Using Multiple Models for Management (M3) in the Chesapeake Bay: A Shallow Water Pilot Project

A STAC workshop at the
Virginia Institute of Marine Science
April 26-27, 2012

Steering Committee

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Scientific Assessment of Hypoxia in U.S. Coastal Waters

A 2010 report by the:

Interagency WG on Harmful Algal Blooms, Hypoxia, & Human Health
Joint Subcommittee on Ocean Science and Technology

"Use of a multiple model consensus, where models use different approaches and assumptions, provides one way to better inform management decisions. This approach is well known for its application to forecasting hurricane paths and predicting the effects of carbon dioxide fluctuations on climate…"

Scientific Assessment of Hypoxia in U.S. Coastal Waters

A 2010 report by the:

Interagency WG on Harmful Algal Blooms, Hypoxia, & Human Health
Joint Subcommittee on Ocean Science and Technology

…it is now possible… for several independent or "competing" modeling efforts to address similar issues for the same geographic location. This development is a positive one because scientific debate and consensus building – which promote **scientific advancement** – **cannot occur effectively if there is only a single modeling program**."

Would a CBP multiple modeling program enhance scientific advancement on Bay issues?

STAC Discussions on CBP Modeling

1. National Academy of Sciences Review (QM June 2011)
2. STAC LimnoTech Review (QM Sept. 2011)
3. CB Hydrodynamic Modeling Workshop Report (QM Sept. 2011)

→ Future of Modeling Letter from STAC to the MB (Oct. 2011)

STAC Future of Modeling Letter: Recommendations

1. STAC strongly recommends that any future hydrodynamic/water quality model shall be selected through **quantitative skill assessment and an independent peer review process**

2. STAC strongly encourages the EPA to direct a portion of its modeling funds each year to the modeling community **to develop and run multiple hydrodynamic/water quality models**. The output from these multiple models shall then be routinely compared to the EPA regulatory model output to build scientist, management, and other stakeholder confidence in the model, which is critical for generating support for the appropriate use of public funds in meeting TMDLs across the region.

A Vision for Using Multiple Models in the CBP Modeling Suite (QM Dec. 2011)

- **CBP model** continue to be used as the **sole regulatory** model for WQ management decisions with several other **community models** being used for comparison and **R&D**.

  This would:

  - Demonstrate that the CBP model is equally as skillful as a range of models routinely used by the scientific community
  - Bolster community-wide (management and academic) support for the TMDL Modeling Framework

STAC Letter: Shallow-water multiple model pilot project (Jan. 2012)

- STAC recommends that the MB consider directing the CBP to **implement a prototype multiple modeling strategy** involving both skill assessment and peer review for the identification of models that best match observations **in this shallow border** of the tidal Chesapeake Bay and its tributaries.

- **STAC volunteers to assist the effort** through the identification of a group of experts to meet with the CBP and identify (1) technical requirements for these models, (2) potential model candidates, and (3) the model inter-comparison requirements that would be needed to ensure adequate skill assessment and peer review.

MB Response: Shallow-water multiple model pilot project (Feb. 2012)

- "A demonstration project in a well monitored system… would serve as a prototype for the application and assessment of multiple models. **The EPA is now examining the potential to fund a few prototype shallow water models this year."**

- "To move this forward, …**[the MB] would welcome STAC's assistance in implementing a prototype multiple modeling strategy** involving both skill assessment and peer review."

- **Request for STAC workshop**

Further STAC/MB conversations
(Feb-Mar 2012)

Two goals for workshop on Multiple Models for Management (M3):

(1) Define elements that should be included in such a pilot project

(2) Discuss benefits and challenges of using multiple models in a regulatory framework

STAC decided two separate workshops would be required:

M3.1 (April 2012; 25 attendees; Virginia)

M3.2 (Fall 2012; 50-75 attendees; Maryland)

M3.1 Workshop Agenda

Day 1:

- Introduction (M. Friedrichs)
- Overview of the CBP modeling capacity and future needs (L. Linker)
- Challenges for CH3D in the shallow waters of the Bay (C. Cerco)
- CB data availability (M. Trice, K. Moore, C. Jones)
- Discussion of pilot project details

Day 2:

- Initial thoughts on M3.2 (benefits/challenges of using M3 in a regulatory framework)

M3.1: A shallow water pilot project

Overall Goal: Improve shallow water CB simulations of DO and light (and thus indirectly SAV)

Additional outcomes:

* Potential identification of new model for the shallow waters and/or suggested improvements to existing model
* Confidence estimates for existing CBP shallow water simulations
* Demonstration of feasibility/utility of using multiple CB models

Methods: Compare relative skill of multiple model simulations of variables that are key to predicting SAV

* At a minimum: T, S, DO, light (Kd), chl, nutrients, TSS, CDOM
* A single empirical SAV model could be applied to the output generated by all the teams, and the results compared to observed SAV distributions

M3.1: A shallow water pilot project

Number of modeling teams: 3-6 (including current CBP simulation)

Number of a model comparison teams: 1 (not one of the simulation teams)

Number of sites: Two contrasting/representative sites; embayments or small rivers; modeling teams could do more sites if enough funds are available

Simulation time scale: 3-5 years in order to capture some interannual variability

M3.1: A shallow water pilot project

Site Selection Criteria:

Most importantly: two contrasting, representative sites with data (3-5 years) available

SAV present vs. absent
Fresh vs. salty
Sandy vs. muddy environment
Tidally vs. wave dominated
Externally forced vs. locally forced
Eutrophic vs. oligotrophic

M3.1: A shallow water pilot project

Modeling teams must:

Provide simulated distributions: daily output for xx years at xx sites of specified variables; base case run plus prescribed sensitivity simulations

May provide simulations of additional shallow water regions (or whole Bay)

Must use forcing fields provided, and CBP model open boundary conditions; could also provide output using their own b.c.'s

Model comparison team must:

Use traditional metrics (RMSD, bias, variability, correlation) and/or new metrics to compare base case runs to observations

Compare sensitivity simulations (multiple nutrient run-off

M3.1: A shallow water pilot project

CBP must provide:

- Necessary forcing for all teams (including CBP model output through 2011; so far only run until 2005)
- Bathymetry/shoreline/shoreline erosion estimates
- Atmospheric forcing (wind/fetch)
- Watershed model output (rivers, groundwater)
- Validation data

Required funding:

- Ideally a two year project
- 3-6 modeling teams + 1 comparison team;
  - $100K-200K per team per year
  - ($400K-$1400K per year)
- No match required
- Selection of teams through open procurement process (?)

Extra Slides