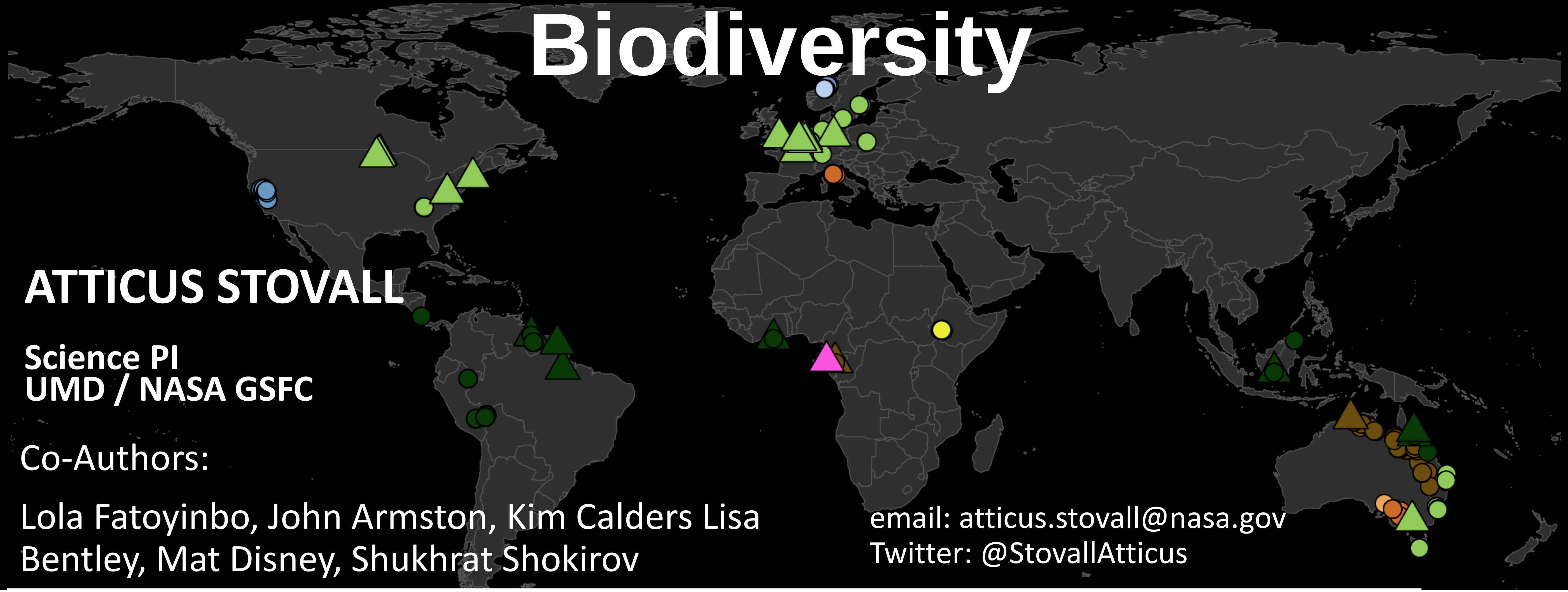
Understanding the 3D Signature of Biodiversity



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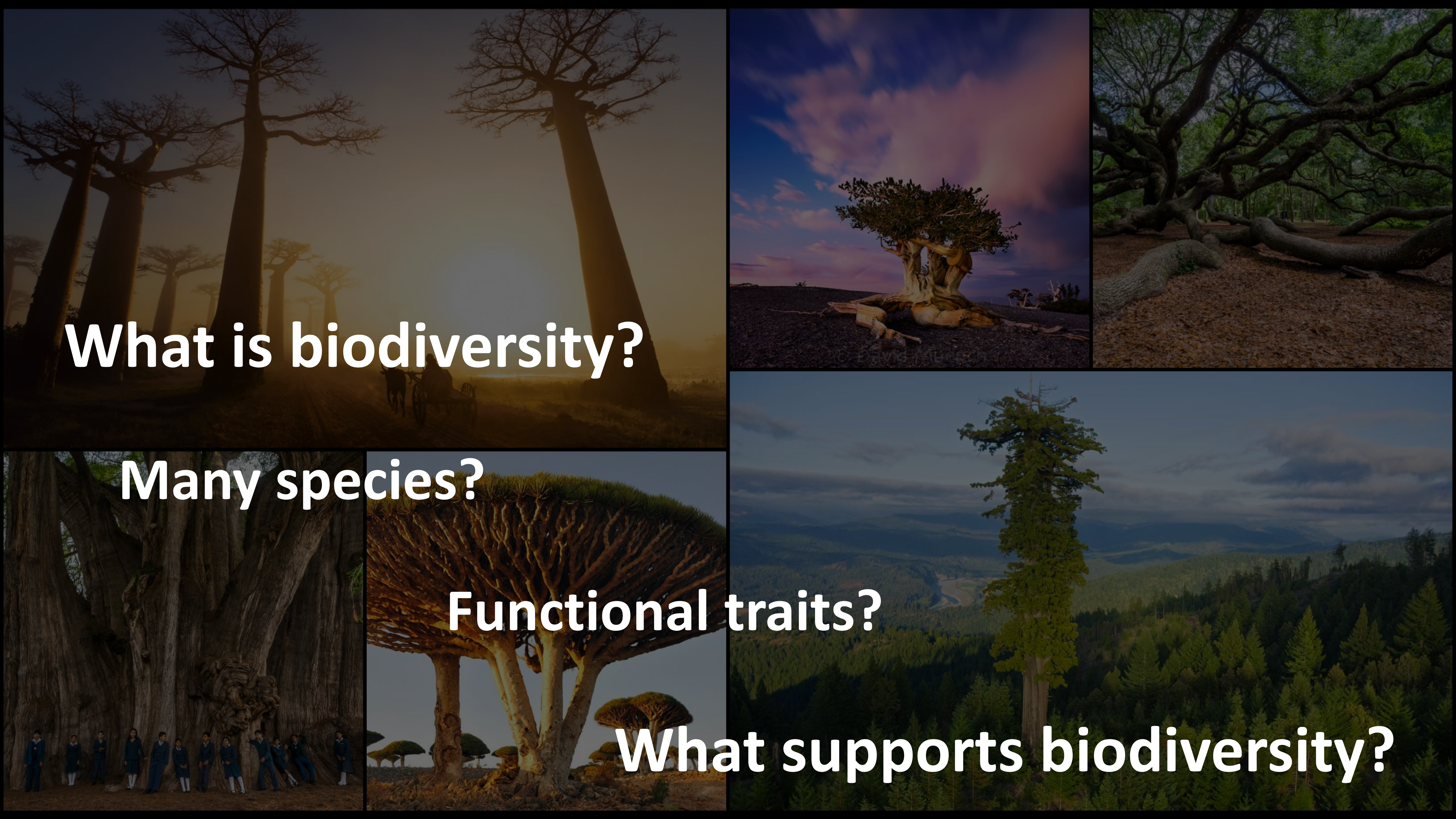
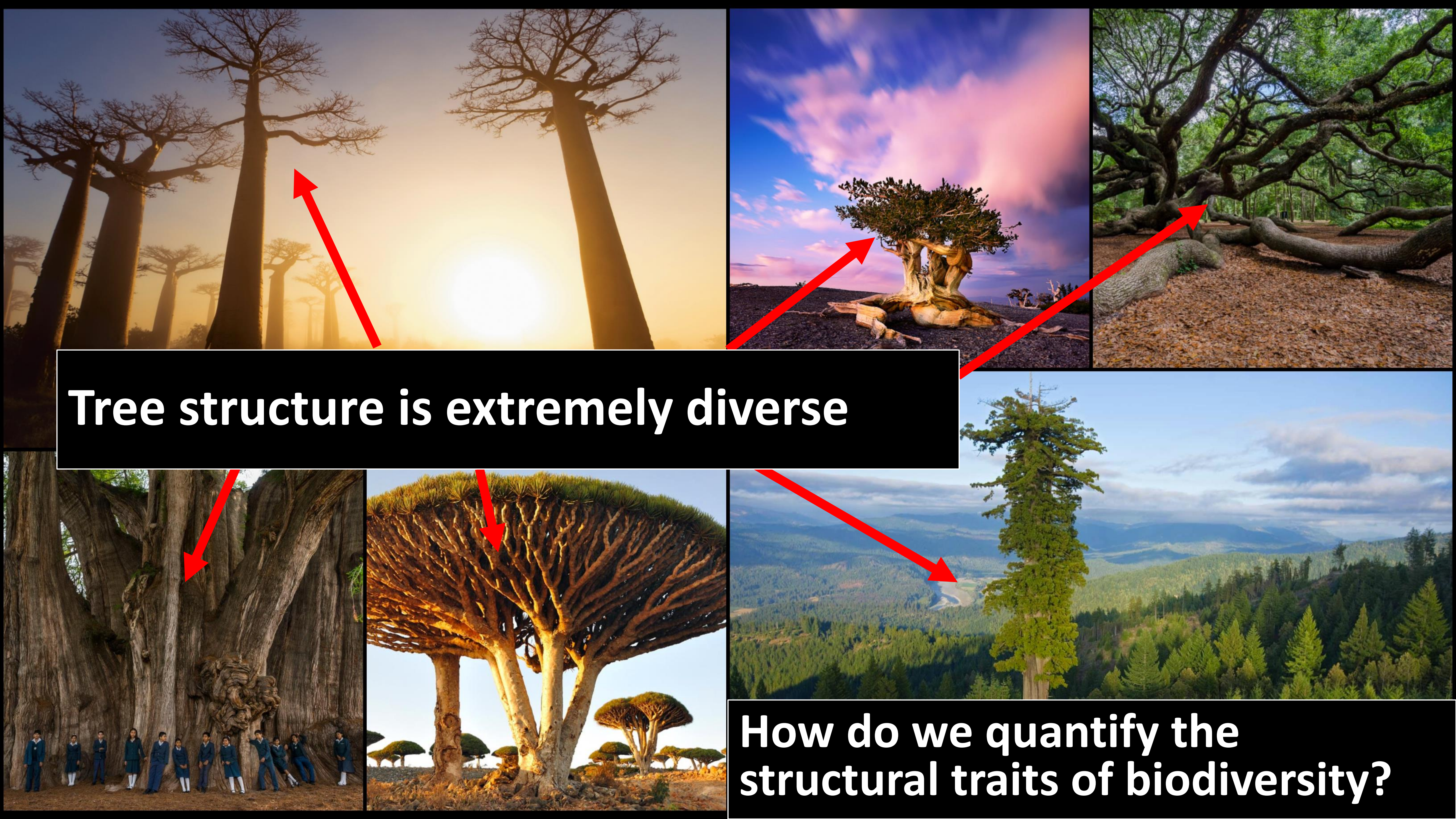
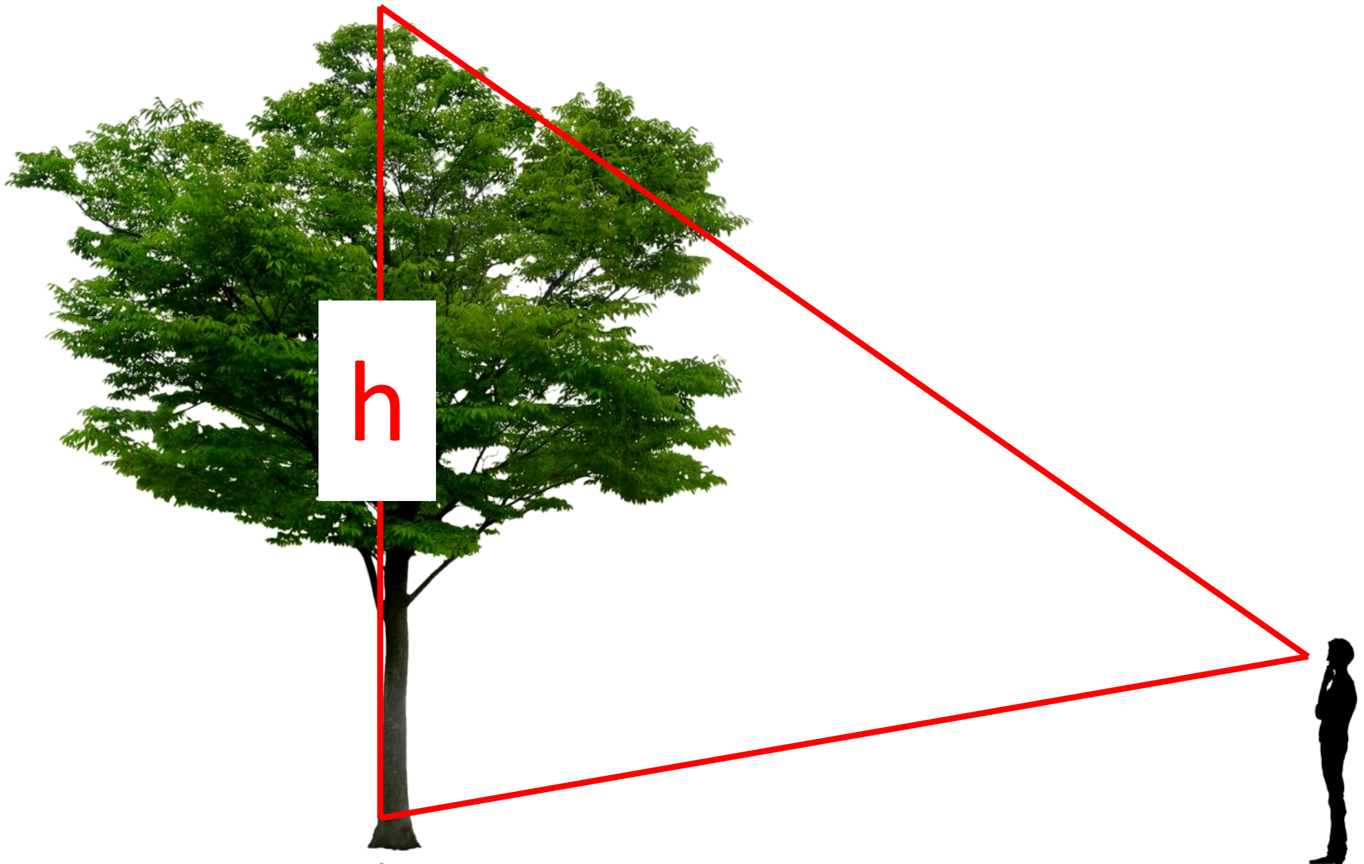
NASA · University of Maryland · Ghent University · UCL · Sonoma State University · GEDI Ecosystem Lidar · TLS


What is biodiversity?
Many species?
Functional traits?
What supports biodiversity?


Tree structure is extremely diverse
How do we quantify the structural traits of biodiversity?

Habitat structure is typically quantified with:

1 Dimensional: Tree Height



Habitat structure is typically quantified with:

2 Dimensional: % Cover

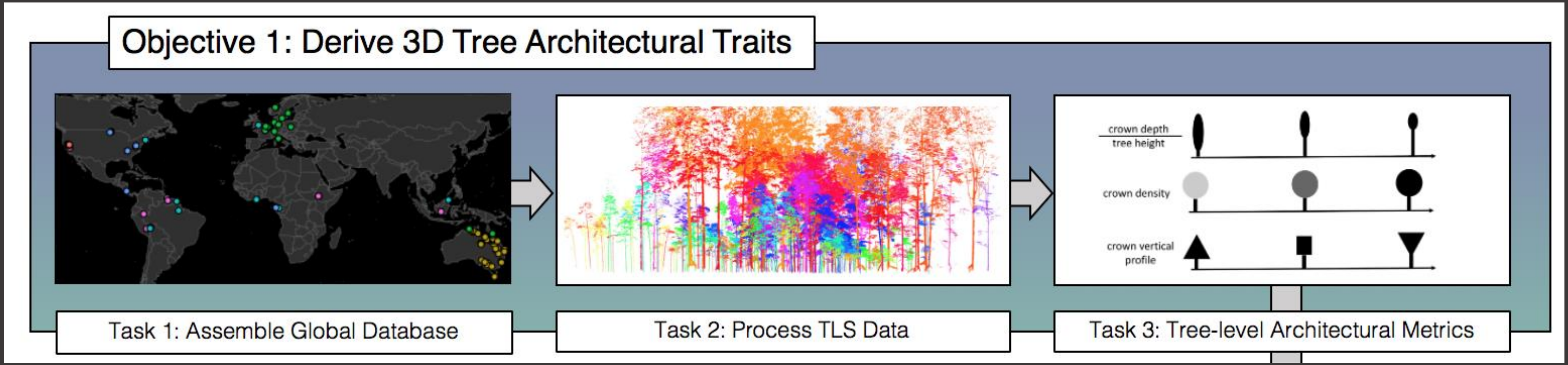
Terrestrial laser scanning brings 3D to biodiversity traits



Goal: Better understand the **structural and functional scaling relationships of trees** by quantifying **drivers of tree-level biodiversity traits** for improved characterization of biodiversity.

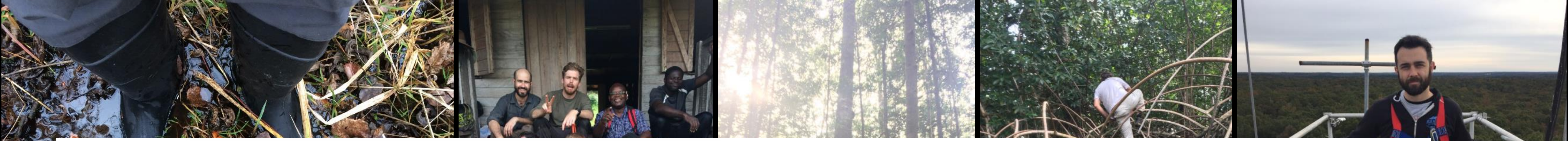


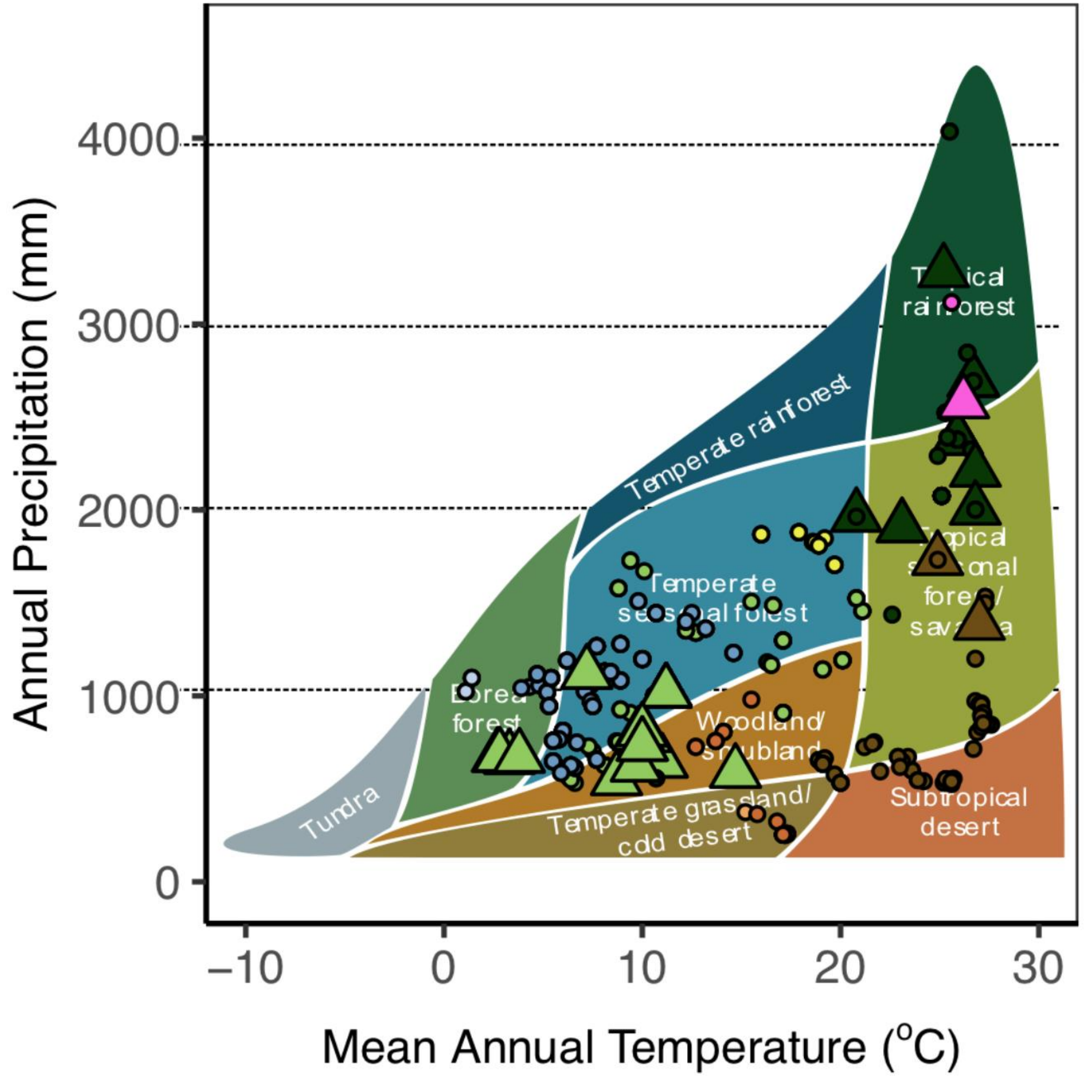
Develop a **global synthesis of tree-level** architectural **traits** from **Terrestrial Laser Scanning** as key **biodiversity indicators**.



Timeline

	2021	2022				2023				2024		
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Postdoc Hired and Starts Work												
Field Campaign in South Africa												
1. **Objective 1** - Develop a global synthesis of tree-level architectural traits from Terrestrial Laser Scanning as key biodiversity indicators.												
a. Task 1: Assemble global plot-level TLS and inventory metadata datasets.												
b. Task 2: Systematically process TLS plot data at focal sites												
c. Task 3: Derive tree-level architectural metrics and associated uncertainties for species-specific architecture												

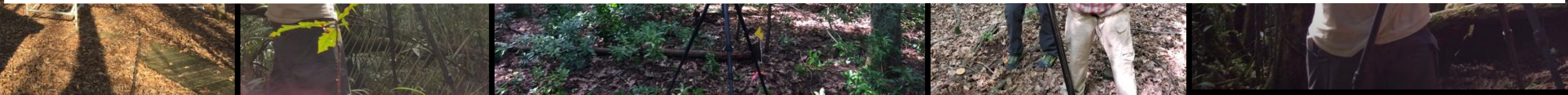




#plots	BIOME
149	Tropical & Subtropical Moist Broadleaf Forests
456	Temperate Broadleaf & Mixed Forests
207	Temperate Conifer Forests
3	Boreal Forests/Taiga
106	Tropical & Subtropical Grasslands, Savannas & Shrublands
28	Montane Grasslands & Shrublands
6	Tundra
32	Mediterranean Forests, Woodlands & Scrub
6	Deserts & Xeric Shrublands
7	Mangroves

Currently, over
1000 TLS plots
in our database

GTLS

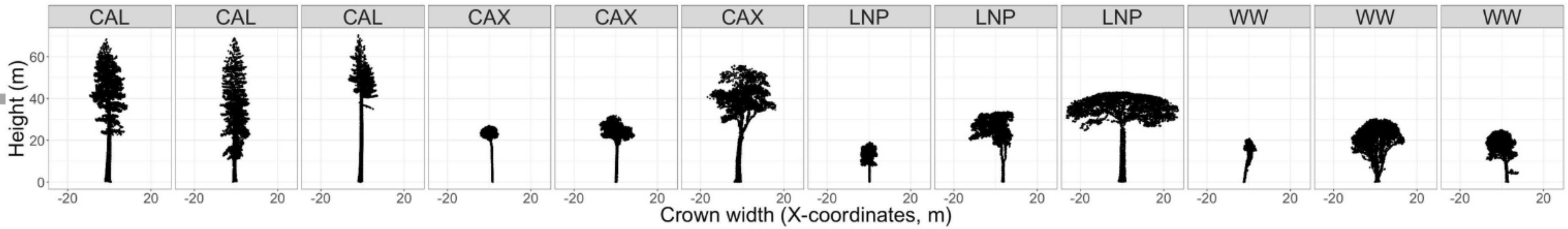


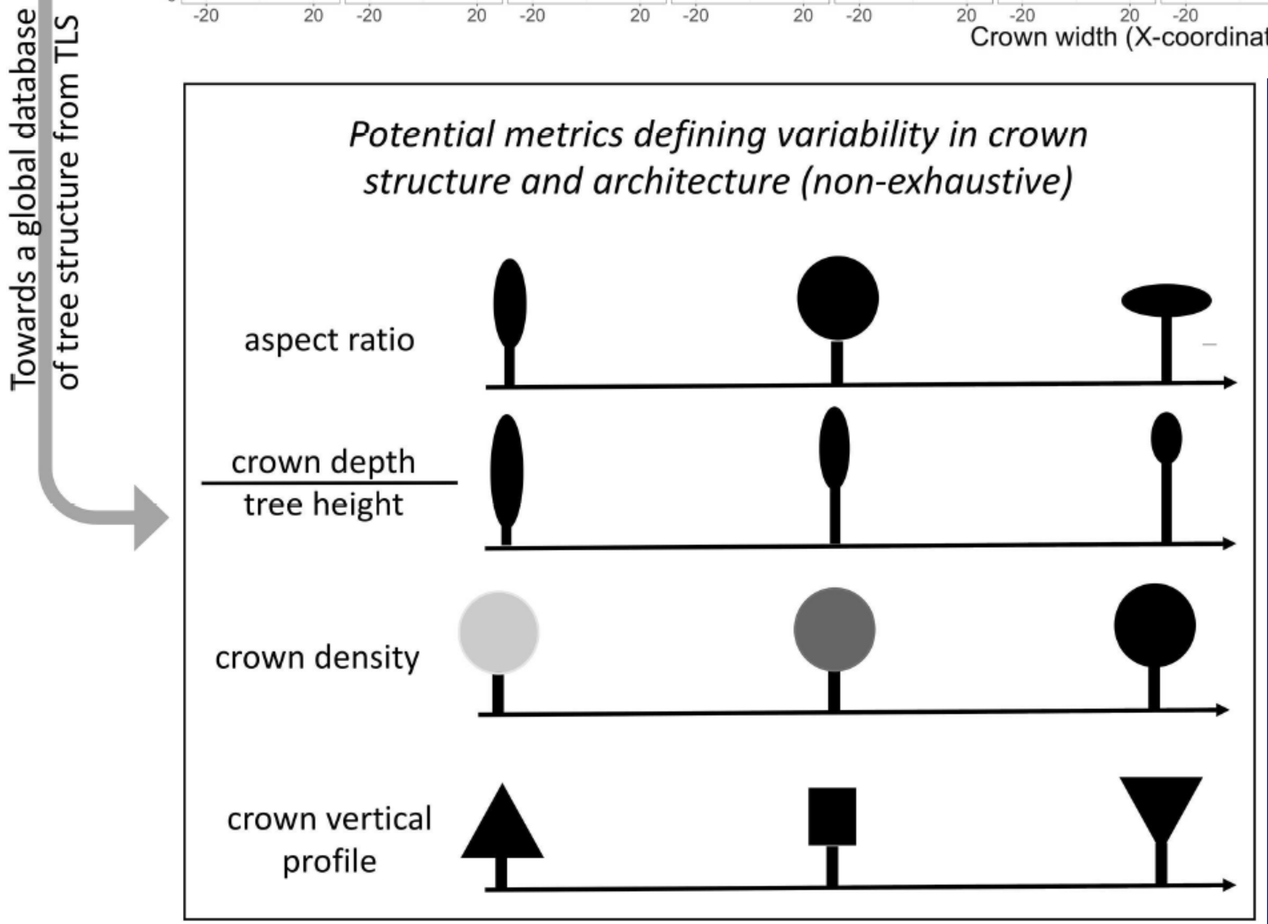
We have assembled a **global** dataset

Group	Name	Datetime	Instrument	Protocol	Area	QSM	Open
Ghent University	BE_HI_T1	2018-07-04T00:00:00	RIEGL VZ400	edge_core_transect_100m_5scans	0.00	No	contact:kim.calders@ugent.be;Pieter.DeFre
Ghent University	BE_HI_T2	2018-07-04T00:00:00	RIEGL VZ400	edge_core_transect_100m_5scans	0.00	No	contact:kim.calders@ugent.be;Pieter.DeFre
Ghent		2018-07-	RIEGL				

40 members and 27 institutions have joined the effort

Tree-level Structural Biodiversity Traits (SBTs)



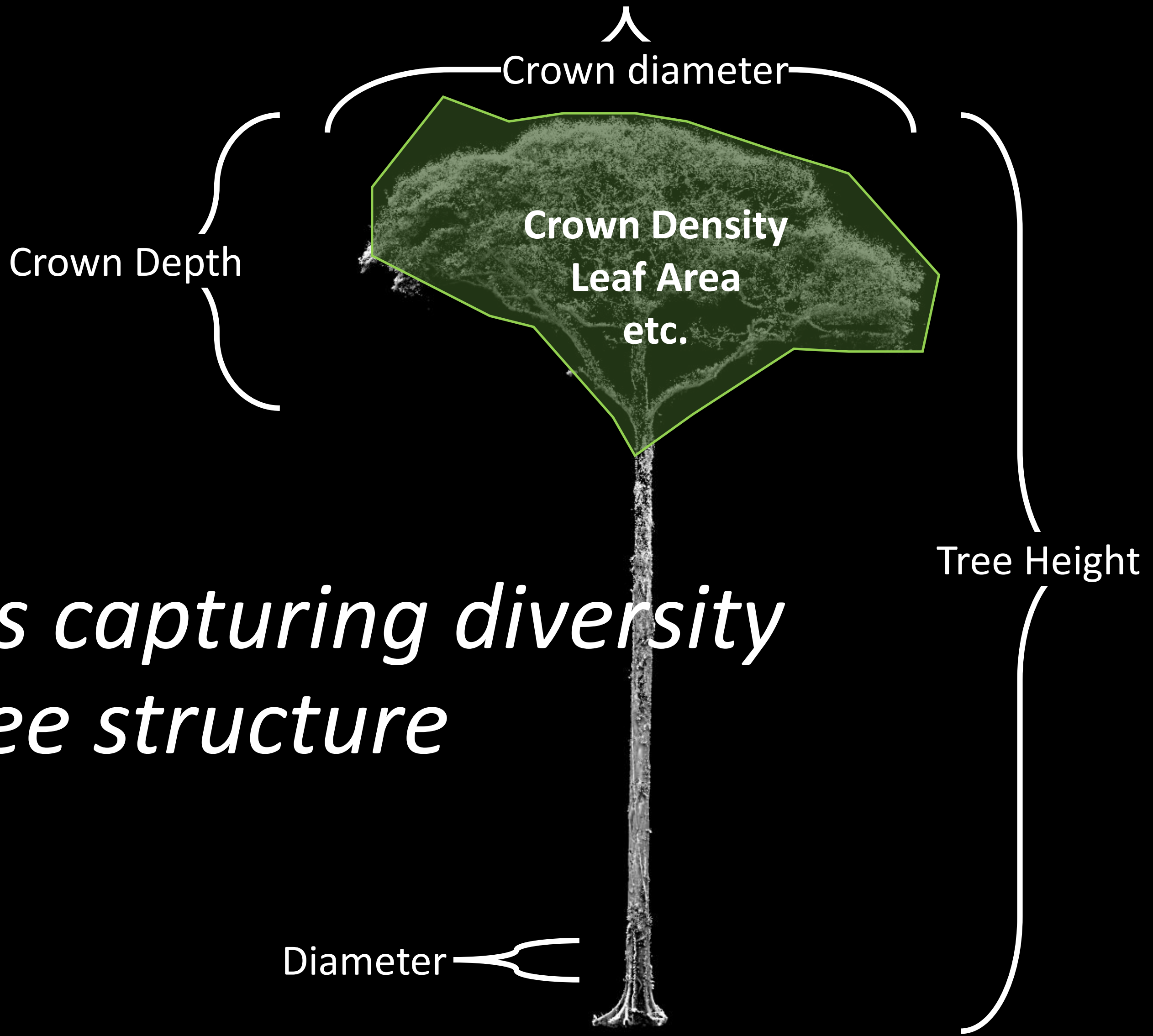


Welcome new PostDoc, Dr. Shokirov

Dr. Shokirov has direct experience processing large volumes of terrestrial laser scanning data and is prepared to systematically process available TLS data in the global database to derive structural biodiversity traits. He began work at the University of Maryland in August 2022.

Tree-level Structural Biodiversity Traits (SBTs)

SBTs
Top-heaviness
Aspect ratio
Relative Crown Width
Crown Area
Leaf Area
Crown Density
Mass Taper Exponent
Path Fraction
Crown Asymmetry
Branching Angle



Traits capturing diversity of tree structure

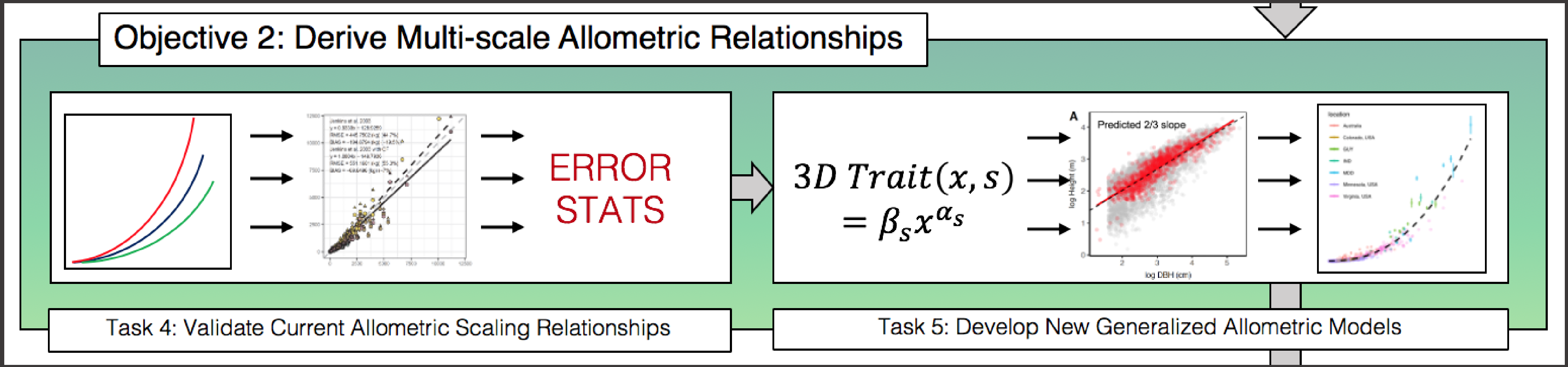
We are developing a standardized processing framework for all Co-Is, Collaborators, and GTLS members to apply

Coincident and synergistic with BioSCape

Now, we are planning a field campaign to fill gaps

Group	Name	Datetime	Instrument	Protocol	Area	QSM	Open
Ghent University	BE_HI_T1	2018-07-04T00:00:00	RIEGL VZ400	edge_core_transect_100m_5scans	0.00	No	contact:kim.calders@ugent.be;Pieter.
Ghent University	BE_HI_T2	2018-07-04T00:00:00	RIEGL VZ400	edge_core_transect_100m_5scans	0.00	No	contact:kim.calders@ugent.be;Pieter.
Ghent University	BE_HI_T3	2018-07-04T00:00:00	RIEGL VZ400	edge_core_transect_100m_5scans	0.00	No	contact:kim.calders@ugent.be;Pieter.
Ghent	[illegible]	2018-07-	RIEGL	[illegible]	[illegible]	[illegible]	[illegible]

Validate and derive structural and functional scaling **relationships** from the **TLS trait database at the species, site, forest type, ecoregion, and global scale**.



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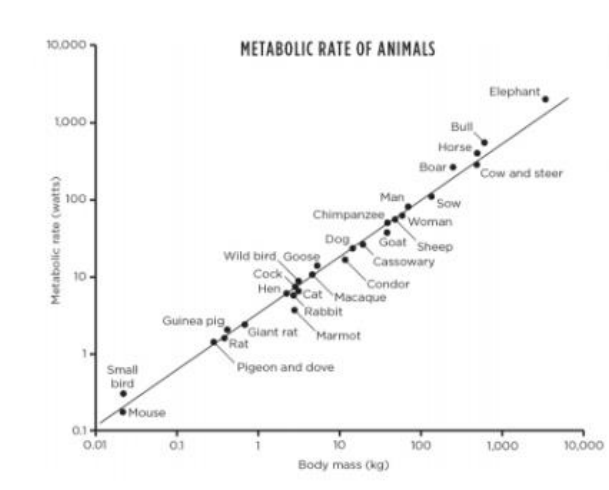
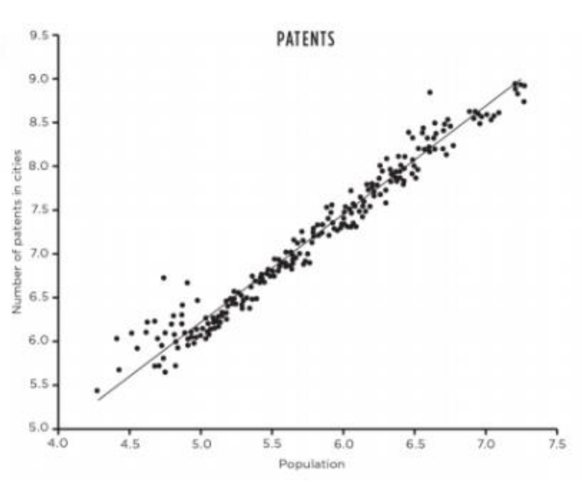
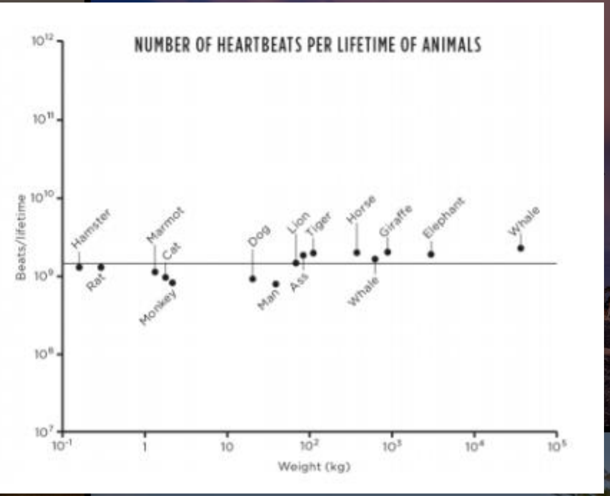
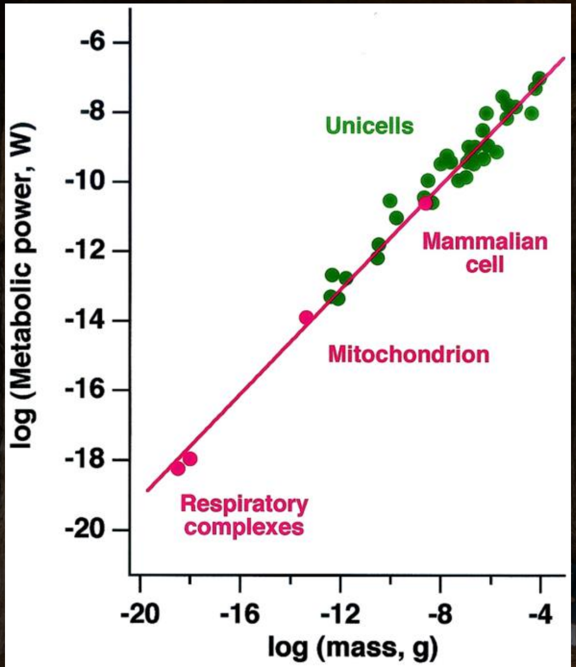
Postdoc Hired and Starts Work												
Field Campaign in South Africa												
2. **Objective 2** - Validate and derive structural and functional scaling relationships from the TLS trait database at the species, site, forest type, ecoregion, and global scale.												
a. Task 4: Validate and quantify errors in allometric scaling relationships												
b. Task 5: Develop new allometric models at local to global scale.												

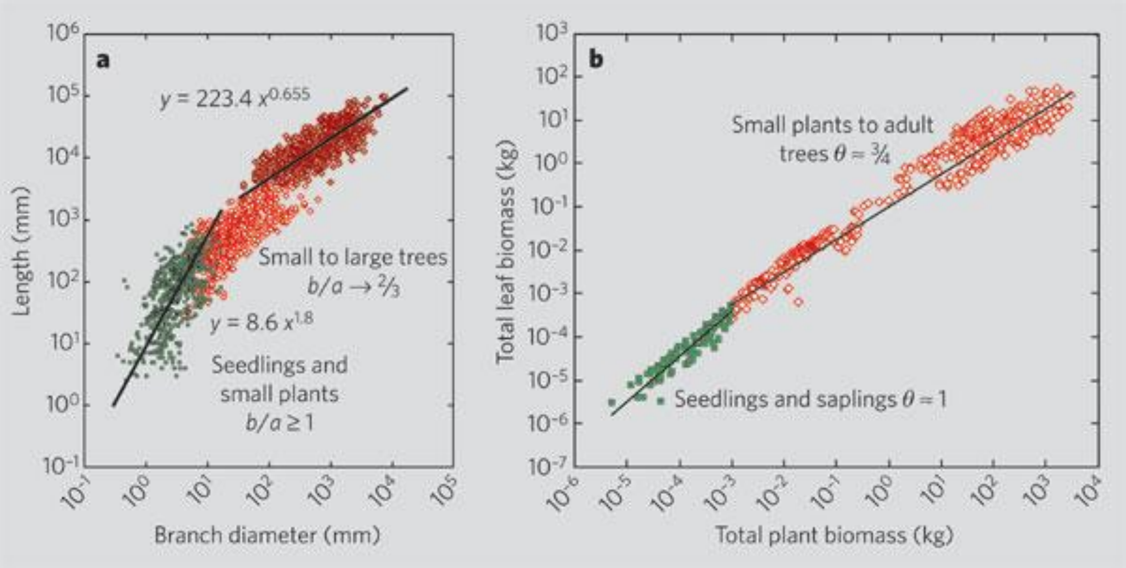
How can this trait data inform allometric scaling theory?



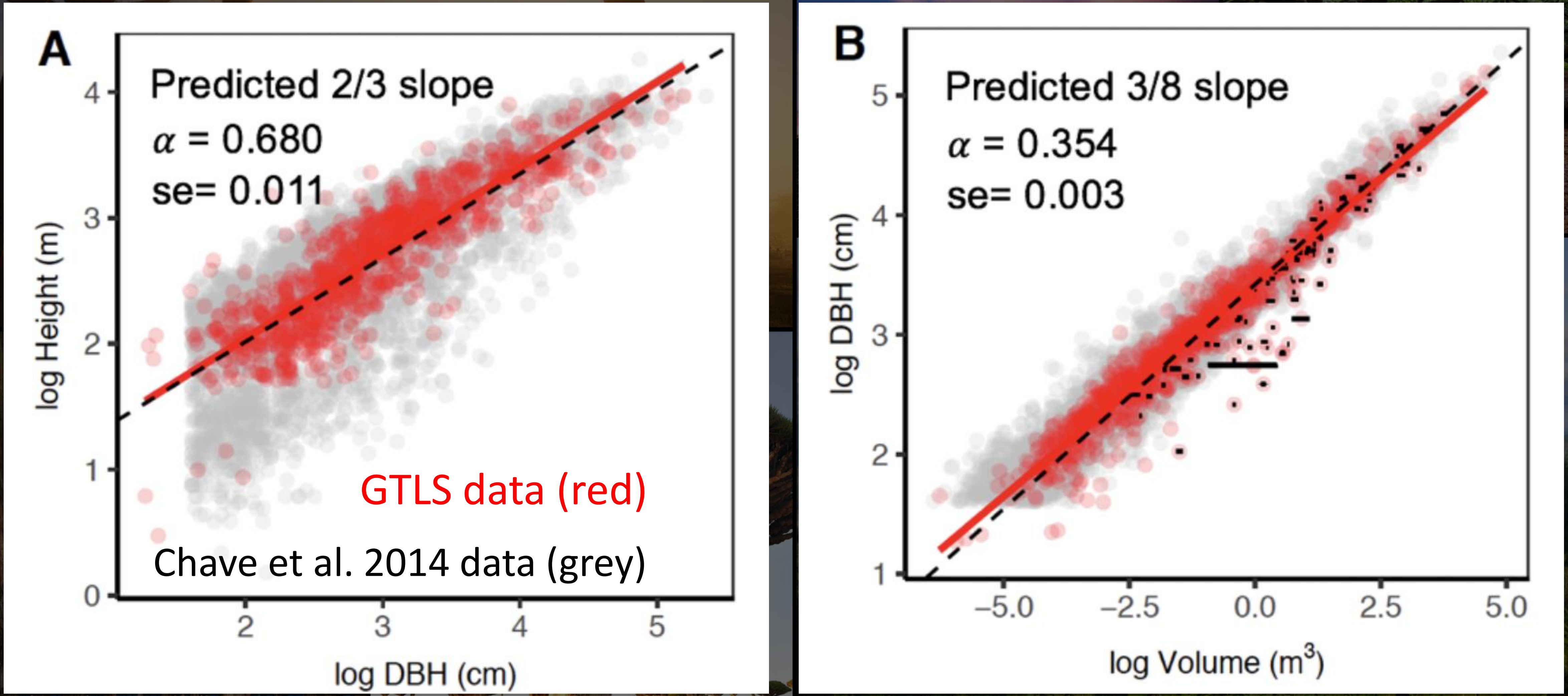








We are beginning to validate local and national-scale allometry at study sites in the GTLS database.



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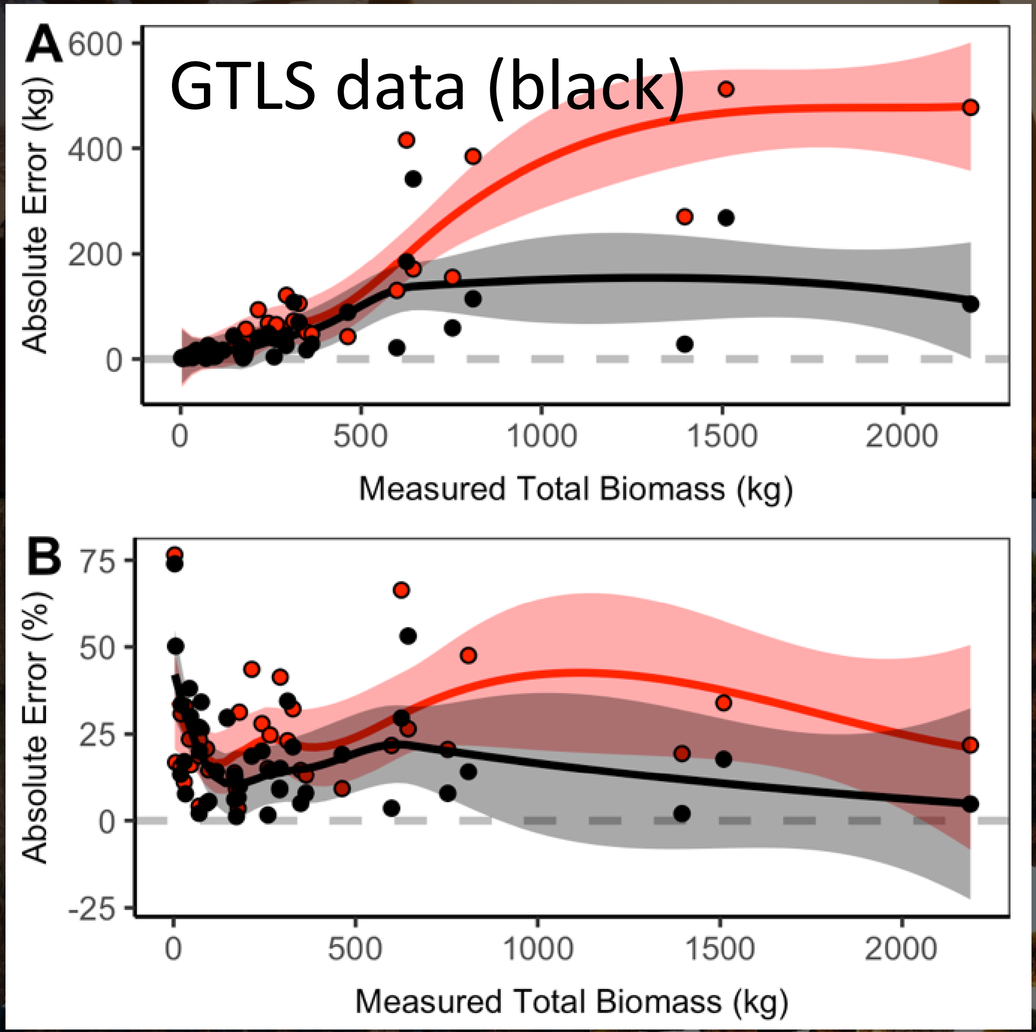
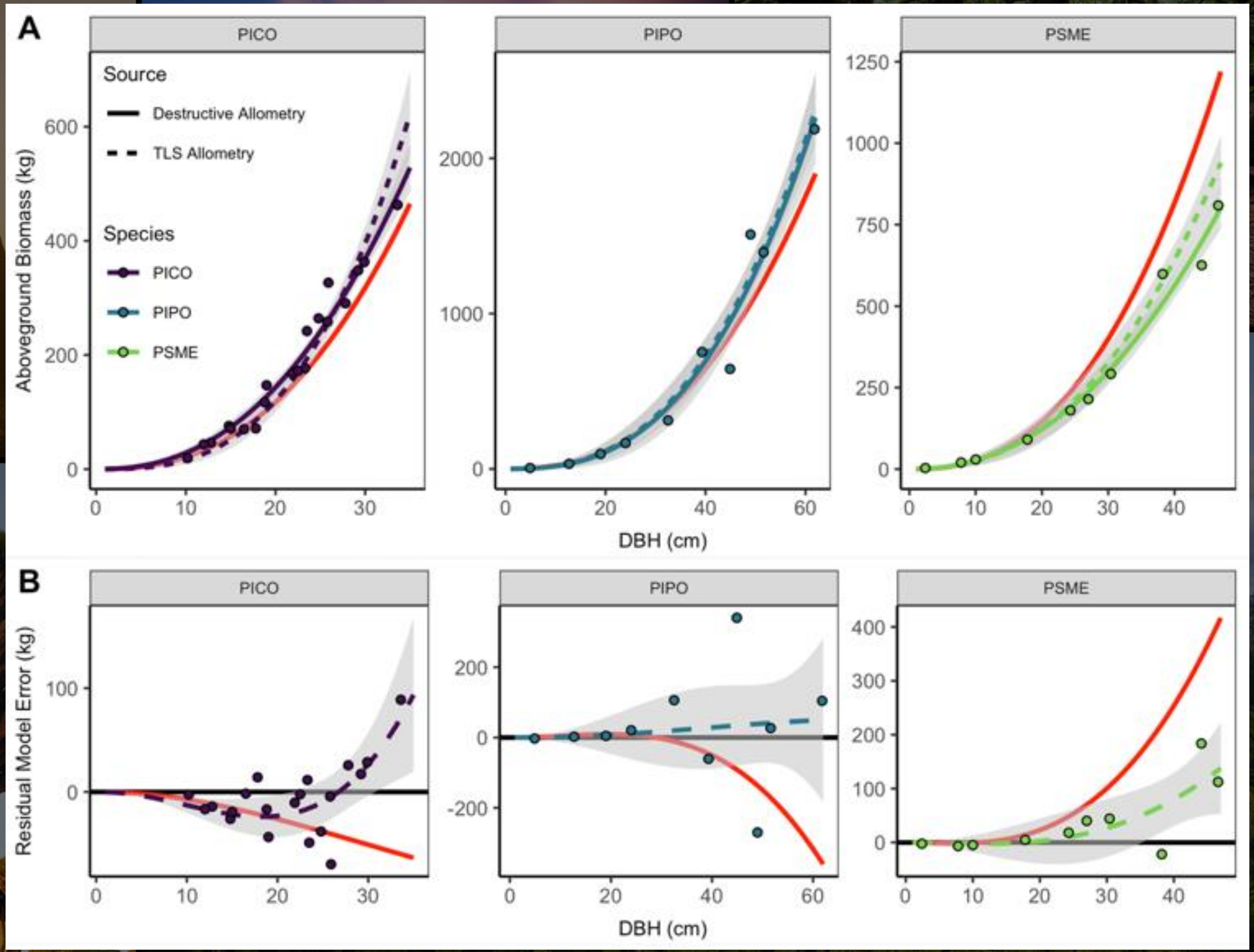
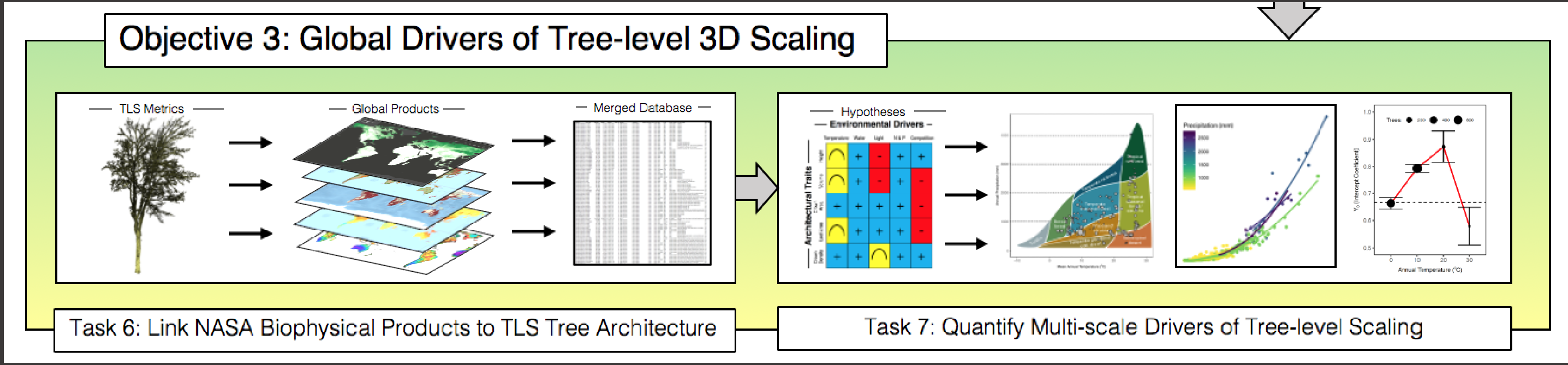




Chojnacky et al. 2014 (red)

Stovall et al. (minor revisions!) at *Methods in Ecology and Evolution*

Disentangle the **dominant drivers** of **tree-level 3D ecosystem structure** with **multi-scale NASA remote sensing** products.



Timeline

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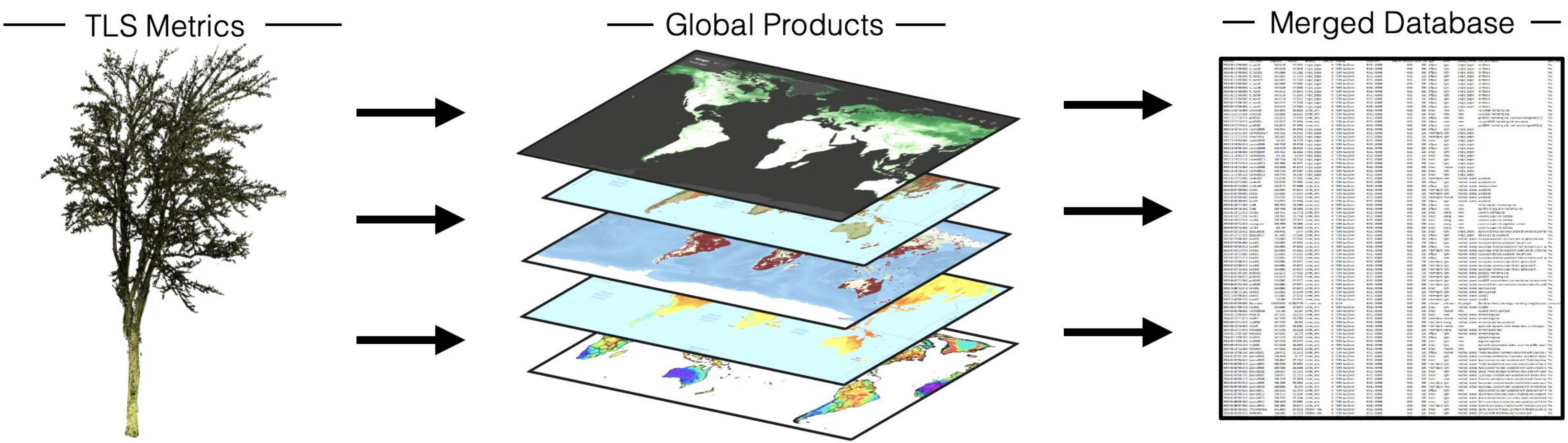
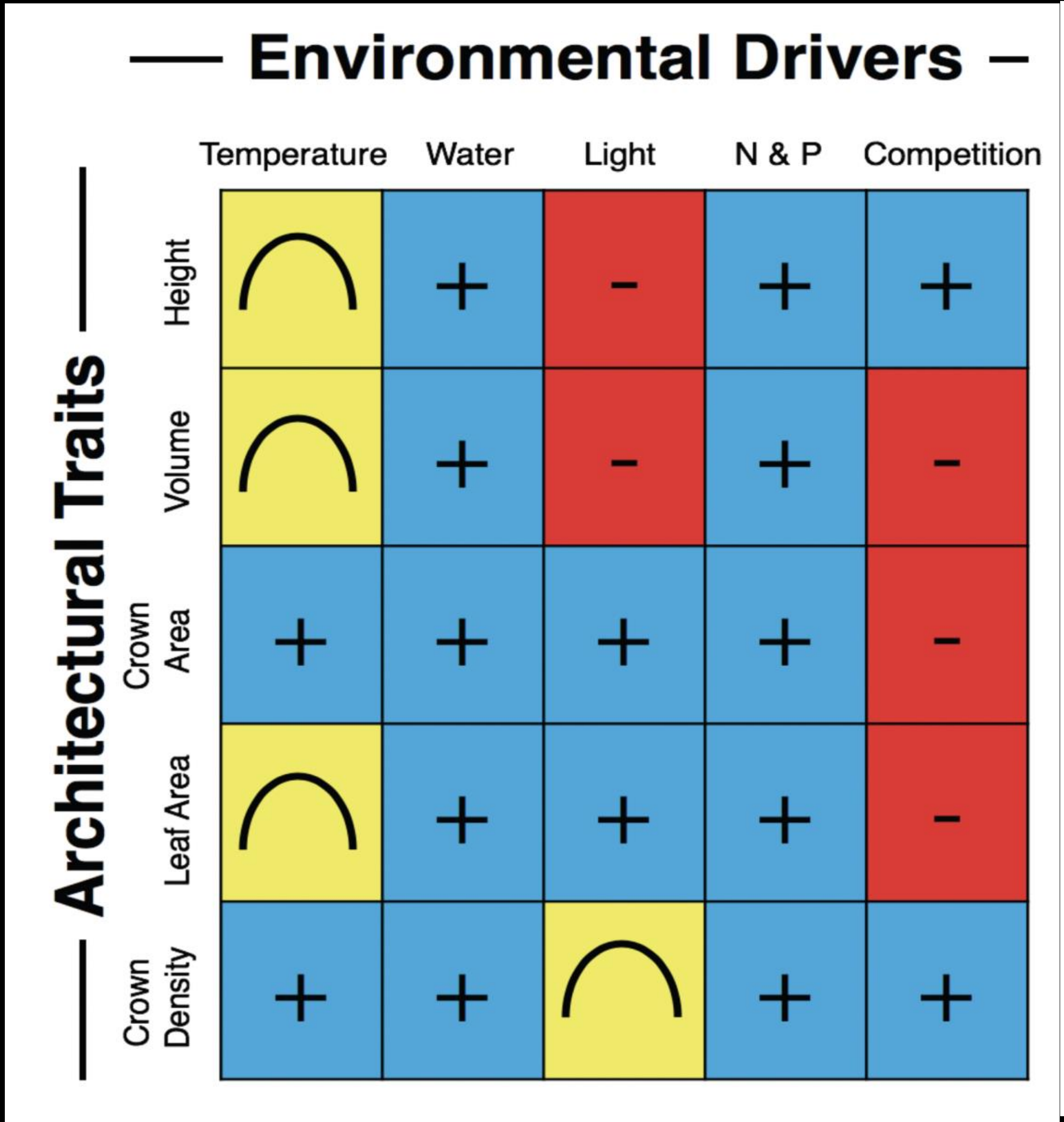
Postdoc Hired and Starts Work												
Field Campaign in South Africa												
3. **Objective 3** - Disentangle the dominant controls of tree-level 3D ecosystem structure with multi-scale NASA remote sensing products.												
a. Task 6: Link global NASA datasets of key biophysical variables to TLS plot data.												
b. Task 7: Quantify multi-scale biophysical drivers of tree-level scaling relationships												

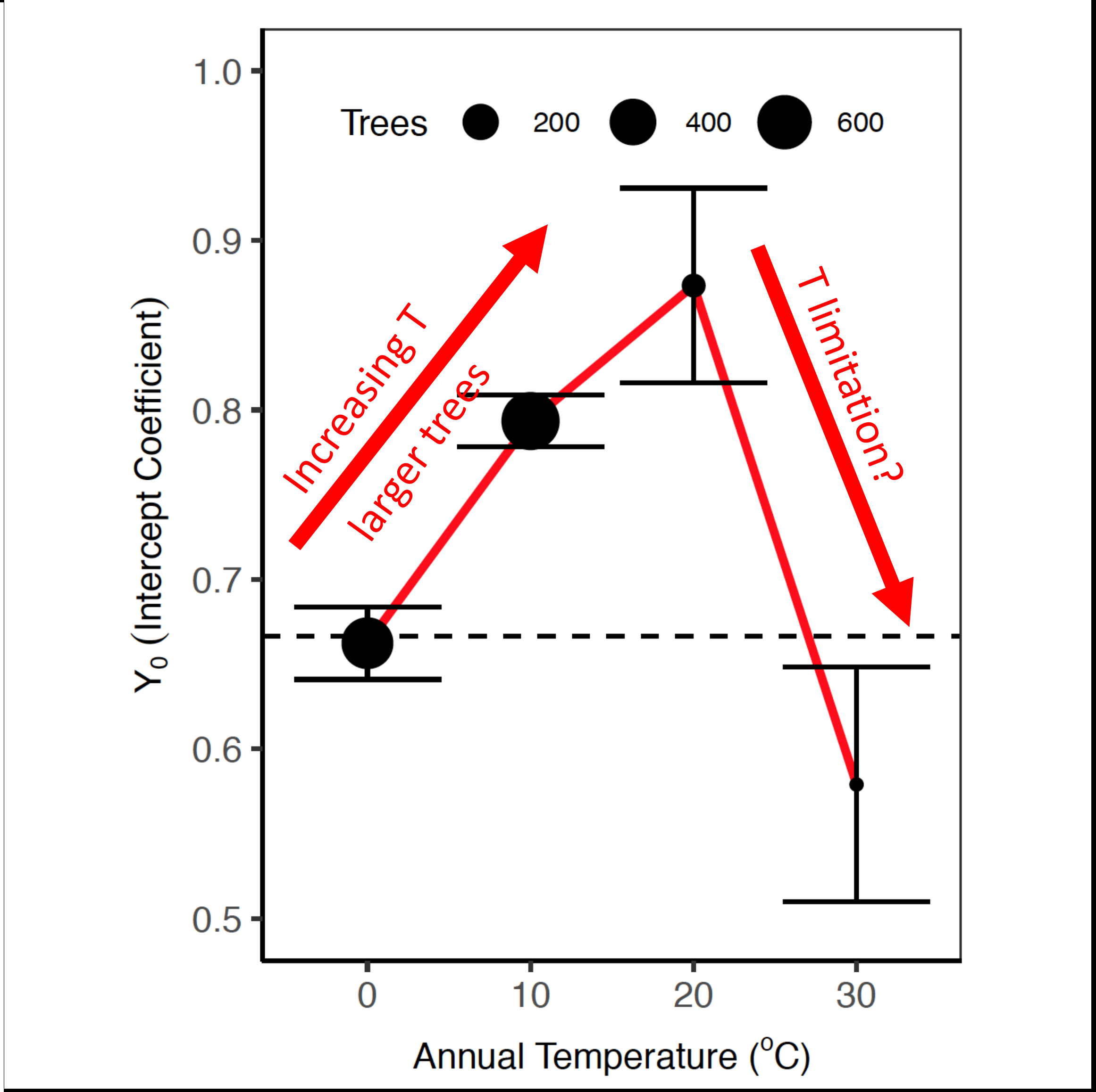


[i] temperature, [ii] water, [iii] light, [iv] nutrients, and [v] competition

- NASA Global Modeling and Assimilation Office (GMAO) MERRA-2 Reanalysis Products
- Reprocessed GLDAS-2.0: Global Land Data Assimilation System
- NASA Digital Elevation Model
- MODIS APAR
- SRTM Continuous Heat-Insolation Load Index
- NASA-USDA Global soil moisture and the NASA-USDA SMAP Global soil moisture datasets.
- (TDX data augmentation funds now add TDX coherence data to this)

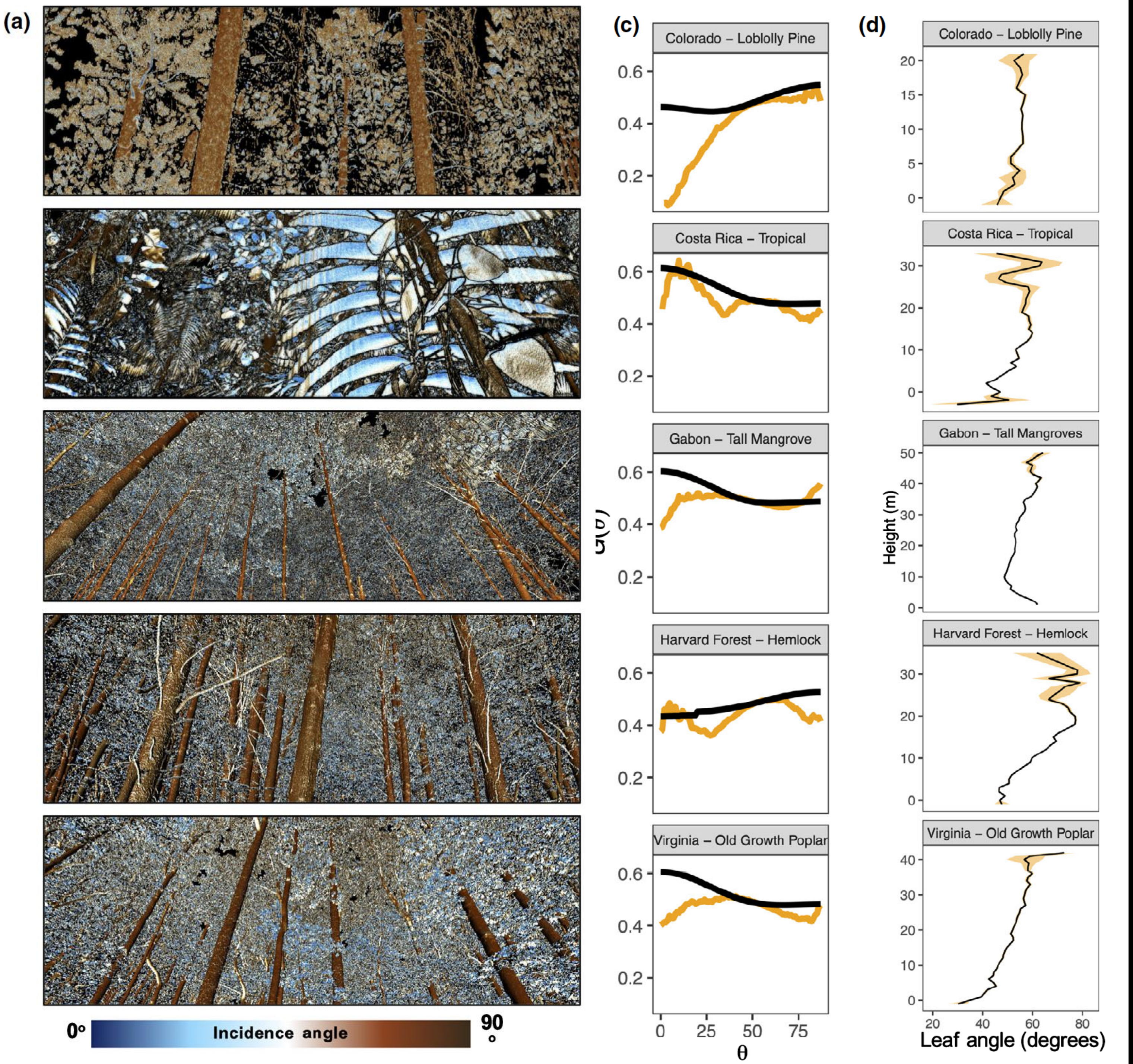
We have a suite of hypotheses that we will test.



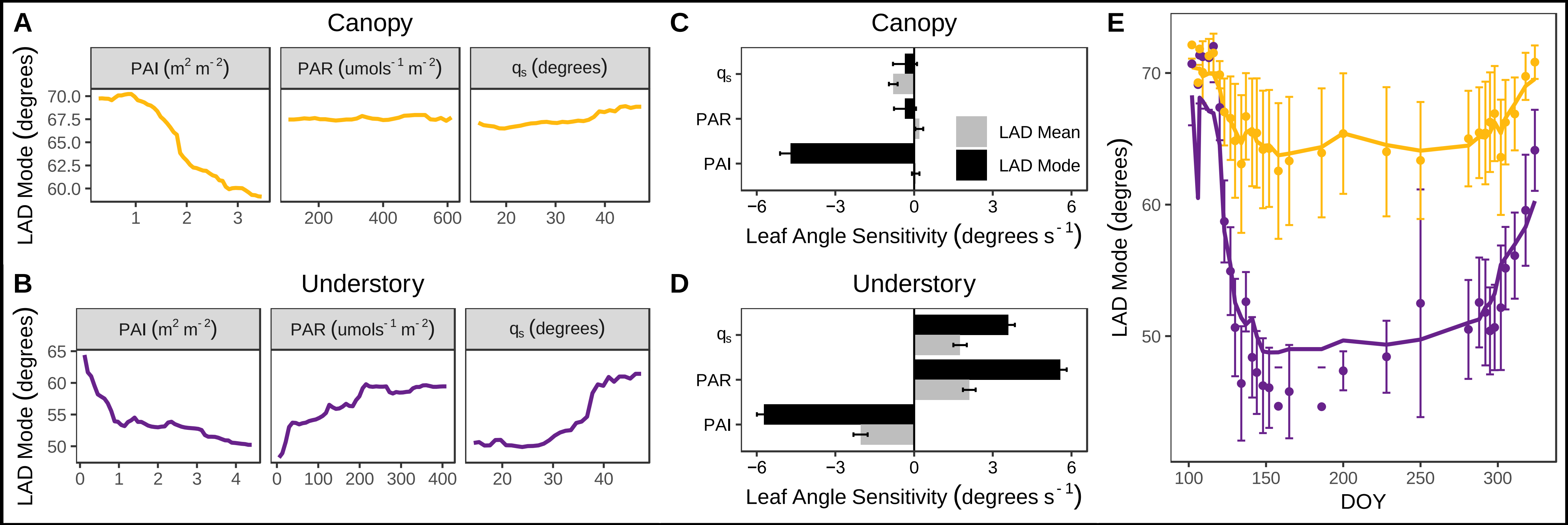


What environmental factors control leaf angle?

TLS LeAF

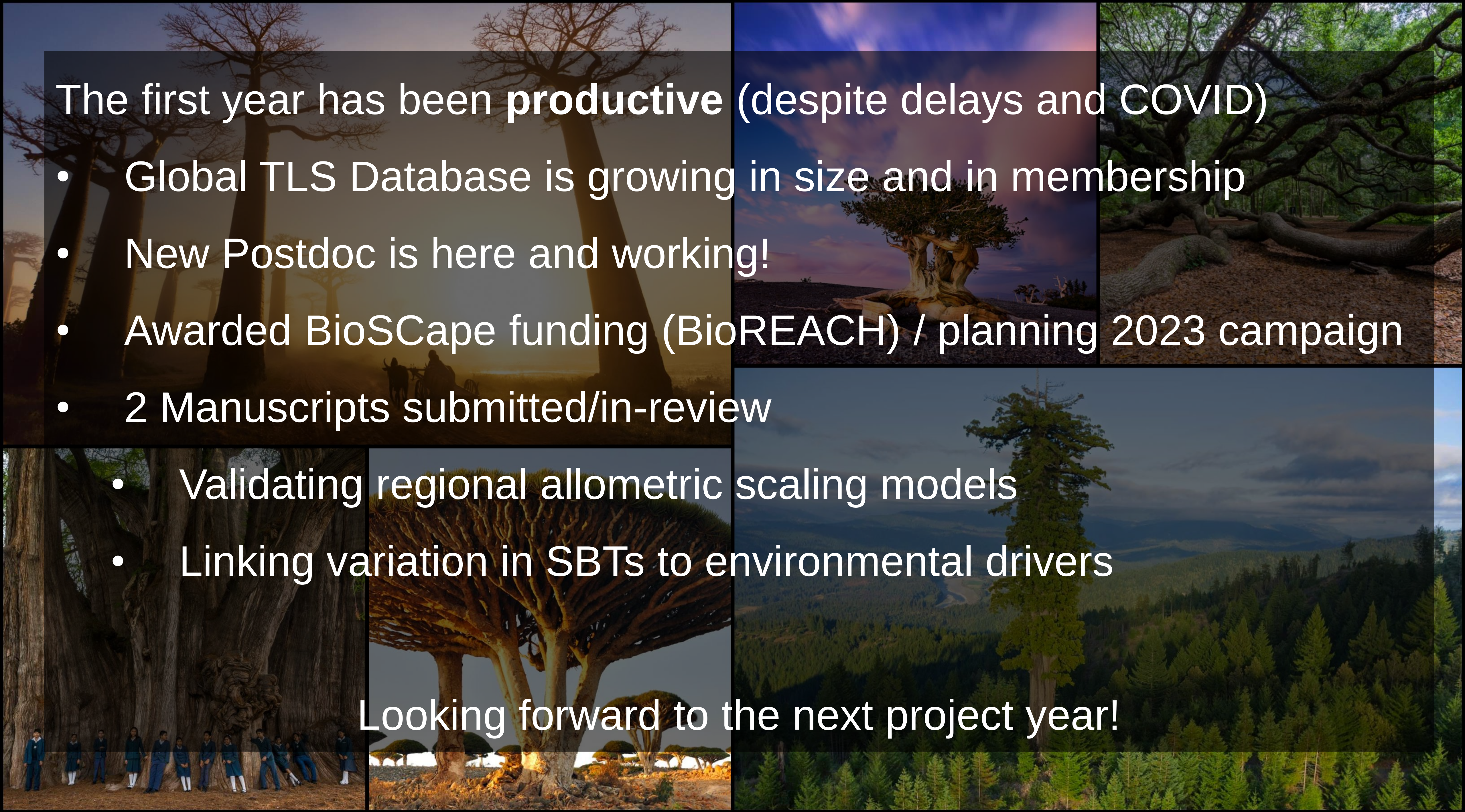


Leaf Angle is Adapting to the Environment



Sensitivity of [A] canopy and [B] understory leaf angle mode (the most commonly observed leaf angle) to seasonal shifts in plant area index (PAI), photosynthetically active radiation (PAR), and solar inclination angle (θ_s).

Stovall et al. Submitted to *PNAS*



The first year has been **productive** (despite delays and COVID)

- Global TLS Database is growing in size and in membership
- New Postdoc is here and working!
- Awarded BioSCape funding (BioREACH) / planning 2023 campaign
- 2 Manuscripts submitted/in-review
    - Validating regional allometric scaling models
    - Linking variation in SBTs to environmental drivers

Looking forward to the next project year!

Thanks to all current contributors:

NASA GSFC
Terrestrial Ecosystem Research Network
University College London
University of Virginia
University of Nevada Reno
Wageningen University

We look forward to more!

For more information, contact:
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Sign up!

GTLS Map