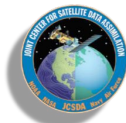# NOAA Unified Forecast System (UFS) Research to Operation (R2O) Project

Jamese Sims[1], Yan Xue[1], Maoyi Huang[2], Chandra Kondragunta[2], Farida Adimi[1], Youngsun Jung[1]

[1]NOAA/NWS/OSTI-Modeling, [2]NOAA/OAR/WPO

Vijay Tallapragada, Jim Kinter, Jeff Whitaker
UFS R2O Project Leads

EMC, PSL, GSL, CSL, NSSL, ARL, GFDL, AOML, NESDIS

Agenda

➤ **Programmatic Overview - Dr. Jamese Sims**

➤ **Technical Overview - Dr. Vijay Tallapragada**

➤ **Integration with EPIC - Dr. Maoyi Huang**

➤ **Engaging with the UFS R2O Project - Dr. Jamese Sims**

➤ **NOFO opportunities to collaborate with UFS - Dr. Yan Xue**

Unified Forecast System (UFS)

UFS R2O

A community-based, coupled Earth modeling system, to support the Weather Enterprise and to serve as the source for NOAA's operational applications.

- First established as part NOAA/NWS/NGGPS program in 2014
- Unify forecast "application" codes and infrastructure, using open, community codes

Engagement opportunities
- Model releases
- Model analysis opportunities
- Annual user tutorials and workshops

Organization
- Steering Committee
- Application Teams
- Working Groups
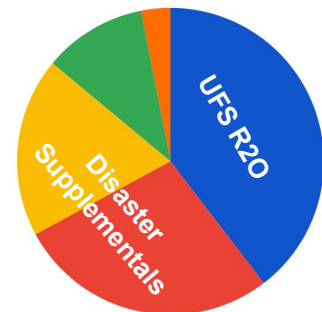
https://ufscommunity.org

UFS Strategic Plan (2021-25); Science Goals:

- Reduce near-surface biases
- Incorporate new data types targeting specific Forecast Skill Priorities
- Test and implement a coupled component capability
- Increase physical consistency of physics and dynamics
- Establish ensemble-based methods to describe uncertainty
- Develop FV3-based Whole Atmosphere Model (for Space Weather application)

NOAA Investments in UFS

Unified Forecast System (UFS)
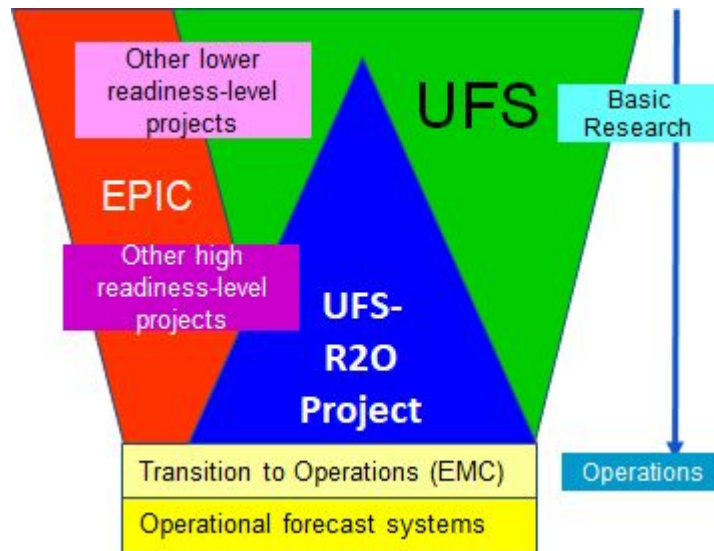
- NOAA programs that support the UFS: NGGPS, Weeks 3&4, JTTI, pre-EPIC, and Hurricane and Disaster Supplementals

UFS Research to Operations (UFS R2O) Project

- Two year project (FY20-22) with 5-year vision
- Developing the next-generation global and regional forecast systems for NOAA's operations by FY24
- NOAA's largest investment in the UFS: $13M/yr, jointly supported by NOAA Operations (NWS) and Research (OAR)
- Community team (NOAA, NCAR, JCSDA, Universities)
- Website: https://vlab.noaa.gov/web/ufs-r2o

NOAA Investments in UFS

- UFS R2O (STI & WPO)
- HSUP1
- HSUP2
- pre-EPIC
- JTTI

Other lower readiness-level projects

EPIC

Other high readiness-level projects

UFS

UFS-R2O Project

Basic Research

Transition to Operations (EMC)

Operational forecast systems

Operations

UFS R2O Project Goals

Develop Next-Generation UFS-based Forecast Systems:

Global Coupled Medium-Range Weather (MRW)/Subseasonal-to-Seasonal (S2S) Applications
Prototypes of GFS v17 and GEFS v13

Regional Short-Range Weather (SRW)/Convection Allowing Model (CAM) Applications:
Prototypes of RRFS v1, 3DRTMA, and HAFS v1

- Data Assimilation (DA):
    - Coupled: Allow observations of one component (e.g. atmosphere) to update all components.
    - Community JEDI for initialization of all forecast systems
    - Advanced ensemble, hybrid and 4D-Var algorithms, enhanced use of satellite radiances.
- Physics: Next-gen moist physics suite for the atmosphere, unified from convective-allowing to global
- Atmospheric Composition: high-resolution inline air quality prediction and direct aerosol feedback
- Hurricane Analysis & Forecast System (HAFS) with multiple moving nests

UFS-R2O Priorities

MRW/S2S Priorities
- **Reduce near-surface biases**
- Improve representation of tropical and stratospheric variability, including **Madden Julian Oscillation (MJO)** and **quasi-biennial oscillation (QBO)**
- Implement a **coupled** ensemble prediction system, including **reanalysis** and **reforecast** capabilities.
- Improve quantification of **model uncertainty**
- **Advance initialization** through improved use of observations and advances in data assimilation algorithms.

SRW/CAM Priorities
- Implement a **Three-Dimensional Real-Time Mesoscale Analysis**, updated every 15 minutes, for real-time nowcasting/situational awareness
- Develop a unified **Rapid-Refresh Ensemble Forecast System** for regional CAM scales to simplify the operational product suite
- Establish connections between SRW/CAM efforts and **Hurricane Analysis and Forecast System (HAFS)**, National Water Model (NWM), and **Community Multiscale Air Quality (CMAQ)**.

UFS-R2O Project History

- **Summer 2019:**
  - EPIC community meeting, need to better organize the UFS community to prepare
- **Fall 2019:**
  - NWS and OAR program managers agree to coordinate and commit resources
  - Program office invited 3-pager ideas from UFS community (approx 60 submitted, $50M/y)
- **Winter 2019-2020:**
  - Proposal invited (2-year project)
  - Project team and proposal assembled
- **March 12-13, 2020:** Face-to-face peer-review
- **April-May 2020:** Funding finalized
  - $13M/yr: NWS-OSTI $10M and OAR-EPIC & JTTI $3M
- **July 2020:** Project launch, Kick-off meeting (July 9-10), 200+ attended
- **October 2020:** First Quarterly Program Review
- **July 2021:** Year 2 kick off
- **July 2021:** First Annual Meeting
- **December 2021:** Year 3 plan review

Participation to the UFS-R2O Kick-off meeting
Total number: 219

Non-NOAA
15.7%

NOAA-Fed
23.7%

NOAA-Aff
60.6%
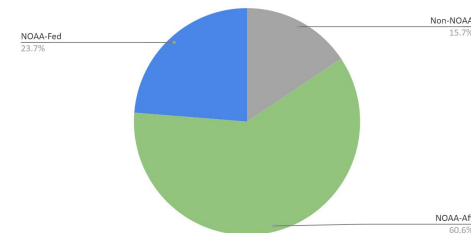
"Leveraged" NOAA Funded Projects

- **NWS/OSTI Notice of Funding Opportunity (NOFO) Projects**
  - NGGPS, Weeks 3-4/S2S, HFIP (applications due Feb 7, 2022)
- **OAR/WPO NOFO Projects**
  - JTTI, CTB, S2S
- **Hurricane Supplemental Projects**
  - **FY18/IFAA**: Physics, Hurricane modeling, SAR & FV3-CAM, Infrastructure, DA/JEDI, and observation processing
  - **FY19/DSAP**: Hurricane modeling, RRFS on cloud, wildfire smoke, and satellite products for fire and smoke
  - **FY22**: Flood and Precipitation, Wildfire, and Hurricane

Future Plans

- **Community and cloud, expand partnerships for:**
  - **Development & simulation**
  - **Model evaluation**
- **Strengthen forecaster engagement:**
  - **Model developments driven by forecaster needs**
  - **Partner on code retirement plans and process**
- **Phase 2 (2023-2025?):**
  - **Broaden NOAA engagement**
  - **Include new applications**
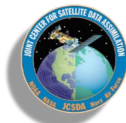- **Strengthen interagency partnerships**

UFS-R2O Technical Overview
https://vlab.noaa.gov/web/ufs-r2o

Project Leads
Vijay Tallapragada, Jim Kinter, Jeff Whitaker

EMC, PSL, GSL, CSL, NSSL, ARL, GFDL, AOML, NESDIS

New Project Structure

UFS R2O

Project leads
Whitaker, Tallapragada, and Kinter

NWS/OSTI   OAR/WPO
Sims, Huang, and Kondragunta

Project Engineers
Adimi and Kumar

MRW/S2S Integrated Application Team (including T&E)
Mehra/Stan

SRW/CAM Integrated Application Team (including T&E)
Alexander/Carley

Hurricane Integrated Application Team (including T&E)
Z. Zhang/X. Zhang

Atmospheric Composition	Marine Components	Atmospheric Physics and Dynamics, (including stochastic physics & land)	Data Assimilation, Reanalysis & Reforecast	Application Support	Modeling Infrastructure	Verification & Post-Processing Infrastructure
Stajner/Frost	Meixner/Hallberg	Yang/Bengtsson	Kleist/Frolov	Wolff/Bernardet	Dunlap/Chawla	Levit/Jensen

Notional Timelines for Operational Implementation

UFS R2O

NPS Modeling System	Current Version	Q4 FY 21	Q4FY21-Q3FY22 Moratorium	Q4 FY 22	Q1 FY 23	Q2 FY 23	Q3 FY 23	Q4 FY 23	Q1 FY 24	Q2 FY 24	Q3 FY 24	Q4 FY 24	Q1 FY 25	Q2 FY25	Q3 FY25	Q4 FY 25	Q1 FY 26	Q2 FY26	Q3 FY26	UFS Application
Global Weather, Waves & Global Analysis	GFS/ GDASv16.2										GFSv17/ GEFSv13								GFSv18/ GEFSv14/ SFSv1	UFS Medium Range & Sub-Seasonal
Global Weather and Wave Ensembles, Aerosols	GEFSv12			Coupled Reanalysis and SubX Reforecast Production								Seasonal Reforecast Production								
Short-Range Regional Ensembles	SREFv7																			
Global Ocean & Sea-Ice	RTOFSv2						RTOFSv3													UFS Marine & Cryosphere
Global Ocean Analysis	GODASv2						GODASv3													
Seasonal Climate	CDAS/ CFSv2																			UFS Seasonal
Regional Hurricane 1	HWRFv13						HAFSv1				HAFSv2				HAFSv3				HAFSv4	UFS Hurricane
Regional Hurricane 2	HMONv3																			
Regional High Resolution CAM 1	HiRes Window v8																			UFS Short-Range Regional HiRes CAM & Regional Air Quality
Regional High Resolution CAM 2	NAM nests/ Fire Wxv4																			
Regional High Resolution CAM 3	RAPv5/ HRRRv4							RRFSv1						RRFSv2				RRFSv3/ WoFSv1	
Regional HiRes CAM Ensemble	HREFv3																			
Regional Mesoscale Weather	NAMv4																			
Regional Air Quality	AQMV6	AQMv6																		
Regional Surface Weather Analysis	RTMA/ URMA v2.8							3DRTMA/ URMA v3							3DRTMA/ URMA v4				3DRTMA/ URMA v5	
Atmospheric Transport & Dispersion	HySPLITv7			HySPLITv8						HySPLIT v9									HySPLIT v10		UFS Air Quality & Dispersion
Coastal & Regional Waves	NWPSv1.3				NWPSv1.4							RWPSv1			RWPSv2					UFS Coastal Waves
Great Lakes	GLWUv1.0.3			GLWUv1.2								GLWUv2			GLWUv3					UFS Lakes
Regional Hydrology	NWMv2.1					NWMv3														UFS Hydrology
Space Weather 1	WAM/IPEv1	WAM/IPE v1											WAM/IPEv2							UFS Space Weather
Space Weather 2	ENLILv1																			

We are here

Technical Approach/Guiding Principles

UFS R2O

- **Evidence-driven development motivated by forecast (stakeholder) priorities and guided by scientific requirements**

- **Coordinated development** of shared modelling and data assimilation infrastructure and algorithms (across Earth prediction enterprise)

- **Open source**, community accessible code with agile development

- **Prototyping and testing** (unit, regression, and scientific)

- **Continuous evaluation** of results

UFS R2O

MRW/S2S -- Medium-Range Weather / Seasonal to Subseasonal

To create more accurate forecast guidance using applications that span the global domain and time scales from about one week to about two years.

Three Applications with Global, Coupled Models:

- **Global Forecast System (GFS)**: deterministic (v17: 13-km grid) medium-range forecast guidance for up to 2 weeks lead-time
- **Global Ensemble Forecast System (GEFS)**: probabilistic (v13: 25-km) sub-seasonal forecast guidance up to 4 weeks
- **Seasonal Forecast System (SFS)**: probabilistic (v1: 25-km) seasonal forecast guidance for 4 weeks to 2 years

MRW/S2S Integrated Application - Major Accomplishments

- Global coupled system (Atm-Ocean-Ice-Wave) **prototype-7 completed** with candidate GFSv17 physics (including Noah-MP land surface model).
  - Final prototype-8 expected in Q1FY22 **(GFS/MOM6/CICE6/WW3/Noah-MP/GOCART)**
- Prototype forecasts have **skill at target lead-times comparable to or superior to existing operational levels**
- Considerable **improvement in weeks 3-4 of MJO** and basket of standard metrics
- **40-year 1 deg marine re-analysis** using marine JEDI (SOCA).

Focus Areas: Gaps and Challenges - MRW/S2S

Data Assimilation
- Delays in JEDI transition and HPC resource limitations have delayed 30-year coupled reanalysis
  → Alternative plan: initialize reforecasts by 'Replaying' prototype 8 to ERA5/ORAS5
- Land surface DA
- Utilize all-sky/all-surface radiances

Testing and Evaluation
- Unified, portable, extensible workflow system, including verification and validation.
- Streamlined verification/validation capability for global coupled system with METplus
- Process-based analysis to attribute sources of bias and RMS error

Model Development
- Land surface modeling
- Aerosol-radiation feedback

Compute Resources
- Insufficient HPC resources
- Exploring cloud computing
- Leveraging non NOAA HPC resources

Communication among developers and evaluators is essential

SRW/CAM -- Short-Range Weather / Convection Allowing Modeling

To create more accurate high-resolution forecast guidance using applications that span the regional domains (CONUS and OCONUS) and time scales from about nowcasting to about three days.

SRW/CAM encompasses three applications

- **3-Dimensional Real Time Mesoscale Analysis (3DRTMA/3DURMA)**
  - 15-minute 2.5-to 1.25 km analysis system

- **Rapid Refresh Forecast System (RRFS)**
  - Based on the FV3-Limited Area Model (LAM)*, Rapidly updated, Convection-allowing (~3 km), Hybrid EnVar assimilation (~ 36 mem), Ensemble forecasts (~9 mem), Stochastic and multiphysics suite, 18h+ hourly, 60h every 6 hours

- **Warn on Forecast System (WoFS)**
  - 18 member forecasts provide probabilistic output; 6-hr fcsts every 30 min (available@T+30 min); Will nest **inside** the RRFS ensemble

SRW/CAM Integrated Application - Major Accomplishments

- **Established 3D-RTMA and 3D-URMA including support for OCONUS**

- **FV3-LAM implemented in operations on 5/11/21 (replaces NMMB member in HREFv3).**

- **Established RRFS model and ensemble configuration**

- **Multi-physics ensemble tested on cloud HPC**

Focus Areas: Gaps and Challenges - SRW/CAM

UFS R2O

- **3DRTMA:**
  - *Add analysis of significant wave height*
  - *AI/ML, improvement of the 3DRTMA background*
- **RRFS:**
  - *JEDI readiness lagging for forward operator transition*
  - *Convective-scale performance issues with storm structure and extreme precipitation rates*
  - *'Reforecast' for RRFS*
- **WoFS:**
  - *Change model core from WRF-ARW to FV3 LAM*
  - *Retune system for FV3 model and rerun many cases for machine learning*

HAFS -- Hurricane Analysis and Forecast System

To create more accurate high-resolution forecast guidance for tropical cyclones across the globe.

Hurricane Integrated Application Team has the following goals:

- Develop cloud-allowing Hurricane Analysis and Forecast System (HAFS) based on UFS
- Finalize two configurations for implementation to replace operational HWRF and HMON in FY23

Hurricane Integrated Application - Major Accomplishments

UFS R2O

- First version of moving nest in global and regional framework

- Self-cycled hybrid 3DEnVar DA system using GDAS and HAFS ensemble

- Surface and PBL schemes for TC forecasts

- Two-way HYCOM coupling and One-way WW3 coupling using CMEPS

- Several Real-time demo configurations of HAFS executed

  - Global-nested (13-3km)

  - Single high-resolution (ESG, 3-km)

  - DA with additional high res. obs. (ESG, 3km)

  - Ensemble (ESG, 6km)

Focus Areas: Gaps and Challenges - Hurricane

- Scale-aware physics at different grid resolutions
  - Scale-awareness, physics for high-res. nests
  - Storm-scale structure forecast and verification
- Vortex initialization and multi-scale DA
- Improve moving nest: flexible refinement, multiple storm, scalability, and feedback schemes
- Coupled Ocean-Wave-Atmosphere (two-way); replace HYCOM with MOM6 in HAFS
- Transition to mature JEDI modules for HAFS DA

Path Forward

- **Integrate with EPIC**
  - Proposal included sections anticipating EPIC engagement
- **Community support (enhanced by EPIC)**
  - Support multiple compute-platforms and community collaborators
- **Organization**
  - Coordinate across multiple institutions using contemporary communication tools and project engineers; integrate other funded NOAA projects
- **Make model output available to the community**
  - NOAA Data Lake & NOAA Big Data Program

Integration with EPIC

Maoyi Huang

EPIC Program Manager, Weather Program Office, OAR, NOAA

EMC, PSL, GSL, CSL, NSSL, ARL, GFDL, AOML, NESDIS
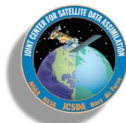
EPIC - Earth Prediction Innovation Center

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

Cloud Use

Community

UFS Code Repository

Research to Operations Screening Funnel

UFS Code on NCEP WCOSS

O2R

R2D

R2O

R2O

1

2

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

Near- and long-term EPIC Contract outcomes

UFS Model and Infrastructure Ports to Cloud Service Providers
User Support and Community Engagement to Accelerate Innovation

Medium-Range Weather, Short-Range Weather
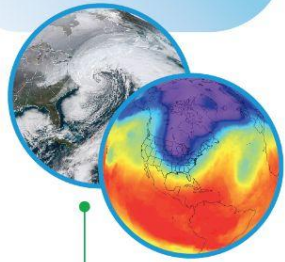
R2O/O2R and UFS Assessments

Cloud-based UFS Buildout

ECC Front End Development

Additional assessments to expand the UFS scope beyond weather scales

Cloud evolution activities, with software infrastructure baselining

Operational and research infrastructure sustainment activities and evolution

Subseasonal-to-Seasonal

Hurricane

Coastal & Maritime

Air Quality

Cryosphere

Hydrology

Community Engagement and User Support

ONGOING

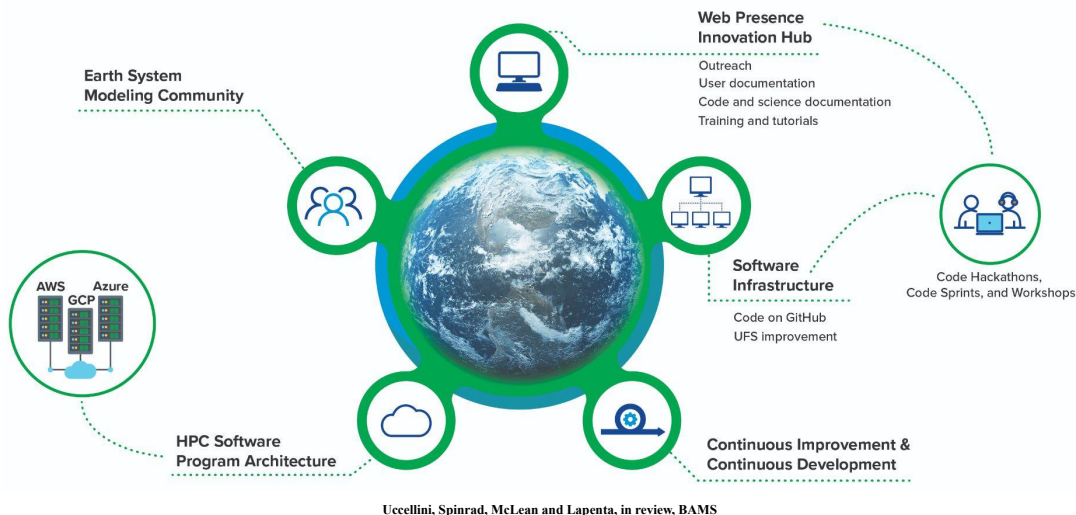FUTURE WORK

Uccellini, Spinrad, McLean and Lapenta, in review, BAMS

EPIC Community Portal

EPIC Community Ecosystem

A Coordinated Approach for Developing the UFS and Supporting NOAA's R2X/X2R Mission

Earth System Modeling Community

Web Presence Innovation Hub
Outreach
User documentation
Code and science documentation
Training and tutorials

Code Hackathons, Code Sprints, and Workshops

Software Infrastructure
Code on GitHub
UFS improvement

AWS Azure GCP

HPC Software Program Architecture

Continuous Improvement & Continuous Development

Uccellini, Spinrad, McLean and Lapenta, in review, 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.

Upcoming EPIC Events and Opportunities

- Publically release of the EPIC community portal
- Establish the EPIC Student Program
- Establish a Community Modeling Board
- EPIC Symposium & Student Workshop at AMS
- 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
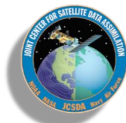- Incorporate support for fire weather, S2S and coastal applications

Engaging with the UFS-R2O Teams

UFS-R2O Web Site
https://vlab.noaa.gov/web/ufs-r2o

EMC, PSL, GSL, CSL, NSSL, ARL, GFDL, AOML, NESDIS

Engagement Opportunities UFS *R2O*

UFS-R2O data on AWS cloud: https://vlab.noaa.gov/web/ufs-r2o
- 40-year 1 deg marine reanalysis using marine JEDI (SOCA)
- MRW/S2S prototype data
- RRFS ensemble prototype data

UFS code releases: https://ufscommunity.org/
- MRW/S2S application
- SRW/CAM application
- Components: METplus, ESMF, CCPP, ...

How to Engage with the UFS-R2O Teams

- **For specific interests contact Application Team and Development Cross Cutting Team Leads (Slide 11)**
- **For sustained collaborations with the UFS R2O Project on the developing systems, partners are encouraged to contribute to UFS development code on Github**

  https://github.com/ufs-community/ufs-weather-model

- **For supported and tested system, the publicly released MRW/S2S v1.1 system is best (https://ufscommunity.org/news/medrangeweatherapp_v1p1/)**

Upcoming UFS Meetings & Reports

- AGU Dec 2021
  - NOAA/UFS Modeling Forum (Hendrik) (Dec 15)
  - A43H, A45H - Diagnostic Tools and Metrics for Improving Subseasonal-to-Seasonal (S2S) Prediction (Dec 16)
- AMS Jan 2022
  - UFS-R2O Project Town Hall
  - UFS Special Session
  - EPIC Symposium
  - EPIC Student Workshop
- UFS Webinar Series *Monthly, Every Second Thursday 1pmMT/3pmET*
- Weeks 3-4/S2S Webinar *Monthly, Every First Monday 4pmMT/2pmET*
- Developmental Testbed Center (DTC) UFS Evaluation Metrics Workshop Report (Final Metrics Lists) METplus Training Series **(**Nov 29 2021 - May 1 2022)
- Forecasters Workshops Report
- Land Modeling Workshop Report (to release soon)

Season Forecast System (SFS v1) UFS R2O

- **SFSv1 will replace the Climate Forecast System version 2 (CFSv2) to provide guidance for seasonal outlooks in FY26**
- **Improve representation of slowly varying processes in the land, ocean, sea ice and aerosols and their interactions with atmosphere**
- **Improve representation of atmosphere-ocean-ice coupling, atmosphere-land coupling, stratosphere-troposphere coupling, and simulation of climate modes such as ENSO, MJO and QBO**
- **Improve ensemble design to best estimate uncertainties, and conduct multi-decade, coupled reanalysis and reforecasts to calibrate real-time forecasts**

FY22 NWS/OSTI NOFO
(NOAA-NWS-NWSPO-2022-2007072 on grants.gov)

UFS R2O

Eligible Applicants: US institutions of higher education , industry, non-profit, state, local, Indian government

Three Competitions: 1) NGGPS; 2) Weeks 3-4/S2S; and 3) HFIP

Total Amounts: Approximately $3,000,000 for the first year of multi-year (2 or 3 year) projects; Maximum $300K per project

Point of Contact (POC) & Readiness Level (RL):
POC from NCEP centers or UFS R2O teams
RL from 4 to 7 with target operational systems

Timeline:
Application due: **Feb 7, 2022**
Project start date: Sep 1, 2022

NGGPS: Advance the **UFS Medium-Range Weather** Application, coupling among atmosphere, ocean, wave, ice, land and atmospheric composition, data assimilation and ensemble techniques, post-processing forecast tools

Weeks 3-4/S2S: Advance the **UFS Subseasonal (GEFS) and Seasonal (SFS)** Applications, coupled data assimilation, reanalysis, process-level diagnostic tools and validation/verification metrics

HFIP: Advance the **UFS Hurricane Application**, improve operational hurricane forecasts to meet societal requirements to save lives and mitigate loss of economic disruption

Contact: nws.sti.modeling.team@noaa.gov

Questions?

For more information:

- UFS-R2O Project: **https://vlab.noaa.gov/web/ufs-r2o**
  - Jamese Sims (NWS STI) jamese.sims@noaa.gov
  - Vijay Tallapragada (NWS EMC) vijay.tallapragada@noaa.gov
- UFS: **https://ufscommunity.org/**
  - Hendrik Tolman (NWS STI) hendrik.tolman@noaa.gov
 - Ricky Rood (U-Michigan) rbrood@umich.edu

NWS/OSTI-Modeling Programs

UFS R2O

OSTI Modeling Program Division is responsible for supporting the scope of NWS modeling and research initiatives to improve numerical weather predictions and forecasts through following programs:

- **Next Generation Global Prediction System (NGGPS)**
  POCs: Jamese Sims, Farida Adimi
- **Weeks 3-4/ Subseasonal to Seasonal Prediction (Weeks 3-4/S2S)**
  POCs: Yan Xue, Deepthi Achuthavarier
- **Hurricane Forecast Improvement Program (HFIP)**
  POCs: Youngsun Jung, Sikchya Upadhayay
- **National Air Quality Forecast Capability (NAQFC)**
  POCs: Youngsun Jung, Jose Tirado-Delgado
- **Consumer Option for an Alternative System to Allocate Losses (COASTAL) Act**
  POCs: Jamese Sims, Stacy Mackell
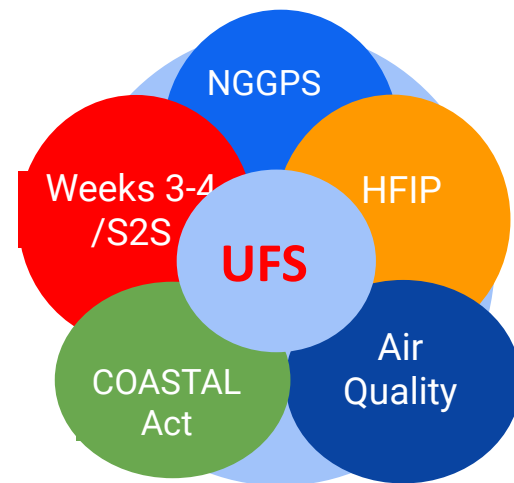
The Unified Forecast System (UFS) was established in 2014 as part of the NWS/NGGPS Program, to unify forecast "application" systems from weather to climate.