

Multilevel Urban Tree Growth equations

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Model Comparisons

Our approach increased model complexity at each step, first fitting a single weibull curve to all trees, and then allowing all parameters to vary by city, genus, and climate. Table 1 provides short descriptions of the models tested and the brms syntax used. Note, in the code used parameters were rescaled so that all parameters would be on roughly the same order of magnitude. This scaling was omitted from table 1 for clarity.

Table 2 shows the models ranked by the approximate leave-one-out expected log point-wise predictive density ?. Lower values indicate better model predictive performance. The standard error for the elpd difference of 131 between model 6 and model 7 is 21.4, giving strong evidence that model 6 is superior to the other models.

Table 1: model numbers, short descriptions, and brms formula syntax

Model	Description	brms formula syntax
1	No varying parameters	$DBH \sim b0 + b1 * (1 - \exp(-b2 * AGE^{b3}))$ $b0 \sim 1$ $b1 \sim 1$ $b2 \sim 1$ $b3 \sim 1$
2	Parameters vary by city	$DBH \sim b0 + b1 * (1 - \exp(-b2 * AGE^{b3}))$ $b0 \sim (1 City)$ $b1 \sim (1 City)$ $b2 \sim (1 City)$ $b3 \sim (1 City)$
3	Parameters vary by genus and species Species is nested in genus	$DBH \sim b0 + b1 * (1 - \exp(-b2 * AGE^{b3}))$ $b0 \sim (1 Genus / Species)$ $b1 \sim (1 Genus / Species)$ $b2 \sim (1 Genus / Species)$ $b3 \sim (1 Genus / Species)$
4	Asymptote (β_1) varies by climate	$DBH \sim b0 + b1 * (1 - \exp(-b2 * AGE^{b3}))$ $b0 \sim 1$ $b1 \sim gdd * precip$ $b2 \sim 1$ $b3 \sim 1$
5	Growth rate (β_3) varies by climate	$DBH \sim b0 + b1 * (1 - \exp(-b2 * AGE^{b3}))$ $b0 \sim 1$ $b1 \sim 1$ $b2 \sim 1$ $b3 \sim gdd * precip$
6	Parameters vary by city, genus, and species (but asymptote does not vary by city). Growth rate varies by climate.	$DBH \sim b0 + b1 * (1 - \exp(-b2 * AGE^{b3}))$ $b0 \sim (1 City) + (1 Genus/Species)$ $b1 \sim (1 Genus/Species)$ $b2 \sim (1 City) + (1 Genus/Species)$ $b3 \sim precip * gdd + (1 City) + (1 Genus/Species)$
7	Parameters vary by city, genus, and species. Growth rate varies by climate.	$DBH \sim b0 + b1 * (1 - \exp(-b2 * AGE^{b3}))$ $b0 \sim (1 City) + (1 Genus/Species)$ $b1 \sim (1 City) + (1 Genus/Species)$ $b2 \sim (1 City) + (1 Genus/Species)$ $b3 \sim precip * gdd + (1 City) + (1 Genus/Species)$

Table 2: \widehat{elpd}_{loo} is the estimated expected log pointwise predictive density. elpd diff is the difference from the \widehat{elpd}_{loo} of the top model. se elpd loo is standard error of ? for descriptions

	Model	\widehat{elpd}_{loo}	difference
Best	6	-18845.41	0.00
	7	-18976.38	-130.97
	3	-18989.24	-143.83
	2	-19764.48	-919.06
	5	-20180.41	-1334.99
	4	-20195.21	-1349.80
Worst	1	-20513.12	-1667.70