# Combining Ocean, Wave, Hydrologic, Riverine Flow Models at a Local and Regional Scale Along the East Coast of the United States

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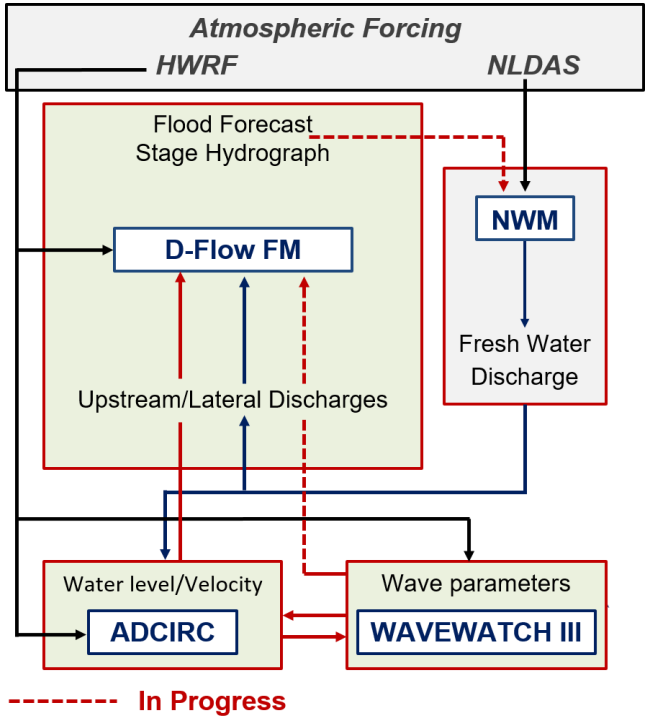
# Problem

- 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

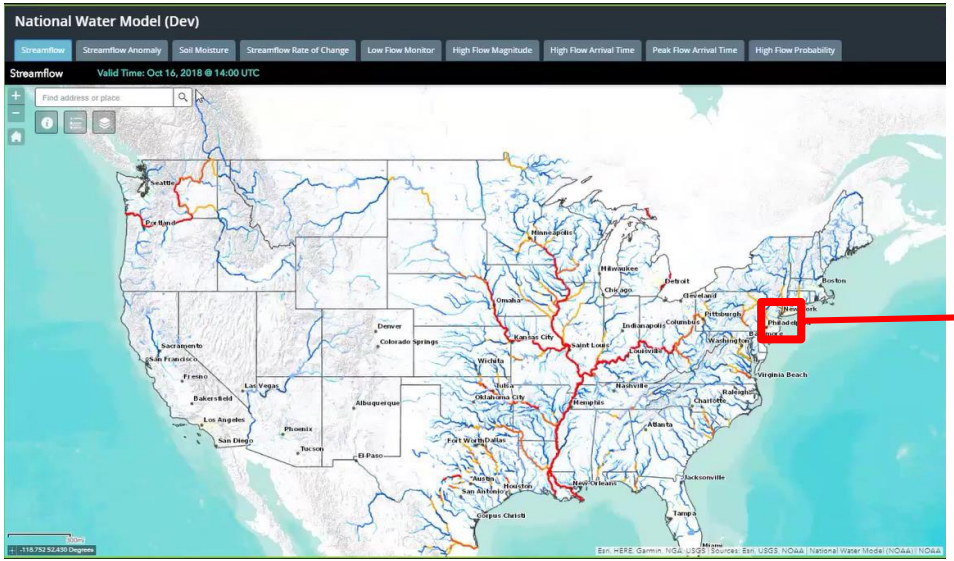
- Goal: Provide accurate flood/inundation simulations at the transition zone
- Solution: Develop a computational framework that combines
  - Ocean Model: Advanced Circulation Ocean Model (ADCIRC)
  - Wave Model: WAVEWATCH III
  - Hydrologic Model: National Water Model (NWM)
  - Hydrodynamic/Hydraulic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



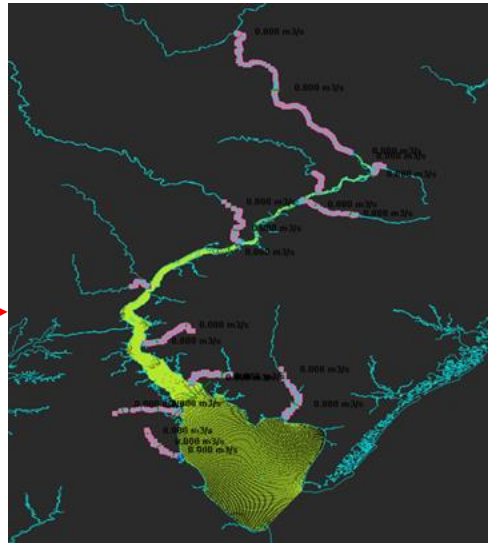
# Local Scale Model - Location

## Delaware Bay

- 250 km of lower Delaware River
- 150/0 Km offshore of river mouth

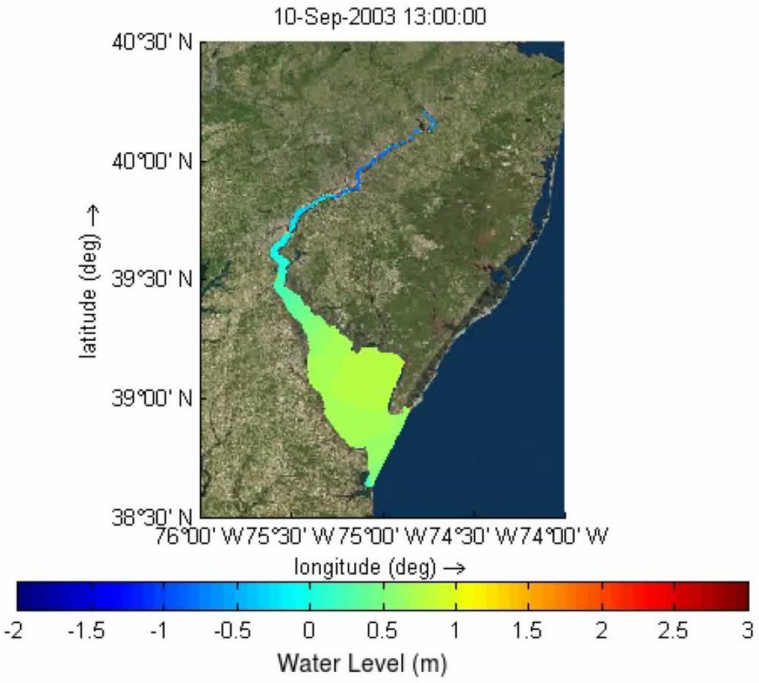



2D/1D Coupled Model

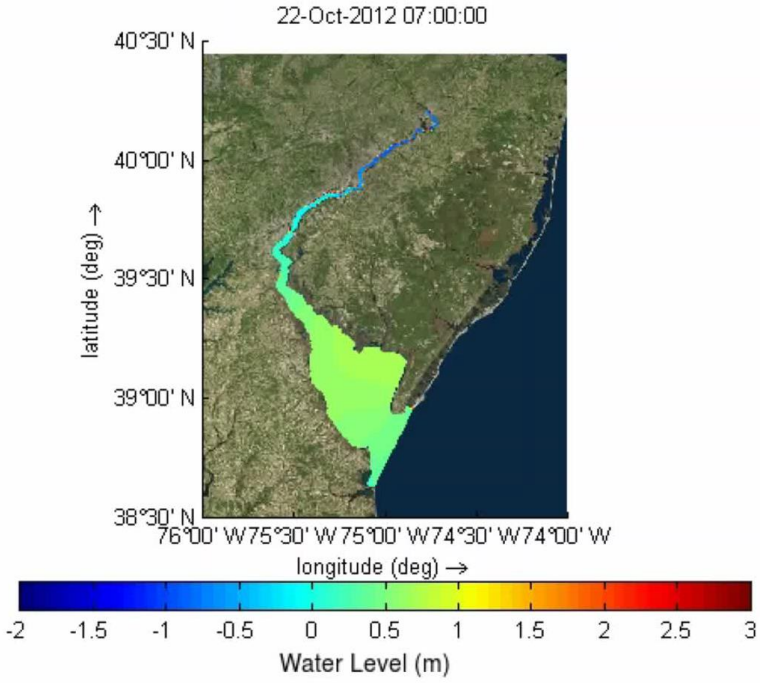


# Local Scale Model - Results

Isabel (2003): Delaware Bay/River Basin
Water Level (m)

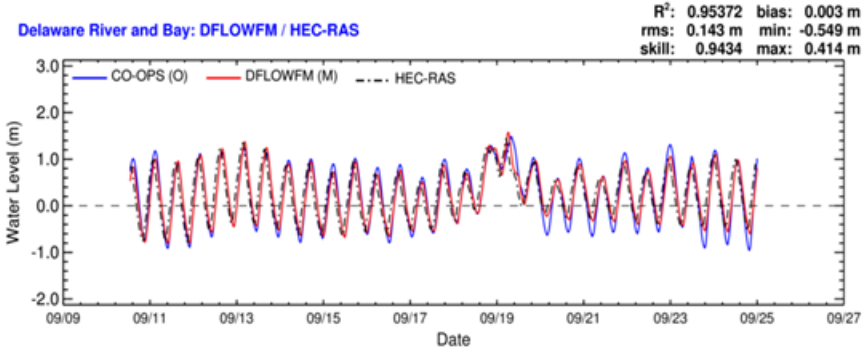


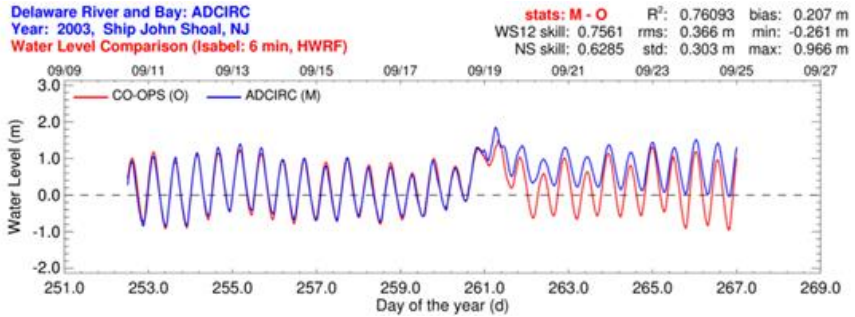

Sandy (2012): Delaware Bay/River Basin
Water Level (m)



# Local Scale Model – Validation of Results

Hurricane Isabel (2003): D-Flow FM vs HEC-RAS and ADCIRC


Water level (m) prediction comparison with NOAA observed data during Hurricane Isabel 2003 for Ship John.

# Local Scale Model - Summary

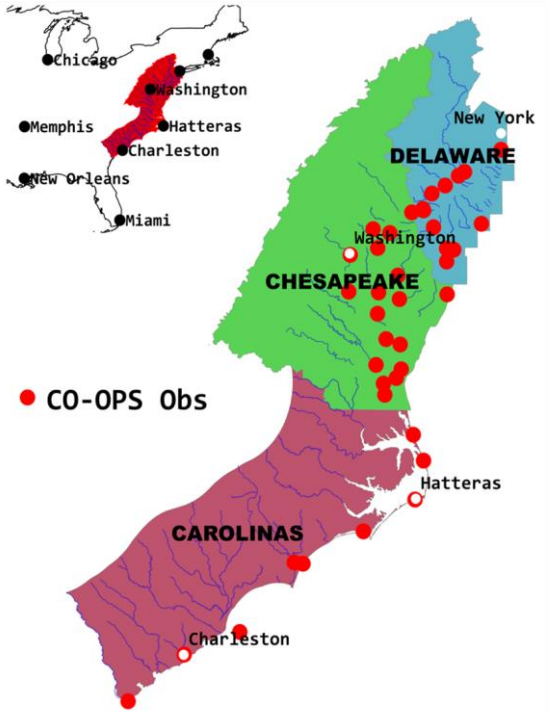
- Results
  - Water levels were generally accurate
  - Hydrodynamic predictions, especially in upstream reaches of Delaware River, were highly dependent on streamflow discharges and less on meteorological inputs
  - Coupled NWM/D-Flow/ADCIRC framework has advantages over existing river hydraulic models, particularly in storm events.

- Challenges / Lessons Learned
  - Bay-Delta and coastal ocean must be modeled in one computational domain to accurately describe highly interconnected hydrodynamics, sediment transport, and subsequent ecological process in these regions

# Regional Scale Model - Location

From Sandy Hook, NJ to Savannah, GA

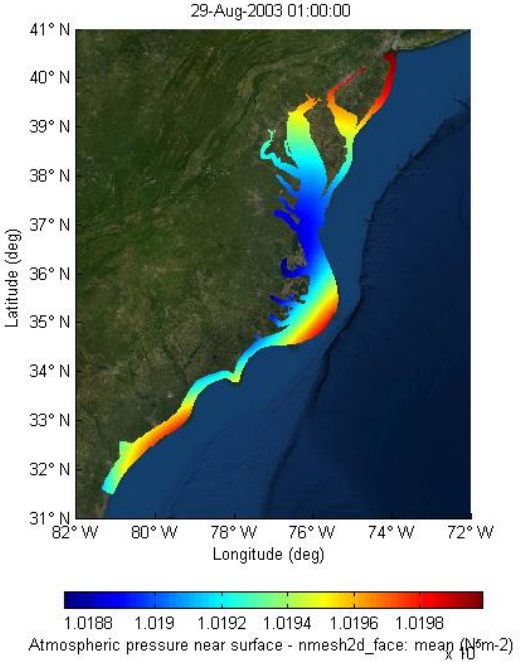
Regional-Scale Domain



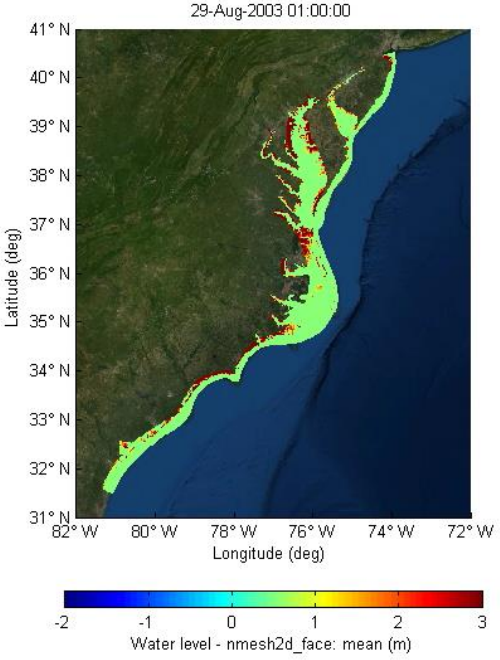

2D/1D Coupled Model

# Regional Scale Model - Results

## Hurricane Isabel (2003)



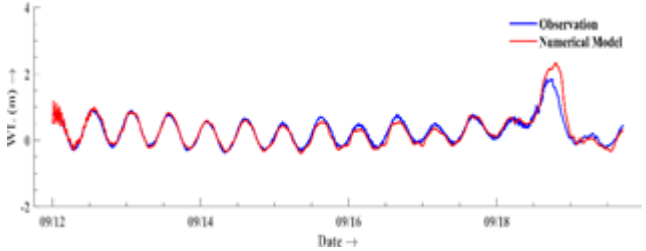

Atmospheric Pressure



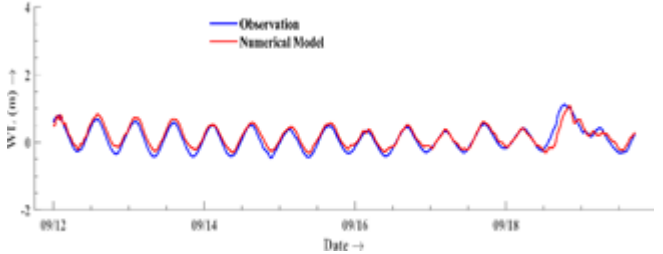

Water Level

# Regional Scale Model – Validation of Results

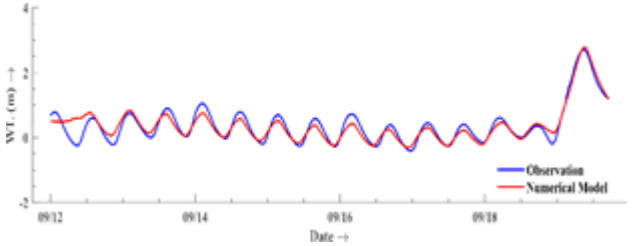
Hurricane Isabel (2003)



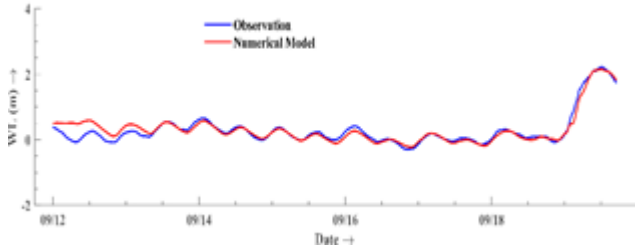

Duke, NC




Beaufort, NC




Washington, DC




Baltimore, MD

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

# Regional Scale 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

# Closing Statement