Use of continuous data in CBEFS

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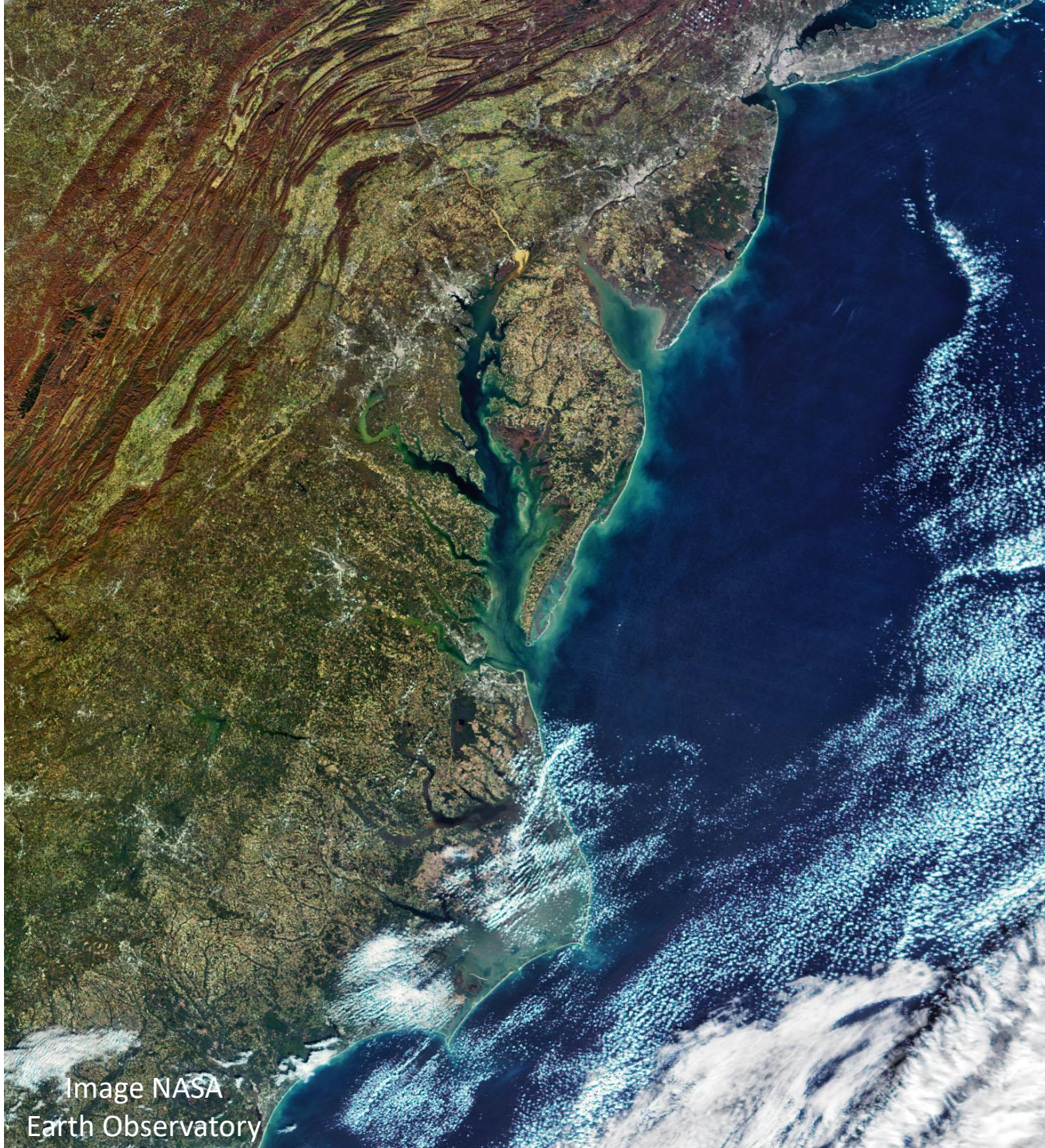
CBP Hypoxia Collaborative Meeting
16 October 2024

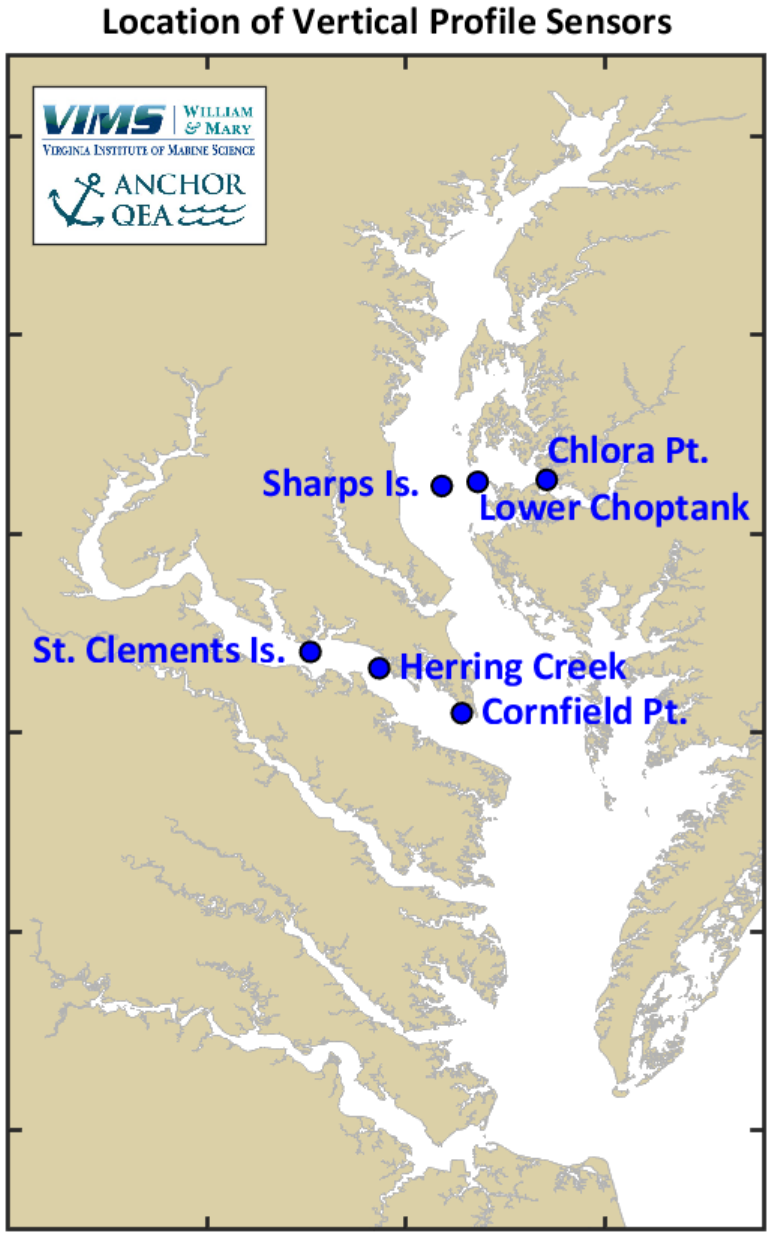


in situ data are critical for:

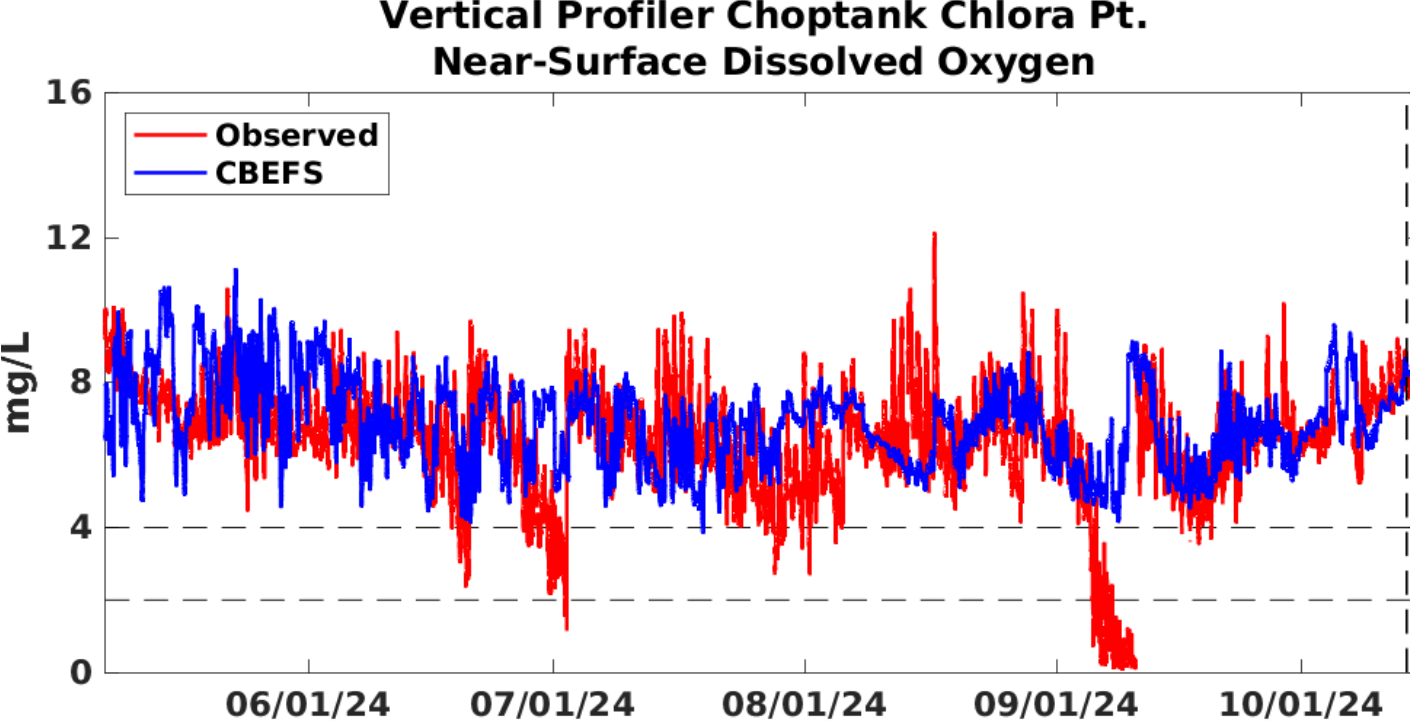
- Model development
- Model improvement
- Model evaluation
- Increasing confidence of end-users

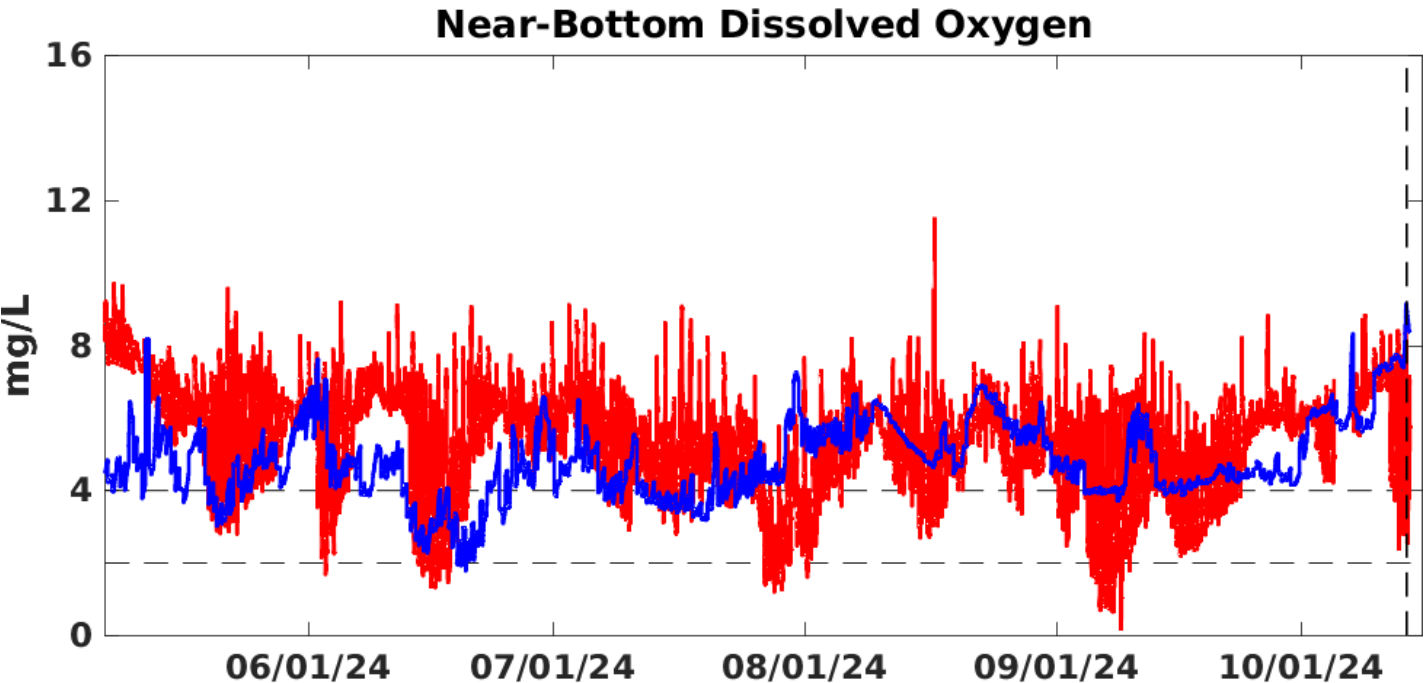
Forecast model (CBEFS) is evaluated with:

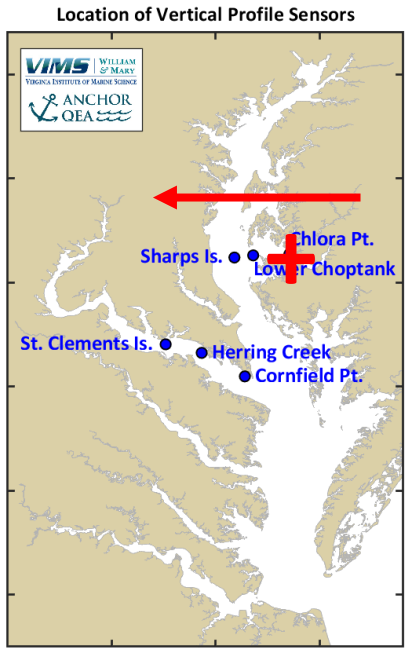
- CBP WQMP station data
- Continuous monitoring station data
- And vertical profile station data

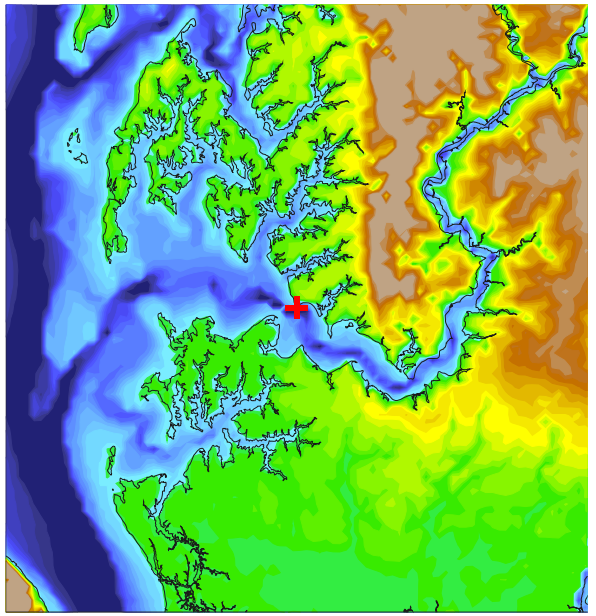


What features are accurately (or inaccurately) captured by CBEFS?



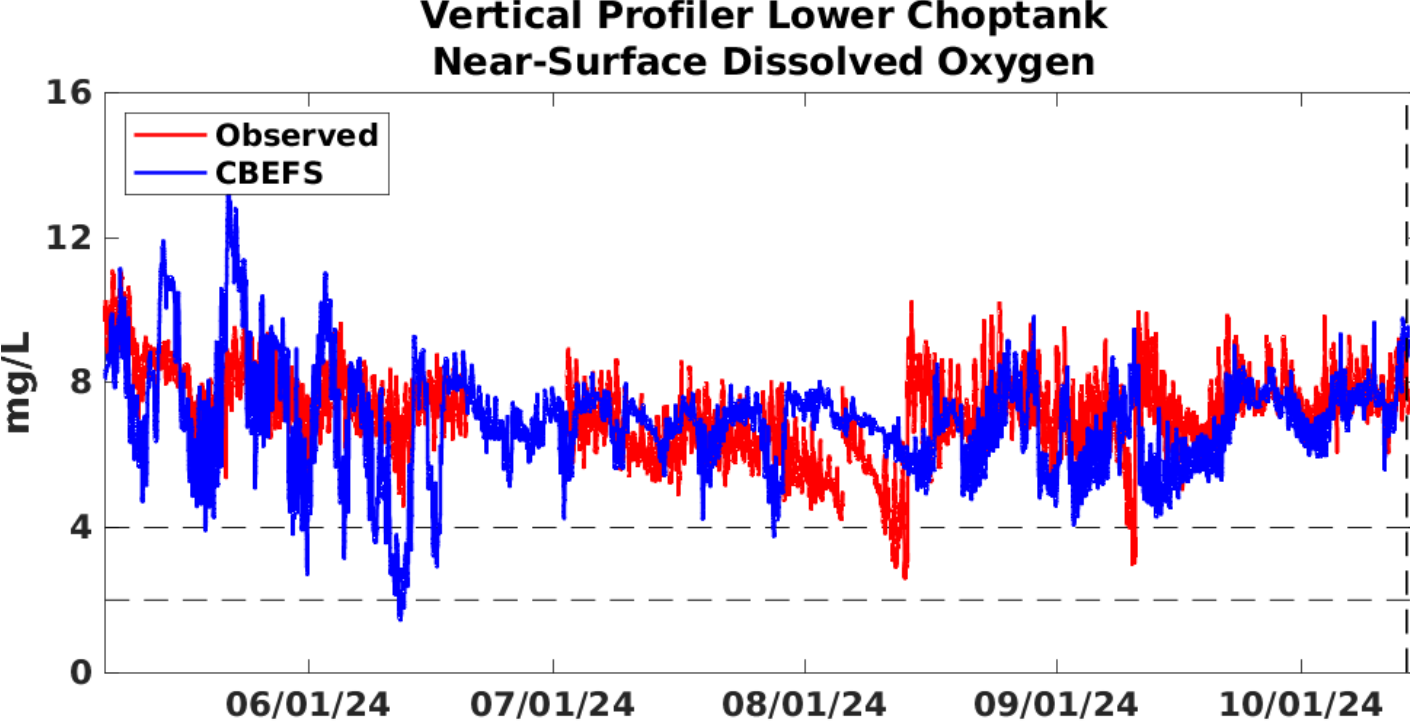


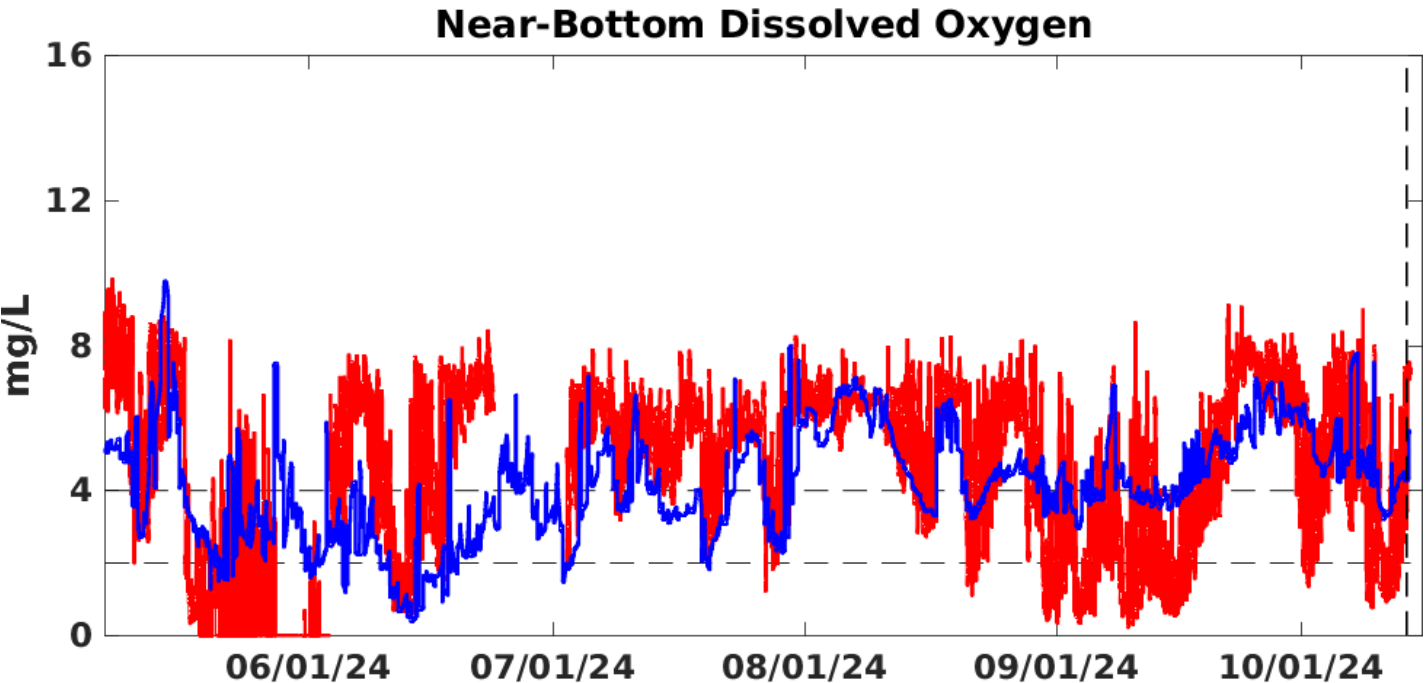


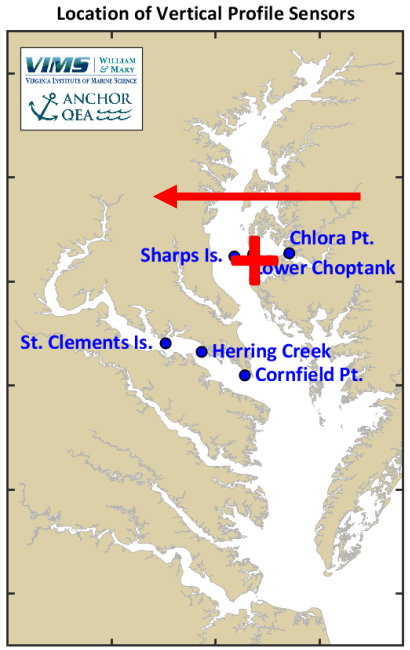


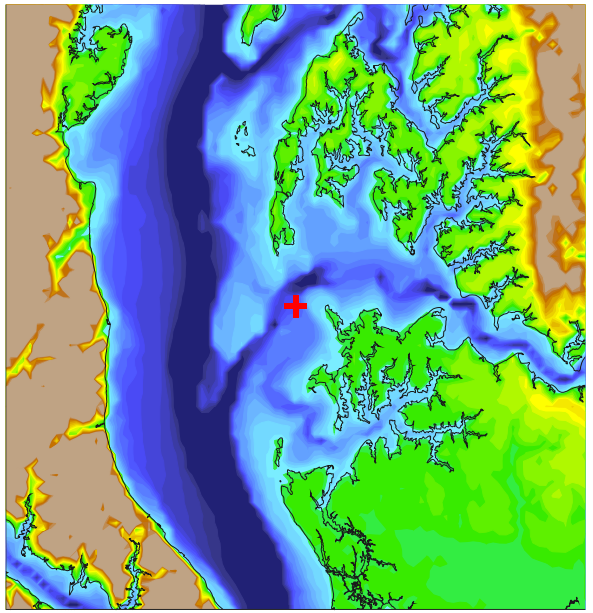
Upstream Choptank (~12m deep)

- Mean surf./bott. O_2 reasonably captured.
- Drops in observed surface O_2 (real?)
- High-frequency variability at bottom severely underestimated.
  (Although model simulates the barotropic tides accurately in the main stem, its mesh size (600m) does not allow for *internal* tides.)



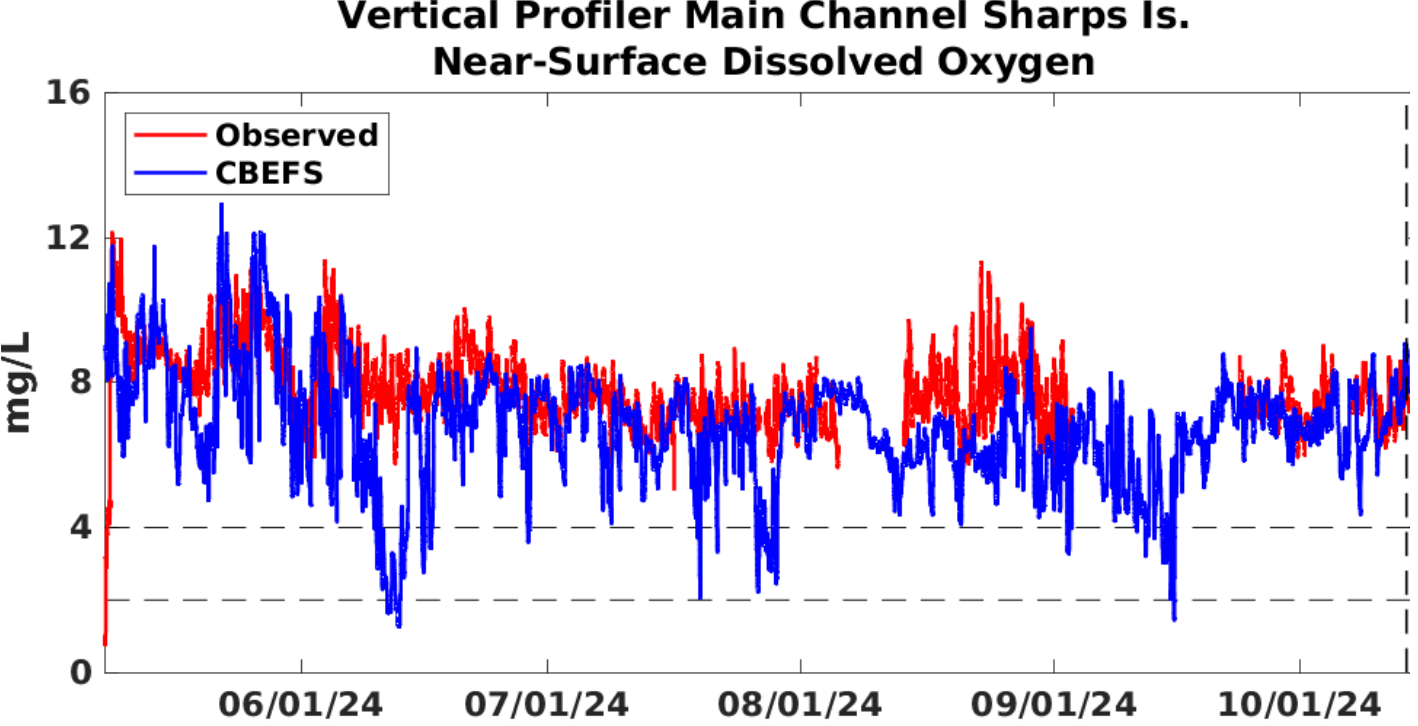


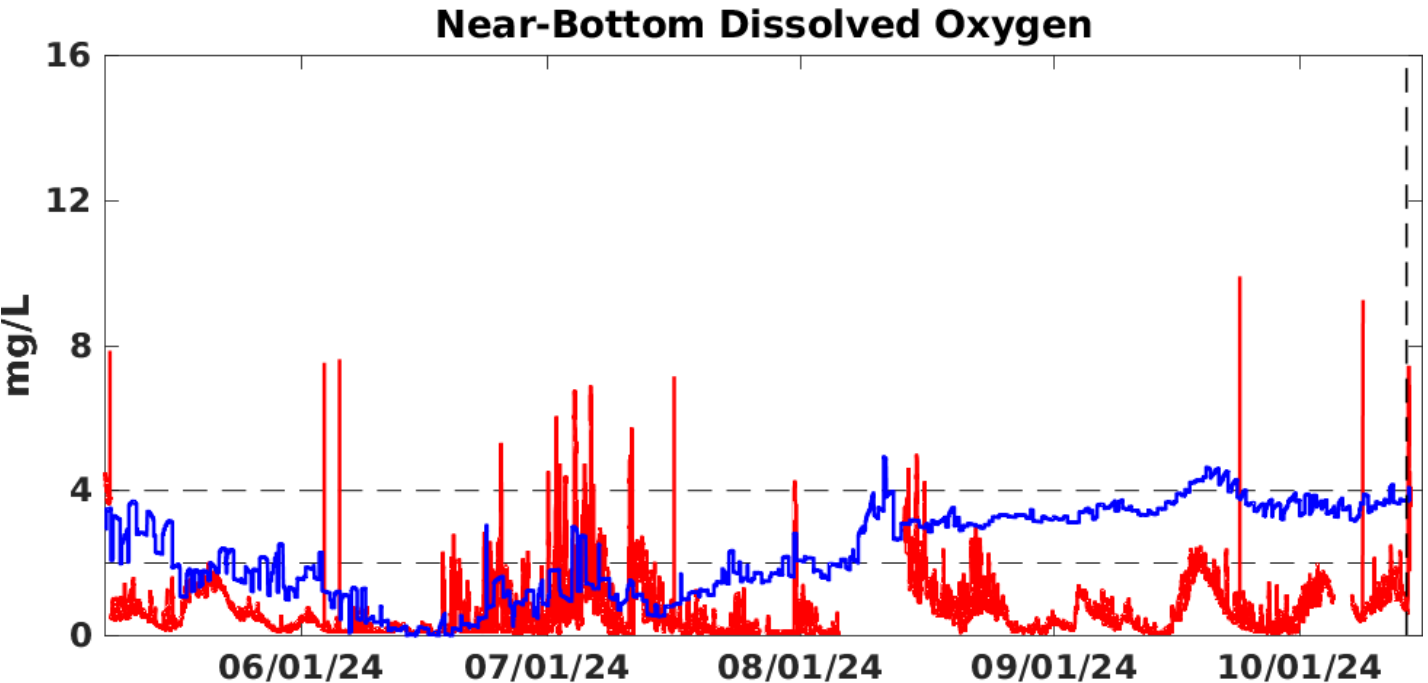


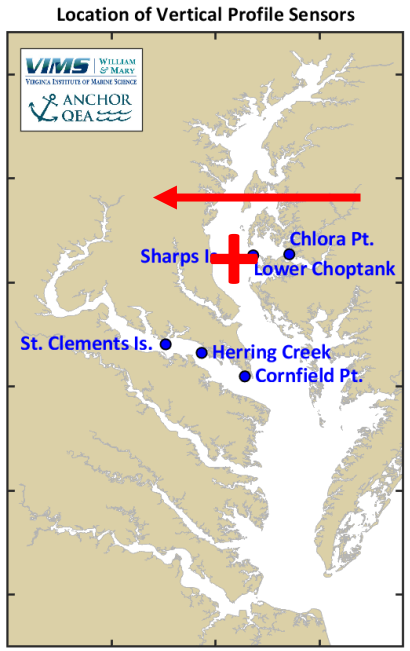


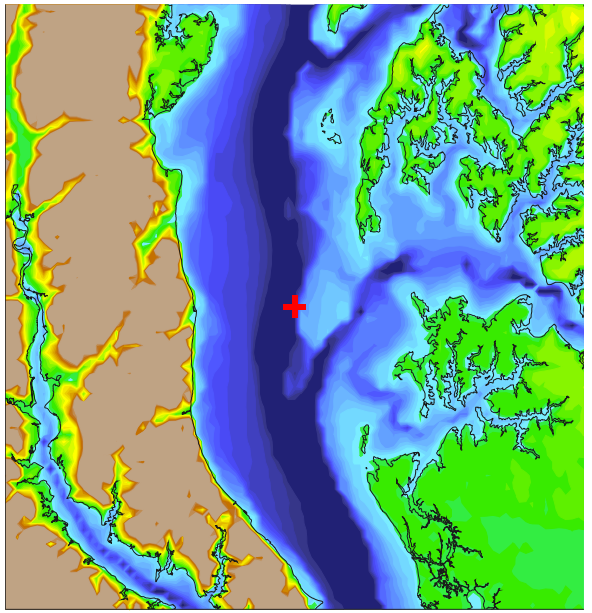
Central Choptank (~11m deep)

- Mean surf./bott. O_2 reasonably captured.
- Model exaggerates weekly var. @surf. in May, but exhibits better agreement afterward.
- High-frequency variability at bottom severely underestimated.
  However, timing of relatively high/low O_2 concentrations is reasonably reproduced.



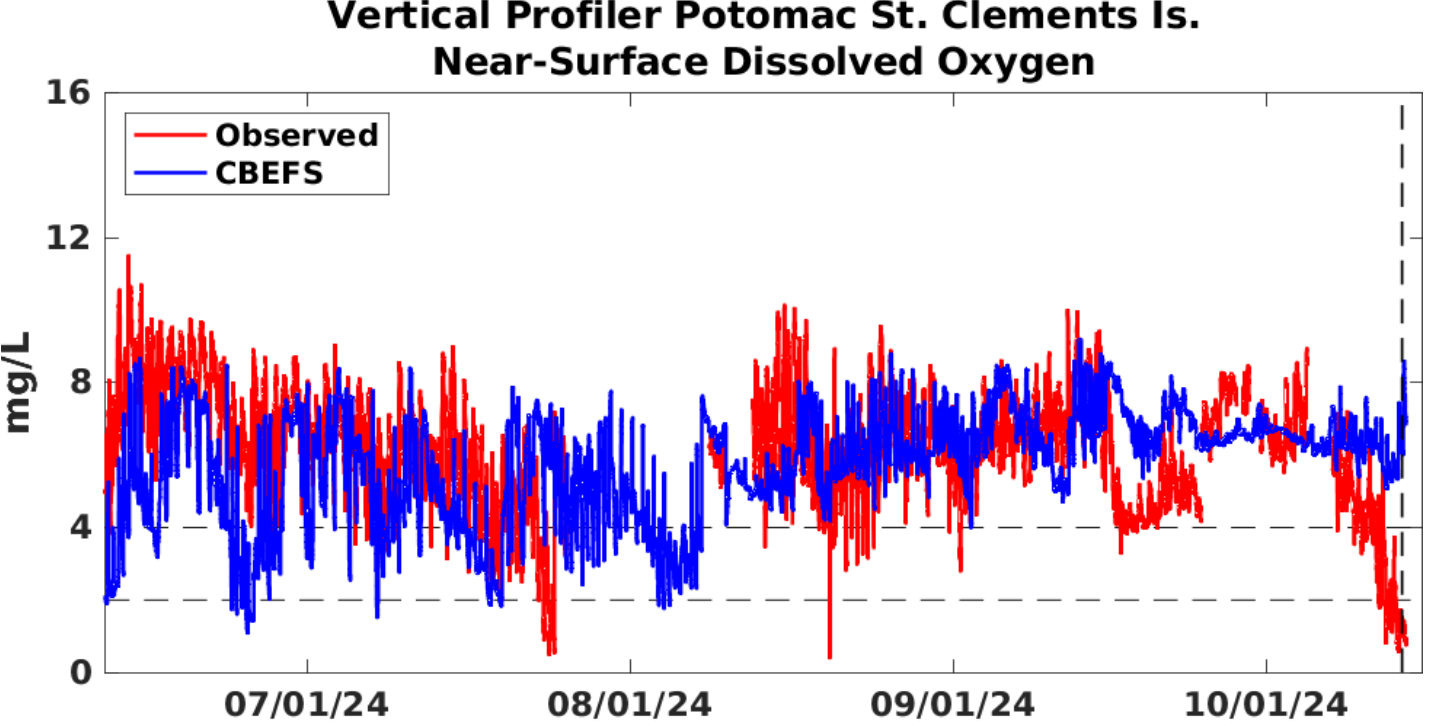


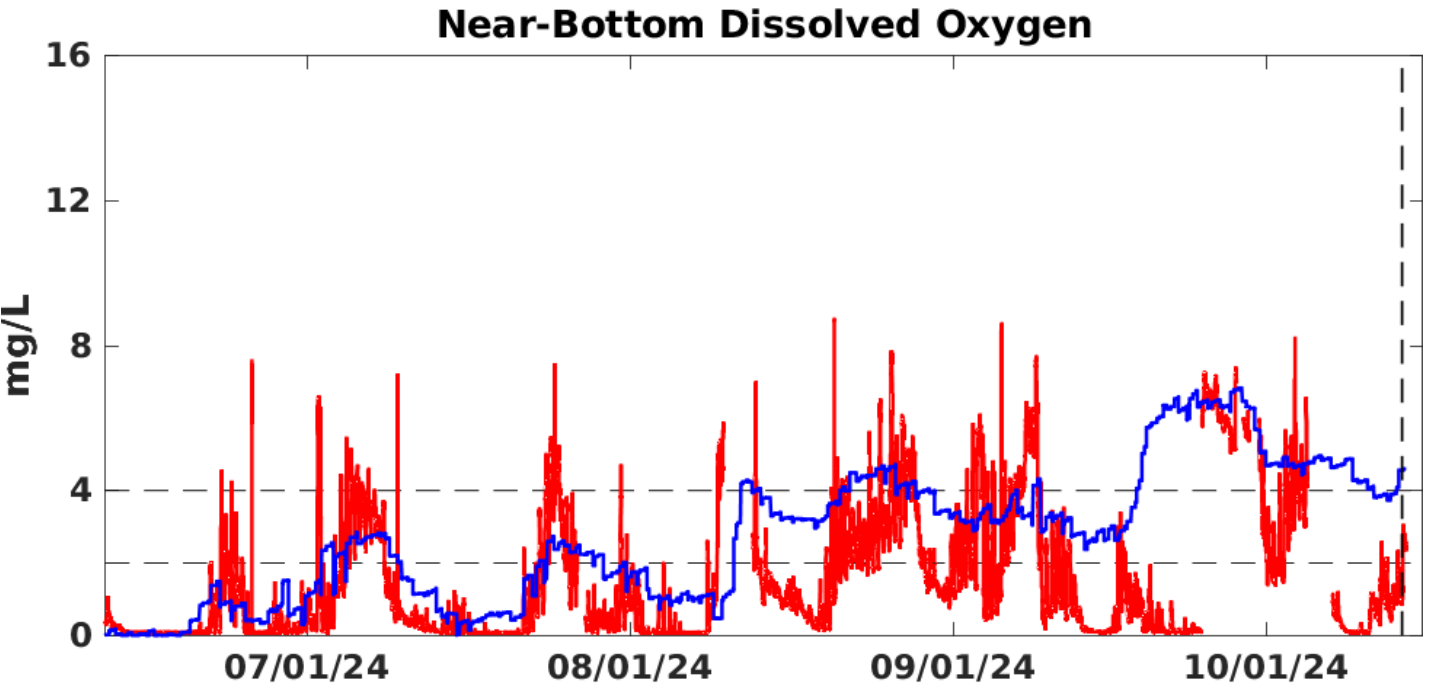


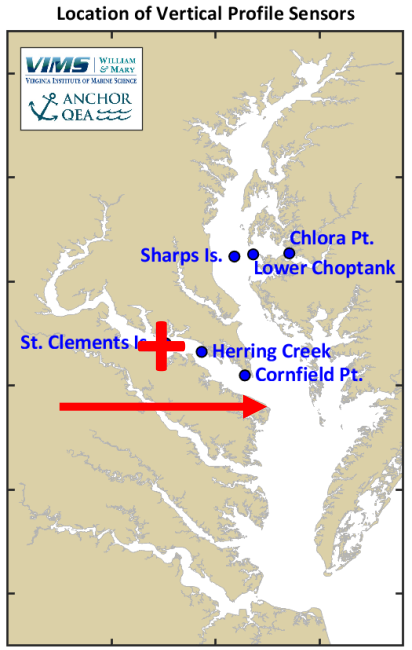


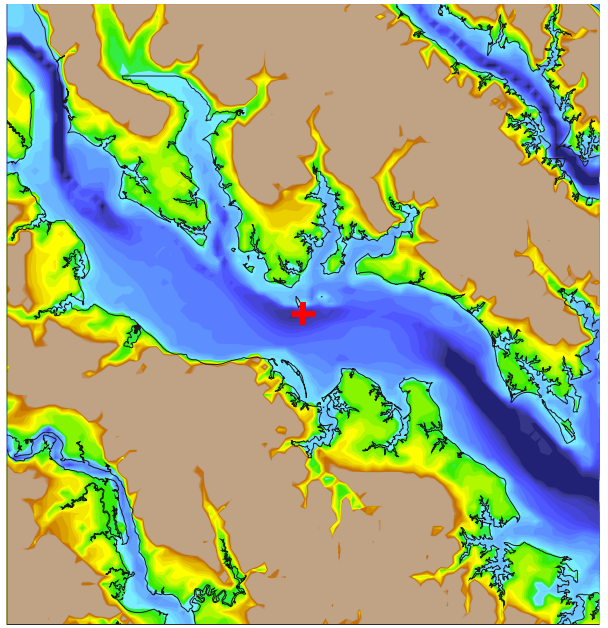
Downstream Choptank / main stem (16m deep)

- Mean surf. O_2 reasonably captured.
- Model exaggerates weekly var. @surf. in May, but exhibits better agreement afterward.
- Bottom consistently hypoxic while model oscillates around 2 mg/L.
- High-amplitude pulses in bottom O_2 (prob. internal waves not captured by model).



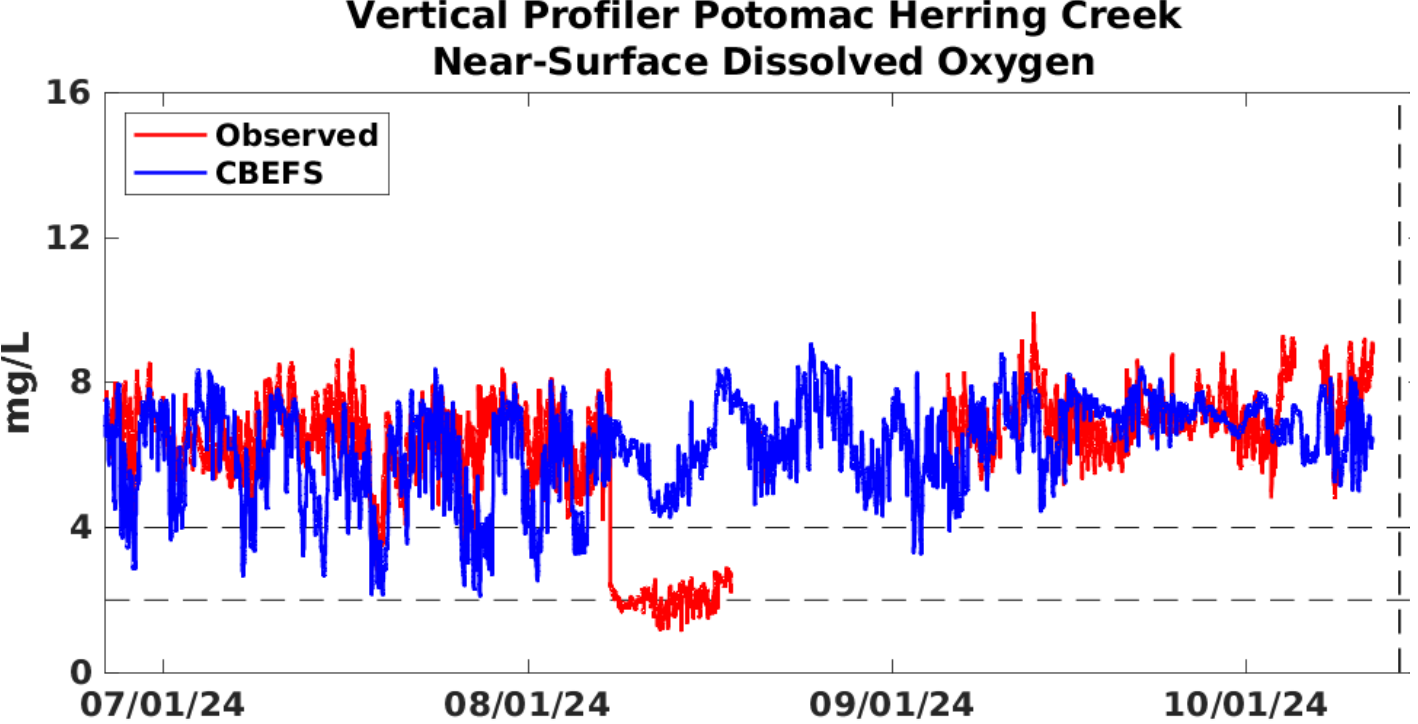


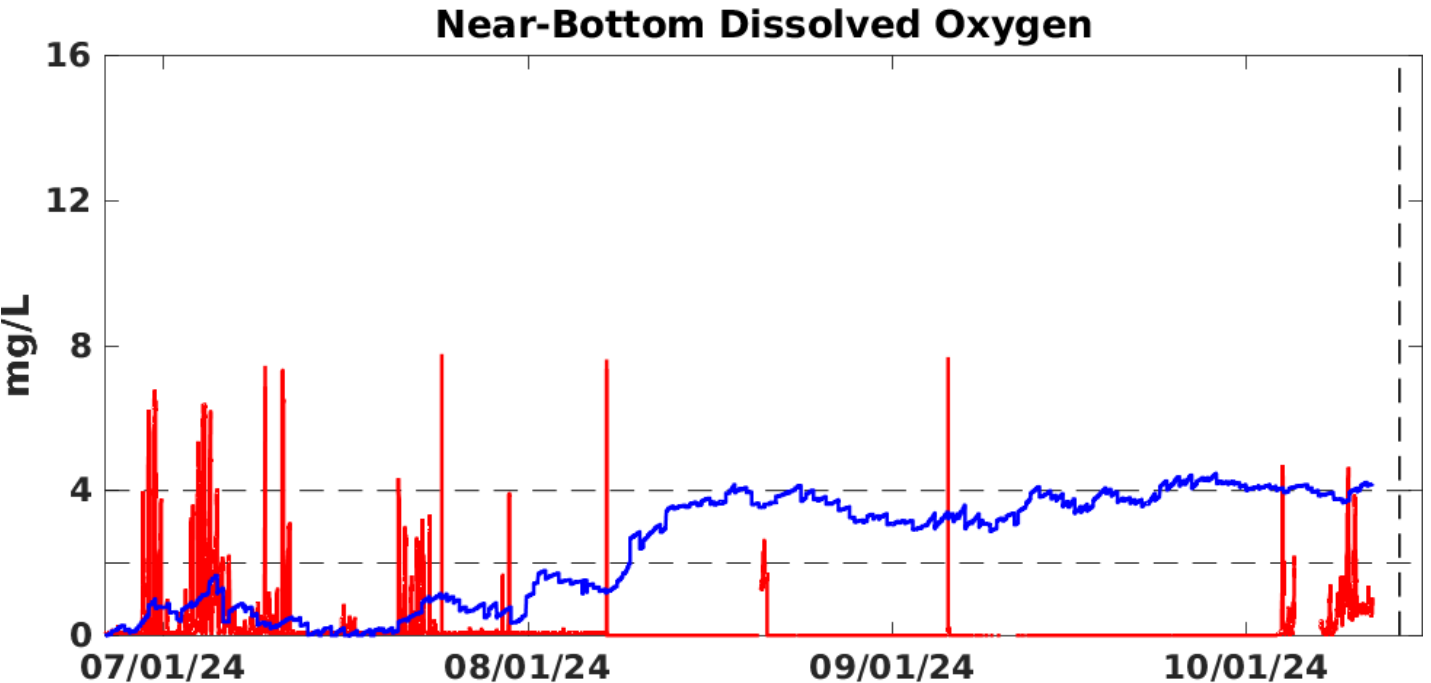


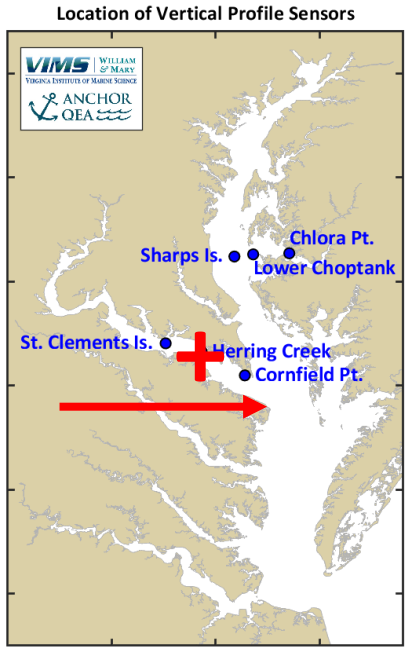


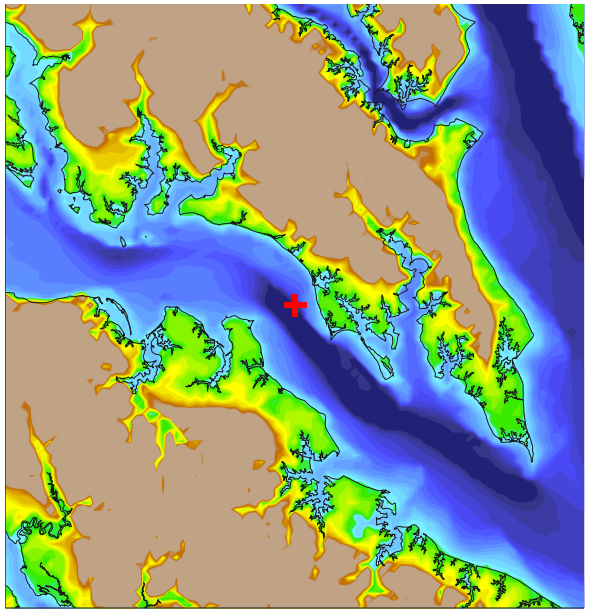
Upstream Potomac (~13m deep)

- Mean surf./bott. O_2 reasonably captured.
- Drops in observed surface O_2 (real?)
- High-frequency variability at bottom severely underestimated.
- Periods of high/low O_2 at bottom are reasonably captured by the model.



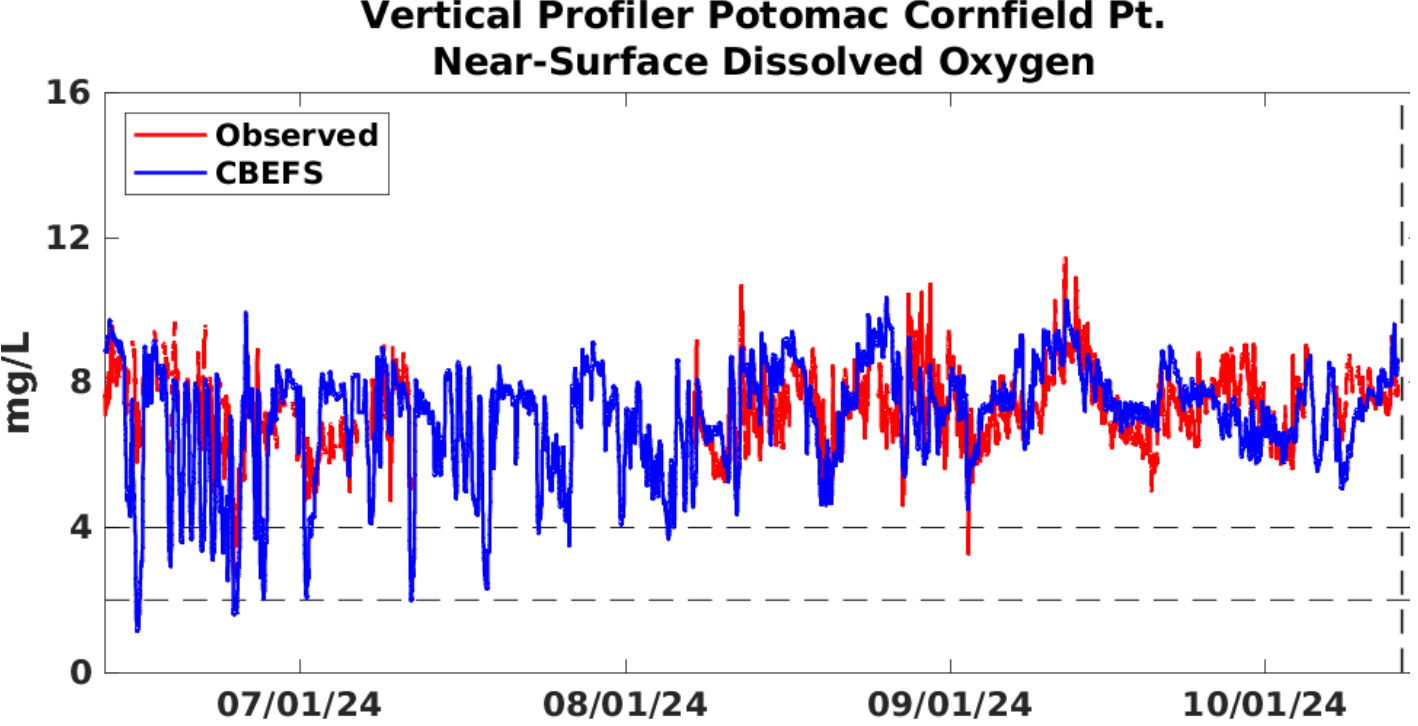


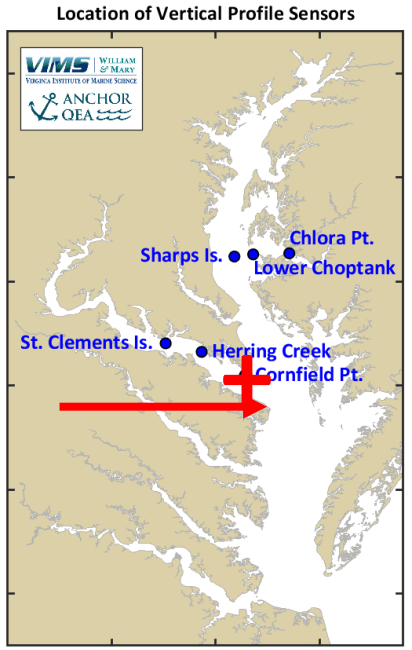


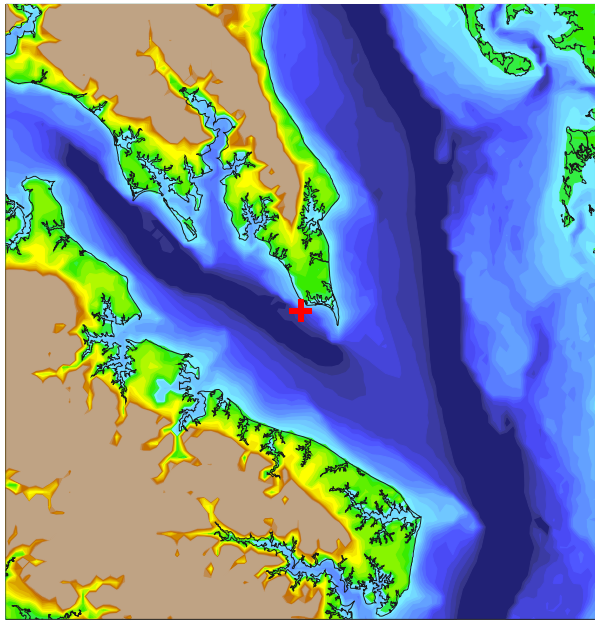


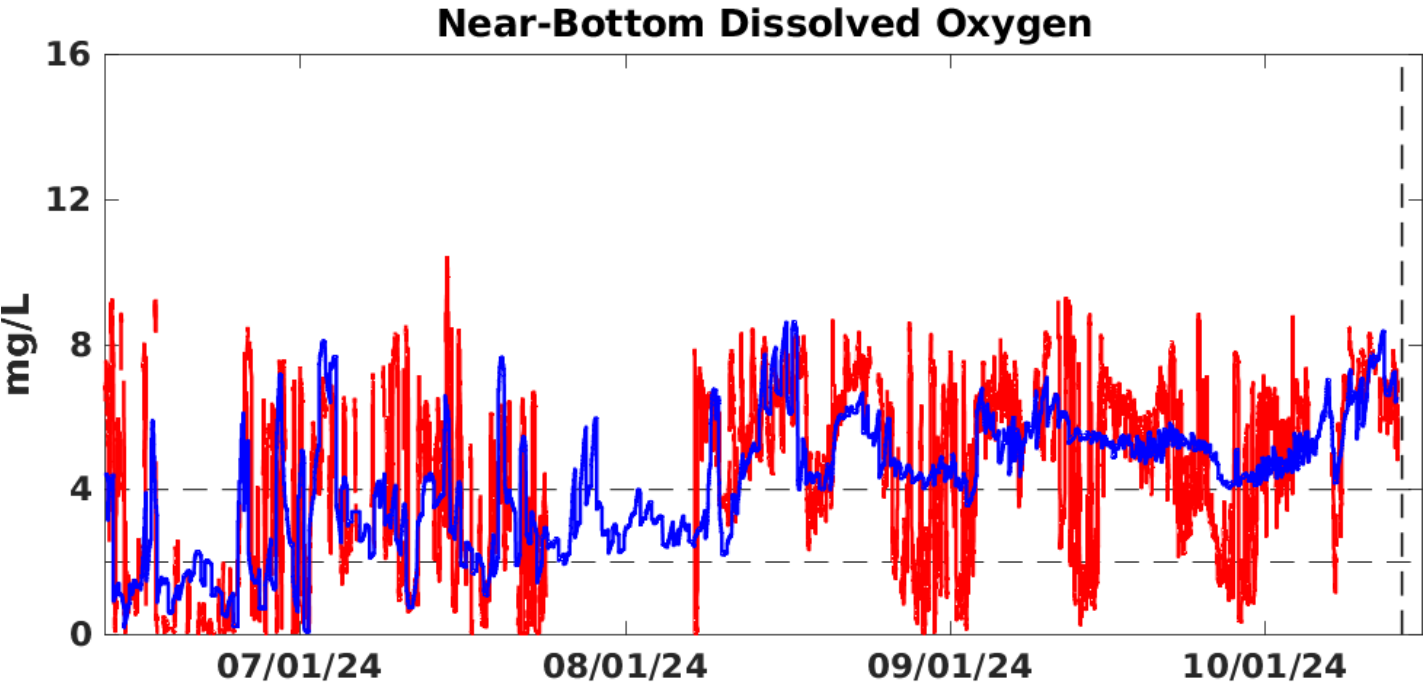
Central Potomac (~16m deep)

- Mean surface O_2 reasonably captured.
- Drop in observed surface O_2 (real?)
- Bottom is consistently hypoxic while model is between 0-4 mg/L; note station located inside a depression.
- Periods of high/low O_2 at bottom are reasonably captured by the model but pulses missing from model.





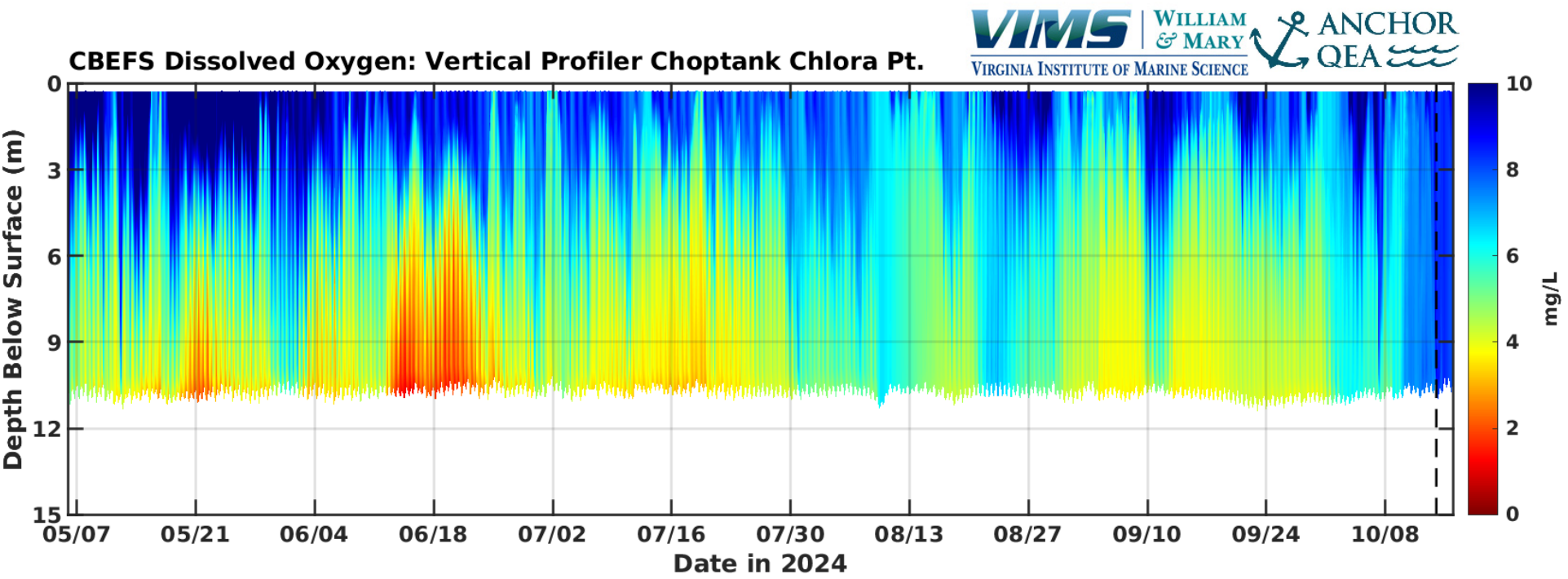


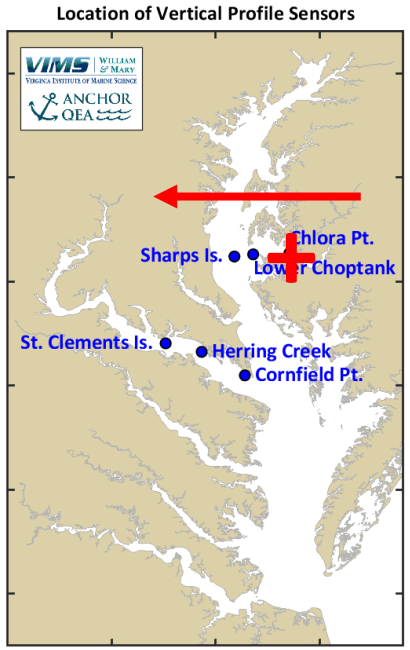


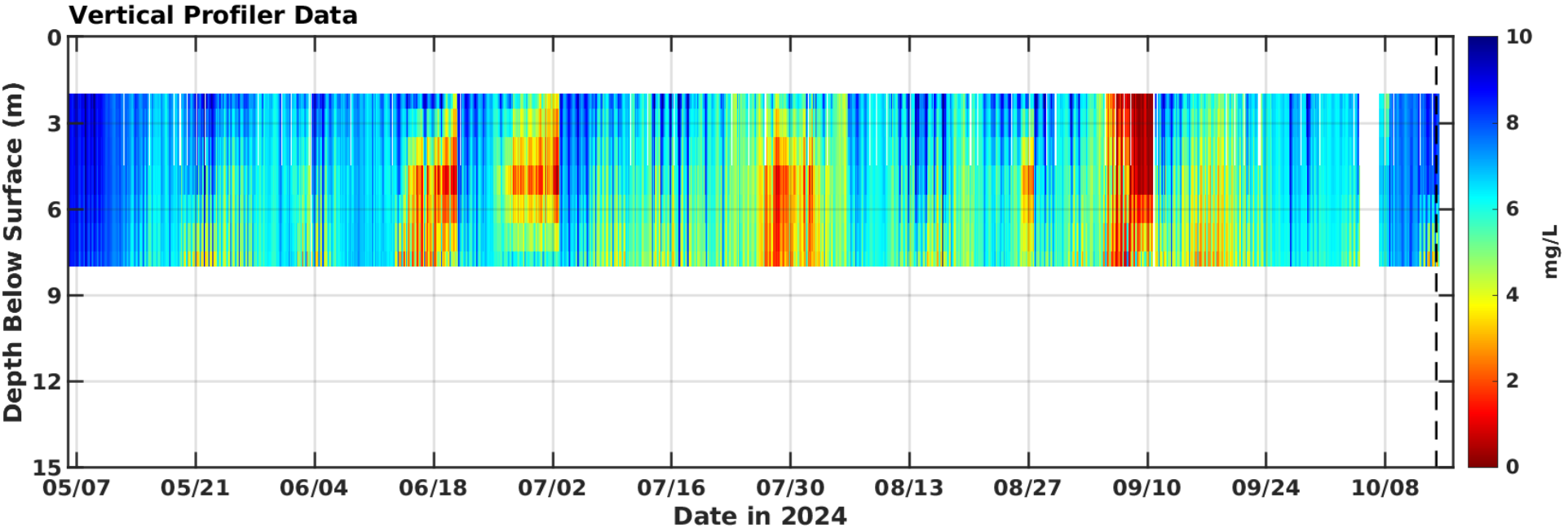
Lower Potomac (~12m deep)

- Mean surf./bott. O_2 reasonably captured.
- Periods of high/low O_2 at bottom are reasonably captured by the model. (Increase in bottom O_2 in early August is due to a storm.)
- High-frequency variability at bottom often underestimated (internal waves).

Mid-water column variability & vertical structure

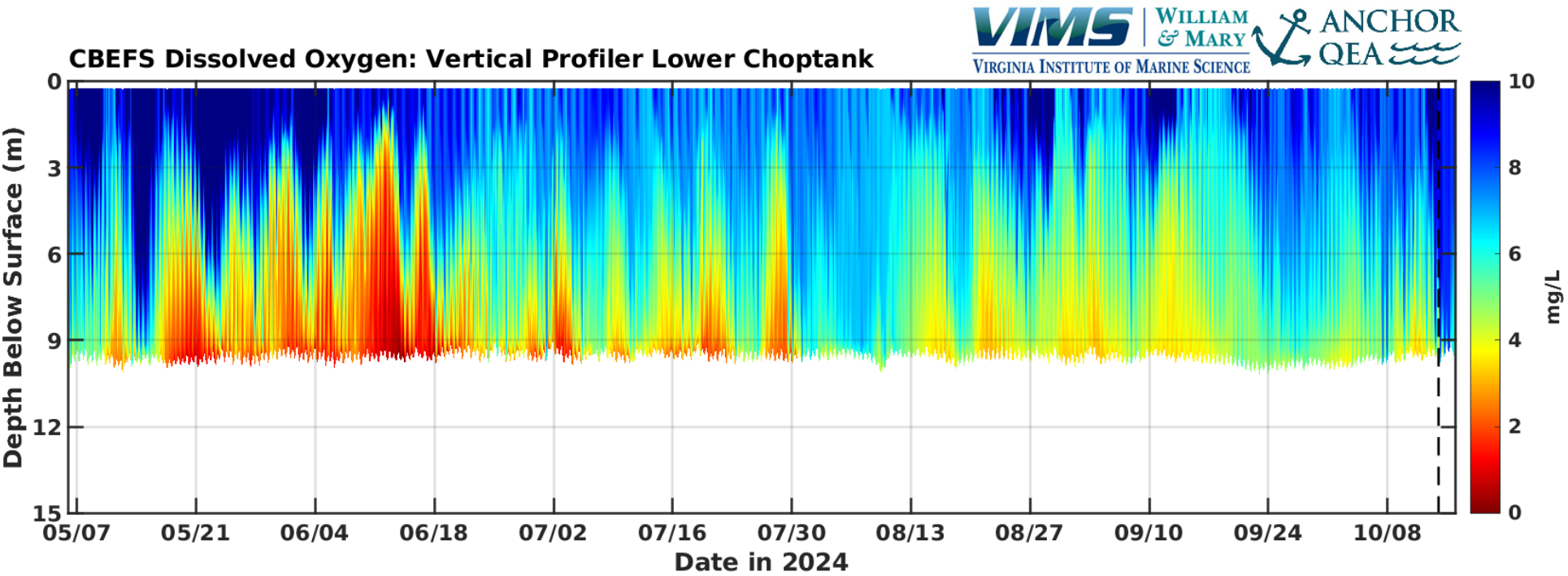


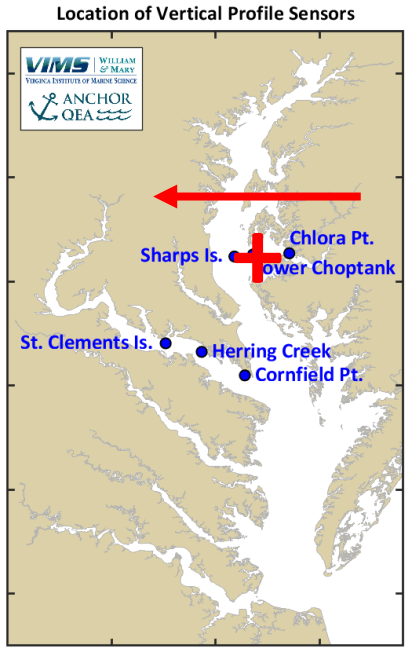




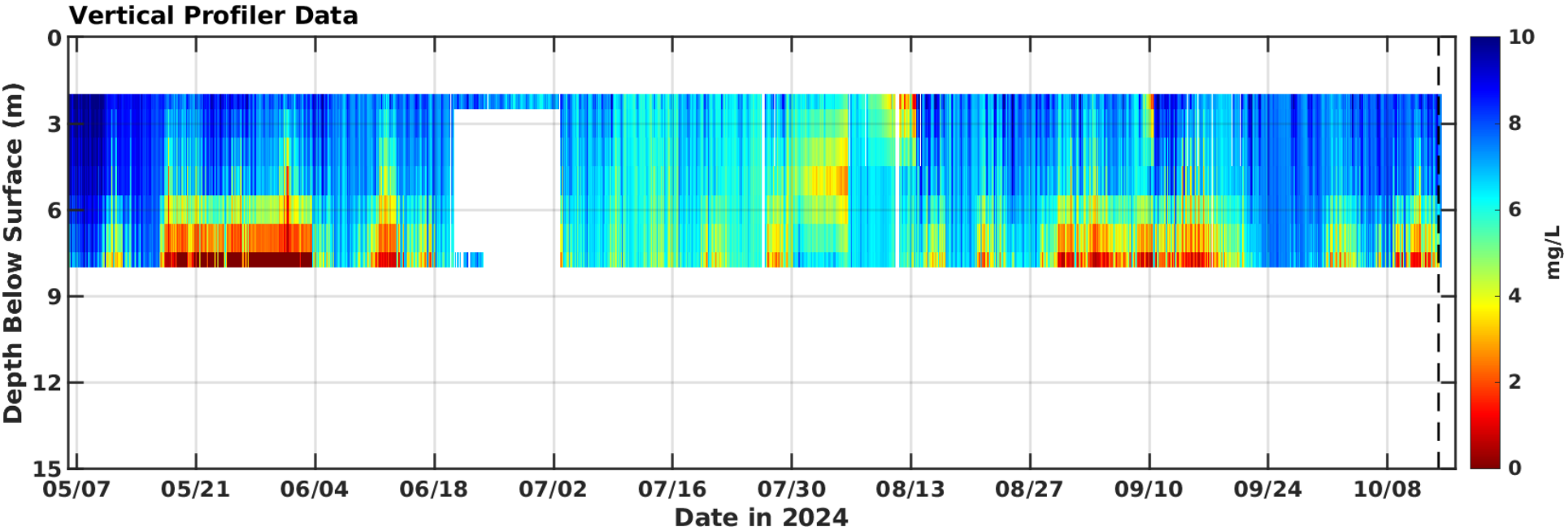
Upstream Choptank

- Mid-depth maximums (June 18,30; Aug.27, Sep.8) are difficult to rationalize and likely to be artefacts.
- Oxycline depth would be a great metric to evaluate model, but artefacts and limited vertical resolution are challenges.

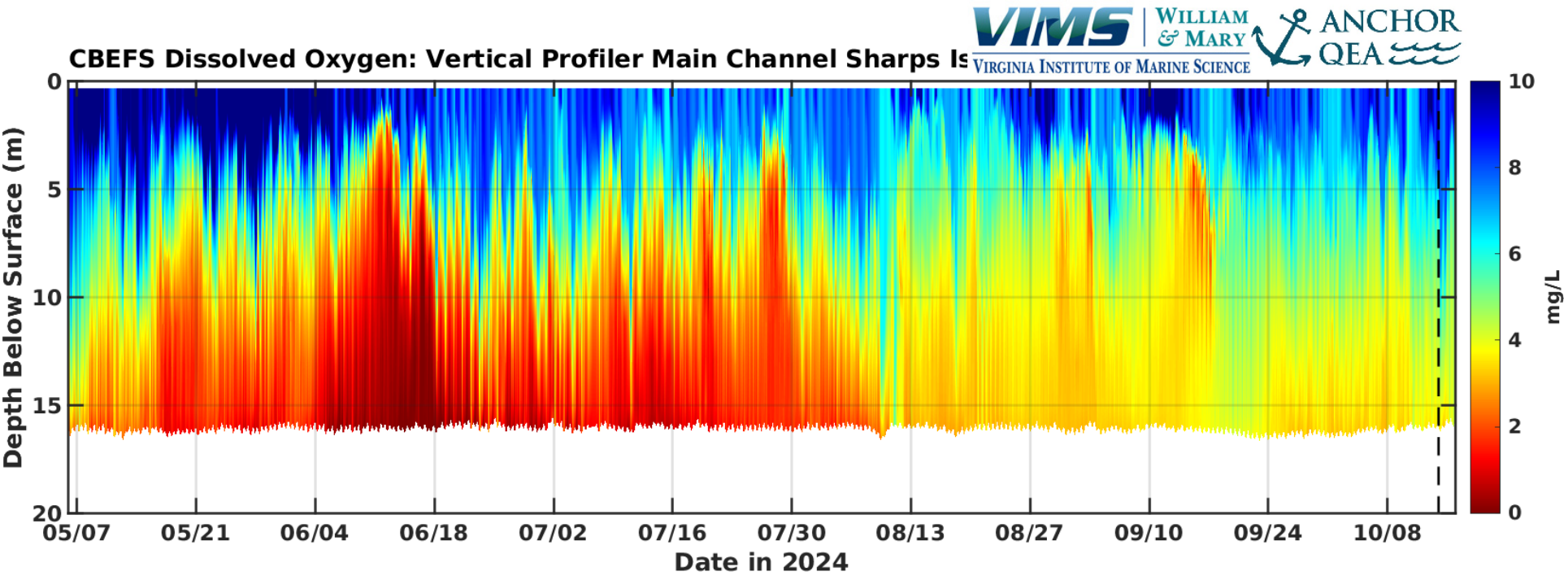


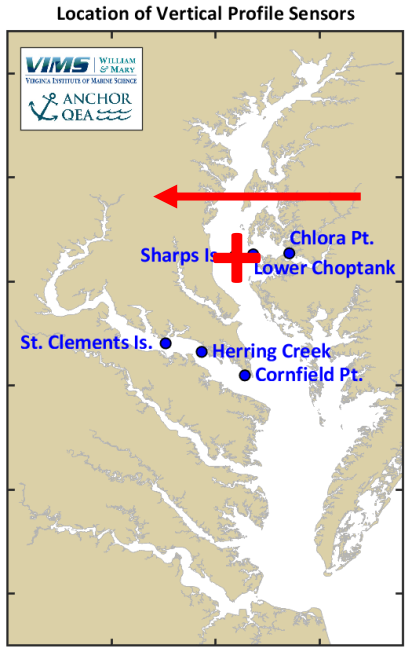


Central Choptank

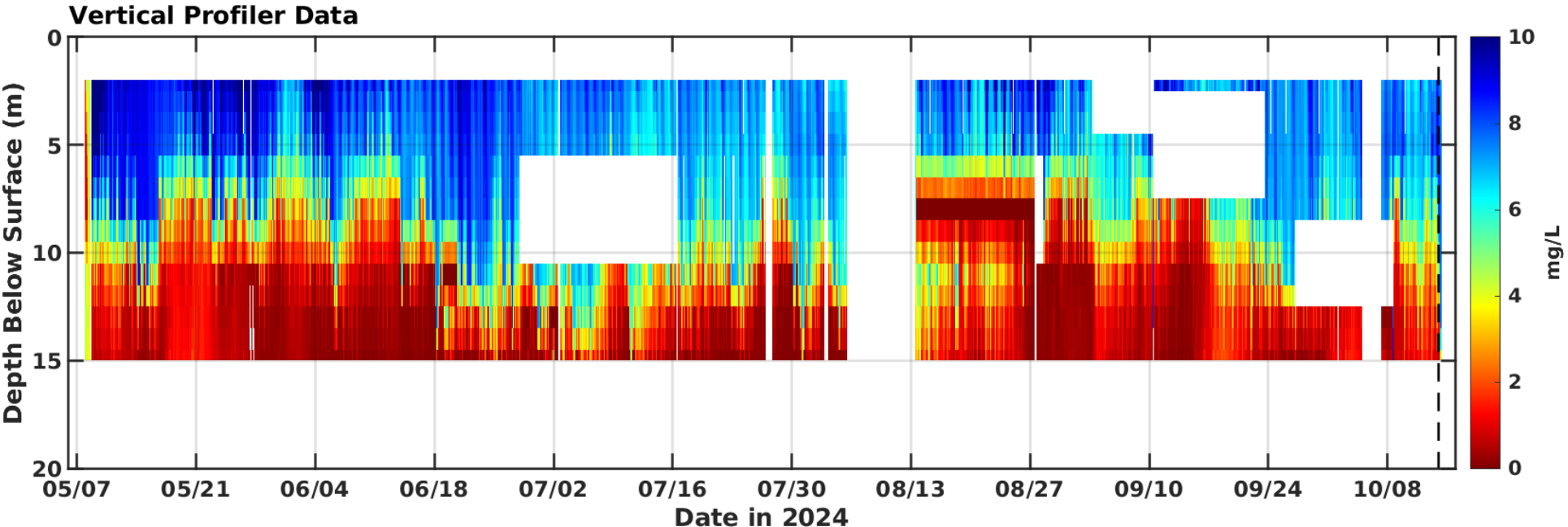


- Mid-depth maximums are difficult to rationalize and likely to be artefacts.

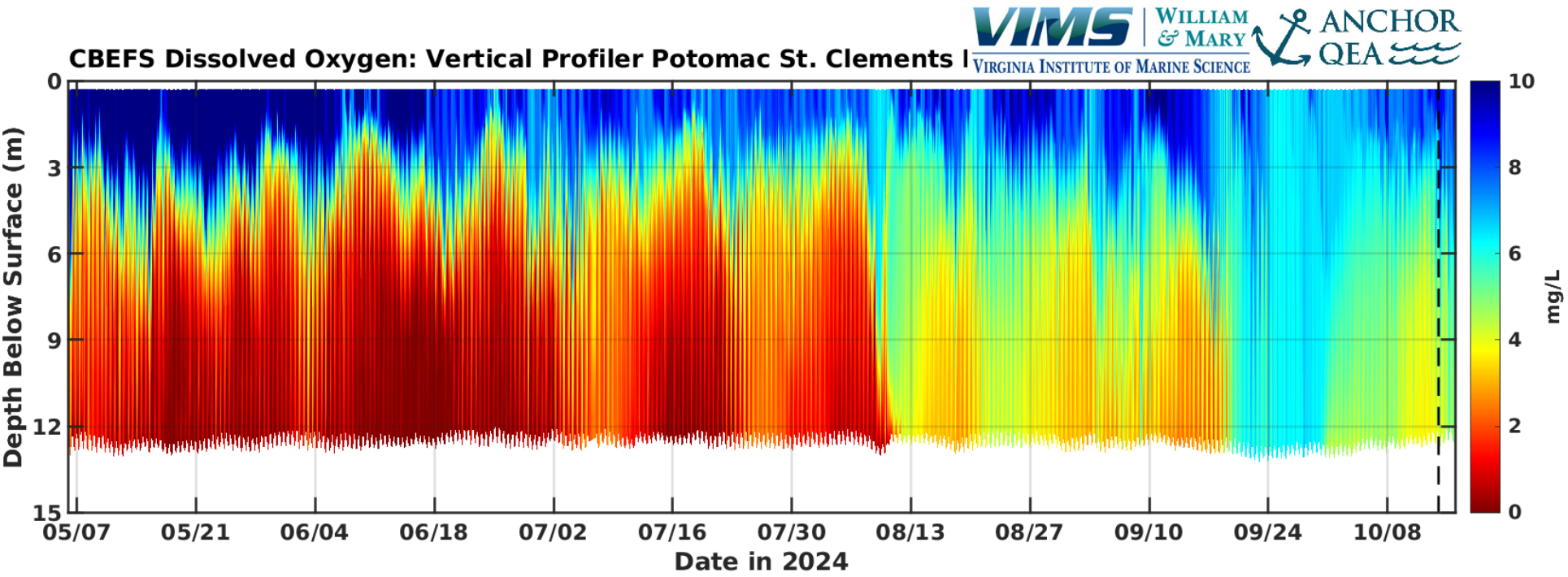


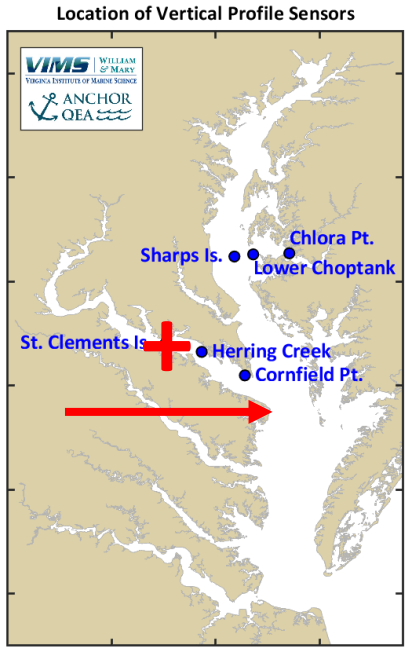


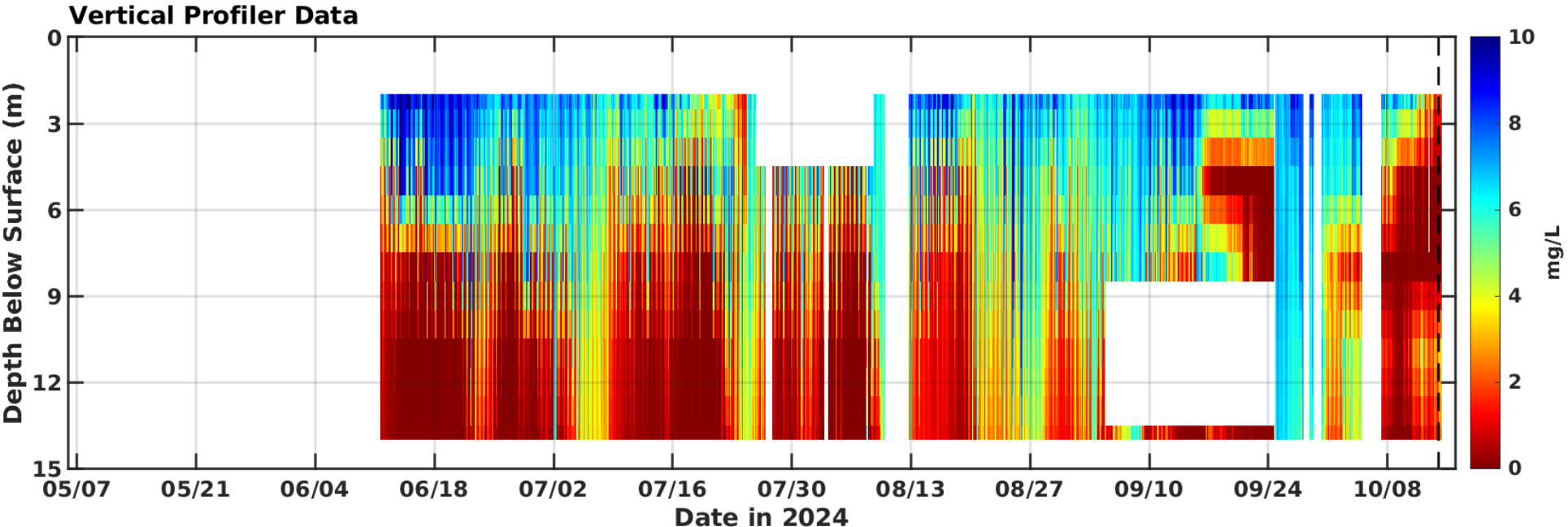
Lower Choptank



- Mid-depth maximums are difficult to rationalize and likely to be artefacts.

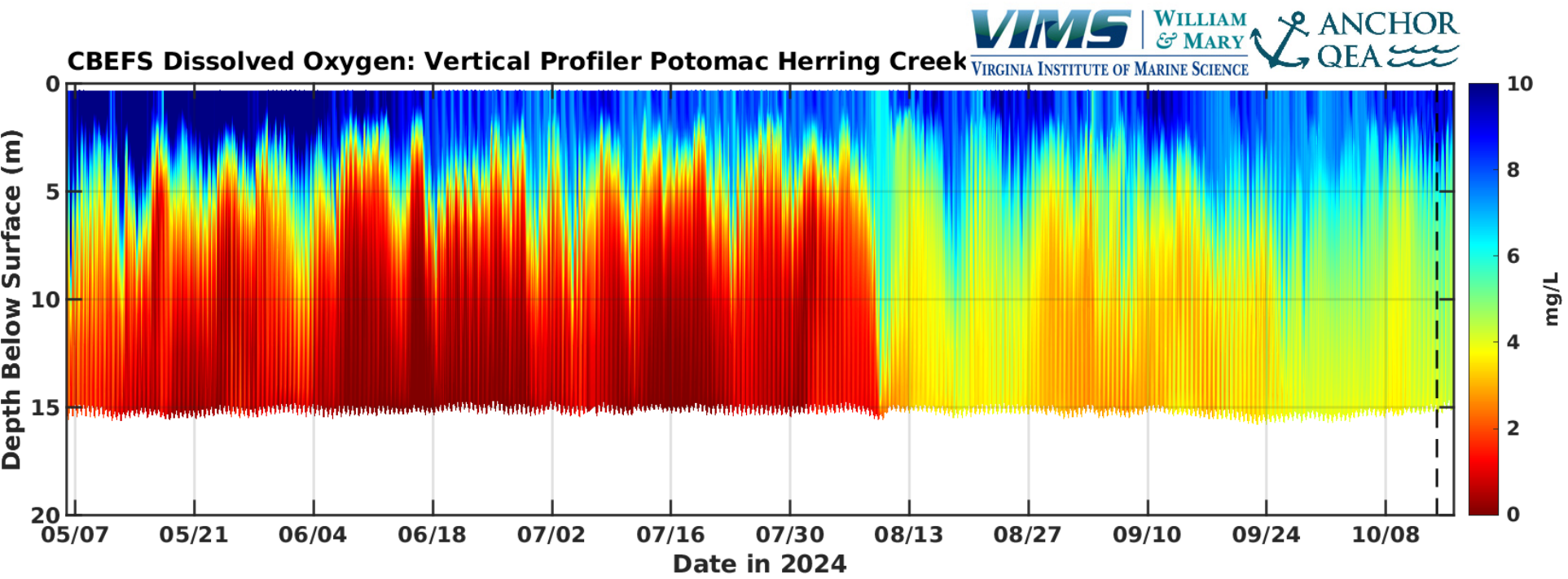


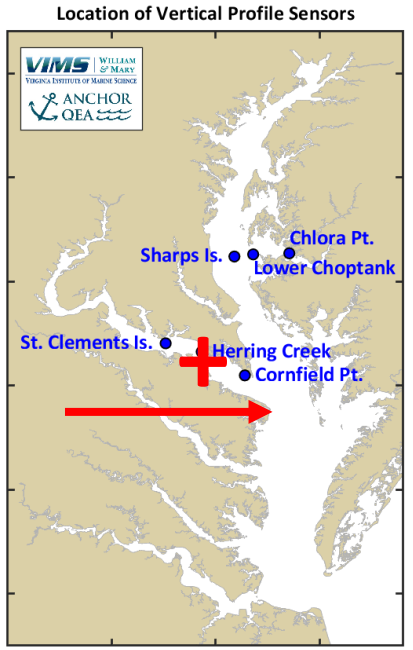


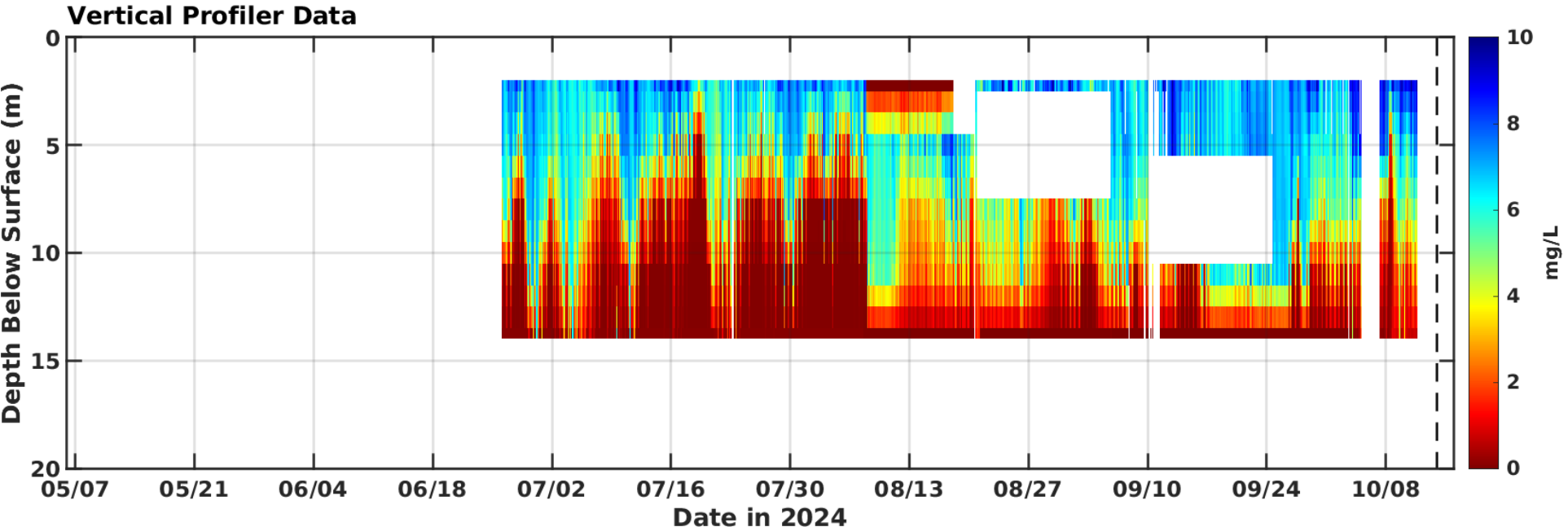


Upper Potomac

- Mid-depth maximums are difficult to rationalize and likely to be artefacts.
- Note systematic decrease in modeled O_2 around Aug.13 (storm). A similar decrease is apparent at the next station.

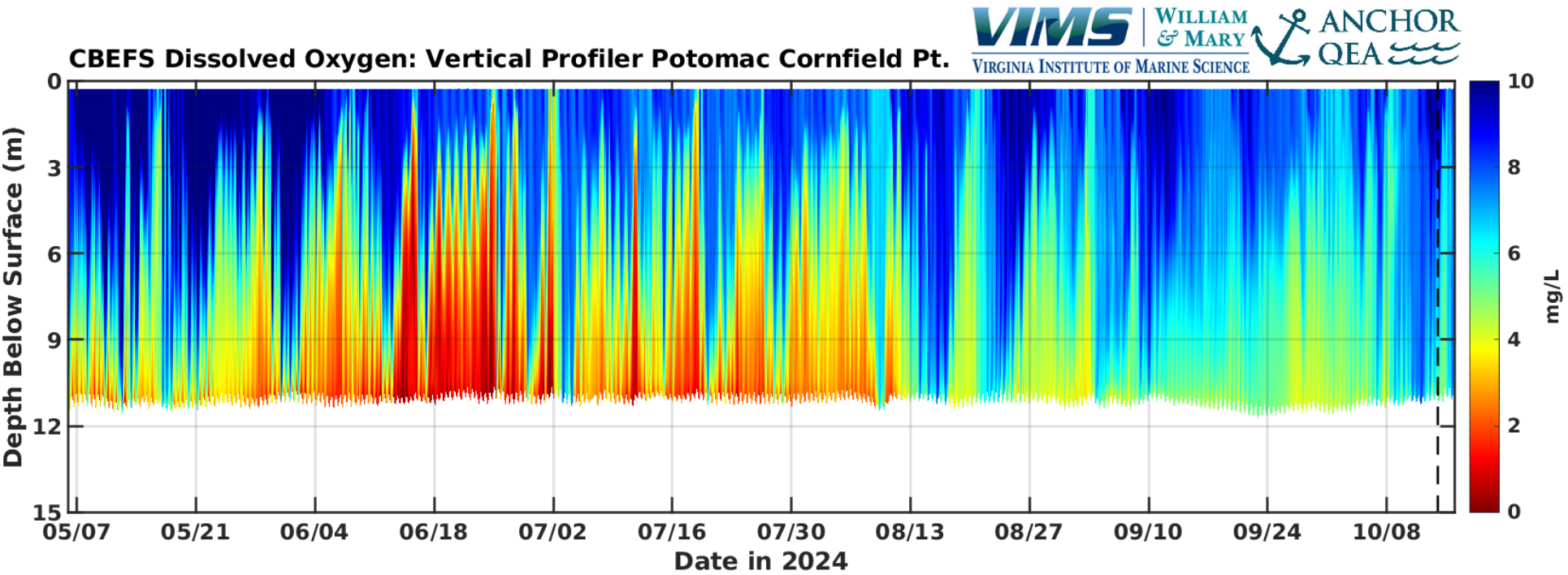


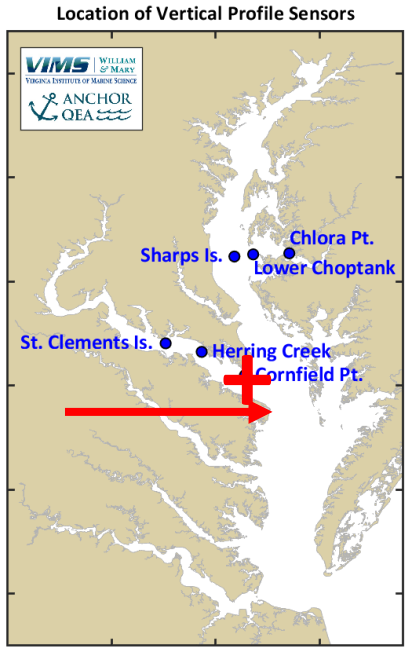




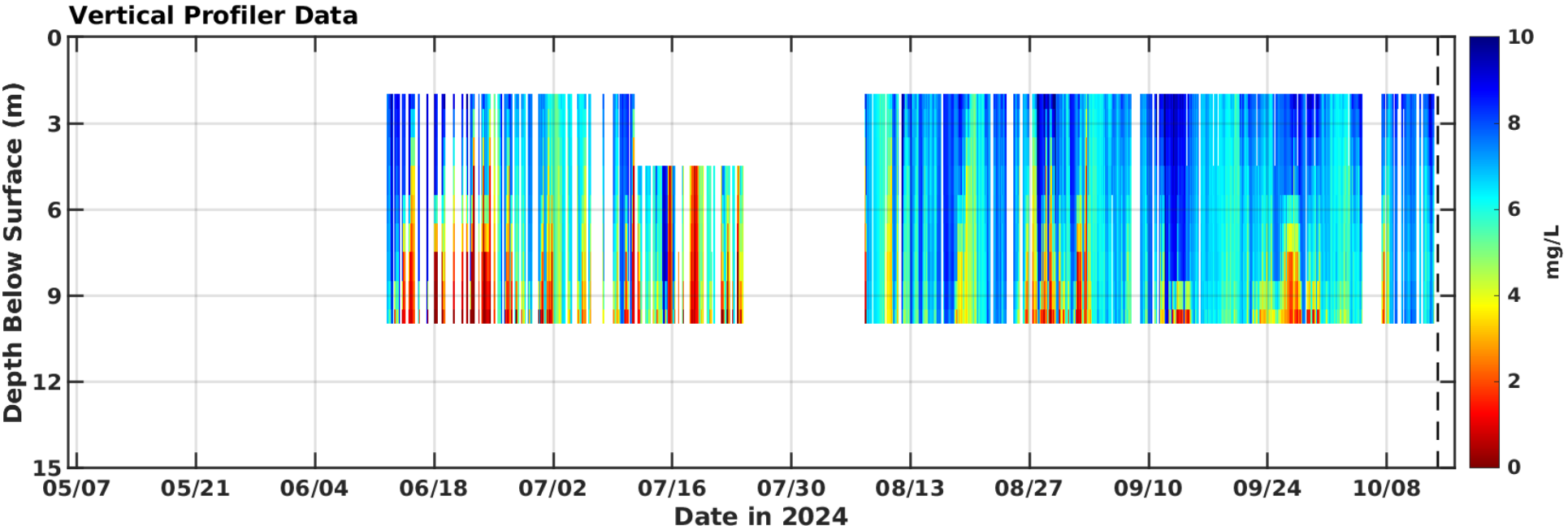
Central Potomac

- The systematic decrease in modeled O_2 around Aug.13 (storm) is apparent in both model/data, but the model exaggerates its impact.





Lower Potomac



Discussion

- I speculated that the variability of surface O_2 would be partly diurnal (solar cycle) and partly barotropic tide (12.42hrs), while bottom O_2 would be primarily internal tides (12.42hrs).

  If this hasn't been done already, one could conduct a spectral analysis on the data. It could confirm that the missing variability at the bottom is due to the limited resolution of the model and its inability to capture internal waves of wavelength *O*(100m).

- Scully 2016 (JGR-O) highlights events of wind-driven lateral tilting of the oxycline in the Bay's main stem. This is an entirely different mechanism that can drive similar oscillations in bottom O_2.

- An ongoing effort is use the profiles to fine-tune vertical mixing in the model (pycnocline and oxycline depth).

- A related effort investigates the response to the early August storm, which is apparent in the data (Central Potomac) but appears to be exaggerated by the model.

- These model improvements are likely to be reflected in the modeled hypoxic volumes computed during the summer period.

- Similar comparisons for temperature and salinity are publicly available on the CBEFS website. They are generally well captured by the model and thus less interesting, but salinity data provide a valuable counterpart to O_2 to evaluate biases in stratification (without the complication of biogeochemical processes).