

Remineralization of Hydrocarbon in the northern Gulf of Mexico bottom waters in 2010 Summer – a multi-year data comparison

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Acidification of subsurface coastal waters enhanced by eutrophication

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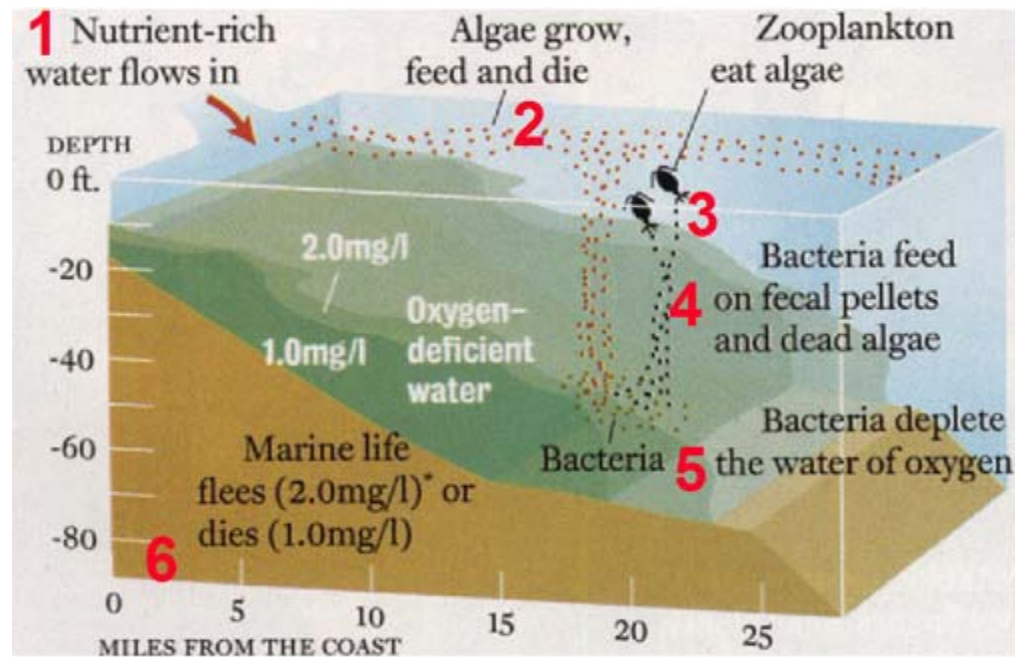
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Nature Geoscience (2011) | doi:10.1038/ngeo1297

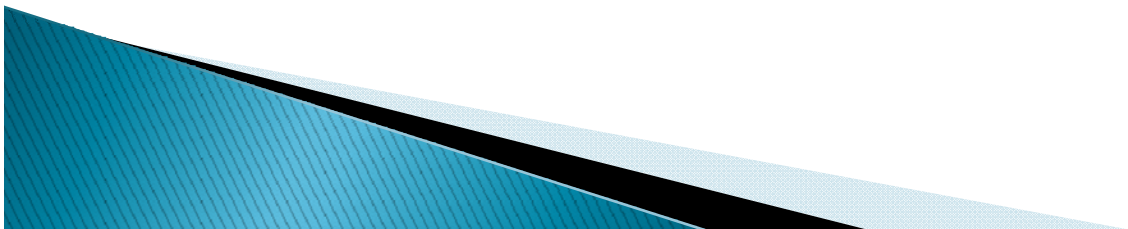
Received 11 April 2011 | Accepted 22 September 2011 | Published online 23 October 2011

A decorative graphic element in the bottom left corner consisting of a blue triangle with a fine grid pattern, a black triangle, and a light blue triangle.

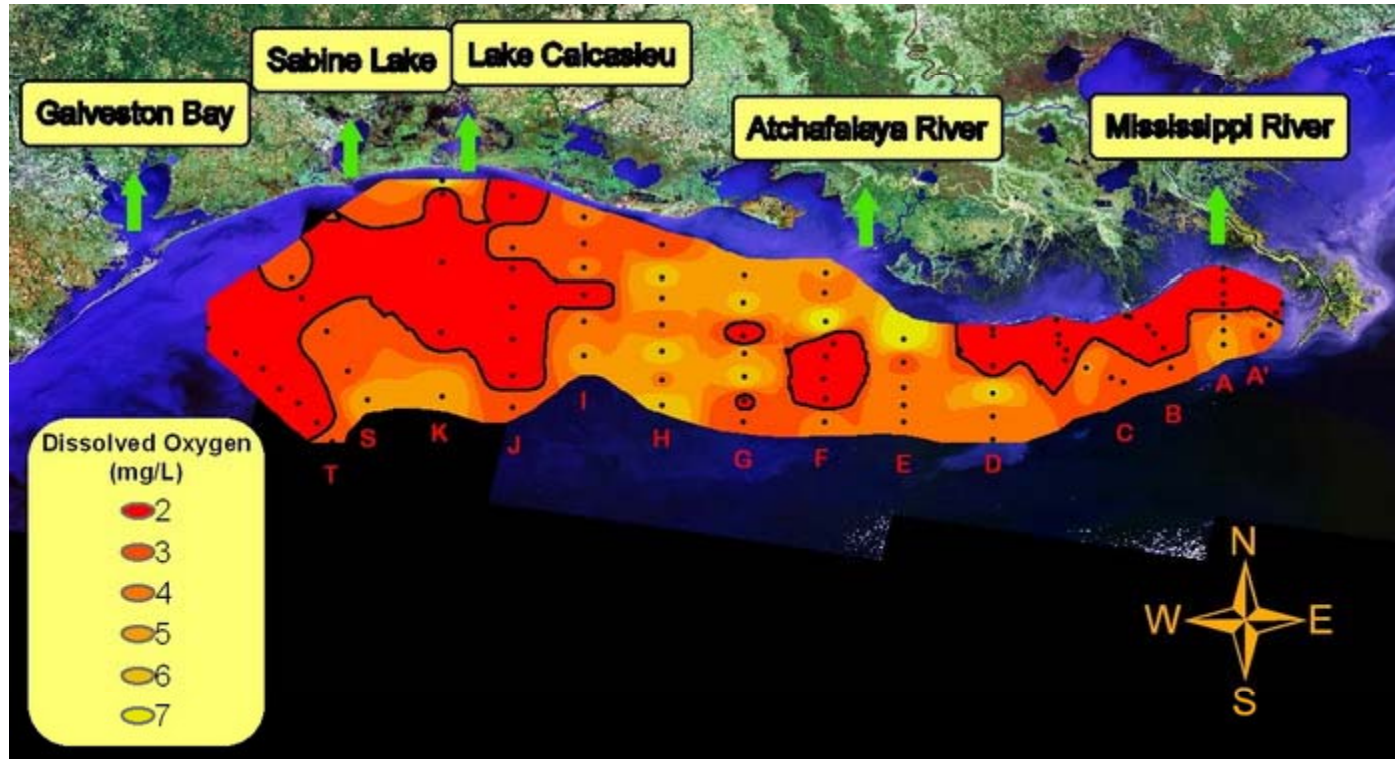
Gulf hypoxia formation mechanism



<http://www.gulfhypoxia.net/>



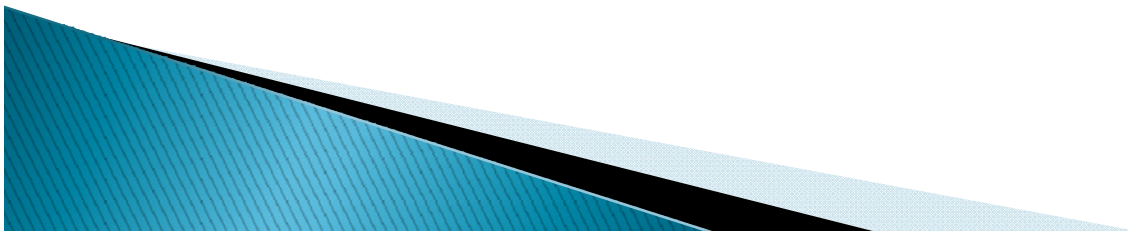
2010 summer hypoxia



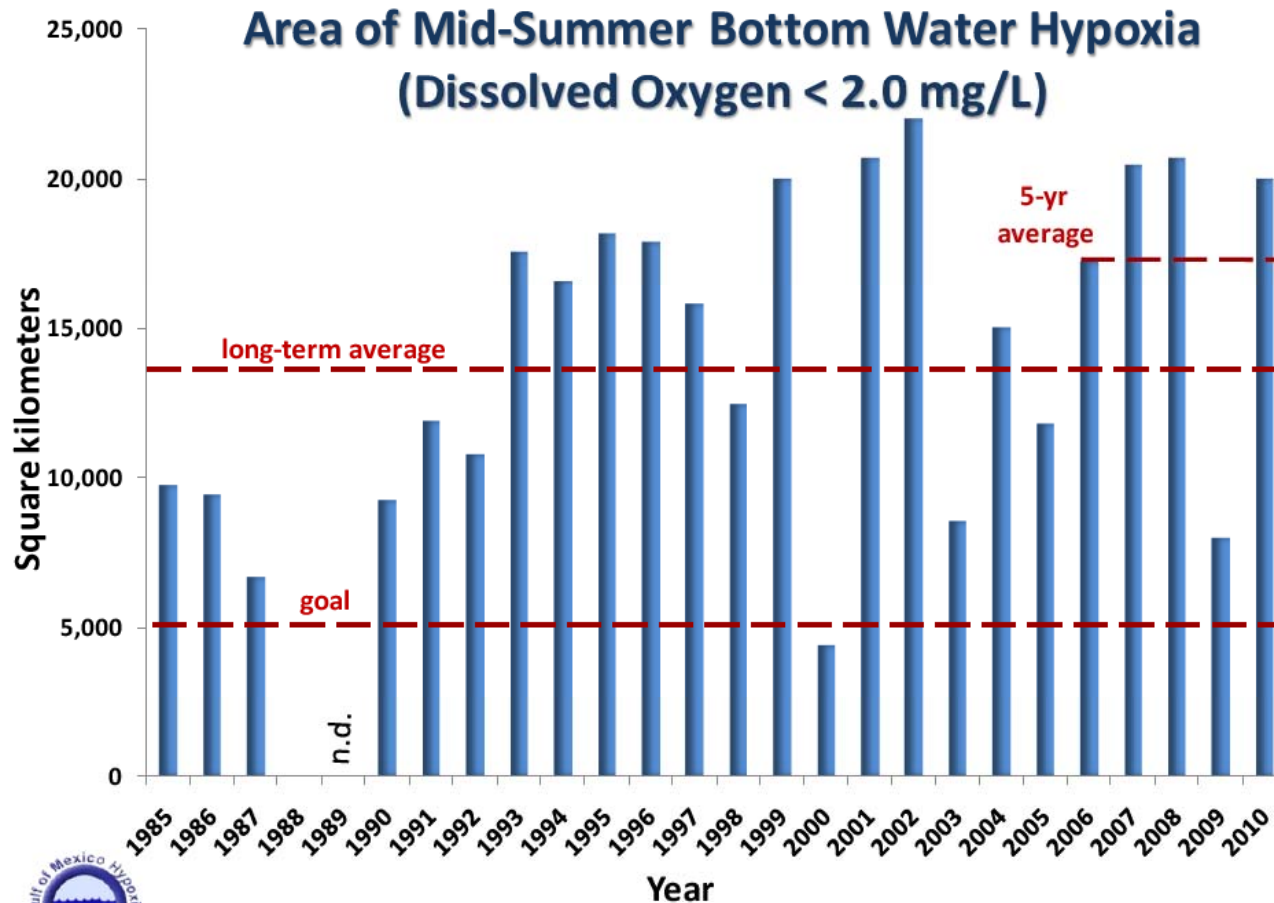
<http://www.gulfhypoxia.net/>

Question:

Did the DWH oil spill contribute to O₂ consumption in shelf waters of the northern Gulf of Mexico in the summer of 2010?



Hypoxic zone record



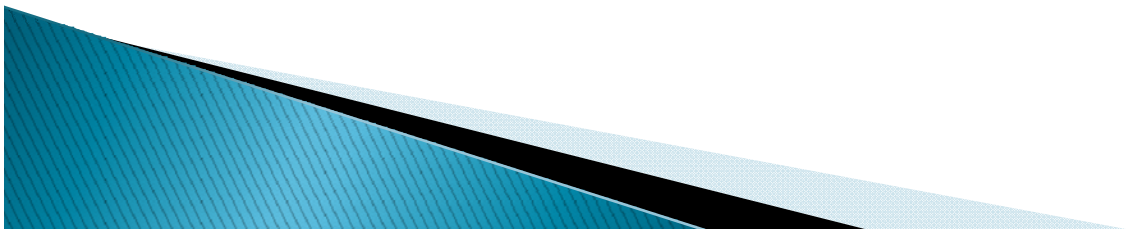
Data source: N.N. Rabalais, Louisiana Universities Marine Consortium, R.E. Turner, Louisiana State University
Funded by: NOAA, Center for Sponsored Coastal Ocean Research

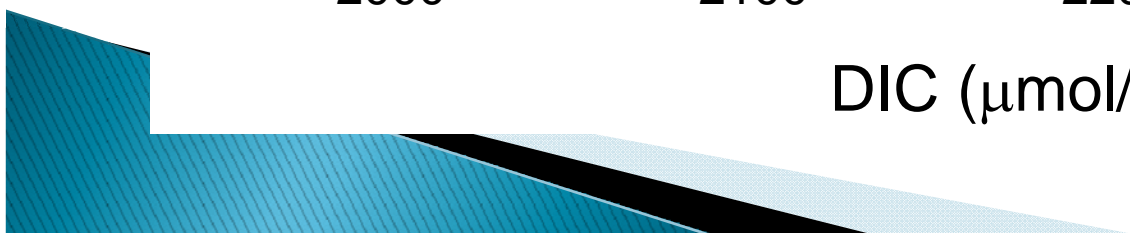
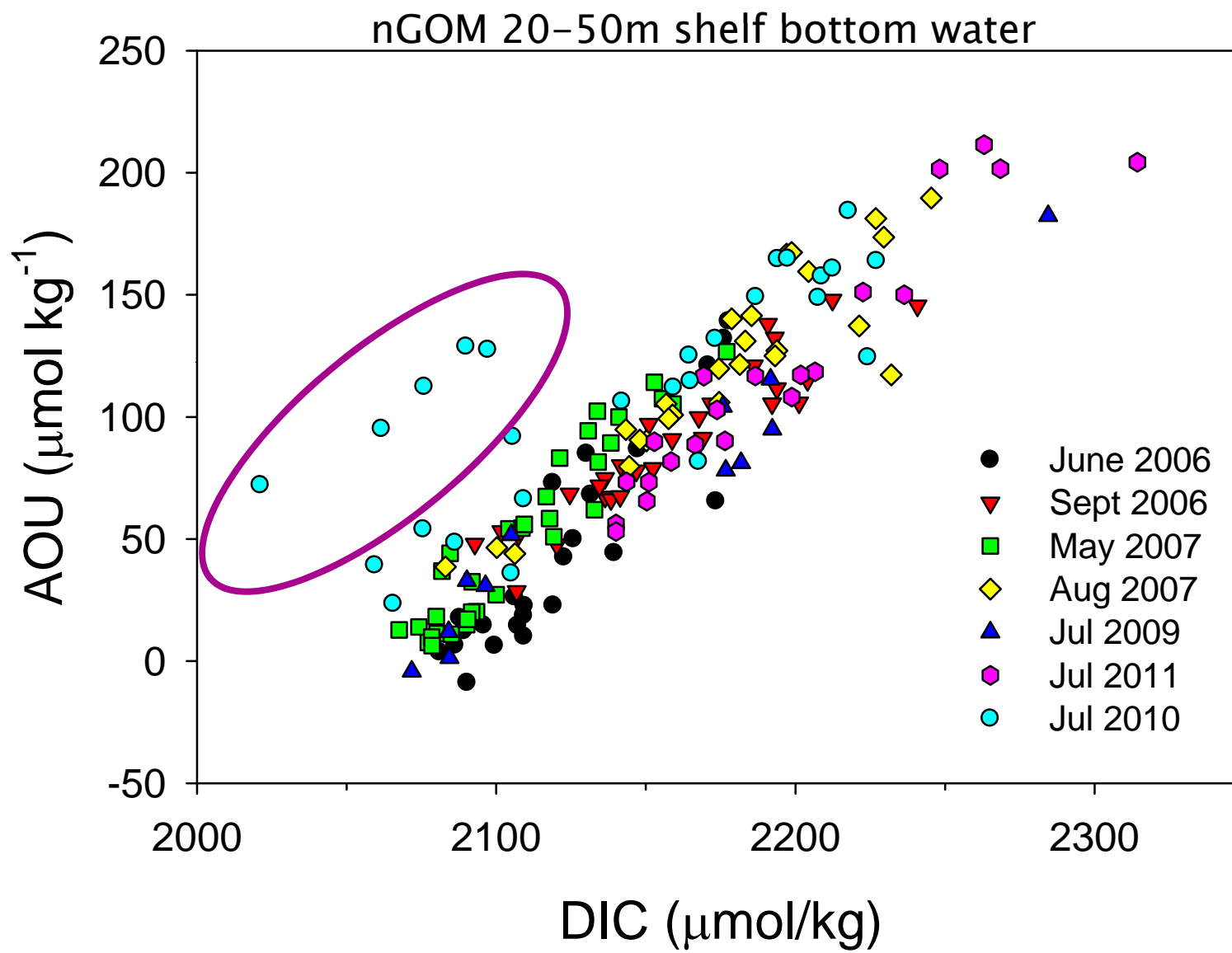
- ▶ The area of Gulf hypoxia was not significantly larger than the 5-yr average

Storm events (Hurricane *Alex*, Tropical Depression *Bonnie*)

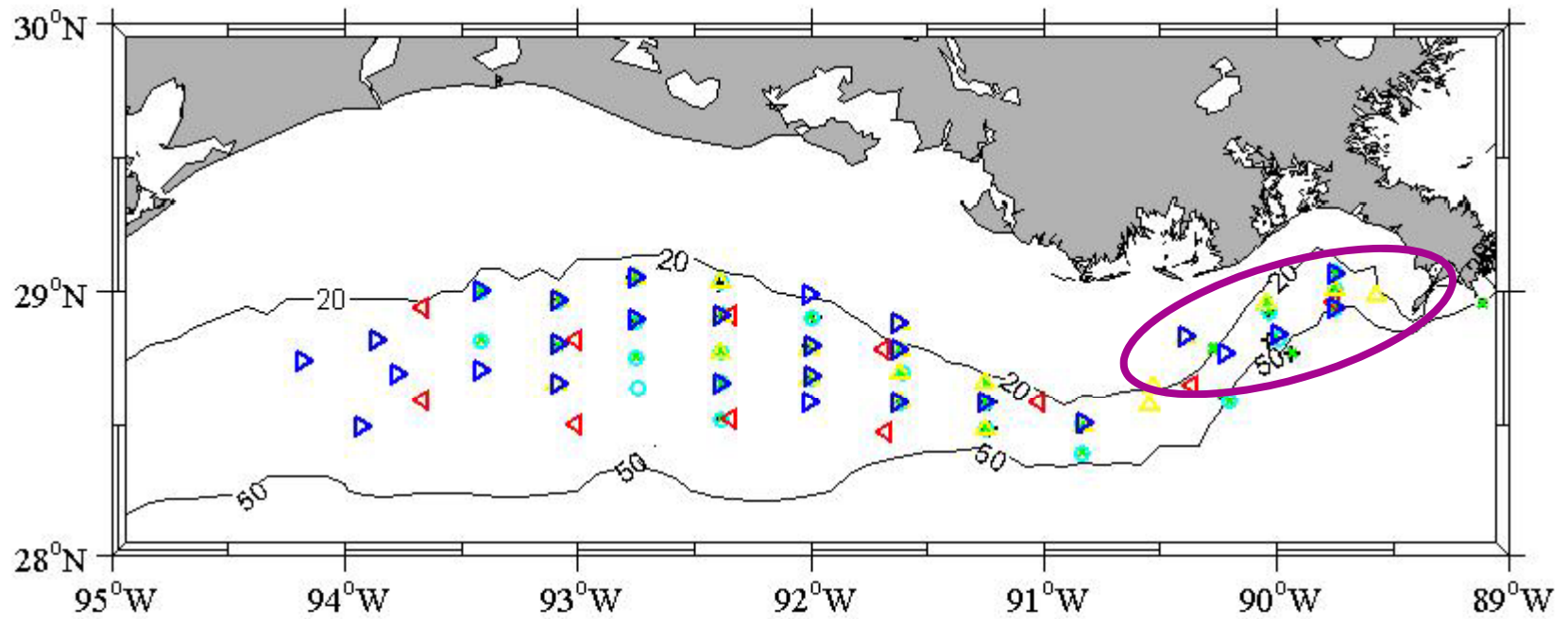
from the river. “It would be difficult to link conditions seen this summer with oil from the BP spill,” said Rabalais, “in either a positive or negative way.” The slicks were not continuous over

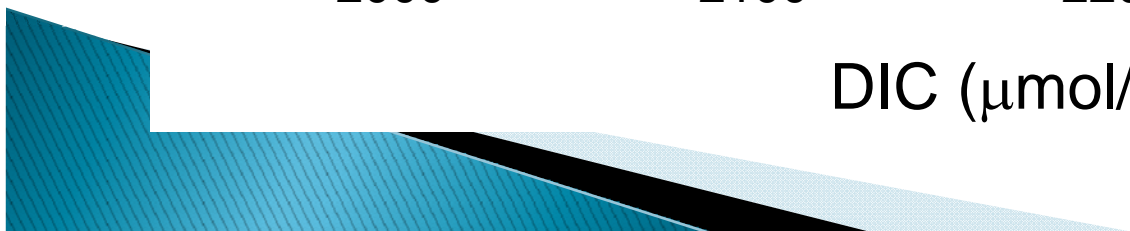
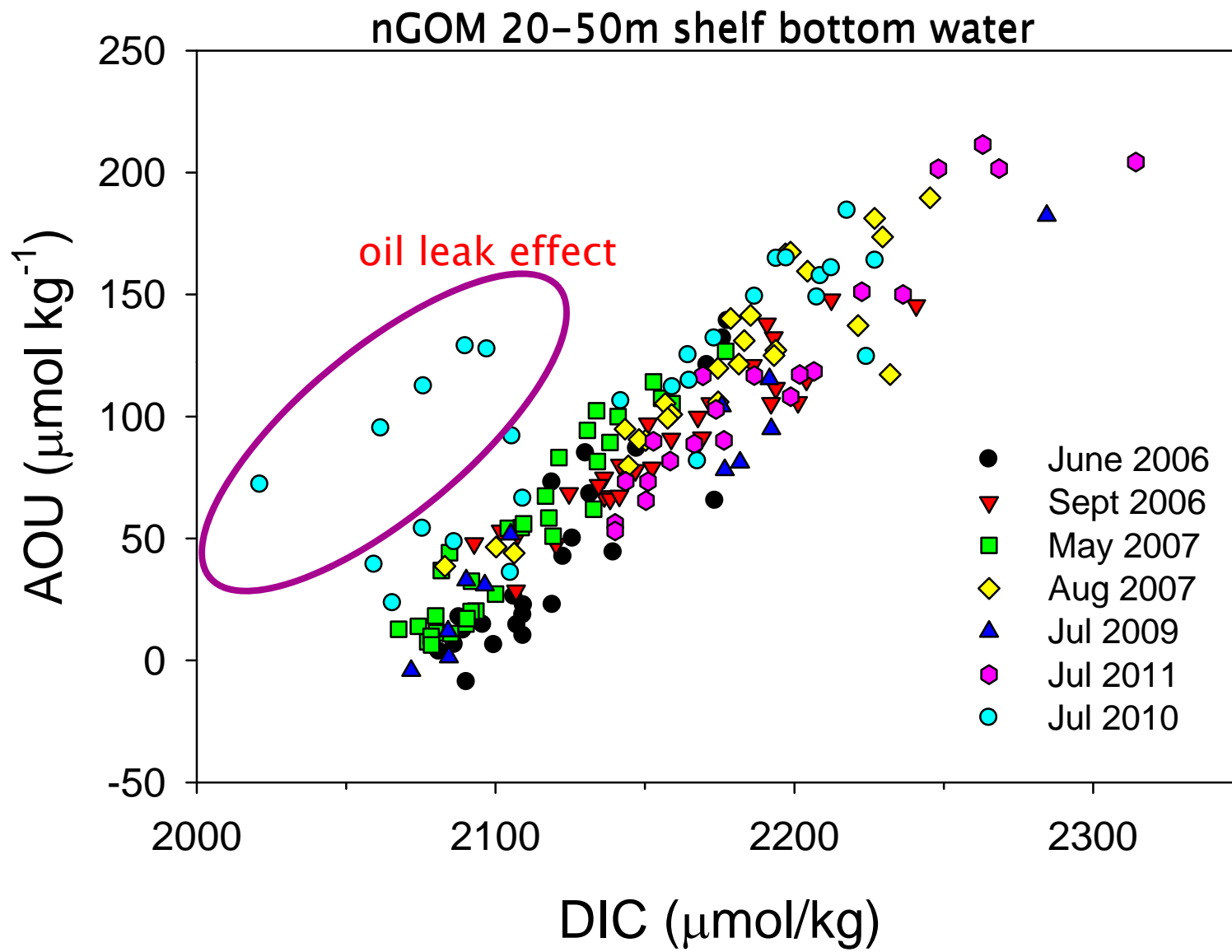
(2010 Gulf Hypoxia Press release, <http://www.gulfhypoxia.net>)





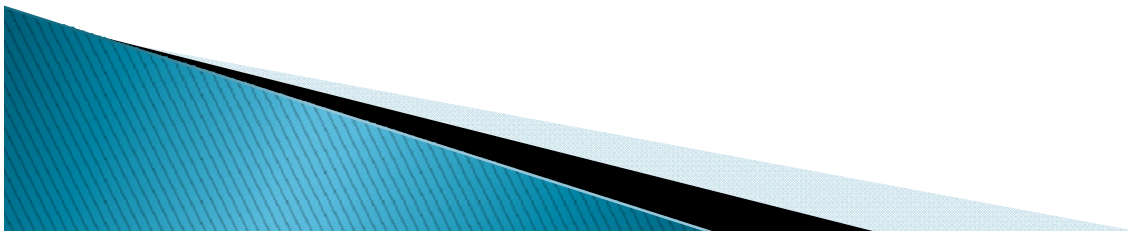
2006–2011 sampling stations (20–50 m)





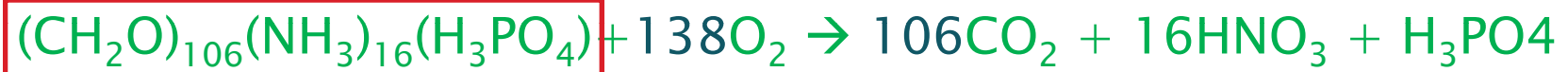
Assumptions

- ▶ Bottom water in the hypoxic zone comes from lateral movement of offshore water
- ▶ During the development of hypoxia, there is no exchange between the atmosphere and the bottom water (i.e., no overturning)



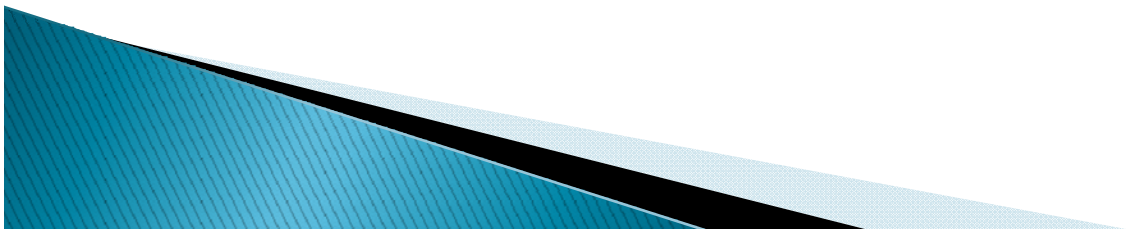
Reaction stoichiometry – marine organic carbon

- ▶ Typical remineralization of marine-produced organic matter (with Redfield composition)



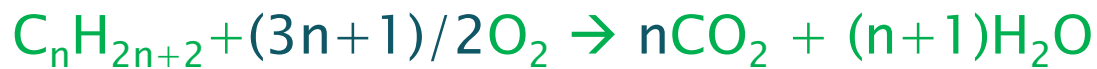
O₂ consumption : CO₂ production
138 : 106

ratio = 1.3



Reaction stoichiometry – hydrocarbon

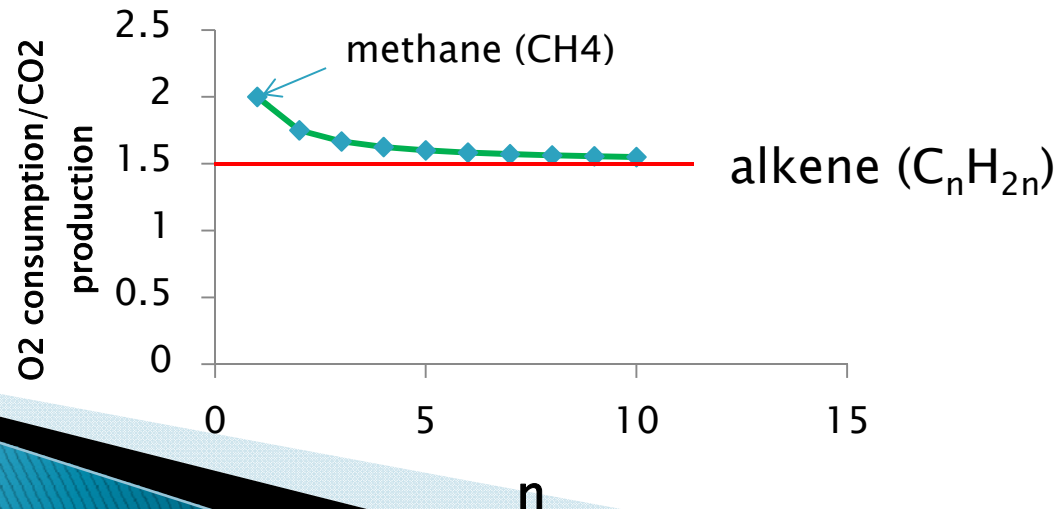
- ▶ Remineralization of alkane (C_nH_{2n+2}) and alkene (C_nH_{2n}) – major components of petroleum



O_2 consumption : CO_2 production

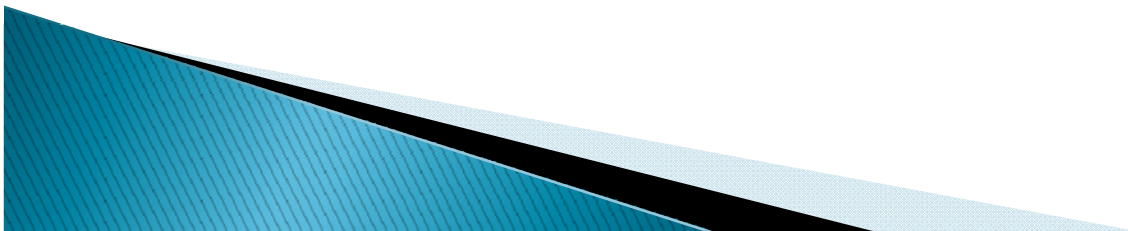
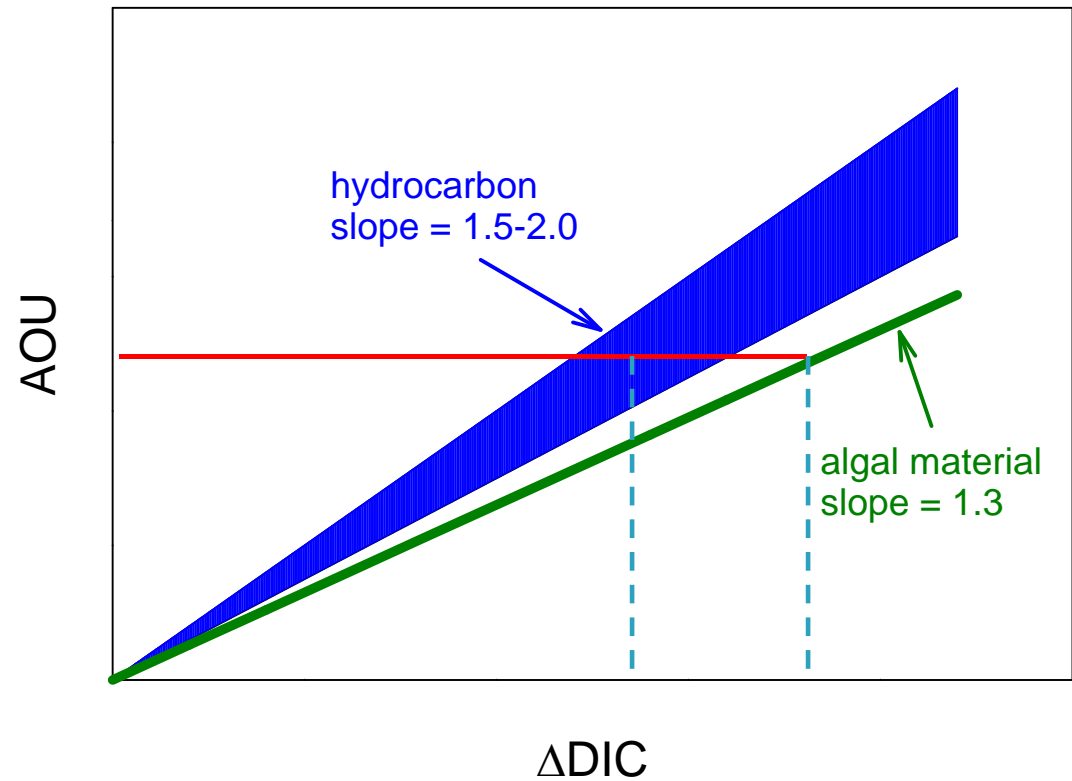
$$(3n+1)/2 \quad : \quad n \quad = \quad 1.5 \sim 2 \quad (\text{alkane})$$

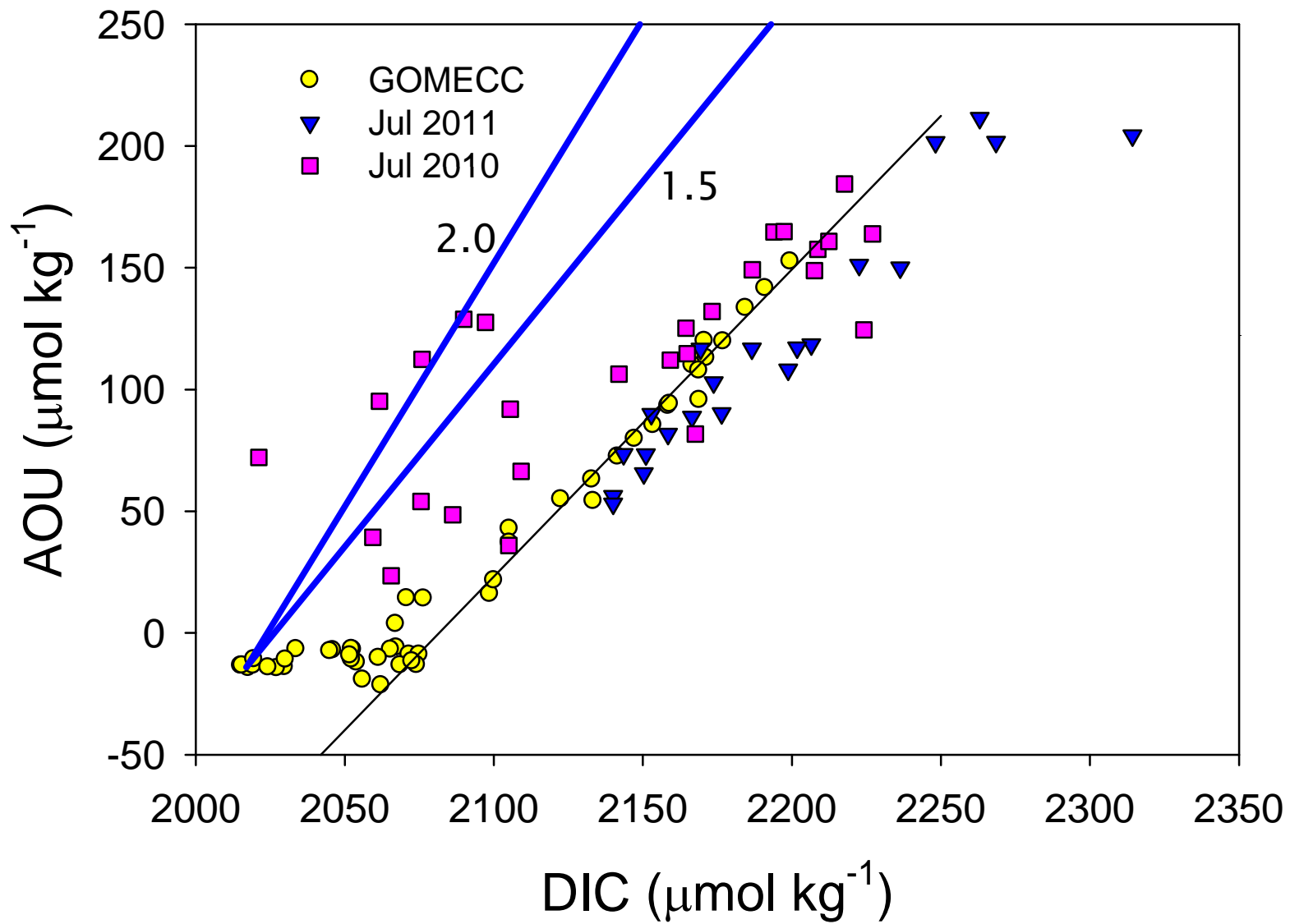
$$3n/2 \quad : \quad n \quad = \quad 1.5 \quad (\text{alkene})$$



Difference in reaction stoichiometry

With the same amount of oxygen consumption, DIC production from remineralization of hydrocarbon is **smaller!**





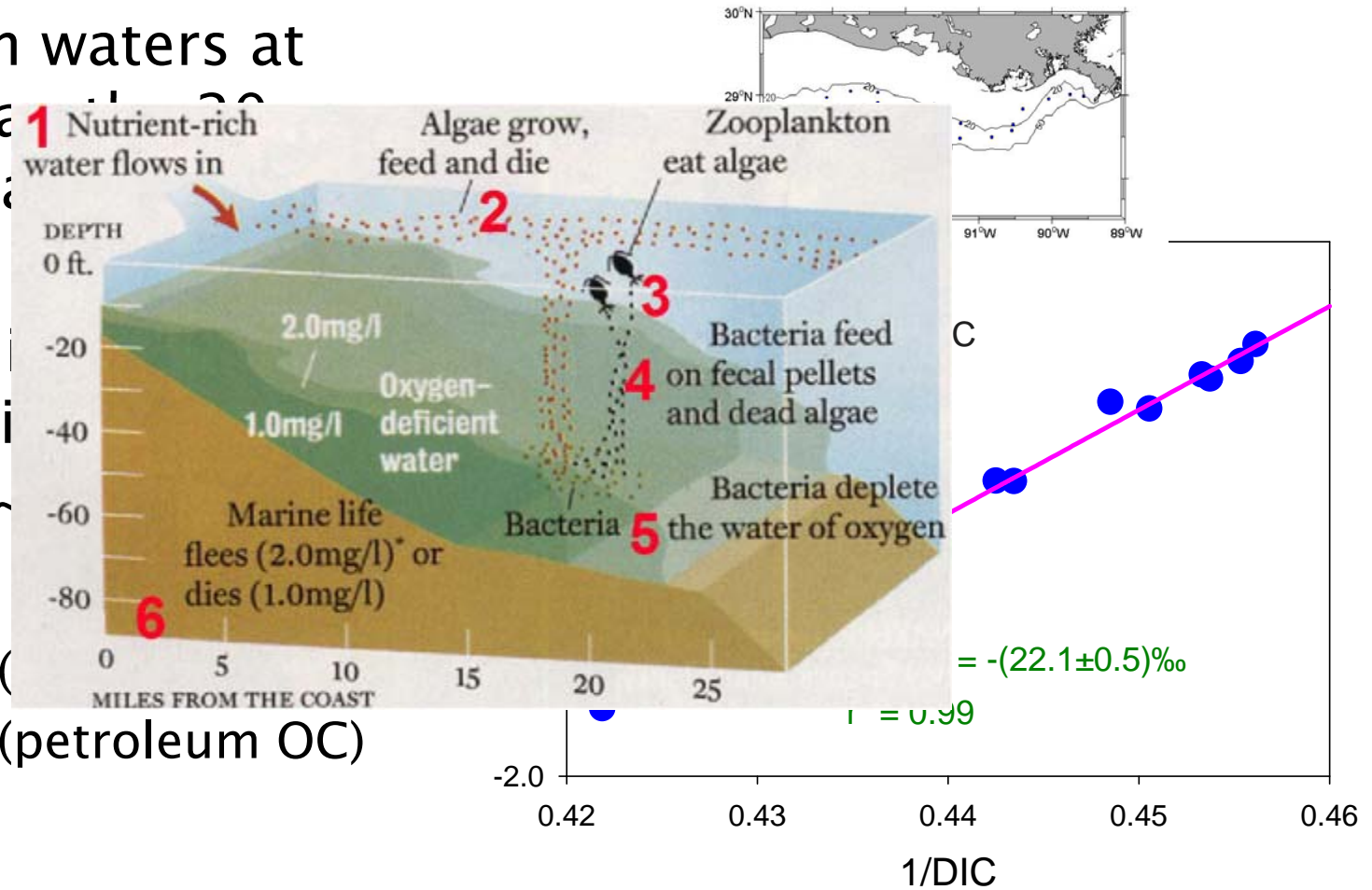
2011 hypoxic bottom water– organic carbon source

All bottom waters at deeper than 20m isobath (S)

Remineralized likely marine (typically ~

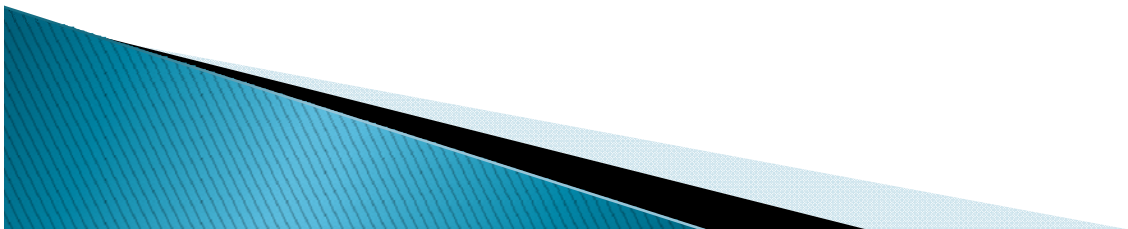
-28~-30‰ (

-40~-60‰ (petroleum OC)



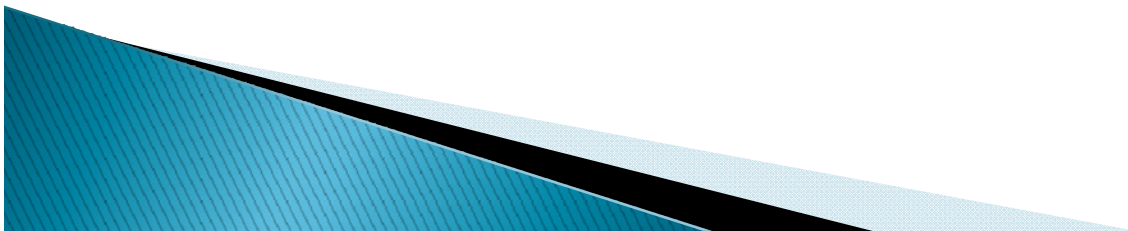
Implications

- ▶ Hydrocarbon remineralization did occur in the nGOM shelf waters following the DWH event
- ▶ Reaction stoichiometry is a useful tool to examine the effect of oil spill on the ocean waters, especially when multi-year data are compared
- ▶ Currently, there was no indication of petroleum hydrocarbon remineralization in the 20–50 m depth band in July 2011, primary driving force for oxygen consumption remains remineralization of algal material ($\delta^{13}\text{C}_{\text{OM}} = -22\text{‰}$)
- ▶ Water column data do not necessarily reflect potential impact of oil contamination/remineralization in coastal/shelf sediments, and shallower depth (<20 m).



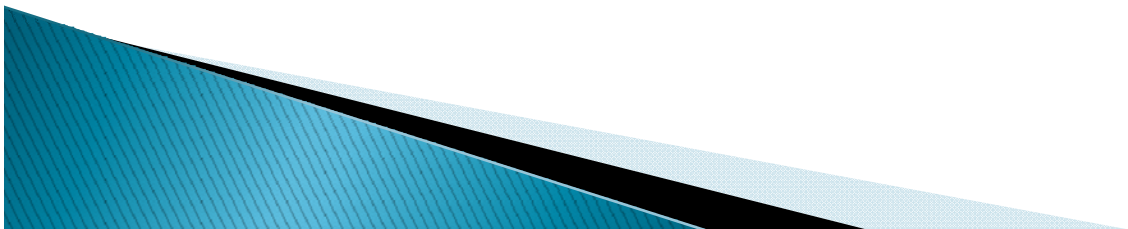
To be analyzed...

water samples from near the oil leak site...



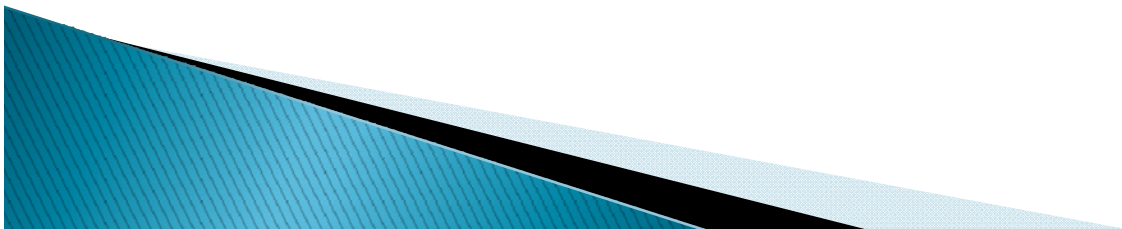
Advertisement (UGA carbon cycle lab)

1. High precision instruments in characterizing seawater inorganic carbon system (DIC, alkalinity, pH)
2. Underway $p\text{CO}_2$ for survey of sea surface CO_2 partial pressure
3. Microelectrochemical sensors for sediment studies

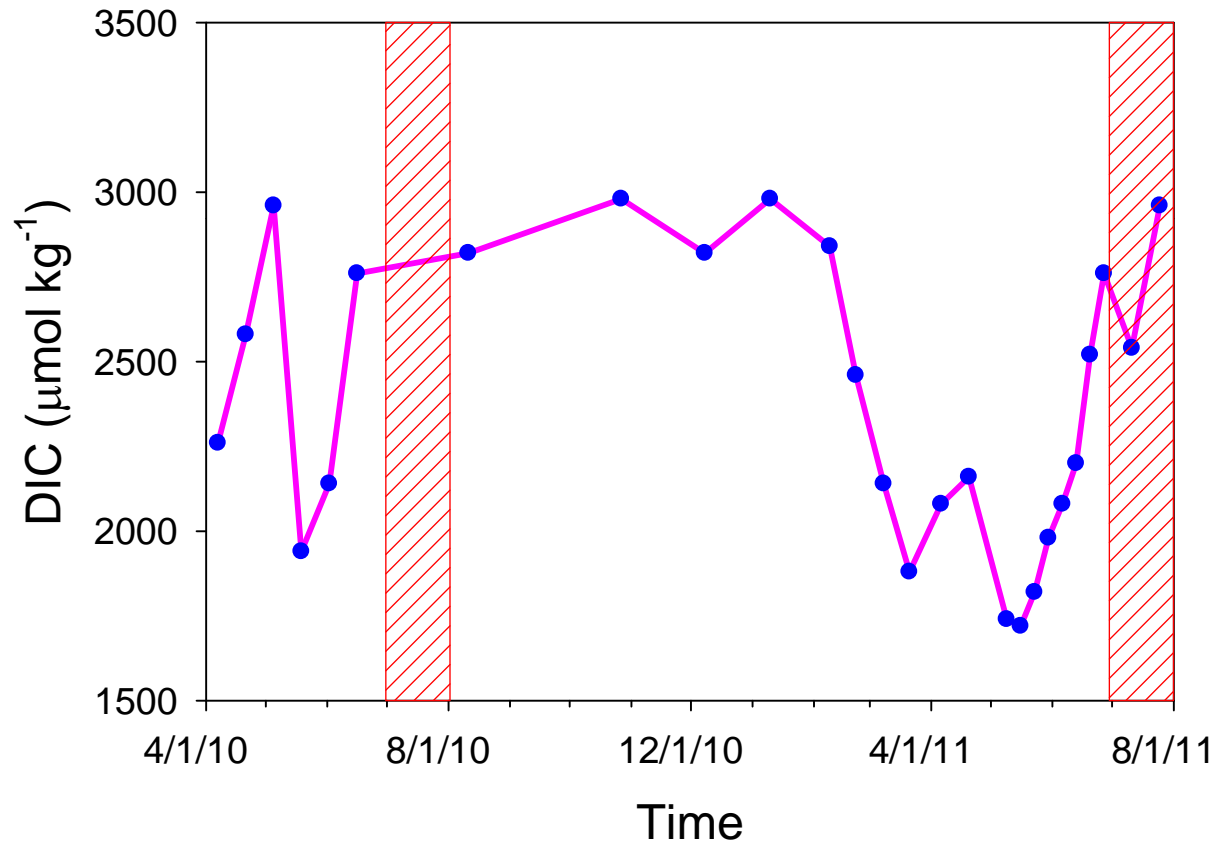


Acknowledgements

- ▶ Wei-Jen Huang, Yongchen Wang, Guirong Han, Baoshan Chen, Qian Li (UGA)
- ▶ Mandy Joye (UGA)
- ▶ Steve Lohrenz, Kjell Gunderson, and Alan Shiller (USM)
- ▶ Mike Murrell, John Lehrter, Jim Hagy (EPA Gulf Ecology Division)
- ▶ Steve DiMarco (TAMU)
- ▶ Lora Pride and Windy Morrison (LUMCON)
- ▶ Chris Langdon (RSMAS)
- ▶ Rik Wanninkhof, Tsung-Hung Peng (AOML/NOAA)
- ▶ Jay Brandes (SkIO)
- ▶ *OSV Bold* (EPA), *R/V Cape Hatteras*, *R/V Pelican*, and *R/V Ron Brown*
- ▶ Gulf of Mexico and US East Coast Carbon (GOMECC) Project

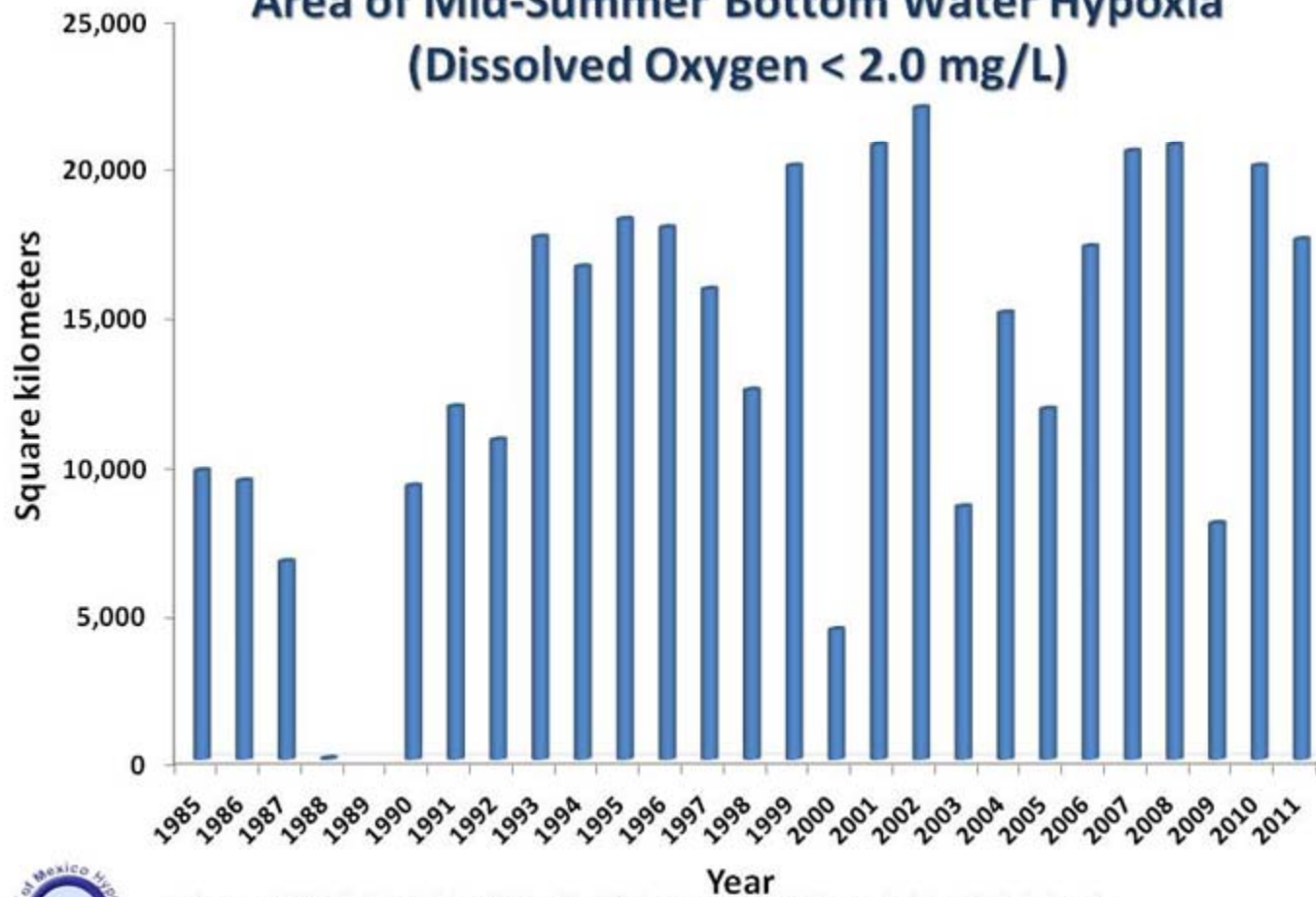


Mississippi River DIC time-series



<http://nwis.waterdata.usgs.gov/usa/nwis/qwdata>

Area of Mid-Summer Bottom Water Hypoxia (Dissolved Oxygen < 2.0 mg/L)



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