Earth Prediction Innovation Center

Accelerating innovation through community modeling.

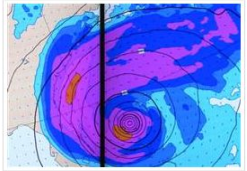
EPIC

Coordinating the Giant: The Earth Prediction Innovation Center

Maoyi Huang, Ph.D.
EPIC Program Manager, Weather Program Office, OAR, NOAA

UFS Webinar
13 January 2022

Hurricane Sandy (2012) Raises Public Awareness of Modeling……



Nightly News | March 08, 2013

European weather forecasts superior to US models

The predictions from European computer models, which have 10 times the computing ability of the National Weather Service, have increasingly become more accurate than our models with the starkest example being Hurricane Sandy. NBC's Al Roker reports.

Share This:

Capital Weather Gang

The inside scoop on weather in the D.C. area and beyond

The Washington Post Weather website | Jump to CWG's Latest Full Forecast | Outside now? Radar, temps and more: Weather Wall

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AT A GLANCE

Tue	Wed	Thu
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54 | 70	53 | 75	58 | 78

Posted at 11:24 AM ET, 03/08/2013

To be the best in weather forecasting: Why Europe is beating the U.S.

By

The

October 28, 2012, 8:17 PM

Why America Has Fallen Behind the World in Storm Forecasting

Article | Comments (34)

Tweet 255

Email | Print

A A

COMMENTARY

By Kerry Emanuel

Monday, February 11, 2013

The U.S. Weather Prediction Computer Gap

It happened again.

WEATHER DATA PROCESSING CENTER

The Washington Post *Democracy Dies in Darkness*

Already, 18 weather disasters costing at least $1 billi… each have hit the U.S. this year

2021 is on pace to be among the most active and costliest years for such disasters, which are becoming… frequent

By Kerrin Jeromin

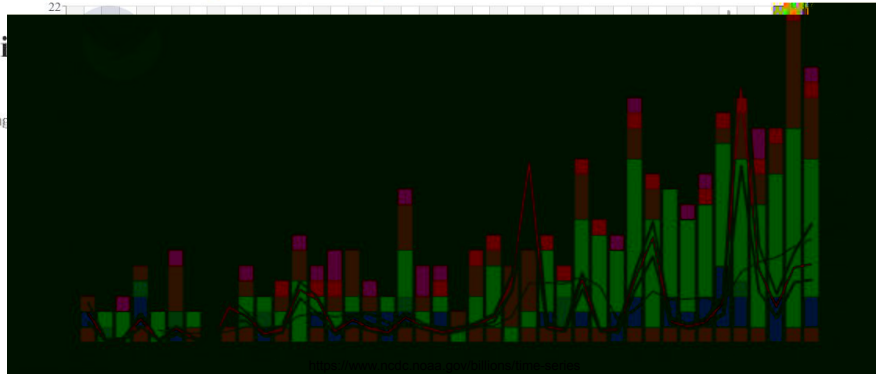
October 11, 2021 | Updated October 11, 2021 at 5:50 p.m. EDT

This year is on pace to be one of the most active and costliest years for disasters in the United States.

United States Billion-Dollar Disaster Events 1980-2021 (CPI-Adjusted)

Drought Count | Flooding Count | Freeze Count | Severe Storm Count | Tropical Cyclone Count | Wildfire Count | Winter Storm Count | Combined Disaster Cost | Costs 95% CI | 5-Year Avg Costs

22



https://www.ncdc.noaa.gov/billions/time-series

DRAFT & PREDECISIONAL

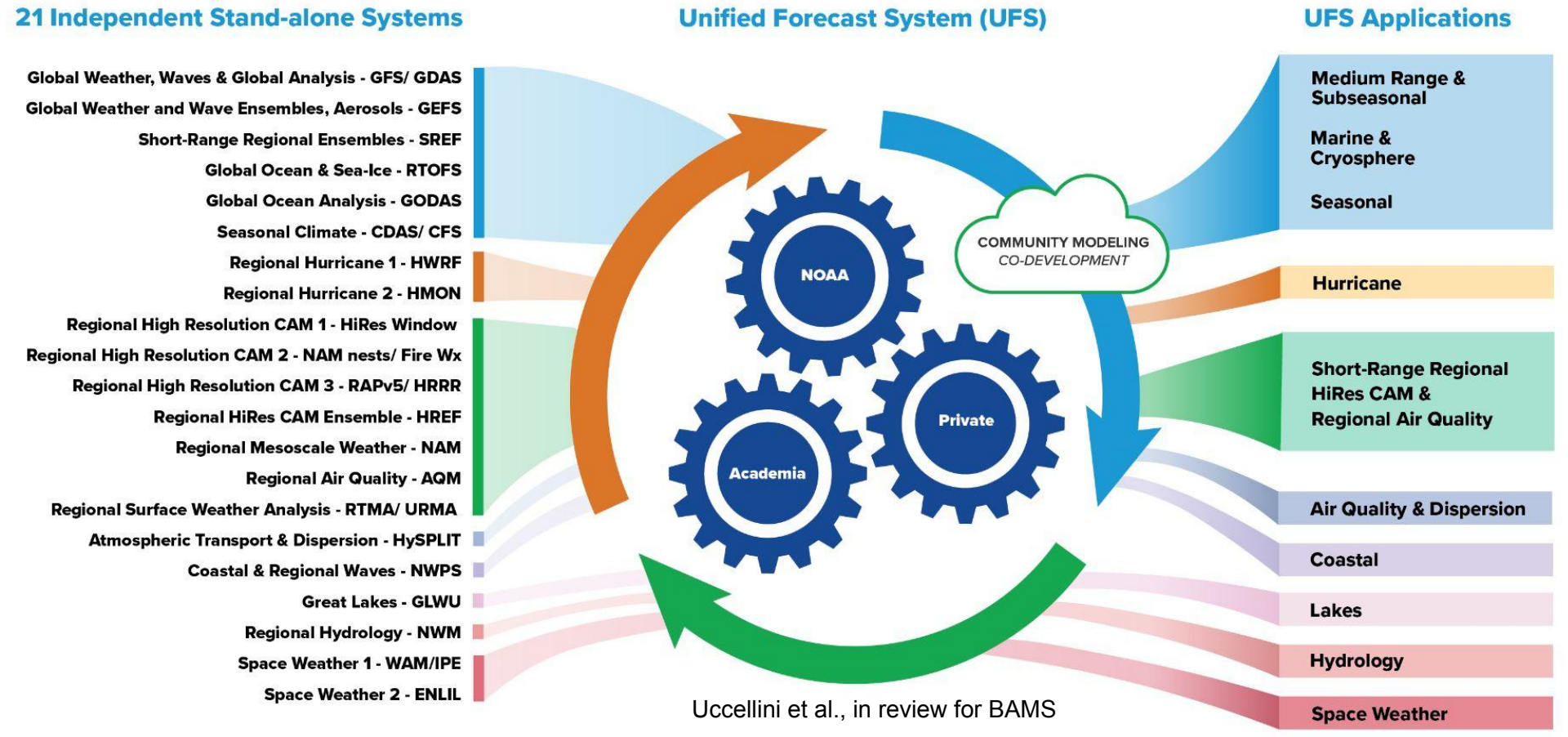
External Review Committee for NCEP Modeling Suite

RECOMMENDATIONS

- Reduce complexity of the NCEP Production Suite
- Create a unified collaborative strategy for model development across NOAA
- Leverage the capabilities of the external community
- Continue to enhance High Performance Computing capabilities
- Execute strategic and implementation plans based on stakeholder requirements

Simplifying NOAA's Operational Forecast Suite

Reducing the 21 Stand-alone Operational Forecast Systems into Eight Applications



Uccellini et al., in review for BAMS

8 UFS Components

Atmosphere

Ocean

Wave

Land

Storm Surge

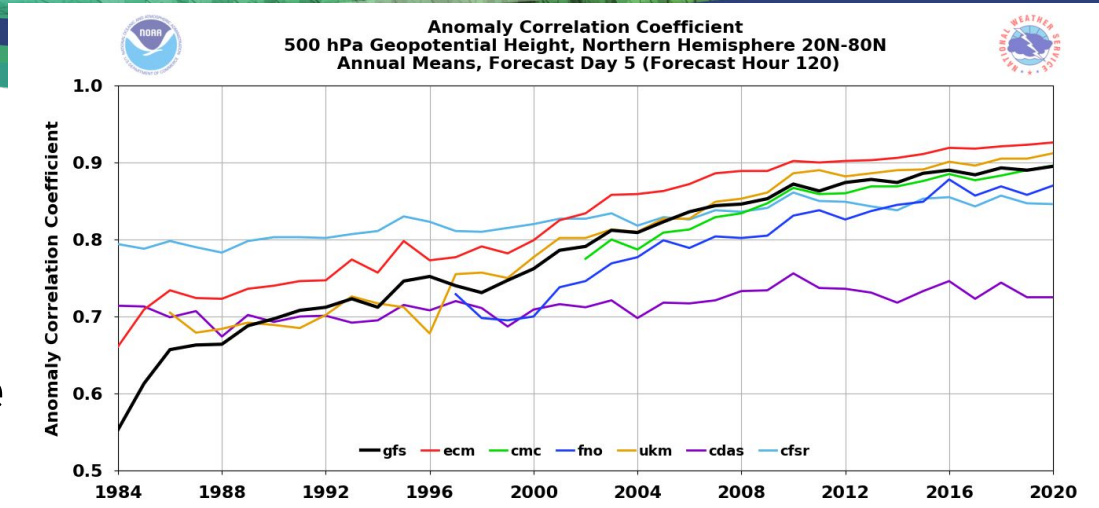
Composition

Sea Ice

Ionosphere

Why is EPIC needed

- Access to **integrated development environment** that is platform-agnostic
- Access to **external expertise in modeling**
- Common UFS infrastructure that **shares components**
- **Clarify** research and operational priorities
- Increase and **accelerate** the rate of **Innovation** into operations and applications



EPIC

Partnering with the community for the benefit of the nation

Vision: *Enable* the most accurate and reliable operational numerical forecast model in the world.

Mission: To be the *catalyst* for community research and modeling system advances that continually inform and accelerate advances in our nation's operational forecast modeling systems.

What EPIC is….

- A virtual community model development environment
- Management of cloud- ready code
- Community access to NOAA observations, data & tools
- Community support & engagement
- Clear research & model transition to operations priorities
- Expected expansion to other additional model components
- EPIC: focus on the Unified Forecast System (UFS)

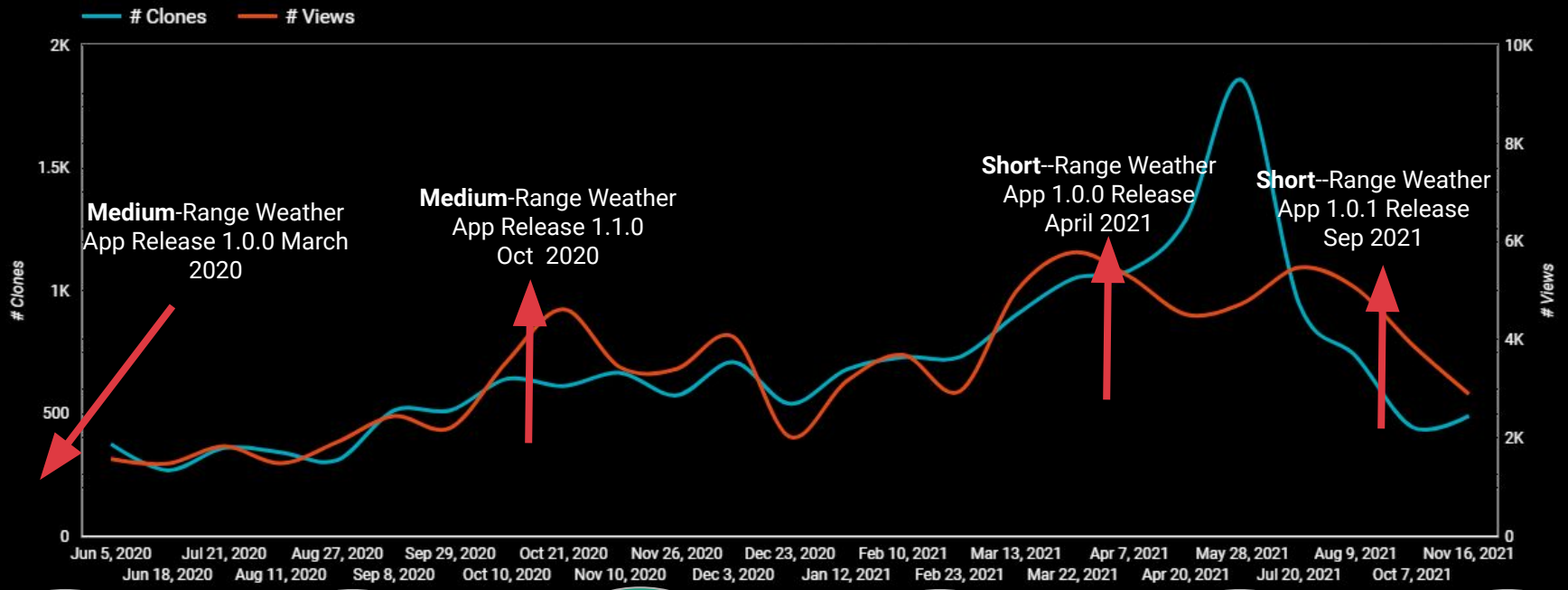
Community Engagement

UFS
UNIFIED FORECAST SYSTEM

Cloud Use

Unified Forecast System (UFS)

Community contributions have increased since code has been released on GitHub. This will be accelerated by EPIC.



2.4K Unique Clones

17.3K total clones

4 forecast model releases

85 people

2.7K total forks

86.4K total views

Community

O2R

R2D

UFS Code Repository

R2O

Research to Operations Screening Funnel

R2O

UFS Code on NCEP WCOSS

Scientists, engineers, graduate students, and collaborators *(NOAA, DOD, NCAR, NASA, Academia, Private Sector)*

Cloud HPC, Hard Iron Research and Development HPC Systems

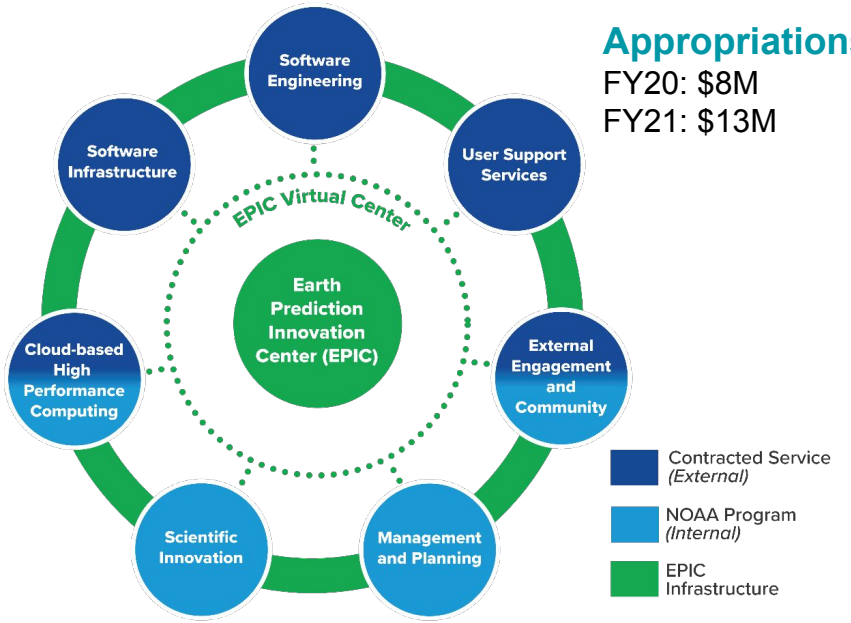
Extensive science testing and validation by the research community 1

Core developers identify candidates for operations and perform testing 2

UFS-based operations on NOAA's production suite

EPIC Innovation Flow

EPIC's Seven Investment Areas



Appropriations
FY20: $8M
FY21: $13M

Key Accomplishments

March 2019
- Program Established

April 2019
- EPIC Vision Paper

August 2019
- EPIC Community Workshop

January 2020
- Released EPIC Strategic Plan

March 2020
- EPIC RFP released

August 2020
- EPIC Strategic Plan approved by Hill

April 2021
- Contract awarded to Raytheon Intelligence & Space

August 2021
- Stakeholder meetings focusing on UFS activities

September 2021
- Release finalized EPIC Strategic Plan

December 2021
- Two EPIC Program Increments completed following a Scaled Agile Framework (SAFe)

Projects supported by EPIC Program 2019-2021

Scientific Innovation

- FV3 Medium Range - S2S Prediction at convective Scales
- UFS R2O MER/S2S DA R&R
- Advances in physics/microphysics parameterization for UFS/Hurricane models
- Coupled Ensemble Prediction and Data Assimilation (DA) for UFS
- Community Radiative Transfer Model for UFS
- Land DA for UFS
- Convection Allowing Model Ensembles for short and longer time scales and Multi-grid Background error covariance model enhancements
- Process-level parameterizations of model uncertainty in the GFS/GEFS ensemble system
- Improving boundary layer parameterization and cloud systems at all scales

Management & Planning

- EPIC Program Office
- JCSDA Directors Office
- Lapenta Interns

Cloud-based High Performance Computing

- EPIC Program supports OAR Cloud Tiger Team
- OAR OCIO Cloud Utility Contract
- Developed OAR Cloud Strategy Document

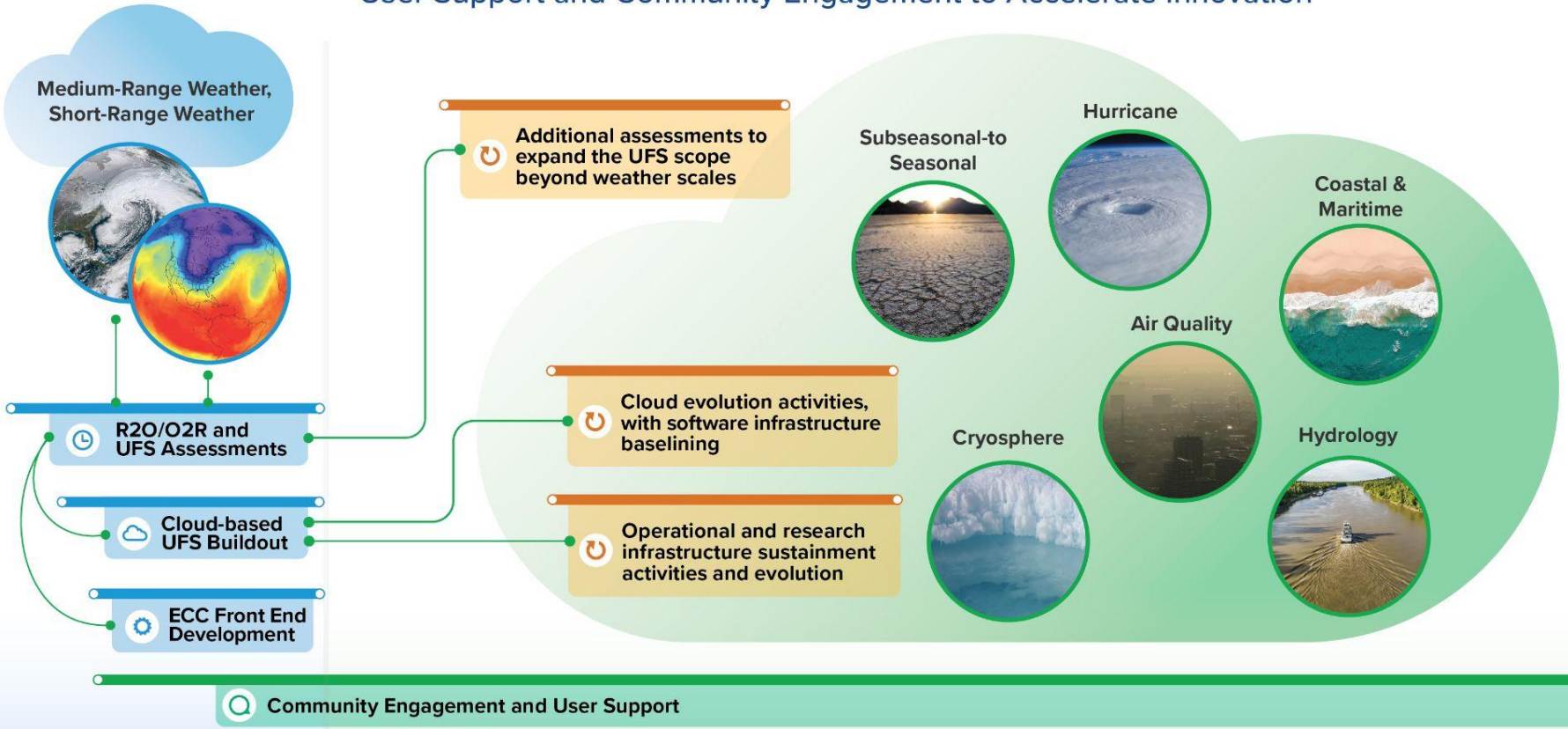
External Engagement & Community

- EPIC Community Workshop
- UFS Workflow Workshop
- UFS Community Modeling Support
  - UFS Weather Model code base/applications
  - CICE
  - Stochastic Physics
  - ESMF
- JCSDA core-funding for DA observations, DA Algorithms - Joint Efforts in Data Assimilation Integration (JEDI), Coupled DA, JEDI framework, Sea-Ice Ocean and Coupled Assimilation
- 2020 International Symposium on Data Assimilation

Near- and long-term EPIC Contract outcomes

UFS Model and Infrastructure Ports to Cloud Service Providers

User Support and Community Engagement to Accelerate Innovation

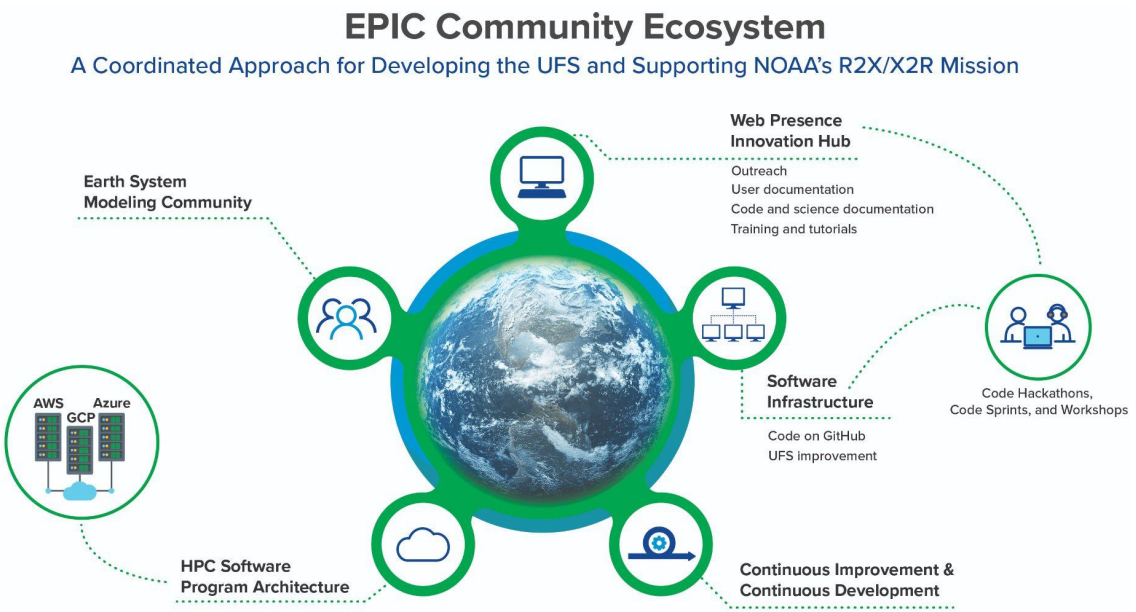


ONGOING

FUTURE WORK

Uccellini et al., in review for BAMS

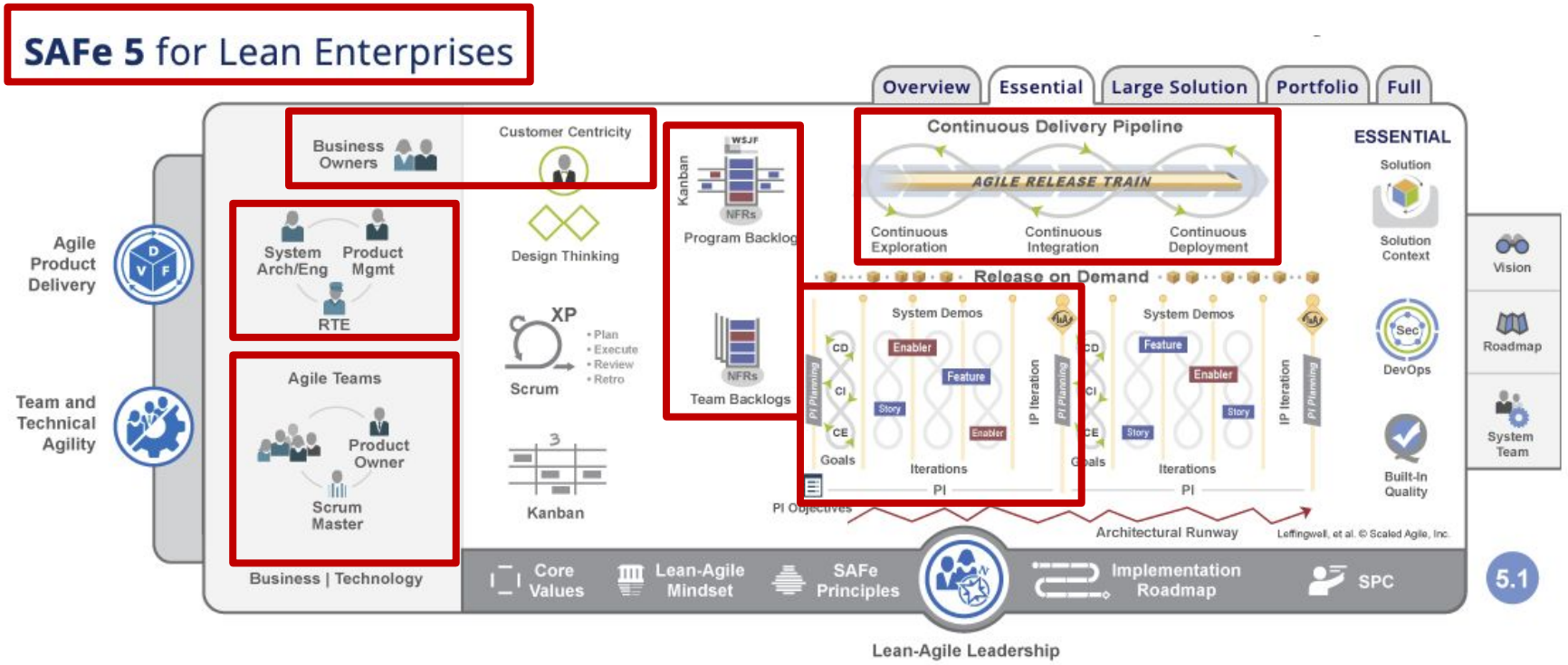
EPIC Community Center



Uccellini et al., in review for BAMS

- **Web presence.** The EPIC Community Center (ECC) portal provides engagement opportunities via centralized access to UFS code repositories integrated with CI/CD pipelines, EPIC content (e.g. tutorials, social media, events), dashboards showing UFS build and test results
- **Multi-Platform Portability.** Platform-agnostic versions of the UFS on Cloud and on-prem HPCs.
- **Advanced User Support.** Documentation, tutorials, and forums with dedicated user support via a help desk, providing opportunities for co-development and community innovation.

Scaled Agile Framework (SAFe)



https://www.scaledagileframework.com/

Agile Release Train

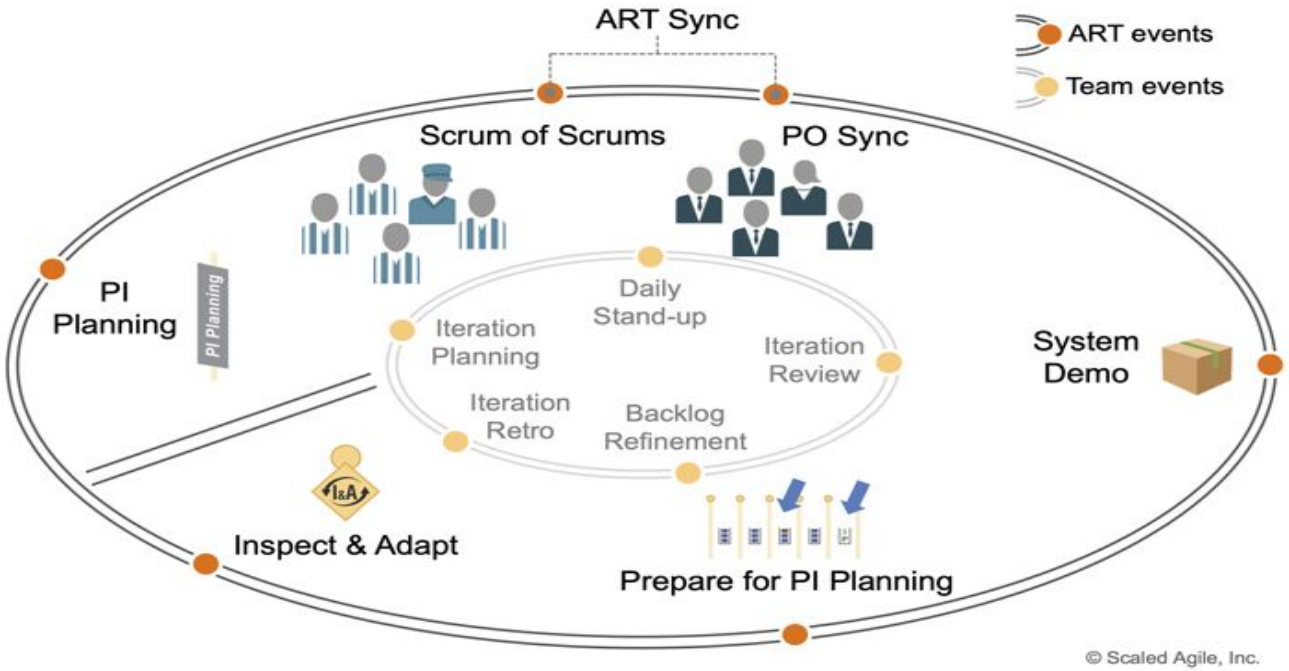


Figure 2. ART events

EPIC Program SAFe

EPIC Program SAFe Home

Created by Peter Plofchan, last modified on Dec 30, 2021

Welcome to your new space!
Welcome to the EPIC Scaled Agile Framework® home page. This space is used to educate on SAFe and to plan the Program Increments for the EPIC ECC Release train (RT).

Below are key SAFe dates. Please see the SAFe Calendar below for more detail.

Current PI dates

PI 1	**35d**	**100%**	**Mon 9/20/21**	**Fri 11/5/21**
Development Sprints	6wks	100%	Mon 9/20/21	Fri 10/29/21
Conduct Program planning retro and make changes	5d	100%	Mon 10/4/21	Fri 10/8/21
Finalize next PI feature list	2d	100%	Fri 10/15/21	Mon 10/18/21
PI 1 Innovation and Planning	1wk	100%	Mon 11/1/21	Fri 11/5/21
PI 2	**50d**	**52%**	**Mon 11/8/21**	**Fri 1/14/22**
Development Sprints	6wks	100%	Mon 11/8/21	Fri 12/17/21
Break	4wks	0%	Mon 12/20/21	Fri 1/14/22
Conduct Program planning retro and make changes	1d	0%	Mon 11/8/21	Mon 11/8/21
Finalize next PI feature list	2d	0%	Mon 11/8/21	Tue 11/9/21
PI 2 Innovation and Planning	1wk	0%	Mon 12/20/21	Fri 12/24/21
PI 3	**56d**	**0%**	**Mon 1/17/22**	**Mon 4/4/22**
Development Sprints	10wks	0%	Mon 1/17/22	Fri 3/25/22
Conduct Program planning retro and make changes	1d	0%	Mon 3/28/22	Mon 3/28/22
Finalize next PI feature list	2d	0%	Mon 1/17/22	Tue 1/18/22
PI 3 Innovation and Planning	1wk	0%	Tue 3/29/22	Mon 4/4/22
PI 4	**55d**	**0%**	**Tue 4/5/22**	**Mon 6/20/22**
Development Sprints	10wks	0%	Tue 4/5/22	Mon 6/13/22
Conduct Program planning retro and make changes	1d	0%	Tue 4/5/22	Tue 4/5/22
Finalize next PI feature list	2d	0%	Tue 4/5/22	Wed 4/6/22
PI 4 Innovation and Planning	1wk	0%	Tue 6/14/22	Mon 6/20/22

EPIC Release Train Program Increments

- Train Sprint Pages
- EPIC Program Increment 3
  - ECC Train - PI3 - Objectives Risks and Dependencies Dashboard
- EPIC Program Increment 2
- EPIC Program Increment 1

EPIC Community Center (ECC) Train

AGILE RELEASE TRAIN

EPIC Community Engagement (ECE) Team

- Technologies that drive interfacing/collaboration
- Community events
- Reoccurring Stakeholder engagement and technical interviews
- Tracking of EPIC adoption/success metrics

Platform Team

- Maintaining On-Prem and Cloud-based HPC environments
- Building CI/CD pipelines in On-Prem and Cloud-based HPC environments
- Monitoring On-Prem/Cloud resources

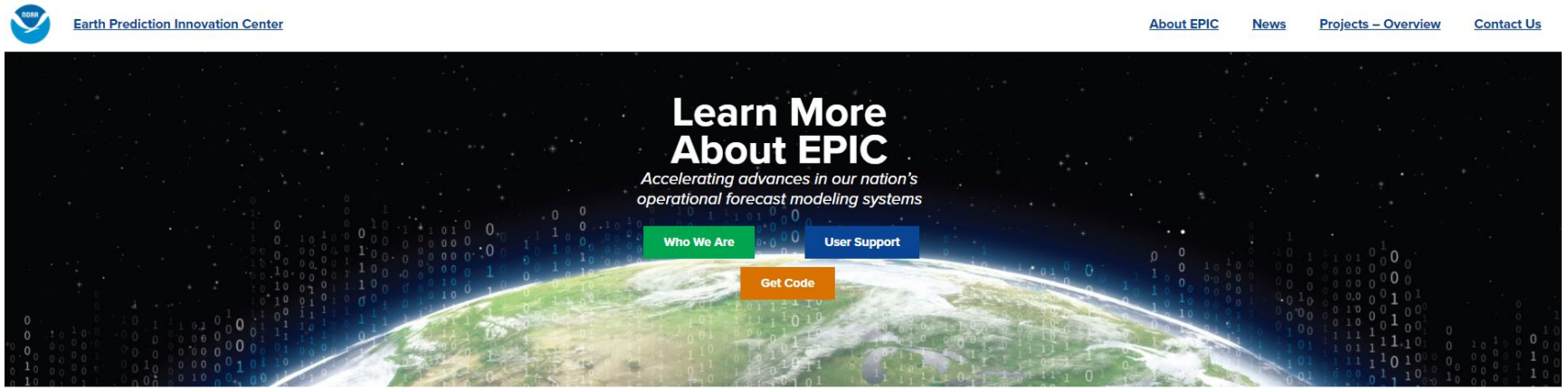
Advanced User Support (AUS) Team

- Establish a standard baseline software stack that is consistent across cloud, containers, and on-prem HPCs
- Establish a plan for the public release of the SRW app
- Determine if/how/when an MRW app release will be done.
- Bootstrap the Unified Post Processor team and feature backlog

Unified Workflow (UWF) Team

- Sharing SME domain knowledge with all team members
- Review, analyze and document prior prototyping efforts
- Unified Workflow Design and Prototyping in Multi Cloud and on-prem HPC platforms

EPIC Community Portal



https://www.epic.noaa.gov

EPIC Student Workshop

Objective: I can use the Short Range Weather application to run, modify, and compare forecast outputs.

From David Wright - Professor at the University of Michigan

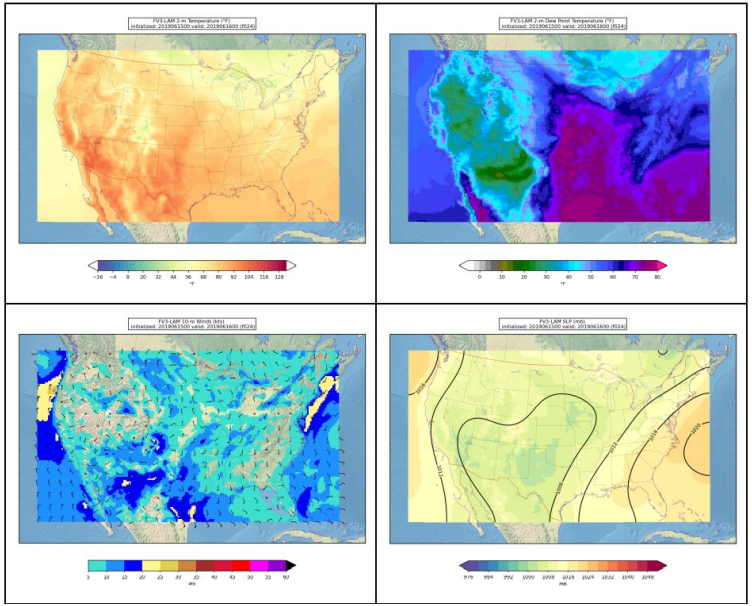
"After learning how to run the Short Range Weather application, I was able to modify it to account for added capabilities to updates such as lake and land information using an external model."

An EPIC Student Workshop: Learn How to Run the Unified Forecast System (UFS) on Cloud

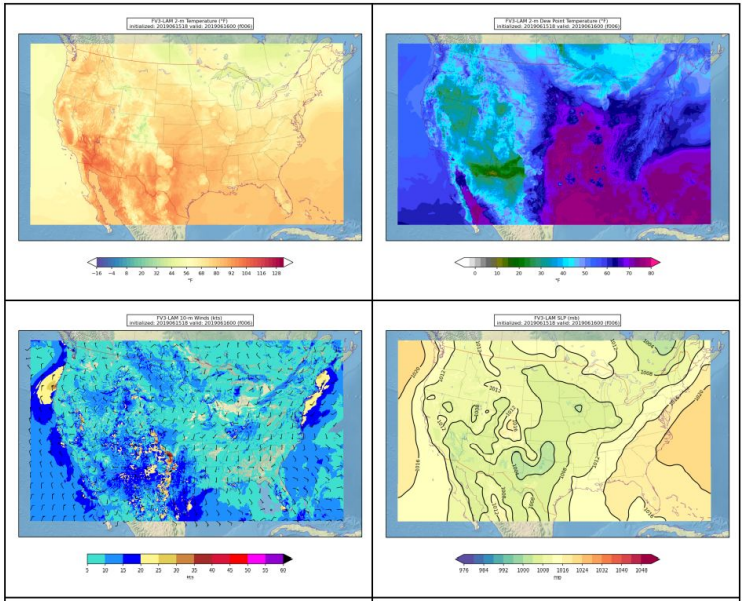
https://ams.confex.com/ams/102ANNUAL/meetingapp.cgi/Session/60979

EPIC Student Workshop

Control
25-km

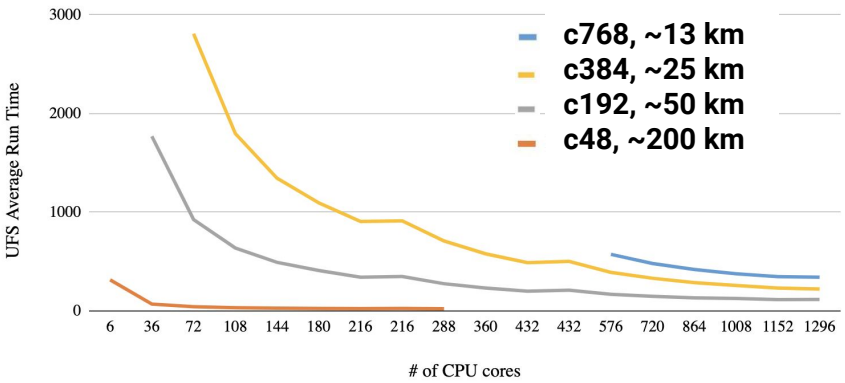


Experiment
3-km, convection allowing



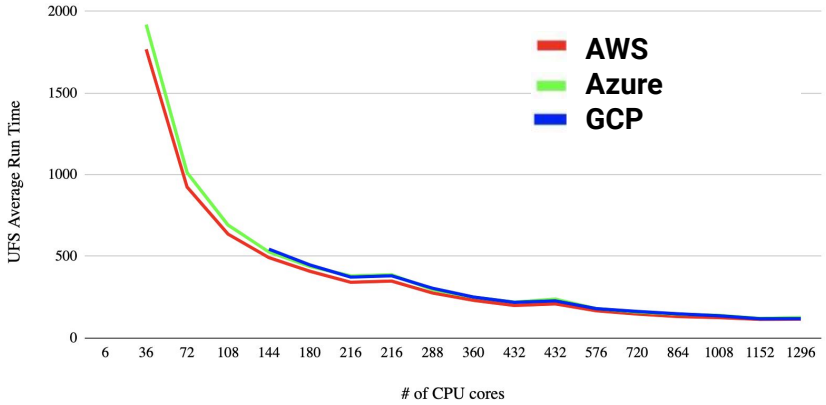
UFS Benchmarking on Cloud

UFS Average Run Time vs. #cores



The same UFS configuration was run up to 14 times with increasing number of CPU cores to assess how well model runtime decreases with increasing compute power.

UFS Average Run Time on 3 CSP

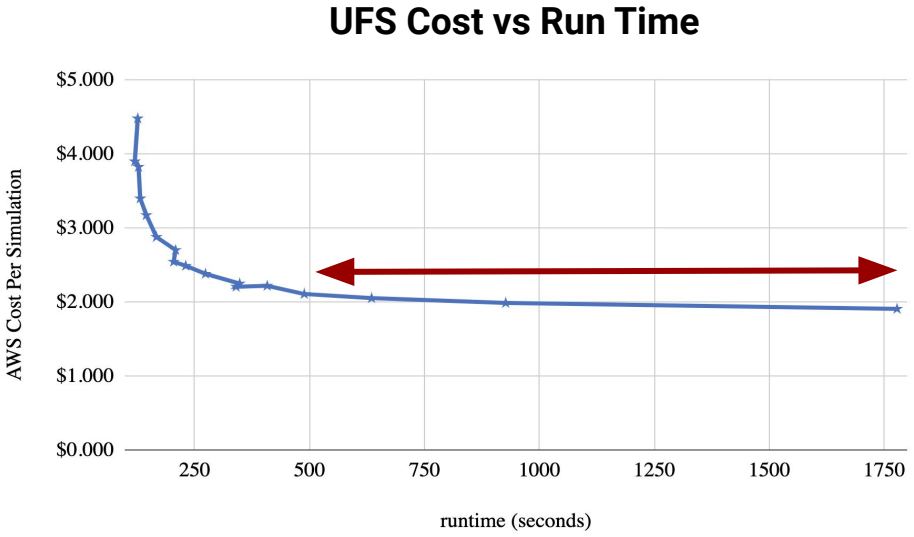


Benchmarking results are comparable across 3 CSPs

UFS Benchmarking on Cloud

Expected by Summer 2022:

- Benchmarking the coupled (Ocean, Wave, etc.) model on three CSPs;
- Extend to end-to-end Medium Range and Short Range Weather applications;
- Establish the CI/CD pipelines and Data Management strategy/tools;
- Create a cloud cost calculator algorithm to include fully coupled weather applications (preprocessor, model, and post processor) to resemble as closely as possible the nature of NOAA operational forecasting systems



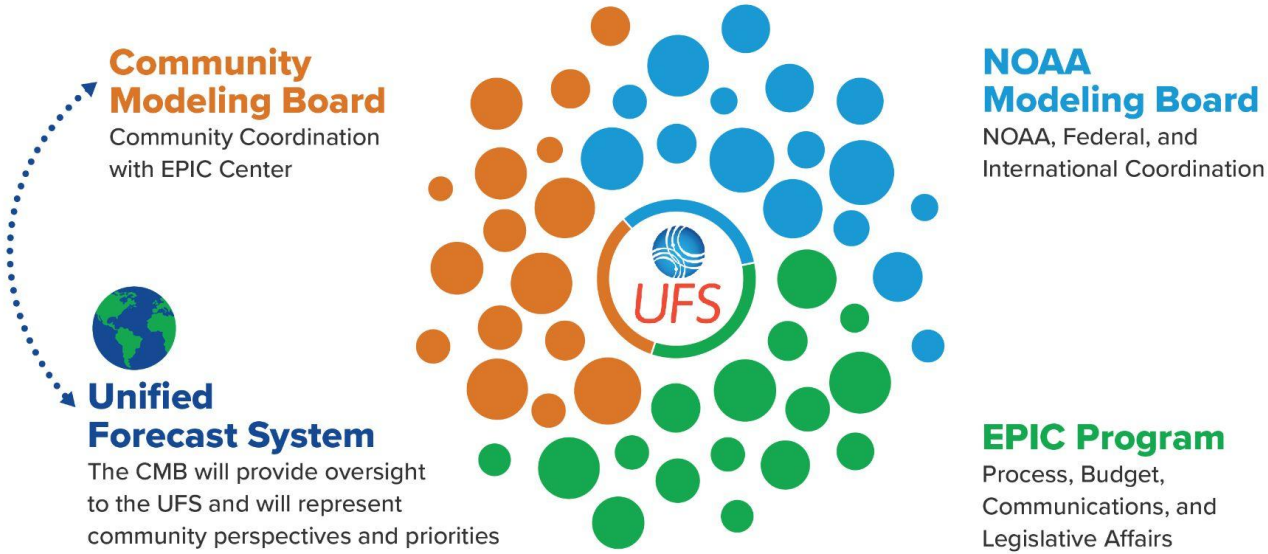
- UFS experiment results available in 500 seconds vs. 1750 seconds both near $2K! More than 3 times faster with little additional cost…
- However if you want experiments back in less than 500 seconds, you can pay more than double!

Upcoming EPIC activities

- Publically release of the EPIC community portal
- Establish the EPIC Student Program
- Establish a Community Modeling Board
- EPIC Symposium at AMS 102
- Student workshops (AMS, Ocean Science Meeting, and more)
- 2nd Annual EPIC Community Workshop
- Facilitate future releases of Joint Effort for Data assimilation Integration (JEDI)
- Release cloud-ready UFS Medium Range Weather and Short Range Weather applications

Challenges and Opportunities

Aligning Priorities with Operational Prediction Goals and Modeling-system Investments



Uccellini et al., in review for BAMS

Thank you!

Contact Information:
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