Responses to Comments by Reviewer #2:
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Reviewer comments are pasted in their entirety in black font. Responses are in blue font.

This manuscript reports the first systematic analysis of the effects of single and dual nutrient load reductions from a spatially explicit physical-biogeochemical model for the northern Gulf of Mexico (GoM). Their manuscript is the next important step in their modeling efforts in the GoM. The manuscript tackles an important question regarding nutrient reduction strategies, it is well written and their work reports important simulations regarding dual nutrient reductions. They come to several additional important conclusions about the behavior of the GoM ecosystem including that reductions are more effective at reducing the area of hypoxia than in reducing primary production, and that the Gulf of Mexico system is saturated with nitrogen.

Response: We are grateful for the positive assessment and appreciate the thoughtful and constructive comments.

Some comments:

The US has not been able to make real nutrient reductions despite decades of voluntary controls. Since the GoM is N saturated, does that mean that it can't get worse as N loads continue to increase. Are we really at the maximum area given the current conditions and climate?

Response: Since the sensitivities are still well above zero, larger N loads would make the situation worse, just not as fast as they would at lower loads. We used the phrase "the system is approaching N saturation" and "already saturated in N" on page 8, lines 13 and 14. We would like to rephrase this to "is on a trajectory toward N saturation" and "almost saturated in N," because we don't want to imply that complete N saturation is reached.

Pg 1, line 8 "Evidence of P. . . since then" is awkward.

Response: Agree and would like to change to:

"Since then evidence of P limitation during the time of hypoxia formation has arisen…"

Pg 3, line 11 One question regarding hypoxia is the legacy of a higher sediment respiratory demand following the build up of organic carbon stores in sediments with eutrophication (Turner et al. 2008) whereby repeated hypoxic events lead to an increased susceptibility of further hypoxia and accelerated eutrophication. I know one group in the GoM that believes that this process can not happen because of the physical conditions on the shelf would prevent the accumulation of organic matter stores. However, there are studies from the Baltic addressing the importance of the legacy of carbon and nutrients in the sediments. Could this be a factor in the GoM?

Response: Yes, it could be a factor in the Gulf, but whether it is remains an open question. Unfortunately our model can't address this question in its present form because we don't have an explicit sediment module that allows storage of organic matter in sediments. We would like to add the following text to address this:

> "Our model does not account for the possibility of a "legacy effect" as proposed by Turner et al. (2006, 2008). Turner and co-authors suggested that organic matter is accumulating in the sediments resulting in an increase in sediment oxygen consumption from year-to-year even as nutrient loads and system-wide productivity are stable. Our model does not include organic matter storage in sediments, and thus cannot address the question of legacy in its present form."

Pg 4, line 17 Revise to "as an additional"

Response: Agree

Pg 7, "Sensitivity" – this is an interesting concept. . .

Turner and Rabalais have examined the role of Si in influencing diatom growth and hence the sedimentation of organic matter. Have you tried any simulation with dissolved silica?

Response: Unfortunately we can't test the sensitivity to Si at present. The model does not include Si as a nutrient, only N and P. Including Si would be interesting, but would require significant changes in the model structure (i.e. including diatoms as a separate phytoplankton group, parameterizing the Si cycling through the zooplankton and detritus pools, and parameterizing the sediment remineralization of Si).