Investigating the impact of spatially-explicit sub-pixel structural variation on the assessment of vegetation structure from imaging spectroscopy data

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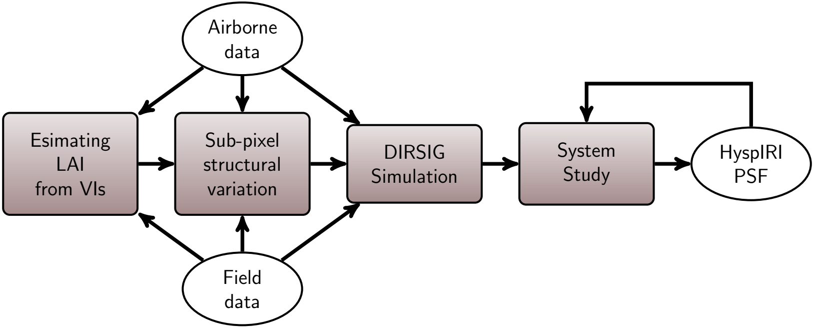
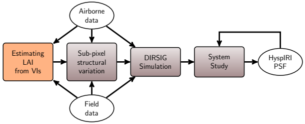
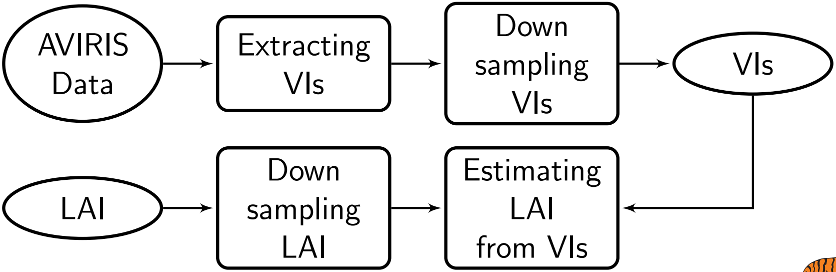
Outline

Introduction
Project outline



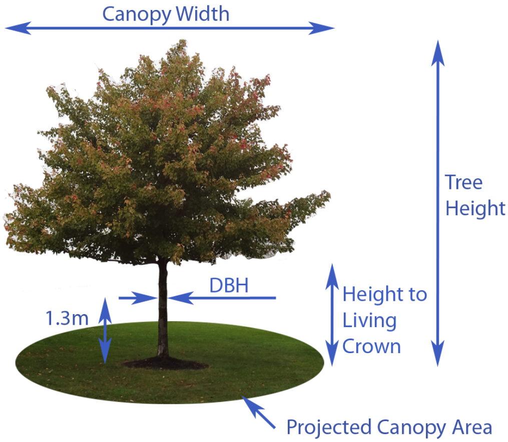
Introduction
Project outline





Introduction

Vegetation structural measurements



- Tree height
- Canopy width
- Height to living crown
- Diameter at breast height (DBH)
- Leaf area index (LAI)

Introduction
Vegetation indices (VIs)

Spectral indices are transformations applied to remotely sensed data to enhance some characteristic of the surface.

Vegetation indices are a type of spectral index for estimating forest biophysical variables.

The most widely used of these transformations is the "normalized difference vegetation index" (NDVI).

Methods

Study area

The National Ecological Observatory Network (NEON), Pacific Southwest Domain (D17)

1. San Joaquin Experiment Range (Core site)
2. Soaproot Saddle (Relocatable site)

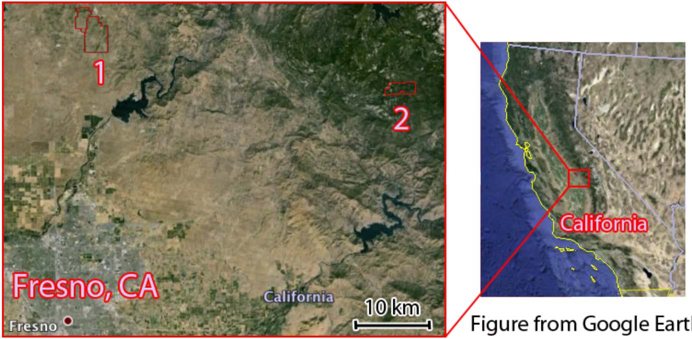


Figure from Google Earth

Methods
Field collection

1. San Joaquin Experiment Range, June 9 - 14, 2013
   12 sites (AOP #): 4, 8, 36, 112, 116, 361, 824, 952

AOP 36

AOP 116

AOP: Airborne Observation Platform

Methods
Field collection

2. Soaproot Saddle, June 16 - 20, 2013
8 sites (AOP #): 43, 63, 95, 143, 299, 331, 555, 1611

AOP 43

AOP 1611

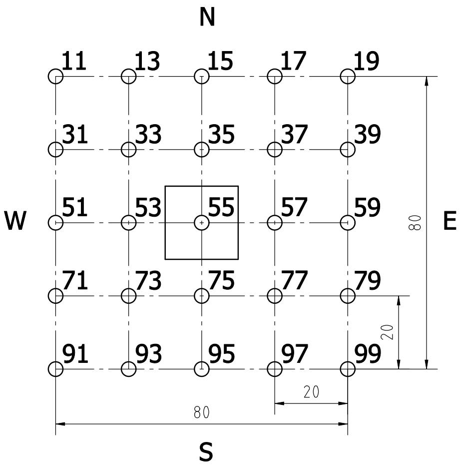
AOP: Airborne Observation Platform

Methods
Airborne collection

AVIRIS data collected during HyspIRI preparatory airborne campaign, summer 2013:

- **June 12, 2013: f130612t01r09 (San Joaquin)**
- **June 12, 2013: f130612t01r07 (Soaproot)**
- June 26, 2013: f130626t01r13 (San Joaquin)
- June 26, 2013: f130626t01r07 (Soaproot)

Methods
Field collection

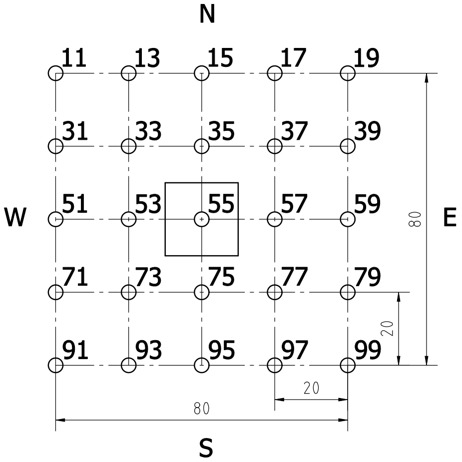


Measurements at NEON's $20 \times 20m$ AOP:

1. Stem maps
2. Height
3. DBH
4. Species

Methods

Field collection



Measurements at each spot within 80 × 80m site:

1. LAI (AccuPAR LP-80)
2. Ground based lidar (SICK LMS-151, RITTL)
3. Spectra (SVC HR-1024i)
4. Grass biomass (only in San Joaquin)
5. GPS position
6. Pictures

Methods

Definitions of vegetation indices

Simple Ratio VI (SR):

$$SR = \frac{R_{800}}{R_{670}}$$

Normalized Difference Vegetation Index (NDVI)

$$NDVI = \frac{R_{800} - R_{670}}{R_{800} + R_{670}}$$

Modified Chlorophyll Absorption Ratio Index (MCARI),
Improved version of MCARI (MCARI2)

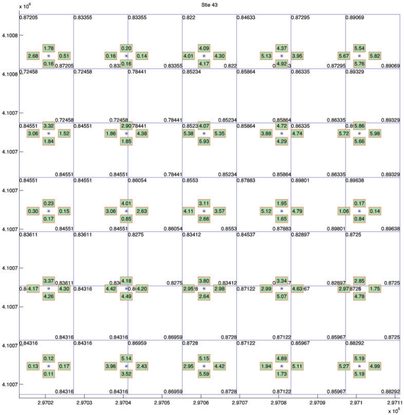
$$MCARI = [(R_{700} - R_{670}) - 0.2(R_{700} - R_{550})](R_{700}/R_{670})$$

Triangular Vegetation Index (TVI), Modified TVI (MTVI1)

Methods

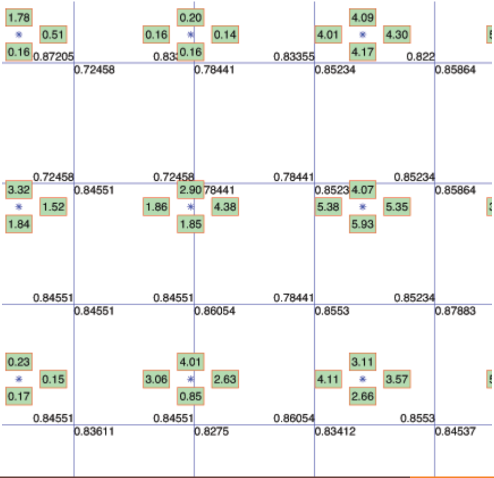
Mapping LAI to VIs

AOP site 43



Methods
Mapping LAI to VIs

AOP site 43



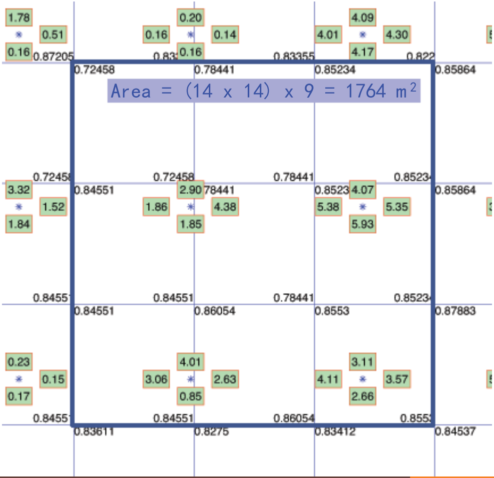
Methods
Mapping LAI to VIs

AOP site 43

Methods

Mapping LAI to VIs

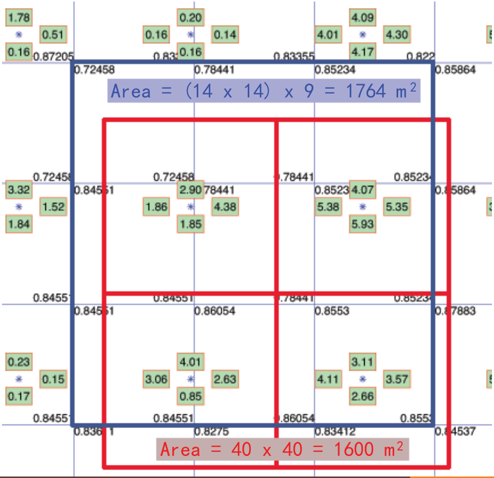
AOP site 43



Methods

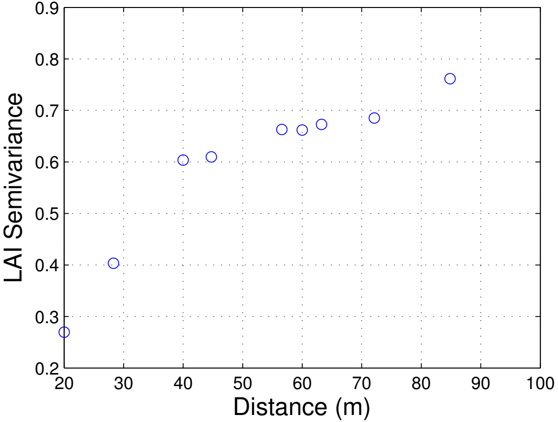
Mapping LAI to VIs

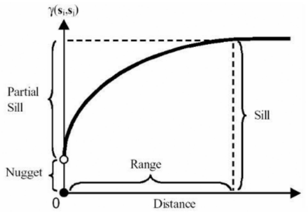
AOP site 43



Methods
Mapping LAI to VIs

Semi-variogram

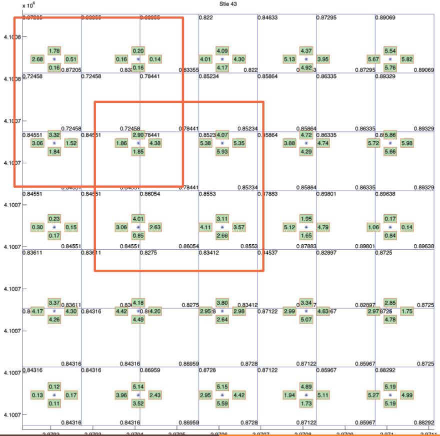




A theoretical semi-variogram.
http://planet.botany.uwc.ac.za/nisl/GIS
/spatial/chap_1_48.htm

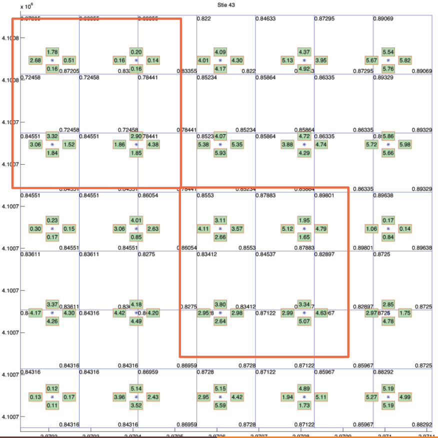
Methods
Mapping LAI to VIs

AOP site 43



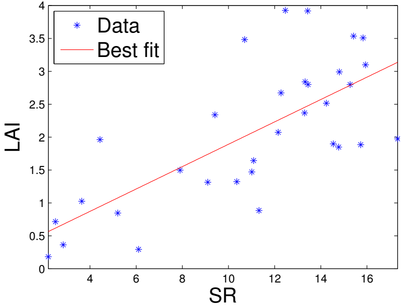
Methods
Mapping LAI to VIs

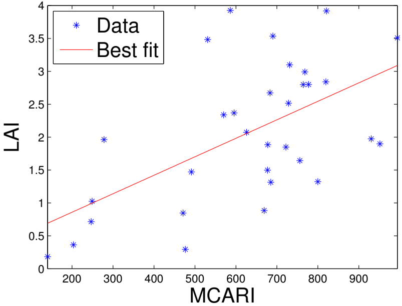
AOP site 43



Results
LAI estimation

Linear function: $LAI = a \cdot VI + b$





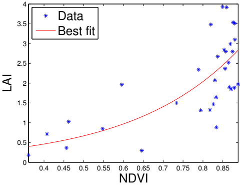
SR
$R^2 = 0.51$

MCARI
$R^2 = 0.33$

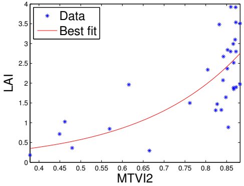
Results

LAI estimation

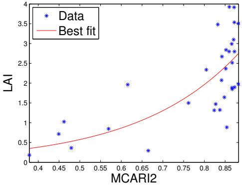
Exponential function: $LAI = a \cdot \exp(b \cdot VI)$



NDVI
$R^2 = 0.52$



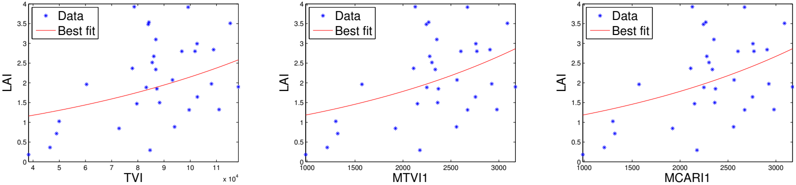
MTVI2
$R^2 = 0.51$



MCARI2
$R^2 = 0.51$

Results
LAI estimation

Exponential function: $LAI = a \cdot \exp(b \cdot VI)$



TVI MTVI1 MCARI1

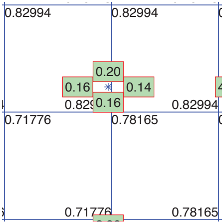
Results
Error analysis

Error on calculated VIs

Site 143

Results
Error analysis

Error on measured LAI



Site 43, spot 13

Conclusions/Outlook

Conclusions

Conclusions:

1. Both LAI and VI are scalable based on consistent results: LAI: $20m \rightarrow 40m$, VI: $14m \rightarrow 42m$
2. SR, NDVI, MCARI2 can be potentially used to estimate LAI from HyspIRI data, although fit improvements are required.

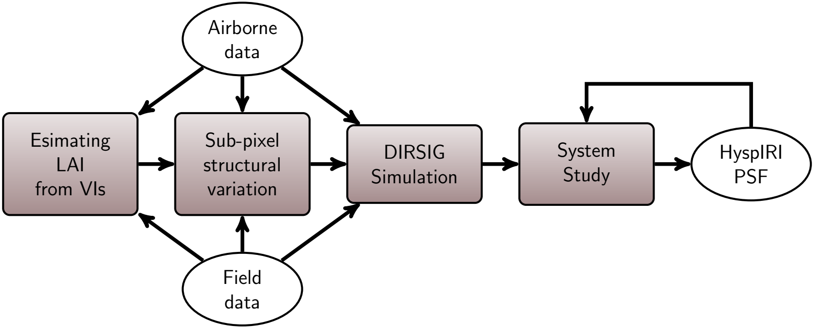
Conclusions/Outlook

Future work

1. Improved estimation of VIs:
   - Use other combinations of bands to calculate VI, find the best bands for HyspIRI data to estimate LAI
2. Improved estimation of field LAI:
   - Use high resolution NEON spectrometer and discrete lidar data to "unmix" coarser scale imaging spectroscopy data
   - Based on height (short photosynthetic vegetation) and spectra

Conclusions/Outlook

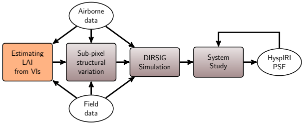
Project outline

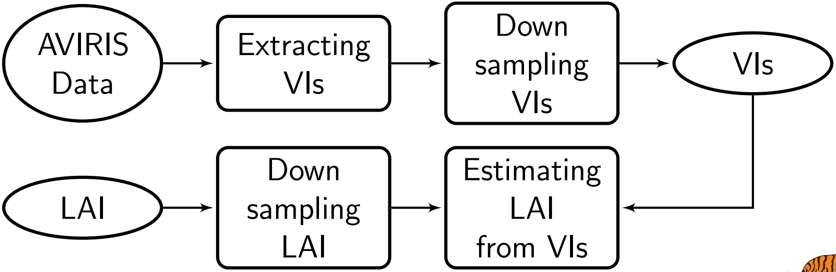


Conclusions/Outlook

Future work

Stage 1: Estimating LAI from VIs

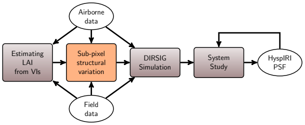


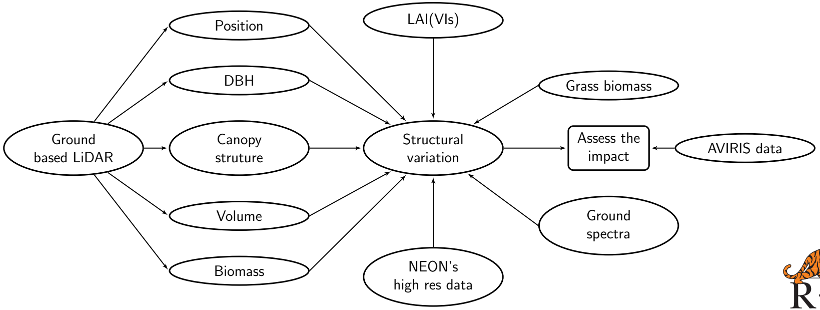


Conclusions/Outlook

Future work

Stage 2: Sub-pixel structural variation

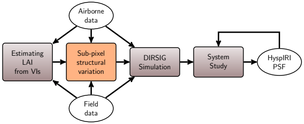


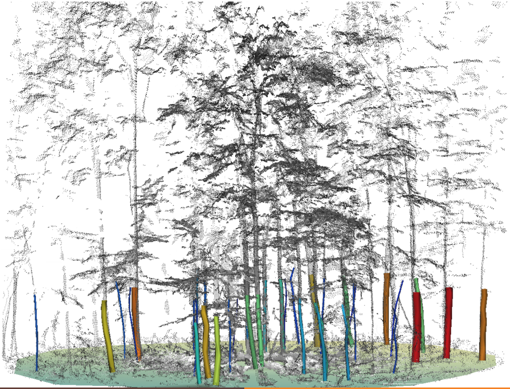


Conclusions/Outlook

Future work

Stage 2: Sub-pixel structural variation

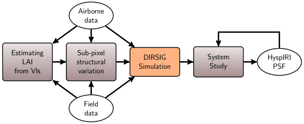


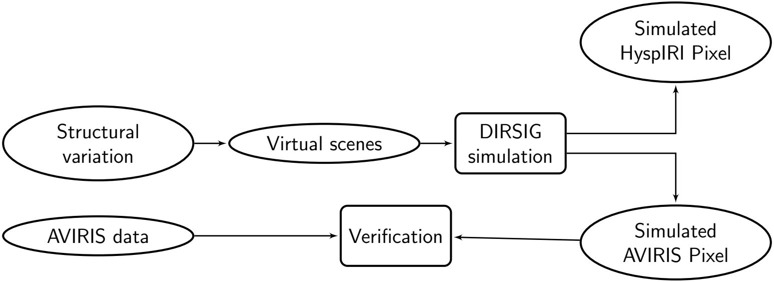


Conclusions/Outlook

Future work

Stage 3: DIRSIG Simulation



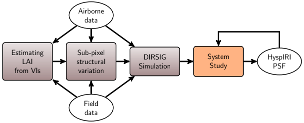


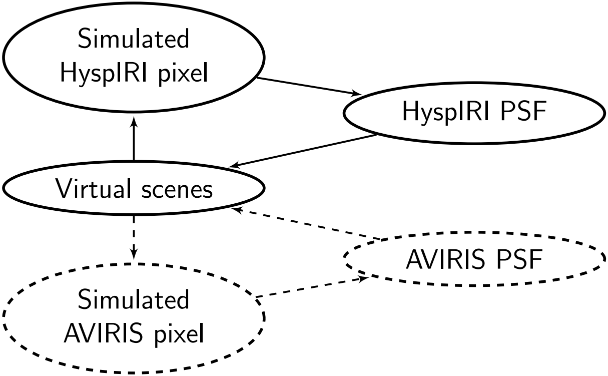
DIRSIG: The Digital Imaging and Remote Sensing Image Generation

Conclusions/Outlook

Future work

Stage 4: System Study





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- NEON AOP team

Thanks!