**Title**

How do warming experiments actually affect microclimate? And what the last generation of experiments could tell us about how to do the next generation (A data synthesis paper?

**Authors**

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**Introduction\***

Experimental *in situ* climate manipulations offers several advantages to understanding biological impacts of climate change (controlled, relative speed- i.e. multiple manipulations can be conducted simultaneously).

These advantages come at a premium, however- experimental *in situ* climate manipulations are expensive. (Discuss here or later in paper?)

Problem:

People want to extrapolate climate change experiments (i.e. those that manipulate temperature and precipitation to simulate some future climate scenario) to real life to understand (and forecast) biological impacts of climate change. However, a detailed assessment of exactly how these experimental treatments alter climate, and the extent to which these manipulations accurately model the real world, is lacking.

To address this need, we use plot-level microclimate data from XX climate change experiments that manipulate temperature and precipitation, to understand:

1. How does the experimental structure itself affect microclimate?
2. Is there daily and/or seasonal variation in experimental warming effects?
3. Do seasonal patterns in experimental climate mirror those in observed climate?
4. (Possibly: Do treatment effects vary by biome/habitat type?)

We then examine the biological impacts of variation due to experimental climate manipulations through a case study- phenology in plants. Finally, we use these data, and experience gained from XX years of field-installed *in situ* experimental warming, to make recommendations for future climate change experiments to ensure that these expensive manipulations.

**Methods**

Summarize datasets (warming types, plot sizes, locations).

Analyses:

1. How does experimental structure affect microclimate?
   1. Compare sham and ambient data on temp, moisture (mixed effects models)
2. Is there seasonal variation in experimental warming effects?
   1. Christy’s plots. Statistical analysis necessary?
3. Do seasonal patterns in experimental climate mirror those in observed climate?
   1. Gothic and Harvard Forest comparisons of observational and experimental data, talk to Aaron and Ann Marie about this
4. (Possibly: Do treatment effects vary by biome/habitat type?)
   1. Use lat/longs and/or reported habitat type to investigate potential patterns…Whiteaker plots
   2. Not sure we really have enough variation to do this. Christy was going to do a bit with this

**Results**

1. Is there seasonal variation in experimental warming effects?
   1. Yes- need to look at Christy’s plots in more detail.
2. How does experimental structure affect microclimate?
   1. Yes- shams (compared to ambient) have higher air temperatures, lower soil temperatures, and lower soil moisture
3. Do seasonal patterns in experimental climate mirror those in observed climate?
   1. Need to see what aaron and ann marie have done with this

**Biological Implications: biological impacts of microclimate variation due to experimental climate manipulations through a case study.**

I am currently thinking of doing this through literature review (i.e. documented effects of scale and type of variations we observed on plant phenology. Alternatively, we could use some of our data to do this but then we may be scooping ourselves and trying to do too much with this paper

**Possible Recommendations**

1. (Easy) things everyone should try to *do in* their experiments
   1. Include controls and collect/use/report their data. Measure before and after experiment, have shams and ambient controls, and collect all data in them
2. Things everyone should *report about* their experiments
   1. Control/Sham data
   2. Timing of warming treatment applied (e.g., summer application impacts fall events more): exact date it started and how it ran throughout seasons/years
   3. Day/night variation (across seasons)
   4. Try to collect climate data at least 2X day, ideally hourly
3. Regression designs for nonlinearity?
4. Community standards for reporting experimental climate data (and phenology -Chuine et al. 2017)
5. Monitoring of temperature that is more useful across designs and that is closest to what focal organisms experience

\*I’m don’t think that the traditional Intro, methods, results, discussion works for this paper but I’ve (sort of) started out with this framework