

AERONET-OC184, MTRI Hyperspectral spectrometer (Sept 19, 2016) and NOAA MODIS CI (Sept 20 2016)



KSU VPCA Spectral decomposition

CyanoHAB and **Green algae**

from:

- AERONET-OC184
- MTRI hyperspectral spectrometer

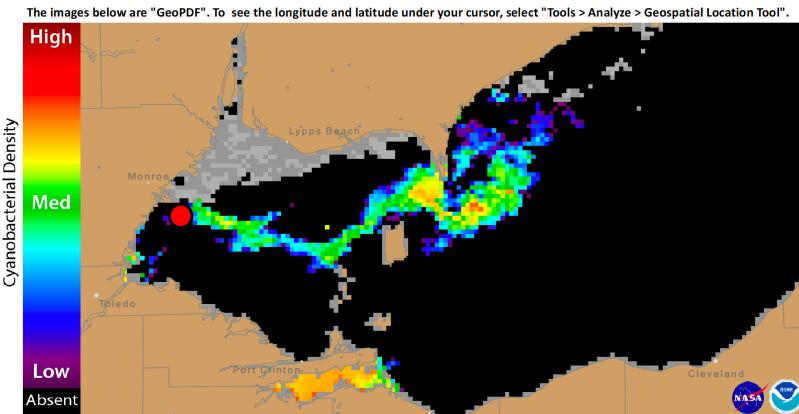
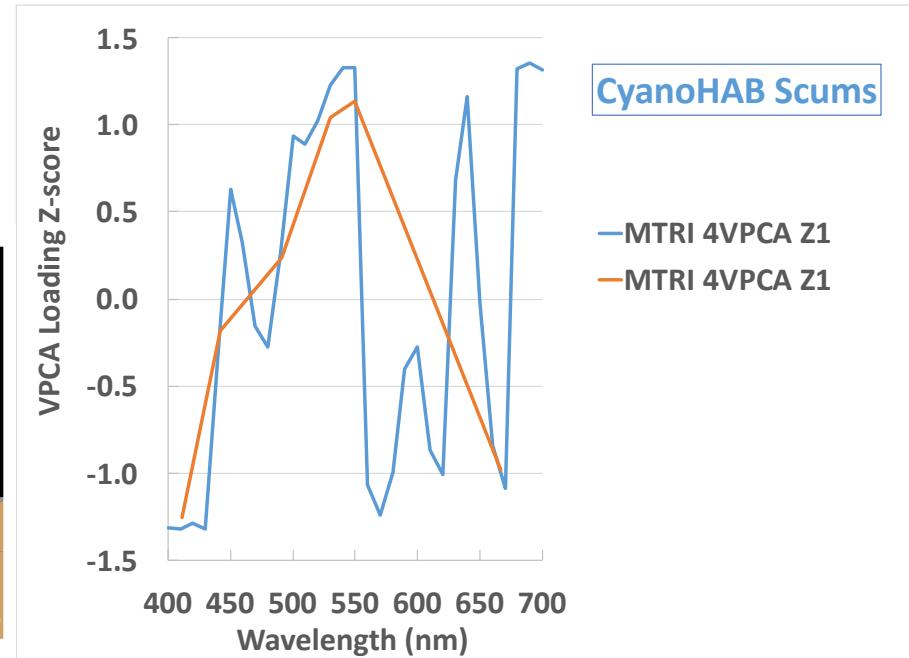
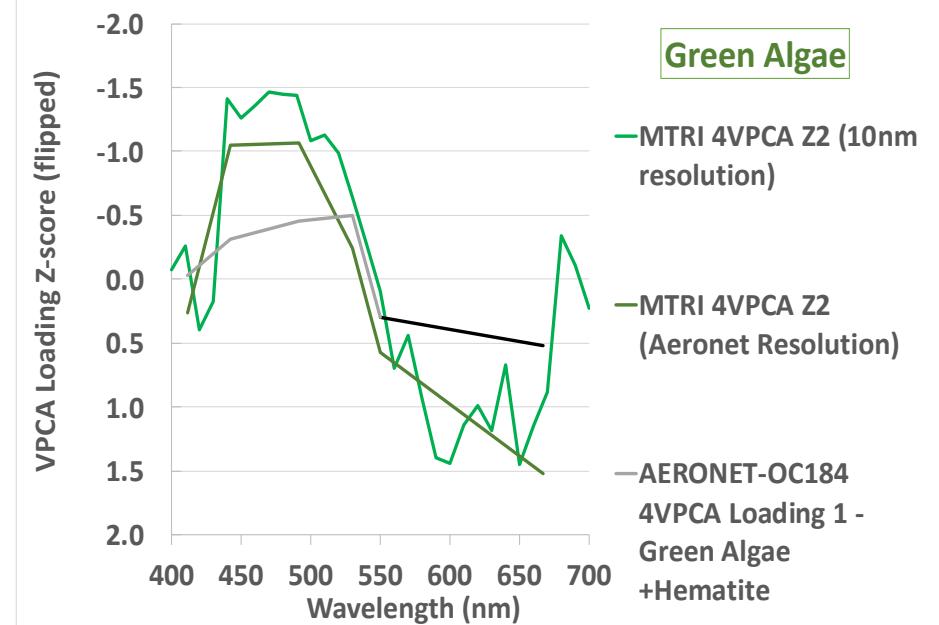
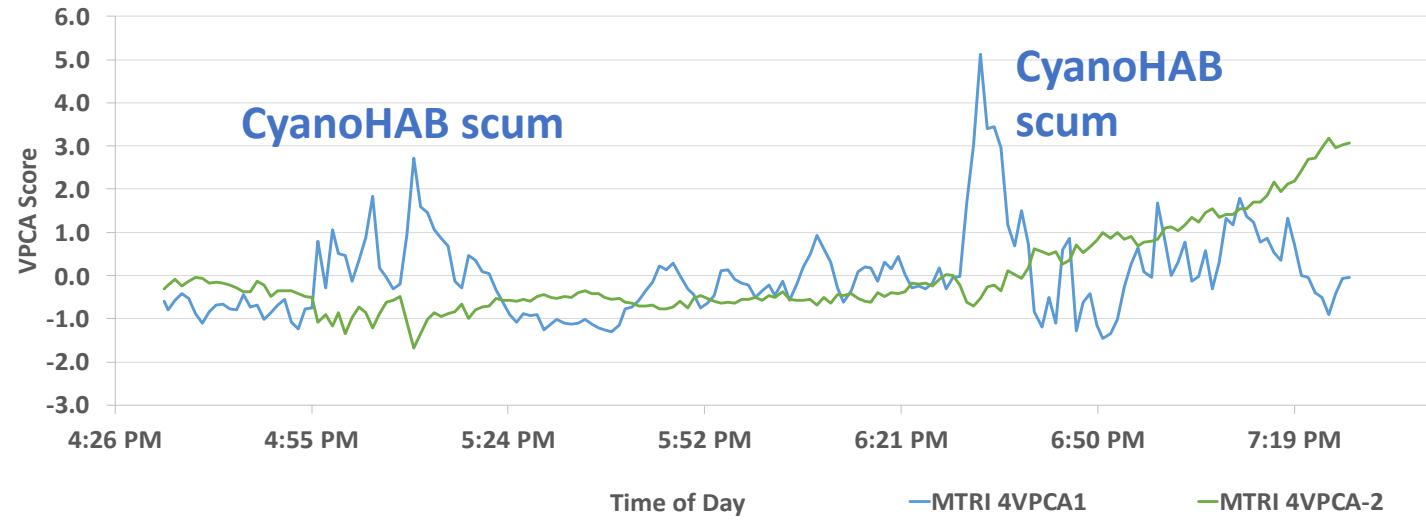


Figure 1. Cyanobacterial Index from NASA's MODIS-Aqua data collected 20 September, 2016 at 2:32 EDT. Grey indicates clouds or missing data. The estimated threshold for cyanobacteria detection is 20,000 cells/mL.



MTRI Hyperspectral Lightweight Specrometer
VPCA Component Time Series (1-minute sampling)



NASA HSI2 based Multivariate approaches to Chl a estimation (U. Cincinnati, U. Alabama)

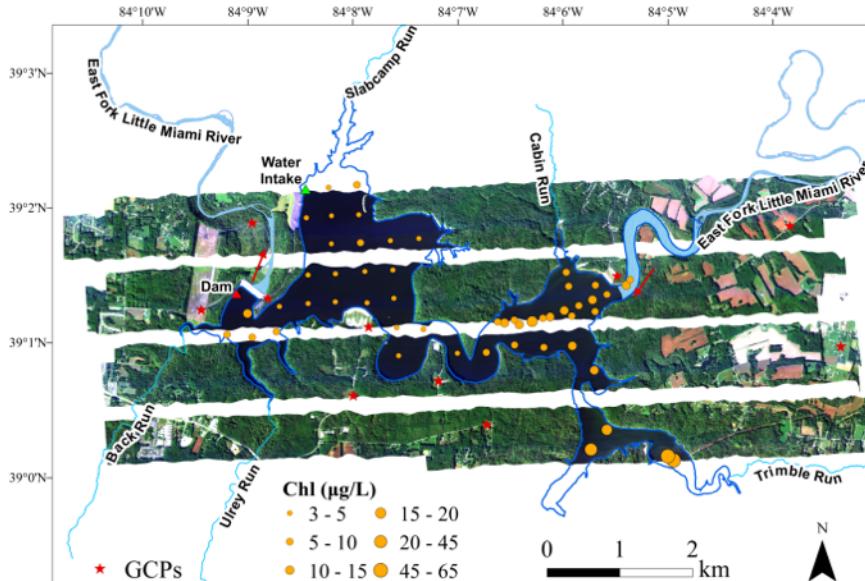
- 2 slide summary
- 1-3m resolution Hyperspectral NASA HSI2 data from Harsha Lake
- Work by Min Xu, and Hongxing Liu, et al. presenting two approaches to high spatial resolution modeling of Chl a
 - Geographically adaptive modeling
 - Multivariate ensemble modeling

See: Xu et al. JGLR, 2019: <https://doi.org/10.1016/j.jgler.2018.09.002>

Xu et al., *IEEE Tran. Geosci. Remote Sensing*, 2019 DOI: 10.1109/TGRS.2019.2892899

Geographically adaptive models for *Chl-a* estimation

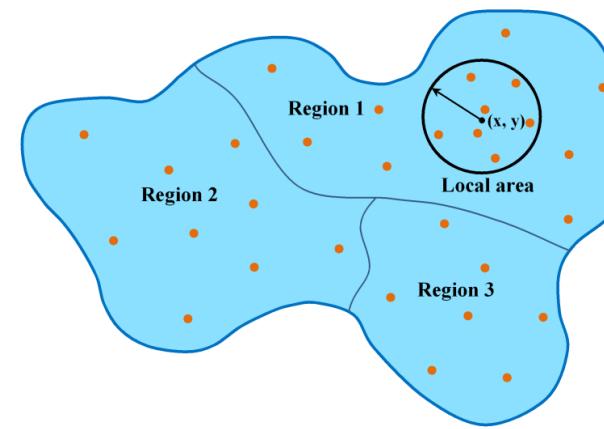
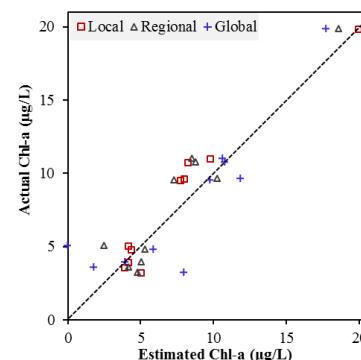
- HSI2 data of Harsha Lake, Oct 5, 2015
- Calibrate empirical algorithms for different regions or local areas of the image
- Significantly improve the *Chl-a* estimation accuracy by 33-47% compared with the best traditional empirical method (global model).



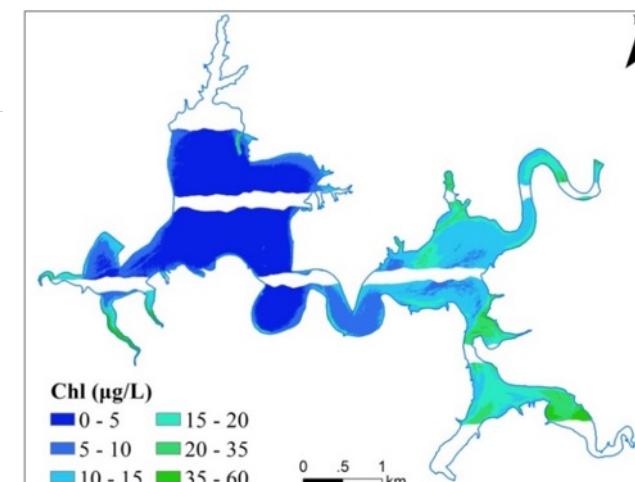
Harsha Lake, in situ data, and GCPs overlaid on HSI2 image stripes, Oct 5, 2015

Models performance evaluated by 10 checking points

RMSE	0-8µg/L	8-16µg/L	16-20µg/L	Overall	r
Global	3.22	1.48	2.75	2.48	0.882
Regional	1.49	1.61	1.91	1.65	0.950
Local	0.94	1.52	1.71	1.31	0.970



Regionally and locally adaptive models



Chl-a distribution by locally adaptive models

Multi-model ensemble for *Chl-a* retrieval

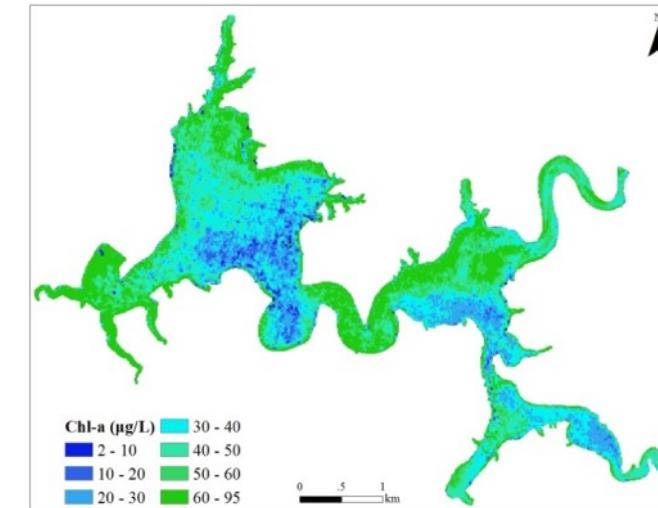
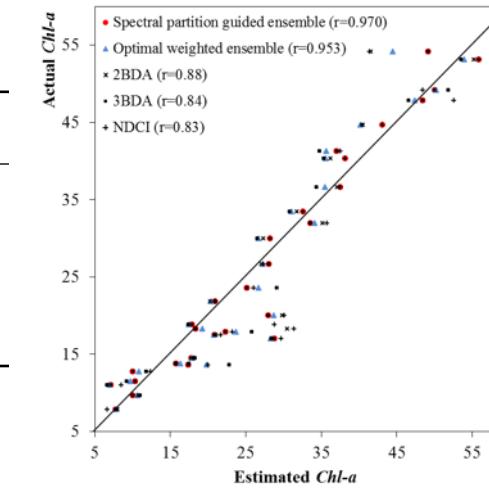
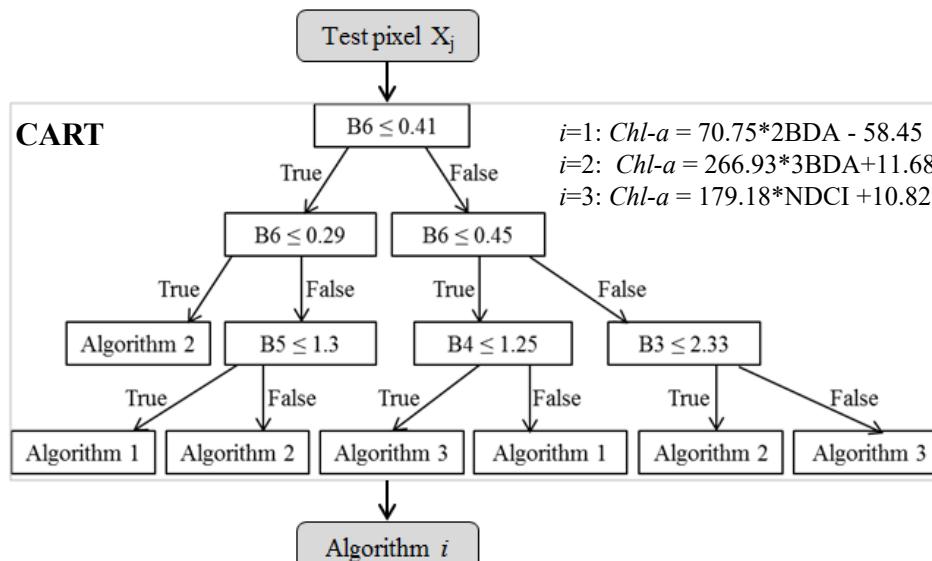
- Sentinel-2A satellite data of Harsha Lake, Oct 7, 2016
- The optimally weighted ensemble and a spectral partition guided ensemble method
- Spectral space partition rules built by the Classification and Regression Tree method
- Considerably better prediction ability of the ensemble than that of all individual empirical algorithms in the ensemble.

Optimally weighted ensemble method (OWEM):

$$Chl-a = \underline{0.48}^*(70.75*2BDA - 58.45) + \\ \underline{0.32}^*(266.93*3BDA + 11.68) + \\ \underline{0.20}^*(179.18*NDCI + 10.82)$$

Models' performance		
Methods	r	RMSE ($\mu\text{g/L}$)
NDCI	0.83	4.70
3BDA	0.84	4.57
2BDA	0.88	4.50
OWEM	0.95	4.07
SSPGSM	0.97	3.57

Spectral space partition guided selection method (SSPGSM):



Chl-a distribution by spectral partition guided ensemble