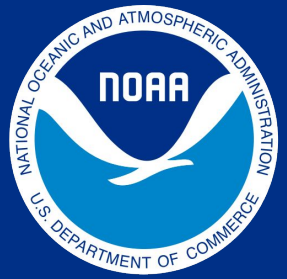


NOAA WEATHER PROGRAM OFFICE

NOAA WEATHER PROGRAM OFFICE

January 25, 2023

Activity Area 2:

Weather Research Models, Observations and Forecasting Tools

Dr. Mark Olsen, S2S Deputy Program Manager

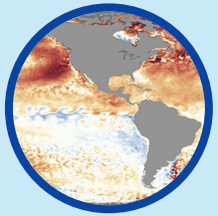
Activity Area 2: Weather Research Models, Observations and Forecasting Tools

WPO seeks recommendations and evaluations of the Observations program, Subseasonal to Seasonal (S2S) program, and the Earth Prediction Innovation Center (EPIC). WPO recognizes that improvements in weather observing technologies need to occur concurrently with model improvements and predictability research.

The WPO activities included in this area are:

Observations

WPO maintains a critical role in weather observation coordination which advances basic research, data assimilation, and model development.



Subseasonal to Seasonal

The WPO S2S Program funds research that plays a critical role in research and model development fulfilling the growing public need at these time scales.

Earth Prediction Innovation Center

EPIC focuses on advancing weather models, such as the widely-used Unified Forecast System (UFS) through community modeling.

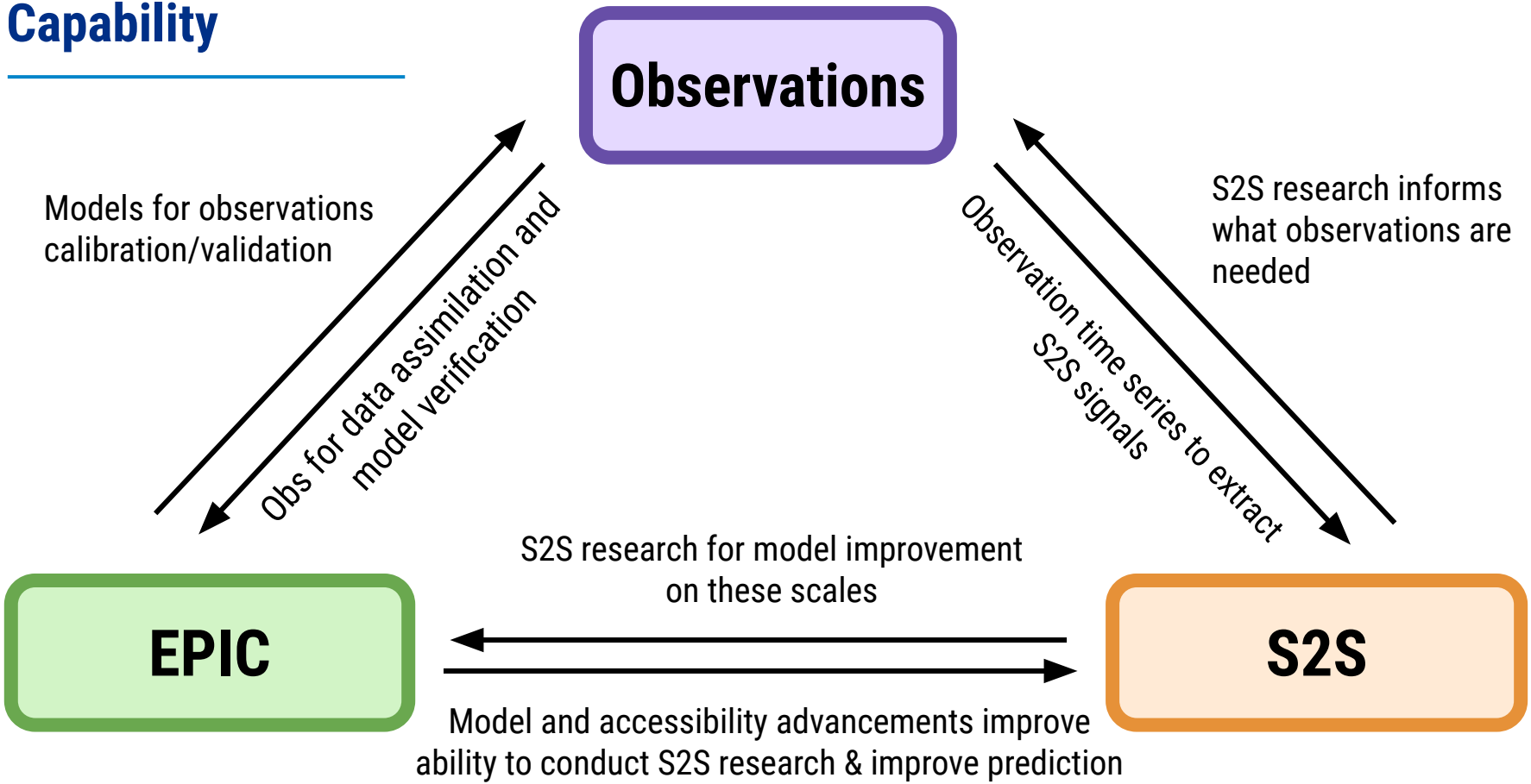
The Fundamentals: Weather Research Models, Observations & Forecasting Tools

WPO maintains a critical role in weather observation coordination, advancing data assimilation, S2S time scale research, and model development and tools.

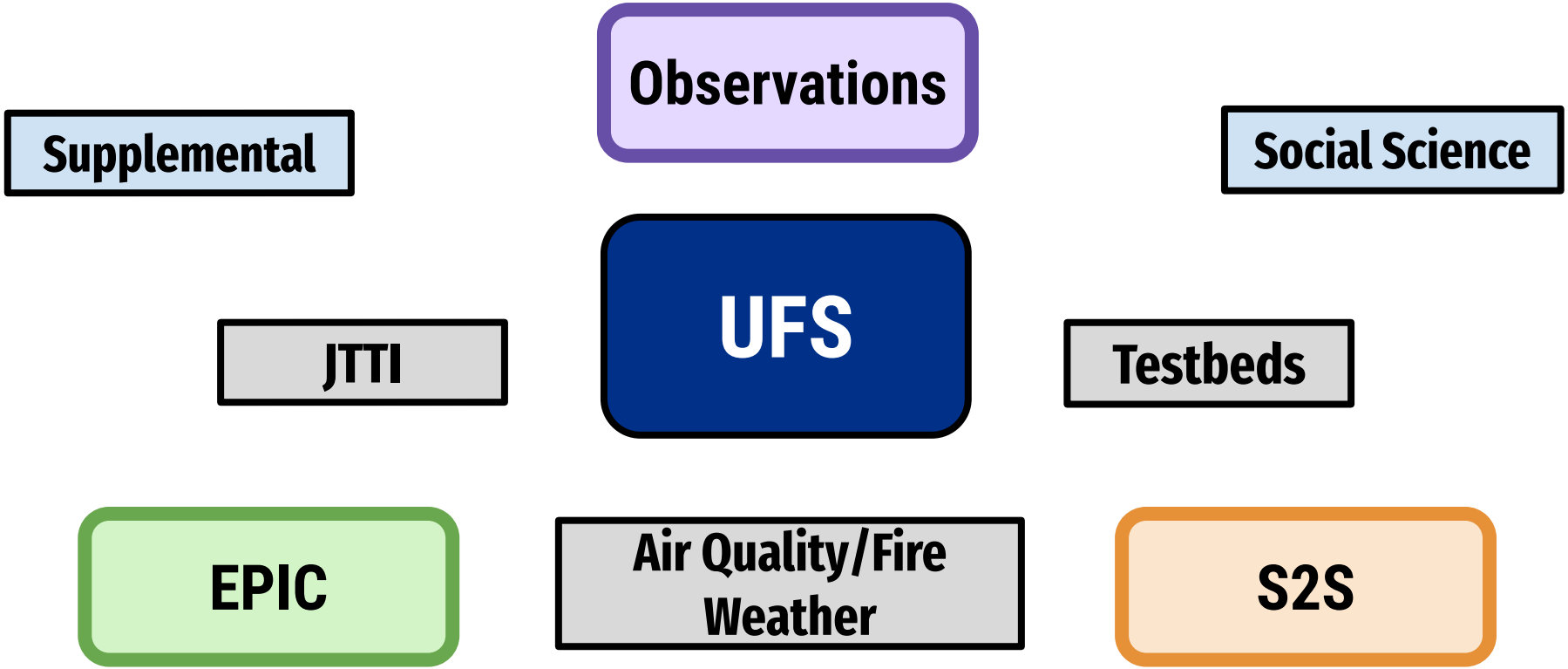
- Observations are limited in their usefulness without models
- Research and models require observations for their usefulness

Thus, WPO programs synergistically facilitate NOAA operational mission goals.

Advancing Predictive Capability

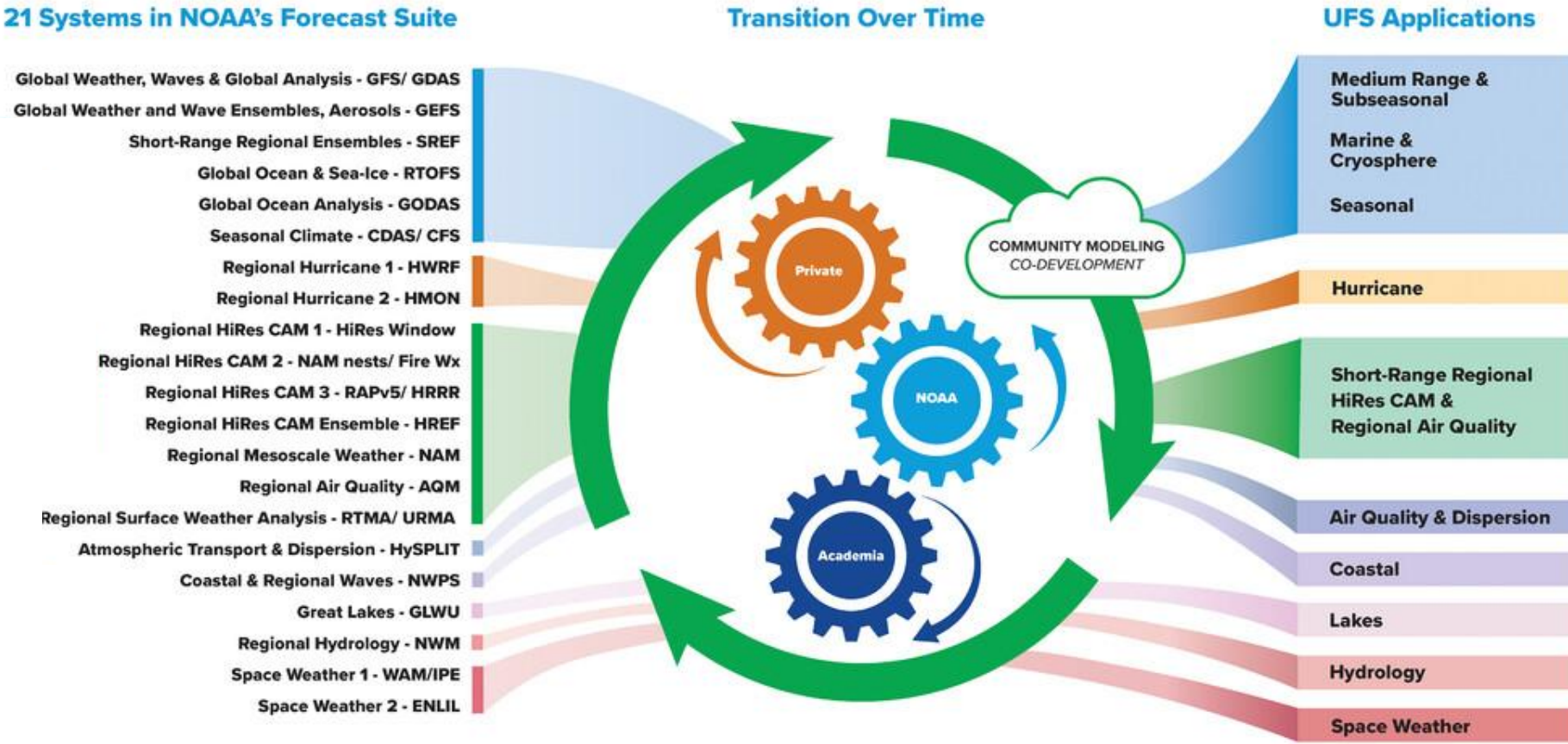


Advancing Predictive Capability through the Unified Forecast System (UFS)

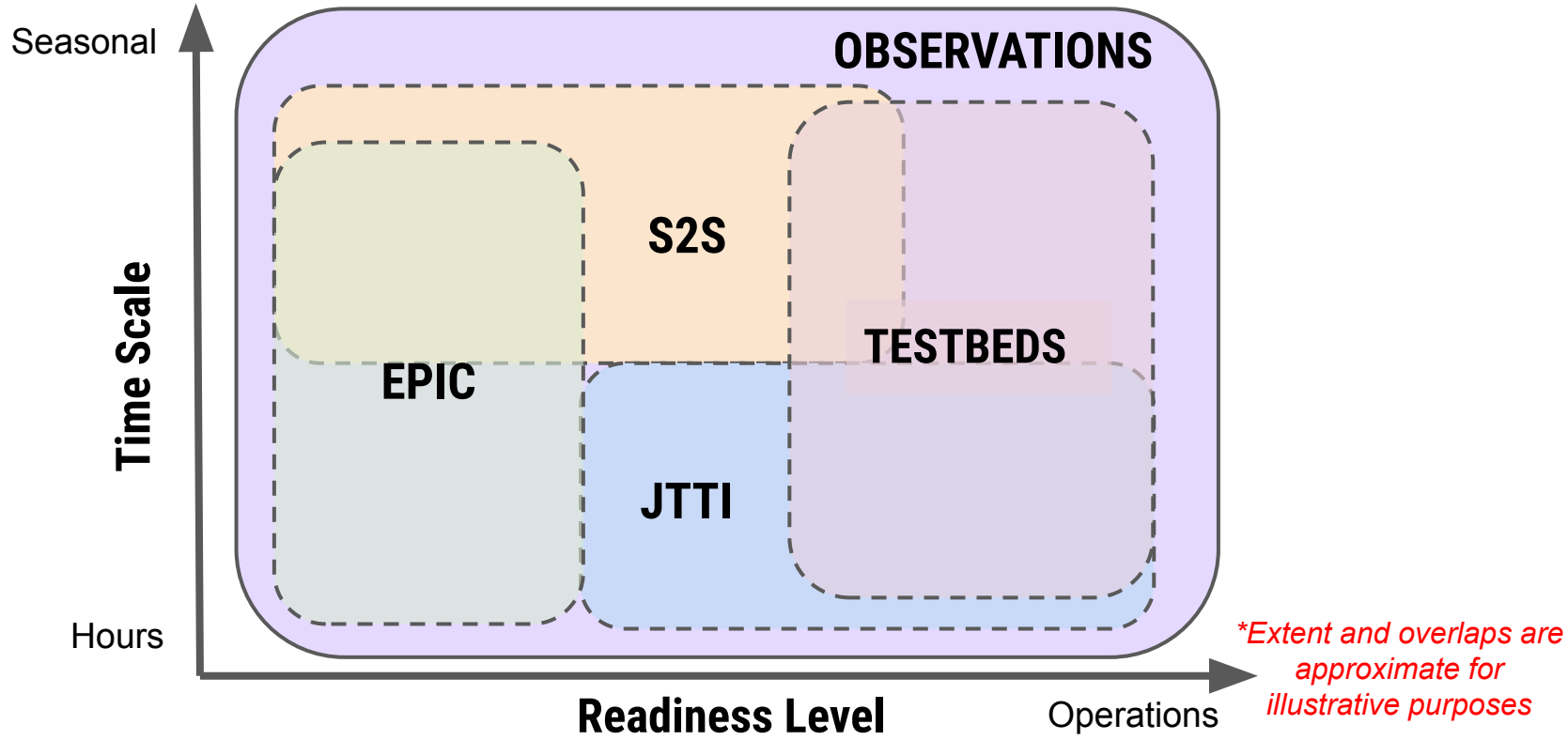


Simplifying NOAA's Operational Forecast Suite

Transitioning 21 of NOAA's Operational Forecast Systems into Eight Applications



Advancing NOAA's Modeling Capabilities Across All Readiness Levels and Time Scales



Observations Program

Advances observation capabilities to improve weather forecasts and decision support:

1. **Find and fund** observation capabilities that:
   - **Strengthen** core systems
   - **Push** the envelope of emerging technologies
   - **Deliver** benefits to NOAA and the broader Weather Enterprise

2. **Coordinate** and facilitate transitions

3. **Manage** interagency and cross-NOAA major Programs such as Phased Array Radar (PAR)

Subseasonal To Seasonal Research (S2S)

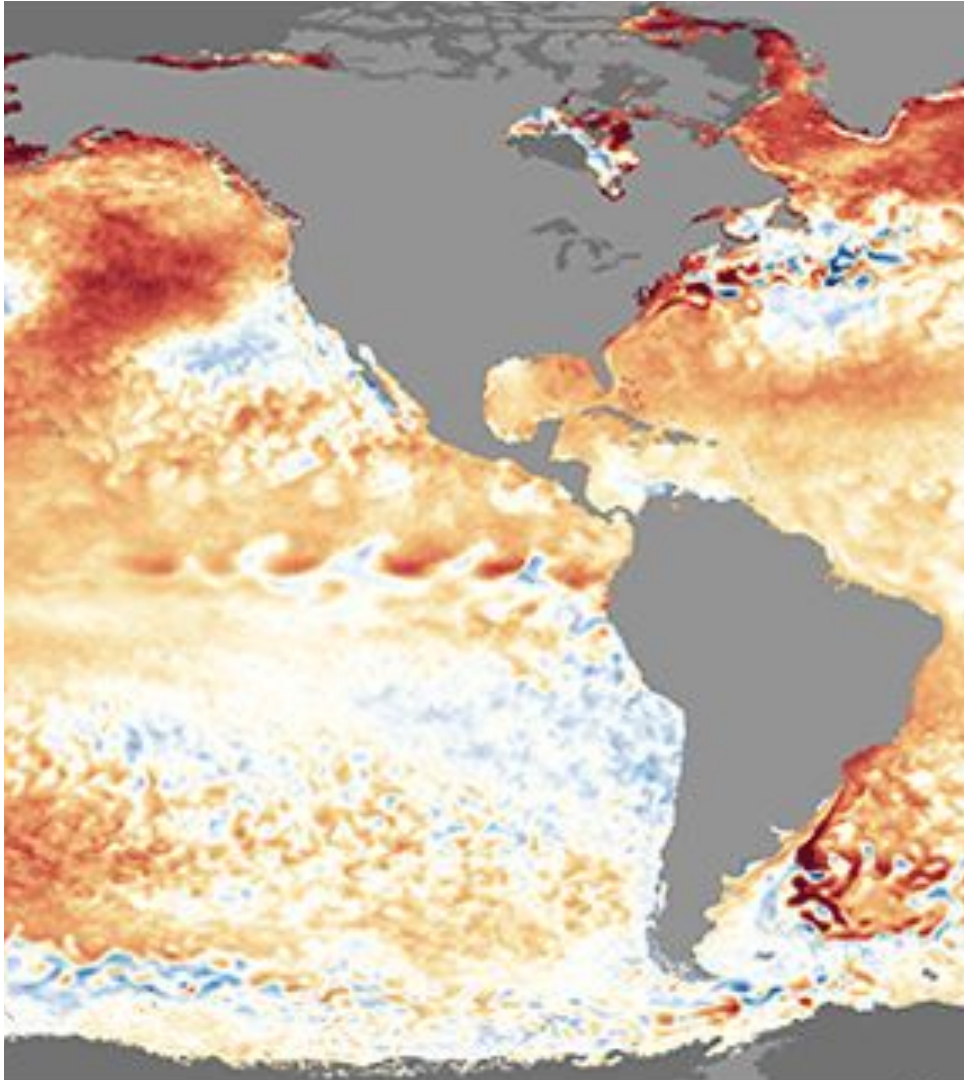
Advances two goals identified by NOAA and in the Weather Act:

- **Improving** the skill of S2S forecasts
- **Enhancing** the value of S2S products for stakeholders

To achieve these goals:

1. **External** competitive awards
    - Low and high RL competitions
2. **Internal** NWS projects
3. **Infrastructure** support (MMEs)
4. **Interagency** coordination (ICAMS)

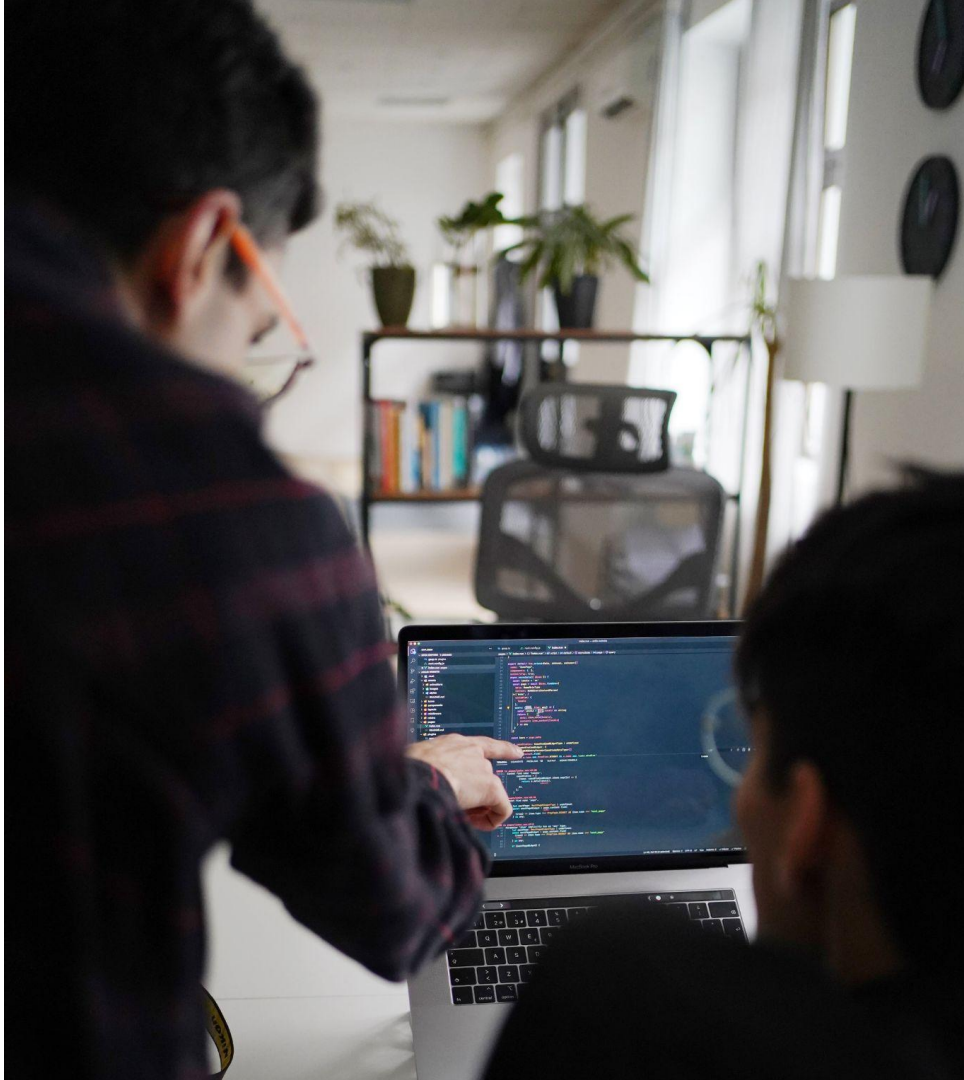
Emerging Focus Area: Western States Hydrology



The EPIC Program

The Earth Prediction Innovation Center (EPIC) focuses on advancing weather models, such as the widely-used Unified Forecast System (UFS) through community modeling. It aims to:

1. **Modernize** modeling infrastructure
   - Code and data management
   - Testing framework
   - Cloud-ready model releases
2. **Provide** Community Support
   - Training and tutorials
   - Hackathons and Code Sprints
   - Service Desk
3. **Accelerate** Community Innovations
   - Community workshops
   - Innovation competition
   - Dissertation Fellowship



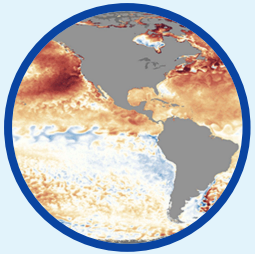
UPCOMING PRESENTATIONS

Activity Area 2: Weather Research Models, Observations, and Forecasting Tools

Observations
Mark Vincent & Segayle Thompson

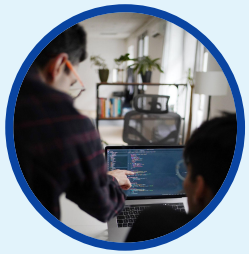
20 Minutes

Subseasonal to Seasonal (S2S)
Jessie Carman



20 Minutes

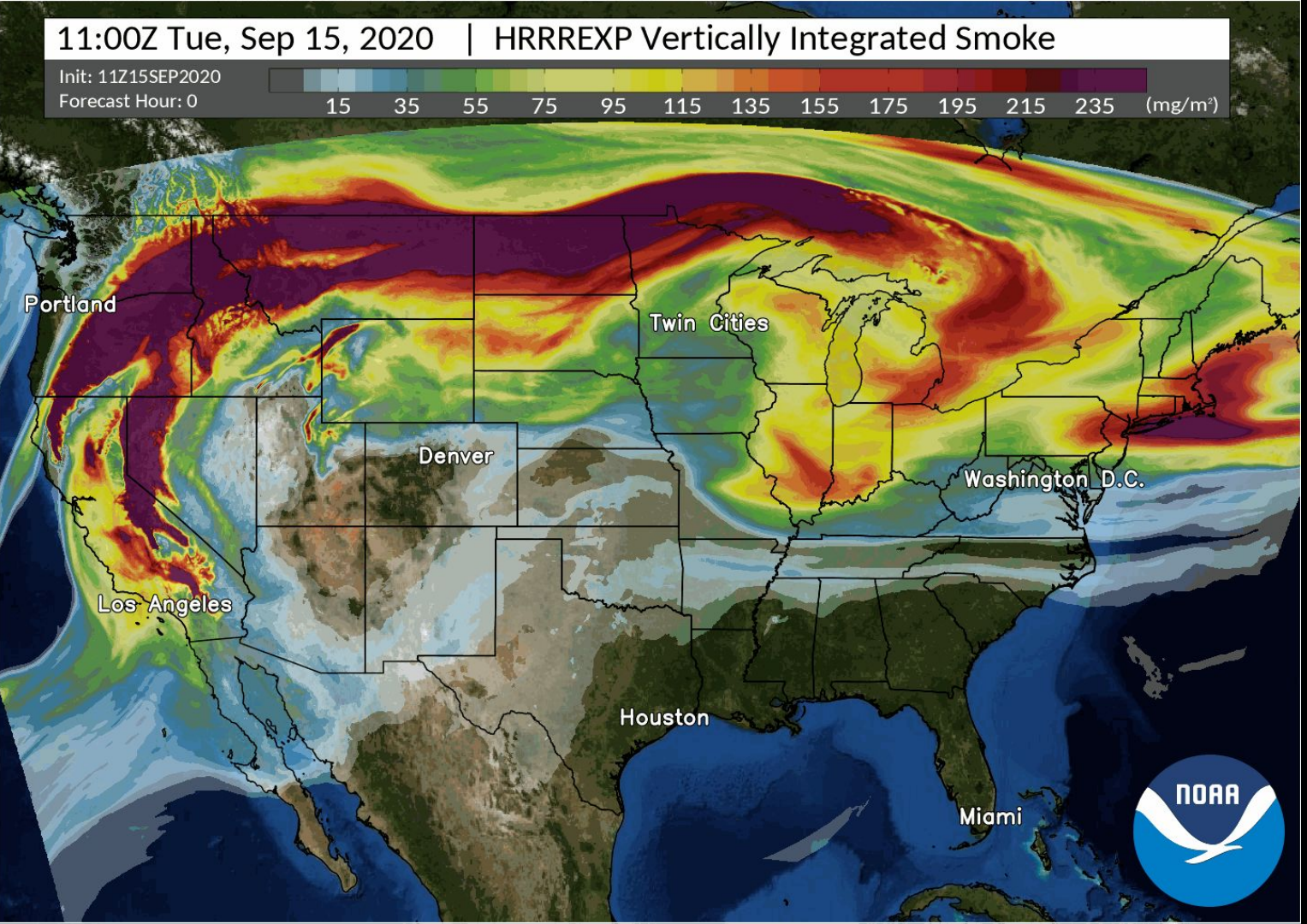
Earth Prediction Innovation Center
Maoyi Huang



20 Minutes

Q&A Session

11:15–12:30pm



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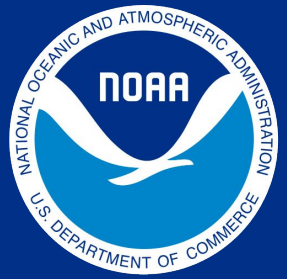
THANK YOU

wpo.noaa.gov

@NOAA_WPO



NOAA WEATHER PROGRAM OFFICE

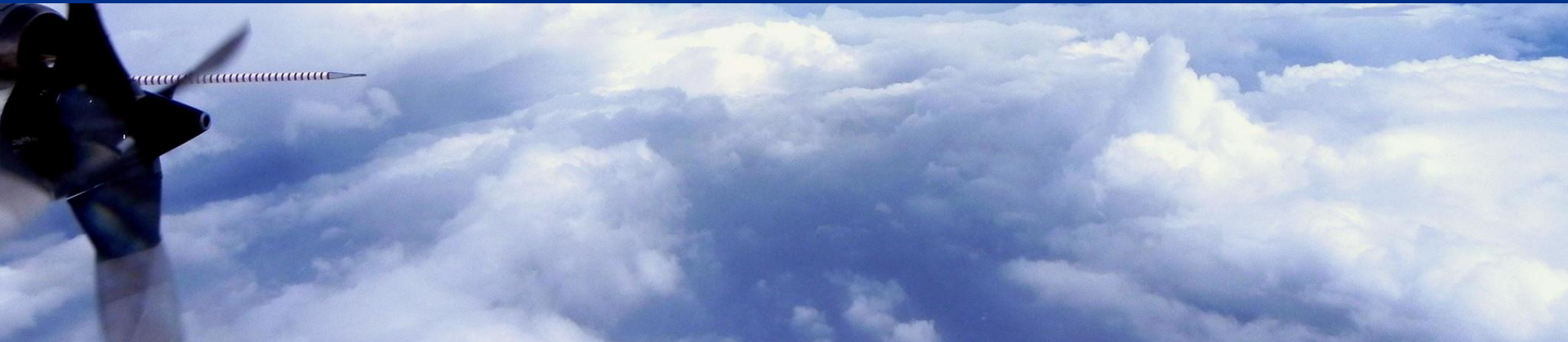
Observations Program

Dr. Mark Vincent, Observations and Research Support Division Chief
Dr. Segayle Thompson, PAR Acquisition Project Manager

Activity Area 2: Weather Research Models, Observations and Forecasting Tools

NOAA WEATHER PROGRAM OFFICE

January 25, 2023



Observations Program

Agenda

- Program Overview
- Partnerships & Collaborations (our force multipliers)
- Highlights
- Path Forward

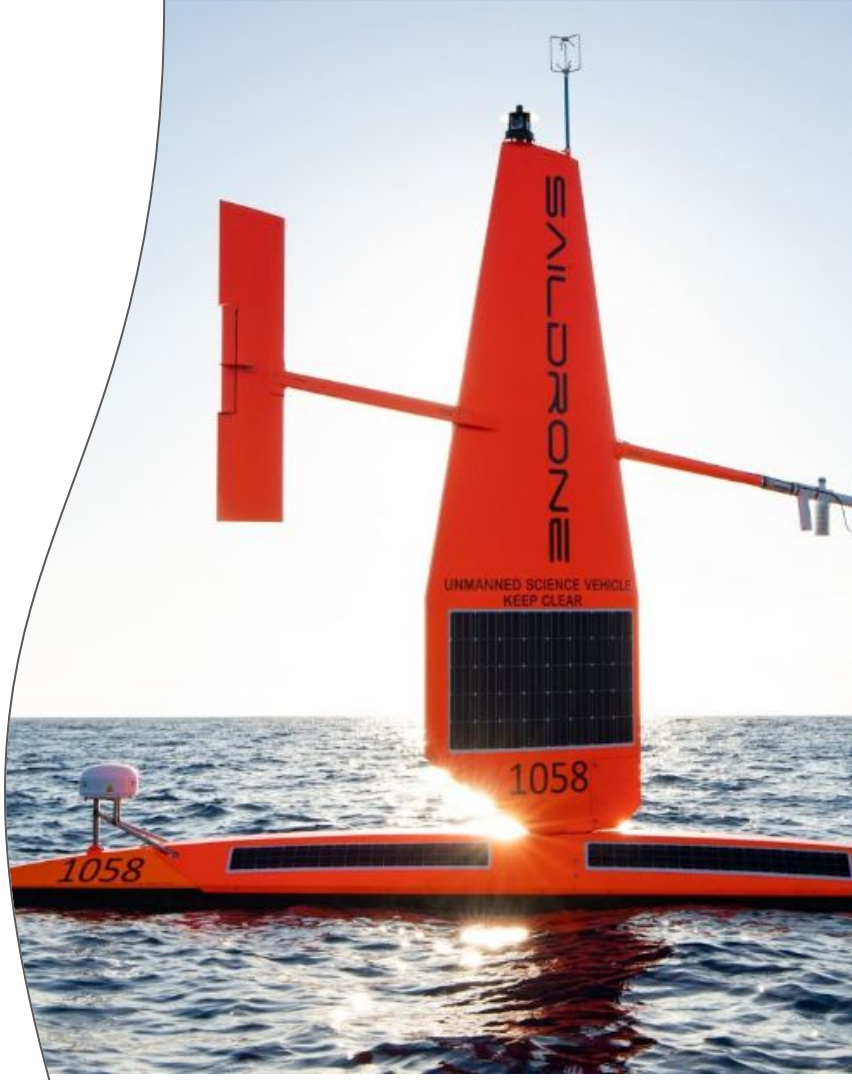
Program Overview

OBSERVATIONS PROGRAM

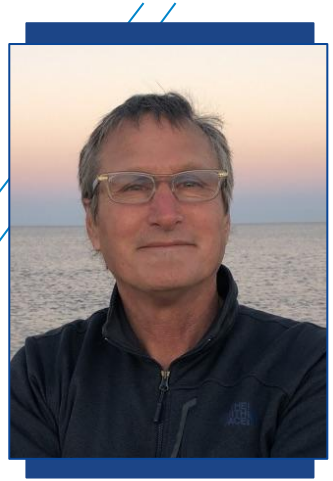
Mission: Advance observation capabilities to improve weather forecasts and decision support

Focus Areas

1. **Find & Fund** observation capabilities that:
   - **Strengthen** core systems
   - **Push** the envelope of emerging technologies
   - **Deliver** benefits to NOAA and the broader Weather Enterprise
2. **Coordinate Transitions**
3. **Manage Major Programs**



OUR TEAM



Dr. Mark Vincent
Program Manager

Dr. Segayle Thompson
Phased Array Radar Acquisition [PAR]
Project Manager

Renee (Richardson) Keller
Program Coordinator

Sandra LaCorte
Program Coordinator

OBSERVATIONS PROGRAM

Program Overview: FY21 Funding Competition

1 Find & Fund

1 Priority - The Weather Act

91 Letters of Intent

18 Funded Projects

22 Extramural Investigators

66 NOAA Collaborators

$10M Funding over **2** years

Partnerships and Collaborators (our force multipliers)

PARTNERSHIPS FOR RESEARCH PUSH AND OPERATIONAL PULL

1 Find & Fund

American Meteorological Society **N**ational **N**etwork **o**f **N**etworks (NNoN)

- Engage R&D and Mesonet communities to stay informed on emerging opportunities
  - RL 4–5
- Broadly communicate funding announcements
- Market results via AMS sessions (chaired 4 sessions at the AMS 2023)

NWS **Office of Observations**

NESDIS **Technology Planning and Integration for Observations**

- Collect documented mission requirements and priorities
  - RL 6–7
- Recruit collaborators, reviewers, Transition Plan contacts
- Facilitate NOAA Emerging Technology Workshops

Research & Development →  → ***Operations***

COORDINATION WITH NCAR TO ADVANCE AIRBORNE WEATHER RADAR

Airborne Phased Array Radar (APAR)

Partners: NCAR, NOAA/OMAO, NWS/EMC, NWS/NHC, OAR/HRD

NCAR/NSF GAP	Lacks airborne weather radar capabilities on their C-130
NOAA RISK	Operational Tail Doppler Radar (TDR) will be retired in 2030 due to P3 being replaced with C-130
CANDIDATE SOLUTION	APAR being developed by NCAR with initial funding from WPO, is a C band radar that is a candidate to provide improved wind and precipitation data for both NOAA and NSF/NCAR aircraft

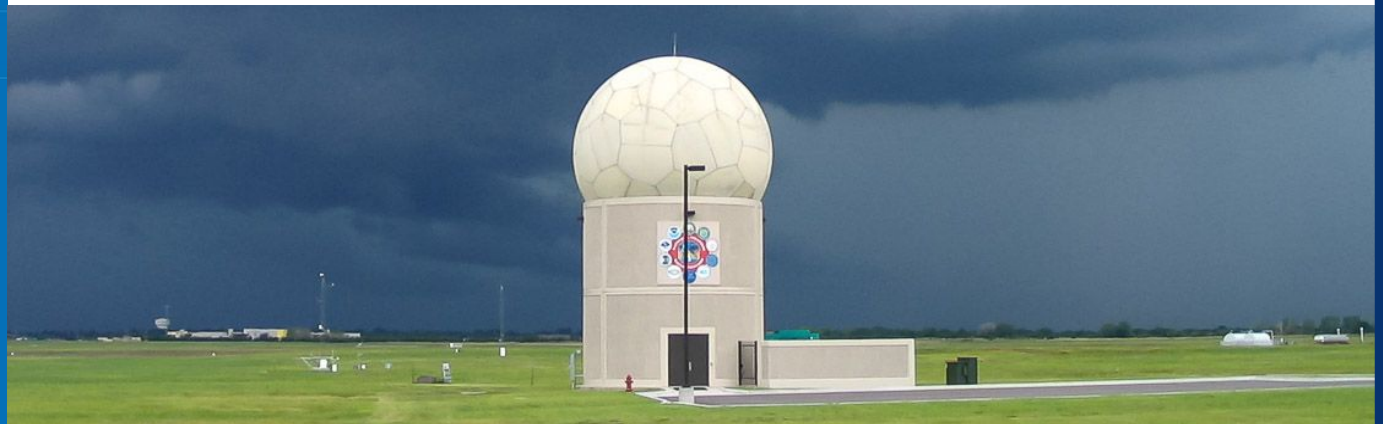
Results enabled by WPO funding to NCAR and NOAA coordination:

- NCAR APAR Preliminary Design Review (PDR) completed November 2021
- Advanced to final review stage of NSF Mid Scale Research Infrastructure (MSRI) $100M competition
- Congressionally required NOAA Transition Plan signed by 5 Office Directors

SHAPING THE FUTURE OF NOAA'S WEATHER RADAR

Context and Challenge:

- The **National radar system (NEXRAD)** provides mission critical data for the detection and forecasting of severe weather
- The system is undergoing a **Service Life Extension Program (SLEP)**.
- Three options are identified in the Report to Congress: **Weather Radar Follow on Plan: Research and Risk Reduction to inform Acquisition Decisions**
  - [1] Sustain the current system with an additional SLEP;
  - [2] Replace WSR-88D radars with new reflector dishes; or
  - **[3] Replace WSR-88D radars with Phased Array Radar (PAR) technology**
    - Four-face stationary or **Single-face rotating PAR**



WPO Project Management of PAR R&D Acquisition will inform future NWS decision for radars from 2040 - 2090

Investigate the feasibility and capability of PAR technology to improve the detection and forecasting of severe weather.

PHASED ARRAY RADAR (PAR)

Acquisition Project Team Structure

Executive Oversight Board (EOB)
Co-Chairs
Members

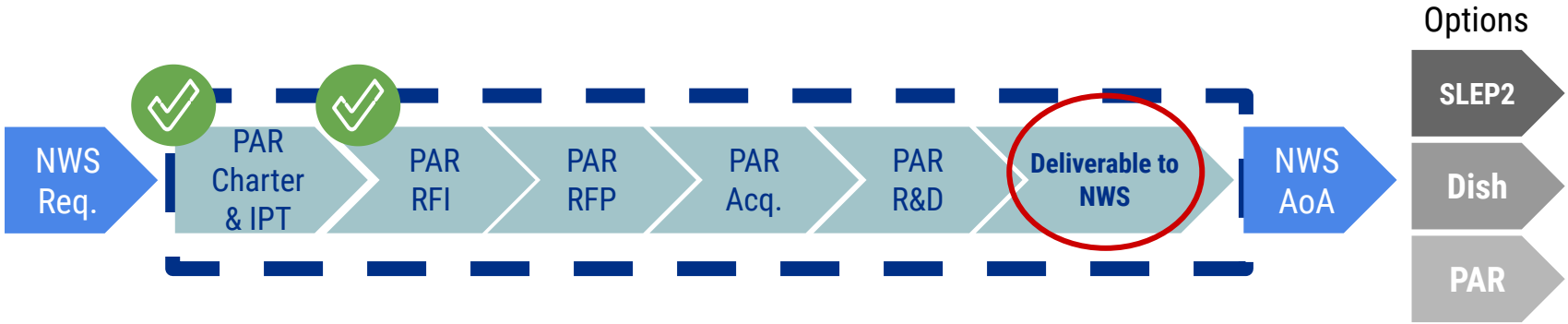
Integrated Project Team (IPT)

- Co-Chairs
  - OAR Deputy Assistant Administrator for Laboratories & Science
  - NWS Director, Office of Planning & Programming for Service Delivery (OPPSD)
- Members
  - **OAR/WPO Director and Project Manager** ⭐
  - OAR/NSSL Deputy Director
  - NWS/OBS Director
  - NWS/OBS/ROC Director of the Radar Operations Center
  - Director, Western Acquisition Division (WAD), AGO

- Stakeholders
  - NWS Office of Observations and the Radar Operation Center (ROC)
- PAR R&D Technical
  - National Severe Storms Laboratory (NSSL) Subject Matter Experts
- OCFO Advisor
- Acquisition and Grants /Contracts
  - WAD, Contract Officer
  - Contracting Officer's Representative
- Budget Execution - NSSL
- Communication

*The EOB is responsible for oversight of the PAR program and the overall guidance of the **Integrated Project Team (IPT)***

SCOPE OF OAR PAR ACQUISITION PROJECT

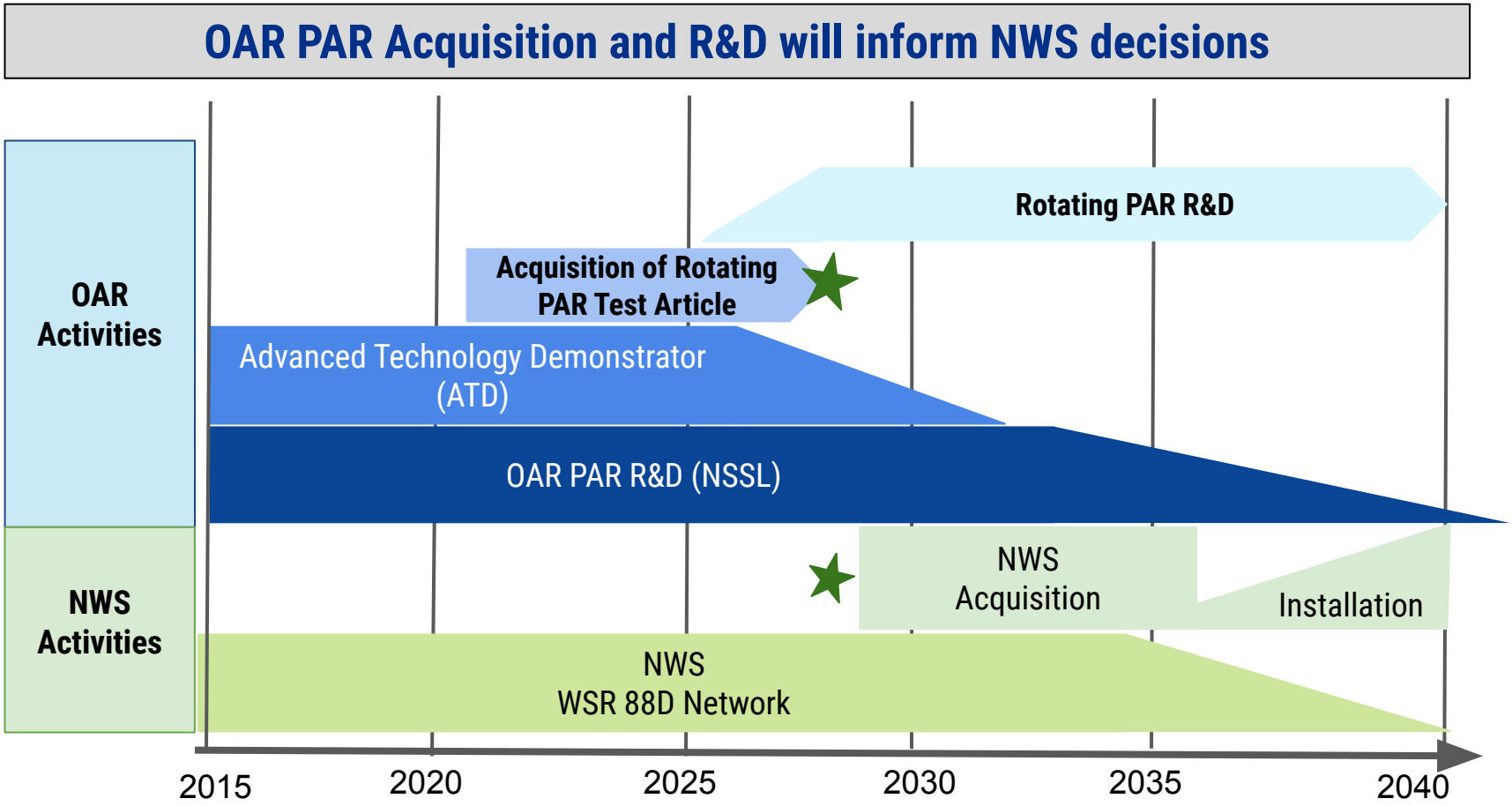


Once acquired, research will be conducted to analyze the feasibility and capability of the rotating PAR Test Article to improve NOAA's weather prediction

- An internal report will be delivered to the NWS to help inform the NWS Analysis of Alternatives (AoA) for the next National Radar System

WPO is managing the collaboration between NWS, OAR, and AGO to drive the acquisition of the single-face rotating PAR Test Article

PHASED ARRAY RADAR (PAR) ACQUISITION



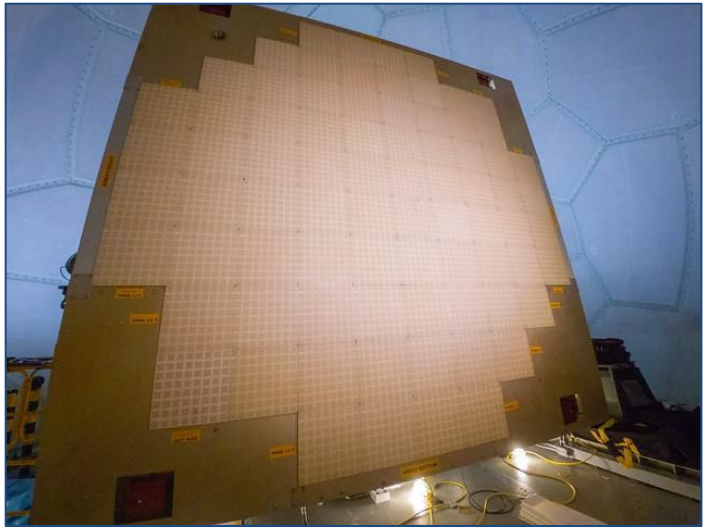
PHASED ARRAY RADAR (PAR)

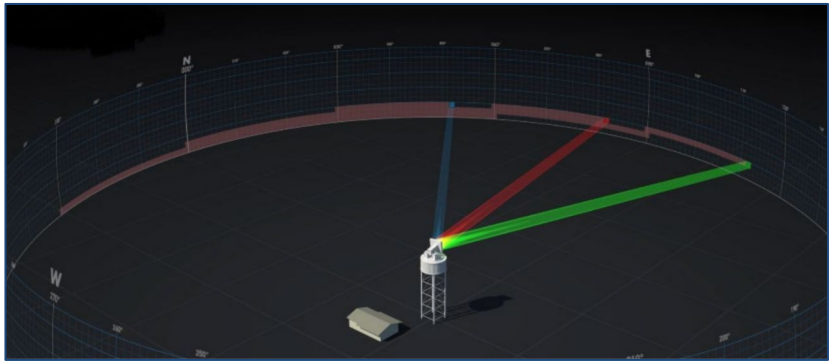
Results of WPO engagement and coordination:

- Extensive market research
- Weekly cross-line office discussions
- Lead writing of the congressional report on the feasibility and capability of a single-face rotating PAR

Forward looking engagement and coordination efforts:

- Research and communication plan development
- Drafting requested long-term transition plan





Highlights

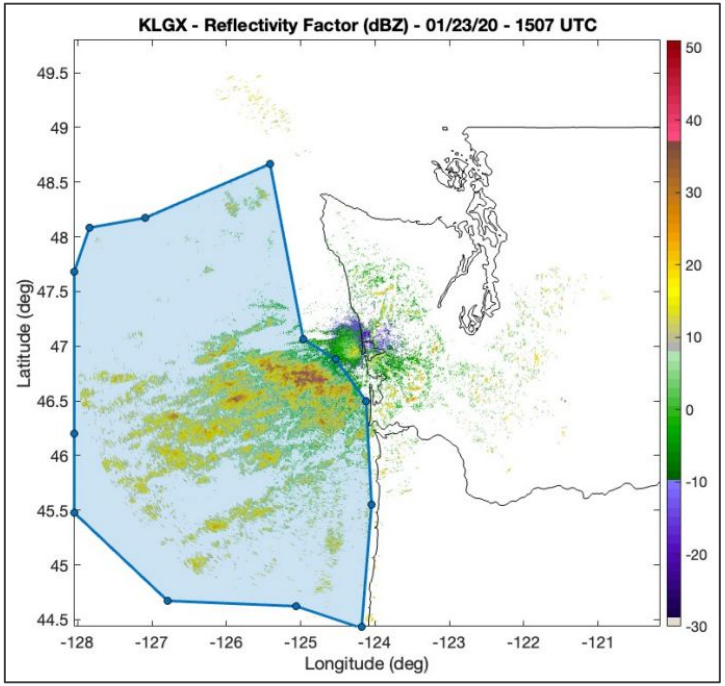
SEPARATING THE WEATHER FROM THE CHAFF

Development and Deployment of a Sea Clutter Class within the Operational WSR-88D Hydrometeor Classification Algorithm

PI: Dr. James Kurdzo, MIT Lincoln Laboratory
NOAA Collaborators: Michael Istok, NOAA/NWS Radar Operations Center

New algorithm distinguishes military chaff and sea clutter from weather

- Developed for NWS WSR-88D [*Weather Surveillance 1988 Doppler*] Radar
- Expected to transition to NWS Radar Operations Center (ROC)
- Improvement to NWS, FAA, and DoD operations



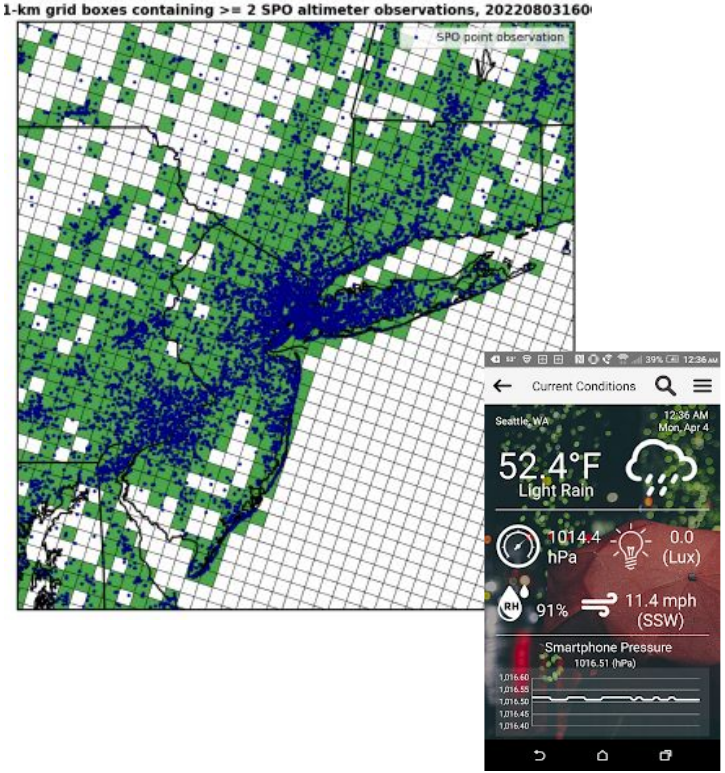
SMARTPHONES MAKING WEATHER FORECASTS SMARTER

Anonymization, Bias Correction, and Assimilation of Smartphone Pressure Observations for Use in Numerical Weather Prediction in NOAA

PI: Dr. Cliff Mass, University of Washington
NOAA Collaborators: Curtis Marshall (NWS/NMP), Vijay Tallapragada (EMC)

Collects over 4 million smartphone pressure observations each hour across the US

- Retrieves smartphone pressure observations from weather apps used by major telecom companies
- Bring bias corrected, **anonymized** smartphone pressure data into Numerical Weather Prediction (NWP)
- Project will include analysis of impact to HRRR



UNLOCKING A TREASURE TROVE OF AIRCRAFT DATA

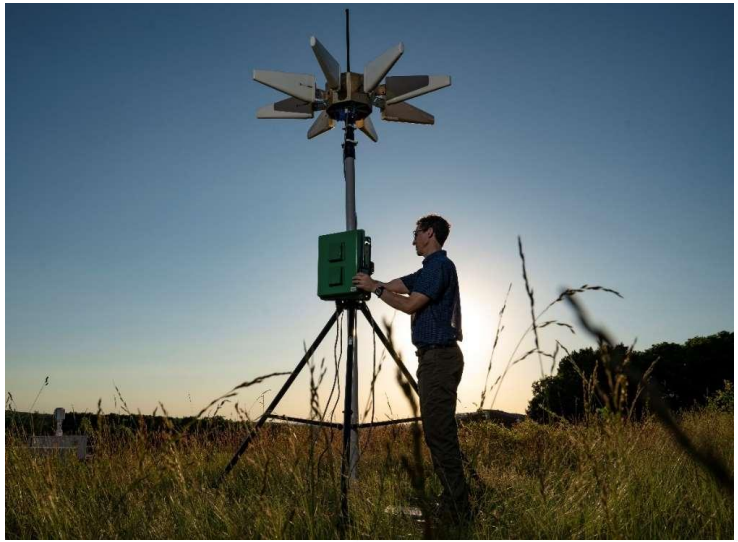
1 Find & Fund: *Push the Envelope*

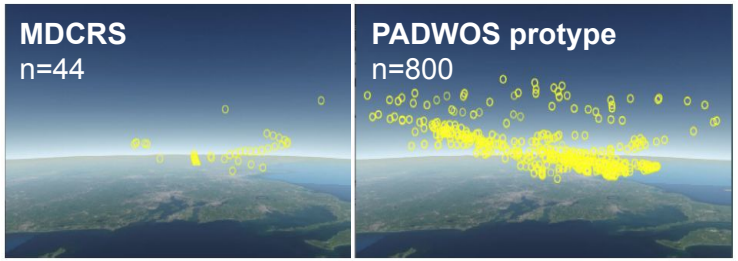
Development and Demonstration of a Low-Cost Standalone Mode S EHS Aircraft Derived Atmospheric Observation System for Enhanced Weather Forecasting

PI: Dr. Michael McPartland, MIT Lincoln Laboratory

> *"Aircraft Derived Observations (ADO) winds and temperatures provide the highest value inputs to NWP models."*
>
> ***James & Benjamin, 2017***

	Current ADO (MDCRS)	Proposed ADO (PADWOS Mode S EHS)
% of Commercial Aircraft	20%	75% ↑
Latency	17 minutes	1 minute ↓
Domain	Major Airports	CONUS ↻





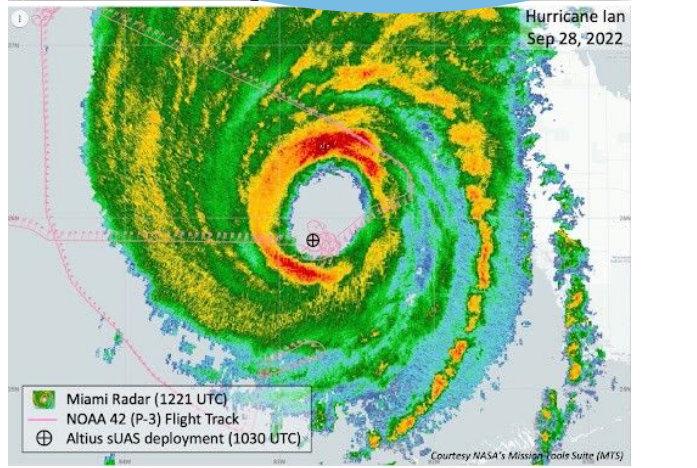
NEW HURRICANE HUNTERS JOIN THE FLEET: DRONES!

1 **Find & Fund:** ***Push the Envelope***

Employing Small Unmanned Aircraft Systems to Improve Situational Awareness and Operational Physical Routines Used to Predict Tropical Cyclone Structure and Intensity

PI: Dr. Jun Zhang, CIMAS/University of Miami
co-PI: Dr. Joe Cione, NOAA/AOML/HRD

On September 28, 2022, the Area-I Altius 600 completed a successful mission into Hurricane Ian, measuring 216 mph winds at an altitude of 2,150ft!



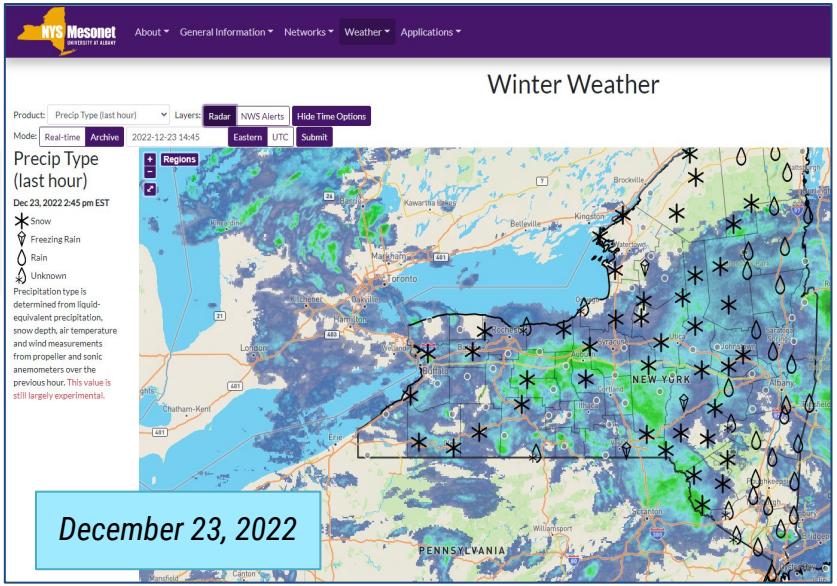
- Deploy small uncrewed aircraft systems (sUAS) into dangerous, low altitude regions within tropical cyclones
- Data assimilation development work will be conducted using this data to improve model physics
- This work holds the potential to improve situational awareness and forecasts

EITHER TOO HOT OR TOO COLD!

Improvement in Winter Weather & Extreme Heat Operations using In Situ Mesonet Observations

PI: Dr. Junhong Wang, University at Albany, NYSM
PI: Dr. Nick Bassill, University at Albany, NYSM

New York State Mesonet data from 126 stations improves NOAA, state and local operations



- **NY Winter Weather Project:**
  Provides real-time snow depth, snowfall rates, snowfall accumulation, snow water equivalent, and precipitation type

- **NYC Urban Heat Project:**
  Provides real-time analysis and communication of extreme temperatures across New York City using a dense network of observations

"... the NYS Mesonet data are routinely interrogated during excessive heat to monitor and refine messaging associated with these impactful events."

Science and Operations Officer (SOO)
NOAA's National Weather Service, New York, NY

Path Forward

OBSERVATIONS PROGRAM

Aligned with SAB PWR report

"Observations are the foundation that supports the NOAA mission."

●●●●

"Recommendation #3 : Fill gaps in existing Earth system observing networks with existing, proven or augmenting technologies"

NOAA Science Advisory Board (SAB), 2021:
A Report on Priorities for Weather Research (PWR)

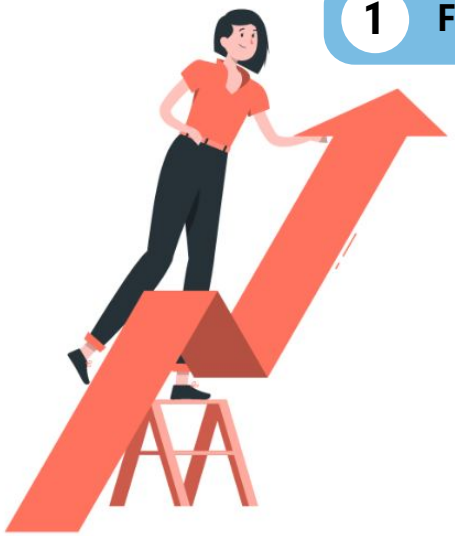
OBSERVATIONS PROGRAM

Path forward: Near Term Activities

3 **Manage Major Programs**

2 **Coordinate Transitions**

1 **Find & Fund**

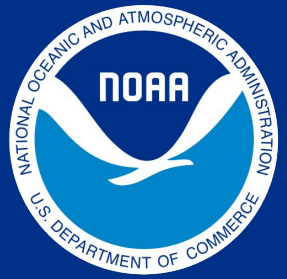


- Manage PAR Test Article Acquisition
- Advance promising FY21 Project Technologies
- Execute FY23 Observations Competition
  - Analyses of existing weather observations
  - Analyses of gaps in current observations
  - Fire Weather
  - Mesonet Boundary Layer Observations
  - Tropical Cyclone Observations
  - Innovative observing technologies including observations of opportunity

OBSERVATIONS PROGRAM

Path Forward: Opportunities to Enable Excellence

- Strengthen advanced competencies in federal acquisition (FAC/PPM certification)
- Increase analysis of existing NWS & emerging systems (OSEs, OSSEs)
- Build targeted partnerships with ICAMS agencies
- Increase private sector participation in funded projects



NOAA WEATHER PROGRAM OFFICE

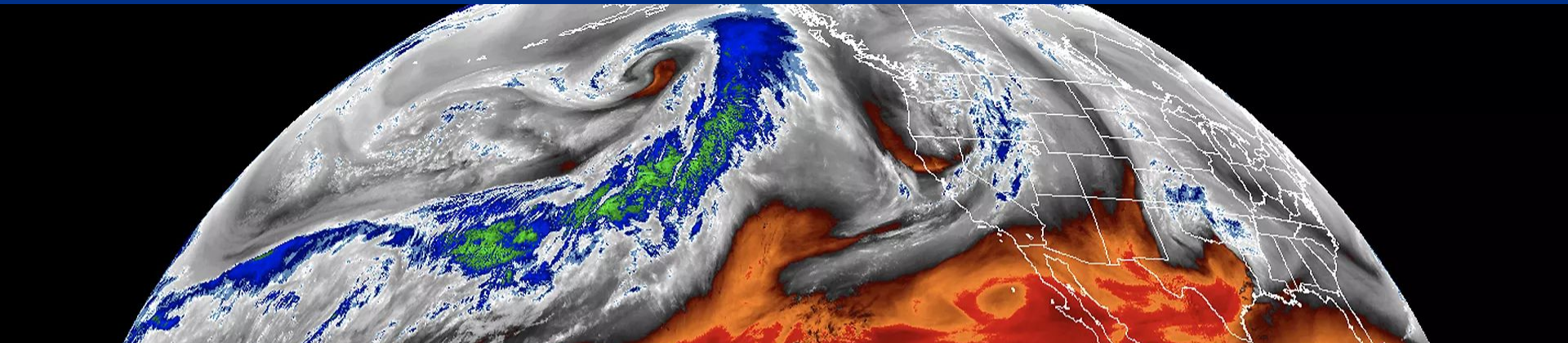
NOAA WEATHER PROGRAM OFFICE

January 25, 2023

Subseasonal to Seasonal Program and Climate Test Bed

Dr. Jessie Carman, Earth System Research and Modeling Division Chief

Activity Area 2: Weather Research Models, Observations and Forecasting Tools



SUBSEASONAL TO SEASONAL (S2S)

OUR TEAM

Dr. Jessie Carman
S2S Program Manager

Dr. Mark Olsen
S2S Program Deputy

Christine Bassett
S2S Program Coordinator

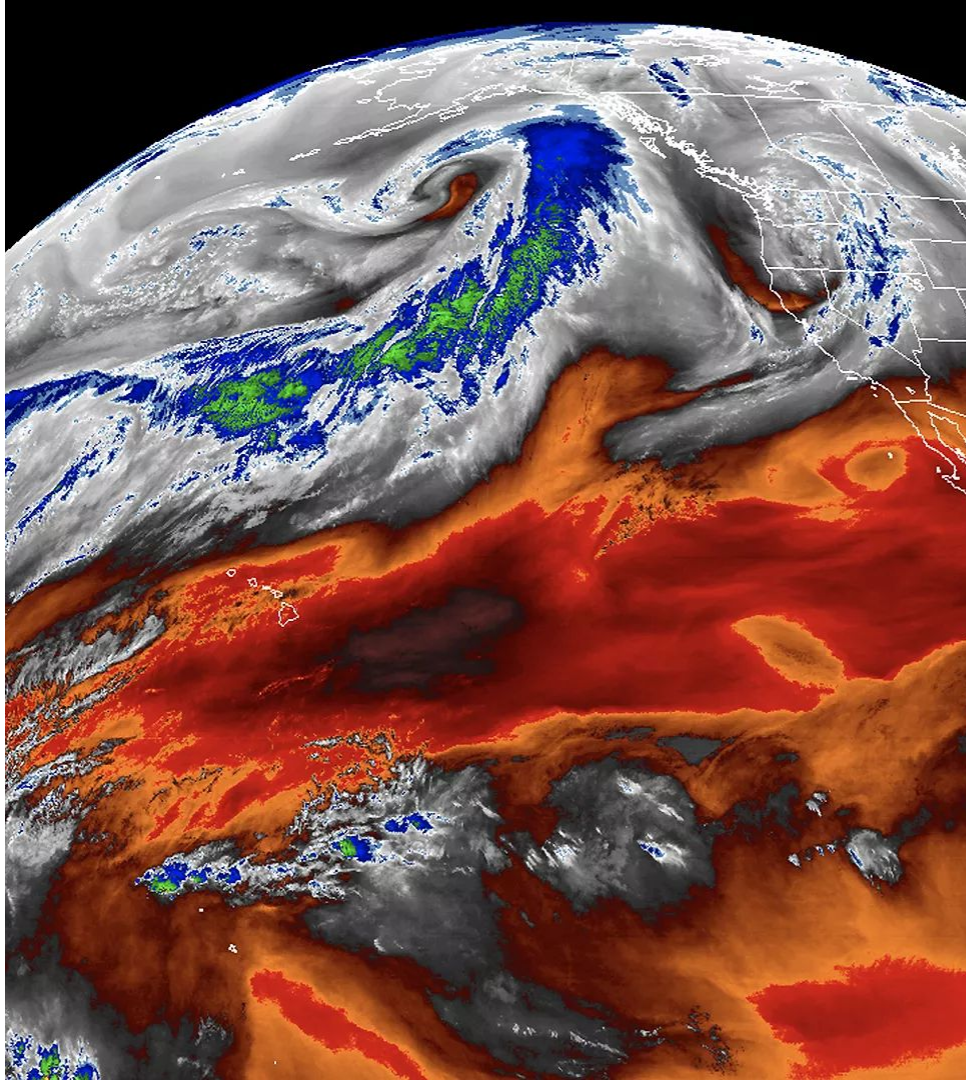
Dr. DK Kang
S2S Program Coordinator

SUBSEASONAL TO SEASONAL (S2S) PROGRAM

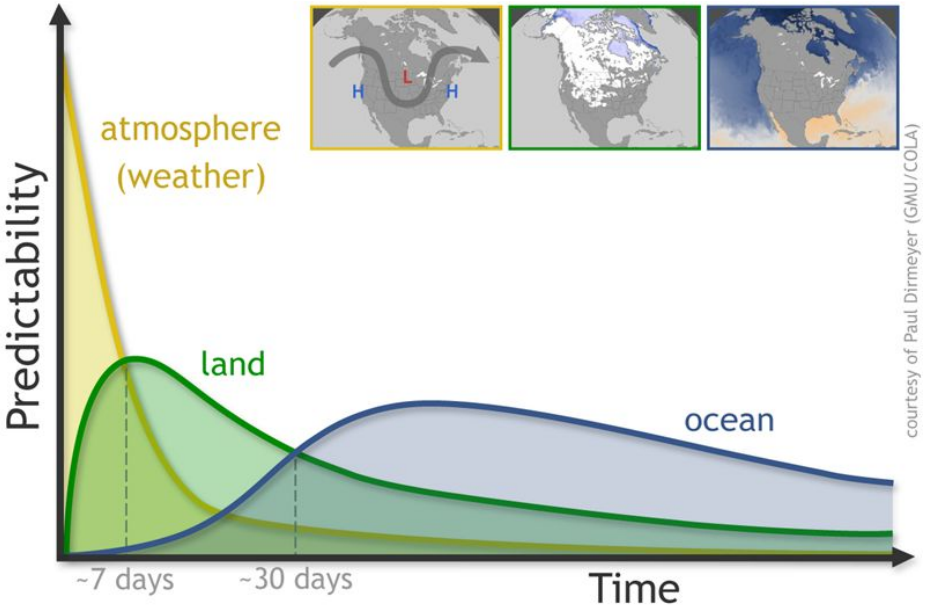
Our Drive

Address the increasing need for actionable S2S predictions and decision support as climate changes and population increases in hazardous areas (coasts, deserts).

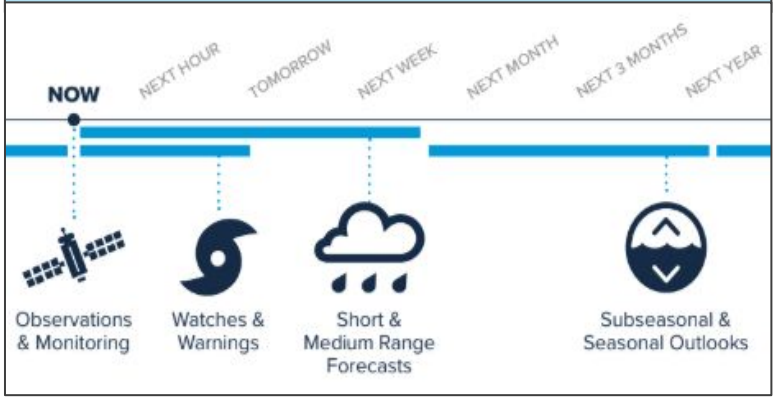
- Support for UFS model component development
- NOAA and external competitions
- Innovations for Community Modeling
- Interagency coordination and partnership
- Looking forward: Western States Hydrology



SUBSEASONAL TO SEASONAL (S2S) PROGRAM



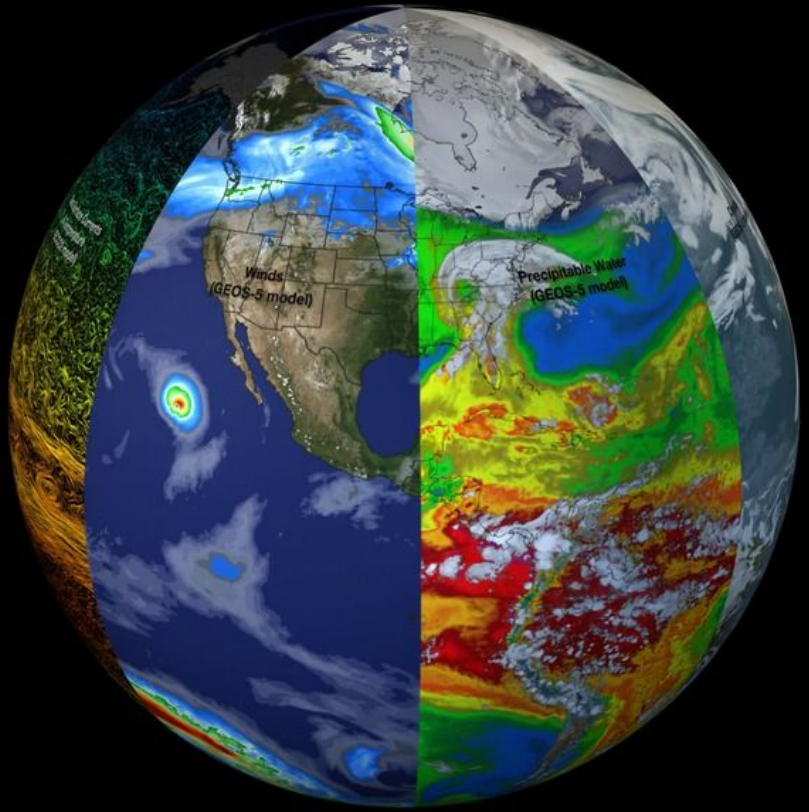
NOAA provides a suite of weather and climate products from near-term forecasts to long-term projections.

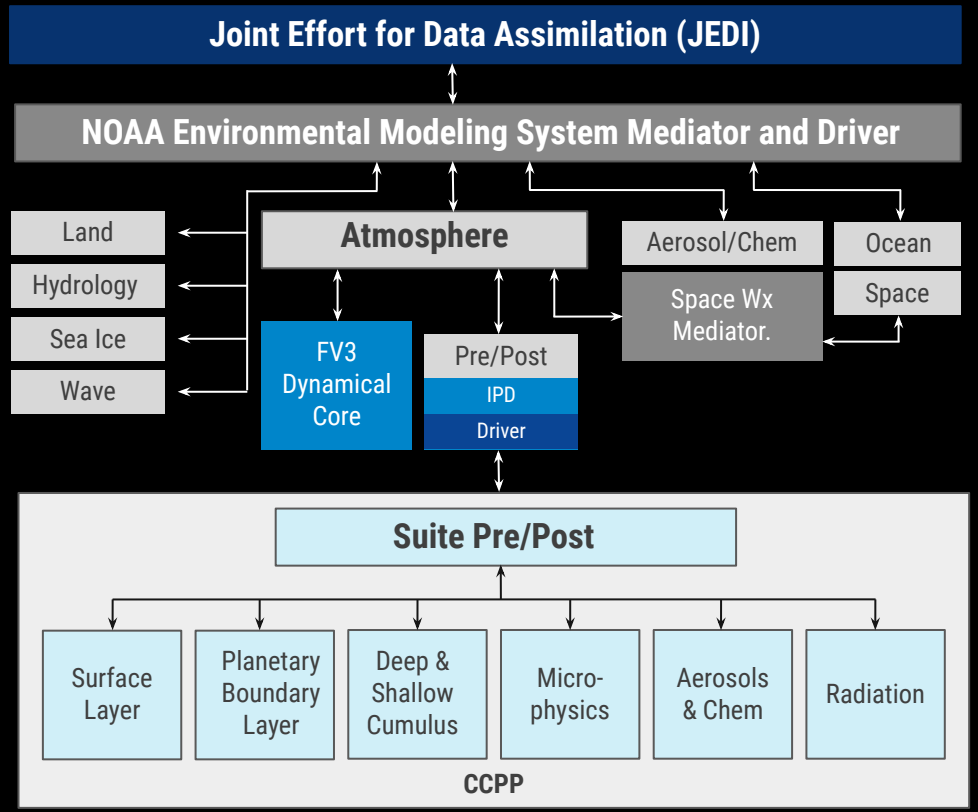


1. Improving S2S model skill by emphasizing global coupled modeling in the UFS, postprocessing and product support tools

2. Stakeholder-driven product development that creates jobs, boosts economies and builds resilience to extreme events

Entraining the community into the UFS

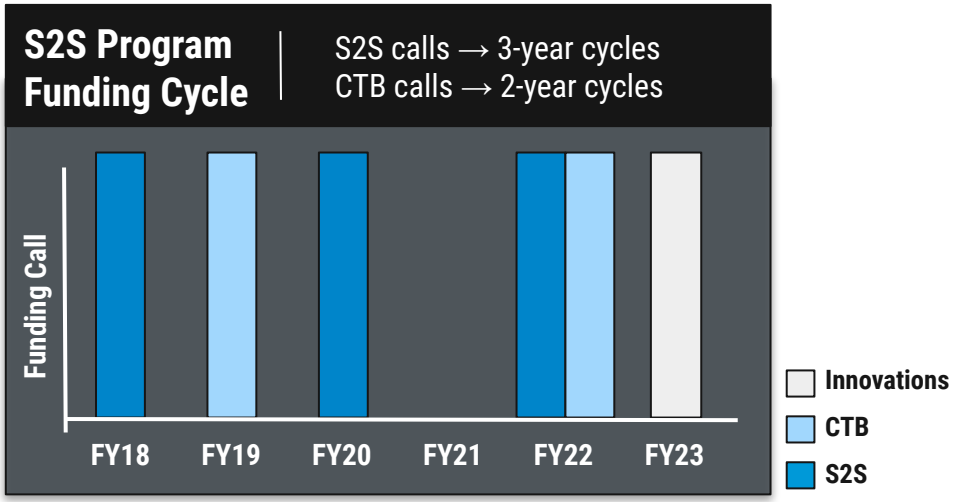




S2S PROGRAM COMPETITIONS

S2S Program funding calls emphasize integration into UFS, coupled data assimilation (DA), ensembles and statistical post-processing. We partner with:

Within WPO: EPIC, JTTI, Testbeds
Cross-Line Office: NWS, EMC, CPC



Close coordination between WPO programs, including EPIC; pushing PIs to leverage EPIC resources
Visit EPIC's website for more information!

Subseasonal to Seasonal (S2S) → Climate Test Bed (CTB) → Innovations

S2S PROGRAM COMPETITIONS

Since 2019, S2S NOFO calls request projects addressing:

1) UFS components/coupling
2) Data assimilation
3) Post-processing, ensemble tools

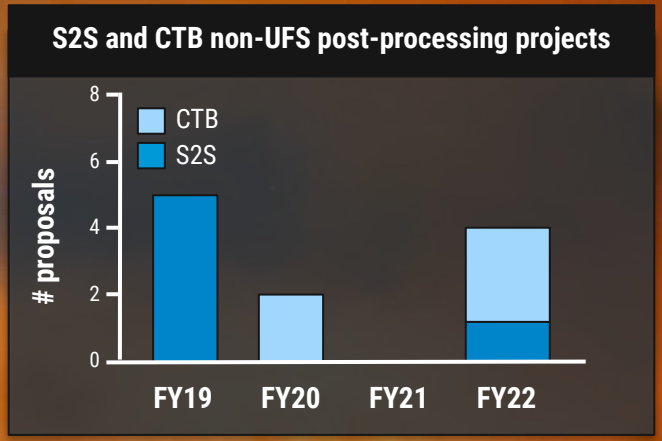
Github releases of components 2020-2022

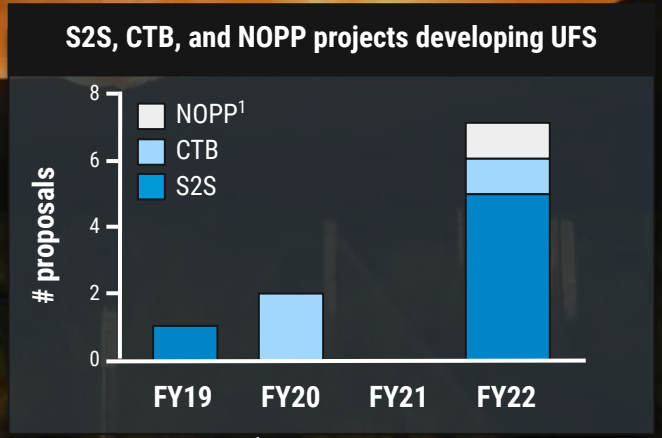
"Innovations" FY23 competition is in progress

Focuses on S2S UFS component/coupling improvements, coupled data assimilation to improve precipitation, drought, hydrology prediction.

S2S projects will be able to easily leverage EPIC support for UFS improvement.

FY23 NOFO





[1]National Oceanographic Partnership Program

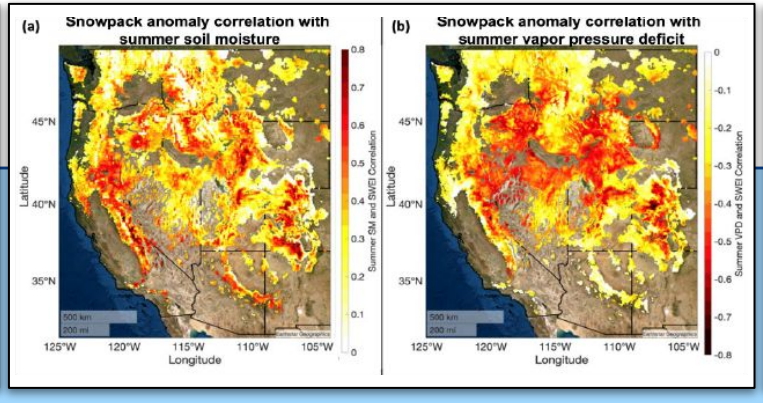
External project highlights

HIGHLIGHTS: S2S (RLs 2-4)

Seeks projects developing the UFS S2S capability that coordinate with developments under the UFS Research to Operations (UFS R2O) Project, particularly developing the Global Ensemble Forecast System.

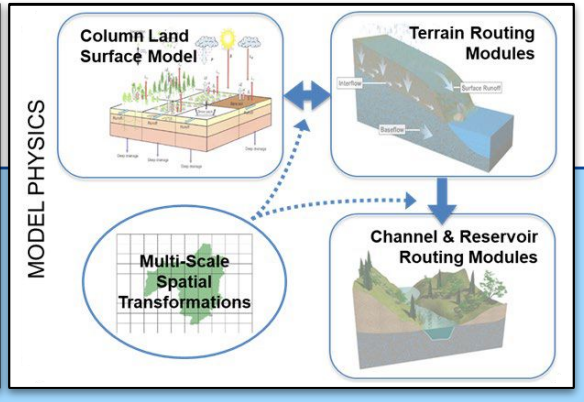
Assessing the impact of dynamic vegetation on drought forecasts
(Otkin - U. Wisconsin)

PRIMARY GOAL: Compare UFS vegetation treatments, particularly flash drought



Enhancing NOAA UFS subseasonal to seasonal predictions of precipitation and drought via improved representation of snowpack processes
(He - NCAR)

PRIMARY GOAL: Advance understanding/modeling of aerosols, vegetation, processes on snowpack in UFS–correlates with summer vapor pressure

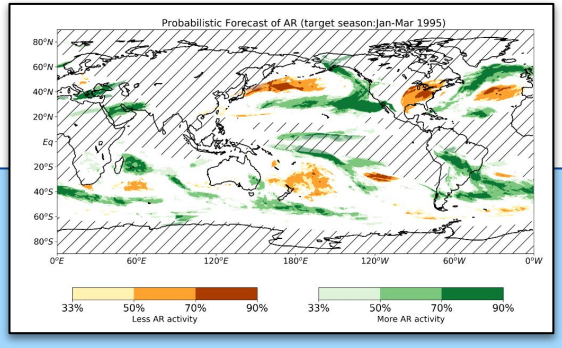


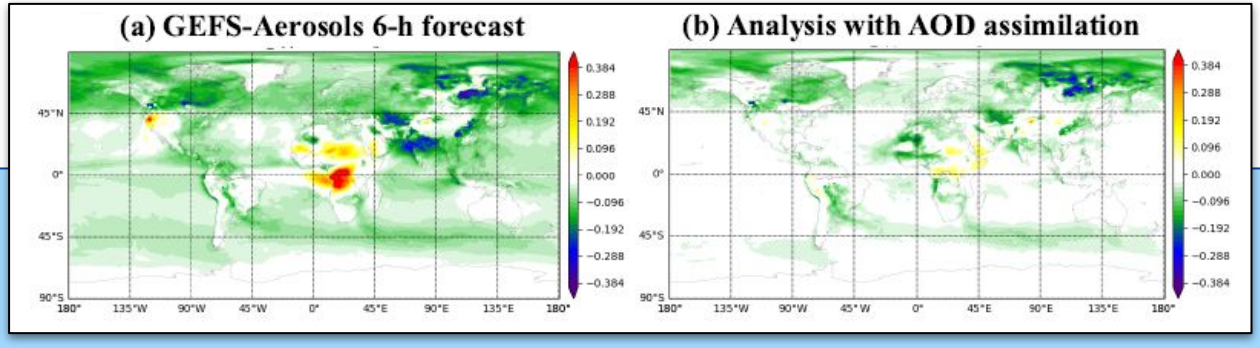
Integrated surface physics for coupled hydrometeorology in the UFS for S2S prediction
(Gochis - NCAR)

PRIMARY GOAL: Extend Noah-MP+WRF-Hydro globally, update coupling, to connect NWP→S2S terrestrial hydrologic processes

HIGHLIGHTS: CTB (RLs 5-8)

In partnership with the Climate Prediction Center (CPC) and the Environmental Modeling Center (EMC), solicits proposals that advance NOAA's operational S2S prediction capabilities via the Climate Test Bed.





Development of a Global Aerosol Reanalysis at NOAA in Support of Climate Monitoring and Prediction
Huang (CU Boulder)

PRIMARY GOAL: Add a Aerosol Optical Depth (AOD) to JEDI-based data assimilation, which is crucial for one of UFS components

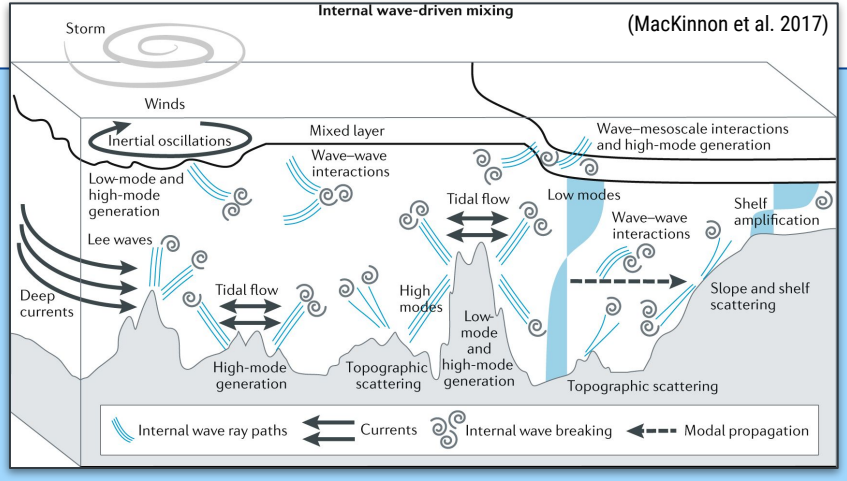
Transitioning NMME-based seasonal predictions of atmospheric river activity into an operational forecast product
Xiang(UCAR/GFDL)

PRIMARY GOAL: Create a seasonal AR forecast tool

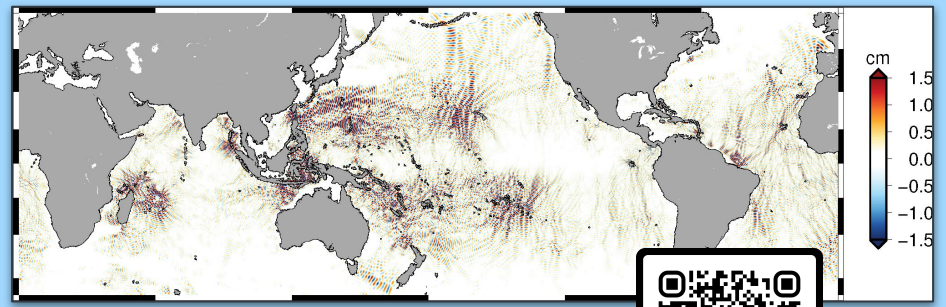
HIGHLIGHTS: NOPP

WPO participated in FY22 year's ONR Broad Agency Announcement (BAA) for National Oceanographic Partnership Program (NOPP) for cross agency collaboration.

Topic: "High Resolution Ocean Models for Coupled Earth System Prediction Across Space and Time Scales"



PRIMARY GOAL: Simulate tides with MOM6, ocean mixing caused by internal tides, and climate scale ocean-cryosphere interactions

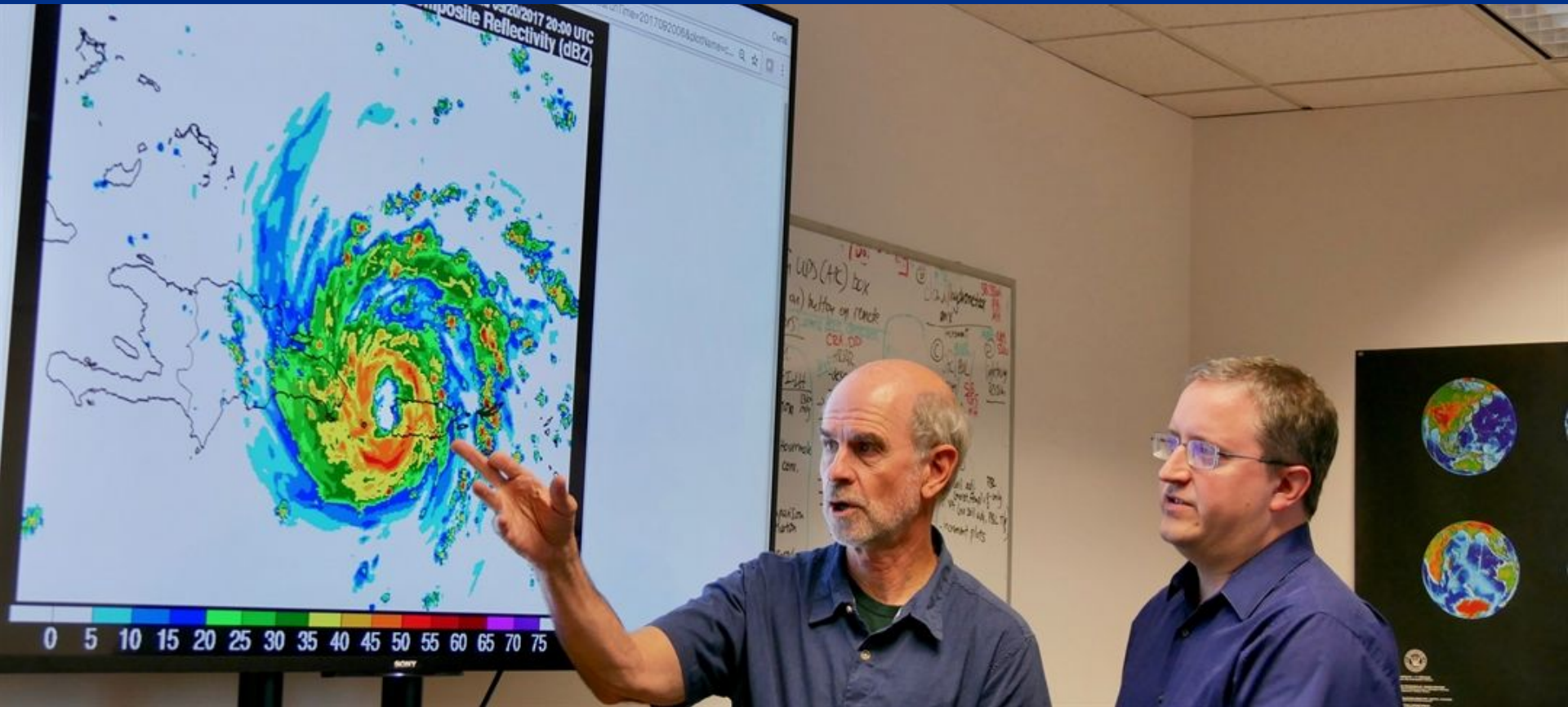


WPO's interest:

- high-res MOM6 projects
- leverage NOAA/NOPP matching
- partner with other agencies

FY22 ONR BAA

Supporting forecaster needs



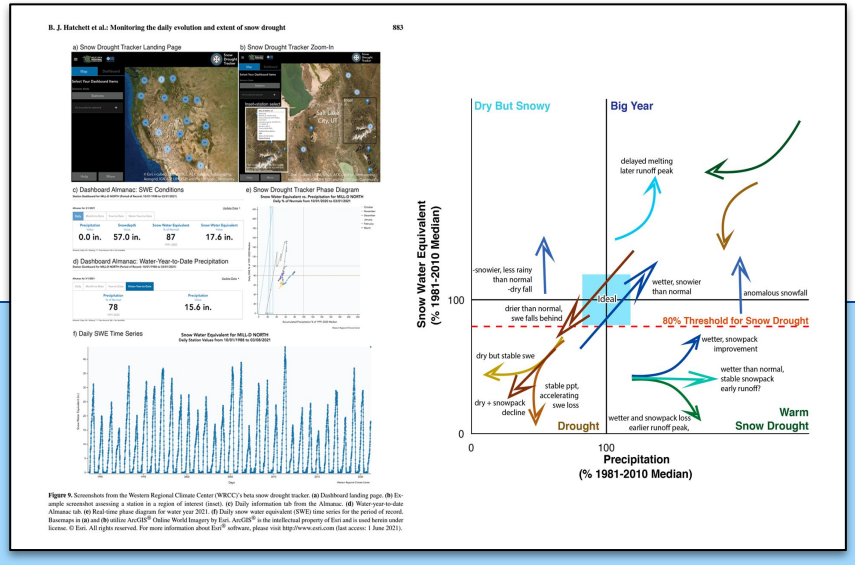
OAR-NWS ANALYZE, FORECAST AND SUPPORT (AFS)

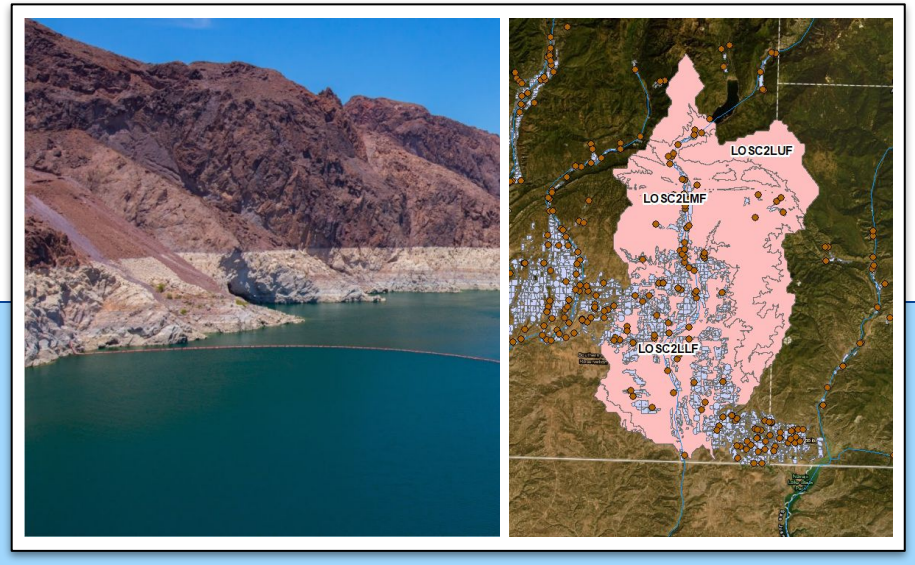
Optimal plan . . . in a year with a signed budget . . .

Projects support product development for topics such as:

- Alaska spring river ice breakup
- CPC spatial downscaling to support hydrology
- Marine freezing spray guidance
- Global heat health predictions

HIGHLIGHTS: NWS AFS





Snow Drought Tracker (FY20)

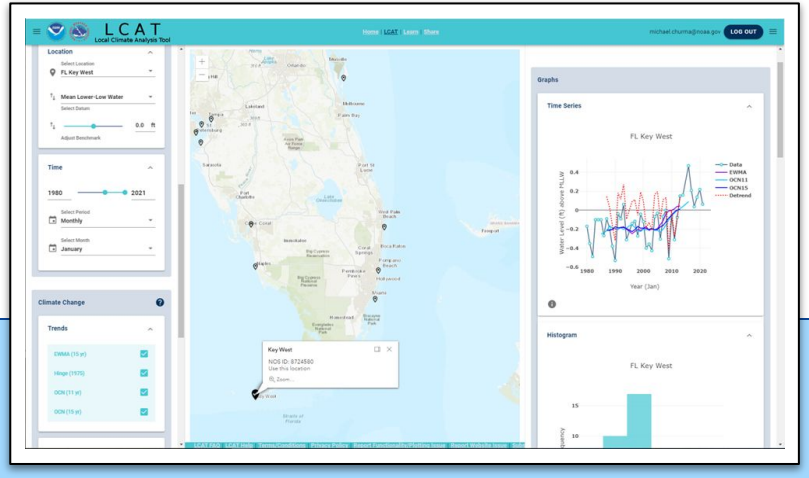
TRANSITIONED TO OPERATIONS

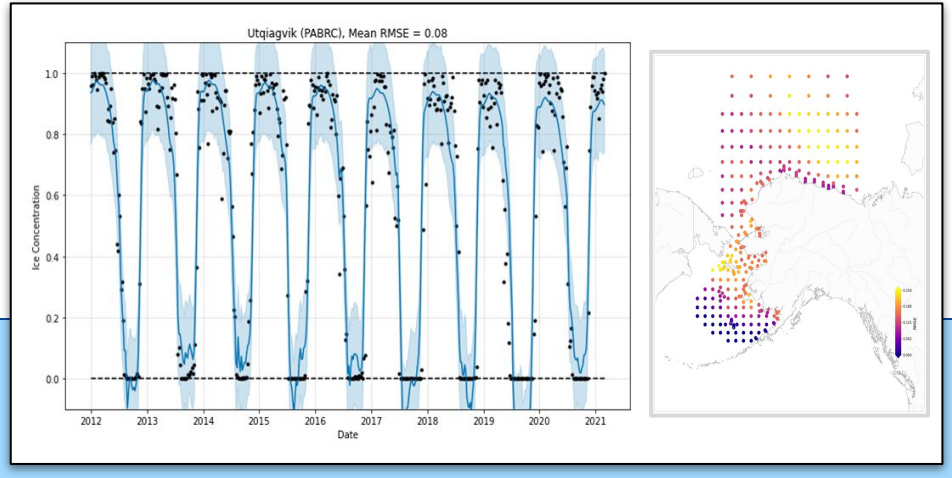
Developed tracker for snow drought for the Western Regional Climate Center (WRCC). The Snow Drought Tracker will be maintained and enhanced by WRCC and is available to the public on the WRCC website.

Consumptive Use Modeling in the Colorado River Basin for CBRFC (FY19)

Implemented state-developed modeling tools and databases into Colorado Basin River Forecast Center (CRFC) forecasts.

HIGHLIGHTS: NWS AFS





Incorporate Coastal Data into LCAT for Regional and Local Decision Support (FY18)

Provides coastal information internally and will be transitioned into operational LCAT site in FY23. Coastal information is currently available internally at: https://lcat-dev2.mdl.nws.noaa.gov/

Probabilistic S2S Sea Ice Guidance (FY20)

TRANSITIONED TO OPERATIONS

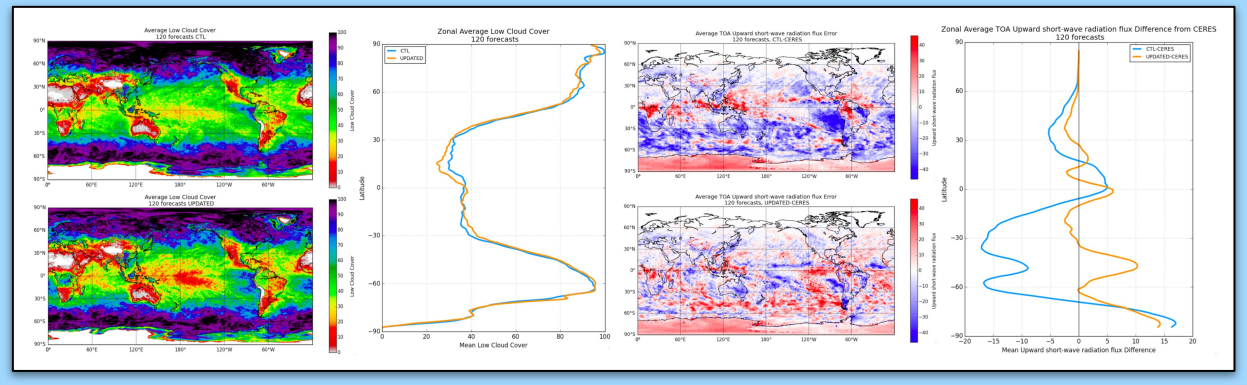
Created a statistical model for probabilistic sea ice concentration guidance at specified points through the Bering Sea and Arctic Ocean for 3 weeks to 9 months using cfsv2 sea ice and atmospheric model guidance. Probabilistic sea ice guidance has been available in real time since late February 2022.

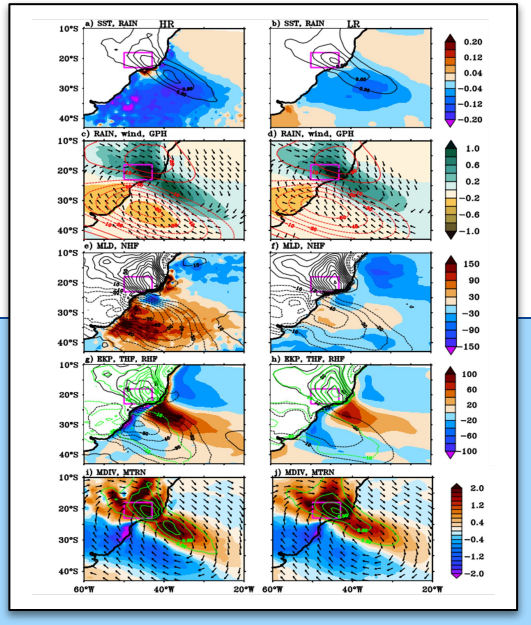
INNOVATIVE RESEARCH: PRECIPITATION PREDICTION GRAND CHALLENGE

NWS Weather Portfolio and S2S funded internal research through innovative research proposals. Projects address quantitative precipitation prediction on all weather timescales, including S2S.

- 1-year projects targeting probability, localization, precipitation amounts
- RLs 2-8
- Funded 7 projects NOAA Labs (AOML, GSL, NSSL, PMEL, PSL)

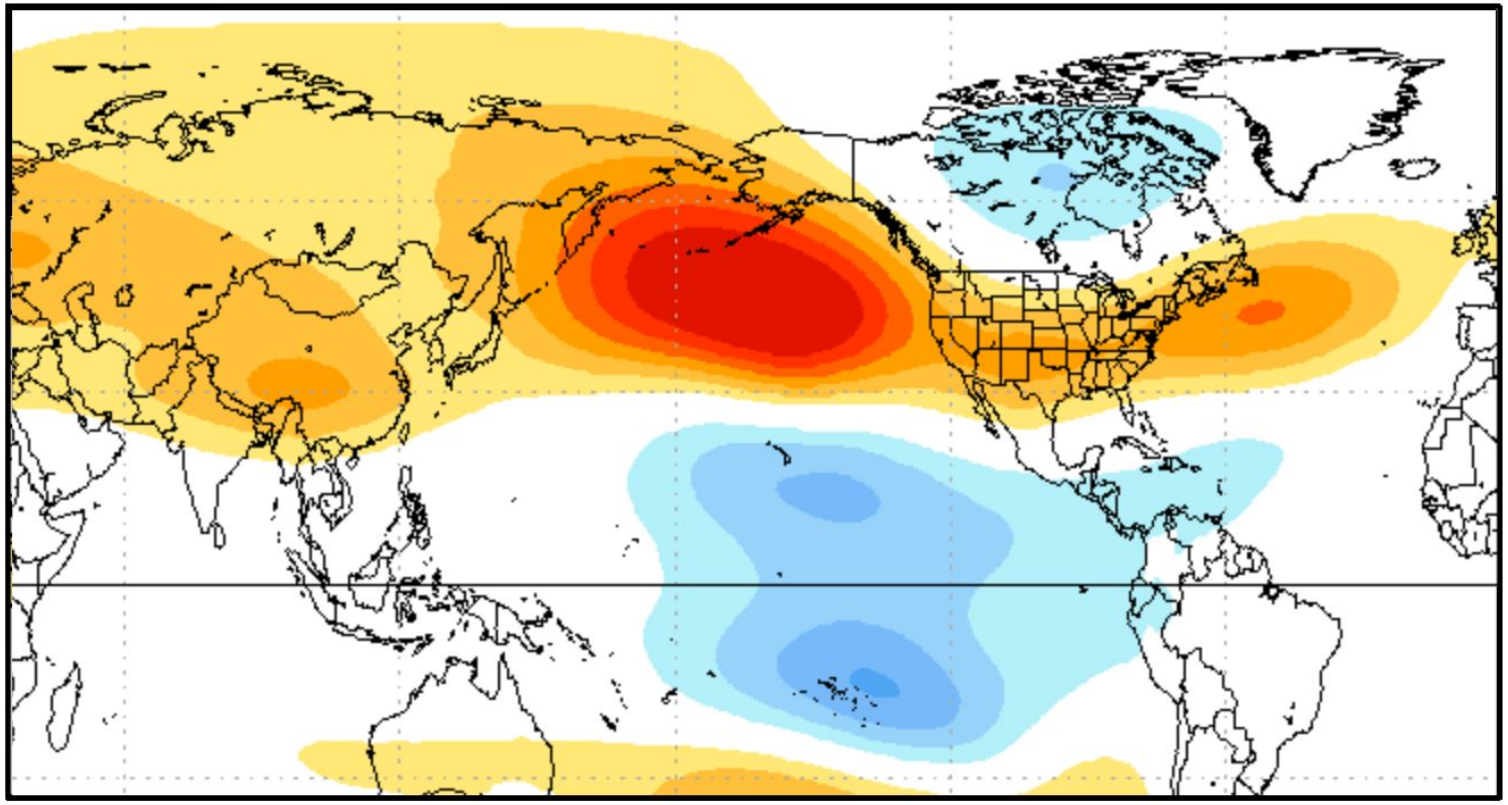
Olson et al.: Updated physics gave small changes in low level cloud, but provided large changes in OLR





Dong et al.: Western Boundary Current impacts on precip: high-res vs. low-res modeling of heat flux, ML depth changes

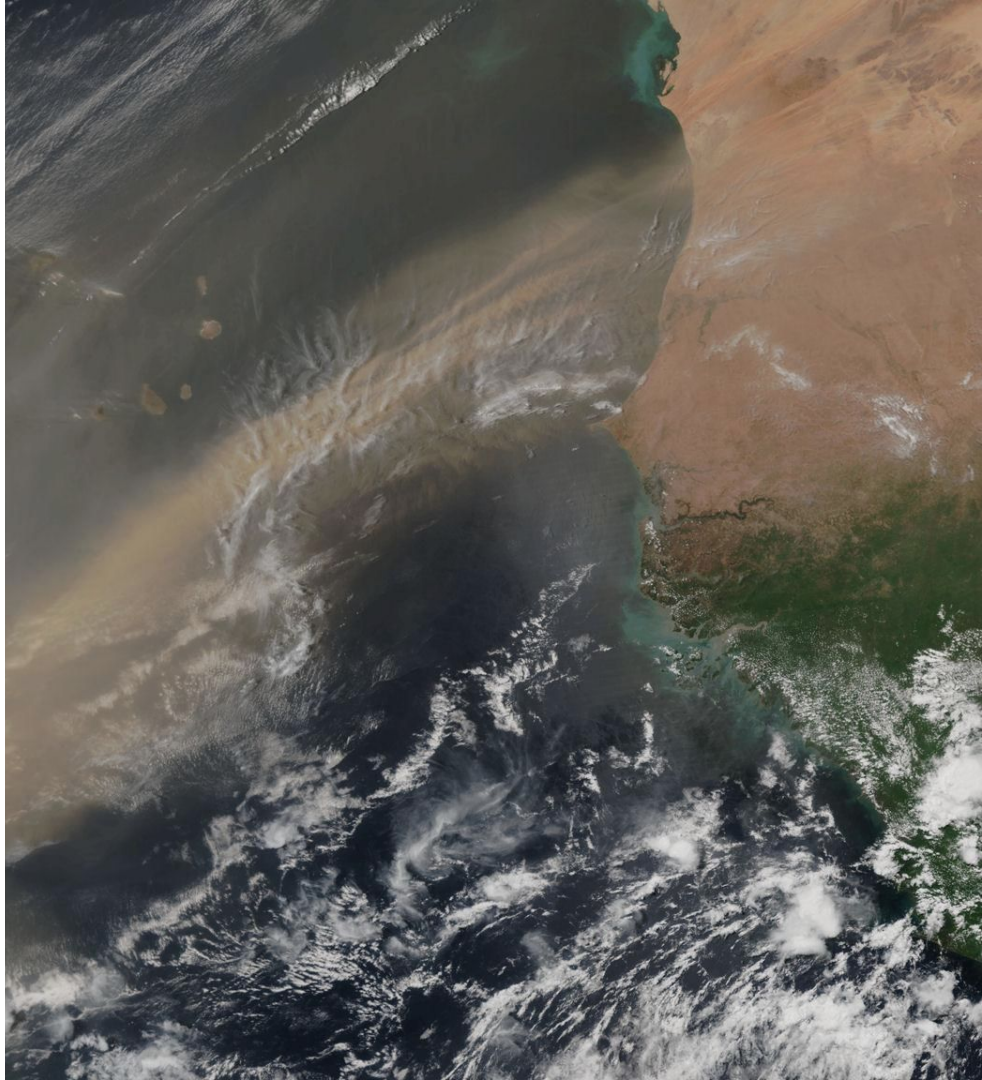
Infrastructure support



MULTI-MODEL ENSEMBLES (MMEs)

Real-time, updating, multi-model ensembles over S2S timescale pull greater, unified benefit from multiple agency investments (e.g., NMME, SubX).

- Operational and research models (dual use)
- MMEs as proxy for modeling uncertainty
- Decision support
- Community data-sharing for decision support, product development
- Constantly updating research tools & materials for case studies/process comparisons



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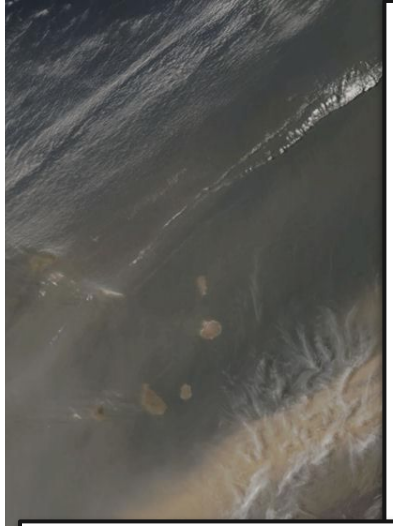

EXTENSION FOR THE COOPERATION ARRANGEMENT FOR THE NORTH AMERICAN MULTI-MODEL ENSEMBLE - SEASONAL SYSTEM AMONG

THE
NATIONAL CENTERS FOR ENVIRONMENTAL PREDICTION
NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

GEOPHYSICAL FLUID DYNAMICS LABORATORY
OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

WEATHER PROGRAM OFFICE
OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH
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NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
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ENVIRONMENT AND CLIMATE CHANGE CANADA
GOVERNMENT OF CANADA

EARTH SCIENCES DIVISION, SCIENCE MISSION DIRECTORATE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

INTERNATIONAL RESEARCH INSTITUTE FOR CLIMATE AND SOCIETY
COLUMBIA UNIVERSITY LAMONT CAMPUS

AND

UNIVERSITY OF MIAMI

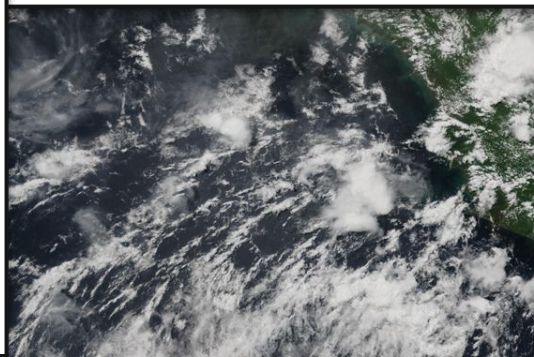
SubX Current and Potential Users Forum Report

August 24 - 26, 2021

Forum Steering Committee:
Jessie Carman, Ph.D. (NOAA Weather Program Office)
Ben Kirtman, Ph.D. (University of Miami)
Mark Olsen, Ph.D. (NOAA Weather Program Office)
Kathy Pegion, Ph.D. (George Mason University)
Matthew Rosencrans (NOAA Climate Prediction Center)
Scott Sandgathe, Ph.D. (Applied Physics Laboratory/University of Washington)

Report Authors:
Christine Bassett (NOAA Weather Program Office)
Jessie Carman, Ph.D. (NOAA Weather Program Office)
Mark Olsen, Ph.D. (NOAA Weather Program Office)
Jonathan Smith, Ph.D. (NOAA Weather Program Office)

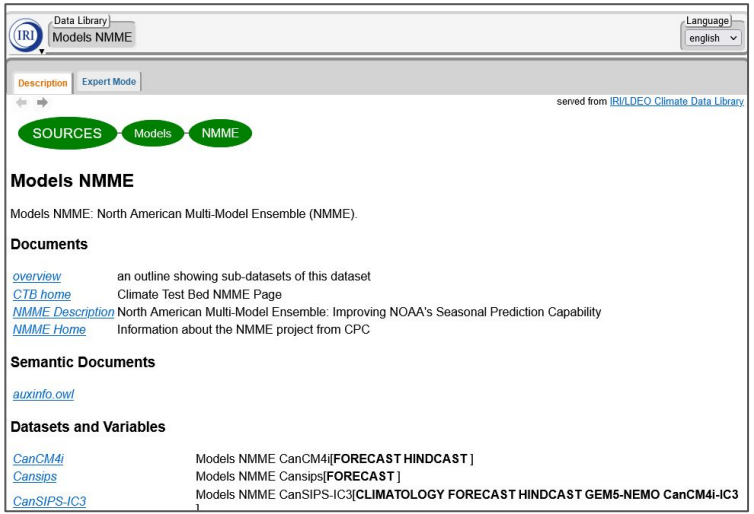
DOI: https://doi.org/10.25923/a7kd-c322



MULTI-MODEL ENSEMBLES (MMEs)

International Research Institute for Climate & Society (IRI)

- Provides Subseasonal real-time updating output to WWRP/WCRP S2S project
- Enables easier research data availability than NOAA Operational Model Archive and Distribution System (NOMADS)

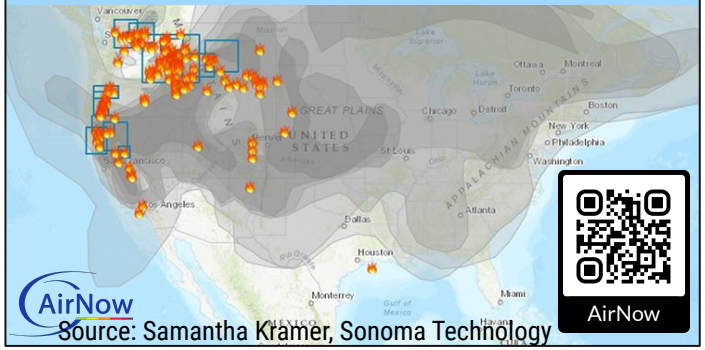


MMEs Enable Broad Community Engagement and Data Sharing

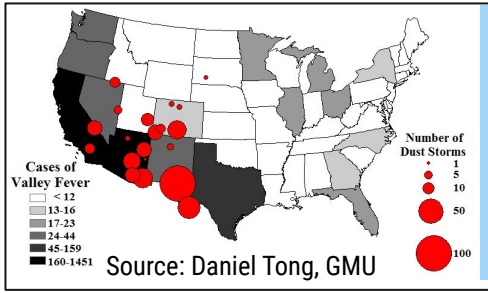
Interagency, multi-model, real-time updating ensembles provide additional information for decision support. Moreover, they are continuously updated research tools and yield material for case studies and process comparisons.

MULTI-MODEL ENSEMBLES (MMEs)

Large fire incidents and HMS smoke plumes
(From EPA's AirNow; August 9, 2021).



Source: Samantha Kramer, Sonoma Technology



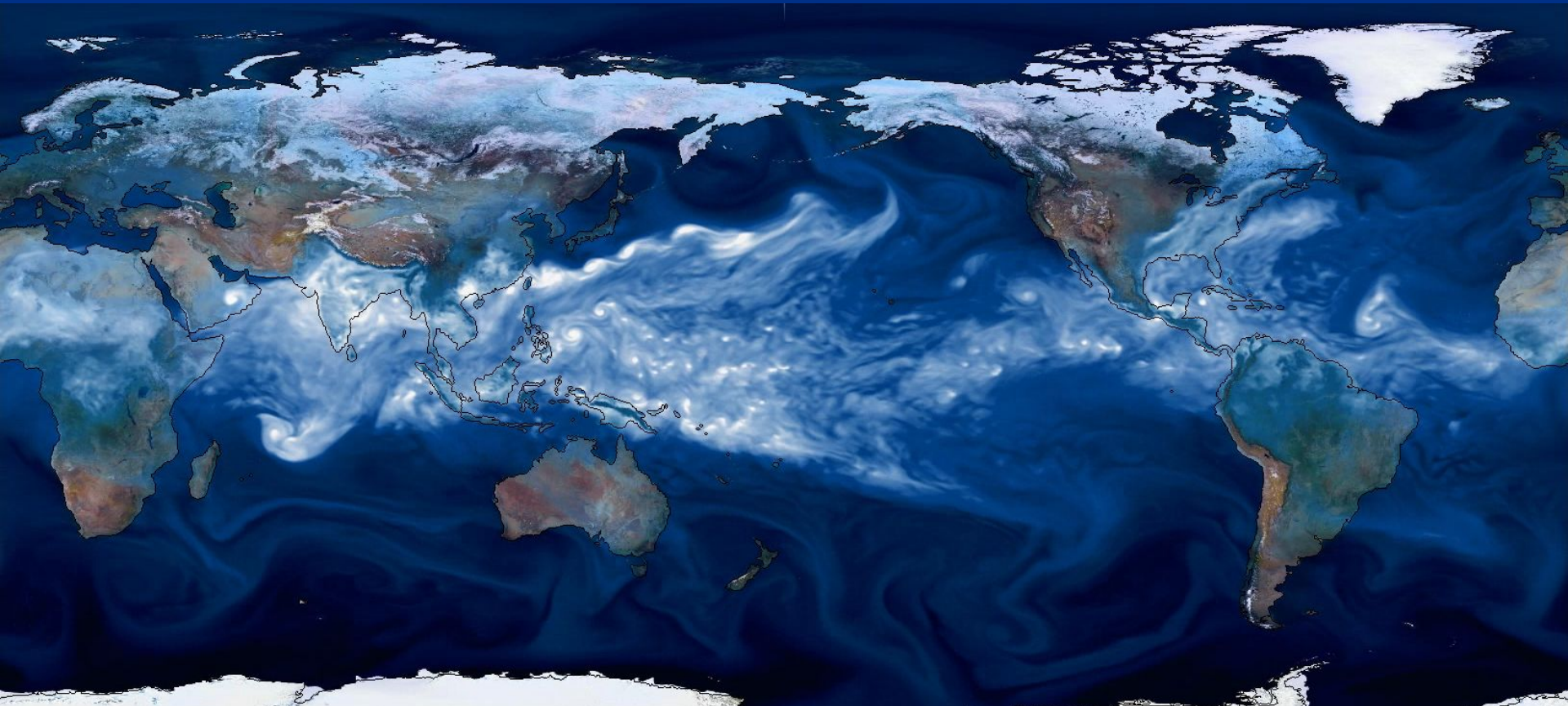
Source: Daniel Tong, GMU

High infection rate of Valley fever spread by dust storms.

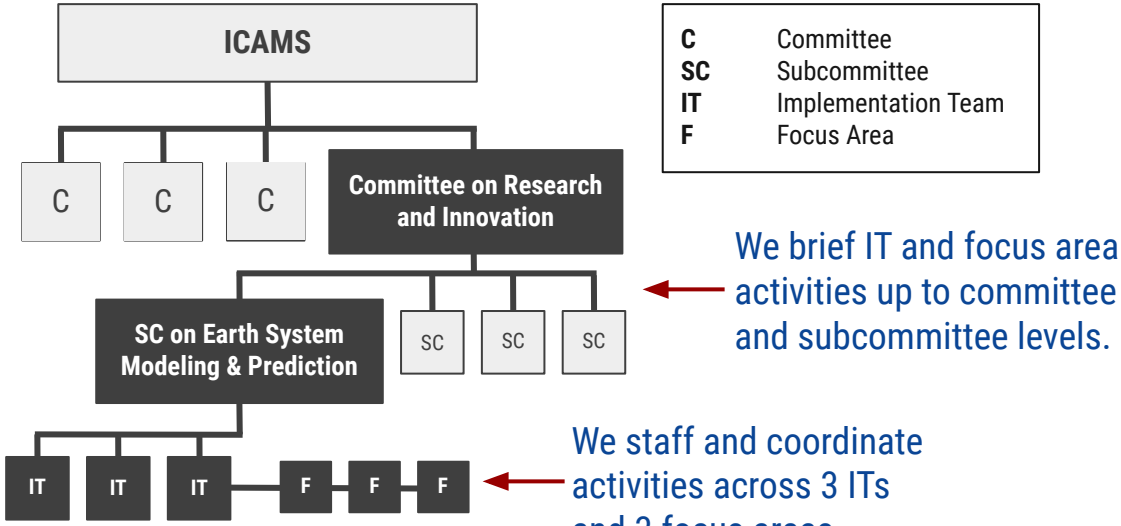
MMEs Enable Broad Community Engagement and Data Sharing

Interagency, multi-model, real-time updating ensembles provide additional information for decision support. Moreover, they are continuously updated research tools and yield material for case studies and process comparisons.

Interagency support



INTERAGENCY COUNCIL FOR ADVANCING METEOROLOGICAL SERVICES (ICAMS)



C	Committee
SC	Subcommittee
IT	Implementation Team
F	Focus Area

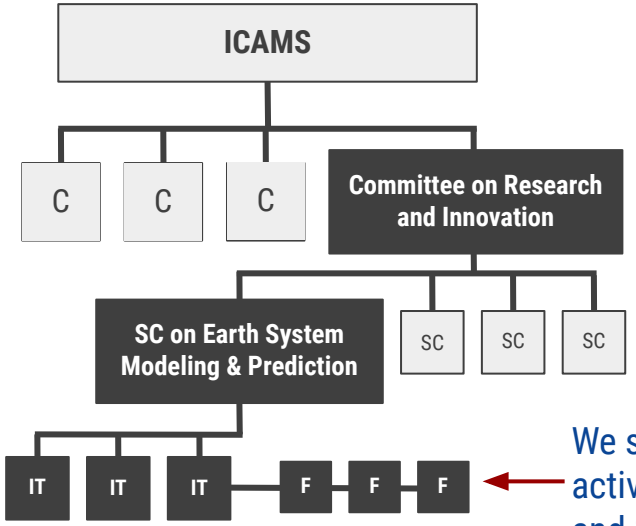
We brief IT and focus area activities up to committee and subcommittee levels.

We staff and coordinate activities across 3 ITs and 3 focus areas.

ICAMS is the formal mechanism by which relevant Federal departments coordinate ***implementation*** of policy and practices to ensure U.S. global leadership in the meteorological enterprise. It is co-chaired by the White House Office of Science and Technology Policy (OSTP) and NOAA.

Visit the ICAMS website:
https://tinyurl.com/4wrbef6r

INTERAGENCY COUNCIL FOR ADVANCING METEOROLOGICAL SERVICES (ICAMS)



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These groups are working on:

- Physics constants dictionary
- Exascale computing readiness report
- Facilitating interagency discussion/cooperation of coupled modeling
- Community standards for physical parameterization interfaces and tools
- Standardized workflow and I/O

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Visit the ICAMS website:
https://tinyurl.com/4wrbef6r

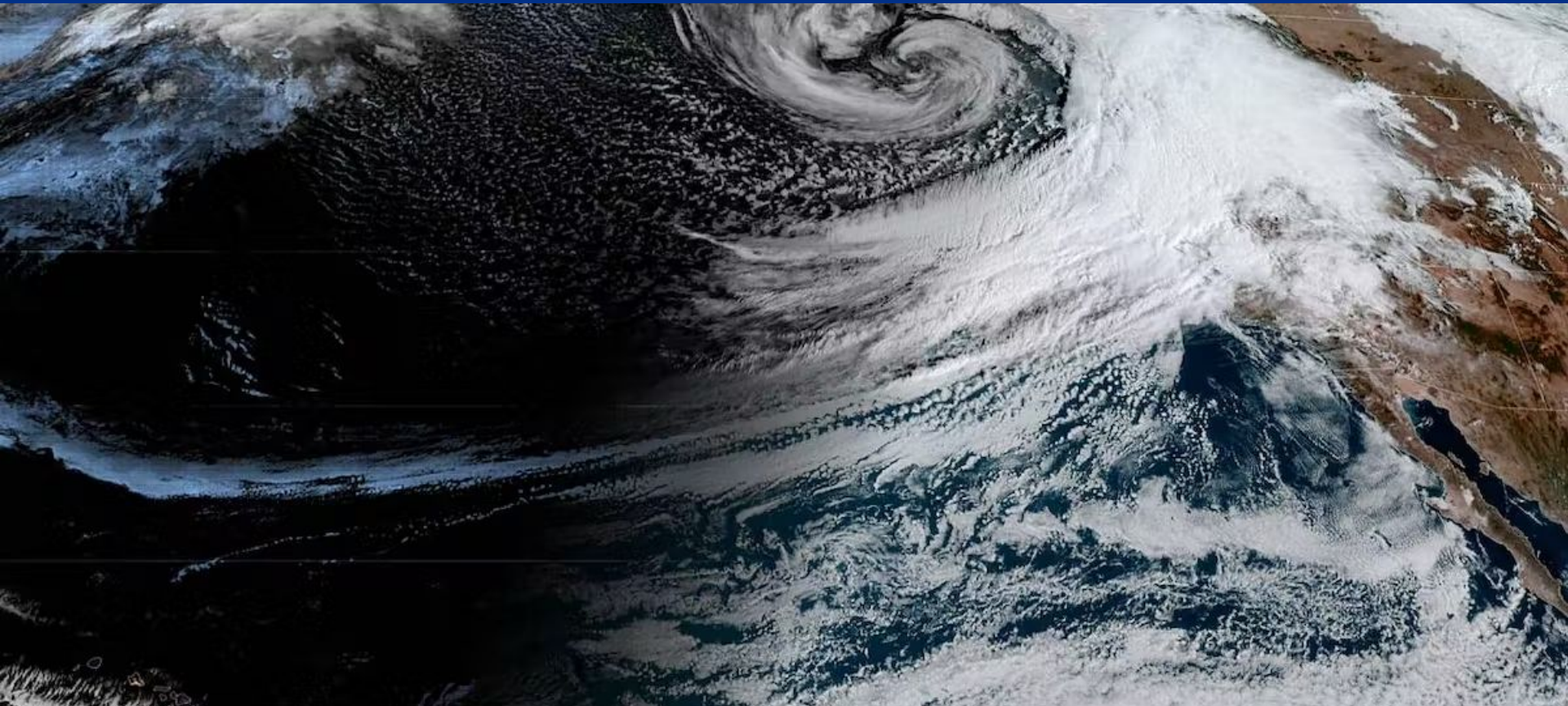
WEATHER MODIFICATION

NOAA is subject to a set of laws encoded in 15 USC 330:

- Requires maintenance of publicly available records (but NOAA is not required to issue permits
- WPO receives initial submissions via weather.modification@noaa.gov
- WPO collects, tracks, and then forwards records to NOAA Library and archived in Weather Modification Project Reports

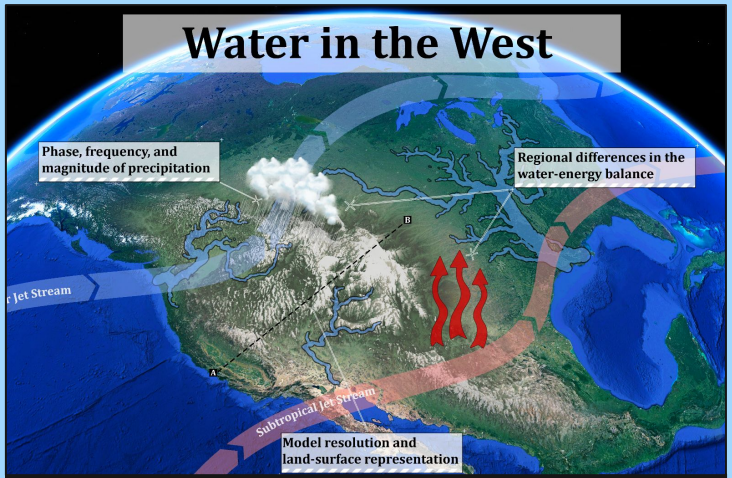
General project types consist of winter snowpack enhancements (ski areas, other mountain projects) or summer reservoir replenishment.

Looking forward



LOOKING FORWARD: WESTERN STATES HYDROLOGY

"NOAA [in collaboration with USGCRP and other partners] shall **conduct a study of hydroclimatological changes in the major river basins of the Western United States over the next 30 years**."



In this first report, NOAA will use existing model output and assess trends in physical precursors to drought and precipitation.

CPO led drafting, review, and submission of the **interagency plan**. **WPO** received a $2M increase and is tasked with coordinating the **study**. This funding will support assessments of:

Geophysical Fluid Dynamics Laboratory

Larger-scale changes in precip., snow, heat, and extreme events within seasonal and decadal changes

Physical Science Laboratory

Baroclinic waves, atmospheric blocking, relationships to teleconnections (e.g., MJO, ENSO, etc.) within larger circulation patterns

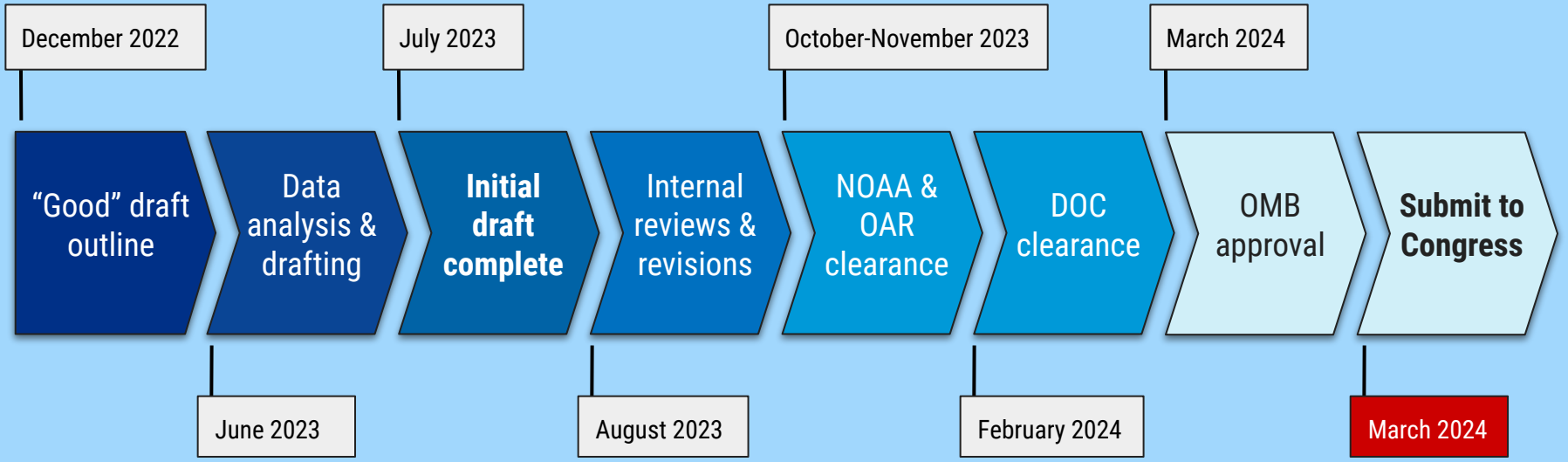
S2S Program (WPO)

UFS prediction of Western States hydrological factors and land modeling (FY22)

LOOKING FORWARD: WESTERN STATES HYDROLOGY

Strategy: Use existing output from NOAA and other-agency models for initial assessments.

- Provide preliminary assessments
- Highlight the need for more in-depth work
- Show what's possible with long-term effort



LOOKING FORWARD: WESTERN STATES HYDROLOGY

NOAA Geophysical Fluid Dynamics Laboratory

- Validate km-scale simulations, potential changes in warmed-climate simulations, for decision-support of precip events e.g. ARs/MCCs.
- Assess SPEAR output for changing WS hydroclimate on seasonal to decadal timescales, e.g. snow cover, river flow, drought/heat waves

NOAA Physical Sciences Laboratory

- Study changes in baroclinic waves delivering precip, changes in S2S precip and temp extremes via CESM ensemble
- Identify changes in large-scale flow regimes, e.g. blocking, QBO, ENSO, MJO.

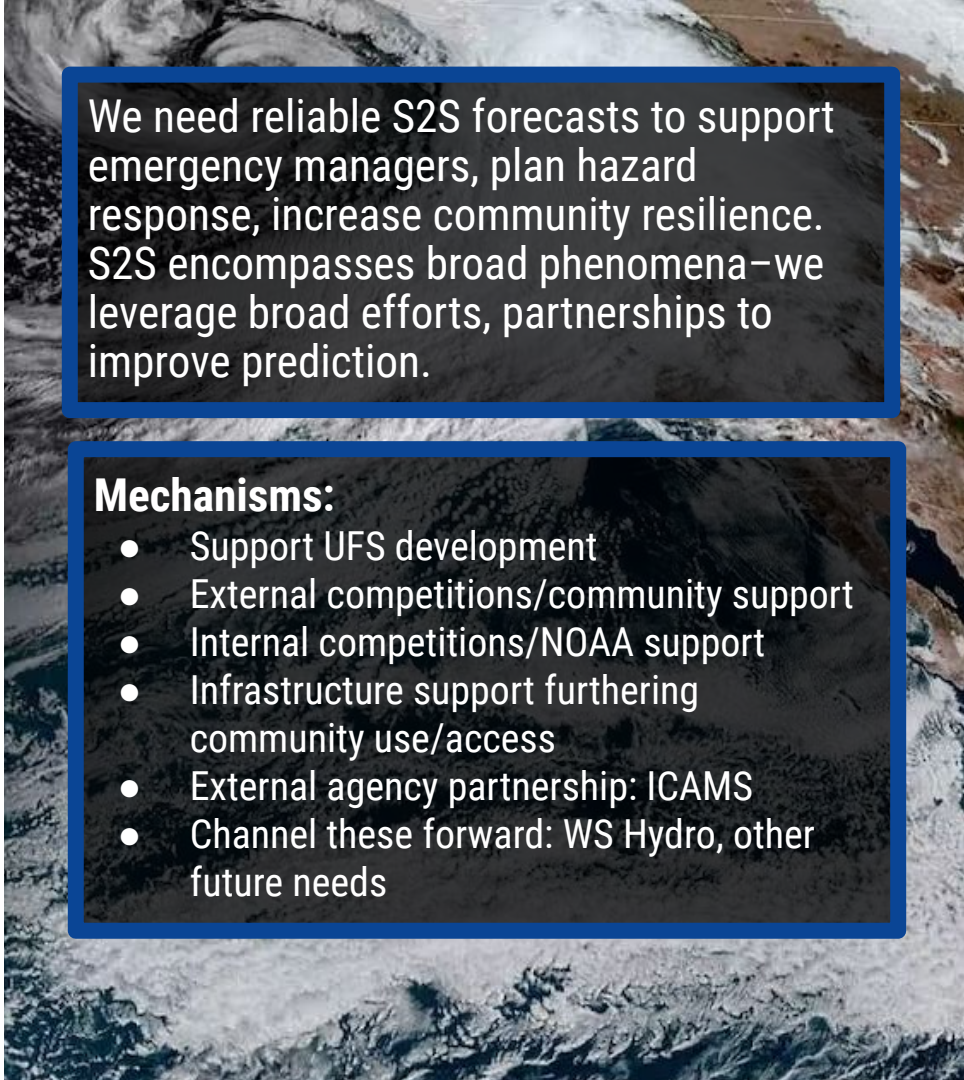
GOAL: SEAMLESS WEATHER TO CLIMATE PREDICTION

1. **Prediction**
   Consistently predict spectrum of extreme events

2. **Modeling**
   Channel model improvements into the UFS

3. **Technical**
   Facilitate resolution changes, post-processing, ensemble design, reanalysis/reforecasting, DA, MMEs

4. **Precipitation/Drought/Hydrology**
   Address challenges across scales and systems; Include modes of variability and predictability



We need reliable S2S forecasts to support emergency managers, plan hazard response, increase community resilience. S2S encompasses broad phenomena–we leverage broad efforts, partnerships to improve prediction.

Mechanisms:

- Support UFS development
- External competitions/community support
- Internal competitions/NOAA support
- Infrastructure support furthering community use/access
- External agency partnership: ICAMS
- Channel these forward: WS Hydro, other future needs

NOAA WEATHER PROGRAM OFFICE

THANK YOU

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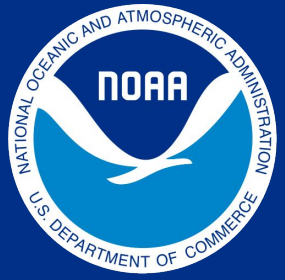
@NOAA_WPO



NOAA WEATHER PROGRAM OFFICE

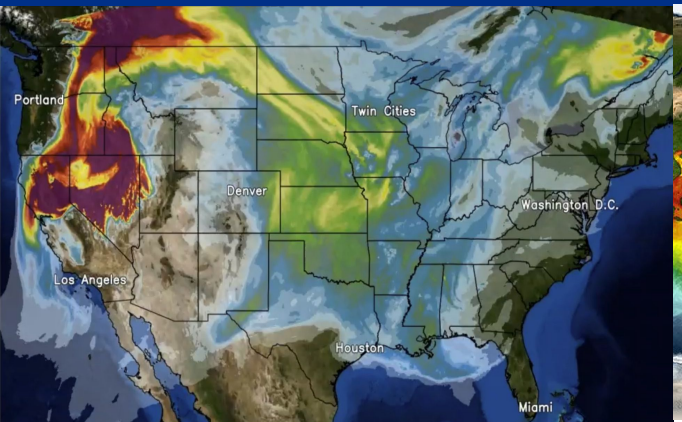
Earth Prediction Innovation Center (EPIC) Program

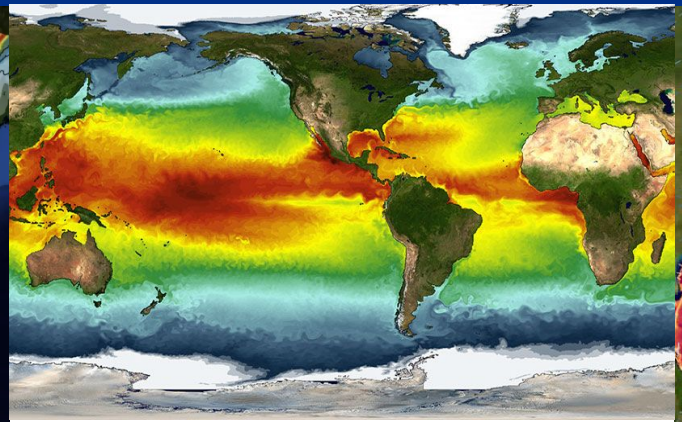
NOAA WEATHER PROGRAM OFFICE

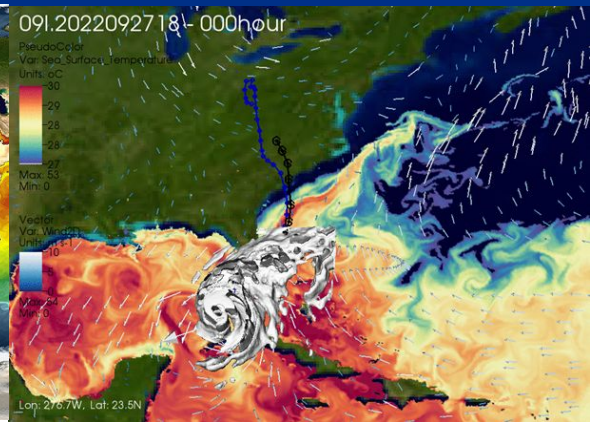
January 25, 2023

Dr. Maoyi Huang, EPIC Program Manager

Activity Area 2: Weather Research Models, Observations and Forecasting Tools







OUR TEAM

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EPIC Management & Program Analyst

Dr. Jose-Henrique Alves
EPIC & JTTI Research Physical Scientist

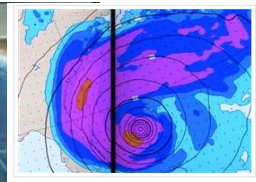
Dr. Krishna Kumar
EPIC Program Coordinator &
Senior Program Scientist

Dr. Maoyi Huang
EPIC Program Manager

Jennifer Vogt
EPIC Project Coordinator

Weather Modeling

HURRICANE SANDY (2012) RAISES PUBLIC AWARENESS OF WEATHER 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.

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AT A GLANCE

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20%	30%	20%
60 | 81	63 | 80	62 | 77

Fri	Sat	Sun

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

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

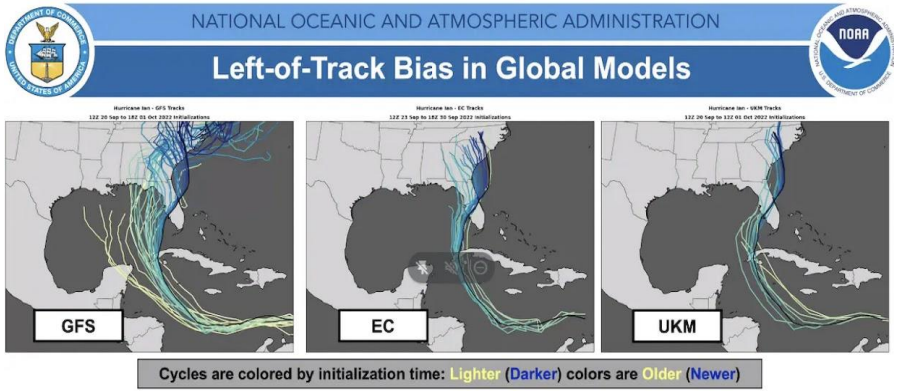
*By Richard B. Rood**

The superior performance of the European forecast model relative to the U.S. GFS model, in high impact storms affecting the East Coast - namely Sandy and Snowquester - has raised the question: why is the U.S. model - generally - not as good? Guest contributor Richard Rood offers an in-depth perspective...

As early as 1995, the weather

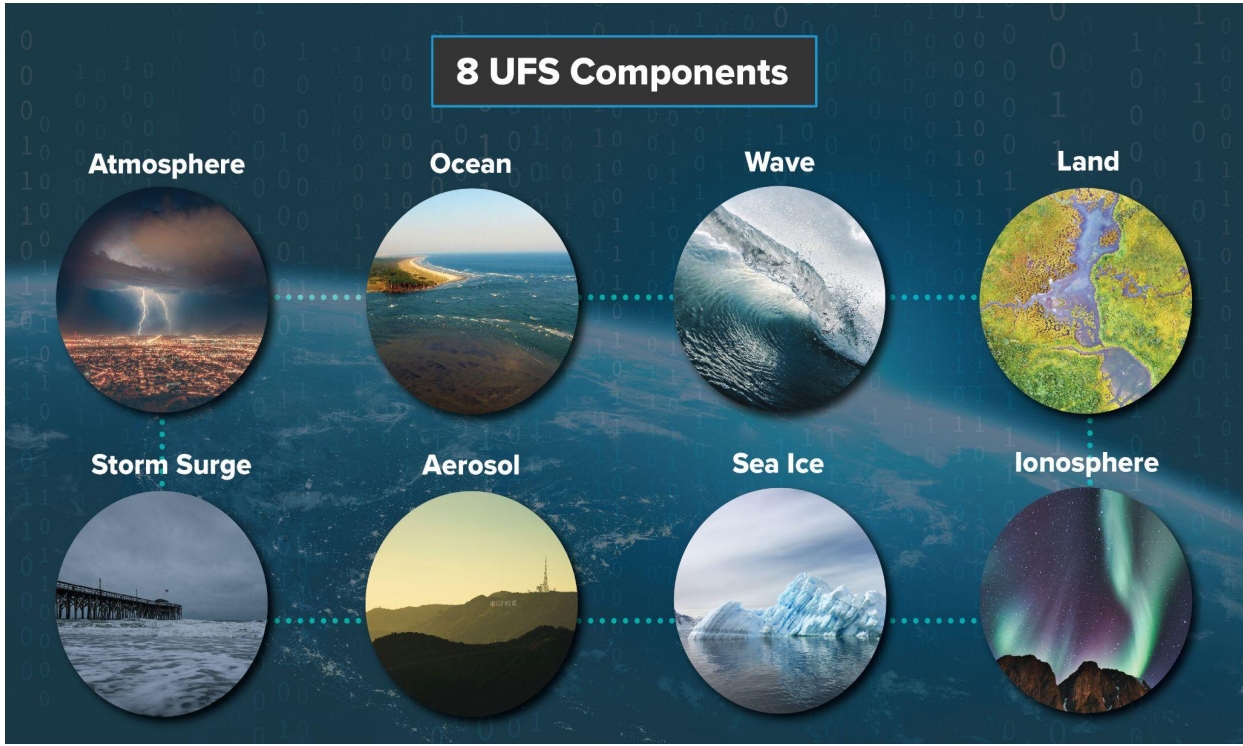
CAPITAL WEATHER GANG

How a trusted weather model fumbled the forecast for Hurricane Ian



UNIFIED FORECAST SYSTEM (UFS)

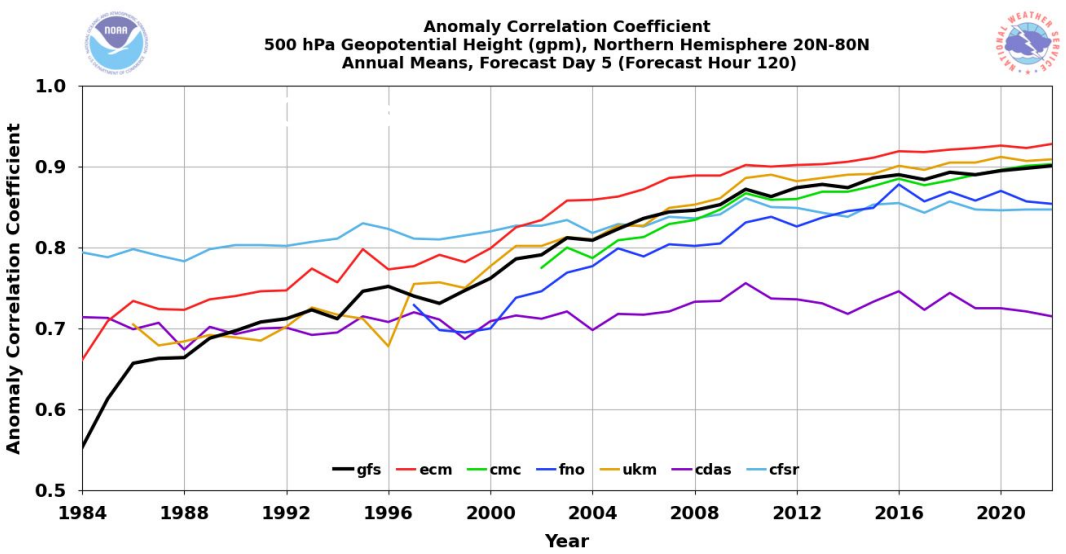
- The Unified Forecast System (UFS) is a **community-based coupled Earth modeling system**, designed to support the Weather Enterprise and also be the **source system for NOAA's operations**.
- UFS applications share agreed-upon numerical forecast system elements.
- Unified infrastructure at the application level allows for coupled interactions among components.



ufscommunity.org

THE NEED FOR EPIC

- Access to an **end-to-end development environment** that is platform-agnostic
- Access to **external expertise in modeling**
- Common UFS infrastructure that **shares components**
- Forum to **clarify** research and operational priorities
- **Accelerate** the rate of **innovation** into operations



EPIC Development

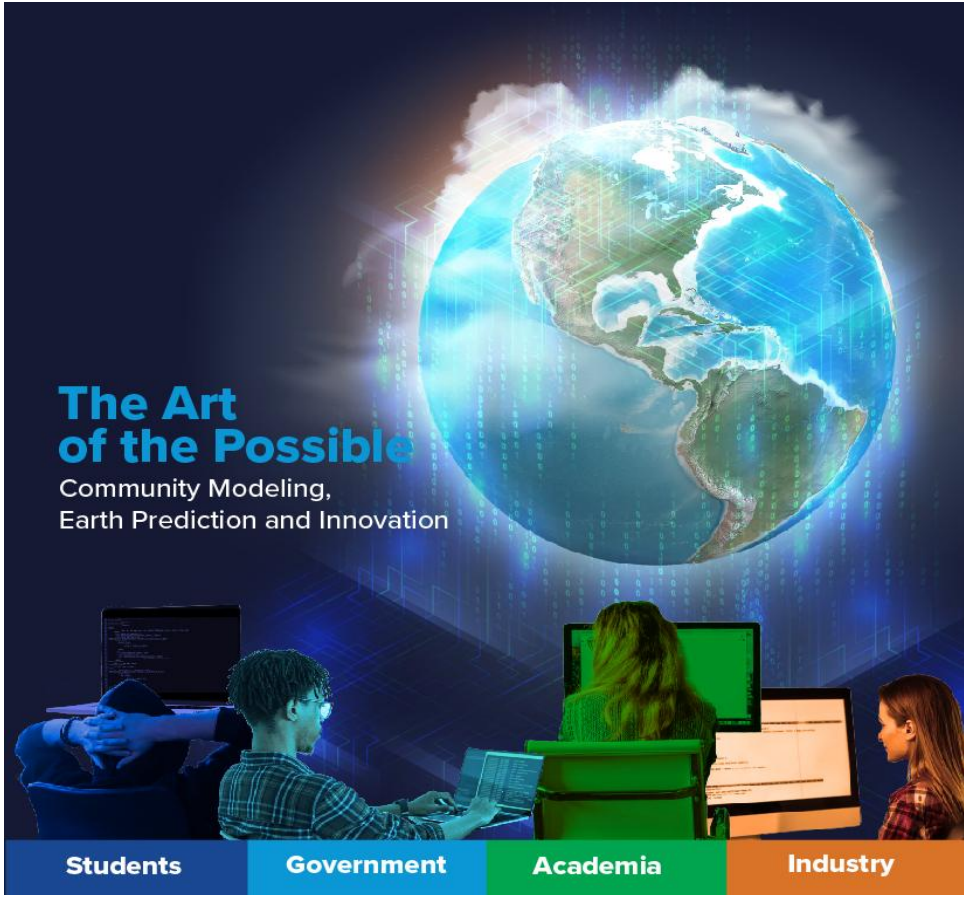
EPIC AS A CATALYST for NOAA'S FUTURE EARTH PREDICTION SYSTEM

Vision

To 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.

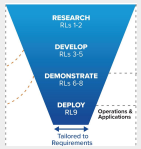


EPIC SUCCESS

1

Community: Nurtures an inclusive and diverse modeling community

2



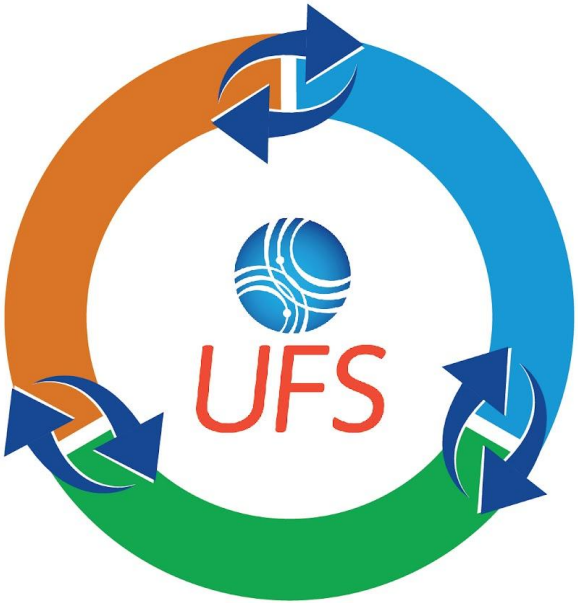
Infrastructure: Develops a publicly accessible end-to-end testing and development environment for the Unified Forecast System

3

Innovation: Brings innovations to improve UFS forecast skill and computation performance via a public facing EPIC Dashboard

COMMUNITY ORGANIZATION

Aligning Priorities with Operational Prediction Goals and Modeling-system Investments



Community Modeling Board

Community Coordination with EPIC Center

NOAA Modeling Team

NOAA, Federal, and International Coordination

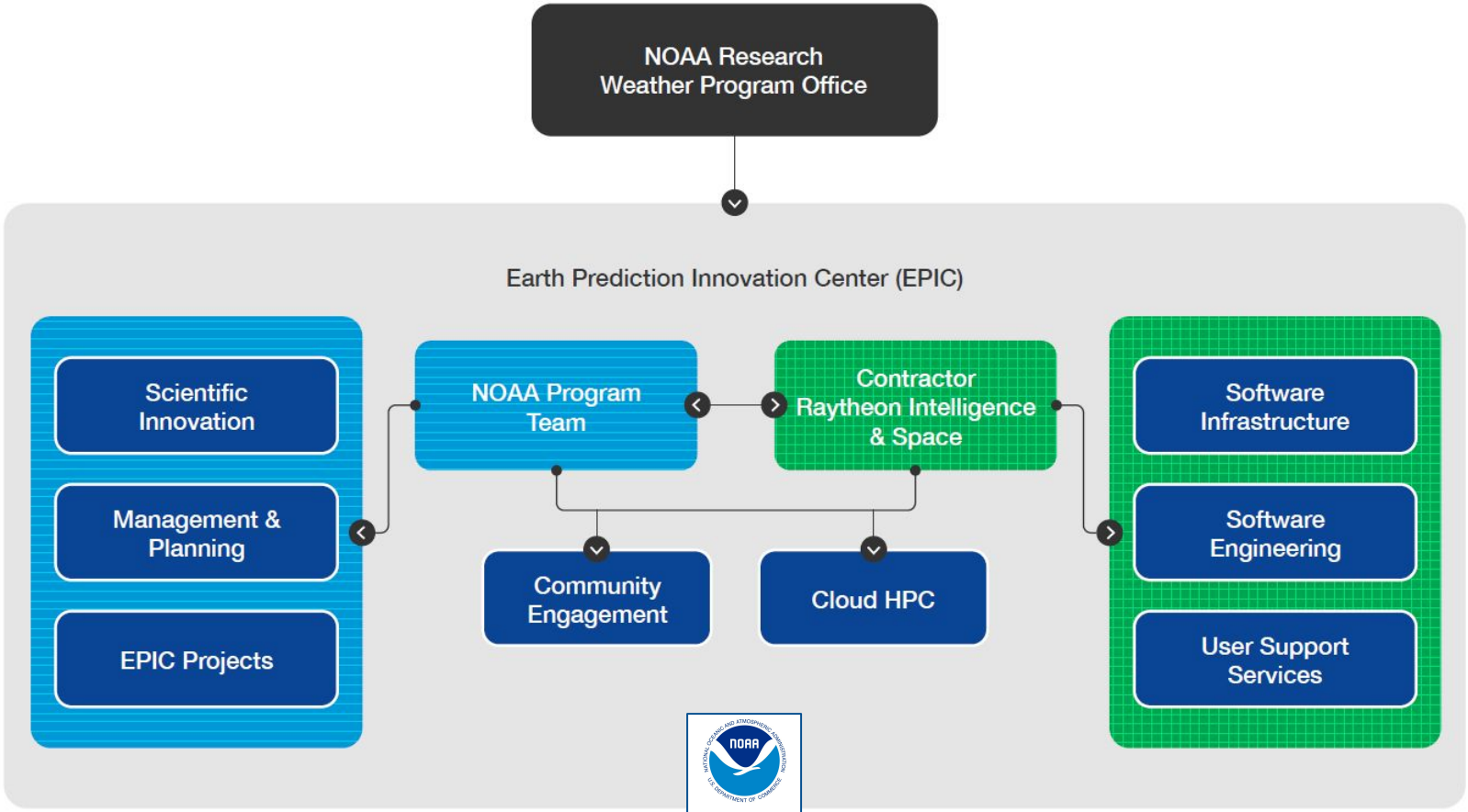
Unified Forecast System

The CMB will provide oversight to the UFS and will represent community perspectives and priorities

EPIC Program

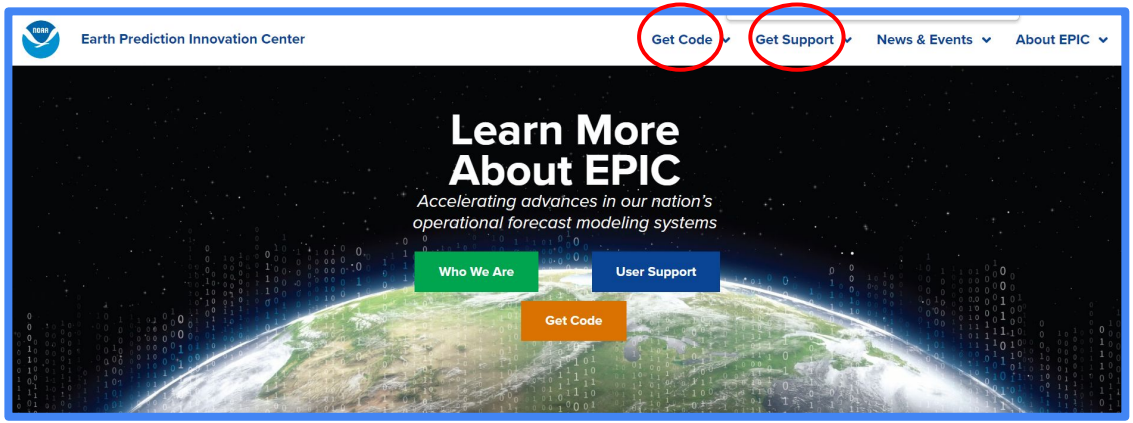
Process, Budget, Communications, and Legislative Affairs

THE EPIC PROGRAM



Community Engagement

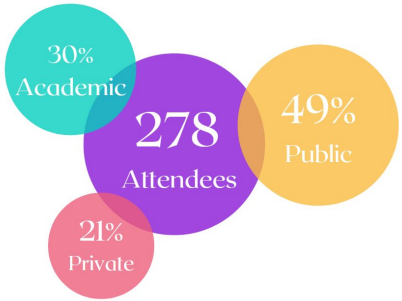
THE EPIC COMMUNITY PORTAL: ENGAGING EVERYONE, EVERYWHERE

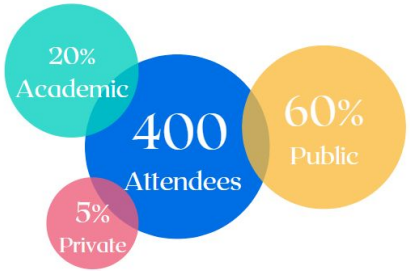


COMMUNITY WORKSHOPS AND INDUSTRY DAYS

EPIC's vision and mission is propelled by a community modeling ecosystem that governs the development of the UFS:

- 2019 Workshop
- 2022 Workshop
- 2023 Workshop and Industry Day





Areas of improvement:

- Develop outreach for cross-sector partnerships
- Capacity building opportunities

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS (CRADAs)

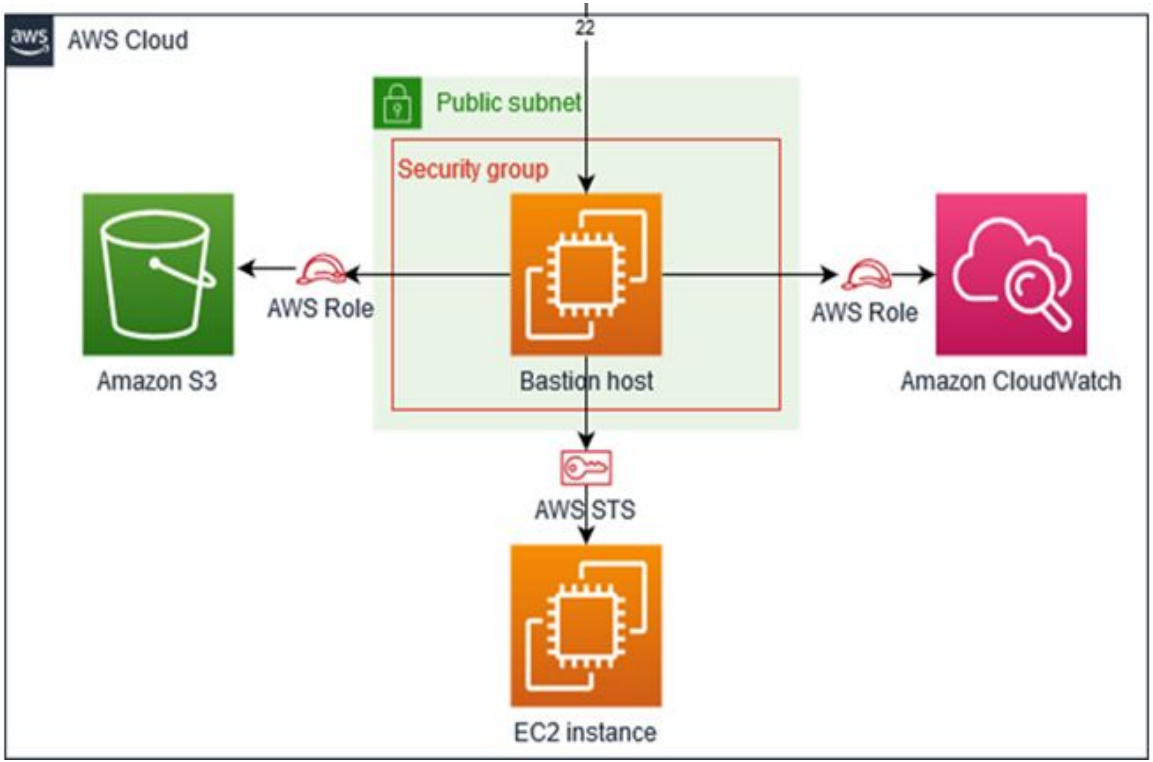
EPIC and Microsoft will work together to implement pilot projects to effectively enable earth system modeling and research using Microsoft Azure, a public cloud computing platform

This CRADA will accelerate innovative contributions from across the Weather Enterprise

WPO and EPIC are open to developing additional CRADAs with the Weather Enterprise.

BUILDING A PUBLIC-FACING CLOUD SANDBOX

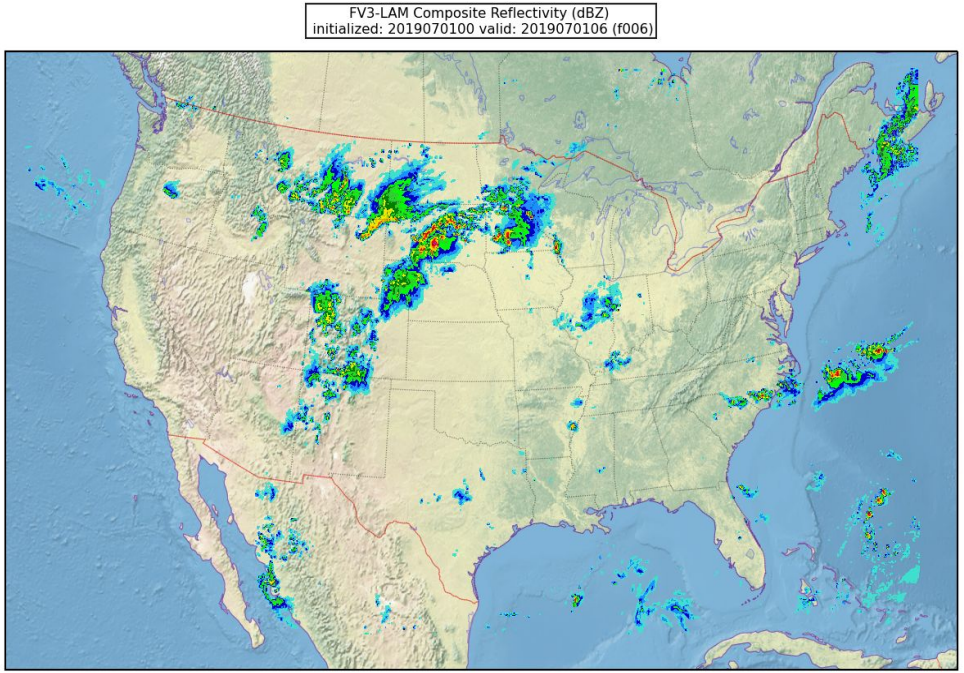
- Used for EPIC training events: AMS Student Workshops, Code Sprints, Hackathons
- Discussing with Cloud Service Providers (AWS, Azure, GCP, Parallel Works) on possible extension to a multi-cloud environment
- Dataset releases are coordinated with NOAA's Open Data Dissemination Program



Improving Capabilities

MODERNIZING UFS RELEASES

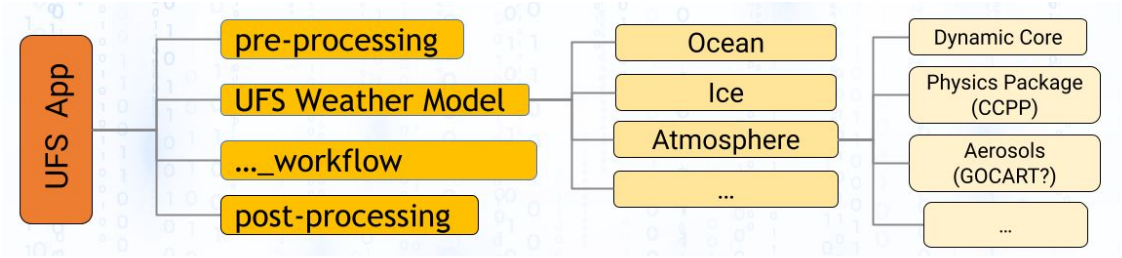
- SRW is NOAA's regional model for near-term and severe weather forecasts
- SRW v2.0 released in June 2022
  - Cloud ready in a container on a computing node, with test cases, no data assimilation
- SRW v2.1 released November 17, 2022
  - A scalable container that can be run across multiple computing nodes using cloud or on-premise platforms.
  - Shifting to a modernized continuous release process
- Next step:
  - SRW v3.0: RRFS-on-cloud with Data Assimilation and forecast cycling capability, ensembles (July 2023)



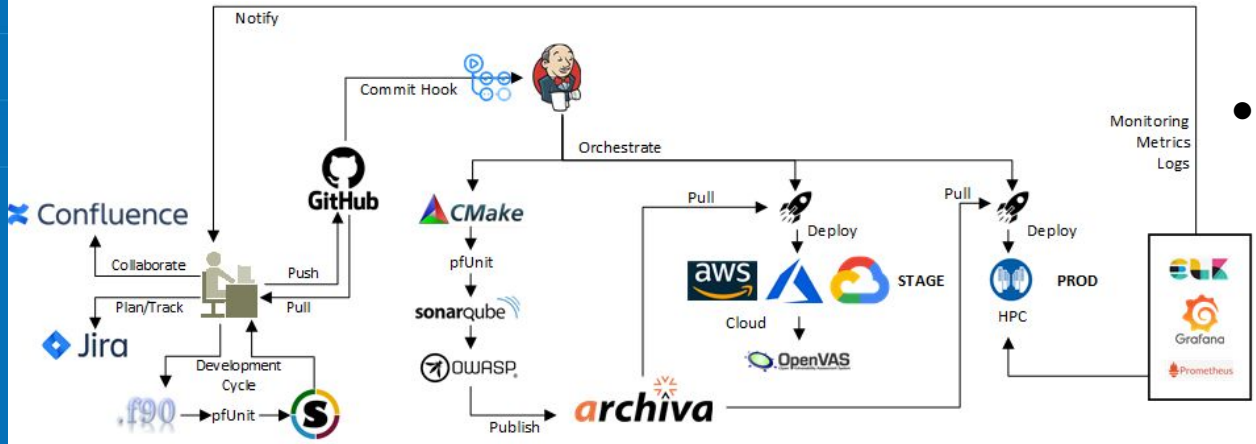
Release Contributors

- NOAA: EMC, EPIC, GSL, NSSL, OSTI, WPO
- Community: DTC, NCAR, CIRES, CIRA
- Jointly funded by WPO, NWS-OSTI, DRSA programs

CODE MANAGEMENT AND CONTINUOUS INTEGRATION



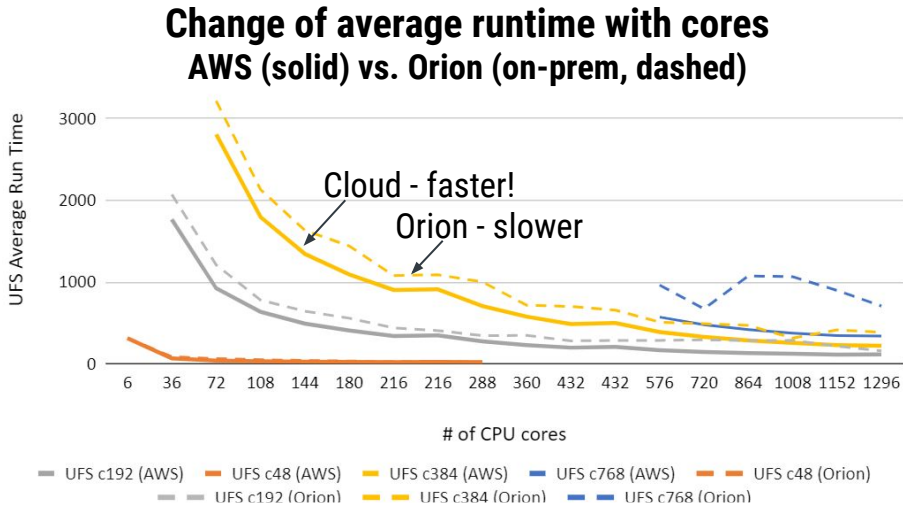
- EPIC leads the management of UFS Weather Model and SRW App, in coordination with UFS teams.
  - Support to Medium Range Weather and Hurricane Application and Forecast Applications are planned

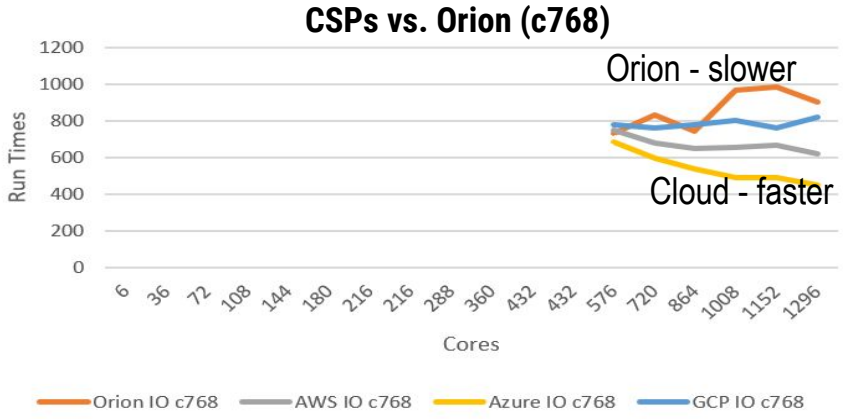


- Automated build pipeline on NOAA Multi-Cloud Platform and On-premise HPCs using Jenkins and Static code analysis to ensure quality, security, and coding standards using SonarQube.

UFS BENCHMARKING ON CLOUD HPC PLATFORMS

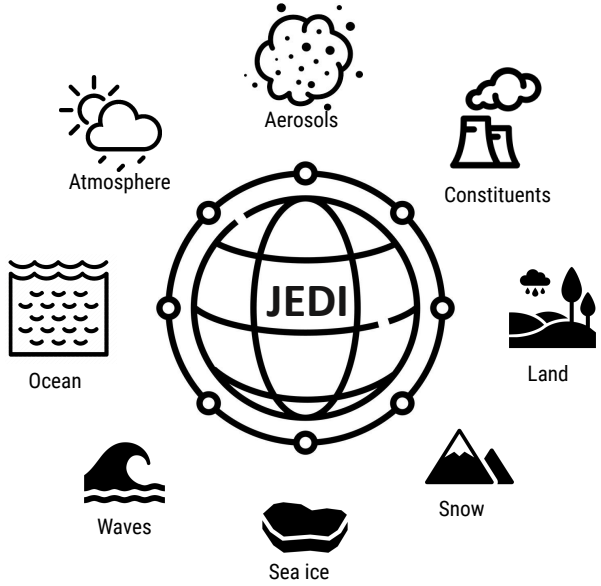
- Benchmark tests for the UFS were performed on Cloud Platforms (AWS, Azure, GCP) and on-premise (Orion); with Intel and GNU compilers.
- The model performance and scalability on all the cloud platforms were similar;
- Computational performance on cloud platforms is comparable to, and sometimes outperforms, on-premise systems.
- These results will be used to build a cloud cost estimator.

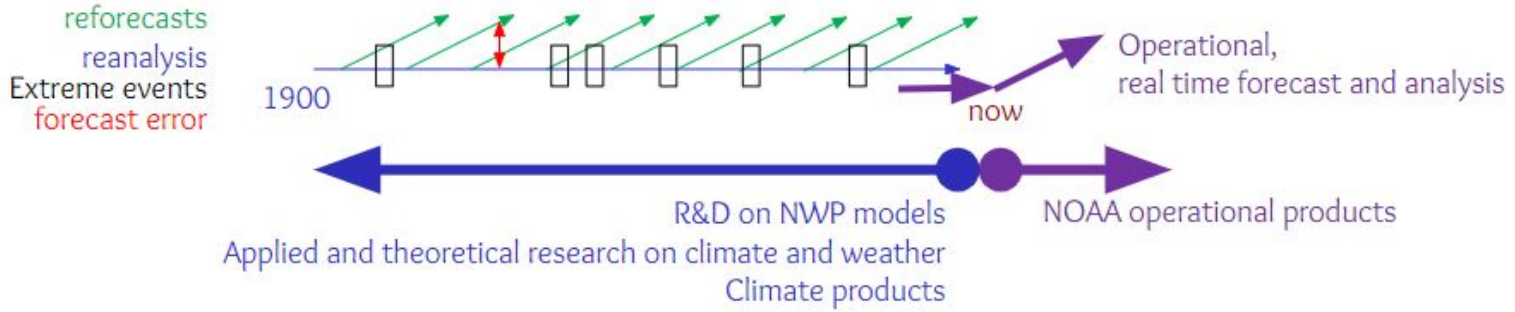




ADVANCE UFS DATA ASSIMILATION CAPABILITIES

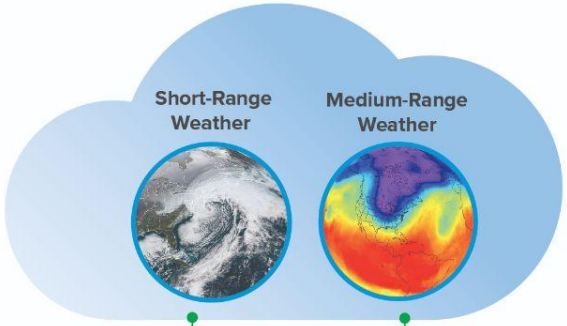
- Providing NOAA Base Funding to the Joint Center for Satellite Data Assimilation (JCSDA). JCSDA released:
  - The Joint Effort for Data assimilation Integration (JEDI)
  - JEDI-Based Marine Data Assimilation Sea-ice Ocean and Coupled Analysis (SOCA).
  - JEDI-SkyLab, an integrated Earth System Data Assimilation capability
- Supporting UFS Data Assimilation and Reanalysis & Reforecast projects





UFS Model and Infrastructure Ports to Cloud Service Providers

User Support and Community Engagement to Accelerate Innovation

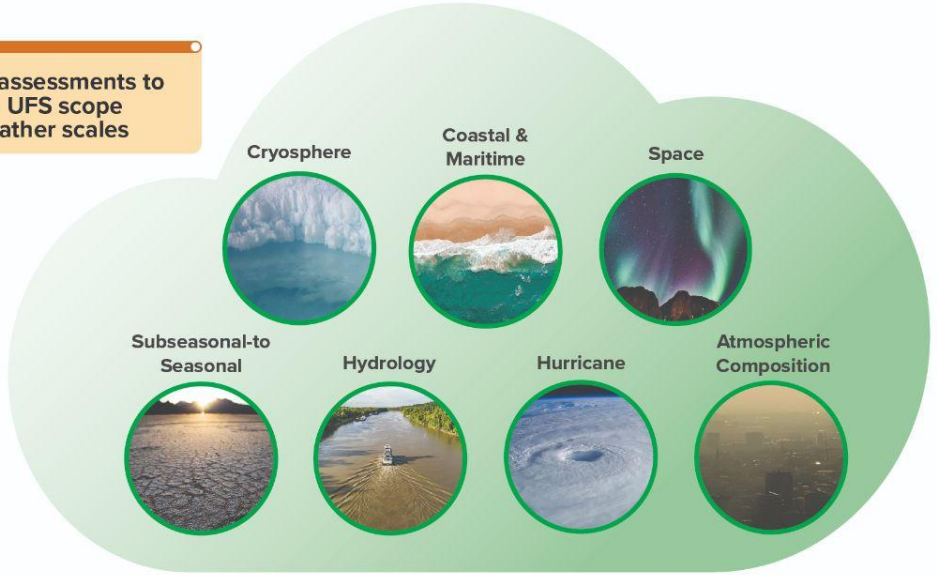


Plan scope of work for product/code integrations

Build cloud-based community modeling infrastructure

Build EPIC Community Portal

Additional assessments to expand the UFS scope beyond weather scales



Continued development of community modeling infrastructure

Adapt modeling portal as new modeling developments are implemented

Provide continuous community engagement and user support

ONGOING

FUTURE WORK

NOAA WEATHER PROGRAM OFFICE

THANK YOU

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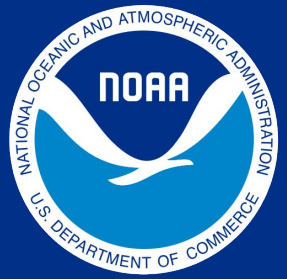

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