OPTIMIZATION OF MARSH RESTORATION FOR STORM SURGE ABATEMENT AND SEA LEVEL RISE: HYDRO-MARSH MODEL

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PRESENTATION OUTLINE

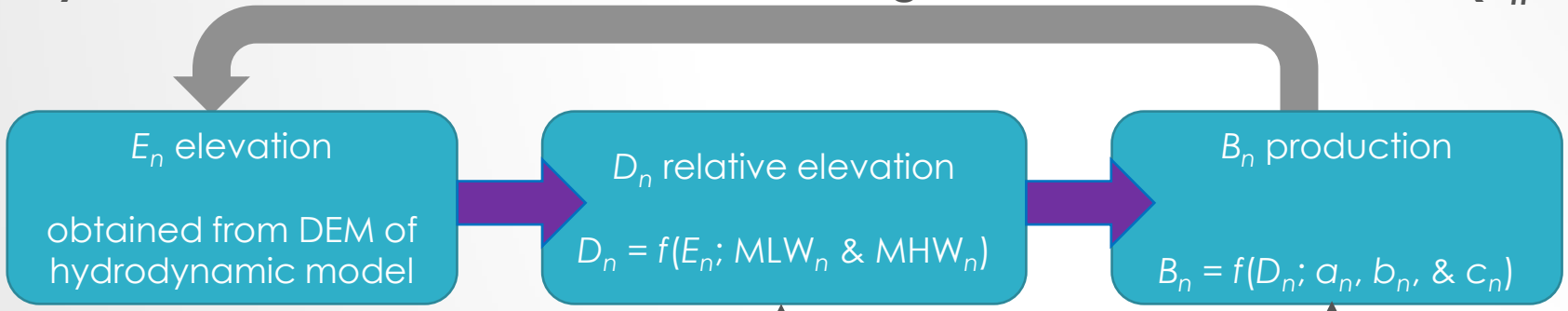
- Methodology
- Results
- Conclusions / Data Needs

To paraphrase a climate science motto:

"The sea level is rising, the best we can do now is to manage the unavoidable and avoid the unmanageable."

A CONCEPTUAL HYDRO-MARSH MODEL

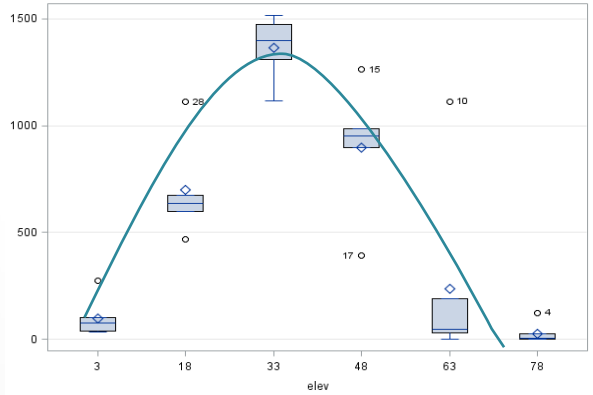
Primary Production and Accumulation of Inorganic Matter: Accretion = $f(B_n, D_n, q_n, k_n)$



Tidal modeling & analysis

$$B = aD + bD^2 + c \quad ; \quad D = \frac{(MHW - E)}{(MHW - MLW)}$$

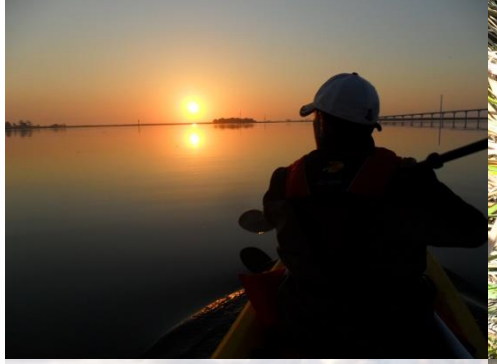
Biomass curve from field experiments



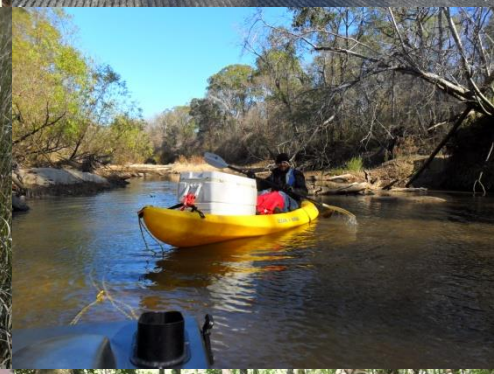
DID I MENTION THAT THIS RESEARCH REQUIRES A LITTLE FIELD/LAB WORK?







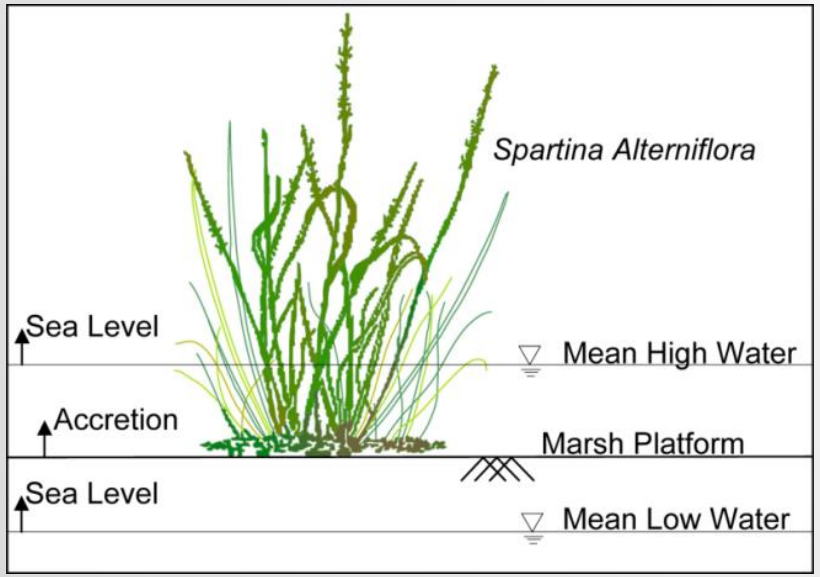


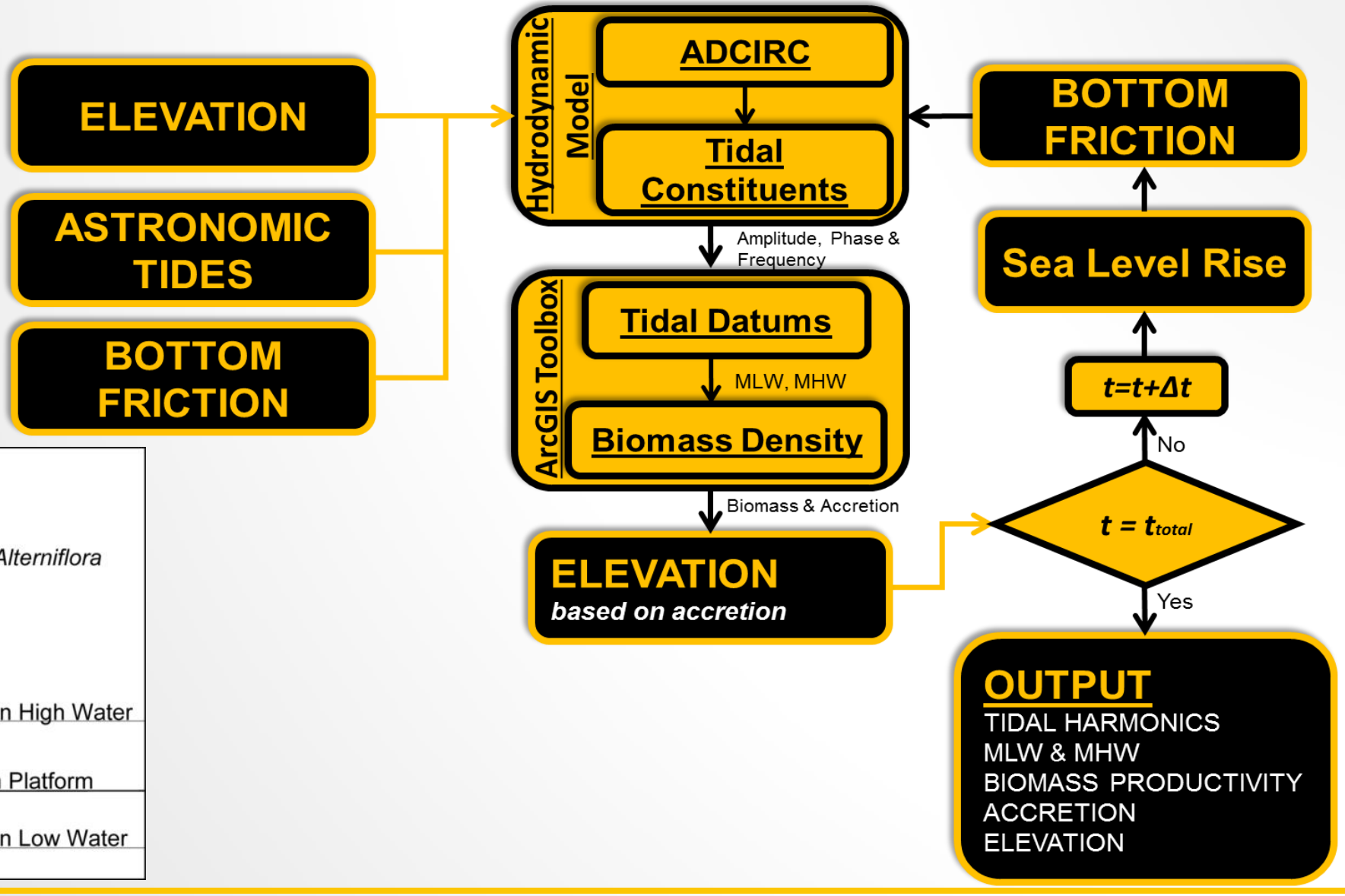





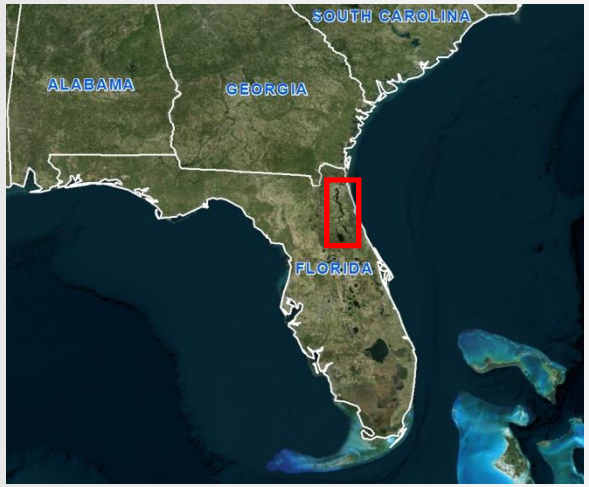


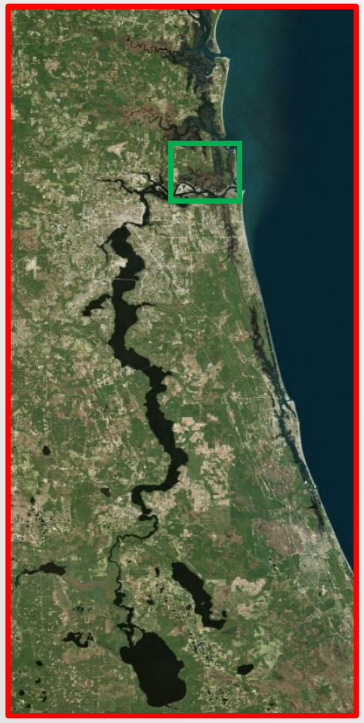
HYDRO-MARSH MODELING FRAMEWORK



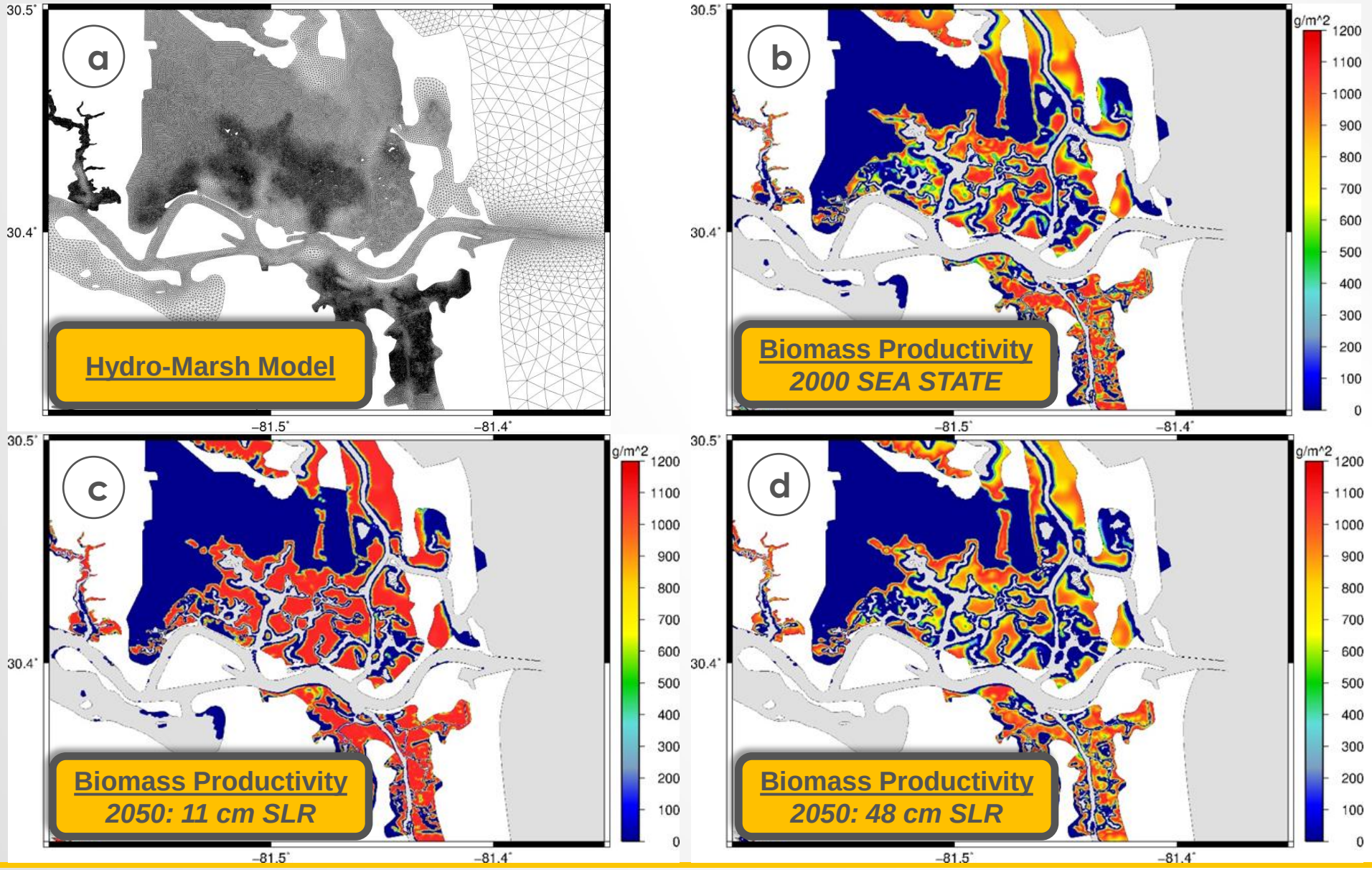


STUDY AREA: TIMUCUAN MARSH

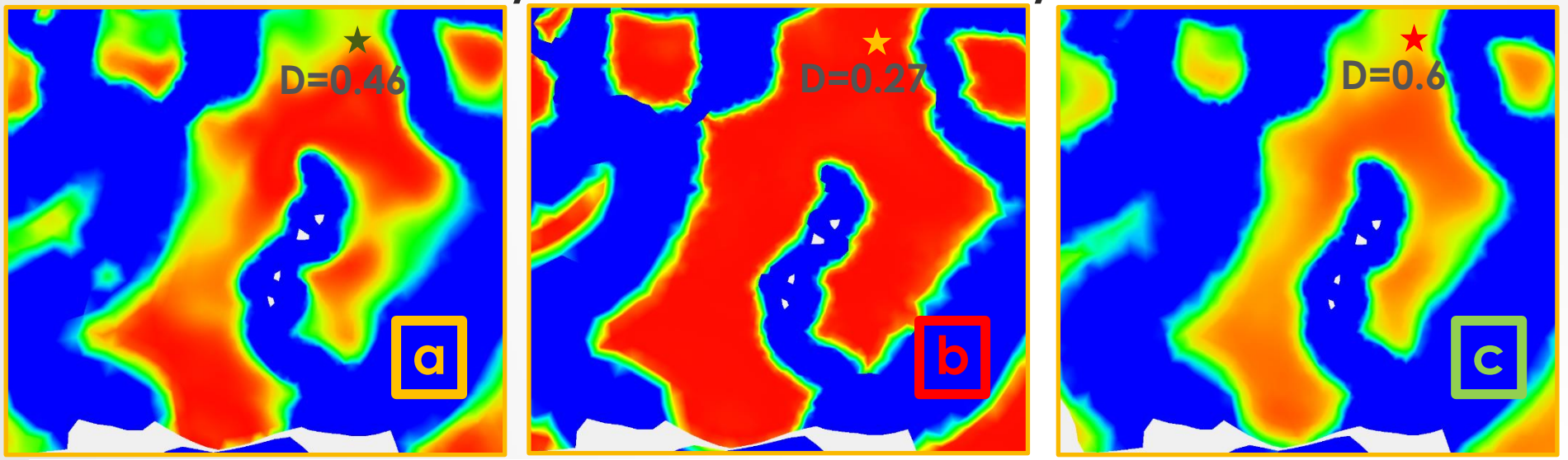


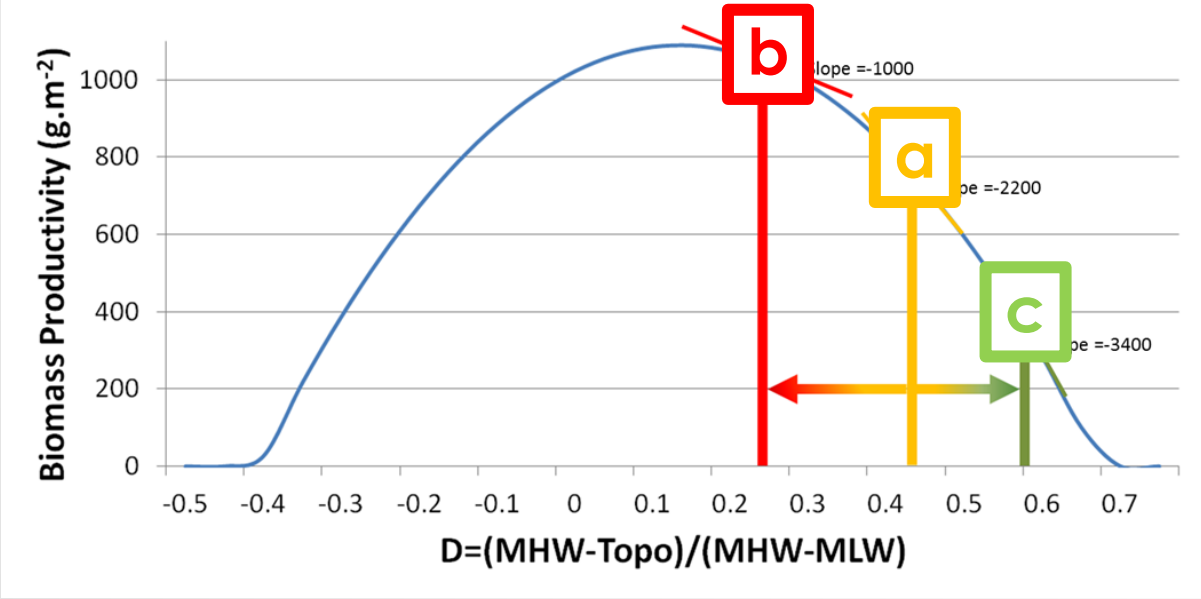


HOW SEA LEVEL RISE MAY IMPACT THE TIMUCUAN MARSH

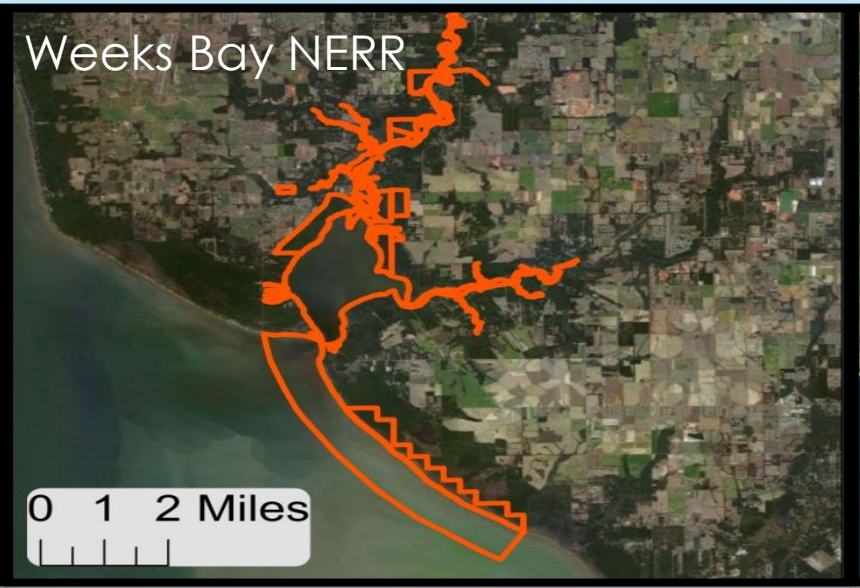


BIOMASS PRODUCTIVITY FOR:
EXISTING SEA STATE / 11 CM SLR / 48 CM SLR



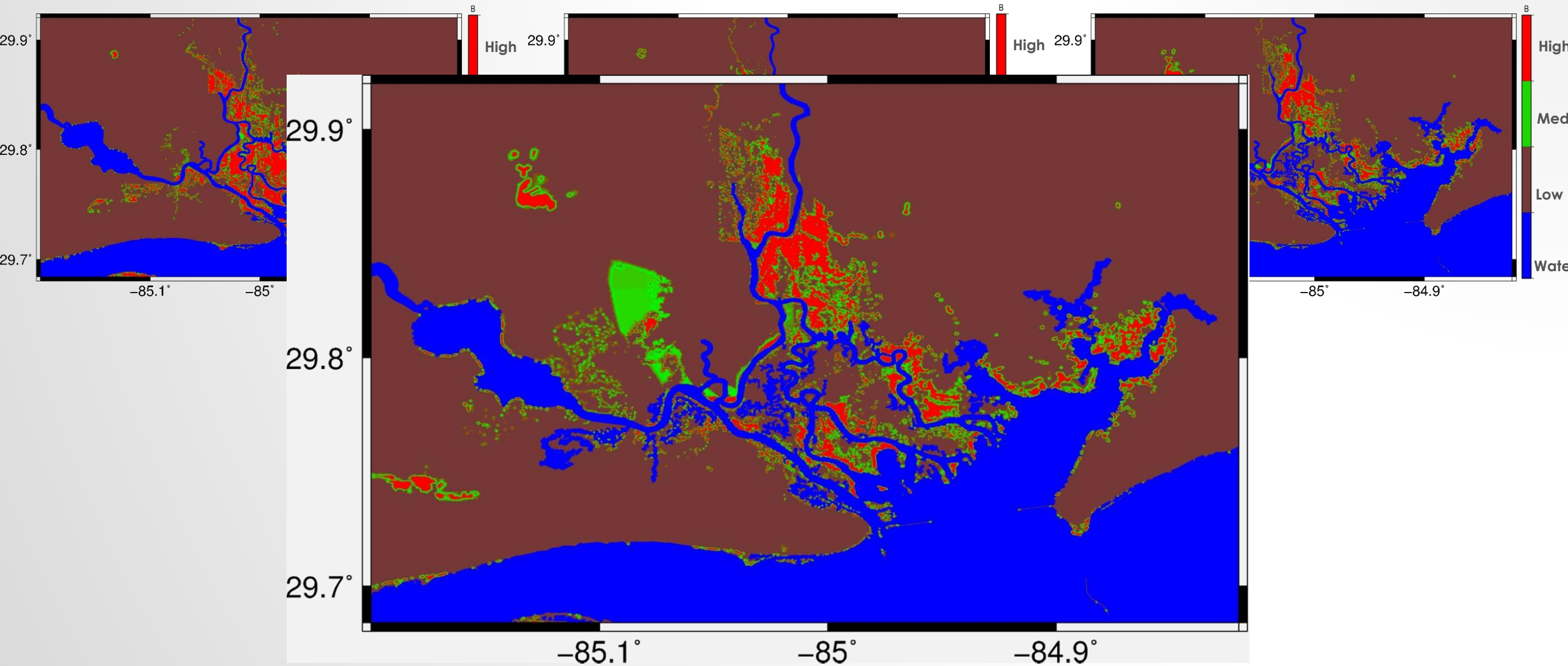


National Estuarine Research Reserves



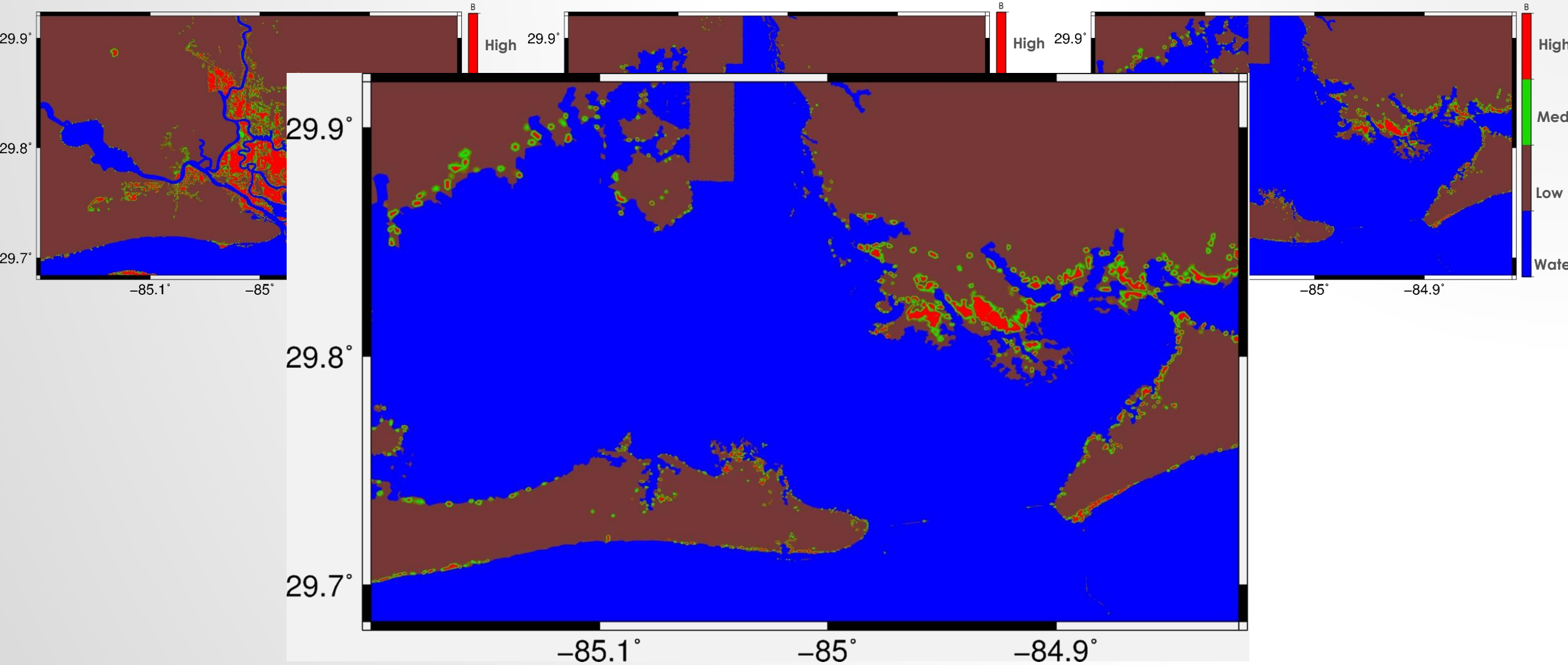
MARSH PRODUCTIVITY IN APALACHICOLA

CURRENT / 20CM SLR / 50CM SLR



MARSH PRODUCTIVITY IN APALACHICOLA

CURRENT / 1.2M SLR / 2M SLR



➔ DATA NEEDS

MLW & MHW is nonlinear & spartially variable throughout a saltmarsh system.

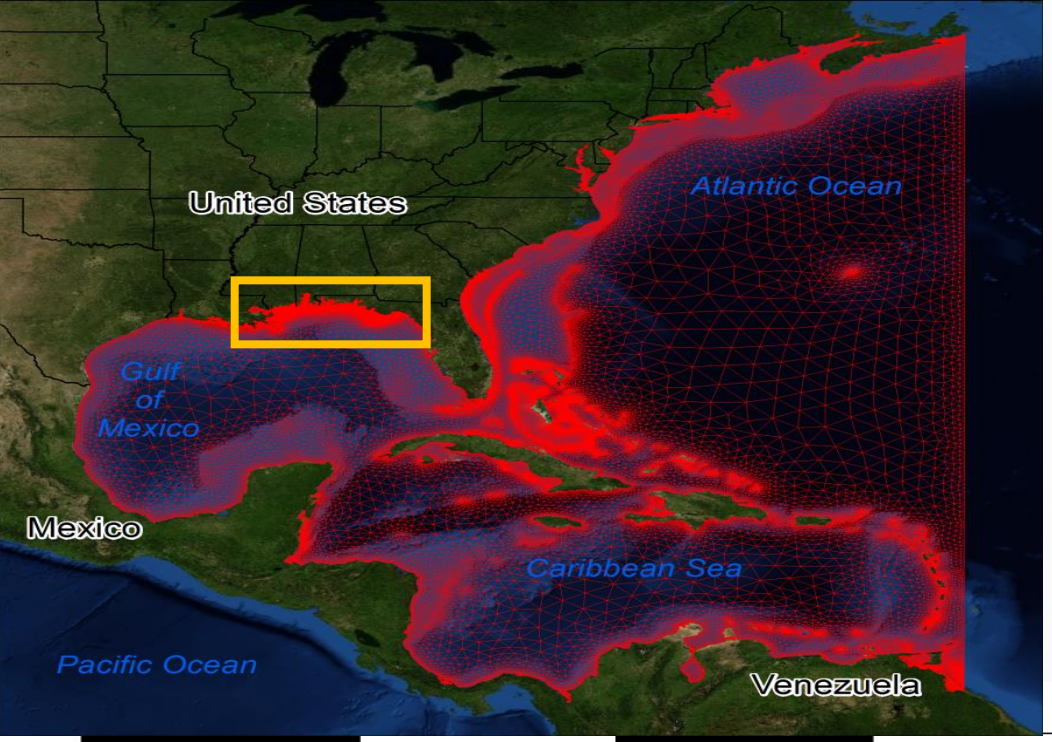
➔ **Lidar** / **RTK GPS** (transects at a minimum) / **Biomass density measures**

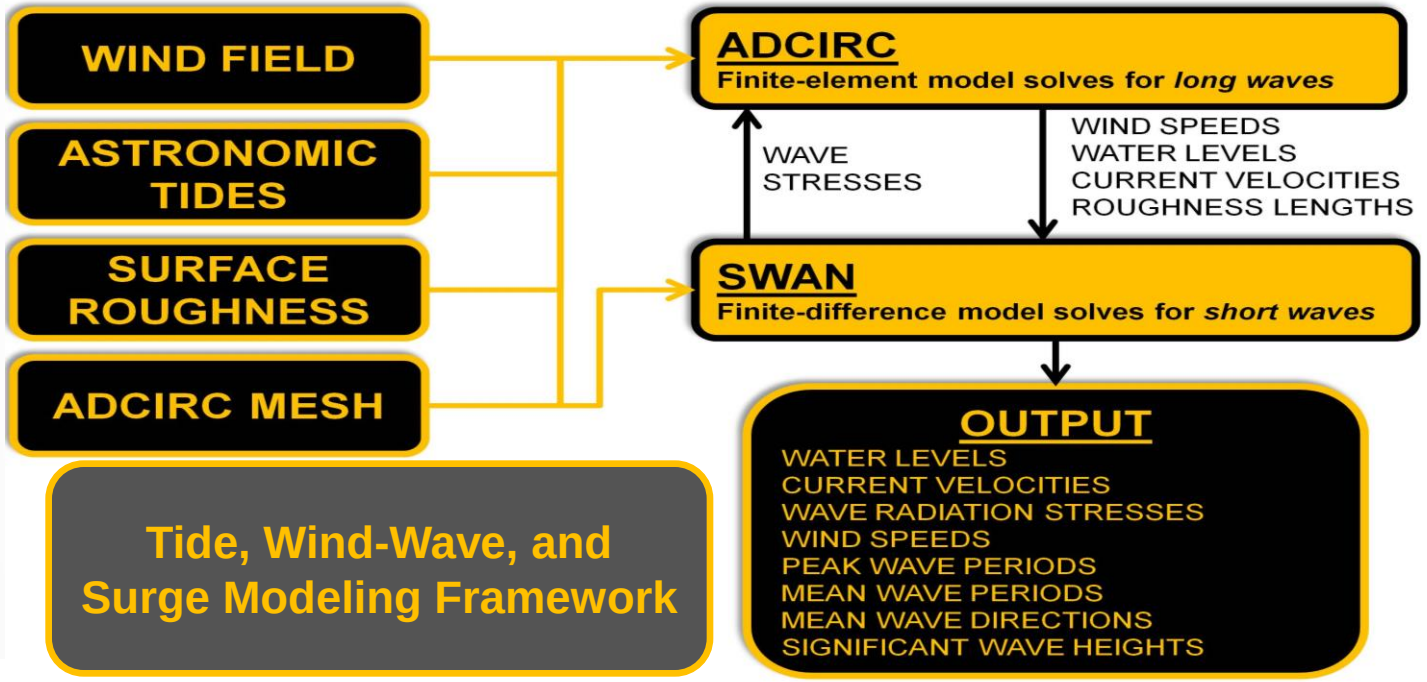
➔ **Bathemetry (e.g., tidal creeks)** / **Top of bank elevations**

➔ **Standard tide gage data** / **Tidal elevations within the marsh system**

➔ **Continuous long-term SET measures** (more frequent is better) / **TSS**

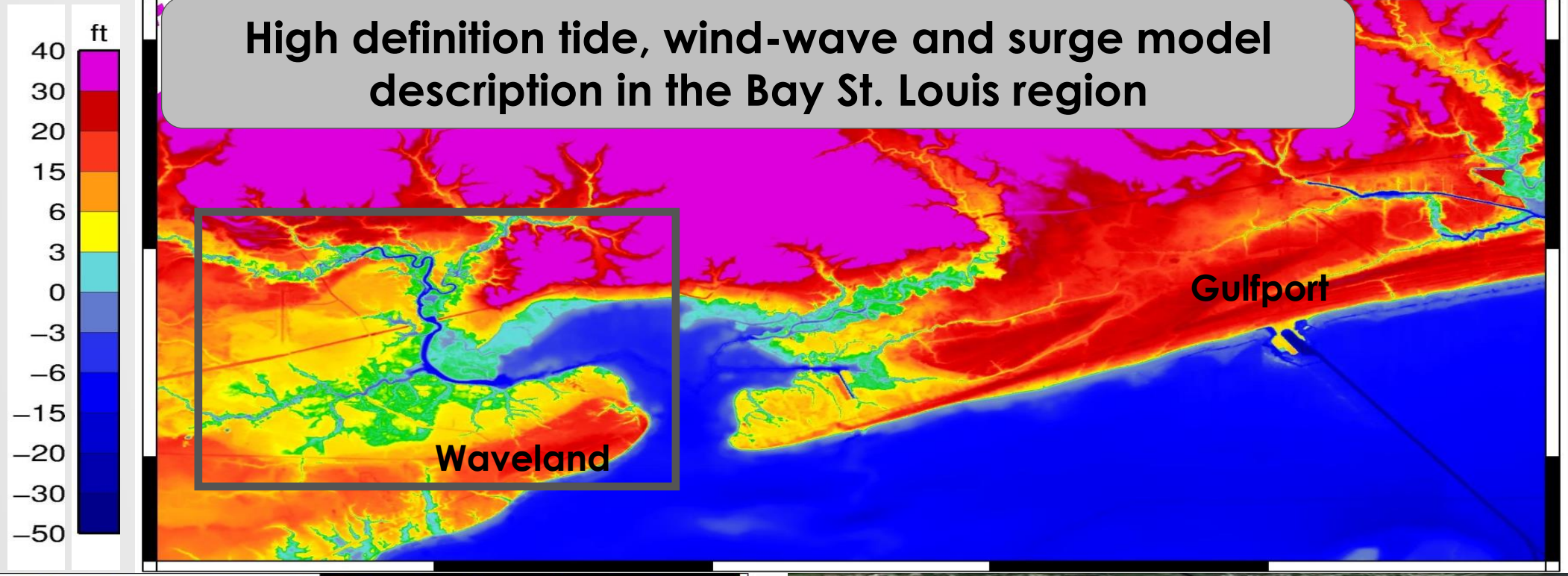
See NOAA talk by Medeiros on Dec. 10, 2014:
"Adjusting lidar-derived digital terrain models in coastal marshes based on estimated above ground biomass density"

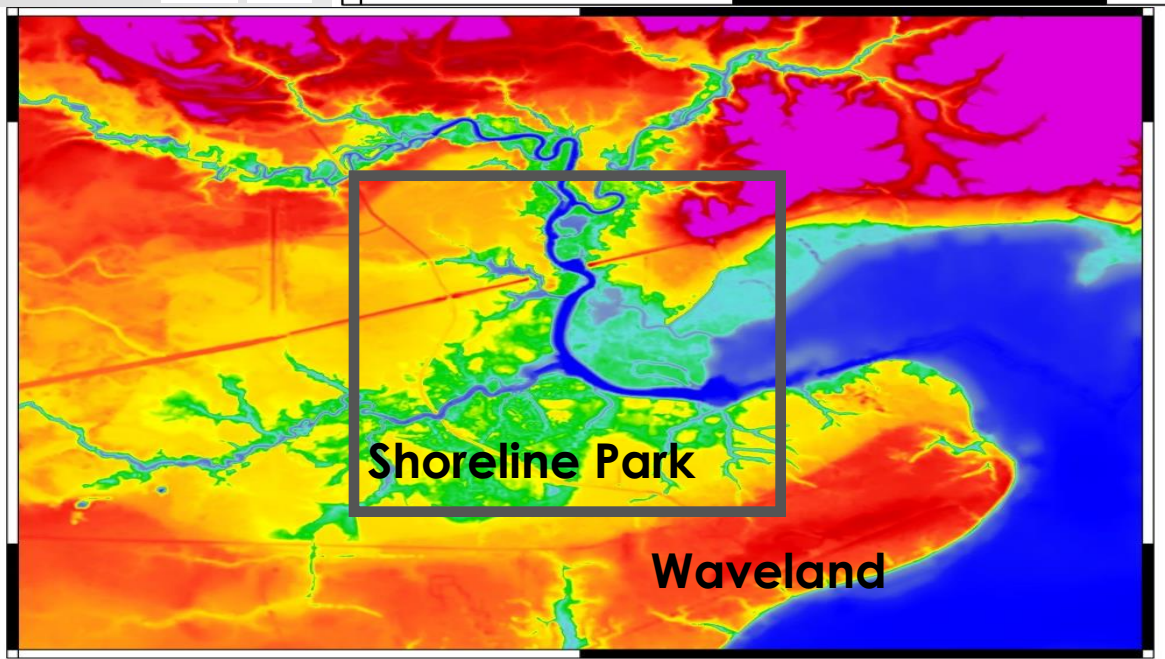

United States
Atlantic Ocean
Gulf of Mexico
Mexico
Caribbean Sea
Pacific Ocean
Venezuela

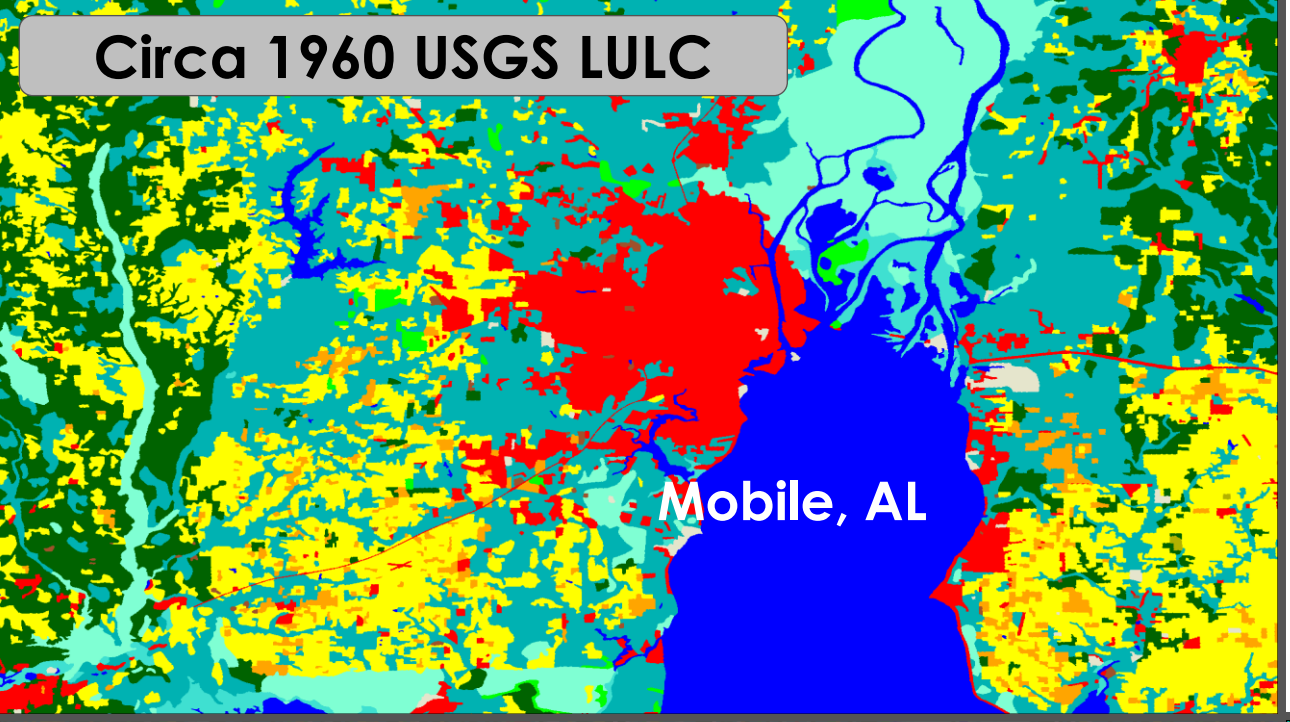

WIND FIELD
ASTRONOMIC TIDES
SURFACE ROUGHNESS
ADCIRC MESH
ADCIRC
Finite-element model solves for long waves
WAVE STRESSES
WIND SPEEDS
WATER LEVELS
CURRENT VELOCITIES
ROUGHNESS LENGTHS
SWAN
Finite-difference model solves for short waves
OUTPUT
WATER LEVELS
CURRENT VELOCITIES
WAVE RADIATION STRESSES
WIND SPEEDS
PEAK WAVE PERIODS
MEAN WAVE PERIODS
MEAN WAVE DIRECTIONS
SIGNIFICANT WAVE HEIGHTS
Tide, Wind-Wave, and Surge Modeling Framework


LA
MS
AL
GA
FL
N
0
100
200
km

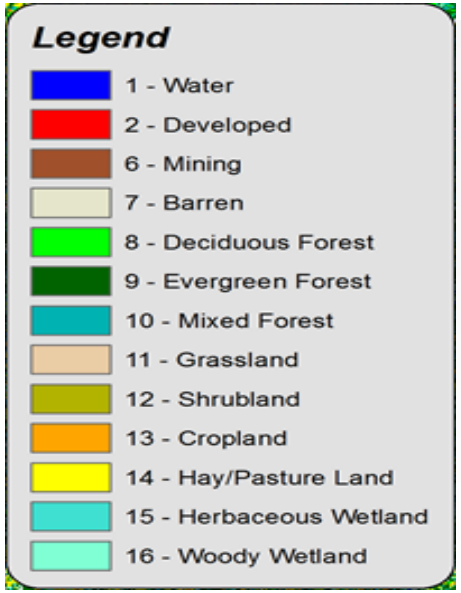
High definition tide, wind-wave and surge model description in the Bay St. Louis region

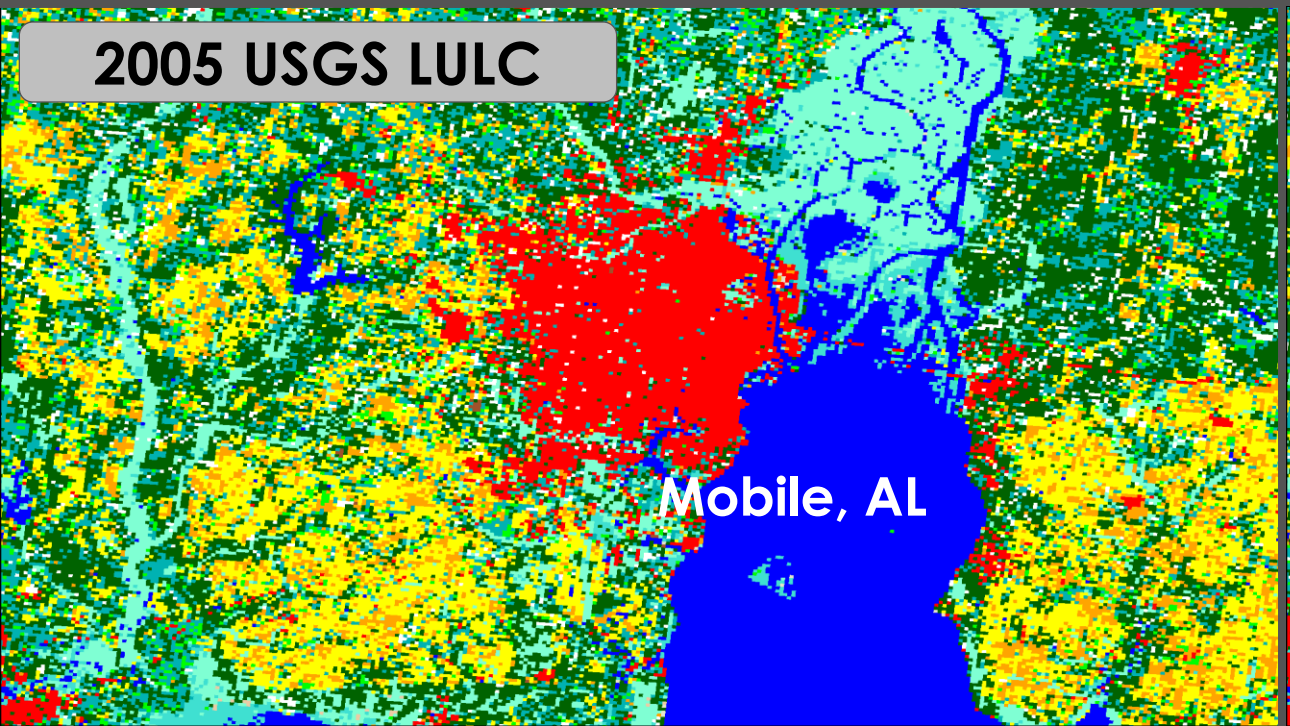


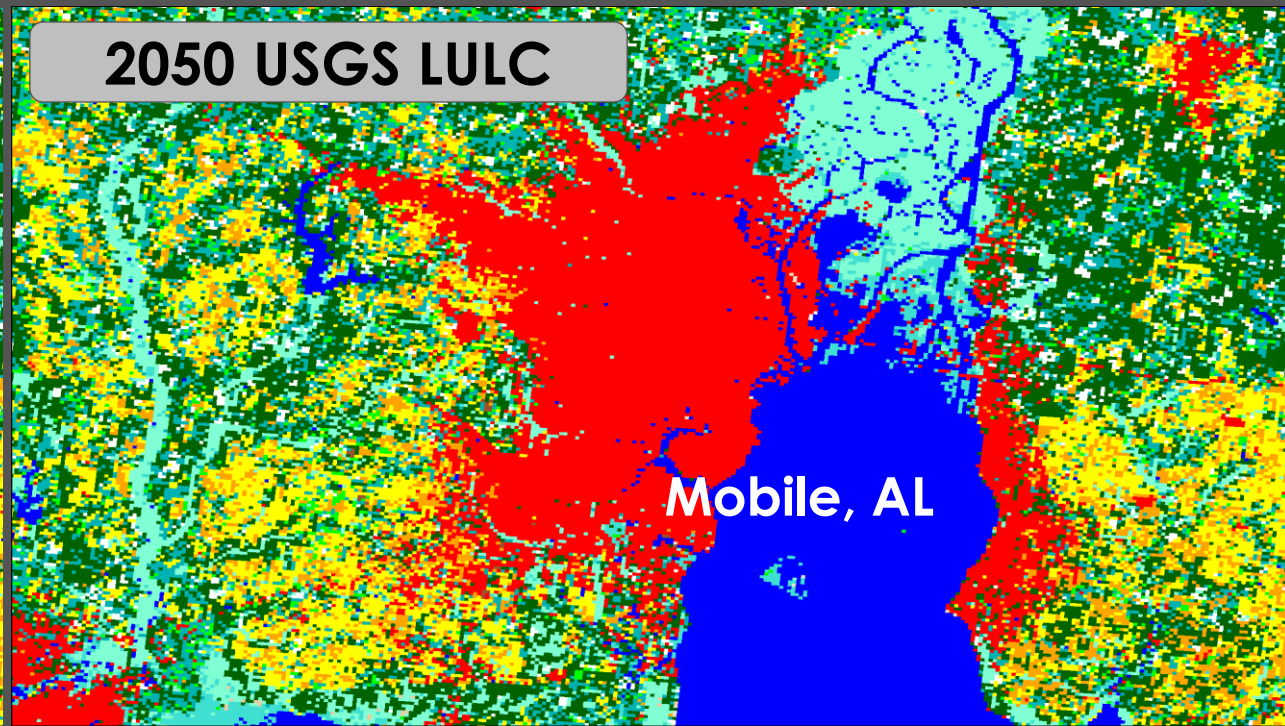




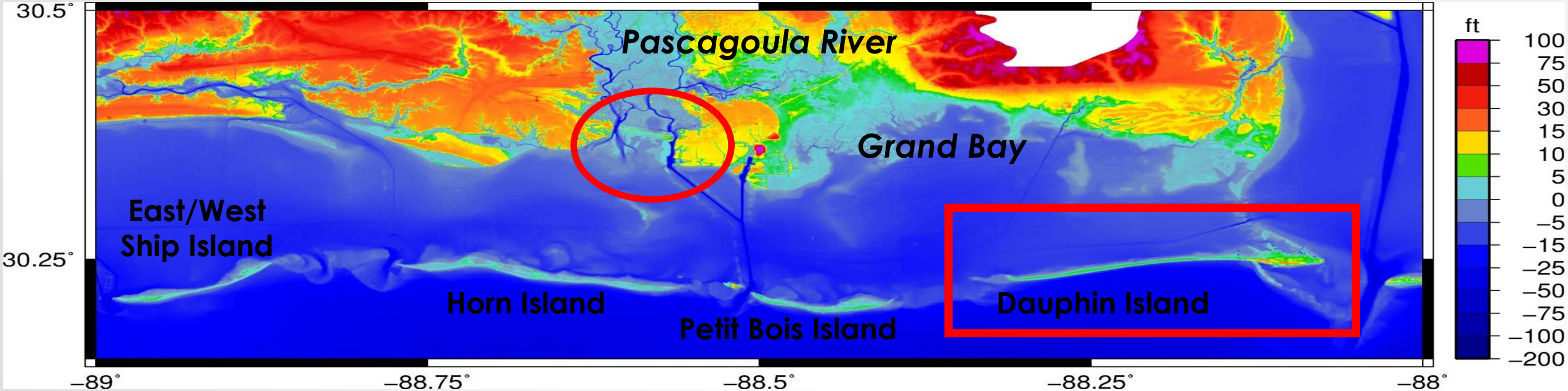
Land use / land cover (LULC)

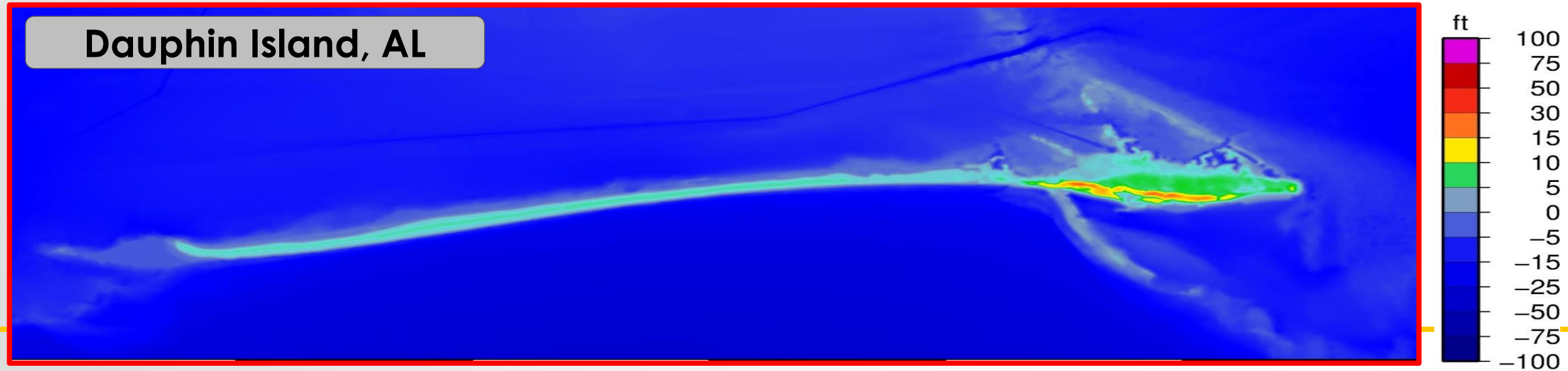




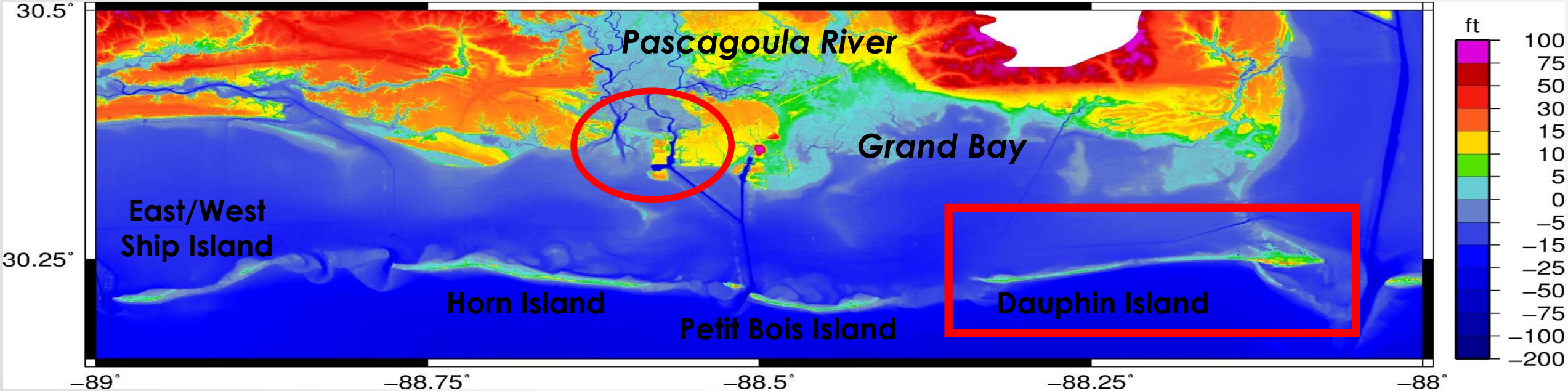


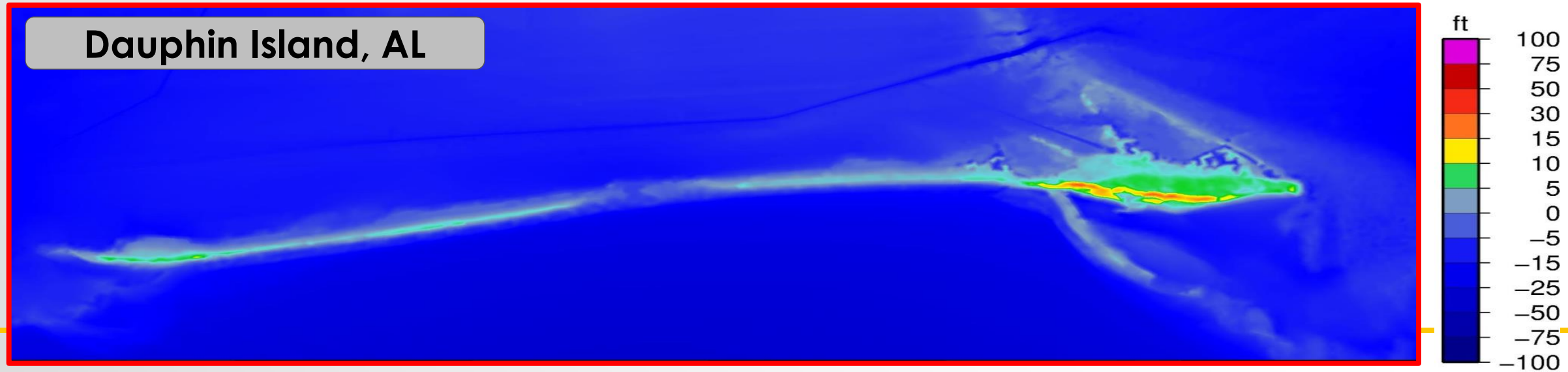
Coastlines are dynamic: 1960 representation.



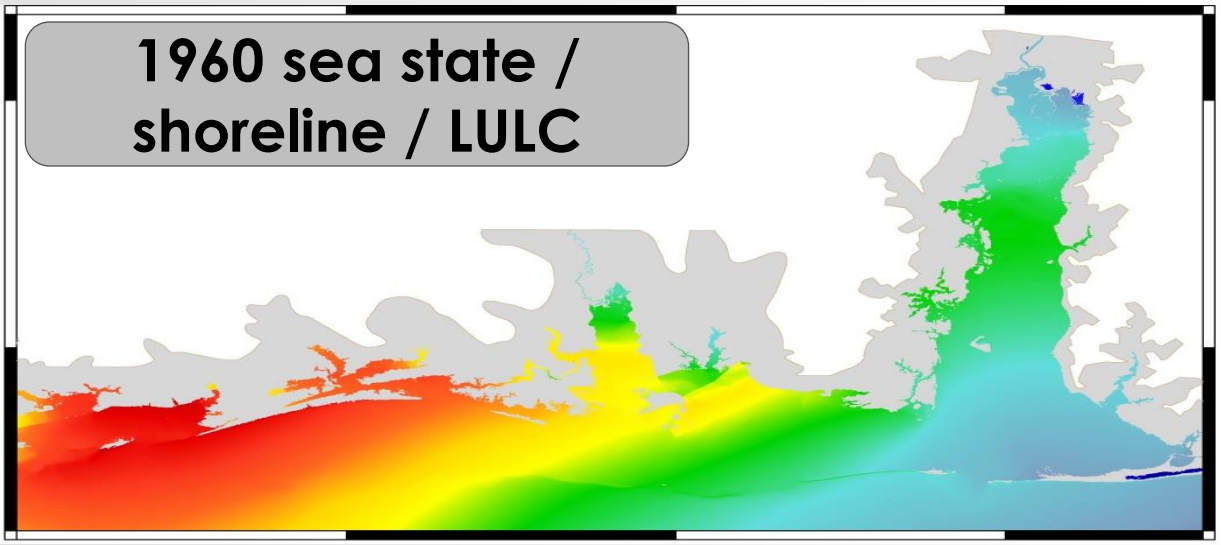


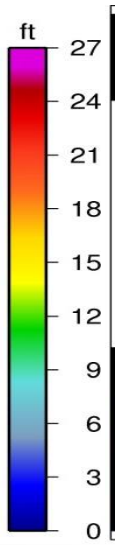
Coastlines are dynamic: 2005 representation.

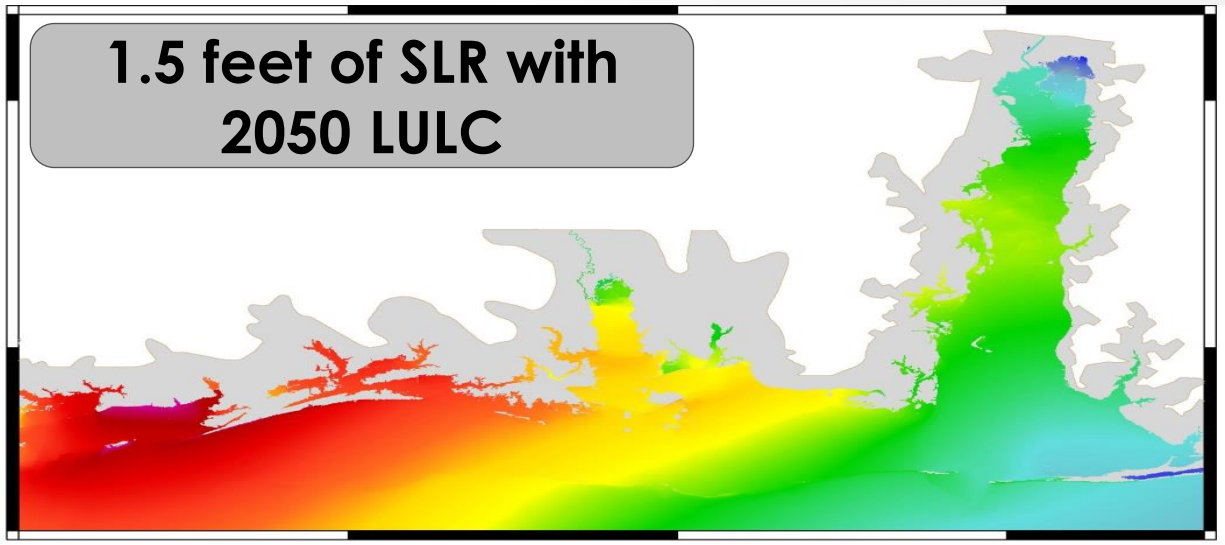




What if…? Hurricane Katrina with various sea states / shorelines / LULC: Surge extents and depths.

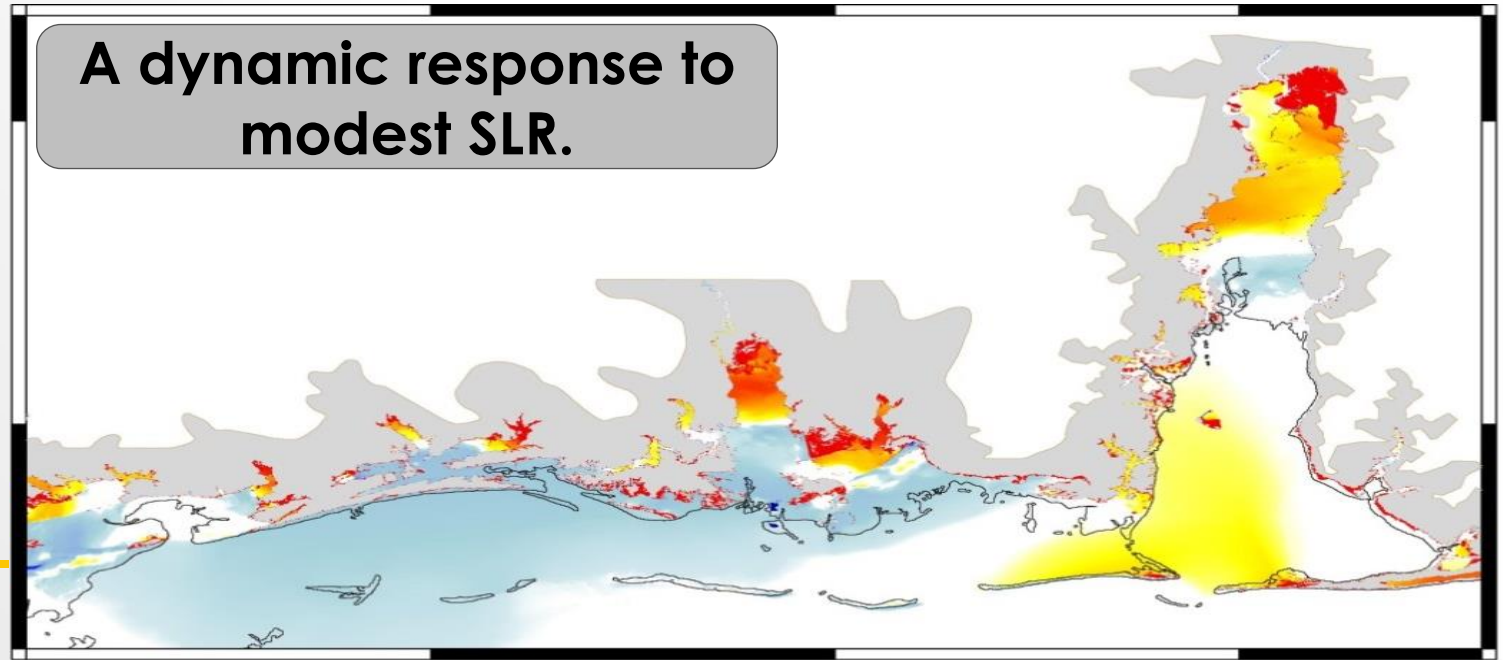


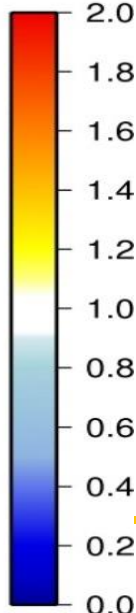




Surge depth comparison between 1960 and 2050 is performed node-by-node:

$$\frac{\text{MaxElev2050} - \text{MaxElev1960}}{\text{1.5 feet}}$$





RELEVANT PUBLICATIONS

Passeri, D.L., S.C. Hagen, M.V. Bilskie, & S.C. Medeiros, "On the significance of incorporating shoreline changes for evaluating coastal hydrodynamics under sea level rise scenarios." *Natural Hazards*, Online Sept, 2014. http://dx.doi.org/10.1007/s11069-014-1386-y

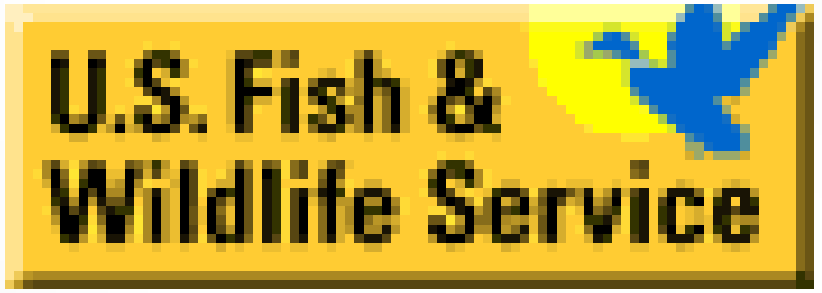
Bilskie, M.V., S.C. Hagen, S.C. Medeiros, D.L. Passeri, "Dynamics of sea level rise and coastal flooding on a changing landscape." *Geophysical Research Letters*, Vol. 41, 2014, pp. 1-8. http://dx.doi.org/10.1002/2013GL058759.

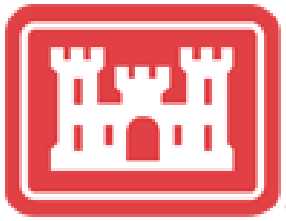
Joshua S. Reece, Davina Passeri, Llewellyn Ehrhart, Scott Hagen, Allison Hays, Christopher Long, Reed F. Noss, Matthew Bilskie*, Cheryl Sanchez, Monette V. Schwoerer, Betsy Von Holle, John Weishampel, Shaye Wolf, "Sea level rise, land use, and climate change influence the distribution of loggerhead turtle nests at the largest USA rookery (Melbourne Beach, Florida)." *Marine Ecology Progress Series*, Vol. 493, 2013, pp. 259–274. http://dx.doi.org/10.3354/meps10531.

Hagen, S.C., J.L. Irish, "Implications, Planning, and Design Considerations for Rising Sea Levels at the Coast." ASCE *Journal of Waterway, Port, Coastal, and Ocean Engineering*, Vol. 139, No. 2, March/April 2013, p. 81. http://ascelibrary.org/doi/abs/10.1061/(ASCE)WW.1943-5460.0000186

Hagen, S.C., J.T. Morris, P. Bacopoulos, and J. Weishampel, "Sea-Level Rise Impact on a Salt Marsh System of the Lower St. Johns River." ASCE *Journal of Waterway, Port, Coastal, and Ocean Engineering*, Vol. 139, No. 2, March/April 2013, pp. 118-125. http://dx.doi.org/10.1061/(ASCE)WW.1943-5460.0000177

ACKNOWLEDGEMENTS





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