The Physical Conditions of the Maryland Coastal Bays (MCBs) and its Impact on the Recruitment of Blue Crab Larvae

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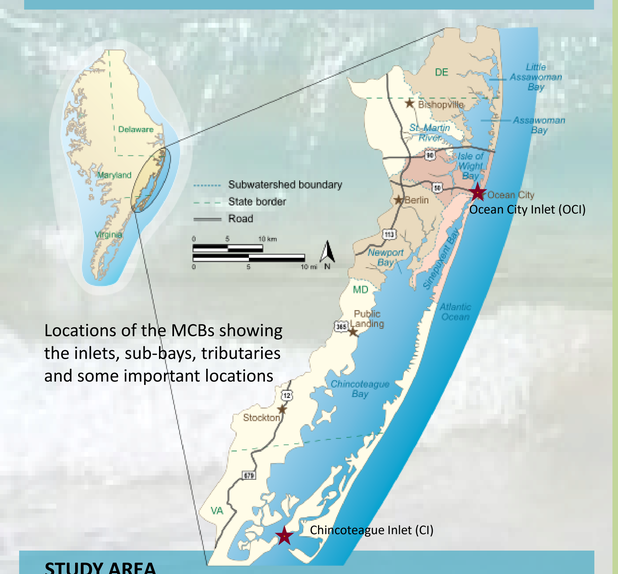
OBJECTIVE

To set up a comprehensive understanding of the hydrodynamics in the Maryland Coastal Bays by relative roles of multiple dynamic processes in a holistic manner and to identify probabilities and consequences of what the future may hold

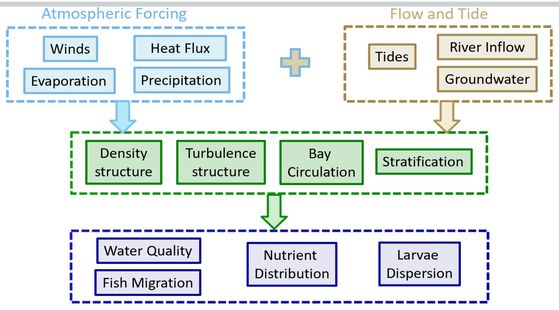


Locations of the MCBs showing the inlets, sub-bays, tributaries and some important locations

STUDY AREA

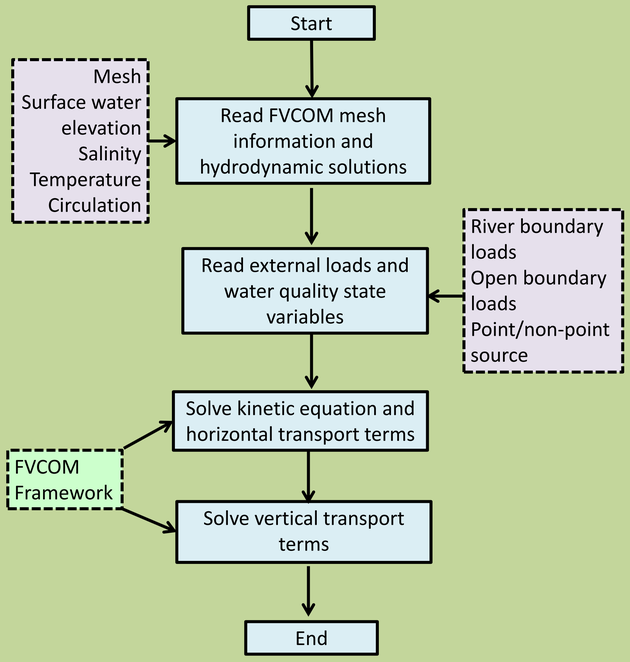
- Shallow interconnected lagoon system with two inlets; heavily influenced by tides and currents, and also sensitive to climate change and storm surge
- Located between the eastern side of Delmarva (Delaware–Maryland–Virginia) Peninsula and its sandy barrier islands which isolate the Bays from the Atlantic Ocean
- Includes five sub-bays and one major river: Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, Newport Bay, Chincoteague Bay, and St. Martin River
- Shallowness: 1-2 m or less except inlet areas

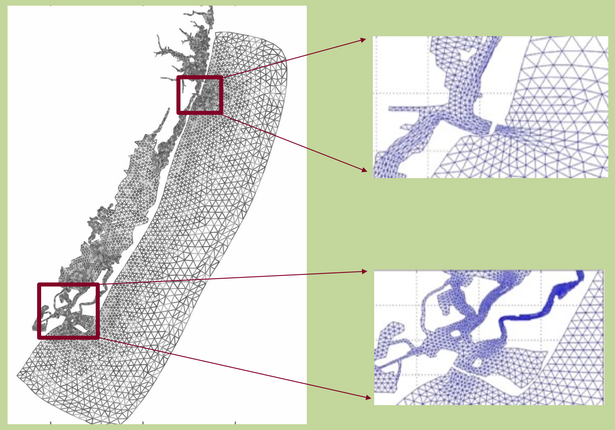
Biophysical Interaction



METHODOLOGY

Observed GPS-tracked Drifter Trajectory + Numerical Model Application (FVCOM, SWAVE, PTM, ICM, CE-QUAL-W2) ⟹ Data Analysis by Parameter Calculation

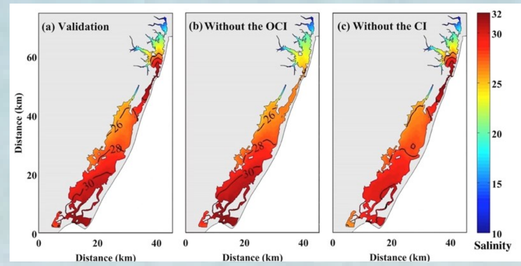




- Unstructured Horizontal Grids
  - 7332 nodes & 12428 elements
- Vertical Sigma Coordinate
- River Inputs & Sea Surface Meteorological Forcing
- Open Boundary Equilibrium Tides
  - 4 Semidiurnal Constituents (M_2, N_2, S_2 & K_2)
  - 4 Diurnal Constituents (O_1, P_1, K_1 & Q_1)

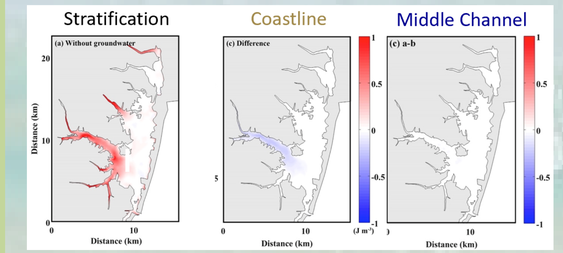
RESULTS

Salt Flux Dynamics (Influence of Inlets)



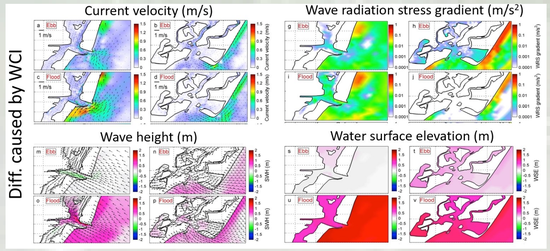
- In the absence of the OCI, 3.7% salinity reduction spatially
- In the absence of the CI, 1.3% salinity reduction spatially

Groundwater Effect (Stratification Difference):



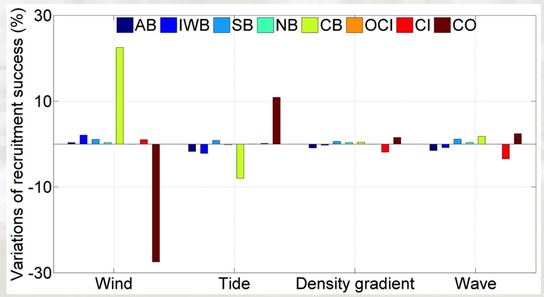
- River inflow mainly results in stable stratification
- Groundwater (coastline) weakly strengthen stratification in St. Martin River

Impacts of Wave-Current Interaction (WCI)



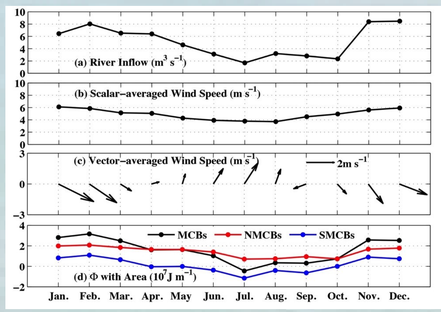
- Strong winds (> 14.5 m/s) significantly affect the coastal circulation near the CI at the 1st maximum flood phase
- Wind-induced waves are mainly behind the inlets
- Wave-current interaction affect currents near inlets through wave radiation stress
- Wave-current interaction affect wave dynamics by the depth-induced breaking

Blue Crab Larvae Particle Transport Modeling (Dynamics of Larval Recruitment during Hurricane Arthur)



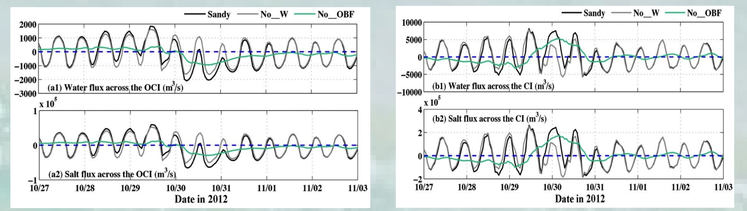
Relative contributions of external forcing to the recruitment success in the MCBs from various regions

Turbulent Mixing (Influence of Wind and Tide)



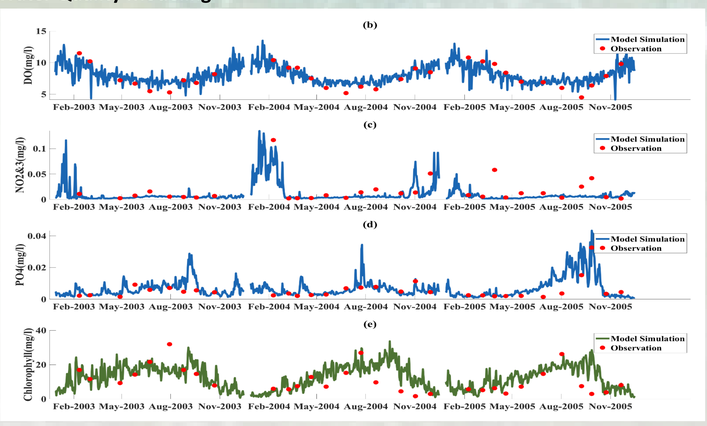
- River inflow is a key to the stratification
- V-wind dominates mixing
- Shallowness of the MCBs masks the authentic roles of winds on vertical mixing and stratification
- Tidal forcing: important source of vertical mixing around inlets
- Wind forcing: dominant role on vertical mixing in the NMCBs

Storm Surge Simulation (Flux Exchange)



- Inlet flux exchange sensitive to external factors

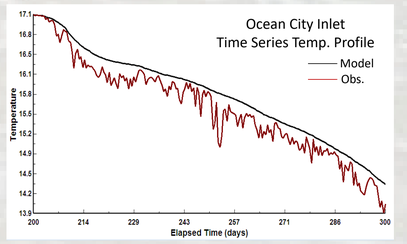
Water Quality Modeling



- Model validation capable of capturing observed patterns

Watershed Modeling and Climate Change Impacts

- Despite following the general trend, the simulation was unable to capture diurnal temperature variation
- Simulation over longer periods taking climate change into consideration will provide understanding of the impacts of the methodology over time



Hydrodynamic Impacts of a Winter Storm

- Model accurately captured wind and wave patterns during the winter storm
- Model water levels showed minimal subtidal fluctuations during the storm
- Pressure gradient = bottom drag (mostly) on tidal scales
- Waves are the primary drivers of flow at OCI
- Winds had larger magnitude than waves at CI
- Momentum balance residuals do not equal zero at OCI or CI