Response to reviewer comments "Parameter sensitivity and identifiability for a biogeochemical model of hypoxia in teh northern Gulf of Mexico", Beck, MW, Lehrter, JC, Lowe, LL, Jarvis BM.

We thank the editor and review for providing thoughtful comments on our manuscript. Responses to these comments are shown in italics. Page and paragraph numbers refer to the revised manuscript.

Editor's comments:

The authors executed the work on parameter sensitivity and identifiability for a biogeochemical model of hypoxia in the northern Gulf of Mexico. The authors did not provide proper conceptual diagram of the model. The model is not presented in detail, it is necessary to give more details on original model. Discussion part is unnecessary long, lot of introduction in the discussion. This part needs major revisions and complete restructure. The sensitivity analysis was adequately implemented but further clarification is needed for how the water quality model was applied in Weeks Bay. In view of the above comments and reports of reviewers, your manuscript has been evaluated and you are informed to resubmit the manuscript after proper and thorough revisions in accordance with the comments of editor/reviewers. Review reports are appended below. Thank you for your submission in Ecological Modelling.

Reviewer 1:

The authors present the sensitivity analysis of a 0-Dimensional biochemical model implemented in Weeks Bay Alabama. The authors evaluated the sensitivity of the model predictions of DO, ammonium, nitrate, chl-a and irradiance to perturbations in several model parameters. In general, the theoretical basis of the sensitivity analysis is very interesting and mathematically sound and the use of the collinearity index (Eq. 3) to explore linear correlations between parameters seems to be very useful to help identify the most important parameters controlling the model performance (in terms of goodness of fit to observed datasets). The paper can be accepted pending major revisions.

My main concern with the manuscript is that while the application of the sensitivity analysis to the FishTank model seems ok, the application of the FishTank model to Weeks Bay, AL is weak and not convincing. First of all, a correct representation of the advective and dispersive transport is critical to be able to capture the fate and transport of water quality in an estuary. Without a correct representation of transport it is almost impossible to be able to obtain a predictive water quality model. The FishTank model in this case neglects all modes of transport in Weeks Bay, AL and therefore assume the estuary is like a bathtub. This is obviously incorrect and represents a clear limitation of the paper.

For the sensitivity analysis the authors manipulated the observations of DO in the estuary filtering the tidal impacts to be able to implement the FishTank model. However, there is no evidence of the resulting time series of DO or of the other variables analyzed. I am

concerned that while removing the DO variations due to tidal cycles, the authors could have also removed the daily variation of DO which can be associated to diurnal cycles of sunlight and temperature. If this is the case, then the DO calibration is based almost on synthetic and unrealistic DO data. The authors must include a section showing the data that was used for the calibration analysis. This section should include a location figure showing Weeks Bay, AL, the stations used to extract the original datasets, plots of the unprocessed and processed time series of DO, ammonium, nitrate, chl-a and irradiance as well as plots showing the processed data against the calibrated model outputs for each variable. The authors must also include a table with the calibrated parameter values. This information is standard in all modeling studies.

Please also describe what are the forcing conditions of the FishTank model. There are two tributary rivers in Weeks Bay and one outlet condition. How is each one simulated in your FishTank model?.

Other comments:

Introduction. I suggest the authors to include also references of couple hydrodynamic and water quality studies available in the region. For example, the work of Camacho et al. (2014a) in St. Louis Bay, MS and part of Mississippi Sound is a relevant citation that is missing in this investigation. The work of Dortch et al. (2007) in Mississippi Sound should also be cited. Sensitivity analyses have also been conducted in the past in the region. For example, Camacho et al (2014b) conducted an uncertainty and sensitivity analysis of a hydrodynamic model of Weeks Bay Alabama. I suggest the authors to include these references. The sensitivity estimates provided by Camacho et al. (2014b) seem to be based on the same equation Eq. (1) included in this manuscript. Can the authors briefly indicate (perhaps one or two sentences) if both methods are the same?

lines 24 - 39 page 3. This part of the text is full of vague statements. Please be more explicit. What are the "characteristics expected from the output" and the "information represented by the structural components". What do you mean with "Given that these characteristics cannot be simultaneously achieved, models are developed in partial dependence of reality and theoretical constructs, completely separate from both, or dependent on one or the other".

lines 24 - 39 page 3. I think the reference Levins (1966) is extremely old and must be removed.

It is interesting to see that the authors constantly use the term "precision" to denote goodness of fit. In general, precision is used to denote the number of digits of a number. Note that a number can be precise but inaccurate. I suggest the authors to revise the text and replace "precision" with a better term to denote goodness of fit. e.g. level of agreement between observations and simulations.

Line 9 page 10. Selection or Selected?

Line 4 page 12. what are the default parameter conditions?. You should include a table with the default parameter values and parameter values under 50% modified conditions.

Lines 29-30 page 16. Please include the units in the reported RMSEs. mmol O2?

References

Camacho, R. A., Martin, J. L., Watson, B., Paul, M. J., Zheng, L., & Stribling, J. B. (2014a). Modeling the factors controlling phytoplankton in the St. Louis Bay estuary, Mississippi and evaluating estuarine responses to nutrient load modifications. Journal of Environmental Engineering, 141(3), 04014067.

Camacho, R. A., Martin, J. L., Diaz-Ramirez, J., McAnally, W., Rodriguez, H., Suscy, P., & Zhang, S. (2014b). Uncertainty analysis of estuarine hydrodynamic models: an evaluation of input data uncertainty in the weeks bay estuary, alabama. Applied Ocean Research, 47, 138-153.

Dortch M. S., Zakikhani M, Noel M.R, and Kim S. C (2007). Application of a Water Quality Model to Mississippi Sound to Evaluate Impacts of Freshwater Diversions.