**Title:** Thermal sensitivity of canopy versus understory leaves: patterns, mechanisms, and ecological implications

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## Abstract

## Introduction

**As the climate warms, understanding forest responses to temperature is critical.** Forest canopy microclimate buffering is emerging as important for forest ecology in an era of climate change.

* Forest canopies buffer temperatures and other conditions
  + Zellweger *et al.* (2020)

We’re seeing increasing evidence that this impacts the ecology, with potential feedbacks to climate change. - Zellweger *et al.* (2020) - (Suggitt et al. 2018, Scheffers et. al 2014) - Larger trees suffer more during drought (Bennett et al. 2015) and may be partially influenced by temperature

**However, we lack a systematic understanding of biophysical and biological patterns across this gradient, how these affect leaf-level processes, and in turn how it affects ecology (Fig. 1).**

This review addresses the following questions:

1. How does the biophysical environment vary with height in forests?
2. How do leaf traits vary with height (or between sun and shade leaves) in forests?
3. How do biophysical environment and traits combine to affect leaf temperature?
4. How does leaf metabolism respond to temperature in canopy and understory settings?
5. What are the implications of these patterns for the ecology and climate change responses of canopy versus understory trees?

\*Our primary interest is the height gradient from the top of the canopy to the understory in forests. However,



**Figure 1. (schematic of a forest summarizing most important gradients.** Current fig is just a rough illustration of how this might look – a draft figure that KAT had on hand illustrating hypotheses (ignore specific content). We could have a set of arrows for each of the major categories considered here. This would be a key figure, and should be beautifully illustrated—KAT could do a watercolor, or Nidhi could illustrate).

## The biophysical environment



**Figure 2. Vertical gradients in the biophysical environment, from NEON data.** Current figure is old version from Ian McGregor’s in-review paper, showing NEON data from SCBI. We could modify his code to analyze all forested NEON sites. We obviously wouldn’t present this much info per site.

## Trait variation

## Leaf temperature

## Leaf metabolism and thermal stress

## Ecology

## Future Questions

## Conclusions

## References

Zellweger F**,** De Frenne P**,** Lenoir J**,** Vangansbeke P**,** Verheyen K**,** Bernhardt-Römermann M**,** Baeten L**,** Hédl R**,** Berki I**,** Brunet J ***et al.*** **2020**. Forest microclimate dynamics drive plant responses to warming. *Science* **368**: 772–775.