Challenges for bio-optical modeling of inland waters

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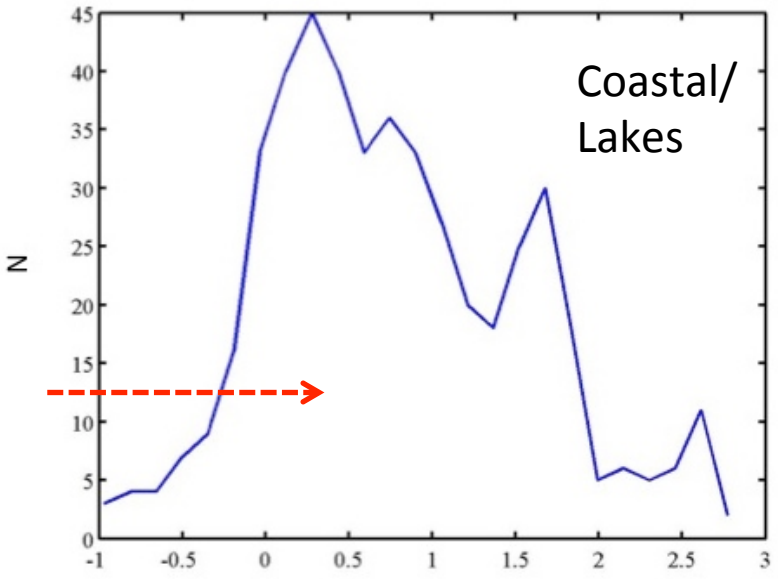
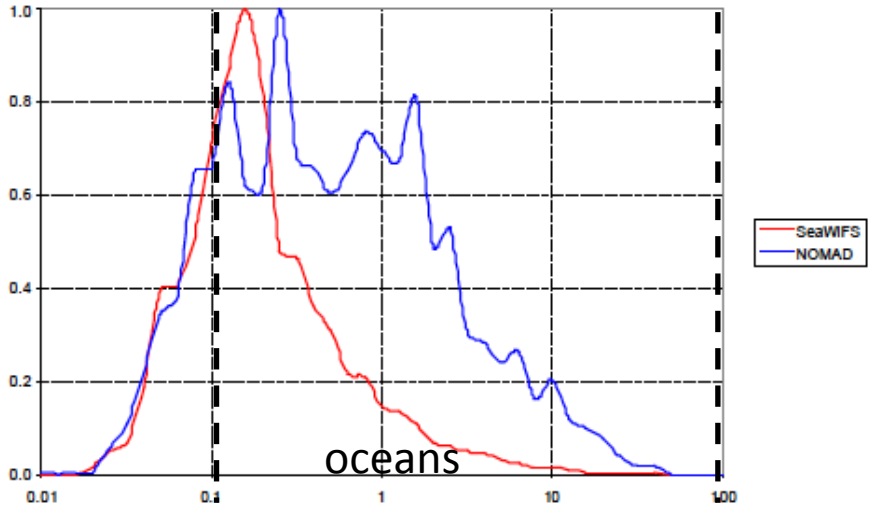
Complex optics with large variety in conditions create challenges to remote sensing applications for inland lakes.

Algorithm Challenges

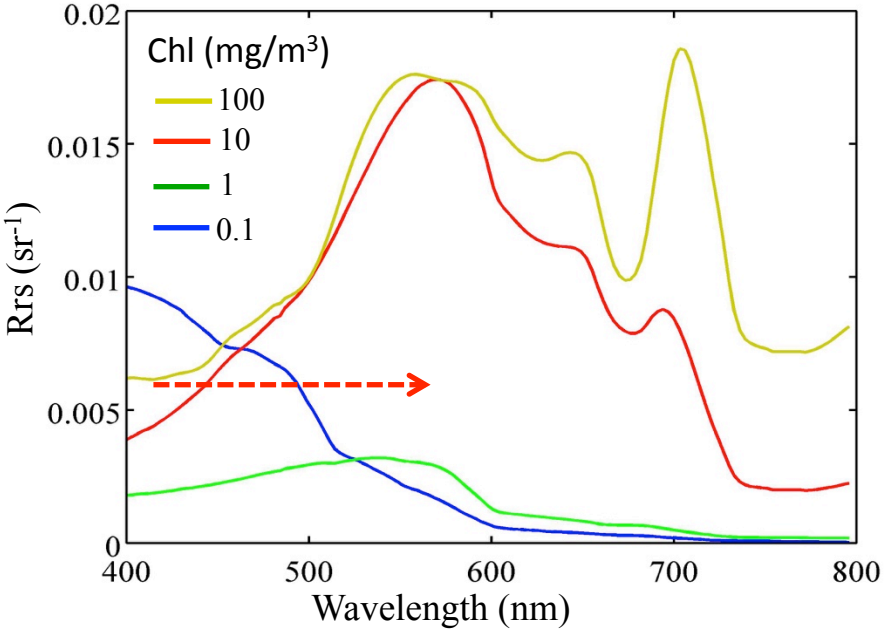
- Complex optical environments − often ‘case 2’
- But, extreme conditions exist from clear to dark waters, from turbid sediment to highly eutrophic (impacting absorbing and scattering).
- Varying optical conditions exist/change over short time/space scales.
- Lack of local in situ data (AOP & IOPs) to test Empirical & SAAs for many lakes and conditions.
- Best choice for optical proxies? => Product limitation across satellites (due to band availability)
- Region/water type differences with model tuning

Inland waters show log-normal biomass distributions, but shifted



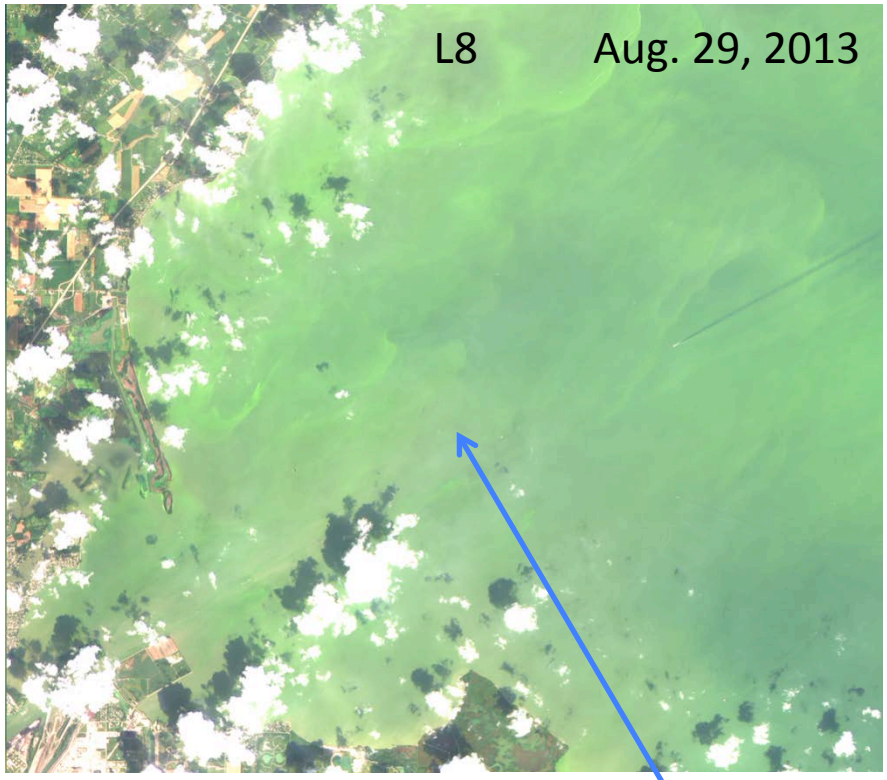


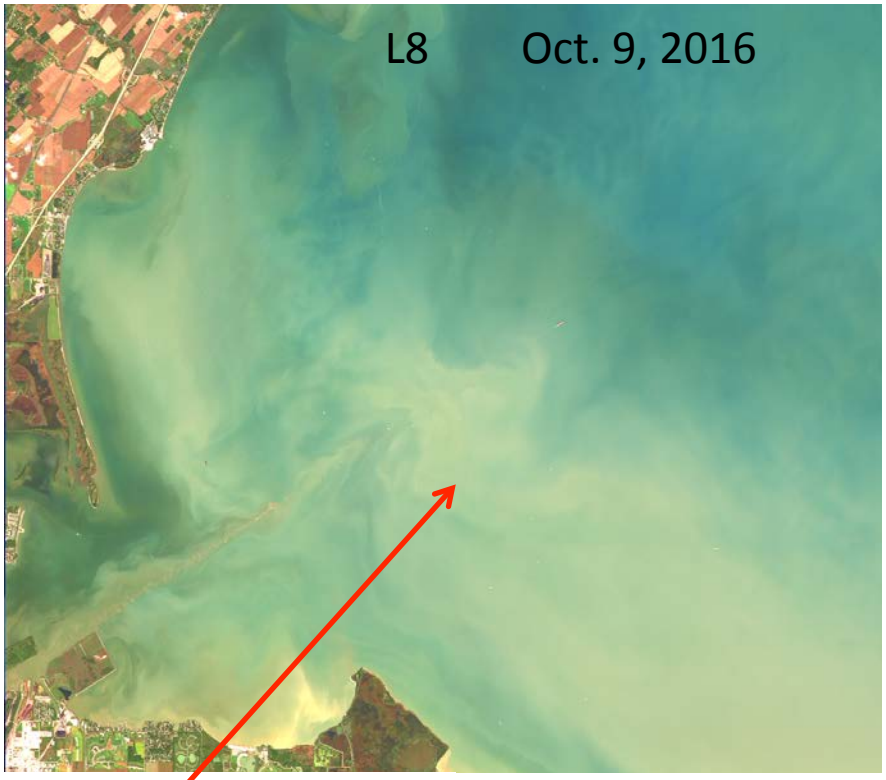
Coastal/Inland Waters



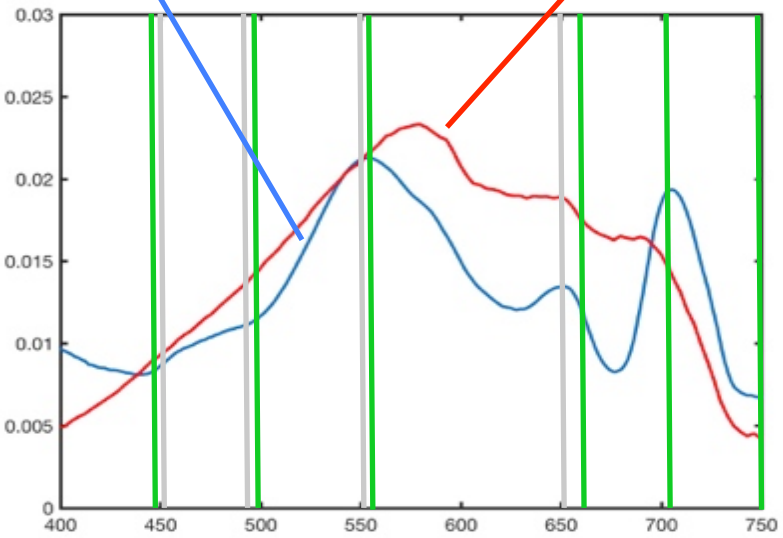
Extreme conditions – Surface cyanobacteria blooms

- Buoyancy (vertical) regulation through gas vacuoles
- Can occur over short time periods
- Form extremely dense aggregates
- Tend to move away from instruments/objects at

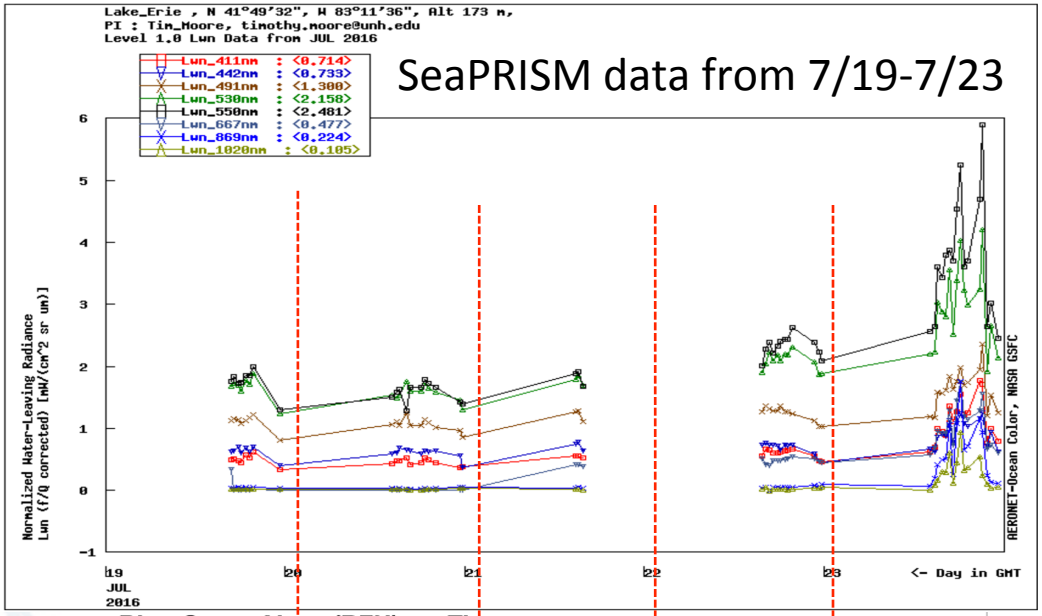


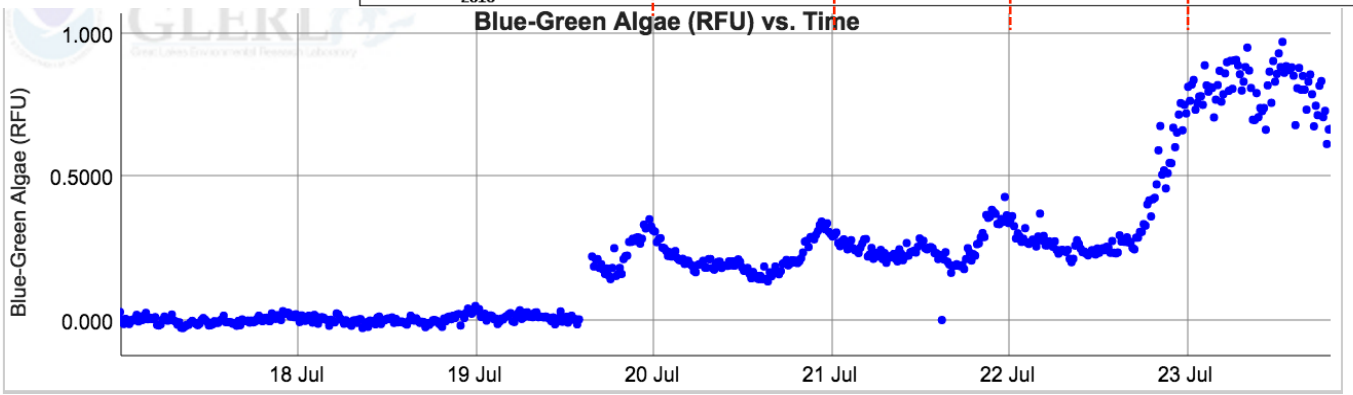


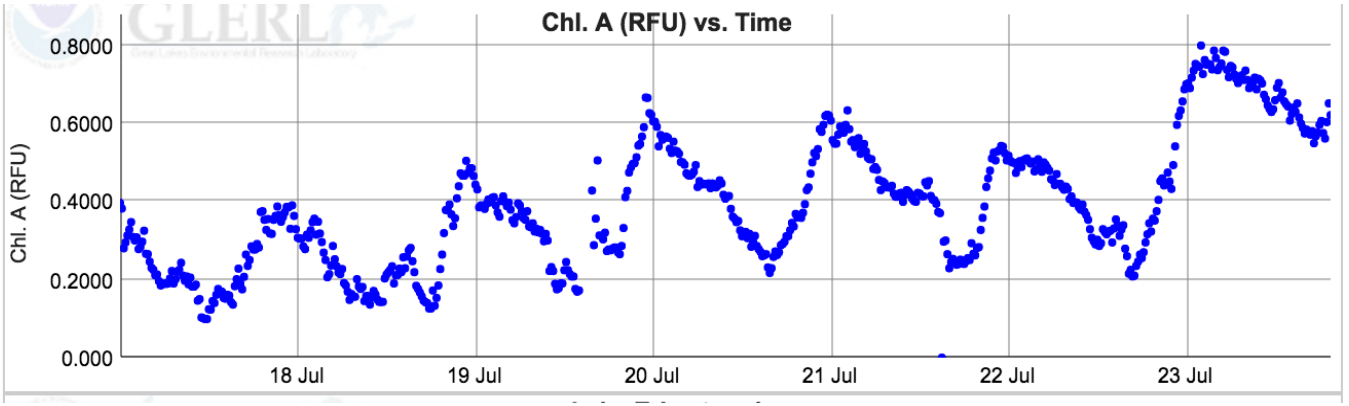
- Cyanobacteria and sediments both elevate Rrs
- Differentiating between them is a challenge



Top: SeaPRISM data
Bottom: in-water buoy measurements showing rise in algal biomass with surface formations on July 23.







Cyanobacteria colony surface formation – July 23, 2016 (Part 1)

9:16 AM

10:16 AM

11:16 AM

12:16 PM

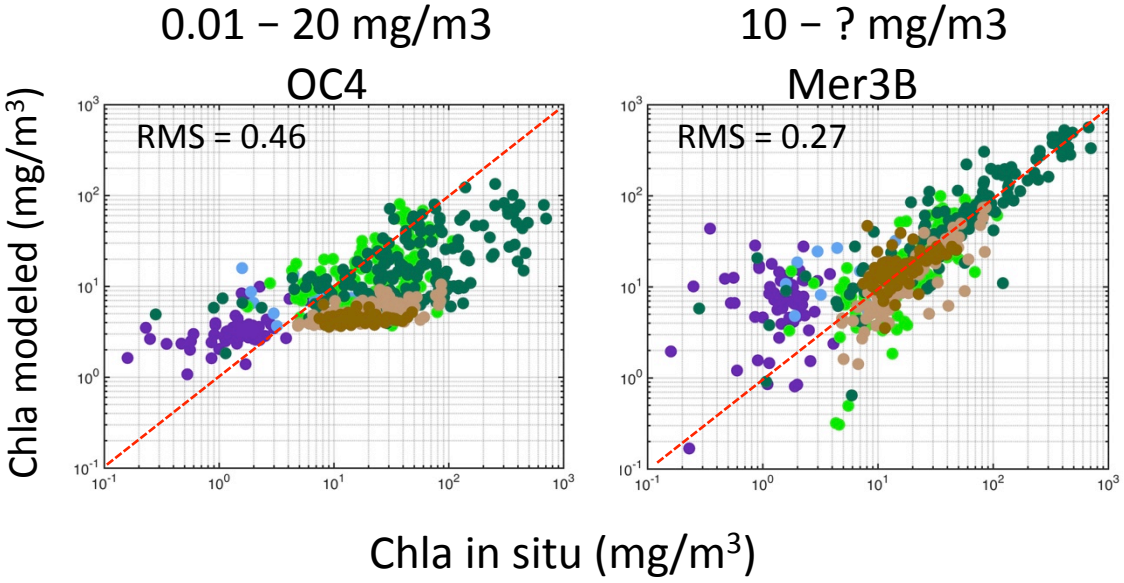
1:16 PM

2:16 PM

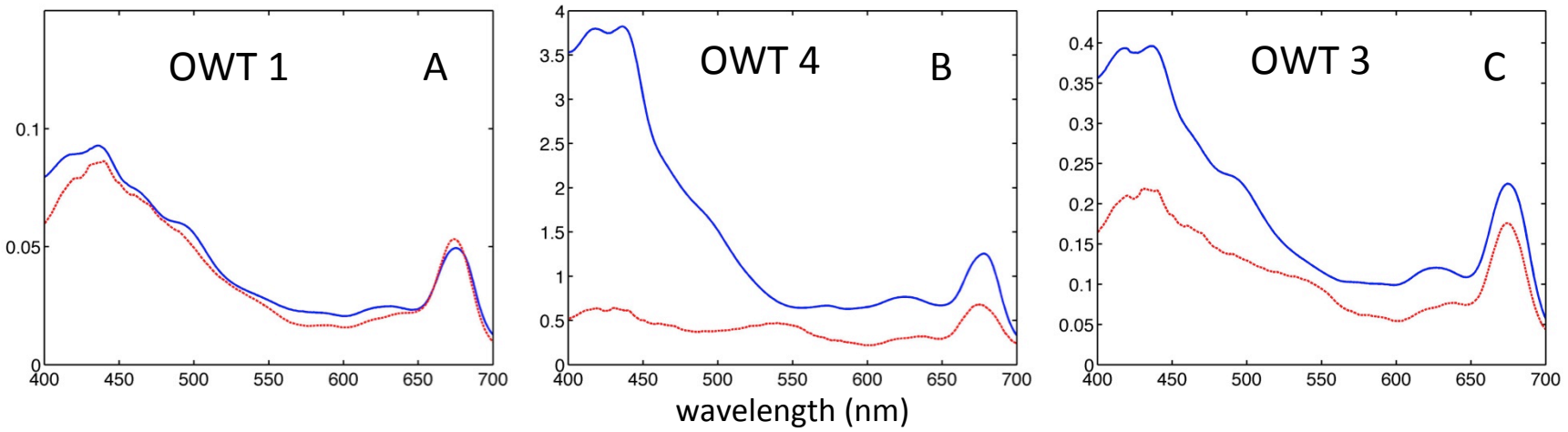
Webcam images at Tower show formation of surfacing cyanobaceria colonies throughout the day of July 23. Winds were low, and water movement was minimal promoting surface accumulations. Corresponding SeaPRISM measurements show significant rise in Rrs. Colonies either were re-mixed and/or advected on following day(s).

Matching algorithm and environment

- What are the operational ranges/limits of algorithms?
- What are environmental ranges of a given system?



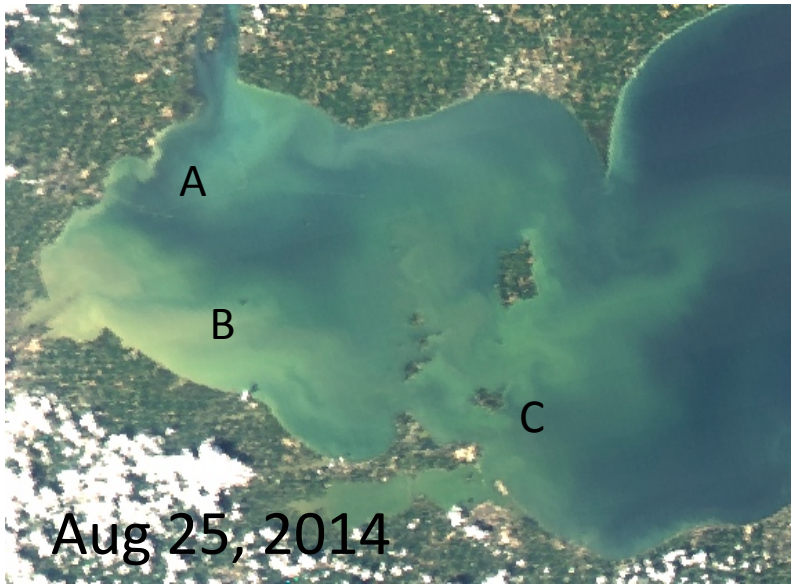
SAA considerations - Phytoplankton absorption

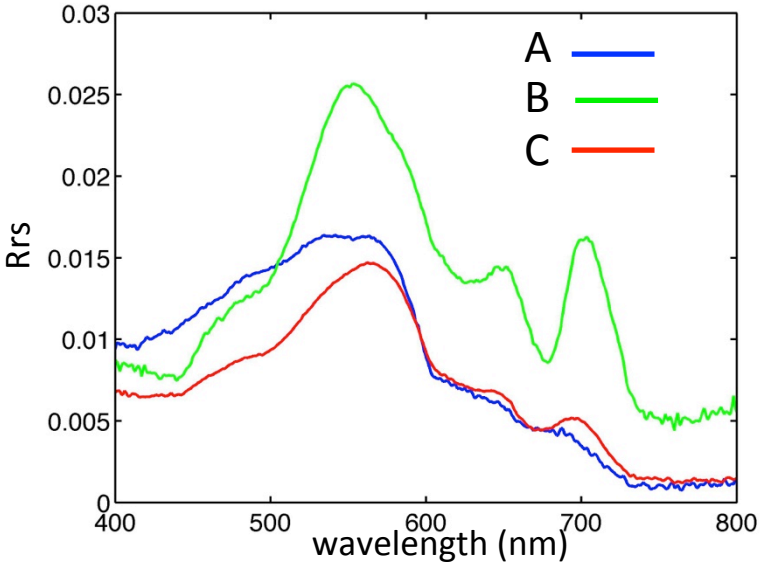


Measured

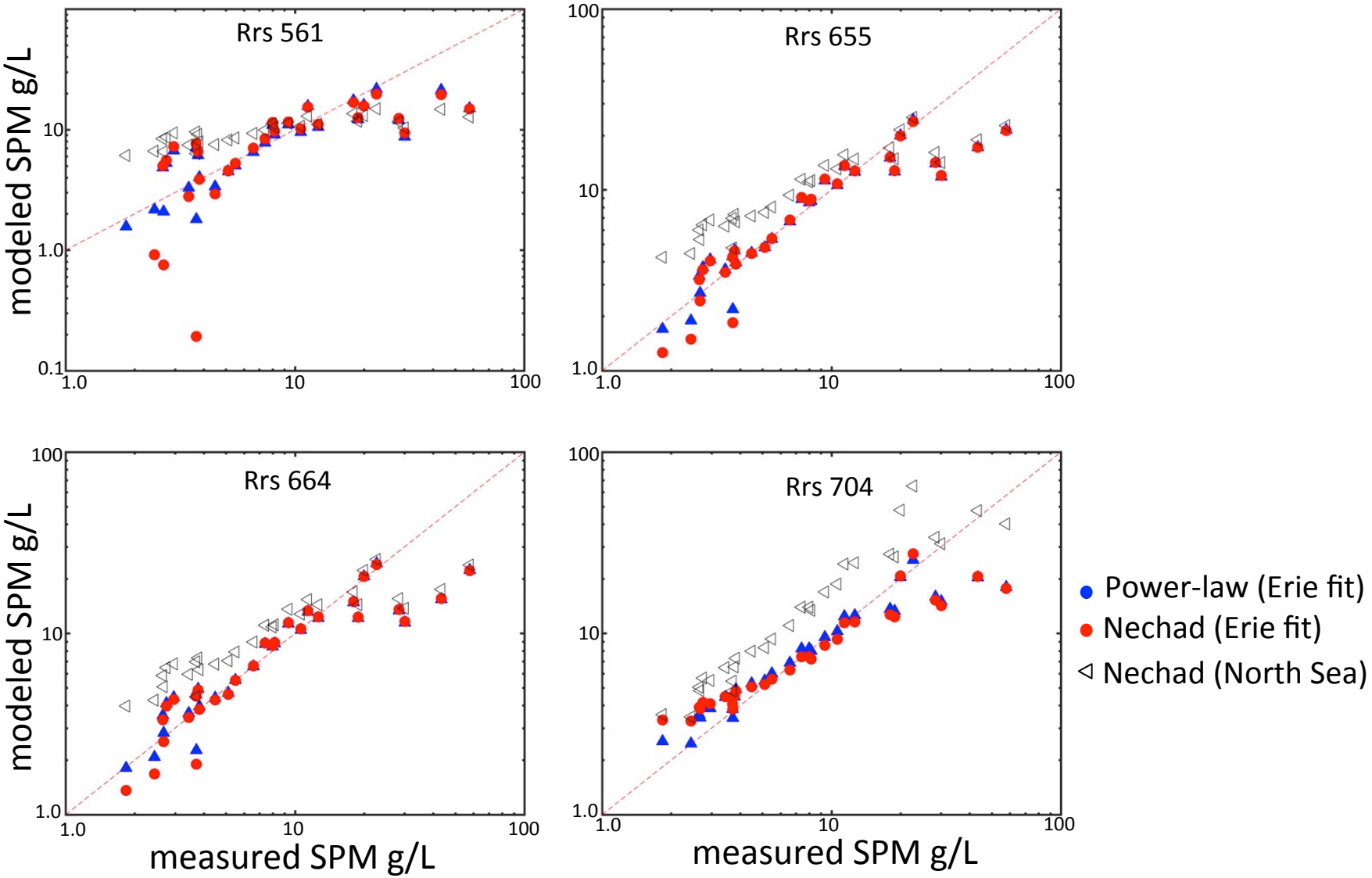
Modeled: NASA standard (GIOP Bricaud power law)

$$R_{rs} \approx \frac{b_b}{a + b_b}$$





Regional tuning issues



Multi-algorithm approaches

- Switching algorithms have been in existence since the CZCS Chl algorithm.
- Blending methods currently exist from simple 2-case weights to ‘fuzzy logic’ schemes.

J.W. Campbell, J.M. Blaisdell, and M. Darzi

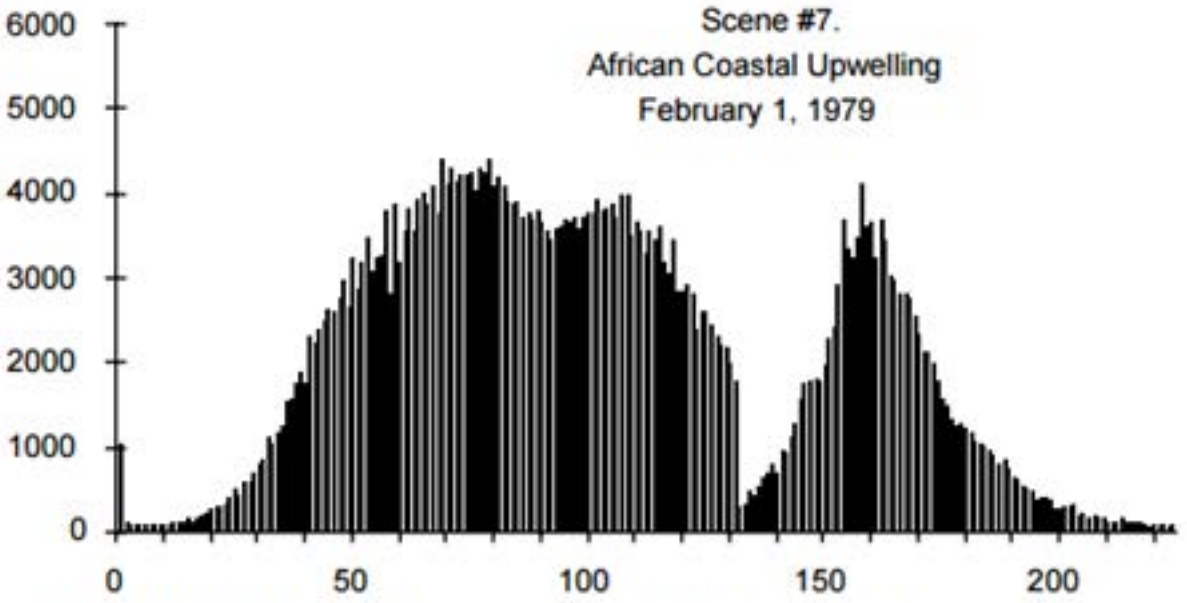
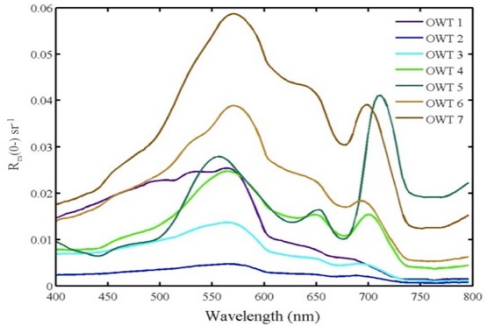


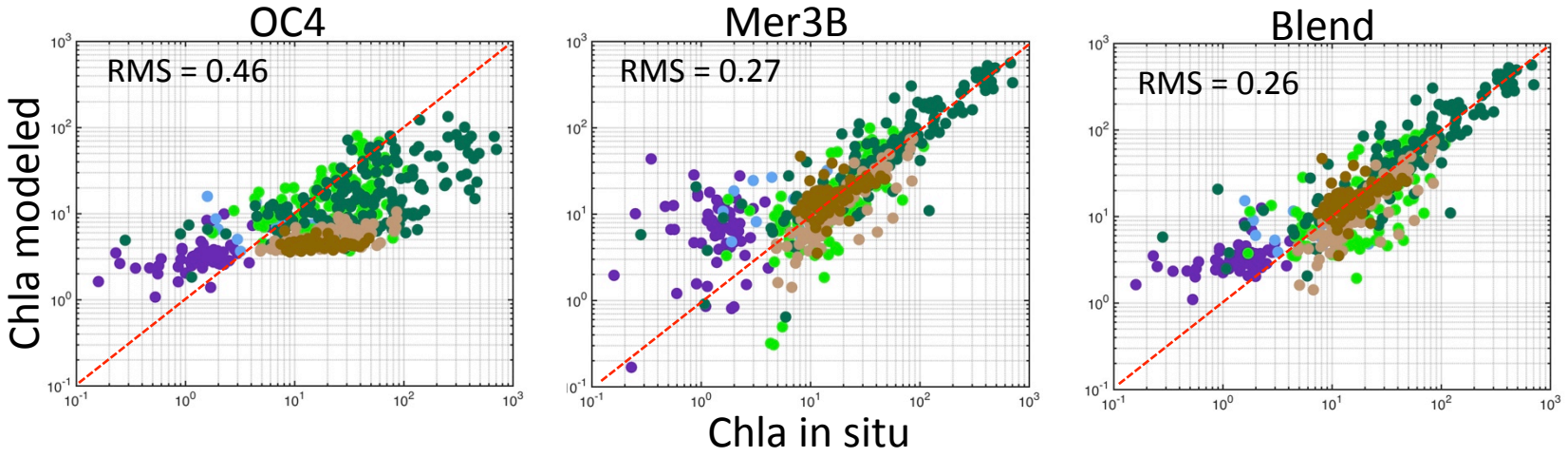
Fig. 4. (cont.) Pigment histograms of seven CZCS scenes used in this analysis.

Algorithm Blending

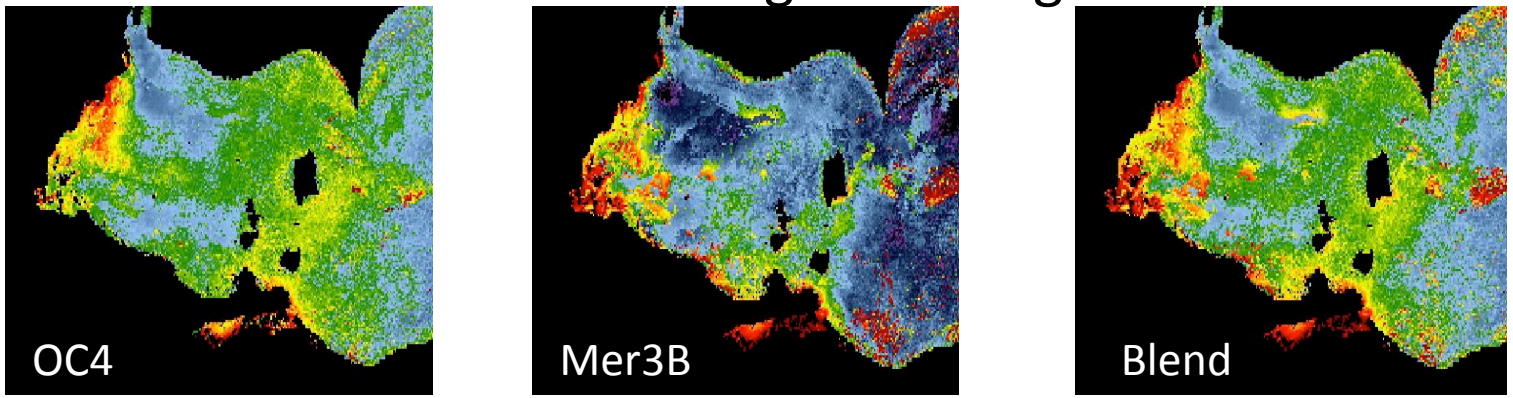
- 7 optical water types used to classify RS imagery
- Water type represents an optical state
- Allows for tuning specific models/ parameters to optical conditions

(Moore et al 2014, RSE)

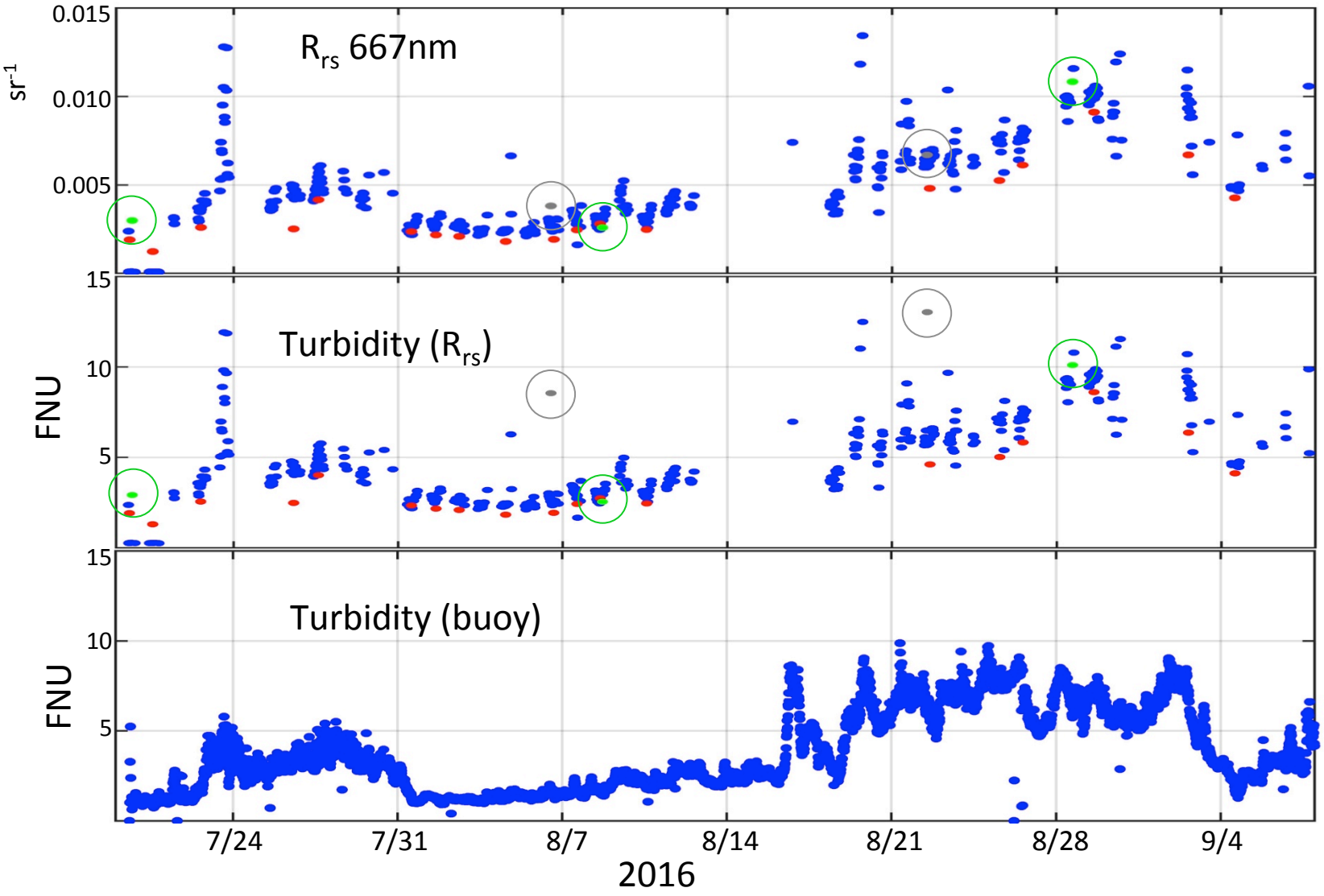




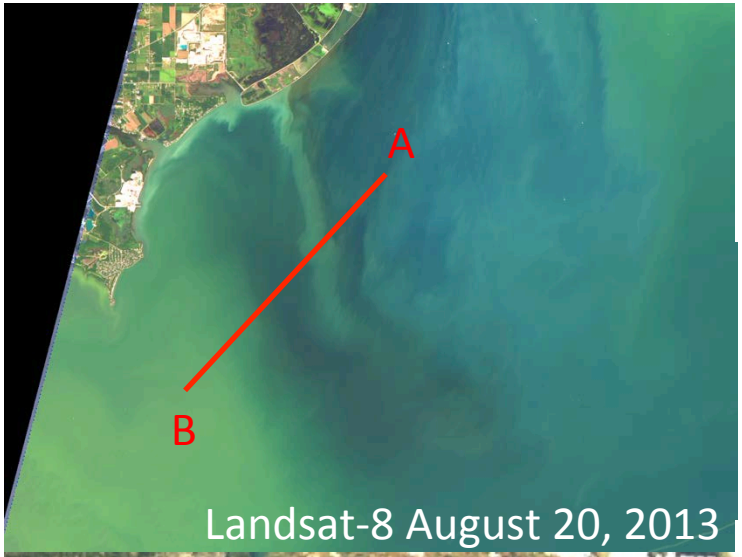
MERIS August averages

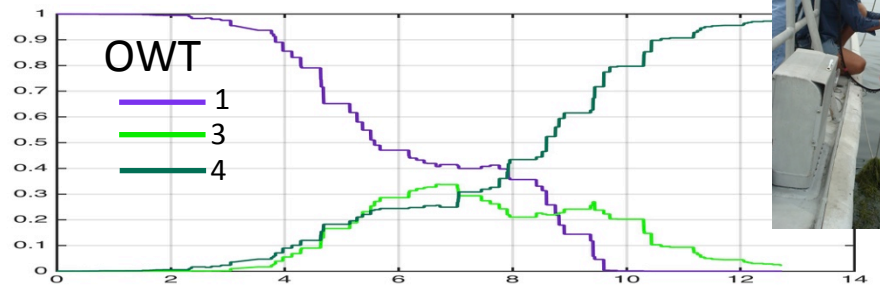


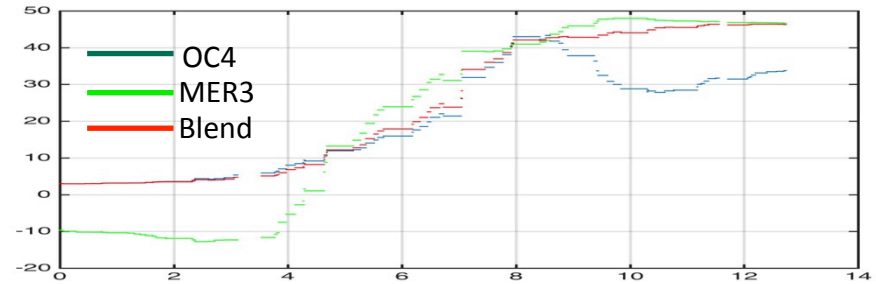
Lake Erie SeaPRISM observations 2016

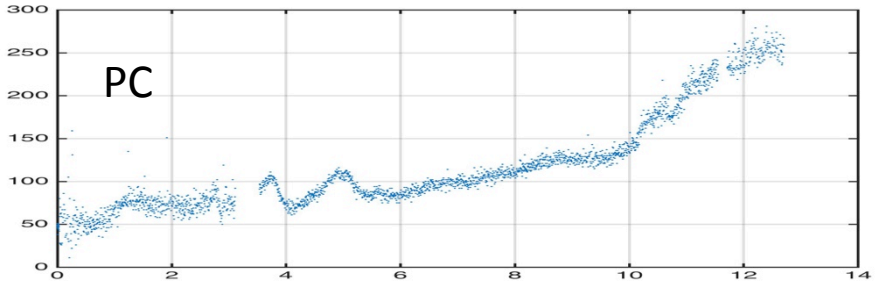


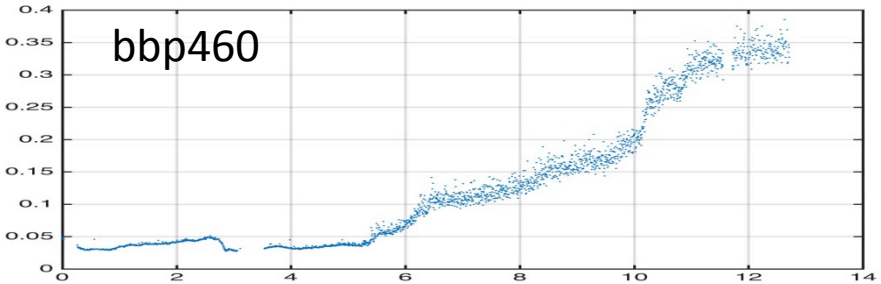
Water type properties across a front











A Distance (km) B

- Ultimately, algorithm use will depend on application, user need for frequency of observation, accuracy requirements.

Acknowledgments

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