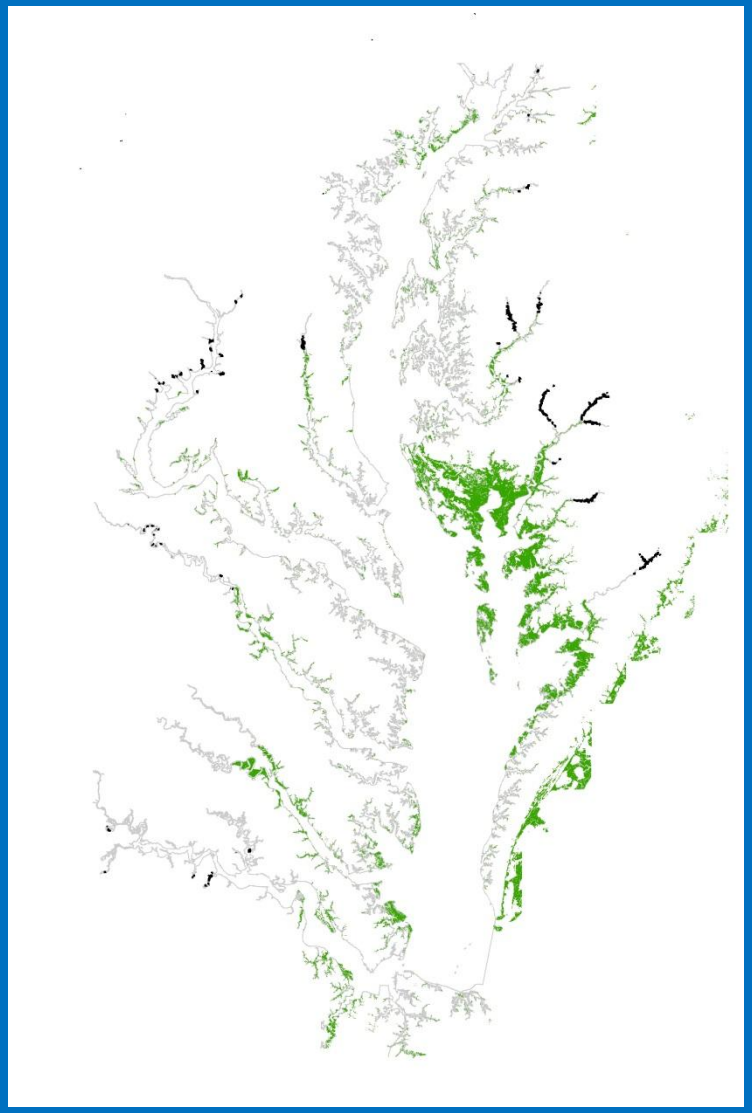
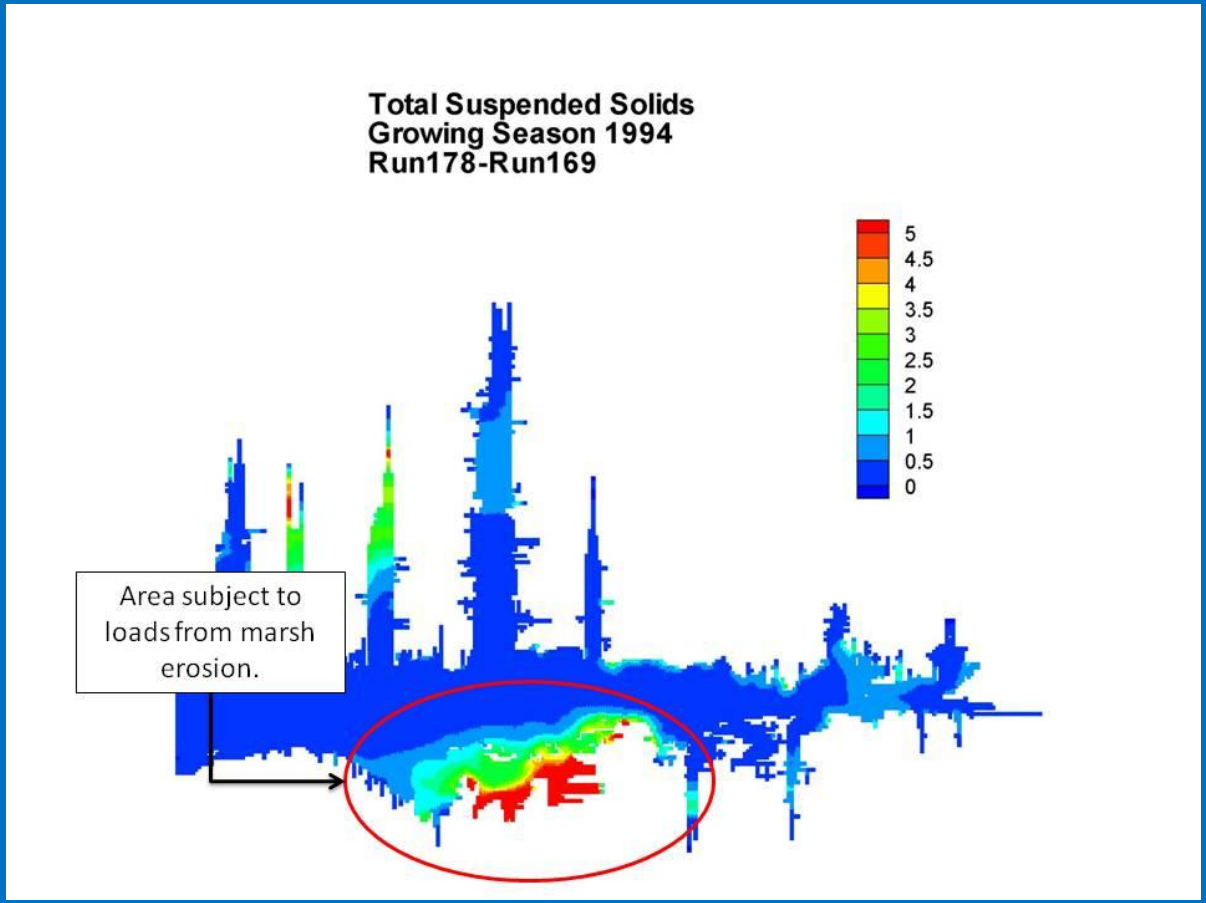
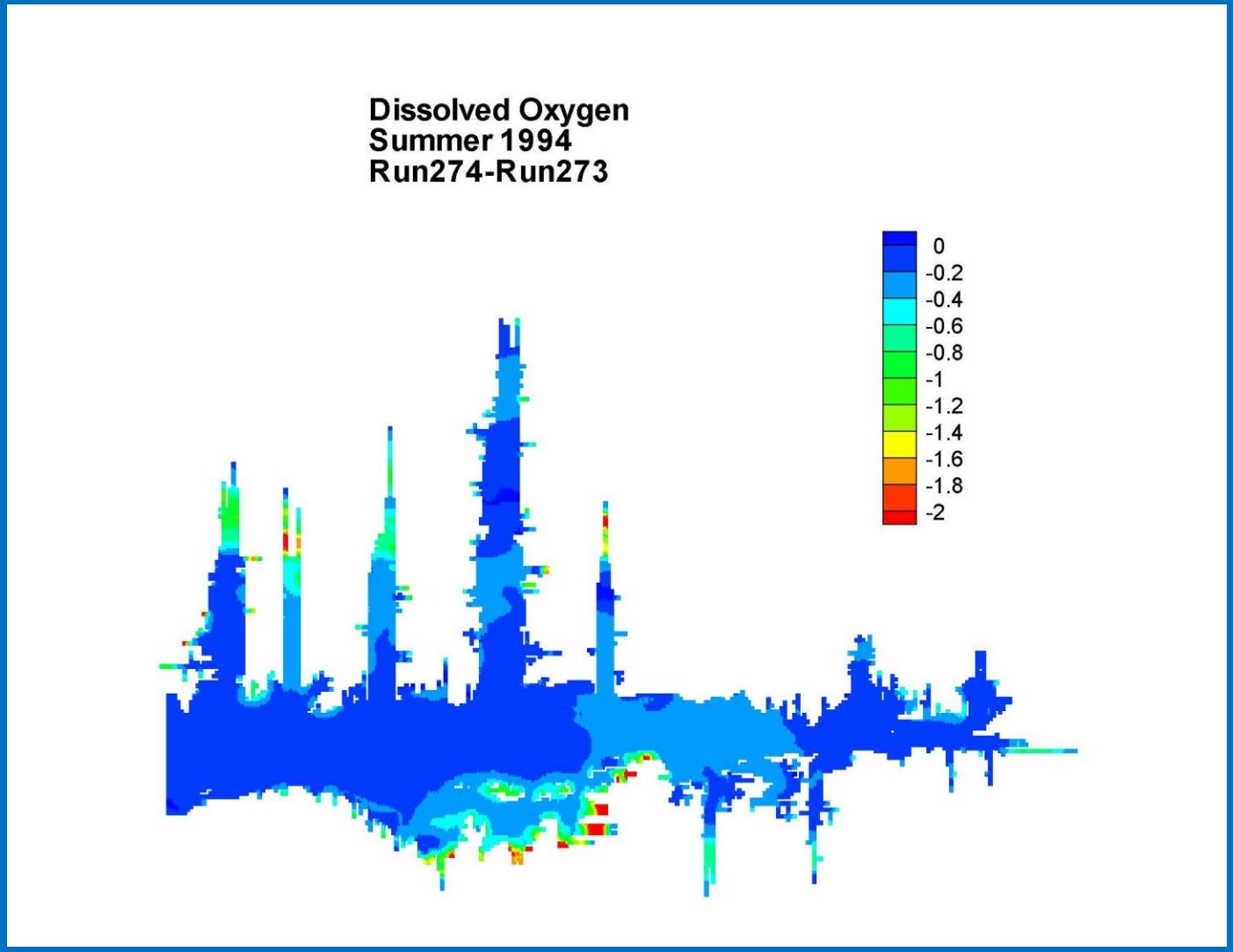
Climate Change, Marsh Erosion and the Chesapeake Bay TMDL



Rising sea level in Chesapeake Bay is inexorable. One environmental effect associated with sea level rise is marsh erosion. Marsh erosion can impact water quality in two fashions. The first is the effect on light attenuation and biogeochemistry associated with eroded materials released to the water column. The second, often overlooked, effect is the loss of marsh function. Beneficial functions include retention and burial of suspended solids, nutrient uptake and sequestration, and nitrogen removal through denitrification. Loss of these functions has the potential to affect water quality standards enforced through enactment of the recent total maximum daily load (TMDL).



Incremental effect of marsh erosion on suspended solids, averaged over an SAV growing season (April – September, 1994). 1994 is considered a year of average flow in the Susquehanna River, the largest tributary to Chesapeake Bay.



Incremental effect of wetlands uptake on dissolved oxygen, averaged over the summer months (June - August, 1994). 1994 is considered a year of average flow in the Susquehanna River, the largest tributary to Chesapeake Bay.

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We propose to examine the potential impact of marsh loss through a three-phase program including:

- Phase I – Estimate marsh loss and transition due to sea level rise.
- Phase II – Investigate the reactivity of material eroded from marshes and released to Chesapeake Bay waters.
- Phase III – Quantify effects of marsh loss on water quality and examine implications for TMDL.

Phase I – Estimate Marsh Loss and Transition

We will investigate and project marsh loss through several approaches:

- The first is to investigate existing projections which may have been conducted for other purposes e.g. flood insurance or shoreline protection.
- The second approach will investigate the use of predictive modeling e.g. the SLAMM (Sea Level Affecting Marshes Model).
- The third approach will utilize GIS and will project the area and characteristics of future marshes by overlaying a projection of future sea level on a representation of existing marsh area and type.
- The projected sea level rise will be taken from climate change scenarios currently being run by the Chesapeake Bay Program.

Phase II - Investigate the Reactivity of Material Eroded from Marshes

Particulate material eroded from marshes includes inorganic sediments, organic carbon, organic nitrogen, and organic and inorganic phosphorus. The carbon and nutrients have the potential to react in the bay water column and/or after settling to bottom sediments. Little is known about the potential reactivity of this material, however, especially in terms that are useful within the current modeling framework.

- We propose that eroding sediments will be collected from two or three marsh environments e.g. salt marsh and tidal freshwater marsh.
- The carbon, nitrogen, and phosphorus in the material will be quantified and classified. Then, reactivity experiments will be conducted to determine the availability of this material to the bay water column and bottom sediments.
- These experiments will be conducted by a local research institute under contract to the Engineer Research and Development Center.

Phase III - Quantify Effects of Marsh Loss on Water Quality and the TMDL

This phase will involve multiple model activities and will interface with two CBP activities. CBP is presently estimating the impact of climate change, including but not limited to sea level rise, on the bay and incorporating these estimates into the 2017 reassessment of the Watershed Implementation Plans (WIPs) and the TMDL.

- The first activity in this phase will be to develop basic algorithms to describe marsh function with relation to water quality. These algorithms will include, at least, solids removal and burial, nutrient removal and burial, denitrification, and respiration. Algorithms will be developed for two or three marsh types, determined by salinity classification. The algorithms will be based on published investigations in Chesapeake Bay and elsewhere.

Phase III - Quantify Effects of Marsh Loss on Water Quality and the TMDL

- These algorithms will be installed and tested in the existing water quality and sediment transport model (WQSTM). Testing will be conducted for the 2001 – 2011 simulation presently under development. Required adjustments to the WQSTM calibration will be completed along with the algorithm development. The algorithms will then be installed in the existing WQSTM implemented with TMDL conditions to assess the influence of marsh processes on the TMDL conditions.

- We will next execute the WQSTM for the climate change scenarios with existing marsh areas and with projected marsh areas determined in Phase I. These two scenarios will help in understanding the impact of marsh loss on bay water quality and will provide improved projections of future conditions. The last stage of model implementation will be to conduct two 2017 TMDL scenarios, one with existing marsh areas and function and one with projected marsh areas and function. These two scenarios will provide insight into the effects of sea level rise and associated marsh loss on WIPs and the TMDL.

Deliverables

- A consensus projection of marsh loss due to sea level rise.
- A set of algorithms describing effects of marsh functions on water quality.
- Documentation of the algorithms.
- All computer codes employed in this investigation
- Model scenarios that examine the effect of marsh function and loss on current bay conditions, under projected climate change conditions, and under TMDL conditions.