

Phase 7 Main Bay Model (MBM) Update: Long-term Water Quality Simulation (1985-2024)

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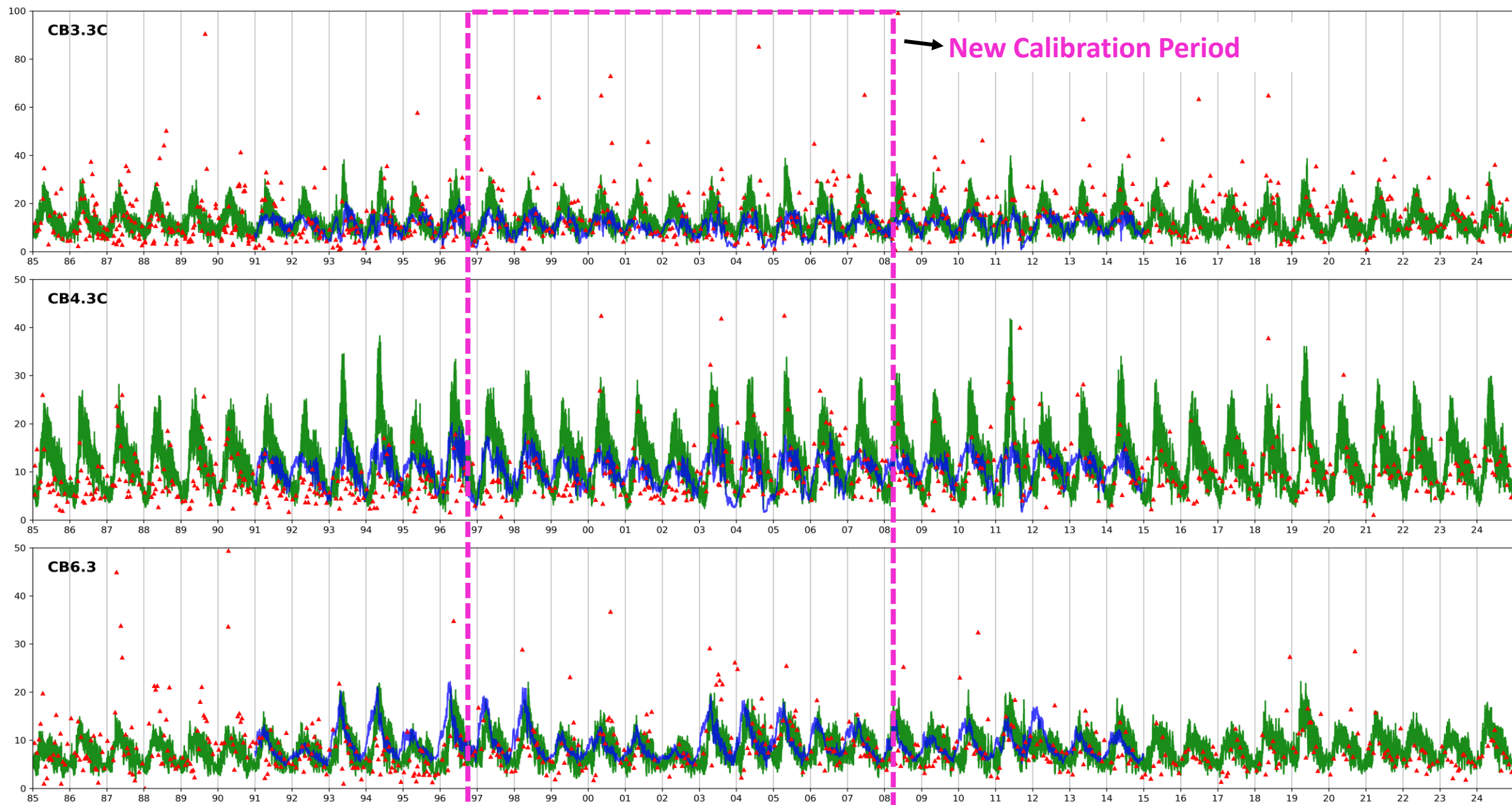


Outline

- ❑ **Comparison of 40-year MBM Water Quality Results with Obs/CH3D**
 - Using latest WSM April beta 2026
 - Time Series Of Chl-a, DO, NH4, NO3 and PO4
 - Transects Along Main-bay Channel
- ❑ **Analysis on The 40-year Hypoxic Volume Simulated in MBM**
- ❑ **Sediment Fluxes and Concentrations**
- ❑ **Summary and Future Work**

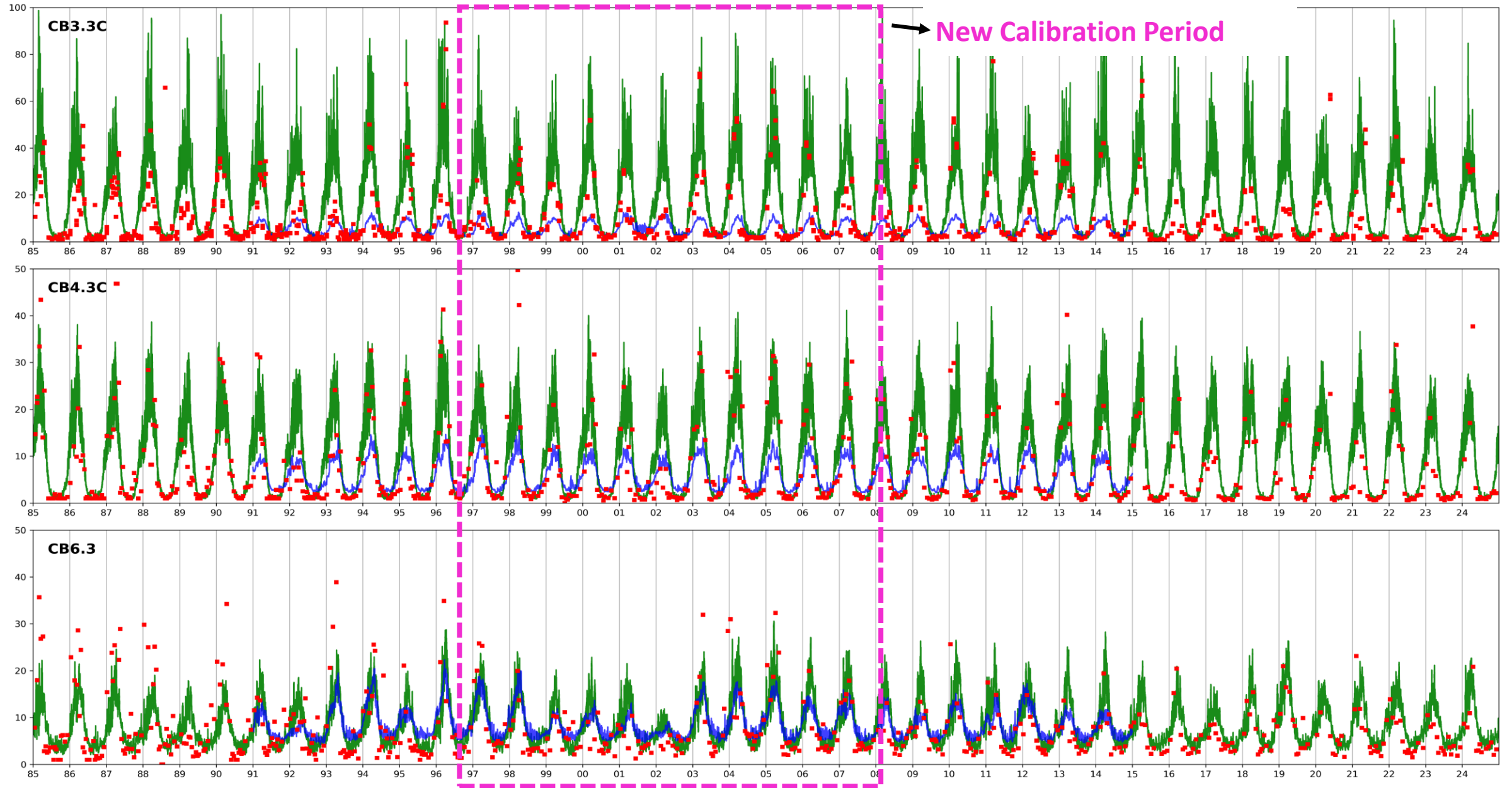
Surface Chl-a

- Both MBM and CH3D capture the seasonal patterns correctly
- Chl-a simulated in MBM is generally higher than in CH3D



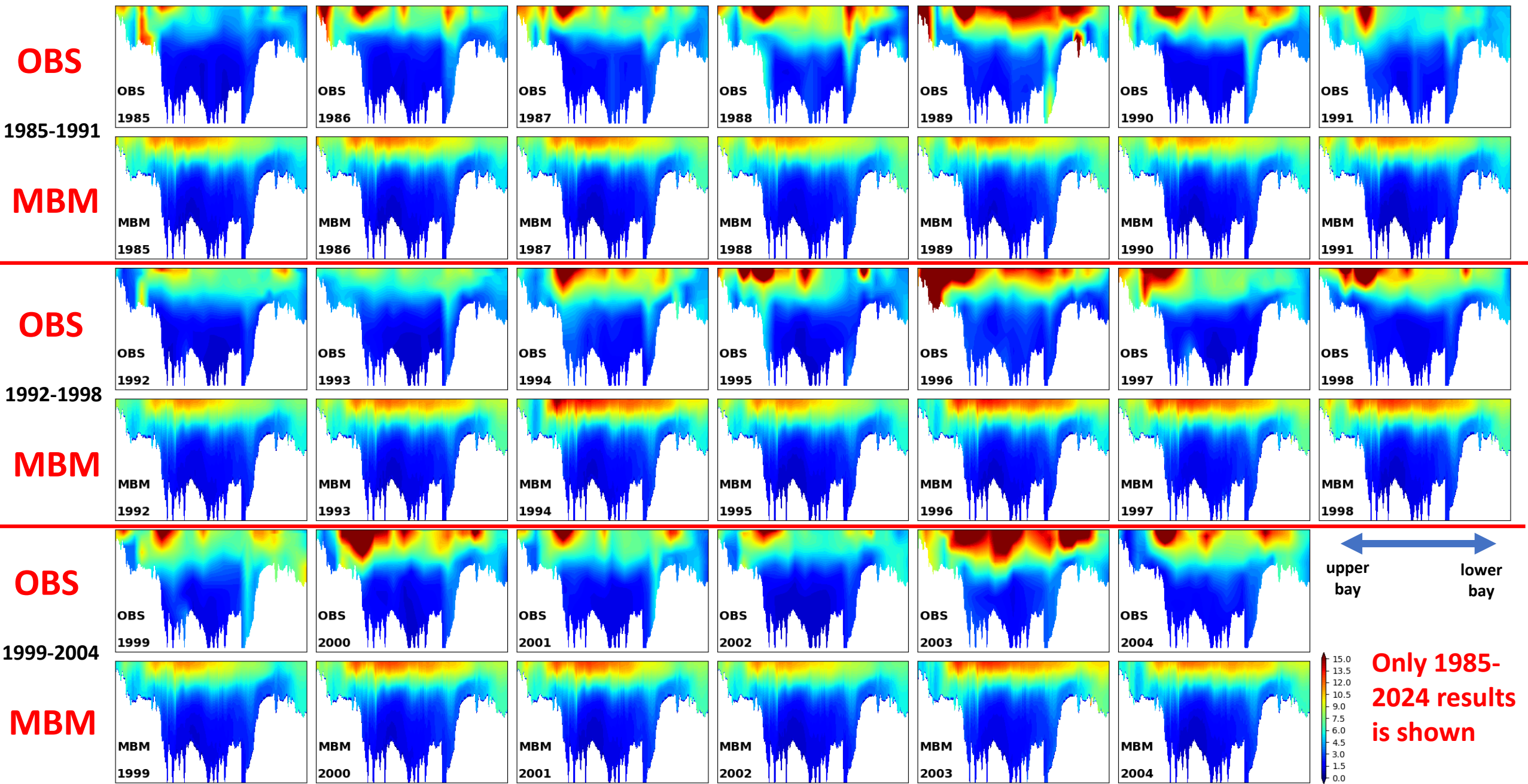
Bottom Chl-a

- MBM reproduced well the spring-winter Chl-a blooms in the bottom, as well as the low Chl-a concentration during the summer.



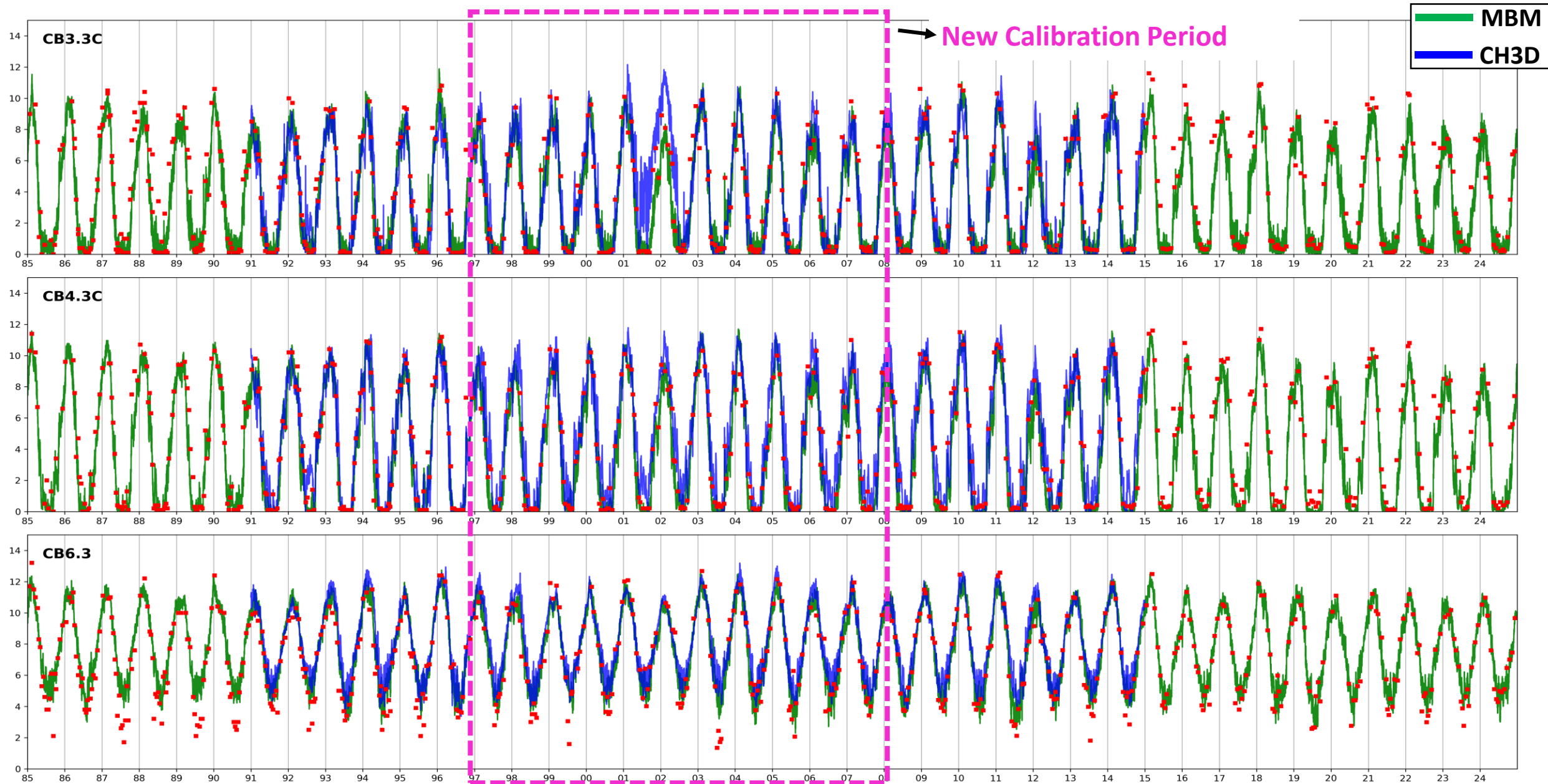
Chl-a Profile along Main-Bay Channel (Jul-Sep)

- Overall, MBM is able to capture spatial variability of Chl-a vertically along the bay channel
- MBM captured the key biological processes related to Chl-a



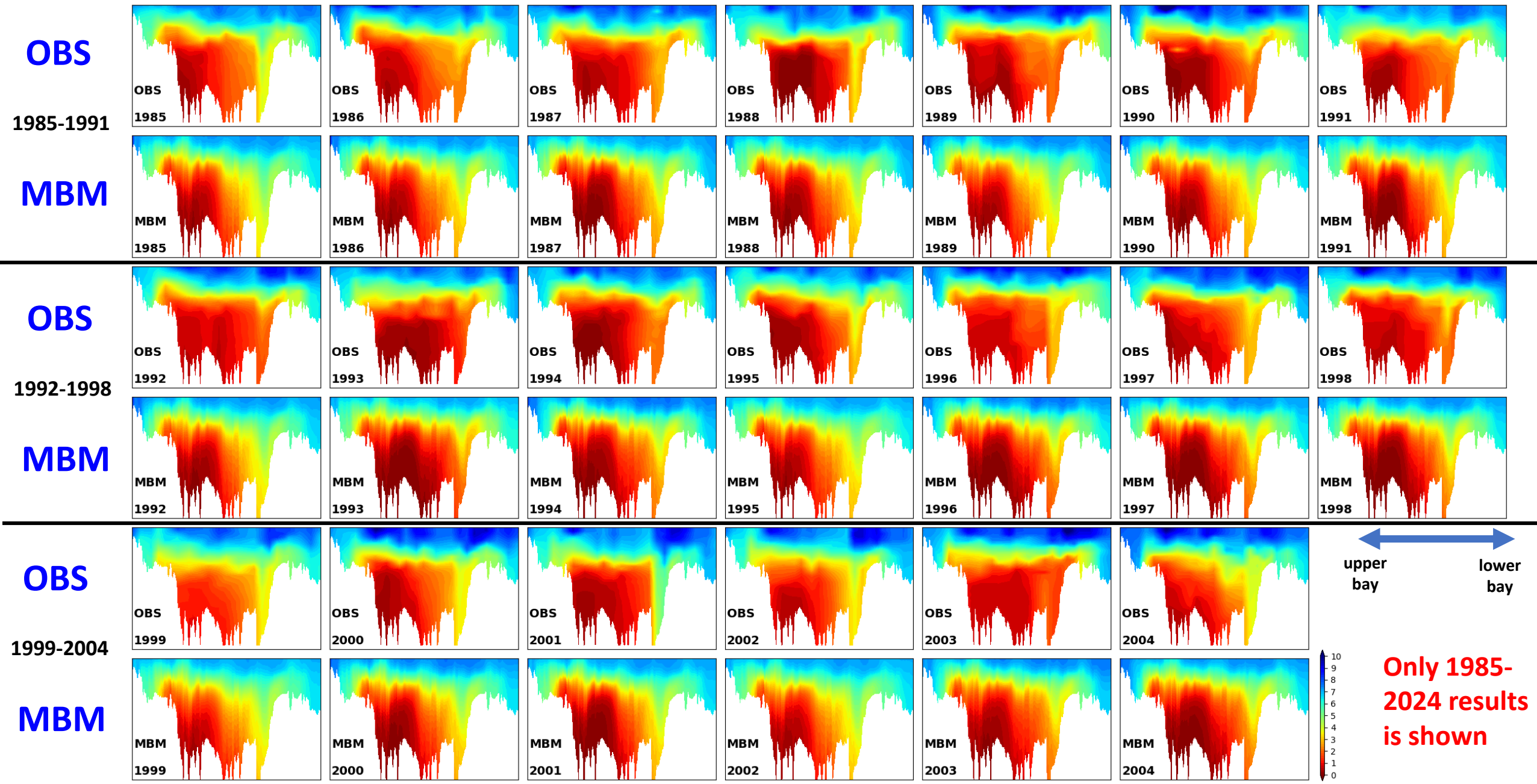
Bottom DO

- Overall, MBM simulates well the seasonal cycle of bottom DO and hypoxia
- MBM performed well for the new hydrologic period (also for the later year)



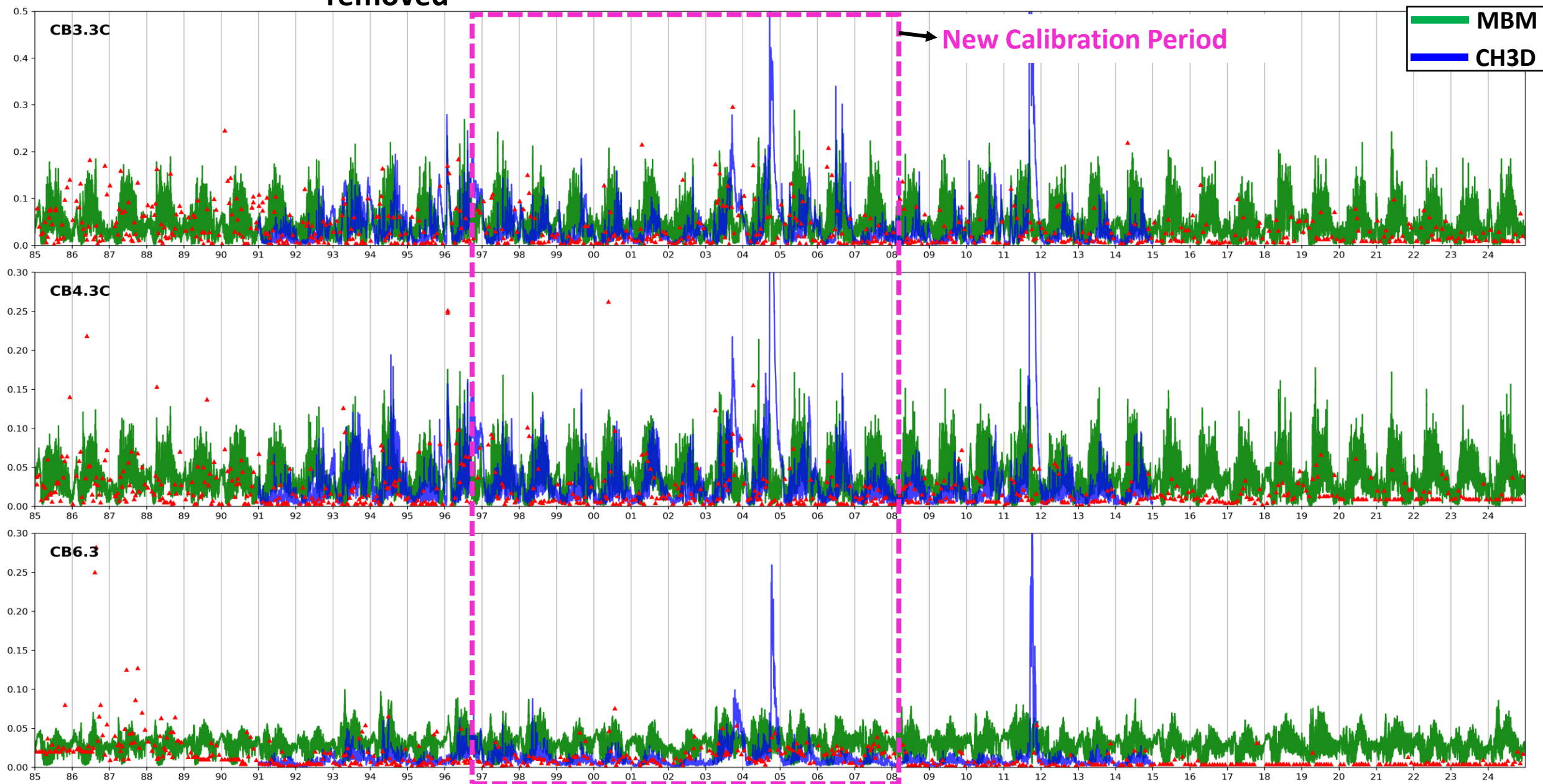
DO Profile

- The hypoxia pattern is well simulated in MBM
- MBM also captured some interannual variability (e.g. 1999 vs 2000)



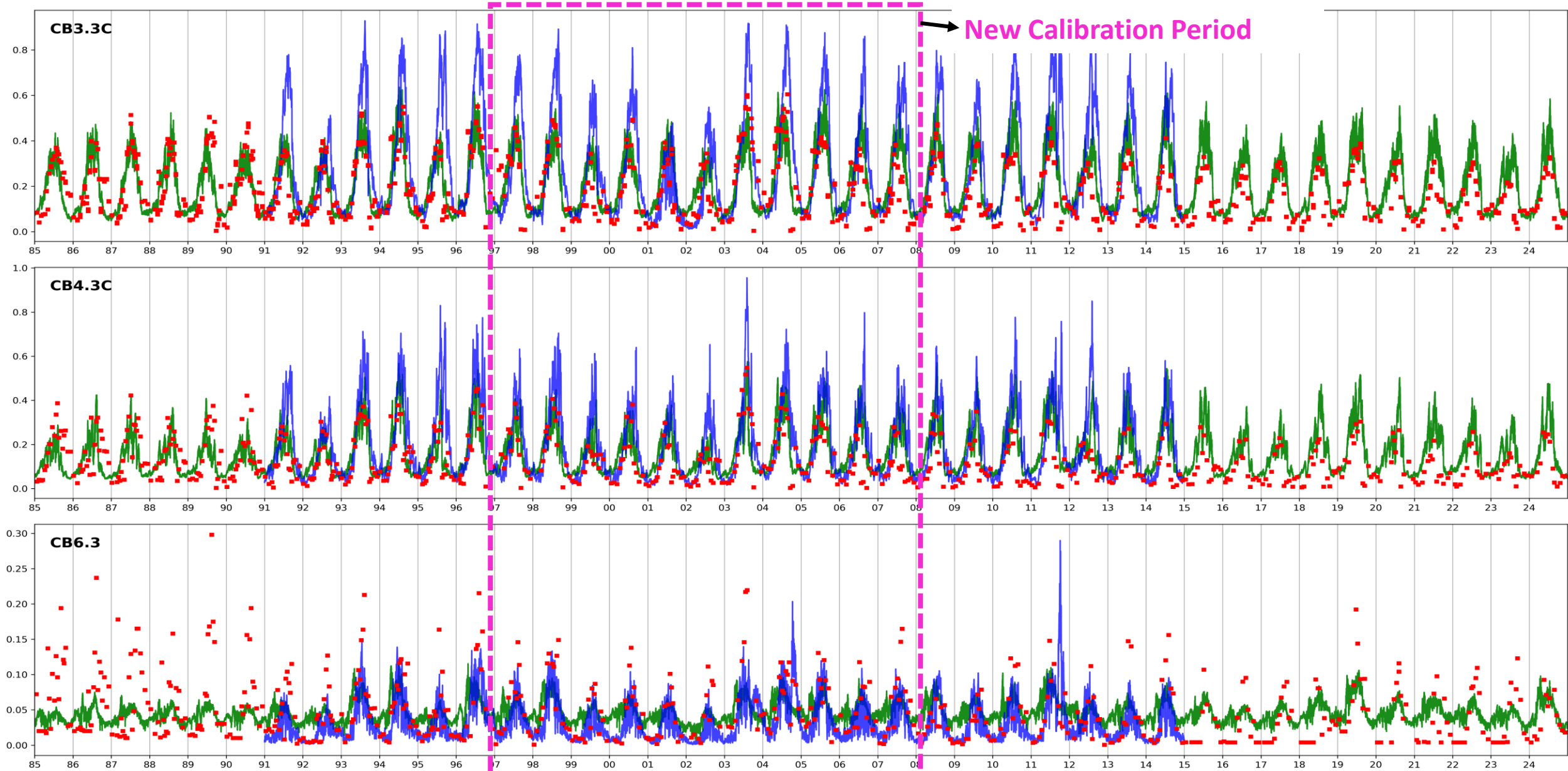
Surface NH₄

- Surface NH₄ simulated in MBM is reasonable in upper and mid bay
- Surface NH₄ in lower Bay tends to be overestimated after the coastal nudging zone is removed



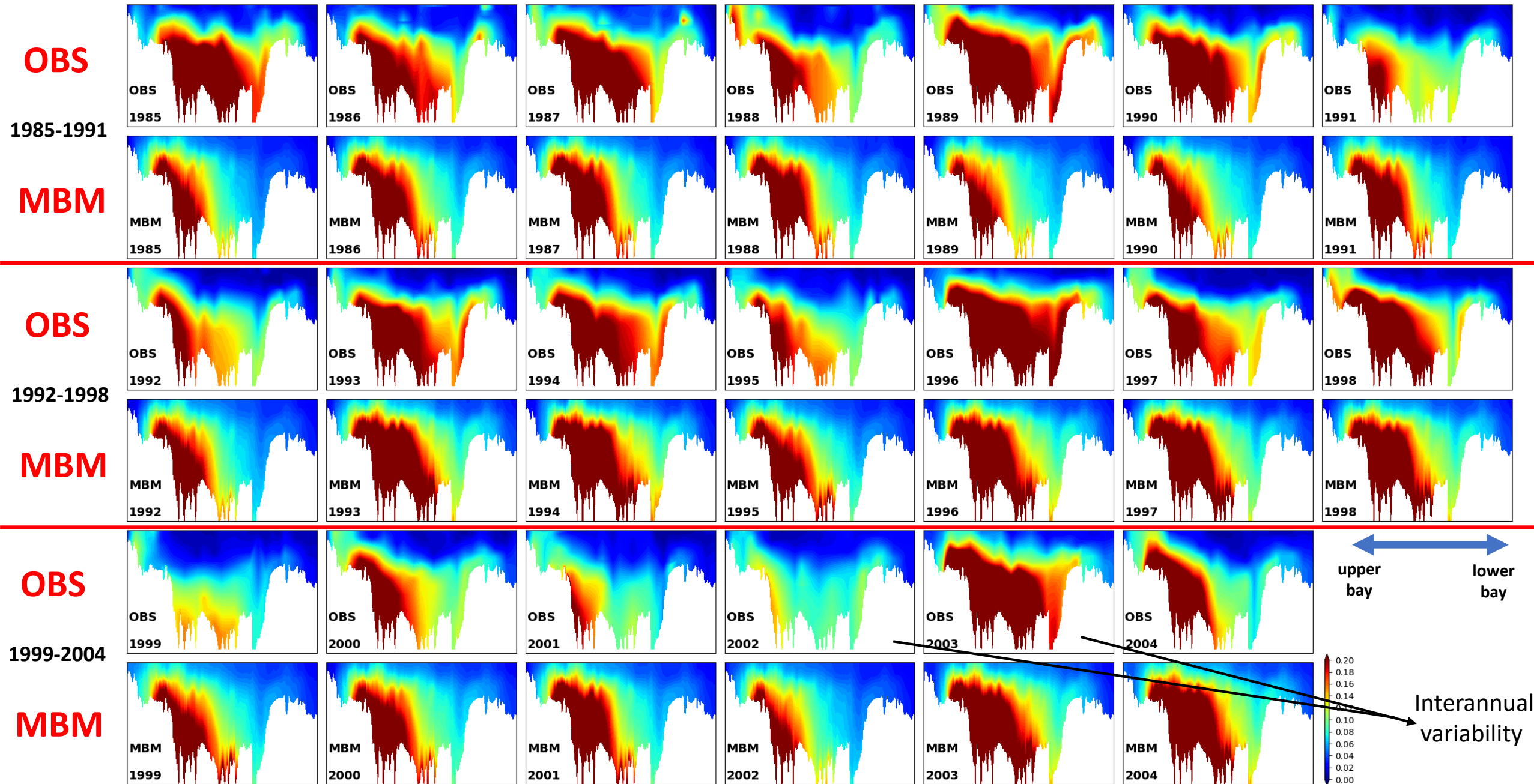
Bottom NH4

- The bottom NH4 is well simulated regarding both seasonal pattern and interannual variability (e.g. 2001-2002 vs 2003-2004)



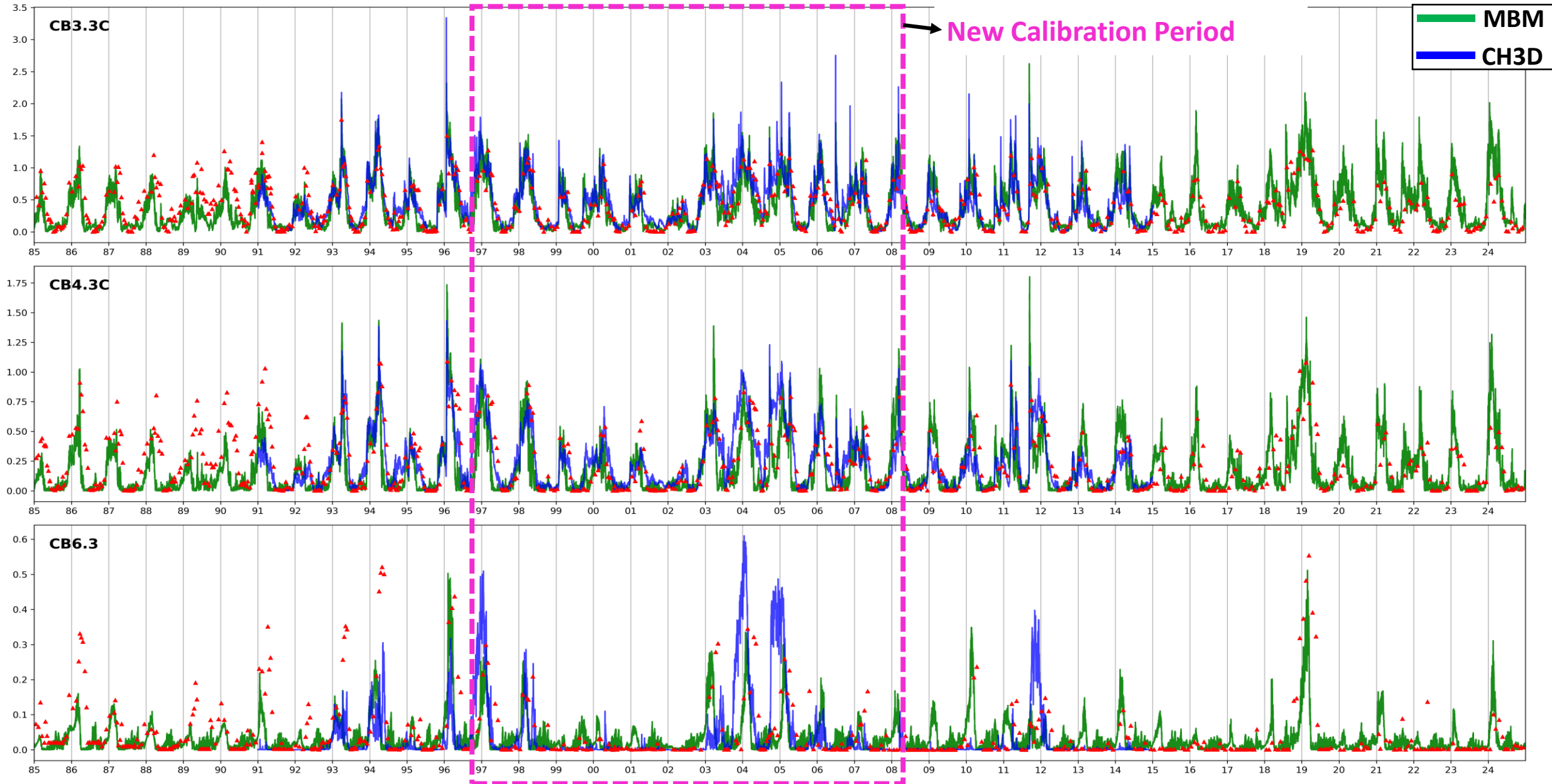
NH₄ Profile (Jul-Sep)

- The spatial variability of NH₄ is well captured by MBM
- NH₄ is higher near bottom in the upper-mid bay, but lower toward surface and sea



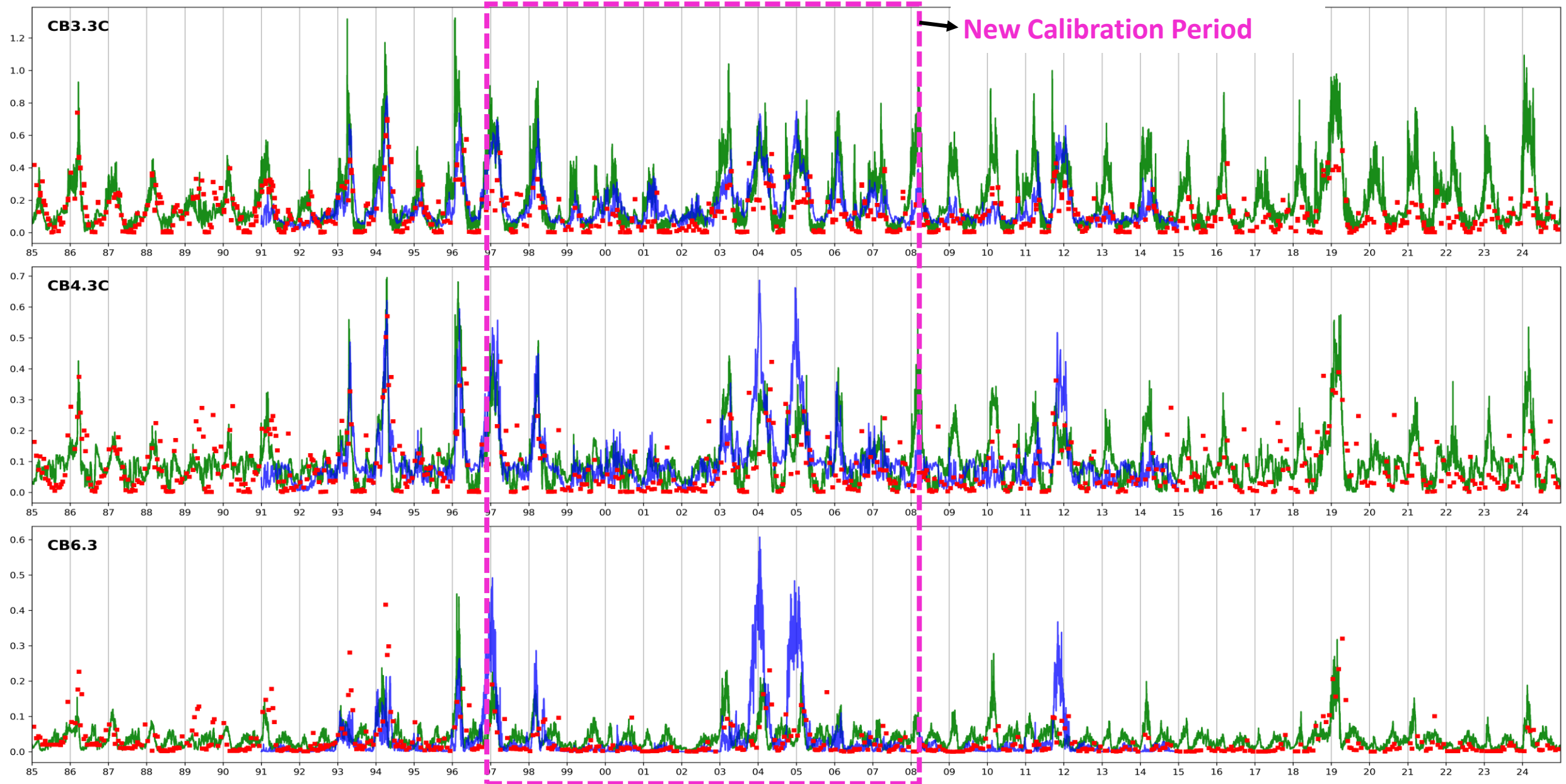
Surface NO3

- Surface NO3 is well simulated in the bay
- Compared to NH4, NO3 is the larger nutrient pool
- MBM also reproduces the interannual variability (thanks to the WSM inputs)



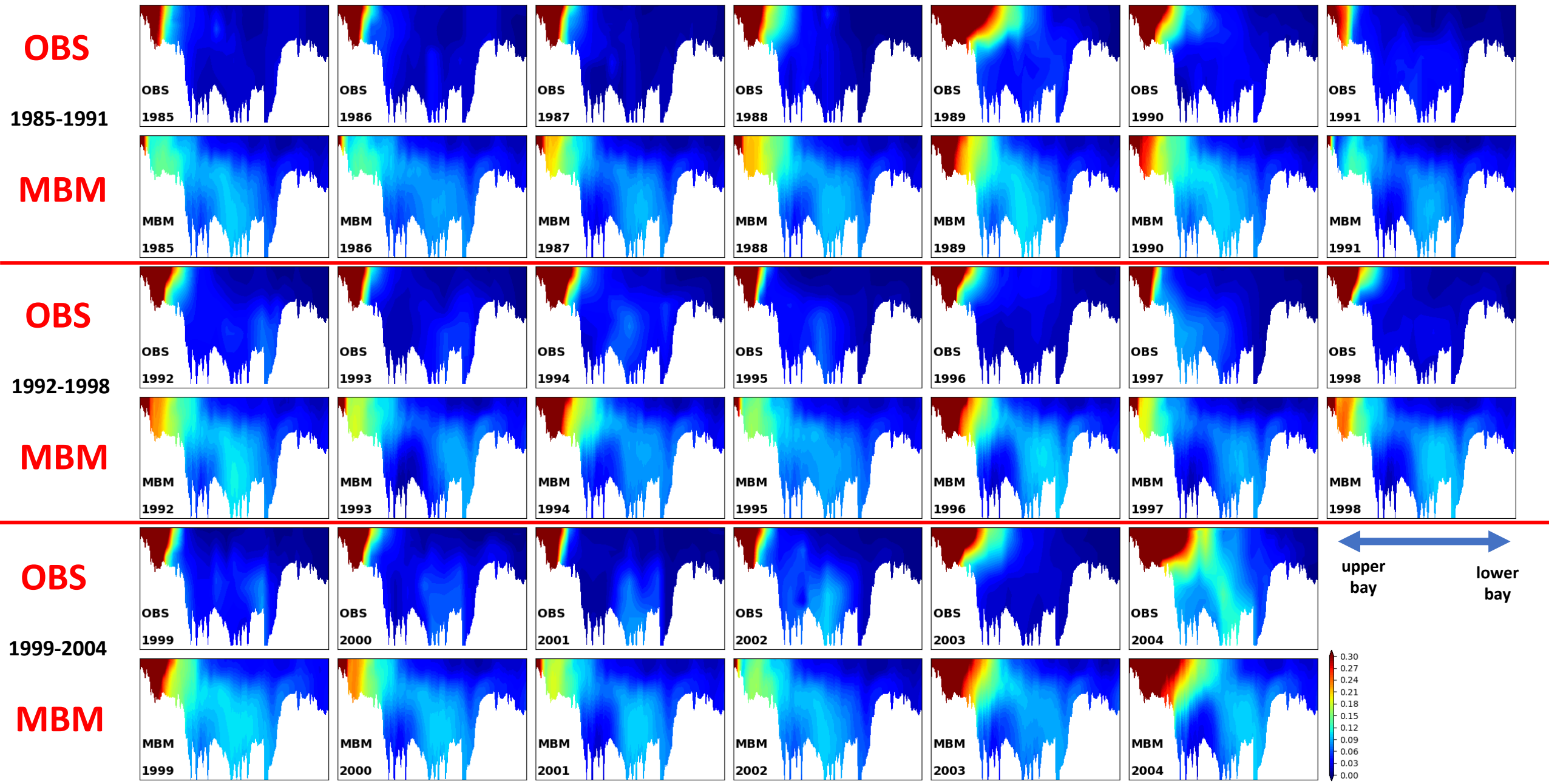
Bottom NO3

- Seasonal variation of bottom NO3 is also well simulated



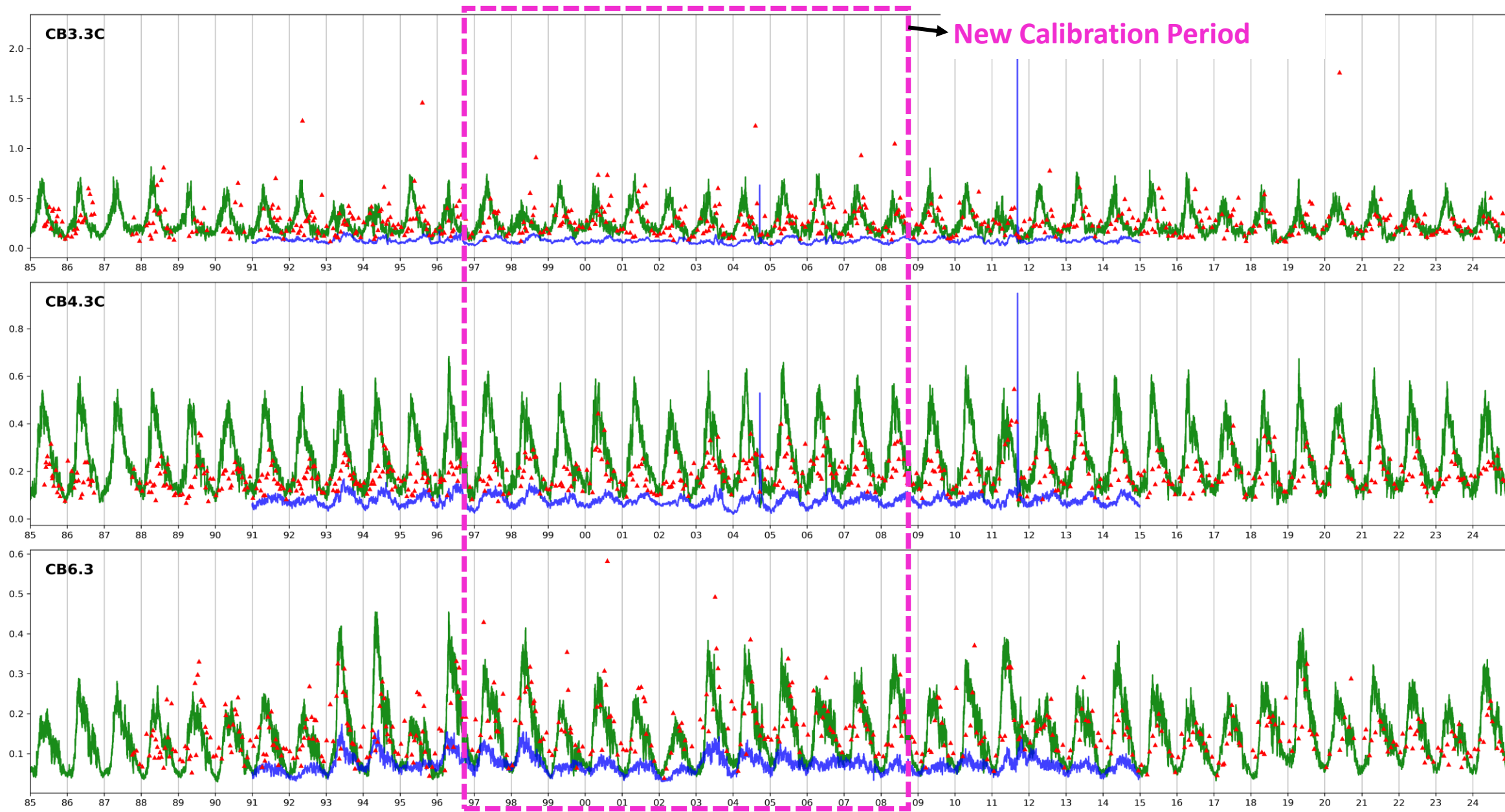
NO3 Profile (Jul-Sep)

- Susquehanna River is the largest source of NO3 into the Bay
- MBM captured the spatial variability of NO3 along the bay channel



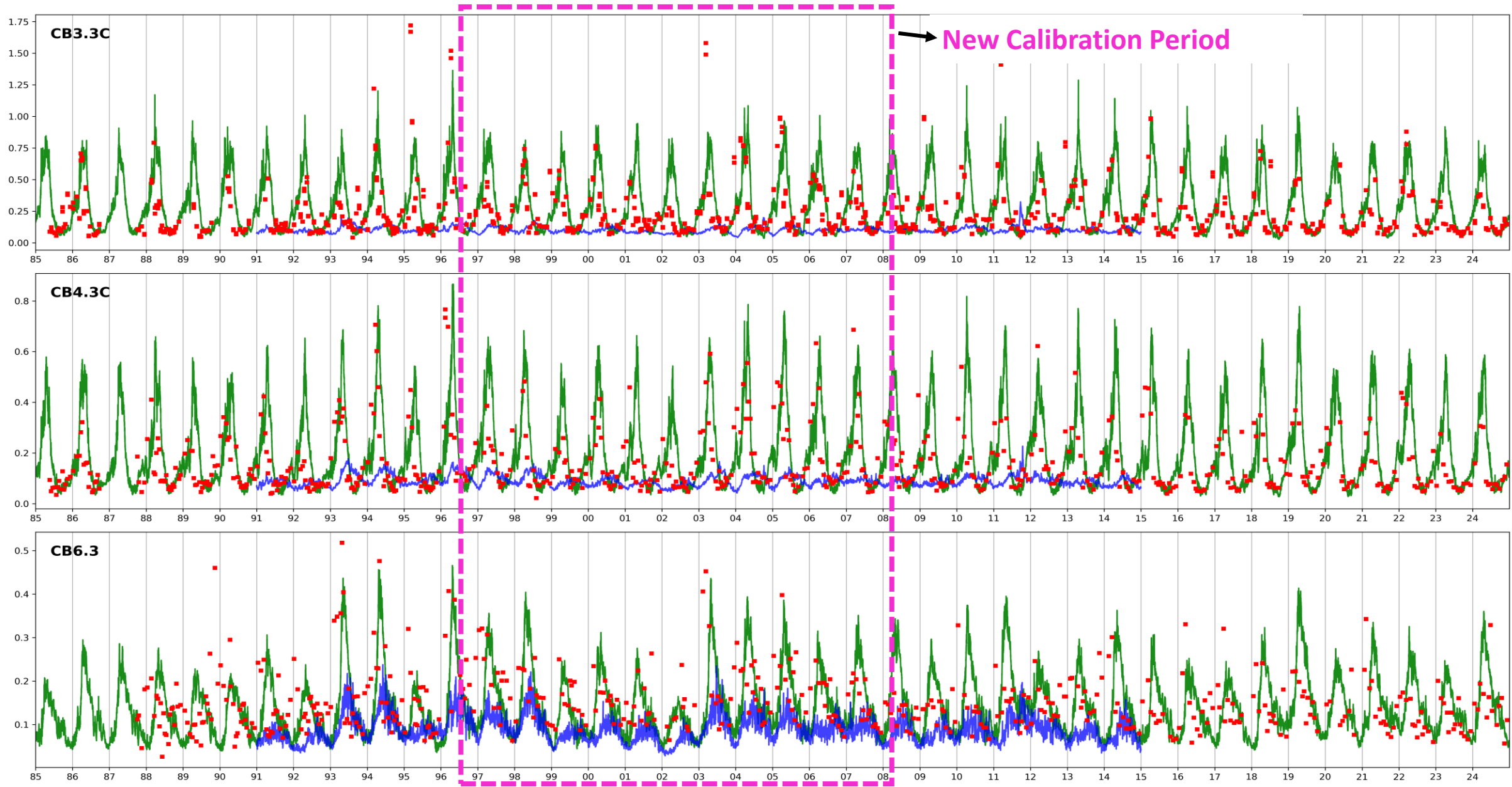
Surface PON

- MBM captured well PON seasonal variation and magnitude
- Spring PON concentration in mid-bay is somewhat overestimated



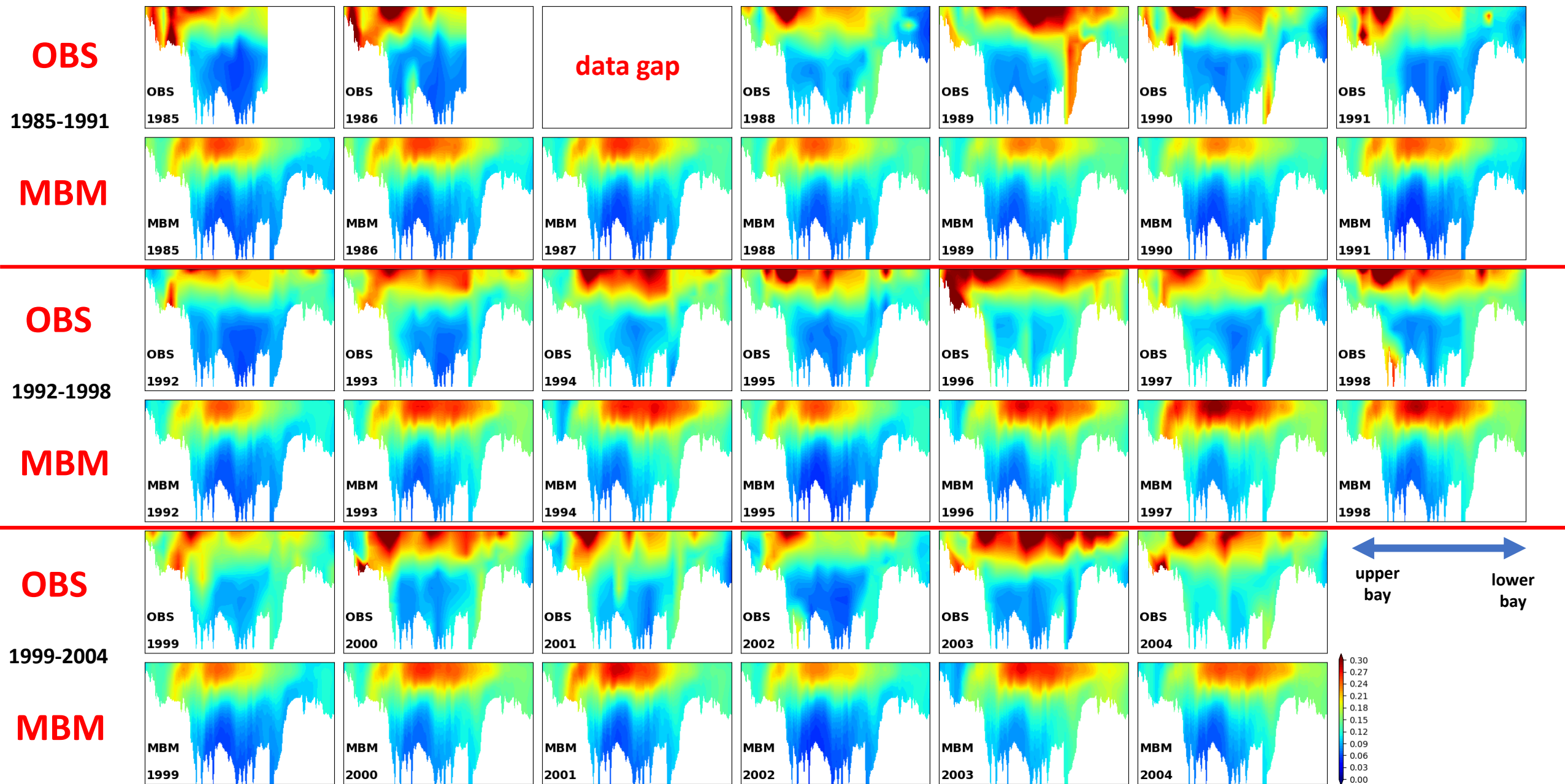
Bottom PON

• Seasonal and interannual variability of bottom PON is also well simulated



PON Profile (Jul-Sep)

- MBM well captured the vertical structure of PON along the bay channel



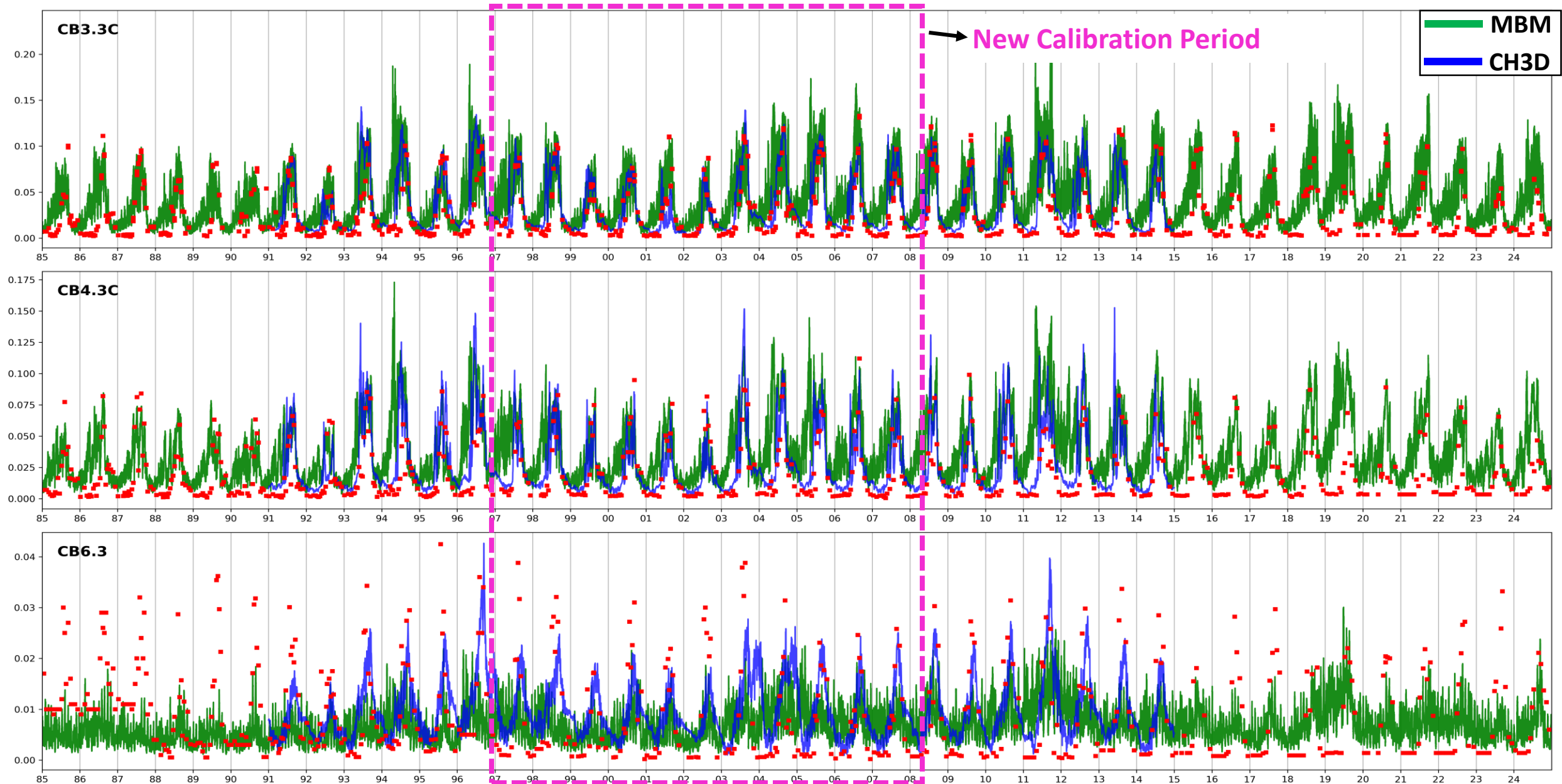
Surface PO₄

- Surface PO₄ tends to be overestimated in MBM, particularly in mid-Bay
- Needs further improvement



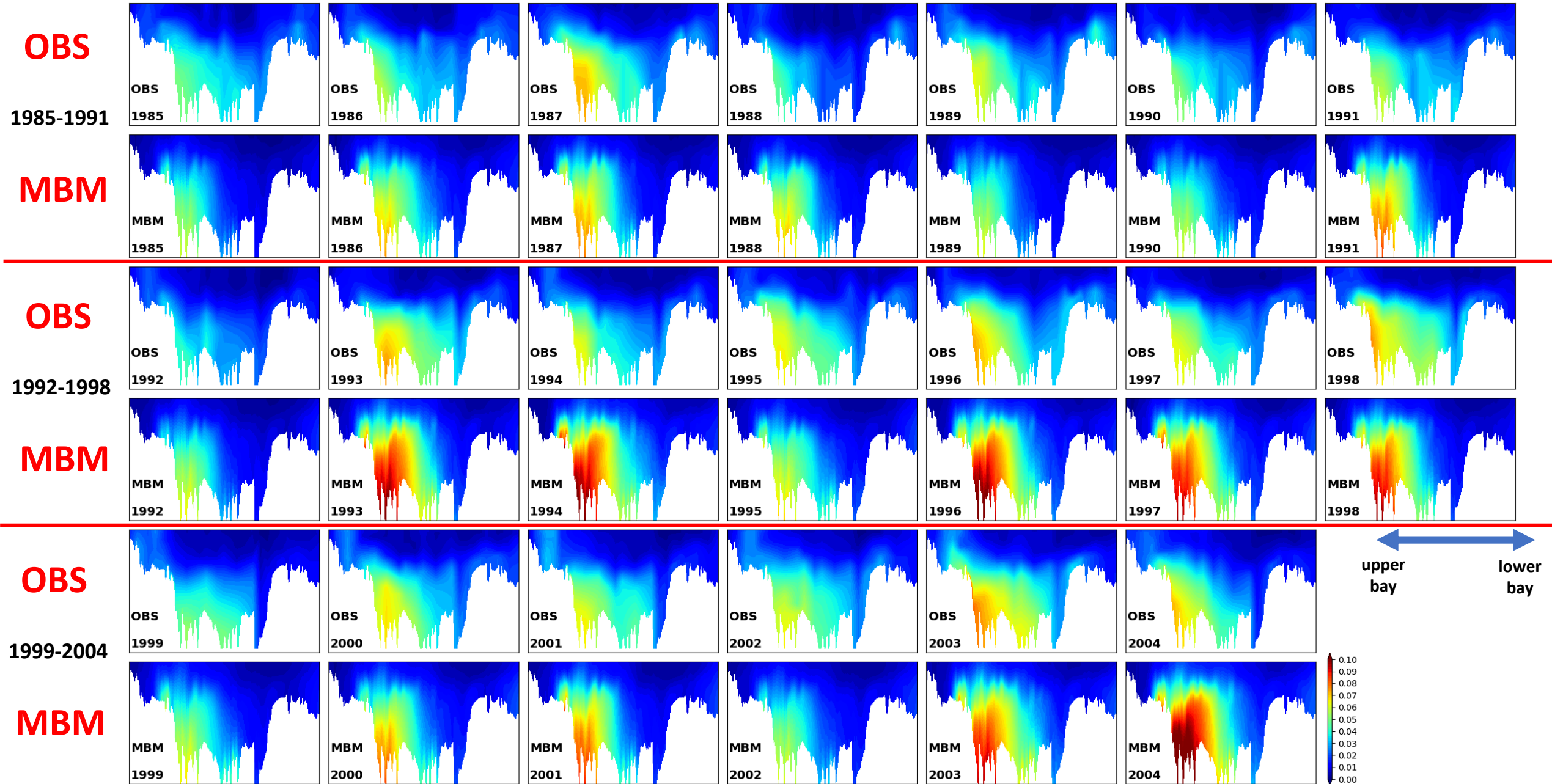
Bottom PO₄

- Seasonal variation of PO₄ is reasonably simulated in MBM
- In lower bay, larger discrepancy may be linked to the uncertainty in the coastal ocean



PO4 Profile

- Although the surface PO4 has larger error (partly due to the extremely low concentration there), spatial variability of PO4 is generally captured by MBM



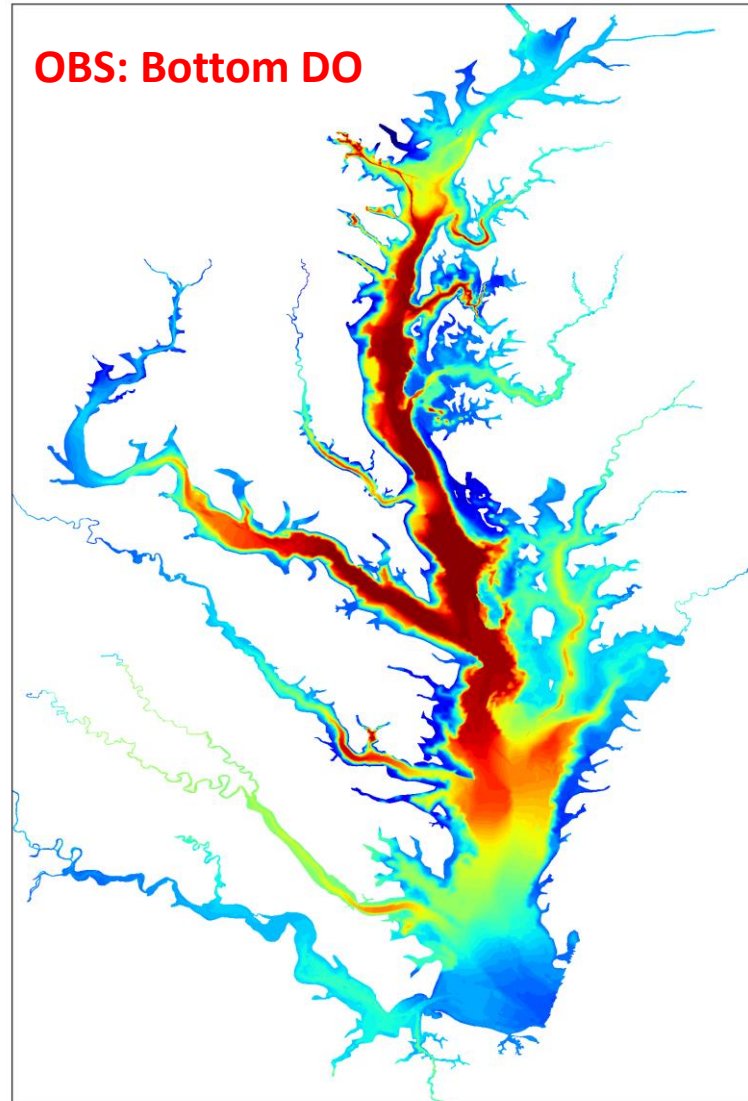
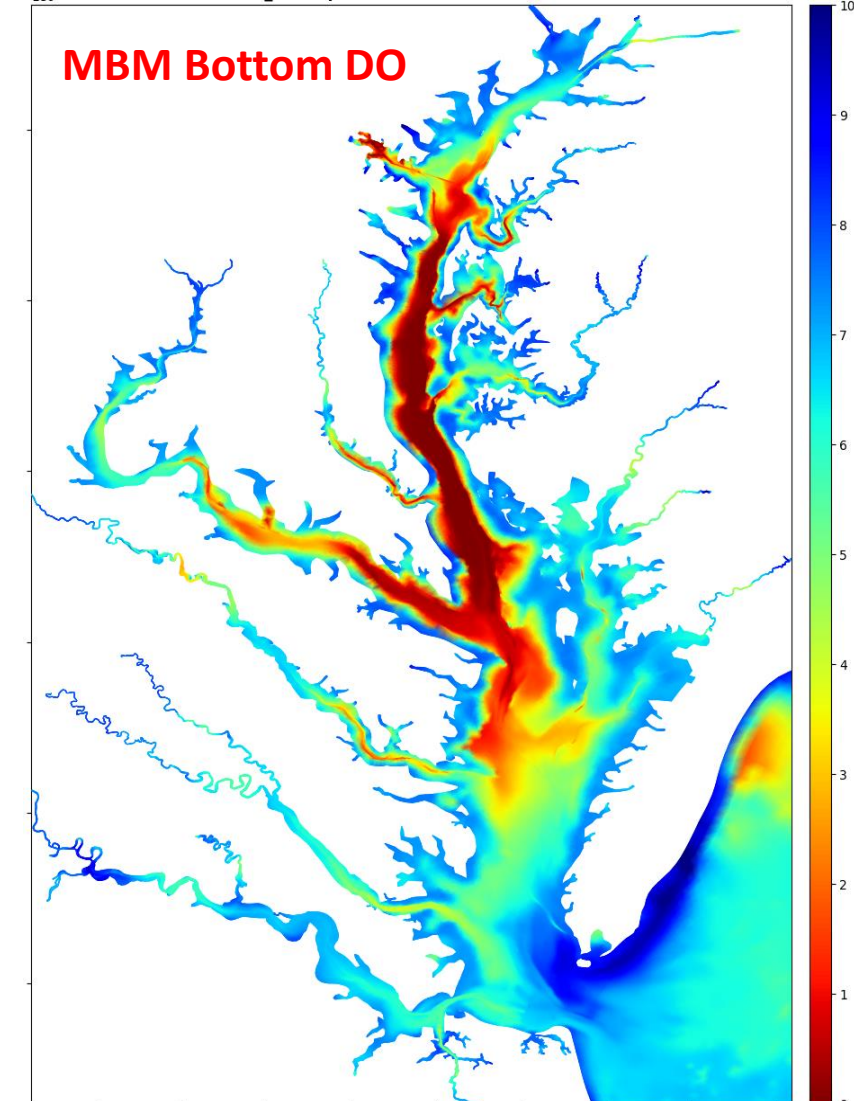
Calculating Hypoxic Volume (HV) using 4D interpolator

In order to perform quantitatively assessment on the HV simulated MBM, we need:

- to develop a 4D interpolator that can generate $DO(t,x,y,z)$ in the Bay. We first interpolate CBP data vertically using FEM to get vertical profiles. Then, we further interpolate the vertical profiles to SCHISM grid.
- to make sure that MBM DO matches DO observations both temporal and spatially
- to develop a method to compute HV, and also verify the calculation with other methods

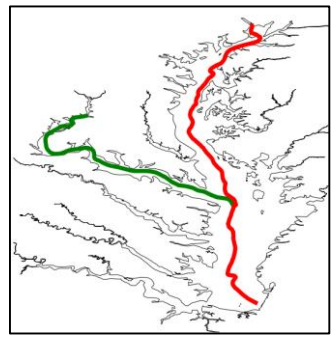
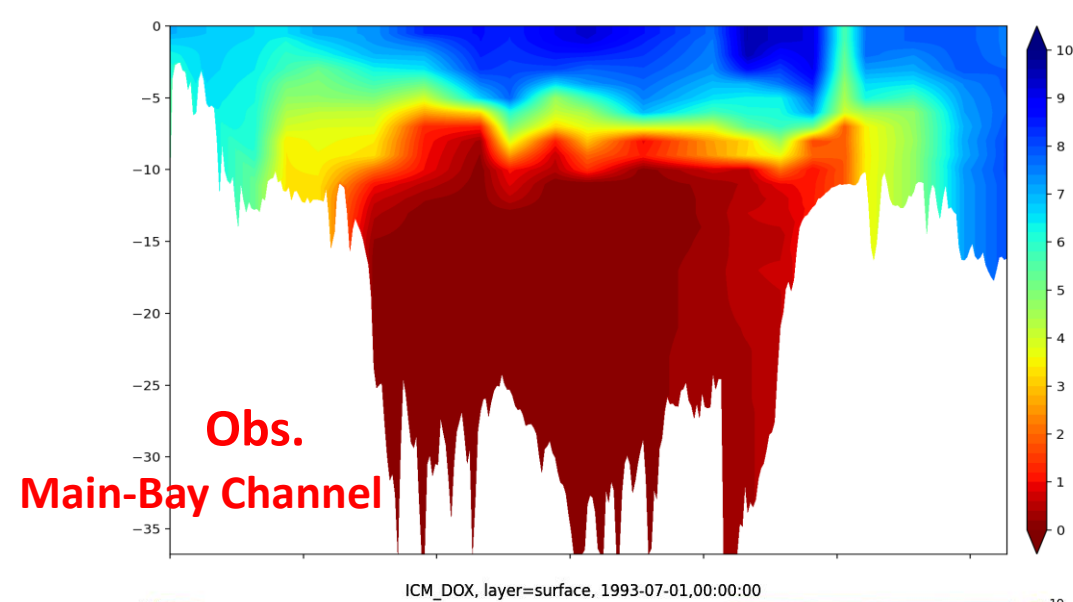
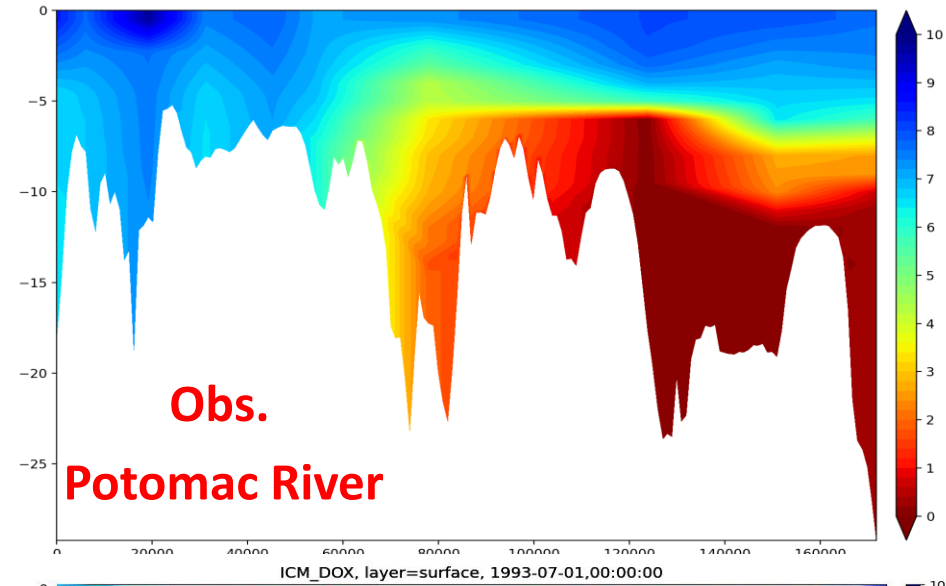
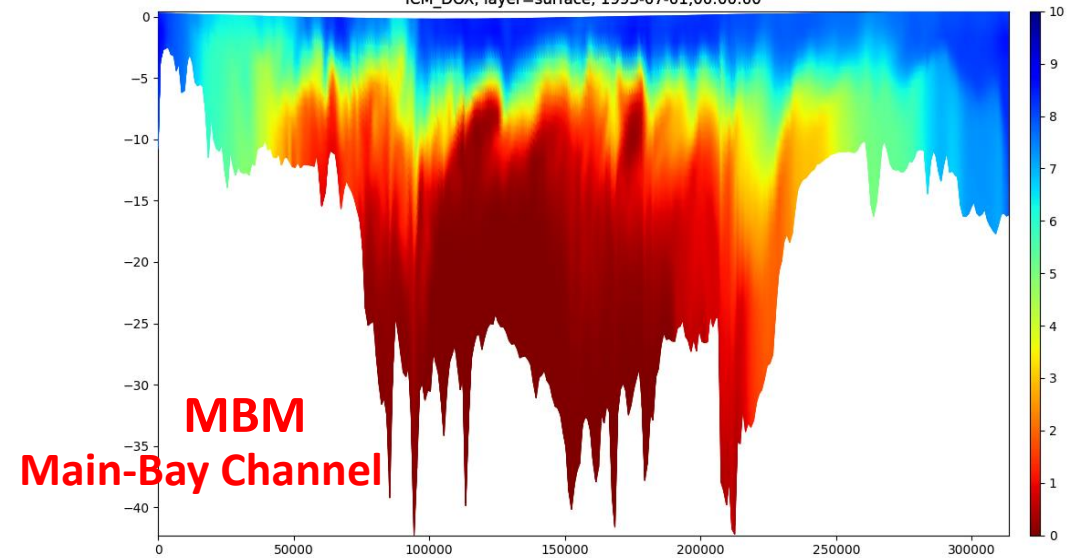
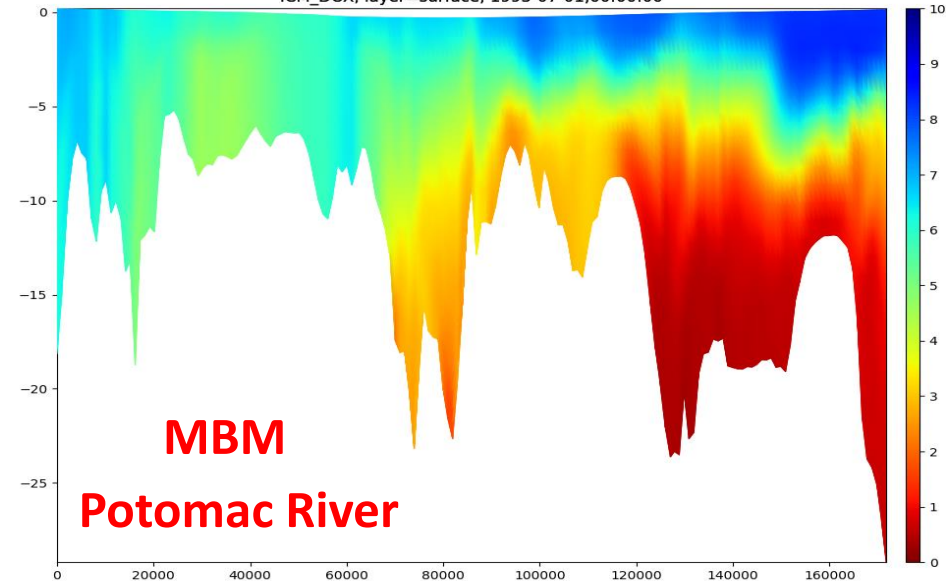
- The 4D interpolator seems to perform well in capturing the details of hypoxia
- MBM also did a good job in capturing the details

1993-07-01



Hypoxic Volume (HV): DO transects on 1993-07-01

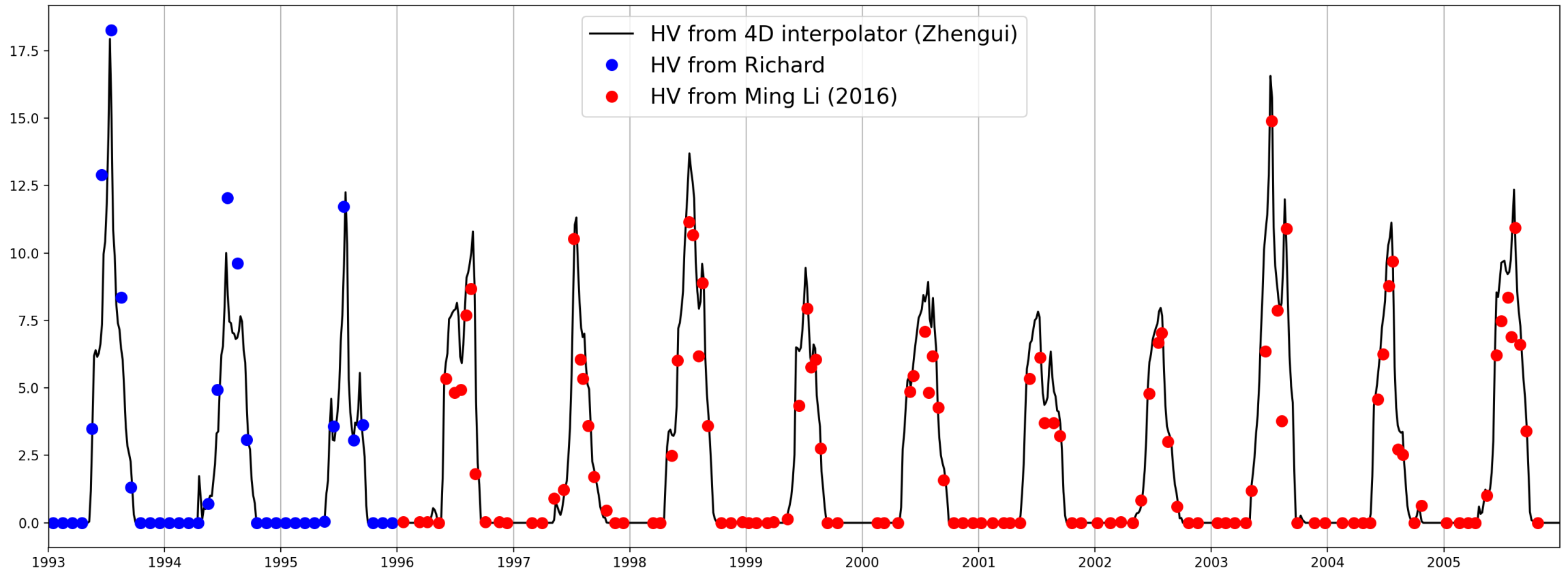
- Spatial variability of DO along Main-Bay channel and Potomac River are well simulated



Comparison of HV calculation with other methods

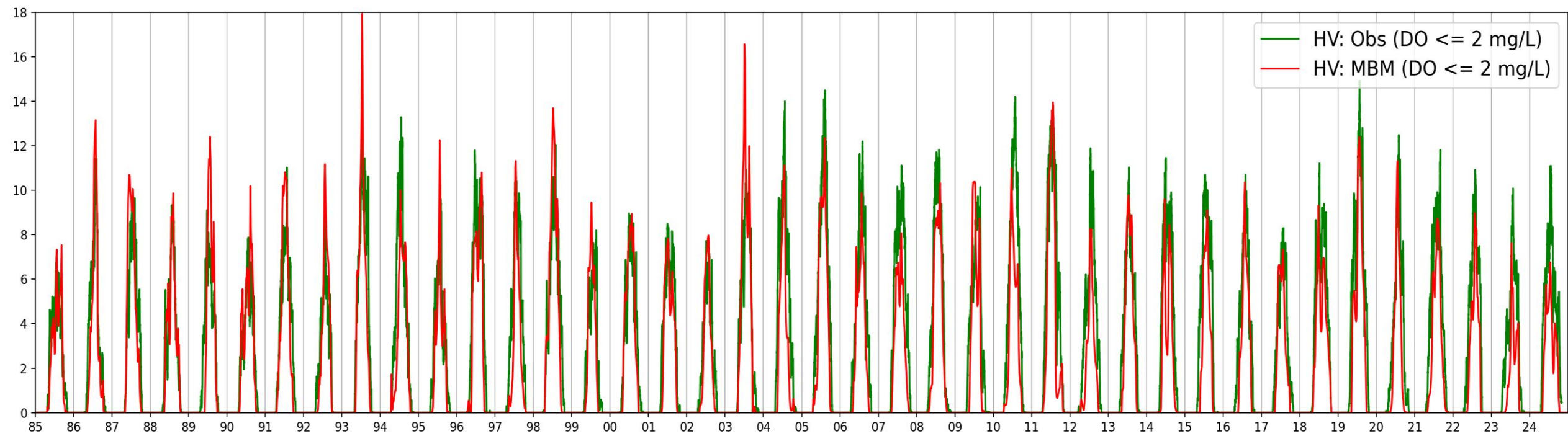
- Observed HV estimated from our 4D interpolator shows good consistency with other data
- Richard's results is the bay program's estimated HV based on observation
- Ming Li's results from their own estimation of observed HV

Observed Hypoxic Volume (km³) for DO (≤ 2 mg/L)



40-year HV simulation in MBM

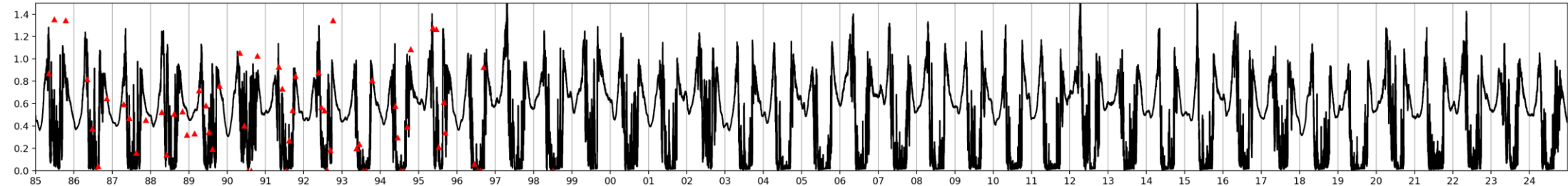
- The interannual variability of HV is well captured by MBM
- MBM captured the timing and magnitude of HV well



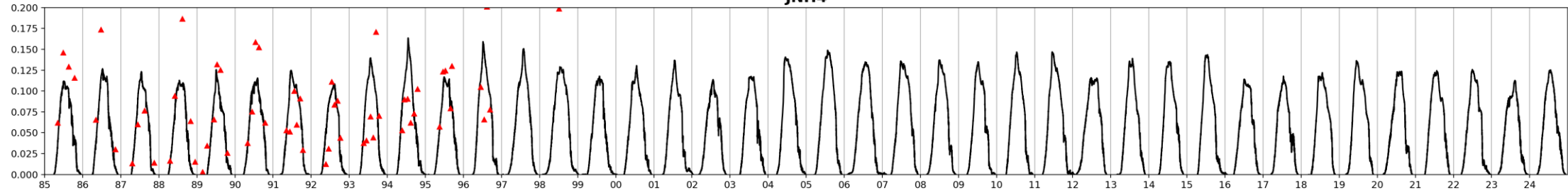
Sediment Fluxes at R-64

- SOD and sediment fluxes of NH_4 and NO_3 are reasonably simulated, but PO_4 flux has larger errors.

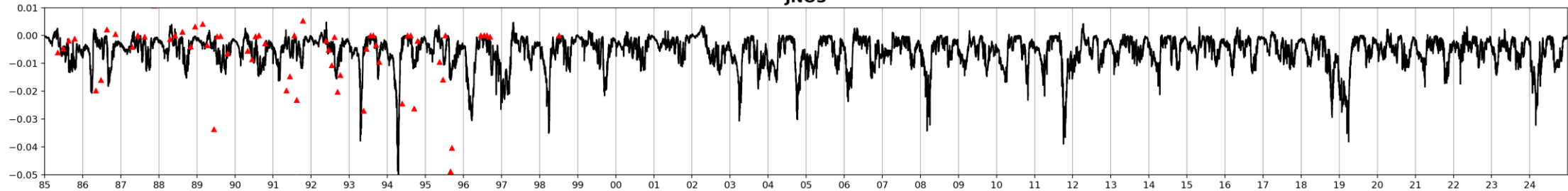
SOD



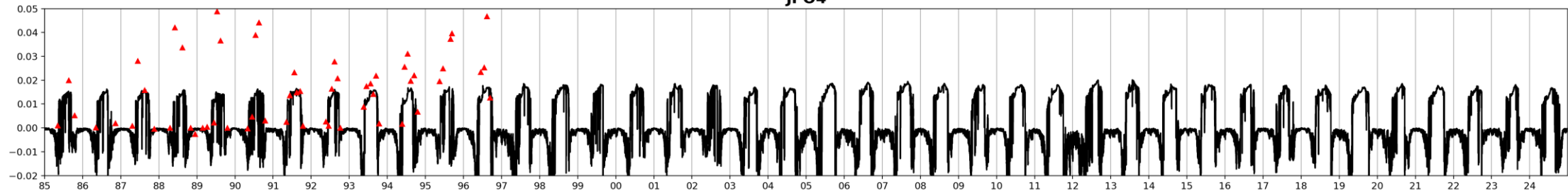
JNH4



JNO3

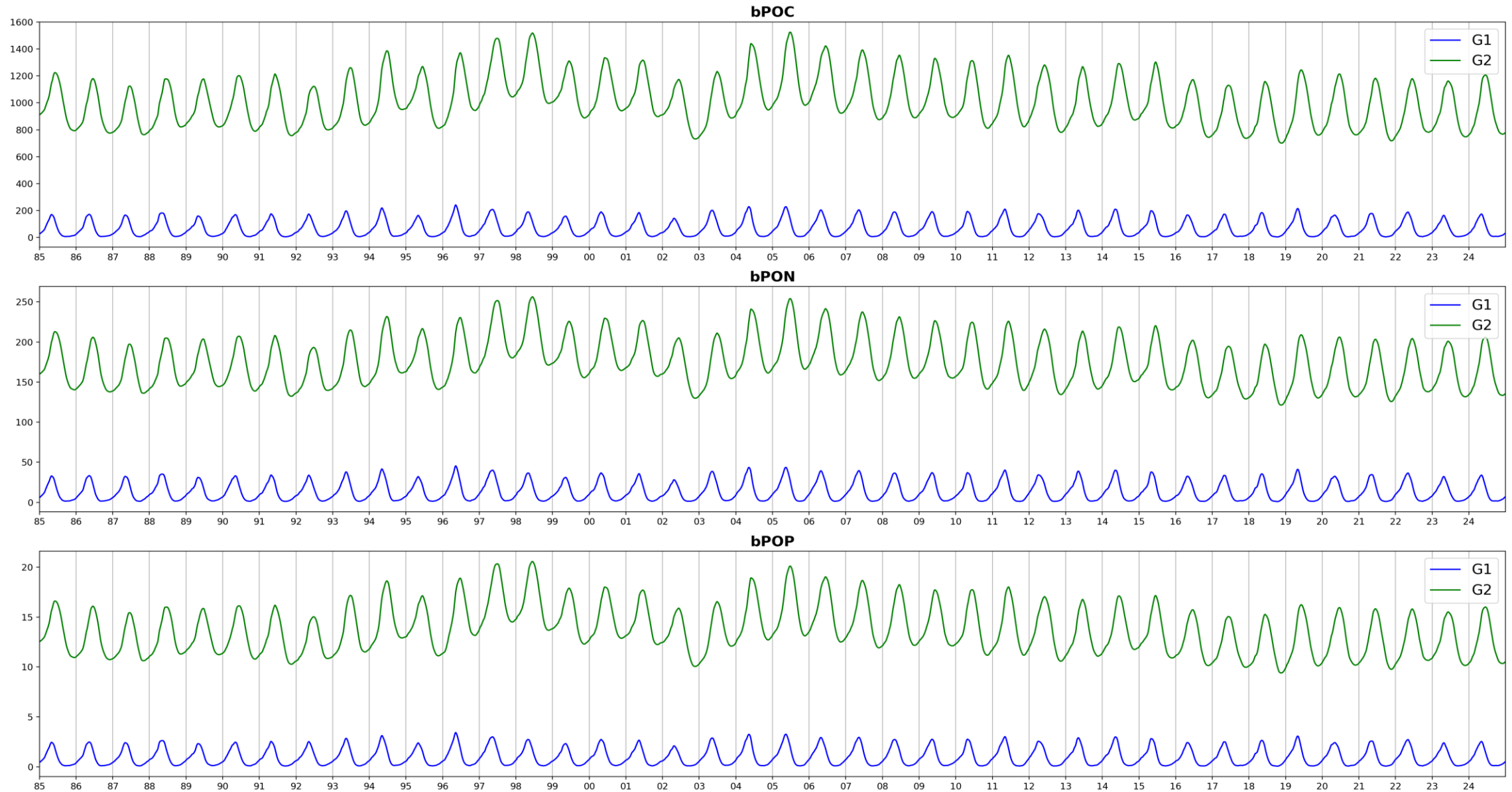


JPO4



Sediment Concentrations at R-64

- In MBM, sediment POM concentrations reach dynamically steady state



Summary and future work

- ❑ A 40-year MBM simulation has been successfully completed. Most key water quality (WQ) variables are well simulated, except for surface PO_4 , which is overestimated.
- ❑ The good agreement in the spatiotemporal patterns of WQ variables indicates that MBM captured key biophysical processes in the Bay.
- ❑ The interannual variability of HV is generally well simulated.
- ❑ Sediment fluxes and organic matter concentrations are reasonably simulated, except for the sediment PO_4 flux.
- ❑ **Future Work**
 - MBM documentation.
 - Continue improving MBM performance, and recalibrate living resources (SAV)