



Lake Erie Airborne Hyperspectral Campaign

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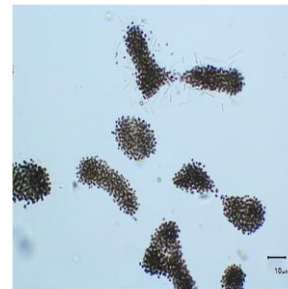


Outline

- Purpose of Deployment
- Location
- Instruments
- Calibrations
- Collaborators/Ground Truth
- Flightlines
- Examples
- Data Status
- Summary

Purpose of Deployment

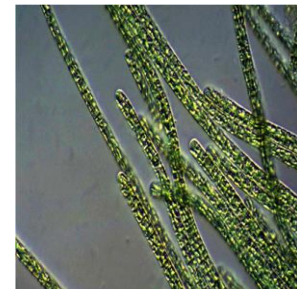
- Support testing of airborne multi-spectral polarimeter
- Designed to provide new information about particles in coastal waters
- Other remote sensing instruments flown for additional context
- Requires some unique flight geometries



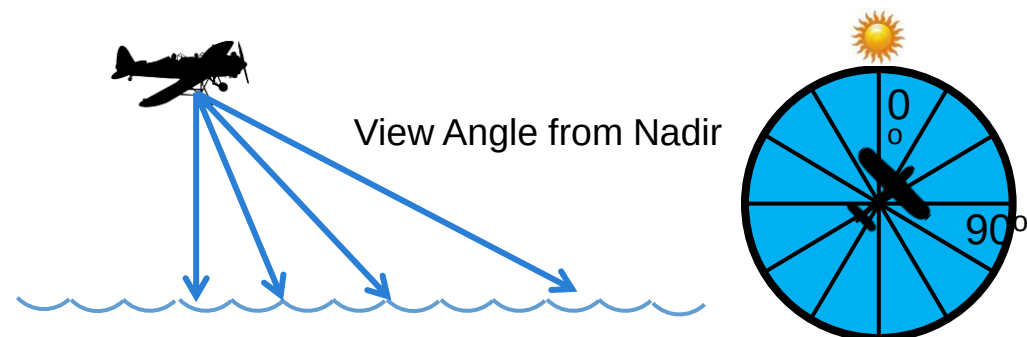
Microcystis



Anabaena

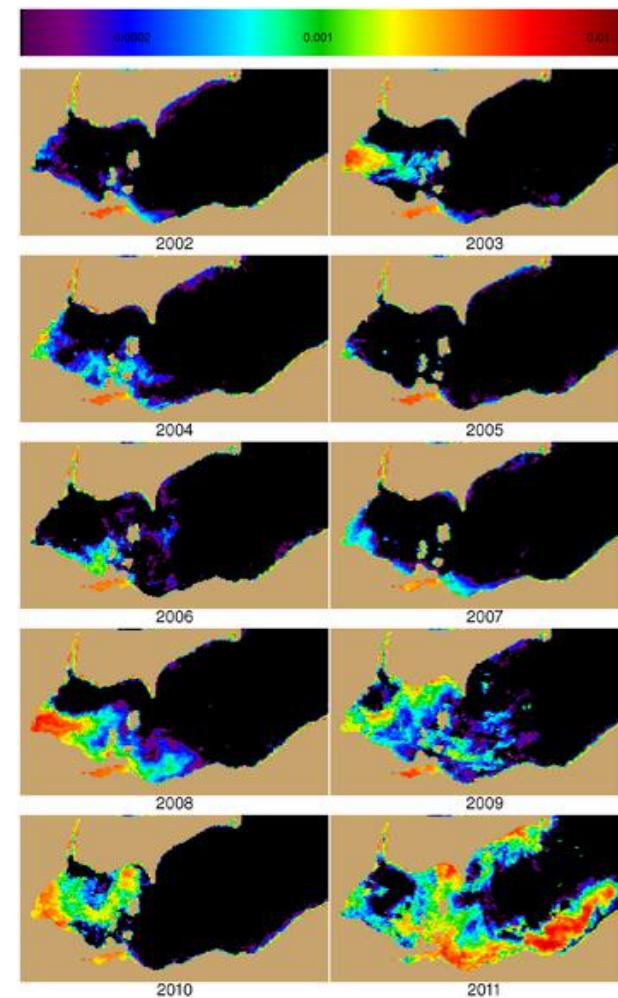


Planktothrix



Location

- Lake Erie
 - Cyanobacterial bloom
 - Various water types
 - Leverage additional research resources



Stumpf et al 2012, PLoS ONE 7(8): e42444.

Instruments

- Itres CASI-1500 VNIR
 - 72 bands, 375 to 1053 nm, 9.6 nm FWHM, 1500 pixels, 27 ms integration time, 40° FOV
- Brandywine MicroSHINE VNIR
 - 160 bands, 350 to 1050 nm, 4.2 nm FWHM, 1360 pixels, 48° FOV
- Applanix POS GPS/INS
 - 200 Hz



Instruments

- SWIR-1700
 - 253 bands, 950-1675 nm, 3.3 nm FWHM, 640 pixels, 35° FOV
- FLIR- SC600 MWIR Imager
 - 3-5 microns, 640x512 pixels, 40° FOV
- Sofradir-EC ATOM LWIR Microbolometers
 - 8-14 microns, 1024x768 pixels, 40° FOV



Instruments

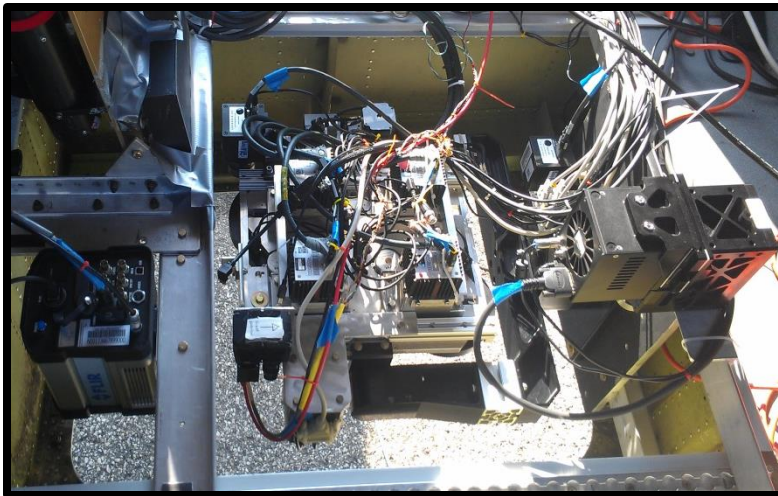
DeHavilland DHC-6 Twin Otter



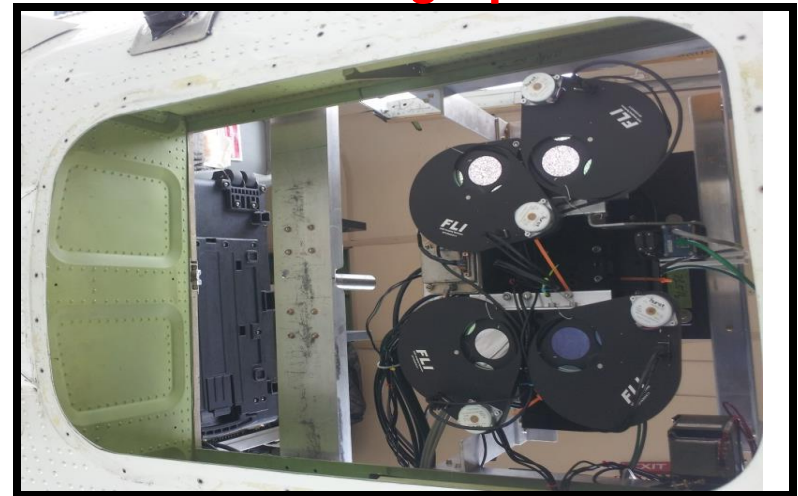
CASI, POS, SWIR - In nose



Looking down



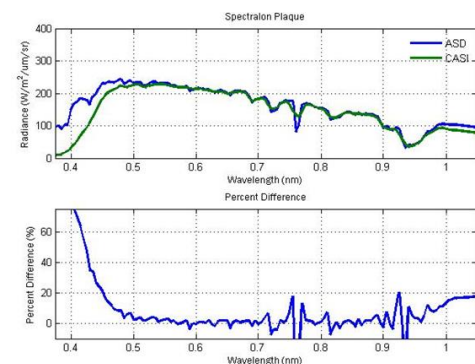
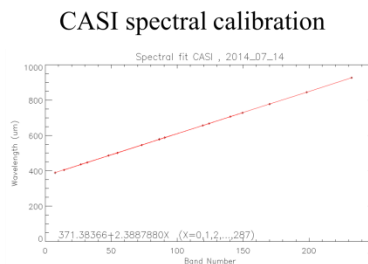
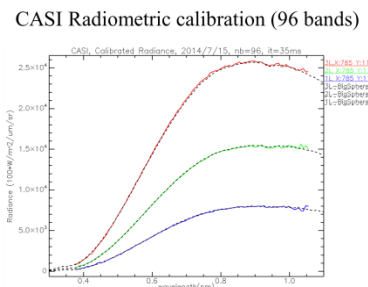
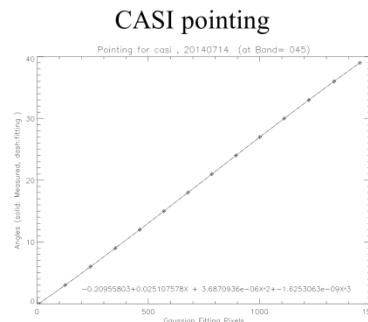
Looking up



VICO, LWIR, MWIR, MicroSHINE - In belly

Calibration

- NIST traceable calibration facility
- 1 meter Labsphere integrating sphere
- Radiometric, spectral, and pointing calibrations all done in-house
- Pre- and Post-deployment calibration checks performed
- VNIR blue (<475nm) is an area of concern and under investigation



Collaborators



NRL Oceanography

NASA Glenn Research Center

Canada Centre for Inland Waters

University of Toledo

Ohio State University

University of New Hampshire

Wetlabs Inc

USGS Great Lakes Science Center

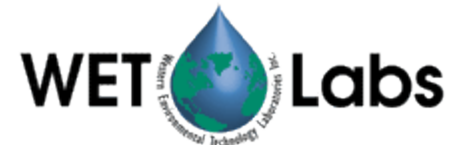
Kent State University

Environmental Protection Agency

Michigan Tech Research Institute

NOAA Earth Systems Research Lab

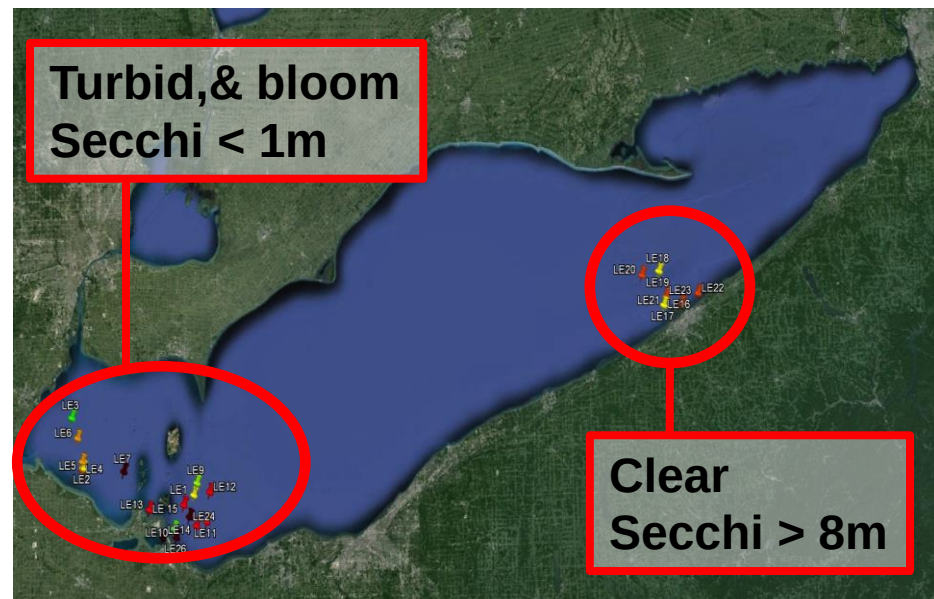
NOAA Great Lakes Environmental Research Lab



Groundtruth



- >30 coincident airborne image-boat sampling matchups with just r/v/ Muskie (NRL boat)
- Additional ground truth still being confirmed with collaborators
- Several unique water types sampled



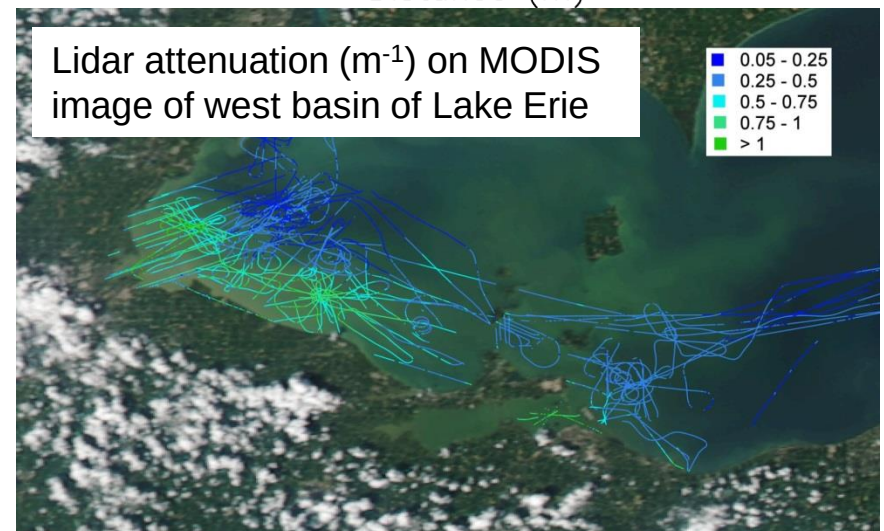
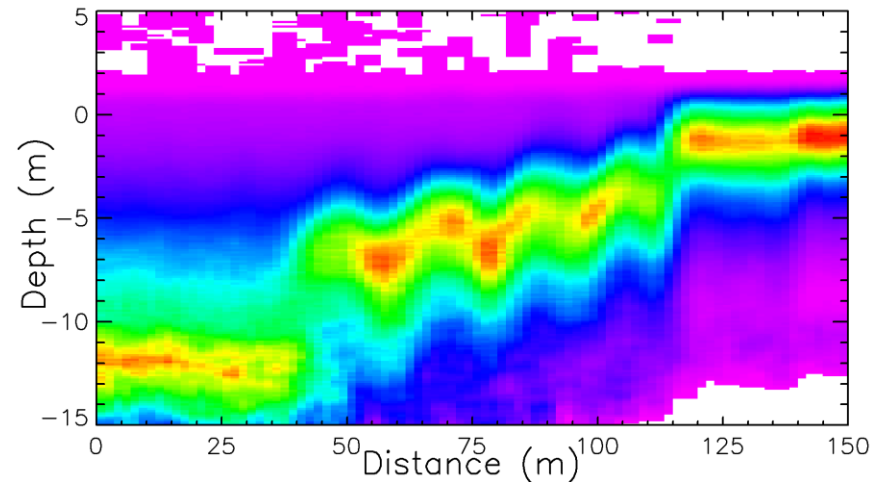
In-situ instrumentation included:

- CTD
- ac-9: 10 cm
- HYDROSCAT
- LIDAR
- Fluorometers/bb/BAM
- Multi-Spectral Volume Scattering Meter
- ac-S
- LISST- VSF
- LISST – HOLO
- CYTOMETER
- ASD/Rrs

NOAA Lidar

- Pulsed green (532 nm) laser
- Dual-polarization receiver
- Non-scanning with 5-15 m swath width depending on altitude
- Pointed 15° off nadir to reduce surface reflection
- Depth resolution of 50 cm
- Depth penetration to 50 m in clear water (less in Lake Erie)
- Attenuation $\approx$ diffuse attenuation coefficient

Relative lidar return vs. depth, distance along track.

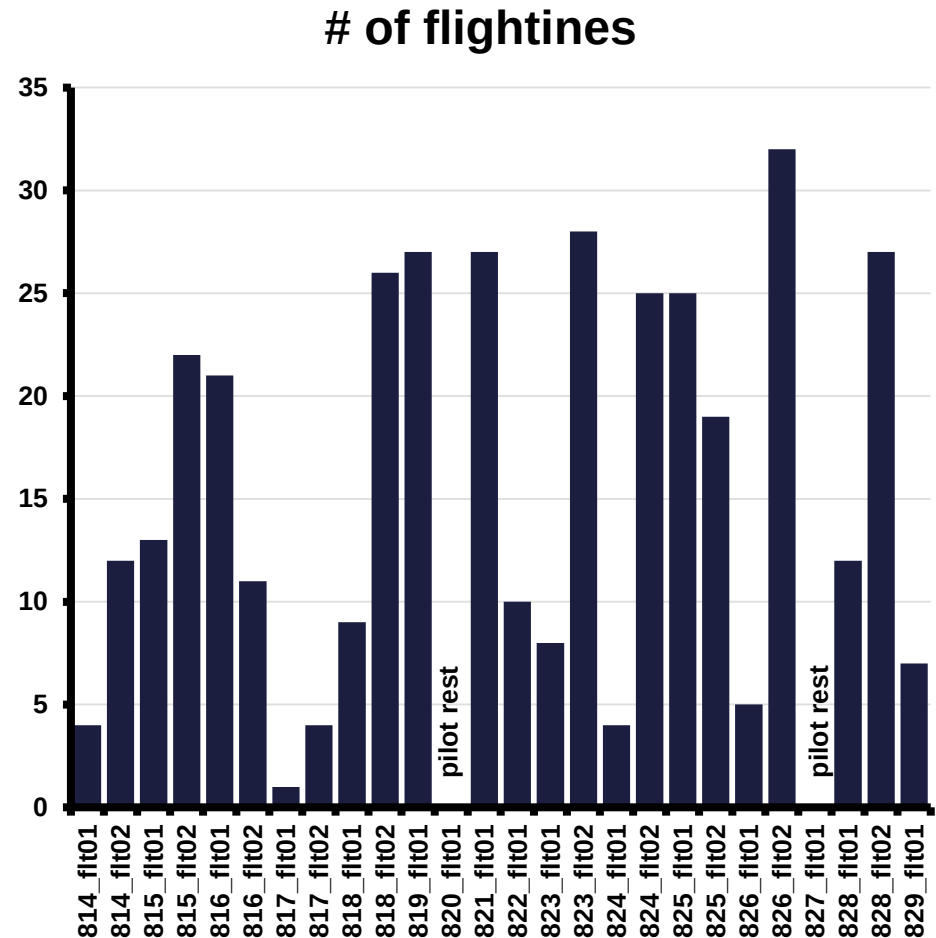


Flightlines

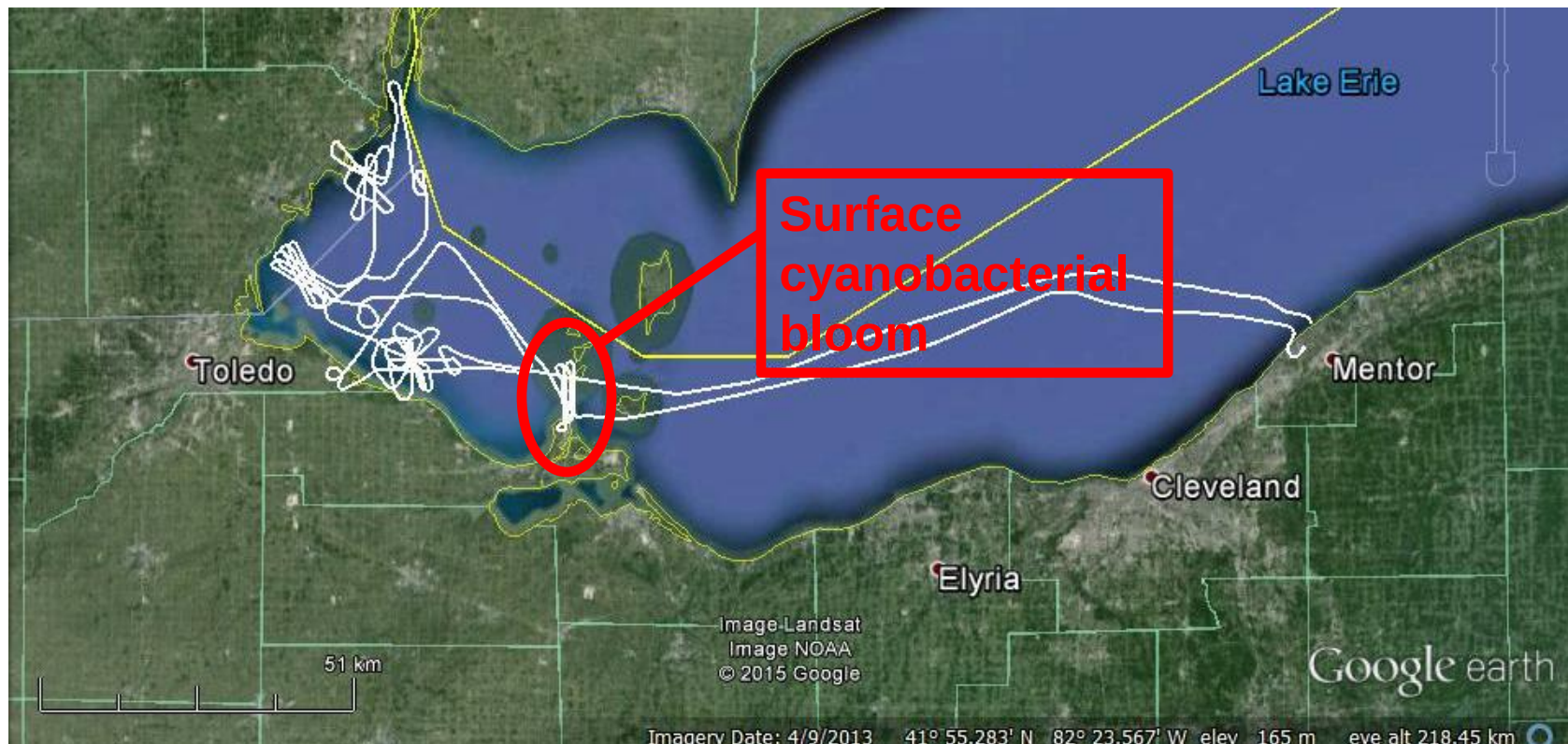


Flightlines statistics

- Data collect from August 14 to August 29 2014
- 2746303 total scan lines of VNIR CASI data
- 379 flightlines (between 1 and 172 km in length)
- 74.6 total science flight hours
- Includes 3 days in Rochester/Finger Lakes



Flightlines August 19th



Example Data

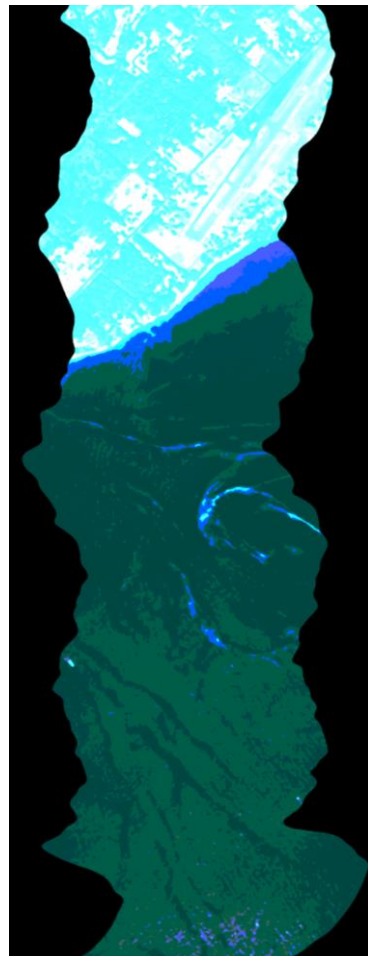
VNIR

375-1050 nm



SWIR

900-1700 nm



MWIR

3000-5000 nm



LWIR

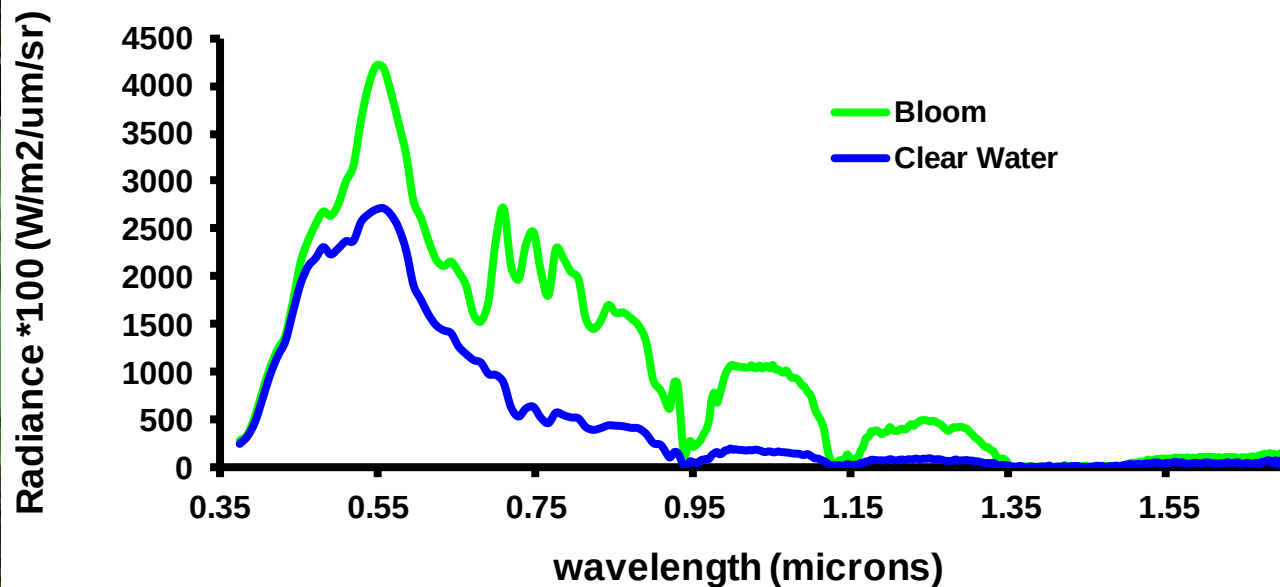
8000-14000 nm



Example Data



Spectral Comparison of *Microcystis* sp. bloom versus clearer water





Data Status

- ~80% of CASI & SWIR data is processed to Level 2 (radiometric calibration applied)*
- Level 3 data (geometrically corrected) produced as needed
- No public repository of imagery-contact NRL-RSD to discuss collaborations
- IR (midwave & longwave) data is also available
- Remaining data will be processed as time, budgets, and collaborator requests permit

* Possible calibration issues with blue wavelengths of VNIR

Summary

- NRL collected VNIR-SWIR hyperspectral and TIR over Lake Erie in August 2014
- >300 flightlines were flown over turbid and clear waters
- Significant groundtruth available for validation
- Can provide data
 - But need to prioritize
 - Data available from HSI and thermal imagers
 - Most data is already calibrated



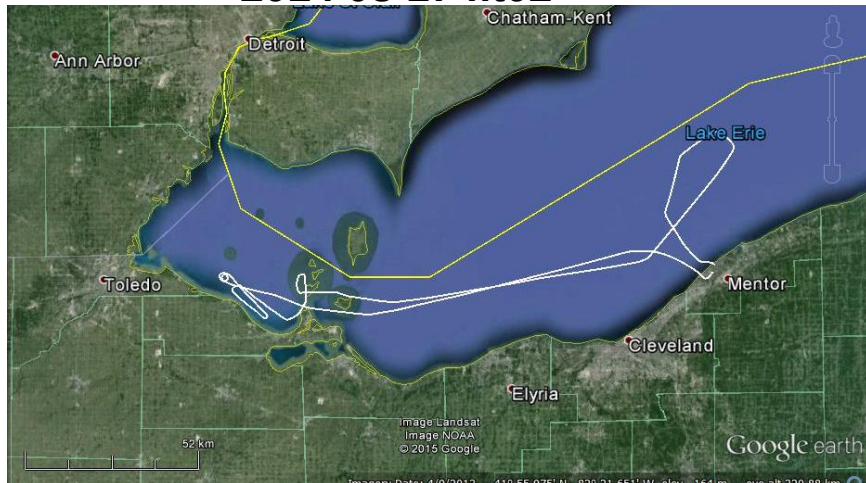
Work funded by the Office of Naval Research



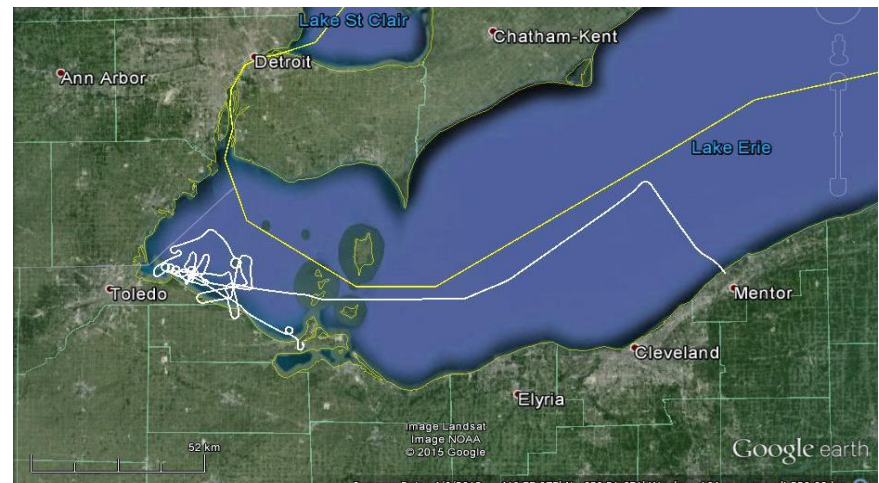
BACKUPS

Flightlines

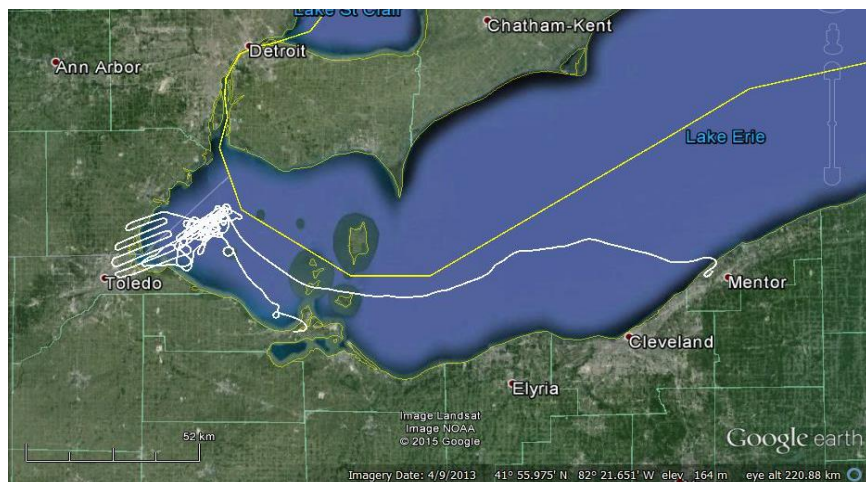
2014 08 17 flt02



2014 08 18 flt01



2014 08 18 flt02

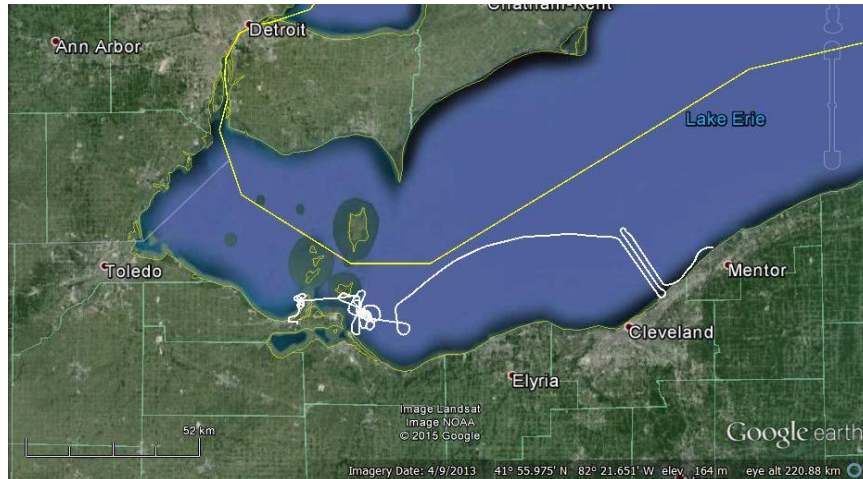


2014 08 21 flt01

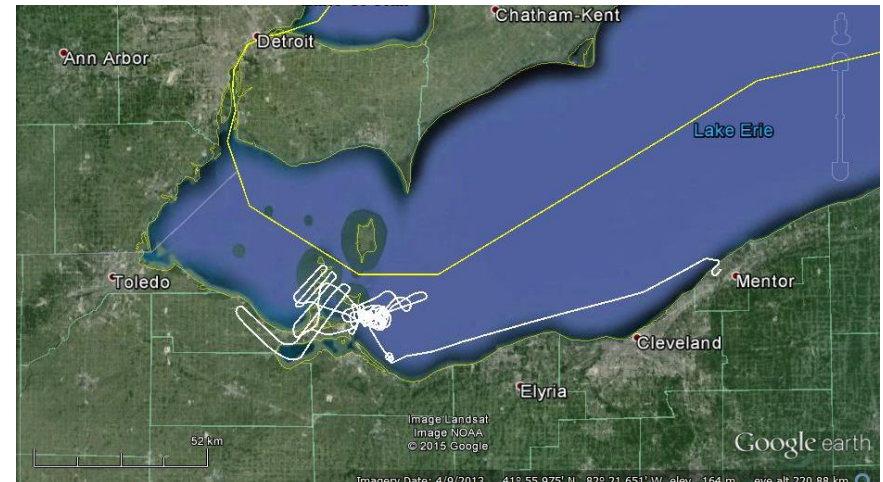


Flightlines

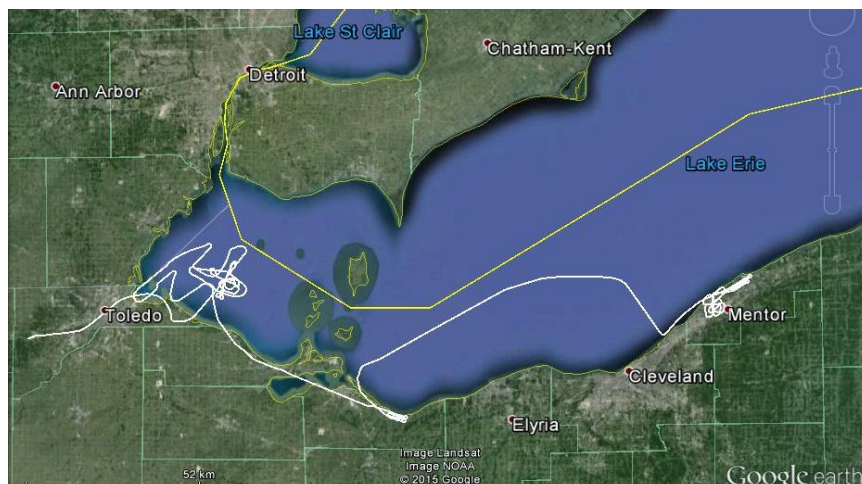
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2014 08 23 flt02



2014 08 24 flt02



2014 08 25 flt01

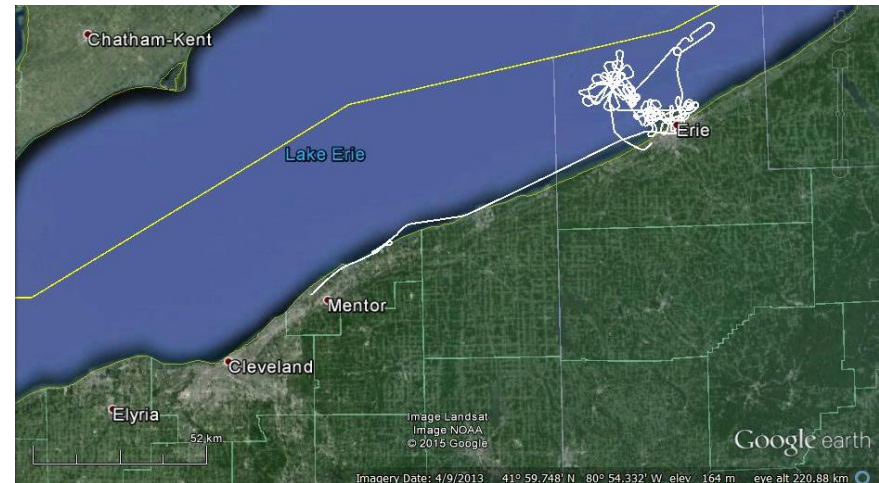


Flightlines

2014 08 25 flt02



2014 08 26 flt02



2014 08 28 flt01



2014 08 28 flt02

