Photosynthetic responses to climate warming differ among forest plant species in a temperate – subtropical forest ecotone

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Introduction

Northern Florida is currently located on the boundary of a subtropical and temperate climate. However, average temperatures in the region are expected to increase 1-2 ºC, heralding a shift to a tropical climate. The purpose of this study was to determine how warming may impact the physiological performance of local flora. We asked the following questions:

- Do species differ in their physiological response to warming?
- Are physiological responses to warming dependent on soil moisture?

Figure 1. Photos of the four species included in this study.

Species included in this study are shown above:
1. *Serenoa repens* (saw palmetto)
2. *Pinus palustris* (longleaf pine)
3. *Andropogon glomeratus* (bushy bluestem)
4. *Quercus laevis* (turkey oak)

Materials and Methods

- **Treatments:** The four species (Figure 1) were grown under ambient or warmed conditions in the Sawmill Slough Preserve on the UNF campus. Treatments were paired and replicated 6 times (Figure 2).
- Air temperature in each plot (ambient, warmed) was measured at 15-minute intervals using HOBO climate sensors
- **Measurements:** leaf photosynthesis, stomatal conductance, and water use efficiency (measured with LiCor 6800 portable photosynthesis system), plant growth and phenology, and volumetric soil water content (VWC)

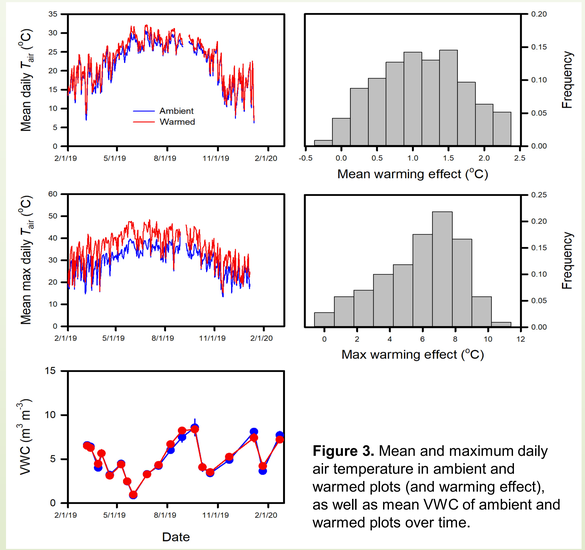

Figure 3. Mean and maximum daily air temperature in ambient and warmed plots (and warming effect), as well as mean VWC of ambient and warmed plots over time.

- Mean daily air temperature was ~1.5 ºC higher in the warmed plots compared to ambient (Figure 3)
- Mean max air temperature was ~5.6 ºC higher in the warmed plots on average
- VWC varied over time (1-9 m^3 m^{-3}) but did not differ between ambient and warmed plots (Figure 3).

Figure 2. Photo of one of the six paired (ambient, blue; warmed, red) plots.

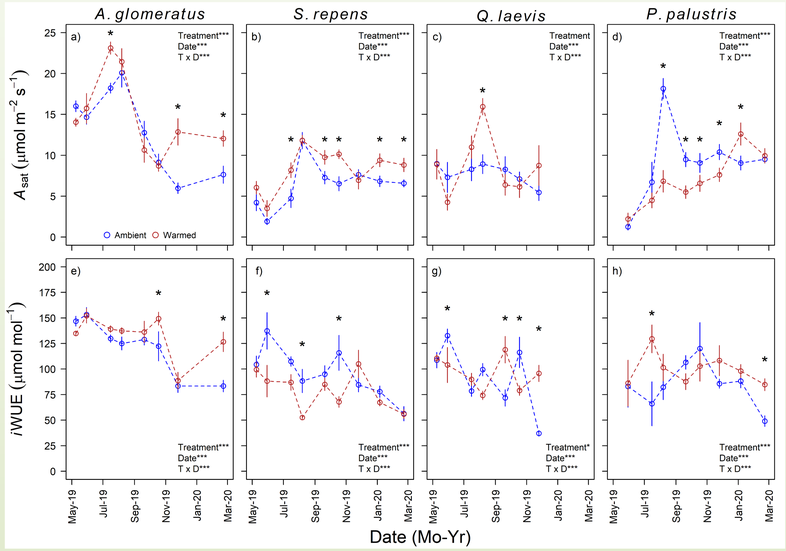

Figure 4. Rates of leaf photosynthesis (A) and the water use efficiency (iWUE) of leaves of all four species in ambient and warmed plots over time.

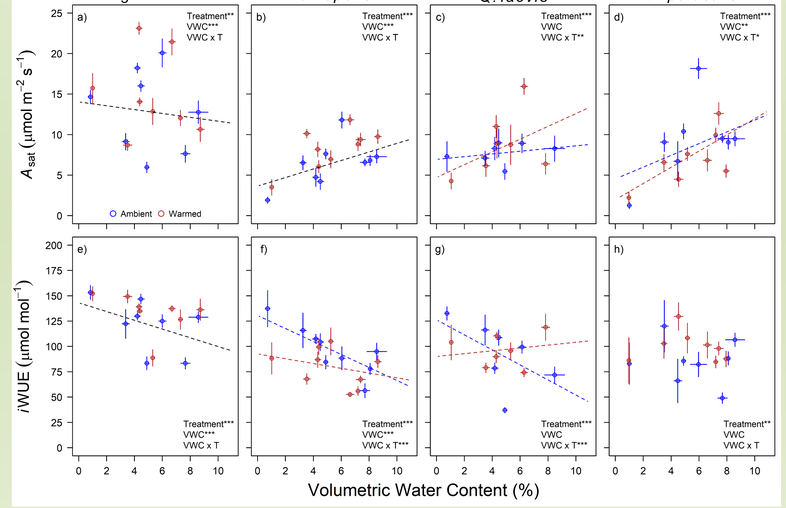

Figure 5. Rates of photosynthesis (A) and the water use efficiency (iWUE) of leaves of all four species in relation to the volumetric soil water content (VWC) in the ambient and warmed plots.

Results

- Warming increased photosynthetic rates in *A. glomeratus* and *S. repens*
- Warming had little or inconsistent effects on photosynthesis in *Q. laevis*
- Warming tended to reduce photosynthesis in *P. palustris*
- iWUE increased with warming in *A. glomeratus*, and decreased with warming in *S. repens*
- Photosynthesis showed no response to VWC in *A. glomeratus*
- Photosynthesis increased with VWC in *S. repens*
- Warming increased photosynthesis in *Q. laevis* *only* when VWC was high
- Warming reduced photosynthesis in *P. palustris*, particularly at low VWC

Discussion

- Warming tended to increase photosynthesis in species with adaptations to high temperature or tropical distributions, but reduced photosynthesis in both tree species, especially when soil moisture was low.
- These results indicate that grasses and shrubs may increase carbon uptake, and potentially productivity, with warming while trees may show reduced carbon uptake. Thus, warming may alter the structure and function of North Florida forests.

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