



# Hydro-MEM applications along the East and Gulf coasts of the U.S.

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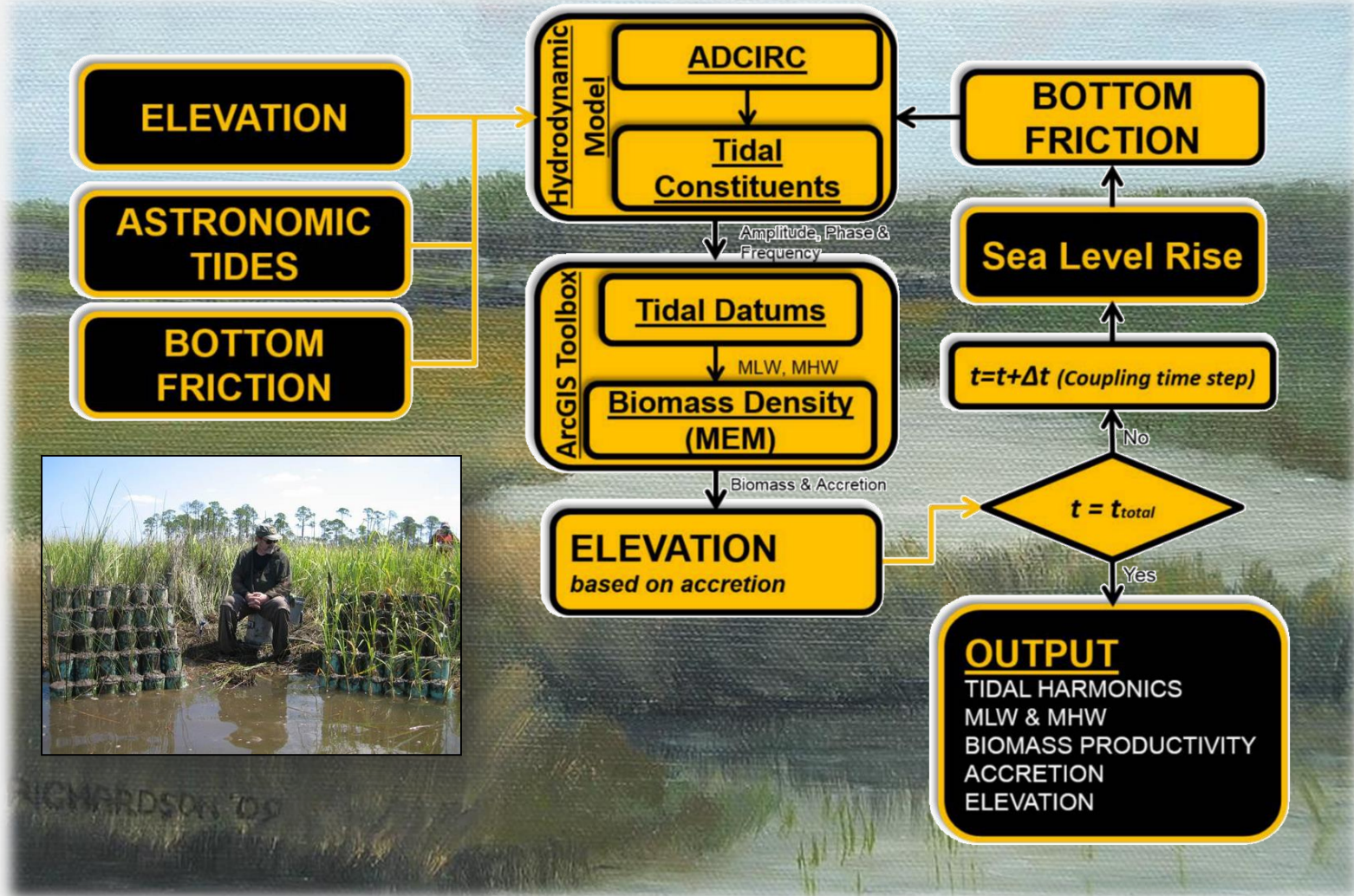


# Question to be answered

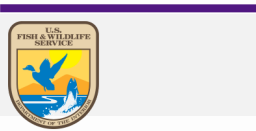
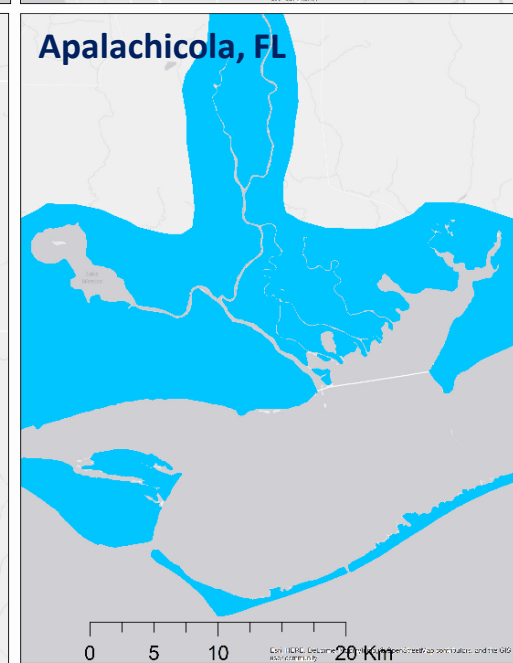
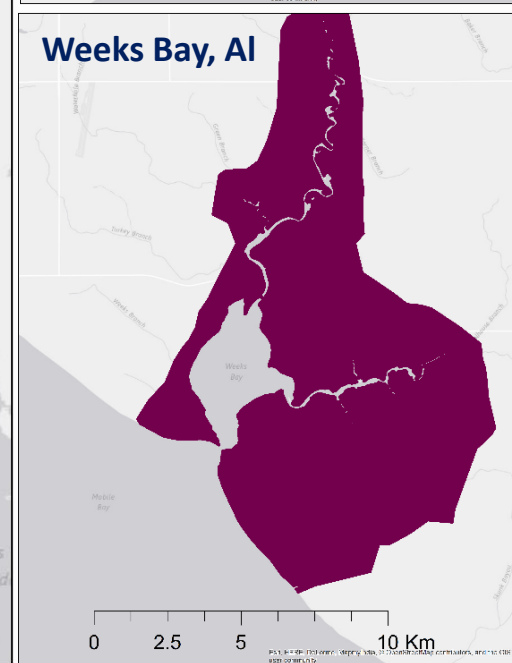
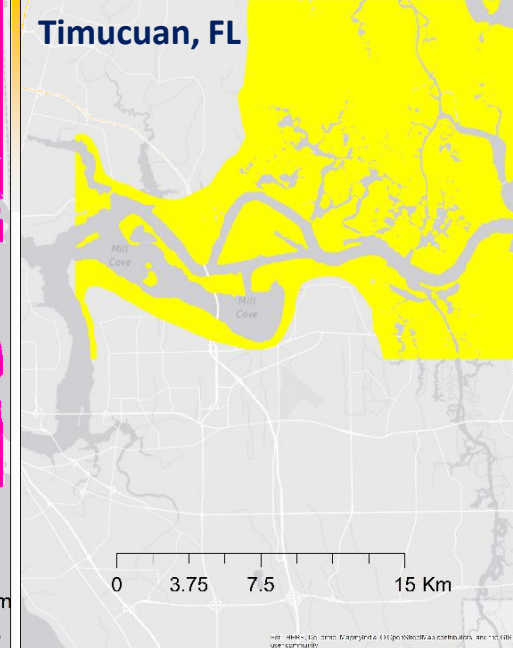
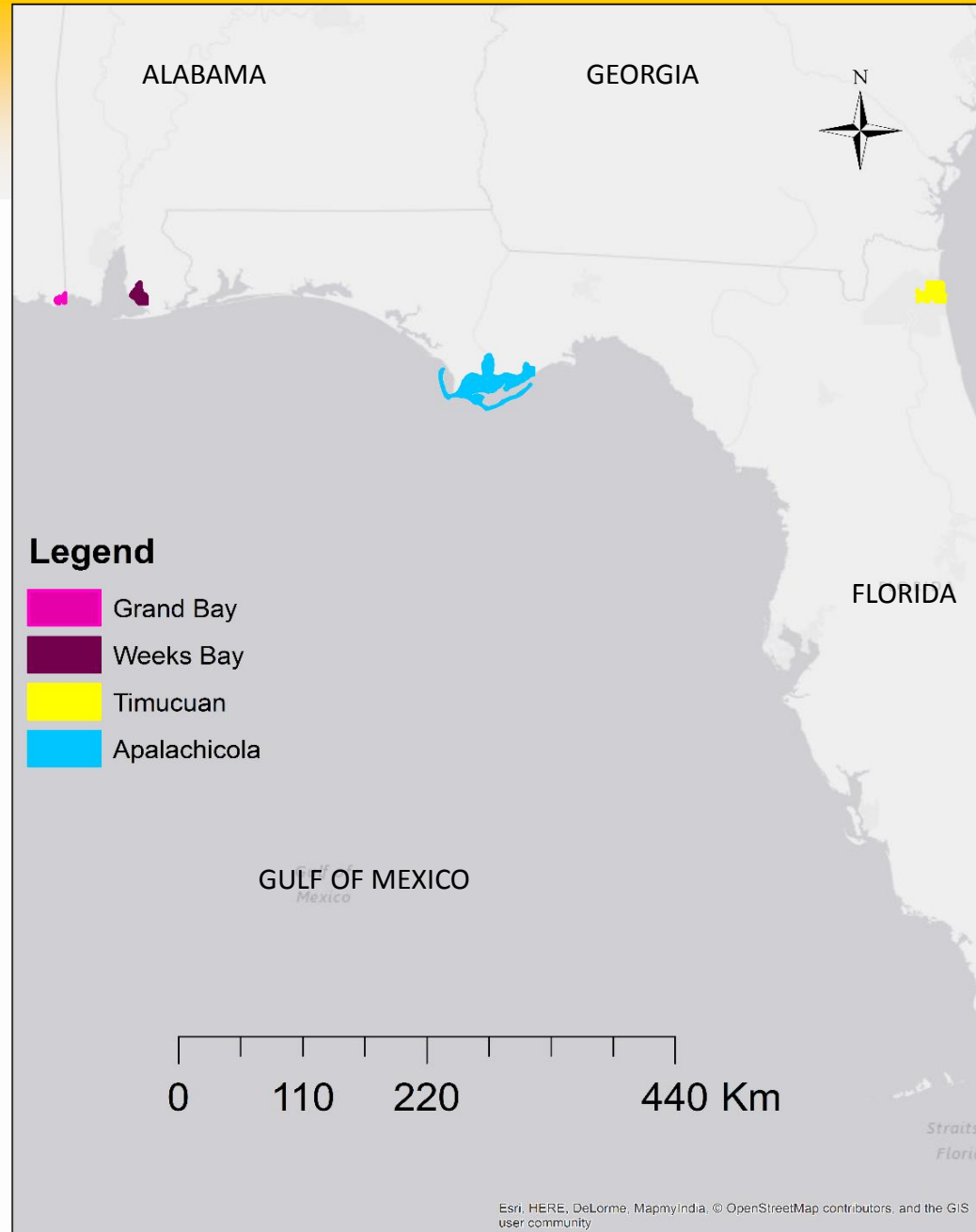
- What is Hydro-MEM (Hydrodynamic-Marsh Equilibrium Model)?
- Where is Hydro-MEM being applied?
- Will you show us an example application?
- How are the results being used?

# 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.

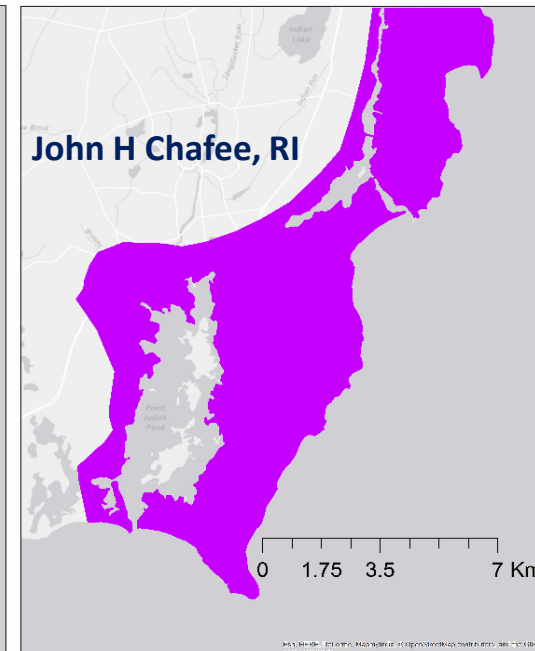
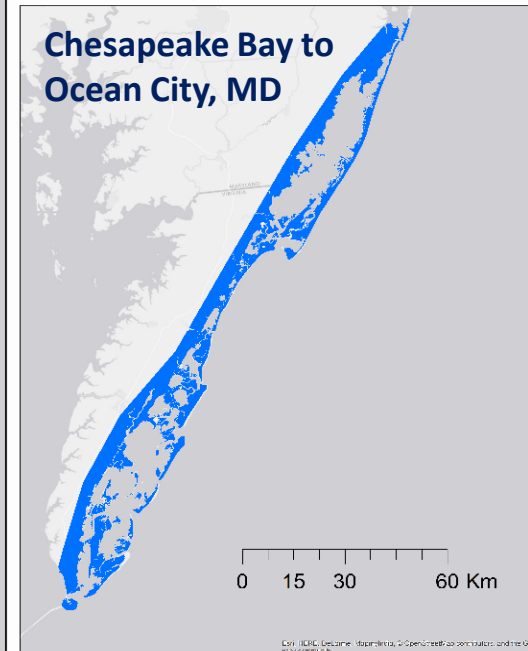
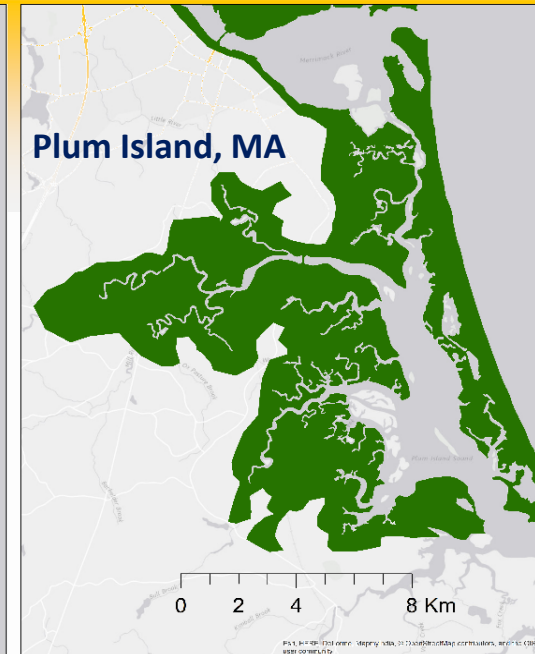
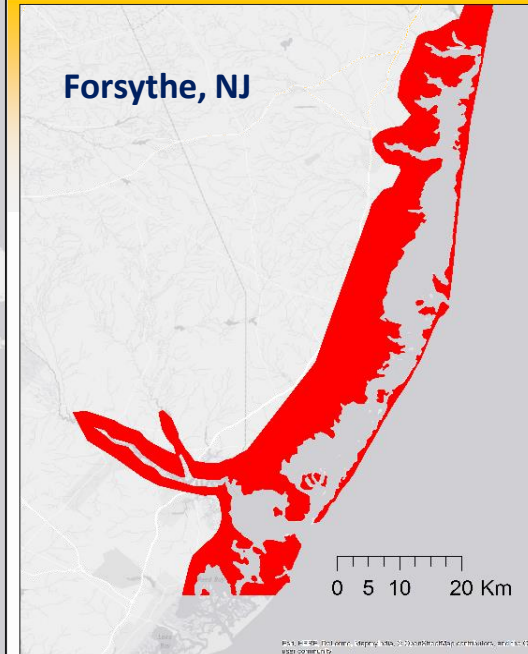
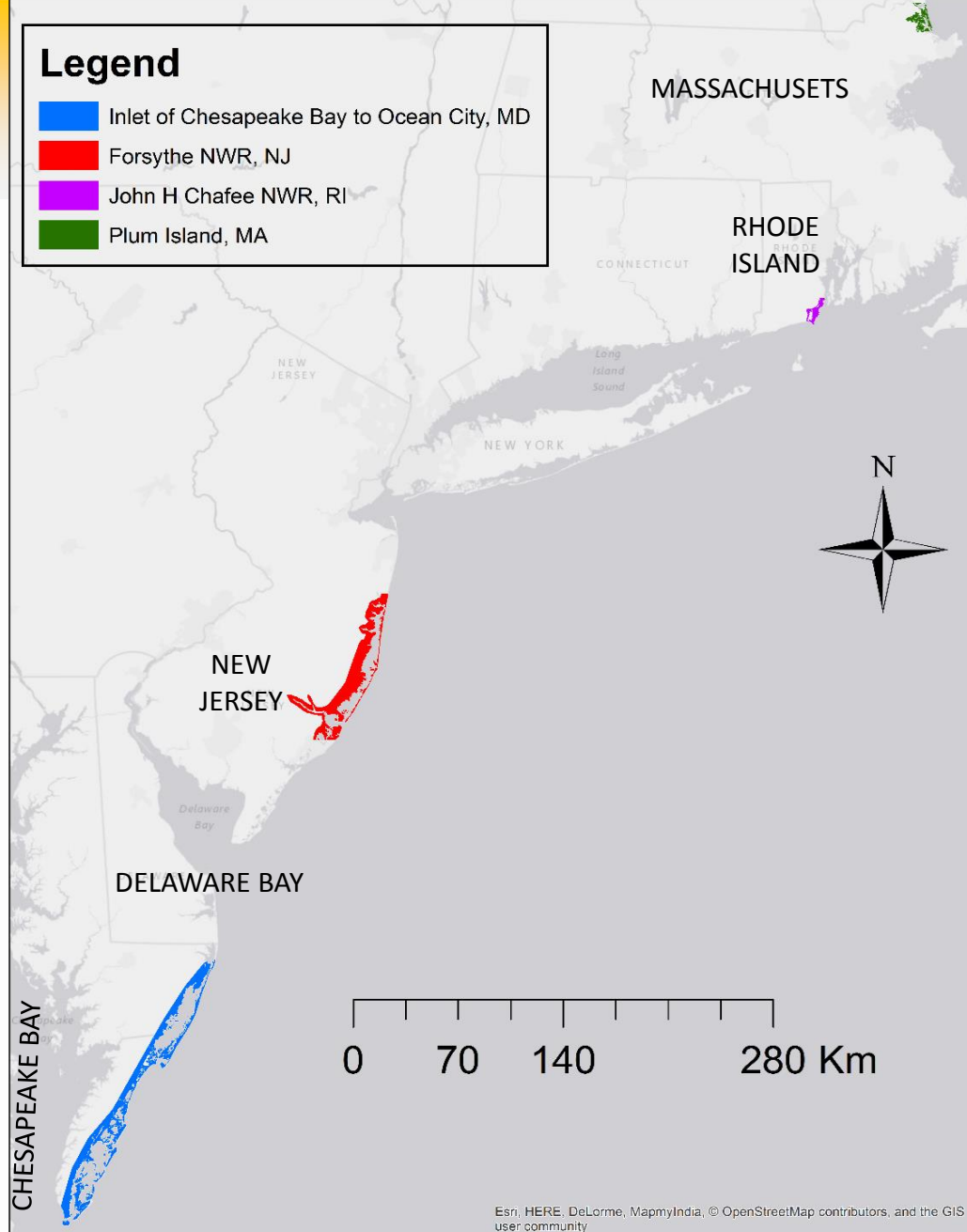


# Hydro-MEM Applications

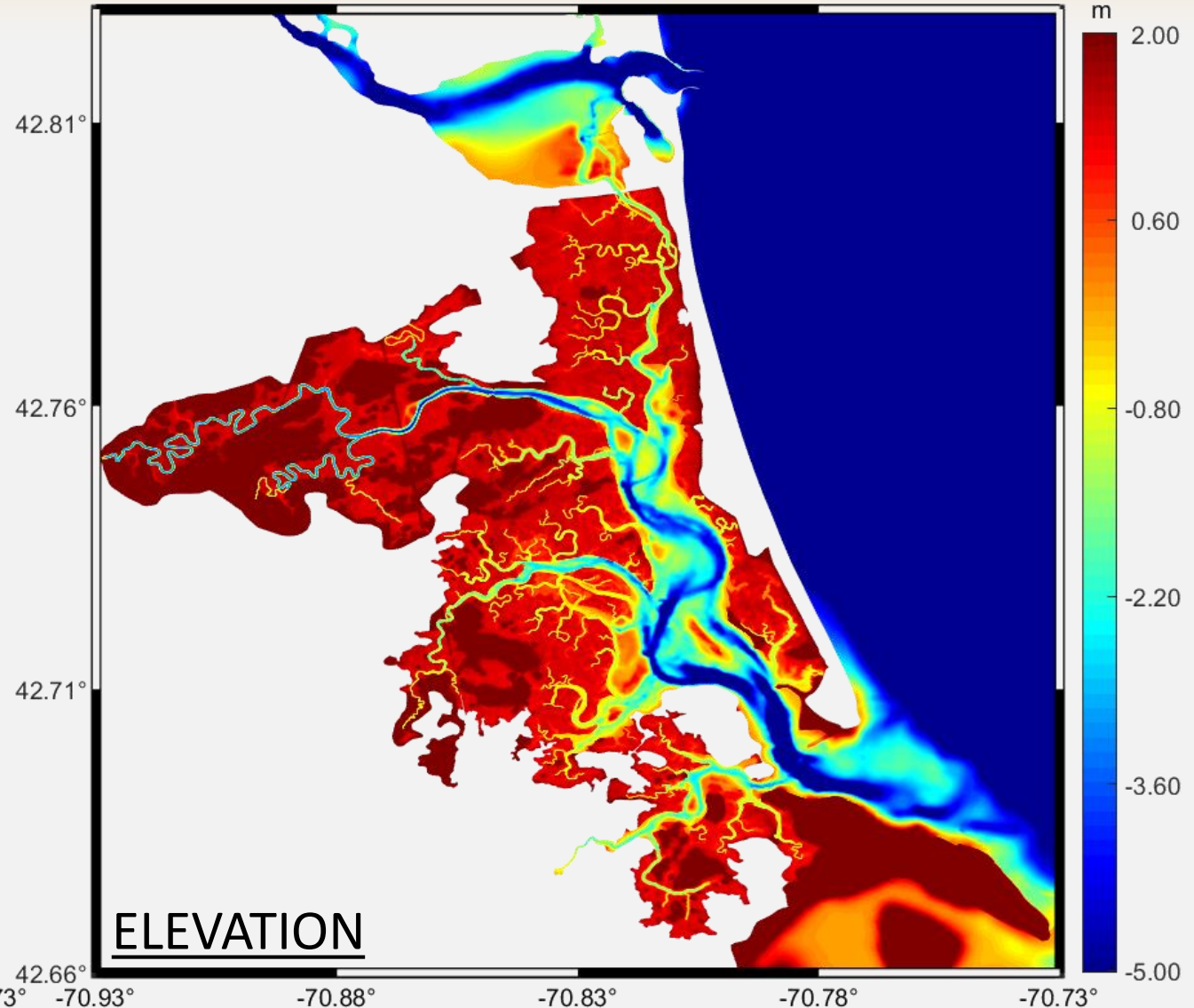
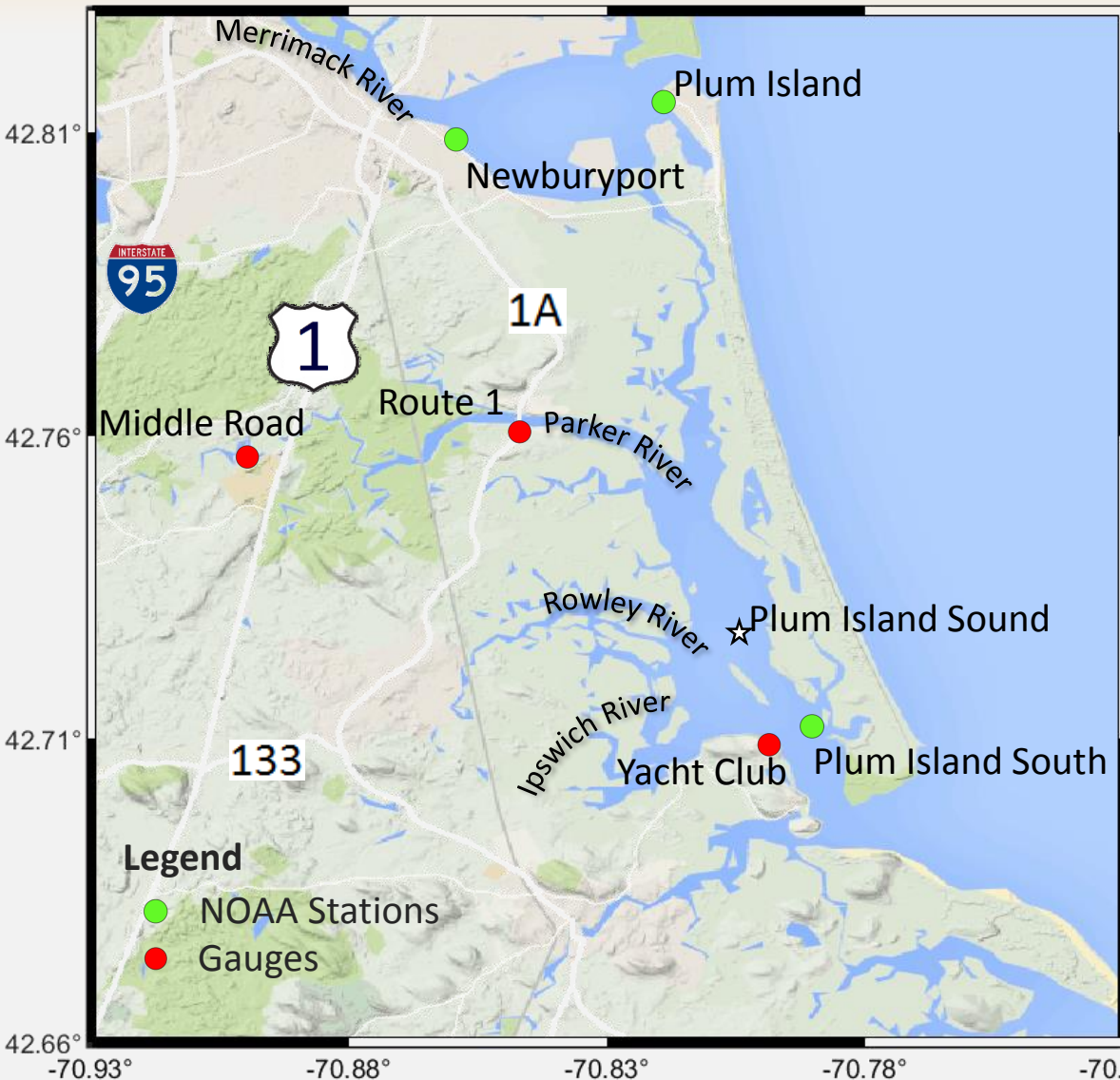




# Hydro-MEM Applications

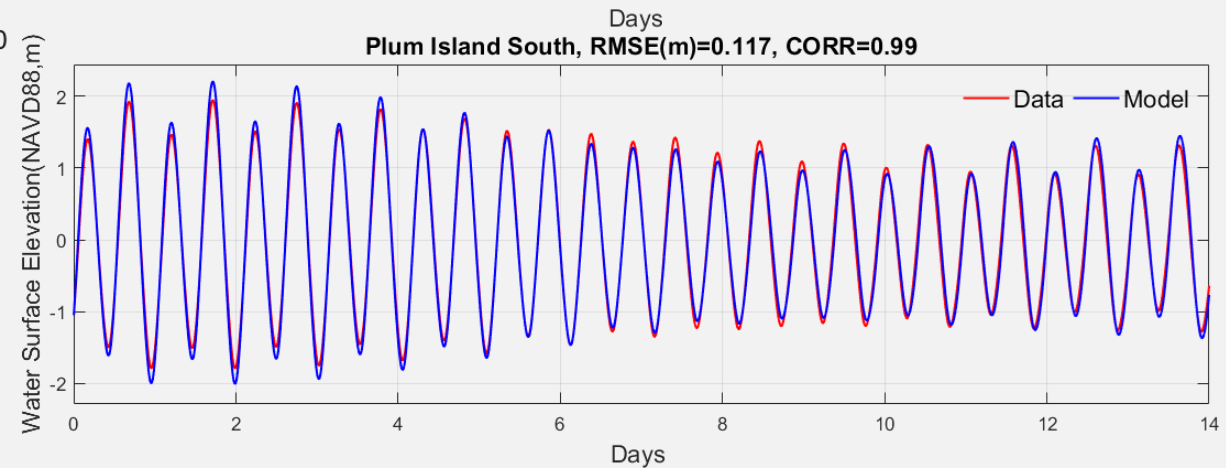
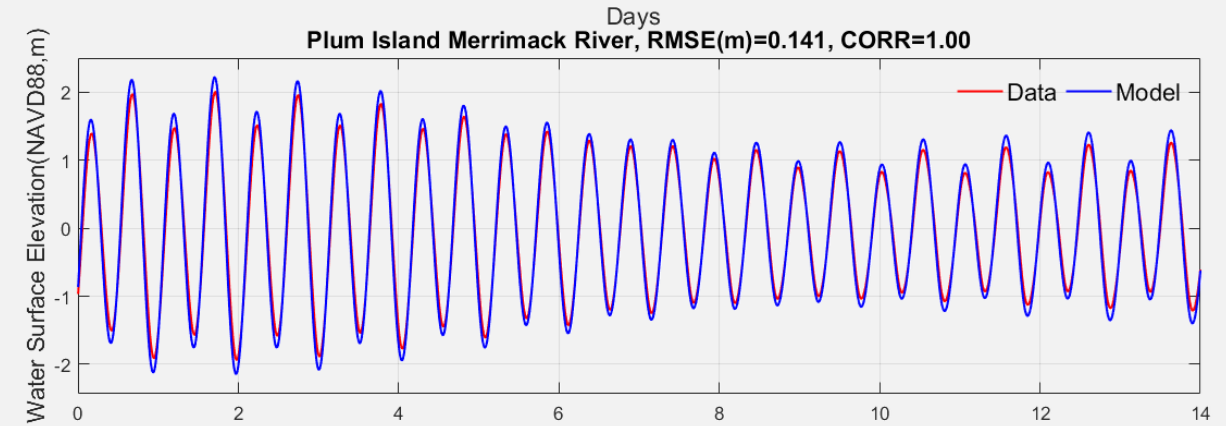
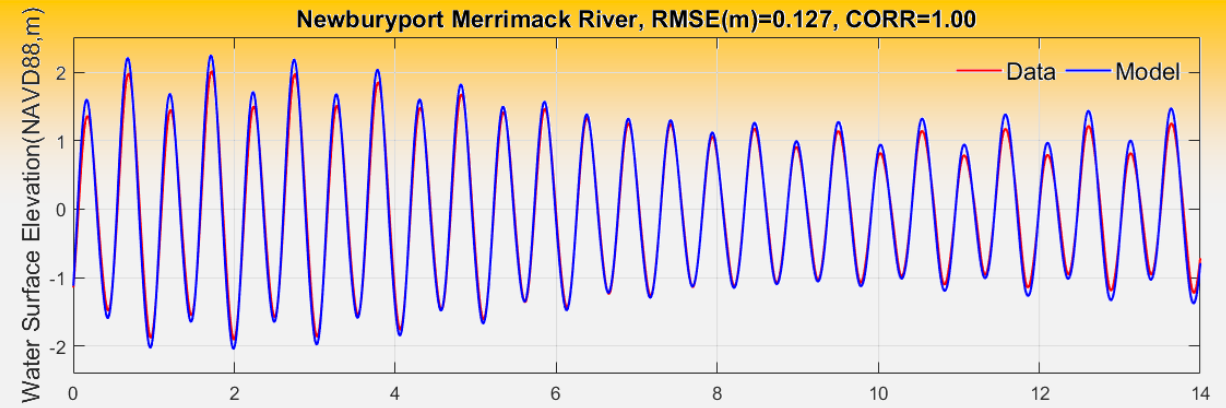
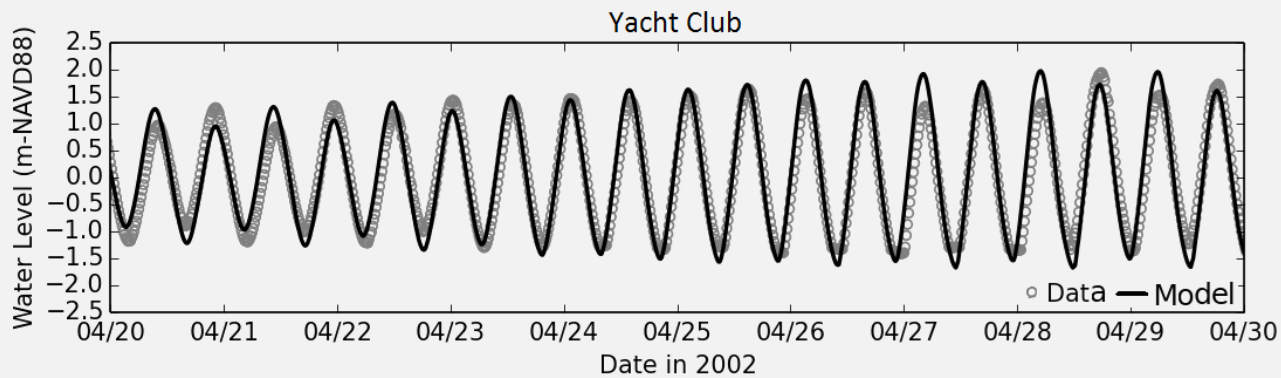
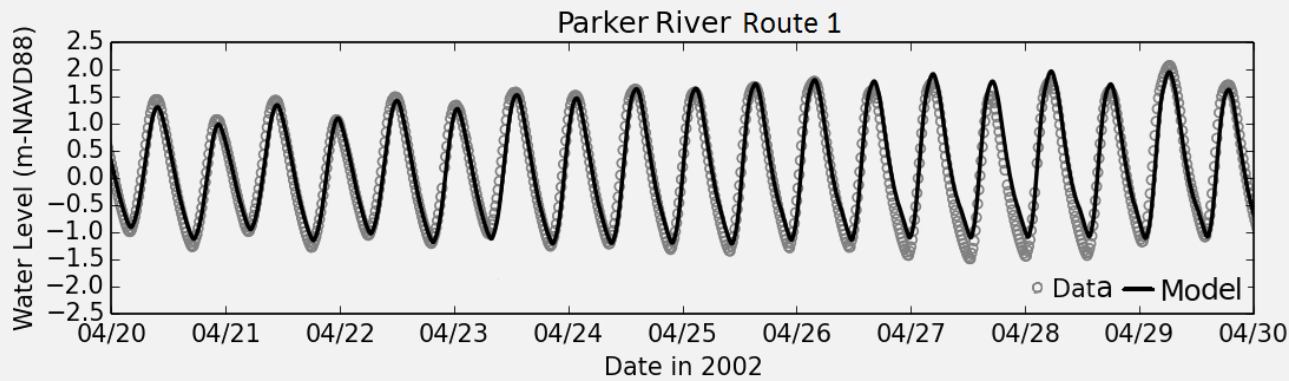
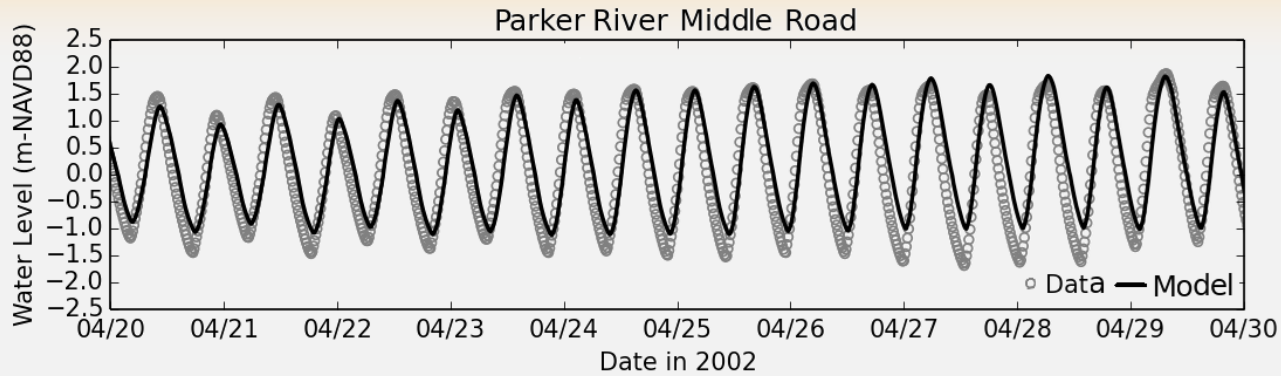


# Plum Island Estuary





# Model Validation





# Tidal flood/ebb for Plumb Island Estuary

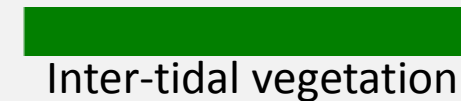
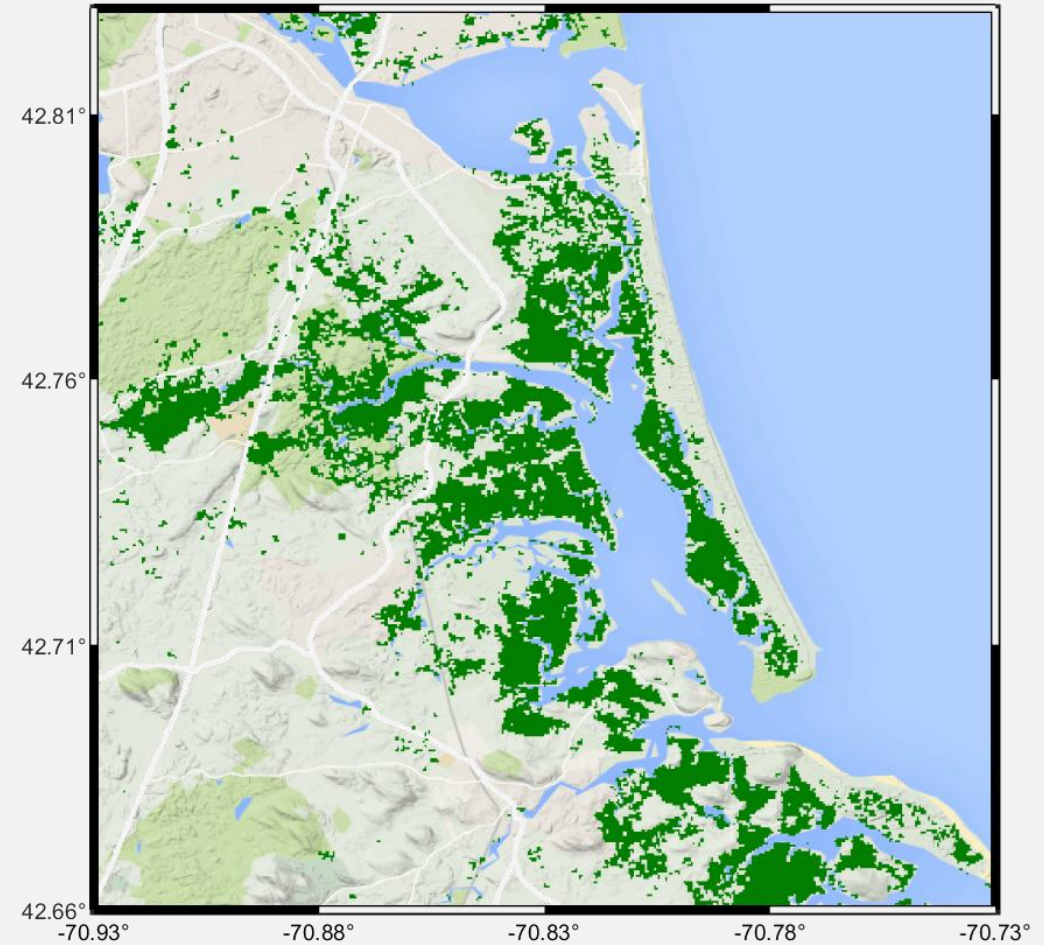
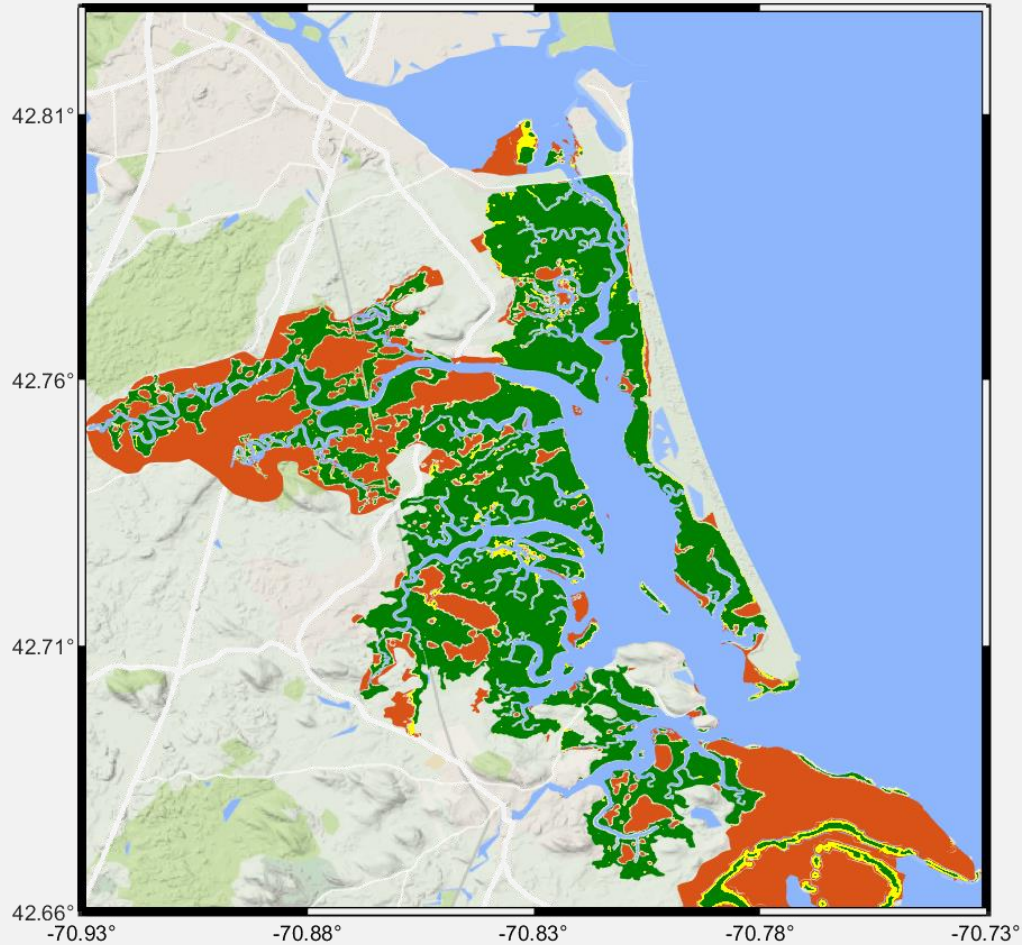
0 0:0 0:0 0  
Day-Hour-Min





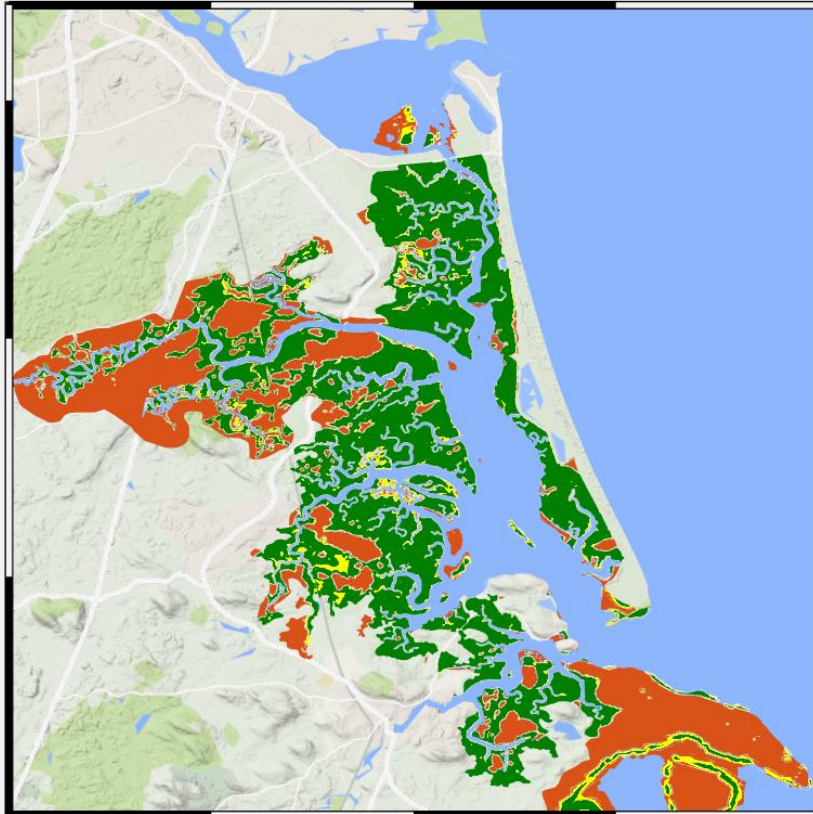
# A qualified result from Hydro-MEM at PIE

## Biomass distribution LULC

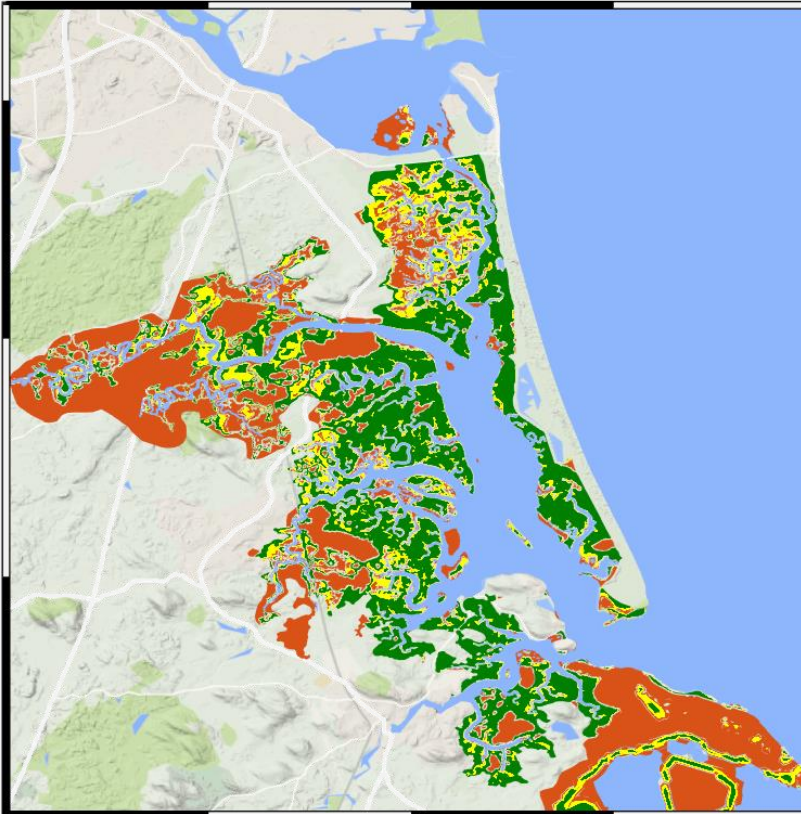




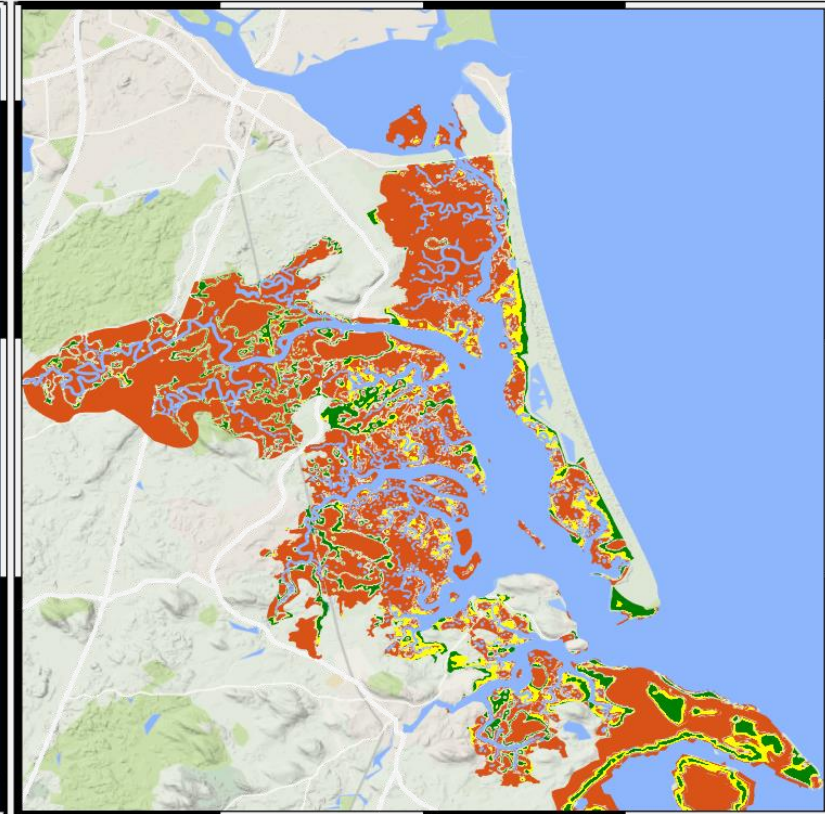
# Hydro-MEM: Biomass density



20 cm SLR



50 cm SLR



120 cm SLR

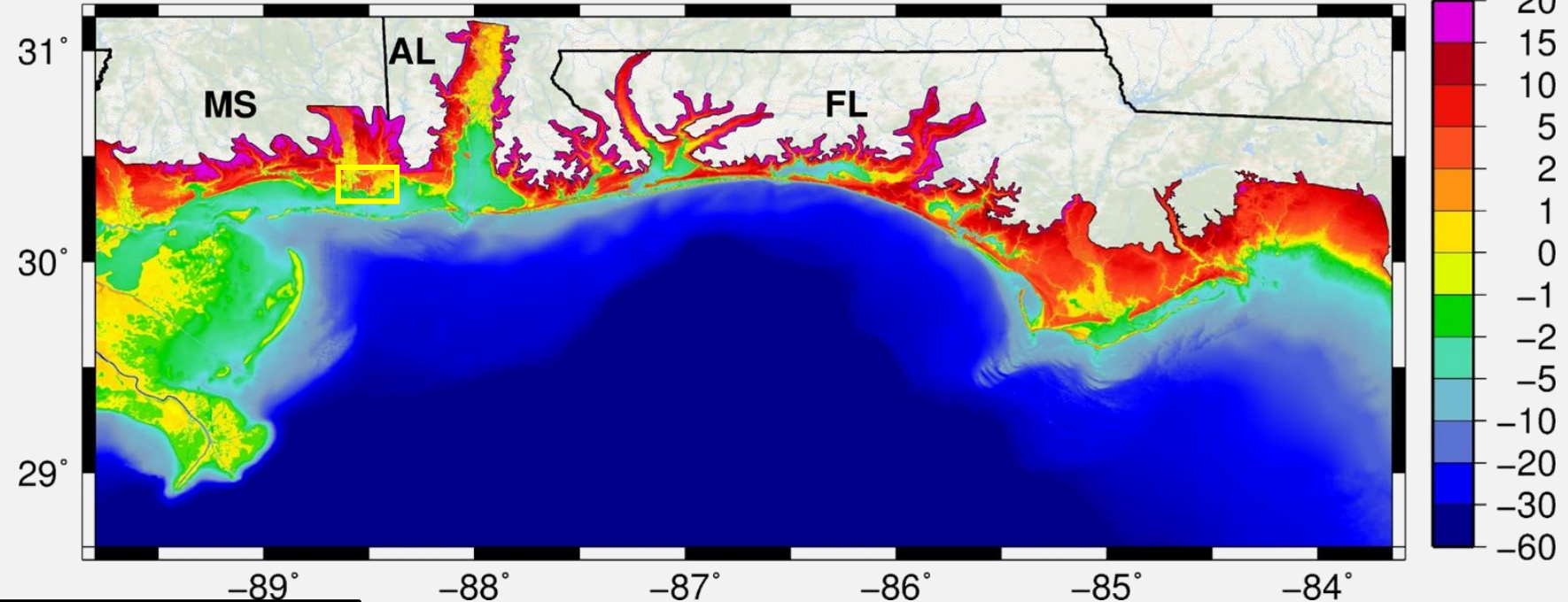


# Tide/surge modeling in the northern Gulf of Mexico

## Large-scale region approach



5.5 million compute nodes / ~20,000 km<sup>2</sup> of floodplain (4.9 million acres)



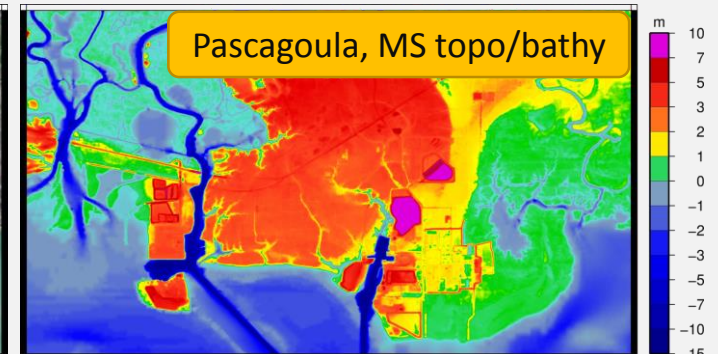
## Five relevant publications

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

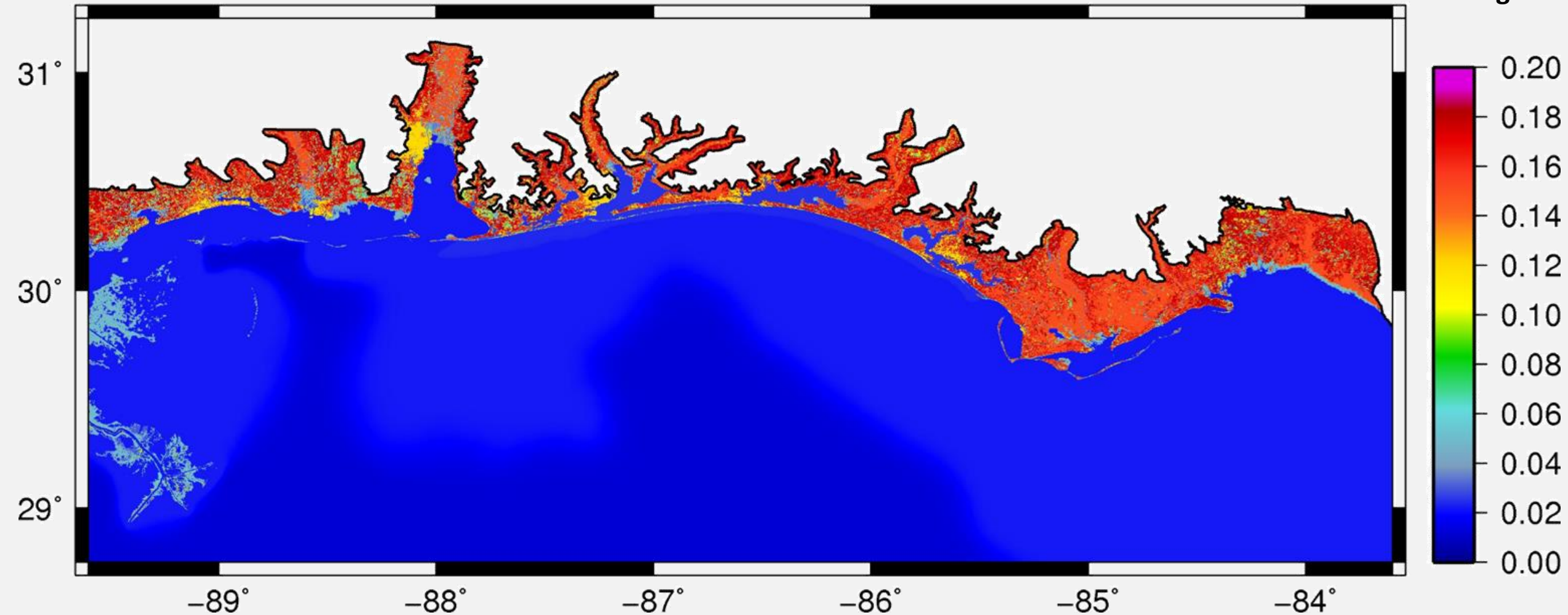




# Marshes / LULC / Shoreline & dune morphology

Present Day

Manning's n

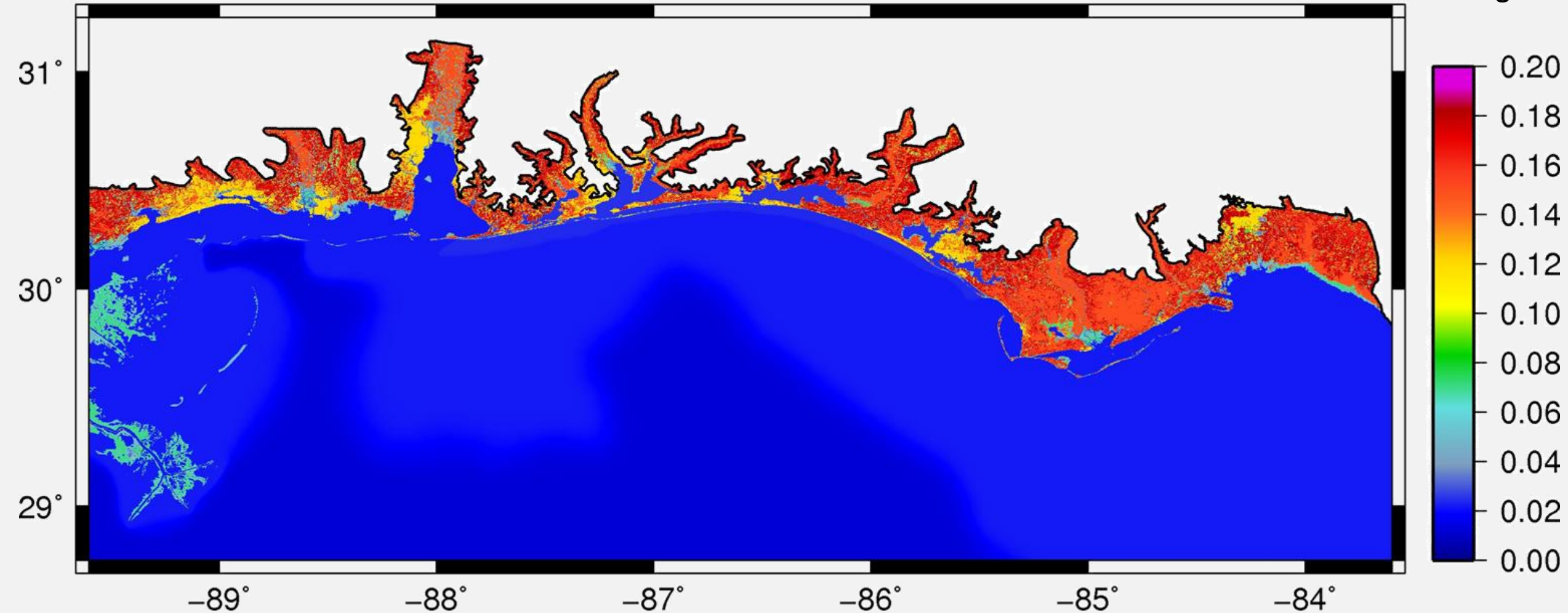


Dynamic simulation and numerical analysis of hurricane storm surge under SLR with geomorphologic changes along the northern Gulf, <http://dx.doi.org/10.1002/2015EF000347>

# Marshes / LULC / Shoreline & dune morphology

2100 Low (0.2 m SLR)

Manning's n



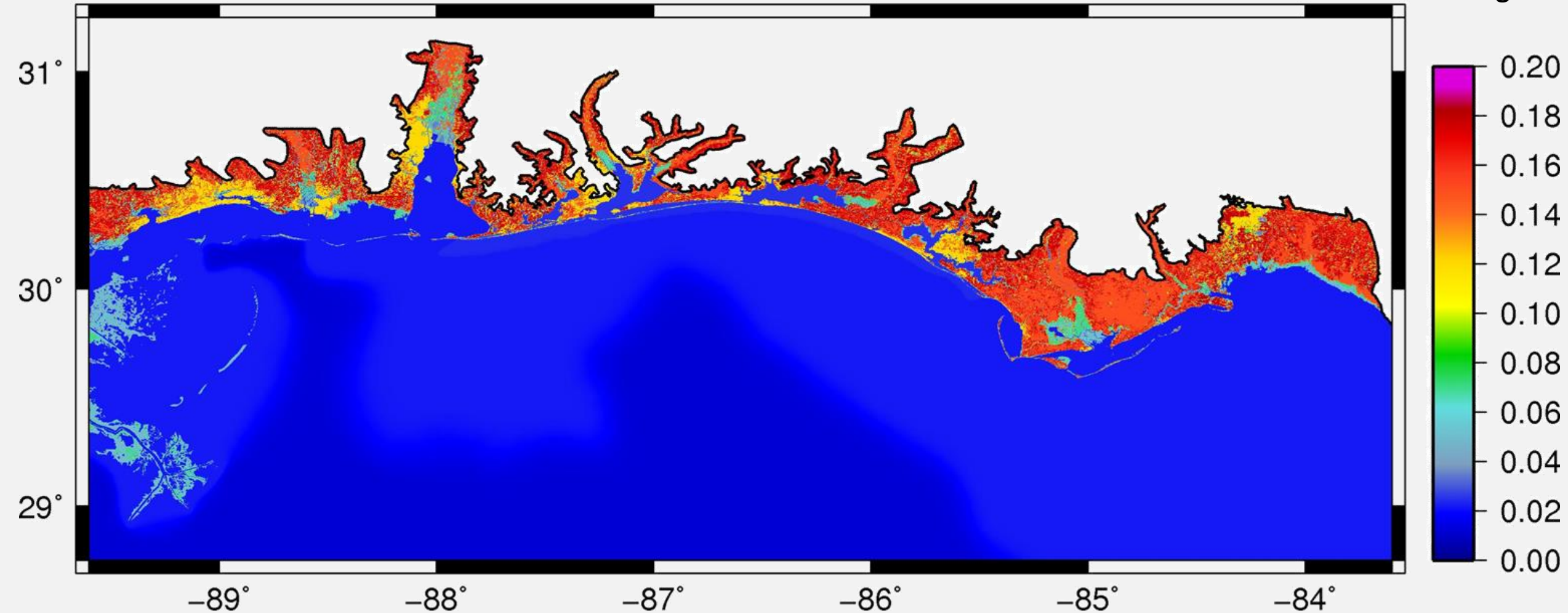
Dynamic simulation and numerical analysis of hurricane storm surge under SLR with geomorphologic changes along the northern Gulf, <http://dx.doi.org/10.1002/2015EF000347>



# Marshes / LULC / Shoreline & dune morphology

2100 Int. Low (0.5 m SLR)

Manning's n



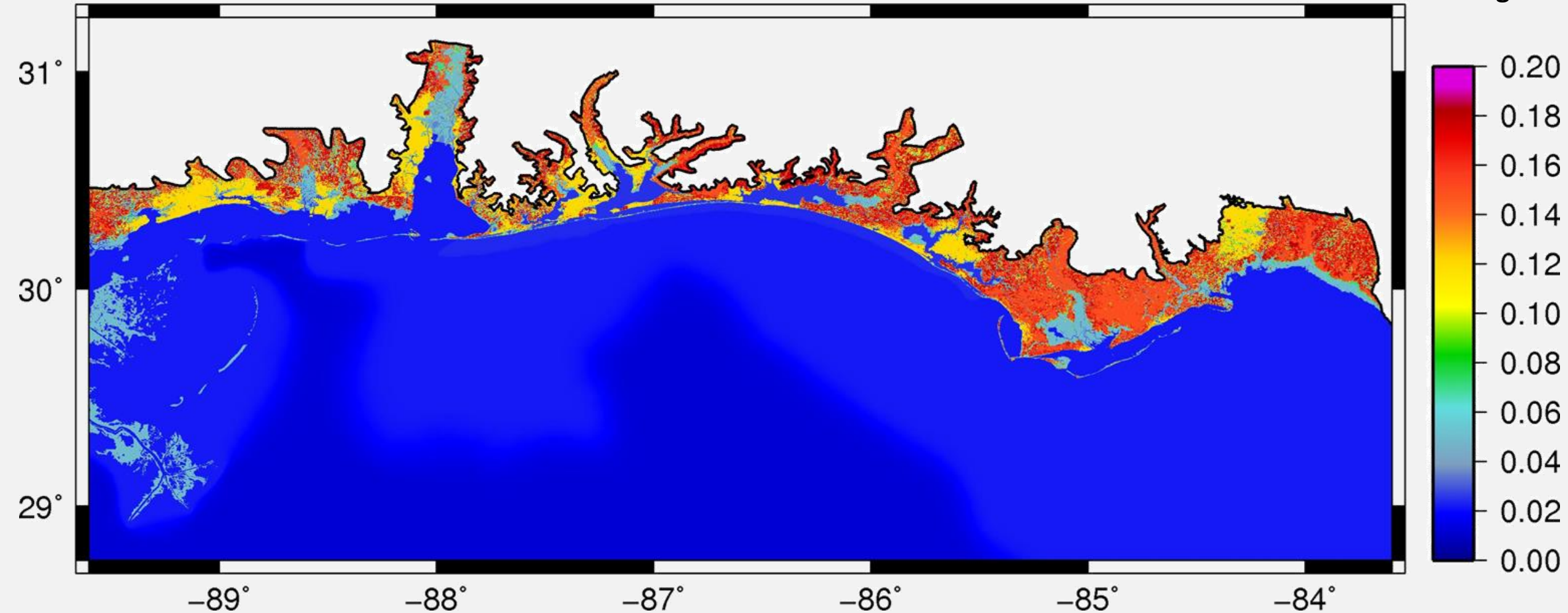
Dynamic simulation and numerical analysis of hurricane storm surge under SLR with geomorphologic changes along the northern Gulf, <http://dx.doi.org/10.1002/2015EF000347>



# Marshes / LULC / Shoreline & dune morphology

2100 Int. High (1.2 m SLR)

Manning's n

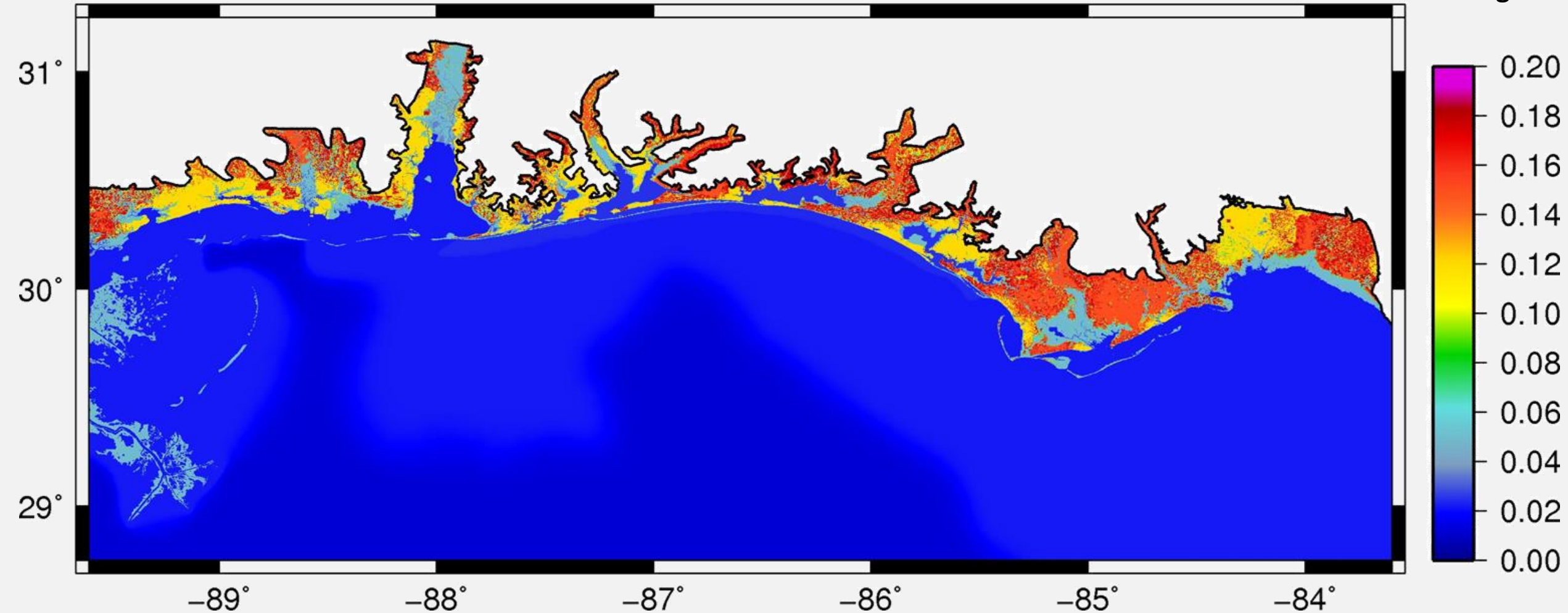


Dynamic simulation and numerical analysis of hurricane storm surge under SLR with geomorphologic changes along the northern Gulf, <http://dx.doi.org/10.1002/2015EF000347>

# Marshes / LULC / Shoreline & dune morphology

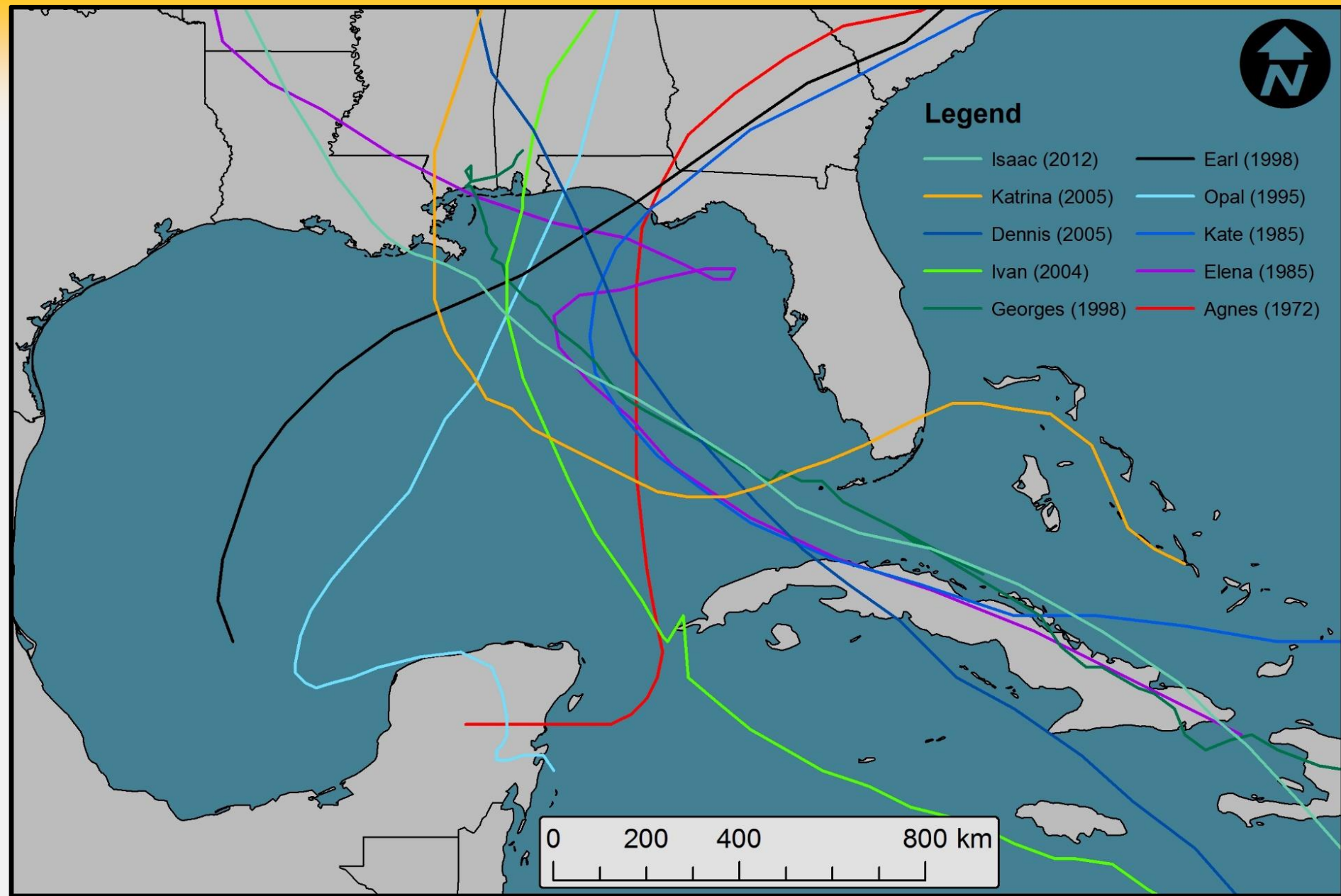
2100 High (2.0 m SLR)

Manning's n



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>

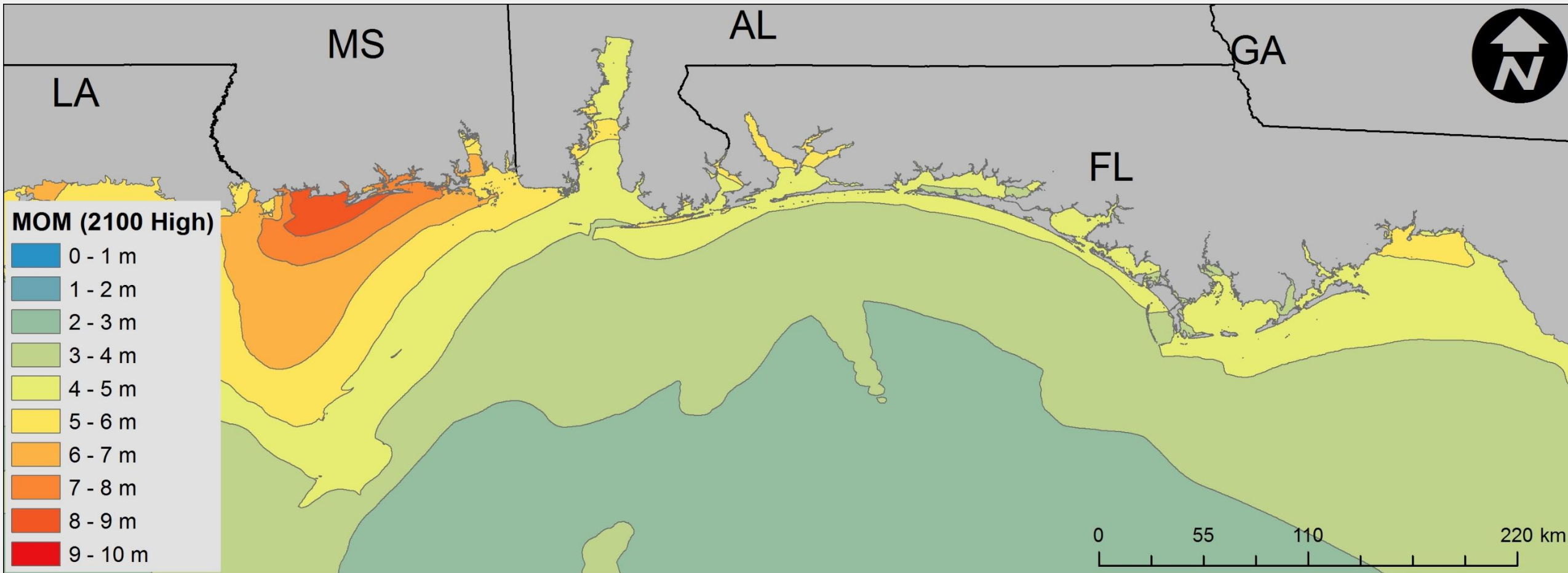
Let's throw a few hurricanes at it and identify the maximum of maximums elevation for a SLR of 2.0 m.





# A floodplain representation from ...

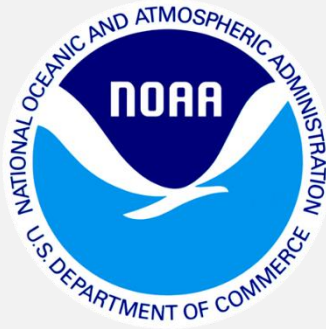
Maximum of maximums (MOM) under SLR of 2.0 m (c. 2100)



# 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



Scott C. Hagen, [shagen@lsu.edu](mailto:shagen@lsu.edu)