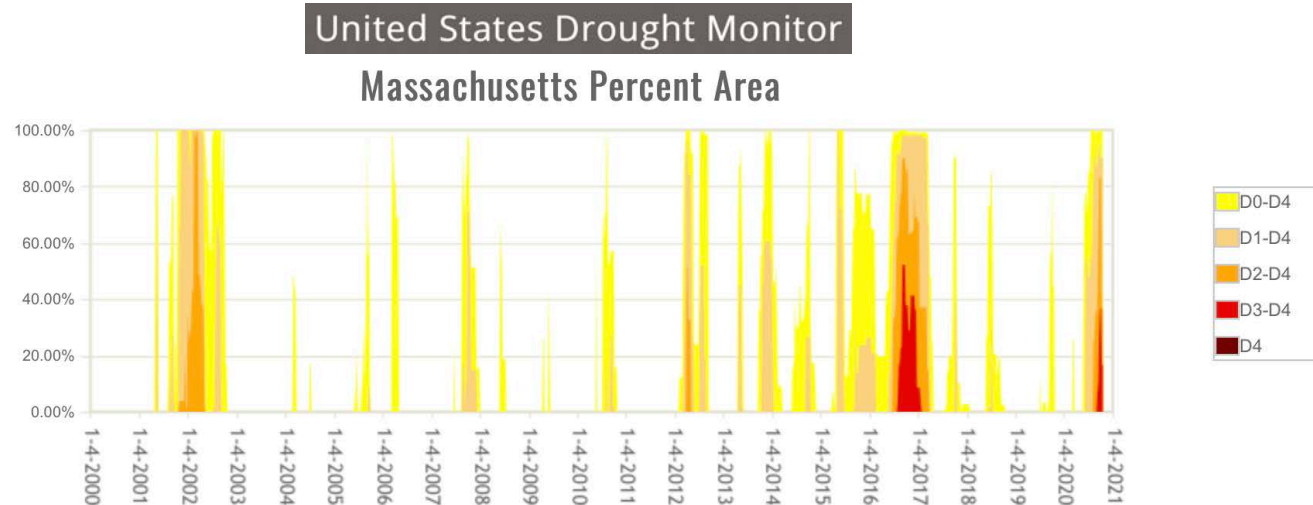


# Observed and modeled interactions between droughts and heat waves for the Northeast US

Matt Barlow, PI, UMASS Lowell  
Chris Skinner, co-PI, UMASS Lowell  
Laurie Agel, postdoc, UMASS Lowell

Idea: droughts ↔ heat waves: daily weather & moisture tracking



# Research Tasks

For the Northeast US:

**Task 1. Observed daily circulation patterns, using "machine learning"**

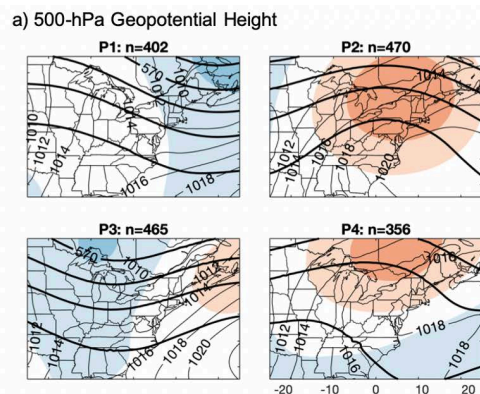


**Task 2. Moisture tracking, in observations and a climate model**

**Task 3. Predictability, at the medium-range and S2S timescales**

**Task 4. CMIP6 model assessment: how well do current climate models do?**

## Weather Patterns



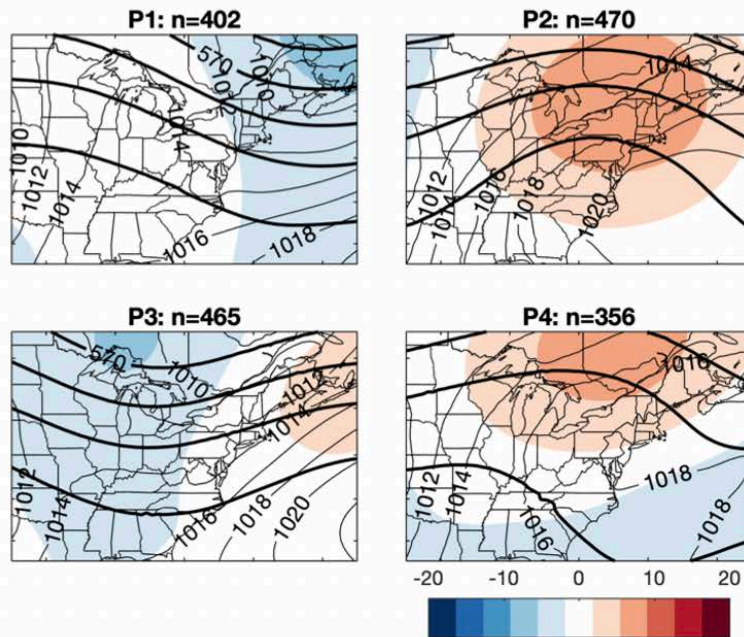
## Moisture Tracking



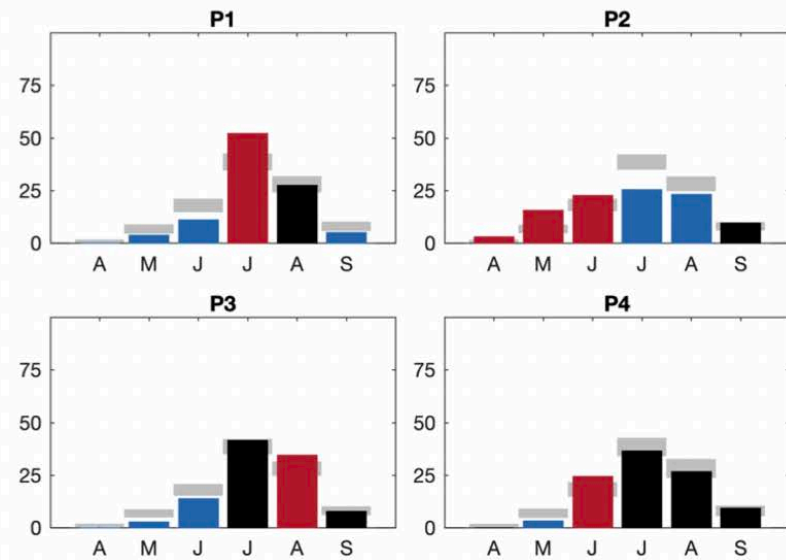
# Pilot Analysis: Heat Waves

## Four Distinct Heatwave Weather Patterns in Northeast Us

a) 500-hPa Geopotential Height



b) Pattern Seasonality

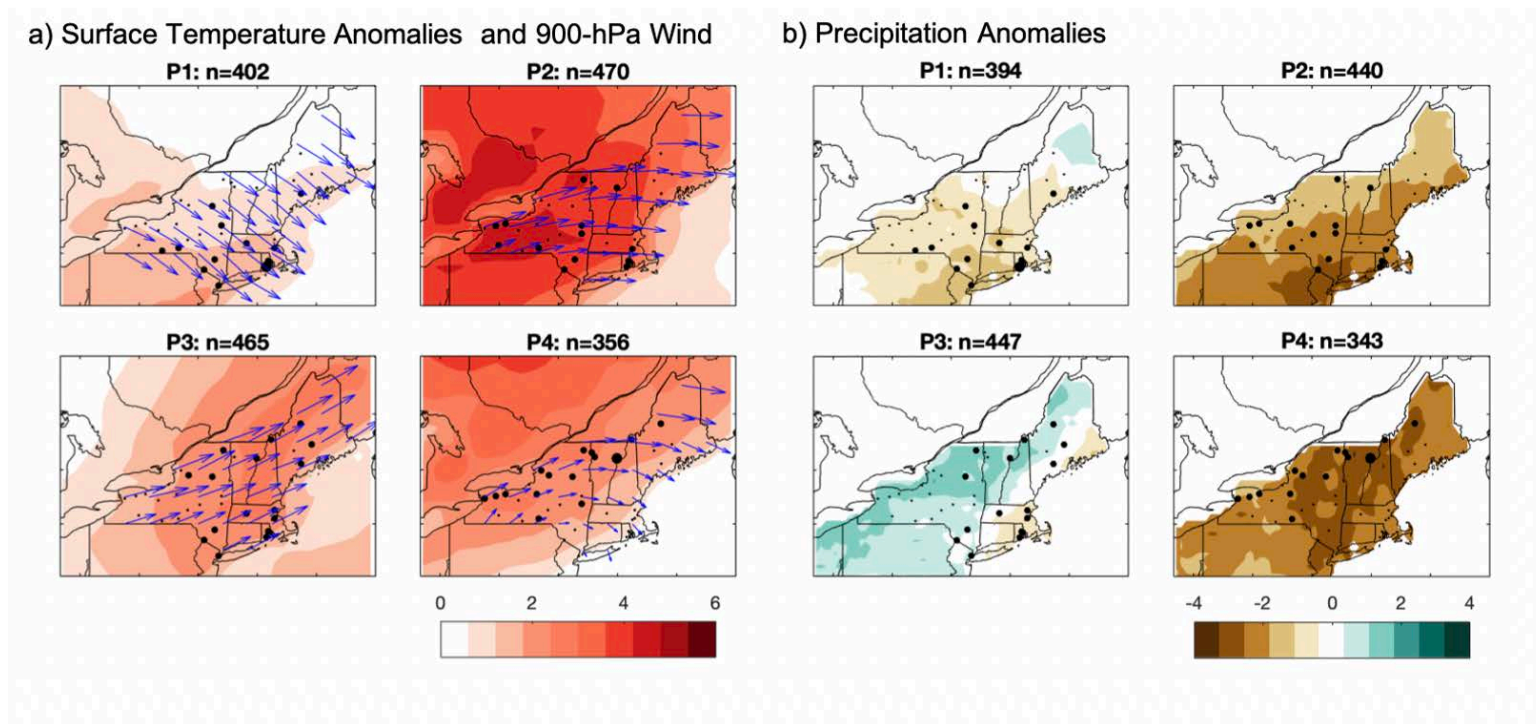


**Figure 1. Heat wave patterns and monthly frequency.** (a) 1980-2018 MERRA-2 500-hPa geopotential heights (thick contours every 6 dam, and anomalies, shaded, every 4 dam) and MSLP (thin contours every 2 hPa) for heat wave days (top 95% daily mean temperature for 3 or more days) within heat wave patterns P1–P4, and (b) monthly frequency of patterns, with grey shading indicating the 95% confidence interval using random sampling of all extreme heat wave days, and red, blue, and black bars indicating, respectively, higher-than-normal, lower-than-normal, and normal monthly values at the .05 level of significance. Heat wave patterns are from *k*-means clustering of MERRA-2 500-hPa geopotential heights and 900-hPa winds.

Agel et al., submitted: Four Distinct Northeast US Heat Wave Circulation Patterns: Associated Mechanisms, Trends, and Electric Usage

# Pilot Analysis: Heat Waves

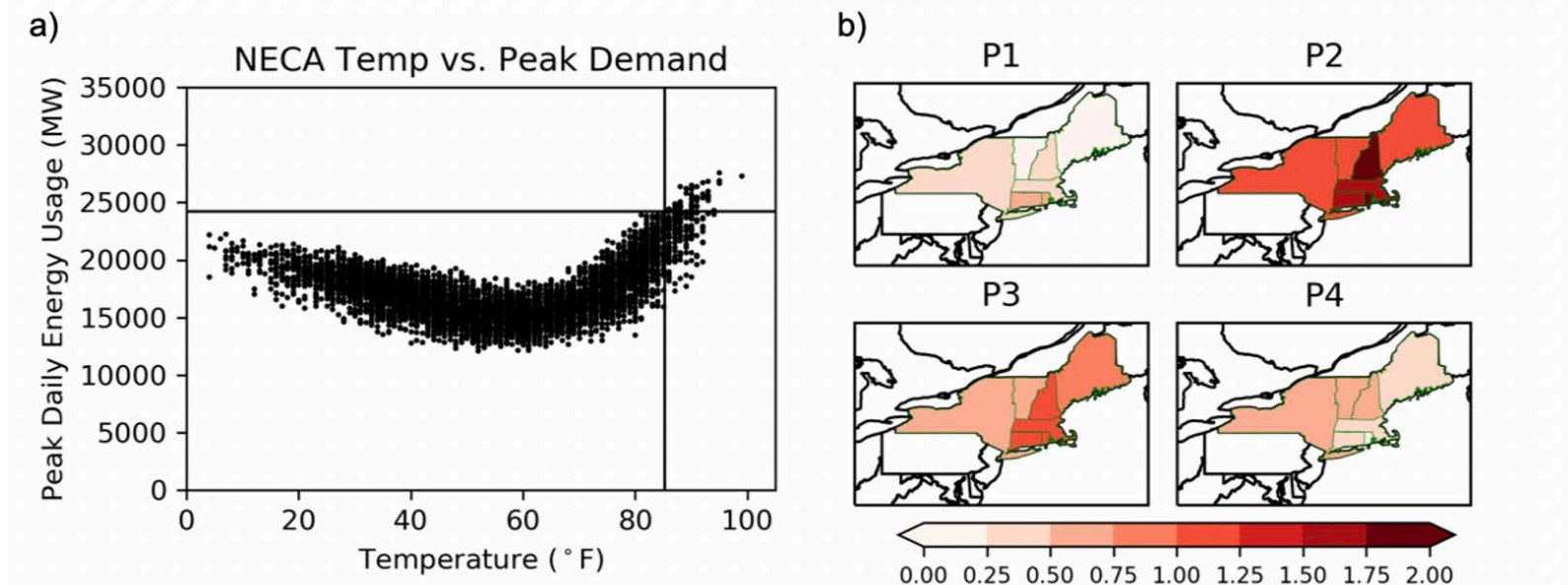
## Different Mechanisms, Relation to Precipitation



**Figure 2. Composite surface temperature and precipitation for heat wave patterns.** (a) MERRA-2 2-m temperature anomalies (shaded, in 0.6 K increments) and 900-hPa winds (blue quivers), and (b) CPCU precipitation anomalies (shaded, in 0.8 mm increments) for heat wave patterns P1–P4. Black dots indicate relative frequency of heat wave days at stations within patterns, with the size of the dot proportional to the relative frequency.

# Pilot Analysis: Heat Waves

## Strong Influence on Electric Usage



**Figure 5. Electrical demand for heat wave patterns.** (a) Maximum daily electrical demand (in MW), 1980–2018, for mean regional daily dry-bulb temperature at peak load (°F), according to ISO New England, encompassing the states of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island, and (b) mean usage by state (shaded, standardized anomalies) for heat wave days in patterns P1–P4.