The hypoxic area located west of the Mississippi River outflow in the northern Gulf of Mexico spans 12,000 to 22,000 km2 annually. Since 1985, this hypoxic zone doubled in size (Rabalais et al., 2002). Management options to reduce the size of Gulf hypoxia focus on reductions in Mississippi River nitrogen loads (CENR, 2000). Riverine nutrient input, chiefly nitrogen, stimulates primary production in the coastal ocean, and the resultant organic matter sinks below the pycnocline, formed from thermal stratification in summer months. Hypoxia occurs when respiration below the pycnocline, in the absence of surface mixing, exceeds oxygen replenishment.

Current models for predicting the size and location of the Gulf hypoxic zone focus on riverine nitrogen as the primary input parameter and succeed in explaining up to 88% of hypoxic zone size (Turner et al., 2006; Scavia et al., 2003). Remote sensing data coupled with in situ measurements have been explored previously in the correlation of satellite-derived chlorophyll concentration with river discharge, nitrate load, and hypoxia (Walker and Rabalais, 2006). We investigated the correlation of time series analyses of satellite-derived sea surface temperature (SST) and chlorophyll a concentration with known hypoxia locations from available NOAA SEAMAP cruise data. We assumed that three main predictors could be used successfully to estimate probabilities of hypoxia location and size: change in density, deviation of total Kjeldahl nitrogen from a threshold value, and increased chlorophyll a concentration.

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Applied Science Program
Gulf of Mexico Initiative

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HYPOXIA

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Density Mapping

We used the International Equation of State to calculate density (r), which is dependent on water temperature, salinity and pressure. From water temperature and salinity data collected during cruises within the Mississippi River Plume and off the Louisiana and Texas coast, we calculated and interpolated water-column densities for cruise data spanning 2001 to 2007. After trend analysis of these data, we decided to use mean monthly density values calculated for the bottom of the water column and averaged over the time period of the available temperature and salinity data. We assumed a pressure of zero for depths less than 100 m. For practical application of our estimated bottom densities, we converted r (kg m^{-3}) to s_t, i.e., r - 1000.

For surface density values, we obtained sea surface temperature (SST) from NASA Moderate Resolution Imaging Spectrometer (MODIS) data of 1-km resolution. We used the inverse relationship known to occur between salinity and absorption coefficient of colored dissolved organic matter (CDOM) at 412 nm within river-dominated environments (Del Castillo and Miller, in press) [Equation 1]. We derived a density gradient (Equation 2) from the difference between surface density, calculated from satellite-derived products, and bottom density, calculated from cruise data.

Hypoxia Probability Mapping

The probability scheme we created for predicting hypoxic areas consists of the following three assumptions for any two-month period: density gradient exceeds 4 kg m-3, monthly total Kjeldahl nitrogen (TKN) exceeds mean TKN averaged for that month over 20 years of available USGS data, and chlorophyll a concentration exceeds 20 mg m^{-3}. The probability map, based on data from three consecutive months, is calculated from the following conditions, where P_s equals the probability associated with density anomaly, P_N equals probability associated with TKN, and P_{chl} equals probability associated with chlorophyll a concentration.

We have not yet performed extensive error analyses on these probabilities to determine if they correspond to any of the NOAA point hypoxia measurements collected during the 2007 SEAMAP cruise. Further work for this project includes the addition of satellite wind and ocean color data to investigate organic matter transport for refinement of hypoxia probabilities.

Text talking about the images here....

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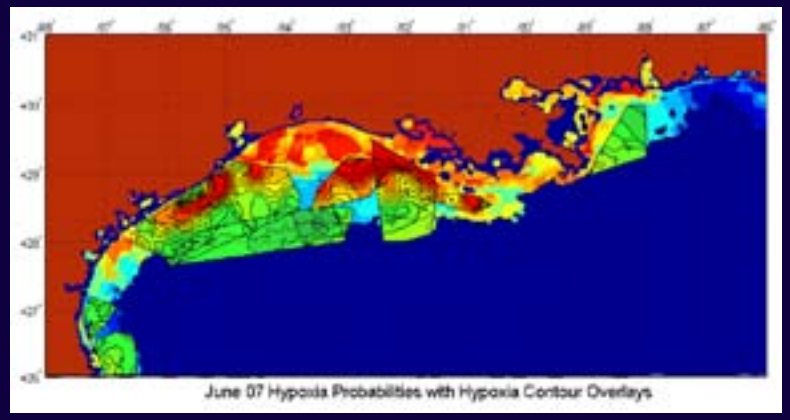
June 07 Hypoxia Probabilities with Hypoxia Contour Overlays

July 2007
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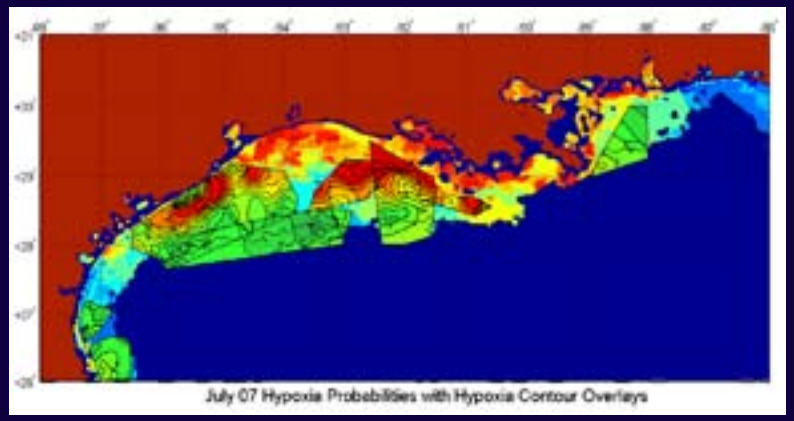
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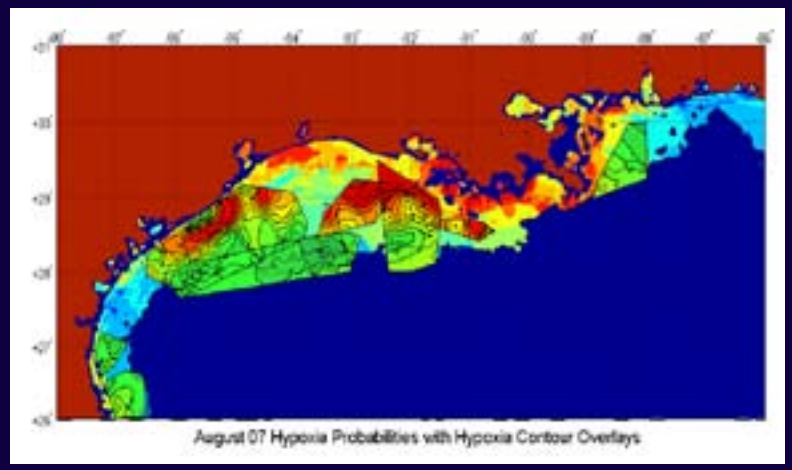
August 07 Hypoxia Probabilities with Hypoxia Contour Overlays