



# Building a Community-Based Unified Forecast System

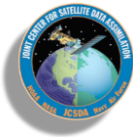
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35th Session of the Working Group on Numerical Experimentation (WGNE)  
2-5 November 2020

**Acknowledgment: slides were taken from the July-2020 UFS-R20 Kickoff Meeting presentation given by Jim Kinter, Vijay Tallapragada and Jeff Whitaker, and the January-2020 AMS100 presentation on the UFS given by Brian Gross.**

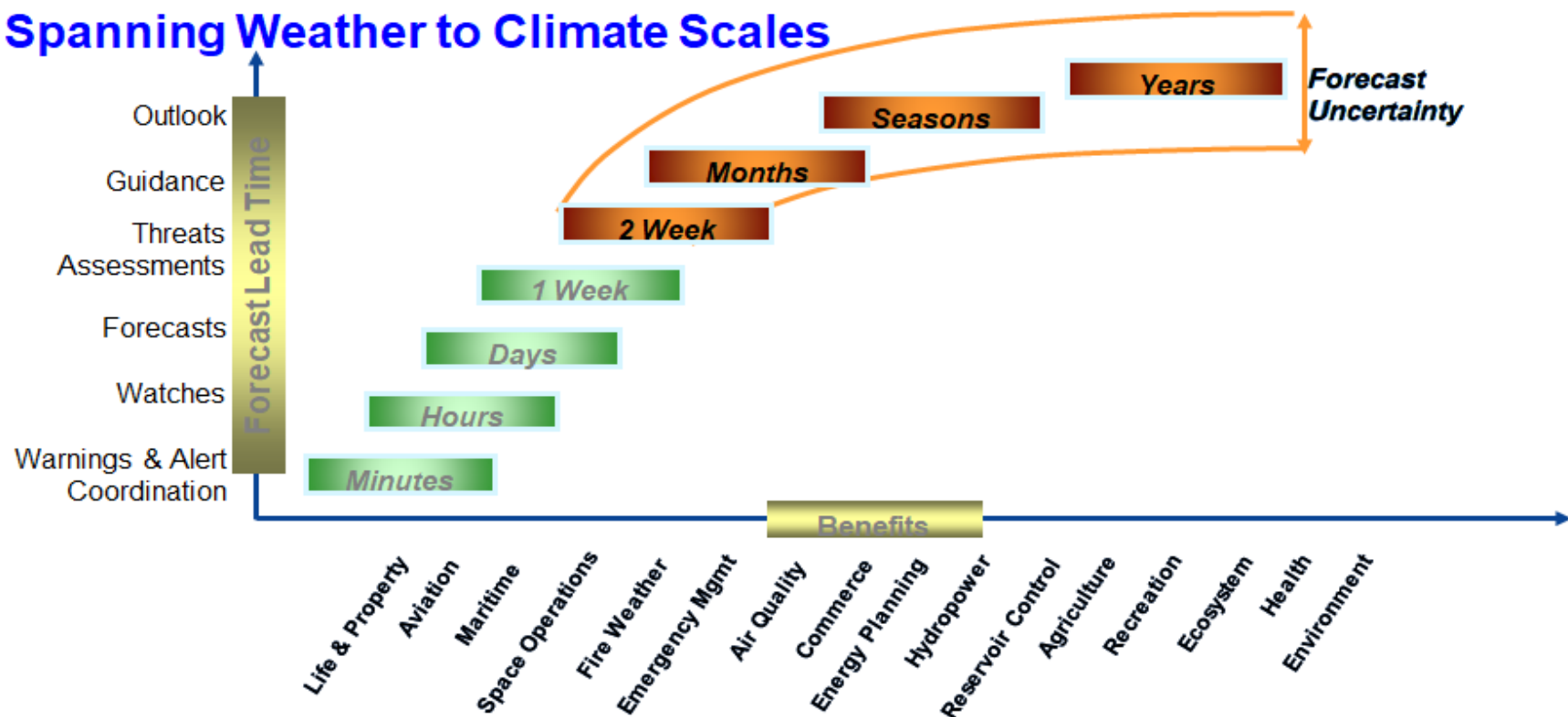


EMC, PSL, GSL, CSL,  
NSSL, ARL, NESDIS

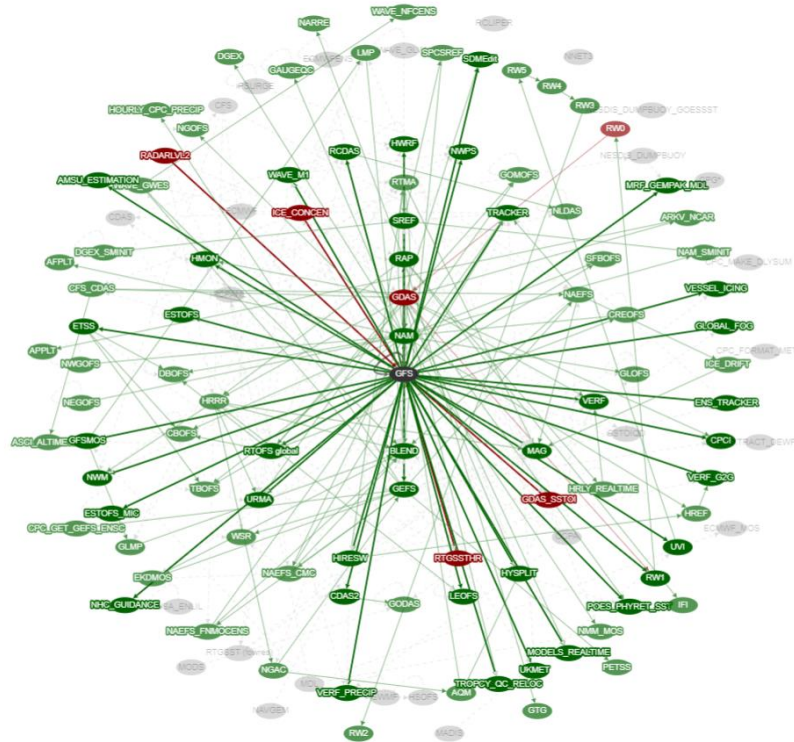


# Scope of NWS Applications

## Spanning Weather to Climate Scales



# Current NCEP Production Suite



## Distinct Modeling Systems of NPS:

- AQM: CMAQ North American Air Quality Model (84 hrs)
- CFS: Spectral model coupled to ocean and ice & weakly coupled DA for seasonal forecasts (9 months)
- GDAS/GFS: FV3 based atmospheric model with GSI based DA (16 days, medium range)
- GEFS: Spectral model with 21 member ensemble (16 days)
- HiRes Window: Regional NMMB (72 hrs)
- HREF: Ensembles of WRF ARW and NMMB (72 hrs)
- HRRR/RAP: Regional WRF ARW with ensemble DA (36 hrs)
- HWRF: Regional WRF NMM-E hurricane model coupled to ocean and waves (126 hrs)
- HMON: Regional NMMB hurricane model coupled to ocean (126 hrs)
- HySPPLIT: Regional on-demand dust/smoke/volcanic ash prediction
- NAM: NMMB North American Mesoscale Model (84 hrs)
- NAM Nests: High-Resolution NMMB Nests (84 hrs)
- NWPS: SWAN Near Shore Wave Prediction System
- NGAC: Global Spectral Model for Aerosols (5 days)
- NLDAS: Regional Land Data Assimilation System
- NAEFS: North American Ensemble Forecast System (GEFS+Canadian Ensembles)
- NWM: WRF Hydro for Water Prediction (5 days)
- RTMA/URMA: Regional Mesoscale Analysis
- RTOFS: HyCOM Global Ocean Model (5 days)
- SREF: Short Range Ensemble with WRF ARW, NMMB (84 hrs)
- Waves: Global multigrid WaveWatch III Model (10 days)
- Wave Ensembles: Global WaveWatch III Ensembles (10 days)
- Great Lakes: WaveWatch III for great lakes (10 days)
- Space Weather: Global Spectral Whole Atmosphere Model
- Space Weather: WSA EnLiI Solar Wind Prediction Model

# The Unified Forecast Systems

## NOAA NGGPS to UFS Strategic Implementation [Plan](#) (FY19-21):

- UFS is a **community-based, coupled comprehensive end-to-end Earth system prediction system, including data assimilation.**
- UFS applications span local to global domains and sub-hourly analyses to seasonal predictions.
- UFS will **support the Weather Enterprise** and be the source system for NOAA's operational NWP applications.
- UFS will **serve both the R&D and Operational communities** engaged in numerical prediction of the Earth System.

# UFS R2O Project

- This project is an experiment to carry out R&D in a **collaborative project within constraints imposed by operational imperatives** and public release timelines
- **Engagement by both NWS & OAR** with coordinated funding
- **Interested/engaged/willing participants from outside NOAA**
- 2-year proposal with 3-5 year vision
  - **Work on 3-5 year vision starts immediately** so the R2O pipeline is continuously fed
  - Not restricted to AOP

# Project Outcomes - 1-2 Years

- **Fully coupled (L-O-SI-A-Ae) ensemble prediction system, including coupled DA, ready for pre-operational testing and suitable for community research use**
  - Addressing science priorities and leading to improvements in forecast priority areas
  - Including reanalysis/reforecast capability for calibration/bias correction (production in year 3)
  - Public release of coupled MER/S2S application
  - Public release of JEDI (including observational data store)
- **Regional rapid refresh (1-hour cadence) ensemble forecast system for CAM scales ready for pre-operational testing**
  - Public release of regional RRFS system
- **Start to sunset existing mesoscale prediction systems**

# 3-5 Year Vision (highlights)

- Strongly-coupled DA capability for MER/S2S.
- JEDI for initialization of all forecast systems - with new advanced ensemble and 4D-Var algorithms, enhanced use of all-sky radiances.
- Next-gen moist physics suite for the atmosphere, unification of physics from CAM to MER/S2S scales.
- CAM-resolution inline air quality prediction system for U.S. and aerosol feedback on MER & S2S prediction.
- WoF system running for Storm Prediction Center Hazardous Weather Testbed and for Weather Prediction Center prediction of significant flash flooding events.
- Hurricane Analysis & Forecast System (HAFS) with moving nests following multiple storms.
- Space-weather application.
- Research publications in high-impact peer-reviewed journals.

# Shared Community Infrastructure Support for UFS Development

## Infrastructure for data assimilation:

Joint Effort for Data assimilation Integration  
(**JEDI**)

## Infrastructure for coupling models together:

- NOAA Environmental Modeling System (**NEMS**) coupler
- based on the Earth System Modeling Framework (**ESMF**)
- using National Unified Operational Prediction Capability (**NUOPC**) conventions

## Infrastructure for interoperable physics:

- Common Community Physics Package (**CCPP**) framework

## Infrastructure for Code Management:

- Git based repositories with Gitflow

### 1. Coupling components

New ESMF/NUOPC mediator (CMEPS/NEMS)

### 2. Interoperable atmospheric physics

CCPP & CPF frameworks

### 3. Community-friendly workflow

CIME - CROW unification, CIME Case Control System

### 4. Hierarchical model development capabilities

Extensions of CIME data models, unit, & system testing

### 5. Forecast Verification: Comparison to Observations

Extension of MET+

### 6. Software Repository Management

NCAR manage\_externals tool

### 7. User / Developer Support

DTC and CESM Capabilities

**NOAA-NCAR MoA Work Areas**



# Operational Models Consolidation Timeline

NPS Modeling System	Current Version	Timeline																UFS Application		
		Q1 FY 20	Q2 FY 20	Q3 FY 20	Q4 FY 20	Q1 FY 21	Q2 FY 21	Q3 FY 21 - Q2 FY 22 MORATORIUM	Q3 FY 22	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	
Global Weather & Global Analysis	GFS/ GDASv15																			UFS Medium Range & Sub-Seasonal
Global Waves	GWMv3																			
Global Weather Ensembles	GEFSv11																			UFS Marine & Cryosphere
Global Wave Ensembles	GWESv3																			
Global Aerosols	NGAC v2																			UFS Seasonal
Short-Range Regional Ensembles	SREFv7																			
Global Ocean & Sea-Ice	RTOFSv1.2																			UFS Hurricane
Global Ocean Analysis	GODASv2																			
Seasonal Climate	CDAS/ CFSv2																			UFS Short-Range Regional HiRes CAM & Regional Air Quality
Regional Hurricane 1	HWRfV12																			
Regional Hurricane 2	HMONv2																			UFS Air Quality & Dispersion
Regional High Resolution CAM 1	HiRes Window v7																			
Regional High Resolution CAM 2	NAM nests/ Fire Wxv4																			UFS Coastal
Regional High Resolution CAM 3	RAPv4/ HRRRv3																			
Regional HiRes CAM Ensemble	HREFv2																			UFS Lakes
Regional Mesoscale Weather	NAMv4																			
Regional Air Quality	CMAQv5																			UFS Hydrology
Regional Surface Weather Analysis	RTMA/ URMA v2.7																			
Atmospheric Transport & Dispersion	HySPLITv7																			UFS Space Weather
Coastal & Regional Waves	NWPSv1.2																			
Great Lakes	GLWUv3.4																			
Regional Hydrology	NWMv2																			
Space Weather 1	WAM/IPEv1																			
Space Weather 2	ENLILv1																			

← Years 1-2 → ← Years 3-5 →