GlobBiomass: Algorithm Development Overview

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Inputs from the whole team

Regional and global products

GlobBiomass has produced regional and global maps of biomass, together with products indicating the accuracy of these maps.

› The **regional** maps are produced independently by the regional teams for the 2005, 2010 and 2015 epochs, and represent the **best biomass estimates** they can make using whatever data are available. Biomass change maps are also produced.

› The **global** biomass map (for 2010 only) is produced in a consistent way from available global datasets of relevant variables. It aims to be better than any of the existing continental scale maps.

The Algorithm Theoretical Basis Document (ATBD)

The fundamental description of how the biomass products are produced in GlobBiomass is the ATBD. The functions of the ATBD are:

› **Concise** description of the data and methods used to produce the various maps and accuracy products;

› To provide enough detail to allow **replication**;

› To give **reasons** for selecting these data and methods (and not selecting others).

Structure of the ATBD: regional

Regional biomass maps (Poland, Sweden, Kalimantan, Mexico, S. Africa):

a. General description of regions

b. Datasets: input, training, accuracy assessment, validation

c. Methods: pre-processing, biomass estimation, training, assigning accuracy, testing accuracy

d. Products

e. Properties of the regional products

f. Methods to calculate regional biomass change

g. Relation of regional methods and maps to global product

Structure of the ATBD: global

Global biomass map:

    a.   Datasets for input, training, validation, accuracy assessment; Rationale for using these datasets

    b.   Methods: pre-processing, biomass estimation, assigning accuracy)

        -   Several candidate methods: comparison and combination

        -   Converting Growing Stock Volume to Above-Ground Biomass

    c.   Products

Regional comparison: biomass ranges

| Region	Biomass Range (t/ha) (reference data)
Poland	0 – 300 t/ha, roughly uniform distribution
Sweden	0 – 250 t/ha, roughly uniform distribution up to 75 t/ha, then declining in frequency
Indonesia	0 - 400 t/ha, dominated by AGD > 200 t/ha
Mexico	Mostly < 150 t/ha, steady decline in frequency with AGB
South Africa	Mostly < 80 t/ha, largest class is 0 - 10 t/ha, decline in frequency after 40 t/ha

Biomass ranges

Kalimantan

Reference AGB histogram
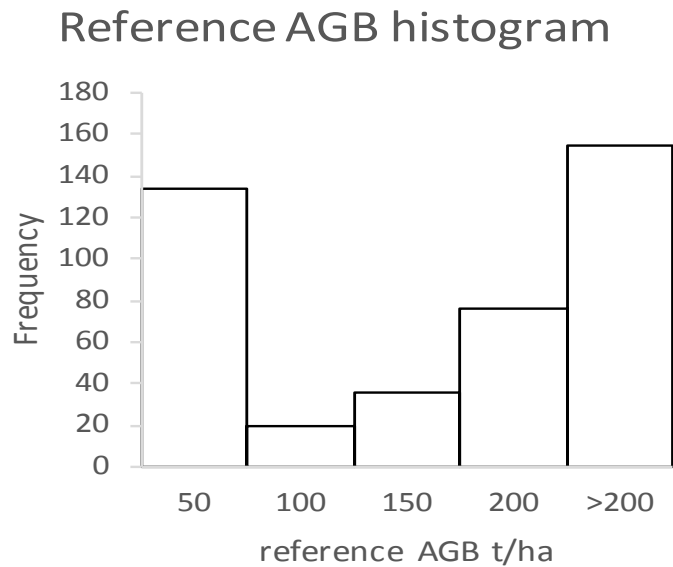
S. Africa
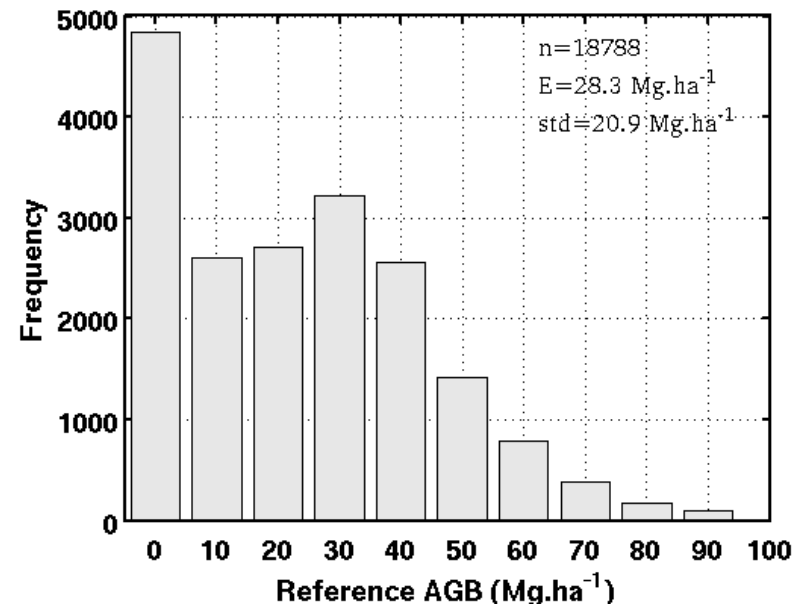
Regional comparison: methods

Region	Primary Data	Primary Method	Reference Data
Poland	PALSAR 25m HH+HV mosaics	RandomForest	Plot data
Sweden	Spot 4/5, PALSAR strips	kNN with Spot 4/5 and NFI data + BIOMASAR approach with multi-temporal PALSAR data.	National Forest Inventory (NFI) plots. Lidar
Indonesia	PALSAR 25m HH+HV mosaics	Regression models including ratio and texture values	Plots + lidar
Mexico	PALSAR 25m HH+HV mosaics, Landsat and DEM	Maximum Entropy	Plots from the Mexican NFI
South Africa	PALSAR 25m HH+HV mosaics	Bayesian approach using the water cloud model	Lidar + plots

Accuracy assessment: Indonesia 2010
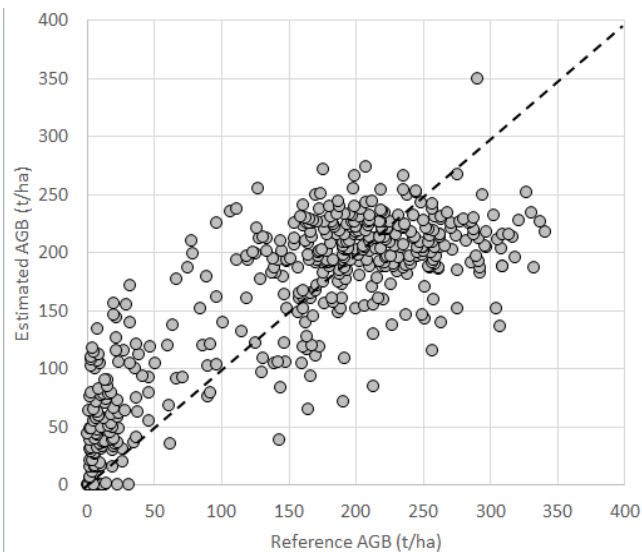
AGB classes (t/ha)	n	Average estimated AGB (t/ha)	Average reference AGB (t/ha)	RMSE (t/ha)	R^2	SD (error) (t/ha)	Bias (t/ha)
0-50	141	50	13	54	0.23	39	37
50-100	21	130	78	71	0.07	50	52
100-150	38	171	132	66	0.08	54	39
150-200	117	194	178	42	0.07	39	16
>200	184	207	247	60	0.01	44	-40
Overall	501	154	149	55	0.69	55	4

Accuracy assessment: Mexico 2010
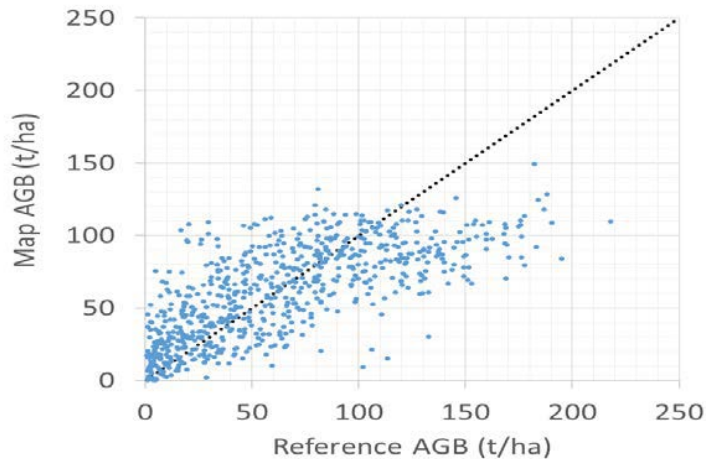
Site	AGB classes (t/ha)	n	Average estimated AGB (t/ha)	Average reference AGB (t/ha)	RMSE (t/ha)	SD(error) (t/ha)	R^2	Bias (t/ha)
Both sites	0-30	213	30.7	13.6	26.6	20.4	0.15	17.1
	30-60	159	55.0	44.1	26.6	24.3	0.03	10.9
	60-90	140	74.4	74.7	22.3	22.3	0.12	-0.3
	90-120	98	85.2	104.6	29.6	22.4	0.00	-19.4
	>120	99	91.8	146.5	58.7	21.3	0.16	-54.7
	Overall	709	60.8	63.6	32.8	32.7	0.51	-2.8

Regional accuracy: general features

All regional data analysis exhibits:
- Overestimation at low biomass
- Underestimation at high biomass (not S Africa)
- Roughly constant residual error (after correcting for bias) across all biomass ranges
  - Poland & Mexico ~20-25 t/ha; Sweden, 25-35 t/ha;
  - Indonesia, ~65 t/ha; South Africa, ~14-21 t/ha

Global accuracy

Estimated using error propagation taking account of:
- radar backscatter measurement errors
- errors in the terms going into the model-based inversion
- geocoding and resampling

Checked against Growing Stock Volume at several sites.

- The importance of bias vs random error in the RMSE varies by biomass range and by region. For Poland, Sweden, Kalimantan (& to some extent Mexico), bias is the crucial issue. For South Africa, random error is dominant except for the lowest biomass class; however, it is still 19% of the 20-40 t/ha class.

- All regions overestimate AGB for AGB < 150 t/ha and underestimate for AGB > 200 t/ha.

- In all regions the random error is almost the same for all ranges; it is an ABSOLUTE ERROR, not a RELATIVE ERROR. SD of error varies with region:

  - Poland & Mexico ~20-25 t/ha; Sweden, 25-35 t/ha;
 - Indonesia, ~65 t/ha; South Africa, ~14-21 t/ha

Accuracy assessment: Poland 2010

2010
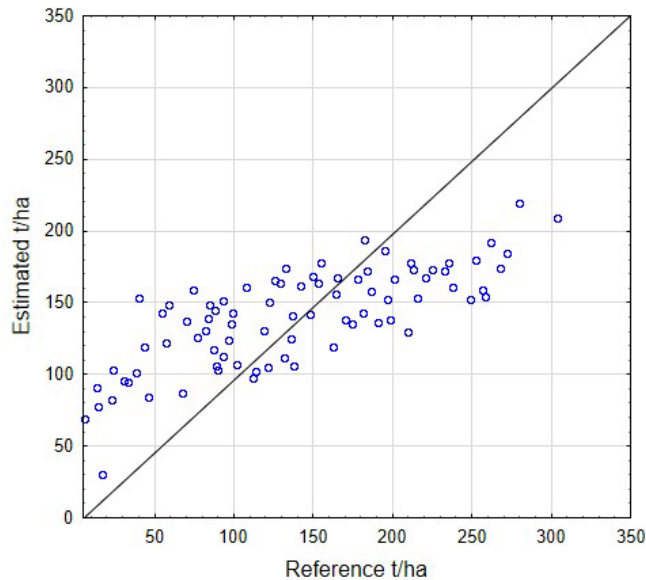
AGB classes (t/ha)	n	Average AGB estimates (t/ha)	Average AGB reference (t/ha)	RMSE (t/ha)	R²	SD(error) (t/ha)	Bias (t/ha)
0-50	13	88.8	25.6	67.0	0.4	23.2	63.2
50-100	19	130.4	81.3	54.4	0.0	24.0	49.2
100-150	17	136.2	127.5	25.7	0.2	24.9	8.7
150-200	16	156.5	177.4	32.1	0.0	25.2	-20.8
200-250	11	172.5	242.4	61.8	0.0	19.8	-58.9
>250	8	184.0	269.1	86.3	0.5	15.5	-85.1
Overall	84	139.6	136.8	53.9	0.6	54.1	2.9

Accuracy assessment: Sweden 2010

NFI vs merged R2=0.42 SE=46SE=57%, N=4147
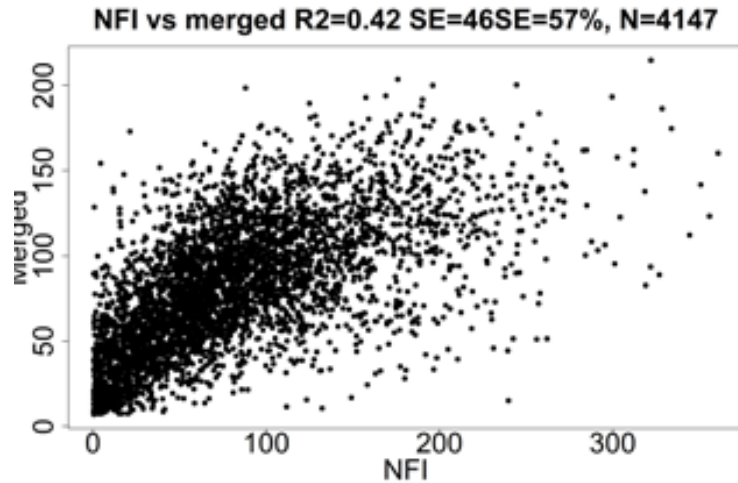
AGB classes (t/ha)	# of validation data	Average estimated AGB (t/ha)	Average reference AGB (t/ha)	RMSE (t/ha)	R²	SD(error) (t/ha)	Bias (t/ha)
0-30	782	40	14	24	0.14	24	26
30-60	807	69	46	35	0.07	26	23
60-90	792	88	74	31	0.03	28	14
90-120	563	101	104	29	0.00	29	-3
120-150	328	108	133	40	0.02	31	-25
150-180	235	117	164	59	0.02	35	-47
180-210	149	124	194	78	0.01	36	-70
Overall	3,805	83	83	30	0.43	30	0

2005
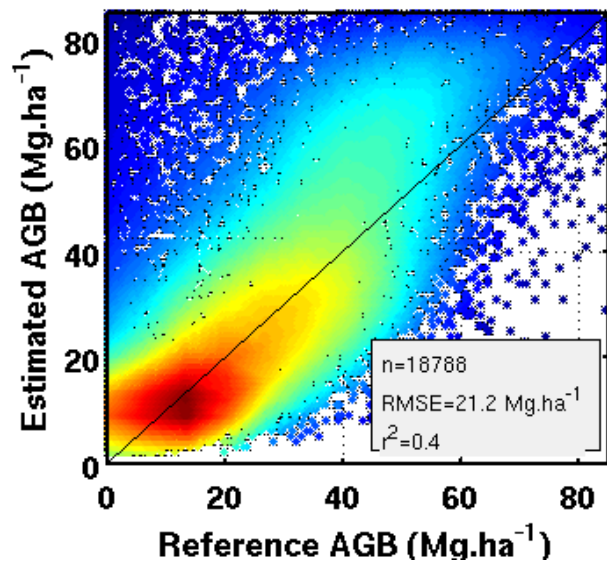
AGB ranges	Nb points	Average AGB estimates (t/ha)	Average AGB reference (t/ha)	RMSE (t/ha)	R²	SD(error) (t/ha)	Bias (t/ha)
0-20	7,441	22.3	7.6	25.7	0.01	21.1	14.7
20-40	5,924	36.2	30.5	18.7	0.07	17.8	5.7
40-60	3,982	53.3	48.2	17.2	0.08	16.4	5.2
60-80	1,163	68.1	67.7	14.0	0.06	14	0.5
All	18,788	36.9	28.3	21.2	0.40	19.4	8.6