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River Discharge, Stratification and Shelf Water Hypoxia in the Mississippi Bight

Kjell Gundersen, Stephan Howden, Donald Redalje & Steven Lohrenz

Department of Marine Science, University of Southern Mississippi, Stennis Space Center, MS 39529

School of Marine Science and Technology, University of Massachusetts-Dartmouth, MA 02744

ABSTRACT

Ecosystem metabolism, driven by available organic and inorganic nutrients, is an important end-point indicator for water quality and health of estuarine systems. When community consumption of dissolved oxygen (DO) exceeds the rate of production, hypoxia (<2mg DO/L) or even anoxia (no oxygen) may develop.

Sources of inorganic and organic nutrients in estuaries are derived from rivers and terrestrial runoff. The regional summer stratification in the Mississippi Bight is strengthened by offshore advection of fresh surface waters and onshore advection of high density bottom waters.

Our monthly Northern Gulf Institute (NGI-NOAA) surveys of the Mississippi Bight show that hypoxia is a regional phenomenon that can extend as far as 10m above bottom and last through the entire summer (4 months). In the fall, hypoxia is interrupted by episodic wind events (hurricanes) and vertical mixing will reintroduce DO to the bottom waters. Results from the 4 year monitoring program suggest that, in addition to fluvial nutrient inputs, physical processes such as river discharge, advection, mixing, and air-sea interactions, exert important controls on the net outcome of DO in the ecosystem.

METHODS

Bottom water (0.5m above sediment) and vertical profiles of DO and Salinity were measured using a SeaBird CTD (SBE49) with an SBE43 oxygen sensor.

Inorganic nutrients were measured by fluorometric (NH_4) and spectrophotometric (NO_3, NO_2, PO_4) detection on an Astoria-Pacific A2+2 Nutrient Analyzer.

Dissolved Inorganic Nitrogen (DIN) = $NH_4 + NO_3 + NO_2$

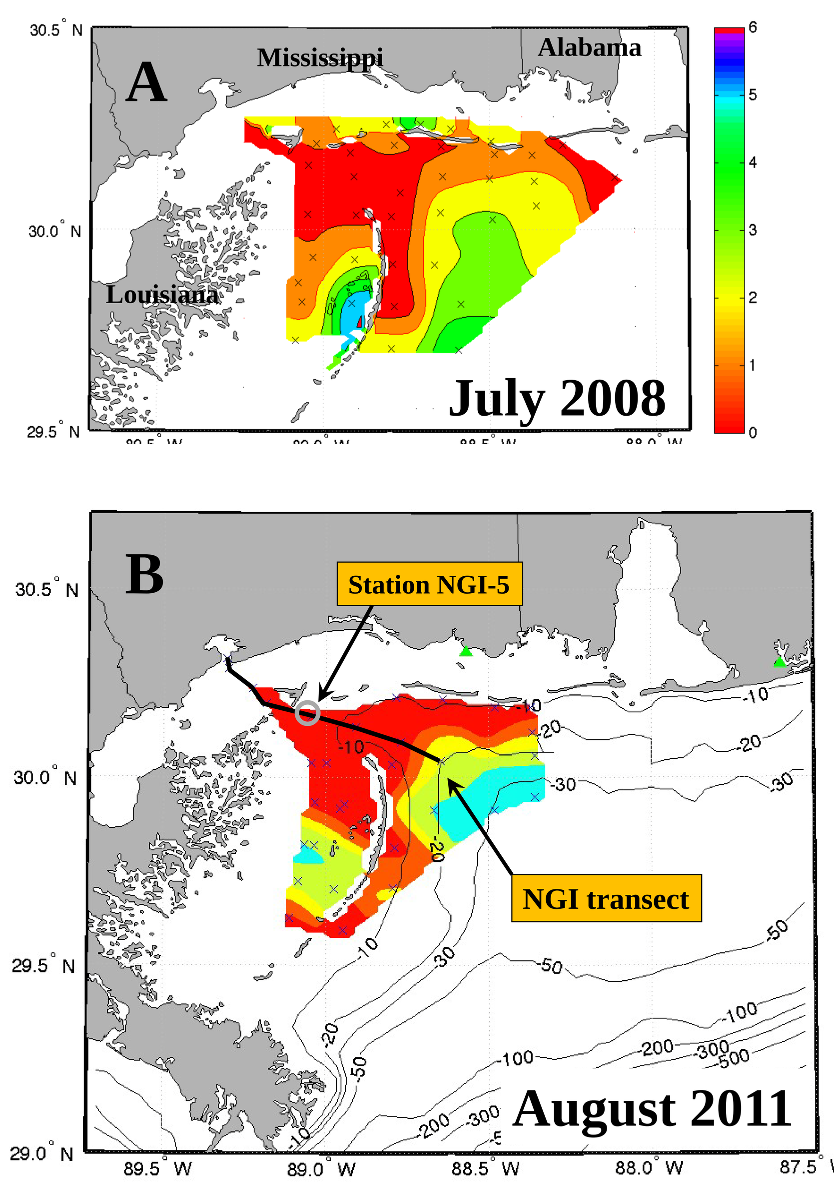

Figure 1
Bottom contour plot of DO (mg/L) measured in the Mississippi Bight in July 2008 (A) and in August 2011 (B).

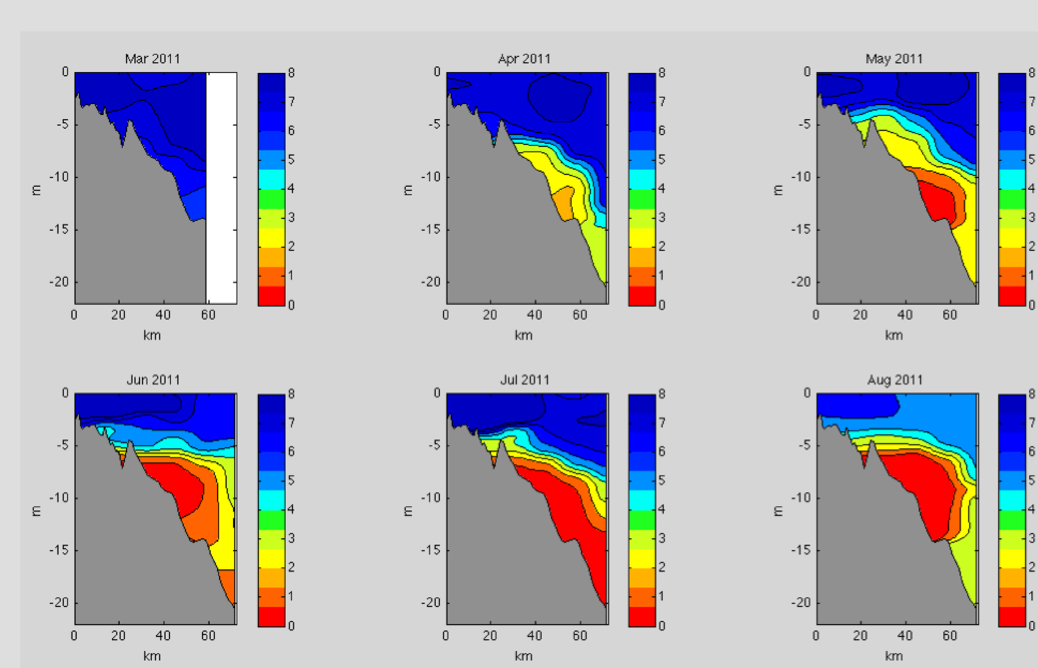

Figure 2
Contour plot of DO profiles along the NGI transect line (black line in Figure 1B).

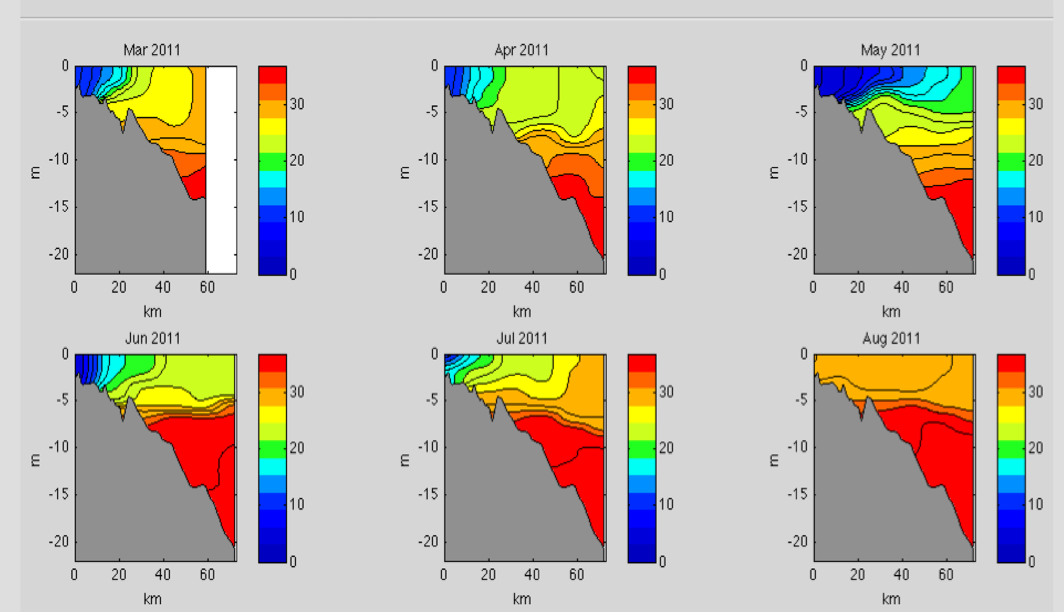

Figure 3
Contour plot of Salinity measured along the NGI transect line (black line in Figure 1B).

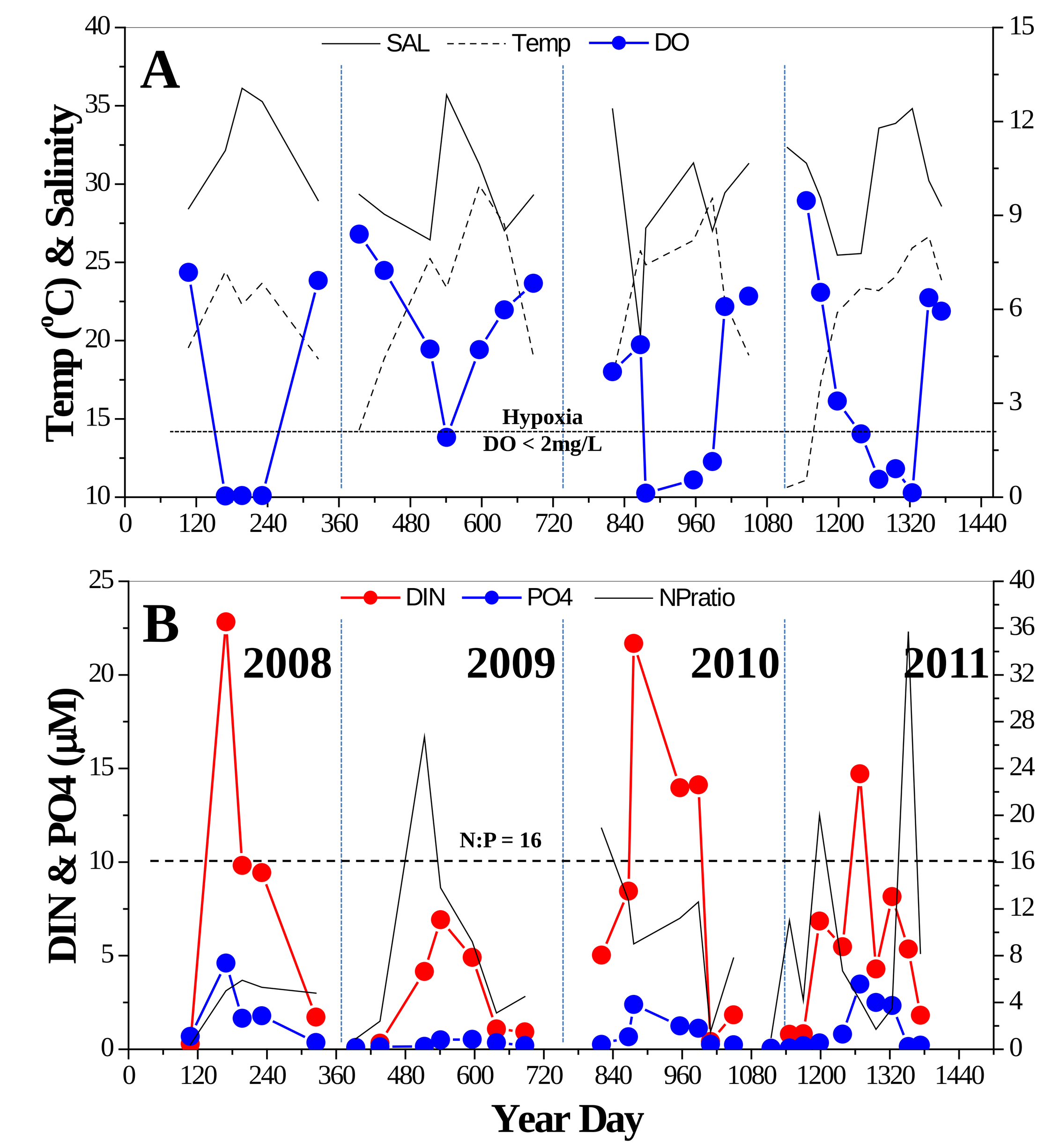

Figure 4
A: Time-series of bottom temperature (Temp), salinity (SAL) and DO measured at NGI station 5 (grey circle in Figure 1B).
B: Time-series of bottom dissolved inorganic nitrogen (DIN), phosphate (PO4) and the calculated molar N:P-ratio of dissolved inorganic nutrients at NGI-5 in 2008-2011.

SUMMARY

- Severe hypoxia was detected during the greater part of the summer in the Mississippi Bight in 2008, 2010 and 2011 (Fig.1 & 4).
- As seen in 2011, hypoxia was initiated in summer at 10-15m depth (Fig. 2) after periods of heavy rain causing extensive local freshwater discharge and a strong surface pycnocline in coastal waters. In 2009, rain and regional river discharge was low (data not shown) and only a brief oxygen minimum was recorded (Fig.4A).
- Years with hypoxia appear to have higher bottom water DIN & PO4 concentrations (Fig.4B) driving the N:P-ratio further below the Redfield relationship of 16.

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