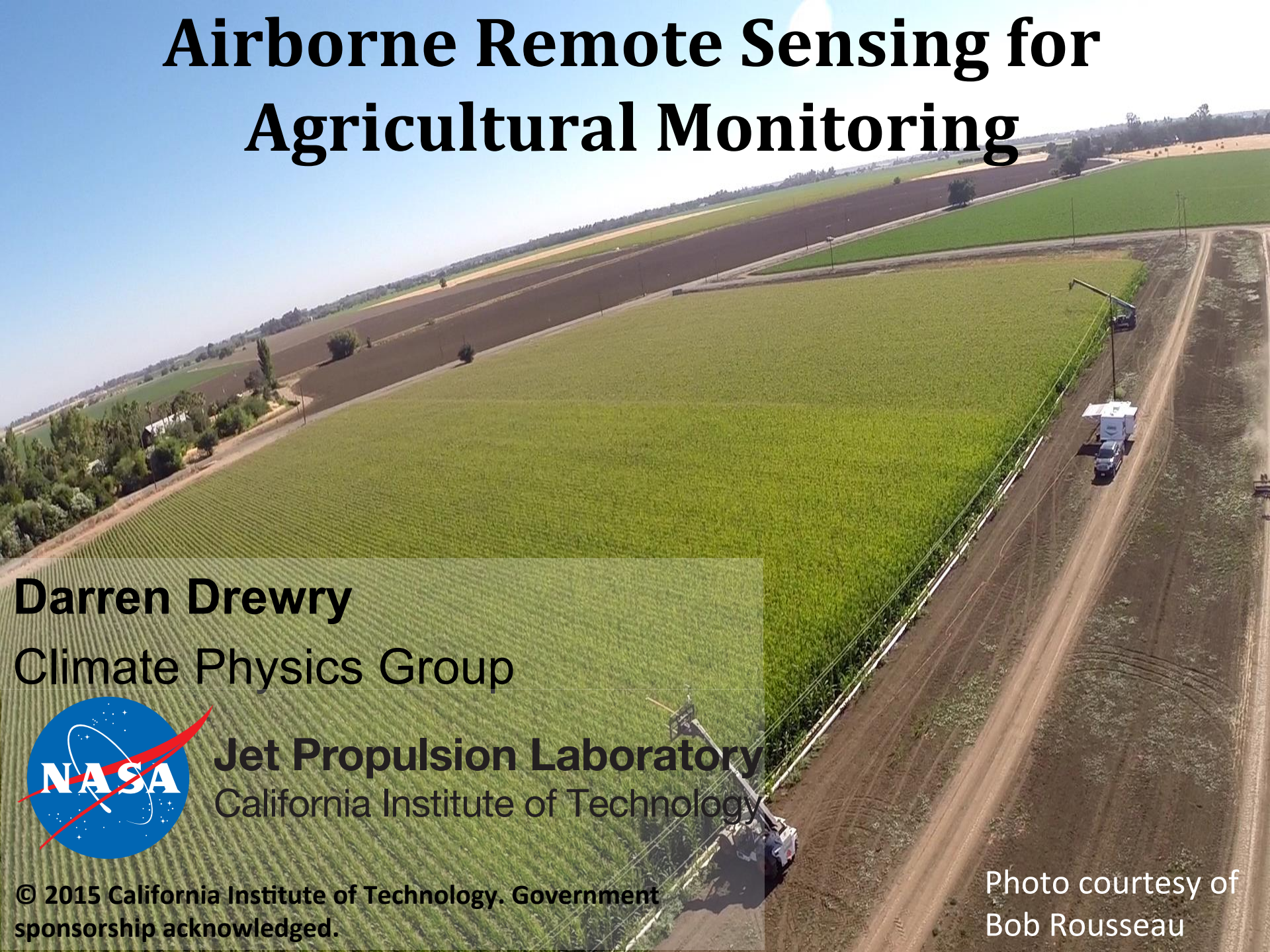
Airborne Remote Sensing for Agricultural Monitoring



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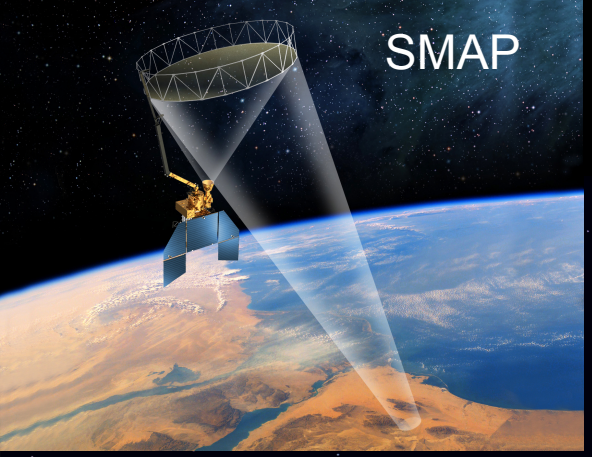
Jet Propulsion Laboratory

California Institute of Technology

Photo courtesy of Bob Rousseau


Curiosity on the parachute
Imaged by the Mars Reconnaissance Orbiter
August 5, 2012



SMAP = Soil Moisture Active/Passive

OCO-2 = Orbiting Carbon Observatory

(-2 because the first one landed in the Indian Ocean)

CALIPSO

Aqua

GCOM-W1

OCO-2

CloudSat

CERES

AIRS

AMSU-A

AMSR-E

AMSR2

MODIS

CALIOP

IIR

CPR

WFC

PARASOL

Aura

MLS

TES

POLDER

HIRDLS

OMI

HyspIRI Mission Concept

Hyperspectral InfraRared Imager (HyspIRI) mission concept will combine optical and thermal sensors for monitoring terrestrial ecosystem health and natural disasters (i.e. volcanic eruptions, drought, wildfires)

Will include two instruments mounted on a satellite in low earth orbit

- Imaging spectrometer that measures from the visible through the ***shortwave infrared (VSWIR: 380-2500 nm) in 10 nm contiguous*** bands, 19-day revisit
- A multi-spectral imager measuring in the mid and thermal infrared (3-12 µm), 5-day revisit
- Will provide 60-meter surface resolution at nadir

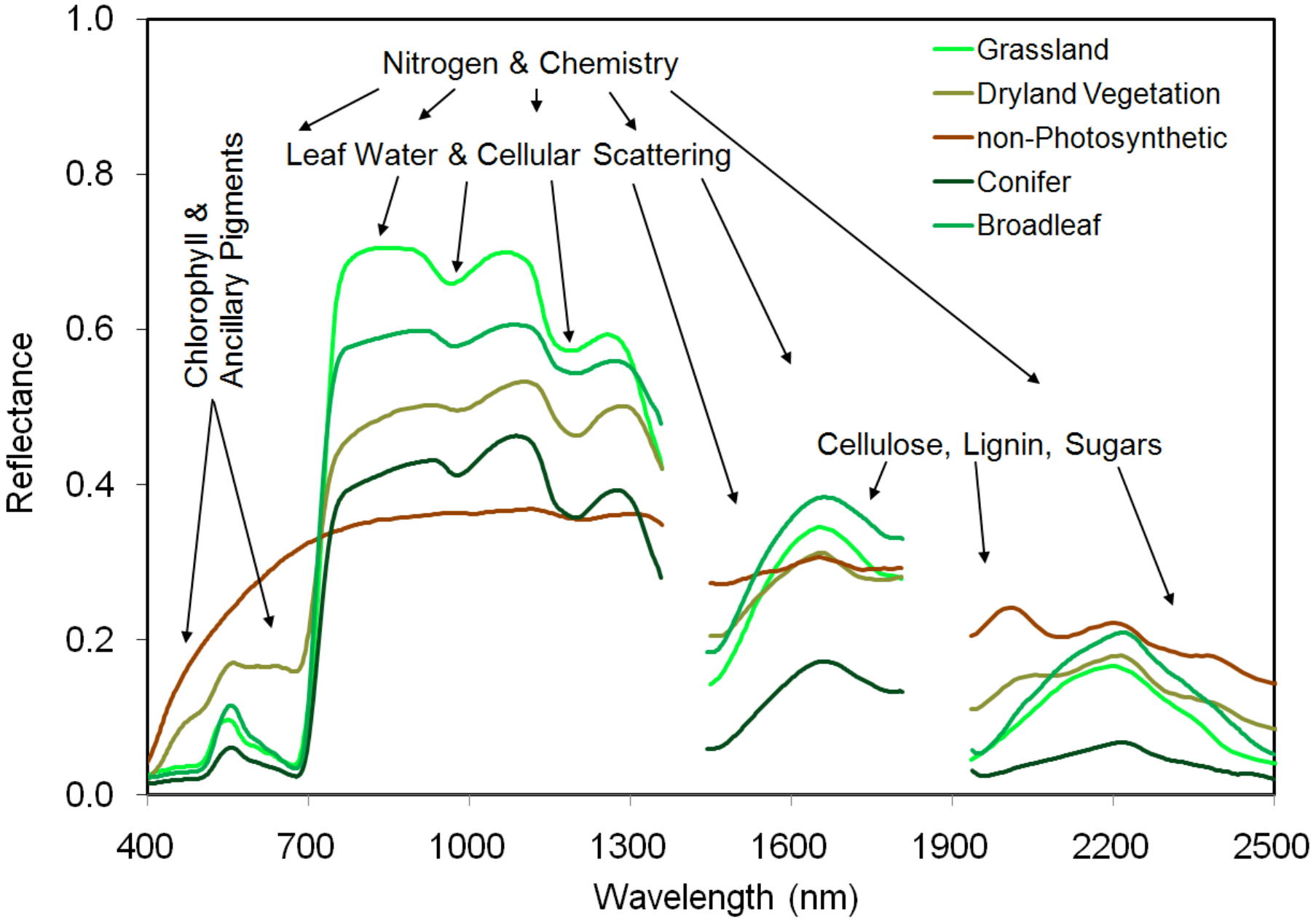
HyspIRI Airborne Campaign

The HyspIRI airborne campaign provides wall-to-wall coverage of 6 sampling boxes across the state of California with the Airborne Visible/ Infrared Imaging Spectrometer (AVIRIS) and the Modis/Aster Airborne Simulator (MASTER), mounted together on a NASA ER-2 aircraft.

This is providing precursor datasets with HyspIRI-like data to demonstrate science and applications research.

Multiple acquisitions per year for last few years.

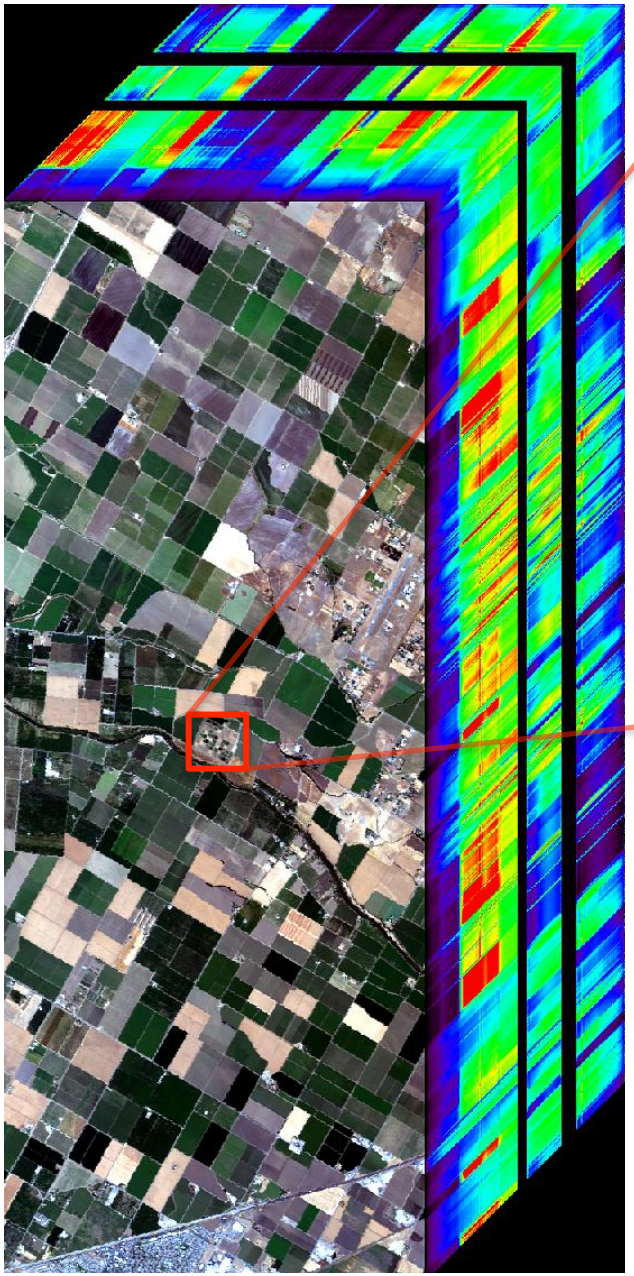
Spectroscopy and Biochemistry

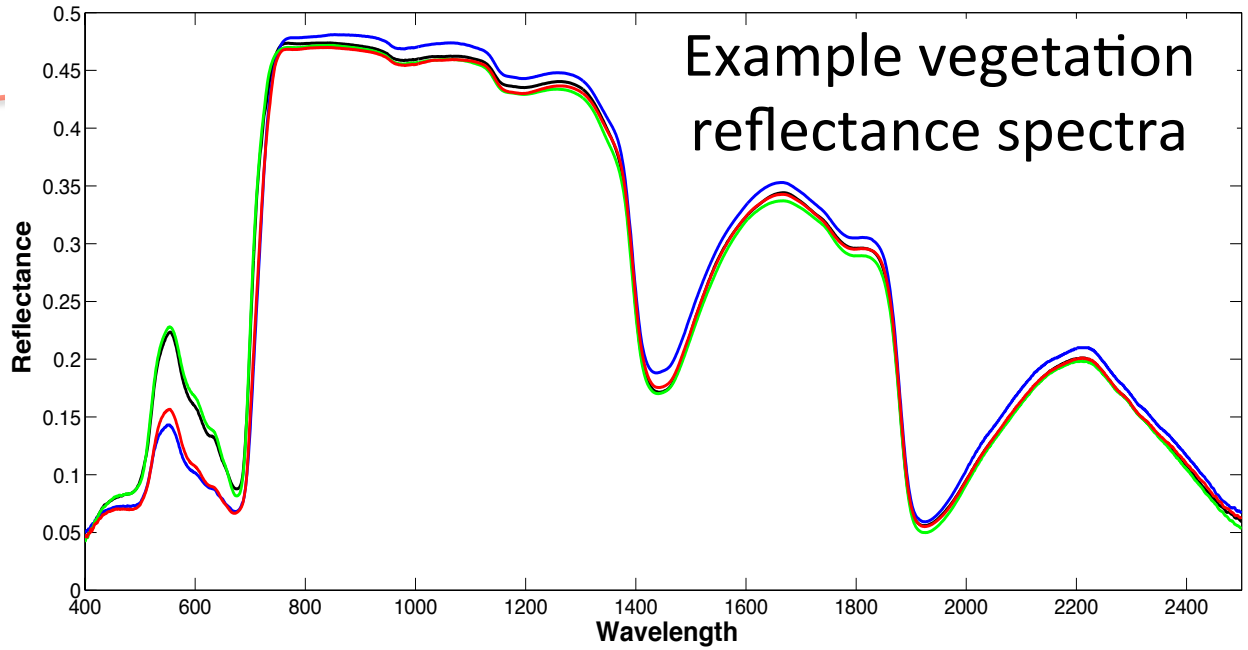


Field Observations

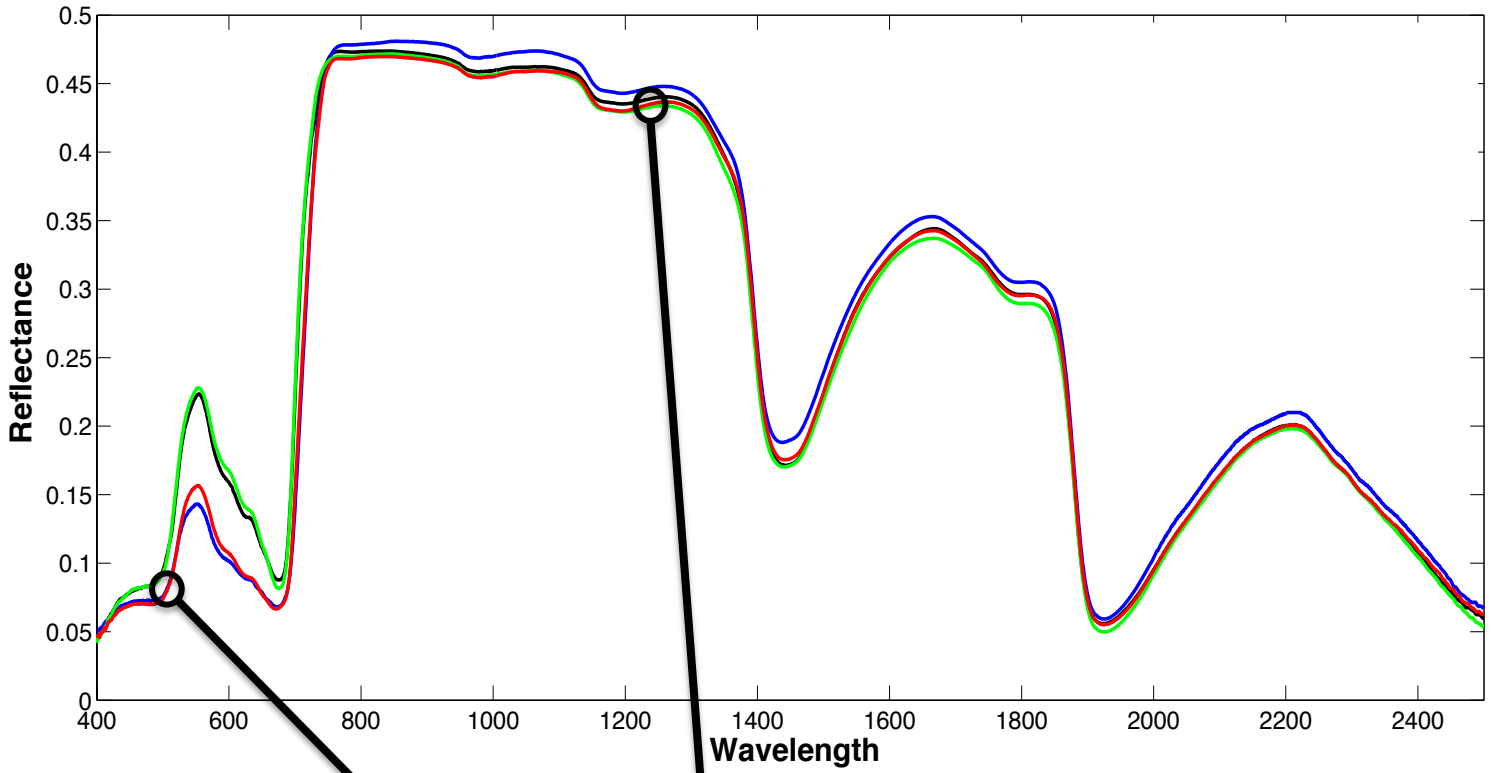
- ***Leaf reflectance and transmission (ASD field spectrometer)***
- Soil reflectance (ASD field spectrometer)
- Gas exchange (CO_2, H_2O) and fluorescence parameters (Licor 6400 gas exchange system)
- ***Leaf chemistry (N/P/K analysis)***
- Canopy structure (Decagon ceptometer)
- Soil moisture (Decagon)
- Wireless sensor pods for within-canopy radiation and met environment

VSWIR Data Cube from AVIRIS Acquisition





Find Optimal NDI for N Content

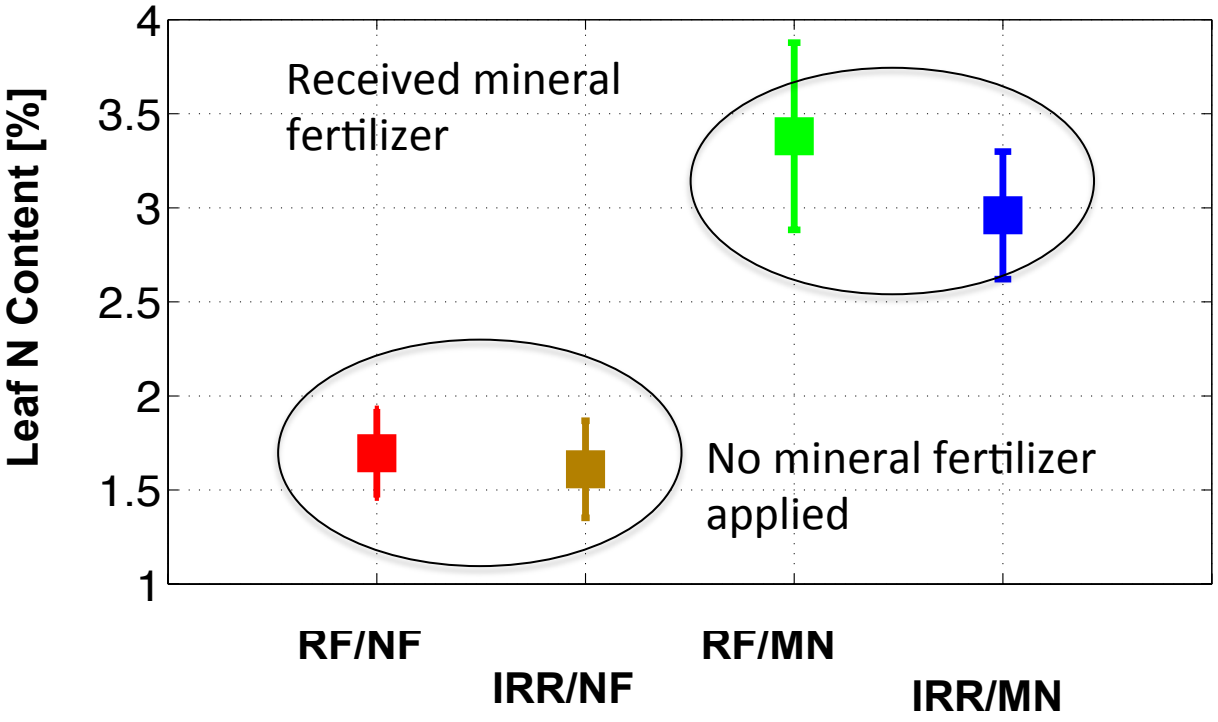


$$NDI = \frac{R_{\lambda 1} - R_{\lambda 2}}{R_{\lambda 1} + R_{\lambda 2}}$$

Normalized Difference Index (NDI)

Explore all possible NDIs

Wheat Analysis from Russell Ranch



[H_2O x N] performed on 18 1-acres plots at Russell Ranch

= Irrigated, Mineral N (IRR/MN)

= Rainfed, Mineral N (RF/MN)

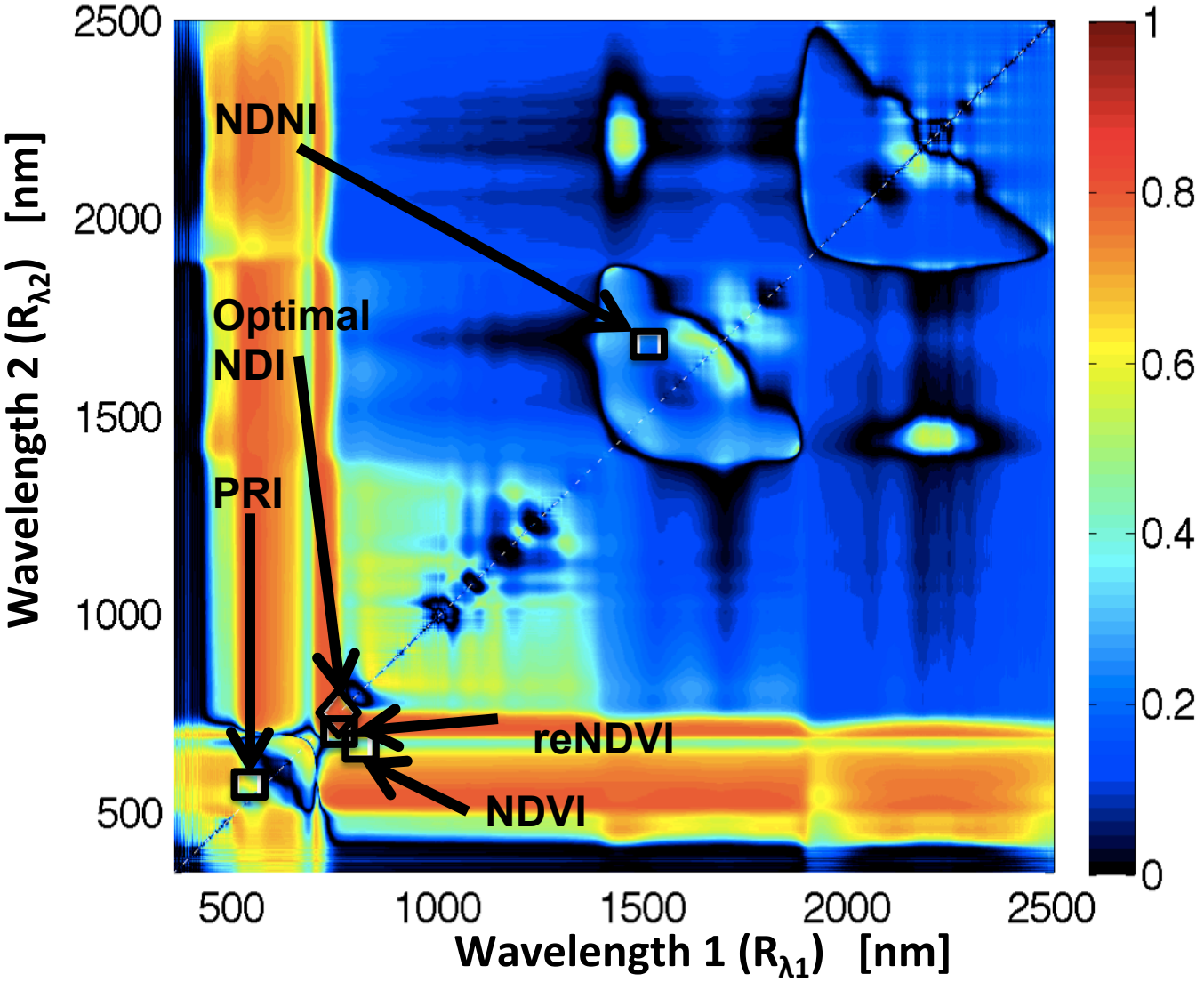
= Irrigated, No Fertilization (IRR/NF)

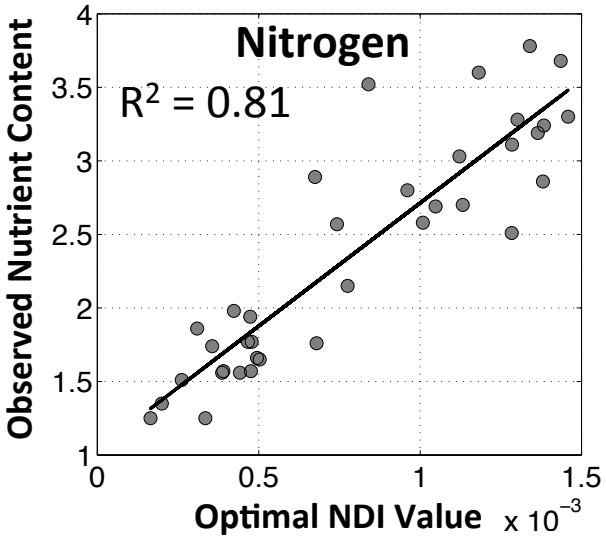
= Rainfed, No Fertilization (RF/NF)

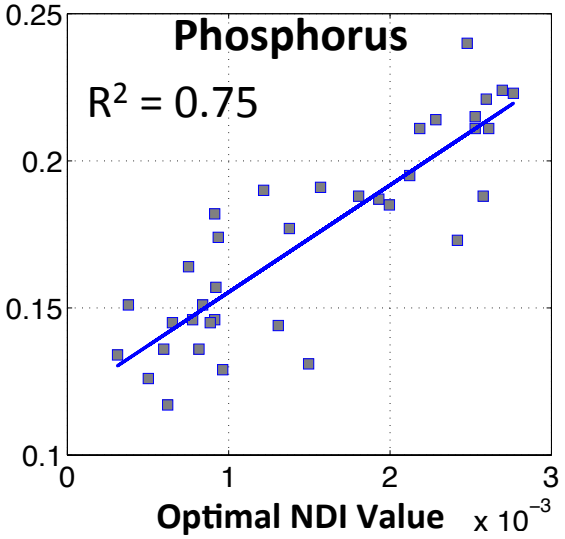
Exploring All Possible NDIs for N Content

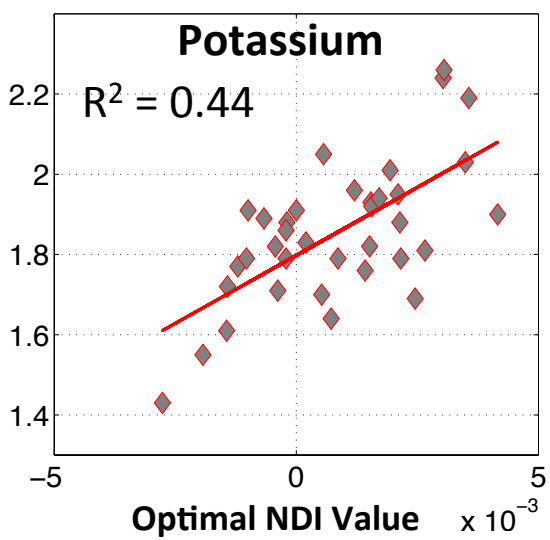
Coefficients of Determination (R^2) for all possible 2-band NDIs.

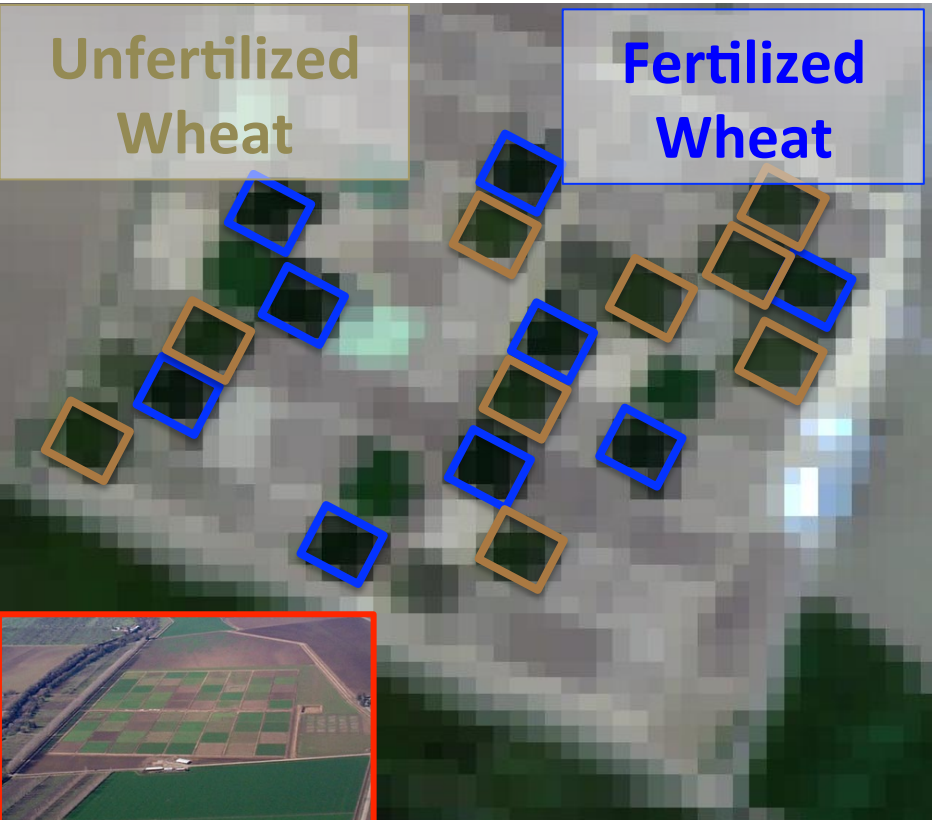
$$NDI = \frac{R_{\lambda 1} - R_{\lambda 2}}{R_{\lambda 1} + R_{\lambda 2}}$$

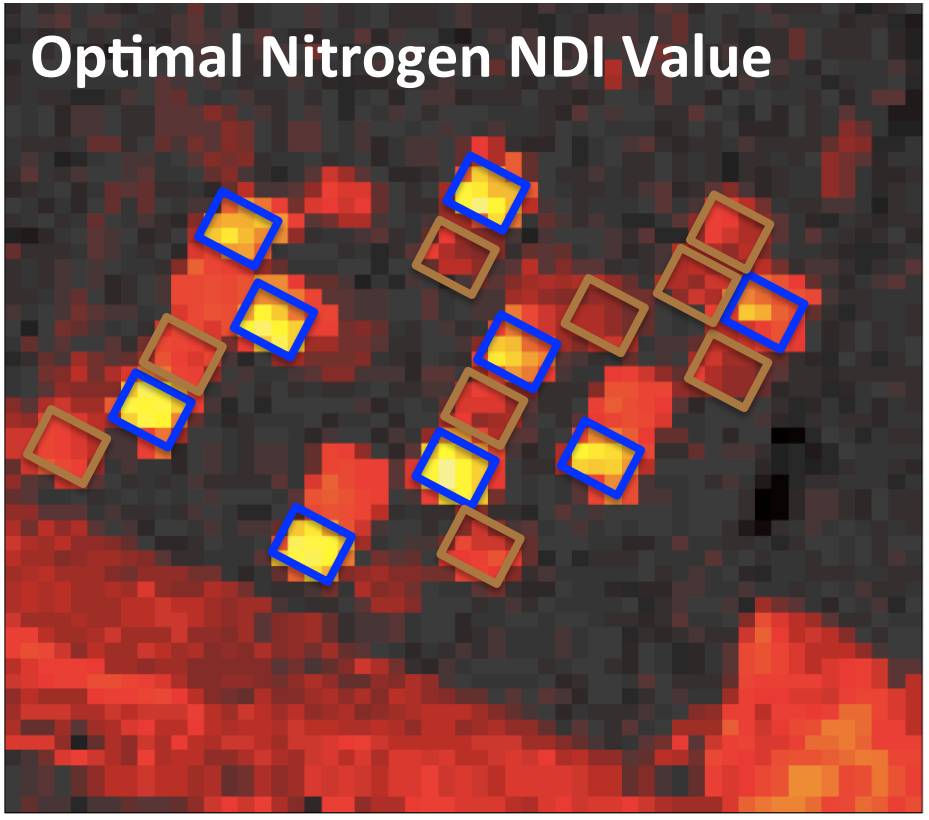



Nitrogen
R^2 = 0.81
Observed Nutrient Content
Optimal NDI Value
x 10^{-3}


Phosphorus
R^2 = 0.75
Optimal NDI Value
x 10^{-3}


Potassium
R^2 = 0.44
Optimal NDI Value
x 10^{-3}


Unfertilized Wheat
Fertilized Wheat


Optimal Nitrogen NDI Value

Thanks!

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