Progress on the Choptank MTM

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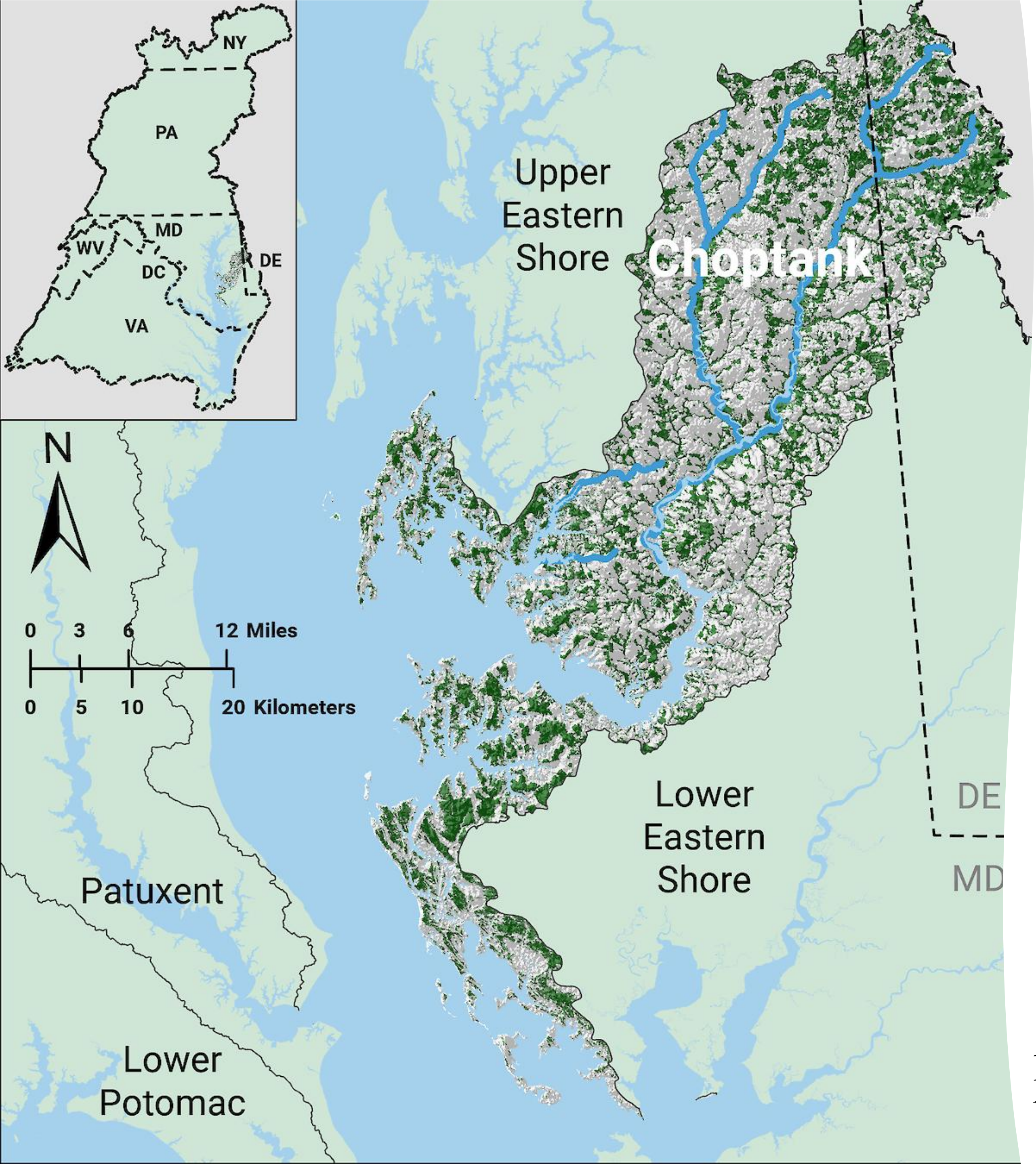
Modeling Workgroup Quarterly Review

October 8, 2025



Choptank River

The Choptank River complex is located on Maryland's Eastern Shore and includes the Choptank River and its major tributaries (Little Choptank River and Honga River).

The largest of the Chesapeake's Eastern Shore river (about 68 miles).

https://ecoreportcard.org/report-cards/chesapeake-bay/watershed-regions/choptank/

Outline

- Hydrodynamic simulations

- ICM simulation

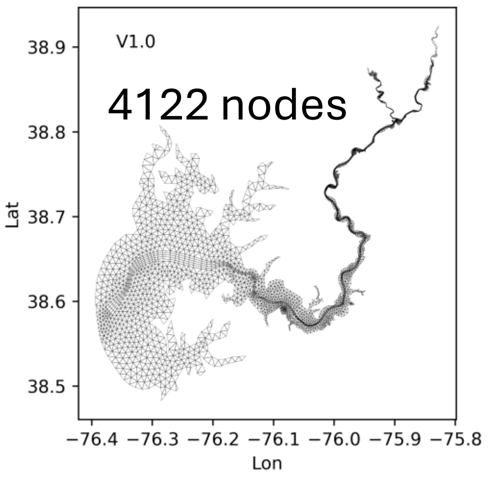
Part I

Hydrodynamic Simulations

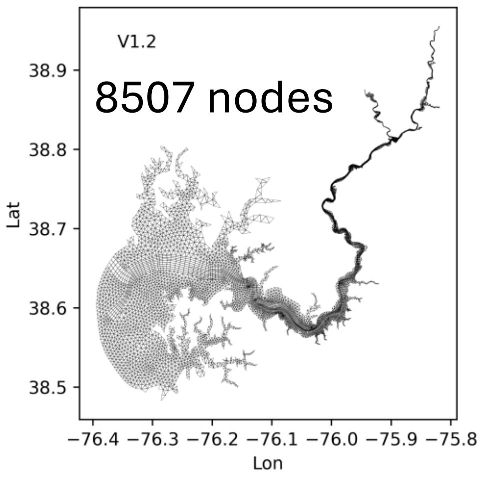
Hydrodynamic modeling

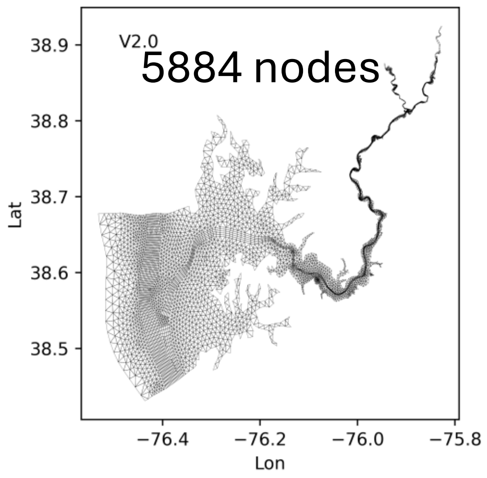
Different model grids were configured.

First run



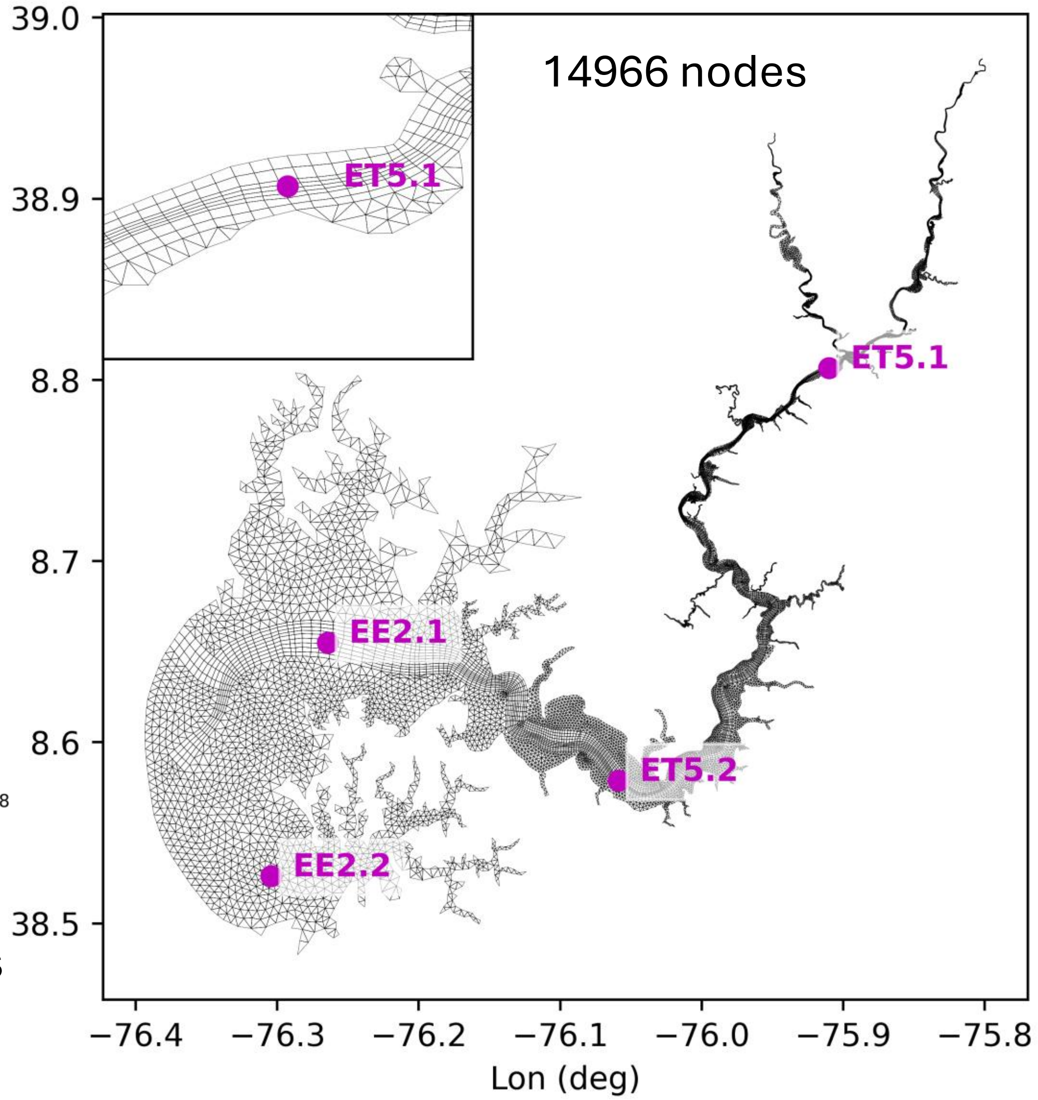
Better resolve the channel





- Based on V1.0
- Two open boundaries

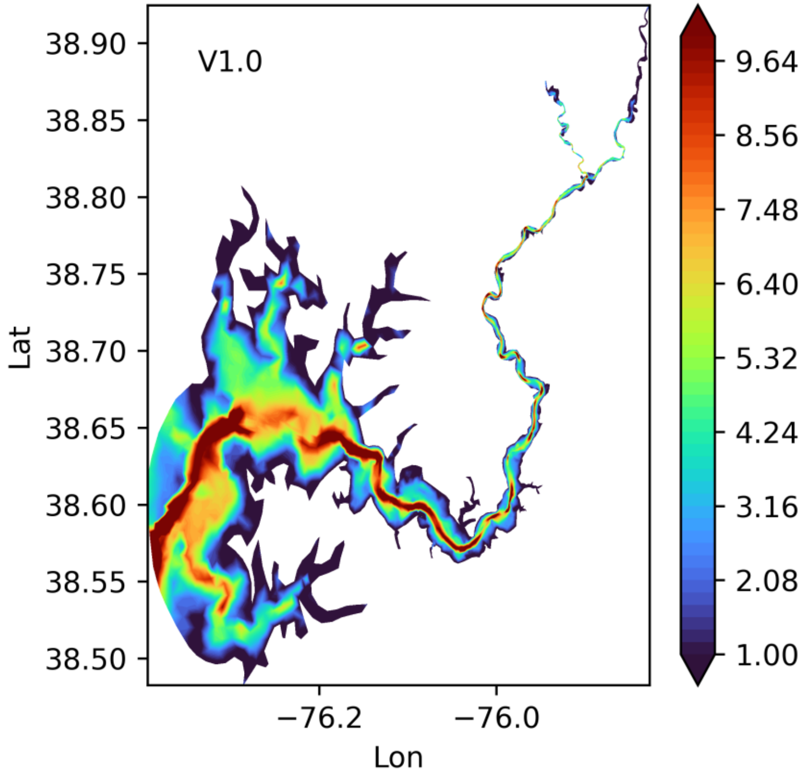
V1.6 (current grid)



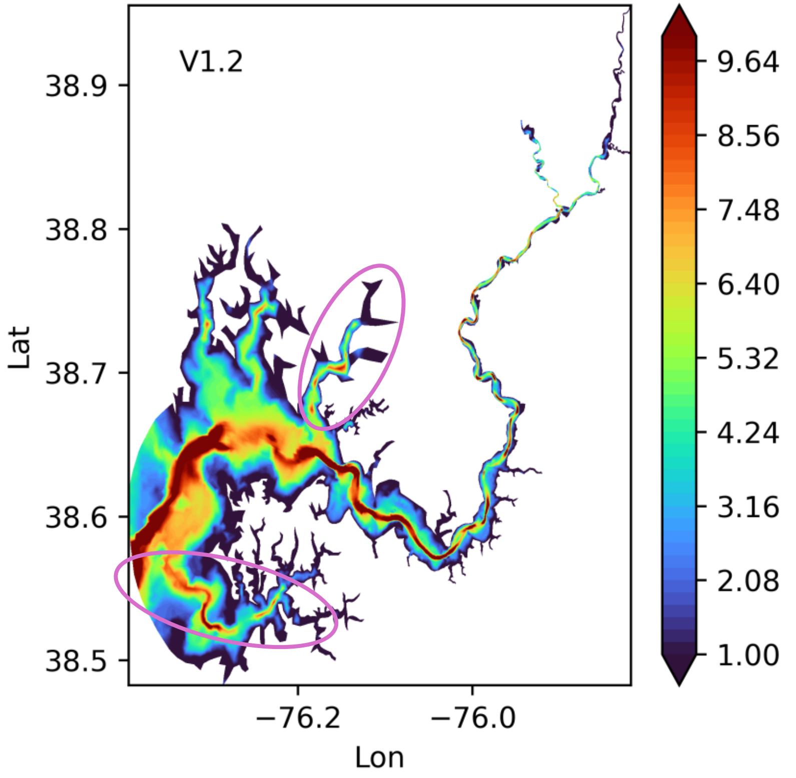
Bathymetry

A deeper channel connects the bay and choptank river.
Shoalings are found near the river entrance.

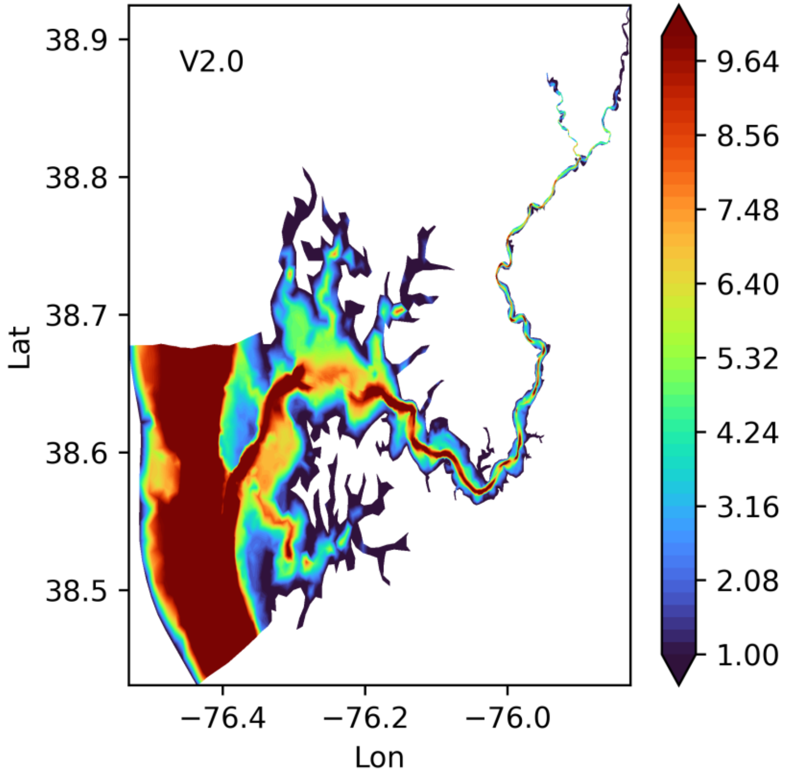
V1.0



V1.2
Better representation of bathymetry

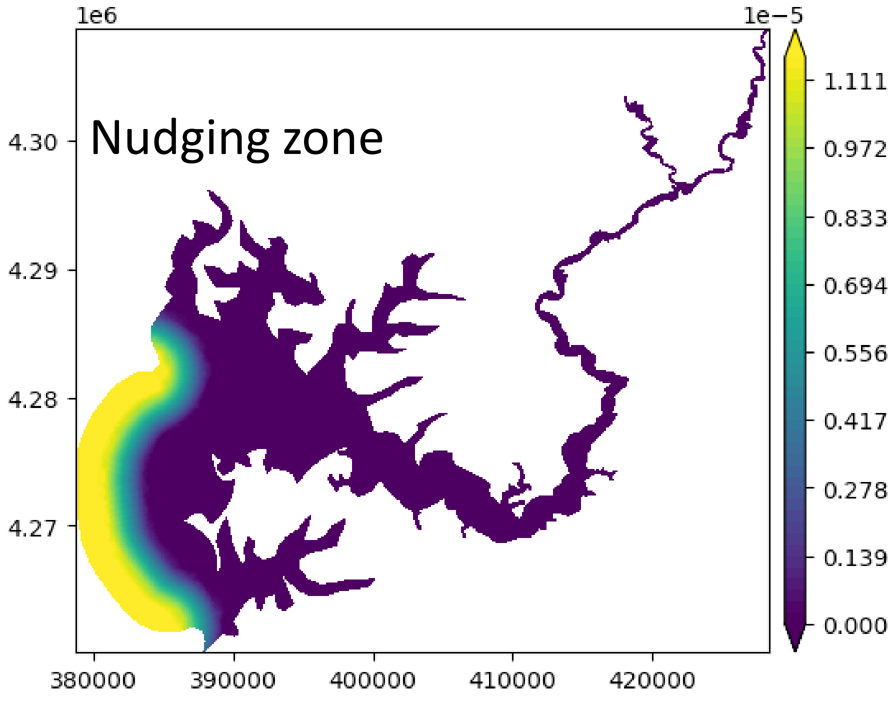


V2.0

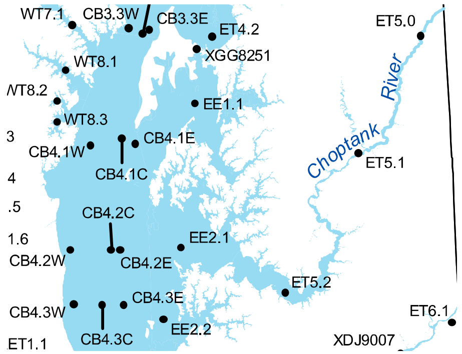


The tributary model is connected with Main Bay Model (MBM)

- Open boundary: salinity, temperature, velocity and surface elevation interpolated from MBM outputs (run07b).
- MBM output frequency: 30-minute
- A 5km nudging zone (383 grid nodes)

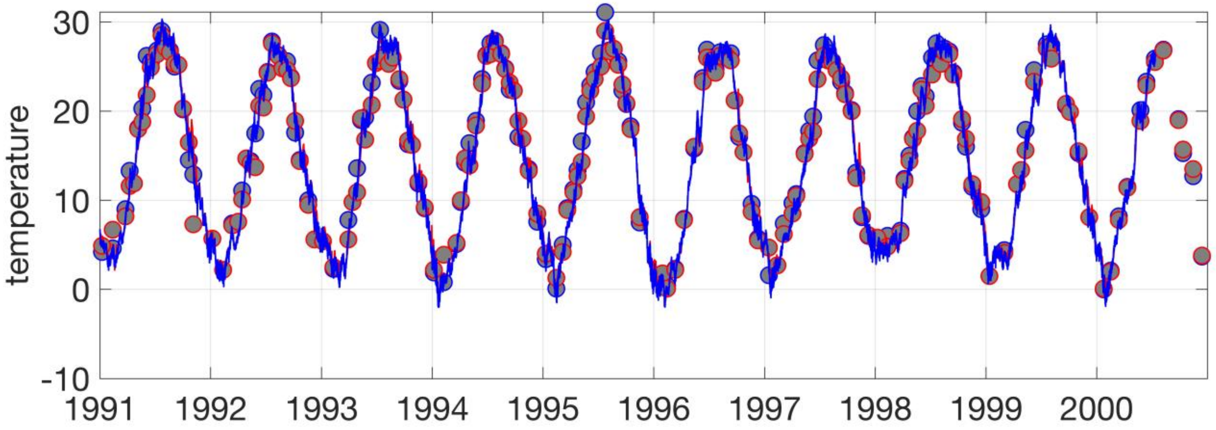


Temperature Validation

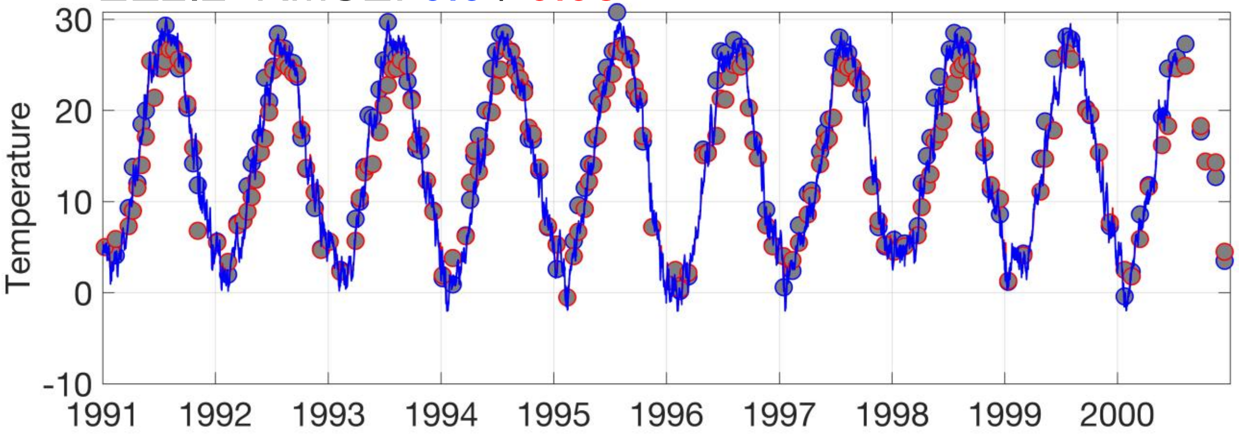


Capture the temperature changes throughout the estuary.

EE2.1 RMSE: 0.8 / 0.92

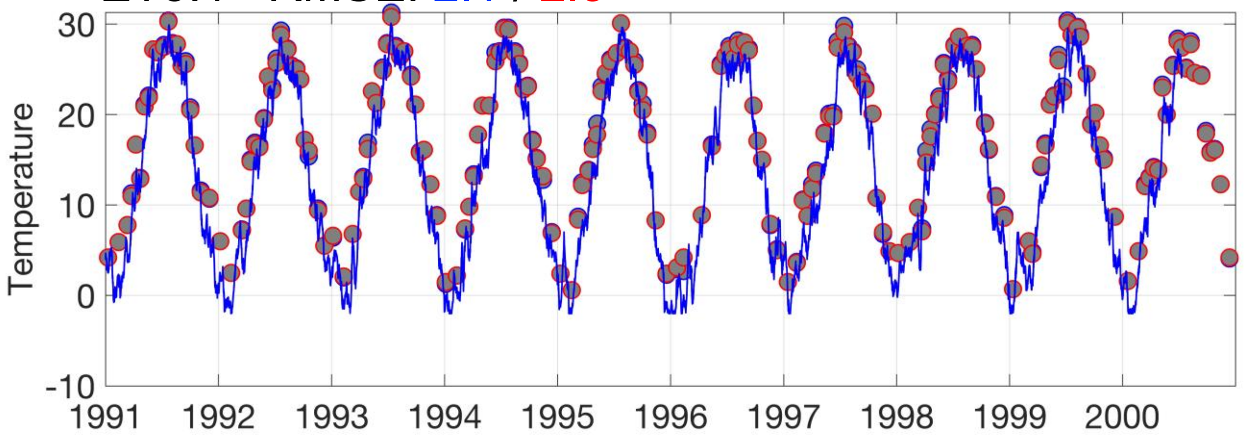


EE2.2 RMSE: 0.9 / 0.98

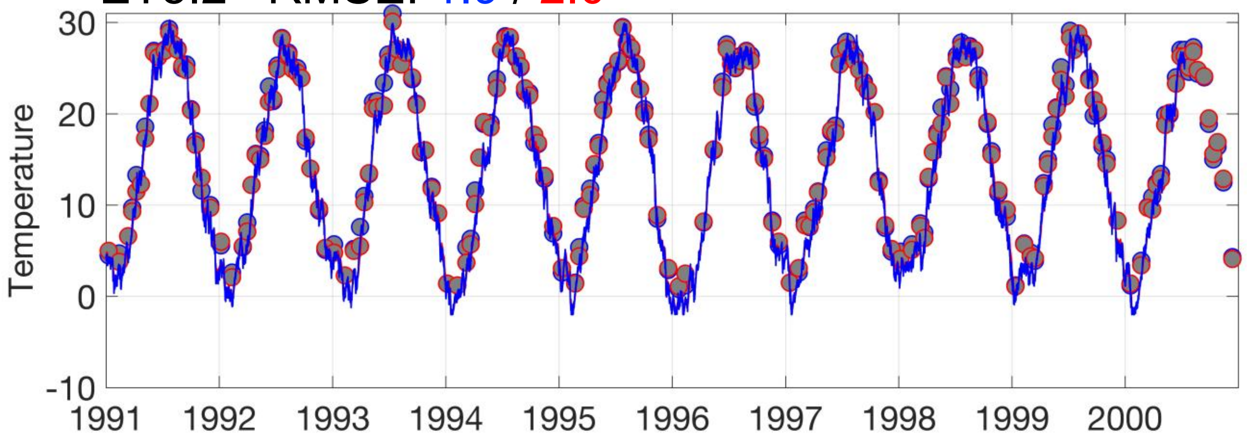


Surface/ Bottom

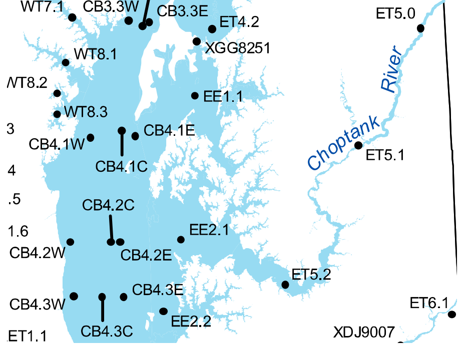
ET5.1 RMSE: 2.1 / 2.3



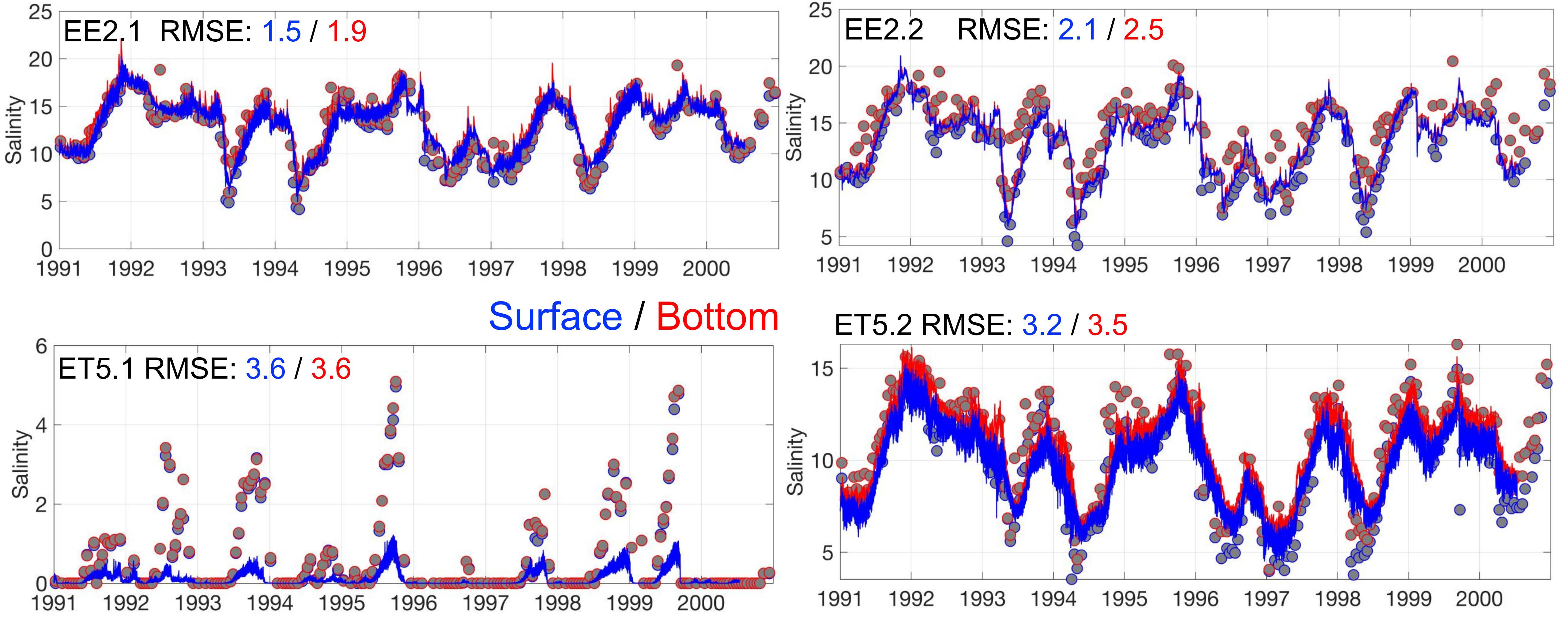
ET5.2 RMSE: 1.9 / 2.0



Salinity Validation



Salt intrusion in the upper part (ET5.1) is underestimated.



Factors affecting the hydrodynamics in the upper estuary.

Flow condition (USGS or watershed) can significantly affect the salt intrusion.

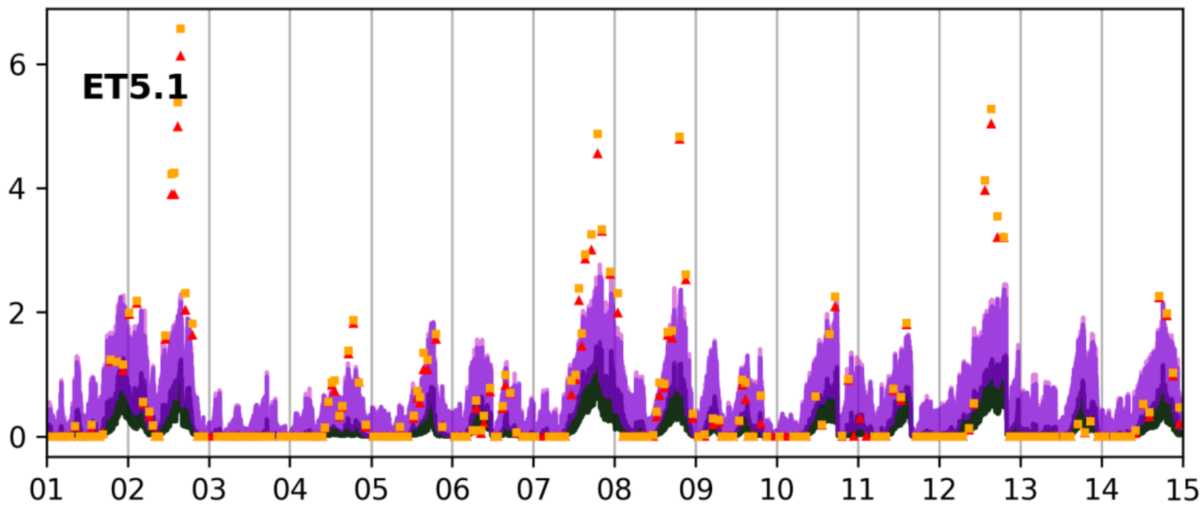
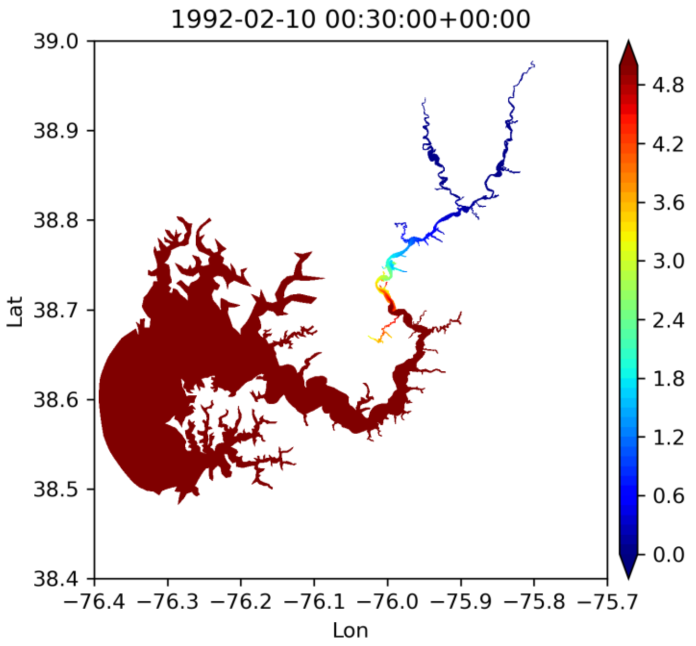


Figure: salinity at ET 5.1 from two different model run

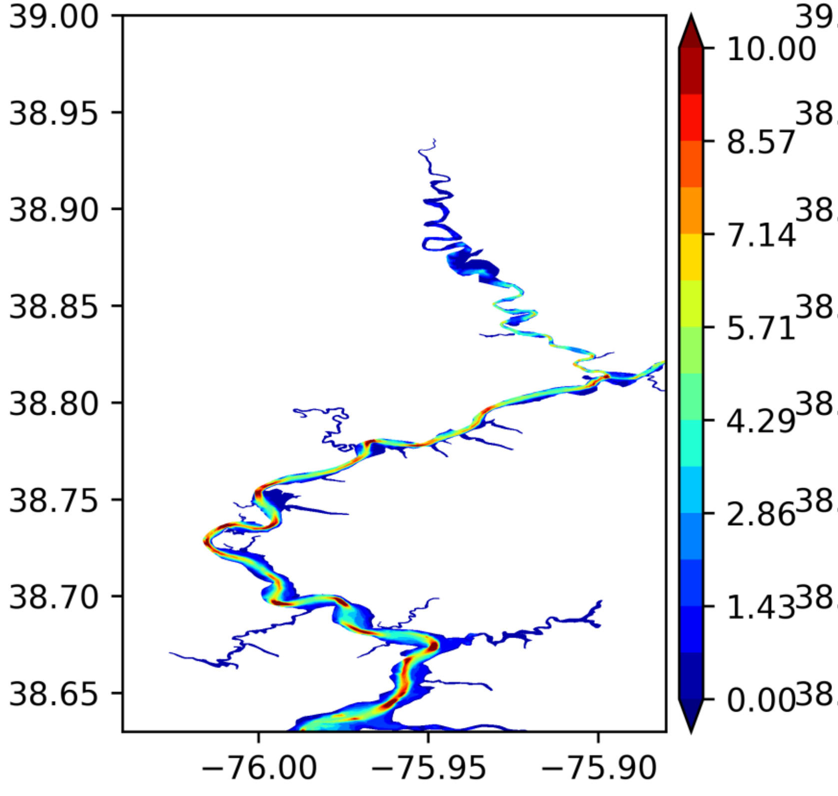
Wenfan's test

Impact of bathymetry in the upper estuary

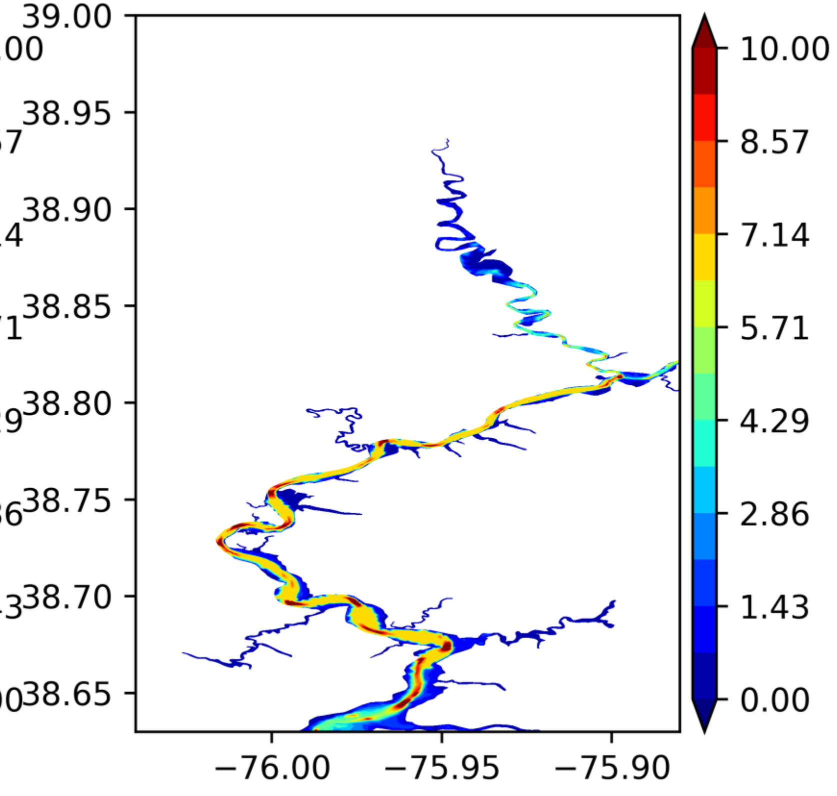
Salinity snapshot



Original bathymetry



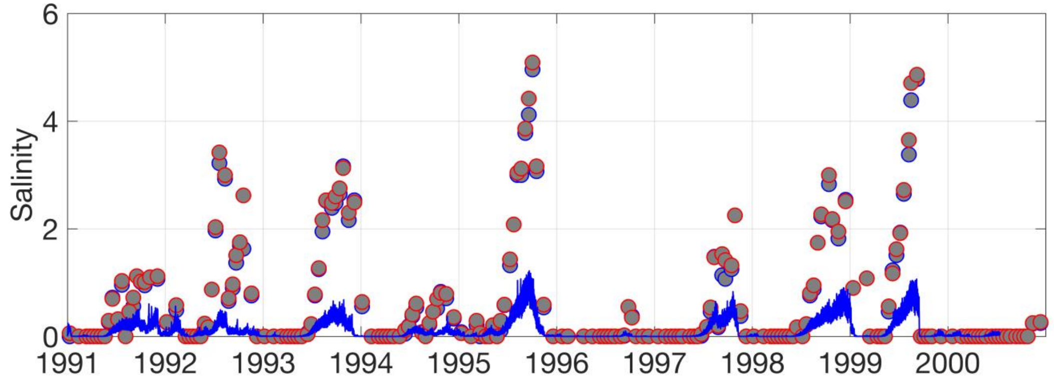
Deepen the central channel:
depth (2-8m) --- changed to 8m
depth (>8m) --- unchanged
depth (<2m) -- unchanged



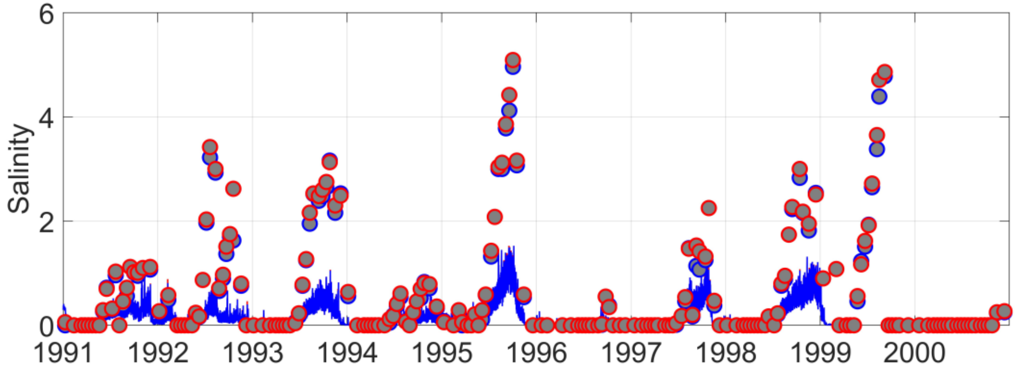
Impact of bathymetry in the upper Choptank

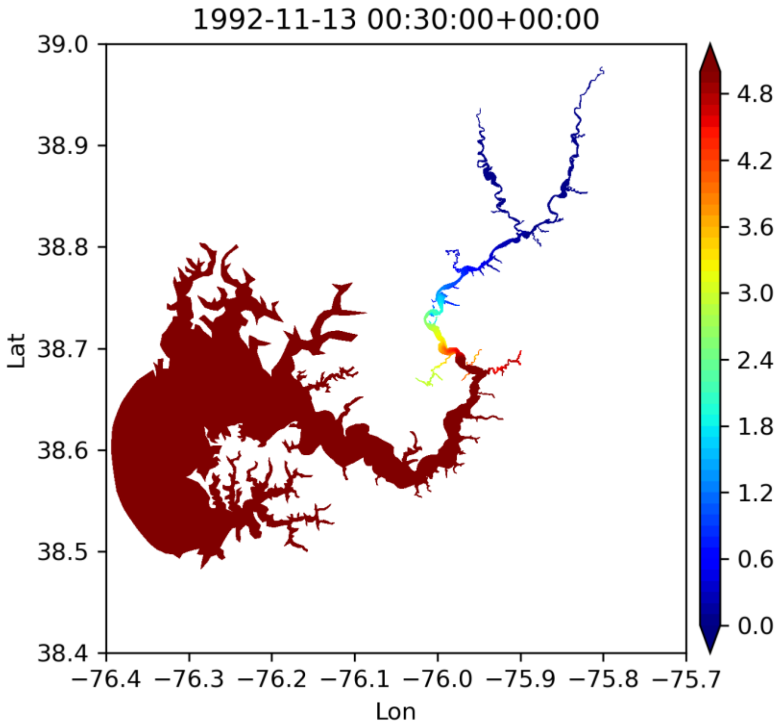
Deeper central channel introduce slightly more salt to the upper estuary.

ET5.1 (original bathymetry)

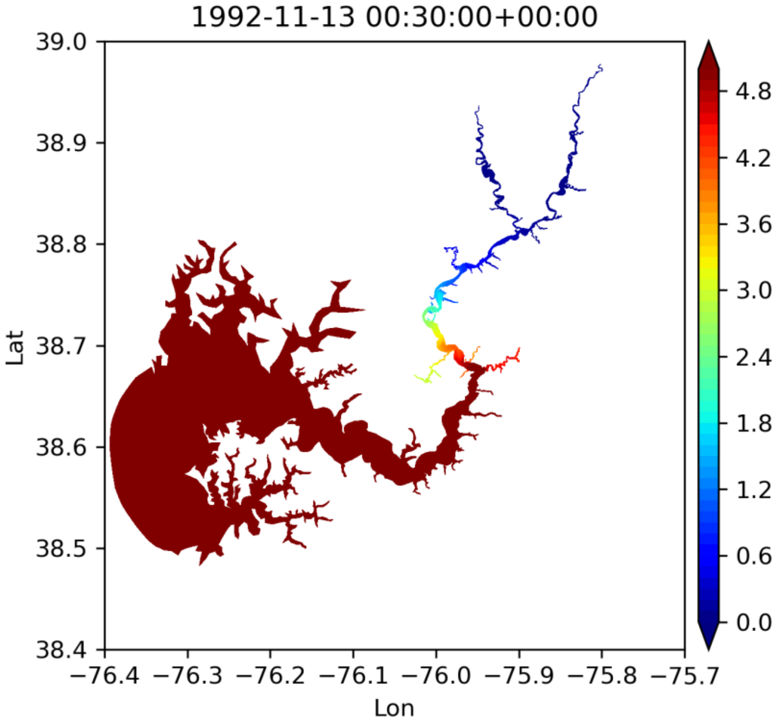


ET5.1 (deeper central channel)





Salinity snapshot



Part II
ICM simulation

ICM simulation configuration

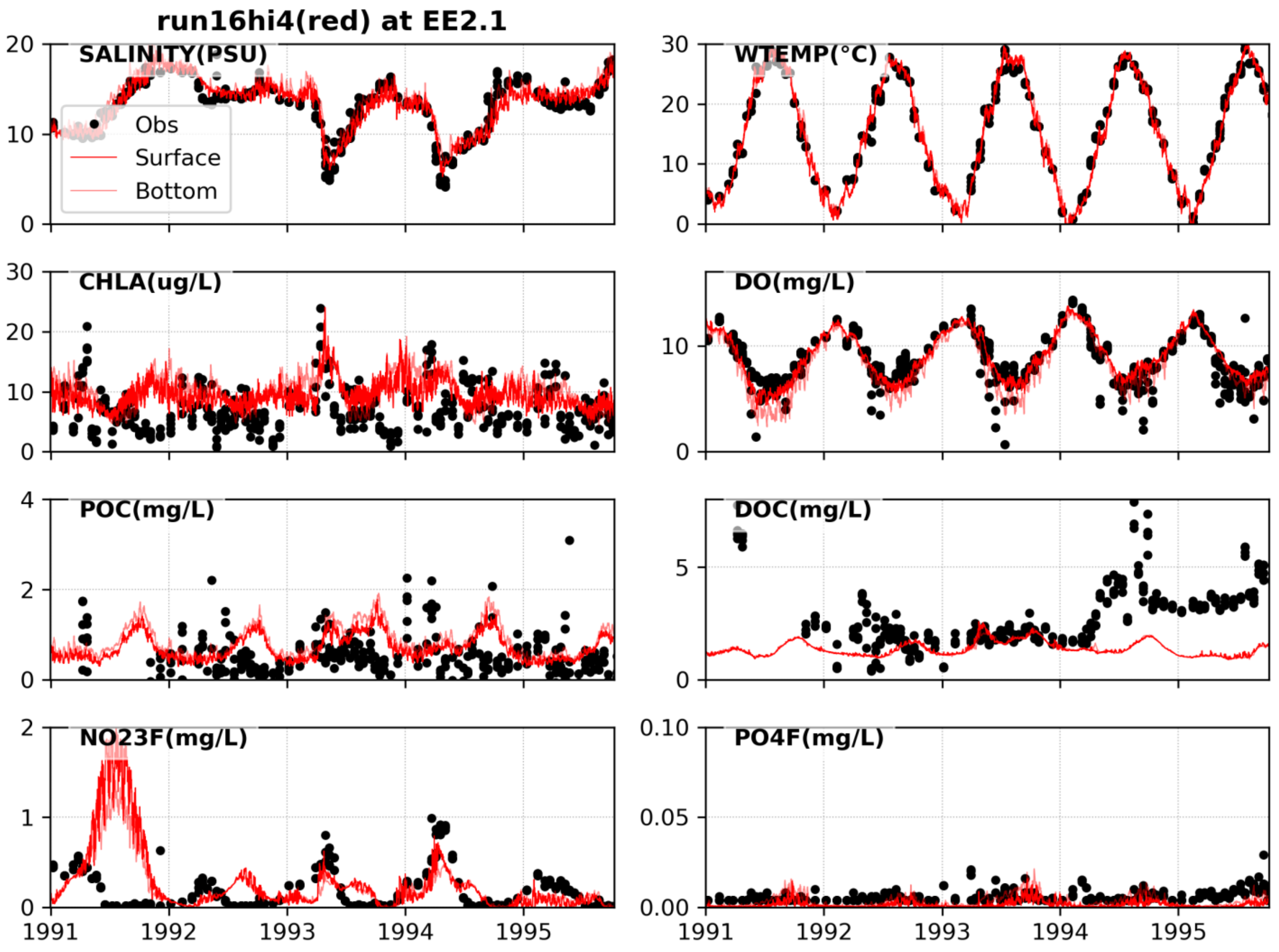
Using Watershed phase 6.

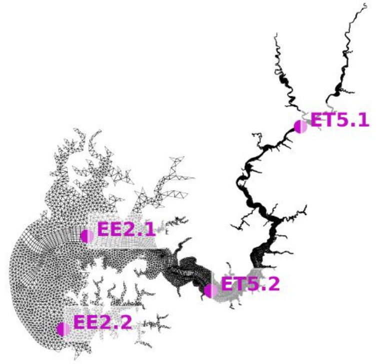
ICM boundary from MBM's RUN09k.

Standalone ICM (offline simulation)

(Coupled ICM vs Standalone ICM yield almost identical results).

ICM results near the entrance





At Station EE2.1

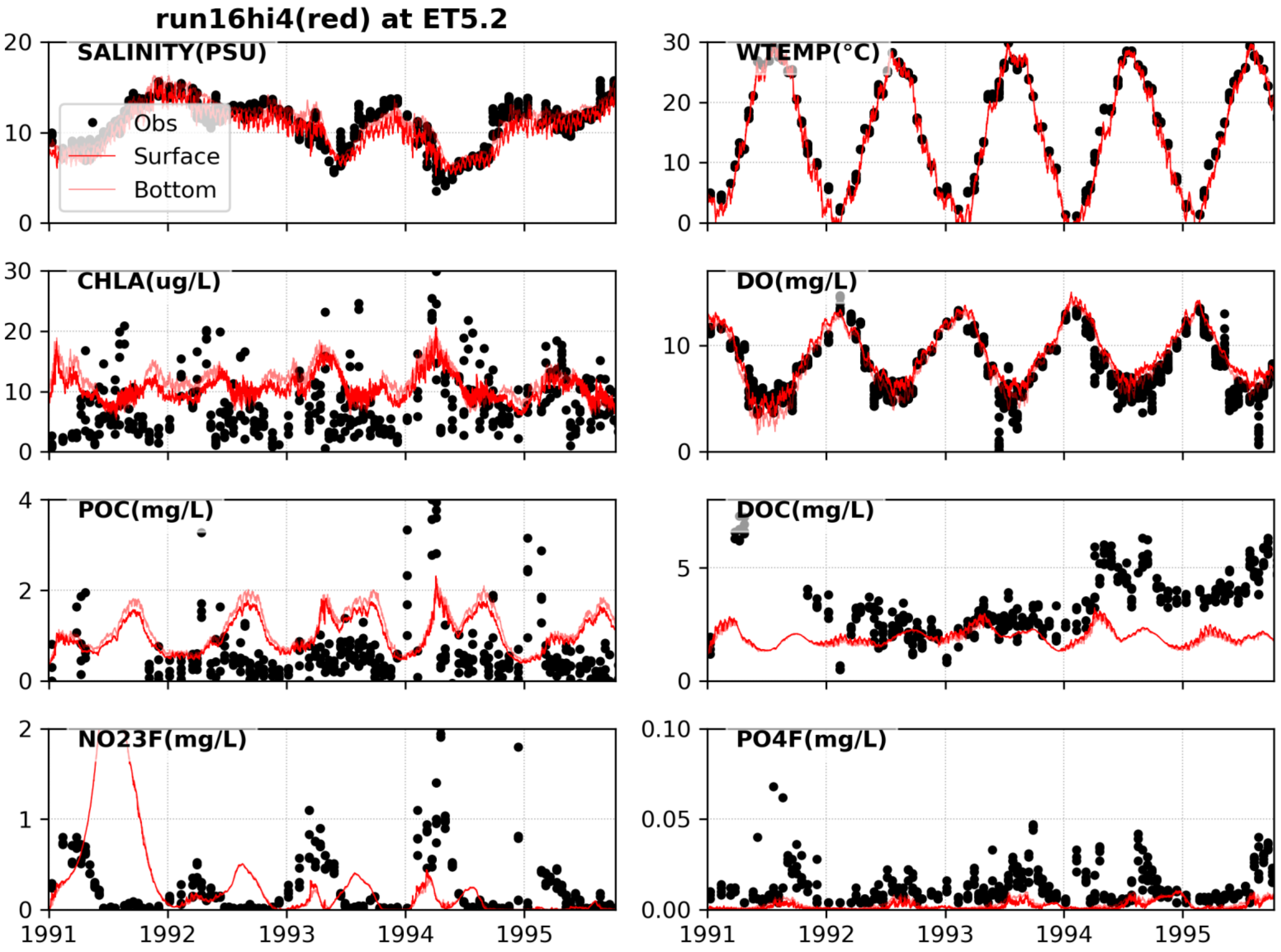
Near the open boundary

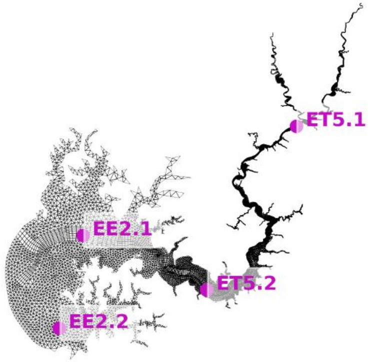
Large error in first year (e.g., NO23F) due to model spin-up.

Performance in salinity and temperature are perfect.

DO is ok too.

ICM results near the middle estuary



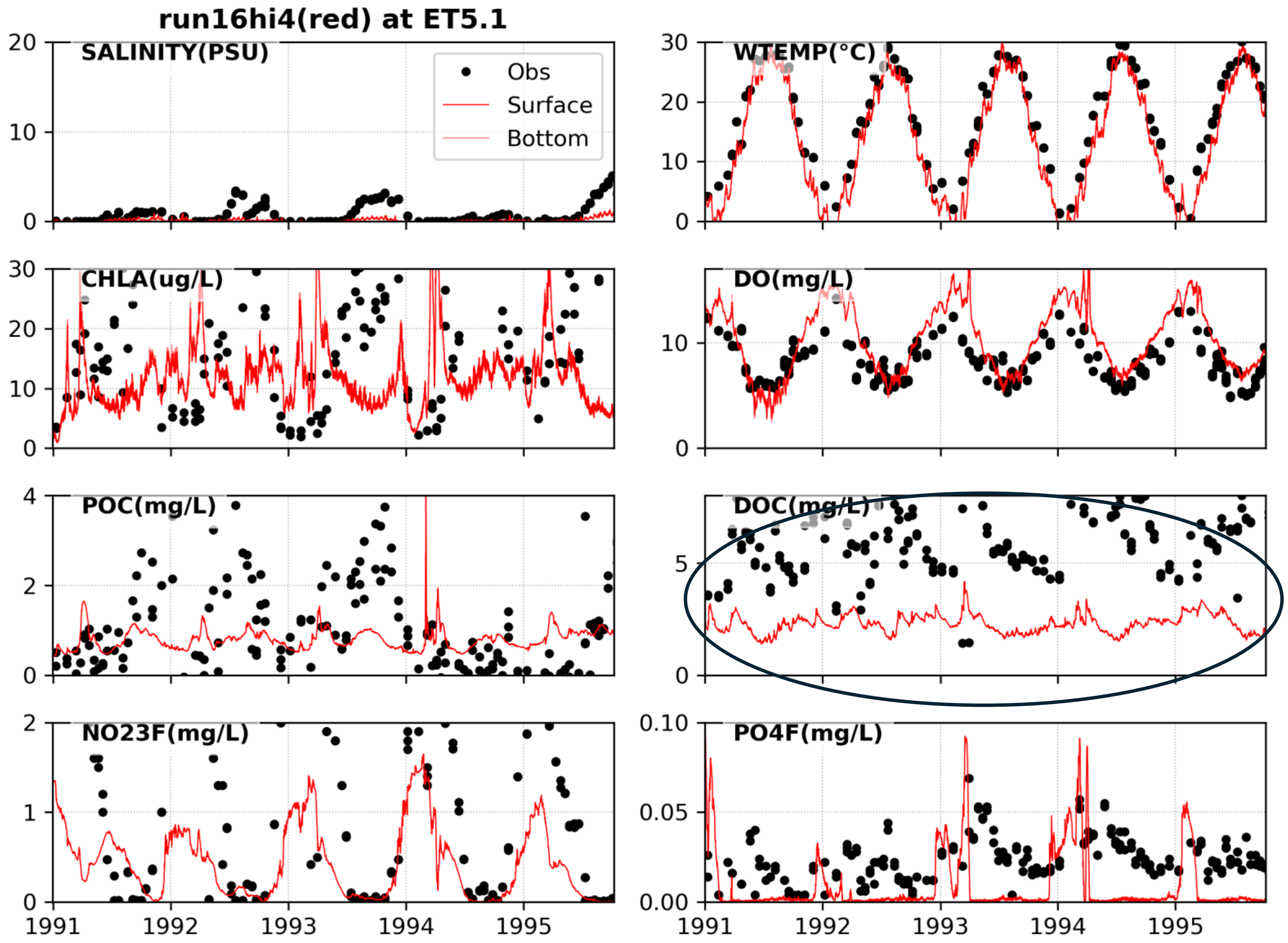


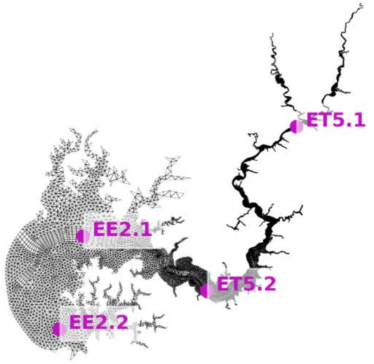
At Station ET5.2

At middle estuary.

Model underestimates NO23 and PO4: they are heavily consumed along the way from the upper river to the middle.

ICM results near the upper estuary





At Station ET5.1

At upper estuary

DOC heavily underestimated

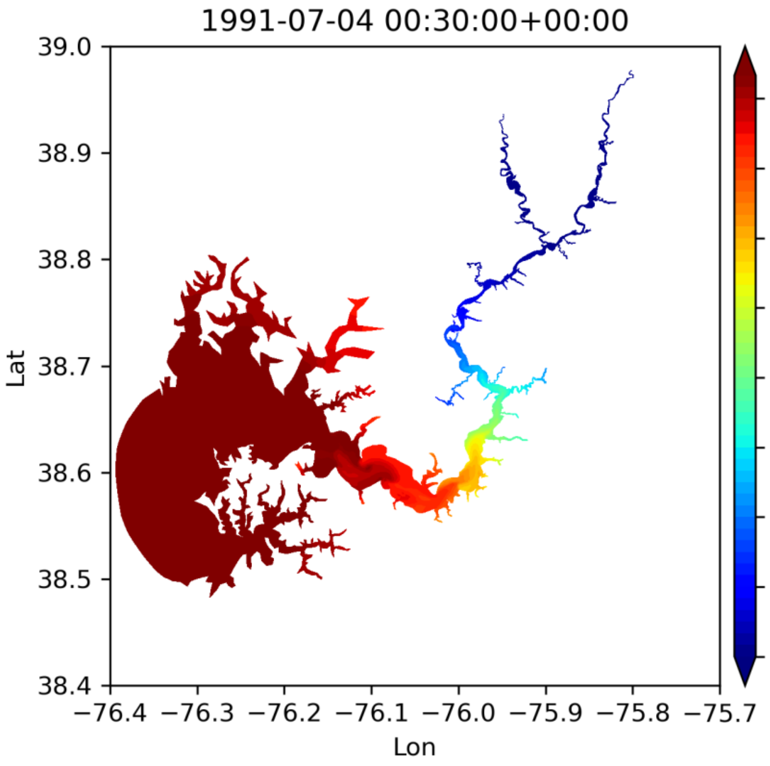
Input from watershed is likely the reason for this upper estuary station. The underestimation affect the performance at middle Bay.

Impacts of light attenuation

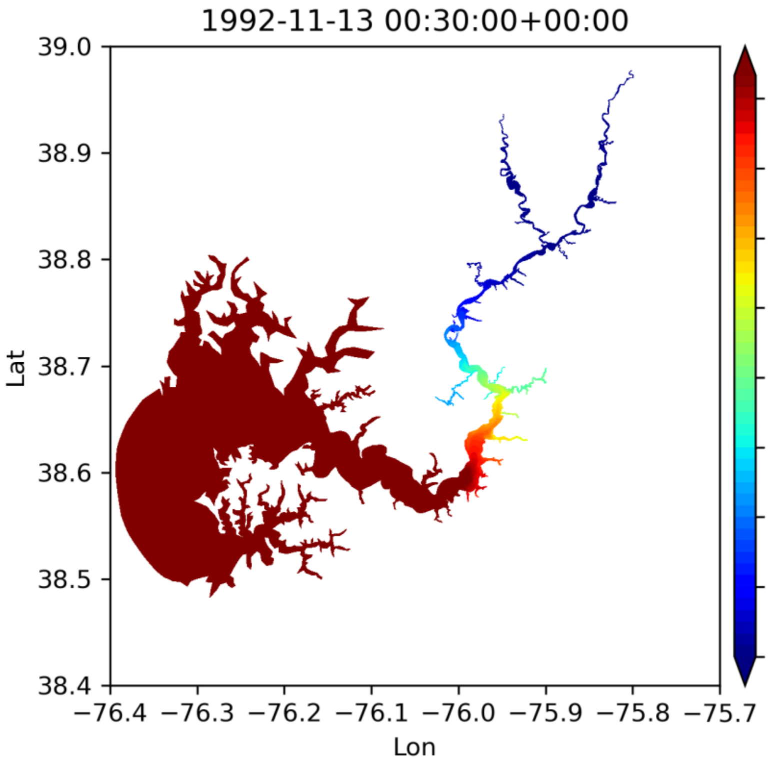
Sediment module is off.

To assess the impact of light attenuation:

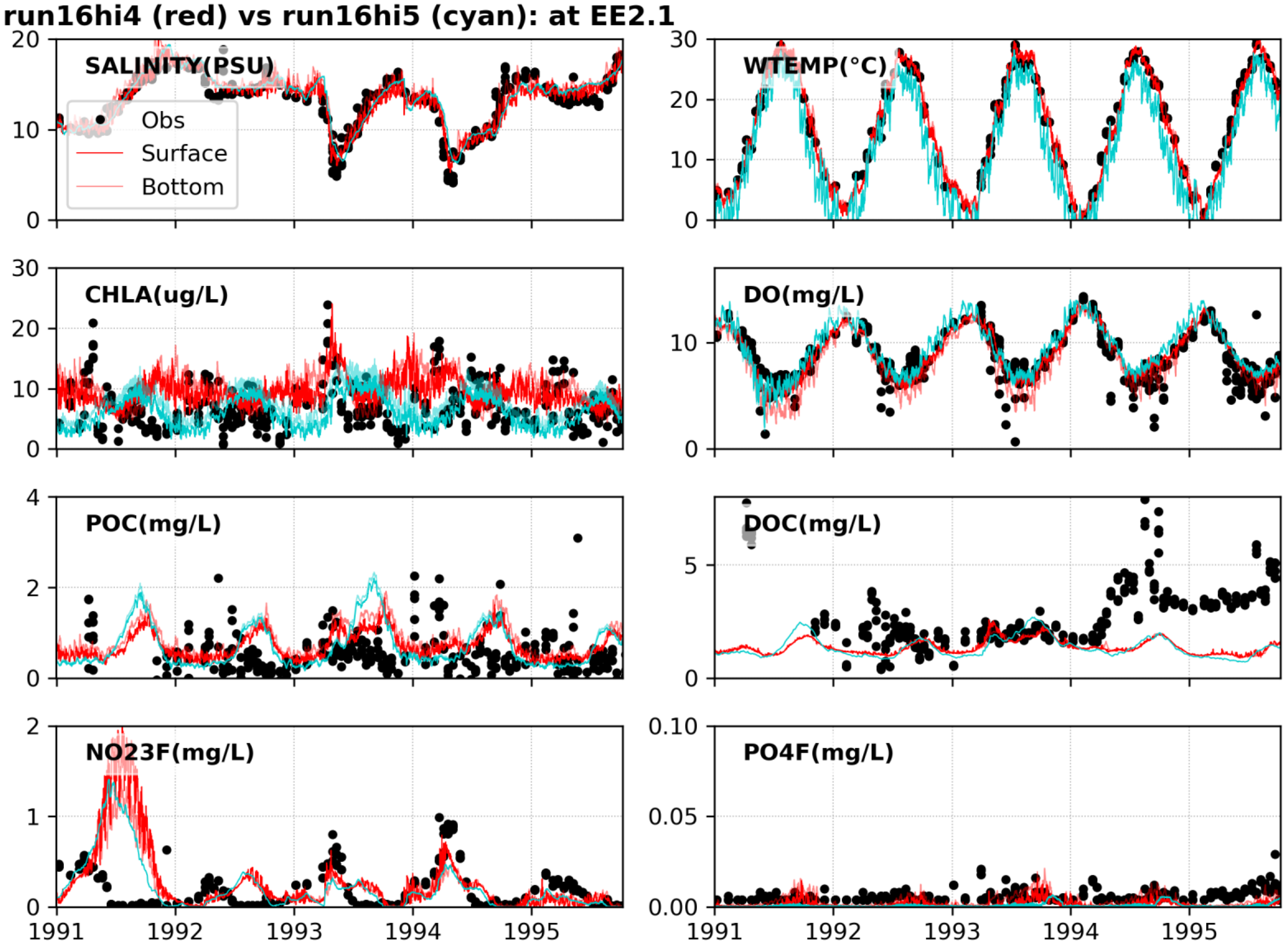
Different light attenuation are applied: Ke=10 near salinity 0 (turbid water in freshwater part), linearly decreasing to Ke=0.0 at salinity 10 (clear water at higher salinity region).

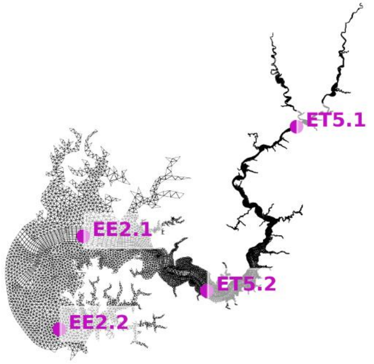


Salinity snapshot



Impacts of light attenuation (near entrance)



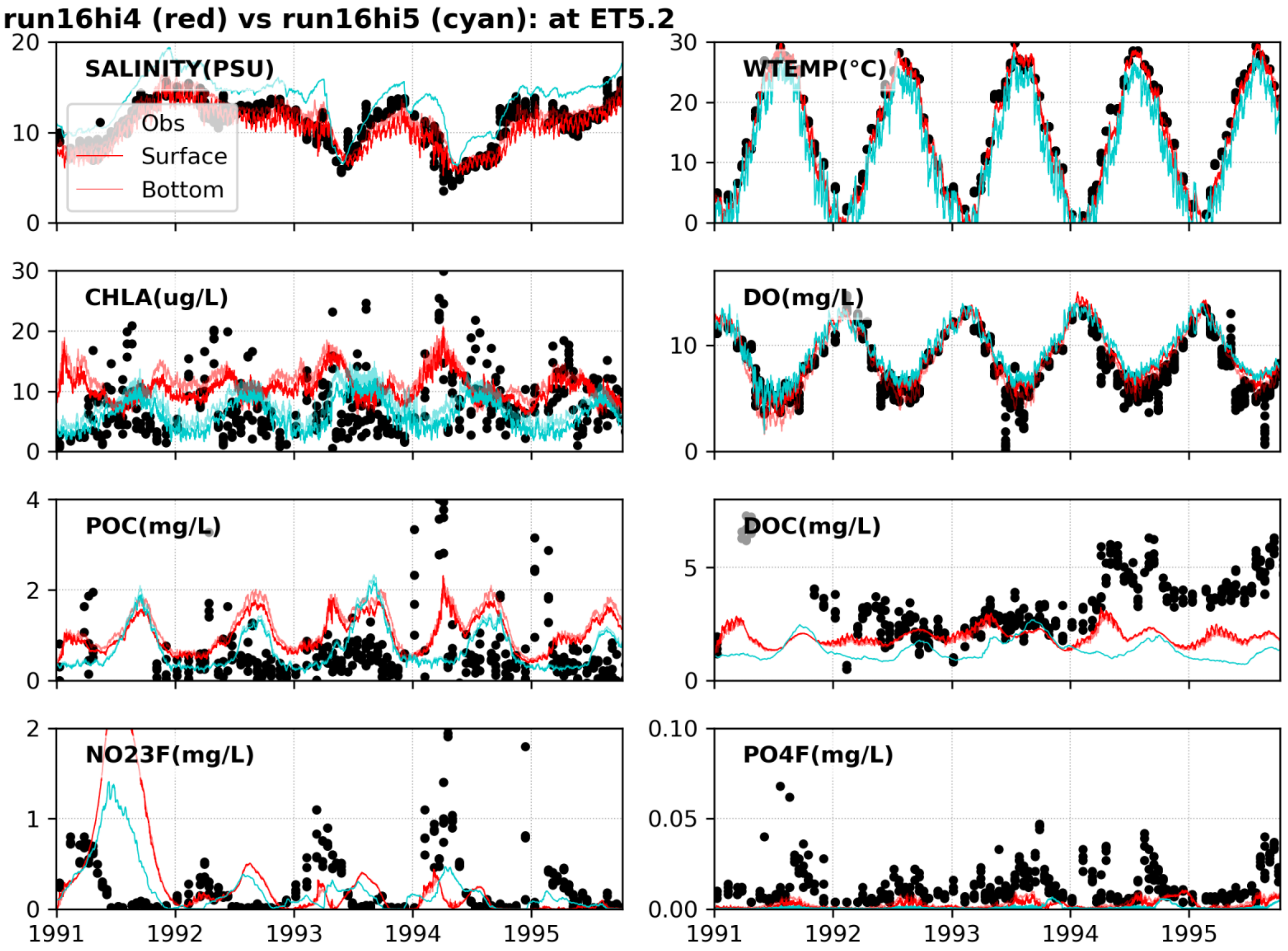


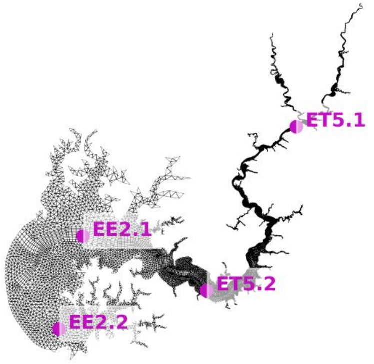
At Station EE2.1

Temperature is cooler

Chla is reduced

Impacts of light attenuation (middle estuary)





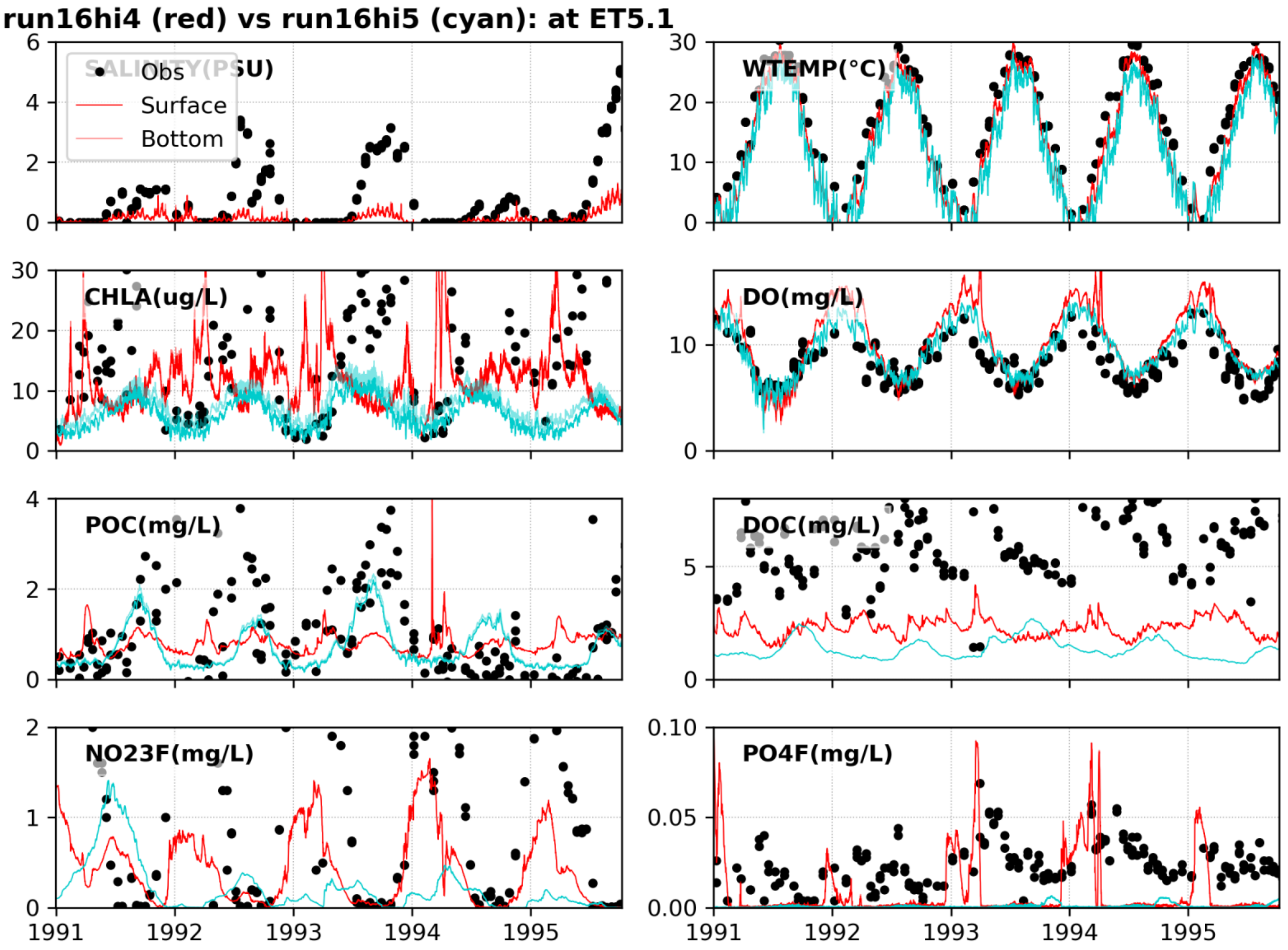
At Station ET5.2

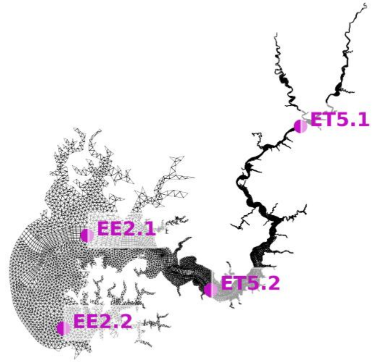
Salinity is increased

Temperature is cooler

Chla is reduced

Impacts of light attenuation (upper estuary)





At Station ET5.1

Temperature is cooler

Chla is reduced

PO4F and NO23F are much weaker

Summary and Next Steps

Local bathymetry is not responsible for the salt intrusion in the upper river.

ICM standalone simulation is performed and validation is ongoing.

Light attenuation can significantly affect the ICM performance throughout the estuary.

Next steps: explore the nutrient inputs in the upper estuary.

explore the sediment module

Questions ?