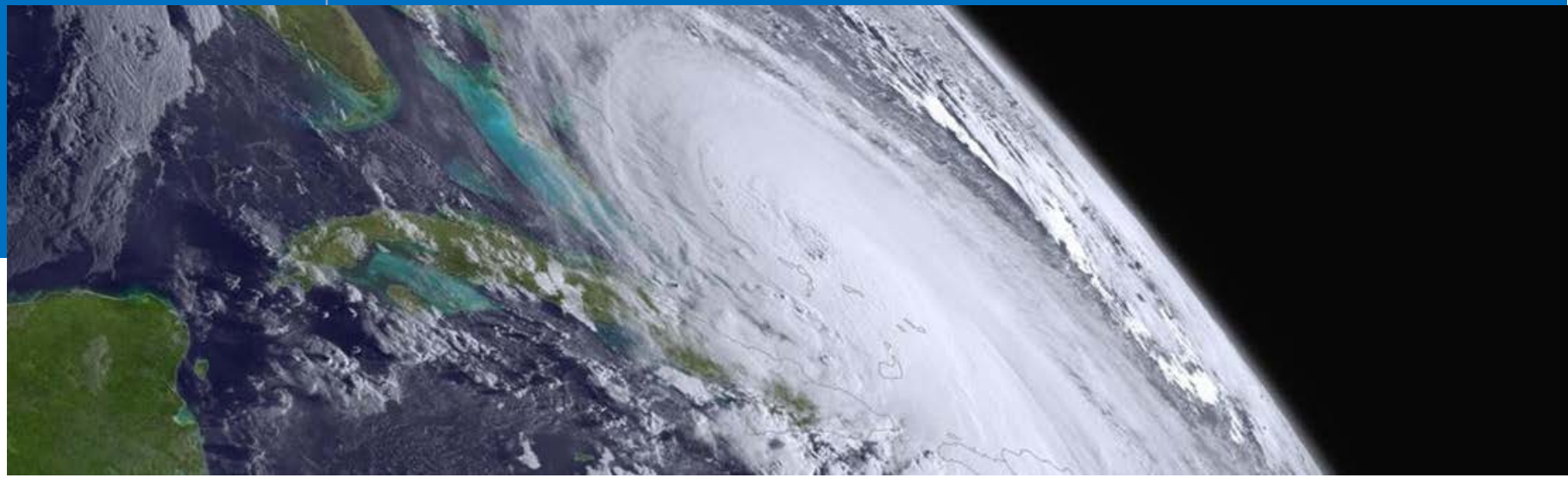
NOAA

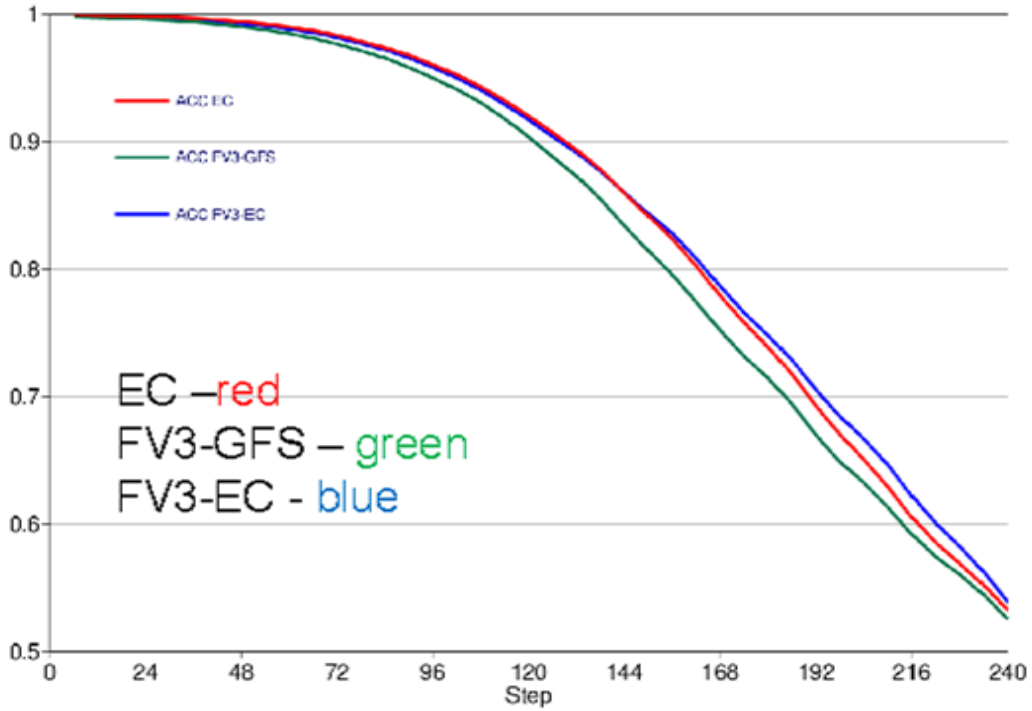
SAB Update
EPIC and NIDIS (WRFIA) Reauthorization



Improving forecast skill and performance

- Strategic Implementation Plan (SIP) for Unified Forecasting System (UFS)
- Quality control of observations
- Data assimilation
- Dynamic core and model physics
- Code efficiency
- Optimized hardware

Anomaly correlation: higher is better



Inherent barriers with the status quo

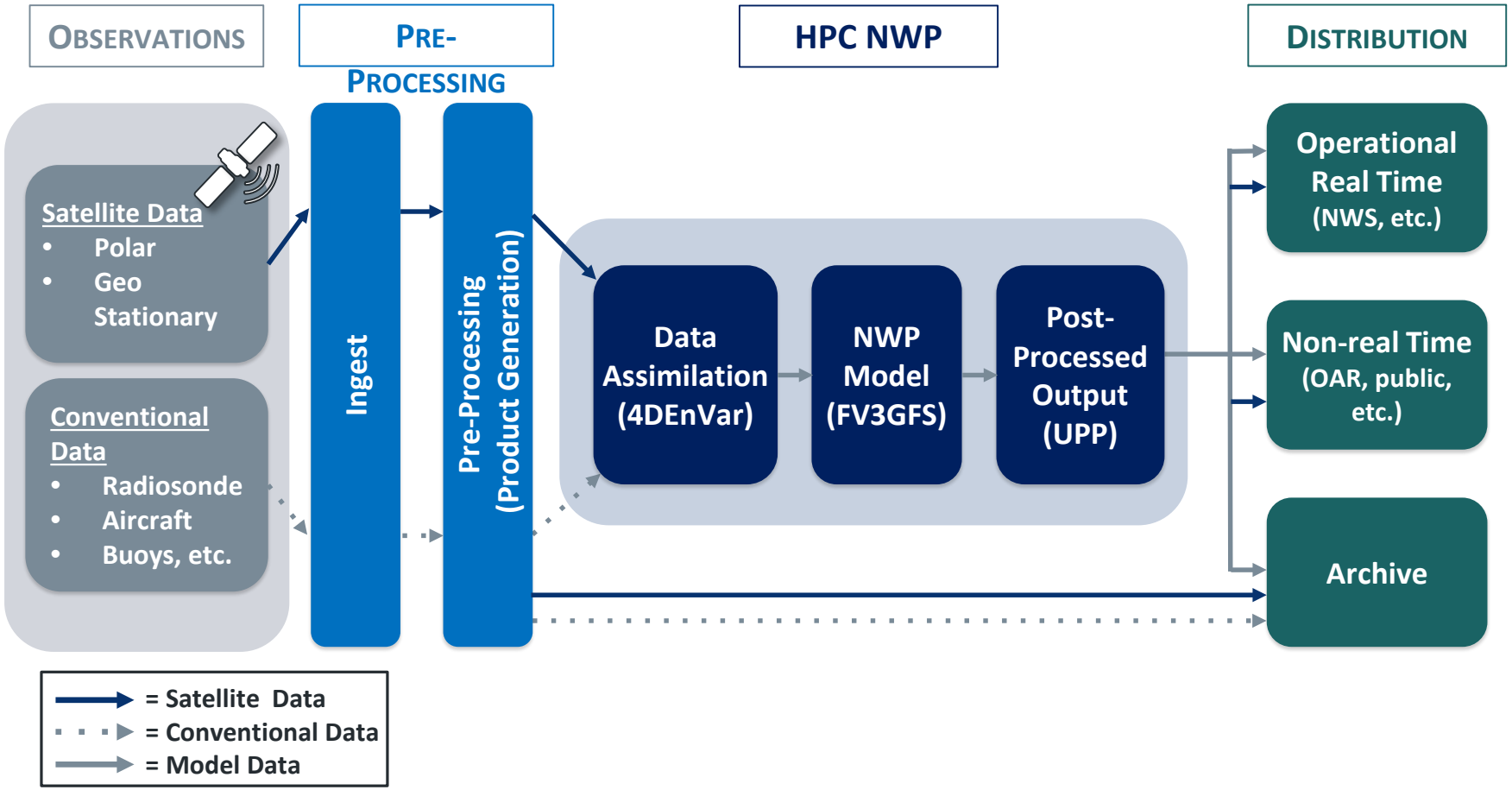
- Fractured internal strategy and mission creep
- Fractured external strategy across various agencies with different priorities
- Obtuse HPC procurement process (both hard iron and cloud)
- Security clearance procedures for visiting scientists
- Cultural (internal and external)
- Funding allocation process disincentivizes collaboration
- Risk aversion (incentive not to fail >> incentive to improve)
- Too many committees with overlapping and conflicting input
- Lack of documented, supported, and portable community code

Accelerate R2O and O2R overview

- End-to-end community model (harness collective advancements)
- Focus on UFS infrastructure (NOAA-NCAR MOA)
- VM (cloud HPC) for on-demand parallel “surge” development
- Visiting scientists (PrepIFS)
- Formalizing the R2O funnel (requirements, gates and transitions)
- Fast-tracking satellite DA / Drive up benefit in cost-benefit ratio
- Agile/nimble “skunk works” sandbox
- Governance, funding, and streamlining committees, etc.
- Accelerating SIP: building off momentum and addressing process deficiencies

High Level Overview of NOAA's Current end-to-end Product and Data Management

All aspects of products and data management should be taken into consideration when exploring Enterprise Cloud solutions.



End-to-end community model

- Weather Research and Forecasting Innovation Act of 2017
- Code development force multiplier once community has access
- UMAC / grad student test
- WRF-ARW
- Initial heavy lift on us / help from vendors
- System architecture agnostic

VMs for on-demand parallel “surge” development

- VM (cloud HPC) for on-demand parallel “surge” development
- Problem : NOAA scientists have long queue to run jobs
- NOAA research : operations compute = 1:1
- ECMWF roughly 5:1
- VMs: X:1 (X=scalable on demand)
- 10 nodes / 1000 h = 1000 nodes / 10 h (same cost, but latter saves 990 h!)
- Parallel experiments and testing already going on at GFDL
- Not meant to replace NCO “hard iron”

Virtual machines and cloud HPC

- Virtual machines (cloud HPC) for parallel community development
- Not all HPC "clouds" are the same
- NWP needs 2 things:

1. Remote Direct Memory Access (RDMA)
   - Remote memory location read/write
   - Direct processor interface bypasses kernel in I/O path
2. Fast interconnect speeds
   - AWS* currently has 25 Gbps (moving to 100 Gbps)
   - Azure currently has 100 Gbps (moving to 400 Gbps)
   - WCOSS has 100 Gbps - Mellanox FDR Infiniband

*Note: NASA study often cited used 25 Gbps AWS and mentions slow interconnect speed as the primary limiting factor

Global model cloud pilot (GMCP)

- Port and test NGGPS in various cloud HPC and VM environments
- Conduct "bake off" with 3rd party software engineering firms and cloud vendors
- Port and containerize FV3 GFS code for various cloud architectures
- NOAA provides raw data and source code
- Vendors are free to select/design cloud architecture and optimize as needed
- Evaluation based on run time, output precision, core count/scalability, portability between vendors, and cost
- Success defined as
  - Ability to match or beat production model run time
  - Numerically replicate production model output
  - Match or beat cost of running on owned on-prim HPC
- Testing initiated by late Q3 FY19 (Shutdown update!!!!)
- Results evaluated by Q1 FY20

Visiting scientists and external expertise

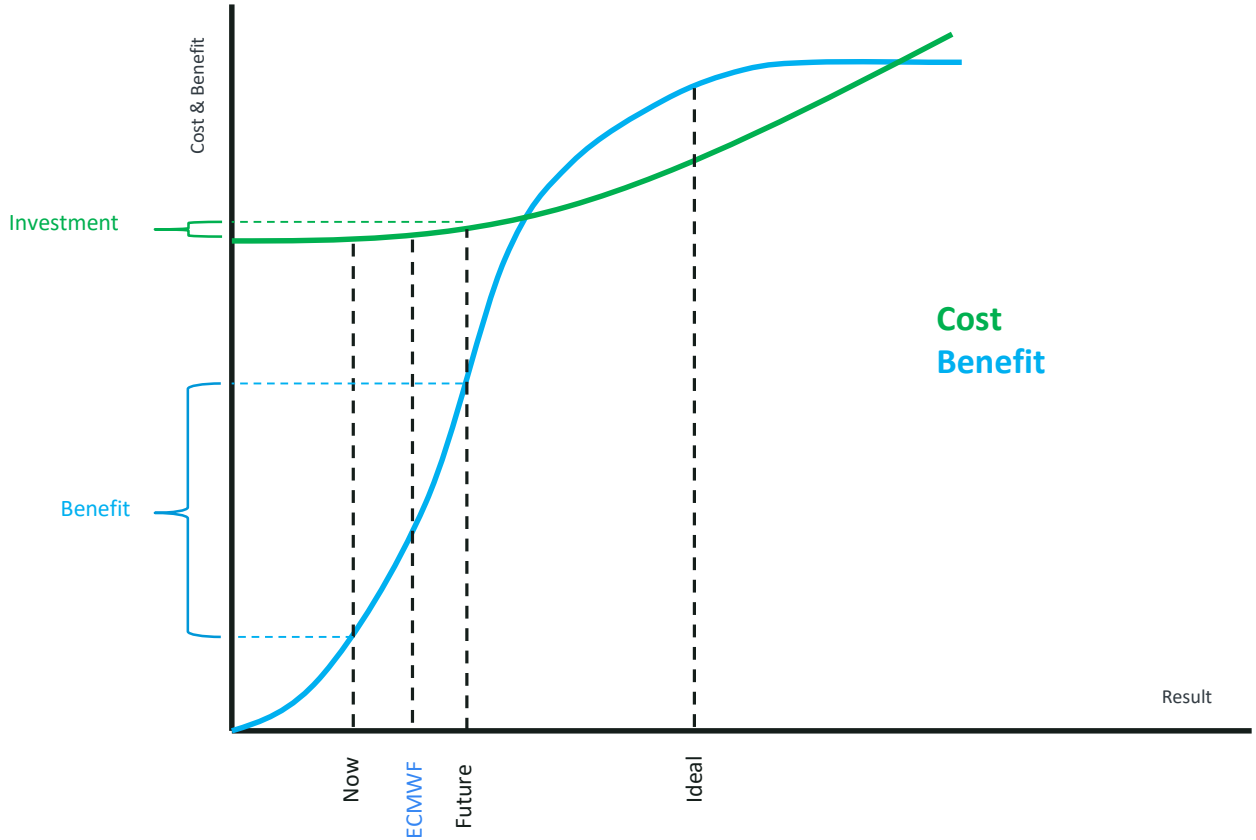
- Move the development sandbox outside NOAA
- Avoid clearance process time lag
- Avoid limited compute resources
- Need accessible interface / PrepIFS
- Will need robust secure ingest (DMZ) for external sandbox
- Modularized code - don't have to know/run entire system
- We need better agency collaboration with NASA, DOE, USAF, NAVY, etc.
- Code sprints / JEDI academy – already have a true 4D-Var FV3 running!!!

Formalizing the R2O funnel

- Follow SIP strategy, but build on momentum and speed up process
- Initial baseline requirements with operations in mind (gates and transitions)
- Problems should be suggested (versus tasks)
- Objective evaluation process to transition though gates
- UMAC: evidence-based decisions
- Parallel production environment (possibly many)
- Academia and labs (community)
- Software engineers brought in at initial stages
- EMC involved throughout the process (avoid forklift approach)

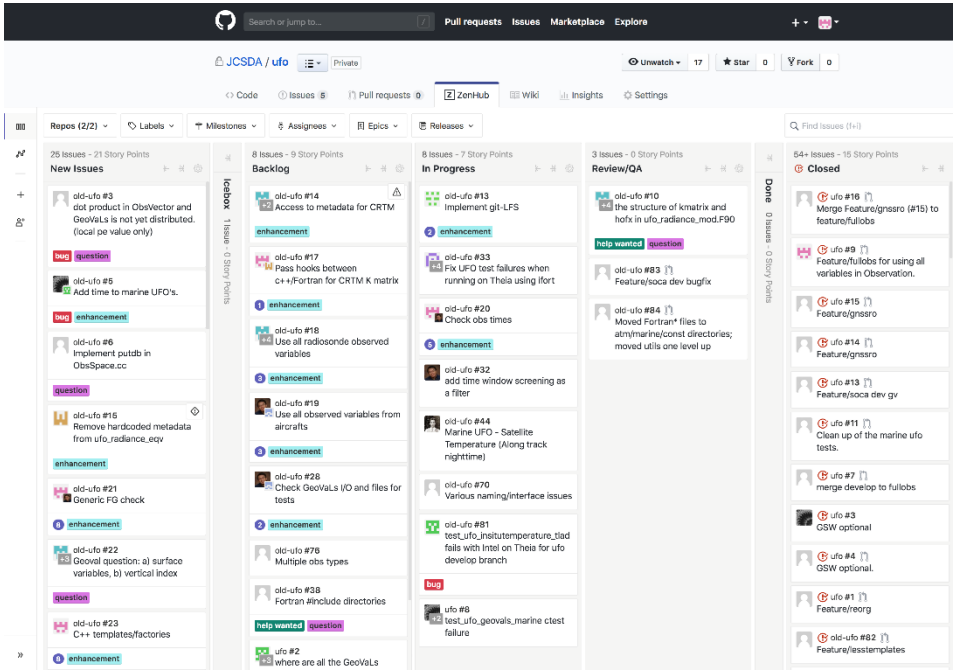
Fast-tracking satellite DA

- Optimize all data, but satellite has a lot of value left on the table
- Critical area we are lagging ECMWF
- Drive up *benefit* in cost-benefit ratio
- JCSDA JEDI



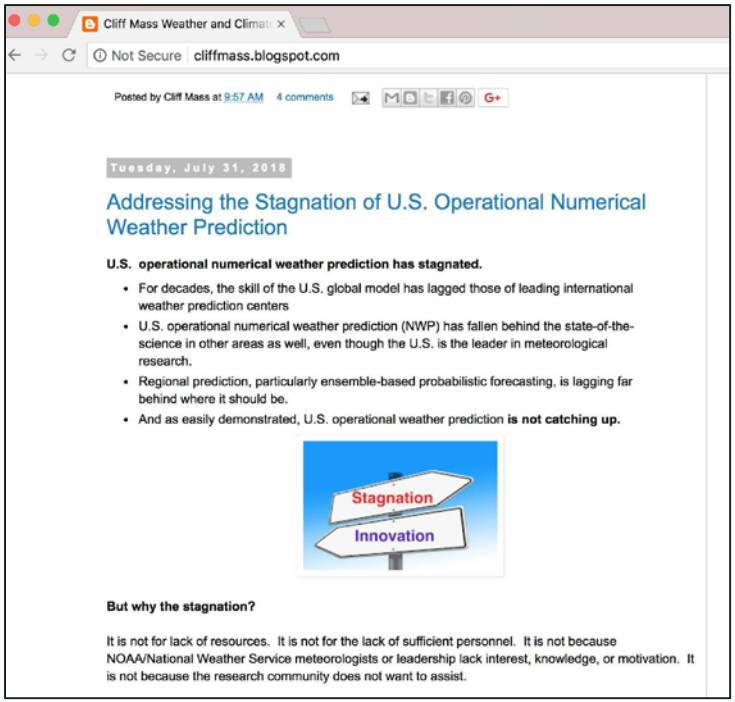
Agile/nimble sandbox

- Avoid risk aversion:
  - IBM's Watson Research Center
  - Lockheed Martin's Skunk Works
  - Google X
  - Boeing Phantom Works
  - Amazon's Lab126
- UK Met Office (offsite dev)
- Avoid outside distractions, etc.



Accelerating Strategic Implementation Plan

- Building off momentum (SIP/DTC progress!)
- Addressing process deficiencies
- Committees and Governance
- Involvement / ownership
- Funding (procurement, stakeholders)
- Branding / image



Cliff Mass Weather and Climate

Not Secure cliffmass.blogspot.com

Posted by Cliff Mass at 9:57 AM 4 comments

Tuesday, July 31, 2018

Addressing the Stagnation of U.S. Operational Numerical Weather Prediction

U.S. operational numerical weather prediction has stagnated.

- For decades, the skill of the U.S. global model has lagged those of leading international weather prediction centers
- U.S. operational numerical weather prediction (NWP) has fallen behind the state-of-the-science in other areas as well, even though the U.S. is the leader in meteorological research.
- Regional prediction, particularly ensemble-based probabilistic forecasting, is lagging far behind where it should be.
- And as easily demonstrated, U.S. operational weather prediction **is not catching up.**

But why the stagnation?

It is not for lack of resources. It is not for the lack of sufficient personnel. It is not because NOAA/National Weather Service meteorologists or leadership lack interest, knowledge, or motivation. It is not because the research community does not want to assist.

From the July 27th NEC briefing…

- Accelerate SIP! (mainly R2O) ✓
- Review committees ✓
- USAF/Navy buy-in ✓
- NASA/DOE collaboration ✓
- Bill L. (governance) ✓
- Vendor conversations / RFIs? ✓
- External and internal funnel – design "gates" (evidence-based decisions) ✓
- Internal funnel – GFDL->ESRL->EMC->NCO (objective verification/evaluation)
- Design mirrored VM prod environment for O2R
- Test secure ingest ✓
- Pilot programs with porting to VM ✓
- Townhalls / AMS ✓

JEDI Update (from JCSDA brief)

Generic interfaces

- Models: several atmospheric models, ocean, sea-ice
- Observations: radiosondes, aircraft, CRTM, marine

Generic solvers

15+ variational including hybrid-4DVar, *EnKF next*

First line of code

Aug 2017 (15 months ago)

JEDI workforce

7 core staff; 39 in-kind (7 FTEs)
36 external collaborators

	State	3D H(x)	M(x)	4D H(x)	3D-Var	TL/AD	4D-Var
FV3-GFS (NOAA)	✓	✓	✓	✓	✓	✓*	✓
FV3-GEOS (NASA)	✓	✓	✓	✓	✓	✓*	✓
MPAS (NCAR)	✓	✓	✓		✓	N/A	N/A
WRF (NOAA)	✓		✓				
LFRic (UKMO)	✓	✓	✓		✓	?	
NAVGEM (NRL)	✓						
NEPTUNE (NRL)	✓					?	
CICE5 (NOAA)	✓	✓			✓	N/A	N/A
MOM6 (NOAA)	✓	✓			✓	N/A	N/A

✓ = technically working ✓ = in progress

* Linearized physics under progress

OOPS

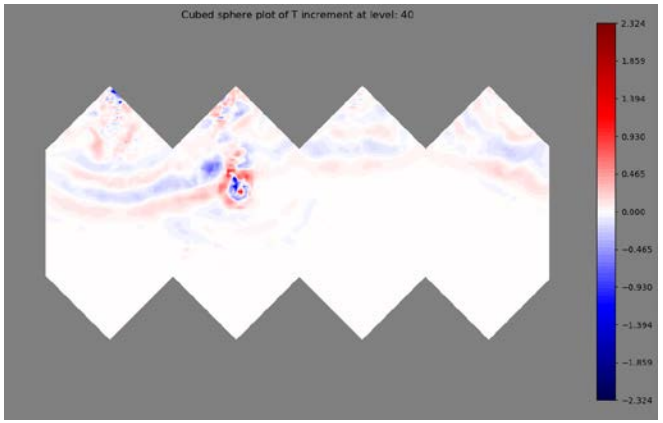
(Object Oriented Prediction System)
Full data assimilation generic algorithms

IODA

(Interface for Observation Data Access)
Performs all the I/O of the observations.
Allows for all kinds of operators

UFO

(Unified Forward Operator)
The 'app-store' of model-agnostic observation operators



First 4DVar analysis with FV3 global model, assimilating AMSU-A satellite radiances, using FV3 TL/AD model from NASA/GMAO

WRFIA Reauthorization

SEC. 3. REAUTHORIZATION OF TITLE II OF THE WEATHER RESEARCH AND FORECASTING INNOVATION ACT OF 2017.

(a) REAUTHORIZATION OF TITLE II OF THE WEATHER RESEARCH AND FORECASTING INNOVATION ACT OF 2017.—Section 1762 of the Food Security Act of 1985 (15 U.S.C. 8521) is amended—

(1) by amending subsection (j) to read as follows:

"(j) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out the activities under this section—

"(1) $26,500,000 for fiscal year 2019;

"(2) $27,000,000 for fiscal year 2020;

"(3) $27,500,000 for fiscal year 2021;

"(4) $28,000,000 for fiscal year 2022; and

"(5) $28,500,000 for fiscal year 2023."; and

(2) by adding at the end the following:

"(k) DERIVATION OF FUNDS.—Amounts made available to carry out this section shall be derived from amounts appropriated or otherwise made available to the National Weather Service.".

(b) UNITED STATES WEATHER RESEARCH AND FORECASTING IMPROVEMENT.—Section 110 of the Weather Research and Forecasting Innovation Act of 2017 (15 U.S.C. 8519) is amended to read as follows:

"SEC. 110. AUTHORIZATION OF APPROPRIATIONS.

"(a) IN GENERAL.—There are authorized to be appropriated to the Office of Oceanic and Atmospheric Research to carry out this title—

"(1) $136,516,000 for fiscal year 2019, of which—

"(A) $85,758,000 is authorized for weather laboratories and cooperative institutes;

"(B) $30,758,000 is authorized for weather and air chemistry research programs; and

"(C) $20,000,000 is authorized for the joint technology transfer initiative described in section 102(b)(4);

"(2) $148,154,000 for fiscal year 2020, of which—

"(A) $87,258,000 is authorized for weather laboratories and cooperative institutes;

"(B) $40,896,000 is authorized for weather and air chemistry research programs; and

"(C) $20,000,000 is authorized for the joint technology transfer initiative described in section 102(b)(4);

"(3) $150,154,000 for fiscal year 2021, of which—

"(A) $88,758,000 is authorized for weather laboratories and cooperative institutes;

"(B) $41,396,000 is authorized for weather and air chemistry research programs; and

"(C) $20,000,000 is authorized for the joint technology transfer initiative described in section 102(b)(4);

"(4) $152,154,000 for fiscal year 2022, of which—

"(A) $90,258,000 is authorized for weather laboratories and cooperative institutes;

"(B) $41,896,000 is authorized for weather and air chemistry research programs; and

"(C) $20,000,000 is authorized for the joint technology transfer initiative described in section 102(b)(4); and

"(5) $154,154,000 for fiscal year 2023, of which—

"(A) $91,758,000 is authorized for weather laboratories and cooperative institutes;

"(B) $42,396,000 is authorized for weather and air chemistry research programs; and

"(C) $20,000,000 is authorized for the joint technology transfer initiative described in section 102(b)(4).

"(b) LIMITATION.—No additional funds are authorized to carry out this title and the amendments made by this title.".

EPIC and Community Modeling

SEC. 4. EARTH PREDICTION INNOVATION CENTER.

(a) WEATHER RESEARCH AND FORECASTING INNOVATION.—Section 102(b) of the Weather Research and Forecasting Innovation Act of 2017 (15 U.S.C. 8512(b)) is amended by adding at the end the following:

"(4) Advancing weather modeling skill, reclaiming and maintaining international leadership in the area of numerical weather prediction, and improving the transition of research into operations by—

"(A) leveraging the weather enterprise to provide expertise on removing barriers to improving numerical weather prediction;

"(B) enabling scientists and engineers to effectively collaborate in areas important for improving operational global numerical weather prediction skill, including model development, data assimilation techniques, systems architecture integration, and computational efficiencies;

"(C) strengthening the National Oceanic and Atmospheric Administration's ability to undertake research projects in pursuit of substantial advancements in weather forecast skill;

"(D) utilizing and leverage existing resources across the National Oceanic and Atmospheric Administration enterprise; and

"(E) creating a community global weather research modeling system that—

"(i) is accessible by the public;

"(ii) meets basic end-user requirements for running on public computers and networks located outside of secure National Oceanic and Atmospheric Administration information and technology systems; and

"(iii) utilizes, whenever appropriate and cost-effective, innovative strategies and methods, including cloud-based computing capabilities, for hosting and management of part or all of the system described in this subsection.".

(b) UNITED STATES WEATHER RESEARCH PROGRAM.—Section 108(a) of the National Oceanic and Atmospheric Administration Authorization Act of 1992 (15 U.S.C. 8520(a)) is amended—

(1) in paragraph (10), by striking "; and" and inserting a semi-colon;

(2) in paragraph (11), by striking the period at the end and inserting "; and"; and

(3) by adding at the end the following:

"(12) carry out the activities of the Earth Prediction Innovation Center as described in section 102(b)(2) of the Weather Research and Forecasting Innovation Act of 2017 (15 U.S.C. 8512(b)(2)).".

HPC, Cloud, and Code

SEC. 5. COMPUTING RESOURCES PRIORITIZATION.

(a) IN GENERAL.—Section 108 of the Weather Research and Forecasting Innovation Act of 2017 (15 U.S.C. 8518) is amended to read as follows:

"SEC. 108. COMPUTING RESOURCE EFFICIENCY IMPROVEMENT AND ANNUAL REPORT.

"(a) COMPUTING RESOURCES.—

"(1) IN GENERAL.—In acquiring computing capabilities, including high performance computing technologies and supercomputing technologies, that enable the National Oceanic and Atmospheric Administration to meet its mission requirements, the Under Secretary shall, when appropriate and cost-effective, assess and prioritize options for entering into multi-year lease agreements for computing capabilities over options for purchasing computing hardware outright.

"(2) ACQUISITION.—In carrying out the requirements of paragraph (1), the Under Secretary shall structure multi-year lease agreements in such a manner that the expiration of the lease is set for a date on or around—

"(A) the expected degradation point of the computing resources; or

"(B) the point at which significantly increased computing capabilities are expected to be available for lease.

"(1) to continually support upgrades to pursue the fastest, most powerful, and cost-effective high performance computing technologies in support of its weather prediction mission;

"(2) to ensure a balance between the research to operations requirements to develop the next generation of regional and global models as well as highly reliable operational models;

"(3) to take advantage of advanced development concepts to, as appropriate, make next generation weather prediction models available in beta-test mode to operational forecasters, the United States weather industry, and partners in academic and Government research;

"(4) to use existing computing resources to improve advanced research and operational weather prediction;

"(5) to utilize non-Federal contracts to obtain the necessary expertise for advanced weather computing, if appropriate;

"(6) to utilize cloud computing; and

"(7) to create a long-term strategy to transition the programming language of weather model code to current and broadly-used coding language.".

Satellite Architecture and OTA

SEC. 6. SATELLITE ARCHITECTURE PLANNING.

Section 301 of the Weather Research and Forecasting Innovation Act of 2017 (15 U.S.C. 8531) is amended by adding at the end the following:

"(c) NEXT GENERATION SATELLITE ARCHITECTURE.—

"(1) IN GENERAL.—The Under Secretary shall analyze, test, and plan the procurement of future data sources and satellite architectures, including respective ground system elements, identified in the National Oceanic and Atmospheric Administration's Satellite Observing System Architecture Study that—

"(A) lower the cost of observations used to meet the National Oceanic and Atmospheric Administration's mission requirements;

"(B) disaggregate current satellite systems, where appropriate;

"(C) include new, value-adding technological advancements; and

"(D) improve weather forecasting and predictions.

"(2) QUANTITATIVE ASSESSMENTS AND PARTNERSHIP AUTHORITY.—In meeting the requirements described in paragraph (1), the Under Secretary—

"(A) may partner with the commercial and academic sectors, non-governmental and not-for-profit organizations, and other Federal agencies; and

"(B) shall, consistent with section 107 of this Act, undertake quantitative assessments for objective analyses, as the Under Secretary considers appropriate, to evaluate relative value and benefits of future data sources and satellite architectures described in paragraph (1).

"(d) ADDITIONAL FORMS OF TRANSACTION AUTHORIZED.—

"(1) IN GENERAL.—Subject to paragraph (2), in order to enhance the effectiveness of data and satellite systems used by the National Oceanic and Atmospheric Administration to meet its missions, the Under Secretary may enter into and perform such transaction agreements on such terms as the Under Secretary considers appropriate to carry out basic, applied, and advanced research projects to meet the objectives described in subparagraphs (A) through (D) subsection (c)(1).

"(2) METHOD AND SCOPE.—

"(A) IN GENERAL.—A transaction agreement under paragraph (1) shall be limited to research and development activities.

"(B) PERMISSIBLE USES.—A transaction agreement under paragraph (1) may be used—

"(i) for the construction, use, operation, or procurement of new, improved, innovative, or value-adding satellites, instrumentation, ground stations, and data;

"(ii) to make determinations on how to best use existing or planned data, systems, and assets of the National Oceanic and Atmospheric Administration; and

"(iii) only when the objectives of the National Oceanic and Atmospheric Administration cannot be met using a cooperative research and development agreement, grants procurement contract, or cooperative agreement.

"(3) TERMINATION OF EFFECTIVENESS.—The authority provided in this subsection terminates effective September 30, 2023.

"(e) TRANSPARENCY.—Not later than 60 days after the date that a transaction agreement is made under subsection (d), the Under Secretary shall make publicly available, in a searchable format, on the website of the National Oceanic and Atmospheric Administration all uses of the authority under subsection (d), including an estimate of committed National Oceanic and Atmospheric Administration resources and the expected benefits

Coastal and Ocean Observations

SEC. 7. INTEGRATION OF OCEAN AND COASTAL DATA FROM THE INTEGRATED OCEAN OBSERVING SYSTEM.

(a) IN GENERAL.—Section 301(a)(2) of the Weather Research and Forecasting Innovation Act of 2017 (15 U.S.C. 8531(a)(2)) is amended—

(1) in subparagraph (A), by striking "; and" and inserting a semicolon;

(2) in subparagraph (B), by striking the period at the end and inserting "; and"; and

(3) by adding at the end the following:

"(C) support increasing use of autonomous, mobile surface, sub-surface, and submarine vehicle ocean and fresh water sensor systems and the infrastructure necessary to share and analyze these data in real-time and feed them into predictive early warning systems.".

(b) COMMERCIAL WEATHER DATA; AUTHORIZATION OF APPROPRIATIONS.—Section 302(c)(3) of the Weather Research and Forecasting Innovation Act of 2017 (15 U.S.C. 8532(c)(3)) is amended—

(1) by striking "2017 through 2020" and inserting "2019 through 2023"; and

(2) by inserting "the" before "National".

Cooperative Observer Program

SEC. 8. IMPROVEMENTS TO COOPERATIVE OBSERVER PROGRAM OF NATIONAL WEATHER SERVICE.

(a) IN GENERAL.—The Under Secretary of Commerce for Oceans and Atmosphere, acting through the National Weather Service, shall improve the Cooperative Observer Program by—

(1) providing support to—

(A) State-coordinated programs relating to the Program; and

(B) States and regions where observations provided through the Program are scarce;

(2) working with State weather service headquarters to increase participation in the Program and to add stations in States and regions described in paragraph (1)(B);

(3) where feasible, ensuring that data streams from stations that have been contributing data to the Program for more than 50 years are maintained and continually staffed by volunteers;

(4) prioritizing the recruitment of new volunteers for the Program;

(5) ensuring that opportunities exist for automated reporting to lessen the burden on volunteers to collect and report data by hand; and

(6) ensuring that integrated reporting is available for qualitative observations that cannot be automated, such as drought conditions, snow observations, and hazardous weather events, to ensure that volunteers in the Program can report and upload observations quickly and easily.

Harmful Algal Blooms and Hypoxia

SEC. 9. HARMFUL ALGAL BLOOM AND HYPOXIA RESEARCH AND CONTROL.

(a) SHORT TITLE.—This section may be cited as the "Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2017".

(b) REFERENCES TO THE HARMFUL ALGAL BLOOM AND HYPOXIA RESEARCH AND CONTROL ACT OF 1998.—Except as otherwise expressly provided, wherever in this section an amendment or repeal is expressed in terms of an amendment to, or repeal of, a section or other provision, the reference shall be considered to be made to a section or other provision of the Harmful Algal Bloom and Hypoxia Research and Control Act of 1998 (33 U.S.C. 4001 et seq.).

(c) INTER-AGENCY TASK FORCE.—Section 603(a) (33 U.S.C. 4001(a)) is amended—

(1) in paragraph (12), by striking "and" at the end;

(2) by redesignating paragraph (13) as paragraph (14); and

(3) by inserting after paragraph (12) the following:

"(13) the Army Corps of Engineers; and".

(d) SCIENTIFIC ASSESSMENTS OF FRESHWATER HARMFUL ALGAL BLOOMS.—Section 603 (33 U.S.C. 4001) is amended—

(1) by striking subsection (f);

(2) by redesignating subsections (g), (h), (i), and (j) as subsections (f), (g), (h), and (i), respectively; and

(3) by amending subsection (g) to read as follows:

"(g) SCIENTIFIC ASSESSMENTS OF MARINE AND FRESHWATER HARMFUL ALGAL BLOOMS.—Not less than once every 5 years the Task Force shall complete and submit to Congress a scientific assessment of harmful algal blooms in United States coastal waters and freshwater systems. Each assessment shall examine both marine and freshwater harmful algal blooms, including those in

(g) HYPOXIA OR HARMFUL ALGAL BLOOM OF NATIONAL SIGNIFICANCE.—

(1) RELIEF.—

(A) IN GENERAL.—Upon a determination under paragraph (2) that there is an event of national significance, the appropriate Federal official is authorized to make sums available to the affected State or local government for the purposes of assessing and mitigating the detrimental environmental, economic, subsistence use, and public health effects of the event of national significance.

(B) FEDERAL SHARE.—The Federal share of the cost of any activity carried out under this paragraph for the purposes described in subparagraph (A) may not exceed 50 percent of the cost of that activity.

(C) DONATIONS.—Notwithstanding any other provision of law, an appropriate Federal official may accept donations of funds, services, facilities, materials, or equipment that the appropriate Federal official considers necessary for the purposes described in subparagraph (A). Any funds donated to an appropriate Federal official under this paragraph may be expended without further appropriation and without fiscal year limitation.

(2) DETERMINATIONS.—

Thank You!