Multilevel Urban Tree Growth equations

erker

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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 sytax 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 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)

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Model	Description	brms formula syntax
		b1 ∼ (1 | City)
		b2 ∼ (1 | City)
		b3 ∼ (1 | City)
3	Parameters vary by genus and species	DBH ∼ b0 + b1 * (1 - exp(-b2 * AGE^{b3}))
	Species is nested in genus	b0 ∼ (1 | Genus / Species)
		b1 ∼ (1 | Genus / Species)
		b2 ∼ (1 | Genus / Species)
		b3 ∼ (1 | Genus / Species)
4	Asymptote (β_1) varies by climate	DBH ∼ b0 + b1 * (1 - exp(-b2 * AGE^{b3}))
		b0 ∼ 1
		b1 ∼ gdd * precip
		b2 ∼ 1
		b3 ∼ 1
5	Growth rate (β_3) varies by climate	DBH ∼ b0 + b1 * (1 - exp(-b2 * AGE^{b3}))
		b0 ∼ 1
		b1 ∼ 1
		b2 ∼ 1
		b3 ∼ gdd * precip
6	Parameters vary by city, genus, and species	DBH ∼ b0 + b1 * (1 - exp(-b2 * AGE^{b3}))
	(but asymptote does not vary by city).	b0 ∼ (1 | City) + (1 | Genus/Species)
	Growth rate varies by climate.	b1 ∼ (1 | Genus/Species)
		b2 ∼ (1 | City) + (1 | Genus/Species)
		b3 ∼ precip * gdd + (1 | City) + (1 | Genus/Spe
7	Parameters vary by city, genus, and species.	DBH ∼ b0 + b1 * (1 - exp(-b2 * AGE^{b3}))

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Model	Description	brms formula syntax
	Growth rate varies by climate.	b0 ∼ (1 | City) + (1 | Genus/Species)
		b1 ∼ (1 | City) + (1 | Genus/Species)
		b2 ∼ (1 | City) + (1 | Genus/Species)
		b3 ∼ precip * gdd + (1 | City) + (1 | Genus/Spe

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

	Model	$\widehat{elpd}_{\text{loo}}$	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

Table 2 shows the models ranked by the approximate leave-one-out expected log pointwise 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.