Working Group on
Net Community Production & Respiration

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Estuaries Shelf Oligotrophic

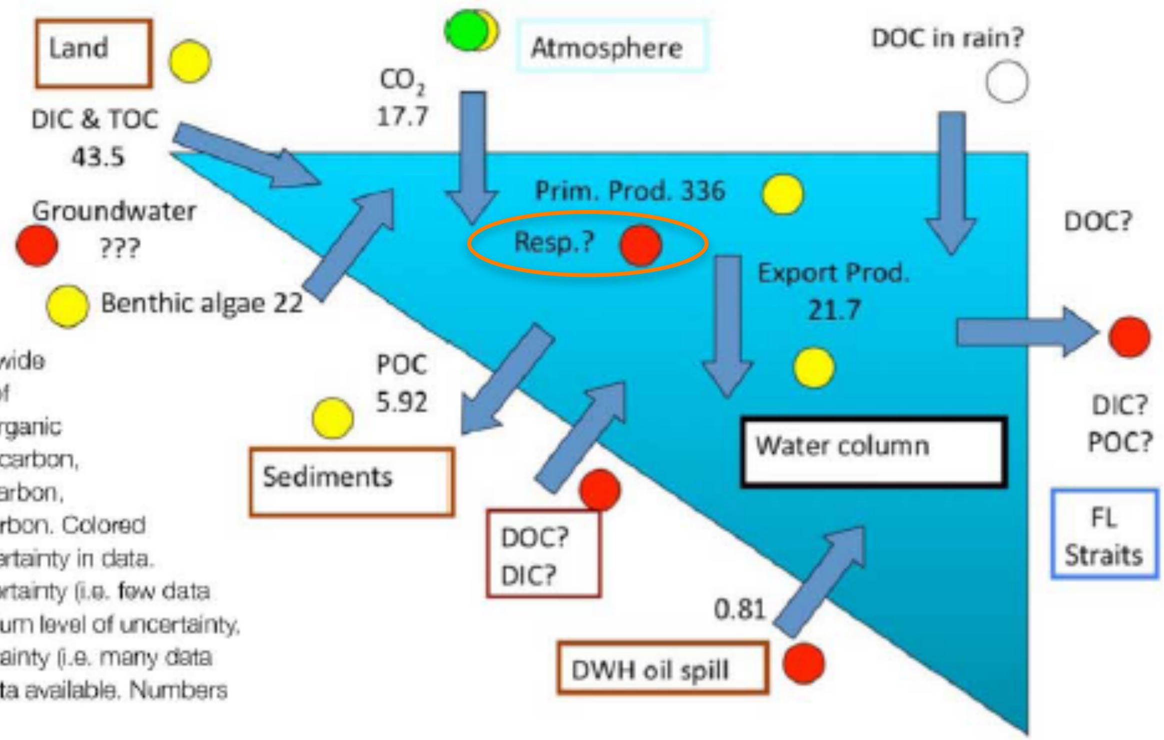


Figure 1. Preliminary shelf-wide carbon budget for the Gulf of Mexico. DIC = dissolved inorganic carbon, TOC= total organic carbon, POC = particulate organic carbon, DOC = dissolved organic carbon. Colored dots represent levels of uncertainty in data. Red dot = High level of uncertainty (i.e. few data available), yellow dot = medium level of uncertainty, blue dot= low level of uncertainty (i.e. many data available), white dot = no data available. Numbers reported in 10^{12} g C yr^{-1}.

DEFINITIONS

GPP = Gross primary production (all autotrophs)

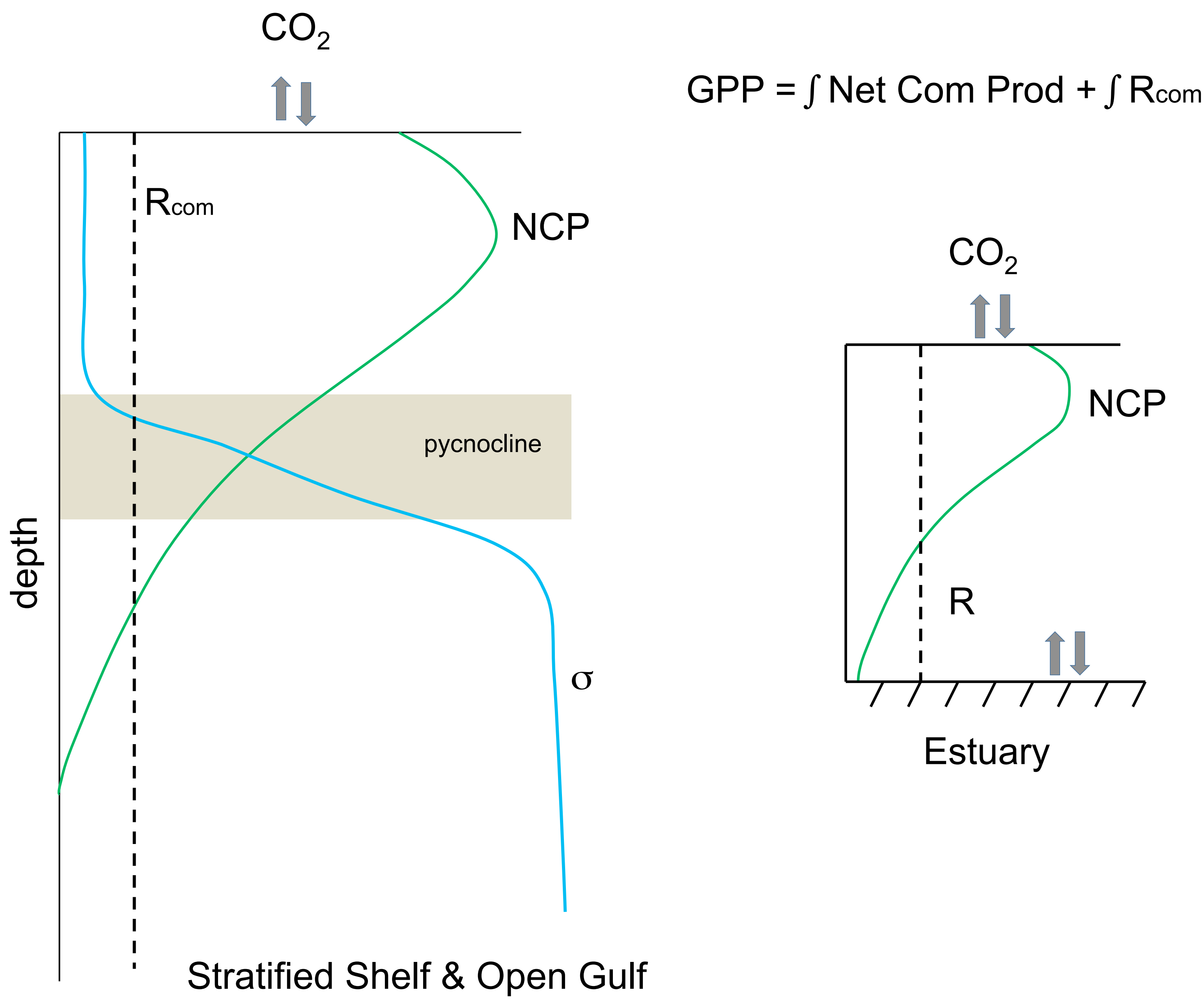
R_{com} = community respiration (autotrophs + heterotrophs)

$$NCP = GPP - R_{com}$$

$$NCP \approx NPP - R_{heterotrophs}$$

If NCP < 0, heterotrophic metabolic state
allochthonous C source
CO_2 source

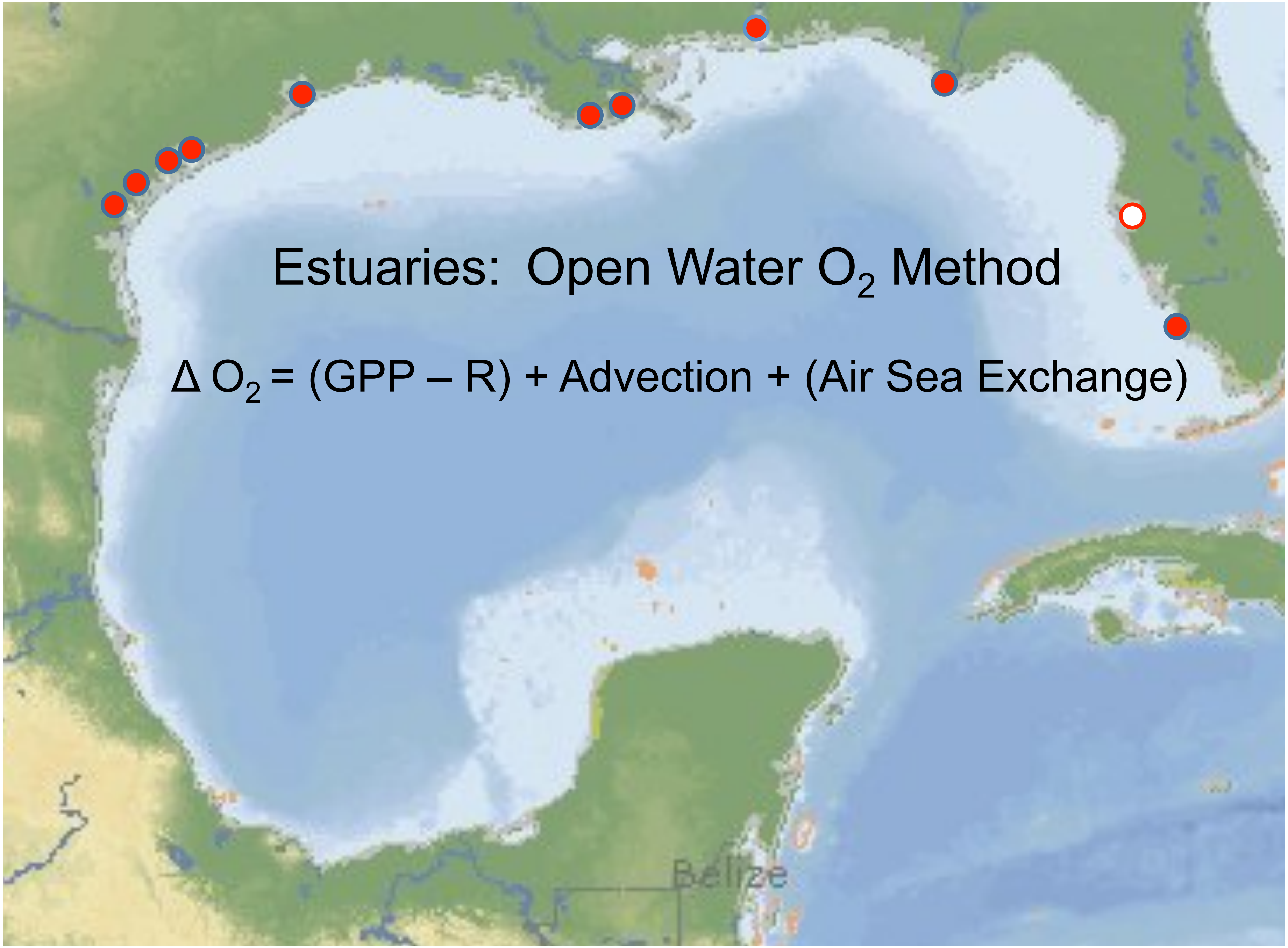
If NCP > 0, autotrophic metabolic state
autochthonous C source
CO_2 sink



CO_2
GPP = ∫ Net Com Prod + ∫ Rcom
Rcom
NCP
pycnocline
depth
σ
Stratified Shelf & Open Gulf
CO_2
NCP
R
Estuary

Estuaries: Open Water O_2 Method

$$\Delta O_2 = (GPP - R) + \text{Advection} + (\text{Air Sea Exchange})$$



Estuary Comparison: open water method

National Estuarine Research Reserve

(Caffrey, 2003, 2004)

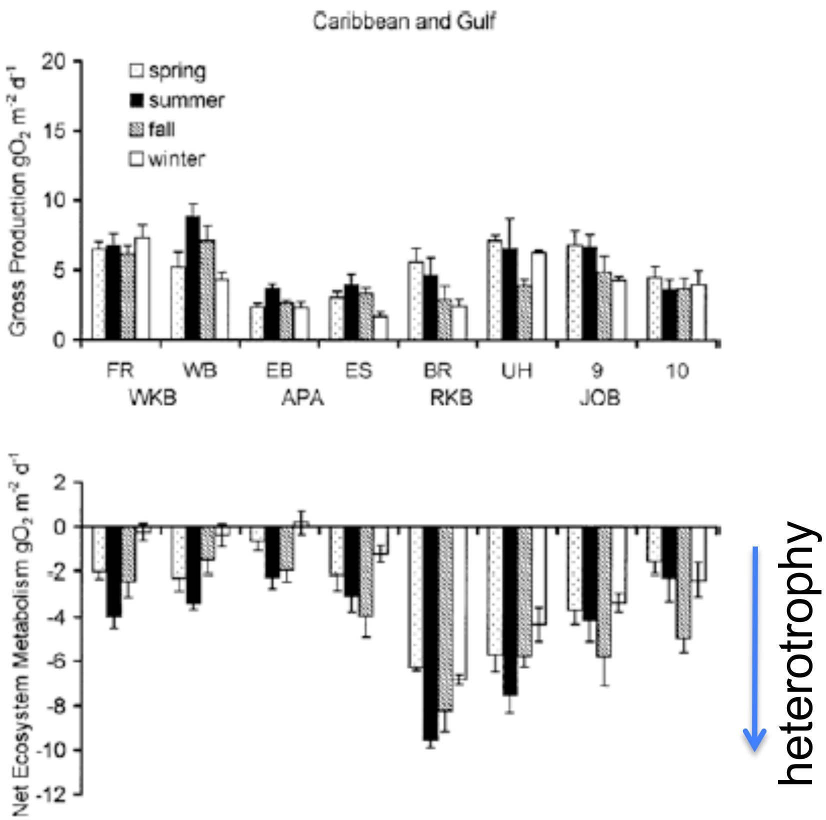
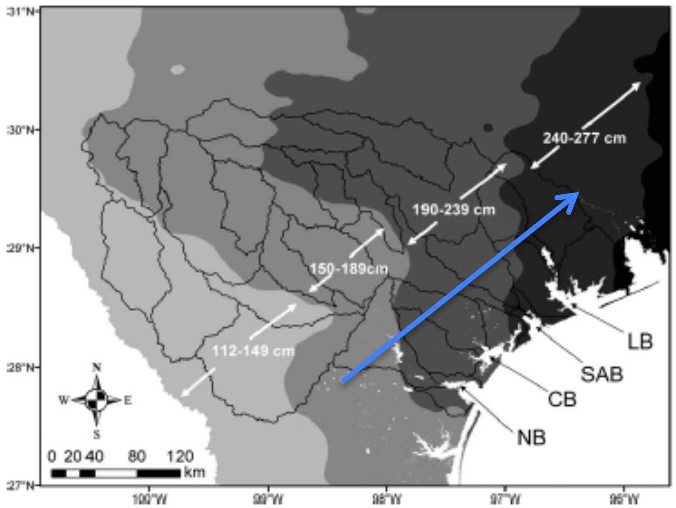


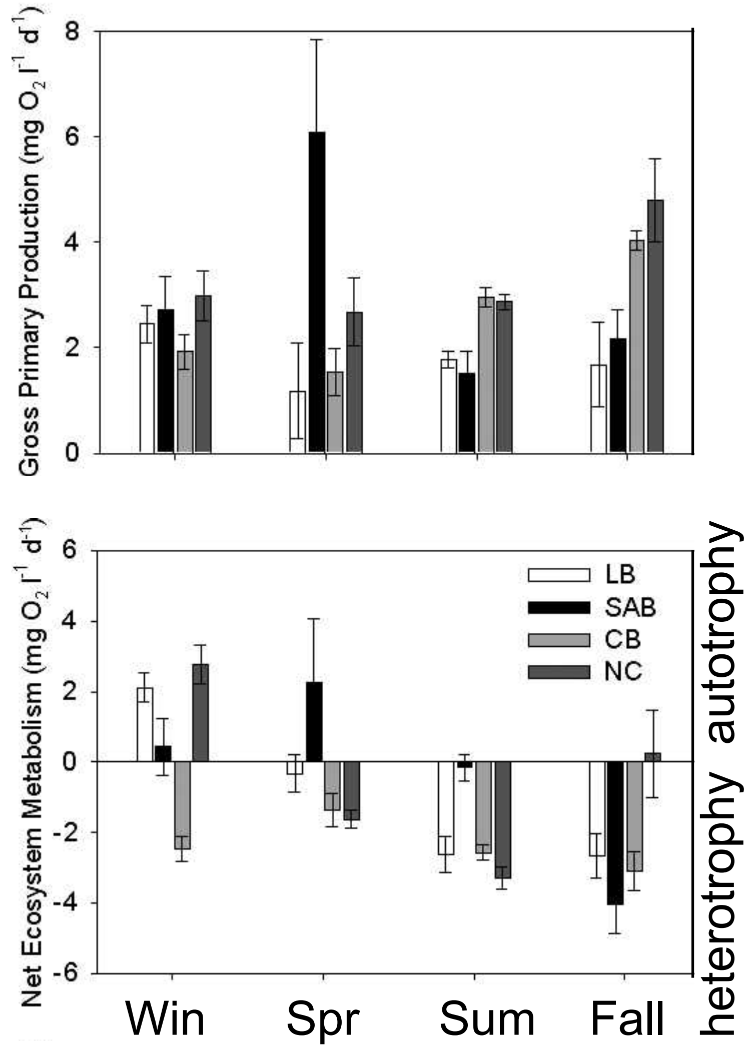
Fig. 3. Seasonal gross production and NEM (g O_2 m^{-2} d^{-1}) in Caribbean and Gulf of Mexico region (mean + SE).

Eastern Gulf of Mexico estuaries:

- Limited seasonality in GPP, R_{com}
- SE estuaries are heterotrophic almost year-round
- Southernmost estuaries have higher R_{com} than temperate waters
- Location (marsh, mangroves) and freshwater input (FWI) are determinants of metabolism

Western Gulf of Mexico: Texas estuaries





Estuarine gradient in precipitation, freshwater inflows

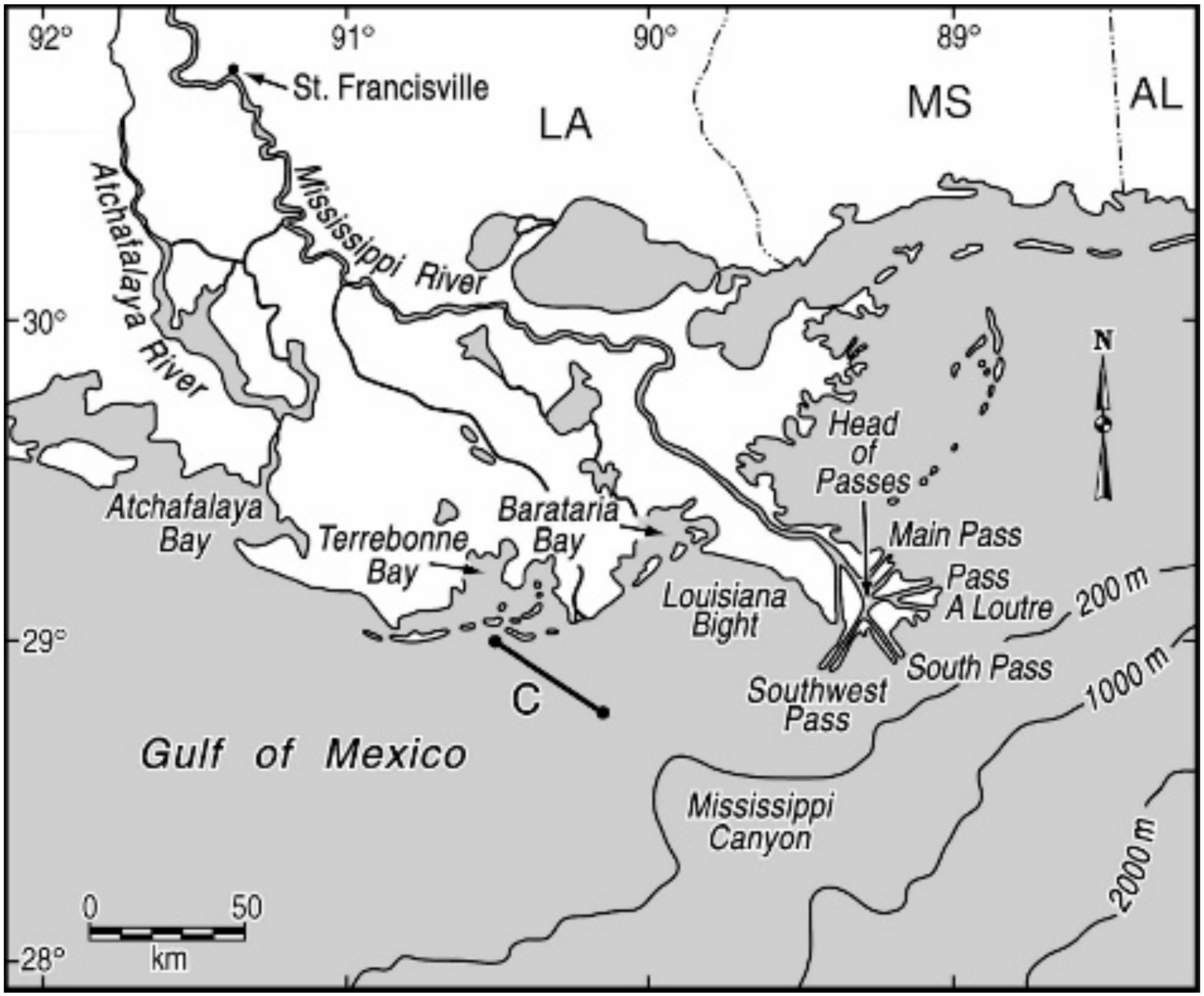
High GPP rates, balanced by high R_{com}

Spatial variability measured for correspondence of GPP, R

Russell, M.J., and P. A. Montagna. 2007. Spatial and Temporal Variability and Drivers of Net Ecosystem Metabolism in Western Gulf of Mexico Estuaries.

Gulf of Mexico Shelf

Mississippi River: SW Pass Plume and Atchafalaya River



Green et al., 2006

Combined biological & physical models

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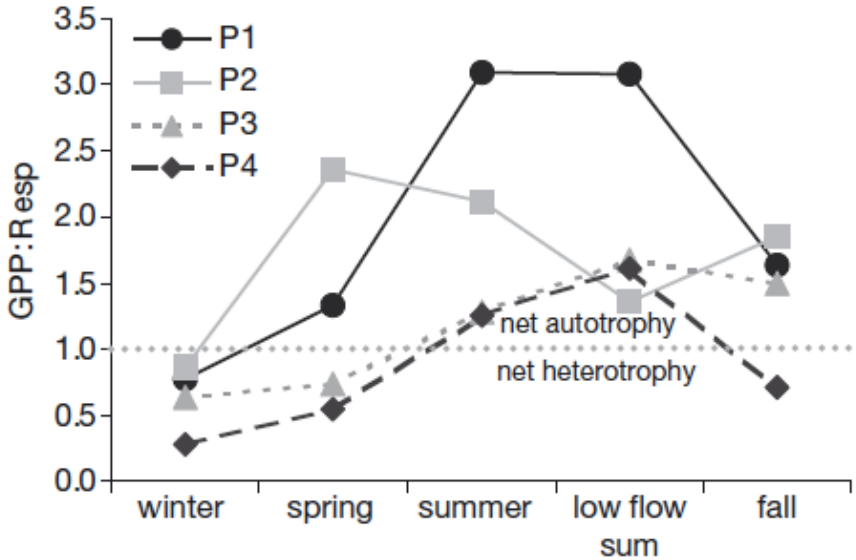


Fig. 7. Ratio of total community respiration to GPP for each region by season. When production exceeds respiration (>1, dotted line), system is net-autotrophic and needs no carbon import to meet respiratory demand

- Bacteria dominate plankton R in winter.

Breed et al. 2004; Green et al., 2008

Inverse and physical model:

- Heterotrophic in winter (entire plume)
- Spring to summer: autotrophic, progresses from SW Pass to west
- Summer: NEM autotrophic with highest rates near SW Pass

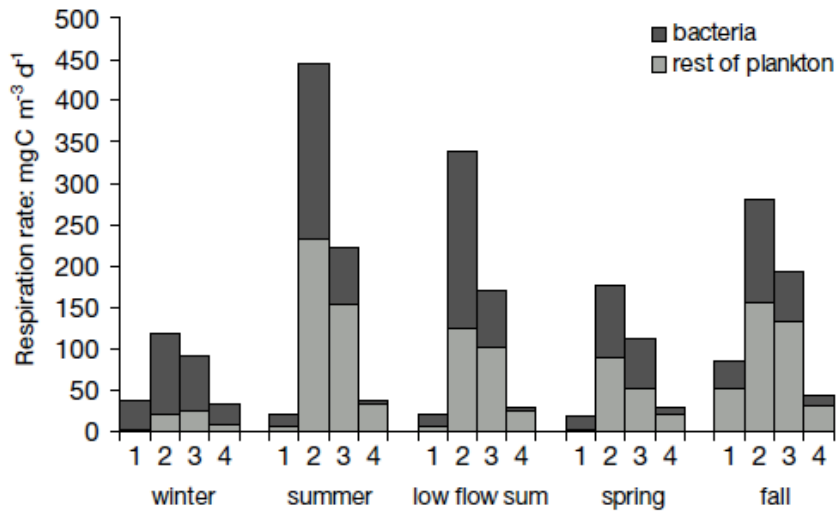
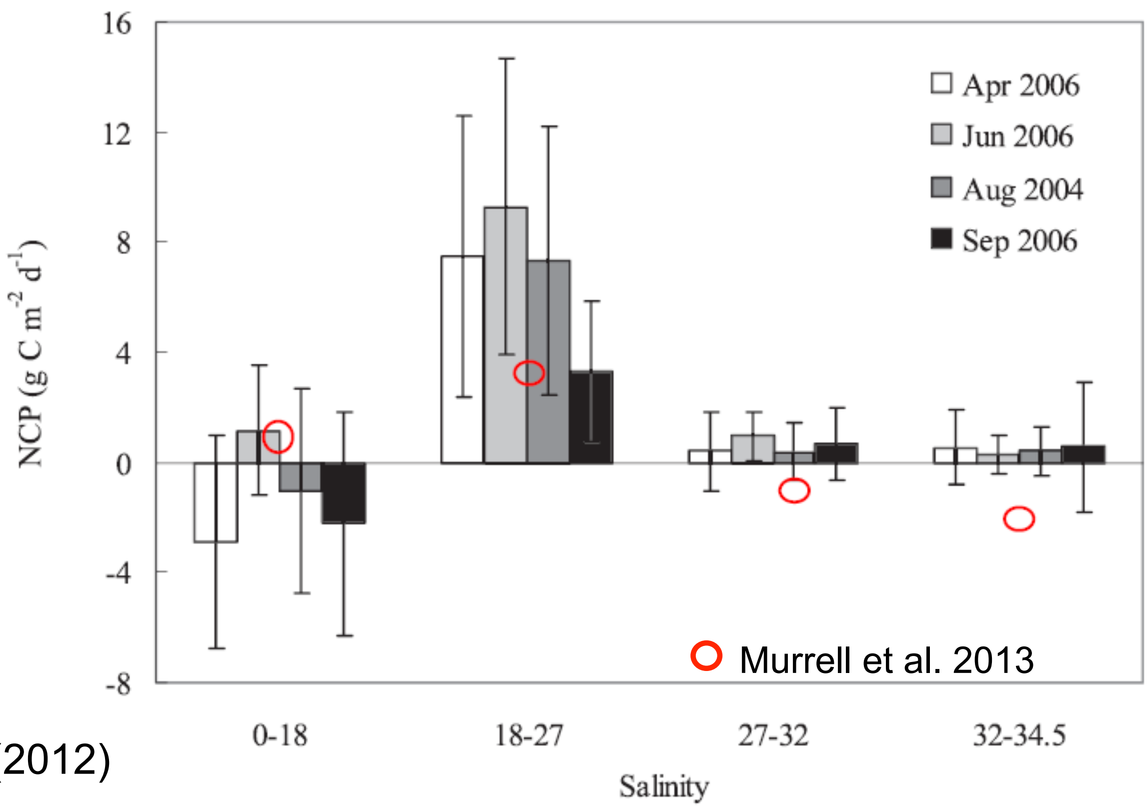


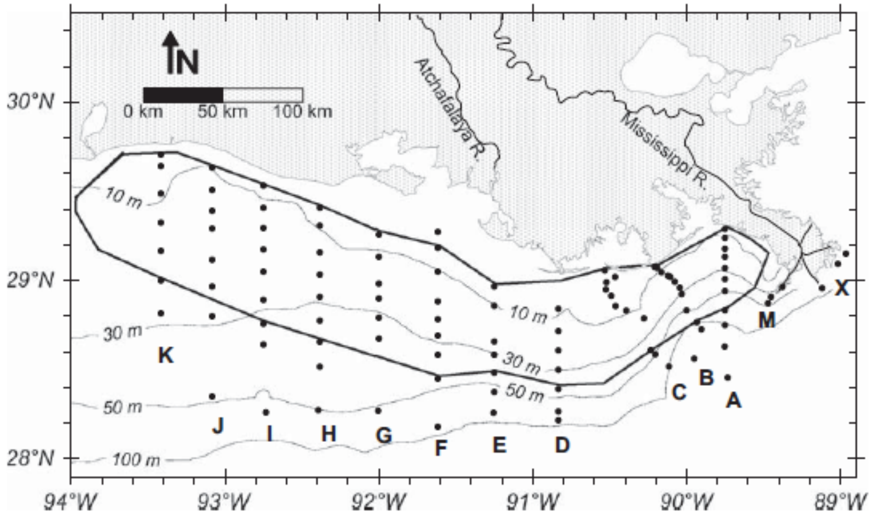
Fig. 6. Planktonic community respiration for each season and region. Respiration rate of bacteria has been separated from respiration rate of rest of the plankton

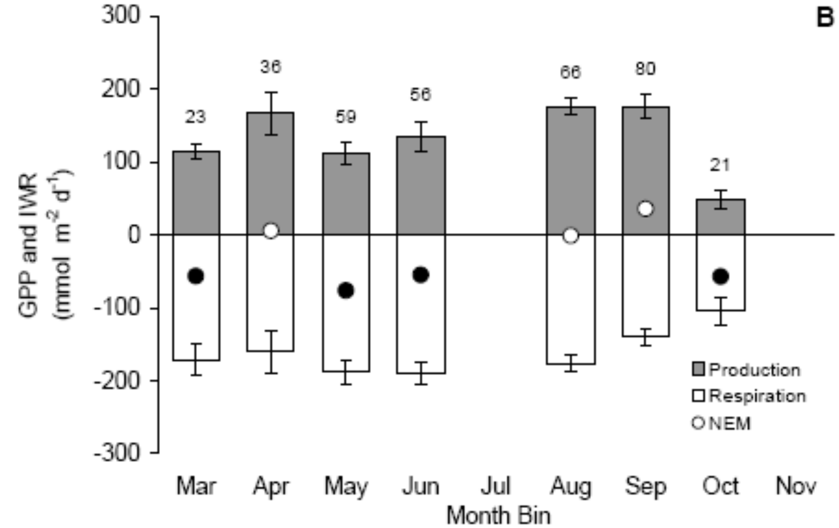


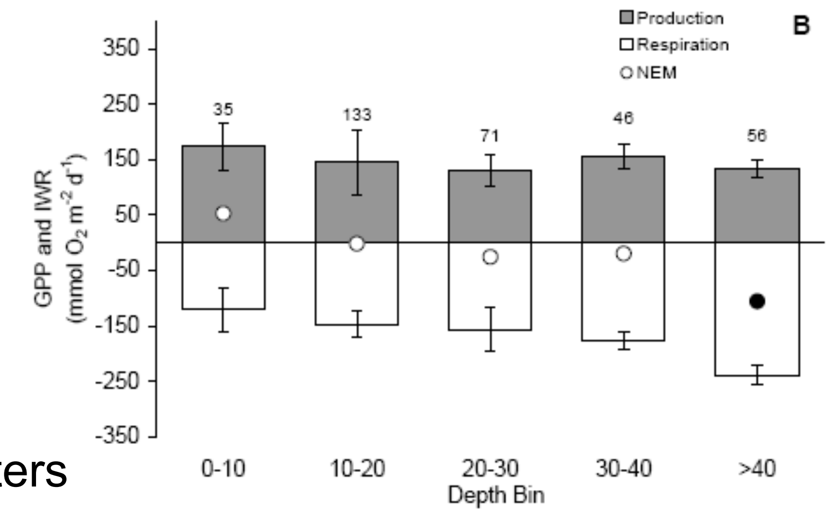
Guo et al. (2012)

Fig. 8. Calculated NCP rates in the four subregions of the Mississippi River plume in the surveyed seasons. The error bars represent the standard deviation.

- NCP from inorganic C mass balance model of plume
- NCP maximum at salinity of 18 – 27
- NCP rates of 1 – 9 g C m^{-2} d^{-1}; global maxima for river plumes
- Higher rates in spring-summer







Highest GPP, R_{com} at < 30 m
spring, summer

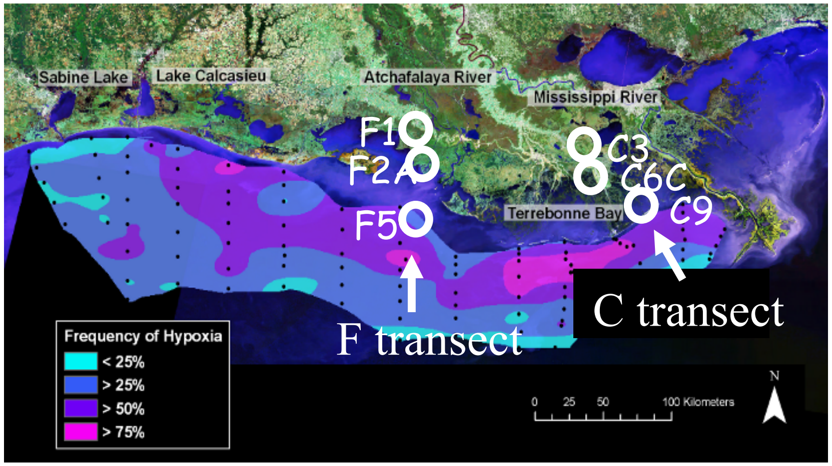
R_{com} in surface > bottom waters

R_{com} decreases east to west

LA Shelf heterotrophic in west, offshore waters
likely fueled by Miss River Org-C

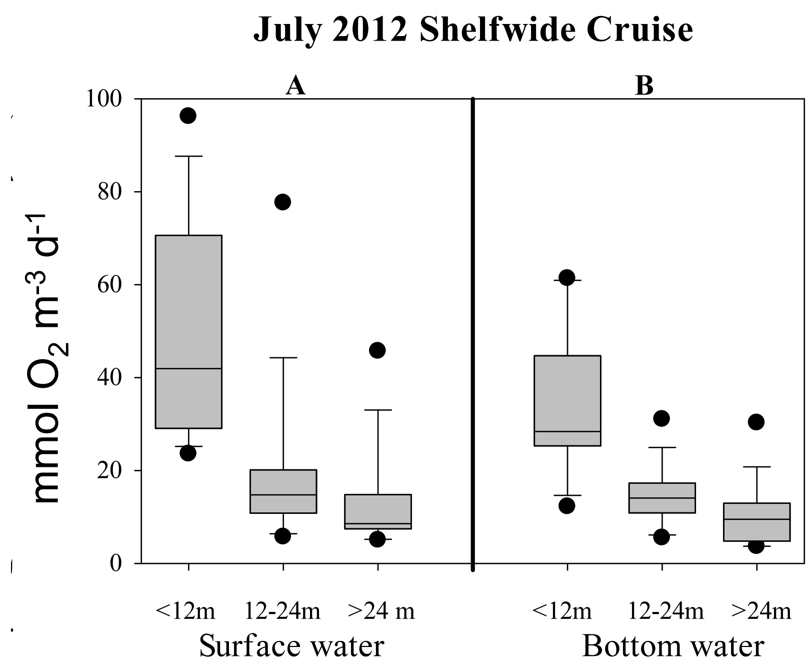
Murrell et al. (2013)

Brian Roberts: LUMCON



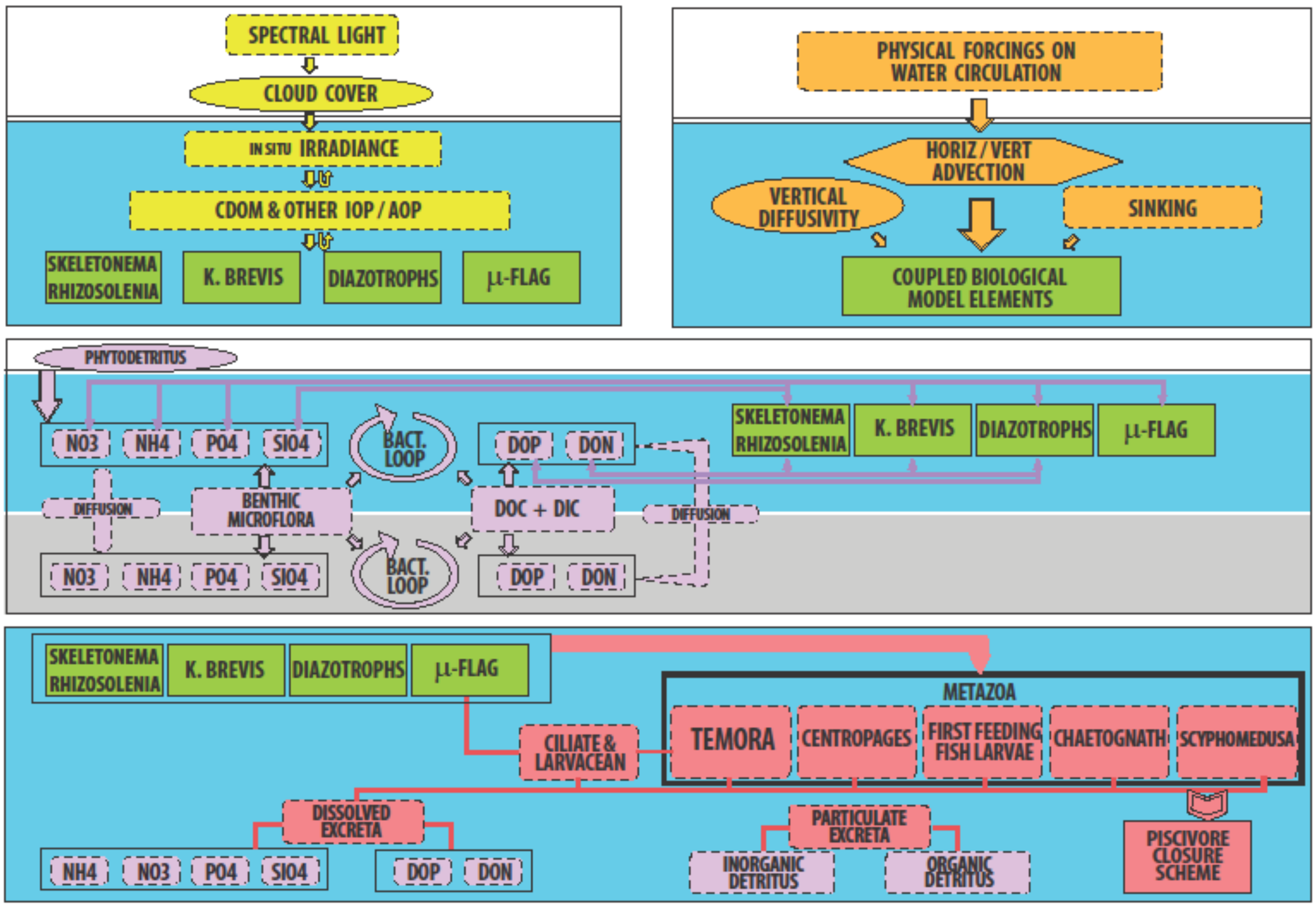
Atchafalaya River, 30% of MARS flow

B. Roberts - LUMCON



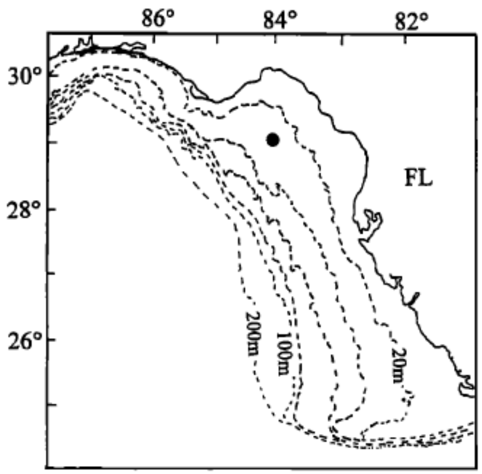
- Variable seasonal patterns of R_{com}, NCP
- Maximum R_{com} near rAR mouth, in surface waters, declines offshore
- R_{com} proportional to DIN uptake

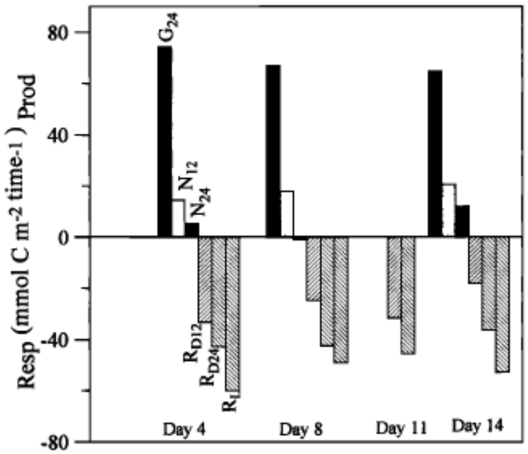
West Florida Shelf:
HABSIM Schematic of Carbon Flows



West Florida Shelf (NCP, R_{com})

Wanninkhof et al. (2007)
Hitchcock et al (2000)



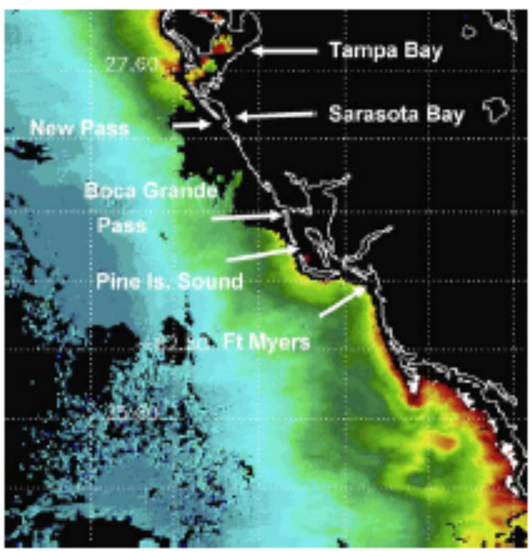


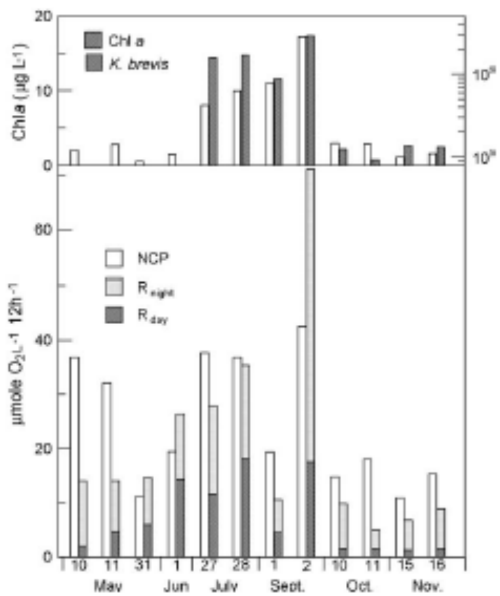
Spring 2007 FSLE

Declining plankton 'bloom'

$^{18}O_2$ GPP ≈ R_{com}

West Florida Shelf (NCP, R) *Karenia brevis* - Hitchcock et al (2010; submit.)



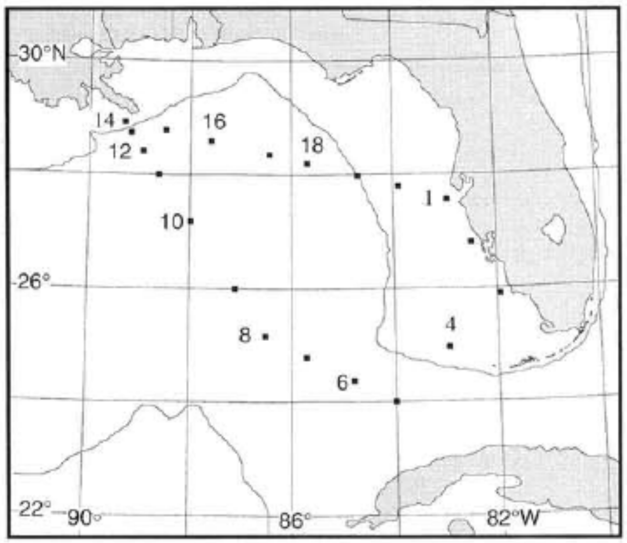


2006 Bloom indicates
K. brevis autotrophic

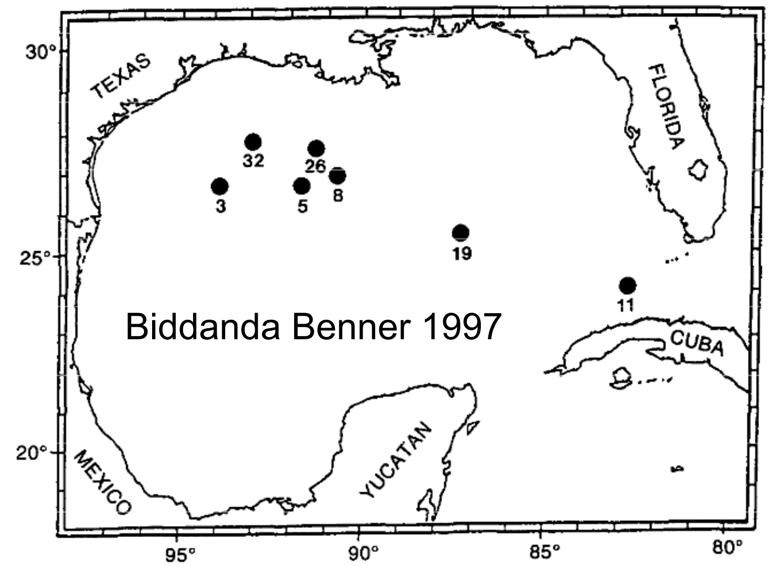
No 'seasonal' progression
of auto to heterotrophic

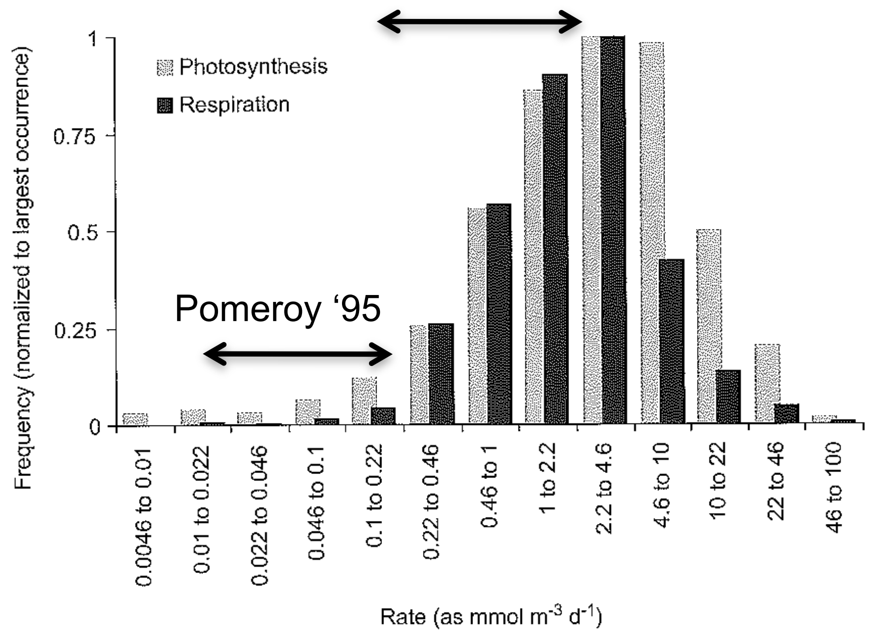
Dense populations may be
net heterotrophic

Open Gulf Waters: Few NCP observations, low R_{com}



Pomeroy et al., 1995





- Few observations in oligotrophic GOM
- R_{com} in surface are relatively low
- Current debate on metabolic state of oligotrophic waters

Group Summary:

- GOM estuaries are predominantly heterotrophic,
  CO_2 source to atmosphere (Cai, 2010)

- Mississippi River Plume best characterized of all regions;
  intermediate salinity waters are autotrophic

- GOM Shelf and oligotrophic waters under-sampled

- Quantify NCP linkage to riverine nutrient and carbon sources,
  N fixation in open Gulf