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

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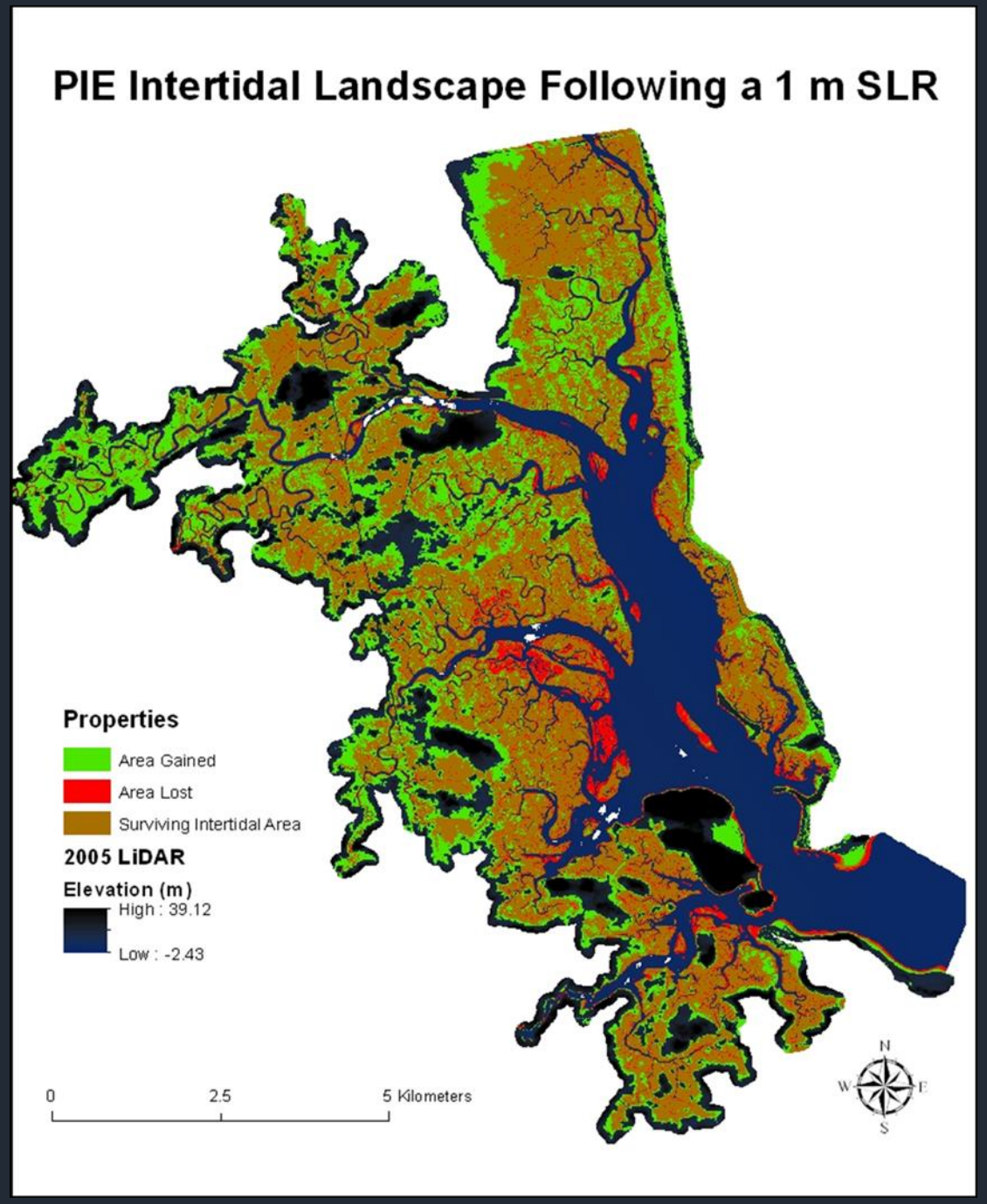
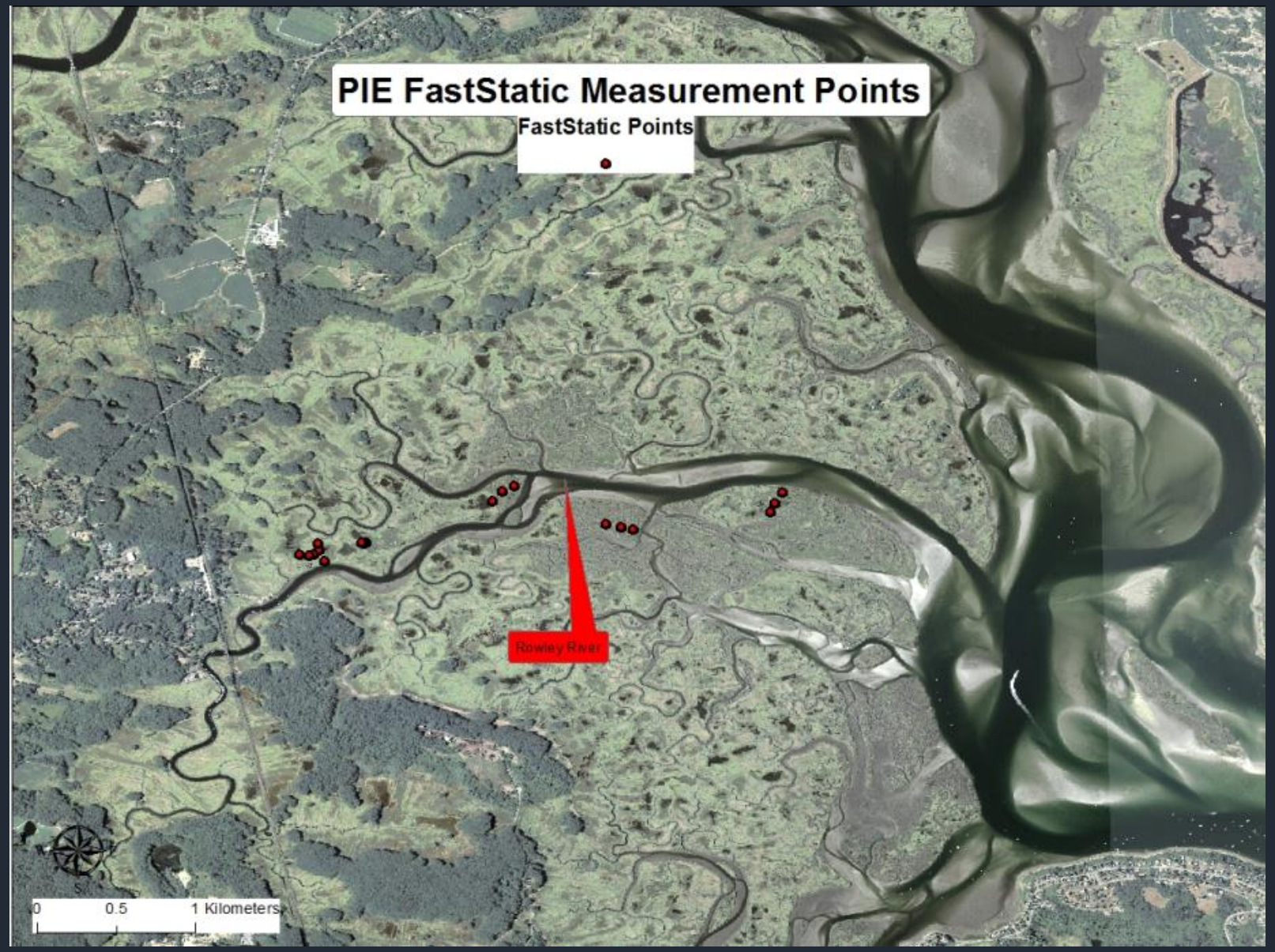


The Plum Island Bathtub Model
Intertidal Marsh (MSL to MHHW) Area
Current and Future
Assumes no erosion, no accretion,
transgression without limit

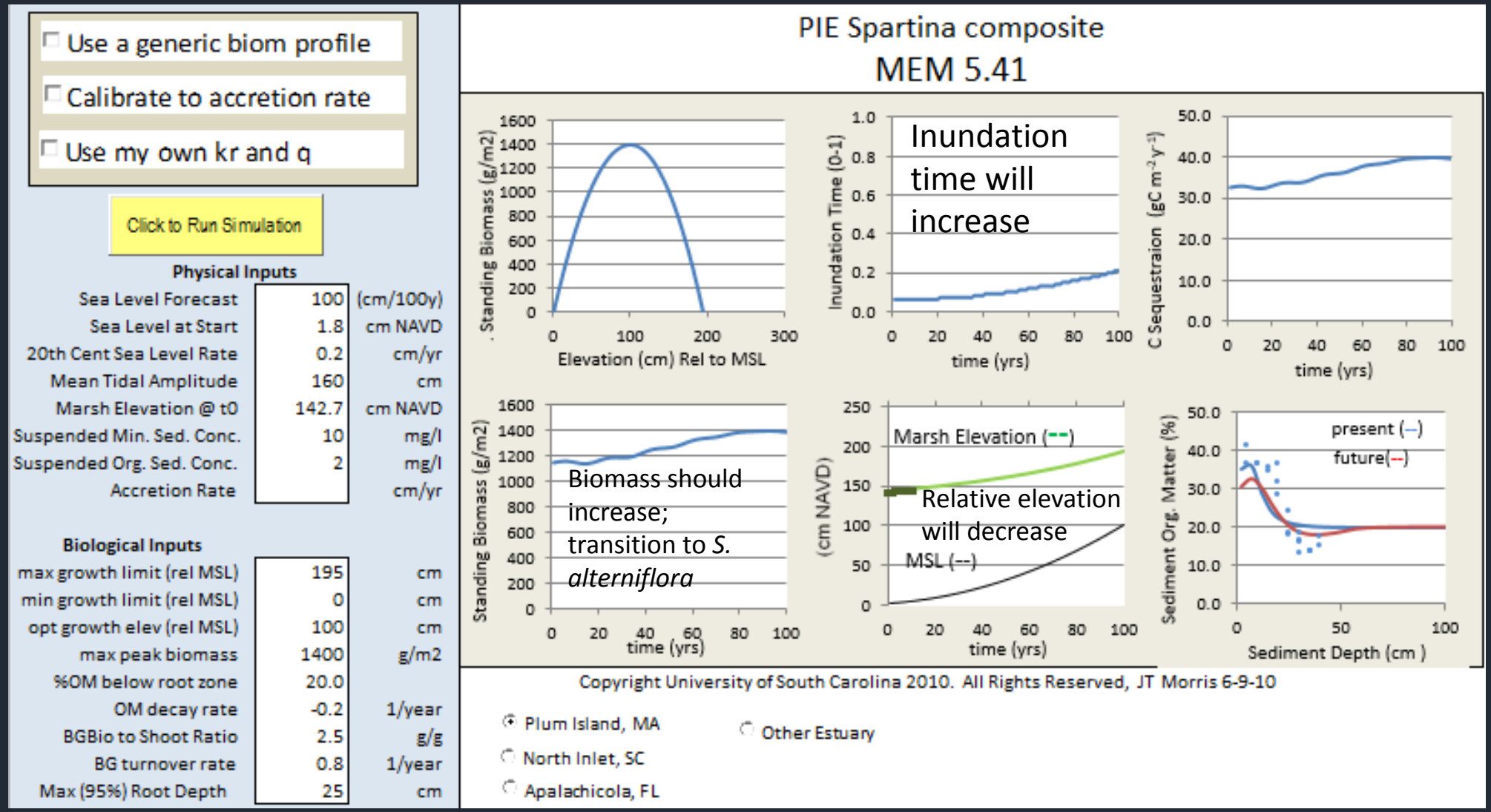
Class	Area (km^2)
Current Intertidal	32.93
Future Intertidal	43.4
Area Gained (transgression)	14.53
Area Lost (submergence)	4.06
Surviving Intertidal	28.87



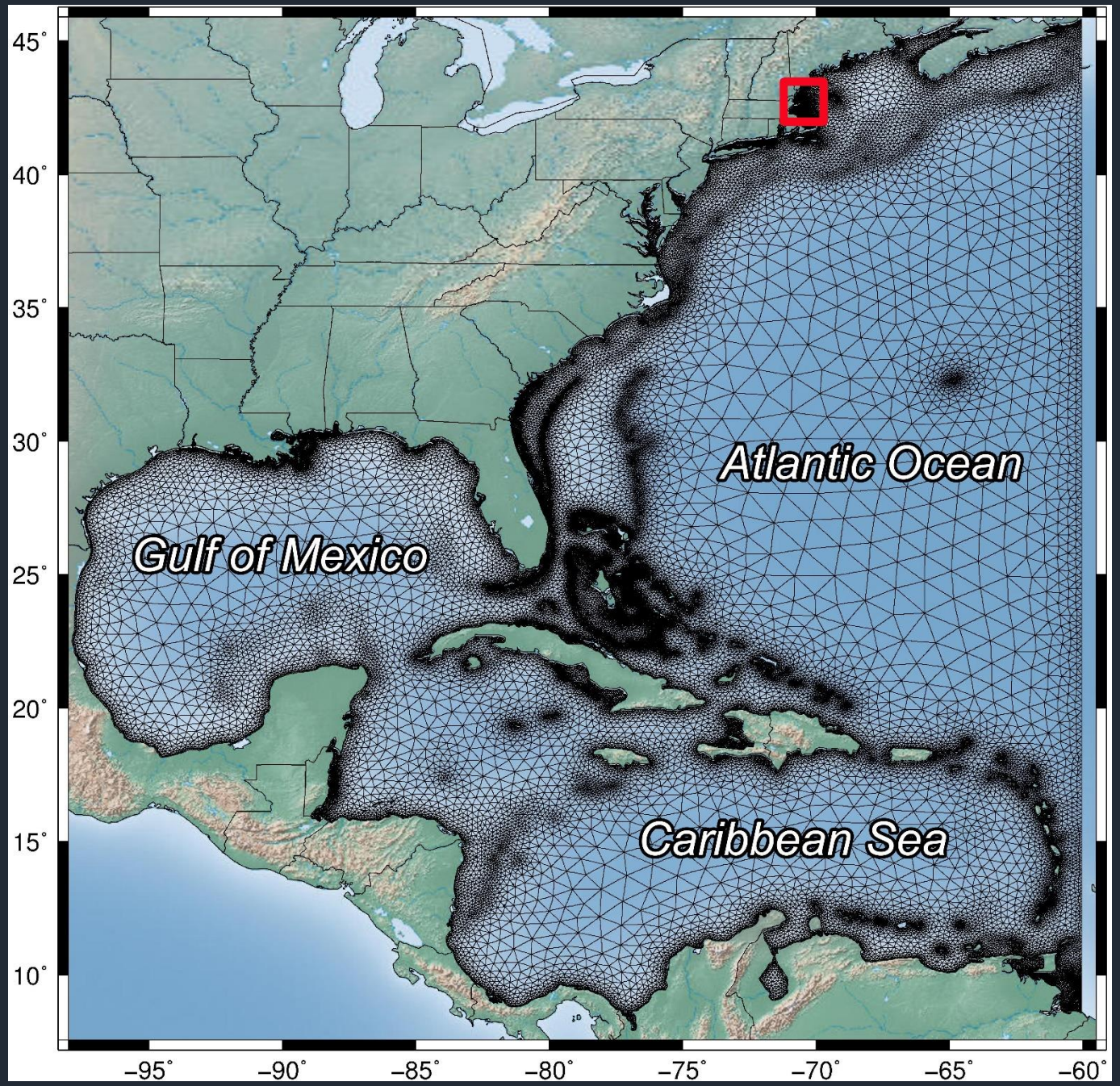
We feel that the DEM is a good one.

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.

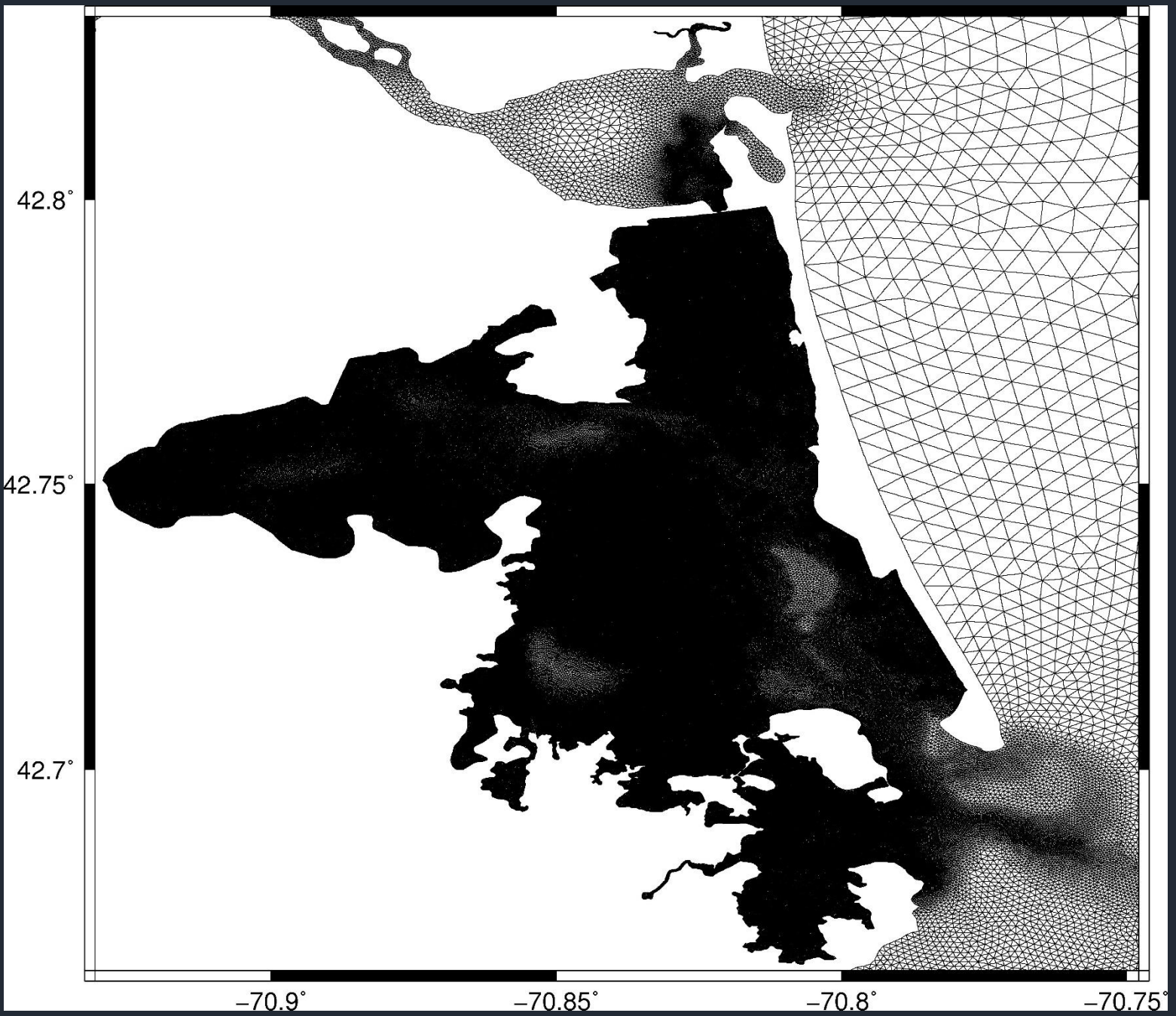
The Marsh Equilibrium Model (MEM)



http://129.252.139.114/model/marsh/mem2.asp

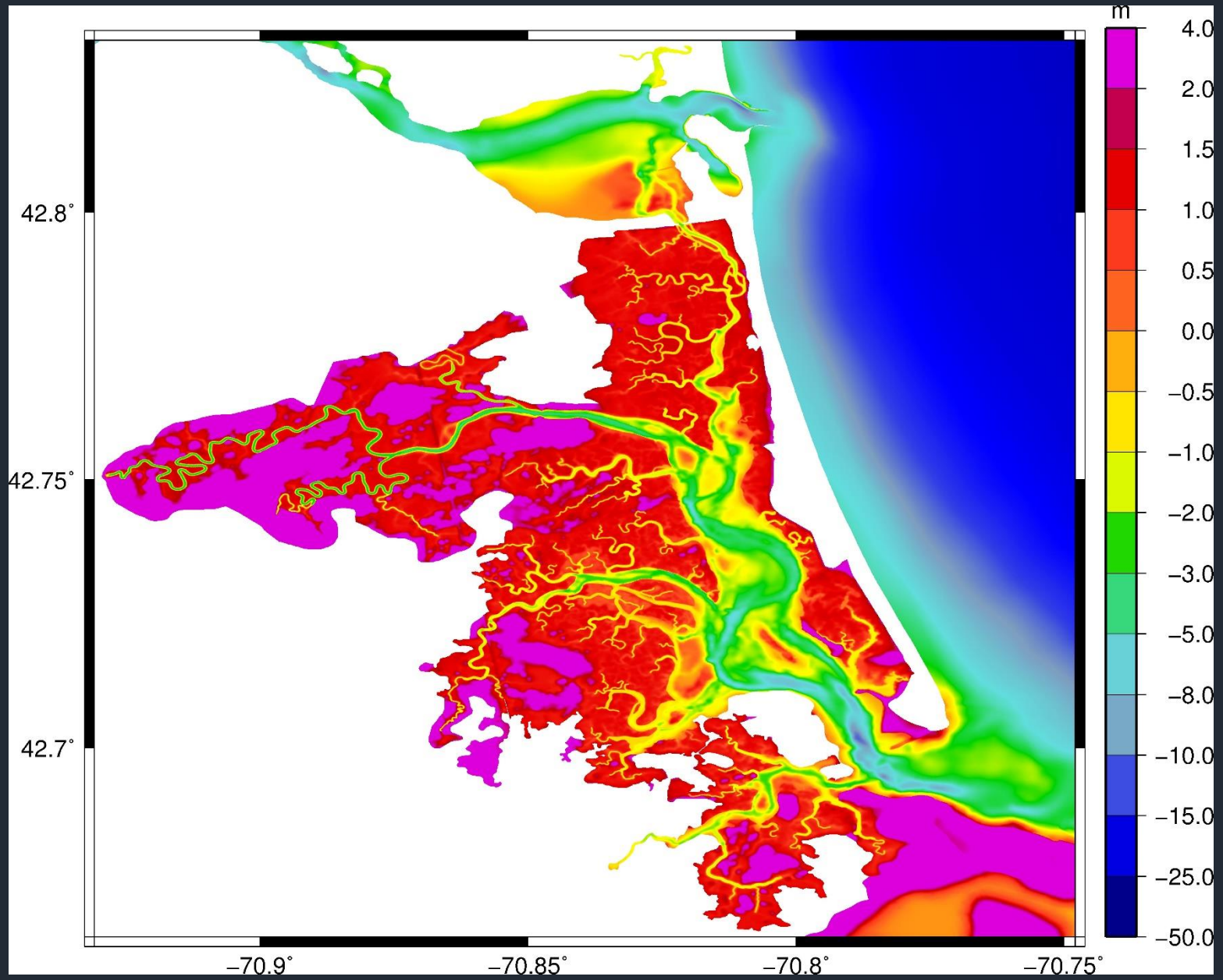


The 53k ADCIRC mesh for the western north Atlantic tidal model domain and zoom in of Plum Island Estuary model bathymetry (m, NAVD88)

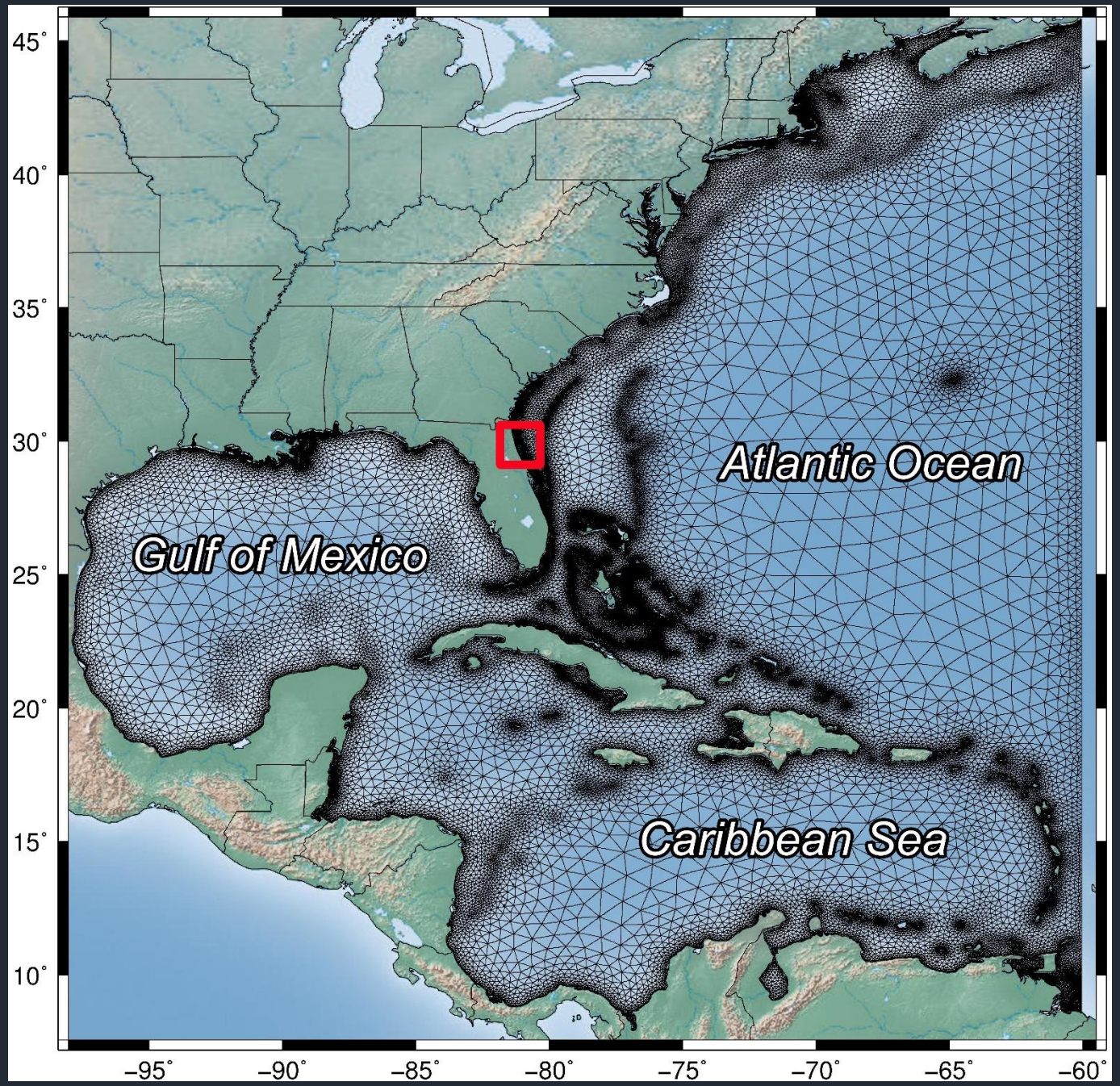


ADCIRC unstructured mesh for the Plum Island Estuary.

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

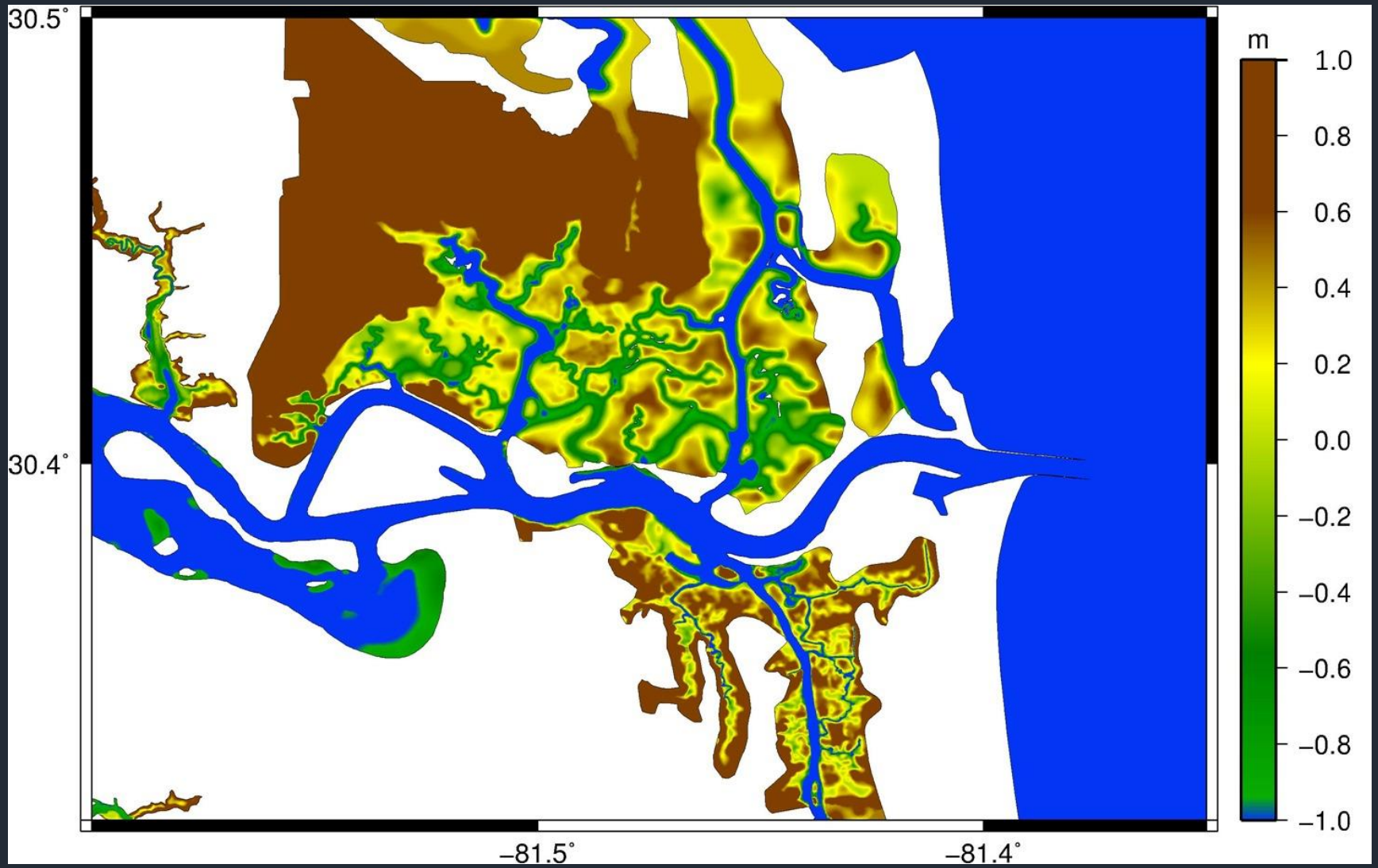


Plum Island Estuary model bathymetry (m, NAVD88)

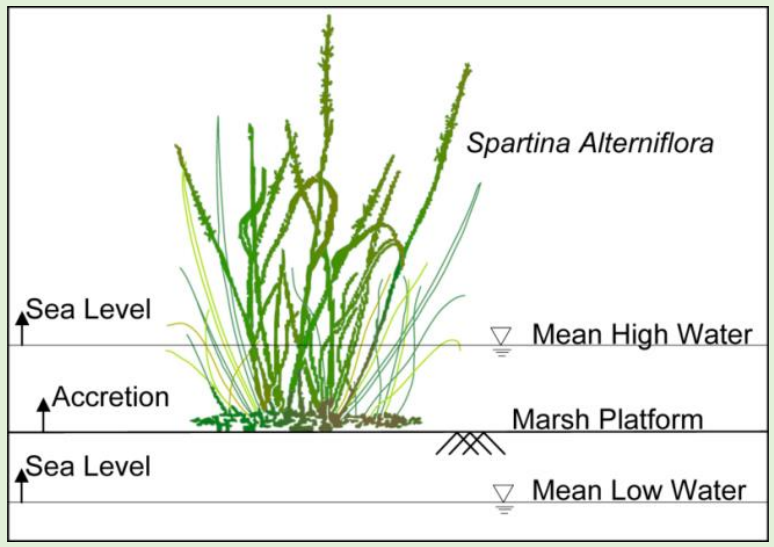


The 53k ADCIRC mesh for the western north Atlantic tidal model domain and zoom in of Plum Island Estuary model bathymetry (m, NAVD88)

Timucuan marsh topography, St Johns River



Hydro-marsh modeling framework



ELEVATION

ASTRONOMIC TIDES

BOTTOM FRICTION

Hydrodynamic Model

ADCIRC

Tidal Constituents

Amplitude, Phase & Frequency

ArcGIS Toolbox

Tidal Datums

MLW, MHW

Biomass Density

Biomass & Accretion

ELEVATION
based on accretion

BOTTOM FRICTION

Sea Level Rise

$t=t+\Delta t$

No

$t = t_{total}$

Yes

OUTPUT

TIDAL HARMONICS
MLW & MHW
BIOMASS PRODUCTIVITY
ACCRETION
ELEVATION

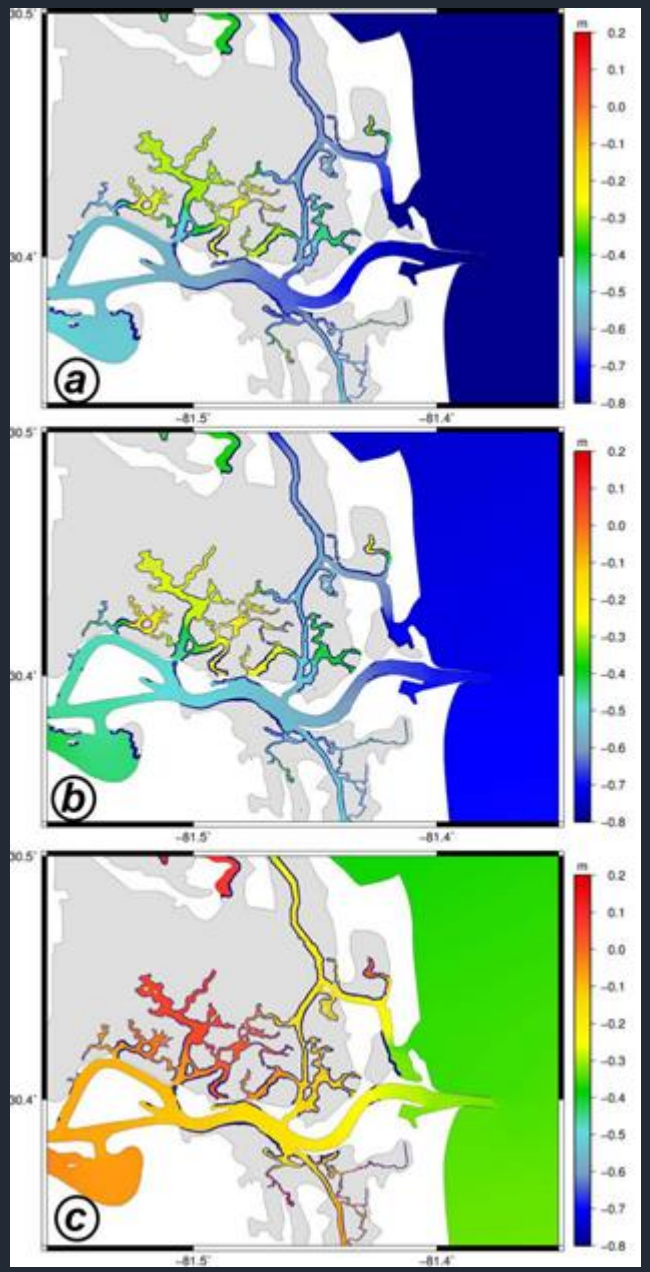
Mean Low Water

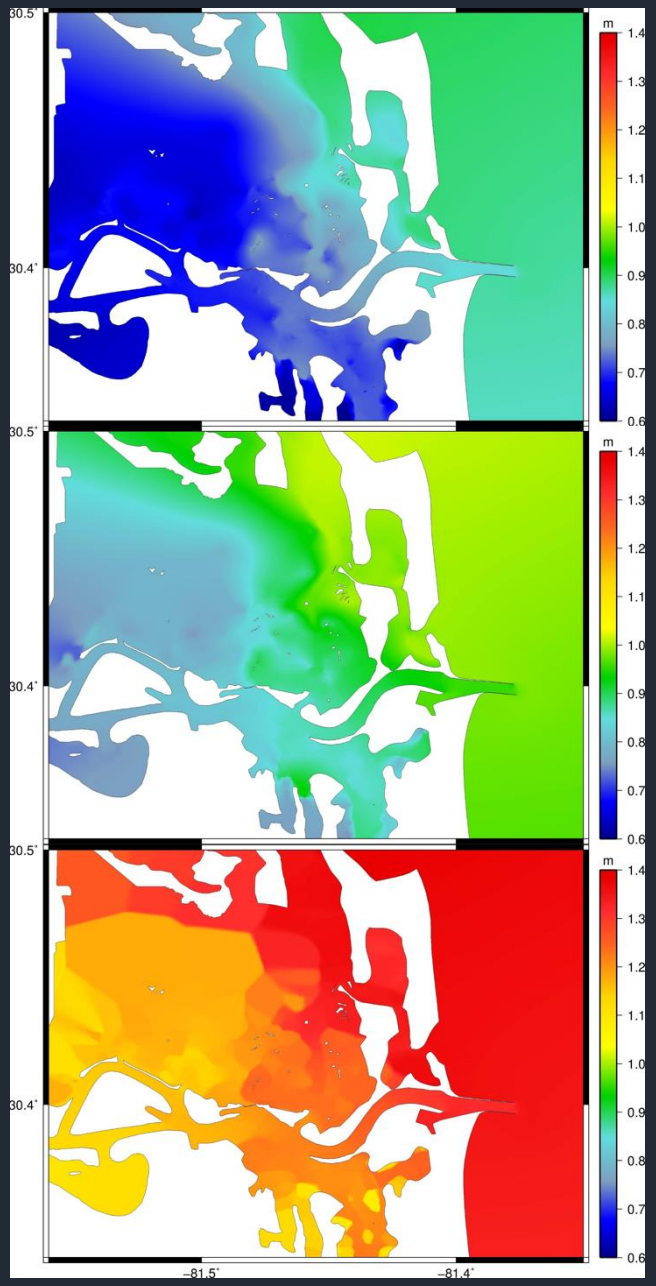
Mean High Water

Today

In 2050 after 11 cm SLR

In 2050 after 48 cm SLR





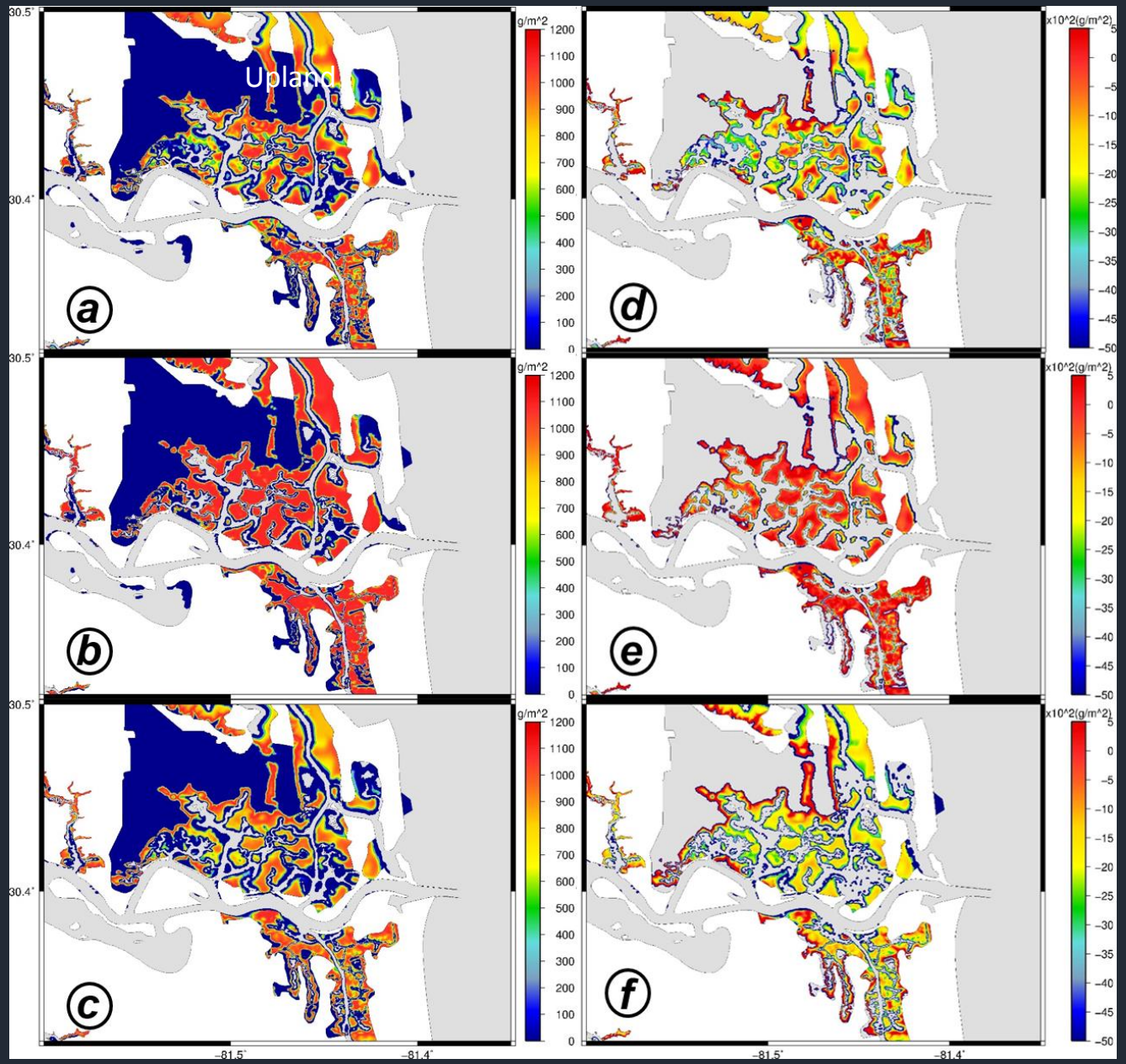
Note that the water surfaces are not uniform across the estuary. This affects biomass and sediment accretion.

Biomass Distribution Biomass 1st Deriviative

Today

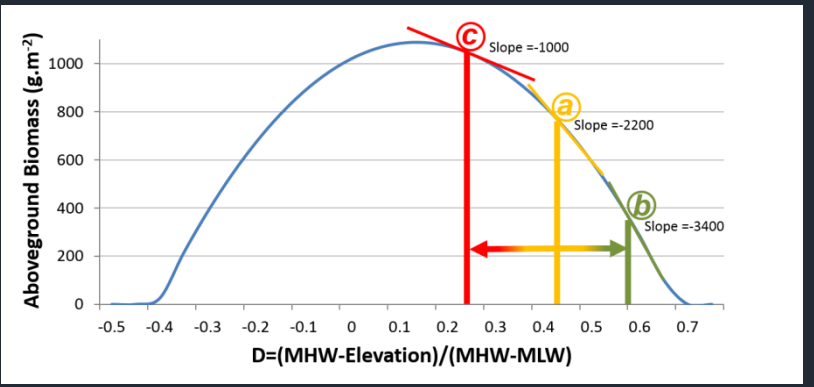
In 2050 after 11 cm SLR

In 2050 after 48 cm SLR



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

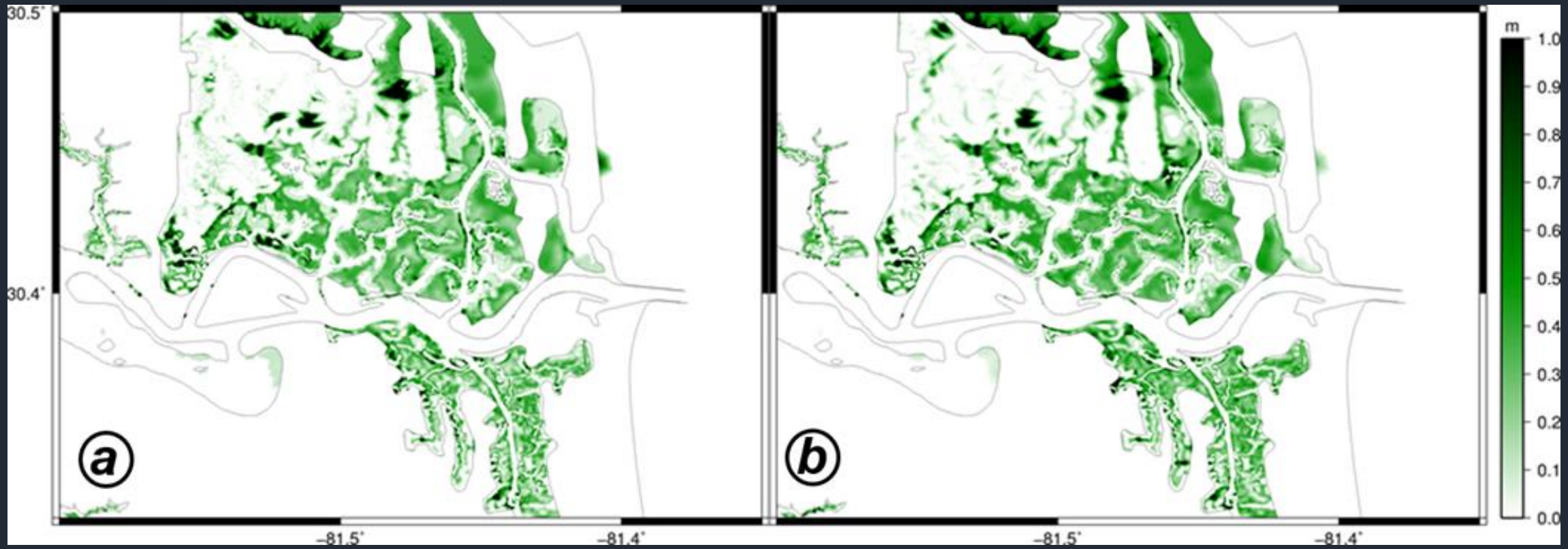
Biomass Distribution vs Dimensionless Depth



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:

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DEPARTMENT OF THE INTERIOR

PIE LTER

NSF