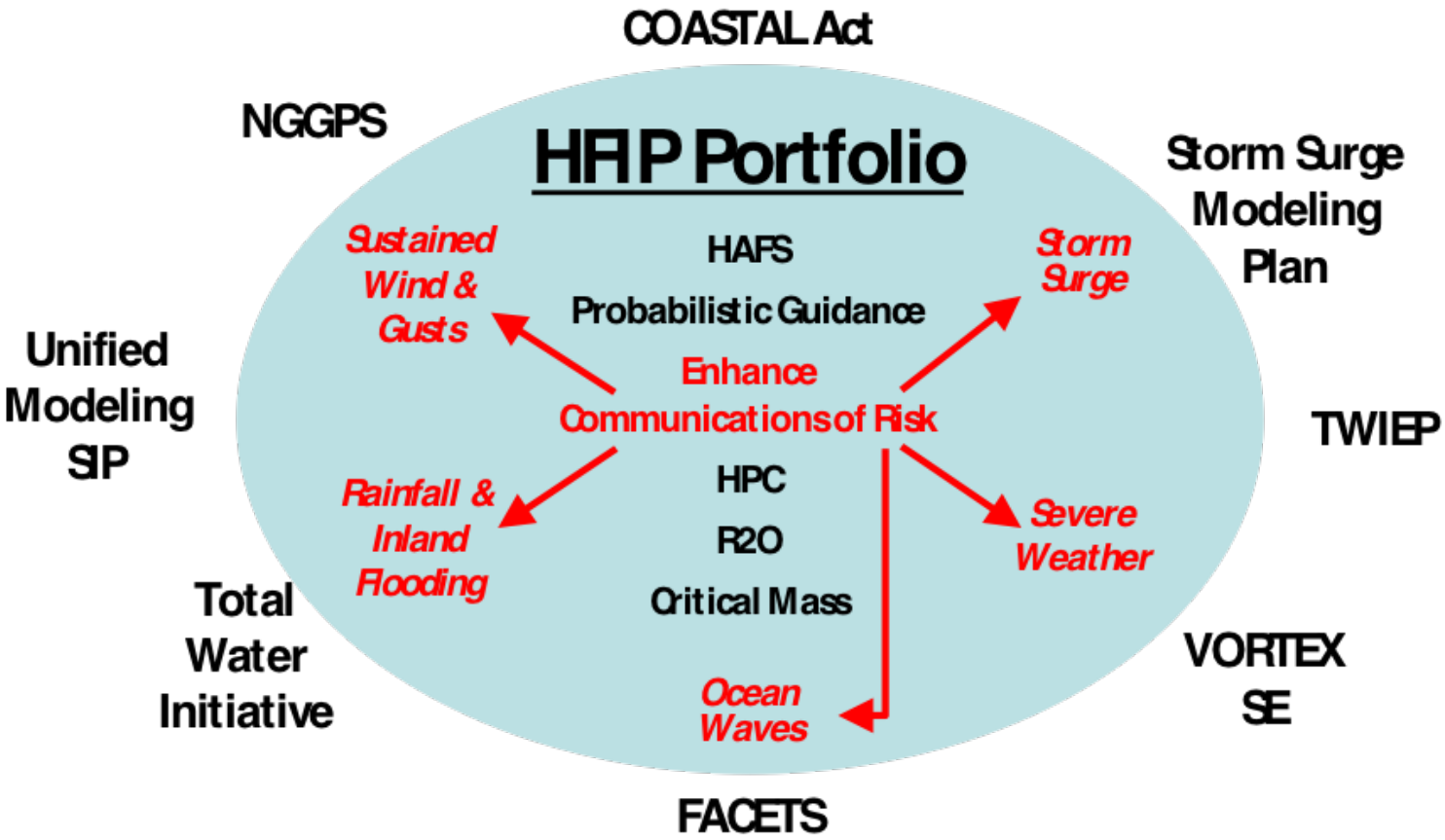
Key Strategies

6. Broaden expertise and expand interaction with external community

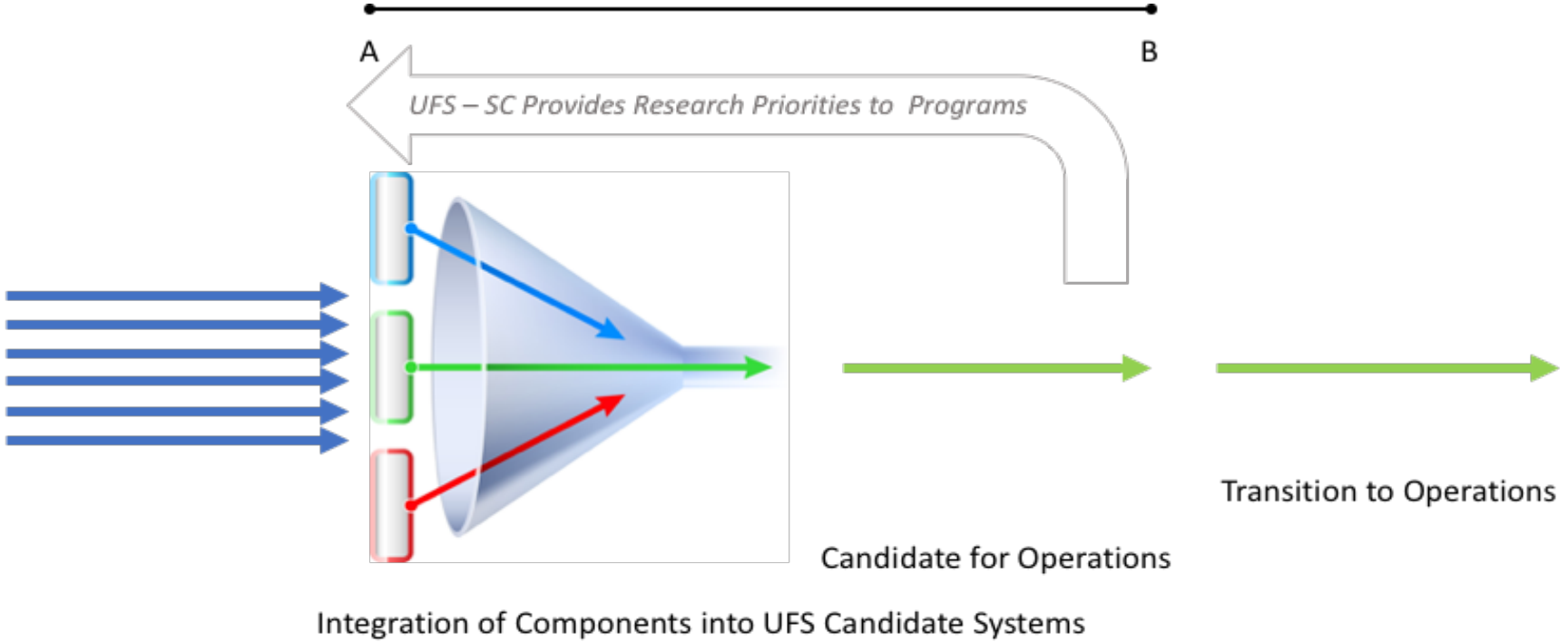
- Re-invigorate the grants program
- Maintain a visiting scientist program at research and operational centers
- Advisory committees, community workshops
- Collaborate/coordinate with social and behavioral sciences
- Outreach to America's Weather Industry (AWI)



Dependencies



Organizing R2O: UFS SC Recommendations



Questions/Discussion