Plant traits and imaging spectroscopy

ZF2 – Manaus, Brazil

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Terrestrial Ecosystem Science & Technology

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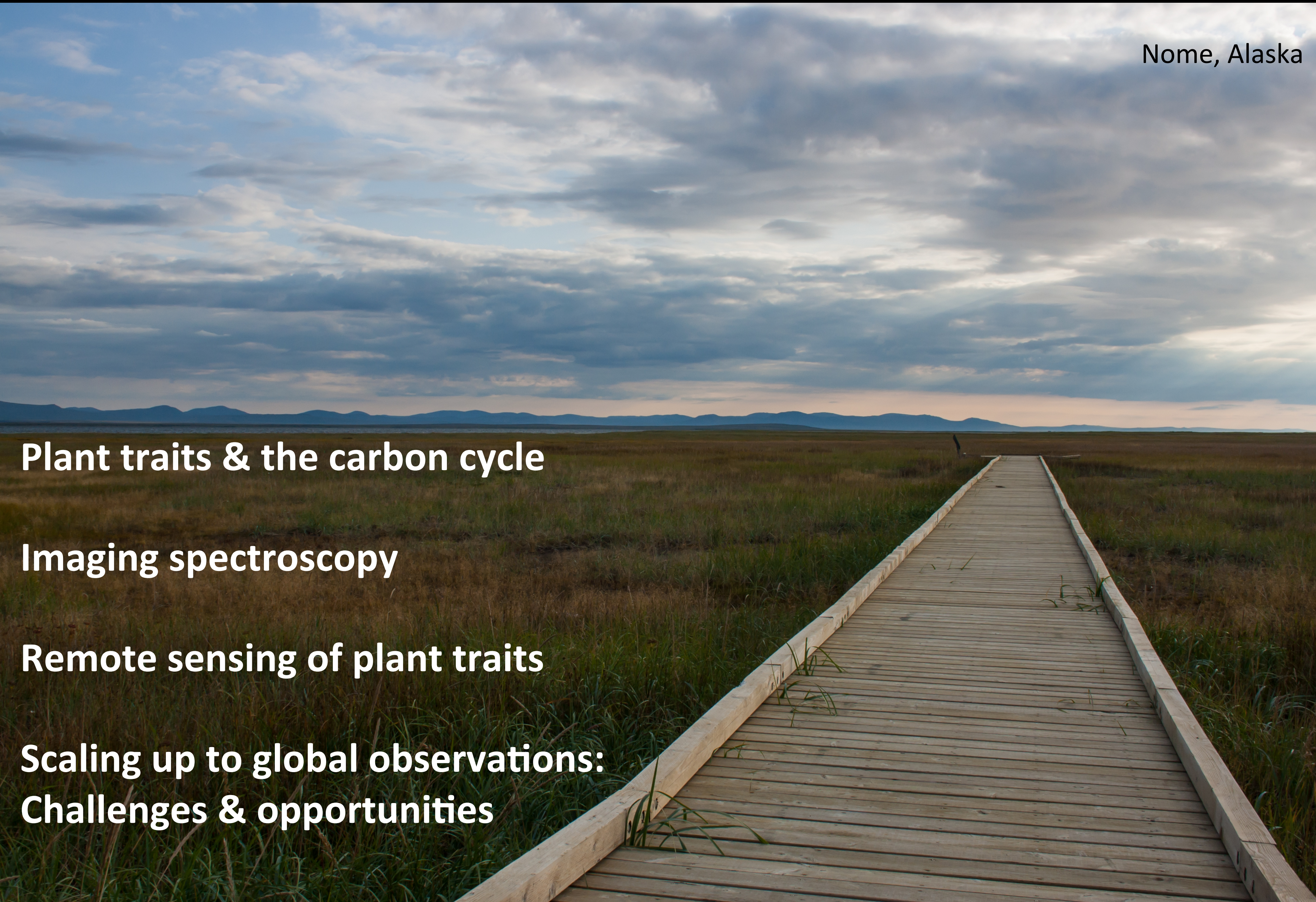
Topics



Nome, Alaska

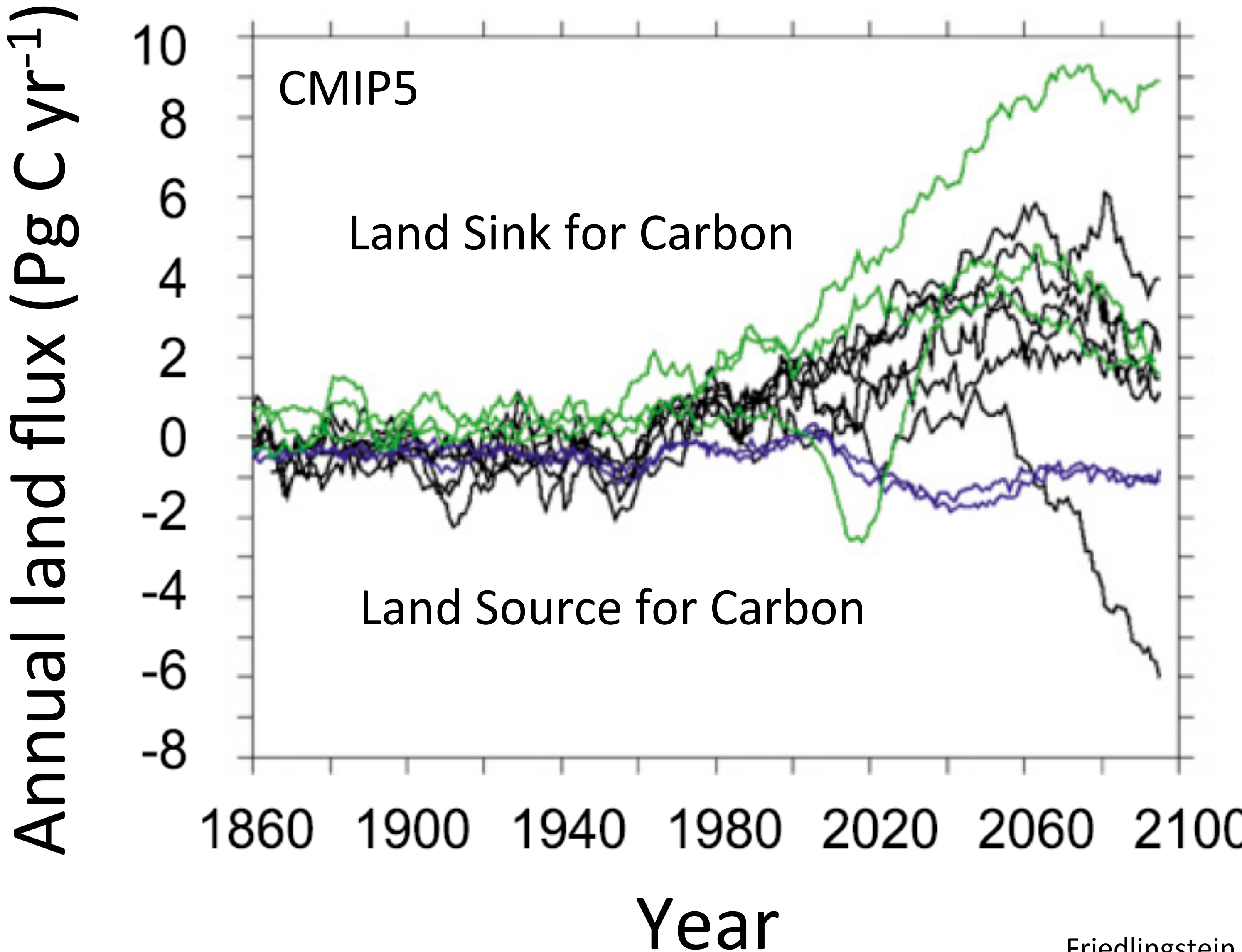
Plant traits & the carbon cycle

Imaging spectroscopy

Remote sensing of plant traits

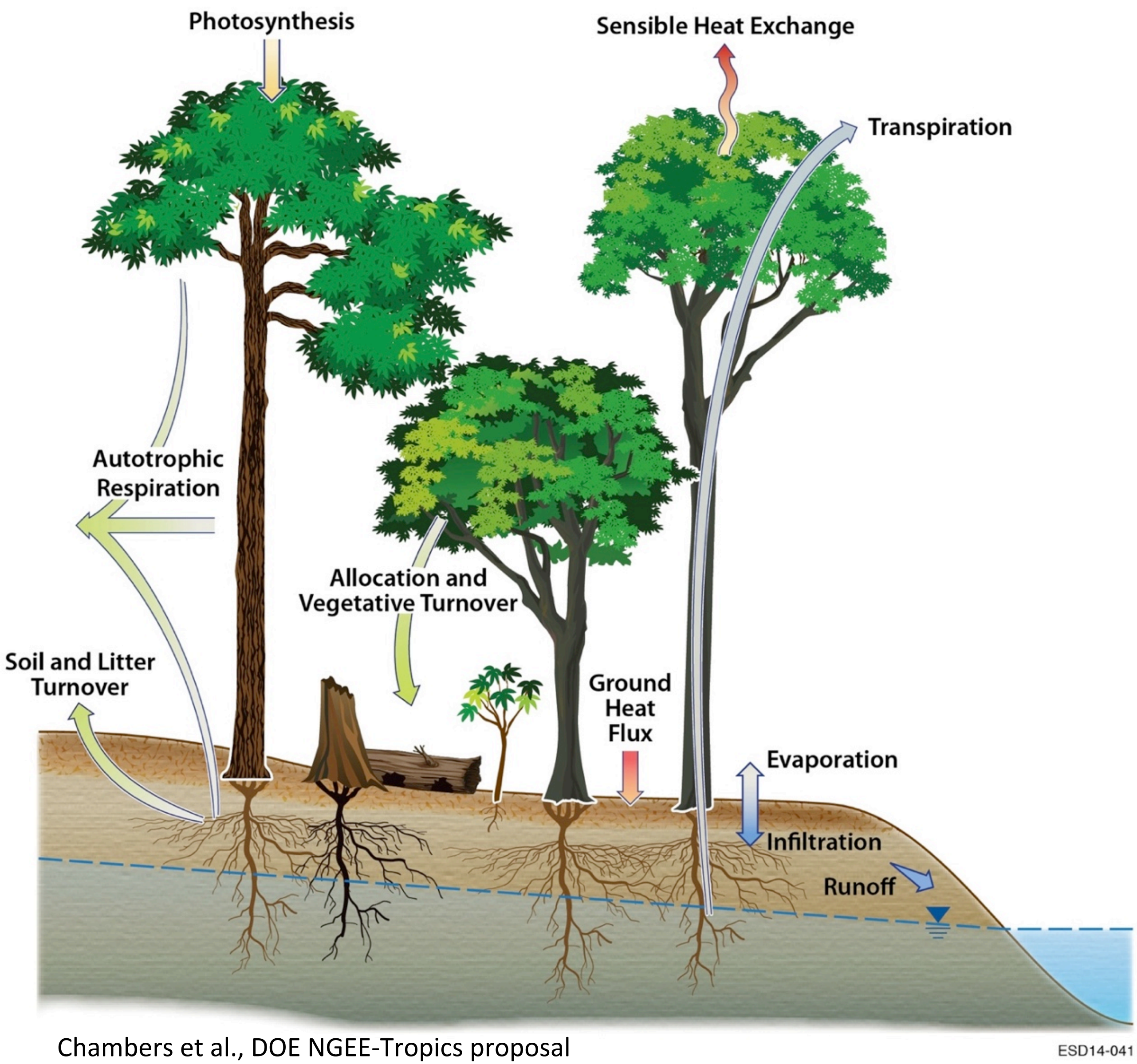
Scaling up to global observations:
Challenges & opportunities

Projections of the terrestrial carbon sink are uncertain



Friedlingstein et al. (2014)

Plant traits and the C cycle

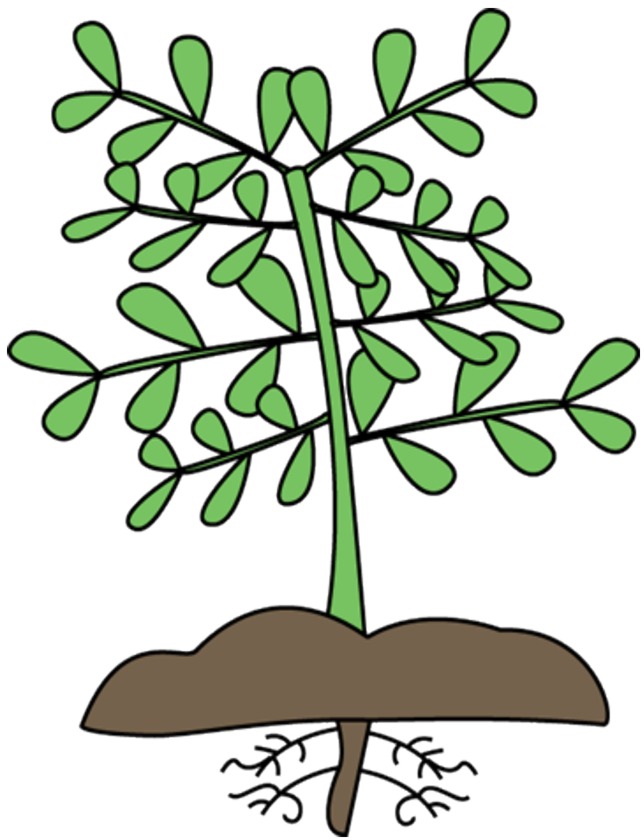


Chambers et al., DOE NGEE-Tropics proposal

Plant traits and the C cycle

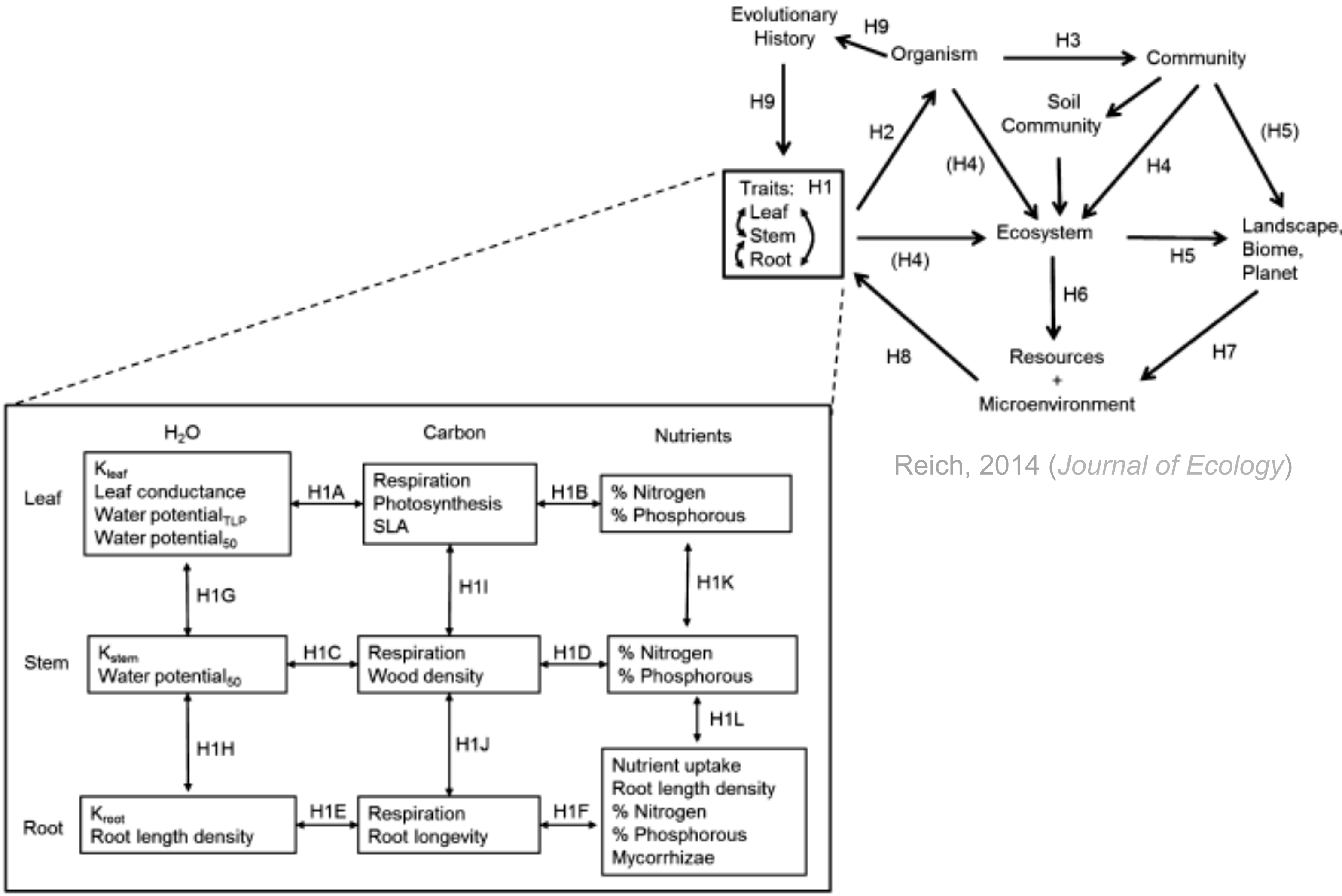
Plant trait: A vegetation property that drives or regulates a specific process.

Plant function	**Plant trait**
Establishment, recruitment	Seed properties (e.g. mass)
Light utilization	E.g. Height, LAD, albedo
Carbon uptake & respiration	E.g. V_{cmax}, LUE, nitrogen
Nutrient cycling	E.g. Leaf nutrients & structure (e.g. C, ligno-cellulose, LMA)
Nutrient uptake & C turnover/fluxes	E.g. Root properties (e.g. density, diameter



Plant traits and the C cycle

The variation of plant traits controls ecosystem processes, functional diversity, & C cycle

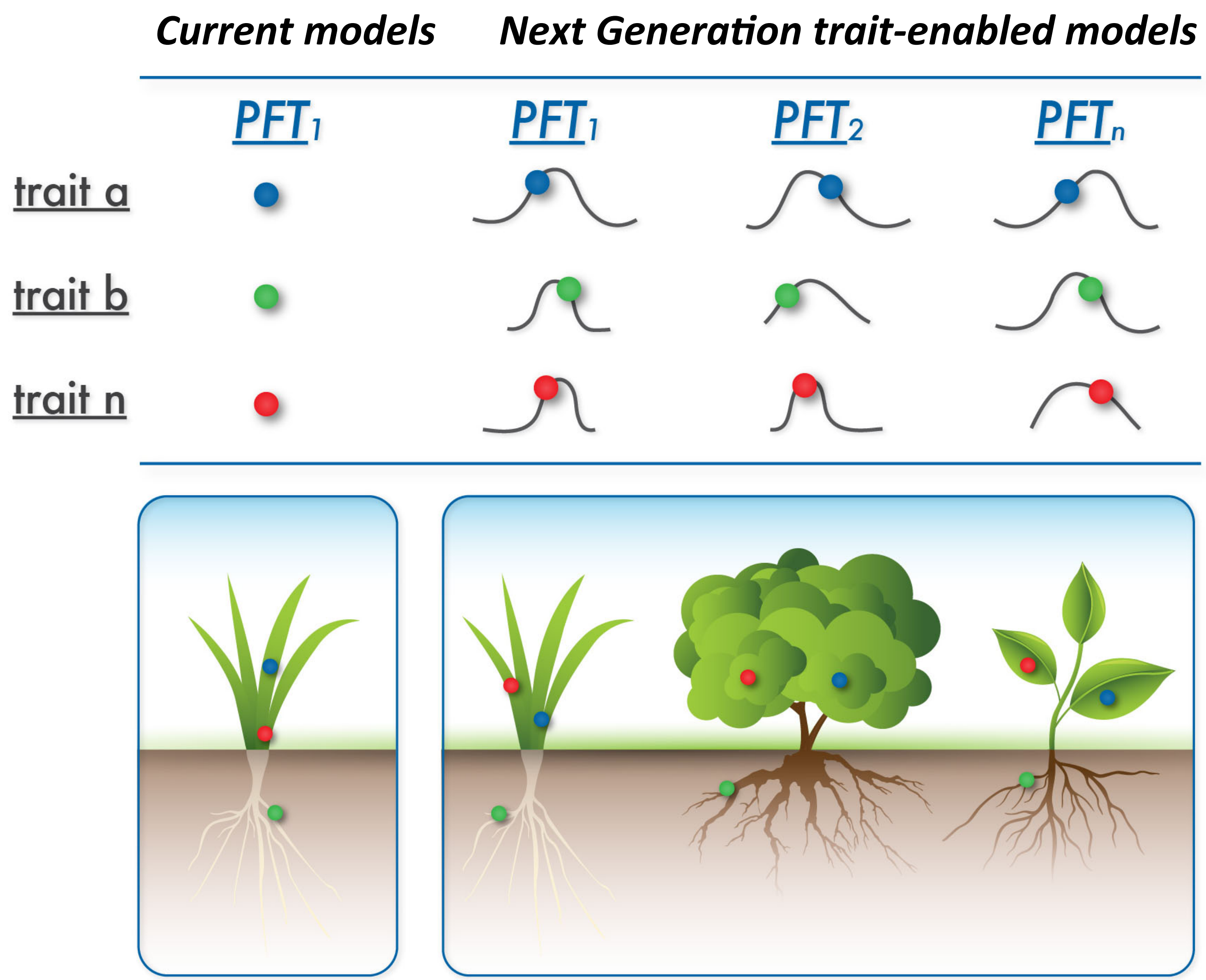


Reich, 2014 (*Journal of Ecology*)

Models use Plant Functional Types

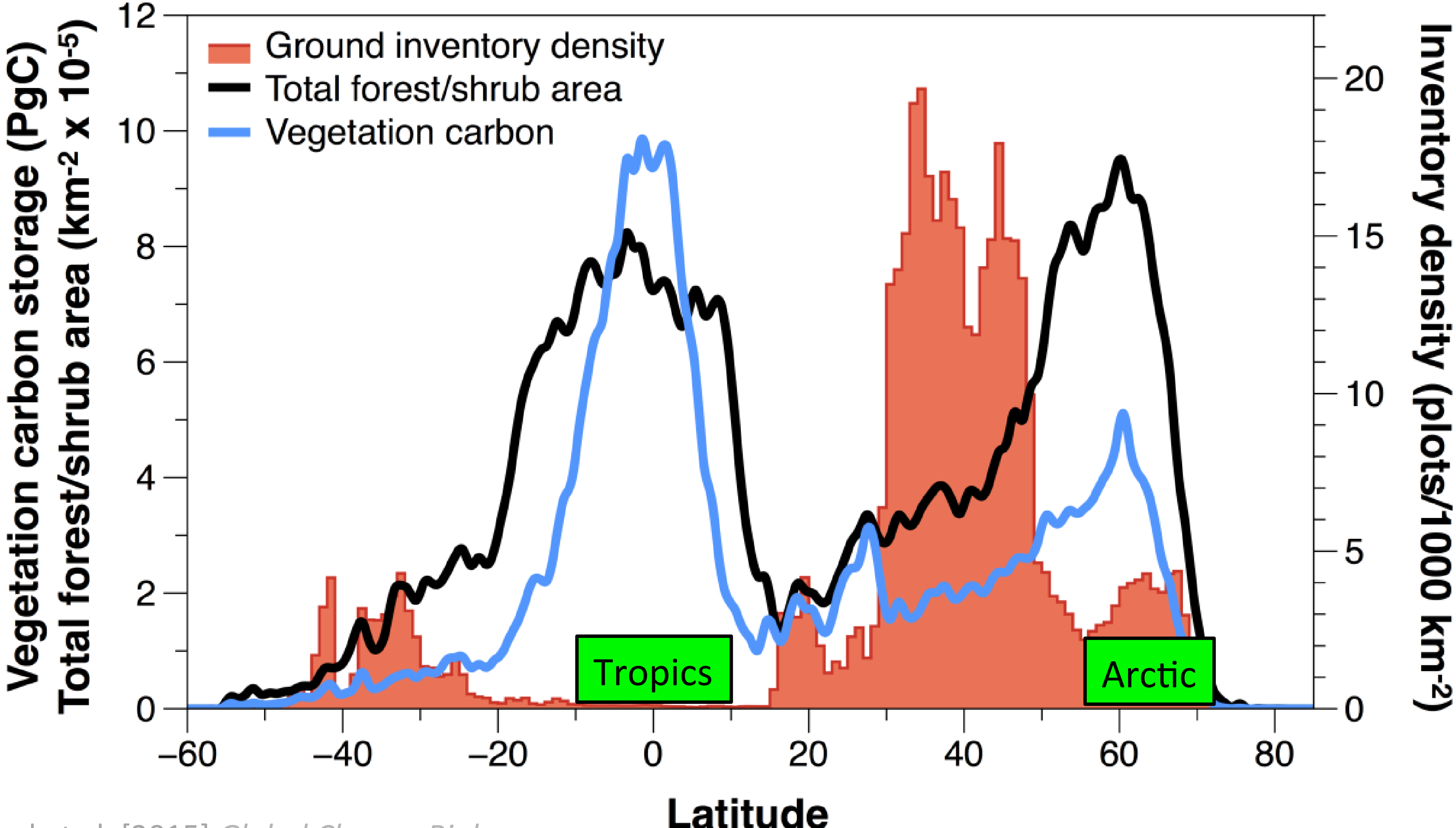
	PFT 1	PFT 2	PFT 3	....	PFT *n*
Trait 1: e.g. Photosynthetic capacity					
Trait 2: e.g. Leaf nitrogen					
Trait 3: e.g. Wood density					
Trait 4: e.g. Root turnover rate					
⋮					
Trait *n*					

Models use Plant Functional Types



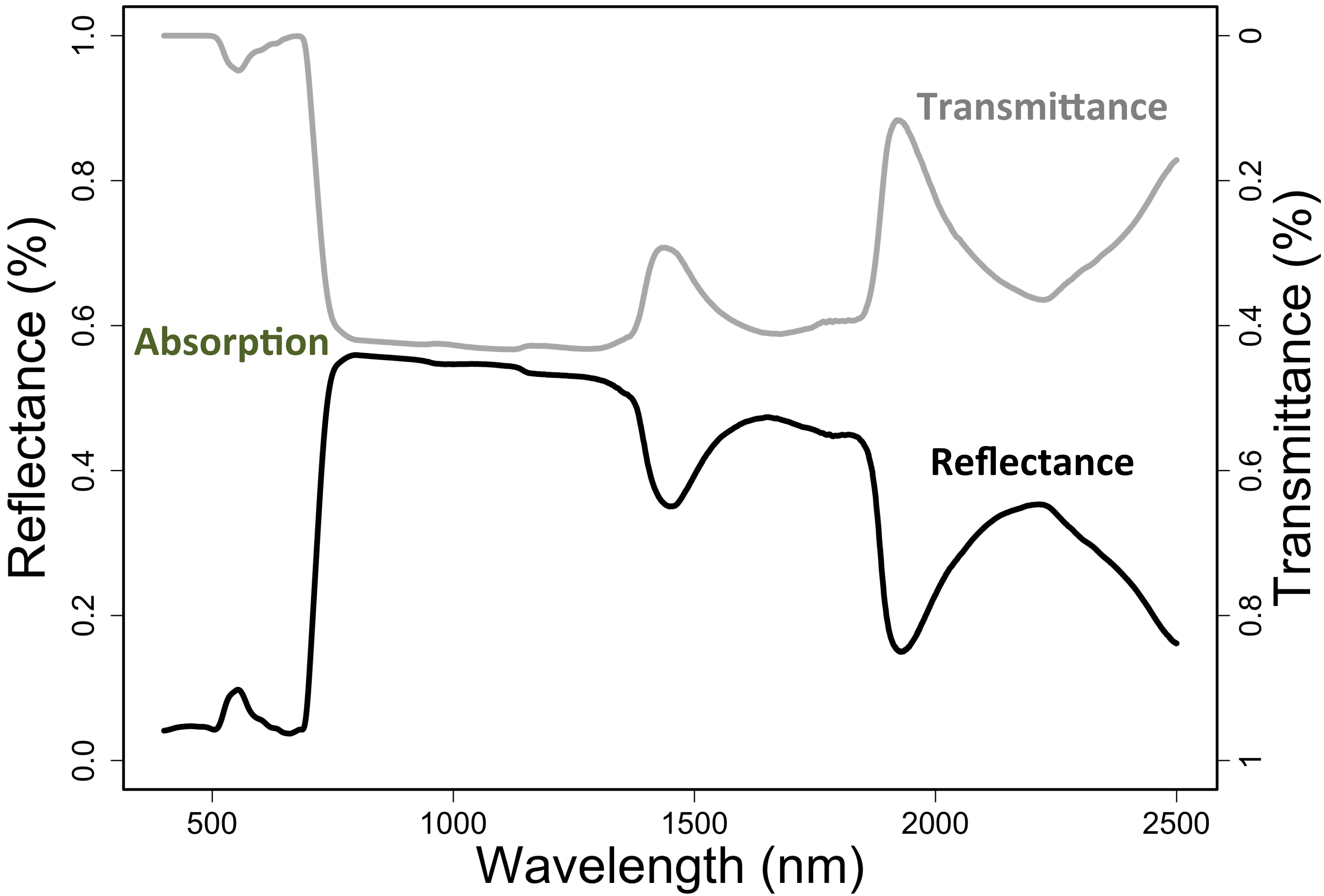
Understudied and poorly represented biomes

- Temperate zone bias
- Arctic, tropical CO_2 stores & fluxes are underrepresented



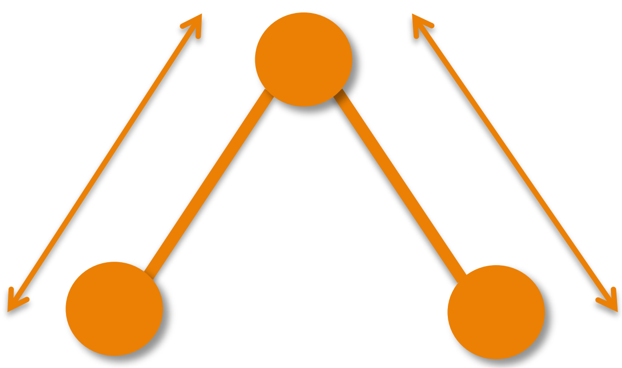
Schimel et al. [2015] *Global Change Biology*

Spectroscopy – Key tool for understanding plant traits

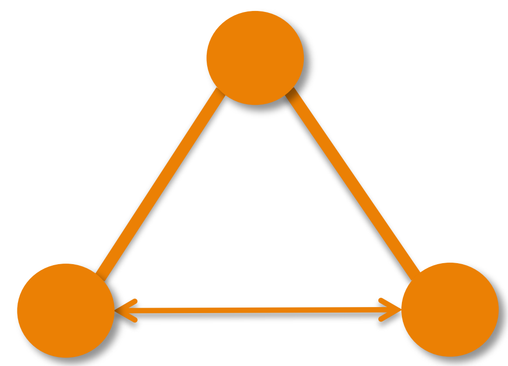


Vegetation spectroscopy: Physical basis

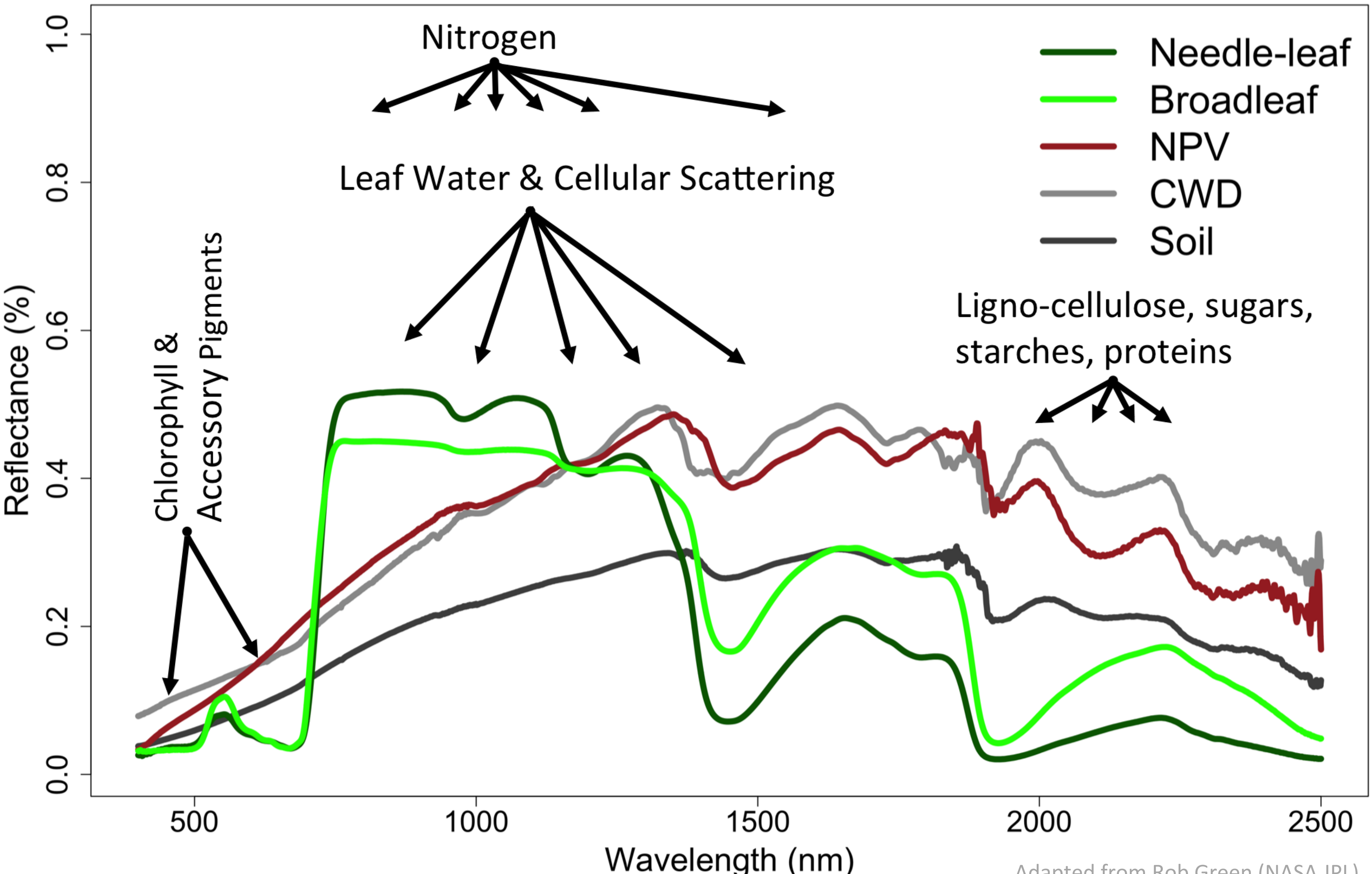
Stretching



Bending & Twisting



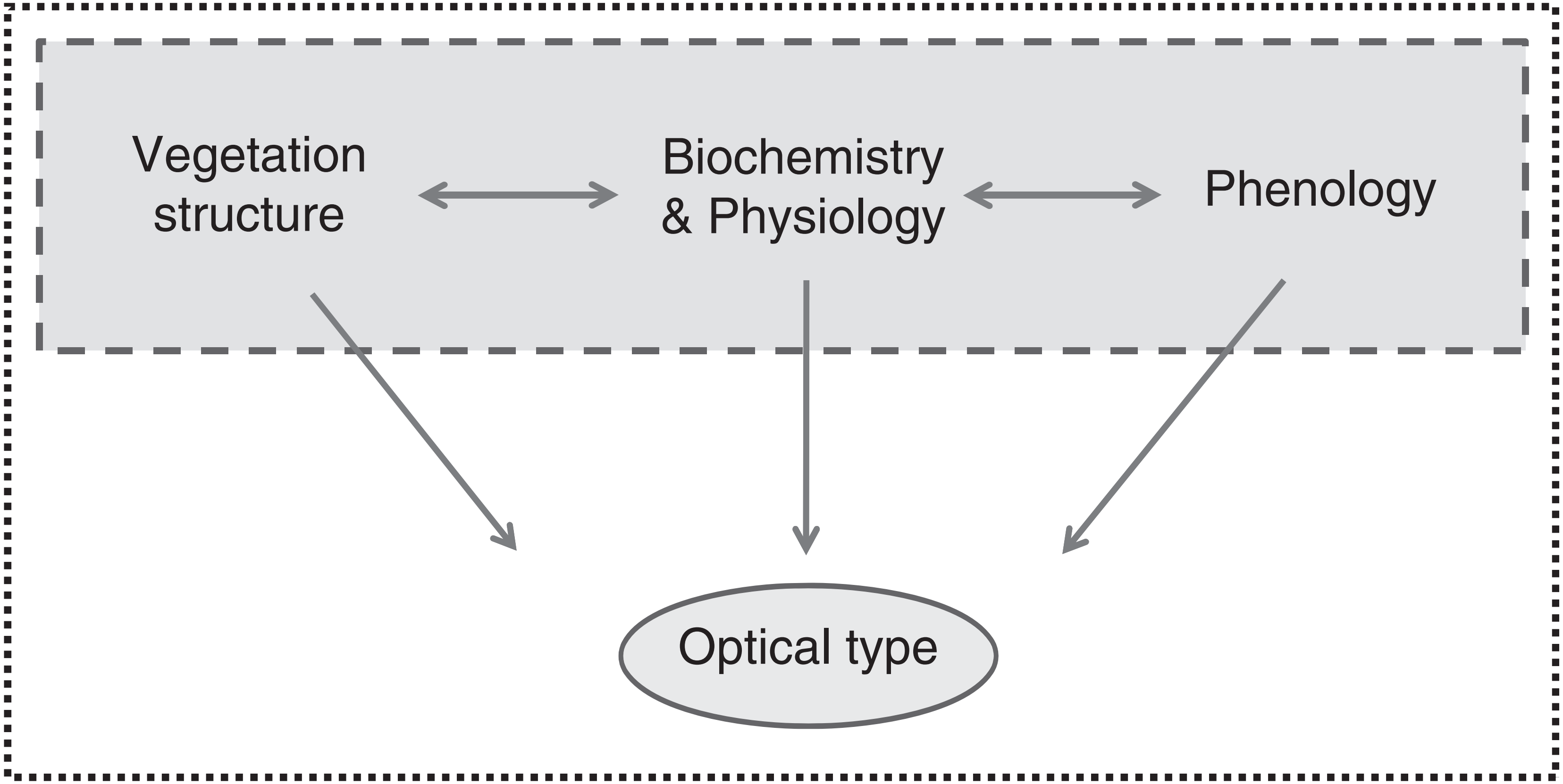
Vegetation spectroscopy



Adapted from Rob Green (NASA JPL)

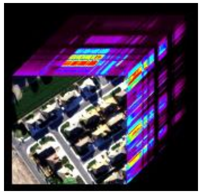
Vegetation spectroscopy – “Optical types”

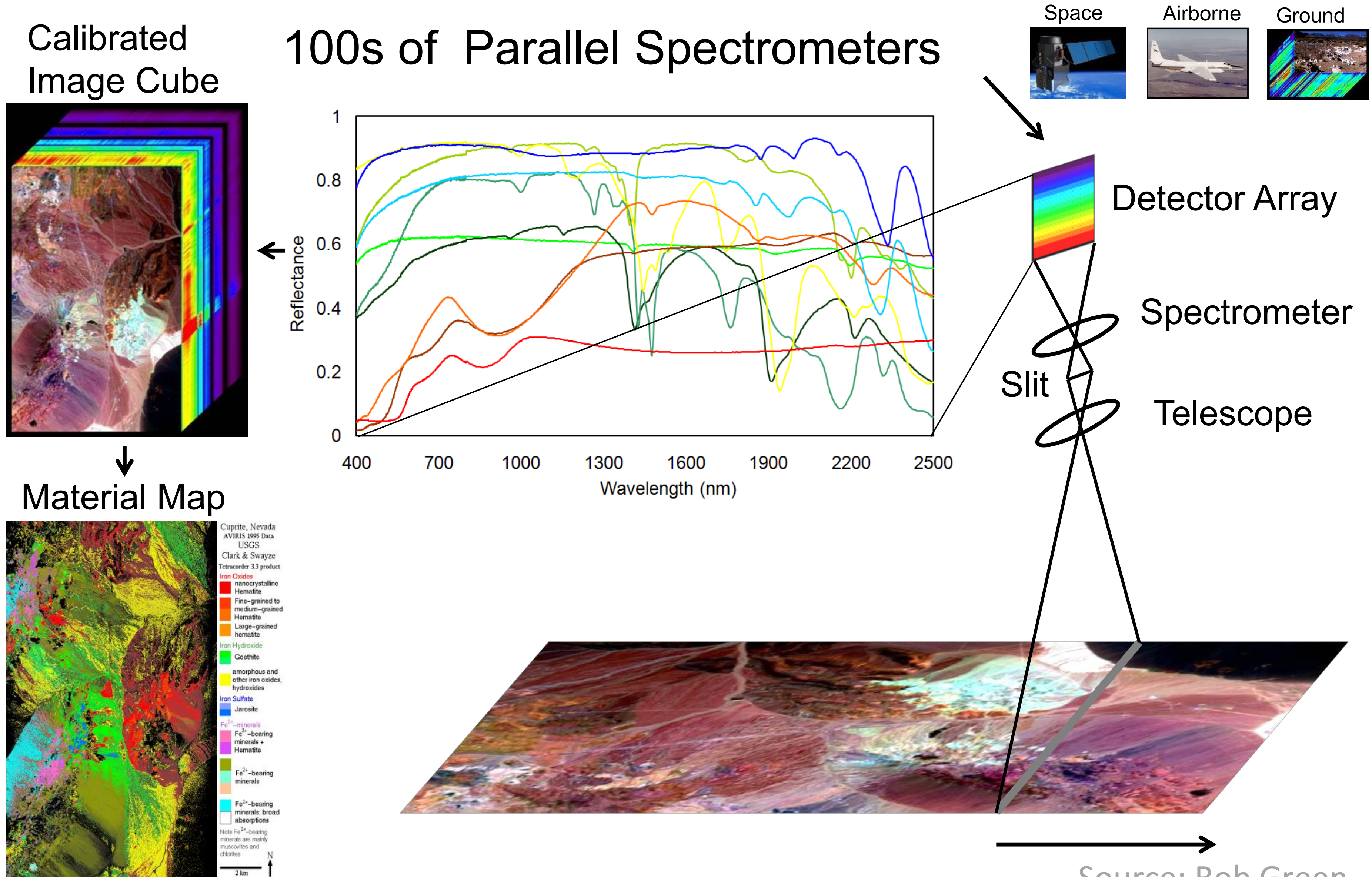
Ustin and Gamon (2010)



Capture plant trait diversity through spectral fingerprints vs categorizing species on the landscape

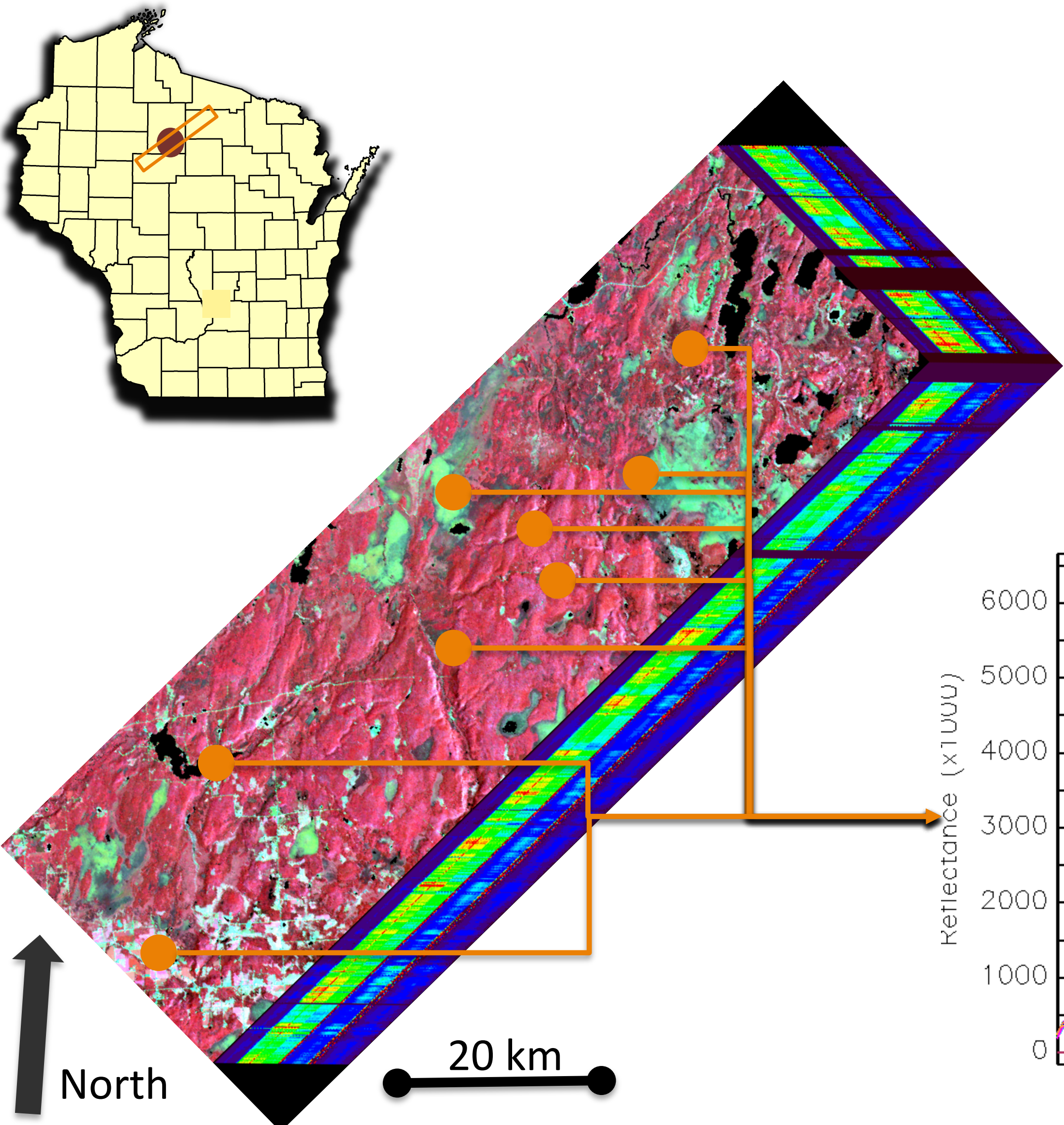
Imaging Spectroscopy: Detect, Identify, Quantify and Monitor

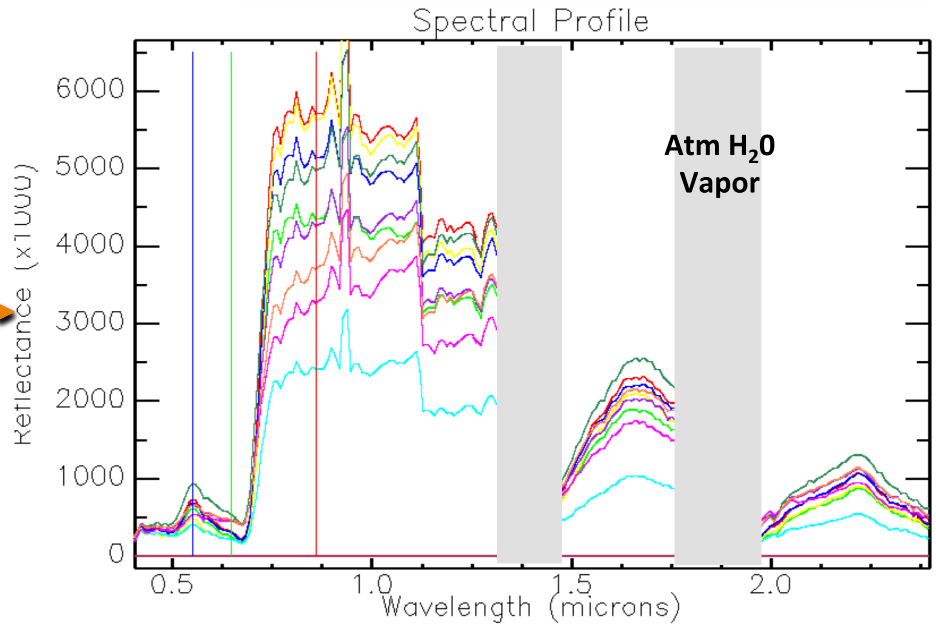




Source: Rob Green

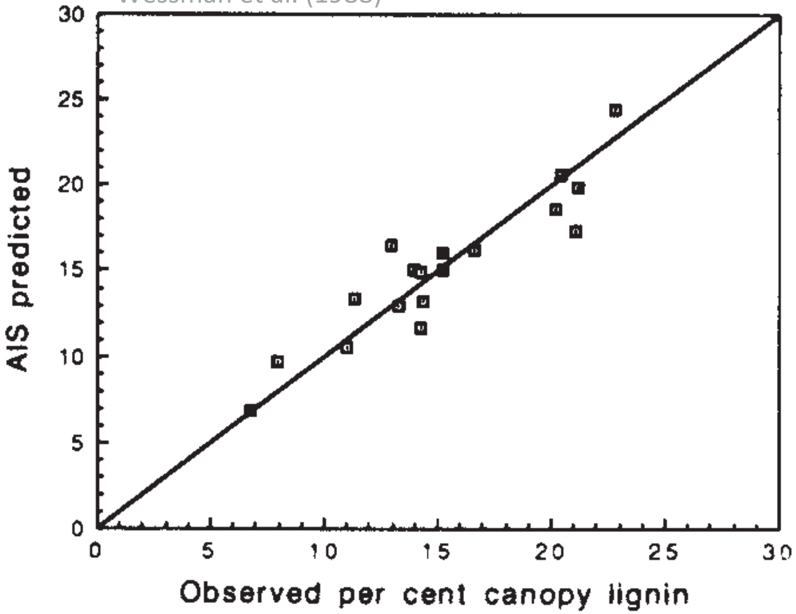
Imaging spectroscopy



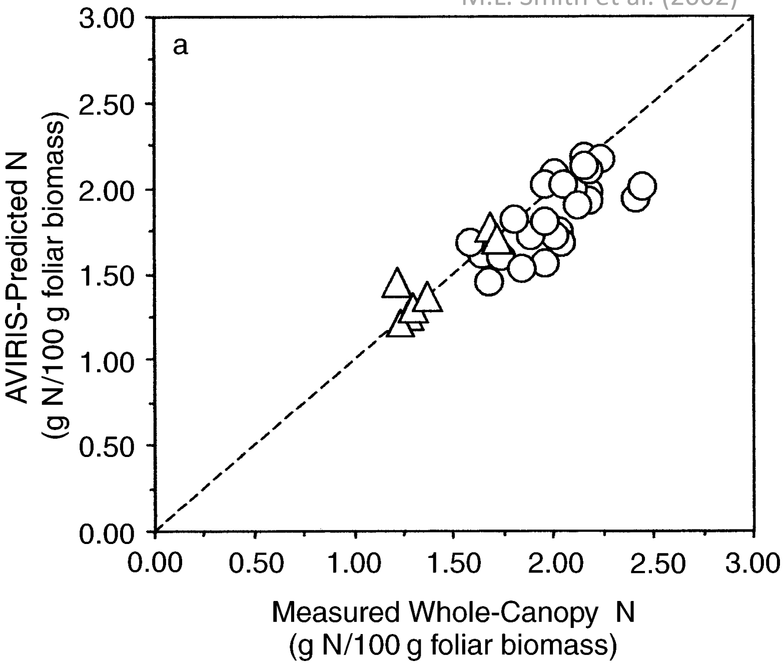


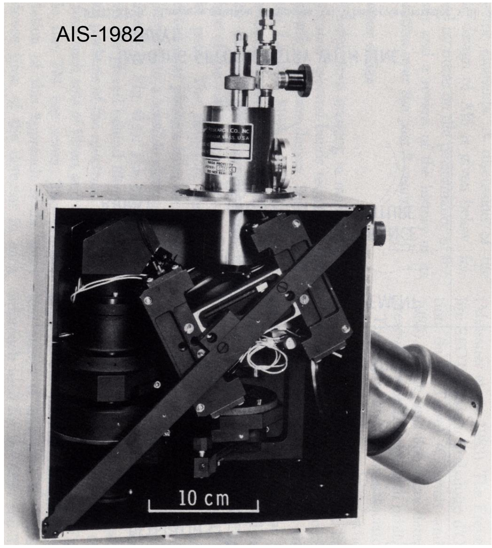
Imaging spectroscopy & plant traits

Wessman et al. (1988)

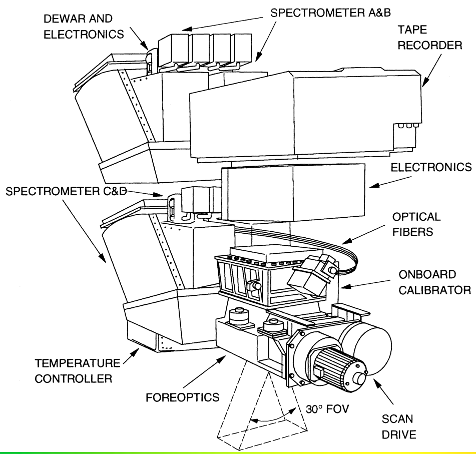


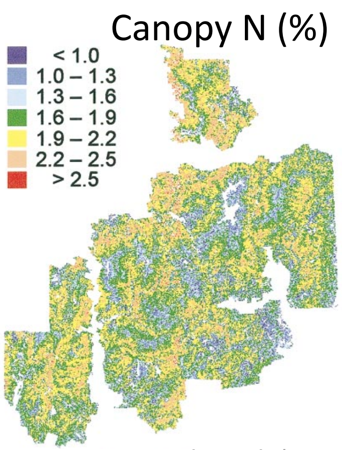
M.L. Smith et al. (2002)





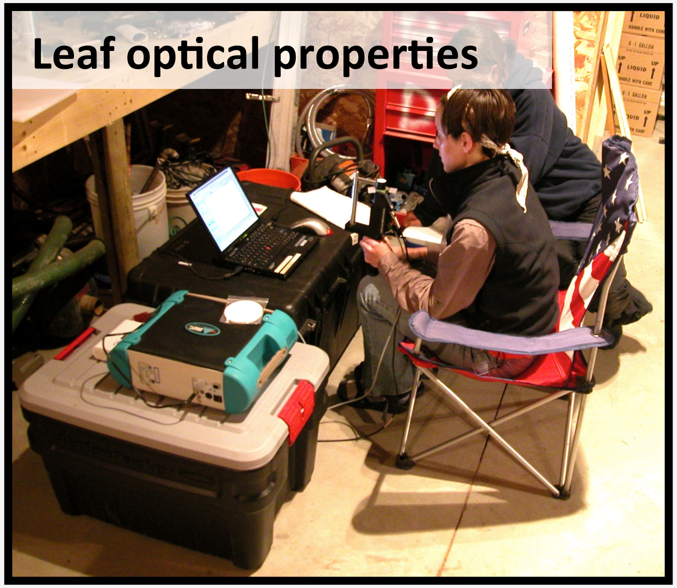
Green et al. (1998)



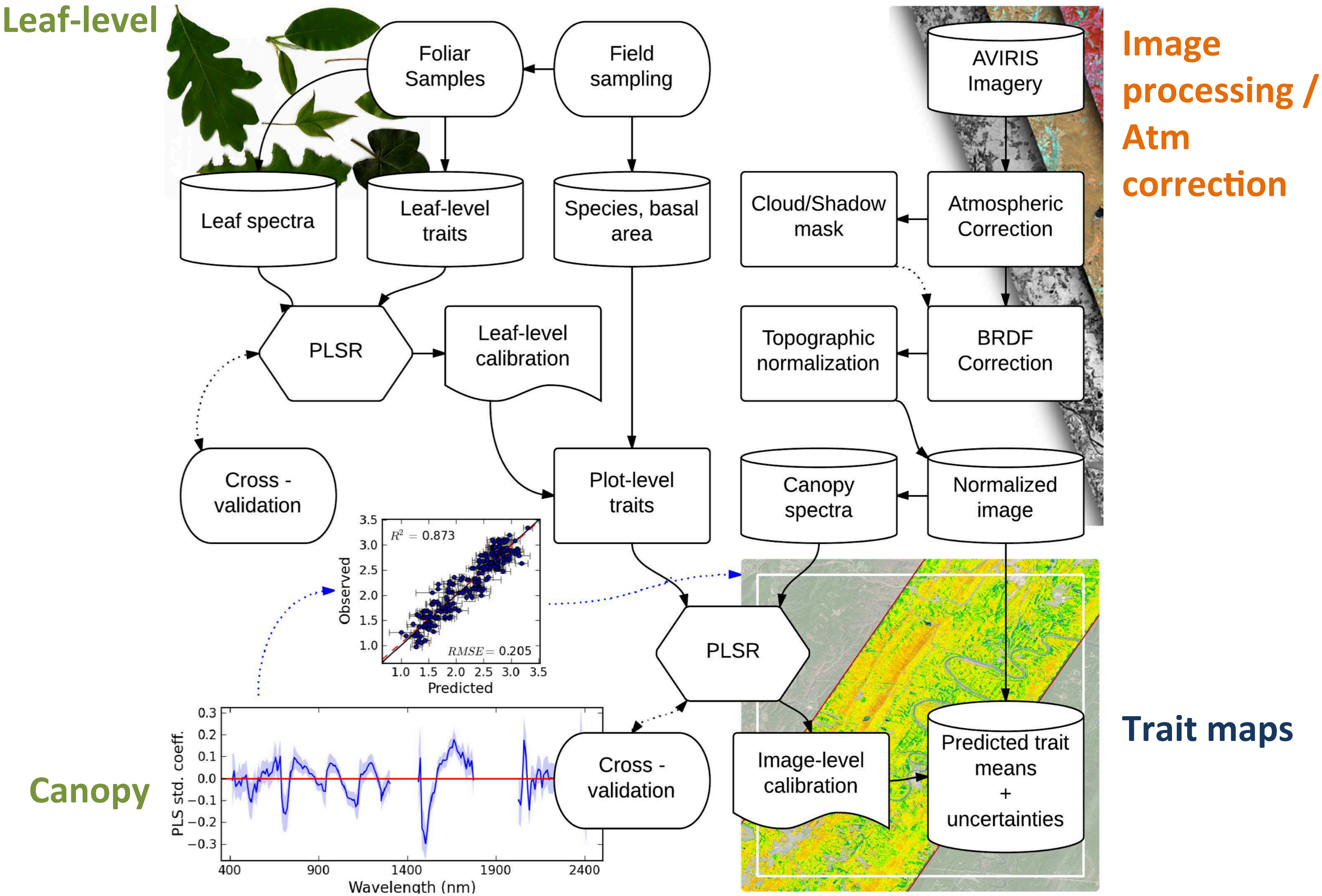


M.L. Smith et al. (2002)

Collecting in-situ trait data



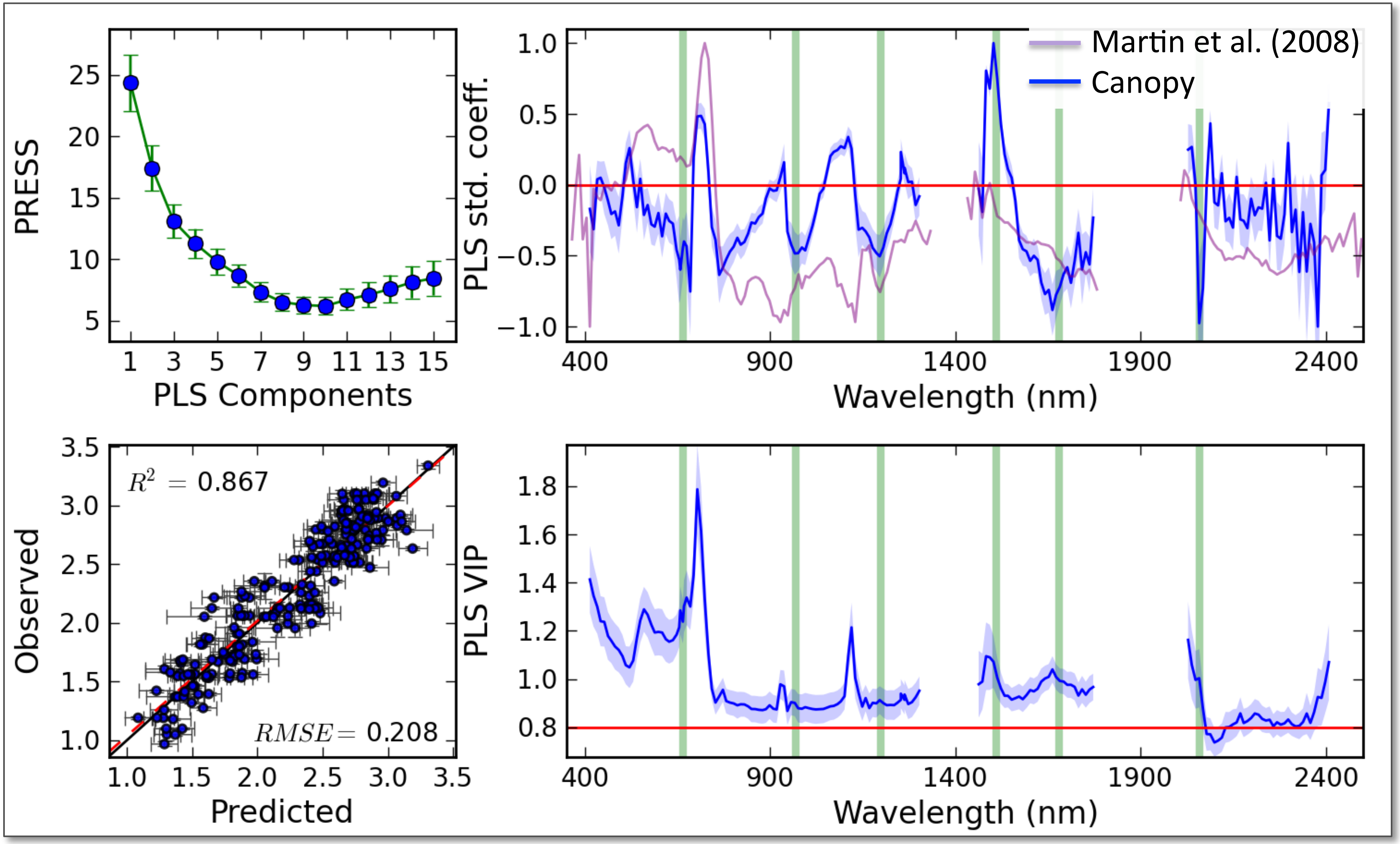
Scaling up vegetation function & plant traits



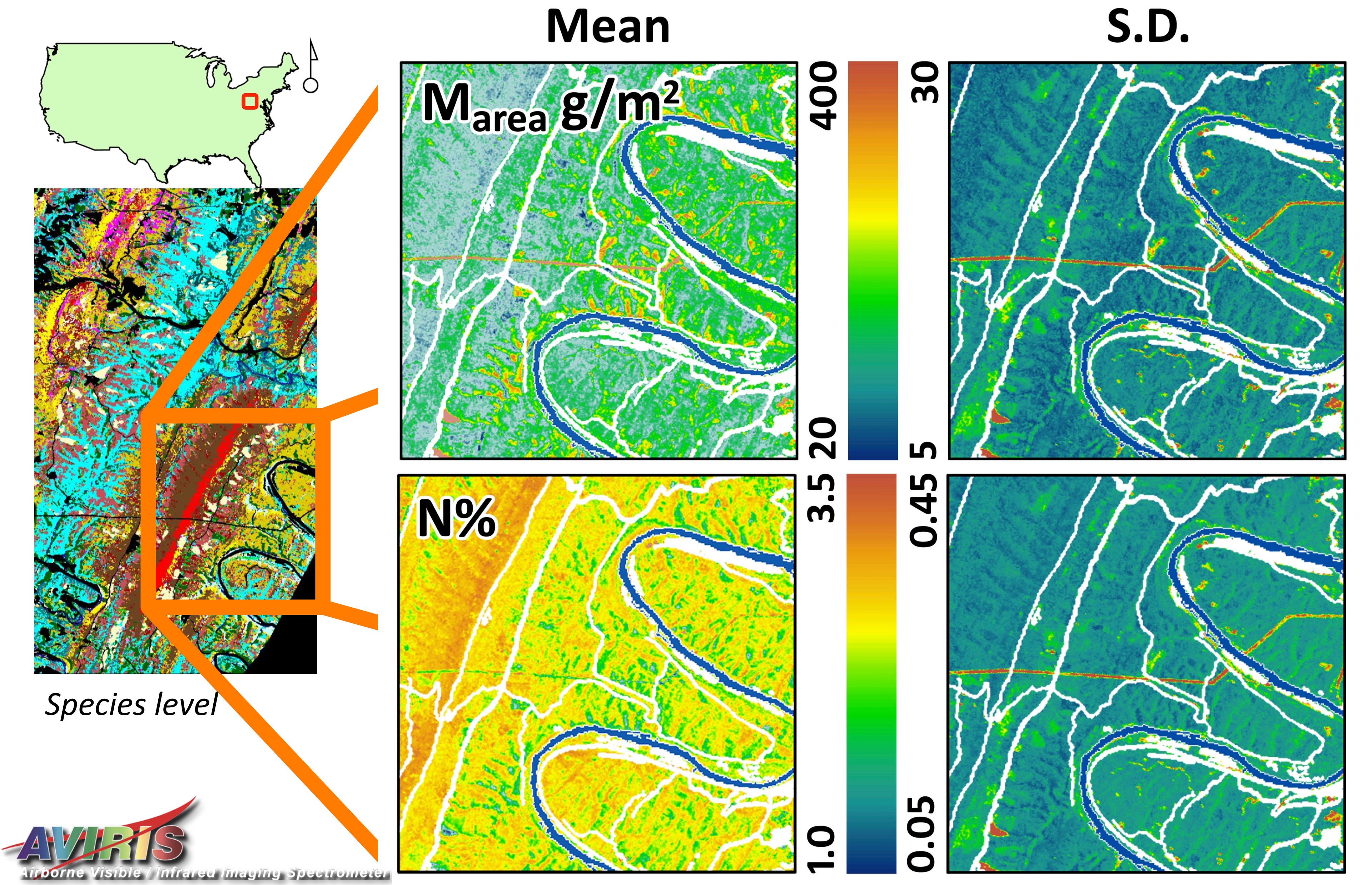
Singh, Serbin et al. [2015] *Eco. Apps*

Leaf nitrogen concentration (%)

Singh, Serbin, et al. [2015] *Eco. Apps*



Capturing landscape patterns of plant function

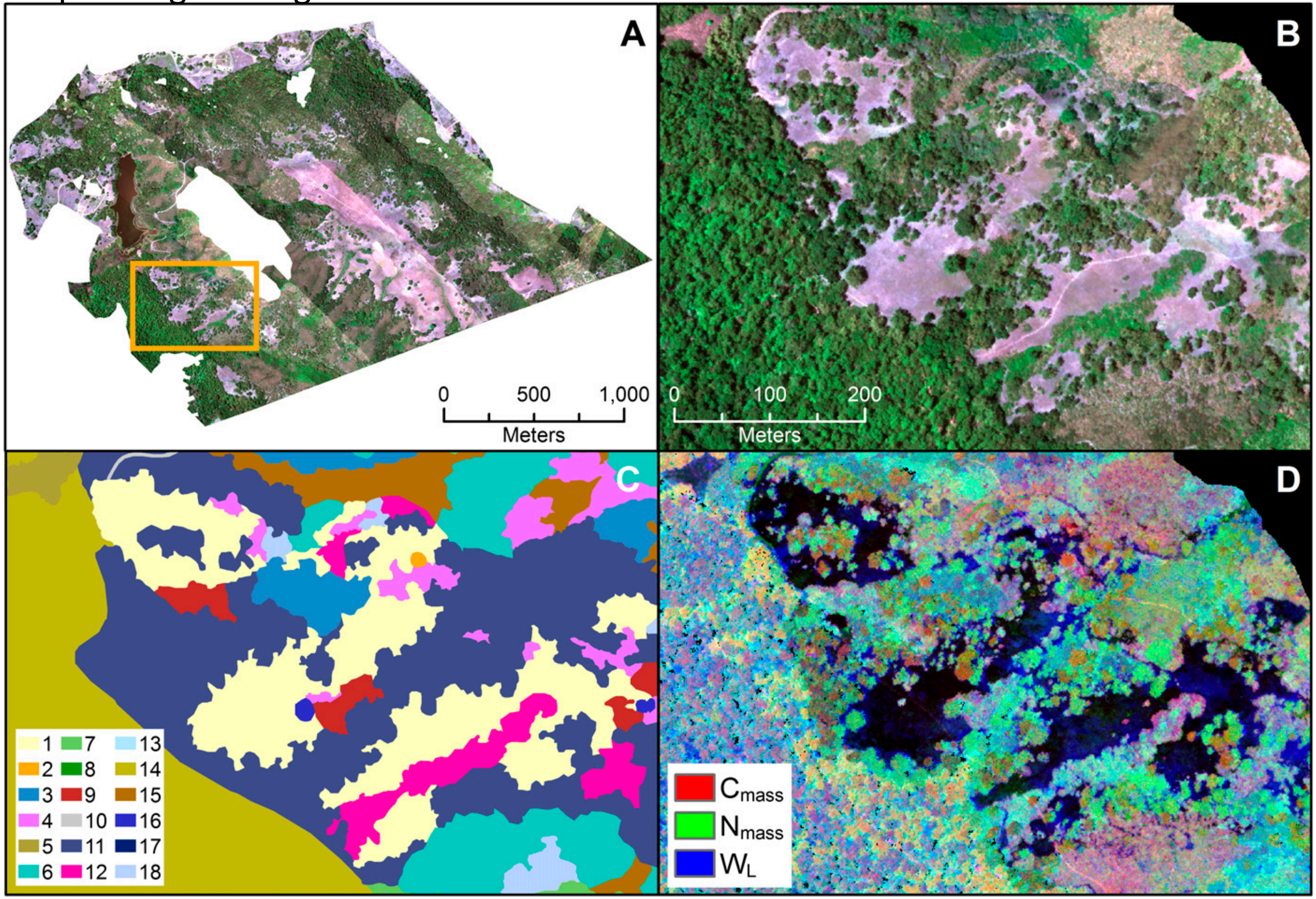


Serbin, Singh et al., [2014] *Ecol. Applications;* Singh, Serbin et al., [2015] *Ecol. Applications;* Serbin et al., [2015] *Remote Sensing of Environ.*

Pattern, process, and functional diversity

Jasper Ridge Biological Preserve

CAO AToMS



Dahlin et al., (2013)

Challenges and opportunities

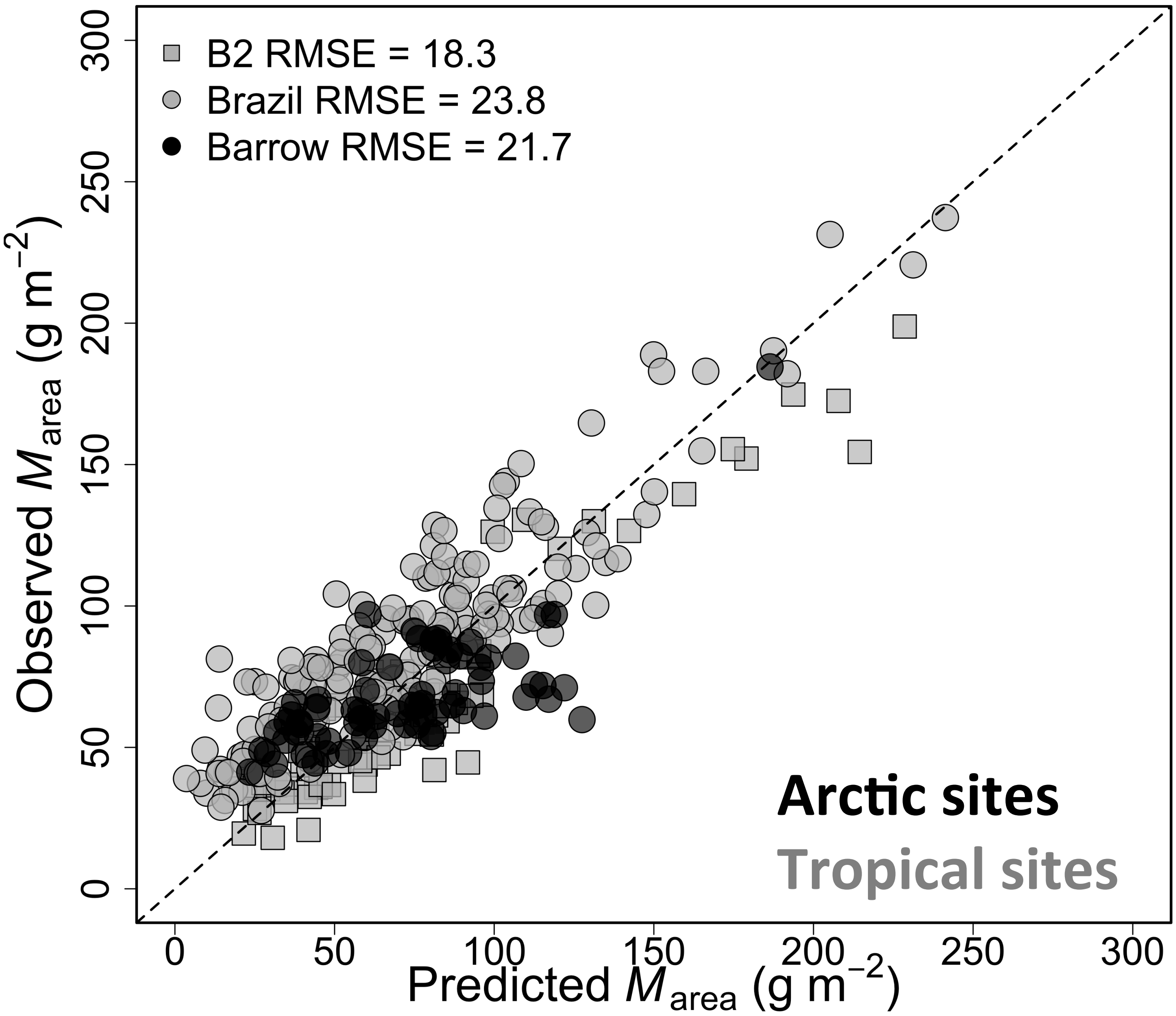
Challenges

- Scaling up from leaf/plant/canopy to pixel/landscape (particularly for diverse systems such as the Tropics)
- Data from many locations - need to generalize approaches
- Consistent data workflow (e.g. processing, atmospheric correction)
- Need to understand & propagate uncertainties in IS trait products

Opportunities

- Next gen. sensors providing increased fidelity and capabilities
- Blending of empirical and mechanistic approaches (e.g. Shiklomanov et al poster)
- Coordination of efforts across sites and coupling with other sensor technologies (e.g. EcoSYS Database; LiDAR, TIR)
- UAS platforms together with airborne and satellite observations
- IS to capture time and space variation of traits to inform modeling

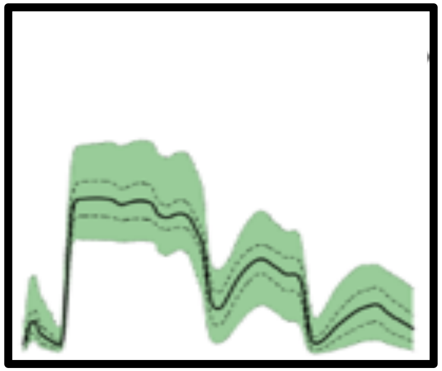
Opportunities: "Global" relationships



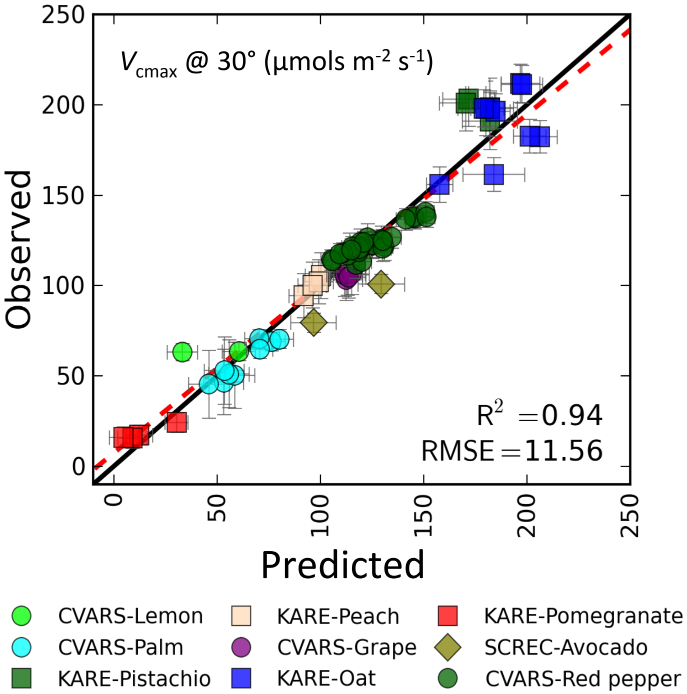
Serbin, Wu, Rogers, Saleska et al *in prep*

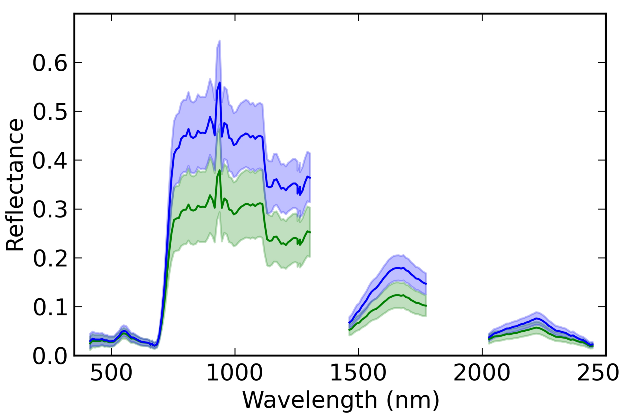
Developing general spectral algorithms of plant traits

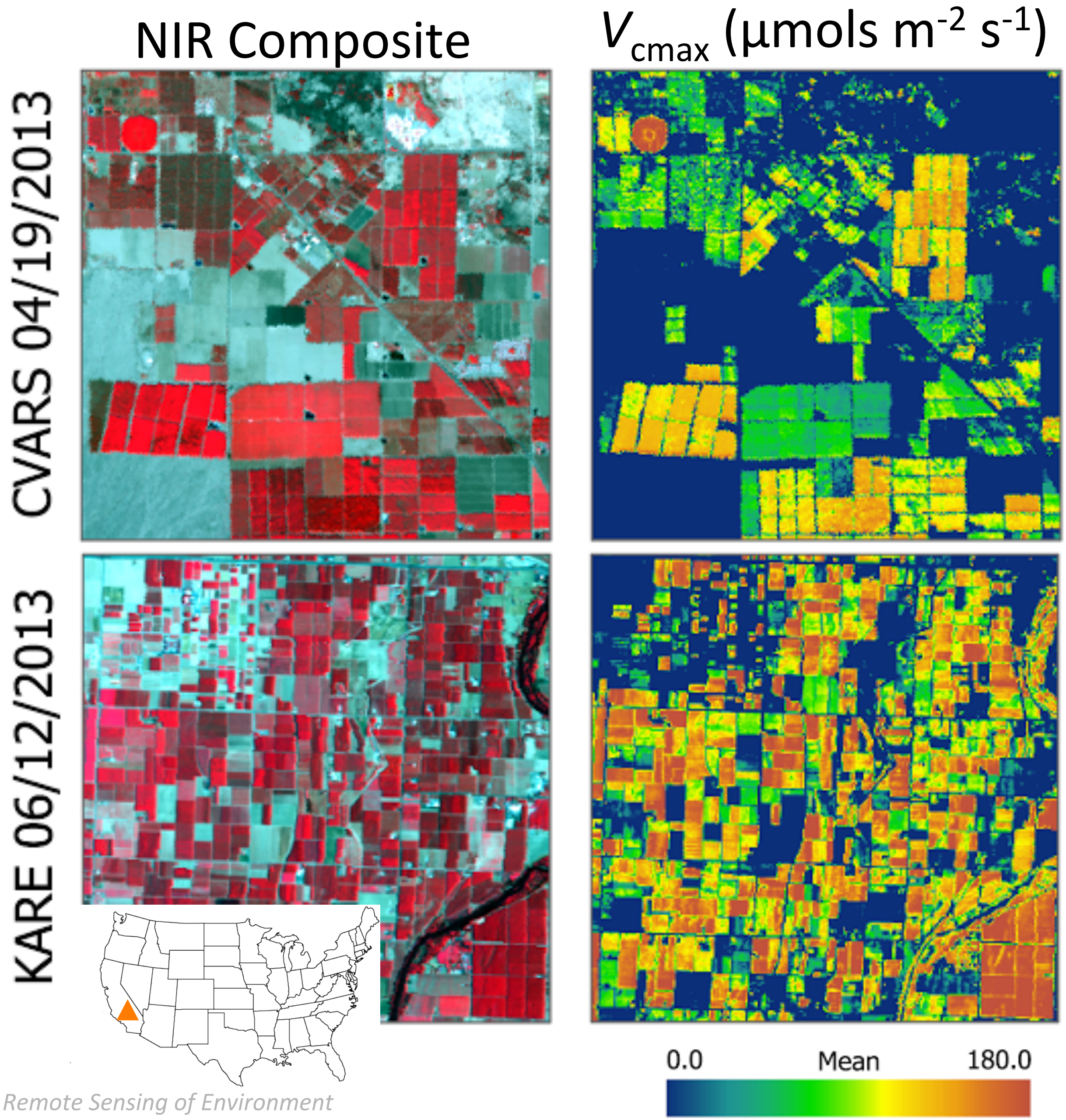
E.g. LMA model developed using temperate & boreal data & applied to new biomes



Opportunities: Mapping photosynthetic traits

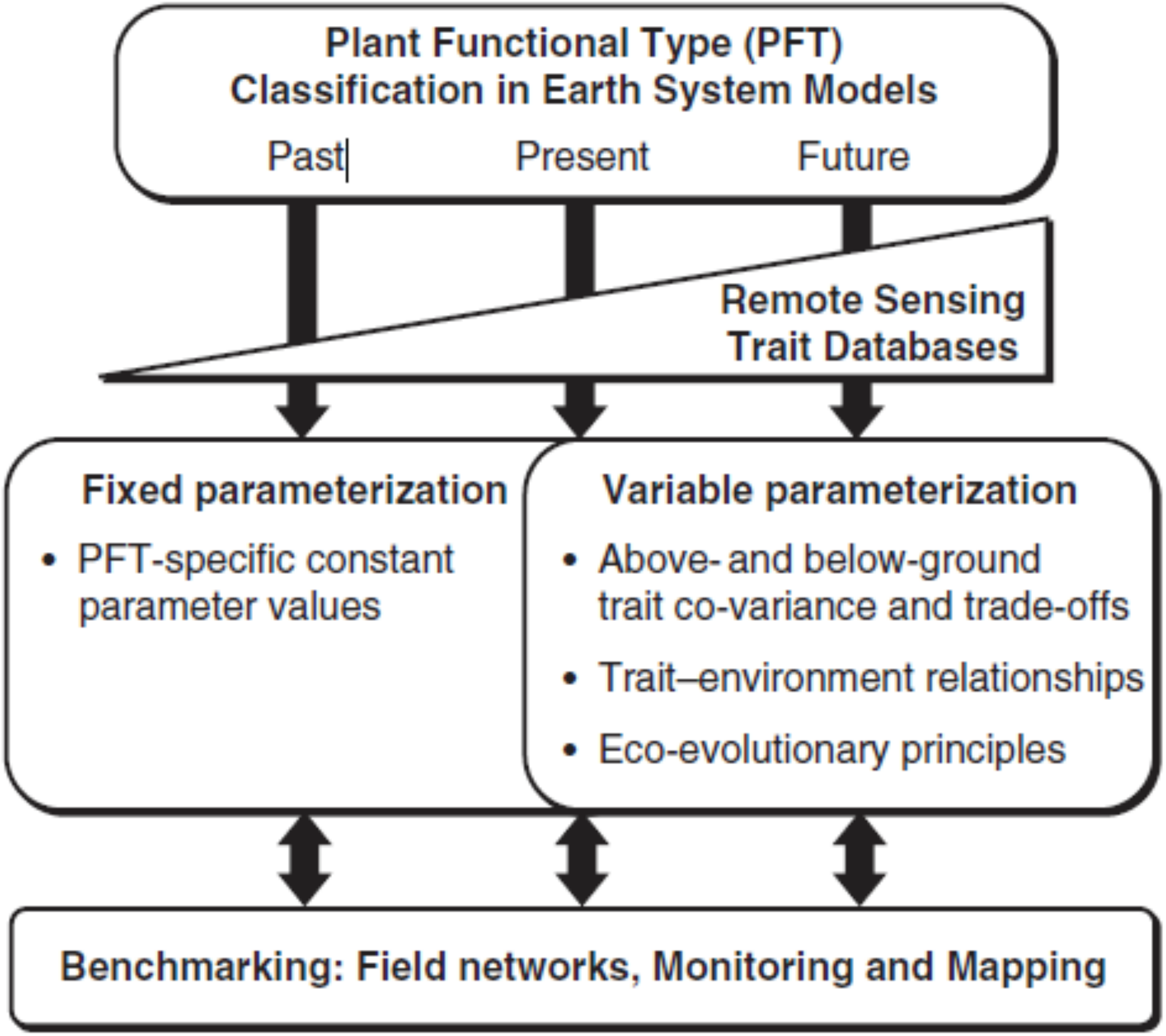






Serbin et al., [2012] *J. Exp. Botany*; Serbin et al., [2015] *Remote Sensing of Environment*

Opportunities: Using IS data to inform models



Wullschleger et al., 2015 (*Molecular Ecology*)

Plant traits from space