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Supplementary Material

Tab. S1 - Distribution of trees sampled by species harvested to fit allometric biomass equations in secondary tropical forests of the southeast Yucatan peninsula. (N): number of trees; (DBH range): range in diameter at breast height (cm); (H range): range in total tree height (m); (Class): wood density classification (H is high, I is intermediate, and L is low).

No	Scientific name	N	DBH range (cm)	H range (m)	Biomass range (kg)				Wood density (g cm^{-3})	Class
					Stem	Branches	Foliage	Total-tree		
1	*Lonchocarpus rugosus*	13	1.4 - 10	3.10 - 11.0	0.22-32.12	0.08-19.48	0.01-2.34	0.32-47.70	0.80 ± 0.03	H
2	*Pouteria campechiana*	14	1.6 - 9.9	2.50 - 11.0	0.25-26.90	0.08-10.72	0.01-2.69	0.34-36.85	0.79 ± 0.02	H
3	*Malmea depressa*	13	1.5 - 10	3.10 - 10.0	0.23-20.65	0.04-9.85	0.05-2.51	0.32-32.09	0.78 ± 0.01	H
4	*Pouteria unilocularis*	17	1.2 - 10	2.90 - 11.30	0.20-29.95	0.09-25.76	0.06-5.33	0.35-54.98	0.78 ± 0.01	H
5	*Chrysophyllum mexicanum*	15	1.2 - 9.9	2.70 - 12.0	0.09-27.63	0.08-9.82	0.05-3.98	0.24-40.68	0.77 ± 0.01	H
6	*Lonchocarpus xuul*	12	1.4 - 9.9	2.15 - 10.60	0.06-28.04	0.07-17.04	0.04-4.51	0.16-46.82	0.76 ± 0.02	H
7	*Psidium sartorianum*	13	1.3 - 9.5	2.80 - 13.40	0.26-32.48	0.05-19.29	0.02-3.01	0.34-52.97	0.75 ± 0.02	H
8	*Coccoloba diversifolia*	13	1.3 - 9.9	1.50 - 11.80	0.08-25.92	0.01-15.34	0.02-3.55	0.12-40.03	0.74 ±0.03	H
9	*Croton reflexifolius*	15	1.3 - 9.8	2.80 - 11.20	0.01-28.91	0.06-14.12	0.03-3.39	0.11-45.58	0.72 ± 0.002	H
10	*Brosimum alicastrum*	14	1.2 - 10	2.80 - 11.20	0.16-24.21	0.13-12.43	0.09-4.21	0.38-40.86	0.71 ± 0.02	H
11	*Dipholis salicifolia*	18	1.1 - 9.9	2.50 - 10.70	0.11-25.12	0.03-18.90	0.04-2.23	0.17-37.43	0.69 ± 0.01	H
12	*Luehea speciosa*	12	1.4 - 10	2.80 - 10.40	0.16-24.80	0.05-10.28	0.02-1.94	0.23-37.02	0.67 ± 0.02	H
13	*Guettarda combsii*	17	1.2 - 10	2.20 - 10.40	0.03-20.39	0.02-16.43	0.01-3.38	0.15-39.24	0.64 ± 0.01	H
14	*Swartzia cubensis*	14	1.1 - 8.9	2.45 - 11.0	0.12-21.10	0.04-6.80	0.02-1.38	0.23-28.11	0.63 ± 0.03	H
15	*Piscidia piscipula*	15	1.2 - 10	2.20 - 10.80	0.11-23.79	0.00-15.37	0.01-3.17	0.15-37.86	0.62 ±0.02	H
16	*Zuelania guidonia*	14	1.1 - 10	2.20 - 12.20	0.14-27.05	0.04-13.34	0.03-2.57	0.20-39.67	0.62 ±0.01	H
17	*Lysiloma latisiliquum*	15	1.3 - 10	2.60 - 11.20	0.14-23.79	0.03-12.85	0.01-3.46	0.20-31.91	0.61 ± 0.02	H
18	*Licaria campechiana*	16	1.4 - 9.9	3.20 - 9.60	0.19-17.78	0.08-19.48	0.09-7.86	0.36-42.85	0.61 ± 0.01	H
19	*Vitex gaumeri*	12	1.2 - 10	2.75 - 10.60	0.12-20.10	0.02-15.17	0.04-5.71	0.17-34.05	0.52 ± 0.04	I
20	*Simarouba glauca*	14	1.4 - 9.8	2.80 - 9.90	0.20-16.00	0.03-11.06	0.03-2.68	0.20-39.67	0.42 ± 0.01	I
21	*Bursera simaruba*	13	1.5 - 10	3.10 - 10.0	0.16-11.95	0.02-3.41	0.03-0.99	0.22-14.80	0.29 ± 0.02	L
22	*Cecropia peltata*	12	1.1 - 9.9	2.20 - 9.0	0.04-10.90	0.00-6.70	0.01-0.84	0.05-16.18	0.25 ± 0.02	L

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Tab. S2 - Allometric regression models tested for estimating biomass from 22 species with high structural importance in secondary tropical forests. (AGB): above-ground biomass (kg) and can correspond to stem, branch or foliage biomass; (β_0, β_1): regression coefficients of the models to be estimated; (ln): natural logarithm function; (DBH): diameter at breast height (cm); (CF): Correction Factor; (H): total tree height (m); (ρ): wood density (g cm^{-3}) by species. We assumed that the error terms are independent and identically distributed as $\varepsilon \sim N(0,\sigma^2_e)$.

No.	Reference	Allometric regression model
1	Hughes et al. (1999)	$AGB=\exp[\beta_0+\beta_1\ln(DBH^2)](CF/10^6)+\varepsilon_i$
2	Ketterings et al. (2001)	$AGB=0.11^x\beta_0{}^xDBH^{2+\beta 1}+\varepsilon_i$
3	Cairns et al. (2003)	$AGB=\exp[-\beta_0+\beta_1\ln(DBH^2)+\beta_2/2]+\varepsilon_i$
4	Bi et al. (2004)	$AGB=\exp[\beta_0+\beta_1\ln(DBH^{2x}H)]+\varepsilon_i$
5	Chave et al. (2005)	$AGB=\exp[\beta_0+\beta_1\ln(\rho^xDBH^{2x}H)]+\varepsilon_i$
6	Urquiza-Hass et al. (2007)	$AGB=[\beta_0+\beta_1\ln(DBH^{2x}H)](\rho/0.72)+\varepsilon_i$
7	Chave et al. (2014)	$AGB=\beta_0(\rho^xDBH^{2x}H)^{\beta 1}+\varepsilon_i$
8	Soriano-Luna et al. (2015)	$AGB=\exp(-\beta_0)(DBH^{2x}H)^{\beta 1}+\varepsilon_i$

Tab. S3 - Program that can be used to fit a system of biomass estimation equations by tree structural component, stem, branches and foliage, using SAS/ETS®.

```
Prior to simultaneous fit, models I and II were selected from a set of models:

#Read the biomass_tree data

proc import out=groups.biomass #library name and file to save the outputs

datafile="direcction\biomass_tree.csv" #file

run;

#Example of simultaneous fit with model I. where B0 to B5 are regression coefficients
of the parameters to be estimated, ρ is the wood density, DBH is diameter at breast
height (cm), H = total tree height (m). We use the command resid.component_type to
indicate the weights but with the expression included within a square root (sqrt) to
correct the heteroscedasticity of the residuals, as indicated in the material and
methods section (see Alvarez-Gonzalez et al . 2005). The term iv that appears in the
fit command for each parameter indicates that a numerical starting value of the
iterative parameter estimation procedure must be included.

proc model data=groups.biomass;

parms B0 B1 B2 B3 B4 B5;

stem=B0*(ρ*DBH**2*H)**B1;

branches=B2*(ρ*DBH**2*H)**B3;

foliage=B4*(ρ*DBH**2*H)**B5;

total=B0*(ρ*DBH**2*H)**B1+B2*( ρ*DBH**2*H)**B3+B4*(ρ*DBH**2*H)**B5;

resid.stem=resid.stem*sqrt(1/(stem+resid.stem));

resid.branches=resid.branches*sqrt((1/branches+resid.branches));

resid.foliage=resid.foliage*sqrt((1/foliage+resid.foliage));

fit stem branches foliage total start=(B0 iv B1 iv B2 iv B3 iv B4 iv B5 iv)/itsur

out=groups.Model1_simultaneous outest=params outcov;

run;
```

Tab. S4 - Program to fit an equation to estimate the total-tree biomass under an independent approach using SAS/ETS®.

```
proc model data=groups.biomass;

parms B0 iv B1 iv;

DBH2=1/(DBH**2*H); # weighting function

total=B0*(ρ*DBH**2*H)**B1

fit total/breusch=(1 ρ DBH H) out=groups.Model1_independent;

weight DBH2;

run;
```

Tab. S5 – Goodness-of-fit statistics for the regression models fit to 22 tree species. (AGB): aboveground biomass (kg); (ρ): wood density (g cm^{-3}); (β_0, β_1): regression coefficients of the parameters to be estimated; (DBH): diameter at breast height (cm); (H): total tree height (m); (ln): the natural logarithm function; (CF): Correction Factor; (adj-R^2): proportion of variance explained by model; (AIC): the Akaike information criterion. We assume that the error terms are independent and identically distributed as $\varepsilon \sim N(0,\sigma^2_e)$.

No.	Allometric model	RMSE	R^2	AIC
1	$AGB=\beta_0(\rho \times DBH^2 \times H)^{\beta 1}+\varepsilon_i$	11.35	0.94	1509.81
2	$AGB=\exp(-\beta_0)(DBH^2 \times H)^{\beta 1}+\varepsilon_i$	11.15	0.93	1511.87
3	$AGB=\exp[\beta_0+\beta_1 \ln(\rho \times DBH^2 \times H)]+\varepsilon_i$	11.76	0.93	1520.21
4	$AGB=\exp[\beta_0+\beta_1 \ln(DBH^2 \times H)]+\varepsilon_i$	13.98	0.92	1570.87
5	$AGB=\exp[-\beta_0+\beta_1 \ln(DBH^2)+\beta_2/2]+\varepsilon_i$	14.06	0.92	1572.56
6	$AGB=\exp[\beta_0+\beta_1 \ln(DBH^2)](CF/10^6)+\varepsilon_i$	16.64	0.91	1620.51
7	$AGB=0.11 \times \beta_0 \times DBH^{2+\beta 1}+\varepsilon_i$	17.05	0.91	1626.69
8	$AGB=[\beta_0+\beta_1 \ln(DBH^2 \times H)](\rho/0.72)+\varepsilon_i$	11.56	0.82	1516.91