The Chesapeake Community Modeling Program's

Chesapeake Modeling Symposium

May 21-22, 2012 Annapolis, MD

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Kevin McIlhany - United State Naval Academy
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Kevin Sellner - Chesapeake Research Consortium
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Scope and Aims

The Chesapeake Community Modeling Program (CCMP) seeks to improve modeling tools and related resources specific to the Chesapeake Bay, its watershed, and connected environmental systems by fostering collaborative open source research. Toward this end, the CCMP is convening the third bi-annual Chesapeake Modeling Symposium as a venue to identify and showcase existing modeling efforts as well as communicate how models are used as decision support tools by different developer and user groups.

Environmental models are increasingly taking on higher profile roles in the management process. In Chesapeake Bay, the Chesapeake Bay Program Watershed and Water Quality models, used in a decision support role, are increasingly being used to support regulatory decisions such as TMDLs, rather than voluntary decisions. One of the effects of this changing role is that it is bringing to light concerns and conflicting interests within different stakeholder communities affected by the regulatory process. Another effect is that the models are increasingly under scrutiny with respect to their scientific validity and skill. It is anticipated that the thresholds set for TMDLs by these models will face numerous scientific and legal challenges in the coming months and years.

The 2012 Chesapeake Modeling Symposium will attempt to shed light on these emerging concerns and conflicts as they relate to regulatory thresholds and the environmental models that are used to set them, focusing on topics such as understanding, communication, and credibility. By bringing together modelers, managers, scientists, and stakeholders for a series of plenary talks, panel discussions, and special sessions, we hope to highlight the unique issues and concerns of each of these groups and provide a venue for open dialogue that will hopefully lead to greater understanding and adoption of these and other models.

Sponsors

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Chesapeake Bay National Estuarine Research Reserve in Virginia
MD-NERRS
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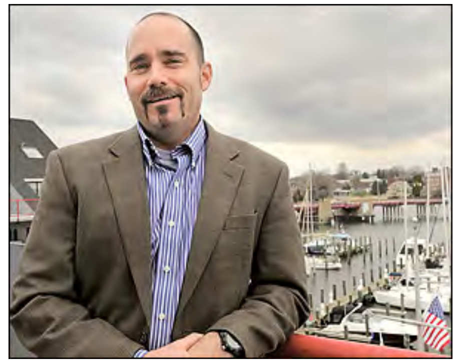
Virginia Coastal Zone MANAGEMENT PROGRAM

Plenary Speakers



Keynote – World Class Modeling in the Chesapeake Bay - May No Good Deed Go Unpunished – Jeff Corbin, *Senior Advisor to the Administrator, USEPA*

Jeff has spent his entire academic and professional career pursuing various avenues of environmental protection.

In March 2011 U.S. EPA Administrator Lisa Jackson appointed Jeff as her Senior Advisor for the Chesapeake Bay and Anacostia River. In that role Jeff helps coordinate all aspects of the agency's Chesapeake Bay restoration efforts and serves as the chief liaison among the Office of the Administrator; federal, state and local government partners; and community and nonprofit stakeholders.

Prior to serving as the Administrator's Senior Advisor, Jeff was Senior Advisor to the EPA Region 3 Administrator. His duties focused primarily on Chesapeake Bay restoration efforts.

From 2006-2009 Jeff had the pleasure of serving Governor Kaine as his Assistant Secretary of Natural Resources and working with the Commonwealth's six natural resource agencies. Duties and responsibilities involved many different aspects of protecting and restoring Virginia's natural resources, including water, air, fisheries, and land issues.

For nine years prior to his work for Governor Kaine, Jeff served as the Virginia Deputy Director and Senior Scientist for the Chesapeake Bay Foundation. During that time he was an outspoken advocate for environmental protection throughout the Chesapeake Bay watershed. His duties were multi-faceted involving aspects of science, policy, education, legislation, advocacy, and media relations.

Prior to moving to Virginia in 1996 with his wife and children, Jeff held several different positions with state and federal environmental regulatory agencies in Texas and Rhode Island.

Jeff has a Bachelor of Science degree in Marine Science from the University of South Carolina and a Master of Science degree in Oceanography from the University of Rhode Island, Graduate School of Oceanography.

Plenary - Using Models to Inform Restoration Decision Making – Denise Reed*, Research Professor, University of New Orleans*.

Dr. Denise Reed is a University Research Professor at the University of New Orleans and for 2011-2012 she is the Arthur Maass-Gilbert White Fellow and Visiting Scholar at the US Army Institute for Water Resources. Her research interests include coastal marsh sustainability in the face of sea-level rise and how this is affected by human activities. She has worked on coastal issues on the Atlantic, Pacific and Gulf coasts of the US, as well as other parts of the world, and has published the results in numerous papers and reports. She is involved in ecosystem restoration planning both in Louisiana and in California. Dr. Reed has served on numerous boards and panels concerning the effects of human alterations on coastal environments and the role of science in guiding ecosystem restoration, including a number of National Research Council Committees, the Chief of Engineers Environmental Advisory Board and the Ecosystems Sciences and Management Working Group of the NOAA Science Advisory Board. She received her BA and PhD from the University of Cambridge in England and has worked in coastal Louisiana for over 25 years.

Plenary – The UVA Bay Game - *Gerard P. Learmonth Sr*, *Research Associate Professor in the Computational Statistics and Simulation Group of the Department of Systems and Information Engineering, University of Virginia.*

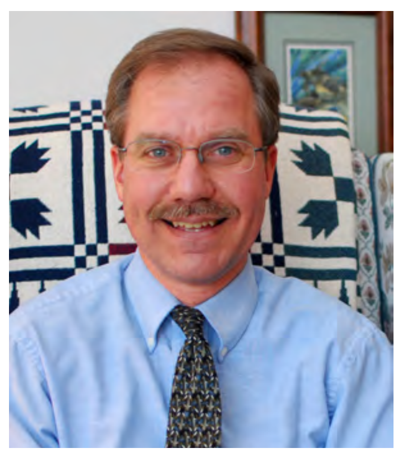
Gerard P. Learmonth Sr. is Research Associate Professor in the Computational Statistics and Simulation Group of the Department of Systems and Information Engineering (SIE) and holds a secondary appointment in the Department of Public Health Sciences. He teaches the two graduate level courses in SIE – *SYS6035: Agent-based Modeling and Simulation of Complex Systems* as well as *SYS6034: Discrete-event Stochastic Simulation*. He managed the development of the UVa Bay Game® and is currently developing the very-large scale simulation-only version of the Chesapeake Bay model that has been selected to run on IBM’s World Community Grid, an architecture with over 1.5M processors. Learmonth’s Complex Systems Modeling Laboratory consists of four Ph.D. students, three Master’s students, and one research assistant all engaged in complexity research and simulation modeling. Other projects include (1) an agent-based model of two villages in Limpopo Province, South Africa where lack of clean water and sanitation facilities has a profound effect on children’s physical and cognitive growth; (2) an agent-based model of the U.S. population assessing the impacts of the Patient Protection and Affordable Care Act on the health care system as the insured population is expanded under the provisions of the Act; and (3) an agent-based model of the Intensive Care Units at the UVa Hospital modeling the transmission of multi-drug resistant infections among patients.

Panel Members

MODERATOR - Jonathan Kramer,
Director for Synthesis and Interdisciplinary Science, SESYNC

Jonathan Kramer is the Director for Synthesis and Interdisciplinary Science at the National Socio-Environmental Synthesis Center (SESYNC) located in Annapolis, MD. SESYNC is supported by the National Science Foundation through the University of Maryland. Its mission is to “create synthetic, actionable science related to the structure, functioning, and sustainability of socio-environmental systems”. Previously, Dr. Kramer served as the Director of the Maryland Sea Grant. He has worked to apply new approaches to link science to policy development and decision-making in the environmental arena. Of particular interest is the use of facilitation, synthesis and consensus building to help address critical issues in the coastal arena as well as the development of effective science outreach mechanisms. Jon received a B.S at the University of Massachusetts, MS at SUNY Stony Brook and Ph.D. at the University of Maryland. His research was conducted at the University of Maryland Center for Environmental Sciences where he studied the physiology and molecular biology of marine phytoplankton.

Rich Batiuk*, Associate Director for Science, USEPA Chesapeake Bay Program Office*.



Rich Batiuk is the Associate Director for Science at the U.S. Environmental Protection Agency's Chesapeake Bay Program Office located in Annapolis, Maryland. In his 27 years with EPA and the Chesapeake Bay Program partnership, he has led the integration of science into multi-partner decision-making.

On a daily basis, Rich has responsibility for providing basinwide monitoring network coordination, model simulation and analysis, information technology and data sharing, web-based and geographical communication, programmatic implementation effectiveness and efficiency evaluation, and watershed implementation plan programmatic and technical support to the Bay Program partners and stakeholders. This work is accomplished through multiple teams of very talented and extremely dedicated colleagues at the Bay Program Office.

He is now focused on helping lead efforts to use EPA's December 2010 publication of the watershed-wide Bay TMDL pollution diet to help state and local partners accelerate on-the-ground implementation of the nutrient and sediment reduction actions to restore local waterways and the Bay.

He received his B.S. in Environmental Science from the University of New Hampshire in 1984 and his M.S. in Environmental Toxicology from American University in Washington D.C. in 1985.

Don Boesch, ***President of the University of Maryland Center for Environmental Science, University of Maryland.***

Donald F. Boesch is a Professor of Marine Science and President of the University of Maryland Center for Environmental Science and University System of Maryland's Vice Chancellor for Environmental Sustainability. He earned his B.S. in biology at Tulane University and Ph.D. in oceanography at the College of William and Mary. Don has conducted research on benthos, marine sedimentary processes, salt marshes, fishery food chains, and ecosystem responses to eutrophication in coastal and continental shelf environments along the Atlantic Coast, and in the Gulf of Mexico, eastern Australia, and the East China Sea. He has been particularly active in extending knowledge to environmental and resource management at regional, national, and international levels. Don is a veteran of the Chesapeake Bay STAC and is a member of the Maryland Governor's Bay Cabinet and the Board of Trustees of the Chesapeake Bay Foundation. He was appointed by President Obama to the Gulf Oil Spill Commission and currently chairs the Ocean Studies Board of the National Research Council.

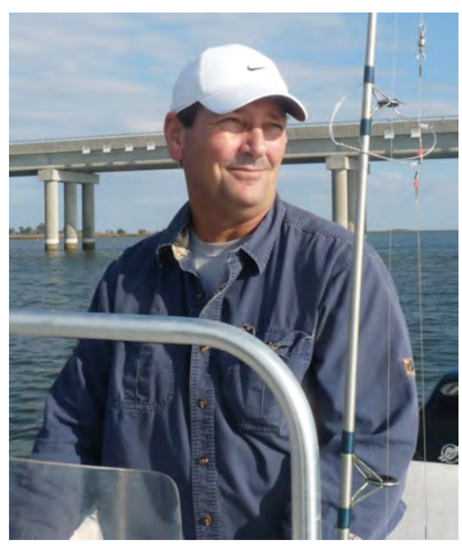
Kim Burgess, ***Division Chief for Surface Water Management, Baltimore City DPW.***

Kim Burgess is a professional engineer, whose 16 years of experience has spanned the spectrum of civil engineering including stormwater management, land development design, environmental site assessment and remediation, geotechnical engineering and forensic analysis, construction management, and materials testing. She can claim that the dirt on her work books has come from project sites in 12 different states and one U.S. territory in the southern and mid-Atlantic United States. After having spent her career as a private engineering consultant, Ms. Burgess joined Baltimore City DPW in December 2011 as the Division Chief for Surface Water Management Division—just in time for Bay TMDL WIPs! The Division is responsible all stormwater related WIP development, infrastructure engineering, watershed restoration engineering, water quality monitoring, inspections and development plans review.

Beth McGee, ***Senior Water Quality Scientist, Chesapeake Bay Foundation***

Dr. Beth McGee is the Senior Water Quality Scientist with the Chesapeake Bay Foundation (CBF). With over 200,000 members and 170 fulltime staff, CBF is the largest non-profit organization dedicated to protecting and restoring the Chesapeake Bay. She has a B.A. in Biology from the University of Virginia, an M.S. in Ecology from the University of Delaware and a Ph.D. in Environmental Science from the University of Maryland. For more than 20 years, Beth has been very active in Chesapeake Bay water quality issues, conducting research, and serving on several technical subcommittees and advisory groups. In addition, she has worked for a variety of state and federal agencies, including the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency and the Maryland Department of the Environment, giving her a broad knowledge of environmental issues.

Michael J. Paolisso, ***Associate Professor of Anthropology, UMD***



Dr. Paolisso is an associate professor of anthropology at the University of Maryland, College Park. His areas of specialization include environmental change, household economics, gender and development, and research methods. He has undertaken short- and long-term fieldwork in numerous countries in Latin America, and in Kenya, and Nepal. His current fieldwork focuses on the gendered use of natural resources in Honduras, and the cultural construction of knowledge related to the causes and consequences of Pfiesteria, a toxic microorganism recently identified in Maryland waterways. In addition, Dr. Paolisso is currently the principal investigator of a three year study funded by the National Science Foundation and the U.S. Environmental Protection Agency (EPA) to study cultural models of pollution and environment. Dr. Paolisso is also co-director of the Resource Management and Cultural Processes track within the Department of Anthropology, University of Maryland, which trains students in the application of anthropological theory and methods to the management of cultural and natural resources. His publications include edited volumes, monographs, journal articles and technical reports. He received his PhD from the University of California, Los Angeles.

John Schmidt, *County Planning Commissioner, Caroline County, MD*
John Schmidt is a 4th generation farmer in Caroline County, quite familiar with land use on the farm to reduce nutrient and sediment loads. As a Magnum Cum Laude University of Maryland graduate in Ag Engineering in 1972, John brings to the fields a deep understanding of farming practices that should result in minimal losses from the farm yet maintaining high production. He has used this understanding to speak for the farming community in the Caroline County as a County Planning Commissioner in its on-going work to draft its Watershed Implementation Plan

Ken Staver, *Associate Research Scientist, Wye Research and Education Center*

Ken Staver has worked at the Wye Research and Education Center since 1984 conducting research on water, nutrient and energy flows in Coastal Plain watersheds. The emphasis of his work has been on the development of strategies to minimize negative environmental impacts of agricultural activities while maintaining agricultural productivity and enhancing soil and water resources. More recently, his research also has focused on nutrient and energy flows at larger scales, including developed areas, and the potential of biofuel production to increase overall nutrient use efficiency in agricultural systems and to reduce net carbon emissions. He has been actively involved in varying roles as technical advisor to Maryland state agencies and the US EPA Chesapeake Bay Program to bring research findings into the watershed management process. He also is an owner/operator of a grain farm in Queen Anne’s county where he lives with his wife and three children.

Ann Pesiri Swanson, *Executive Director, Chesapeake Bay Commission*

Ann Pesiri Swanson has served as Executive Director of the Chesapeake Bay Commission for the past 24 years. The Commission is a tri-state legislative commission, representing the general assemblies of Maryland, Pennsylvania and Virginia. Ann is trained as an ecologist and is widely recognized as a leader in Bay restoration issues. One of the responsibilities of the commission is to provide policy, research and options to its members states. Most recently, the Commission has partnered with RTI International to conduct an economic analysis on nutrient credit trading that provides insight into how markets can minimize the costs of pollution reduction.

Chesapeake Modeling Symposium 2010 At a Glance

Monday, May 21

	Mainsail	Mainsail	Mainsail
8:00a		Coffee	
8:30a		Introduction Introduction and charge for the meeting	
8:45a		Keynote Jeff Corbin - USEPA	
9:30a		Plenary 1 Denise Reed - *University of New Orleans*	
10:15a		*Morning Break*	
10:30a		Plenary 2 Gerard Learmonth - *UVA - Baygame*	
11:15a		Plenary 2 *Baygame (cont.)*	
12:00p		Lunch (provided)	
	Coastal West	**Coastal Main**	**Coastal East**
1:00p	General Processes and Modeling Aspects of the Chesapeake Bay and Estuaries with Similar Settings (Day 1) Boicourt, Long, Harris, Townsend, Suk, Zhang, and Sherwood	Building Blocks for the 2017 Assessment Linker, Shen, Shenk, Cerco, Di Toro, and Batiuk	Observations and Physical-Biogeochemical Modeling at the Fringes - Land-Water and Air-Water Interactions Tzortziou, Cerco, Sanford, Hood, Neale, and Rose
3:00p		*Early Afternoon Break*	
3:20p	General Processes and Modeling Aspects of the Chesapeake Bay and Estuaries with Similar Settings (Day 1) Boicourt, Long, Harris, Townsend, Suk, Zhang, and Sherwood	Building Blocks for the 2017 Assessment Linker, Shen, Shenk, Cerco, Di Toro, and Batiuk	Observations and Physical-Biogeochemical Modeling at the Fringes - Land-Water and Air-Water Interactions Tzortziou, Cerco, Sanford, Hood, Neale, and Rose
6:00p		*Poster Session & Evening Reception*	

Tuesday, May 22

	Mainsail	Mainsail	Mainsail
8:00a	Coffee		
8:30a	**Panel Discussion** TMDLs, politics, litigation, and conflicting stakeholder interests **Moderator:** Jonathon Kramer **State Representatives:** • Wayne Gilchrest (former US Representative, MD) • Anne Swanson (Chesapeake Bay Commission) **Stakeholders:** • Beth McGee (Chesapeake Bay Foundation) • Rich Batiuk (Chesapeake Bay Program) • Kim Burgess (Baltimore DPW Surface Water Management Division) • Ken Staver (UMD Wye Institute) • John Schmidt (Caroline County Planning Commission) **Scientists/Modelers:** • Donald Boesch (UMCES President) • Michael Paolisso (University of Maryland)		
10:30a	*Morning Break*		
10:45a	**Panel Discussion - Continued**		
12:00p	Lunch (provided)		
	Coastal West	**Coastal Main**	**Coastal East**
1:00p	General Processes and Modeling Aspects of the Chesapeake Bay and Estuaries with Similar Settings (Day 2) Boicourt, Long, Harris, Townsend, Suk, Zhang, and Sherwood	Interfacing between modeling, management and the public: TMDLs, politics, litigation and conflicting stakeholder interests Hood, Paolisso, Jasinski,and Sellner	Modeling approaches to water resource/water supply issues Schultz and Moltz
3:00p	*Early Afternoon Break*		
3:15p	General Processes and Modeling Aspects of the Chesapeake Bay and Estuaries with Similar Settings (Day 2) Boicourt, Long, Harris, Townsend, Suk, Zhang, Sherwood	Big Science and Chesapeake Bay - Embracing the NAS recommendations: options for a modeling laboratory McIlhany, Shenk, and Kemp	Modeling Alternative Future Land-Cover and Land-Use Scenarios to Inform Chesapeake Bay Restoration Efforts Claggett, Donato, and Thompson
5:30p	*Adjourn*		

Sessions

Modeling Alternative Future Land-Cover and Land-Use Scenarios to Inform Chesapeake Bay Restoration Efforts

Session Lead: *Peter R. Claggett*
Session Co-Lead(s): *David I. Donato and Renee Thompson*
Date: *May 22, 2012*
Time: *3:15 pm*
Room: *Coastal East*

Abstract:
Intended for both modelers and the managers who make use of model results in decision making, this session will cover current and future work in land-change modeling (LCM) in the Chesapeake Bay Watershed. The session will emphasize the role of LCM in understanding the potential drivers of land change in the Bay watershed and the role of loosely coupling LCM and watershed models for quantifying the impacts of land-use planning on nutrient and sediment loads to the Bay.

The session will also introduce the USGS National Land Change Modeling Framework consisting of a set of open-source software tools and standards for building customized regional LCMs. Presentations may range from detailed descriptions of models, data, and software to broad discussions of planning and policy relevance. Presenters are encouraged to explain how they develop or apply scenarios in modeling alternative futures for the Watershed.

3:35 PM	Plunkett	Assessment of Landscape Changes in the North Atlantic Landscape Conservation Cooperative
3:55 PM	Kaza	Linking land cover change models with economic forecasts
4:15 PM	Jantz	After 15 years with the SLEUTH model, what we've learned and where we're headed
4:35 PM	Claggett	Current Land-Change Modeling in Support of the Chesapeake Bay Program
4:55 PM	All	Discussion

Building Blocks for the 2017 Assessment

Session Lead:	*Lewis Linker*
Session Co-Lead(s):	*Jian Shen, Gary Shenk Carl Cerco, Dominic Di Toro and Rich Batiuk*
Date:	*May 21, 2012*
Time:	*1:00 pm*
Room:	*Coastal Main*

Abstract:
In 2017, the Chesapeake Bay Program will assess the progress of the Chesapeake TMDL and make plans for the implementation of the last phase of nutrient and sediment reductions prior to the 2025 TMDL deadline. To get to the 2017 Assessment, many of the modeling and assessment building blocks we have available today will be expanded and refined in order to provide a range of best available model decision support tools for the 2017 Assessment and beyond. This session explores extensions and applications of the current CBP modeling toolkit with an eye toward how that toolkit can be applied to future Chesapeake Bay Program environmental management challenges.

1:00 PM	Linker	A Survey of the Challenges of the CBP 2017 Assessment
1:20 PM	Devereux	CAST: An Online Tool for Facilitating Local Involvement in WIPs
1:40 PM	Loomis	Potential Impacts of Nutrient Trading on the Spatial Distribution of Nutrient Loads in the Chesapeake Bay Watershed
2:00 PM	Duffy	Data, Models and Information: Sharing Assets Through Virtual Services in the Chesapeake Bay Watershed
2:20 PM	Bhatt	Development of multi-scale, multi-state application of physics-based fully coupled hydrologic model for the Chesapeake Bay watersheds
2:40 PM	Sanford	A New USGS Model Coupling Groundwater Travel Times with a Stream-Nitrate, Mass-Balance Regression to Forecast Nitrogen Fluxes from Chesapeake Bay's Eastern Shore
3:00 PM		Break
3:20 PM	Coles	Quantifying Nutrient Inputs to Chesapeake Bay: What are appropriate sampling intervals for estimating mean nutrient concentrations?
3:40 PM	Friedrichs	Comparison of Hydrodynamic and Dissolved Oxygen Models of the Chesapeake Bay
4:00 PM	Shen	Development of TMDLs of Polychlorinated Biphenyls in the Baltimore Harbor
4:20 PM	Wang	Modeling Support for James River TMDL Chlorophyll Study
4:40 PM	Bierman	Multi-Functional Algal Group Dynamics in the Tidal Fresh Potomac
5:00 PM	Brush	A rapidly deployable, reduced complexity model for estuarine management: case studies and development of an online decision-support interface
5:20 PM	Shenk	Multiple Watershed Models in a Management Context

Observations and Physical-Biogeochemical Modeling at the Fringes - Land-Water and Air-Water Interactions

Session Lead: *Maria Tzortziou*
Session Co-Lead(s): *Carl Cerco, Larry Sanford, Raleigh R. Hood , Patrick J. Neale and Kevin Rose*
Date: *May 21, 2012*
Time: *1:00 pm*
Room: *Coastal East*

Abstract:
Among our biologically and economically most valuable natural resources, estuaries are hot-spots of biogeochemical exchanges. Due to their location, estuarine systems are also particularly vulnerable to climate variability, coastal urban development, land-use changes and other anthropogenic disturbances. Despite recent advances in modeling biogeochemical cycles in coastal and open ocean waters, a large gap still exists in our ability to accurately model and predict changes in the sources, quality and fate of carbon, nutrients and pollutants in estuarine margin ecosystems. Improved understanding and predictive modeling of biogeochemical processes and exchanges in shallow waters and at the land-estuarine interface is imperative for effective management of estuarine resources and decision-making support. It is also crucial for gaining insights into how future changes will affect estuarine biogeochemical cycles, metabolism and ecosystem functioning, and subsequently the role of wetlands and estuaries in regional and global carbon cycling and atmospheric CO2 control.

1:00 PM	Griffith	The 2011 U.S. Carbon Cycle Science Plan and BGC research in the Chesapeake Bay
1:20 PM	Loughner	Modeling air pollution deposition into the Chesapeake Bay watershed
1:40 PM	Cerco	The Shallow-Water Component of the Chesapeake Bay Environmental Model Package
2:00 PM	Sanford	Physical characteristics of nearshore environments in Chesapeake Bay
2:20 PM	Harris	A missing modeled habitat: The role of wetlands at the land-water interface of the Chesapeake Bay and some suggestions for modeling approaches
2:40 PM	Brush	A reduced complexity, hybrid empirical-mechanistic, management-relevant model for shallow, fringing embayments
3:00 PM		Break
3:20 PM	Shen	Evaluate Model Uncertainty in Estimating Bacteria Nonpoint Source Loadings
3:40 PM	Rose	Modeling attenuation across the UV-PAR spectrum in the Rhode River sub-estuary
4:00 PM	Infantes	Integrated Modeling of SAV Habitat Requirements: Near Bottom Wave Orbital Velocity as a Limiting Factor Under Current and Future Climate Conditions.
4:20 PM	Mannino	Biogeochemical and Optical Analysis of Coastal Organic Matter for Satellite Retrieval of DOC, POC, CDOM and Terrigenous DOM from Chesapeake Bay and U.S. Middle Atlantic Bight
4:40 PM	Urquhart	Remotely Sensed Estimates of Surface Salinity and Environmental Vibrio in the Chesapeake Bay

5:00 PM	Canuel	Climate Change Iimpacts on the Organic Carbon Cycle at the Land-Ocean Interface
5:20 PM	All	Discussion

Modeling approaches to water resource/water supply issues

Session Lead: *Cherie Schultz*
Session Co-Lead(s): *Heidi Moltz*
Date: *May 22, 2012*
Time: *1:00 pm*
Room: *Coastal East*

Abstract:
A number of models, including the Chesapeake Bay Program's Phase 5 Watershed model, provide scientists and water managers in the Chesapeake Bay watershed with tools to support investigations and management decisions concerning water quantity. This session will provide an opportunity for presenters to report on hydrologic modeling applications to water resource and water supply management problems. Example applications include, but are not limited to, water supply planning, environmental flow studies, and flow TMDLs. In regions that depend on stream flow for water supply, flow forecasts are needed to assess whether or not future demand can be met by future resources under the impact of projected changes in climate and land use. Stream flow predictions are also needed in environmental flow studies, currently underway or planned in a number of states in the Chesapeake Bay watershed. These efforts benefit from efficient simulation of multiple flow scenarios at ungaged locations to understand how flow alteration affects biota. Finally, since many urban streams are devastated by the high flows that occur during storm events, some states may be considering the possibility of flow TMDLs to address biological impairments in streams.

1:00 PM	Bhaskar	Evaluation of the interaction between urban development and water availability using a watershed model
1:20 PM	Mobley	Environmental Flow Components for Measuring Hydrologic Model Fit during Low Flow Events
1:40 PM	Moltz	Modeling environmental flows in the Potomac basin
2:00 PM	Motesharrei	Exploring Water Management Options using SIWA

Big Science and Chesapeake Bay - Embracing the NAS recommendations: options for a modeling laboratory

Session Lead:	*Kevin McIlhany*
Session Co-Lead(s):	*Gary Shenk, Michael Kemp*
Date:	*May 22, 2012*
Time:	*3:15 pm*
Room:	*Coastal Main*

Abstract:
The long history of modeling of the Chesapeake Bay has produced many research groups and several competing models. The question arises: Is the Chesapeake modeling effort ready to coalesce into a Big Science model, where many smaller groups band together and form a large collaboration, spanning several universities and state institutions? Models for how big science is working in other communities will be presented as well as the pitfalls of creating such large collaborations. Many questions will need to be addressed such as; what should the structure of a large collaboration be, how can the group include new members, what funding opportunities could be opened up as a result of a larger collaboration and how desirable is the idea of many smaller groups merging their various modeling efforts?

3:15 PM	Mcilhany	Is the Chesapeake Bay Ready for a Bis Science Approach?
3:35 PM	Bennett	Evaluation of Options for a Chesapeake Modeling Laboratory
3:55 PM	All	Group Discussion

General Processes and Modeling Aspects of the Chesapeake Bay and Estuaries with Similar Settings (Day 1)

Session Lead:	*William Boicourt*
Session Co-Lead(s):	*Wen Long, Courtney Harris, Howard Townsend, Namsoo Suk, Xinsheng Zhang, Christopher Sherwood*
Date:	*May 21, 2012*
Time:	*1:00 pm*
Room:	*Coastal West*

Abstract:
In this session, we will address process and modeling issues for Chesapeake Bay and similar systems, including the estuary and its watershed, airshed, and aquifiers, in a general and synergistic way. Within this general modeling session, we will bring together a diverse and interdisciplinary set of researchers who are addressing issues within Chesapeake Bay and similar estuarine systems. Showcasing a range of modeling issues and approaches for aspects of these estuaries, the session will generate exchanges of ideas, and discussion. The aggregation of presentations and posters from individuals who work on a range of issues will provides opportunities for information exchange, and help to increase our understanding and management of entire estuarine systems.

The session will feature oral presentations and posters and group discussion. Based on abstracts submitted, the topics in this session include unstructured grid modeling; submerged aquatic vegetation habitat; sediment processes; model coupling; Chesapeake and Delaware (CnD) Canal and its impact on the two-bay system; hurricane flood hazards; data assimilation; spatial interpolation methods; marsh sedimentation and morphology etc

1:00 PM	Ganju	Atmospheric and tidal controls on suspended-sediment fluxes in two Chesapeake Bay wetland complexes (Invited Speaker)
1:30 PM	Tao	Study on Eco-environmental Characteristics of Bohai Bay, China (Invited Speaker)
2:00 PM	Wiggert	Application of a Coupled Physical-Biogeochemical Model to Simulate and Forecast Water Quality and Ecological Variability in Chesapeake Bay
2:20 PM	Harris	Coupling sediment transport to biogeochemical processes: Effects of resuspension on oxygen consumption
3:00 PM		Break
3:20 PM	Aretxabaleta	Stratigraphy, Morphology, and Cohesive Sediment Modeling in ROMS
3:40 PM	Hoffman	Reanalysis Validation of a Chesapeake Bay Assimilation System
4:00 PM	Palinkas	Spatial and temporal variability of marsh sedimentation in Dyke Marsh Preserve (VA, USA): potential controlling factors and relevance for models
4:20 PM	Long	The Impacts of CnD Canal on Modeling Chesapeake Bay and Delaware Bay Circulation
4:40 PM	All	Discussion

Interfacing between modeling, management and the public: TMDLs, politics, litigation and conflicting stakeholder interests

Session Lead: *Raleigh Hood*
Session Co-Lead(s): *Michael Paolisso, David Jasinski and Kevin Sellner*
Date: *May 22, 2012*
Time: *1:00 pm*
Room: *Coastal Main*

Abstract:

Environmental models are increasingly taking on higher profile roles in the management process. In Chesapeake Bay, the Chesapeake Bay Program Watershed and Water Quality models are now being used to support regulatory decisions such as TMDLs, rather than voluntary decisions. One of the effects of this changing role is that it is bringing to light concerns and conflicting interests within different stakeholder communities affected by the regulatory process. Another effect is that the models are increasingly under scrutiny with respect to their scientific validity and skill. It is anticipated that the thresholds set for TMDLs by these models will face numerous scientific and legal challenges in the coming months and years. In this session we will attempt to shed light on these emerging concerns and conflicts as they relate to regulatory thresholds and the environmental models that are used to set them, focusing on topics such as understanding, communication, and credibility. An open forum will comprise much of this session where non-modelers and model tool users will discuss specific needs, provide examples of successful and unsuccessful models used in management, and elaborate on what can and should be done to increase transparency and acceptance of such models in the near- and several year term. By bringing together modelers, managers, scientists, and stakeholders for a series of broadly assessable presentations and discussions we hope to also highlight the unique issues and concerns of each of these groups and provide a venue for open dialogue that will hopefully lead to identification and planning for the development of vetted, useful and accepted models and modeling tools for routine application by the management and non-modeling community.

1:00 PM	Voinov	Integrating models and integrating stakeholders: what are the lessons learned?
1:20 PM	Shenk	Stakeholder Involvement in Model Building and TMDL Decision-Making
1:40 PM	Paolisso	When Environmental Models Stand in for Nature
2:00 PM	All	Discussion
2:20 PM	Merrick	Environmental Science Training Center: Opportunities for outreach
2:40 PM	Muller	Find the Commonality, Communicating, and Engaging, among Your Communities in the Chesapeake Bay Watershed: Listen, Think, Do; the Art of Scientific Story-Telling
3:00 PM	Mcilhany	Presenting Scientific Results to the Public – Do's and Don'ts

General Processes and Modeling Aspects of the Chesapeake Bay and Estuaries with Similar Settings (Day2)

Session Lead:	*William Boicourt*
Session Co-Lead(s):	*Wen Long, Courtney Harris, Howard Townsend, Namsoo Suk, Xinsheng Zhang, Christopher Sherwood*
Date:	*May 21, 2012*
Time:	*1:00 pm*
Room:	*Coastal West*

Abstract:
In this session, we will address process and modeling issues for Chesapeake Bay and similar systems, including the estuary and its watershed, airshed, and aquifiers, in a general and synergistic way. Within this general modeling session, we will bring together a diverse and interdisciplinary set of researchers who are addressing issues within Chesapeake Bay and similar estuarine systems. Showcasing a range of modeling issues and approaches for aspects of these estuaries, the session will generate exchanges of ideas, and discussion. The aggregation of presentations and posters from individuals who work on a range of issues will provides opportunities for information exchange, and help to increase our understanding and management of entire estuarine systems.

The session will feature oral presentations and posters and group discussion. Based on abstracts submitted, the topics in this session include unstructured grid modeling; submerged aquatic vegetation habitat; sediment processes; model coupling; Chesapeake and Delaware (CnD) Canal and its impact on the two-bay system; hurricane flood hazards; data assimilation; spatial interpolation methods; marsh sedimentation and morphology etc

1:00 PM	Khangaonkar	Use of FVCOM-ICM platform for simulation of annual biogeochemical cycles of nutrient balance, phytoplankton bloom(s), and DO in Puget Sound
1:20 PM	Cheng	ChesFVCOM: an unstructured-grid model of Chesapeake Bay for examining climate impacts
1:40 PM	Zimmerman	Integrated Modeling of SAV Habitat Requirements: Improving Predictions of Water Quality Impacts on a Critical Marine Resource
2:00 PM	Gallegos	Integrated Modeling of SAV Habitat Requirements: Modeling Light Availability to Seagrass Canopies
2:20 PM	Patrick	Multiple stressors affecting the distribution of submerged aquatic vegetation in the Chesapeake Bay region
2:40 PM	Irish	A statistical method for estimating future hurricane flood hazards
3:00 PM		Break
3:20 PM	Murphy	Estuary-Specific Spatial Interpolation Methods for Water Quality and Model Performance Evaluatio
3:40 PM	Kim	Response of hydrologic calibration to replacing gauge-based with NEXRAD-based precipitation data in the USEPA Chesapeake Bay Watershed model
4:00 PM	All	Discussion

Abstracts

Aretxabaleta, Alfredo - *U.S. Geological Survey*

STRATIGRAPHY, MORPHOLOGY, AND COHESIVE SEDIMENT MODELING IN ROMS

PRESENTATION - *The stratigraphic record is the product of sedimentary processes acting over time. The Regional Ocean Modeling System (ROMS) includes algorithms for the processes of erosion, deposition, and mixing of both non-cohesive (sandy) and cohesive (muddy) sediment, and routines capable of tracking the evolution of event-scale stratigraphy with layers as thin as a few grain diameters thick. In addition, ROMS can model the morphological evolution of bathymetry associated with net erosion and deposition, with an option to simulate an accelerated process using a flux multiplier (morphological acceleration factor). Thus, ROMS allows users to develop a time-series of the sediment stratigraphy over time scales ranging from a few seconds to years, over vertical space scales of ~0.1 mm to meters, and over horizontal scales of meters to hundreds of kilometers. ROMS requires users to specify the number of bed layers to be tracked at compile time. This improves model efficiency on parallel systems, but complicates the task of tracking stratigraphic evolution. In addition to the number of layers, users can control the minimum and maximum layer thickness, the initial stratigraphy, and the morphological acceleration. This presentation will outline recent algorithm developments and provide examples of processes with mixed sediment types in several idealized estuaries, deltas, and continental shelves.*

Barnes, Michael - *University of Maryland Baltimore County Center for Urban Environmental Research and Education*

HIGH-RESOLUTION DISTRIBUTED WATERSHED MODELING OF URBAN LANDSCAPES IN THE CHESAPEAKE BAY WATERSHED USING PARFLOW

POSTER - *High-resolution data and the urban landscape present a unique set of opportunities and challenges to a watershed modeling application. The use of LIDAR-derived topography and land use/land cover data allow the description of urban surface features at a much finer scale, but using this data poses unique demands on the methods used for overland flow and routing within watershed models. Watershed modeling simulations of urban landscapes are conducted using ParFlow, a parallel watershed flow model. Parflow uses a free surface overland flow boundary condition to simulate integrated groundwater-surface water interactions. The overland flow component is modeled using the kinematic wave approximation, in which the diffusion terms of the momentum equation are neglected, and backwater effects are hence not included. Application of this solution technique necessitates the input of topographical information (slopes) that function in conjunction with the kinematic wave approximation for overland flow. The approach used to condition high-resolution LIDAR topography for use in ParFlow is the focus of this presentation. Code was developed that leverages information from Geographic Resources Analysis Support System (GRASS) GIS routines to create input topographic slopes for ParFlow while retaining the detail afforded by the LIDAR DEM. These methods help expand the scale of feasible application of ParFlow, allowing watershed-relevant questions to be addressed at the appropriate scale. Preliminary results of the methods described will be shown for the Dead Run subwatershed of the Gwynns Falls in Baltimore. The domain is approximately 3 square kilometers, and horizontal model resolution is 1m by 1m. This domain provides a challenging test for the slopes methodology above, as the surface layer alone is made up of 3 million cells, and demonstrates the effectiveness of this method of DEM conditioning for ParFlow.*

Bennett, Mark - *USGS Virginia water Science Center*

EVALUATION OF OPTIONS FOR A CHESAPEAKE MODELING LABORATORY

PRESENTATION - *The Evaluation of Chesapeake Bay Program Implementation for Nutrient Reduction to Improve Water Quality report recently completed by the National Research Council (NRC) of the National Academy of Sciences (NAS) recommended establishing a Chesapeake Bay Modeling Laboratory charged with evaluating monitoring data and uncertainty in model simulations, improving the predictive skill of the models, and continuously seeking model improvements to accommodate new scientific understanding of the system. Multiple modeling approaches in which open-source models are exercised cooperatively with the scientific community are key features of the approach recommended by the NRC panel and by the Chesapeake Bay Program's Science and Technical Advisory Committee (STAC). The development of the Total Maximum Daily Load for the Chesapeake Bay has brought increased scrutiny to the models that are being used and the credibility of these models with the scientific, engineering, and management communities that are concerned with protecting Bay water quality is critically important. In its recommendations, the NRC panel also stressed the importance of integrating modeling in the ongoing adaptive management of the Bay and indicated an important component of a modeling laboratory would be the integration of monitoring with modeling efforts within an adaptive management program.*

An Action Team under the Bay Program's Science and Technical Analysis and Reporting (STAR) Team has been created to proceed forward with more in-depth evaluation of the recommendation for establishing a Chesapeake Bay Modeling Laboratory and other alternatives to achieve the recommendations of the NRC panel. The charge of the Action Team will include: evaluation of other existing modeling laboratories in the context of their *structure and function and their applicability to the mandate of the Chesapeake Bay Program Partnership; consideration of a range of options for what would constitute a Chesapeake Bay modeling laboratory, a virtual laboratory, or responsive program reorganization that is capable of carrying out the functions outlined by the NRC panel; development of options and recommendations for actual institutional sponsorship and how the laboratory would function for carrying out mandates; and assessment of the possible range of financial investments and funding mechanisms required for the establishment and long-term operation of a Chesapeake Bay modeling laboratory and its alternatives. The Action Team is expected to report back to the Chesapeake Bay Management Board with its finding, options and recommendations early in 2013.*

Bever, Aaron - *Virginia Institute of Marine Science*
Combining observational and numerical model results to improve estimates of hypoxic volume within the Chesapeake Bay
POSTER - *Hypoxia is a significant ecological stressor and has been increasing in prevalence and frequency over the last 50 years. Management plans in Chesapeake Bay are partly based on estimates of hypoxic volume, but little information is available on how reliably point measurements of dissolved oxygen (DO) can be scaled up to hypoxic volume. To better understand uncertainties associated with hypoxic volume time-series in the Chesapeake Bay, we compared hypoxic volume estimates computed from Chesapeake Bay Program (CBP) water column DO profiles to hindcasts calculated from three-dimensional numerical models: the CBP Chesapeake Eutrophication Model and three one-equation DO implementations in the Regional Ocean Modeling System.*

Multiple methods of calculating hypoxic volume from modeled DO distributions were used to: (1) examine the uncertainties associated with computing hypoxic volume estimates from point measurements of DO and (2) design alternative observational sampling strategies with reduced hypoxic volume uncertainties. Overall, the volume of hypoxic water computed from the full three-dimensional simulated DO fields was greater than that interpolated from modeled DO at the discrete observation station locations using the CBP's standard interpolator. Model results also showed that uncertainty in the hypoxic volume estimates resulting from the observed water column profiles being collected asynoptically over a period of about two weeks generally exceeded the uncertainty derived from only sampling a finite number of points. Finally, the models were used to derive a function that, when applied to the hypoxic volume computed from a small subset of DO stations that can be sampled in about two days, improves estimates of hypoxic volume within the Chesapeake Bay. A final product of this analysis is an improved two-decade time series of hypoxic volume within the Chesapeake Bay system.

Bhaskar, Aditi - *UMBC*
Evaluation of the interaction between urban development and water availability using a watershed model
PRESENTATION - *In seeking to understand the feedbacks between urban development and water availability, we are in the process of coupling an integrated hydrologic model with an urban growth model, both of the Baltimore, Maryland, USA region.. The urban growth model SLEUTH has been calibrated, validated and run by collaborators at Shippensburg University. We are implementing ParFlow.CLM, a parallel integrated hydrologic model, for the 13,000 sq km Baltimore metropolitan area. The initialization for this model is being generated by a dynamic spin-up process, run on the UMBC High Performance Computing Facility. We are assimilating a number of hydrogeological, meteorological, and urban datasets for this study. Hydrogeological datasets include soil and subsurface hydraulic conductivity. The model is forced using observed meteorology, such as hourly precipitation and air temperature, which are used by the land surface model, CLM, to calculate spatially-variable evapotranspiration and land-energy fluxes. Urban datasets include residential (municipal and private) well water use, reduced evapotranspiration, and low permeability urban surfaces. We are particularly interested in the effects of these urban hydrologic features on groundwater recharge in the Baltimore area. Our water balance study has found that evapotranspiration and infiltration to water supply pipes are important anthropogenic modifications to the water balance in the Baltimore area.*

Bhatt, Gopal - *Penn State University*
Development of multi-scale, multi-state application of physics-based fully coupled hydrologic model for the Chesapeake Bay watersheds
PRESENTATION - *Understanding the spatial variability in watershed responses is critical to effective management of water resources and ecosystem services. Various modeling efforts that incorporate distributed source-loadings and simulate their transport through the watersheds to streams and to the bay are an essential part of the decision making process and especially as they relate to the complexity of TMDL's. Clearly, our ability to simulate multiple physical, geochemical and biological processes relies on the spatial distribution of hydrologic and ecological states and fluxes across the watershed. Such predictions are consistent if the best available geospatial data are properly represented in the numerical model.*

In this paper we show how multi-scale applications of Penn State Integrated Hydrologic Modeling System (PIHM) have the ability to simulate hydrologic *distributed processes while accounting for spatially explicit information associated with topography, climate, land use/cover, soil and geology. We discuss issues surrounding the data development for the Chesapeake Bay watersheds including a proposal for establishing the essential or common data necessary for modeling in the Chesapeake Bay watershed. The modeling framework we propose is carefully designed to enable high-resolution numerical representation of a large-scale watershed using the database. Computational scalability under a high performance computing environment was achieved through automated synthesis of multiple model units based on Hydrologic Unit Count. Development of the system is demonstrated on a large-scale test-bed at Juniata River Basin (~ 8800 sq. km). The Juniata River is a major tributary of Susquehanna River in Pennsylvania. Model was calibrated at a small-scale sub-watershed (~ 114 sq. km) using partition calibration strategy with Covariance Matrix Adaptation Evolutionary Strategy (CMAES). The calibration was extended to the rest of the watershed. Model was validated with streamflow observations at multiple monitoring stations across the watershed.*

Bierman, Victor - *LimnoTech*
Multi-Functional Algal Group Dynamics in the Tidal Fresh Potomac
PRESENTATION - *The Potomac River Estuary is the largest tributary to Chesapeake Bay and has been plagued for decades by blooms of cyanobacteria (blue-green algae) in the tidal fresh portion. As part of the overall effort to develop an improved Water Quality and Sediment Transport Model (WQSTM) for Chesapeake Bay, a revised multi-functional algal group model was developed for the Potomac portion and calibrated to available data for 1994-2000. There are five algal groups in the model and they represent tidal freshwater diatoms, lower estuary diatoms, greens plus cryptophytes, dinoflagellates, and blue-greens. The calibration results are a reasonable representation of the spatial and temporal distributions of chlorophyll, total algal biomass, carbon fixation rates and algal biomass for the five individual functional groups. To investigate responses of algal dynamics in the tidal freshwater portion, the calibrated model was run for two different loading scenarios using the same 1994-2000 hydrology as in the calibration. The first corresponded to 1985 land uses and point sources, and the second corresponded to the loads for the Potomac in the 2010 Chesapeake Bay TMDL. In general, blue-green algae in the tidal fresh Potomac were more responsive to changes in nutrient loads than total algal biomass. Furthermore, algal biomass appears to be more responsive to changes in nitrogen loads than changes in phosphorus loads. Results for 1996, the year with the highest flow, were anomalous in that results for both total and blue-green algal biomass for the TMDL scenario were systematically higher than those for the calibration period. Another difference was that computed algal concentrations were lower for 1996 than for any of the other years. A confounding factor was that, due to programmatic considerations, point source phosphorus loads were higher in the TMDL scenario than in the calibration period, whereas the reverse was true for point source nitrogen loads. Consequently, results for 1996 are confounded by the simultaneous influences of nutrient loads, flows and possibly light attenuation. Overall, the results are consistent with the hypothesis that algal biomass in the tidal fresh Potomac is proportional to nutrient load, with a stronger relationship to nitrogen than to phosphorus, but that the influence of hydraulic washout can become dominant at high flows.*

Brush, Mark - *Virginia Institute of Marine Science*
A rapidly deployable, reduced complexity model for estuarine management: case studies and development of an online decision-support interface
PRESENTATION - *The use of ecosystem simulation models to inform coastal management has virtually exploded in recent decades. Concurrent with this explosion has been an increase in calls for development of alternative and in some cases simplified approaches that can be used in concert with existing models to inform management. With the ever-increasing need for TMDL development and assessment of ecosystem status at smaller spatial scales including the myriad of small embayments and tributary estuaries around the Chesapeake Bay, simplified tools that can be rapidly deployed and used by a variety of stakeholders are becoming increasingly important. I will present a reduced complexity estuarine model designed for both research and management applications including TMDL development, and proposed as approach for use in concert with more complex models, and in cases where resources are unavailable to support larger modeling efforts. The model is rapidly deployable, readily calibrated against widely-available monitoring data, and fast running which enables multiple simulations on a desktop PC. Three case studies will be presented where the model is being used to inform management, including (1) assessment of near- vs. far-field influences on hypoxia in a sub-estuary of Narragansett Bay, RI, (2) development of nutrient budgets in the New River Estuary, NC, and (3) application to restoration scenarios in the West-Rhode Rivers, MD. The latter application is now served online through the VIMS Ecosystem Modeling Program, allowing use by a variety of stakeholders over the internet without the need for purchase of software, large investments of time and money, or extensive modeling expertise.*

Brush, Mark - *Virginia Institute of Marine Science*
A reduced complexity, hybrid empirical-mechanistic, management-relevant model for shallow, fringing embayments

PRESENTATION - *Efforts to model and control eutrophication in systems like Chesapeake Bay are typically focused at the relatively large scale, while the myriad of small, shallow fringing estuaries around the perimeter of the bay often go overlooked. However, these small systems often receive elevated watershed loads which become concentrated in the small volumes typical of these systems, thereby having the potential to result in deleterious impacts; conversely, these systems may also be active zones of nutrient sequestration and removal via microphytobenthic uptake, denitrification, and benthic filtration. These systems are also at the scale at which local managers make decisions related to land use and load reductions; therefore modeling tools relevant to both research and management are urgently needed in these systems. I will present a reduced complexity, estuarine ecosystem model designed specifically for these fringing ecosystems. The model was originally developed in New England and has subsequently been applied in the Delmarva lagoons and the New River Estuary, NC, and is currently being applied in selected shallow fringing systems in the Chesapeake Bay. The model simulates the first order processes involved in estuarine eutrophication, formulates selected rate processes with robust, cross-system empirical relationships, and has been developed with multiple "plug-and-play"modules for specific habitat components such as eelgrass and benthic suspension feeders. The model is rapidly deployable, readily calibrated against monitoring data, fast running enabling multiple simulations on a desktop PC, and readily transferable to an online decision-support tool.*

Canuel, Elizabeth - *Virginia Institute of Marine Science*

CLIMATE CHANGE IMPACTS ON THE ORGANIC CARBON CYCLE AT THE LAND-OCEAN INTERFACE

POSTER - *Humans have modified estuaries across the globe by altering the delivery of water, sediments and elements such as carbon and nitrogen that play important roles in biogeochemical processes. These activities have caused declines in the health and quality of estuarine ecosystems globally and this trend will likely continue due to increasing population growth in coastal regions, expected changes associated with climate change, and their interaction with each other, leading to serious consequences for the ecological and societal services they provide. A key function of estuaries is the transfer and transformation of carbon and biogenic elements between land and ocean systems. The anticipated effects of climate change on biogeochemical processes in estuaries are likely to be both numerous and complex but are poorly understood. Climate change has the potential to influence the carbon cycle in estuaries through anticipated changes to organic matter production, transformation, burial and export. Estuarine biogeochemical processes will likely be altered by: 1) sea level rise and increased storm intensity which will amplify the erosion and transfer of terrigenous materials, 2) increases in water temperatures which will enhance the rates of biological and biogeochemical processes (e.g., enzyme kinetics, decomposition rates, and remineralization), while simultaneously decreasing the concentration of dissolved oxygen, 3) changes in particle (or sediment) loadings in response to altered patterns of precipitation and river runoff, and 4) altered inputs of nutrients and dissolved organic materials to coastal waters, also resulting from changing precipitation and runoff. In this presentation, we review the effects of climate change on the carbon cycle in estuaries, with a focus on the temperate estuaries of North America.*

Cerco, Carl - *US Army ERDC*

The Shallow-Water Component of the Chesapeake Bay Environmental Model Package

PRESENTATION - *The spatial resolution of Chesapeake Bay management models has been subject to continuous improvement since the beginning of the modern management era, circa 1985. The objective of the increased resolution is to move the model domain into regions of smaller spatial extent and less depth. As the model moves into regions of smaller extent, the importance of physical and biogeochemical processes at the land-water interface increases. The movement into shallow, enclosed regions will continue in the next phase of management modeling, likely necessitating new and improved modeling of processes at the fringes of the model domain. The present model incorporates numerous modules that represent processes at the land-water interface. These include sediment resuspension, sediment loads from shoreline erosion, bivalve production and filtering, production by submerged aquatic vegetation, and diagenesis in bottom sediments. The formulations, successes, and shortcomings of these modules are reviewed for potential use in upcoming model activities. The addition of further complexity to the present framework may not, however, be feasible or desirable. We suggest the development of less complex modular models of processes at the fringes and propose some ideas. We conclude with a proposition to develop community modeling modules for use in Chesapeake Bay and elsewhere.*

Cheng, Peng - *Horn Point Laboratory*

ChesFVCOM: an unstructured-grid model of Chesapeake Bay for examining climate impacts

PRESENTATION - *Estuaries are vulnerable to climate change. To investigate the impacts of climate change on the Chesapeake Bay, we have developed an unstructured-grid model using the Finite Volume Coastal Ocean Model (FVCOM). The model domain covers the Chesapeake Bay, Delaware Bay and part of the Atlantic Ocean. Compared to the ocean models* *that use orthogonal curvilinear grid, the distinct advantage of FVCOM is the unstructured-grid which can fit complicated coastline very well so that the shelf, estuary, and tributaries can be resolved in details simultaneously and efficiently. The tidal simulation for 2010 has been completed with 7 tidal harmonic constituents forced at the open boundary and river discharge specified at 8 tributaries. The results showed accurate prediction of tides and reliable subtidal salinity structure and currents. On the basis of the 2010 simulation, four sensitive experiments with sea level changes of 0.5, 0.5, 1.0 and 1.5 m initiated at the open boundary were conducted. It showed that sea-level rise leads to salt intrusion into the Bay, increasing estuarine length and stratification. The strength of residual currents, however, show a relative complicated response. Further study will focus on estuarine response to changes in river flow and shelf salinities.*

Claggett, Peter - *USGS*

Current Land-Change Modeling in Support of the Chesapeake Bay Program

PRESENTATION - *In order to relate current and future land cover and land use in the Chesapeake Bay Watershed (CBW) to sediments and nutrients reaching the Bay, we are conducting a varied but interrelated set of land-change research and development. We will describe our development of a series of consistent land-cover data sets for the CBW; the results of a workshop for creating policies and scenarios for alternative CBW futures; development of a new patch-based urban-change model for the CBW; new procedures for monitoring and modeling urban infill and redevelopment; new approaches for interpretation of image data in order to prepare more accurate estimates of impervious surface in the CBW; efforts to foster a community of practice and standards of practice for land-change modeling; and initial development of a National Land-Change Modeling Framework. We will summarize how this work will support the Chesapeake Bay Program's restoration efforts through the coupling of alternative land-use and land-cover futures with hydrologic models and other environmental and socio-economic models.*

Coles, Victoria - *UMCES/HPL*

Quantifying Nutrient Inputs to Chesapeake Bay: What are appropriate sampling intervals for estimating mean nutrient concentrations?

PRESENTATION - *Nutrient monitoring throughout the Chesapeake Bay region typically occurs at bi-weekly to monthly sampling intervals and demonstrates high interannual and seasonal variability. This variability makes temporal trend detection and attribution of nutrients to different sources challenging. We investigate the effect of nutrient sampling at different intervals on accurate estimation of the mean. We employ one to two-month duration 2-hourly nutrient time series in the Pocomoke River to estimate variability and use Monte Carlo methods to estimate the error associated with sampling at different intervals. Variability in nutrient concentrations occurs at the frequency of the semi-diurnal tide, daily and at the synoptic timescale associated with rainfall patterns, although the expression of these frequencies differs between nutrients. Avoiding these frequencies and associated harmonics significantly decreases the error in estimating the mean. Because monthly sampling does not capture the synoptic timescale in particular, the 95% confidence interval spans +- 100% of the true mean for nitrate plus nitrite concentrations. The inability of monthly sampling to detect mean nutrient concentrations may have implications for determination of the Bay regulatory Total Maximum Daily Load (TMDL). We find that sampling intervals less than three days are required to estimate nutrient concentrations to within plus or minus 20% of the true mean in this location and season. The Chesapeake Bay Act of 2000 stipulated 40% nutrient reductions as a target for restoration efforts. Using a synthetic time series generated from the monthly nutrient time series we produce two 10-year long time series of fall nitrate plus nitrite concentrations, one with a 40% nutrient reduction. Even biweekly sampling of this trend in fall nutrient concentration is unlikely to be detected as a significant difference of means. If the short, targeted nutrient time series used in this analysis are representative of broader time and space scales, monitoring protocols may need to be altered to determine the efficacy of management and restoration strategies.*

Cui, Zhengtao - *Department of Chemical, Biochemical and Environmental Engineering and Center for Urban Environmental ReUniversity of Maryland Baltimore County*

Coupling Nitrogen Biodegradation with a Particle-Tracking Transport Model

PRESENTATION - *Numerical models that simulate nitrogen transport and transformation in aquifers have become one of the vital tools to quantify nitrogen loading to groundwater and nearby streams. Classical Eulerian numerical methods such as finite-element or finite-difference methods suffer from numerical dispersion, low computational performance and mass conservative problems in advection-dominated systems. The random walk particle Tracking (RWPT) method is an effective alternative to overcome such problems encountered by Eulerian methods.*

To take advantage of the RWPT method, we coupled nitrogen biodegradation with an existing RWPT based solute transport code, SLIM-FAST. The biogeochemical reactions are modeled using a mechanistic approach, in which both organic and inorganic reactions are assumed to be kinetic. The denitrification and nitrification processes are *simulated with the multiple-Monod equations. By applying the operator splitting technique, within each simulation time step, the physical transport of the solute (advection and dispersion), and the biogeochemical reactions are simulated in two sequential steps. The physical movement of the solute is simulated by the RWPT method; and the local concentrations of the species are calculated for each of the grid cells. Finally, the system of equations for biodegradation reactions is solved with an ordinary differential solver.*

The particle-tracking code coupled with nitrogen biodegradation is capable of simulating subsurface nitrogen transport and transformation in a three-dimensional domain with variably saturated conditions. Verification with analytical solutions and other numerical codes shows that the new code captures the main features of biogeochemical reactions with aquifers. An example application and a discussion of implementation challenges will be presented as well.

Devereux, Olivia H. - *Devereux Environmental Consulting*

CAST: An Online Tool for Facilitating Local Involvement in WIPs

PRESENTATION - *The Chesapeake Assessment Scenario Tool (CAST) is developed as an online nutrient and sediment load estimator to streamline and facilitate Watershed Implementation Plan (WIP) and Milestone preparation consistent with the Chesapeake Bay Total Maximum Daily Load (TMDL). The purpose of the tool is to simplify the process for building scenarios and to provide initial estimates of nitrogen, phosphorus, and sediment load reductions using a variety of best management practices (BMPs). CAST builds on the science that went into development of the Watershed Model by providing a broadly accessible online tool to facilitate efficient management decision making and greater environmental protection. CAST approximates loads using similar logic, rules and assumptions as the Watershed Model, which was used in determining the TMDL and allocations. This ensures consistency with the TMDL so that when progress is measured using the Watershed Model, the loads are comparable to CAST's predicted loads. However, CAST does not actually "run"the Watershed Model, but rather approximates that model's output for rapid online scenario development. CAST facilitates an iterative process to determine if TMDL allocations are met. Because CAST is online and easy to use, local jurisdictions may deeply engage, thereby improving local management decisions and securing a higher likelihood of actual implementation. CAST allows users to select the geographical area for their plan and identify the level of implementation of various BMPs. CAST predicts pollutant loads and compares these against allocations. Local planners can compare among different scenarios that they create, so they can determine which scenario meets the allocation and is politically feasible. In this way, planners can develop multiple options rapidly. Each local jurisdiction that uses CAST uses the same methodology, which ensures the ability to replicate results. Since CAST approximates the loads from the Watershed Model, there is consistency also with the load predictions based on BMP implementation. CAST also automatically can create inputs to the model that pass the model's validation, saving time and effort for Chesapeake Bay Program staff. This presentation will provide an overview of the tool, the data requirements necessary for tool development, and the use of the tool in the WIP and Milestone process.*

Ducca, Fred - *National Center for Smart Growth, University of Maryland College Park*

Water Quality Assessment: Experience from Chesapeake Bay Megaregion

PRESENTATION - *The concept of mega-regions is derived from the observation on central-city-based growth in land use, transportation and communication on multiple regions to act together as an economic unit. The Chesapeake Bay Mega-region (CBM) consists of Baltimore / Washington D.C. / Richmond / Norfolk regions and is designed to develop and examine a suite of forecasting and evaluation models. Urbanization increases imperviousness, which in turn increases surface runoff. Urbanized surface runoff contains a large amount of pollutants such as nutrients and sediments, and these increases in non-point source (NPS) pollutants will have a negative effect on surface water quality. Total runoff and nitrogen loading are two of the most critical water quality assessment factors. For CBM, total runoff and nitrogen loading are estimated within the Long-Term Hydrologic Impact Assessment (L-THIA) model. L-THIA calculates mean surface runoff and NPS pollutant loading for a given region and a period using daily precipitation series, a land use map, and a hydrological soil group map. The LTHIA model was run with land use maps simulated by LEAM from 2001 to 2030 for the Montgomery County of Maryland. Surface runoff and total nitrogen pollutant loading generally increase with urbanization but it depends on the land use type, potential regulations and land cover type it replaces. For CBM, a number of other results were derived from the proposed model which can be used as a tool to assess water quality impact in response to changes in land use, transportation, economic demand, and fiscal impact.*

Keywords: mega-region, nutrient loading, runoff, hydrology, land use

Duffy, Christopher - *Penn State University*

Data, Models and Information: Sharing Assets Through Virtual Services in the Chesapeake Bay Watershed
PRESENTATION - *Data, models and information assets within the Chesapeake Bay Watershed must be made more accessible to all stakeholders if we wish to assure a transparent process for decision making informed by shared knowledge. Our concept for sharing model and data assets for the Chesapeake Bay watershed focuses on a new delivery system that integrates data, models and information as a service. In addition this service must enable researchers, water managers and all stakeholders the ability to perform complex workflows that can examine retrospective model simulations and future model scenarios; that can evaluate impacts on human and ecosystem services risk and vulnerability; or that can implement new model scenarios that test water policy assumptions.*

In this talk we outline and demonstrate a strategy for virtualized web services where the user has access to geospatial tools that generate current model results and/or examine geospatial data for any domain or segment that can be represented in a GIS (e.g. sub-watershed, county, stream reach, urban center, hillslope, or farm).. The prototype under development is deployed in a "cloud" environment that provides an essential foundation to new operational approaches to managing knowledge resources. Users need not have knowledge of, nor expertise in, nor control over the technology infrastructure in the "cloud" that supports them. Our vision is that the prototype must evolve as data and computational requirements grow nationally and globally in the future. This growth will demand a greater degree of virtualization such as those offered by cloud computing environments that can handle the predicted peta-scale computation.

Duffy, Maura - *Department of Geographical Sciences - University of Maryland*
The Effects of Atmospheric Deposition on the Chesapeake Bay
POSTER - *Atmospheric inputs have been shown to play an important role in marine biochemical cycles. In near shore regions, atmospheric inputs may affect estuarine and coastal ecosystems through both direct deposition onto surface water, and through deposition onto the terrestrial landscape with subsequent downstream export in streams, rivers, and coastal wetlands. We will show temporal and spatial trends in wet and dry nitrogen deposition in the Chesapeake Bay watershed with the National Atmospheric Deposition Program's (NADP) National Trends Network (NTN), Atmospheric Integrated Research Monitoring Network (AIRMoN), and Ammonia Monitoring Network (AMoN) and EPA's Clean Air Status and Trends Network (CASTNET). In addition, air pollution emissions from EPA's National Emissions Inventory (NEI) will be analyzed alongside the deposition data and estimates to ascertain relationships between trends in air pollution emissions versus deposition. We will investigate to see if trends in air pollution and deposition over time are correlated to environmental policy changes. The networks will also be used to establish if there is a relationship between the amount of deposition and the extent of eutrophication and hypoxia in the Chesapeake Bay. This research will help illustrate the connection between emission sources, atmospheric pollution, estuarine water quality, and biology.*

Friedrichs, Marjorie - *Virginia Institute of Marine Science*
Coastal Carbon Fluxes along the U.S. Eastern Continental Shelf Derived from a Coupled Biogeochemical-Circulation Model
POSTER - *The role of coastal margins in regional and global carbon budgets is not well understood, primarily because many key shelf fluxes are not yet well quantified over annual time scales, e.g. the exchange of carbon across the land-ocean and shelf-slope interfaces, air-sea exchange of CO2, burial, and biological processes including productivity. Because of the temporal and spatial undersampling typically associated with most observational studies, model-derived carbon flux estimates are likely to be the only viable approach for defining these fluxes in a consistent manner on annual time scales. However, such models require the interfacing of estuarine, shelf and oceanic systems, which remains a challenge for the modeling community.*

The goal of our USECoS (U.S. Eastern Continental Shelf Carbon Cycling) project is (1) to estimate coastal carbon fluxes along the U.S. east coast using models quantitatively evaluated by comparisons with observations, and (2) to establish a framework for predicting how these fluxes may be modified as a result of climate and land use change. Recent efforts have been geared toward linking our coastal biogeochemical-circulation model with a dynamic land ecosystem model, as well as directed toward refining the role of estuarine processes in linking the riverine and coastal ocean systems. Development of a coupled biogeochemical-hydrodynamic model of Chesapeake Bay is currently underway, and will be used to assess the effects of climate and land-use changes on carbon cycling both within the estuary and on the continental shelf.

Friedrichs, Marjorie - *Virginia Institute of Marine Science*
Comparison of Hydrodynamic and Dissolved Oxygen Models of the Chesapeake Bay
PRESENTATION - *Results from multiple 3-D hydrodynamic and dissolved oxygen models for Chesapeake Bay have been compared to each other and to EPA monitoring data for the years 2004 and 2005. On seasonal time-scales, the models all do well*

in capturing fundamental aspects of the hydrodynamic and oxygen fields, although the intensity of the pycnocline is underestimated. Models with constant net respiration independent of nutrient supply reproduce hypoxia nearly as well as much more complex, nutrient-dependent ecological models. Seasonal variation in DO was insensitive to seasonal cycles in the respiration rate, freshwater input, and density stratification. Rather, seasonal variation in DO was found to be very sensitive to seasonal variations in wind, likely due to wind-induced lateral upwelling of hypoxic areas. The overall intensity of stratification and resulting hypoxic volume was also found to be sensitive to numerical formulations of turbulence closure and advection. Another significant finding with regards to future modeling strategies is the result that the ensemble hindcast for dissolved oxygen using multiple models was more accurate than the hindcast from any one model.

Gallegos, Charles - *Smithsonian Environmental Research Center*

Integrated Modeling of SAV Habitat Requirements: Modeling Light Availability to Seagrass Canopies

PRESENTATION - *Increasing light attenuation due to deterioration of water quality is a common cause of seagrass habitat loss. The capability to model the quantity and quality of light reaching the tops of seagrass canopies is, therefore, a critical element in the development of tools to assist managers in diagnosing water quality impediments to seagrass restoration. We have developed a model that predicts irradiance spectrum at the top of a seagrass canopy which is then available to propagate through the seagrass canopy and drive plant physiological processes. The model is based on relationships between inherent optical properties and commonly measured water quality parameters. The model is being formulated to utilize continuously monitored water quality data, so that temporal resolution is improved over what can be determined from relatively infrequent cruises. Conceptual plans to enhance the model to utilize data from underway water quality mapping data are being developed.*

Ganju, Neil - *USGS*

Atmospheric and tidal controls on suspended-sediment fluxes in two Chesapeake Bay wetland complexes (Invited Speaker)

PRESENTATION - *The Blackwater National Wildlife Refuge contains 53 km2 of tidal marshes, on the eastern shore of Chesapeake Bay. Two adjacent wetland complexes, which drain into the Blackwater and Transquaking Rivers respectively, have shown significant morphologic differences over the past century. Despite positive surface sediment accretion in both regions, landward tidal marshes drained by the Blackwater River have largely subsided and deteriorated into large expanses of submerged marsh plain while seaward marshes adjacent to the Transquaking River have successfully maintained their structure. Surface accretion does not guarantee stability, however: net sediment fluxes constrain the sediment budget of the marsh-channel complex allowing inference into their relative stability. We measured sediment fluxes in tidal channels at both sites over a 10 week period in Fall 2011.*

At the Blackwater River site flux events mainly exported sediment and were correlated with northwesterly wind events that resuspended sediment over the submerged marsh plain; these same atmospheric events are responsible for forcing water out of Chesapeake Bay and out of the tidal channels on the subtidal timescale. The relative lack of tidal energy prevented seaward sediments from reaching the site. Conversely, at the Transquaking River site southerly wind events resuspended sediment in Fishing Bay and mainly imported sediment, compensating for export during northerly wind events. An estuarine turbidity maximum in the Transquaking River channel acted as a seaward sediment source and also contributed to net landward sediment fluxes on the tidal-timescale.

In terms of net sediment availability, the Transquaking marsh complex is importing sediment at a faster rate than the regional relative sea-level rise (~0.95 kg m-2 y-1, or 5 mm y-1), while the degraded marsh along the Blackwater River is exporting sediment ostensibly due to a combination of resuspension and shoreline erosion. These results suggest that landward marshes with limited modern sediment supply, possibly formed during rapid land-clearing colonization, may be a source of sediment to seaward marshes that are favored by tidal processes over the short-term.

Griffith, Peter - *NASA GSFC*

The 2011 U.S. Carbon Cycle Science Plan and BGC research in the Chesapeake Bay

PRESENTATION - *This talk will review how biogeochemical research and modeling in the Chesapeake Bay addresses expectations articulated in the 2011 U.S. Carbon Cycle Science Plan. The Plan calls for "linking terrestrial and ocean systems for better understanding of how carbon, nutrients, and sediments are moved from terrestrial ecosystems through estuaries to the ocean, where the fate of carbon can be long-term storage in the marine environment or release to the atmosphere as CO2. Some environments are of limited geographic extent yet play major roles in the global carbon cycle and these provide rich possibilities for focused research. The transport of carbon into and through rivers and other freshwater networks, the transformations of these constituents in these networks, and the delivery and fate of this carbon in deltas and coastal ecosystems; including the* *processes that control the conversion and loss of carbon in coastal oceans and along continental margins often take place over limited regions and vary significantly with time." Current research projects in the North American Carbon Program are integrating models and observations in a manner that should ultimately be of use to estuarine resource management.*

Haer, Toon - *University of Groningen*

ADAPTING TO SEA LEVEL RISE A COMPARATIVE ANALYSIS BETWEEN SELECTED USA STATES AND EU MEMBER STATES

POSTER - *Since the beginning of human history, civilizations have always been attracted toward bodies of water. Abundance of food and benefits of water-based transportation were major reasons behind this attraction. Even today, population in the coastal areas continues to rise. Currently, about 44% of the world's population is living within 150 kilometers of a coastline. With rising sea levels, threats due to extreme weather conditions, such as storm surges and flooding become more imminent and frequent. In this research, a model is built to assess the impact of local sea level rise on coastal population and infrastructure in certain areas. The model is programmed in Vensim, Ventana System's simulation package. The input for the model is based on the sea level rise information from the Permanent Service for Mean Sea Level (PSMSL). The model can be used to assess the impacts on a local level. Different measures and strategies are studied using this model. The effect of these strategies will be different for each region of interest. Information from studying these options can help to devise policies for adaptation to the impacts of local sea level rise.*

Harris, Lora - *UMCES-CBL*

A missing modeled habitat: The role of wetlands at the land-water interface of the Chesapeake Bay and some suggestions for modeling approaches

PRESENTATION - *In the coastal plain of the Chesapeake Bay, the habitat found between the head-of-tide and subtidal waters is frequently defined by a tidal wetland community. In many cases, simulations of water quality in subtidal waters using the existing Chesapeake Bay Program modeling suite are only accurate when estimates of wetland nutrient and sediment uptake are included, suggesting a missing link between the watershed loading and estuarine water quality models. We present examples of this while also proposing a variety of modeling techniques to fill in this gap in the modeled estuarine landscape. We propose that models of tidal wetlands are needed at multiple scales. On the one hand, empirical relationships between wetland type, area, and nutrient/sediment removal may provide reasonable ways to modify land-derived inputs to the subtidal water quality model. On the other hand, with tidal wetlands at risk from sea level rise and changed inundation, simulations at the meter square scale are needed to help inform predictions of how these valuable fringing habitats may change in size and function in the coming decades. Hybrid Individual-based models that simulate both resource allocation to above and below ground biomass as well as the response of plants to environmental conditions allow us to investigate biological-physical feedbacks, for example sediment trapping by emergent wetland plants or the effects of nitrogen fertilization on stem morphology. Examples of modeling approaches using both regression relationships at the larger scale and marsh platform feedbacks with IBMs at the square meter scale will be presented as possibilities for improving future simulation efforts.*

Harris, Courtney - *VIMS*

Coupling sediment transport to biogeochemical processes: Effects of resuspension on oxygen consumption

PRESENTATION - *Though it enhances the exchange of porewater and solids with the overlying water, the role that sediment resuspension and redeposition play in biogeochemistry of coastal systems is debated. Numerical models of geochemical processes and diagenesis have traditionally parameterized relatively long timescales, and rarely attempted to include resuspension. Likewise, numerical models that represent sediment transport have largely ignored geochemistry.   Here, we couple the Community Sediment Transport Modeling System (CSTMS) to an NPZD (Nitrogen â€“ Phytoplankton â€“ Zooplankton â€“ Detritus) biogeochemical model within the Regional Ocean Modeling System (ROMS). The multi-layered sediment bed model accounts for erosion, deposition, and biodiffusion; and has been modified to include dissolved porewater constituents, particulate organic matter, and geochemical reactions.*

We explore the role that resuspension and redeposition play in biogeochemical cycles within the seabed and in the water column by running idealized, one-dimensional test cases designed to represent a 20-m deep site on the Louisiana Shelf. Results are compared to another model, configured similarly to a standard diagenesis model. Comparing these, the results indicate that resuspension acts to enhance sediment bed oxygen consumption.

Herrmann, Maria - *NASA GSFC/Sigma Space*

Climate-change simulations with HSPF phase 5.3.0 model of the Chesapeake Bay watershed

POSTER - *The objective of this study was to assess how future climate change will affect the Chesapeake Bay watershed in terms of stream flow, nutrients, and sediment. To assess climate change impacts, we conducted six 10-year simulations of the*

Chesapeake Bay watershed model for the last decade of the 21st century, where mean annual cycles in air temperature and precipitation forcing were altered according to the projections of six General Circulation Models (GCMs) for the A2 scenario form the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (SRES). On a bay-wide basis, all considered GCMs projected warming in every season, with the average annual temperature increase of 4.0 Â± 0.3 Â°C (mean Â± standard error of the mean for the six GCMs). Projected precipitation changes varied considerably in sign and magnitude on the annual basis, but most GCMs suggested an increase in winter (8 Â± 6%) and spring (8 Â± 5%) precipitation. Simulated stream flow decreased in all seasons for most model runs. Annually, all but one model run produced a substantial decrease in stream flow, with the mean decrease of 0.11 Â± 0.05 m yr-1 relative to a historic baseline of 0.5 m yr-1. Anomalies in simulated nitrogen, phosphorus, and sediment fluxes did not show a consistent pattern among the six runs. Seasonal and annual changes were on the order of Â± 20% for nitrogen, Â± 50% for phosphorus, and Â± 100% for sediment. Averaged over the six runs, annual anomalies were slightly negative for nitrogen (-0.1 Â± 0.3 kg s-1 relative to a baseline of 5 kg s-1) and phosphorus (-0.02 Â± 0.04 kg s-1 relative to a baseline of 0.29 kg s-1), and positive for the sediment load (32 Â± 45 kg s-1 relative to a baseline of 137 kg s-1). Our results suggest that projected climate change will likely lead to a substantial decrease in stream flow but the impacts on nutrient and sediment loads are difficult to quantify, mostly because of large disagreement among the GCMs in projected precipitation changes for the watershed area.

Hoffman, Matthew - *Rochester Institute of Technology*

Reanalysis Validation of a Chesapeake Bay Assimilation System

PRESENTATION - *An advanced data assimilation system has been set up for the Chesapeake Bay using the local ensemble transform Kalman filter (LETKF) and the ChesROMS model of the Bay. Errors in wind forcing dominate the chaotic grown of initial condition errors, but using an ensemble of forcing fields as well as adaptive inflation techniques these errors are managed. We will show results from the assimilation of real SST from NOAA's AVHRR instrument and in situ temperature and salinity profiles. Performance is evaluated for the year 2003 as compared to both dependent and independent in situ observations of temperature and salinity. We also investigate the nature of the flow changes made by the assimilation.*

Infantes, Eduardo - *University of Maryland Center for Environmental Science*

Integrated Modeling of SAV Habitat Requirements: Near Bottom Wave Orbital Velocity as a Limiting Factor Under Current and Future Climate Conditions.

PRESENTATION - *In recent years, it has become evident that, in addition to light availability, the distribution of SAV in Chesapeake Bay is also influenced by other parameters such as sediment composition and wave exposure. Unfortunately, nearshore sediment data is sparse and existing Chesapeake Bay wave models are not suitable for the shallow habitats (< 2 m) inhabited by SAV. As a result, site selection for SAV restoration projects continues to rely mainly on light availability. In order to improve restoration success rates as well as the ability to predict the future of Chesapeake Bay SAV distribution under globally changing climate (e.g. increased storm frequency and intensity, increased sea level rise), we began to apply a model previously used in seagrass habitats in the Mediterranean, in SAV habitats in the Bay. The model propagates wave data available from local buoys into SAV habitats considering the local bathymetry and then calculates the orbital velocities exerted on the bottom. By comparing these data with SAV distribution available from VIMS, we are able to determine threshold orbital velocities limiting SAV distribution. Limitations seem to be related to sediment stability. In areas where orbital velocity exceeds the threshold for sediment transport, SAV is absent. The first results of this model seem promising for the development of a Bay wide tool to define wave-sheltered areas suitable for SAV growth and restoration and to predict the future distribution of SAV in the Bay under different climate and sea level conditions. Coupled with the global warming and ocean acidification model of colleagues at Old Dominion University, these tools will allow us to estimate SAV distribution in Chesapeake Bay under different scenarios of global change.*

Irish, Jennifer - *Virginia Tech*

A statistical method for estimating future hurricane flood hazards

PRESENTATION - *Reliable hurricane flood hazard estimates are essential for effective management and engineering in coastal and estuarine environments. Yet, uncertainty in future climate conditions presents a challenge for assessing future conditions. Studies suggest that sea-level rise may accelerate and hurricanes may intensify and occur less or more often. Here, a framework is presented for incorporating future sea level and hurricane conditions, along with discrete computational surge simulations, into extreme-value flood statistics analysis. By considering an idealized coast, physical surge scaling laws are used with joint probability statistics to define time-varying continuous probability mass functions for hurricane flood elevation. Uncertainty in the flood estimates introduced by uncertainty in future climate is quantified by considering variance in future climate and sea level* *projections. It will be shown that future global warming can increase the flood elevation at a given return period by 1 to 3% per decade, but that climate-related uncertainty only marginally contributes to the overall uncertainty associated with hurricane flood statistics. Finally, it will be demonstrated that adaptive management practices are the most effective means of optimizing future activities in coastal and estuarine environments in the face of climate change. The methods proposed here will help to communicate the potential future hurricane hazard to stakeholders and decision-makers. These methods may also be applied to other computational simulation sets, for example waves, currents, erosion, and water quality, in order to quantify extreme-value statistics of these environmental parameters.*

Jantz, Claire - *Shippensburg University*

After 15 years with the SLEUTH model, what we've learned and where we're headed

PRESENTATION - *We report findings from the SLEUTH modeling symposium held at the recent Association of American Geographers 2012 meeting in New York, NY. The symposium focused on synthesizing advances and innovations in urban simulation modeling using SLEUTH with a view towards a new research agenda. SLEUTH has been adopted widely because: it allows what-if type urban growth scenarios to be evaluated; the source code is open source and written in C; it has relatively few data requirements; its growth rules (growth processes) are theoretically informed and adaptable; and it can simulate dynamic rates of change. The current SLEUTH model is powerful, but it has well-documented limitations of its scalability, adaptability, and ability to meet the future challenges of applied land change modeling. The need for coupled modeling frameworks in particular is strongly apparent in order to 1) simulate processes of land change at multiple scales, and 2) evaluate the social and environmental impacts of forecasted land-use change scenarios. SLEUTH's current capacity for coupled modeling is limited and to build this capability would likely require a comprehensive rewrite of its source code. Future models will preserve SLEUTH's successes while correcting its limitations.*

Jasinski, Michael - *NASA Goddard Space Flight Center*

Investigation of Future Satellite Altimetry Requirements for Improved Hydrodynamic Modeling of the Chesapeake Bay

POSTER - *Future satellite altimetry missions will allow improved accuracy of water surface level modeling of oceans, coasts and rivers through data assimilation. In particular, the Surface Water Ocean Topography (SWOT) mission, due to launch in late 2019, will measure water surfaces over a wide range of targets, from open oceans and coastal zones to inland rivers and lakes. Sensor measurement requirements are being studied that best meet the range of observations for each of these areas. The current project being reported here specifically examines the observation requirements needed to model the Chesapeake Bay, where tides, winds, storm surge and bottom topography are the dominant factors affecting wave dynamics. The approach is first to employ MIKE21, a state-of-the-art, high resolution, numerical hydrodynamic model to generate a range of bay height scenarios including; i) typical neap tide and spring tide scenarios where tidal and wind forcings dominate, and ii) a storm-surge case represented by Hurricane Isabel (2003) where atmospheric pressure is also a factor. Analysis of the statistics of the modeled water heights provides an indication of SWOT sampling requirements to meet future calibration and assimilation needs for modeling the Chesapeake Bay. Also assessed are water level fluctuations during normal and hypothetical extreme precipitation events via several hydrodynamic simulations and their comparison with data from National Oceanic and Atmospheric Administration (NOAA) tide gauges.*

Kaza, Nikhil - *UNC Chapel HIll*

Linking land cover change models with economic forecasts

PRESENTATION - *Land cover change models do not accurately account for the various economic and demographic drivers because they are not reflected in the land cover consumption. This presentation will present a preliminary method of converting between land cover demand, household type and industry type. We use various forecasts from the Maryland scenario project to illustrate the possible linkages between the econometric, demographic models and how different futures can be used to get a range of possible, if not the most likely outcome, effects on the Bay. We will use the data from the Maryland Property View to analyse the effect the land consumption of various household types and industry types and derive spatially disaggregate demand characteristics for multiple scenarios. This will help test if the contemplated conservation measures have efficacy in a range of scenarios.*

Khangaonkar, Tarang - *Pacific Northwest National Laboratory, Battelle*

Use of FVCOM-ICM platform for simulation of annual biogeochemical cycles of nutrient balance, phytoplankton bloom(s), and DO in Puget Sound

PRESENTATION - *Nutrient pollution from rivers, nonpoint source runoff, and nearly 100 wastewater discharges is a potential threat to the ecological health of Puget Sound with evidence of hypoxia in some basins. The relative contributions of various streams entering Puget Sound from natural and anthropogenic sources, and the effects of exchange flow from the Pacific Ocean are not yet fully understood. A model of Puget Sound focused on* *simulation of annual biogeochemical cycles including all major loads is thus being developed. Site specific needs related to complex geometry, fjordal circulation, presence of numerous island, tidal marshes and mudflats, sediment water interaction, and a desire for an established carbon based biogeochemical model were important considerations during the model selection process. The unstructured grid Finite Volume Coastal Ocean Model (FVCOM) framework and the Integrated Compartment Model (CE QUAL-ICM) water quality kinetics were selected for this effort. Results based on 2006 data show that phytoplankton growth and die-off, succession between two species of algae, nutrient dynamics, and dissolved oxygen (DO) in Puget Sound are strongly tied to seasonal variation of temperature, solar radiation, and the annual exchange and flushing induced by upwelled Pacific Ocean waters. Concentrations in the mixed outflow surface layer occupying approximately 5−20 m of the upper water column show strong effects of eutrophication from natural and anthropogenic sources, spring and summer algae blooms, accompanied by depleted nutrients but high DO levels. The bottom layer of Puget Sound however showed a steady reduction of DO through the summer, reflecting nutrient-rich, low DO, upwelled water entering the Puget Sound. By late winter, the low DO waters at the bottom, along with other water column constituents of interest, were renewed and the system appeared to reset with cooler temperature higher DO waters from the Pacific Ocean.*

Kim, Sunghee - *Department of Civil and Environmental Engineering/University of Maryland*

Response of hydrologic calibration to replacing gauge-based with NEXRAD-based precipitation data in the USEPA Chesapeake Bay Watershed model

PRESENTATION - *This study investigated the response of hydrologic calibration to replacing gauge-based with NEXRAD-based precipitation data in the USEPA Chesapeake Bay Program (CBP) Watershed (CBW) model over the Potomac River Basin. Specific objectives were to (1) compare gauge-based and NEXRAD radar-based (Multisensor Precipitation Estimator, MPE) data at the (a) point-pixel and (b) spatially aggregated level; (2) evaluate the model's calibration accuracy using the different precipitation data sets; and (3) examine the response of model hydrology. Hourly gauge-point and MPE-pixel data were compared at 80 locations. The CBP's interpolated and aggregated precipitation data at the model unit (county) level were compared with MPE data aggregated to the same 114 county-based spatial segments. The model calibration followed the CBP's automated approach, using observed streamflow at 37 gauge stations. Model performance was evaluated using calibration and hydrologic statistics, and GIS-aided spatial information. Calibrated parameters and model hydrologic fluxes were compared. The average annual gauge-point and MPE-pixel values (excluding hours when either was missing) agreed well. Differences in average annual values between the spatially aggregated data sets were, however, significant in parts of the study area. When parameter constraints were relaxed to allow calibration to adjust to the smaller volume of precipitation, the model using MPE outperformed the model calibrated to CBP precipitation data at 65% of the 37calibration sites. The model response was controlled largely by the seasonal difference in precipitation inputs: (1) calibration process could not compensate for large differences in seasonal flow bias caused by the seasonal volume of precipitation; (2) seasonal flow bias affected the lower zone nominal soil moisture storage parameter (LZSN), mainly affecting interflow and groundwater flow. The surface flow component was generally the same for the different precipitation inputs. The two precipitation data types can be used interchangeably to simulate surface-flow dominated processes, but care must be taken in simulations where subsurface pathways and residence times are important. MPE is a strong alternative to gauge-based precipitation data because of its spatiotemporal coverage and rare missing records. Using MPE in hydrologic modeling is appealing because of the improved calibration accuracy of the CBW model demonstrated in this study.*

Ladino, Cassandra - *USGS*

USGS Chesapeake Bay Decision Support Tools to Support Ecosystem Management

POSTER - *State and local government agencies in the Chesapeake Bay watershed are required by Federal mandate to make management decisions that will improve the water quality and other aspects of the health of the Bay ecosystem. These decisions are commonly based on opportunities and incentives to implement mitigative actions therefore actions may not be targeted in areas that could provide the greatest environmental benefit. The U.S. Geological Survey (USGS) has been developing web-based decision-support tools to help State and local stakeholders make optimum decisions based on environmental improvement. These decision support tools align with Chesapeake Bay Program (CBP) goals and the designated outcomes of the 2009 Executive Order for the Chesapeake Bay. The tools provide access to a diverse suite of model results, monitoring data, and supporting information to help managers better target, implement, and assess the effectiveness of their activities. Thus far, the USGS has developed tools to address restoration and preservation of water quality, forested lands, and the prioritization of watershed areas for conservation This presentation will demonstrate the decision support tools developed and currently available by the USGS and plans for future tools to support the CBP.*

Lee, Minjin - *Princeton University*

Adapting a dynamic land model, LM3V, to simulate nitrogen exports and transformations in the Susquehanna River

POSTER - *Biologically available nitrogen loads have doubled since the late 19th century via anthropogenic nutrient inputs. We have modified the Princeton-Geophysical Fluid Dynamics Laboratory (GFDL) LM3V land model, which includes a terrestrial nitrogen cycle, to assess these human influences on the nitrogen cycle, how they are linked to different weather patterns, and how much nitrogen is exported to river systems. By coupling biophysical and biogeochemical dynamics, the model captures key mechanisms of the climate-plant-soil-river systems and estimates the integrated effects of point and non-point nitrogen sources on concentrations and loads of nitrate, ammonium, and dissolved organic nitrogen in streams.*

The model was forced with the output from the GFDL AM2 model and observed precipitations cycled over a horizon of 30 years to perform long-term simulations. The model has been applied to the largest watershed in the northeastern U.S., the Susquehanna River basin, to analyze the consequences of land use changes and human influences on nitrogen leaching rates and loads in the Susquehanna River, using a historically reconstructed scenario of land use change from 1700 to 2005 and anthropogenic nitrogen inputs of atmospheric deposition, fertilizer and manure applications. Comparison of the measured and simulated river temperatures and discharges are in close agreement. Nitrogen leaching rates and loads to rivers appreciably increase during months with high discharges. The model simulates forest (17.2%), crop (28.9%), pasture (8.4%), and primary forest (45.5%) land uses in the 1890s and forest (77.1%), crop (17.4%), and pastures (5.5%) land uses in the 1990s. This shows that agricultural lands have been cleared since the late 19th century. Nitrogen fixation, harvest, and leaching rates vary depending on the different land use types. During the mid 19th and early 20th centuries, land use changes substantially increase nitrogen leaching rates and loads to rivers mainly due to high nitrogen fixation rates in the increased crop lands. Since the mid 20th century, anthropogenic atmospheric deposition and fertilizer and manure applications to the crop land greatly increase nitrogen leaching rates and loads as well as riverine denitrification rates. While the absolute amount of removed nitrate to the atmosphere via riverine denitrification increases, the percentage of removed nitrate per total nitrogen inputs to the watershed decreases. This implies that increasing nitrogen loads to the land surface result in a higher fraction of nitrogen that is exported in river systems. These results suggest that models such as LM3V can be used to determine N sources to streams and estimate nitrogen exports to sensitive environments like the Chesapeake Bay.

Acknowledgements: The contributions of PCD Milly from the USGS are gratefully acknowledged

Linker, Lewis - *U.S. EPA Chesapeake Bay Program Office*

A Survey of the Challenges of the CBP 2017 Assessment

PRESENTATION - *An assessment of what is needed to complete one of the Nation's largest ecological restorations will be made by the Chesapeake Bay Program in 2017. The 2017 Assessment will examine the Chesapeake TMDL progress at the midpoint of the restoration process and assess management actions needed to be in place by 2025 to complete water quality standard attainment for dissolved oxygen, chlorophyll, and SAV/clarity. In addition, the influences of climate change on the Chesapeake TMDL will be considered. The CBP seeks to develop value added modeling tools to assist decision makers in developing the most equitable, cost effective, and environmentally protective watershed implementation plans that will reduce nutrient and sediment loads from the watershed, as well as nitrogen loads from the airshed, in order to achieve the Chesapeake living resource based water quality standards. The range of available model decision support tools for the 2017 Assessment will be surveyed, and the process of CBP model development that includes the active participation and support of State, Local, Federal and other Bay Program decision makers will be discussed.*

Long, Wen - *Marine Sciences Lab, Pacific Northwest National Lab*

The Impacts of CnD Canal on Modeling Chesapeake Bay and Delaware Bay Circulation

PRESENTATION - *The CnD Canal connecting the Upper Chesapeake Bay and Delaware Bay is of great interest in the estuarine circulation research community. The linkage between the two Bays has profound impacts on the physical and biogeochemical characteristics in the region, especially on salinity structure and budget. Historical research showed intriguing and sometimes contradictory conclusions. The Canal also poses difficulty in simulating Chesapeake Bay or Delaware Bay separately. Some practices simply close it in the modeling domain for convenience or treat it as a one way source/sink. In this presentation, the MACROMS open source model (based on Rutgers University ROMS), with both Chesapeake Bay and Delaware Bay in its domain, is modified to open or close the Canal with typical scenarios of wind and river forcing for a series of simulations. Statistics regarding the flow direction, salt flux through the Canal and circulation difference made by closing vs opening of the Canal are collected to detect the impacts quantitatively. The findings will be analyzed and implications to both physical and biogeochemical characteristics will be discussed.*

Keywords: CnD Canal, Chesapeake Bay, Delaware Bay, Circulation, Salinity Structure, Salt Budget.

Loomis, Ross - *RTI International*
Potential Impacts of Nutrient Trading on the Spatial Distribution of Nutrient Loads in the Chesapeake Bay Watershed
PRESENTATION - *RTI International has developed an optimization model to estimate the lowest cost combination of BMPs to meet nutrient reduction targets within the Chesapeake Bay watershed. This optimization model, which relies on data and parameters from the Chesapeake Bay Watershed Model, provides an opportunity to understand cost-effective BMP implementation and potential gains from nutrient trading within the watershed. One barrier to widespread nutrient trading is the concern for impacts to local water quality. Compared to conditions without trading, some areas would experience more load reductions and others would receive less. Using our optimization model, we explore how alternate geographic restrictions affect the potential cost savings of nutrient trading, how trading could alter the geo-spatial distribution of nutrient loads, and what the potential implications are for water quality in both the tidal and nontidal areas of the watershed.*

Loughner, Christopher - *ESSIC University of Maryland / NASA GSFC*
Modeling air pollution deposition into the Chesapeake Bay watershed
PRESENTATION - *Air pollution is deposited into watersheds and estuarine waters contributing to water quality degradation and affecting estuarine and coastal biogeochemical processes. Pollution that is deposited onto land can be transported into storm drains, groundwater, streams, and rivers where it is eventually transported into near-shore waters. Air quality models, which simulate the chemical transformation, atmospheric transport, and deposition of pollutants onto land and surface waters, can play an integral role in forecasting water quality, preparing water quality regulations and providing information on the sources of nutrients and pollutants for advanced estuarine biogeochemical models. We will investigate air pollution deposition of nitrogen species into the Chesapeake Bay watershed using the Community Multi-scale Air Quality (CMAQ) model alongside observed and estimated deposition rates from the National Acid Deposition Program (NADP) and the Clean Air Status and Trends Network (CASTNET), respectively. The model simulation is conducted for the months of June and July 2011. Large air and water quality field campaigns were conducted in July 2011, and data obtained from these field experiments will be used to evaluate the model simulations. Previous studies have found that Chesapeake Bay breezes cause localized areas of high air pollution concentrations and that model simulations with horizontal resolutions coarser than about 5 km are not able to capture bay breeze circulations. For this reason, the model is run at a high spatial resolution with grid spacing of 1.3 km. We will investigate how meteorological circulations, such as bay breezes, impact the spatial and temporal variability of air pollution deposition.*

Mannino, Antonio - *NASA Goddard Space Flight Center*
Biogeochemical and Optical Analysis of Coastal Organic Matter for Satellite Retrieval of DOC, POC, CDOM and Terrigenous DOM from Chesapeake Bay and U.S. Middle Atlantic Bight
PRESENTATION - *Estuaries and coastal ocean waters experience a high degree of variability in the composition and concentration of particulate and dissolved organic matter (DOM) as a consequence of riverine/estuarine fluxes of terrigenous DOM, sediments, detritus and nutrients into coastal waters and associated phytoplankton blooms. Our approach integrates biogeochemical measurements (elemental content, molecular analyses), optical properties (absorption, beam attenuation, radiometry) and remote sensing to examine POC and DOC distributions within Chesapeake Bay and terrestrial DOM contributions into the U.S. Middle Atlantic Bight. We measured dissolved lignin phenol composition, DOC, POC and CDOM absorption within Chesapeake Bay and Delaware Bay mouth, plumes and adjacent coastal ocean waters to derive empirical relationships between optical properties and biogeochemical measurements for satellite remote sensing application. Our results demonstrate that satellite-derived CDOM is useful as a tracer of terrigenous DOM in the coastal ocean.*

Mcilhany, Kevin - *US Naval Academy*
Is the Chesapeake Bay Ready for a Bis Science Approach?
PRESENTATION - *Coming from the experimental medium energy particle community, a \\"big science\\" model is presented. The specifics of how and why big science has been successful for the past forty years is detailed. Can the Chesapeake Bay form its own unique big science model? How would this fit into the current scheme of collaborations and requirements put on the community?*

The long history of modeling of the Chesapeake Bay has produced many research groups and several competing models. The question arises: Is the Chesapeake modeling effort ready to coalesce into a Big Science model, where many smaller groups band together and form a large collaboration, spanning several universities and state institutions? Models for how big science is working in other communities will be presented as well as the pitfalls of creating such *large collaborations. Many questions will need to be addressed such as; what should the structure of a large collaboration be, how can the group include new members, what funding opportunities could be opened up as a result of a larger collaboration and how desirable is the idea of many smaller groups merging their various modeling efforts?*

Mcilhany, Kevin - *US Naval Academy*
Presenting Scientific Results to the Public - Do's and Don'ts
PRESENTATION - *The recent adoption of TMDLs for the near future of the Chesapeake Bay will bring to the public's eye the involvement of scientists and their extensive modeling efforts of the Chesapeake.   Scientific results can be presented in a manner that is thought provoking to an academic and opaque to everyone else. Some practical examples will be given of the "do's and don'ts" for scientific presentation to the public. Emphasis will be given to Chespeake Bay specific metrics.*

Merrick, Bart - *NOAA Chesapeake Bay Office*
Environmental Science Training Center: Opportunities for outreach
PRESENTATION - *The NOAA Environmental Science Training Center provides training and in-depth experiences for environmental education and science professionals to advance their abilities to effectively convey the latest information on science, technology, engineering, and math to teachers and students. Trainings focus on integrating science into the classroom, drawing on NOAA and partner expertise and capabilities.*

During this part of the session we will discuss strategies for identifying opportunities and communicating with diverse audiences about regional efforts.

Mobley, John - *University of Virginia*
Environmental Flow Components for Measuring Hydrologic Model Fit during Low Flow Events
PRESENTATION The Indicators of Hydrologic Alteration (IHA) is a statistical flow methodology for characterizing ecologically important stream flows. Typically, IHA has been used to identify the extent of human impacts on a stream’s hydrology and to set management goals to restore the stream ecology. In this work, we extend the use of the seven “extreme low flow” statistics of IHA to the evaluation of the performance of a hydrologic simulation model under low flow conditions. Specifically, this work uses the IHA framework to evaluate the accuracy of the Chesapeake Bay Program Phase 5 (CBP5) watershed model during low flow events on a regional scale that is relevant to many water supply planners and managers. Because the CBP5 model\'s primary focus is predicting the Bay’s water quality, the measures used to calibrate the CBP5 model focused primarily on the calibration of the entire hydrological record and had only secondary emphasis on specific flow regimes, such as low flows and very low flows, although these flows are important for both stream ecologies and water supply planners. To provide a comparative performance benchmark, the performance of the simple Drainage Area Ratio (DAR) method relative to the IHA low flow statistics is also determined. This paper demonstrates the use of IHA statistics for model evaluation in a case study, the Rivanna River watershed, a subcatchment within the Chesapeake Bay drainage. For rivers with a large proportion of unregulated flow contributions, we conclude that the computationally simple DAR model with appropriate surrogate watershed generally characterizes the extreme low flow conditions slightly more accurately than the CBP5 model. However, unlike the CBP5 model, the DAR model predicts future flows based solely on historical data, and thus the DAR model cannot predict flow impacts caused by hydrological alterations, thus limiting its use in water supply management. Nevertheless, our IHA analysis suggests that incorporation of a low-flow-specific metric into the CBP5 calibration could improve its utility for water supply management and planning at a regional scale.

Moltz, Heidi - *Interstate Commission on the Potomac River Basin*
Modeling environmental flows in the Potomac basin
PRESENTATION - *The Middle Potomac Watershed Assessment endeavored to define environmentally sustainable flows in the Middle Potomac basin utilizing the Ecological Limits Of Hydrologic Alteration (ELOHA) framework. A primary project component involved coupling biological sampling data with flow data at numerous locations across the study area to understand how hydrologic alteration affects ecological health. Because the majority of biological samples in the Potomac basin were collected on small and medium sized streams, corresponding observed flow data was limited. Simulating flow data to pair with available biological data, therefore, required hydrologic modeling to estimate flow time series at un-gaged locations. The Chesapeake Bay Program’s Phase 5.2 HSPF model and the Virginia Department of Environmental Quality’s Online Object Oriented Meta-Model were utilized to estimate daily streamflows at 747 watersheds draining to biological monitoring locations for unaltered and current scenarios and at 153 HSPF river segments for five future scenarios. A suite of flow metrics were calculated from the time series. The difference in flow metric values between unaltered (“baseline”) and current scenarios was an indication of the amount of hydrologic alteration that has already occurred in a given watershed, while the difference between current and future scenarios is an estimation of potential future alteration. This presentation will*

describe the hydrologic modeling approach, evaluation of model performance, identification of model limitations, and directions for future efforts. The Middle Potomac Watershed Assessment was funded by The Nature Conservancy and the US Army Corps of Engineers with technical efforts led by the Interstate Commission on the Potomac River Basin (ICPRB).

Motesharrei, Safa - *University of Maryland*
Exploring Water Management Options using SIWA
PRESENTATION - *With a changing climate and intensified hydrological cycle, the importance of water resources is very likely to increase in the near future. Potential droughts, floods, and storms can have adverse impacts on availability of water supply for agricultural, industrial, and residential usages. We have constructed a simple coupled Human-Water model (SIWA) in order to explore the effectiveness of different policies on mitigation of, as well as adaptation to, the water-related problems. Water-efficient technologies (Western Water, 2009), better pipe quality, water recycling (Bryck et. al., 2008), and rooftop rainwater collection should all be very useful for sustaining the water supply. However, fully implementing all of these solutions would be very costly. We have conducted a series of numerical experiments that measures lifetime of freshwater sources and supplies as we vary each of the above factors. Our results show that there is a critical value for each parameter, dependent upon the value of the other parameters, below which the lifetime of the supply becomes very short. Combining the results for different parameters can lead to an optimum set of parameters given funding constraints.*
References:
Bryck, J.P., Prasad, R., Lindley, T., Davis, S.P., and Carpenter, G., 2008: National Database of Water Reuse Facilities Summary Report: 02-004-01, 90 p.
Western Water, Fact Sheet: Choosing Water-Efficient Appliances, Aug 2009: http://www.westernwater.com.au/SiteCollectionDocuments/Fact%20sheets%20and%20brochures/Water%20Efficient%20Appliances%20fact%20sheet.pdf

Muller, Diana - *South River Federation*
Find the Commonality, Communicating, and Engaging, among "Your"Communities in the Chesapeake Bay Watershed: Listen, Think, Do; the Art of Scientific Story-Telling
PRESENTATION - *In 2009 President Obama signed into law the Chesapeake Bay Executive Order recognizing the Chesapeake Bay as a national treasure. This forces Federal, State, and Local agencies to work together for one common goal: reducing nitrogen, phosphorus and sediment into the Chesapeake Bay to allow it to become a healthy ecosystem. The feedback from the general community has been mixed. In fact in some areas of the Chesapeake Bay Watershed, the general community is resentful and down-right angry. So, how can the scientific community relate and speak with the general public about the Science and Models of the Chesapeake Bay? First is to understand that science is a language, just like Greek or Latin. Therefore, a language barrier must be broken. I will discuss three areas that must be covered in order to effectively communicate with the general public in order to tell your story. Commonality, Communicating, and Engaging is performed through the Art of Scientific Story-Telling. Enforcement, Monitoring, Restoration, and Modeling are going to be the keys to nutrient and sediment reductions in the Chesapeake Bay Watershed, getting the Chesapeake Bay resident's buy-in is critical to the success for a healthy Chesapeake Bay. Diana Muller, South Riverkeeper and Environmental Chemist will share her personal experiences of finding commonality, communication, engagements, through story-telling.*

Murphy, Rebecca - *Johns Hopkins University*
Estuary-Specific Spatial Interpolation Methods for Water Quality and Model Performance Evaluatio
PRESENTATION - *Spatial interpolation is an important tool for water quality and modeling studies in estuaries. In Chesapeake Bay, spatial interpolation is used for the evaluation of water quality criteria and was used as a key step in the iterative process to develop a Bay TMDL. There are, however, challenges for implementing spatial interpolation methods in estuaries, with one of the biggest of these being estuaries' complex shapes and disparities between actual distances through water and simple Euclidean distance. In Chesapeake Bay management, an inverse distance weighting-based interpolation method is currently used for water quality evaluation and the issues of complex shape and non-Euclidean distance are addressed by segmenting the Bay data into regions and interpolating by region. This method usually avoids interpolating over land, but also greatly restricts the number of samples used in some interpolations and creates artificial boundaries in the interpolation output. We have addressed these issues by creating a new interpolation method for the Bay that is based on water distance (the shortest path over water between any two points) and kriging (a statistical interpolation method). In a set of case study comparisons, we found that water-distance-based kriging performed just as well, and in most cases better, than the currently applied segmented-Bay method. Surface water interpolations were performed using Chesapeake Bay Program data, and then later evaluated and validated using two additional data sets (Maryland Department of Natural Resource and Virginia Estuarine and Coastal Observing System continuous monitoring data). Benefits of the water-distance-based method include ease of use, smoother interpolation estimate transitions at many locations, improvements in regions with only one or*

two samples, the generation of a measure of uncertainty, and improved performance based on comparison to validation data. Current work, which we will touch upon, includes expansion of our method comparisons in three-dimensions and incorporation of travel times computed from tracer runs of a hydrodynamic model as a new "distance"metric for spatial interpolations.

Najjar, Raymond - *Pennsylvania State University*
Long-Term Salinity Change in the Delaware Estuary
POSTER - *Salinity is the most important variable for characterizing an estuary and thus an understanding of salinity change is a prerequisite for understanding and modeling other long-term estuarine changes. Here, a long-term record of salinity in the Delaware Estuary (immediately to the east of the Chesapeake) is constructed from several data sources and analyzed for long-term trends. The initial focus is on the upper estuary, near Reedy Island, where the United States Geological Survey (USGS) has maintained an automated conductivity sensor since the early 1960s. These data are supplemented with data digitized manually from reports of The U.S. Army Corps of Engineers, The Delaware Geological Survey, and the USGS. The earliest measurements digitized are from the 1930s. Salinity variability due to streamflow and tides is estimated using statistical models, and the residual salinity change is found. At Reedy Island, this residual salinity has increased from about 2 in the 1930s to about 4 in recent decades. Possible explanations for the increase, including dredging and sea-level rise, will be discussed. A preliminary analysis of similar data for the Chesapeake Bay will also be presented.*

Palinkas, Cindy - *UMCES-Horn Point Lab*
Spatial and temporal variability of marsh sedimentation in Dyke Marsh Preserve (VA, USA): potential controlling factors and relevance for models
PRESENTATION - *Tidal freshwater marshes are critical components of fluvial and estuarine ecosystems, yet sediment dynamics within them have not received as much attention as their saltwater counterparts. This study examines sedimentation in Dyke Marsh Preserve, located on the Potomac River (VA, USA), focusing on understanding the controls on its spatial variability. To accomplish this, push cores were collected at 26 sites across the marsh in April and August of 2010 and 2011. The character (grain size, organic content) of sediments varied considerably across the marsh, with low marsh sites generally having finer and less organic sediment than sites located in the high marsh. Sediment deposition rates were calculated with the naturally occurring radioisotope 7Be (half-life 53.3 d), using spatially variable values for sediment bulk density (generally ranging 0.2-0.4 g/cm3) and the atmospheric 7Be inventory, which varies due to differences in the duration of inundation at each site. 7Be profiles generally showed uniform activities with depth, and maximum penetration depths were typically 1-2 cm. However, not all sites had detectable 7Be, likely due to dilution by large inputs of organic material at some sites and/or net erosion at others. Deposition rates ranged -0.3-1.4 g/cm2/y and varied significantly with elevation and distance to the nearest channel, highlighting the roles of inundation and sediment availability. These results are then compared to the vegetation community at each site to assess potential feedbacks between sedimentation, as well as to physical parameters such as tidal height and suspended-sediment concentration. Lastly, results are compared with expectations from the ecogeomorphological modeling literature to assess the potential importance for modeling efforts.*

Paolisso, Michael - *University of Maryland*
When Environmental Models Stand in for Nature
PRESENTATION - *The use of mathematical models in environmental restoration and management is now standard practice in many coastal regions throughout the world. Such complex modeling is important and necessary to advance our understanding of these complex socio-ecological systems, and to provide policymakers, resource managers and the public with predictions, forecasts and estimates of key human and environment interactions. In the future, computational modeling of the environment will only become more sophisticated, widely used, and important to our understanding of human and natural world interactions. As research on how to improve environmental modeling continues, there is also a need to understand modeling as a socio-cultural process that is also changing our interactions and understanding of natural world and specific ecosystems, including how we manage and restore natural resources and reduce human impacts on the environment. Thinking along these lines raises new questions: How and what type of environmental knowledge is included in modeling efforts? What in fact constitutes \environmental knowledge\"? How does the practice of modeling result in specific forms of environmental understanding*

Patrick, Christopher - *Smithsonian Environmental Research Center*
Multiple stressors affecting the distribution of submerged aquatic vegetation in the Chesapeake Bay region
PRESENTATION - *Submerged aquatic vegetation (SAV) provides many important ecosystem functions, but SAV has been greatly reduced in many estuaries. We investigated the controls on the distribution of SAV between and within subestuaries of the Chesapeake and Maryland Coastal Bays. We used % watershed land-use, % shoreline construction, % shoreline land-use, physical characteristics, average*

secchi depth, salinity, and average annual precipitation for each subestuary to predict SAV coverage using multiple regressions, CART, and ANOVA models. We also looked at the effect of shoreline type on small patches of SAV adjacent to shore. Shoreline marsh, forested shoreline, and density of docks were the most significant predictors of SAV coverage in regression models. % Riprap shoreline (5.4%) was the most important split in a CART analysis, and repeated measures ANOVA showed that subestuaries with less than 5.4% riprap followed a significantly different temporal trajectory than those with more than 5.4% riprap. SAV coverage has increased steadily since 1984 in subestuaries with <5.4% riprap , but reached a plateau by 1996 in subestuaries with >5.4% riprap. These preliminary findings suggest that multiple factors interact to control the distribution of SAV and help identify factors that managers should consider in efforts to increase SAV coverage.

Plunkett, Ethan - *University of Massachusetts*

Assessment of Landscape Changes in the North Atlantic Landscape Conservation Cooperative

PRESENTATION - *The primary goals of habitat conservation are to protect, manage and restore habitat, minimize the forces of habitat degradation, and design landscapes to ensure habitat connectivity within the limits imposed by the socio-economic realities of human population growth. To achieve these objectives we developed a landscape change, assessment and design (LCAD) model for the NALCC that allowed us to predict changes to the landscape under a variety of climate change and urban growth scenarios.*

We downscaled general circulation models to project potential changes in climate and developed an empirically based land-use conversion model to project land use change through 2080 under different scenarios of conversion-demand and sprawl intensity. The model applies multiple logistic regression models, trained by historical growth information, non-uniformly across the landscape using a unique matching approach. In this way, the model is non-stationary across space and time; as a region becomes more urbanized in the future, it will change its growth rates and patterns to match the way more urbanized regions grew historically. We also developed habitat capability models for a suite of representative species to be used as a fine filter, and ecological integrity models to be used as a coarse filter to assess the effects of predicted landscape and climate change scenarios in three pilot watersheds. We compared the areas identified as important habitat for the representative species (fine filter) with those having high ecological integrity (coarse filter). We describe the implications for strategic habitat conservation planning given uncertainty in future landscape conditions.

Rose, Kevin - *Smithsonian Environmental Research Center*

Modeling attenuation across the UV-PAR spectrum in the Rhode River sub-estuary

PRESENTATION - *Transparency across the ultraviolet (UV, 300-400nm) to photosynthetically active radiation (PAR, 400-700nm) spectrum regulates aspects of many biogeochemical cycles and estuarine ecosystem characteristics. For example, transparency to both UV and PAR play an important role in regulating the fate and quality of colored dissolved organic matter (CDOM) through photobleaching and mineralization. However, despite the importance of understanding variation and trends in UV attenuation, it is rarely measured as part of monitoring programs. We investigated the controls, variability, and trends in diffuse attenuation coefficients across the spectrum 300-700nm at three sites in the Rhode River sub-estuary using a 25 year record of filtered chemical oxygen demand (a proxy for dissolved organic carbon concentration), chlorophyll a, and total suspended solids measurements. We correlated these measurements with CDOM, algal and non-algal spectral absorption in a multi-year calibration dataset to generate wave-length specific contributions of algae, detritus, DOM, and scattering to attenuation. The model was validated using independent measurements of attenuation, and then extended to the full 25 year record. We found substantial variation in attenuation at seasonal, spatial, and spectral scales. Attenuation coefficients were highest in summers and at short wavelengths and there was a trend of increasing attenuation coefficients at all wavelengths. These wavelength, site, and season models can be used to improve estuarine biogeochemical models and our understanding of these important ecosystems.*

Sanford, Ward - *USGS*

A New USGS Model Coupling Groundwater Travel Times with a Stream-Nitrate, Mass-Balance Regression to Forecast Nitrogen Fluxes from Chesapeake Bay's Eastern Shore

PRESENTATION - *Nitrogen is a major pollutant to the Chesapeake Bay, and EPA is currently establishing total maximum daily loads (TMDLs) across the bay watershed to try to limit or reduce loads of nitrogen to the bay. Many of the current watershed models (for example HSPF and SPARROW) can reproduce current loads to the bay and their spatial distributions, but they cannot take into account the large amount of dissolved nitrogen in storage in groundwater and the distributions of groundwater travel times. Therefore they cannot predict the temporal response of nitrogen outflows from watersheds to changes in nitrogen loading at the land surface. A groundwater model was developed in this study of the Eastern Shore (the Maryland and Delaware drainages to the Bay on the Delmarva Peninsula) that calculates distributions of groundwater* *travel times across the region. These travel times were coupled with a stream-nitrate, mass-balance regression model and fit to spatial and temporal data from seven different watersheds within the Eastern Shore. The data indicate smaller increases in stream nitrate over the last few decades, and the model suggests these smaller increases could be the result of the implementation of best management practices (BMPs). The parameterized regression model was applied to HUC-11 and HUC-12 watersheds across the region to forecast changes in the total nitrogen flux from the Eastern Shore to the bay. These fluxes include estimates from both base flow and high flow conditions. The EPA has established a target for reduction in the TMDL from the Eastern Shore of approximately 3 million pounds of nitrogen per year by 2020. Results from this new model suggest that this target is highly unlikely to be reached due to the very sluggish (decadel) response time of the groundwater system. The calibrated regression equation has also been used to create maps that can help target the most effective areas for future reductions in loading at the land surface.*

Sanford, Lawrence - *UMCES, Horn Point Laboratory*

Physical characteristics of nearshore environments in Chesapeake Bay

PRESENTATION - *One of the least developed aspects of the current version of the US EPA Chesapeake Bay Program (CBP) Water Quality and Sediment Transport Model (WQSTM) is its treatment of shallow water nearshore habitat. Nearshore zones represent critically important interfaces between land and water in much of the Bay, and serve as critically important habitat for submerged aquatic vegetation (SAV) and other biological communities and organisms. However, because local scales of variability are small, local water property gradients are large, and ecosystem interactions are complex, modeling the nearshore within the framework of the larger WQSTM has remained a formidable challenge. Downscaling restoration efforts to local scales will require that these challenges be met.*

This presentation will offer an overview of the physical processes that affect nearshore environments in the Chesapeake and its tributaries. From the water side, these processes include tidal elevation and currents, waves, and wind- and density-forced circulations. From the land side, they include morphology, bathymetry, connection to adjacent wetlands and embayments, and groundwater flows. The nearshore is also affected to first order by interactions between biological communities and water flow. A framework will be suggested for categorizing and cataloging different nearshore zones from a physical point of view, with the ultimate goals of providing a basis for local model simplifications and for estimates of habitat suitability. Examples from the literature and the author's research will be presented to illustrate different nearshore physical characteristics.

Seck, Alimatou - *UMBC*

A 3D integrated surface-subsurface model of the Chesapeake Bay Watershed using ParFlow.CLM : Model discretization, initialization and hydrogeologic data

POSTER - *Accurate representation of hydrogeological properties is one of the most important tasks in developing subsurface flow models. For large scale applications, the necessary integration of scarce or scattered data from varied sources becomes even more of a challenge. As a part of the development of a highly resolved 3D integrated hydrologic model of the Chesapeake Bay Watershed, we have populated the conceptual hydrogeological model of the study domain. The model domain encompasses an area of 400,000 sq. km within the states of New York, Pennsylvania, Delaware, Maryland, Virginia, and West Virginia and traverses five physiographic provinces. We have constructed a relational database in combination with GIS, geologic modeling and geostatistical tools to compile, analyze, aggregate and visualize the data. The database combines information on aquifers dimensions and their hydraulic properties including storage coefficients, porosity, and hydraulic conductivity. Aquifer characteristics and hydraulic properties have been retrieved from existing hydrogeological studies including aquifer tests and groundwater modeling studies within the region, geologic maps, and investigation of drillers' logs, and well test data. Well log information has been collected from four state environmental agencies and analyzed to derive hydraulic conductivity values from specific capacity. The database is constructed in the Microsoft Access environment. Subsurface properties and well locations are georeferenced in ESRI Arcmap. A geologic model platform, Rockworks TM, is used to further visualize and present the subsurface data in 3D form. As a part of the model construction, we present here a comparison of model spatial resolution and initialization methods. We have studied the effect of horizontal discretization on overland flow processes at a range of scales. Three nested model domains have been considered: the Monocacy watershed (5600 sq. km), the Potomac watershed (92,000 sq. km) and the Chesapeake Bay watershed (400,000 sq. km). Models with homogeneous subsurface and topographically-derived slopes were evaluated at 500-m, 1000-m, 2000-m, and 4000-m grid resolutions. Land surface slopes were derived from resampled DEMs and corrected using stream networks. Simulation results show that the overland flow processes are reasonably well represented with a resolution up to 2000 m. We observe that the effects of horizontal resolution dissipate with larger scale models. Using a homogeneous model that includes subsurface and surface terrain characteristics, we have evaluated various initialization methods for the integrated Monocacy watershed model. This model used several options for water table depths and two* *rainfall forcing methods including (1) a synthetic rainfall-recession cycle corresponding to the region's average annual rainfall rate, and (2) an initial shut-off of rainfall forcing followed by a rainfall-recession cycling. We observe that the influence of groundwater runoff increases in dissected relief areas characterized by high slope magnitudes. As a result, in the domain conditions for this study, an initial shut-off of rainfall forcing proved to be the more efficient initialization method. Ongoing work includes coupling with Land Surface Model (CLM) and use of spatially variable meteorological forcing using the National Land Data Assimilation System (NLDAS) data products.*

Shen, Jian - *1Virginia Institute of Marine Science*

Development of TMDLs of Polychlorinated Biphenyls in the Baltimore Harbor

PRESENTATION - *Observations in recent years indicate that the Baltimore Harbor (BH) is impaired by Polychlorinated Biphenyls (PCBs) due to elevated concentrations in fish tissues. To investigate the transport and fate of PCBs and develop Total Maximum Daily Loads (TMDLs) for the BH, a PCB transport model coupled with organic carbon species was developed and linked to a three-dimensional hydrodynamic model of the upper Chesapeake Bay. The Chesapeake Bay watershed Phase V loadings (flow and nutrients) were used to drive the upper Bay eutrophication model and simulated organic carbon species were linked to the PCB sorption model. Model simulations indicate that PCB loadings from the bottom sediment, nonpoint source and regulated stormwater runoff, atmospheric deposition, and point source are 63.4%, 24.6%, 9.5%, and 2.6%, respectively. The sediment flux dominants the PCB sources to the water column. A major pathway of PCB loss is the surface volatilization which is about 384 ng/m2/day and accounts for approximately 8.6 times the atmospheric deposition to the BH's surface. The PCB concentration in the water column of the BH is highly influenced by the hydrodynamic conditions in the upper Chesapeake Bay due to its unique three-layer circulation pattern. The net PCB loss due to circulation transport is much less than that due to the volatilization. The time needed for the system to meet the water quality standards with the implementation of TMDL is estimated. Model sensitivity tests with respect to model parameters, loadings, and boundary conditions were conducted. The results indicate that the model is reliable and is capable of conducting simulations for designing management plans for the BH restoration.*

Shen, Jian - *Virginia Institute of Marine Science*

Evaluate Model Uncertainty in Estimating Bacteria Nonpoint Source Loadings

PRESENTATION - *Large uncertainty in estimation of bacteria nonpoint source loads often results in a poor simulation of bacteria concentration in estuaries using a deterministic model. The accuracy of nonpoint sources inputs and it impact on the uncertainty of model simulations are rarely tested. To understand the uncertainty associated with numerical model simulations with respect to loading variations, the inverse model was used in two TMDL studies for Wye River of upper Chesapeake Bay and Holdens Creek, a tidal river of the Pocomoke Sound. The convergence for loading estimation, and the associated errors and uncertainties with respect to data availability were investigated. The results indicate that bacteria nonpoint source load can be adequately estimated given sufficient observations. With limited observations, the loads can be estimated within an acceptable error range, but large uncertainty exists when conducting TMDL allocation. Local information is highly desirable to reduce such uncertainty. From numerical modeling perspective, the inverse modeling has the additional advantage of addressing the uncertainty problems, which provides useful information for designing implementation plan for watershed nonpoint source management.*

Shenk, Gary - *EPA/CBPO*

Multiple Watershed Models in a Management Context

PRESENTATION - *In 2017, the Chesapeake Bay Program will prepare for the next phase of bay restoration by developing plans designed to put the management practices in place by 2025 that will lead to attainment of water quality standards. Prior to 2017, new model versions or entirely new models will be developed and tested by the partnership for use in these plans. The watershed model used for decision making has traditionally had three major uses: accounting for all loads to tidal water by source and jurisdiction in a flow-normalized manner, providing spatially explicit loads to estuarine models on a daily time step, and modeling watershed processes to estimate the effects of various perturbations such as a change in climate or crop system. These uses must be preserved in future versions of the watershed model. Having recently been through the TMDL and Watershed Implementation Plan process, the partnership is well-positioned to articulate the requirements for the 2017 models. Generally, the partnership would like to increase the usability, flexibility, and transparency of calculations. In addition to management concerns, the scientific community is pressing for the use of multiple models among other suggested lines of improvement.*

Shenk, Gary - *EPA/CBPO*

Stakeholder Involvement in Model Building and TMDL Decision-Making

PRESENTATION - *The Chesapeake Bay TMDL, released in 2010, was based in part on a series of models and decision rules about how to apply them. The models and the decision rules were developed with tremendous stakeholder input using the* *organizational structure of the Chesapeake Bay Program as the mechanism to foster discussion. The Water Quality Goal Implementation Team and its workgroups were the focal point of discussion for the decision rules regarding how the load reduction effort would be split between basins and jurisdictions. These same groups also weighed in repeatedly on the development of the watershed model and the effectiveness attached to Management Practices. The Modeling Workgroup was instrumental in guiding the building of the major models used in the analysis. The Scientific and Technical Advisory Committee conducted reviews and held workshops to gather scientific community input and the EPA held meetings with the regulated community and in specific regions to discuss the TMDL. The extensive public meetings dramatically increased stakeholder buy-in and set a foundation for resolution of issues during the creation of the TMDL and the resulting Watershed Implementation Plans.*

Southerland, Mark - *Versar, Inc.*

Conceptual Framework for Incorporating Urban Watershed Functions into Maryland's TMDL Program

POSTER - *Currey, Kasko*

The TMDL program of the Maryland Department of the Environment (MDE) must address all state waters on the Clean Water Act 303(d) list of impaired waters. To date, TMDLs have been developed for specific, identified pollutants such as PCBs, bacteria, pH, and nutrients. In Maryland, however, 8-digit watersheds are also listed on the 303(d) list as impaired based on the proportion of streams that possess degraded biological communities. This biological approach allows MDE to identify impairments from unmeasured stressors and comprehensively address watershed degradation across the state. The challenge is to apply a TMDL program designed for specific pollutants to unidentified or multiple stressors that may be causing watershed-scale impairment. In 2006, MDE developed a threshold for sediment impairments based on the normalized sediment load (beyond the all-forest condition) that correlated with degraded instream biological and instream habitat conditions. Following in 2009, MDE developed a Biological Stressor Identification (BSID) methodology that used a case-control, risk-based approach to identify categories of stressors (sedimentation, habitat conditions, and water chemistry). While the BSID makes maximum use of field monitoring data obtained statewide by the Maryland Biological Stream Survey (MBSS), it cannot address all stressors present in urban environments, because stressors such as flow are not adequately characterized by the MBSS. Here we present a project that synthesizes the literature on the "urban stream syndrome"with the latest research on surrogate urban stressors, such as impervious cover, in a conceptual framework that provides a consistent and comprehensive approach to addressing all "limiting factors"affecting Maryland streams. Specifically, the framework addresses each potential limiting factor through a series of management metrics. The primary management metric (in this case the core TMDL target) is the amount of "effective impervious area"(EIA) in the subwatershed. EIA is the amount of imperious area that produces runoff after subtractions are made for attenuation and treatment of runoff. Additional metrics address (1) condition of the riparian area, (2) physical habitat in the stream channel, (3) transportation-related contaminants, and (4) invasive species effects. Ultimately, the urban TMDL would provide targets for each limiting factor to be addressed in a watershed management plan.

Stehr, Jeffrey - *University of Maryland*

Improving Deposition Modeling in Watersheds

POSTER - *We have partnered with the EPA Gulf of Mexico Program Office and the Gulf of Mexico Hypoxia Modeling and Monitoring project at the EPA Office of Research and Development to use NASA satellite remote sensing data products and other observations to improve the EPA's Gulf of Mexico Modeling Framework. The Gulf of Mexico Modeling Framework is a suite of coupled models linking the deposition and transport of sediment and nutrients to subsequent bio-geo chemical processes and the resulting effect on concentrations of dissolved oxygen in the coastal of waters of Louisiana and Texas. The hypoxic zone in this area of the Gulf of Mexico has been observed to be as large as 22,000 sq. km, an area the size of New Jersey. The nitrogen reaching these waters is significantly enriched by anthropogenic activity, with a fraction of that coming by air. We have used PRISM (Parameter-elevation Regressions on Independent Slopes Model) data to adjust modeled precipitation and subsequent nutrient deposition in the model, and will present the results of our research. The PRISM data set employs a variety of data to estimate precipitation between observations, with a strong emphasis on the effects of terrain. This technique has recently been evaluated by others (Latysh and Weatherbee, 2012), and found to increase deposition estimates two to four fold, especially in mountainous and coastal areas. Most of the Gulf of Mexico watershed is over the relatively flat Great Plains, but a significant portion of it is over the Eastern Rockies and Western Appalachians, so some effect is to be expected, though not as large as the extremes mentioned above. From the standpoint of the dead zone, these locations are also well away from the mouth of the hypoxic zone and less likely to be dramatically altered by such changes to the model.*

Tao, Jianhua - *Tianjin University*

Study on Eco-environmental Characteristics of Bohai Bay, China (Invited Speaker)

PRESENTATION - *Bohai Bay is a semi-enclosed coastal bay located at the west part of Bohai Sea, China, with mild-slope muddy beach and shallow* *water. The mean water depth of the bay is about 10m, and the width of intertidal zone is 3-5km. The water mixing within the bay is limited and exchange with other bays and the open ocean waters is weak, leading to a poor self-purifying capacity. Bohai Bay receives both industrial and domestic wastewater discharges from surrounding metropolitan cities (Beijing, Tianjin) and Hebei Province. The wastewater loads, through sewage rivers and channels, drain into the near-shore waters of the Bohai Bay directly or with limited treatment. In recent years, with the rapid economic development along this the Bohai coast soaring, discharge of nutrients and pollutants into the bay increased dramatically. Recently, some projects of land reclamation have also been started. Thus, the coastal water of Bohai Bay has encountered increasing eutrophication, frequent red tides and abnormal changes in plankton community structure. Investigation of the aquatic eco-environment in this area is of great significance for providing important insights into the characteristics of the region and mechanisms of environmental processes, which are crucial for better reclamation project planning and eco-environmental management. In this presentation, the hydrodynamic characteristics of water exchange and wave-induced alongshore current of Bohai Bay have been analyzed by numerical simulation. The distributions of major pollutants and plankton biomass in space and time were investigated. An eco-hydrodynamic model was set up to simulate the N, P nutrients and plankton ecosystem in the coastal waters of Bohai Bay, consisting of a hydrodynamic sub-model and an eco-system sub-model. The results agreed favorably with the measured data. By using numerical simulation, the impacts of coastal exploitation on eco-environment of Bohai Bay coastal water were analyzed, including land-reclamation, sluice construction, and seawater desalination. In the end, further development of numerical simulation of aquatic eco-environment for coastal water will also be introduced.*

Keywords: 2-D tidal circulation model, water quality model, COD, aquatic environment, Bohai Bay

Urquhart, Erin - *Johns Hopkins University*
Remotely Sensed Estimates of Surface Salinity and Environmental Vibrio in the Chesapeake Bay
PRESENTATION - *The Chesapeake Bay is the largest estuary in the United States, and home to an increasing number of harmful marine species including Vibrio bacteria. While routine water monitoring has been successful in preventing Vibrio outbreaks in the Chesapeake Bay, there is a pressing need for advanced technology to prevent the future spread and severity of this public health problem. The objective of this research is to apply the power of near real-time satellite-derived observations to the problem of Vibrio spp. monitoring and prediction in Chesapeake Bay. Remotely sensed SST and empirically derived surface salinity are presented focusing on an in-depth spatial and temporal comparison within the Chesapeake Bay estuary. Results show that sea surface salinity can be accurately predicted via 1km L2 MODIS color products with an accuracy that is more than sufficient for many physical and ecological applications. Spatial analysis of remotely sensed SST and SSS will be carried out to quantify patterns and association of Vibrio spp., applicable environmental parameters, as well as distribution and spread of future Vibrio disease transmission. Furthermore, model comparison of spatially interpolated satellite fields, ChesROMS modeled fields, and data assimilated fields will be performed to ensure accurate parameter inputs to empirical Vibrio spp. prediction models. Successful execution of the methods listed above will advance our ability to predict, via continuous remote sensing data, the presence of Vibrio spp. in the Chesapeake Bay.*

Voinov, Alexey - *International Institute for Geo-information Science and Earth Observation (ITC)*
Integrating models and integrating stakeholders: what are the lessons learned?
PRESENTATION - *There is much interest in model integration, which supposedly should help to take into account more factors and therefore better explain the system dynamics. It can also lead to more complex models and may be counterproductive by increasing the sense of uncertainty making it harder to take action. However in most cases by looking at the bigger picture the solutions may be clearer and easier to communicate. For many complex problems there are simple answers, but the problem is often in the implementation of the right policies and management practices. Engaging stakeholders in the modeling process can be an efficient way to keep model complexity under control and to produce better and more useful models. It is generally agreed that better decisions are implemented with less conflict and more success when they are driven by stakeholders, that is by those who will be bearing their consequences. Participatory modelling, with its various types and clones, has emerged as a powerful tool that can (a) enhance the stakeholders knowledge and understanding of a system and its dynamics under various conditions, as in collaborative learning, and (b) identify and clarify the impacts of solutions to a given problem, usually related to supporting decision making, policy, regulation or management. Participatory modeling is also a good way to synchronyze and integrate stakeholder knowledge, and to build more consensus, more â€˜buy-in' into the modeling results. Models provide the necessary formalism to describe and integrate stakeholders perceptions and system conceptualizations. The modeling experience can be used to integrate the knowledge about the system coming from various, perhaps biased, stakeholder groups and individuals. At the same time stakeholders can be instrumental in*

choosing the appropriate models for integration and deciding about their spatial, temporal and structural resolution. Also our experience from stakeholder facilitation and organization can inform the model integration process, especially in part of model standardization and communication of information between components.

Wang, Yan - *University of Maryland*
CALIBRATING SHENANDOAH WATERSHED SWAT MODEL USING A NONLINEAR GROUNDWATER ALGORITHM
POSTER - *This study contributes to a project with the Interstate Commission on the Potomac River Basin to build a model of the Potomac watershed using the Soil Water Assessment Tool (SWAT). The 2,937 mi2 Shenandoah watershed represents about 40% of the Potomac Basin by area. The model subdivides the Shenandoah watershed into 28 subwatersheds and 489 hydrologic response units. SWAT's linear-reservoir groundwater algorithm is modified into a new non-linear method. Modeled flows are compared to observations (dating from 1996 to 2006) at 15 USGS stream gauges. The model is auto-calibrated using the Parameter Estimation Software (PEST), experimenting with options to improve model performance. The best model results are obtained by applying ordinal weights to the observation groups, decreasing from headwaters to outlet, and pre-calibrating the roughness coefficients using empirical equations. The calibrated model will contribute to understanding hydrological processes, predicting the effects of land use and climate change in the watershed, and making decisions on water resources management.*

Wang, Harry - *VIMS*
Modeling Support for James River TMDL Chlorophyll Study
PRESENTATION - *A multi-disciplinary, multi-algal-species water quality model framework is being developed to support the James River Chlorophyll study. This model framework, consisting of a watershed, hydrodynamic, and two eutrophication-based water quality models, is intended to support the Virginia Department of Environmental Quality (DEQ) in reexamining current chlorophyll-a criteria and provide a scientifically defensible tool to assist in setting numerical chlorophyll standards within the tidal James River ecosystem.*

The proposed approach consists of several unique features including: (1) A watershed model designed to deliver chronic, episodic and locally accurate watershed nutrient loading (2) A hydrodynamic model capable of simulating shallow water dynamics as well as the unique features of non-tidal eddy and frontal system in the James. (3) Adoption of a dual water quality model approach in which both "traditional"algal dynamics and high frequency harmful algal blooms (HABs) are to be modeled. The two water quality models will be driven by the same hydrodynamics and watershed loading but slightly different algal kinetics so the model results can be differentiated, cross-referenced, and in the end complemented and meshed with each other to reduce uncertainty. (4) Incorporation of additional experimental and intensive monitoring data collected by VIMS, ODU and VCU. Finally, related to criteria attainment and assessment, we propose to investigate the development of a linked deterministic-empirical (statistical) model approach, wherein the key water quality variables/environmental forcings used in the empirical model will be provided for by either or both of the deterministic models.

The resulting model will provide DEQ with a predictive tool that can be used to assess the chlorophyll-a response of the tidal James River to potential changes in nutrient loading and the consequences of various management strategies under the VA Tributary Strategy and Chesapeake Bay TMDL.

Wang, Ping - *VIMS*
Simulation of Denitrification in Watershed Model Stream Processes
POSTER - *Stream denitrification plays an important role in nutrient processes and in the fate and transport of nitrogen in the Chesapeake watershed. A refined simulation of stream denitrification can improve estimates of stream nitrogen loss and in estimated nitrogen transport factors, which have implications to watershed management. The current version of the HSPF watershed simulation, version 11, simplifies stream denitrification as a process taking place in the entire water body within a reach of river. However, denitrification is a process of the anoxic interstitial waters of sediment bed except for the rare cases of anoxic waters in rivers and lakes. The stream denitrification module developed in this presentation considers denitrification as a process of the sediment bed. The responses of denitrification to nutrient load reductions will be presented and the implications and importance in estimates of the edge-of-stream load and in stream denitrification to delivered loads will be discussed. The stream denitrification module has the potential to improve the simulation stream nutrient processes and to better estimate nitrogen transport, providing useful information for watershed nutrient management and better assessments at more local scales.*

Wiggert, Jerry - *The University of Southern Mississippi*
Application of a Coupled Physical-Biogeochemical Model to Simulate and Forecast Water Quality and Ecological Variability in Chesapeake Bay

PRESENTATION - *The Chesapeake Bay is a valuable recreational, ecological and economic resource that is commonly subject to harmful algal bloom (HAB) and pathogen outbreaks. With expanding knowledge of the water quality conditions likely to promote HAB and pathogen occurrence, forecasting these events is becoming ever more tenable. HAB and pathogen triggers include both physical and biogeochemical environmental properties; therefore a fully coupled physical-biogeochemical numerical model that accurately simulates, and forecasts, the Bay's water quality fields is well-suited for application as a means of generating nowcasts or forecasts of HAB and pathogen occurrence. Attaining this technological capability has been a primary motivation for the development of the biogeochemical version of the Chesapeake Bay Regional Ocean Modeling System (ChesROMS). The coupled model framework includes components that explicitly accommodate the physical, biogeochemical and/or bio-optical impact of river borne sediments, nutrient inputs via point and diffuse sources as well as atmospheric deposition, and dissolved organic matter. A mechanistic dissolved oxygen formulation has been implemented to resolve seasonally developing hypoxic conditions within the Bay. Here, simulations for the year 1999 will be presented and characterized with respect to in situ observations made available by the Chesapeake Bay Program. These results will highlight and assess the realism of model simulated phytoplankton bloom dynamics, nutrient availability and the seasonal evolution of dissolved oxygen distributions in the Bay. Insights into ecosystem processes of the Bay gained from these numerical experiments will be discussed.*

Zhang, Qian - *Johns Hopkins University*

Long-term Seasonal Nutrient Trends for the Non-tidal Portions of the Major Tributaries to Chesapeake Bay

POSTER - *Chesapeake Bay has experienced persistent summertime hypoxia in its bottom waters that has attributed to a combination of anthropogenic nutrient inputs from the watershed and naturally occurring vertical stratification. Reduction of nitrogen and phosphorus inputs has therefore been a principal focus of Chesapeake Bay management for decades. As a means of assessing progress in the reduction of nutrient loads from non-tidal portions of the major tributaries to Chesapeake Bay, we have applied the recently developed statistical method of Hirsch et al. (J. Amer. Water Resources Assoc., 2010) to reconstruct the long-term and seasonal trends of total nitrogen (TN) and total phosphorus (TP) loads from 1980 to 2010. Our study began with the compilation of TN (TP) concentration and daily streamflow records from nine monitorting stations that have been managed by U.S. Geological Survey's River Input Monitoring Program. We then applied Hirsch et al.'s method, which uses weighted regressions on time, discharge and season (WRTDS), to produce so-called "flow-normalized" load estimates. The flow-normalization algorithm, which is an essential feature of the WRTDS method, estimates the target daily concentration and load using the full set of discharges occurring on that day of all years in the 30-year record, while holding the temporal and seasonal components constant. We have used such flow-normalized daily estimates to compute monthly averages of TN (TP) load for each major tributary and for their sum. The long-term records of monthly averages for each month of the year were then examined, revealing some interesting trends. In regard to the total load of the nine tributaries, our observations include the following: (1) TN loads in all twelve months exhibited similar "rise-and-then-fall" trends, with the 30-year peak generally occurring in the late 1980s. These peak TN loads were 1.21 to 1.27 times of the 2010 values. (2) By contrast, TP loads in all twelve months displayed "fall-and-then-rise" trends, with the 30-year minimum mostly occurring around 1995 and with 2010 TP loads being about 1.22 to 1.64 times these minimum values. (3) Consistent with the above trends, the TN:TP molar ratios have generally decreased in recent years. Indeed, general trends of decreasing TN:TP in most months have been observed in all but three of the nine tributaries, with the Appomattox, Mattaponi, and Choptank Rivers (altogether accounting for 4% of the non-tidal watershed area) being exceptions that have comparatively flat trends. Within the Susquehanna and James Rivers, however, the effect is strong, especially in September, when TP loads have steadily increased to 2010 values that are 1.98 and 1.83 times the minima observed in the late 1990s. A continuation of such trends will cause gradual switch from currently common conditions of P-limitation (at tributary fall-lines) to conditions of co-limitation or N-limitation. In on-going work with additional collaborators, we are extending our analysis to include point-source observations and model-based non-point source estimates for historical loads from the tidal watershed. An important longer-term goal is to better understand the mechanistic causes of the observed trends and to apply such understanding toward consideration of management options.*

Zhao, Fang - *University of Maryland*

River Routing Module for the Potomac River Basin

POSTER - *With a changing climate and intensified hydrological cycle, the importance of water resources is very likely to increase in the near future. As part of our goal to construct a coupled Human-Water-Climate model for the water-related problems using the Potomac River Basin (PRB) region, we are developing a river-routing model and coupling it to the UMD-ICTP earth system model to conduct an offline run with the downscaled results of the North American Regional Climate Change Assessment Program (NARCCAP) for the PRB region. From the runoff output information for each model grid, total river* *inflow and outflow for the PRB region will be calculated. Then the simulated precipitation, evaporation, and river inflow and outflow rates will be fed into an existing regional human-water model, which is also part of our coupled Human-Water-Climate model system. Similar to the concept of the Total Runoff Integrating Pathways (TRIP) developed by T. Oki and Y.C. Sud at the University of Tokyo, we will create a river direction file for the PRB region based on the USGS HYDRO1k database, which is a hydrologically modified version of the elevation model GTOPO30 with additional features such as aspect, flow directions, flow accumulations, slope, drainage basin boundaries and stream lines. This module can determine the rate at which surface and subsurface water leaves (or enters) any grid box of the river network, which is related to many factors including the river mass for the surface and subsurface parts, the mean distance between the gird boxes, and the downstream topography gradient. The river direction file from TRIP assigns a number (1-8) to indicate the eight possible outflow directions for each grid. With the USGS HYDRO1k data, we will create the river direction file for the PRB region at 1 km resolution. The river-routing module we propose here will be coupled with the UMD-ICTP model, using its 1 km offline output data. As a result, the rate at which surface and subsurface water coming in and out of the PRB region will be determined. By performing a retrospective offline run, the river-routing module will be validated with the historical daily streamflow measurements from USGS.*

Zimmerman, Richard - *Old Dominion University*

Integrated Modeling of SAV Habitat Requirements: Improving Predictions of Water Quality Impacts on a Critical Marine Resource

PRESENTATION - *Although light availability is widely regarded as the most limiting resource controlling seagrass distribution, the development of reliable metrics for environmental parameters that control their distribution remain elusive. Consequently, our ability to predict the spatial patterns of seagrass distribution, and their responses to climate change, are largely rudimentary. Seagrasses have returned to portions of the Chesapeake Bay system, particularly in the coastal bays of the DelMarVa Peninsula, but many previously vegetated areas have never recovered, and current bay-wide targets call for restoring submerged aquatic vegetation to <10% of its original distribution. We are developing tools for data assimilation, prediction and visualization that will assist managers in diagnosing water quality impediments to seagrass restoration and to aid with recovery efforts. These tools focus on (i) water quality measures that control the transparency of the water column to visible light, (ii) the propagation of light through plant canopies submerged in an optically active water column, and (iii) plant physiological processes that integrate the biological response to the light environment. Coupled with other factors such as ambient temperature and ocean acidification these tools will allow us to provide managers with a mechanistic prediction of daily carbon balance and light requirements that control the distribution of SAV across the submarine landscape in response to changing water quality and climate.*