# Ground Measurement Support for Airborne Campaigns: Susan Ustin

LI-COR 1800 Integrating Sphere

Integrating Sphere (RF & TM)

Measure with leaf clip or integrating sphere?

Leaf Clip (RF only)

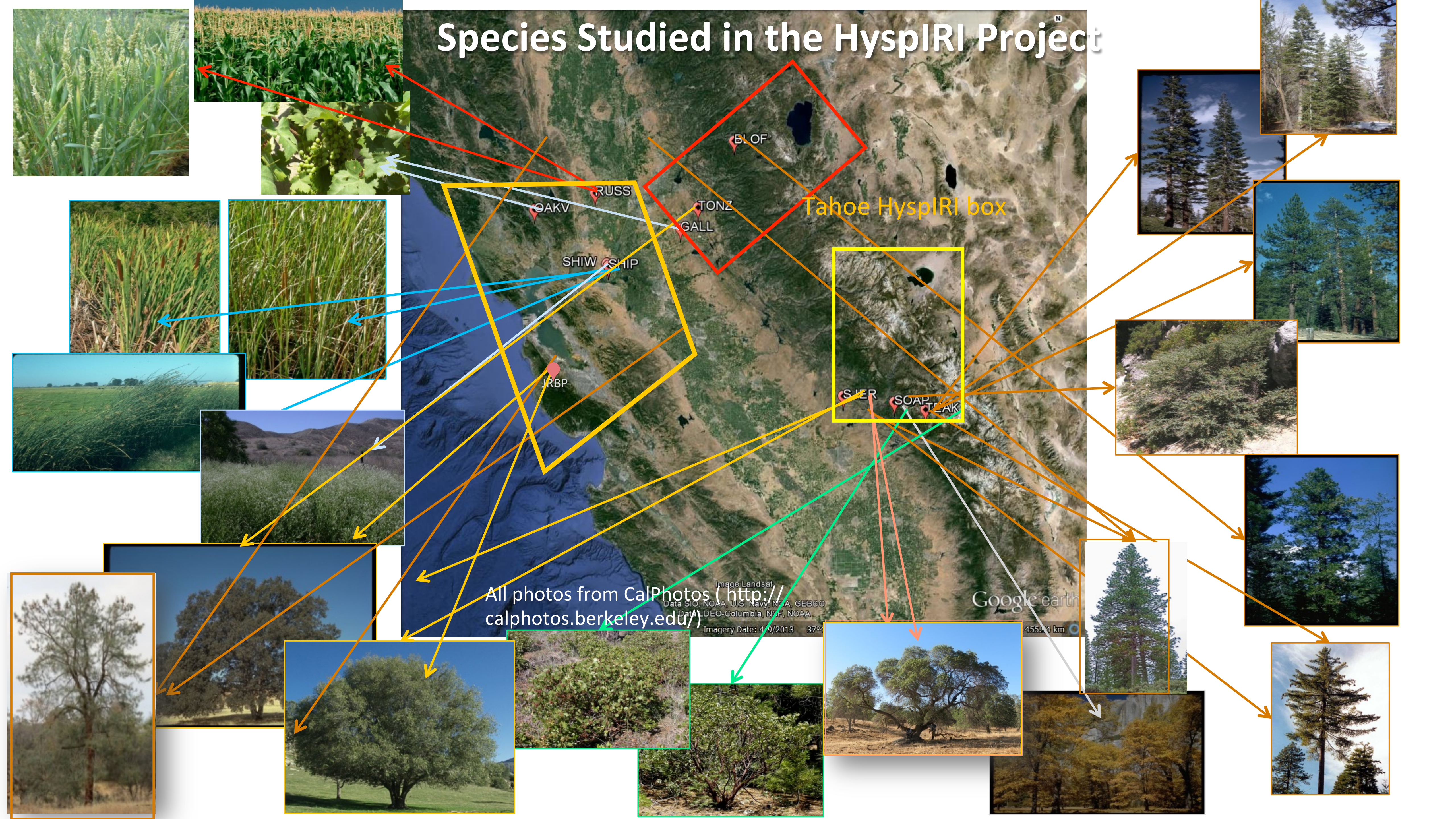
## Imaging spectroscopy provides information rich images that require more understanding of field conditions:

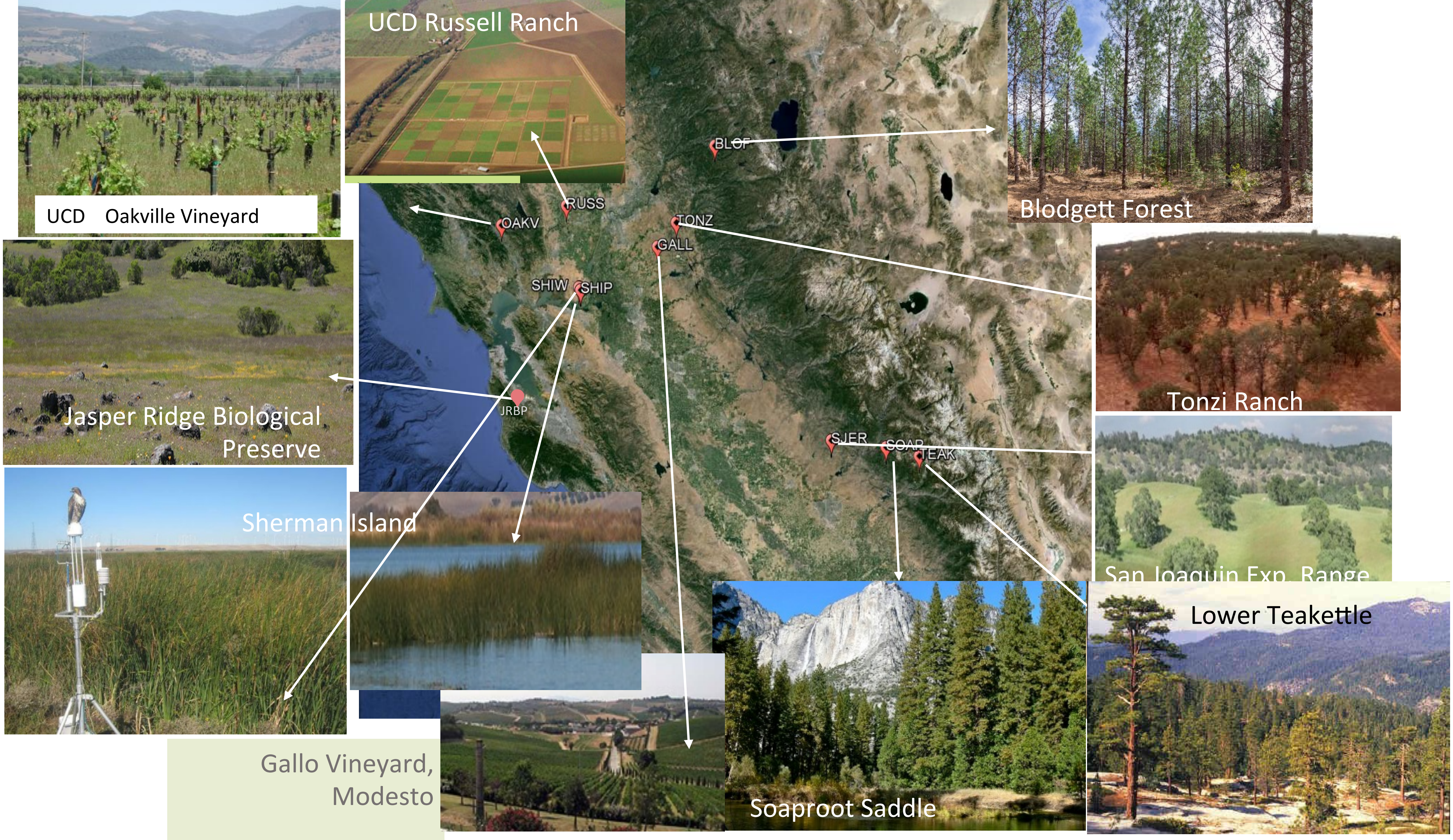
- We lack ability to retrieve environmental information from first principles
- We don't understand scattering processes in complex canopies
- We don't understand the impact of spatial resolution on spectral observations in non-homogeneous vegetation stands
- We don't know when spectral relationships are linear or non-linear
- IS data dimensionality exceeds our current ability to explain

## Why Invest Time/Money in Field Campaigns?

1. Calibration and Geolocation Data
2. Collect Data to Quantify State and Condition of the Environment
3. Provide Independent Data for Validation
4. To Understand Environmental Processes
5. To Collect Data for Model Development
6. Document Discovery of Unexpected Condition in Environment

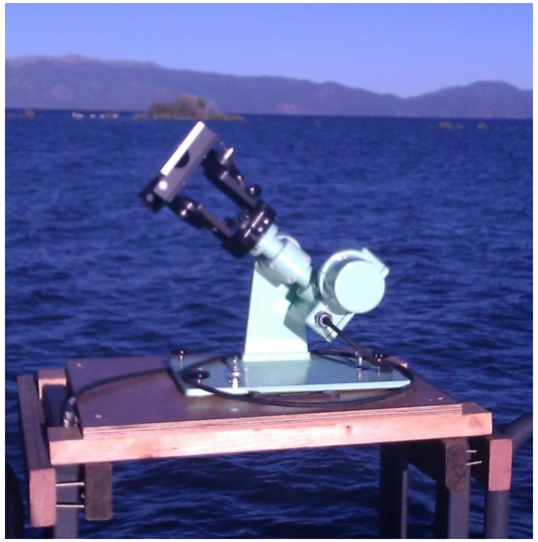
- Understand biochemical and structural changes with phenological cycle in native species
- Determine background spectral materials (soils, rock outcrops, different types of plant detritus and woody debris and understory live vegetation
- Characterize trait patterns  relevant for RS in different species (leaf mass area and thickness, leaf size, biochemistry,
- Characterize stand structure, size classes, density, height,
- Characterize stand level leaf angle distribution, leaf area index
- Characterize unusual or unexpected events (such as the California Drought)


Species Studied in the HyspIRI Project
BLOF
RUSS
OAKV
TONZ
GALL
Tahoe HyspIRI box
SHIW
SHIP
JRBP
SJER
SOAP
TEAK
All photos from CalPhotos ( http://
calphotos.berkeley.edu/)
Google earth


UCD Russell Ranch
UCD Oakville Vineyard
Blodgett Forest
BLOF
RUSS
OAKV
TONZ
GALL
SHIW
SHIP
JRBP
Tonzi Ranch
Jasper Ridge Biological Preserve
SJER
SOAP
TEAK
San Joaquin Exp. Range
Sherman Island
Lower Teakettle
Gallo Vineyard, Modesto
Soaproot Saddle

# 1. Calibration and Geolocation Data

Atmosphere—Yankee sun photometer (at Lake Tahoe) and balloon radiosonde



Surface Radiance—ASD FR spectrometer

Measure atmospheric properties for Reflectance Calibration

Soil sampling boxes for surface emissivity measurements


Measure Surface Temperatures


GPS measurements for geolocation information

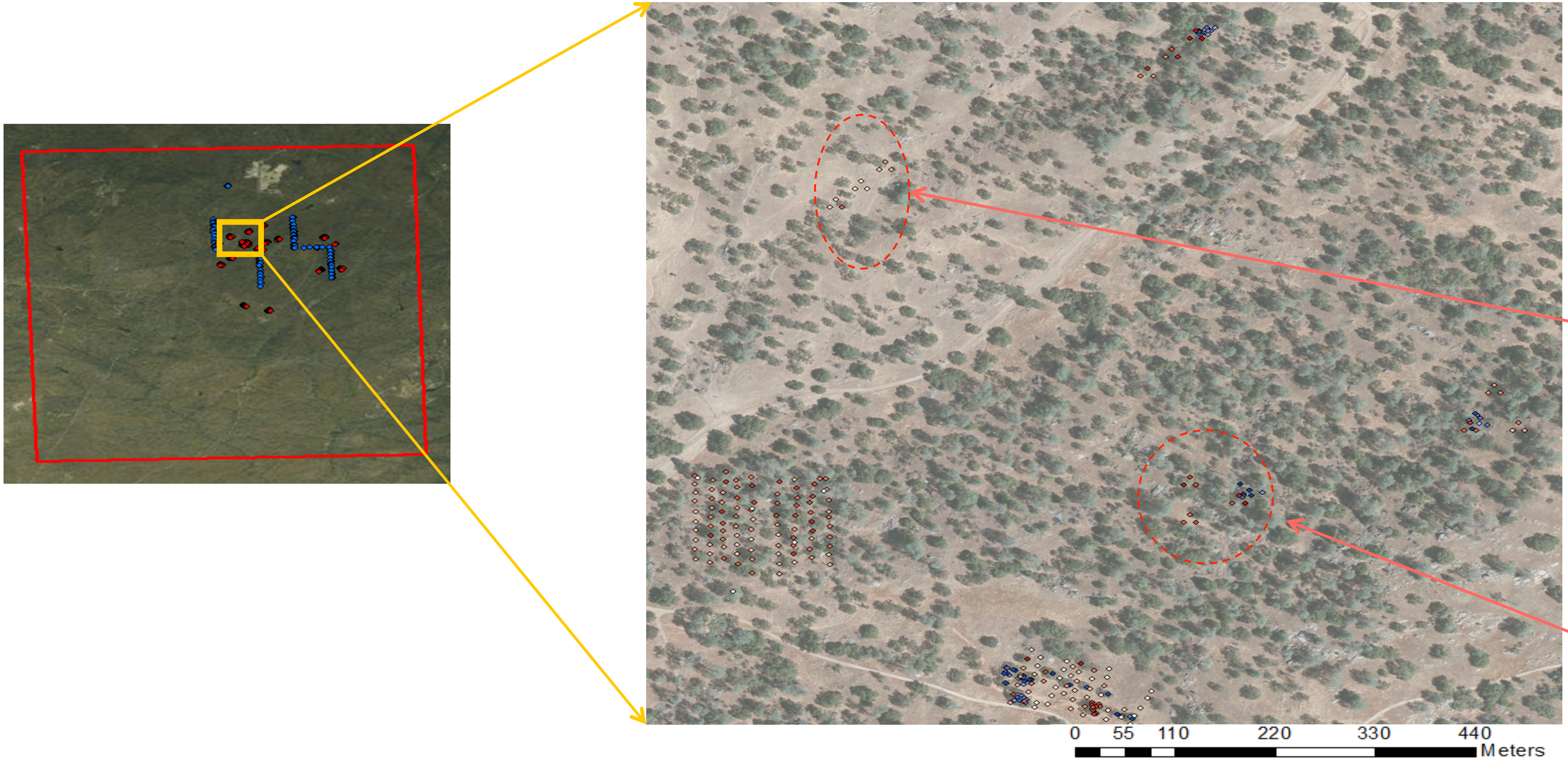
## 2. Collect data to quantify state and condition of the environment

a) How do traits vary within and between plant functional types (PFTs)?
   1) Collect data at multiple sites of common species that represent different PFTs.

b) What is the physiological condition of the forest each year since first NEON image collection in 2012
   1) Measure spectral reflectance of leaves of target species
   2) Measure trait properties: fresh weight, dry weight, leaf area, pigments, C, N

c) Evidence for drought stress
   1) decline in LAI
   2) decline in trait values for canopy water content, pigment concentration, increase in LMA, increase in fraction of NPV

# USFS San Joaquin Experimental Range




Dr. Marguarita Huesca et al. Canopy Structural Attributes Derived from AVIRIS Data in a Mixed Broadleaf/Conifer Forest. RSE 2016.

# Canopy structure assessment using imaging spectroscopy data

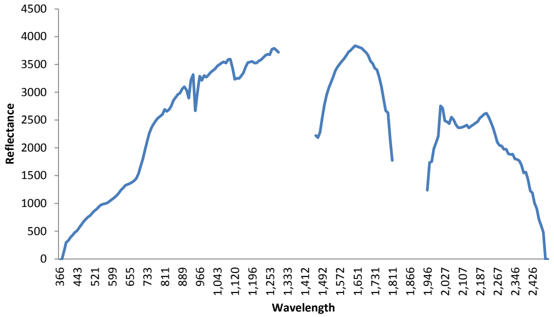
## Estimation of leaf biochemistry with the use of remote sensing data

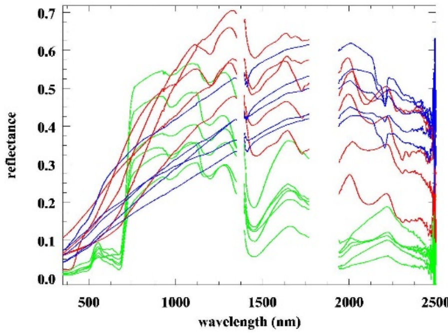
- Challenges due to the variability of the pixel composition

**Canopy Reflectance**

influenced by

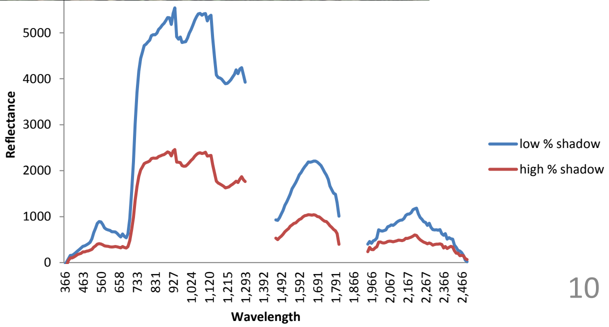
**Background/undercover materials**




**Shadow fraction**

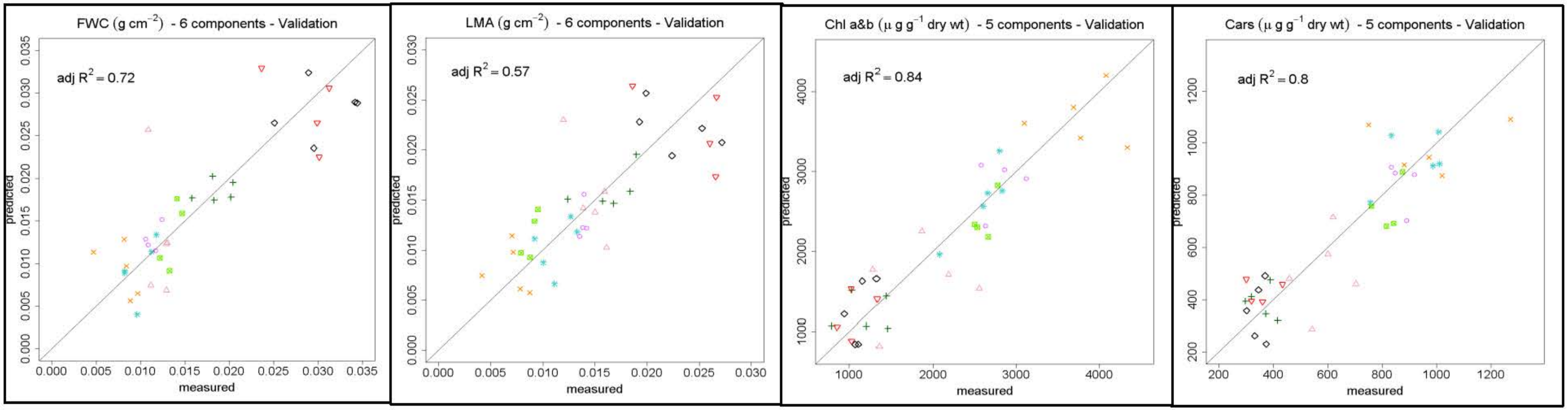
**Canopy composition and structure**



| SITE | HYSPIRI BOX | ECOSYSTEM | FOCAL SPECIES | DATA COLLECTION (Spring, Summer, Fall)-yr |
|---|---|---|---|---|
| Sherman Island Wetland (SHIW) | SF Bay | restored wetland | Typha spp.<br>Schoenoplectus acutus | SP-13, SM-13, F-13<br>SP-14, SM-14, F-14 |
| Sherman Island Pasture (SHIP) | SF Bay | grazed pasture | Lepidium latifolium | SP-13, SM-13, F-13<br>SP-14, SM-14, F-14 |
| Oakville Vineyard (OAKV) | SF Bay | Agricultural | Vitis vinifera | SM-13 |
| Russell Ranch (RUSS) | SF Bay | Agricultural | Zea mays<br>Triticum spp. | SP-13, SM-13<br>SP-14, SM-14 |
| Blodgett Forest (BLOF) | Tahoe | mixed broadleaf/conifer forest | Quercus kelloggii<br>Abies concolor<br>Calocedrus decurrens<br>Pinus ponderosa | F-13<br>SP-14, SM-14, F-14 |
| Tonzi Ranch (TONZ) | Tahoe | oak savanna woodland | Quercus douglasii<br>Pinus sabiniana | SP-13, SM-13, F-13<br>SP-14, SM-14, F-14 |
| Gallo Vineyard (GALL) | Tahoe | agricultural | Vitis vinifera | SM-13<br>SP-14, SM-14 |
| San Joaquin Experimental Range (SJER) | Yosemite/NEON | oak savanna woodland | Quercus douglasii<br>Quercus wislizeni<br>Pinus sabiniana | SP-13, SM-13, F-13<br>SP-14, SM-14, F-14, SM-15 |
| Soaproot Saddle (SOAP) | Yosemite/NEON | mixed broadleaf/conifer forest | Quercus kelloggii<br>Quercus chrysolepsis<br>Pinus ponderosa<br>Calocedrus decurrens<br>Arctostaphylos spp. | SP-13, SM-13, F-13<br>SP-14, SM-14, F-14, SM-15 |
| Teakettle Experimental Forest (TEAK) | Yosemite/NEON | high elevation conifer forest | Abies concolor<br>Abies magnifica<br>Ceanothus cordulatus<br>Pinus jeffreyi | SP-13, SM-13, F-13<br>SM-14, F-14, SM-15 |

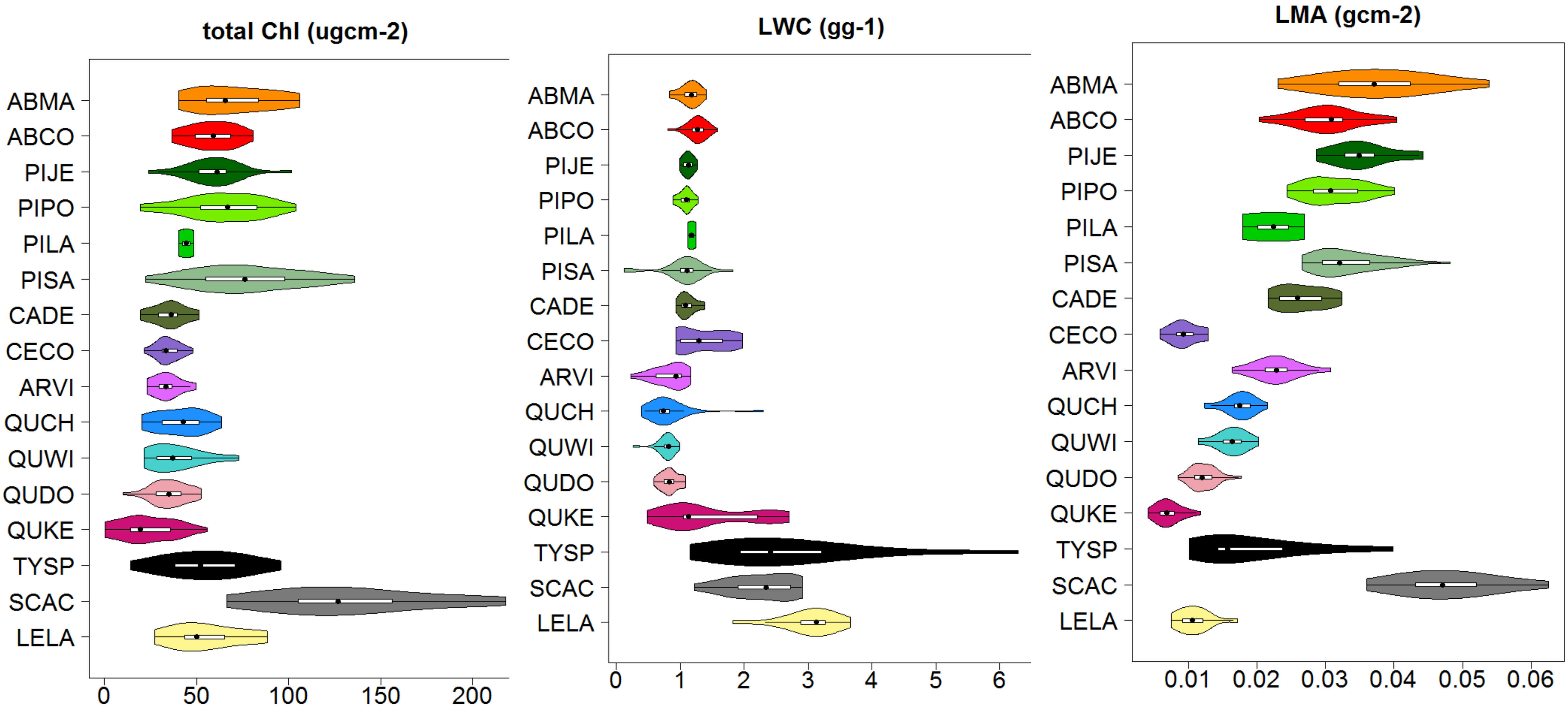
| Site | Hemispherical Leaf Spectra (individuals; 2013 & 2014) | Leaf Clip Spectra (individuals) | Leaf Traits (individuals) | Field Spectra (unique targets) | LAI/Biomass (points) | Inventory (trees) |
|---|---|---|---|---|---|---|
| **BLOF** | 55 | 90 | 55 | 2 soil; 20 NPV; 5 rock | 225 | 406 |
| **TONZ** | 50 | 109 | 50 | 1 annual GV plot; 4 soil; 14 NPV; 7 rock | 325 | 282 |
| **SJER** | 67 | 108 | 67 | 4 annual GV plots; 3 soil; 17 NPV; 10 rock | 253 | 542 |
| **SOAP** | 86 | 108 | 86 | 7 understory GV; 4 soil; 18 NPV; 1 rock plot | 281 | 1500 |
| **TEAK** | 76 | 54 | 76 | 6 understory GV; 3 soil; 10 NPV; 5 rock | 111 | 1553 |
| **SHIP** | 25 | n/a | 25 | 3 GV plots | 30 | n/a |
| **SHIW** | 50 | n/a | 50 | n/a | 4/4/4 | n/a |
| **GALL** | 48 | 26 | 48 | 2 GV transects; 1 soil transect | n/a | n/a |
| **RUSS** | 103 | 66 plots | 103 | 1 GV; 4 soil; 1 NPV | n/a | n/a |
| Total | 640 (35/site) | 561 (80/site) | 640 (35/site) | | 1241 | 4283 |

# Examples of Predicted vs. Measured Leaf Trait Values (n=37, June data)




- *Quercus douglasii*, Tonzi Ranch
- *Quercus douglasii*, San Joaquin
- *Quercus kelloggii*, Soaproot Saddle
- *Quercus wislizeni*, San Joaquin
- *Quercus chrysolepsis*, Soaproot Saddle
- *Ceanothus cordulatus*, Teakettle
- *Abies concolor*, Teakettle
- *Abies magnifica*, Teakettle

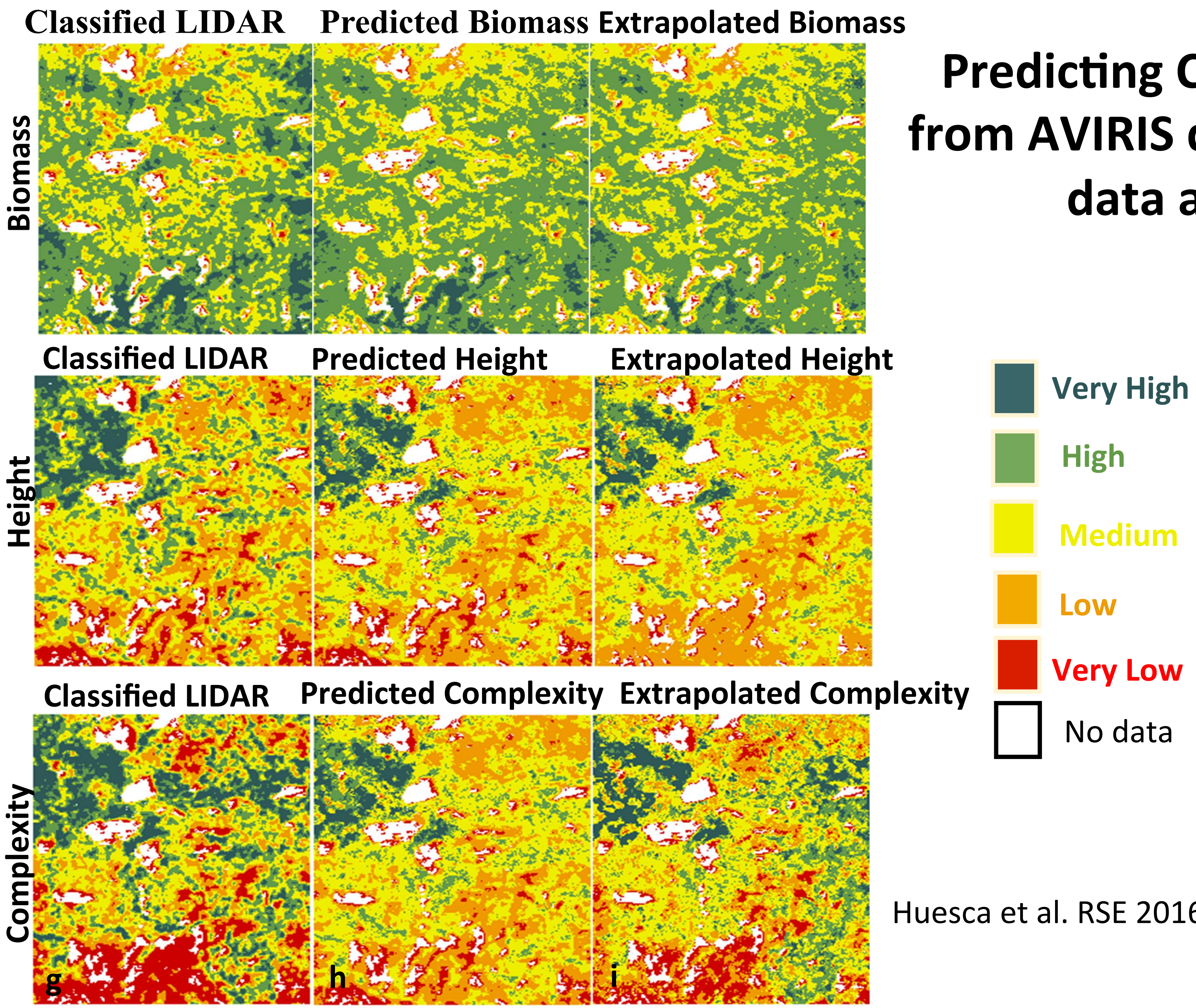
Trait plots (mean, variance, Min, Max) by Species



# 3. Provide Independent Data for Validation

1) Measure spectral reflectance of leaves of target species
2) Measure trait properties: fresh weight, dry weight, leaf area, pigments, C, N
3) Measure LAI, trees/area, species distribution
4) Measure reflectance of invariant calibration targets
5) Measure locations with GPS to provide secondary georectification or validation

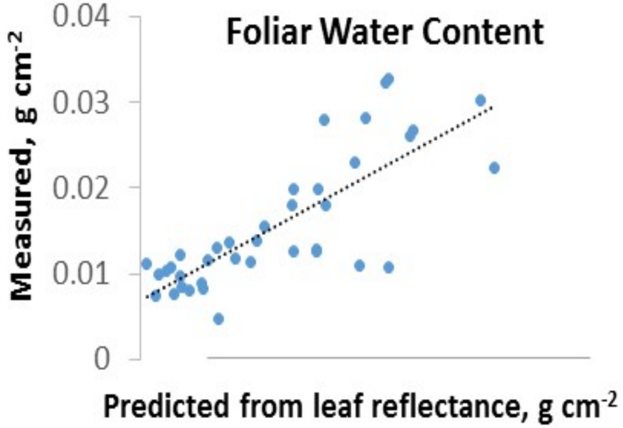
# Predicting Canopy Structure from AVIRIS data using LIDAR data and field data for Validation

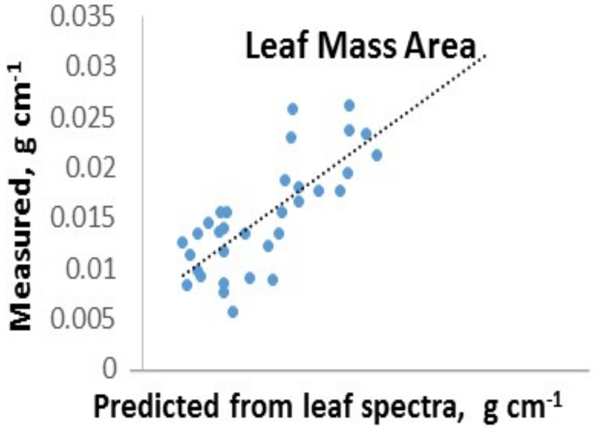



Huesca et al. RSE 2016

# 4. Collect Field Data To Understand Environmental Processes

## **Leaf and Canopy Traits:** Inversion of Prospect Radiative Transfer Model




## Species:

Broadleaf deciduous:

Quercus douglasii,
Q. kelloggii
Q. chrysolepis

Broadleaf evergreen:

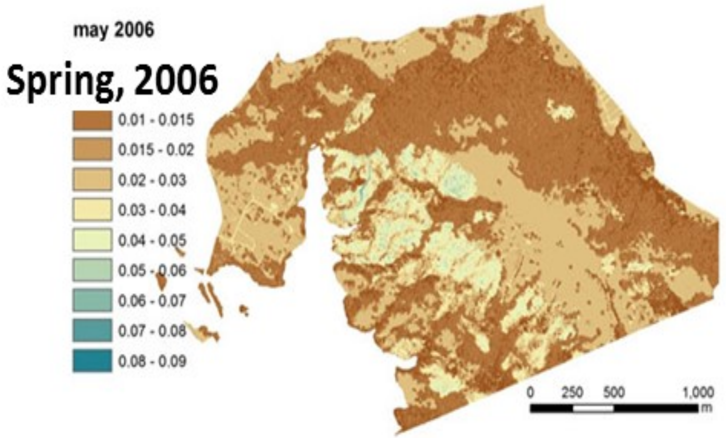
Quercus wislizeni,
Ceanothus cordulatus

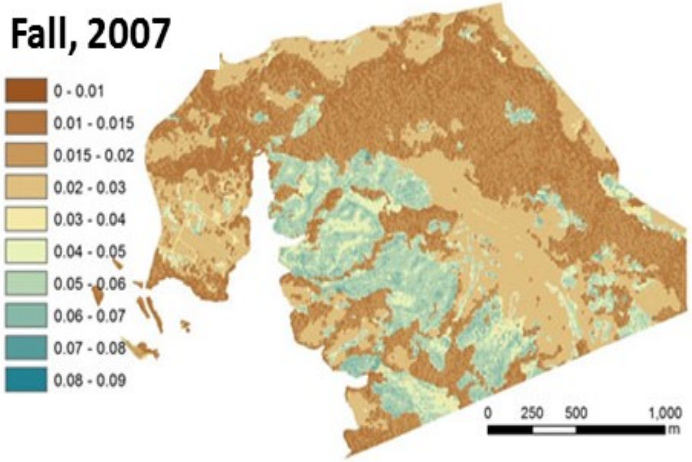
Conifer evergreen:

Abies concolor,
Abies magnifica

**Leaf Mass Area (LMA)**

Stanford's Jasper Ridge Biological Preserve



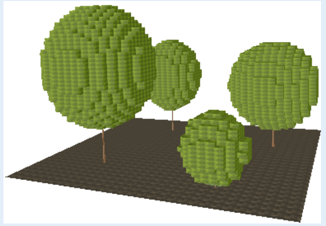



# 5. Collect Field Data for Model Development

## modeling strategies applied to savanna woodland ecosystems (ongoing study)

**1) Simple forest representation**

-> homogeneous stand in terms of species composition and stage development
-> ellipsoidal trees described by allometric parameters or ancillary information, same structural traits
-> leaf angle distribution fixed
-> impact of woody stems neglected

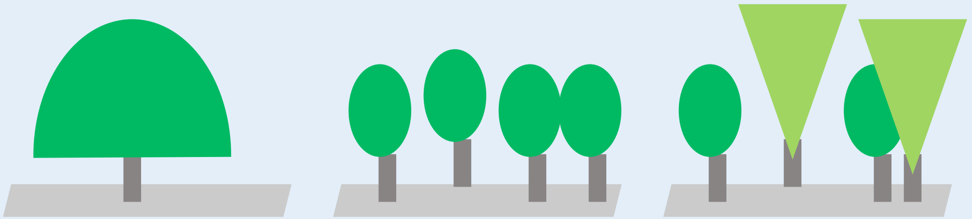


**Influence of tree species and structure, and landscape spatial patterns**

**2) Geometric trees representation**

-> crown shapes approximated by half ellipses or cones
-> canopy cover (CC) accounting for spatial tree distribution and spatial tree growth development

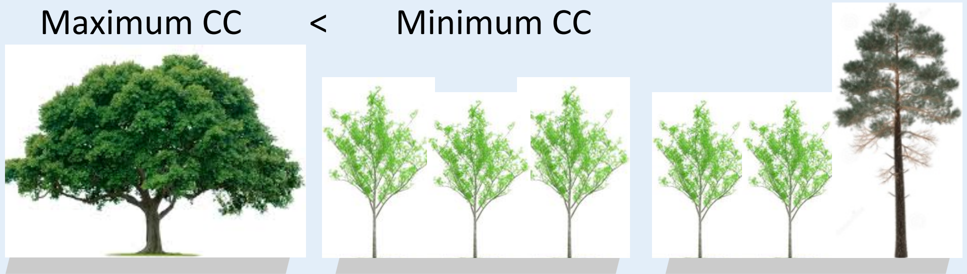
PLOT A] QUDO isolated | PLOT B] QUDO grouped | PLOT C] QUDO /PISA mixed



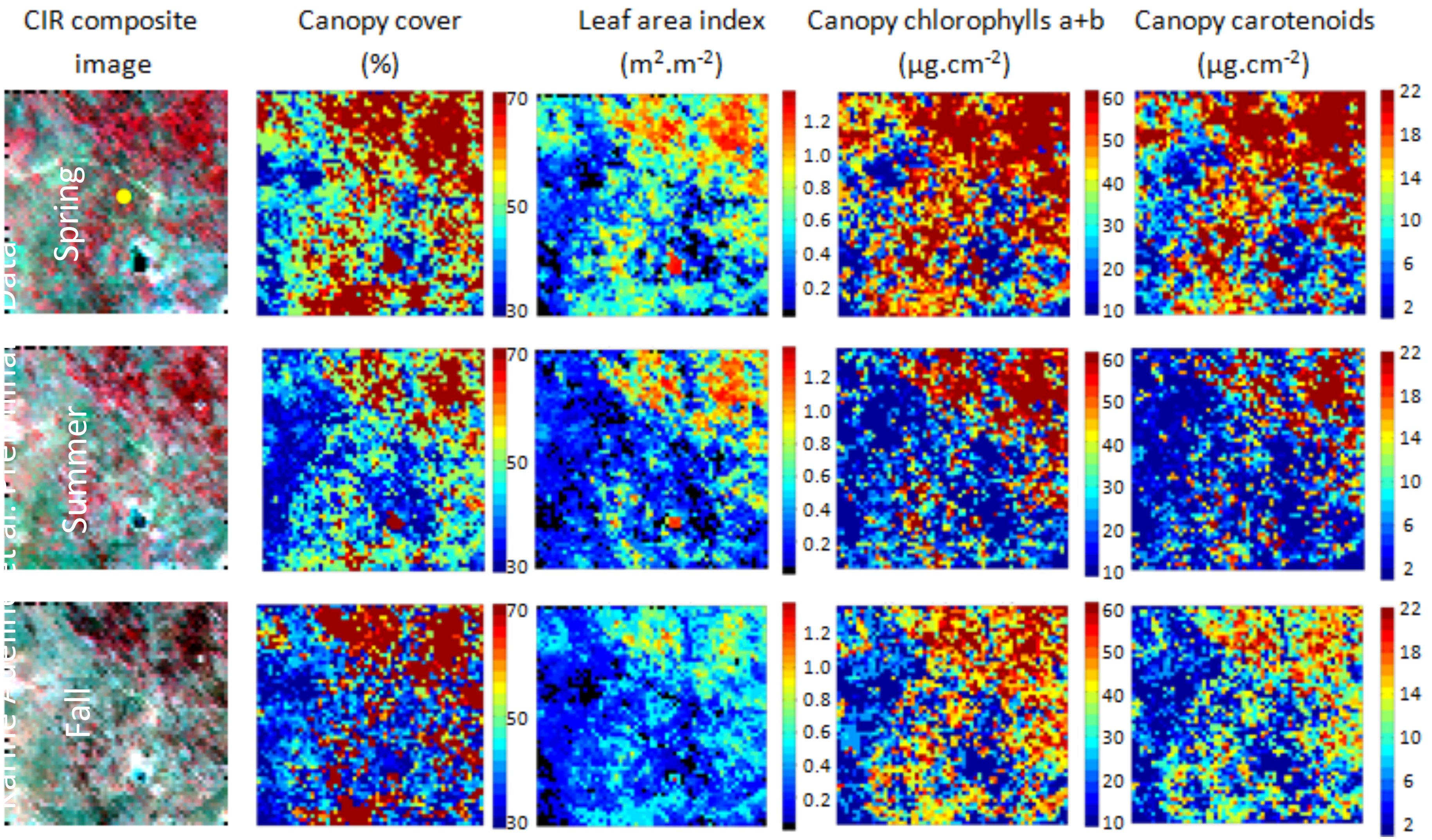
Maximum CC < Minimum CC

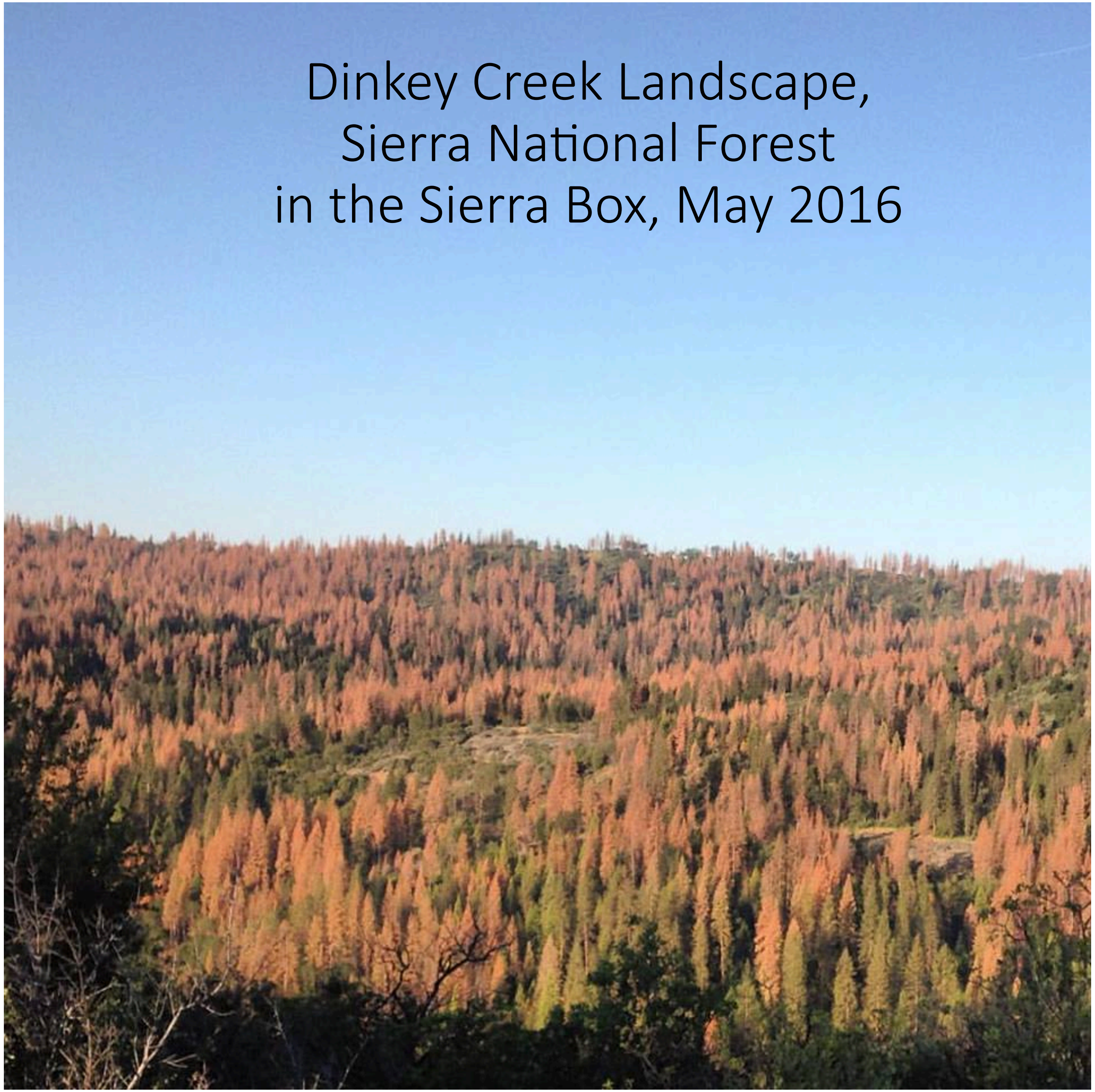
**3) Tree models reconstructed from terrestrial LiDAR acquisitions**

-> exact leaf/crown clumping and crown shape
-> exact wood structure



# Prediction of canopy leaf chemistry & structure from Inversion of linked DART-PROSPECT radiative transfer models at the TONZI Ameriflux Site (Tahoe Box; Foothill Woodland Savanna)






## 6. Document Discovery of Unexpected Condition in Environment

The 2012-2016 California Drought is an unplanned experiment in ecosystem change and resilience

- When (in drought) did individual trees die?
- What was their condition before they died (prior measurements)?
- What was condition of surviving trees?
- What impsvy did prior management actions have on survival or mortality
- What will be the trajectory of recovery?
- What changes in forest composition will occur?