Estuaries in a Changing World
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Dynamics of CO_2 system and community metabolism in the Mississippi plume

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OCEAN CARBON GROUP 厦门大学海洋碳循环研究组

Outline

- Background-Why Mississippi plume
- Our Result

  Carbonate System (DIC, TAlk, pH, pCO_2)

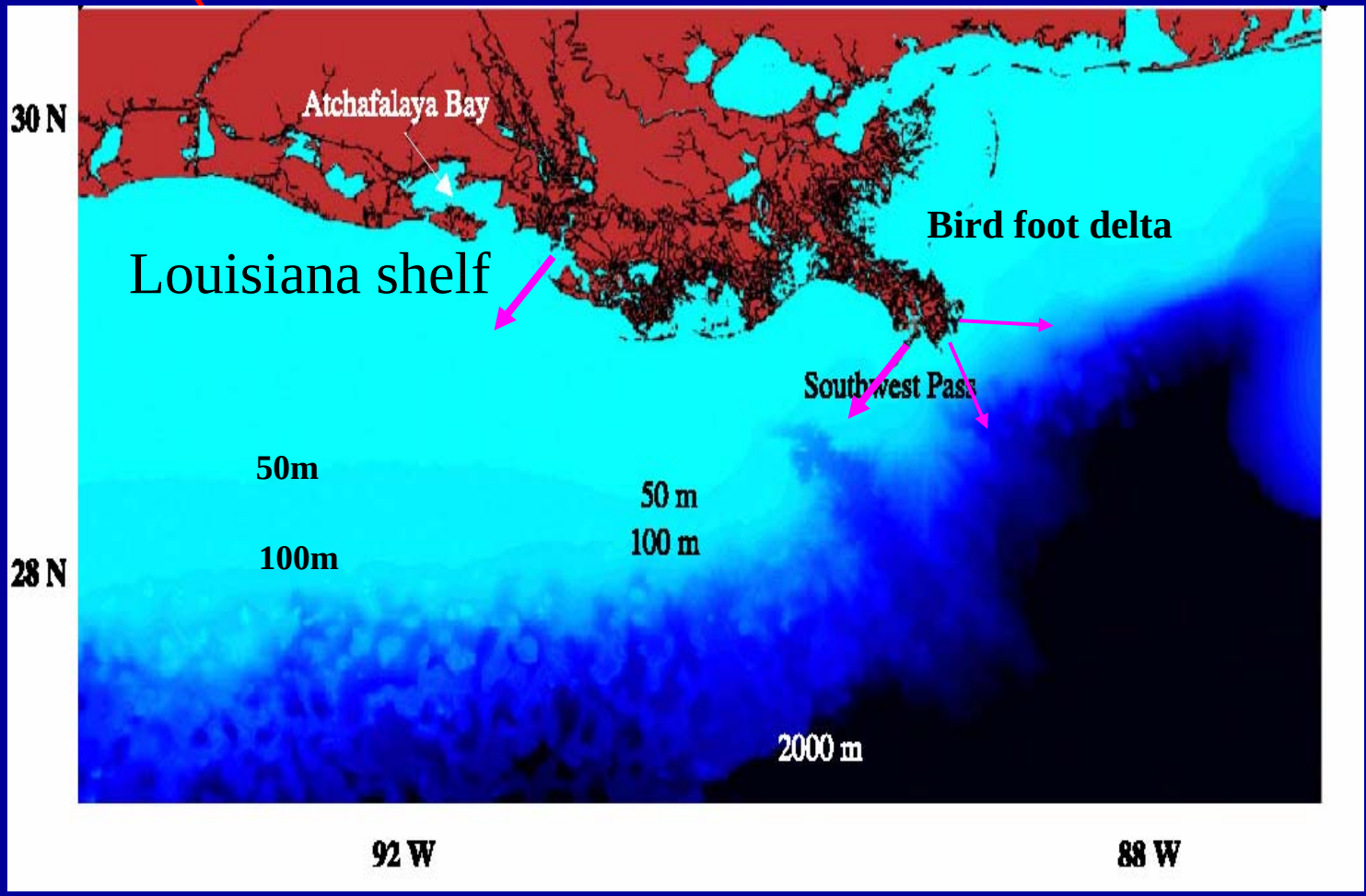
  Net Community Production (from DIC and TAlk)

- Summary

Why Mississippi plume ?

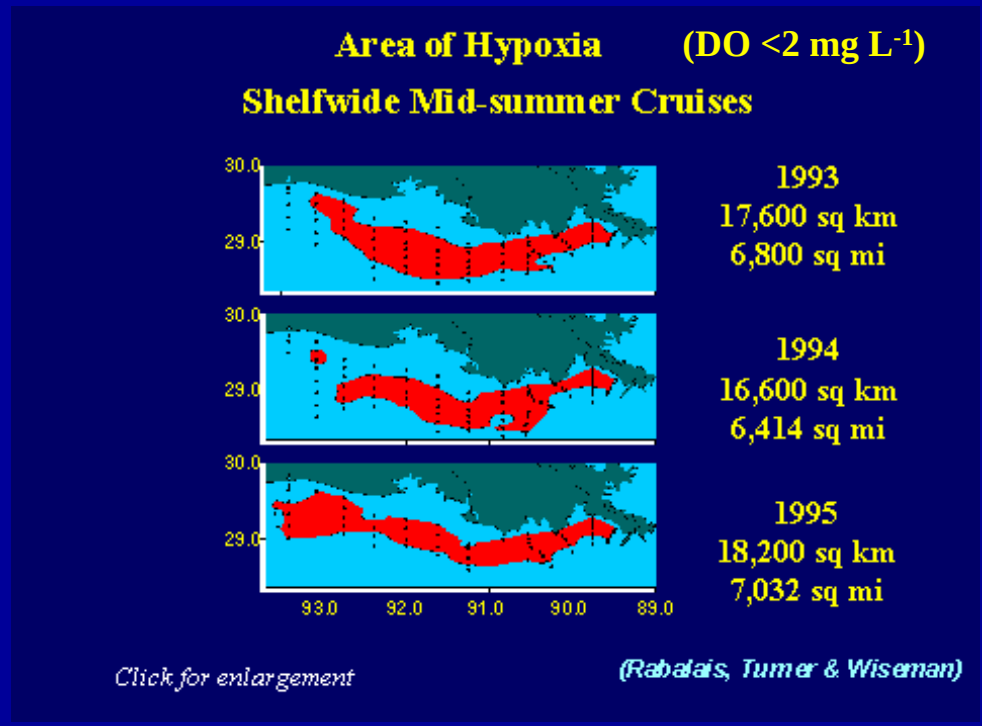
Mississippi basin

Mississippi & Gulf of Mexico



Hypoxia in Gulf of Mexico

Spring-later summer



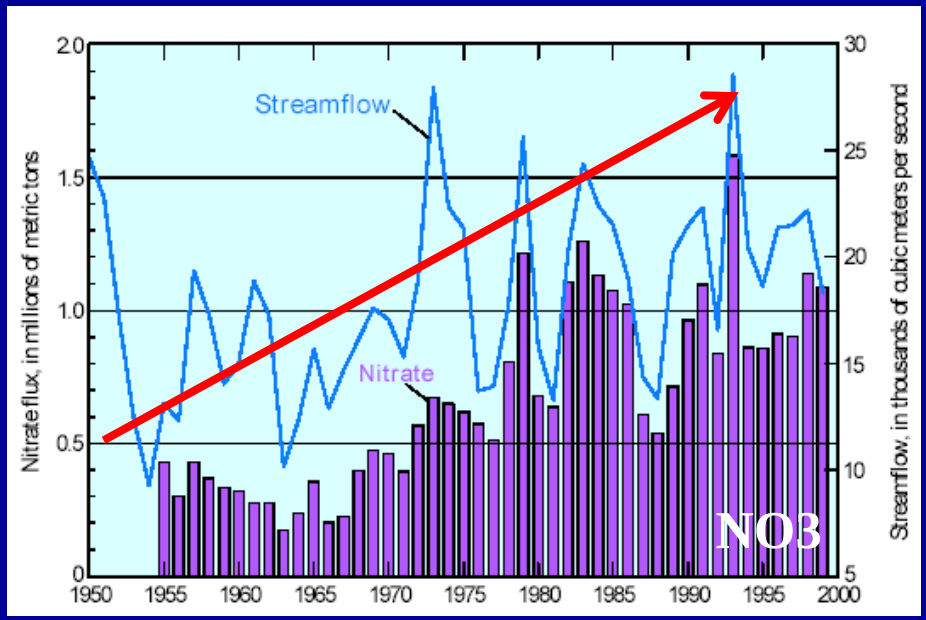
http://www.ncat.org

Louisiana inner shelf

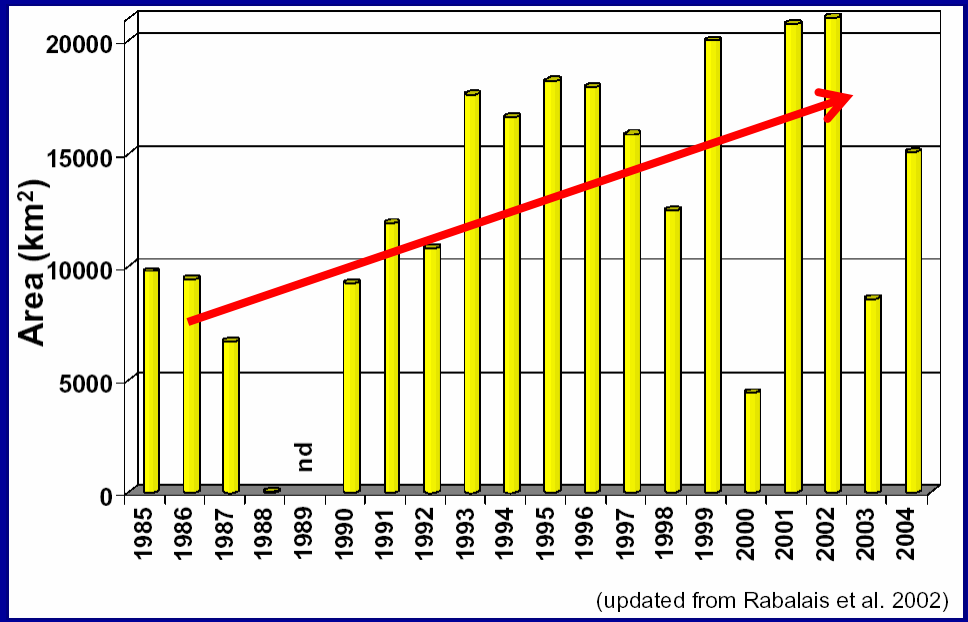
Mississippi-Atchafalaya plume

Hypoxia & Nutrients input

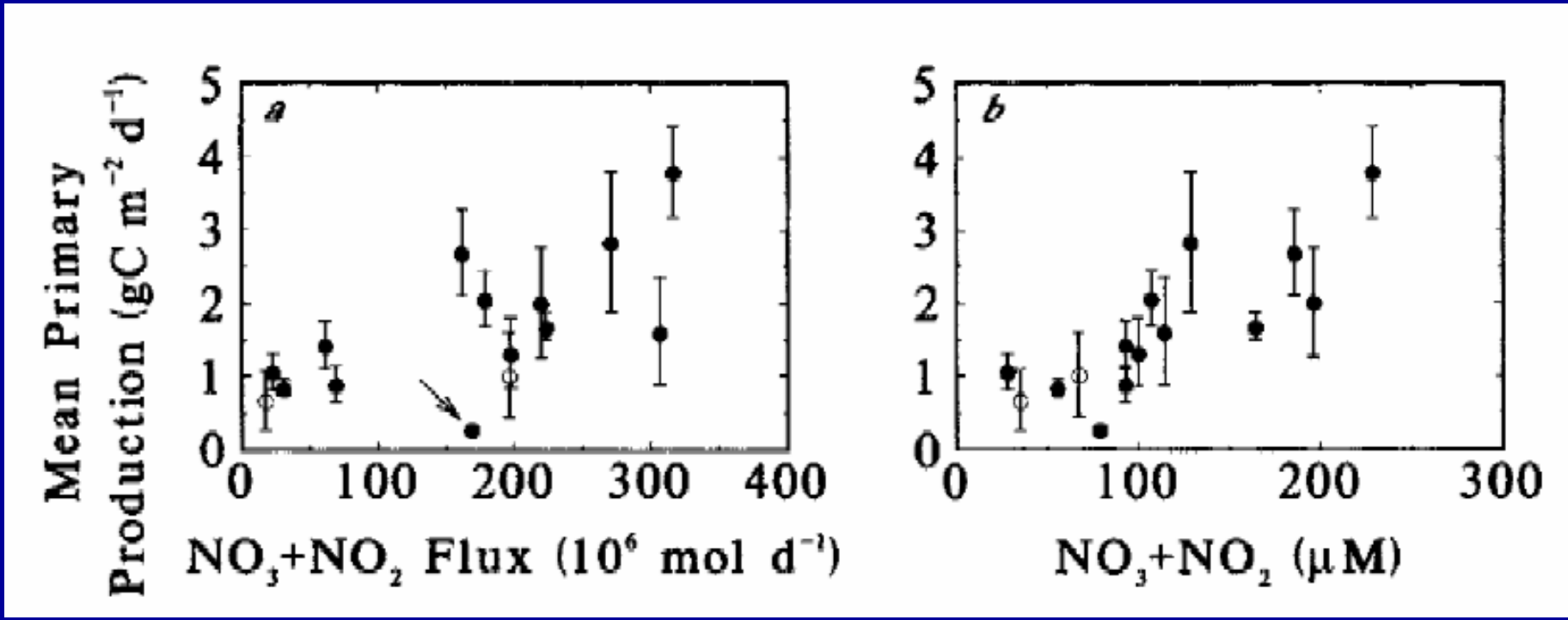
Increasing nutrients input



Increasing hypoxic zone

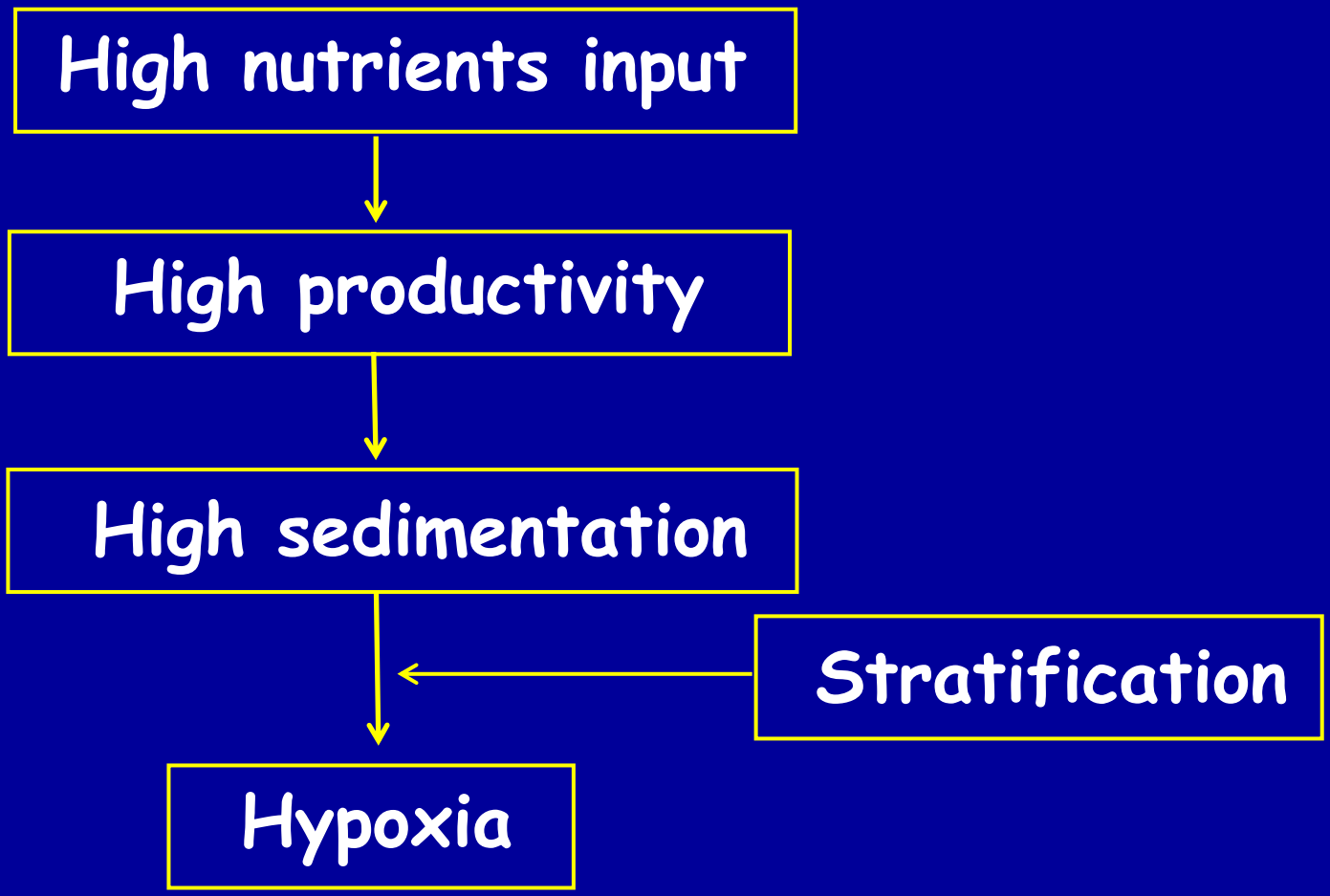


Productivity vs Nutrients



(Lohrenz et al. 1997)

Possible Maintaining Mechanism

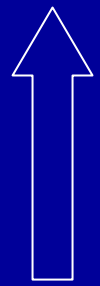


(Lohrenz et al. 1997; Justic et al. 1993)

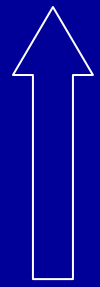
Mississippi plume provides enough labile OC for demand of the hypoxia?

—Big question

Quantify the labile organic carbon produced in the plume



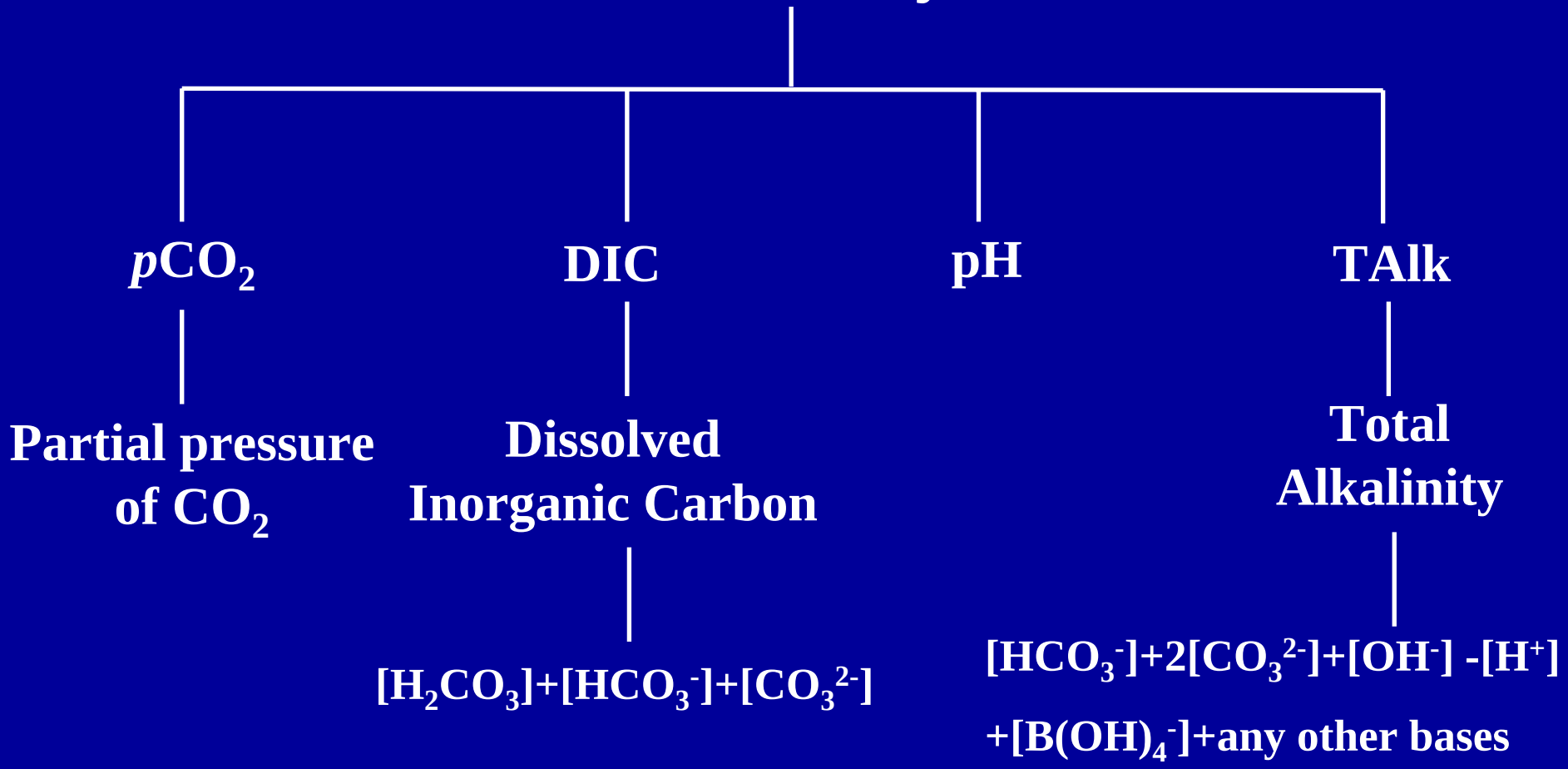
Net Community Production



Carbonate System

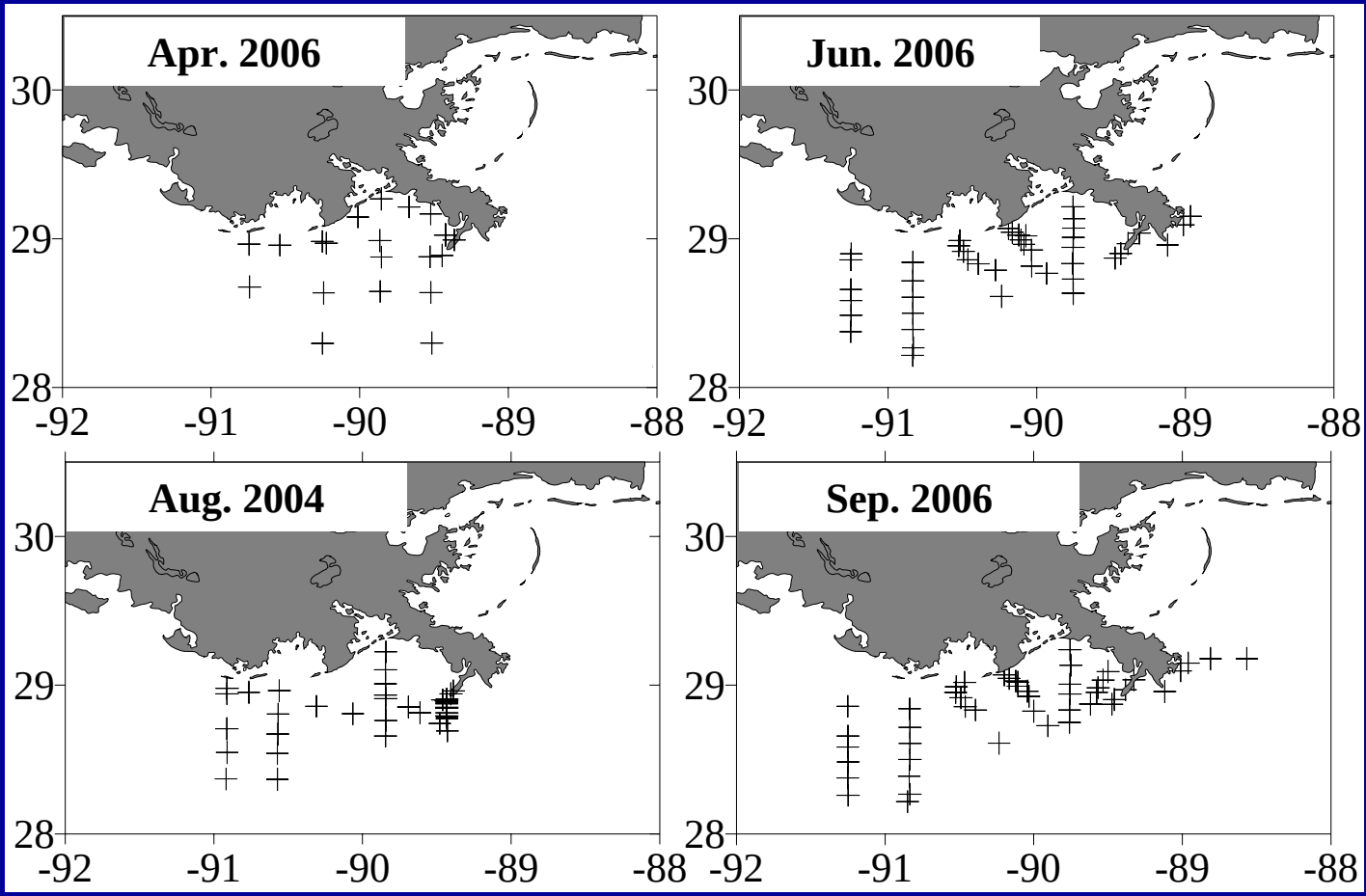
(DIC and TAlk)

Carbonate system

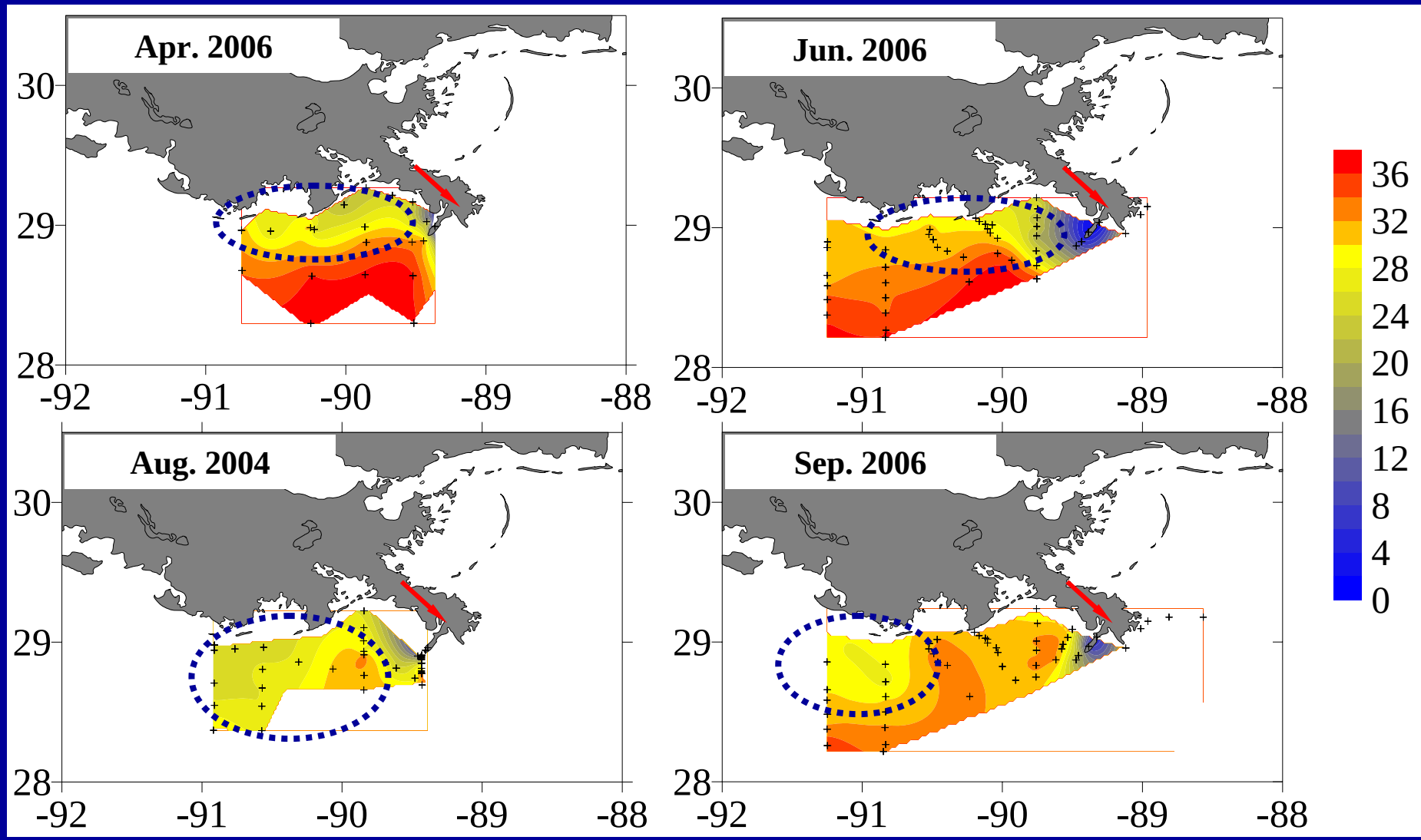


Our Research

Sampling stations



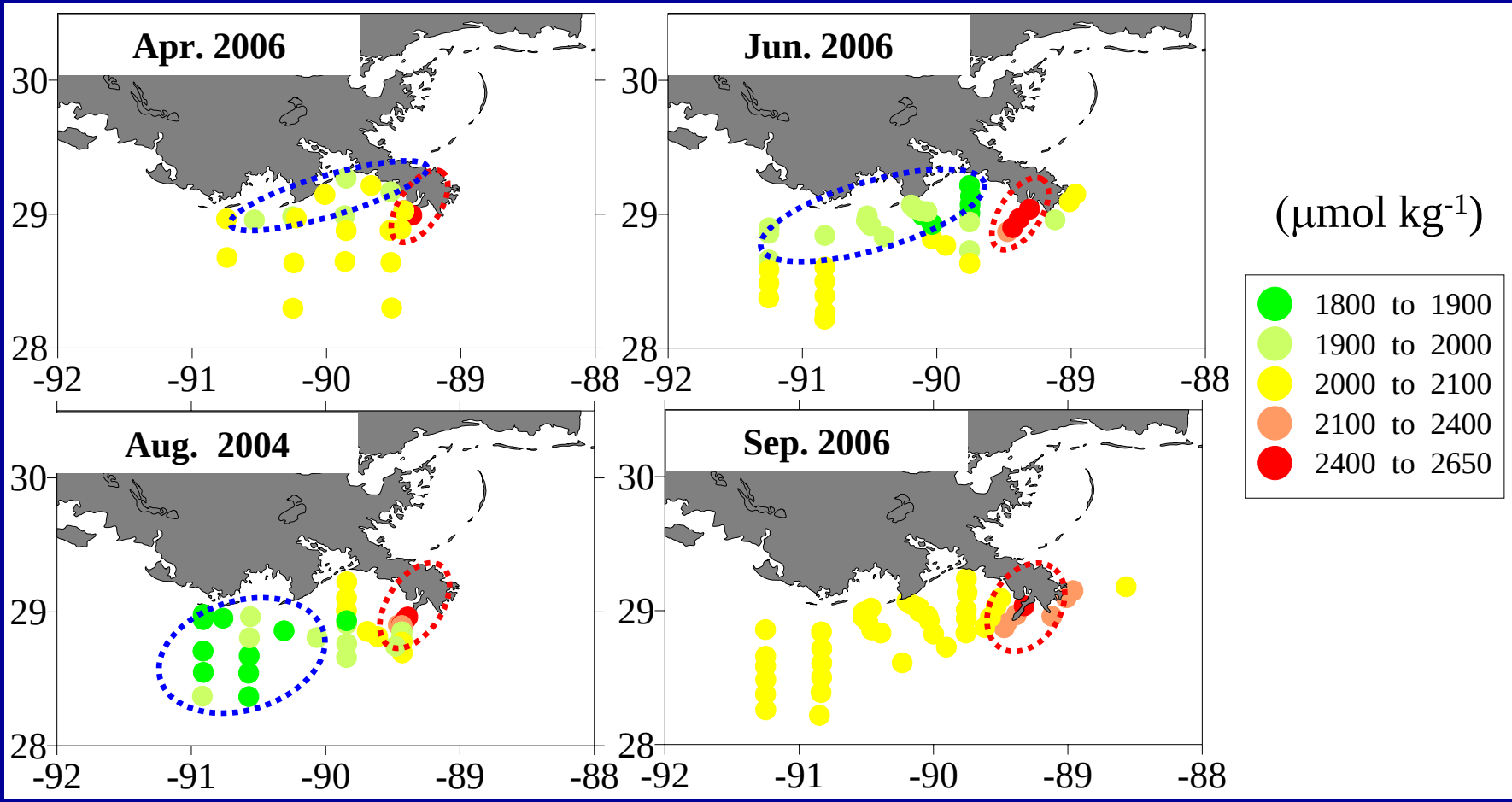
Salinity distribution



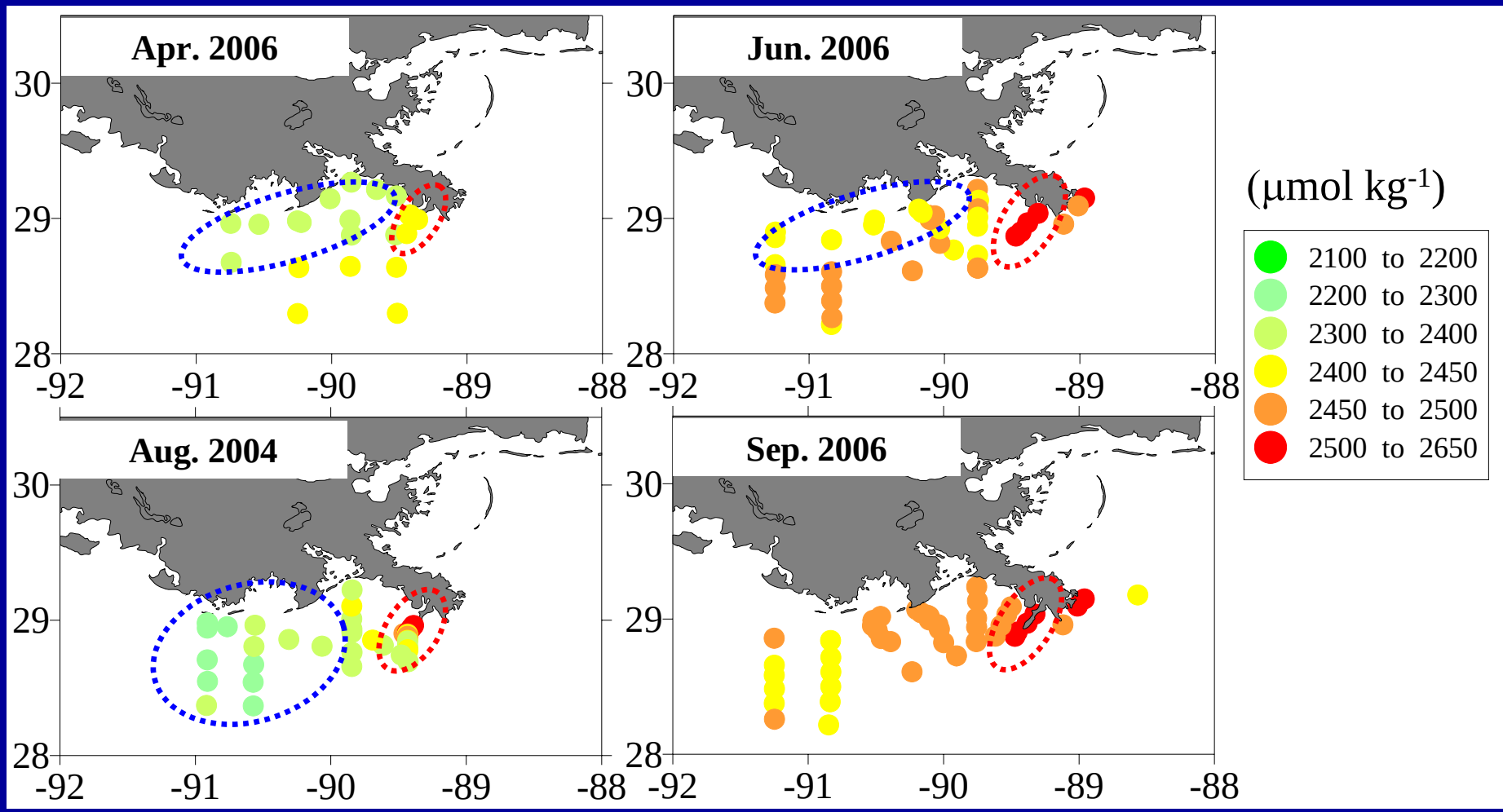
Carbonate system

1 Spatial distribution

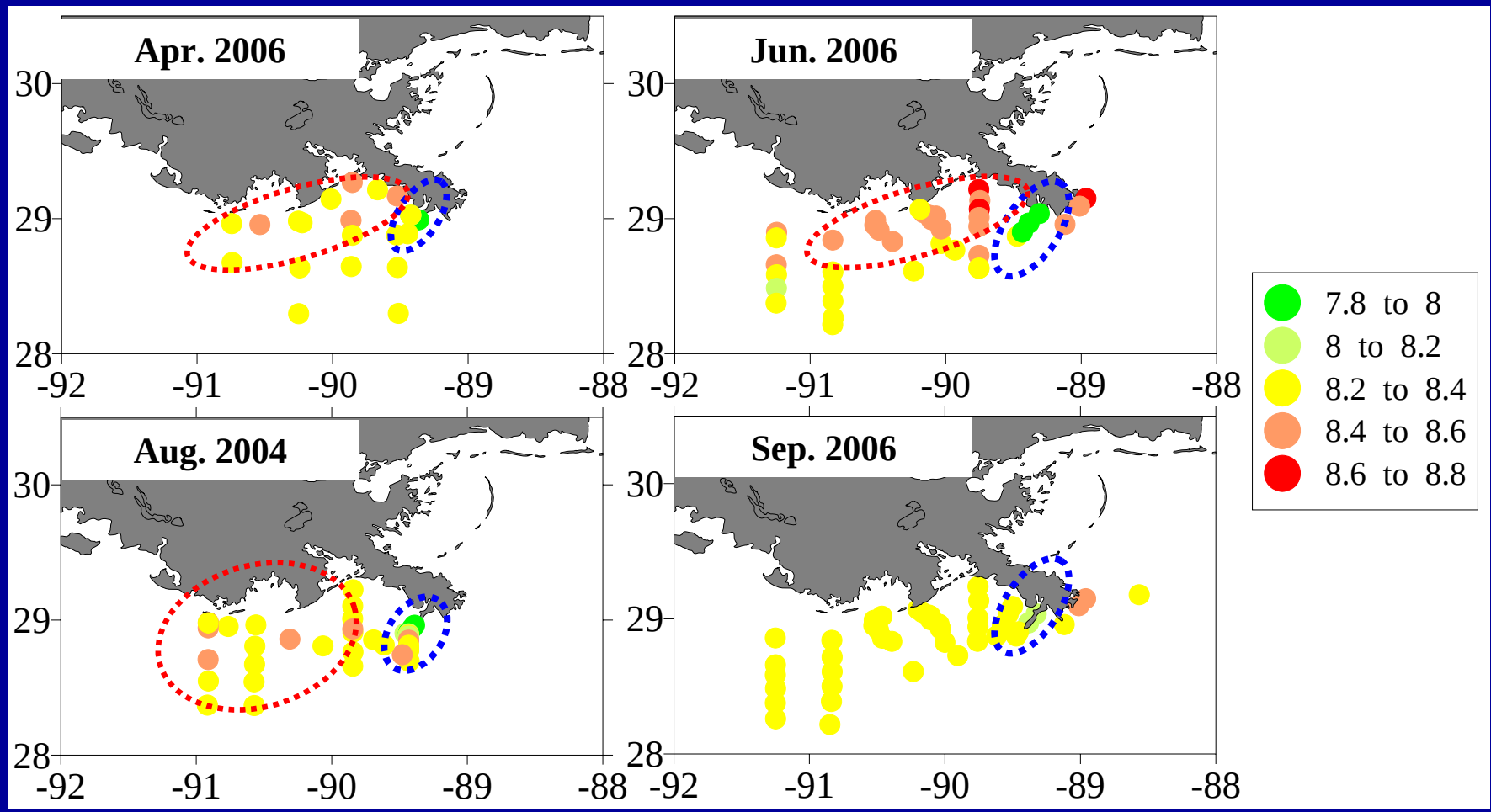
DIC distribution



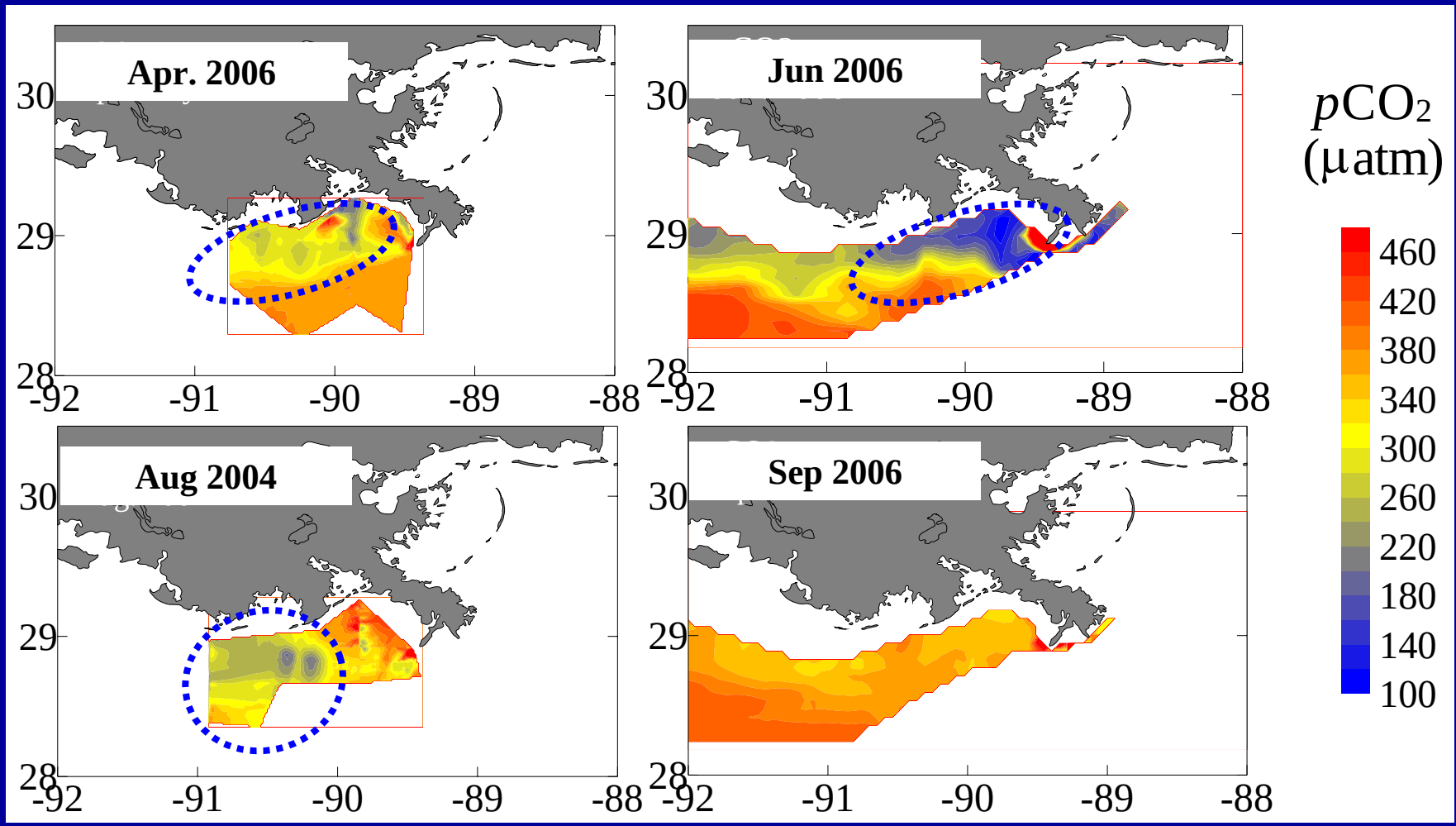
TAlk distribution



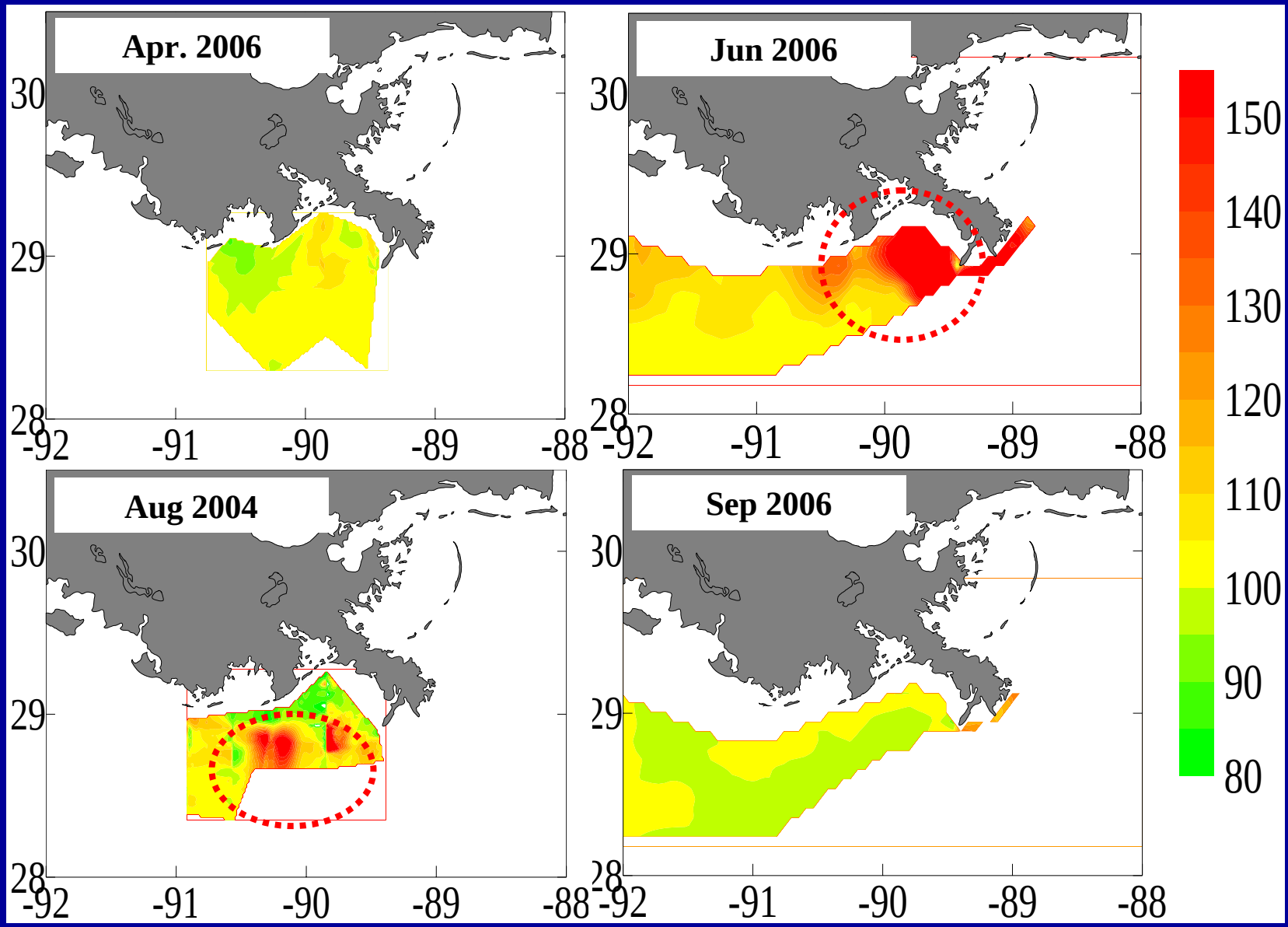
pH distribution



pCO_2 distribution



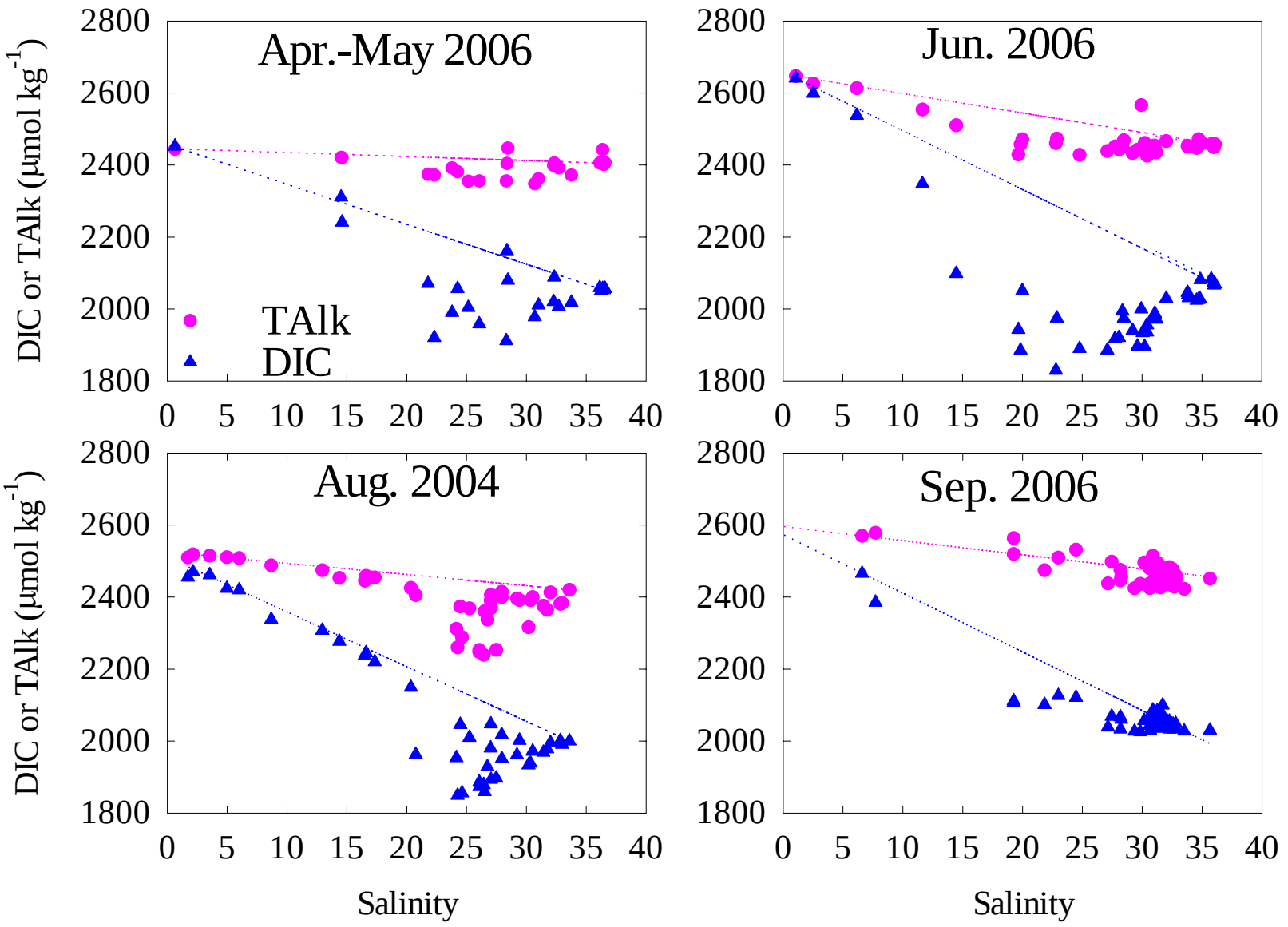
DO saturation (%) distribution



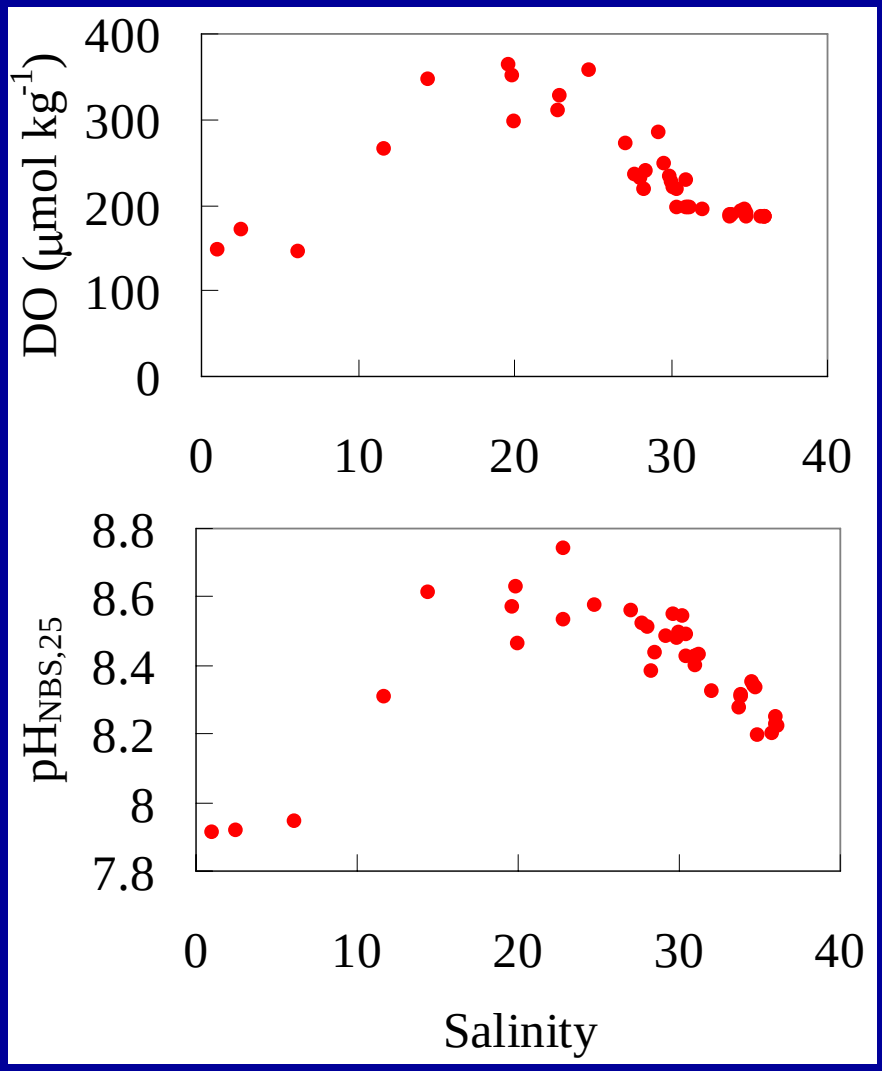
Carbonate system

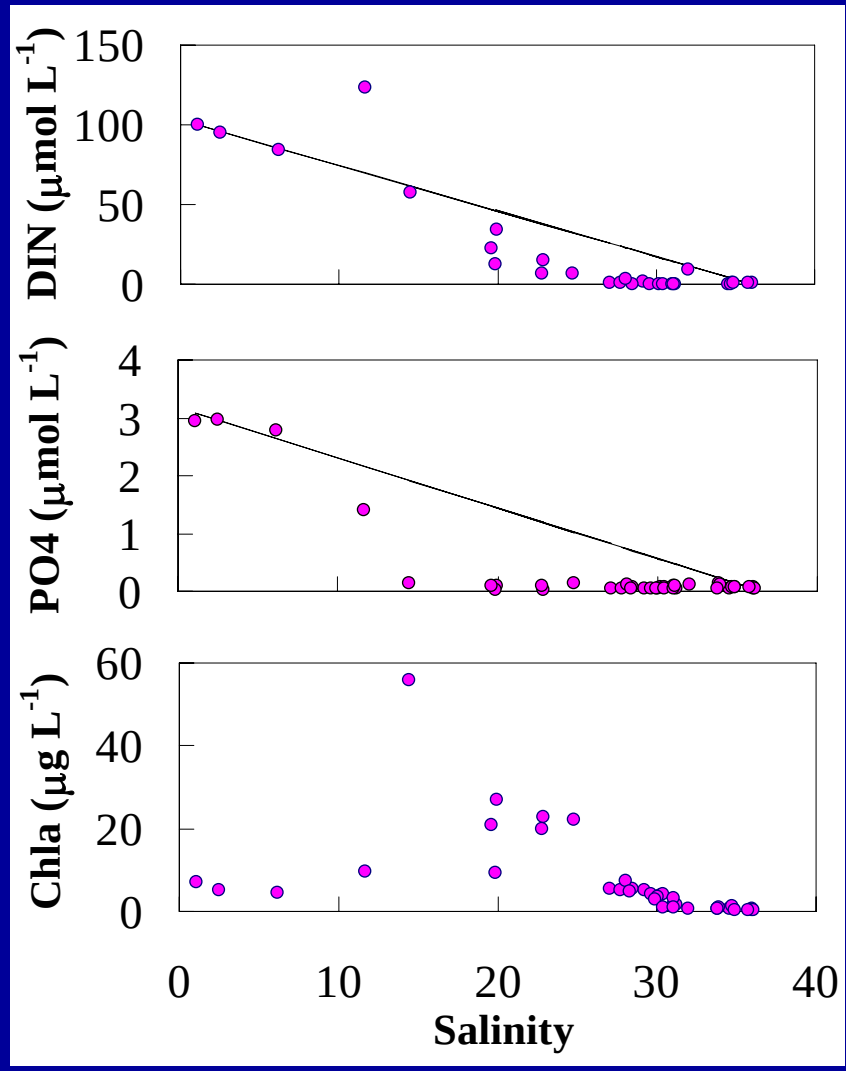
2 Carbonate system vs Salinity

DIC & TAlk vs Salinity



DO, pH and nutrients vs salinity





Data of June 2006

Observations

DIC removal

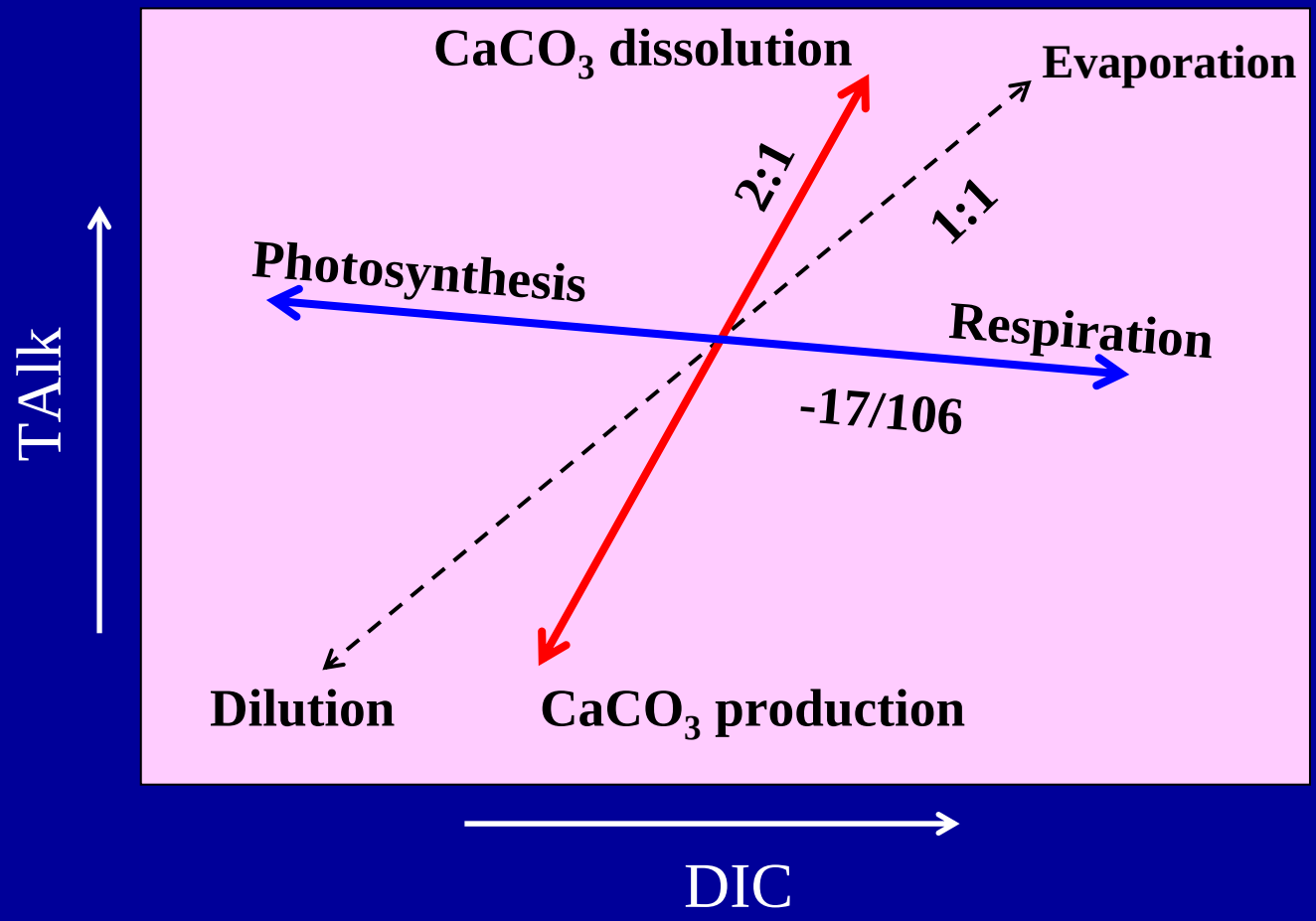
Nutrients removal

High DO & pH

High Chlorophyll

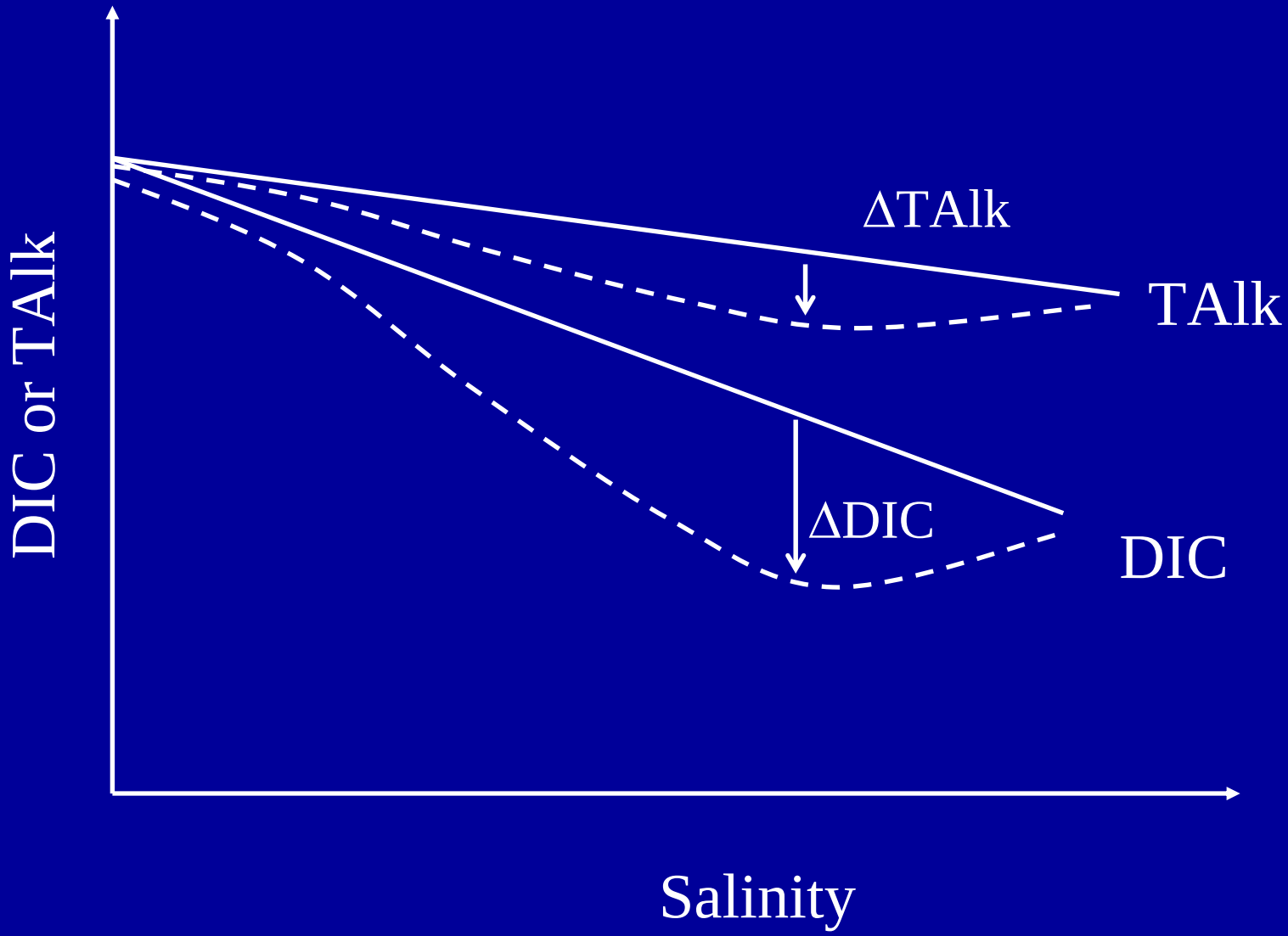
Net Community Production

Main processes influencing DIC and TAlk



$(CH_2O)_{106}(NH_3)_{16}(H_3PO_4)+138O_2 \leftrightarrow 106\ CO_2+16\ HNO_3+H_3PO_4+122\ H_2O$

$Ca^{2+} + 2HCO_3^- \leftrightarrow CaCO_3 + CO_2 + H_2O$



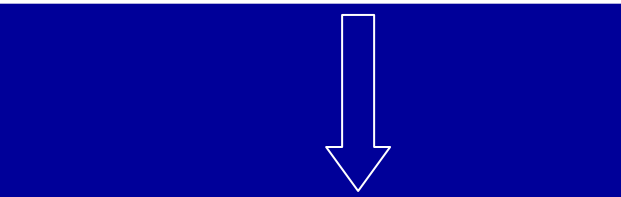
$$\Delta DIC = \Delta DIC_{biological} + \Delta DIC_{sea\text{-}air}$$

NCP (Net community production)

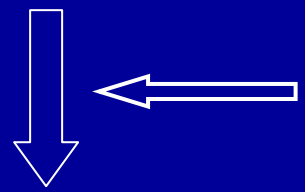
NCC (Net community calcification)

$$\Delta DIC_{NCP} + \Delta DIC_{NCC} = \Delta DIC_{biological}$$

$$\Delta TAlk_{NCP} + \Delta TAlk_{NCC} = \Delta TAlk$$



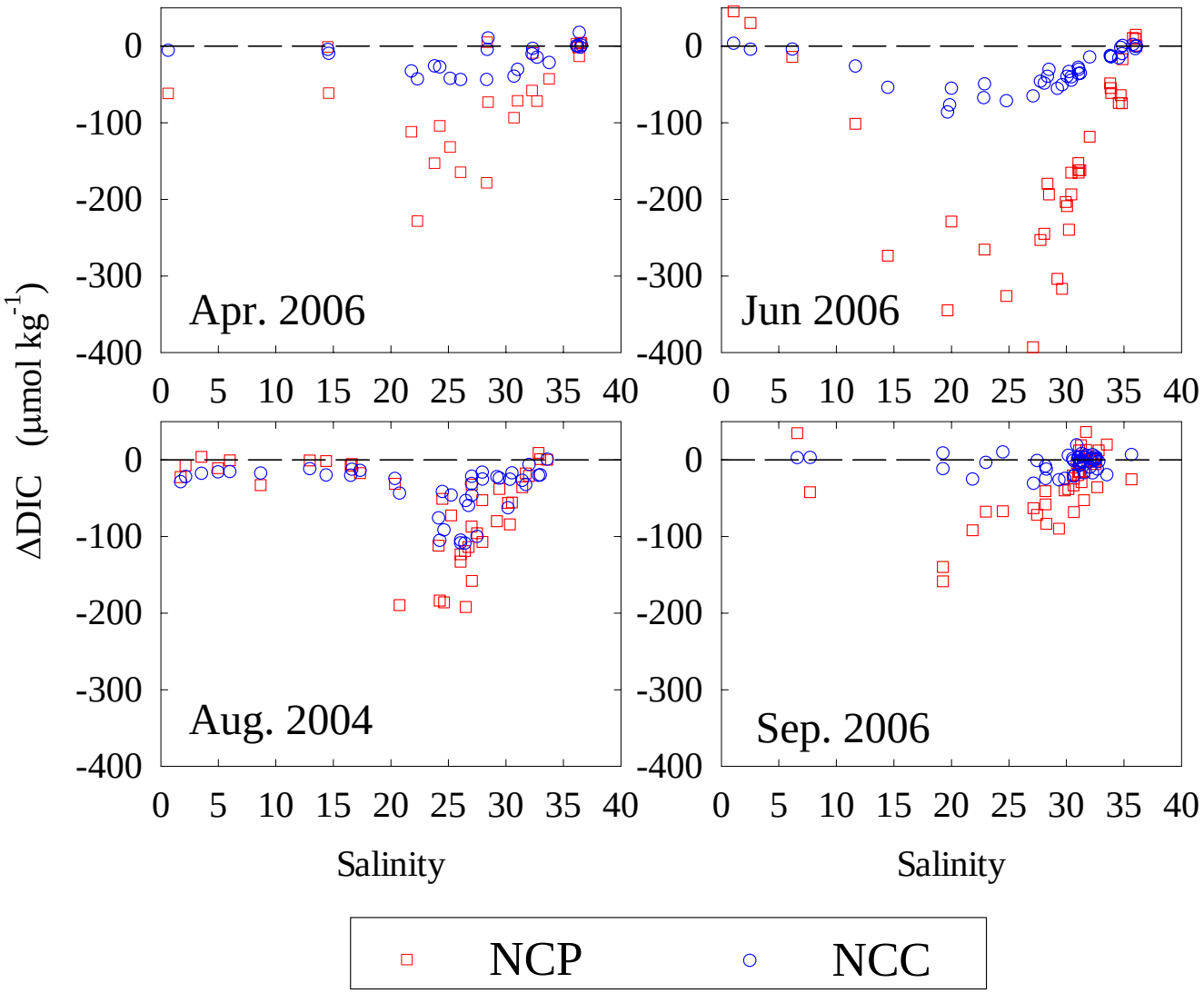
ΔDIC_{NCP} and ΔDIC_{NCC}



Mixed Layer Depth
Residence time

NCP

ΔDIC_{NCP} & ΔDIC_{NCC} vs Salinity

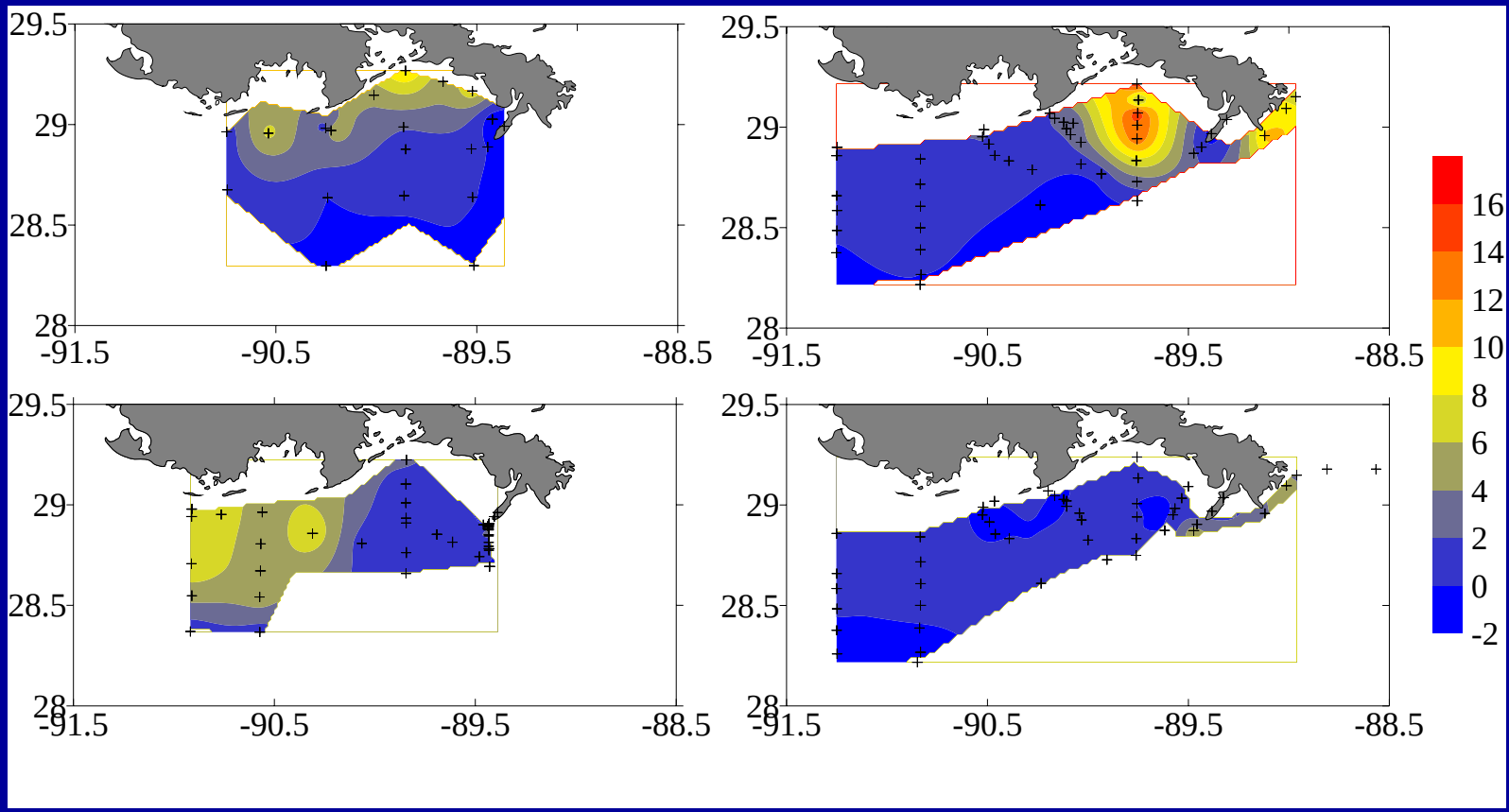


NCP in mixed layer

Unit: g C m^{-2} d^{-1}

Apr. 2006

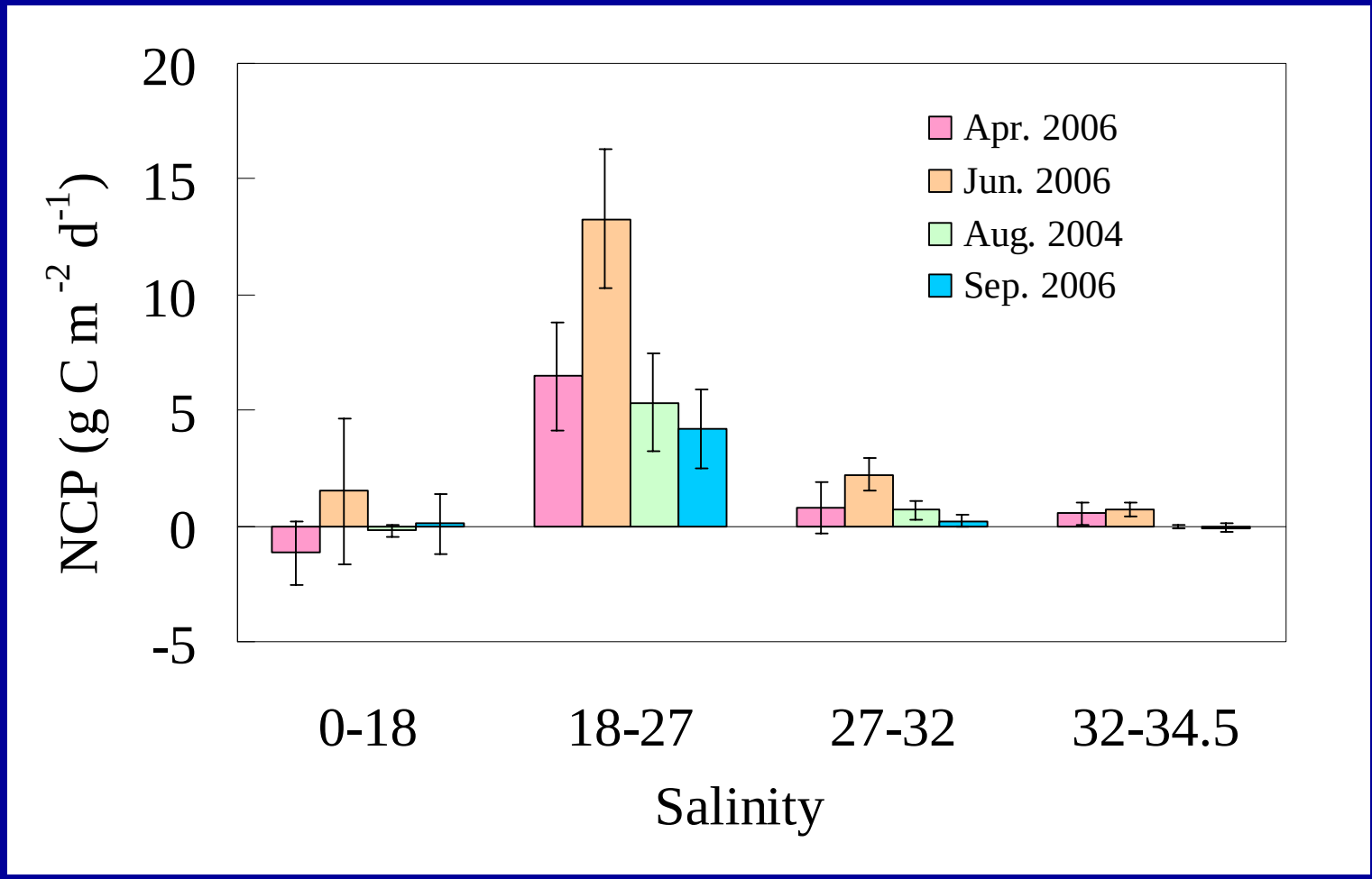
Jun. 2006



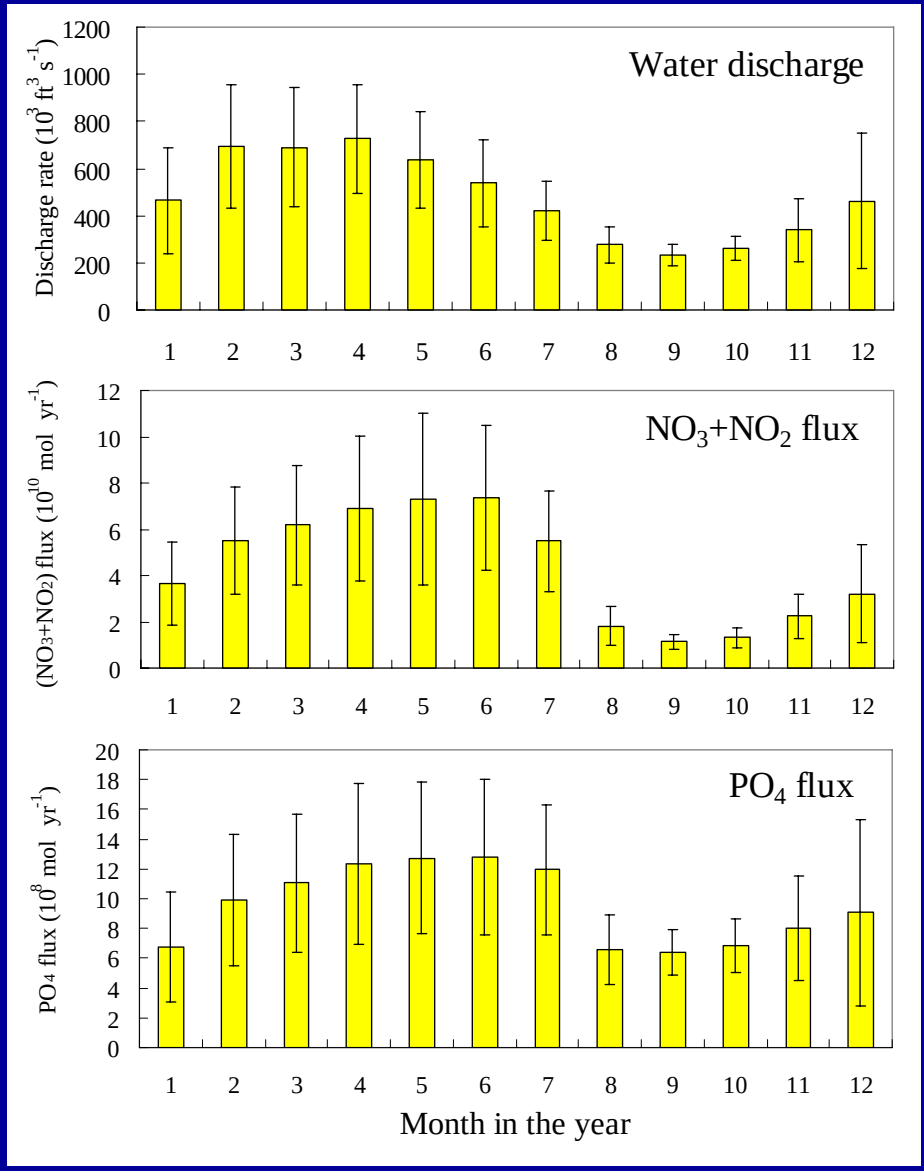
Aug. 2004

Sep. 2006

Spatial and seasonal distribution of NCP



Seasonal pattern of river discharge & nutrients flux



High nutrients flux in summer

Mississippi at St. Francisville (USGS Station#: 07373420), LA.

Preliminary Coupling of marine organic carbon and O_2

OC needed for the hypoxia (March-June): **5.2×10^{11}** *g C* (Green et al. 2006);

Net labile OC production: **6.3×10^{11}** *g C* (this study)

Produced OC in the plume provides most of the labile OC resulting in hypoxia !

Summary

- High DIC and TAlk in the Mississippi River;
- DIC & TAlk removal in spring and summer;
- High net community production in summer;
- Net ecosystem production provides most of the OC for hypoxia.

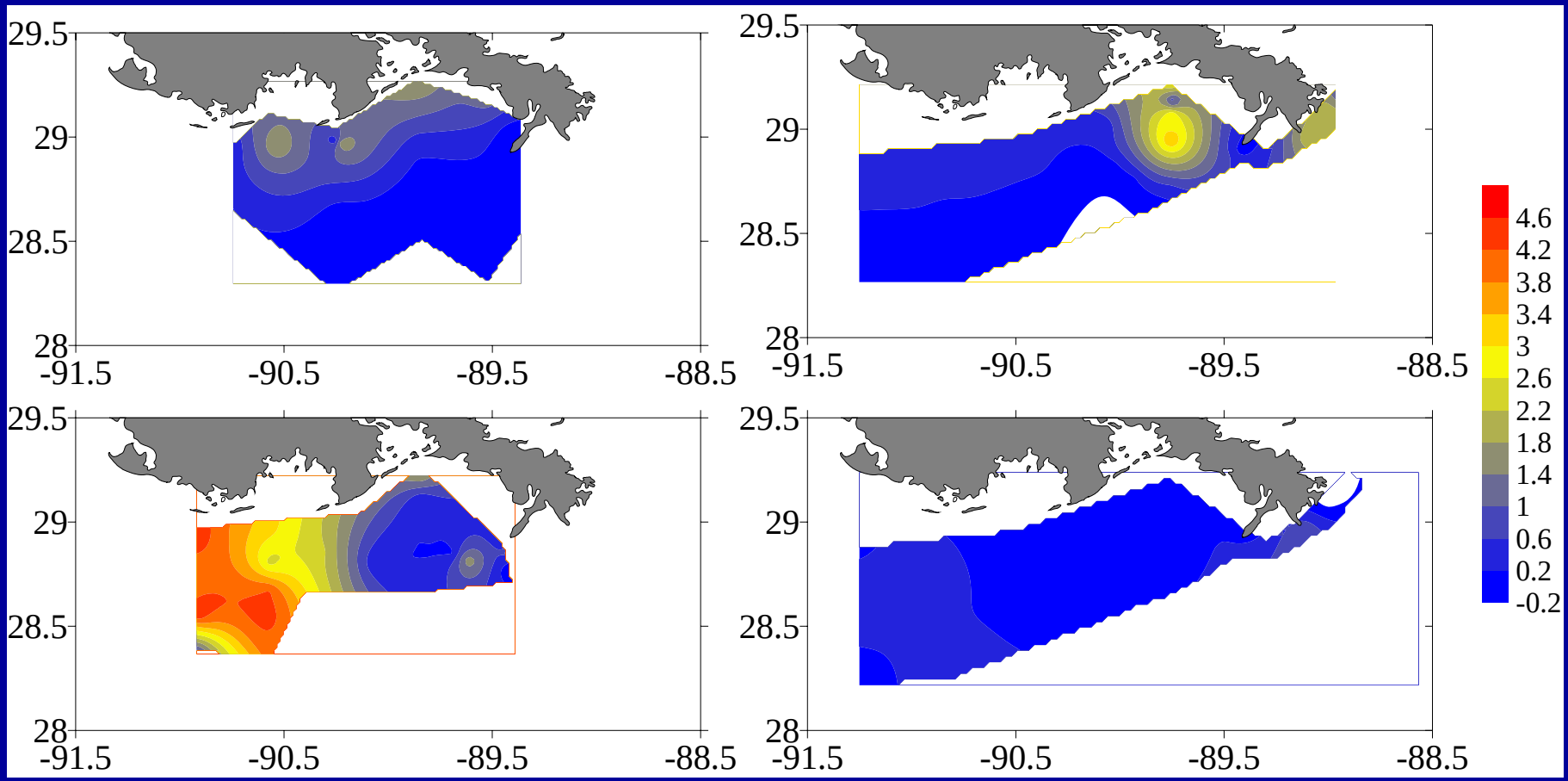
Thanks !

Calcification in mixed layer

Unit: g C m^{-2} d^{-1}

Apr. -May 2006

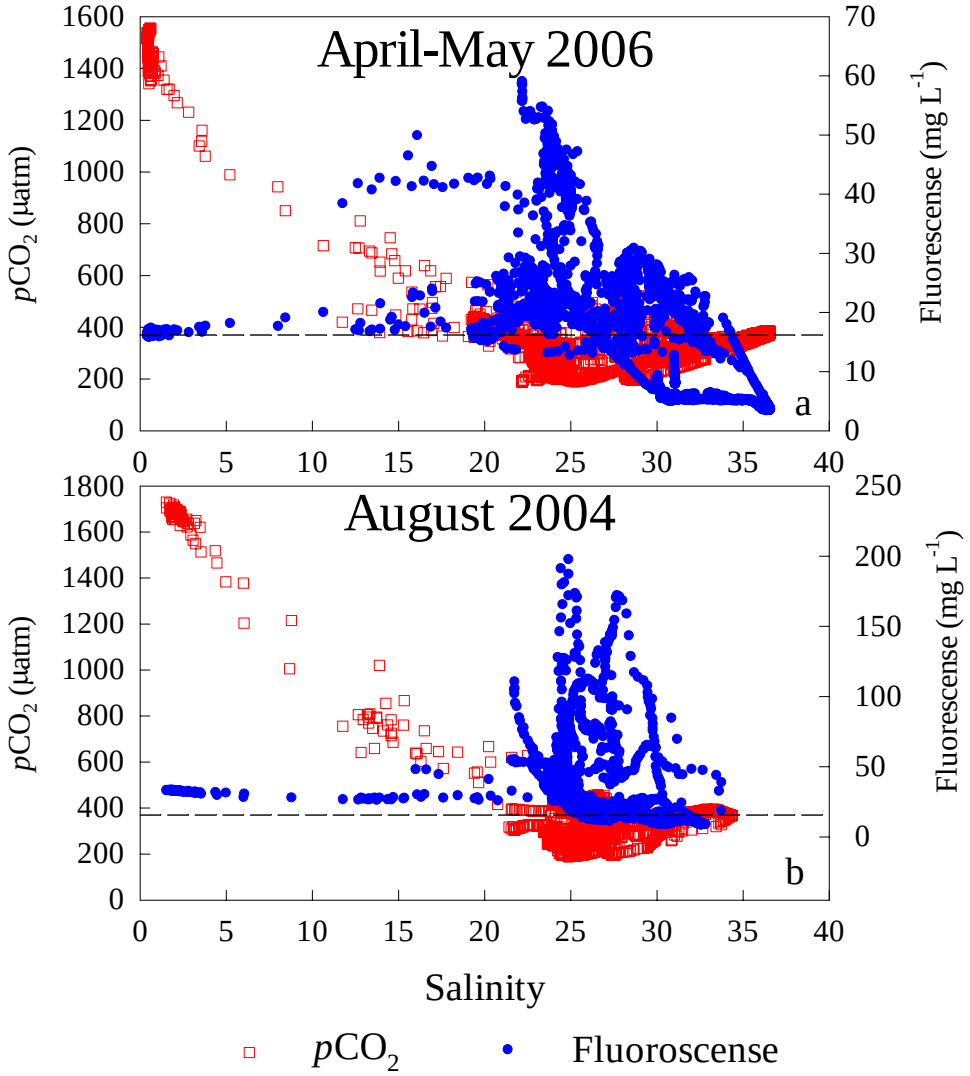
Jun. 2006



Aug. 2004

Sep. 2006

pCO_2 & Fluorescence vs salinity



Low pCO_2 and high fluorescence in mid-salinities

Mississippi plume is a two end-member mixing system (Cai 2003)