

Development of A Hydrodynamic and Water Quality Model in the Delaware River and Bay System

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Background

Delaware River is the longest undammed rivers in the US east coast and the Delaware River and Bay (DRB) system (Figure 1) is important for environment and fishery. A numerical model has been developed for the DRB and numerical simulations have been carried out using two different model grids for Feb-Sept, 1984. The objective of this study is to compare the model performance between results from these two grids and with results from other models developed by the NOAA NOS. A water quality model is being developed.

Model and Data

The numerical model is based on the Delft3D modeling system, which consists of a suite of modules including hydrodynamics, water quality, morphology and waves (<http://oss.deltares.nl/web/delft3d>). Two grids are used: 1) the original grid used by NOS for their ROMS and POM models, 2) a new grid in which the river portion is redesigned with RGFGRID software package while keeping the estuary and shelf portion (Figure 2). The river discharges, meteorological forcing and boundary conditions are provided by the NOS, which were used to drive their models as well in the DRBMEE project. The observed data were collected by the NOS.

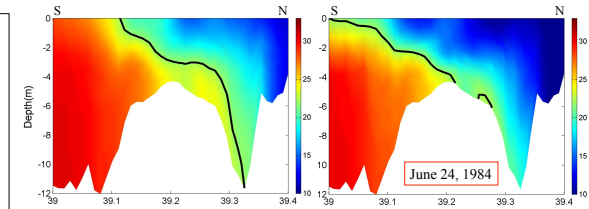


Figure 7. Salinity front along a transect from the shelf to estuary (Figure 6) between the results with NOS(left) and RGF(right) grids. Black line indicate salinity contour S=22 psu.

Summary and Future Plan

A hydrodynamic model based on Delft3D has been developed and the model skills (tides, sea level, T&S, currents) assessed. Overall, the Delft3D model performs similarly to the other models except within the tidal frontal zone, where the Delft3D model is able to better simulate the tidal mixing and frontal movements. A further analysis suggests that the better simulation of tidal front processes is the result of a better representation of river dynamics near the upper end of the TFZ, which in turn affects the downstream tidal-river interactions.

The modeled results, especially upstream sea level are sensitive to bottom friction coefficient (results not shown). A similar conclusion has been found by Warner et al. (2005).

The water quality in the DRB system remains a significant concern to the environment and fishery, although the water quality has improved dramatically in the last two decades (e.g. Kauffman et al. 2011). A water quality model based on Delft3D-WAQ (<http://oss.deltares.nl/web/delft3d>) is being developed to understand the biogeochemical processes in the system.

Acknowledgement: We thank Jesse Feyen at NOAA/NOS for providing the DRBMEE model files and the observed data. Dick Schmalz at the NOS provides valuable modeling suggestions.

References

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- Warner, J.C. et al. 2005, J. Geophys. Res.-Oceans, 110, C05001.

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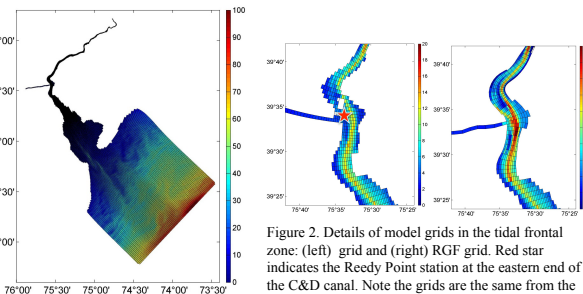


Figure 2. Details of model grids in the tidal frontal zone: (left) grid and (right) RGF grid. Red star indicates the Reedy Point station at the eastern end of the C&D canal. Note the grids are the same from the lower estuary to the shelf (not shown).

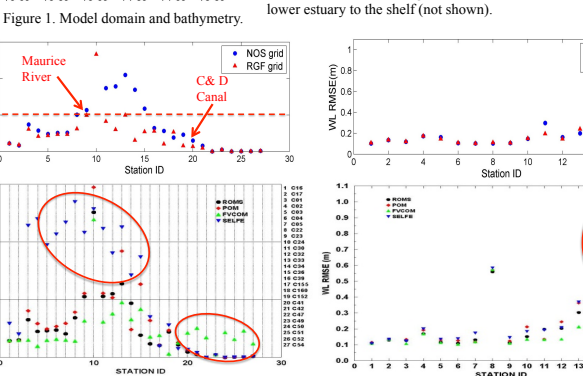


Figure 5. Model RMSEs: a) Delft3D salinity, b) salinity from other models, c) Delft3D sea level, and d) sea level from other models. RGF grid salinity has lower RMSE than the NOS grid, especially within the tidal frontal zone. Overall, RGF grid model performs similarly or better than the NOS models. Panels c) and d) are adapted from Patchen (2007).

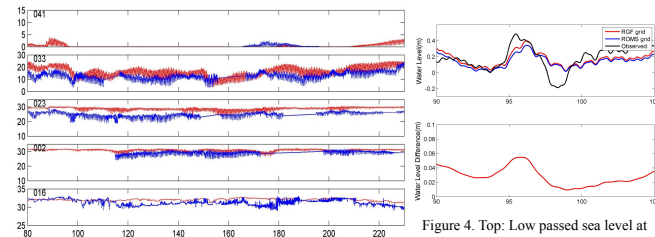


Figure 3. Modeled salinity from the model with RGF grid at selected stations from river (top) to estuary (bottom) (Red: Model, Blue: Observation).

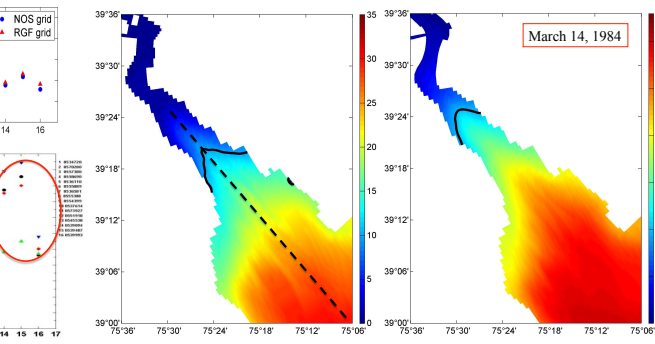


Figure 6. Bottom salinity between results with NOS grid (left) and RGF grid (right). In this simulation, no river or surface forcing is imposed, and thus the front is driven by tides. Black solid lines indicate salinity contour S=10 psu. Black dashed line indicates a transect from the shelf to estuary.

Figure 4. Top: Low passed sea level at Reedy Point (see Figure 2). Bottom: the difference between the results with RGF grid and NOS grid.