Assessment and Mapping Phytoplankton Chlorophyll Patterns in Inland and Coastal Habitats

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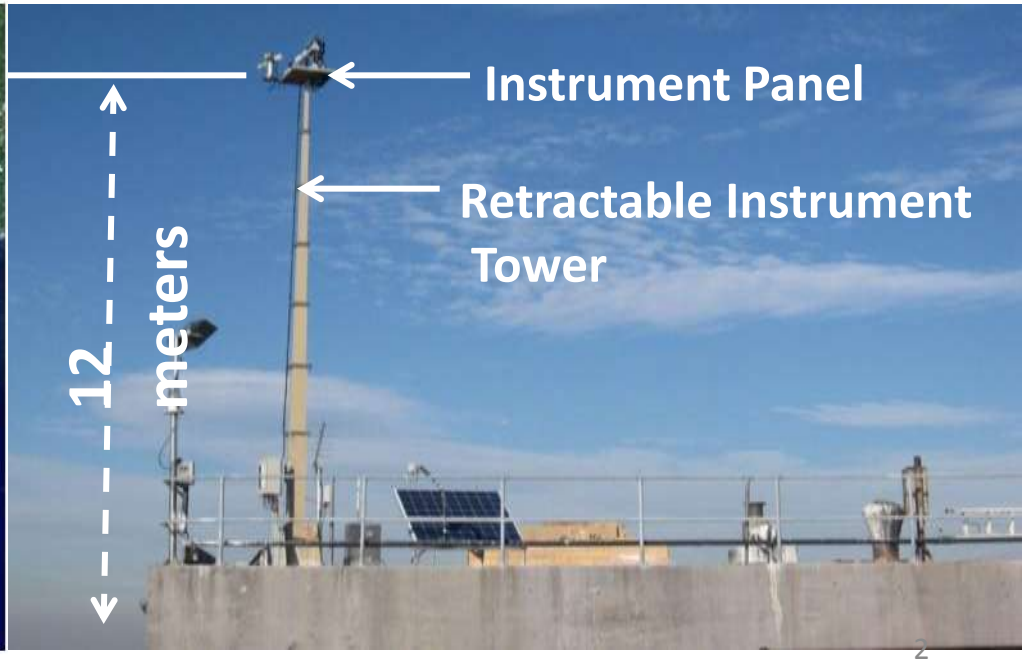
Long Island Sound Coastal Observatory (LISCO) – City College of New York

Platform: CCNY has collected multispectral **SeaPRISM data,** along with unique, co-located hyperspectral **HyperSAS** instrument data since October, 2009

MODIS Top of Atmosphere True Color Composite Image of Long Island Sound



LONG ISLAND SOUND COASTAL OBERVATORY (LISCO)

SeaPRISM instrument

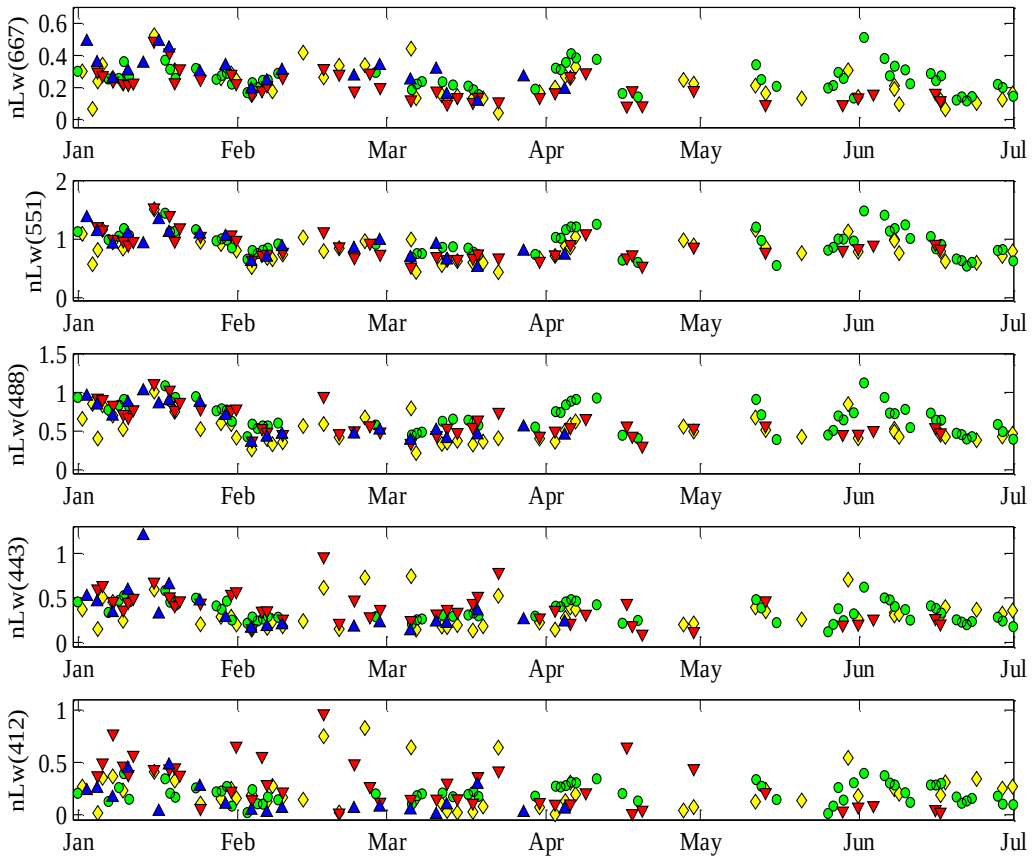
- Sea Radiance
- Direct Sun Radiance and Sky Radiance
- Bands: 413, 443, 490, 551, 668, 870 and 1018 nm

HyperSAS Instrument

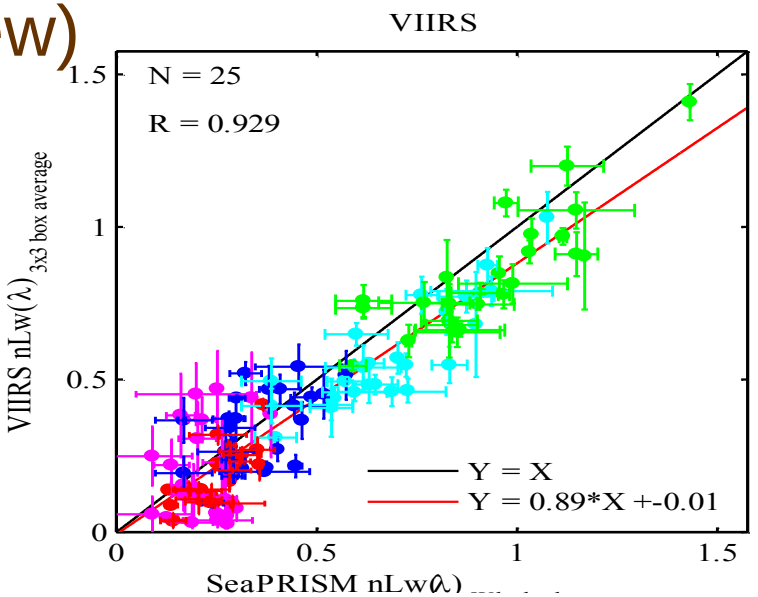
- Sea Radiance
- Sky Radiance
- Downwelling Irradiance
- Linear Polarization measurements
- 180 wavelengths [305,900] nm

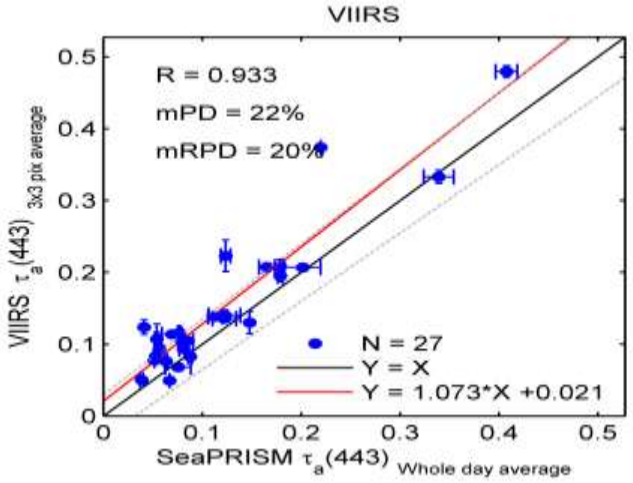
Data acquisition every 30 minutes for high time resolution time series

Validation of nLw and atmospheric parameters on the LISCO site (Ahmed *et al*., in review)

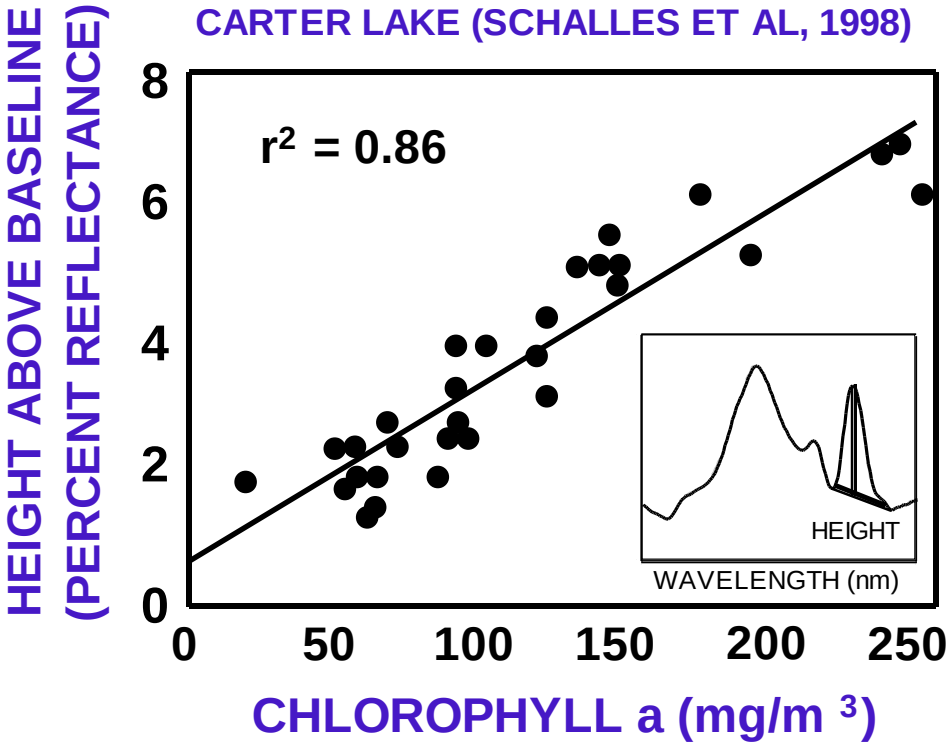


Time series of normalized water leaving radiance, nLw(λ), retrieved from **SeaPRISM** **MODIS** **VIIRS** and **MERIS** at the SeaPRISM spectral bands (NASA processing).





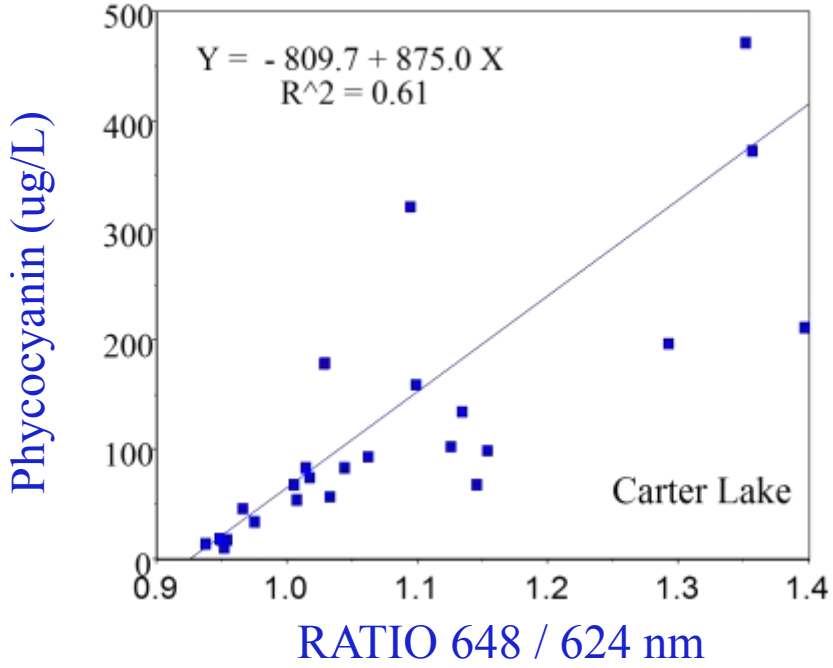
Matchups between SeaPRISM and VIIRS - nLw and aerosol optical thickness τ_a



CHLOROPHYLL FROM HEIGHT OF NIR PEAK ABOVE NORMALIZING BASELINE

Schalles et al. 1998. Measurement of chlorophyll a from time series measurements of high spectral resolution reflectance in a eutrophic lake. J. Phycology. 34: 383-390.

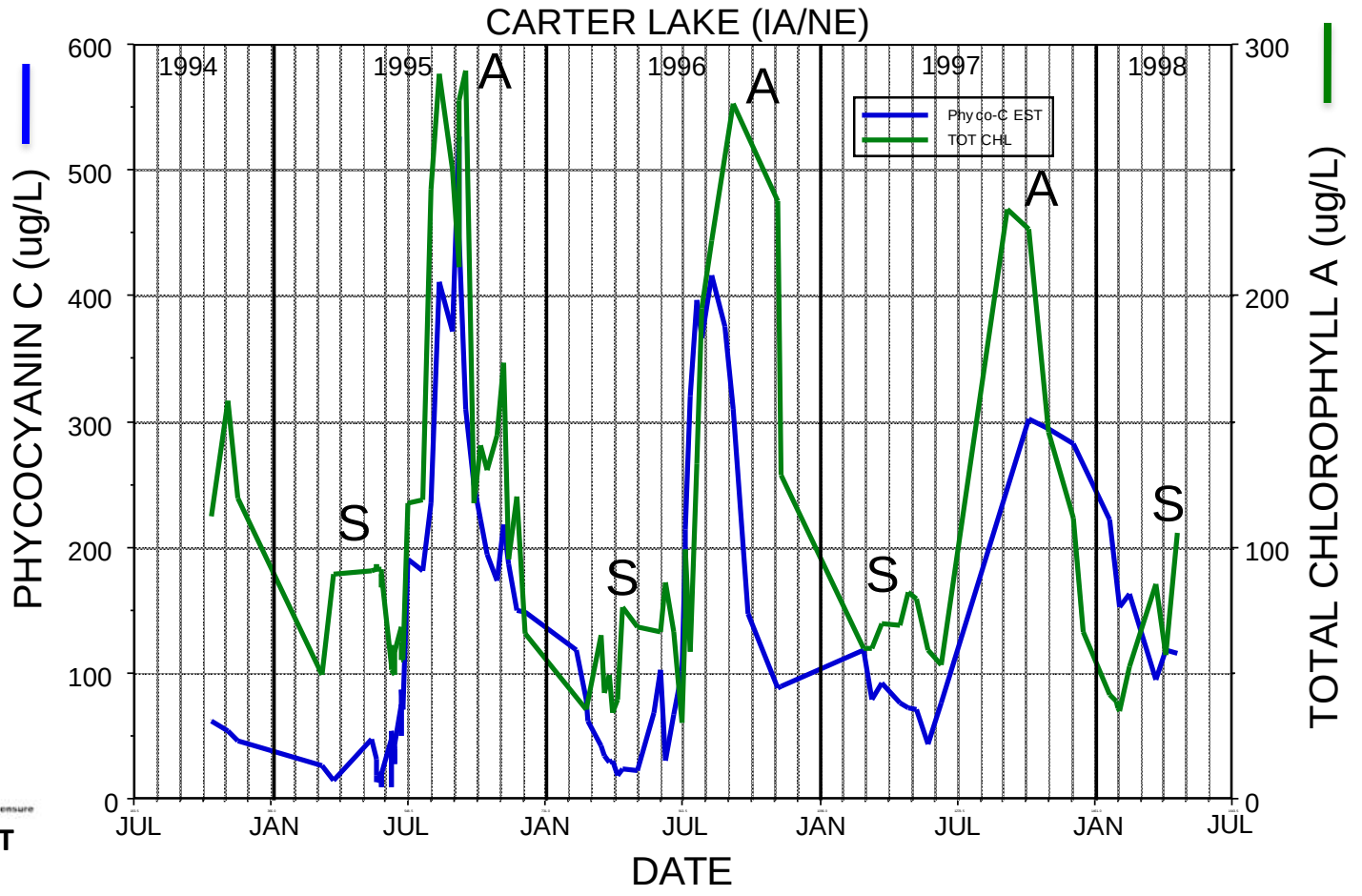
CYANOBACTERIAL PHYCOCYANIN FROM RATIO OF 648 TO 624 nm

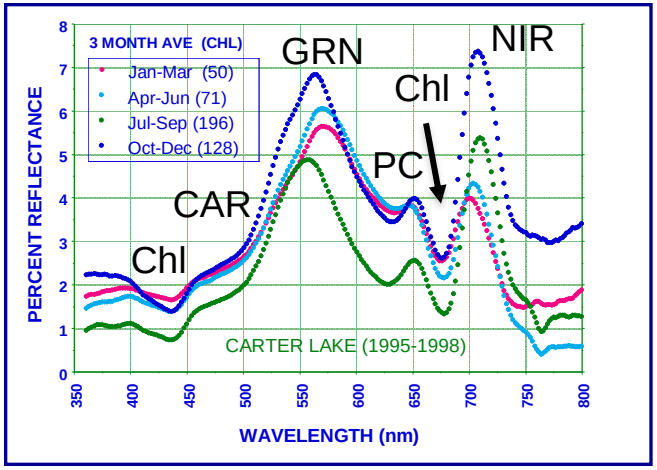


Schalles, J.F., and Y.Z. Yacobi. 2000. Remote detection and seasonal patterns of phycocyanin, carotenoid, and chlorophyll pigments in eutrophic waters. Arch. fur Hydrobiol. - Special Issues Advanc. in Limnol 55: 153-168.

News Release
Nebraska Health and Human Services System
Department of Health & Human Services — Department of Regulation & Licensure
Department of Finance & Support

CARTER LAKE ON JOINT ALERT

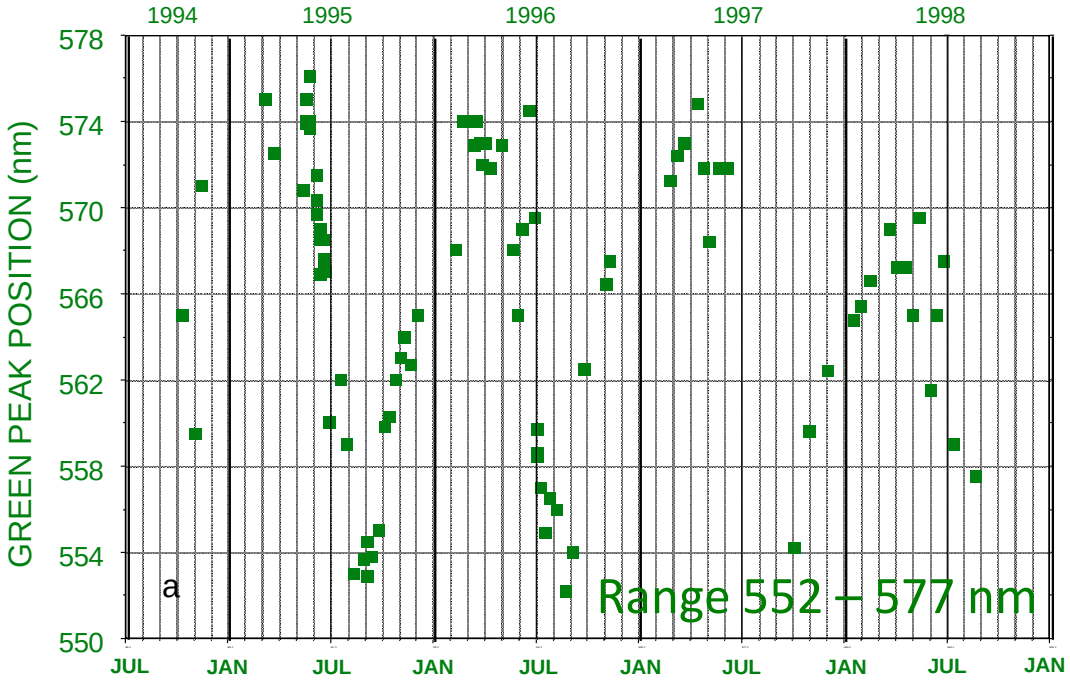


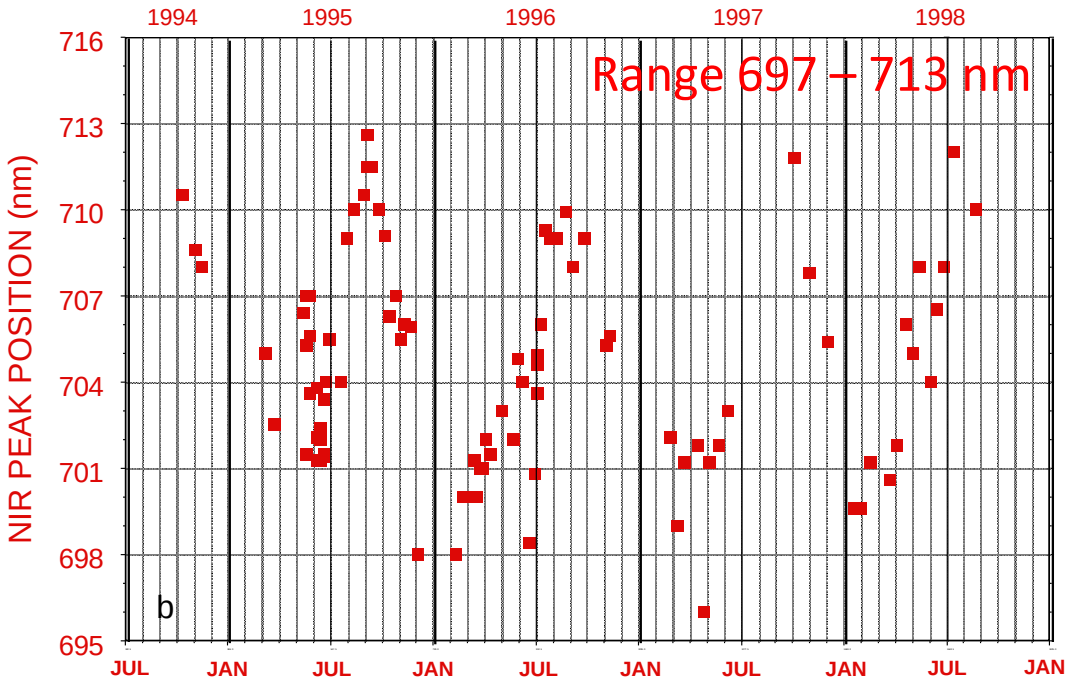


STRONG SEASONALITY

S = spring diatom bloom
(*Synedra*)

A = summer cyanobacteria bloom
(*Anabaena*)



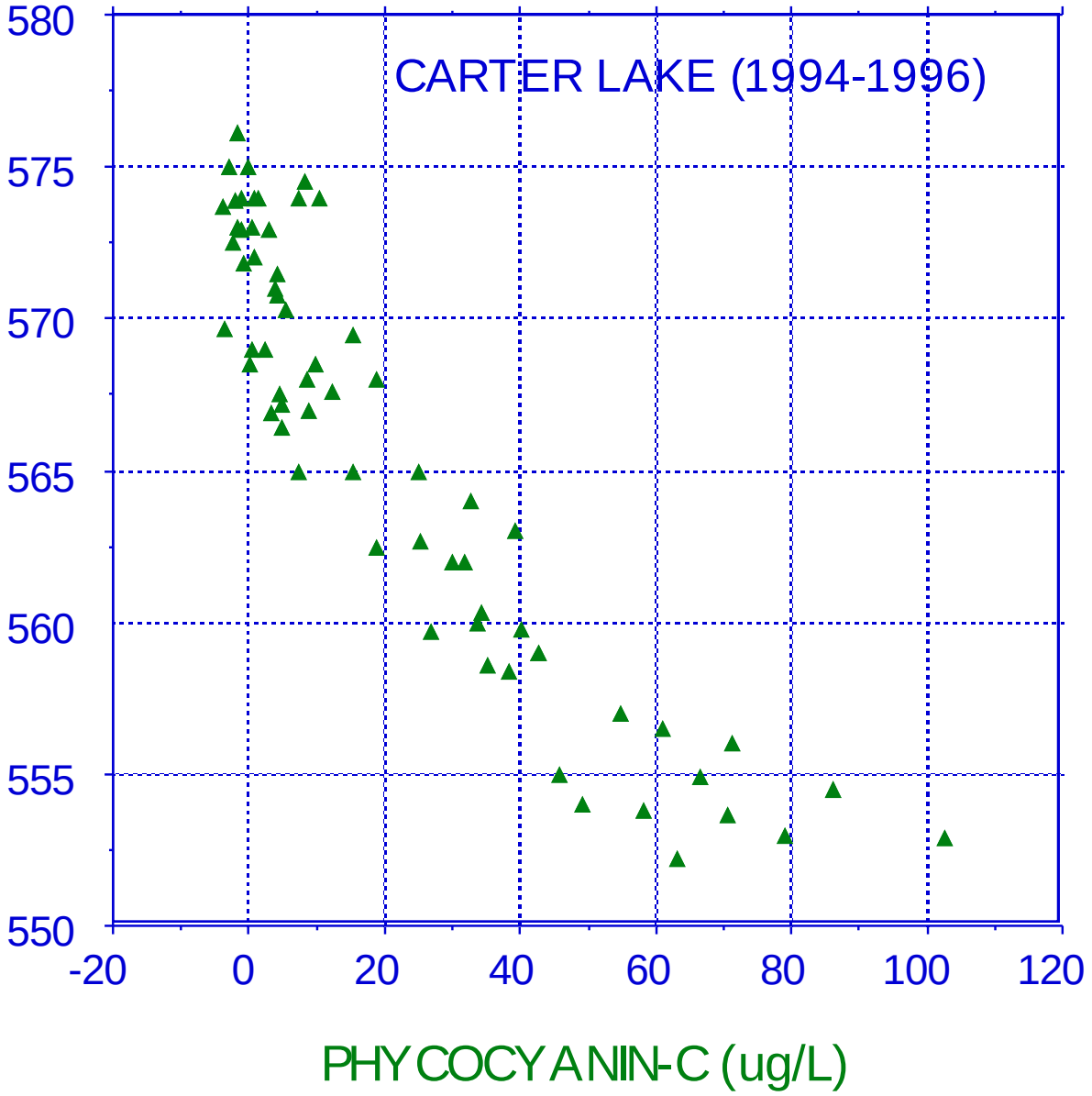


<- GREEN PEAK

CARTER LAKE SEASONAL PATTERN OF PEAK POSITIONS

<- NIR PEAK

Schalles & Yacobi (2000)



Green peak position largely controlled by phycocyanin
(Schalles & Yacobi, 2000)

Advanced versions of two- and three-band MERIS Red/NIR Chl models

THE CITY COLLEGE OF THE CITY UNIVERSITY OF NEW YORK

$$a^*_{ph}(665) = 0.022\,[Chl]^{-0.1675}$$

Two band model

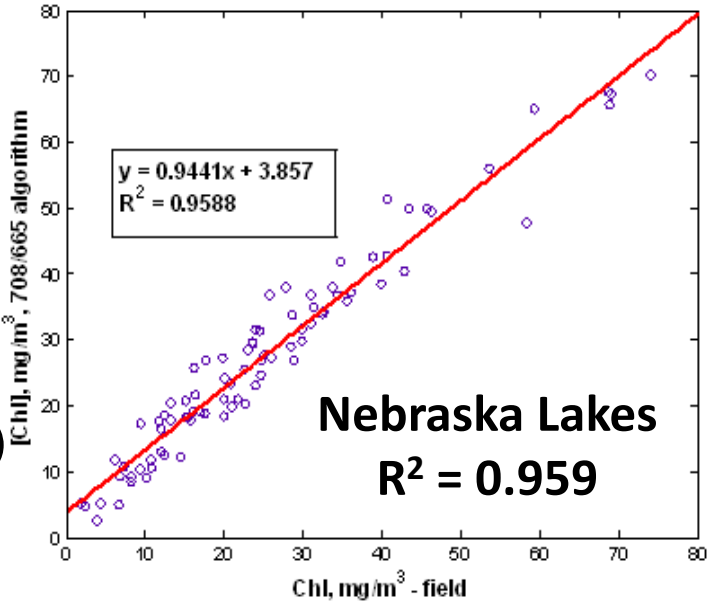
$$R2 = R_{rs}(708)/R_{rs}(665)$$

$$[\mathrm{Chl}] = [35.75 * R2 - 19.30]^{1.124}$$

Three band model

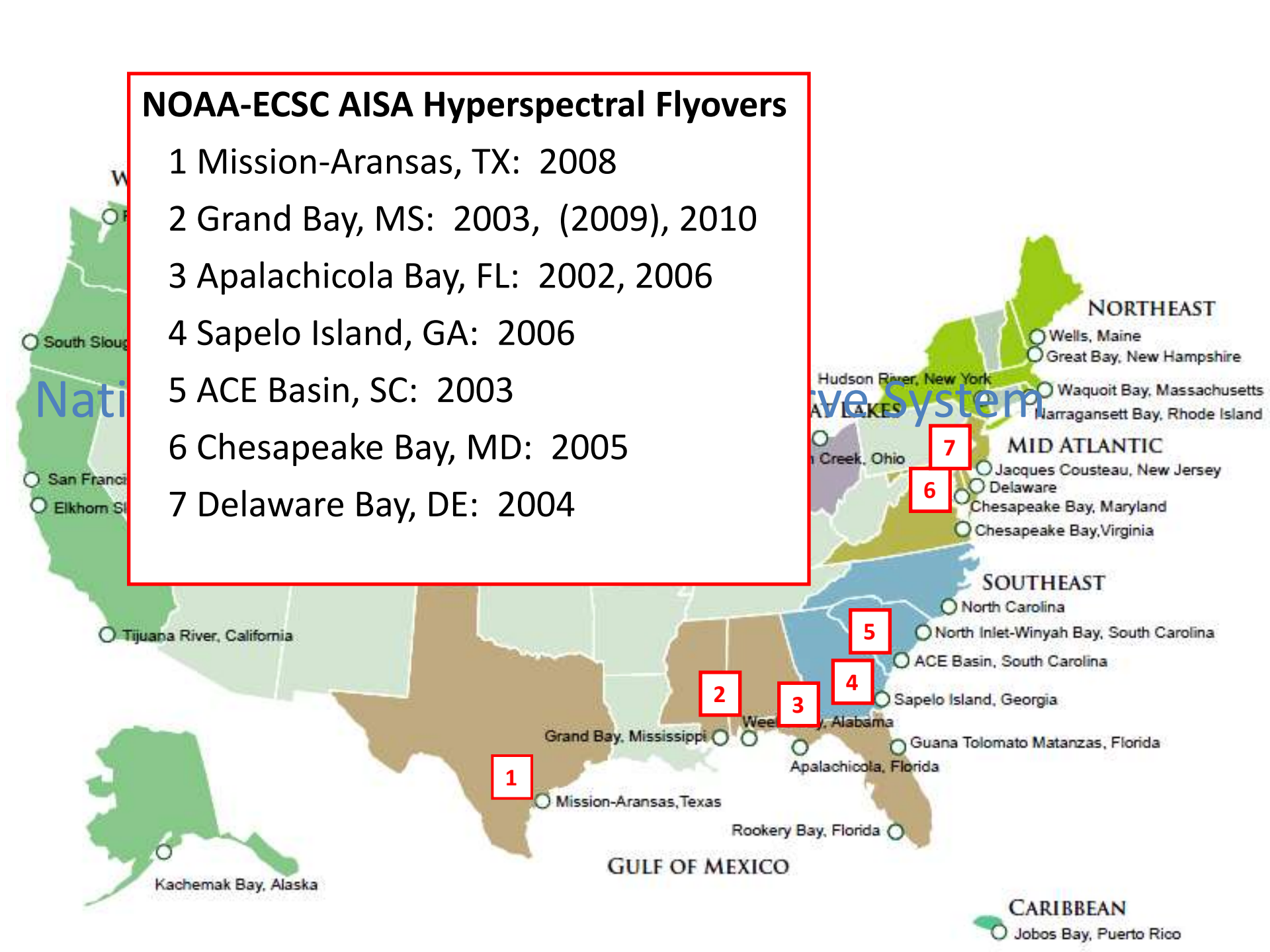
$$R3 = [Rrs(665)^{-1} - Rrs(708)^{-1}] * Rrs(753)$$

$$[\mathrm{Chl}] = [113.36 * R3 + 16.45]^{1.124}$$



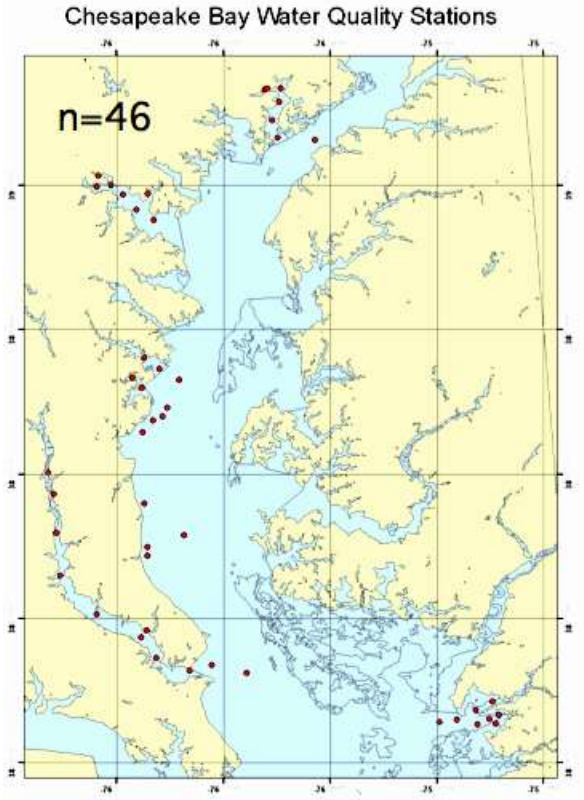
Algorithms were recently successfully validated (R^2 >0.9) by different groups for: NE and Gulf of Mexico coasts – (420 stations –J. Schalles, et al.), 1997-98 cruises around Europe (95 stations –M. Babin), Azov Sea, Russia (113 stations, W. Moses and A. Gitelson), Indiana waters (65 stations), Lake Tai, China (45 stations) – W. Yang, et al., Lake Kinneret, Israel (54 stations, Y. Yacobi) - includes field and satellite data

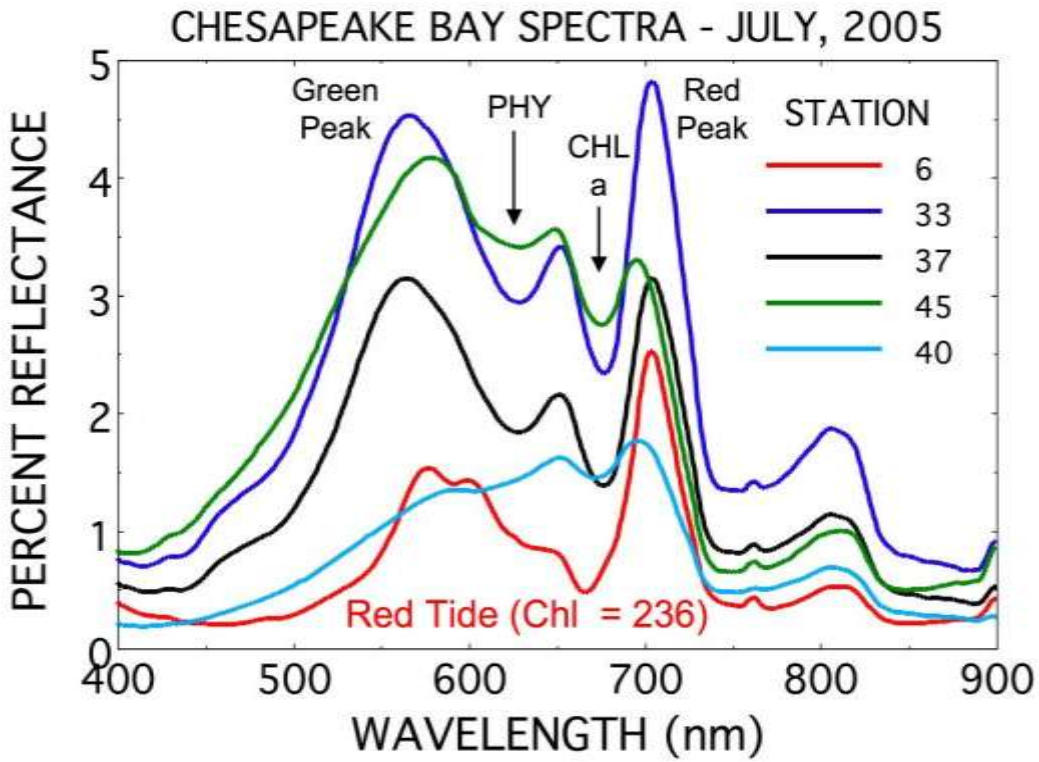
Gilerson, Gitelson, Zhou, Gurlin, Moses, Ioannou. 2010. Optics Express 18: 24109 - 24125


NOAA-ECSC AISA Hyperspectral Flyovers
1 Mission-Aransas, TX: 2008
2 Grand Bay, MS: 2003, (2009), 2010
3 Apalachicola Bay, FL: 2002, 2006
4 Sapelo Island, GA: 2006
5 ACE Basin, SC: 2003
6 Chesapeake Bay, MD: 2005
7 Delaware Bay, DE: 2004
NORTHEAST
Wells, Maine
Great Bay, New Hampshire
Waquoit Bay, Massachusetts
Narragansett Bay, Rhode Island
MID ATLANTIC
Jacques Cousteau, New Jersey
Delaware
Chesapeake Bay, Maryland
Chesapeake Bay,Virginia
SOUTHEAST
North Carolina
North Inlet-Winyah Bay, South Carolina
ACE Basin, South Carolina
Sapelo Island, Georgia
Guana Tolomato Matanzas, Florida
Apalachicola, Florida
Rookery Bay, Florida
Mission-Aransas,Texas
Grand Bay, Mississippi
Tijuana River, California
Kachemak Bay, Alaska
Hudson River, New York
GULF OF MEXICO
CARIBBEAN
Jobos Bay, Puerto Rico
1
2
3
4
5
6
7

From the Chesapeake Bay Joint Campaign – July, 2008

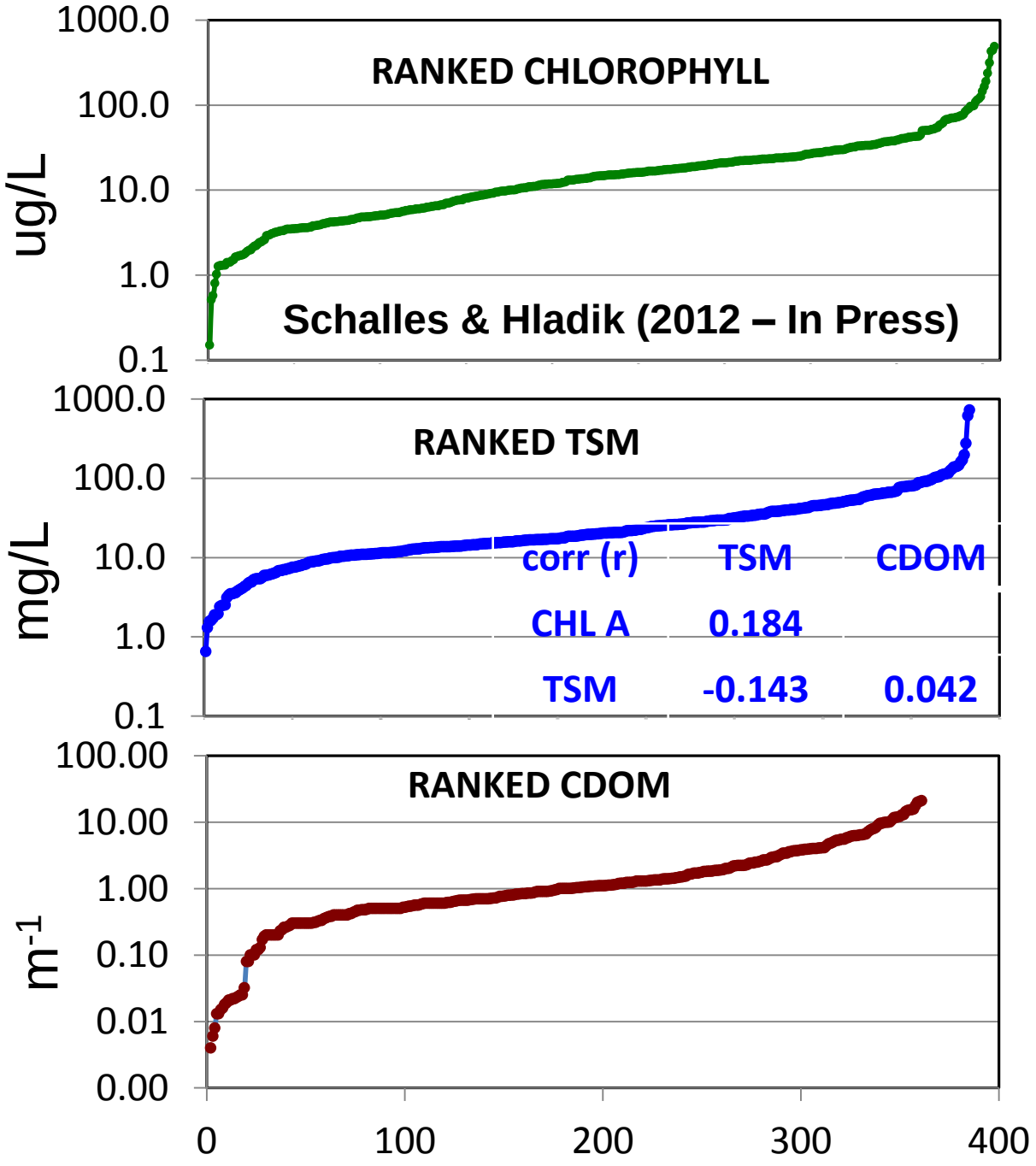
- AISA Eagle Imagery
- Optics: Refl, ABS, Scatter
- Pigments, TSM, Nutrients
-





Team: Creighton, CCNY, Morgan State, Florida A&M, Kent State, NOAA-Beaufort

Gitelson, A.A., J.F. Schalles, and C.M. Hladik. 2007 Remote Sensing of the Environment 109(4): 464-472.



Chl *a* (ug/L)	
Ave	24.2
Med	14.6
Min	0.2
Max	490.1

TSM (mg/L)	
Ave	33.4
Med	19.3
Min	0.7
Max	726.3

CDOM (m^{-1})	
Ave	2.27
Med	1.00
Min	0.01
Max	21.08

44 Estuaries and Nearshore
91% Coastal / 9% Inland

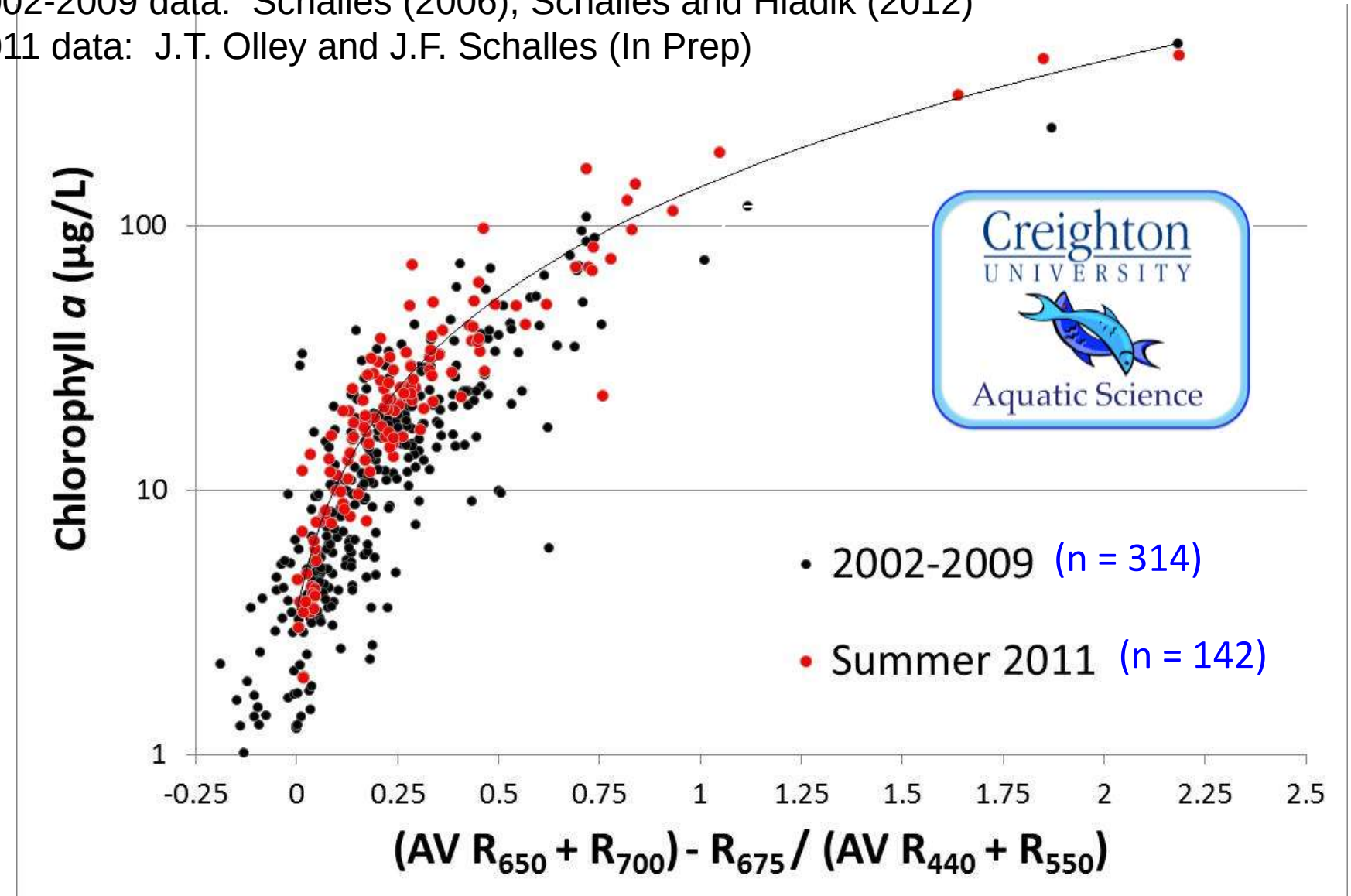
Comparison of different semi-empirical models with our 456 coastal and inland stations

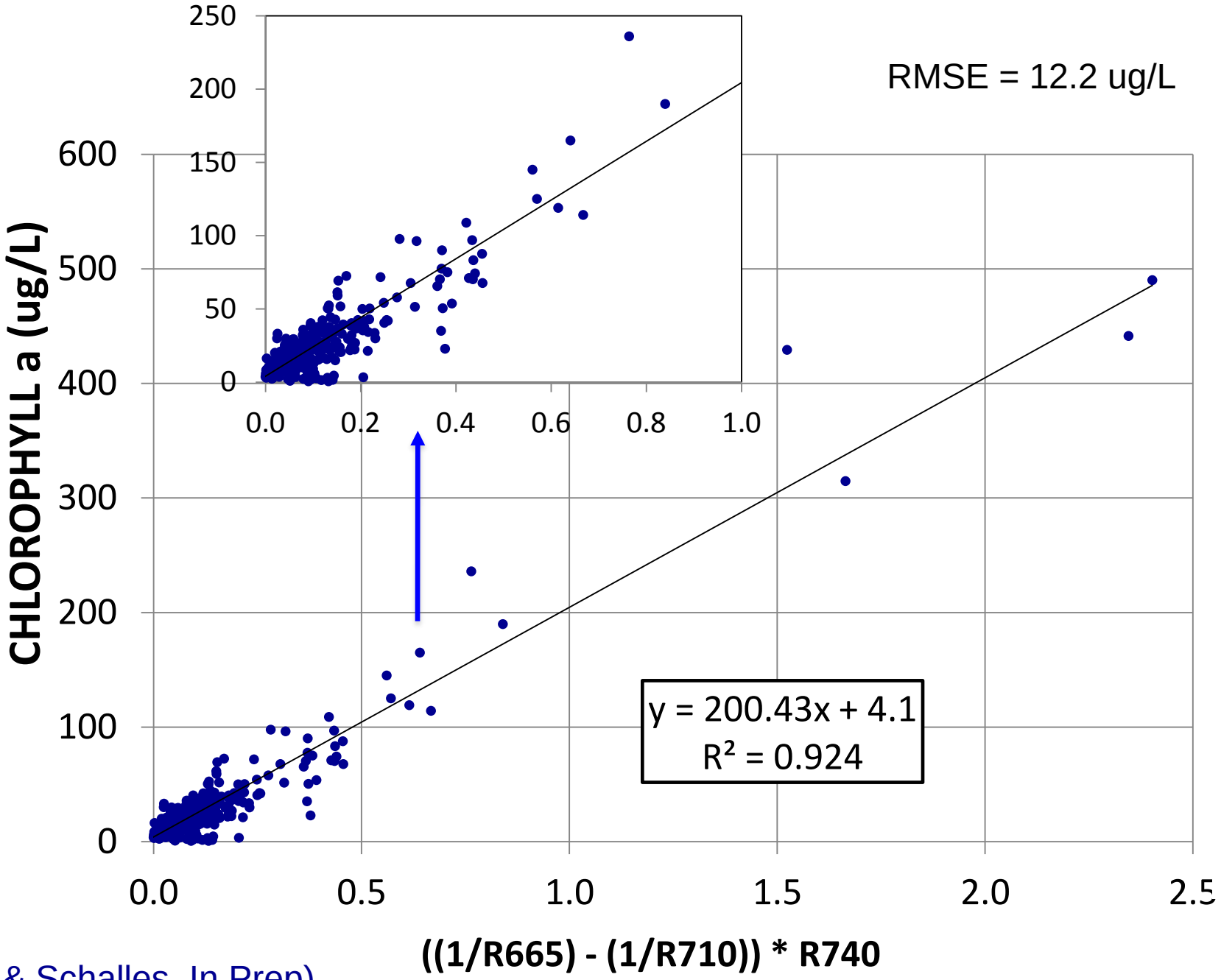
Model	Equation	R^2
Ocean Color (OC4)	$Max(R_{443},R_{490},R_{510}) / R_{555}$	0.104
Depth of 675	((AV650+700)-675)	0.300
Gilerson 3B MERIS	$((1/R_{665})-(1/R_{708})) * R_{753}$	0.857
Schalles & Hladik	((AV650+700)-675)/(AV440+550)	0.902
Gitelson 3 Band	$((1/R_{665})-(1/R_{710})) * R_{740}$	0.924

Schalles & Hladik (2012); Olley & Schalles (In Prep)

MODEL	AUTHORS	r^2 (n = 142)	r^2 (n = 456)
$[(R_{675}^{-1})-R_{695}^{-1})] \times R_{730}$	GITELSON et al. (2007)	0.947	0.924
$[(R_{665}^{-1})-R_{708}^{-1})] \times R_{753}$	GILERSON et al. (2010)	0.942	0.857
$[Av\ R_{650}+R_{700})-R_{675}]/(Av\ R_{440}+R_{550})$	SCHALLES & HLADIK (2004)	0.863	0.902

2002-2009 data: Schalles (2006), Schalles and Hladik (2012)
2011 data: J.T. Olley and J.F. Schalles (In Prep)

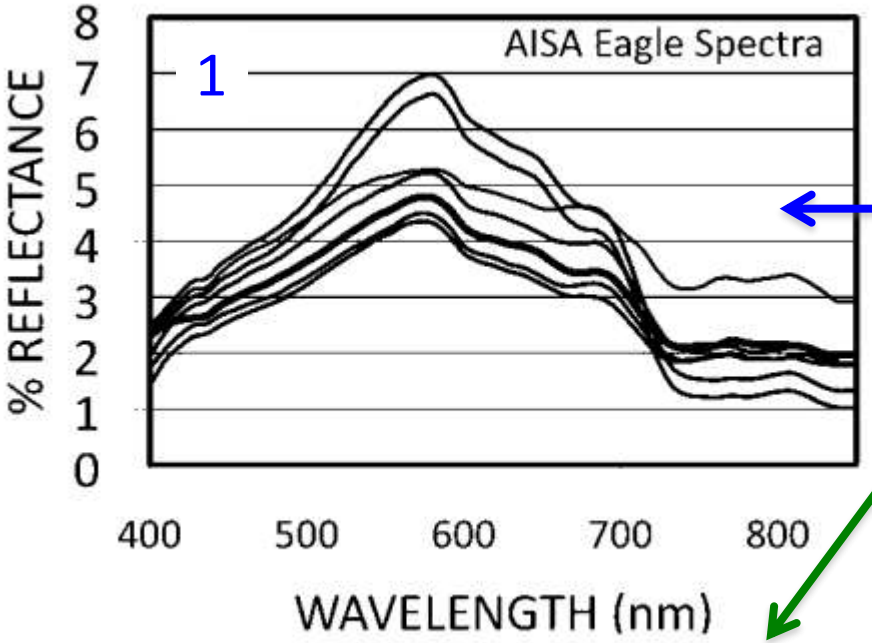


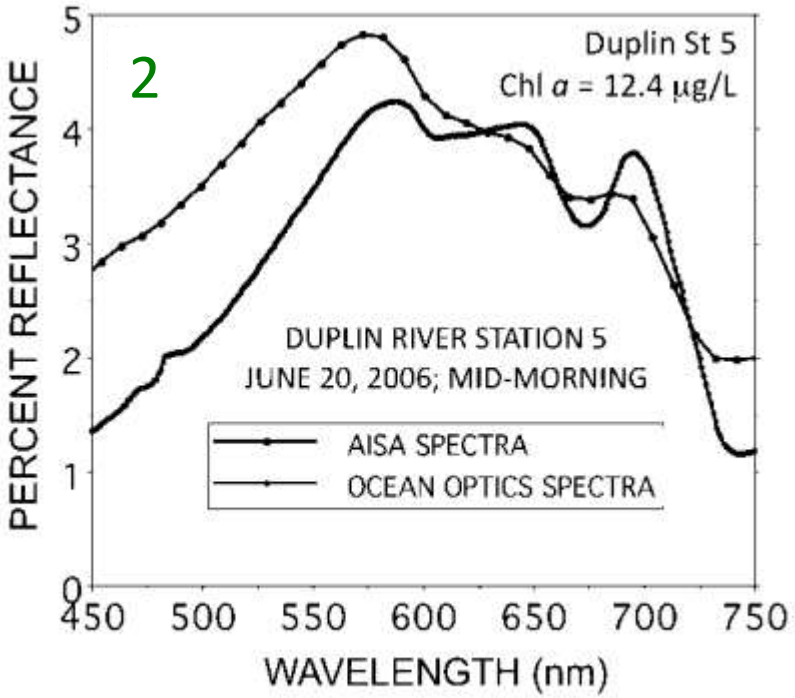


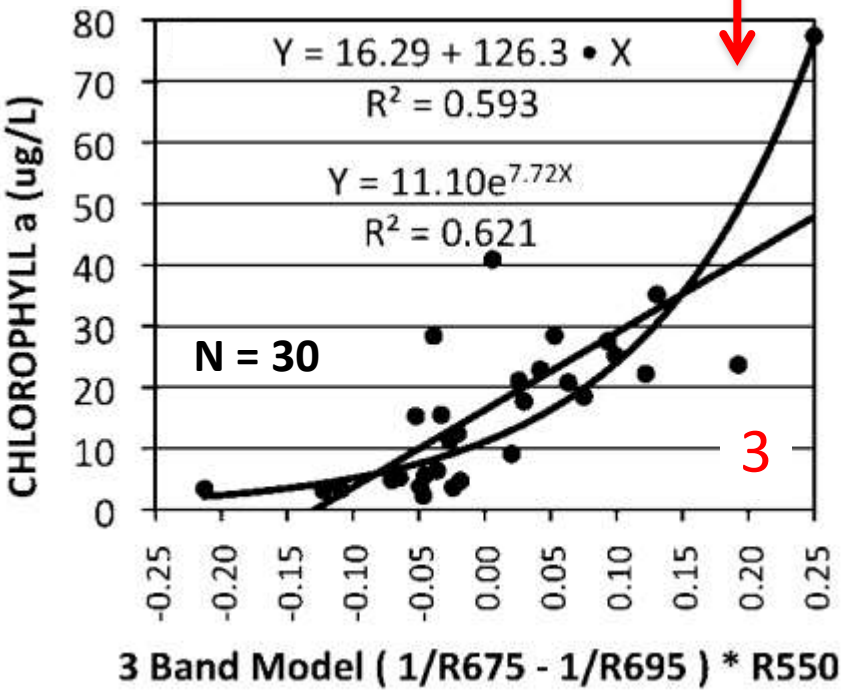
(Olley & Schalles. In Prep)

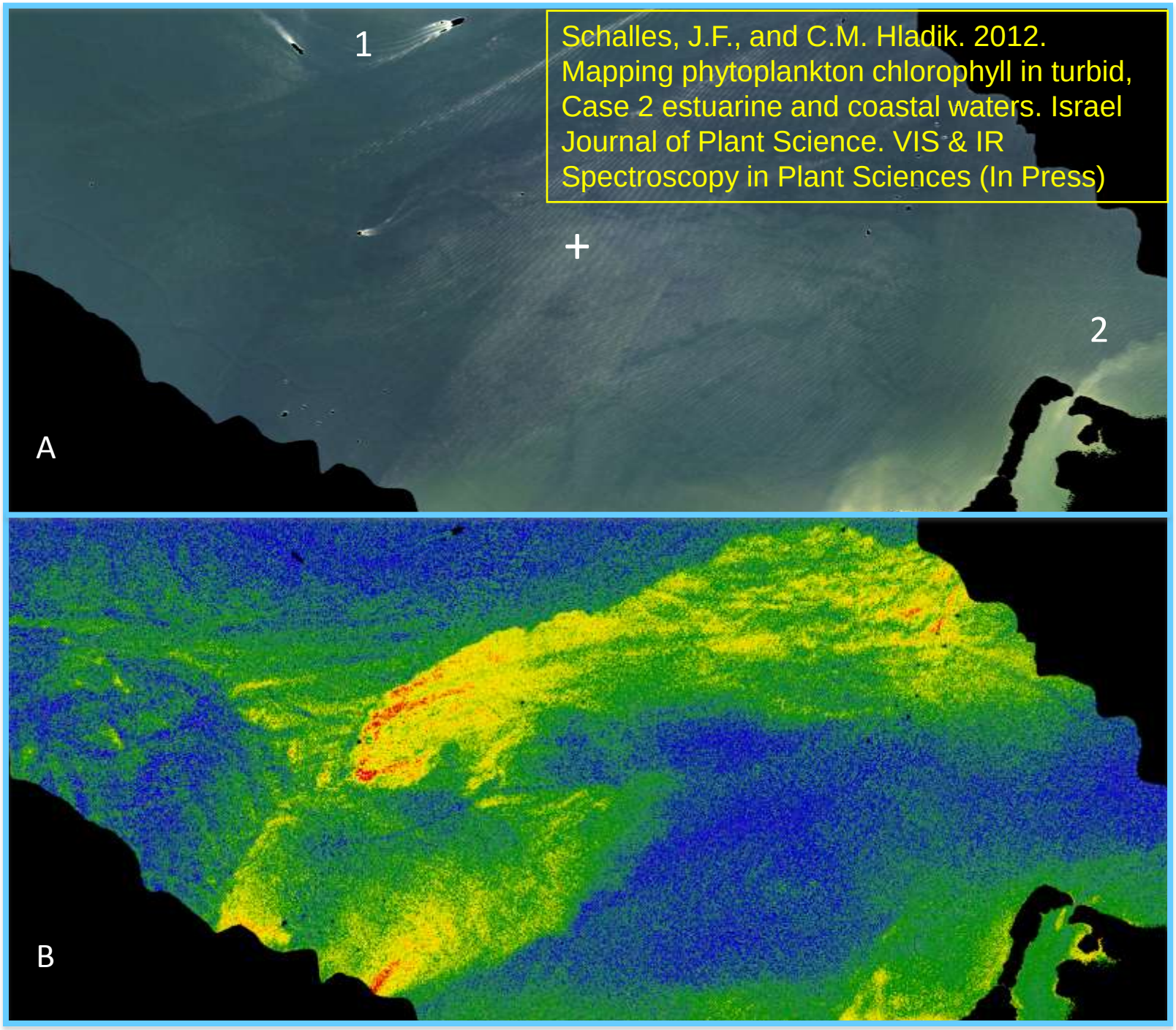
FROM AISA PIXEL SPECTRA TO ALGORITHM PARAMETERIZATION FOR CHL a ESTIMATION:

1. **EXAMPLES OF AISA SPECTRA (5 X 5 PIXEL AVERAGES)**
2. **COMPARISON OF AISA SPECTRA (63 BANDS, 5 X 5 PIXEL AVERAGE) VS. IN SITU OCEAN OPTICS SPECTRA**
3. **THREE-BAND INDEX VALUES FROM AISA 5 X 5 PIXEL AVERAGES VS. MEASURED CHL *a* AT STATIONS**









Schalles, J.F., and C.M. Hladik. 2012. Mapping phytoplankton chlorophyll in turbid, Case 2 estuarine and coastal waters. Israel Journal of Plant Science. VIS & IR Spectroscopy in Plant Sciences (In Press)

LOWER PATUXENT RIVER

CHL *a* µg/L

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 – 80
- 80 - 90
- 90 - 100

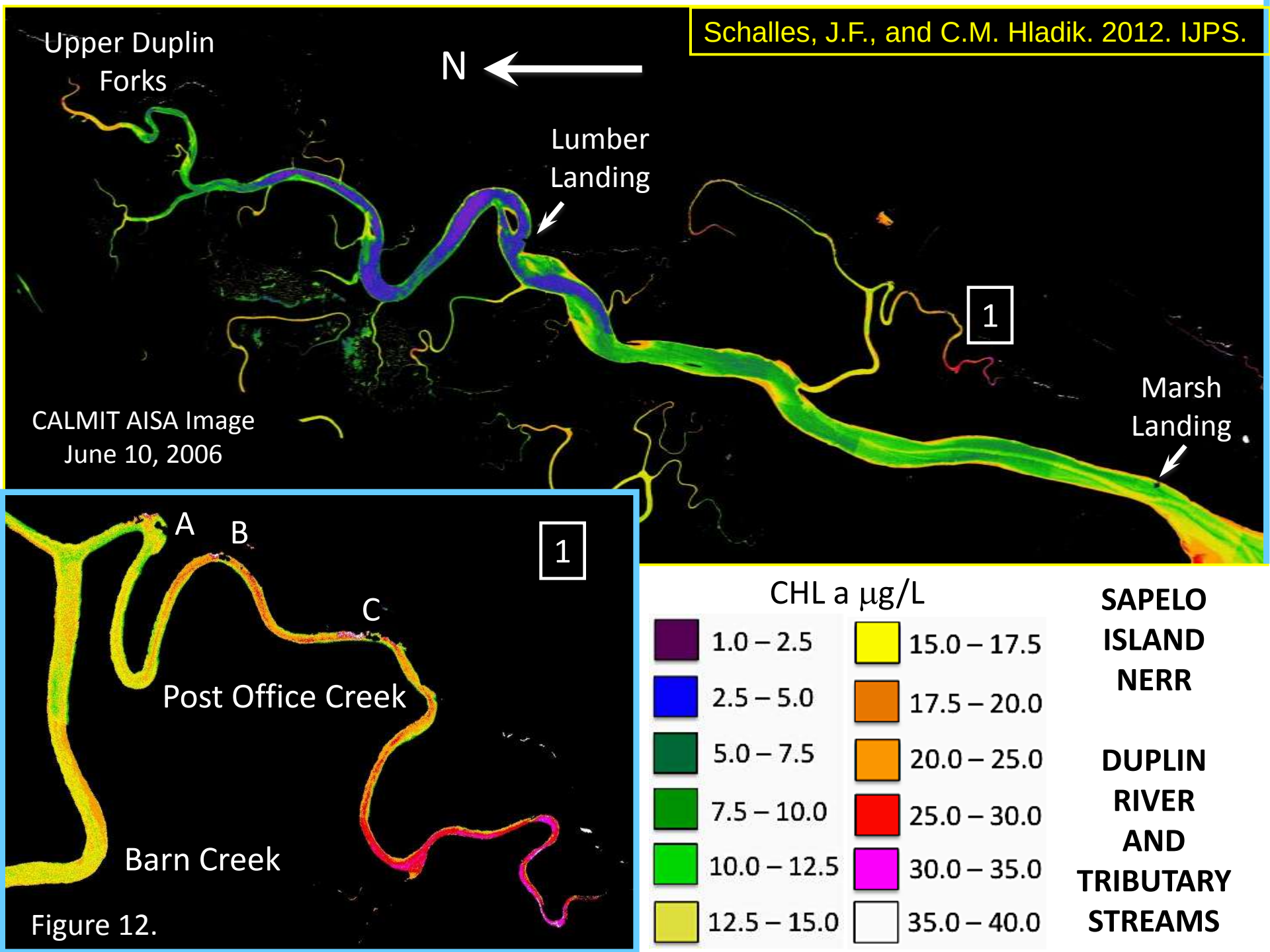
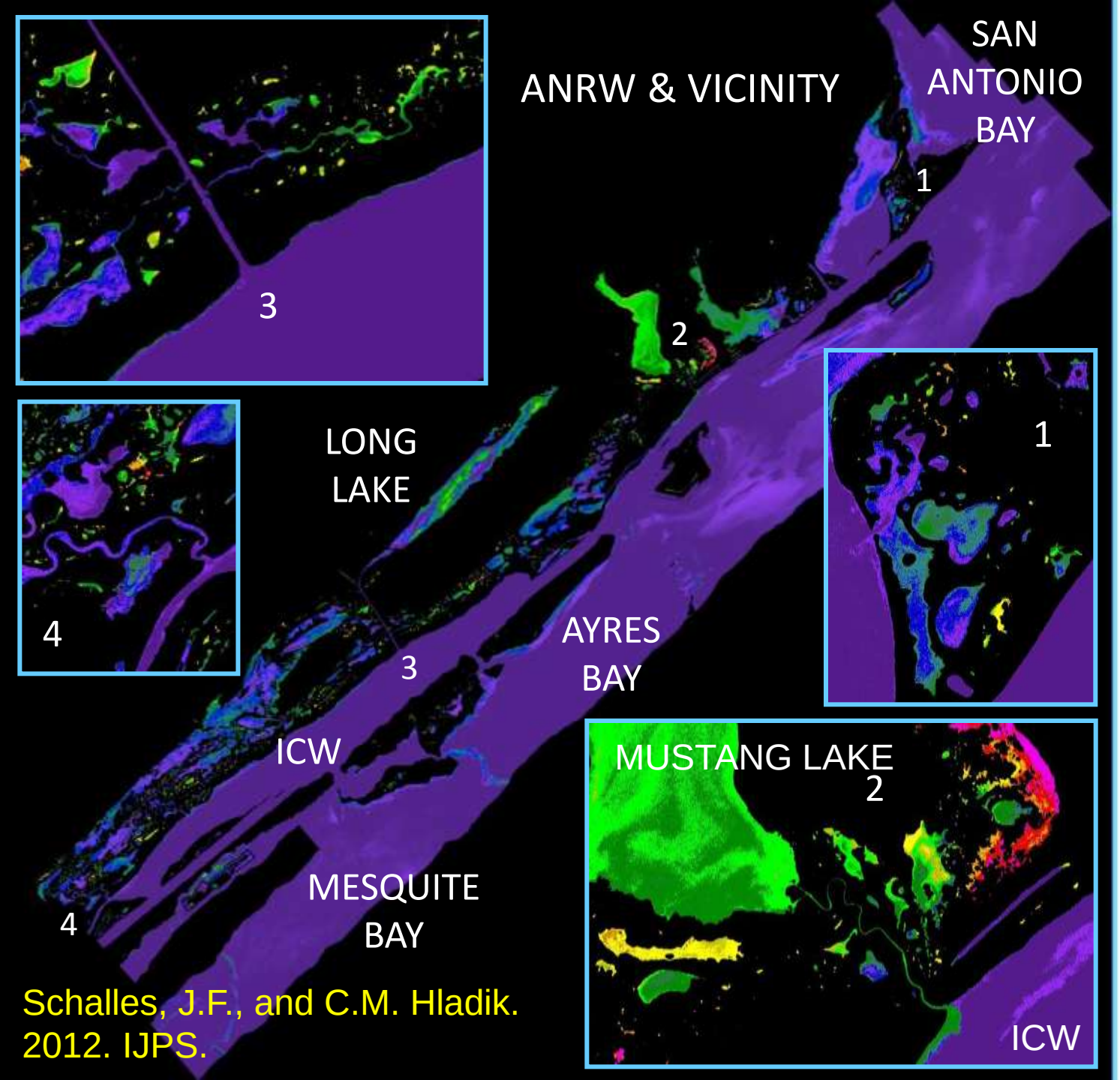

Schalles, J.F., and C.M. Hladik. 2012. IJPS.
Upper Duplin Forks
N
Lumber Landing
1
Marsh Landing
CALMIT AISA Image June 10, 2006
A
B
C
1
Post Office Creek
Barn Creek
CHL a µg/L
1.0 – 2.5
2.5 – 5.0
5.0 – 7.5
7.5 – 10.0
10.0 – 12.5
12.5 – 15.0
15.0 – 17.5
17.5 – 20.0
20.0 – 25.0
25.0 – 30.0
30.0 – 35.0
35.0 – 40.0
SAPELO ISLAND NERR
DUPLIN RIVER AND TRIBUTARY STREAMS

Figure 12.



ARANSAS NWR

CHL *a* µg/L

- 0.0 – 5.0
- 5.0 – 10.0
- 10.0 – 15.0
- 15.0 – 20.0
- 20 – 30
- 30 – 40
- 40 – 50
- 50 – 60
- 60 – 80
- 80 – 100
- 100 – 120
- 120 – 140
- 140 – 180

Schalles, J.F., and C.M. Hladik. 2012. IJPS.