



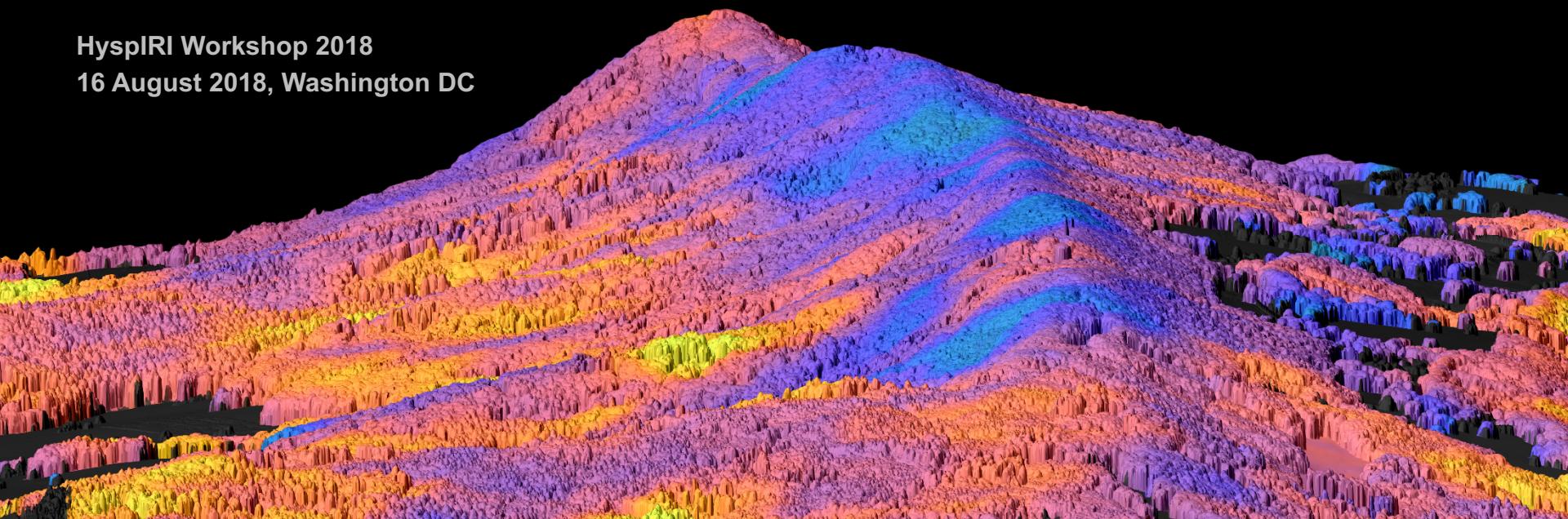
Jet Propulsion Laboratory
California Institute of Technology

Mapping plant diversity from space and using it to inform ecosystem models

FD Schneider, ME Schaepman, P Moorcroft, F Morsdorf, P Townsend, R Pavlick, DS Schimel

HyspIRI Workshop 2018

16 August 2018, Washington DC



Biodiversity-Productivity Relationship

Plant diversity as indicator for ecosystem health, stability and functioning

RESEARCH ARTICLE

FOREST ECOLOGY

Positive biodiversity-productivity relationship predominant in global forests

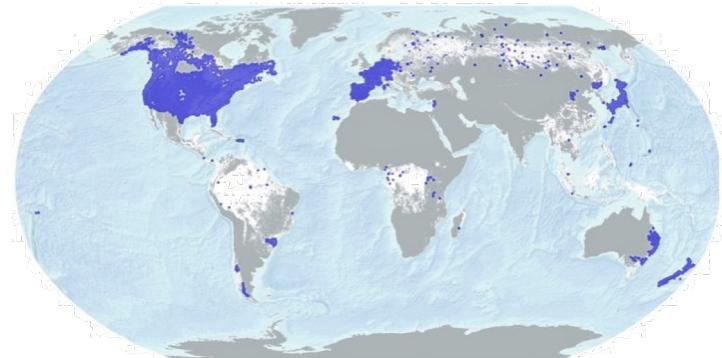
Jingjing Liang,^{1*} Thomas W. Crowther,^{2,3†} Nicolas Picard,⁴ Susan Wiser,⁵ Mo Zhou,¹ Giorgio Alberti,⁶ Ernst-Detlef Schulze,⁷ A. David McGuire,⁸ Fabio Bozzato,⁹

LETTER

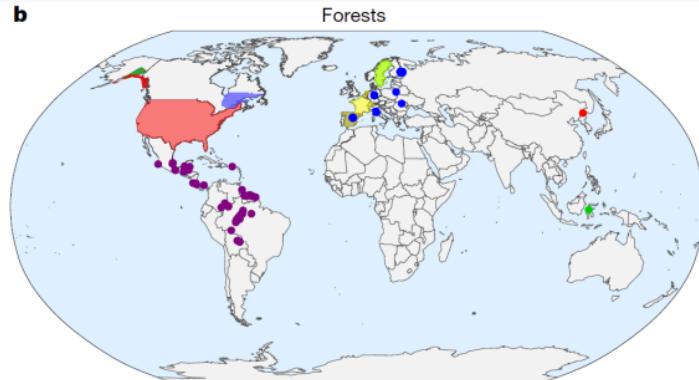
doi:10.1038/nature23886

Biodiversity effects in the wild are common and as strong as key drivers of productivity

J. Emmett Duffy¹, Casey M. Godwin² & Bradley J. Cardinale²



b

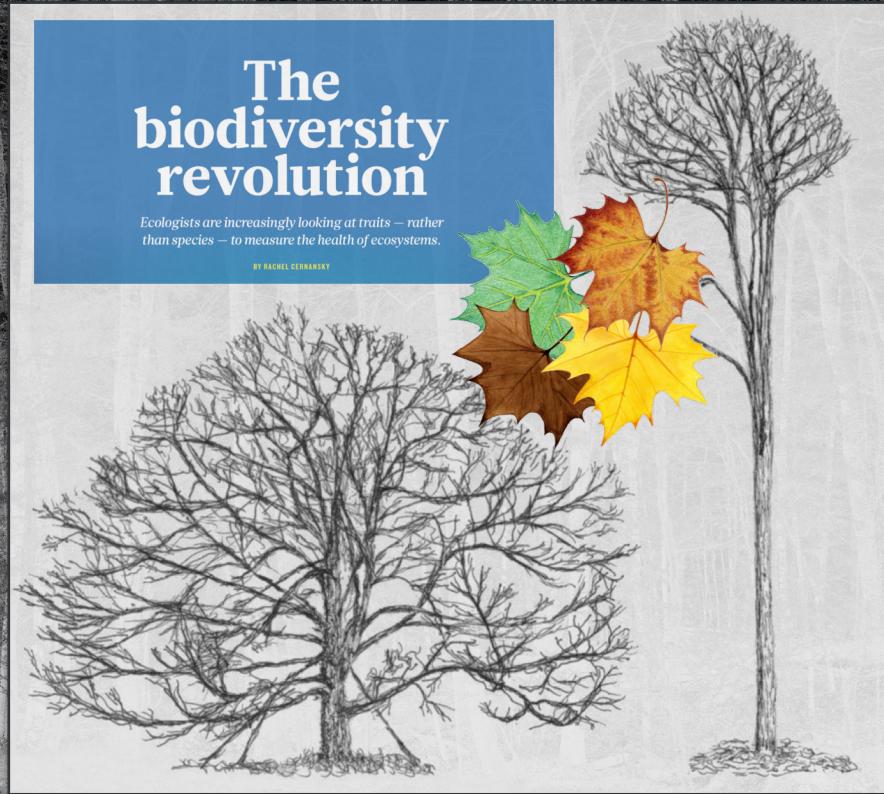


How do we measure Biodiversity?

Remote Sensing of Plant Functional Traits

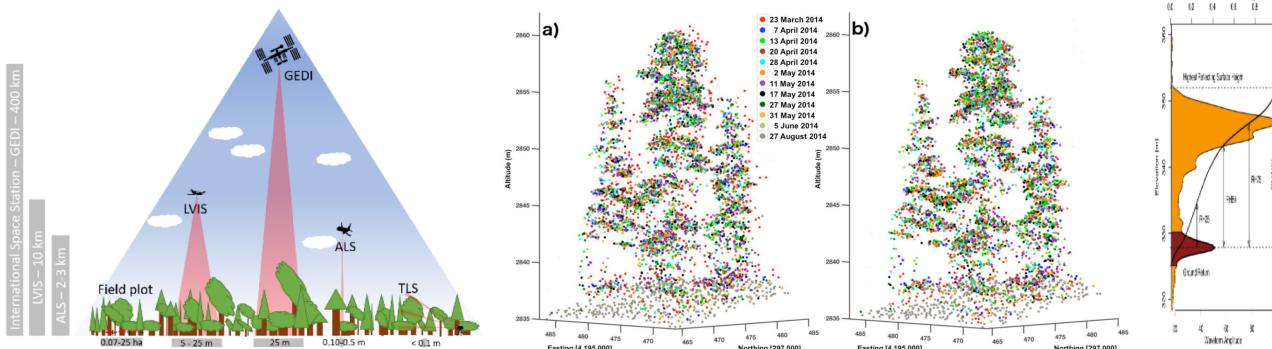
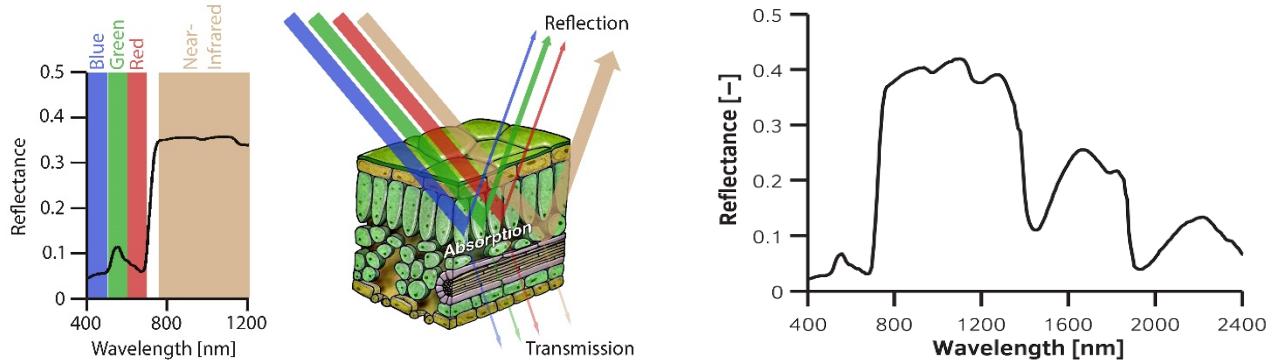


“Just going for species numbers doesn’t allow us to harness all this incredibly rich information of how the real world operates.”



Methods to Measure Traits

Imaging Spectroscopy and Laser Scanning



Schaepman, et al. (2015) RSE; Lee, et al. (2015) RSE; Schneider, et al. (2014) RSE; Ferraz, et al. (2018) RS

APEX
400 – 2500 nm
@3-14 nm and 2 m

AVIRIS Classic
400 – 2500 nm
@10 nm and 15 m

Airborne LiDAR
30 cm Footprint
5-40 pts per m²

Spaceborne LiDAR
25 m Footprint
10-30 pts per km²

Test Case in Switzerland

Small-Scale Airborne Data at Individual Tree Level

Canopy Morphological Traits

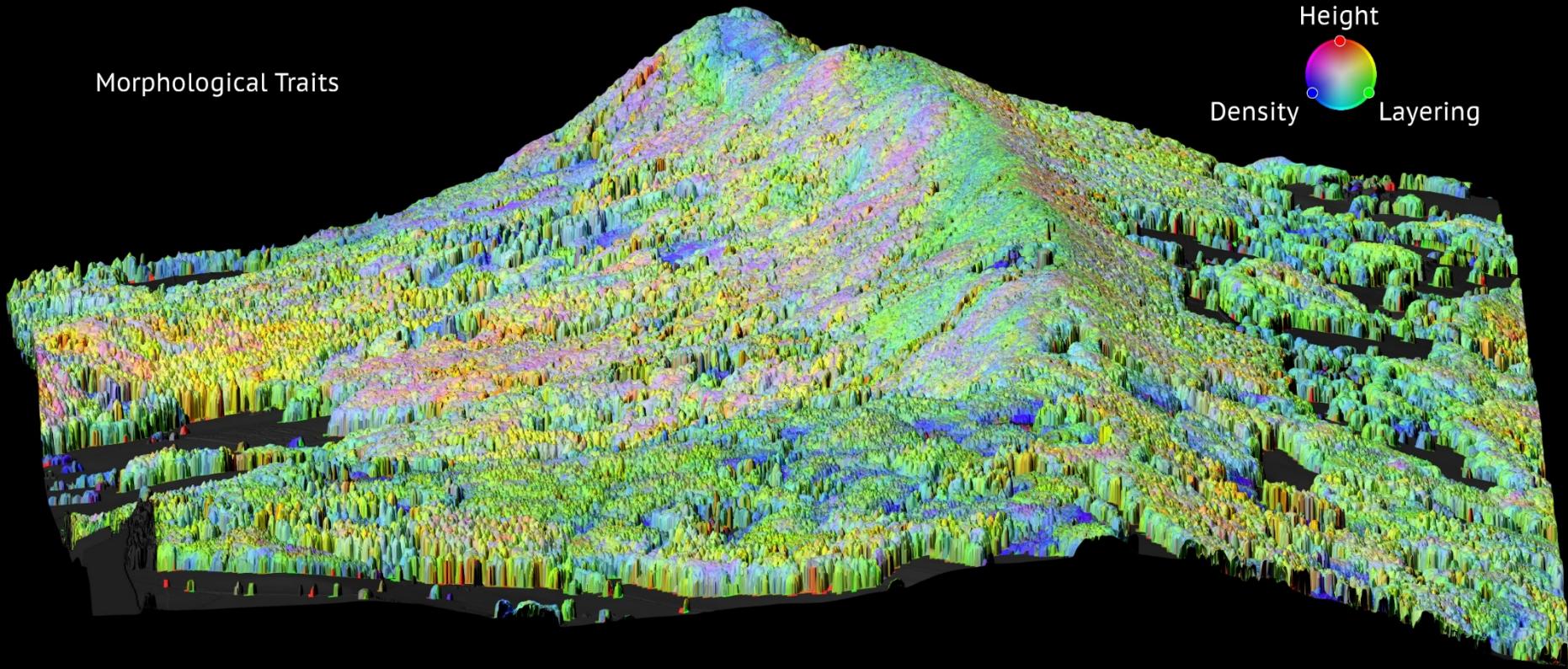
Morphological Traits

Height

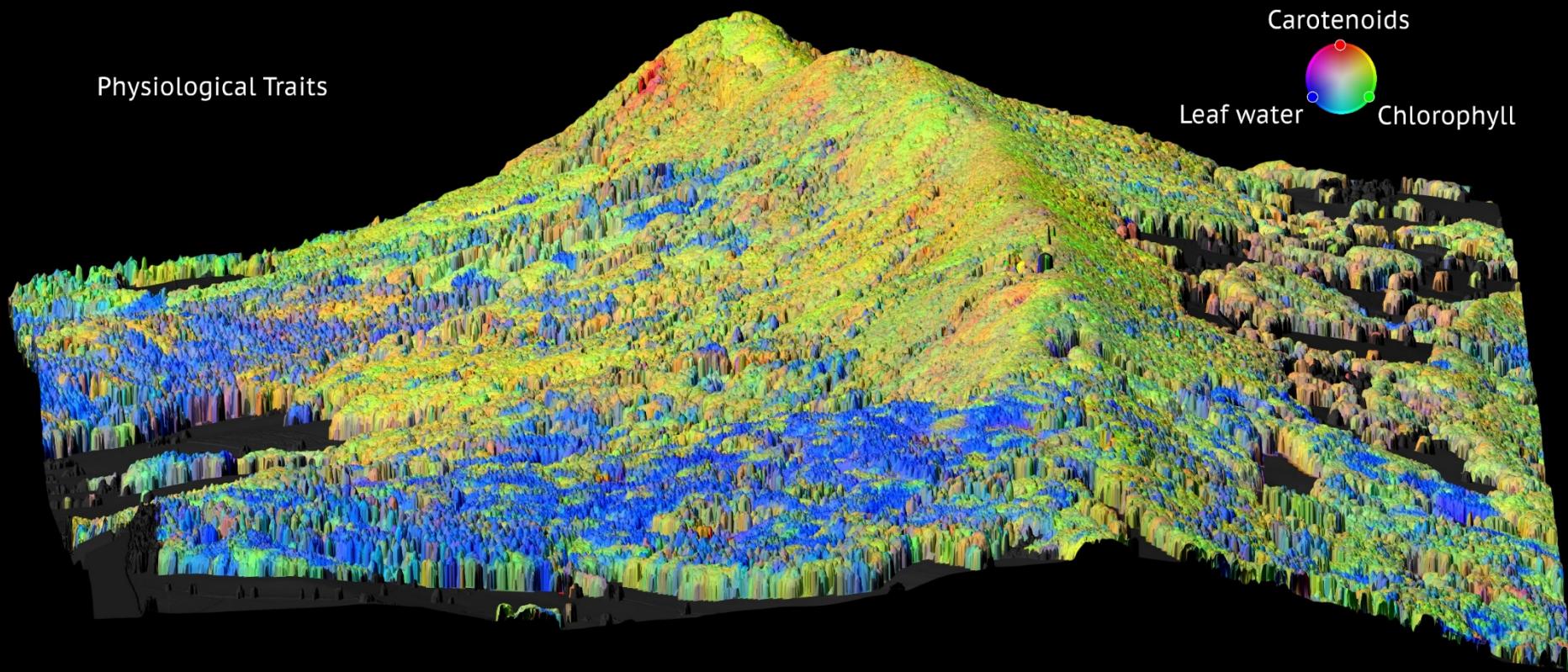


Density

Layering



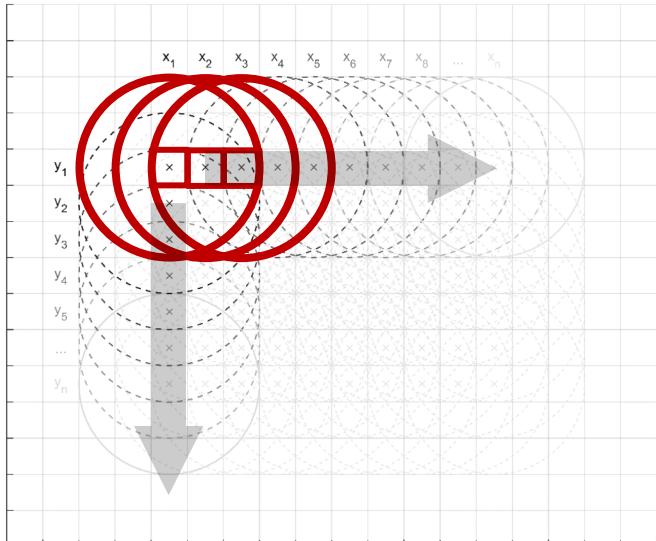
Leaf Physiological Traits



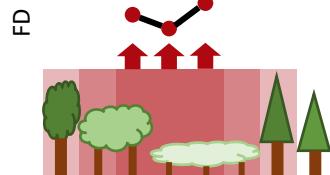
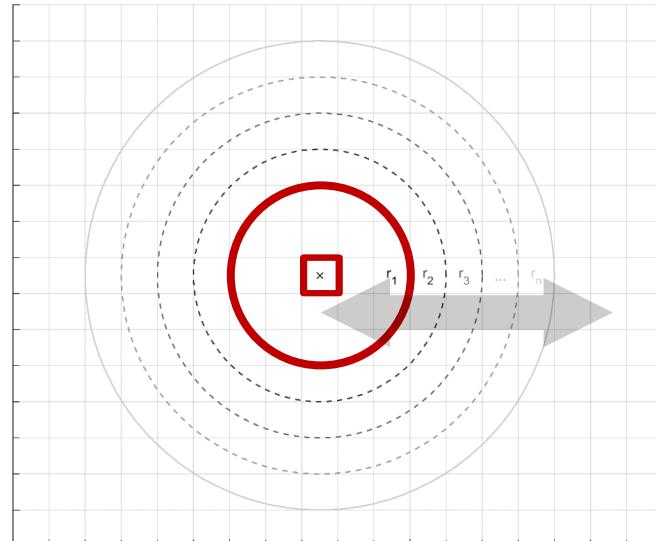
Continuous Diversity Mapping

From Traits to Diversity

Moving-Window

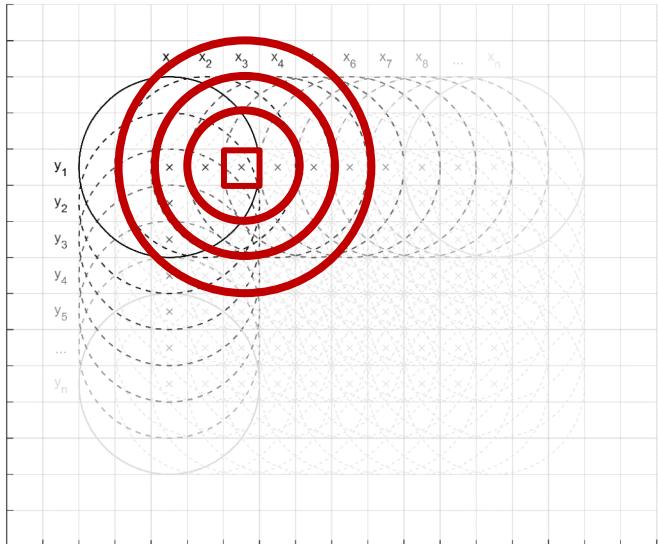


Radius

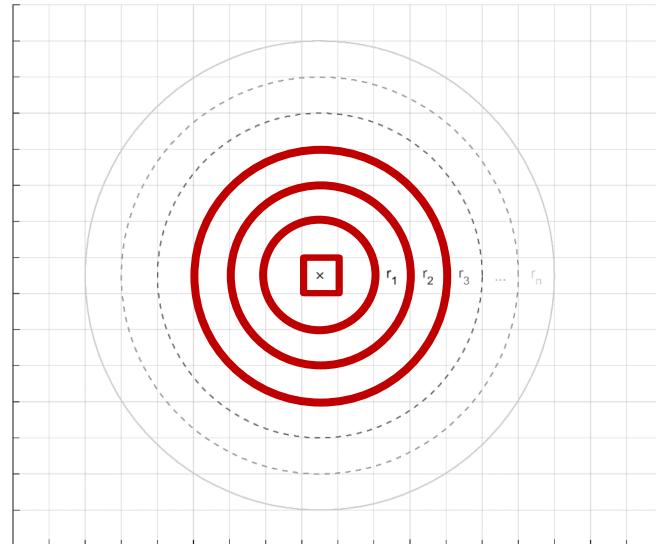


Continuous Diversity Mapping

From Traits to Diversity

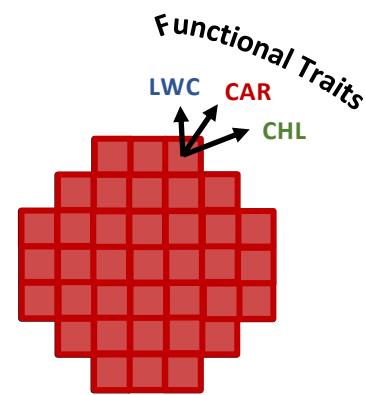
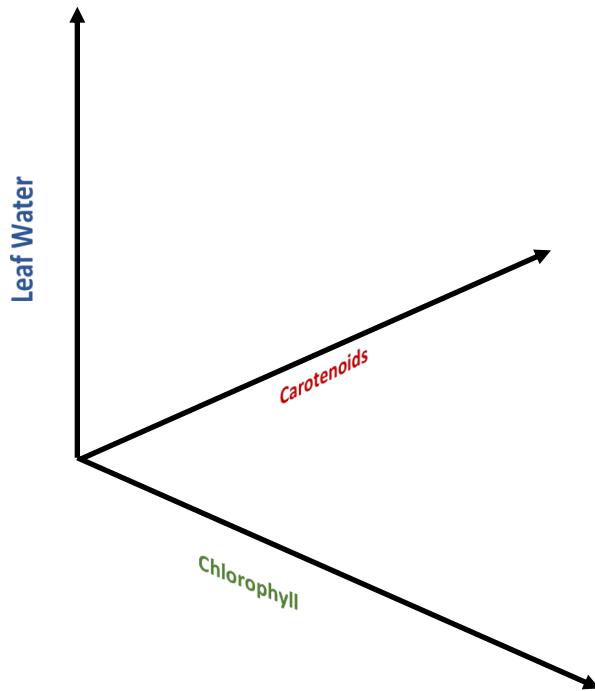


Radius



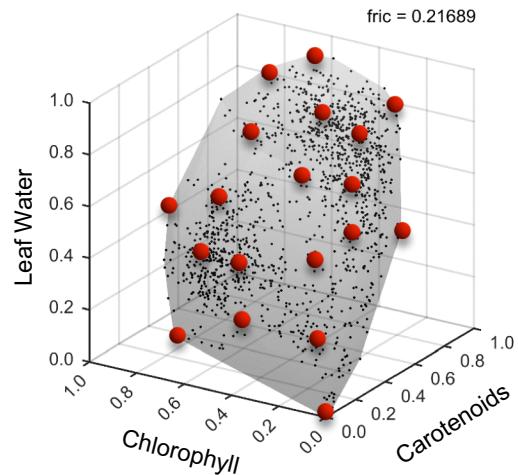
Functional Diversity Measures

Analyzing the Trait Space

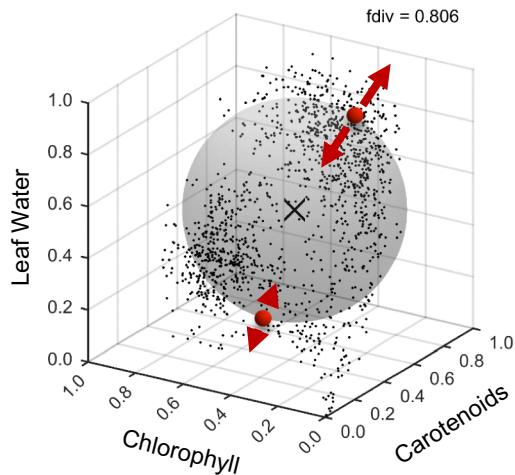


Functional Diversity Measures

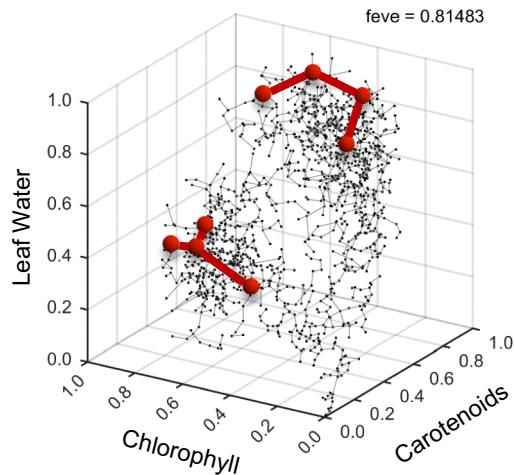
Analyzing the Trait Space



Functional Richness



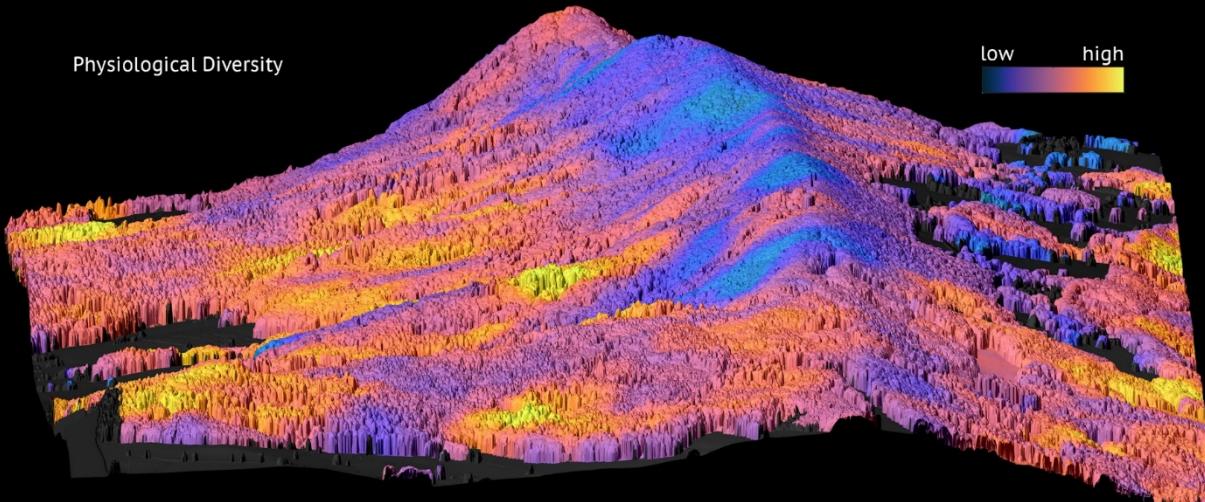
Functional Divergence



Functional Evenness

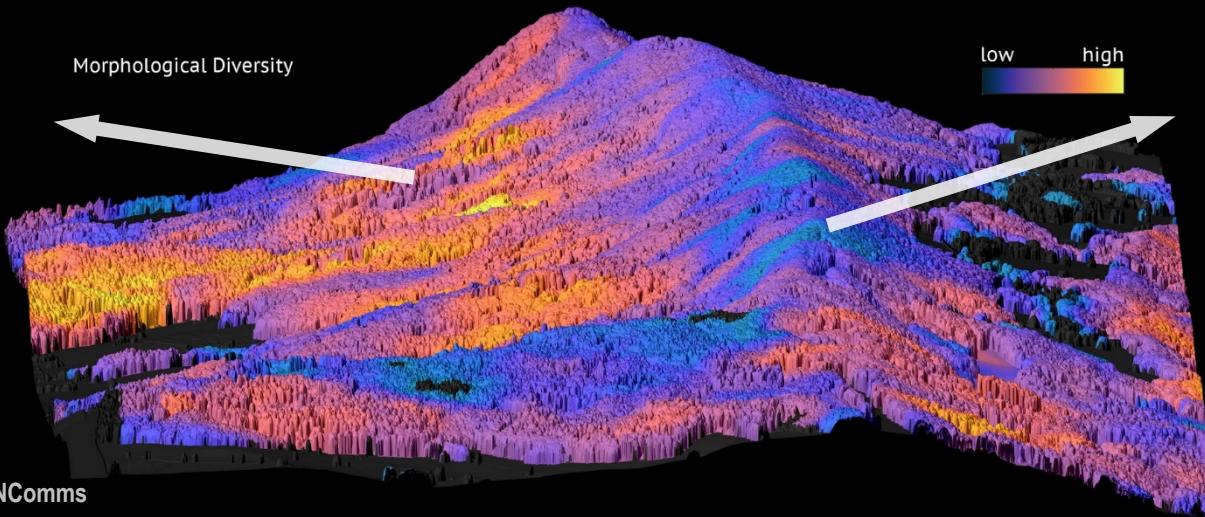
Physiological Diversity

low high



Morphological Diversity

low high

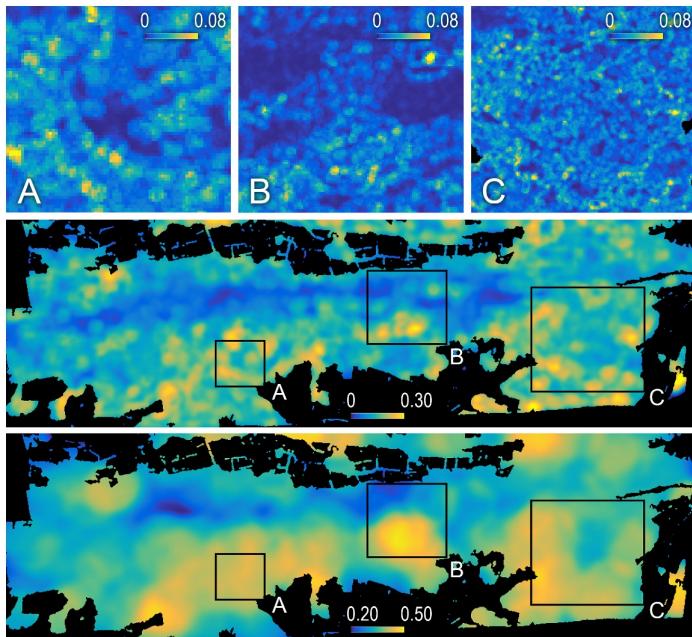


Photos: edaskiokys.ch, rainolo.ch

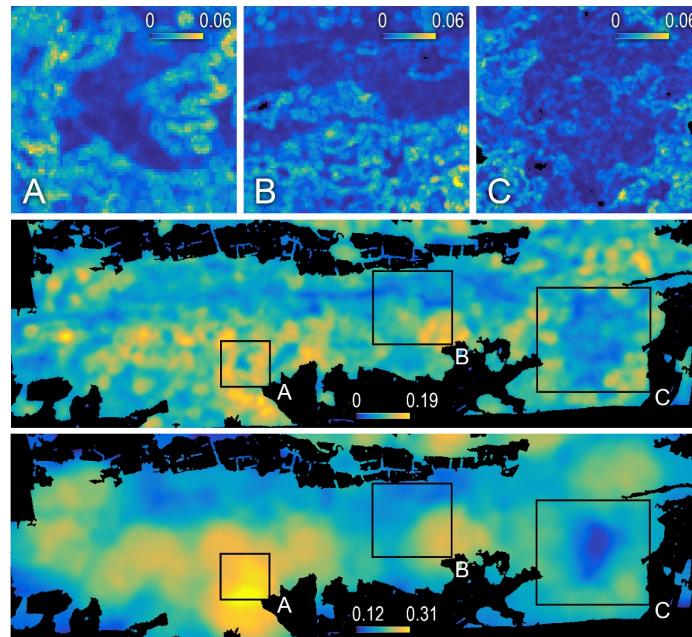
Scale Dependence of Diversity

Diversity-Area Relationship

Physiological Richness



Morphological Richness



Radius

12 m

60 m

240 m

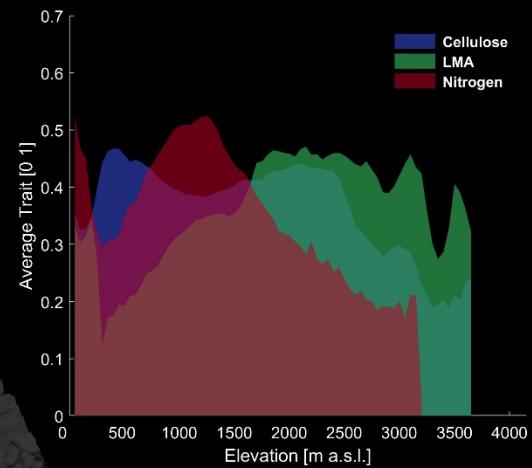
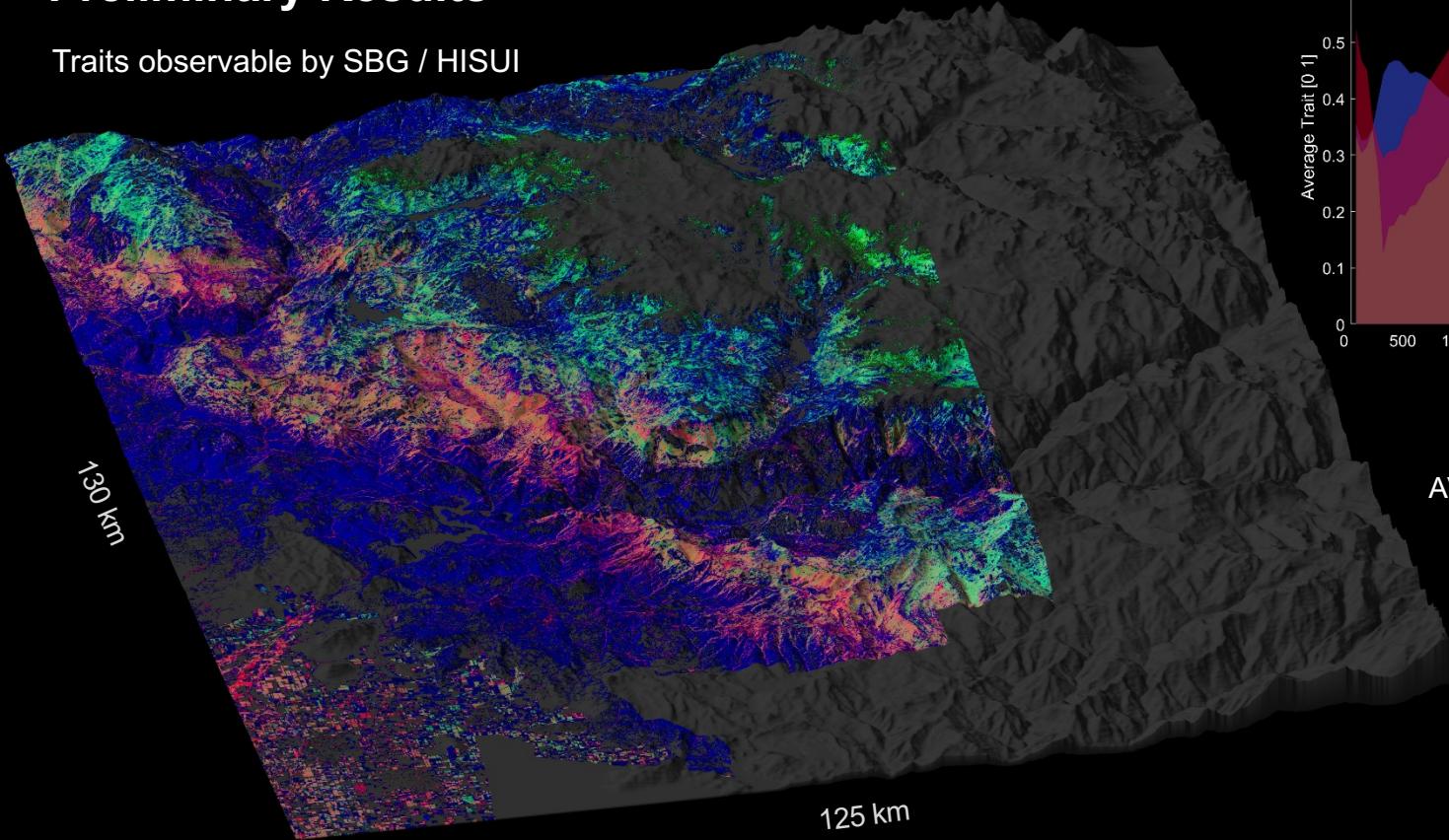
Test Case in California

Large-Scale Airborne Data at Community Level



Preliminary Results

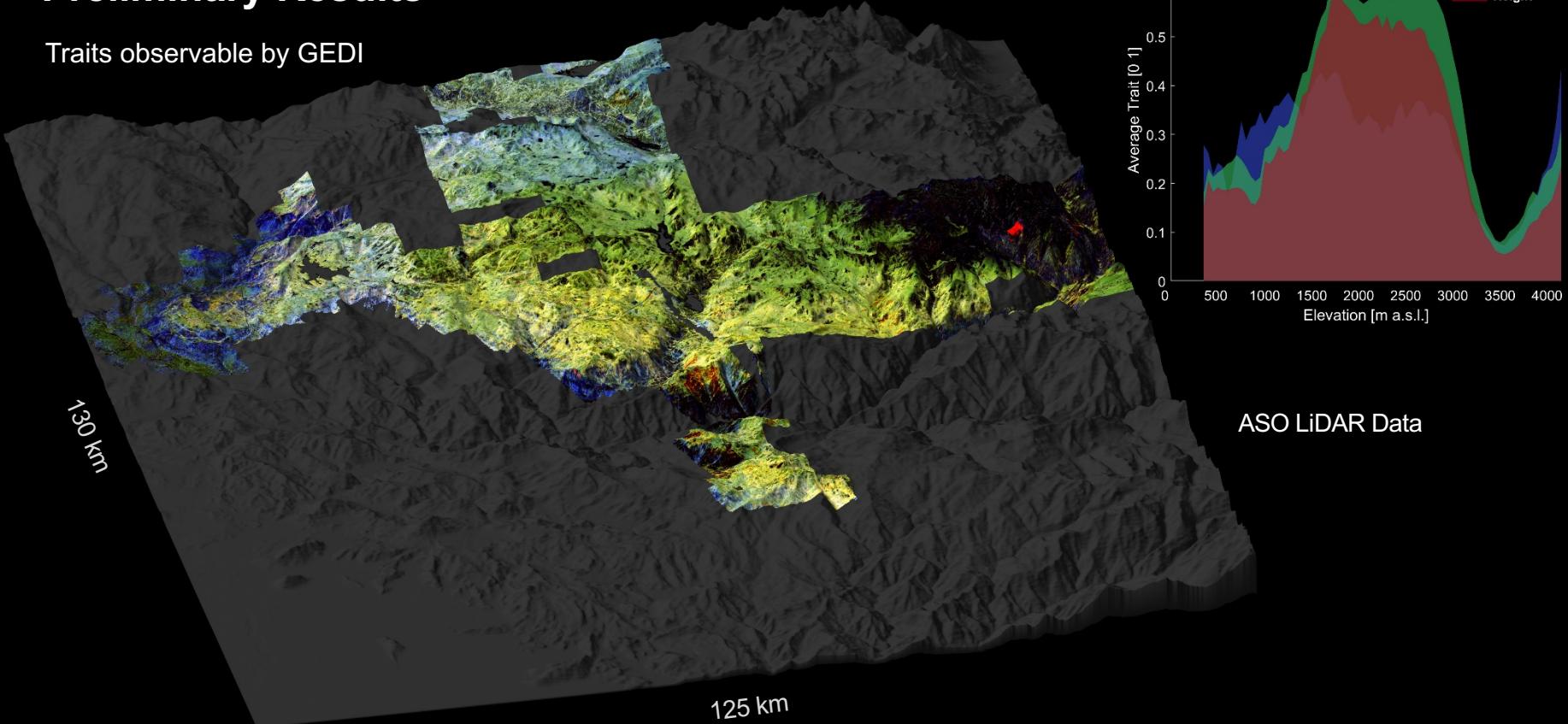
Traits observable by SBG / HISUI



AVIRIS Classic on ER-2

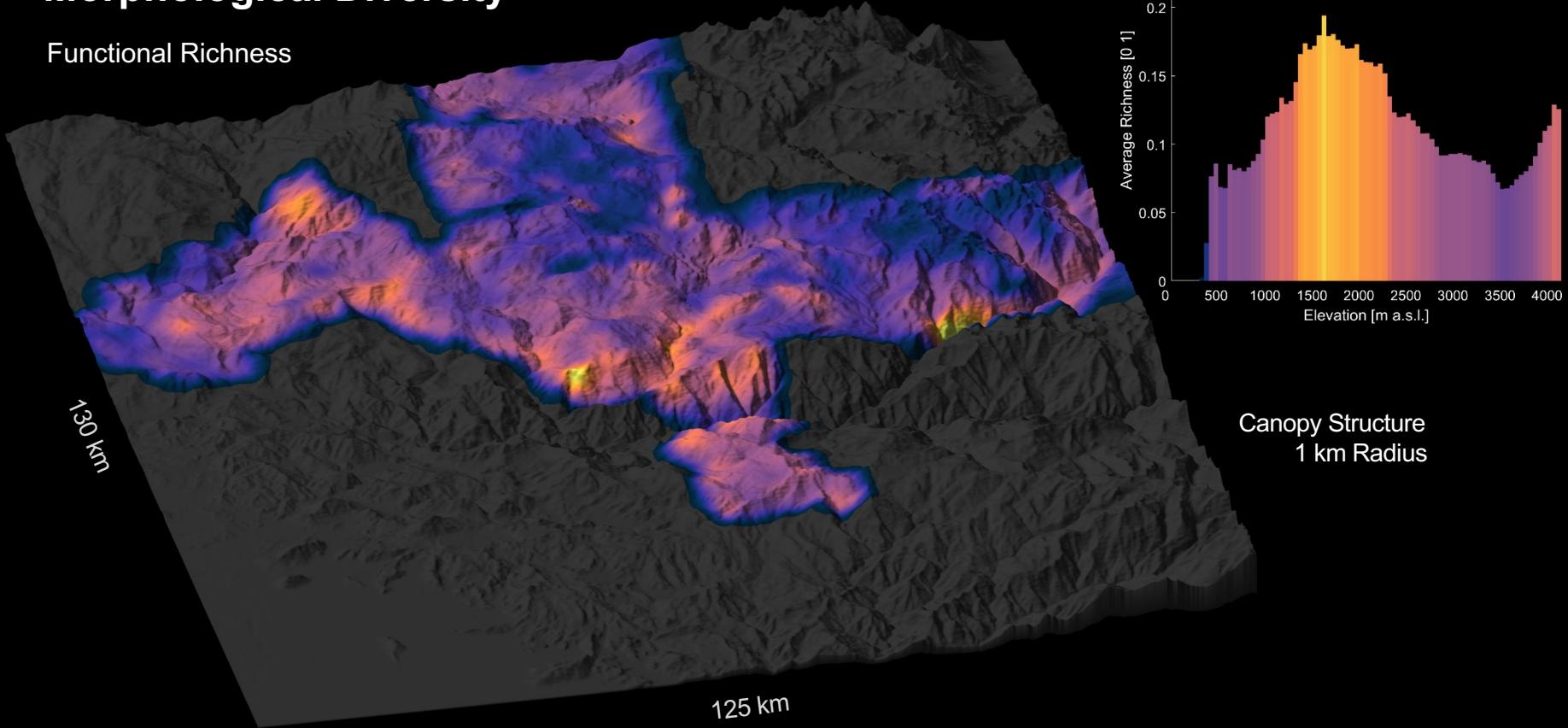
Preliminary Results

Traits observable by GEDI



Morphological Diversity

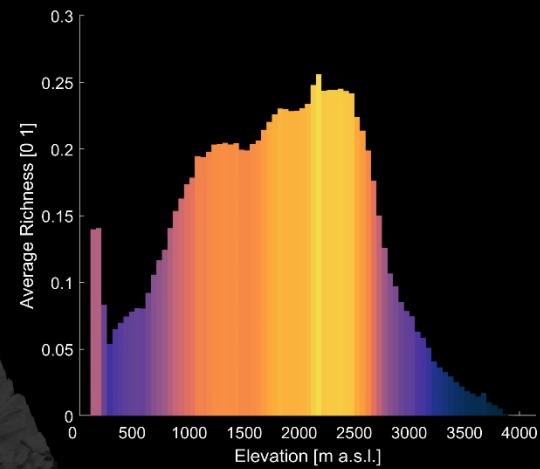
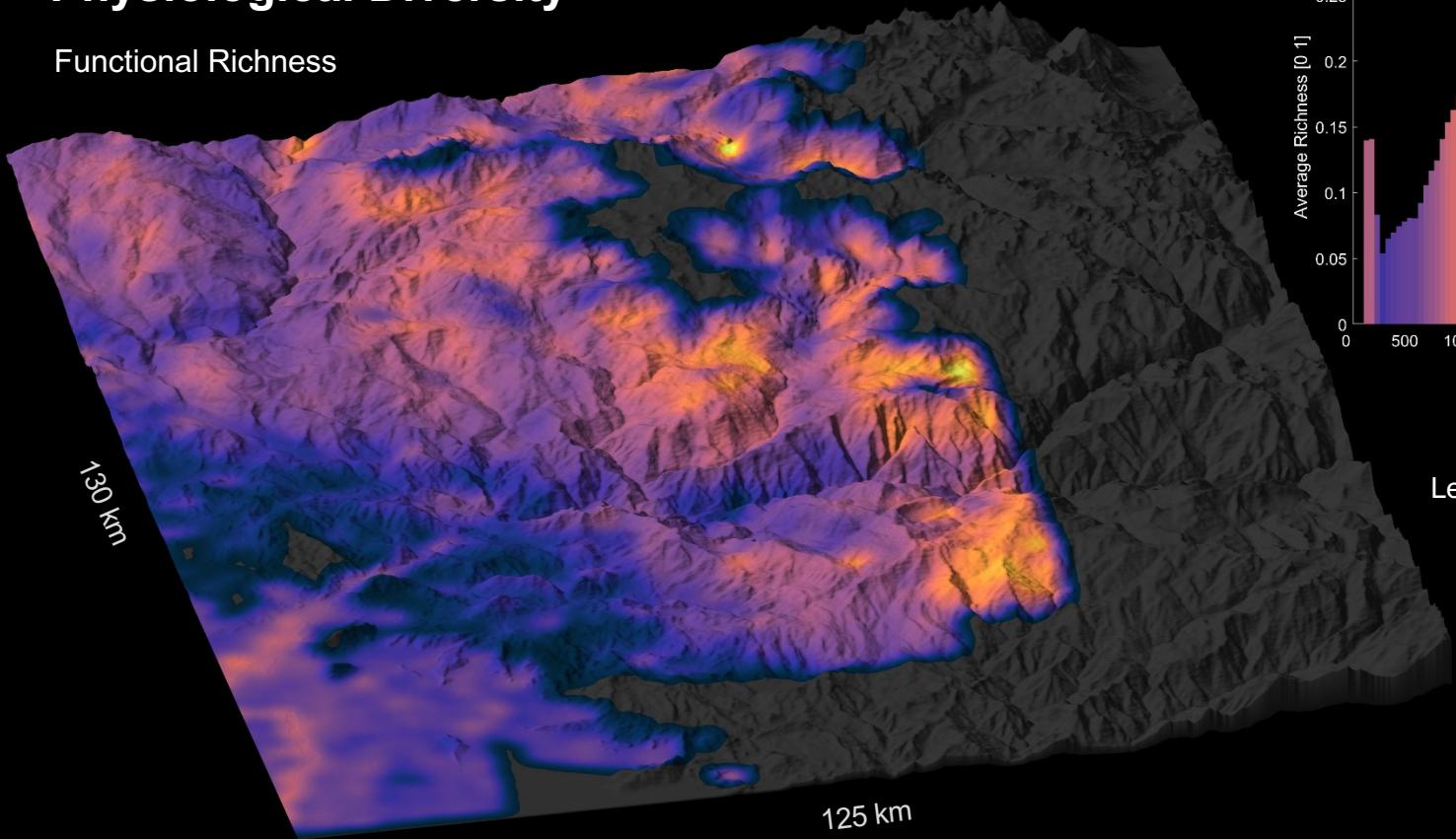
Functional Richness



Canopy Structure
1 km Radius

Physiological Diversity

Functional Richness

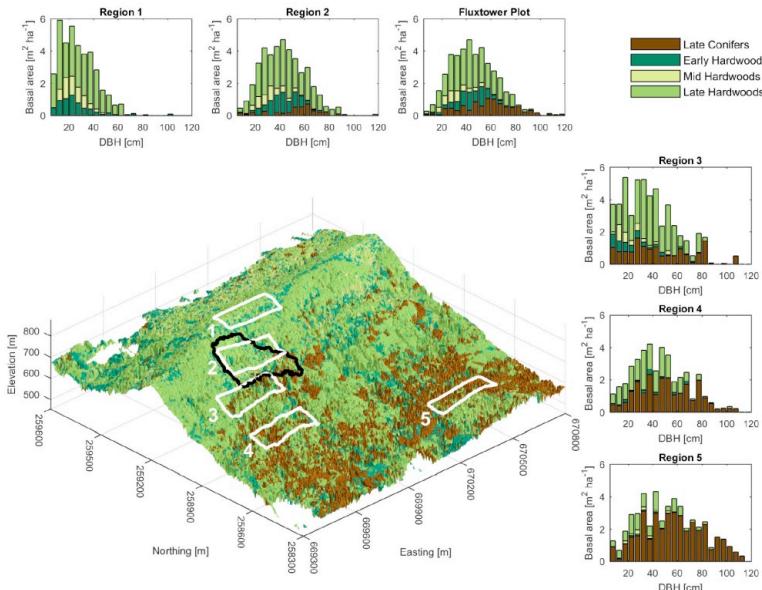


Leaf Physiology
1 km Radius

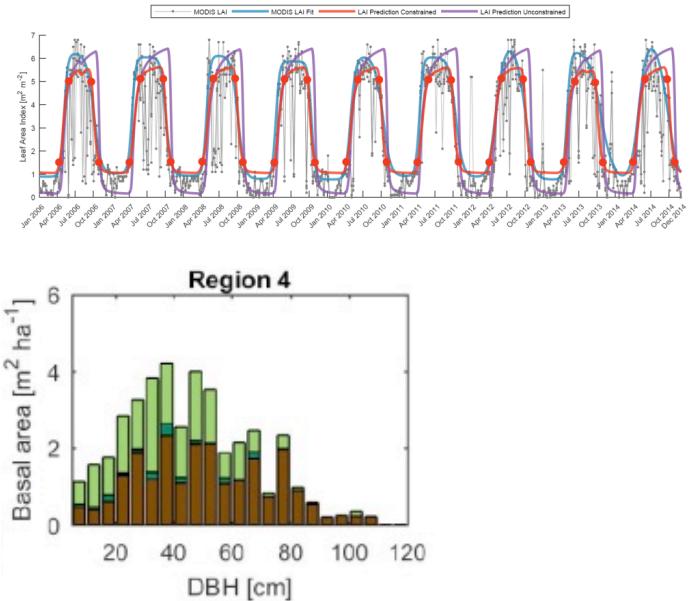
From Diversity to Functioning

Informing an Ecosystem Model with Remote Sensing Data

- Composition, Structure, Phenology



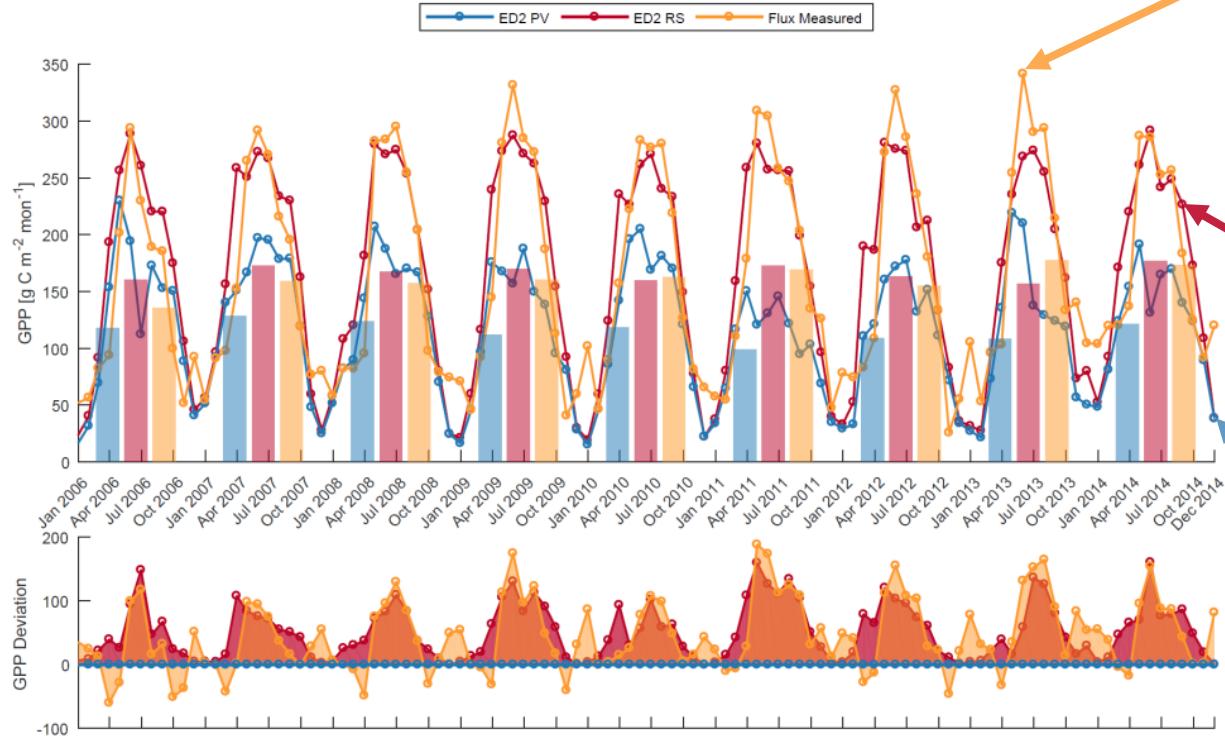
Phenology



Structure Composition

Predicting Carbon Uptake

RS Data to Improve Model Predictions in ED2

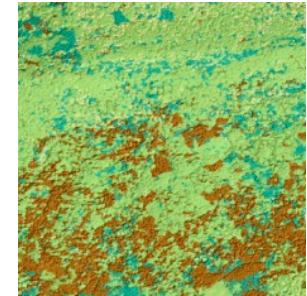


Fluxtower

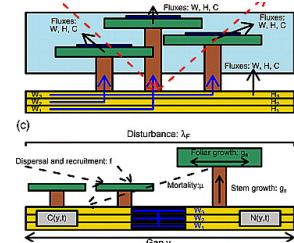


Photo: Reik Leiterer

RS informed

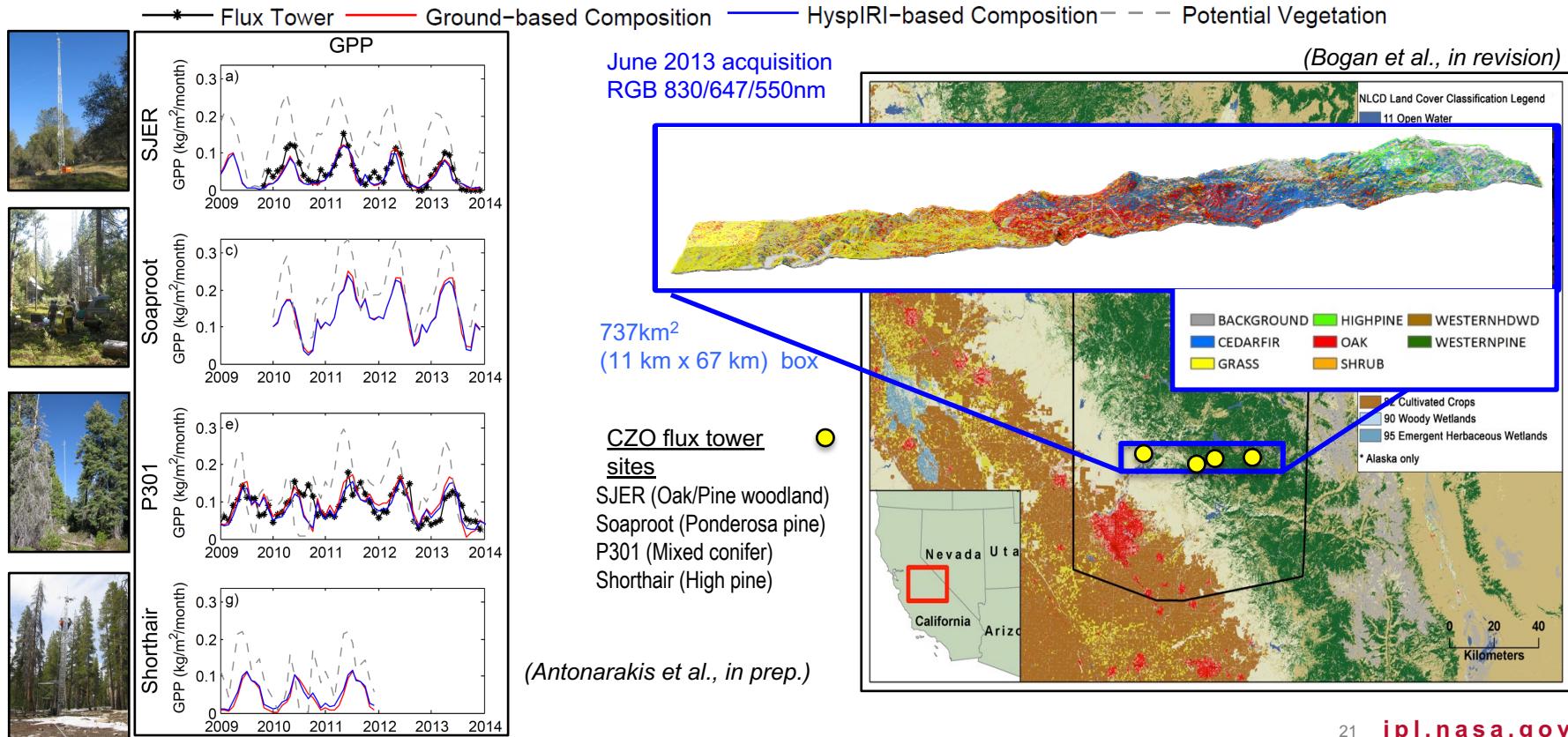


Uninformed
model

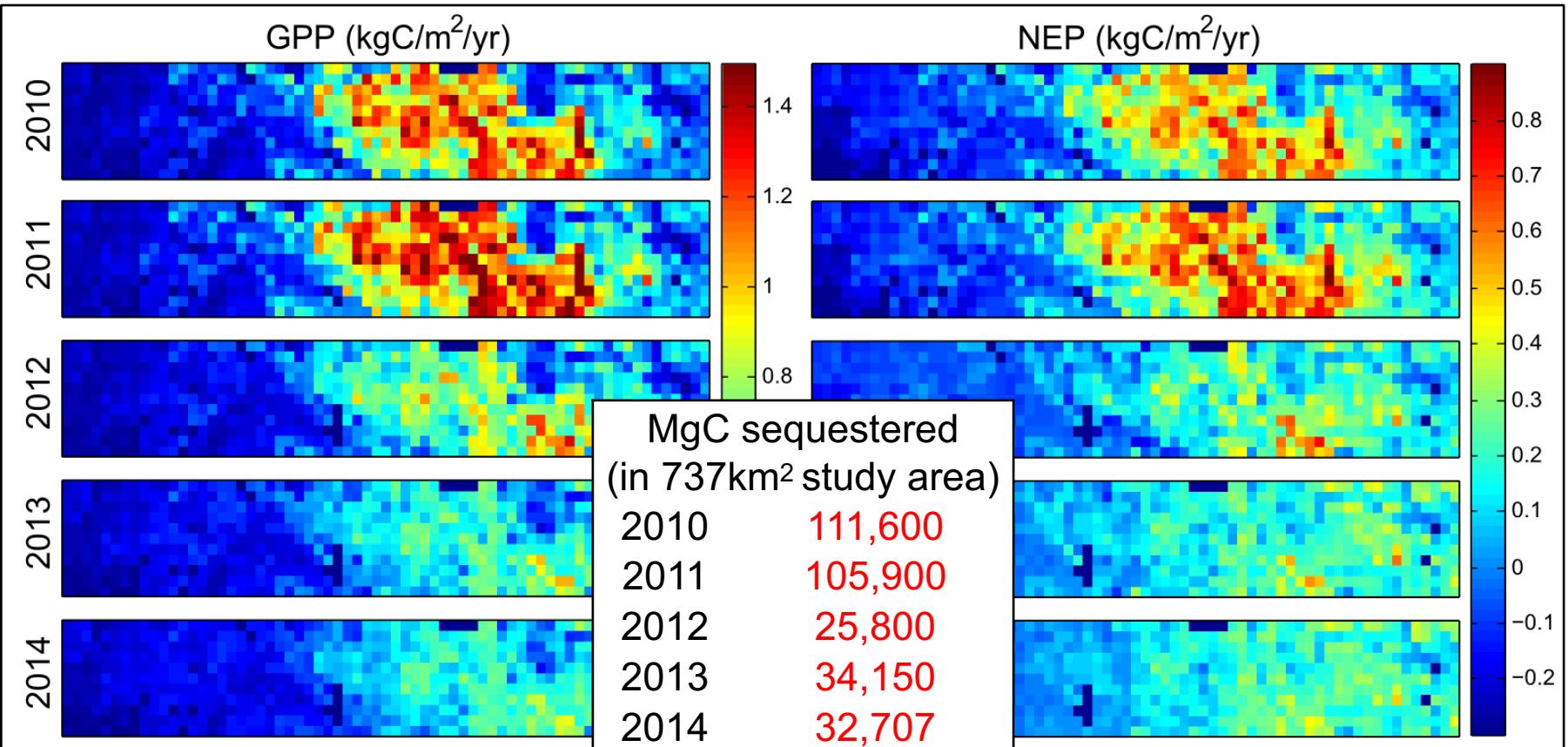


California GPP Prediction

Critical Zone Observatory Flux Towers



California GPP Prediction



Conclusion

- Diversity mapping based on plant functional traits
 - Which traits are most relevant and how much of total diversity can be explained?
- Community-scale measurements from space
 - Airborne campaigns for scaling between in-situ and spaceborne measurements
- Link diversity patterns to ecosystem stability and productivity
 - Global biodiversity observatory
- Integration with ecosystem models
 - Wall-to-wall functional traits and trait diversity can help to improve modeling and predicting energy, water and carbon fluxes

Diversity mapping based on plant functional traits

Which traits are most relevant and how much of total diversity can be explained?

Community-scale measurements from space

Airborne campaigns for scaling between in-situ and spaceborne measurements

Link diversity patterns to ecosystem stability and productivity

Global biodiversity observatory

Integration with ecosystem models

Wall-to-wall functional traits and trait diversity can help to improve modeling and predicting energy, water and carbon fluxes

Thank you

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David Thompson, Antonio Ferraz, Tom Painter,
John Chapman, Adam Chlus, Zhiwei Ye



URPP
Global Change
and Biodiversity



Jet Propulsion Laboratory
California Institute of Technology



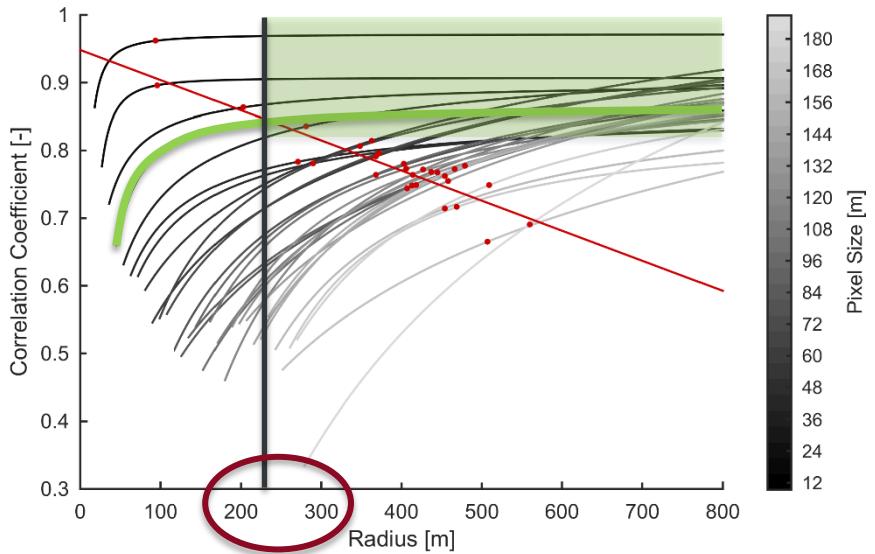
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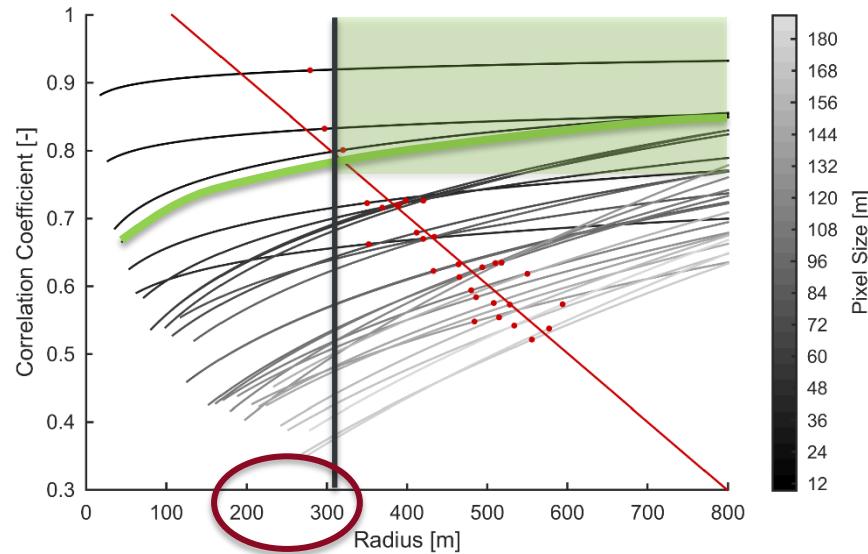
Scale Dependence of Diversity

Changing Grain and Extent

- Correlation to fine spatial grain, for...
...morphological richness



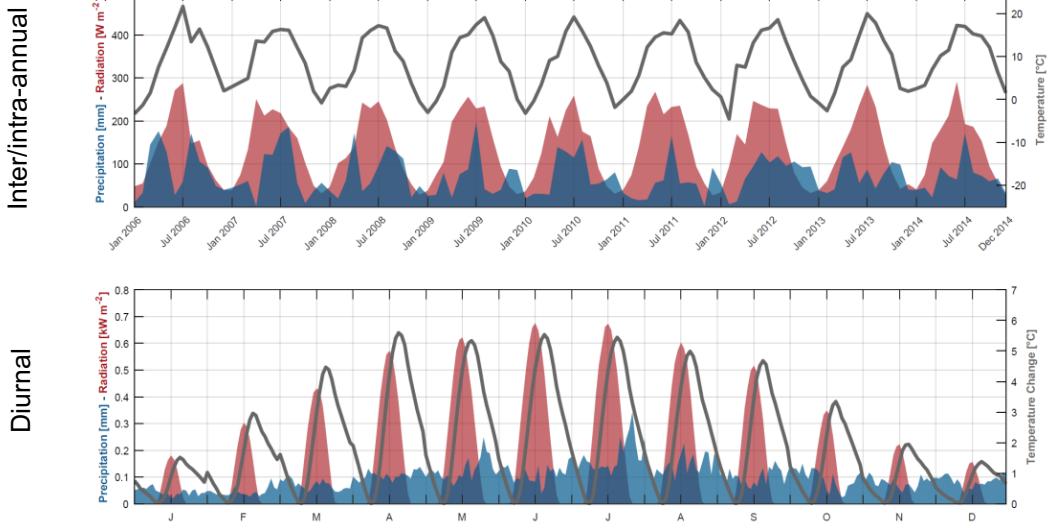
...physiological richness



From Diversity to Functioning

Informing an Ecosystem Model with Remote Sensing Data

- Meteorological Drivers



Decadal

