Responses to comments by Referee #1

Comment on bg-2022-4
Anonymous Referee #1

General Comments:
This manuscript applies an ensemble regression approach to produce daily predictions of hypoxic area for the Louisiana-Texas shelf. The manuscript is well written and provides more than adequate descriptions of the methods used to develop, train, and apply the multiple regression models considered for application. Although the ensemble model's application to global HYCOM seems an important aspect of this work, it's sole focus in the discussion feels somewhat like an afterthought. HYCOM presentation in the discussion also presents material that seems better suited for the methods section. Although not essential for publication (in my opinion), I would ask the authors to consider expanding the discussion of HYCOM application in the manuscript by addressing relevant technical details in the methods section and focusing on model outcomes for both the ROMS and HYCOM model in the discussion.

Authors' Responses: The main objective of this study is to apply the trained model to the HyCOM global dataset for an efficient forecast of hypoxic areas. As the application to the independent data (HyCOM) demonstrates the model's robustness, we treat it as a sole section and put it in the discussion section. Nevertheless, we would like to move specific technical details to the method section. We will expand the discussion section about the model's performance based on HyCOM to that found on ROMS and Shelfwide observations.

Specific Comments:

Line 55: "The effects of water column stratification are not included or only partially considered" In the previous paragraph you describe several models as incorporating water reaeration and wind velocity in the regression model. Are these not at minimum proxies for water column stratification? Suggest this be re-phrased to address the need to include stratification explicitly.

Authors' Responses: The previous models mentioned in the previous paragraph did consider stratification-relevant predictors like wind speed, water transport, and riverine nutrient loads (usually correlated to river discharges). However, water stratification is affected by all these variables and can be represented directly by the water density profiles. The statement of "the effects of water column stratification are not included or only partially considered…" may be improper and we could restate it as:

"The effects of water column stratification are considered only implicitly by the associated wind speeds, water transport, and riverine nutrient loads (usually highly correlated to river discharges), although stratification is documented as a crucial factor in regulating HA variability."

Line 155: where was the "temperature-dependent decomposition rate of organic matter" derived?

Authors' Responses: The SOC is modeled in the accompanying paper (Part I) (in Eq. (8) and Eq. (10)) proportional to sedimental organic matter concentration (estimated as sedimental particulate organic nitrogen, PON_{sed}, and is output from the 3-D coupled model) and a temperature-dependent decomposition rate:

$$SOC = PON_{sed} \cdot VP2N_0 \cdot e^{K_{P2N} \cdot T_b}$$

where $VP2N_0$ is a constant representing the decomposition rates of PON_{sed} at 0 ºC, K_{P2N} a constant (0.0693 $ºC^{-1}$) indicating temperature coefficients for decomposition of PON_{sed}, and T_b the bottom water temperature. In this study, we use the variation of Mississippi River inorganic nitrogen loads with some leading days to represent the variation of PON_{sed} and keep the temperature-dependent decomposition rate same as that of the 3-D coupled model. Such decomposition rate follows the Q_{10} assumption that the reaction rate, R, depends exponentially on temperature, i.e.,

$$R = R_0 \cdot Q_{10}^{(T-T_0)/10}$$

For most biological systems, Q_{10} is from 2 to 3. Here, we assume it as a constant 2. R_0 is the reaction rate at temperature T_0 (measured in ºC). The SOC scheme we applied takes the R_0 as $VP2N_0$ and T_0 as 0 ºC. Thus, the above equation can be simplified as:

$$R = R_0 \cdot 2^{\frac{T_b}{10}} \approx R_0 \cdot e^{0.0693 \cdot T_b}$$

Line 179: Is a shelfwide average appropriate for all predictors? Was any attempt made to derive predictors for different longitudinal zones of the shelf? For example, the ROMS grid extends far to the western limits of the hypoxic zone along Texas, and thus stratification predictors averaged across the entire domain may be less dynamic than otherwise expected.

Authors' Responses: We aim to develop a statistical model to predict the hypoxic area in the LaTex Shelf. Since the hypoxic area is the summation of the area which meets the hypoxic condition (Fig. 1 see below, we may need to add a map of LaTex Shelf in the Appendix), we averaged all the predictors over the same shelf region to represent the averaged hydrodynamic and biochemical conditions over this region. A median of the predictors over this region does also indicate averaged conditions and may provide a less PEA averaged condition (more dynamic) than using the regional average. However, models developed using regionally averaged predictors perform better than those built using median values.

Cruise surveys indeed observed hypoxic bottom water along the coastal Texas water (Fig .2). As one of the most well-known hypoxia cruises, the Shelfwide surveys do not usually cover waters west of 93.5W, however, in some summers (like 2017), the survey did reach the west of 94W along the Texas

coast where hypoxic water was reported. In addition, according to the SEAMAP summer Groundfish Survey (Fig. 2), hypoxic bottom water can be found to the west of 94W along the Texas coast. Thus, we expand the LaTex Shelf coverage which is larger than that shown in the Shelfwide cruises measurements. In this study, we have not yet considered the effects of location (like longitudes) on the hypoxic area prediction.

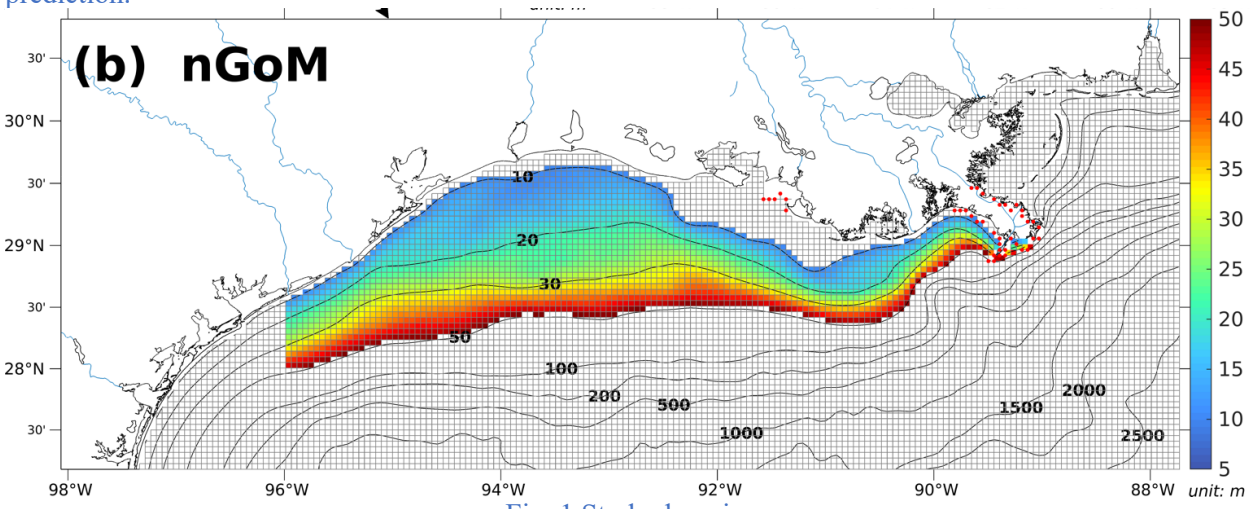

Fig. 1 Study domain.

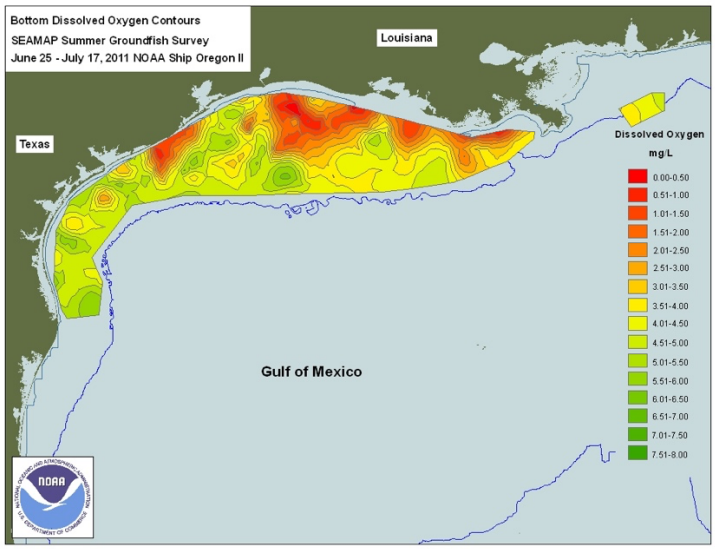

Fig. 2 Distribution of bottom dissolved oxygen concentration provided by the SEAMAP Summer Groundfish Survey in 2011 summer.

Figure 4: The 95% CI are not visible. Is this because the confidence intervals are extremely tight and not visible at this multi-annual scale?

Authors' Responses: The ranges bagging 95% prediction intervals (PIs) are narrow and can be hardly seen here. We will choose another color to distinguish the PI and bagging mean curves.

Figure 7: Please clarify in the caption where the hypoxic area from the ROMS hindcast is coming from. Is it from the ensemble model, and if so, should 95% CI's be applied here?

Responses: The ROMS hindcast hypoxic area is from the 3-D coupled hydrodynamic-biogeochemical model described in the accompanying paper (PartI). For the application using HyCOM application, we trained the model using the ROMS hindcast results and then applied the trained model to the HyCOM dataset to predict the hypoxic area from 2019 to 2020. We then compared the predicted hypoxic area by the ensemble model using HyCOM and the ROMS hindcast hypoxic area in Figure 7.

Technical Corrections:
Authors' Responses: We will correct the below-mentioned sentences or phases according to the comments.

Abstract line 20: suggest changing "is by far the first one providing" to "is the first"

Line 24: superscript "L-1"

Line 56/57: "The information of future conditions is limited although some models are built upon multiple predictors, thus these forecast models are indeed "pseudo-forecast" ones." This sentence is awkward. Suggest rewording to: "Information on future conditions is often limited to few predictors, thus limiting these forecast models to "pseudo-forecasts""

Line145/146: "However, by far, global forecast model systems like HYCOM does not include biochemical fields" This sentence is a little confusing. When you say "fields", do you mean "parameters"? HyCOM is strictly a hydrodynamic model, so it is sufficient to say "However, global forecast models such as HYCOM do not simulate biochemical parameters. Therefore, the biochemical-related term SOC needs to be replaced by an alternative term (denoted as SOCalt)."

Line 150: It may be more appropriate to describe nitrogen as available for plankton growth, not bloom.

Line 164/165: "For simplification, we denoted this variable as (Qh), W3, and ð□□□ as PEAheat, PEAwind, and DCPTemp, respectively." It took me a few reads to figure out what this sentence was trying to say. Suggest removing the word "this" and modifying to "denoted the variables"

Line 316: Change "It implies" to "This implies"