Modeling Effects of Basin Hypsometry on Long-term Sediment Dynamics at Inlets

INLET GEOMORPHOLOGY WU

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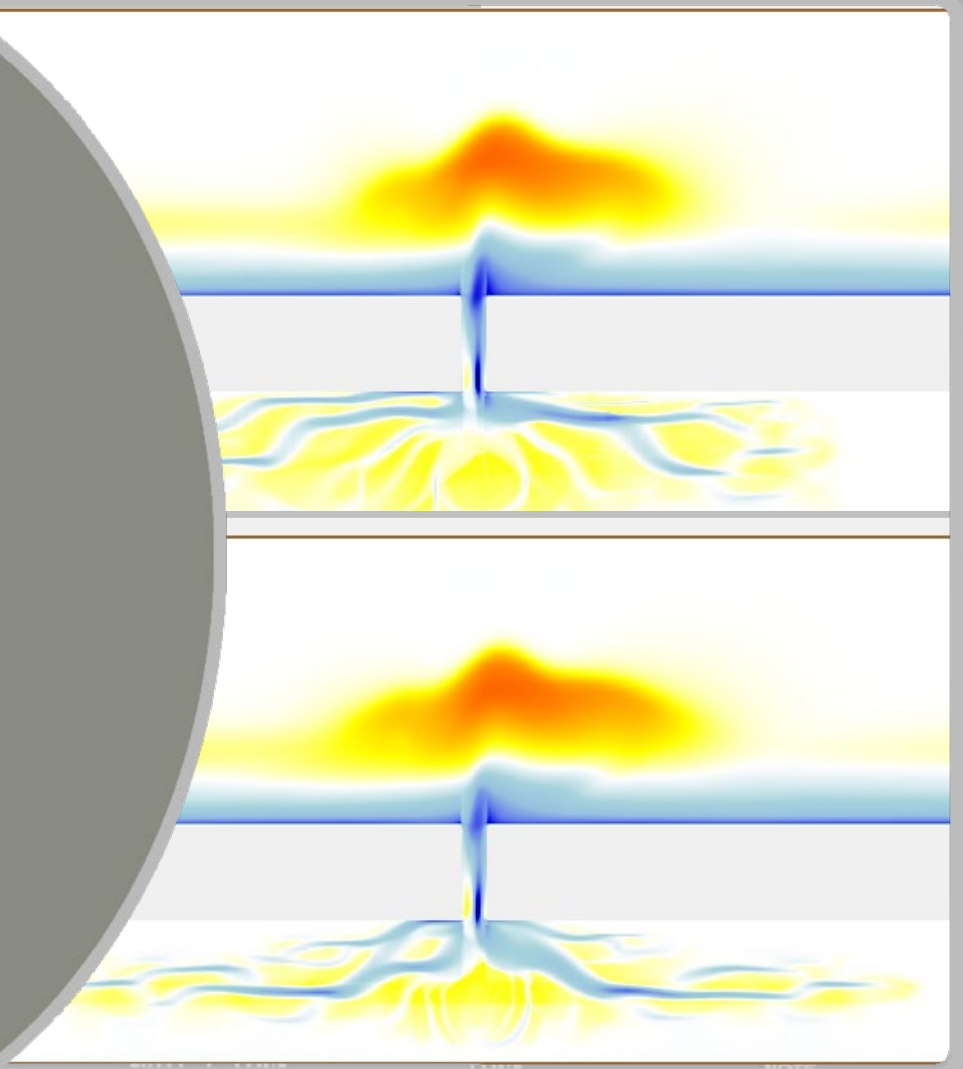

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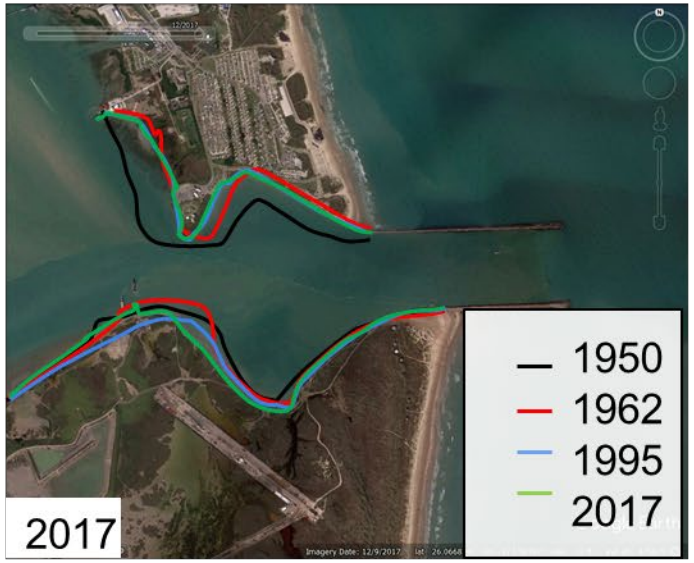
Long-term modeling

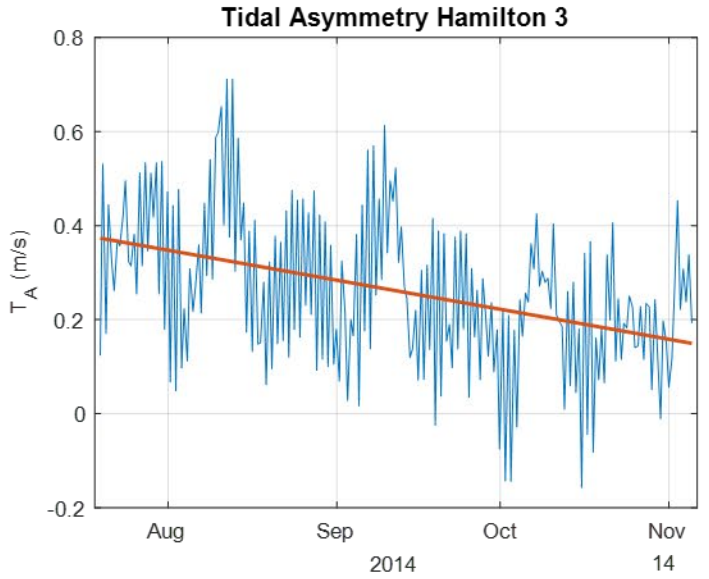
- Completed long-term modeling of 9 idealized inlets
  - Demonstrated requirements to complete long-term simulations
  - Compared basin characteristics, i.e., shoal volume/tidal storage with established theory

- Investigate Basin Dynamics
  - Import vs export
  - Hypsometry
  - Sediment availability

"Investigate the effect of changes in sediment supply and bay hypsometry to changes in sediment transport characteristics"

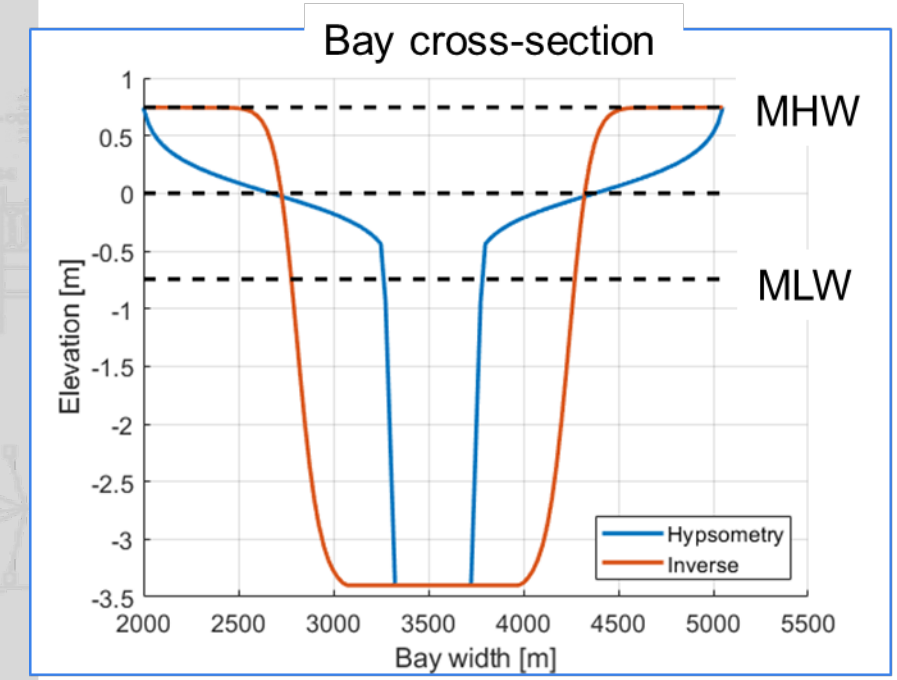
- Existing theory suggests a primary factor controlling hydrodynamics and, by analogy, sediment transport is hypsometry
- One factor not previously explored is sediment availability, which can alter bay morphology and hypsometry leading to potential feedbacks that could modify hydrodynamics of the system.
- Continuing evolution of land use practices (armoring, reclamation) combined with sea level change may alter coastal inlets/bays from present day configurations and associated sediment transport characteristics.
- Need to develop approaches to asses inlet/bay system likelihood of undergoing changes in sediment transport patterns due to these influences (anthropogenic, sea level rise)

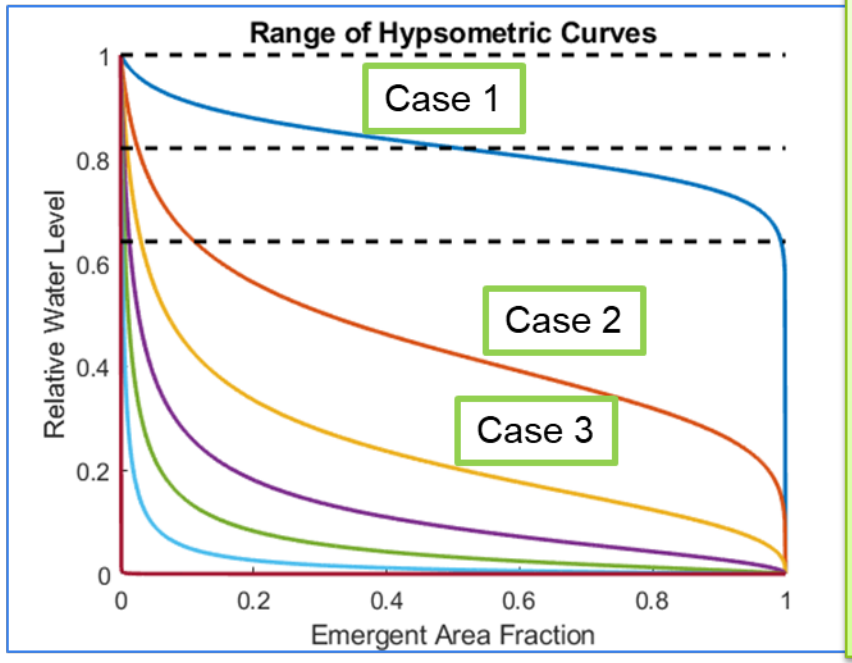




Hypsometry

1. Minimal tidal flats with large inter-tidal storage “bathtub”
2. Extensive inter-tidal flats minimal inter-tidal storage (creek networks)
3. Transition between the two cases

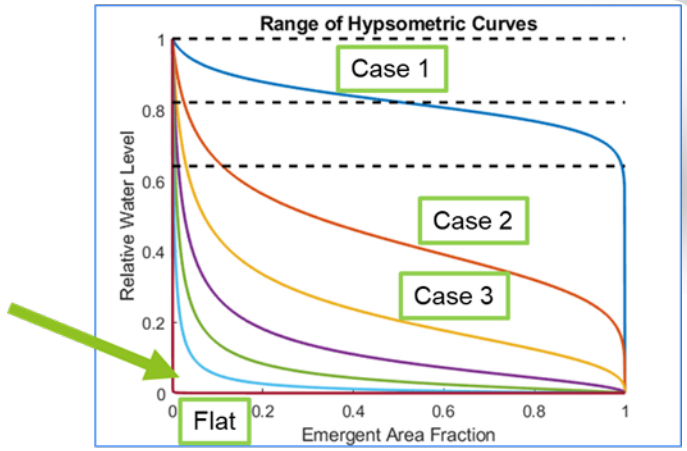




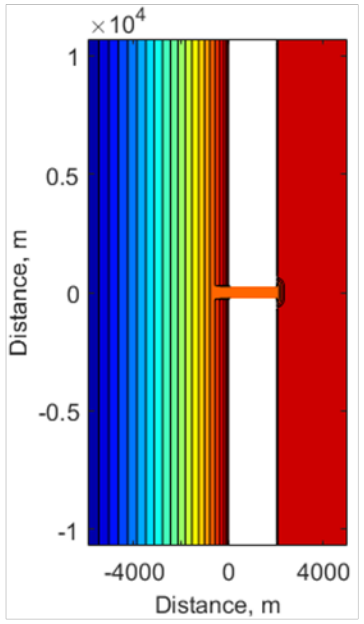
Methodology

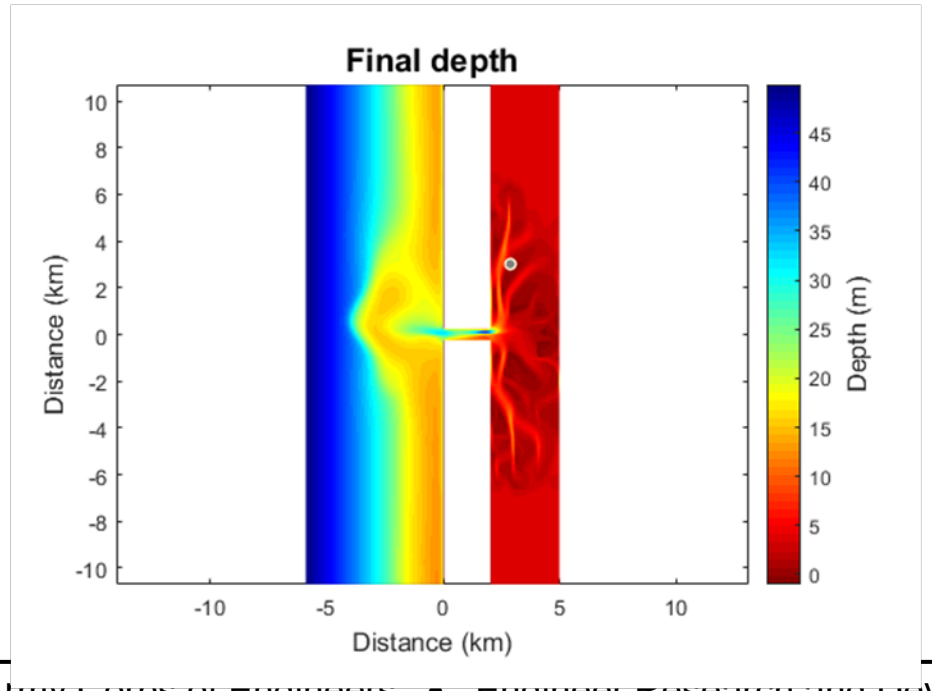
- Run 200 ‘effective’ years using a Morphology Acceleration Factor of 10
- 20 years of wave conditions at 2-hour intervals
- Idealized grids forced with tides based on harmonic constituents for Humboldt, CA and Mouth of Columbia River (Astoria, OR)
- 4-different hypsometric curves implemented

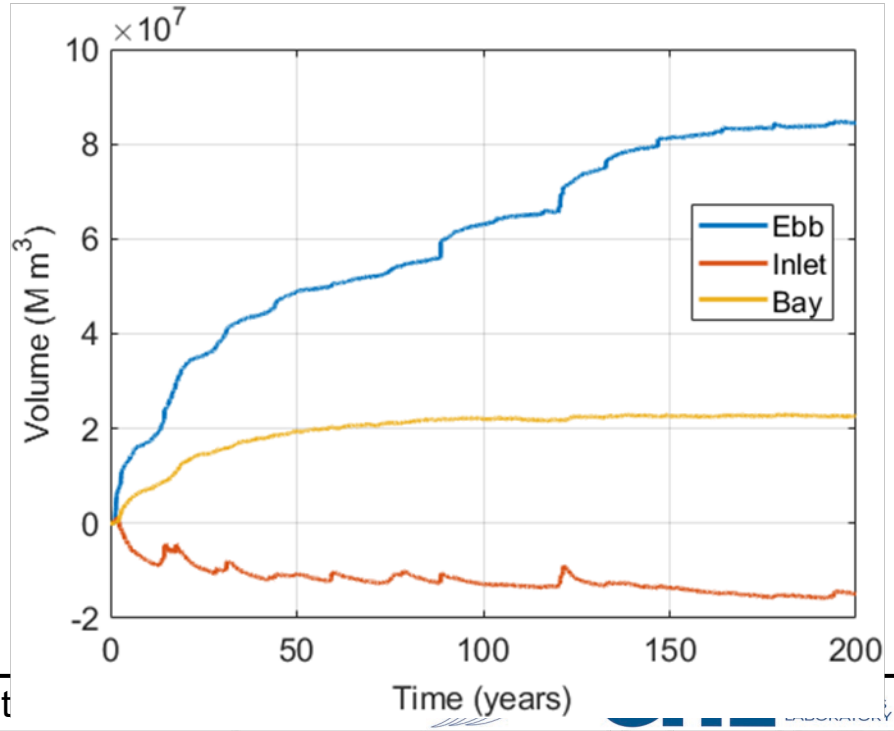
Flat Bathymetry



Flood dominated – import sediment

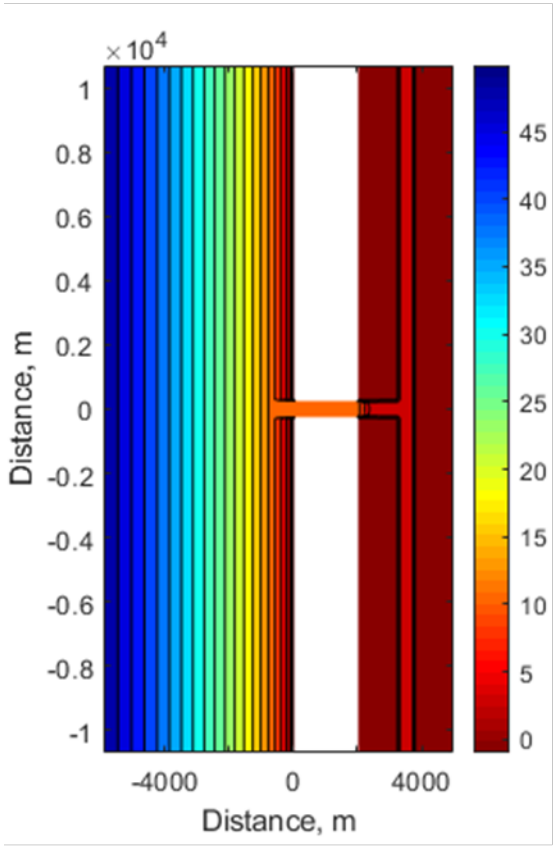


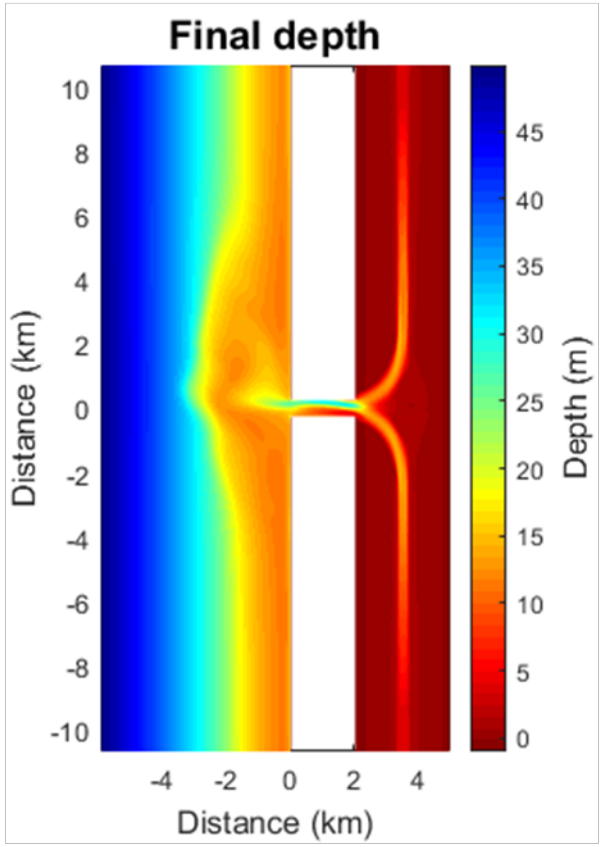


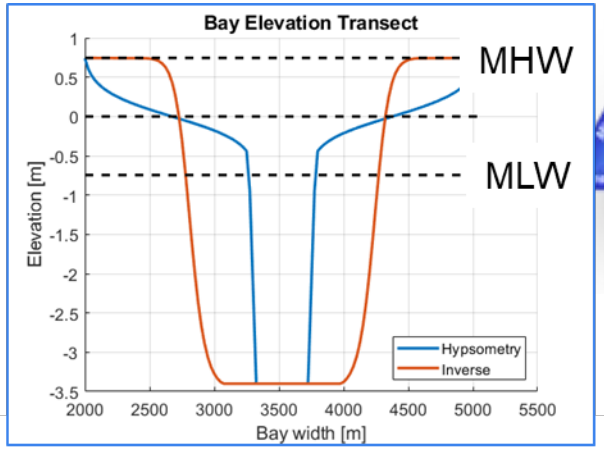


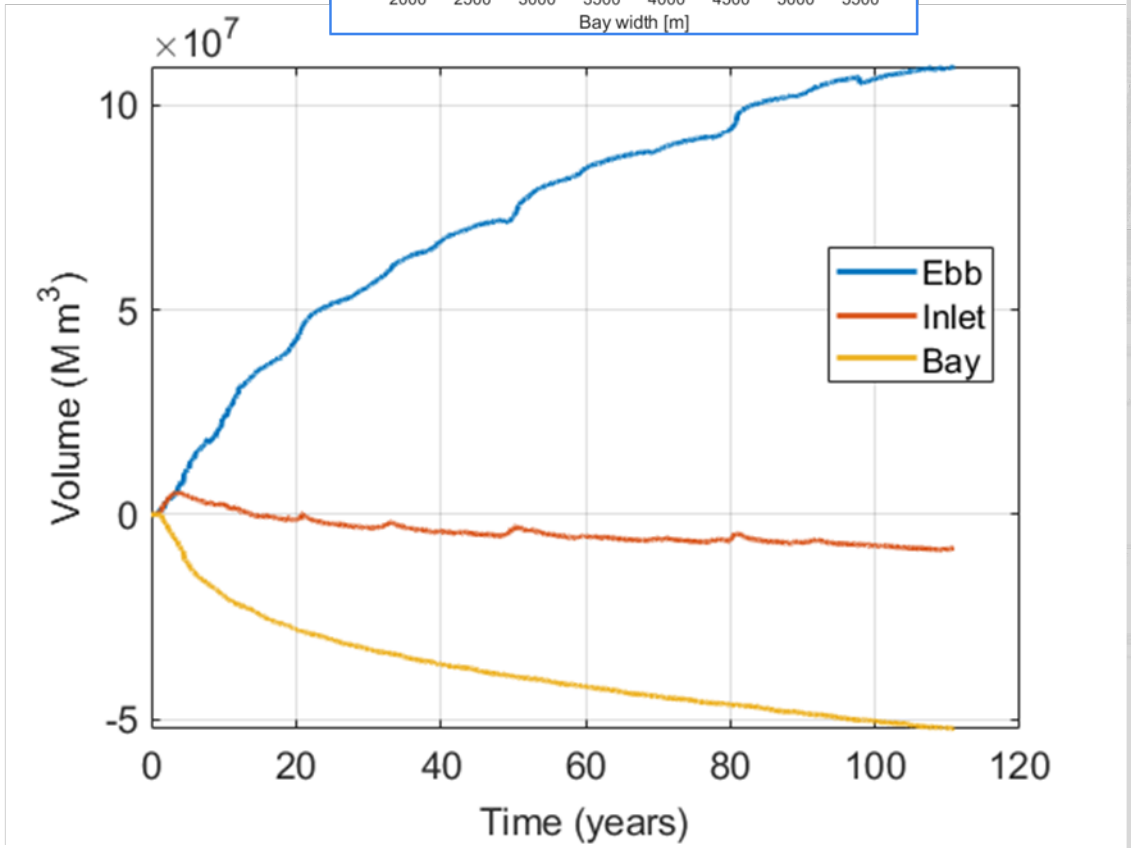
Hypsometry

Ebb dominated - export sediment



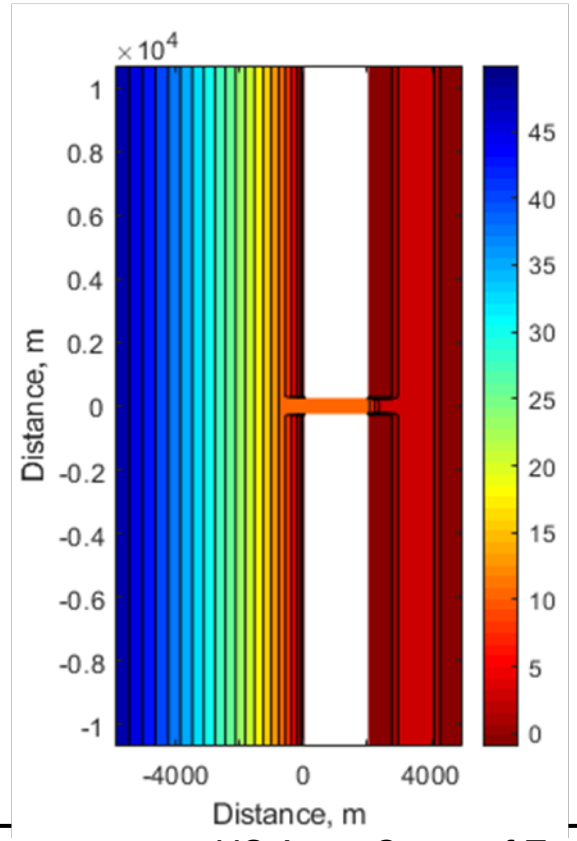


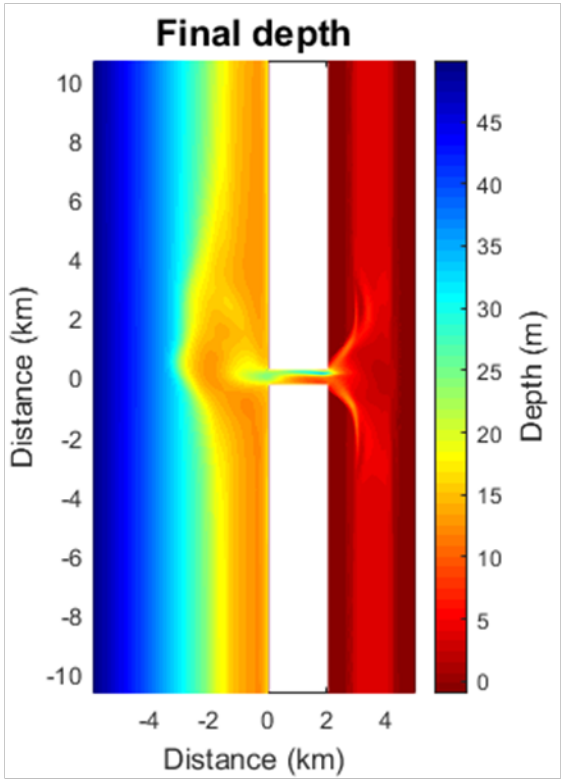


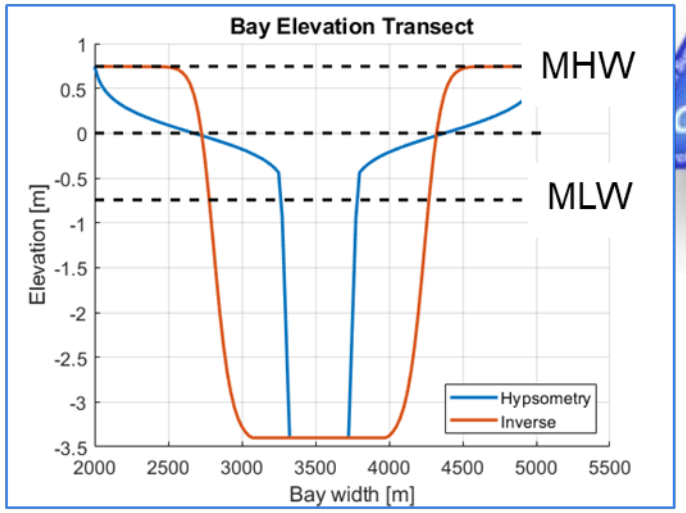


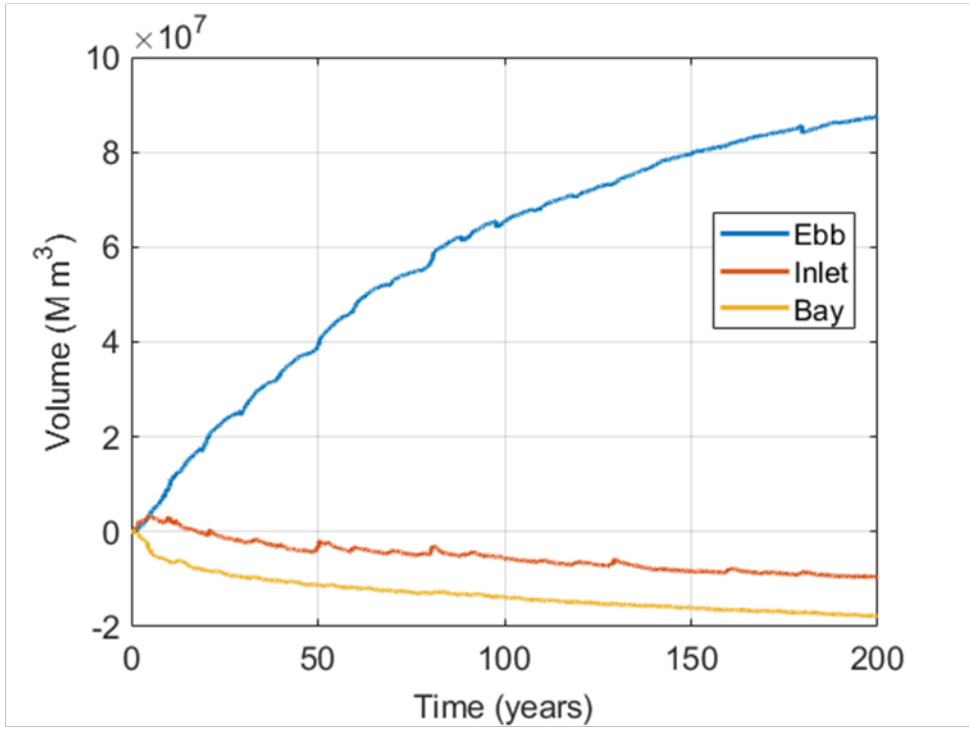
Inverse Hypsometry

Should import sediment??



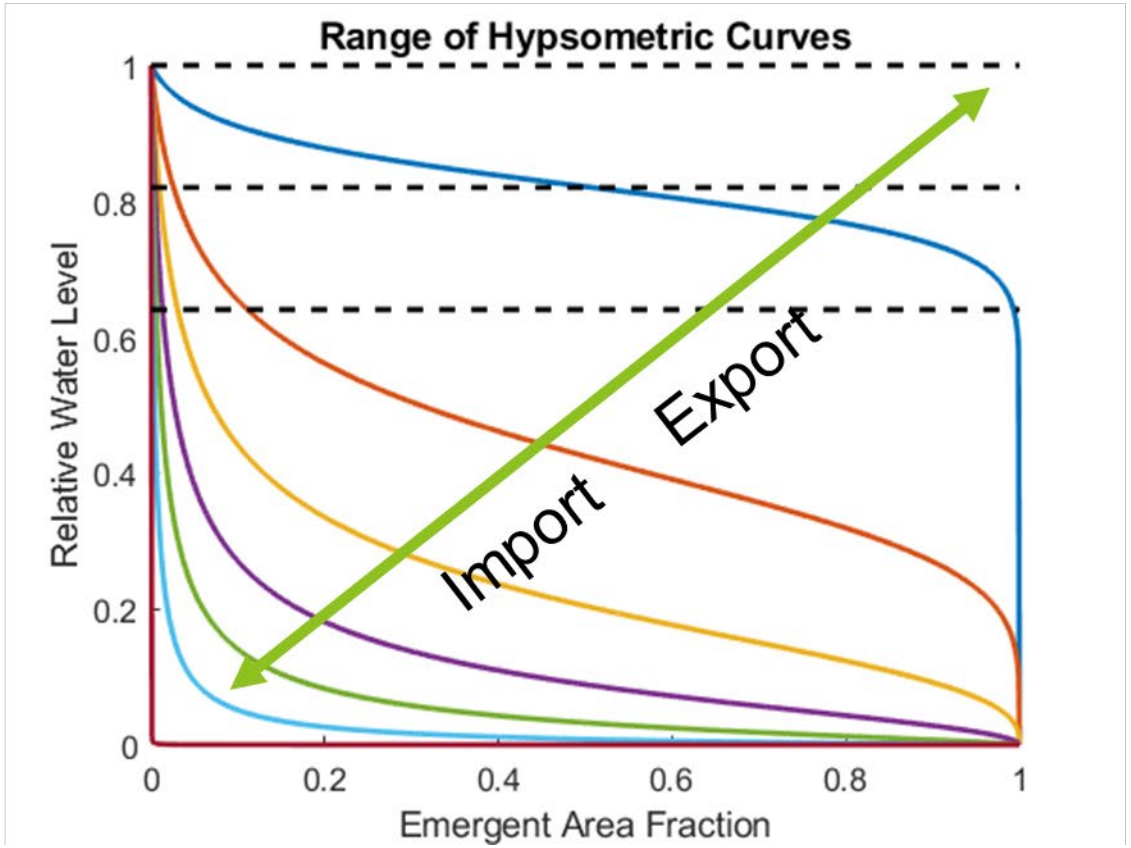






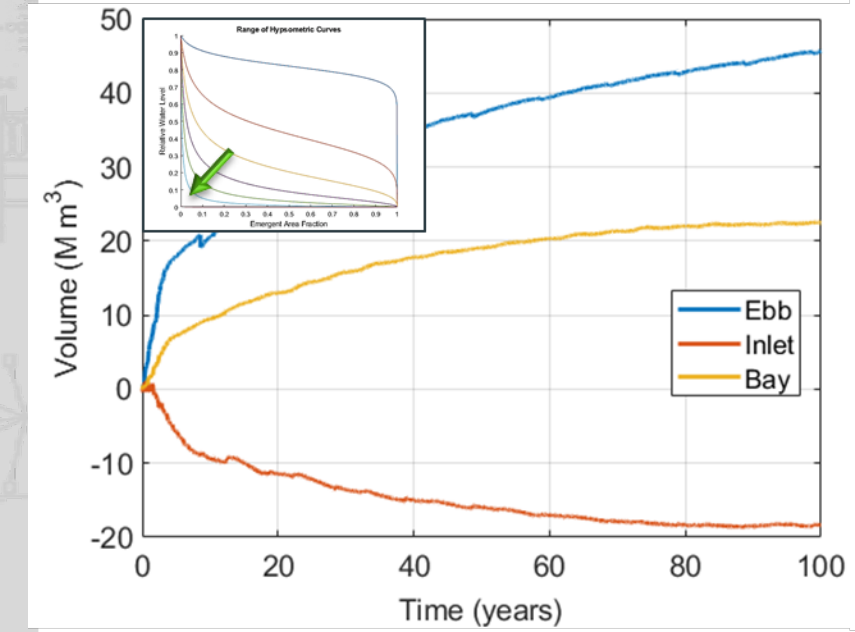
Hypsometry Variation

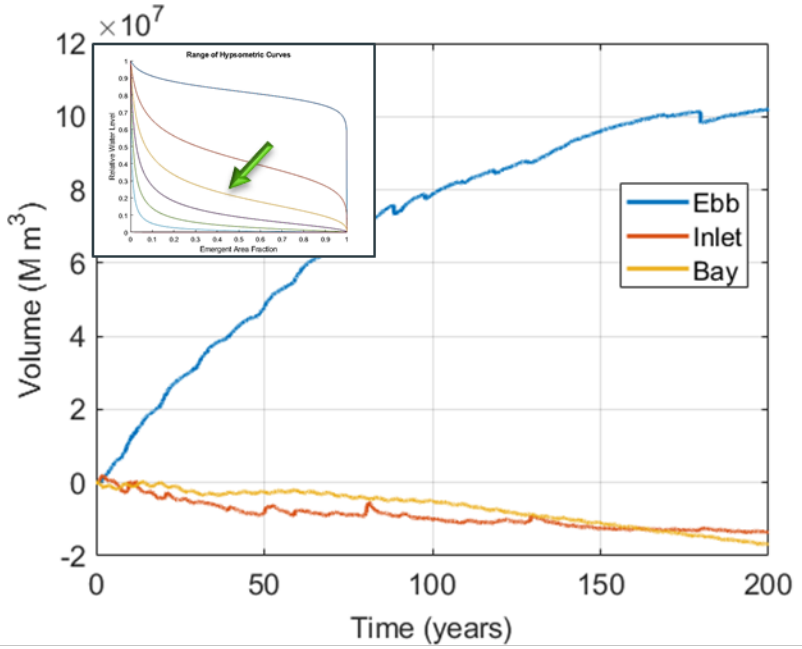
Beginning with half of the bay area emergent and half submerged at mean tide, and varying to flat bathymetry. Also includes the inverse of the half emergent half submerged at mean tide curve, shifted to match the same criteria.

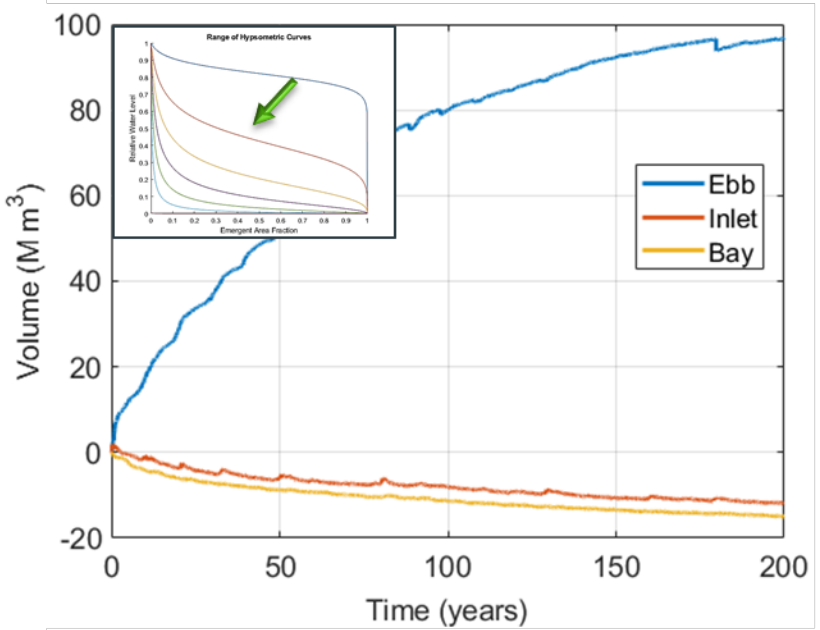


Hypsometry and import vs export sediment

- In all cases ebb shoal gains sediment
- In all cases inlet throat loses sediment
- Only the bay w/o tidal flats, i.e., “bathtub” exports sediment
- Transition point from import to export between Case 2 and Case 3

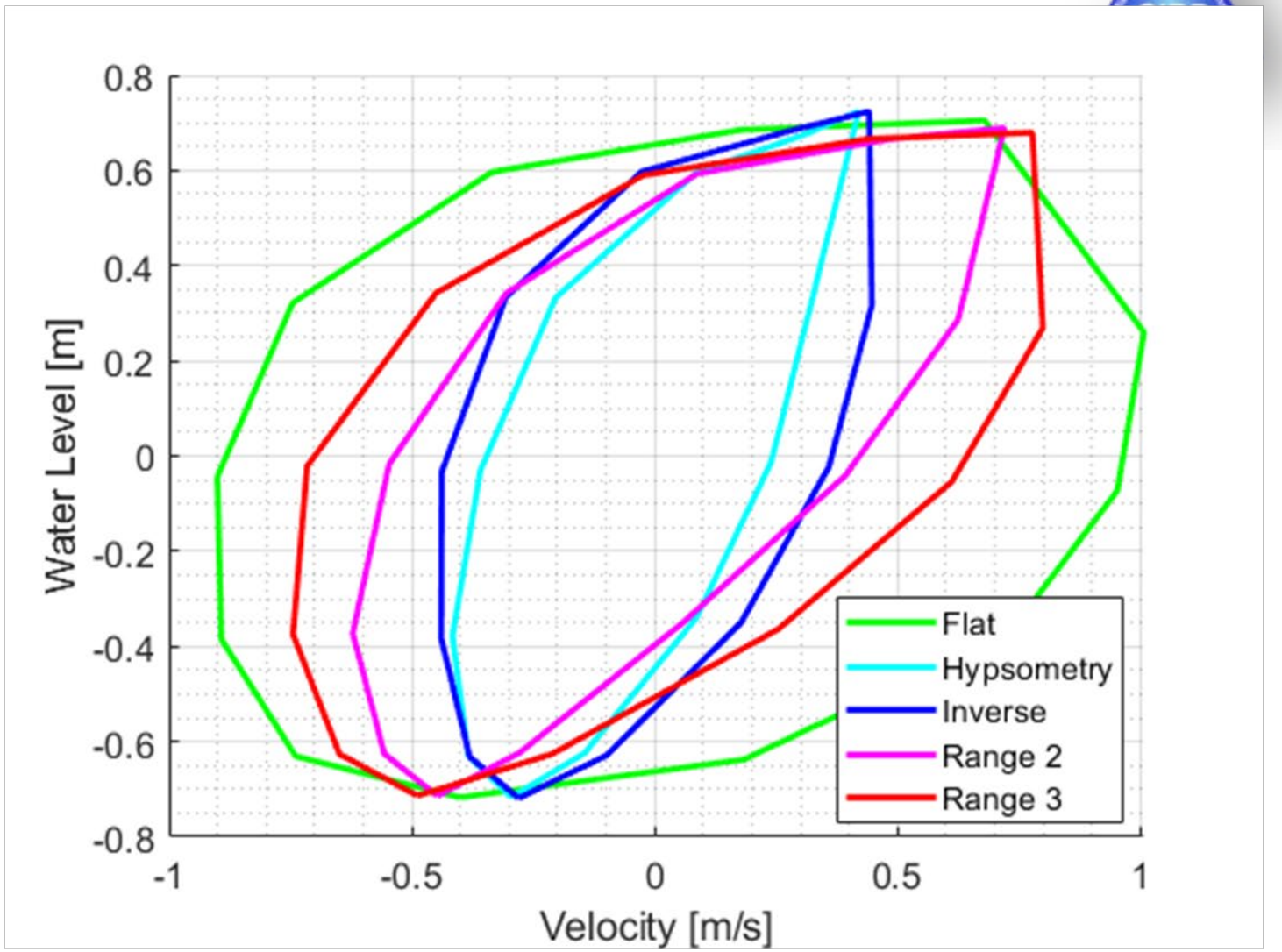




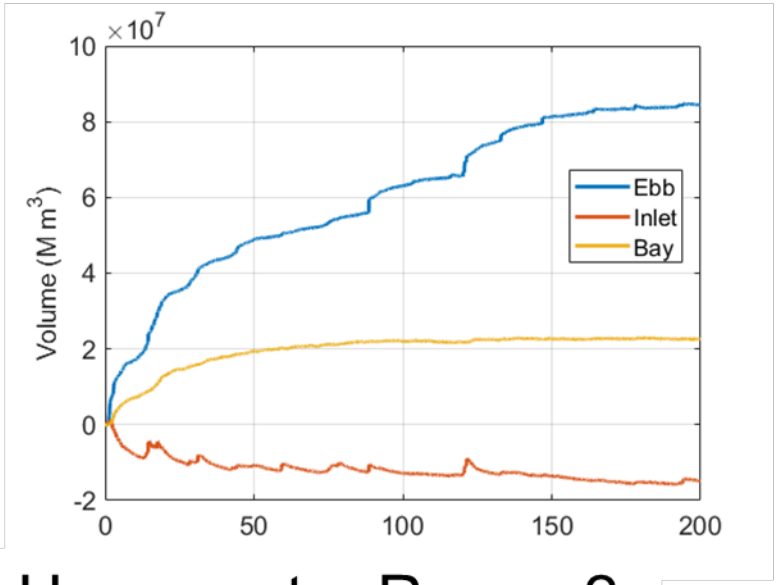


Next Steps

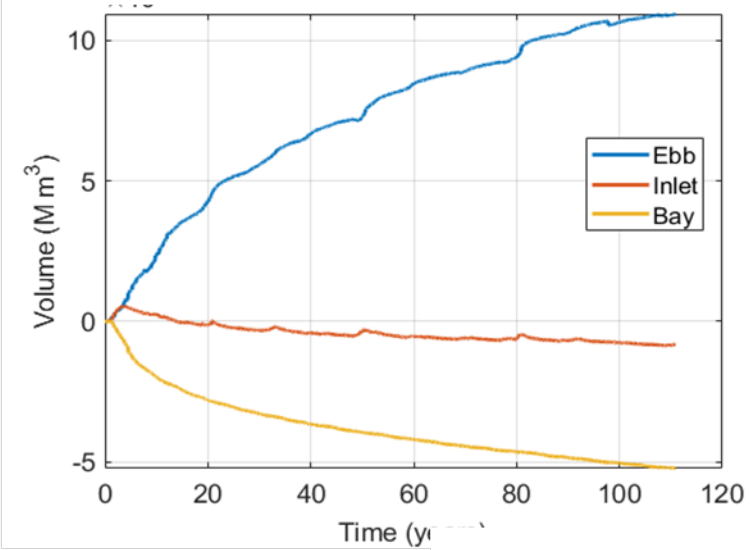
- Explore ebb/flood dominance vs bay geometry/sediment transport
- Relate to theory on bay dynamics
- Identify small class of real tidal inlets and investigate their properties



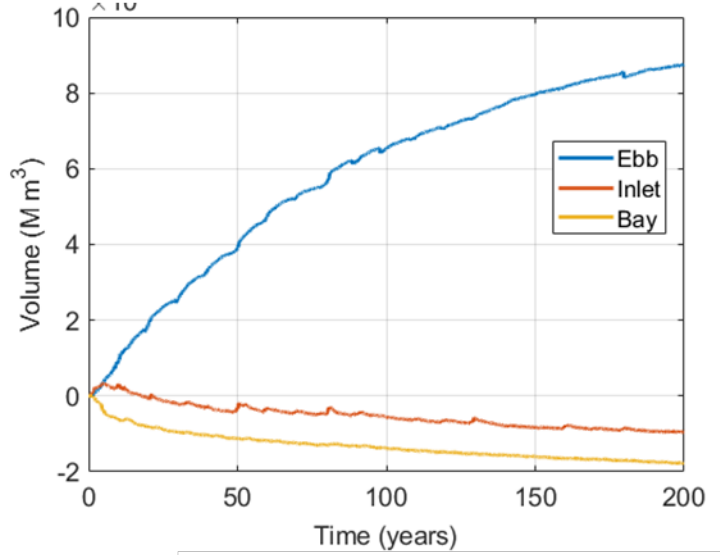
Flat Bathymetry
(No intertidal areas)



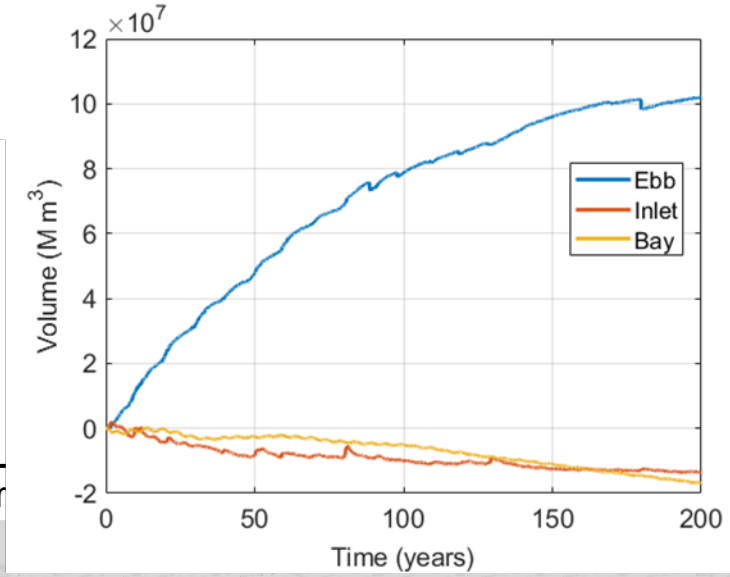
Hypsometry
(Extensive intertidal areas, submerged throughout tide)



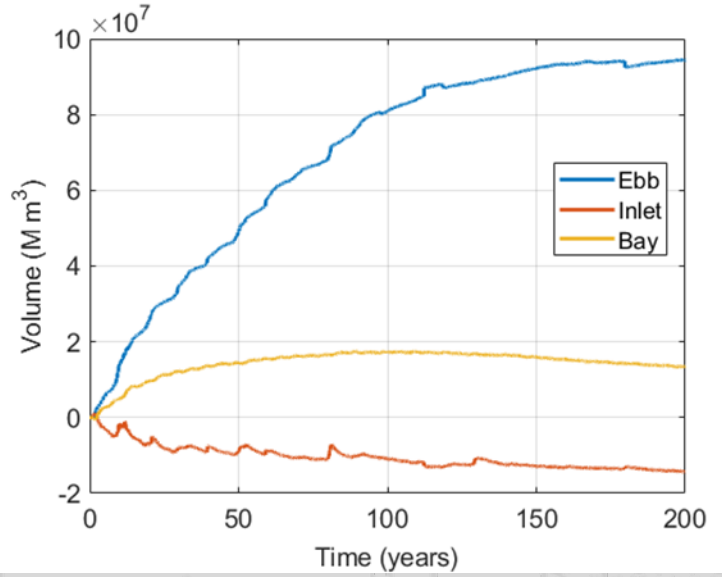
Inverse Hypsometry
(Extensive intertidal areas, submerged near high tide)



Hypsometry Range 2
(Some intertidal area)

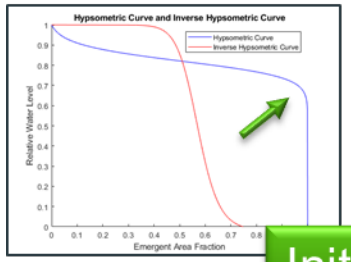


Hypsometry Range 3
(Less intertidal Area)



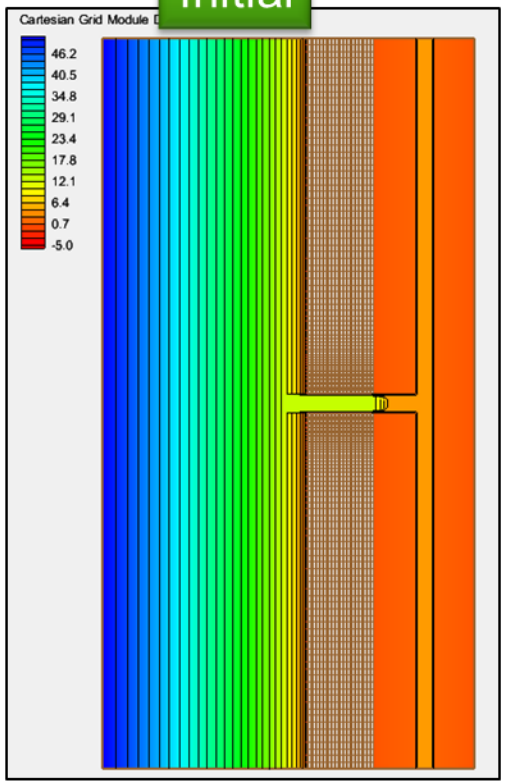
FY19 research – Variation of Hypsometry Curves on Bar Built Bay (Humboldt)

after ~130 'effective' years of sediment transport with tides & waves using acceleration factor

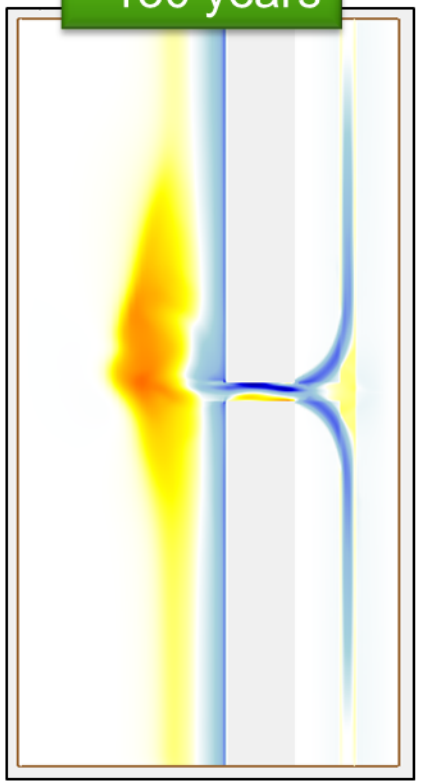


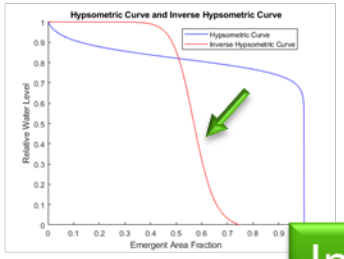
Hypsometry

Initial



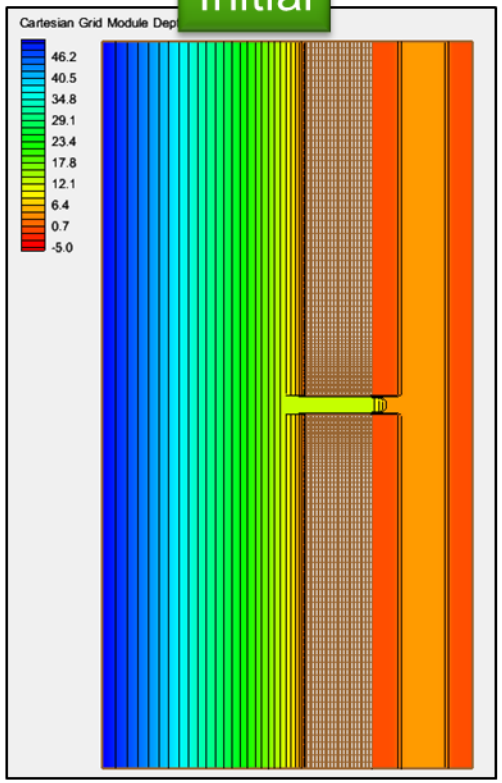
~130 years





Inverse Hypsometry

Initial



~130 years