# Multilevel Urban Tree Growth equations

erker

November 19, 2018

## 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. ##+begin$_{\text{table}}$ ##+end$_{\text{table}}$

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.

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<br>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 ($\beta_1$) 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 ($\beta_3$) 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, species<br>(but asymptote does not vary by city).<br>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, species.<br>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: $\widehat{elpd}_{\text{loo}}$ 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 |