BioCube: Integrating dimensions of Biodiversity in California and Wisconsin

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Jet Propulsion Laboratory
California Institute of Technology

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UNIVERSITY OF WISCONSIN-MADISON

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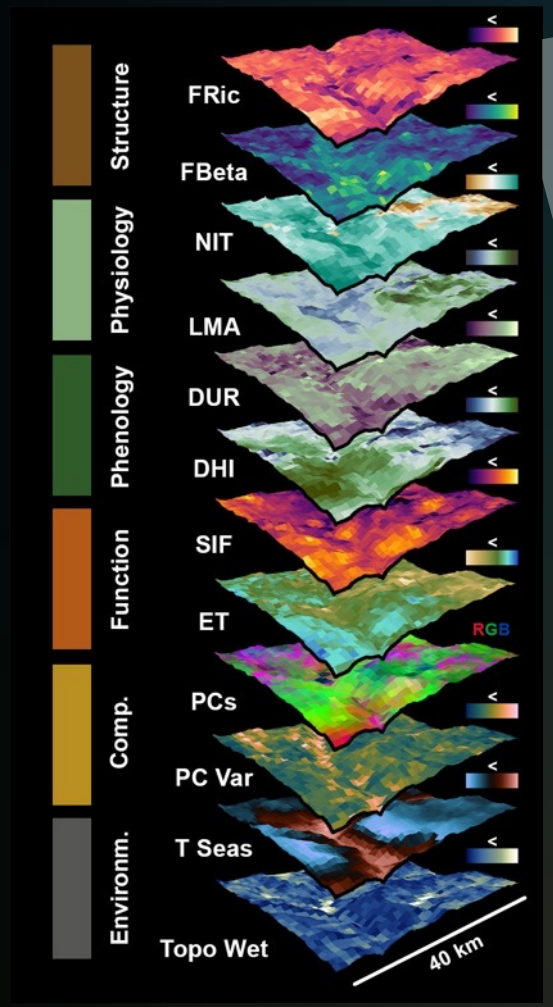
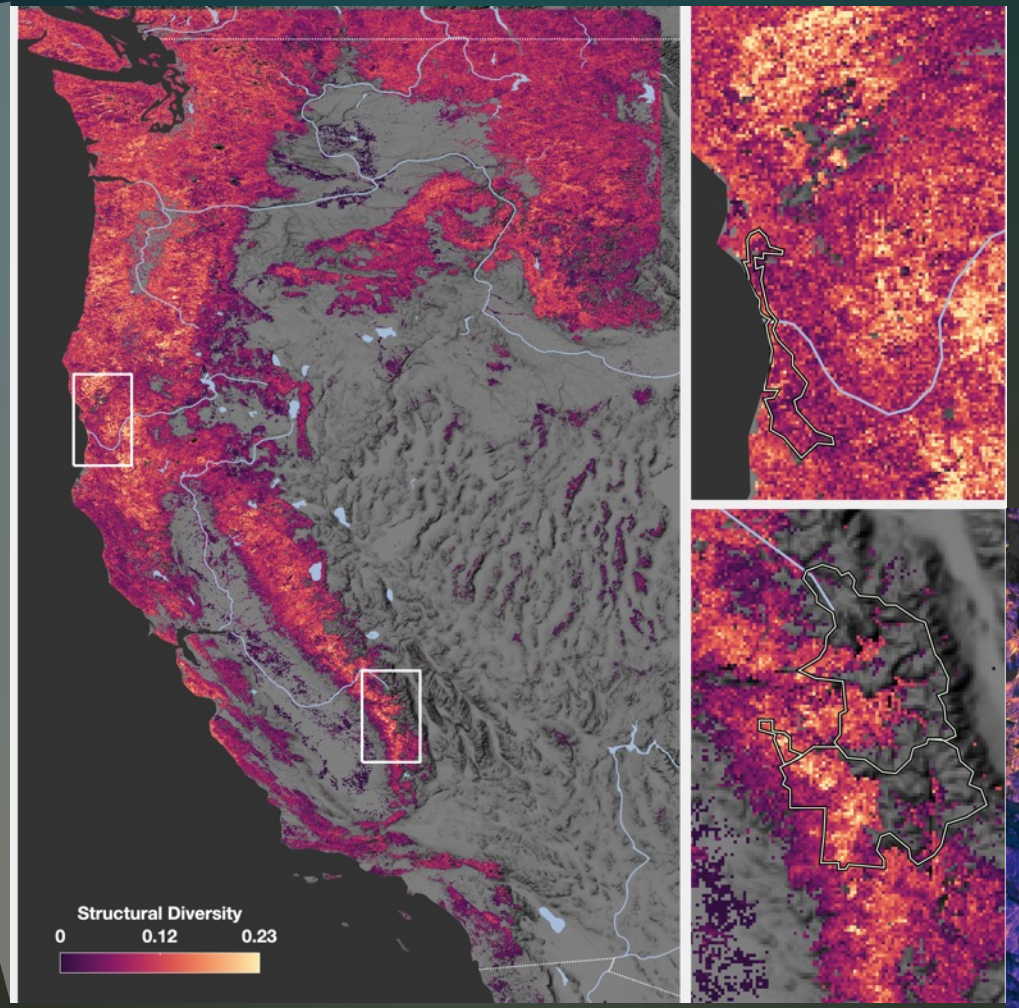
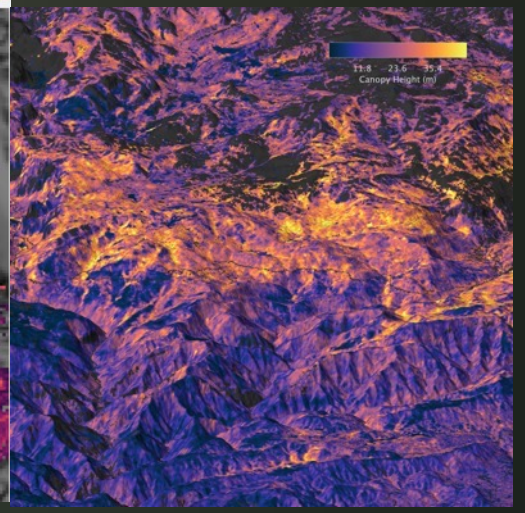
What is BioCube?

A data cube to study relationships among dimensions of biodiversity at landscape scale







Structural Diversity derived from GEDI
Schneider et al. (in preparation)

Canopy Height derived from GEDI and Sentinel-2
Favrichon et al. (in review)

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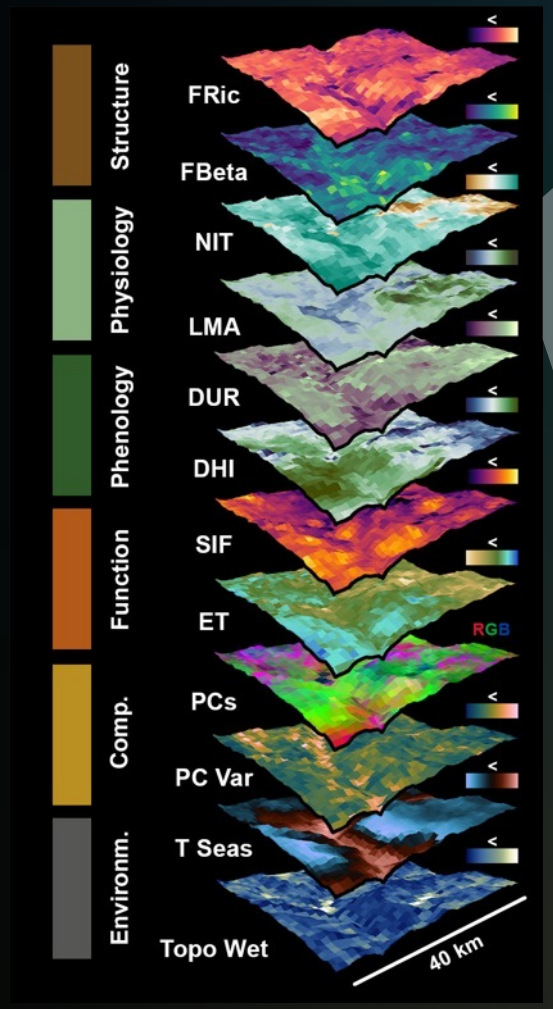
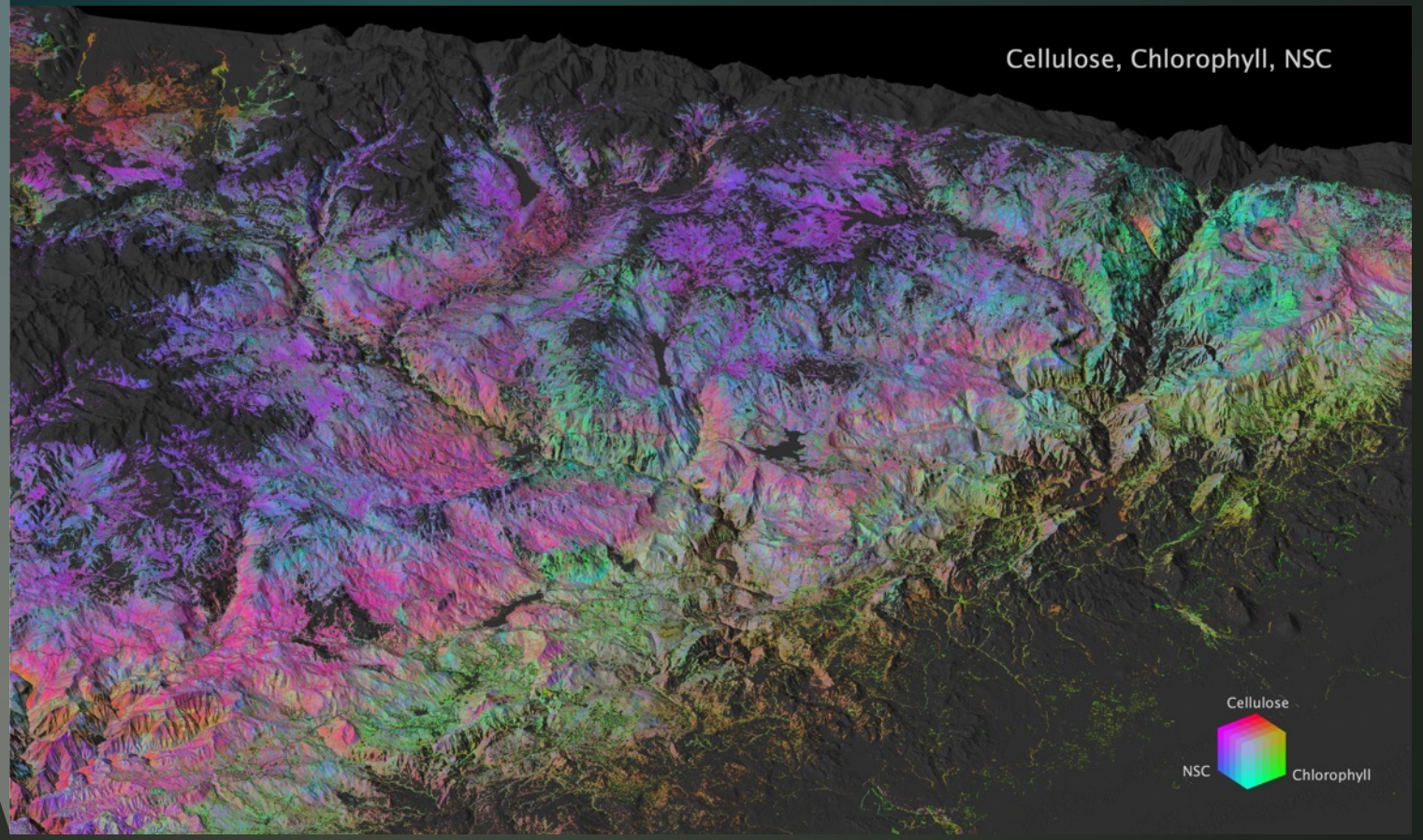


Plant foliar traits and functional diversity derived from AVIRIS-Classic

Zheng et al. (in preparation), Shafron et al. (in preparation), Schneider et al. (in preparation)



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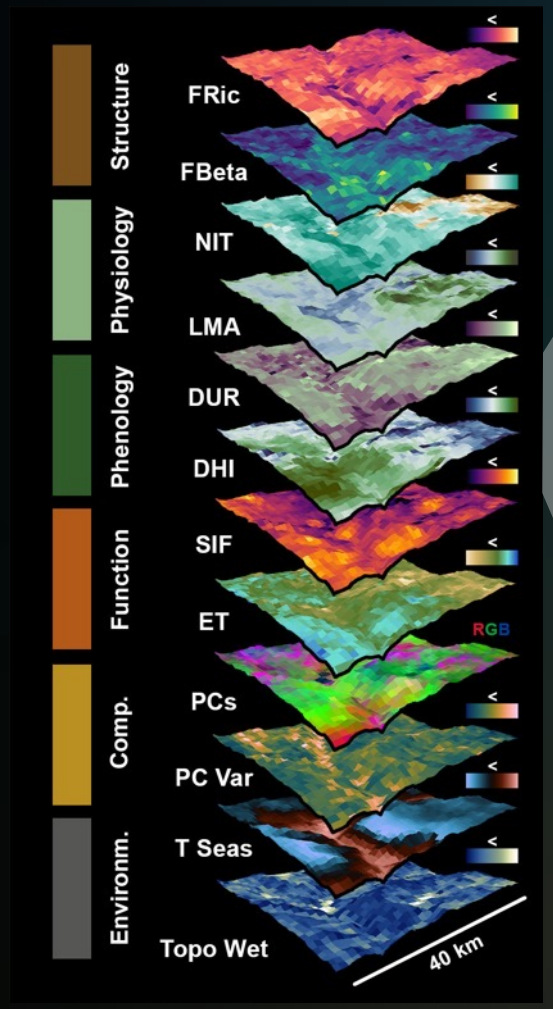
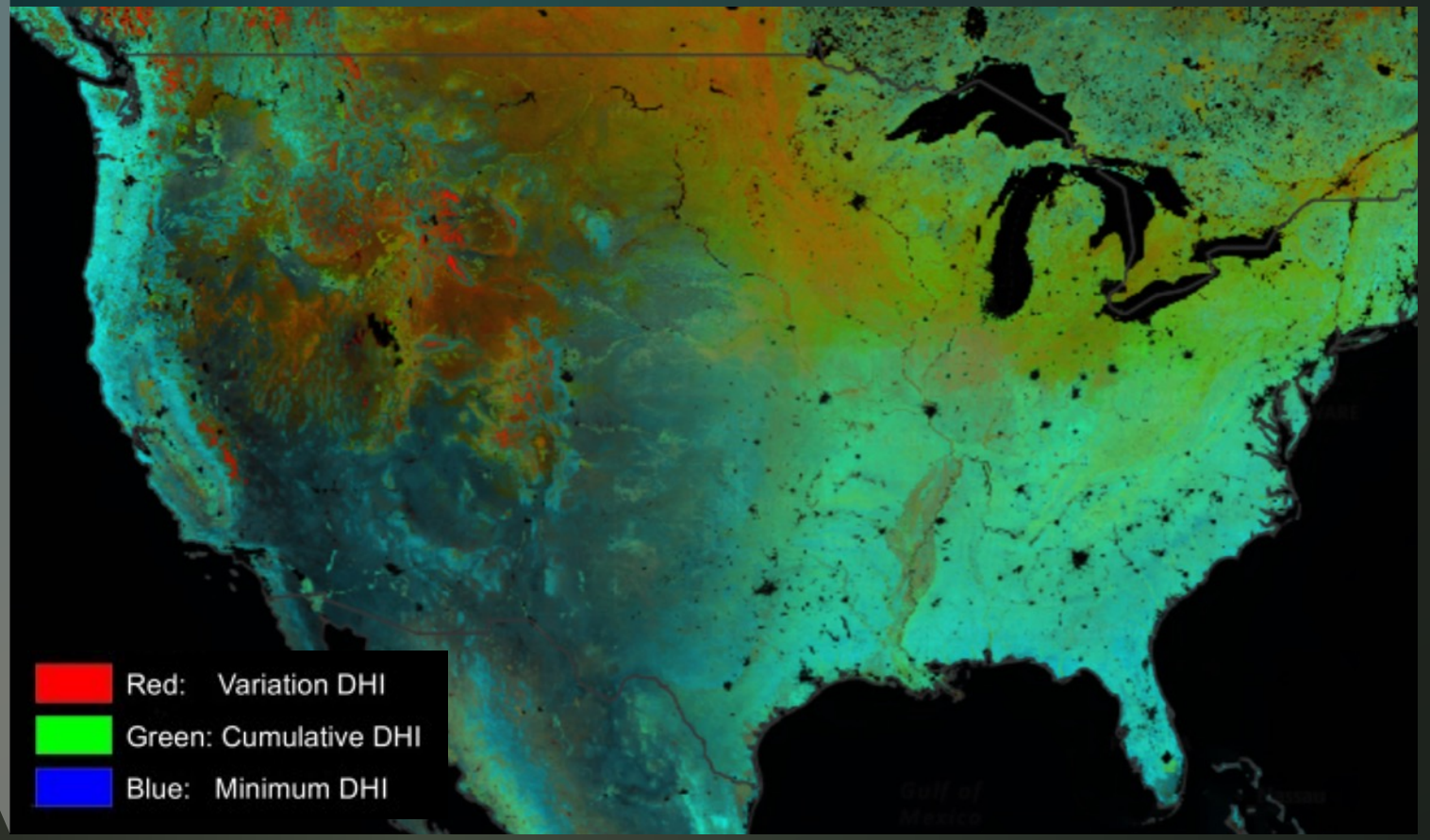


Dynamic Habitat Indices produced by SILVIS LAB

Radeloff et al. (2019), Hobi et al. (2017)



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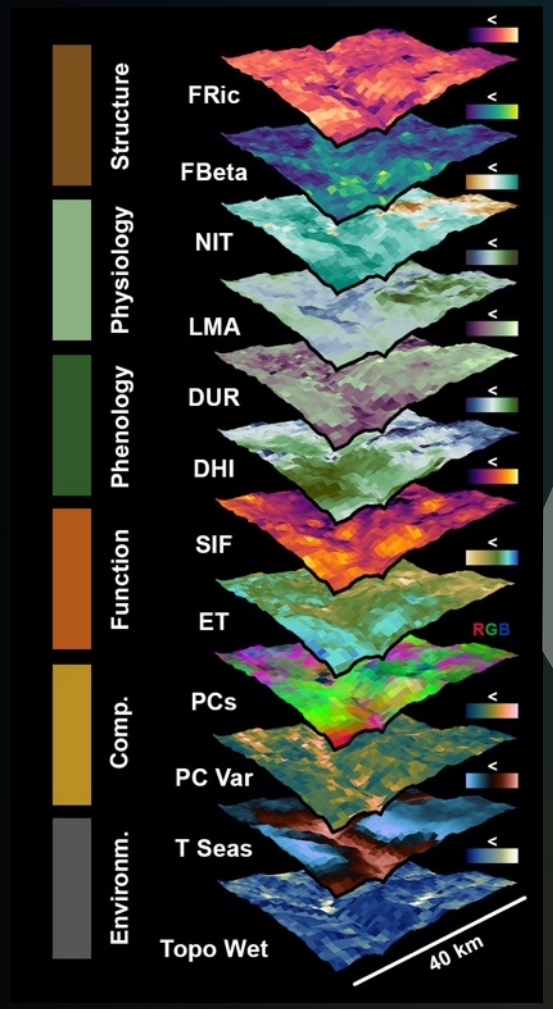

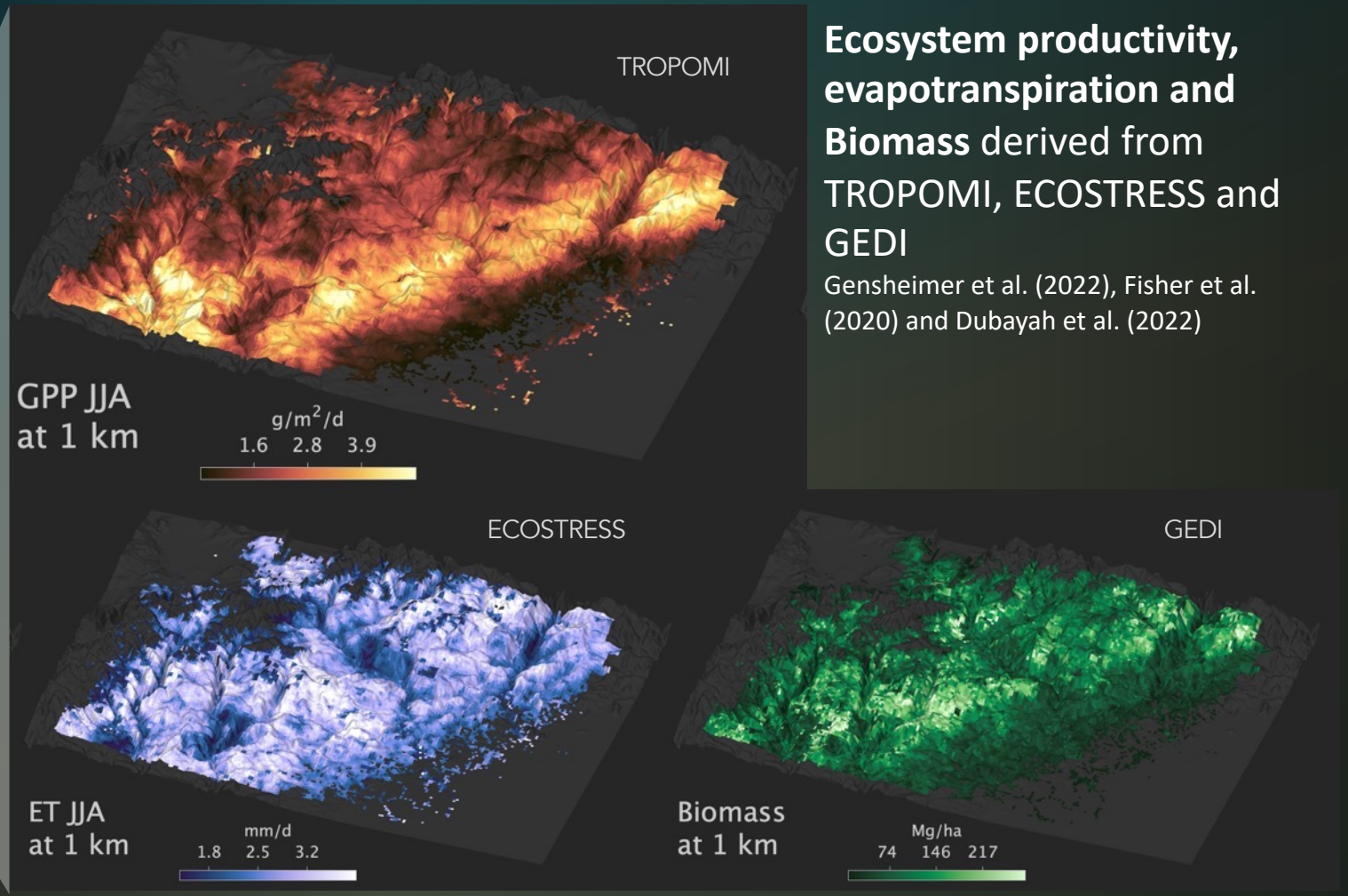

Ecosystem productivity, evapotranspiration and Biomass derived from TROPOMI, ECOSTRESS and GEDI

Gensheimer et al. (2022), Fisher et al. (2020) and Dubayah et al. (2022)

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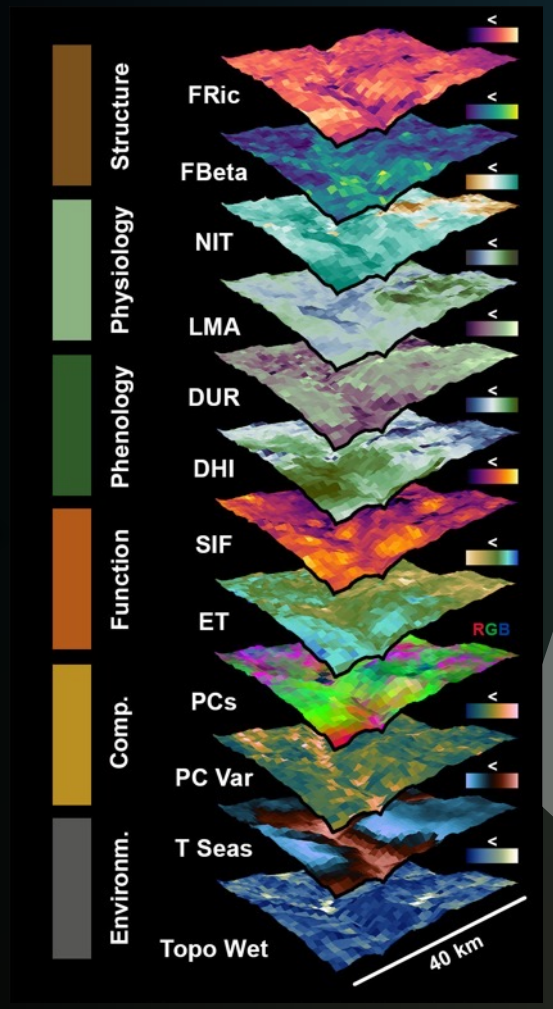
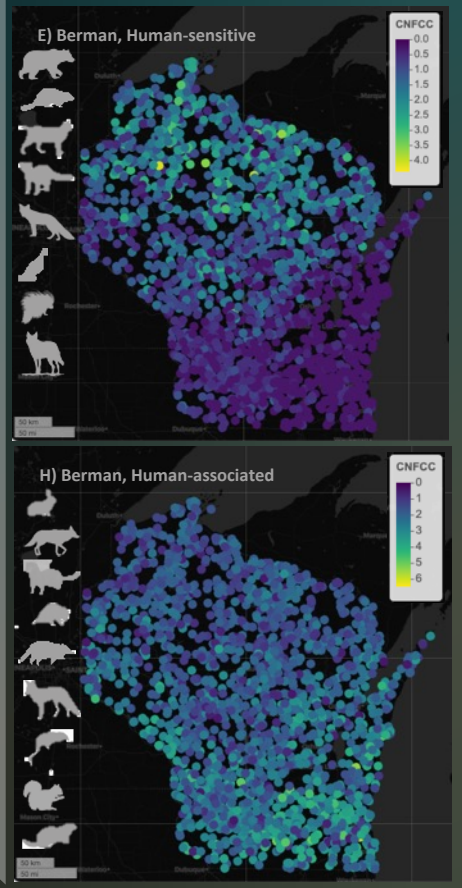


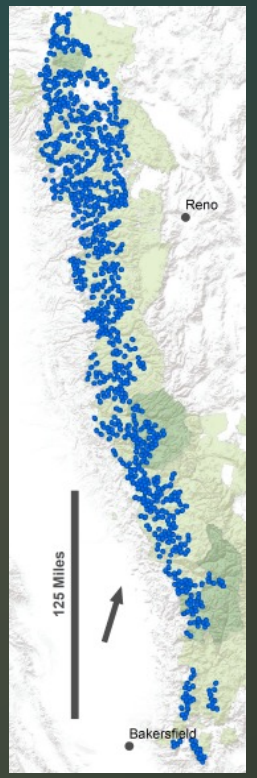
Camera Trap Network from Snapshot Wisconsin

Berman et al. (in review)



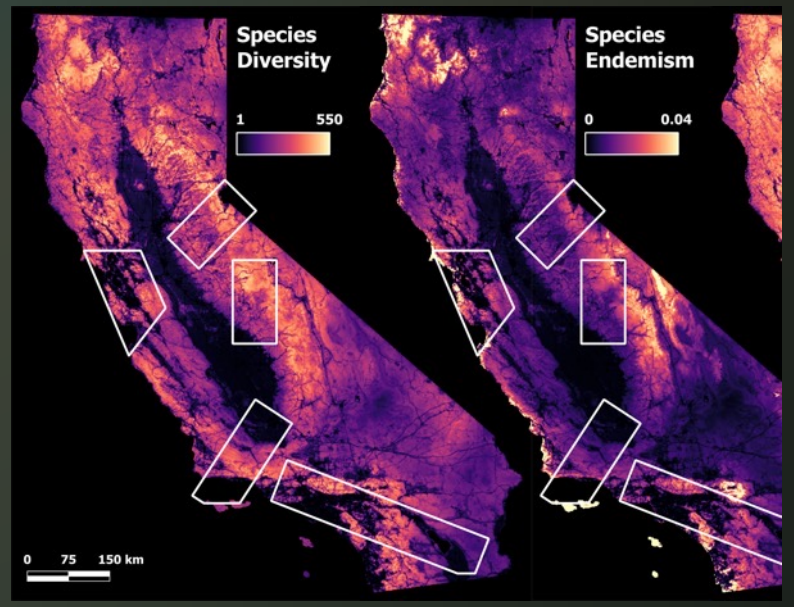
Bioacoustic Monitoring in the Sierra Nevada

Wood et al. (2021)



Plant Species Diversity from species distribution models in California

Kling et al. (2018)



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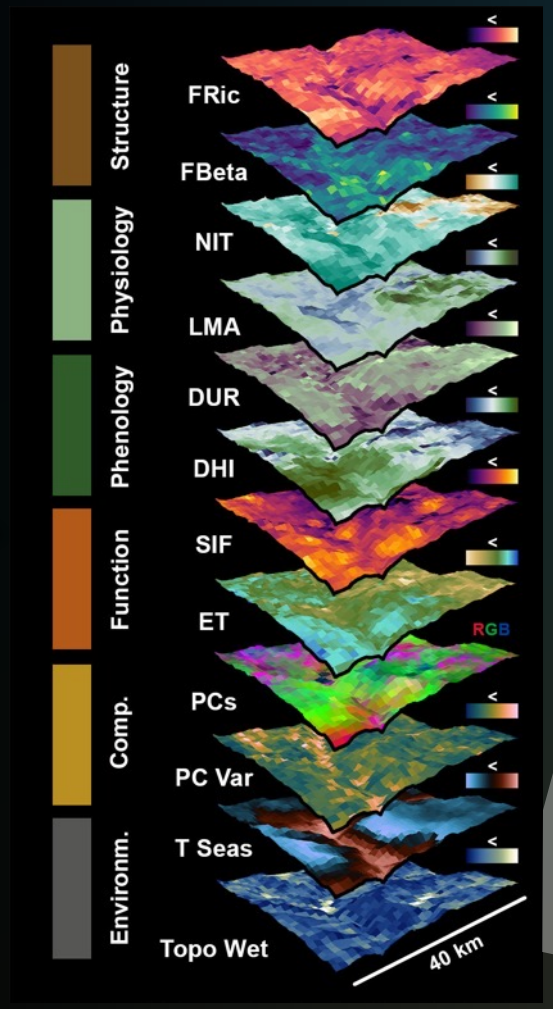
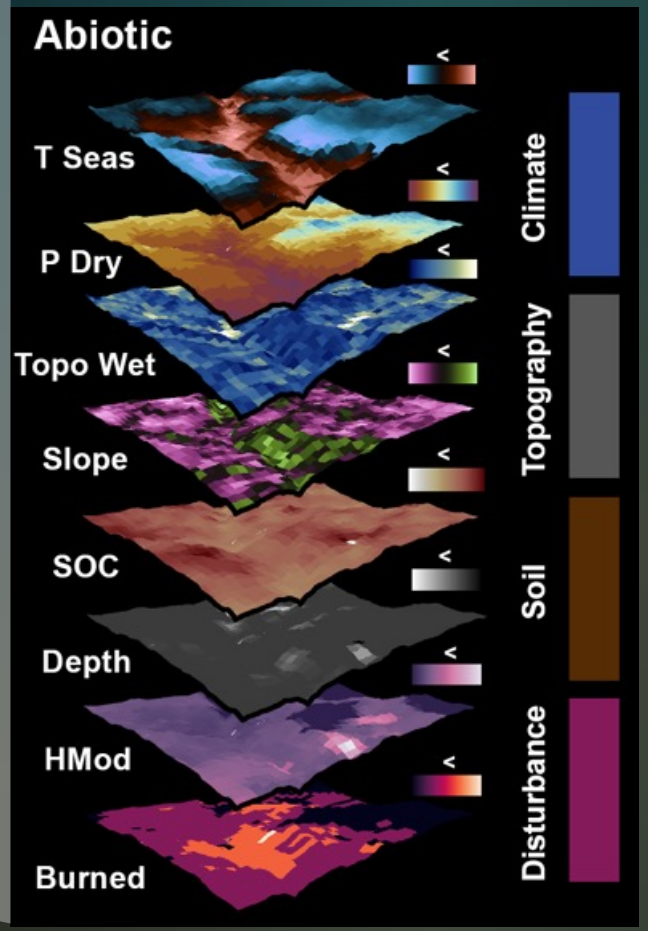
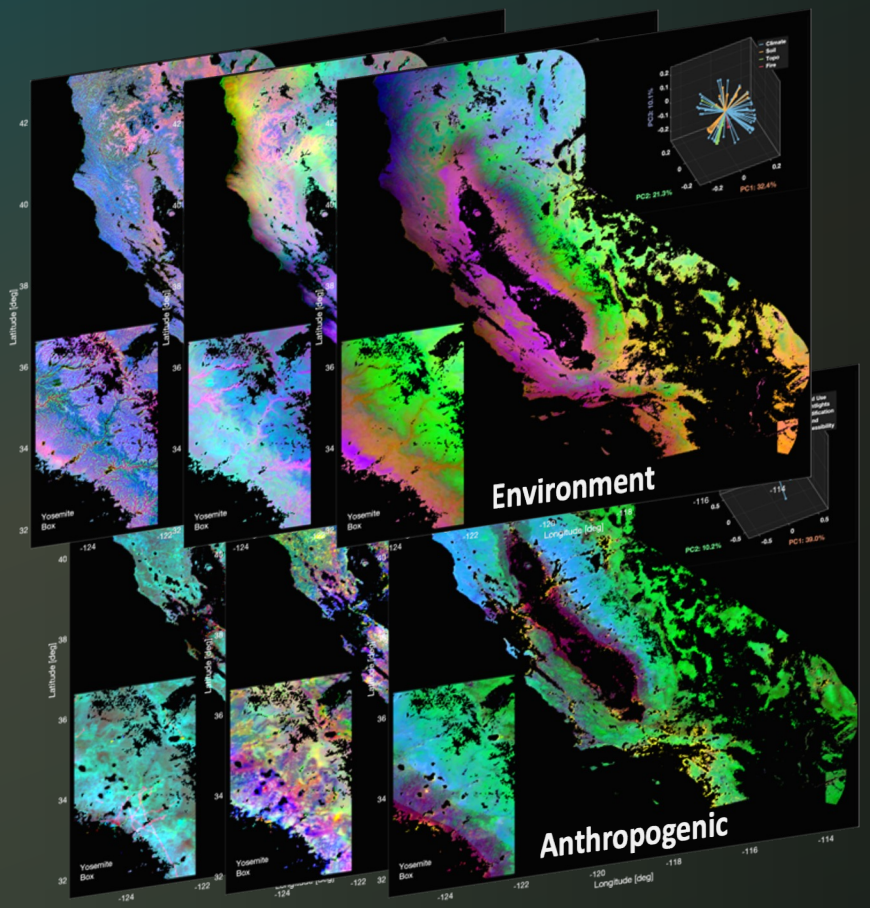
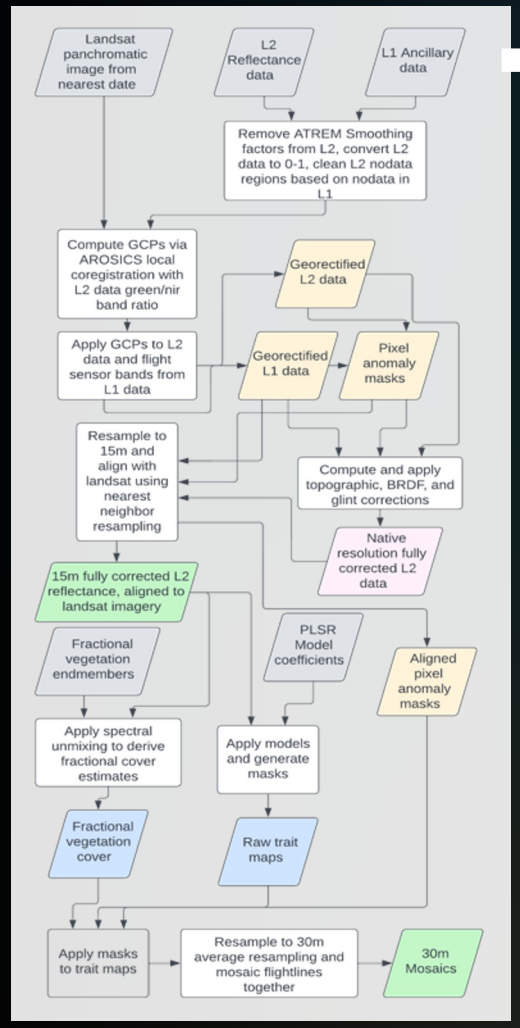




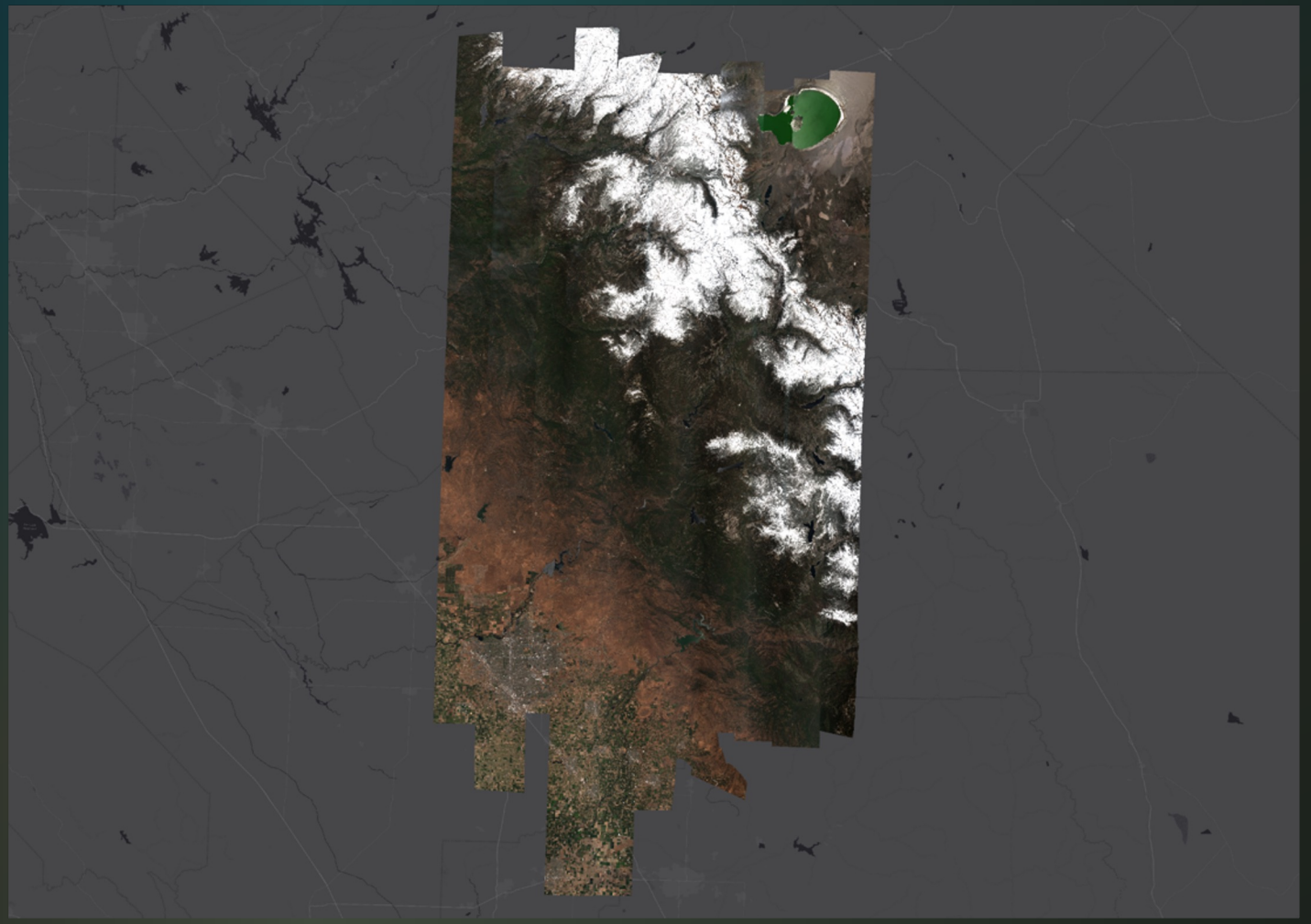


Progress towards a consistent plant trait time series

At landscape scale across California using the Western Diversity Time Series



Reflectance Data



Shafron et al. (in preparation), Zheng et al. (in preparation), Queally et al. (2022)

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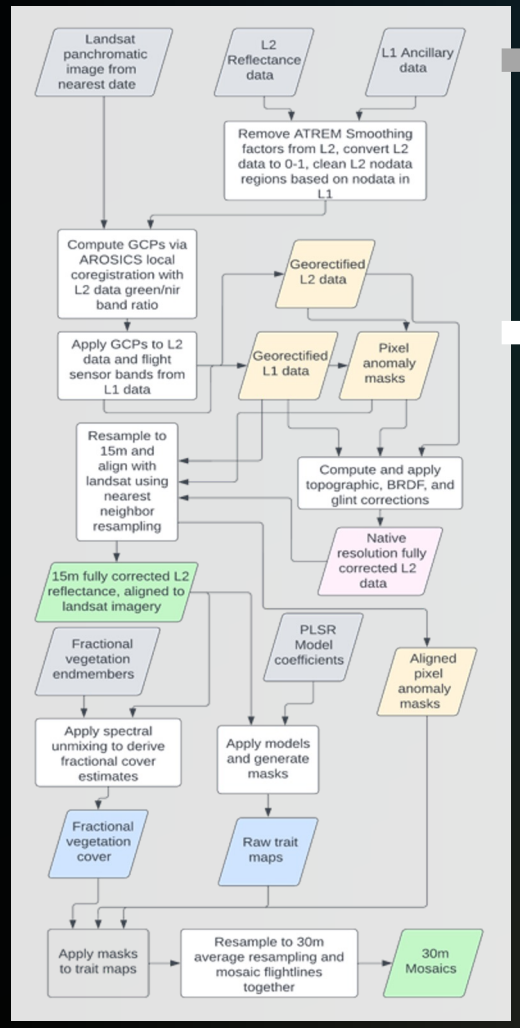

Reflectance Data

Geocorrection

Shafron et al. (in preparation), Zheng et al. (in preparation), Queally et al. (2022)

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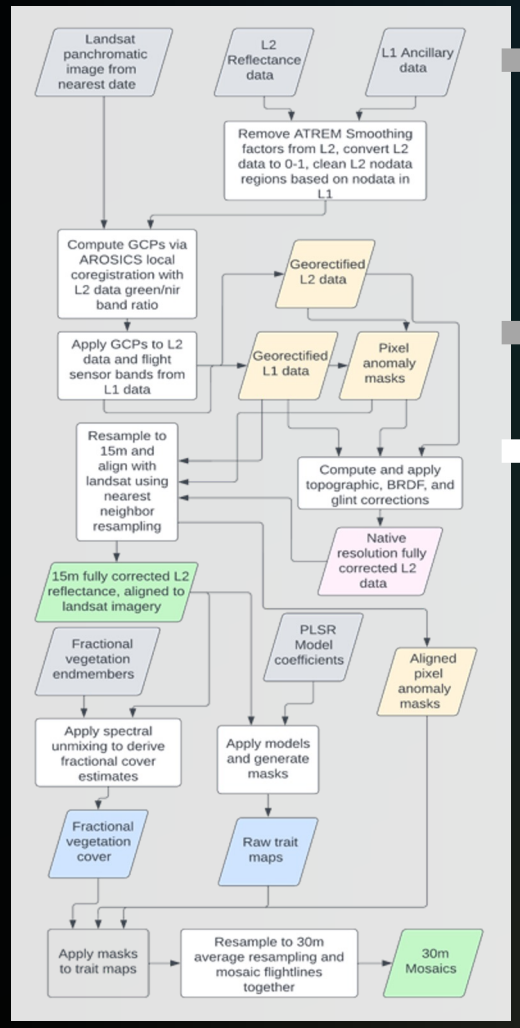
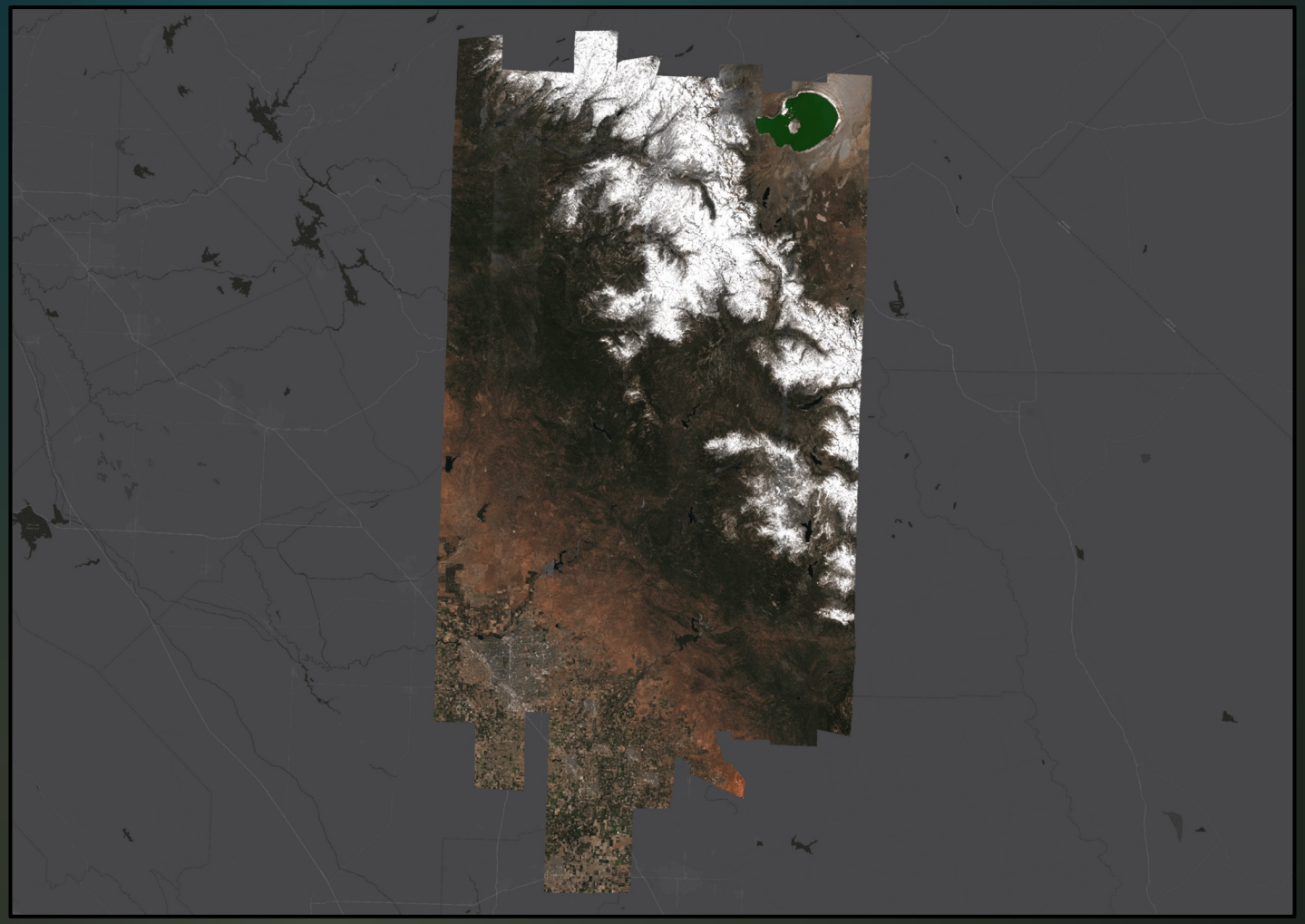


Reflectance Data

Geocorrection

Illumination Correction



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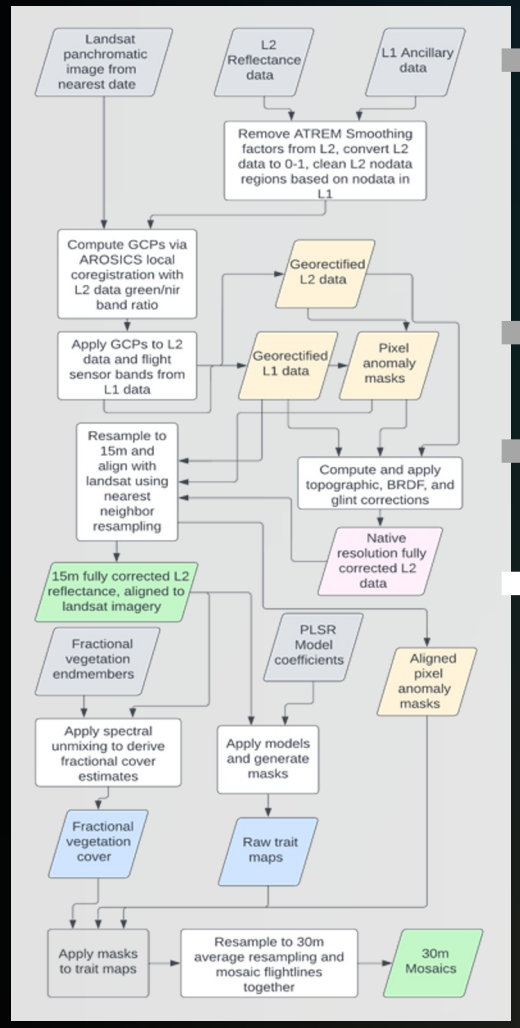
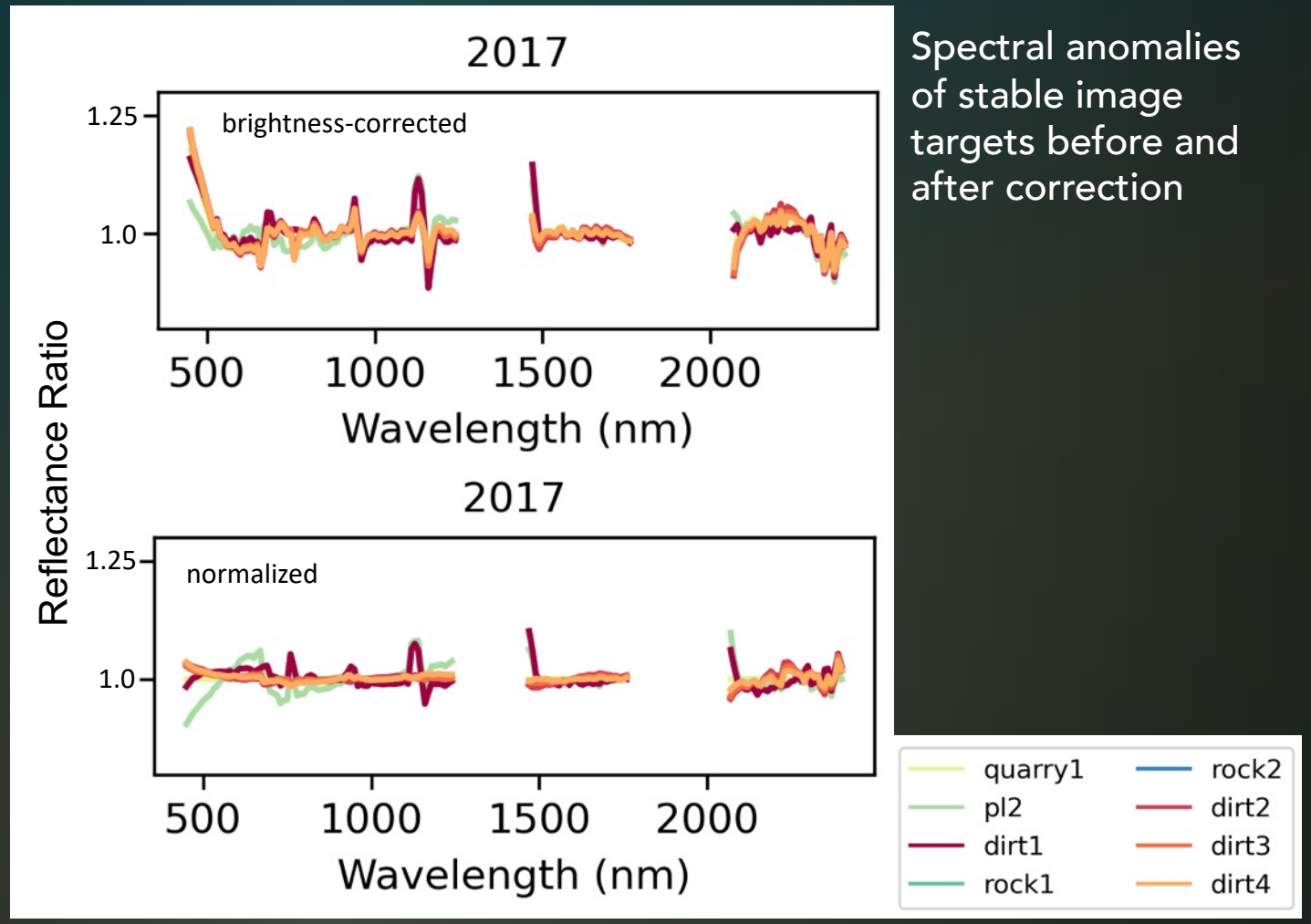


Reflectance Data

Geocorrection

Illumination Correction

Radiometric Normalization



Spectral anomalies of stable image targets before and after correction

Shafron et al. (in preparation), Zheng et al. (in preparation), Queally et al. (2022)

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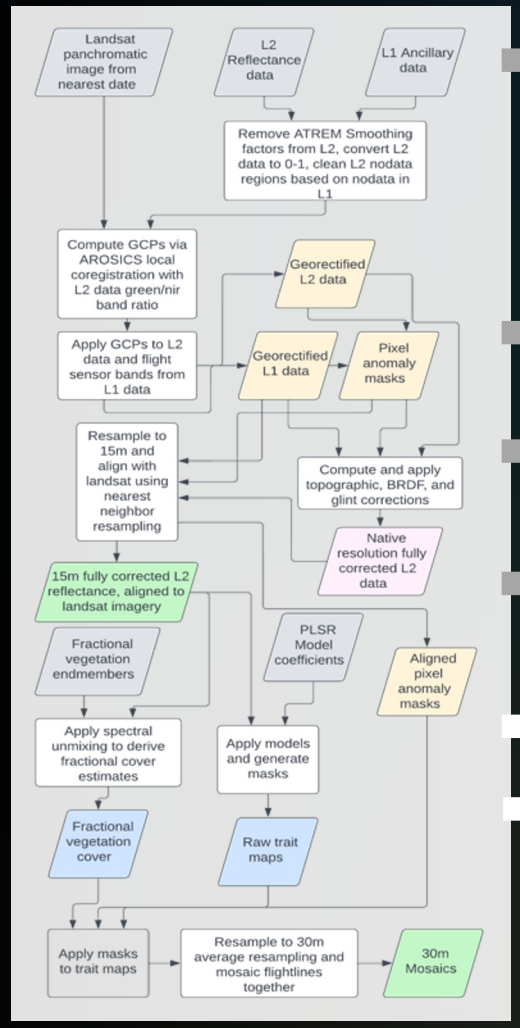


Reflectance Data

Geocorrection

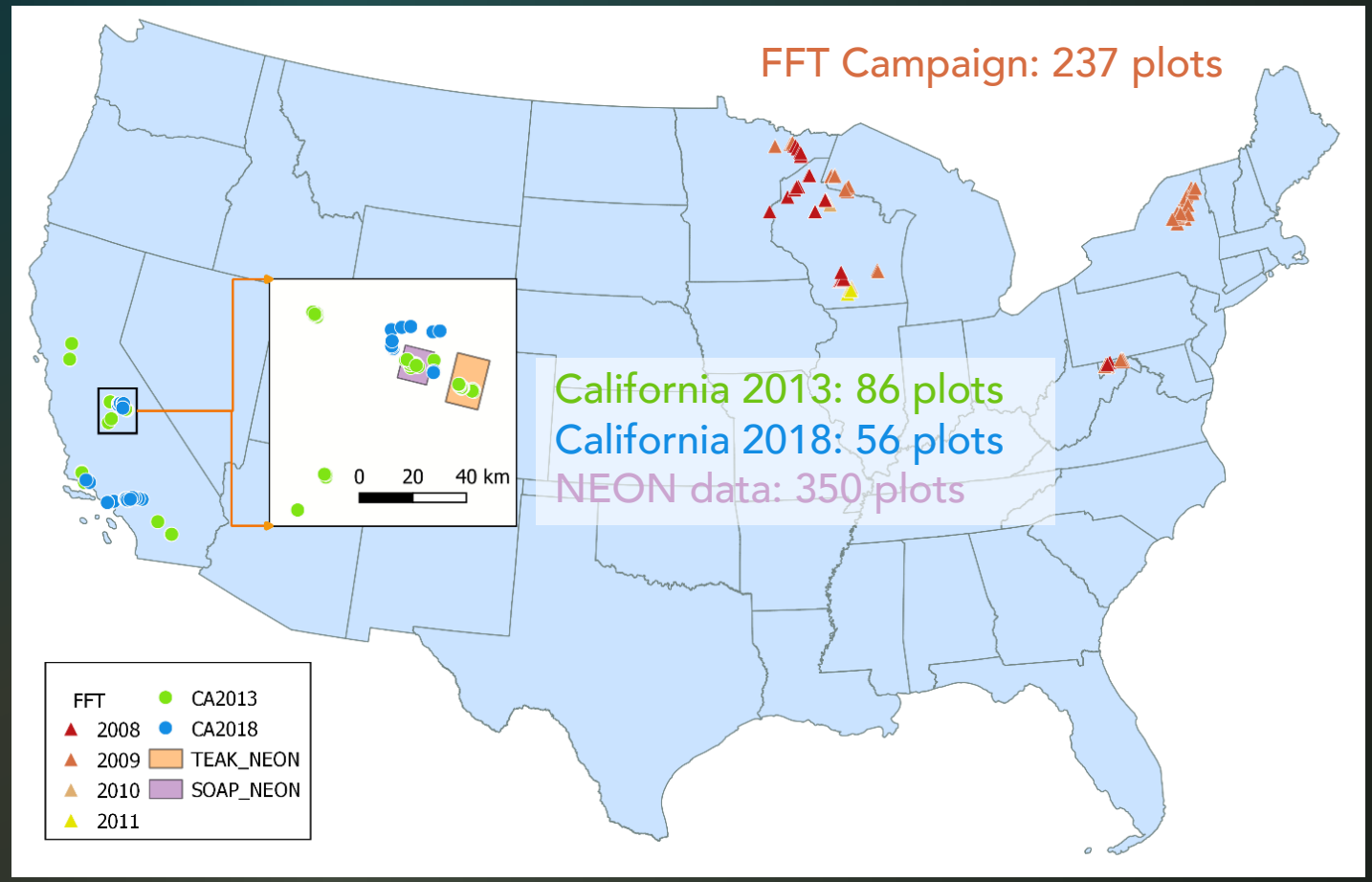
Illumination Correction

Radiometric Normalization

Trait Model

Filtering & QC

Field data and plot locations for training, testing and validation



Shafron et al. (in preparation), Zheng et al. (in preparation), Queally et al. (2022)

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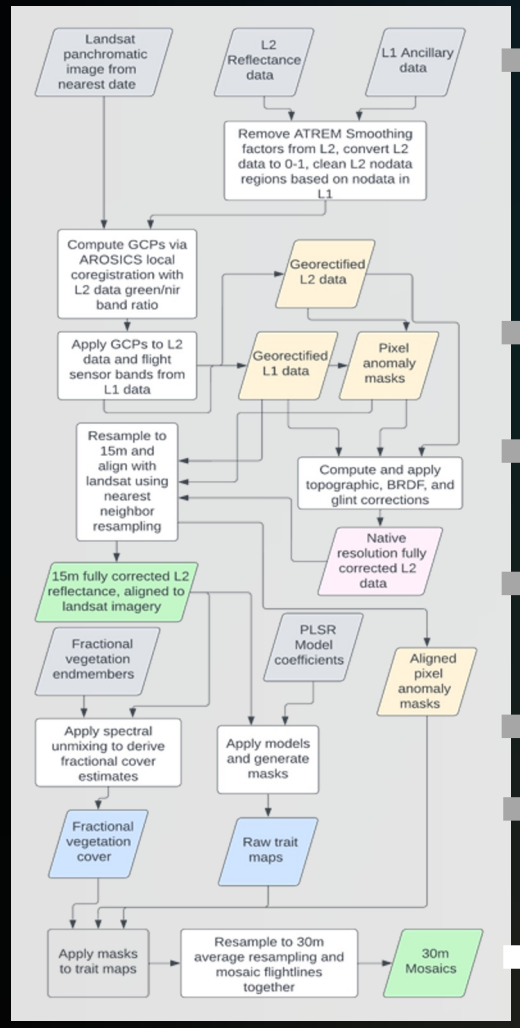

Reflectance Data

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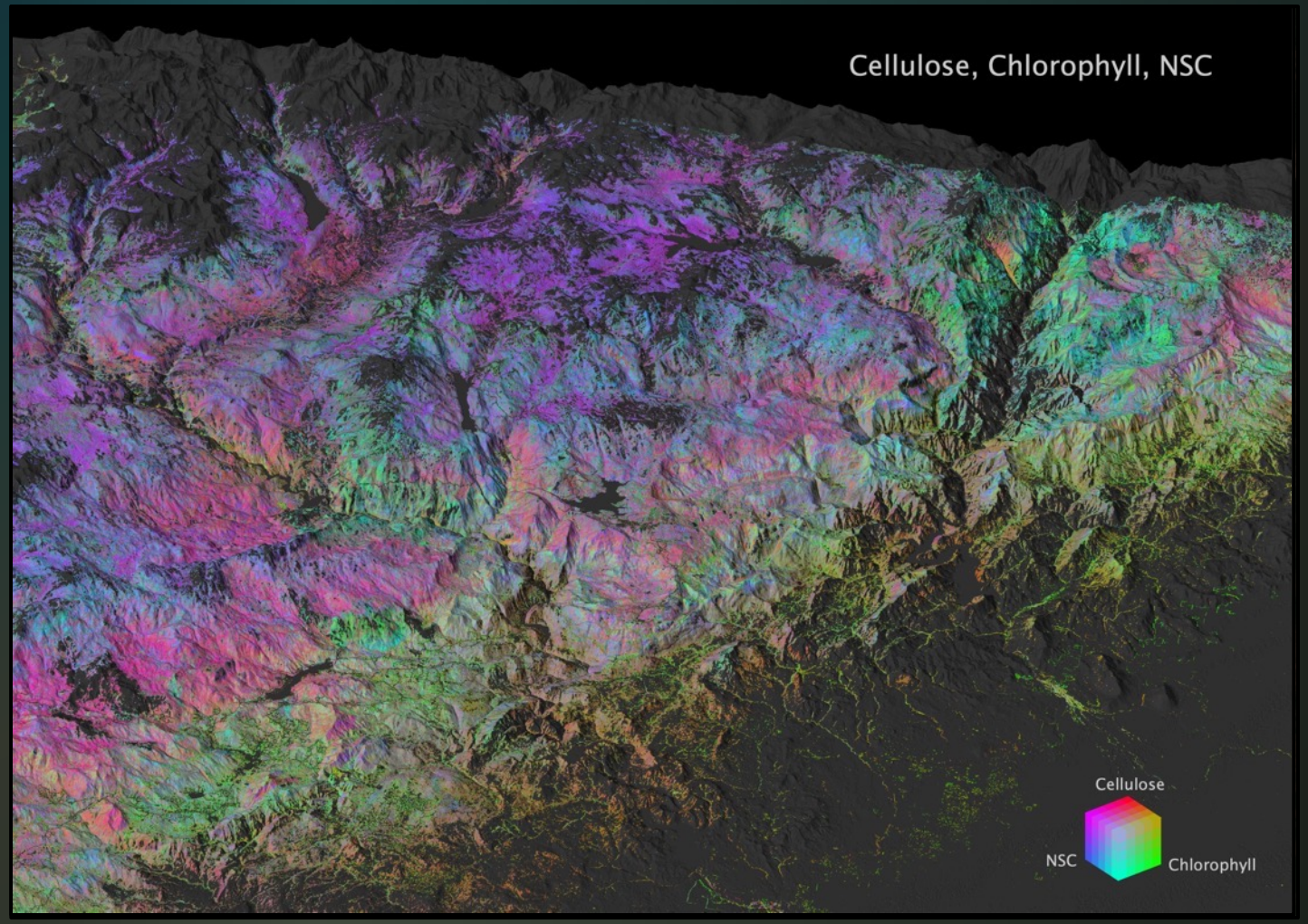
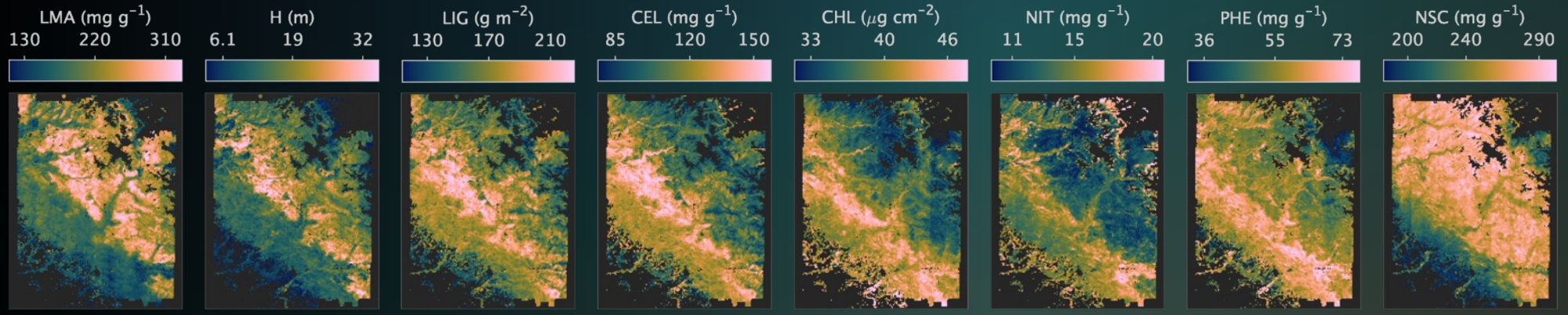
Trait Mosaics At 30 m

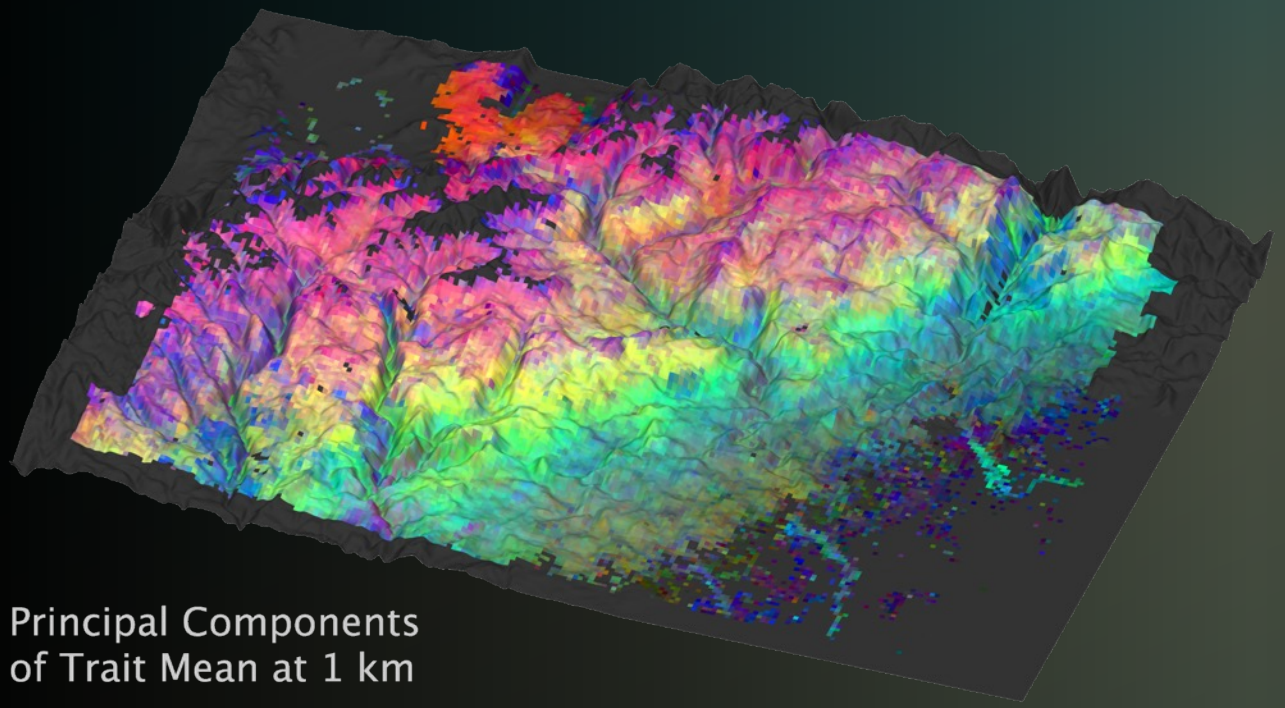


Shafron et al. (in preparation), Zheng et al. (in preparation), Queally et al. (2022)

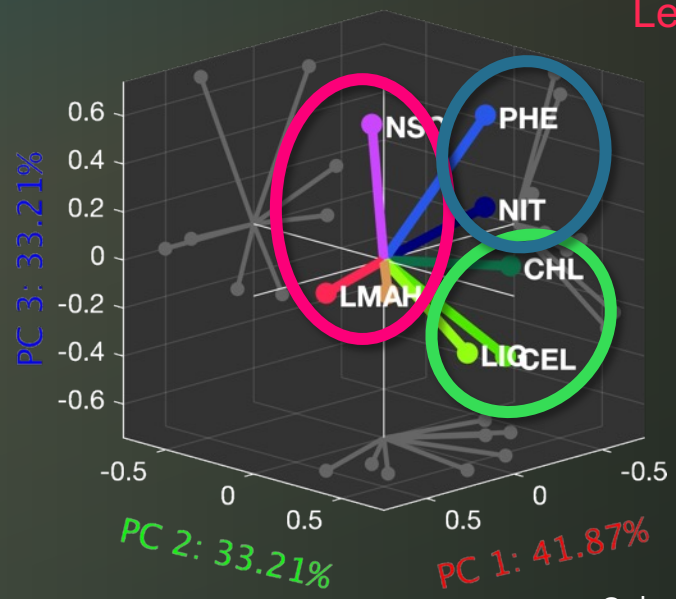
Understanding axes of plant functional diversity

What are trait-trait relationships and important tradeoffs?





Principal Components
of Trait Mean at 1 km

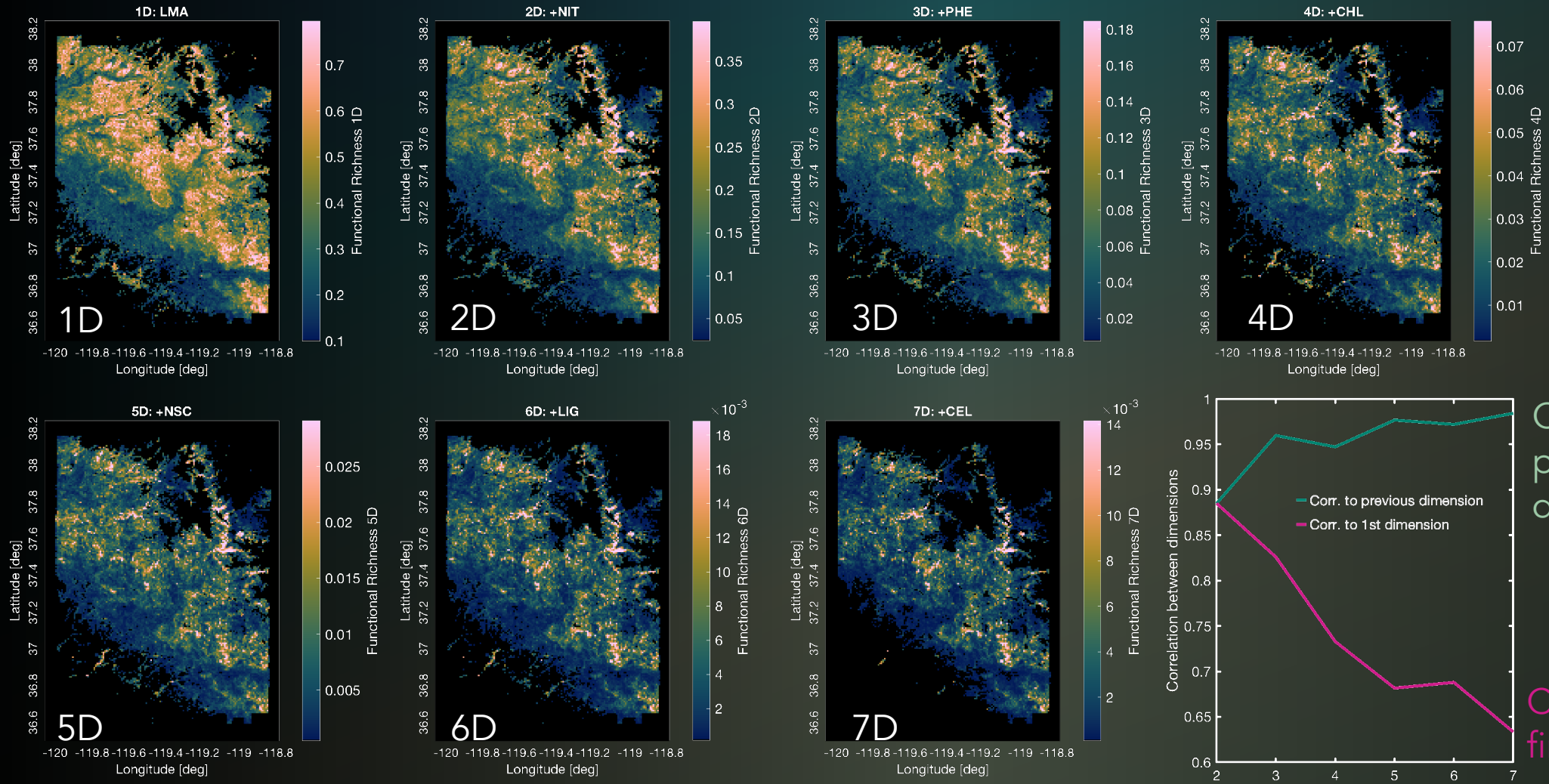


Non-Structural Carbohydrates
Leaf Mass per Area
Height
Lignin
Cellulose
Chlorophyll
Nitrogen
Phenolics

Schneider et al. (in preparation)

Understanding axes of plant functional diversity

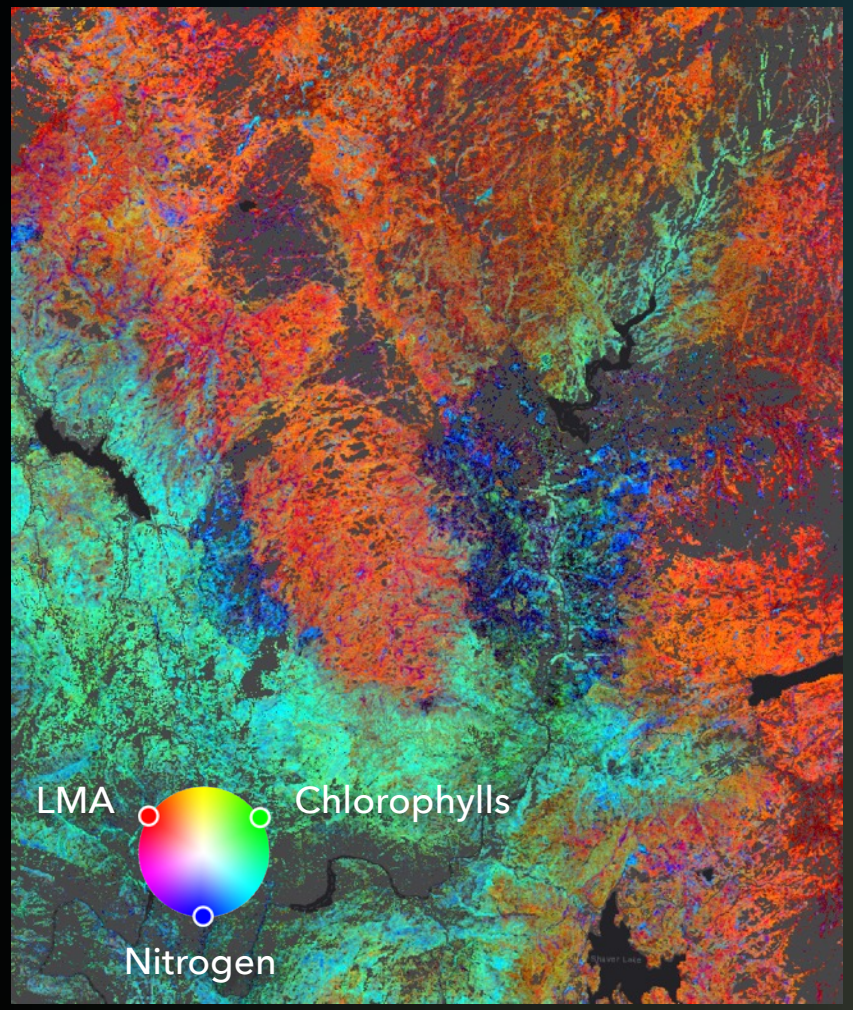
Convergence of diversity patterns at 3-5 dimensions

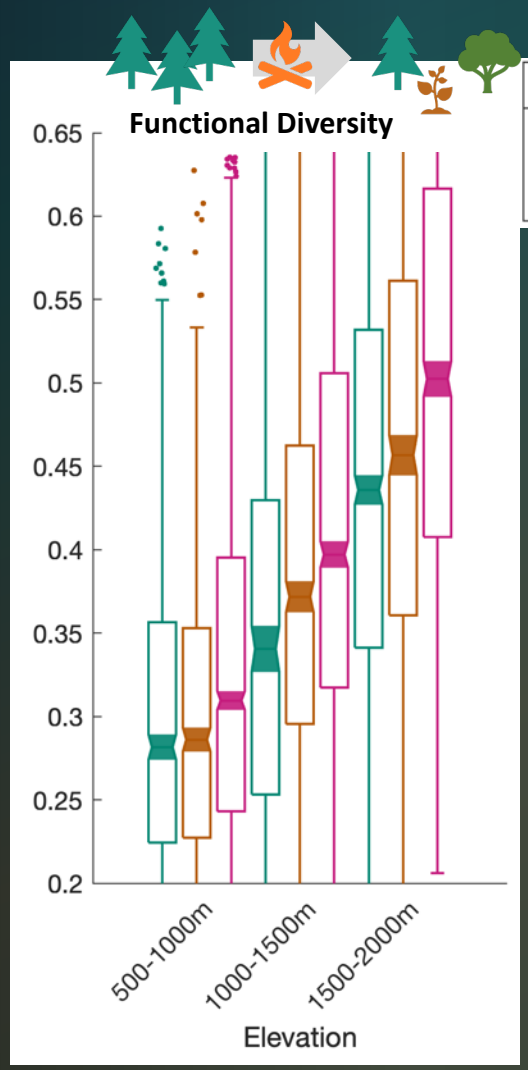


Schneider et al. (in preparation)

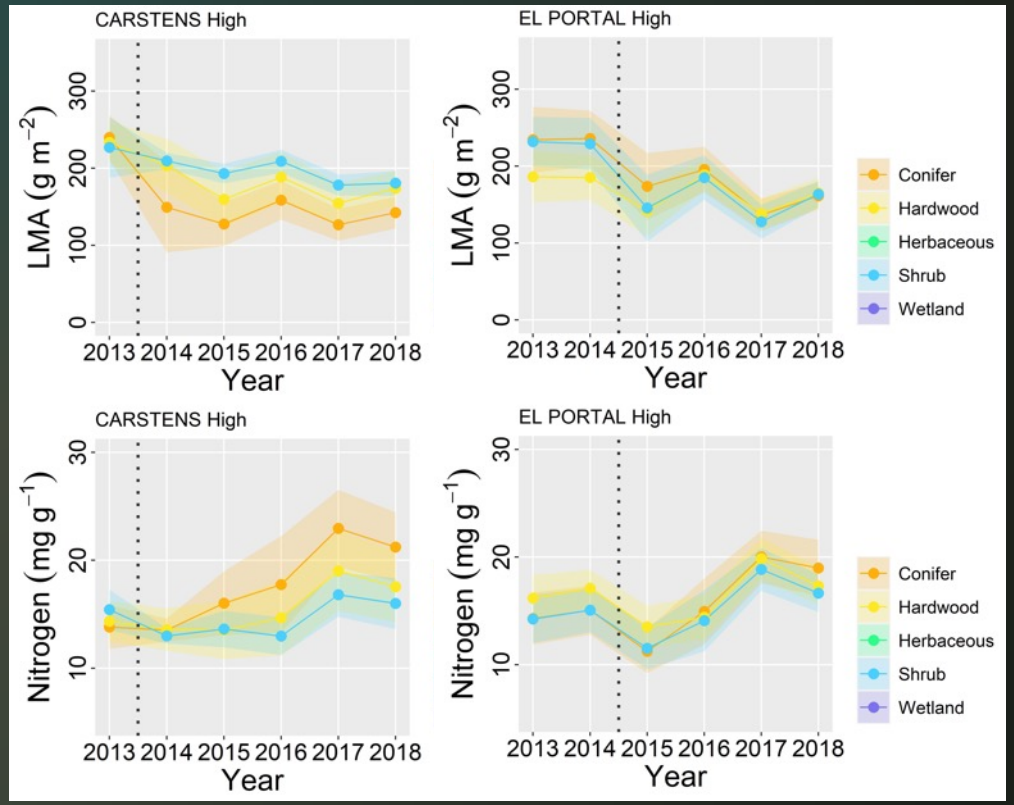
Understanding the impact of wildfires on trait turnover

What is the resilience of ecosystems to wildfires, and what is the role of functional diversity?





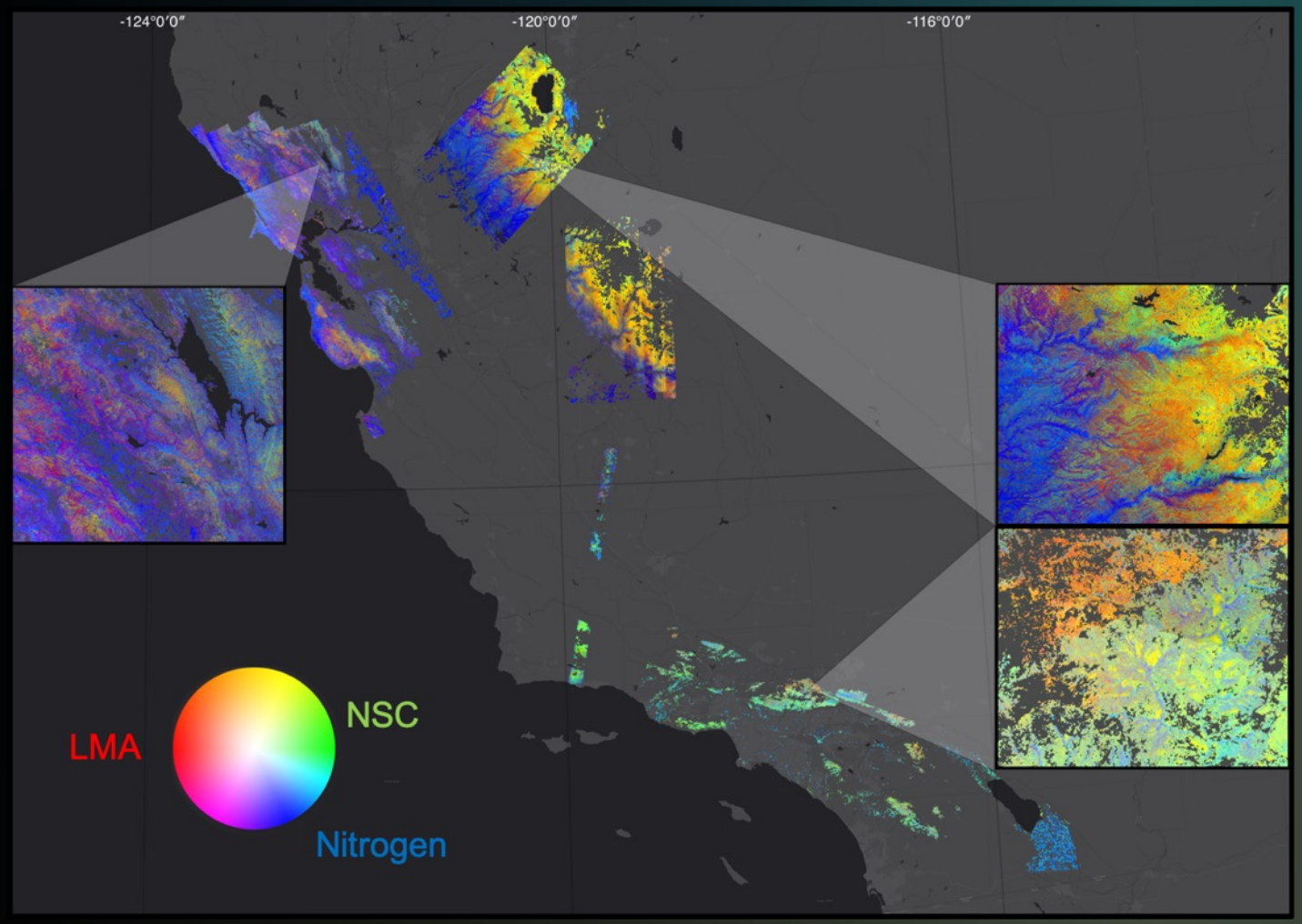
Impact of high-intensity fires
on leaf mass per area and nitrogen



Tagliabue, Schneider et al. (in preparation)

Understanding large-scale patterns of functional diversity

Outlook: California-wide analysis across the Western Diversity Time Series



What are the predictors of plant functional diversity at the landscape scale?

Goal: Predict functional diversity across California using the BioCube, and assess the predictor importance.

What is the relationship between plant functional, structural and species diversity?

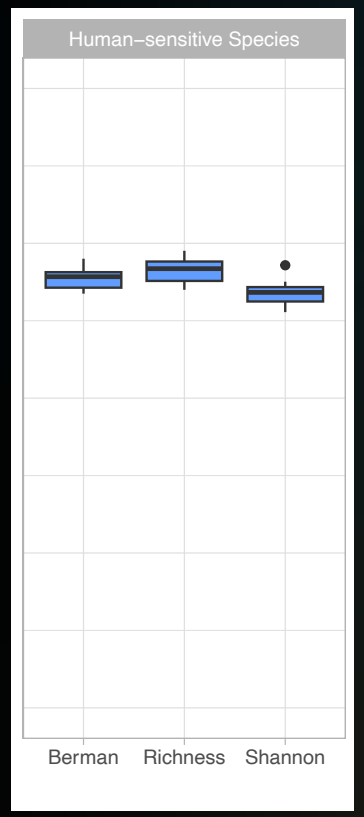
Goal: Assess the strength and shape of the relationships, and how they are varying across ecosystems.

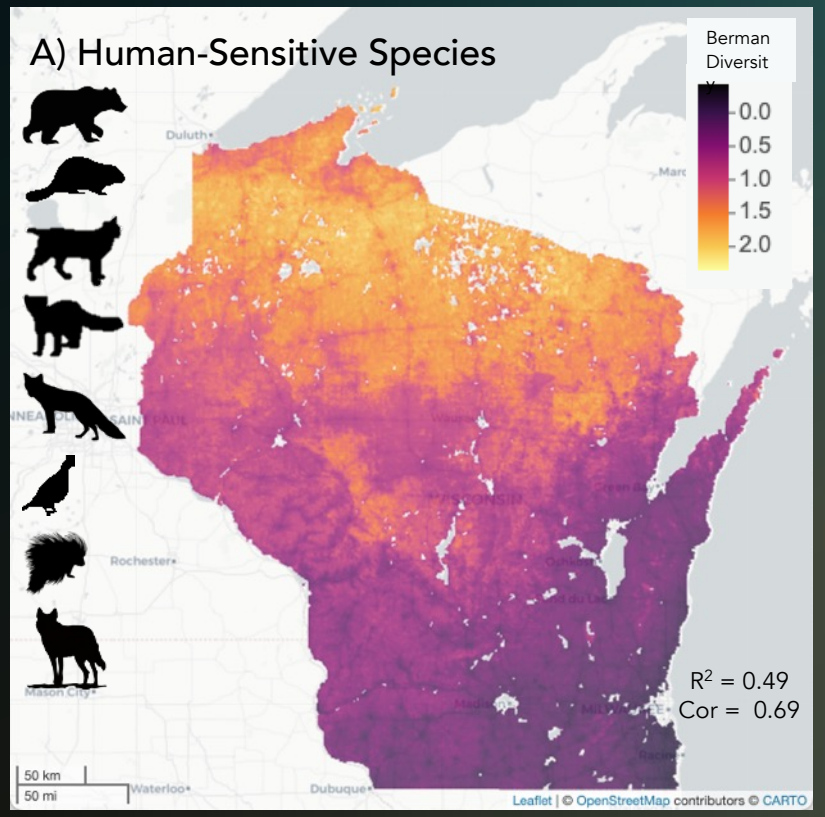
Understanding large-scale patterns of animal diversity

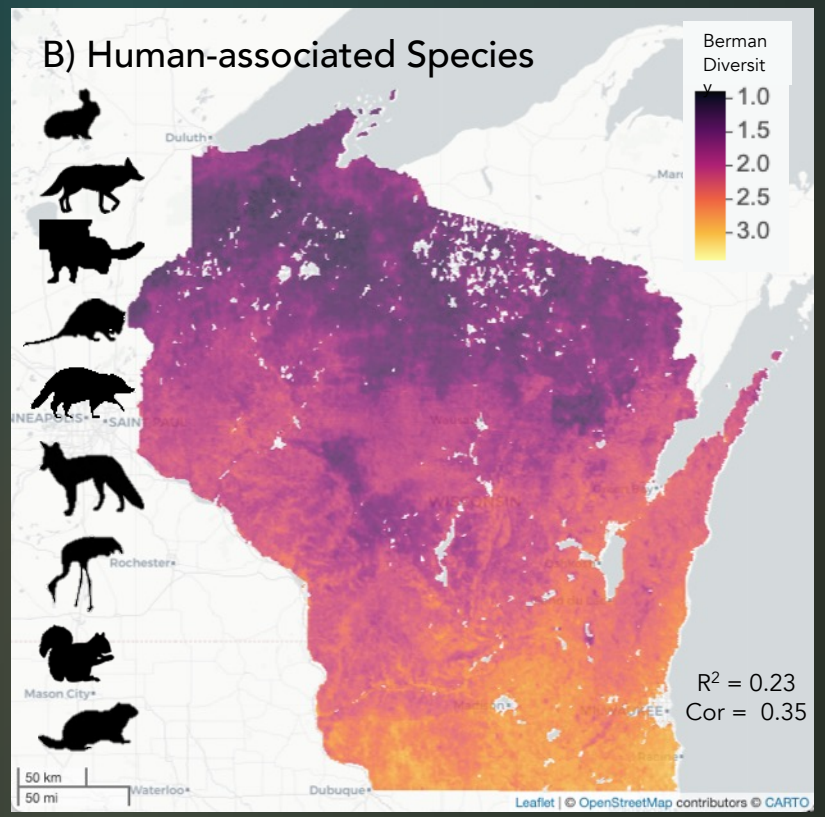
Wisconsin-wide analysis using Snapshot Wisconsin and BioCube

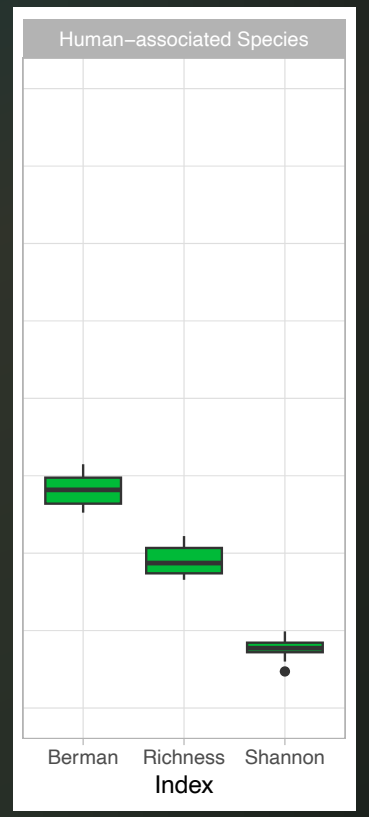
$$Diversity_{site} = \sum_{i=1}^{n} \left(\frac{d_{site,i}}{d_{max,i}} \right)^{\frac{\log 0.5}{\log\left(\frac{d_{site,i}}{d_{max,i}}\right)}}$$

Berman Diversity: A diversity index for camera trap networks







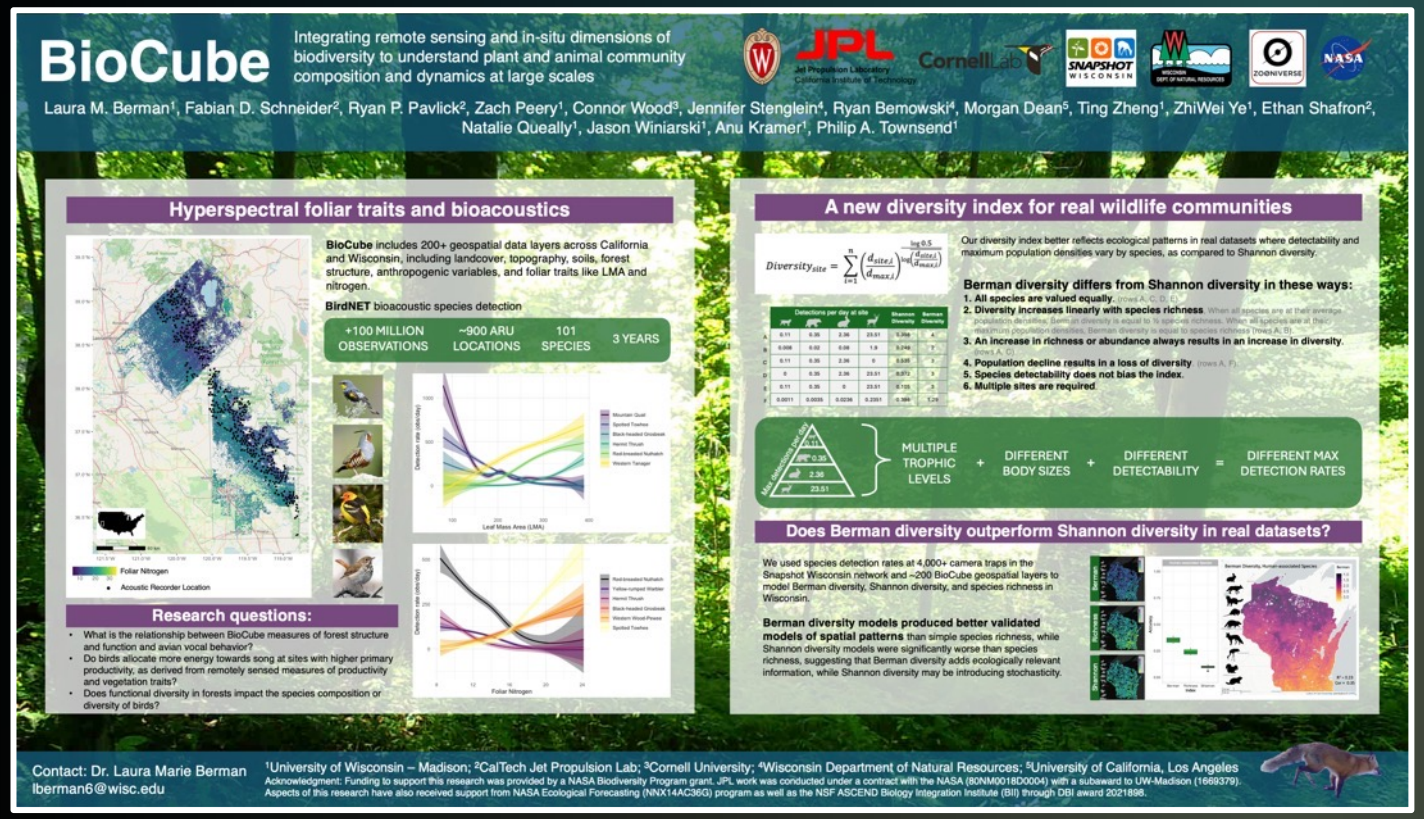


Berman et al. (in review)

Understanding large-scale patterns of animal diversity

Outlook: Animal diversity and activity in the California Sierra Nevada

Poster by Laura Berman



What is the relationship between BioCube measures of forest structure and function and avian vocal behavior?

Do birds allocate more energy towards song at sites with higher primary productivity, as derived from remotely sensed measures of productivity and vegetation traits?

Does functional diversity in forests impact the species composition or diversity of birds?

Thank you

Adam Chlus (JPL), Alex Turner (UW), Camila Cortez (UW Madison/JPL), John Clare (UC Berkeley), Morgan Dean (UCLA/JPL), and many others

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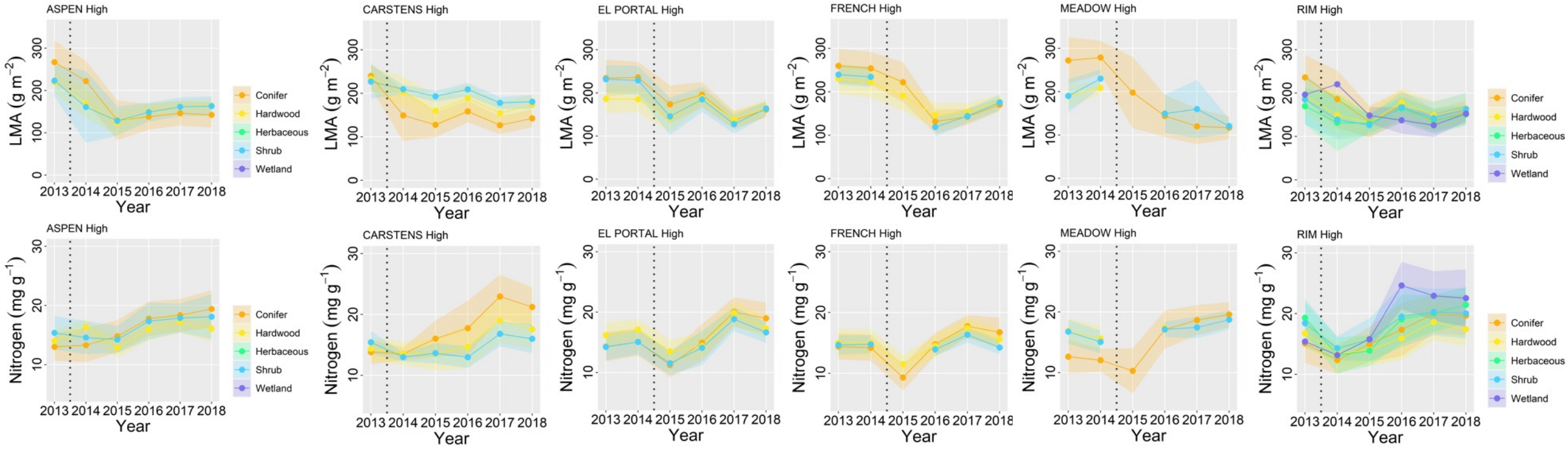
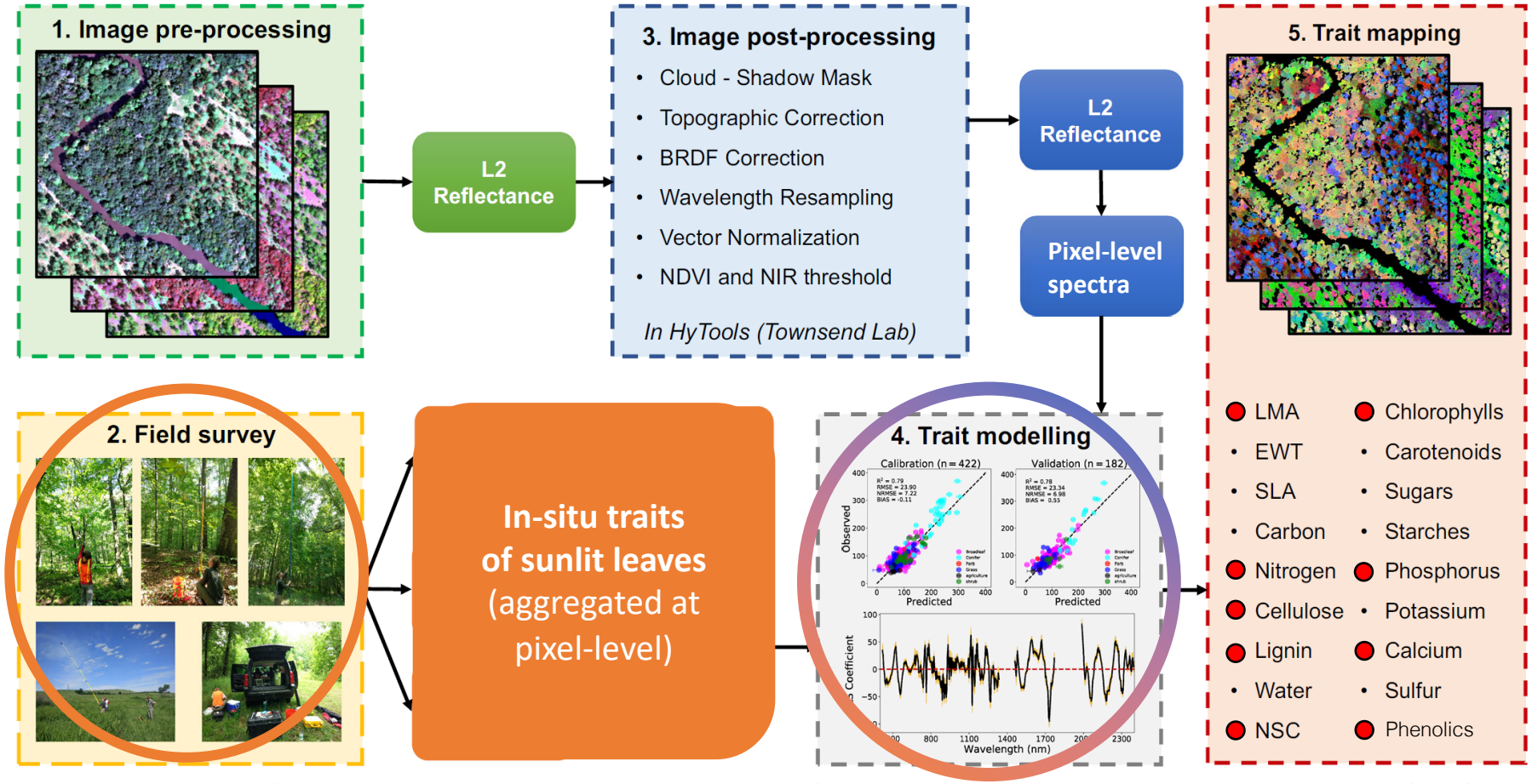
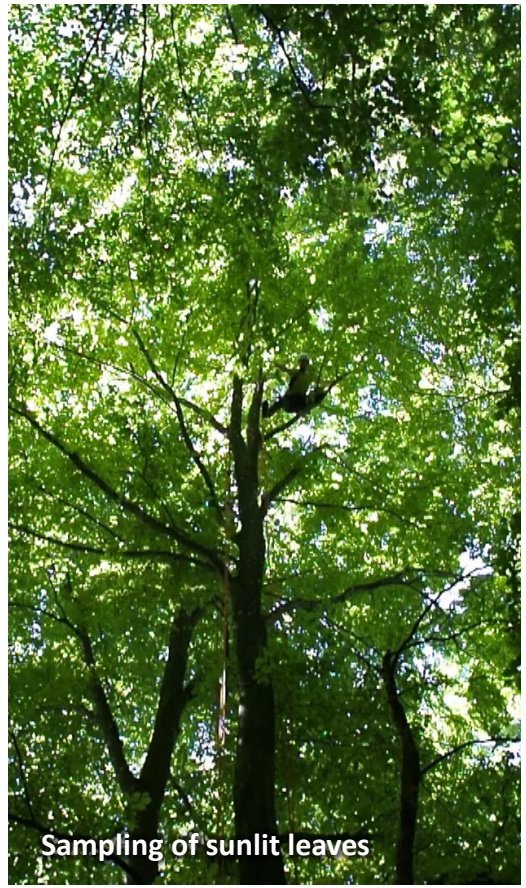
High intensity fires



California Foliar Trait Mapping

Using AVIRIS Classic as precursor to SBG

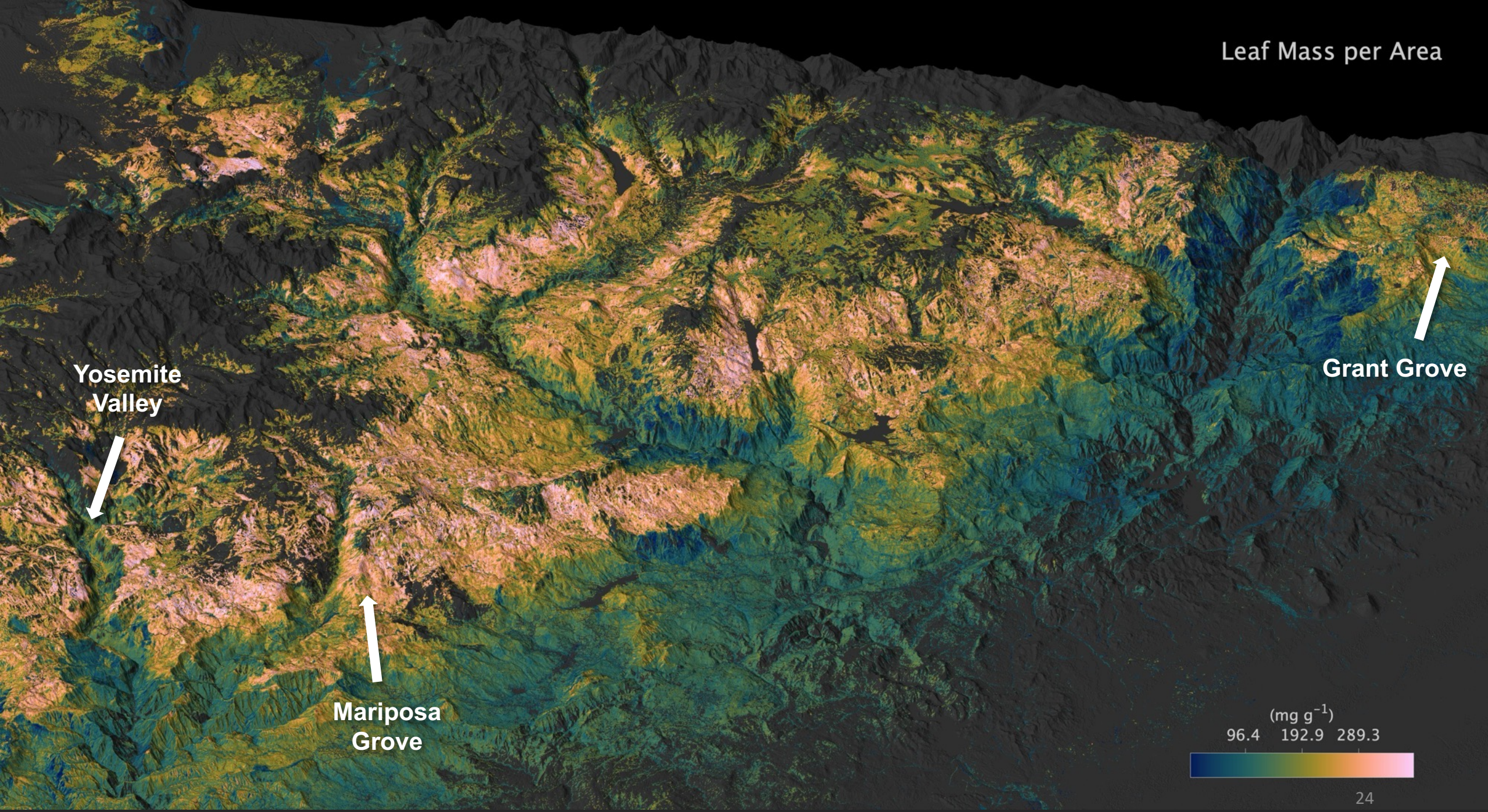




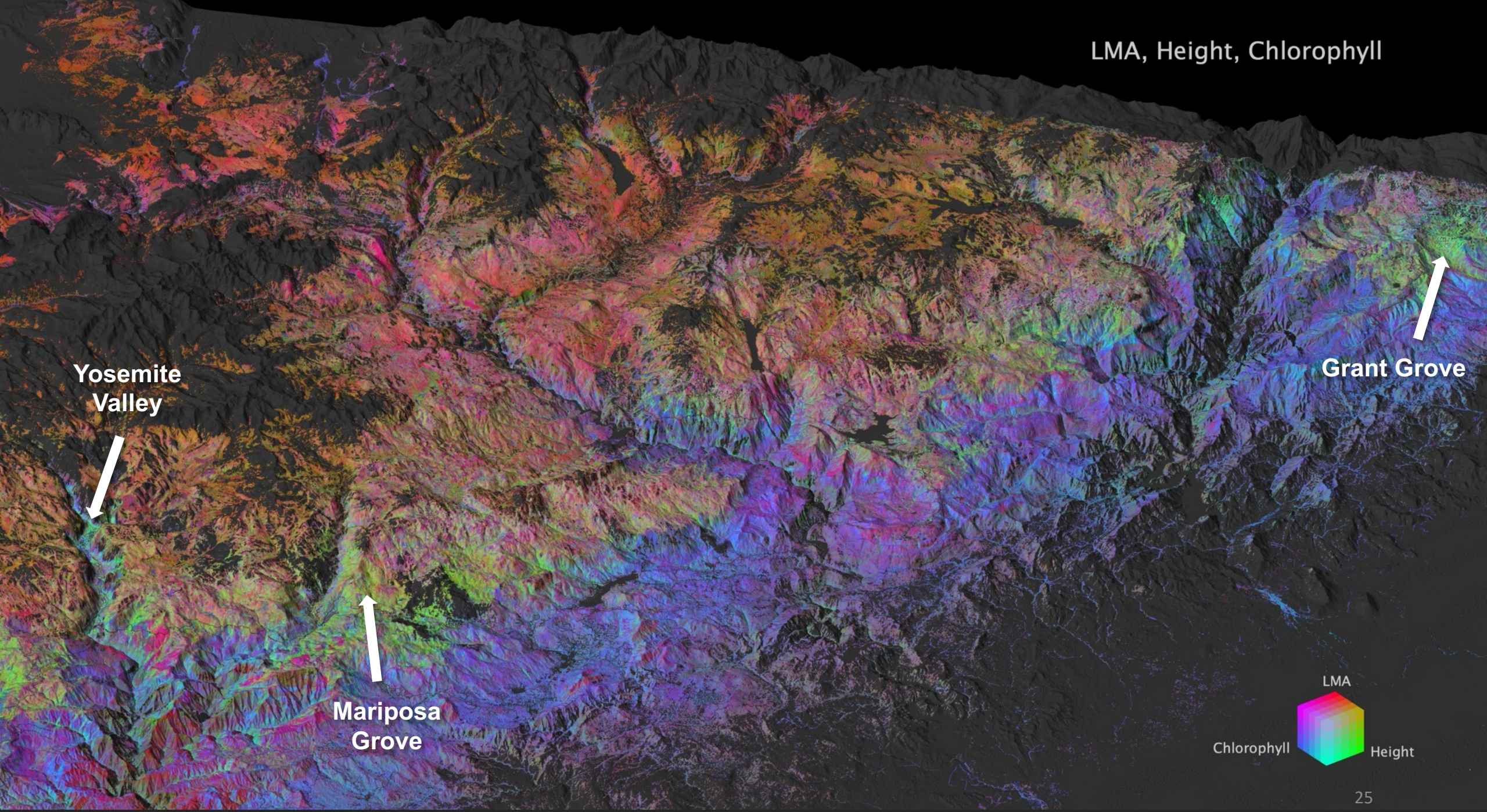
Video: Fabian Schneider

Fig. 2 Trait mapping workflow using NEON AOP images and field data. LMA, leaf mass per area; EWT, equivalent water thickness; SLA, specific leaf area; NSC, nonstructural carbohydrate.

Adapted from Wang et al. (2020) *New Phytologist*



Trait data credit: Ting Zheng, UW Madison; NASA JPL; Spectroscopy data credit: AVIRIS Classic, NASA JPL; Synthesis and visualization: Fabian D. Schneider, NASA JPL



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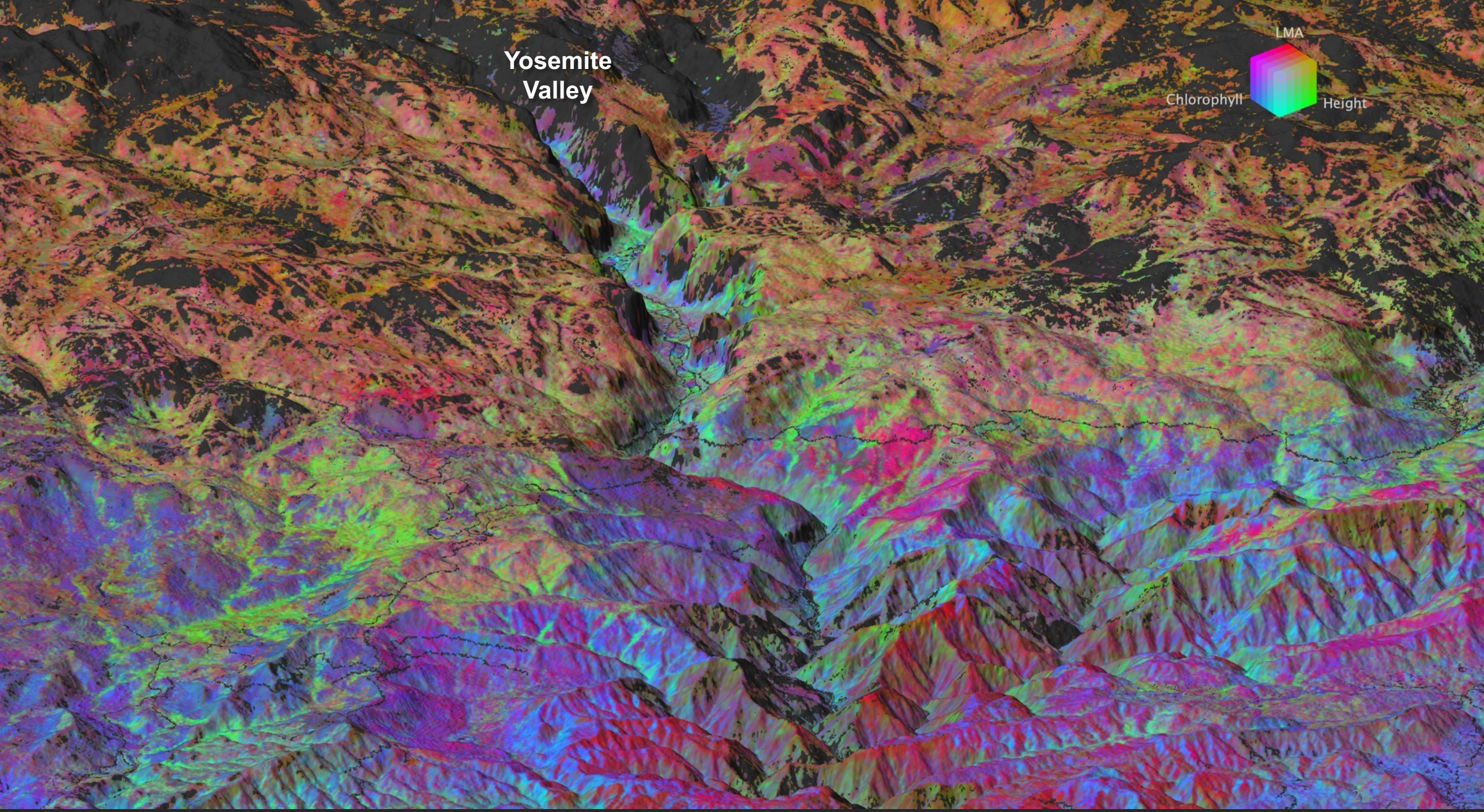

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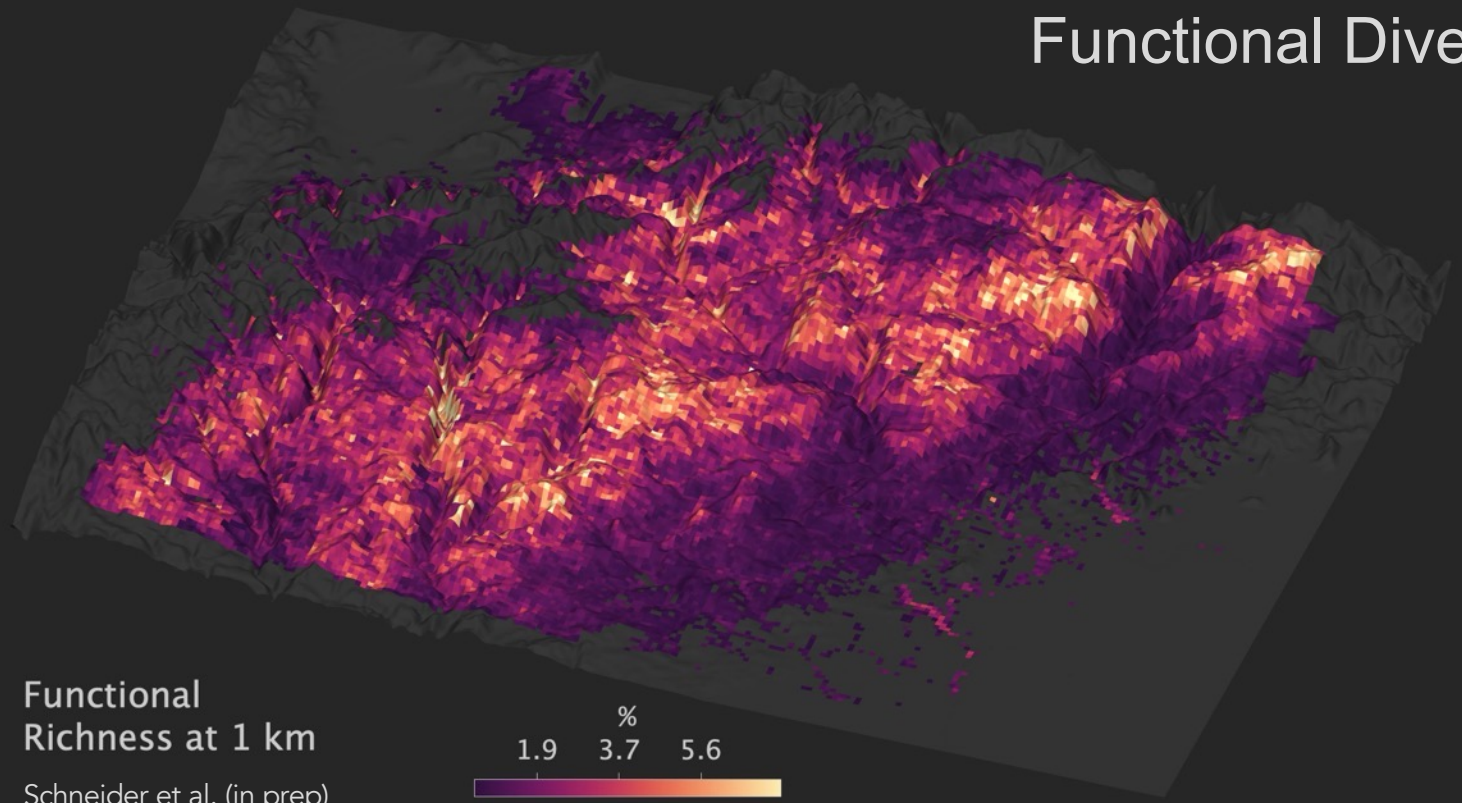
Functional Diversity and Ecosystem Functions

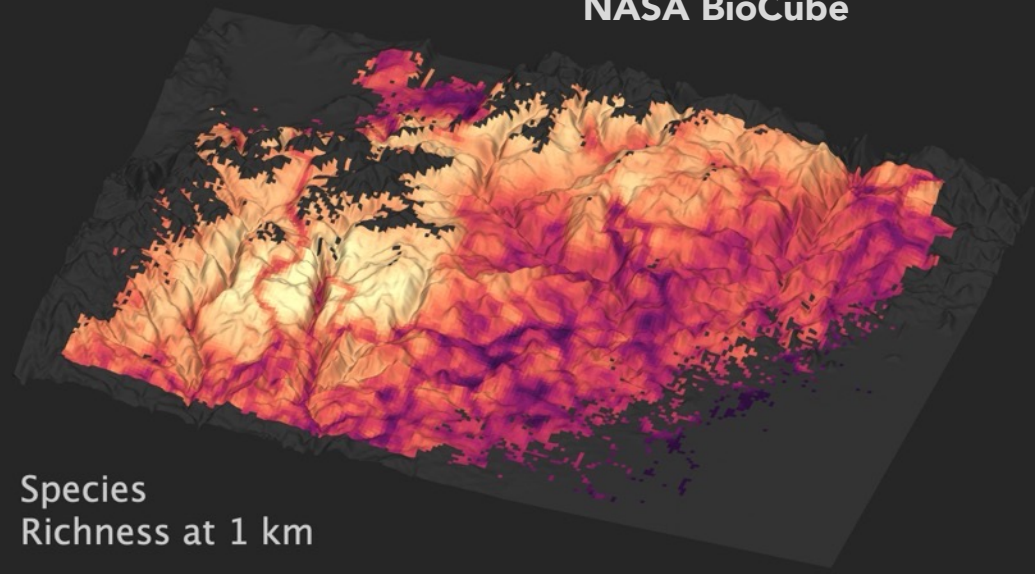
NASA BioCube



Functional
Richness at 1 km

Schneider et al. (in prep)

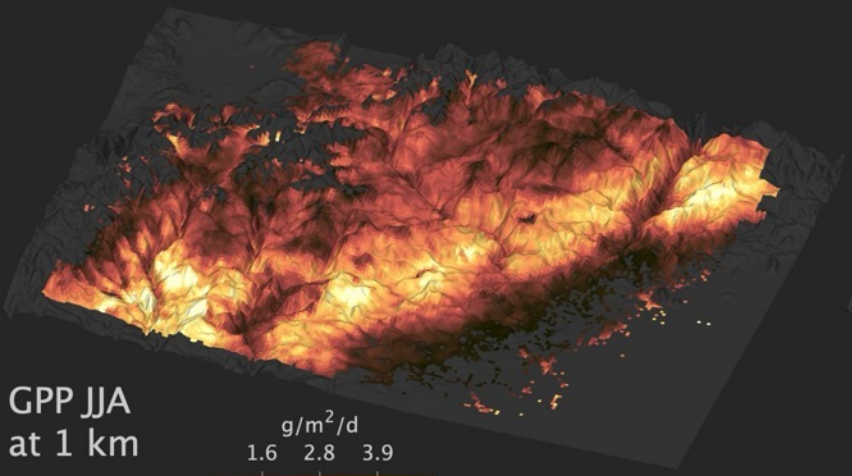
%
1.9 3.7 5.6



Species
Richness at 1 km

Kling et al. 2019

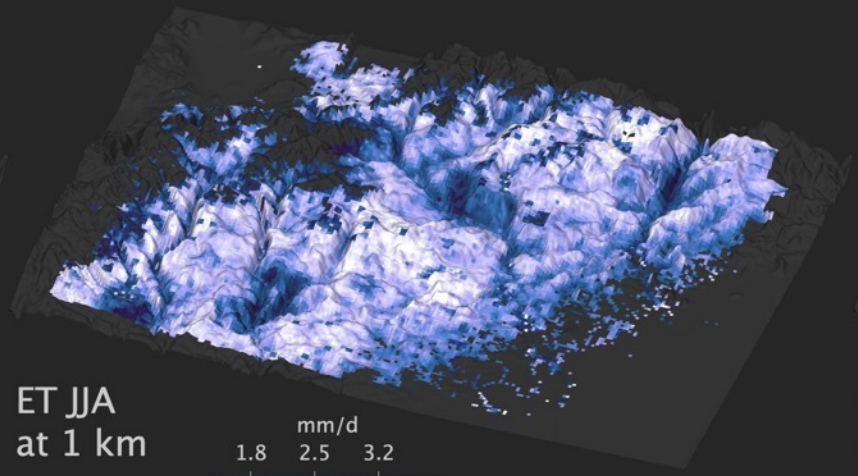
#Species
156 267 379



GPP JJA
at 1 km

$g/m^2/d$
1.6 2.8 3.9

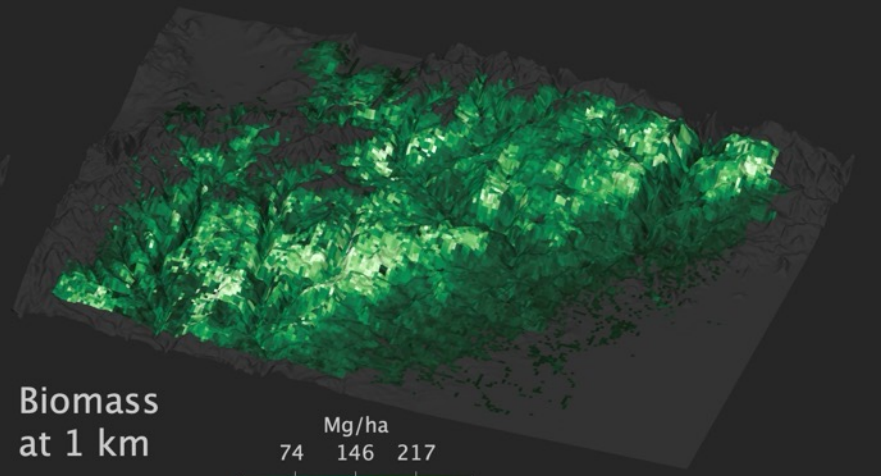
TROPOMI



ET JJA
at 1 km

mm/d
1.8 2.5 3.2

ECOSTRESS



Biomass
at 1 km

Mg/ha
74 146 217

GEDI

Schneider et al. (in prep)