Gulf of Mexico Hypoxic Zone Modeling Technical Review Meeting

Guidelines for Gulf Modelers

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Introduction

The *Gulf of Mexico Hypoxic Zone Modeling Technical Review Meeting* has an overarching goal to provide perspectives to NOAA re. the next potential steps in hypoxia modeling in the Gulf in support of management efforts to mitigate the hypoxic zone. The Modeling Technical Review Panel will work with Gulf Modelers to assess the state of forecast models that can be applied to hypoxic zone dynamics in the northern Gulf of Mexico, and develop recommendations on modeling approaches to most effectively meet the Hypoxia Task Force management directive to mitigate hypoxia.

The Panel, in collaboration with Gulf Modelers, is tasked with assessing modeling approaches for improving the predictive understanding of the quantitative relationship between nutrient loading and hypoxic zone size. We are looking for models to inform nutrient reduction targets to mitigate hypoxia, to monitor management progress toward achieving hypoxia mitigation through nutrient reduction, and to conduct hindcast simulations to understand past events. We are also looking for models to produce seasonal and synoptic scale forecasts, for the important outreach purpose of alerting the public and managers to the state of the hypoxia problem and the role of nutrients in causing the problem - but in future these types of forecasts could be used to inform fishing activities and fishery management strategies. There is some overlap that makes delineating these 2 types of forecasts perhaps an academic exercise because you'll note that the two forecasts currently used for the annual seasonal forecast issued by NOAA (Scavia, Turner) are the only models currently used by the Hypoxia Task Force to set nutrient reduction targets for N; no forecast is used currently for P.

The Steering Committee for the *Modeling Technical Review Meeting* developed a *Terms of Reference* to provide a framework for the charge to the Modeling Technical Review Panel. Based on that framework, the *Guidelines for Gulf Modelers* is intended to guide the presentations of Gulf modelers to provide the information necessary to do a thorough assessment.

Overview of presentation and working session expectations:

1. Presentations: Gulf Modeler Presentation" Session (Day 2, 10:15-12:00 and 1:00-2:50)
    a. 15 min per model
    b. Q&A will be held until later session (3:30-4:45 – see below)
    c. ~10 slides: these should address the following topics but does not have to be constrained to one slide per topic:

        i. What **management questions** are addressed? See "Key Management Questions" below.

        ii. What key **assumptions** are made for the physical and biological components of the model? For physical models, assumptions include turbulence closure, surface fluxes, river flows, … For biological models assumptions may include N and P flows, biology, bottom interactions, light and nutrient interactive effects on phytoplankton growth…

        iii. **Inputs:** On what input information is the system dependent (e.g. river flow, nutrient loads, offshore boundary conditions, observations types, initial conditions, surface fluxes, biological conditions). What data are available to support these inputs?

        iv. **Outputs**: What are the outputs or state variables of the physical and biogeochemical components in the model? What are not represented?

        v. What is the **scalability** of the model? This is important because one researcher's implementation of a model may be constrained by available computer resources. So a domain may be small or of low resolution. How well does the model scale when going to a larger domain or finer resolution? For statistical models, what are the regression variables?

        vi. **How applied so far:** What historical re-analyses, hindcasts, or forecasts have been done relative to hypoxic zone size? What management outcomes have been achieved?

        vii. **Skill assessment:** Prior performance evaluations (references) for tides, wind-driven events, density-driven events, mesoscale events, biological properties; What is the statistical significance of the skill that has been evaluated? Over what range of hypoxic events has prediction been demonstrated, and what is the skill over that range? If relevant, what is the skill of the ancillary variables, such as phytoplankton biomass, nutrients, etc.

        viii. **Remaining needs:** Given the available resources, research systems are what they are. What existing capabilities (things the science community

generally knows how to do) remain to be implemented in the research system? How are those remaining components expected to change the hypoxic forecast skill? What are the fundamental shortcomings in basic understanding of physics, biology, parameterizations, input data, … that remain to be addressed to enable skillful predictions?

ix. **Transition to operations:** What is the user cycle for operation? How much interaction is required to construct a forecast? What inputs must be constructed vs what is automatically pulled in from operational sites? What skill set would a user be required to have? Must the user have a complete understanding of model numerics and biology? What level of training would be required for a user to be able to spot a 'bad' forecast?

2. Working Sessions:

   a. Session 1: Day 2, 2:50 to 3:15 p.m.: Modeling Technical Review Panel Session: The Modeling Panel will be deliberating in a short closed session and developing questions in preparation for the Q&A session with the Gulf modelers at 3:30.

   b. Session 2: Day 2, 3:30 to 4:45 p.m.: Modeling Panel & Gulf Modelers: Q&A between Panel and Modelers to clarify talking points from slides, followed by group discussion on modeling vision.

3. Framework for developing White Paper on *Recommended Modeling Approaches for Scenario Forecasts of Gulf Hypoxia*:

   a. After meeting deadline of August 2013;

   b. Gulf Modelers will have opportunities to review drafts and provide edits and comments; the final draft will be a joint effort between the Panel and Gulf Modelers; Steering Committee will be involved in coordinating the process;

   c. There will be a section describing the state of the science in Gulf hypoxia modeling, based on the meeting presentations, meeting discussions, and references included in the Model Inventory. There will also be a "Recommendations" section, which will address scenario forecast modeling approaches for best informing nutrient reduction goals and seasonal to synoptic scale predictions.

Key Management Questions:

1. What is the quantitative relationship between the size of the hypoxic zone (areal extent and volume) and nutrient loadings from the Mississippi/Atchafalaya Watershed? Is there a critical period or season during which nutrient loading has a relatively greater impact on

the size and persistence of the hypoxic zone than other seasons or periods within the year?

2. What is the influence of freshwater flows, as it affects stratification, on the size of the hypoxic zone (areal extent and volume)?

3. What nutrient reduction levels are required to meet the goal to reduce the size of the hypoxic zone to a 5-year running average of 5,000 km^2?

4. What is the minimal amount of sustained nutrient reduction required to obtain a reduction in the size of the hypoxic zone that can be quantified and statistically verified? How long will reduced nutrient inputs need to be sustained before this reduction in size is realized?

5. If interim nutrient reduction targets are developed, what will be their resultant reduction in hypoxic zone size and over what time frame?

6. In addition to nutrients and river flow, what is the influence of ocean and weather conditions on the measured size of the hypoxic zone?

7. What is the effect of coastal restoration activities, such as large-scale river diversions, on the spatial and temporal extent of the hypoxic zone?

8. What is the long-term effect of climate change on the spatial and temporal extent of the hypoxic zone?

9. What are the linkages between the predicted size of the hypoxic zone and the resultant impacts to living resources?

<u>Considerations for next steps in modeling approach:</u>

1. ***Forecasts*** – Current goals of the Gulf Hypoxia Task Force emphasize the need to reduce Mississippi/Atchafalaya nutrients (N, P) fluxes into the Gulf of Mexico by 45% in order to meet the goal of reducing the size of the hypoxic zone to 5,000 km^2. The ability to refine these reduction targets and evaluate them in the context of additional ecosystem drivers is required to advance restoration efforts within the Gulf of Mexico and Mississippi River watershed. Characteristics of the modeling approach may include:

    a. quantitative assessment of nitrogen flux, especially nitrate, as well as phosphorus, and the relative role of their loading (amount, timing) on the formation and maintenance of the hypoxic zone;

    b. capabilities for discriminating the relative roles of physical characteristics such as river discharge, winds, episodic tropical storms, and currents;

    c. ability to inform the development of interim nutrient reduction targets and goals;

d. capabilities for assessing the influences of restoration management actions (e.g. Mississippi River diversions) or climate change on the timing and spatial characteristics of the hypoxic zone;

e. seasonal to synoptic-scale forecasting capabilities.

2. ***Model Requirements –*** Consideration of model requirements is a significant factor in balancing the ability of a model to address management needs with operational requirements. Key questions include:.

    a. What are the observational requirements for the initiation and validation of scenario forecasting models? What key processes need to be included in model? Which observations are required to objectively assess model skill?

    b. What are the infrastructure requirements for each modeling platform? Infrastructure needs include, but are not limited to:

        i. Computing needs and time;

        ii. Personnel time for initiation, validation, and system administration;

        iii. Output analysis and dissemination.

    c. Does the model output have quantifiable uncertainties, and if so, what are those uncertainties?

    d. What additional research is required prior to the transition of forecast models to operations?

    e. Are there priority research needs required to improve model performance after they are transferred to operations?