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

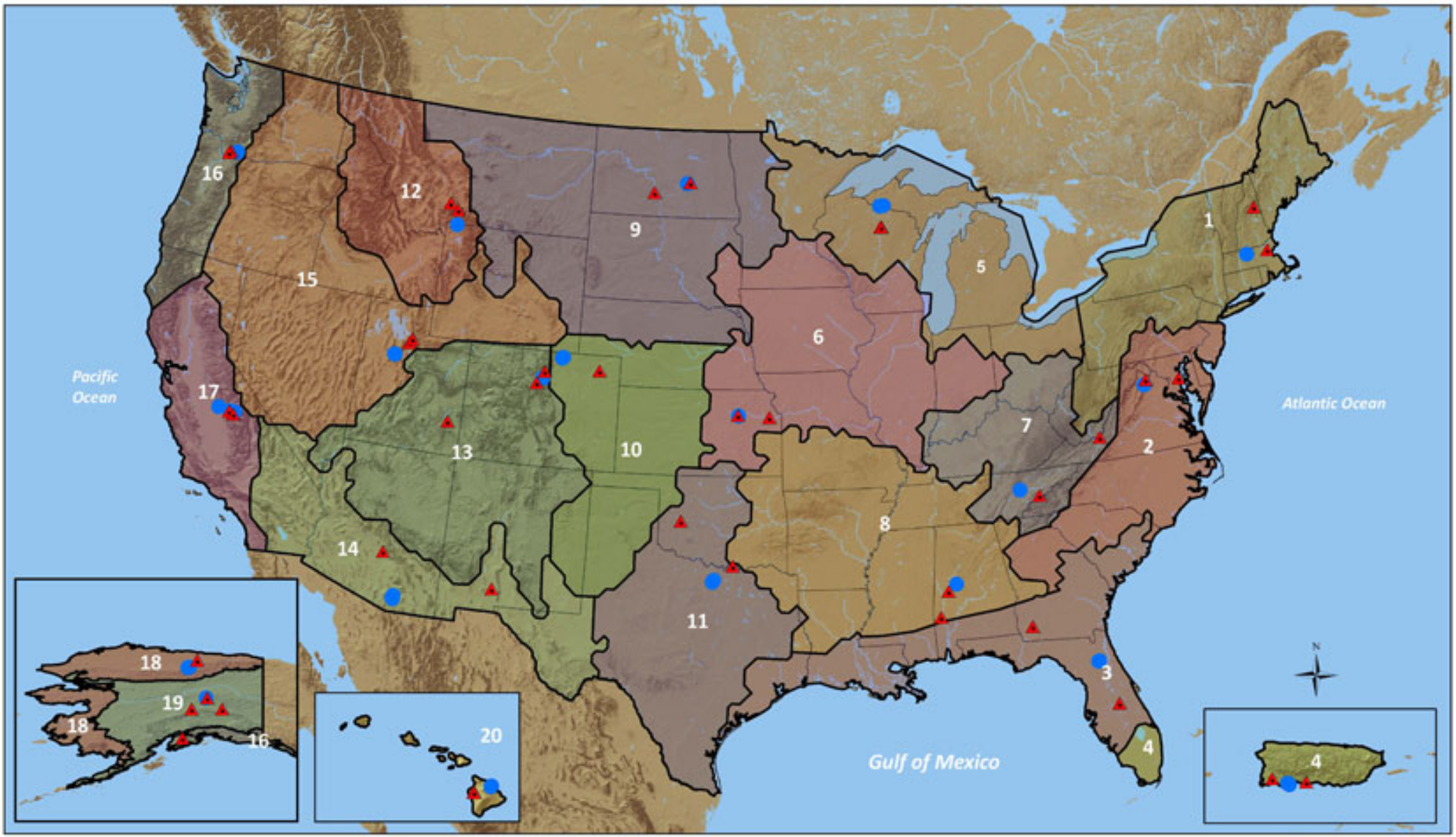
Science Facilities

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



NEON Domains

1 Northeast
2 Mid Atlantic
3 Southeast
4 Atlantic Neotropical
5 Great Lakes
6 Prairie Peninsula
7 Appalachians/Cumberland Plateau
8 Ozarks Complex
9 Northern Plains
10 Central Plains
11 Southern Plains
12 Northern Rockies
13 Southern Rockies/Colorado Plateau
14 Desert Southwest
15 Great Basin
16 Pacific Northwest
17 Pacific Southwest
18 Tundra
19 Taiga
20 Pacific Tropical

Role of Airborne Remote Sensing

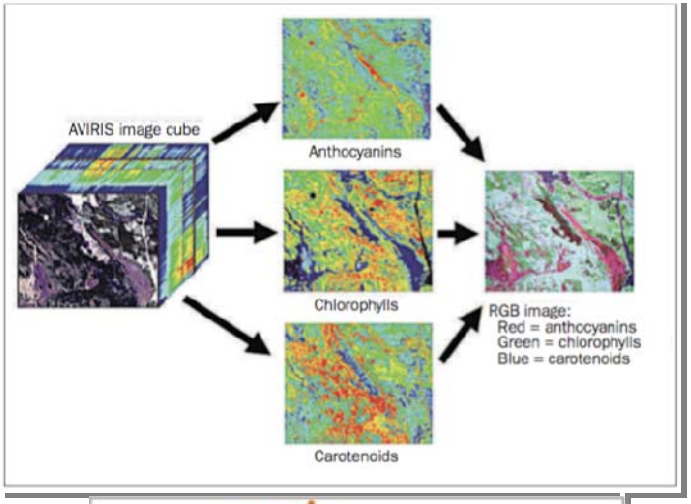
- AOP will observe land use drivers and ecosystem responses surrounding the NEON Core and Re-locatable sites
  - land cover
  - vegetation structure
  - Invasive plant species
  - biochemical and biophysical properties
  - ecosystem functioning
- Bridge scales from organism and stand scales to the scale of satellite based remote sensing

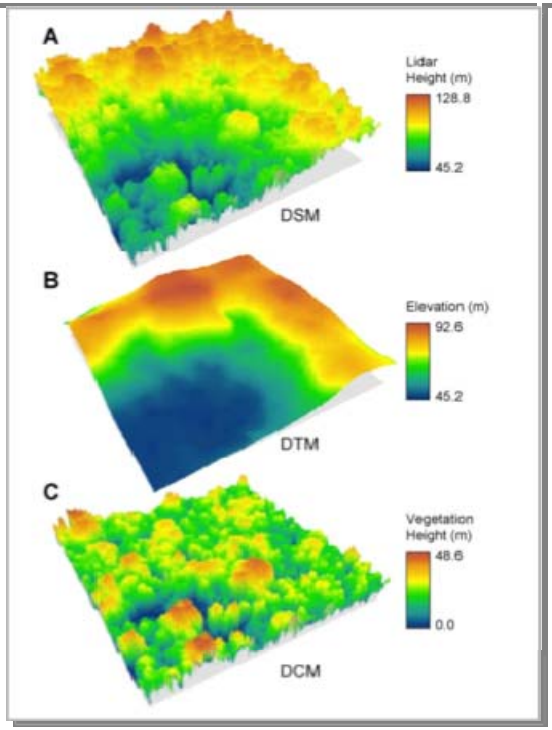
The Airborne System

- 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



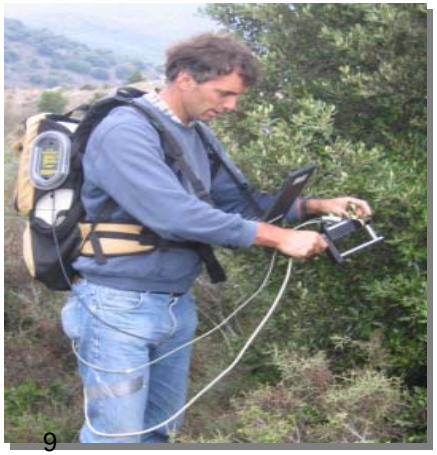


Integrated Observations

- 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

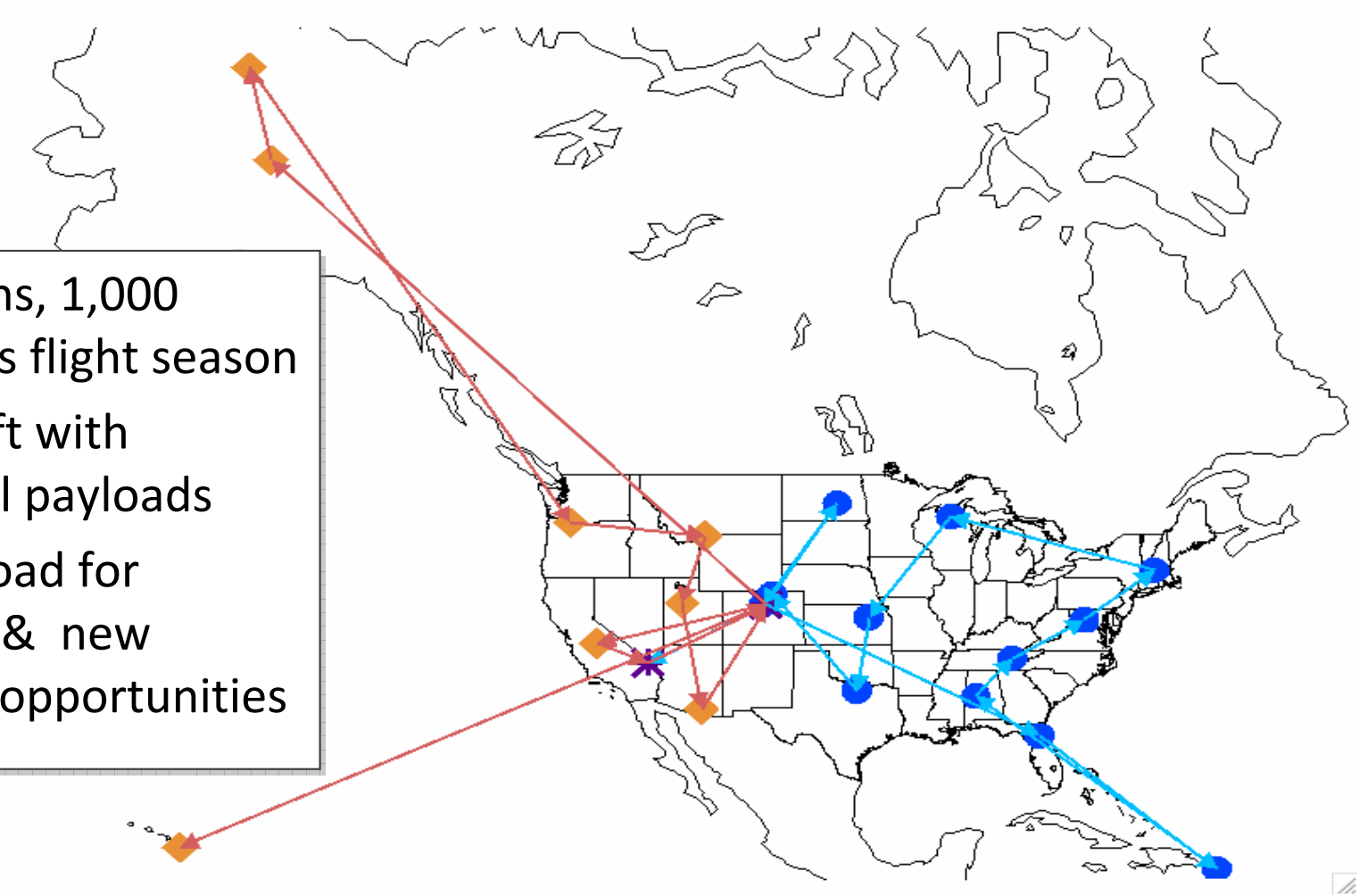
Standard AOP Observations

- 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”



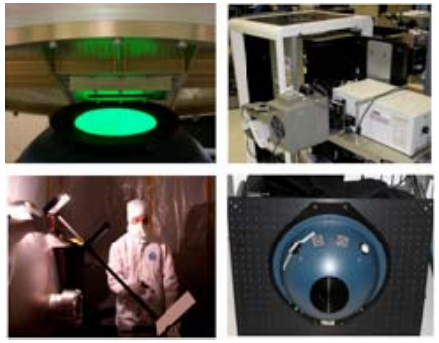
Example Flight Plan

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

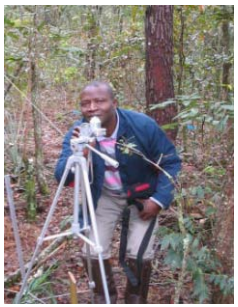


Calibration & Validation

- 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



Courtesy JPL



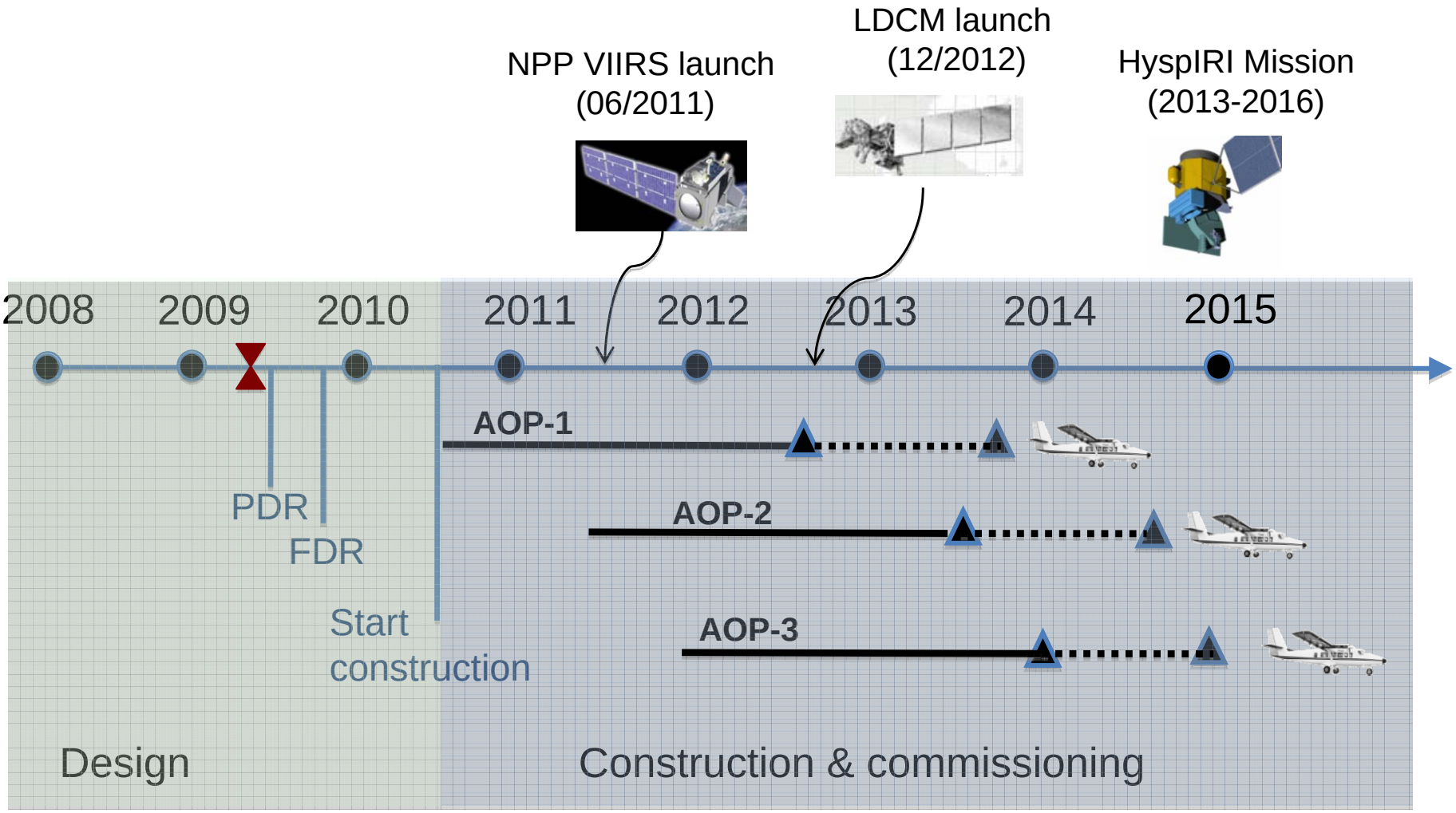
NEON Synergy with HyspIRI

- **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 CO_2, 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



More information available at: http://www.neoninc.org/

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 Final Design Review: Sept./Oct., 2009
  - 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

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