COASTAL COUPLING
COMMUNITY OF PRACTICE

ANNUAL MEETING

Coastal Coupling Community of Practice
May 25, 2023

Access to Meeting Materials
WiFi: Coastal Coupling
Password: co@$t2C0@$T!

Day 2 Highlights

Today we are building on what we heard on Day 2, including:

1. Excitement about the year ahead, including potential working groups for coastal modeling model repositories and strategic communications.
2. The ideas for specific activities and projects that will ensure we reach our Community's goals.
3. Discussions about the timeline for including NWM in UFS.

Day 3 Look-Ahead

Today we will build on our successes to focus on best practices, shared agreements, and next steps through lightning talks, subject matter presentations, and an open discussion about the next steps for this community.

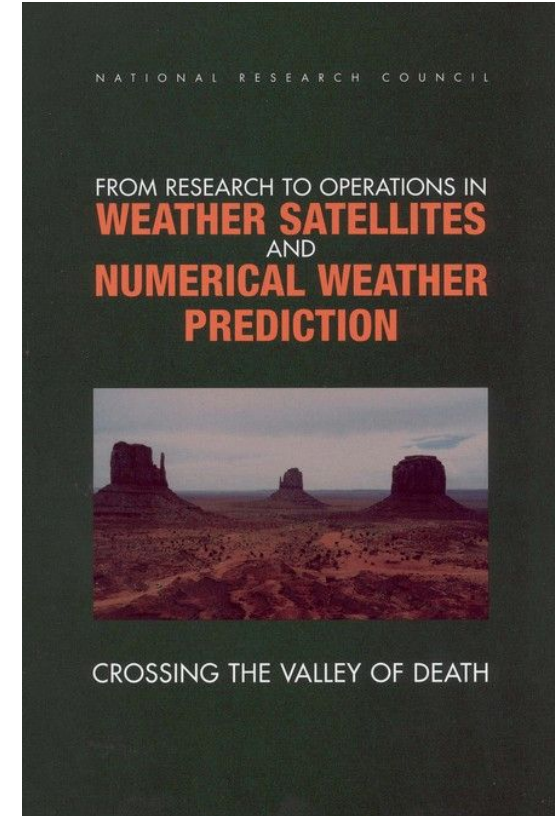# Opportunities with JTTI

CHANDRA KONDRAGUNTA

Program Manager, Joint Technology Transfer Initiative (JTTI)
NOAA
chandra.kondragunta@noaa.gov

Coastal Coupling Community of Practice Annual Meeting
May 25, 2023

Joint Technology Transfer Initiative

- **Background:** JTTI was created by the US Congress in FY16 with a $6M in NOAA/OAR's budget
  - In 2017, JTTI became part of the "Weather Research and Forecasting Innovation Act of 2017"
- **Mission:** Continuous development and cost-effective *transition of the latest scientific and technological advances into the NWS operations, while working in* close coordination with the National Weather Service (NWS) and in cooperation with the American Weather Enterprise
  - The Charge is to cross the "Valley of Death"

NATIONAL RESEARCH COUNCIL

FROM RESEARCH TO OPERATIONS IN
WEATHER SATELLITES AND
NUMERICAL WEATHER PREDICTION

CROSSING THE VALLEY OF DEATH

JTTI funding & Relevant Transitions

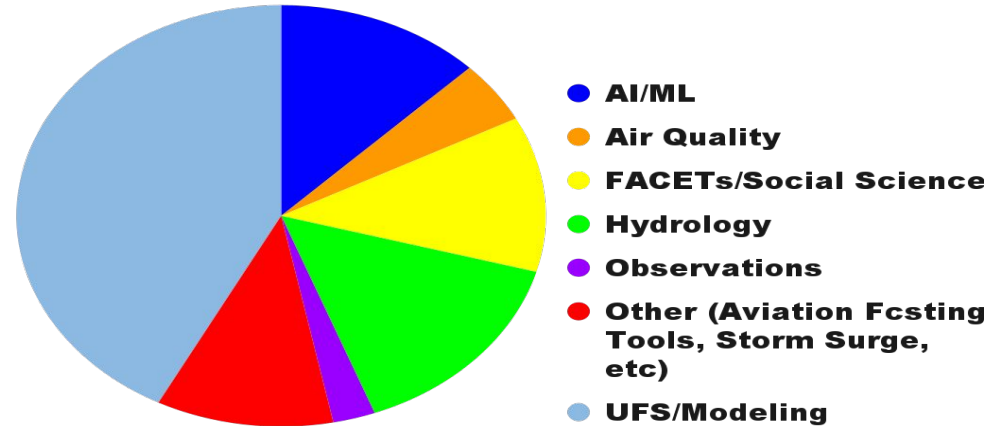**Total number of R2O projects funded to date : 152**

External = 116

- **Academic sector = 106**
- **Private sector = 10**

Internal (NOAA) = 36

Total number of transitions = 18

JTTI Funding by Topic Area (FY16-FY22)

- 🔵 **AI/ML**
- 🟠 **Air Quality**
- 🟡 **FACETs/Social Science**
- 🟢 **Hydrology**
- 🟣 **Observations**
- 🔴 **Other (Aviation Fcsting Tools, Storm Surge, etc)**
- 🔵 **UFS/Modeling**

Relevant Transitions to CC CoP:

- **Project Title: Advancing ADCIRC U.S. Atlantic and Gulf Coast Grids and Capabilities to Facilitate Coupling to the National Water Model in ESTOFS Operational Forecasting**
    - PI:Joannes Westerink, University of Notre Dame
- **Project Title: Improving Water Cycle Prediction in the National Water Model through Regional Calibration, Meteorological Forcing Improvements, and Coastal Coupling**
    - PI:Thomas Johengen,Cooperative Institute for Great Lakes Research, Univ. of Michigan

JTTI Fundng Opportunities

JTTI runs two types of competitions:
- **Notice of Funding Opportunity (NOFO) for external community (Academia and private sector)**
  - **Readiness Levels 4 and above (Developmental and Demonstration phases)**
- **Internal Competition for NOAA scientists**
  - **Readiness Levels 6 and above (Demonstration including pre-operational testing)**

Future Funding Opportunity: FY25 JTTI funding cycle
- **Internal Competition for NOAA Scientists**
- **Expected Funding Announcement Date: 3rd quarter of FY24**
- **Expected Project Start date: 3rd quarter of FY25**
- **Eligibility: Federal Scientists from OAR labs and NWS centers/operational units**
- **Eligible Readiness Levels: RL-6 and above (Previously funded NOFO projects from JTTI or one of other NOAA R&D programs)**
- **Areas of Interest: Weather Modeling, including DA, post-processing, coastal coupling etc.**
- **Funding Period: 2-3 years**
- **Funding Amount: Maximum funding limit = $500K**
- **Proposal structure: Joint proposals between OAR labs and NWS Centers/operational units**
  - **Proposals must have NWS partners**

THANK YOU

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THE PROJECT:

The NWS Effort to Implement Forecast Flood Inundation Mapping

- FIM services will greatly improve our ability to provide Impact-based Decision Support Services (IDSS) to our core partners
- Coastal Coupling will drive a more accurate inundation solution along the coast
- We have requirements for such a solution to be most useful:
  - Guidance must be accurate to meet the warning mission (trusted source)
  - Modeling system must run efficiently and guidance/output delivered in timely manner
  - Drive toward probabilistic services - this is the direction the NWS is headed

TRANSLATION:
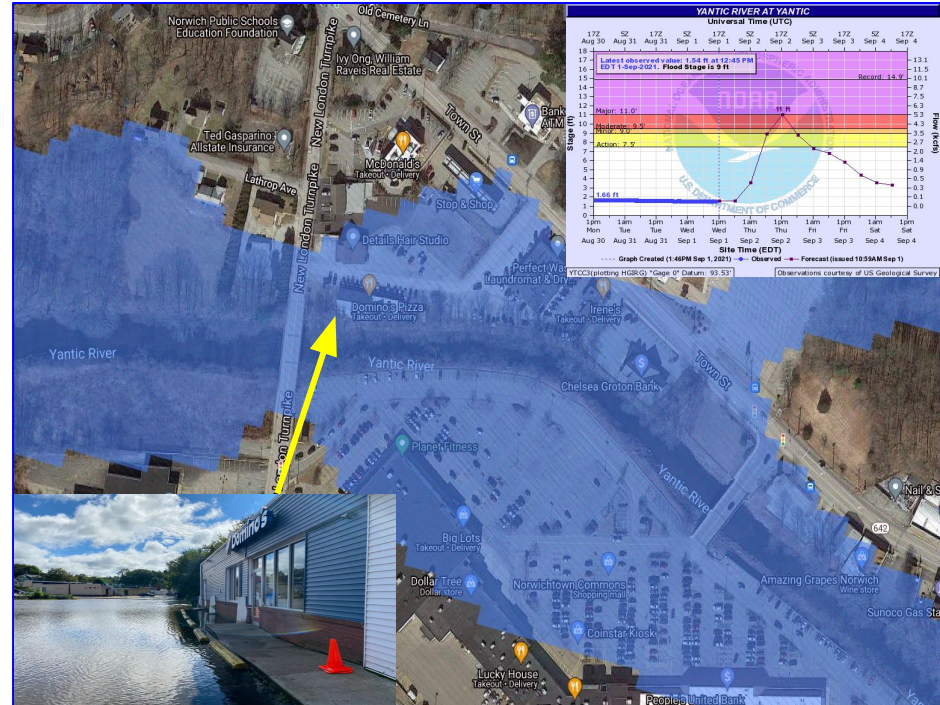
The key component to our success

- Tremendous investments by OWP to develop training to support the field!
- Combination of CBT, Webinars, and Workshops
- For Coastal Coupling integration - we need your help!
  - You are the Subject Matter Experts
  - The effort doesn't end with the implementation of the model…education is key
  - A successful training effort will lead to our success

Flood Inundation Mapping IDSS Workshop

Day 01.
FIM Review (Introduction and Tools)

FIM Reviewer
Instructions for Display
FIM Reviewer Exercises – Morning

Answer Keys to Morning Exercises:
One
Two
Three

Day 02.
FIM IDSS Process

Day 03.
Collaboration & Customer Interactions for Scenarios

FIM Tabletop Exercises

Morning Exercises with Answer Keys:
Texas
Mid-Atlantic

Training Program Supporting NWS FIM Implementation

Required for SME's Only	Required for Field Forecasters
National Water Model Part 1: Science and Products	National Water Model Part 1: Science and Products
National Water Model Services	National Water Model Services
NWM Flood Inundation Mapping Services	NWM Flood Inundation Mapping Services
NWM for IDSS Support	NWM for IDSS Support
National Water Center Public Products and Services – Pa…	National Water Center Public Products and Services – Pa…
National Water Center Public Products and Services – Pa…	National Water Center Public Products and Services – Pa…
Height Above Nearest Drainage Method (HAND) Method	Height Above Nearest Drainage Method (HAND) Method
Hydrography & DEMs Specifications Webinar	HAND FIM Performance Evaluation Module
Water Surface and Rating Curves Webinar	Categorical FIM (CatFIM) Module
HydroVIS Introduction Webinar	
HAND FIM Performance Evaluation Module	
Categorical FIM (CatFIM) Module	
Using the FIM Reviewer v2 Webinar	
FIM Quality Control Webinar	

THE RESULT: SAVING LIVES & PROPERTY
No more heartbreaking scenes like this ➜

The NWS Mission Statement:
Provide weather, water and climate data, forecasts, warnings, and impact-based decision support services for the protection of life and property and enhancement of the national economy.

The NWS Vision:
A Weather-Ready Nation: Society is prepared for and responds to weather, water, and climate-dependent events.

We need your help to truly fulfill our obligations to the Nation!

Residents of La Vita Bella, Dickinson, Texas - flooded during Hurricane Harvey, August 2017.

THANK YOU

David R. Vallee
Director, Service Innovation and Partnership Division
Office of Water Prediction, NOAA
david.vallee@noaa.gov

Partnerships & Opportunities

LAURA REAR McLAUGHLIN ▪ MAY 25, 2023
Branch Chief, Stakeholder Services Branch, NOAA/NOS/CO-OPS

Partnerships

Coastal Resilience COP

BIL & IRA Funding

And So Much More!

Thank You!

LAURA REAR McLAUGHLIN ▪ MAY 25, 2023
Branch Chief, Stakeholder Services Branch, NOAA/NOS/CO-OPS

EPIC AS A CATALYST
for NOAA's Future Earth Prediction System

Maoyi Huang, Ph.D., EPIC Program Manager, Weather Program Office
Oceanic and Atmospheric Research, National Oceanic and Atmospheric Administration
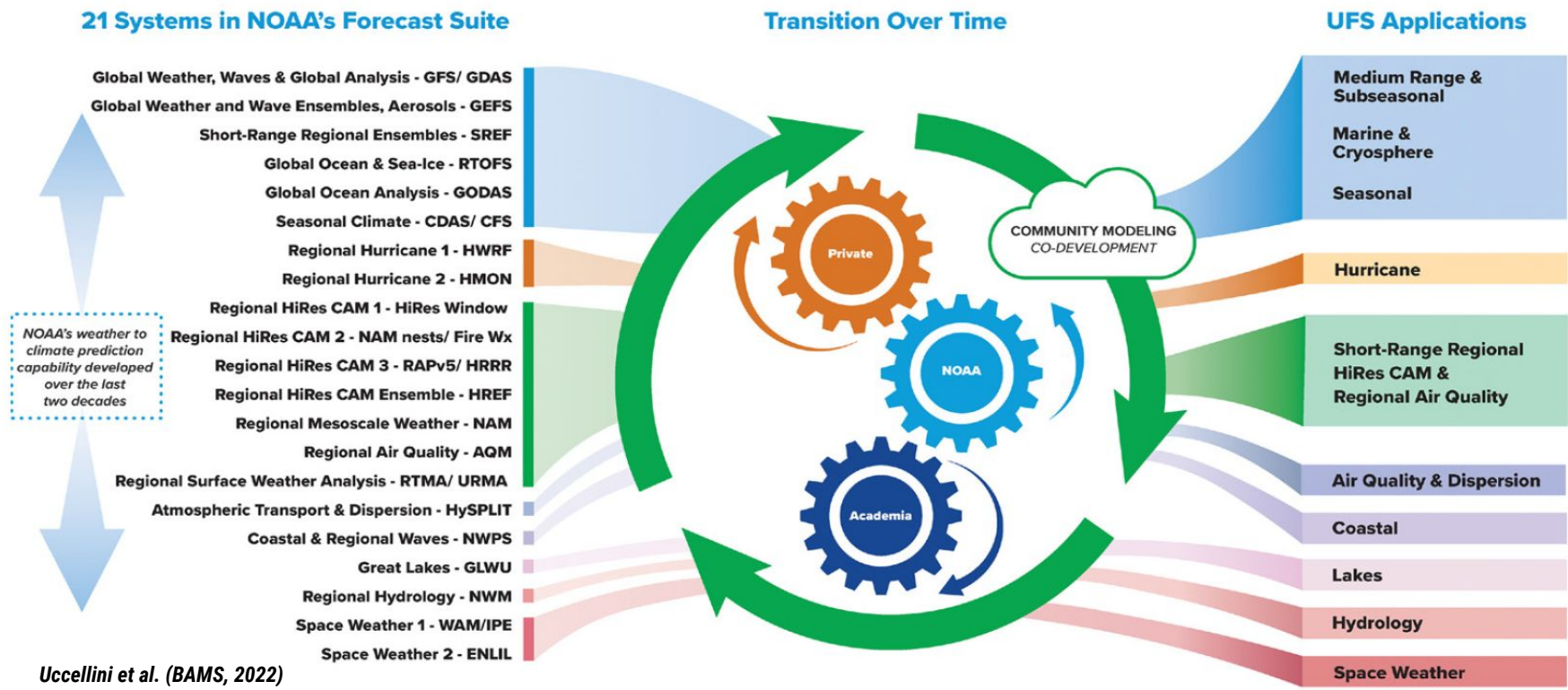Coastal Coupling Community of Practice Annual Meeting, 22 May 2023

- 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.

8 UFS Components

Atmosphere Ocean Wave Land

Storm Surge Aerosol Sea Ice Ionosphere
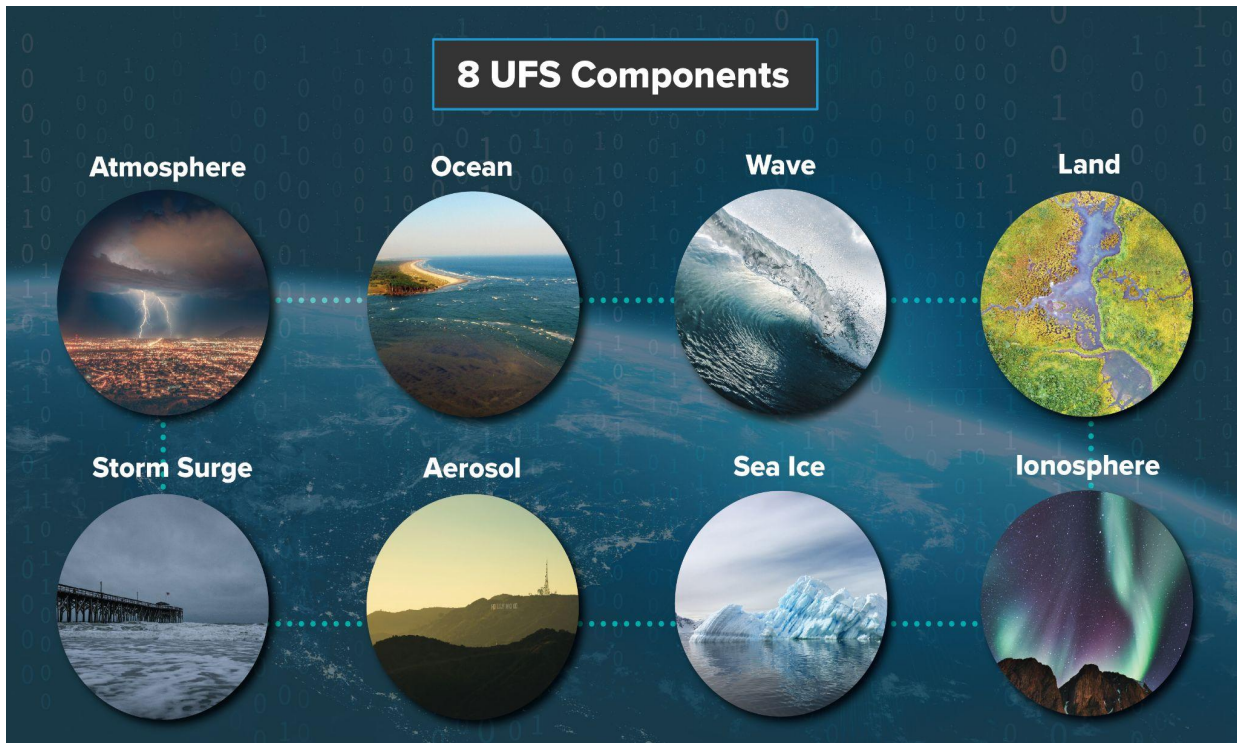
ufscommunity.org

Simplifying NOAA's Operational Forecast Suite

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

21 Systems in NOAA's Forecast Suite

- Global Weather, Waves & Global Analysis - GFS/ GDAS
- Global Weather and Wave Ensembles, Aerosols - GEFS
- Short-Range Regional Ensembles - SREF
- Global Ocean & Sea-Ice - RTOFS
- Global Ocean Analysis - GODAS
- Seasonal Climate - CDAS/ CFS
- Regional Hurricane 1 - HWRF
- Regional Hurricane 2 - HMON
- Regional HiRes CAM 1 - HiRes Window
- Regional HiRes CAM 2 - NAM nests/ Fire Wx
- Regional HiRes CAM 3 - RAPv5/ HRRR
- Regional HiRes CAM Ensemble - HREF
- Regional Mesoscale Weather - NAM
- Regional Air Quality - AQM
- Regional Surface Weather Analysis - RTMA/ URMA
- Atmospheric Transport & Dispersion - HySPLIT
- Coastal & Regional Waves - NWPS
- Great Lakes - GLWU
- Regional Hydrology - NWM
- Space Weather 1 - WAM/IPE
- Space Weather 2 - ENLIL

NOAA's weather to climate prediction capability developed over the last two decades

Transition Over Time

COMMUNITY MODELING
CO-DEVELOPMENT

Private

NOAA

Academia

UFS Applications

- Medium Range & Subseasonal
- Marine & Cryosphere
- Seasonal
- Hurricane
- Short-Range Regional HiRes CAM & Regional Air Quality
- Air Quality & Dispersion
- Coastal
- Lakes
- Hydrology
- Space Weather

2 2

Uccellini et al. (BAMS, 2022)

PARTNERING WITH THE COMMUNITY FOR THE BENEFIT OF THE NATION

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.

The Art of the Possible

Community Modeling, Earth Prediction and Innovation
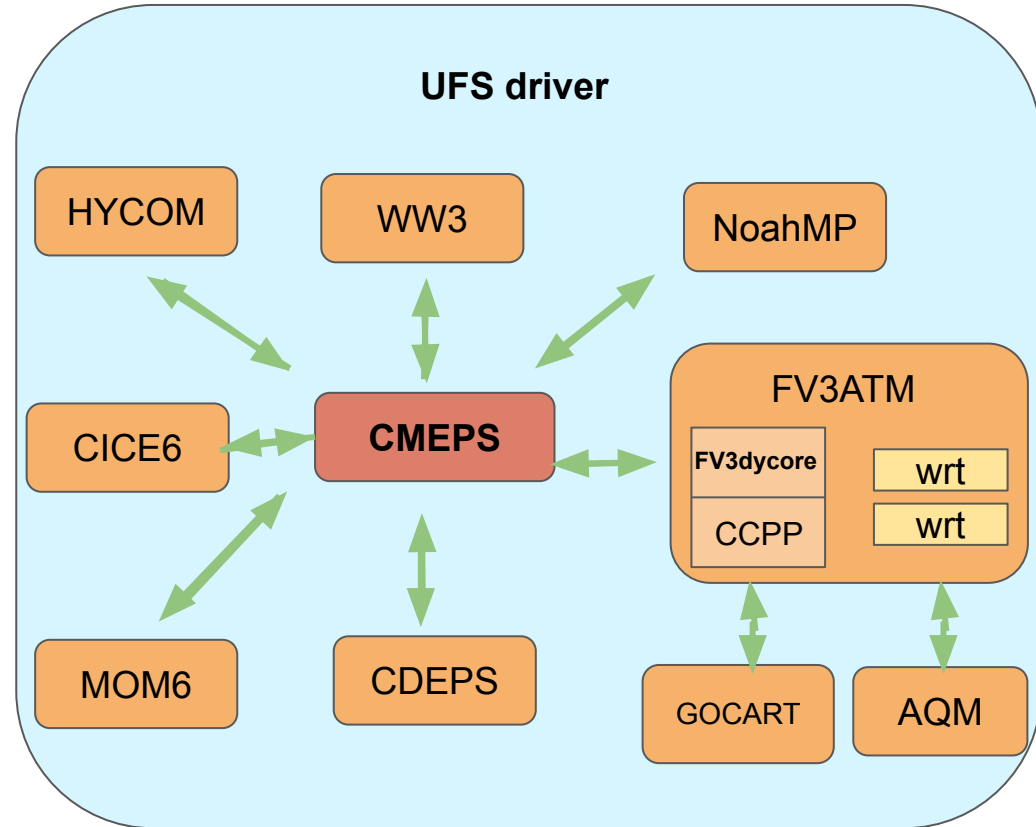
| Students | Government | Academia | Industry |

EARTH PREDICTION INNOVATION CENTER

EPIC Innovation Flow
Creating an Environment for Co-development and Inclusion

Modeling Community

Innovation to Research

INNOVATION PROCESS
Through User Support

User Forums

Code Repository

Documentation

Building a Community

Bringing greater alignment between NOAA, academia, private industry, and research centers

Creating the next generation of scientists

Supporting agencies' environmental modeling mission needs

Transition to Operations

Protecting life and property

Bolstering the economy and industry

Uccellini et al. (BAMS, 2022)

UFS Weather Model

Model infrastructure has been developed to build the unified system to support applications with various levels of complexity.

- Coupled model prototypes P1-P8
- GFSv17 high resolution experiments HR1
- GEFSv13 ensemble prediction experiments EP1-EP4
- RRFS v1
- HAFS v1
- AQM v7
- Offline file-based coupling of FV3 within JEDI framework
- Marine DA forecast model
- Land DA forecast model

Courtesy: Arun Chawla (EMC)

UFS driver

HYCOM · WW3 · NoahMP · CICE6 · **CMEPS** · FV3ATM (FV3dycore, CCPP, wrt, wrt) · MOM6 · CDEPS · GOCART · AQM

Plus a number of libraries like FMS, MAPL, ESMF, NetCDF, HDF5 etc.

TIMELINE AND ACCOMPLISHMENTS

- EPIC program established under OWAQ (now WPO)
- Release EPIC Vision Paper
- Host first EPIC Community Workshop
- Release EPIC Strategic Plan
- Align EPIC and JCSDA under same budget line item
- **Release UFS Medium Range System v1.0 to Github**
- **Release UFS Short Range System v1.0 to Github**
- Award the RFP Contract to Raytheon Intelligence & Space
- Release Final EPIC Strategic Plan
- Release EPIC Community Portal website (epic.noaa.gov)
- **Release UFS Short Range System v2.0 and v2.1**
- Provide UFS training and tutorial regularly
- WPO FY23 Innovation Competition, and WINGS Dissertation fellowship
- Establish an integrated testing environment for UFS
- **Release a hierarchical development framework (land DA, SRW 3.0, test cases)**
- **Expand the release and support to all UFS Applications (MRW/S2S, Hurricane, fire, coastal, SFS)**
- Establish a publicly accessible cloud innovation environ. for the weather enterprise
- Demonstrate Improvement in UFS skills and performance via EPIC

2019 2020 2021 2022 2023 2024 onward

THANK YOU

MAOYI HUANG
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NOAA National Ocean Service
Coastal Ocean Models Coupling Infrastructure:
A Community-driven Development Approach

SAEED MOGHIMI

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Coastal Coupling Community of Practice Annual Meeting
May 25, 2023

UFS-Coastal Team

Saeed Moghimi (NOAA/NOS/OCS)
Maoyi Huang (NOAA/OAR/WPO/EPIC)

Panagiotis Velissariou (NOAA/NOS/OCS)
Yunfang Sun (NOAA/NOS/OCS)
Ed Myers (NOAA/NOS/OCS)
Corey Allen (NOAA/NOS/OCS)

Tracy Fanara (NOAA/NOS/IOOS)
Derrick Snowden (NOAA/NOS/IOOS)

Patrick Burke (NOAA/NOS/CO-OPS)
Carolyn Lindley (NOAA/NOS/CO-OPS)

Arun Chawla (NOAA/NWS/EMC)

Ufuk Turuncoglu (UCAR/NCAR)
Dan Rosen (UCAR/NCAR)

Carsten Lemmen (Hereon)
Joseph Zhang (VIMS)

Damrongsak Wirasaet (UND)
Joannes Westerink (UND)

Jianhua Qi (UMASS-Dartmouth)
Changsheng Chen (UMASS-Dartmouth)

Hernan G. Arango (Rutgers)
John Wilkin (Rutgers)

Ayumi Fujisaki-Manome (CIGLR)

Chris Domanti (EPIC project team)
Keven Blackman (EPIC project team)

COASTAL OCEAN MODELS COUPLING FRAMEWORK
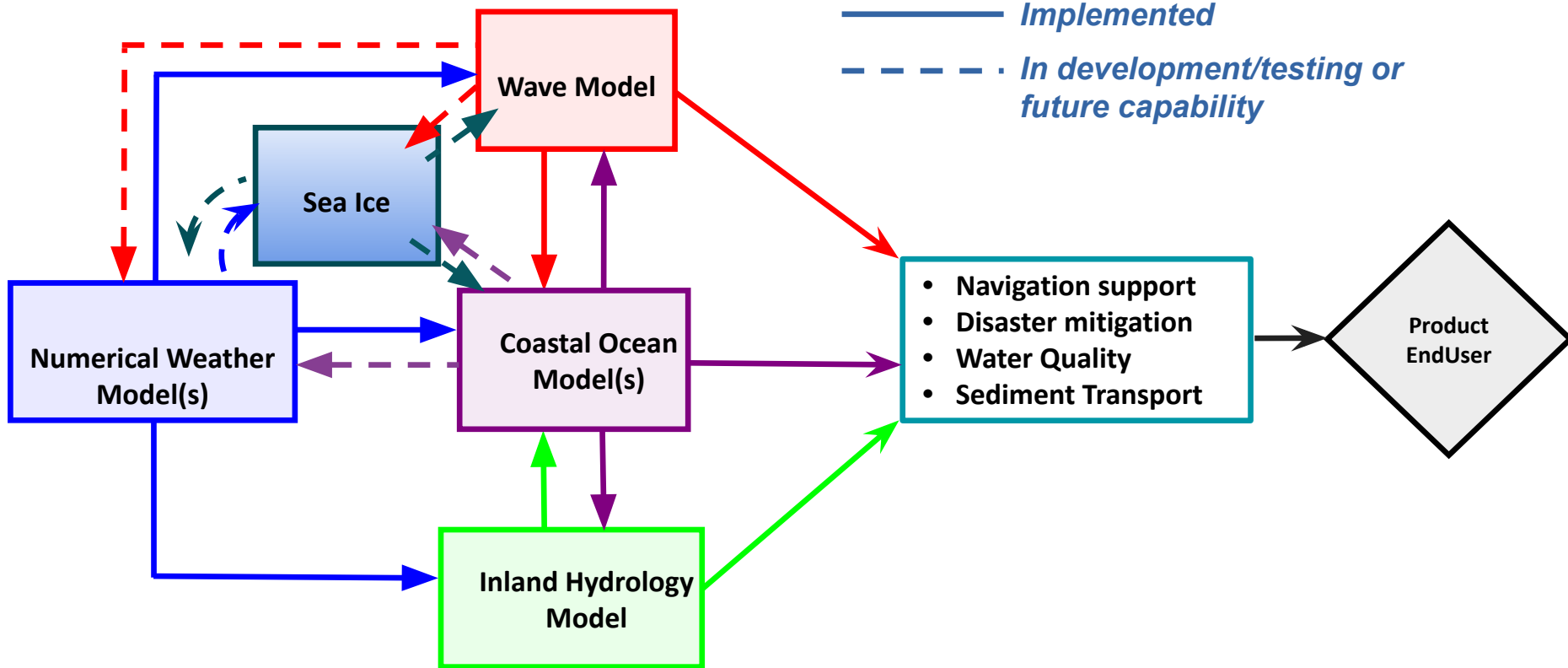
Current status - CoastalApp

pvelissariou1 NEMS: added the FVCOM component into the NEMS system ✕ ad067d3 2 days ago 🕐 **275** commits

📁 .github/workflows	create new GitHub Action to test submodule pointers (#72)	2 years ago
➡️ ADCIRC @ bd62a3c	updated ADCIRC on 02/13/2023	3 months ago
➡️ ATMESH @ a337c93	modified the ATMESH submodule pointer	6 months ago
➡️ BARDATA @ 8acb271	BARDATA: removed OC-GTSM/OGCM_DL-orig.f90	last year
➡️ FVCOM @ 7789b4b	FVCOM: initial commit	2 weeks ago
➡️ NEMS @ e4648bb	NEMS: added the FVCOM component into the NEMS system	2 days ago
➡️ NWM @ 3bc401d	update NWM and WW3 on linux file system	2 years ago
➡️ PAHM @ c1f3870	added the ParallelWorks platform into the system	2 months ago
📁 SCHISM	updated tp latest SCHISM sources on 02/13/2023	3 months ago
➡️ WW3 @ de9a246	WW3: removed ParMETIS sources; fixed the GCC variable in cmplr.env	2 months ago
➡️ WW3DATA @ beda5f2	update submodules to point to new pull request commits	2 years ago
📁 conf	CoastalApp build script and gitmodule changes to allow for WW3 com…	7 months ago

CoastalApp is a NUOPC application implemented following UFS best practices to couple coastal ocean models and other domains (Sea Ice, Atmosphere, Wave, Inland Hydrology, …)

📖 Readme

⚖️ CC0-1.0 license

☆ 8 stars

👁 8 watching

⑂ 24 forks

Current status -

Number of reg tests: 20

Model components:
- ADICRIC
- SCHISM
- FVCOM
- WW3
- PaHM
- ATMESH
- WW3DATA

Platforms Tested:
- RDHPCS - Hera, Orion, Cloud, …
- NSF - TACC (Frontera, Stampede)
- Various institutions HPC/Clusters
- Local Clusters/Desktops

### Job Scheduling:
- Slurm
- PBS
- Plain mpirun/mpiexec

Folder	Description	Last updated
📁 florence_hsofs.adc_spinup	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 florence_hsofs.atm2adc	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 florence_hsofs.atm2adc2ww3	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 florence_hsofs.atm2ww3	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 florence_hsofs.ww3_multi	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 florence_hsofs.ww3_nems	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 ike_shinnecock.adc_spinup	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 ike_shinnecock.atm2adc	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 ike_shinnecock.atm2adc2ww3	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 ike_shinnecock.atm2sch	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 ike_shinnecock.atm2sch2ww3	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 ike_shinnecock.atm2sch2ww3data	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 ike_shinnecock.atm2ww3	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 ike_shinnecock.sch	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 ike_shinnecock.ww3	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 images	fixed the slurm/pbs scripts to allow additional options from the comm...	3 months ago
📁 sandy_shinnecock.pam2adc	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 sandy_shinnecock.pam2adc2ww3	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 sandy_shinnecock.pam2ww3	fixed job submission scripts (SLURM, PBS) and added the SCHISM cases;...	last week
📁 scituateharbor.atm2fvc2ww3	added FVCOM test cases for Scituate Harbor (MA).	5 days ago
📁 scituateharbor.fvc	added FVCOM test cases for Scituate Harbor (MA).	5 days ago

UFS-Coastal Infrastructure

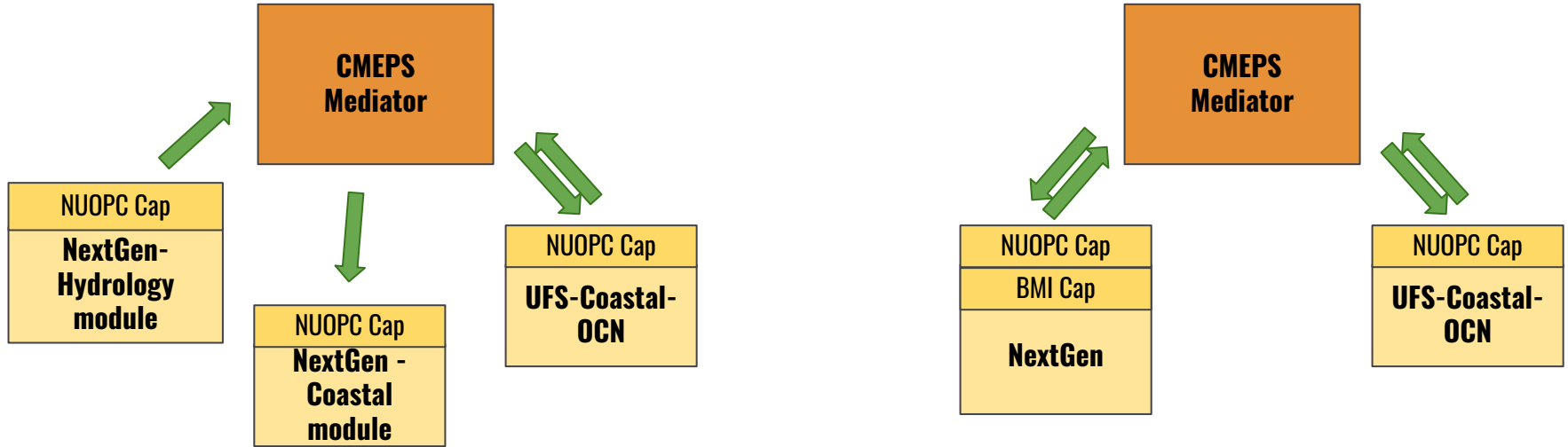oceanmodeling / **ufs-coastal**   Public

forked from ufs-community/ufs-weather-model

- "Data" models for integrating forcing datasets
- Component-level testing and cap optimization
- Configurable driver
- Coastal Mediator component
- Asynchronous output & regridding
- Computational performance optimization
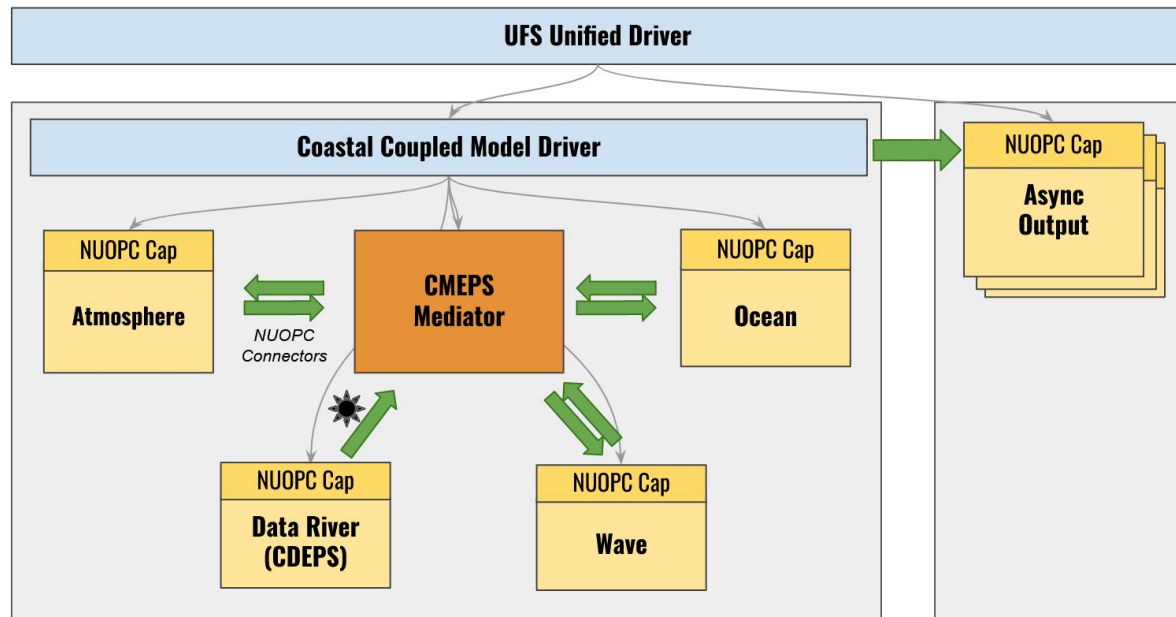
https://github.com/oceanmodeling/ufs-coastal/tree/feature/coastal_app

Courtesy to Rocky Dunlap (NCAR team)

✴ **ufs-coastal** one-way coupled to inland-hydrology until NextGen become a UFS ready model (i.e. to have ESMF/NUOPC capability)

UFS-Coastal and NextGen: Two-way coupling scenarios!?

1) UFS-Coastal to be connected to NextGen modules to exchange information *similar to Coastal Act project*.

2) UFS-Coastal and NextGen connection through NUOPC cap that wraps entire NextGen.

Inland-hydrology and coastal ocean models coupling (for BIL/CIFIM) - draft

Phases	Action items	Coupling modes	Expected time
Phase 1	1. OWP develop and validate the first version of NextGen 2. NOS develop and validate the first version of ufs-coastal	Stand alone model development	2024
Phase 2	1. NextGen developes BMI data models to import NOS coastal ocean models to enable one-way coupling from ufs-coastal to NextGen 2. The ufs-coastal to develop CDEPS NUOPC data wrapper to enable one-way coupling from NextGen to ufs-coastal 3. The ufs-coastal team to support NextGen team in designing NextGen NUOPC cap / BMI connection	One-way coupled	2025
Phase 3	1. NOS team will support OWP to start implementing NUOPC connectivity to BMI system 2. Basic testing of two way exchange among ufs-coastal and NextGen will be done 3. Prototype testing of the two-way coupled system 4. Preoperational testing of the two-way coupled system	Two-way coupled	2026 and beyond (in accordance with NextGen and ufs-coastal milestones)

THANK YOU

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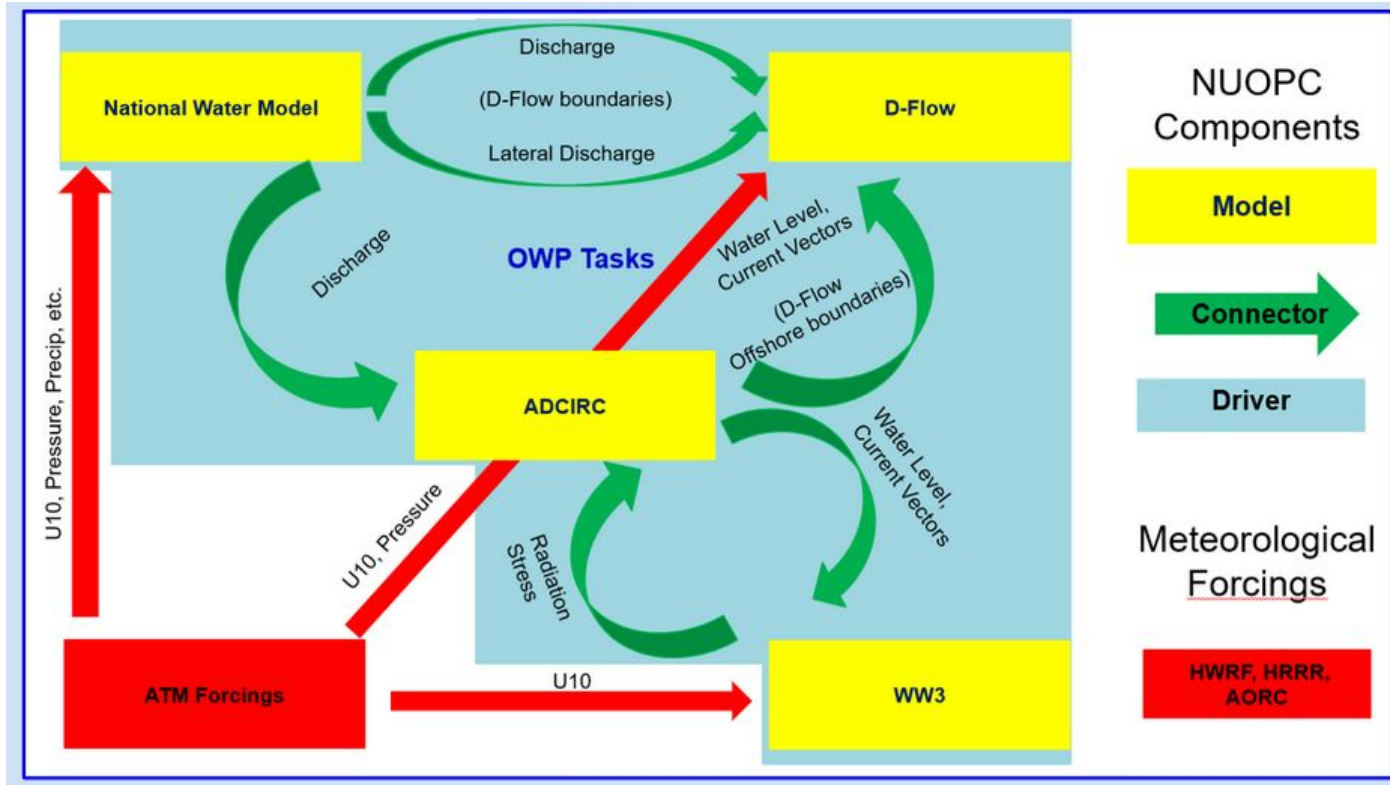
Credit: OWP presentation on September 28, 2022, Coastal Act 2022 annual meeting

Demonstrating the Coupling Architecture with the University of Massachusetts-developed Northeast Coastal Ocean Forecast System (NECOFS)

CHANGSHENG CHEN

Montgomery Charter Chair Professor
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Coastal Coupling Community of Practice Annual Meeting
May 25, 2023

Coupling Architectures of NECOFS and NWM

Changsheng Chen[1], Siqi Li[1], Tom Shyka[2], Alexander Prusevich[3], Jake Kritzer[2], Joe Salisbury[3], Qichun Xu[2]

University of Massachusetts-Dartmouth[1]
NERACOOS[2]
University of New Hampshire[3]

Outline

❖ Current NECOFS-NWM/WBM forecast/hindcast system

❖ Designs of NECOFS-NWM-WRF coupling with hydrostatic and non-hydrostatic dynamics

❖ Preliminary accomplishments

Northeast Coastal Ocean Forecast System (NECOFS)
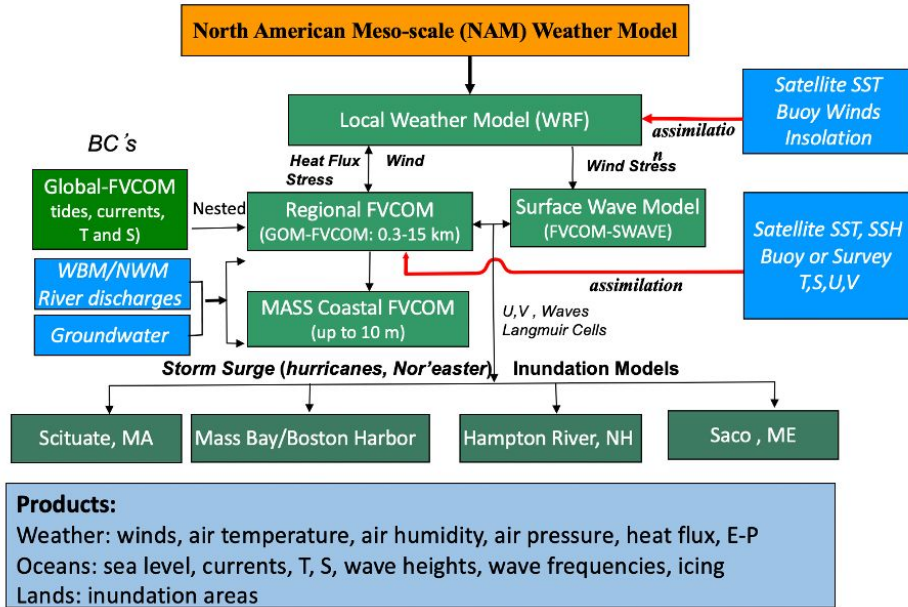
NECOFS/WBM grid and coverage areas

41
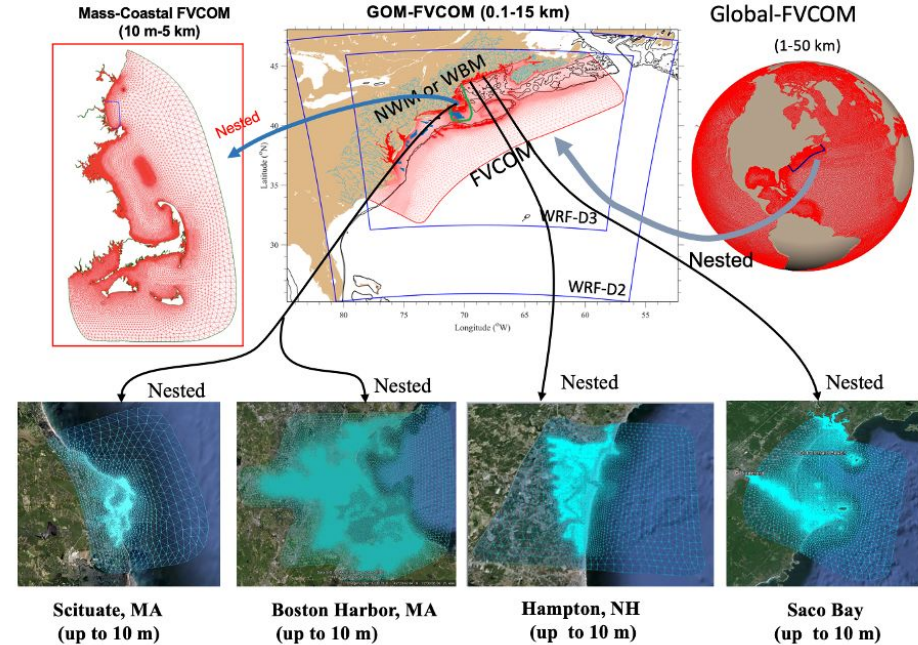
The Nor'easter storm Forecast
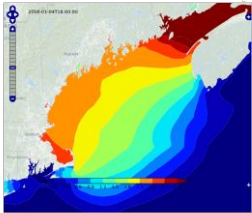
Surface elevation
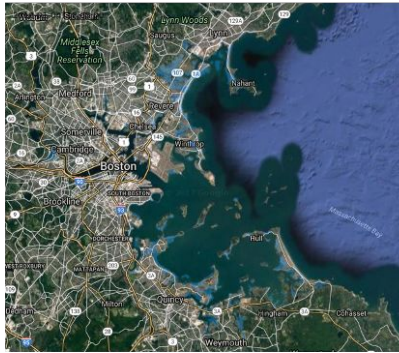
Significant wave height

Icing risk

Coastal inundation
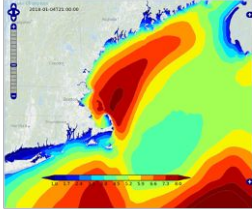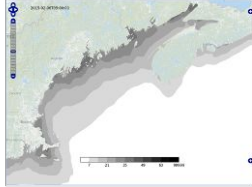
Data comparison

Buoy wind and waves
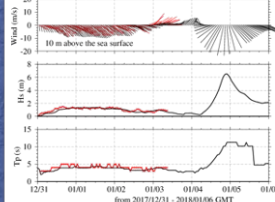
Buoy wind and waves
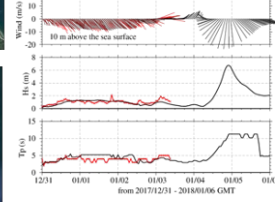
Elevations
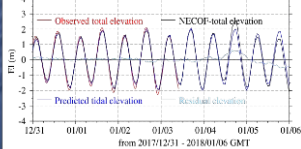
Comparison of NWM with USGS data
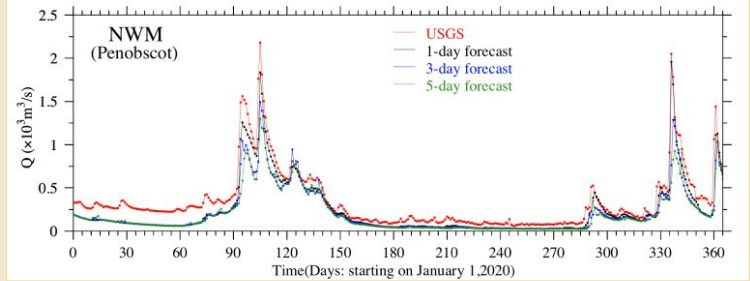
Comparison of NECOFS with observations
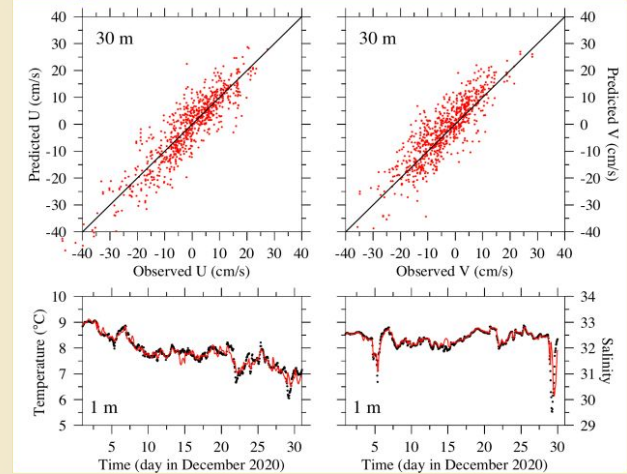
# Designs of Two-way Coupling of FVCOM and NWM
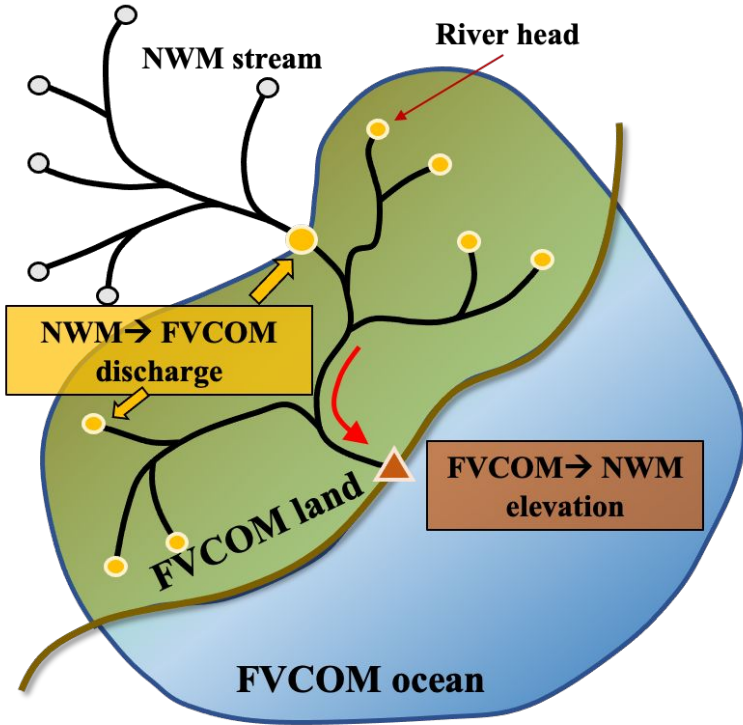
- Extend the FVCOM grid to cover the land.
- Divide the FVCOM grid to FVCOM-land and FVCOM-ocean. FVCOM-land overlaps the NWM domain.

Two-way online coupling

- NWM to FVCOM: freshwater discharges at
  - river heads in FVCOM-land domain
  - jointed points between NWM streamlines and FVCOM-land boundary.
- FVCOM to NWM: water elevation at
 - FVCOM-NWM main stream intersected sites at the coast.

Forced by meteorological data

- NWM: forced in the whole domain
- FVCOM: forced only in the ocean region, to prevent precipitation from being counted twice.
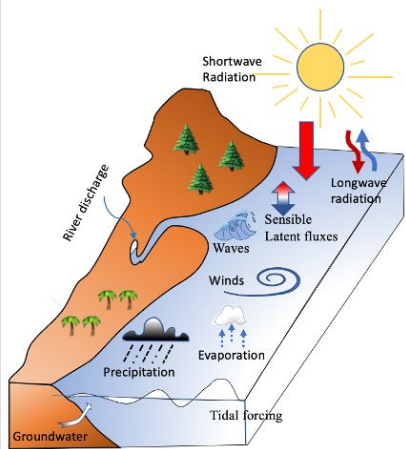
Working Plan

- Select Saco Bay as an initial test site to develop a coupled FVCOM-NWM-WRF-WW3 system prototype under NUOPC. The coupler used in NUOPC is ESMF.

- Apply the coupled prototype to the Hampton River, NH.

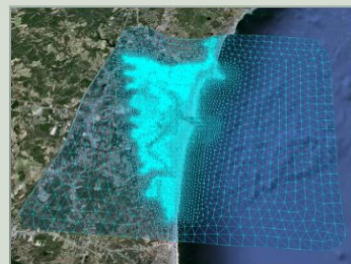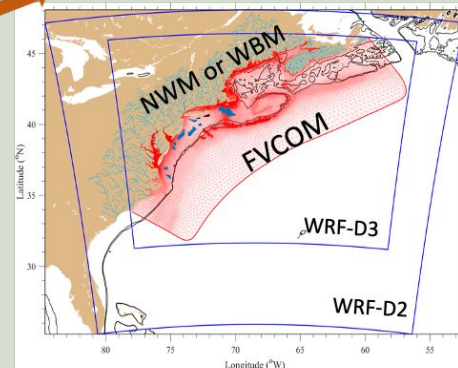- Extend the coupling to cover the entire NECOFS domain.
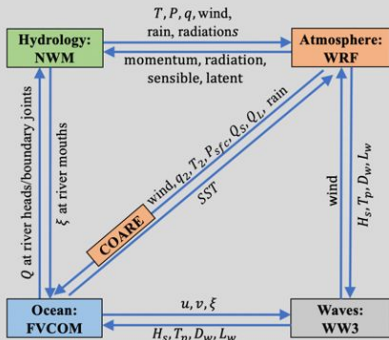
Saco Bay, ME → The Hampton River, NH → The Northeast US (NECOFS)

Code: NWMv2.1.3

https://github.com/NCAR/wrf_hydro_nwm_public/releases/tag/nwm-v2.1-beta3

Startup: cold start

- 2022-01-01 to 2023-01-01

Forcing:
- CFSv2 climatological dataset
- 6-hour interval
- ~1° resolution
- Interpolated to CONUS domain
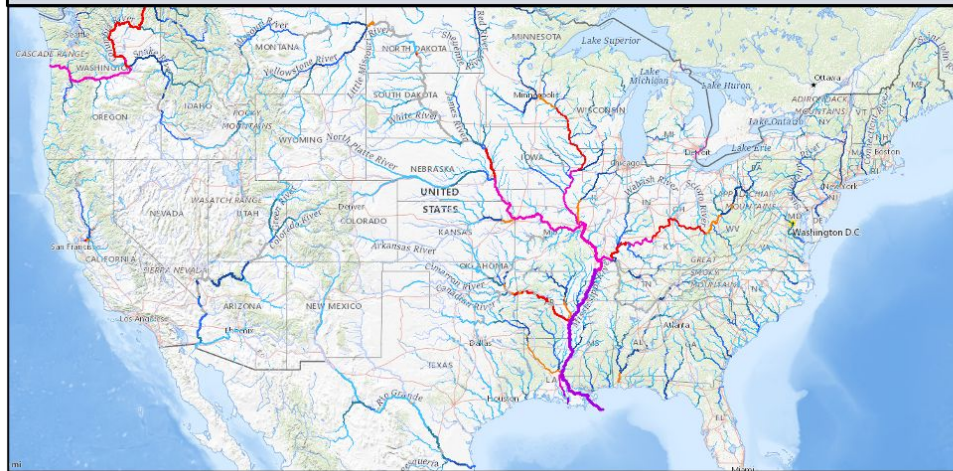
TBL files:
- CHANPARM.TBL
- GENPARM.TBL
- MPTABLE.TBL
- SOILPARM.TBL

Static inputs:

- Fulldom_CONUS_FullRouting.nc

- geo_em_CONUS.nc

- GEOGRID_LDASOUT_Spatial_Metadata_CONUS.nc

- GWBUCKPARM_CONUS_FullRouting.nc

- hydro2dtbl_CONUS_FullRouting.nc

- LAKEPARM_CONUS.nc

- reservoir_index_AnA.nc

- RouteLink_CONUS.nc

- soilproperties_CONUS_FullRouting.nc

- spatialweights_CONUS_FullRouting.nc
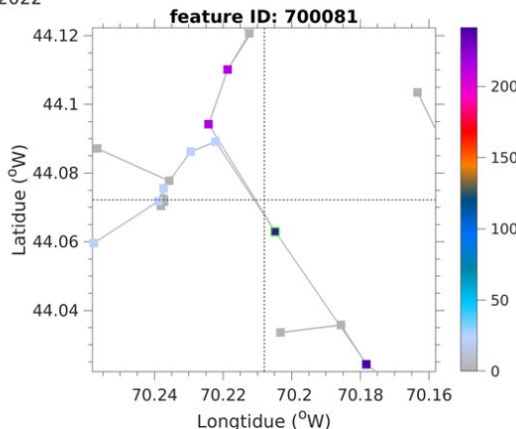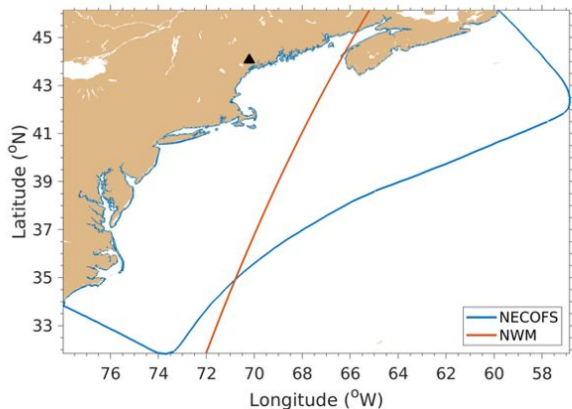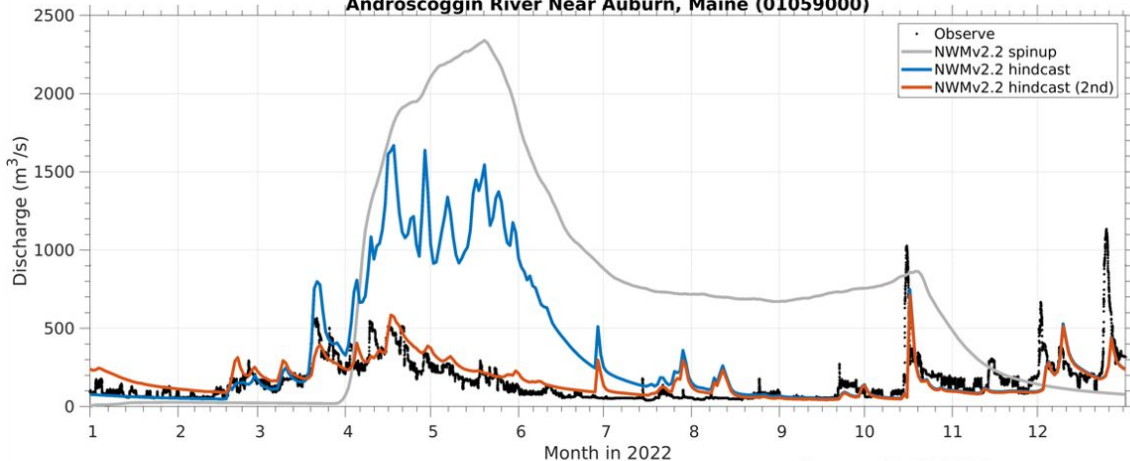
- wrfinput_CONUS.nc
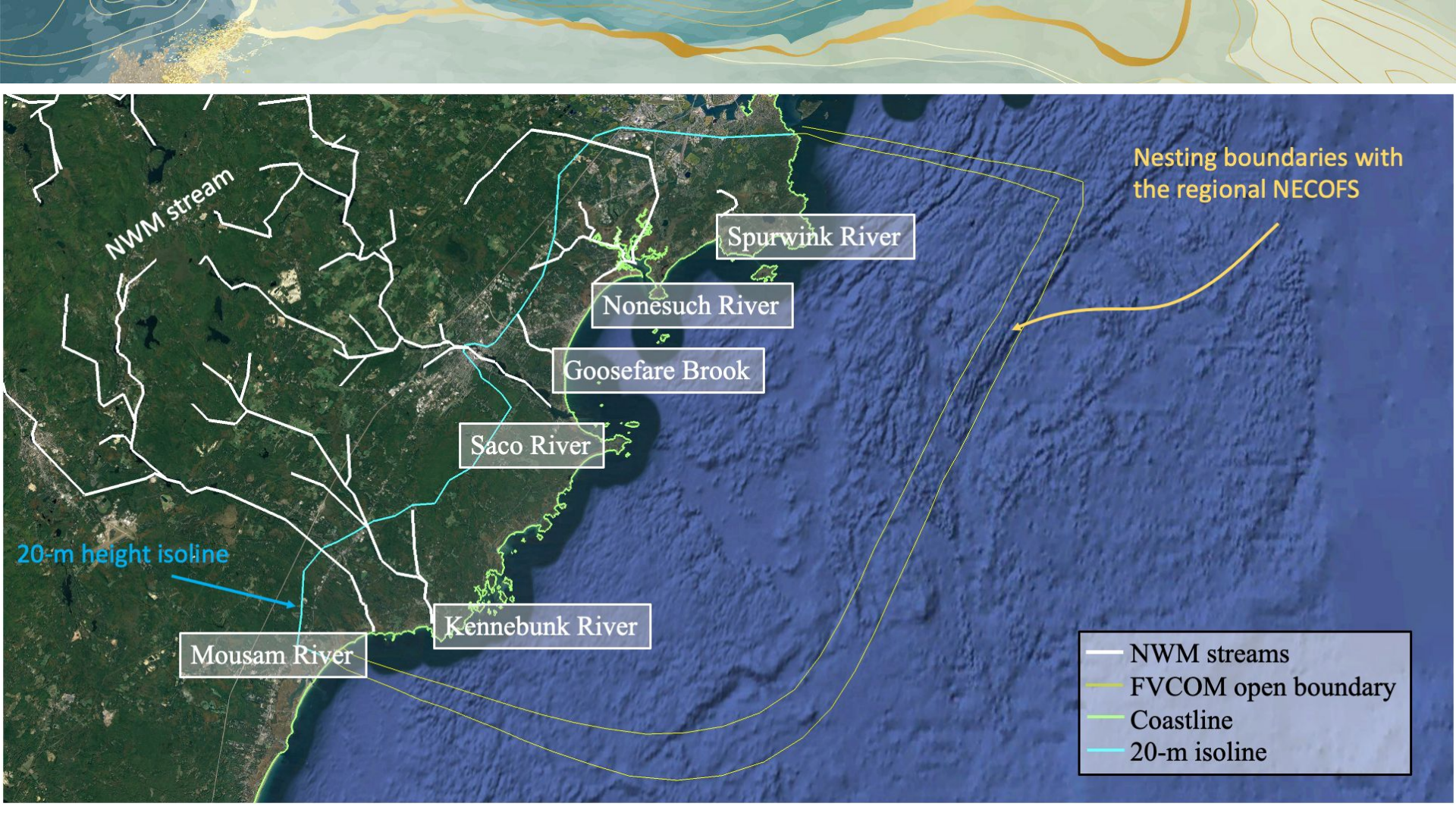
Domain: CONUS

- 1.0-km resolution (18,432 x 15,630)

Spin-up run of NWM-2.13:

- Year 1: initial spin up. Warming up with CFSv2 climatological meteorological forcing

- Year 2: Hindcast run. Treadmill running with HRRR forcing of 2022

- Year 3: Repeat hindcast run for 2022 without data assimilation.

Hindcast run for the second year started capturing the observed river discharge.
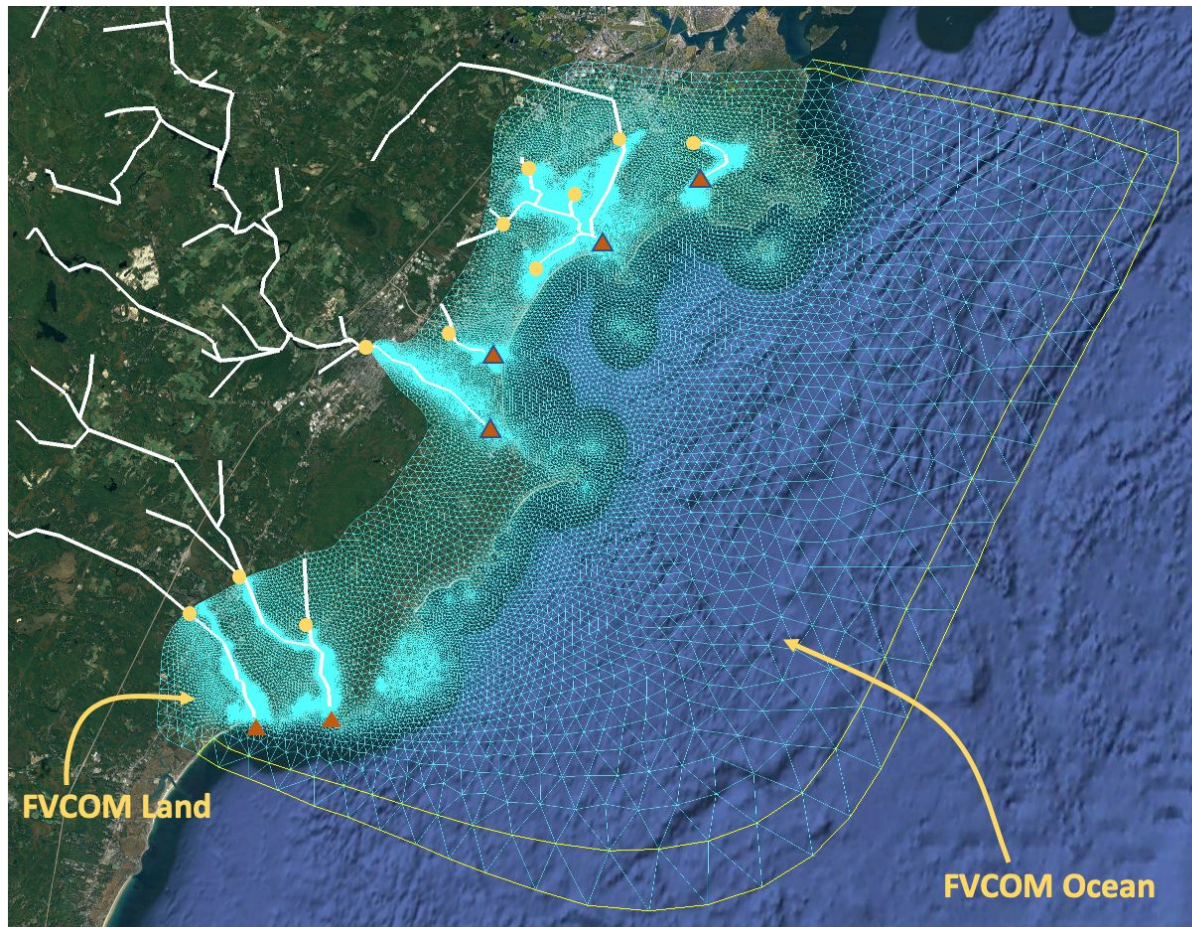
Illustration of the two-way NWM-FVCOM coupled grid and setting in Saco Bay, ME

- FVCOM-land boundary is determined based on the route geometry.

- Initial setup for FVCOM-Land varies from ~8 to ~500 m.

The FVCOM code is upgraded to allow to add the freshwater discharges at the river head where the water depth is negative (above the mean sea level).
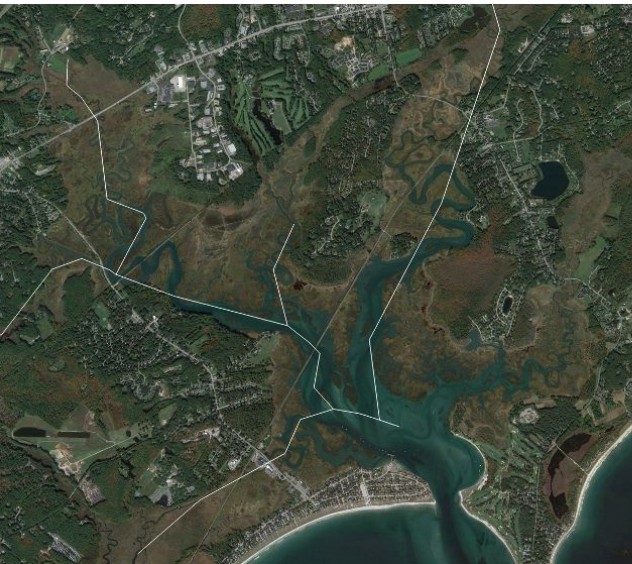
● NWM ⇒ FVCOM

▲ FVCOM ⇒ NWM

— NWM stream
— FVCOM open boundary
— FVCOM grid
— 20-m isoline

FVCOM Land

FVCOM Ocean

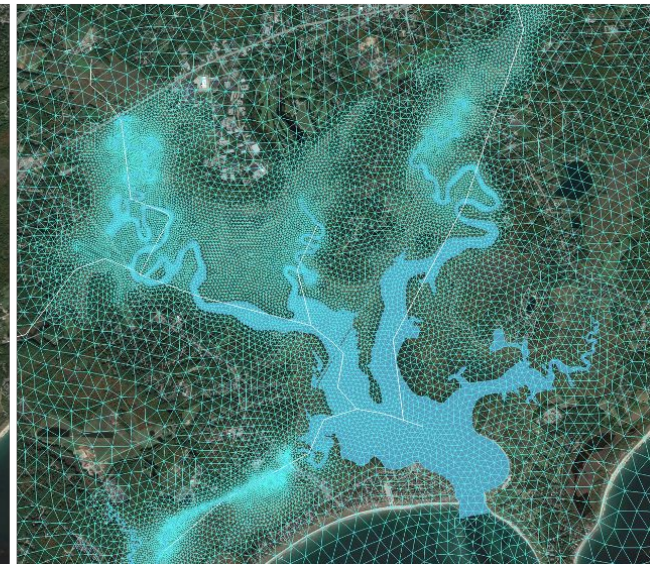# Zoom-in view of the Nonesuch River

Satellite image

River + Marsh/wetland area

FVCOM-Land grid

Summary

This project will produce a two-way coupling prototype of FVCOM and NWM under NUOPC framework. A three-stage development is designed, first NWM-FVCOM, second NWM-FVCOM-WRF, and third NWM-FVCOM-WRF-WW3.

Saco Bay, ME is chosen as a first testbed site for the development. The coupler system will be applied to the Hampton River, NH, and then to the entire Northeast US NECOFS domain.

The two-way coupling prototype developed in this project could be used for other unstructured-grid models.
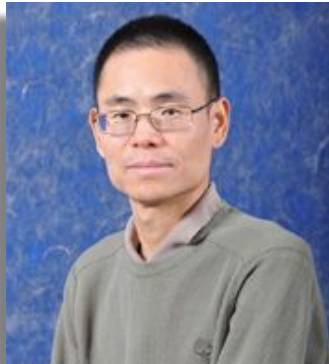
THANK YOU

CHANGSHENG CHEN
Montgomery Charter Chair Professor
University of Massachusetts Dartmouth
c1chen@umassd.edu

Demonstrating the Coupling Architecture with the Virginia Institute of Marine Science-developed Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM)

JOSEPH ZHANG

Professor of Marine Science
Virginia Institute Of Marine Science
yjzhang@vims.edu

Coastal Coupling Community of Practice Annual Meeting
May 25, 2023

THANK YOU

JOSEPH ZHANG
Professor of Marine Science
Virginia Institute of Marine Science (VIMS)
yjzhang@vims.edu

20:00

Opportunities to connect with NOAA's Cooperative Institute for Research to Operations in Hydrology (CIROH)

CIROH Goals
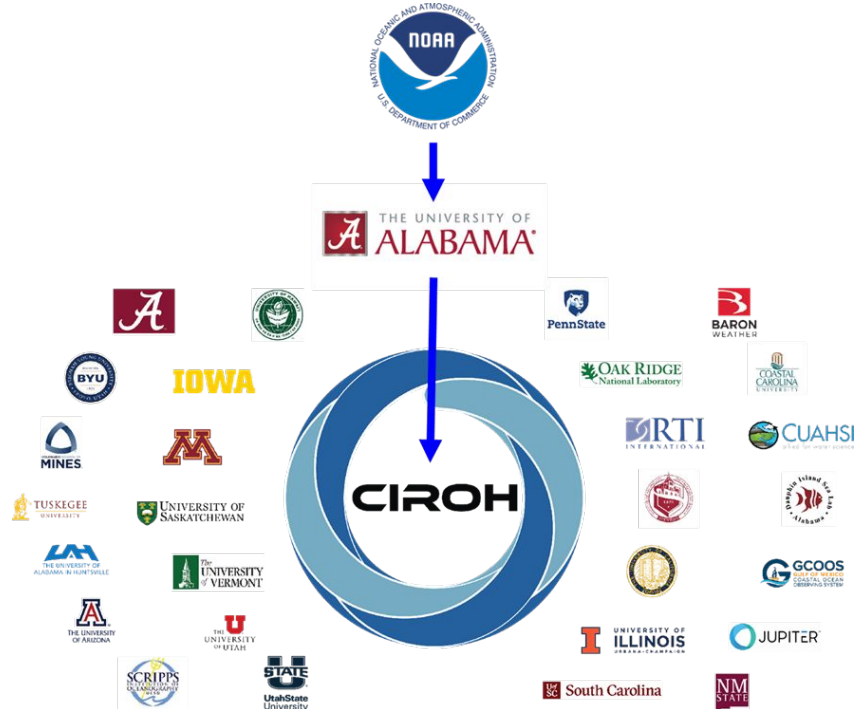
1. Support the NWC's mission to deliver a new generation of water data and services
2. Advance research supporting NOAA's vision of a climate-ready nation
3. Mobilize a community of practice to co-produce innovative research & education

CIROH's Unique Features

1. Connected to Ops
2. Consortium

CIROH's Vision

Research enabling delivery of actionable water intelligence

CIROH's Research Themes

RT1: Advancing Water Prediction Systems and Workflows

- Prediction system testbed
- Inputs, forcings, data assimilation
- Remote sensing and sensor technologies
- Model and forecast evaluation

RT2: Developing Community Water Modeling Frameworks

- Research cyberinfrastructure
- Hydrologic process advances
- Large-scale hydrologic modeling
- Artificial intelligence and machine learning

RT3: Water Data Science and Hydroinformatics Solutions

- Extreme data management
- User interactions and apps
- Flood inundation mapping
- Impact assessment and risk analytics

RT4: Designing Forecasts for Community Resilience

- Risk perceptions and behaviors
- Impact-based decision science
- Improving forecasts for underserved
- Building community resilience
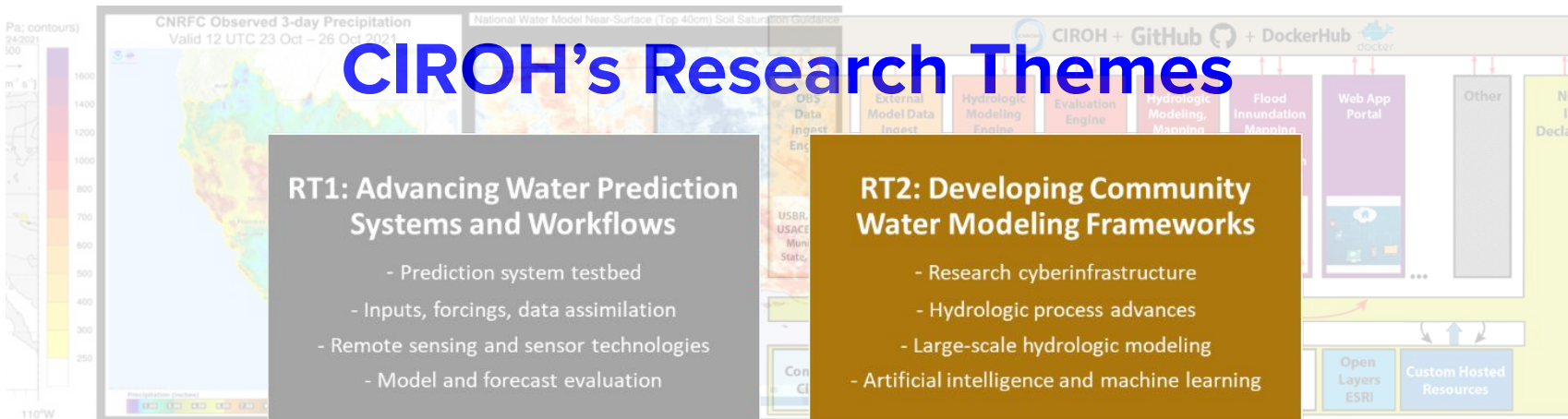
CIROH's Education and Outreach

Mobilized Research Community Connected to Operational Impact

- Science Meeting
- Developers Conference
- Water Tech Forum
- Visiting Scholars
- National Webinar
- Think Tanks
- Research Synthesis

Strengthened Workforce

- REU
- Summer Institute
- Experiential Learning
- Study Tours
- Courses / Training
- Programs / Degrees
- Hackathons

Inspired Next Generation

- K-12 Camps, Research, and Curriculum
- Youth Summit
- Public Outreach & Education
- Community Engagement

CIROH's R2O Enabling Cyberinfrastructure

Big Data Access and Handling

JupyterHubs for Experiments

Accessible NextGen

https://github.com/AlabamaWaterInstitute/CloudInfra
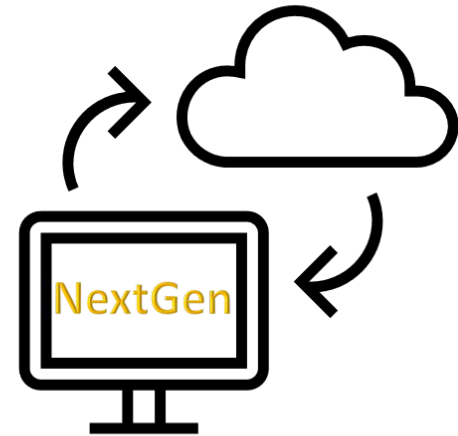
CIROH Project Spotlight: Advance riverine-coastal model coupling and forecast verification for total water quantity and quality (Bao and Pietrafesa, Coastal Carolina University)
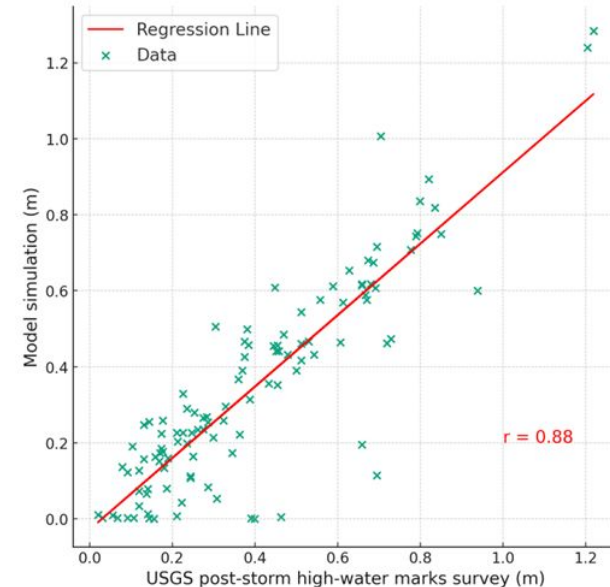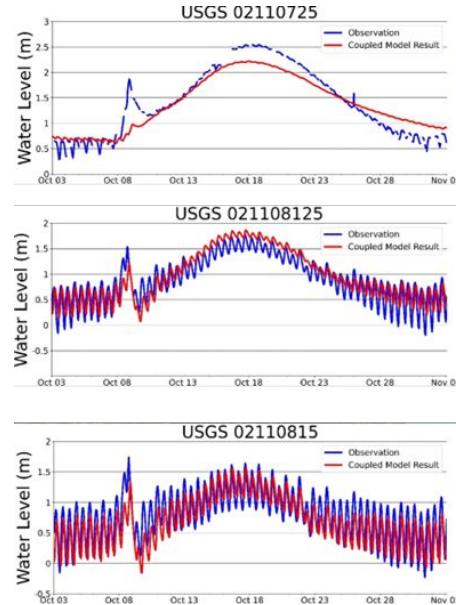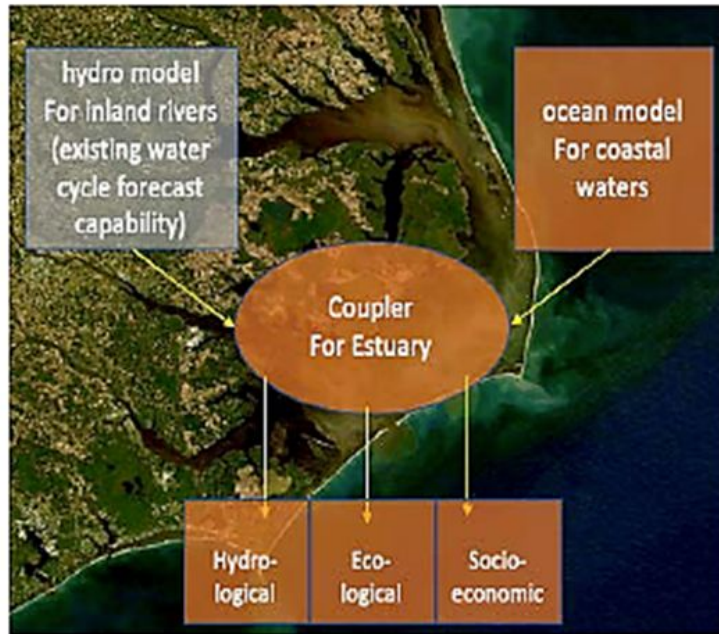
CIROH Project Spotlight: Coastal Nature Based Solutions to Mitigate Flood Impacts and Enhance Resilience (Moftakhari, University of Alabama)
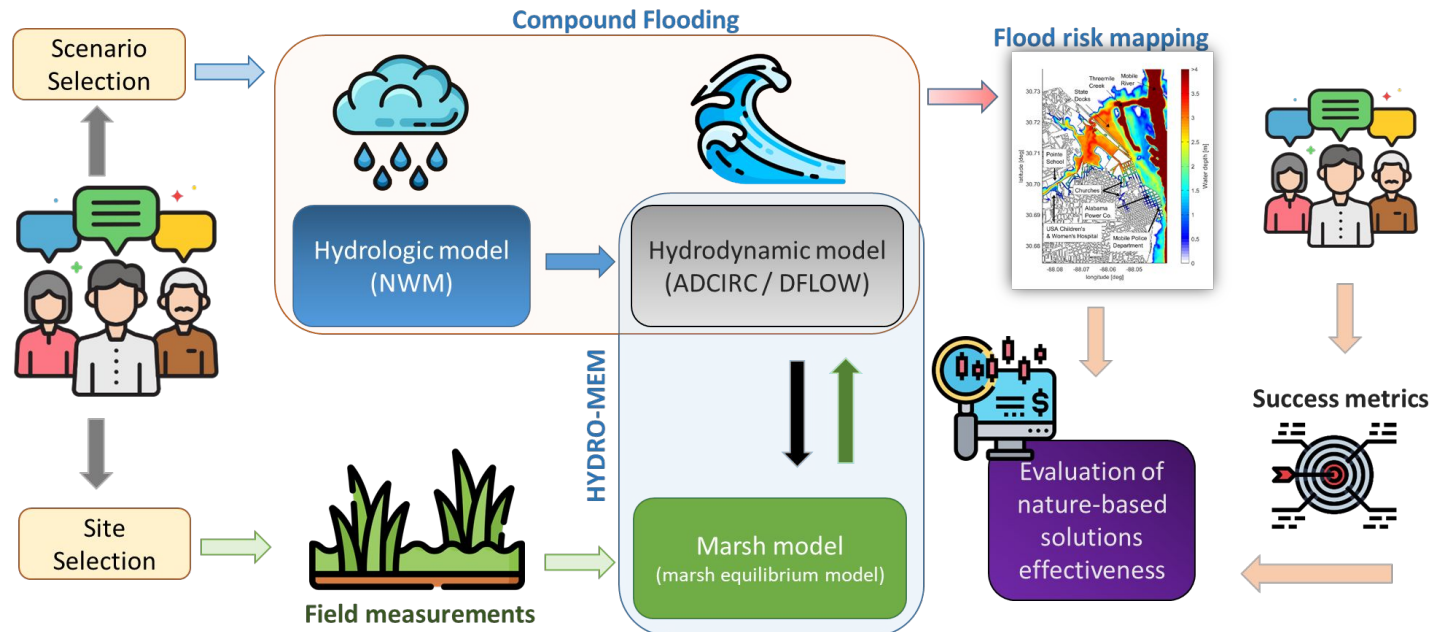
COASTAL COUPLING
COMMUNITY OF PRACTICE

THANK YOU

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Dr. Len Pietrafesa, PhD

Professor Emeritus, North Carolina State University
Burroughs & Chapin Scholar, Coastal Carolina University
Chair Emeritus, NOAA Science Advisory Board (the NOAA SAB)
Fellow, American Meteorological Society (the AMS)
Commissioner Emeritus, The AMS Weather, Water, Climate Enterprise
Chair Emeritus, APLU Board on Oceans, Atmosphere & Climate

A Brief History of Forecasting in the USA and the GOAL of establishing Validated, Reliable Operational Forecasts of Interactively Coupled - Compound Coastal, Inland & Upland Flooding: thus, connecting the NWC to CIROH and the NWM to the Ocean

1ˢᵗ, Some History on Weather Forecasting in the United States:

- Rapid exchanges of weather data first became <u>feasible</u> with the development of the electric <u>telegraph</u> in 1837 by <u>Samuel Morse</u> of the USA.
- In 1869 <u>Cleveland Abbe</u> at the Cincinnati Observatory began to provide regular atmospheric weather forecasts using data received telegraphically
- The 1ˢᵗ "national weather service" in the USA, was established in 1870 by the 41ˢᵗ US Congress & President Ulysses S. Grant. The Weather Bureau (WB), was assigned to the <u>U.S. Army Signal Corps</u>, then moved in 1890 to the <u>Dept. of Agriculture</u>. It became responsible for issuing public flood "warnings" in 1891
- The WB became the <u>National Weather Service</u> in 1970 and moved to the DoC
- In 2001, the NOAA SAB recommended that NOAA issue Flood Forecasts after NCSU studies [1,2,3] showed that ~ 75% of deaths & destruction from TCs were Caused by flooding and not by winds.
- The NOAA SAB shared this with Bill Simpson of the Saffir-Simpson Scale ;
- Bill concurred

- But I digress: Following WWII, in 1945, the Question arose: What was the most urgent Issue that challenged the USA, its Allies and The US Military at the beginning of WWII?
- The Answer: When to Cross the English Channel and invade Europe and fight Hitler and the Fascist/Nazi Axis

- The next Q was: What was required of the US Government?
- The Answer was "R2O" in the Atmospheric & Oceanic Sciences
- So the Office of Naval Research was created in 1946 with $$$

- The AtSci. created mainly UG programs to educate Forecasters
- The OcSci. created GS programs to buy Ships and study Ocean Basins
- We Note here that Hydrological Systems were not even considered
- So, R2O was weak on the AtSci side and O2R was absent in the OcSci

In 1999, Hurricane Floyd was blamed by NOAA for the huge coastal and inland flooding and inundation along the NC coast resulting in 56 deaths by drowning

- But We at NC State did not accept the hypothesis that Floyd was singularly responsible for the massive coastal and inland flooding that occurred [1]

- We looked at the USGS River time series data and the NOAA-NOS coastal and inland water level time series

- And made a Discovery @ the Floyd Flood which reached ~ 100 miles inland

- There were => two consecutive events, Hurricane Dennis and then 10 days later, Floyd passed by (Dennis & Floyd were wet events of 2 feet of rain

- BTW, NCSU studies showed that Damage statistics from all direct land-falling Hurricanes that 25% was due to Wind and 75% to Flooding [2]

- More recently, [3], "Compound Flooding" has been introduced

1999 Hurricane Tracks
● Dennis   ◆ Floyd

▲ Water Level
+ Met/Met Buoy/C-man
★ Current Meter

ALBEMARLE SOUND
ducn7
Duck
Tarboro
Oregon Inlet
Washington
Marina
Pungo River
Kinston
PAMLICO SOUND
Neuse River
dsln7
Cape Hatteras
Ocracoke Inlet
Beaufort   clkn7

50 km

18
8
17
7
6
5
2
1 (Sep)
31
3
4
16
30
29
15
28
27
14
26
25
13
12
24 (Aug)   Dennis
11
10
9
Floyd
8 (Sep)

500 km

85.0 W   75.0 W   65.0 W   55.0 W   45.0 W

Chesapeake Bay
Cape Hatteras
Beaufort
ngton
Charleston

- However, in 1999, there were 26 Offices in Wash - DC that claimed that they owned the rights to the Water; an untenable situation….VP A. Gore committed to get this resolved in 2000 and 2001 but he lost. And so, No US Agency did real-time flood forecasting. But, the NOAA SAB recommended a NOAA Water Center in 2001=>
  In 2003, NOAA created an Office of Hydro (OoH) and this led to the Coastal and Inland Flooding Act passed by the U.S. Congress in 2002
- The bill was introduced by NC Cong. Bob Etheridge in the 107th Congress and passed by the House of Reps & the Senate
- It appropriated $6.25M in federal funds to be used to develop a Flood Forecast Warning System Scale; like the SS Cat Scale with $3.5M for NOAA and $2.75M was supposed to go to the Universities
- I have a Red Line Copy of the Bill on my Office Wall (signed by Byrd and Bush)
- But the Director of NOAA's Office of Hydrology sequestered the money and when queried by the NOAA SAB about it, He said
- "we were able to create a new Risk Scale of "High, Moderate and Low' Risk" (!!!)

- Thus, a new window of opportunity emerged and the NWC was created @UAL (at the time it was TBD'd)
- But, to address that void, a new kind of NOAA CI was envisioned (via visionaries such as Uccellini, Graziano & Rayder)

- You see, up to then all of NOAA's CI's were housed in NOAA's Office of Oceanic & Atmospheric Researh (OAR) for O2R
- But then through efforts within the NWS, the UAL, and an AL Senator, the NOAA NWS was granted a CI, with the dual Missions of coupling O2R and R2O (with the leadership of Rayder & Burian)
- **And thus, CIROH was spawned**

- **Today, across the CIROH Constellation, the Atmospheric, Oceanic, Hydrologic and Socio-Economic Sciences, must be coupled, some Interactively and 2-Way, and some 1-Way in order for success**
- **This is TBD'd and will require Hand's On, Visionary Leadership and Not "Business As Usual", which, unfortunately, has been NOAA's**
   traditional way of doing things and is difficult to overcome
- **The NAS/NRC Study "Fair Weather" in 2001 addressed this and called R2O in NOAA "Crossing the Valley of Death" …..   However,**
- **For the Record, the constellation of NOAA CI's have been amongst the most prominent and productive Parts of the NOAA Empire**

- **So, CIROH has the Potential to establish the totality of Operational Hydrologic Forecasting to the fore within the NWS and thus, NOAA**

So, the "Q" now is: Can CIROH Cross the Valley of Death as relates to Compound Coastal-Inland-Upland Flooding? The "Answer" is: That "It is To Be Determined"

Thank You! ljpietra@ncsu.edu, 704-910-7047

References:
1. Pietrafesa and Dickey, 2001. Interactively coupled Coastal & Inland Flood Forecasting of Hurricanes Dennis & Floyd. ECU Press.
2. Pietrafesa and Hamilton, 2001. The Need for a Flood Risk Scale, Chpt. In Hazards in the Natural Environment, Conference Proceedings, Sintra, Portugal.
3. Pietrafesa, Zhang, Bao and Gayes, 2019.
On Coastal, Inland and Upland Flooding During Extreme Compound Flood Events. Journal of Marine Science & Engineering.

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FACILITATED DISCUSSION

COASTAL COUPLING
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THANK YOU!

Please provide us with your feedback and reflections

The information you submit will be incorporated into the meeting summary