Assessing and enhancing salt marsh resiliency under climate change for fluvial vs. marine fed systems

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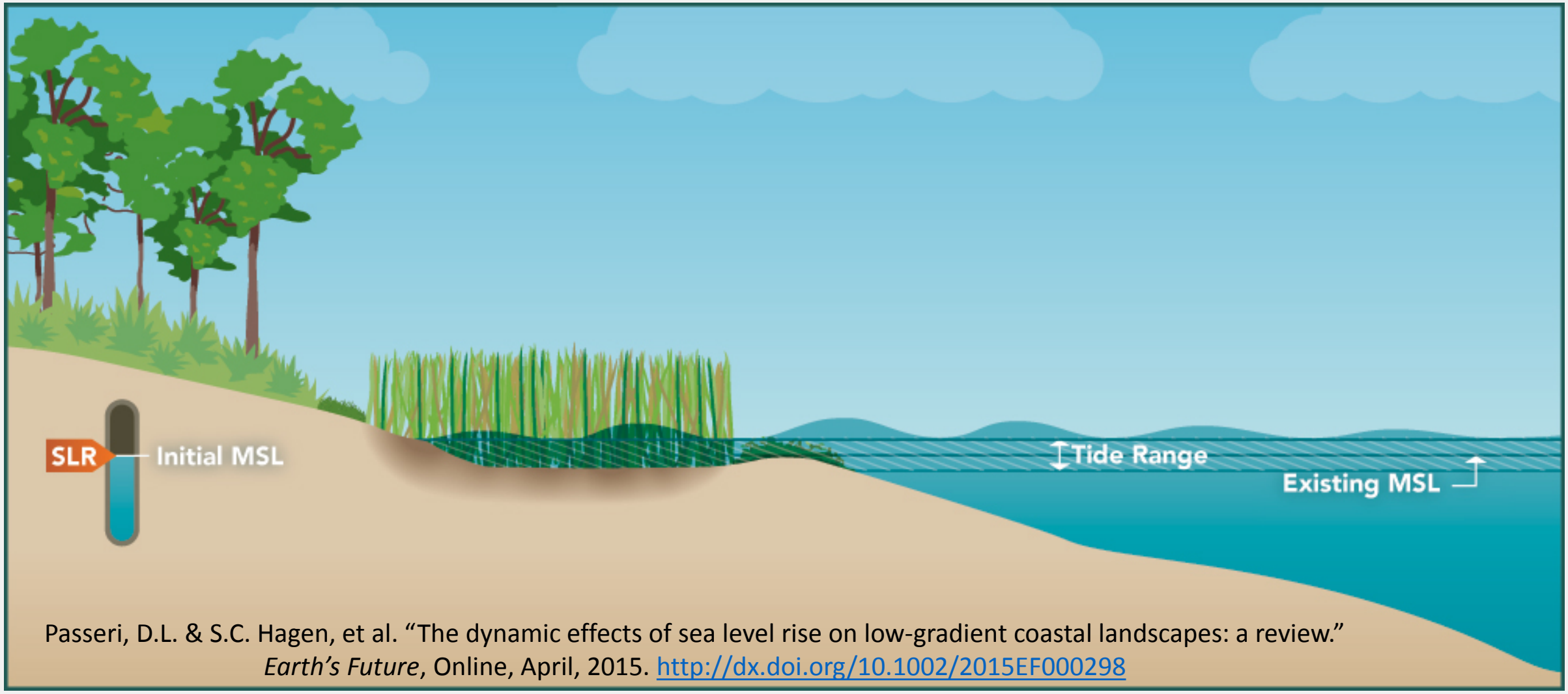
Question to be answered

- What is Hydro-MEM (Hydrodynamic-Marsh Equilibrium Model)?
- Where is Hydro-MEM being applied?
- Will you show us an example application?
- How are the results being used?

Impact of SLR on salt marshes



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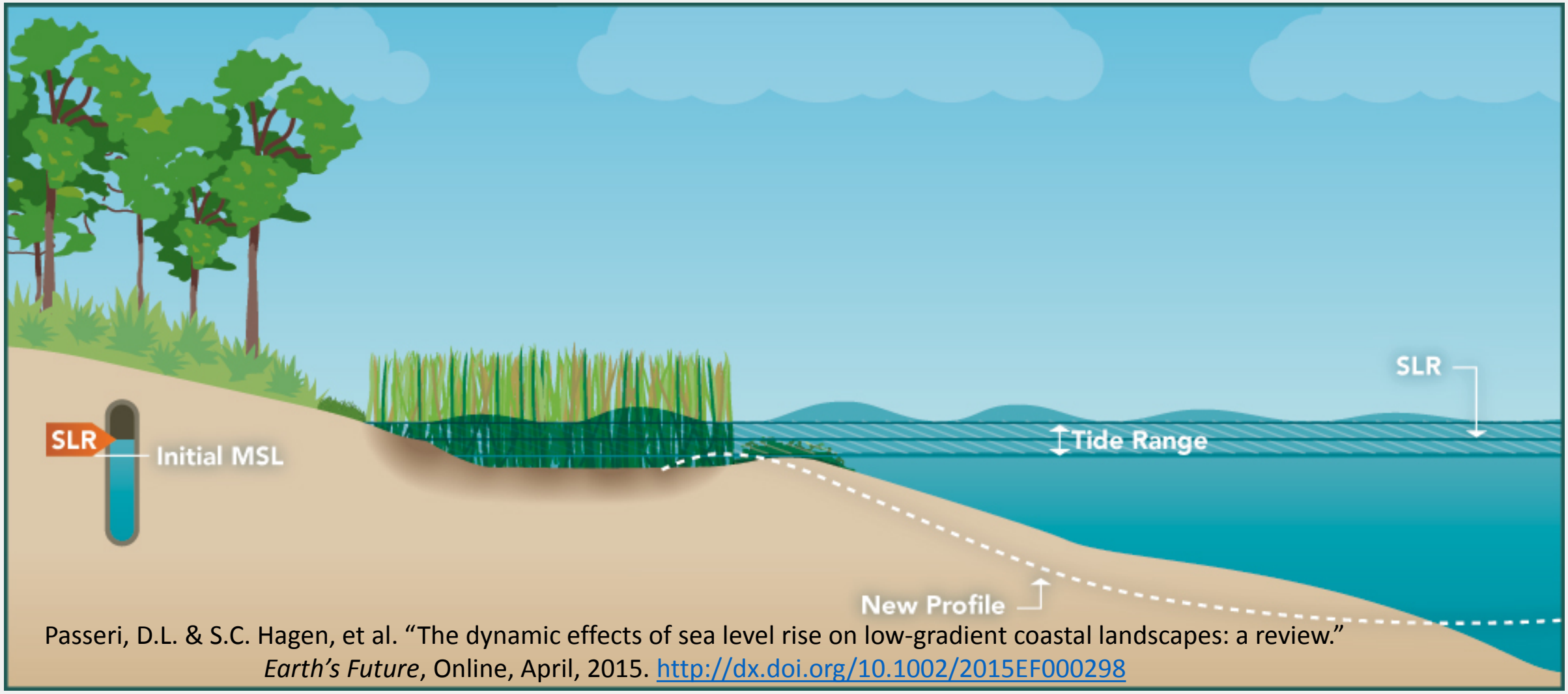

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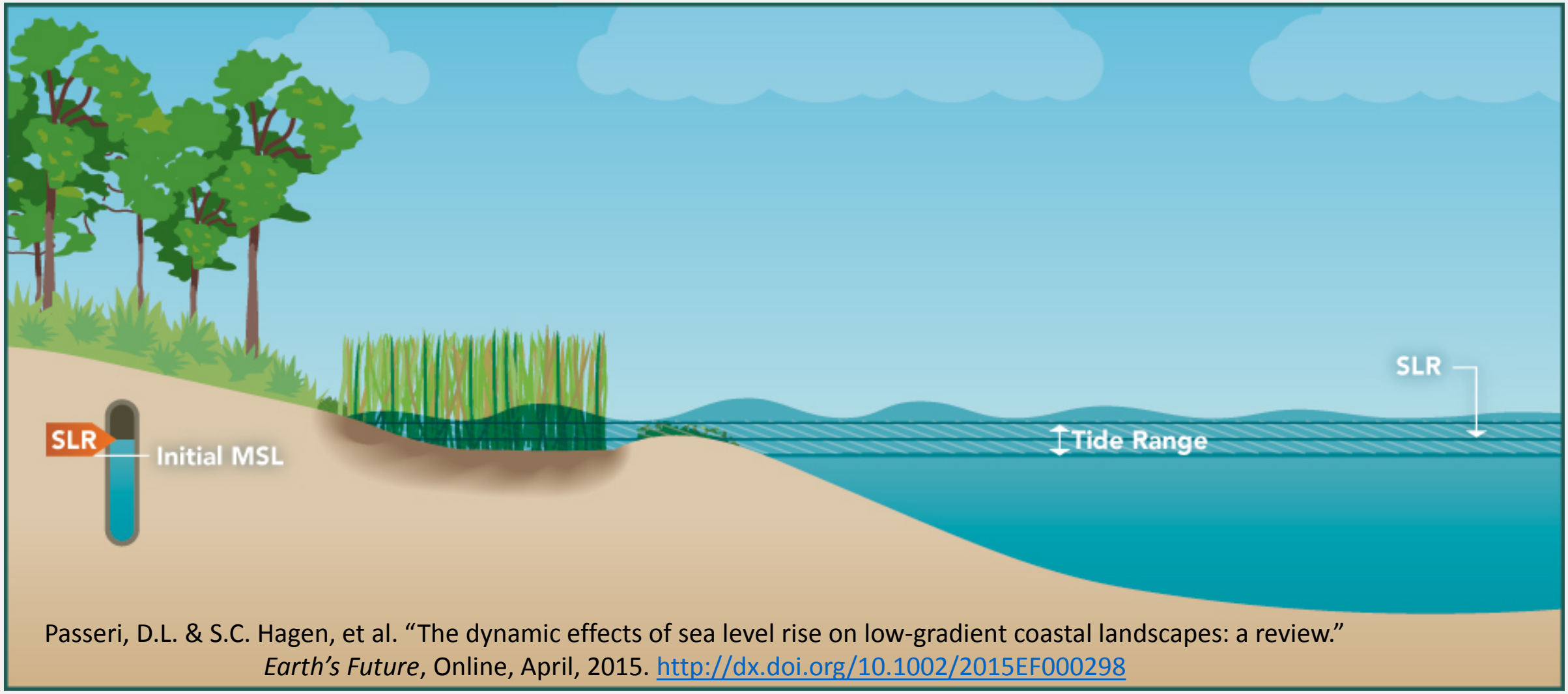

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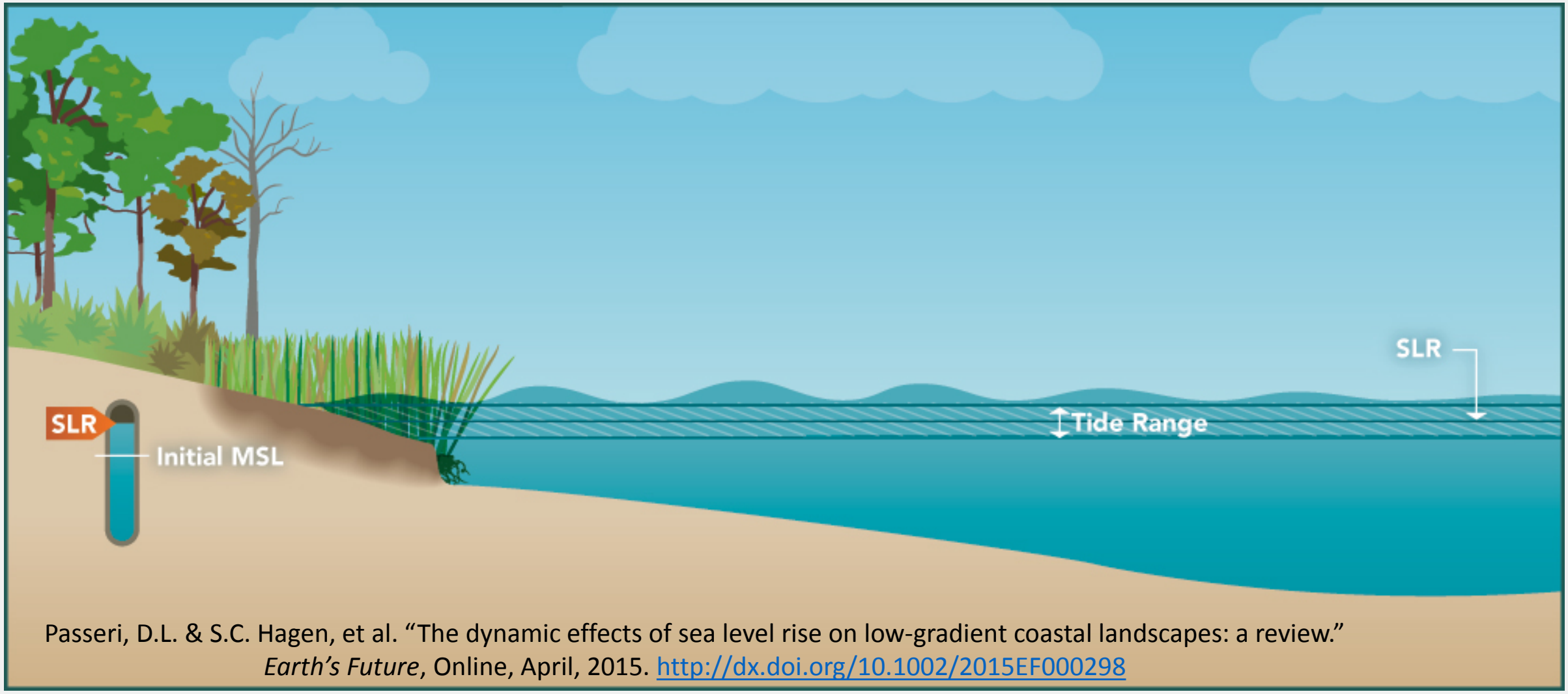

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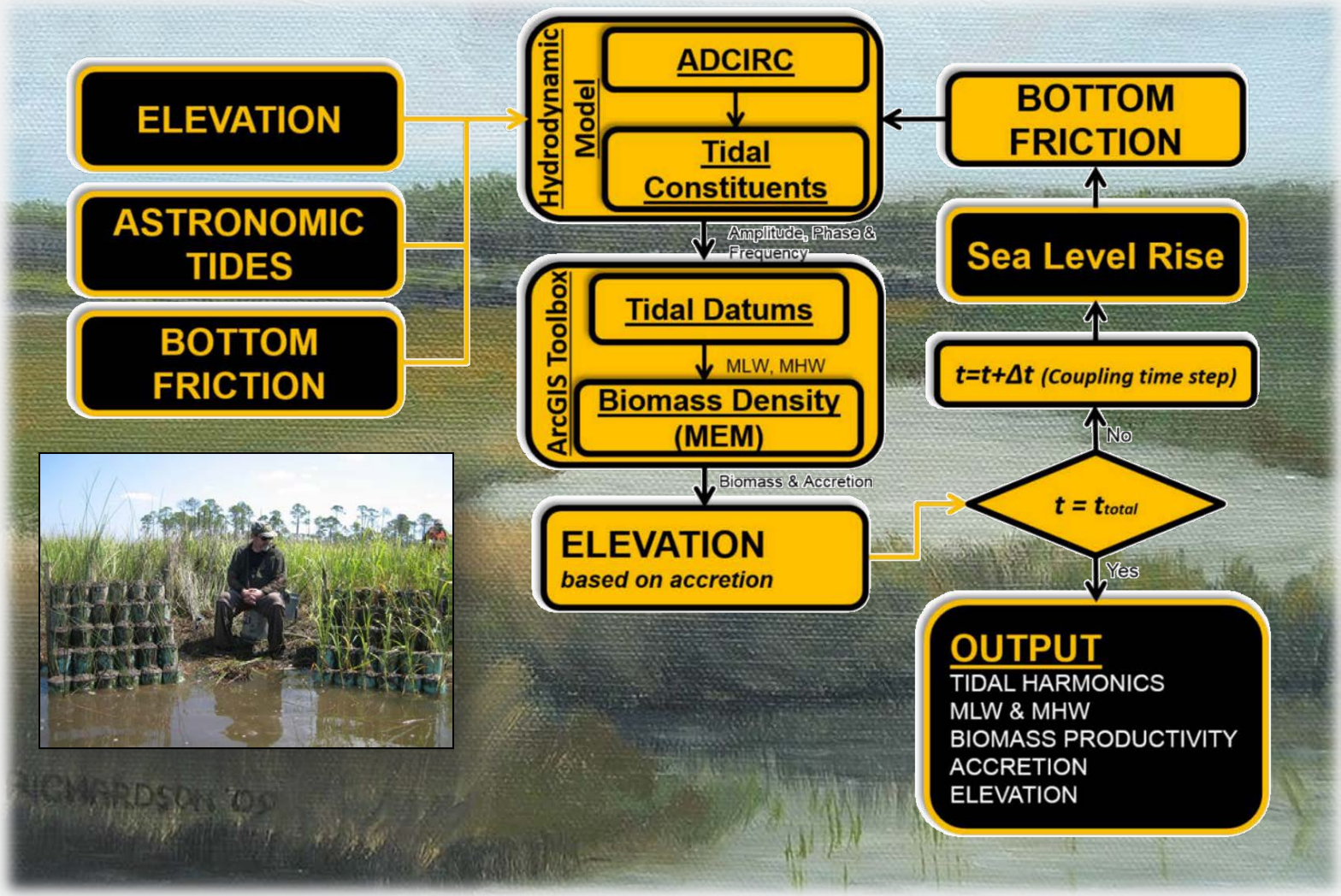
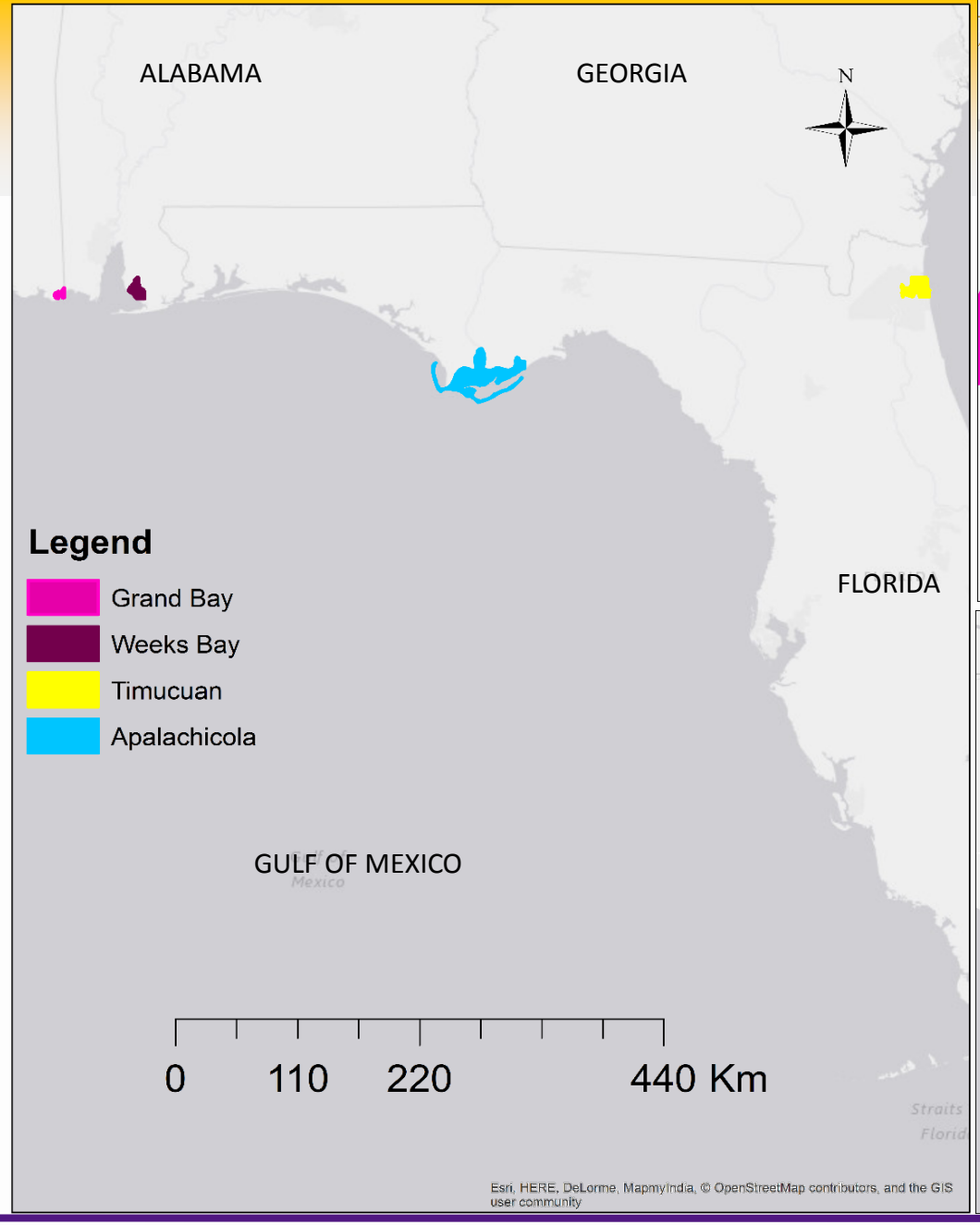
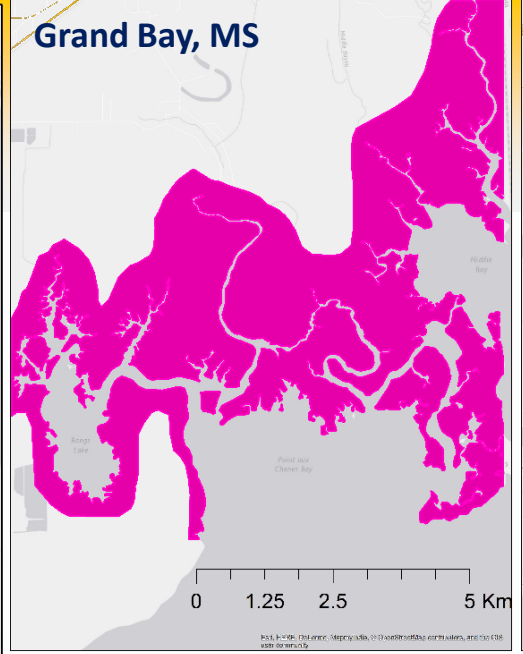
Hydro-MEM (Hydrodynamic-Marsh Equilibrium Model

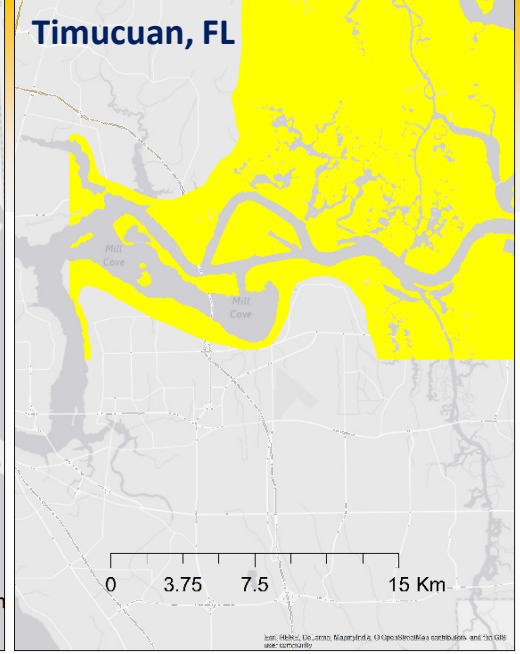
- Alizad, K., S. C. Hagen, Morris, J.T., Bacopoulos, P., Bilskie, M.V., Weishampel, J.F., Medeiros, S.C. (2016). A Coupled, Two-Dimensional Hydrodynamic-Marsh Model with Biological Feedback. *Ecological Modeling, Vol. 327, pp. 29-43.*
- Hagen, S.C., J.T. Morris, P. Bacopoulos, & J. Weishampel. 2013. Sea-Level Rise Impact on a Salt Marsh System of the Lower St. Johns River. *ASCE J. of Waterway, Port, Coastal, and Ocean Engineering, Vol. 139, No. 2, Mar./Apr. 2013, p. 118-125.*
- Morris, J.T., P.V. Sundareshwar, C.T. Nietch, B. Kjerfve, and D.R. Cahoon. 2002. Responses of coastal wetlands to rising sea level. *Ecology 83: 2869-2877.*

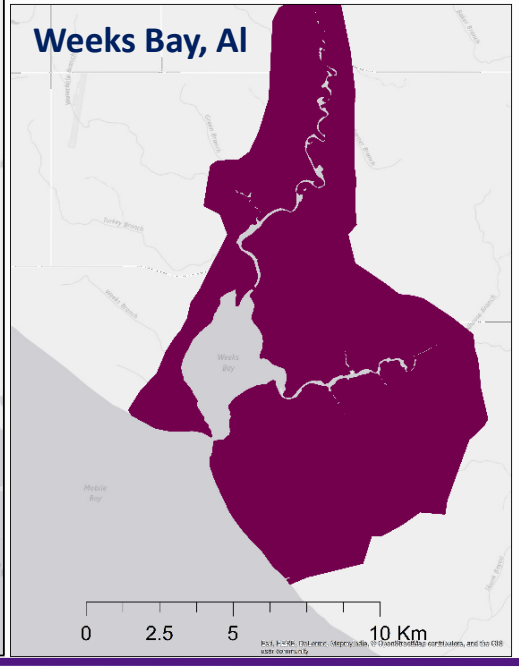


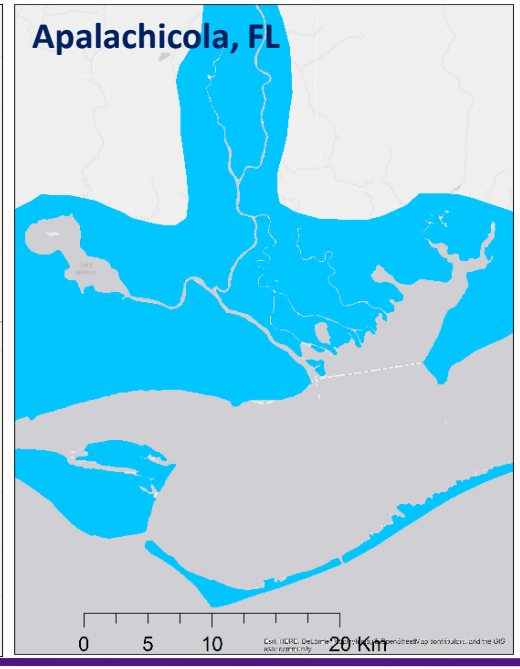
Hydro-MEM Applications



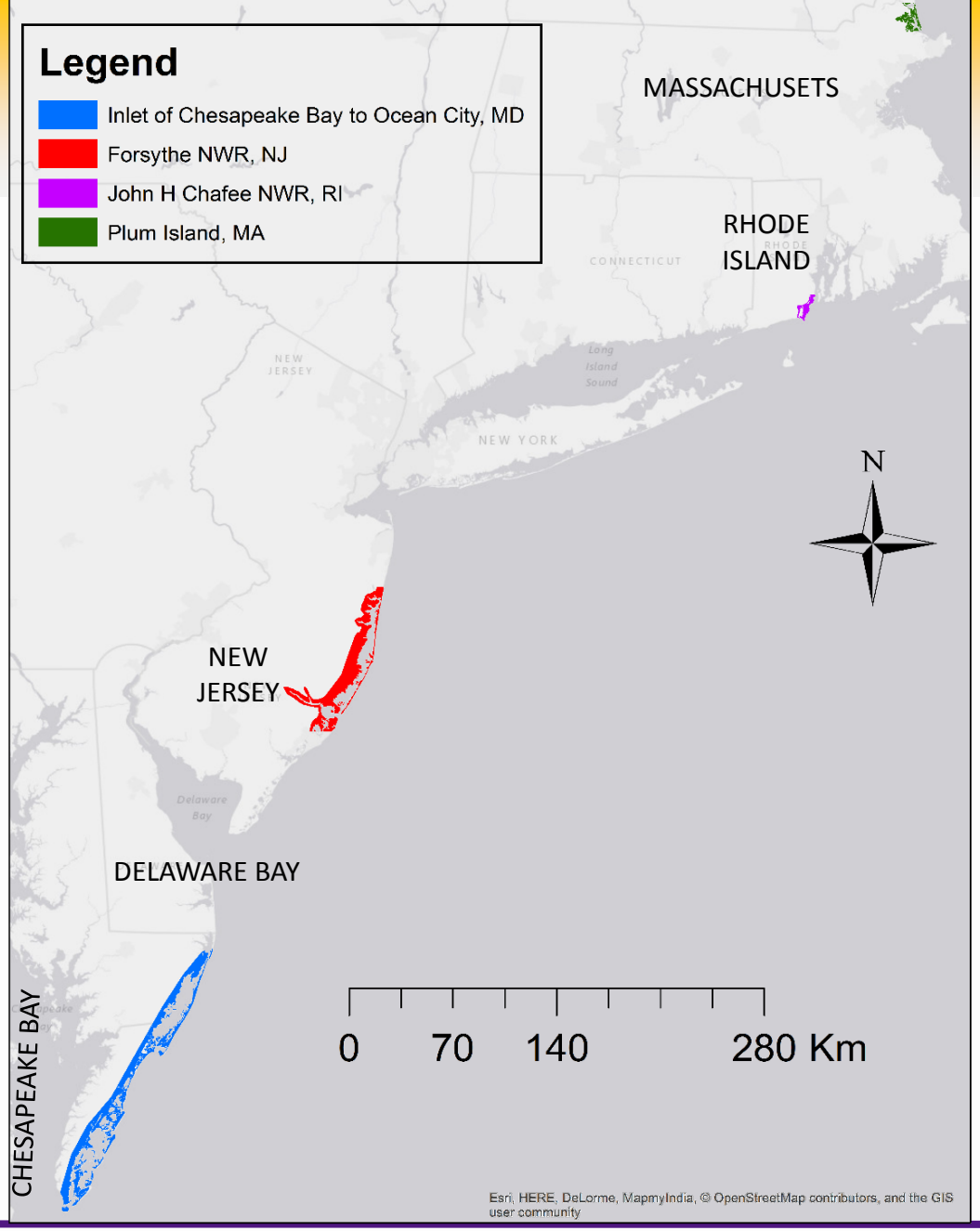


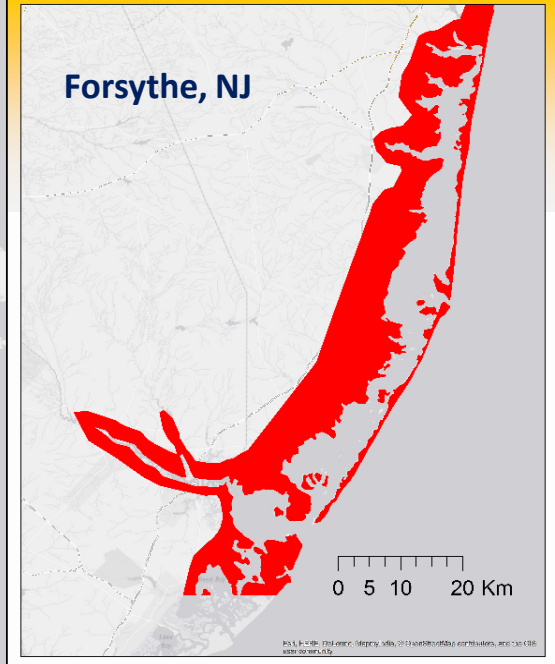


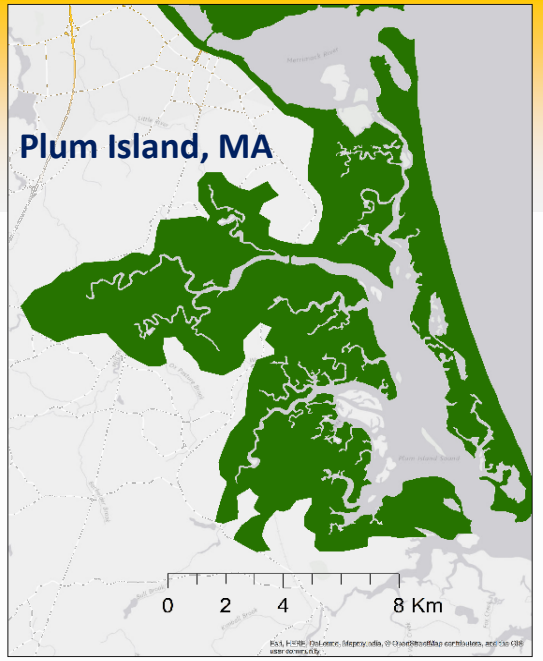


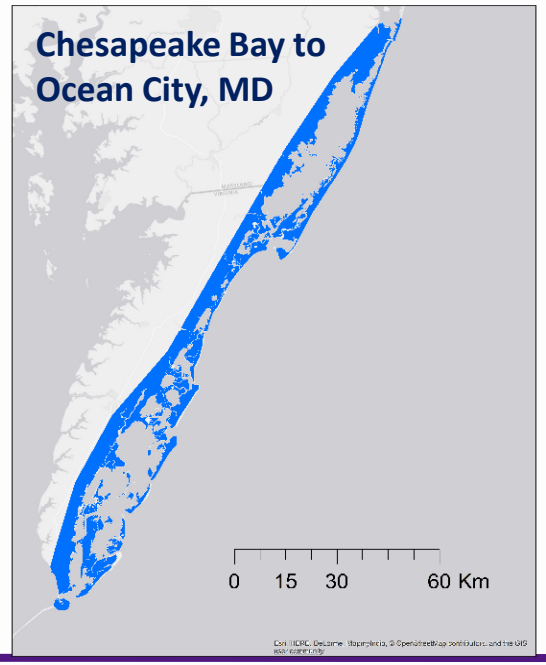


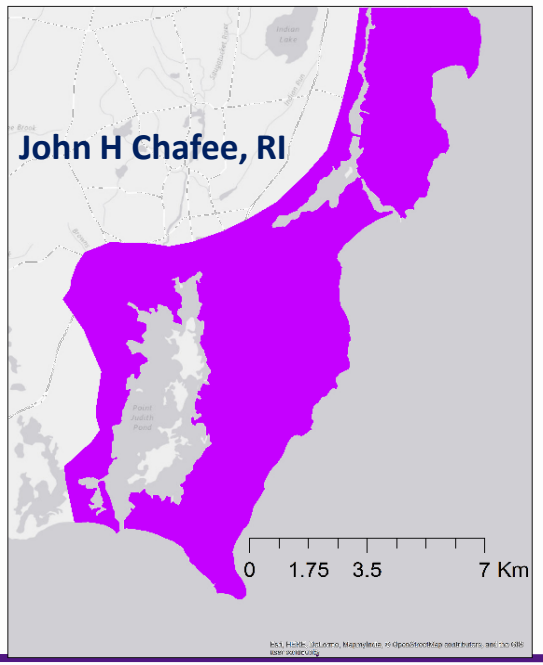
Hydro-MEM Applications



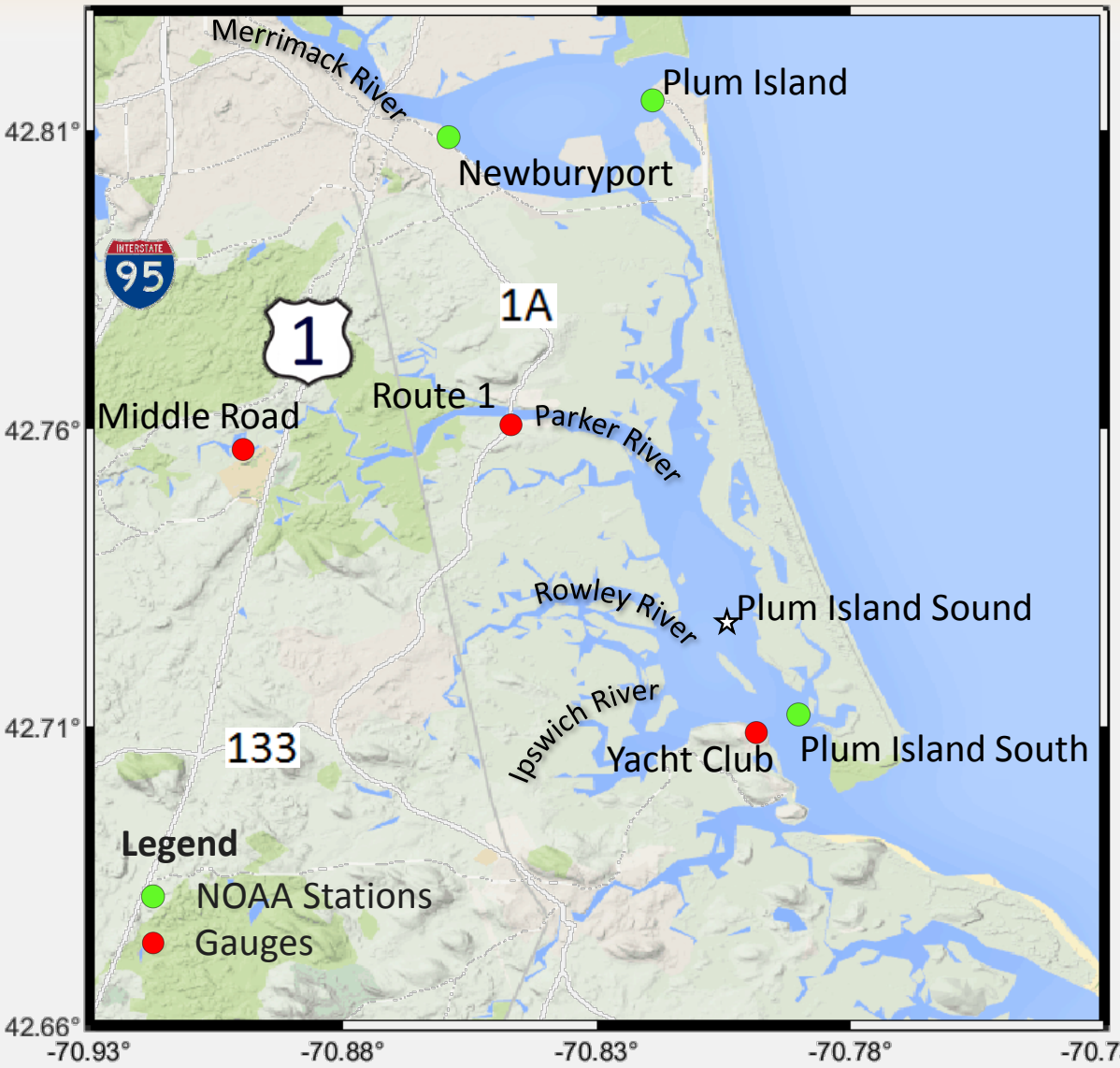


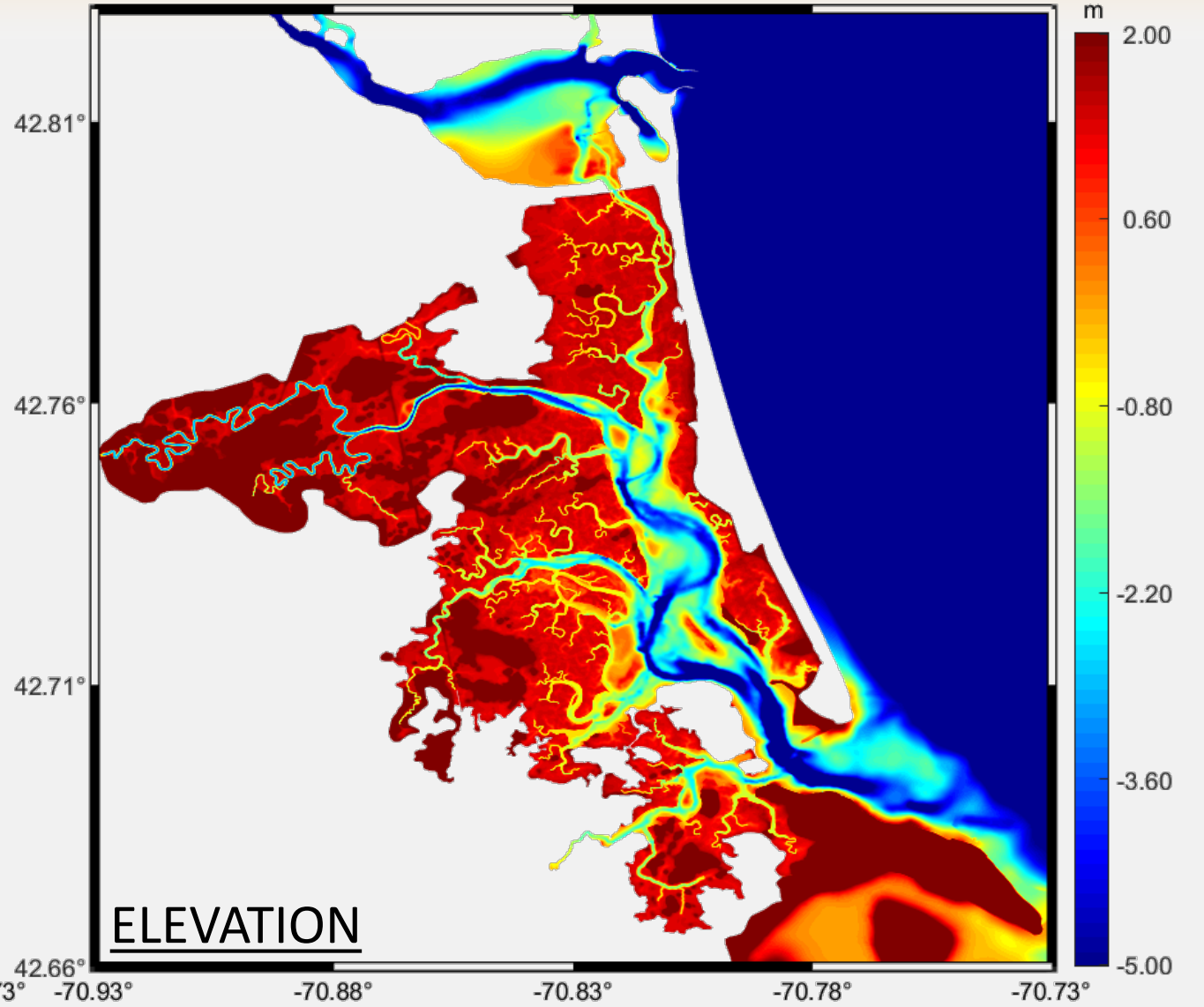




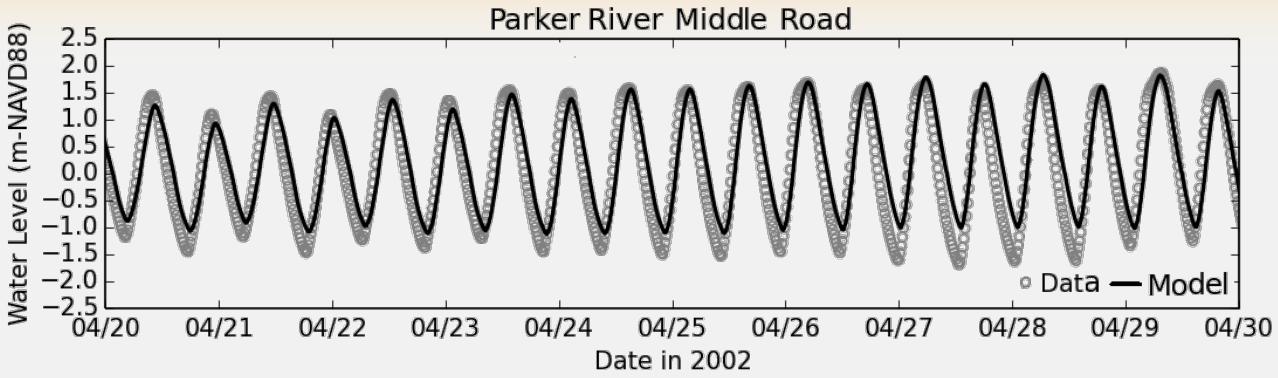


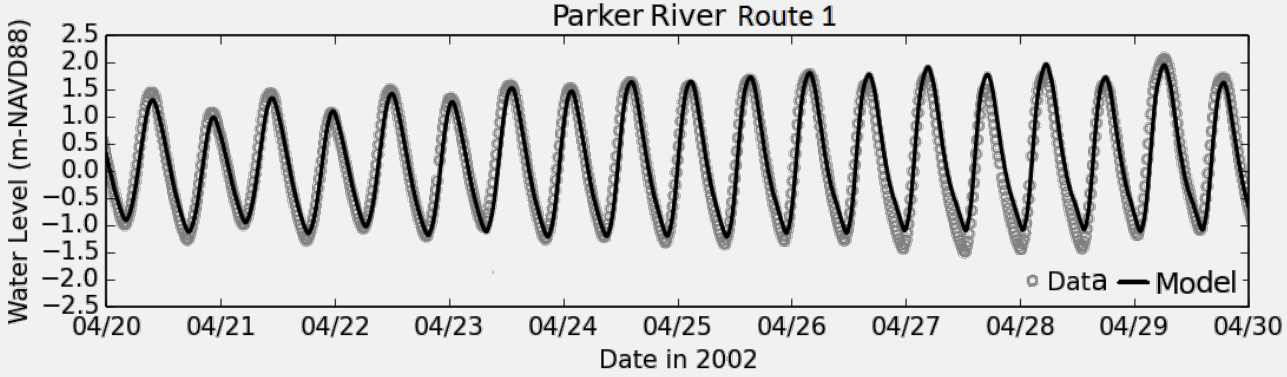
Plum Island Estuary

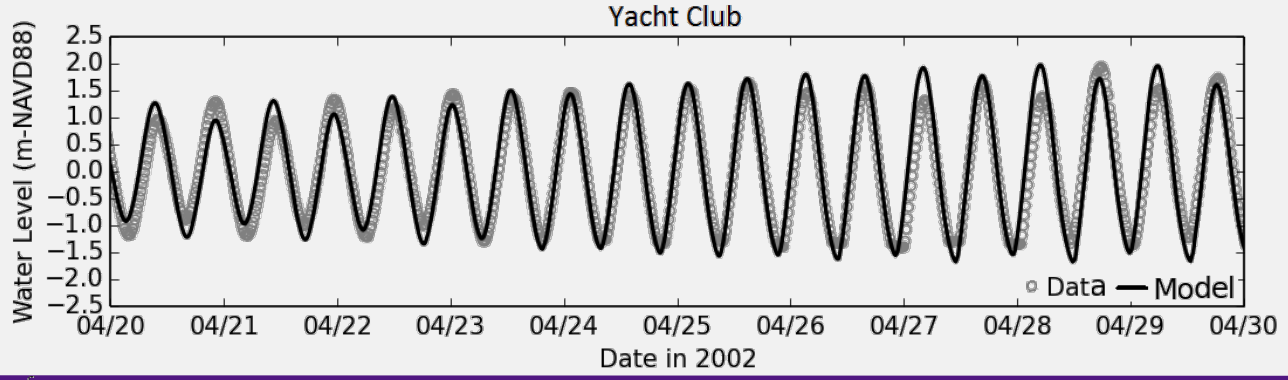


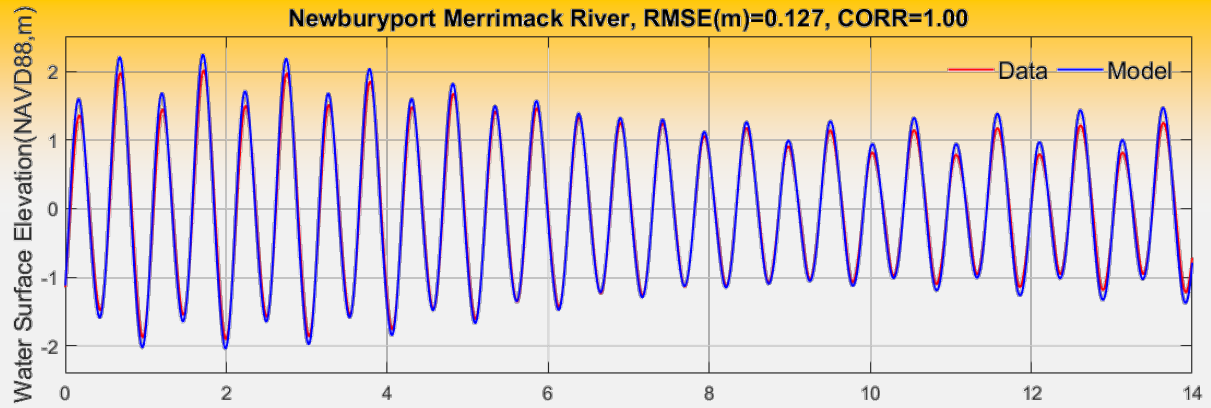


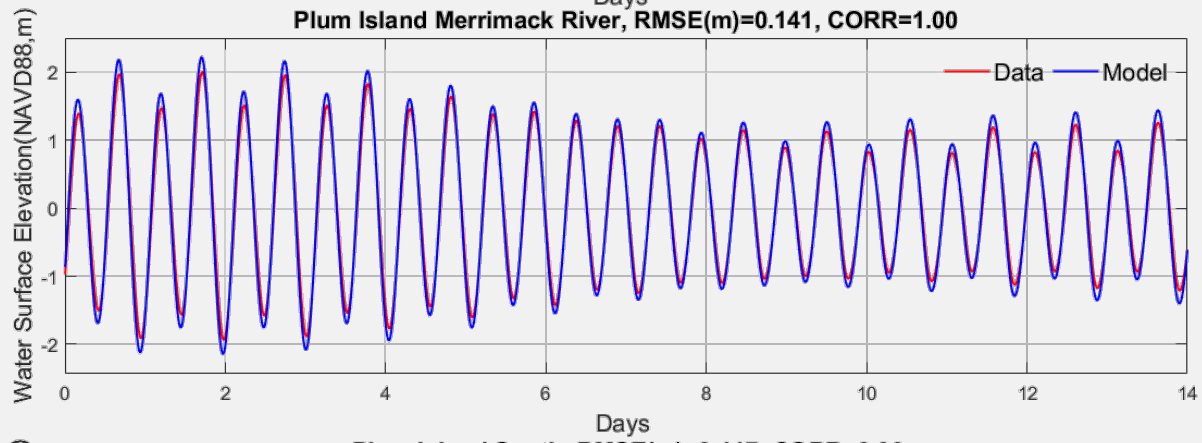
Tidal Model Validation

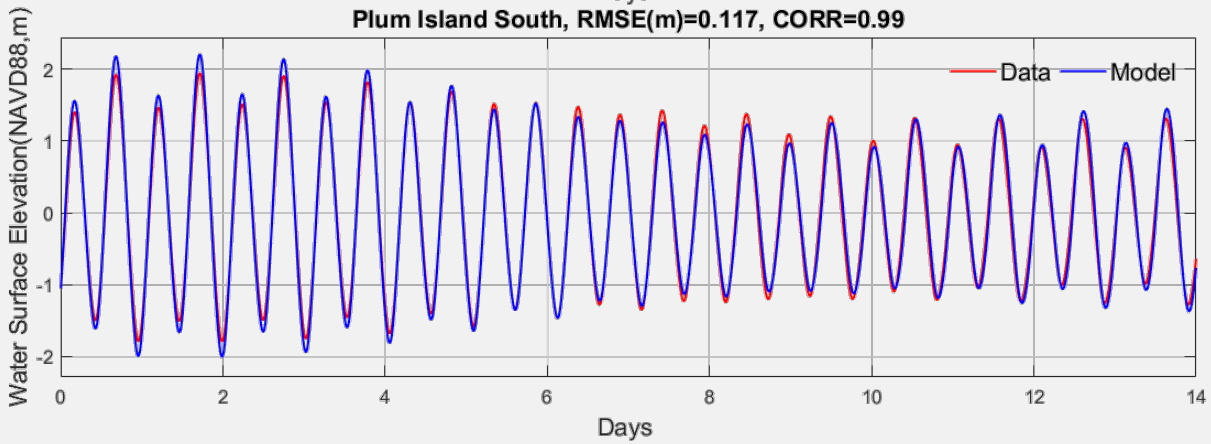








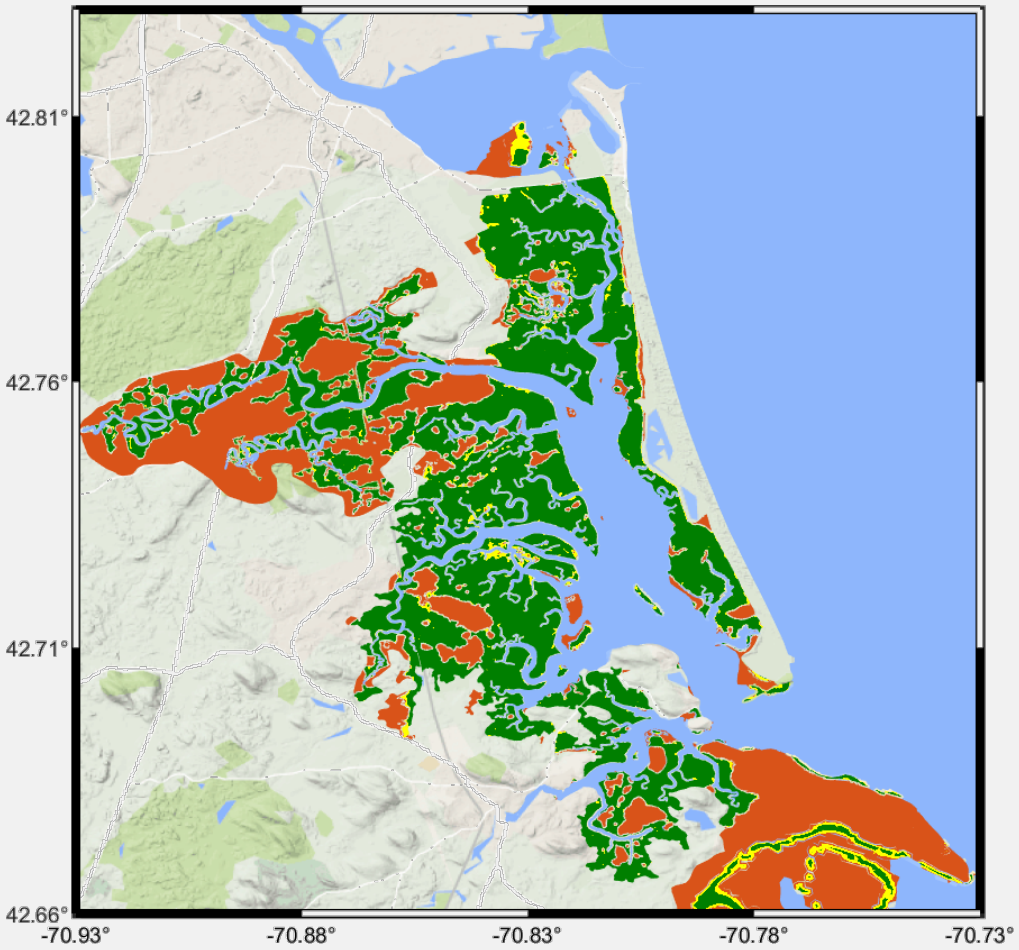




Tidal flood/ebb for Plumb Island Estuary

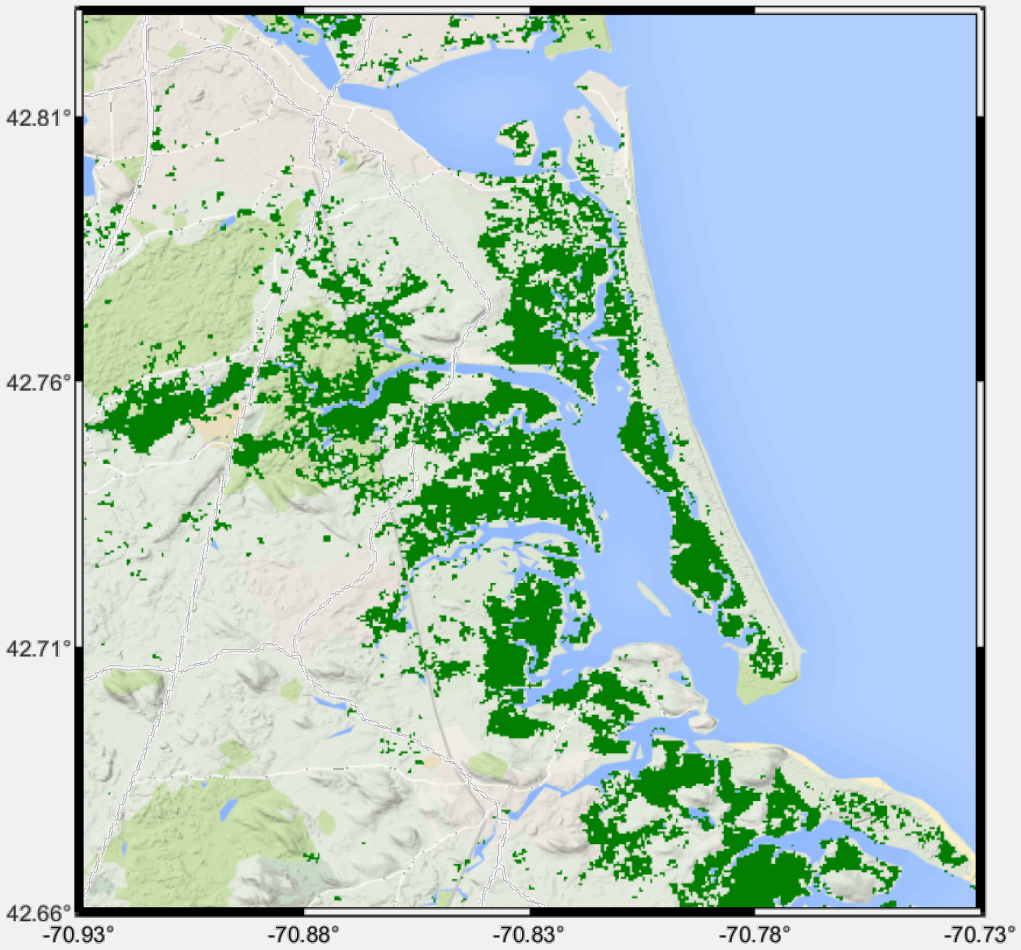
A qualified result from Hydro-MEM at PIE

Biomass distribution



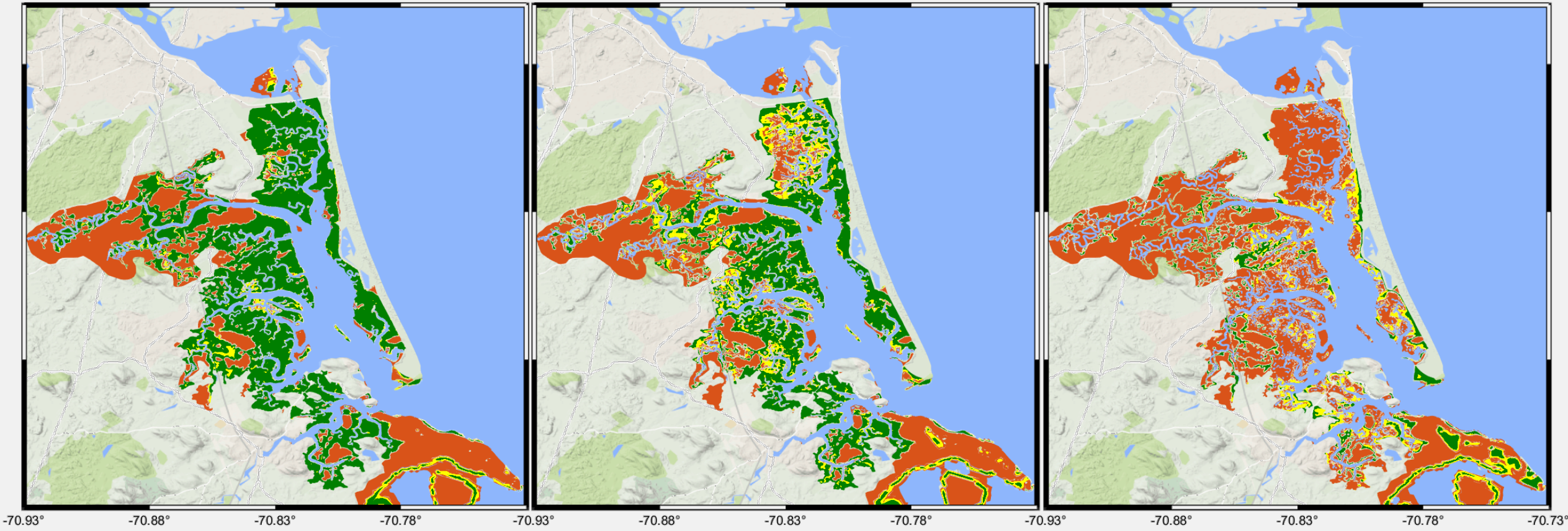
Low Medium High

LULC



Inter-tidal vegetation

Hydro-MEM: Biomass density



20 cm SLR

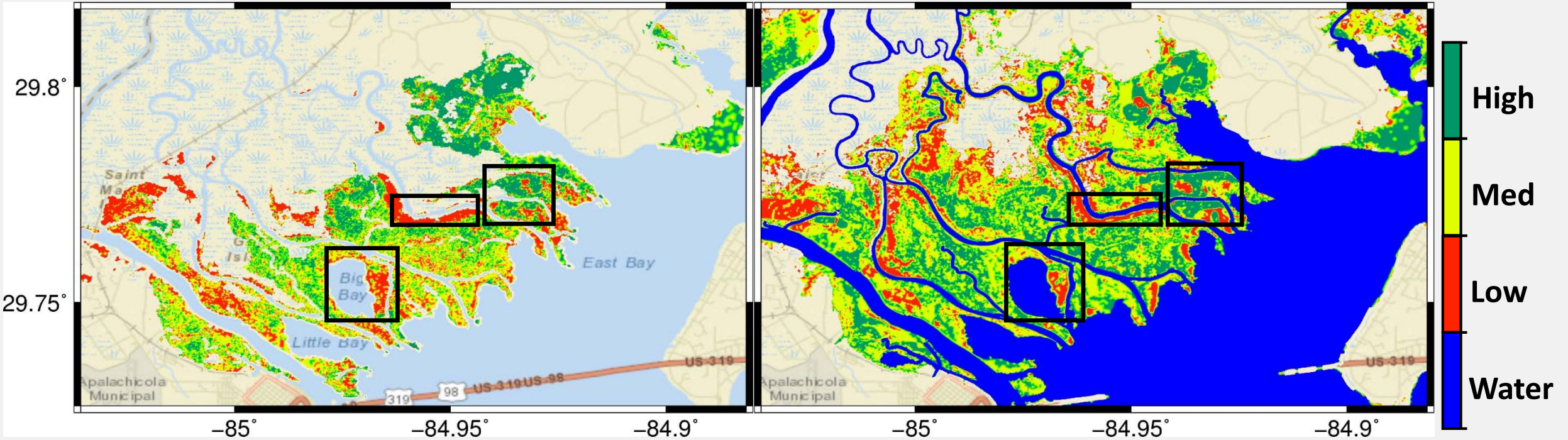
50 cm SLR

120 cm SLR

Hydro-MEM at Apalachicola: Biomass density validation

*IfSAR Biomass Density

Hydro-MEM Biomass Density

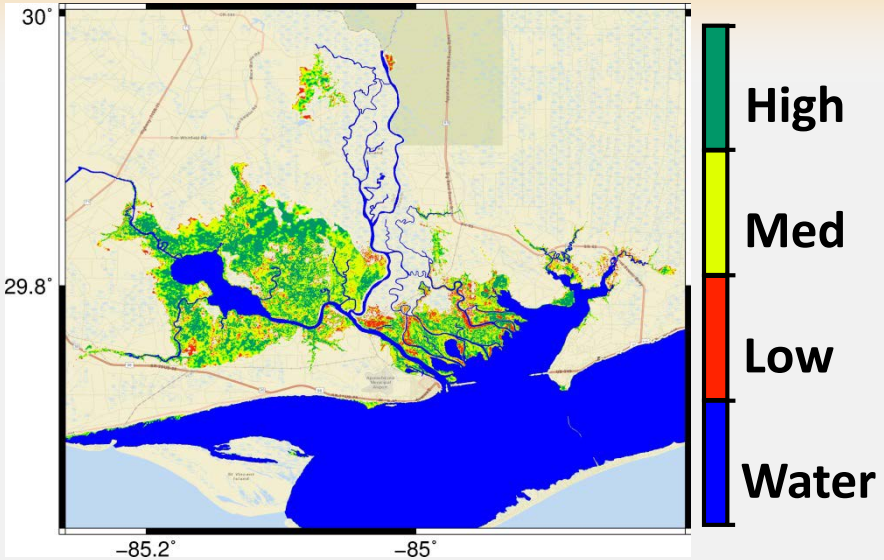


*Medeiros, S., S. Hagen, J. Weishampel, and J. Angelo (2015), Adjusting Lidar-Derived Digital Terrain Models in Coastal Marshes Based on Estimated Aboveground Biomass Density, Remote Sensing, 7(4), 3507.

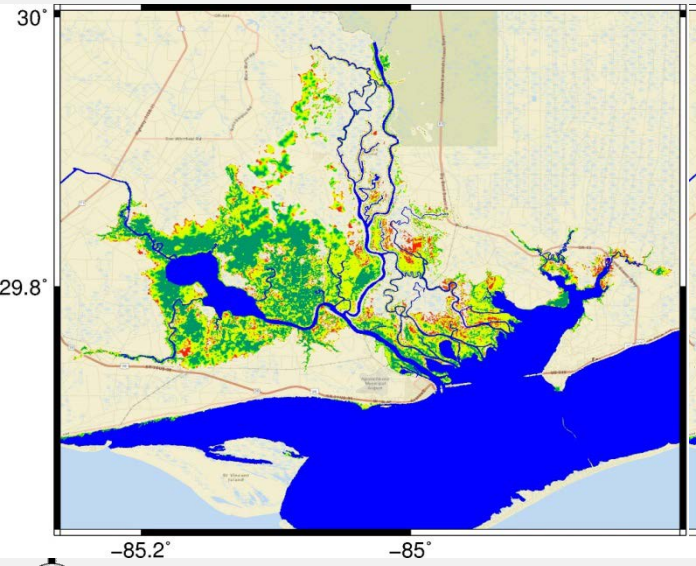
Hydro-MEM at Apalachicola:

Year 2020 SLR scenario
Biomass density

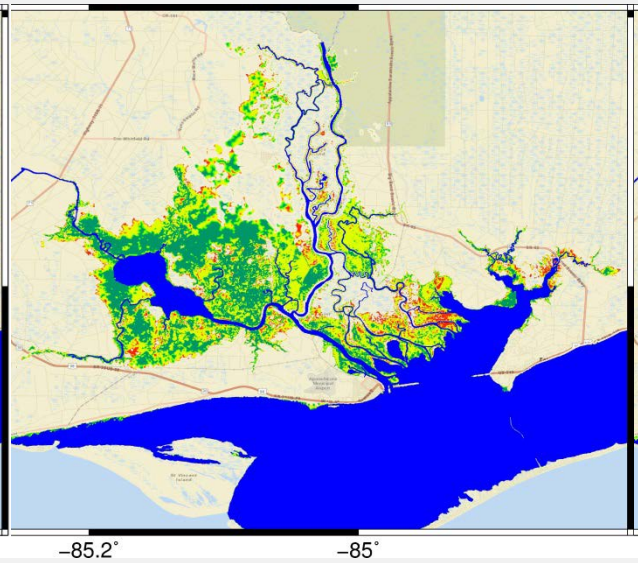
Present day



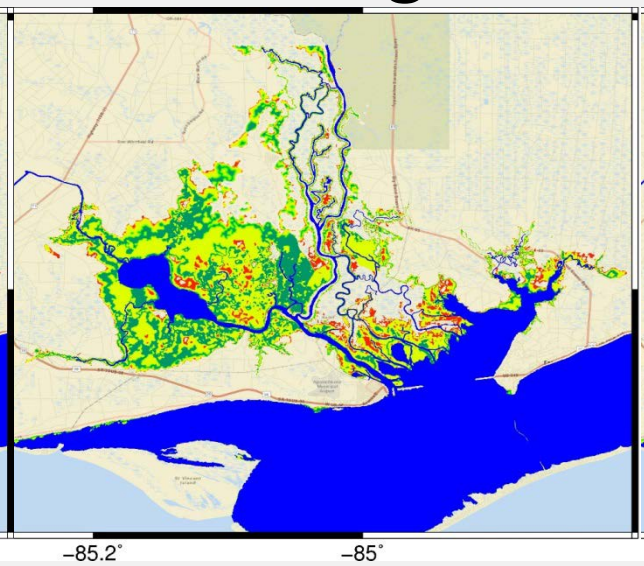
Low



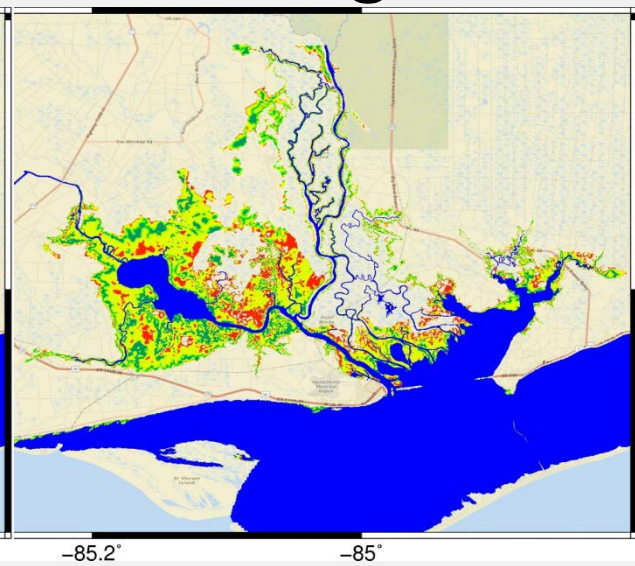
Int. Low



Int. High



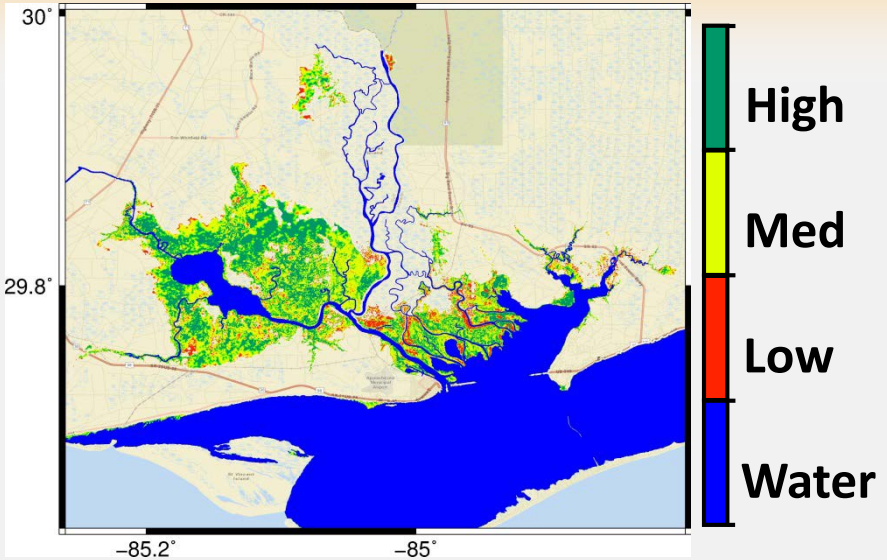
High



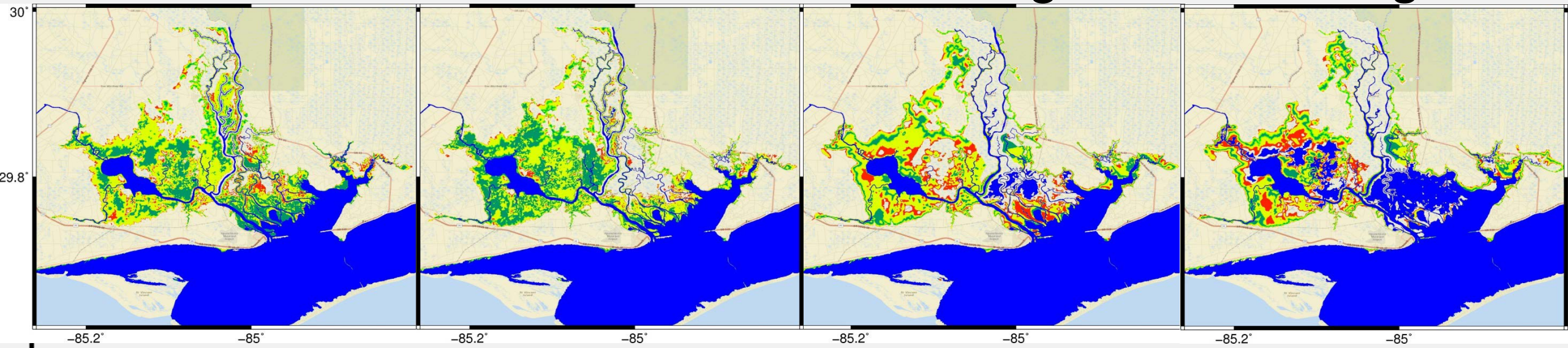
Hydro-MEM at Apalachicola:

Year 2050 SLR scenario
Biomass density

Present day



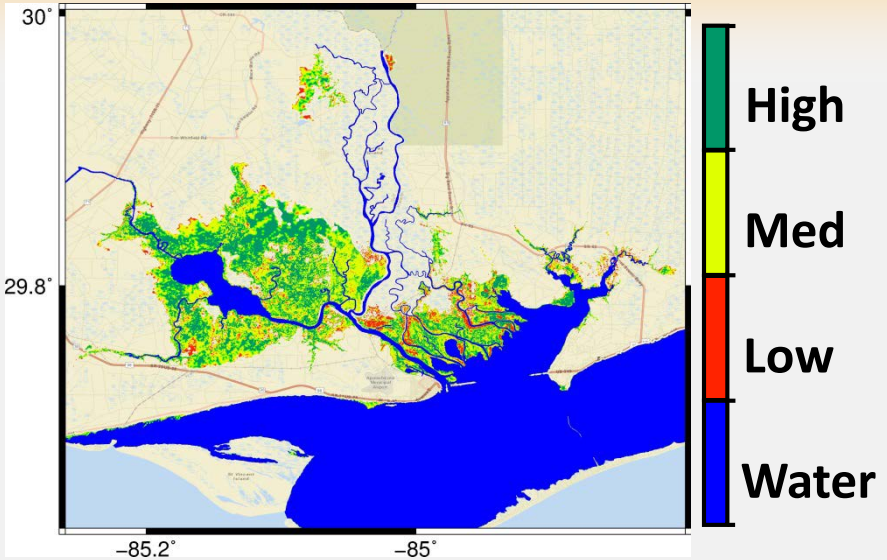
Low | Int. Low | Int. High | High



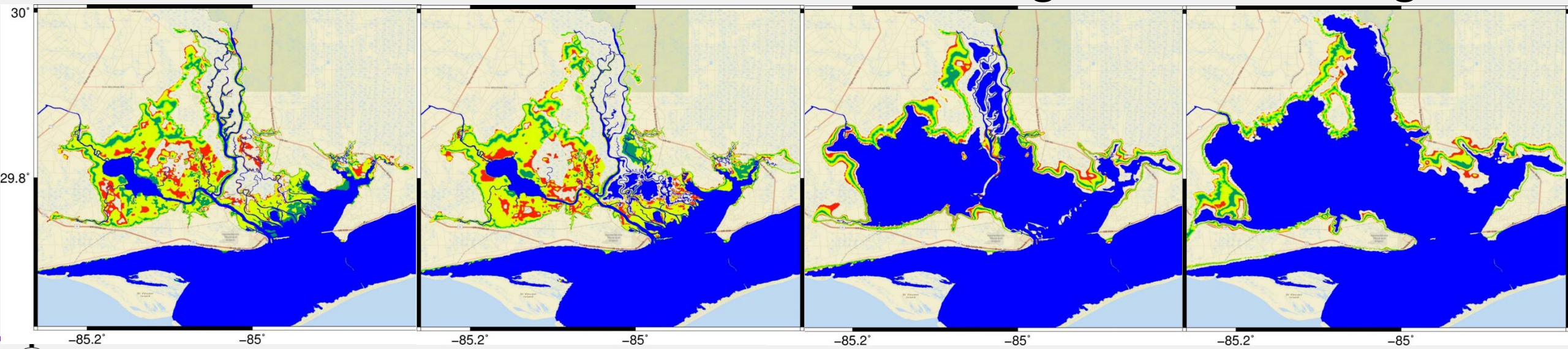
Hydro-MEM at Apalachicola:

Year 2100 SLR scenario
Biomass density

Present day

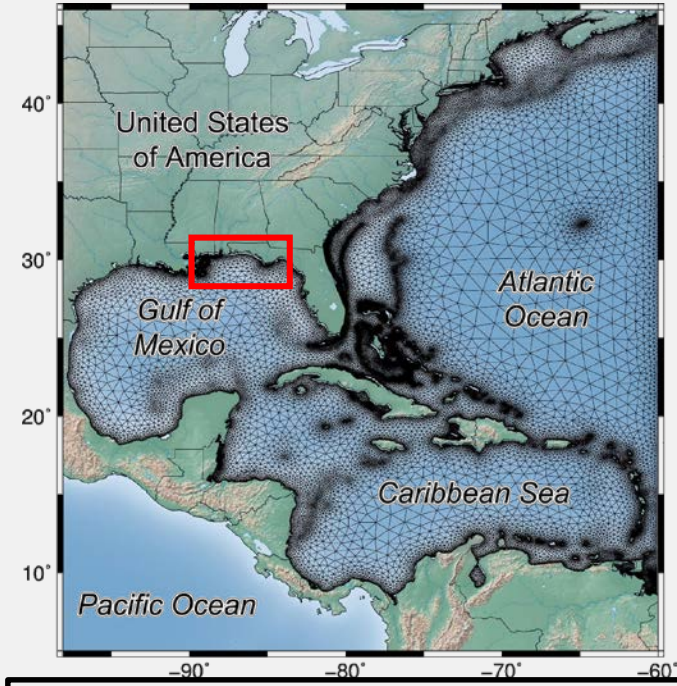


Low | Int. Low | Int. High | High

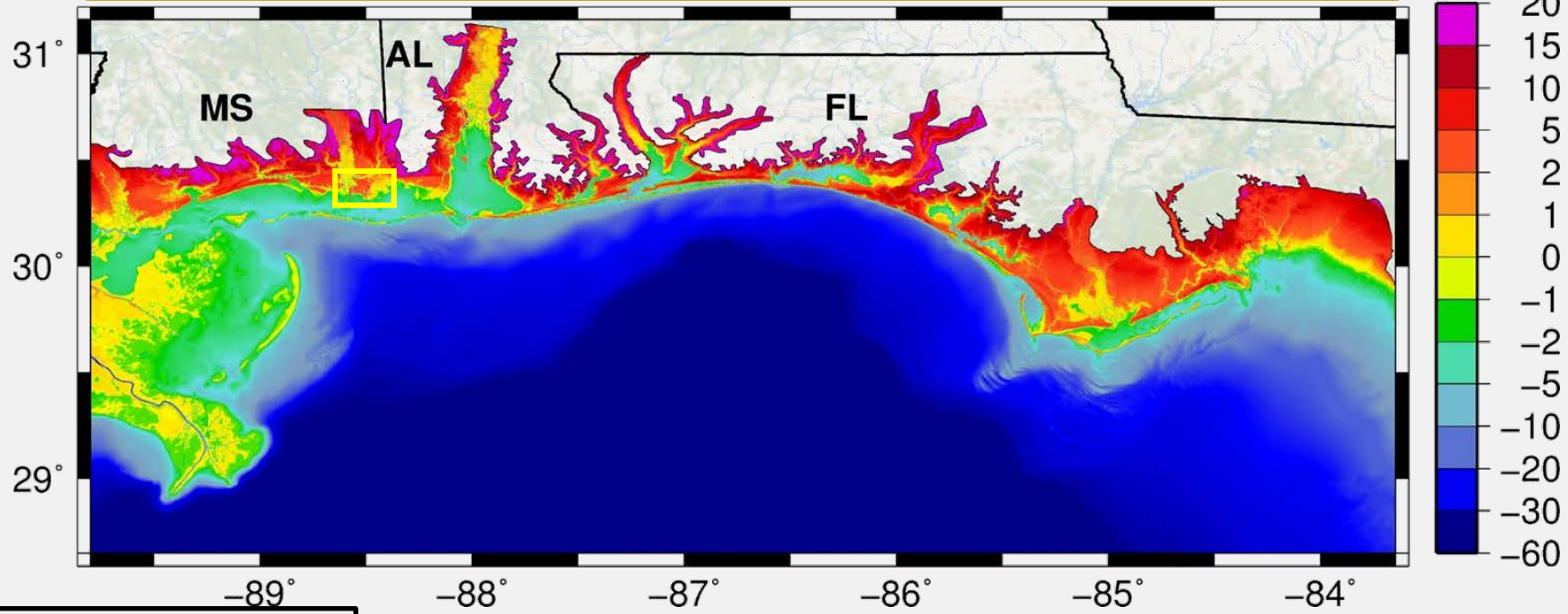


Tide/surge modeling in the northern Gulf of Mexico

Large-scale region approach



5.5 million compute nodes / ~20,000 km2 of floodplain (4.9 million acres)

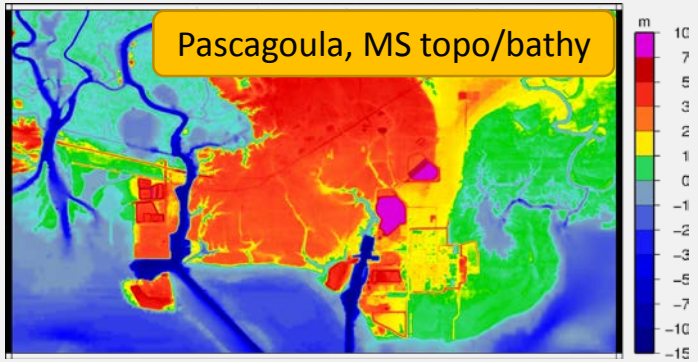


Five relevant publications

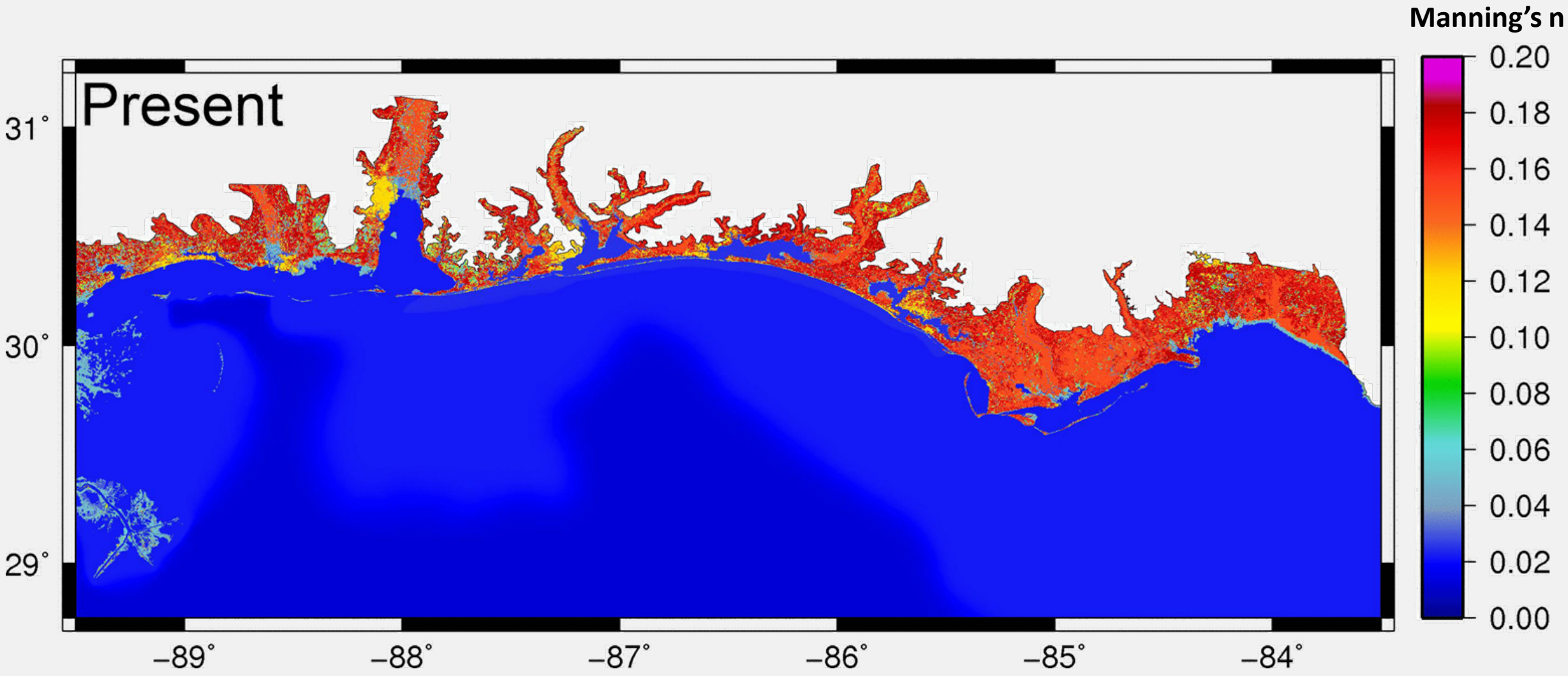
1. Dynamics of sea level rise and coastal flooding on a changing landscape, http://dx.doi.org/10.1002/2013GL058759
2. The dynamic effects of sea level rise on low-gradient coastal landscapes: a review, http://dx.doi.org/10.1002/2015EF000298
3. A coupled, two-dimensional hydrodynamic-marsh model with biological feedback, http://dx.doi.org/10.1016/j.ecolmodel.2016.01.013
4. Tidal Hydrodynamics under Future Sea Level Rise and Coastal Morphology in the Northern Gulf of Mexico, http://dx.doi.org/10.1002/2015EF000332
5. Dynamic simulation and numerical analysis of hurricane storm surge under SLR with geomorphologic changes along the northern Gulf, http://dx.doi.org/10.1002/2015EF000347

Pascagoula, MS aerial

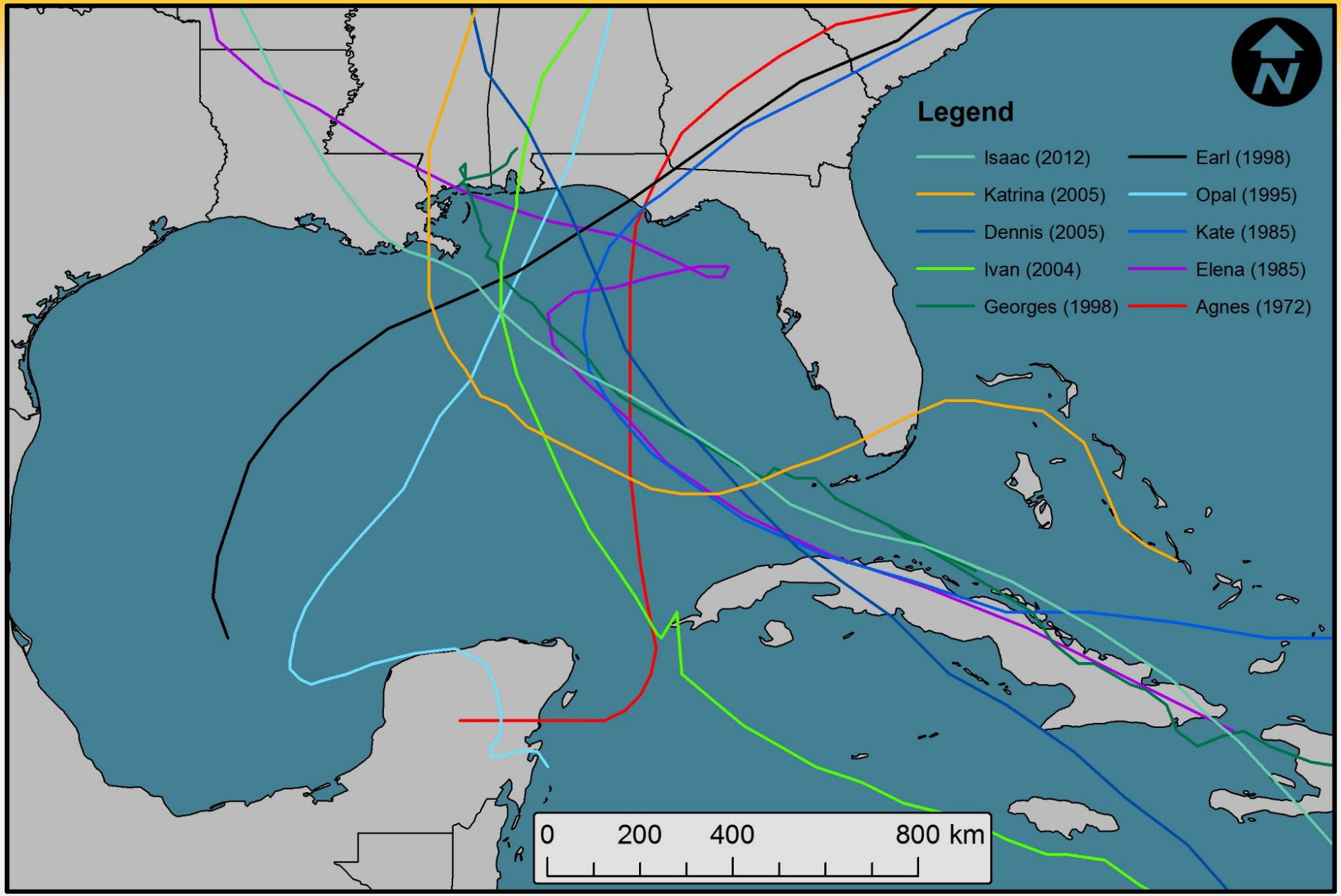
Pascagoula, MS topo/bathy



Marshes / LULC / Shoreline & dune morphology

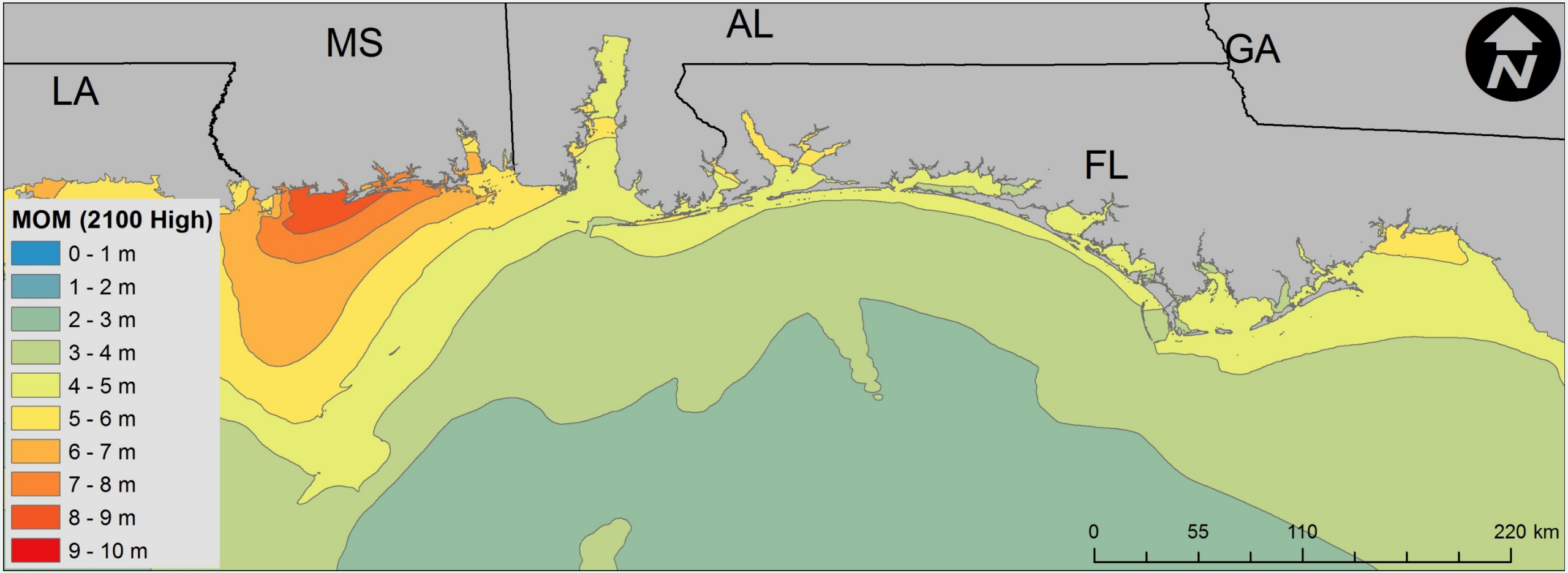


Let's throw a few hurricanes at it and identify the maximum of maximums elevation for a SLR of 2.0 m.



A floodplain representation from …

Maximum of maximums (MOM) under SLR of 2.0 m (c. 2100)



Concluding remarks

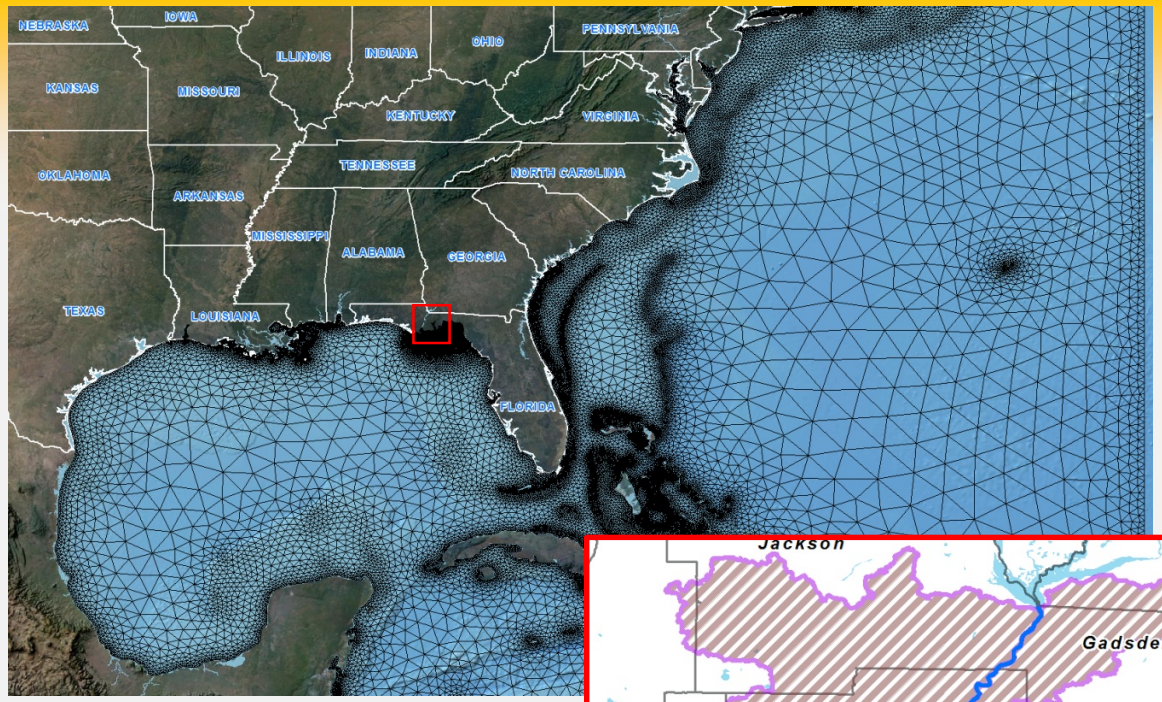
- We no longer have the luxury of stationarity.
- We can now step out of the bathtub and model the dynamic system.
- Hydro-MEM describes the spatial and temporal variation in tides, accretion, biomass, and provides a scientifically-defensible platform upon which we can build more complexities.
- Climate change is a generational problem that we can address, but not will away.
- While our numerical modeling technology is awesome, with respect to climate change, the models can only serve as advanced diagnostic tools.

Acknowledgments

- National Oceanic & Atmospheric Administration / NOS (Award: NA10NOS4780146)
- LSU/LONI High Performance Computing
- Louisiana Sea Grant

Note: The views expressed herein are the presenter's and do not necessarily reflect the opinions of his co-authors or:

How to assess event-based climate change/sea level rise impacts to Apalachicola Bay



- River and Bay boundary
- Tide, wind-wave, and surge modeling
- Overland flow & transport
- Hydro-MEM model
- Bay transport model (sediment and salinity)
- 2D/3D model interface