Progress report on wave-driven dynamics simulation of shoreline erosion - Testbeds Corsica and Choptank Rivers

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Current protected shoreline in the Choptank River based on VIMS inventory

Quadrangle cartography

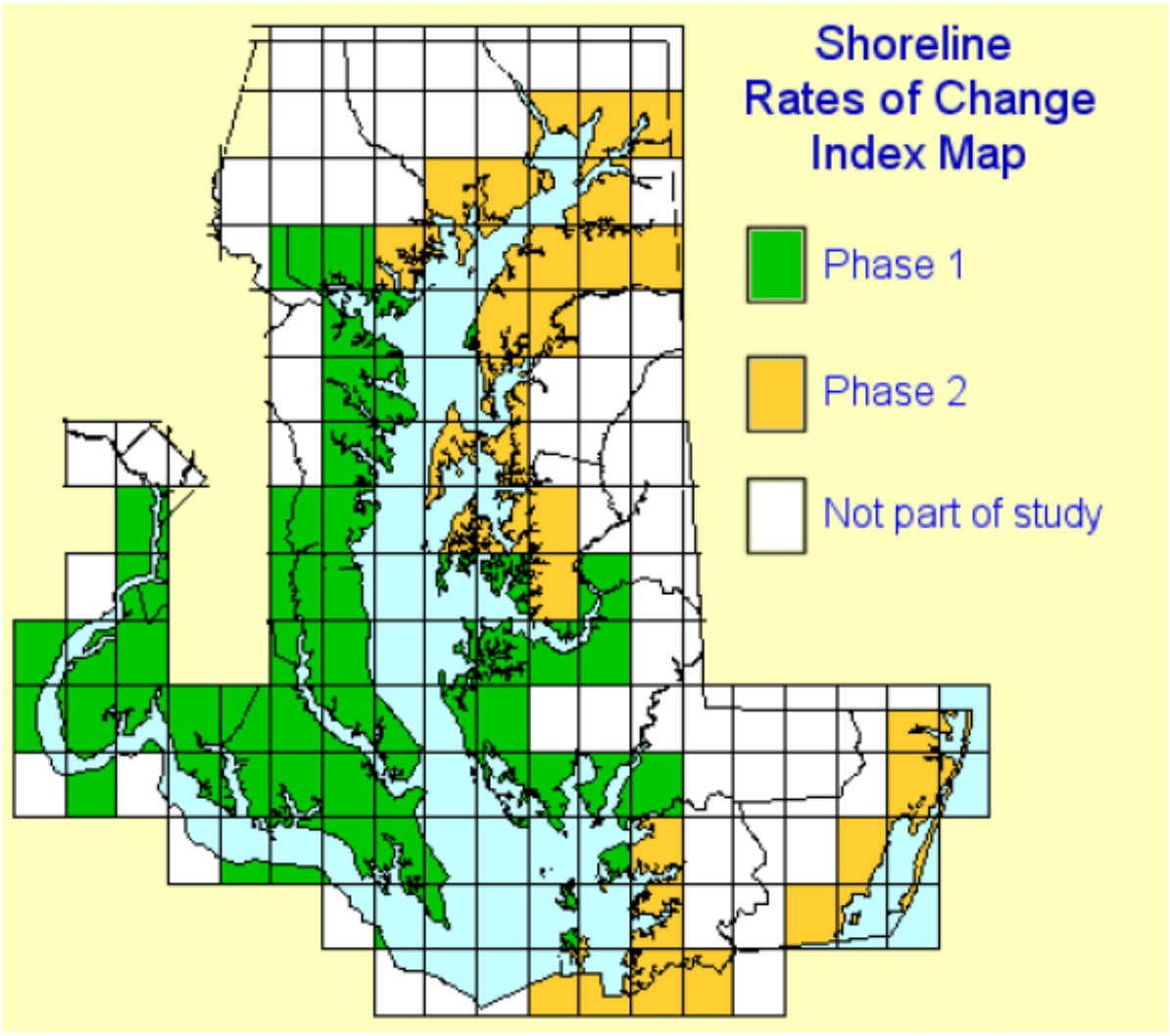
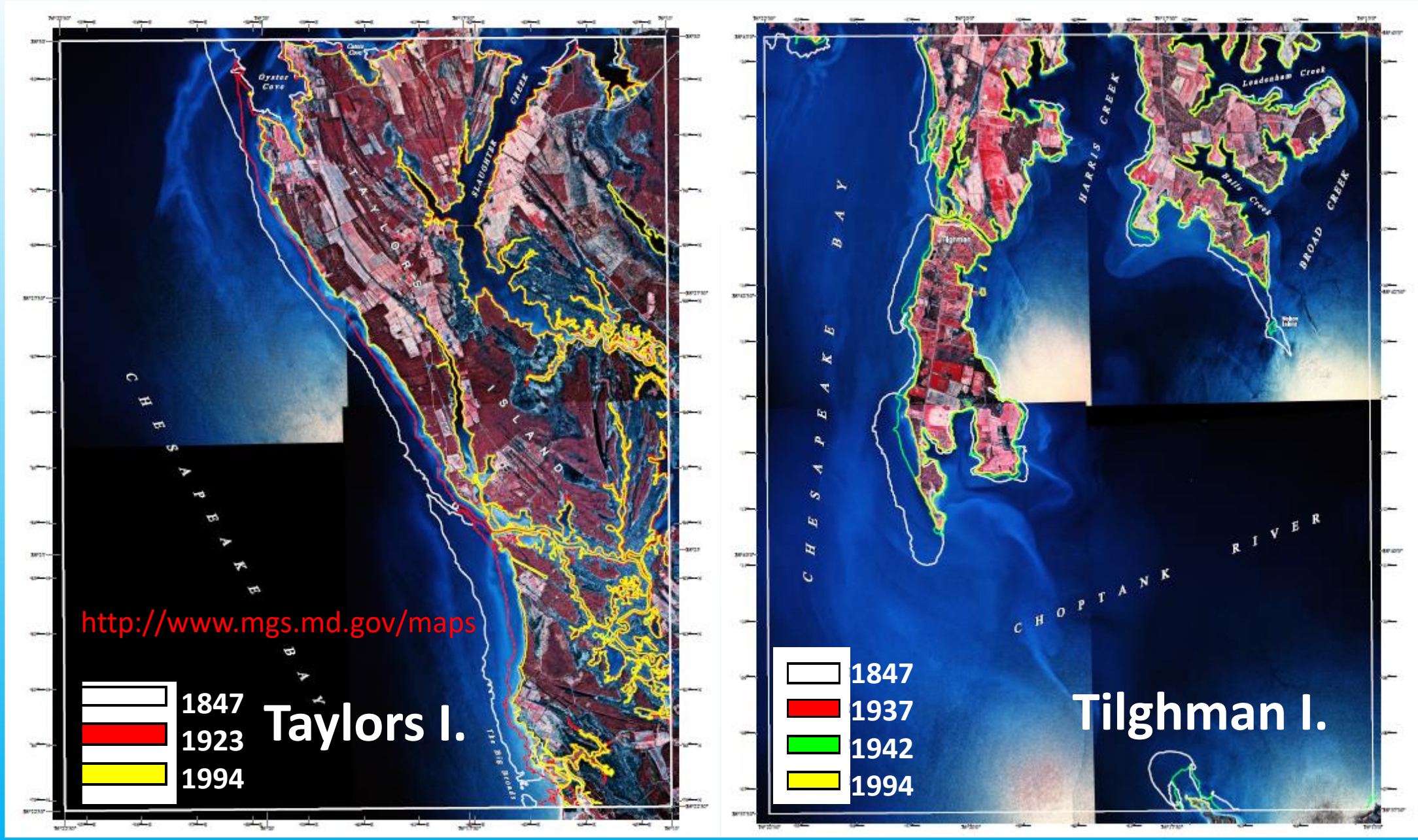


Figure 1: Quadrangles for which shoreline rates of change were determined
The 60 quadrangles processed during an earlier phase are shown in green
39 processed during this phase, in orange.

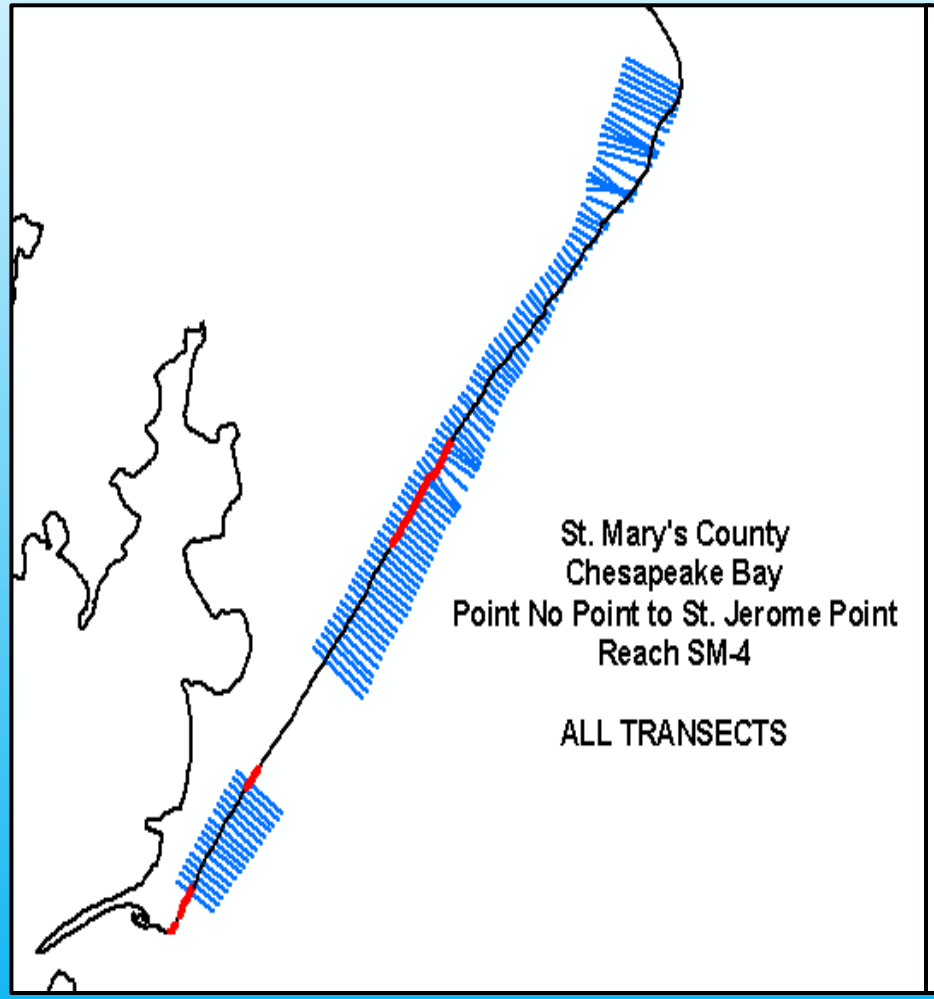
Hennessee, 2003

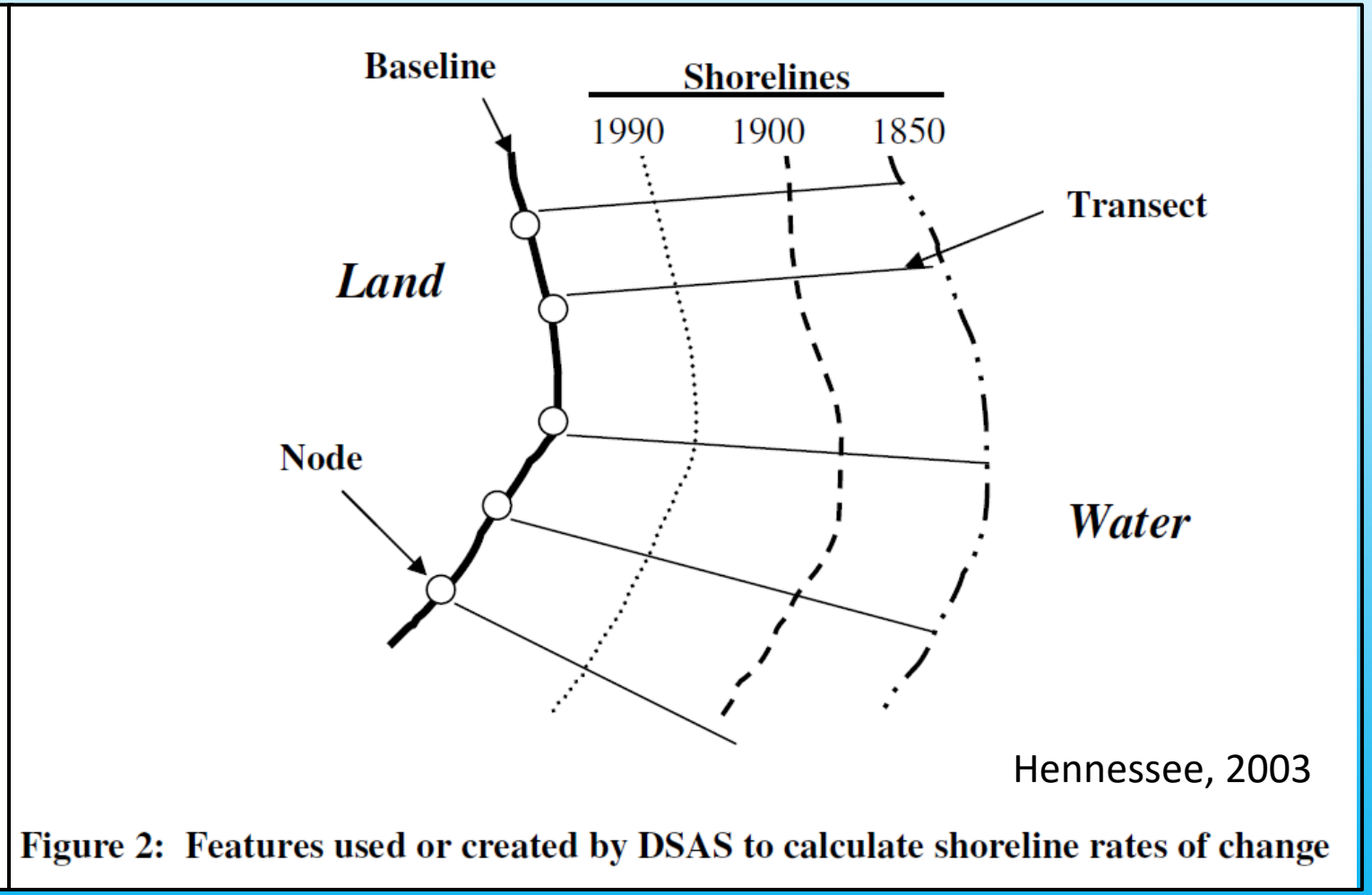
Historical shoreline



Transect to measure shoreline change

(Ca. 250k transects at 20 m interval, 10 m interval in Anne Arundel, Baltimore, Prince George, Calvert and Harford counties)



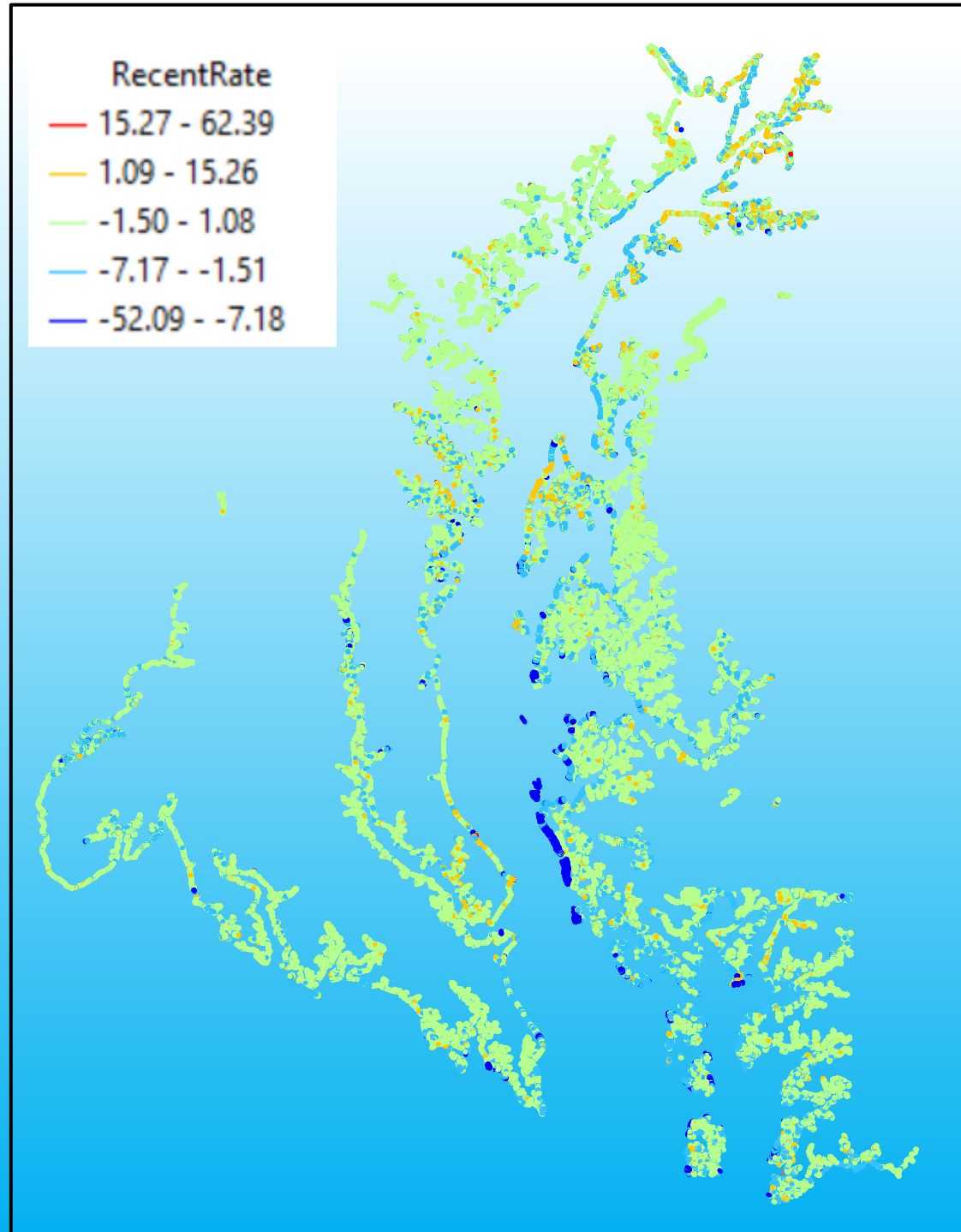


Hennessee, 2003

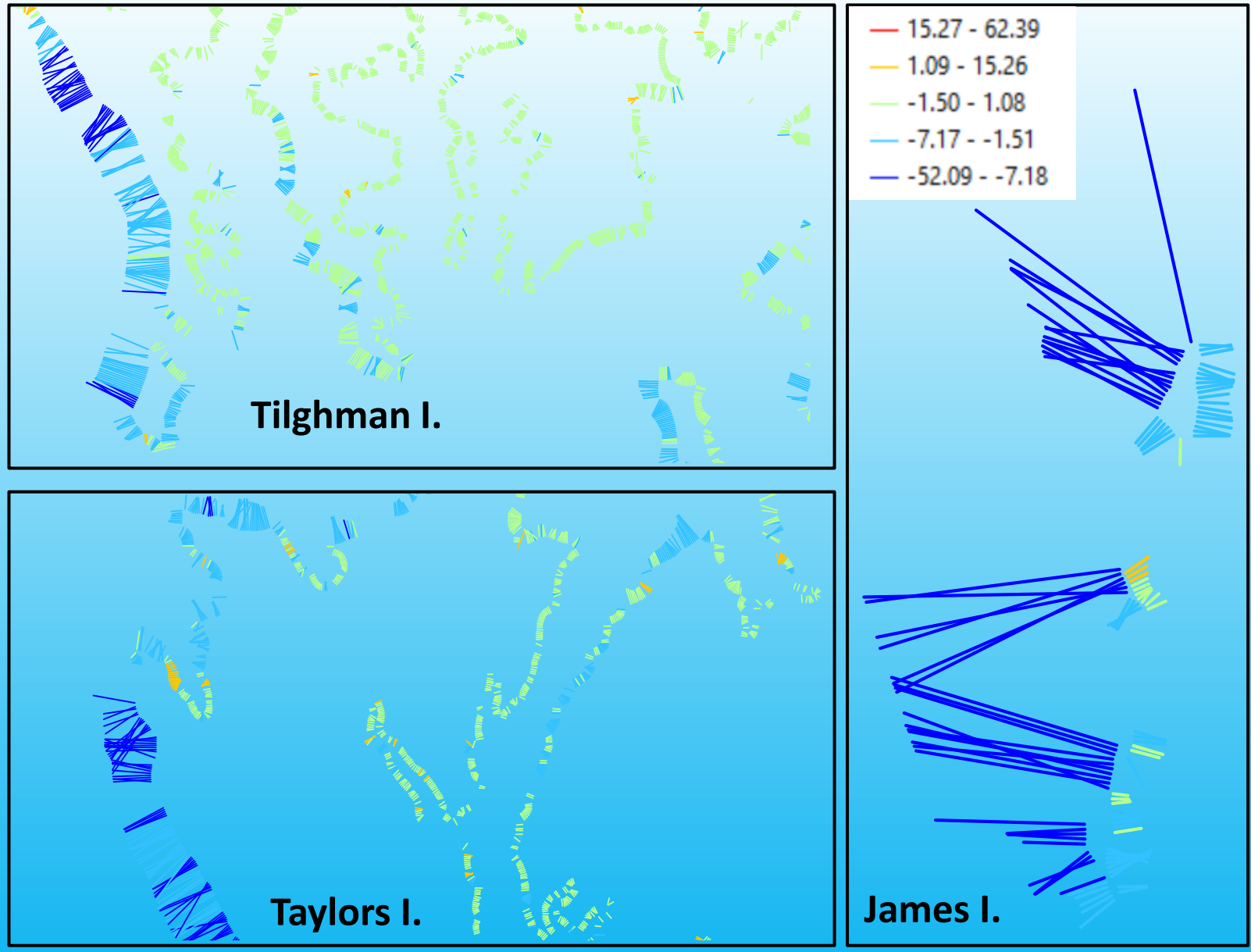
Figure 2: Features used or created by DSAS to calculate shoreline rates of change

MD recession rate
(ft/yr; MDUSGS)

- Protected transects were not included, nearby rates were used.
- Transect rate was not directly used, but integrated to reaches.
- Reaches were defined at similar recession rate.
- 207 reaches in MD, 1.99-83.7 km long.

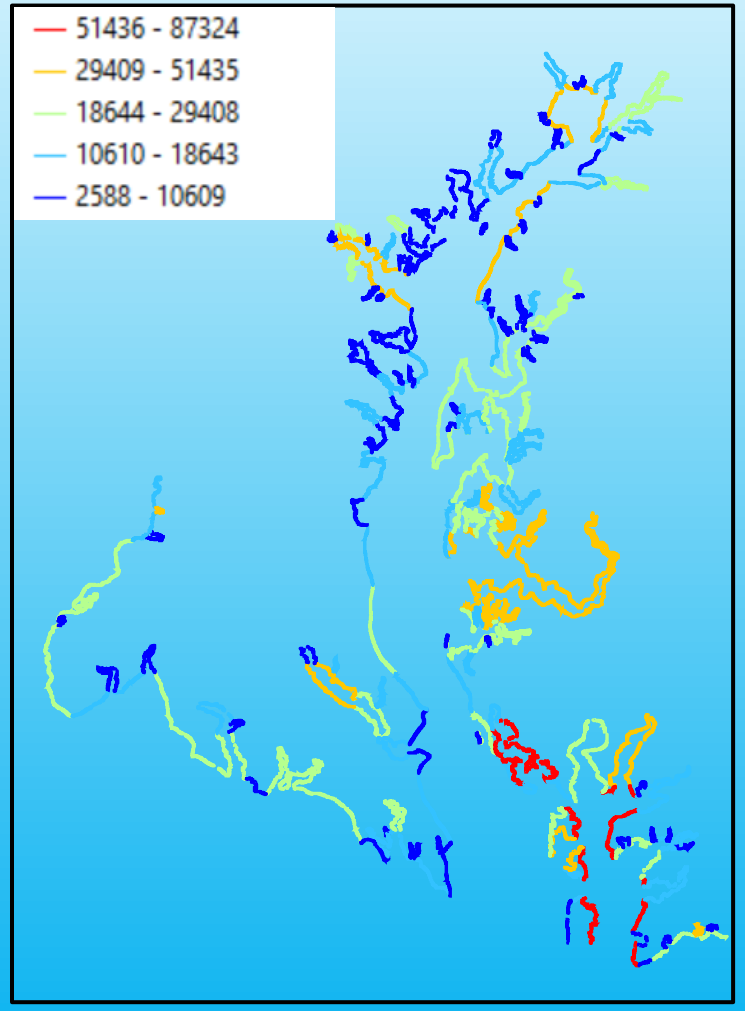


Recession rate (ft/yr) at Tilghman, Taylors and James Ilands

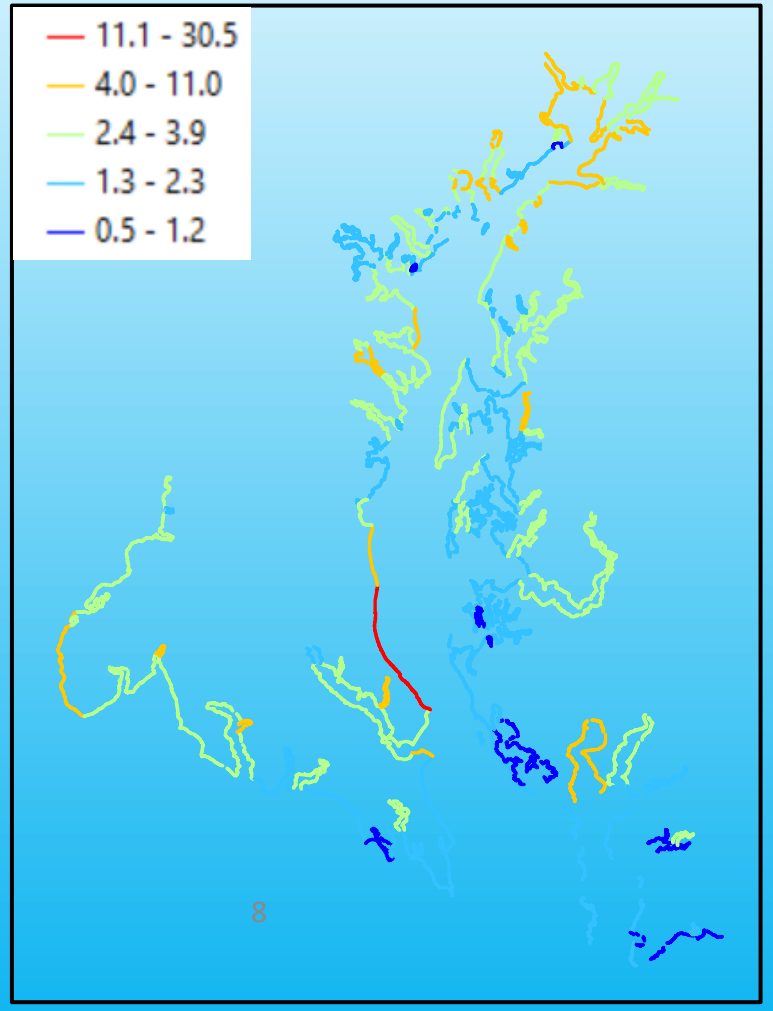


MD Reaches (207)

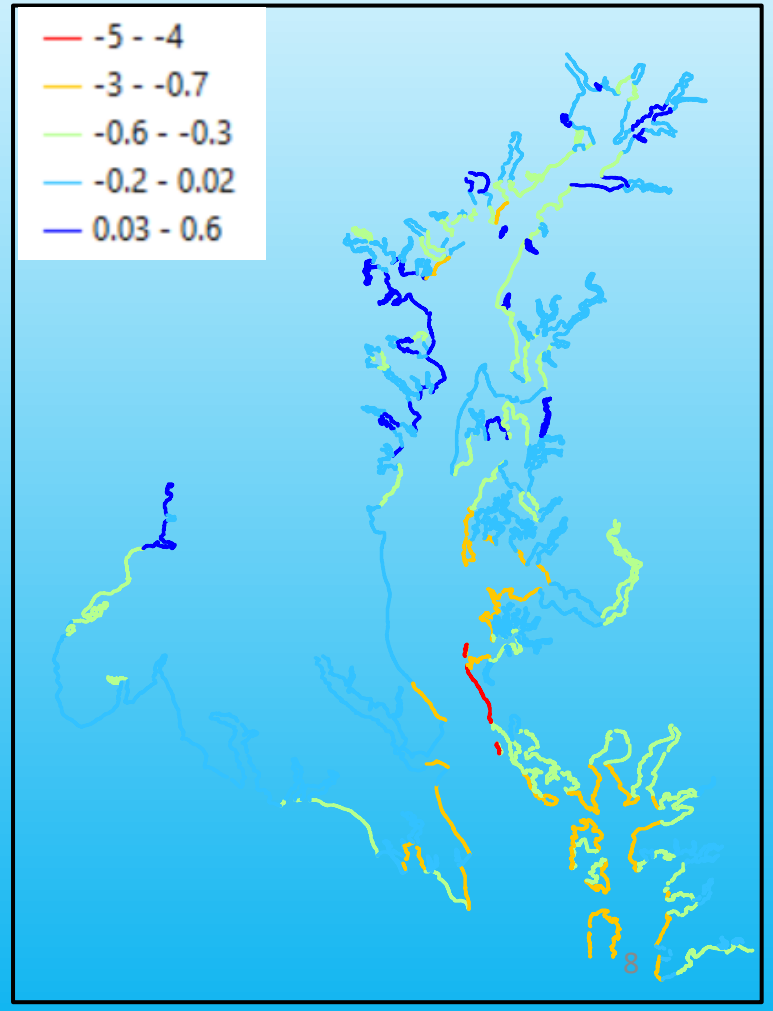
Length (m)



Height (m)

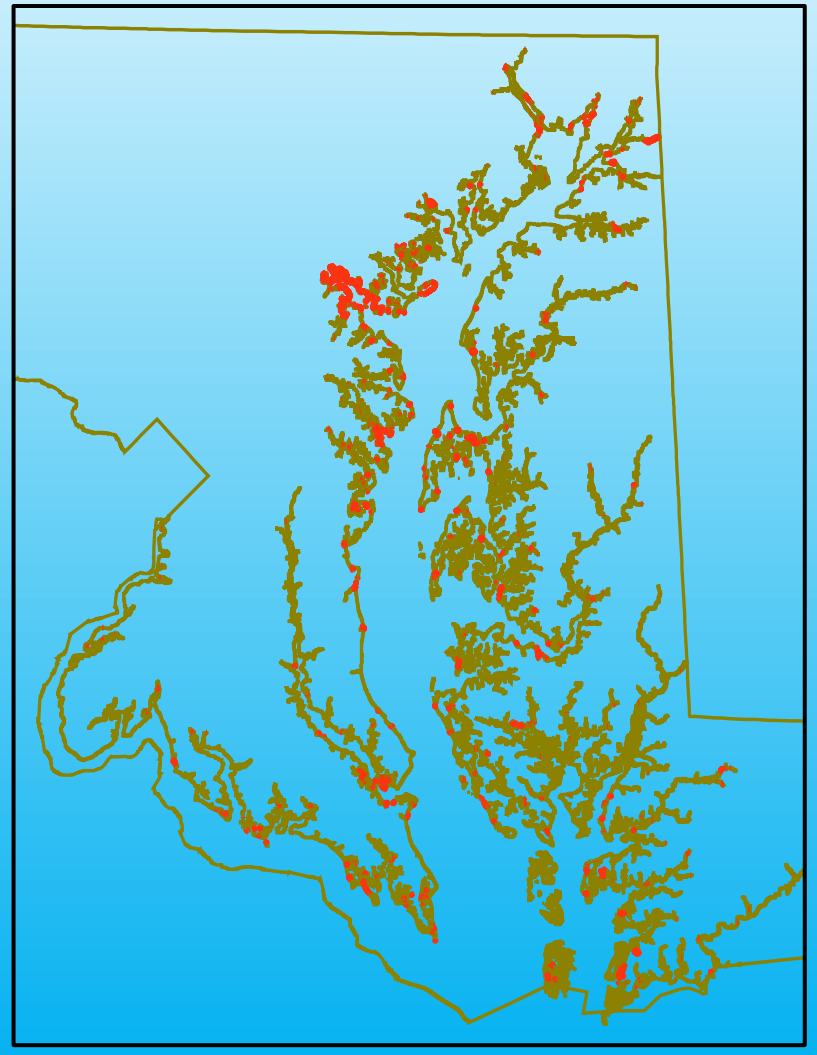


Recession (m/y)

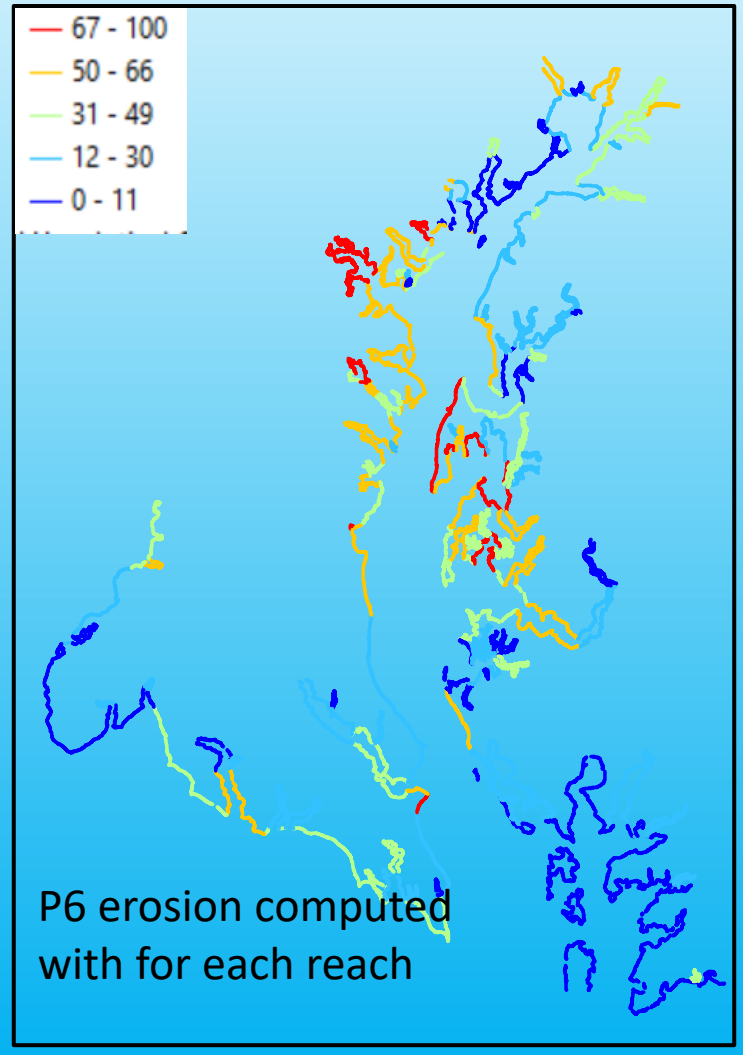


MD protected shoreline

MD shoreline with structure

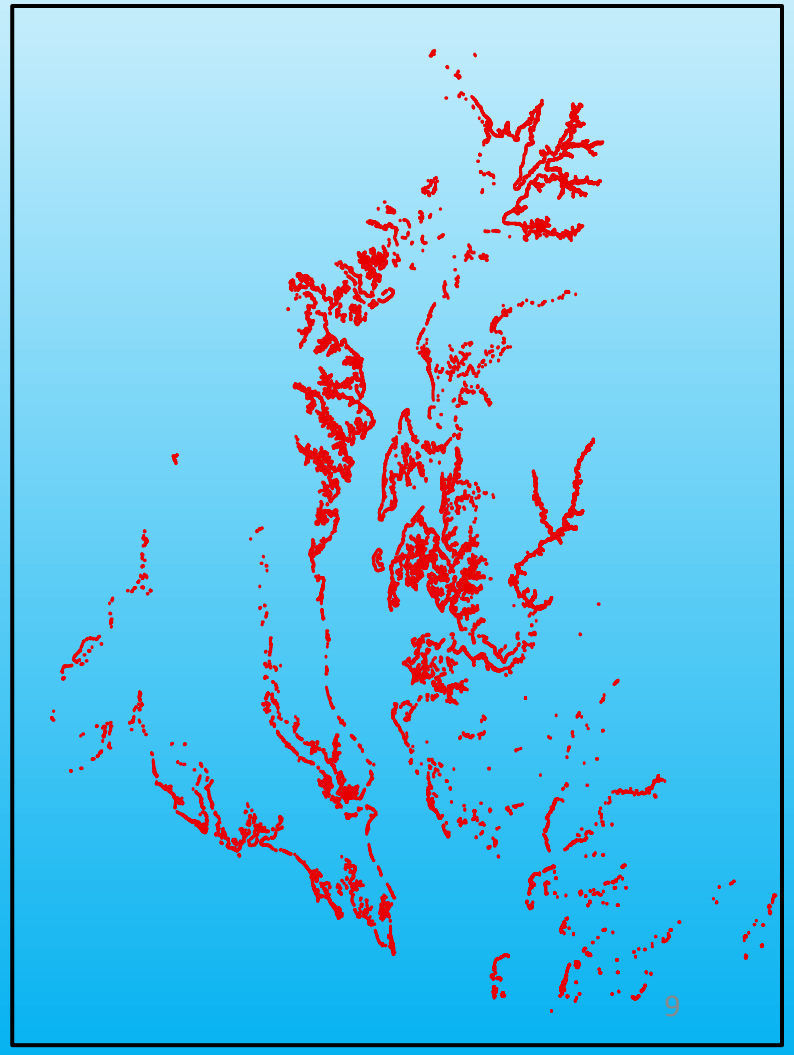


MD protected shoreline percent



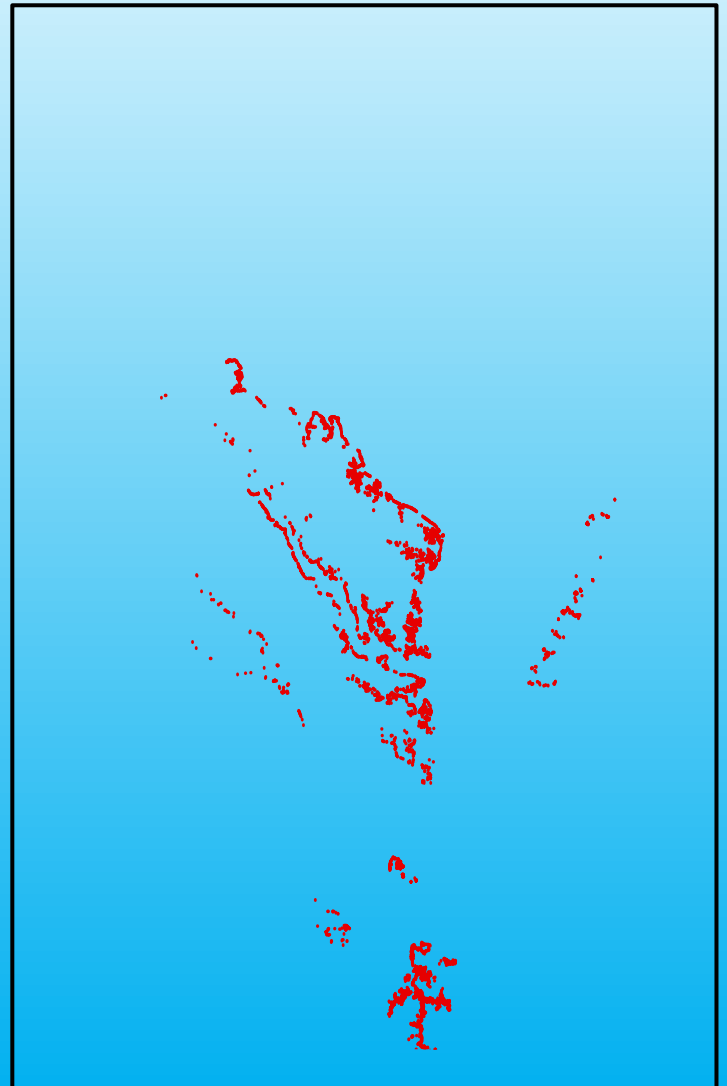
P6 erosion computed with for each reach

Current MD shoreline with structure (VIMS inventory)

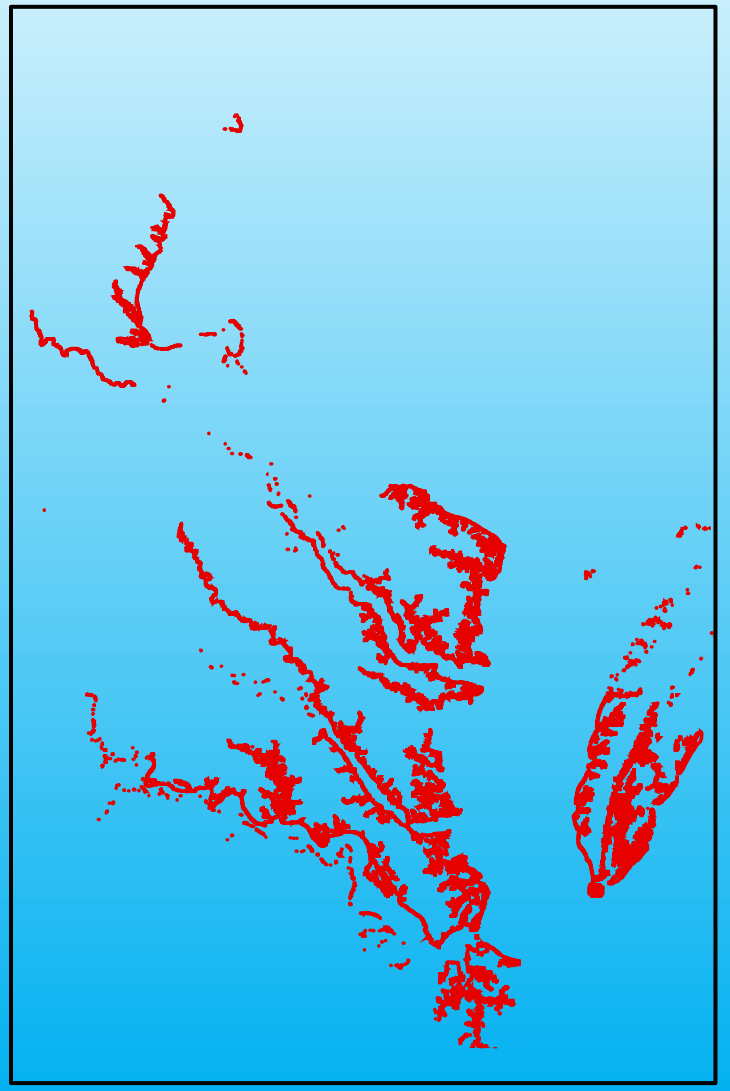


VA protected shoreline

Phase 6



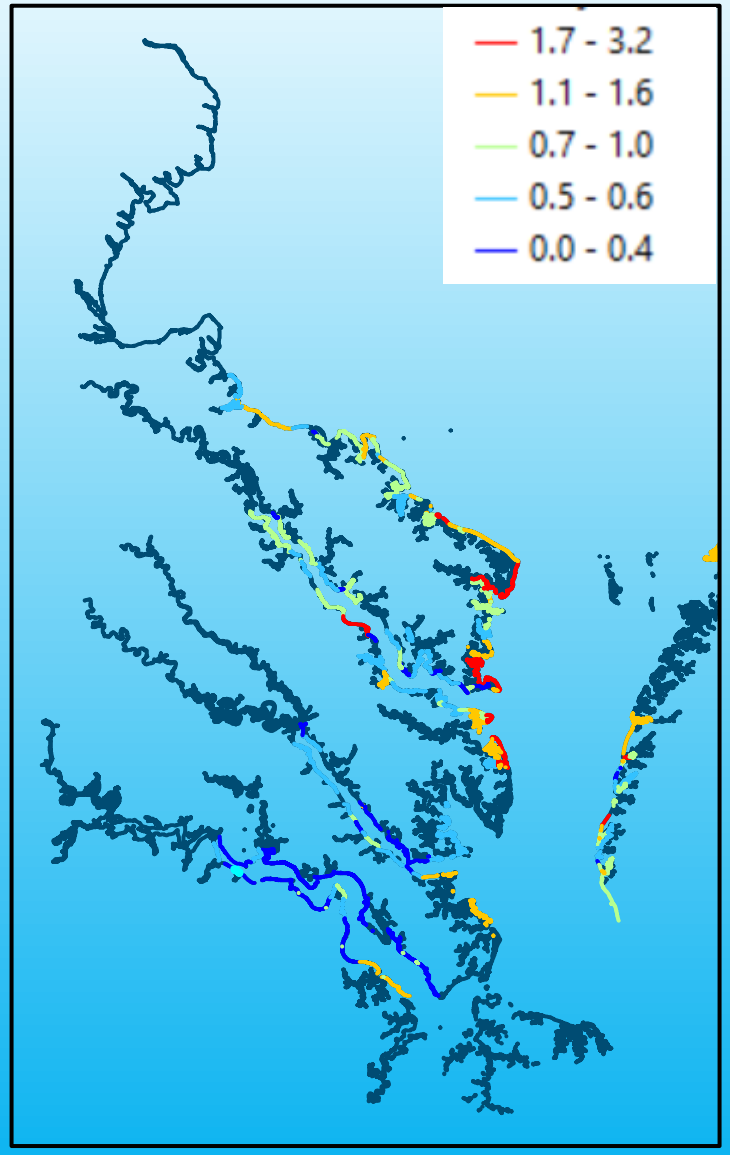
Currently available data
(VIMS inventory)



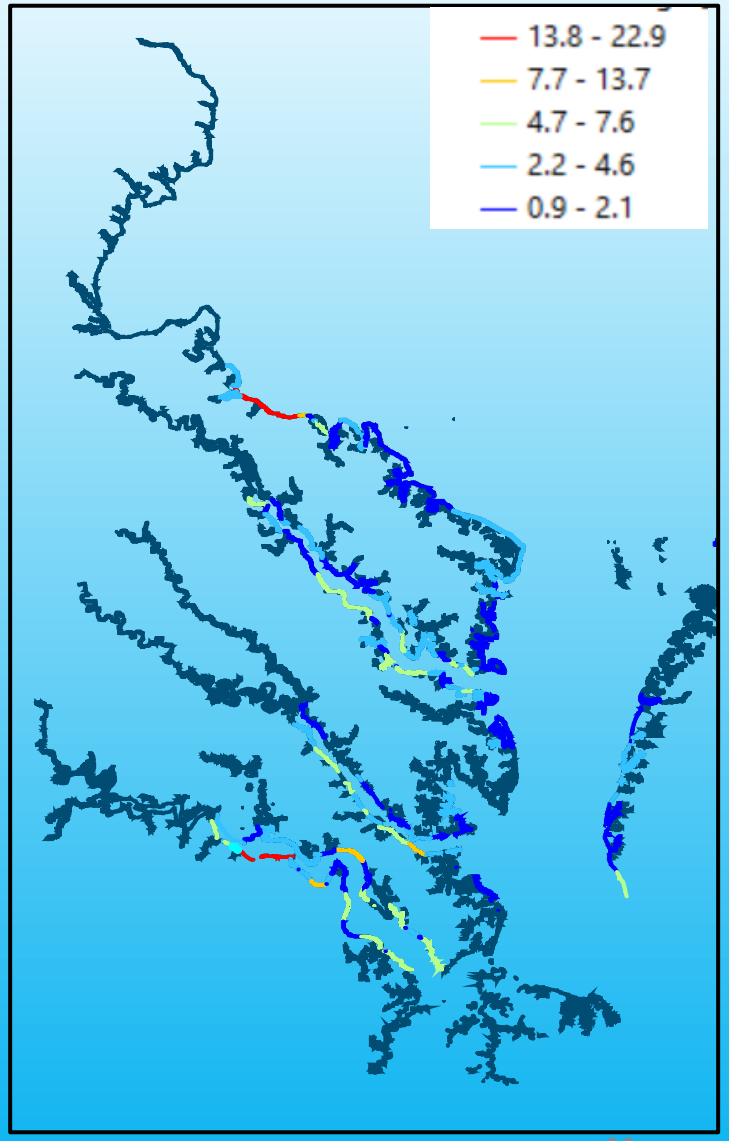
VA Reach shoreline bank height and erosion

- Dark green: lack of data
- Study of main reaches, incomplete shoreline, 15 years old protection data
- Data outside the BES study coded with river/shore average)
- Average 19% protected.
- 15% protection assumed for unknown regions

Recession rate (m/yr)



Bank height (m)
Dark blue no data



Phase 6 shoreline erosion

- Digitally measured long-term shoreline erosion
- Partitioned in time based on hydrology
- Kilometer spatial resolution of CH3D grid

Phase 7 recommendation from Larry Sanford

Wave-driven time dependent dynamics simulation of shoreline erosion

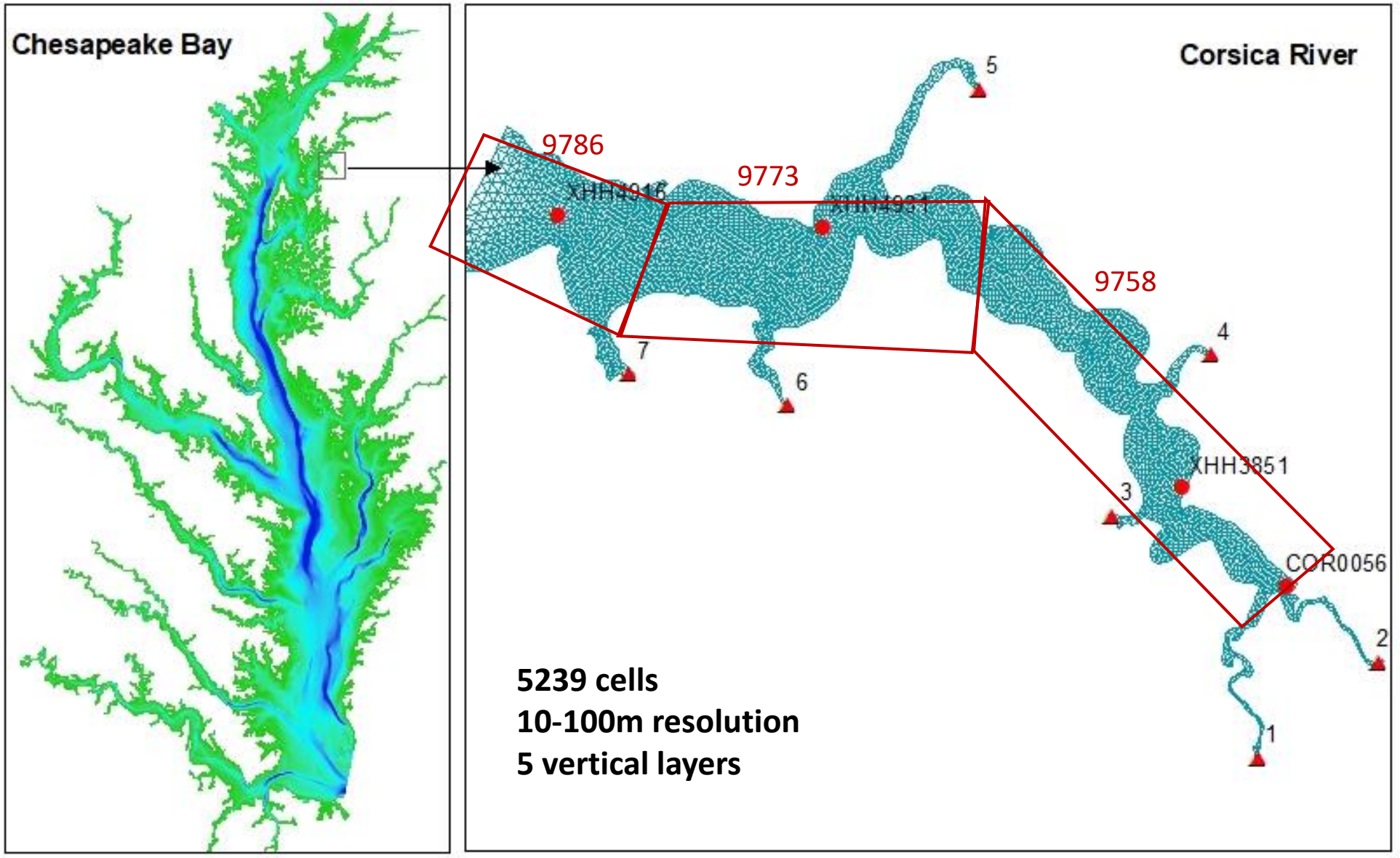
$$Eh\rho_{dry} = \alpha'(P - P_{crit}) f(\frac{D}{h}) \quad (1)$$

$$P = \frac{1}{8}\rho g H_s^2 c_g \cos(\alpha) \quad (2)$$

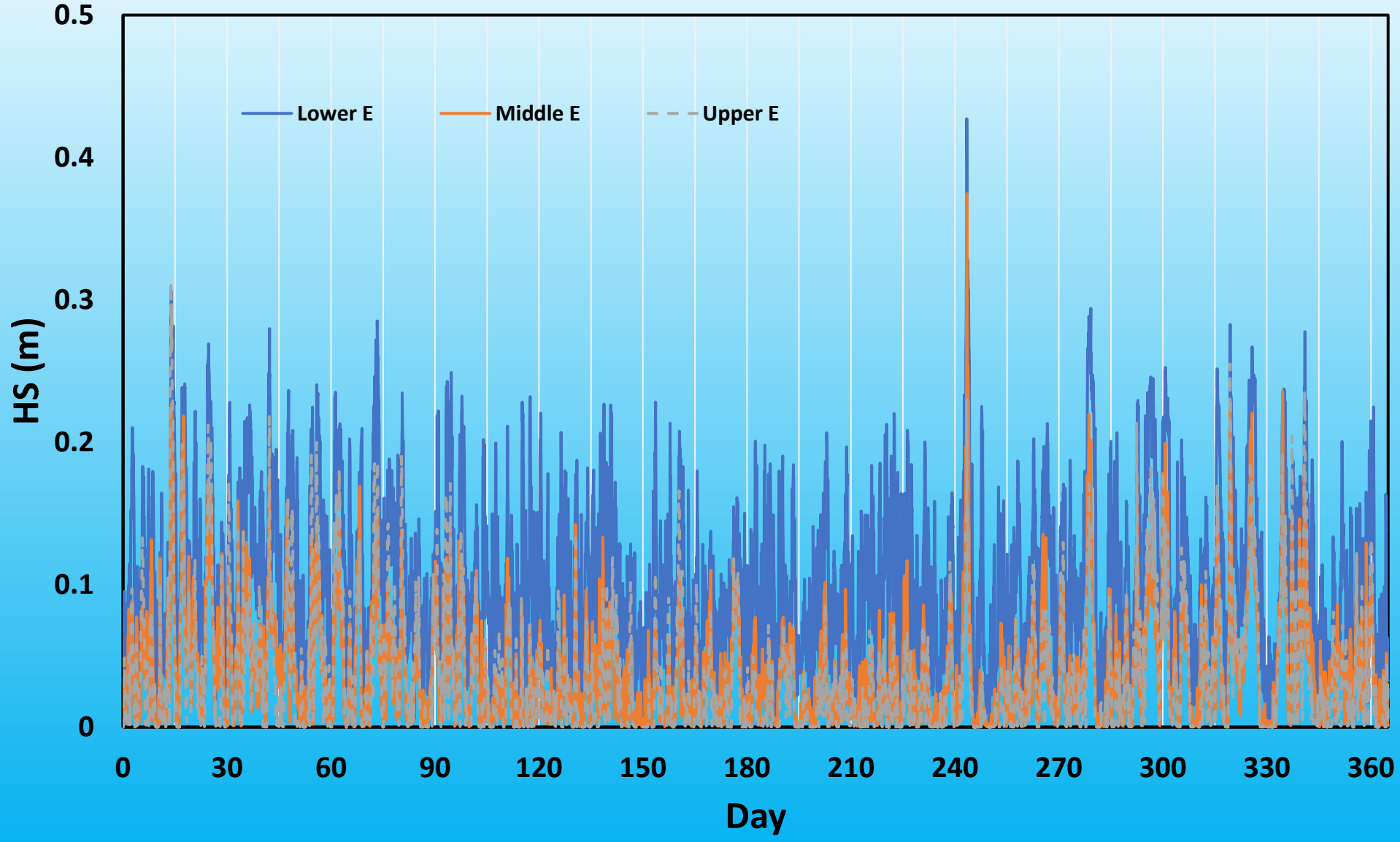
Significance

- Coastline erosion is a challenge, particularly under future climate change and sea level rise conditions.
- A new piece of best available science

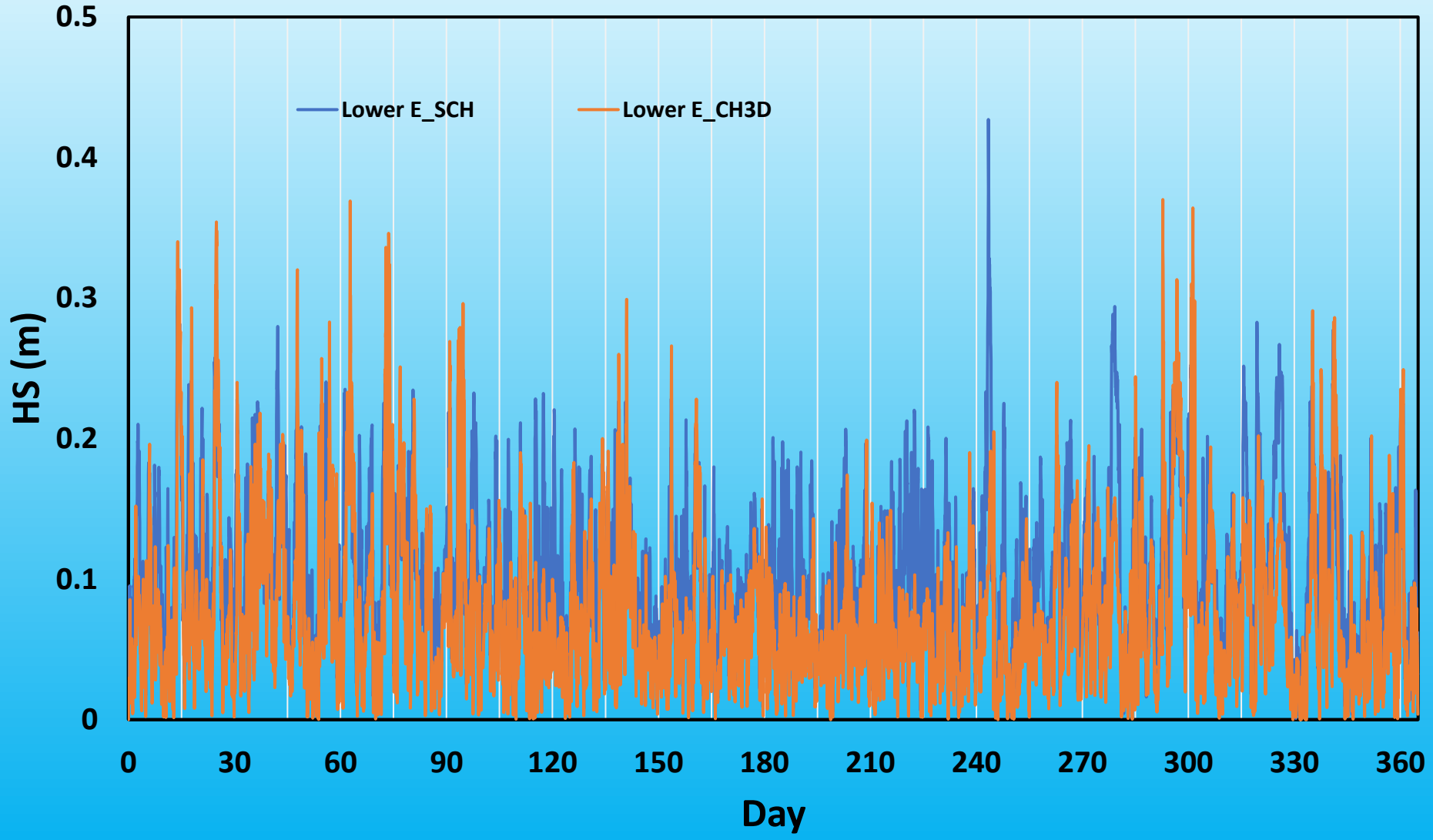
Corsica river grid



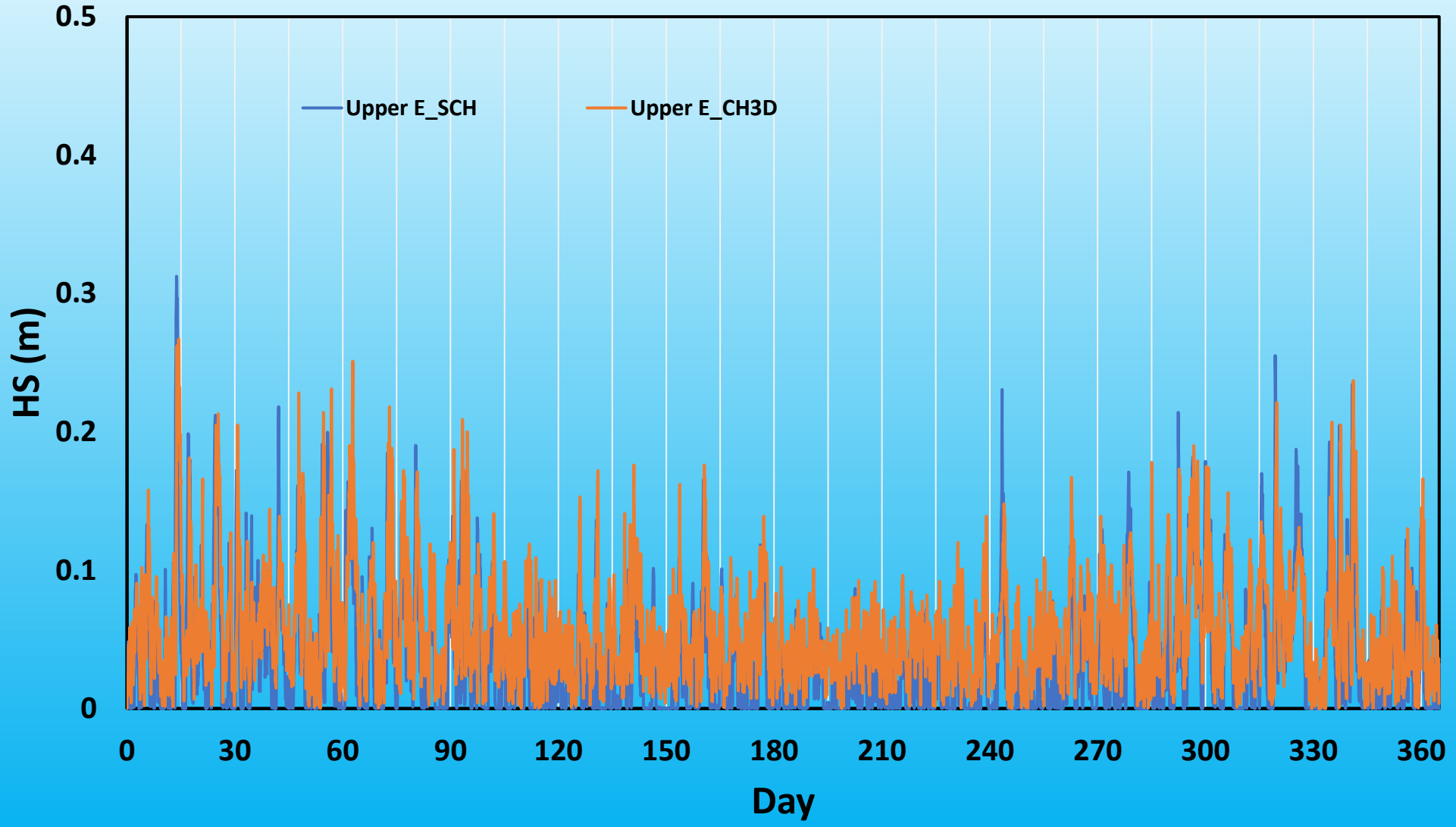
Significant wave height at the lower, middle and upper estuary stations in the Corsica River



Comparison between schism (blue) and CH3D (red) at the lower estuary station



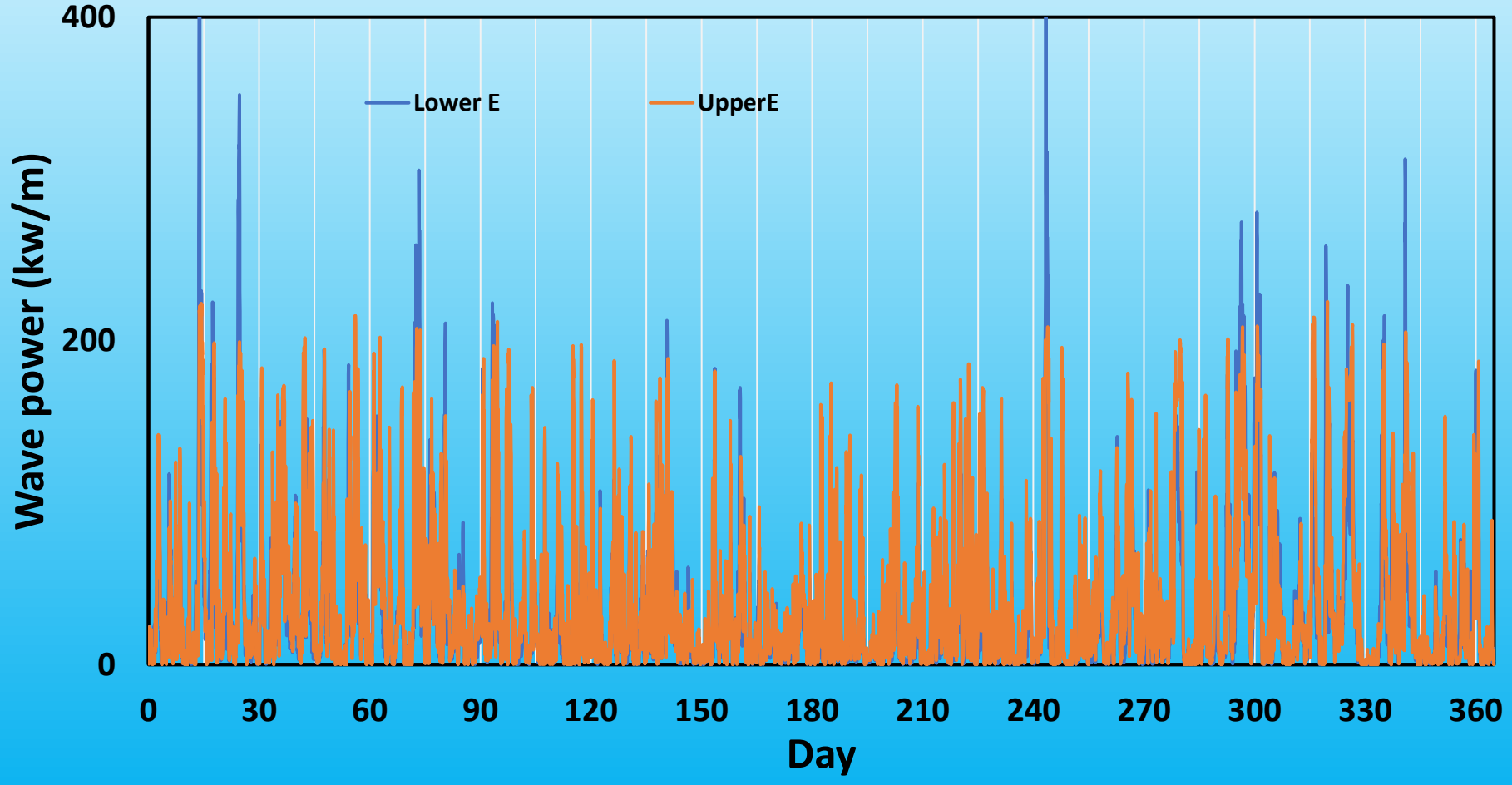
Comparison between schism (blue) and CH3D (red) at the upper estuary station



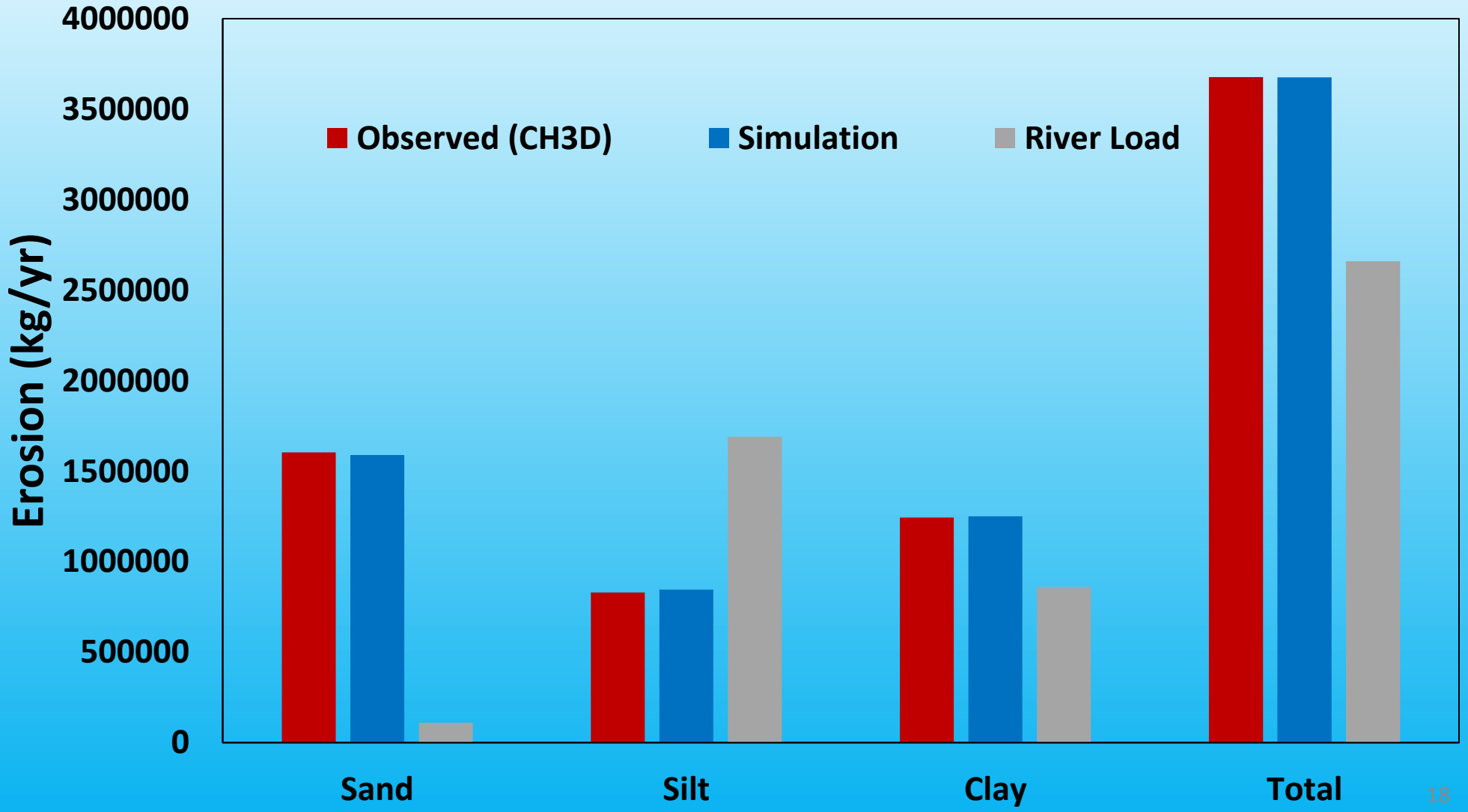
Wave Power

$$P = \frac{1}{8}\rho g H_s^2 c_g \cos(\alpha) \quad (2)$$

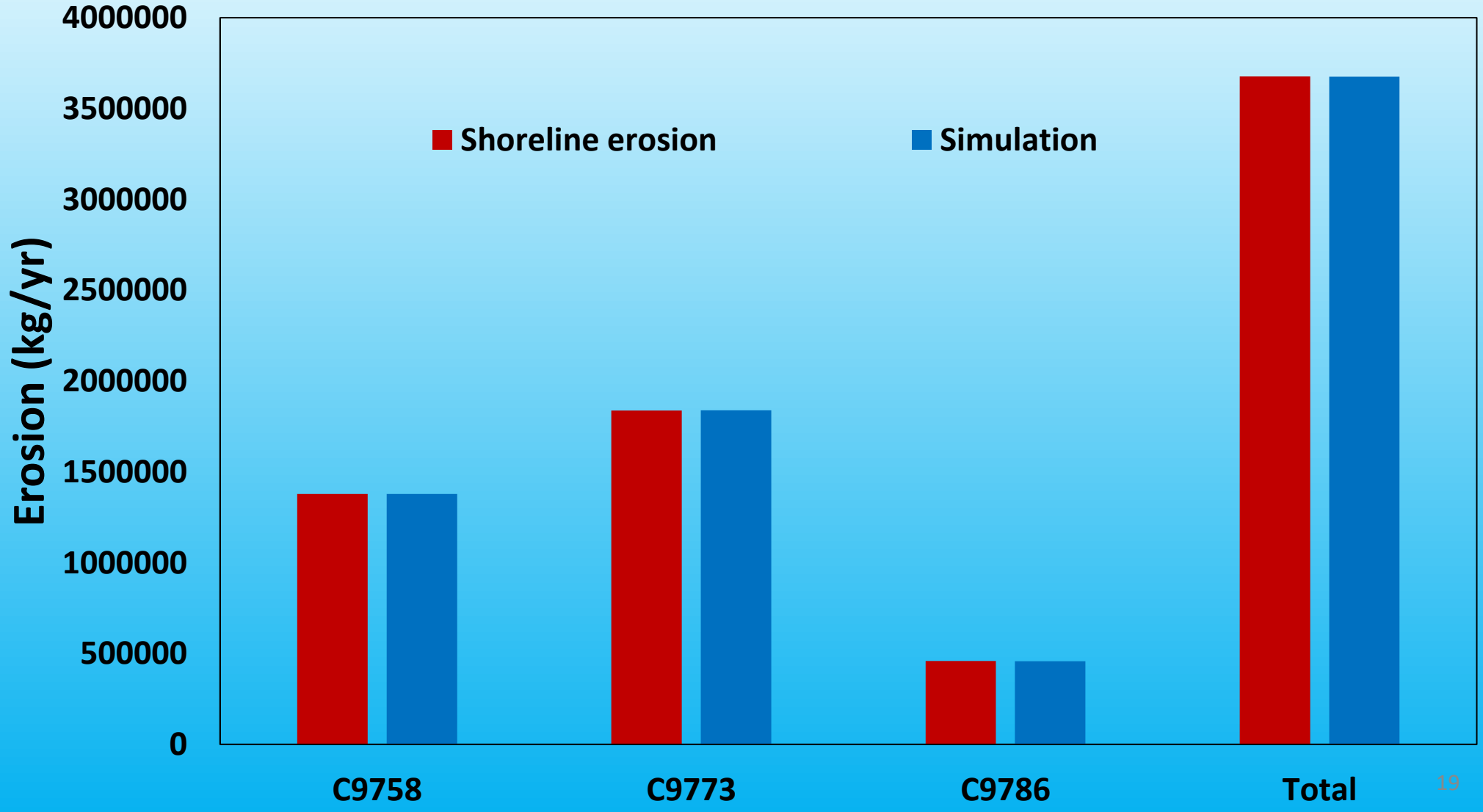
Where H_s is significant wave height, c_g is wave group velocity, and α is the angle of wave approach.



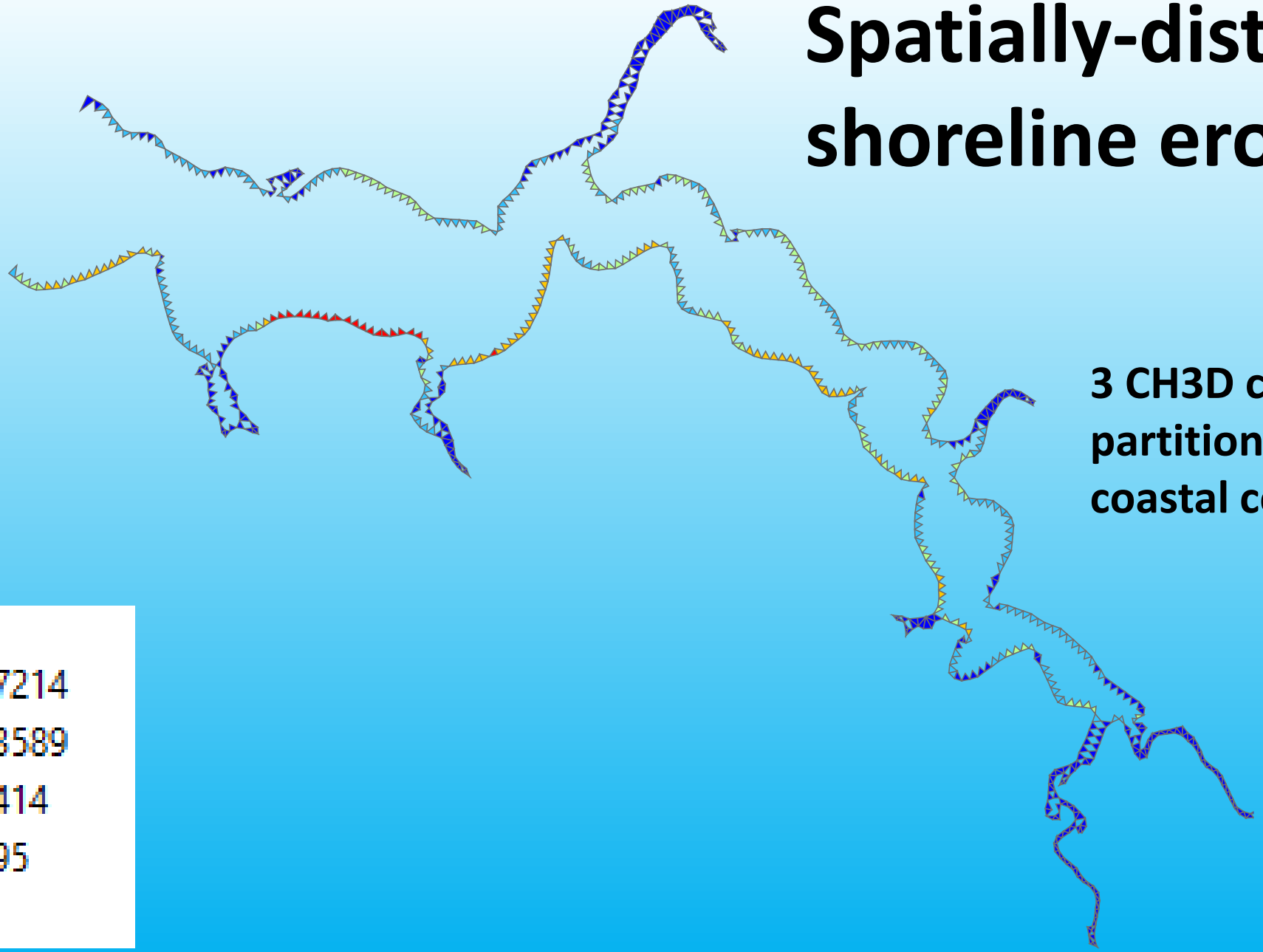
Simulated versus observed shoreline erosion in the whole estuary



Simulated versus observed shoreline erosion at each calibration cell (20230428)

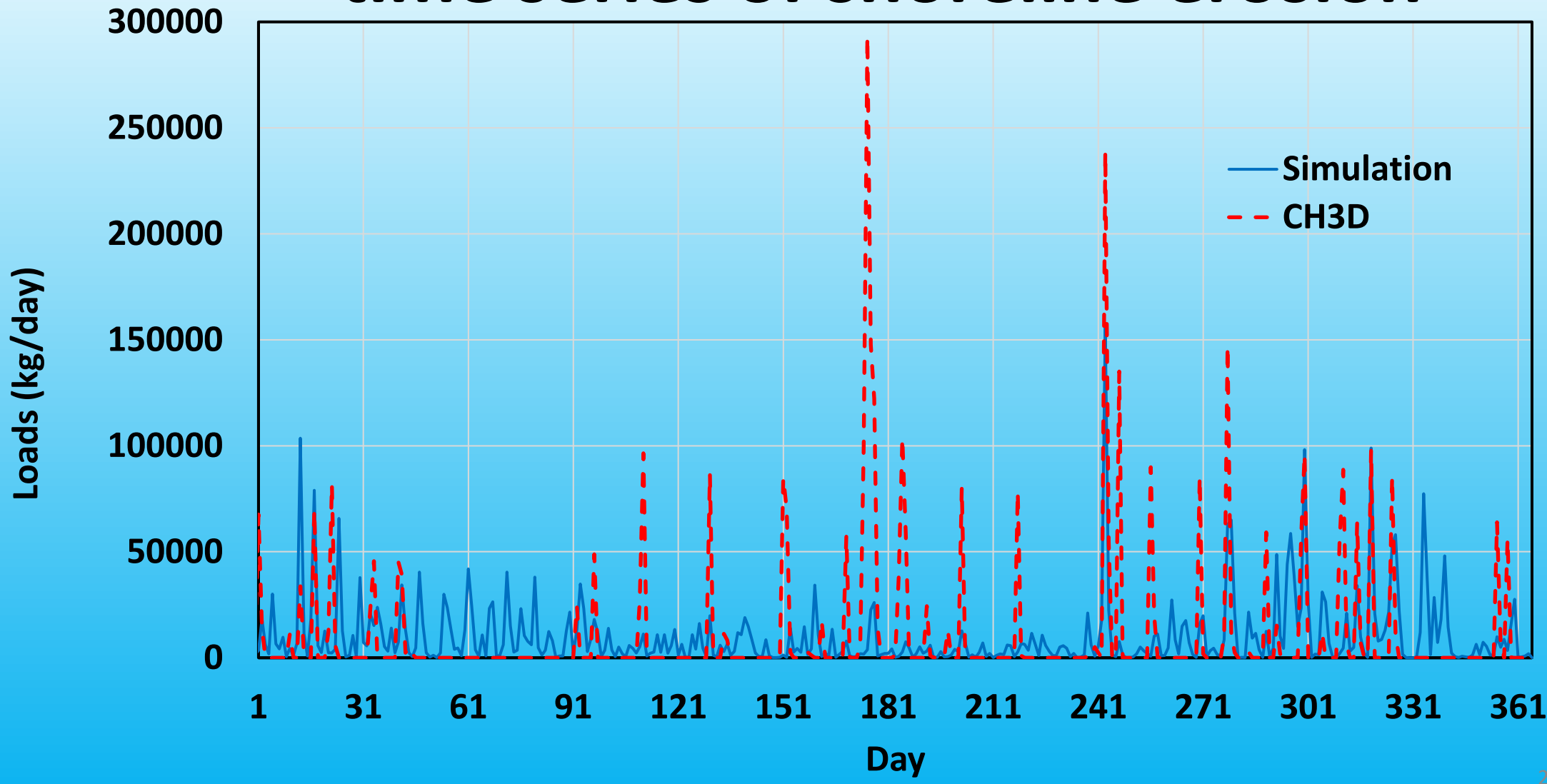


Spatially-distributed shoreline erosion



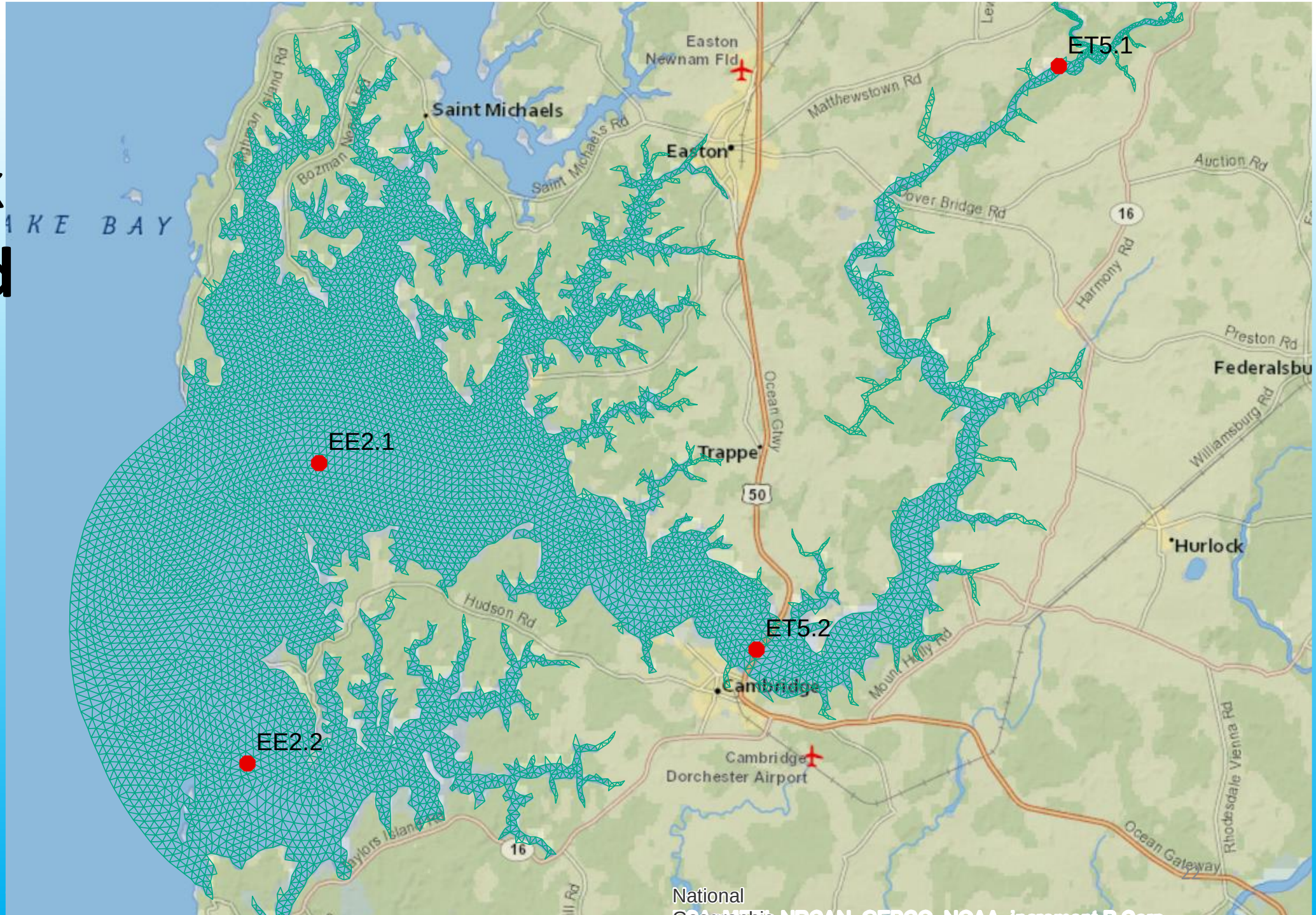
3 CH3D cell partitioned to 733 coastal cells

Wave-driven versus hydrology-driven time series of shoreline erosion

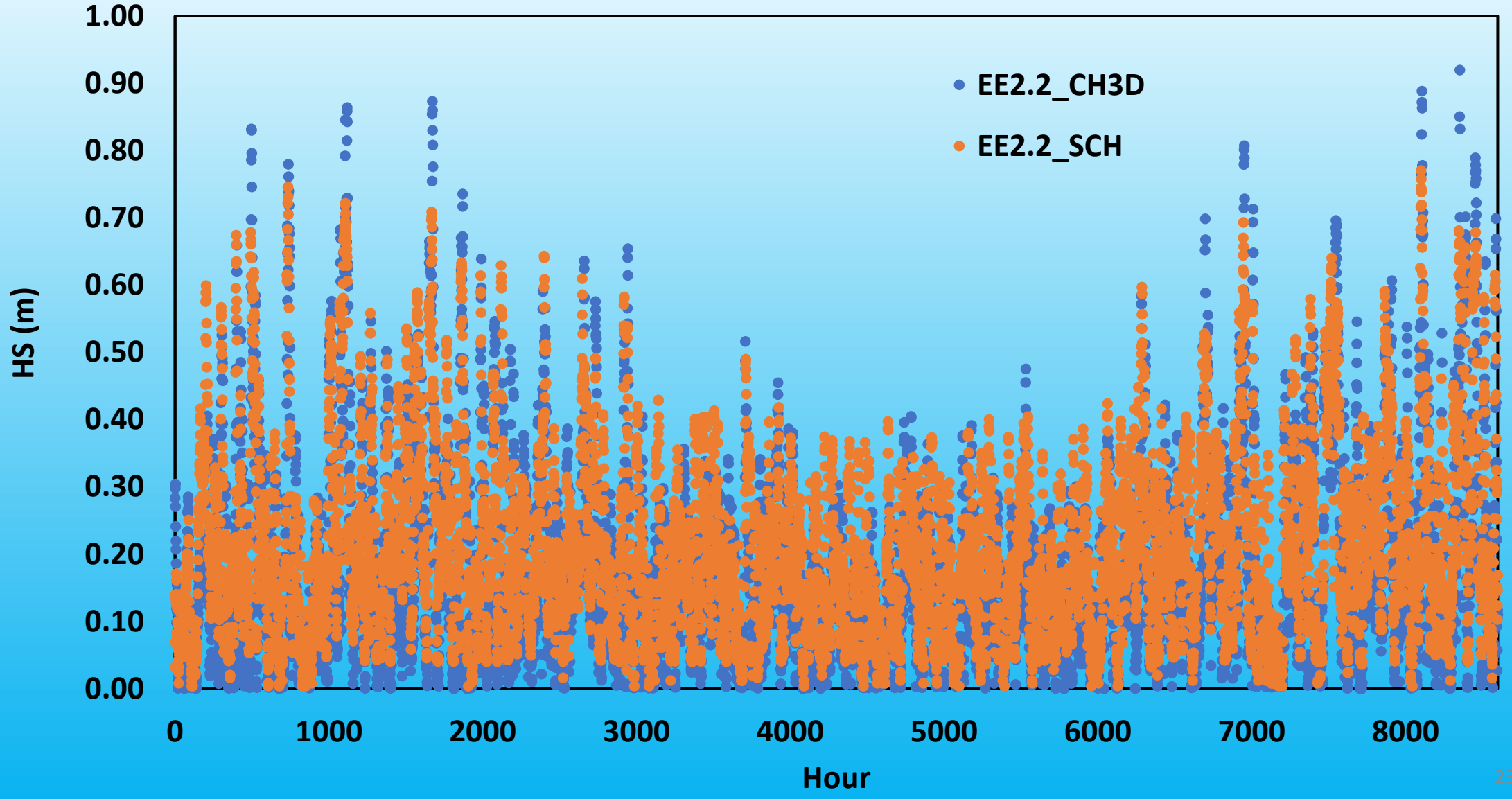


Choptank River Grid

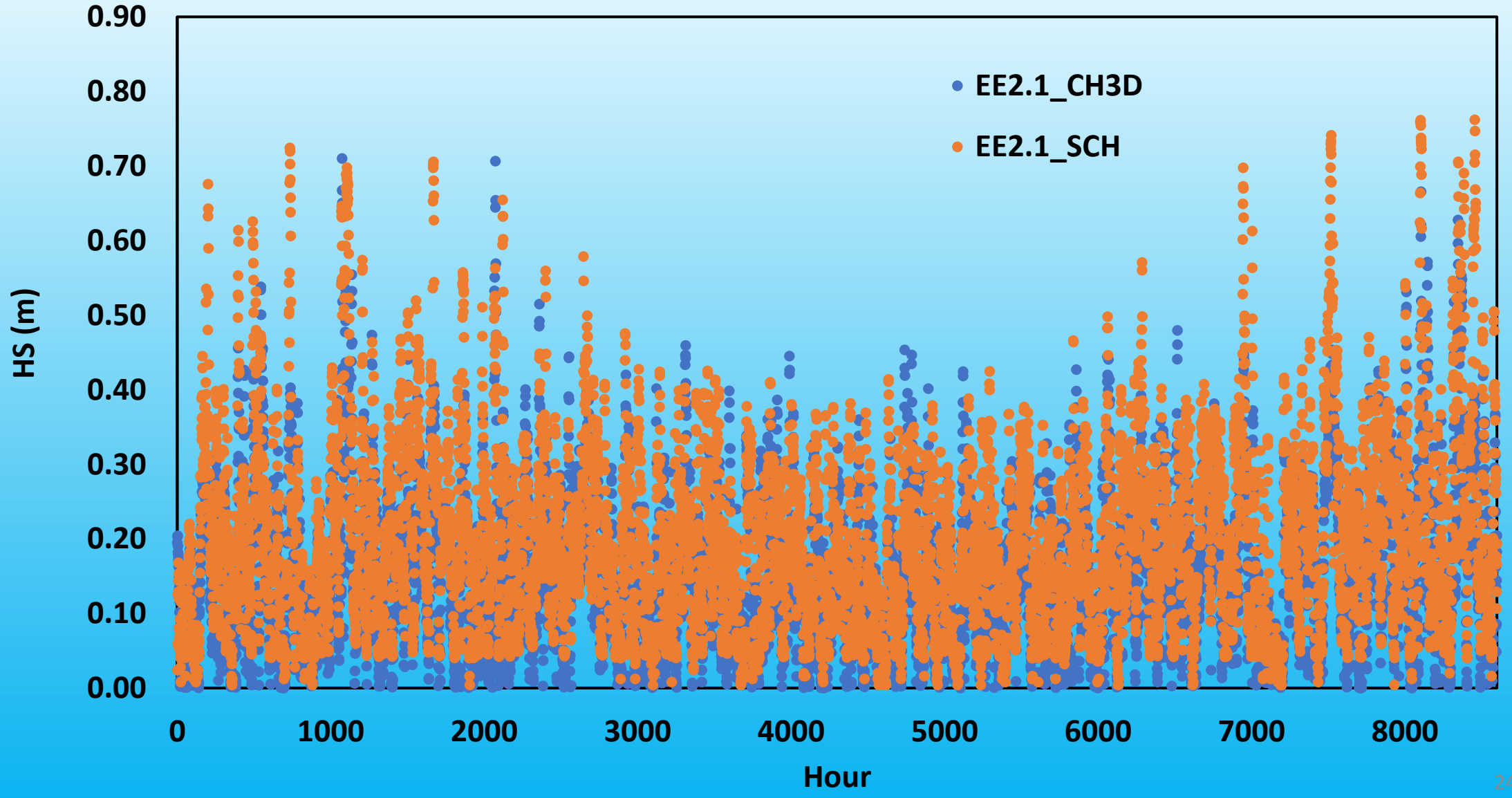
15829 ells
27 vertical layers
50-200m resolution



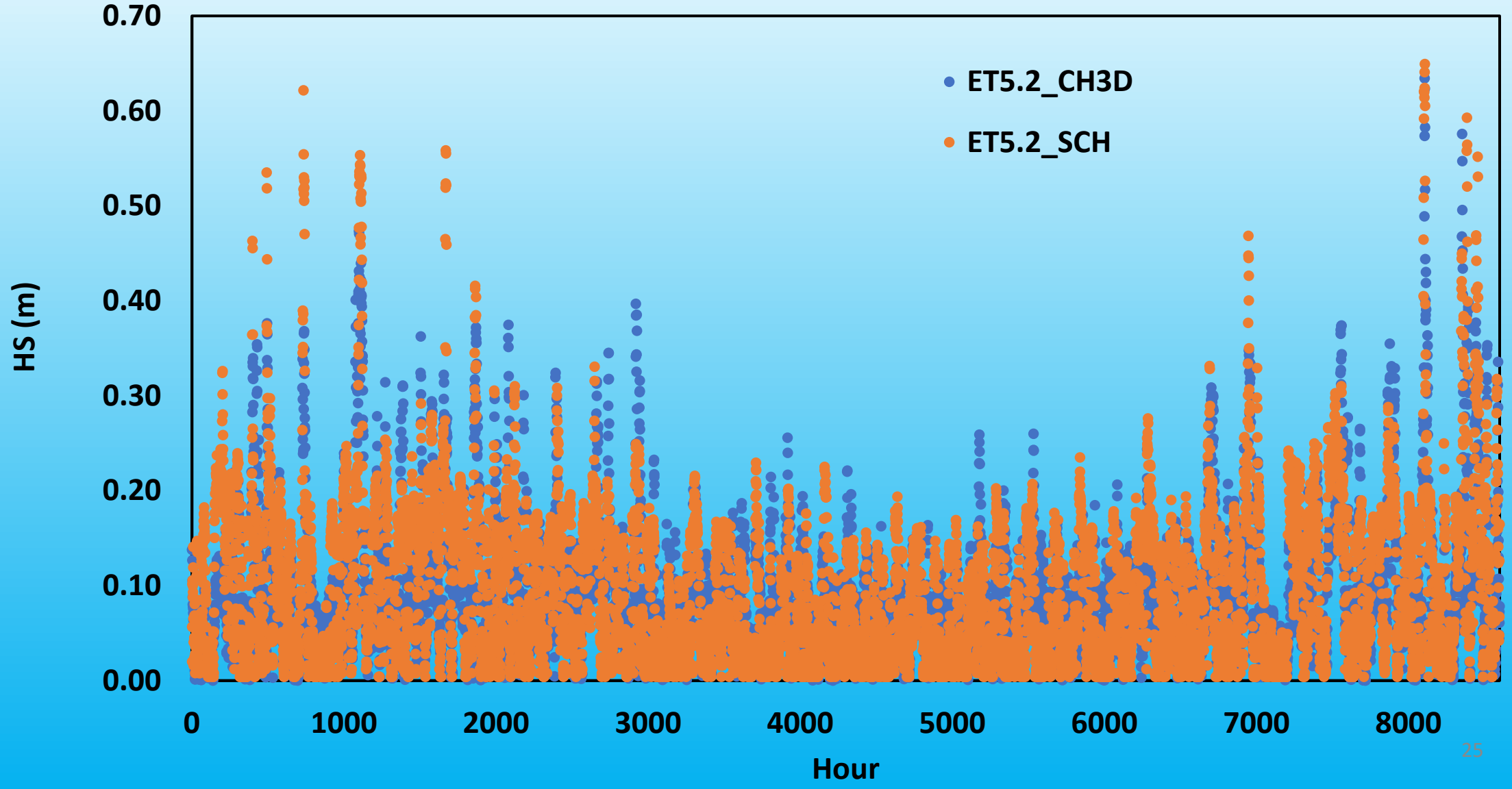
Significant wave height at Station EE2.2



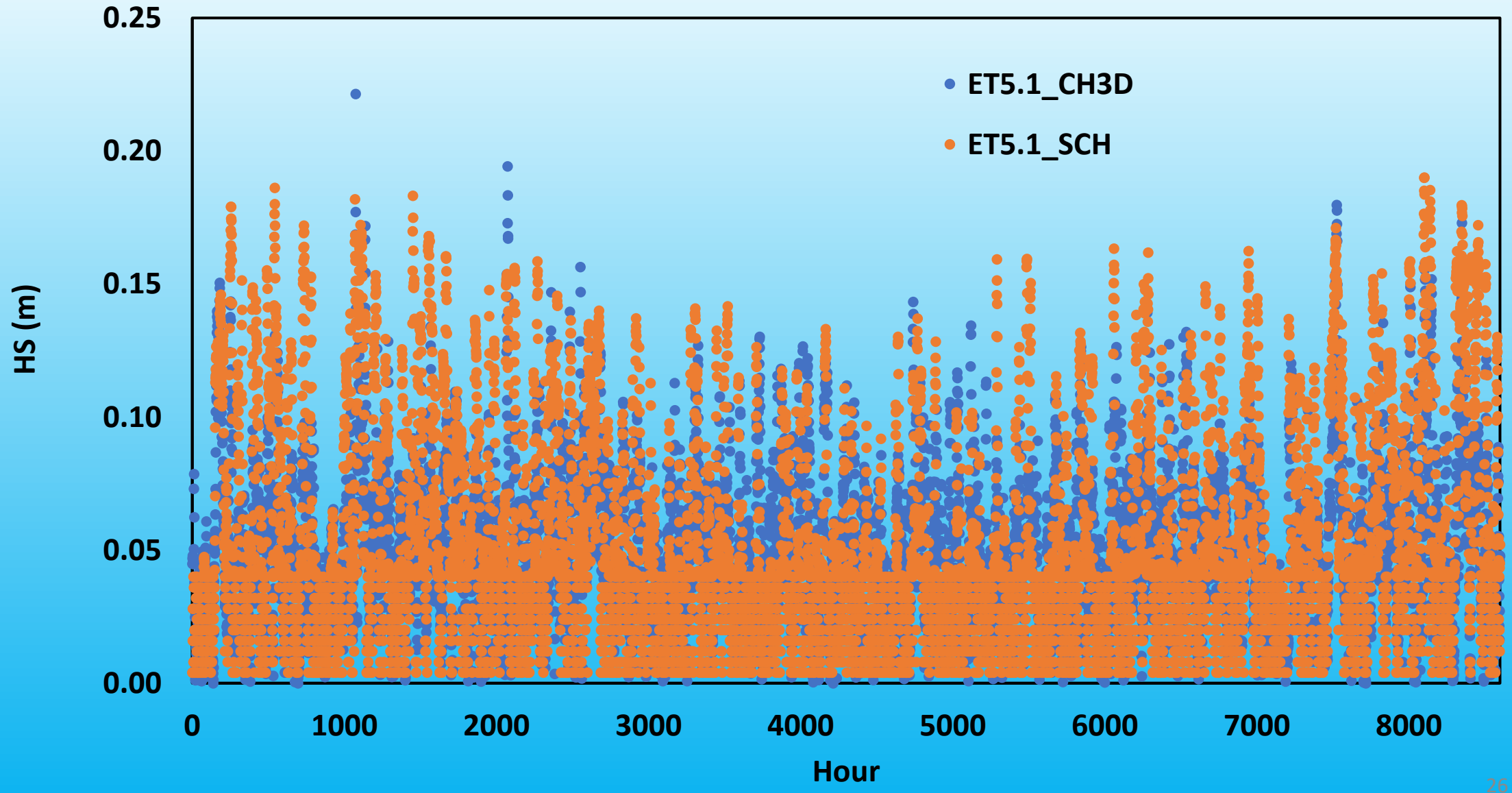
Significant wave height at Station EE2.1



Significant wave height at Station ET5.2



Significant wave height at Station ET5.1



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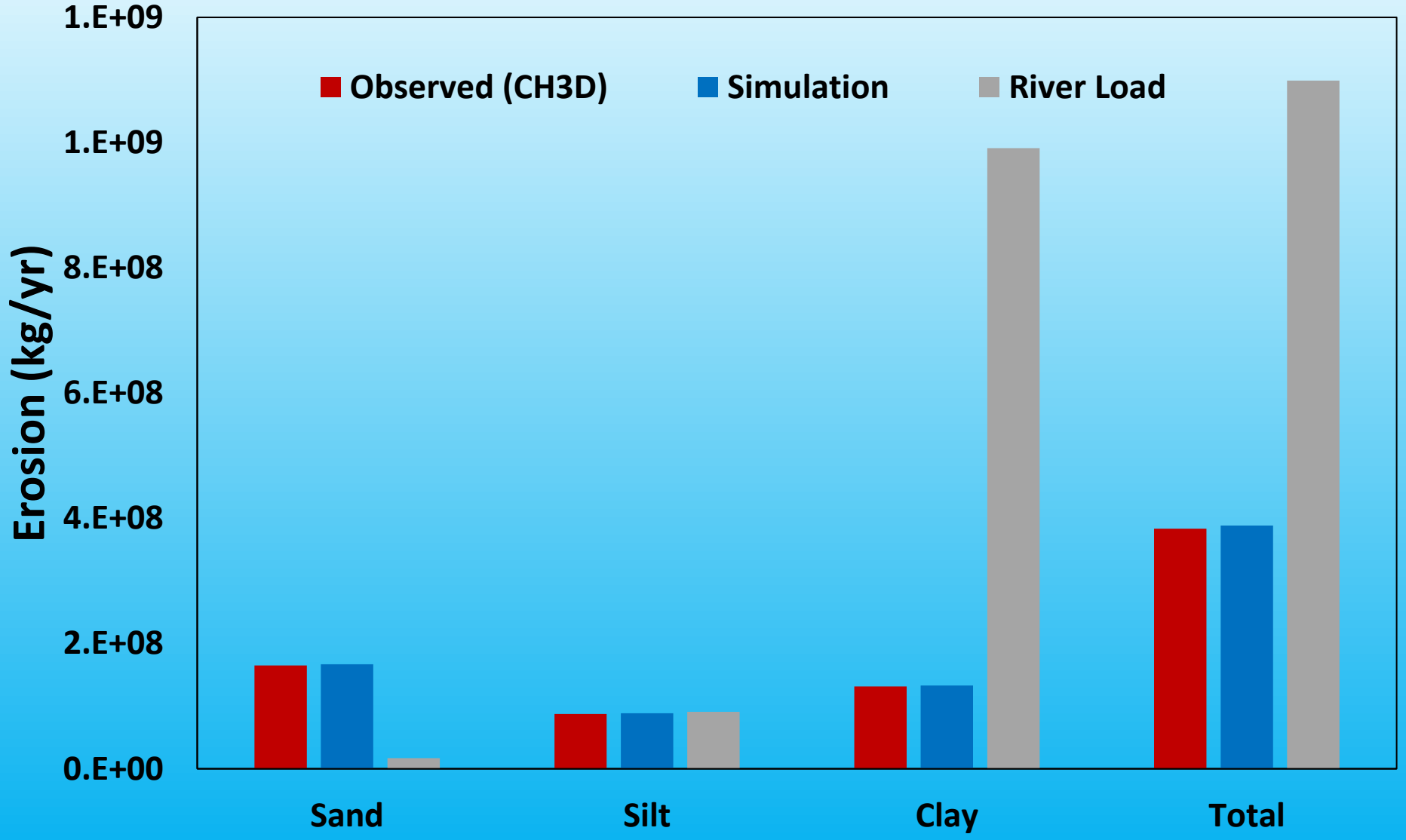

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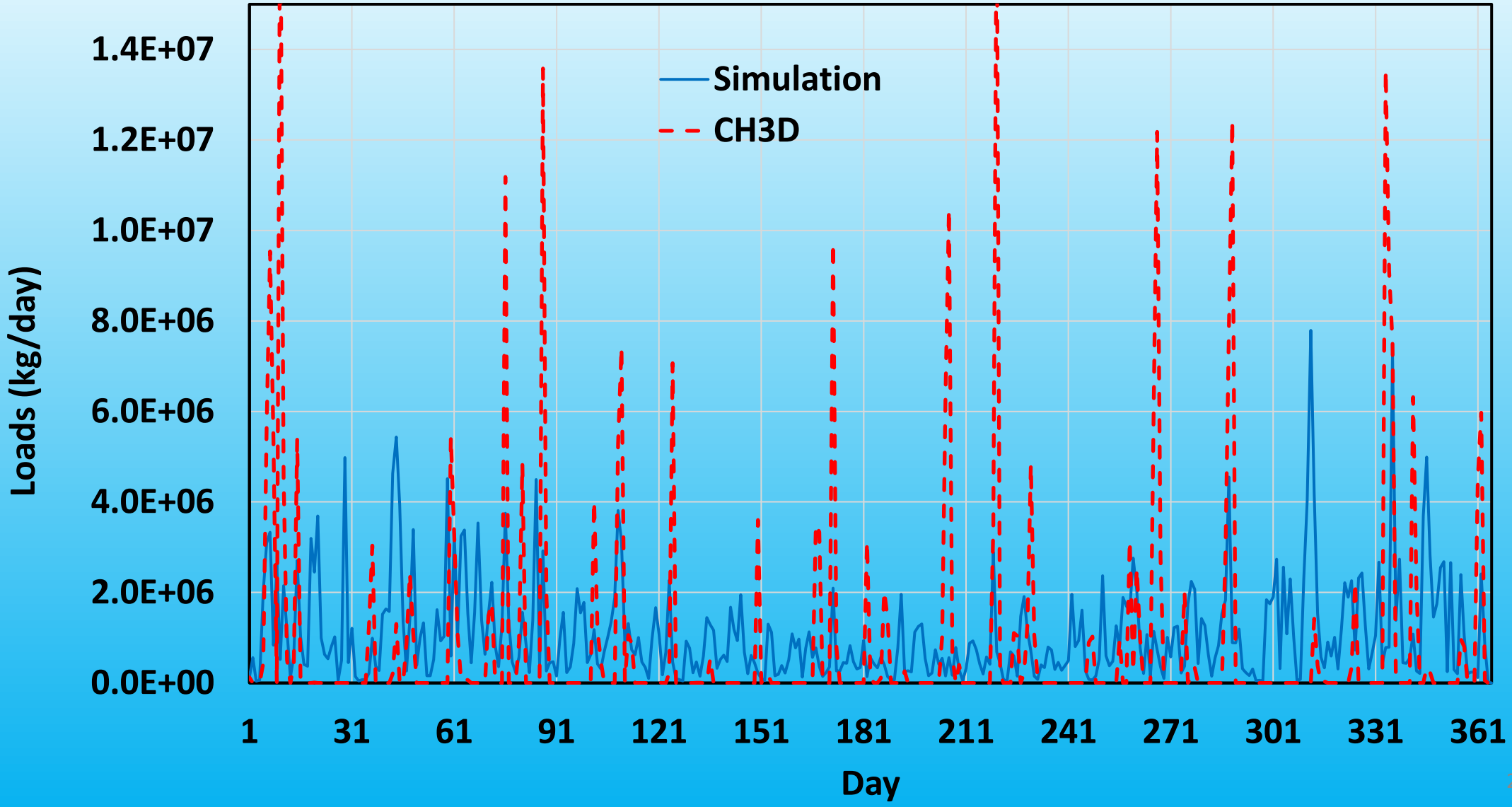
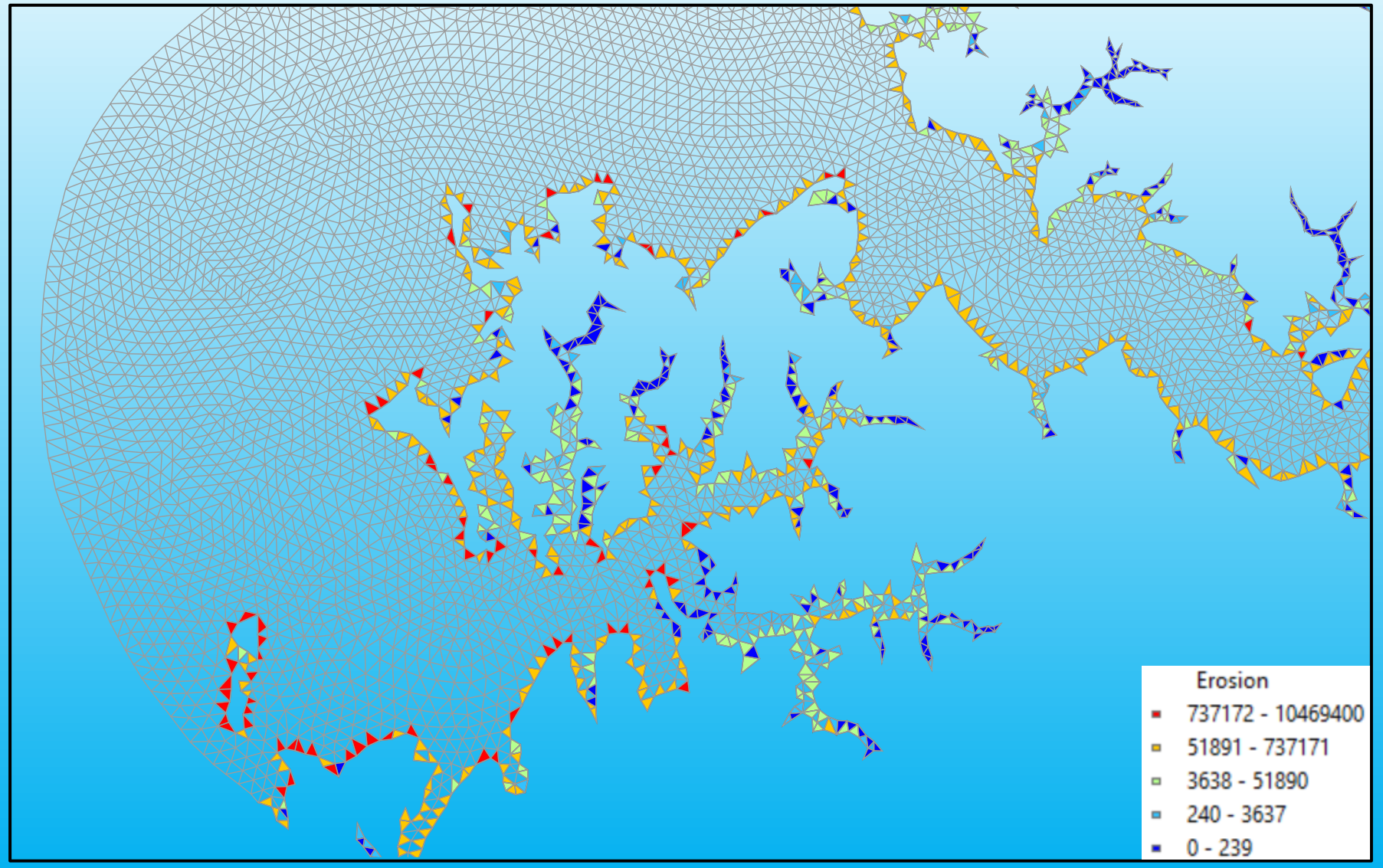


Spatial distribution of wave-driven shoreline erosion in the Choptank River



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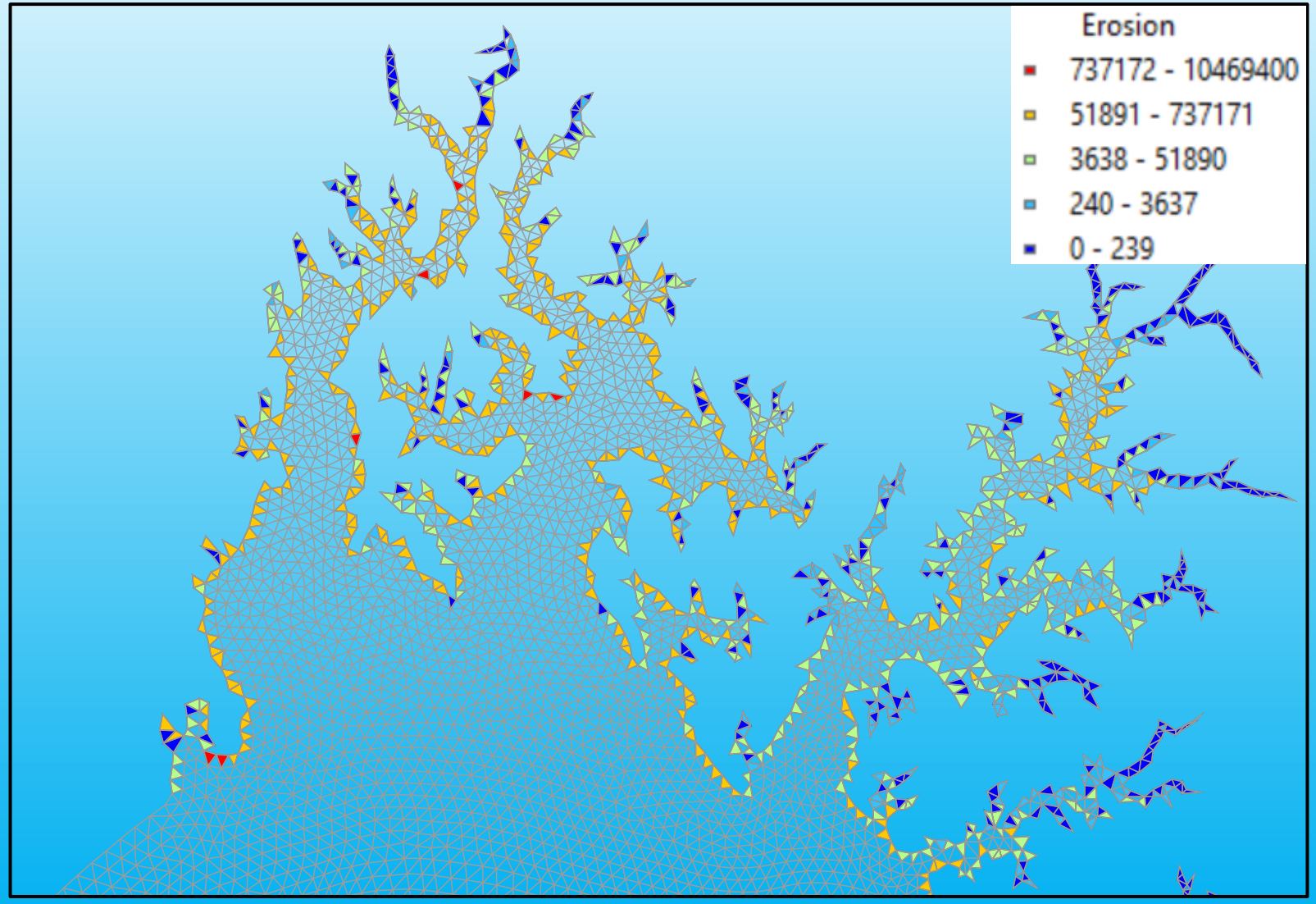

Question

- Should be applied bay-wide?

- Keep the original Phase 6 erosion for the calibration period 1991-2000, re-partitioning in space and time?
- Update shoreline protection for management scenarios and BMPs?
- Simulation under climate change condition?