The NEON Project and Potential Parameter/Algorithm Validation for HyspIRI

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What is NEON?

- The National Ecological Observatory Network (NEON) is a continental-scale research platform for understanding and forecasting the impacts of climate change, land-use change, and invasive species on ecology
  - Observe both drivers and ecosystem response
- 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 currently led and funded by the NSF to plan, design, build and operate NEON
Science Facilities

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

**Fundamental Instrument Unit** — automated sensors for measurement of climate & climate-related physical variables in atmosphere, soil and water

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

**Land Use Analysis Package** — land-use, land management and other national datasets plus satellite observations
Role of Airborne Remote Sensing

• AOP will observe land use drivers and ecosystem responses surrounding the NEON Core and Re-locatable sites
  – land cover
  – vegetation structure
  – Invasive plant species
  – biochemical and biophysical properties
  – ecosystem functioning

• Bridge scales from organism and stand scales to the scale of satellite based remote sensing
The Airborne System

• Three identical airborne remote sensing instrument payloads
  – Waveform-LiDAR altimeter
  – Imaging spectrometer
  – High-resolution digital camera
  – GPS-Inertial measurement unit
• 2 AOP payloads dedicated to annual surveys of NEON sites
• 3rd payload available for PI-driven science and as “hot back-up”
• Leased aircraft
• Instrumentation maintenance and calibration facility
• Science and flight operations
Measurement Approach

- **Spectroscopy** – vegetation biochemistry and biophysical properties, cover fraction, invasive species
- **LIDAR altimetry** – vegetation structure, cover fraction, biomass
- **High resolution imagery** – fine-scale land cover/land-use, structures, stream morphology
Integrated Observations

- Spectral reflectance signatures of vegetation affected by canopy structure and shadows between canopies

- LiDAR alone provides little information to distinguish plant species and plant functional types
  - Improved estimates of above ground biomass

- Co-location of the LiDAR, spectrometer and camera sensors is necessary to achieve a high degree of registration of data on the ground
Standard AOP Observations

- Annual revisit over each of the NEON core and relocatable ground sites
  - Capture inter-annual trends in ecosystem response, productivity
  - Collect data at or near peak greenness to minimize variation in signal due to phenology
- Coordinated regional observations at high spatial resolution to scale ground sampling, flux tower measurements
  - Bridge scales
  - Observe both “cause and effect”
Example Flight Plan

- 7-months, 1,000 flight hrs flight season
- 2 aircraft with identical payloads
- 3rd Payload for reserve & new science opportunities
Calibration & Validation

- Laboratory calibration of instrumentation
- Vicarious calibration, cross-sensor calibrations (e.g. Ivanpah Playa)
- In-flight calibration of relative sensor pointing offsets
- Aerosol, water vapor correction
- Differential GPS base-station
- Coordinated collection of correlative data
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
  – FSU provides ground validation of AOP measurements
  – FIU towers provide point measurements of CO₂, aerosol, 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
NEON Synergy with HyspIRI

- **Operational Science Algorithm Development**
  - 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 will be developed to an operational level

- **Calibration Comparisons with Spaceborne Sensors**
  - Yearly vicarious calibration flights over well-characterized ground validation sites (e.g., Railroad Valley, Ivanpah Playa)
  - 30-year record of spectral reflectance 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
AOP Development Schedule

- **2008**: Design
- **2009**: Start construction
- **2010**: Construction & commissioning
- **2011**: NPP VIIRS launch (06/2011)
- **2012**: LDCM launch (12/2012)
- **2013**: HysPIRI Mission (2013-2016)
- **2015**: HysPIRI Mission (2013-2016)

Summary

• NEON AOP will provide remote sensing data:
  – on land cover, invasive plant species, canopy properties;
  – bridging scales from organism level (FSU) and stand scales (FIU) to the national scale of satellite based measurements (LUAP)

• Major Milestones:
  – NEON Preliminary Design Review: June, 2009 - completed
  – NEON construction start in Oct. 2010
The National Ecological Observatory Network is a project sponsored by the National Science Foundation and managed under cooperative agreement by NEON Inc.
# Data Products

<table>
<thead>
<tr>
<th>Data Product</th>
<th>Description</th>
<th>Sensor</th>
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<tbody>
<tr>
<td>Leaf water content</td>
<td>Upper canopy leaf water content measured as an equivalent water thickness (EWT)</td>
<td>Imaging Spectrometer</td>
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<tr>
<td>Leaf nitrogen content</td>
<td>Upper canopy nitrogen content</td>
<td>Imaging Spectrometer</td>
</tr>
<tr>
<td>Pigment concentration</td>
<td>Computed vegetation indices sensitivity to concentrations of Chlorophyll (NDVI), Xanthophylls (PRI), carotenoids and anthocyanins</td>
<td>Imaging Spectrometer</td>
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<tr>
<td>Lignin concentration</td>
<td>The Normalized Difference Lignin Index (NDLI) is used to estimate the relative amounts of lignin in structural components of vegetation canopies</td>
<td>Imaging Spectrometer</td>
</tr>
<tr>
<td>Fraction of photosynthetic active radiation</td>
<td>Fraction of photosynthetic active radiation (fPAR) is a measure of available radiation in the specific wavelengths that a canopy absorbs</td>
<td>Imaging Spectrometer</td>
</tr>
<tr>
<td>Albedo</td>
<td>Computed as the fraction of the total incident light striking a surface that is reflected by that surface.</td>
<td>Imaging Spectrometer</td>
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