Lake Erie Airborne Hyperspectral Campaign

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Outline

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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
Location

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

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

VICO, LWIR, MWIR, MicroSHINE - In belly

Looking up
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 ≈ diffuse attenuation coefficient

Relative lidar return vs. depth, distance along track.

Lidar attenuation (m⁻¹) on MODIS image of west basin of Lake Erie.
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

Surface cyanobacterial bloom
Example Data

<table>
<thead>
<tr>
<th>VNIR</th>
<th>SWIR</th>
<th>MWIR</th>
<th>LWIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>375-1050 nm</td>
<td>900-1700 nm</td>
<td>3000-5000 nm</td>
<td>8000-14000 nm</td>
</tr>
</tbody>
</table>
Example Data

Spectral Comparison of Microcystis sp. bloom versus clearer water

Bloom
Clear Water

Radiance *100 (W/m²/µm/sr)
wavelength (microns)
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

2014 08 23 flt01

2014 08 24 flt02

2014 08 23 flt02

2014 08 25 flt01
Flightlines

2014 08 25 flt02

2014 08 26 flt02

2014 08 28 flt01

2014 08 28 flt02