Eight Years of Manipulative Treatments Alters Fine Root Production, Root traits, and Fungal Biomass

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INTRODUCTION

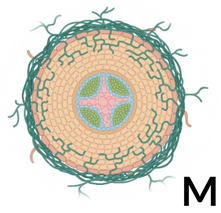
Fine-root traits and fungal interactions are central to nutrient cycling and ecosystem function, particularly under a changing climate. Root morphology and production are closely linked to fungal associations that facilitate plant nutrient acquisition. Ergosterol, a fungal cell wall component, serves as a proxy for fungal biomass and reflects shifts in free-living fungi as well as mycorrhizal fungi. In warmed SPRUCE plots, the dominance of shrubs has been increasing aboveground, likely paralleled by shifts in belowground plant biomass and fungal interactions. Previous studies have shown that warming more strongly influences root traits than CO_2.

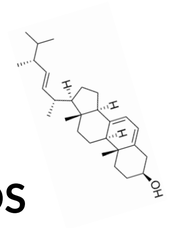
HYPOTHESES

H1. As in earlier years of the experiment, shrub fine root production will increase with warming but eCO_2 will have a minimal impact (Malhotra et al. 2020)

H2. Due to increased plant nutrient demand, warming will be associated with an increase in fine root diameter as plants rely more on mycorrhizal fungi for nutrient acquisition (Bergmann et al. 2020)

H3. Ergosterol will increase with temperature to a point but then will decrease in strongest warming treatments due to moisture constraints.

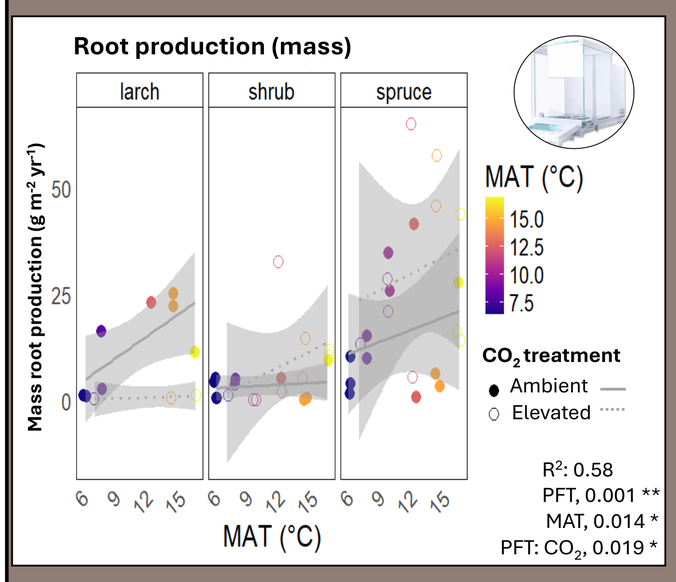


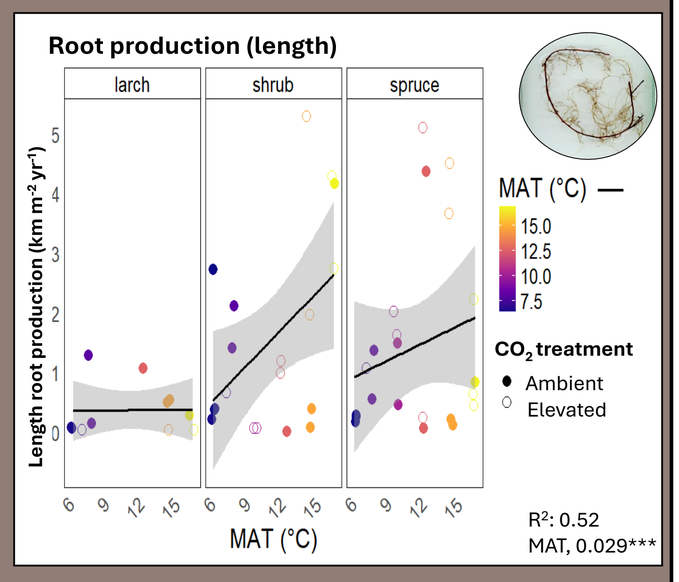


METHODS

- Ingrowth cores were deployed from 2023-2024 in hummocks and hollows across 12 plots under levels of warming and either ambient or elevated CO_2. Cores were frozen and cut into two depth increments (0–10 cm, 10–20 cm) for processing. After thawing, roots were removed, scanned for morphological traits, and ~1.5 g of fresh peat was subsampled for ergosterol extractions.
- Root production was summed for the two depth intervals and analyzed using a linear regression model with terms for topography, CO_2 treatment, and mean annual temperature (MAT).
- Ergosterol results were analyzed using a linear regression model with terms for depth interval, topography, CO_2 treatment, and MAT.

PRELIMINARY RESULTS

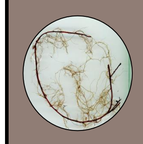




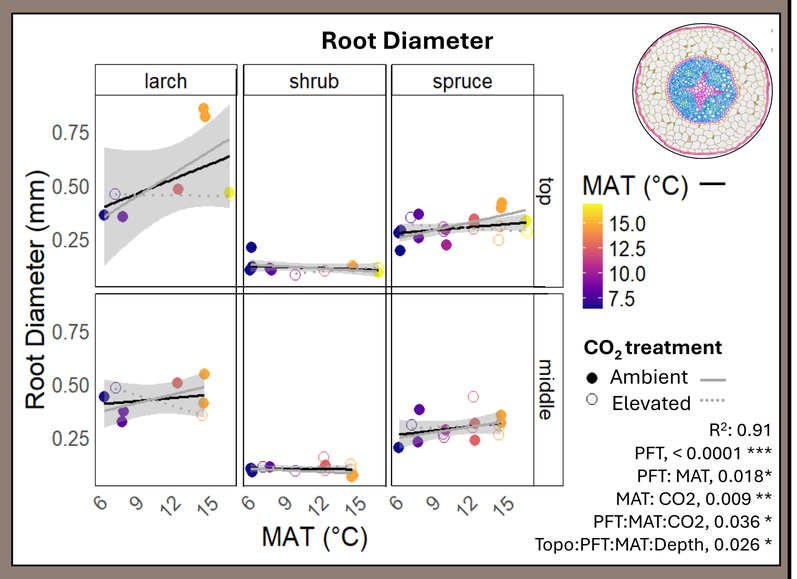
Fine root production

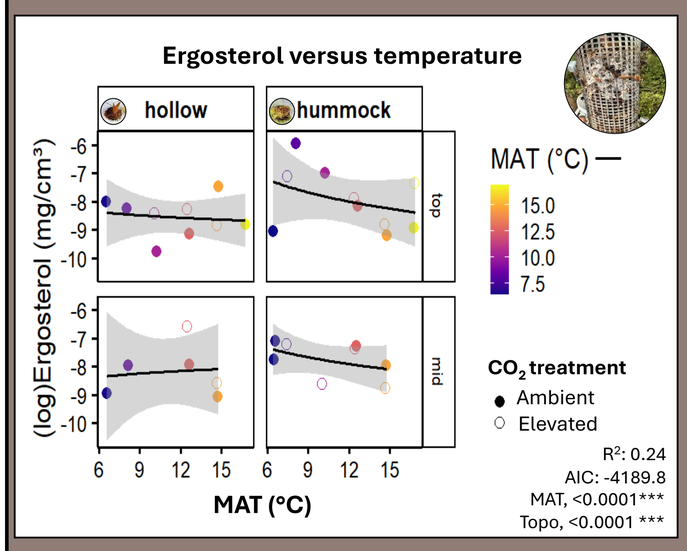
- Fine root production increases with temperature when calculated by a mass or length.
- Differences between plant functional types (PFTs) and the influence of the eCO_2 treatment were only significant when root production was analyzed per unit mass.

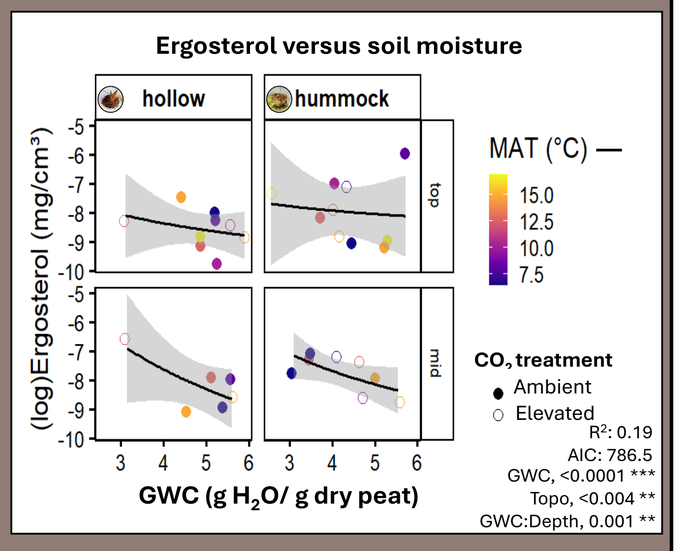
Root D



- Root D is influenced by PFT, depth, CO_2, and temperature.
- Trees generally have higher root diameter with warming but in larch this effect is dampened by eCO_2.
- Diameter of shrub fine roots shows little response to treatments.

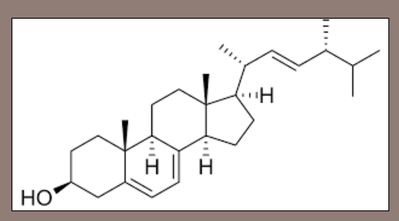




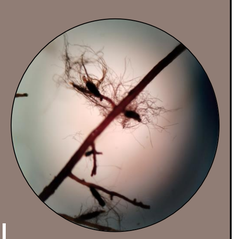


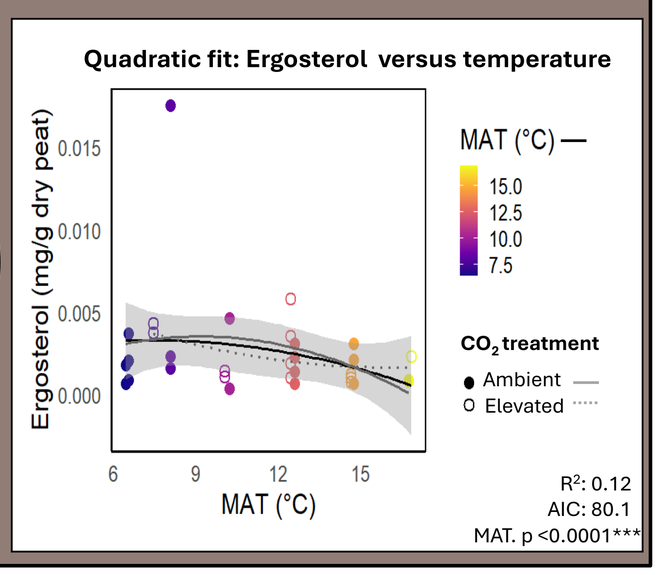
Ergosterol

- Extractable ergosterol declined with both MAT and gravimetric water content (GWC) and was shaped by microtopography.
- Microtopography was consistently a strong predictor of extractable ergosterol.



- Across all samples, ergosterol showed a weak unimodal relationship with MAT.
- MAT and GWC were not correlated, so lower ergosterol levels at higher MAT can not necessarily be attributed to dry conditions.





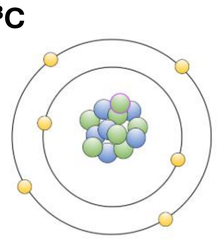
CONCLUSIONS

- H1 was partially supported: fine-root production (g m-2 y-1) increased with temperature and was higher in plots under eCO_2.
- H2 was partially supported: fine root diameter of trees increased with temperature
- H3 was partially supported: Ergosterol extracted from bulk peat was lower at the highest warming treatments. but this could not be attributed to drying. Topography was an important predictor of ergosterol.
- Temperature and moisture vary independently across microtopographic positions and depths, suggesting that fungal presence may respond to complex interactions associated with these microsites.

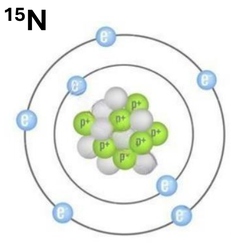
FUTURE DIRECTIONS

- The mechanisms driving fungal biomass responses remain unclear, and further investigation into fungal species-specific dynamics are needed. We will therefore be extracting ergosterol from shrub, larch, and spruce roots next.
- We will also analyze these root tissue for ^{13}C and ^{15}N as well as %C and %N.
- In 2025, we will sample fine root biomass pools at SPRUCE so that we can understand pools versus fluxes at SPRUCE.

^{13}C



^{15}N



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