Evidence that growing season length and tree growth are decoupled in an urban arboretum

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Anthropogenic climate change affects many natural systems at the global scale. The most frequently observed biological impact of climate change—shifts in the timing of recurring life history events (phenology)—is likely to have cascading/additional/knock-on effects. For trees, shifted phenology has extended the vegetative growing season, which is widely expected to increase tree growth, with important effects on forest carbon sequestration dynamics. However, multiple recent studies have failed to find this relationship and suggested shifts in drought or competition may prevent increased growth. Here, we address this decoupling by leveraging two unique datasets of vegetative phenology and growth (tree rings) data, one from a common garden and the other from a citizen science program

With these two datasets, we aim to provide an explanation for the recently observed decoupling between growing season length and tree growth.

First, with the common garden project, we monitored leaf phenology for three years for 75 juvenile trees of four species and four provenances, and we collected cross sections for which we have seven years of growth data through tree rings. Second, we leverage nine years of phenology data collected by citizen scientists, and we collected tree cores from 50 of these mature trees. We analysed how the growing season length drives tree growth across our studied species using a Bayesian hierarchical model. Our observational projects provide the rare opportunity to investigate the relationship between growth and vegetative phenology in an urban Arboretum, where drought and competition are limited

Across our 14 deciduous tree species of different age classes over 10 years of growing season length data spanning 111 to 157 days, we found contrasting evidence that trees grow more during longer seasons. Indeed, nine of our studies species did not change their growth, two grew less and three grew more with longer seasons. Fast growth species should take opportunistically shift their growth with changing conditions. However, our results indicate that some slow growth, conservative species, were the most responsive to changing season length. In addition, by comparing juvenile and mature trees, we show contradicting evidence from the litterature where the growth of juvenile trees was less flexible than the mature trees. Moreover, with the common garden study we show an absence of any local adaptation that would affect tree growth with potential consequences in assisted migration efforts.

In addition, the common garden data support the recently observed decoupling between growing season length and growth, but suggest it may be driven by other constraints than currently proposed.

Together, our two studies support the recently observed decoupling between tree growth and growing season length and even rule out drought and competition as potential growth inhibitors. This could substantially affect future forest carbon sequestration dynamics in the context of a rapidly changing climate.