



# The future of Plum Island, MA marshes and their importance to storm surge abatement

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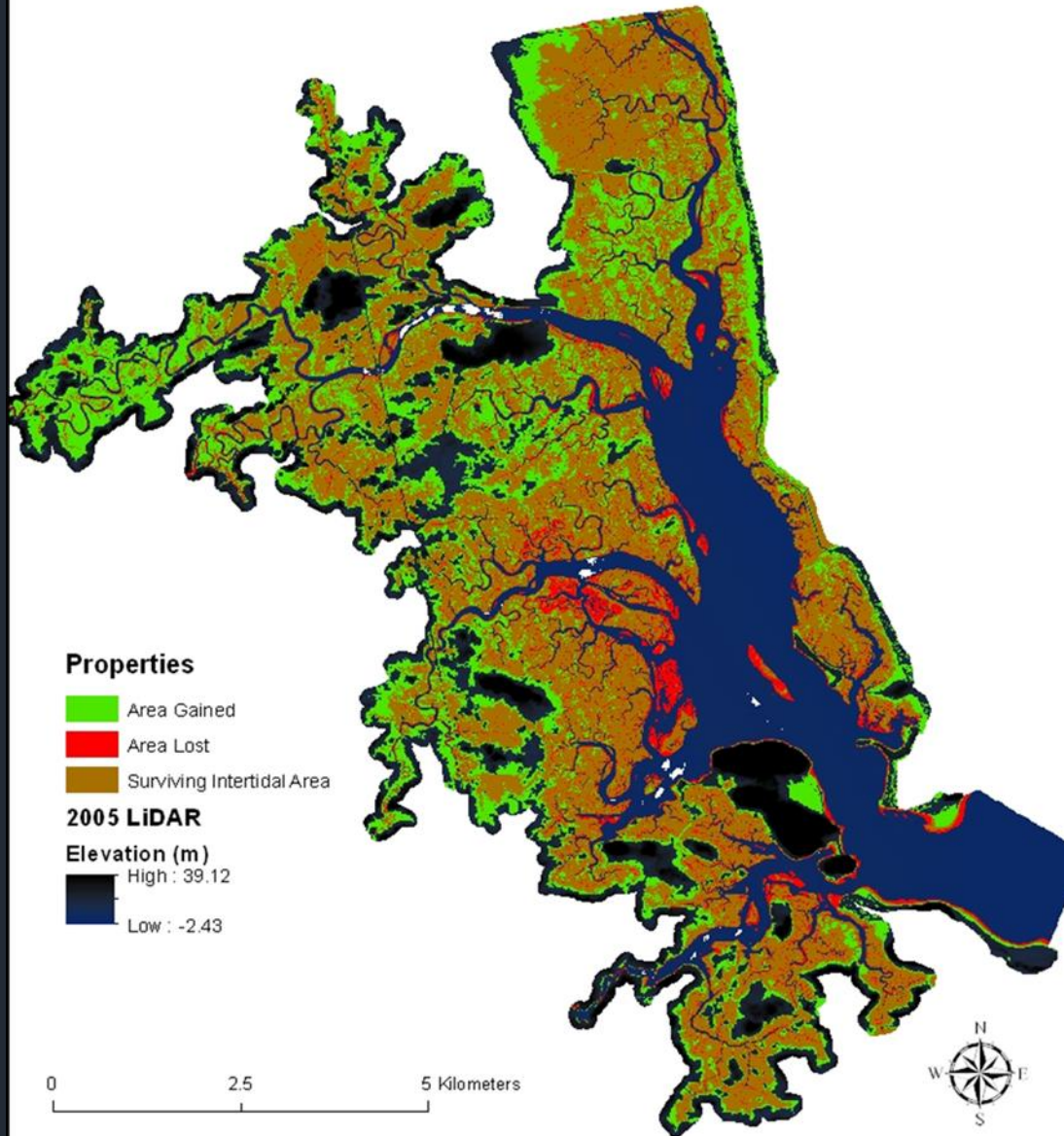
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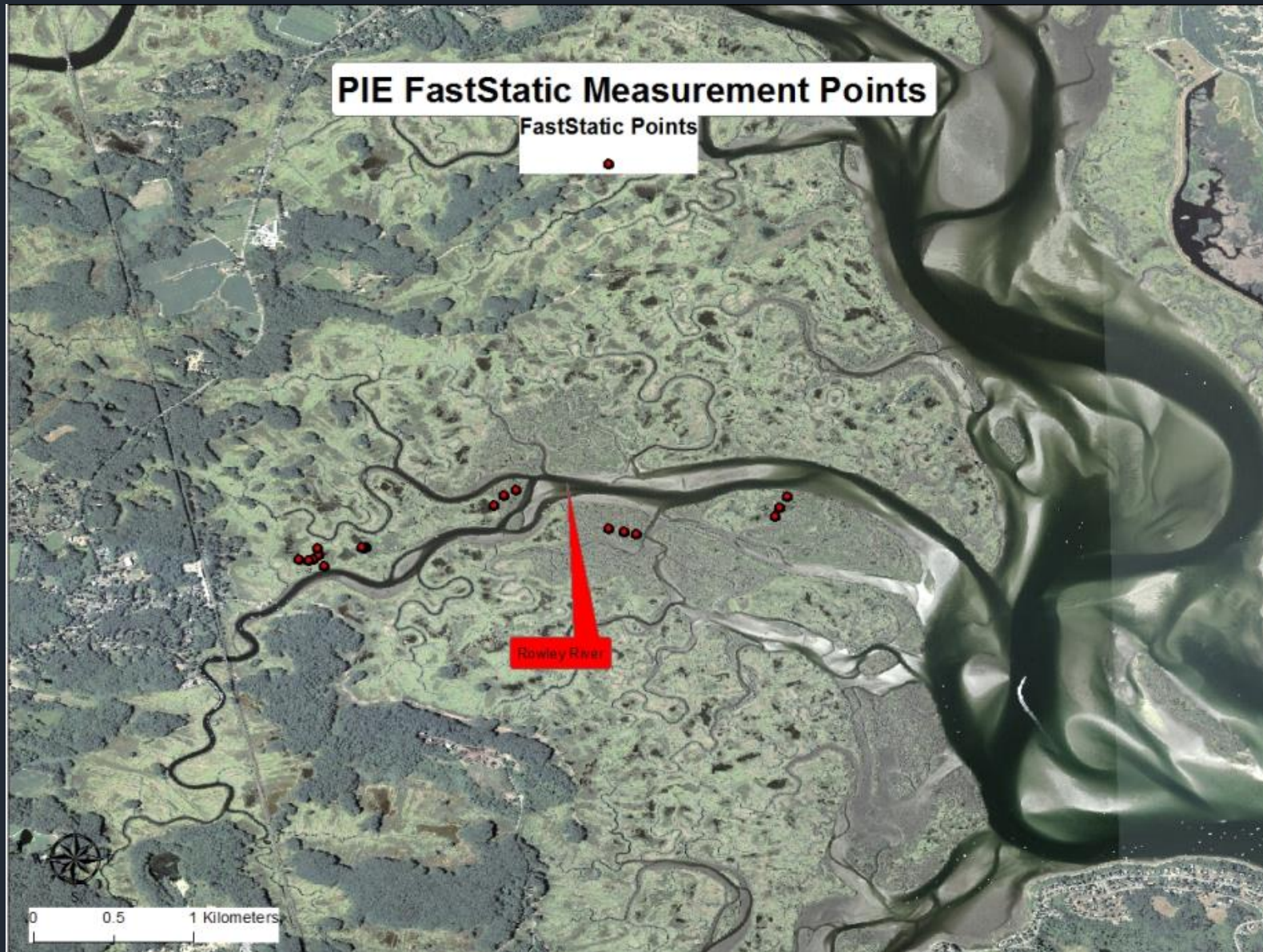
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## PIE Intertidal Landscape Following a 1 m SLR



The Plum Island Bathtub Model  
Intertidal Marsh (MSL to MHHW) Area  
Current and Future  
Assumes no erosion, no accretion,  
transgression without limit

| Class                       | Area (km <sup>2</sup> ) |
|-----------------------------|-------------------------|
| Current Intertidal          | 32.93                   |
| Future Intertidal           | 43.4                    |
| Area Gained (transgression) | 14.53                   |
| Area Lost (submergence)     | 4.06                    |
| Surviving Intertidal        | 28.87                   |



We feel that the DEM is a good one.

LiDAR elevation are 9 cm greater than points surveyed by RTK at SET sites. This is the internal RMSE for the LiDAR compared against the turnpike.

# The Marsh Equilibrium Model (MEM)

Use a generic biom profile  
 Calibrate to accretion rate  
 Use my own kr and q  

Click to Run Simulation

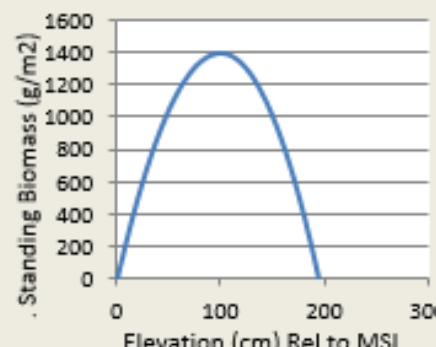
**Physical Inputs**

|                           |       |           |
|---------------------------|-------|-----------|
| Sea Level Forecast        | 100   | (cm/100y) |
| Sea Level at Start        | 1.8   | cm NAVD   |
| 20th Cent Sea Level Rate  | 0.2   | cm/yr     |
| Mean Tidal Amplitude      | 160   | cm        |
| Marsh Elevation @ t0      | 142.7 | cm NAVD   |
| Suspended Min. Sed. Conc. | 10    | mg/l      |
| Suspended Org. Sed. Conc. | 2     | mg/l      |
| Accretion Rate            |       | cm/yr     |

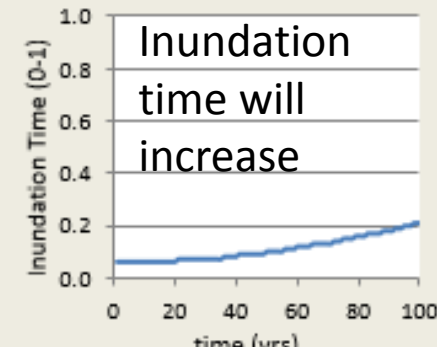
**Biological Inputs**

|                            |      |                  |
|----------------------------|------|------------------|
| max growth limit (rel MSL) | 195  | cm               |
| min growth limit (rel MSL) | 0    | cm               |
| opt growth elev (rel MSL)  | 100  | cm               |
| max peak biomass           | 1400 | g/m <sup>2</sup> |
| %OM below root zone        | 20.0 |                  |
| OM decay rate              | -0.2 | 1/year           |
| BGBio to Shoot Ratio       | 2.5  | g/g              |
| BG turnover rate           | 0.8  | 1/year           |
| Max (95%) Root Depth       | 25   | cm               |

### PIE Spartina composite MEM 5.41

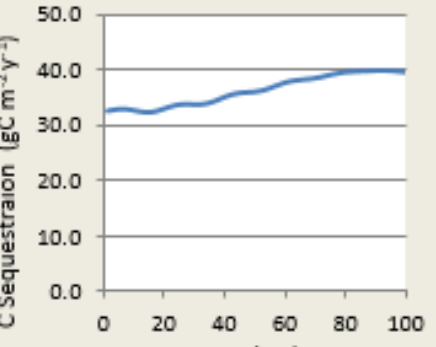


Standing Biomass (g/m<sup>2</sup>) vs Elevation (cm) Rel to MSL

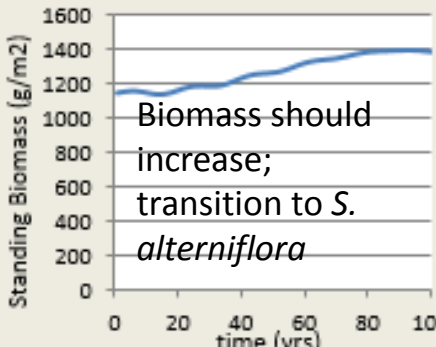


Inundation Time (0-1) vs time (yrs)

Inundation time will increase

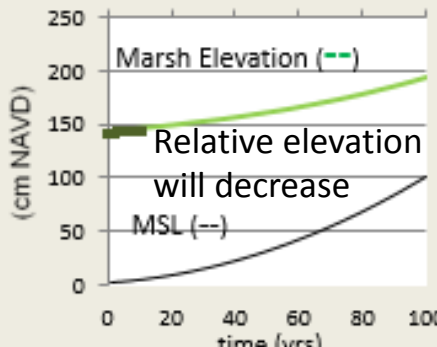


C Sequestraion (gC m<sup>-2</sup> y<sup>-1</sup>) vs time (yrs)



Standing Biomass (g/m<sup>2</sup>) vs time (yrs)

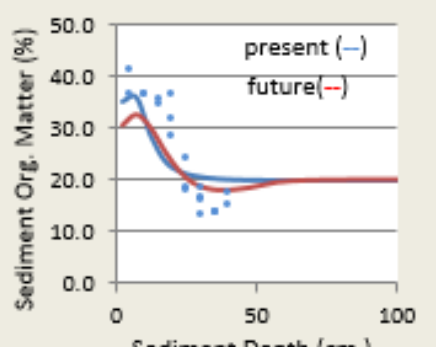
Biomass should increase; transition to *S. alterniflora*



Marsh Elevation (---) vs time (yrs)

MSL (---)

Relative elevation will decrease

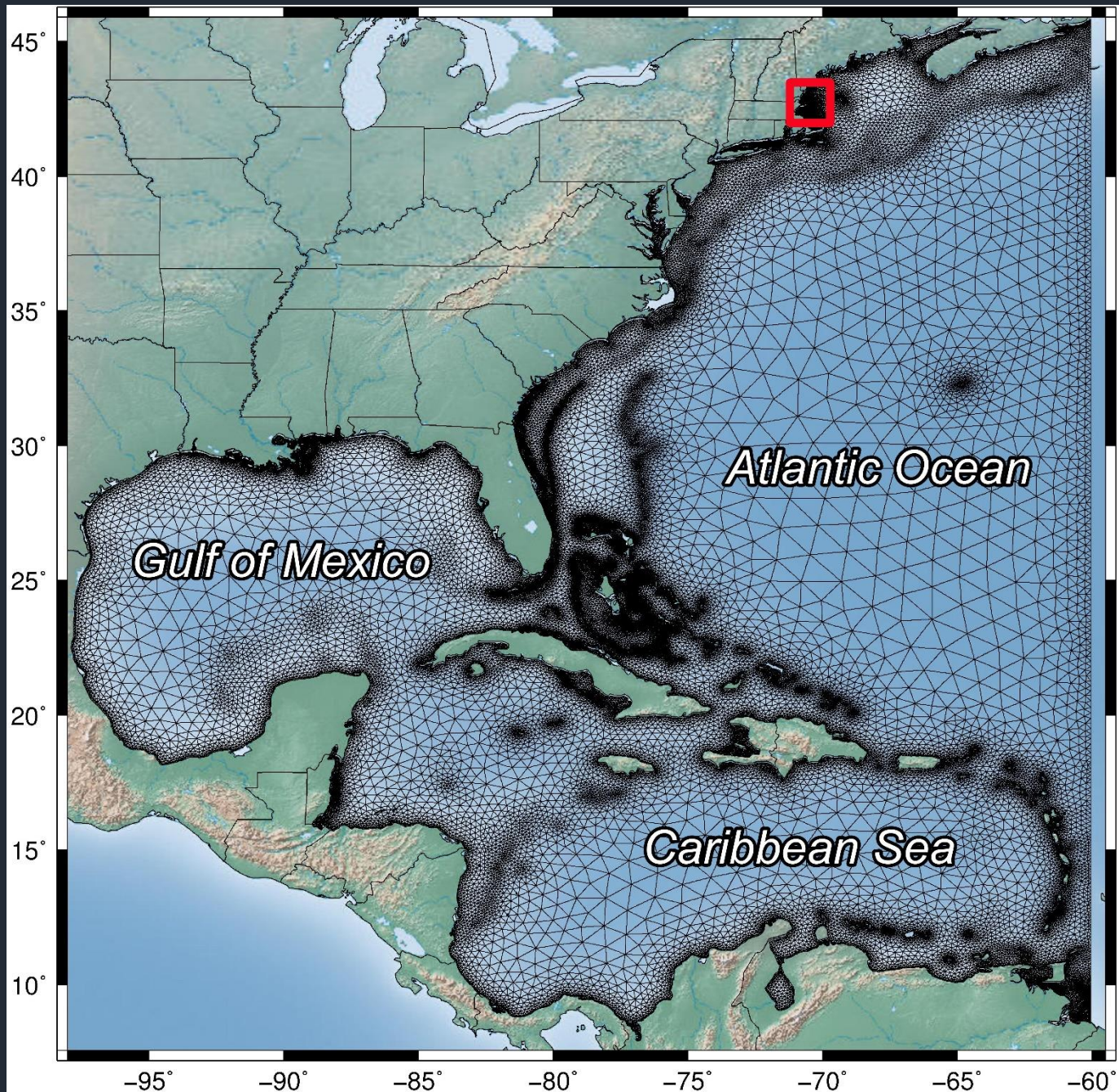


Sediment Org. Matter (%) vs Sediment Depth (cm)

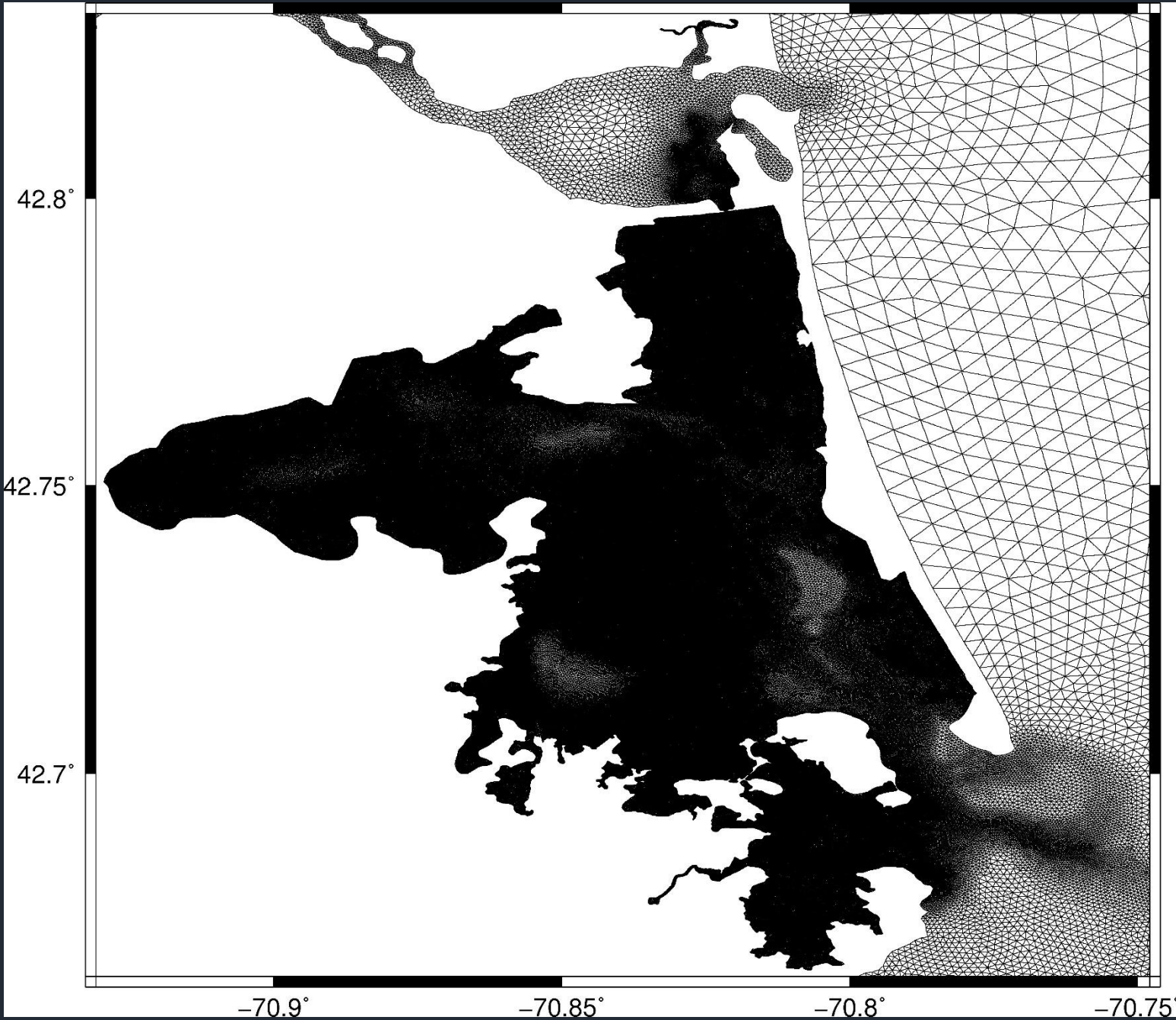
present (---)  
future (---)

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Plum Island, MA      Other Estuary  
 North Inlet, SC  
 Apalachicola, FL

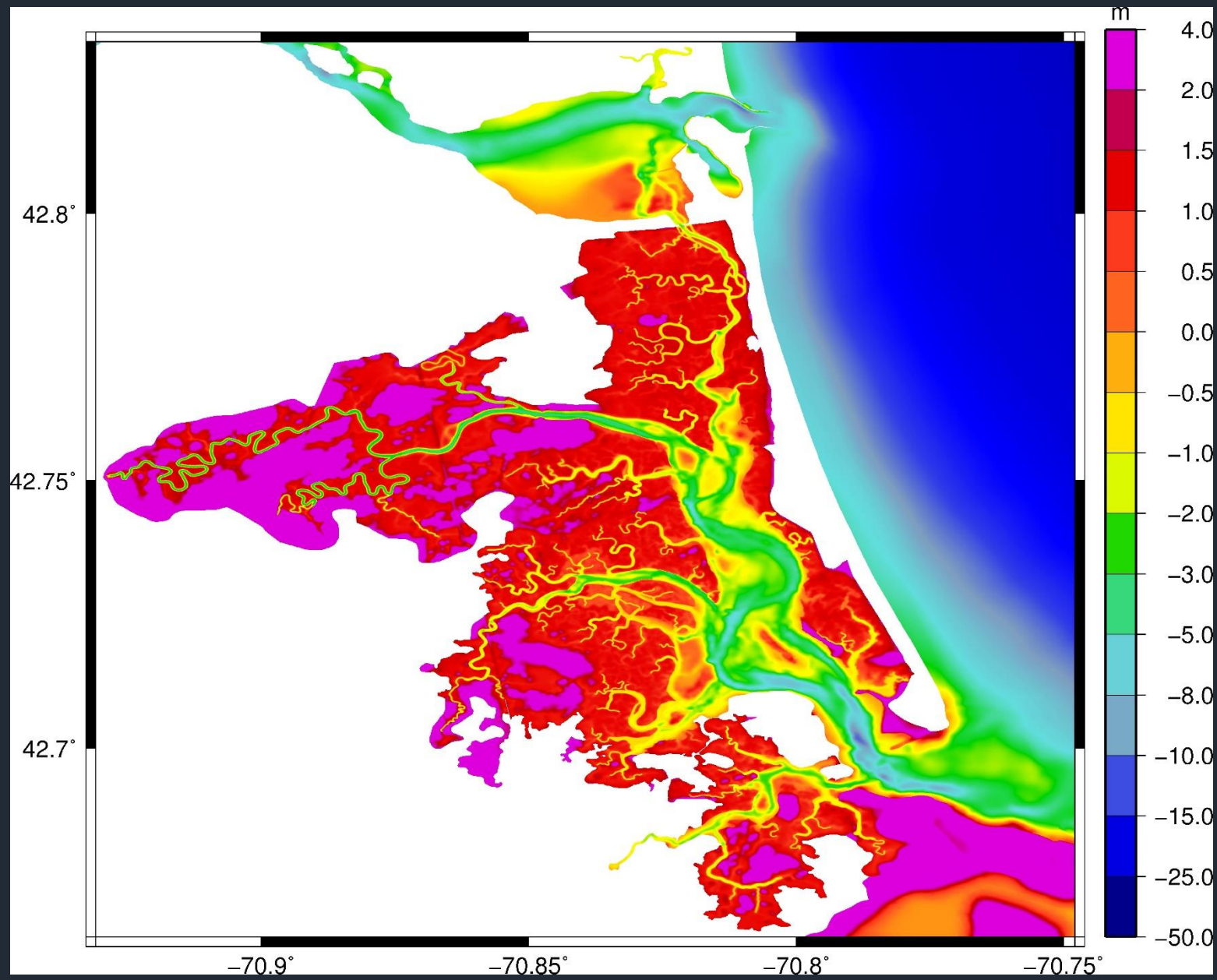


*The 53k ADCIRC mesh for the western north Atlantic tidal model domain and zoom in of Plum Island Estuary model bathymetry (m, NAVD88)*

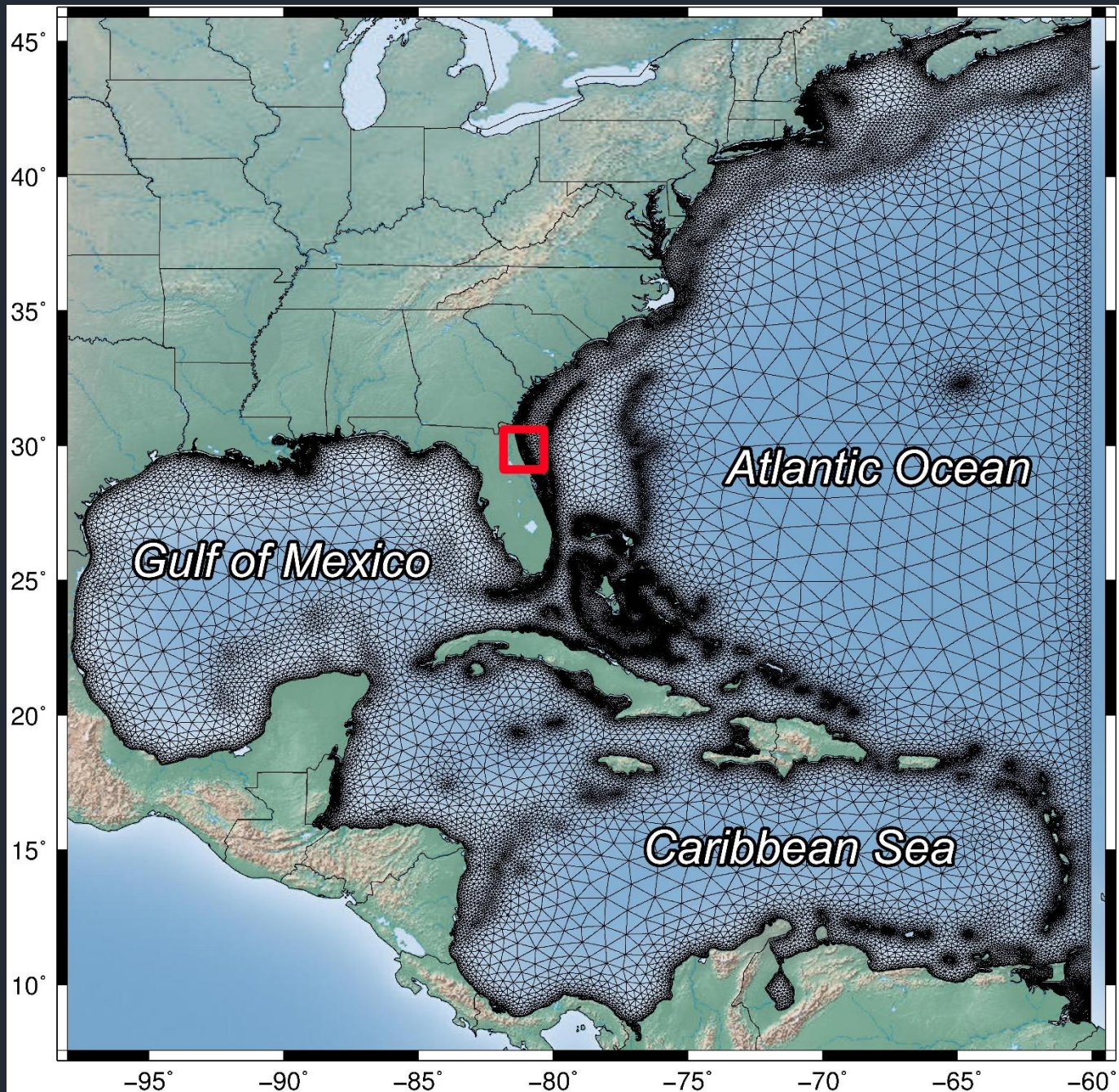


*ADCIRC unstructured mesh for  
the Plum Island Estuary.*

*Mesh resolution ~10-20 m  
within the tidal creeks and  
marsh platform.*



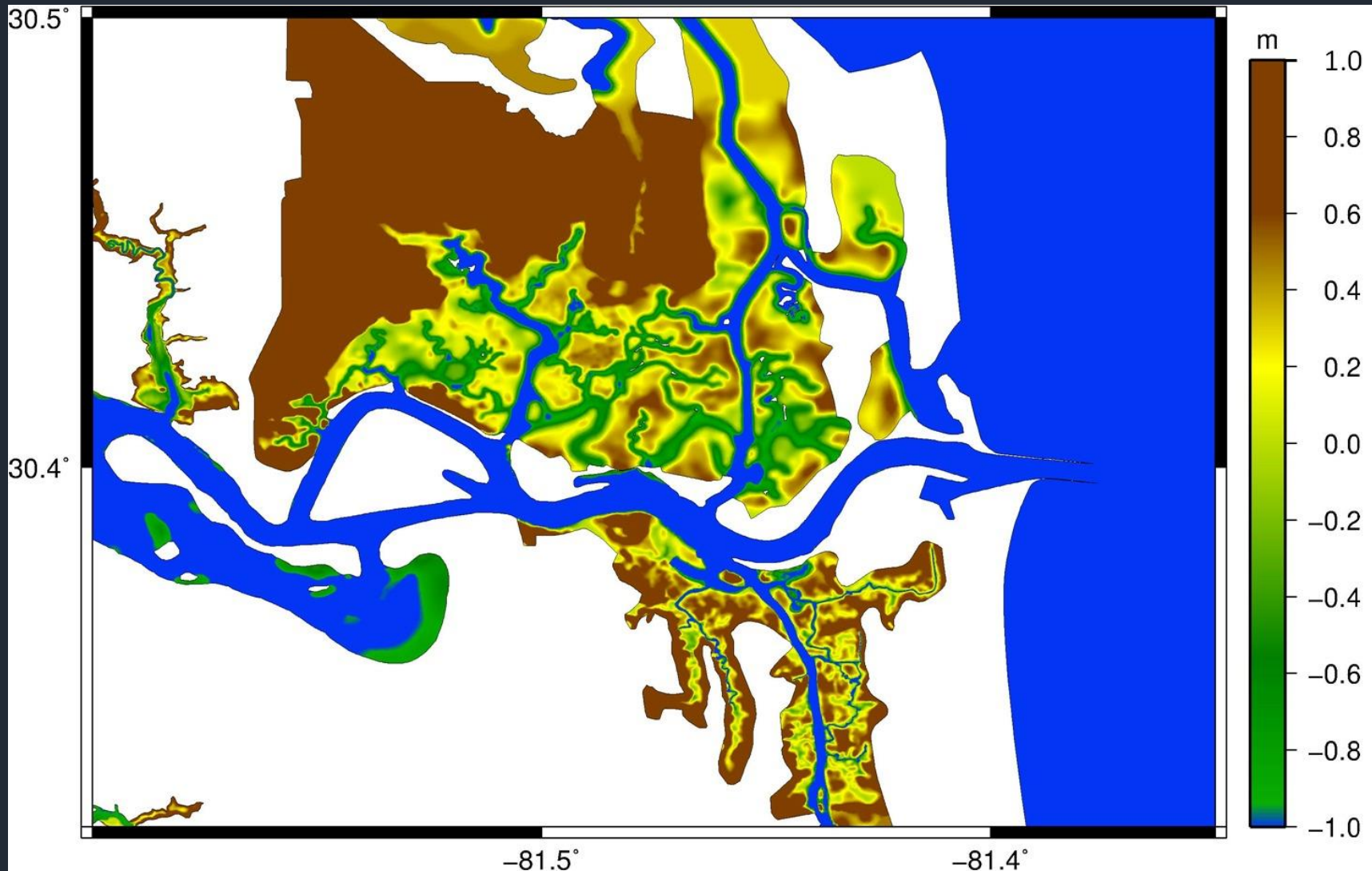
*Plum Island Estuary model bathymetry (m, NAVD88)*



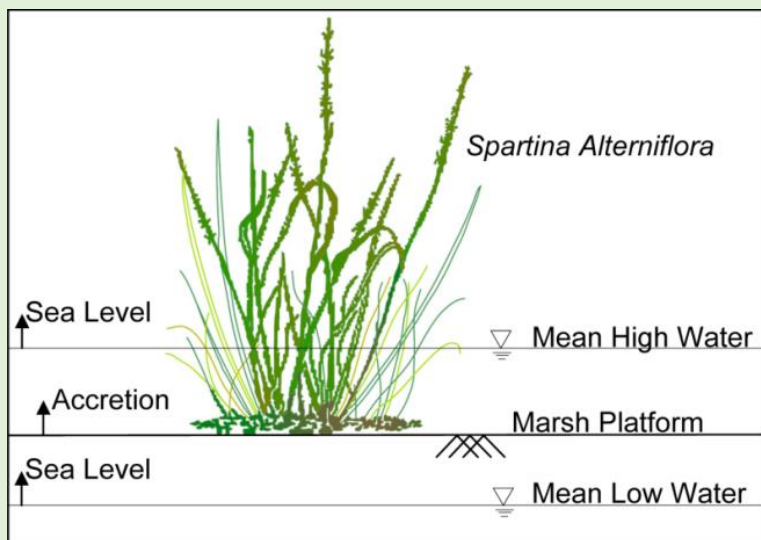
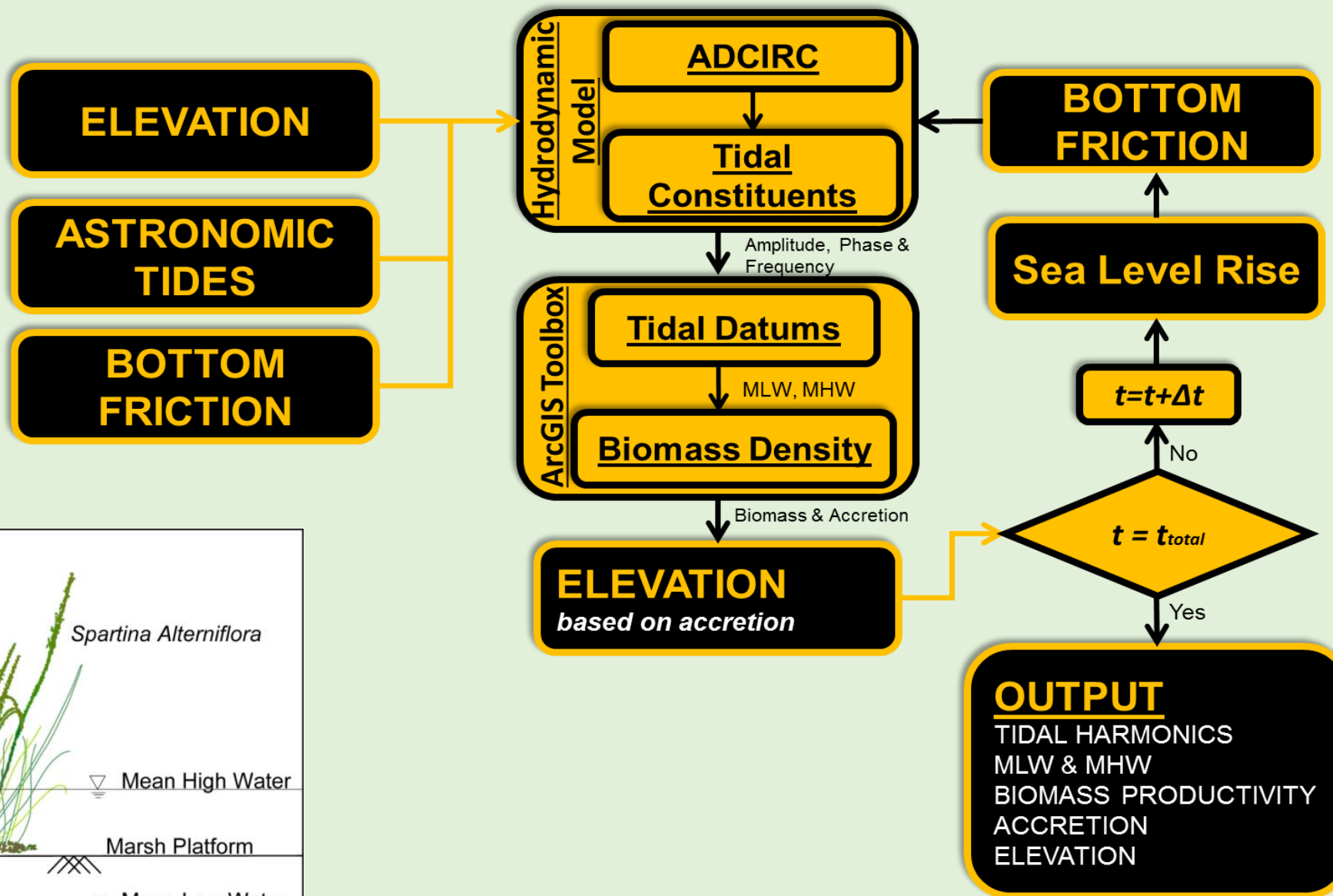
*The 53k ADCIRC mesh for the western north Atlantic tidal model domain and zoom in of Plum Island Estuary model bathymetry (m, NAVD88)*



# Timucuan marsh topography, St Johns River



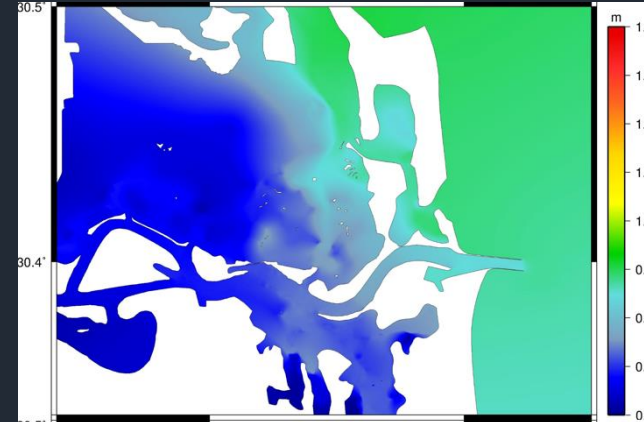
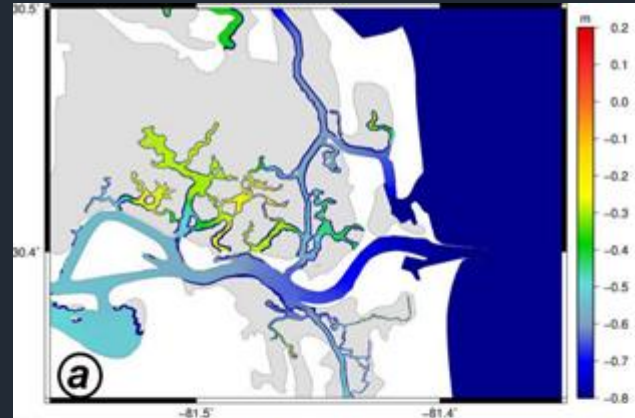
# Hydro-marsh modeling framework



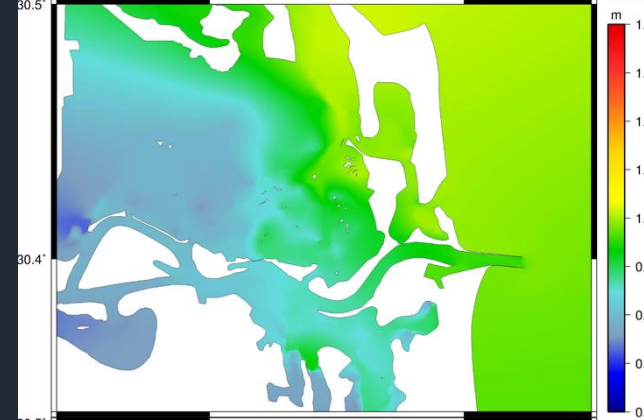
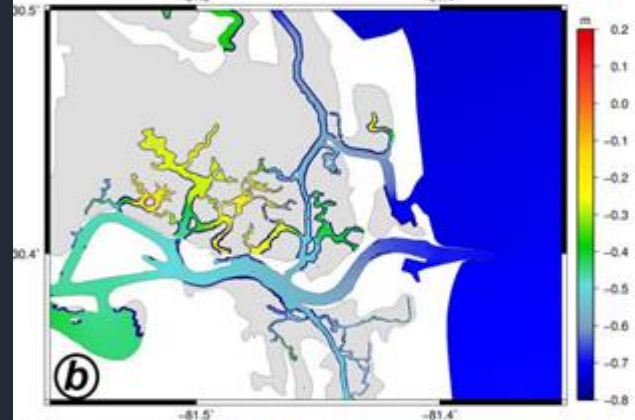
# Mean Low Water

# Mean High Water

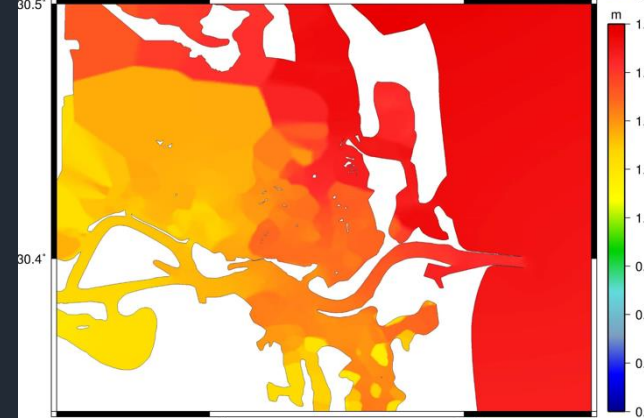
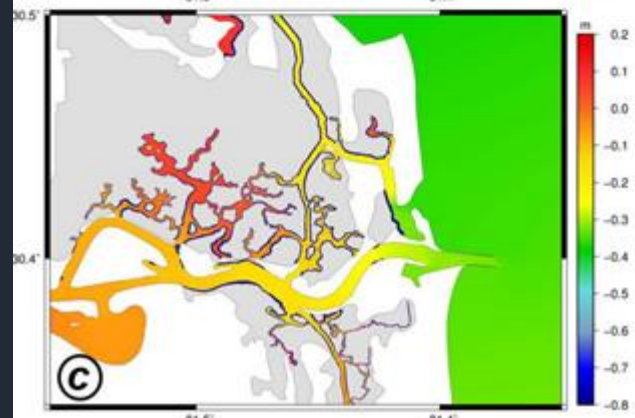
Today



In 2050 after  
11 cm SLR



In 2050 after  
48 cm SLR

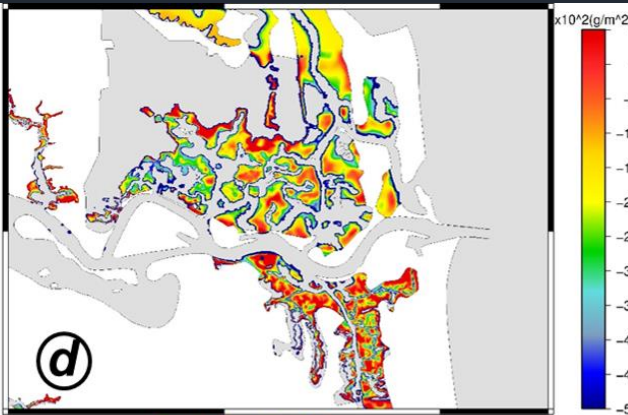
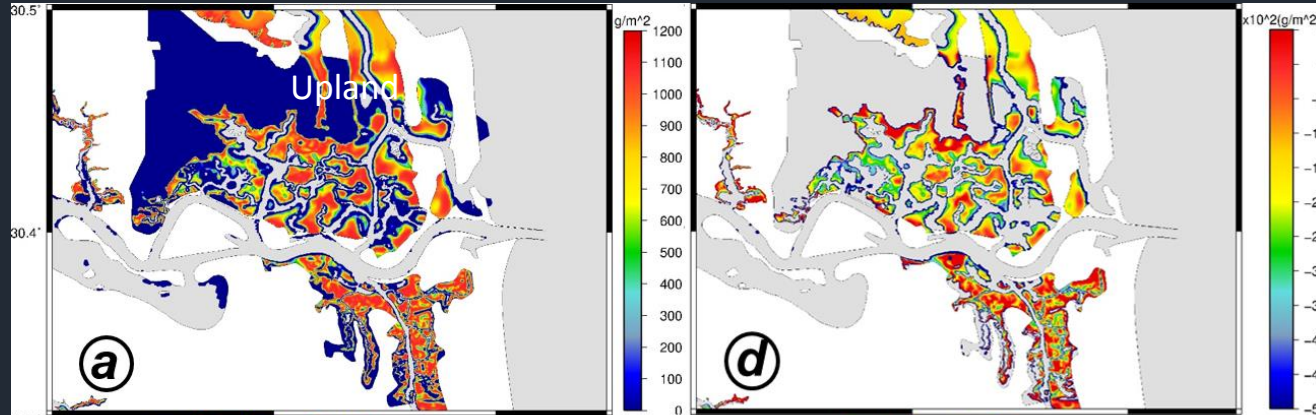


Note that the water surfaces are not uniform across the estuary. This affects biomass and sediment accretion.

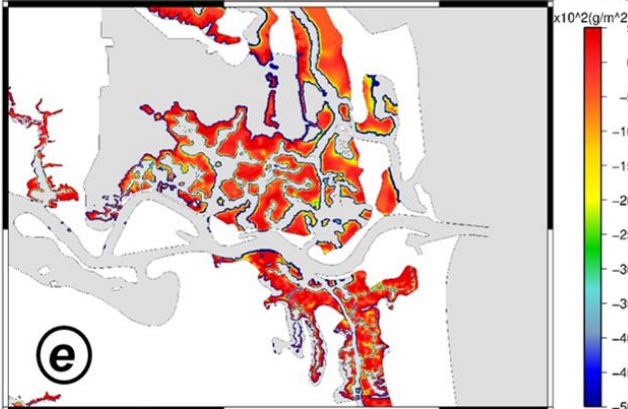
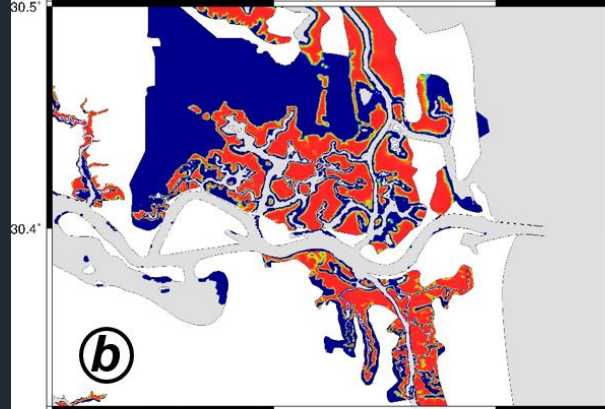
## Biomass Distribution

## Biomass 1<sup>st</sup> Derivative

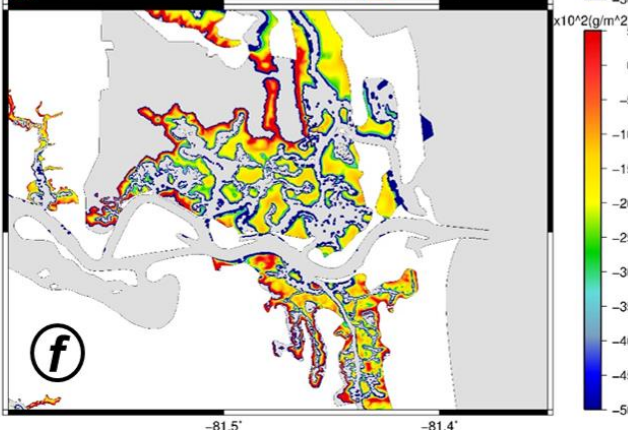
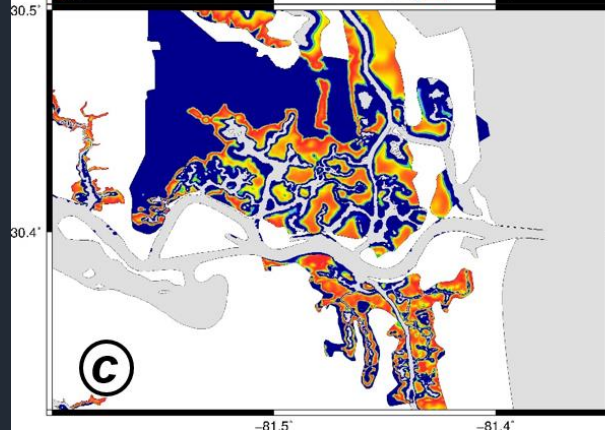
Today



In 2050 after  
11 cm SLR

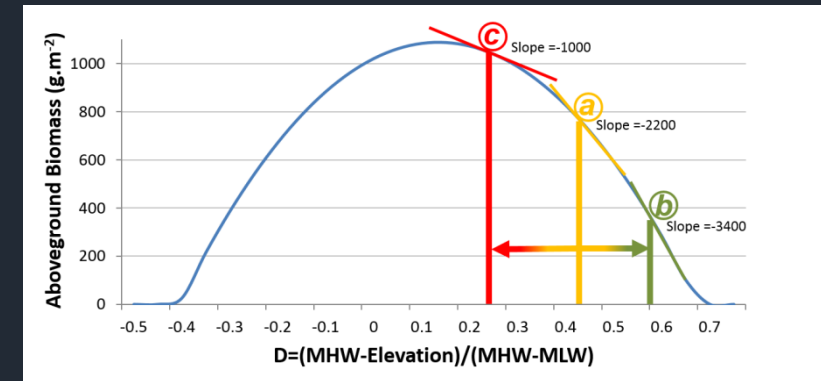


In 2050 after  
48 cm SLR



Biomass is a function of relative elevation and tide range (inundation time).

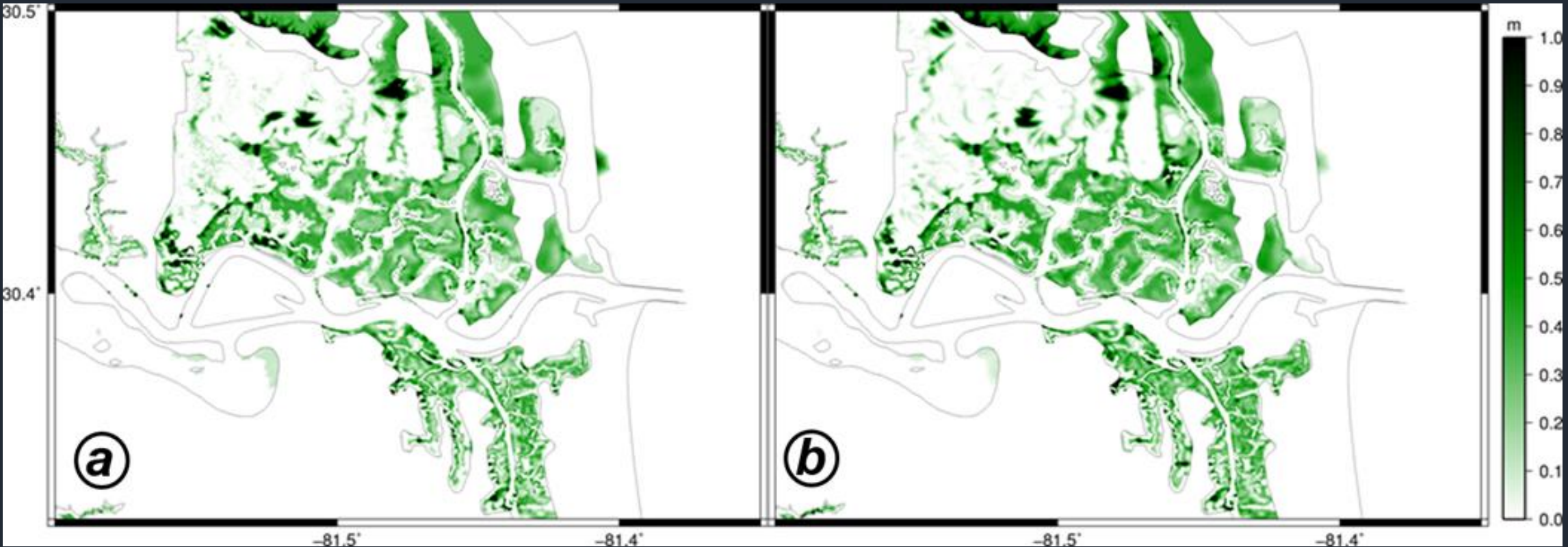
Biomass Distribution vs Dimensionless Depth



# Forecast of platform accretion in Timucuan marsh after 50 yr of sea-level rise

After 11 cm of sea-level rise

After 48 cm of sea-level rise



# Challenges



**Marsh slumping occurring at the marsh platform – tidal creek boundary.**



**Marsh ponding occurring on the platform.**

## Take Home Points

1. MEM runs now as a spatial model linked to the hydrodynamic model ADCIRC
2. The coupled models are being implemented in Plum Island Sound
3. Ultimately we hope to run the coupled ADCIRC-SWAN-MEM models to simulate storm surge with and without designer marsh landscapes

Acknowledgements:



PIE LTER

