Characterizing Compound Coastal-Riverine Behavior along the U.S. East Coast using a Coupled Hydrologic-Hydrodynamic Model

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Agenda

- Problem
- Approach
- Regional Scale
  - Results
  - Challenges
  - Lessons Learned
- Closing Statement
- Questions

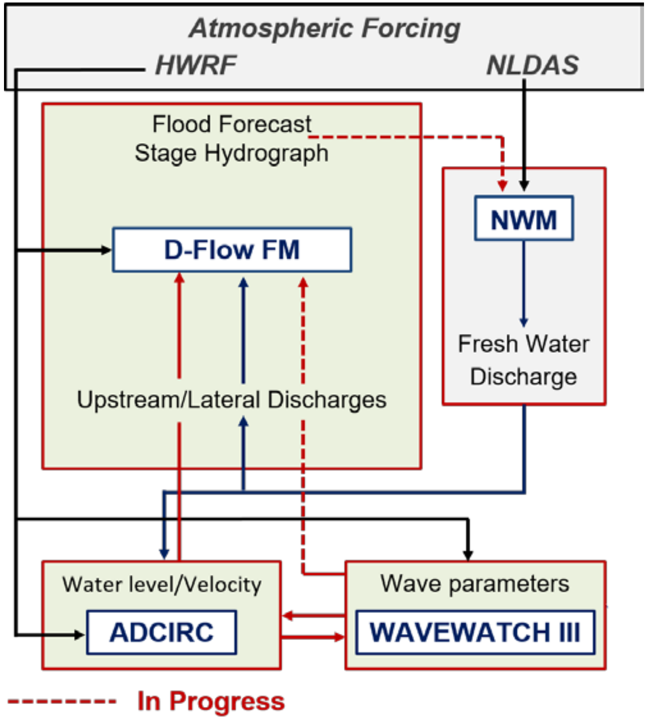
Problem

- US East Coast is highly vulnerable to coastal floods and waves
- 80-90% of the deaths due to TCs are caused by fresh water flooding and storm surge (NOAA-HRD)
- Currently, linkages between inland forecast points and National Weather Service (NWS) estuary-ocean models have not been made; thus, accurate streamflow, stage, and velocity guidance in the coastal zone is not currently available
- Accurate model derived flood/inundation maps are needed to assess storm wind vs. water-specific losses

Over 100 million people live in the red space near the coast (transition zone) do not get an integrated flood forecast today.

Solution, Approach and Validation

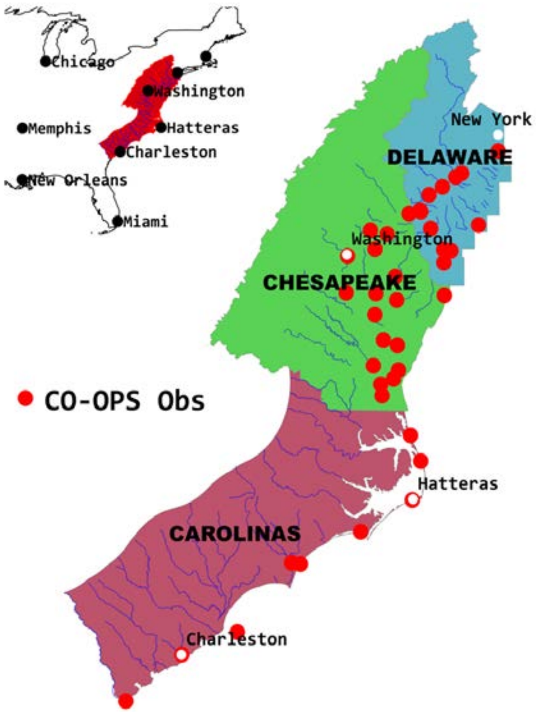
- Goal: Provide accurate flood/inundation simulations at the transition zone
- Solution: Develop a computational framework that combines
  - Ocean Model: Advanced Circulation Ocean Model (ADCIRC)
  - Wave Model: WAVEWATCH III
  - Hydrologic Model: National Water Model (NWM)
  - Hydrodynamic/Hydraulic Model: DFlow FM
- Approach
  - Local Scale
  - Regional Scale
  - Atlantic and Gulf Coasts
- Validation
  - Super Storm Sandy (2012)
  - Hurricane Irene (2011)
  - Hurricane Isabel (2003)



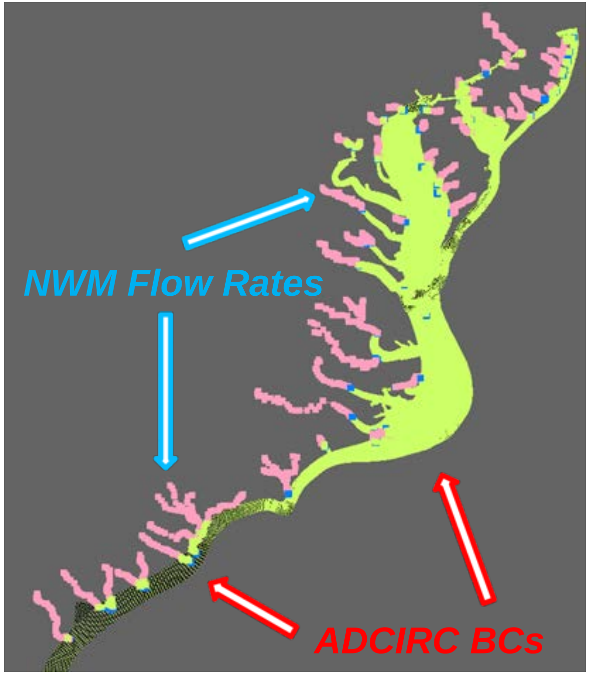
Model Domain, 1D-2D Setup

From Sandy Hook, NJ to Savannah, GA

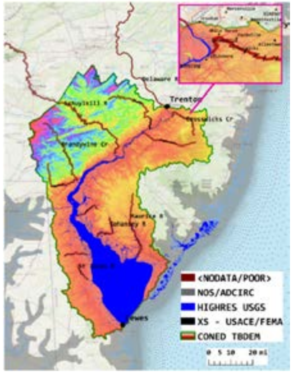
Regional-Scale Domain



2D/1D Coupled Model



Model Domain, 1D-2D Setup (cont'd)



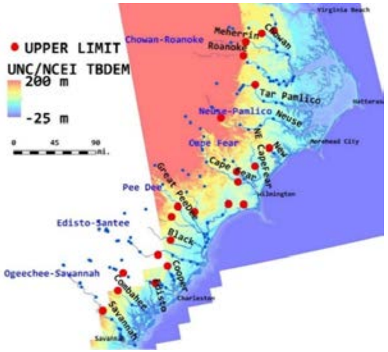


Table 1. Delaware 1-D Elements

Tributary Name	
Delaware main-stem	246 kr
Rancocas Creek	21 km
Crosswicks Creek	11 km
Leipsic River	26 km
St. Jones River	35 km
Schuylkill River	8 km u
Christina River	12 km
Brandywine Creek	5 km u
Alloways Creek	11 km
Maurice River	39 km
Cohansey River	24 km

Table 2. Chesapeake 1-D Elements

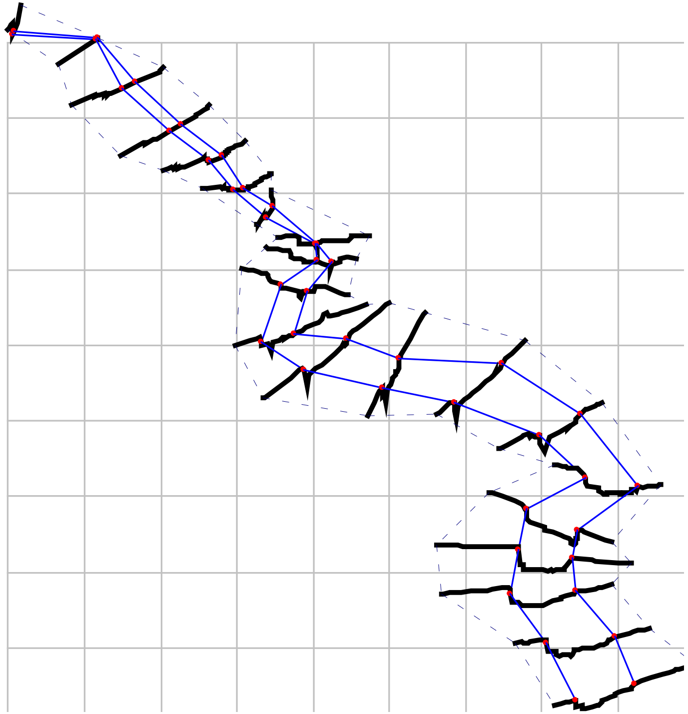
GNIS_NAME	Tidal Limit (mi)	Remark
Potomac R	5	Above DC, near Little Falls
Susquehanna R	6	HEP Lock&Dam
Rappahannock R	65	
James R	95	D/S Richmond
Wicomico R	50	Nr Salisbury
York R		All
Mattaponi R	5	Above York R
Pamunkey R	6	Above York R
:		:

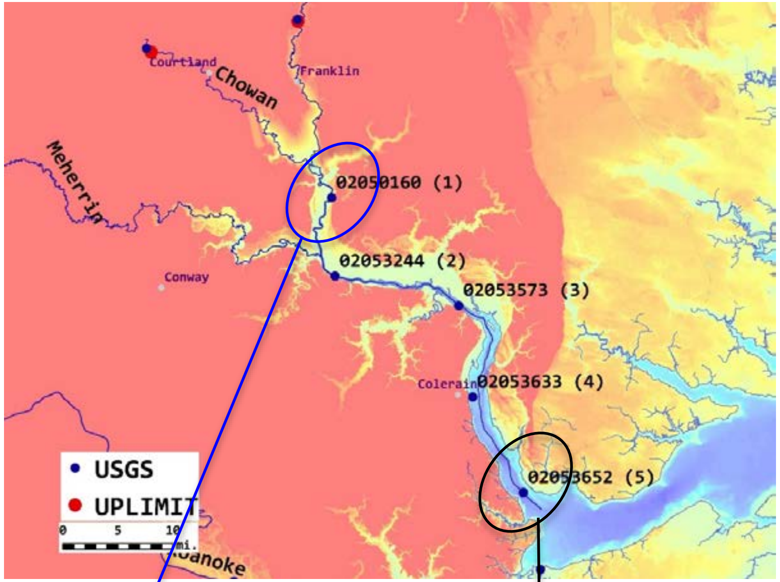
Table 3. Carolinas 1-D Elements

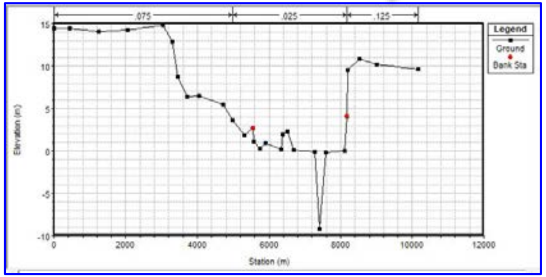
GNIS_NAME	Tidal Limit (mi)	Remark
Chowan R	50	
Tar-Pamlico R	59	
Neuse R	59	
Cape Fear R	65	Lock #1
G. Pee Dee R	33	
Santee R	37	Santee Dam
Cooper R	35	L. Moultrie
Ashley R	40	
Edisto R	50	
Combahee R	37	
Savannah R	59	
Black R	40	
Waccamaw R	60	
Roanoke R	6	

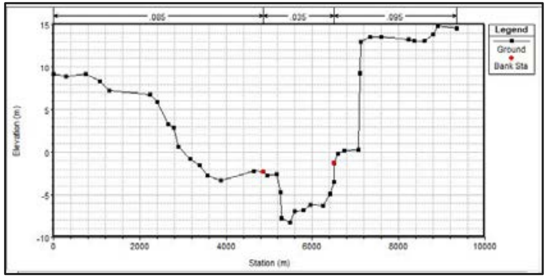
1D Rivers/Tributaries

1D Modeling Considerations

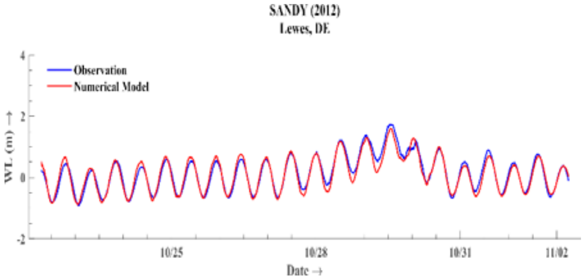


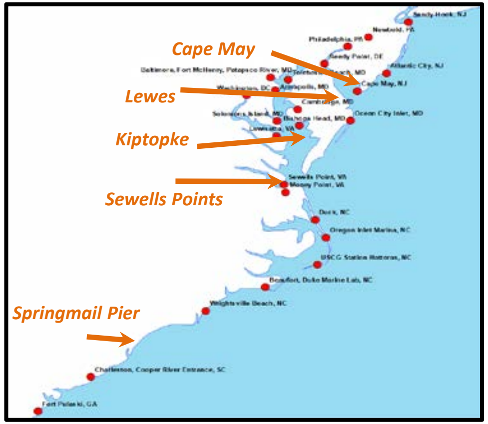


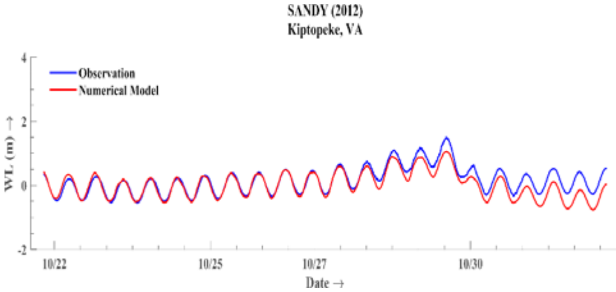


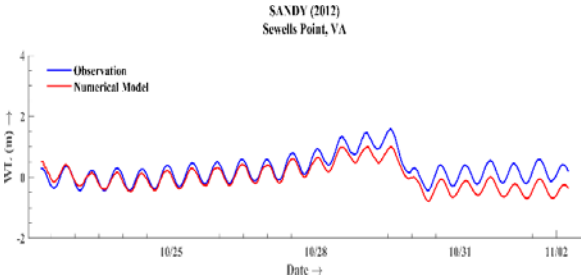


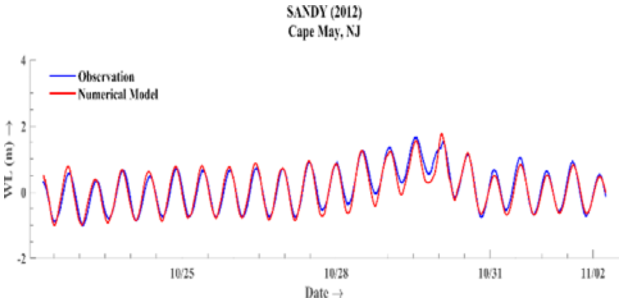
Model Results: Superstorm Sandy 2012

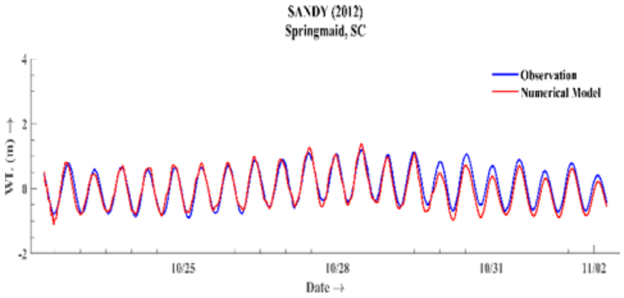






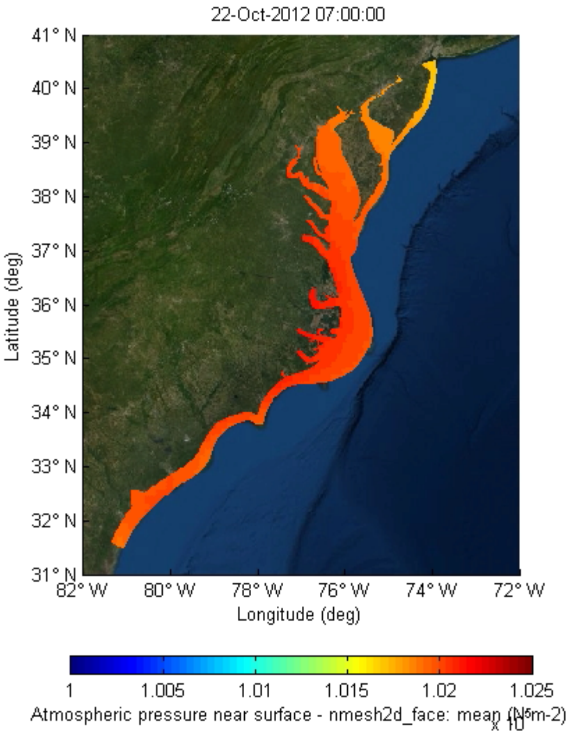




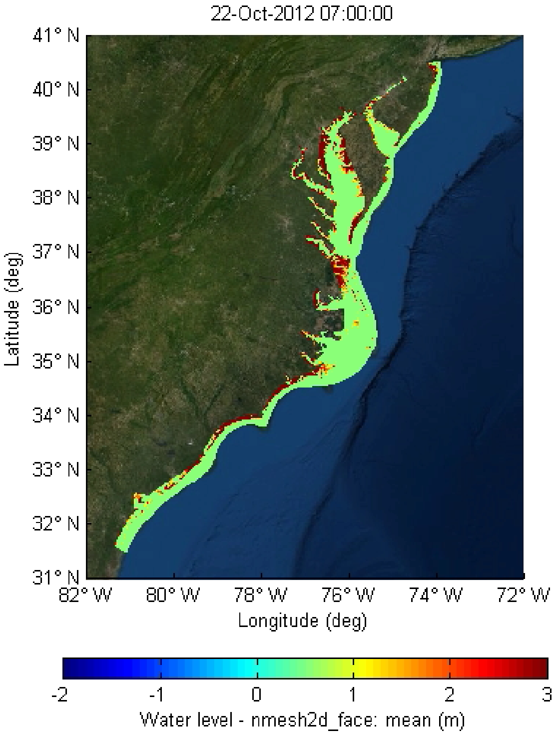


Water level (m) prediction (red) comparison with NOAA observed data (blue)

Model Results: Superstorm Sandy 2012 (cont'd)

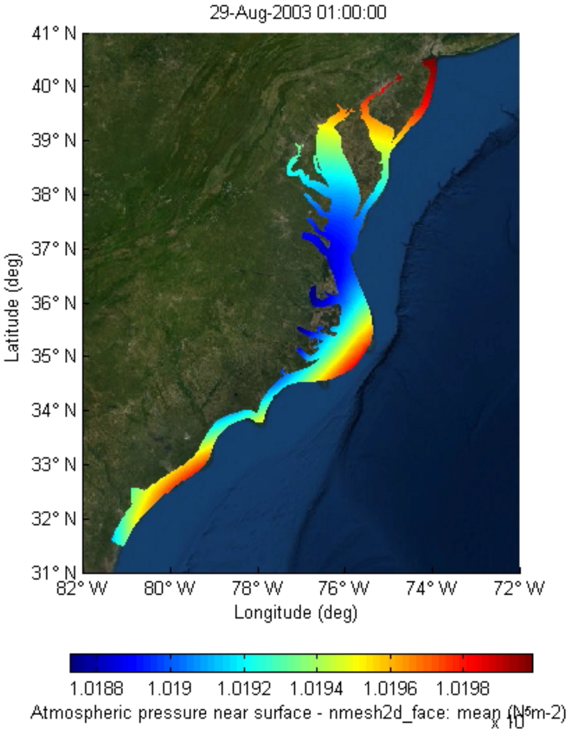


Atmospheric pressure

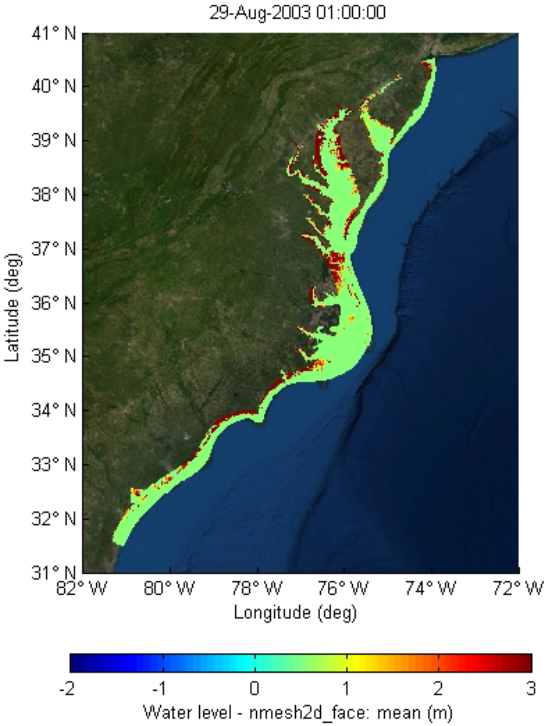


Water level

Model Results: Hurricane Isabel 2003



Atmospheric pressure



Water level

Model Summary

- Results
  - 1D/2D hydrodynamic coupling was more robust, resulting in more accurate simulation of water levels in bay and tributaries than the Local Scale Model
  - Water level were generally accurate; the model can capture the peaks, especially for Isabel and Irene
  - Hydrodynamic predictions are dependent on atmospheric forcing

- Challenges / Lessons Learned
  - Input uncertainties/errors (e.g., bathymetry, wind, cross-section profiles, NWM discharges)
  - High resolution topo-bathymetry data is required to capture correct channel geometry
  - Spatial variability of roughness needs to be optimized

Questions

Questions?

Thank you