Evaluating the efficacy of five chlorophyll algorithms in the Chesapeake Bay (USA) for operational monitoring and assessment

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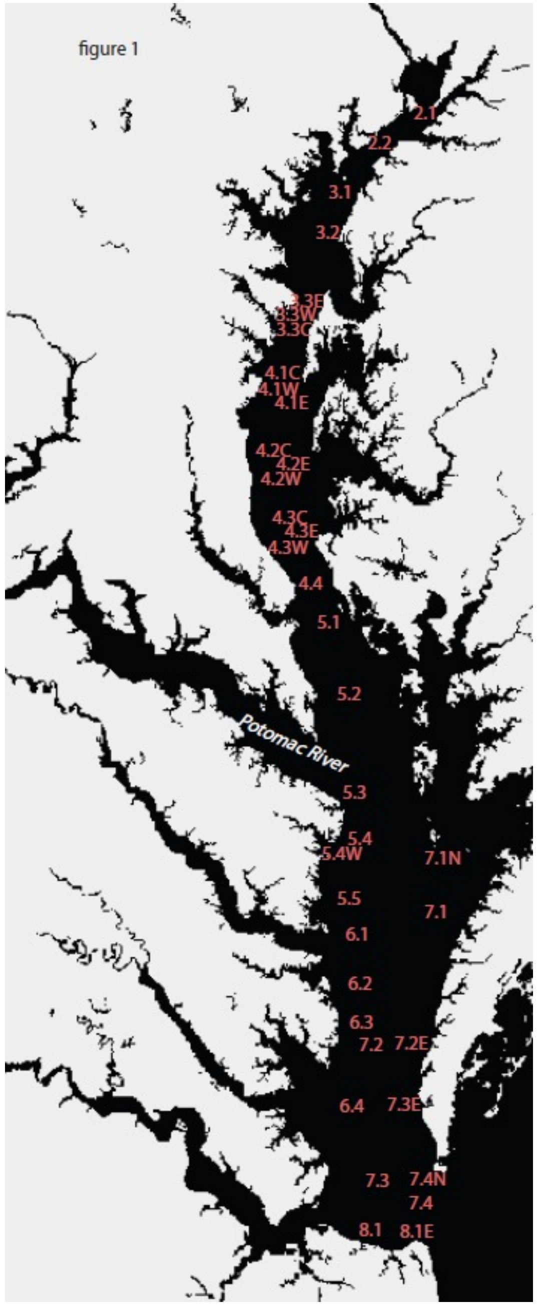
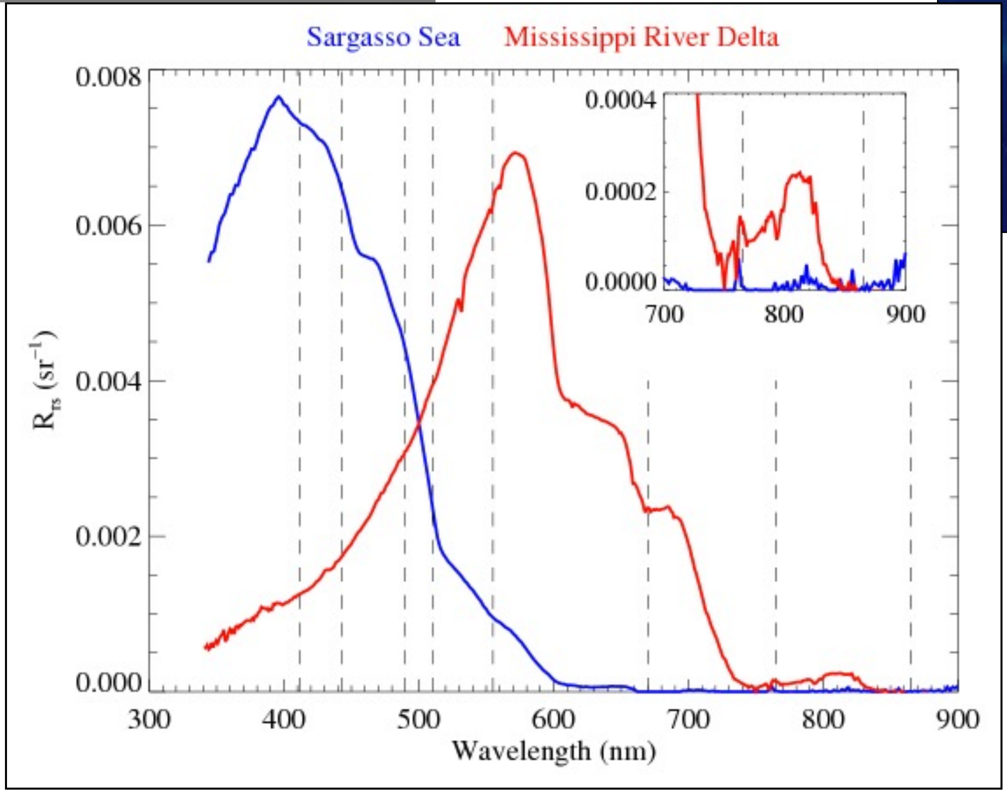


Methods

- 38 Stations along the center of the Bay were selected for analysis
- A red-edge chlorophyll (chl-a) algorithm was compared with 4 other algorithms (1 open ocean OC4 algorithm, and 3 operational algorithms delivered at CoastWatch East Coast Node)
- Algorithms varied by sensor, resolution and satellite reflectance used
- A median of a 3x3 pixel box surrounding the field sample were used in the analysis
- All pixels at a station were extracted and a time-series analysis was conducted to assess stability
- The degree of agreement between field and satellite chl-a was evaluated using the multiplicative median bias and absolute error

Case-1 versus Case-2 water

Case 1
water where the optical properties are determined primarily by phytoplankton and their derivative products



Case 2
everything else, namely water where the optical properties are significantly influenced by other constituents, such as mineral particles, CDOM, or microbubbles, whose concentrations do not covary with the phytoplankton concentration

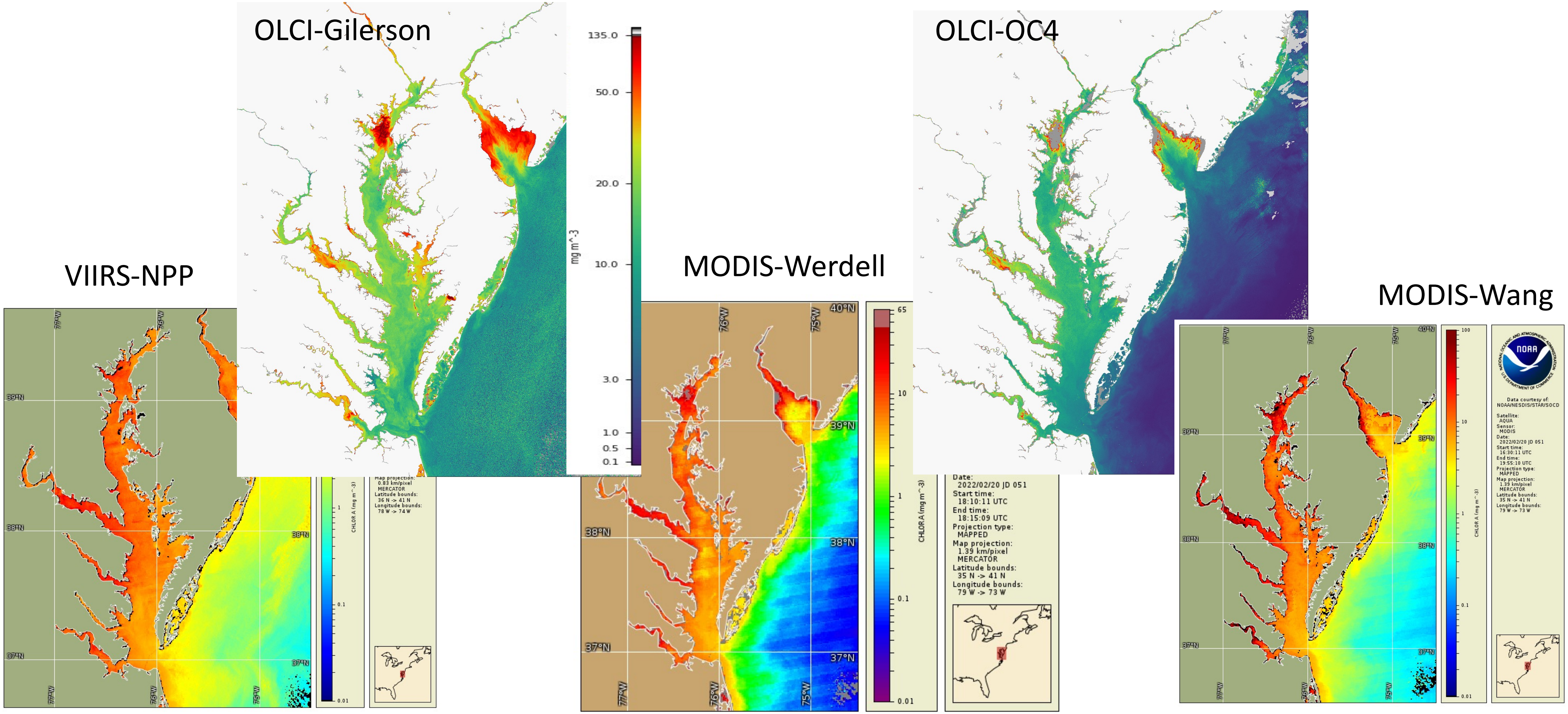
The algorithms

Algorithm	Sensor	Spatial Resolution	Optical bands	Input	Reference
Gilerson[a]	OLCI	300 m	Red edge with NIR correction	Rhos	Gilerson et al. (2010)
OC4[a]	OLCI	300 m	OC4 (blue-green) applied to OLCI with NIR correction	Rhos	O'Reilly (1999)
Wang[b]	MODIS	1 km	OC3 (blue-green) with SWIR-NIR Atmospheric Correction	nLw	Wang et al. ATBD (2017)
Werdell[b]	MODIS	1 km	OC3 (blue green) bias adjusted for Chesapeake Bay	Rrs	Werdell et al. (2009)
Science Quality[b]	VIIRS	750 m	OC3 (blue green) open ocean (blue-band calibration), 14-day lag	nLw	O'Reilly (1999)

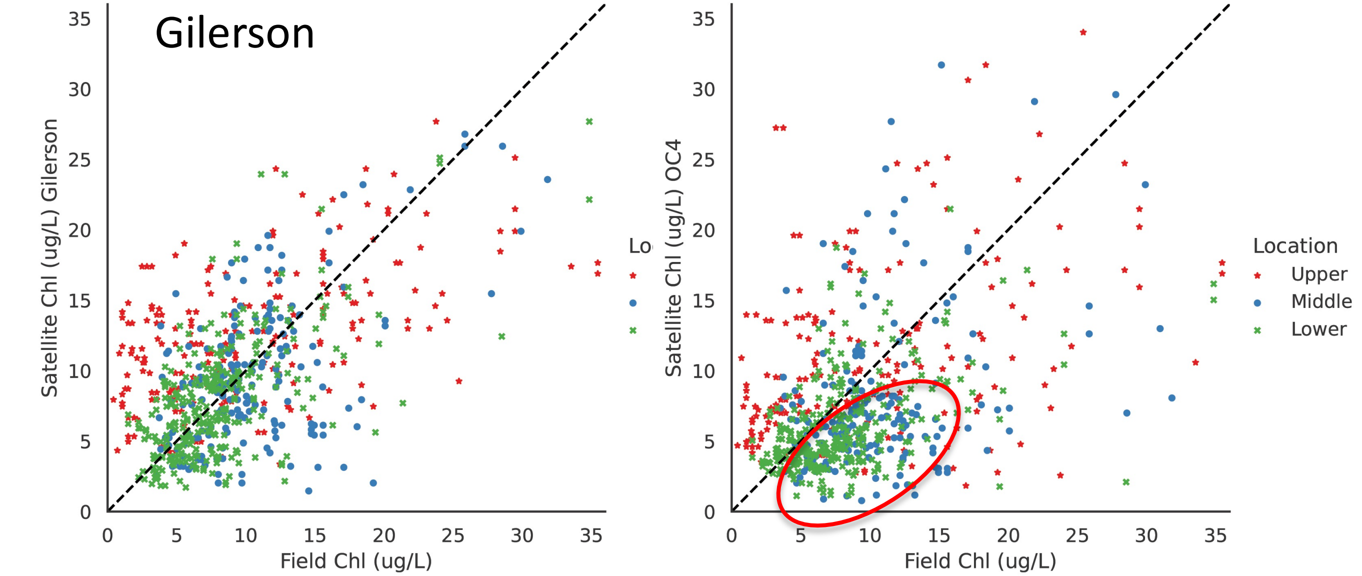
[a]https://coastwatch.noaa.gov/cw_html/NCCOS.html

[b]https://eastcoast.coastwatch.noaa.gov/cw_data_types.php

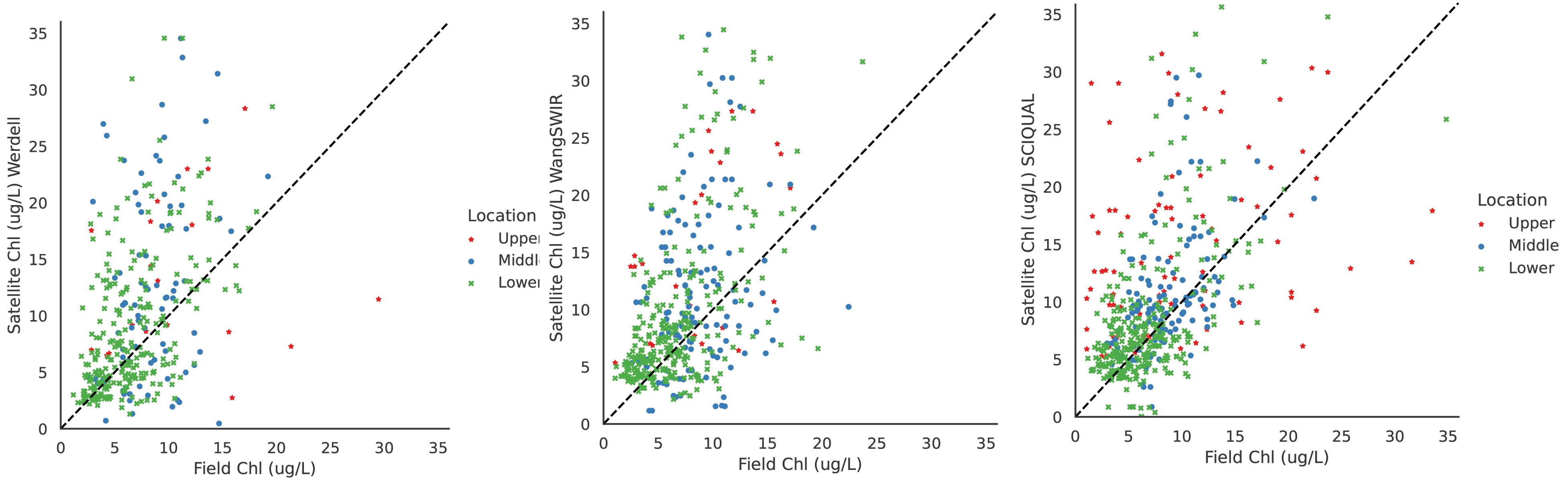
Imagery from 2/20/2022



Field to Extracted Chl Match ups



- Gilerson fell along 1:1 line best, less scatter
- OC4 is underestimating chl-a
- All operational algorithms overestimate chl-a
- Due to resolution and atmospheric correction, less upper Bay pixels



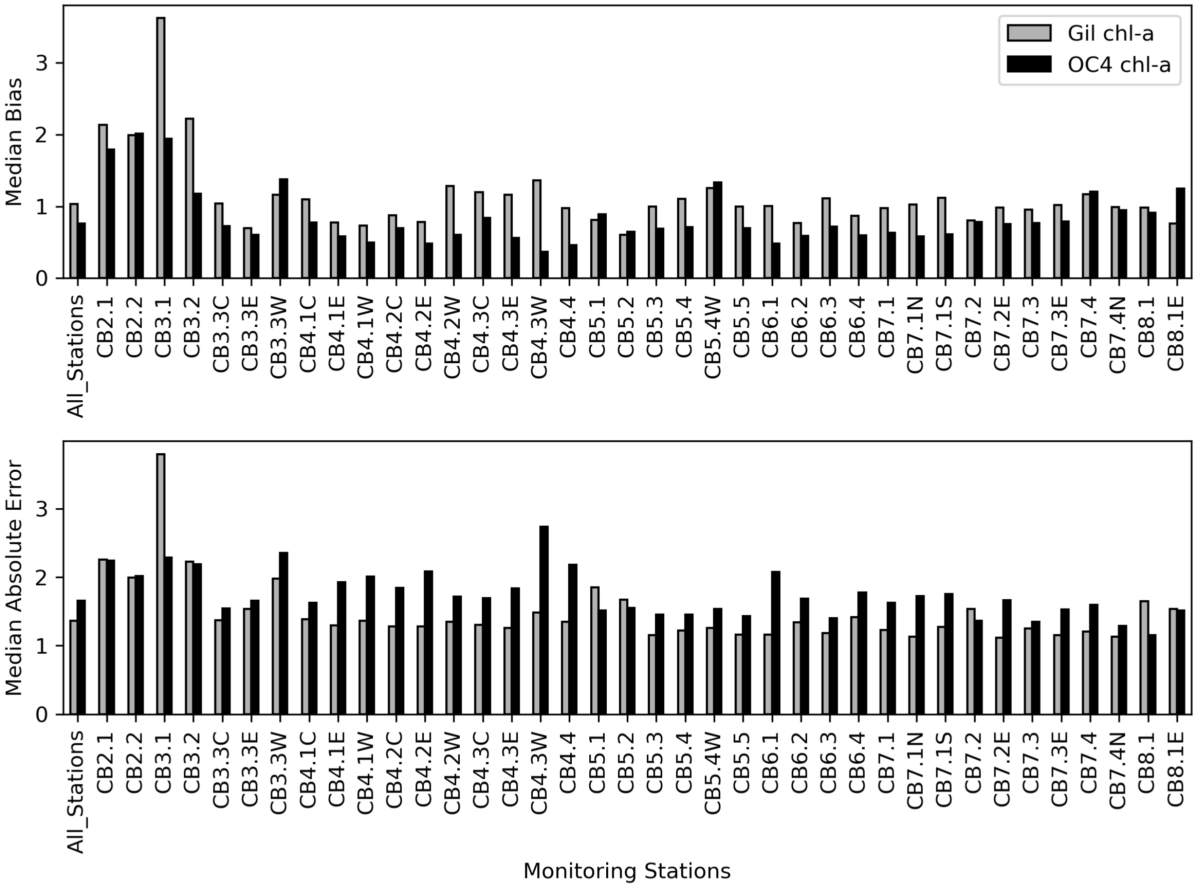
Bulk Statistics

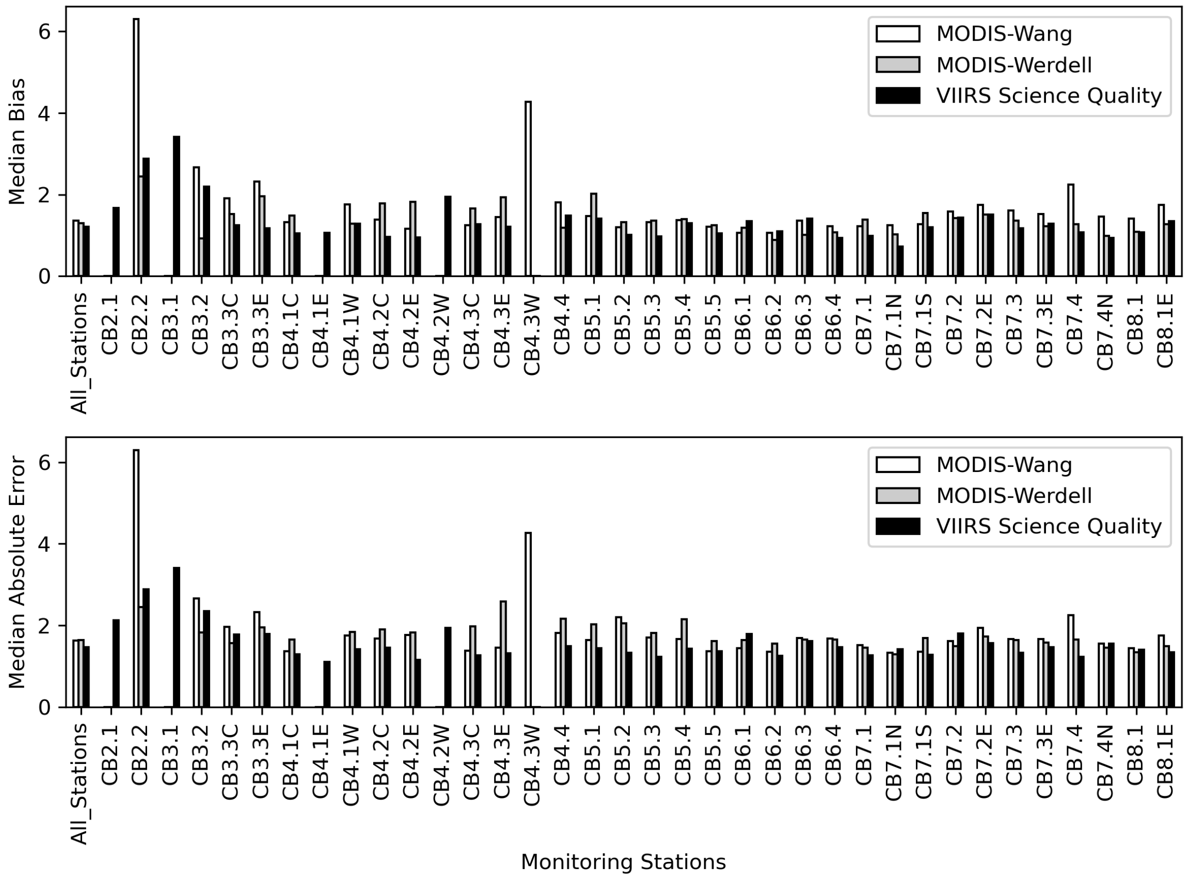
Metrics	Gilerson	OC4	Science Quality	Werdell	Wang
n	1679	1679	518	383	467
Linear Bias	-0.419	-2.756	16.431	5.715	5.05
Multiplicative Mean Bias	1.044	0.791	1.29	1.328	1.394
Multiplicative Median Bias	1.037	0.765	1.209	1.294	1.358
Linear MAE	4.499	5.86	18.632	7.717	6.894
Multiplicative MAE	1.596	1.87	1.745	1.866	1.839
Multiplicative MDAE	1.36	1.655	1.465	1.637	1.63

- The Multiplicative Median Bias of 1.037 indicates no bias.
- The Multiplicative Median Absolute Error (MDAE) shows a median error of 36%

For Methods see: Seegers et al, 2018 Optics Express

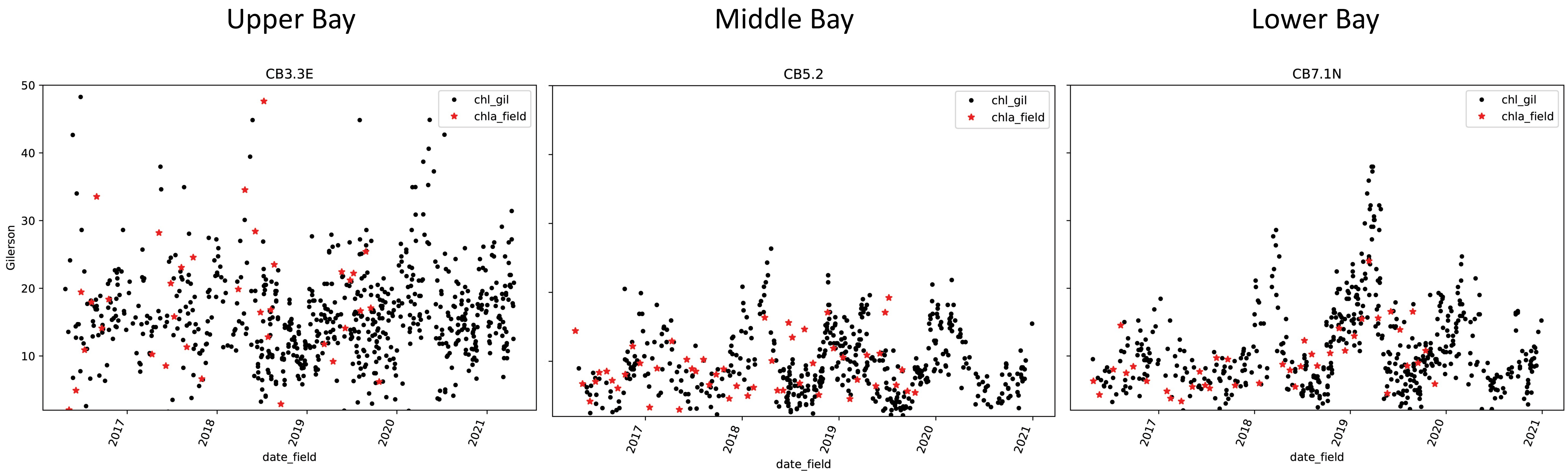
Error estimates by station for 5 algorithms





- Overall, Median Multiplicative Bias and MAE varies with location and chlorophyll concentration.
- Upper Bay stations on left, with lower Bay stations on the right

Time-series analysis

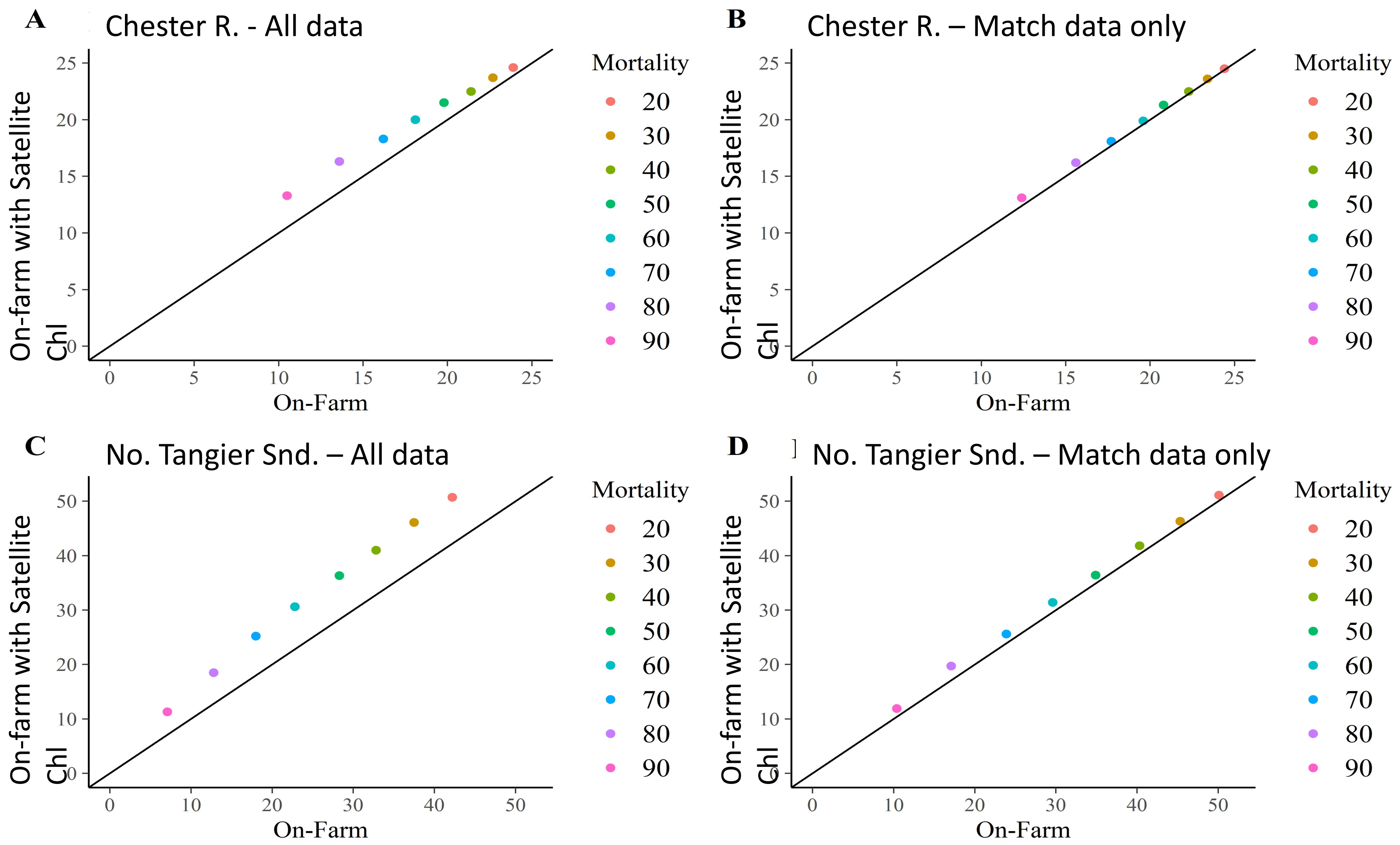


- All available pixels were extracted at each CBP monitoring station
- Overall, tighter relationship in the Middle and Lower Bay regions, with good alignment with field estimates

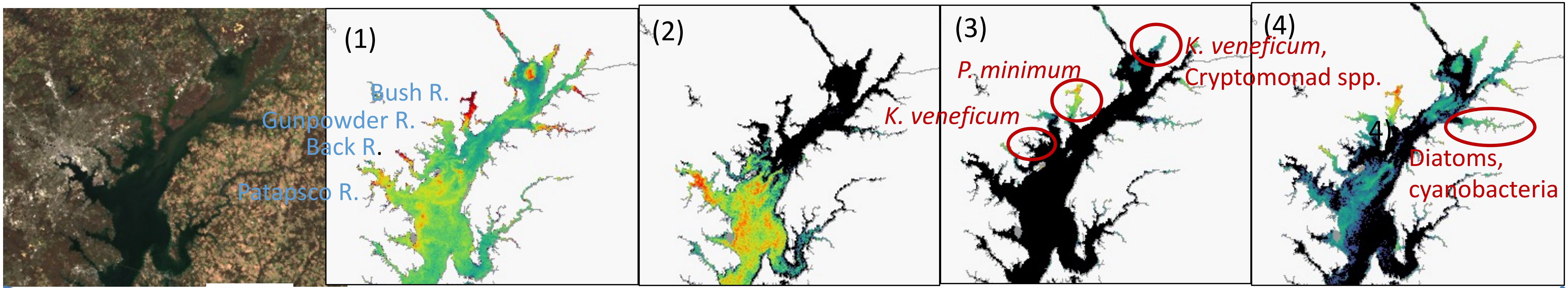
Substituting satellite Chl for on-farm data for aquaculture modeling

S. Bricker, V. Ransibrahmanakul, S. Tomlinson , E. Davenport, R. Vogel, R. Karrh, K. Okada

FARM model harvest results (metric tons/ cultivation cycle)



Satellite-derived products for algal bloom monitoring in Chesapeake Bay

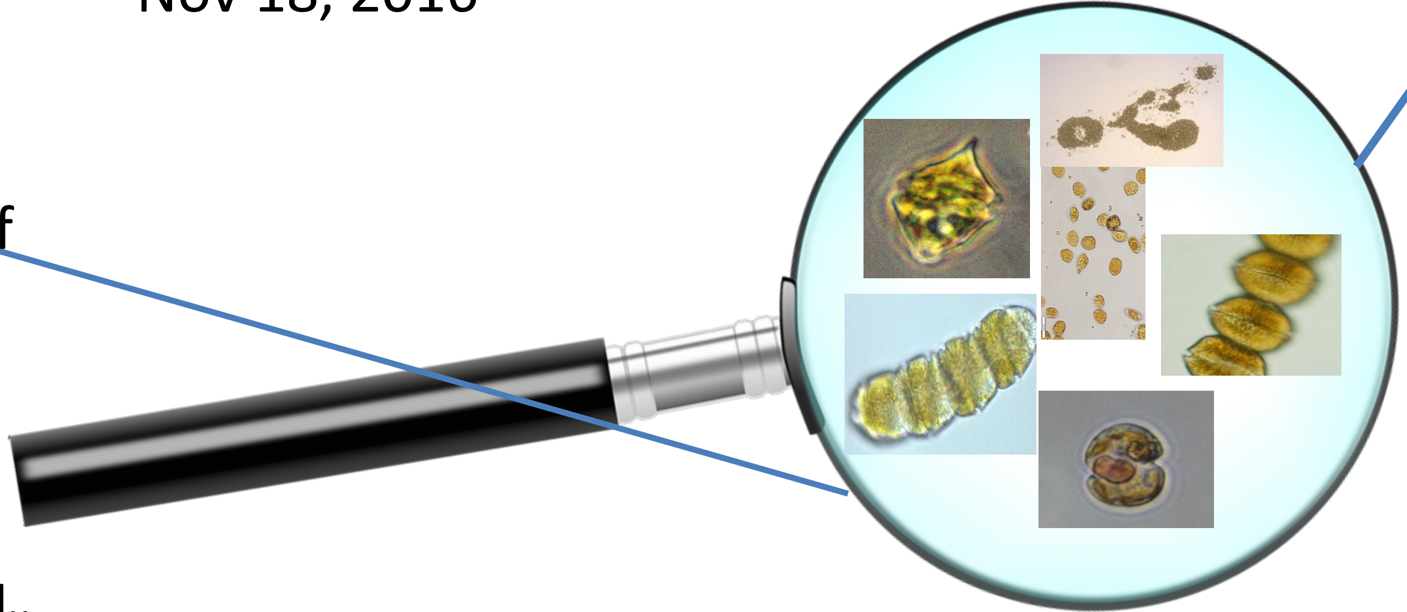


EUMETSAT esa

Nov 18, 2016

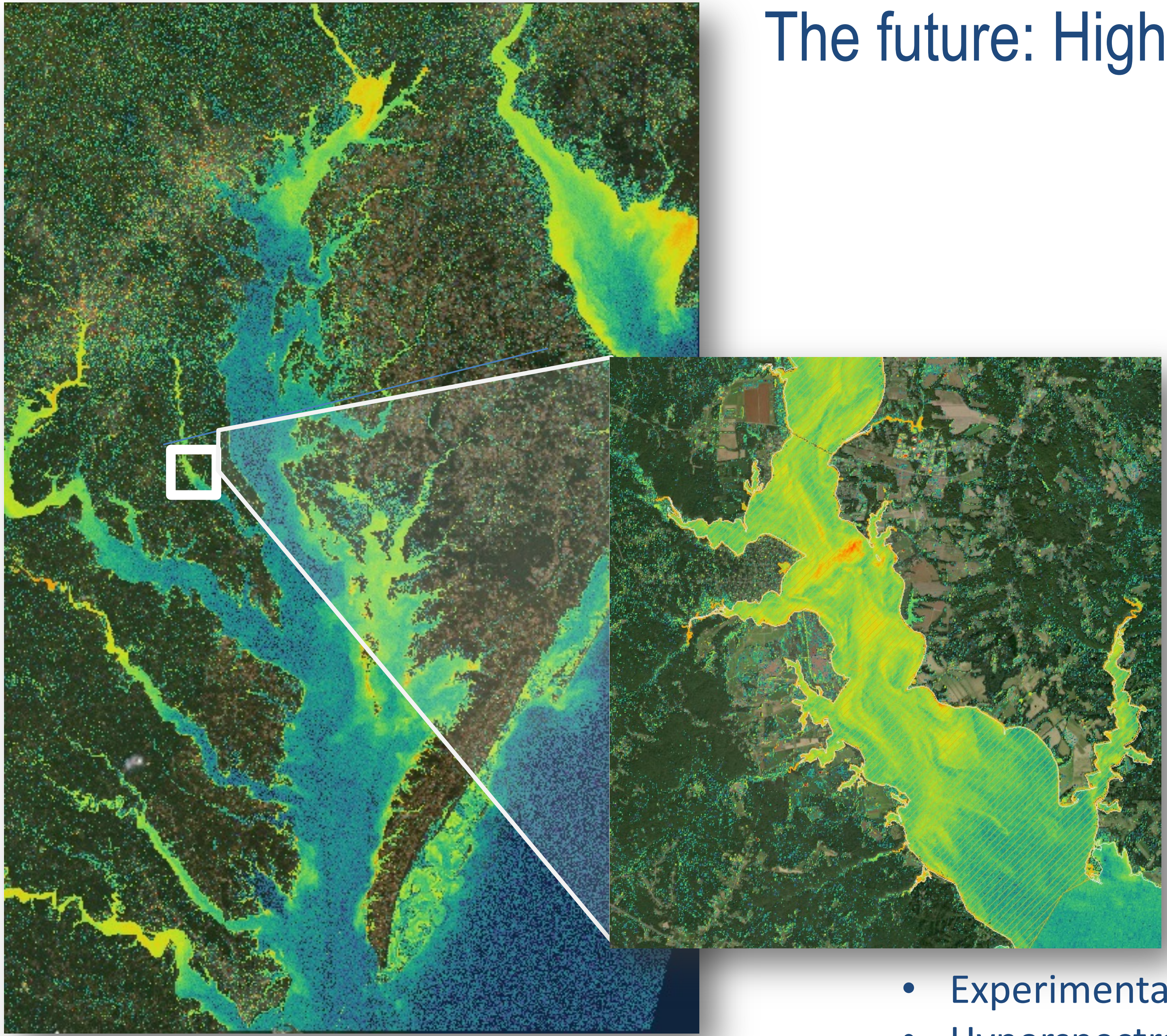
Developing and providing algorithms for bloom monitoring routinely to MD DNR, MDE, VA Dept. of Health and VIMS from OLCI since 2016

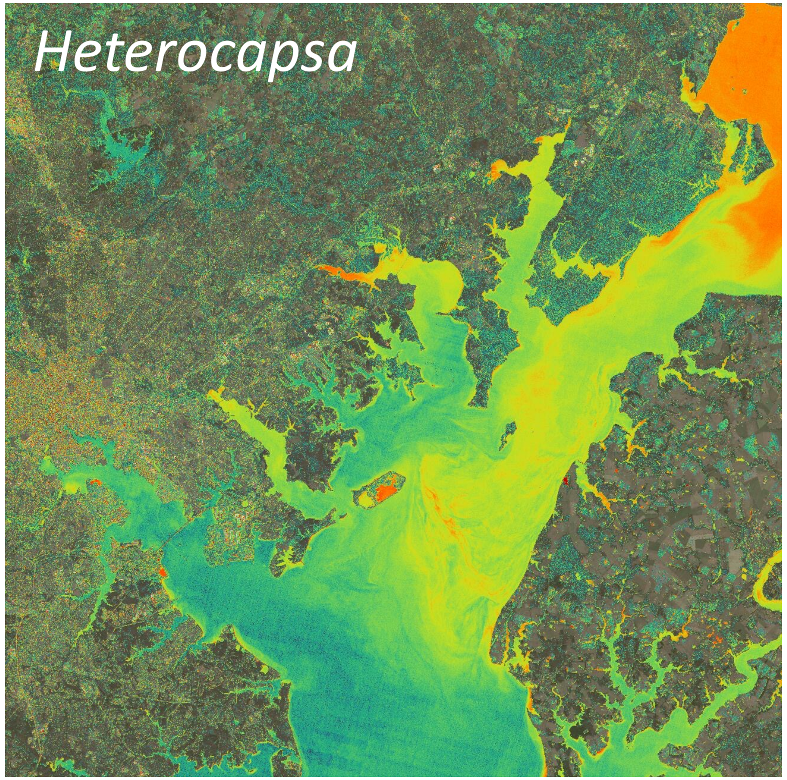
(1) Red Band Difference (RBD) (Amin et al., 2009)
(2) Red-Edge (Gilerson, 2010)
(3) Cyanobacteria Index (Wynne et al., 2008) modified by a negative shape at 620 nm
(4) Maximum Chlorophyll Index (MCI) (Gower et al., 2008, 2010)



https://coastwatch.noaa.gov/cw_html/NCCOS.html

The future: Higher spatial resolution Sentinel 2





Sentinel-2A February 9, 2022
MCI Composited (6 daily tiles) 20 meter pixels
Approximately 5 day repeat with 2 satellites

- Experimental Maximum Chl Index and true color available
- Hyperspectral imagery coming online through PACE, GLIMR, GEO-XO

https://coastwatch.noaa.gov/cw_html/NCCOS.html

CoastWatch Satellite Training Module for Water Quality

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Fill out our survey!

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CAPACITY BUILDING AND EDUCATION IN OCEAN SATELLITE DATA

We help people access and make sense of satellite data for use in coastal and ocean applications.

NOAA COASTWATCH

Identifying and using satellite data products appropriate for a given application can be challenging for users outside of the satellite community.

NOAA CoastWatch is a value-added data provider assisting users through a range of services, from data distribution to capacity-building to tool development and direct collaboration on projects and applications.

The goal of the CoastWatch satellite course is to build capacity in using satellite data by providing background knowledge, tools, tutorials and hands-on help on individual projects to course participants. Courses are free to all, can be taught in person or virtually and are tailored to specific audiences, based on participants interests, needs and technical level.

Course materials can be found at: https://coastwatch.gitbook.io/

CAPACITY BUILDING FOR AQUACULTURE

We are planning to start organizing classes targeting various audiences engaged in aquaculture to help government, research and commercial users in the aquaculture fields get more familiar with ocean satellite data products, their strengths and weaknesses and their potential for informing siting and operations.

Course contents would include:
Sea Surface Temperature
Ocean Color
Water Quality
Harmful Algal Blooms
Data Visualization and Download
Tool Demonstrations
ArcGIS

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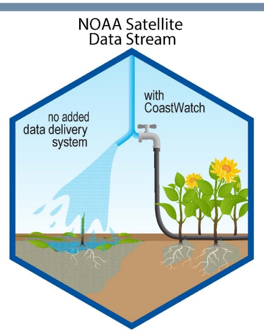
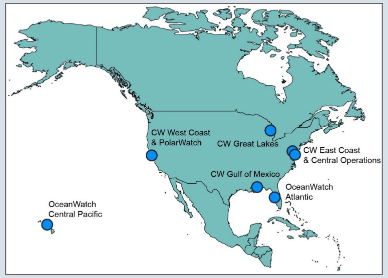
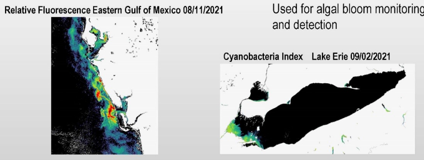




EXAMPLES OF SATELLITE-DERIVED PRODUCTS



How *In-Situ* and Satellite observations roughly correspond

In-Situ	Satellite
Water Temperature	Sea Surface Temperature (SST)
Chlorophyll Concentration and Algal Pigments	Chlorophyll-a Absorption Chlorophyll Fluorescence Phytoplankton Community Composition Spectral characteristic algorithms
Colored Dissolved Organic Matter (CDOM)	Absorption by CDOM (α_{dg})
Turbidity, Water Clarity	Diffuse Attenuation of Light at 490 nm (K_d) Diffuse Attenuation for Photosynthetically Active Radiation (K_dPAR) Euphotic Zone Depth
Total Suspended Solids (Total Suspended Matter, Suspended Particulate Matter)	Total Suspended Solids (Total Suspended Matter, Suspended Particulate Matter)
Salinity	Sea Surface Salinity (open ocean only, not available for coastal areas)

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