POTOMAC TRIBUTARY MODEL DEVELOPMENT

MWCOG WATER RESOURCES
TECHNICAL COMMITTEE
September 9, 2022

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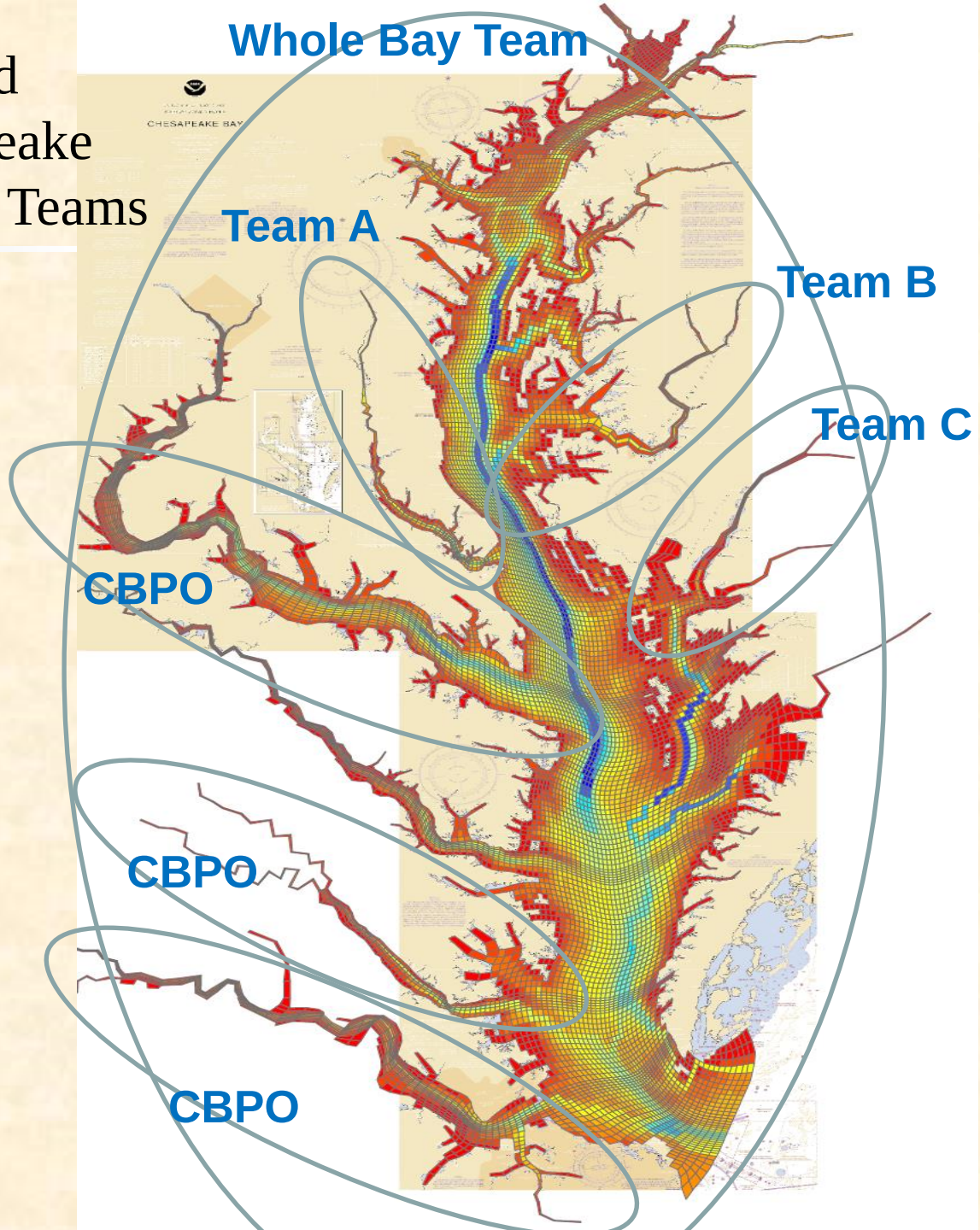
Chesapeake Bay Program
Science, Restoration, Partnership

An Unstructured Grid Model in the Chesapeake with Multiple Model Teams

- Main Bay Model (MBM) of all tidal waters is used for integration of MTM findings and for CBP TMDL management.
- Multiple Tributary Model (MTM) teams working in tributaries and sharing collaboratively information with all model teams on a monthly basis.
- Similar to CMAQ multiple model approach.
- CBPO in-house teams should do Potomac, James, and York.

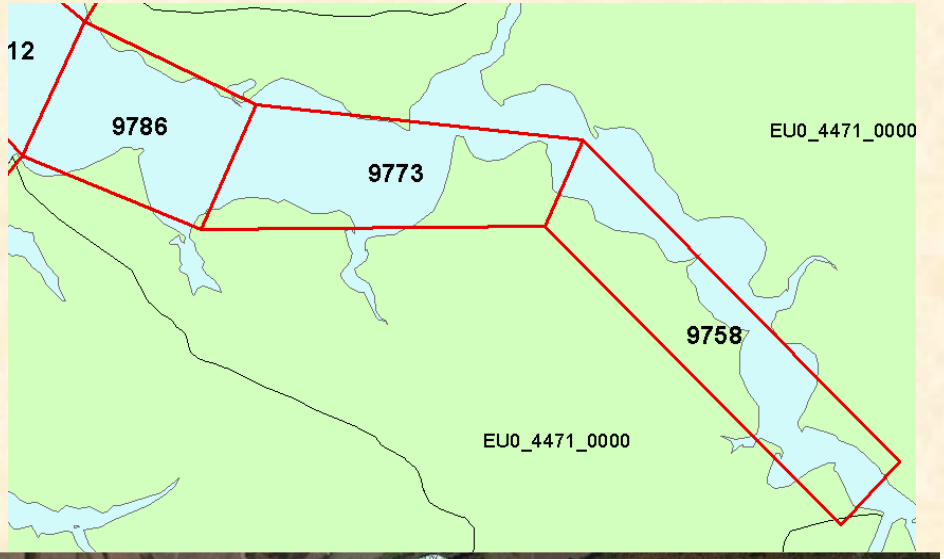


Motivation for Development and Application of MTMs

Improved Assessment of Shallow Water Processes. The MTMs will be able to better assess shallow water processes in the shallow Open-Water regions of the Bay. The majority of the 93 Chesapeake TMDL segments, also called designated uses, have only an Open-Water DO water quality standard and entirely lack Deep-Water DO and Deep Channel DO standards. The current 2017 CBP Bay Model is unable to effectively simulate shallow water Open-Water DO standards under climate change conditions. Generally, the simulation of shallow water processes are poorly understood and documented. The MTM models will provide the CBP partners with enhanced decision support tools for determining how to best restore and protect the Bay's extensive shallow water habitats. Also, the ability to better simulate the fate of key living resources under climate change such as SAV, tidal wetlands, etc. will be improved with MTMs.

Improved Assessment of Shallow Water Processes

The 2017 Bay Model had a three segment Corsica River. The Corsica River Shallow Water Test Bed for the MBM and MTMs has 5,029 cells with up to 20 m resolution and 5 sigma layers of depth.



The Watershed Model loading to the Corsica River in 2017 was on an order of a 30 square mile watershed that in Phase 7 will be quantified at about a one square mile watershed.

Motivation for Development and Application of MTMs

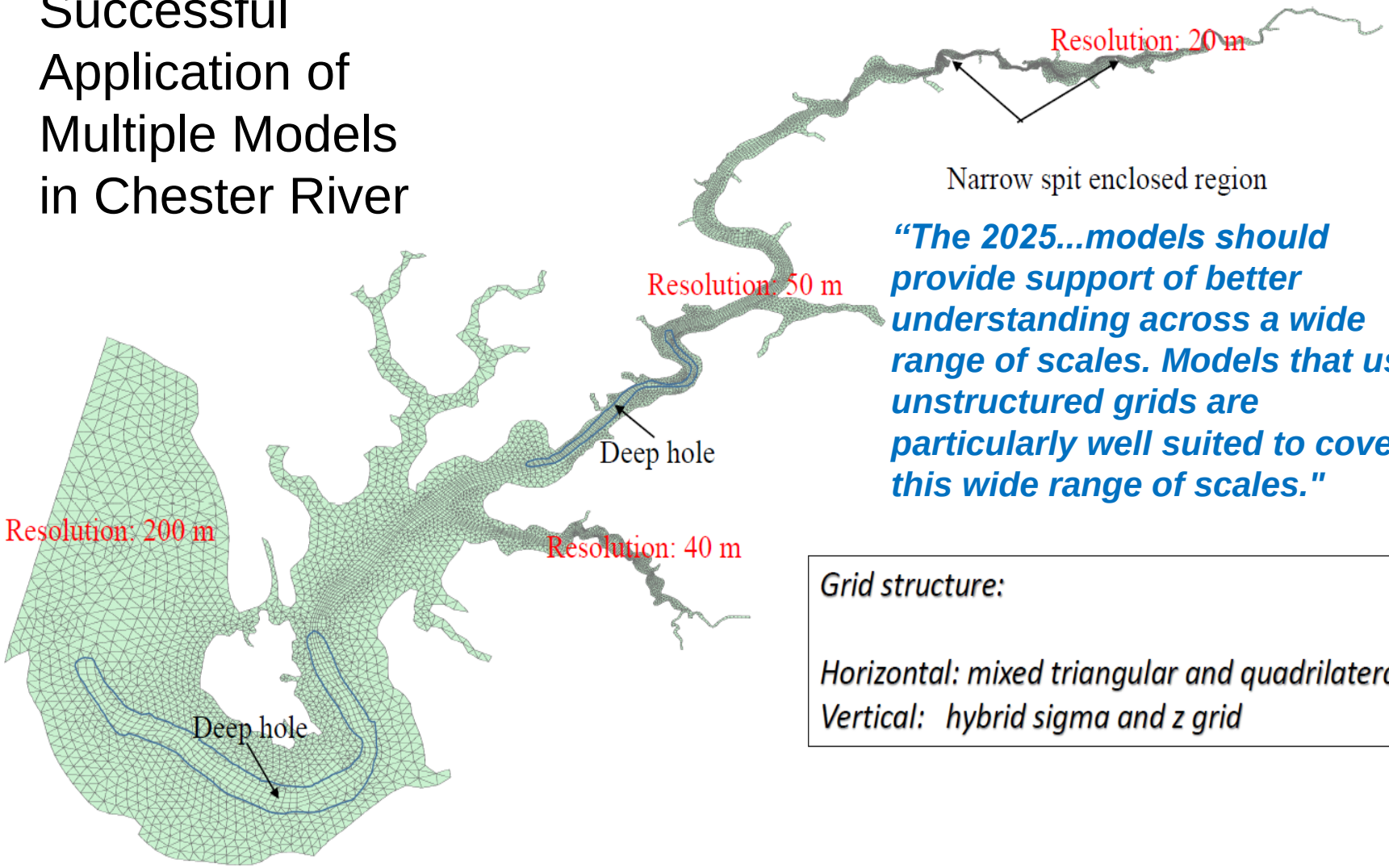
Assisting and Improving All Tidal Chesapeake TMDLs and Water Quality Assessments. The MTMs will be able to bring all the TMDLs in Chesapeake tidal waters up to date and link with the latest 2025 watershed, airshed, and estuary models. This will allow an updating and integration of local tidal Bay TMDLs completely into CBP's 2025 Chesapeake TMDL. A major advantage of the MTMs would be the ability for updating of all Chesapeake tidal water TMDLs to future climate change conditions and to have them be entirely consistent among themselves and to the overall Chesapeake TMDL.

Motivation for Development and Application of MTMs

Improving CBP Science, Analysis, and Implementation for Chesapeake Climate Change Impacts. The MTMs will fully integrate and dovetail into the MBM by increasing the CBP science teams looking into Chesapeake water quality issues. Over the course of the project, five MTM modeling teams will apply a fine scale grid in the tributaries that will share the same unstructed model codes, water quality state variables, and watershed and airshed loading as the MBM. The MTM teams will improve Chesapeake Bay shallow water simulations of dissolved oxygen, chlorophyll, suspended solids, and water clarity in order to better understand the impacts of alternative management strategies on water quality and living resources in the tidal Chesapeake Bay. In addition, the MTMs will be able to utilize the CBP investment in shallow water continuous monitoring for the first time in the Chesapeake TMDL. The MTMs will augment the MBM in a collaborative investigatory approach with the MBM team collaborating and coordinating with the five MTM teams on a monthly basis over the entire project period. Under this structure the MBM and MTM teams will learn from each other in understanding and simulating newly developed shallow water nutrient dynamics and processes, improving both the MBM and the MTMs and the estuarine restoration implementation work they support.

An Example of an Unstructured Grid Model in the Chesapeake

Successful Application of Multiple Models in Chester River



"The 2025...models should provide support of better understanding across a wide range of scales. Models that use unstructured grids are particularly well suited to cover this wide range of scales."

Grid structure:

Horizontal: mixed triangular and quadrilateral
Vertical: hybrid sigma and z grid

Source: Chester River Hydrodynamic and Water Quality Modeling using SCHISM/HEM3D. Wang, Zhang, et al. *STAC Shallow Water Modeling Workshop* April 20, 2016

Motivation for Development and Application of MTMs

Resolving Special Issues - James River Chlorophyll Assessment. The MTMs will be able to resolve special issues like the James Chlorophyll Assessment. The James River chlorophyll Assessment is currently oriented to 2025 climate change conditions but there is an interest in updating the assessment for climate change conditions anticipated beyond 2025. With the MTMs this can be done by taking advantage of the CBP work in the assessment of 2035 conditions with updated watershed, airshed, and estuary models and in leveraging the combined analysis to provide the most complete assessment available for the James Chlorophyll Assessment at least cost.

Motivation for Development and Application of MTMs

Adherence to STAC Guidance on Bay Modeling.
The MTMs support the recommendations by STAC in the 2019 report *Chesapeake Bay Program Modeling in 2025 and Beyond: A Proactive Visioning**

* Hood, R.R., G. Shenk, R. Dixon, W. Ball, J. Bash, C. Cerco, P. Claggett, L. Harris, T.F. Ihde, L. Linker, C. Sherwood, and L. Wainger. 2019. Chesapeake Bay Program Modeling in 2025 and Beyond: A Proactive Visioning Workshop. STAC Publication Number 19-002, Edgewater, MD. 62 pages.

2022 RFA for Development and Application of MTMs

- EPA is developing a 2022 RFA to support three MTM teams.
- CBPO can support two in-house MTM teams.
- CBPO can also complete a York MTM based on Nicole Cai's previous work in the York.
- Who decides which tributaries will have MTMs? WQGIT decides – Mod WG will propose criteria matrix.
- Assume MTM project begins ~ first Quarter of 2023.
- The MTMs will have the following timeline: 2025 Fully Operational, 2026 CBP Review, and 2027 CBP Application.
- The MTM teams will work in close collaboration with each other and with the MBM team.

2022 RFA for Development and Application of MTMs

- Suggest CBP partners reserve the Potomac, James, and York for CBPO in-house MTM work because of possible assessments that could be done by VA, MD, and/or DC in 2027 or beyond.
- The WQGIT will choose the five tributaries for MTM development and application. The WQGIT should confirm that the Potomac & James should be included in the MTMs chosen even though CBPO does the MTM work for them.
- The WQGIT can choose among the Patuxent, Choptank, Rappahannock, Chester, Nanticoke/Wicomico, and other tributaries for the three RFA MTMs.
- The August WQGIT initiates the discussion of the process for the selection of the three tributaries to be assessed by MTMs.

Criteria CBP Partners could use for MTM selection:

- Prioritize tributaries with management challenges.
- Prioritize well-studied tributaries with multiple monitoring and shallow water monitoring sites and with a sizeable body of research.
- Prioritize tributaries with oyster sanctuaries and/or a high concentration of filter feeder aquaculture.
- Prioritize tributaries that have, or are adjacent to, the new high frequency tidal monitoring sensors being deployed in 2022-2023.
- Prioritize tributaries with a relatively high number of local TMDLs.

Criteria CBP Partners could use for MTM selection:

- Large tributaries should be prioritized.
- Prioritize tributaries that can best support and inform water quality processes in the Chesapeake Bay Main Bay Model (MBM).
- Prioritize tributaries where current model performance with the CBP 2017 Bay Model is particularly deficient.
- Assuming that the Potomac, James, and York are a given for MTM work, the Eastern Shore tributaries are underrepresented. Two or more East Shore tributaries should be considered for MTMs.

Section of an Example Criteria Matrix

		Potomac		James		York	
Selection Criteria	1-3 with 3 being the highest weight.	Value	Weighted Value	Value	Weighted Value	Value	Weighted Value
Prioritize tributaries with management challenges.	Partnership Defined = 3	1	3	1	3	1	3
Prioritize tributaries with local TMDLs and water quality assessments that would benefit from hamonizing with the Chesapeake TMDL and updating to 2035 cliamte change conditions.	Partnership Defined = 3	1	3	1	3	0	0
Prioritize well-studied tributaries with multiple monitoring and shallow water monitoring sites and with a sizeable body of research.	Partnership Defined =2	1	2	1	2	1	2
Prioritize tributaries with oyster sanctuaries and/or a high concentration of filter feeder aquaculture.	Partnership Defined = 2	1	2	1	2	1	2
Prioritize tributaries with continuous hypoxia vertical profilers (The locations of the two pilot locations are CB4.3E and CB4.3W)	Partnership Defined = 1	1	1	0	0	0	0