An Overview of NASA Ocean Color Data Products

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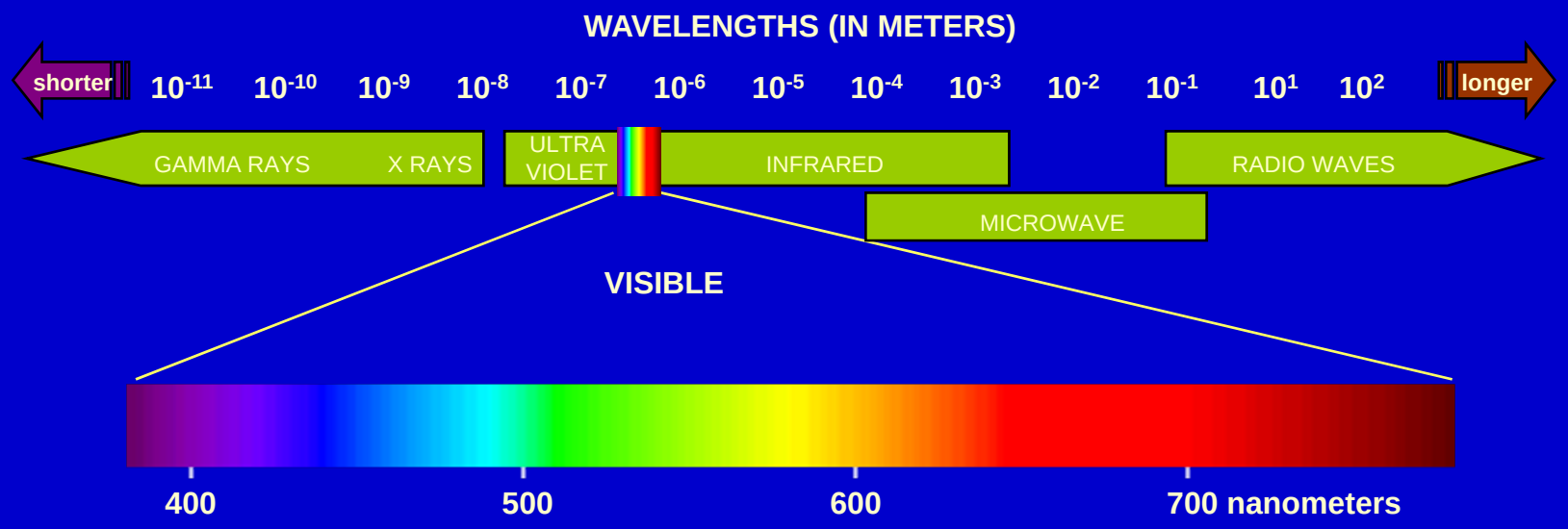
Topics

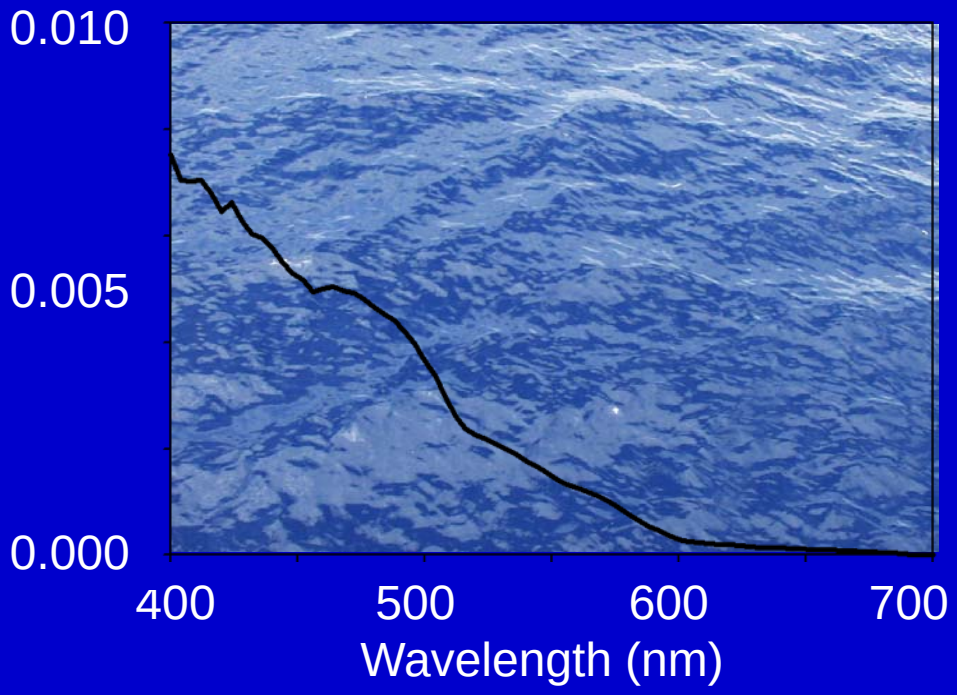
1. Principles and History
2. Current Status
3. Examples
4. What’s Next?

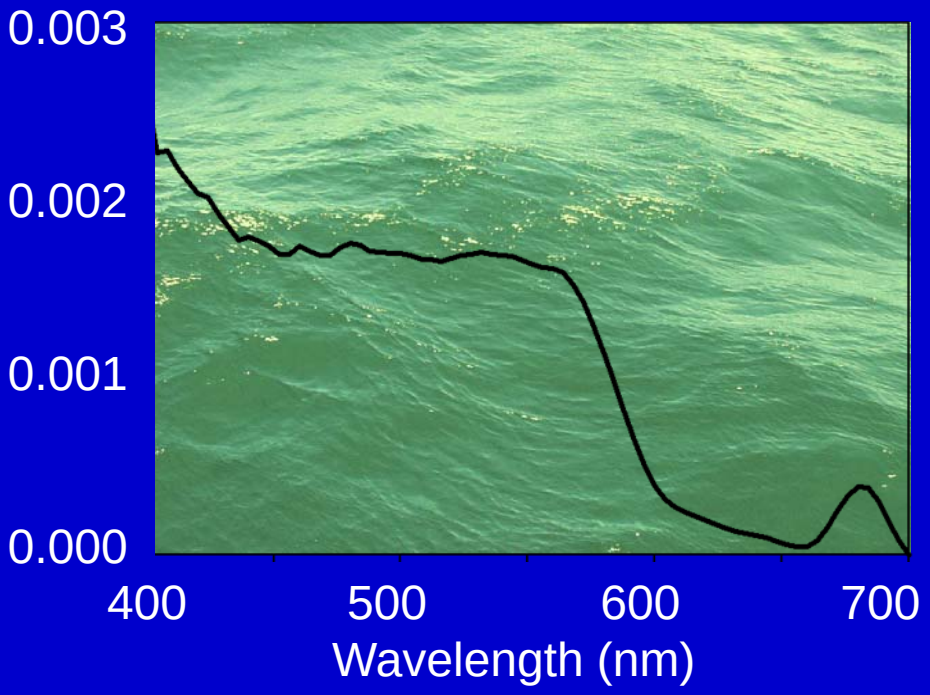
Optical Remote Sensing:
The science of light propagation

Electromagnetic Spectrum



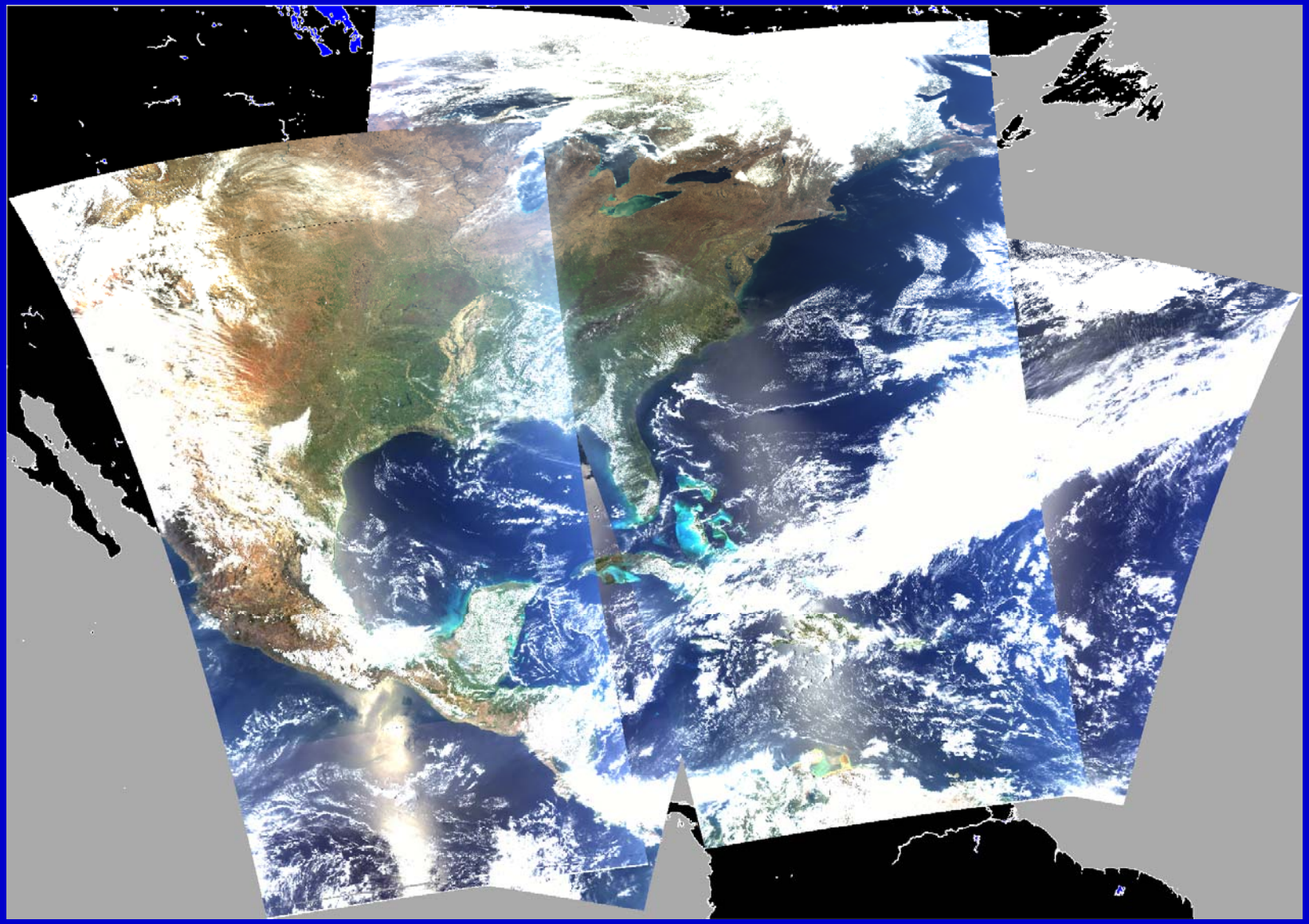
Optical Remote Sensing:
Principles



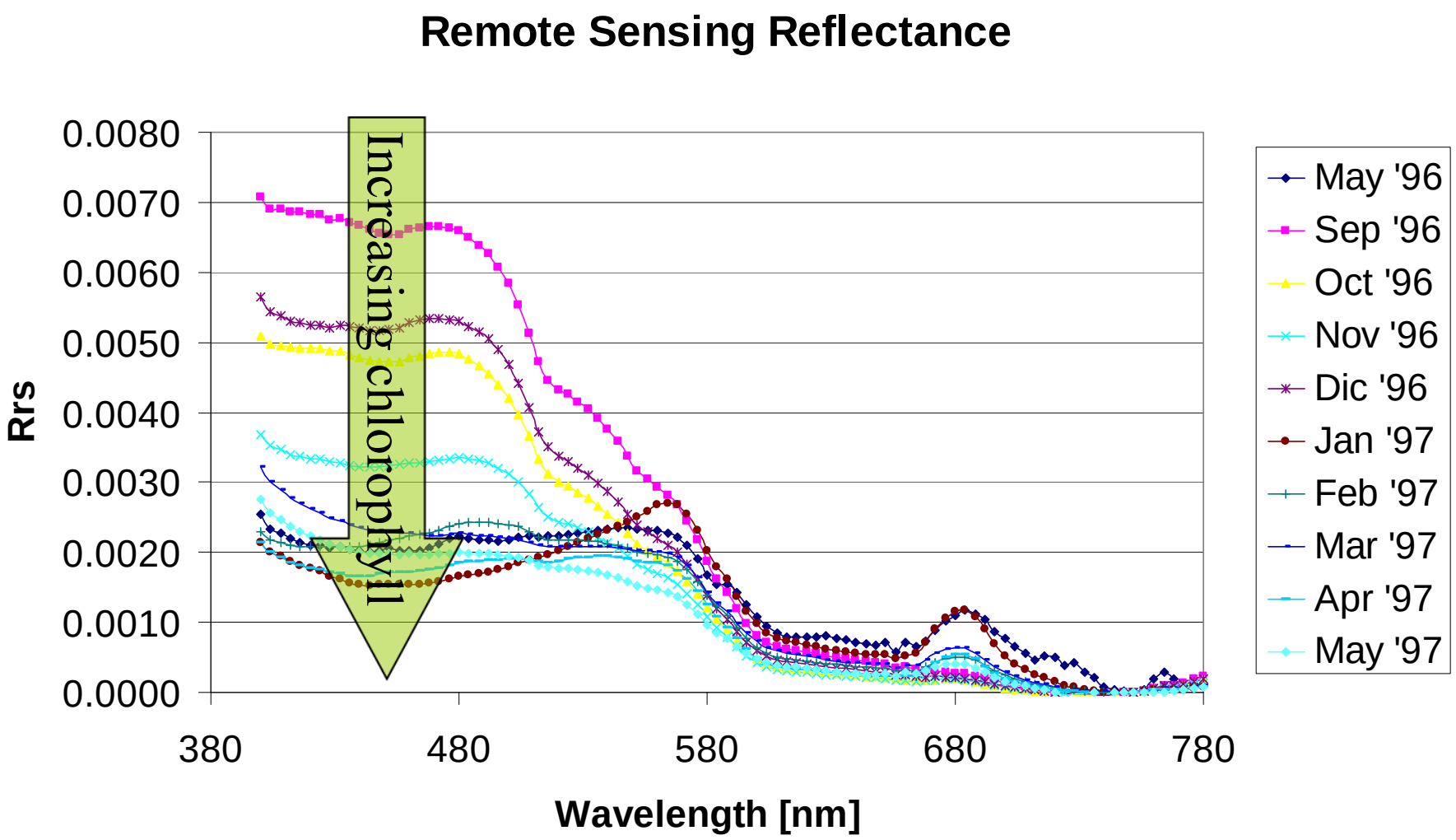


The Beauty of Ocean Color

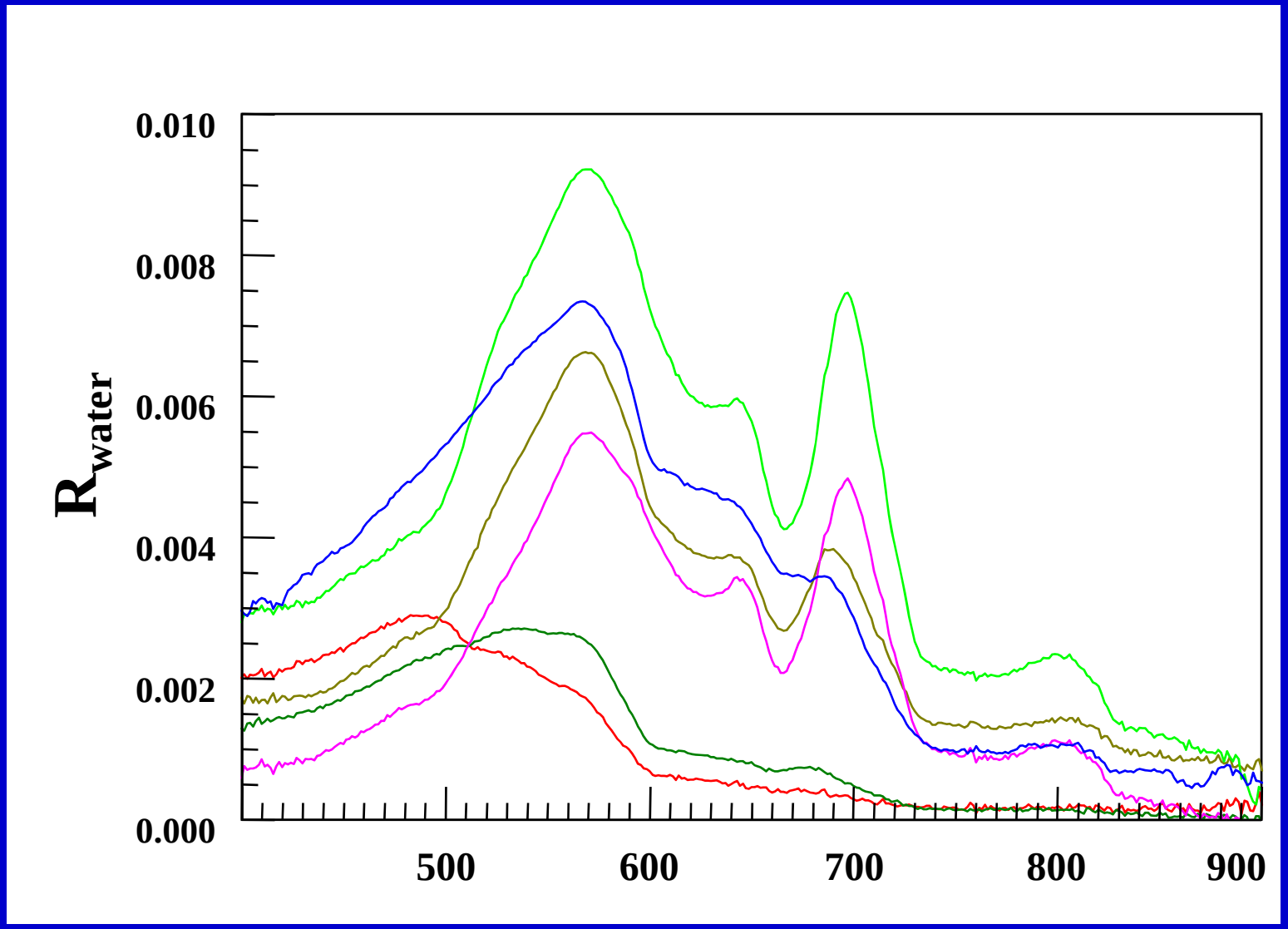
The Beauty of Remote Sensing



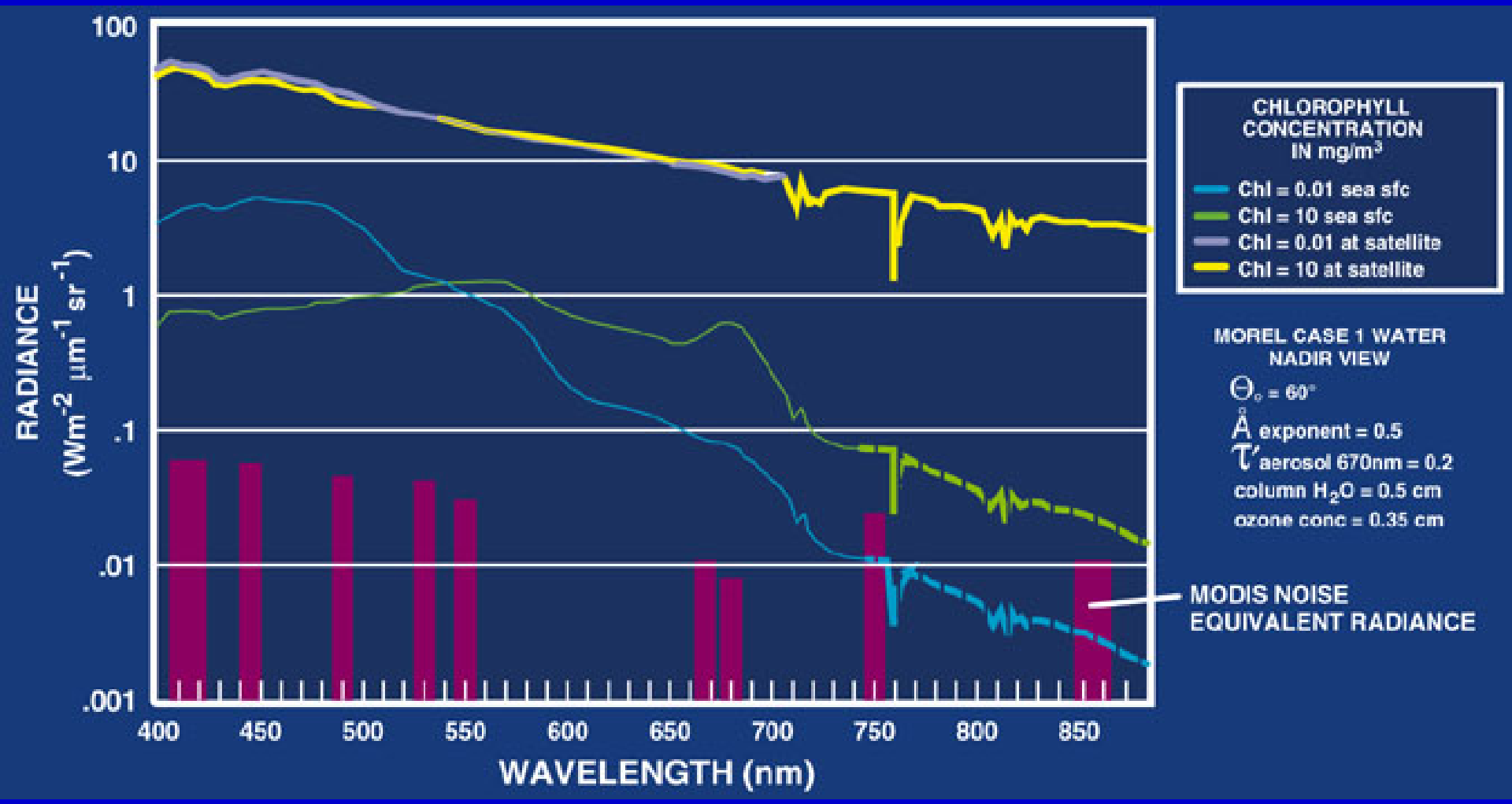
Simple Interpretation



Complex Interpretation

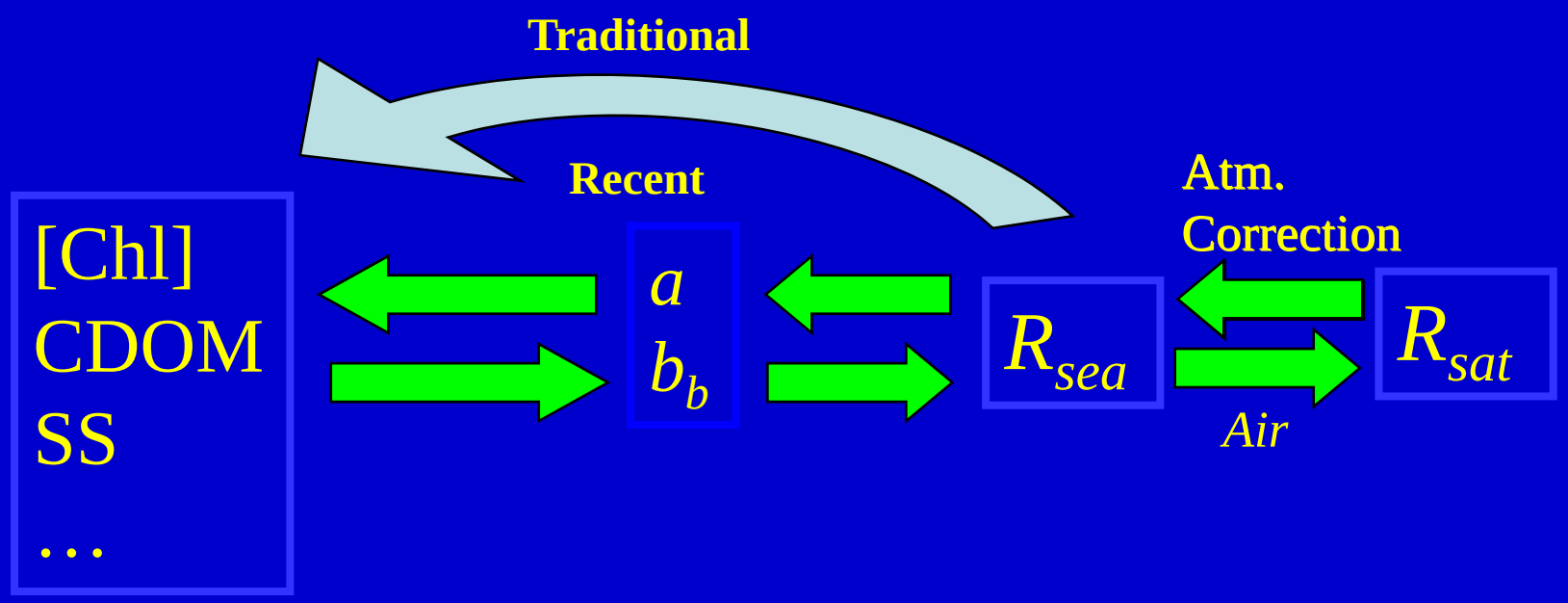


Satellite vs Surface Observation



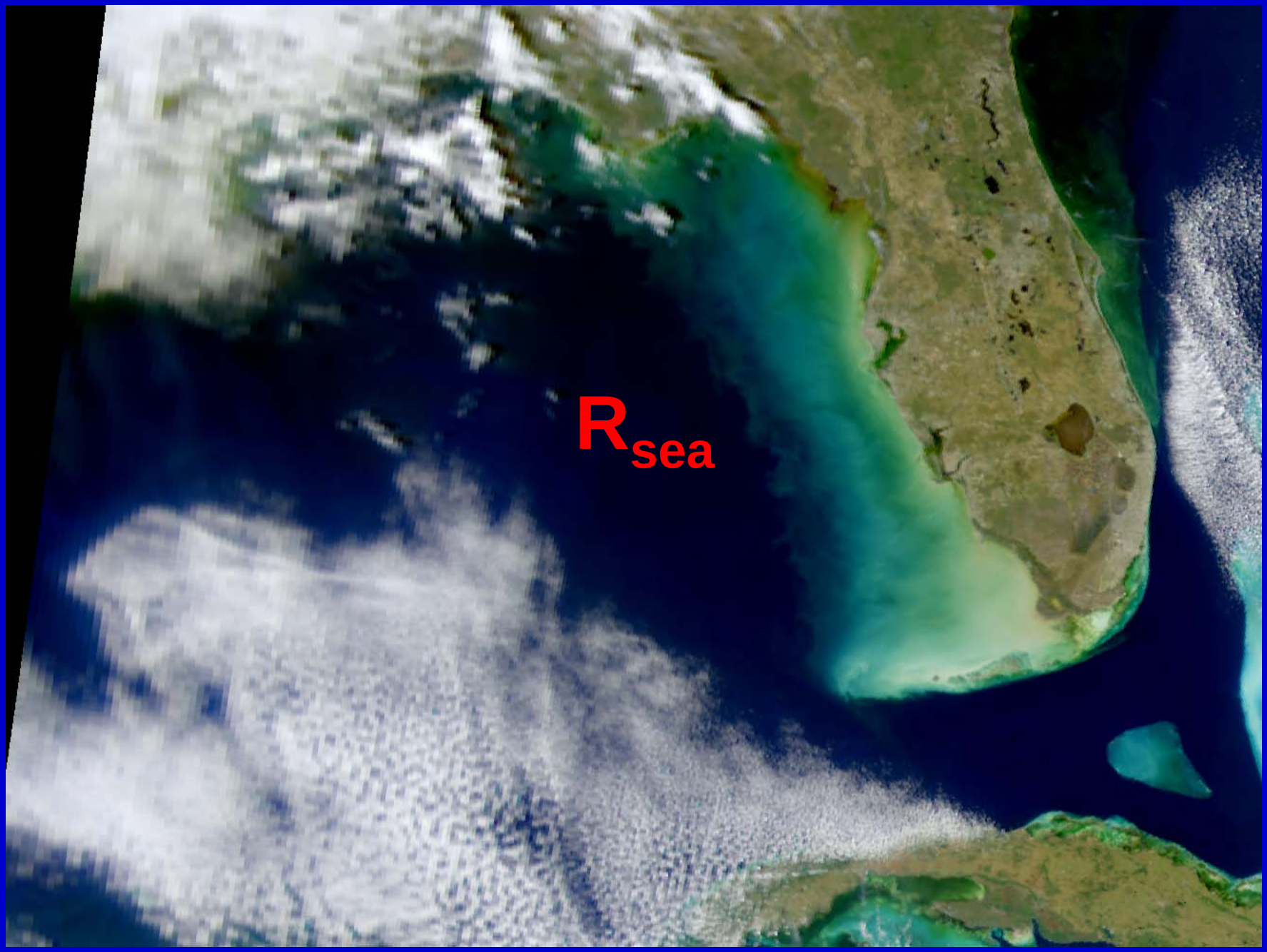
Gordon (1983)

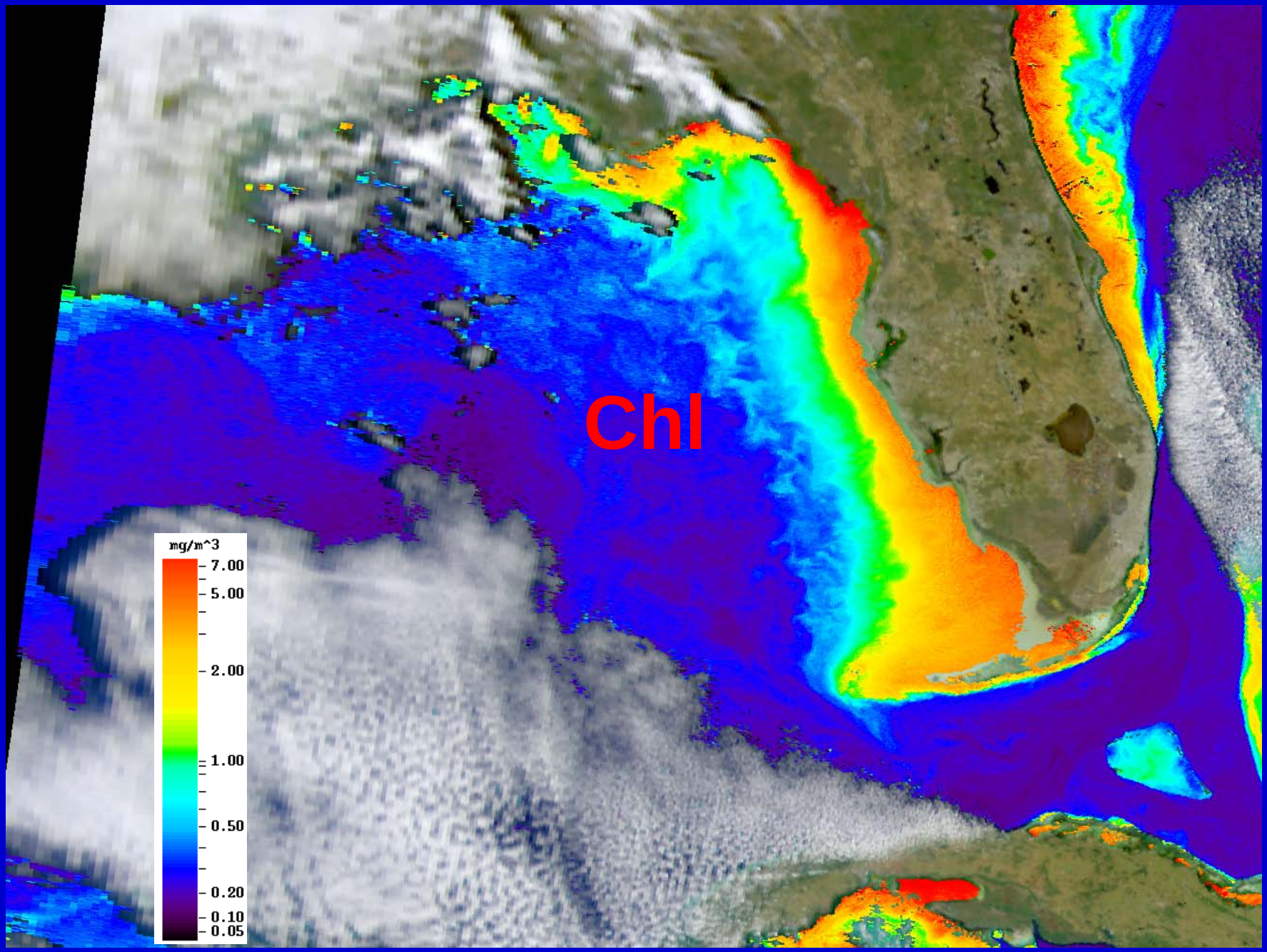
Forward and Inversion Algorithms



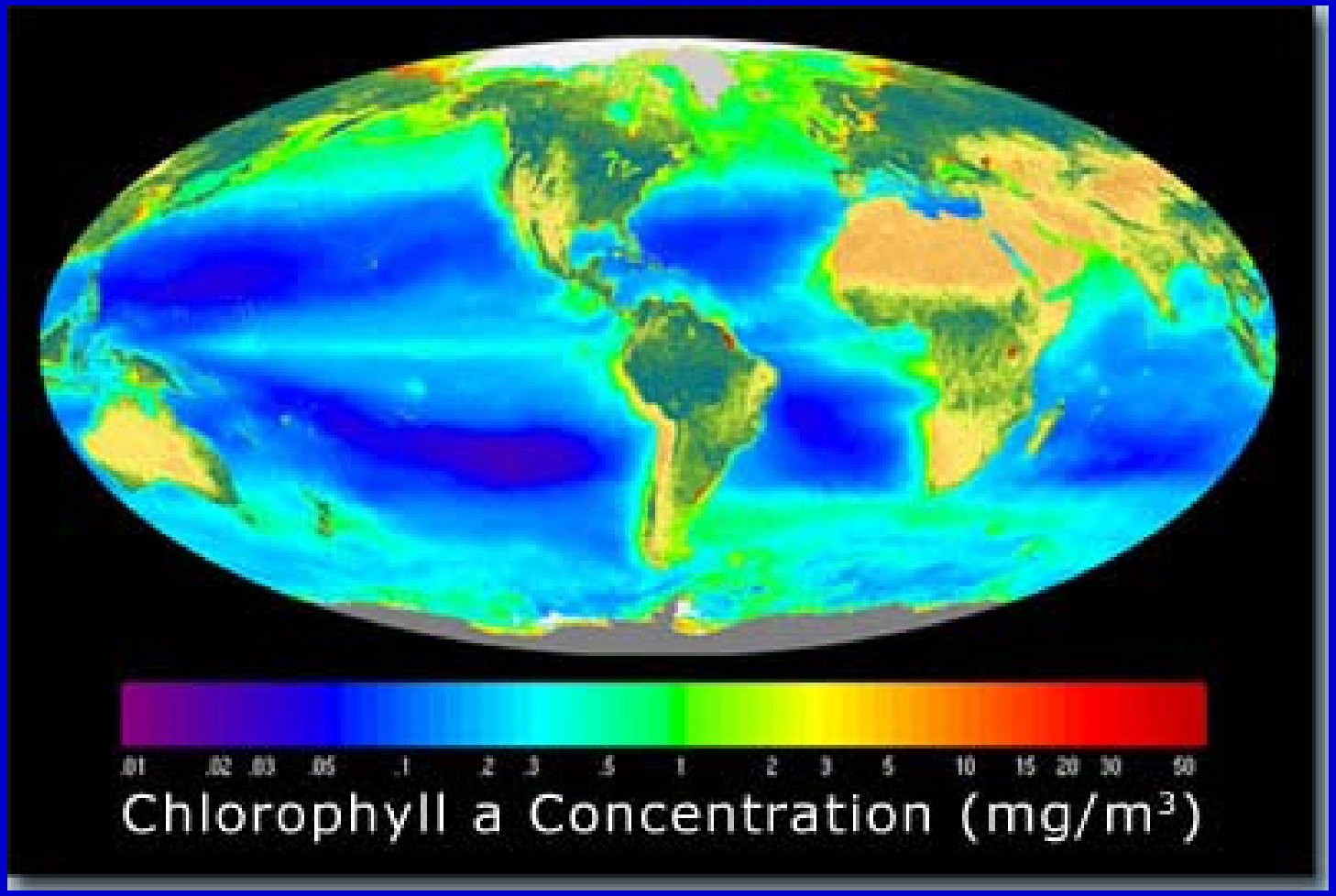
$$R_{sea} = f(a_{\mathrm{p}}, a_{\mathrm{d}}, a_{\mathrm{CDOM}}, b_{\mathrm{bp}})$$

R_{sat}


R_{sea}


Chl
mg/m^3
7.00
5.00
2.00
1.00
0.50
0.20
0.10
0.05

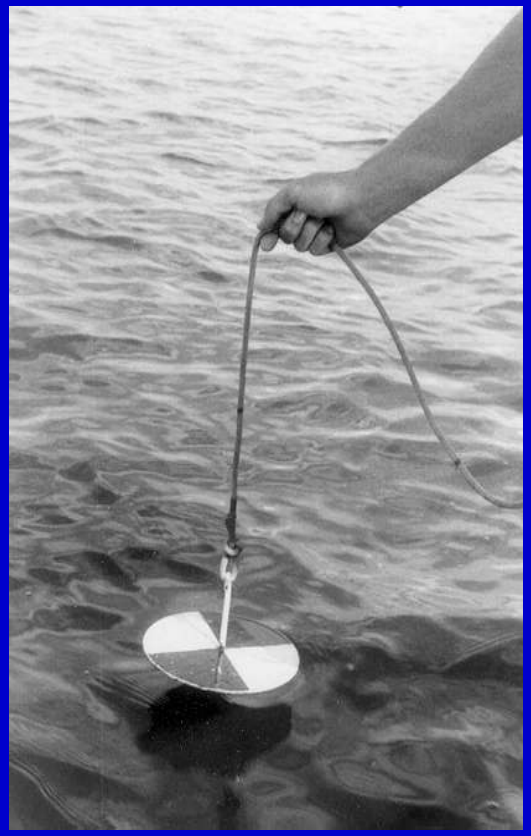
Mean Chl (9/1997 – 8/2000)



Source: NASA/GSFC

A Little History

1950's



Today

Today's Gears

Satellite Instruments

CZCS on NIMBUS-7
(1978-1986)

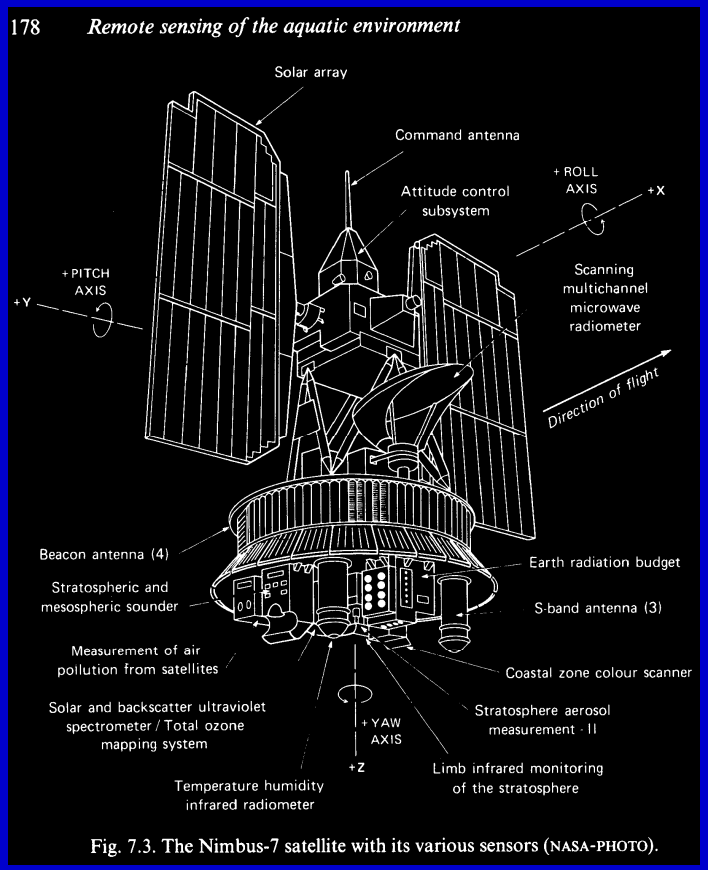
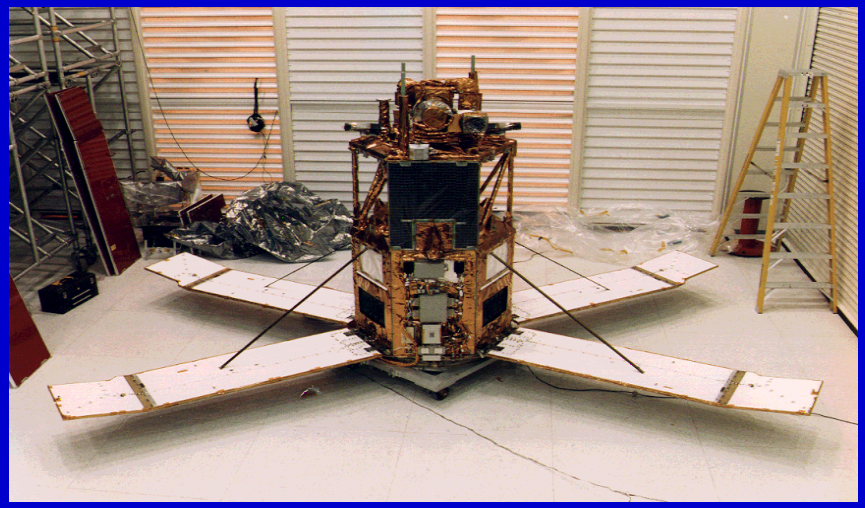


Fig. 7.3. The Nimbus-7 satellite with its various sensors (NASA-PHOTO).

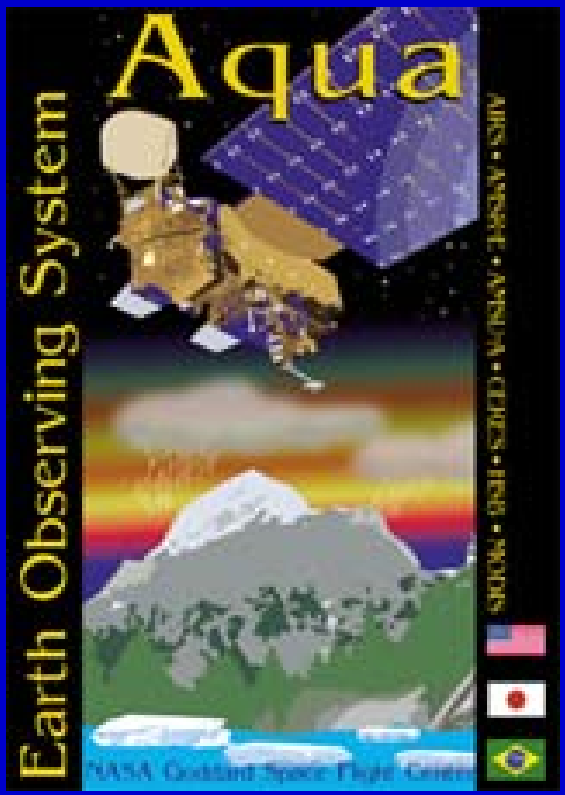
SeaWiFS on Orbview-2
(1997 – present)



Satellite Instruments

MODIS on Terra
(1999-present)

MODIS on Aqua
(2002 – present)



Computing Power

- 1970s: First CZCS image in a month
- Today: 10-year SeaWiFS archive in 2 days

Algorithms

- 1970s: Subtraction, ratio, etc.
- Today: Semi-analytical, optimization, etc.

Data/Image Availability

- 1970s: Barely anywhere
- Today: Free everywhere

Peer Recognition

- 1970s: One image deserves publishing in Science
- Today: Images without story published nowhere

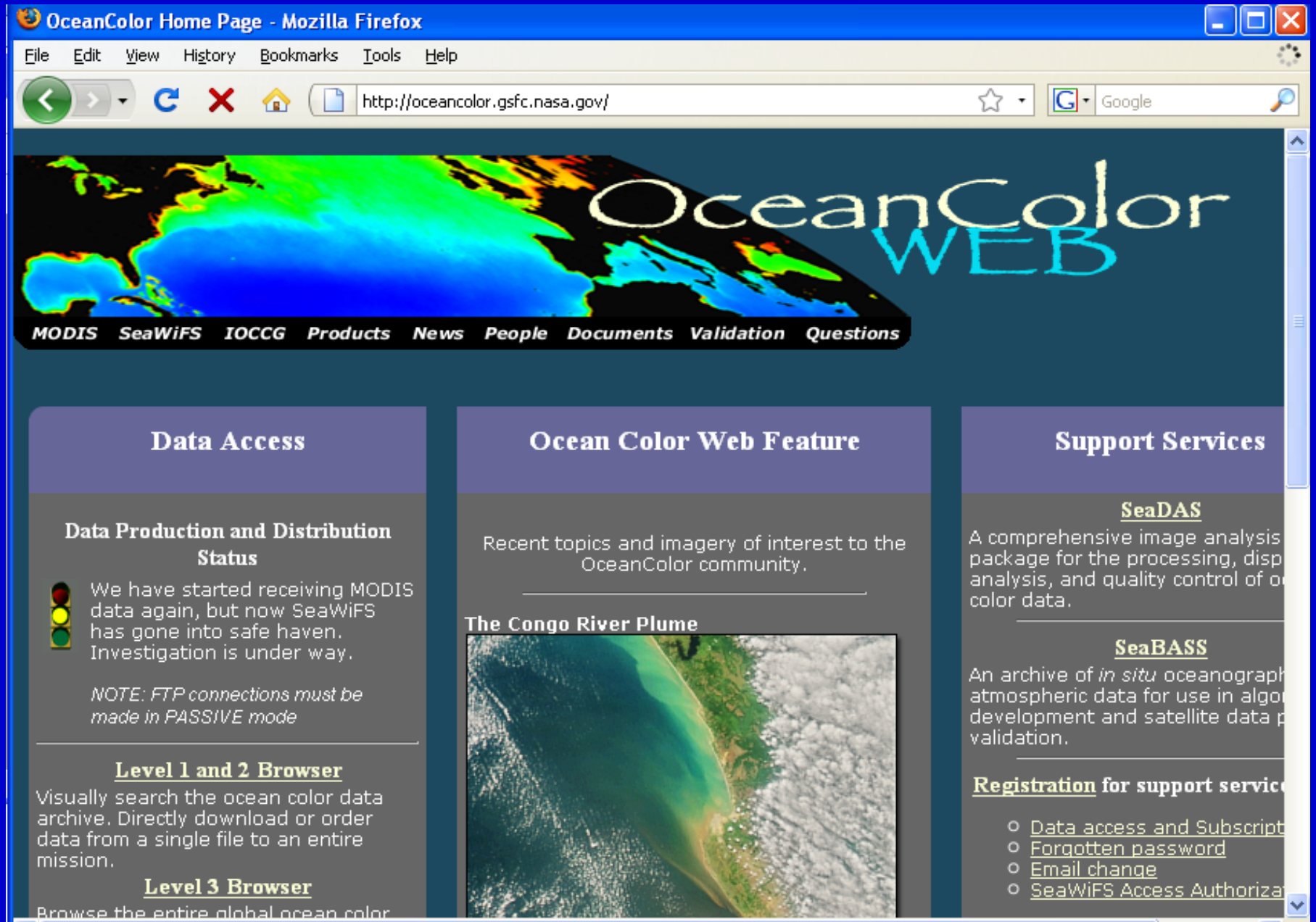
What data products?

- Spectral reflectance
- Chlorophyll-a concentration
- Surface irradiance
- Attenuation coefficient
- Backscattering coefficient
- CDOM absorption coefficient
- Euphotic depth
- Total suspended sediments
- Fluorescence line height
- ……

Where?

- NASA (global archive)
- Regional (customized for GOM)

http://oceancolor.gsfc.nasa.gov



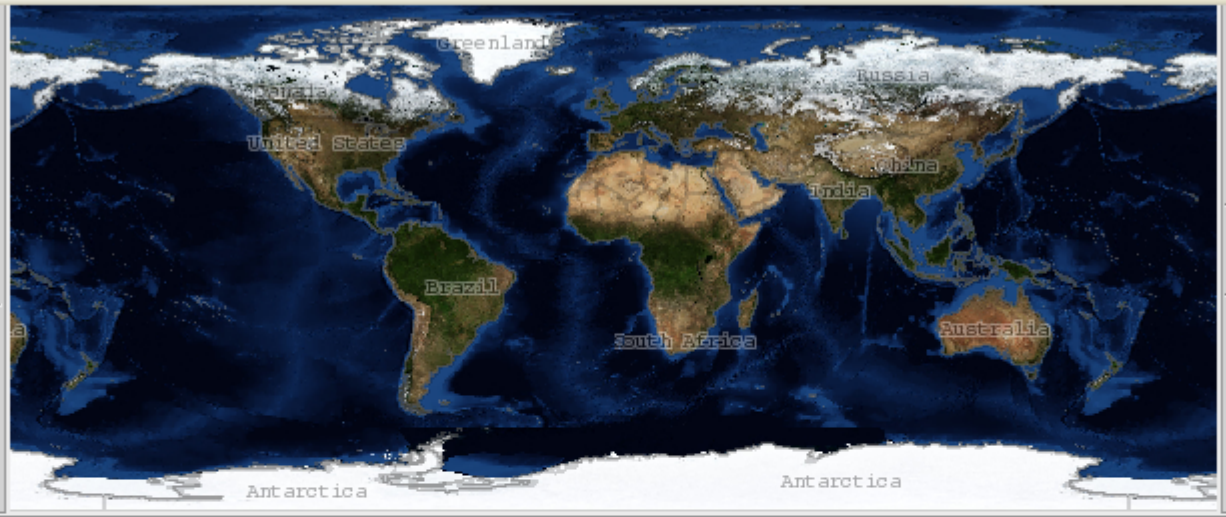
http://reason.gsfc.nasa.gov/Giovanni/

Giovanni - Ocean Color Radiometry Online Visualization and Analysis - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=ocean_mo

Google



Area of Interest: West: -180 North: 90 South: -90 East: 180 Update Map

Parameters

Display: ☑ Data Product Info ☐ Climatology Info ☐ Units ☐ Only Parameters with Climatology

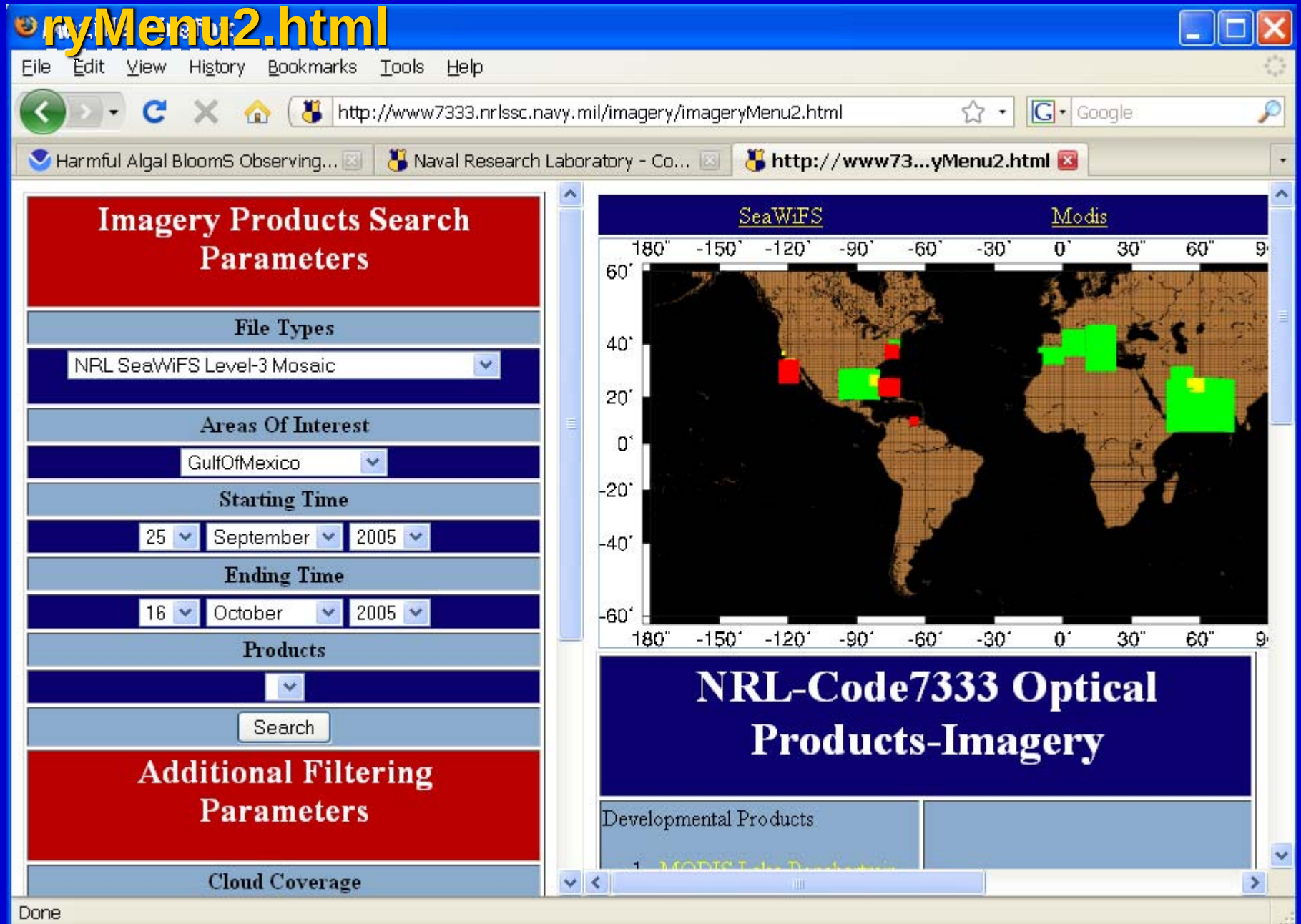
Analysis Options: ◉ Parameter ○ Climatology ○ Anomaly **Show Notes...**

☐ **SeaWiFS**(1997/09/01 - 2009/07/01)

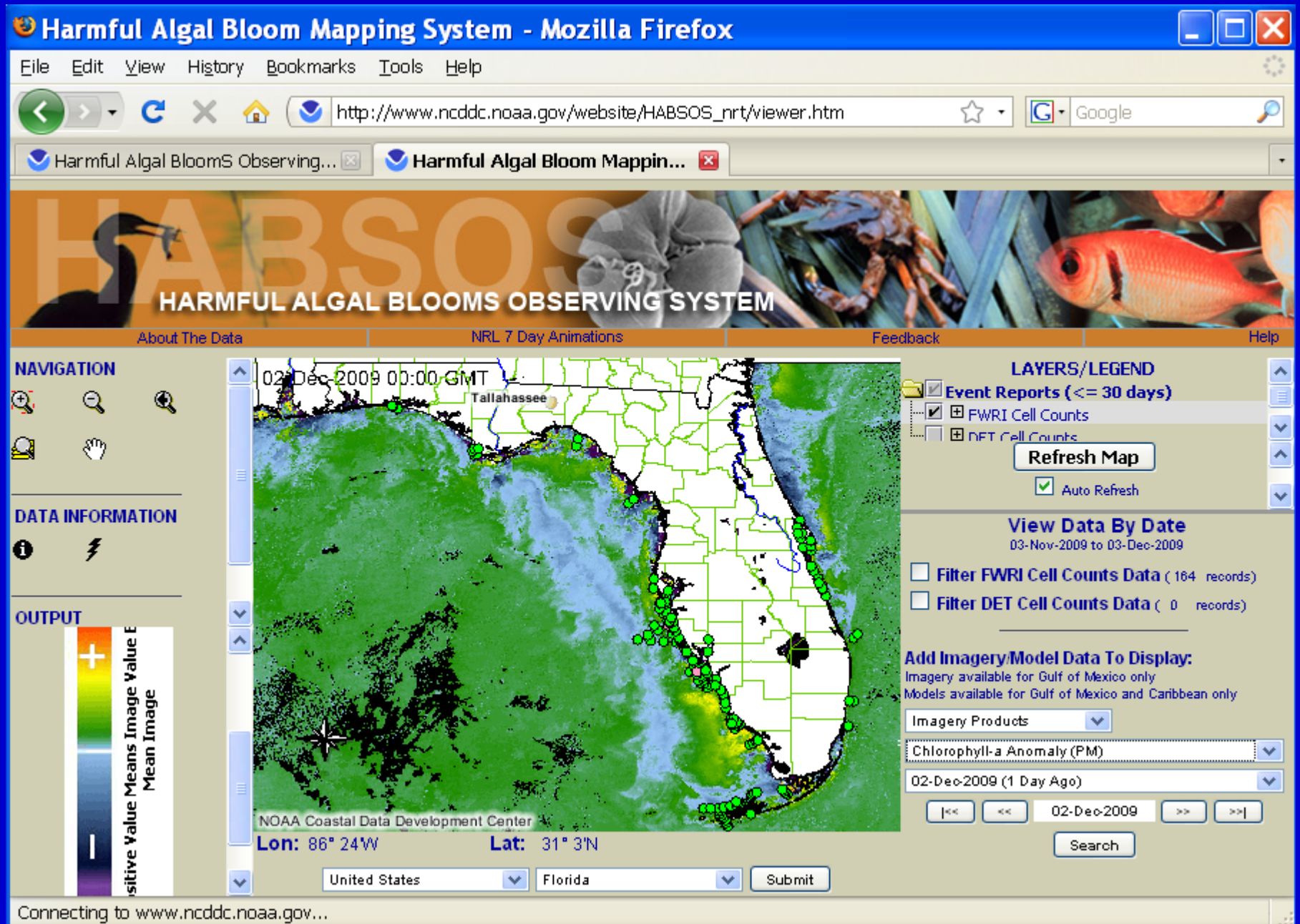
Parameter	*Data Product Info*		
☐ Aerosol optical thickness at 865 nm	SWFMOT865.005	SeaWiFS	1997/09 - 2009/07
☐ Angstrom coefficient 510 to 865 nm	SWFMOA510.005	SeaWiFS	1997/09 - 2009/07
☐ Chlorophyll a concentration	SWFMOCHLO.005	SeaWiFS	1997/09 - 2009/07
☐ Diffuse attenuation coefficient at 490 nm	SWFMOK490.005	SeaWiFS	1997/09 - 2009/07
☐ Epsilon of aerosol correction at 765 and 865 nm	SWFMOEPS78.005	SeaWiFS	1997/09 - 2009/07

Done

http://www7333.nrlssc.navy.mil/imagery/imageryMenu2.html



http://habsos.noaa.gov/



http://www.nodc.noaa.gov/SatelliteData/OceanColor/

NODC Ocean Color Archive - Mozilla Firefox

File Edit View History Bookmarks Tools Help

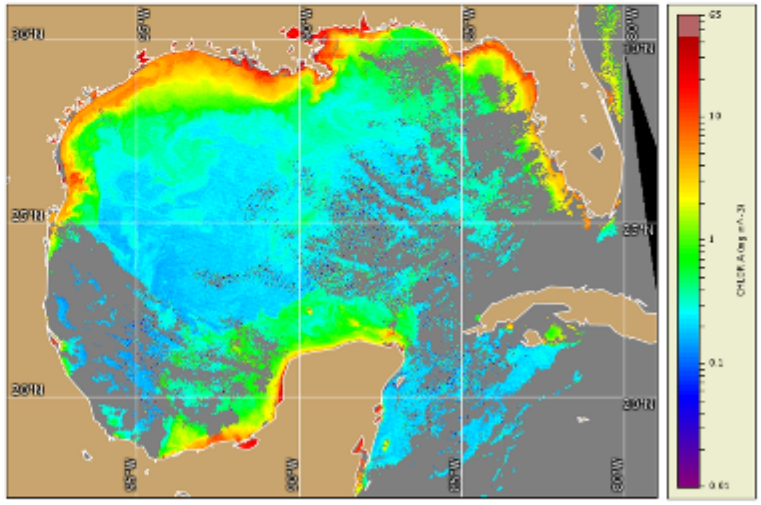
http://www.nodc.noaa.gov/SatelliteData/OceanColor/

Harmful Algal BloomS Observing... | Naval Research Laboratory - Co... | NODC Ocean Color Archive

using NOAA's Comprehensive Large Array-data Stewardship System (CLASS). Under the new NOAA Data Center-CLASS relationship, CLASS will focus on information technology in support of the archive (ingest, archival storage and access) while NODC is responsible for the overall archive services, including preservation planning, scientific stewardship, documentation and metadata management. An archive team consisting of representatives from CoastWatch, NODC and CLASS is currently working to fulfill the archive requirements for these products. One of these requirements is the completion of the NODC Submission Information Form (SIF), which contains detailed descriptions of the products as well as information about data submission and dissemination, and links to other relevant documentation. While this is a living document, the most current version of the CoastWatch L2 ocean color SIF is available here.

Ocean Color Product Information

The L2 ocean color products generated by CoastWatch from SeaWiFS, MODIS and MERIS data consist primarily of spatial information on chlorophyll-a concentration, as well as turbidity (reflectance), covering 13 CoastWatch regions globally. Products derived from all three sensors have approximately 1 km-per-pixel resolution, and will be delivered as both daily and 61-day composites. All files will be in CoastWatch Hierarchical Data Format (HDF). For more detailed information about these products, refer to the SIF in the section above.



CoastWatch ocean color for Gulf of Mexico from MODIS Aqua, 2008/12/02

While more interoperable connections are being established between CLASS and NODC information

Done

http://www.esl.lsu.edu/home/

HOME - Earth Scan Laboratory, LSU - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.esl.lsu.edu/home/

Harmful Algal BloomS Observing... | HOME - Earth Scan Laborato...

Storms

There is presently no significant tropical storm activity

Recent Seasonal Activity

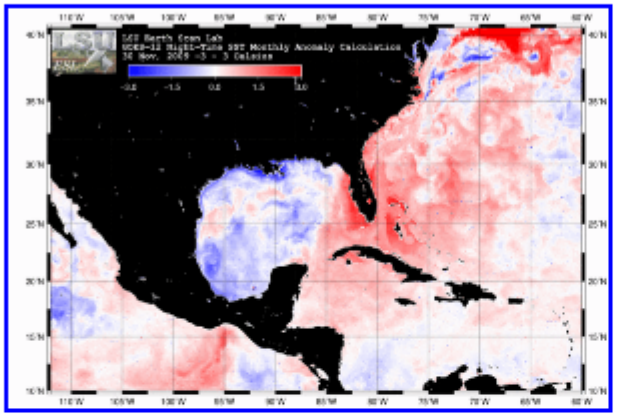
Tropical Outlook & Discussion

2008 Hurricane Season

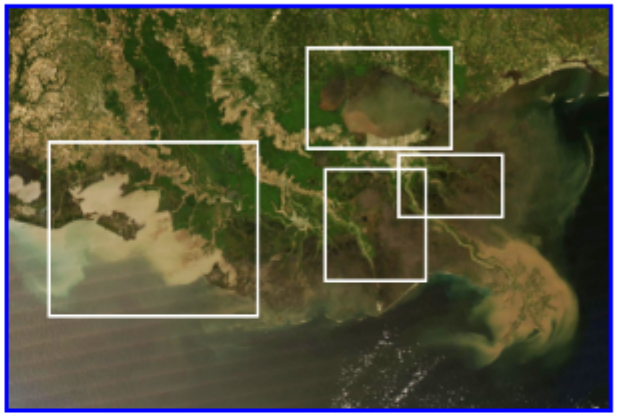
Image of the Month

Related LSU Sites

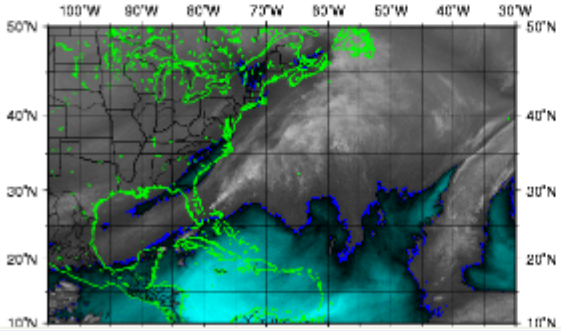
Coastal Studies Institute



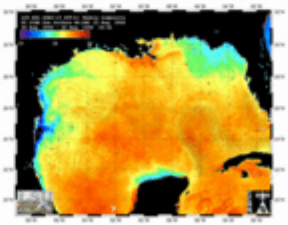
GOES-12 Monthly Composite SST Anomaly
Calculated from 11-year mean, November 2009



Recent Atmospheric Imagery



Recent Ocean Temperatures



Gulf Loop Current and Surface Temperatures

Links to imagery

Research

Done

http://gulf-coast.lsu.edu/

GCIS - Latest CHLO image from MODIS-Aqua - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://gulf-coast.lsu.edu/aqua_chlo.html

Reload current page

COASTAL STUDIES INSTITUTE

WAVCIS

Gulf-Coast Information System

GCIS

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Satellite Data

Coastal Model

GIS

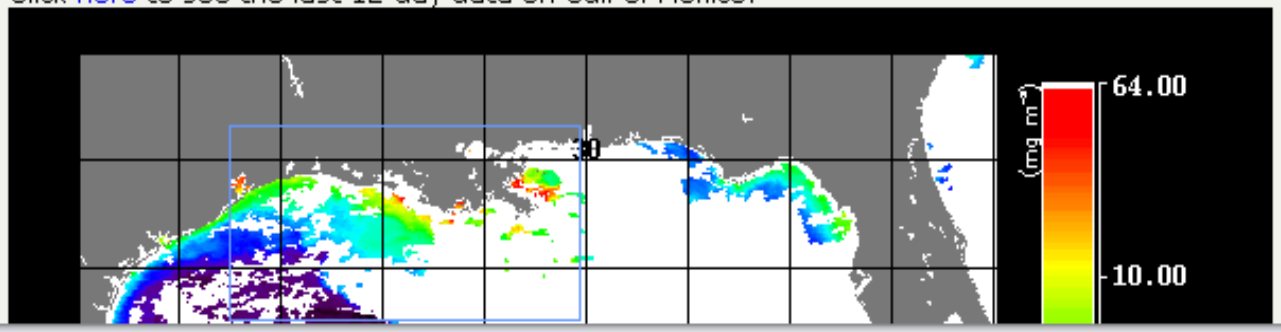
Field Data

Links

Latest Chlorophyll Concentration Map from MODIS - Aqua

Historical Data

Click here to see the last 12-day data on Gulf of Mexico.



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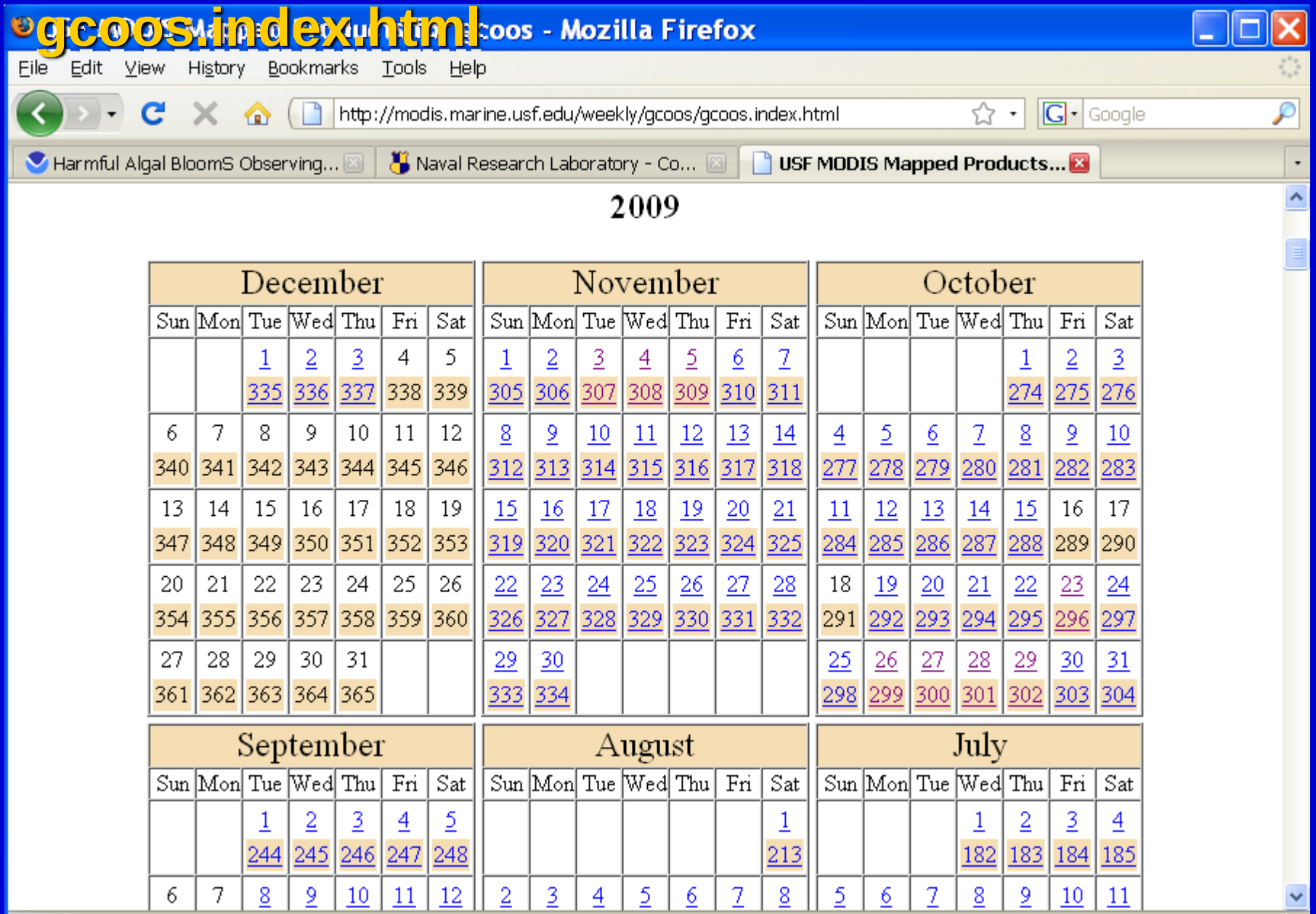
http://modis.marine.usf.edu/weekly/gcoos/gcoos.index.html



2009

December						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
		335	336	337	338	339
6	7	8	9	10	11	12
340	341	342	343	344	345	346
13	14	15	16	17	18	19
347	348	349	350	351	352	353
20	21	22	23	24	25	26
354	355	356	357	358	359	360
27	28	29	30	31		
361	362	363	364	365		

November						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
305	306	307	308	309	310	311
8	9	10	11	12	13	14
312	313	314	315	316	317	318
15	16	17	18	19	20	21
319	320	321	322	323	324	325
22	23	24	25	26	27	28
326	327	328	329	330	331	332
29	30					
333	334					

October						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
				274	275	276
4	5	6	7	8	9	10
277	278	279	280	281	282	283
11	12	13	14	15	16	17
284	285	286	287	288	289	290
18	19	20	21	22	23	24
291	292	293	294	295	296	297
25	26	27	28	29	30	31
298	299	300	301	302	303	304

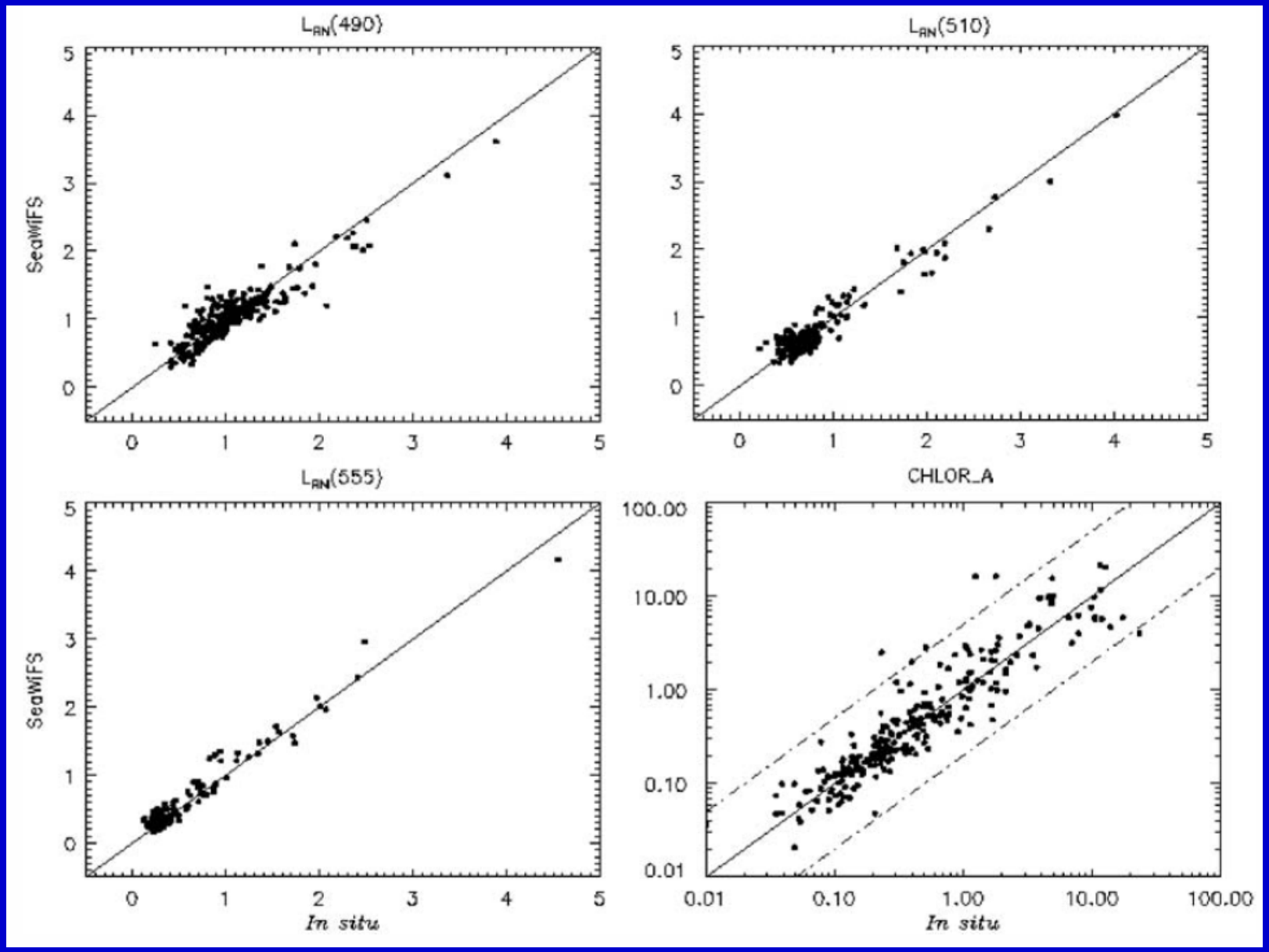
September						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
		244	245	246	247	248
6	7	8	9	10	11	12

August						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
						213
2	3	4	5	6	7	8

July						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
			182	183	184	185
5	6	7	8	9	10	11

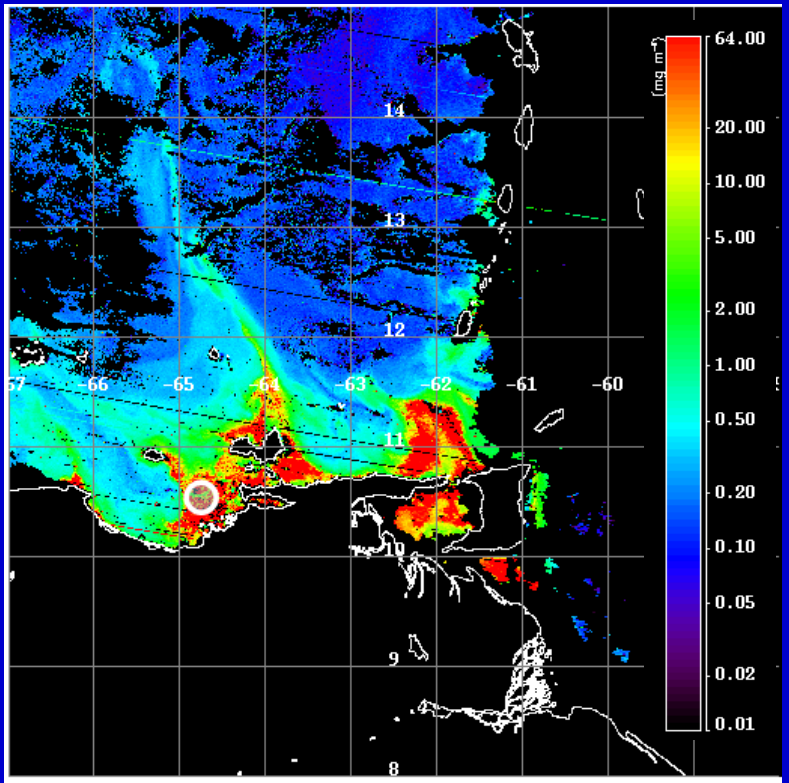
How shall we trust these products?

Global Oceans

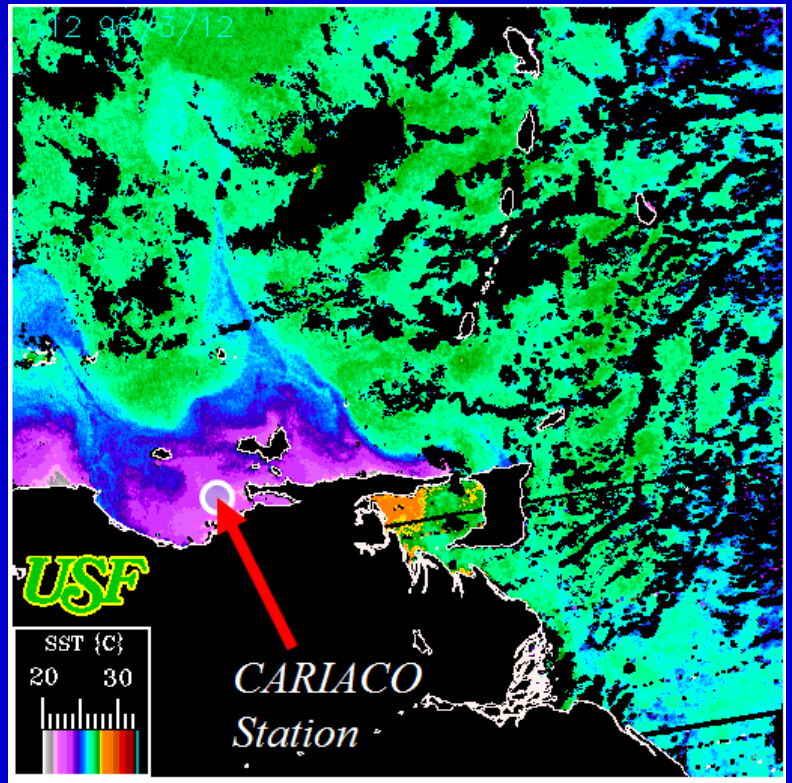


McClain et al., (2004, DSR-II)

Upwelling and River Plume



SeaWiFS (Chlorophyll a)
15 March 1998

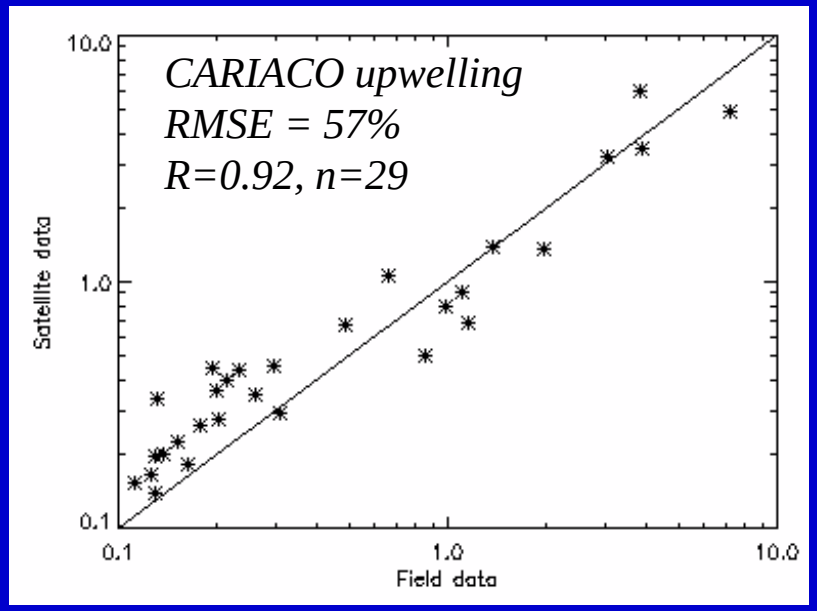


AVHRR (SST)
12 March 1998

From Muller-Karger (2001, EOS)

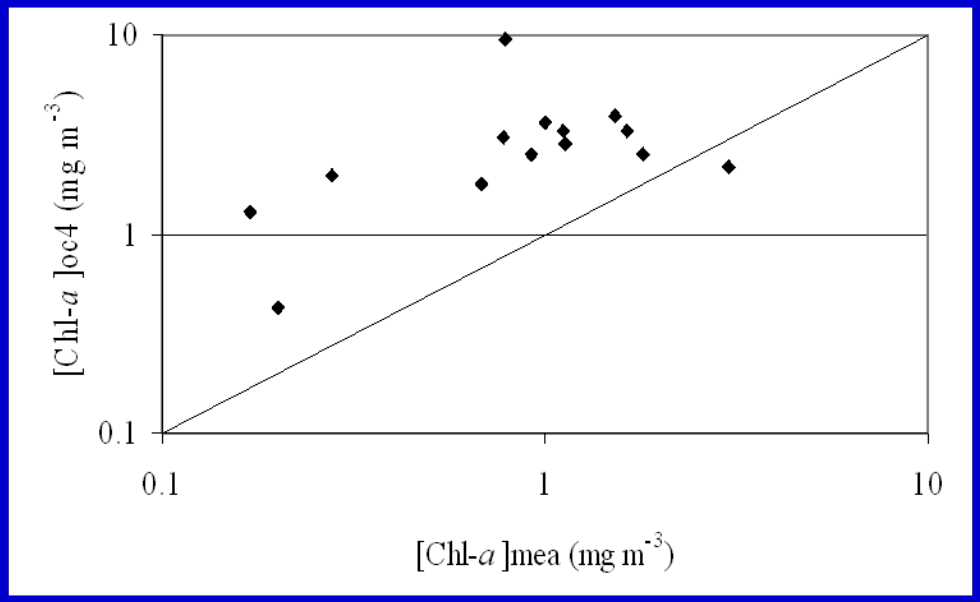
Upwelling and River Plume

CARIACO upwelling:
RMSE = 57%



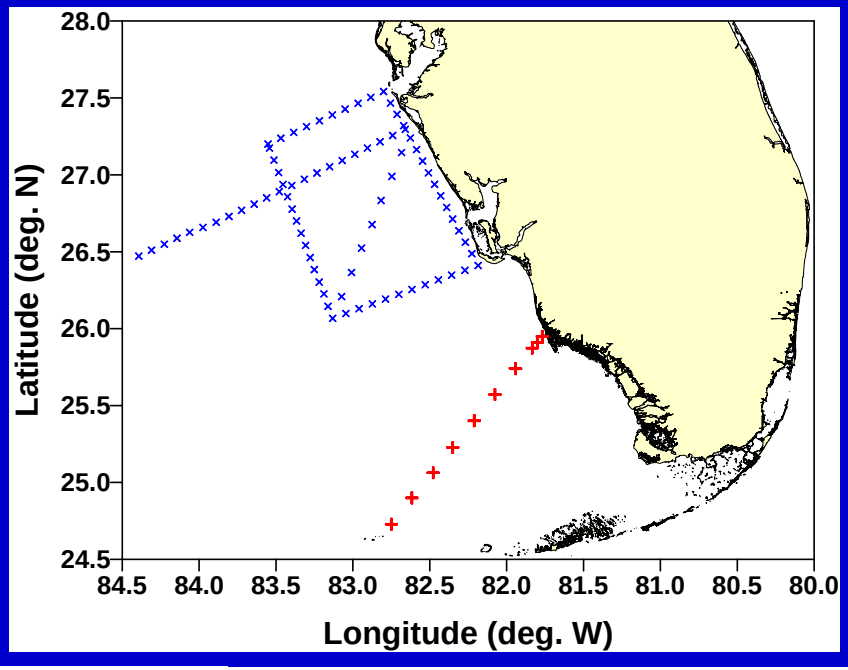
Unpublished data

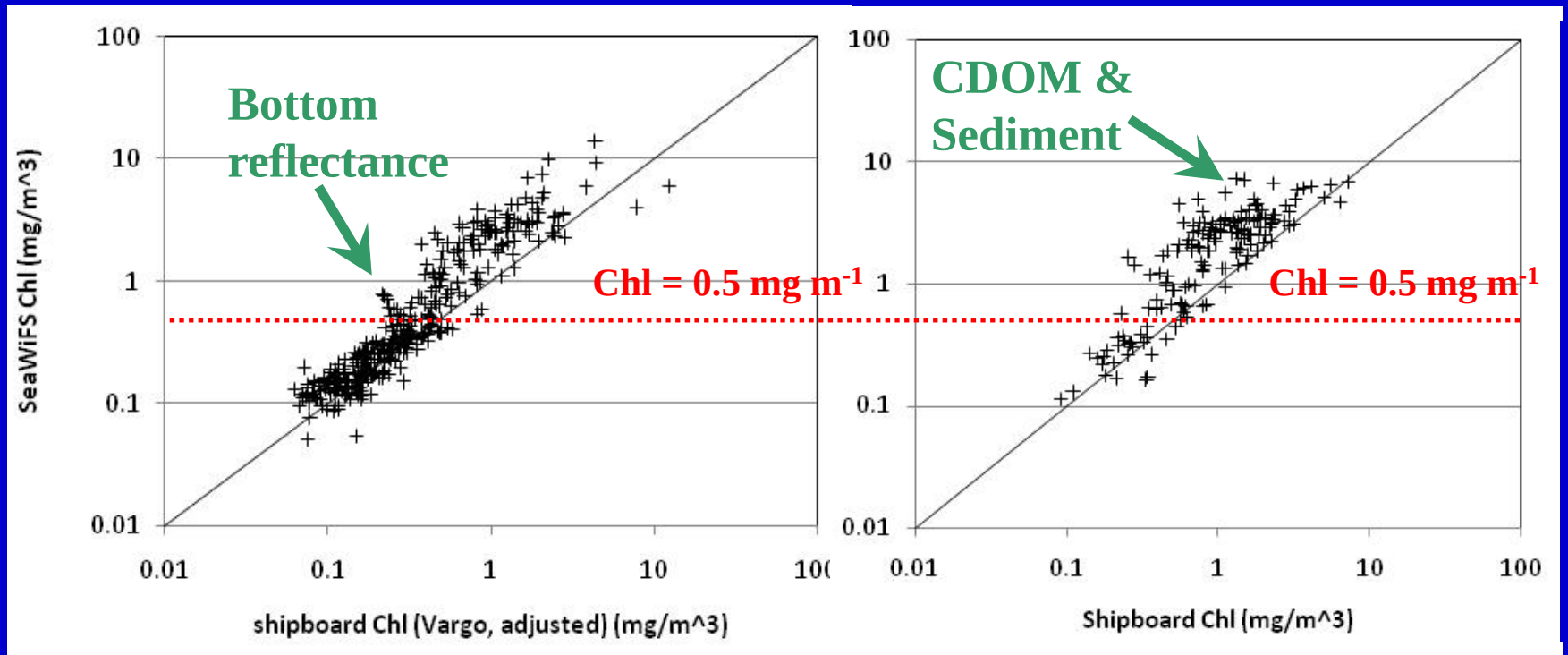
Orinoco plume:
RMSE > 150%



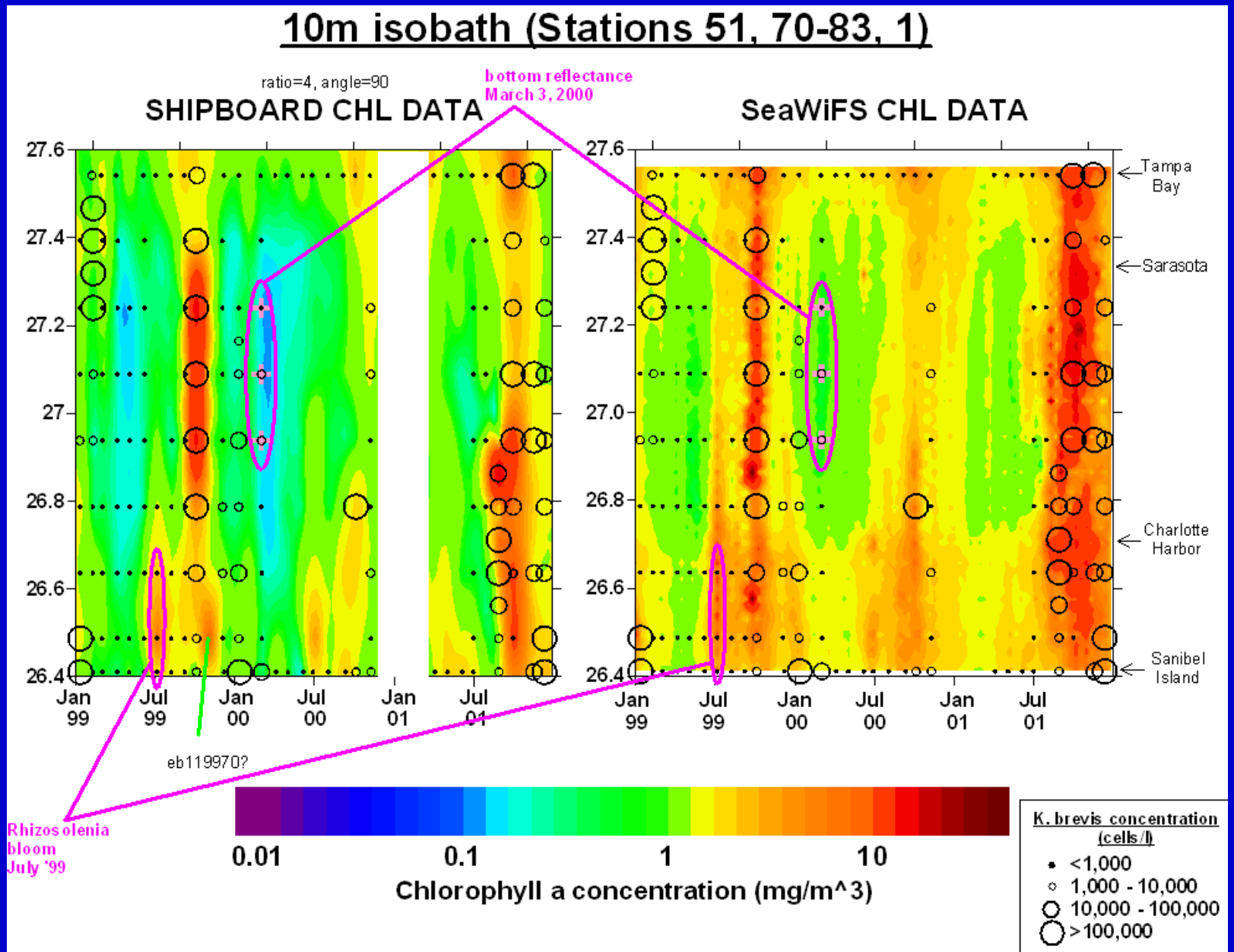
Odriozola et al. (2007, CSR)

Florida Coastal Water

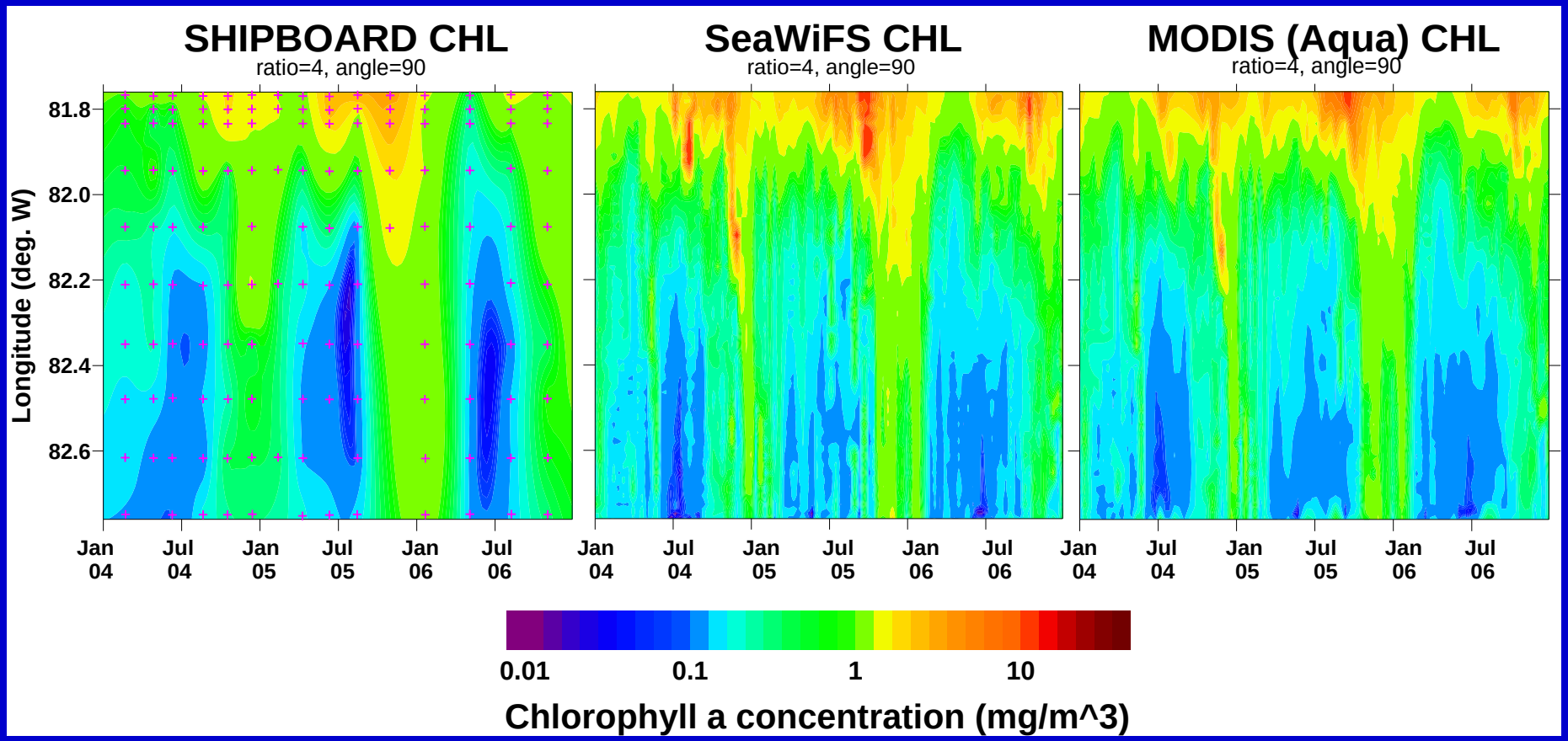




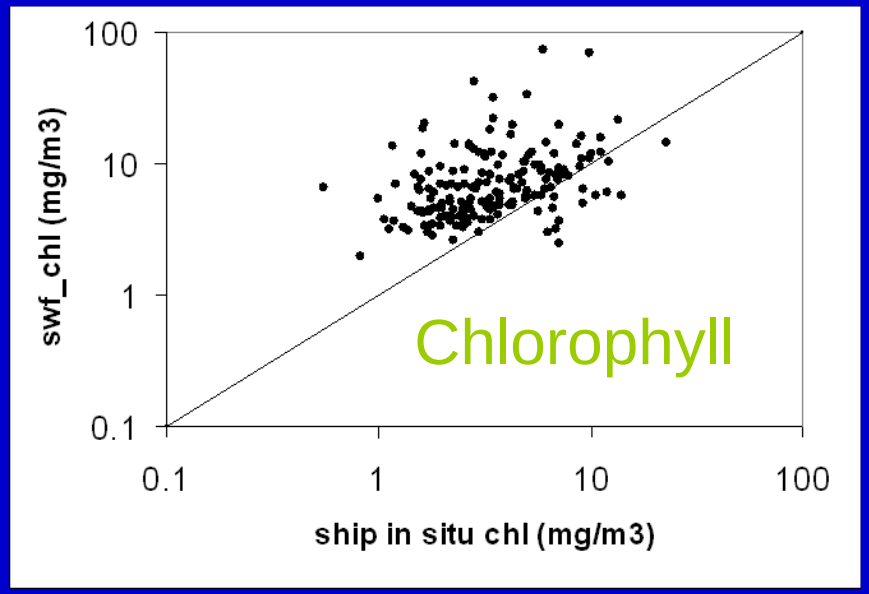
10-m Isobath, West Florida

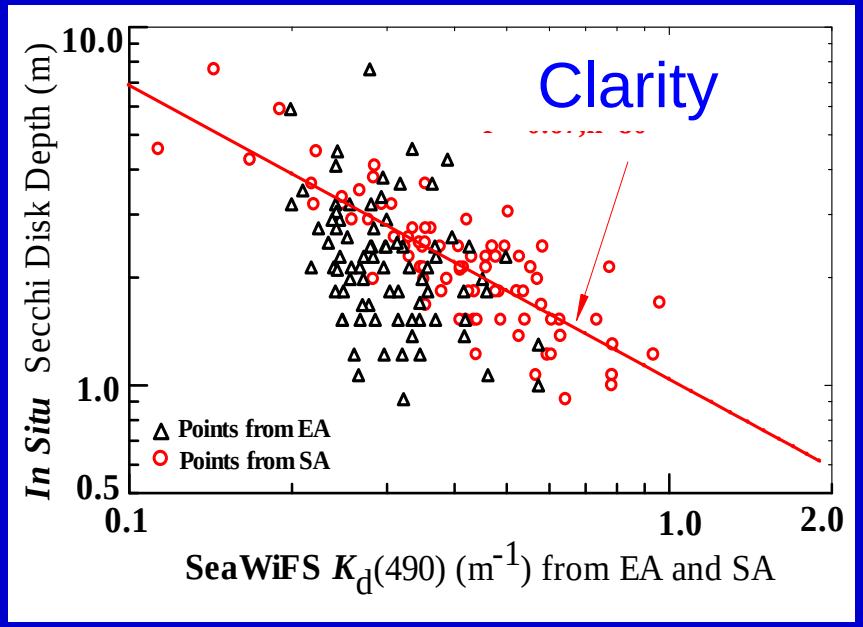


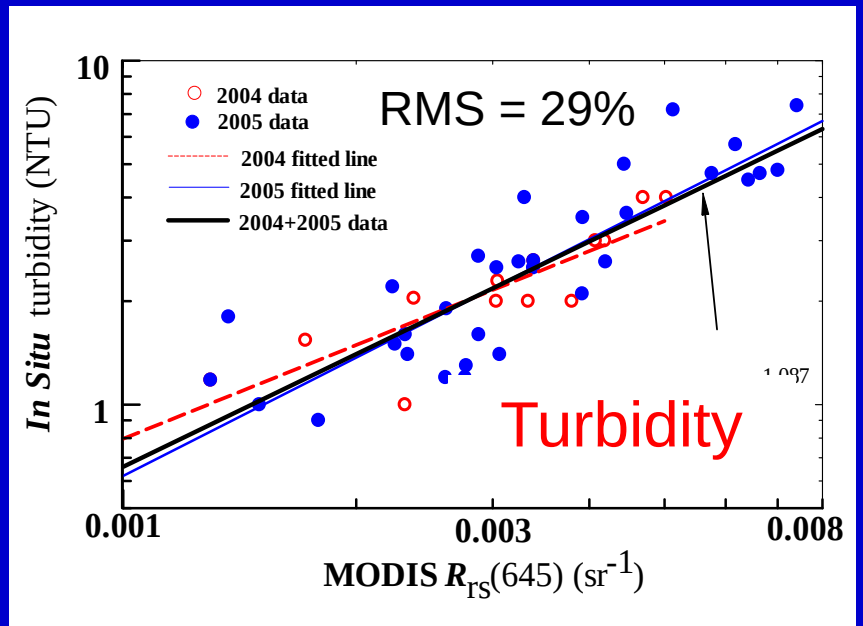
Cross-shelf, West Florida

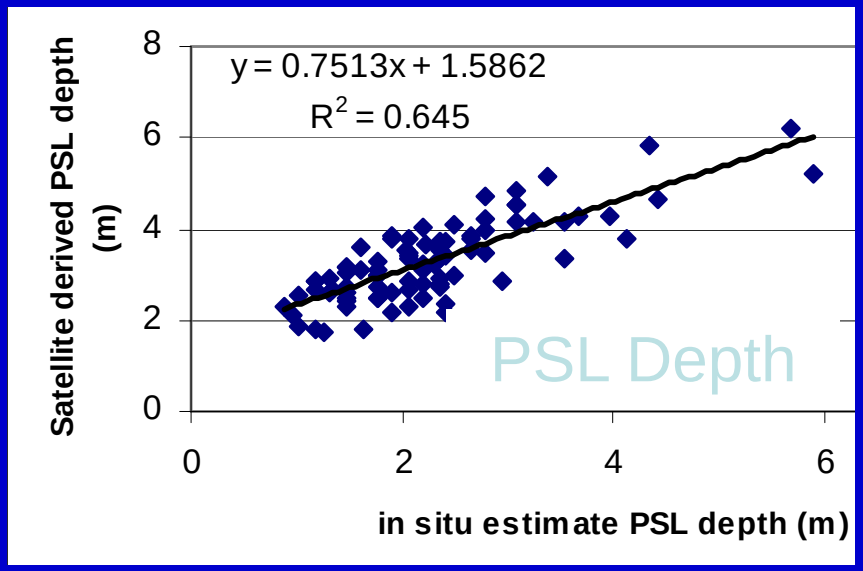


Tampa Bay, Florida



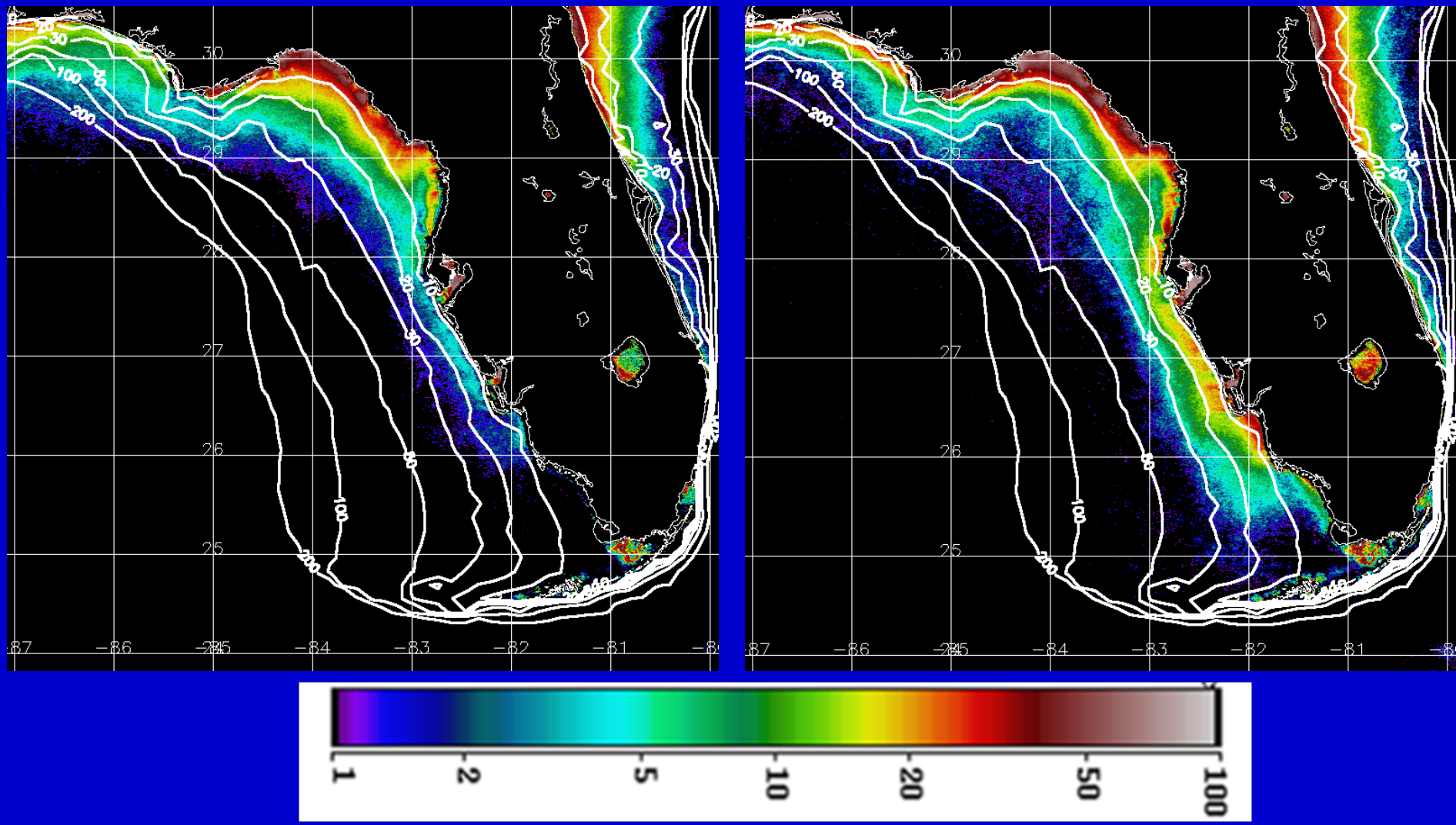


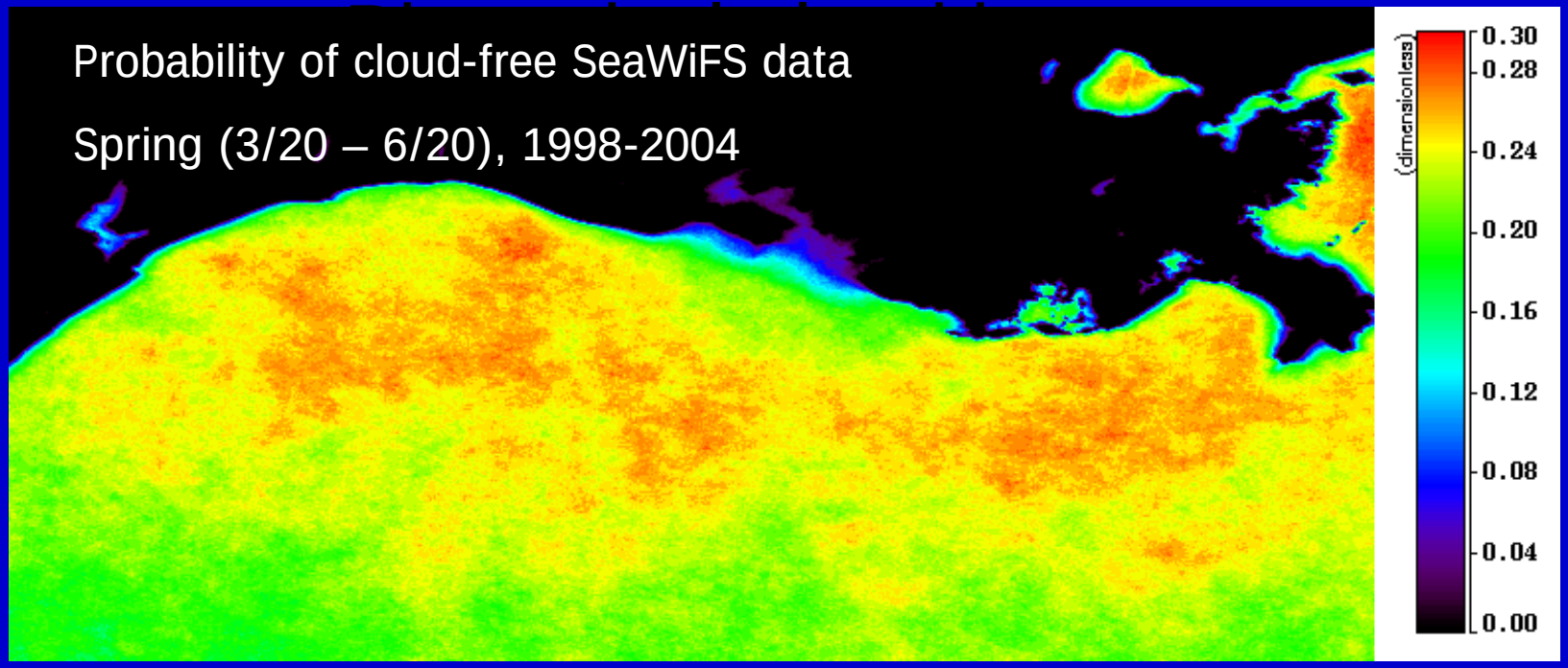


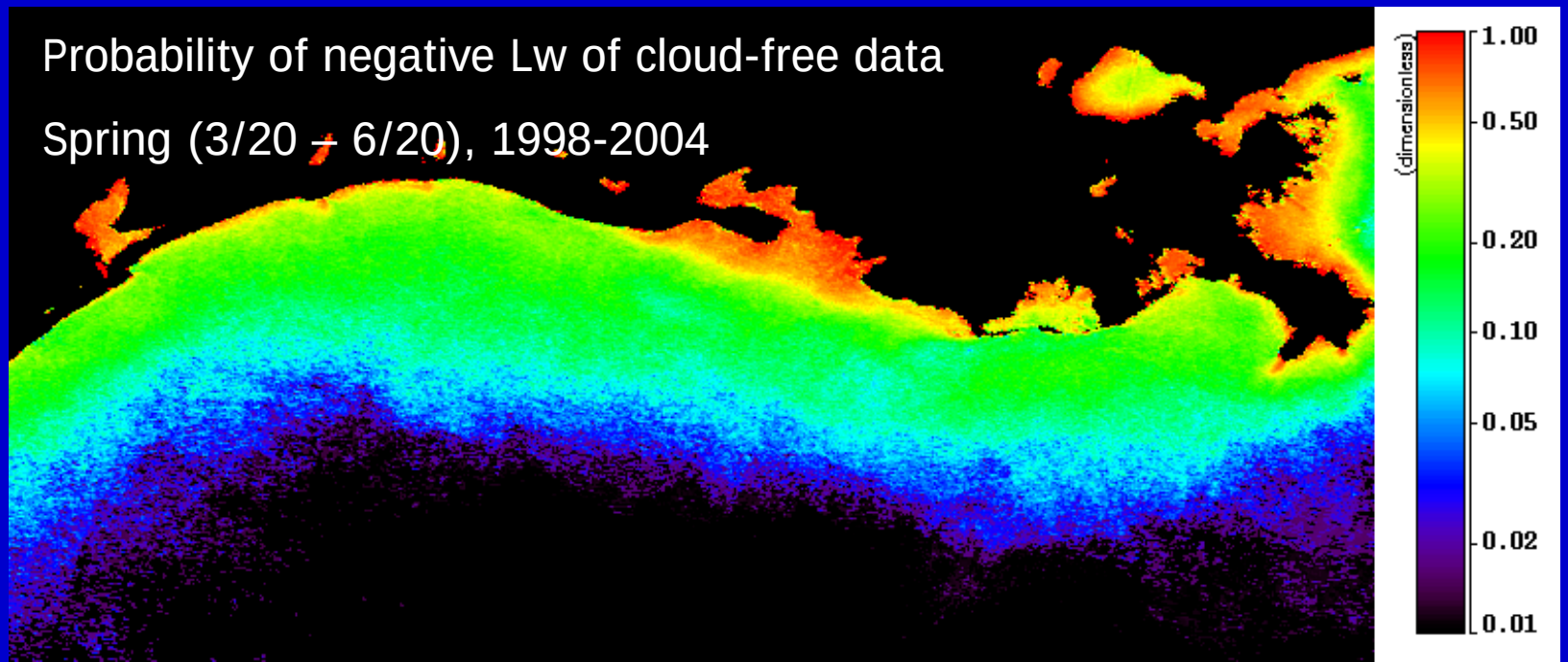


Percentage of Negative Lw (1998-2007)

Spring **Autumn**

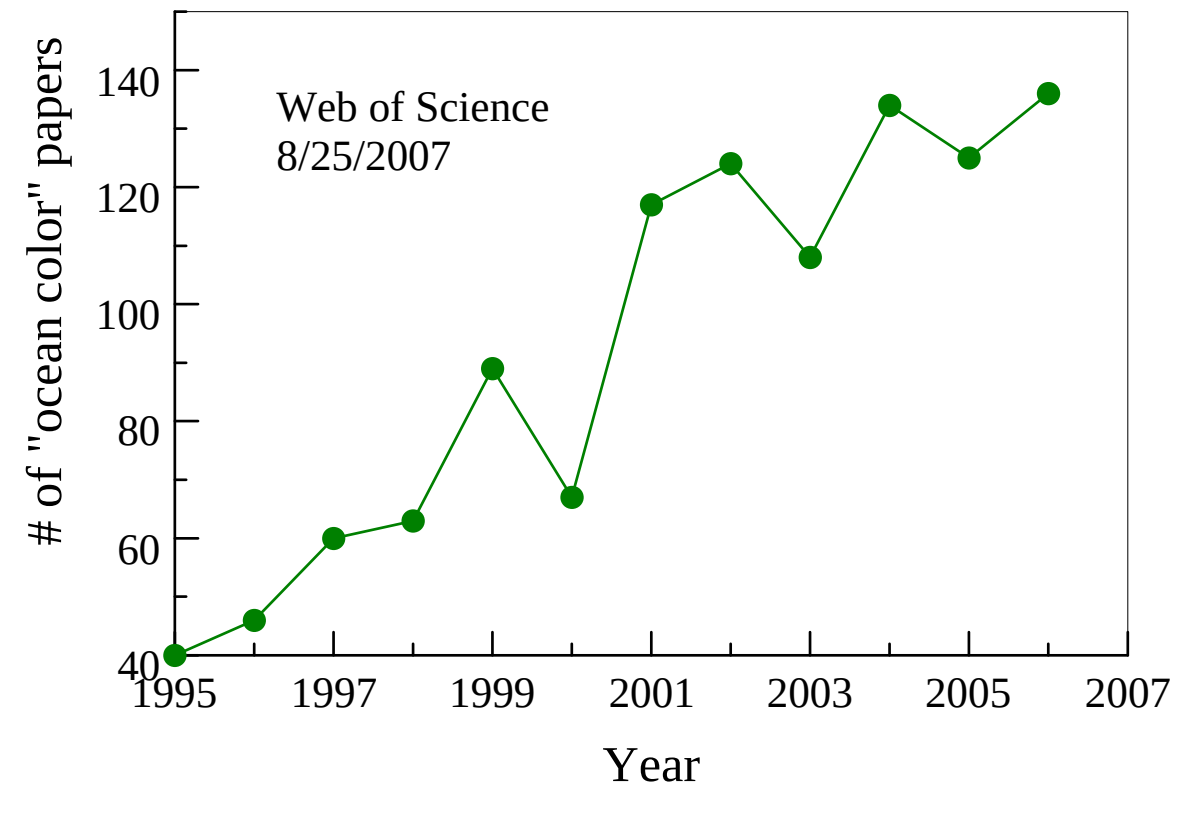


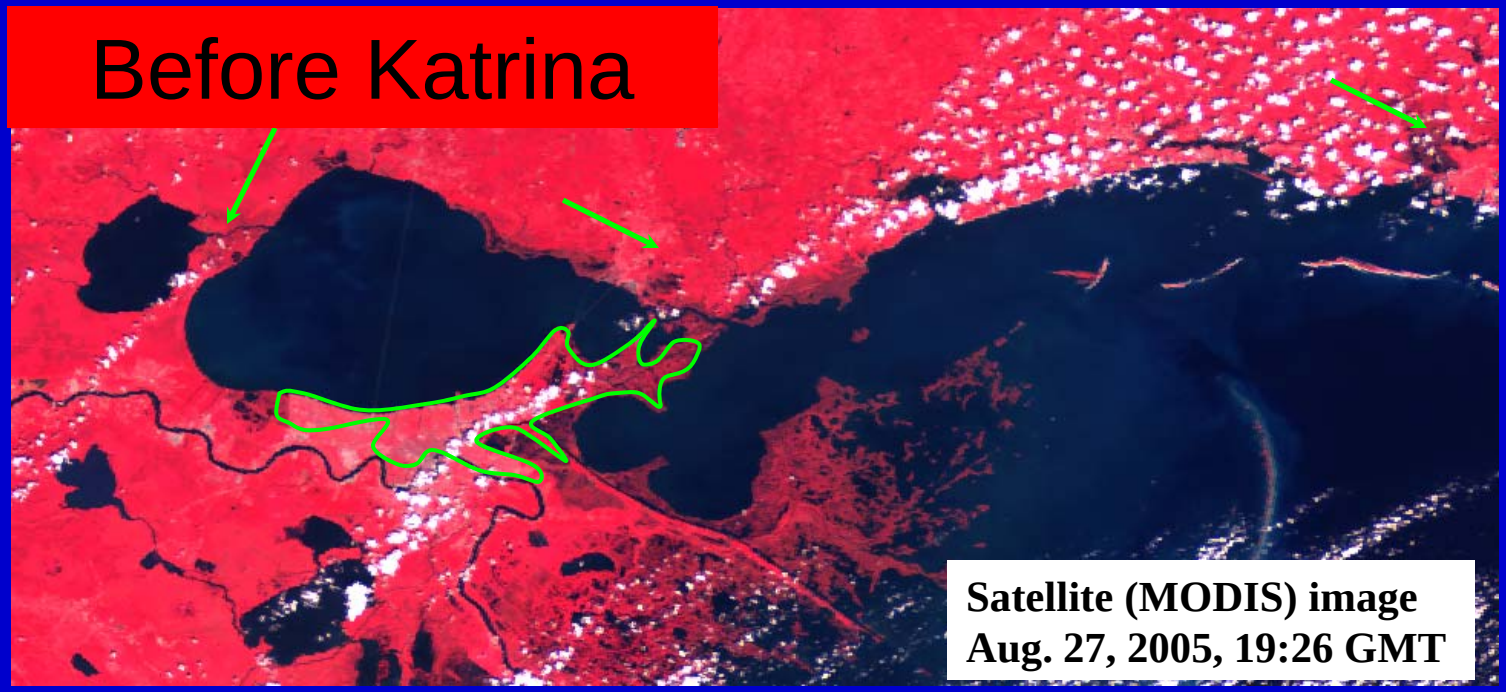

Probability of cloud-free SeaWiFS data
Spring (3/20 – 6/20), 1998-2004
(dimensionless)
0.30
0.28
0.24
0.20
0.16
0.12
0.08
0.04
0.00

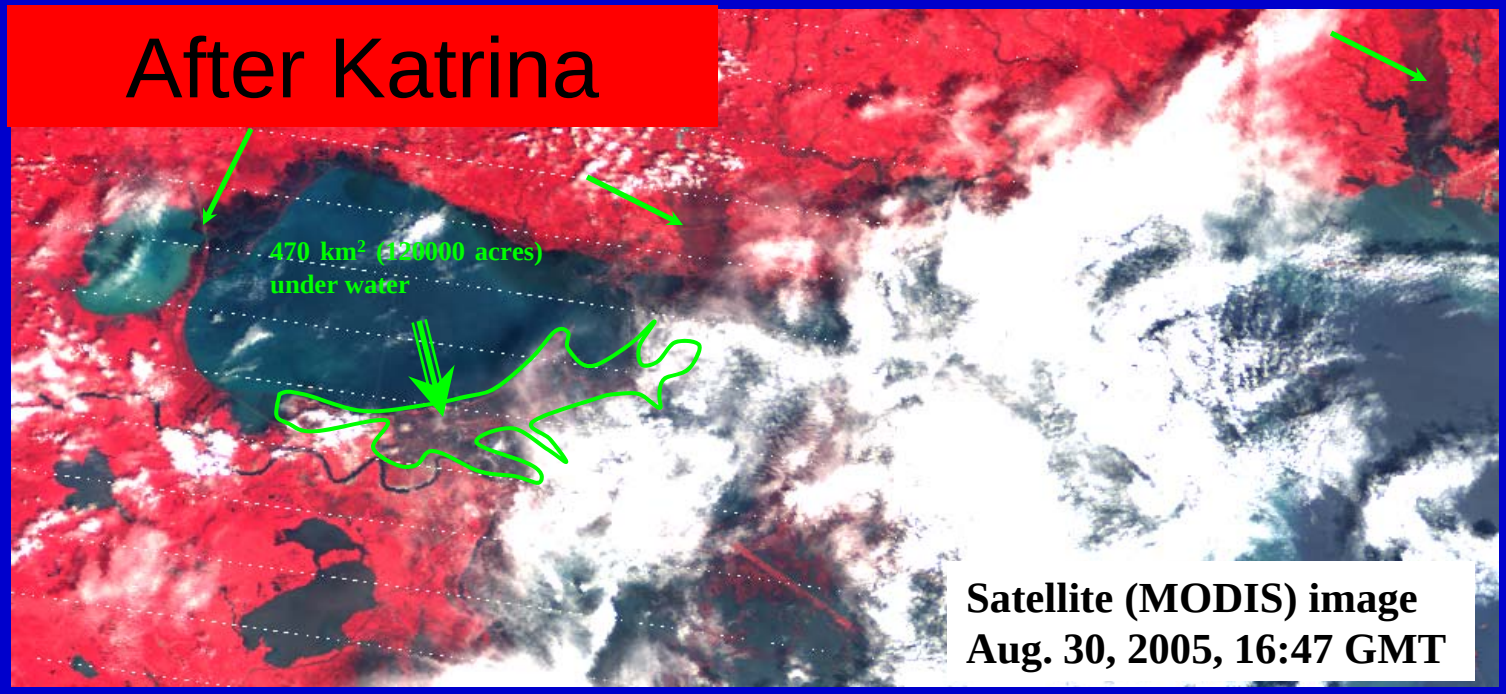

Probability of negative Lw of cloud-free data
Spring (3/20 – 6/20), 1998-2004
(dimensionless)
1.00
0.50
0.20
0.10
0.05
0.02
0.01

“Ocean color” in Research

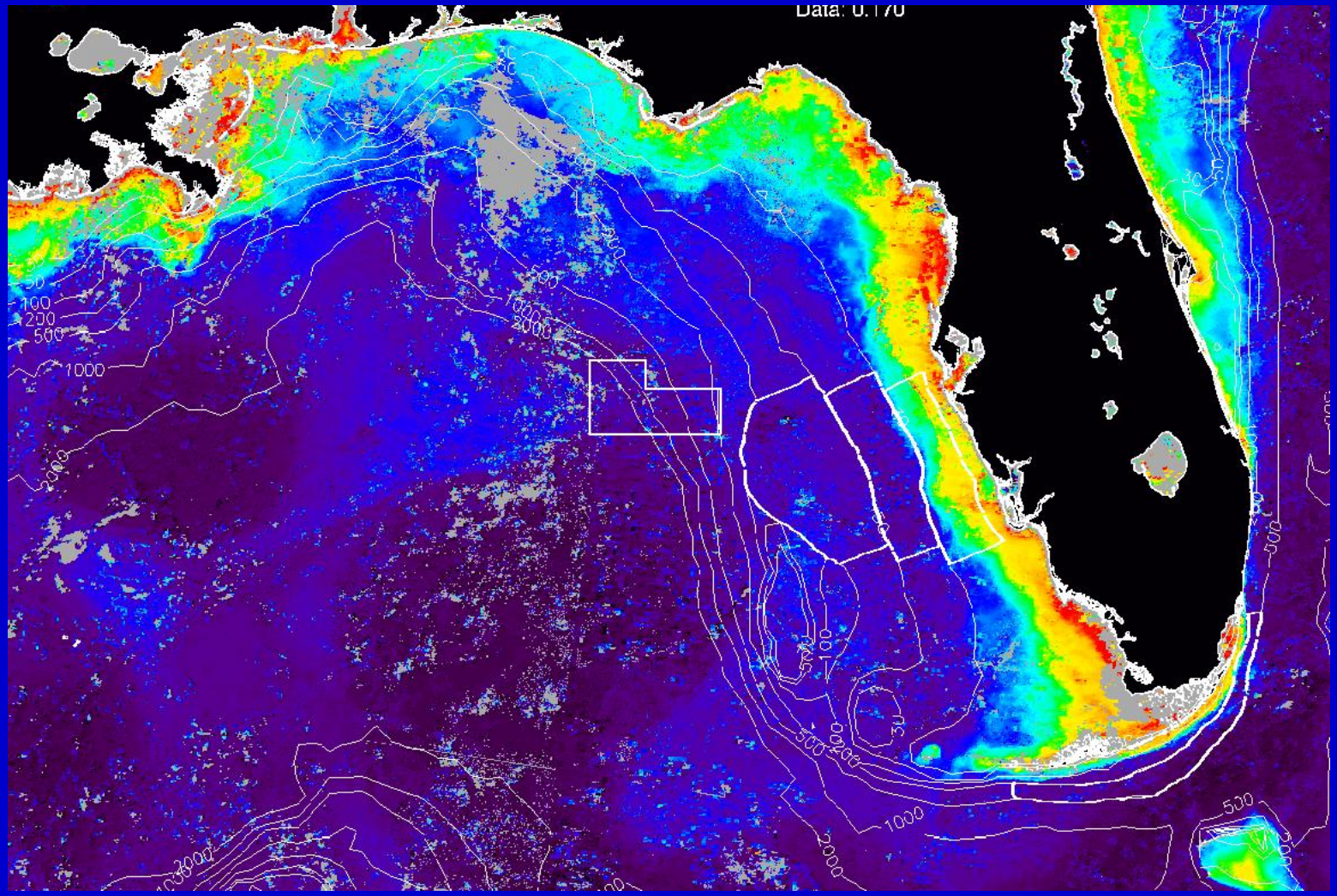
1. Carbon Cycle
2. Climate
3. Ecology and Fishery
4. Oceanography



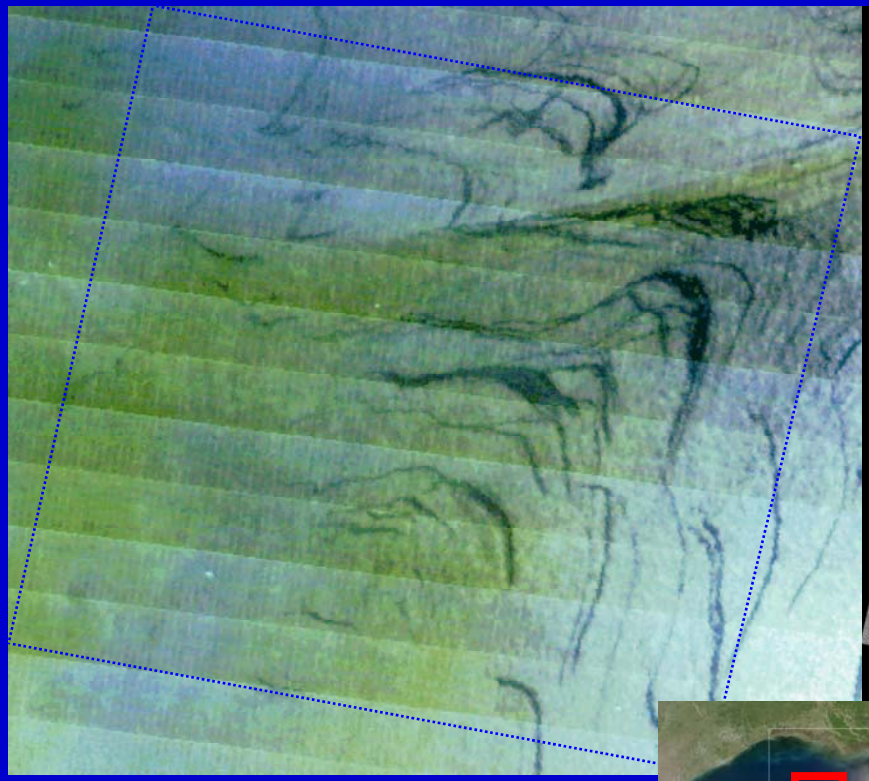

Before Katrina
Satellite (MODIS) image
Aug. 27, 2005, 19:26 GMT

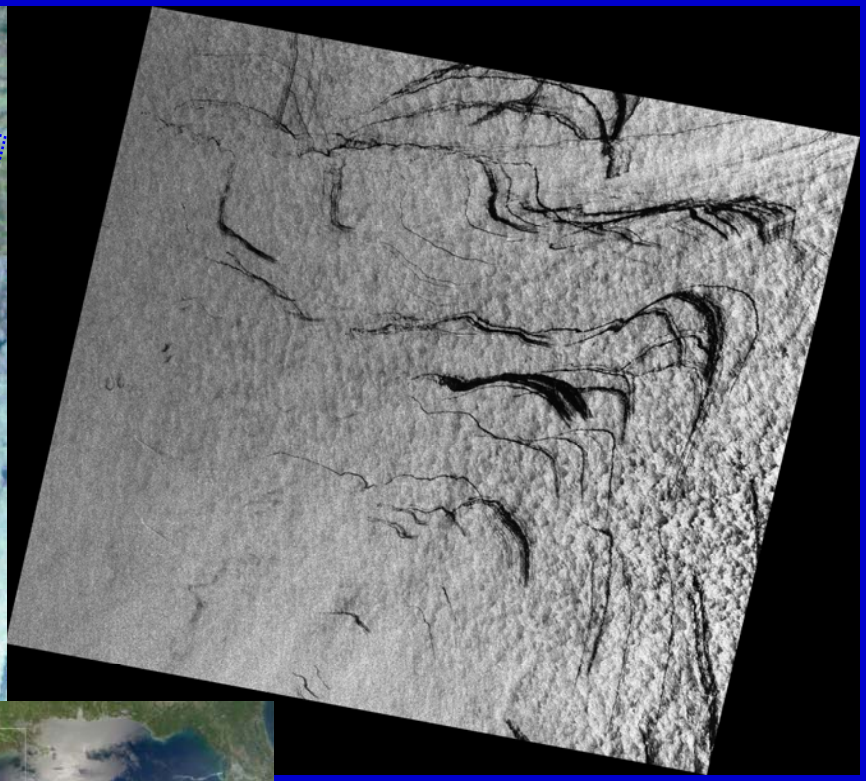

After Katrina
470 km² (120000 acres)
under water
Satellite (MODIS) image
Aug. 30, 2005, 16:47 GMT

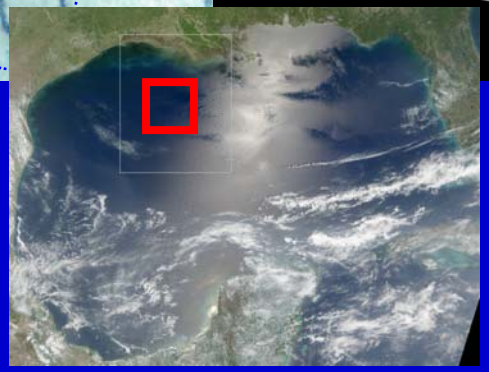
Wastewater Management



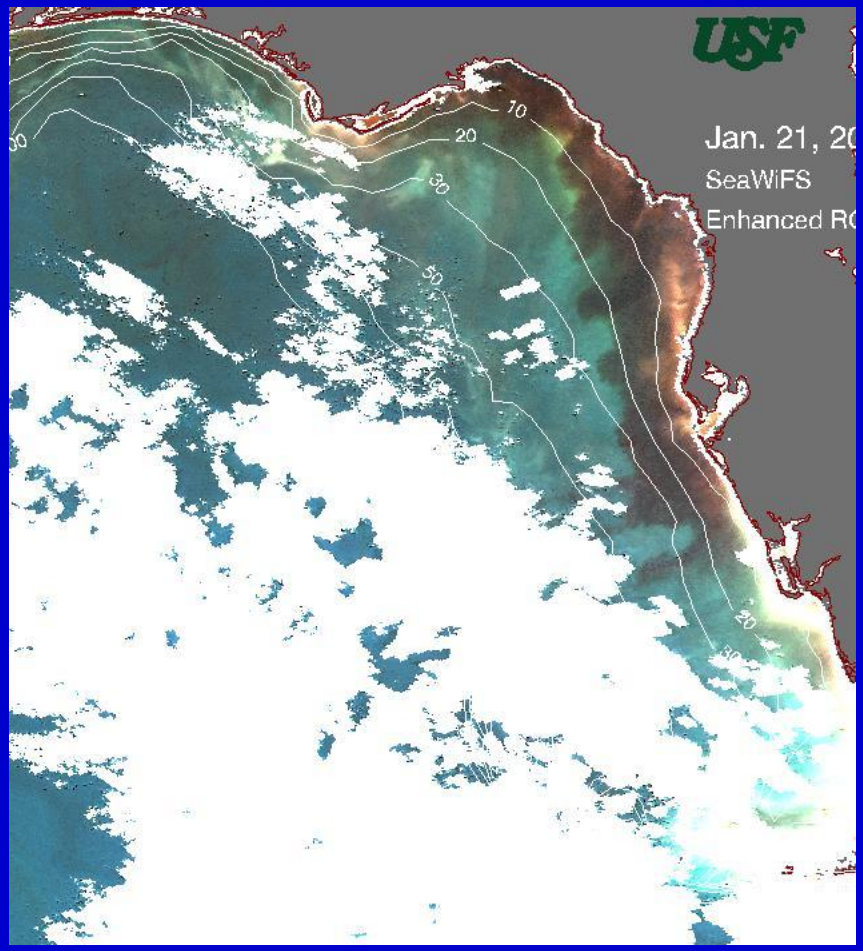
Oil Search

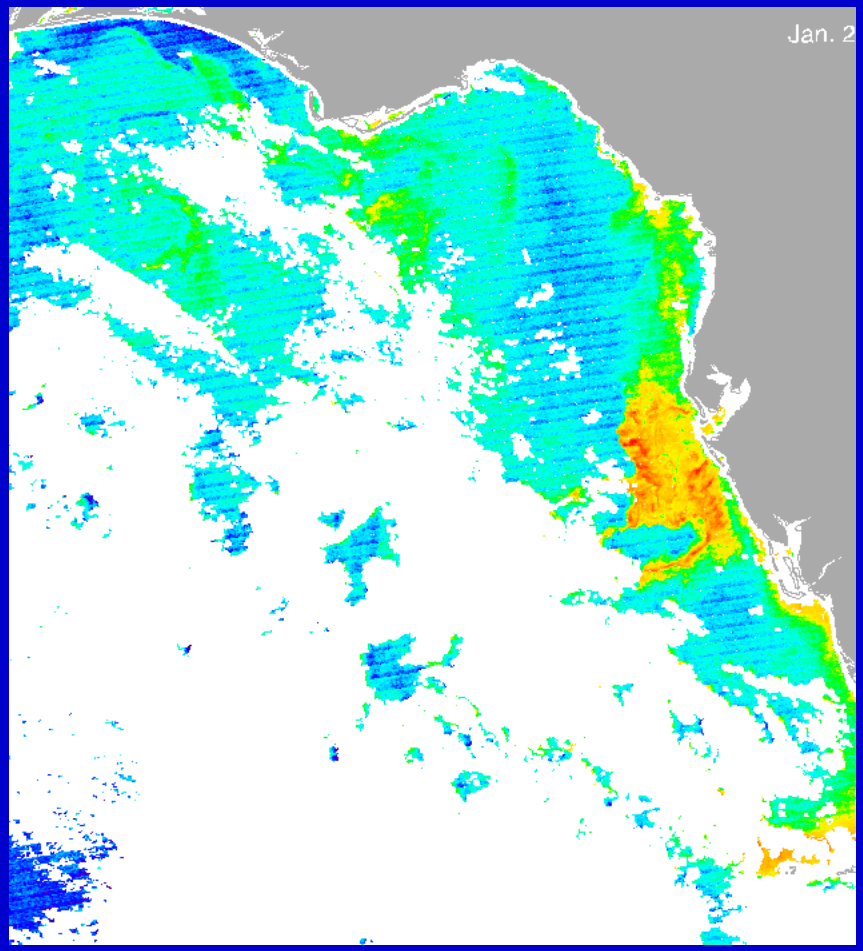




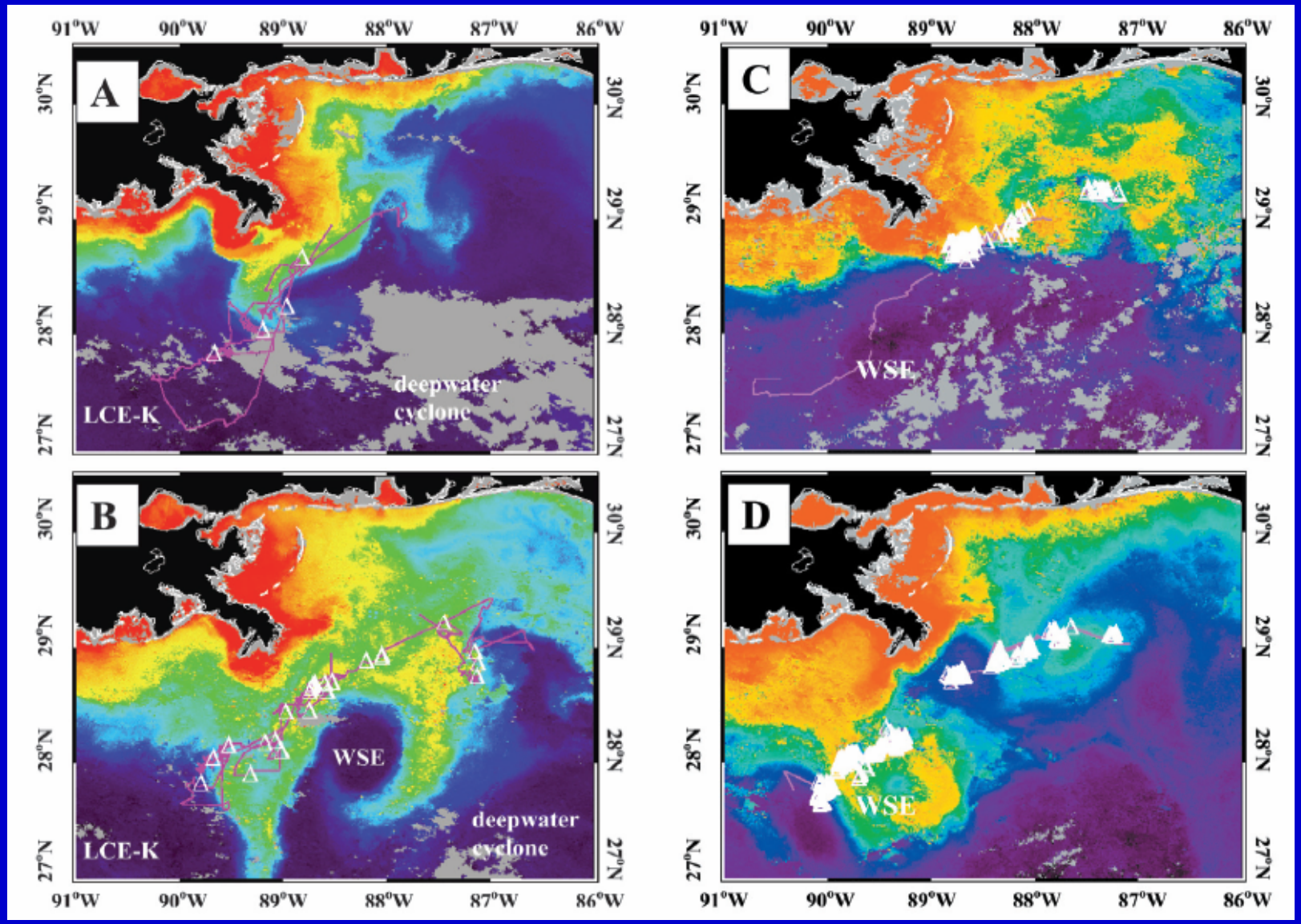


Plume or Bloom



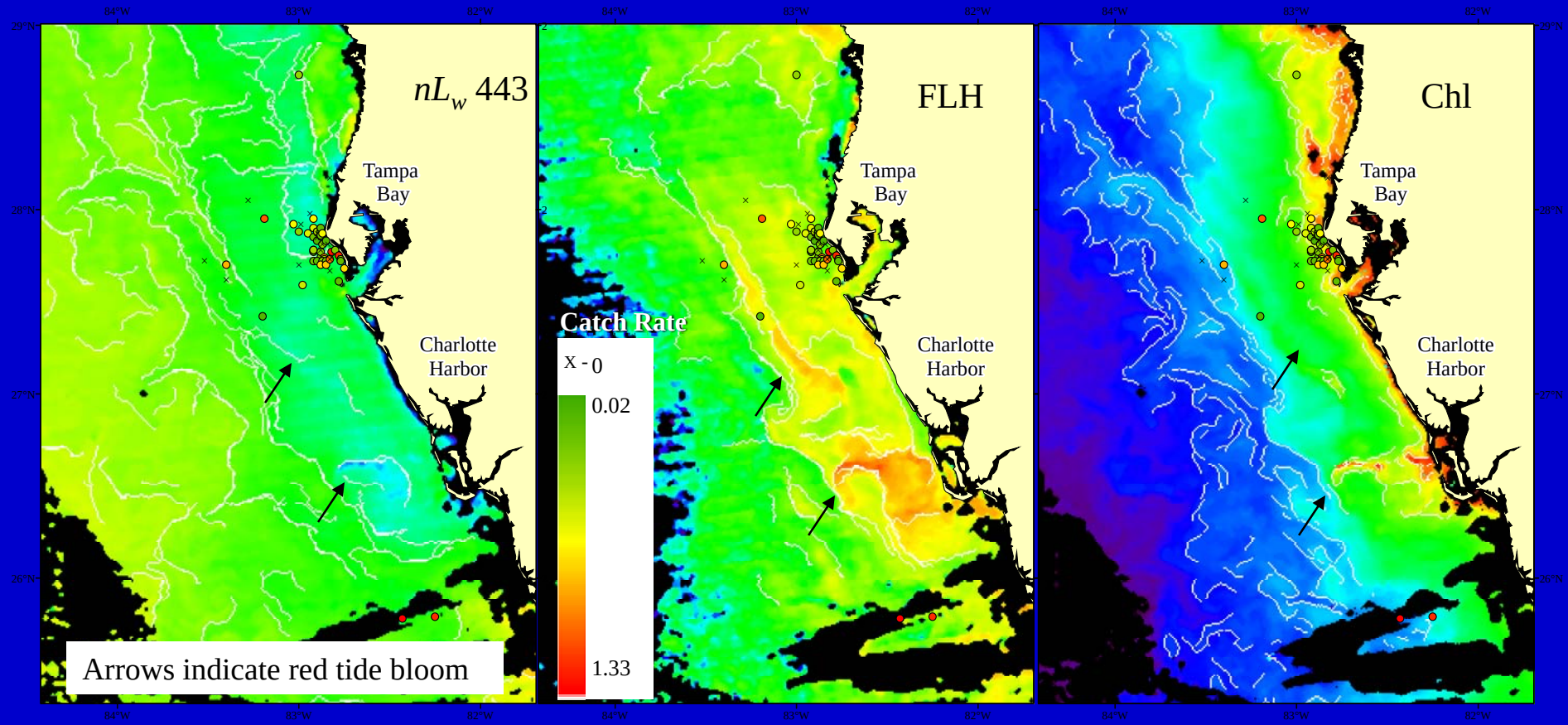


Whale Locations



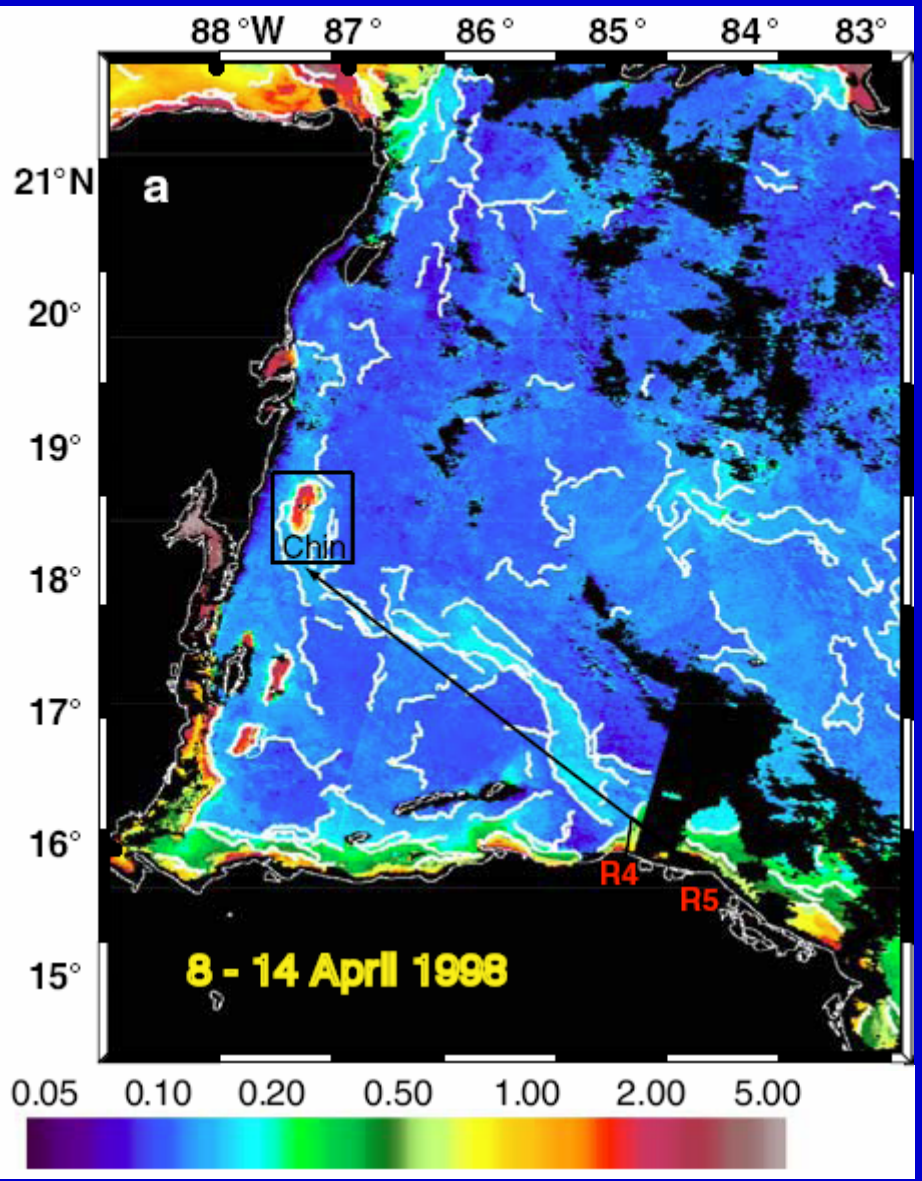
Biggs et al. (2006, AGU monograph)

Fronts and Fish



Wall et al., (2009)

Coral Reef Connectivity



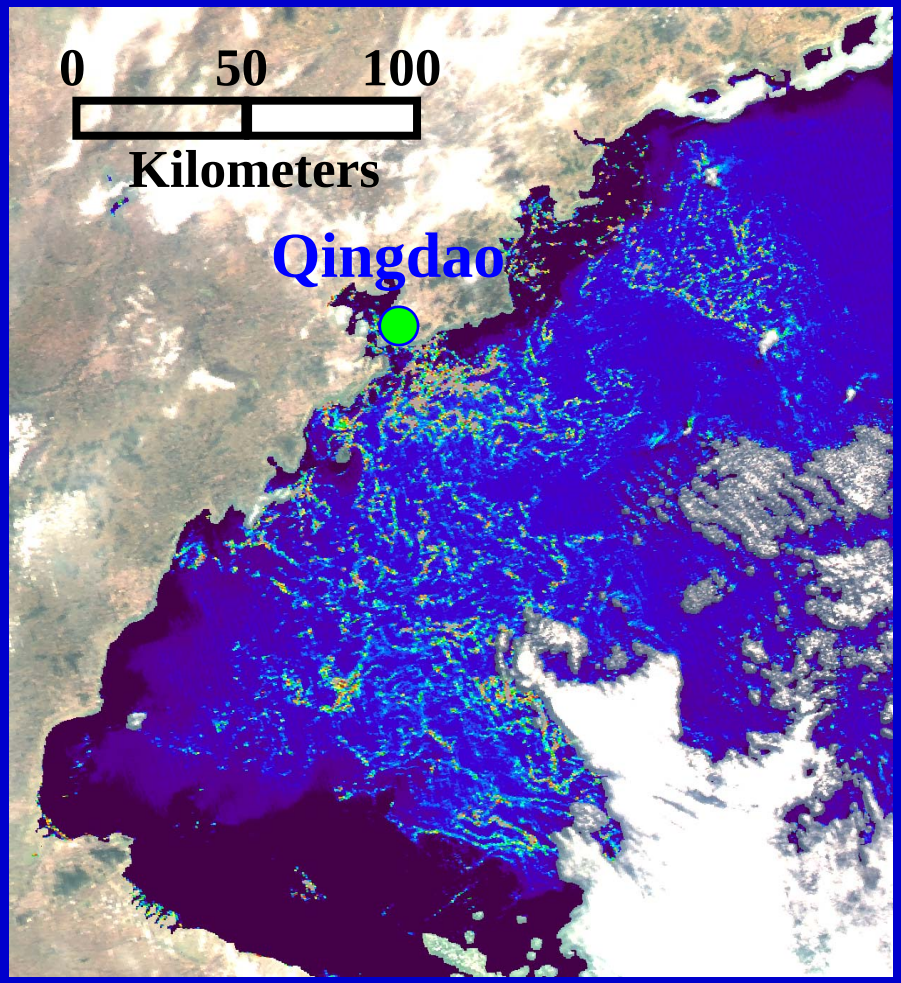
	BR1	BR2	BR3	TF	GLO	LH	Chin	COZ
Ulúa River (R1)	285	4	2	4	81	19	0	0
Cangrejal River (R2)	0	0	0	0	18	7	3	0
Aguán River (R3)	0	0	0	1	5	9	6	0
Sico Tinto River(R4)	0	0	0	0	0	5	23	6
Patuca River (R5)	0	0	0	0	0	0	1	1
Nicaragua (NIC)	0	0	0	0	0	0	0	1
Barrier Reef South (BR1)				1	5	0	0	0
Barrier Reef Middle (BR2)				108	116	6	0	0
Barrier Reef North (BR3)				114	1	4	1	0
Turneffe Atoll (TF)					81	8	11	0
Glovers Atoll (GLO)						50	0	0
Lighthouse (LH)							5	0
Chinchoro (Chin)								8
Cozumel (COZ)								
Guanaja (GUA)								
Roatán								
Utila								

≥ 50%
40% - 49.9%
30% - 39.9%
20% - 29.9%
10% - 19.9%
0.1% - 9.9%
0%
Not Determined

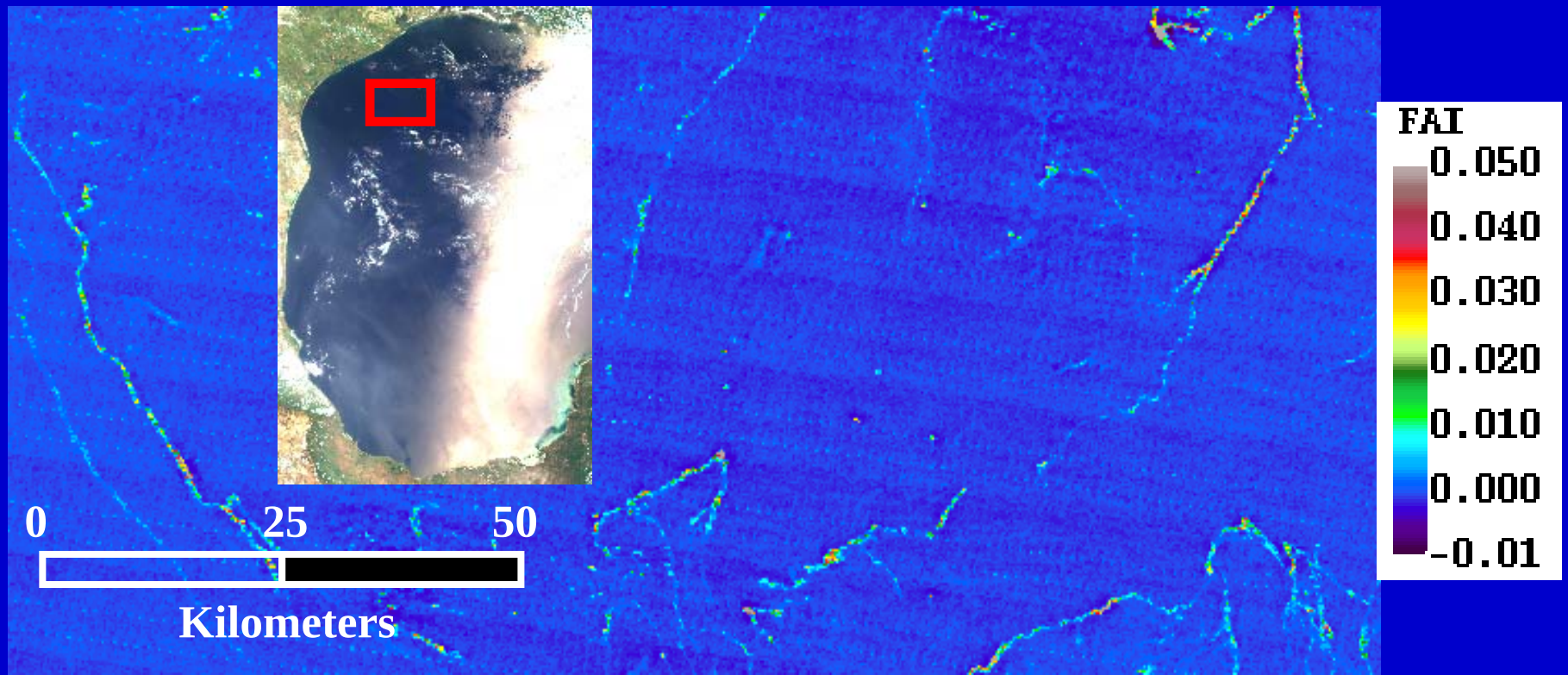
Soto et al. (2009)

Green Tides

Dead Calm


0
50
100
Kilometers
Qingdao
FAI
0.050
0.040
0.030
0.020
0.010
0.000
-0.01

Sargassum Pollution



What's Next

1. Increase usage
   - User-friendly products
   - Involvement of end-users
2. Improve quality
   - Accuracy
   - Resolution
3. Inter-disciplinary
4. Increase $

Acknowledgements

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