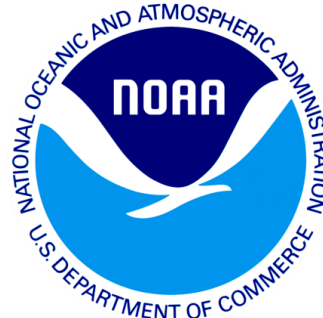# Cyanobacteria Assessment Network

Rick Stumpf and Shelly Tomlinson

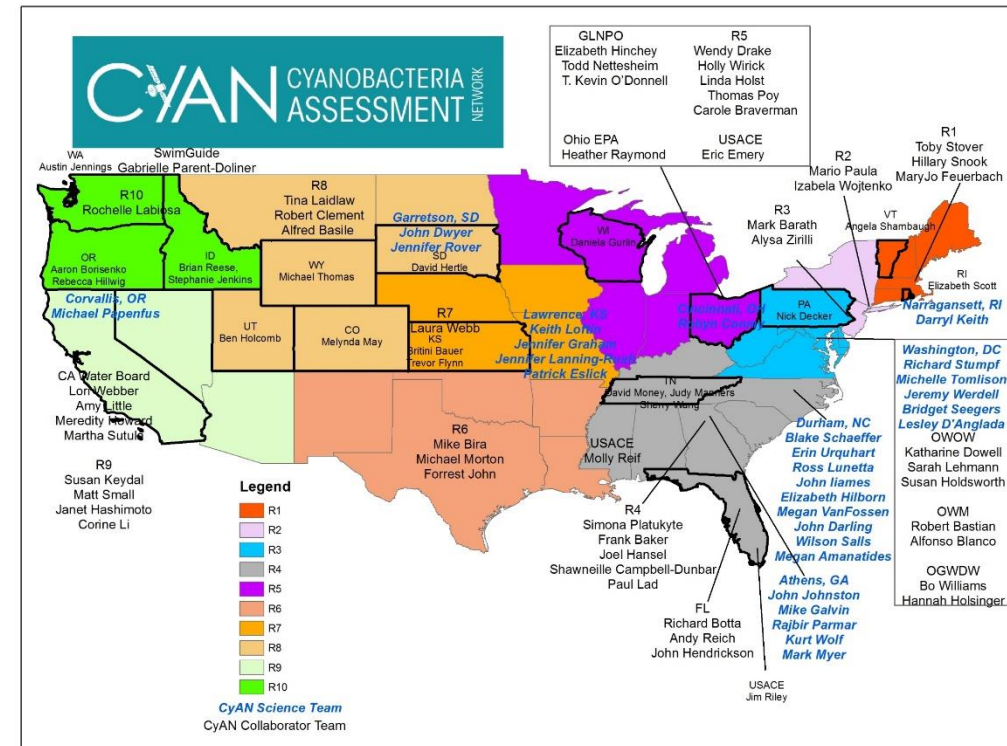National Centers for Coastal Ocean Science, NOAA

Goal of CyAN:
Create a national assessment and monitoring capability for cyanobacterial blooms in lakes using satellite observations

Inter-agency effort: PIs: Blake Schaeffer, EPA; Rick Stumpf, NOAA, Keith Loftin, USGS, Jeremy Werdell, NASA

Stakeholders and participants:

- EPA Office of Water

    Office of Wetlands, Oceans, and Watersheds

    Office of Wastewater Management

    Office of Science and Technology

    Office of Ground Water and Drinking Water

- EPA Regions

- U.S. Army Corps of Engineers

- State collaborators

CyAN objectives for satellite monitoring

- Where are blooms now?
  - How bad are they (concentration)?

- Are they worse than last week (or last month) ?
  - For swimming or for water suppliers?

- Which lakes are typically bad
- Have lakes changed over the last decade?

- Can we start to assess what causes blooms?
  - Help with seasonal forecasts and mgmt scenarios
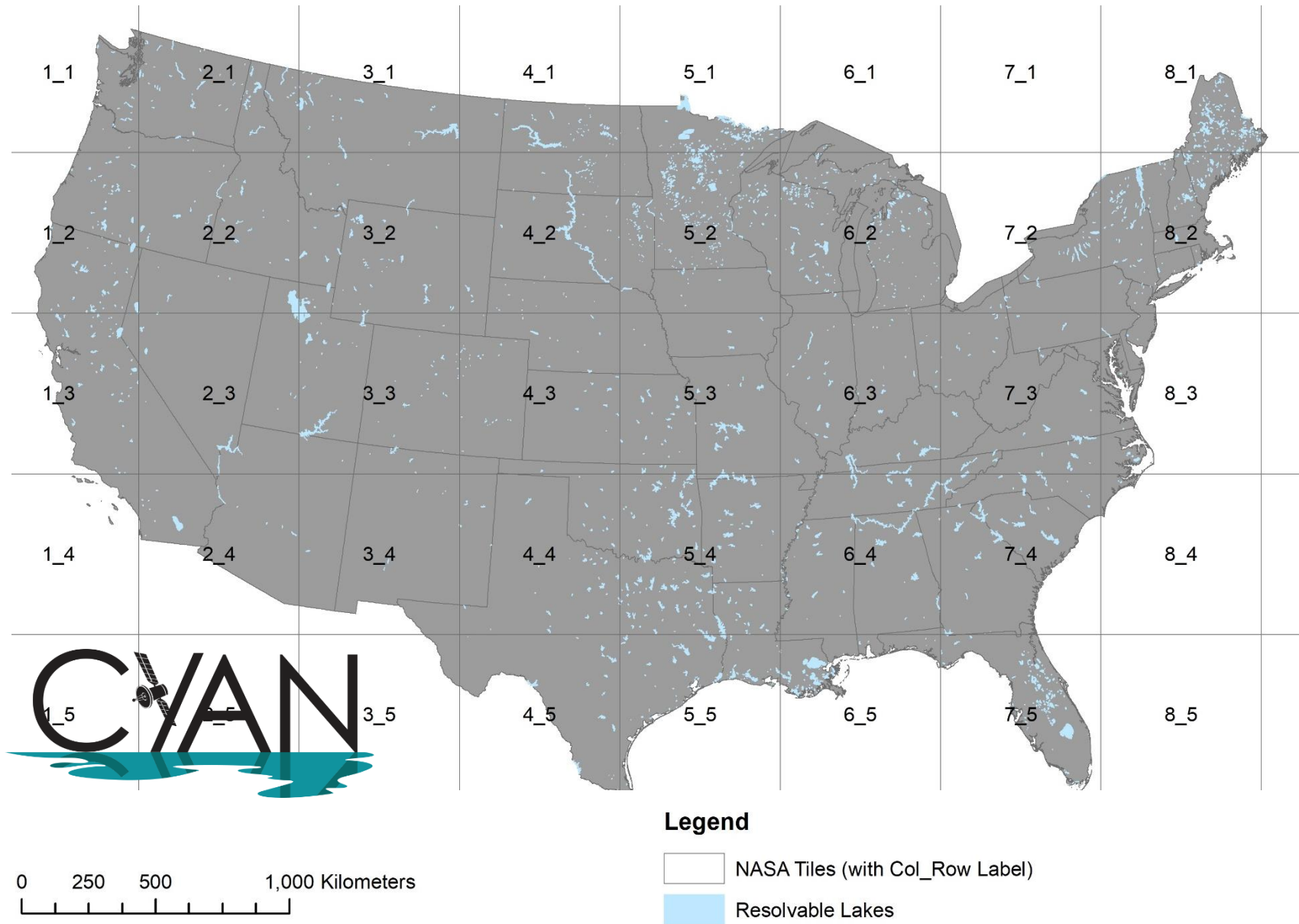 - Inform management to reduce blooms by reducing nutrients

Satellite Comparison for bloom applications

Satellite	Spatial	Temporal	Key Spectral
MERIS 2002-12 OLCI Sentinel-3a 2016-	300 m *OK*	2 day *good*	10 (5 on red edge) *good*
MODIS high res Terra 1999; Aqua 2002	250/500 m *OK*	1-2 day *good*	4 (1 red, 1 NIR) *marginal*
MODIS low res	1 km *poor*	1-2 day *good*	7-8 (2 in red edge) *OK*
Landsat	30 m *good*	8 or 16 day *poor*	4 (1 red, 1 NIR) *marginal*
Sentinel-2a (2015) 2b (2017) MSI	20 m *good*	10 day each 5 day with 2 satellites *Potential with 2*	5 (1 red; 2 NIR, 1 in red edge) *potential*

Sentinel-3 OLCI national tiles

Few lakes in MD/VA at this resolution

Cyanobacteria Index (CI) products only for S3.

Legend

☐	NASA Tiles (with Col_Row Label)
▨	Resolvable Lakes

Map tile labels: 1_1, 2_1, 3_1, 4_1, 5_1, 6_1, 7_1, 8_1, 1_2, 2_2, 3_2, 4_2, 5_2, 6_2, 7_2, 8_2, 1_3, 2_3, 3_3, 4_3, 5_3, 6_3, 7_3, 8_3, 1_4, 2_4, 3_4, 4_4, 5_4, 6_4, 7_4, 8_4, 1_5, 3_5, 4_5, 5_5, 6_5, 7_5, 8_5

Scale: 0 250 500 1,000 Kilometers

A look at Sentinel-2
S2 (MSI) vs S3 (OLCI) 2017 Baltimore true color

Sep 28 day 271

Sentinel-2 Processing

- Multi-Spectral Instrument (MSI) now available on two satellites (Sentinel-2a, b)
  - Spectral Resolution: 20 m resolution
  - Temporal Resolution: every 5 days
- NOAA S2 status
  - S2 can produce Maximum Chl Index (MCI) and may produce "high chlorophyll" red-edge algorithm (Gilerson et al., 2010).
- We are working on simplifying S2 processing
- We are testing S2 in Florida, and have run some MD scenes.

Gilerson A.A., et al. 2010. *Optics Express*, 18(23): 24,109-24,125.

Sentinel 2 Challenges

- We need to improve current cloud masking algorithm
  - implemented cloud mask based on MERIS/OLCI but needs work
- Investigating "corrections" for MCI false positives from sediment
- Scene position is all the same (swaths don't shift from day to day as with Sentinel 3)
- The spatial data volume is huge, need to work on ways to extract data for lakes/reservoirs
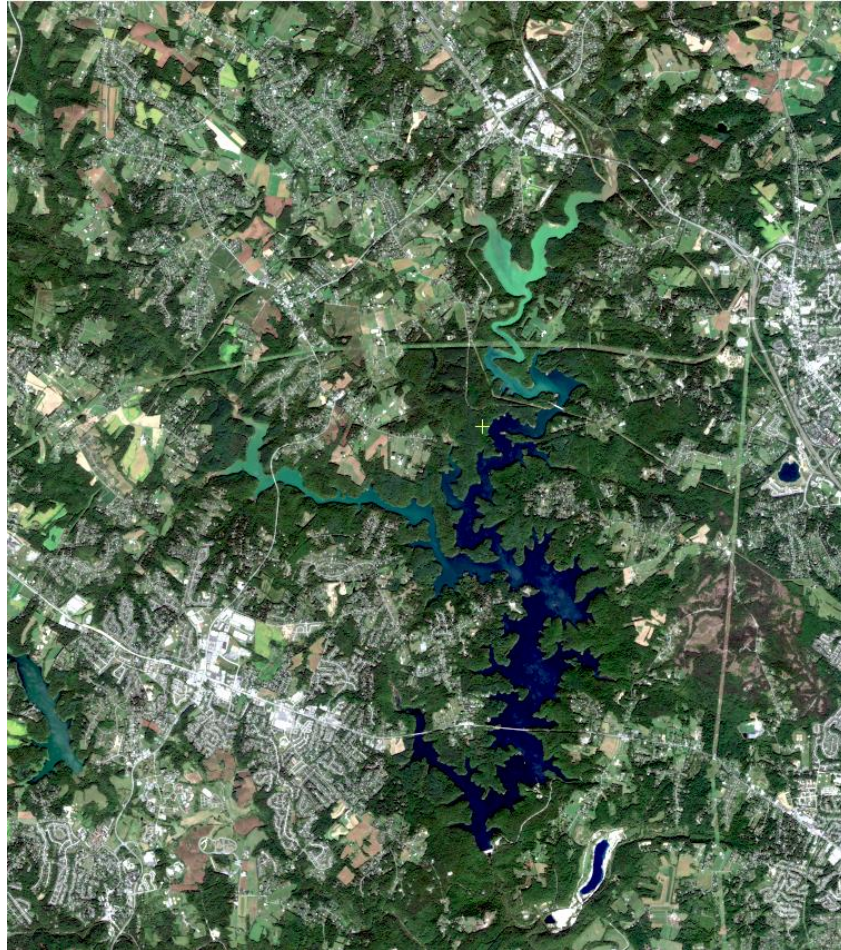 - hard to automate without some level human intervention to filter imagery

Potomac River 9/28/2017

Gilerson Chl *a*

True Color (Dramatic removal of surface Reflection from Sentinel 3)
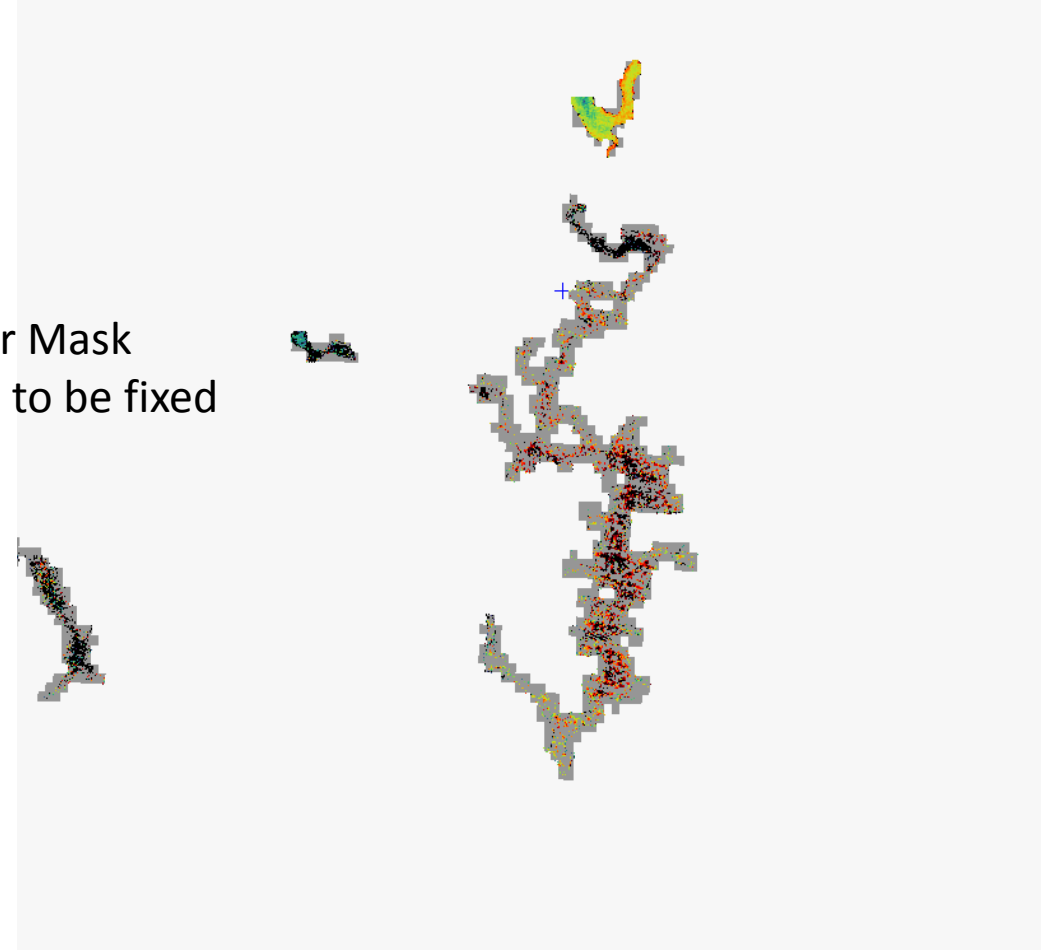
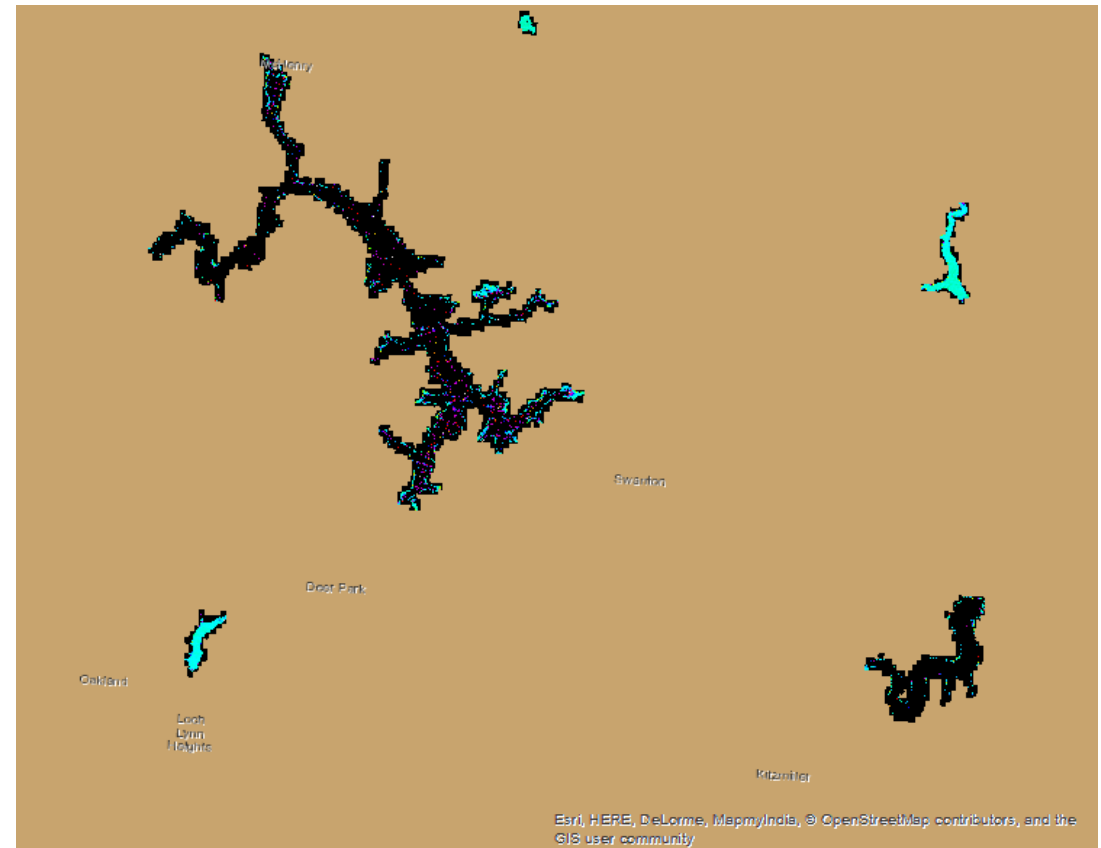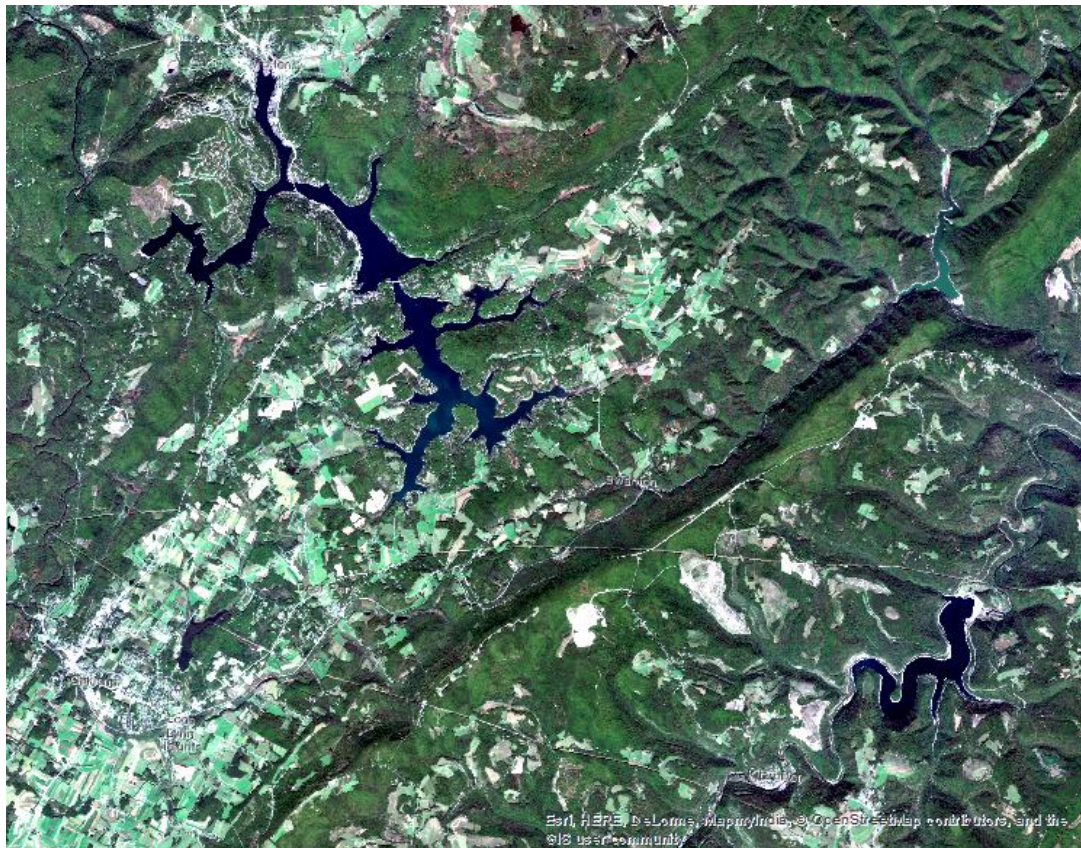# Liberty Reservoir NW of Baltimore 9/28/2017

Stretched True Color

MCI

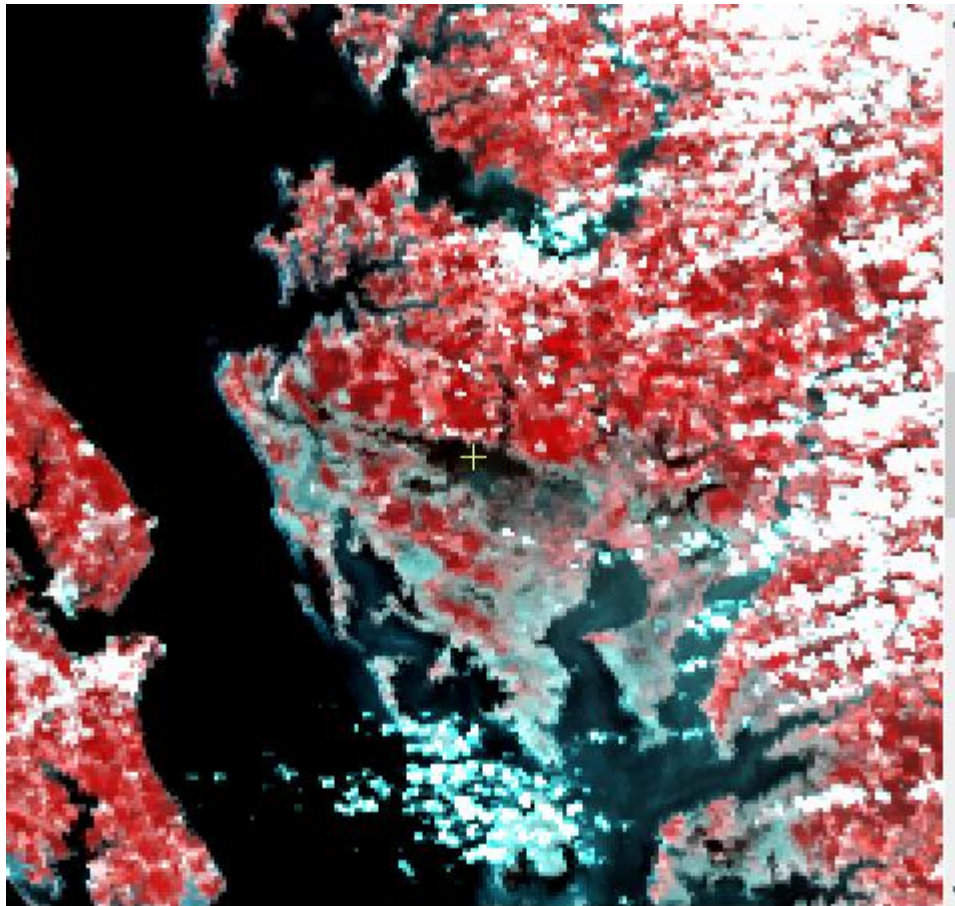*Water Mask needs to be fixed
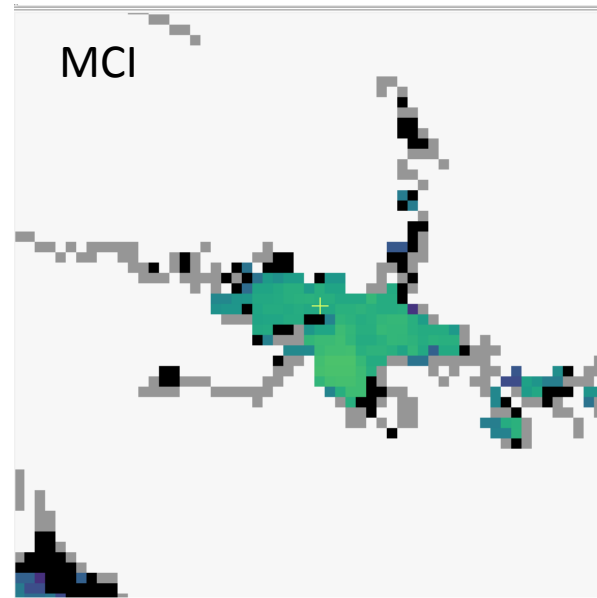
Sentinel-2
Oct 1, 2017
Deep Creek Lake and vicinity

Sentinel 3: Blackwater NWR
Aug 14, 2018

Aug 14, False color
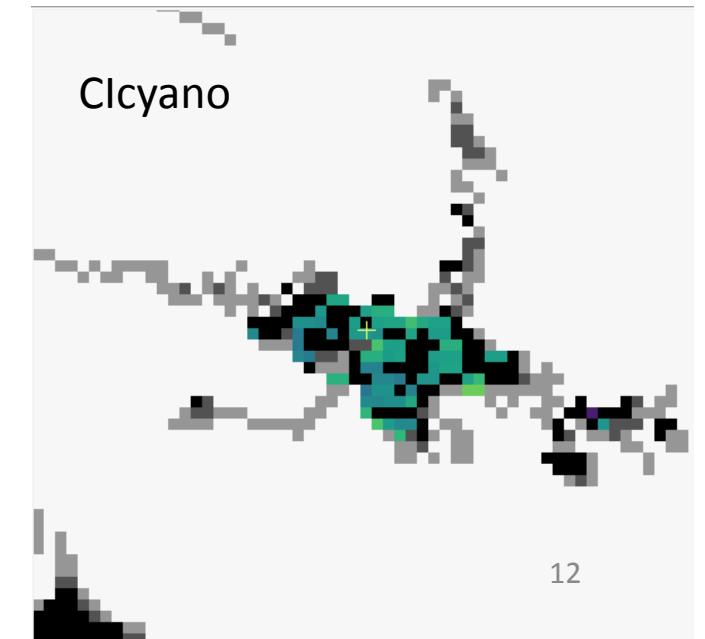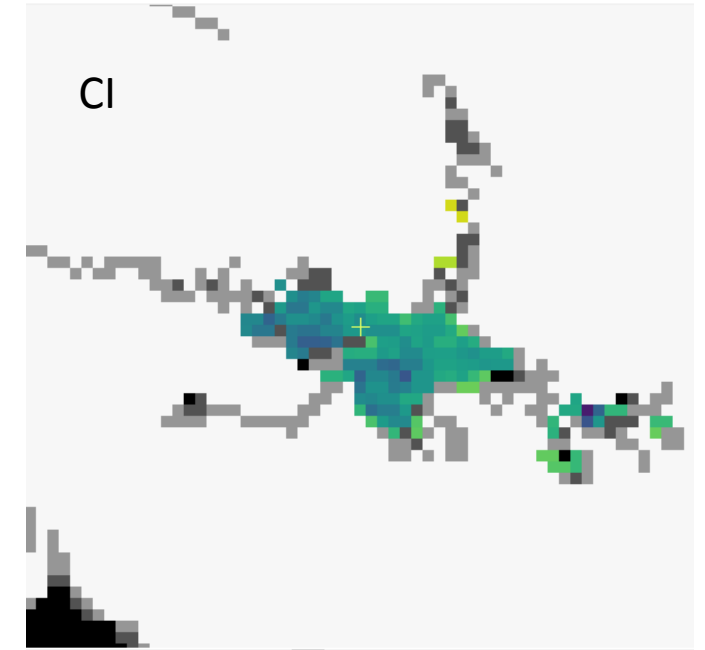709, 681, 665 bands

CI

MCI

CIcyano

d all groups 2018_08_17___13_59_10_000000 N_3825.5516000000 W_7604.3

620 drop, this flags CIcyano.
May be an artifact of the
intense absorption due to
CDOM.
(CDOM absorption reduces
reflectance more at shorter
wavelengths)

708 peak, produces MCI.
Which is an indicator of
chlorophyll presence

681 dip, CI product.
Consistent with chlorophyll
strong scattering, weak
fluorescence (like cyanos)