

# Supplementary Materials: Mapping Global Forest Aboveground Biomass with Spaceborne LiDAR, Optical Imagery, and Forest Inventory Data

Tianyu Hu, Yanjun Su, Baolin Xue, Jin Liu, Xiaoqian Zhao, Jingyun Fang and Qinghua Guo

**Table S1.** The main literature provided the AGB using allometry equation.

ID	Author	Year	Title	Journal	Plots
1	Keeling and Phillips	2007	The global relationship between forest productivity and biomass.	Global Ecology and Biogeography	55
2	Liu, et al	2013	How temperature, precipitation and stand age control the biomass carbon density of global mature forests	Global Ecology and Biogeography	160
3	Malhi, et al.	2006	The regional variation of aboveground live biomass in old-growth Amazonian forests	Global Change Biology	227
4	Ma, et al	2012	Regional drought-induced reduction in the biomass carbon sink of Canada's boreal forests	PNAS	155
5	Mitchard, et al	2014	Markedly divergent estimates of Amazon forest carbon density from ground plots and satellites	Global Ecology and Biogeography	413

**Table S2.** The distribution of plots in each continents and ecoregions.

Continent	Original	Filtered
Africa	157	118
Asia	2486	1932
Australia	68	49
Europe	163	127
North America	368	317
South America	814	787
Oceania	34	18
Total	4090	3348
Ecoregion	Original	Filtered
Boreal coniferous forest	244	219
Boreal mountain system	57	31
Boreal tundra woodland	19	5
Polar	15	1
Subtropical desert	36	27
Subtropical dry forest	14	10
Subtropical humid forest	976	899
Subtropical mountain system	274	238
Temperate continental forest	269	257
Temperate desert	50	9
Temperate mountain system	838	521
Temperate oceanic forest	87	80
Temperate steppe	90	32
Tropical desert	1	0
Tropical dry forest	41	31
Tropical moist deciduous forest	154	116
Tropical mountain system	59	51
Tropical rainforest	824	812
Tropical shrubland	10	7
Other	32	2
Total	4090	3348

**Table S3.** The national level forest AGB density and biomass stock in this study.

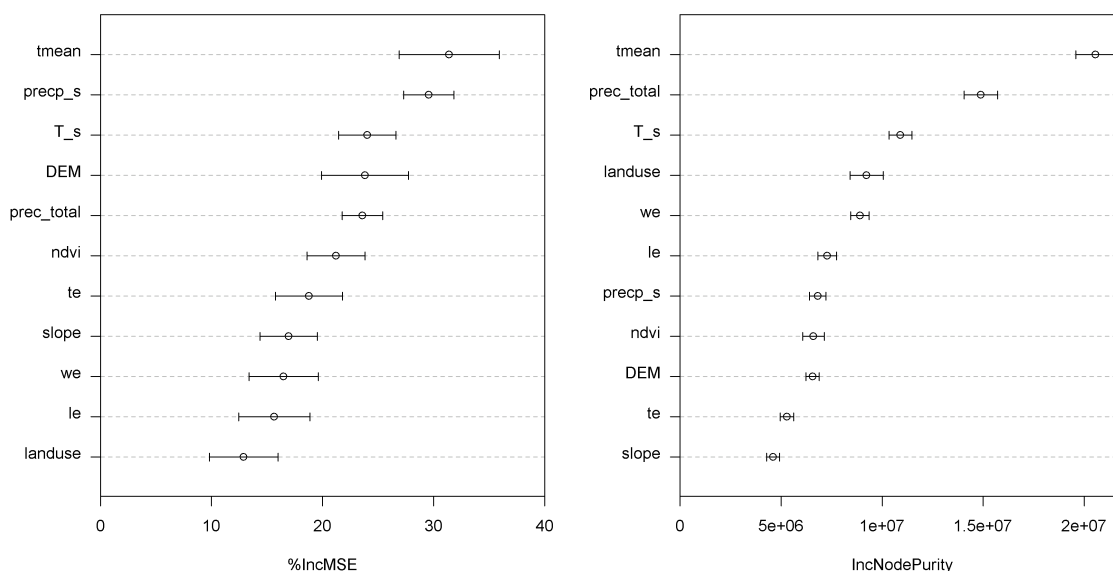
Country	Mean AGB (Mg/ha)	Forest Area (Mha)	Total AGB (Pg)
Angola	221.03 ± 42.44	2.8	0.63
Argentina	163.14 ± 95.93	16.39	3.33
Australia	415.85 ± 131.69	20.28	8.68
Austria	165.56 ± 25.48	3.96	0.66
Belgium	205.02 ± 54.55	0.67	0.14
Bangladesh	297.96 ± 33.34	0.45	0.14
Bulgaria	168.08 ± 22.79	2.68	0.45
Bosnia and Herzegovina	181.86 ± 22.16	1.99	0.36
Belarus	104.72 ± 10.28	7.59	0.79
Belize	302.78 ± 24.54	1.27	0.39
Bolivia	255.94 ± 59.79	38.66	10.45
Brazil	306.79 ± 36.1	317.34	97.44
Brunei Darussalam	279.71 ± 33.71	0.42	0.12
Bhutan	277.98 ± 36.84	2.45	0.68
Central African Republic	355.58 ± 36.77	4.32	1.54
Canada	141.38 ± 64.68	268.81	38.26
Switzerland	203.56 ± 74.53	1.17	0.23
Chile	410.6 ± 104.67	21.11	8.81
China	160.74 ± 45.16	101.34	16.41
Cameroon	373.62 ± 49.06	16.86	6.36
Democratic Republic of the Congo	342.01 ± 49.17	103.67	35.52
Republic of Congo	325.16 ± 52.88	17.72	5.85
Colombia	322.76 ± 53.71	59.34	19.33
Costa Rica	346.5 ± 52.41	1.99	0.7
Cuba	279.08 ± 56.83	1.08	0.31
Czech Republic	142.47 ± 20.76	2.56	0.37
Germany	146.04 ± 44.15	10.95	1.61
Dominican Republic	339.69 ± 39.43	0.66	0.22
Ecuador	328.16 ± 54.17	12.2	4.05
Spain	265.65 ± 67.1	4.2	1.11
Estonia	99.17 ± 8.07	2.53	0.25
Ethiopia	307.51 ± 54.37	2.36	0.75
Finland	89.42 ± 7.99	15.51	1.37
Fiji	316.05 ± 19.23	0.99	0.31
France	261.66 ± 85.86	14.92	4.05
Gabon	354.3 ± 56.66	15.59	5.55
United Kingdom	265.09 ± 87.3	3.22	0.87
Georgia	187.09 ± 27.24	2.21	0.42
Ghana	343.08 ± 27.22	1.42	0.48
Guinea	325.04 ± 31.96	0.51	0.17
Equatorial Guinea	382.23 ± 31.71	1.85	0.7
Greece	163.55 ± 20.46	1.31	0.21
Guatemala	290.15 ± 34.62	3.72	1.08
Guyana	333.05 ± 30.02	15.12	5.02
Honduras	312.28 ± 34.71	3.64	1.14
Croatia	164.64 ± 30.4	1.83	0.3
Hungary	137.06 ± 25.52	0.98	0.13
Indonesia	328.25 ± 43.39	102.79	34.04
India	253.38 ± 61.34	19.46	5.25
Ireland	246 ± 80.9	0.79	0.18
Iran	151.72 ± 17.77	1.19	0.18
Italy	188.72 ± 44.85	5.16	0.98
Jamaica	323.08 ± 23.02	0.37	0.12
Japan	175.78 ± 41.69	22.83	4.03
Kazakhstan	125.04 ± 26.21	1.02	0.13

Table S3. Cont.

Country	Mean AGB (Mg/ha)	Forest Area (Mha)	Total AGB (Pg)
Kenya	334.59 ± 107.12	0.55	0.2
Cambodia	279.47 ± 38.84	4.05	1.15
Republic of Korea	141.72 ± 9.57	4.16	0.59
Lao PDR	276.6 ± 26.71	13.42	3.73
Liberia	350.27 ± 31.01	4.27	1.5
Sri Lanka	279.46 ± 56.08	1.44	0.4
Lithuania	101.31 ± 11.39	1.89	0.19
Latvia	102.98 ± 9.67	3.31	0.34
Madagascar	239.17 ± 66.35	6.34	1.62
Mexico	243.66 ± 50.25	17.83	4.51
Myanmar	289.05 ± 40.36	24.65	7.25
Mongolia	106.86 ± 11.96	2.01	0.21
Malaysia	322.33 ± 35.03	20.64	6.69
New Caledonia	316.87 ± 35.14	0.66	0.21
Nigeria	322.46 ± 45.55	3.59	1.16
Nicaragua	329.52 ± 33.37	3.31	1.1
Norway	210.15 ± 116.76	9.04	1.95
Nepal	230.36 ± 40.42	3.16	0.74
New Zealand	488.69 ± 107.94	12.24	6.07
Panama	335.61 ± 30.78	3.82	1.29
Peru	316.49 ± 34.14	66.13	20.84
Philippines	336.33 ± 29.98	8.97	3.03
Papua New Guinea	357.15 ± 46.76	32.32	11.55
Poland	108.36 ± 23.93	8.78	0.95
Dem. Rep. Korea	143.6 ± 9.1	5.41	0.78
Portugal	253.7 ± 56.38	0.7	0.18
Paraguay	163.04 ± 67.7	6.83	1.28
Romania	163.32 ± 22.88	6.15	1.01
Russian Federation	110.14 ± 23.48	530.48	59.87
Solomon Islands	336.73 ± 25.59	2.13	0.71
Sierra Leone	297.04 ± 32.75	1.4	0.42
Serbia	177.91 ± 24.6	1.61	0.29
Suriname	339.81 ± 26.28	11.31	3.84
Slovakia	170.73 ± 23.31	2.22	0.38
Slovenia	173.12 ± 22.76	1.33	0.23
Sweden	108.11 ± 16.39	26.32	2.82
Thailand	279.58 ± 41.75	7.21	2.05
Turkey	175.62 ± 33.7	4.39	0.77
Taiwan	370.45 ± 79.48	1.76	0.67
Tanzania	231.22 ± 58.5	1.17	0.29
Uganda	391.6 ± 63.5	0.96	0.38
Ukraine	124.65 ± 30.26	7	0.88
United States	180.96 ± 92.44	150.61	27.71
Venezuela	318.49 ± 31.54	36.52	11.63
Vietnam	277.58 ± 34.41	9.35	2.62
Vanuatu	325.07 ± 23.98	0.71	0.23
South Africa	256.31 ± 93.44	1.45	0.4

**Table S4.** The mean AGB and FN differences for each major region.

Region	Map	FN	AGB (Mg/ha)	Our AGB (Mg/ha)
Tropical forest area	Baccini map	0.75 ± 0.2	246.71 ± 79.17	294.37 ± 75.77
	Saatchi map	0.68 ± 0.24	216.04 ± 92.08	
	Avitabile map	0.65 ± 0.23	229.41 ± 120.11	
	Ruesch & Gibbs map	0.72 ± 0.19	330.11 ± 112.13	
North America	Margolis map	0.55 ± 0.17	71.52 ± 24.53	127.6 ± 23.36
	Thurner map	0.34 ± 0.14	43.81 ± 19.72	
	Ruesch & Gibbs map	0.56 ± 0.26	60.49 ± 20.21	
Euro-Asia	Neigh map	0.59 ± 0.18	71.2 ± 34.85	107.8 ± 23.78
	Thurner map	0.34 ± 0.14	43.81 ± 19.72	
	Ruesch & Gibbs map	0.47 ± 0.16	52.66 ± 22.34	
U.S.	Saatchi map	0.64 ± 0.21	153.15 ± 94.3	175.82 ± 70.62
	Blackard map	0.67 ± 0.17	129.80 ± 71.42	
	Ruesch & Gibbs map	0.47 ± 0.17	122.91 ± 101.02	



**Figure S1.** The mean importance of variables for 100 runs AGB estimation Random Forest model, indicated by percentage increase of mean-squared error (%IncMSE) (left) and the increase in node purity (IncNodePurity) (right). The le, we, te, prec\_total, precp\_s, tmean, T\_s, ndvi, and landuse represent the leading edge extent, waveform extent, trailing edge extent, annual total precipitation, annual precipitation seasonality, annual mean temperature, annual temperature seasonality, cumulative NDVI, and landcover type, respectively.

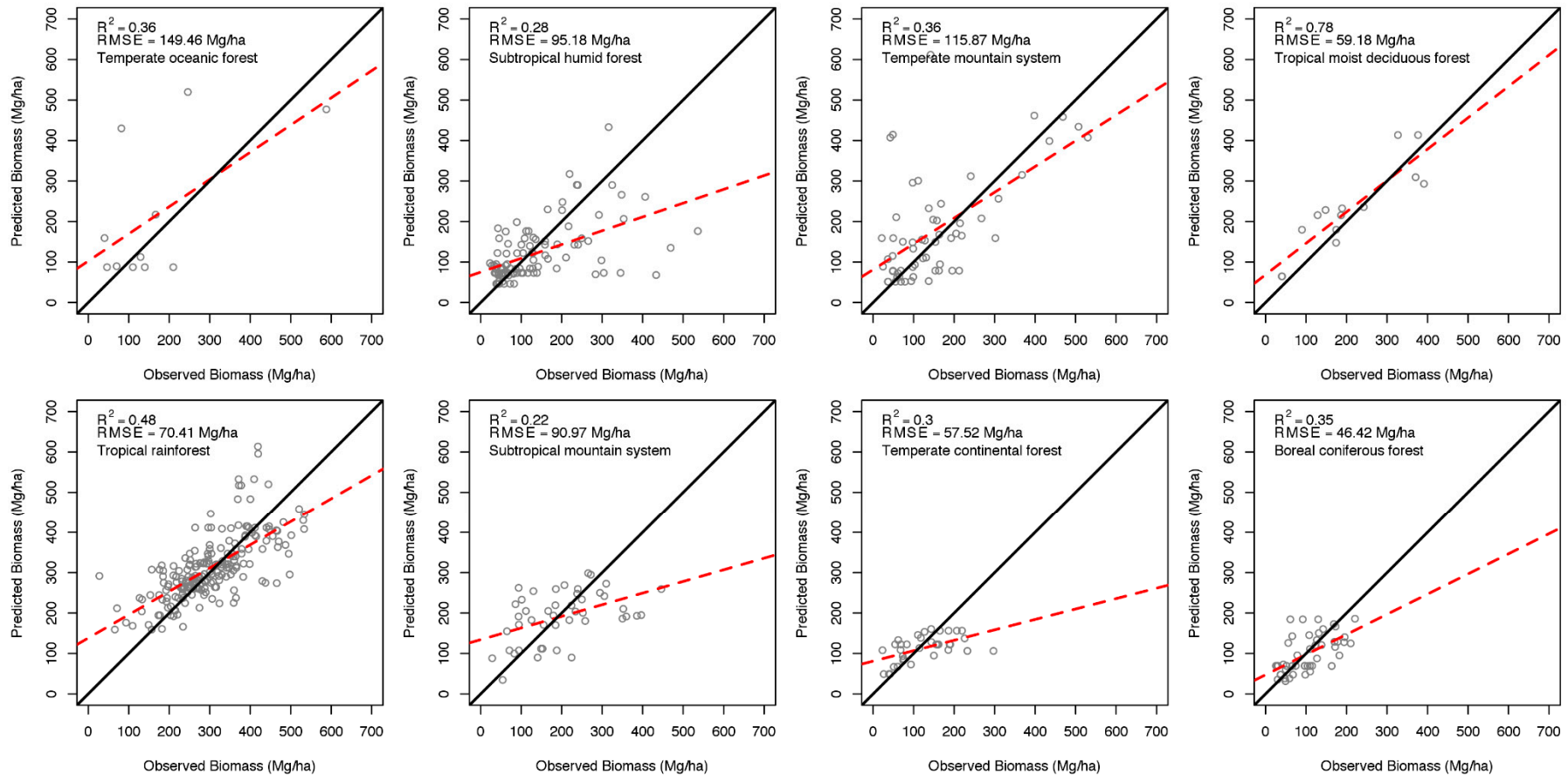


Figure S2. Validation of AGB map at different ecoregions.

