Integrated Ecosystem Modeling of the Causes of Hypoxia

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Reducing the size of the persistent and widespread area of low oxygenin the northern Gulf of Mexico (NGOM) represents one of the nation‘s crucial water management challenges. There is overwhelming evidence that river‘s freshwater volume and nutrient load determines both the biomass and production of phytoplankton, and the size of the hypoxic zone on the inner shelf. There is a sense of urgency for decisive actions to reduce the areal extent of hypoxia to the environmental goal of 5000 km2, because of the ineffective results to date to reduce the hypoxic zone size, the evidence that the hypoxic zone is growing and becoming more unmanageable, and because land use within the watershed is moving towards even more intensified agricultural production and fertilizer applications. We will address these issues through a series of linked statistical and two-dimensional models and supportive field efforts that:

(1) couple the Mississippi River watershed with the northern Gulf of Mexico (NGOM),
(2) explain diverse synergistic influences the physical and biological factors in the NGOM that control the development of hypoxia, and
(3) provide improved forecasting tools for effective management of hypoxia.

The continuing discourse about the relative contribution of physical and biological processes to the development and maintenance of hypoxia highlights the need for integrated physical and ecosystem models simulating the factors contributing to the development of hypoxia and its maintenance on the Louisiana-Texas continental shelf. In addition, if we are to link management options to desired changes in the size of the hypoxic area, we must also link the watershed with the coastal ocean. We propose using an approach integrating modeling, observations, and experiments to: (1) better define the processes that drive and maintain hypoxia, (2) describe how hypoxia has changed over time, and (3) determine how hypoxia will likely change in response to changes in watershed land use, differences in physical structure, and the biological responses within these contexts. The main objectives of this project are to: (a) advance the science of hypoxia forecasting for the NGOM, and, (b) serve management needs. This will be accomplished by linking observations, hypoxia research, data acquisition, and modeling into a fully integrated Gulf of Mexico Hypoxia Forecasting System – HYFORS. Statistical models of the relationships between nutrient loads and the summertime area of hypoxia will be improved and expanded, and the information about watershed nutrient fluxes will be used to develop 2-D model scenarios. Water quality and sediment diagenesis model modules (WASP, GHM) will be developed for incorporation into 3-D hydrodynamic models developed by other NGOMEX researchers. Model development will be supported by coastal ocean observations (shelfwide monitoring cruises, spatially explicit monthly and seasonal cruises, observing systems, satellite imagery and river monitoring), analysis of historical data, and experimental process-oriented studies to provide data for calibration and input to the models. Our team will routinely communicate the results of our research projects to scientists, managers and the general public.