# Live fast-die young: Scaling CO2 fertilization effects from leaf to ecosystem levels

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## Approach

Rising $CO_2$ atmospheric concentrations have been reported to increase photosynthesis by increasing light use efficiency and water-use efficiency.

**We want to test if a leaf-level $CO_2$ fertilization effect (increased light use efficiency) leads to an increase in the biomass stock in forest stands.**

Do increased $CO_2$ assimilation and enhanced tree growth rates …

- … automatically lead to increased biomass storage, while biomass turnover rates remain constant, or…
- … accelerate a tree's lifecycle, while a constant self-thinning relationship precludes an increase in stand-level biomass (Live-Fast-Die-Young Hypothesis)?

Increasing photosynthetic light use efficiency (LUE) leads to higher biomass stocks and to a shift upwards in the self-thinning relationships, with more dense stands and bigger trees.

The negative relationship between longevity vs. growth rates arises from variations between species, but hasn't been confirmed when looking at variations between sites.

Next steps: To explore alternative mortality formulations and their implications for the links between changes in leaf-level C assimilation and stand-level biomass stocks.

RSOFUN package and example application of LM3-PPA

## Methods and preliminary results

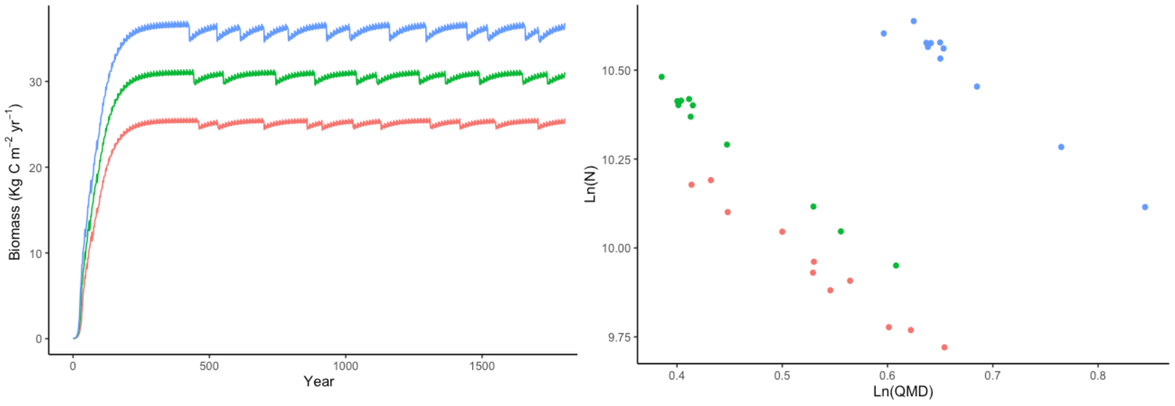
### Which model do we use?

We use a Vegetation Demography Model, **LM3-PPA** (Weng et al. 2015), which combines representations of cohort-level forest stand dynamics and biogeochemical cycling. It is implemented as part of the **rsofun** R package (stineb.github.io/rsofun).

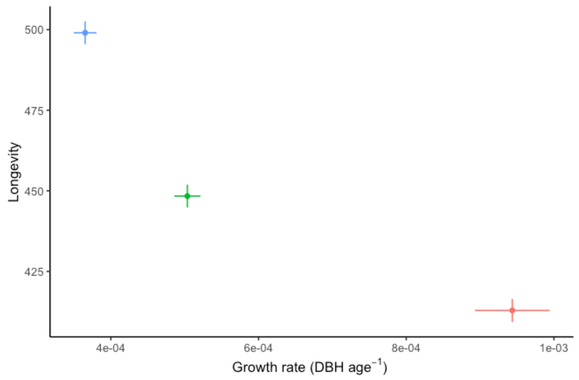
### What advantages does the LM3-PPA model have?

LM3-PPA simulates vegetation dynamics and biogeochemical processes by explicitly scaling from leaf up to ecosystem level by resolving leaf-level physiology, growth, and height-structured competition for light, using the perfect plasticity approximation (PPA). Woody biomass turnover is not prescribed but emerges from light competition and size-dependent mortality.

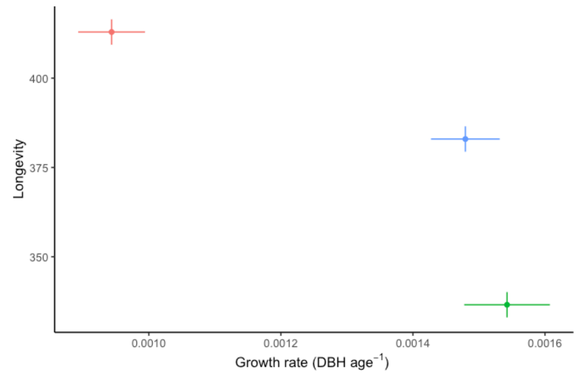
Levels of Light Use Efficiency




Levels of Wood density




Levels of Light Use Efficiency




Legend 1 - Low 2 - Medium 3 - High