# 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 located in an urban Arboretum, where drought and competition are limited With these two datasets, we aim to provide an explanation for the recently observed decoupling between the growing season length and tree growth. First, with the common garden project, we monitored leaf phenology for three years across four species and four provenances (75 individuals), and we collected cross sections spanning seven years of growth data through tree rings. Second, we leverage nine years of phenology data collected by citizen scientists across 11 species of mature trees (50 individuals), which we relate to their tree rings. We analyzed how the growing season length drives tree growth across our studied species using a three-level Bayesian hierarchical model. 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 species did not change their growth, two grew less and three grew more with longer seasons. Fast-growth species should opportunistically shift their growth with changing conditions. In contrast, our results suggest that some of the most responsive species to changing season length were slower-growing, conservative species. In addition, our juvenile and mature tree comparison shows that juvenile trees were less flexible than the mature trees, which differs from some previous studies. Moreover, with the common garden study, we show an absence of clear local adaptation, suggesting provenance effects may be weak for growth under current conditions, which could inform assisted-migration strategies. Together, these two complementary datasets indicate that longer growing seasons do not uniformly increase tree growth in an urban Arboretum, and that factors other than drought and competition may underlie this observed decoupling. This could substantially affect future forest carbon sequestration dynamics in the context of a rapidly changing climate.