Developing Collaborative Solutions for Continental-Scale Integrated Water Prediction

COASTAL COUPLING COMMUNITY OF PRACTICE

May 7, 2019

WiFi: Coastal Meeting
Password: Pelicans

Edward Clark

Director of the National Water Center

Deputy Director, Office of Water Prediction

National Weather Service

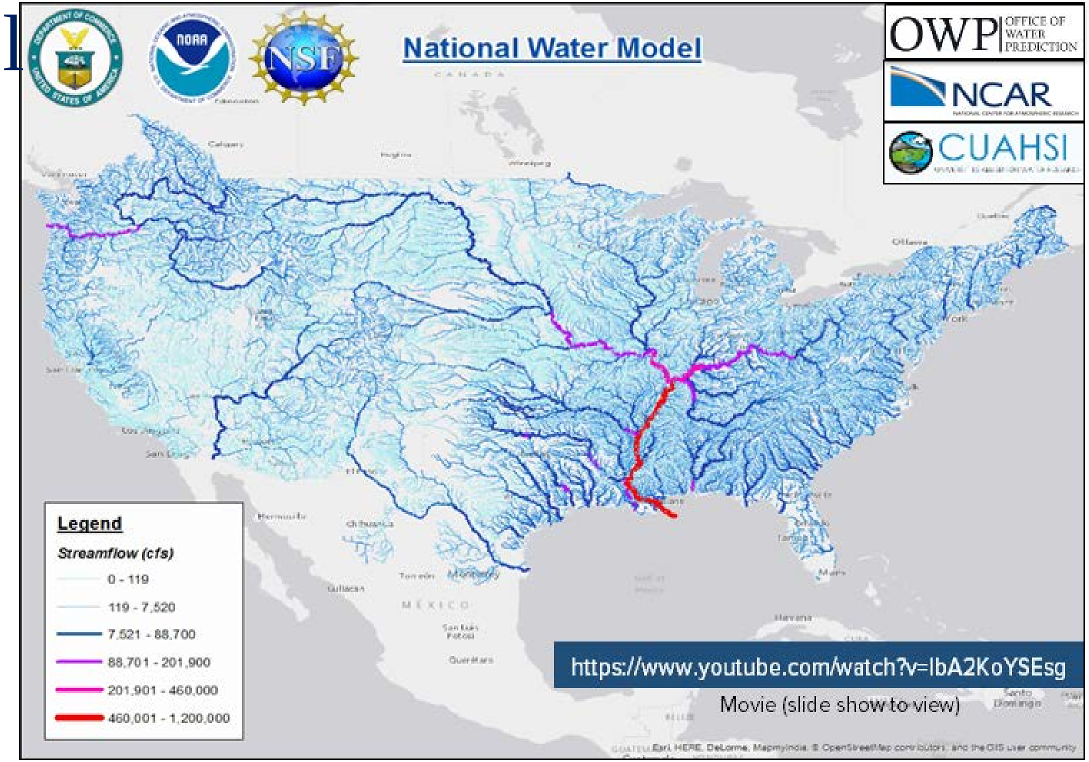
NOAA

National Water Center

The National Water Center promotes collaboration across the scientific community, serving as both a catalyst to accelerate the transition of research into operations and a center of excellence for water resources science and prediction. Since the ribbon-cutting, the NWC has hosted more than 80 scientific and technical meetings with over 2,600 participants.

National Water Model

- First ever operational modeling of the Nation's entire stream & river network simultaneously.
- Spatially continuous estimates of major water cycle components (e.g., snowpack, soil moisture, channel flow, major reservoir inflows, flood inundation).
- Employs an Earth system modeling architecture (WRF-Hydro) that permits rapid model evolution of new data, science and technology.



The Challenge

Approximately 100 million people who live in coastal areas do not have useable flood forecasts because current models cannot skillfully and appropriately represent complex riverine, estuarine, and coastal hydraulic processes.

Meeting Scope

Meeting Goal

The goal of the meeting is to create a sustainable framework for engagement between Federal agencies and model developers that supports collaborative solutions for continental-scale integrated water prediction. To identify the priorities for engagement, participants will discuss technical requirements and transition approaches (Day 1). To create the engagement approach, participants will engage in a facilitated discussion informed by experience- and research-guided best practices (Day 2).

Meeting Objectives

1. Discuss national-scale coupling (freshwater to coastal forcing) enhancements and issues related to operational forecasting.
2. Develop a structure and strategy for information exchange through a Coastal Coupling Community of Practice (CCCoP).
3. Provide updates on case studies from current coastal coupling efforts.
4. Consider operational transition approaches to increase transparency with external audiences.
5. Identify future engagement opportunities and the timeline for sustained engagement.

Successful Communities of Practice

1. Community Usable Code
2. Test Data and Data Services
3. Community Commitment

Meeting Facilitators

AUDRA LUSCHER
Coastal Hazards Program Manager

CAYLA DEAN
CO-OPS Outreach Specialist/Coastal Scientist, National Water Center

Coastal Coupling Activities and Opportunities: What's Going on at NWS

Trey Flowers

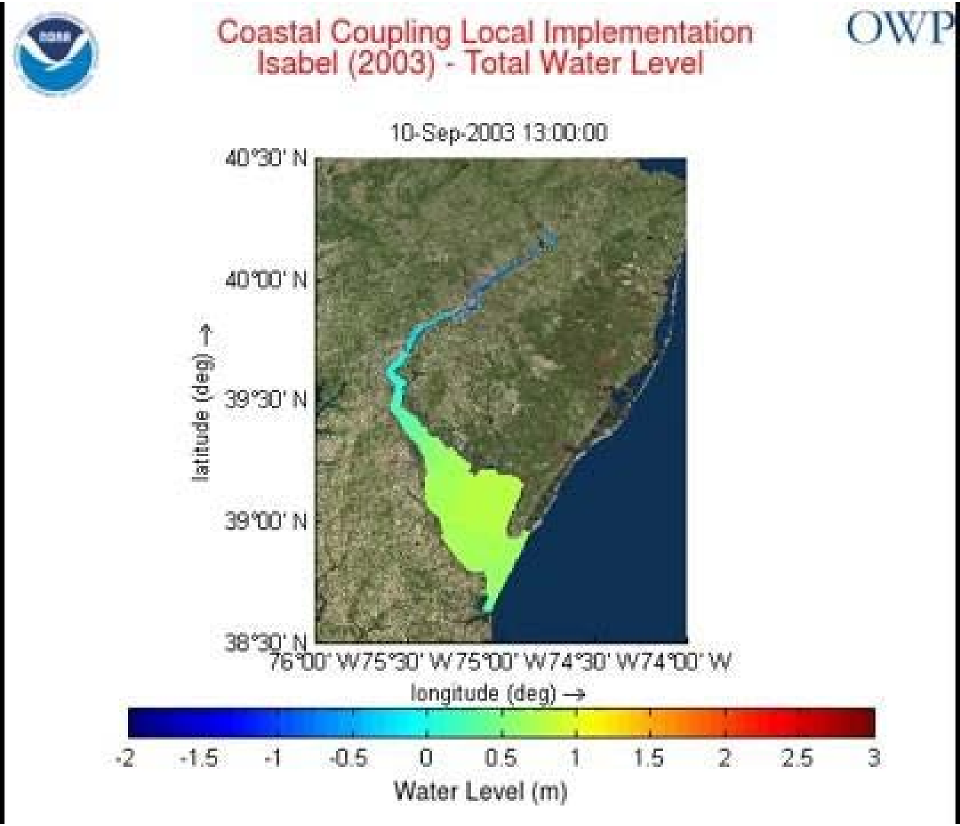
Director of the Analysis and Prediction Division
at the National Water Center

Background

Over 100 million Americans who live near the coast aren't protected by total water forecasts that account for combined freshwater and saltwater flooding. The NOAA Water Team is collaborating to provide lifesaving environmental intelligence through **coastal coupling**.

Current Results

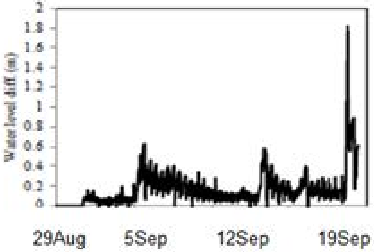
- Collaborating with OSTI, NOS, EMC to couple NWM to ADCIRC/ESTOFS/ WaveWatchIII
- Demonstrated local solution in Delaware River and Bay in 2018



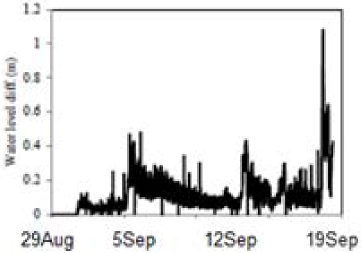
Current Results

- Piloting techniques for translating forecast water levels into forecast flood inundation maps
- Provide actionable intelligence in advance significant flooding events

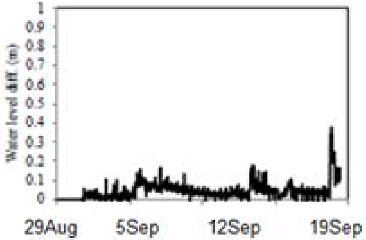
Sensitivity to River Discharge



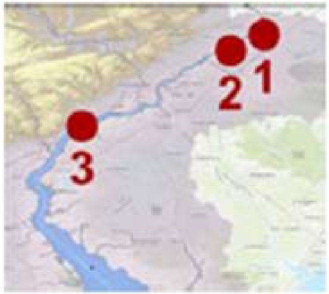
(1) Newbold, PA



(2) Burlington, NJ



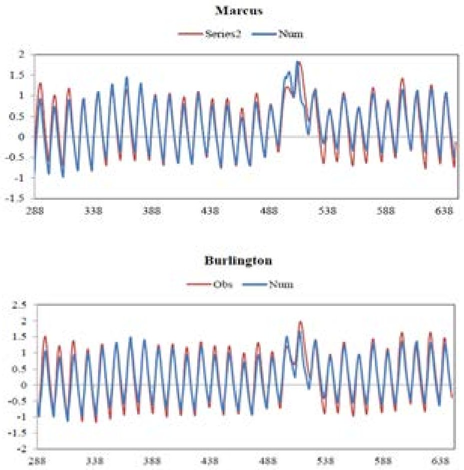
(3) Marcus Hook, PA

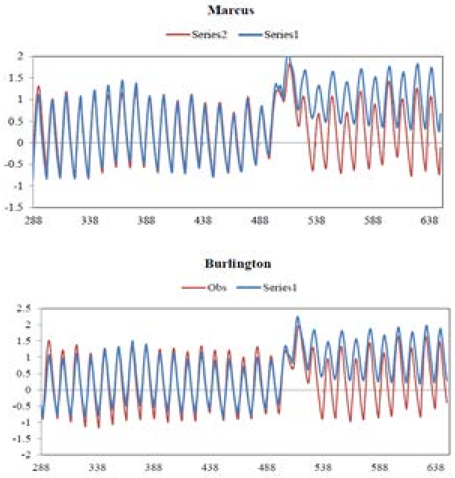


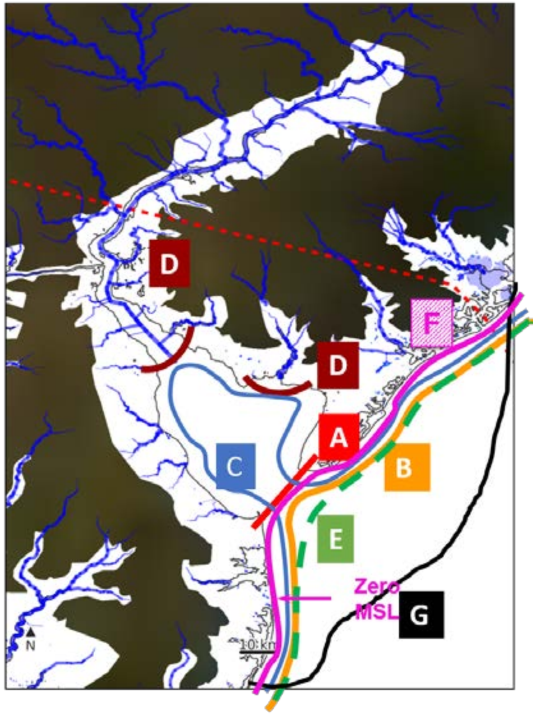
Water-level Difference (2Q-Q, Q is the NWM streamflow at upstream in Delaware River (1) Newbold, (2) Burlington and (3) Marcus Hook

NWM Coastal Hydraulics and ADCIRC in Inland Locations

- Hurricane Isabel
- NWM on Left
- ADCIRC on Right







Investigation of Boundary Data Handoff

A. Receive boundary conditions at the entrance of the bay.

B. Receive boundary conditions parallel to the shoreline at about 1-m water depth contour cutting into the bay entrance.

C. Similar to case B however cuts deep into the bay.

D. Receive boundary conditions at each individual river or tributary domain.

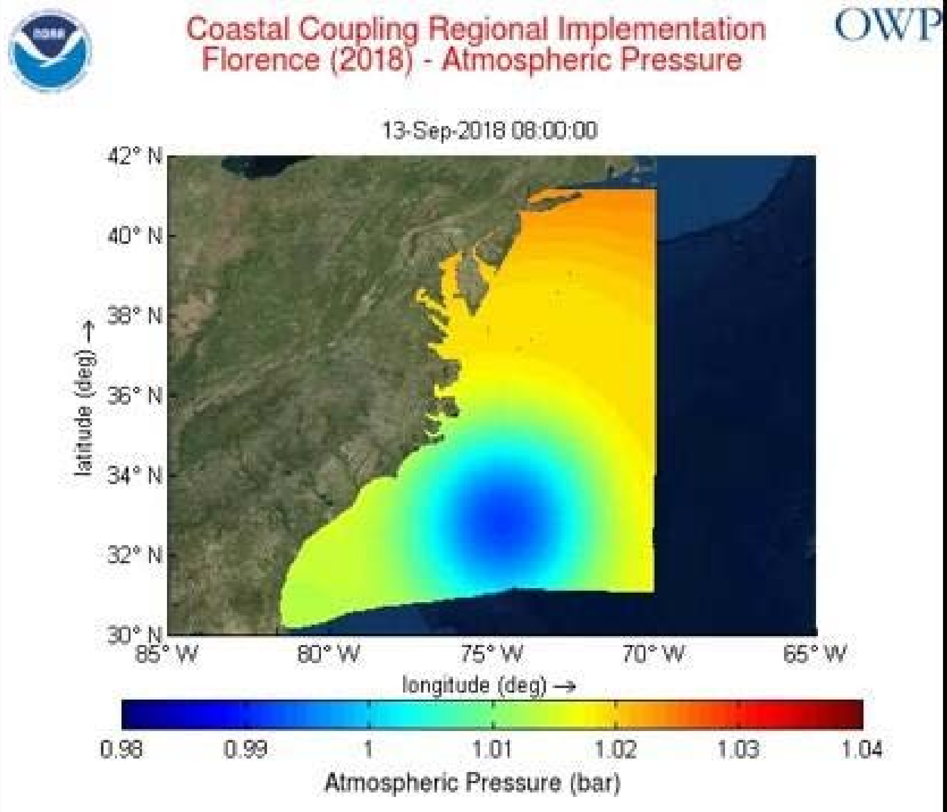
E. Similar to case B but does not cut into the bay entrance.

F. Similar to case A but extends at both sides of the bay entrance to encompass the shoreline.

G. Receive boundary conditions offshore.

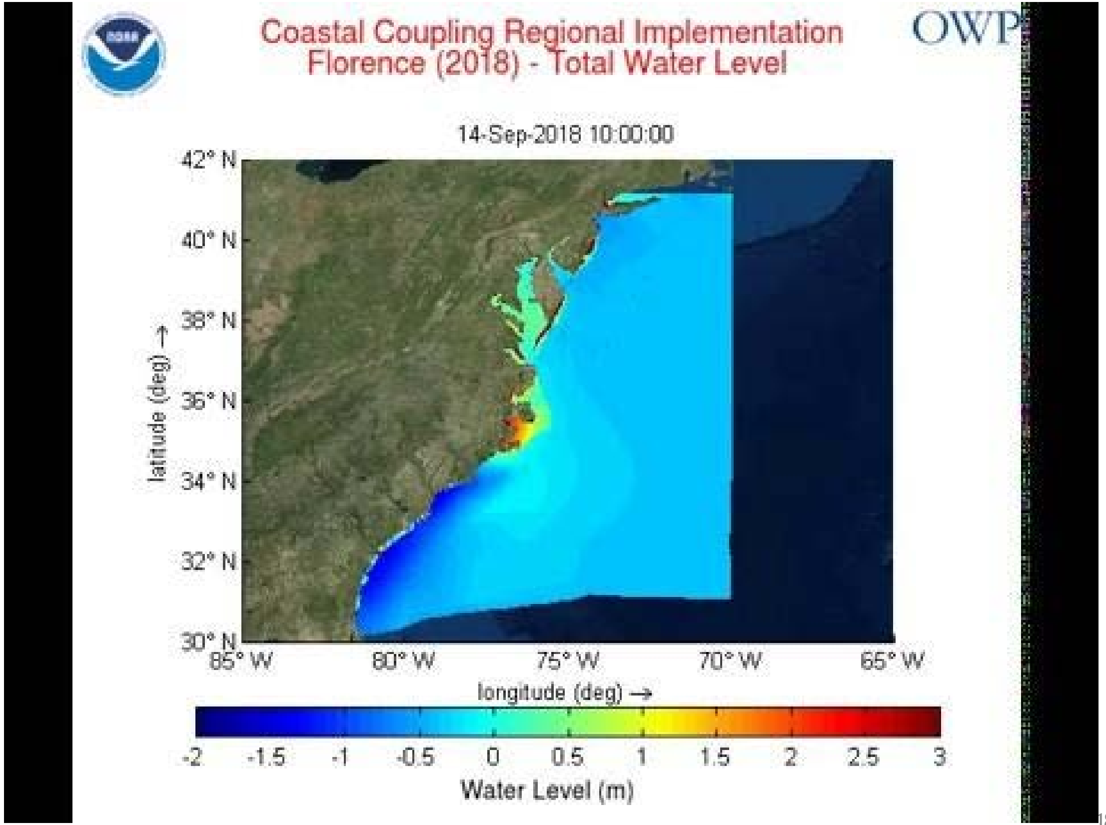
Current Results

- Scaling the solution to regional implementation
- Initial proof of concept is running

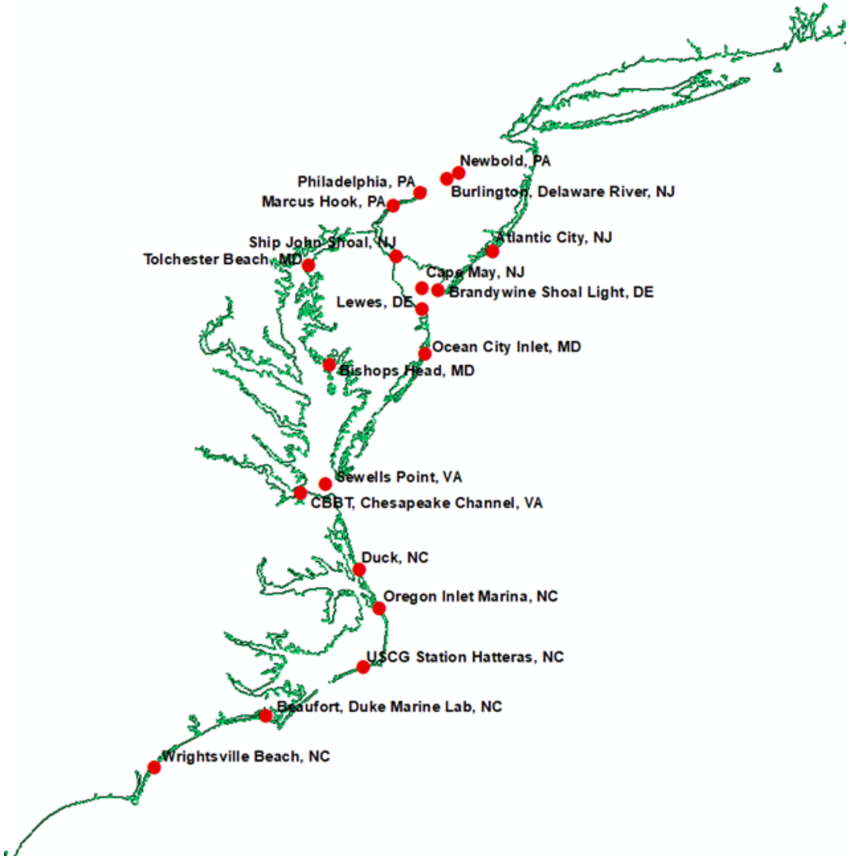


Current Results

- Working to refine and validate in 2019

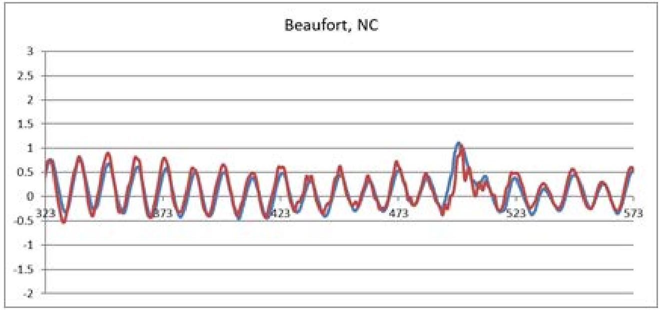


Current Activities



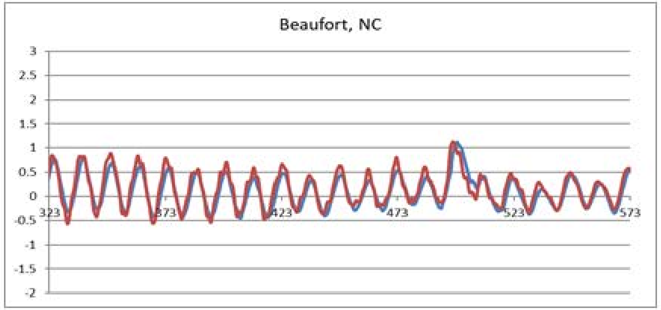
Selected stations for model validation

Current Activities

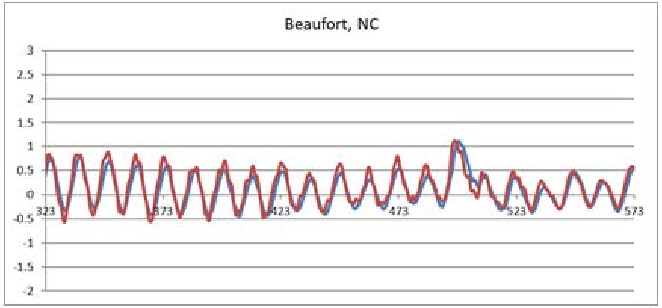


Mouth of the Bay

Hurricane Isabel (2003)
Beaufort, NC

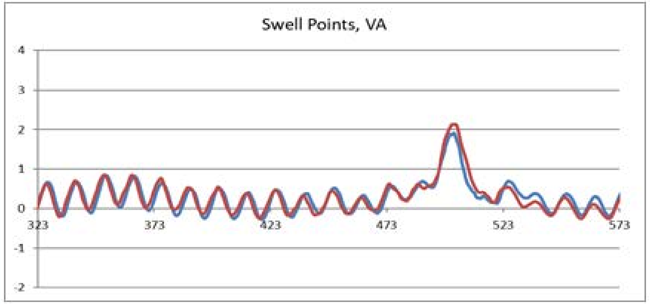


Nearshore



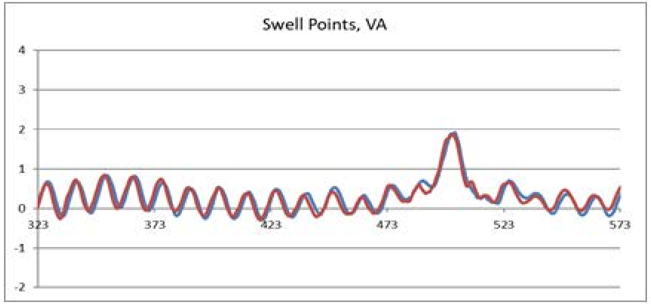
Offshore

Current Activities

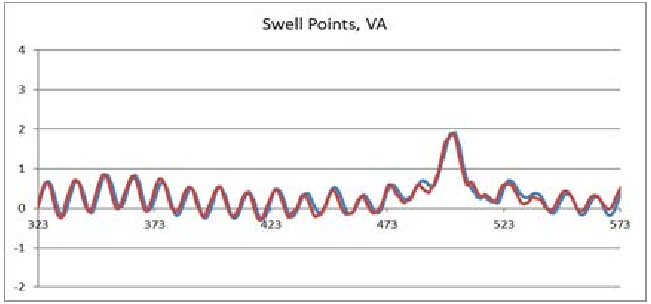


Mouth of the Bay

Hurricane Isabel (2003)
Swell Points, VA

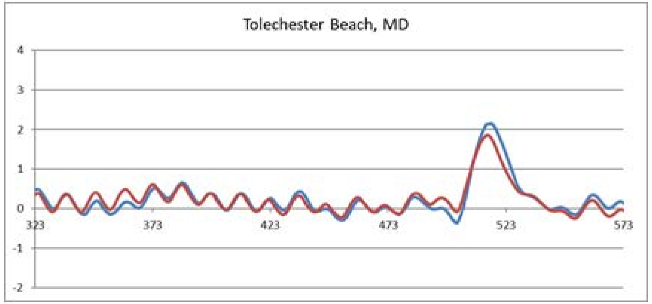


Nearshore



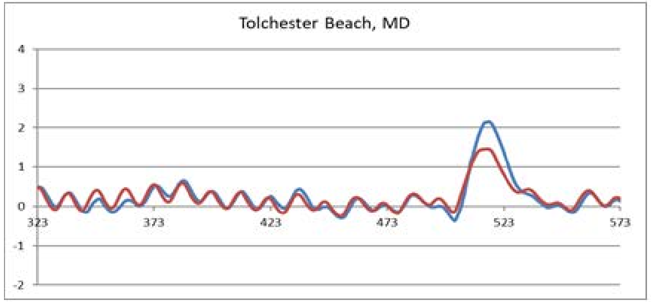
Offshore

Current Activities

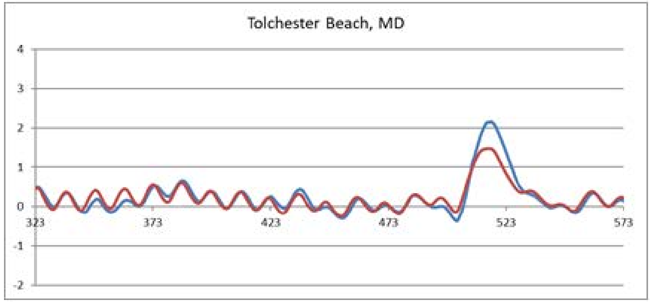


Mouth of the Bay

Hurricane Isabel (2003)
Tolechester Beach, MD



Nearshore



Offshore

Current Activities

Q4 FY2018

Demonstrate Hindcast Coupling on a Single River System

In support of the COASTAL Act Named Storm Event Model

Q4 FY2019

Demonstrate Hindcast Coupling on a Regional River System

In support of the COASTAL Act Named Storm Event Model

Q4 FY2020

Prototype Forecast Coupling at a National Scale

In support of Hurricane Harvey Supplemental

Q4 FY2021

Demonstrate Hindcast Coupling for the Atlantic and Gulf coasts

In support of the COASTAL Act Named Storm Event Model

????

Implement Forecast Coupling at a National Scale

Need support

Goal: The ability to forecast total water level for all of the Nation’s coasts

Coastal Coupling Activities and Opportunities: What's Going on at NOS

Saeed Moghimi and Edward Myers

NOAA's National Ocean Service

NOAA collaborators

Sergey Vinogradov, Lei Shi*,Andre Van der Westhuysen**,Lianyuan Zheng*, Zizang Yang*, Ali Abdolali**,Zaizhong Ma**, Hassan Mashriqui**, Roham Bakhtyar**,Panagiotis Velissariou**, Kazungu Maitaria**, Beheen Trimble**, Trey Flowers**,Patrick Burke*, Cecelia DeLuca***, Fei Liu***, Nicole Kurkowski**,Hendrik Tolman**,Aijun Zhang*, Derrick Snowden*, Audra Luscher*, Cayla Dean*, Cristina Urizar*, Julia Powell*,Neeraj Saraf*.*

* NOAA/NOS
** NOAA/NWS
*** ESMF-NUOPC Development Team

Table of content

NOS' 3D Operational Forecast Systems

- Currently FVCOM, ROMS and SELFE models
- Full 3D models
- Limited local/regional grid setup implementations

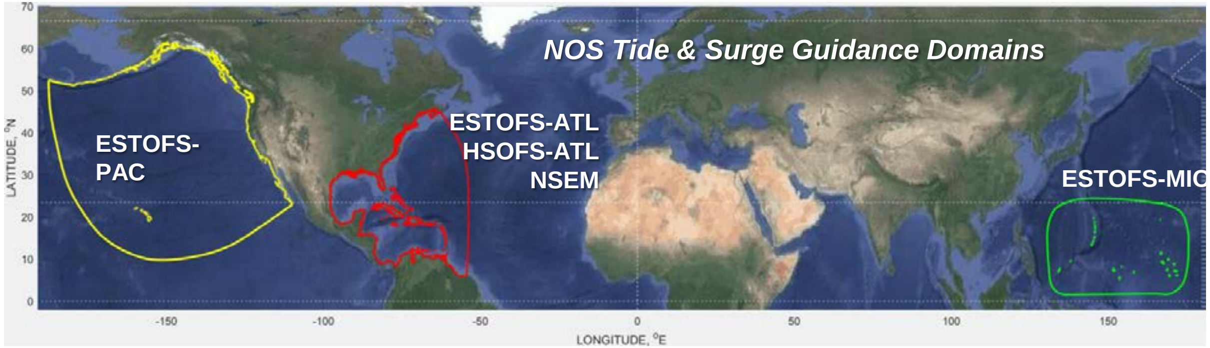
Existing OFS Coverage

OFS Regions In Development

NOS' Storm Surge Applications

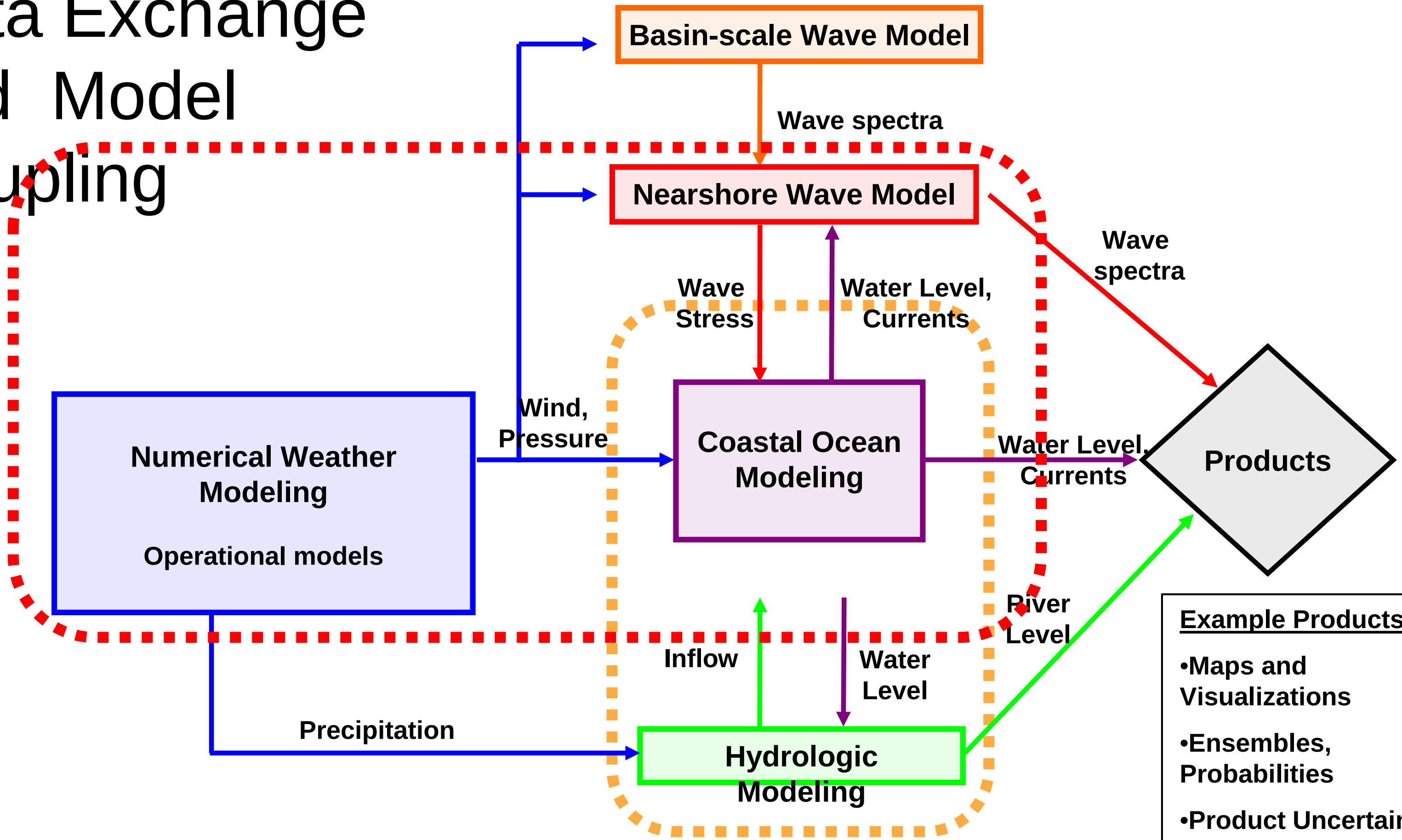
- Coastal inundation
    - Currently using the ADCIRC finite element model
    - 2D depth-integrated
    - National scale computational domain coverage

- Extratropical Storm & Tide Operational Forecast System (**ESTOFS**) – ran by NCEP/NCO continuously
- Hurricane Surge *On-Demand* Forecast System (**HSOFS**) – ran by NHC pre-/post-landfall
- COASTAL Act Named Storm Event Model (**NSEM**) – post-landfall hindcast with wind reanalysis



Component	ESTOFS-ATL	ESTOFS-PAC	ESTOFS-MIC	HSOFS-ATL	NSEM
Grid resolution	160+ m	2+ km	200+ m	160+ m	160+ m
Forcing	GFS 13km	GFS 55km	GFS 13km	NHC TRACK	HWRF/URMA/RTMA
Ensembles	1	1	1	5-7	?
Forecast frequency/ lead time	4/day 180 hrs	4/day 180 hrs	4/day 180 hrs	Pre/post landfall	Post-landfall hindcast
Inland flooding	Yes	No	Yes	Yes	Yes
Coupled	No	No	No	No	WW3 via NUOPC
Runtime bias correction	No	No	No	Yes	Yes

Data Exchange and Model Coupling



Example Products

- •Maps and Visualizations
- •Ensembles, Probabilities
- •Product Uncertainties
- •Wave Conditions

Using Partnerships to Meet NOAA's Needs for its Next Generation Storm Surge System, Feyen et al, 2013

Coastal circulation and hydrology connection

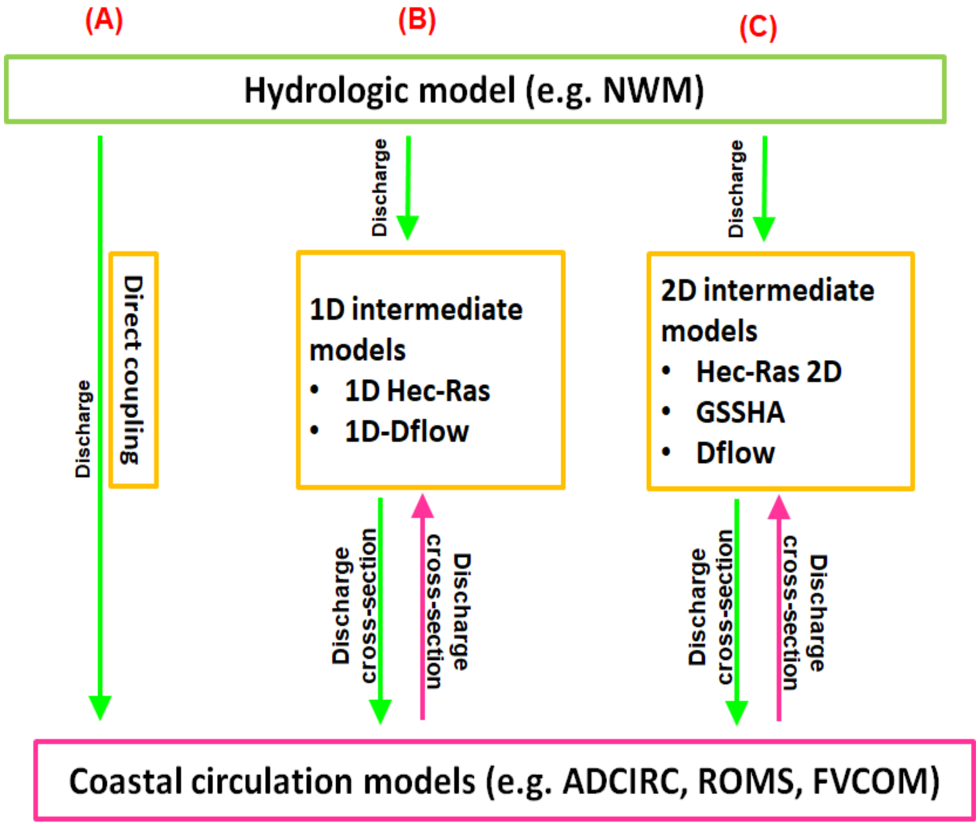
There are at least ***three viable and accepted solutions***:

(A) Direct coupling of a coastal circulation model to the hydrologic model,

(B) Utilizing 1D intermediate models between the coastal and hydrologic models and

(C) Using 2D intermediate models between the coastal and hydrologic models.

It is also possible to apply combination of these three approaches.



NOS’ Long-Term Strategy

The long-term approach regarding NOS coastal modeling capability is to ***move towards implementing full 3D coastal modeling linked to the inland hydrology models, on a national scale***.

We have identified that ***direct coupling of the coastal circulation model to the inland hydrology model is the suggested long-term approach for NOS’*** national scale coastal circulation models.

Boundary conditions from NOS’ operational models are always available to OWP or other NOAA partners to support their inland flood modeling efforts.

Some of the on-going and planned efforts

COASTAL Act

NOAA Water Initiative (TWL-projects, NOS/CSDL)

University of Oklahoma: “Steps Towards Automating River Connections and Addressing Precipitation in ADCIRC”

Notre Dame University: “Grid Development and Automated Grid Generation for River Connections”

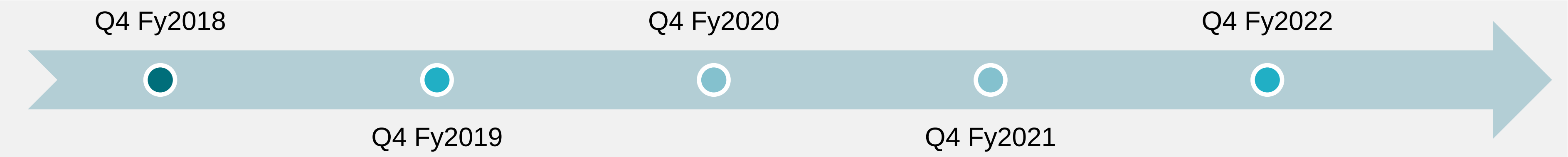
Virginia Institute of Marine Sciences: “Implementing SCHISM model to Improve Integrated Water Modeling”

Hurricane Harvey supplemental projects

NWC/CSDL/EMC: Develop and Demonstrate Dynamic Coastal Coupling between the National Water Model and NOS Extratropical Surge and Tide Operational Forecast System

CSDL/EMC/STI: Pre-Operational HSOFS Wave-Surge Coupling

CO-OPS: Test & Evaluate External Model Coupled with NWM & for Implementation



Some of the on-going and planned efforts

IOOS (COMT, OTT)

University of North Carolina: “Coupling the National Water Model to the Coastal Ocean for Predicting Water Hazards”

University of Massachusetts-Dartmouth: “Coupling the Northeast Coastal Ocean Forecast System (NECOFS) to NWM and the Water Balance Model”

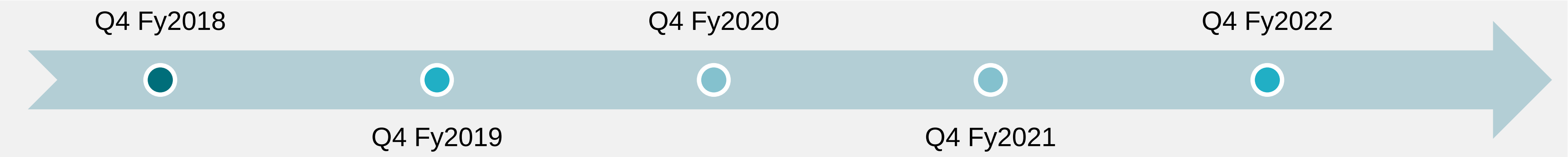
North Carolina State University: “Multi-Level River-Ocean Coupling using the Coupled Northwest Atlantic Prediction System”

Notre Dame University: Building Coupled Storm Surge and Wave Operational Forecasting Capacity for Western Alaska

Joint Technology Transfer Initiative (JTTI)

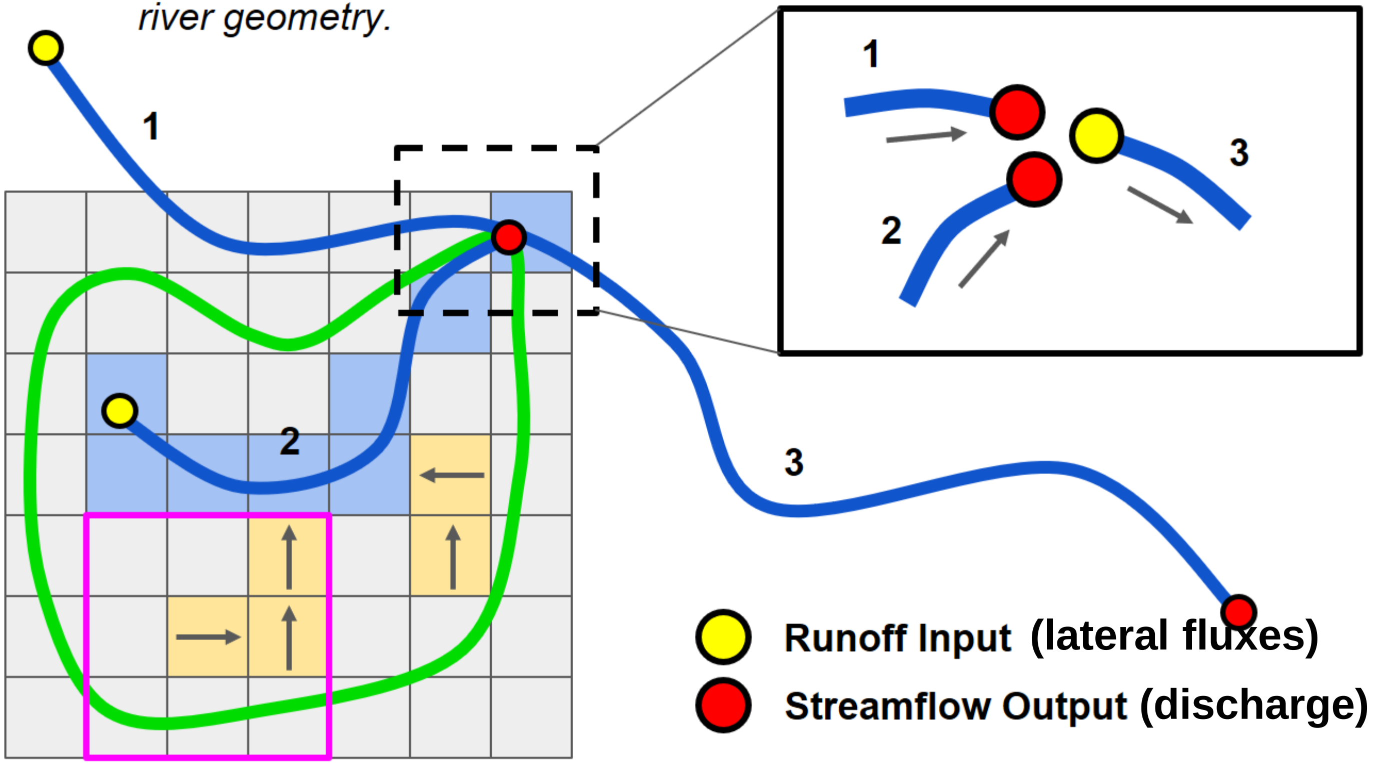
Notre Dame University: “Advancing ADCIRC U.S. Atlantic and Gulf Coast Grids and Capabilities to Facilitate Coupling to the National Water Model in ESTOFS Operational Forecasting”

NOAA Great Lakes Environmental Research Laboratory: “Improving Water Cycle Prediction in the WRF-Hydro National Water Model Through Regional Customization of Calibration, Data Assimilation, and Coastal Coupling Schemes”



NWM/hydrology channel structure

NWM streamflow output indexed by feature_id. Does not contain river geometry.



Cosgrove et al, 2018

Exported and imported variables

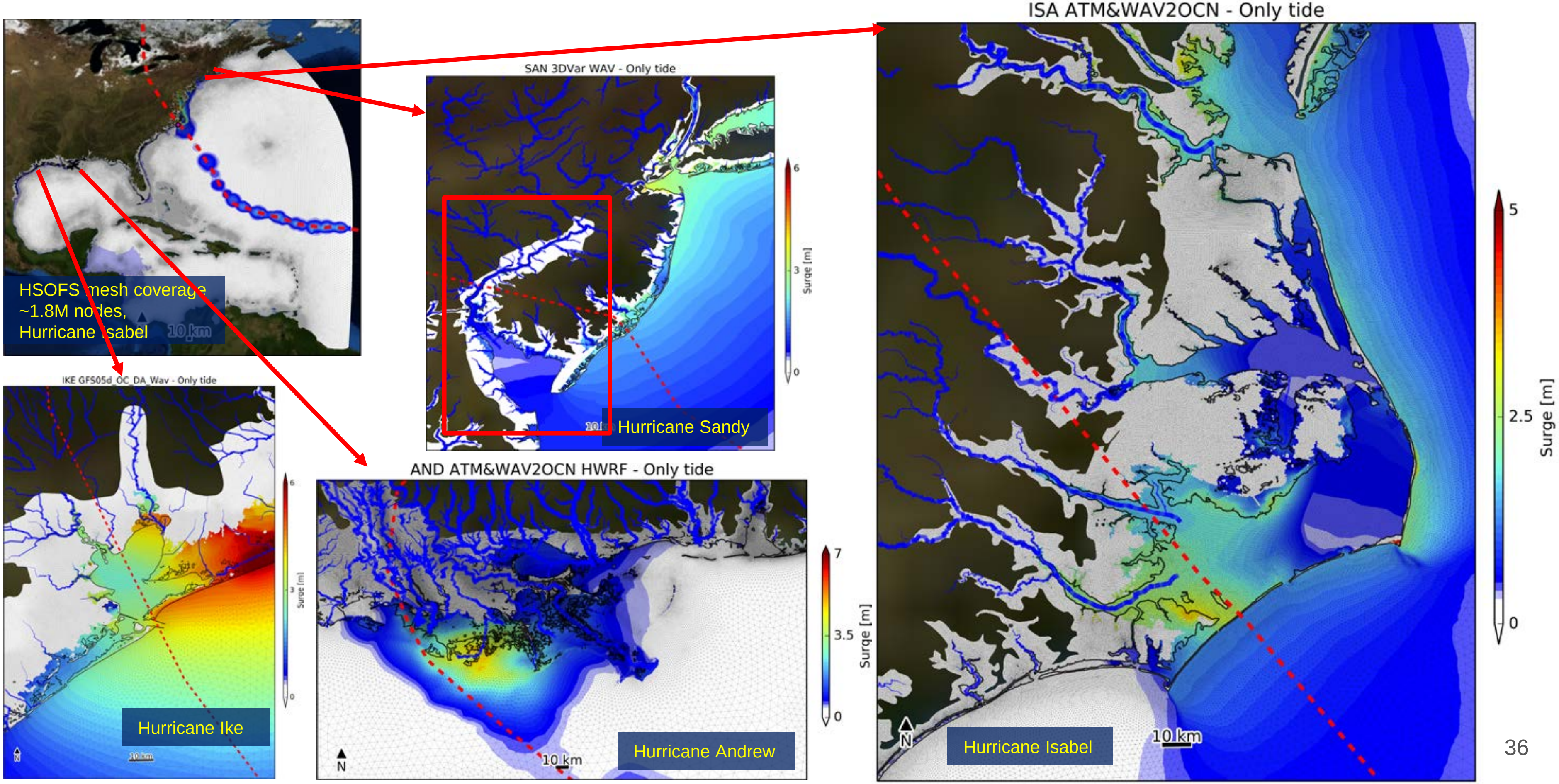
Inland hydrology to Coastal models

Data Field	Exported	Imported
Discharge	Inland hydrology	Coastal models
Lateral fluxes	Inland hydrology	Coastal models
Other variables?		

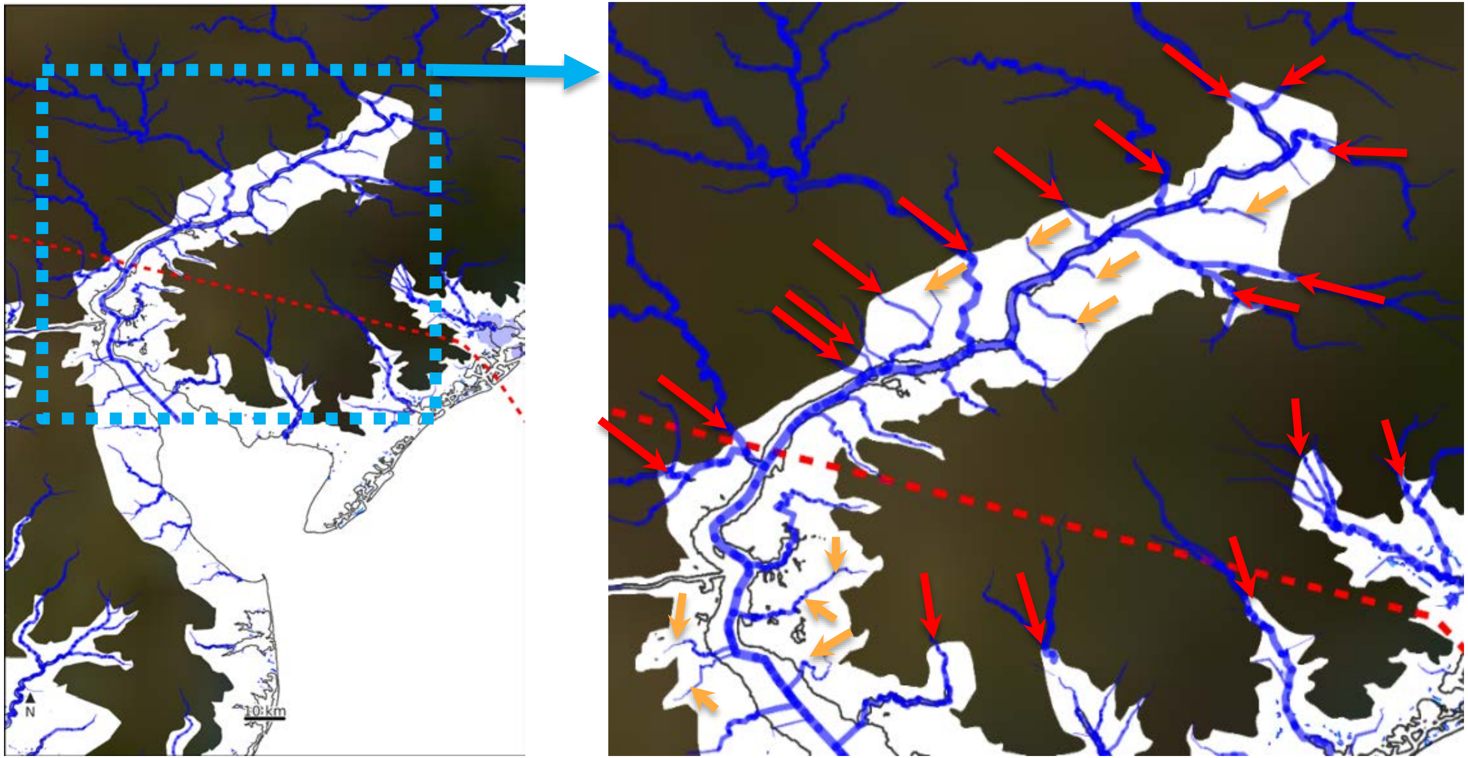
Coastal models to Inland hydrology

Data Field	Exported	Imported
Sea surface elevation	Coastal models	Inland hydrology
Eastward sea water velocity	Coastal models	Inland hydrology
Northward sea water velocity	Coastal models	Inland hydrology
Other variables?		

HSOFS mesh and NWM network coverage



Suggested locations for handing-off NWM data to Coastal Ocean Models

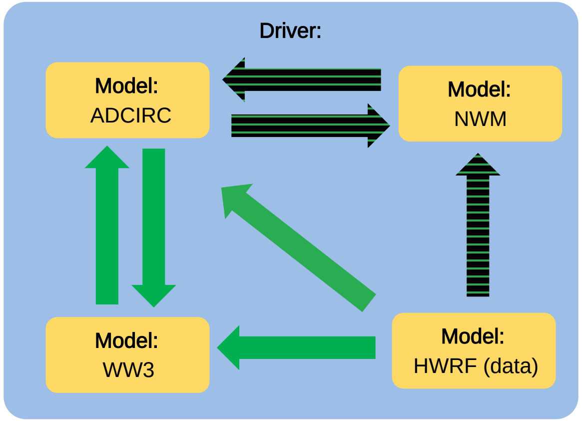


Discharges from NWM

Lateral fluxes from NWM

COASTAL Act program

Implementing a NOAA-Wide Unified Coupling: NOAA's Environmental Modeling System (NEMS)



NUOPC components

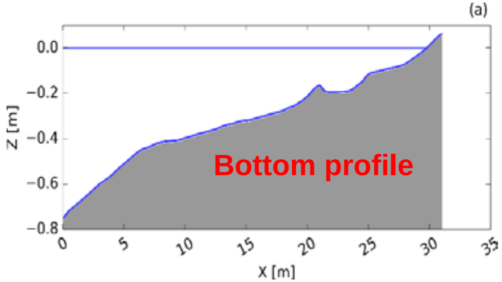
NOAA Technical Memorandum NOS CS 33

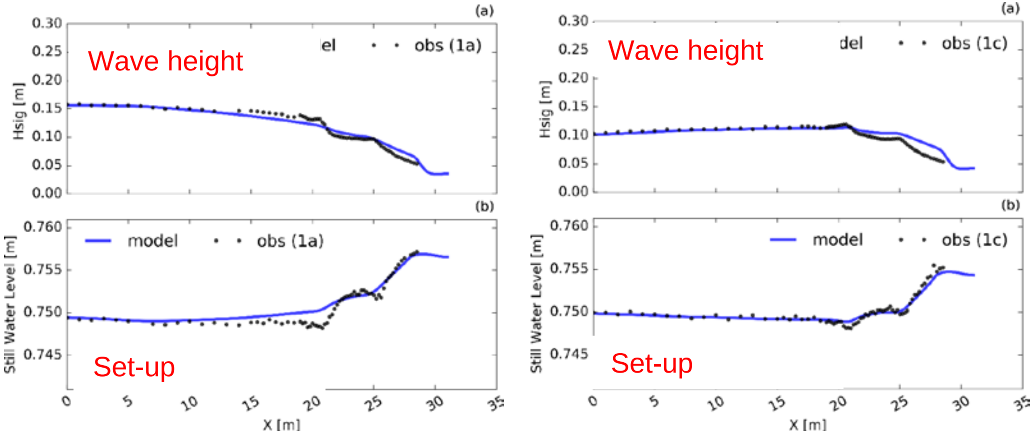
Development of a flexible coupling interface for ADCIRC model for coastal inundation studies

Saeed Moghimi, Sergey Vinogradov, Edward P. Myers, Yuji Funakoshi
Office of Coast Survey, Coast Survey Development Laboratory
Silver Spring, Maryland

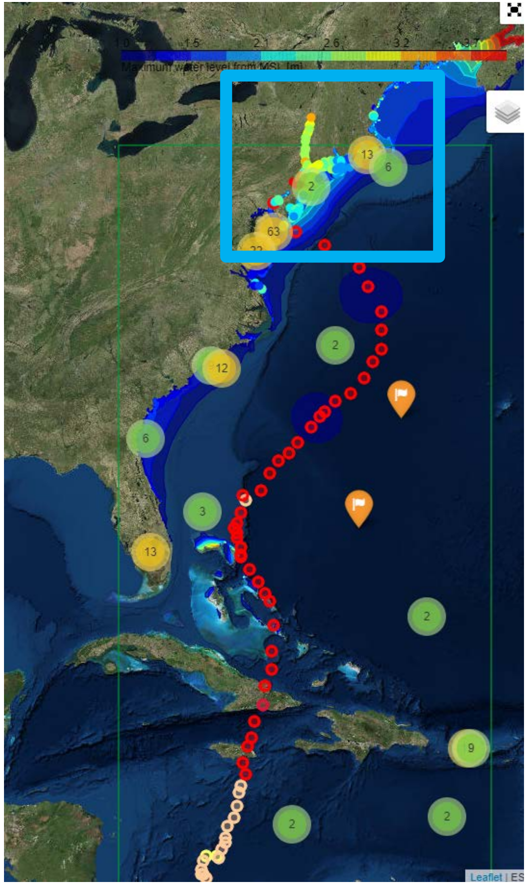
WaveWatch III and ADCIRC sub-system validation

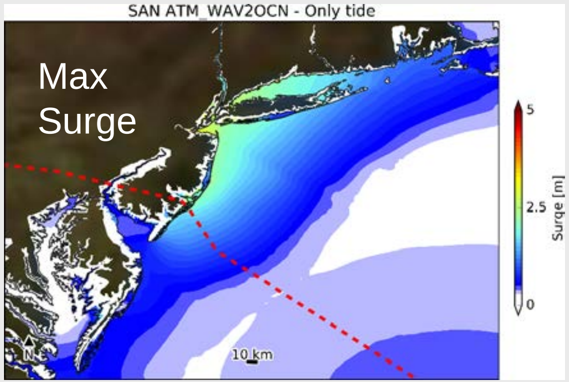
Boer, 1996 wave flume test case





HWRF+WW3 to ADCIRC for Sandy, 2012

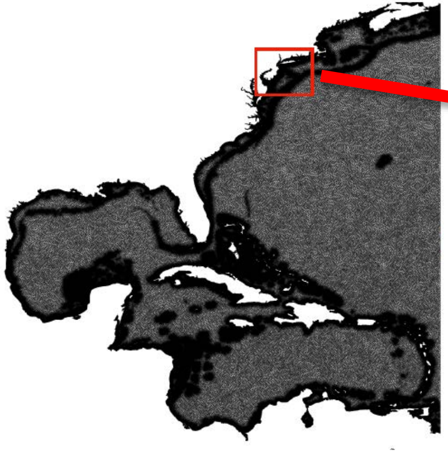


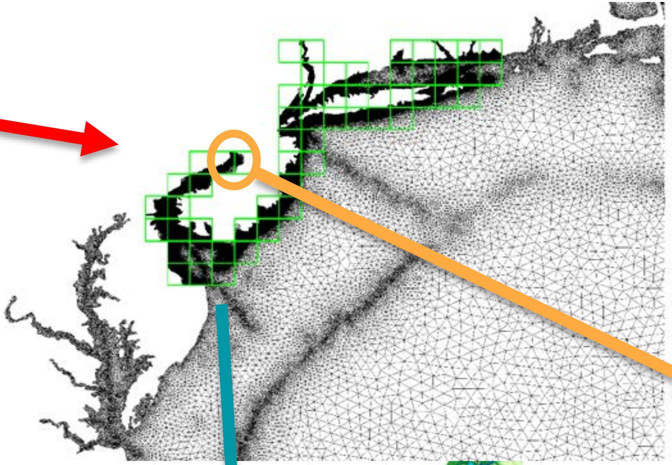


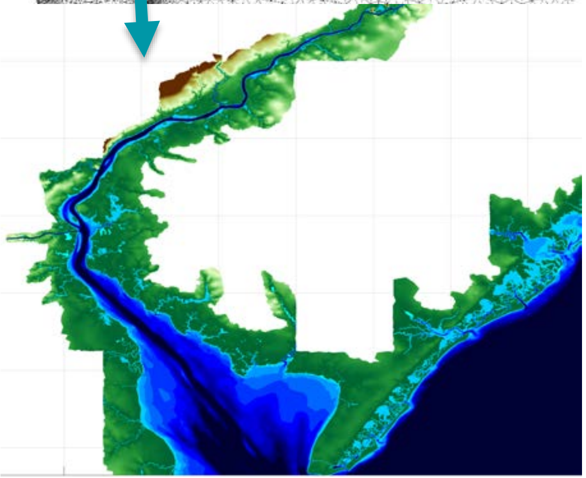
TWL-Mesh project
Automating mesh generation based on NWM network

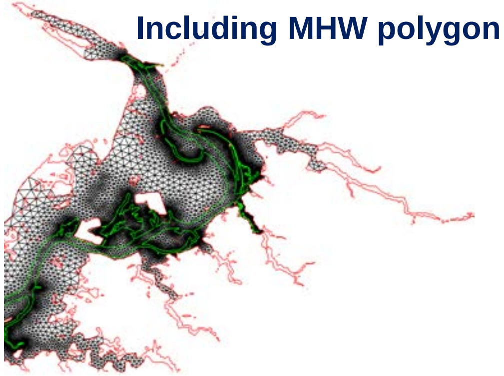
In collaboration with:
Keith Roberts, William Pringle, Maria Teresa Contreras-Vargas, *Joannes Westerink*
University of Notre Dame

Post Sandy Mesh/Bathy update (automated)

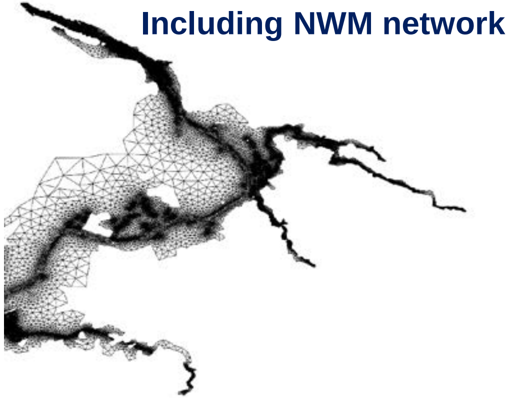








Red: 10m above MSL Green: MHW



57 tiles 1/9 arc-second LiDAR tiles(~3-m)

25-m minimum sized grid built using OceanMesh2D

957,662 vertices underwater

1,762,081 vertices with floodplain

OceanMesh2D
https://github.com/CHLNDDEV/OceanMesh2D

TWL-River project
Steps Towards Automating River Connections and Addressing Precipitation in ADCIRC

In collaboration with:
Kendra Dresback, Christine Szpilka, Randall Kolar
University of Oklahoma

Addressing volume of the precipitation and automated river boundary forcing

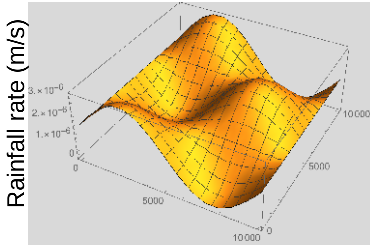
Inclusion of the volume of the rainfall

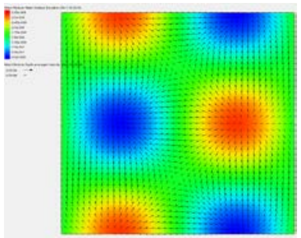
Rainfall (I) is added as a source/sink term to primitive continuity equation

$$L = \frac{\partial \zeta}{\partial t} + \frac{\partial (H\,U)}{\partial x} + \frac{\partial (H\,V)}{\partial y} = I$$

Adds two new terms to the GWCE:

$$W^G = \frac{\partial^2 \zeta}{\partial t^2} + G\,\frac{\partial \zeta}{\partial t} - \boxed{\frac{\partial I}{\partial t} - G\,I} - \frac{\partial}{\partial x}(\tilde{J}_x) - \frac{\partial}{\partial y}(\tilde{J}_y) - U\,H\,\frac{\partial G}{\partial x} - V\,H\,\frac{\partial G}{\partial y} = 0$$

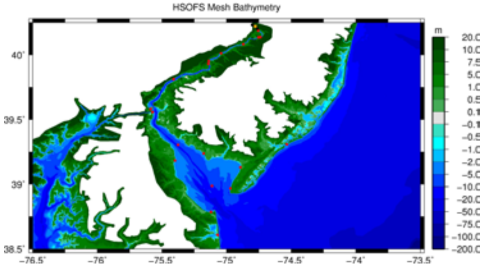


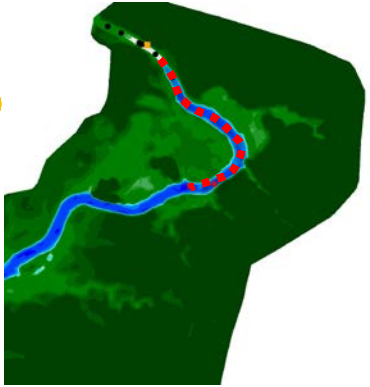


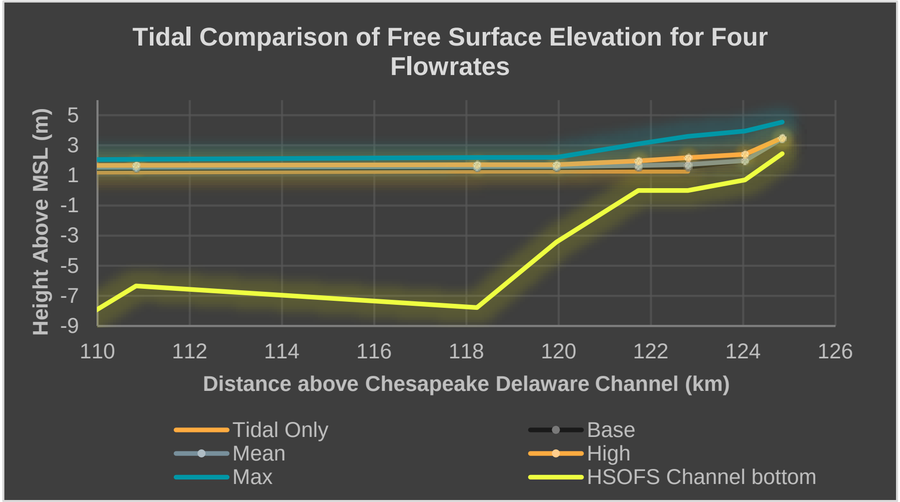
Color: **Water surface elevation**
Vectors: **Current speed**

From USGS Gauge at Trenton, NJ:

- ❑ BaseFlow (65cms)
- ❑ AvgFlow (283 cms)
- ❑ HighFlow (708 cms)
- ❑ MaxFlow (2265 cms)



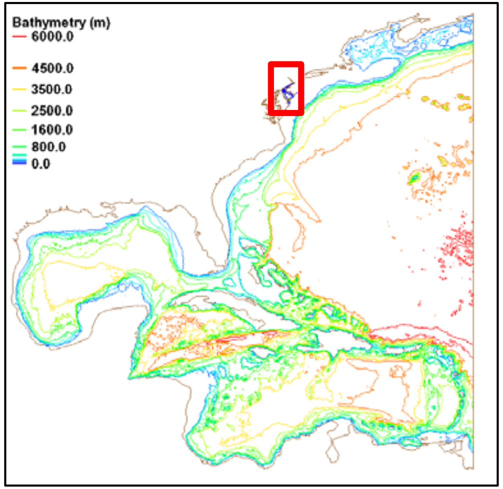


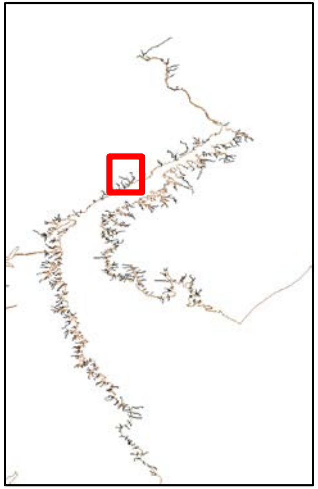


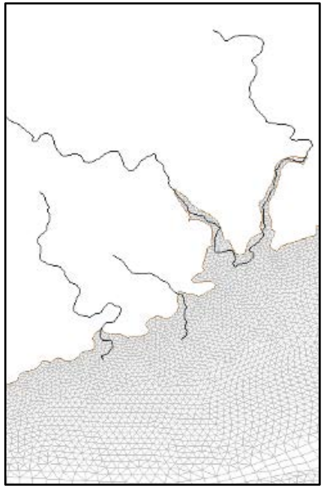
Exploring Creek-to-Ocean 3D modeling: NWM and SCHISM

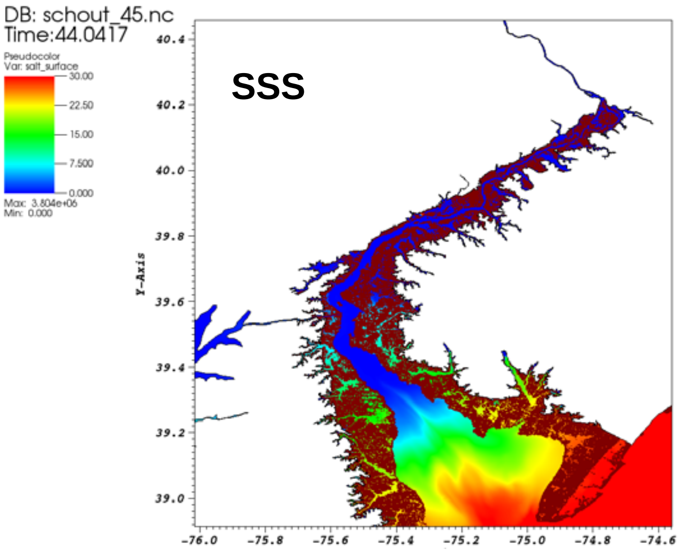
In collaboration with:
Fei Ye, Joseph Zhang
Virginia Institute of Marine Science

Creek-to-Ocean 3D modeling





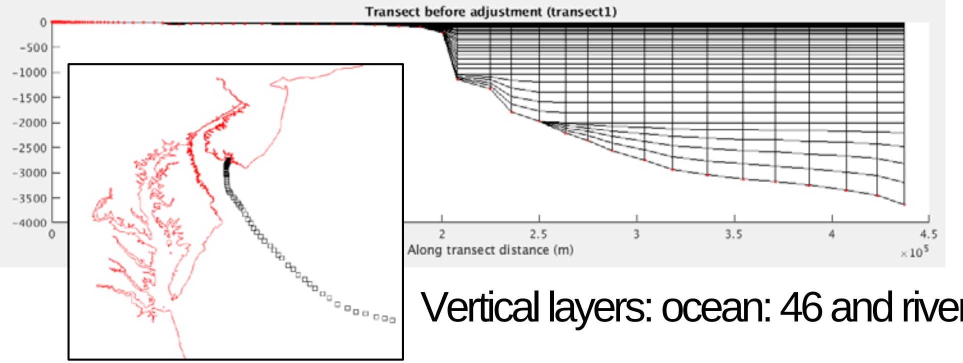




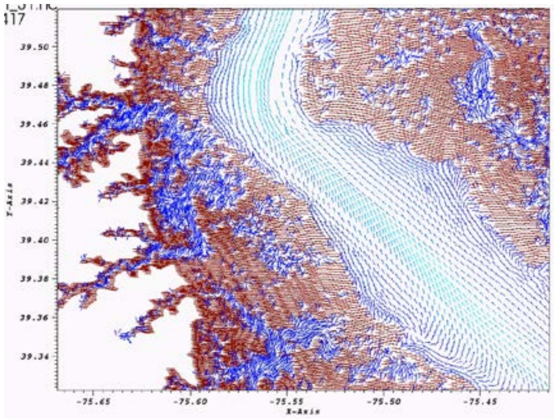
Brown color is dry land

Computational domain (~ 50m)

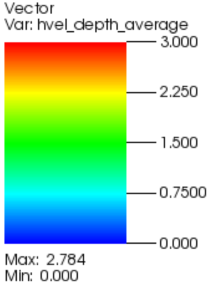
Horizontal nodes : 760K, Vertical layer: 19 (average)



Vertical layers: ocean: 46 and river: 1



Depth-averaged velocity (m/s)



NOAA water initiative objectives (Re-visit)

1. Build strategic partnerships for water information services (on research, measurement, modeling, educational and decision-support requirements. These areas include:
    - **Flooding and coastal inundation**;
    - Water resource and water supply management;
    - **Water quality** risks to ecosystems and communities; and
    - **Transportation and navigation**.
2. Strengthen water decision support tools and networks.
    - Flooding and coastal inundation tools for emergency managers;
    - Water resource management tools, including seasonal forecasting tools, at multiple time scales for sectors such as agriculture, **energy**, planning, and municipal water supply;
    - Water quality (e.g., temperature and **salinity**) and **ecological modeling** and forecasting tools for a variety of water resource, water quality, and ecological functions; and
    - High-flow, **ice**, and low-flow risks for the navigation sector.
3. Revolutionize water modeling, forecasting, and precipitation prediction.
    - Water resource management across short- to long- range time scales and across high- to low-flow conditions;
    - Flash-flood and urban water prediction;
    - Total water levels propagating **up and downstream in coastal and estuarine environments**, particularly during storm events; and ultimately
    - **Water quality** forecasting, including demonstrations of **water temperature** forecasting.
4. Accelerate water information research and development (R&D).
    - **Coupling land surface and coastal estuary** models to improve the prediction of total water level in the coastal zone;
    - Advancing water quality forecasting, including temperature, **in stream, riverine, estuarine and coastal ocean** environments;
5. Enhance and sustain water-related observations.

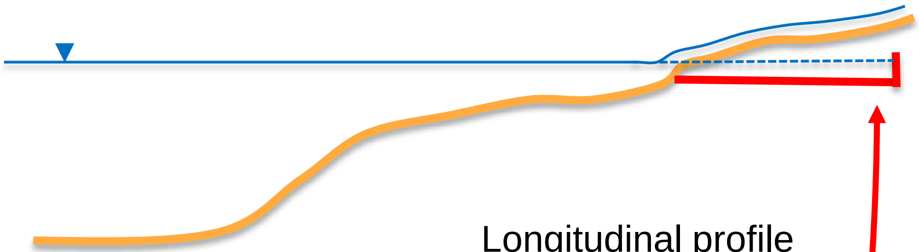
Themes / challenges

- Inundation / total water level
- 3D coastal ocean circulation
- Unified coupling framework
- Navigation
- Water quality and ecological modeling and forecasting
- Sea-Ice-freshwater coupling
- Integrated dissemination system
- Partnerships: Federal (Army/USGS/FEMA/Energy/Coast Guard/...); Research institutions; Private Sectors; …

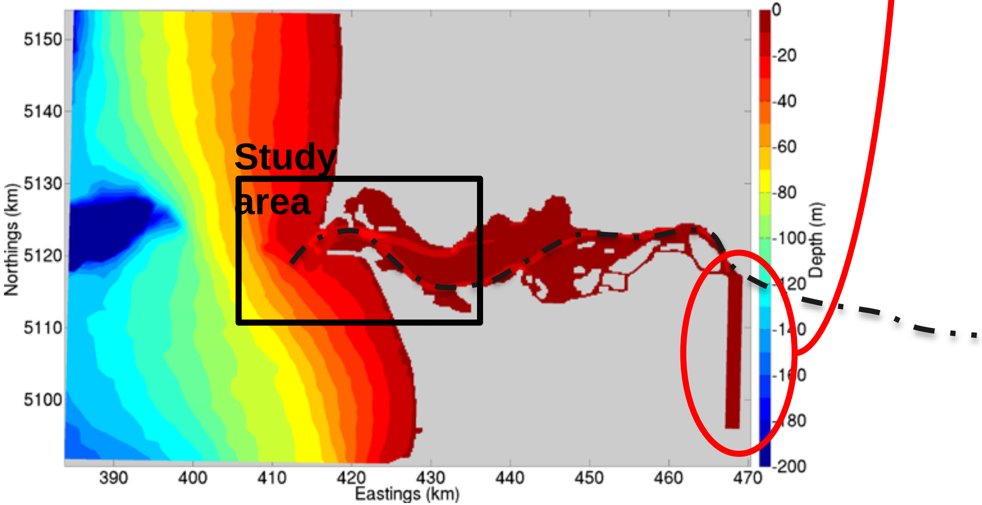
Would it be possible to draw a line?

A. **Inundation/total water level/overland processes**
B. **Coastal water column processes**
C. **Both!?**

Variable	End user
Water level / inundation	**FEMA, Coastal communities, …**
Surface current	**Navigation, Coast guard, …**
Water column properties	**Biogeochemical modelers, Ecosystem engineers, …**
Temperature and salinity	**Fisheries, …**
!?	**!?**



Longitudinal profile



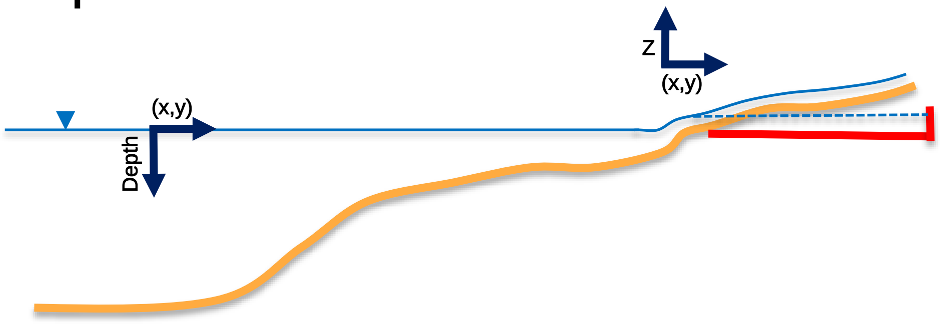
Columbia River (ROMS setup)

Possible model developments/questions

- Extending the numerical domains to cover overland/inundation region. ***<u>Shall we do this for all the ocean models!?</u>***

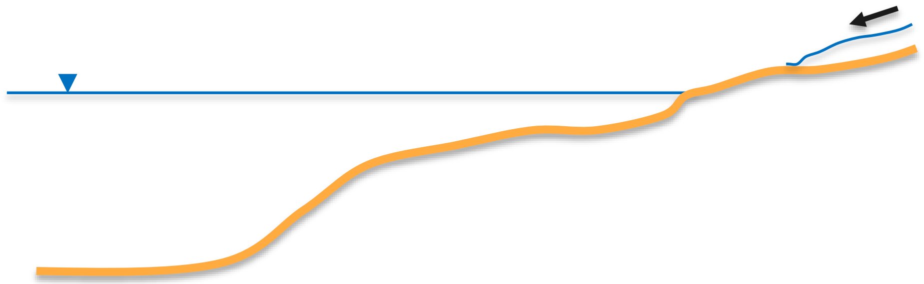
- Topo-bathy z-coordinate system VS. conventional positive downward depth coordinate system

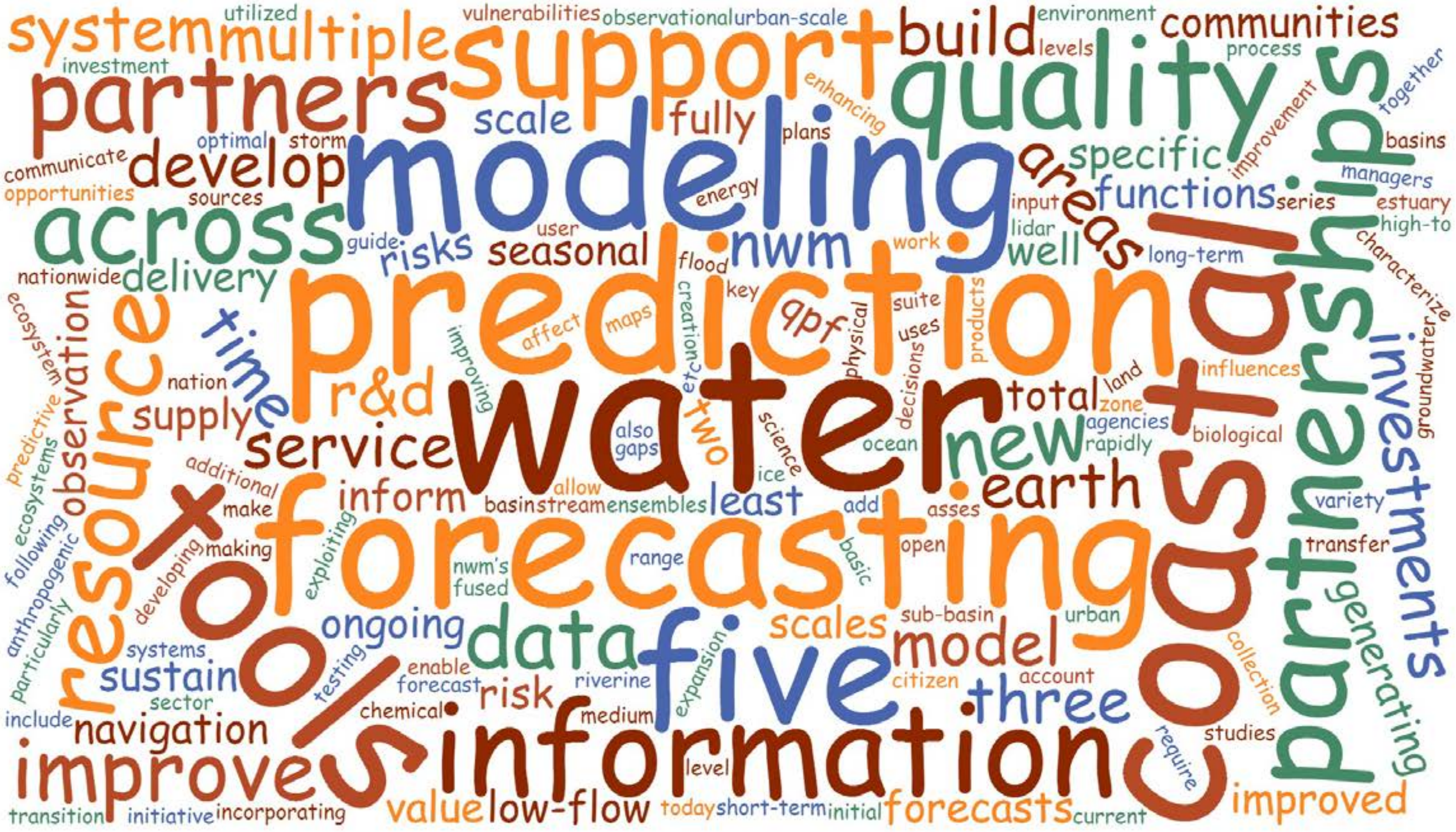
- Geo-potential based vertical datum VS. MSL



- Wetting and drying algorithm capable of generating river normal flow above MSL (e.g. flash flood)

- Volume of precipitation
  - ❑On wet elements/cells
  - ❑Flood routing on dry elements/cells





Thanks for your attention

Summary of Pre-Work Responses

Based on the draft Coastal Coupling White Paper, the previous presentations, and the following summary of the responses received prior to the meeting, we will work together to arrive at a consensus answer for each question

Q1. What does coastal coupling mean?

- User requirements/end products could/should define what coupling means.
- Future considerations beyond inundation should be considered when defining what coupling means (i.e. Water quality, Beaches/Dunes, Health and ecosystem services)
- “One integrated water solution” verses “Two independent modeling systems exchange output”
- “Dynamic” needs to be defined, but often related to automation, interplay between systems, and how often conditions are exchanged
- Should be part concept of a unified forecasting system

Q2. Are we using the right techniques and technologies?

- Need standards and consistency related to approaches and protocols,
- Common definitions and language
- Metrics for model skill
- Unconstrained by infrastructure considerations - (i.e. Cloud-based solutions)
- Reduce barriers and improved efficiencies (i.e. GUI, non-proprietary codes, community “sandbox”)
- Reduced computational times and automation
- Leveraging - (model libraries, open code repositories, grid catalogs)
- Open-mindedness/risk tolerance for new/novel techniques
- People resources are important

Q3. How might we decide the location to exchange boundary conditions?

- Mission/Service requirements driven (resolution, forecast, range, time step, accuracy)
- Physics and model objective driven
- Flexible, overlapping, and dynamic (Does it have to be the same for both systems?)
- Balance best available data for validating with capacity to process
- When a governing process becomes zero (i.e. tides)
- Avoid over-constrained models

Q4. What are the hurdles around conducting collaborative coupling work?

- Cultural differences across organizations, ownership, and territoriality
- Funding, infrastructure, and computing architecture
- Consistent open communication, standard definitions, units, datums
- A collaborative unified plan to develop, test, and transition this capability to operations
- Access and common operating platform
- Research is a barrier to sharing codes
- Number of different codes and coupling them in a consistent way
- A common understanding related to how models with be tested and evaluated

BREAK

2:45-3:15 PM CT

Operational Transition Approaches: Lessons Learned on Transitions

Chris Massey

USACE-ERDC Coastal & Hydraulics Lab

Brian Blanton

Director, Earth Data Science; RENCI (Renaissance Computing Institute)

Transitions

•Selection of individual physical processes and the corresponding numerical models

•Coupling Decisions :

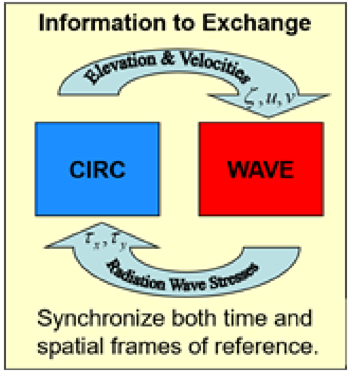
  * Which Quantities Need to be Linked
  * Where and How Frequent to Link
  * Which Goes First : Particularly important when time dependent models are involved

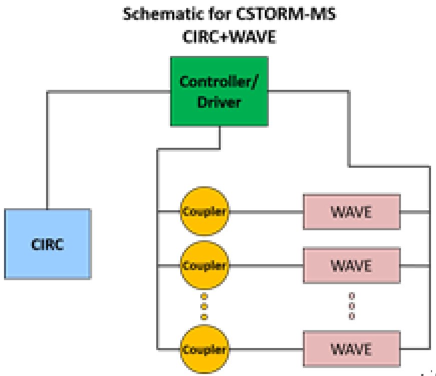
•Computational Efficiency : Of the Codes and the Linking Processes

•Software Source Code Availability; Supported Platforms; Level of Development Maturation;

•Verification and Validation of Coupled Systems

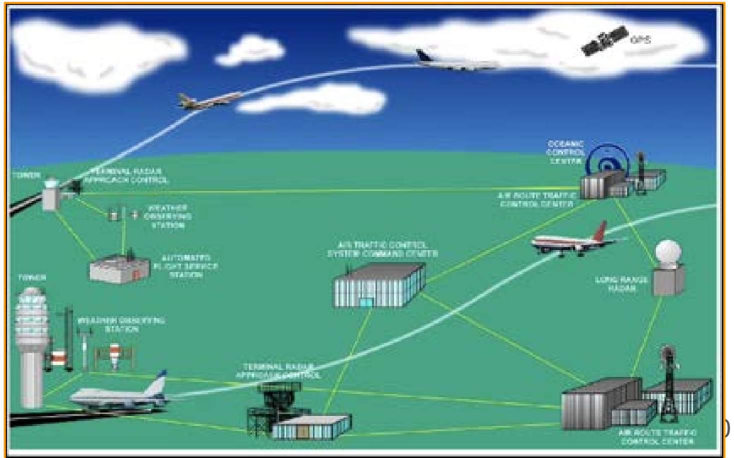
•User Interfaces and Documentation : Individual Codes and Linking Module





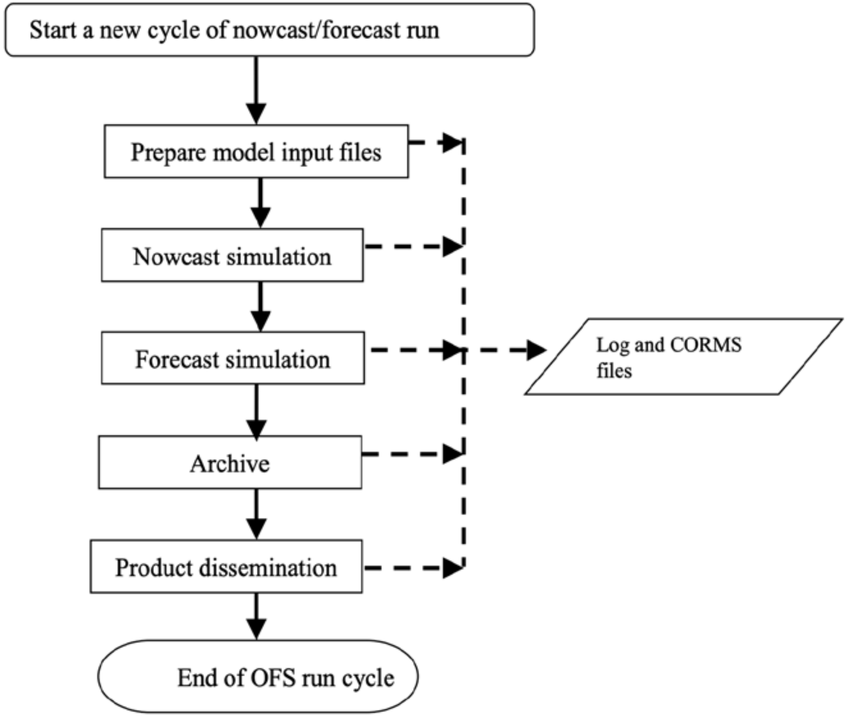
Transitions

- R2O
  - There is research into how to do operations
  - Computer Systems, IT, scheduling, testing, monitoring
  - Operations Adoption “ease” a function of *consequences* of failure.
    - Think “Air Traffic Control” vs *academic* operation
  - Operations informs research
- Why would we want to transition research models?
  - (software) Life after/beyond academics
  - More than just process-study models
  - Demonstrable predictive ability
- What exactly are we transitioning?
  - Literal model software/code, APIs?



Transitions

- Each group/project here may already run a quasi-operational forecast/prediction system
  - Real-time, skillful, with actual end-users and stakeholders
  - Reliable, robust, fault-tolerant, well-documented, hardened against I/O failures, numerically stable/accurate
  - Generally in the middle of the Technology Readiness Spectrum
- What does it take to go beyond the “hardened academic” level?



Transitions

- **Unified modeling system? NEMS?**
- What are the ***literal requirements*** that code has to meet to fit in to the operational job stream?
- What does the operational environment (OpEnv) actually look like?
  - Details of NCEP Central Operations (NCO)
  - Tell us literally how a model exists in the NCO context
    - NEMS/NUOPC/ESMF/etc

If this is important to NOAA/OpEnv, this needs to be documented and explained.

- Establish a sandbox OpEnv that looks exactly like NCO
  - *As does ECMWF with OpenIFS*
  - Same OS, software stack (compilers, mpi, etc)
  - Same scheduler
  - Same data availability/storage
  - AWS, docker image?

Something like this could be part of the Testbed, not a "next step" beyond it.

Transitions

- AMS Conference on the Transition of Research to Operations
- High-level NOAA Unified Modeling Overview
- Transitioning Research to Operations: Transforming the "Valley of Death" Into a "Valley of Opportunity" Francis J. Merceret, T. P. O'Brien, William P. Roeder, Lisa L. Huddleston, William H. Bauman III, and Gary J. Jedlovec, SPACE WEATHER, **11**, 637–640, doi:10.1002/swe.20099, 2013.
- The ECMWF research to operations (R2O) process R. Buizza, E. Andersson, R. Forbes and M. Sleigh, Research Department Tech Mem 806, ECMWF, July 2017

OpenIFS provides research institutions with an easy-to-use version of the ECMWF IFS (Integrated Forecasting System). OpenIFS provides the forecast capability of IFS (no data assimilation), supporting software and documentation. OpenIFS has a support team at ECMWF for technical assistance but limited resources for detailed scientific assistance.

Transitions Breakout Group Discussion

- What must be considered at the various stages?
- Which connections must be established, and when?
- How might we leverage the requirements for transition plans and Readiness Levels?
- What else is possible as part of a new concept for research to operations?
- What are the various criteria (formal and informal) for a “successful” transition to operations?

Transitions Breakout Group Discussion

- 35 minute discussion
- Group 1: Black Warrior
- Group 2: Proving Ground
- Group 3: Rotunda
- Group 4: Auditorium

DAY 1 HIGHLIGHTS

Reminder: Join us at 7:00 PM CT for a no-host dinner at R Davidson Chophouse

Developing Collaborative Solutions for Continental-Scale Integrated Water Prediction

COASTAL COUPLING COMMUNITY OF PRACTICE

May 8, 2019

WiFi: Coastal Meeting
Password: Pelicans

DAY 1 RECAP &
DAY 2 PREVIEW

Common Themes from Day 1

- Communication!
  - With end-users as part of an ongoing iterative process to understand their requirements
  - Between R&D and Operations to define needs and expectations
  - Between feds and academics to identify issues and arrive at solutions
- Define success at the start of a research project in order to increase the chance that it will make it to operations
- Define common terms/establish a common vocabulary
- Provide data access and a common operating platform
- Develop code management/documentation

A Look Ahead to Day 2

- Now that some of the issues facing those working in the realm of coastal coupling have been identified, it is time to turn to establishing an ongoing Community of Practice.
- We will do so by 1) defining the vision and mission of the Community of Practice, and 2) developing a framework for the Community to continue the engagement started at this meeting.

Establishing the CCCoP Breakout Group Discussion

- What is wrong/missing/incomplete from the draft vision/mission/pillar statements?

LUNCH

12:00-1:15 PM CT
Optional 20 minute tour of NWC

Establishing Ongoing Engagement for the CCCoP

- How may the CCCoP continue to engage over the coming year?
- What processes can be established that will help to instantiate the CCCoP?

Summary of Breakout Group Responses

Based on the breakout group responses to (1) establishing the foundation for the CCCoP; and (2) establishing ongoing engagement for the CCCoP, we will work together to arrive at a consensus answer for each question

Breakout Group Consensus

CCCoP Vision Statement

The **vision** of the Coastal Coupling Community of Practice (CCCoP) is to build and sustain communication pathways and relationships to facilitate collaborative development of continental-scale solutions to integrated water prediction and analysis in the coastal zone.

- Definitions: Coastal zone, stakeholder
- Add technical challenge?

Breakout Group Consensus

CCCoP Mission Statement

The **mission** of the CCCoP is to enable:

- Coupling of hydrologic and ~~oceanographic~~ hydrodynamic models across the coastal zone to better ~~predict~~ simulate and analyze water inundation from both freshwater and saltwater and their compounding effects.
- Integrated prediction of coastal total water level, flow timing and duration, currents, waves, geomorphic change, ice, and water quality accounting for both in-channel and overland water surface elevations.
- Actionable information on these parameters provided to stakeholders in user-friendly formats.
- Accelerated national coverage of ~~hydrodynamic models~~ integrated water prediction capabilities through the adoption of ~~3rd party~~ community research and models.
- Regional requirements, solutions, and prioritization

OR - Replace bullets 1 and 2: Coupling of relevant atmospheric, land, and ocean models across the coastal zone to simulate processes and provide physical parameters, such as: water levels, flows, water quality, sediment, geomorphic changes, etc.

Breakout Group Consensus

CCCoP Pillar #2

Who ~~The community~~: Identify the groups/people that would be helpful to this discussion (i.e., federal, state, local and Indian tribal governments (e.g., NOAA, USACE, USGS, NASA, Reclamation, FEMA, USDA, EPA, etc.), academia, industry, and other stakeholders).

- How big can the community be and still be effective?
- Should the following be called out explicitly: Service delivery? End users? Data providers? Data producers? Science communicators? Decision makers?

Breakout Group Consensus

CCCoP Pillar #1

What ~~The domain~~: ~~Build~~ Relationship building between the members that allow for open communication pathways that are needed to do the collaborative work of developing coastal coupling of models for integrated water ~~prediction~~ simulations and analysis enabled by ~~third party~~ community research and approaches ~~models~~.

OR -- Coastal coupling of models for integrated water prediction enabled by collaborative community research and models.

OR -- Collaborative community with active members that contribute to integrated coastal solutions through research, model development and application, observations, and analysis.

Breakout Group Consensus

CCCoP Pillar #3

How ~~The practice~~: Develop the framework to exchange information, share perspectives, and better align members' goals and pull our collective ~~the~~ work in the same direction, including:

- Identifying community members~~; strengths, priorities, and resources~~
- Identifying community members strengths, priorities, and resources;
- Identifying knowledge gaps;
- Identifying the available models and understanding their strengths and weaknesses;
- Determining and prioritizing t~~he best strategies and~~ stakeholder requirements for coastal model coupling ~~including stakeholder needs;~~
- Determining the best strategies for coastal coupling, considering business models that include focus and diversity
- Determining the best ~~strategies and~~ requirements for coastal coupling including science and operational requirements for implementation of the coupled models.
- Determining the best strategies ~~and requirements~~ for coastal coupling including science and operational requirements for implementation of the coupled models
- Establishing an active, functioning community that continues to interact, develop, compare, and apply coastal solutions

Breakout Group Consensus

In-Person Meetings			
Date	**Event**	**Location**	**Proposed Frequency**
May 7-8, 2019	CCCoP Kick-off Meeting	NWC Tuscaloosa, AL	Annually
May 9, 2019	Technical Modeling Session	NWC Tuscaloosa, AL	As needed
July 26, 2019	Summer Institute Capstone Meeting	NWC Tuscaloosa, AL	Annually
October 22-24, 2019	Coastal and Modeling Testbed (COMT) Annual Meeting	Silver Spring, MD	Annually
December 9-13, 2019	AGU Fall Meeting Town Hall	San Francisco, CA	Annually
February 16-21, 2020	Ocean Sciences Meeting Scientific Session	San Diego, CA	Biennially

Breakout Group Consensus

Online Meetings		
Event	**Purpose**	**Proposed Frequency**
Coast Survey Development Lab (CSDL) Monthly Technical Calls	Discuss ongoing NOS 2D and 3D modeling details	Monthly
Webinars	Provide briefings on CCCoP ongoing efforts and new initiatives	Quarterly
Working Group Monthly Meetings	Forum for the working groups once they are established around specific topics	Monthly

Breakout Group Consensus

Other Resources		
Event	**Purpose**	**Proposed Frequency**
Digital Newsletters	Provide information about upcoming meetings and progress of CCCoP efforts	Quarterly
Library of Best Practices/Lessons Learned	Database of organizational and technical documents related to the CCCoP	Continually maintained
Website for the CCCoP	Provide information one upcoming meeting location and materials, engagement opportunities, etc.	Continually maintained
Slack Collaboration Tool	Tool for ongoing communications that is easy to install, manage, and share information; it may be an option in place of the website	Ongoing communication

Breakout Group Consensus

Where else might the CCCoP put this into practice:

- Funding opportunities, including research and reporting requirements
- Transition documentation
- Day-to-day best practices

Breakout Group Consensus

- What is industry's role?
- What types of questions might we address with industry?

Breakout Group Consensus

- When should the CCCoP start to bring end users (e.g., Jupiter, ESRI, First Street Foundation, etc.) into the conversation?
- What types of questions might we address with end users?

BREAK

2:45-3:00 PM CT

Connections to the Summer Institute Panel

Celso Ferreira

Associate Professor, George Mason University

Trey Flowers

Director of the Analysis and Prediction Division at the National Water Center

Ehab Meselhe

Professor, Tulane University

National Water Center Innovators Program: Summer Institute

The Summer Institute is a unique program which brings together graduate students, academic researchers, and National Water Center staff to work on projects designed to improve water-related products and decision-support services.

The 2019 Summer Institute will take place June 9 - July 25, 2019. Among the themes for the 2019 Summer Institute, we will explore:

1) coupled inland-coastal hydraulics
2) scaling hydrologic and hydraulic models from small basins to regional watersheds
3) utilizing hydroinformatics to address flood inundation
4) support remote sensing of water information through engagement with the computer science community

NWC Summer Institute: Coupled inland-coastal hydraulics

Theme leads:

- Ehab A. Meselhe (Tulane University)
- Celso Ferreira (George Mason University)
- Kyle Mandi (Columbia University)
- Patrick Burke (NOAA/NOS/CO-OPS)
- Saeed Moghimi (NOAA/NOS/CSDL)

NWC Summer Institute: Coupled inland-coastal hydraulics

What are the relevant physics in the coastal -estuarine-tidal regions and the ideal modeling framework for total water forecasts in tidal environments?

Students will work on one or multiple science objectives from the list below to:

- Evaluate the threshold of the tidal signal amplitude to identify the limit of the coastal zone “influence” for tidal predictions in upland reaches.
- Investigate the relevant physical processes contributing to total water prediction (wind patterns; topography; wave action; roughness/vegetation, sediment transport).
- Investigate the relevant forcing conditions besides the riverine/coastal boundary conditions that are relevant in these reaches.
- Investigate the spatial scale relevance of these processes (i.e. the spatial scale of the transition zone between inland and coastal hydraulics).
- Evaluate the effects of anthropogenic changes impacting the coastal/riverine interface delineation (e.g. deep/wide ship channels convey tides/surges deep inland).
- Evaluate numerical modeling configurations relevant to water predictions in these areas (e.g., Wetting and drying, 1D vs 2D vs 3D). Specific codes used will be discussed with the students.
- Perform an intermodel comparison to evaluate the computational cost vs accuracy of simulating total water forecasts in these reaches using different models (e.g., D-FLOW, ADCIRC and GEOCLAW)

Tee-up Questions for Day 3: 2D and 3D Modeling

Meeting Highlights and Wrap-up