Large Corals in Florida Bay: Faithful Recorders of the Environmental Conditions Over the Past 200 Years

Peter K. Swart, Remy Okazaki, & Chris Langdon

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RSMAS, University of Miami

Genny Healy, Phil Kramer, Dave Rudnick

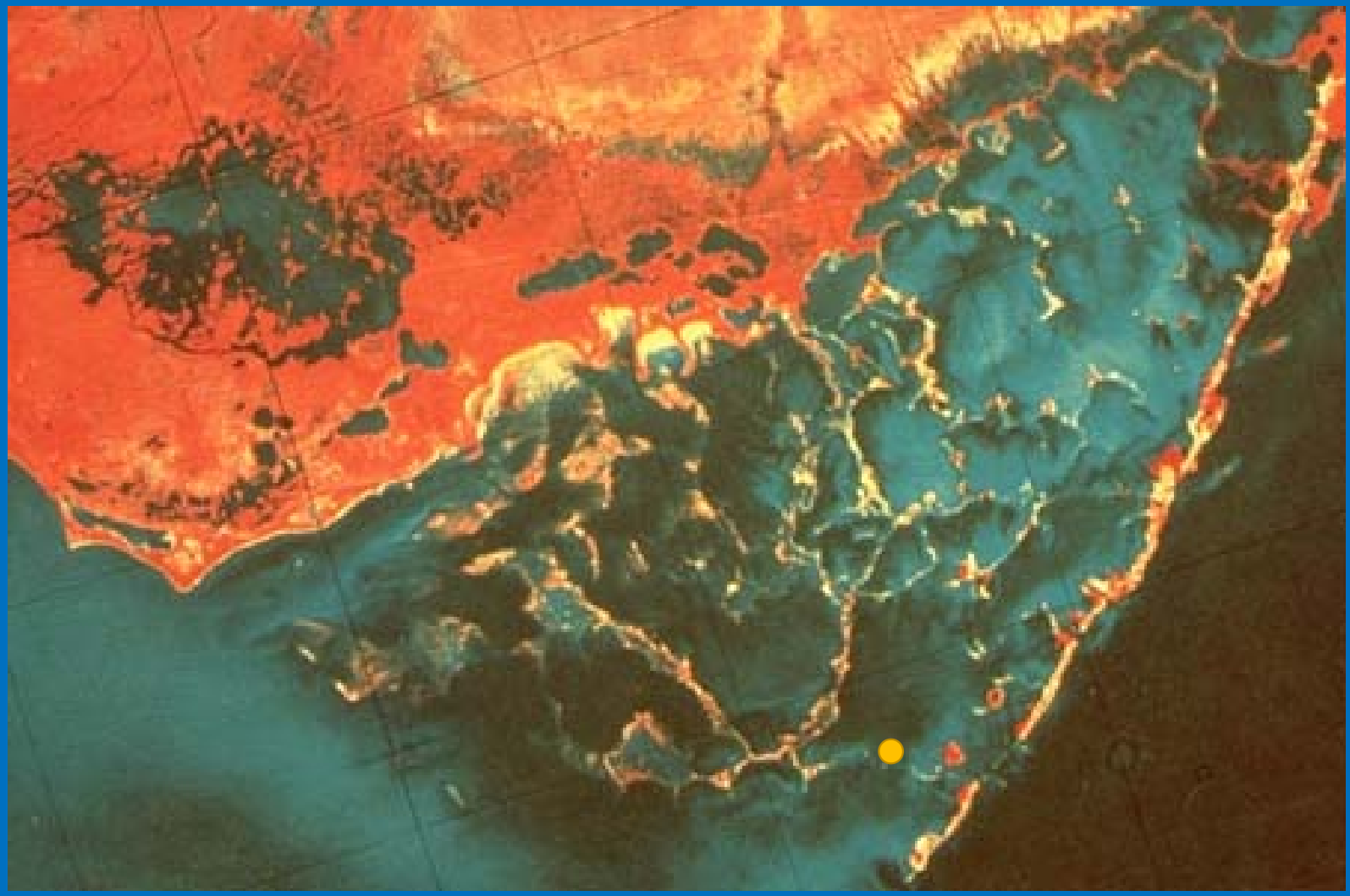
Funding : SFWMD, NSF

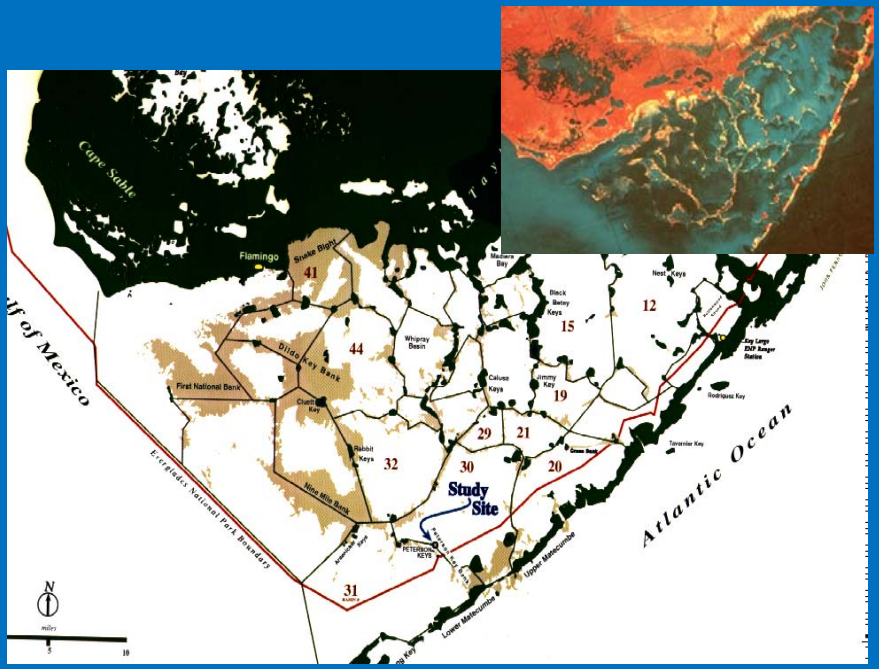
FIU

GEER 2015

Key Points

- Florida Bay is changing
  - Sea level rise
    - More dominated by marine waters
    - Less Variable
  - The monitoring which was carried out by FIU between 1989 and 2007 was very far sighted
  - Although it was unfortunately discontinued, based on these data and data collected previously we have a picture of was has happened in the Bay over the past 50 years.
  - There are corals which have grown in FB for 200 years, but the manner in which the corals respond to salinity and temperature has changed because of sea level and anthropogenic manipulation.

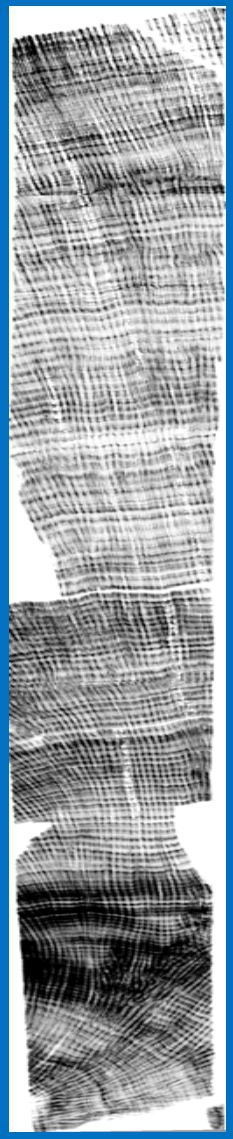


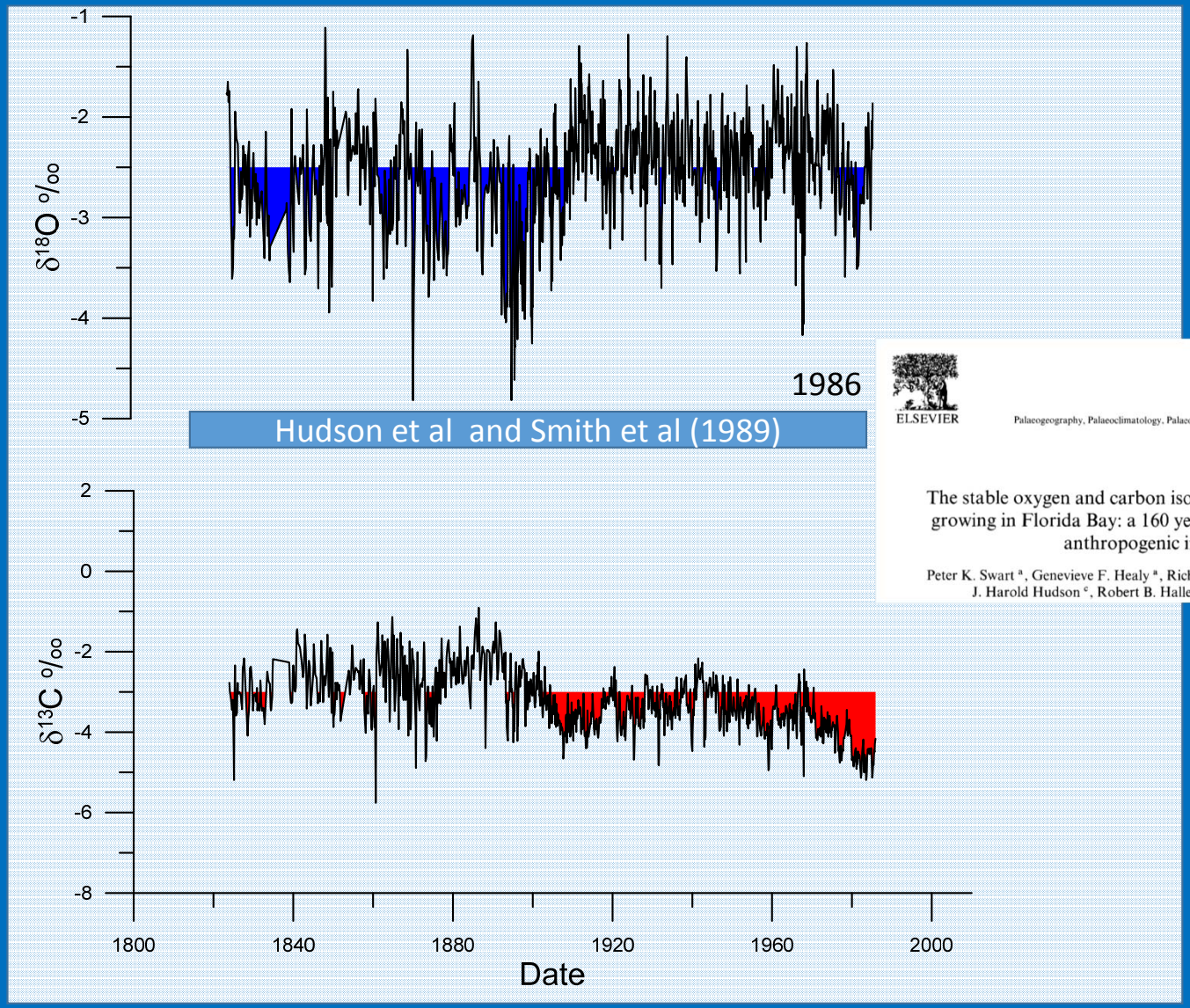


1986- Cored by Harold Hudson

Hudson, J.H., Powell, G.V.N., Robblee, M.B. and Smith, T.J. (1989) A 107-Year-Old Coral From Florida Bay - Barometer Of Natural And Man-Induced Catastrophes. *Bull. Mar. Sci., 44, 283-291.*

Smith, T.J., Hudson, J.H., Robblee, M.B., Powell, G.V.N. and Isdale, P.J. (1989) Fresh-Water Flow From The Everglades To Florida Bay - A Historical Reconstruction Based On Fluorescent Banding In The Coral *Solenastrea bournoni*. *Bull. Mar. Sci., 44, 274-282.*





ELSEVIER

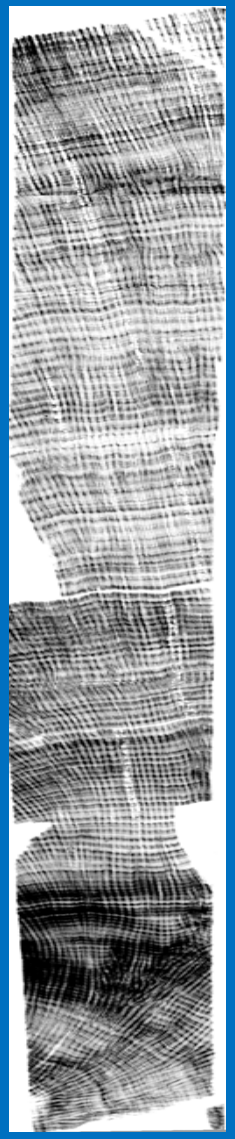
PALAEO

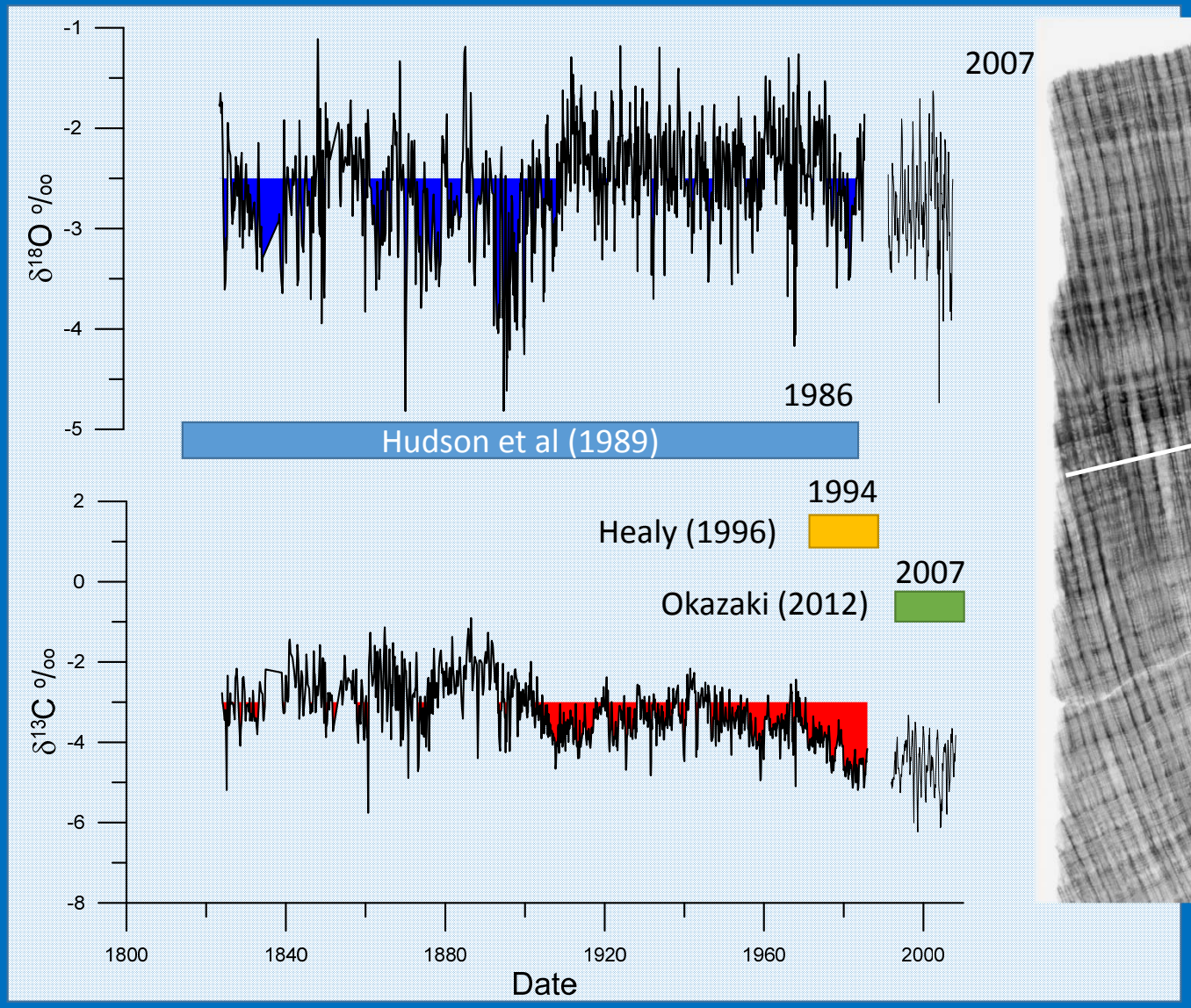
Palaeogeography, Palaeoclimatology, Palaeoecology 123 (1996) 219–237

The stable oxygen and carbon isotopic record from a coral growing in Florida Bay: a 160 year record of climatic and anthropogenic influence

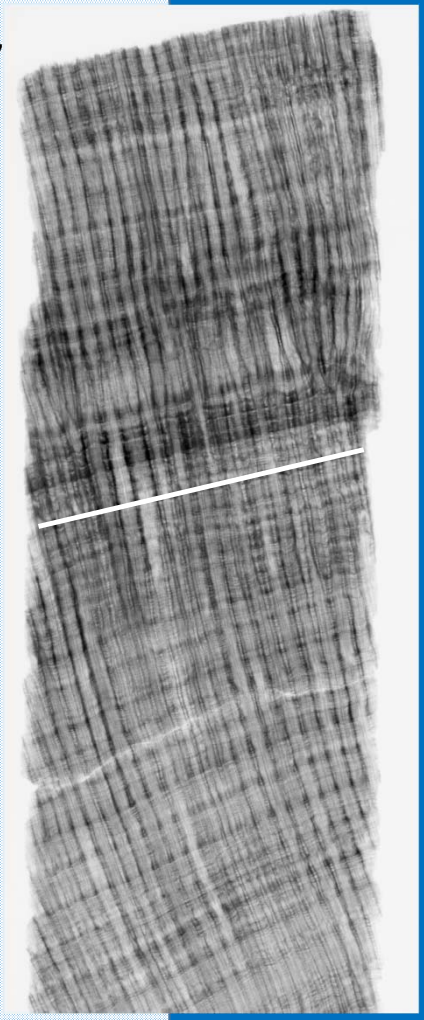
Peter K. Swart [a], Genevieve F. Healy [a], Richard E. Dodge [b], Philip Kramer [a], J. Harold Hudson [c], Robert B. Halley [d], Michael B. Robblee [e]

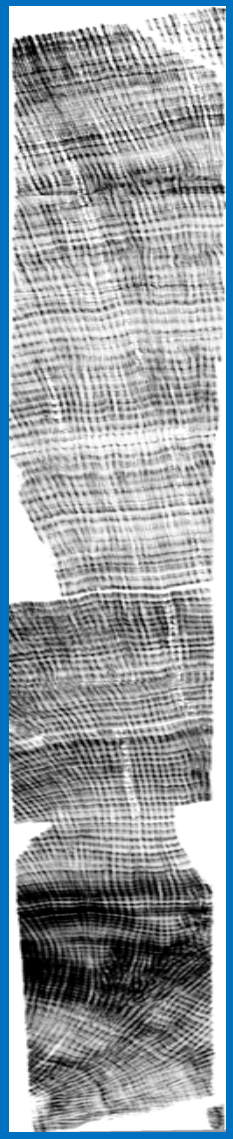
1986

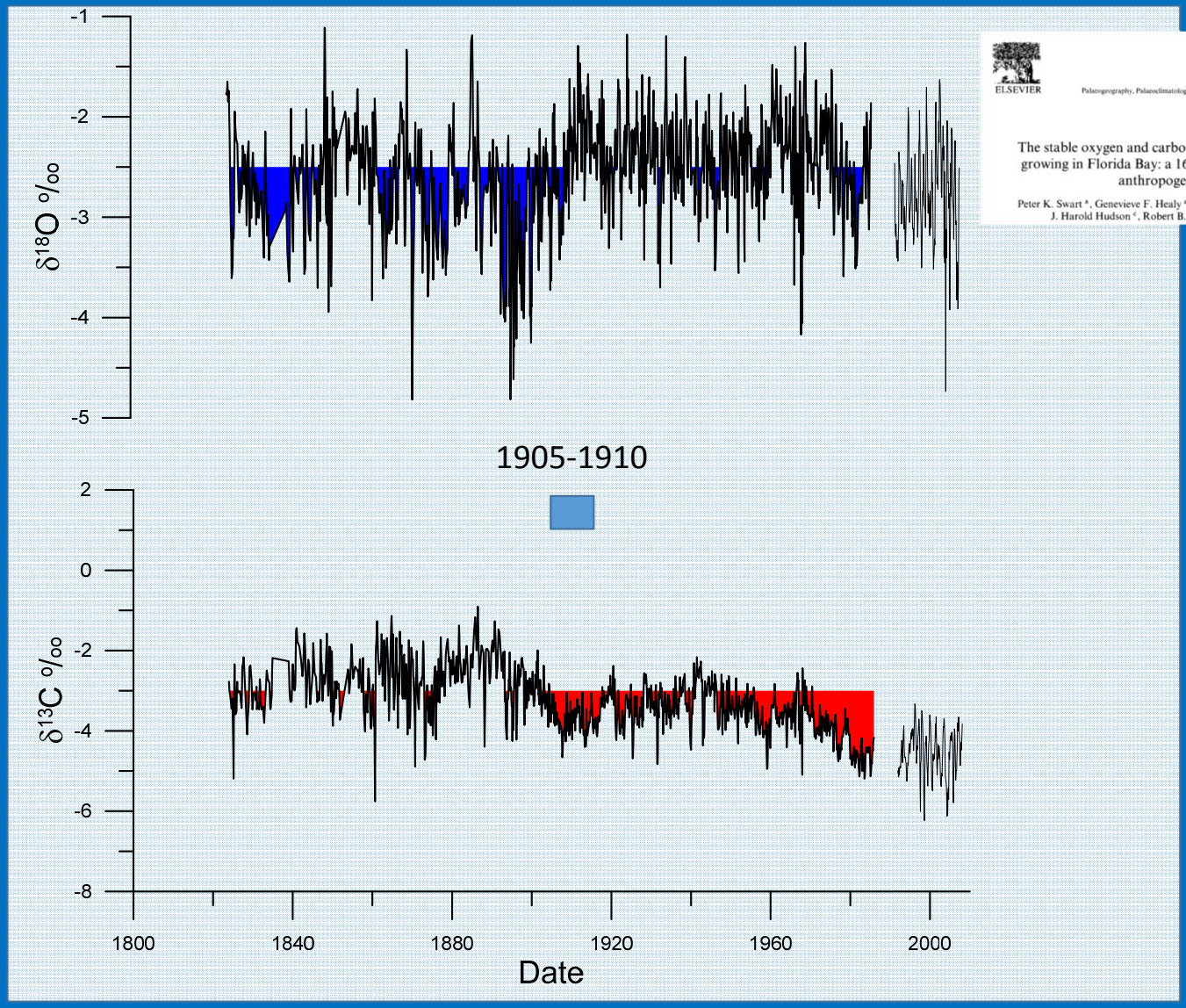


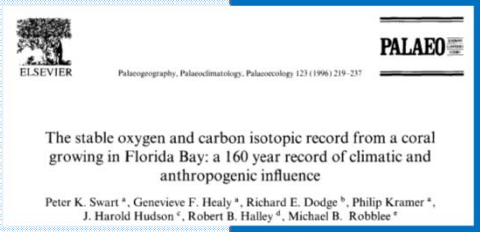

-1
-2
-3
-4
-5
δ18O °/oo
1986
Hudson et al (1989)
1994
Healy (1996)
2007
Okazaki (2012)
2
0
-2
-4
-6
-8
δ13C °/oo
1800
1840
1880
1920
1960
2000
Date

2007









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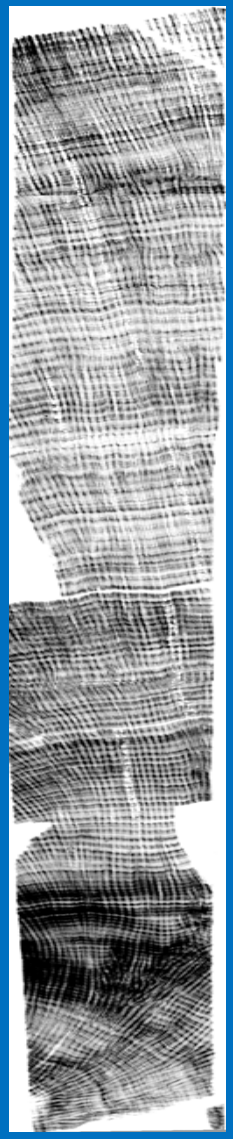
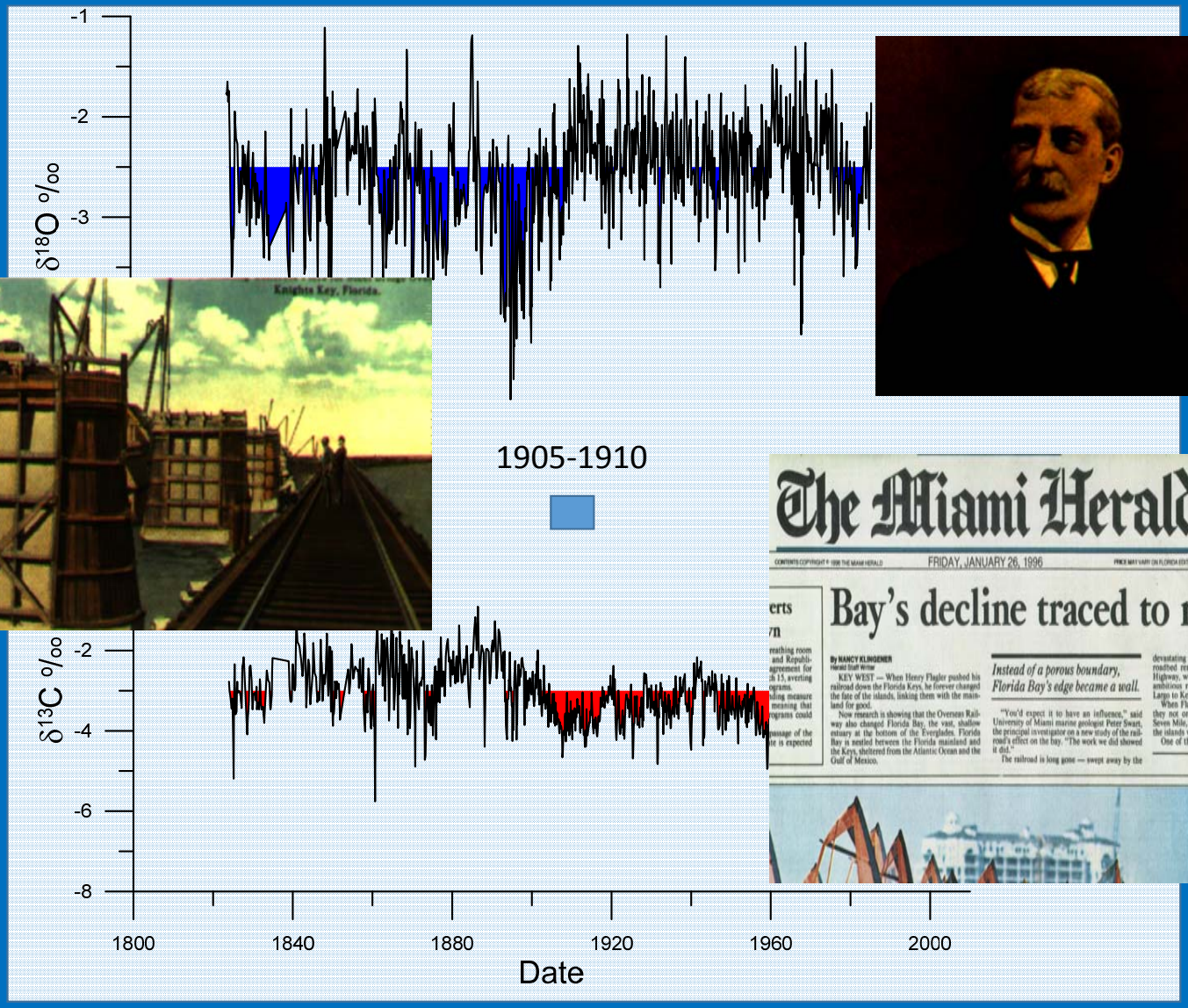
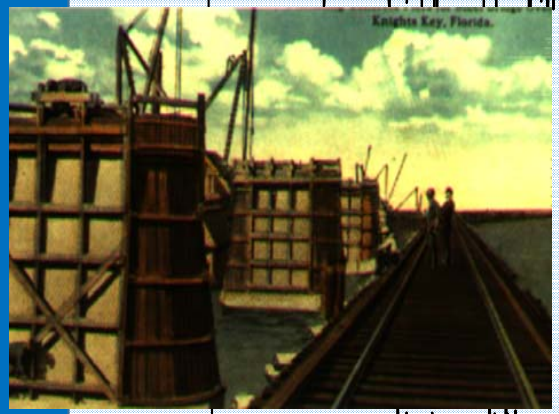
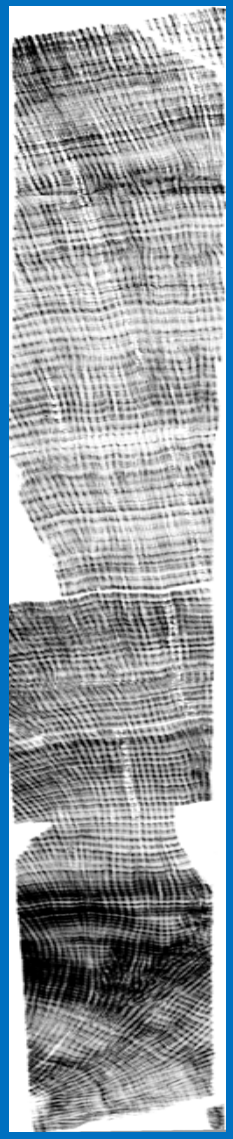
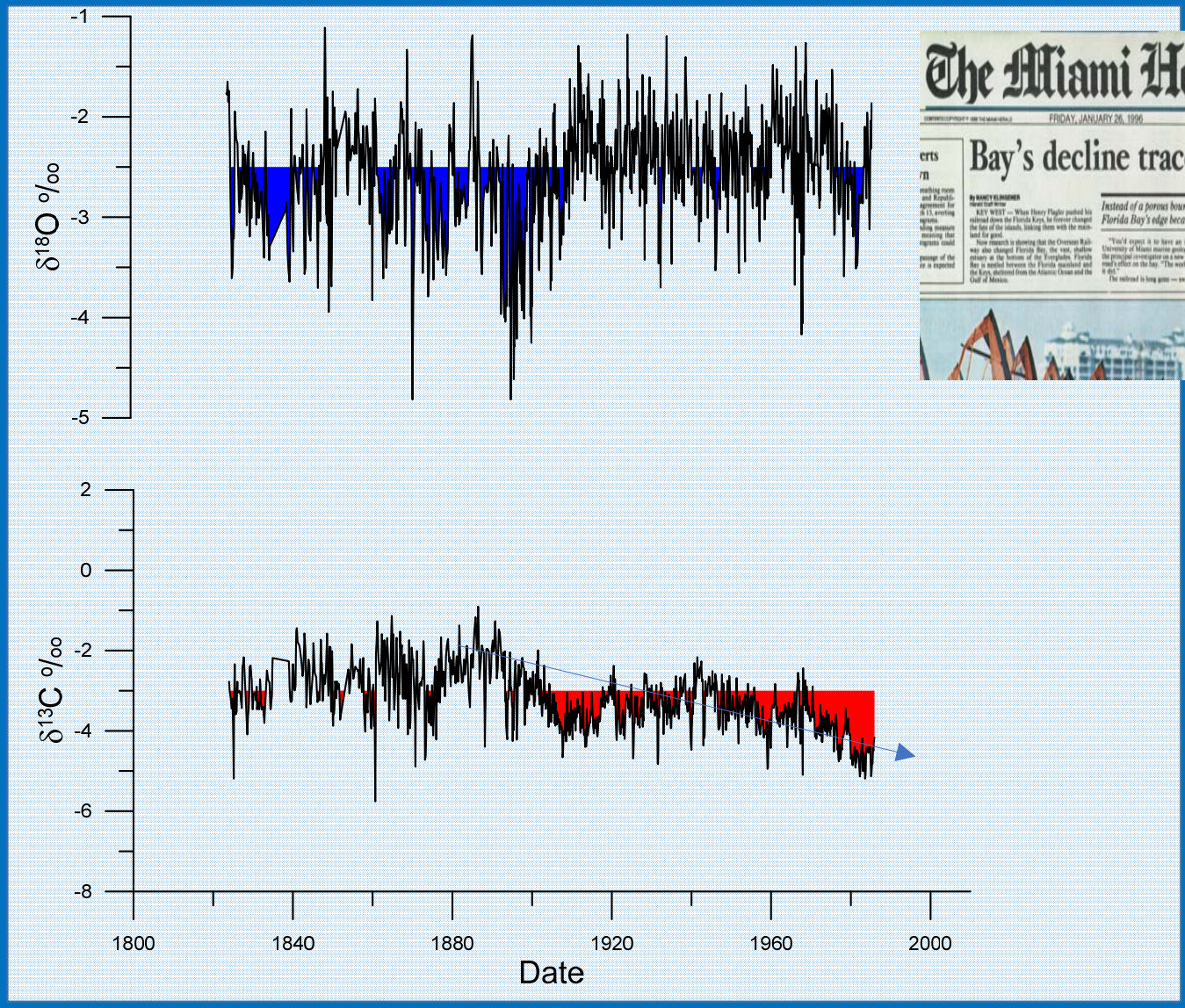



-1
-2
-3
$\delta^{18}O$ ‰
-2
-4
-6
-8
$\delta^{13}C$ ‰
1800
1840
1880
1920
1960
2000
Date
1905-1910


Knights Key, Florida.


The Miami Herald
FLORIDA EDITION
75 CENTS
FRIDAY, JANUARY 26, 1996
Bay's decline traced to railway
Instead of a porous boundary, Florida Bay's edge became a wall.
Hoping Frisco fumbles





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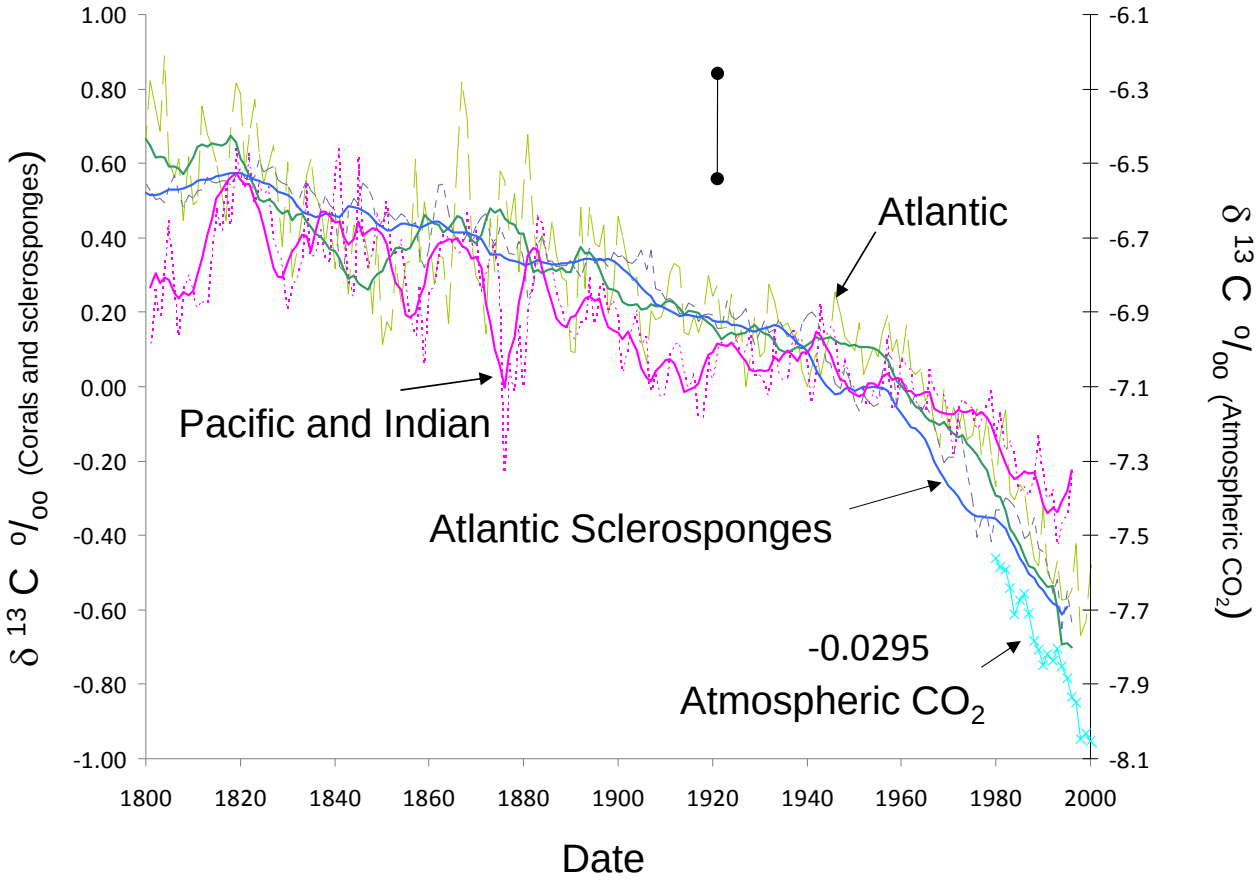
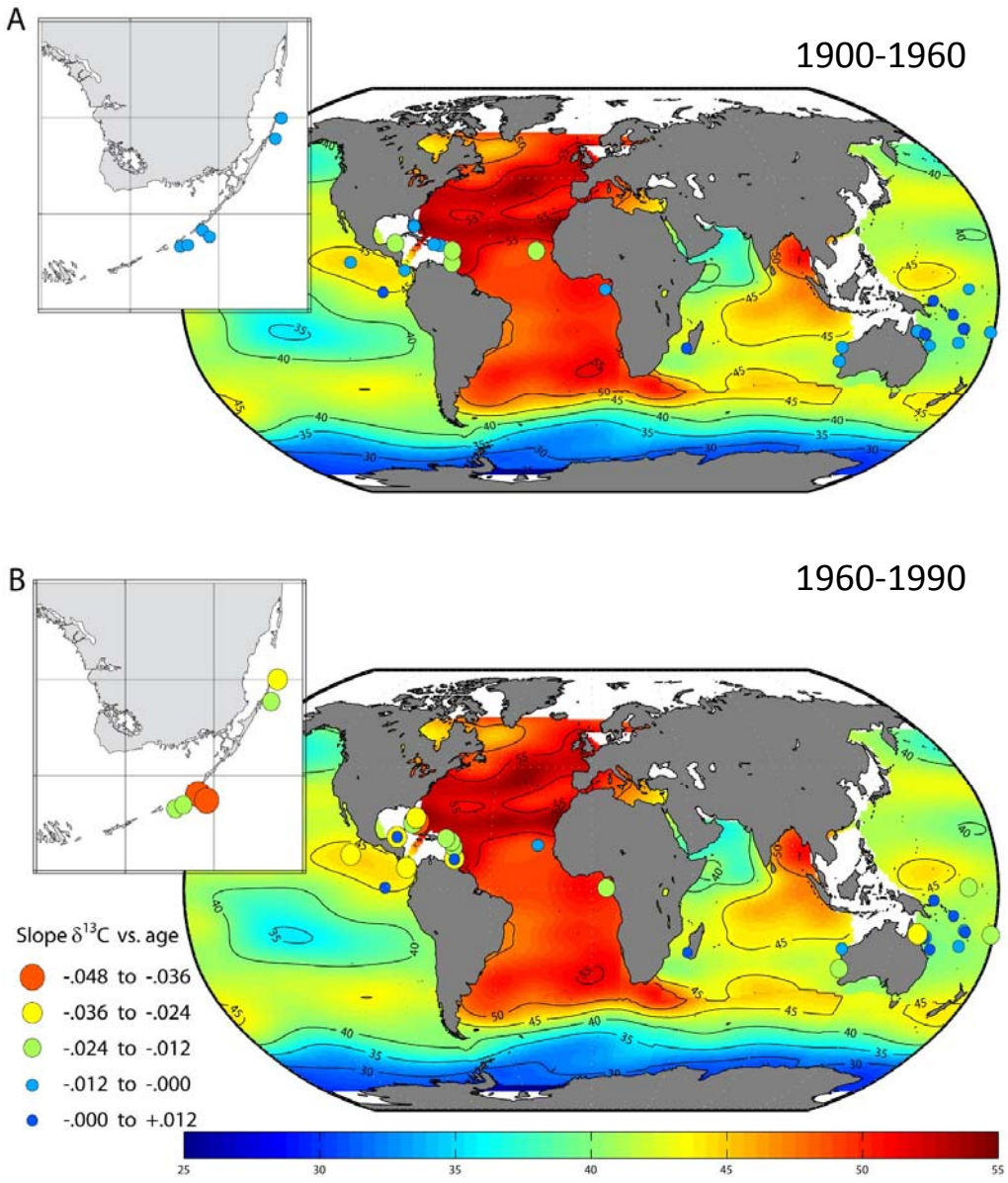
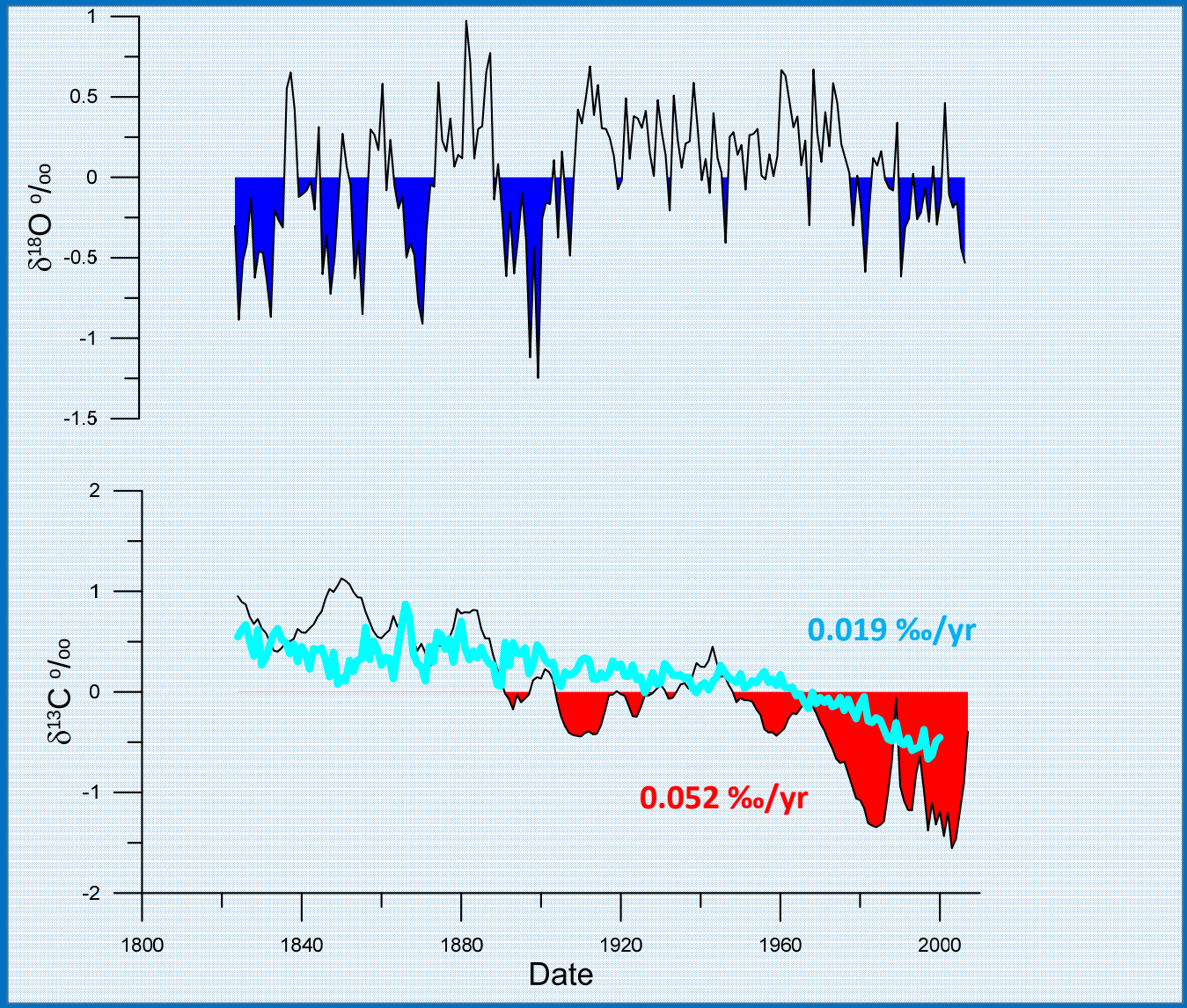


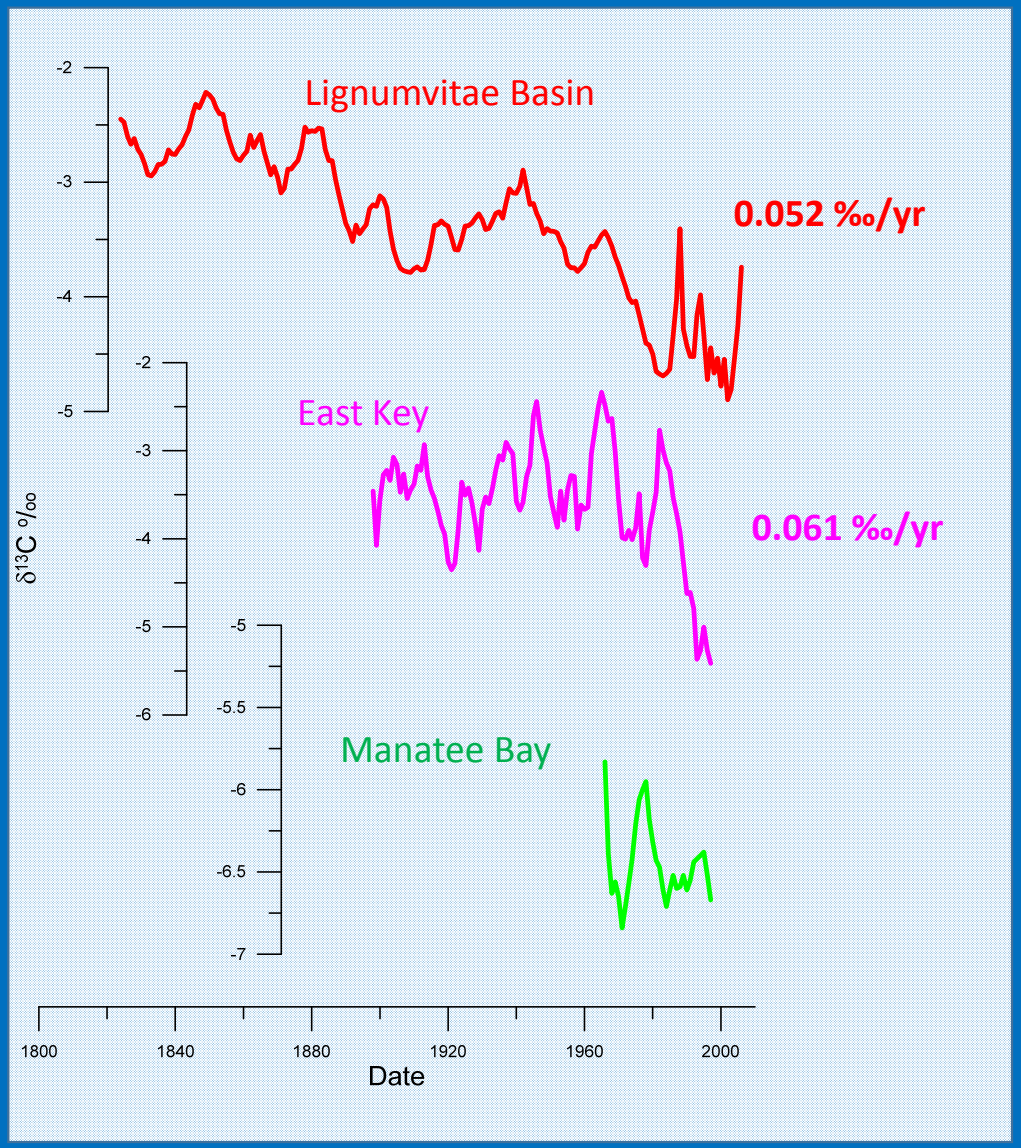
Swart, P.K., Greer, L., Rosenheim, B.E., Moses, C.S., Waite, A.J., Winter, A., Dodge, R.E. and Helmle, K. (2010) The C-13 Suess effect in scleractinian corals mirror changes in the anthropogenic CO2 inventory of the surface oceans. *Geophysical Research Letters, 37.*



Pacific	-0.007
Atlantic	-0.019
LB 1986	-0.052

Swart, P.K., Greer, L., Rosenheim, B.E., Moses, C.S., Waite, A.J., Winter, A., Dodge, R.E. and Helmle, K. (2010) The C-13 Suess effect in scleractinian corals mirror changes in the anthropogenic CO2 inventory of the surface oceans. ***Geophysical Research Letters, 37.***


1
0.5
0
-0.5
-1
-1.5
δ18O ‰
2
1
0
-1
-2
δ13C ‰
0.019 ‰/yr
0.052 ‰/yr
1800
1840
1880
1920
1960
2000
Date


Lignumvitae Basin
0.052 ‰/yr
East Key
0.061 ‰/yr
Manatee Bay
δ13C ‰
-2
-3
-4
-5
-2
-3
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-5
-6
-5
-5.5
-6
-6.5
-7
1800
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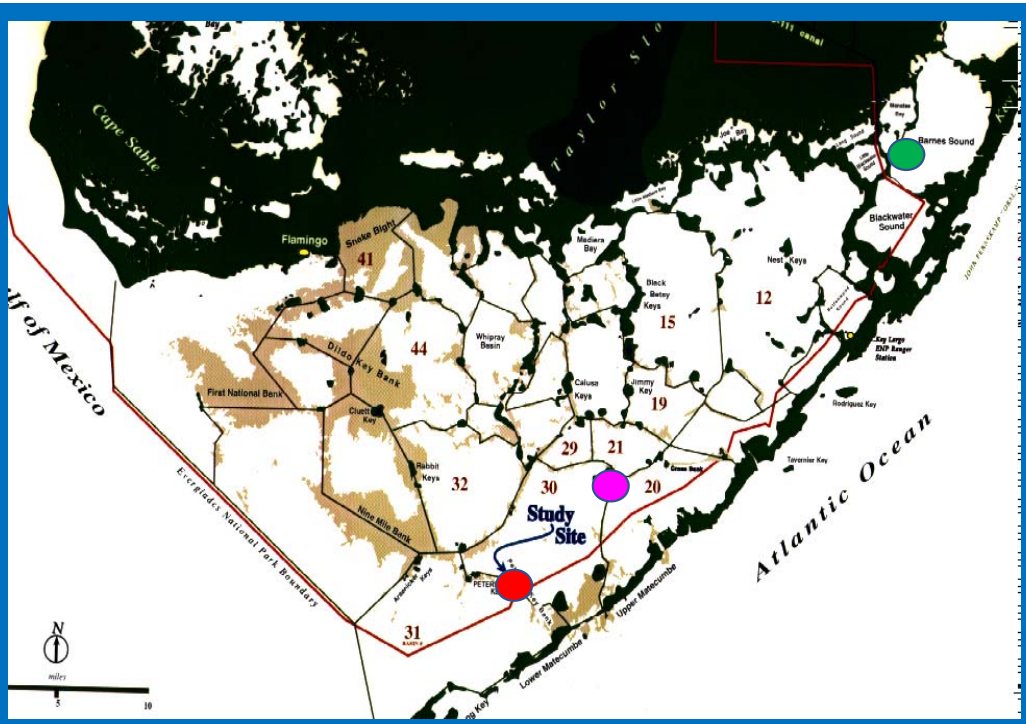
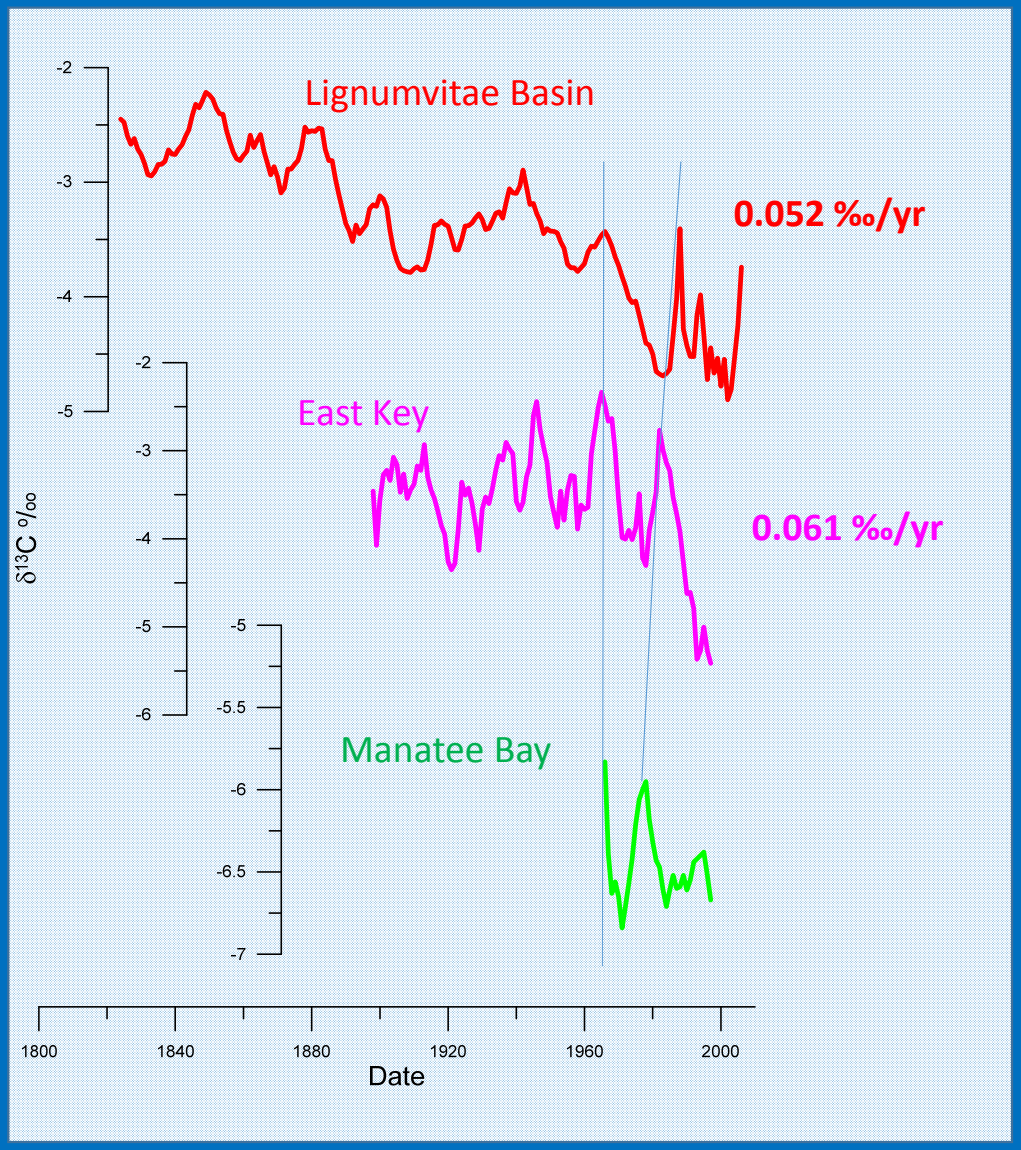
1920
1960
2000
Date


Cape Sable
Flamingo
Snake Bight
Barnes Sound
Blackwater Sound
Madeira Bay
Black Betsy Keys
Nest Keys
Whipray Basin
Dildo Key Bank
First National Bank
Chatt Key
Rabbit Keys
Nine Mile Bank
Caluosa Keys
Jimmy Key
Rodriguez Key
Tavernier Key
Key Largo DNP Ranger Station
Study Site
Everglades National Park Boundary
Upper Matecumbe
Lower Matecumbe
Atlantic Ocean
Gulf of Mexico
41
44
32
31
30
29
21
20
19
15
12
N
miles
5
10


Lignumvitae Basin
0.052 ‰/yr
East Key
0.061 ‰/yr
Manatee Bay
δ13C ‰
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-6.5
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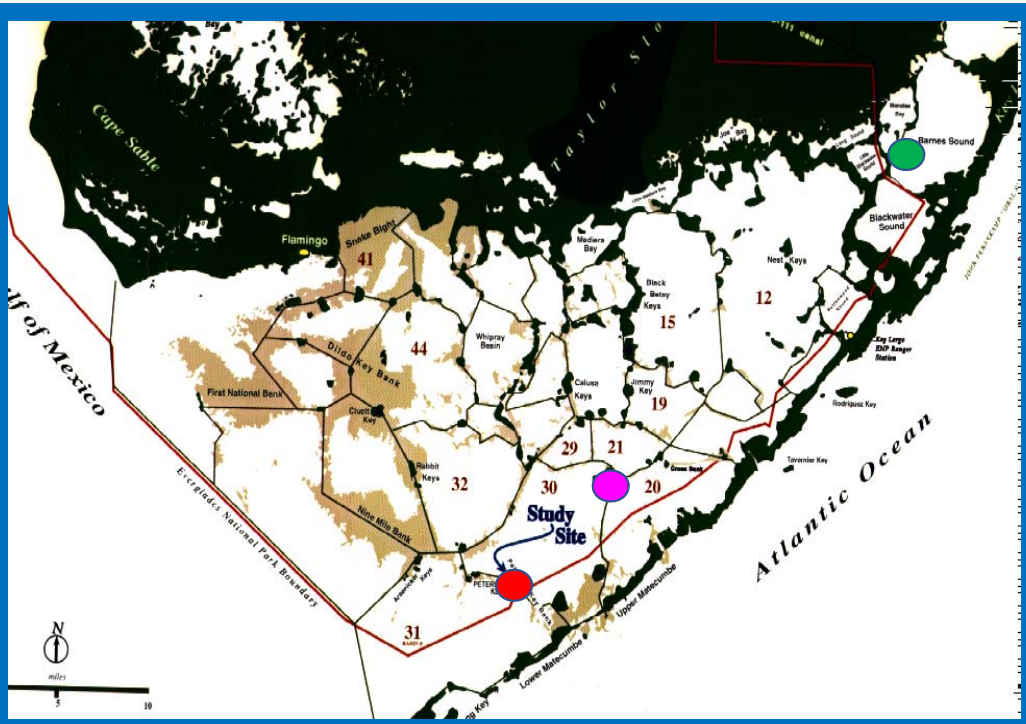
Date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Everglades National Park Boundary
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Upper Matecumbe
Lower Matecumbe
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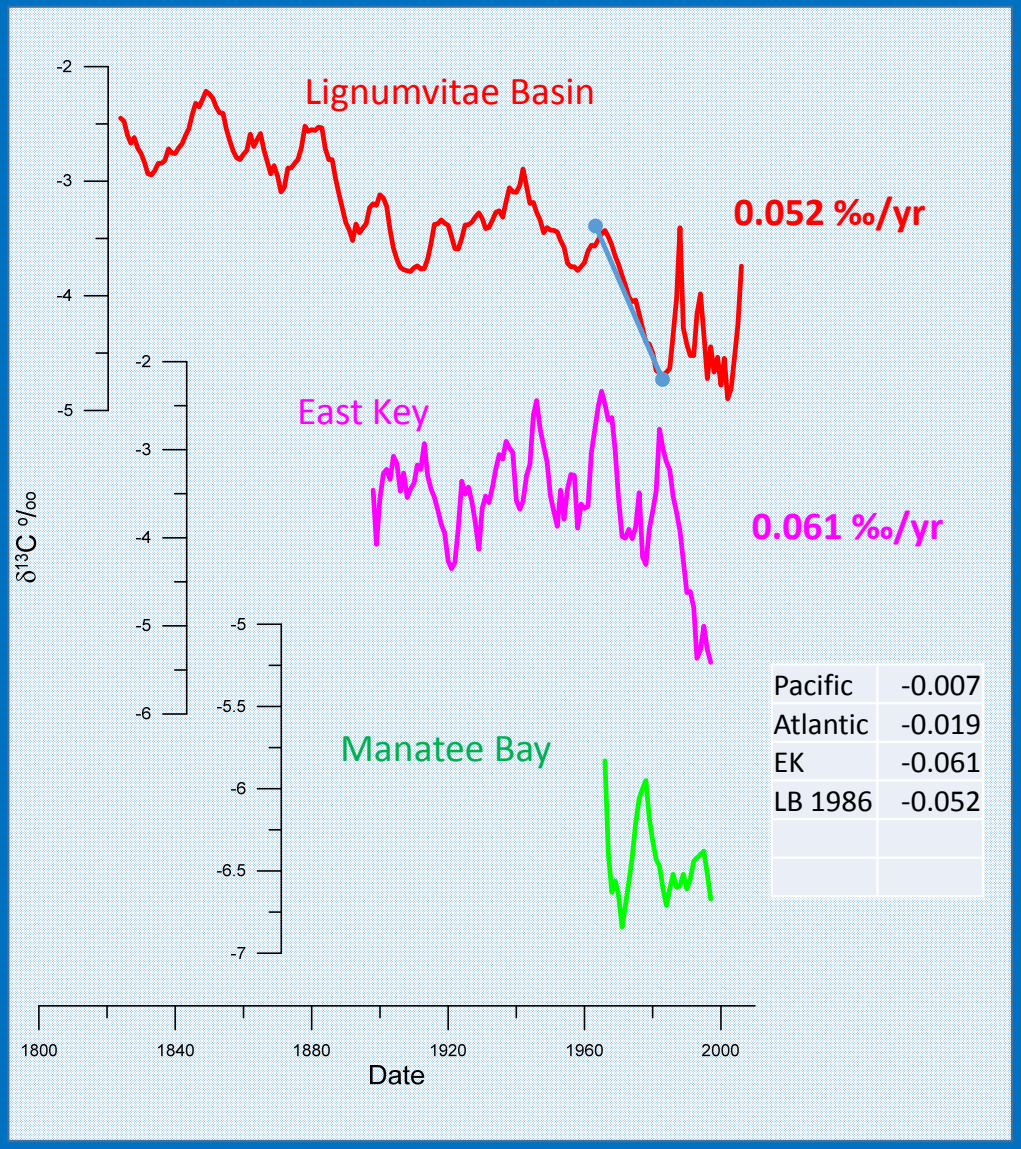
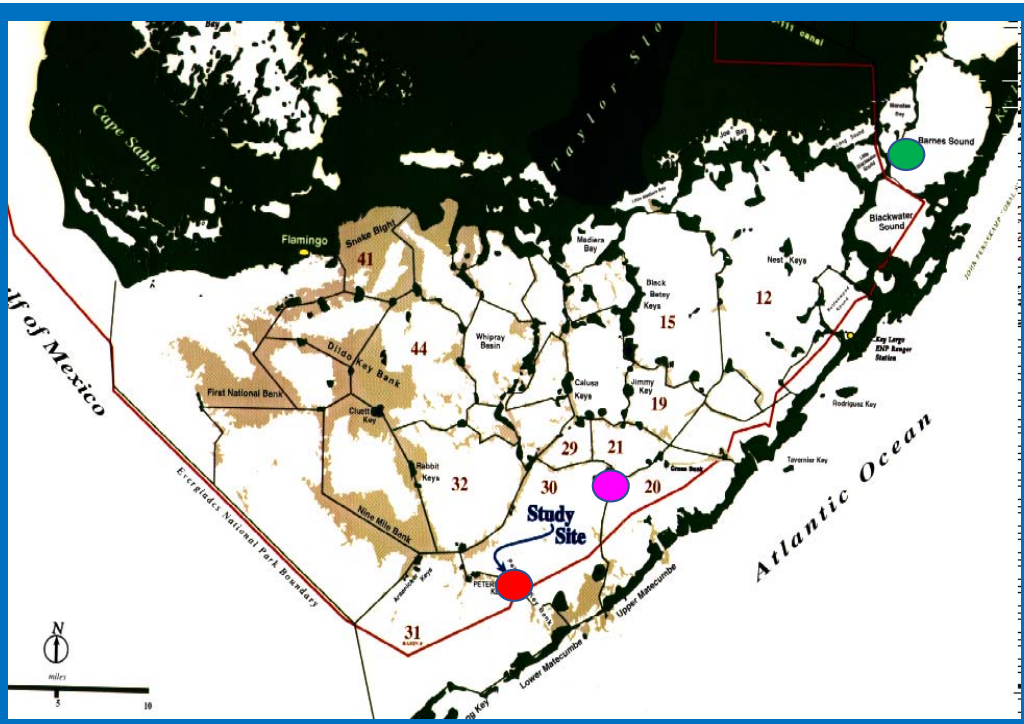
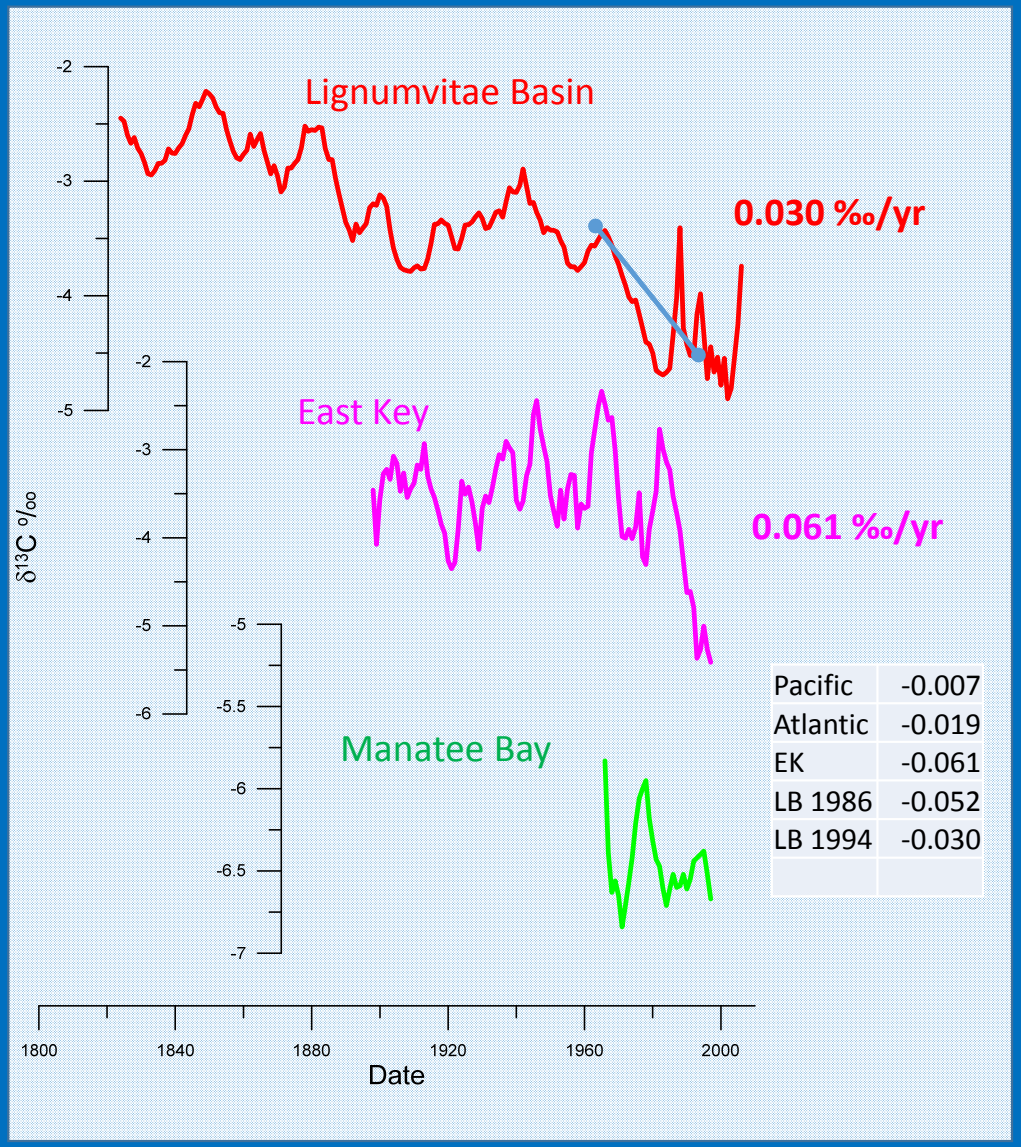
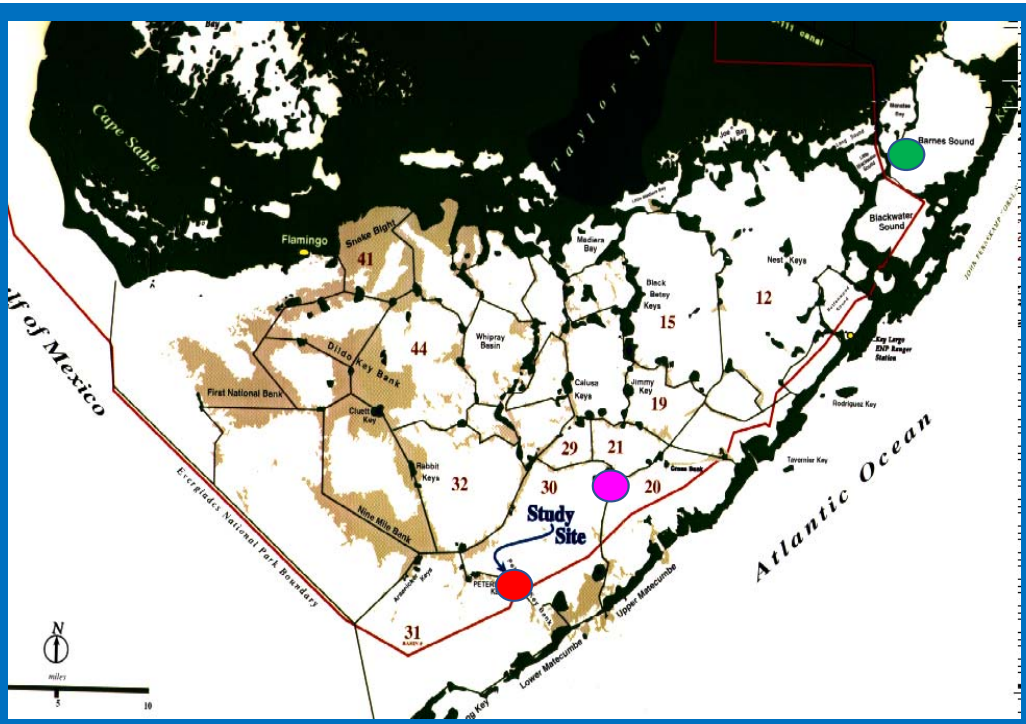


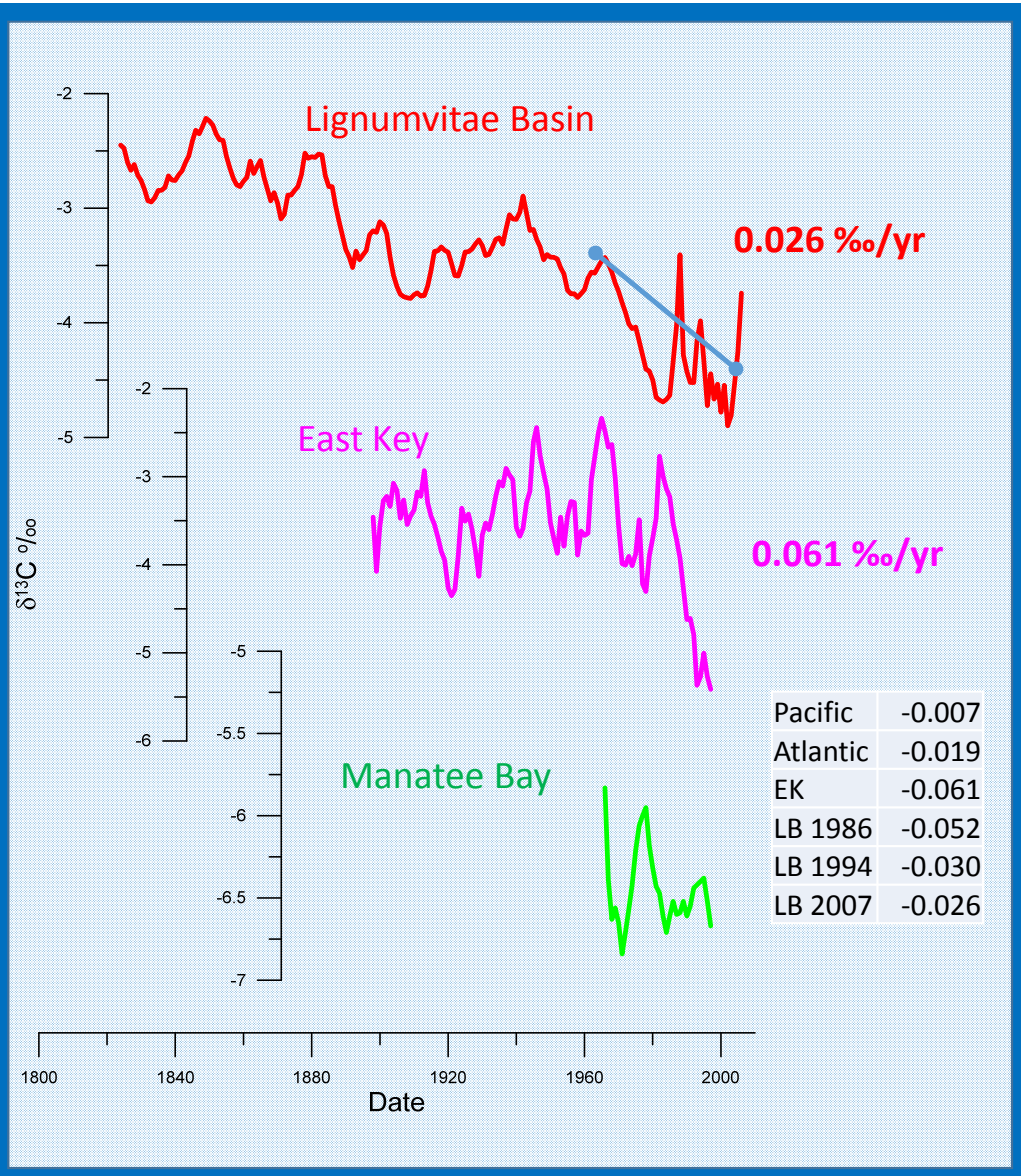
Pacific	-0.007
Atlantic	-0.019
EK	-0.061
LB 1986	-0.052



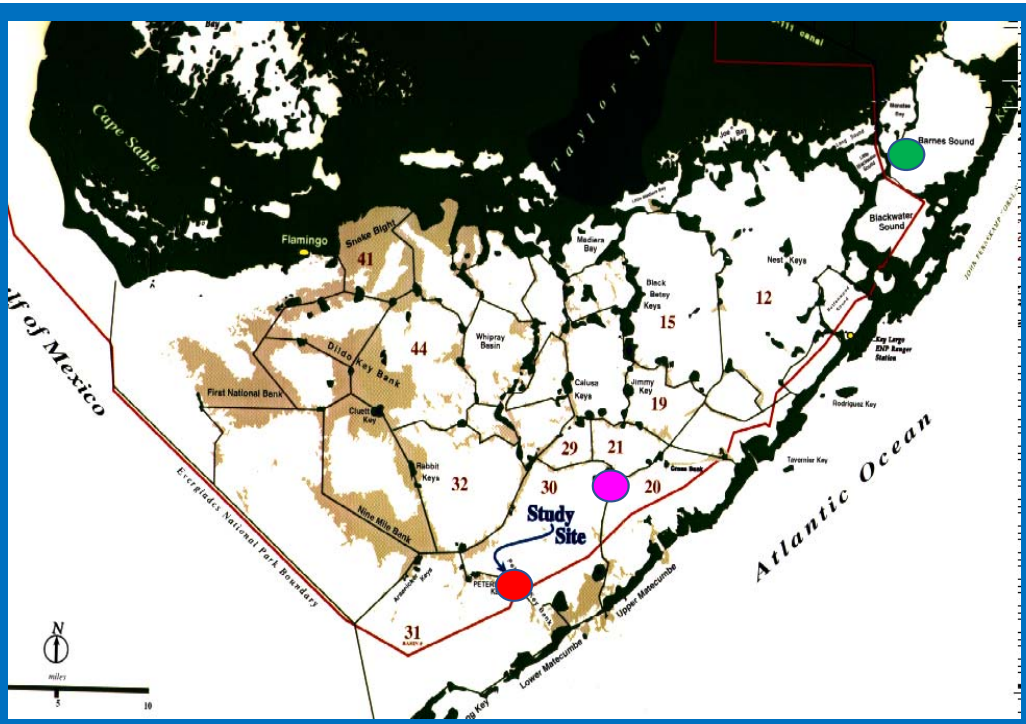


Pacific	-0.007
Atlantic	-0.019
EK	-0.061
LB 1986	-0.052
LB 1994	-0.030





Pacific	-0.007
Atlantic	-0.019
EK	-0.061
LB 1986	-0.052
LB 1994	-0.030
LB 2007	-0.026



Windowed Regression

x	y
9.17167	4.906609
9.196699	4.748279
9.209477	4.478991
9.239608	4.42316
9.22858	4.741372
9.199365	4.802283
9.164409	4.962246
9.106221	4.893308
9.134055	5.061498
9.156272	4.375838
9.17167	4.906609
9.196699	4.748279
9.209477	4.478991

Slope= ?
Regression ?

Windowed Regression

x	y	x	y
9.17167	4.906609	9.17167	4.906609
9.196699	4.748279	9.196699	4.748279
9.209477	4.478991	9.209477	4.478991
9.239608	4.42316	9.239608	4.42316
9.22858	4.741372	9.22858	4.741372
9.199365	4.802283	9.199365	4.802283
9.164409	4.962246	9.164409	4.962246
9.106221	4.893308		
9.134055	5.061498		
9.156272	4.375838		
9.17167	4.906609		
9.196699	4.748279		
9.209477	4.478991		

Slope= S1
Regression =R1

Windowed Regression

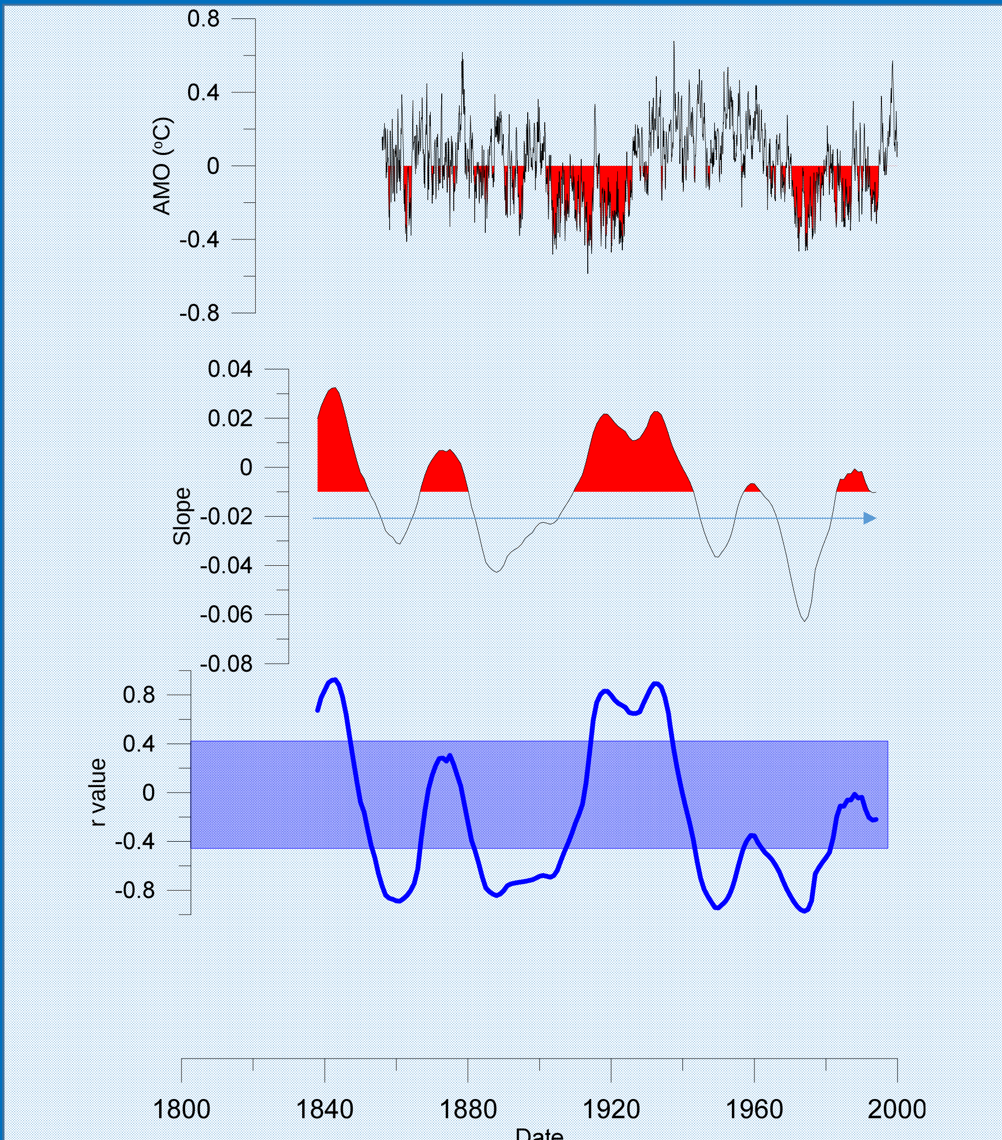
x	y	x	y
9.17167	4.906609		
9.196699	4.748279	9.196699	4.748279
9.209477	4.478991	9.209477	4.478991
9.239608	4.42316	9.239608	4.42316
9.22858	4.741372	9.22858	4.741372
9.199365	4.802283	9.199365	4.802283
9.164409	4.962246	9.164409	4.962246
9.106221	4.893308	9.106221	4.893308
9.134055	5.061498		
9.156272	4.375838		
9.17167	4.906609		
9.196699	4.748279		
9.209477	4.478991		

Slope= S2
Regression =R2

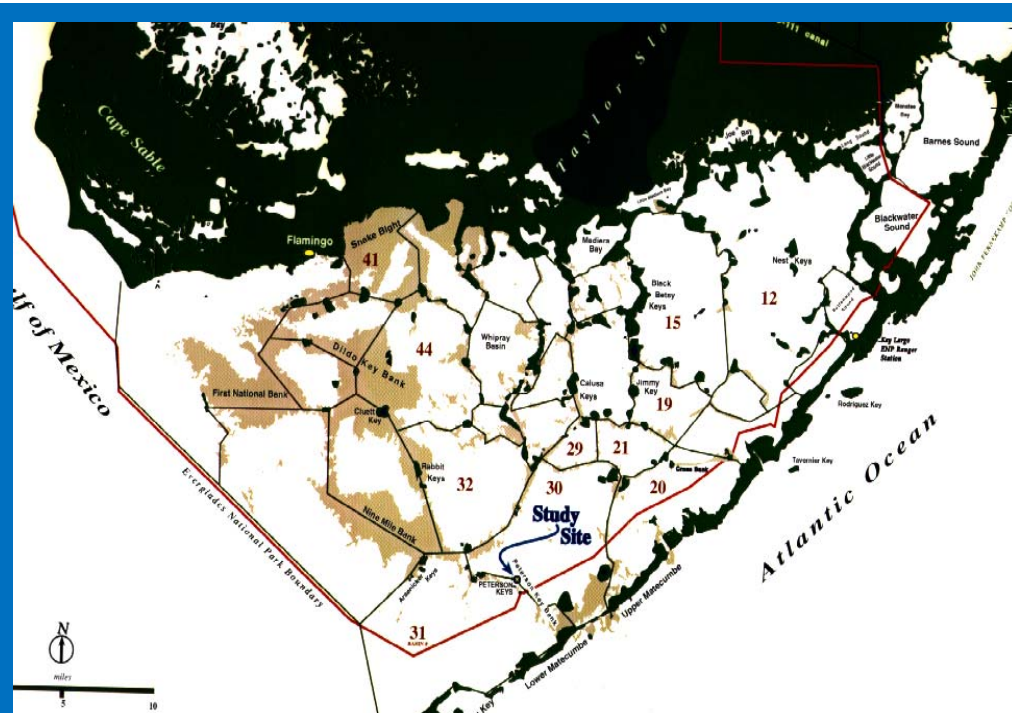
Windowed Regression

x	y	x	y
9.17167	4.906609		
9.196699	4.748279		
9.209477	4.478991	9.209477	4.478991
9.239608	4.42316	9.239608	4.42316
9.22858	4.741372	9.22858	4.741372
9.199365	4.802283	9.199365	4.802283
9.164409	4.962246	9.164409	4.962246
9.106221	4.893308	9.106221	4.893308
9.134055	5.061498	9.134055	5.061498
9.156272	4.375838		
9.17167	4.906609		
9.196699	4.748279		
9.209477	4.478991		

Slope= S3
Regression =R3



0.8
0.4
0
-0.4
-0.8
AMO (ºC)
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
Slope
0.8
0.4
0
-0.4
-0.8
r value
1800
1840
1880
1920
1960
2000
Date



Cape Sable
lf of Mexico
Flamingo
Snake Bight
41
44
Dildo Key Bank
First National Bank
Cluett Key
Whipray Basin
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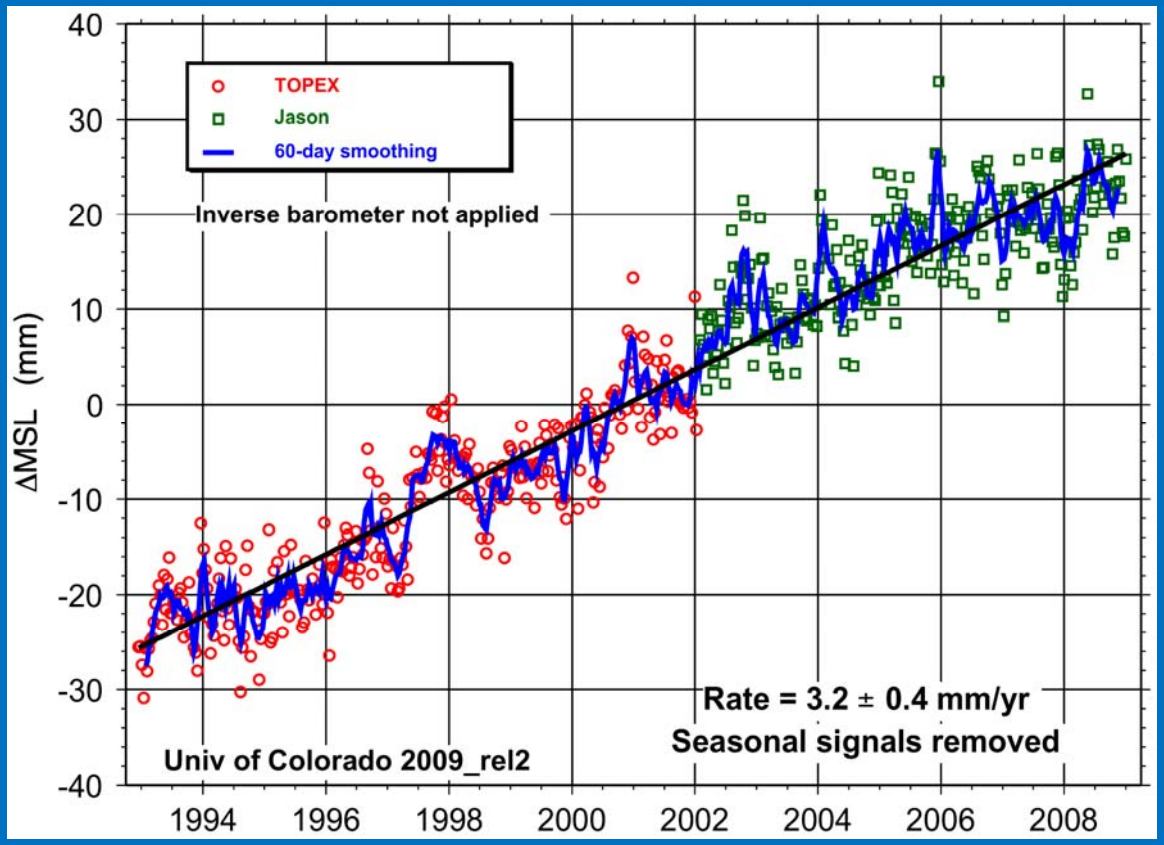
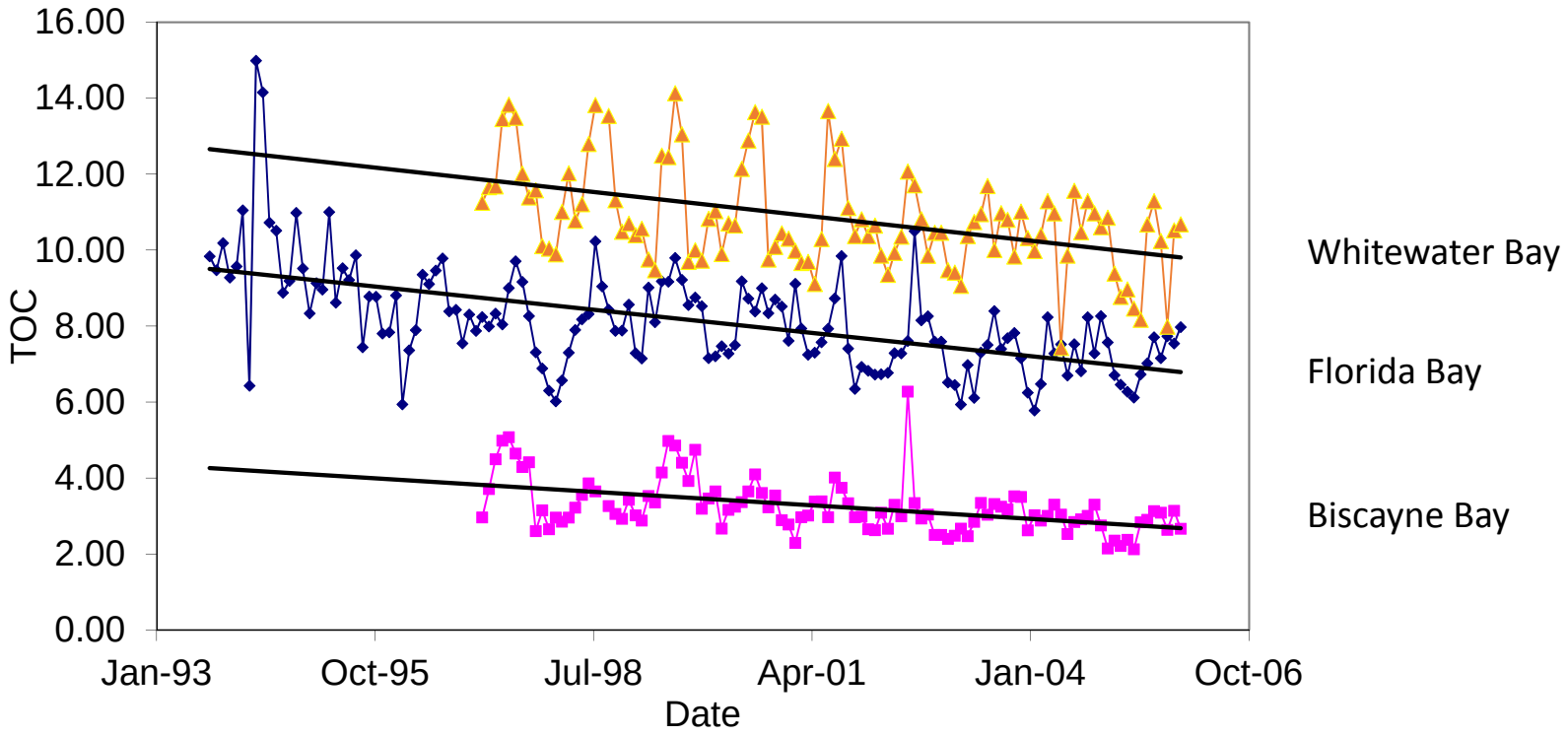
32
Nine Mile Bank
Everglades National Park Boundary
Madeira Bay
Black Betsey Keys
15
Nest Keys
12
Barnes Sound
Blackwater Sound
Calusa Keys
Jimmy Key
19
29
21
30
20
Study Site
Peterson Keys
31
Upper Matecumbe
Lower Matecumbe
Atlantic Ocean
Rodriguez Key
Tavernier Key
N
miles
5
10

What is Changing in Florida Bay

- Water Supply
  - C111?
- Supply of Nutrients
  - Organic material
  - Direct input
- Sea-Level

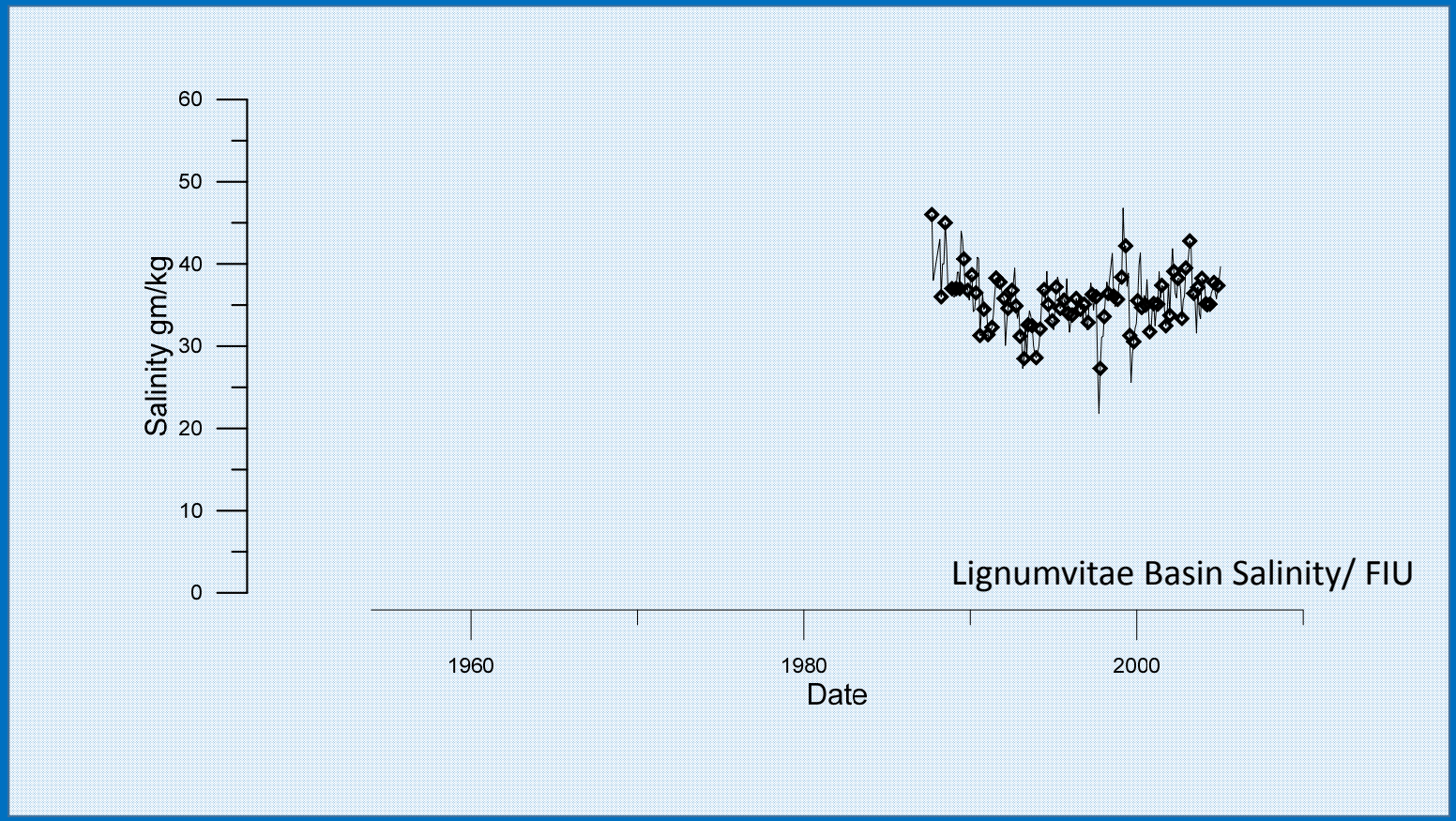


Supply of Organic Material

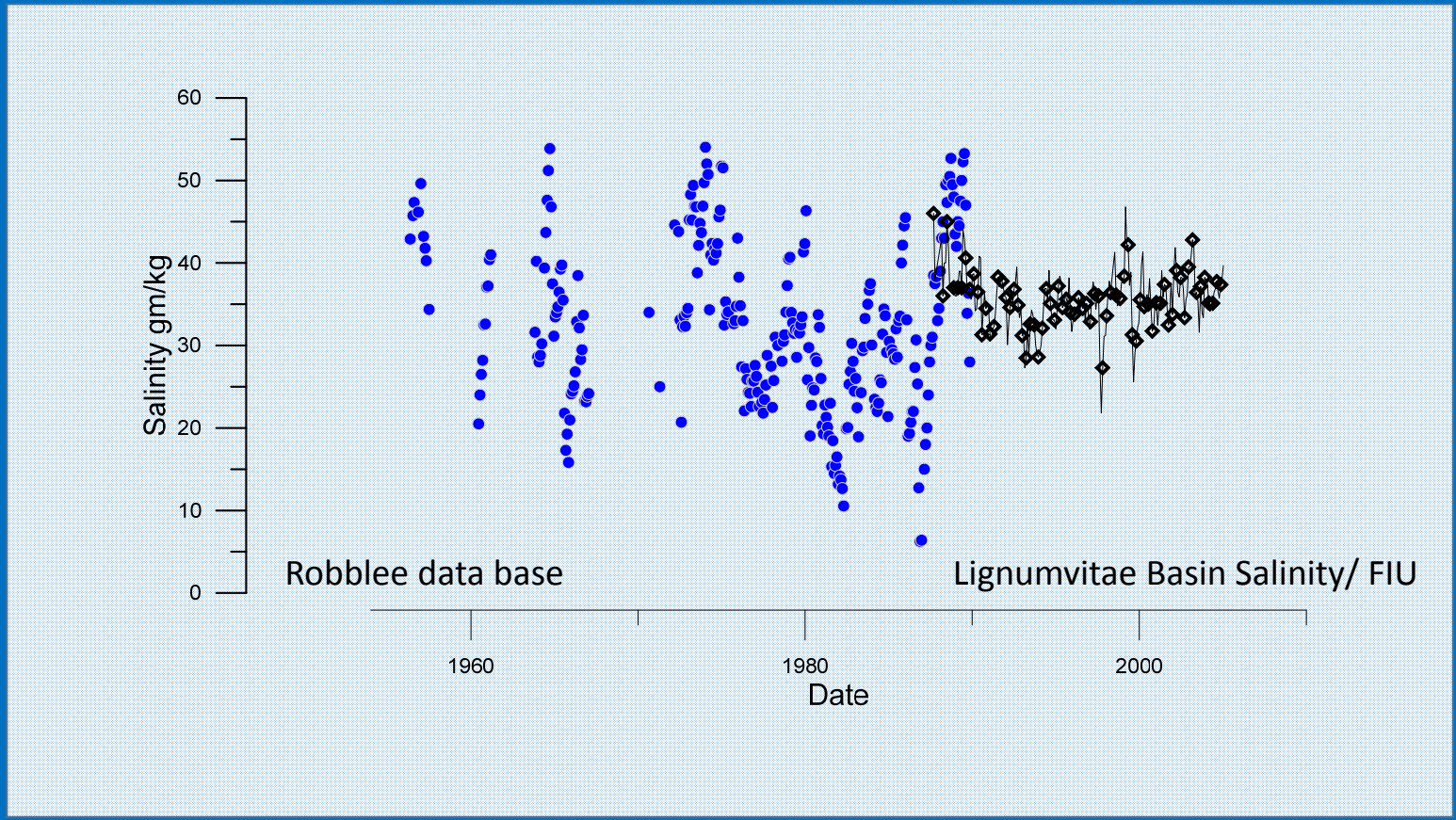


Data from FIU

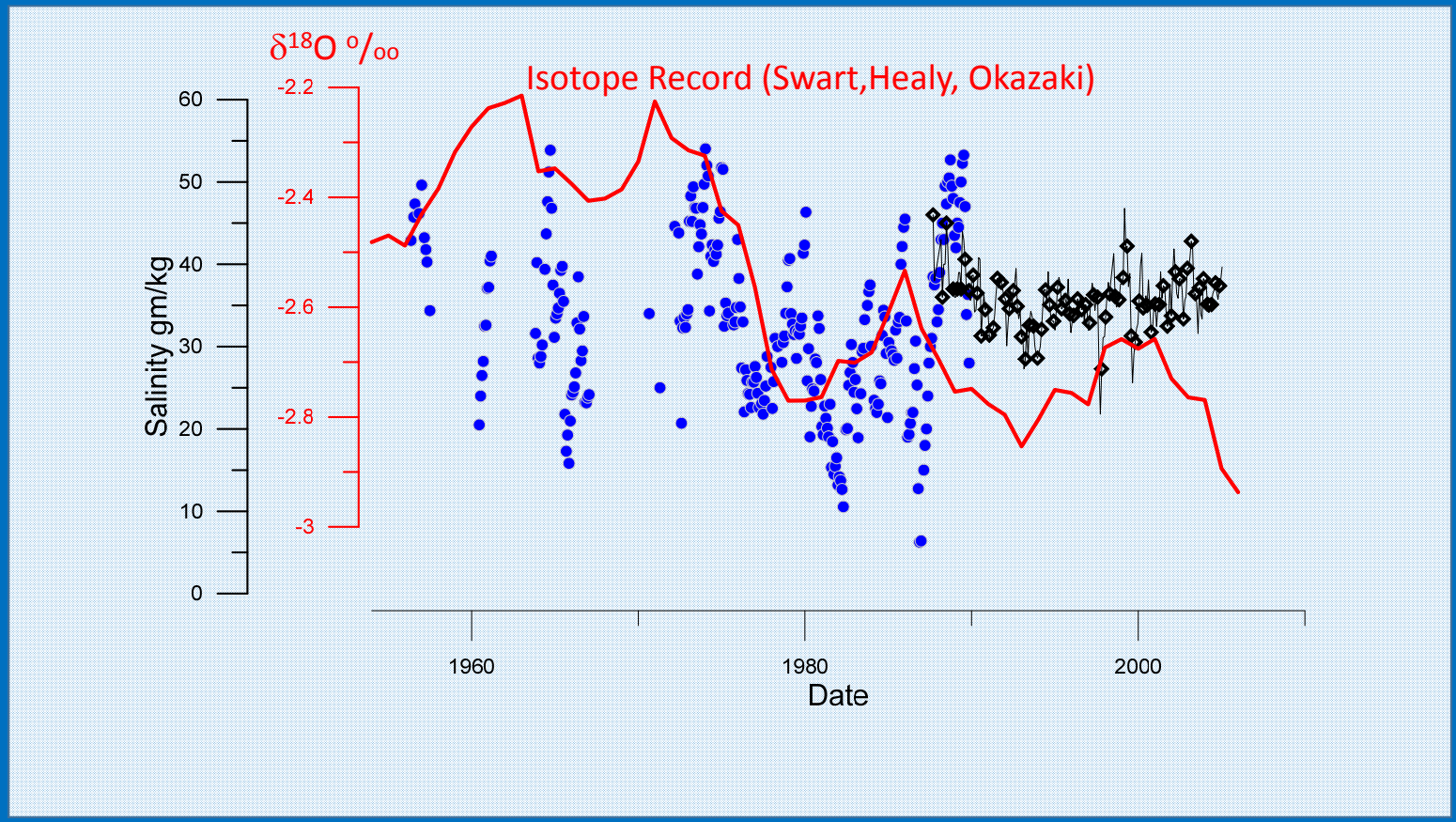
Water Supply



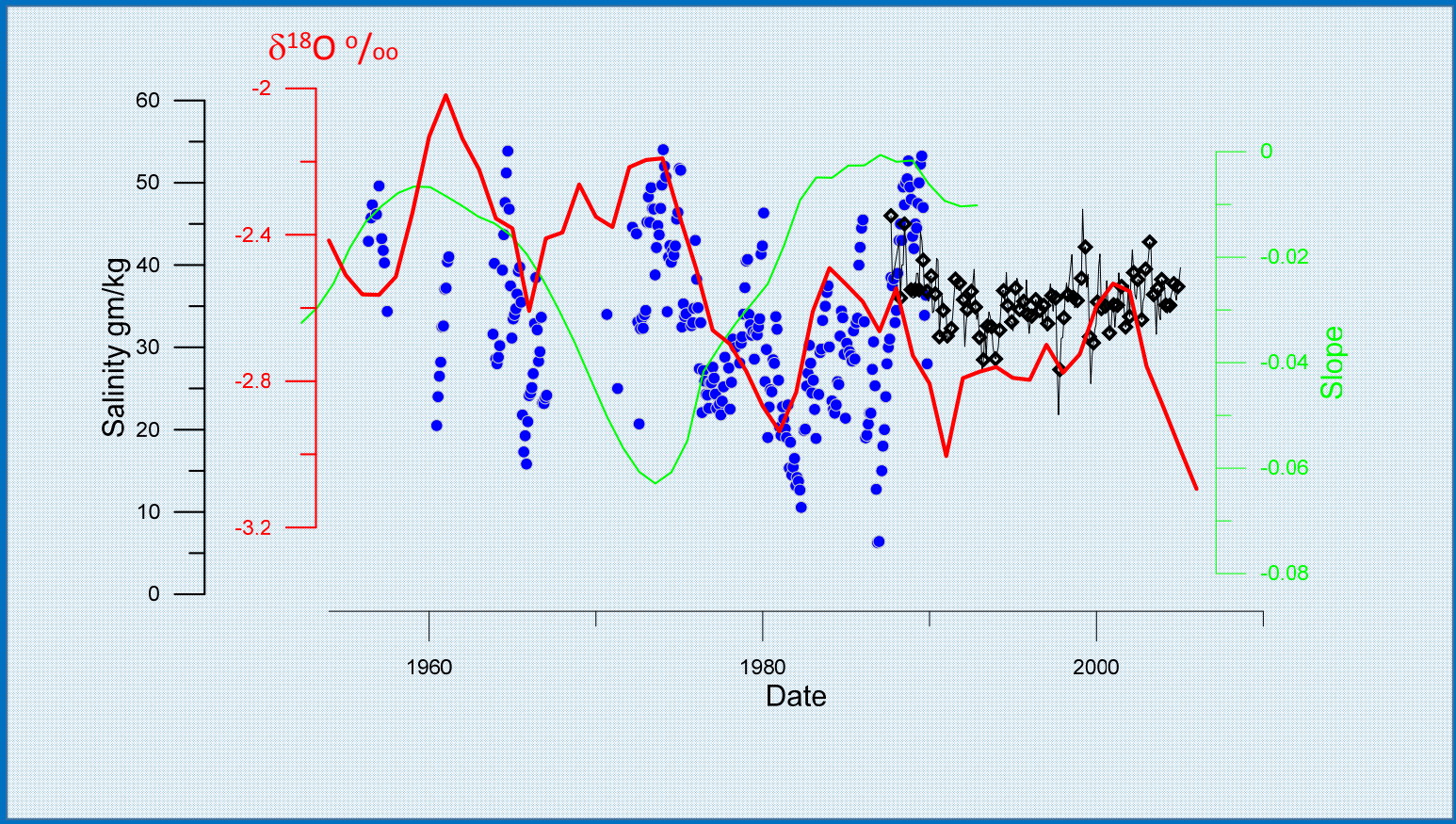
Water Supply



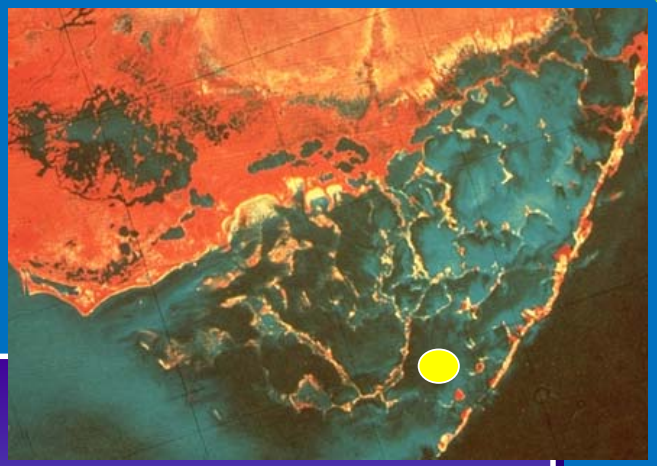
Water Supply

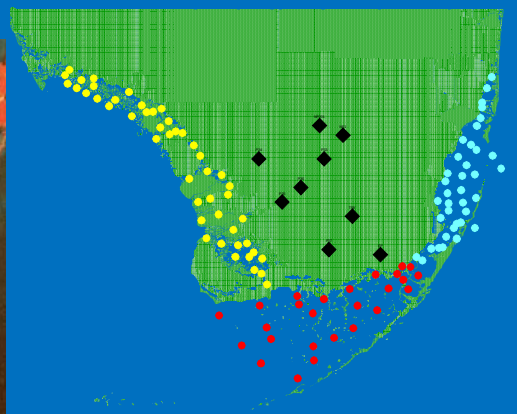


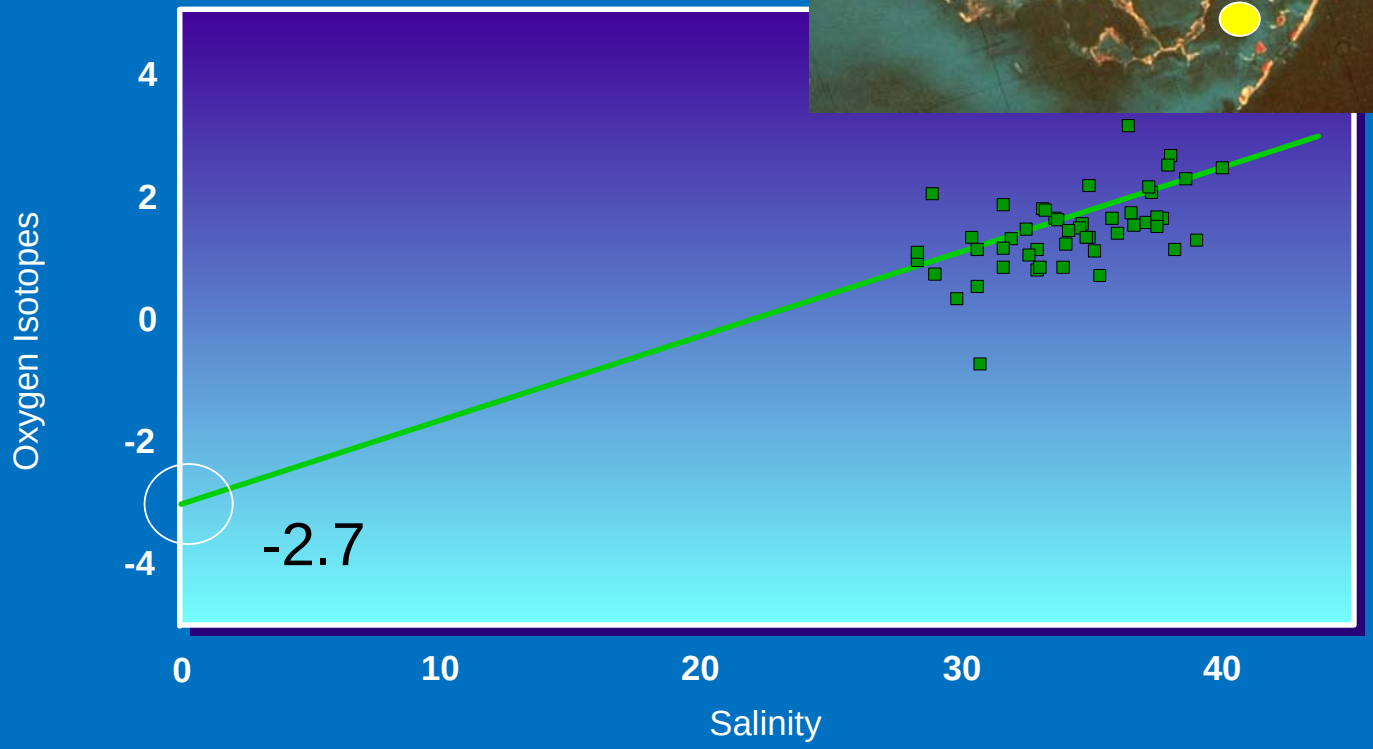
Water Supply



Lignumvitae Basin

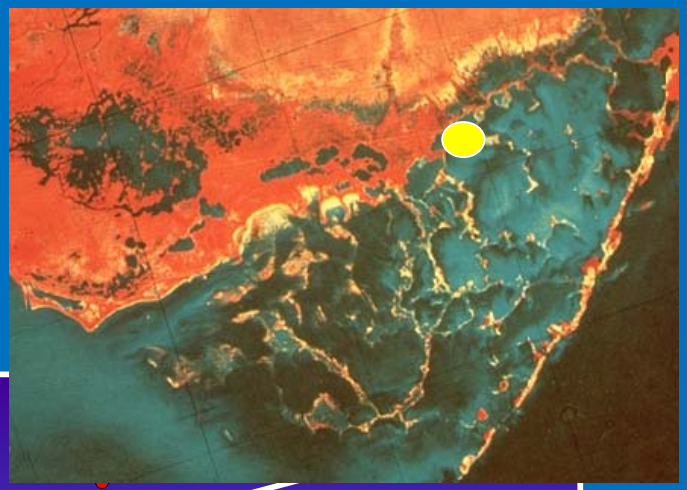


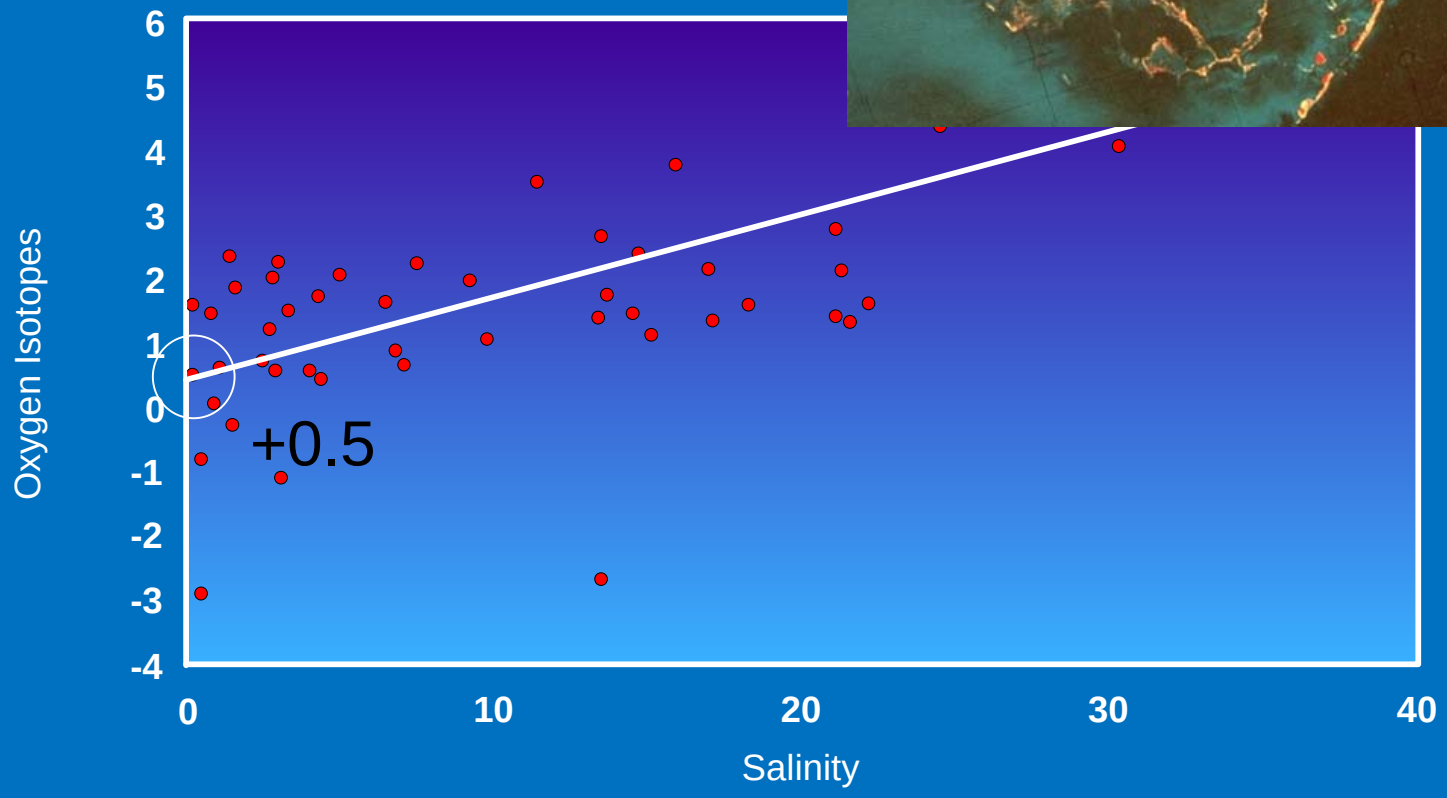




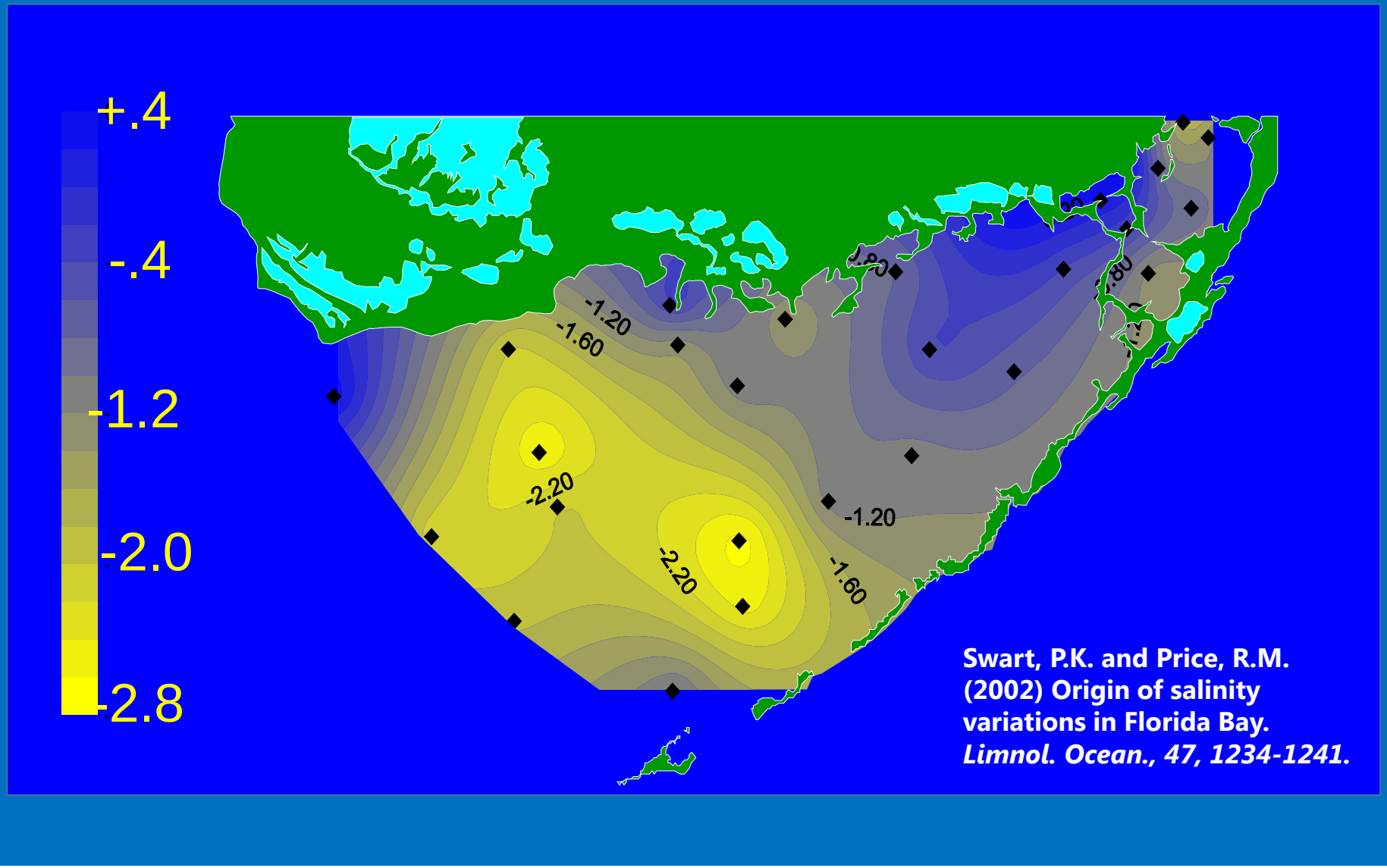
Swart, P.K. and Price, R.M. (2002) Origin of salinity variations in Florida Bay. *Limnol. Ocean., 47, 1234-1241.*

Joe Bay

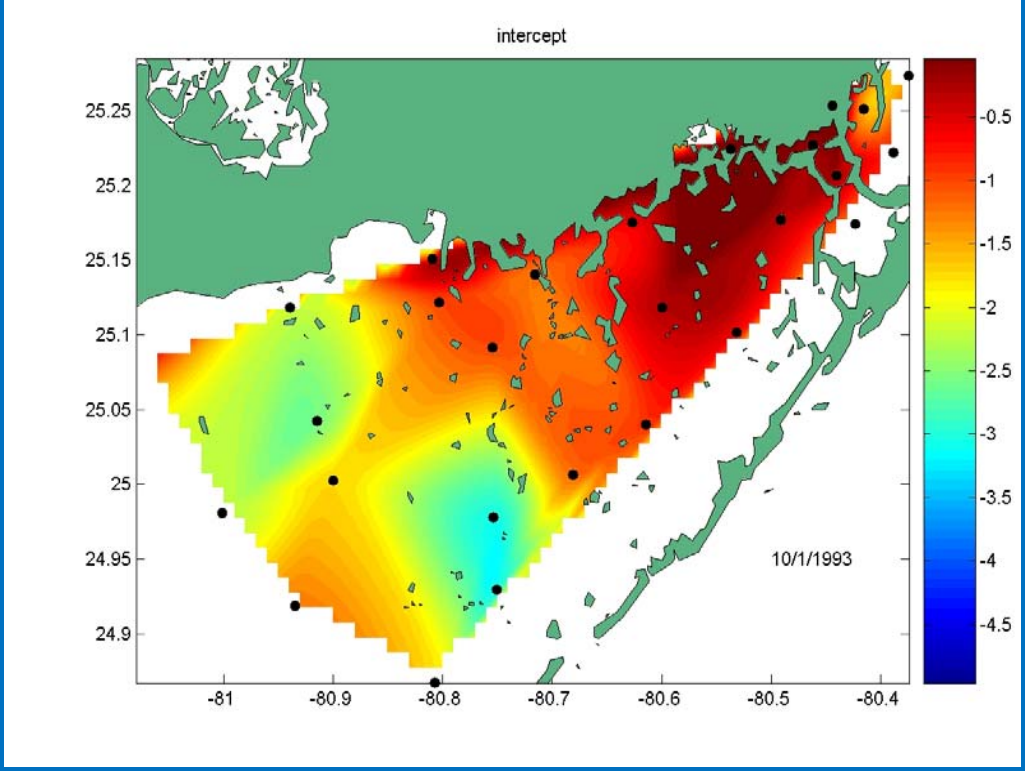


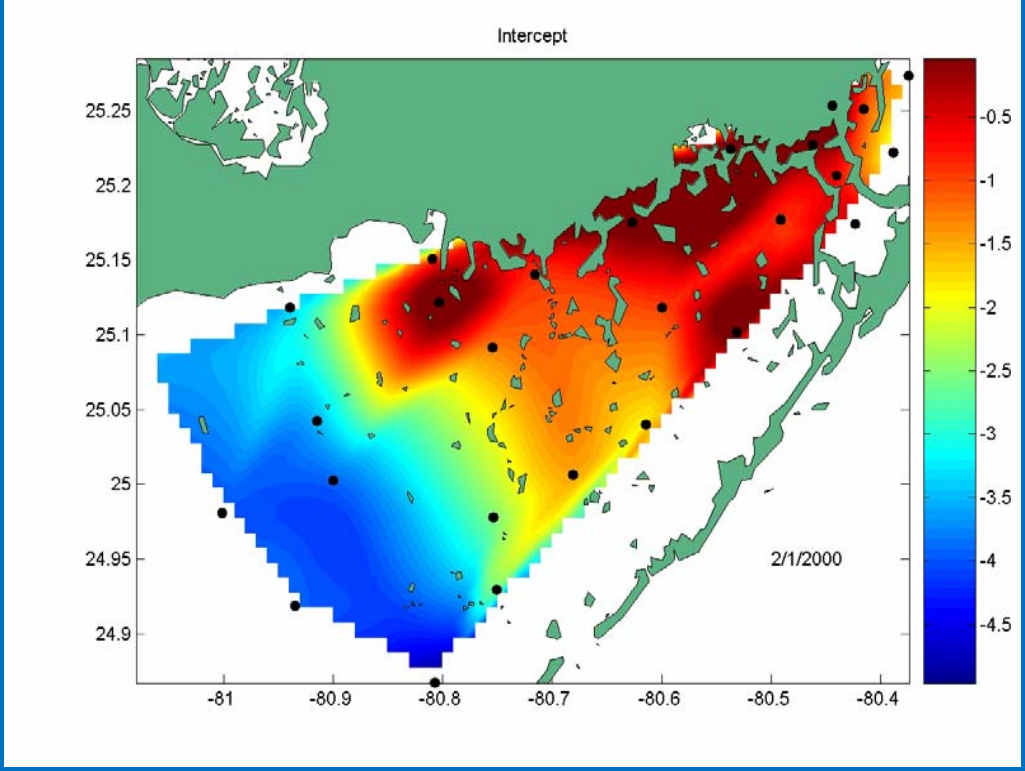


Swart, P.K. and Price, R.M. (2002) Origin of salinity variations in Florida Bay. *Limnol. Ocean., 47, 1234-1241.*

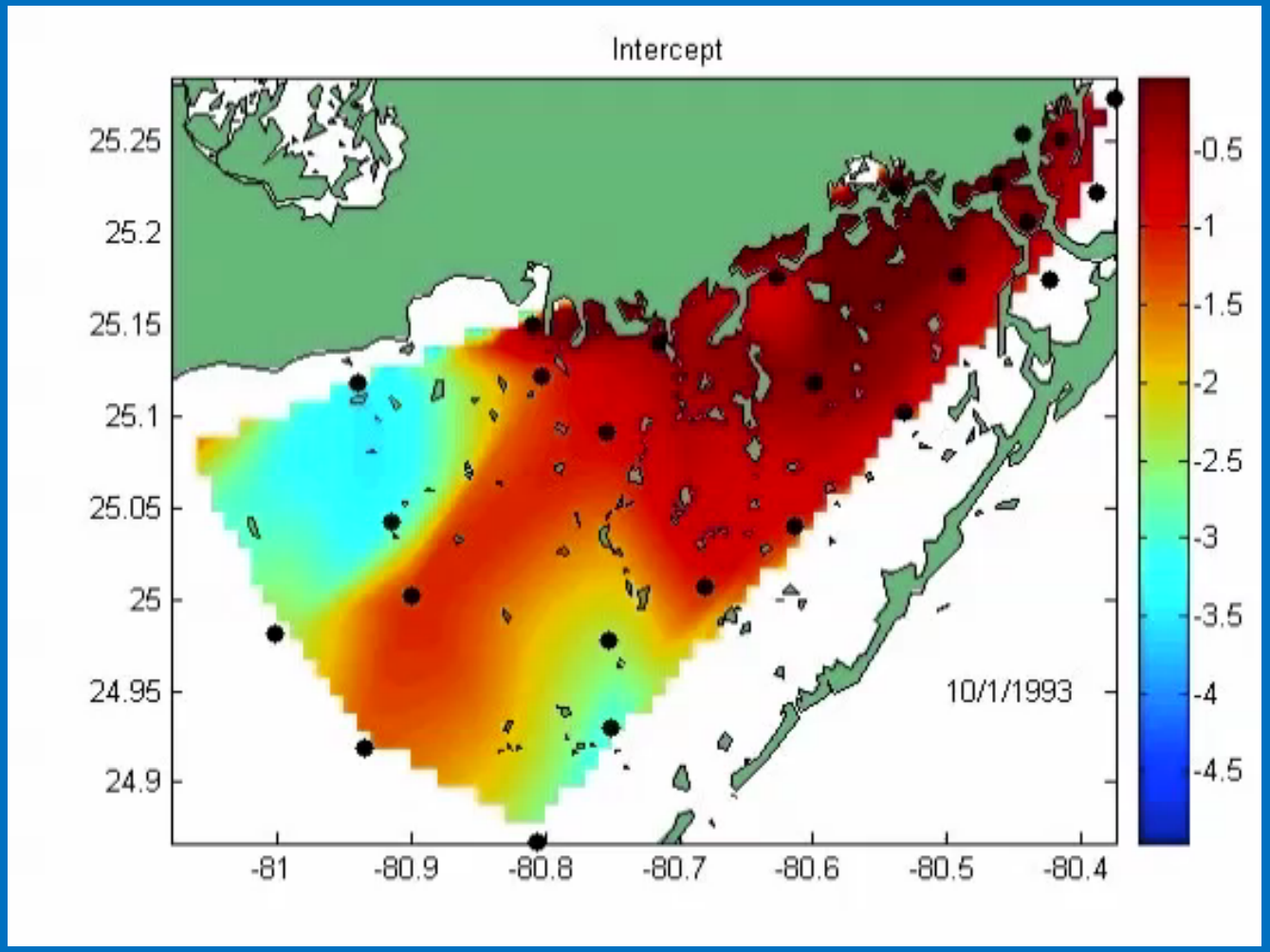

+.4
-.4
-1.2
-2.0
-2.8
-1.20
-1.60
-2.20
-2.20
-1.20
-1.60
Swart, P.K. and Price, R.M. (2002) Origin of salinity variations in Florida Bay. *Limnol. Ocean., 47, 1234-1241.*

Water Supply




Intercept
25.25
25.2
25.15
25.1
25.05
25
24.95
24.9
-81
-80.9
-80.8
-80.7
-80.6
-80.5
-80.4
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
2/1/2000

Water Supply



Conclusions

- Florida Bay is changing
  - Sea level rise
    - More dominated by marine waters
    - Less Variable
  - Is this related to increased freshwater supply from the C111?
  - Salinity more related to rainfall than freshwater input
- The manner in which coral skeletal chemistry have responded to salinity and temperature has changed