From point to pixel

Deriving NEON data products From Multi-Scale Measurements

Leah A. Wasser, NEON, Shawn P. Serbin, Brookhaven National Laboratory;Kyla M. Dahlin, Michigan State University; Keely L. Roth, University of California Davis; Nathan Leisso, National Ecological Observatory Network (NEON, Inc.);Shelley Petroy, NEON, Inc.

LeahAWasser

#WorkWithData

PLEASE TWEET DURING MY TALK!! ☺

What is NEON?

- **Large science facility fully funded by the National Science Foundation**
- **A continental-scale ecological observatory that:**
  - Collects and provides data on the drivers/responses of ecological change
  - Serves as an experimental infrastructure/backbone for other experiments
  - Develops and provides educational resources to engage communities in working with scientific data
- **Project Timeline**

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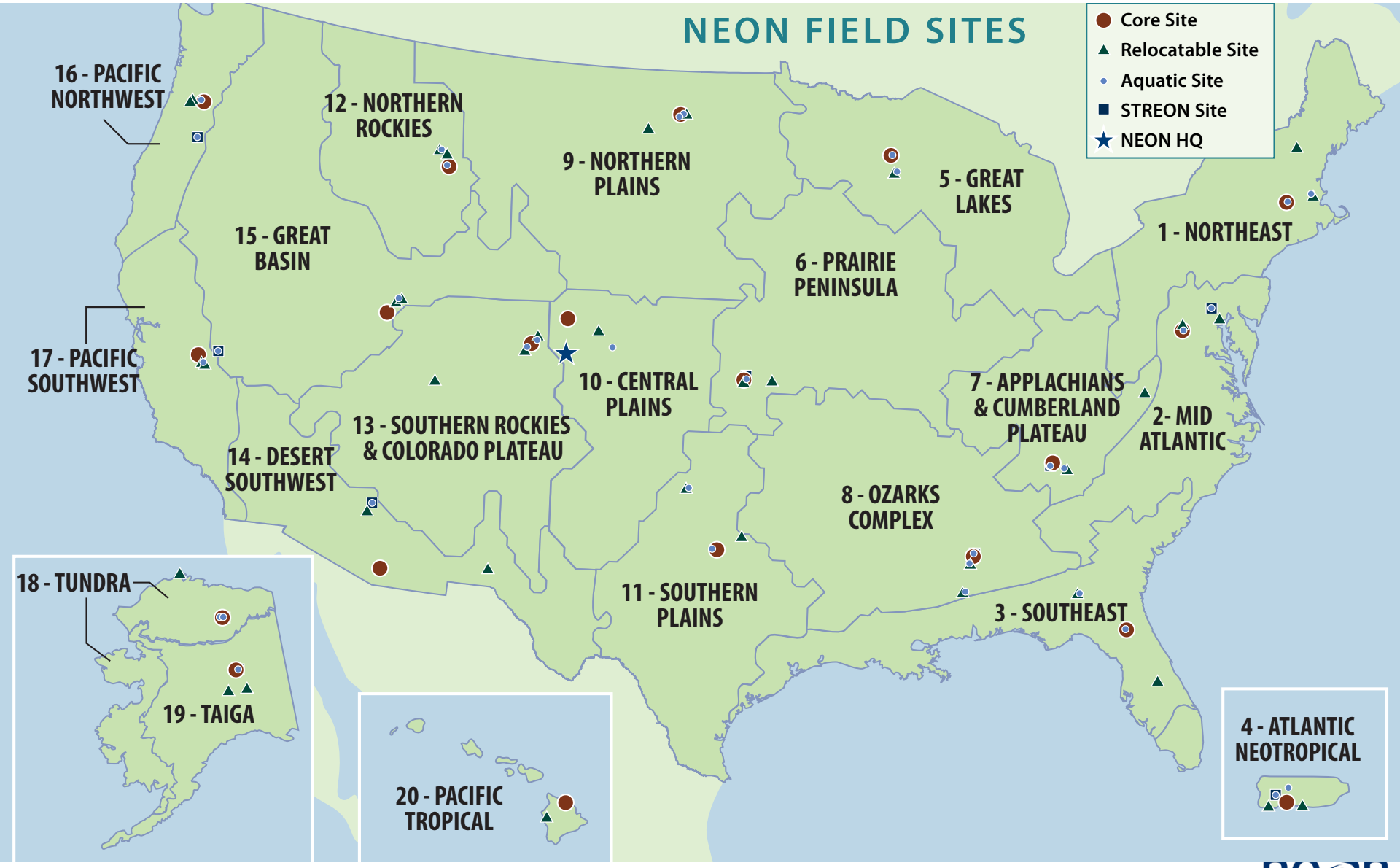
Continental-Scale Observatory



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TIS - Terrestrial Instrumented System

AIS – Aquatic Instrumented System

TOS – Terrestrial Observation System

AOS – Aquatic Observation System

AOP – Airborne Observation Platform

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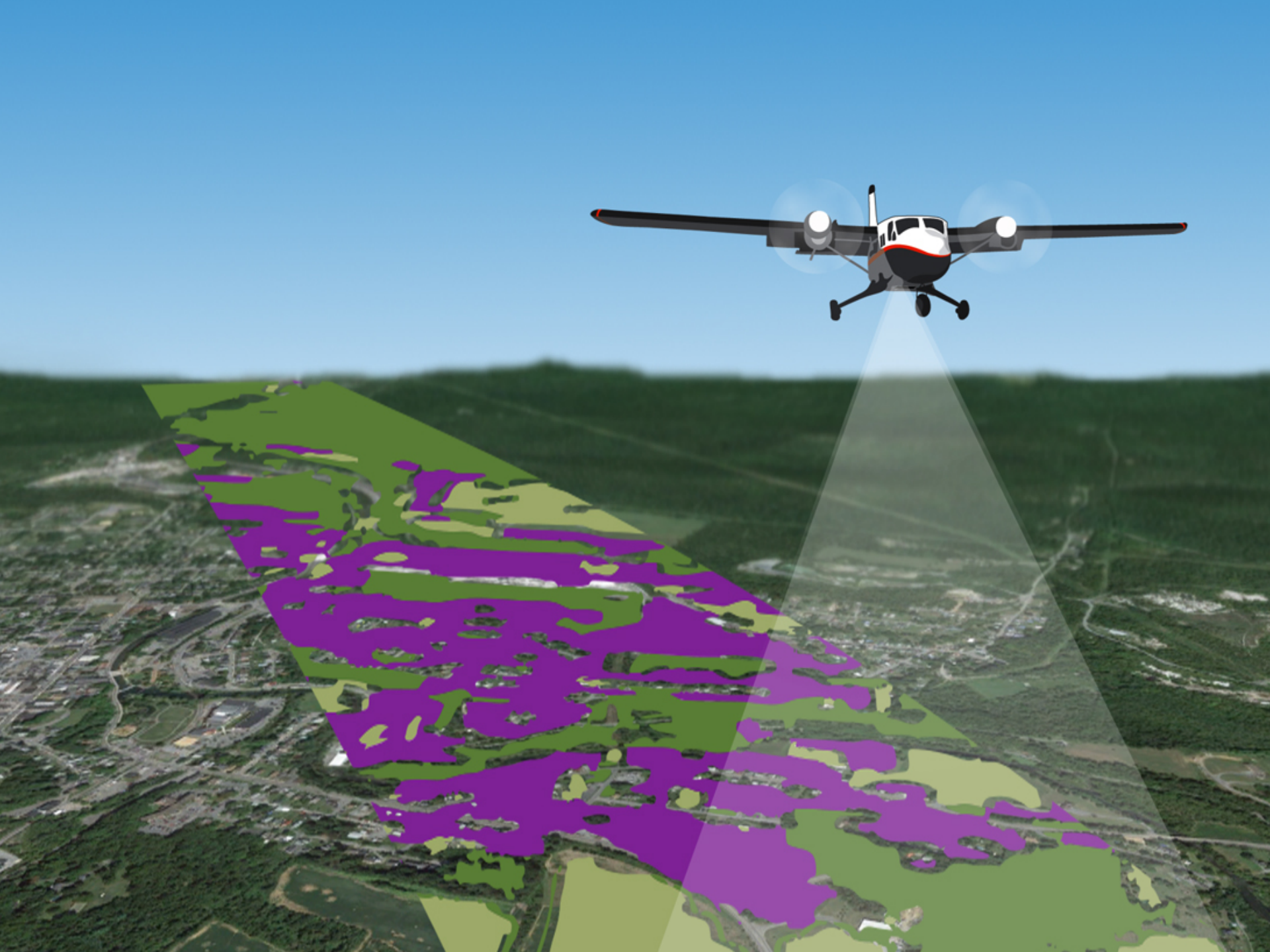
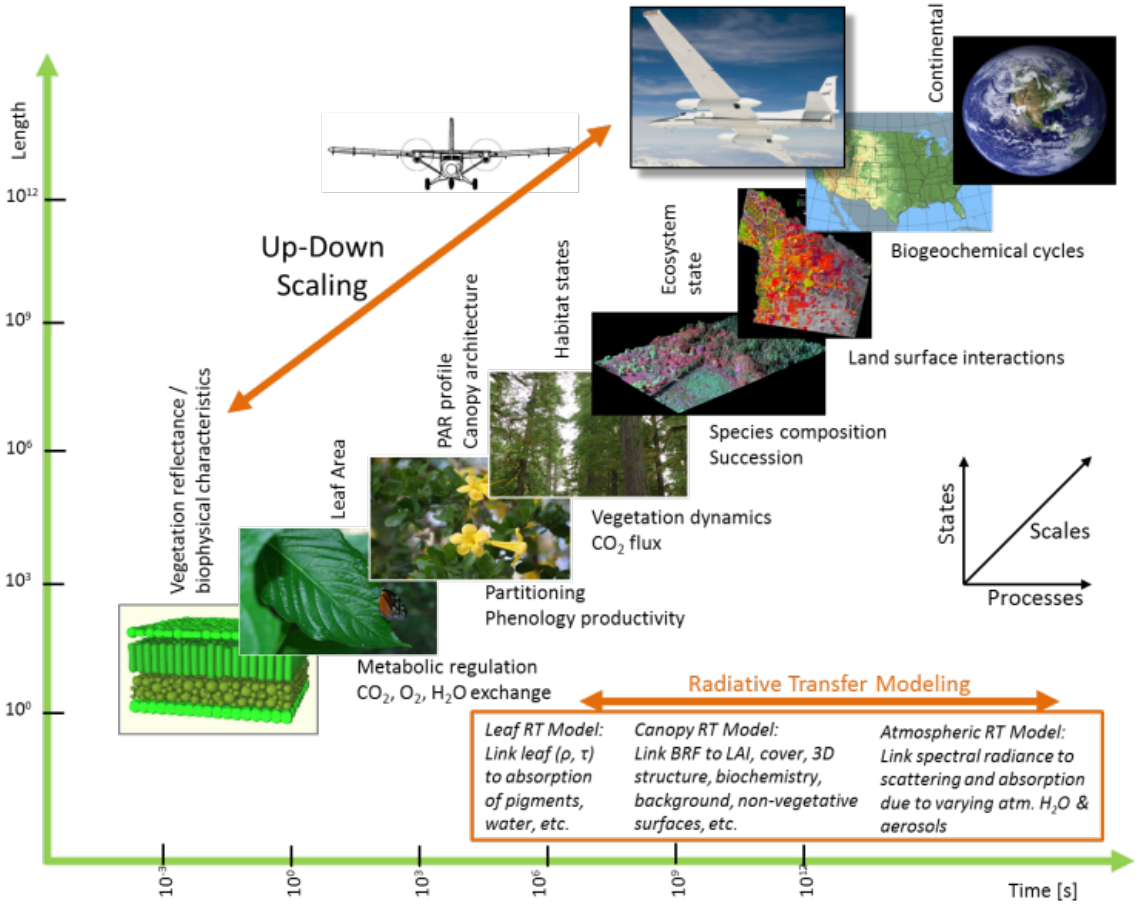


Observations Across Scales



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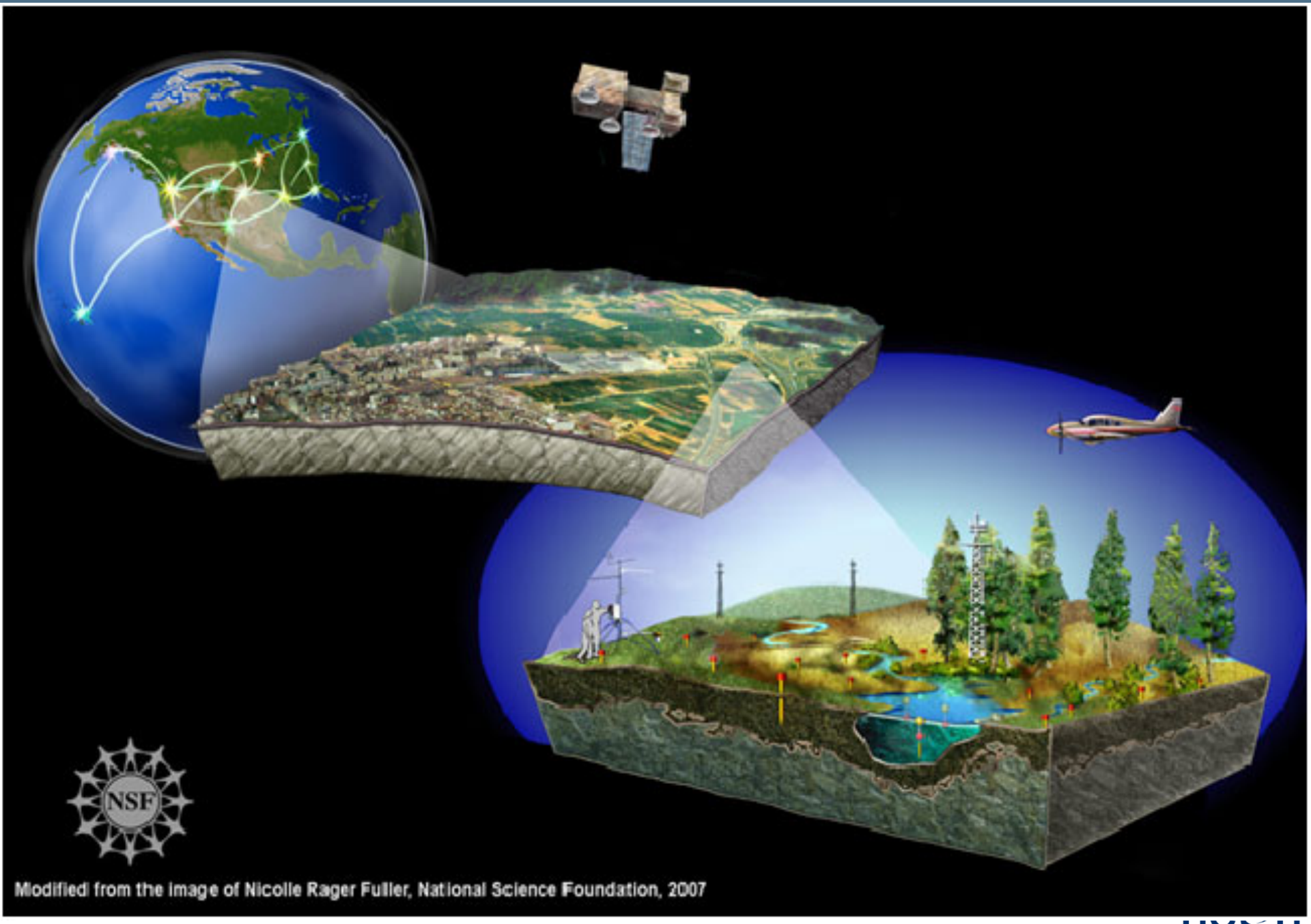
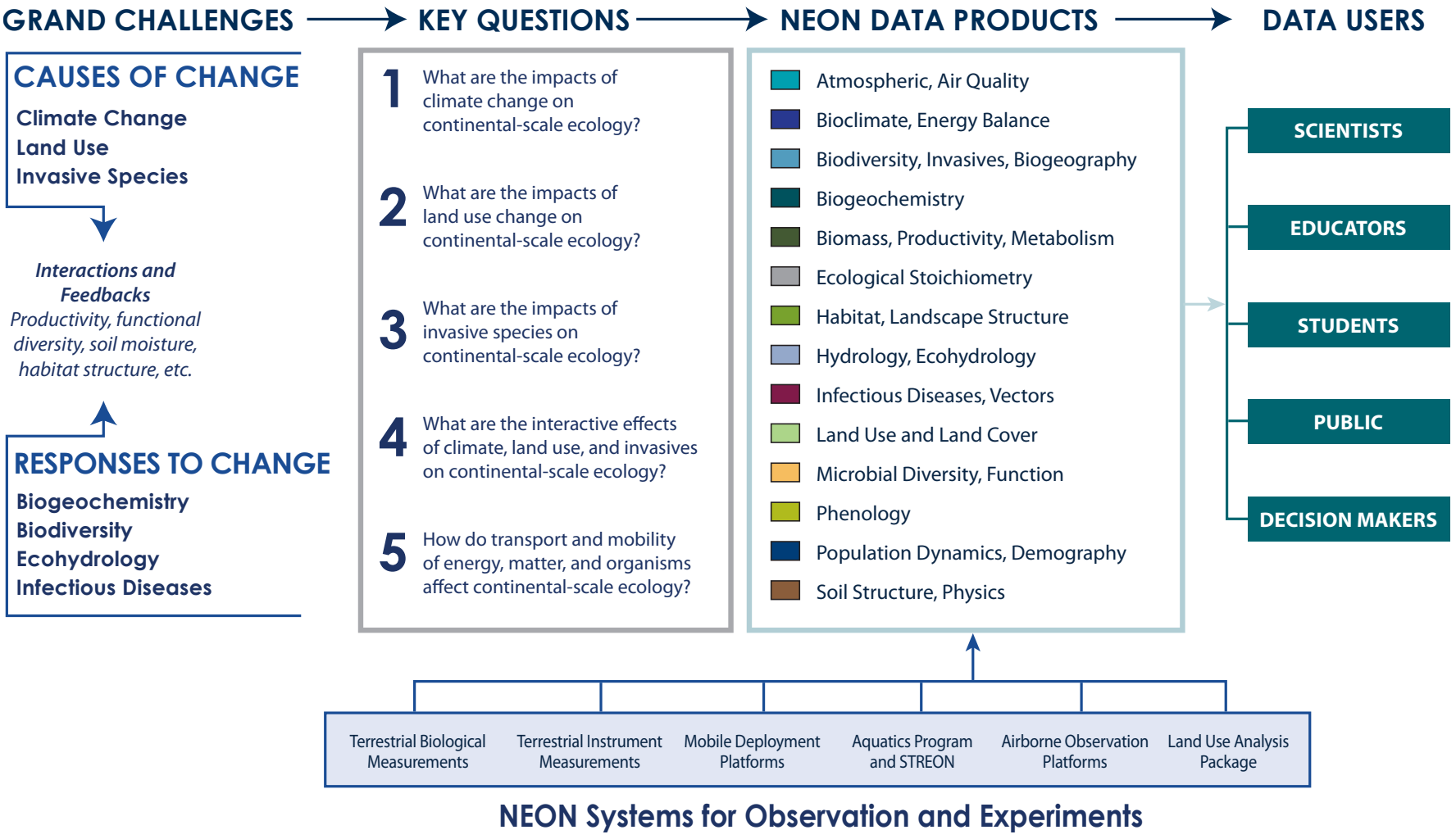

NSF
Modified from the image of Nicolle Rager Fuller, National Science Foundation, 2007

Deriving requirements



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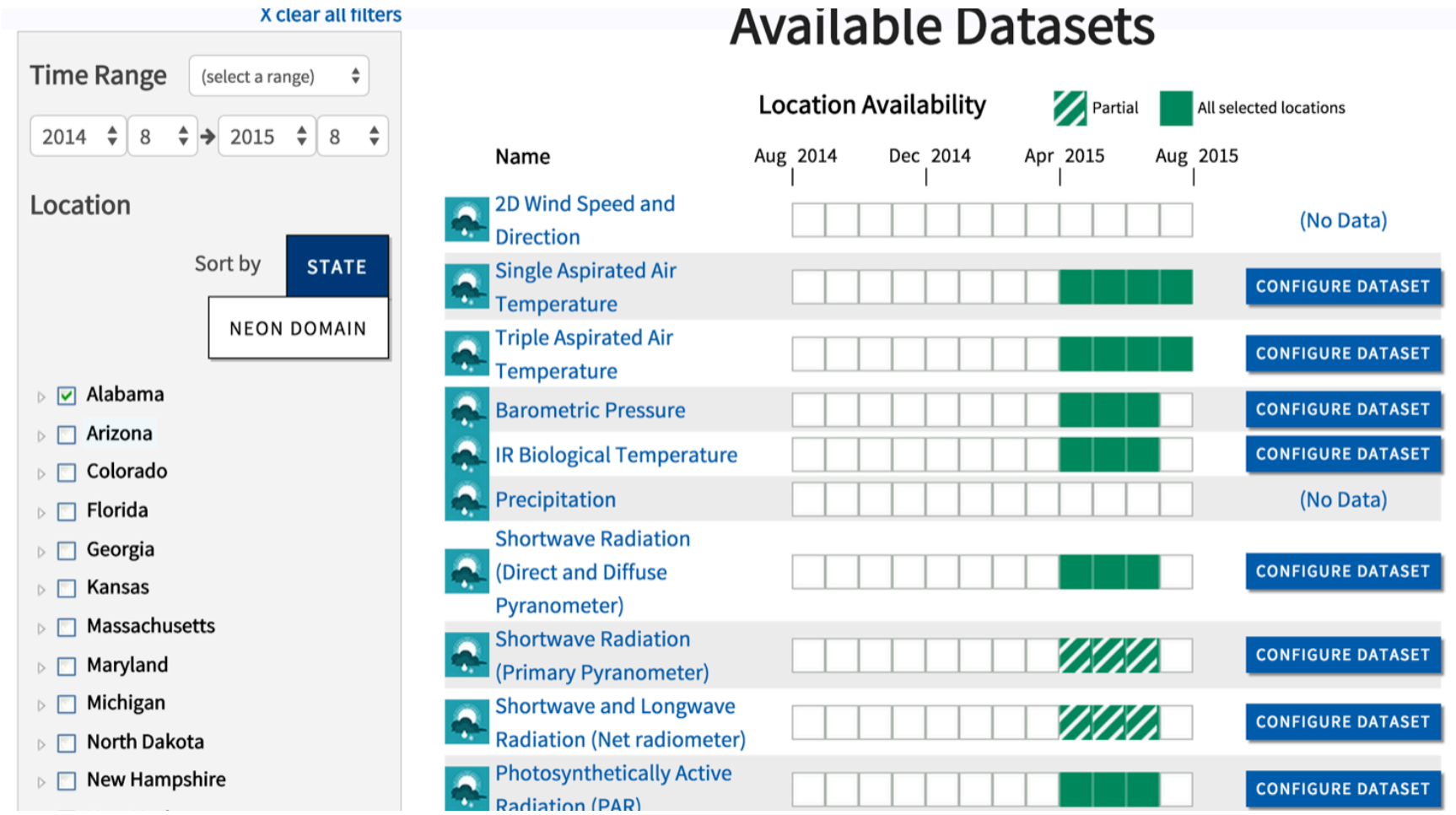
data.neoninc.org



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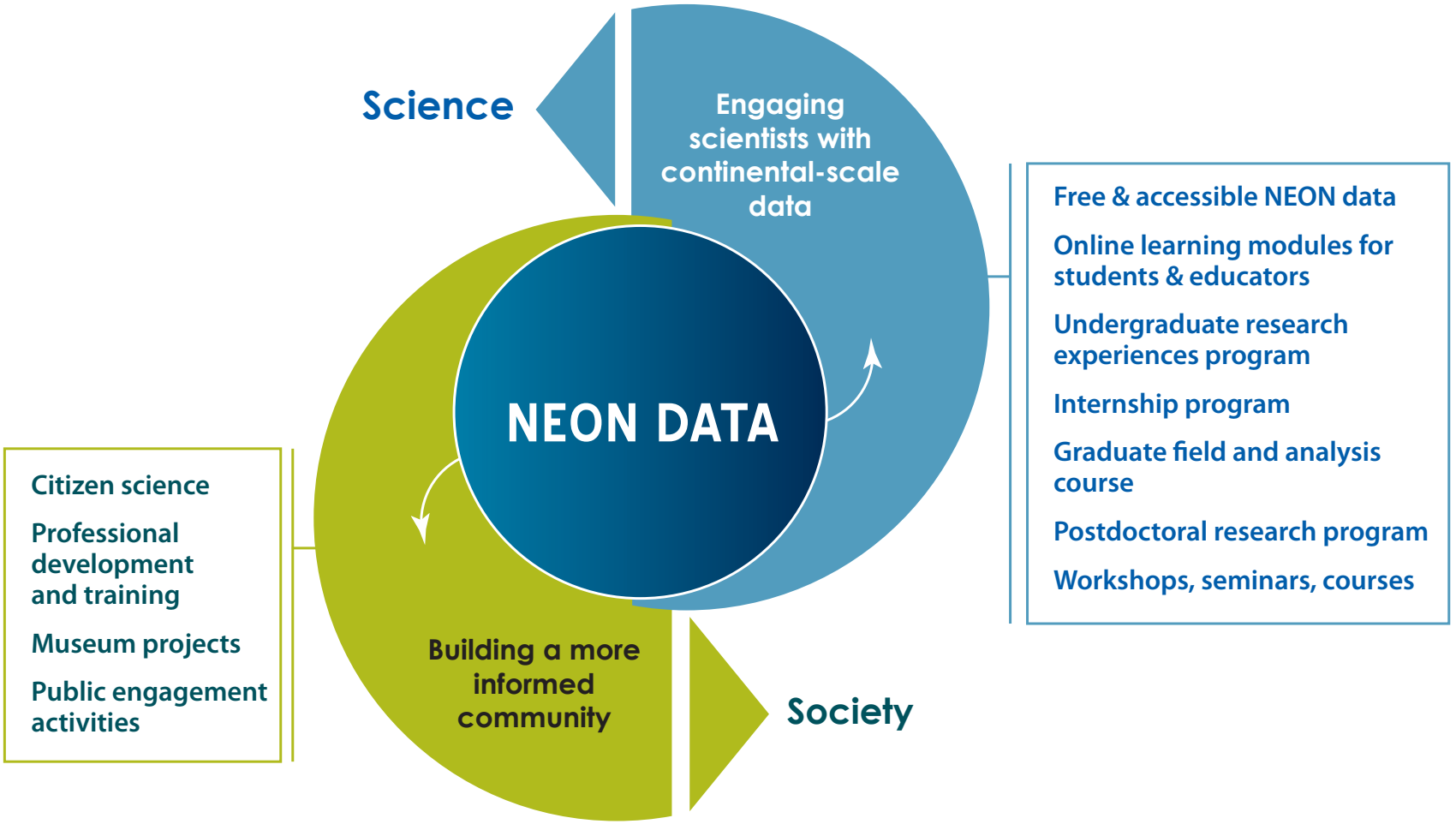

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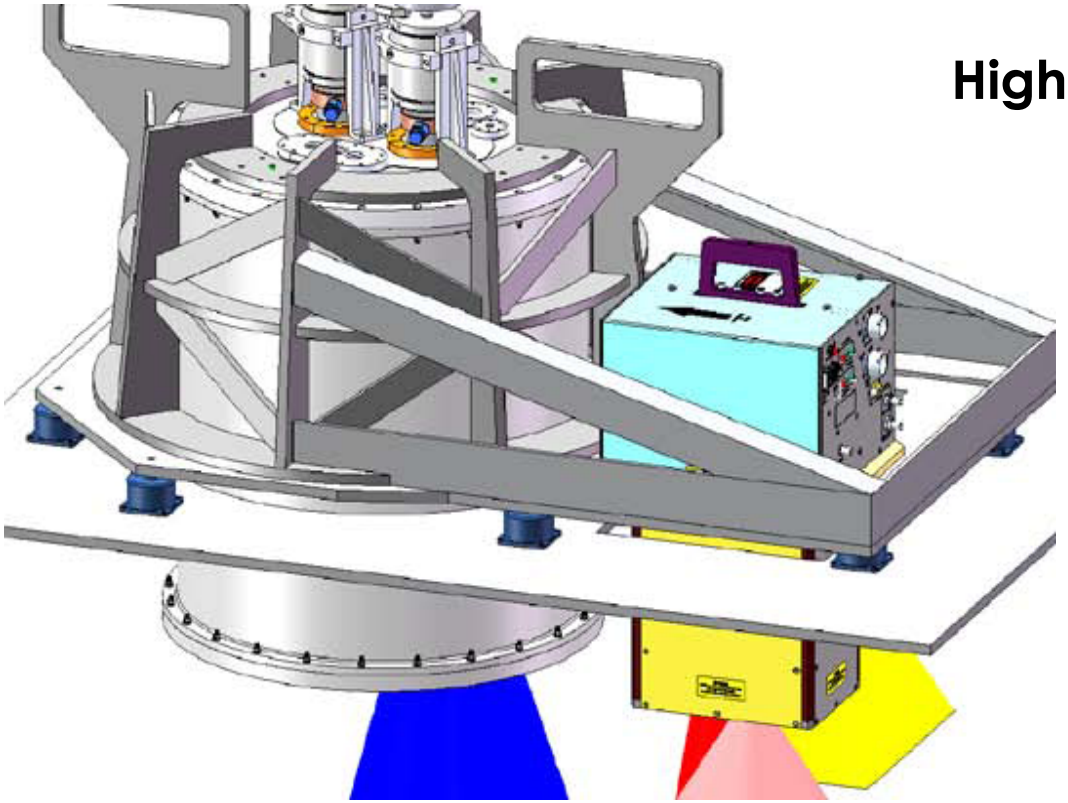
…Our Airborne Platform

NEON Remote Sensing Instruments

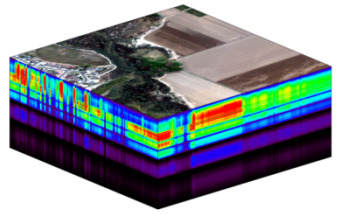


Hyperspectral Data

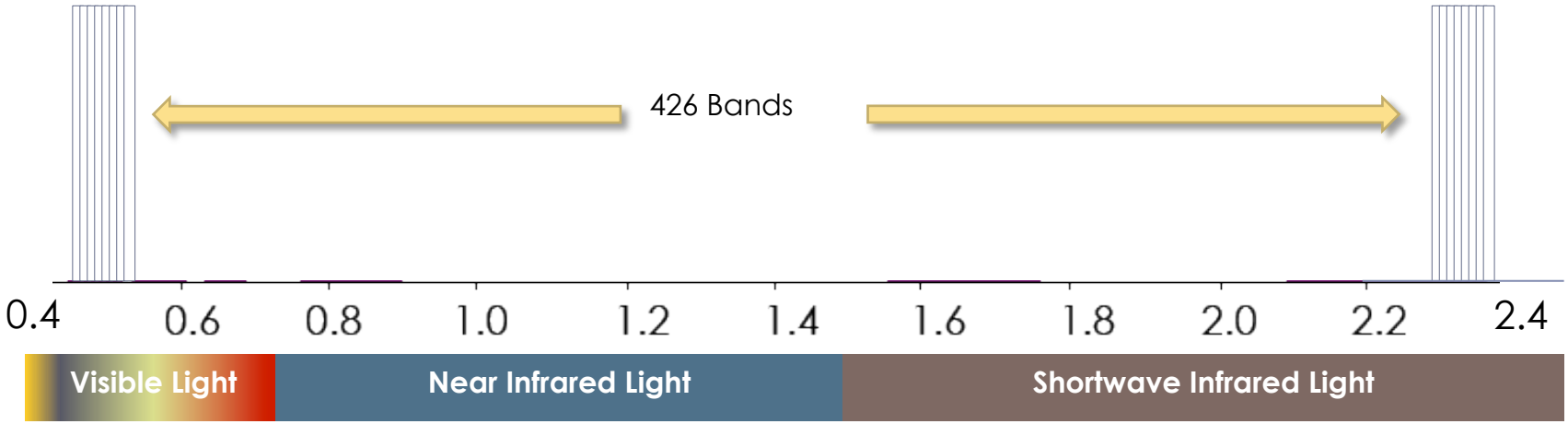
Lidar Data
Full Waveform + Discrete Return

High Resolution RGB Camera

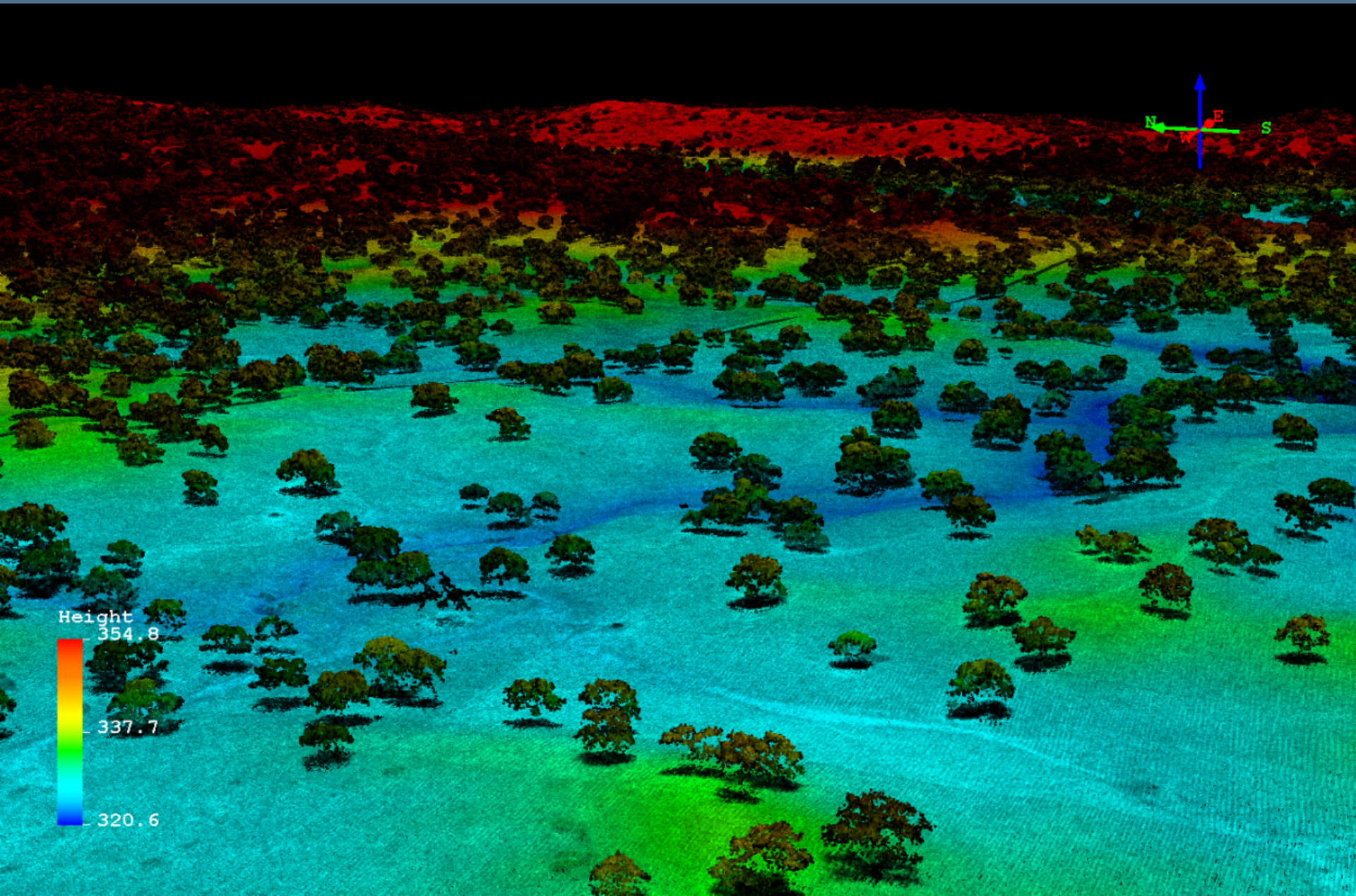
NEON Imaging Spectrometer



- NASA JPL
- Push broom instrument
- 426 bands, ~5 nm spectral resolution
- 1 m spatial resolution



Discrete & Waveform LiDAR



RGB Imagery

AOP Products Available Now

LiDAR

- Slant Range Waveform
- Discrete Return LiDAR Point Cloud
- Elevation, canopy height model
- Slope and Aspect

Spectrometer

- Orthorectified Surface Directional Reflectance
- Spectrometer Orthrorectified at-Sensor Radiance
- Canopy Xanthophyll , Lignin
- NDVI, EVI

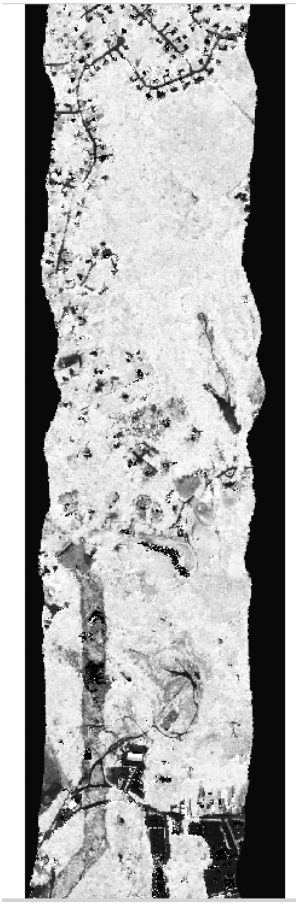
RGB camera imagery

Field Spectral Data

L2 spectrometer products

NDVI

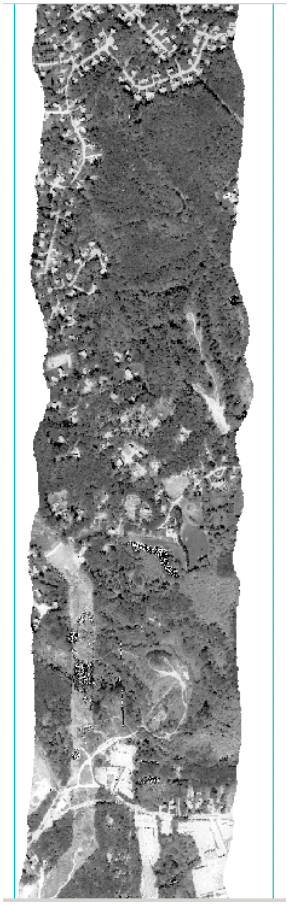
EVI



ARVI

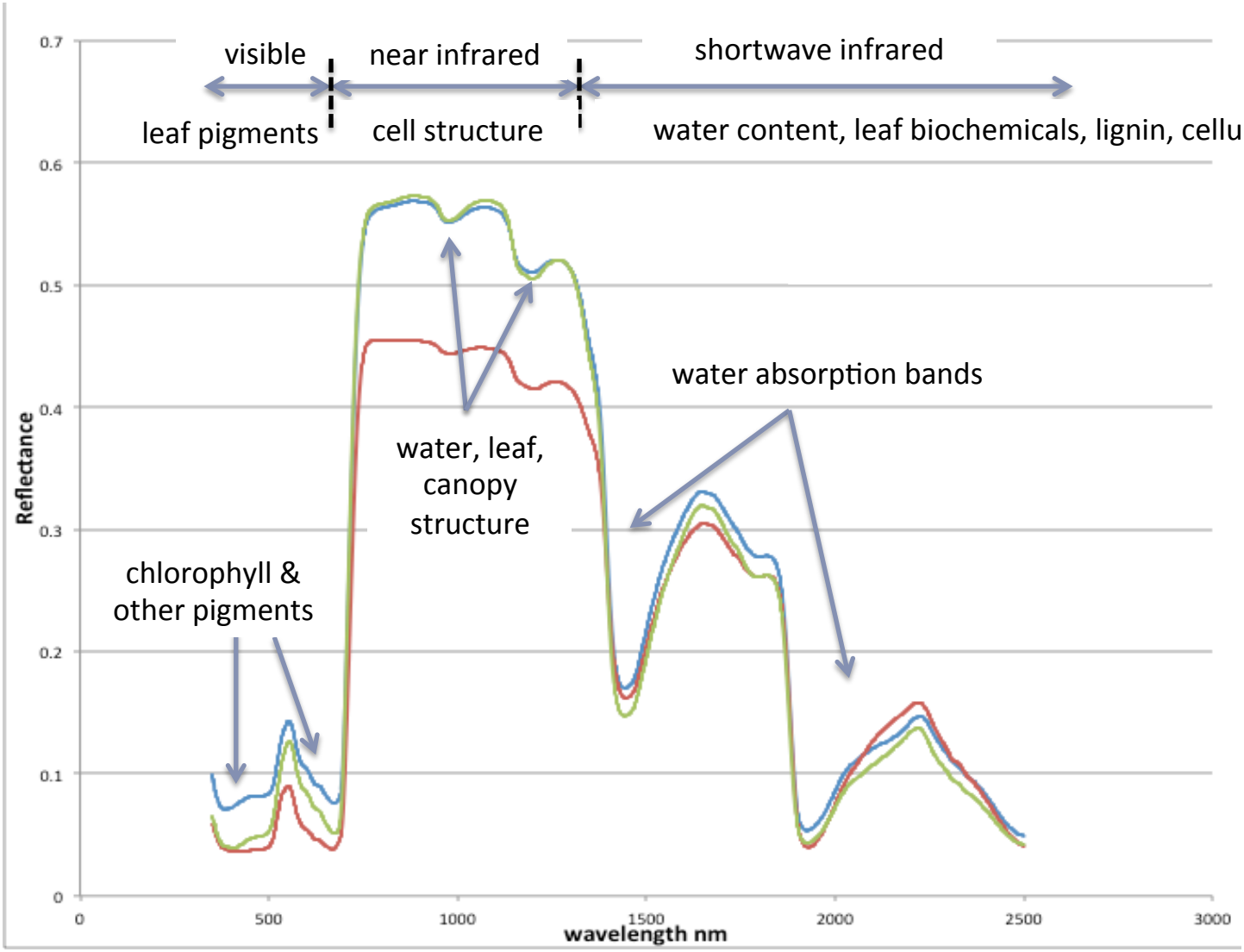
Xanthophyll

Lignin



http://www.neoninc.org/data-resources/get-data/airborne-data

Quick Review – Why We're Interested in Spectra



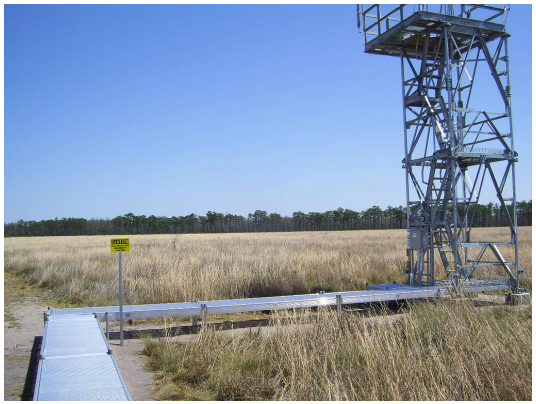
…From Plot to Airborne

Standards Across Diverse Sites

Teakettle (D17, California)

Ordway (D03, Florida)

Sterling (D10 Colorado)



Disney (D03, Florida)

San Joachin (D17, California)

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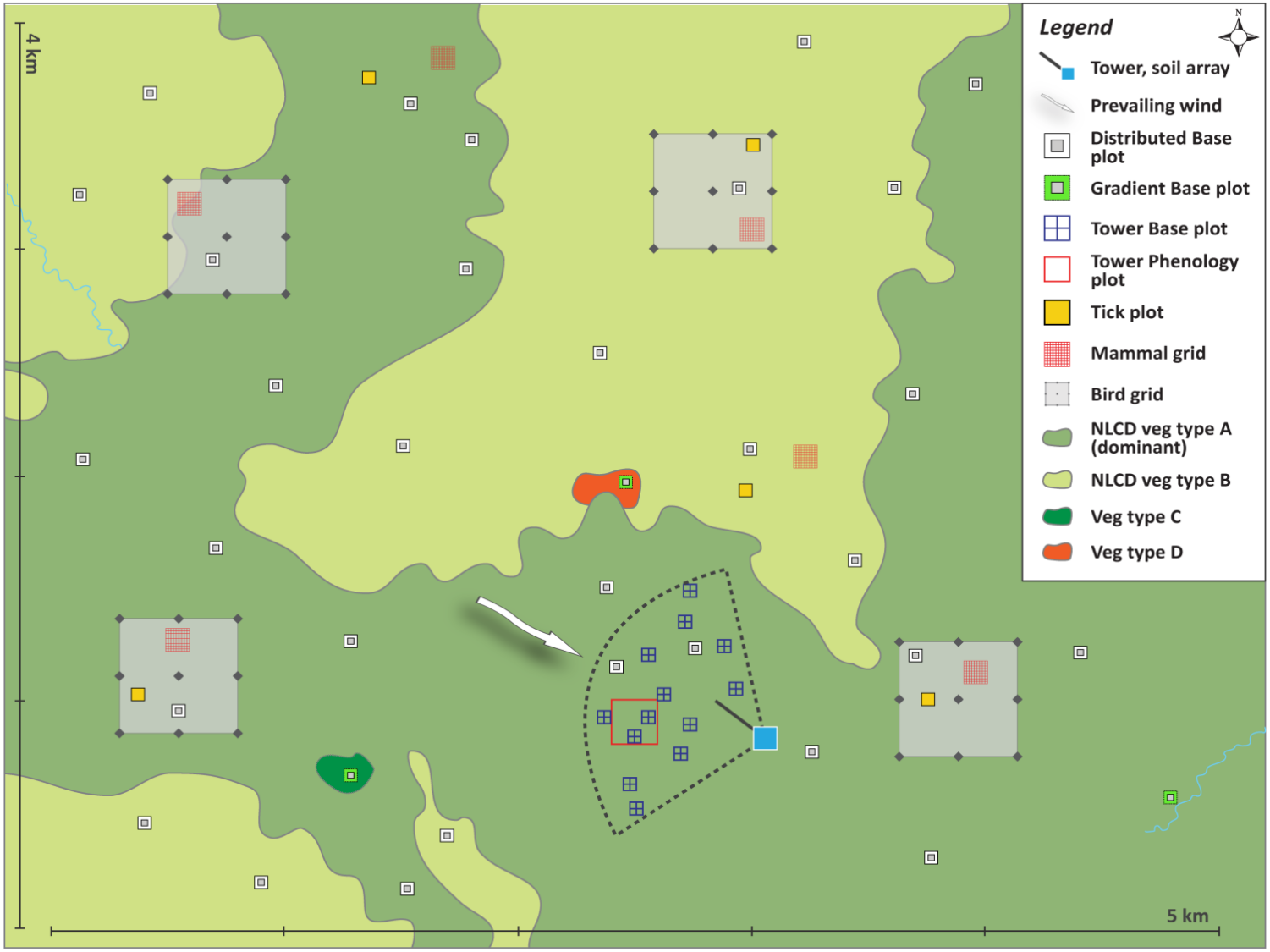
Generalized terrestrial sampling scheme



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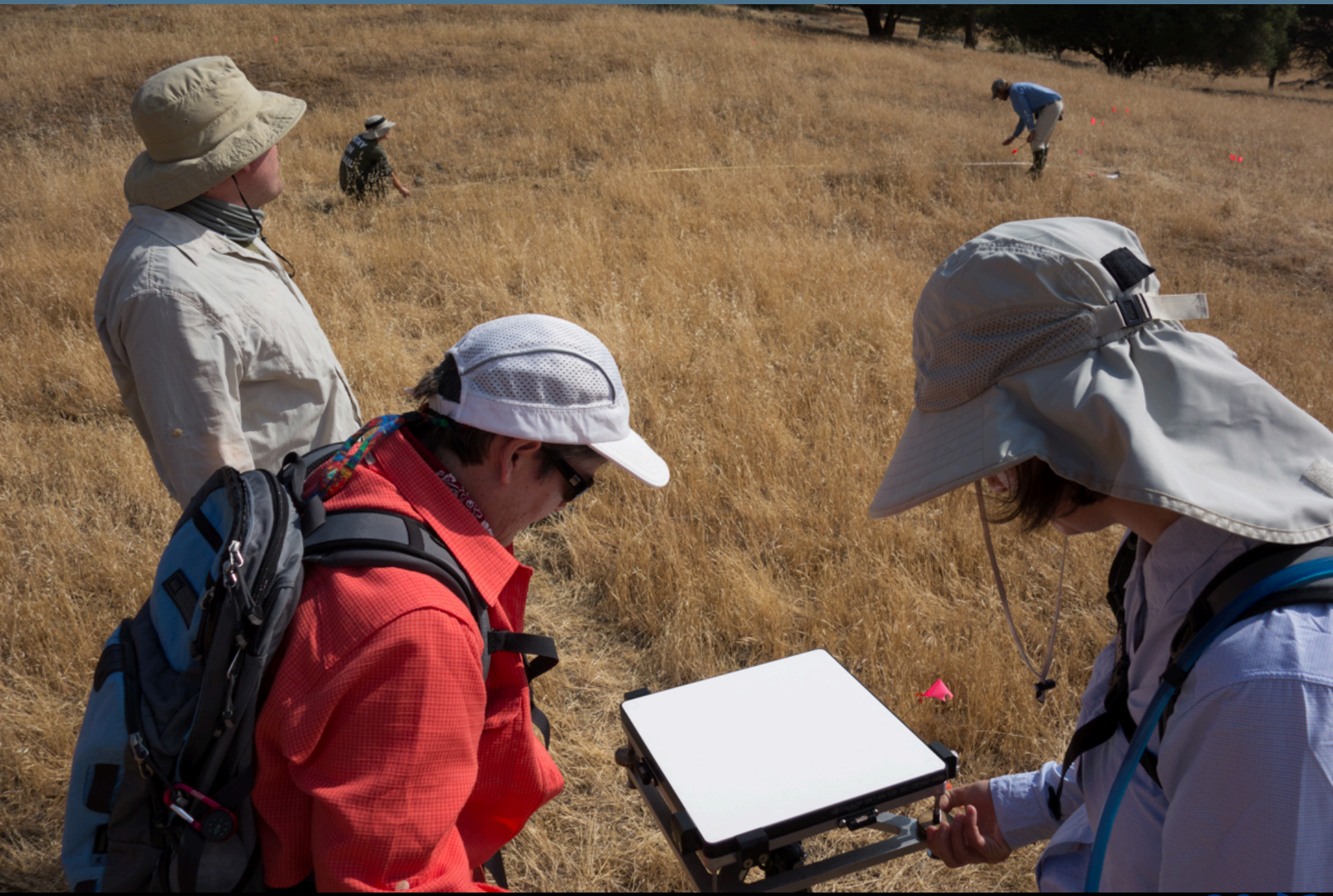
A Vegetation Indice Approach to Standardization??

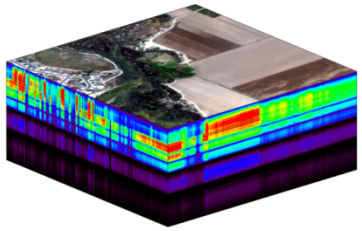


Normalized Difference Nitrogen Index

Relationship in the peak between 1510 and 1680 nm observed in the AVIRIS instrument

$$\frac{[\log(1/R1510)\log(1/R1680)]}{[\log(1/R1510) + \log(1/R1680)])}$$

Serrano et al, 2002 – Remote Sensing of Environment



HSI Data

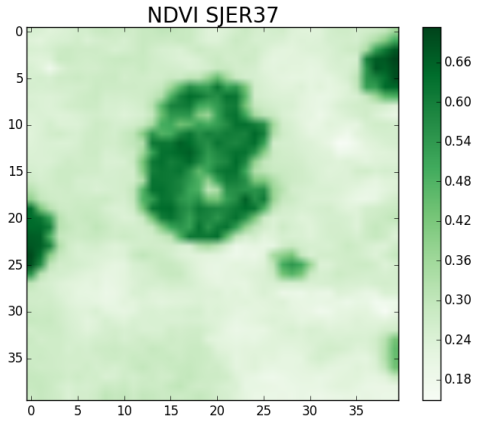
- 3-4 GB flightlines, not tiled, mosaicked
- FORMAT: H5

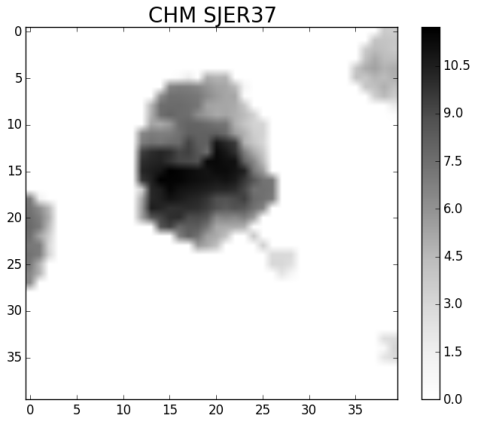
LiDAR Data

- NEON L1 Canopy Height Model
- FORMAT: Geotiff

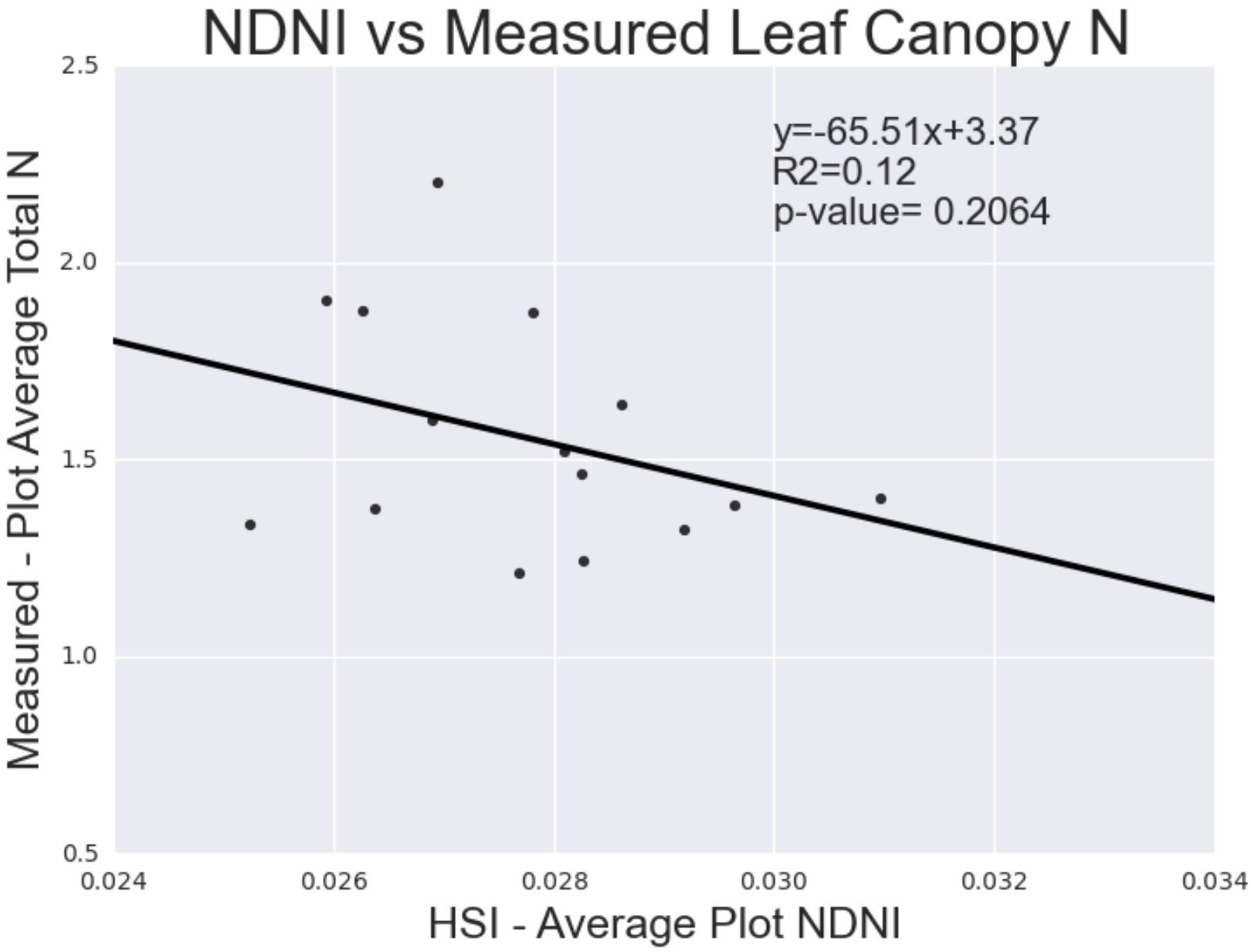
Extract plot spectra: pixels closest to NADIR
Create NDVI mask

Create height mask:
pixels > 2m





Calculate Nitrogen

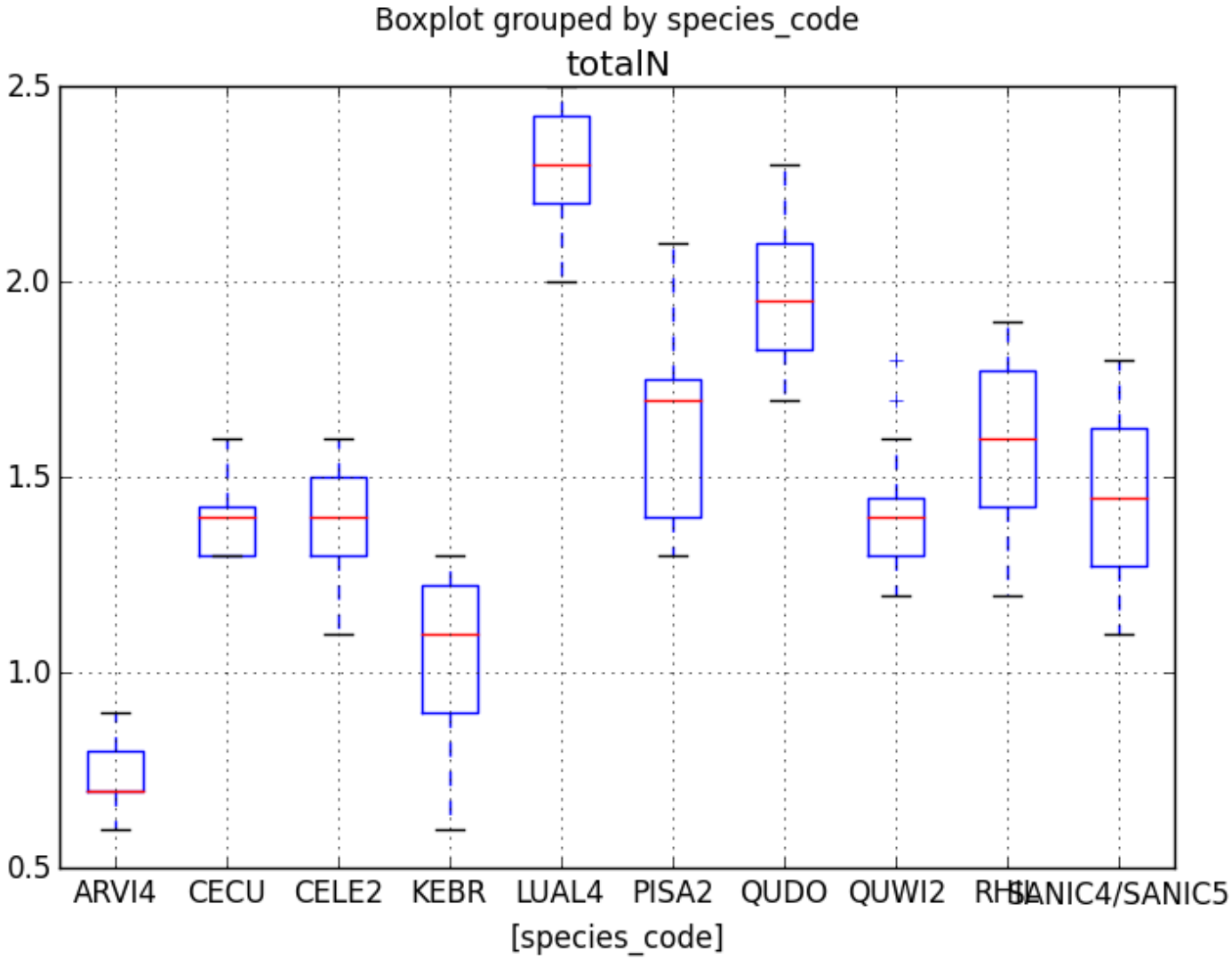

NDNI vs Measured Leaf Canopy N
y=-65.51x+3.37
R2=0.12
p-value= 0.2064
Measured - Plot Average Total N
HSI - Average Plot NDNI
2.5
2.0
1.5
1.0
0.5
0.024
0.026
0.028
0.030
0.032
0.034

Standardized Operational Algorithm Development Challenges

- Samples must comprise full diversity of dominant species across all plots.
- *In situ* sampling must identify stems contributing canopy top
- Time mismatches between chemistry sampling & flights
- Chemistry data only available for a few sites.
- Funding availablility to perform addition sampling at other sites.

Canopy N has not been derived consistently at the spectral and spatial resolution of NEON's instrument

Nitrogen Across Species



Next Steps

Collect enough data to run PLS

- We know that many traits are related in terms of how they reflect and absorb light
- “How a trait contributes to the spectra throughout the spectra”
- Pull together data from other sources to run other sites.
- Also run NDNI across a suite of sites to better understand distribution

Community contributions to data product development.

Python code on git: Neondataskills.org

Leah A. Wasser, Supervising Scientist
lwasser@neoninc.org

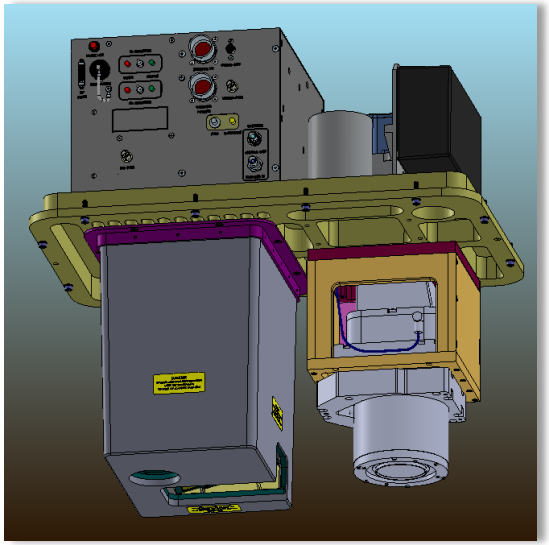
LeahAWasser

NEON Remote Sensing Payload

Spectral range	380-2510 nm
Spectral sampling (FWHM)	6 nm
IFOV	1.0 milliradian
Cross-track pixels	> 600 pixels
Cross-track swath	1.0 km @ 1000m altitude

NEON Imaging Spectrometer: high-fidelity visible-to-shortwave infrared (VSWIR) imaging spectrometer built by JPL based on AVIRISng

Waveform LiDAR		Digital Camera	
Laser wavelength	1064 nm	Spectral band-pass	400-700 visible
Laser pulse repetition freq.	100 kHz	Ground sampling distance	8.5 cm @ 1000 m AGL
Scan frequency	50 Hz		
Flying altitudes	1000-1500 m		
Scan angle	Programmable18.5°		
Point density	< 2-4 ppm		



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