Nutrient Dynamics in the Ocean

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Lab Review 2008

AOML Nutrient Program
Contribution to NOAA's mission

Ocean and Climate

Water mass tracer in ocean circulation

Quantifying oceanic uptake of CO_2

Ecosystem

Source and transport of nutrient

cycling of nutrient within ecosystem (e.g. sediment/water)

Outline

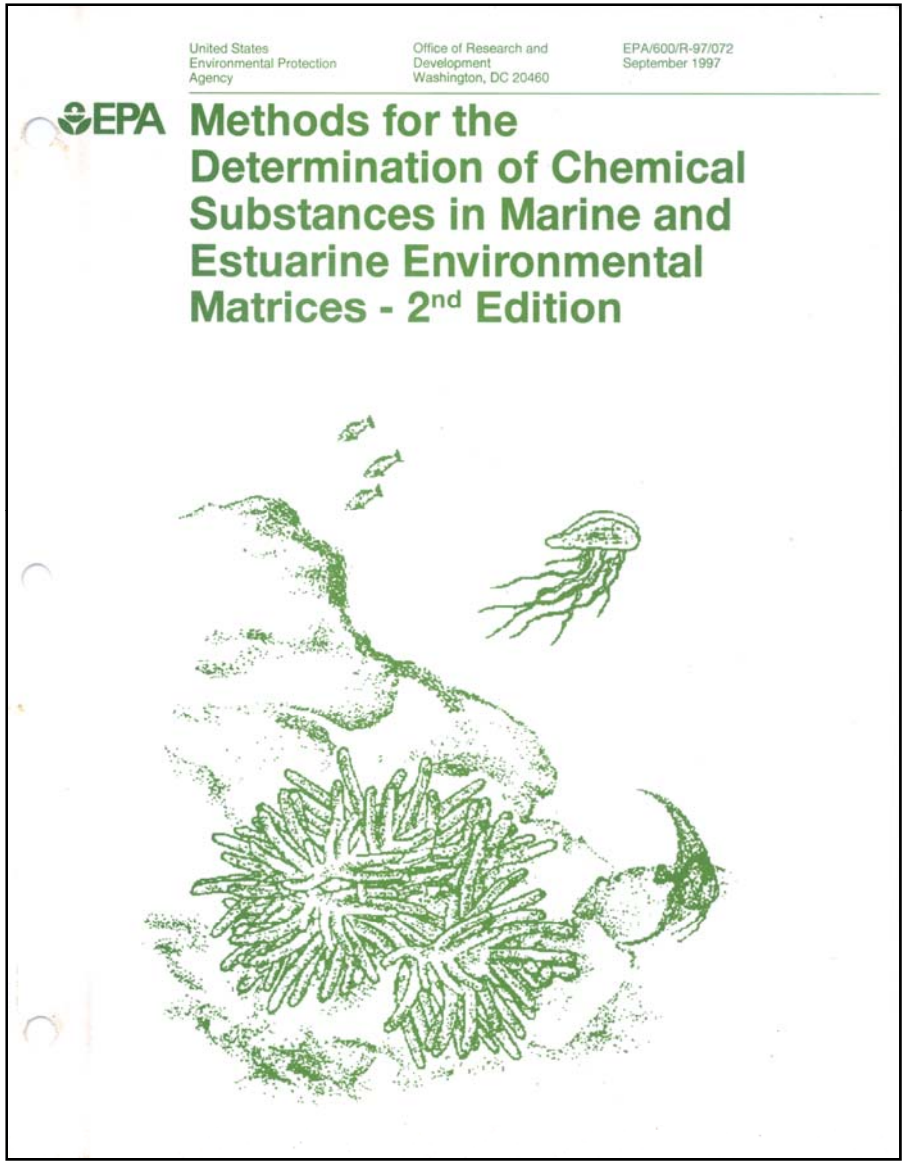
Cutting Edge technology development

- EPA standard methods
- Underway instrumentation
- Liquid waveguide

Preeminent Research

- Phosphorus cycle in Florida
- Repeat Hydrography

- nitrate/nitrite
- ammonium
- silicate
- total N
- total P



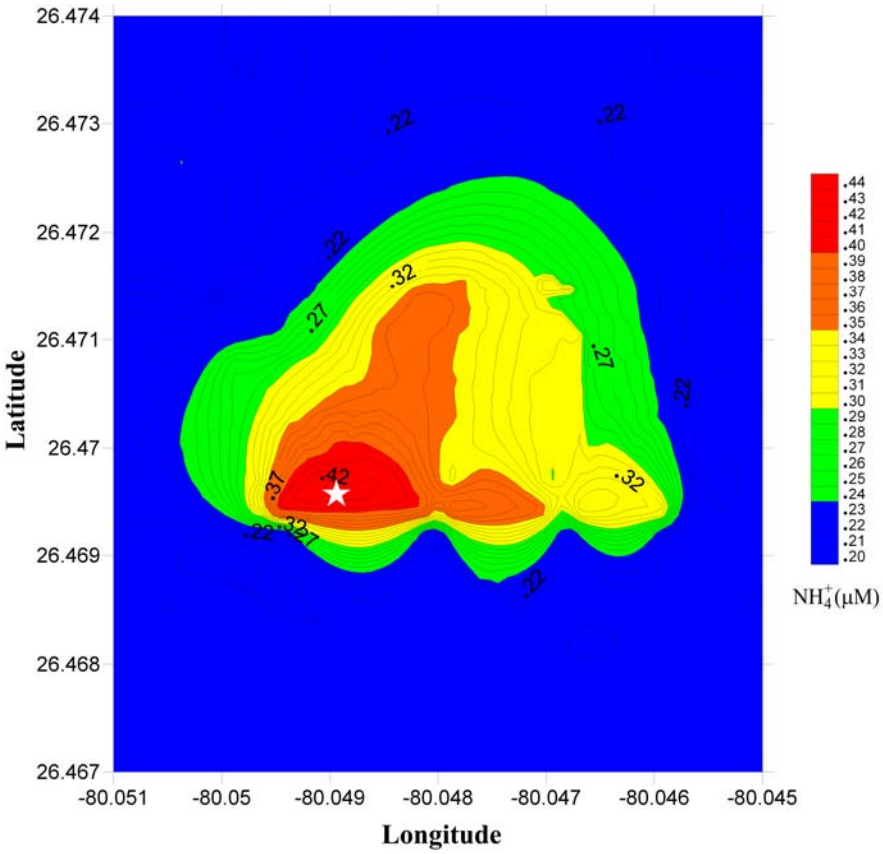
United States Environmental Protection Agency

Office of Research and Development Washington, DC 20460

EPA/600/R-97/072 September 1997

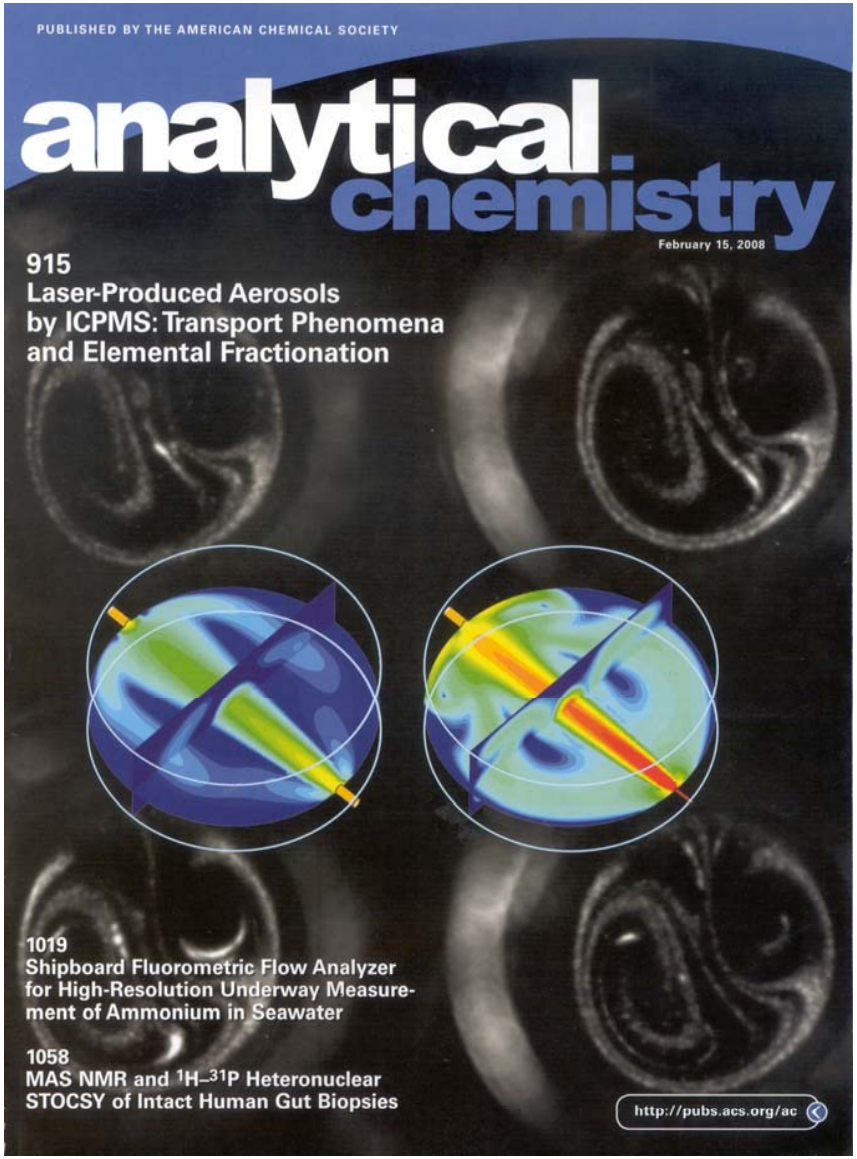
EPA

Methods for the Determination of Chemical Substances in Marine and Estuarine Environmental Matrices - 2nd Edition



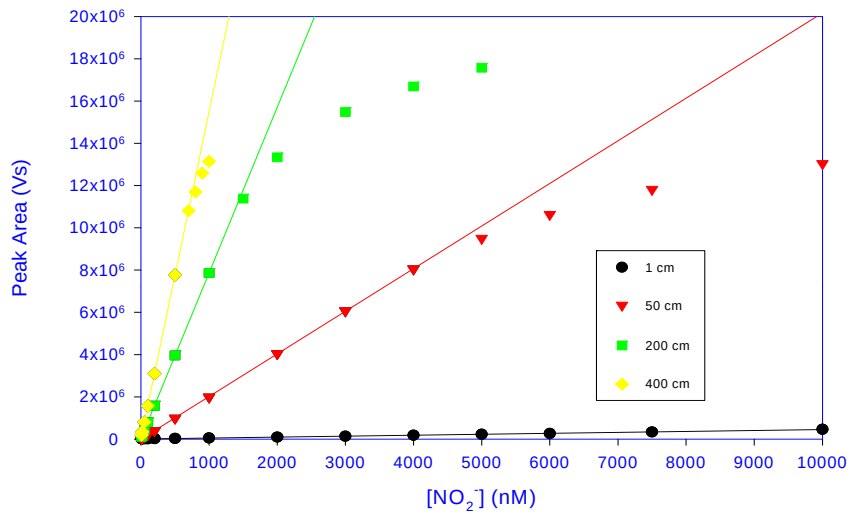
Mapping ammonia dispersion in an oceanic outfall

Amomthammarong & Zhang 2008

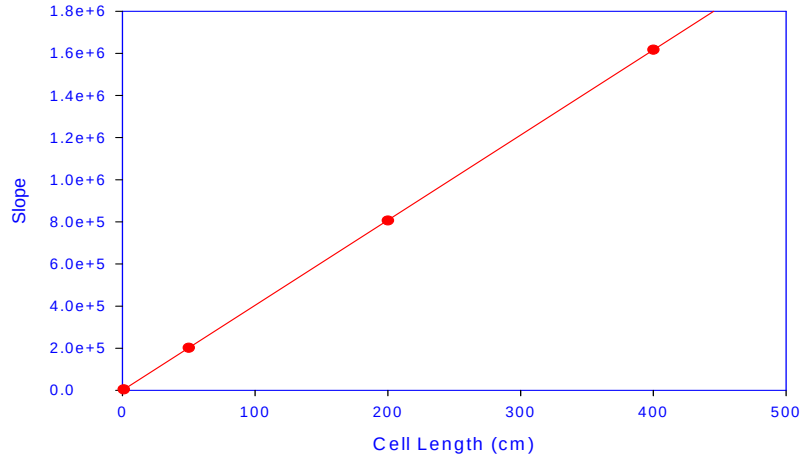


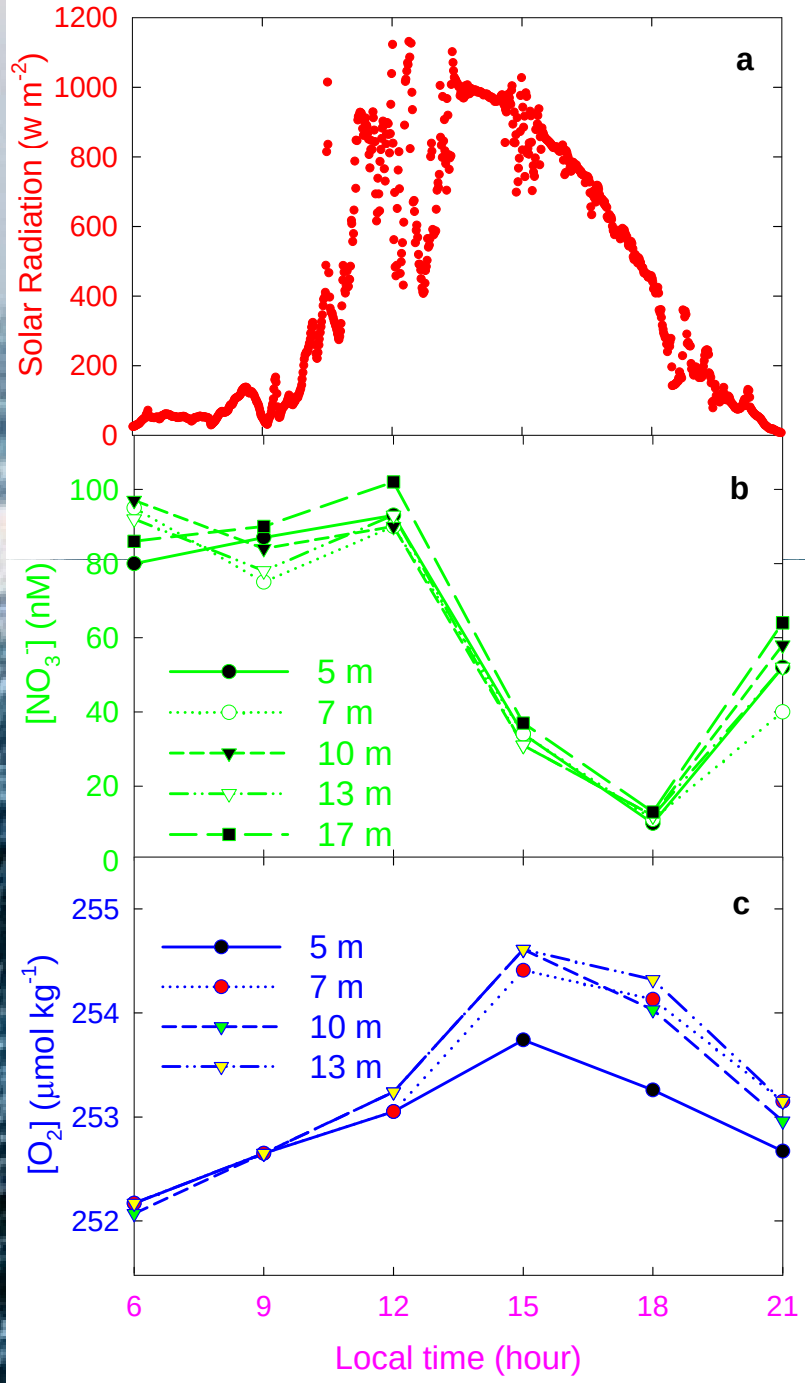
Sensitivity Enhancement by Liquid Waveguide

Zhang 2006



Sensitivity Proportional to light pathlength




a
Solar Radiation (w m^{-2})
1200
1000
800
600
400
200
0
b
[NO_3^-] (nM)
100
80
60
40
20
0
5 m
7 m
10 m
13 m
17 m
c
[O_2] (μmol kg^{-1})
255
254
253
252
5 m
7 m
10 m
13 m
6
9
12
15
18
21
Local time (hour)

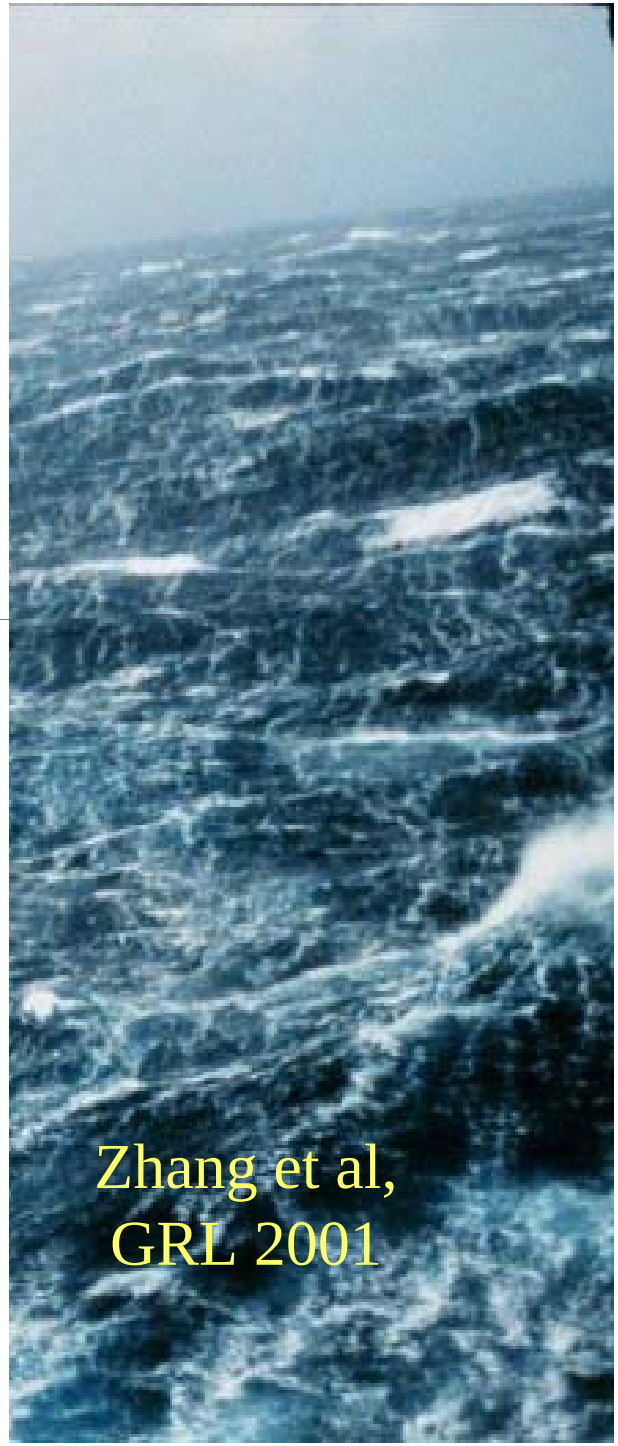
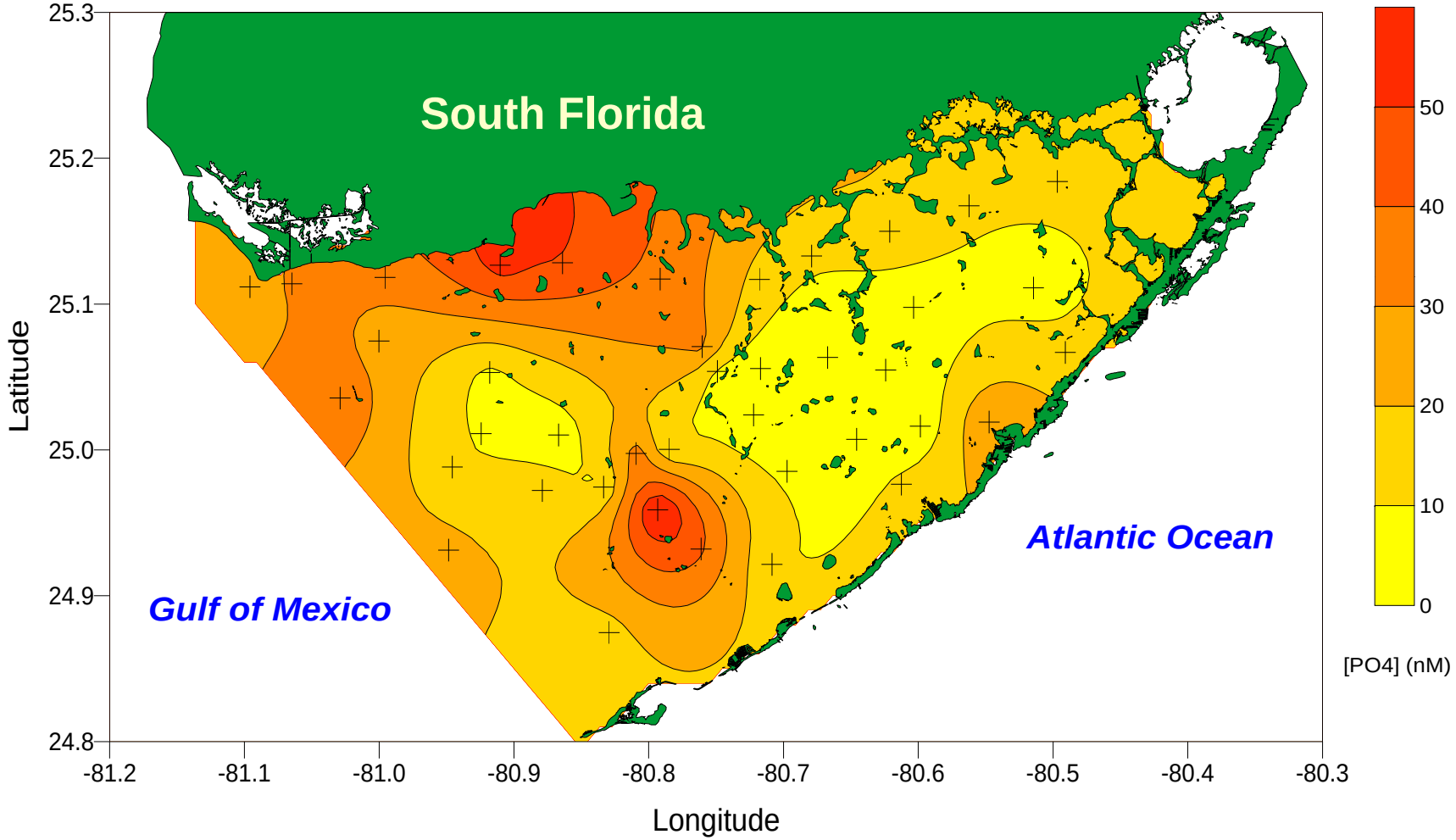

Zhang et al,
GRL 2001

Table 2. Ancillary Parameters and Example Methods for GEOTRACES

Parameter	Method	Detection Limit	Example Reference
Salinity	Conductivity	NA (not applicable)	Standard methods
Oxygen	Automated Winkler, amperometric end point	1 $\mu mol\ l^{-1}$	Culbertson and Huang, 1987
Ammonium	Automated colorimetric w/ liquid waveguide flow cell	5.0 $nmol\ l^{-1}$	Li et al., 2005
Nitrite	Automated colorimetric w/ liquid waveguide flow cell	0.1 $nmol\ l^{-1}$	Zhang, 2000
Nitrate	Automated colorimetric w/ liquid waveguide flow cell	2.0 $nmol\ l^{-1}$	Zhang, 2000
Phosphate	Automated colorimetric w/ liquid waveguide flow cell	0.5 $nmol\ l^{-1}$	Zhang and Chi, 2002
Silicate	Automated colorimetric	0.4 $\mu mol\ l^{-1}$	Parsons et al., 1984
Pigments	HPLC	NA	Bidigare, 1991
DOC/DON	Oxidative Combustion	NA	Sharp et al., 2002a, b
POC/PON	Oxidative Combustion	NA	Cutter and Radford-Knoery, 1990

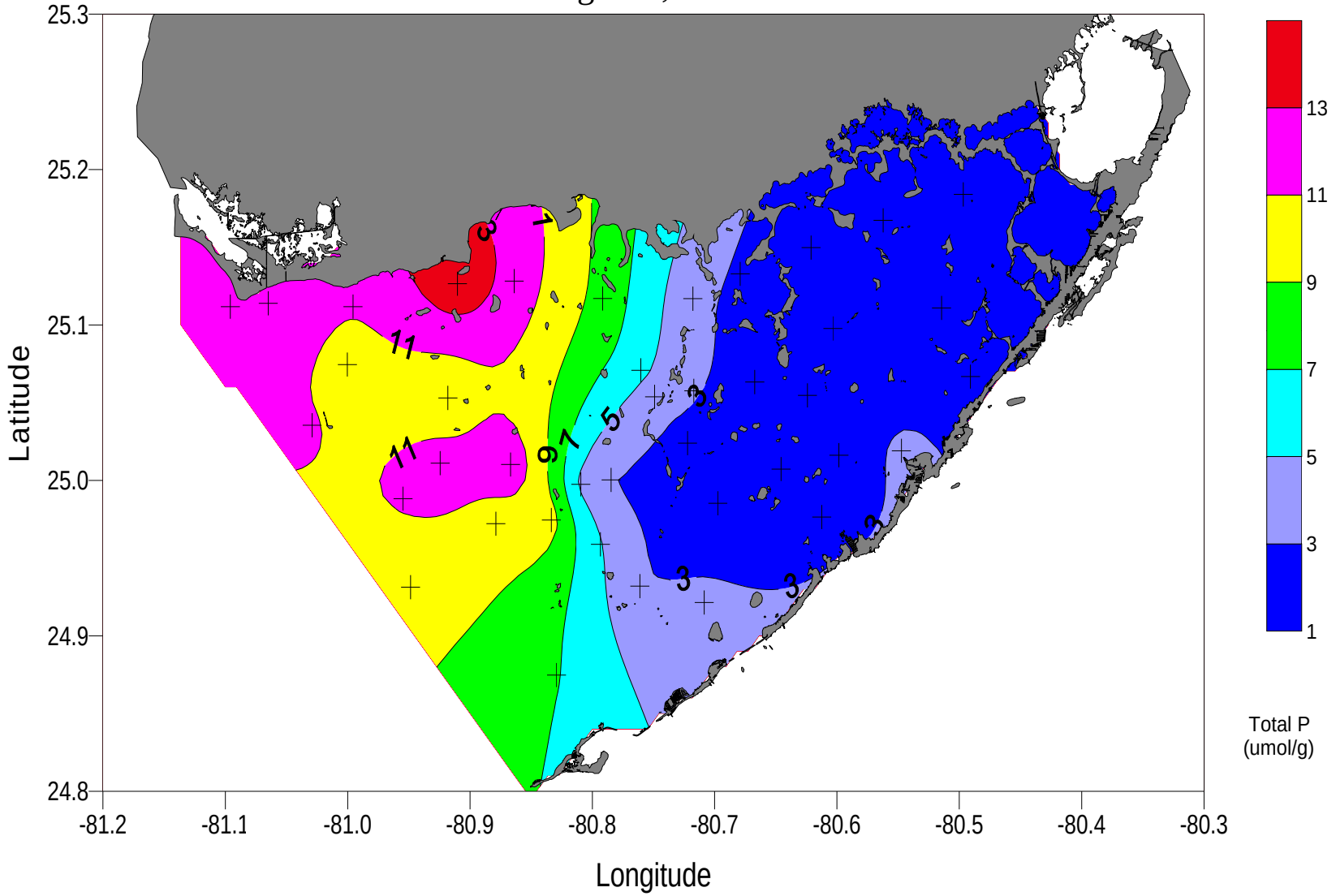
Spatial pattern of nM dissolved phosphate in Florida Bay water

Zhang & Chi, ES&T 2002

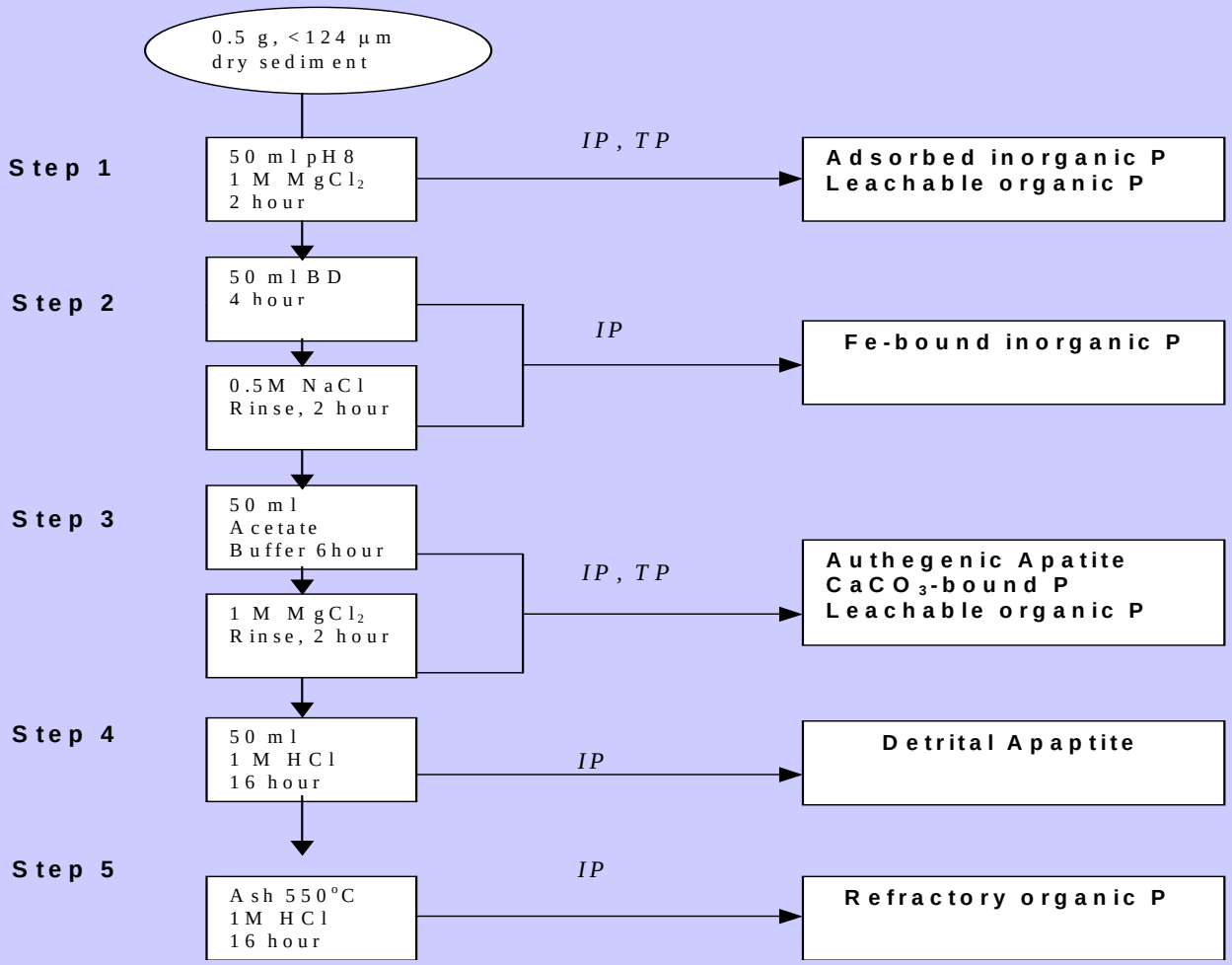


Total Sedimentary Phosphorus in Florida Bay

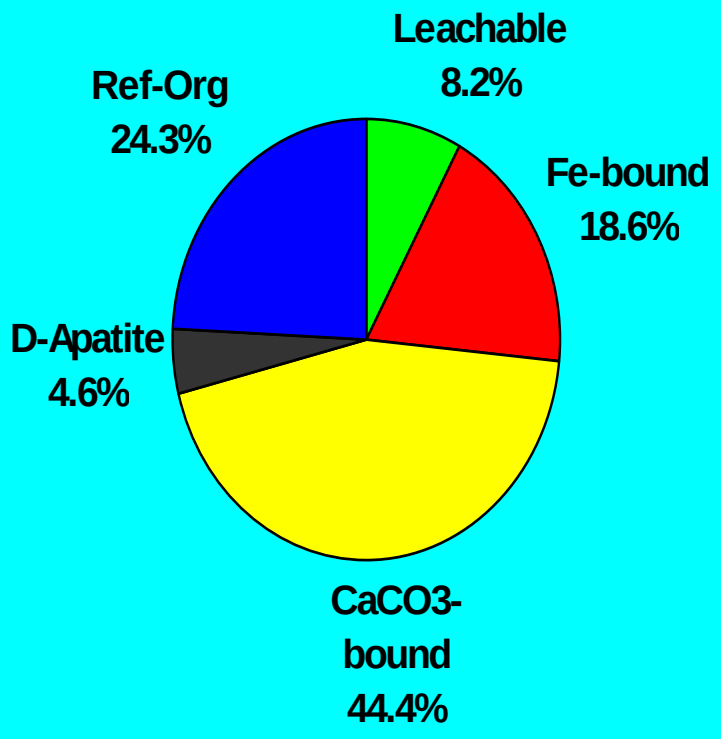
Zhang et al, GBC 2004

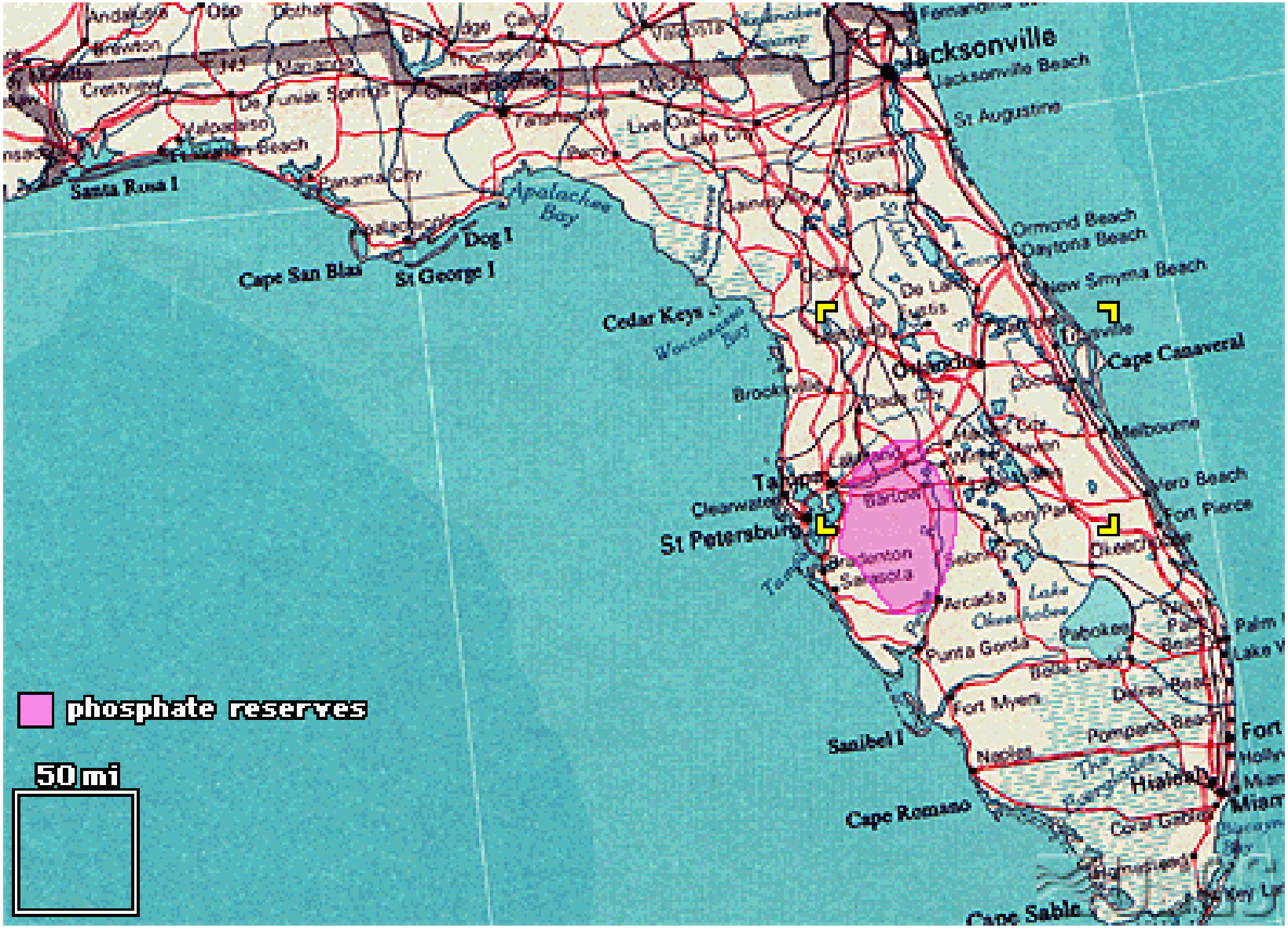


Sequential extraction procedure

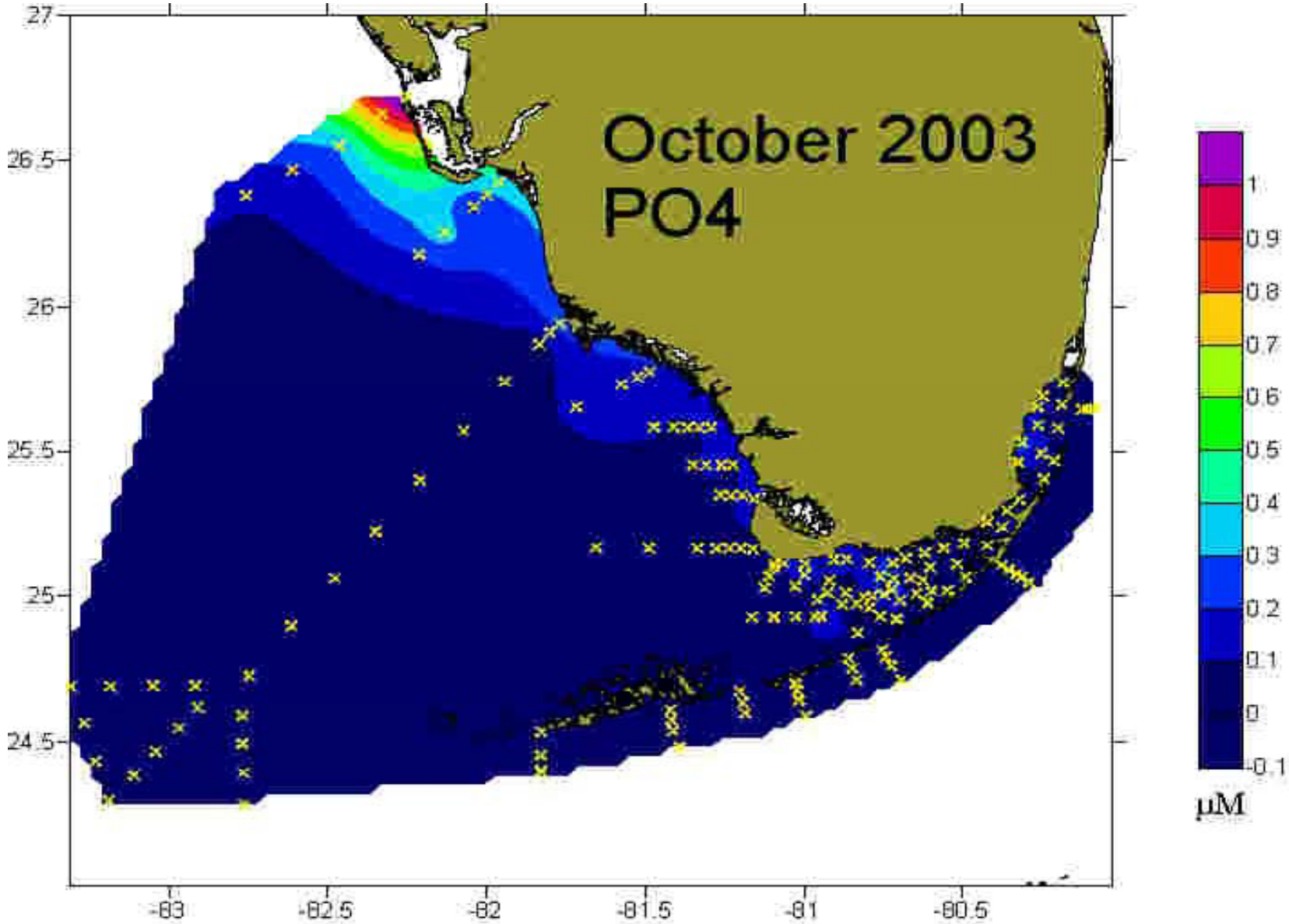


Fractions of P in Florida Bay sediment





Jacksonville
Jacksonville Beach
St Augustine
Ormond Beach
Daytona Beach
New Smyrna Beach
Cape Canaveral
Melbourne
Vero Beach
Fort Pierce
Santa Rosa I
Cape San Blas
St George I
Dog I
Apalachee Bay
Cedar Keys
Brooksville
Tampa
Clearwater
St Petersburg
Bradenton
Sarasota
Arcadia
Punta Gorda
Fort Myers
Sanibel I
Cape Romano
Cape Sable
Hialeah
Fort
phosphate reserves
50 mi


October 2003
PO4
27
26.5
26
25.5
25
24.5
-83
-82.5
-82
-81.5
-81
-80.5
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
µM

Parameters essential to model sediment/water exchange of phosphate

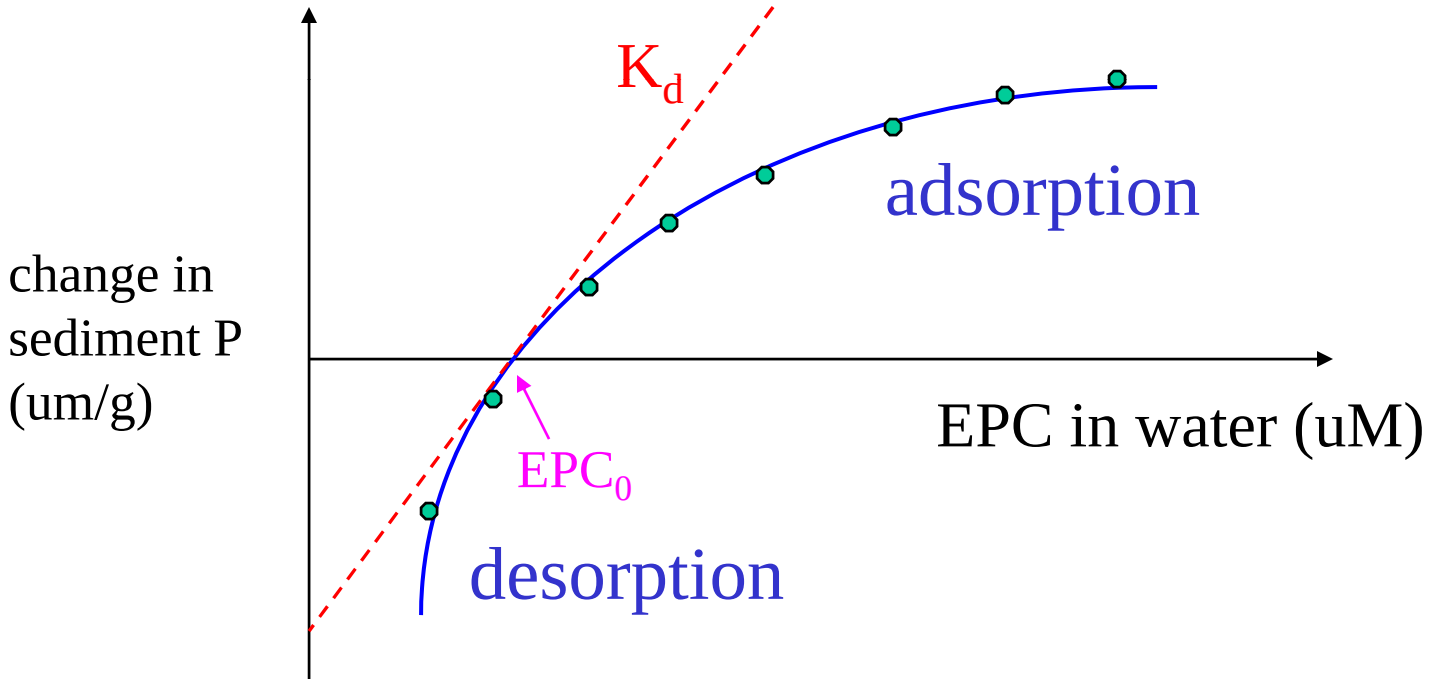
1. Distribution coefficient

$$K_d = P_{sediment} / P_{water}$$

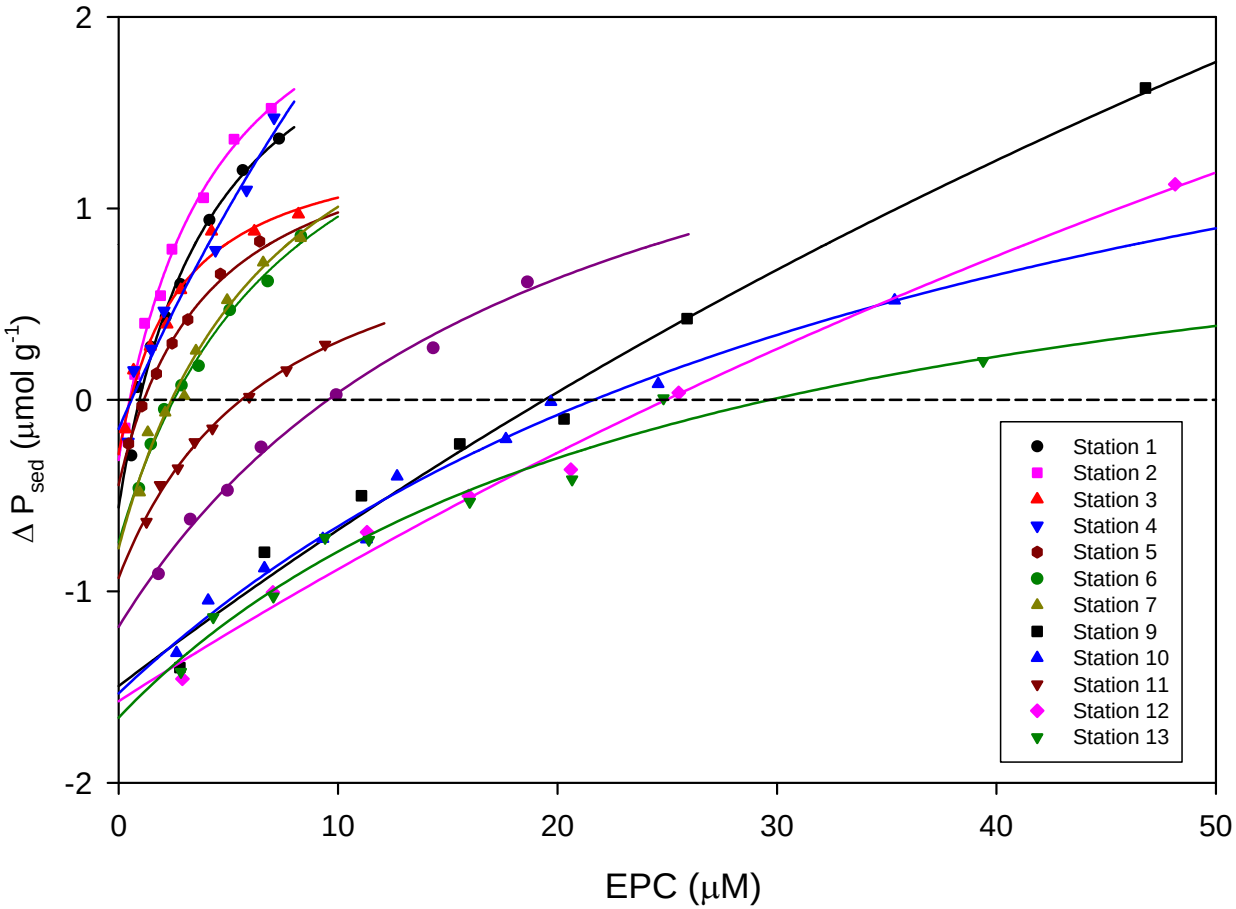
2. Zero Equilibrium Phosphate Concentration (EPC_0)

   P concentration in water where no exchange of P takes place between sediment and water

Sorption experiments to quantify K_d and EPC_0

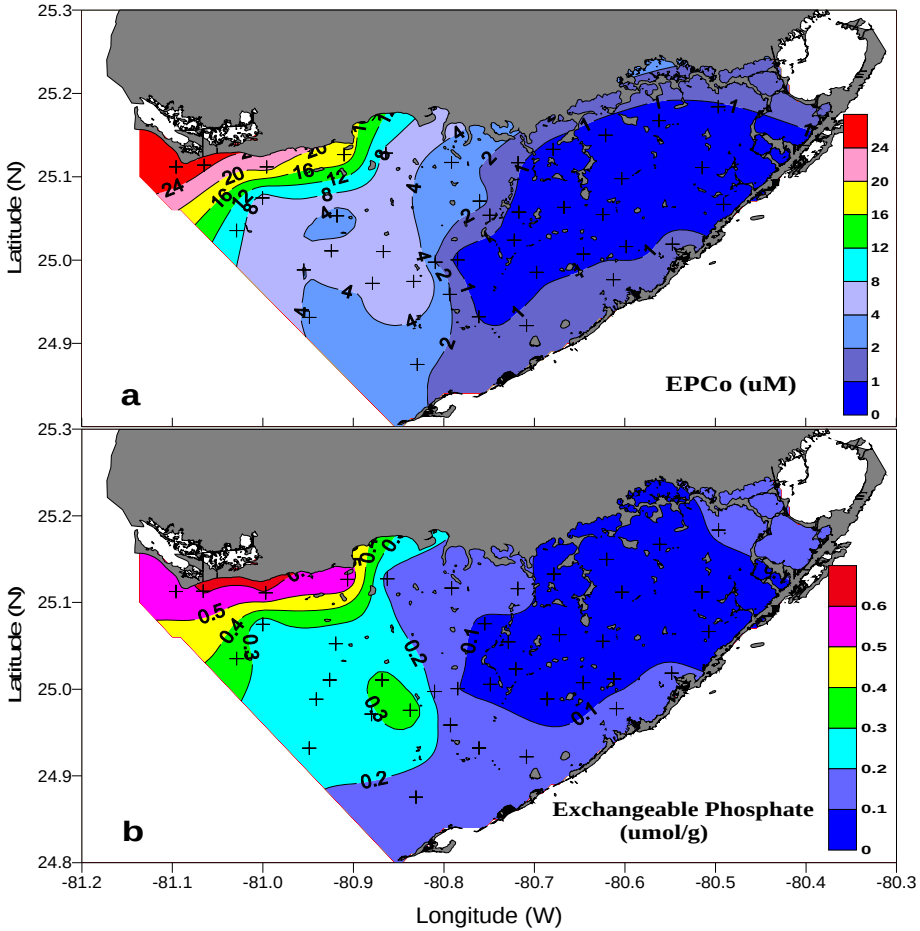


Typical sorption isotherms of sediments across sedimentary P gradient along the northern coast (stations 1 to 13) in Florida Bay

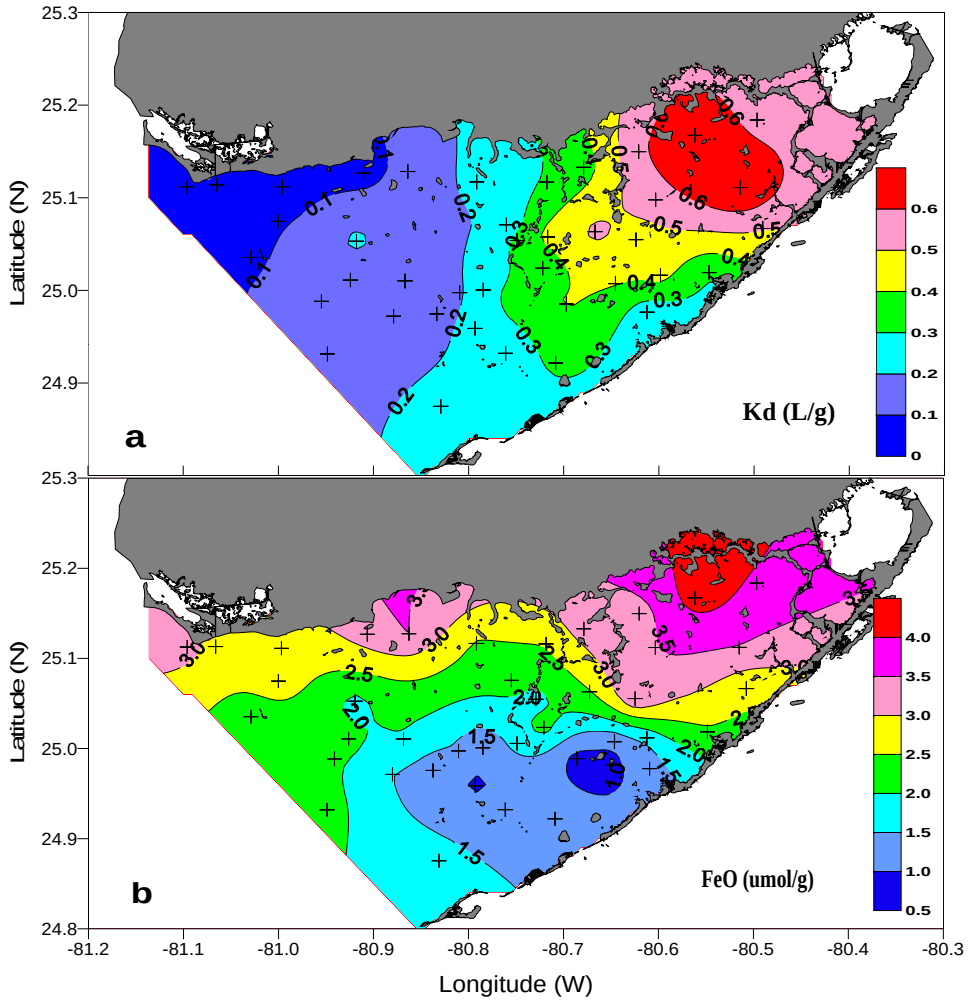


Spatial distribution of (a) EPC_0 and (b) P_{exch} in Florida Bay

Zhang &Huang, ES&T 2007

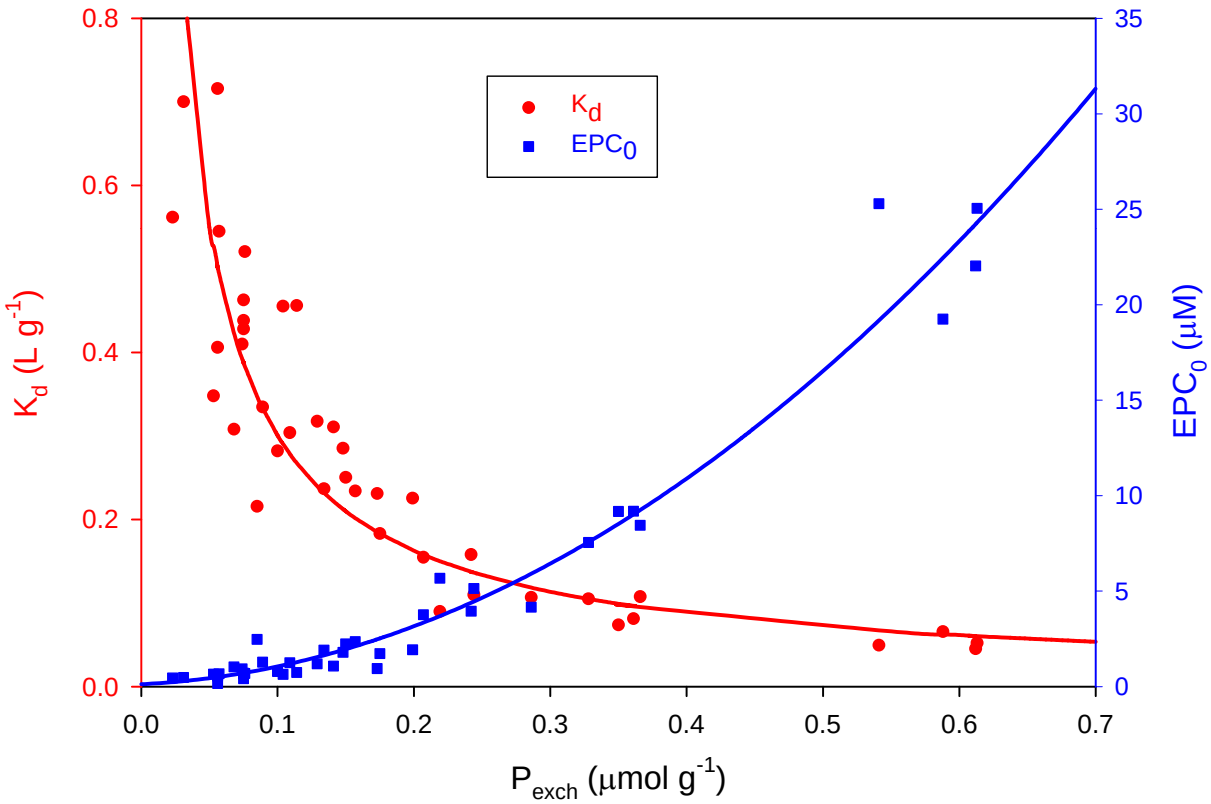


Spatial distribution of (a) K_d and (b) FeO in Florida Bay

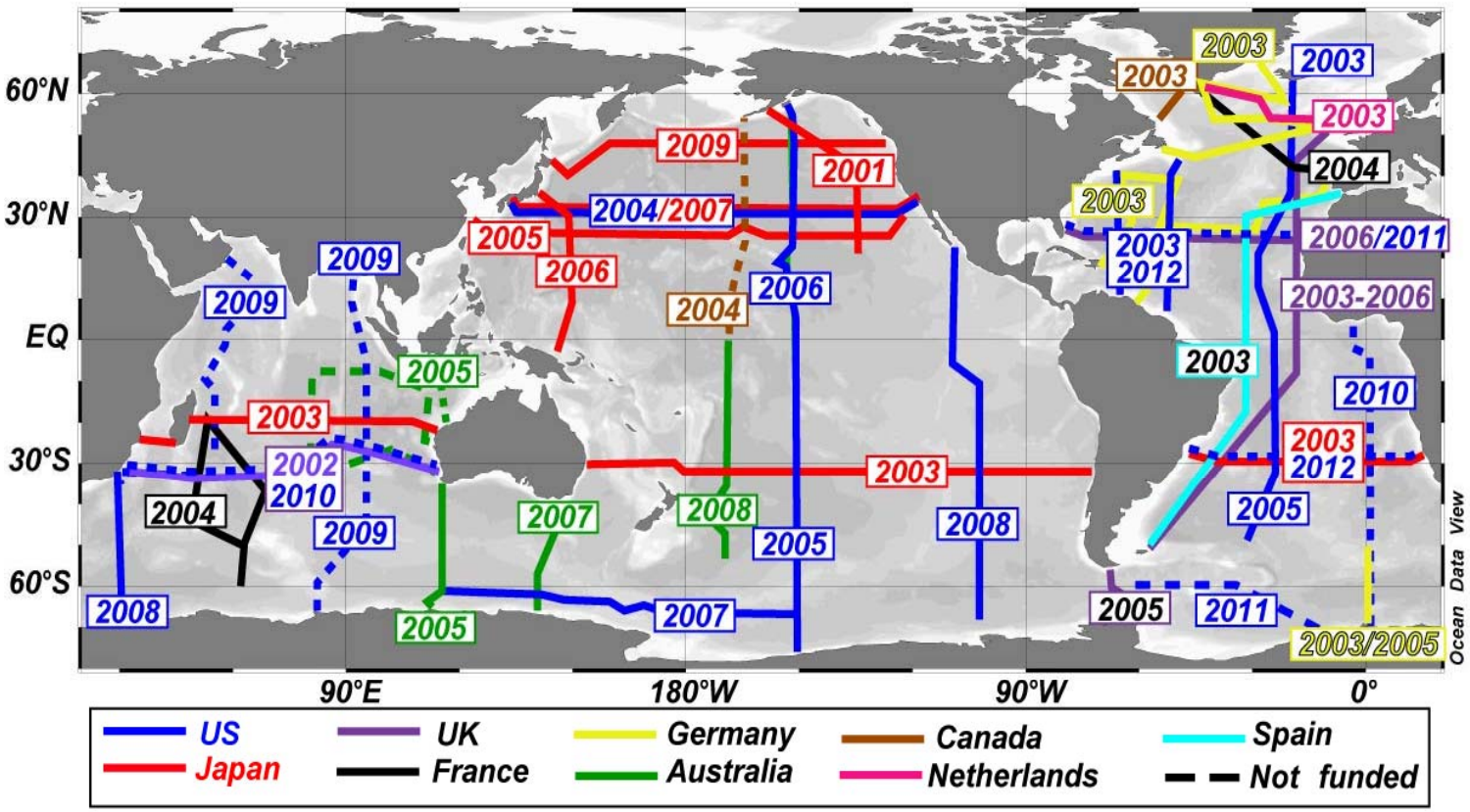


EPC_0 and K_d as a function of P_{exch} in Florida Bay

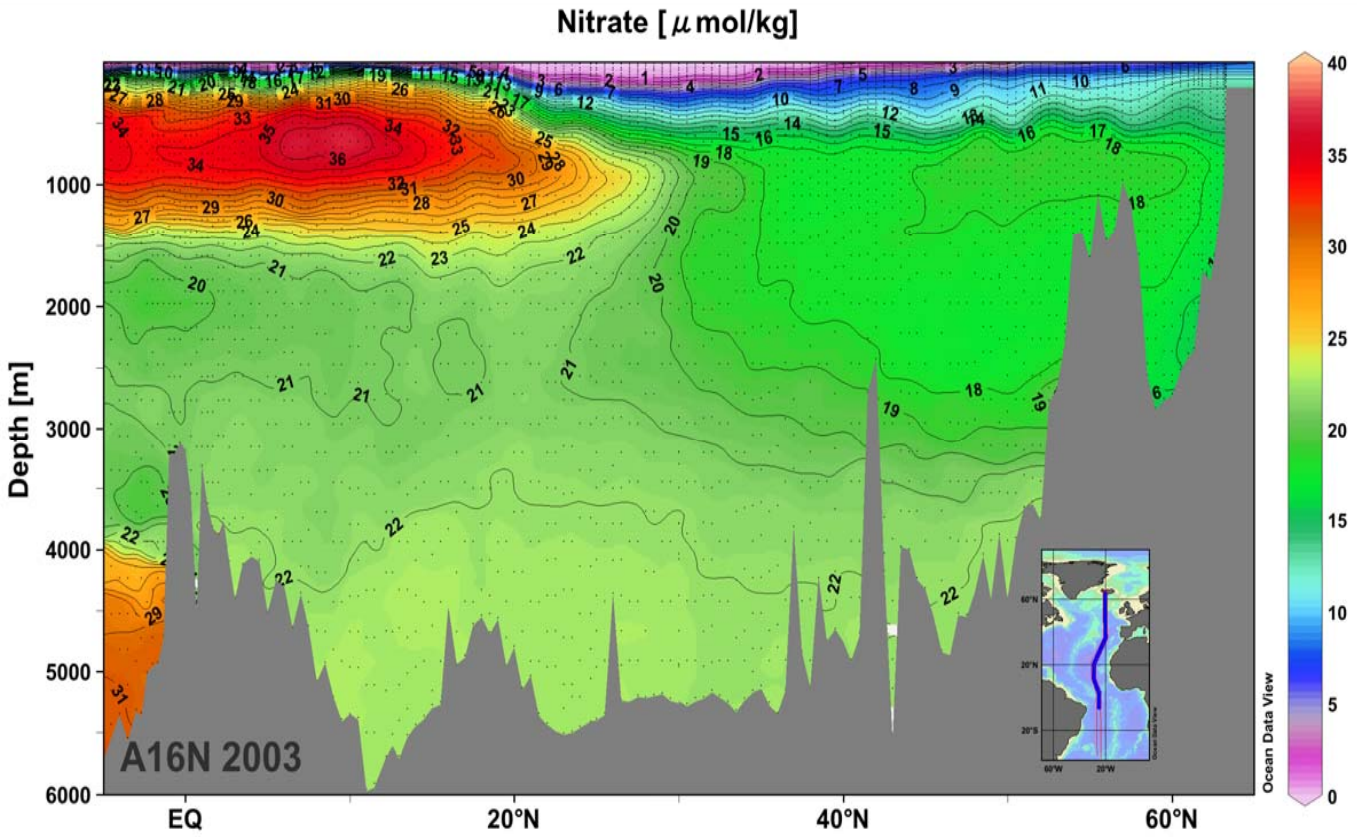
Zhang &Huang, ES&T 2007



Repeat Hydrography CO_2/tracer Program hydrographic sections



Nitrate in N. Atlantic



Outlook & challenges

Nutrient Dynamics/Ecosystem Functioning

- Shipboard underway measurement for oligotrophic ecosystem
- In situ nutrient sensors for time-series monitoring(e.g. coral reefs)
- Developing CRM to Improve accuracy