Update on NEON (National Ecological Observatory Network) and Complimentarily with HyspIRI

Thomas Kampe and the AOP Team

National Ecological Observatory Network, Inc.,
1685 38 St, Suite 100, Boulder, CO 80301

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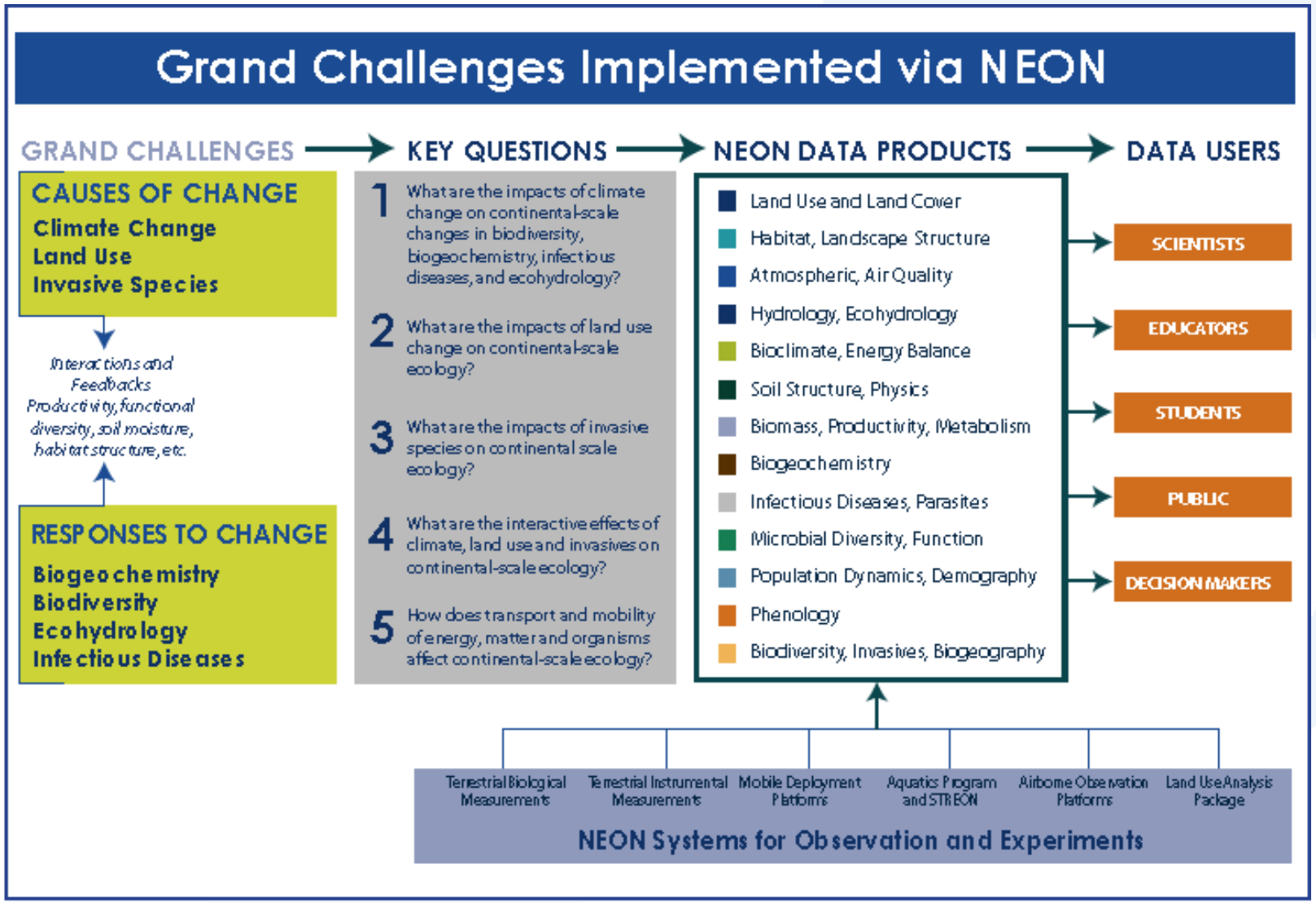
Introduction

The overarching goal of NEON is to enable understanding and forecasting of climate change, land use change, and invasive species on continental-scale ecology *by providing infrastructure* to support research in these areas.

- NEON design is in response to NRC Grand Challenges in Environmental Sciences: Biodiversity, Biogeochemical cycles, Climate change, Ecohydrology, Infectious disease, Invasive species, Land use
- The NEON Project is the observatory funded by the U.S. National Science Foundation (NSF)
- NEON Inc. is a not-for-profit corporation that is funded by the NSF to plan, design, build and operate NEON

Addressing Grand Challenges in Ecology



NEON Infrastructure

- Headquarters (incl. CI, labs, etc.) – Boulder, CO
- 20 Domains
- 20 Core sites (wildland)
- 40 Relocatable sites (land-use sites)
- 36 Aquatic sites
- 3 Airborne Observation Platforms
- 10 Mobile Deployment Platforms (AK, HI, CONUS+PR)
- Cyberinfrastructure/Data Center/LUAP
- STREON Experiment

- 542 Primary (i.e., raw) observations
- 118 Continental scale data products
- ~500 Terabytes data/year
- 5 year construction
- 30 year operations

NEON Science Facilities

Fundamental Sentinel Unit – measurement of key response variables in selected taxa (e.g. plants, birds, insects, …)

Field sampling

Fundamental Instrument Unit – automated sensor for climate & climate-related physical variables in the atmosphere and soil

Towers

Aquatics– field sampling and automated sensors for Algal cell count, macroinvertebrate biovolume, stream discharge, water height

Surface and ground water

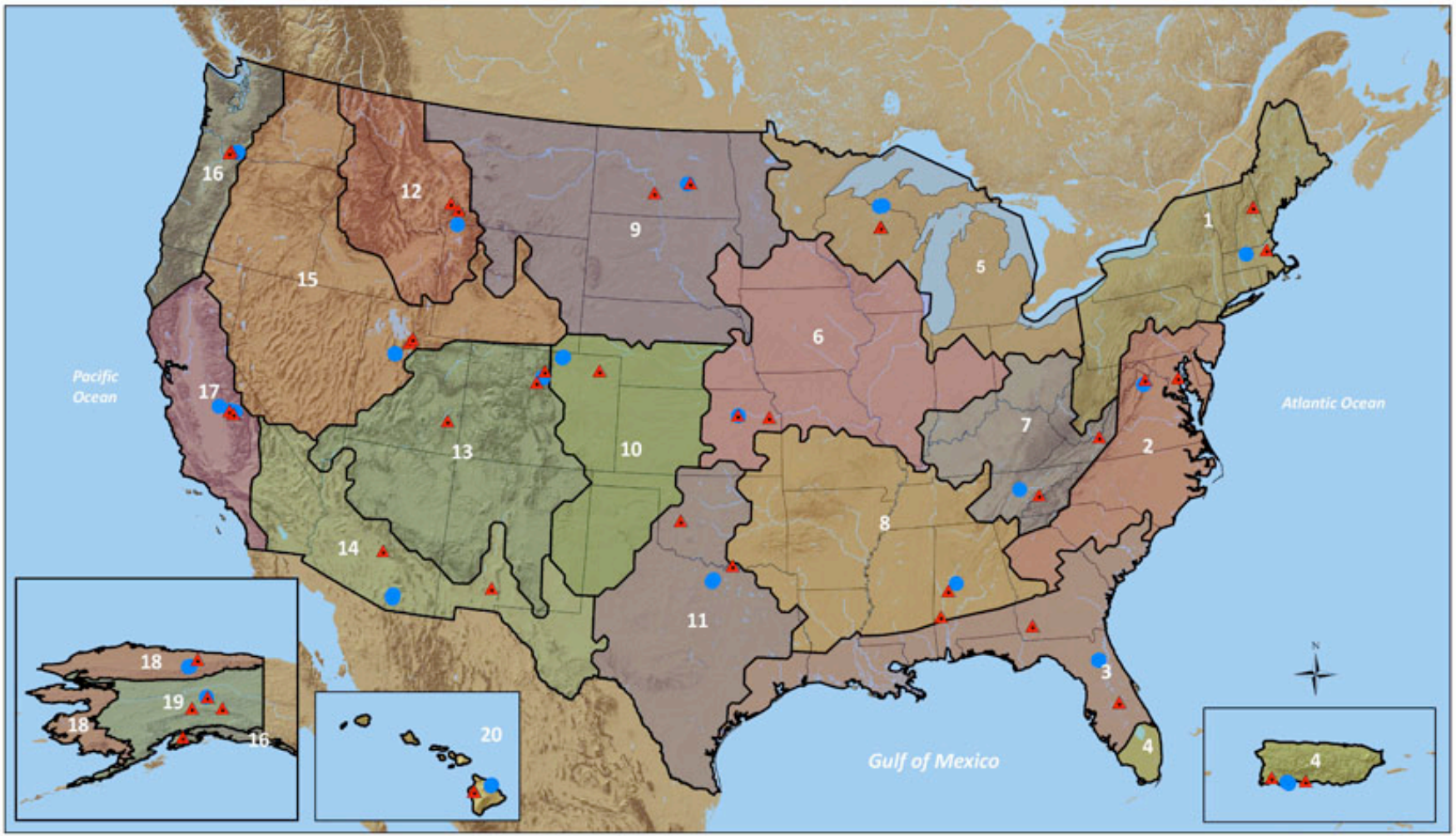
Airborne Observation Platform – remote sensing observations of land-use change, and vegetation biochemistry and structure

Aircraft

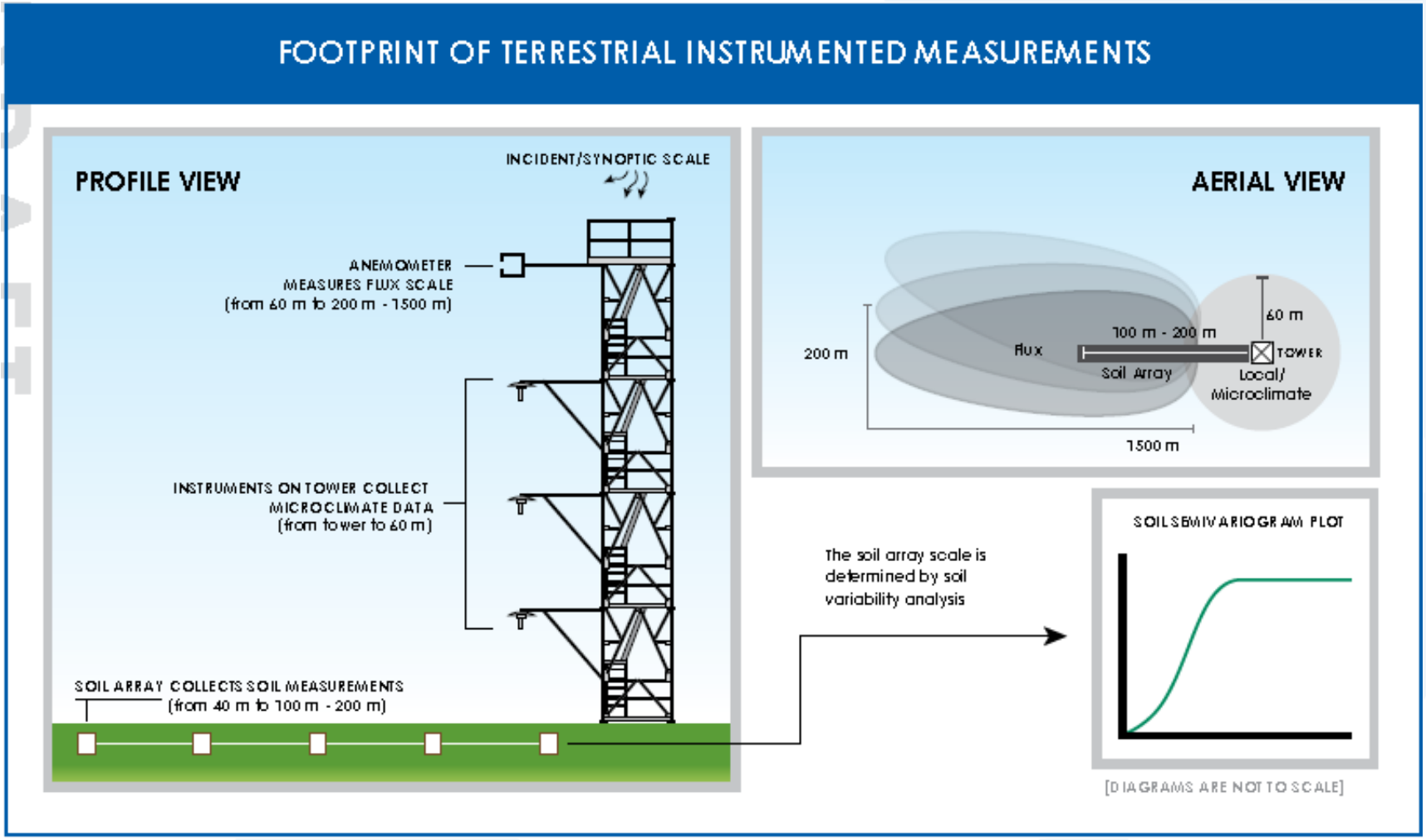
Land Use Analysis Package – land-use, land management and other national datasets plus satellite observations

Satellite Data

National Observatory: 20 Eco-climatic Domains



Terrestrial Instrument Measurements



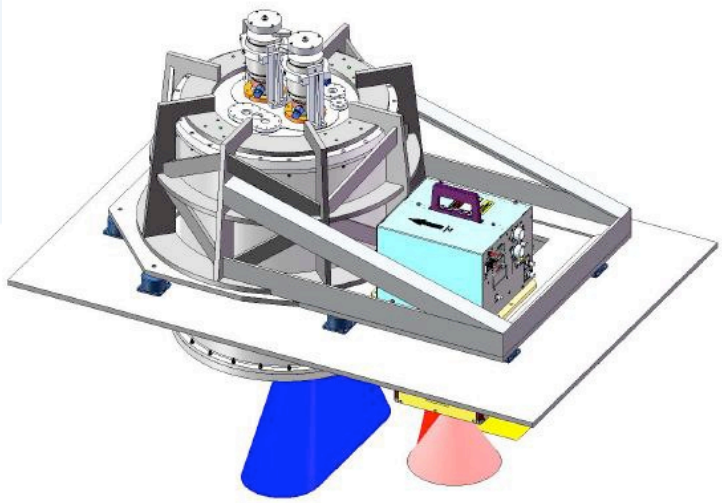
Role of the Airborne Observation Platform

- AOP will observe land use drivers and ecosystem responses surrounding NEON flux tower sites
  - Land cover
  - Vegetation structure
  - Invasive plant species
  - Biochemical and biophysical properties
  - Ecosystem functioning

- Bridge scales from organism and stand scales (e.g., meter-scale) to the scale of satellite-based remote sensing
- Connection to satellite observations (coverage of 300 km^2 about each site)

NEON Airborne Observation Platform (AOP)

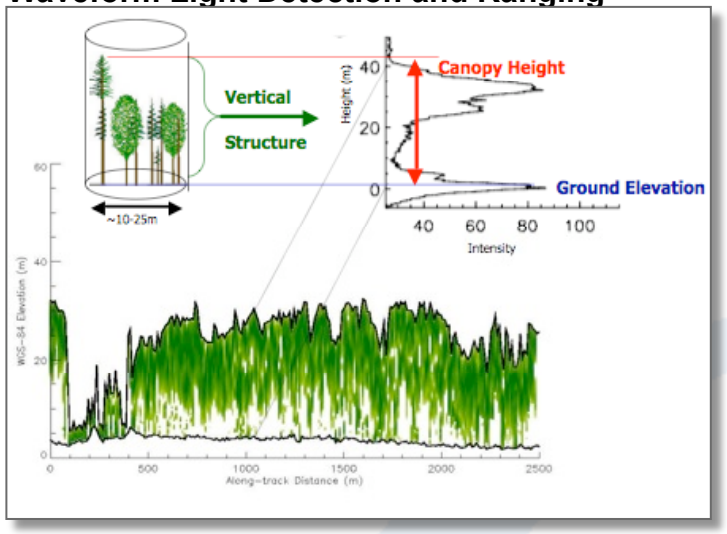
- Three airborne remote sensing payloads:
  - Waveform-LiDAR altimeter
  - Imaging spectrometer
  - High-resolution digital camera
  - GPS-Inertial measurement unit
- Leased Twin Otter aircraft
- Instrumentation maintenance and calibration facility
- Science and flight operations



9

Integrated Airborne Observations

Waveform Light Detection and Ranging



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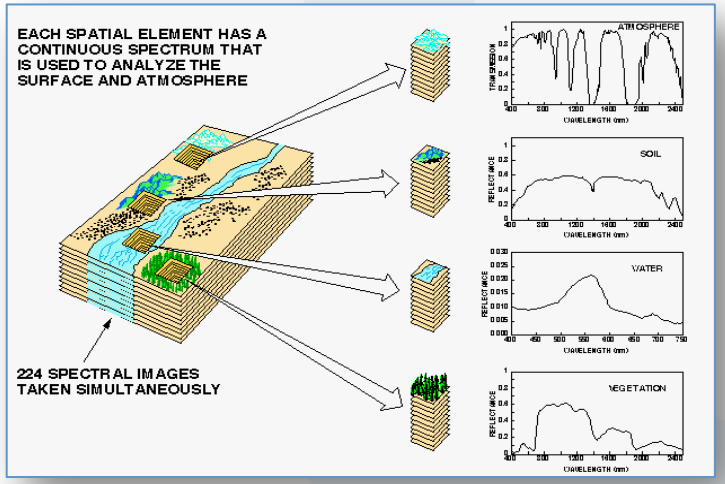
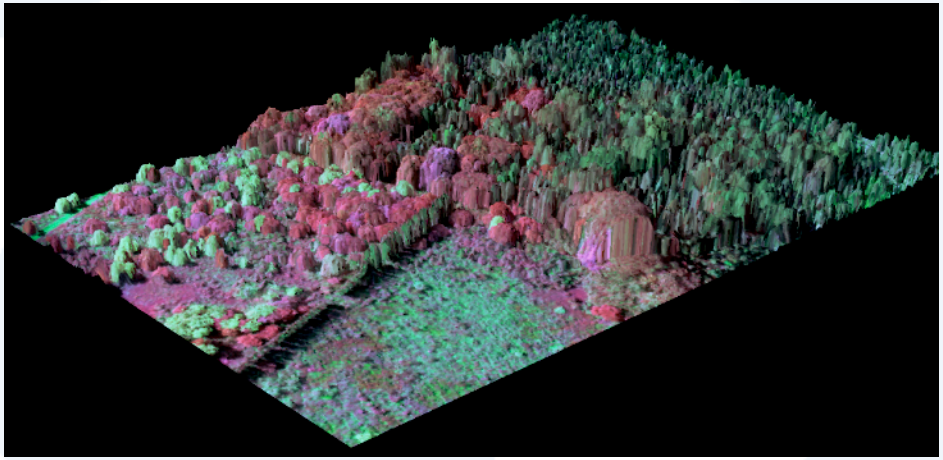
High-fidelity Imaging Spectroscopy

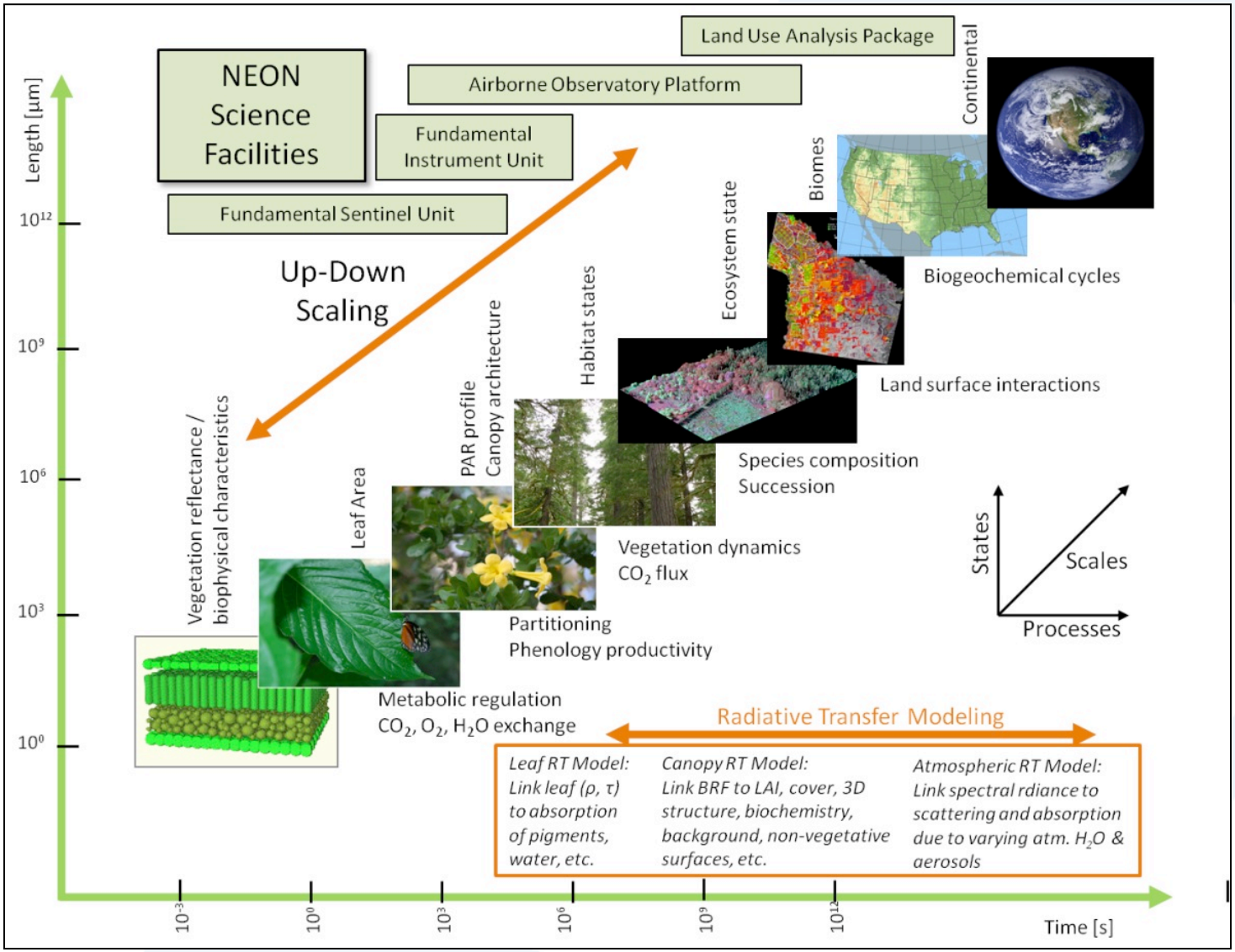


- LiDAR Altimetry to measure 3-D vegetation structure
  - —sub-canopy topography
  - —mapping of vegetation height
  - — Mapping of cover and canopy structure
  - —Biomass



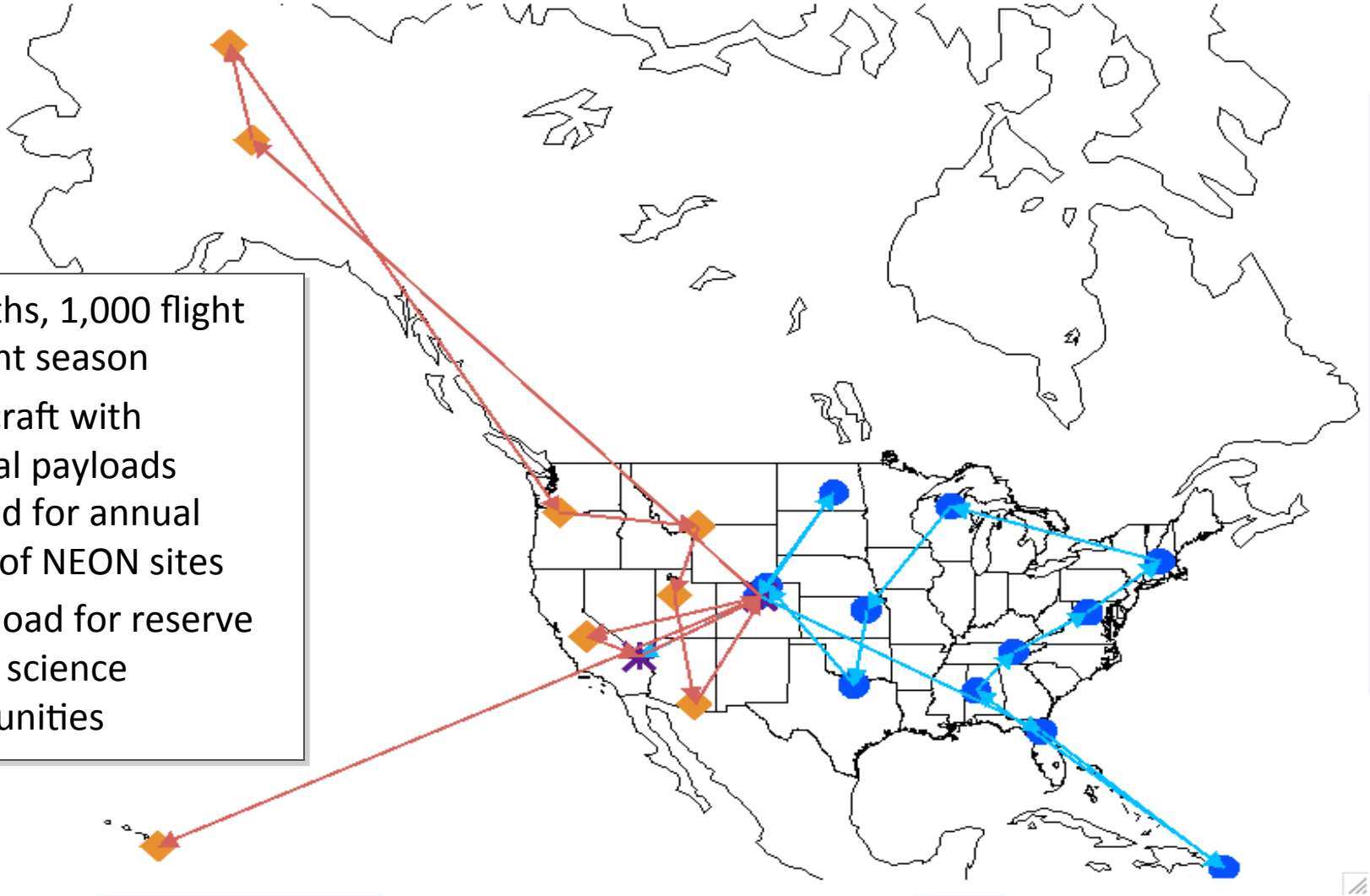
- Spectroscopy
  - —Determine biochemical & biophysical properties of vegetation
  - —Cover type/fraction
- Information contained in subtle variations in surface reflectance

Spatial Scaling Strategy



AOP Flight Operations

- 7-months, 1,000 flight hrs flight season
- 2.3 aircraft with identical payloads required for annual survey of NEON sites
- 3rd Payload for reserve & new science opportunities

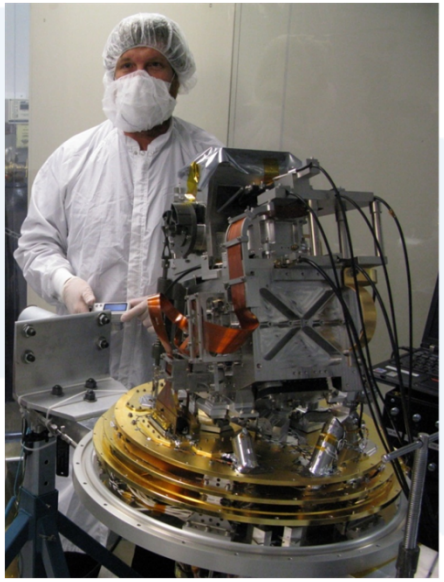


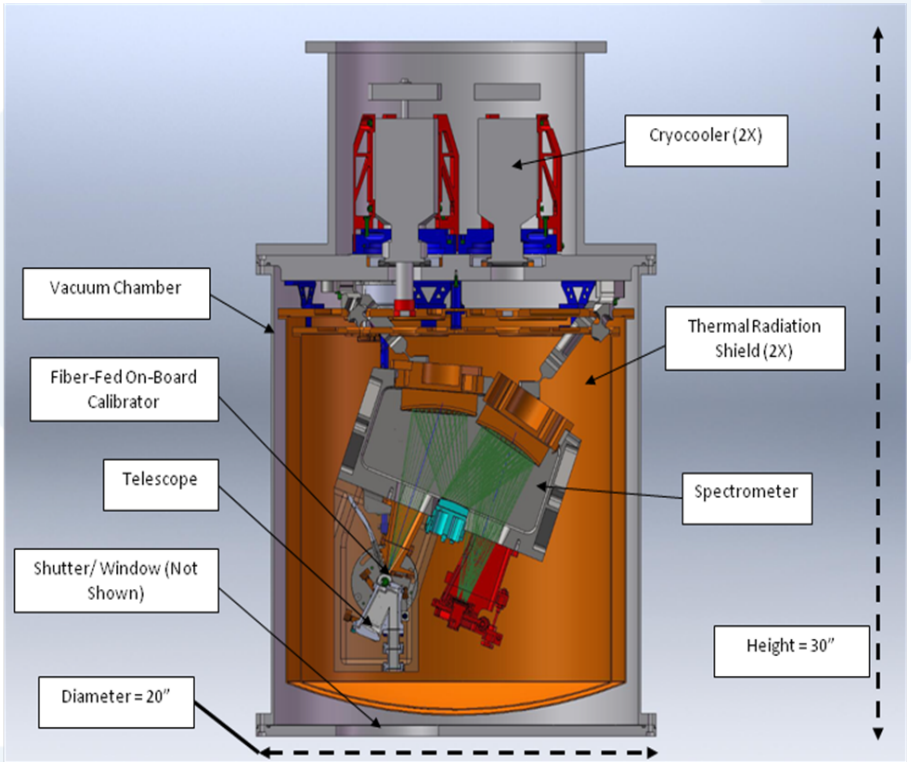
Imaging Spectrometer Development Status

- In Sept 2009, NEON Inc. received Stimulus funding for the development of the NEON Imaging Spectrometer Design Verification Unit (NISDVU)
- The NISDVU is currently being developed at NASA JPL
- Goals:
  - Verification of imaging spectrometer design, performance, and operations
  - Provide a clear demonstration that a significant portion of AOP development risk has been retired
  - Ensure that imaging spectrometer performance requirements are met prior to committing to the build of NIS units 2 and 3
- Prototype science algorithm development
- Test flights to validate laboratory radiometric calibration of the DVU and instrument boresight and cross-calibration with existing heritage instruments (i.e., AVIRIS)
- 24-month program - complete in December 2011

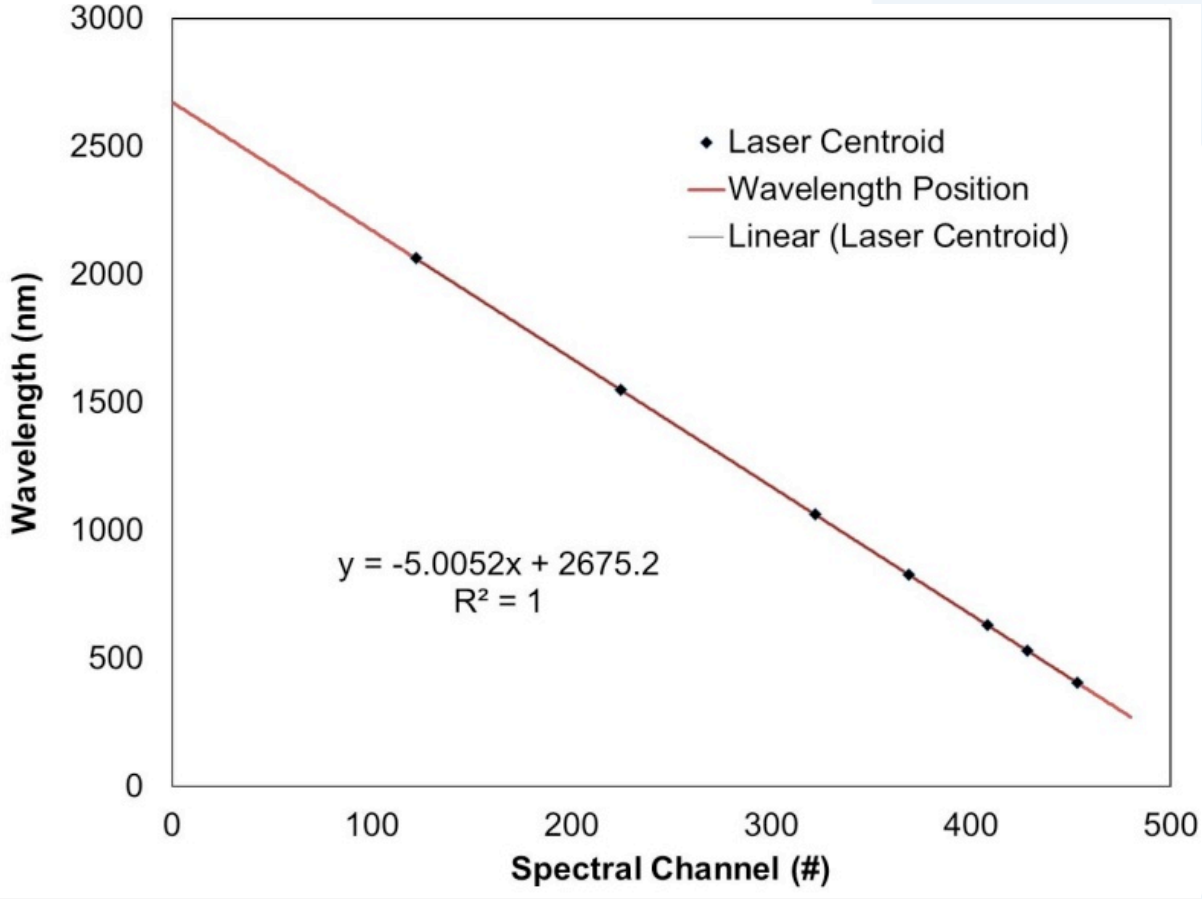
NEON Imaging Spectrometer

Spectral range	380 to 2510 nm
Spectral resolution	10 nm
Spectral sampling	5 nm
Spatial Registration	≤ 0.05 pixel
Radiometric Accuracy	> 95% absolute
Radiometric precision	SNR > 1000 @ 550 nm SNR > 1000 @ 2100 nm
Dynamic Range	0 to saturation radiance
Sensor IFOV	1 milliradian
Sensor FOV	34 degrees
Spectral & Spatial response uniformity	≥ 95%
Cross-track pixels	> 600 pixels
Cross-track swath	1.0 km @ 1000 altitude





Current Status and Measured Performance



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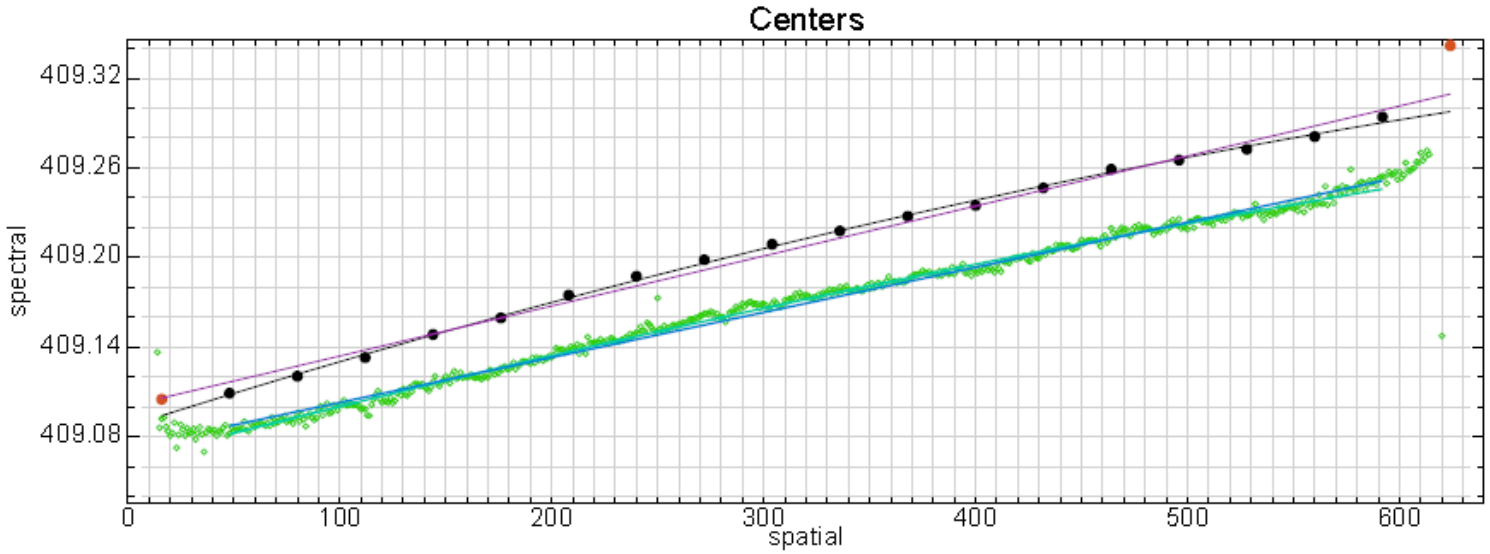
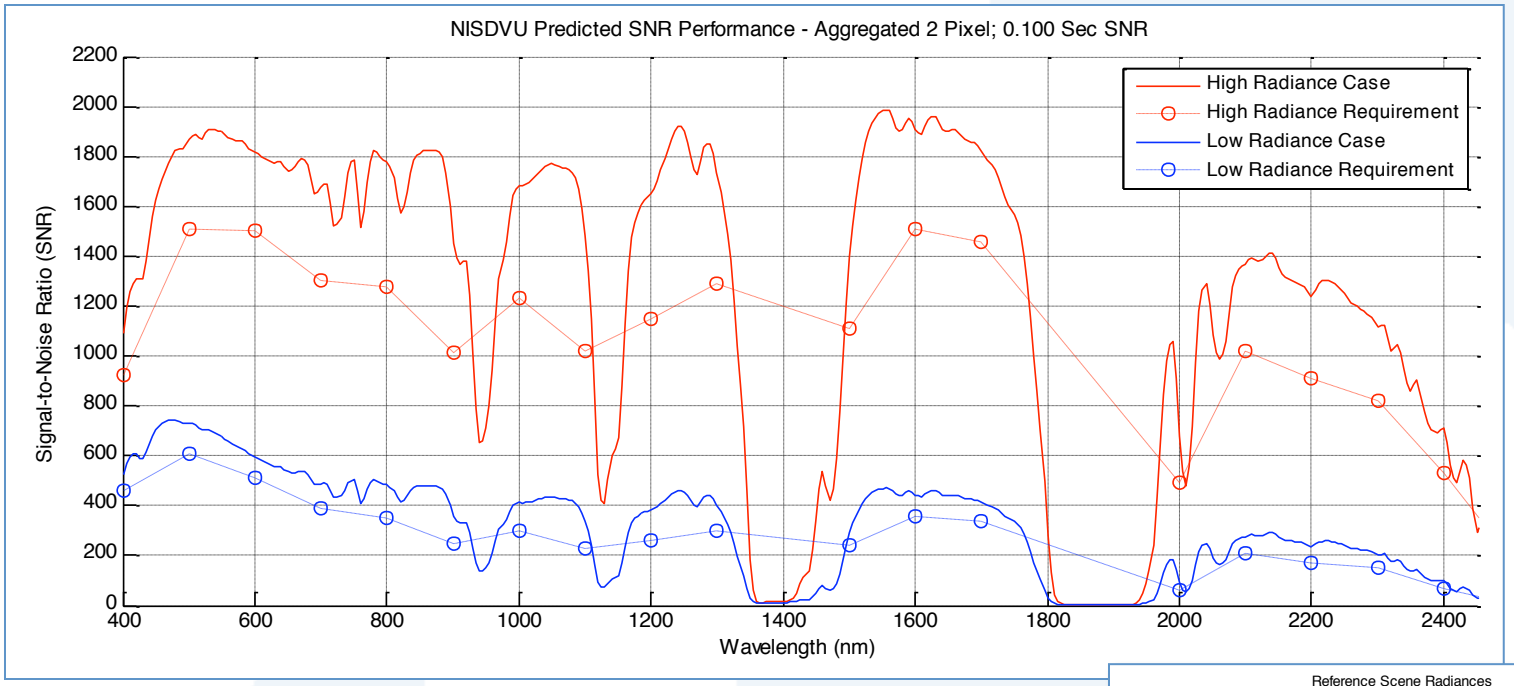
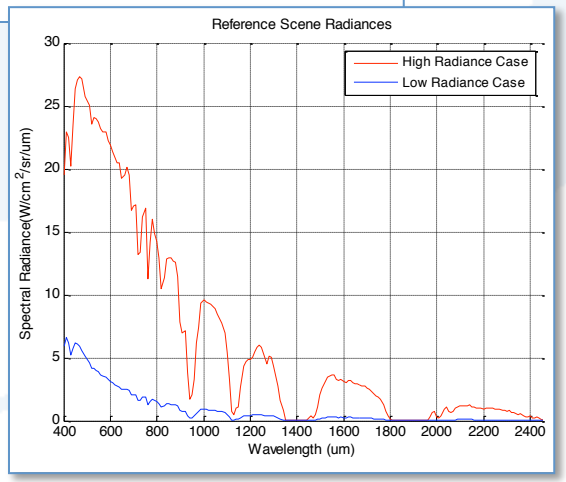


- NISDVU in cold alignment and nearly complete
- Results from cold cycle 5
  - Spectral smile <1%
  - Small amount of FPA clocking required (15-20% pixel)

Predicted System-Level Performance



- Predicted SNR exceeds requirement over full VIS to SWIR band
- Predictions account for measured component data



Representative Data Acquisitions

- **NEON 2010 Pathfinder Campaign**

High-Level Goals

Collect a combined waveform LiDAR and spectrometer dataset
Prototype ground truth measurement & field sampling techniques that will be required for validation of higher level data products

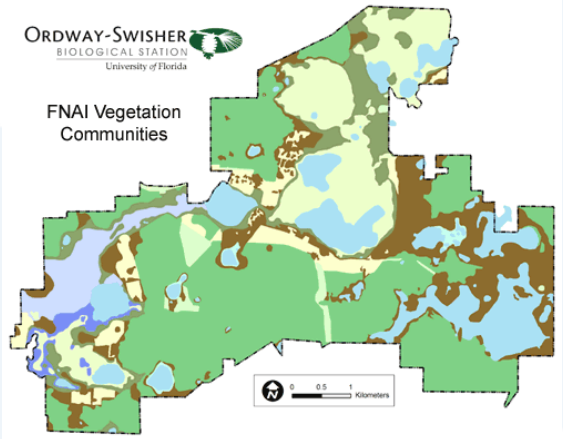
AOP Goals

Reduce sensor data product development risk
Develop prototype field and airborne measurement techniques
Develop ground validation techniques
Develop data processing algorithms
Inform validation of atmospheric correction methodologies in a humid environment

Terrestrial Biology Goals

Develop field training and data collection protocols
Collect ground-based data to calibrate airborne data
Determine time-frame in which ground data must be collected
Prototype plot design for measuring plant biodiversity
Assess ability of airborne platform to monitor invasive species

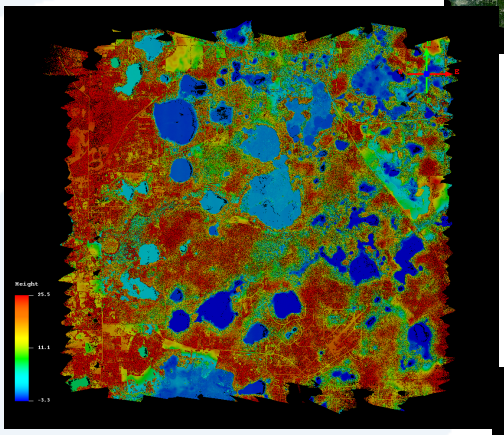
- Twin Otter Aircraft
- NASA AVIRIS Spectrometer
- NCALM LiDAR



- Florida study areas:
  - Ordway-Swisher Biological Station
  - Donaldson Plantation
  - Calibration Sites

Pathfinder 2010 Airborne and Satellite Observations

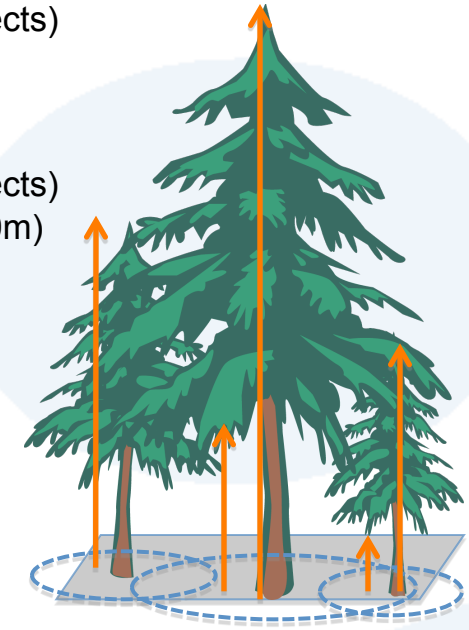
- JPL AVIRIS
  - 9/4/10 OSBS morning flight
  - 9/6/10 Donaldson Plantation
  - 9/10/10 OSBS mid-day flight
- NCALM flying an Optech Gemini
  - 8/31/10 Aquatic Sites
  - 9/1/10 OSBS
  - 9/2/10 Donaldson Plantation
  - 9/3/10 Ashley Prairie
- Satellite Observations
  - Hyperion and ALI tasked
  - Landsat 5 and 7 overpasses
  - MODIS overpasses



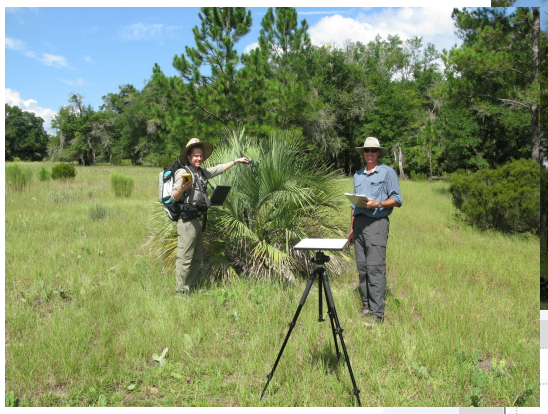
Pathfinder 2010 Ground Measurements

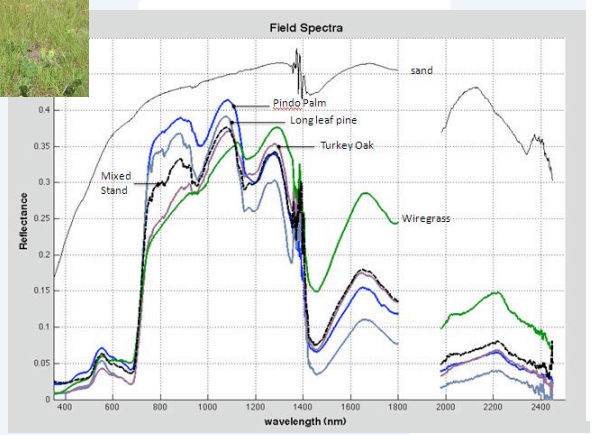
- Airborne Observation Team
  - Atmospheric - CIMEL
  - Weather – Kestrel pocket weather station
  - Reflectance – ASD measurements
    - Above canopy long-leaf pine, turkey oak, and mix from an aerial boom lift
    - Ground measurements of short wire grass, fennel, and pindo palm
    - Radiometric calibration sites
  - Leaf Area Index (along several 500m long transects)
  - Differential GPS base stations

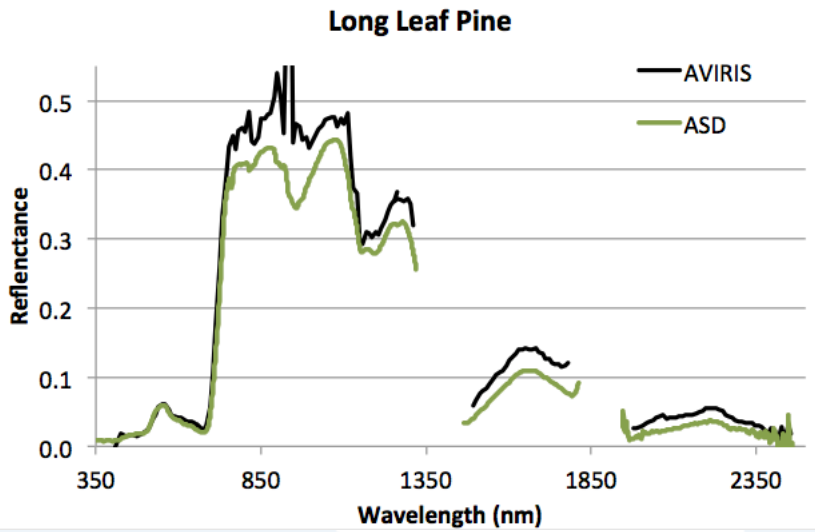
- Terrestrial Biology Team
  - Leaf Area Index (along several 500m long transects)
  - Vegetation Structure (along small plot 20m x 120m)
    - Canopy diameter
    - Diameter at breast height, DBH
    - Height
    - Height to first branch
    - Species ID
  - Biodiversity (several locations across site)
    - Plant species richness
    - Locations of invasive Pindo Palm

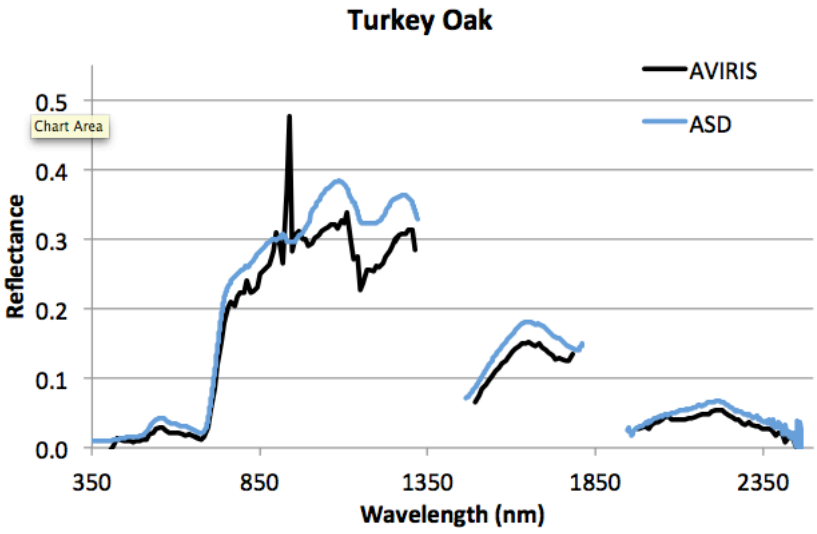


Comparison of JPL AVIRIS Spectral Reflectance With ASD Ground Measurements









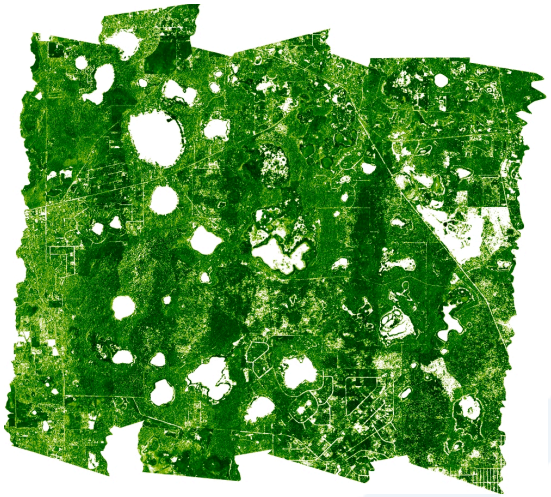
Pathfinder 2010 Prototype Results To Date

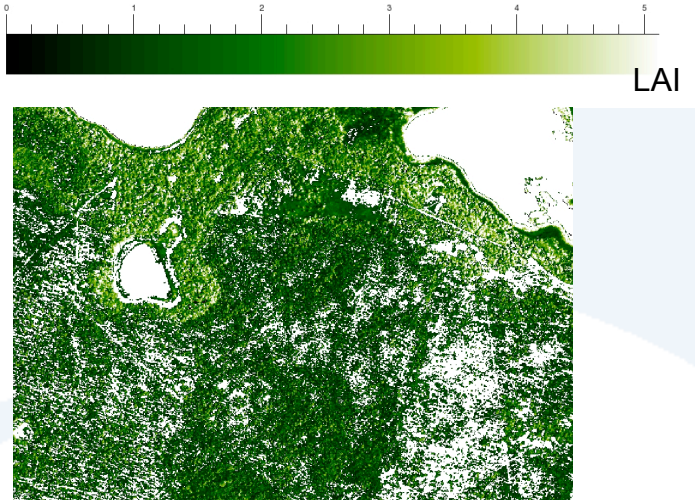
- Use the Pathfinder 2010 data collected over Ordway-Swisher Biological Station and Donaldson Plantation to inform spectrometer and LiDAR algorithm flow and identify required algorithm/ processing steps
  - Full end-to-end view of Level 0 raw data through Level 4 science data products

- Spectrometer and LiDAR Prototype Data Sets
  - Nine spectral inversion algorithms are applied to the imagery to prototype six AOP Level 4 products including:
    - Bioclimate_004 Leaf Area Index
    - Biogeochemistry_009 Canopy Nitrogen
    - Biogeochemistry_010 Canopy Water Content
    - Biogeochemistry_011 Canopy Xanthophyll Cycle (PRI)
    - Biogeochemistry_012 Canopy Chlorophyll
    - Biogeochemistry_013 Canopy Lignin
    - Cellulose
  - A basic ground finding algorithm is applied along with COTS software processing in Quick Terrain Modeler and ENVI to prototype three AOP Level 4 products including:
    - Land_Use_002 Elevation (digital elevation model DEM)
    - Land_Use_004 Slope and Aspect
    - Biodiversity_018 Ecosystem Structure (canopy height model CHM)
    - Digital surface models (DSM) are also required in order to create the canopy height models

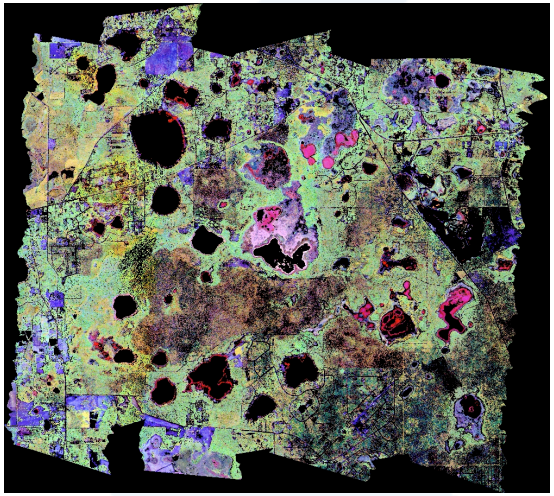
22

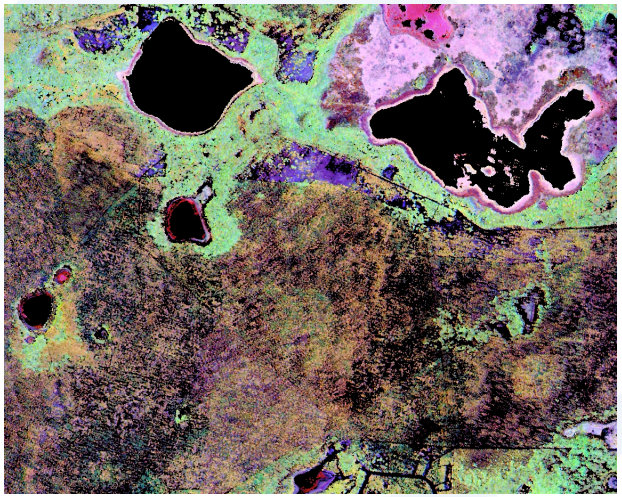
Spectrometer Prototype Data Sets:





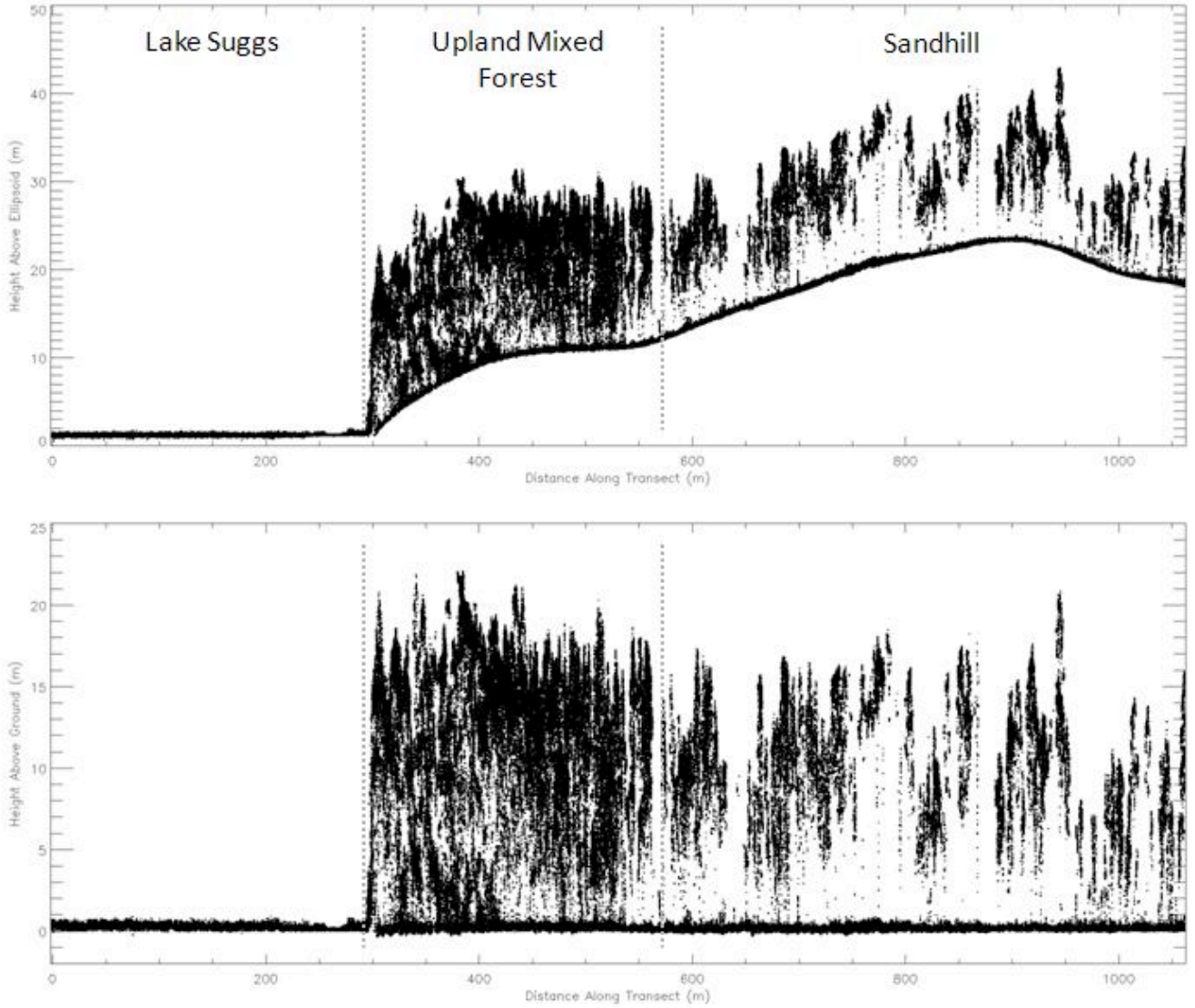
Spectrometer Prototype Data Sets: Leaf Area Index





Spectrometer Prototype Data Sets: R,G,B: Water, Chlorophyll, Nitrogen

Discrete LiDAR Point Cloud Visualization:



Data from Prototype Campaign available at:

http://neoninc.org/pds/

Prototype Data Sharing - Windows Internet Explorer provided by NEON

http://neoninc.org/pds/

View Favorites Tools Help

NEON Prototype Data Sharing

National Ecological Observatory Network

Prototype Data Sharing

Welcome to NEON's Prototype Data Sharing (PDS) system. The PDS allows you to browse various "prototype" data sets that are available for limited use. It is important to understand that the data, metadata, and file formats distributed do not necessarily correspond to those planned for Operations.

The grid below lists the datasets that are currently available, along with descriptions of their spatial and temporal range as well as format and size. You may sort the list by any of the columns by clicking on its heading. Entering search terms in the box provided will immediately filter the list to show only those items that match, regardless of the column in which the match appears.

To request access to any of the datasets, please click the appropriate [Request] link below. You will then be presented with a page containing the detailed metadata associated with the data and instructions of how to request the data for your use.

Copy CSV Excel PDF Print

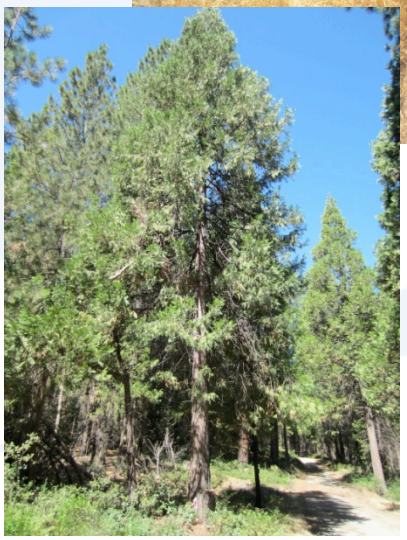
Search:

Link	Description	Contact	Size	Format	Notes
Request	Reaeration & Discharge Rating Curve Data	K. Goodman	20.5 MB	.xls	Single archive file contining .xls files for water chemestry, reaeration rates, and discharge rating curves.
Request	Leaf Area Index & Vegetation Structure Data from D3	C. Meier	500 KB	ASCII (csv)	Single archive file containing individual data files (LAI & VS for Ordway-Swisher and Donaldson sites).
Request	NEON Terrestrial Insect DNA Barcode Library	C. Gibson	1.9 GB	jpg; ab1; xls	CO1 gene reads (images and both traces) and associated metadata, averaging 1.2 MB per specimen.
Request	Soil Temperature And Soil Moisture Data From NEON Candidate Sites	E. Ayres	1.2 MB	.txt (tab delimited)	Single archive file containing 60 site files each detailing ~130 locations in the expected airshed.
Request	Pathfinder Discrete LIDAR, Donaldson Plantation	T. Kampe	5.5 GB	.las	17 separate flightline archives, averaging 340 MB each.
Request	Pathfinder Discrete LIDAR, Ashley Prairie	T. Kampe	1.9 GB	.las	10 separate flightline archives, averaging 190 MB each.
Request	Pathfinder Spectrometer, OSBS Morning Flight	T. Kampe	18 GB	ENVI	16 separate flightline archives, averaging 1.2 GB each.
Request	Pathfinder Discrete LIDAR, OSBS	T. Kampe	15 GB	.las	33 separate flightline archives, averaging 450 MB each.
Request	Pathfinder Spectrometer, OSBS Mid-day Flight	T. Kampe	21 GB	ENVI	16 separate flightline archives, averaging 1.4 GB each.
Request	Pathfinder Spectrometer, Donaldson Plantation	T. Kampe	11 GB	ENVI	14 separate flightline archives, averaging 800 MB each.
Request	Pathfinder Discrete LIDAR, Aquatic Sites	T. Kampe	4.2 GB	.las	18 separate flightline archives, averaging 233 MB each.
Request	Pathfinder Ancillary Ground Data	T. Kampe	10.1 MB	various	Atmospheric, meteorological, and spectral reflectance measurements collected on the ground during the Pathfinder Campaign.

There are currently 12 prototype datasets available.

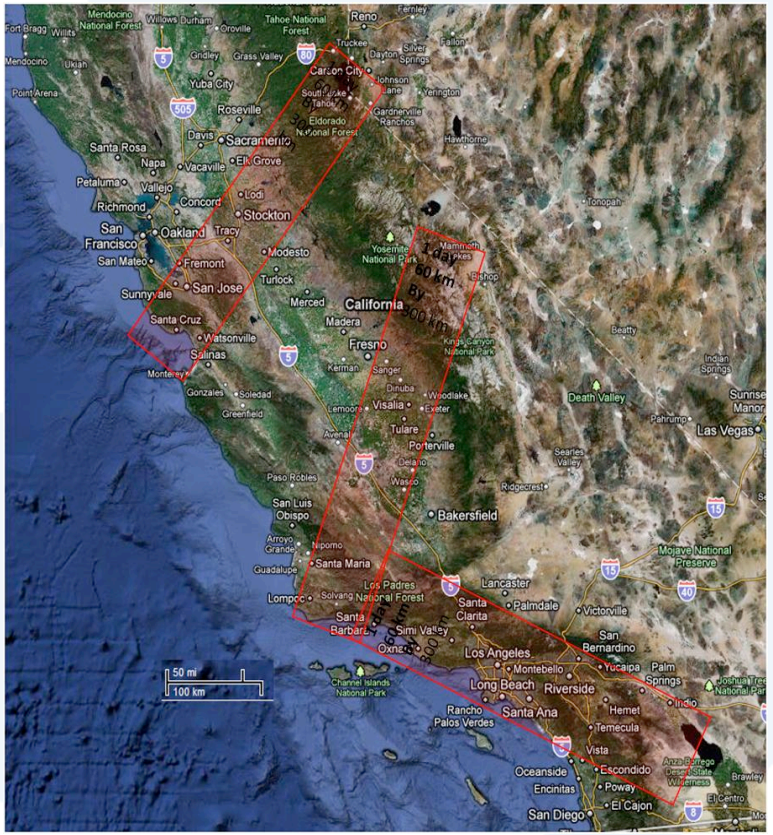
Upcoming 2011 Pathfinder Flight Campaign

- Domain 17 Sites (Southern Sierra, California)
- Flying the NASA AVIRIS imaging spectrometer
- San Joaquin Experimental Range
  - Open woodland dominated by oaks (blue and interior live oaks) and gray pine with scattered shrubs
  - 1000 ft. elevation
- Soaproot Saddle, Upper Teakettle
  - Southern Sierra pine/fir forests
  - 5000 – 7500 ft. elevation
- Science focus:
  - Assessing rangeland dry matter
  - Species distributions



Candidate Opportunity for Interaction with HyspIRI

- **HyspIRI Preparatory Airborne Activities (Summer of 2012)**
  - Obtain precursor science data representative of what could be expected from HyspIRI
  - Fly regions with large climate gradients and diversity
  - Large areas; 3 seasons; ≥ 2 years
  - Acquisition from ER-2 (20 km native resolution; aggregated to 60 km to match HyspIRI)
- **NEON's Role**
  - Early AVIRIS flight over Domain 17 sites (2011) – 4m resolution
  - Underflights of ER-2 AVIRIS (20km) with NISDVU @ 1-km altitude (1m res)
  - Concurrent satellite acquisitions (MODIS, Landsat, Hyperion)
  - Supporting ground measurements (field spectroscopic measurements, LAI, radiometric calibration, AOD, etc)



Goals:

- Obtain spectroscopic data at multiple spatial scales useful for assessing sampling strategies for the extrapolation of biophysical processes
- Spectroscopic and lidar data at 1-m resolution to support HyspIRI science product development

Potential NEON Synergy with HyspIRI

- **NEON Ground/Airborne Validation of HyspIRI**
  - Well-validated annual measurements at 60 sites across the continental US –grasslands, deserts, agricultural areas, deciduous forest, conifer forest, tundra and Arctic
  - Vegetation chemical & structural information measured at all sites; site-specific spectral databases developed
  - FSU can provide ground validation of AOP and HyspIRI measurements
  - FIU towers provide point or airshed measurements of CO_2, aerosol optical depth and other atmospheric constituents
- **Bridging to Continental Scale**
  - HyspIRI continental-wide 60 m spectroscopic data will support NEON's mission to bridge from AOP plot scale to continental scale

28

Potential NEON Synergy with HyspIRI

- **Operational Science Algorithm Development**
  - NEON science algorithms developed over a broad range of ecoregions
  - Algorithms and associated error budgets documented in publically-available ATBDs
  - NEON science algorithms and associated software code to be developed to an operational level
- **Calibration Comparisons with Spaceborne Sensors**
  - Yearly vicarious calibration flights by NEON over well-characterized ground validation sites (e.g., Railroad Valley, Ivanpah Playa)
  - Multi-decadal record of spectral reflectance measurements suitable for calibration comparisons with satellite and other airborne sensors
  - 3rd AOP platform potentially available to support dedicated under-flights of satellite sensors (Landsat, OLI, MODIS, NPOESS VIRRS, HyspIRI)
- **Education**
  - NEON data will be openly available to all potential users
  - NEON AOP data will provide the opportunity for developing broad scientific user community of terrestrial remote sensing information in anticipation of the HyspIRI launch

Current Status

- Design Phase completed in June 2011
- On July 20, 2011, the Natl. Science Foundation announced that it will fund the Construction of the NEON Observatory beginning in late Summer 2011
  - The construction phase, during which the observatory infrastructure will be built out, is expected to extend over five years
  - NEON anticipates beginning to construct the first of its sites in Colorado and New England over the next 12 months
- Test flights of the1st AOP remote sensing payload test flights begin in Spring 2012
  - Remote sensing payload “checkout” flight
  - Vicarious calibration campaign
  - First flight campaigns over NEON sites

The National Ecological Observatory Network (NEON) is a project sponsored by the National Science Foundation and managed under cooperative agreement by NEON, Inc. This material is based in part upon work supported by the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.