Improved characterisation of vegetation height from lidar observations: implications for above-ground biomass retrieval from space

João Carreiras, Shaun Quegan – University of Sheffield

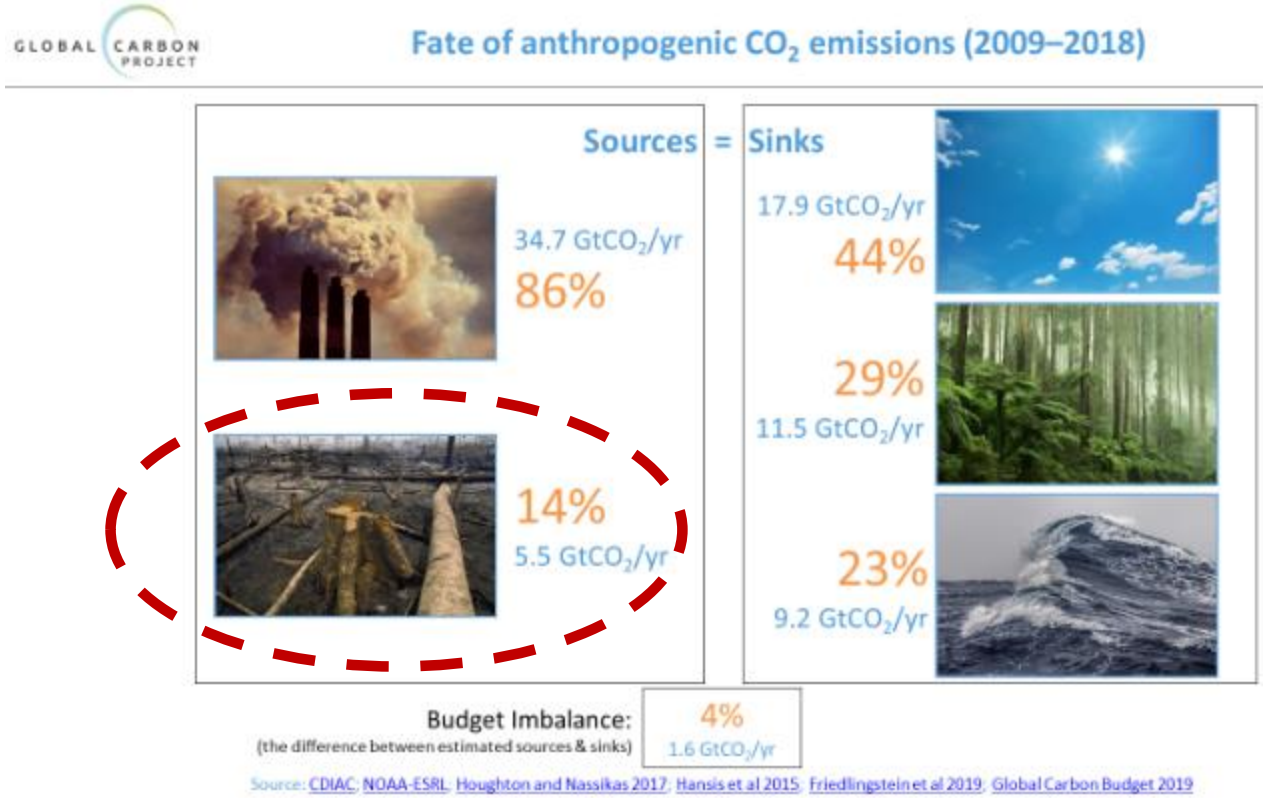
Pedro Rodríguez-Veiga, Heiko Balzter – University of Leicester

Outline

- Background
- Vegetation height measurements from space (GEDI)
- From vegetation height to above-ground biomass
- Above-ground biomass retrieval in the dry tropics
- Next steps

Background

Estimates of vegetation biomass are deeply embedded in the estimates of global carbon fluxes from (i) land use change (net source) and (ii) terrestrial land sink



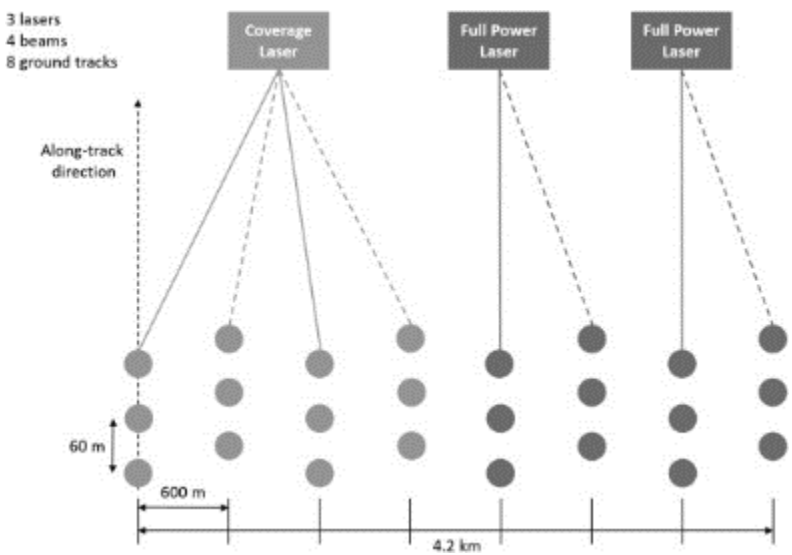
Land use change

- **high uncertainty: σ ~ 50%**
- **e.g., carbon stocks in vegetation are a major source of uncertainty**
- **major efforts are required to resolve these issues, given the importance of this sector for climate change mitigation strategies**

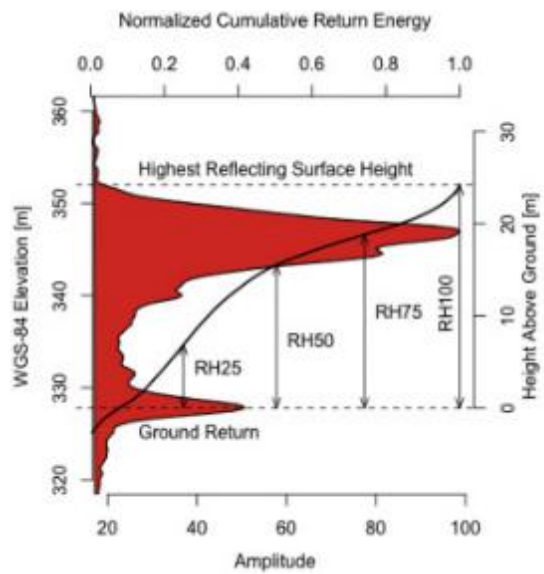
Vegetation height measurements from space (GEDI)

Global Ecosystem Dynamics Investigation (GEDI) lidar

- International Space Station, Dec 2018
- Nominal lifetime: 2 years
- 25-m footprint, 51.6˚ North and South
- high-quality observations of forest vertical structure
- first set of observations released end-January 2020



Dubayah et al. (2020)



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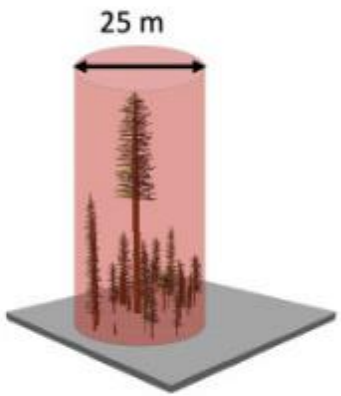


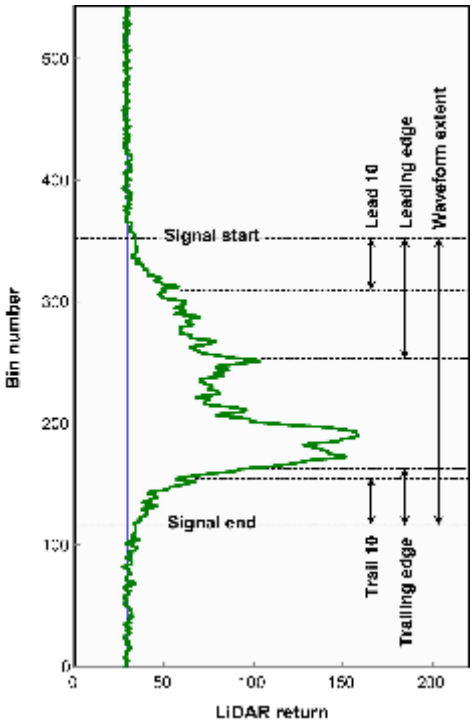
From vegetation height to above-ground biomass

A common index of vegetation height used in the processing of lidar observations is Lorey's height:

basal area weighted height of all trees

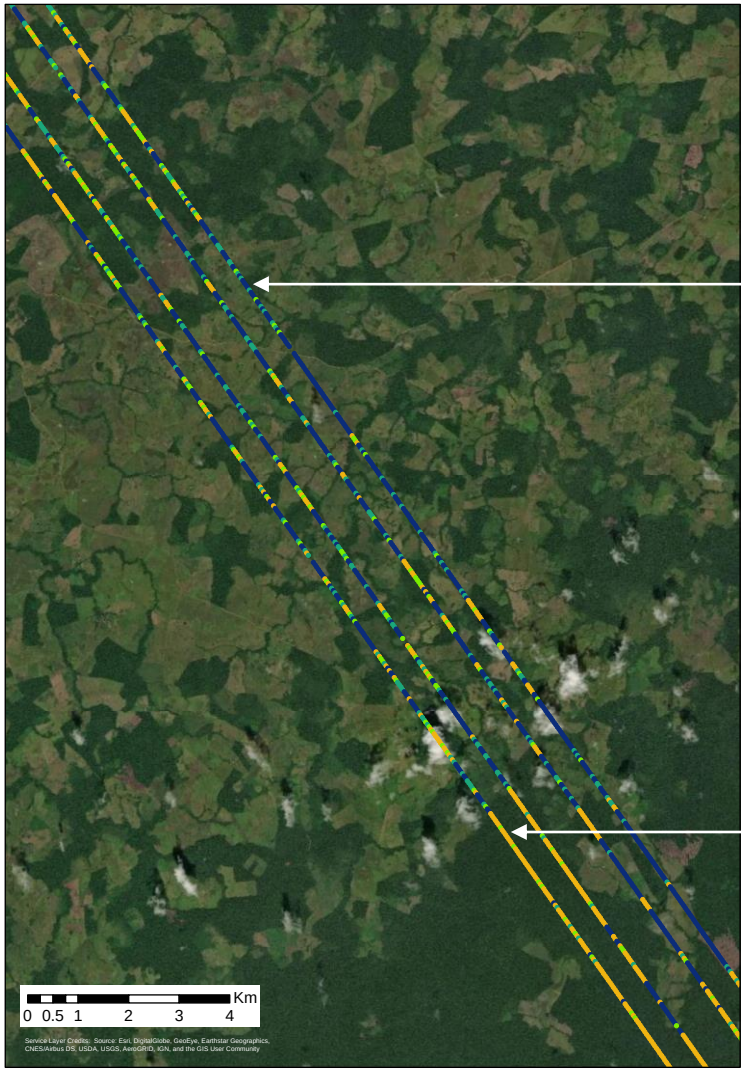
Lefsky (2010) used a set of plots in the Brazilian Amazon and overlapping lidar measurements to derive the following relationship:

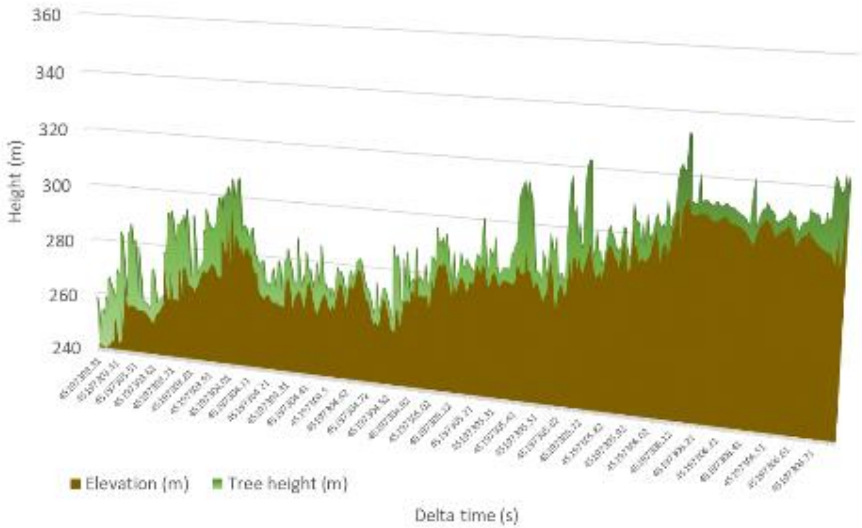
$$Lorey\_broad = -4.5 + (0.55*extent) - (0.102*lead10) - (0.0895*trail10)(n = 95)$$

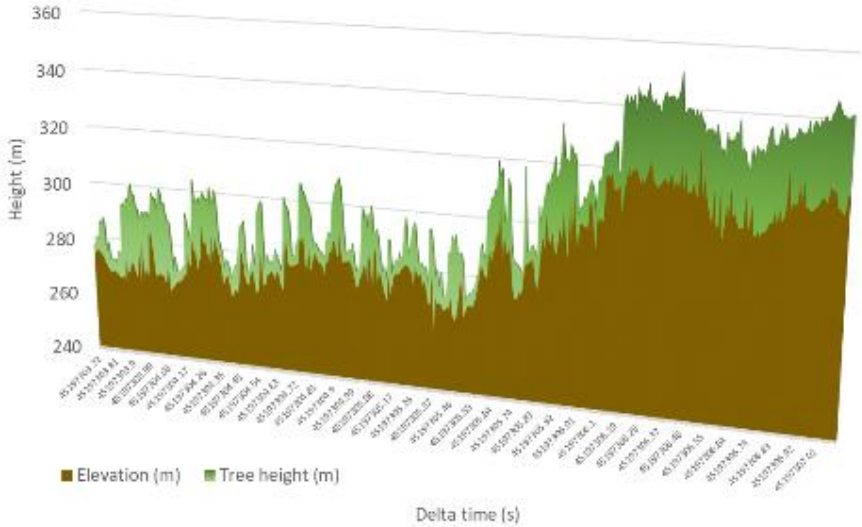


Hayashi et al. (2015)

From vegetation height to above-ground biomass

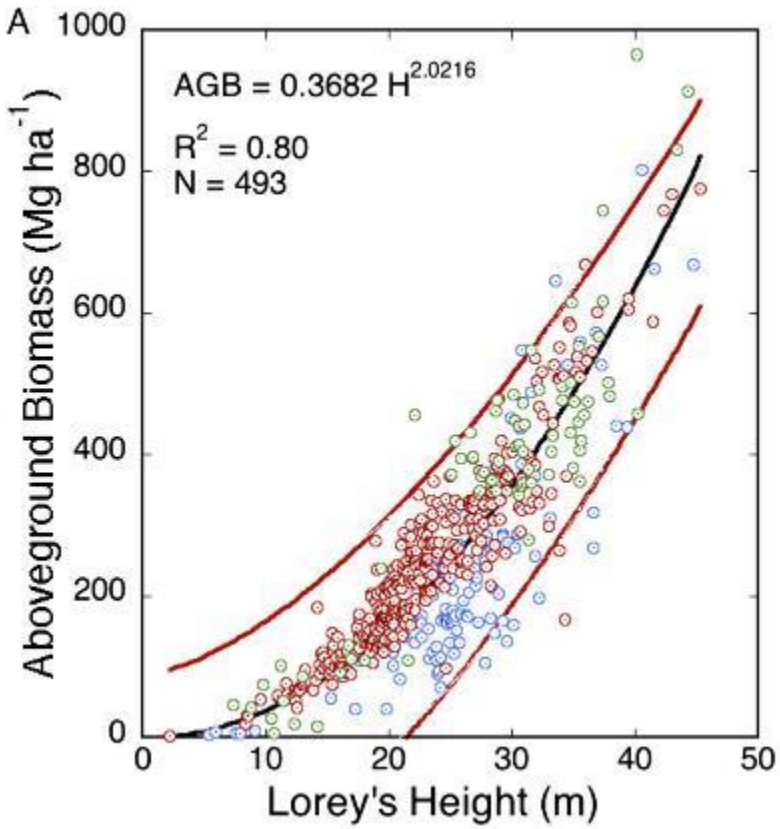


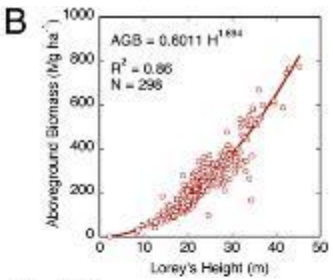




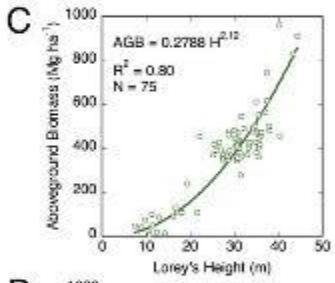
From vegetation height to above-ground biomass

Saatchi et al. (2011) fitted pantropical and continental power-law equations relating Lorey's height from lidar data to above-ground biomass from reference field plots

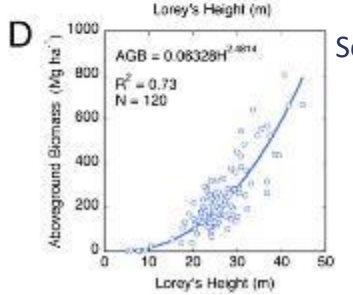




Latin America



Sub-Saharan Africa



Southeast Asia

Saatchi et al. (2011)

From vegetation height to above-ground biomass

GEDI height metrics

Lorey's height = f(height metrics)

Lorey's height

AGB = f(Lorey's height)

Above-ground biomass

GEDI-based above-ground biomass estimates

- footprint level
- wall-to-wall mapping requiring gridded observations
- L-band Synthetic Aperture Radar (ALOS-2 PALSAR-2)
- other datasets (e.g., optical)

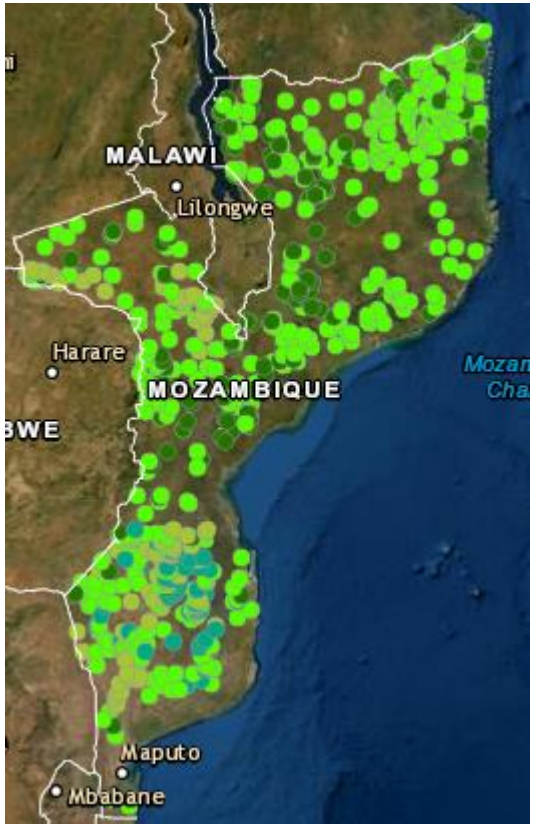
Machine learning regression

GEDI-based AGB = f(ALOS-2 PALSAR-2)

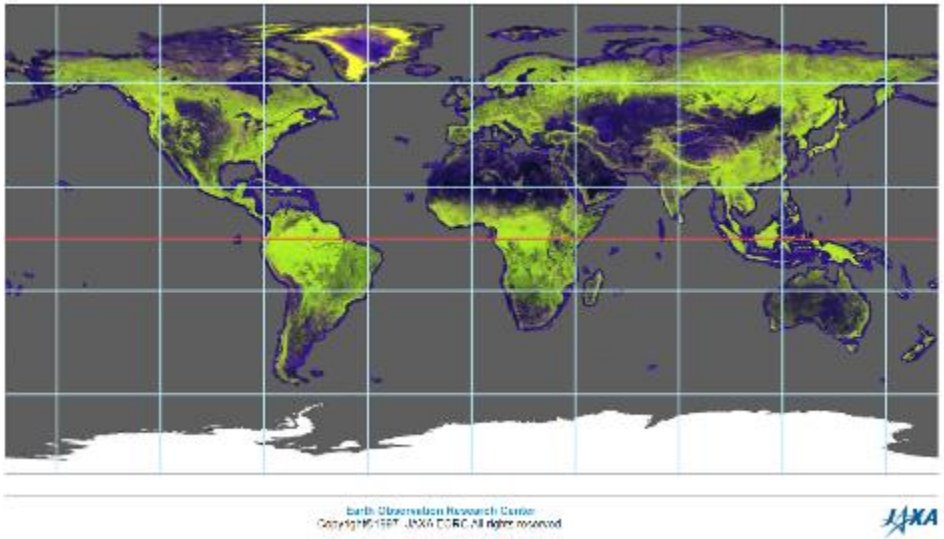
Above-ground biomass retrieval in the dry tropics

Mozambique

- National Forest Inventory 2015-2017
- > 3,000 field plots
- open access
- validation

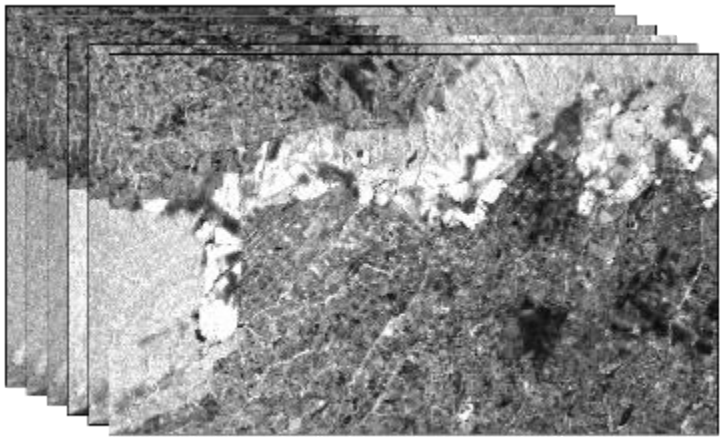


Above-ground biomass retrieval in the dry tropics

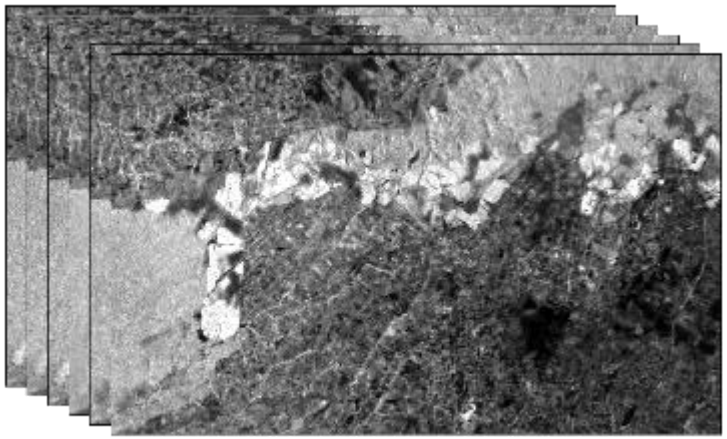


L-band SAR global mosaics from JAXA

- Annual mosaics
  - ALOS PALSAR (2007-2010)
  - ALOS-2 PALSAR-2 (2015 - 2018)
- Dual-polarisation, 25-m resolution
- Open access



Inter-calibration →



Next steps

- Filtering GEDI data: best quality observations
- Derive locally calibrated power-law equations relating above-ground biomass as a function of Lorey's height (IF overlapping observations of plot and lidar data)
- Intercalibration ALOS PALSAR and ALOS-2 PALSAR-2 acquisitions
- Benchmarking approaches to deliver wall-to-wall maps of above-ground biomass based on GEDI observations
- Combining above-ground biomass maps to estimate change