



Modeling Workgroup Quarterly Review

January 4, 2022

Event webpage: [Link](#)

This meeting was recorded for internal use to assure the accuracy of meeting notes.

9:00 Announcements and Amendments to the Agenda – Mark Bennett, USGS and Dave Montali, Tetra Tech

9:05 [Outlining an Initial Watershed Model Phase 7 Work Plan](#) – Gary Shenk, USGS-CBPO

Gary discussed a draft Phase 7 Workplan outline that's responsive to the discussions and recommendations provided in November and December by the Water Quality Goal Implementation Team (WQGIT) and other Goal Implementation Team (GIT) chairs. Further input from the Scientific and Technical Advisory Committee (STAC), water quantity partners, and collaborating scientists was incorporated.

Summary

Gary began by sharing the overall scope of feedback in terms of the providers and context of their comments. The main categories of feedback from the WQGIT were nutrient application, improve climate modeling, physical process simulation, uncertainty quantification, co-benefits, fine-scale, multi-scale, and other. Gary then discussed the feedback from other GITs, goals, and outcomes before paraphrasing the feedback from STAC on Phase 6, Phase 7, and modeling efforts going forward. Gary concluded with the initial outline and draft of the Phase 7 Model tentative schedule.

9:45 Discussion of Initial Watershed Model Phase 7 Work Plan

Summary

Bill Keeling asked about the scope of feedback from Gary's presentation. Gary responded that the comments being considered are from members or the WQGIT and chairs of other GITs. These are not the final recommendations of the WQGIT or other GITs, but are instead comments gathered from individual and group meetings. These comments reflect input that have been gathered so far, and are not finalized.

Dave Montali asked about a potential disconnect between the timeline for years 2022 and 2023 and when the Agriculture Census data becomes available in 2024/2025. Gary responded that they are working on using the 10m product as it is now in Phase 6 of the Watershed Model and then converting when available to the new data. Lew commented that the model needs to advance on all fronts even while still waiting on data, so Phase 6 outputs will be necessary until they can be replaced with Phase 7 outputs. Olivia Devereux commented all of the agricultural inputs are still at the county scale and are being disaggregated to smaller scales in relation to the Agriculture Census data. Olivia added that the Chesapeake Assessment Scenario Tool (CAST) is currently undergoing maintenance and will run quickly for the entire Chesapeake Bay Watershed but

should be up shortly. Gary agreed that scale will not be an issue for running CAST, but may be more difficult when involving optimization.

Lew commented that Gary's presentation highlights how Phase 7 development is in the midst of planning and throughout the process the modeling team will be incorporating feedback. Lew emphasized the modeling team will return to the WQGIT to get more feedback and present a more finalized version of the workplan, but that it will not truly be final as the modeling team will respond dynamically to changes and the situation.

Bill Keeling asked about the importance of updating the model and if there is groundbreaking, new research which requires the updates to the model to work more effectively. Gary responded it's a valid question and that some parts of the model will not likely see many updates, but other parts may need updating and there was feedback from the WQGIT to review the model. Loretta Collins agreed that some parts need review, while other parts not so much. Loretta perceived it as measure to be thorough and make adjustments, not completely revise everything. Bill asked if one of the primary roles of the model is to help managers with planning purposes and many plan at the current scale of the model, why is there a need to move to finer resolution. Gary said that he hears what Bill is saying, but that there is a lot of demand in the partnership to include more functionality within the model. Bill expressed that he would like less in the model and that there should be two different tools to answer the questions of the current state and hypotheticals. Bill also expressed that he wants outputs to be at the same scale as the planning targets. Lew said that's a fair comment about the scale, but that the partnership is very wide and very are many different interests. Lew emphasized Kristen Saunders's comment in the chat which said on behalf of the chairs of the other goal implementation teams, thank you for taking the extra time to walk through all the model information and considering their feedback and input. Dave urged Bill to continue raising these concerns at future Modeling and WQGIT meetings.

10:00 [Progress in Phase 7 WSM Development](#) – Gopal Bhatt (Penn State)

Gopal provided a progress update on the extension of the watershed model simulation period to year 2020. With this effort the simulation period is being increased from 30 years (1985-2014) to 36 years (1985-2020). It is being done without any recalibration of the model but with an anticipation that the simulation period can be extended periodically for supporting various partnership needs leading up to the development of Phase 7 Model and beyond. The presentation described some of the key data processing steps, refinements, along with an analysis of model results.

Summary

Gopal began with a reminder of the purpose of this extension effort, explaining the four main reasons for this work: collaborating with the Chesapeake Hypoxia Analysis and Modeling Program (CHAMP) and STAC Climate Change 2.0 workshop request; supporting a non-tidal Total Maximum Daily Load (TMDL) local indicator that has a lag-time component; developing a workflow for supporting periodic extension of the model simulation period; and phase 7 model development, calibration, and applications. The first section of the presentation focused on rainfall and meteorological inputs. The second section focused on the estimation of atmospheric Nitrogen deposition. The third section focused on other inputs for the model prototype. The fourth section focused on model results and prototype verification. Gopal also compared Phase 6 and the extension to the Weighted Regressions on Time, Discharge, and Season model (WRTDS) using the loads from River Input Monitoring (RIM) stations. Gopal concluded with a summary which emphasized that the Watershed Model simulation period was extended from 30

years (1985-2014) to 36 years (1985-2020); the model prototype developed using draft datasets performed well showing good agreement with simulation for the shorter time period; the differences as compared to USGS-WRTDS loads were due to changes in the WRTDS data; and the model will be ready for providing 1985-2020 data needed for various efforts after best available inputs are incorporated in the model simulation.

10:30 Discussion of Phase 7 WSM Development Progress

Summary

Lew commented that this is solid progress for Phase 7 development and expressed he was impressed by the annual air temperature graph on slide 6 and stated that the Phase 7 model should very carefully correct for average annual temperature increases. Lew also brought up the implications of changes in the growing season as a future area to explore. Gopal agreed and added that these changes fall within the category of process improvement.

Dave asked about the lagging of loads for the dynamic model and if there was new research that would inform Phase 7, or if it would draw from Phase 6. Gopal explained that there might be some new research there, but there are other tune ups that might need to be completed, such as certain assumptions for lag estimates.

Isabella mentioned the significant difference between the WRTDS results from 2014 and the WRTDS-k results from 2020 and that it is most likely caused by changes in methodology. The developer of WRTDS, Bob Hersch, has shown that the WRTDS-k model for 2020 is a superior model. Qian Zhang added that the most recent about for the RIMs uses the WRTDS-k approach and suggested comparing methodologies to quickly confirm what Isabella suggested. Qian added that the differences in the table can plausibly be explained by the differences in this methodology.

Guido Yactayo asked about climate change downscaling given it being a major source of uncertainty and if it would be a focus of future work. Guido asked about the calibration of the model and asked if it would only focus on hydrology, or if it would also focus on nutrients. Gopal agreed that the highest degree of uncertainty for climate change depends on the downscaling method. Gopal shared that currently they have been using an extrapolation of historical trends of temperature. Gopal added that they are comparing this extrapolation with Intensity, Duration, Frequency (IDF) curves and other potential methods. For calibration, Gopal responded that they should expect work for both nutrients and hydrology. There has not been in depth discussion yet nor a determination on if there will be new methodology for calibration.

Bill Ball asked about if there will be calibration for lag in understanding nutrients. Gopal said that is a good idea and it has been talked about, but not in detail.

10:45 [Representation of Small Impoundments in the Phase 7 Watershed Model](#) – Labeeb Ahmed, USGS-CBPO

Labeeb Ahmed described the work his team is doing to place small ponds and impoundments that are not storm water facilities into the Chesapeake Bay Program (CBP) land use and into Phase 7 Watershed Model consideration. Studies by Jud Harvey, Noah Schmadel, and others have shed some light on the influence these landscape features have in reducing nutrient and sediment loads, and their work could assist in

filling gaps in our understanding of the watershed dynamics of small impoundments in retention of nutrients and sediment.

Summary

Labeeb began by introducing the importance of small ponds and impoundments for water quality. Labeeb explained that currently there is poor inventory of pond features on the landscape and overviewed some of the current and previous data products for these features. Some of the data products have issues with crude geometries not aligning with elevation and/or imagery, while surface water mapping has issues with shadows, eutrophication, and tree canopy. Additionally, some water treatment facilities and man-made pond like features were mistakenly identified. Labeeb then reviewed pond metrics based on preliminary results across the watershed and noted some artifacts in the data in different counties.

11:15 Discussion of Small Impoundments in the Phase 7 Watershed Model

Summary

Lew Linker commented that for man-made ponds (and a few natural ponds and reservoirs) in the landscape, they are akin to black holes where nutrients go in and generally do not come out. Lew said that there must be a delineation between nutrient sinks and stormwater management. He also emphasized the importance of knowing the associated watershed area for impoundments, whether NHD or land river segment. Labeeb followed up with Lew asking about which exact watershed area scale was being proposed. Lew said NHD scale would be ideal but there is no formal decision on scale yet. Lew added that ponds in the rural areas are much more of interest than ones in urban areas that might be associated with stormwater management. If it is not possible to distinguish between stormwater storage, maybe it is best to not include it at all to prevent errors of commission. Peter Claggett stated that it is very unlikely they can remove all the stormwater Best Management Practice (BMP) impoundments unless they have all their coordinates. Peter added that the tradeoff is between errors of omission and commission. Peter suggested one potential methodology where ponds with no drainage area (as identified by LiDAR) can be removed from the model as the assumption would be that those are stormwater impoundments. Lew said this is potentially a good path forward and said that even generalizing the amount of area associate with ponds in an NHD segment or even a watershed would be helpful as currently the model does not count these impoundments at all.

Dave Montali agreed with Lew's comments and said we need that delineation to prevent double counting. Dave asked if the 2017 data was used the prototype and the prototype will be applied to new imagery going forward. Labeeb confirmed that yes, this was done with version 1 data and once version 2 land cover data is available this methodology will be applied. Dave asked if there are locations where the water not identified where it should have been, or if it was identified where there was not water. Labeeb commented at this point, they do not know how many issues (mis-identified water, false water) the version 2 data will fix, but they will take steps to minimize false water.

Gary Shenk commented that in reference to the model paper cited in the presentation, the authors used classifications and coefficients to identify target areas. Gary suggested it may be possible to take those classifications and coefficients and apply them within Cal-CAST to do the

calculations there. Gary said this is something that can be brought to a smaller group where these details can be explored. Dave asked if we are already capturing this information in the land to water factors, and if this would be used instead of land to water factors. Gary responded that these actions would help inform the usage of the land to water factors.

In the chat, Gopal Bhatt asked Labeeb, did you also compare the farm pond acres in addition to numbers and If so how did the differences stacked up. Labeeb responded he needs to review his notes, but that he has not done a complete comparison since the data is still preliminary. Karl Berger agreed with Gopal and expressed that the numbers seem really high to him, but it would be better to know acreage extent compared to total acreage of the other land uses in a land-river segment. Gopal said that acreage would be a helpful metric to have and agreed with Gary's comments about that information that could be made in Cal-CAST.

KC Filippino asked if Labeeb would please come back to the Land Use Workgroup on this topic as it seems this would/should be part of the accuracy assessment for this dataset as well.

Robert Burgholzer asked in the chat if they can separate BMPs from other ponds simply by doing a count of BMP ponds that are reported by segment, then eliminate that much volume from the simulation. Dave responded that it would be variable by jurisdiction and may not be discernable from the current data. Lew stated this would be an interesting path forward to consider, but may not be possible.

In the chat, Olivia Devereux said water filtration facilities are a real issue. Some states are reporting those loads in their annual point source data, other states are not. ECHO includes many facilities not in the model. A presentation about the water filtration facilities and their loads is scheduled for [Thursday, January 6th's Watershed Technical Workgroup meeting](#).

Labeeb will share his metrics with Gopal and Gary and offered to return and present at the Modeling Workgroup and Land Use Workgroup.

11:30 BREAK

12:00 [Optimization Update: Integration with CAST – Gregorio Toscano, Kalyan Deb, Pouyan Nejadhashemi, Sebastian Hernandez-Suarez, and Julian Blank, MSU](#)

Substantial progress on the web interface needed for the CBP user testing by the Optimization Guidance Group was presented and discussed.

Summary

The optimization team showed a video that Gregorio developed showcasing the current optimization interface and how to run optimizations suiting particular needs. Gregorio then did a live demonstration.

12:30 Optimization Discussion

Lew asked if this video will be available for potential future optimization users. Pouyan responded that yes, the optimization has been made available on the calendar webpage for the event (linked above) and will be accessible for future users, as will other demonstration videos

Lew asked if it would be possible to compare at a county level the Watershed Implementation Plan (WIP) III optimized for cost with an optimized WIP. Lew also asked if then the cost savings between different optimizations can be clearly shown and if so when can it be done and what utility might be found. Pouyan responded that typically in this case a tier system is used and multiple tiers have already been built and can be utilized by different members of the optimization team. Pouyan added that the optimization team can utilize what they call wireframe, which will allow different sets of users to optimize based on their needs while using the same data.

George Onyullo asked in the chat and Dave Montali asked verbally if would it be possible for the tool to incorporate other scales beyond the Land River Segment and for future versions to have different geography options. Pouyan responded that yes, there can be several scales including county, state, and the entire Chesapeake Bay Watershed. Pouyan explained these different geographical options will be available later on in the timeline of the optimization development. Dave suggested following a format similar to CAST so as to reduce any redundant effort.

Norm Goulet commented in the chat that Virginia WIPS were built up from the Planning District Commissions (PDC), not the Counties Planning District Commission. Olivia Devereux commented in the chat that they do have PDCs in CAST.

George Onyullo asked in chat if optimization be done on a load sector basis. Pouyan responded yes, this is possible.

Lew suggested a marketing example, like optimizing for the counties from Delaware, West Virginia, or New York within the watershed, to reach more users and demonstrate the cost savings the optimization team can provide. Pouyan and Gregorio responded that while they do not have all the BMPs in at the moment, they have started with all the efficiency BMPs and are testing each category so that they will all be included eventually.

Dave made a pitch for more participants in the optimization guidance group. They only meet once every three months for an hour and it is important to have representatives from different geographies and backgrounds. Reach out to Dave or Lew if you want to participate.

Norm Goulet commented that the optimization method is technically impressive, but in the state of Virginia neither the county nor the state can dictate to a developer which type of BMP is installed. Norm added counties and states are not the “customers” of the tools and said the optimization tool does not have influence over the development on the ground. Pouyan responded this needs to be split into two different components: the different scale options and the role of optimization. Pouyan said an optimization can be used for whichever boundary is needed. Pouyan emphasized that optimization helps guiding the right BMP to the right place and it part of the process towards establishing necessary BMPs. It is not the end of the process. Pouyan and Norm agreed to continue this conversation offline.

12:45 [CMAQ Tracer Runs](#) – Jesse Bash and Sarah Benish, EPA-ORD

Progress on estimating the transport and fate of atmospheric emissions of oxidized nitrogen (NO_x) and ammonium (NH₄⁺) was presented. The analysis centers on the question, “For a nitrogen emission sources, such as from power plants, mobile sources, or animal waste, from different regions in the Chesapeake watershed, what is the fraction

that is ultimately deposited to a particular region or point?”. In addition, the analysis can be used to estimate reductions in nitrogen deposition to the Chesapeake watershed and tidal Bay under future conditions of greater penetration of electric vehicles into the existing mobile fleet, greater wind and solar electric generation, and other types of future economic conditions.

Summary

Sarah began by reviewing the reasons why the Chesapeake Bay partnership should care about atmospheric nitrogen deposition and how total nitrogen inputs have changed over the Chesapeake Bay Watershed from 1985-2019, showing an overall decrease of 12% for atmospheric sources. The main research questions include: how do new estimates of deposition compare to observations; where and why does deposition change throughout the United States between 2002 and 2017; which emission sources are contributing to the Bay’s high nutrient loading? Sarah then introduced the EQUATES model (EPA’s Air QUALity Time Series Project) and compared wet deposition model outputs with observations. Sarah described how nitrogen deposition has changed from 2002-2017 and provided some causes for these changes by sector or emissions. Sarah explained the sources contributing to the high nitrogen loading to the Chesapeake Bay Watershed and identified the next steps for this work.

1:15 Discussion of CMAQ Tracer Runs

Summary

Lew made a comment on slide 17 about the steep decline in annual nitrous oxide emission reductions from 2002-2017 in the On-road and Electric Generating Unit categories. Lew expressed that any lessons learned from these trends should be considered in post 2025 planning and modeling. Sarah responded that the success of these regulations targeting motor vehicles and Electric Generating Unit is quite exciting. Lew said that going forward for 2035 and 2050 modeling, the impacts of regulations and the increasing presence of electric vehicles need to be incorporated. Jesse Bash added that he is part of a team addressing these issues and modeling what future emissions might look like under the executive order using energy systems future emissions models estimates. Jesse said they plan on submitting a proposal to run the model out farther into the future (not as fine resolution as 2025) for the continental United States and land use specific emissions. The timeline is currently unknown, but should be more understood in the spring. Lew should having the information within a year would be ideal and the Chesapeake Bay Program will help where necessary, but will continue to use Phase 6 extensions until then. Jesse said that they will do their best to put it together sooner, but it might need until September 2023.

Lew asked what obstacles Jesse, Sarah, Gopal, and Gary might face for creating a time series for atmospheric deposition from 2002 to present and modeling forward scenarios going forward. Lew asked can we move away from a dependence on the National Atmospheric Deposition Program (NADP) regression wet deposition going forward? Jesse said he doesn’t think there would be a problem moving forward with that.

Gary added that getting everything back to 1985 is part of the issue. Lew said maybe 1985-2002 would be best path forward based on the inputs we have for the Community Multiscale Air

Quality (CMAQ) model. Gary said they will most likely need to use two datasets, one for relative values and one for absolute values.

1:30 [Chesapeake Bay BMP Climate Synthesis Report](#) – Jeremy Hanson, CRC and Zach Easton, Virginia Tech

Jeremy and Zach provided the current state of the report on the BMP climate resilience assessment of agriculture and nature-based BMPs based on a systematic literature review.

Summary

Jeremy began with a brief review of the purpose of this report, specifically to evaluate how climate change impacts efforts to restore and protect the Chesapeake Bay and a few other considerations. The key review questions were: how does climate change affect nutrient/sediment cycling; how do climate change and climate variability affect BMP performance; by what mechanisms can climate change and climate variability affect BMP nutrient and sediment removal efficiency; how does climate change uncertainty affect BMP performance; which BMPs will likely result in the best water quality outcomes under climate uncertainty? Zach then reviewed the expected climate impacts in the Bay and watershed. They then outlined the conceptual frameworks that they developed and leveraged from the literature to characterize risk and better understand knowledge gaps. They also categorized the BMPs based on the differing frameworks, before discussing preliminary findings from the report. Jeremy and Zach concluded with an abridged summary of the knowledge gaps identified by the report.

2:00 Discussion of Chesapeake Bay BMP Climate Synthesis Report

Summary

Lisa Beatty said in the chat the Natural Resources Conservation Service (NRCS) has many 10 year contracts and asked if that data is being tracked and compared to average rainfall and other climate factors. Lisa asked if they reached out to NRCS if they have some of this data. Jeremy said they did not have capacity to reach out to NRCS due to time constraints and that it was beyond the scope of their work as they were focused on what was in the literature. Jeremy added sometimes data from states does not end up in the literature as it is mostly academics, but that data from NRCS can be utilized and reached out to if that is of interest to the Chesapeake Bay Program partnership. Lisa suggested reaching out to NRCS to ask if they are tracking the life spans and efficiencies in regard to climate change because EPA Chesapeake Bay Program Office bases their credit duration on many NRCS recommendations. Many jurisdictions are tracking BMP life spans and asking for their data may be helpful. Lisa stressed that the BMP lifespan in the field and what is on paper should be science based before making any programmatic recommendations or policy changes.

Lew asked about the results on slide 16 and asked the application of the classification schemes was applied to all BMPs in the report and asked if there was a column of information on BMP utility under climate change. Zach responded that would be a good column to add to the table and that information is already within the narrative. Lew recommended the summary table as many jump to those points of the paper. Zach added that there are 4 or 5 tables that incorporate every BMP considered in the report. Jeremy caveated that not every BMP from CAST is within the report, as that would have made it too unwieldy.

Lew commented on the results on evapotranspiration (ET) and asked if all of the studies were using the same calculations for ET and if not, how would they account for that discrepancy. Zach said no, there were two main calculations used for evapotranspiration: the Hargreaves–Samani method and the Penman-Monteith method. Lew said that is good news because they are the respected methods and there is a fair bit of consistency between the two.

Zach said the final version of the report will be submitted on January 21st.

Robert Burgholer asked Zach in the chat that he found the decrease in ET with increased CO₂ counterintuitive, ie $ET = f(PET, \text{plant growth})$, and asked him to clarify. Zach described the CO₂ fertilization effect as the change in leaf level transpiration due to elevated atmospheric CO₂ concentrations, thus increasing the photosynthetic efficiency of C3 plants, suppressing stomatal conductance and reducing leaf level water loss and the evaporative flux. Essentially, they produce more biomass and require less CO₂ per unit of biomass.

Gary asked what the next steps are for Bay Program and if the Bay Program should take next steps. Zach said that will be most likely addressed in the knowledge gaps sections. Gary followed up asking if the only direction would be to focus on a research agenda and do nothing in the meantime until the research has been completed. Zach said the final product will most likely include next steps for the Bay Program. Jeremy said they will make recommendations where they can, but for somethings their research has too many gaps. Lew said ideally, this information will help inform the changes in efficiencies of BMPs under climate change in 2050 and further. Lew said his interpretation from the report is most BMPs will see a decrease in efficiency, some might increase, but generally will not fail. Zach suggested using mechanistic models for specific BMPs as a next step forward.. Jeremy said he hopes this report will serve as a springboard for future work.

Dave asked if this report included design factors like IDFs. Zach replied they incorporated information from the RAND report on precipitation and IDFs, but it is not as comprehensive as that report. Zach added that there are different types of vulnerabilities to BMP performance, so even if the stormwater BMPs are built under revised IDFs that include climate change, there may still be efficiency reductions. Jeremy emphasized there are many different management implications in these results.

2:15 ADJOURN

Participants: Alexander Gunnerson, Amy Goldfischer, Andy Fitch, Arianna Johns, Bhandu Paudel, Bill Ball, Bill Keeling, Breck Sullivan, Cassandra Davis, Clifton Bell, Cherie Schultz, Clint Gill, Dave Montali, Durelle Scott, Gary Shenk, George Onyullo, Gopal Bhatt, Gregorio Toscano-Pulido, Guido Yactayo, Hassan Mirsajadi, Isabella Bertani, Jamileh Soueidan, Jim George, Jesse Bash, Jeremy Hanson, Jeremy Testa, Jhih-Shyang Shih, Joey Kleiner, Karl Berger, Karl Blankenship, KC Filippino, Kristin Saunders, Kyle Hinson, Labeeb Ahmed, Lee McDonnell, Lew Linker, Lisa Beatty, Loretta Collins, Michael Woodman, Mukhtar Ibrahim, Neil Ganju, Nicole Cai, Norm Goulet, Olivia Devereux, Pouyan Nejadhashemi, Qian Zhang, Richard Tian, Robert Burgholer, Sarah Benish, Sarah McDonald, Steve Bieber, Ted Tesler, Zach Easton.



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January 5, 2022

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9:00 Announcements and Amendments to the Agenda – Mark Bennett, USGS and Dave Montali, Tetra Tech

9:05 [Overview of the Phase 7 Main Bay Model \(MBM\) and Multiple Tributary Models \(MTMs\)](#) – Lew Linker, EPA-CBPO

An overview of the Main Bay Model's (MBM) final workplan and the associated fine-scale Multiple Tributary Models (MTMs) of the tidal Bay that may be developed beginning in the fourth quarter of 2022 was provided. The utility of the MBM and the MTMs and how they would work together to provide the most detailed and complete assessment of the tidal waters of the Bay and the 93 separate TMDLs that actually make up the historic 2010 Chesapeake TMDL was described. An overview of how the MBM and MTM teams will be organized and the preparation for the MBM and MTM work that is now underway was discussed.

Summary

Lew's presentation included the broad timelines of development for the MBM and MTMs, along with the corresponding primary steps. Lew also provided context for the types of needed inputs for the MBM and MTMs, such as the types of data sets and models considered for usage. Lew incorporated feedback from the WQGIT, STAC, the GITs writ large, and the modeling workgroup in the presentation.

9:35 Discussion of the MBM and MTM Overview – 37:45

Summary

Karl Berger asked how financial decisions will be made. Lew responded that first a budget is needed from the Bay Program, and once that occurs a competitive request for applications (RFA) will be developed. Lew said he cannot speculate on the details of the RFA, but that the limitations will be the budget and number of teams that can be realistically be managed.

Dave Montali asked about maintaining consistency for the tributaries that won't get their own models across the bay for the MTMs. Dave expressed concern about some tributaries having greater information and finer resolution than others, and the impact on model outputs as a result. Lew said yes, the issue here will require careful thinking, but explained that certain tributaries might need finer resolution to meet TMDL requirements, such as the Potomac and Anacostia Rivers. Lew emphasized that the MBM will also be at a finer scale, so there will be improvements across the entire Chesapeake Bay. Lew stated linkages between the MBM and MTMs will be developed and that time considerations for the model are ever present tradeoffs. Dave said he does not see how the MTMs will be able to cover all the problem segments. Lew agreed that not all segments will be covered by the MTMs, but that most of them will be covered.

Karl Berger asked if the current monitoring information was sufficient for higher resolution MTMs. Lew responded there are always information limitations and monitoring needs, but

unless there are unknown specific decision maker needs for particular areas, they will make sure that the MTMs that are developed can be validated by the monitoring data. Lew emphasized that the Modeling Workgroup and other GITs will continue to receive updates throughout the development of the MBM and MTMs.

9:50 [Phase 7 Watershed and Tidal Water Model Boundaries](#) – Andy Fitch, USGS-CBPO

The high resolution Phase 7 Models require an attention to detail not previously needed in the lower spatial resolution Phase 6 Models. Andy reviewed the refined boundaries of the Phase 7 Watershed Model and the tidal Bay MBM and MTMs, with the spatially detailed estimates of the tidal wetlands in between. The detailed spatial work and its documentation was presented.

Summary

Andy began by reviewing the previous actions and decisions regarding the tidal shoreline layer boundaries. Andy then compared the NOAA Sea Level Rise dataset with the current tidal shoreline layer, noting that the NOAA data increased accuracy, increased detail along small tributaries, and updated shorelines where land has been eroded, submerged, or added. Andy explained that data is missing nearby the Aberdeen Proving Grounds area, most likely due to data collection issues, but these gaps were filled using the NOAA Composite Shoreline layer. Andy then asked for user preferences concerning the potentially unnecessary level of detail in the layers which may complicate GIS analyses. Andy said a potential solution to this unnecessary detail issue might be the tidal wetlands layer being developed by the Chesapeake Bay Program Land Change modeling team.

10:10 Discussion of Phase 7 Watershed and Tidal Water Model Boundaries – 1:01:11

Summary

Dave asked what the term “Mean higher high water” (MHHW) represents in this context. Andy and Joseph Zhang responded that in most parts of the world, tidal signals are dominated by diurnal patterns, so there are two highs and two lows in one day. MHHW represents the daily average of the two highs, essentially the highest water one would expect short of flood status.

In the chat Neil Ganju commented his understanding is that it is the VDatum (via ADCIRC) solution mapped on to a high-res Digital Elevation Model (DEM) so you could optimize by coarsening the DEM to the relevant scale and re-map the VDatum solution on to that DEM. Andy responded that the NOAA data can be applied to a 3 meter DEM and re-add the elevation data to remove the unnecessary detail. Joseph responded to Neil saying VDatum is being updated by NOAA, as are its uncertainties. Neil replied that his team re-ran the high res Region 3 ADCIRC grid and the solution is here:

<https://www.sciencebase.gov/catalog/item/616d8715d34e653770012f3d>.

Lisa Beatty asked in the chat if there will be non-tidal wetland data released in February 2022. Andy said that he believes that will be case. Peter Claggett said the non-tidal wetland data for Pennsylvania has not been changed since 2013 mapping but will be included in the 2017 mapping which will be complete in February.

Gopal asked in the chat if they can use the new shoreline data layer for obtaining islands that may not be included in the NHD catchment layer? Lew replied that's a good idea and invited

Gopal and Gary to the small group technical meeting on 1/14/2022. Andy replied yes, that topobathy is 1m resolution.

10:20 [The Main Bay Model \(MBM\) Workplan and Initial Work Underway](#) – Joseph Zhang, VIMS

The entire scope of the six-year Main Bay Model's (MBM) final workplan was discussed, the initial work underway was described, and the MBM collaborating Principal Investigators (PIs) were introduced.

Summary

Joseph began by reviewing the different model types and providing background on the MBM. Joseph then outlined the five major tasks of the MBM development, including linkages to the MTMs and the watershed model.

10:50 Discussion of the Main Bay Model (MBM) Workplan and Initial Work

Summary

Lew asked about the extension of the grid into the ocean on slide 8 and expressed the desire to push the boundary condition as far out as possible at the recommendation of STAC. Lew then asked the workgroup to consider possibly reigning in the grid due to scale, resolution, and computational tradeoff times. Joseph replied that they have experimented with impacts of changing the boundary location for performance. Joseph indicated that it is not difficult to schematically represent the edge of the grid at a coarser resolution and that there are credible models for setting boundary conditions that can be utilized. Lew said this idea should be put on hold for the moment but be reconsidered at a later date. Richard Tian asked about the extent of Marjy Friedrich's model and if that is an adequate domain for the new model. Joseph said that could work as the most important consideration is the boundary condition, not necessarily the boundary location. Marjy replied that's correct, their model domain has a somewhat smaller oceanic boundary.

Carl Cerco commented that the project looks promising and is impressed. He expressed that he is concerned about the connection between the MTMs and MBM. Carl asked if it is possible to have an independent Potomac River Model for the entirety of river, or for any other tributary model. Carl wondered if the boundaries will make it such that one either has to switch between the MBM and MTMs, or the MTMs will not be fully inclusive of the lower portions of each tributary. Lew commented that this is an excellent point, and that there will need to be a careful set up of boundary conditions and constant exchange between the MBM and MTMs. Lew also mentioned how there need to be resolution differences in order to model at the scale needed for the Anacostia, while also modeling for the MBM. Joseph said those are points they are considering and that they have two options: 1) Cut the boundary close to the tributaries or 2) take the MBM and refine the tributaries one by one. The tradeoffs are that the first option may not be as accurate while the second approach is more computationally intensive. Joseph said the second approach appears to be more conceptually defensible. Nicole Cai added that she can address these issues using her work on the James River as a case study. Richard said that you can cut the simulation anywhere you know the boundary condition, so he thinks the boundary between the MTMs and MBM is not as critical. Lew reminded everyone that we will need to live with constraints and tradeoffs, such as the need to run the entire James River model in one day for a ten year simulation.

Larry Sanford asked about surface wave forcing in shallow waters since it dominates sediment transport and bottom stress in these areas. Larry asked if these considerations were expected to be present in simulation models. Joseph replied that yes, they included the sediment and increased wave energy in the shallow waters, emphasizing that it works well in high resolution. Joseph said that including the wave model doubled the computational costs, so they do not include it for every simulation they run. Larry asked if it would be possible to use a look-up table or pre-packaged wave model that could reduce computational time. Joseph said his concern was that the look-up table method was considered by some wave modelers to not be as effective. Larry agreed there are issues with that approach, but it might be better than nothing. Richard added the look-up table approach is what was used for the Curvilinear-grid Hydrodynamics in 3D (CH3D). Larry commented that the mechanics behind sediment transport are non-dynamic. Lew said these are the types of conversations that need to be had to balance the tradeoffs in the regulatory decision making.

Marjy Friedrichs commented on the boundary extent of the model and said it does not extend as far out as the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM). Marjy does not think the MBM needs to stretch as far out, but that can be a research question and those larger cells farther out into the ocean do not necessarily add much computational stress on the model. Marjy expressed that she did have some of Carl's concerns about boundaries between the MBM and MTMs, but that after experimenting with the York and Rappahannock she is not as concerned anymore. Marjy added that for wave forcing, they run those models ahead of time offline, save, then apply it to when the model is running to save time. Joseph agreed that approach has potential since they can use the same hydro results for multiple water quality runs.

Lew emphasized that these conversations will continue to be brought to the Modeling Workgroup and the advisory committee.

11:00 [Set-up of a MTM in the Tidal Patuxent River](#) - Richard Tian, UMCES-CBPO

Richard provided insights into an initial setup of a MTM using the Patuxent River as an example.

Summary

Richard began by overviewing the recent flooding in Annapolis, MD in October of 2021, clarifying that while concerning, this is not sea level rise but instead storm surge. Richard then discussed expected sea level rise scenarios for the Patuxent River and the Eastern Shore of Maryland in conjunction with salt marsh migration. Richard then explained the details of the Patuxent grid, resolution, and parameters required by use. Richard concluded with the test results of the CH3D open boundary conditions for different metrics.

11:20 Discussion of the Patuxent River Initial MTM Setup.

Summary

Joseph Zhang asked if the CONED 1 meter DEM was used here, and with Richard's confirmation, indicated that the bathymetry has major issues. Richard stated he corrected the bathymetry issues. Joseph suggested that for the vertical aspect of the grid, Richard continue with five layers, but for very shallow waters less than one meter, one layer will work fine. Joseph asked how confident Richard is in terms of freshwater flow. Richard mentioned the freshwater flow data is from the Phase 6 Watershed model and there will be a better result in Phase 7

Watershed model as there will be a higher resolution output with more flow inputs. Richard said the freshwater flow of the Watershed model is robust and is validated using the RIM stations, but expressed he is less confident about temperature than river flow.

Lew commented it is good to see the Patuxent demonstrated as an example and the results run within the time constraints. Lew asked if going forward it would be beneficial to have precipitation in the MBM. Joseph confirmed that is already included in the plans for the MBM. Lew directed Gopal to include the mainstem bay in the NLDAS extension work as well.

Lew commented the usage of an observation station for salinity measurements in the Patuxent is most likely going to be replaced by the MBM going forward. Richard said that going forward the MBM will improve the connection and boundary and that precipitation is currently included. Richard said regarding freshwater flow, he is concerned about climate change impacts on the model. Lew said there will continue to be group learning and decision rules will be an important characteristic to standardize across MBM and MTMs.

Carl Cerco said he was impressed by the status of the Patuxent model and Joseph Zhang agreed.

11:30 BREAK

12:15 Initial Set-up of a MTM in the Tidal James River – Nicole Cai, EPA ORISE

Nicole described work in an initial trial set up of a MTM in the tidal James River drawing from her experience in simulating the York with an unstructured grid model.

Summary

Nicole began with a review of the current Main Bay Model and James River model. Nicole then shared her progress updated on the James River model development. Nicole shared preliminary results for salinity, temperature, and surface chlorophyll-a. The discussion questions Nicole raised are the target resolution in MTM and MBM, the protocol to neglect certain embayment and small creeks, and how the tidal marshes should be included in the MTM or MBM. Nicole concluded with some next steps and a call for locations of interest for the James River.

12:25 Discussion of the James River Initial MTM Setup

Summary

Lew responded to the questions Nicole posed on slide 25, saying as a first draft of an answer to include the Lynnhaven and Appomattox in some way. Lew said yes, the tidal wetland simulations in the MTMs and MBM should be included along with the sediment and dissolved organic material they include. Nicole commented she was curious about the tidal wetlands being included because if the grid is coarser, it may introduce uncertainty for simulating the hydrology. Lew said maybe a middle path forward is the association of rates for the 2017 model, saying the level of detail is the question.

Richard Tian commented on linking the estuary model to the watershed model, expressing he agrees with her point that they can easily find a host cell and assign the load there. If doing partition, the uncertainty would overwhelm the gain because there is not enough information to partition correctly. Richard also said the NHD is already double the loading and much higher resolution, so it is not necessary to partition further. Richard supported Lew's idea of a middle

path is good, including a bio-geochemical impact so that the influence of tidal wetlands is at least captured and a kinetics approach to understand marsh migration

Richard then asked about building on what Jian Shen did in the SCHISM for the James River and learning from his work. Nicole said why not, the documentation from Jian Shen's model has already guided her in some ways, but she will look to it again for further adjustments in the James River.

Joseph Zhang asked that Nicole send the current Phase 1 grid mesh over to them. Nicole said she would.

Lew asked Sarah Benish about the connection of the MBM and MTMs with the airshed grid and wet deposition, specifically if the 12 km CMAQ grid picks up the land-sea breeze and the linkage between the airshed and bay model. Sarah said the 4 km grid is probably more effective, but deferred to Jesse. Jesse said that both the 4 km and 12 km CMAQ grid is quite limited in picking up those phenomena.

12:40 Corsica River Shallow Water Simulation – Jeremy Testa, UMCES and Richard Tian, UMCES-CBPO

Findings of a study of shallow water processes in the simulation in the Corsica River with SCHISM were presented and the advantages of the application of SCHISM in the Corsica River as a test platform for shallow water processes using the very detailed tidal water and watershed loading observations were discussed.

Summary

Jeremy began by providing the reasoning for the focus on Corsica River, explaining that it is considered highly degraded and has extensive monitoring programs and historical data. Jeremy showed a map of the Corsica watershed and some of the historical data. Jeremy then walked through some model simulations that Richard Tian worked on and the different validation methodology that has been used. Most of the presentation focused on dissolved oxygen.

1:10 Discussion of Corsica River Simulation and Its Use as a Test Bed for the Simulation of Shallow Water Processes

Summary

Carl Cerco asked about the ability of the SOD model to compute more than 3 grams per meter squared per day. Carl asked if this was caused by a diffusion parameter or benthic algae parameter, or if that is simply outdated information he has. Jeremy replied that in doing sensitivity tests around aquaculture, the numbers did rise above 3, but it is still somewhat of an open question. Richard said they will look further into the diffusion parameter, but they have already looked at the benthic parameter and it was commented out in the model, so Richard wants to know if it will be in the newer version of the model. Nicole said it was commented out because when they revamped the sediment flux model, they were not comfortable with the code but plan on developing it further. Nicole used the example of SAV in the Lynnhaven as a potential other metric to pursue.

Lew asked Carl about his paper on benthic algae in the inland bays of Maryland where most of the nutrients were being gathered during sediment diagenesis. Carl said the main finding was that the benthic algae were intercepting the ammonium and phosphate being released from the

sediment. Lew suggested there might be some insight from that paper for Nicole's and Joseph's simulations.

Carl Cerco asked about whether algal responses were done in the dark. Jeremy responded they compared tests done in the dark and light, and found there were changes in the benthic algae. They are using the tests done in the dark in these results.

Lew commented how this presentation illustrates how everything is coming together and that it will be a challenge to compare these shallow water systems to the MBM. Lew asked Jeremy if the shallow water dynamics work is still primarily being influenced by the STAC technical synthesis. Jeremy said that is a main driver, but there are other reasons too for pursuing this, such as the nutrient load signal and understanding what that means. He does not know if the models will generate that sort of feedback. Lew said this work should continue because it has evolved.

Carl asked if Jeremy has done or could do a sensitivity run on how SOD reacts to the diffusion parameters in the sediments. Jeremy said he does not see why not, but thinks it is less straightforward and prefers to start with SFM analysis. Jeremy added that they have been thinking what model outputs and observations actually represent to understand the cores and sulfide oxygen flux and methane.

Jian Shen said when they work in the Lynnhaven they see the same trend, but by using the high resolution data for algae and DO found in the shallow water that the algae production is much lower and found differences in carbon in marshes. Jian said this would be interesting to check in the Corsica. Jian also stated the mixing dynamic of sulfate release in the lower bay can be more challenging, but Nicole has tested some dynamic effects for the benthic flux model. Jeremy responded those are good points and that resuspension, considering Larry's point from earlier, are interesting in these shallow water systems.

Dave said how impressed he was with the work going on here and looks forward to future developments.

1:40 [Tributary Summaries](#) – Vanessa Van Note, EPA-CBPO, Breck Sullivan, USGS-CBPO, and Rebecca Murphy, UMCES-CBPO

The Tributary Summaries now being developed for all the tidal basins of the Chesapeake will be a useful tool for the MTM Teams and will provide loading trends, tidal monitoring site trends and information on trends from major influences on loads like BMP implementation, growth, climate change, and atmospheric deposition. The completed Tributary summaries of the Potomac and Rappahannock were presented and plans for completion of all Tributary Summaries were discussed.

Summary

Breck began with an overview of what the tributary summaries are, explaining how they focus on tidal water quality and trends, watershed characteristics and changes, and landscape drivers for 13 tributaries in the Chesapeake Bay Watershed. Breck then showed where to access the tributary summaries (on [CAST](#) and the [ITAT webpage](#)) and the questions this information is used to answer. The first case study focused on the Potomac Tributary Summary and the different trends in tidal waters, specifically water quality, chlorophyll-a, dissolved oxygen, and secchi depth. The Potomac Tributary summary also includes an "Insights on Change" section which provides context for understanding the trends. The two main findings from the Potomac Tributary Report were the local response to large nutrient reductions happens and is clearly shown with the data and secondly, long-term response to watershed-wide nutrient reductions is

happening in the tidal waters. The second case study focused on the York River and some major trends there.

Breck next focused on how the Modeling Workgroup can use this data and provided some possible linkages. Breck then showcased the [Potomac Tributary Summary StoryMap](#) and how it might be used to communicate this work. Breck concluded with the next steps for tributary summaries.

2:00 Discussion of Tributary Summaries

Summary

Lew asked about the next steps and the priority for the tributary summaries, are all four bullets being worked on simultaneously or is there an order. Breck stated updating the summaries with 2020 tidal trends data is a priority, with the short list of tributaries (Rappahannock, James River, York River, Eastern Shore Tributary, Patapsco/Back River) including the addition of the Insights on Change section and climate change considerations. Lew endorsed the short list and replied that the modeling team would find the James and York interesting given the work on the MTMs and the Patapsco given the robust data available. Lew stressed the importance of incorporating climate change data to fully understand the trends. Lew added that the nutrient loading information by sector over time would most closely align with the work on the MBM and MTMs. Lew reiterated his support for the tributary summaries.

Lew asked if the tributary summaries are living documents. Breck replied the ones currently in existence are being refined and will continue to be for the next several months. Breck added if anyone else has data or connections for a particular tributary, they are encouraged to reach out to support the refinement and development of more tributary summaries. Lew offered information related to climate change for those parameters.

Dave asked if the climate change data desired would need to be for a particular tributary watershed, not just overall. Breck confirmed they would need data for specific regions.

Gary asked the estuarine modelers about how to best use the data presented here to validate the watershed and estuarine models. He added there is not an easy answer and provided historical context which showed how previously they relied on time series plots, then distribution plots of simulated vs observed. Gary explained how this built believability in the eyes of stakeholders when it replicates the correct animal numbers or land uses in their areas. He explained how the modeling workgroup has evaluated the success of the watershed model through the success of predicting the average load spatially, finer scale temporal metrics, or replicates the hydrology for particular statistics. However, Gary noted that none of these metrics are what the Chesapeake Bay Program actions are trying to accomplish with load reductions, so they been using WRTDS and flow normalized loads to validate these issues from a watershed perspective. Gary said that for estuarine modelers, maybe they can start to validate for nutrient reductions using the information in the tributary summaries. Gary suggested that the question modelers need to ask themselves going into 2023 and 2025 is how to replicate the change in dissolved oxygen and changes in nutrients from management actions now that they are replicating from a hydrodynamic and process standpoint. This question includes what kinds of information do modelers need to validate. Gary suggested that the information in tributary summaries is part of the answer to that question. Lew responded this is something that should be thought about and discussed in anticipation of the April Quarterly review, and that the tidal waters could certainly benefit from this information in the context of validation, especially given first principle models. Gary and Lew both agreed that this will be a question to consider going forward and that the

estuary and watershed model divergence of approaches should not answer this question on its own.

Richard Tian commented he felt Gary's thoughts were both a good orientation and challenge for the estuary modelers. Richard suggested which types of scenarios should be done for the CH3D, such as capital candidate, impact of management, and progress runs over time, but said that they do not perfectly fit with the long term trends data presented today. Richard agreed with Lew's suggestion from earlier in the day that a future task involved running a time series from 1995 to present and Richard asked Gary that in this situation, the model could reproduce the trends in the data. Richard added that if this is the case, then they can tease out the impact of management. Gary responded one possible experiment to try out is running GAMs (general additive models) on the model output to compare the results with the actual data.

Joseph Zhang commented that from a deep ocean and climate perspective, models are evaluated based on point of anomaly. Joseph suggested focusing on the change (delta) as opposed to the absolute value. Gary agreed with this approach.

Jian Shen commented that sometimes most of the focus is on comparing the data, but the question of whether the model results are right can be difficult to assess. Jian added that these changes could help illuminate the response to loading and temporal response rates. Richard agreed and said this is often an overlooked question, saying these analyses should be run.

Karl Berger commented that from a manager perspective, he supports Gary's idea. Karl shared how Rebecca's presentation on the Potomac tributary summary was helpful because managers are more trusting of the monitoring data and more trusting of models when they understand the validation.

Breck thanked the workgroup for their feedback asked about the most effective way to share tributary summary information with the PIs and modelers to help them validate and apply the information where applicable. For example, would they want one on one meetings or different forms of the data. Breck said they hope to present and share this information at future Ad Hoc meetings and Modeling Quarterly meetings. Lew replied with the offer to invite Breck and Vanessa to future MTM meetings connected to tributary summaries.

2:15 ADJOURN

Participants: Alexander Gunnerson, Andy Fitch, Arianna Johns, Bhanu Paudel, Bill Keeling, Breck Sullivan, Cassandra Davis, Cathy Wazniak, Carl Cerco, Carl Friedrichs, Clifton Bell, Dave Montali, Gary Shenk, George Onyullo, Gopal Bhatt, Guido Yactayo, Harry Wang, Isabella Bertani, Jian Shen, Jim George, Jeremy Testa, Jesse Bash, Joseph Zhang, Karl Berger, KC Filippino, Labeeb Ahmed, Larry Sanford, Lisa Beatty, Marjy Freidrichs, Mukhtar Ibrahim, Neil Ganji, Nicole Cai, Norm Goulet, Peter Claggett, Rebecca Murphy, Richard Tian, Robert Burgholzer, Sarah Benish, Steve Bieber, Zhengui Wang.