Large area biomass monitoring from satellites

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- Focus on global maps
- Where we are now
- Where we will be within 3-4 years

The University Of Sheffield.

National Centre for Earth Observation
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Estimating biomass from space: instrument capability and reference data are key issues

No current space-based sensor is designed to estimate biomass. Typical issues:

- Saturation/loss of sensitivity at high AGB
- Ground contamination at low AGB

Reference data is a key factor:

- For countries with lots of in situ data, data-driven approaches are possible.
- At continental or global scale we have to live with sparse *in situ* data, particularly in the tropics.

Ability to *monitor* AGB (to see change) is limited by availability and accuracy of data

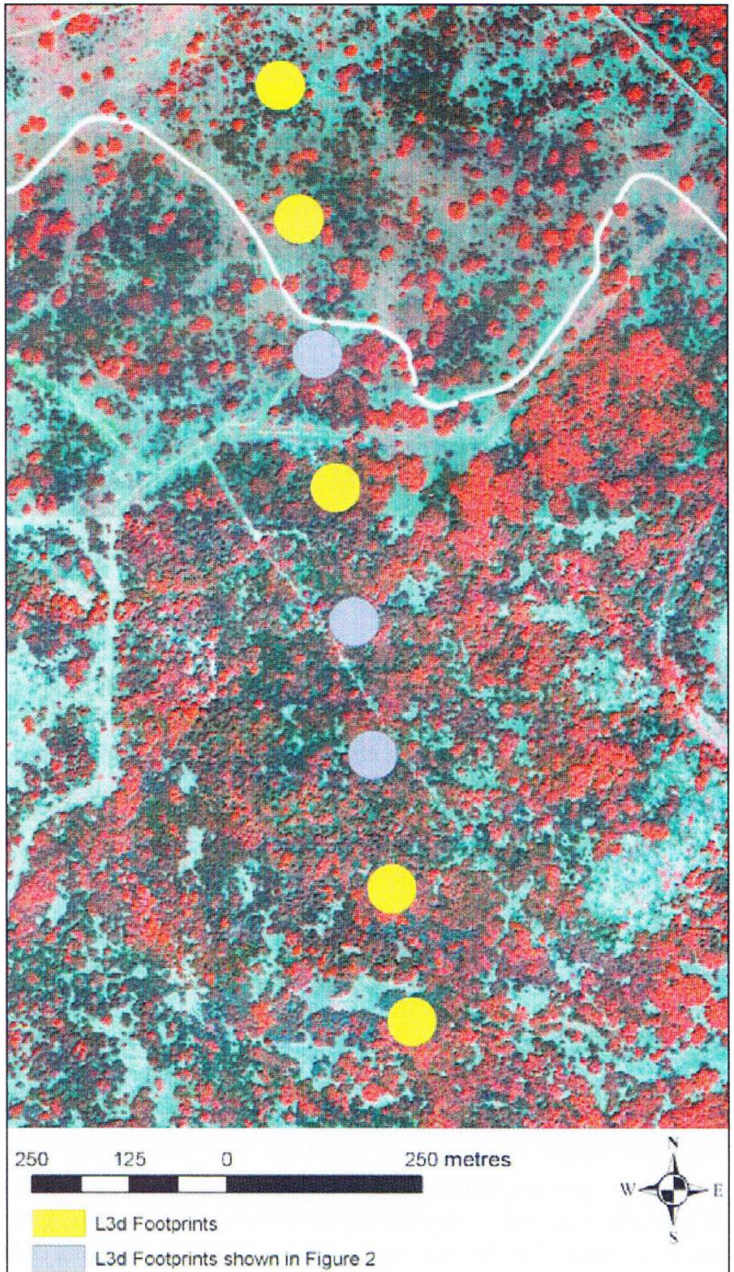
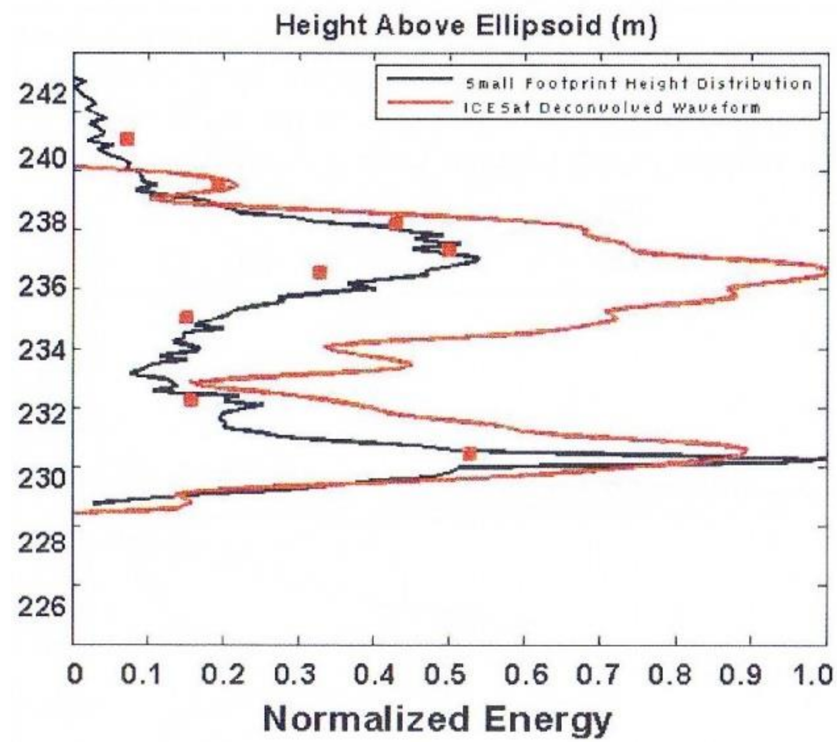


Figure 1. Location of ICESat footprints from campaign L3d used in this research over Freeman Ranch. Background image is a false color QuickBird composite acquired in June 2005.

Space-based lidar: IceSAT Geoscience Laser Altimeter System (2005-2009)

- 65 m diameter footprints
- 140 m sampling along track
- irregular global coverage from many tracks



Producing AGB maps from GLAS

Producing an AGB map from GLAS is a 3-stage process:

1. Estimate Lorey's height from the lidar waveform by training against reference data.
2. Use reference data to train the conversion from Lorey's height to AGB; then estimate AGB at the GLAS footprints.
3. Train mapping sensors against the GLAS data and use them to fill the large gaps between the GLAS samples.

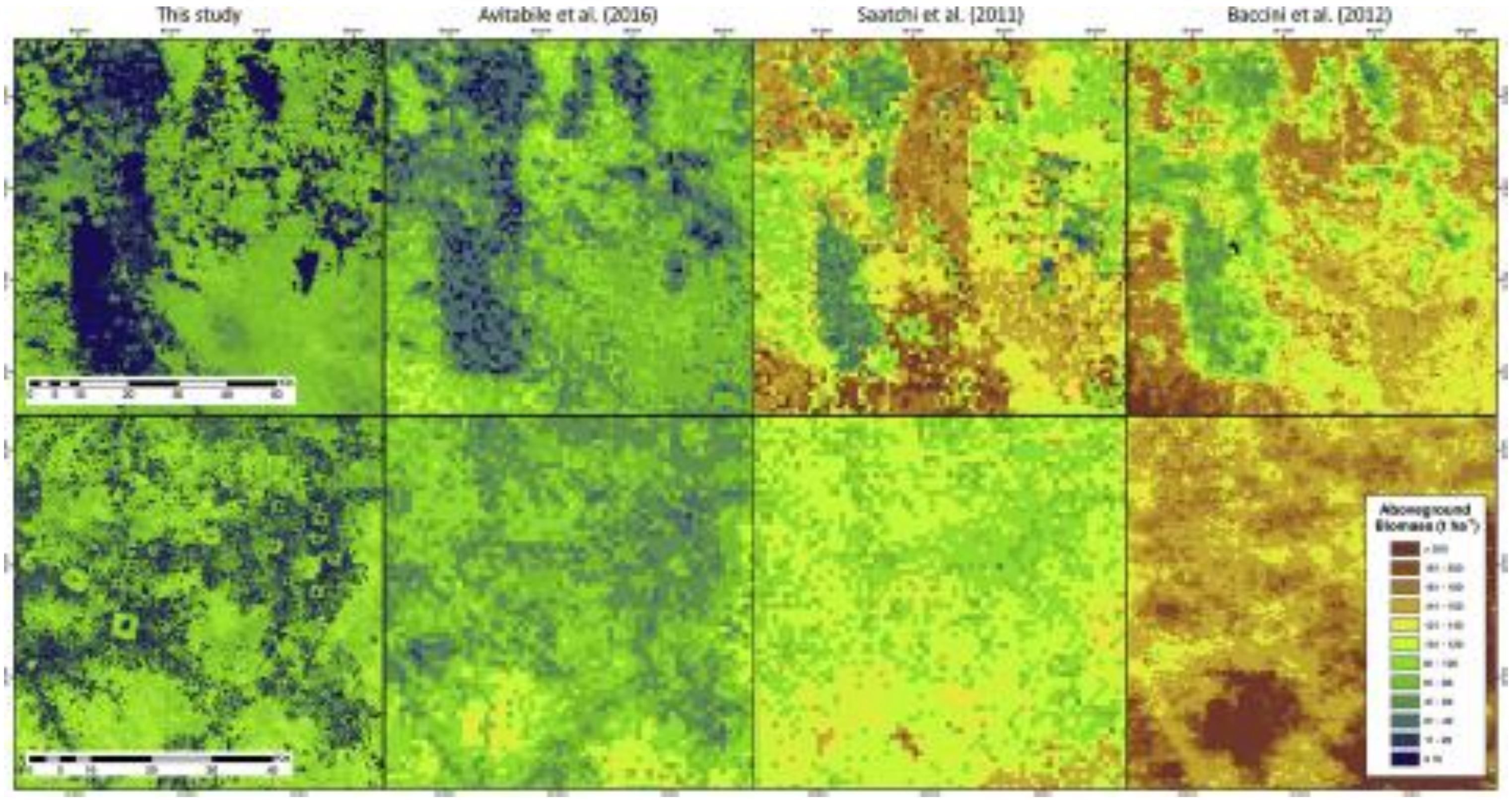
Numerous sources of error, e.g.

- the mapping sensors (usually optical) have low sensitivity to AGB
- the quality of the 3-stage training is crucial

Comparison of maps (Yucatan peninsula) indicates map biases

Region 1

Region 2



Rodríguez-Veiga et al. (2019)

Mexican AGB map. Lots of in situ data.

Avitabile et al. (2016)

Combination of 2 maps at right with greatly extended reference data

Saatchi et al. (2011)

Pan-tropical map from GLAS

Baccini et al. (2012)

Pan-tropical map from GLAS

Space radar

Radar-based estimates of AGB combine L-band (PALSAR) and time series of C-band (Envisat and Sentinel-1) data.

To address the lack of reference data:

1. The estimation is based on a PHYSICAL MODEL
2. NO TRAINING DATA are used
3. Information from other sensors (e.g. canopy cover) is used to constrain the estimation

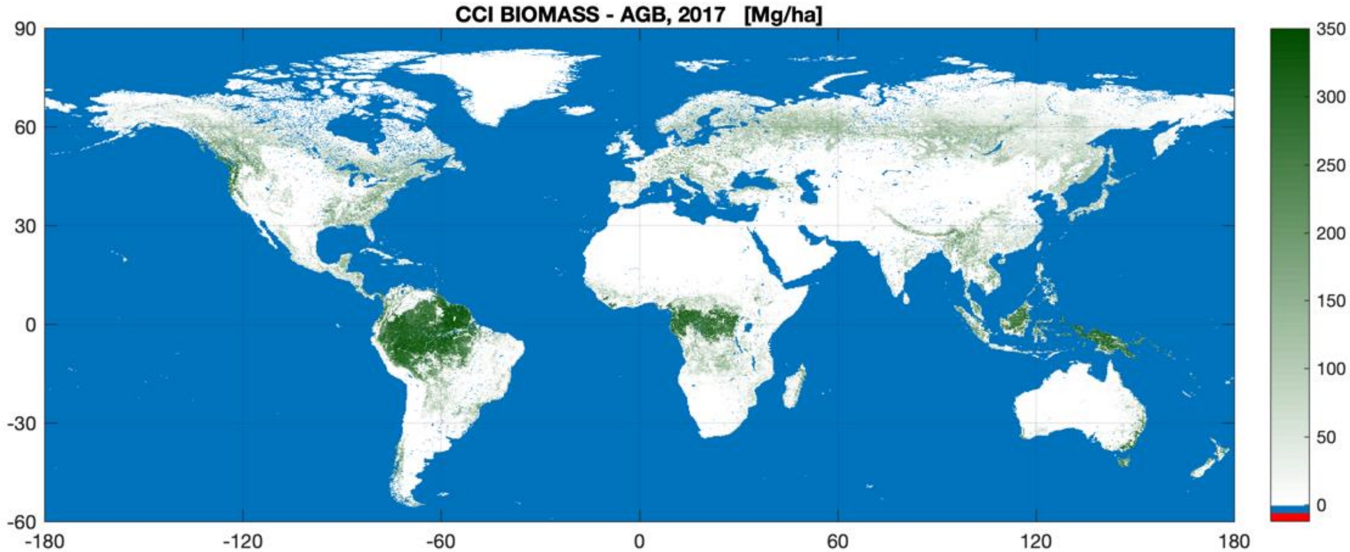
Key point:

- the estimation adapts to local conditions

BUT

- because reference data are not used, it cannot *directly* use local AGB estimates to improve its performance

CCI BIOMASS AGB for 2017 at 100 m grid scale

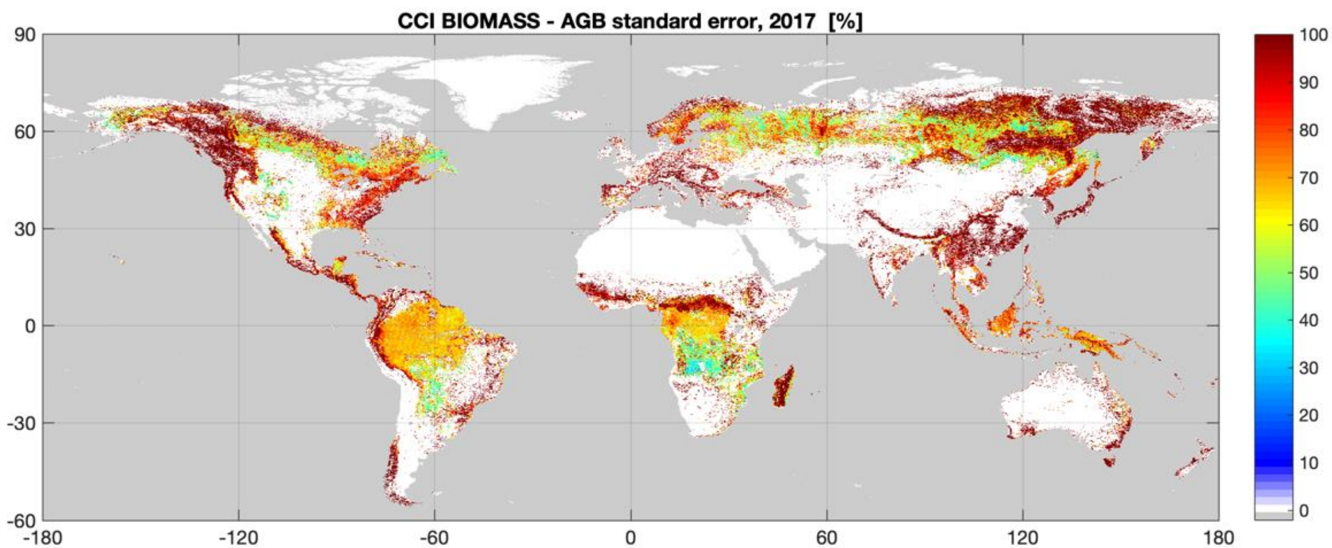


350

AGB (t/ha)

200

0

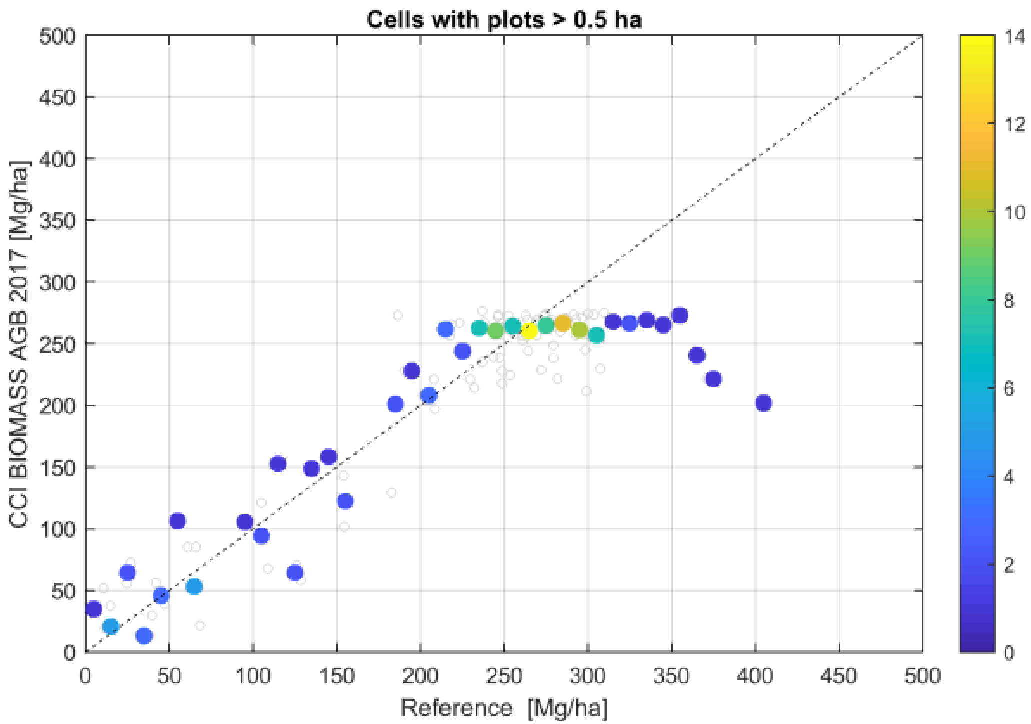


100

Relative
Standard
deviation (%)
at 100 m

0

Assessment against in situ data

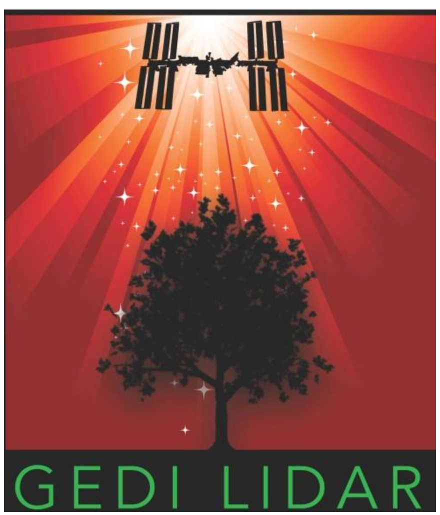


Average plot AGB and average pixel-at-plot AGB

- in 0.1 deg cells
- using only cells with plots > 0.5 ha

- Little bias below 250 t/ha
- Reasonable accuracy requires sacrificing resolution
- Sensor limitations lead to saturation at higher biomass

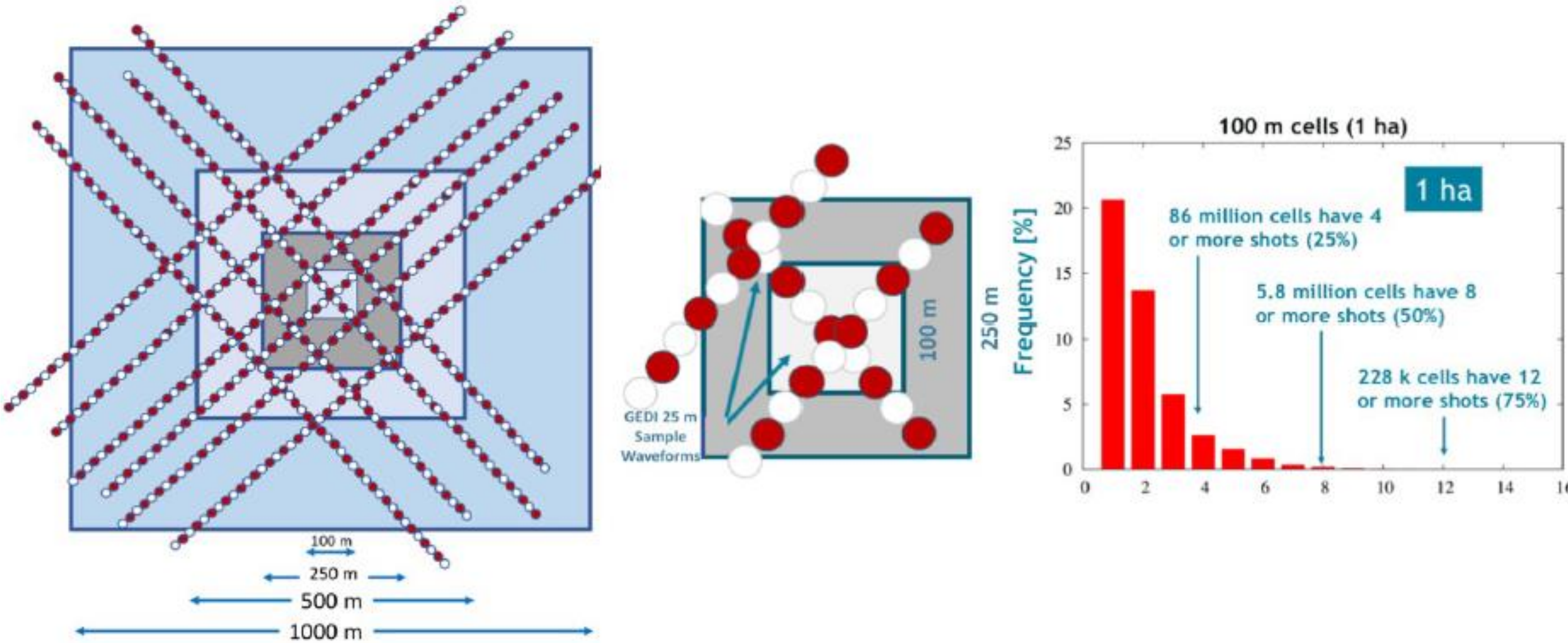
Step change in capability: 3 missions designed for forest structure and AGB



GEDI (2018-2023)

The “4th mission”; in situ networks

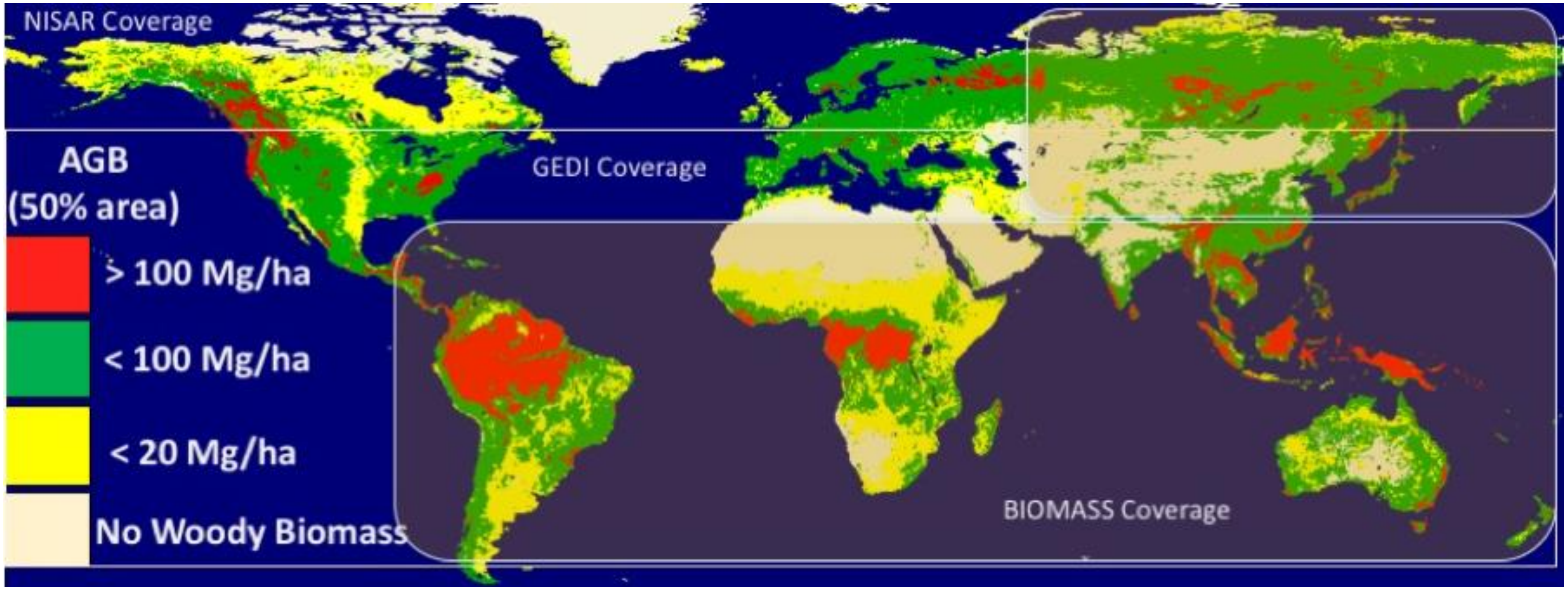
GEDI gives much denser coverage: 25 m footprint, 60 m along-track, multiple beams



GEDI is a sampling device, so will follow the same methodology as GLAS, but has MUCH better coverage.

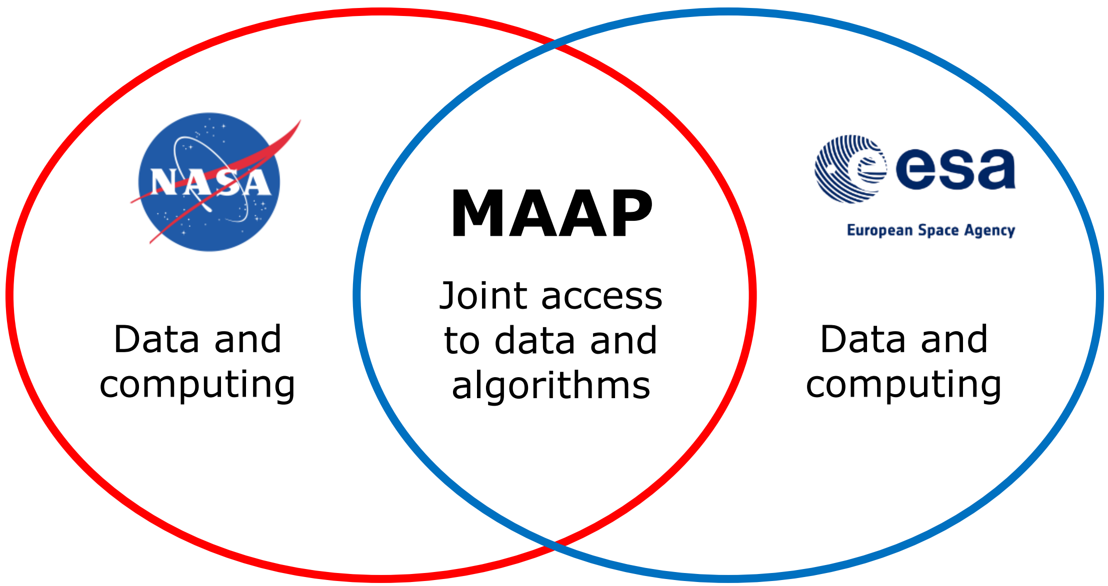
AGB product: average AGB and its SD in a 1 km^2 cell

The 3 missions are highly complementary



GEDI: full biomass range, sampling between ± 51.5°.
BIOMASS: full biomass range but poorer at low biomass; global except for N. America & Europe.
NISAR: frequent global coverage < 100 t/ha.

Full power of the 3 missions harnessed in the joint ESA/NASA Mission Algorithm and Analysis Platform model



Up to date data and algorithms + *Collaborative community*

Unified user access to all space and ground data in a single open access platform that supports data processing: **Move user activities to the data, not data to the users**