[1]Alok K Shrestha, [1]Tristan Goulden, [1]Ian Crocker, and [2]Joe Boardman

1 Battelle (NEON Project)
2 AIG LLC

NEON Imaging Spectrometer (NIS) Calibration Updates

National Ecological Observatory Network

A project sponsored by the National Science Foundation and operated under cooperative agreement by Battelle.

CALCON Technical Meeting (Sep 23, 2020)

calcon
www.calcon.sdl.usu.edu

This material is based upon work supported by NSF's National Ecological Observatory Network which is a major facility funded by the National Science Foundation

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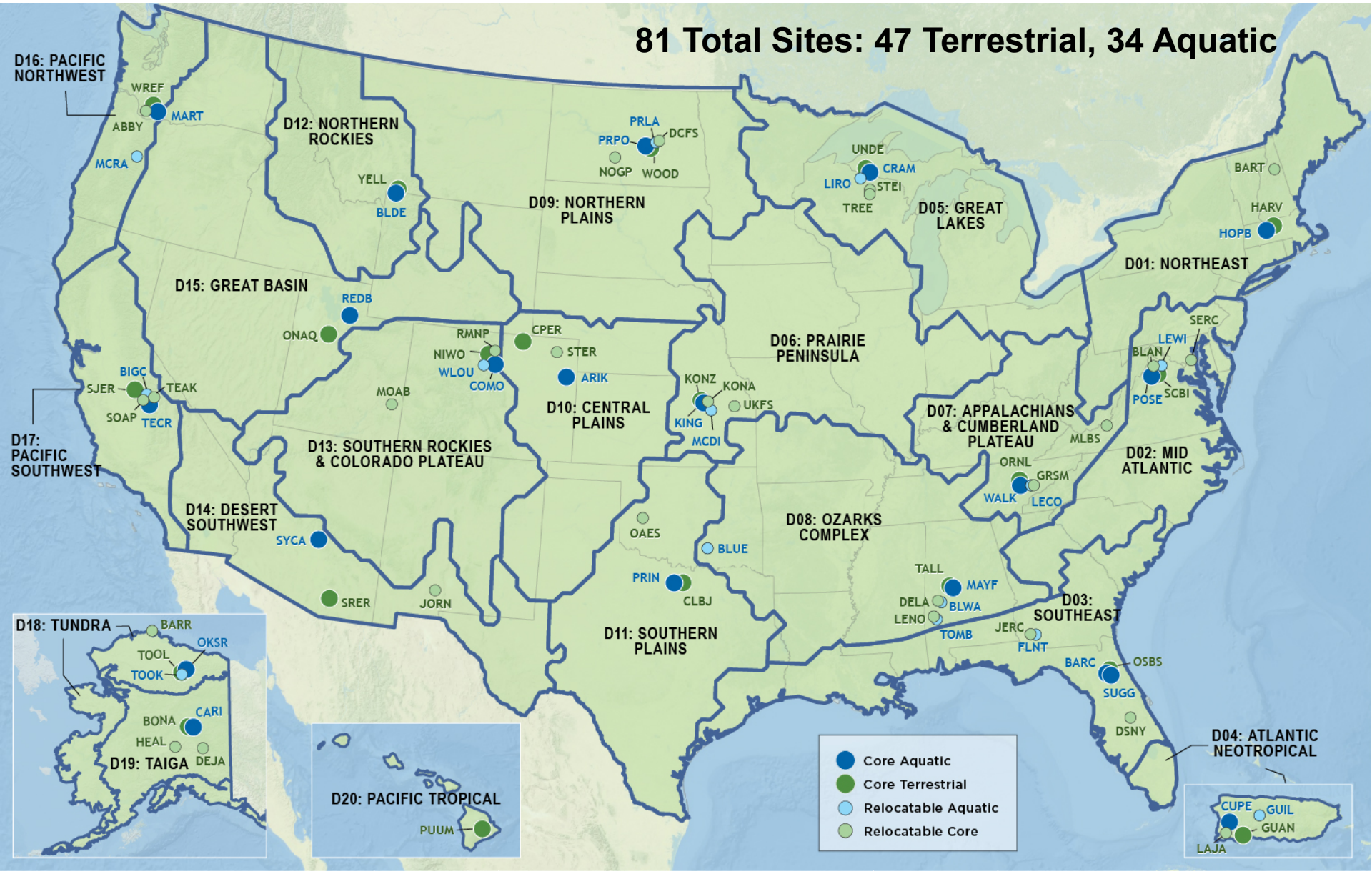
What is NEON?

The National Ecological Observatory Network: Open data to understand how our aquatic and terrestrial ecosystems are changing

- Large science facility funded by the National Science Foundation
- Continental-scale ecological observatory designed to:
  - Collect and distribute data on the drivers of and responses to ecological change
- Collect observations for 30-years
- All data are free and open-access



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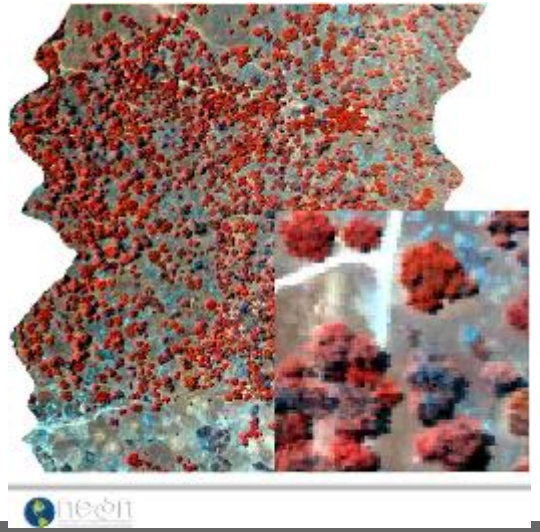
Airborne Observation Platform (AOP)

- Collects airborne remote sensing data
- Covers ‘regional scale’ (min of 100 km^2)
- Data products generated at high spatial resolution (<=1 m^2)
- Waveform Lidar, Imaging Spectrometer and RGB camera



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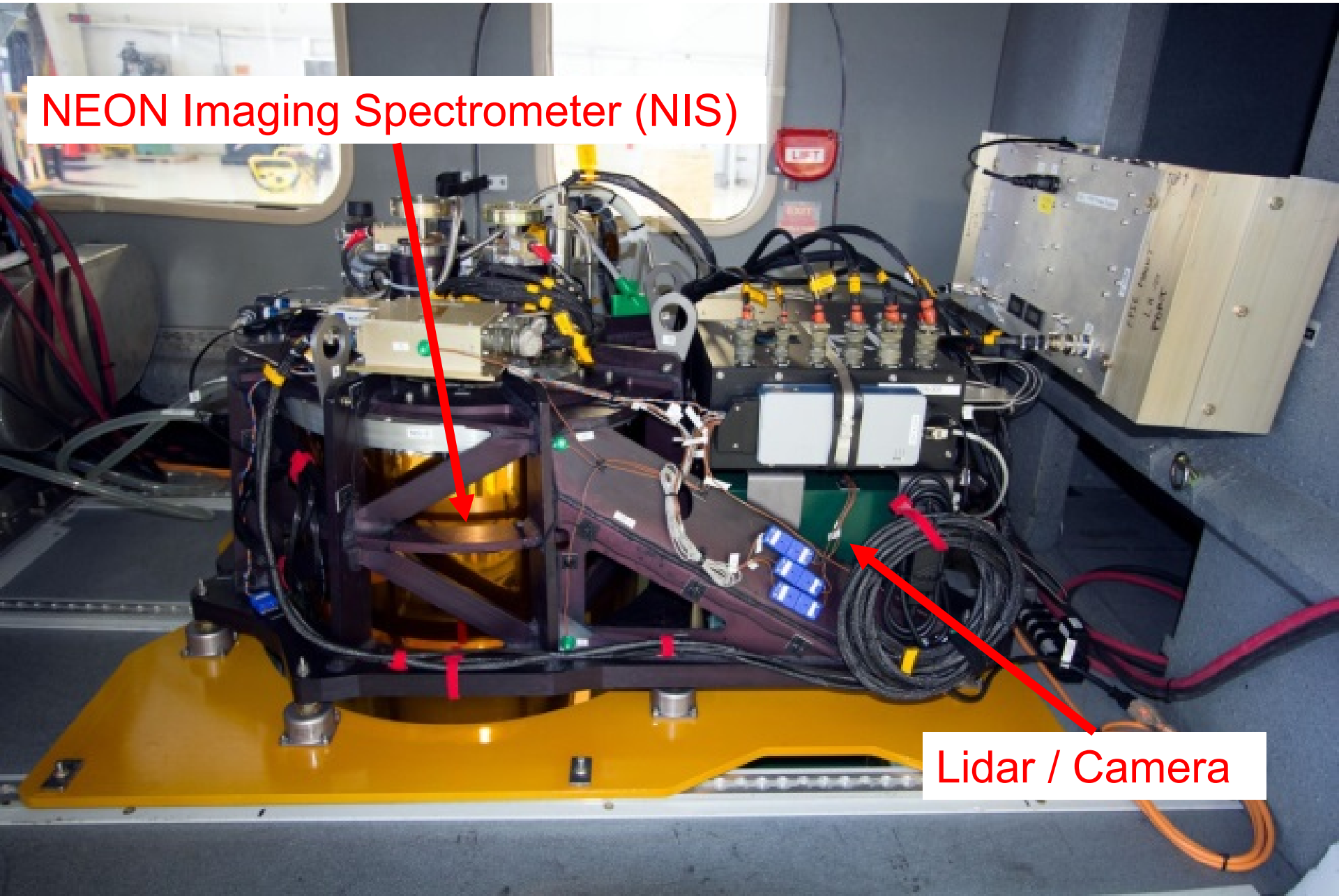
AOP Payloads – (Total three payloads)

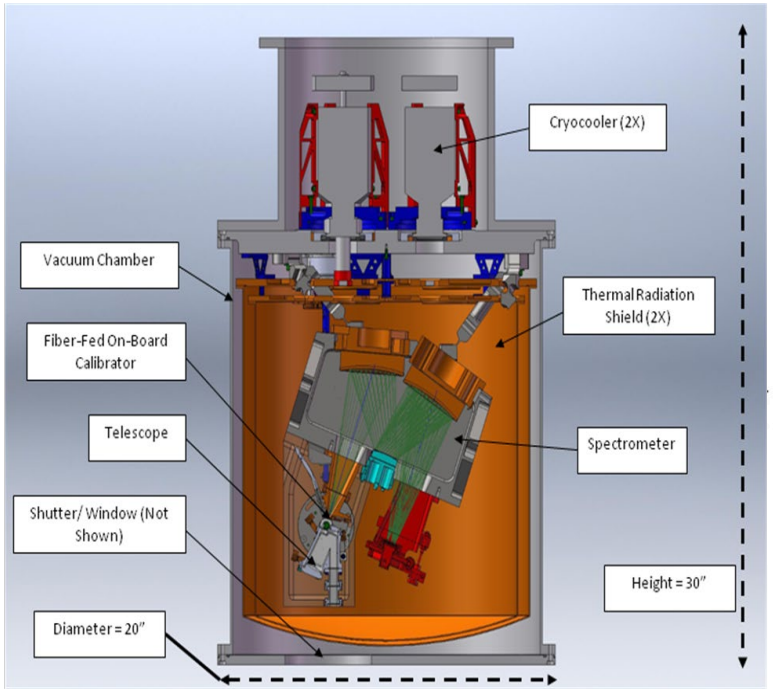


AOP Payloads

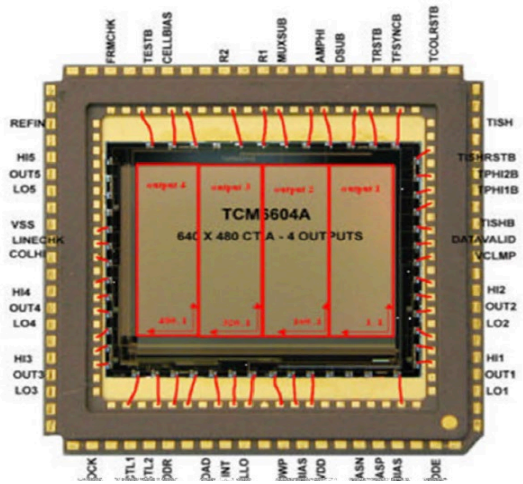
AOP Payload	Hyperspectral Imaging Spectrometer	Lidar Sensor	Digital Camera
1	[1]NIS1	[2]Optech Gemini	[3]Optech D-8900
2	[1]NIS2	[2]Optech Gemini	[3]Optech D-8900
3	[1]NIS3	[2]Riegl Q870	[3]Riegl PhaseOne iXA 180

[1] Designed by NASA JPL based on AVIRISng
[2] Capable of collecting both waveform and discrete data simultaneously, operate at a wavelength of 1064 nm near the peak vegetation reflectance
[3] Integrated with Lidar System, a RGB framing camera

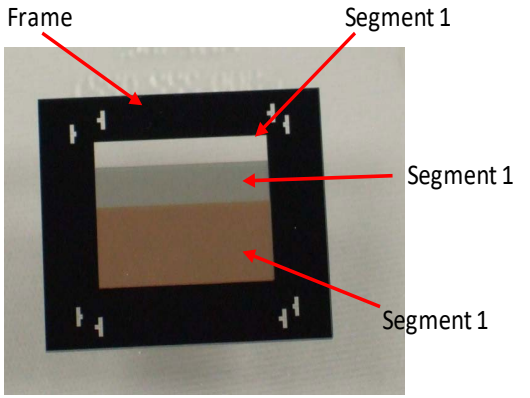
NIS (NEON Imaging Spectrometers)



Pushbroom Imaging Spectrometer



NIS Focal Plane (TCM6604A)



Order Sorting Filter (OSF)

Spectral Range: 380 – 2510 nm	FOV: 34 ± 1 degrees
Spectral Sampling: 5 ± 0.5 nm	Radiometric Sampling: 14 bit
Spectral Resolution: < 7.5 nm	Spectral cross-track uniformity: >95% uniformity
IFOV: 1 ± 0.1 mrad	Spectral-IFOV: > 95% uniformity

Focal Plane (TCM6604A)
Spectral Pixels: 480 rows
Spatial Pixels: 640 columns

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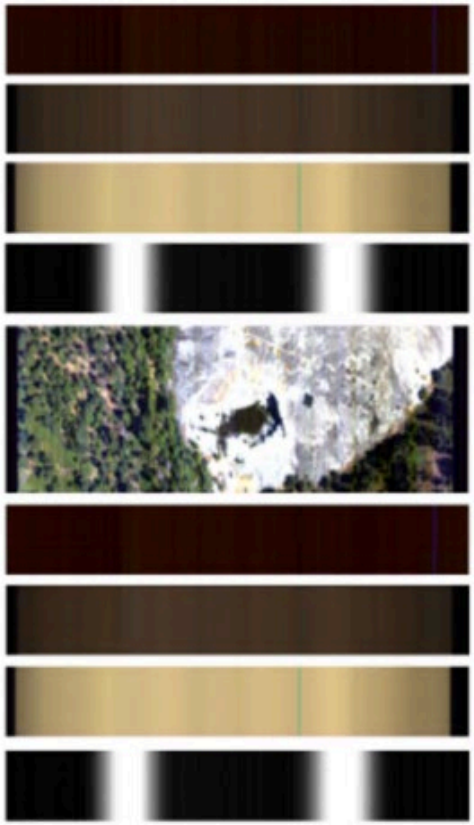
NIS On-Board Calibration System

Onboard Calibration (OBC)

- **Radiometric on-board Calibration (ROBC)**
- **Spectral on-board Calibration (SOBC)**



1000 Frames of Dark Offset

1000 Frames of Dim OBC

1000 Frames of Bright OBC

500 Frames of SOBC

Science collect of target flight line

1000 Frames of Dark Offset

1000 Frames of Dim OBC

1000 Frames of Bright OBC

500 Frames of SOBC

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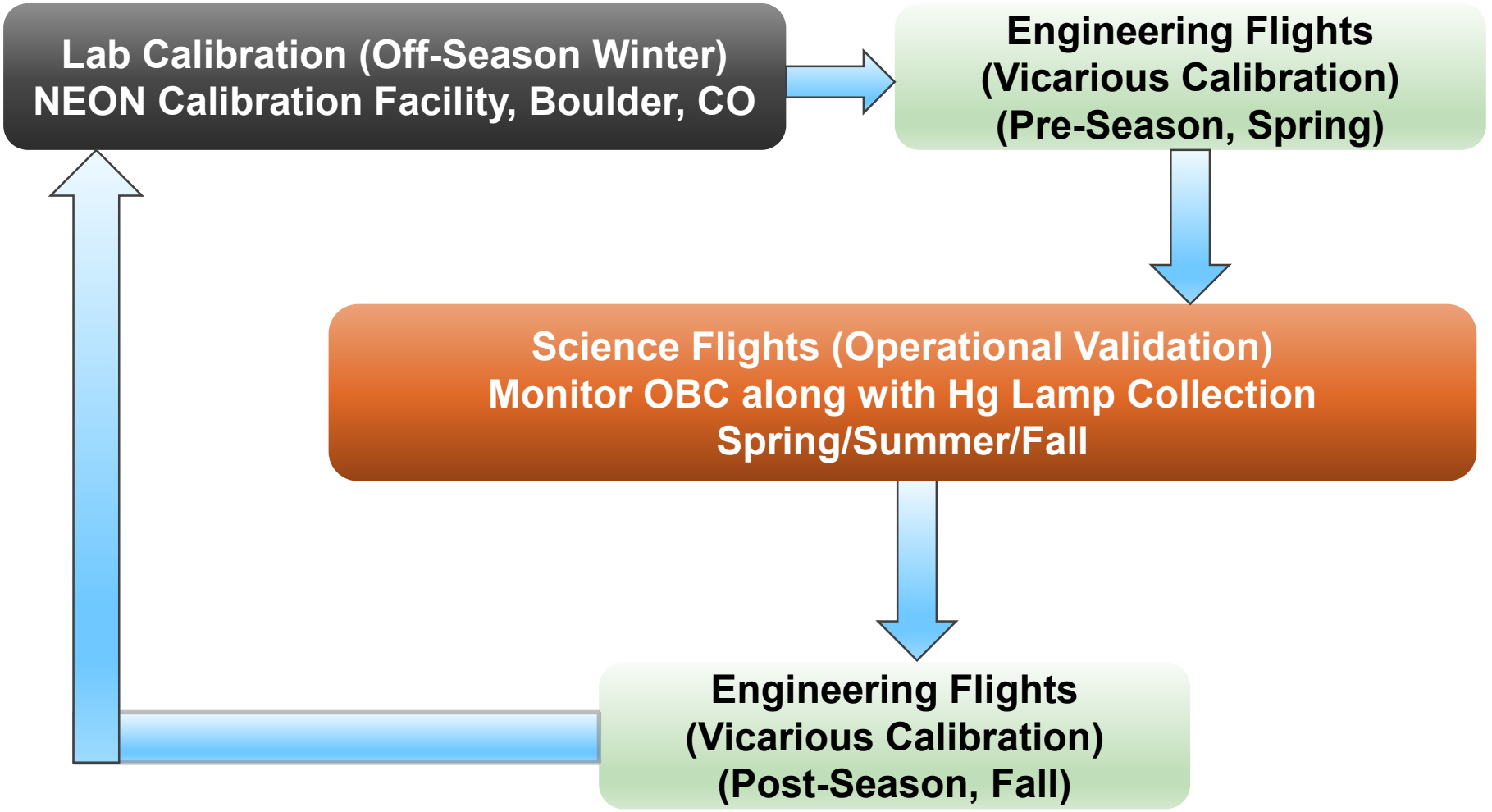
NIS Annual Calibration Activities



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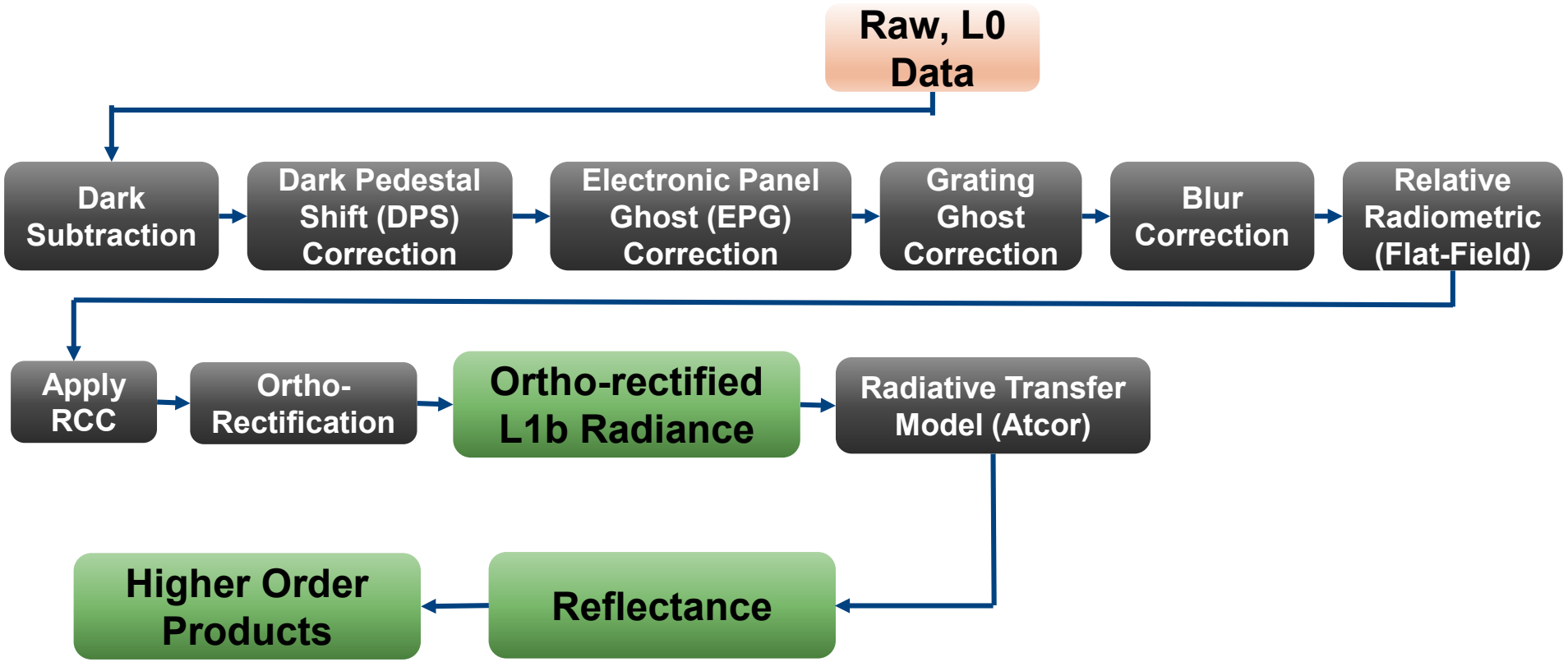
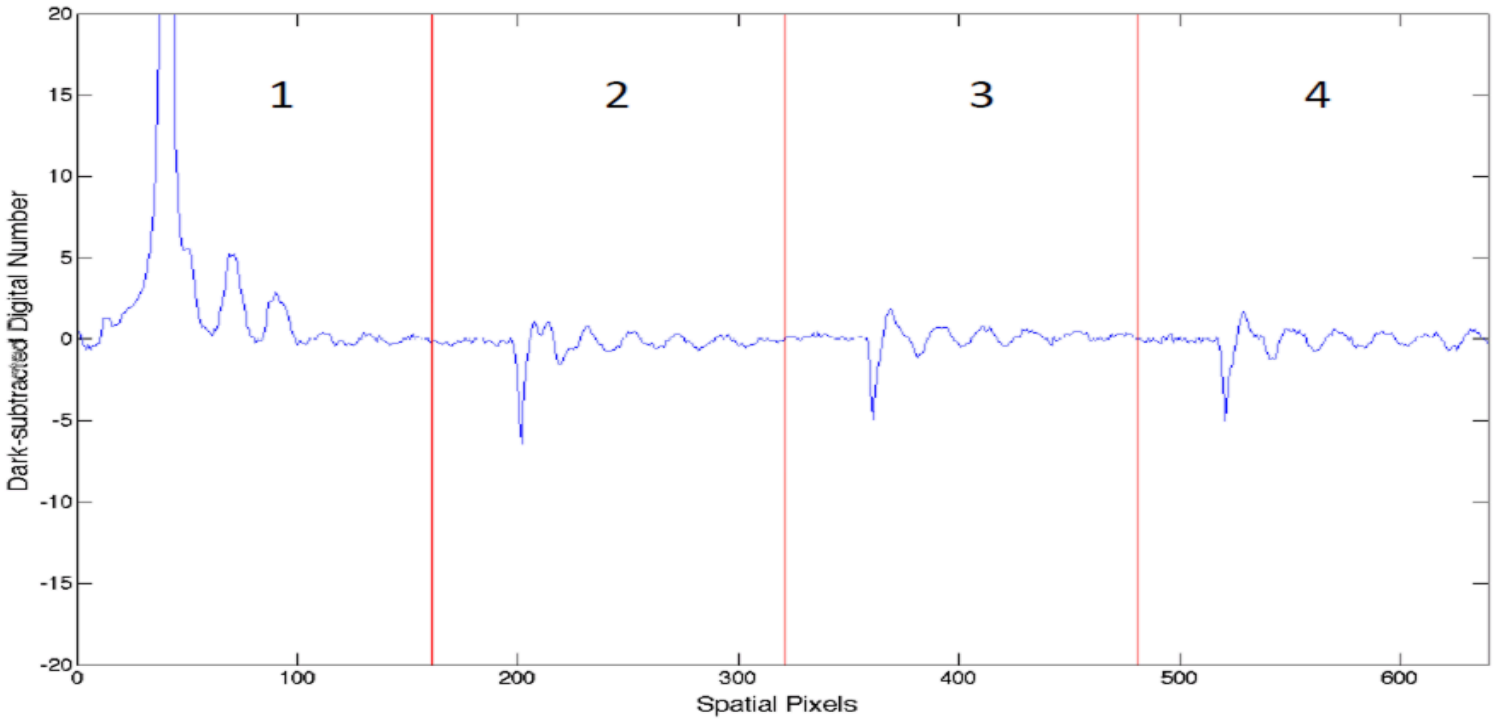
NIS Data Processing

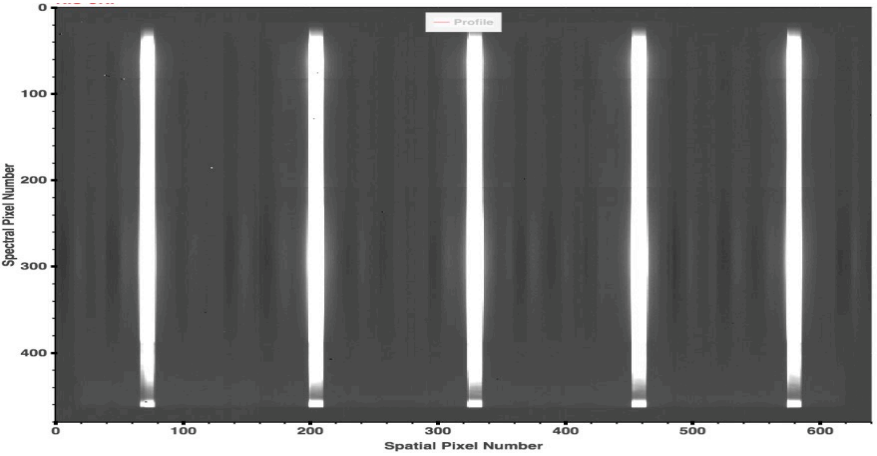


RCC: Radiometric Calibration Coefficients

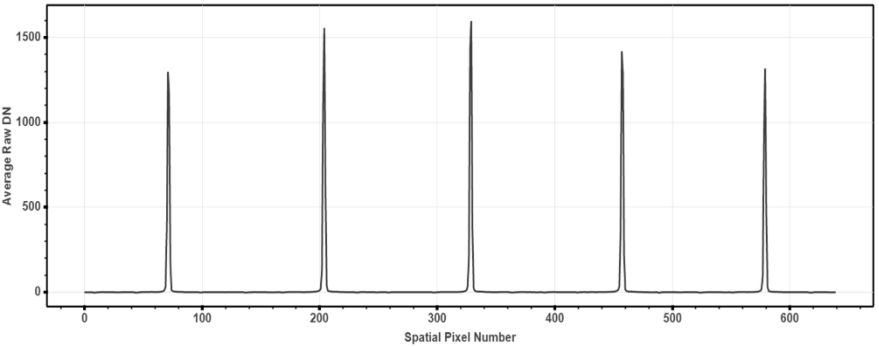
Electronic Panel Ghost (EPG)

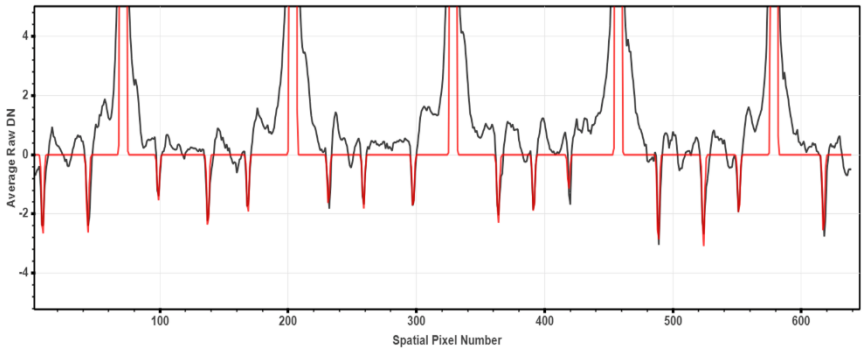


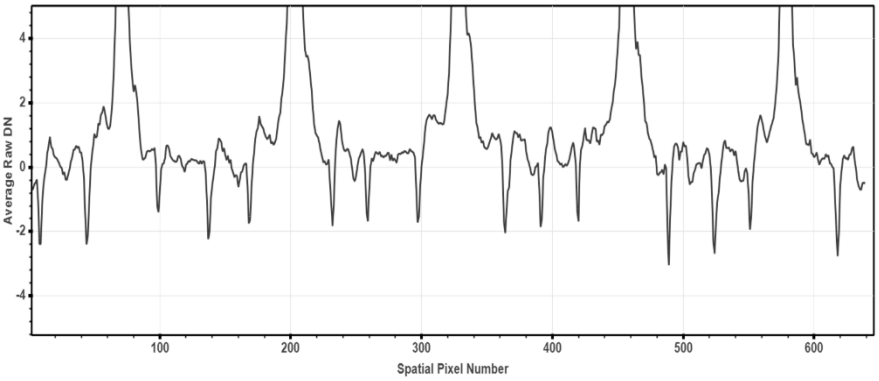
Electronic Panel Ghost (EPG)



$$A = \begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} \\ a_{21} & 1 & a_{23} & a_{24} \\ a_{31} & a_{32} & 1 & a_{34} \\ a_{41} & a_{42} & a_{43} & 1 \end{bmatrix}$$







https://github.com/segasai/astrolibpy/tree/master/mpfit

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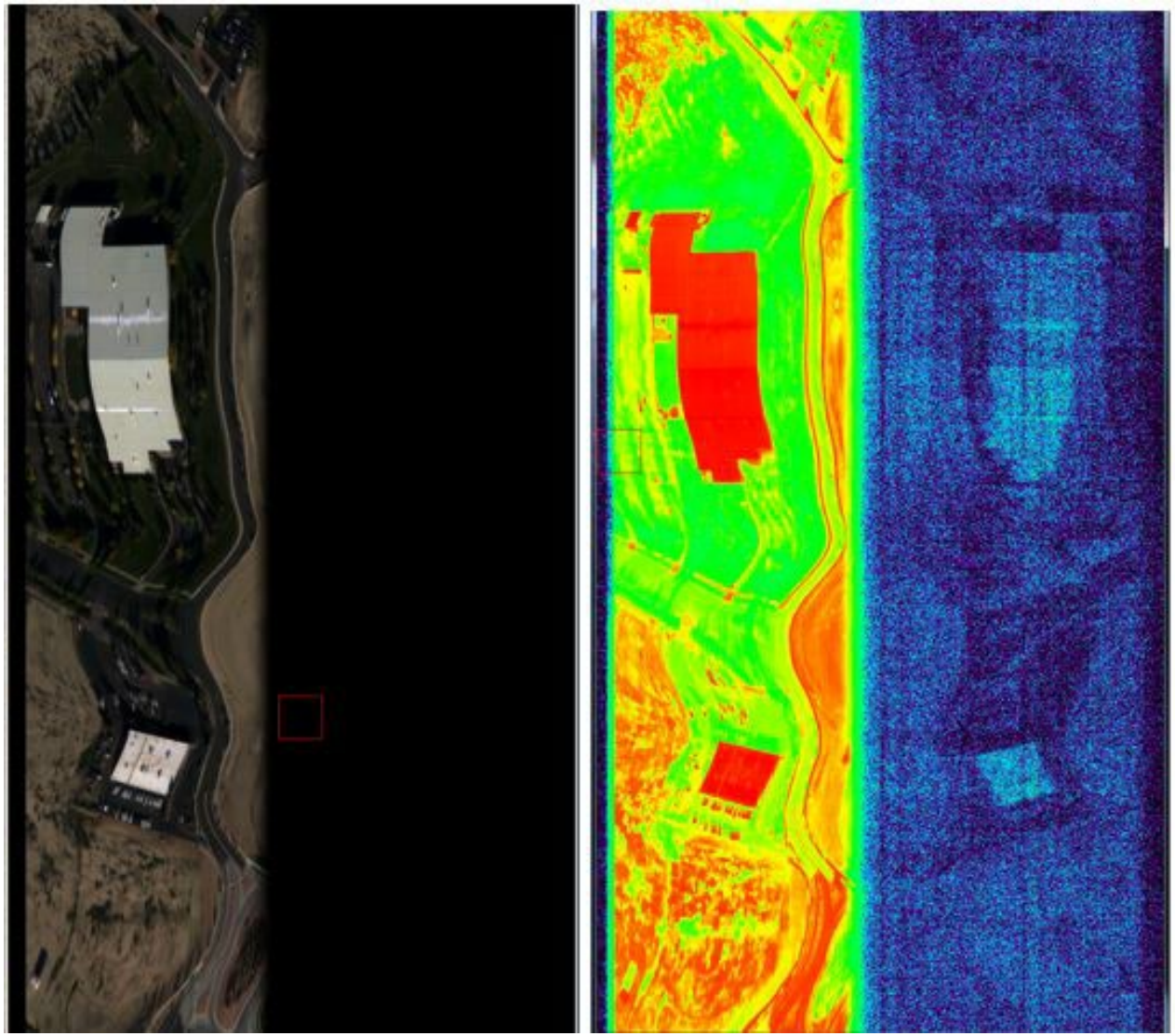
Grating Ghost

Raw



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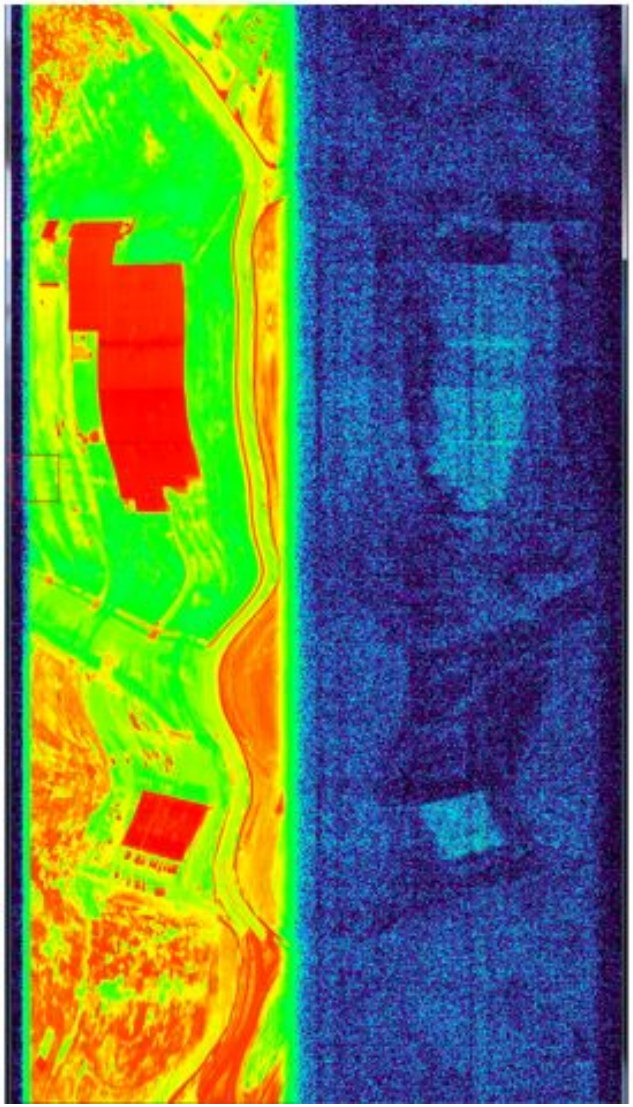
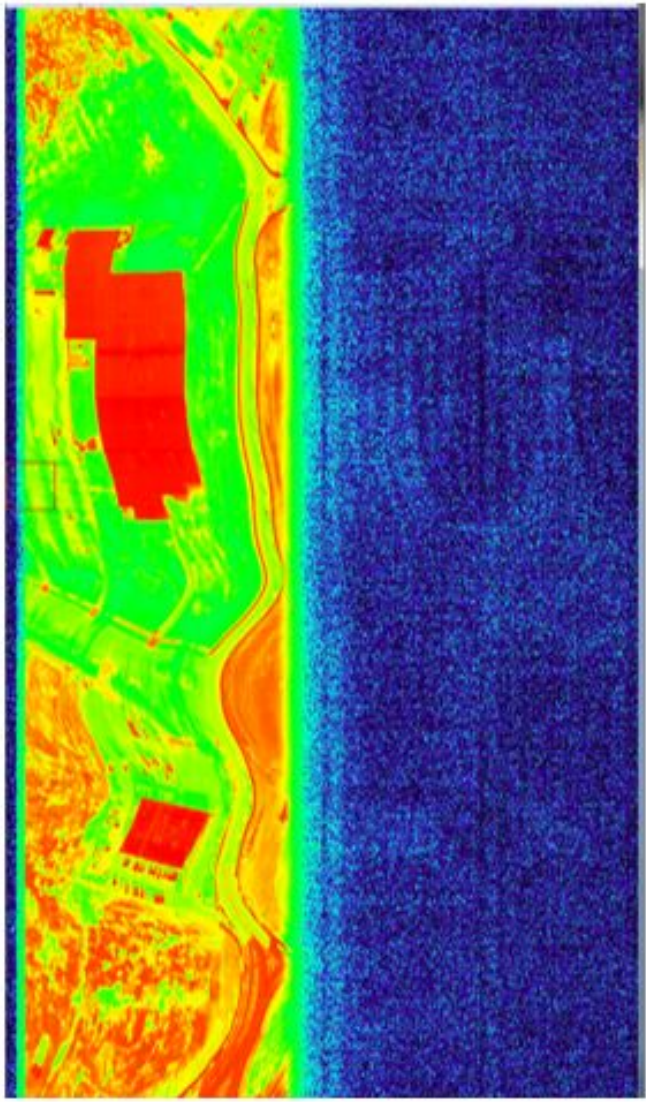
Raw

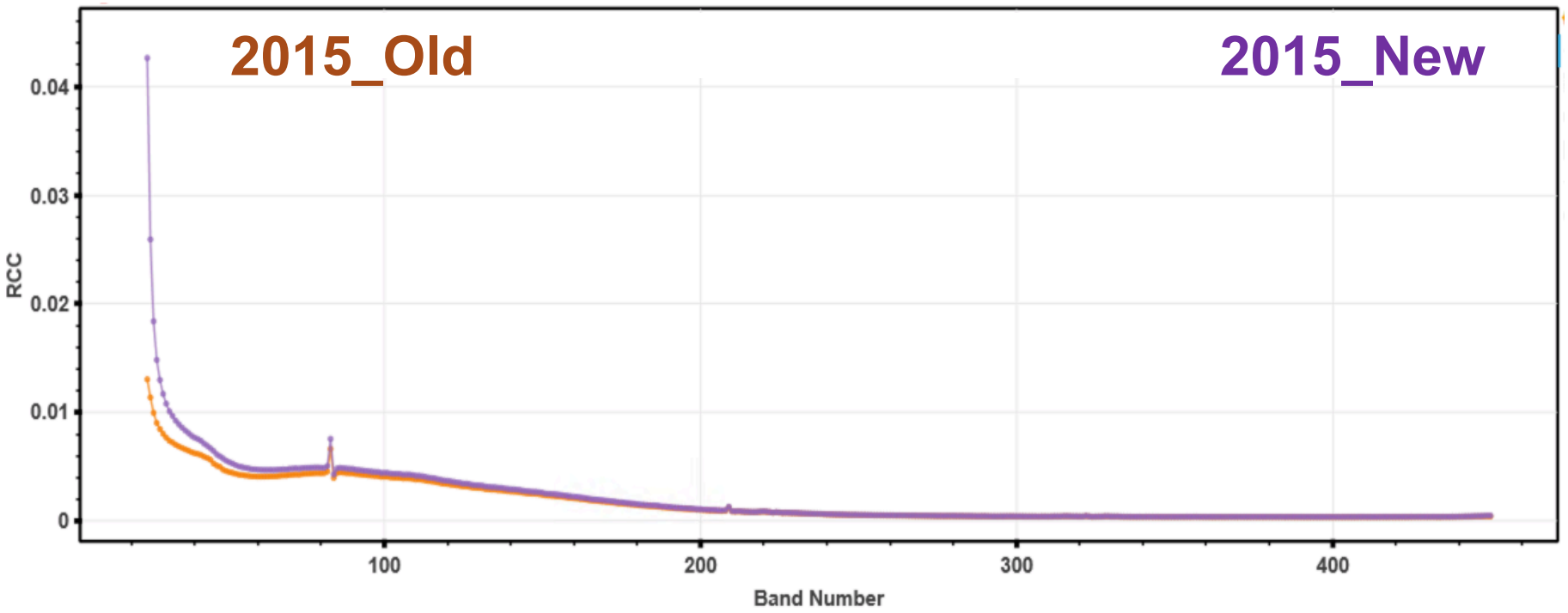
W/O Correction



Corrected

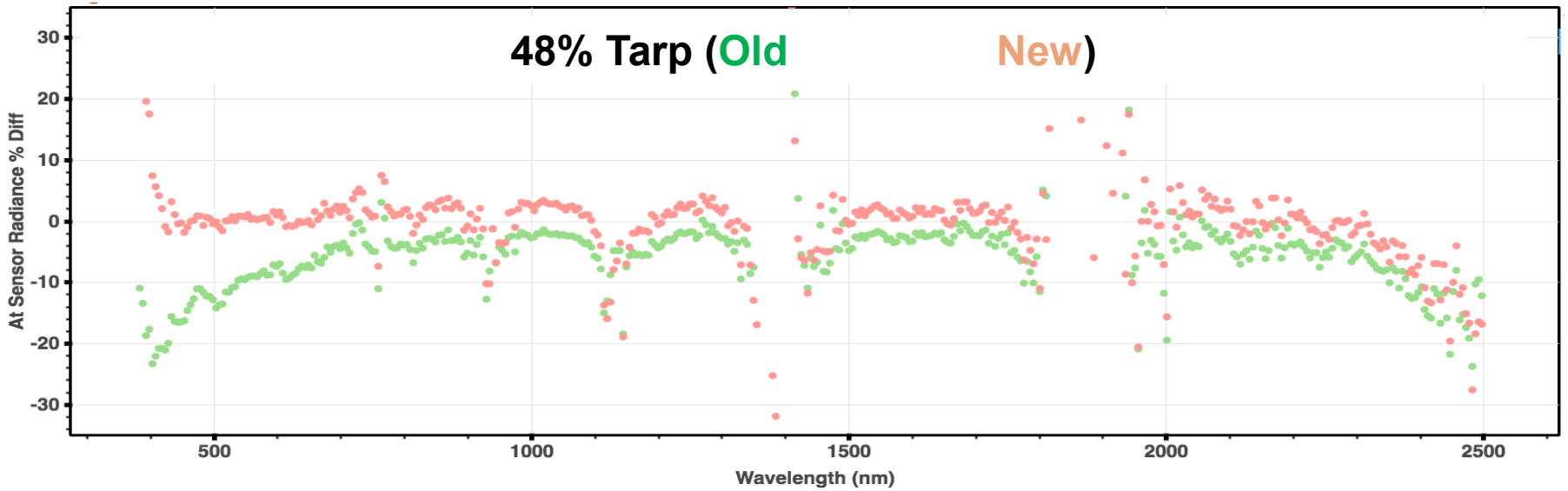


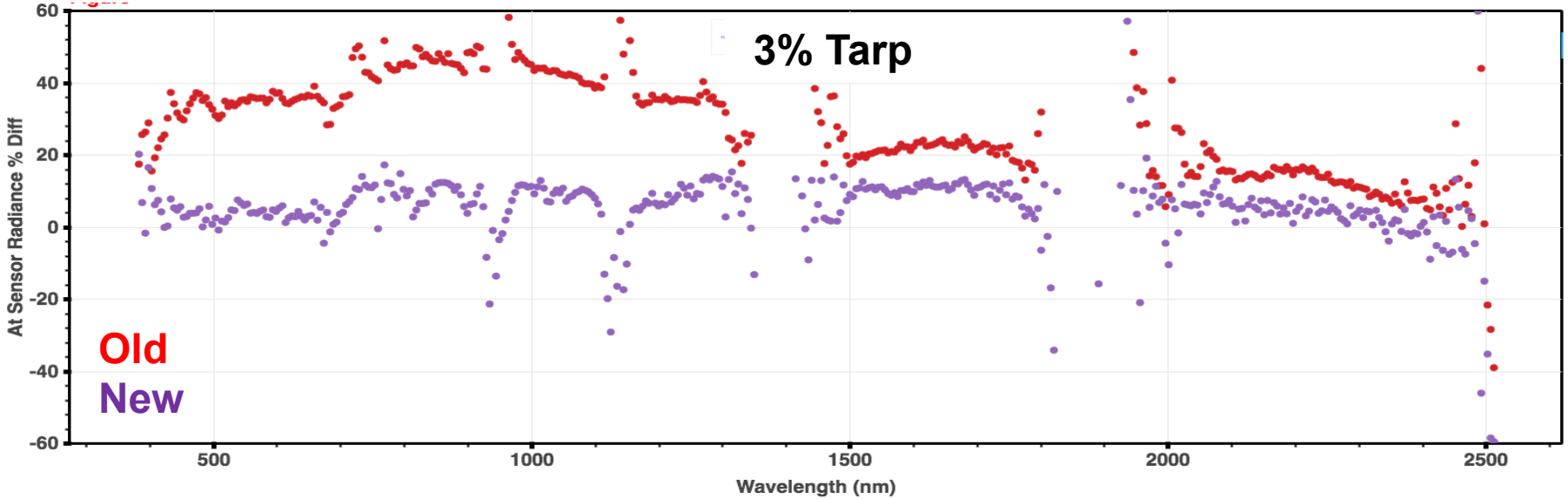
NIS RCC with and Without Ghost Correction



- **The correction implemented at NEON has relatively higher effect in the shorter wavelength.**

Vicarious Calibration





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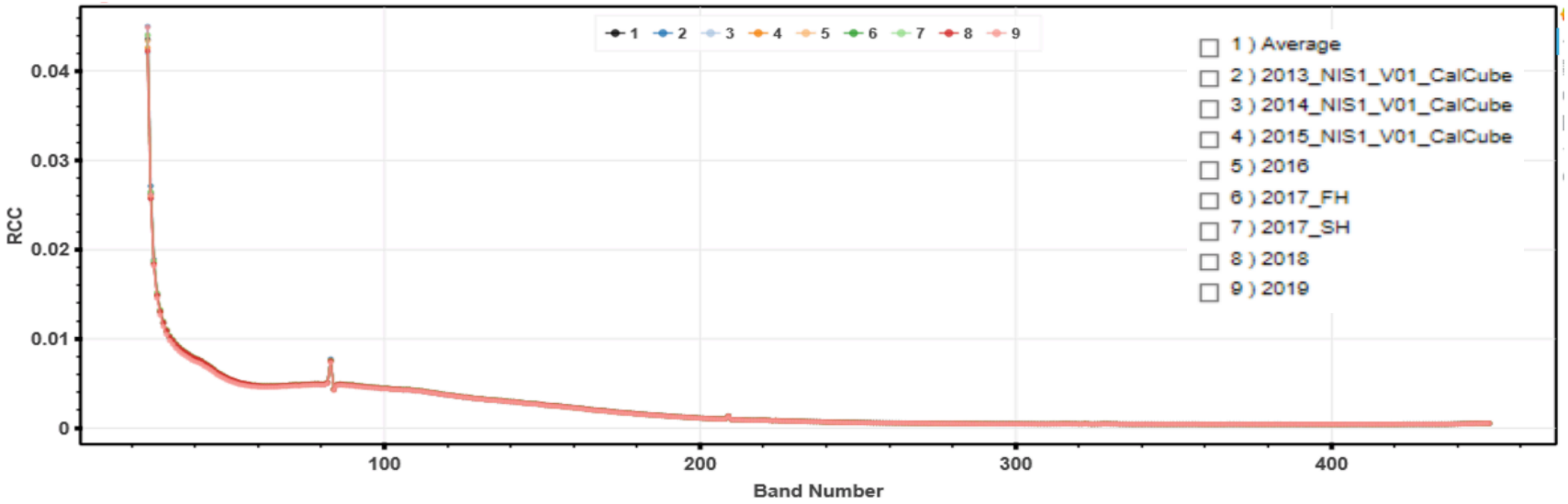
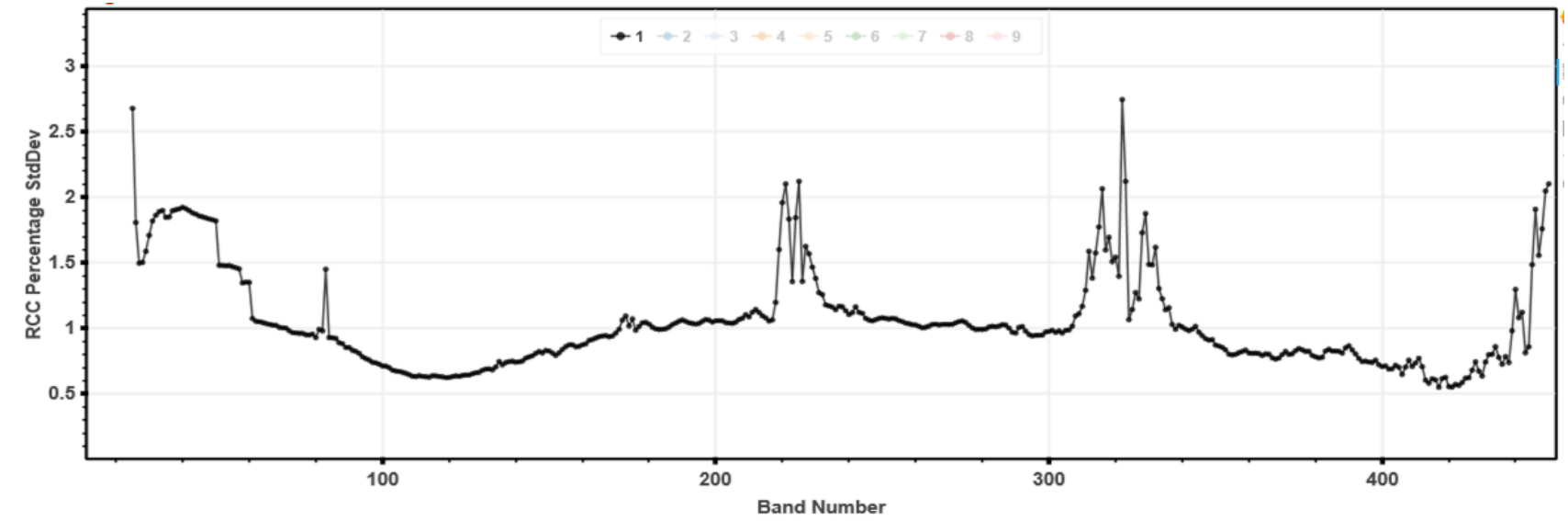
NIS RCC and its Stability





NIS AOP Data Products

Level 1 Raw data to physical units

- **Spectrometer Orthro-rectified at-Sensor Radiance**
- LiDAR Slant Range Waveform
- Discrete Return LiDAR Point Cloud
- **Spectrometer Ortho-rectified Surface Directional Reflectance**
- High-resolution Orthorectified camera imagery

Level 2 (Derived Products, eg: indices)

- Canopy Nitrogen
- Canopy Water Content
- Canopy Xanthophyll Cycle
- Canopy Lignin
- Vegetation Indices - Spectrometer
- Albedo - Spectrometer
- LAI - Spectrometer
- fPAR - Spectrometer
- Total Biomass Map - Spectrometer

Level 3 (Derived Products Mosaics)

- Spectrometer Ortho-rectified Surface Directional Reflectance
- High-resolution Orthorectified camera imagery mosaic
- Albedo - Spectrometer
- LAI - Spectrometer
- fPAR - Spectrometer
- Total Biomass Map - Spectrometer
- Canopy Nitrogen
- Canopy Water Content
- Canopy Xanthophyll Cycle
- Canopy Lignin
- Vegetation Indices - Spectrometer
- Ecosystem Structure
- Elevation - LiDAR
- Slope and Aspect - LiDAR

ATBDs (Algorithm Theoretical Basis Documents) describing the process for data product creation

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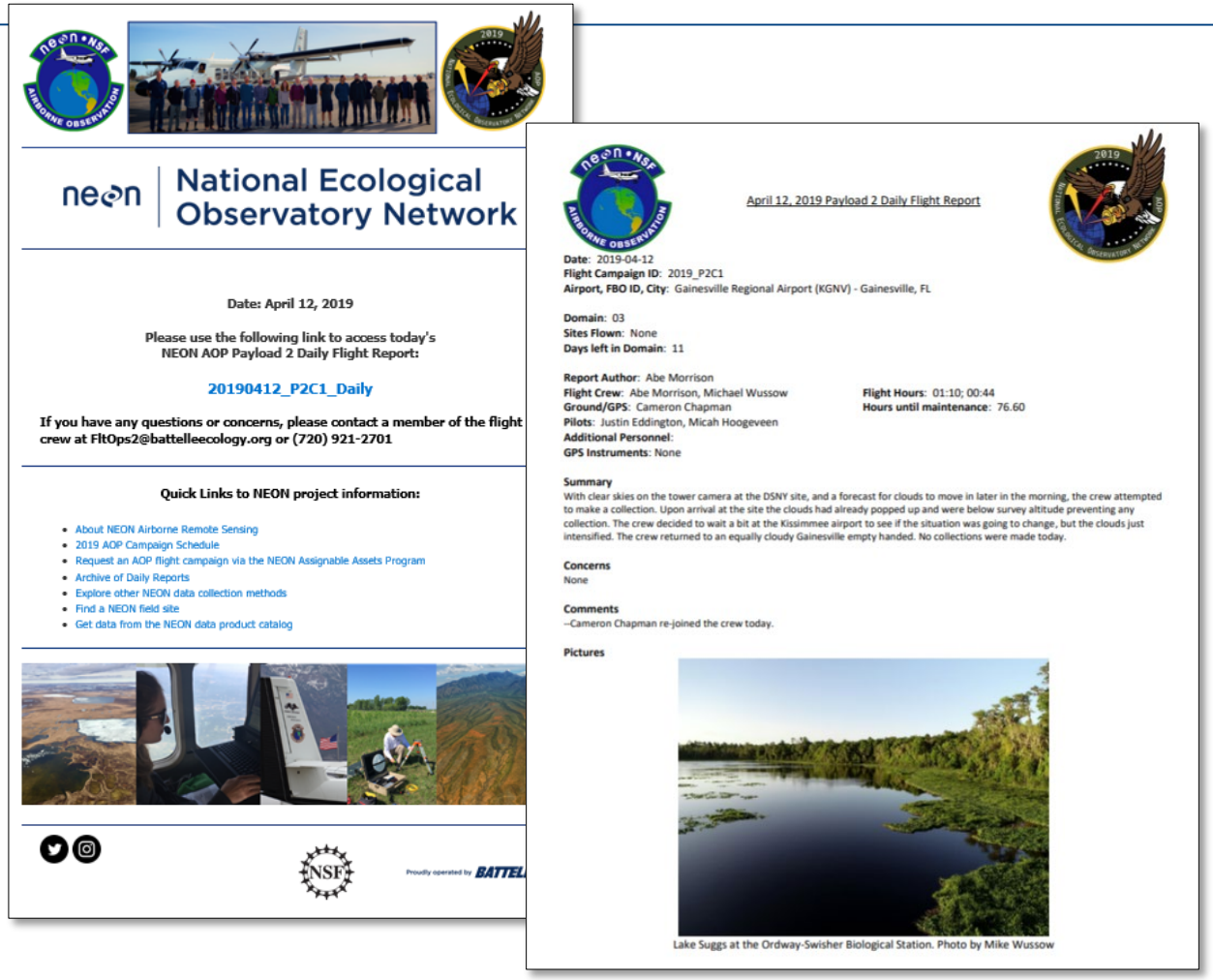
NEON Infrastructure Assets

Components of NEON infrastructure available to members of the community to support their own research or other activities

- **Assignable Assets Program**
  - Airborne Observation Platform (AOP)
  - Mobile Deployment Platform (MDP)
  - Sensor Infrastructure (SI)
  - Observational Sampling Infrastructure (OSI)
  - Letters of Support/Collaboration

For more information
www.neonscience.org/assignable-assets

Daily Reports from the Flight Campaign



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Date: April 12, 2019

Please use the following link to access today's NEON AOP Payload 2 Daily Flight Report:

20190412_P2C1_Daily

If you have any questions or concerns, please contact a member of the flight crew at FltOps2@battelleecology.org or (720) 921-2701

Quick Links to NEON project information:

- About NEON Airborne Remote Sensing
- 2019 AOP Campaign Schedule
- Request an AOP flight campaign via the NEON Assignable Assets Program
- Archive of Daily Reports
- Explore other NEON data collection methods
- Find a NEON field site
- Get data from the NEON data product catalog

April 12, 2019 Payload 2 Daily Flight Report

Date: 2019-04-12
Flight Campaign ID: 2019_P2C1
Airport, FBO ID, City: Gainesville Regional Airport (KGNV) - Gainesville, FL

Domain: 03
Sites Flown: None
Days left in Domain: 11

Report Author: Abe Morrison
Flight Crew: Abe Morrison, Michael Wussow
Ground/GPS: Cameron Chapman
Pilots: Justin Eddington, Micah Hoogeveen
Additional Personnel:
GPS Instruments: None

Flight Hours: 01:10; 00:44
Hours until maintenance: 76.60

Summary
With clear skies on the tower camera at the DSNY site, and a forecast for clouds to move in later in the morning, the crew attempted to make a collection. Upon arrival at the site the clouds had already popped up and were below survey altitude preventing any collection. The crew decided to wait a bit at the Kissimmee airport to see if the situation was going to change, but the clouds just intensified. The crew returned to an equally cloudy Gainesville empty handed. No collections were made today.

Concerns
None

Comments
--Cameron Chapman re-joined the crew today.

Pictures

Lake Suggs at the Ordway-Swisher Biological Station. Photo by Mike Wussow

Sign up at https://www.neonscience.org/daily-flight-reports

Summary

- NEON has implemented the ghost correction, both due to electronic panel and grating, which improves the accuracy of estimated radiance.
- Although ghost correction improves the radiance estimate over all the bands, significant improvement is observed in the shorter wavelengths.
- The radiometric calibration coefficients change is within 1% for most of the bands suggesting a highly stable instruments.

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