Modeling Workgroup Quarterly Review

April 5, 2022

Event webpage: Link

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

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10:00 Announcements and Amendments to the Agenda – Mark Bennett, USGS and Dave Montali, Tetra Tech

Summary

Dave provided an overview of the agenda for the day. Lew Linker re-introduced Tom Butler, who has rejoined the Modeling Team with EPA and will focus on the agriculture modeling subgroup, as well as nutrient applications.

Lew remined attendees that abstract submissions for the Chesapeake Community Research Symposium were due the previous week and the conference is taking place on June 7th and 8th in Annapolis. Registration is available here.

10:05 Phase 7 Model Development Web Site– Gary Shenk, USGS-CBPO

Gary introduced the Phase 7 Model Development Web Site and demonstrated how the Modeling Workgroup can track the Phase 7 Watershed Model development with the tool.

Summary

Gary began with an overview of the Phase 7 tools and where those can be found. First Gary reiterated the governance of the modeling team, and the roles that the Water Quality Goal Implementation Team (WQGIT), Modeling Workgroup, and Scientific and Technical Advisory Committee (STAC) play. Gary outlined the Phase 7 Development tracks and their respective lead organizers, including the overlaps between optimization, CAST, and Watershed Modeling. Gary noted there are additional topics from the partnership that are being worked on, like WQGIT processes, planning target calculations, and co-benefits, but they are not part of Phase 7 Development. Gary highlighted the documents, Gantt chart, and spreadsheets being used to guide the Phase 7 Development. Gary identified the Phase 7 Webpage as the central location for information on Phase 7 Development.

The second part of the presentation focused on Watershed Model (WSM) development. Gary started with the big picture and slowly provided more detail from the Gantt charts and spreadsheets being used to organize the WSM development. Gary explained how the full details are in the Phase 7 draft documentation, which is still a work in progress. If someone would like to see draft documentation before it is made widely available (there will be rolling releases as sections are completed), they can reach out to Gary (gshenk@chesapeakebay.net). Gary briefly overviewed the Phase 7 WSM structure, highlighting the roles and calibrations of the major components: CAST, CalCAST, and the Dynamic Model. Gary concluded with the reminder that the partnership should expect updated on the development of the structure this year, improvements in inputs and calibration through 2025, and documentation as task are completed.

10:30 Discussion of the Phase 7 Model development site and Watershed Model progress

Summary

Norm Goulet asked if Tom Butler would be working on urban nutrient applications in addition to agriculture. Olivia Devereux said she does not believe so because Tom will be working with the agriculture modeling subcommittee. Gary replied that in a role outside of the agriculture modeling subcommittee, it would be a good idea to have Tom involved in urban nutrient applications.

Scott Phillips expressed his surprise at the nutrient focus of the Phase 7 suite of models and asked why there was not more focus on co-benefits. Olivia replied co-benefits are a part of the CAST workplan and it is currently underway because it is independent of the Phase 7 development. Olivia said there will be more information on the integration of co-benefits into CAST at April WQGIT meeting. Scott responded this seems like mixed messaging based on what was communicated to the goal teams and that there would be more than just a CAST effort. Lew replied that Phase 7 is a regulatory model oriented towards the Chesapeake Bay Total Maximum Daily Load (TMDL), so while it does include co-benefits, it is inherently a nutrient model and that is where its focus will be. Scott said he felt like this point should have been made clearer earlier on in the conversations with other goal teams. Scott asked what is going to get done for the other goal teams. Lew said the idea is that modeling workgroup might not have the expertise to address certain topics like Toxic Contaminants, but if there was a toxics workgroup that could provide the inputs and processes for the models it can be integrated into the model. Lew said it was made very clear in conversations with the goal teams that the expectation was co-development with the modeling team to integrate co-benefits. Dave said that from his perspective, Olivia can and intends to incorporate the benefits of Best Management Practices (BMP)s on other ecosystem services and co-benefits. Dave said while Phase 7 development is focused on nutrients, information on other outcomes has to be provided to us. Gary replied that this presentation today is about the TMDL models and that specific timeline. Gary added that any point, the Modeling team can include any co-benefits that are available. Gary said the CBP staff are intensely interested in including co-benefits and think it is a great idea, but they simply do not have the time at the moment to find and incorporate the research because of the duty to complete the Phase 7 development. Gary expressed his opinion that the modeling team needs to work with other workgroups to identify resources that can take the co-benefits the last mile for model integration. Gary provided the example of taking the work Ryann Rossi did on ecosystem services and transforming it into model ready measurements as a good next step. Scott replied that he feels this structure is very rigid in an orientation towards nutrients and that it should be the other way around: more flexibility built into the model to accommodate co-benefits.

Lew commented that on slide 4, Tom Butler should take particular note of the impact of climate change on the watershed model nutrient applications, such as longer growing seasons and the precipitation volume. Tom agreed and said he would be taking note of these aspects.

Dave asked if Tom would be working on the urban phosphorus data and the Association of American Plant Food Control Officials (AAPFCO) data. Norm said that connects to his earlier question, which was if Tom would be working on this and if the Urban Stormwater Workgroup needs their own modeling subgroup. Gary replied that in the organizational spreadsheet, there is an evaluation of urban phosphorus which includes storage and soil of urban areas and predictors of urban phosphorus. Important predictors that have been identified include prior land use, age of the urban area, and the geomorphic setting. Gary said in the model, these predictors are not well

understood, so there will be a STAC workshop between June 2022 and May 2023 that will use Fairfax, Roanoke, and Hampton Roads data. Gary said that the Urban Stormwater workgroup is welcome to get started on this now, but Gopal and Isabella will be preoccupied with building the model for the rest of the year. Dave said he did not see it in the spreadsheet. Gary said he will go back to double check and add it if it isn't in the spreadsheet already.

Guido Yactayo commented in response to the criticism of the model's nutrient focus, that the Phase 7 hydrology calibration is an important product and has co-benefits to other outcomes. Guido asked where climate change falls within the Phase 7 Model Development timeline. Gary said that climate change is an application that is being considering right now, but it is not being applied until revisions to Phase 7 in 2026 and 2027. Lew added that the considerations of climate change and sensitivity tests will be done throughout, but that the applications will be made at the end of the Phase 7 period. Robert Sabo commented that in relation to sensitivity analysis, the big question is "Will climate change enhance or degrade nitrogen and phosphorus loads into the Chesapeake Bay?" and we need to communicate the uncertainties and contingencies to stakeholders. Gary added there are many in the watershed interested in these questions who are publishing papers and working on their own models. Gary emphasized that Phase 7 Model development will include a literature review of these models and research to incorporate components, where appropriate, into Phase 7.

In the chat, Robert Sabo said in regards to co-benefits, if phase 7 provides reasonable estimates of nutrient loads and concentrations across the watershed then we can leverage response relationships established with systematic literature reviews. Robert's branch has recently completed and published a systematic literature review for chlorophyl-A and TP/TN but they also have assembled dataset for macroinvertebrates and fish assemblages. Here is the Chlorophyll-A paper: https://environmentalevidencejournal.biomedcentral.com/articles/10.1186/s13750-021-00238-8. Scott replied this is good to hear and data sets for freshwater macroinvertebrates and fish assemblages exist for the watershed. Scott asked if the data sets mentioned are for the estuary. Since the ultimate goal of the TMDL is to improve conditions for fisheries (not just reducing nutrients) these could be useful relations to explore. Robert replied these reviews are for freshwater systems and can ideally inform nutrient criteria decisions. Robert said he can follow up with his branch about this estuarine information need.

10:40 Progress in Phase 7 WSM Development – Gopal Bhatt, Penn State

Gopal described progress made in development of the Phase 7 Dynamic Watershed Model with – (a) refinements in the incorporation of CalCAST flow in a NHDplus scale hydrology model prototype, (b) expansion of the simulation period from 2014 to CY 2020, and (c) a method for nesting of NHD streams with Phase 6 river segments for modeling and analysis of model results.

Summary

Gopal began by outlining the presentation and his purpose for this presentation. Gopal then explained that the Dynamic Watershed Model uses CalCAST spatial estimates and precipitation data to create daily and hourly estimates. Gopal showed the differences between Phase 6 and Phase 7. Then Gopal defined what a native versus nested geography represents in Phase 6 and

Phase 7. Gopal walked through the steps to develop a nested geography, hybrid simulation. Gopal shared the results of this new methodology, emphasizing the better overall agreement in Phase 6 calibration. Gopal explained that it would have been unfair to expect CalCAST to be more accurate as it was calibrated for average annual flow. Gopal dug into the model performance at a greater temporal scale and used box plots to showcase the biases in streamflow at the monitoring stations and the Nash-Sutcliffe Efficiency (NSE) of monthly flow at the monitoring stations. Gopal concluded with a summary of the progress completed and the further refinements expected.

11:00 Discussion of Phase 7 WSM Development Progress

Summary

Lew asked about the nested geography for the hybrid simulation on slide 11 to clarify if he understood why it was being done. Lew asked if the NHD segments in the Hydrological Simulation Program – FORTRAN (HSPF) river simulation was being calibrated to the monitoring station. Gopal replied that the information CalCAST has a level of calibration built into it, such as average annual calibration. Gopal added that the dynamic model is our opportunity for further calibrating the model parameters for capturing the event scale responses. Gary added that STAC did not like how in Phase 6 all the calibration was taking place in the river because everything upstream was being aggregated with the river itself. CalCAST is focused on getting to the question of why there are issues, while the dynamic model will be the temporal calibration and works to allow for greater flexibility. Lew followed up asking if there is a benefit to parsing out some of the river segments with more than one HSPF reach or if that is a necessary limitation. Gopal explained how the image on slide 11 is of the Susquehanna river in the Conowingo segment, and is a generalized example of large watersheds having one HSPF reach. Gopal said this should be sufficient as there is only one monitoring station in that watershed, but it does not preclude us from adding more where necessary. Gopal said the point here is that the methods being built are flexible. Lew replied by referencing Gary's point, that we will now have much better information about what is going into the reach and will be able to separate out what is happening in that segment more effectively in Phase 7.

In the context of the climate change application, Lew asked which evapotranspiration method Gopal was using for the current simulation and in the future. Gopal said this is an important question as evapotranspiration is critical to getting the hydrology right. Gopal said that right now they are using the Hamon method, but since one of the roles of CalCAST will be to test different methods, Gopal plans on testing the Hargreaves-Samani and Penman-Monteith methods to see which one did better. Gopal's hope is that CalCAST will be the climate change model tool on an average annual scale and the dynamic model will be the tool for event scale predictions. Lew replied he is hearing two things: we are looking into future evapotranspiration responsive to climate change and we will be able to test these methods.

11:10 Structure and Development of CalCAST – Isabella Bertani, UMCES

Isabella described the role and overall structure of the CalCAST simulation and the progress being made in its development. CalCAST is a relatively parsimonious modeling

tool that is being developed to test predictors and spatially calibrate parameters that will ultimately inform prediction of flow and loads at monitoring stations throughout the watershed. Isabella provided an overview of initial steps taken to implement CalCAST in a Bayesian calibration framework and get feedback on potential next steps, including initial thoughts on future GIS and land-use data needs.

Summary

Isabella began with a quick overview of what CalCAST is and why it is needed. Isabella emphasized the role of CalCAST is to inform CAST and the dynamic model. CalCAST is being used as a spatial calibration tool and the prototype was developed last year. The prototype was used to test candidate predictors of streamflow. Isabella outlined the plan for this year, then explained that Bayesian inference is being used because it treats all unknown quantities as random variables. Isabella detailed some of the advantages of Bayesian inference, such as modeling spatial and temporal variability at different organizational levels and quantifying uncertainty.

Isabella then highlighted some of the progress so far. Isabella showed the model formulation and briefly explained the parameters. The current focus of work on CalCAST is making sure the code and structure works, then focus can be directed to quantifying uncertainty. Some of this work includes looking at land-use specific PET parameters for total flow and checking to make sure the magnitude is comparable, which it is. The code appears to be working as expected. Then Isabella shifted to current work to get the machinery working, with a comparison between observed vs. predicted stormflow/total flow results as a first step. Isabella explained the efforts to understand margins of improvement by calibrating for carbonate lithology, land use, and small ponds. These approaches are not final and at this point the focus is on exploring benefits. Isabella concluded with the next steps for this year and next year.

11:30 Discussion of CalCAST development

Summary

Lew commented on slide 29 that it is good to see the sediment and nutrient loads this year extended and how this will connect with the practitioners using the Main Bay Model. Lew asked if we should expect the Bayesian approach for nutrient inputs to the Main Bay Model to be finished by the end of this year or the first quarter of next year. Isabella replied that she does not think so since the primary goal for this year is to develop the structure and they will not be able to test the results until next year. Isabella said she does not think they will have a product the estuarine modelers can trust by the end of this year. Lew said that is a fair answer and followed up asking if the estuarine modelers will want to mix the Phase 6 and Phase 7 nutrient loads. Lew said that there needs to be some sort of product by the end of 2023 or it will be time to shift to plan B. Gary said that the final loads will not be added until the end of 2025 because in the time period leading up to then, the loads for the estuarine model will be tested. The goal is for the entire system that loads the estuarine model to be up and running by the end of 2022. The initial connection will be up by 2022, but it will continue to be refined until end of 2025. Lew emphasized that although the final loads should be expected in 2025, there may be further tweaks in 2026.

KC Filippino asked about identifying small ponds and impoundments in relation to previous presentations given by Peter Claggett. KC said she was under the impression that this would require significant ground truthing for the ponds, and asked Isabella to expand on that and provide the link to the paper showing modeled loads from ponds. Isabella provided the link to the Schmadel et al. 2019 paper on the importance of small ponds and added that although the product is not there yet, there has been a lot of back and forth between Peter Claggett and Labeeb Ahmed on improvements. Isabella explained in some counties, more ponds are picked up by one of the three products available, so while the product is not yet ready for integration into the model, the different methods to account for them are being investigated. KC asked that in addition to land use, the age and maintenance of the ponds be considered.

In the chat, Pouyan responded to Isabella and Gary sharing that his former graduate student used a similar approach for a watershed model calibration and parameterization. The paper is under review in WRR and it is titled "Probabilistic Predictions of Ecologically Relevant Hydrologic Indices Using a Hydrological Model," the third study in this dissertation. Isabella replied she would look through the dissertation.

11:45 Development of Efficient Multi-Objective Optimization Procedures – Gregorio Toscano, Kalyan Deb, Pouyan Nejadhashemi, Sebastian Hernandez-Suarez, and Julian Blank, MSU

Progress in the development of efficient multi-objective (MO) optimization procedures including developing generative MO optimization using the current hybrid optimization procedure developed and to develop simultaneous MO customized optimization using population-based evolutionary algorithms.

Summary

Gregorio began with an overview of what was presented at the last two quarterlies and the objective of focus for current work: development of efficient multi-objective (MO) optimization procedures. Gregorio walked through the four experiments performed, which were knowledge incorporation through solution injection, reduction of constraints with a repair approach, a scale-up study, and deciphering common patterns of BMP allocation in final trade-off solutions. For the scale up study, optimization focused on the West Virginia counties in the watershed because it represented the problem of a large-scale, highly constrained optimization effort. Gregorio then outlined the methodology and interpreted the results. Next, Gregorio showed schematics to illustrate the primary components of the code and computational infrastructure that supports optimization. Gregorio concluded with the overview of the schedule for optimization development and that more information on optimization work can be found on the Phase 7 Development webpage.

12:20 Optimization Discussion

Summary

Dave asked why the counties in West Virginia were grouped together in that particular combination, given that they were a mixture of developed and rural land uses. Kalyan Deb said these groups of counties were randomly generated as part of the testing underway, but in further iterations they will take into account Dave's point about land use and utilize other heuristics.

Kalyan commented on the optimization results, saying that it might be easier to achieve a 10% nitrogen reduction when considering two counties as opposed to just one as the upstream county might have greater influence on nitrogen loads. Kalyan emphasized that the point here is to show that the optimization literature would normally suggest improved nitrogen loading as more variables are included (slide 9), but instead the results indicate a different pattern. Kalyan suggested Dave's point about land use and other external factors should be considered as potentially have greater weight. Dave offered to provide insight for those West Virginia counties as experimentation progresses.

Guido asked if the optimization team was relying on the existing scenarios in CAST or if they were planning on including the capability of running brand new scenarios. Gregorio replied that they run scenarios that might not have been run before and provide all the agencies sources and BMPs as all the information comes from CoreCAST. In the future for example, they will include where manure might be moved from one county to another. Pouyan Nejadhashemi added that none of the scenarios being run are in the CoreCAST system as they are using the base scenario as a starting point and running a new scenario for each optimization. Kalyan highlighted on slide 9 that it is promising that computational requirements did not expand greatly, suggesting that it is feasible to expand the optimization algorithm to the entire watershed. Kalyan added that once Pareto solutions are developed, characterized by tradeoffs between costs and nitrogen, despite the algorithm including about 200 BMPs, only 9-10% of the BMPs were needed to arrive at the optimal solutions. The optimization team is now looking at the land-river segments for the optimal solution, to understand the patterns and land river segments that should be treated with which BMPs. This will allow for the optimization algorithm to be scaled up to the watershed and for Gregorio to connect the optimization code to CoreCAST directly. Kalyan commented that they are working towards evaluating with CoreCAST instead of the math model.

Lew replied it might be useful to look at the Watershed Implementation Plans (WIPs) for West Virginia and the question why BMPs were implemented if they are not the 10% most optimal, considering the factors of co-benefits, financial availability, and who was signing up. Lew said they should consider the current state (what has been done), what is planned, and what the optimization says. Kalyan said this can be done and would provide strengths and differences, in addition to some ideas on what might not have been considered in the model and any mismatch. Kalyan emphasized that based on these results, not all BMPs are equal when considering the costs. Lew added he knows that the optimization team has built in a lot of flexibility for the user around cost, so perhaps if there are strong co-benefits around a particular BMP, riparian forest buffers for example, the user could artificially adjust the cost to account for those co-benefits. Kalyan agreed and said the users will be given other opportunities to provide input on preferences, like a requirement to include certain BMPs, to guide the optimization algorithm. The key is finding a balance between guiding the optimization algorithm and allowing for variability for it to calculate the optimal results.

Lew said we have expert guidance in Dave and insight on current implementation and expected implementation in CAST. Lew suggested consulting these resources continually in development.

Dave said that optimization across the watershed might be less helpful for state managers compared to within state as he sees this optimization tool being most helpful in informing WIP development. Dave also said that the situation in West Virginia makes it such that optimization might be less helpful since it is a rural headwater state and most of the BMPs will be

agriculturally driven. Perhaps in states with more varied conditions, optimization may be more useful.

Dave asked about the status of non-efficiency BMPs in the system and if they has been incorporated yet. Gregorio said they have still been testing the efficiency BMPs up until now, but once they are connected to CoreCAST testing will begin for the non-efficiency BMPs. Dave said that's fine, but added the results may be different when non-efficiency BMPs are included as well as the computational efficiency because they are tougher to deal with, an example being forest buffers that have three different mechanisms going on. Pouyan replied that the bottleneck is connecting to CoreCAST through the API they are developing. They started with efficiency BMPs because the math model facilitated initial testing. The end product will not need to define BMPs because it will directly connect to CoreCAST and at different scales there will be a lot of flexibility for the end user in terms of grouping counties and introducing constraints.

Olivia Devereux said in the chat that regarding hitting CAST, there is no CAST other than CoreCAST. She hopes the API is hitting and using the REST services rather than the database tables. The database tables change and are really a product of CAST for secondary users like Olivia. CAST is generating parquet files.

12:30 BREAK

1:00 Relative Confidence Index - Katie Walker, Chesapeake Conservancy and Mike Campagna, Drexel

The Relative Confidence Index (RCI), an application that quantifies the local impact of BMPs on nutrient and sediment runoff, was reviewed. The index helps BMP implementers identify projects that have a higher likelihood of meeting or exceeding regional reduction calculations.

Summary

Katie began by defining the Relative Confidence Index (RCI) and its goals. Katie emphasized this tool is a planning support model and designed to support work in the field; it is not direct connection to the WSM nor is it designed to be used at the watershed scale. The intended user audience is grant managers and users of FieldDoc, like National Fish and Wildlife Foundation (NFWF), Maryland Department of Natural Resources (MD DNR), and Virginia Environmental Endowment (VEE). Katie then provided an example of how RCI incorporates modeling using a comparison between two riparian forest buffers within the same parcel (slide 5) and how modeling is used to make a decision on which forest buffer to prioritize.

Michael then walked through some of the methodology and how it connects to the BMP load reduction API. FieldDoc serves as repository for project and metric tracking. Michael provided a status update on which work has been done and what work is underway. Michael connected back to the forest buffers example Katie provided, explaining how the RCI can illustrate underperforming and overperforming buffers. Katie concluded with an overview of the partners involved in the RCI development.

1:40 Discussion Relative Confidence Index

Summary

Dave asked about the example on slide 17 and for greater clarification as to how the determination was made that forest buffer 2 is better than 1 because there is more pasture in buffer 2 or there is more urban residential draining to it. Dave asked if the point here is that there is not enough pasture to account for runoff being treated. Michael replied that he thinks the difference here is that RCI does not use the 2 to 1 or 4 to 1 credit for the spatial calculation, but instead convert the land cover within the buffer zone from whatever it is to forest based on the land cover dataset. Katie added that with CAST or the WSM, the most prevalent land cover type within that drainage area is assumed to be the only land cover, but in the RCI all of the possible conversions are considered. Barry Evans said in this case, "watershed" refers to land area draining to the buffer zone. Barry added that for this example it is not an exclusion buffer but instead is a riparian buffer. Dave said he does not think one can get credit for that situation, but said his overall concern is that the message here will be that it is more efficient to implement a shorter buffer. Dave asked why buffer 1 gets less credit for Total Suspended Sediment (TSS) compared with buffer 2, and guessed that it was caused by the road present in this example. Michael replied that this tool is useful if there is only enough funding for a half mile long buffer, one could buffer number 2 and part of number 1 to reduce more pollutants based on the spatial reduction because of the land use composition. Katie added it comes down to in this case that some of buffer 1 already has some forest in it, where as buffer 2 does not. Dave asked what the size of the two buffers were. Michael said he does not know off the top of his head, but can look it up and let them know later. Barry said that these buffers are probably about 20 or so acres, so it's more accurate in terms of the total land area draining to a buffer compared to the default 2-4 acres drained. Katie reiterated that this is a tool for on the ground implementers in working with landowners and this modeling effort is strictly for planning purposes. It is designed to allow landowners to understand the localized impacts.

Dave asked if there was any consideration of the slope of the land. Michael said right now it is just a function of land use, but they can incorporate soil loss and slope factors to tailor the land use factor rates and delivery rates due to the high availability of rasterized data.

Mark Bennet asked if the functioning of forest buffers work that way as he believes they function for sheet flow, and if flow is being concentrated it does work in the same way. Barry replied that could be true, but one of the areas of work currently under way is to look at the areas of concentrated flow that might blow through the buffer and calculate the drain and area to the drain of a particular land cover that the flow passes over to subtract those loads. Mark replied that the efficiencies being used are for sheet flows. Barry said that is what we are intending and that this tool is implementing CAST and applying the results to a local scale, not doing any additional modeling, so any conversations about the modeling should be directed towards CAST. Barry said that the next steps are to understand concentrated flow. Katie said another part of the conversation is looking at the confidence of the WSM and understanding the local scale impacts of the simple inputs of drainage area and land use, instead of assuming averages across the board.

Lew asked what the timeline for roll out is for this tool, how it will be promoted, and which technical groups are being targeted (like the agricultural modeling workgroup, conservation districts, and state agencies). Lew asked what the expected level of use and penetration would be for the RCI. Katie said that from the project team perspective, there are still 2 years left to the

cooperative grant, and in that time they will focus on considering how to package this tool, develop the pilot full planning module and sandbox environment, and where to present the information. The question of roll out will be addressed in the next two years. Katie said they plan to bring this information to planning commissions, and their intended users are going to be technical service providers. Katie said they would be happy to bring the RCI to other technical CBP workgroups as needed. Lew said the Modeling Workgroup would like to hear from the RCI team when it is ready for the rollout to help with distribution and would also like to know what the level of use ends up being in the watershed.

KC Filippino expressed that she does not find FieldDoc to be an easy environment to work in. KC said that language in FieldDoc says it is only a rough connection to CAST, so it's quite generalized and the ability to calculate credits is limited. KC asked how the RCI is more helpful and how it will not overly complicate the experience for the user. Katie replied that RCI will help because it will create an explicit place in FieldDoc for a sandbox environment/planning module that is separate from the current tracking and reporting capacity for individual grants. The goal is to help alleviate some of the tensions between the annual recording process and understand the accreditation expected from the watershed model. Katie added they have been working with the CAST team to develop some of the language to be incorporated in FieldDoc.

1:55 CMAQ Tracer Runs – Jesse Bash and Sarah Benish, EPA-ORD

Progress on estimating the transport and fate of atmospheric emissions of oxidized nitrogen (NOx) and ammonium (NH_4^+) was presented. The analysis centers on the question, "For a nitrogen emission source from different regions in the Chesapeake watershed, what is the fraction that is 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 with a brief overview of the trends in atmospheric deposition using EPA's Air Quality Time Series Project (EQUATES) from 2002-2017, but spent most of the presentation focused on source apportionment for the Chesapeake Bay Watershed using the Integrated Source Apportionment Method (ISAM). This involved an explanation of the ISAM model set up, such as the geographic regions, emission streams, and compounds of interest. Sarah then walked through tables showcasing total oxidized nitrogen deposition and total reduce nitrogen deposition by each emission stream for each source region of the Chesapeake Bay Watershed. Sarah discussed mobile sector comparison between ISAM and the Community Multiscale Air Quality model (CMAQ), explaining that ISAM cannot be directly compared to observations for evaluation. Sarah then showed some preliminary results for wet deposition on the Delmarva for poultry emissions. Sarah concluded that source apportionment modeling within CMAQ is a critical tool for decisionmakers that relies on accurate spatial and temporal emissions, and that satellites may be an additional tool to help constrain emissions in critical areas.

2:10 Discussion of CMAQ Tracer Runs

Summary

Lew asked about table values on slides 9 through 11, specifically asking if it is only counting emissions deposited within the watershed and that approximately 50% falls within the watershed. Sarah replied this is correct. Lew commented that the mobile sector emissions for the central region (in blue) seem to make sense given that I-95 runs through this region. Lew asked what the icons beneath the table represent. Sarah said the cart represents total oxidized nitrogen deposition coming to the Chesapeake Bay from boundary conditions, the corn cob represents bidirectional ammonia, and the abacus represents the catch-all category. Lew asked how the boundary conditions are defined. Sarah answered they account for any deposition coming from the west of the watershed, as defined by the CMAQ domain.

Lew asked about marine vessels as a sector of nitrate source apportionment on slide 11. Lew suggested that the Delmarva is collecting most of the emissions from the marine vessels as an artifact of where the boundaries for the regions of the Bay were located.

Lew asked about the status of the poultry emissions issues in the model. Sarah said that for this publication, the issue will not be able to be fixed but it will be acknowledged. Sarah said Jesse Bash is re-running some of the poultry emissions. Jesse said they have the actual emissions, since the issue was that EPA simulations accidentally replaced the state provided emissions data. Jesse said they are going back and evaluating the data from 2002-2017 to determine to what extent they need to re-run the simulations. Jesse said they hope to use ISAM to estimate the missing deposition from the missing emissions. Lew said that sounds good since there is a resolution and there is work being done to fix it.

2:20 ADJOURN

Participants: Alexander Gunnerson, Barry Evans, Bill Ball, Breck Sullivan, Carlington Wallace, Cassandra Davis, Clifton Bell, Clint Gill, Dave Montali, Doug Austin, Elizabeth Hoffman, Gary Shenk, George Onyullo, Gopal Bhatt, Gregorio Toscano, Guido Yactayo, Hassan Mirsajadi, Isabella Bertani, Jesse Bash, Jian Shen, Joseph Zhang, John Clune, Karl Berger, Karl Blankenship, Katie Walker, KC Filippino, Kyle Hinson, Lee McDonnell, Lew Linker, Lin Perez, Lisa Beatty, Mark Bennet, Michael Campagna, Mukhtar Ibrahim, Nicole Cai, Norm Goulet, Olivia Devereux, Richard Tian, Robert Sabo, Ruth Cassilly, Sarah Benish, Scott Phillips, Ted Tesler, Tom Butler, Vahid Rafiei, Vanessa Van Note.

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

Summary

Dave gave a brief overview of the day's agenda.

9:05 Progress Update-Provisional Data: Climate Change and Striped Bass Chesapeake Habitat – Tom Parham, Andrew Keppel, Jim Uphoff, and Renee Karrh, MD-DNR

Progress in an analysis to assess DO and water temperature related striped bass summer habitat conditions, Bay-wide, by State, and by CB Segment, under 2025 and 2055 climate conditions was reviewed. Key Bay restoration/climate scenarios of Full WIP3 Implementation and No Action scenarios were used to estimate to determine change in the quantity/quality of habitat rated as Suitable, Tolerable, Marginal, or Unsuitable.

Summary

Tom began with a reminder that this analysis is in the early stages and the results are provisional, so there is still more work to be completed. Tom explained the importance of the striped bass fishery in Maryland, and explained the concept of the striped bass "Squeeze," which refers to the combined stressors of hypoxia and high water temperatures. Tom explained how they revised Chesapeake Bay striped bass habitat thresholds for oxygen and temperature. Tom outlined and defined the revised thresholds and categories: suitable, tolerable, marginal, and unsuitable. The team applied monitoring data and the Bay interpolator to the thresholds to create a basic 3-D model of striped bass habitat in the Chesapeake Bay. Tom then presented a series of graphs showcasing the total volume of water temperature, dissolved oxygen, and the combination using the categories of habitat suitability for striped bass. The initial trend results indicate that habitat and water temperature both had significant worsening changes in the period from 2011-2020.

Tom then turned to some scenarios to answer the series of related questions: how would striped bass fare under differing climate change, land use, and Watershed Implementation Plan III (WIP) conditions? What would striped bass habitat look like if the Chesapeake Bay Program (CBP) did not exist? Using a series of graphs, Tom explained the preliminary results for Maryland and the whole Chesapeake Bay indicate that with the WIP III under climate change conditions, striped bass habitat will fare better than a no action scenario where the CBP did not exist. Tom added that even if the CBP partnership meets its 2025 goals, we should expect climate change to still reduce habitat. Tom added the caveat that this preliminary model still considers all parts of the Bay as possible habitat, but in the future it will be refined to only include habitat that could be suitable for striped bass. Tom concluded with next steps and thanked for everyone involved and the monitoring programs.

9:40 Discussion of Climate Change and Striped Bass Chesapeake Habitat

Summary – 35:00

Lew commented this presentation does a great job of framing and said that based on what he heard, it looks like with the WIPs it gives the Chesapeake Bay more resiliency in the face of greater challenges from climate change. Lew clarified that Gopal provided the loading data and Richard provided the hypoxia. Lew commented on slide 24 that the summer periods experience the greatest habitat reduction for striped bass. Lew asked what kind of emphasis should be put on the period of intense spatial-temporal habitat compression and if that is where the focus should be on communications going forward under the different climate change scenarios. Tom replied it would be good to have Jim Uphoff's input here, but that based on Tom's limited fishery knowledge, at certain times of the years the habitat conditions are much more stressful and that the fishery should consider the lack of suitable habitat from June-August when making regulations. Tom also indicated that attention should be directed outside of the watershed to other Atlantic states given that the Chesapeake Bay serves as the home for 60% of the coastal striped bass stock and the Chesapeake Bay is not unlimited.

Dave asked if there is a planned effort to remove the deep trench from the model since that really is not striped bass habitat, even under restored conditions. Tom replied that is a good point and is something they can definitely look at when they refine the model. Tom added typically striped bass migrate downstream from the tributaries in the spring and into the main Bay in summer. One of the trends they are noticing is that striped bass have been migrating to the upper parts of the main Bay in the summer.

Larry Sanford said he likes seeing the no action scenario and asked what the correlation is between striped bass habitat and striped bass population numbers, related to a topic being discussed in STAC. Tom said he will ask Jim to get a more detailed response, but offered that these plots are watered down because they spread out over a huge area and they are seeing striped bass not return to former habitat.

Karl Berger asked if the 2025 WIP scenario was based on achievement of WIPs or achievement of planning targets (where there is a difference between the two)? Gopal replied the 2025 scenario was the one with achievement of Planning Targets.

Karl Berger commented that he thought this was great work and asked if it will be possible to link dollar values to the striped bass habitat gained or lost? Tom said he wasn't sure because of the variability of fish movement across the Bay, so he would need to check across Maryland and Virginia. Tom emphasized the large economic role of the striped bass recreational and commercial fishery. Tom said he will check with Jim and get back to him. Dave said maybe they can look at the economic effect of a closure of the striped bass fishery as a proxy for the impact on habitat.

Peter Tango commented in the chat that he is enjoying the presentation and it is exciting work. Peter shared a few thoughts: you report on "Hypoxic Volume" - that would seem to be a reference to a single event maximum. Fish are experiencing the stress across the warm season. Might you consider building out the results to reflect hypoxic volume days or stress (DO-Temp) volume days as a cumulative measure of stressful conditions summarizing what is in your graphs? Also - seasons are changing, is it time to extend your "summer" to reflect when hypoxia is present, e.g. April-Oct, versus just Jun-Aug? Peter said these comments are food for thought and thanked everyone involved for their great work. Tom replied that yes, they are looking at

duration of hypoxia and that this effort is still underway so there are many more considerations and tweaks to be made. Tom, Dave, and Lew agreed that at the July Modeling Quarterly Review this team should expect to present another updated on their work.

Dave commented that he disagreed with the assertion made on the first day of the quarterly that the modeling team does not care about co-benefits. Dave pointed to this presentation on the striped bass habitat squeeze modeling efforts as a demonstration of the collaboration and work the modeling team is putting into co-benefits.

Lew said that he thinks communicating this work on a segment-by-segment story is a good way to demonstrate the challenges from climate change and resiliency afforded from the implementation of the WIPs. Lew suggested once the analysis is further down the road, it would great to see results reported for Virginia as well to create a more comprehensive story for striped bass.

9:55 Phase 7 Watershed and Tidal Water Model Boundaries – Andy Fitch, USGS-CBPO

Andy described a prototype shoreline product of updated and refined model boundaries for the Phase 7 Watershed Model, Main Bay Model (MBM), and Multiple Tributary Models (MTMs) including spatially detailed estimates of the tidal wetlands.

Summary

Andy started off with a summary of previous actions and decisions, such as the decision to use the highly accurate NOAA Mean Higher High Water (MHHW) Sea Level Rise dataset and to not combine tidal wetlands with the shoreline area so as to account for tidal wetlands separately. Andy then detailed some examples where the new layer has improved accuracy and resolution, like Hart-Miller Island and Tangier Island. Andy gave the caveat that in some places the NOAA dataset has issues with unnecessary complexity and linework that would slow down modeling and GIS processes, like the Blackwater National Wildlife Refuge in Dorchester County, Maryland. Andy proposed a methodology to simplify the layer to a manageable complexity for the model using the 2022 Version 2 land use dataset. Andy then showcased a pilot project for Dorchester County using the 2017 Version 1 land use dataset, indicating which classes were removed and highlighting examples of how the line work changed.

10:15 Discussion of Phase 7 Watershed and Tidal Water Model Boundaries

Summary

Kirk Havens asked in the chat how this layer compares with the VIMS shoreline and tidal wetlands inventories/layers, which are done for both Virginia & Maryland. Andy replied the biggest difference is that the Virginia Institute of Marine Science (VIMS) layer had lots of disconnected line work and the CBP GIS team goal for this layer was to get one single polygon, so it made sense to use the NOAA MHHW layer instead. Andy said he has not overlaid the two layers yet, but it would probably be worthwhile to do so in case it reveals any potential issues. Kirk said that the VIMS layer was generated by aerial and field verification and offered to discuss this further offline.

Lew said this level of detail is great, but due to computational restraints in running a scenario in 24 hours for decision makers, the level of detail needs to be aggregated up. Lew provided the example of how Fishing Bay will be gridded up and the Blackwater NWR will be aggregated to understand volume. Joseph Zhang agreed and added that while they would prefer a single polygon, they can work with multiple polygons if that is necessary.

Larry Sanford said he was not aware there was a separate layer for wetlands and asked about wetlands that appear to be within the watershed model land area. Andy said that Larry is correct, theoretically there would be no wetlands included within the yellow polygon. For modeling purposes, the wetlands within the watershed model segments would be calculated and aggregated to be accounted for that way. Lew expanded on this by saying the primary goal of this layer is to delineate tidal waters and said the wetlands would be related to the adjacent main bay model cells. Larry asked if the wetlands were part of the function of the watershed model. Lew said they are more connected to the main bay model and will not be in the watershed model because their influences on water quality will be accounted for in the main bay model.

Joseph Zhang asked if Andy thought about the bathymetry of the interior for volume calculation purposes, in addition to thinking about the delineation of the boundary. Joseph shared that most of the bathymetry data is wrong and outdated, despite being high resolution. Andy said that is good to know, but he has not been looking at the bathymetry yet since his focus has been on the boundary. Lew commented this might be an area to acknowledge the limitations and then move on.

Dave asked if an update on the final product could be expected to be provided at the July Quarterly review. Andy replied that yes, he believes this will be the case.

10:25 Main Bay Model (MBM) Progress Tracking – Lew Linker, EPA-CBPO

Lew presented on tracking MBM progress with the Phase 7 Model web site.

Summary

Lew began with an overview of the MBM workplan and then gave an overview of the timeline for MBM development. Lew explained in detail the steps in the initial stage of development, which runs from 2022 to 2023. Lew concluded with a reminder that information on Phase 7 Development can be found and tracked at this designated webpage.

10:35 Discussion of Phase 7 MBM Progress Tracking

Summary

Karl Berger asked about the status of budget authority for the MTMs and when Lew will how much money is available and which tributaries will be chosen. Lew said that EPA has a budget, but it is still being decided about how to apply the budget. Lew said we will know by the July Quarterly what/if any the line item is for the MTMs. In the meantime, Lew said we should make a preliminary decision now about which five tributaries will be prioritized if the resources are available. Karl asked if the modeling workgroup will be making this decision. Lew said he believes this decision should be made by the partnership, but the modeling workgroup could propose certain tributaries. Lew made the case that based on partnership needs, he believes the

James and Potomac Rivers should be included in the MTMs. Lew said perhaps the Modeling Workgroup could make a proposal and then get feedback from the partnership. Dave asked if the partnership in this case means starting with the WQGIT. Lew said maybe. Dave said he thinks maybe it should be a joint WQGIT-Modeling Workgroup meeting since there is a strong role for both. Lew said he is leaning towards starting with the Modeling Workgroup since there is a lot of initial preliminary work that could use the guidance from the modeling team and that the overall message might be lost in translation.

10:45 The Main Bay Model (MBM) Progress – Jian Shen and Joseph Zhang, VIMS

The overall approach and key questions to be resolved over the four year MBM development period were discussed and the initial work underway was described.

Summary

Jian began with an overview of the Estuarine Model framework and the SCHISM ICM update. Jain then walked through the different updates within the MBM, such as water quality, shallow water capacity, and considerations for climate change. Jian outlined a few water quality model calibration enhancements, as well as approaches and decisions that the MBM PIs request discussion on from the Modeling Workgroup, such as state variables, modules, boundary of inundation and wetland, and improvement consideration.

11:20 Discussion of the Main Bay Model (MBM) Progress

Summary

Lew asked about slide 6, commenting that this connects to the work of Carl Cerco and Particulate Inorganic Phosphorus (PIP) is a big component of shoreline erosion in addition to coming from the watershed. Lew said there should be some sorption key related to oxygen and the removal of phosphorus from the water column in fall, and its addition in spring. Carl Cerco said there are many forms of PIP, one being iron bound that dissolves under anoxic conditions and other related to rock, and that the group needs to make a decision to either hardwire or simulate the flux otherwise it will frustrate the calibration given the differing conditions in fall versus spring. Lew replied the MBM could carry iron oxy hydroxides in the model and keep track of their oxidation status and sorption states, but this will add to computational times. Lew said he much prefers just clearing the water column after a particular date. Jian replied that he likes this idea since it is much more flexible in calibration.

Lew commented oysters are a management action and must be included in the model, so a distinction must be made between sanctuaries, aquaculture, and natural beds. Lew said for shallow water systems, biovalves, corbicula, and filter feeders should be included. Carl said corbicula in the Potomac, James, and Patuxent rivers is very important and that there is a dilemma about weighing the model down by investing too much into these issues. Carl said it might be best to parameterize these influences, but ultimately it is up the MBM team. Lew said that besides oysters, which must be included, these questions are open to discussion and can be done at the MBM team monthly meeting. Jian added that the most computational part of the model in this case is when there is transport.

Dave asked about the process for determining how to respond to these questions and making decisions. Lew replied that the Main Bay Modelers have a monthly meeting to address these questions. Marjy Friedrichs added that there is an advisory committee for the MBM as well, and it includes a subset of modeling workgroup members. Joseph said he will invite the advisory committee members and Larry Sanford to the monthly MBM meetings. Lew said at future quarterlies the modeling workgroup will review the work of the Main Bay Modelers and the advisory committee to then determine a resolution to these questions. Lew gave the example of the need to accurately simulate SAV and outlined how a presentation outlining the tradeoffs for each section can be presented to the full Modeling Workgroup. Dave said this plan sounds good. Jian added the whole purpose of today is to introduce what work is being done and get input for the next phase.

Lew asked about slide 12, specifically if the algal bloom is terminating because it runs into nutrient and light limitation. Jian said this is the aggregated version so this is removed at a much higher velocity compared to the normal settling velocity. Jian said the reality is that the model cannot drop that fast so it is included in this way. Lew said he hears algo aggregation under very high concentrations is an observed, known physical process which increases the settling rate of aggregates and would only be implemented when there are very high concentrations of algae.

Lew said that with the three assemblies of algae (blue-greens, greens, and diatoms), there will be periods of time where there is the presence of two or three different algal groups in the same area at the same time, so we need to make sure not all of the nutrients go to one group. Jian replied that this is correct.

Larry Sanford asked about waves and sediment transport in the chat, specifically what might be capable now with the new model version that was not achievable under the previous model. Larry and Jian agreed to talk about this offline since there was not enough time left in the question and answer session of the meeting.

Lew said that for the July Quarterly, the questions outlined here will be segmented into separate presentations and addressed with a tentative Plan A. In the meantime, the modeling workgroup should provide a consideration, evaluation, and judgement on an initial plan.

Carl Friedrichs commented on the great job Carl Cerco did on the previous model to balance many tradeoffs. Carl Friedrichs said that despite the understandable needs to update the model mechanisms, he is afraid the new Phase 7 MBM will not be comparable to the results from the previous Phase 6 MBM. Carl Friedrichs recommended including comparable subroutines in the Phase 7 MBM so both the need for higher spatial resolution and comparability for action accountability are preserved. Larry Sanford and Mark Bennet agreed, saying there is a need to be able to go back and see what has caused the inevitable changes. Lew added this pairs nicely with the decision made to compare the watershed model results with previous results to help evaluate the change using a reference point. Jian replied this is a good suggestion and that the MBM team will separate problems of a different kinetic model and the impact of greater resolution. Joseph replied is a great suggestion and due diligence they plan on doing. Joseph emphasized the first step is to reconcile the model with the previous version and so far Nicole's results have indicated there is consistency. Joseph added the change between models and the drivers of change are included in the documentation. Joseph said this will be wholescale change because the driver of change is a new grid and noted that ICM is very different from SCHISM now. Lew said this

approach sounds fine and that there is a lot of flexibility with shallow water processes since Phase 6 of the model was silent on that component. Lew emphasized the changes between models for the deep water, deep channel, and open water in the larger segments.

Neil Ganju commented in the chat that he is trying to model SAV near Eastern Neck NWR and finds it difficult to reproduce spatial patterns even with a complex model with all inputs. Re-initializing might be the best approach, and it is what they are likely doing for our small-scale investigations into SLR/sediment supply effects on SAV.

11:40 Corsica River Shallow Water Simulation Progress – Richard Tian and Jeremy Testa, UMCES and Nicole Cai, EPA-ORISE

The Corsica presents a unique opportunity to examine the effects of nutrient load reductions on a shallow ecosystem with both models and data. In particular, the Corsica will be a good test of MBM & MTM's ability to reproduce diel-cycling hypoxia and the forces that drive it (shallow water metabolism, wetland inputs, etc.) and very high chlorophyll concentrations often found in Chesapeake shallow water systems. The recent incorporation of benthic algae and tidal wetlands was presented.

Summary

Richard explained how the results presented here come from the monthly meeting of the Corsica team. Richard began with a series of questions of whether one can model the high variability continuous monitoring data for dissolved oxygen and chlorophyll-a at the Corsica stations, and how these questions inform the work to be presented here. Richard then outlined the partitioning of the model grid and watershed model loading for the Corsica, dissolved oxygen empirical mode decomposition, and sea surface elevation spectral analysis. Richard explained how Classification and Regression Tree (CART) and Generalized Additive Models (GAM) analysis were used and compared to understand dissolved oxygen (DO) trends in the Corsica. Richard showed a simulation of DO and chlorophyll at 4 stations from the upper to the lower portion of the Corsica, concluding that you cannot develop a model to simulate everything and that if feasible, it would be best to resolve sub-hydrologic units for shallow water systems by the watershed model. Richard also showed a simulation of sediment oxygen demand and ammonia. Richard said that the take home message for benthic algae simulation is that work is underway, so no reliable results yet, but it appears that benthic algae are not growing well in the upper estuary. The major limitation is the lack of data for calibration. Richard concluded that it seems physical dynamics can be important as biogeochemical processing in determining DO variability in the Corsica and that future work will focus on benthic algae simulation to see whether it can have a significant impact on water quality.

12:10 Discussion of the Corsica River Shallow Water Model Development Work

Summary

Lew provided some context on previous efforts related to the Chester River to simulate the high variability of DO and chlorophyll in the Corsica. Lew emphasized how the work on the CART and GAM is a good approach for the Corsica. Lew asked about slide 10 and if it would be possible for Gopal to overlay the NHDPlus grid for the area around the Corsica River using some sort of surrogate to create some sort of different loading schema. Lew asked Richard if we would prefer to wait until the last quarter of 2022 for the loading if he would rather spread out the loading using aerial waiting right now. Gopal replied this is a good point and shared that there

has been some coordination between the watershed model team and estuarine model team about the finer resolution afforded by the NHDPlus scale. Gopal said that they have not yet looked into how much finer the data will be for the Corsica, so Gopal suggested that would be an area of focus and with help from Richard, they could develop a surrogate prototype to see how influential the new scale would be. Lew agreed with this is the right approach and said the work around NHDPlus should be taken offline. Lew said if this does not work, an aerial weighting approach could be applied for the Corsica. Richard responded that his understanding for Phase 7 is that the loading resolution will be NHDPlus. Gopal replied that was the initial discussion and that in Phase 6, they were further disaggregating the load generated from the watershed in this case, where one river segment encompassed three cells. Gopal said the question became, do we need to disaggregate further from NHDPlus scale to the same scale as the estuarine model, but his understanding was that the scale was fine enough, so a 1-1 or 1-many approach for applying loads at the NHDPlus scale appears to work.

Dave asked for greater clarification on Gopal's question in the chat. Gopal's question was "Richard, excellent investigation and explaining the interactions of the forcing variables. I appreciate the point that better geographic loading from the watershed may go in the direction of addressing the issue you are seeing in two upstream monitoring stations. But I am wondering if the fact that DO from the watershed is provided from the non-tidal (simulated) river and not from the tidal watershed may be implicated here?" Richard replied the difference from the CH3D is that they use the DO loading directly to the Corsica model. Richard said it does not matter because they directly use the loads. Richard said this connects to his presentation on the Patuxent this afternoon. Gopal said he is hearing that it will become more important if they do not provide the DO load.

12:20 BREAK

12:50 SAV Nutrient Flux Assessment – Carl Cerco, Attain

The findings and initial documentation of the 2017 WQSTM estimated SAV nutrient flux by submerged aquatic vegetation and consequences for Chesapeake hypoxia were presented.

Summary

Carl started his presentation with a brief background on the influence of SAV on sediment-water nutrient fluxes and a quick overview of previous activities. Carl presented some primary conclusions: 1) SAV diminishes nutrient retention in sediments and 2) diminished nutrient retention is equivalent to an increase in loading. Carl then reviewed a series of graphs that show the relationship between SAV and DO by segment and WIP scenario. Carl presented some overall conclusions, such as a full build-out of SAV enhances recycling of nutrients from sediments to water column; the enhanced recycling results in diminished DO in Deep Channel and Deep Water; the enhanced recycling is equivalent to 2.7% of watershed N load, 10.4% of watershed P load; these numbers result from comparison of build-out to no SAV Conditions; to quantify marginal effect of SAV build-out, we should compare build-out conditions to existing conditions.

1:10 Discussion of SAV Nutrient Flux Assessment

Summary

Carl began with a point about how he has never seen such rapid growth in chlorophyll levels like that seen in the Corsica, except what was seen in the Potomac embankments at Gunston Cove, and he never got to the bottom of it. Lew replied that conversation can be continued at the next Corsica meeting or offline, and asked if the cause might be resuspension. Marjy Friedrichs, Larry Sanford, and Richard suggested it was caused by advection. Carl replied that if that were case, there would need to be a significant spatial gradient. Richard said data flow mapping the chlorophyll is kind of mapping patches. Lew said those elements can be integrated. Jian said they are having the same issues of patching attaching to the high frequency monitoring data, where they are getting high readings and the calibration can be quite tricky. They trust the instrument, but the readings are unlikely because of how extreme they are. Richard said that is a good comment and originally he thought there was an issue with the sensor, but after checking with the team that manages the instrument, they said they trust the data. Lew said it is possible it could be resuspension, and gave the example of high chlorophyll levels in the deep channel.

Lew commented that if you grow biomass in mass balance models, you have to decay biomass and that consumes oxygen.

Lew asked about the average effect of SAV on DO in open water, specifically about the relative impact on tidal fresh and oligohaline since they are shallower compared to the deeper mesohaline and polyhaline where the surface is farther away from the bottom. Carl replied that the coverage of an open water segment is probably greater than the segment of a mesohaline segment and provided the example of the Susquehanna flats. Carl said his feeling is you will get a much bigger effect from SAV in the tidal fresh because more of the segment is covered by SAV. Lew said this might connect to results presented here that relate to nitrogen and biomass. Carl added that there is the dynamic of different species in the tidal fresh and there might be differences in species impacts that he needs to investigate.

Jian Shen said they have a similar issue in the marsh asked if for this SAV bed the DO goes to zero in the evening because of the release of phosphorus. Carl said he has not seen this from the model, but has seen it in real life from hydrilla. Jian asked if the portion of the nitrogen is due to recycling from leaf respiration. Carl said they have not identified it yet, but he thinks the biggest thing is the roots are taking up nitrogen from the sediments and they supply nitrogen into the shoots (the above ground biomass), and when the SAV dies or respires it releases organic nitrogen into the water column. Jian agreed, saying this should connect to the Lynnhaven since it is only 1 meter deep in some locations, but they do not have any data. Carl shared an anecdote about getting a reading of zero DO in a large hydrilla bed in Hunting Creek off the Potomac River at 6am as an example of this issue.

Richard said that while you might see this observation, you do not see it in the model because effectively there is only layer. Jian replied that for the Lynnhaven, they need to have multiple layers even though it is only 1 meter deep because it is so stratified. Richard said this connects to what Jeremy said for the Corsica. Carl said he is hopeful SCHISM will show some results that were not available using CH3D.

1:20 Initial Set-up MTMs in the Tidal York and James Rivers – Nicole Cai, EPA ORISE

Progress in the MTM simulations in the tidal York and James Rivers, with the incorporation of benthic algae, was discussed.

Summary

Nicole began with a review of the shallow habitat modules in SCHISM and the different component model structures. Nicole then moved on to a demonstration of how the model has been implemented in the York and James Rivers. Nicole presented preliminary results for tidal marshes, benthic algae, and SAV. Nicole concluded with current limitations and plans for the next steps.

1:50 Discussion of the York and James River Initial MTM Setup

Summary

Lew commented on how these results are encouraging, especially how incorporating benthic algae impacts dissolved organic carbon and how it connects with the rest of the work going on in the team. Lew recommended generating a legend for the governing equation's symbology so it will be easier for people to follow. Lew said it does not need to be done right now and it can wait until next month. Nicole agreed.

Jian Shen commented that typically tidal marshes reduce phosphate and support the denitrification process. Jian said there is not a lot of data on this topic, but since the model behavior seems to align with Carl's SAV model results, this is encouraging.

Carl asked how Nicole decided on the nutrients available in the sediment and the water column. Nicole said she made five options to decide is they want to have limitations for nutrients and for her quick calibration on slide 37, she omitted the nutrient limitation trends so the first purpose is to get a reasonable distribution and then see its sensitivity on the dissolved organic carbon simulation since it is the only data she had available to calibrate and validate the model. Nicole said they haven't gone into the details of each mass of the mutual limitations and that Richard is working on this. Carl asked if the SAV take up nutrients from layer 2 of the sediment model. Nicole said if she does not limit the growth by the nutrients, then they are assumed to have sufficient nutrients from the second layer of the sediment.

Richard asked Jian about observing benthic algae below one meter. Jian replied that for the James River model, measurements for the benthic algae and flux showed a clear distribution in the data. Jian said that for the Lynnhaven, they collected soil samples, and found the average number was 200 mg per square meter for DO. Jian guessed that for Richard's work, it is mostly likely different because of higher turbidity and the stratification. Jian said he did not know if the flux has been added to the flow. Richard said it has been added via the loading.

2:00 Progress in the Patuxent MTM – Richard Tian, UMCES

Progress in the MTM simulation of the Patuxent was presented.

Summary

Richard began with a reminder about the new, higher resolution grid used for the Patuxent, the Bathymetry interpolation using the nearest neighbor method, the watershed loading points, and monitoring stations for model calibration. Richard then compared the simulations with the observed data at the monitoring sites for temperature, salinity, DO, and chlorophyll for the Patuxent. Richard concluded he is working on the mid-Patuxent estuary and light attenuation in the upper estuary. Richard asked the modeling workgroup their perspectives' on adding salinity limitation on diatom and green algae, and a spatially varying growth rate.

2:20 Discussion of Patuxent MTM Progress

Summary

Carl commented that cyanobacteria is only allowed to grow in the tidal fresh water Potomac because there distribution is relatively limited, so Richard should turn that off. Carl added that diatoms are limited by salinity, so they should not be in the tidal fresh. Carl said group 3 for algae grow anywhere. Richard said he will update the model to reflect that information.

Carl asked about the graph in the bottom right of the chlorophyll page (slide 9) and if that was the tidal boundary condition. Lew said those values look very high and would be surprised if the watershed model was delivering loads that high. Lew said Richard should check that out. Richard said he thinks it is a combination of mostly growth and perhaps a little bit of import from the watershed model.

Lew said yes, inert suspended solids (ISS) is needed, and it would play a role in light limitation in the upper estuary. In response to Richard's questions, Lew emphasized the need to have global principles for the entire model given how many different users there are for the model. Given this need, it will not be possible to constantly adjust local conditions. Lew gave the example of diatoms everywhere being limited by salinity.

Jian commented that the model is missing spring blooms, and that there are two possible causes: the temperature threshold is set too high or the hydrology is too fast. Jian commented that for station LE1.2 the DO is too high. Richard commented this might be because it should have been nutrient limited, and light limitation is also a major issue. Jian said the cause might be the temperature curve being used. Jian said that TSS is not having the same effect as dissolved organic carbon.

Lew said for slide 7, the main issue appears to be a lack of salinity in the Patuxent. Lew wondered if it would be helpful to include the shipping channel from the sill into the model, and that there might be data available from UMCES here with coordinates and buoys. Richard said this is a good suggestion.

Lew said he believes the only significant point source (PS) wastewater treatment plant is on the Western Branch of the Patuxent, and it has pretty good PS controls, but they have changed over time. Otherwise the Patuxent has large drinking reservoirs. Richard said for the 1991 simulation, they will need to incorporate this variability.

Carl said it was great to see the SCHISM model up and running for the Patuxent.

2:30 ADJOURN

Dave asked when the Modeling Quarterlies should begin having in-person components. Lew said he expects it to be hybrid going forward, as it was before COVID and that the decision will be put in front of the workgroup as time goes on.

Participants: Alexander Gunnerson, Alimatou Seck, Andrew Keppel, Andy Fitch, Andy Stoddard, Arianna Johns, Bill Keeling, Breck Sullivan, Carl Cerco, Carl Friedrichs, Carlington Wallace, Cassandra Davis, Cathy Wazniak, Clifton Bell, Dave Montali, Donna Marie Bilkovic, Elizabeth Hoffman, Fei Da, Gary Shenk, George Onyullo, Gopal Bhatt, Gregorio Toscano, Guido Yactayo, Hassan Mirsajadi, Isabella Bertani, Jamileh Soueidan, Jesse Bash, Jian Shen, John Clune, Joseph Zhang, Julie Reichert-Nguyen, Karl Berger, Karl Blankenship, Katie Walker, KC Filippino, Kirk Havens, Kristin Saunders, Kyle Hinson, Larry Sanford, Lee McDonnell, Lew Linker, Lisa Beatty, Mandy Bromilow, Marjy Friedrichs, Mark Bennet, Mukhtar Ibrahim, Neil Ganju, Nicole Cai, Peter Claggett, Peter Tango, Qubin Qin, Renee Karrh, Richard Tian, Robert Sabo, Ron Vogel, Sarah Benish, Tom Butler, Tom Parham.