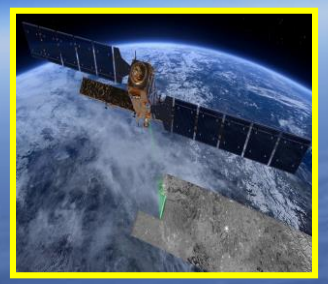

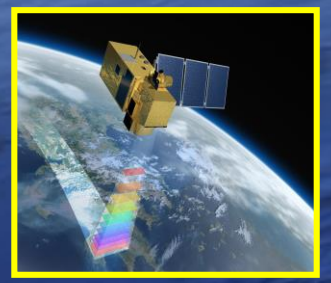

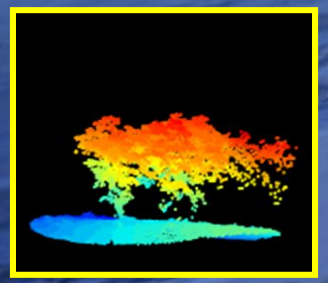

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ERSLab
Earth Remote Sensing Laboratory

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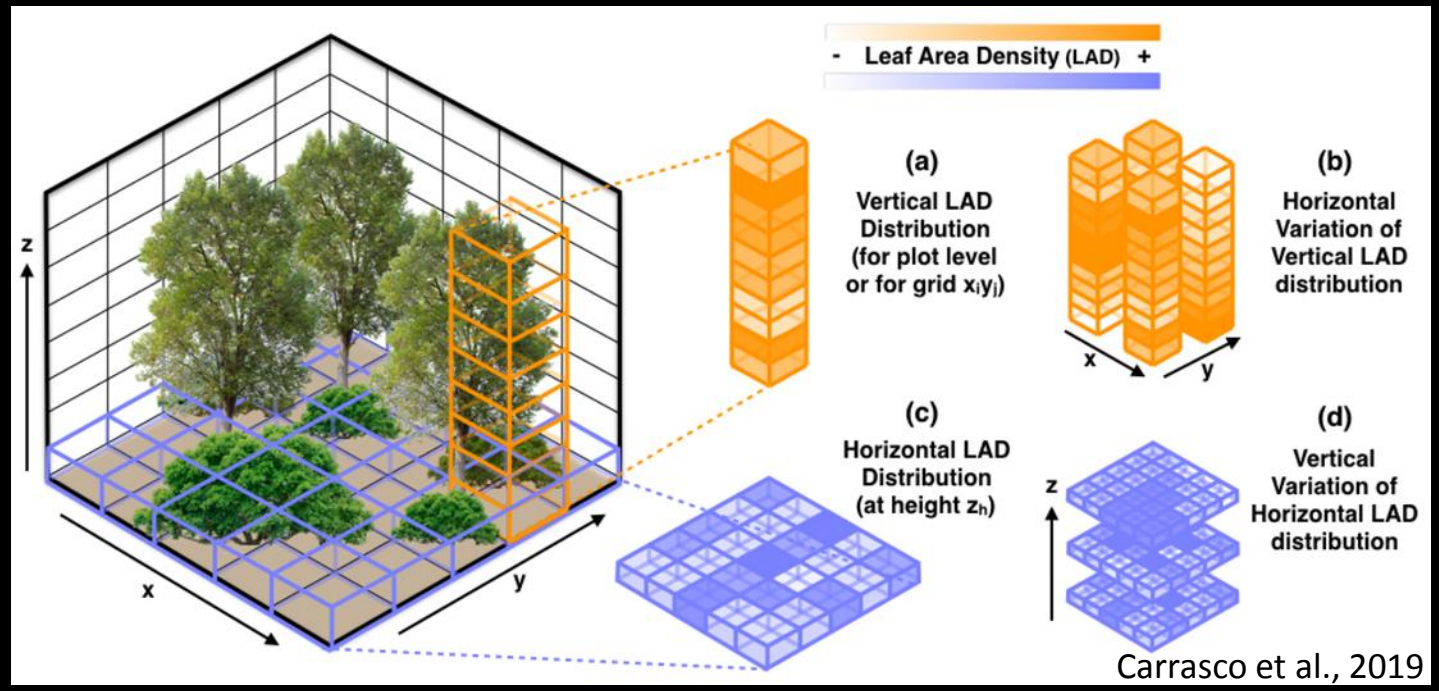
fct Fundação para a Ciência e a Tecnologia

Ecosystem Structure

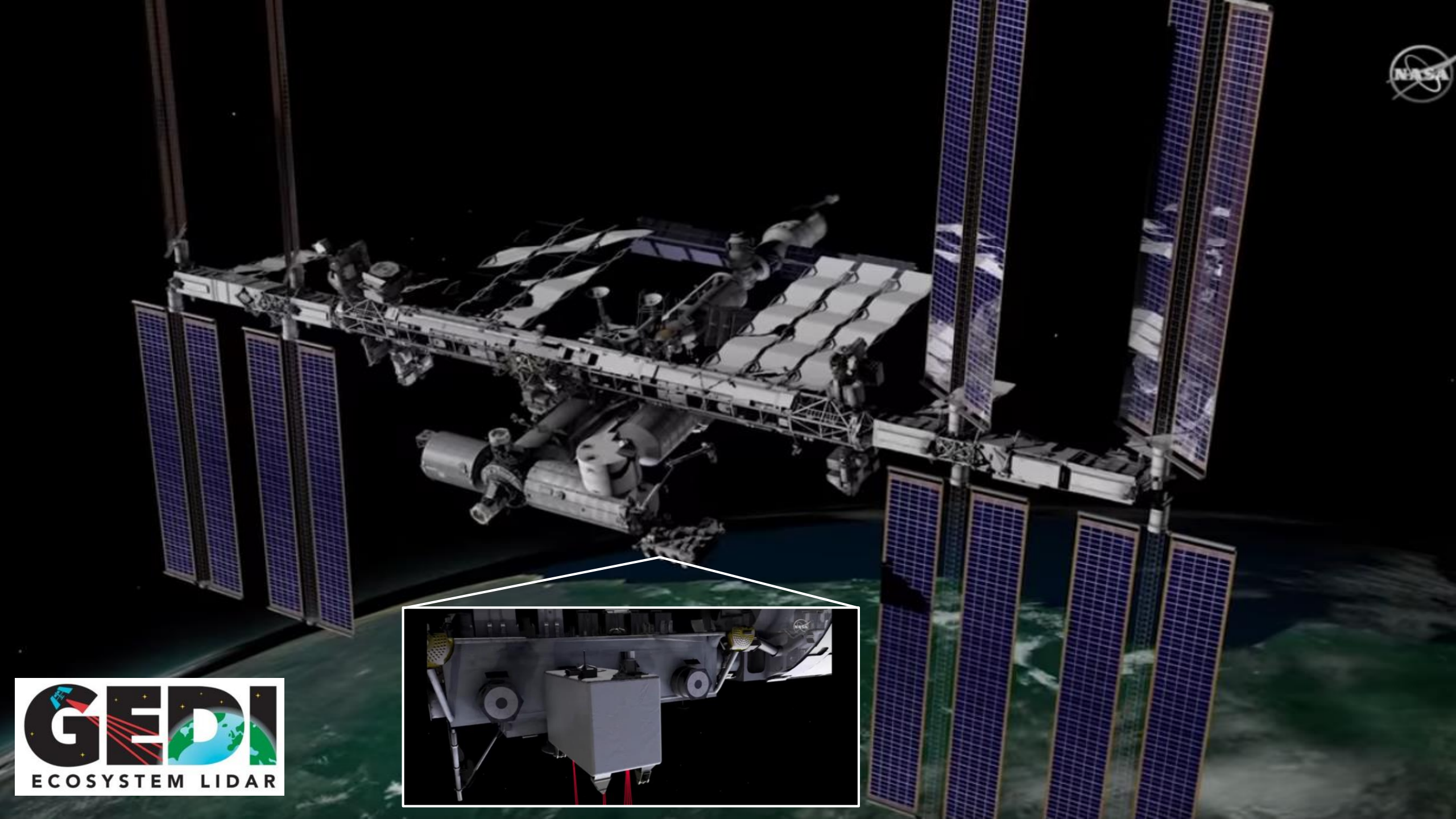
Ecosystem Function

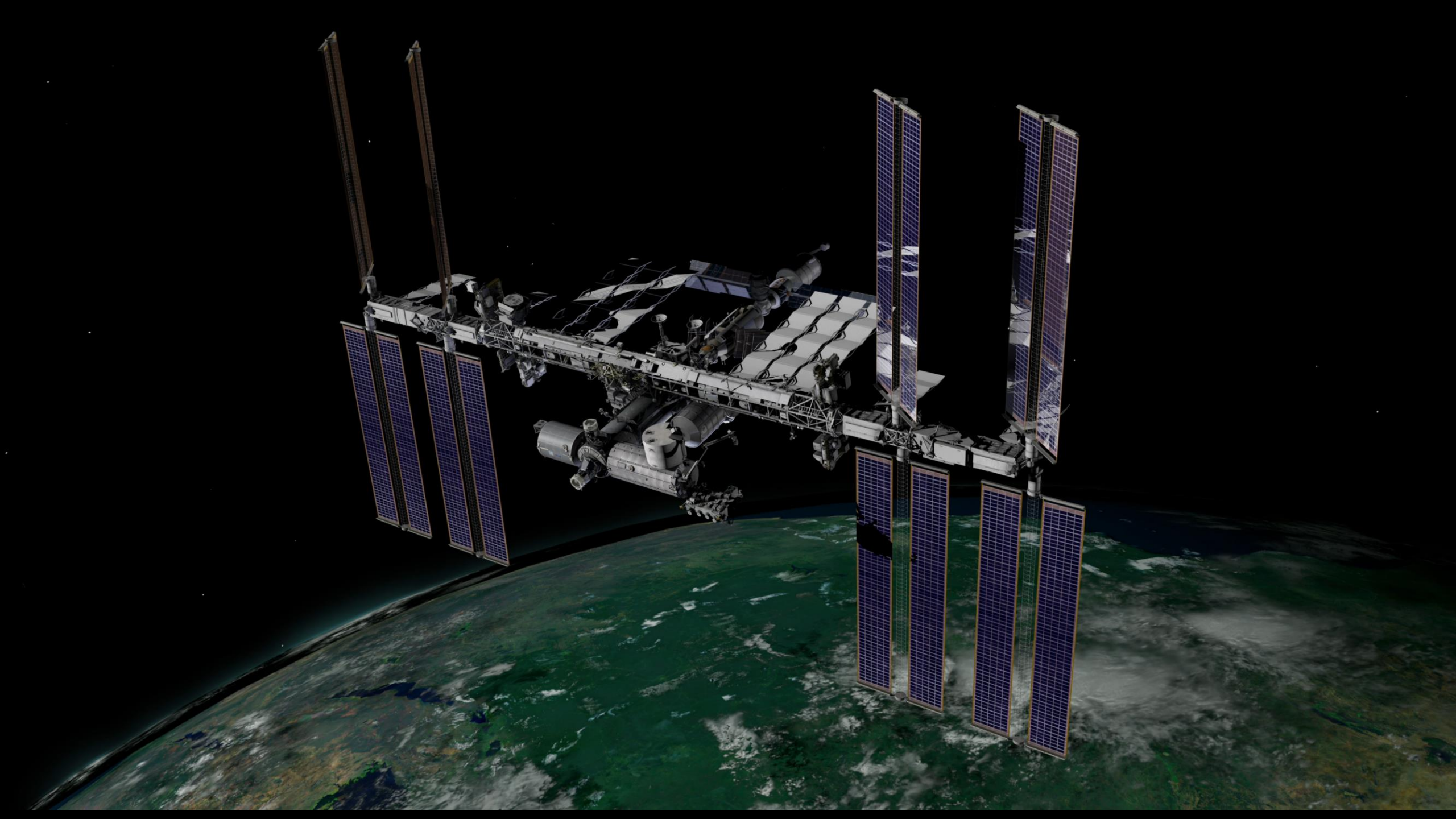


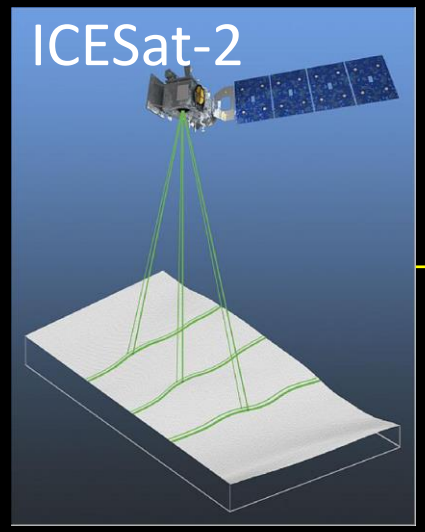
Carrasco et al., 2019

1. **Height metrics** : canopy height
2. **Area and density metrics :** LAD, LAI, PAI
3. **Cover and opnness metrics:** canopy cover, gap fraction
4. **Heterogeneity metrics:** FHD, canopy rugosity


ICESat-2
LASER
FOCUS


GEDI
ECOSYSTEM LIDAR





ATL08: Land and Vegetation Height

Mission objectives:

- is primarily designed for studying Earth's polar ice sheets, sea ice, and the elevation of land surfaces.
- It can also provide information on forests, but it is not its primary mission.

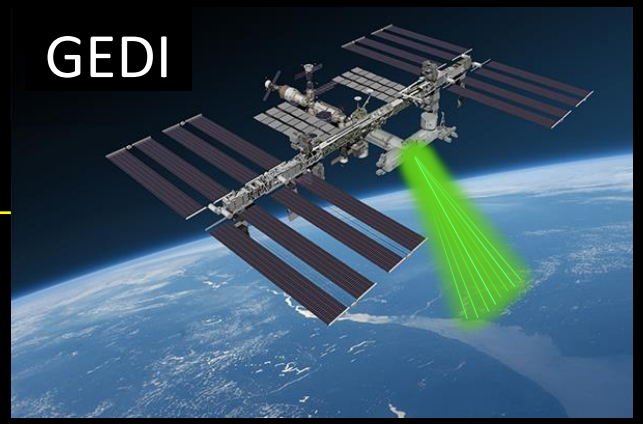
Pulse characteristics:

- Is a photon counting system;
- Emits laser pulses in the Green region of the ES (532 nm);

Footprint geolocation error:

- < 5 meters.

L1B: Geolocated waveforms.
L2A: Ground elevation, canopy top height, relative height (RH) metrics.
L2B: Canopy Cover Fraction (CCF), CCF profile, Leaf Area Index (LAI), LAI profile.
L4A: Footprint level above ground biomass;
L4B: Footprint level above ground biomass;



Mission objectives:

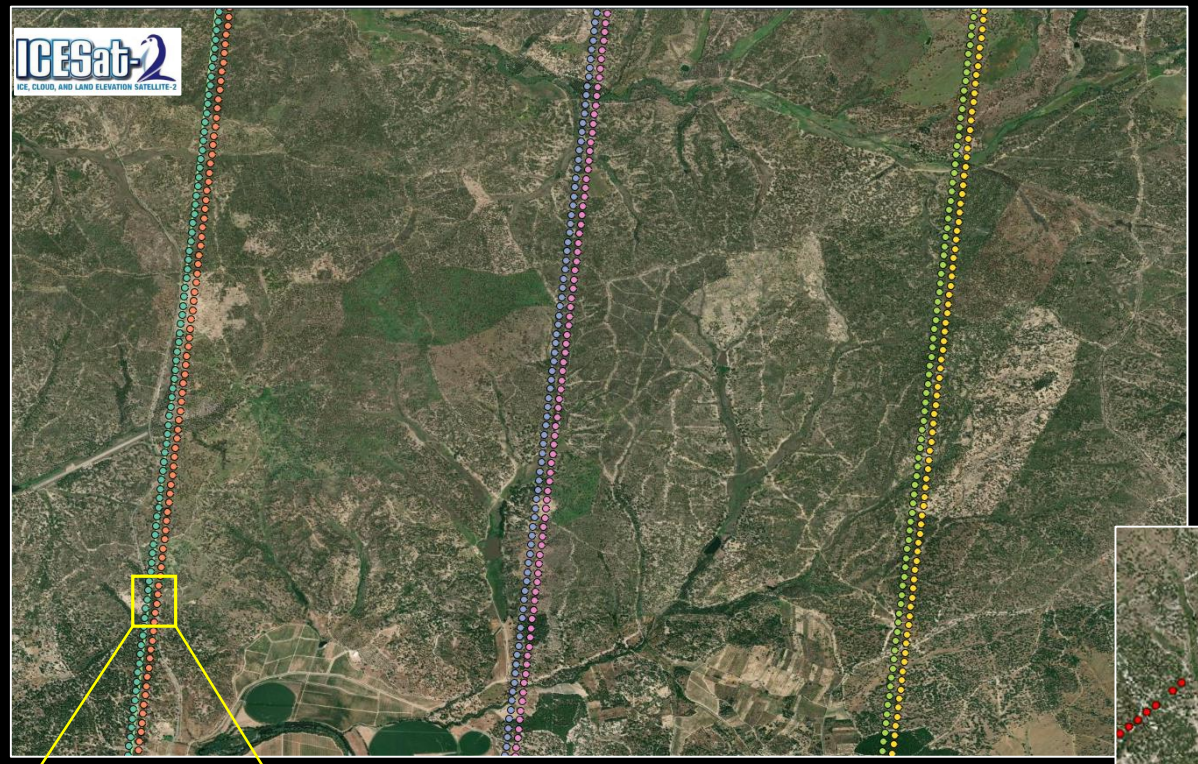
- is designed to study the Earth's forests and vegetation, focusing on terrestrial ecosystems..
- specifically designed for monitoring the vertical structure of vegetation, including canopy height, canopy cover, and vertical profile information.

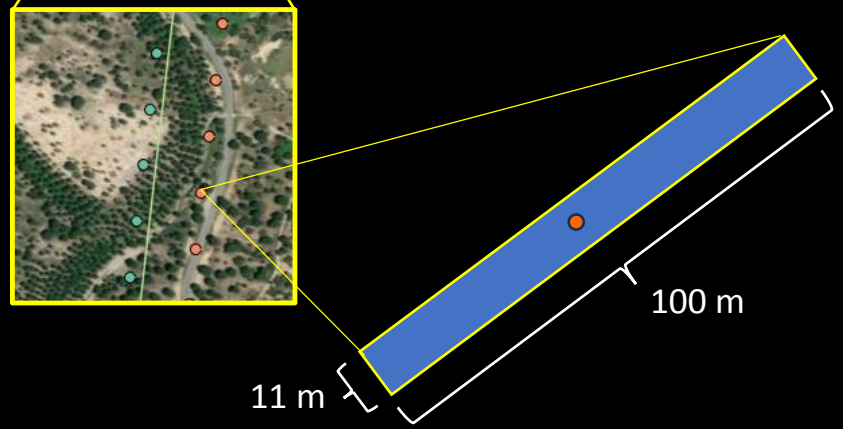
Pulse characteristics:

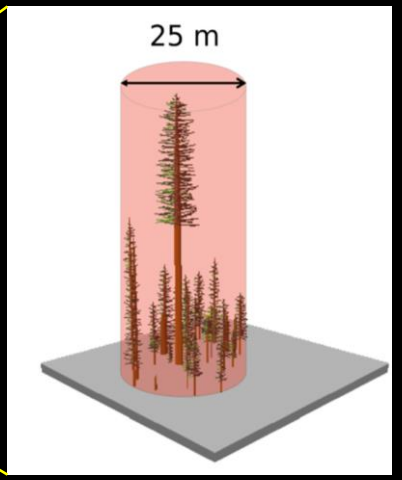
- Is a full-waveform system;
- Emits laser pulses in the NIR region of the ES (1064 nm);

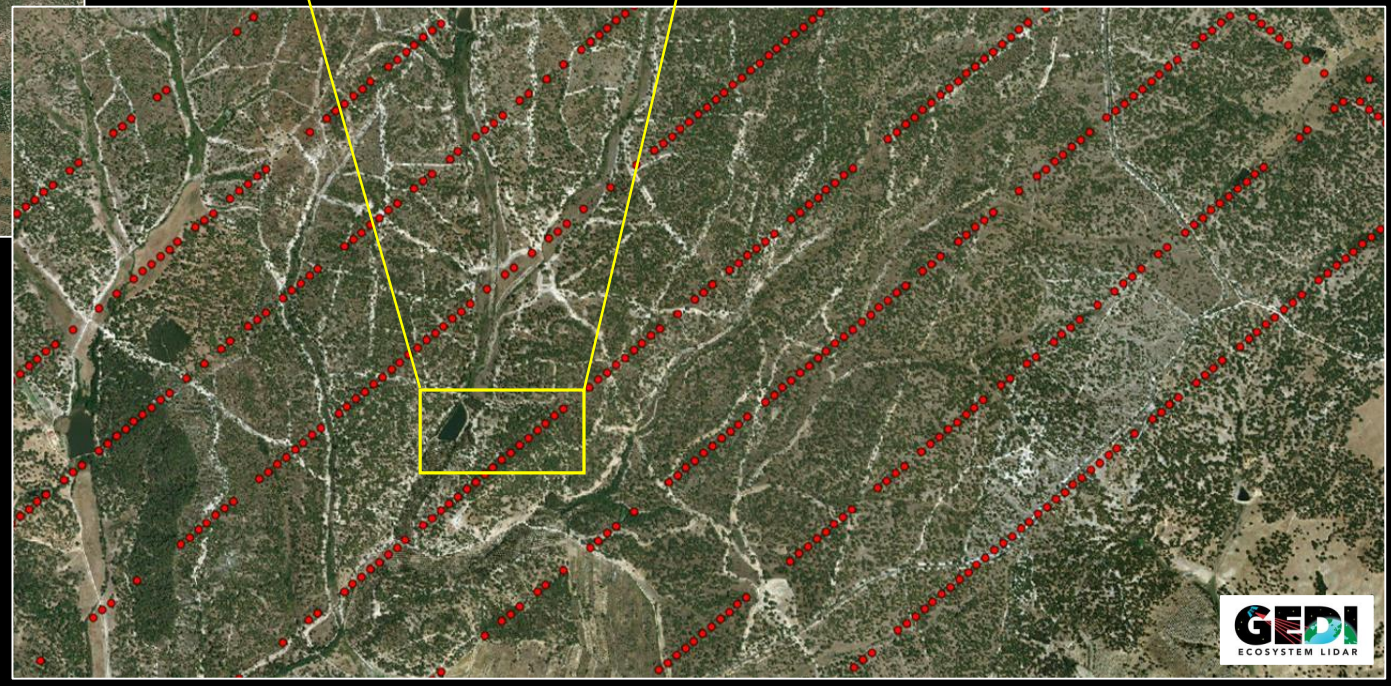
Footprint geolocation error:

- 8 – 10 meters (in Version 2).


ICESat-2
ICE, CLOUD, AND LAND ELEVATION SATELLITE-2


100 m
11 m


25 m


GEDI
ECOSYSTEM LIDAR

GISCIENCE & REMOTE SENSING
2022, VOL. 59, NO. 1, 1509–1533
https://doi.org/10.1080/15481603.2022.2115599

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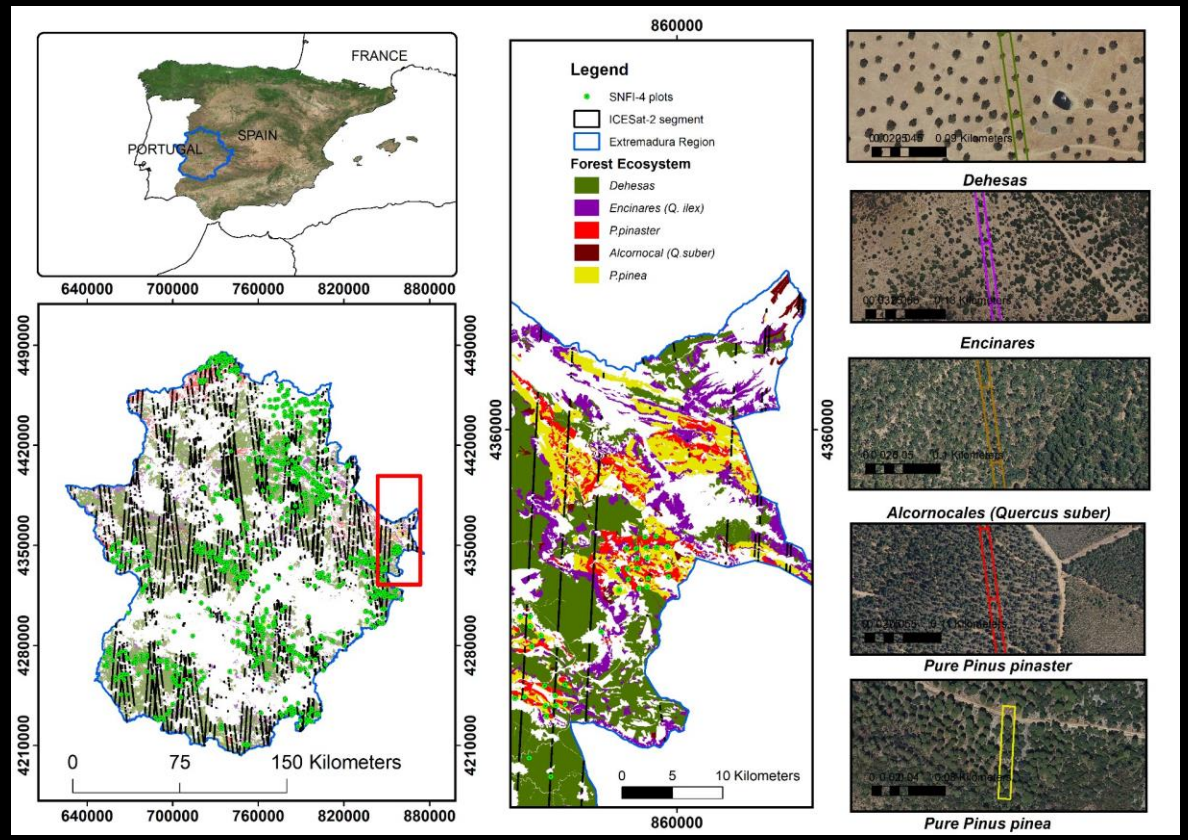
RESEARCH ARTICLE

OPEN ACCESS Check for updates

Aboveground biomass mapping by integrating ICESat-2, SENTINEL-1, SENTINEL-2, ALOS2/PALSAR2, and topographic information in Mediterranean forests

Juan Guerra-Hernández[a], Lana L. Narine[b], Adrián Pascual[c], Eduardo Gonzalez-Ferreiro[d], Brigite Botequim[e], Lonesome Malambo[f], Amy Neuenschwander[f,g], Sorin C. Popescu[f] and Sergio Godinho[h,i]



Objectives

1. Evaluate the accuracy of ICESat-2-derived canopy height statistics by comparing these with ALS derived metrics;
2. Analyze the performance of ICESat-2-derived statistics on canopy metrics (height and cover) to predict AGB;
3. Construct a wall-to-wall map of AGB at 25 m resolution by integrating ICESat-2 with multi-source remotely sensed data;
4. Compare generated AGB maps with field-, ALS-, and ICESat-2-based AGB observations;

1 Evaluate the accuracy of ICESat-2-derived canopy height statistics by comparing these with ALS derived metrics;

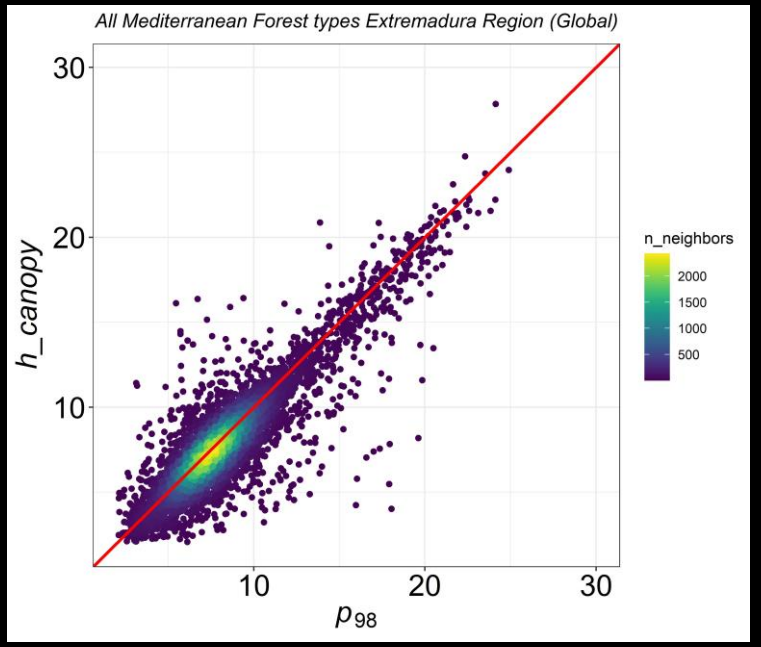
2 Analyze the performance of ICESat-2-derived statistics on canopy metrics (height and cover) to predict AGB;

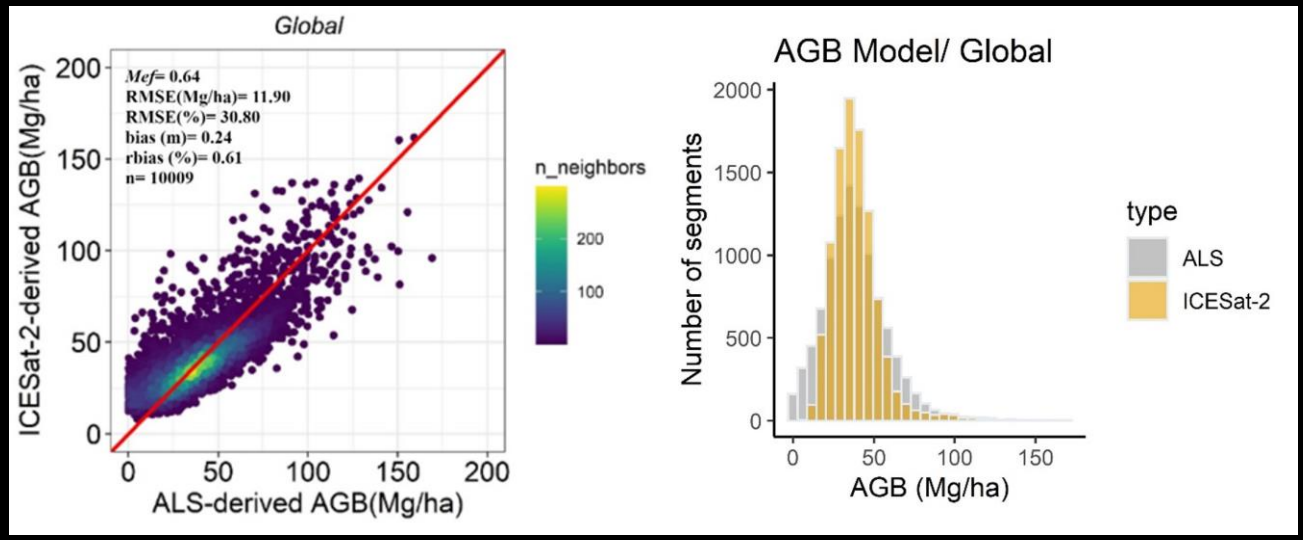
Table 5. Comparison of ALS-based canopy height (p98) and ICESat-2 relative height *h_canopy* (rh98) metrics.

Forest Ecosystem	Metrics comparison	Pearson correlation (r)	RMSE (m)	rRMSE (%)	Bias (m)	rBias (%)
Dehesas	p98 – rh98	0.83	0.95	12.13	−0.26	−3.34
Encinares	p98 – rh98	0.70	2.24	25.62	−0.14	−2.24
Alcornocales	p98 – rh98	0.74	1.71	22.31	−0.46	−6.08
Pinaster	p98 – rh98	0.93	2.22	17.99	−0.56	−4.47
Pinea	p98 – rh98	0.93	1.24	11.94	−0.30	−2.93

Table 6. Summary of ICESat-2-based AGB

		Regression fitting statistics				
Forest type	*Model*	Mef	RMSE (Mg/ha)	rRMSE (%)	Bias	rBias (%)
Dehesas	$AGB = a \cdot hmean_{ICS2}^{b} \cdot CC1_{ICS2}^{c}$	0.74	7.76	19.05	−0.02	−0.05
Encinares	$AGB = a \cdot hquad_{ICS2}^{b} \cdot CC1_{ICS2}^{c}$	0.57	9.05	43.57	0.30	1.47
Alconocales	$AGB = a \cdot hmean_{ICS2}^{b} \cdot CC1_{ICS2}^{c}$	0.66	14.20	55.21	0.80	3.10
Pinaster	$AGB = a \cdot hmean_{ICS2}^{b} \cdot CC2_{ICS2}^{c}$	0.80	17.45	34.09	1.15	2.25
Pinea	$AGB = a \cdot hmean_{ICS2}^{b} \cdot CC1_{ICS2}^{c}$	0.74	17.71	37.54	0.02	0.04
	All SNFI-4 combined Model	**Mef**	**RMSE (Mg/ha)**	**rRMSE (%)**	**Bias (Mg/ha)**	**rBias (%)**
Global	$AGB = a \cdot hmean_{ICS2}^{b} \cdot CC1_{ICS2}^{c}$	0.64	11.90	30.80	0.236	0.61





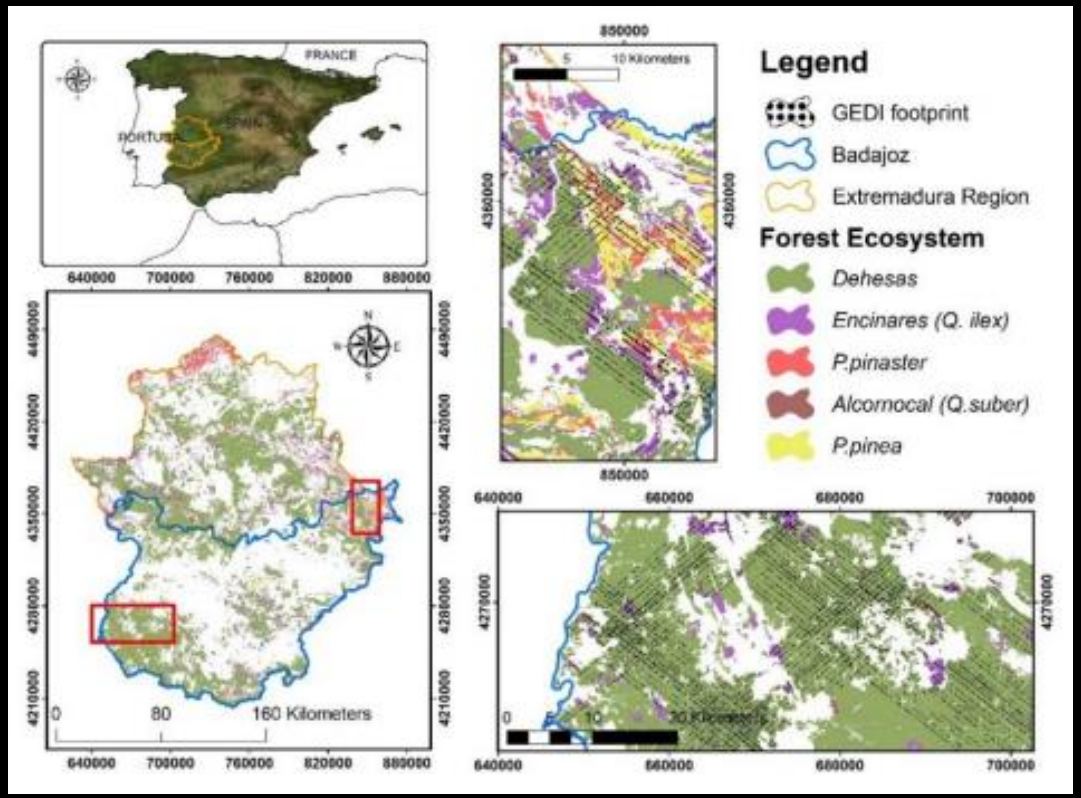
remote sensing

MDPI

Article

Assessing the Accuracy of GEDI Data for Canopy Height and Aboveground Biomass Estimates in Mediterranean Forests

Iván Dorado-Roda [1], Adrián Pascual [2], Sergio Godinho [3,4], Carlos A. Silva [5,6,7], Brigite Botequim [8], Pablo Rodríguez-González [1], Eduardo González-Ferreiro [1] and Juan Guerra-Hernández [8,9,*]

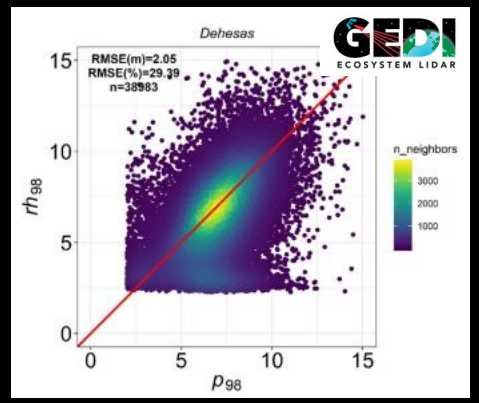


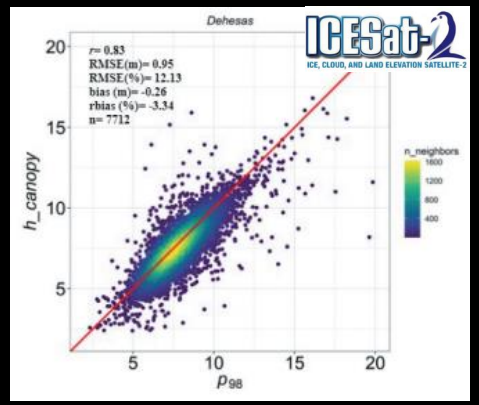
1. Assess the accuracy of GEDI-derived canopy height
2. Analyze the performance of GEDI-based metrics to predict AGB;

1 Assess the accuracy of GEDI-derived canopy height

Table 4. Comparison between the 95th, 98th, and 99th percentile ALS-based forest height (*p*) distribution and GEDI relative height (*rh*) metrics in terms of *r*, RMSE, rRMSE, Bias, and rBias. **In red ICESat-2 results**

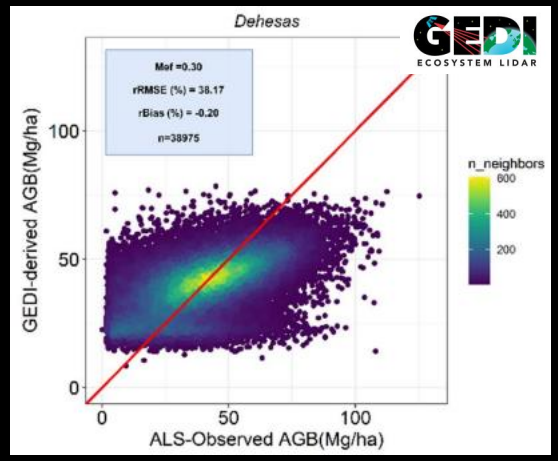
Forest Ecosystem	Metrics Comparison	Pearson Correlation (r)		Root-Mean-Square Error (RMSE, m)		Relative Root-Mean-Square Error (rRMSE, %)	Bias (m)	rBias (%)
Dehesas	*p*95–*rh*95	0.465		2.39		35.45	−1.37	−20.35
	*p*98–*rh*98	0.496	**0.83**	2.05	**0.95**	29.39	−0.51	−7.26
	*p*99–*rh*99	0.497		2.02		28.40	−0.05	−0.70
Encinares	*p*95–*rh*95	0.529		2.03		38.26	0.40	7.52
	*p*98–*rh*98	0.544	**0.70**	2.17	**2.24**	38.68	0.39	7.016
	*p*99–*rh*99	0.545		2.36		41.37	0.82	14.46
Alcornocales	*p*95–*rh*95	0.640		2.03		33.98	−0.80	−13.45
	*p*98–*rh*98	0.651	**0.74**	1.95	**1.71**	31.14	−0.06	−0.99
	*p*99–*rh*99	0.653		2.04		31.87	0.35	5.53
Pinaster	*p*95–*rh*95	0.713		4.17		31.30	−1.69	−12.71
	*p*98–*rh*98	0.716	**0.93**	3.96	**2.22**	28.36	−0.96	−6.86
	*p*99–*rh*99	0.712		3.95		27.68	−0.65	−4.58
Pinea	*p*95–*rh*95	0.718		2.36		29.80	−0.53	−6.76
	*p*98–*rh*98	0.716	**0.93**	2.37	**1.24**	28.29	0.28	3.39
	*p*99–*rh*99	0.709		2.51		30.05	0.70	8.41

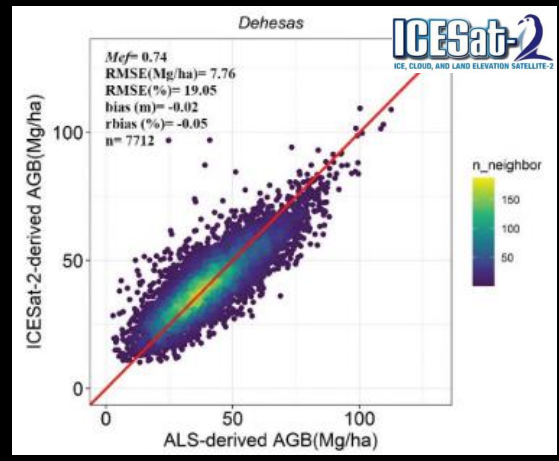


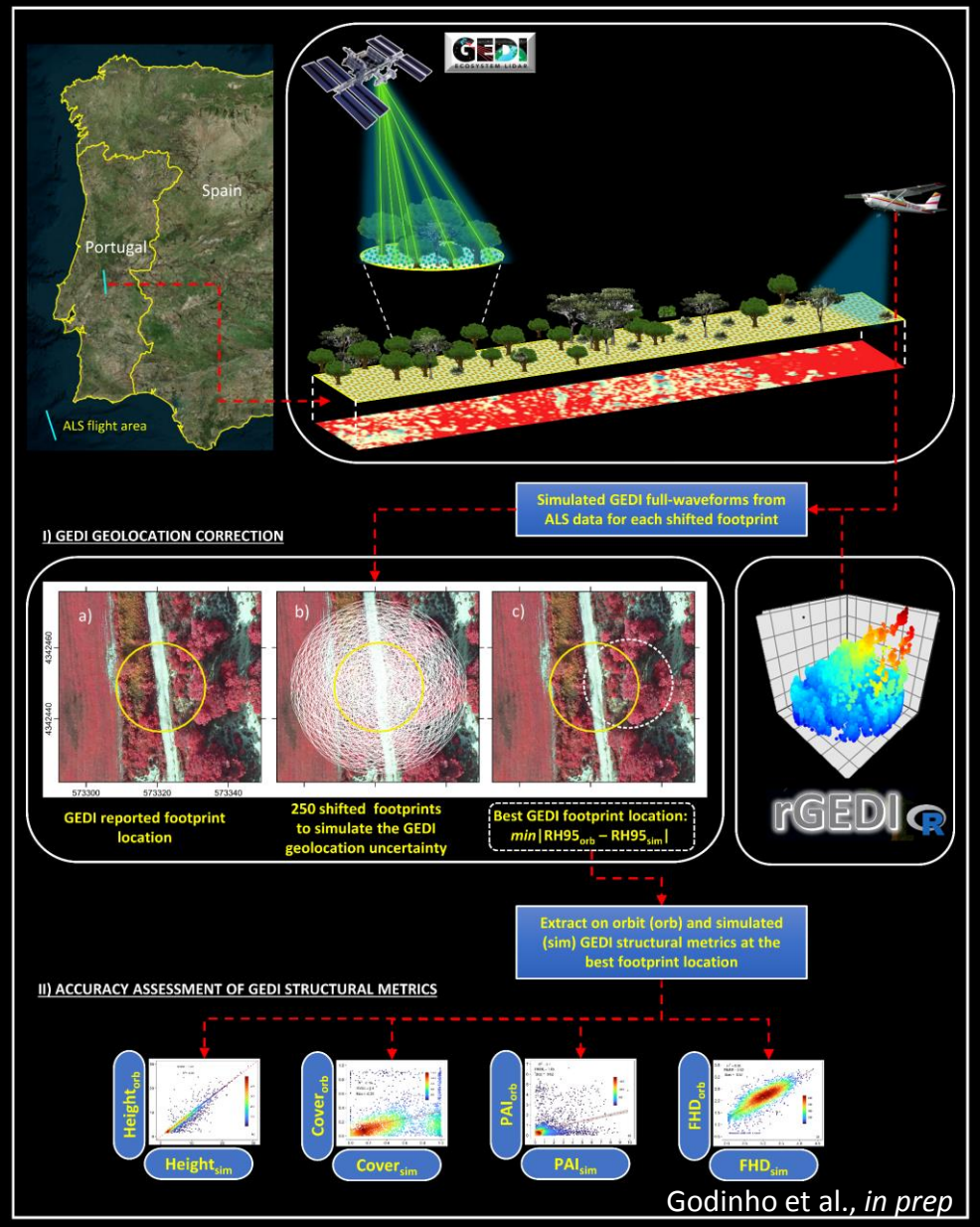


2 Analyze the performance of GEDI-based metrics to predict AGB;

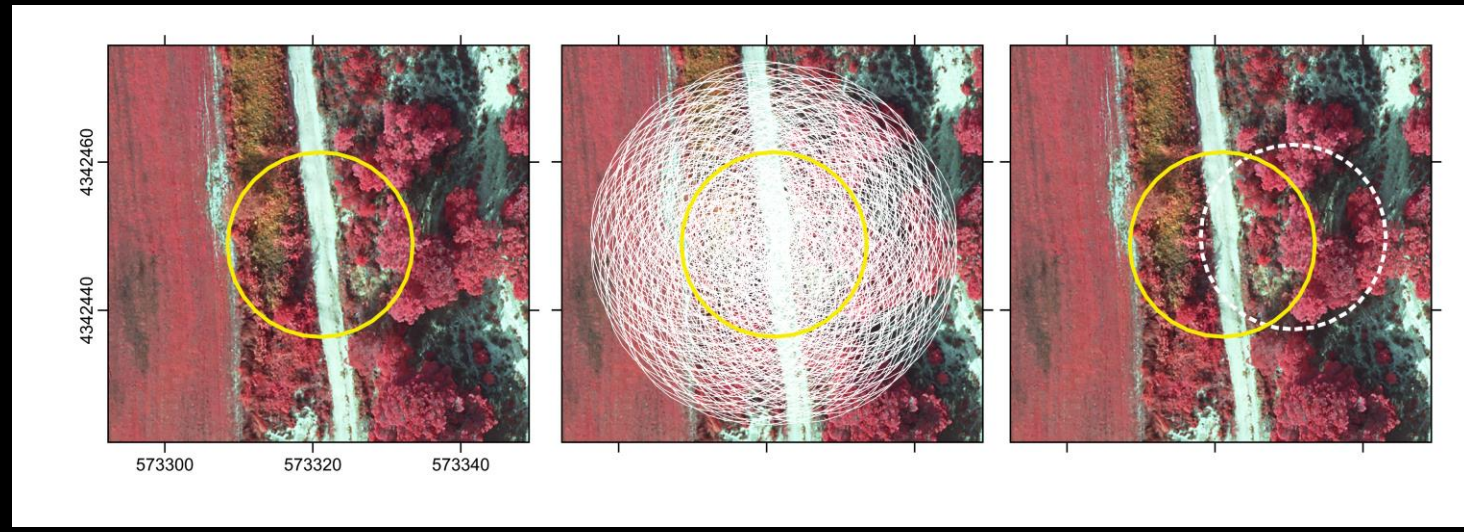
Forest Type	Model	Regression Mef		RMSE (Mg/ha)		rRMSE (%)	Bias (Mg/ha)	rBias (%)
Dehesas	$AGB = a \cdot rh99^b \cdot CC^c_{GEDI}$	0.30	**0.74**	15.38	**15.4**	38.17	−0.08	−0.20
Encinares	$AGB = a \cdot rh90^b \cdot PGP\_THT^c$	0.33	**0.57**	14.13	**9.05**	57.87	0.14	0.65
Alconocales	$AGB = a \cdot rh90^b \cdot FHD^c$	0.38	**0.66**	22.06	**14.2**	84.74	0.71	2.73
Pinaster	$AGB = a \cdot rh98^b \cdot CC^c_{GEDI}$	0.37	**0.80**	32.16	**17.5**	48.19	−0.45	−0.67
Pinea	$AGB = a \cdot rh95^b \cdot CC^c_{GEDI}$	0.46	**0.74**	28.37	**17.7**	63.97	−0.56	−1.27



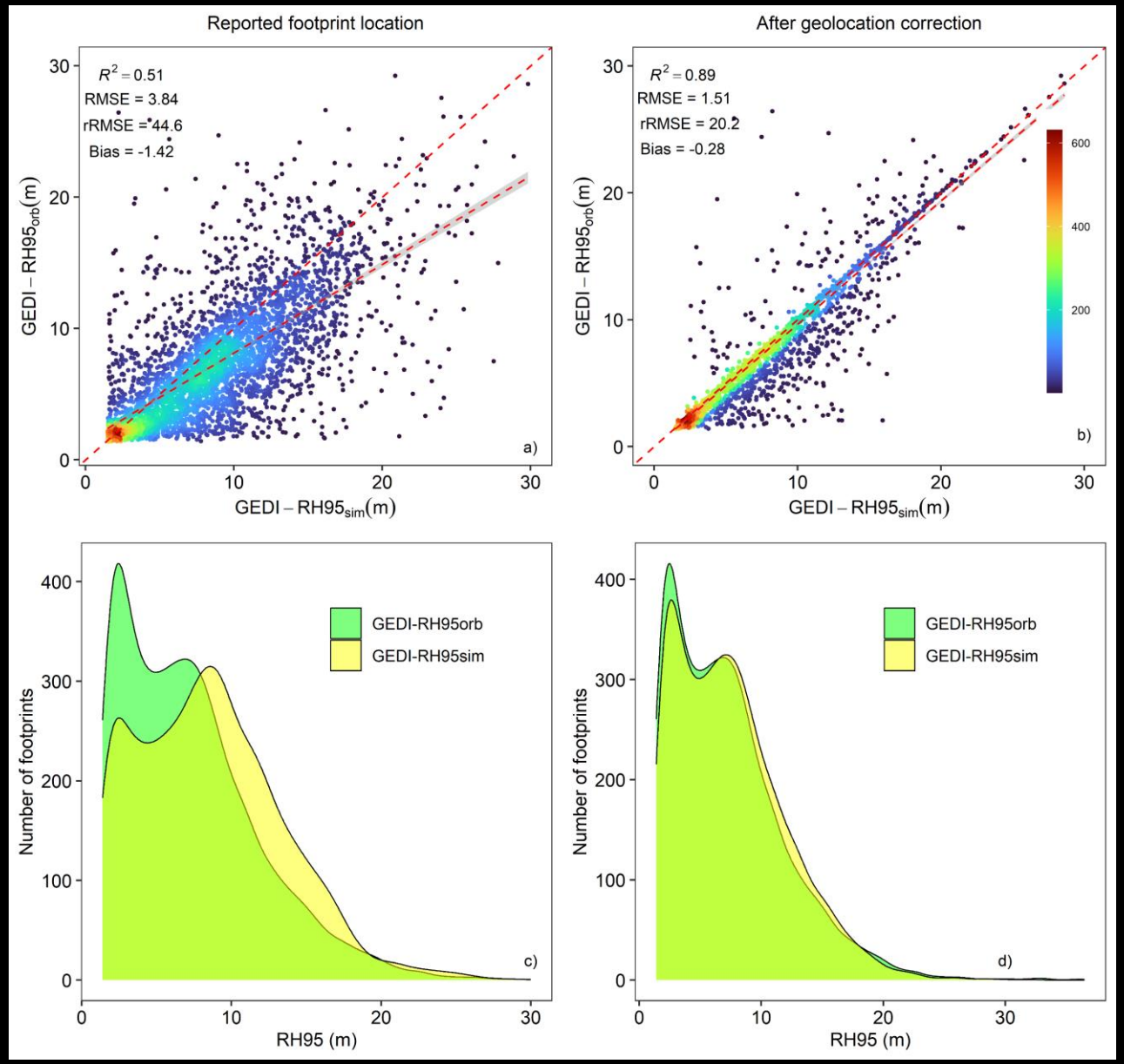




Godinho et al., *in prep*



Canopy Height (RH95)



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GEDI
ECOSYSTEM LIDAR

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Foliage Height Diveristy (FHD)