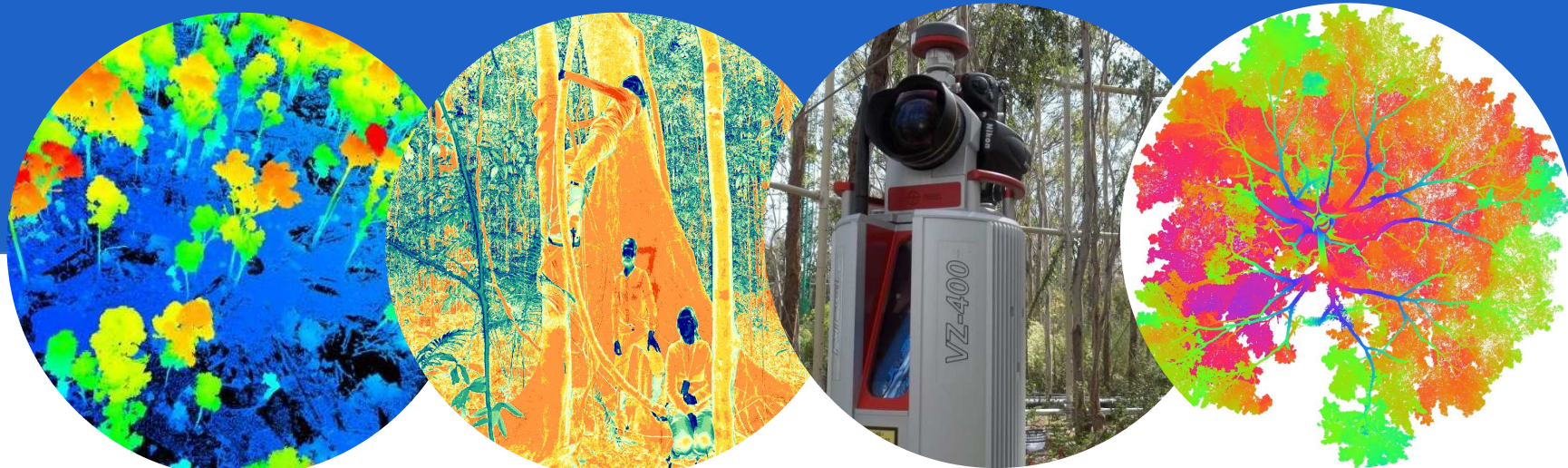


Time for a plant structural economics spectrum?

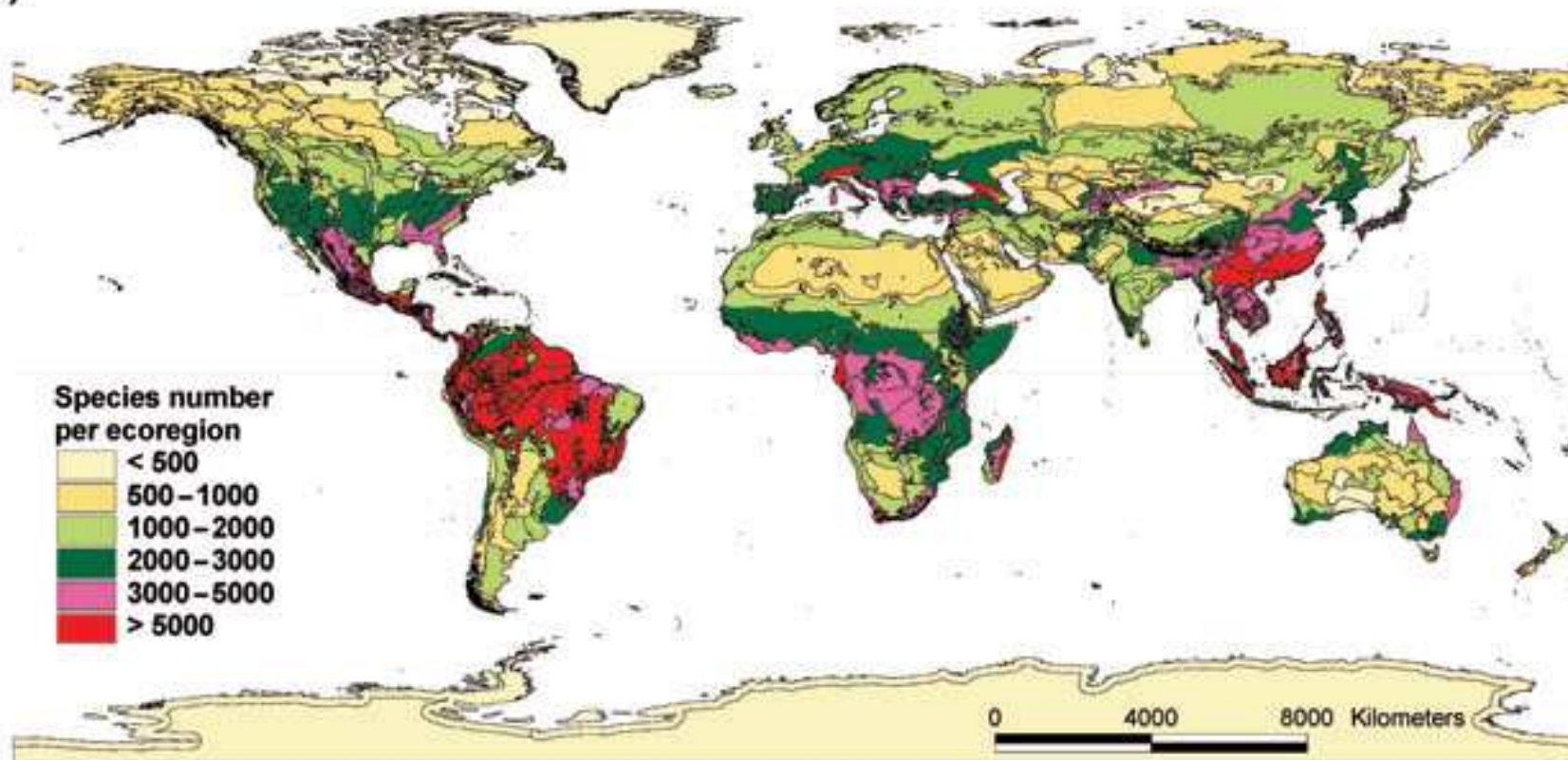
Hans Verbeeck

Marijn Bauters, Tobias Jackson, Alexander Schenkin, Mathias Disney and Kim Calders

EGU 2020



(a)



Vascular plant species richness -- Kier et al. 2005 *Journal of Biogeography*

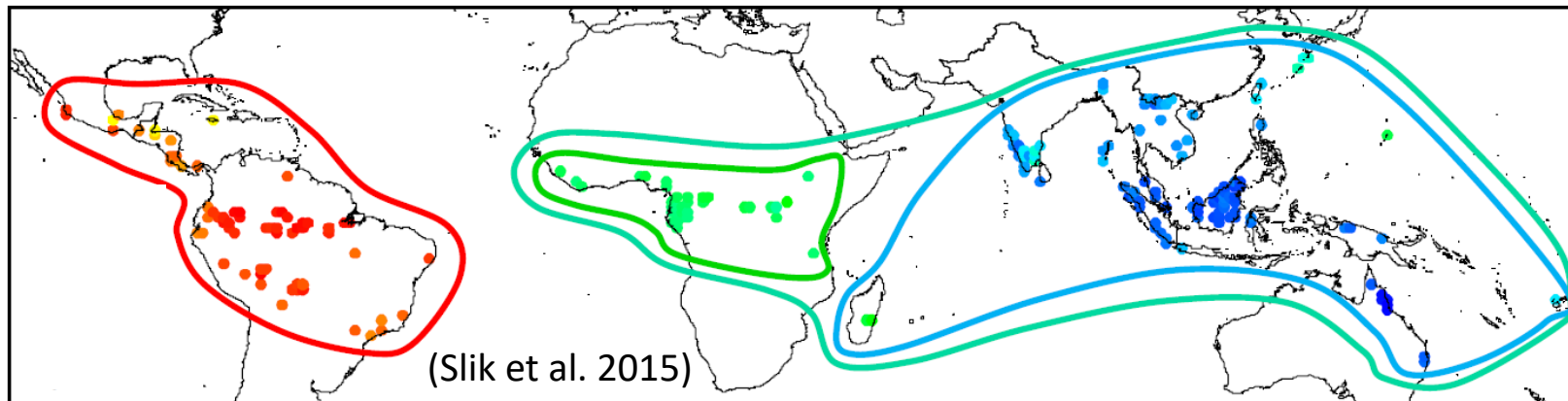
Tree species diversity in tropical forests

40,000 – 53,000 pantropical

Neotropics
21,500

Africa
5,300

Asia
22,000



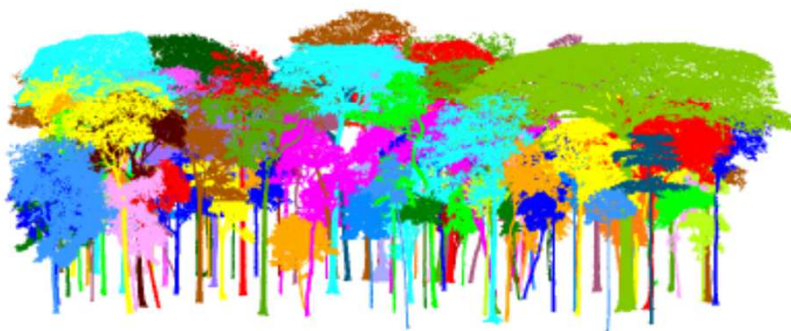
Large structural diversity



(a) CAX



(b) ANK

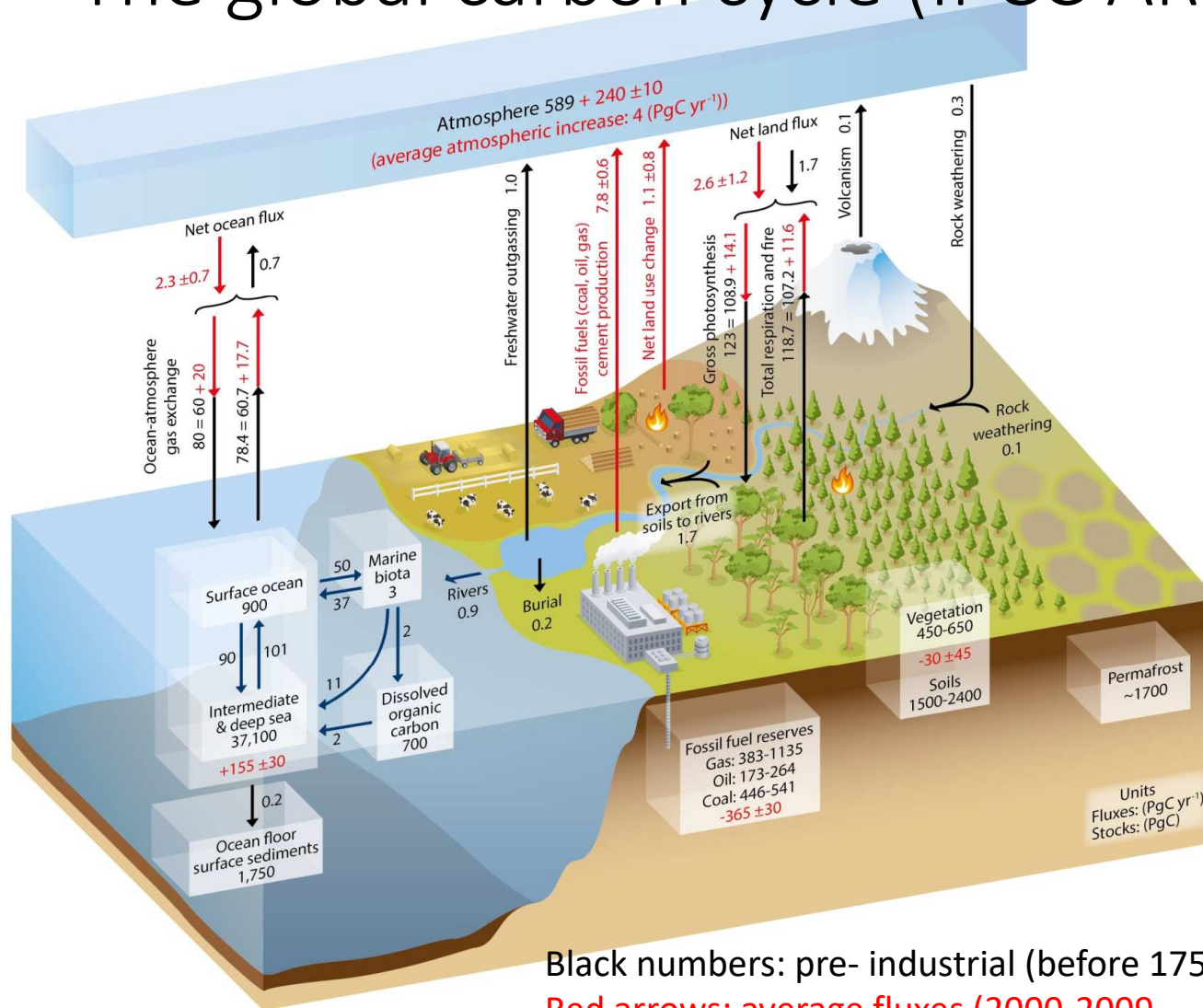


(c) LPG



(d) NOU

The global carbon cycle (IPCC AR5 2014)

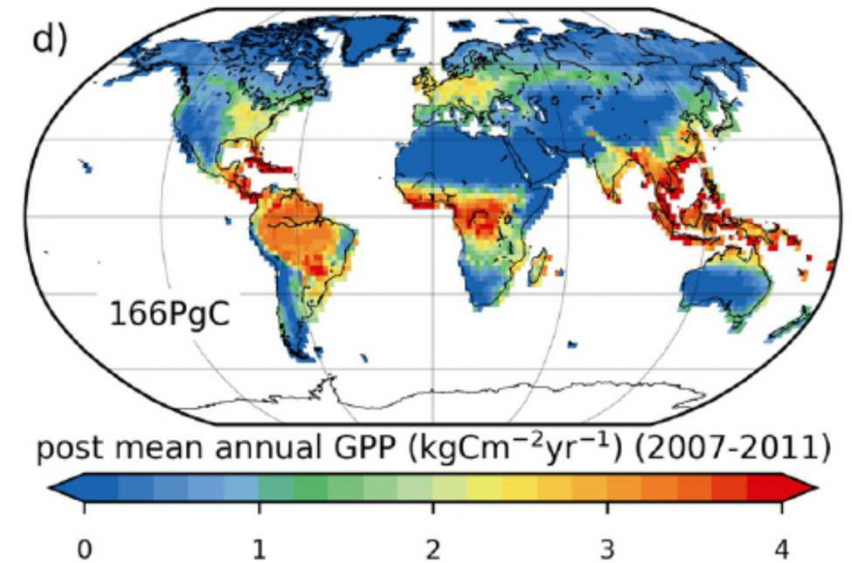
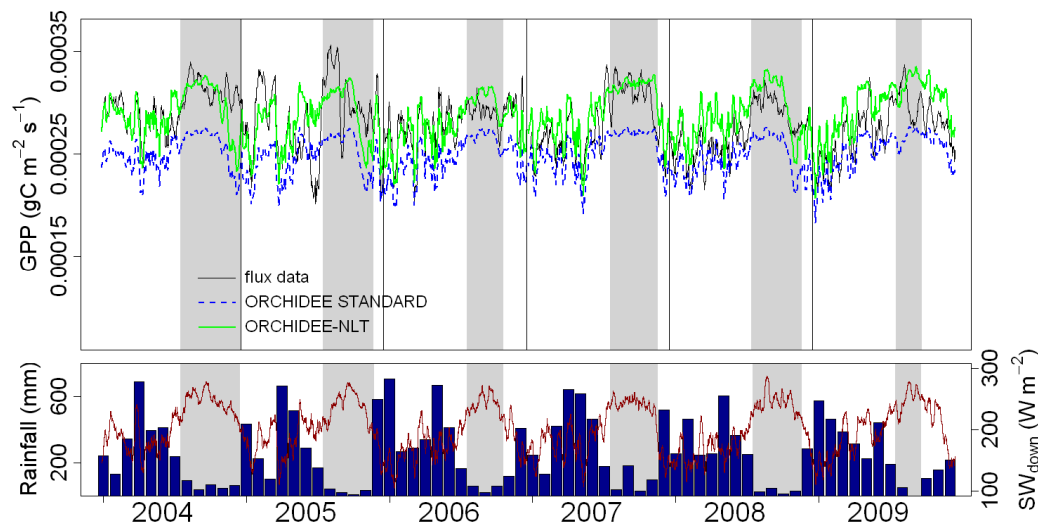


Black numbers: pre- industrial (before 1750) stocks and fluxes

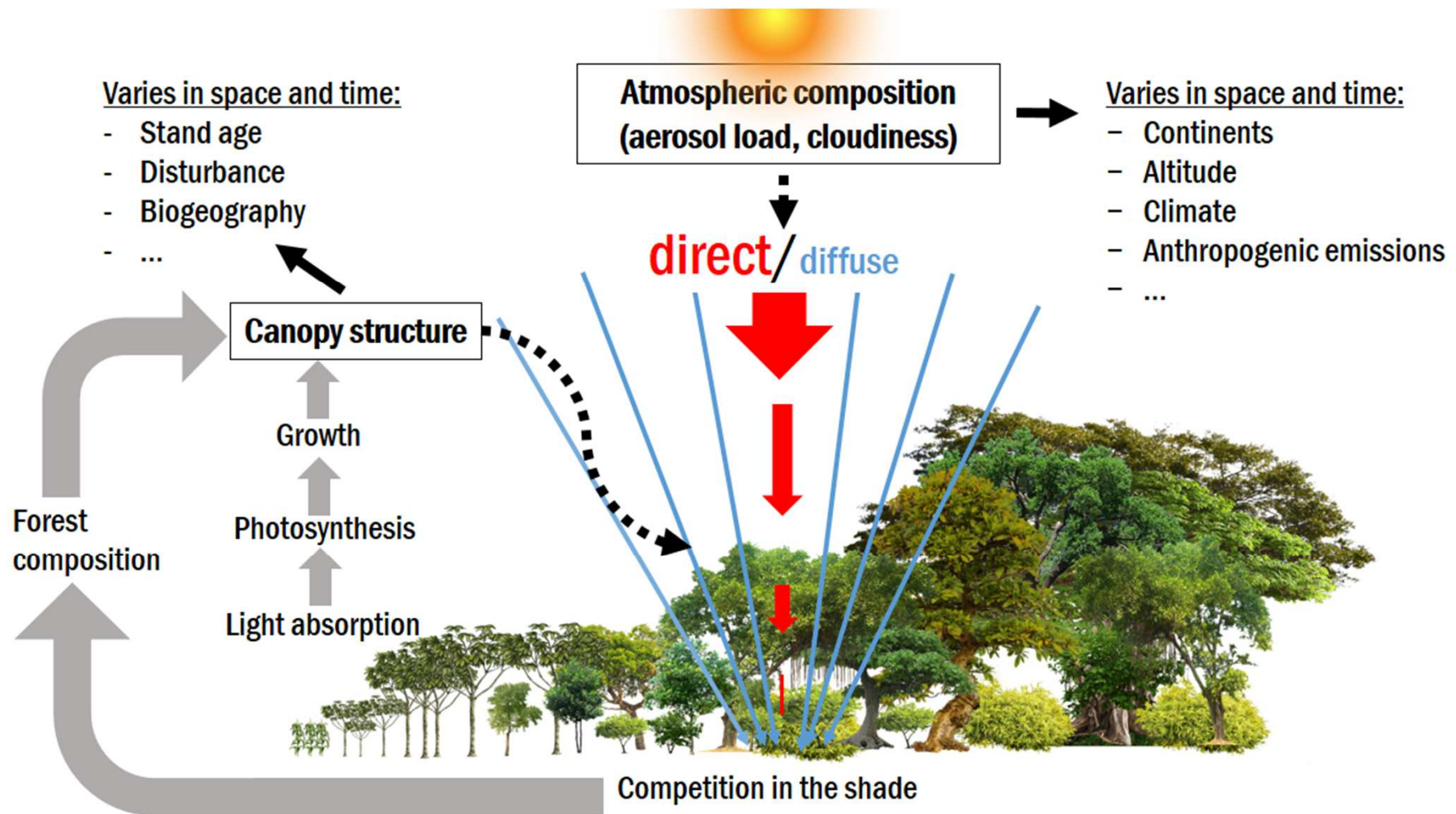
Red arrows: average fluxes (2000-2009-

Red stocks: changes (1750 ->2011)

Simulating the vegetation carbon cycle from site to global scale



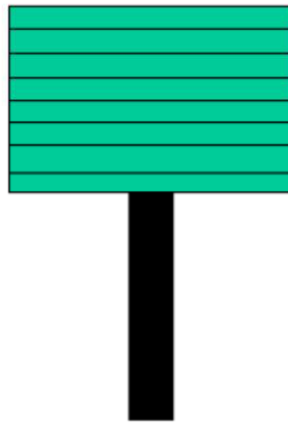
Radiation forest structure feedbacks



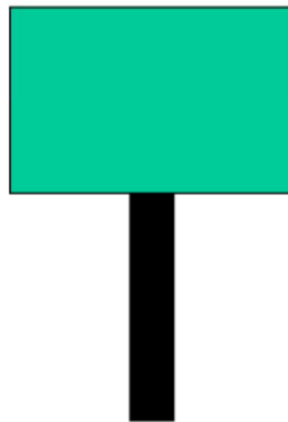
Poor representation of forest structure and radiative transfer in vegetation models

Big leaf models

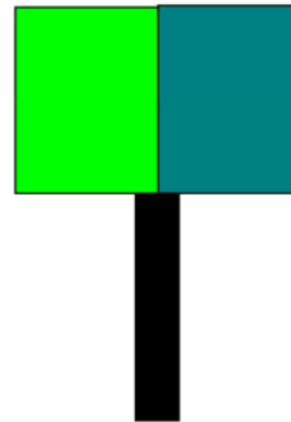
multilayer



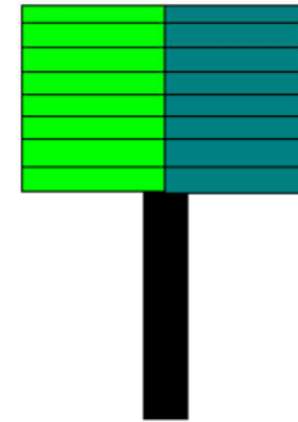
Big-leaf



Sun/shade

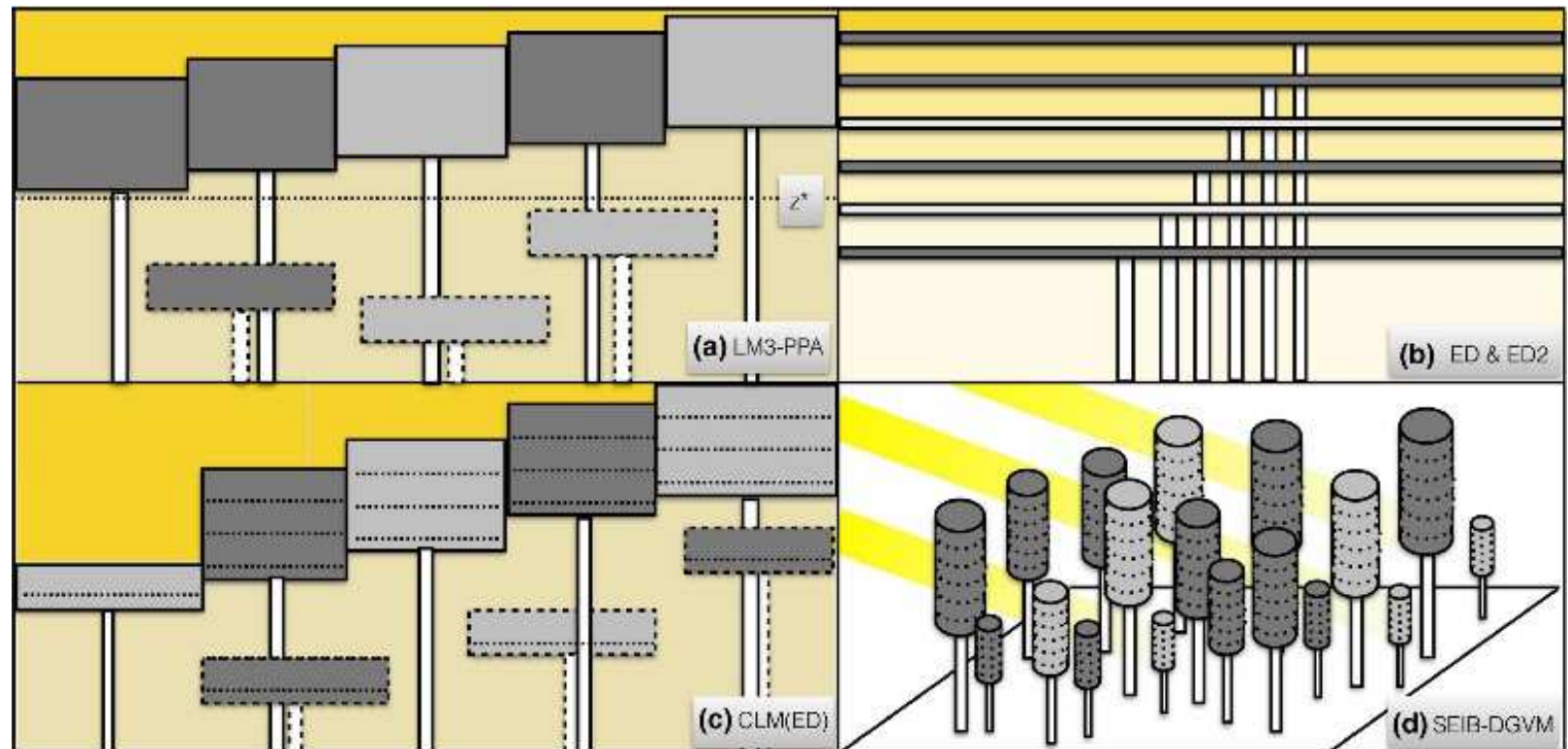


Multilayer
&
Sun/shade

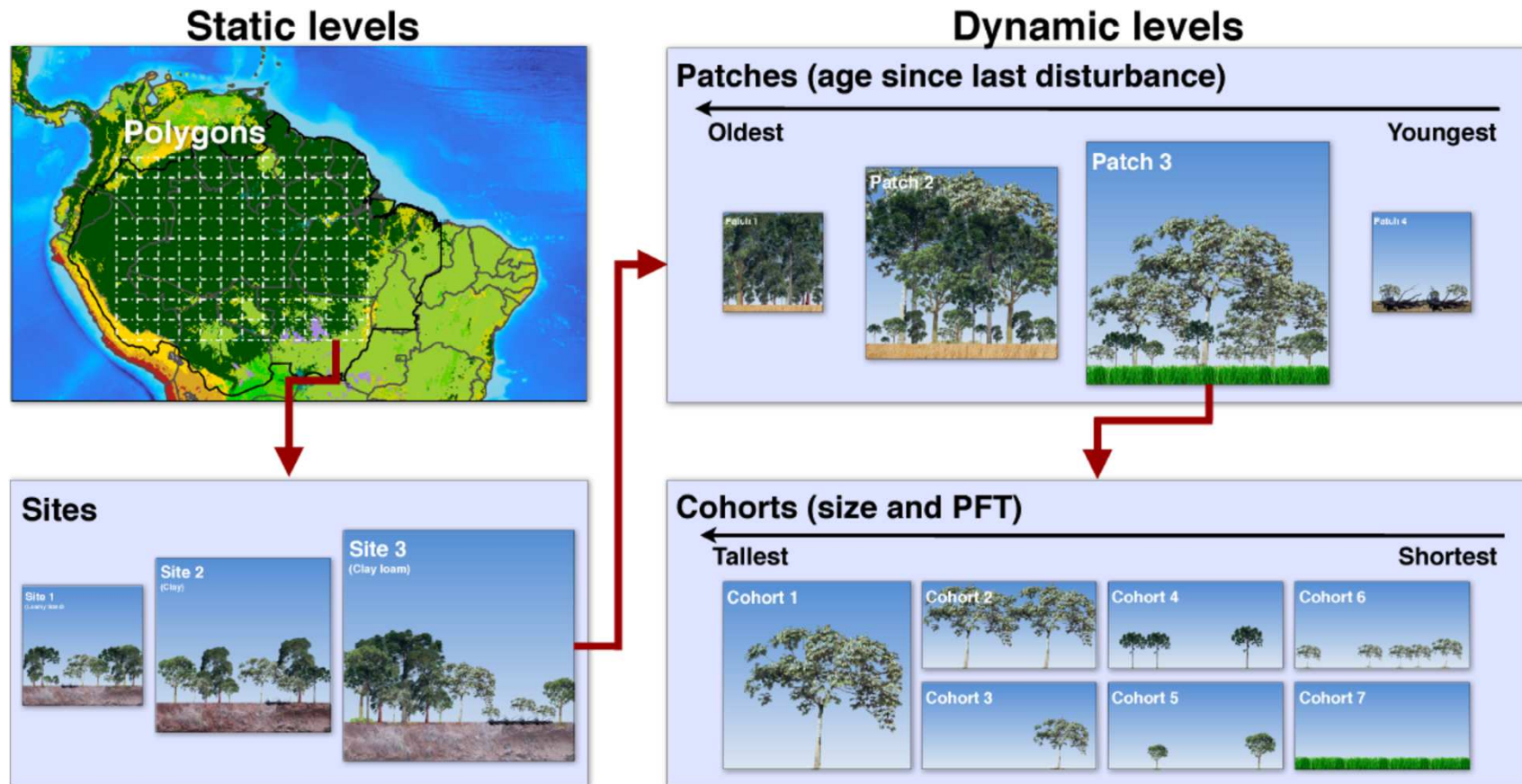


Poor representation of forest structure and radiative transfer in vegetation models

Demographic models



The ED2 model



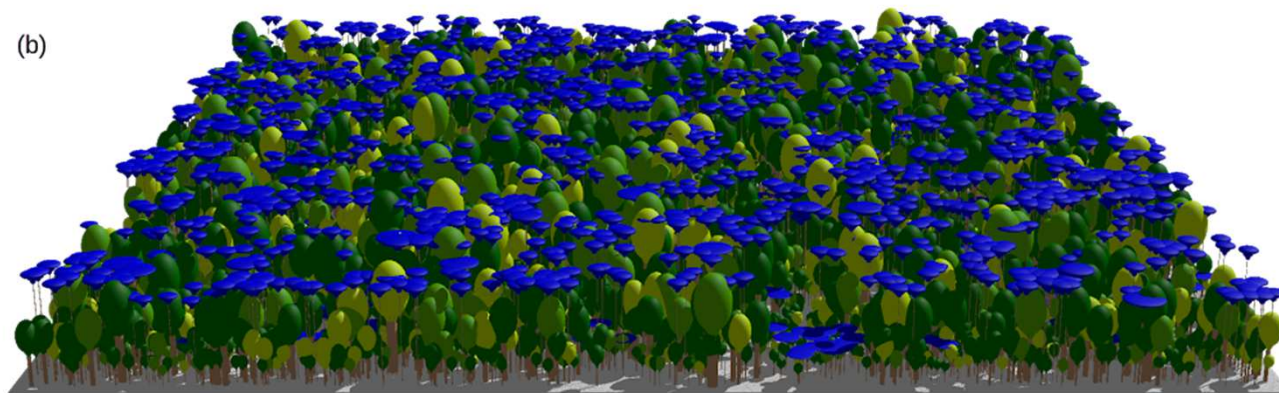
Taxonomic framework



Functional framework



(b)



Functional traits

PhotosyntheticPathway

Respiration LeafAreaNfixationCapacity

PlantLifespan

SLA

RegenerationCapacity

WoodDensity

GrowthForm

PhenologyType LeafN

LeafP LeafLongevity PhotosyntheticCapacity

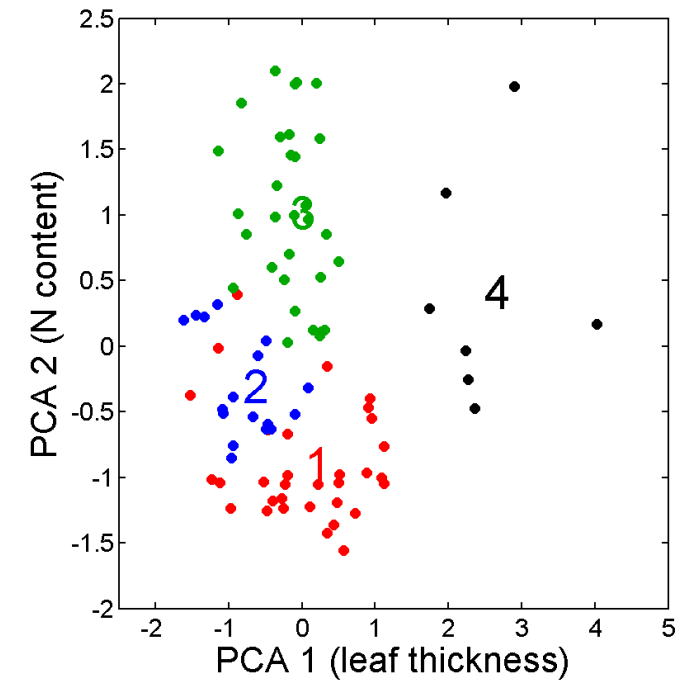
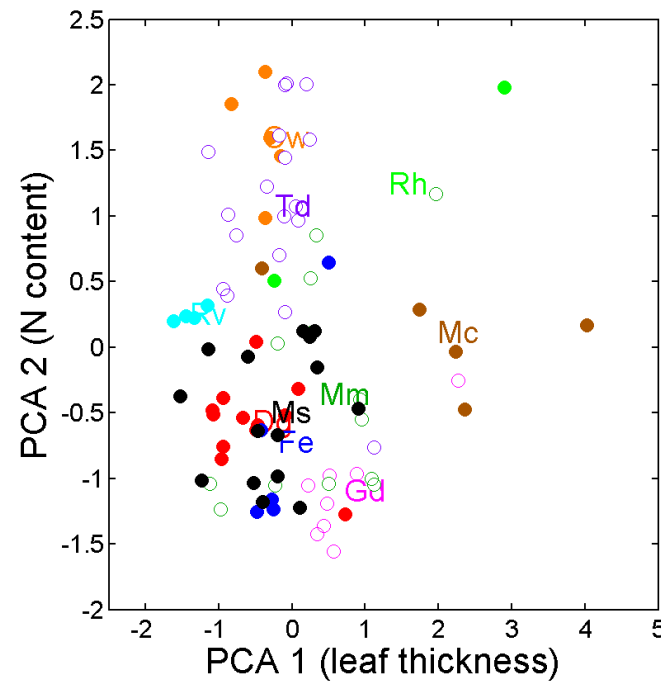
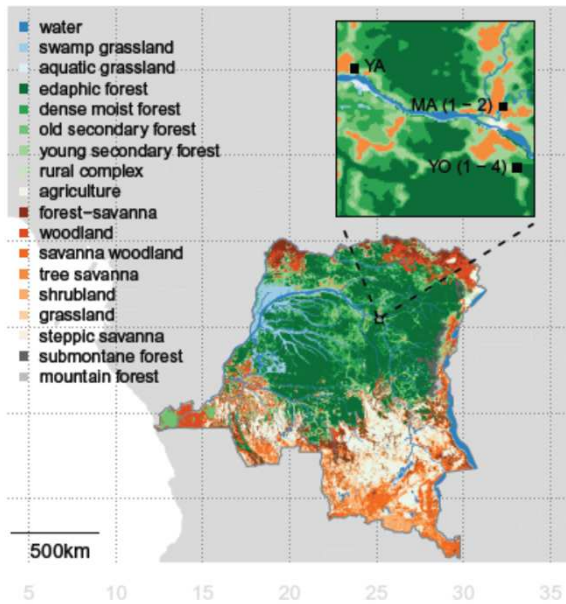
SeedMass

MaxPlantHeight

Structural traits are functional too

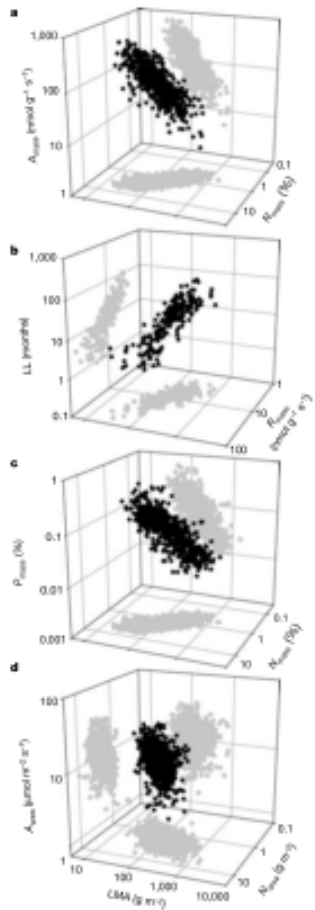
- Metabolic scaling
- Resource acquisition
- Mechanical support
- Competition
- Allocation strategies

Example: secondary forests in Congo



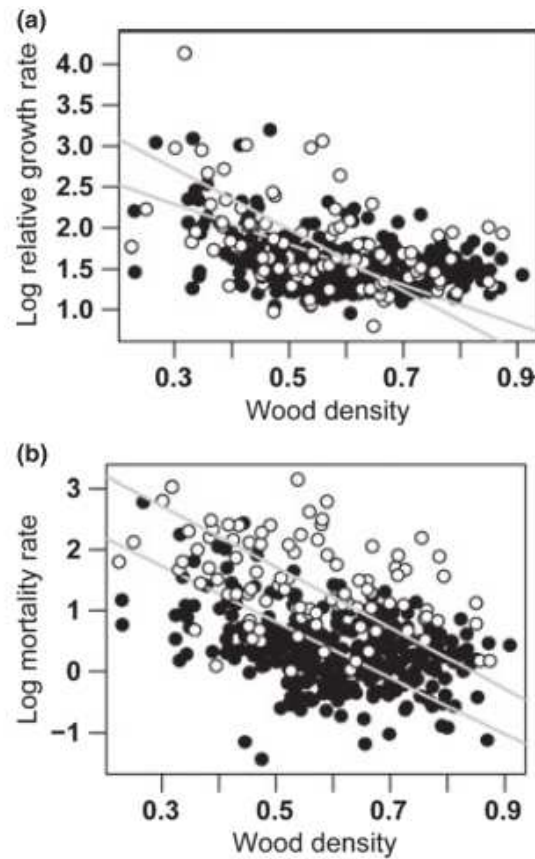
Verbeeck et al. 2014, Journal of Tropical Forest Science

LES



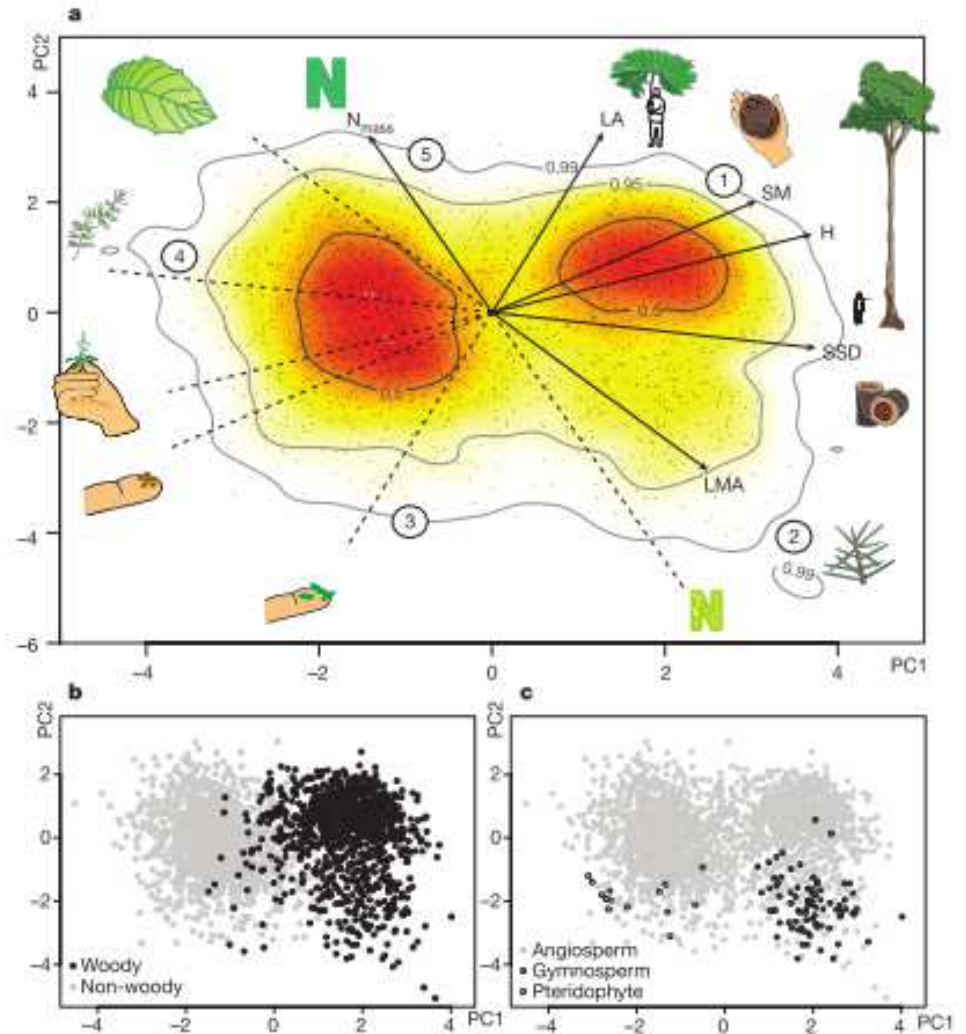
Wright et al. 2004 *Nature*

WES



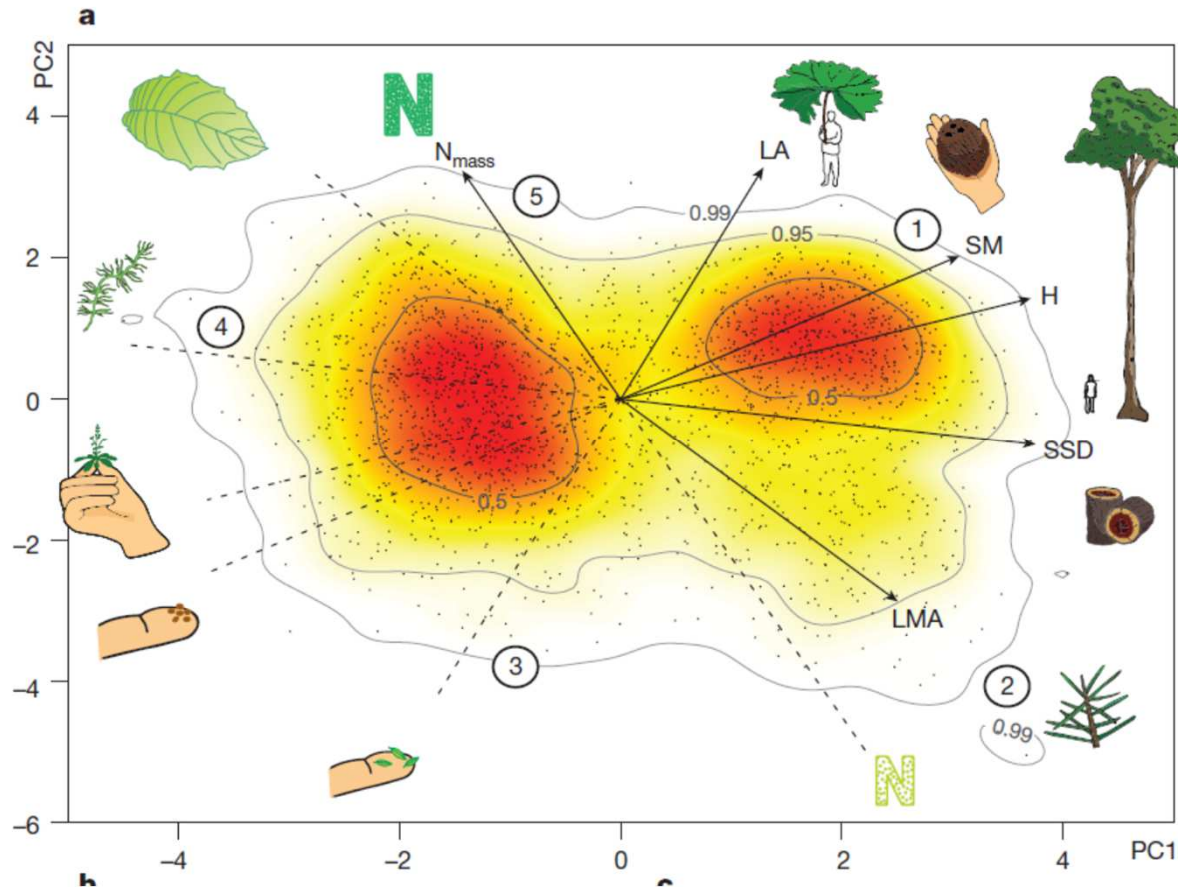
Chave et al. 2009 *Ecol. Lett.*

PES



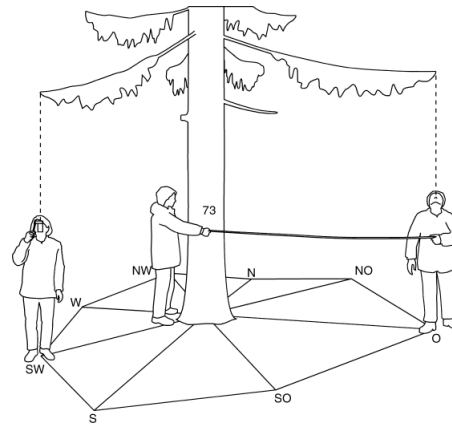
Diaz et al. 2015 *Nature*

Trade-offs in tree structural and functional (leaf and wood) traits can be combined in a unified framework.



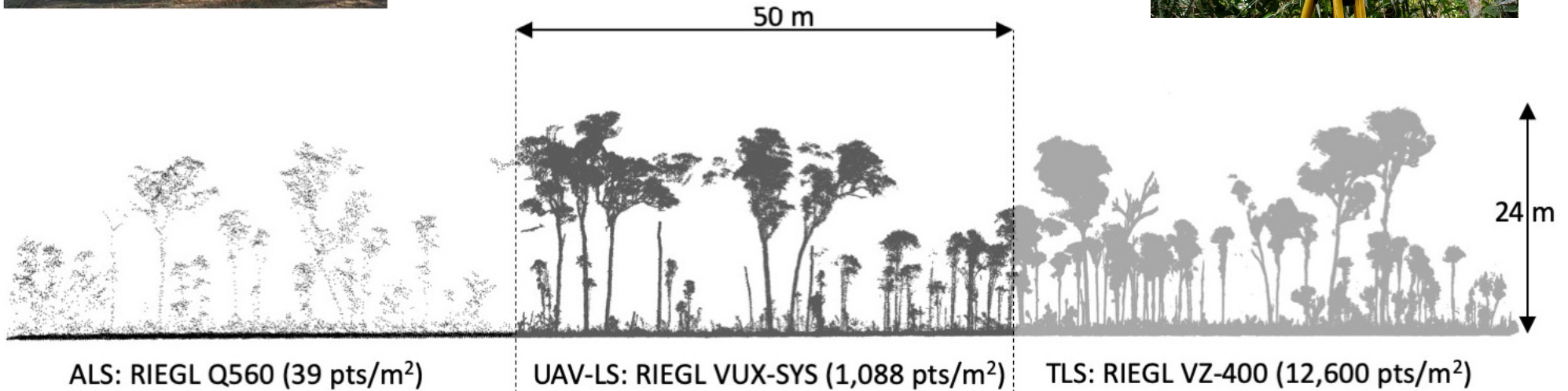
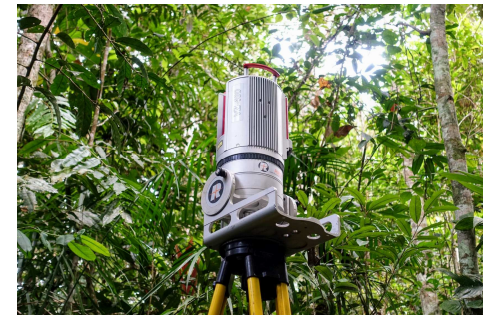
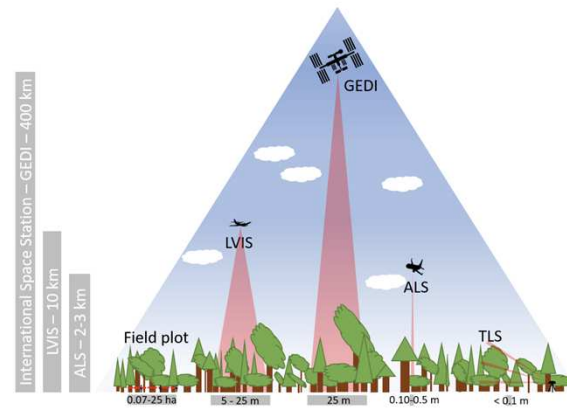
Since centuries the same simple observations of tree structure are used → BUT now we have Terrestrial Laser Scanning!!

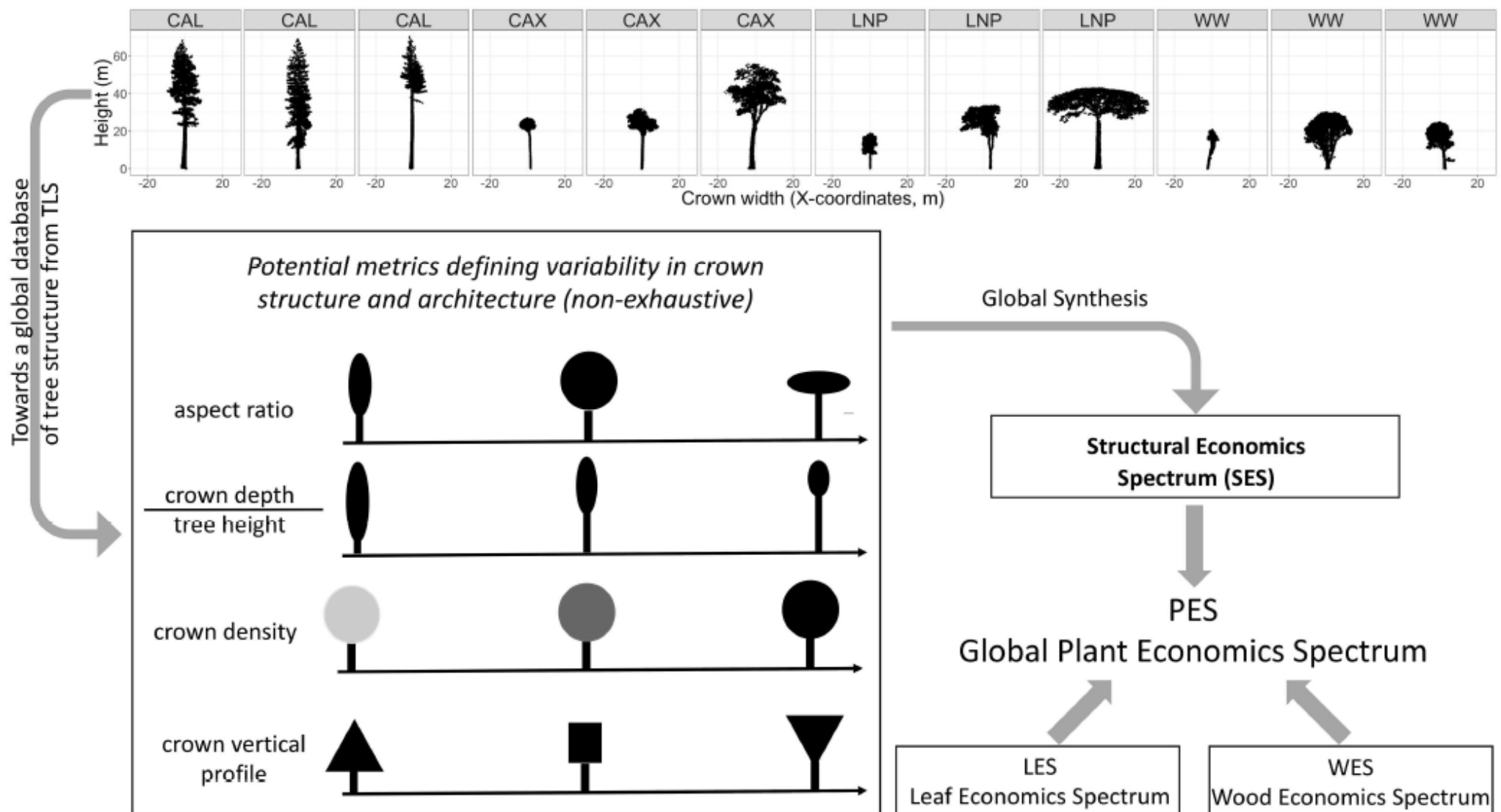
Da Vinci (500 y ago)



LiDAR platforms

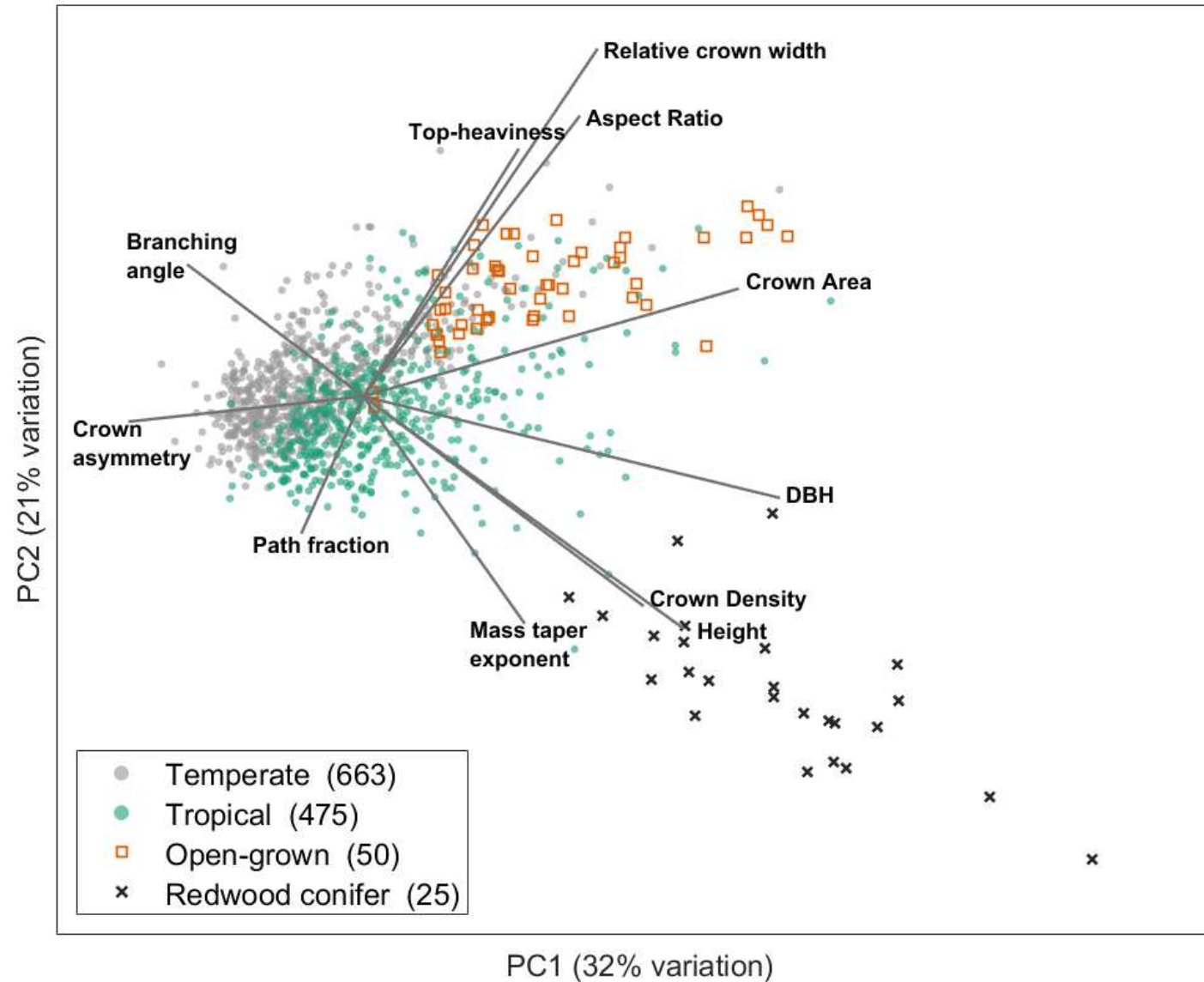
- Space borne
- Air borne
- UAV (drone)
- Terrestrial





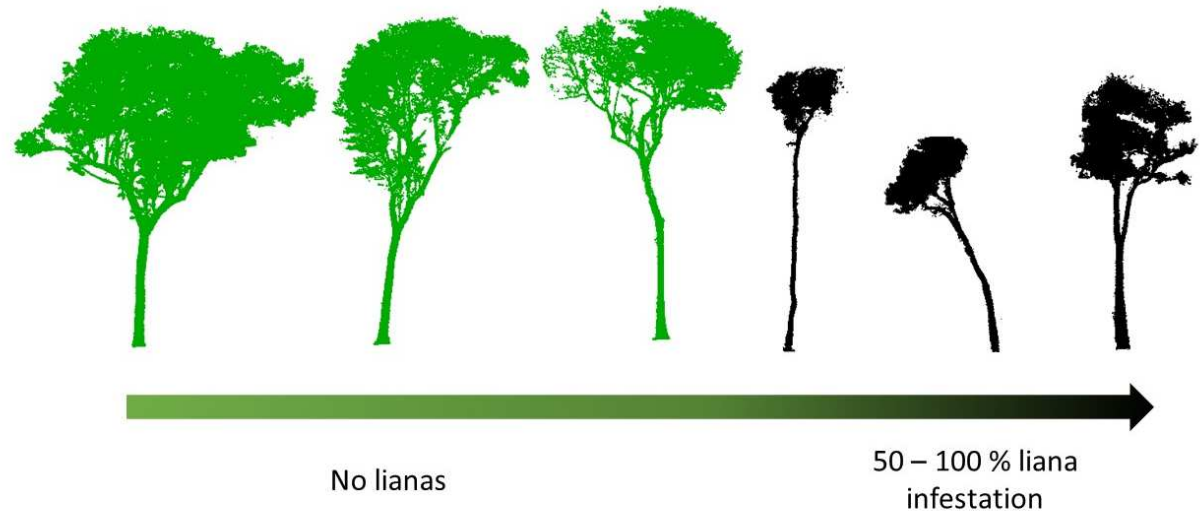
Verbeeck et al. 2019, Frontiers in Forests and Global Change

Plant Structural Economics Spectrum: Proof of concept

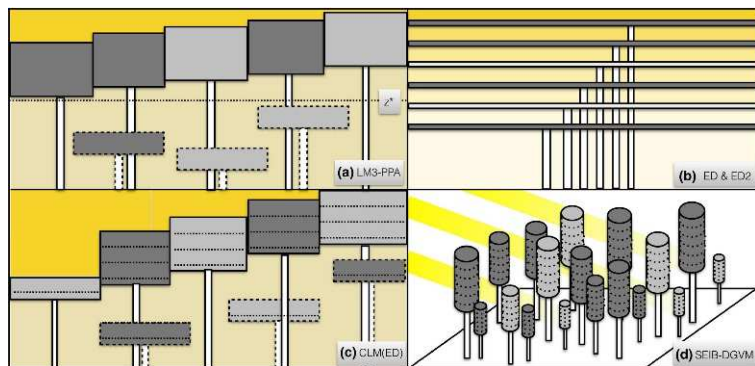


Influencing factors

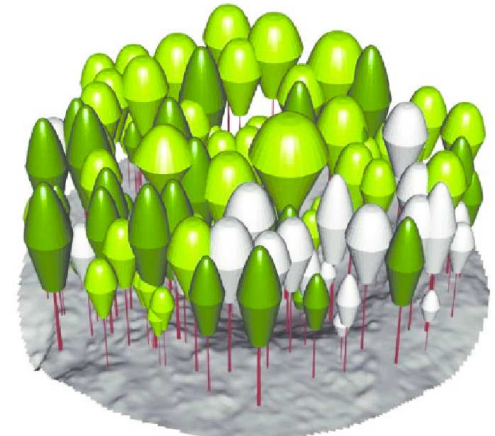
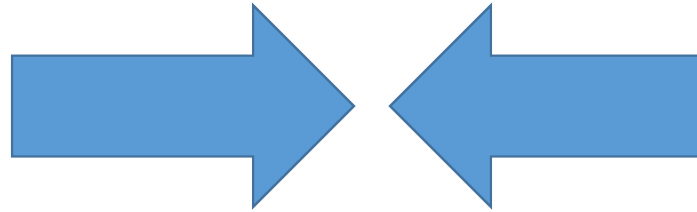
- Intra-species variations of structural traits
- Habitat
- Competition with neighbouring trees
- Crown shape plasticity
- Liana load
- Successional stage
- Climate
- Management
- ...



PFT → PFST: Plant Functional-Structural Types



Demographic models



Spatially explicit individual based models
(e.g. SORTIE, LES, ...)

Outlook

- Synthesize TLS data
 - Global database effort → previous talks and discussion
- Database of structural traits
- Link with functional trait data (e.g. TRY)
- Analyse this multidimensional dataset and construct a PES
- Cluster tree species in PFSTs
- Develop advanced radiative transfer models for 2D vegetation models

Thank you!



Questions?