

# Choptank Tributary Model

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# Progress summary

- Using phase 7 watershed model
- Examine the difference between P7 and P6 in hydrodynamic and ICM simulation.
- Test hydrodynamic + 3D sediment and use sediment concentration for light limitation function.

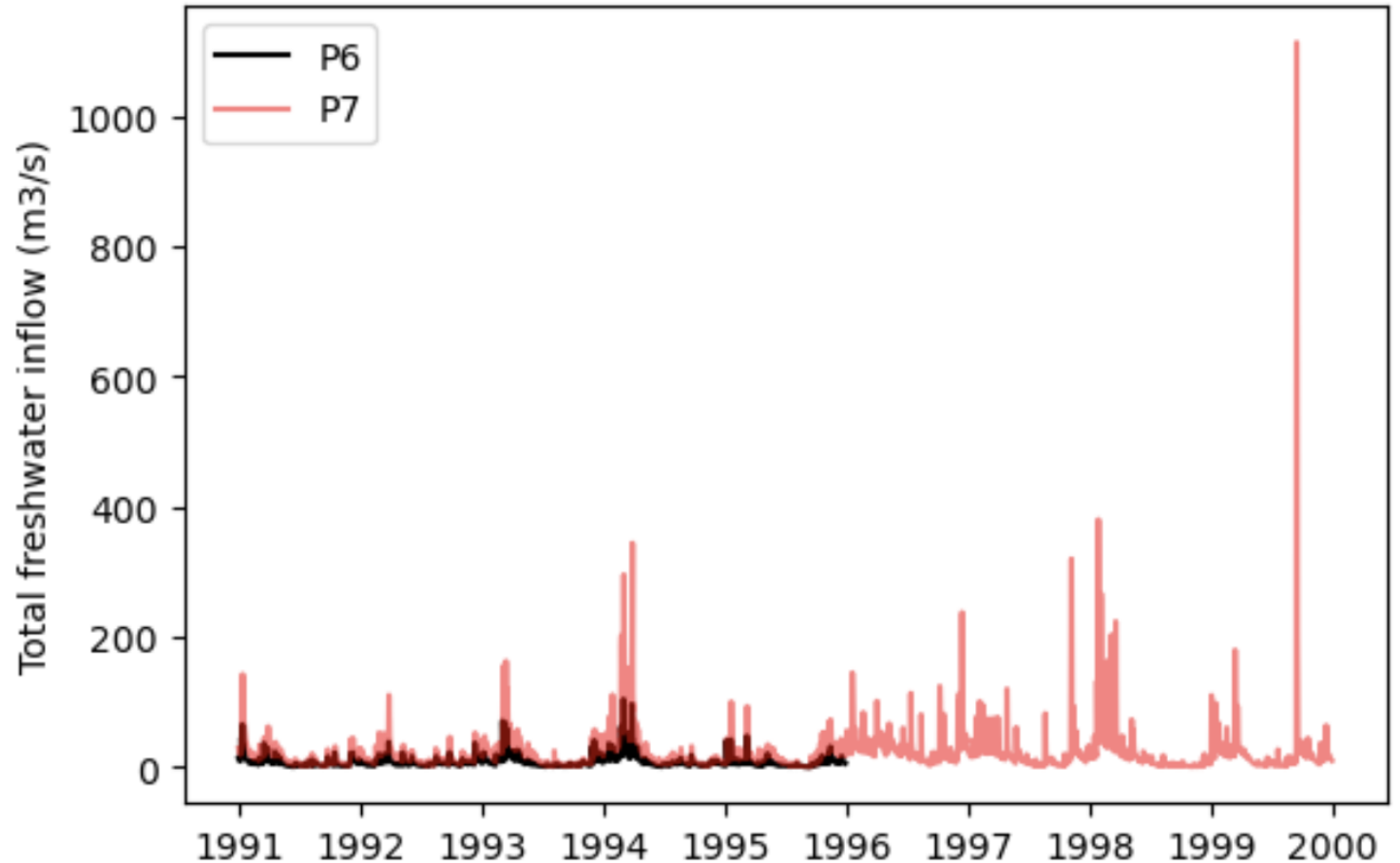
# Phase 7 watershed: freshwater inflow

- Doubled mean freshwater inflow

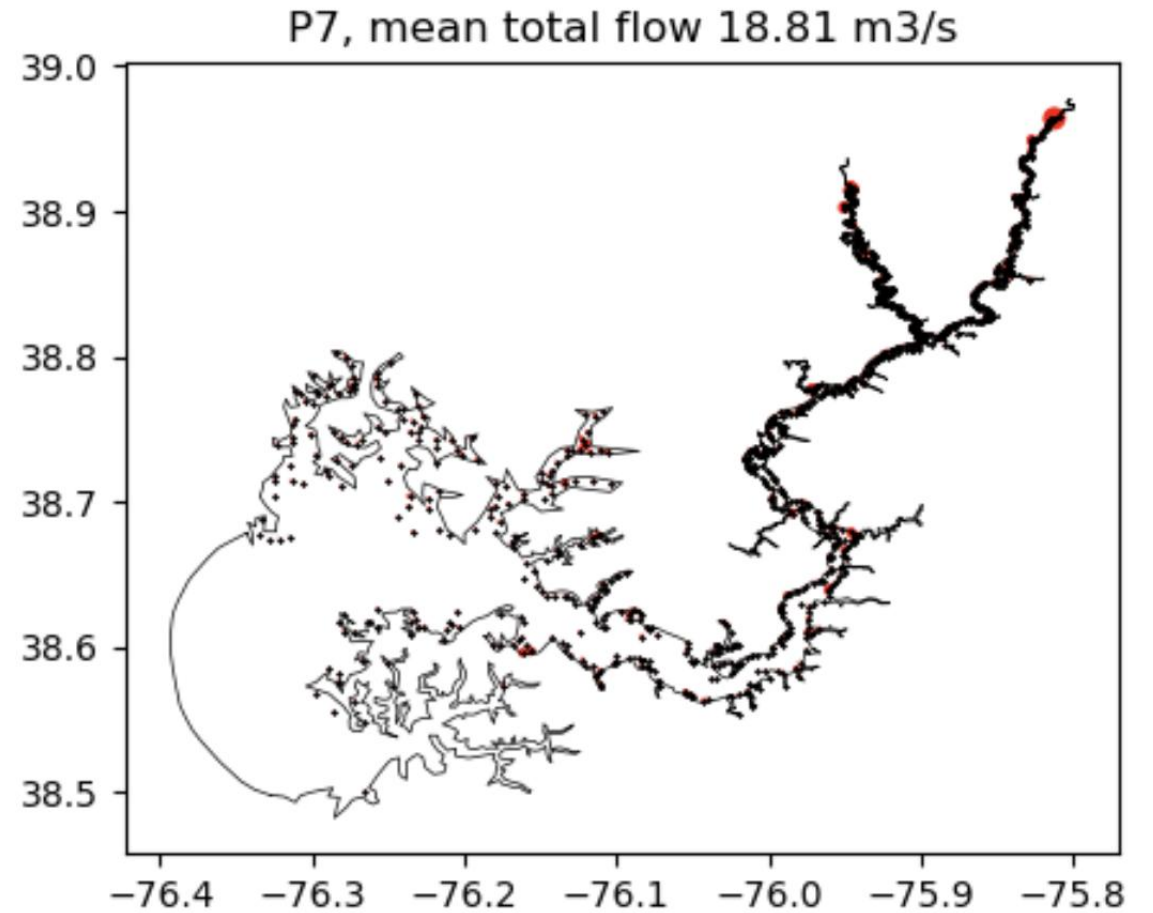
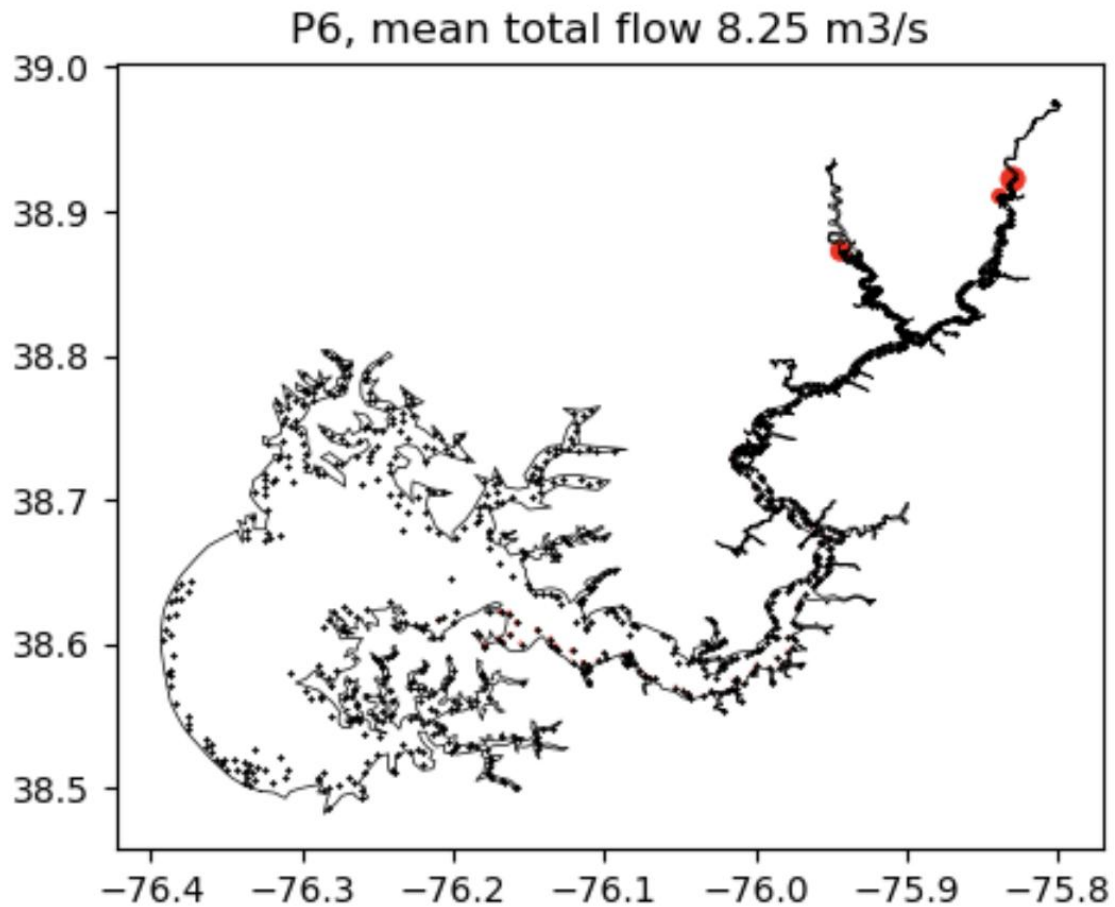
Over the same five-year period 1991-1995

P6 mean flow: 8 m<sup>3</sup>/s

P7 mean flow: 19 m<sup>3</sup>/s



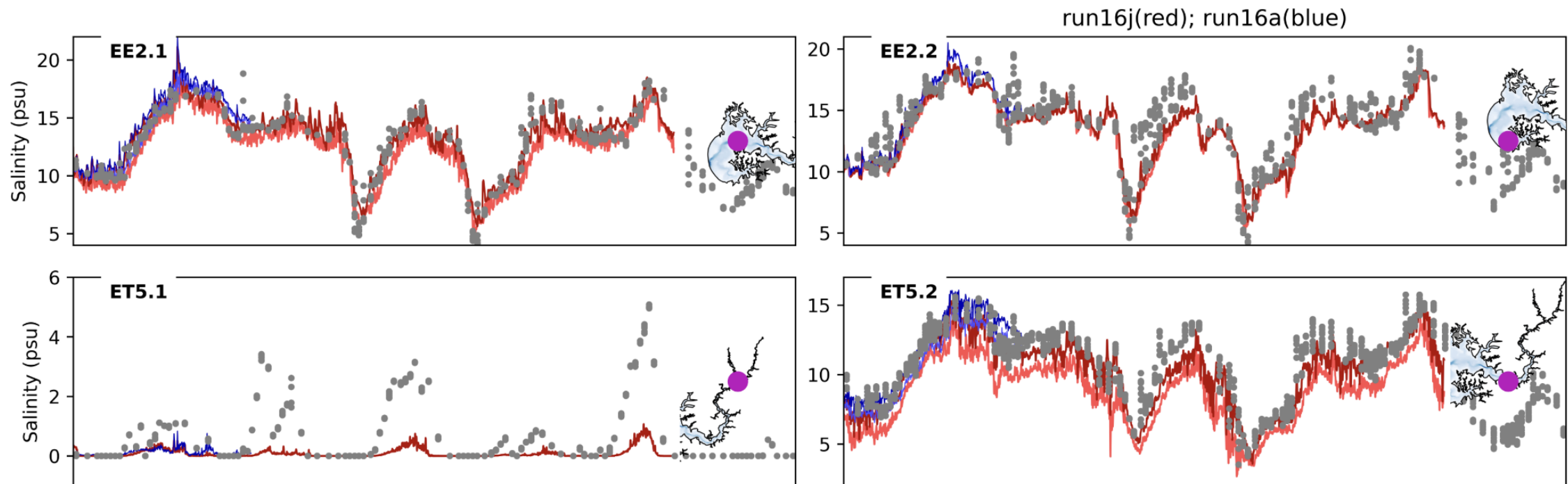
# Some notable increases in downstream watersheds



# Phase 7 watershed: impact on salinity

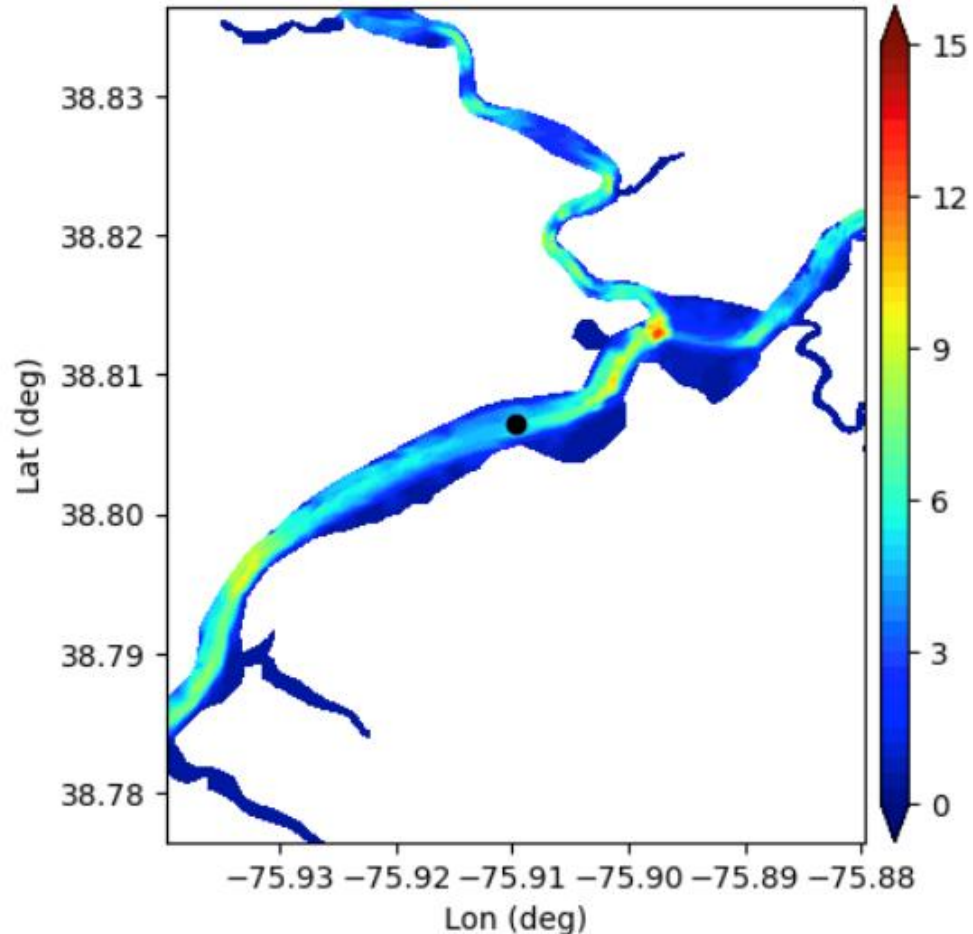
Decrease of salinity at ET5.2 by about 2 psu.

It would be worthy to fix the problem for this tributary.

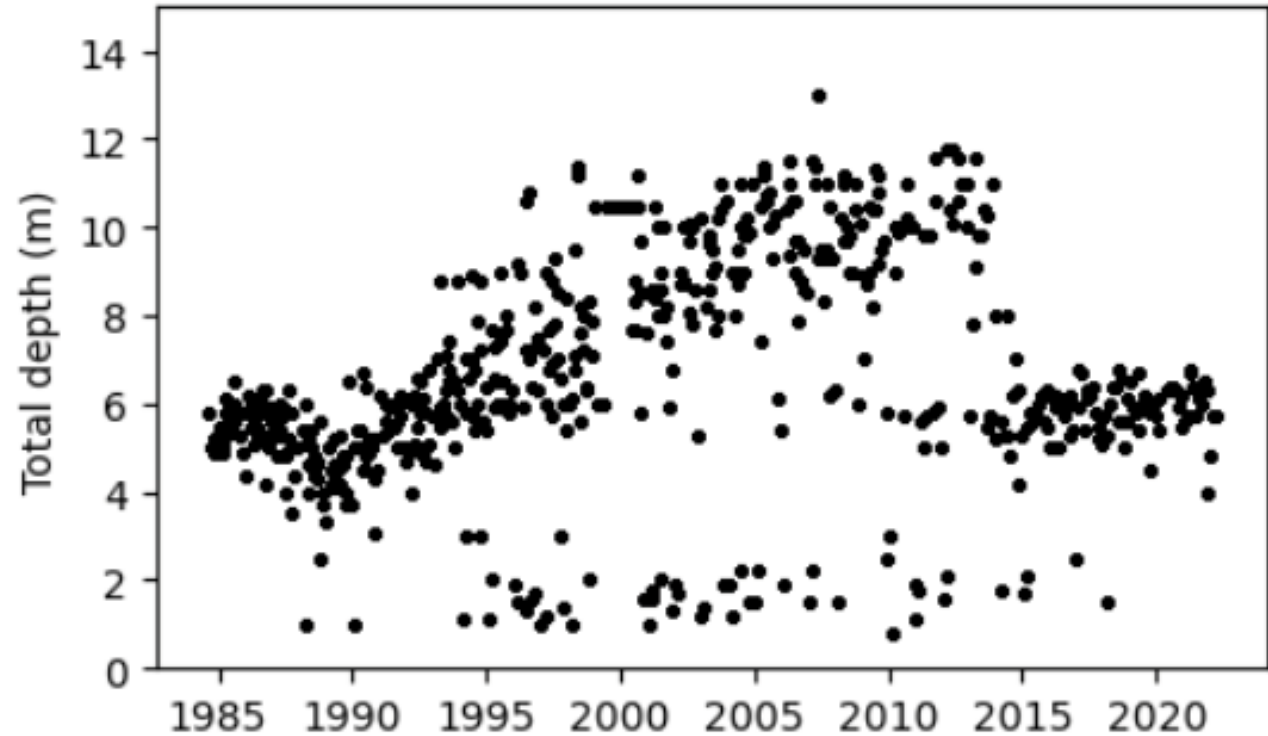


# Potential bathymetry issue near ET5.1

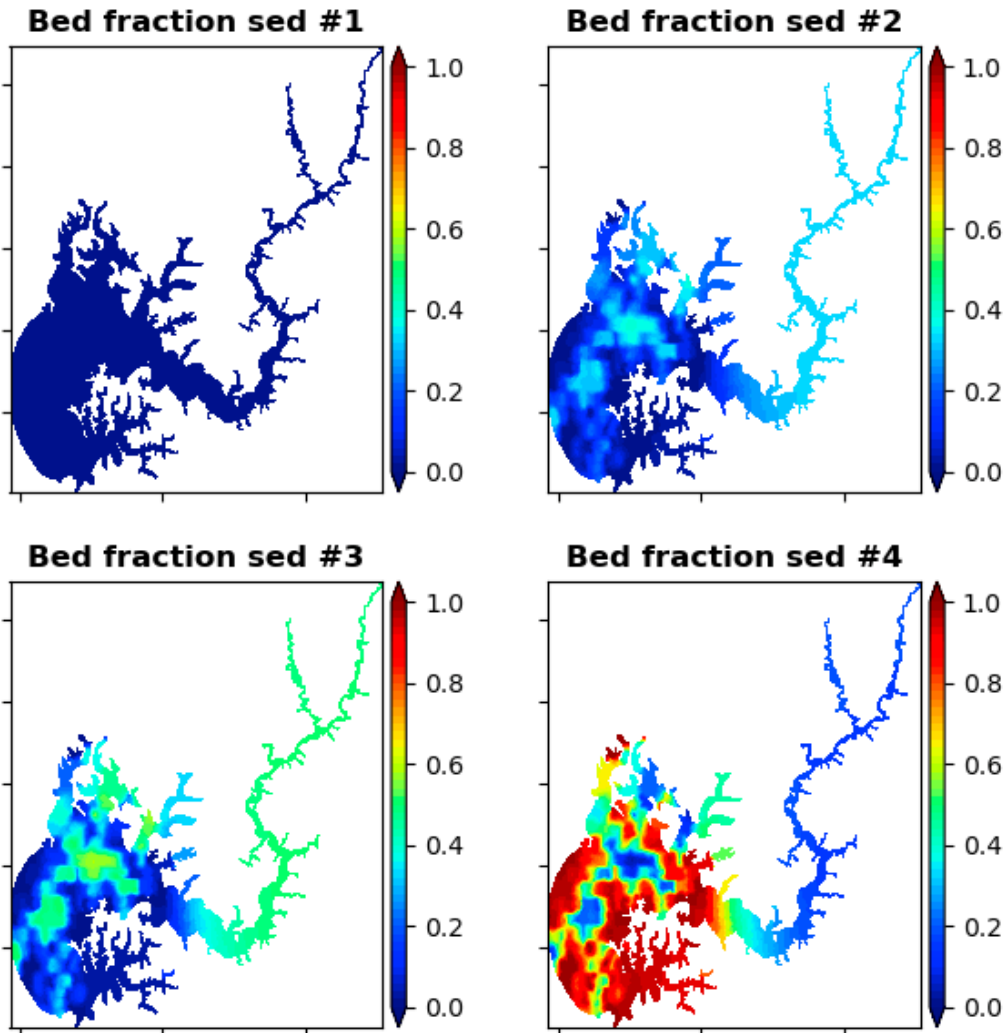
In current model ET5.1 has a depth of 5m



Total depths recorded in CBP data, however, show up to 12 meters in 2000s.



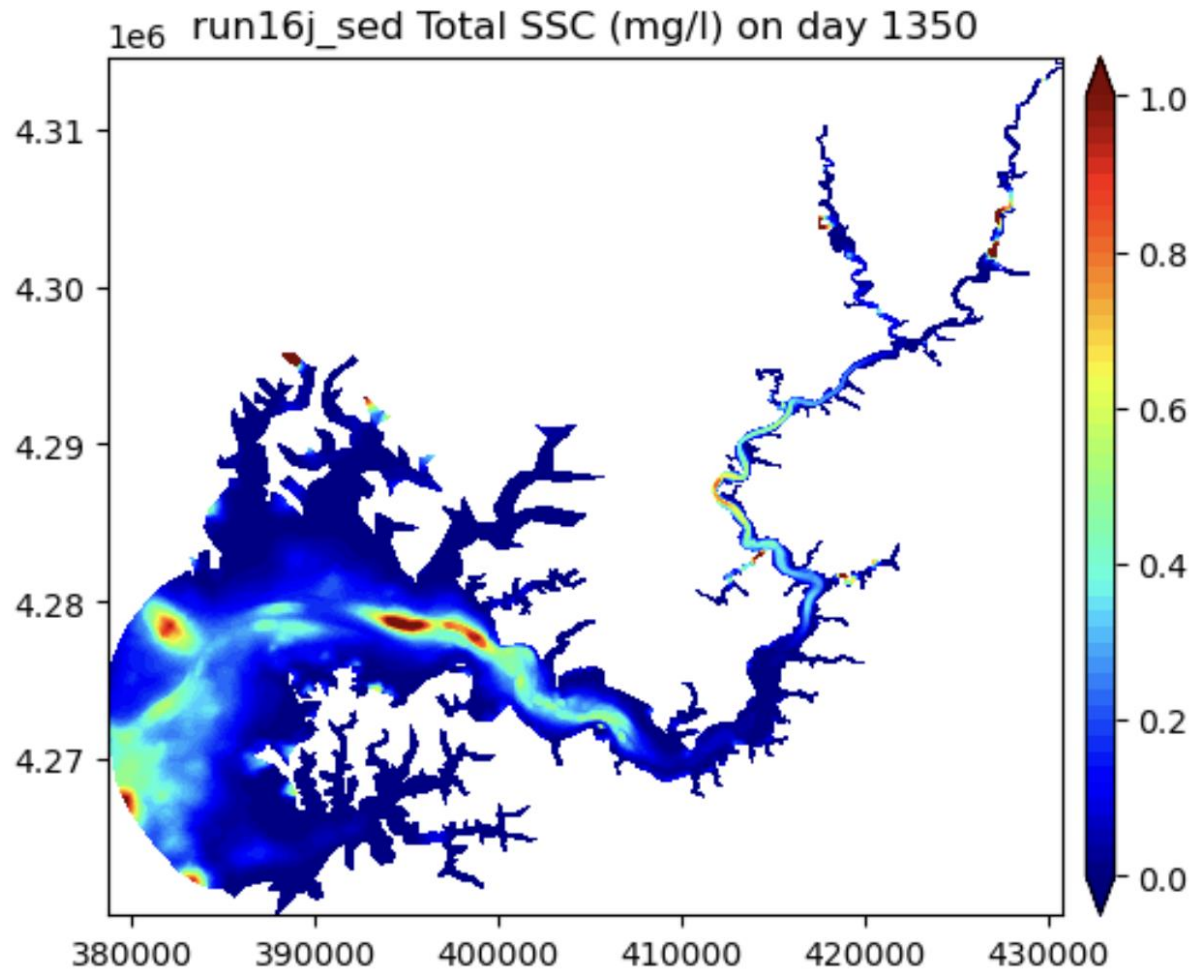
# Bed fraction (based on MBM)



Sediment	Critical shear stress	Settling velocity (mm/s)
Class 1 (fine clay)	0.05	0.1
Class 2 (clay)	0.05	0.6
Class 3 (silt)	0.1	5
Class 4 (sand)	0.5	40

Based on Raston et al. (2012)

# With one single thick sediment layer

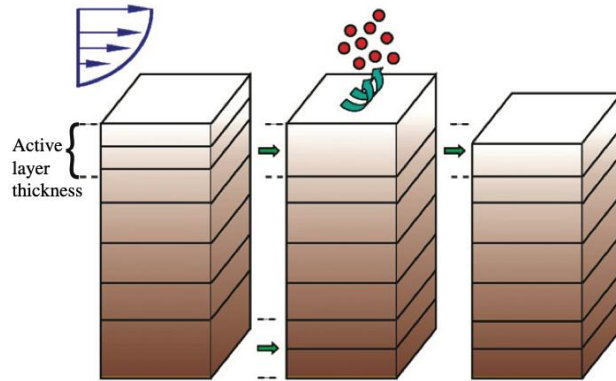


The overall sediment concentration seems greatly underestimated.

May need to use same parameter as in main bay model, which use critical shear stress of  $0.03 \text{ N/m}^2$  for class 1-3.

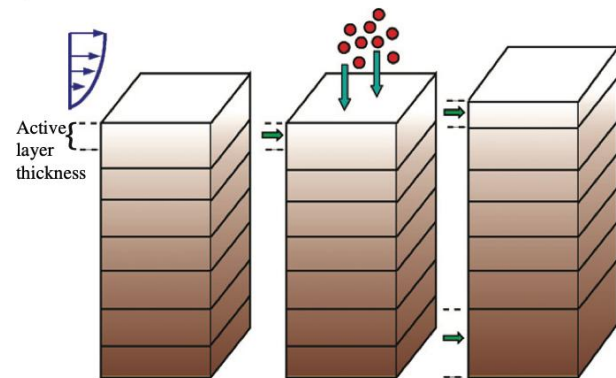
# Multiple layer sediments

Active layer thickness (Harris and Wiberg, 1997).  
 $z_a = k_1(\tau_{sf} - \tau_{ce}) + k_2 D_{50}$



**Erosion.** ( $\tau_{sf} > \tau_{ce}$ )  
 Entrain sediment from lower layers so that surface layer is at least  $z_a$  thick. Split bottom layer. Erode from surface layer.  
 For each sediment class  
 erosion\_flux =

$$\text{MIN} \left[ \begin{array}{l} dt * E_s * (1 - \text{poro}) * \text{frac} * (\tau_{sf} / \tau_{ce} - 1), \\ \rho_s * (1 - \text{poro}) * \text{frac} * z_a + \text{dep\_flux} \end{array} \right]$$



**Deposition.**  
 Create new layer if deposition > user defined thickness. Mix surface layer to be at least  $z_a$  thick. Combine bottom layer. For each sediment class  
 $\frac{\partial C}{\partial t} = -w_s \frac{\partial C}{\partial z}$

Active layer: the top layer

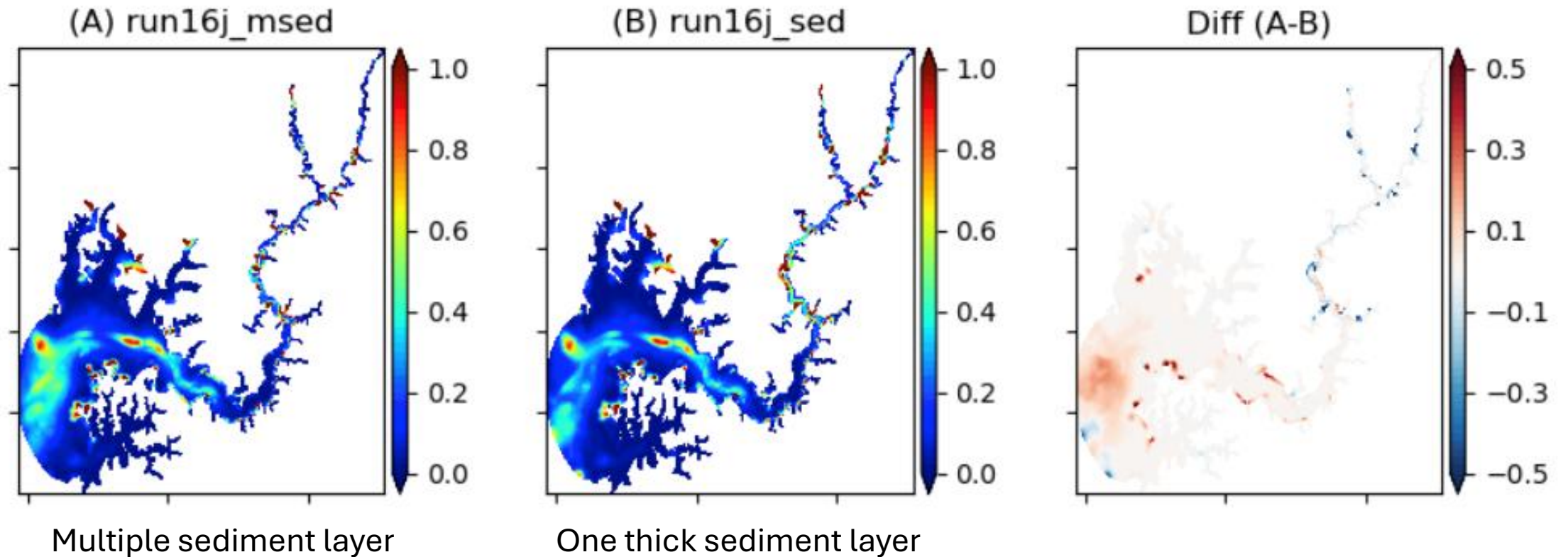
Thickness of layers:

Layer	Thickness
1	1 cm
2	2 cm
3	3 cm
4	5 cm
5	10 cm
6	20 cm
7	40 cm

Fig. 2. Distribution of vertical layers in bed model. During erosion top layer thickness is increased to meet active layer thickness. Deposition creates a new layer if timing and thickness criteria are met. Total number of layers must be constant, often requiring a merge or splitting of bottom cells.

# One layer vs multiple layer

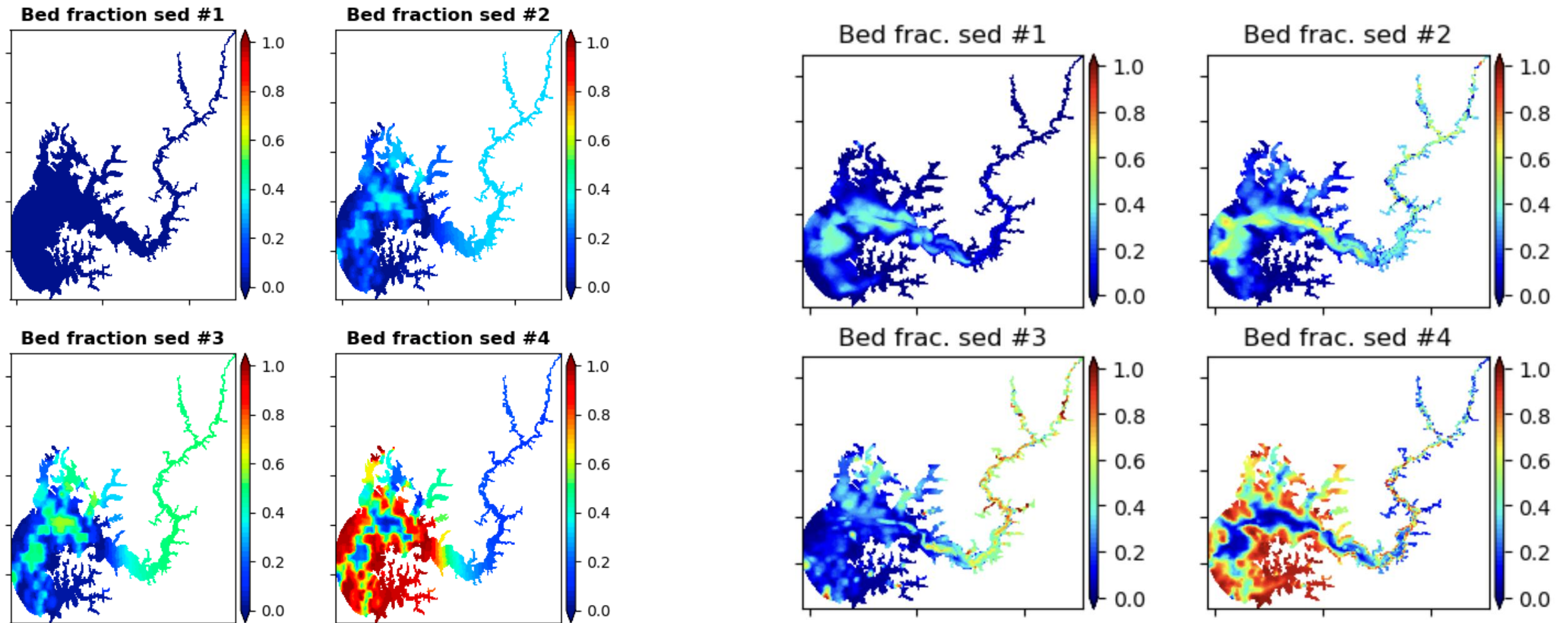
Total suspended sediment concentration (mg/l)



# Multiple layer sediment model (a lot of difference in sediment bed fraction)

Initial bed fraction

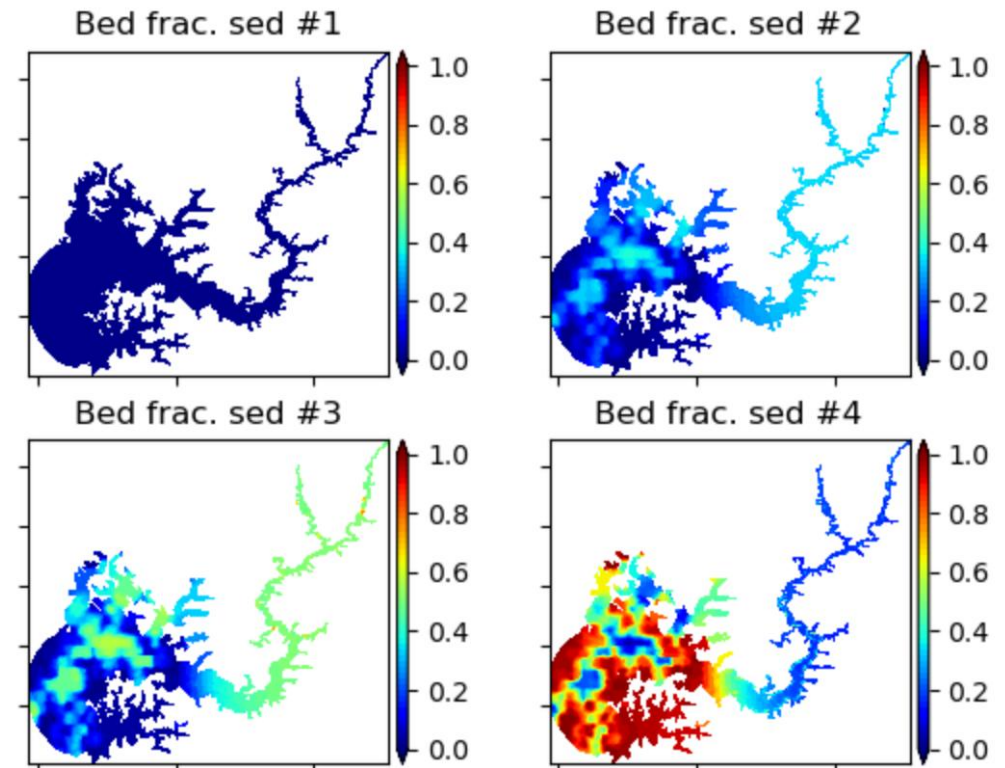
Bed fraction on day 1500



In contrast, there is no change at all in sea bed condition when using one single layer of sediment

This is because of an unrealistic thickness of single layer sediment is used.

Day 1500 for run16j\_sed

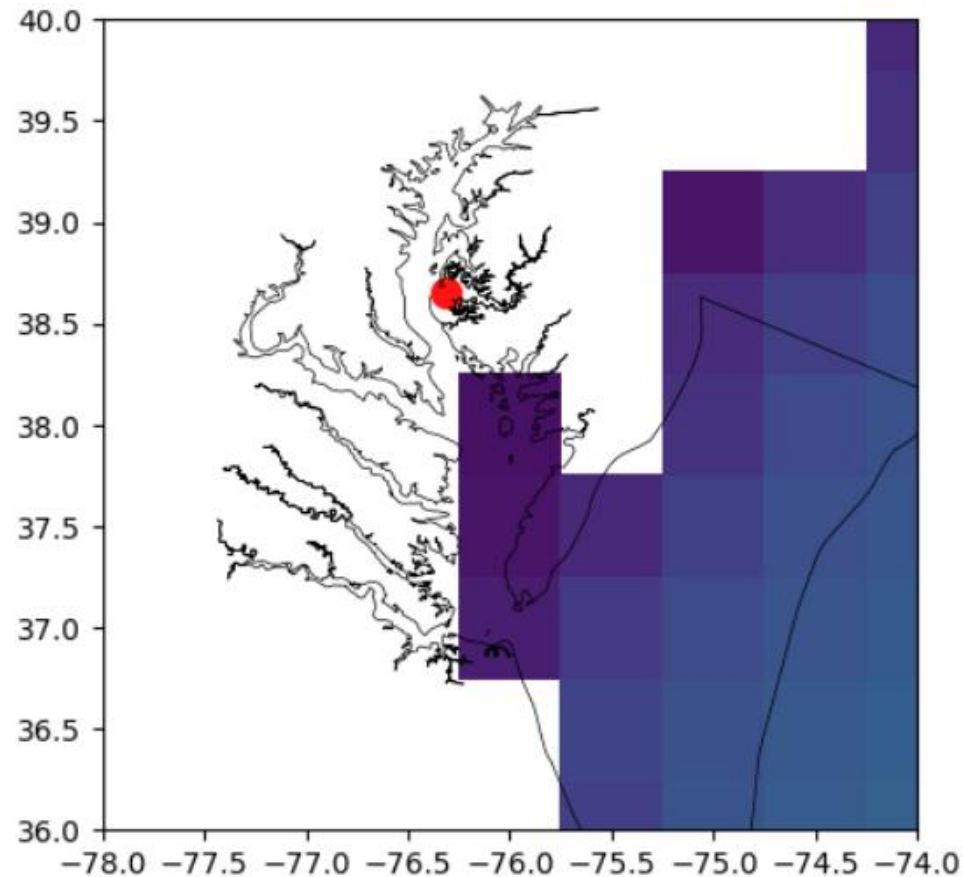


# Multiple layer sediments +WWM

Not available,  
because no wave  
data to drive the  
open boundary.

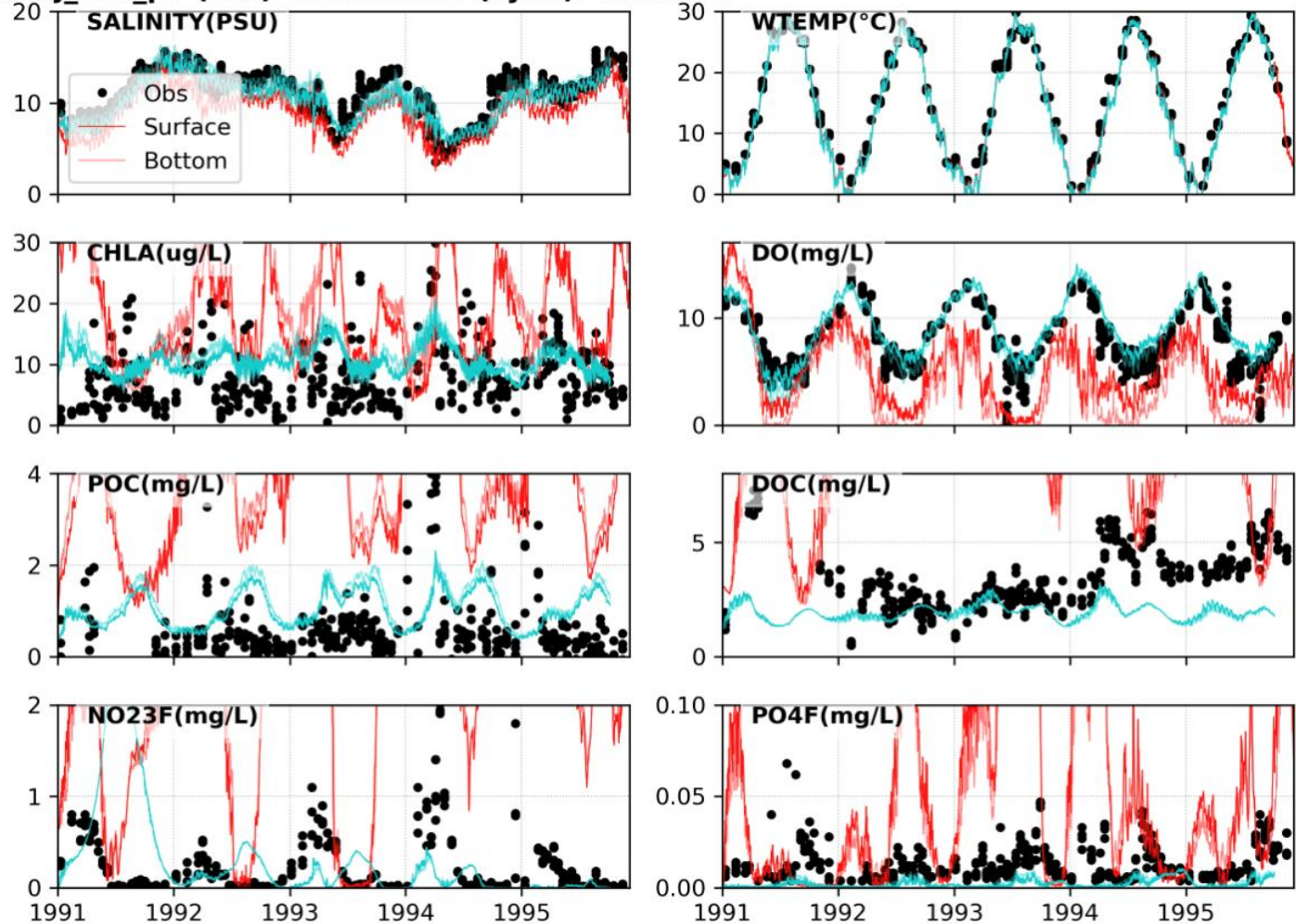
The exist global wave  
product has no valid  
data point near the  
Choptank River  
mouth.

Available global wave data, relative  
to the Choptank River.



# ICM model run with Phase 7 watershed loading

in16j\_icm\_p7 (red) vs run16hi4 (cyan): at ET5.2



Red: ICM model run with P7

Cyan: ICM model run with P6.

Nutrient/carbon loading is totally off.

# P6 vs P7 nutrient concentration

Variable	: p6,	p7
Temp	: 12.124,	13.205
Salinity	: 0.000,	0.000
PB1	: 0.025,	0.003
PB2	: 0.182,	0.022
PB3	: 0.002,	0.000
RPOC	: 0.516,	45.892
LPOC	: 0.659,	17.361
DOC	: 5.200,	251.900
RPON	: 0.084,	6.910
LPON	: 0.032,	2.184
DON	: 0.359,	31.666
NH4	: 0.210,	23.207
N03	: 1.135,	153.927
RPOP	: 0.012,	1.478
LPOP	: 0.006,	1.013
DOP	: 0.027,	4.015
P04	: 0.103,	4.976
COD	: 0.000,	0.000
DOX	: 9.115,	11.332
PIP	: 0.000,	79.405

We found the concentration is totally not right.

There must be some coding issue when we tried to use the p7 results.

# Future directions

- Work with MBM team and watershed model team to identify the issue about freshwater and nutrient loading
- Carry out some sensitivity tests on sediment transport model and find the best setup.
- Solving the wave model boundary problem, as wave is an essential part for sediment transport.
- More calibrations on water quality model.