



Environmental, Earth,
& Atmospheric Sciences



Heatwaves and Drought in the Northeast US

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A Short Drama in 3 Acts

1. Heatwave circulation patterns in the Northeast US
2. Connecting heatwaves and droughts
3. Predictability of heatwaves (preliminary)

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& Atmospheric Sciences

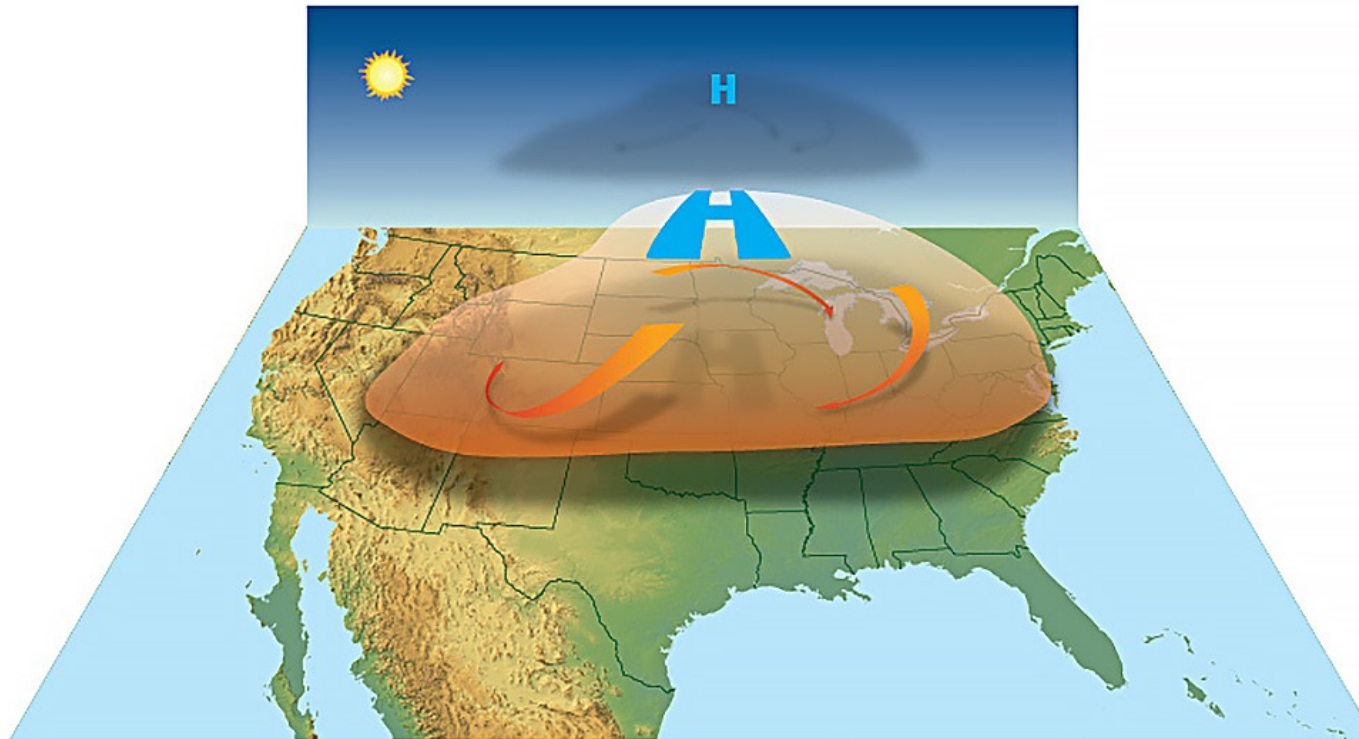


Act I

1. **Heatwave circulation patterns in the Northeast US**
2. Connecting heatwaves and droughts
3. Predictability of heatwaves (preliminary)

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Basic Heatwave Circulation



noaa.gov

What does the circulation pattern look like for Northeast US Heatwaves?

-35 stations

-3 or more days $T_{\max} > 95^{\text{th}} \%$

-1980–2018

-pattern analysis of circulation

● Non-hierarchical k-means clustering

● Self-Organizing Maps (SOMs)

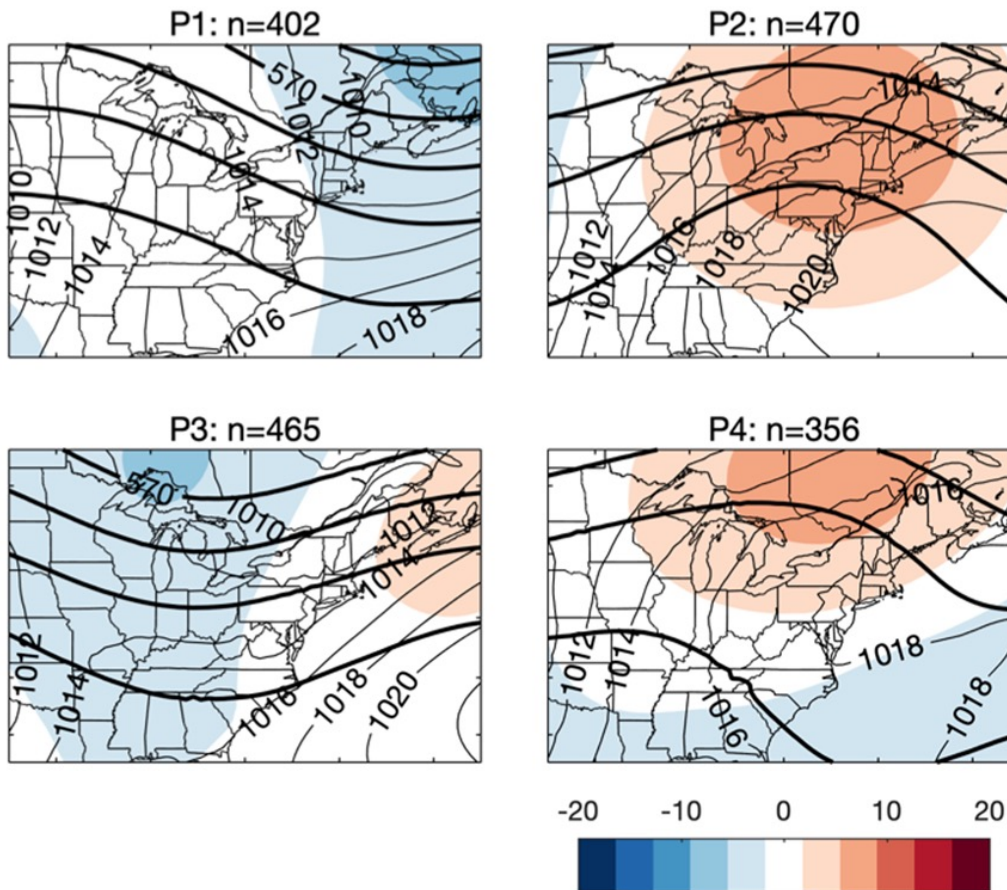
-rh, soil moisture, energy use, etc.

Agel, L., M. Barlow, C. Skinner, F. Colby,
and J. Cohen, 2021: Four Distinct Northeast
US Heat Wave Circulation Patterns and
Associated Mechanisms, Trends, and
Electric Usage. *npj Clim Atmos Sci*, **4**, 31.
<https://doi.org/10.1038/s41612-021-00186-7>



Four Circulation Patterns for Northeast US Heatwaves

a 500-hPa geopotential height



Four flavors!

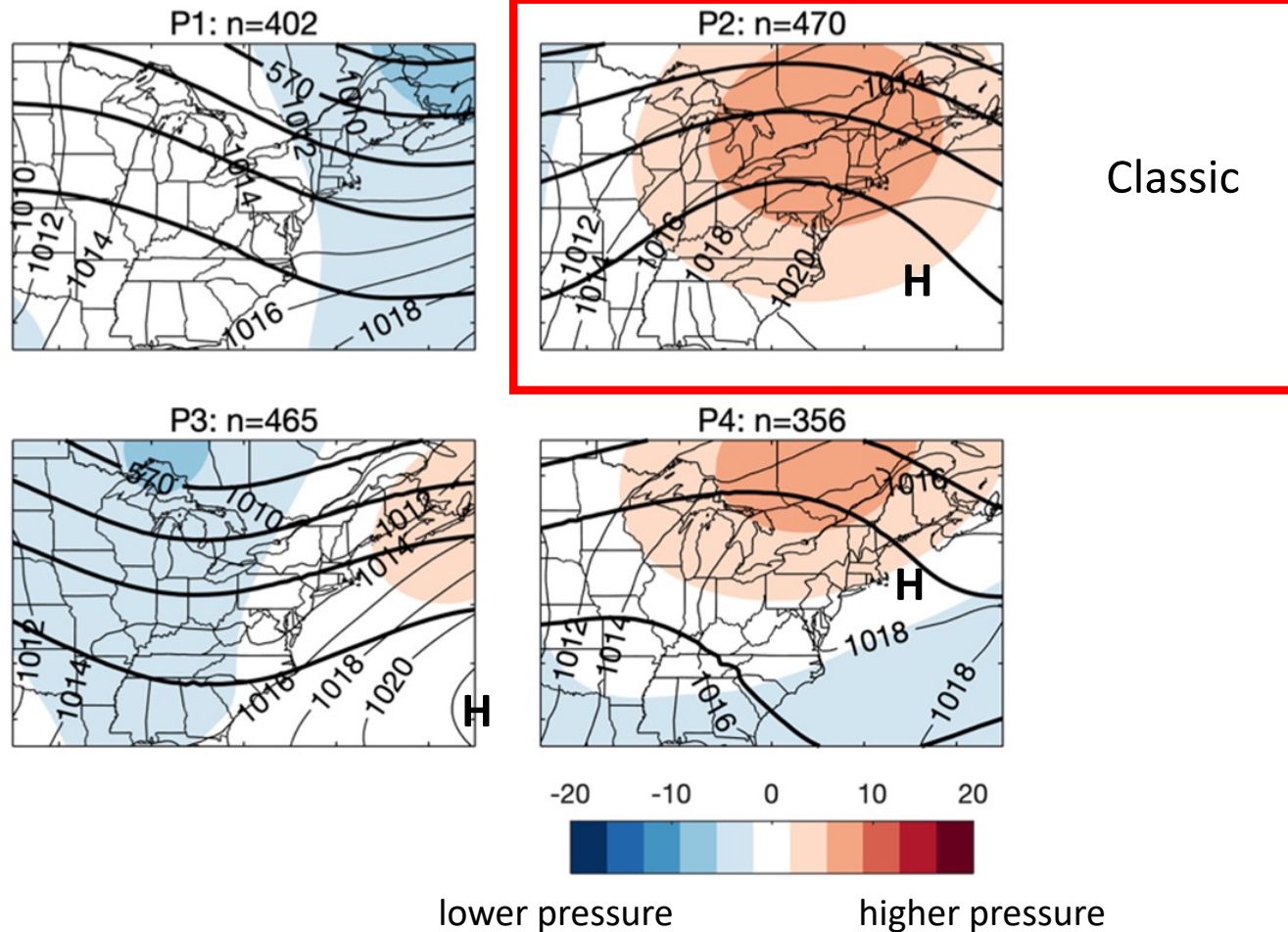


olympicmountainicecream.com

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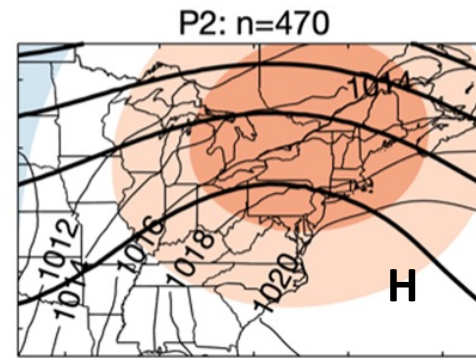
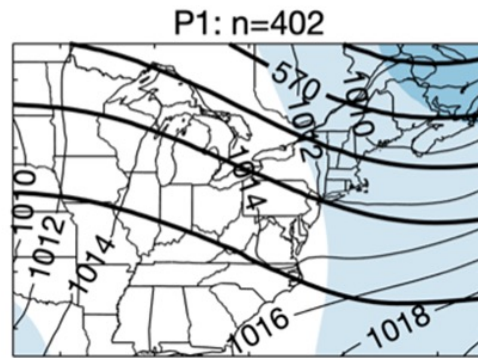
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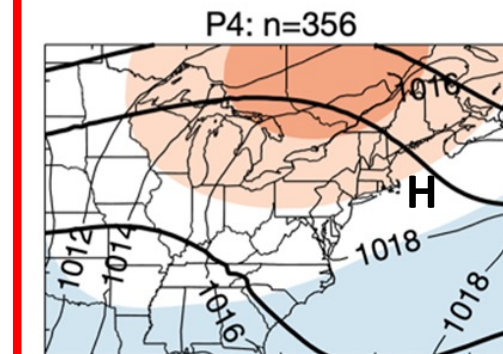
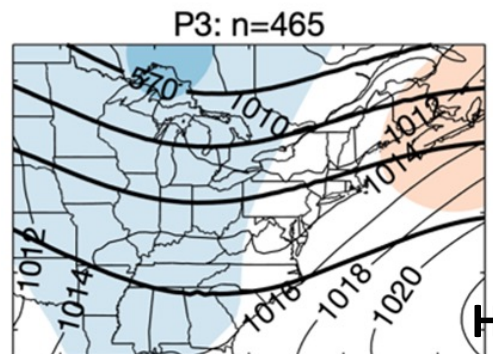


Four Circulation Patterns for Northeast US Heatwaves

a 500-hPa geopotential height



Classic



Local Classic

-20 -10 0 10 20



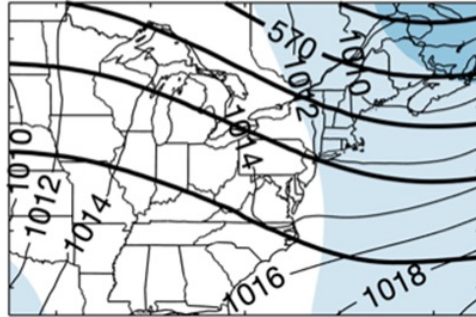
lower pressure

higher pressure

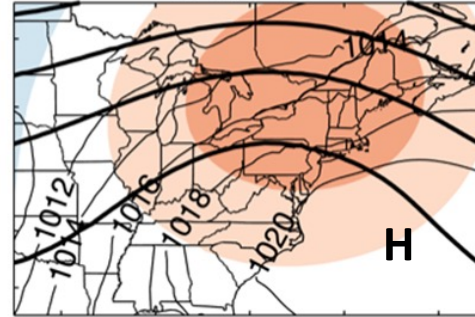
Four Circulation Patterns for Northeast US Heatwaves

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P1: n=402

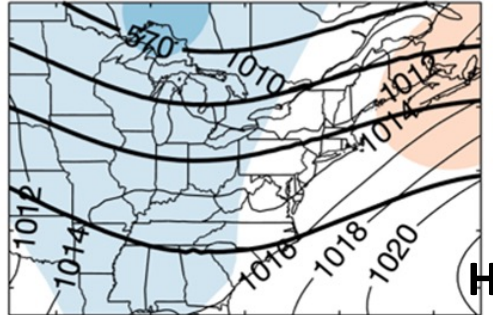


P2: n=470



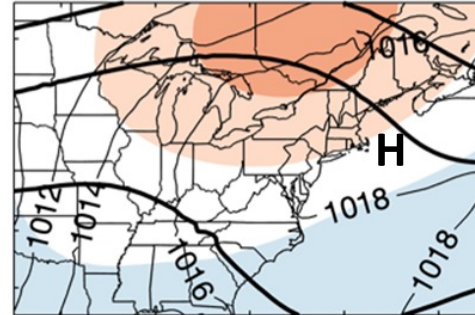
Classic

P3: n=465

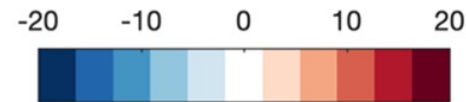


Classic-ish

P4: n=356



Local Classic

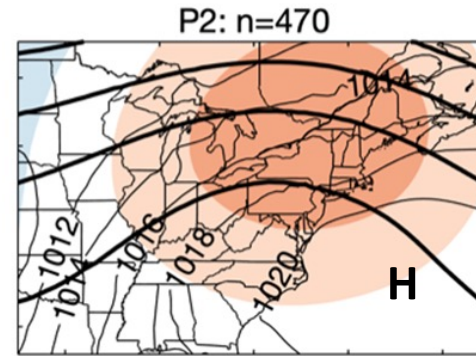
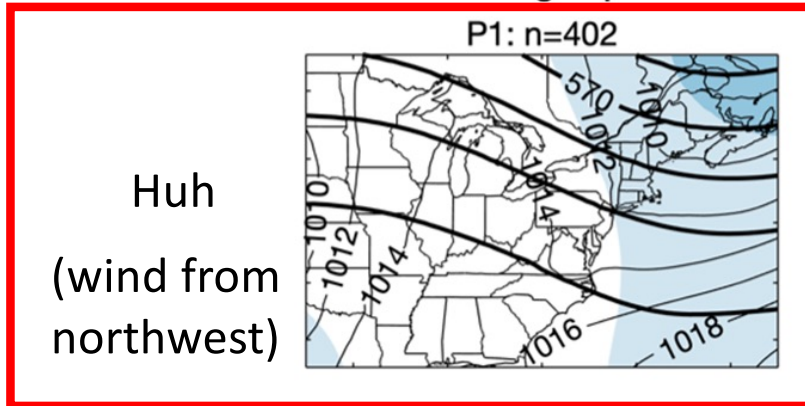


lower pressure

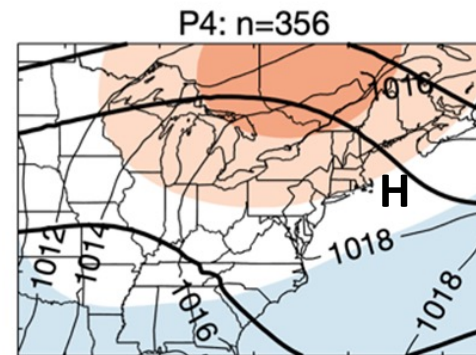
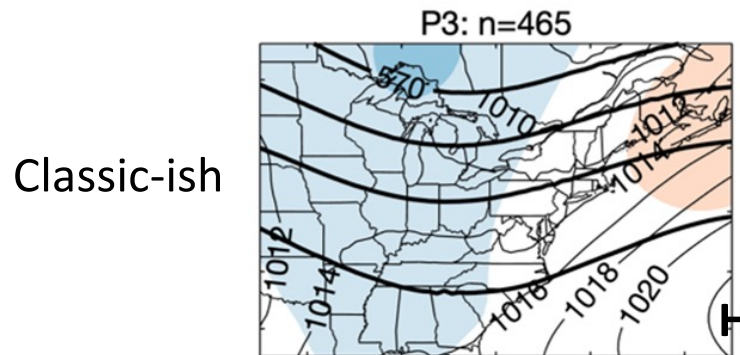
higher pressure

Four Circulation Patterns for Northeast US Heatwaves

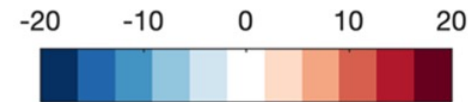
a 500-hPa geopotential height



Classic



Local Classic

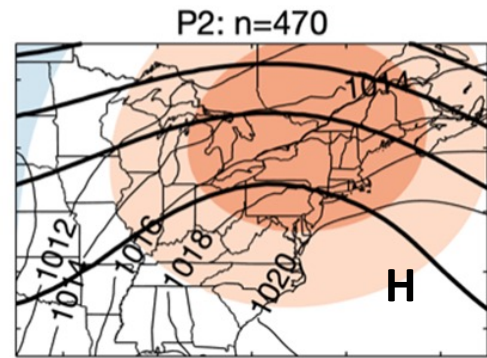
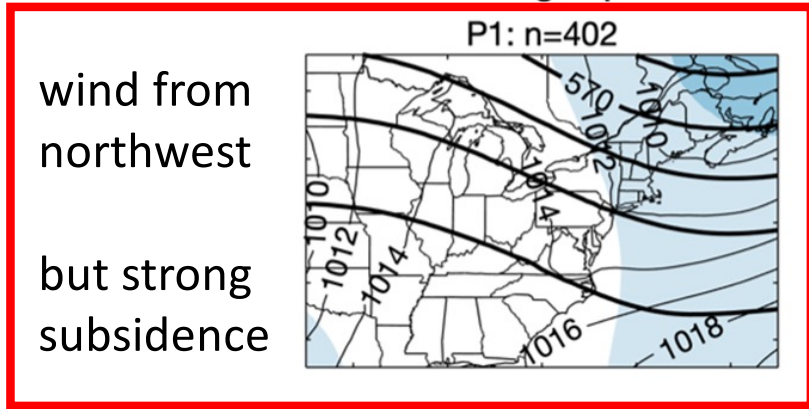


lower pressure

higher pressure

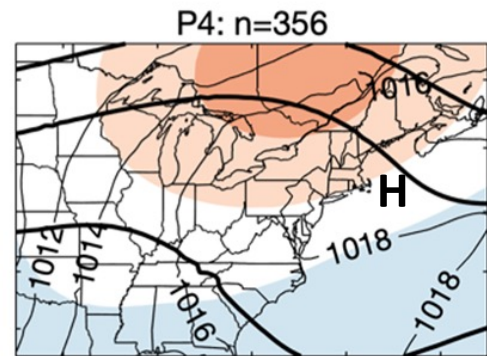
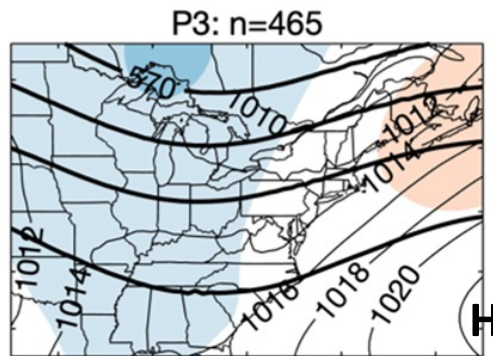
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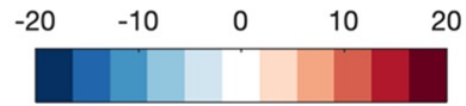


Classic

Classic-ish



Local Classic

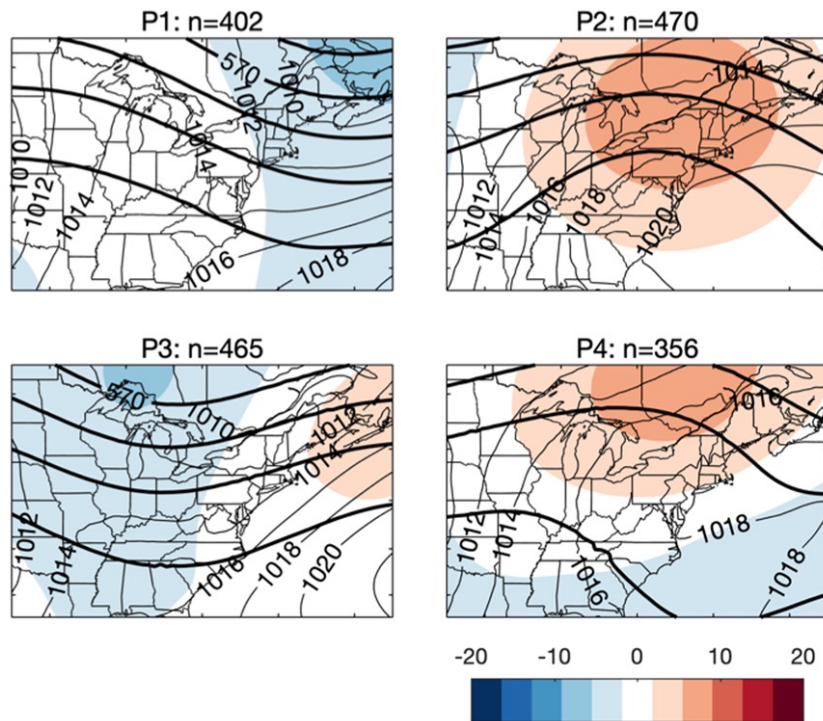


lower pressure

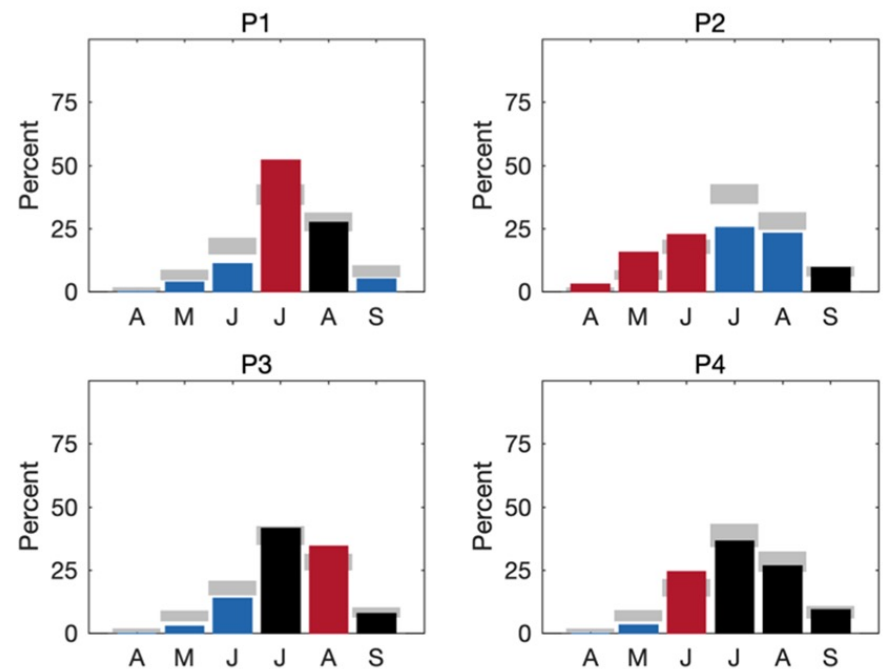
higher pressure

Seasonality

a 500-hPa geopotential height



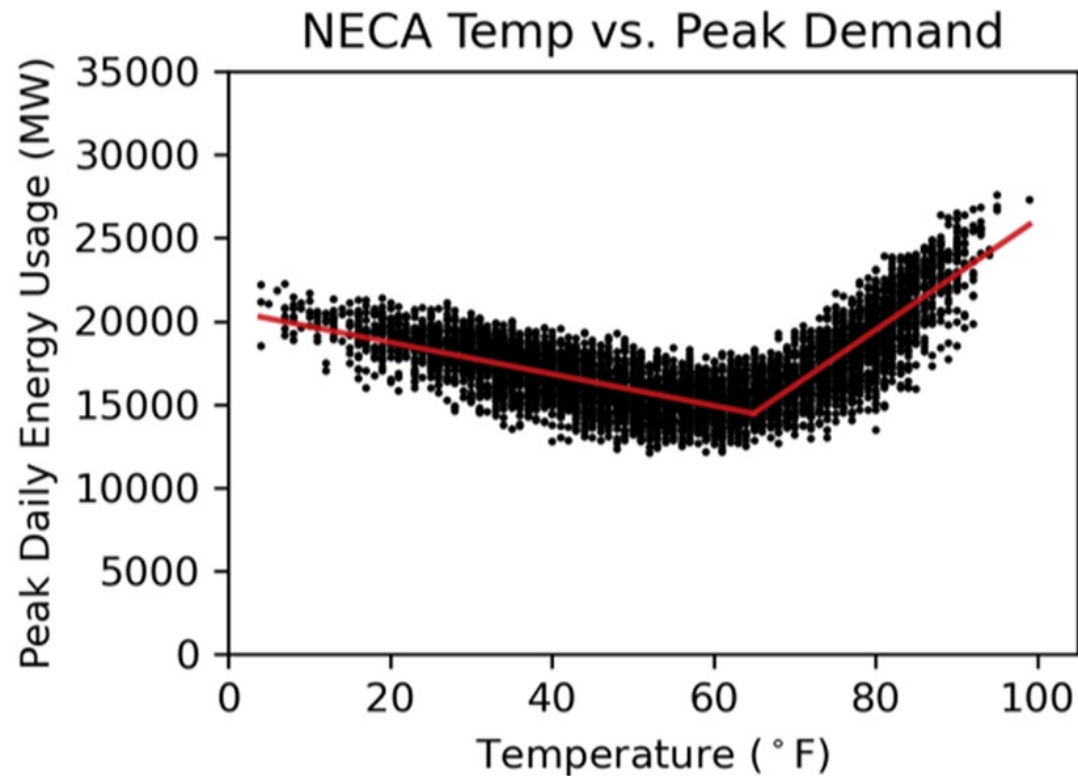
c Monthly frequency of patterns



seasonality

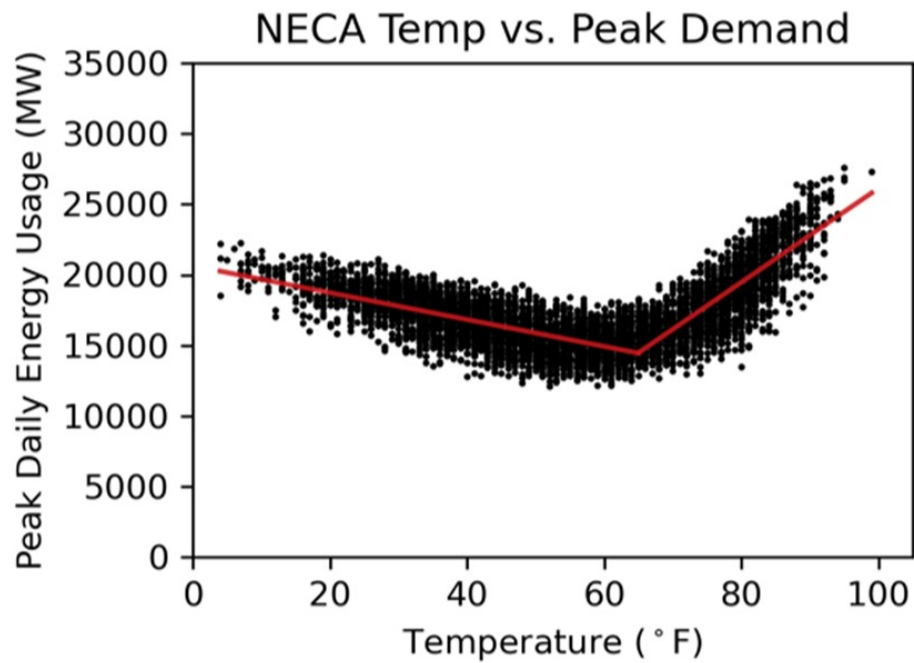
High temperatures in NE → high energy use

a



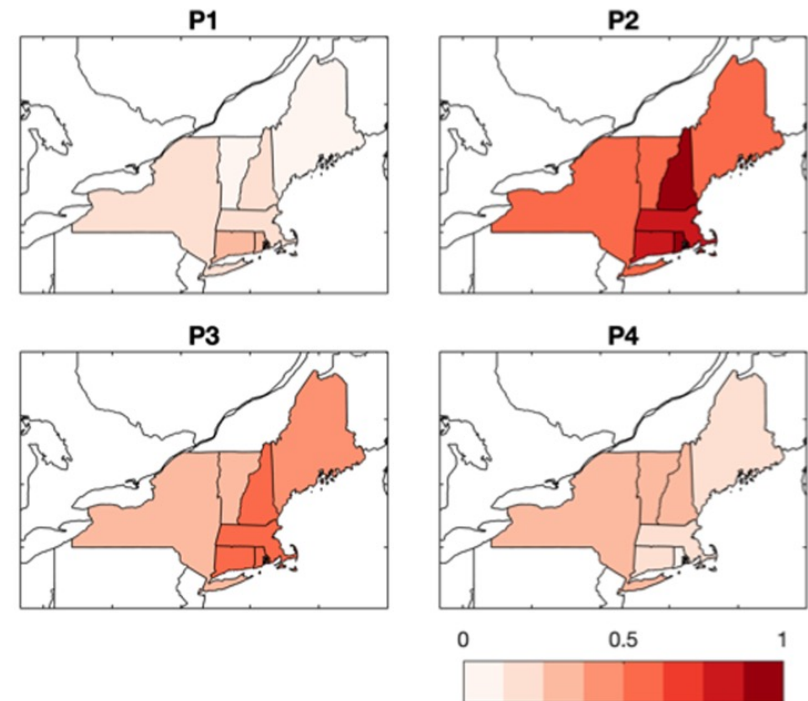
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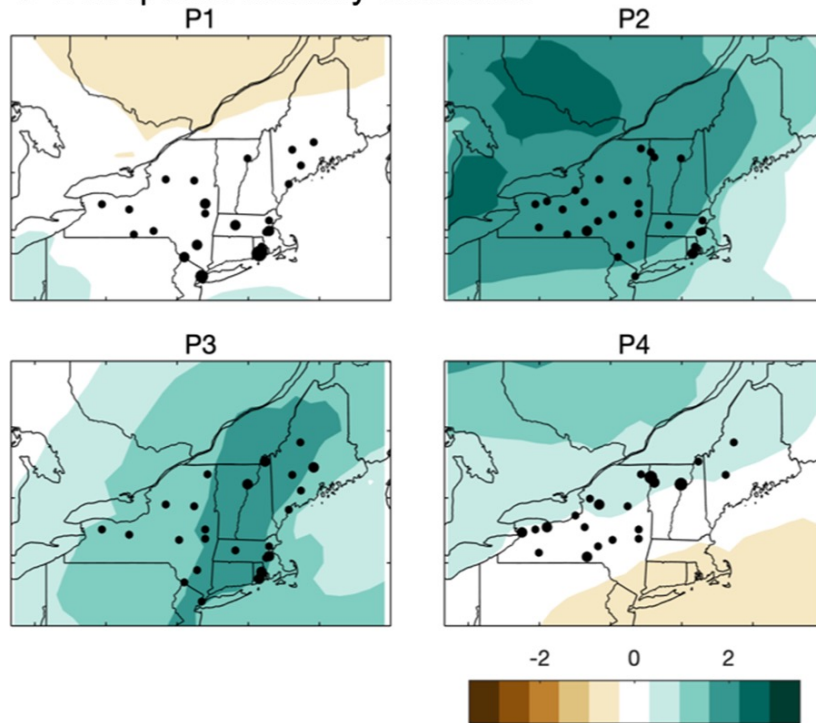
b

Mean usage by state

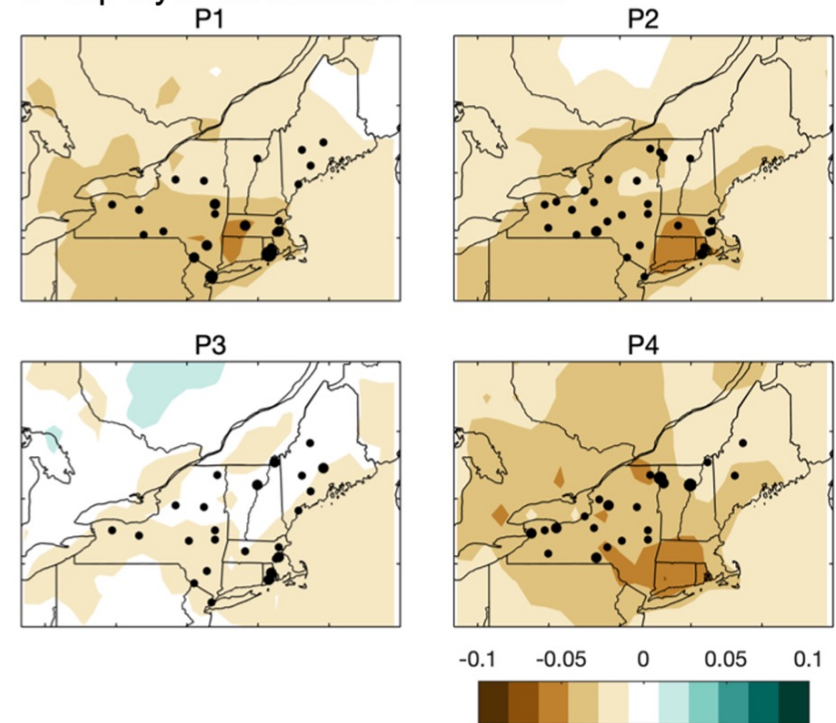


Humid vs Dry Heatwaves

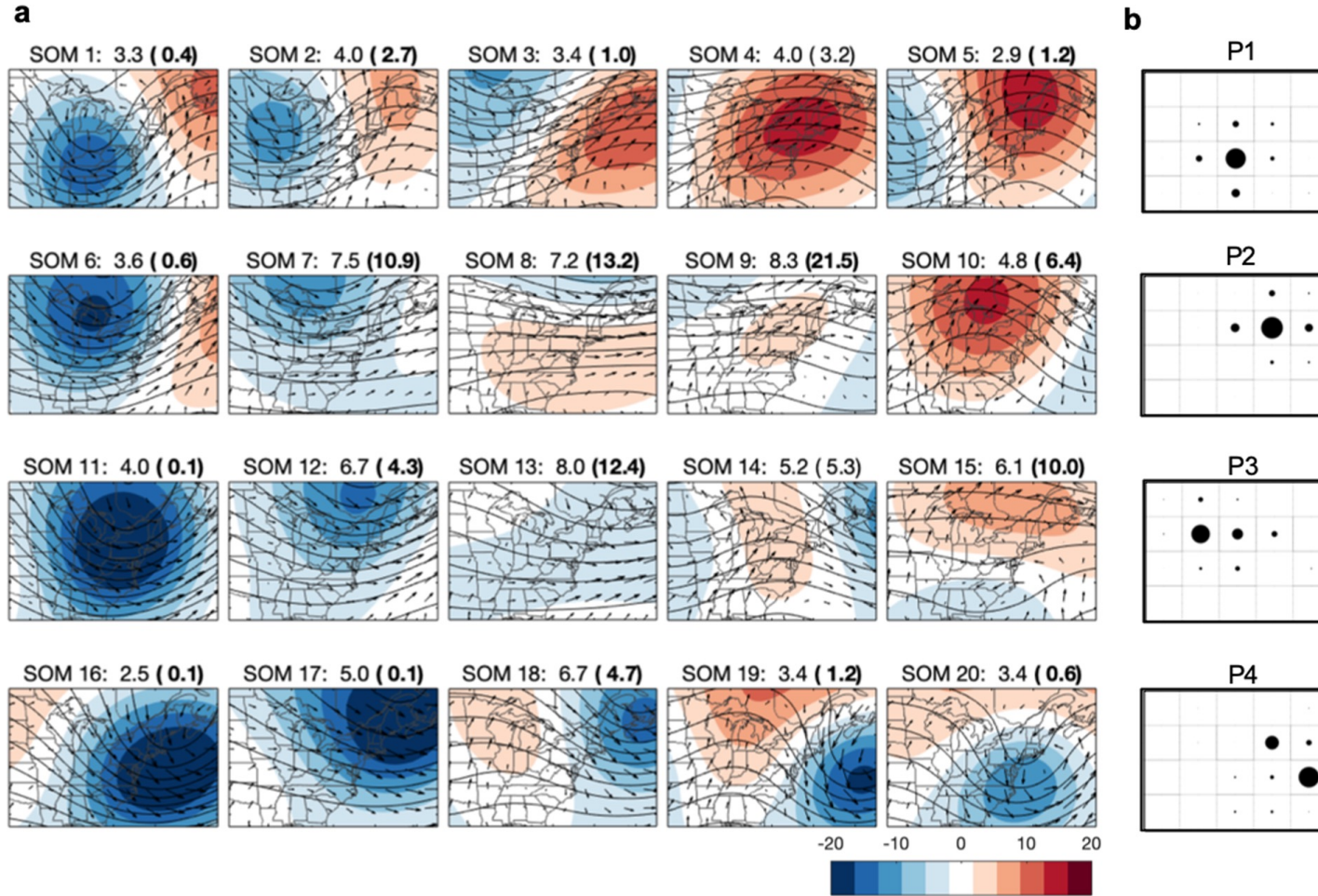
c 2-m specific humidity anomalies



d Top-layer soil moisture anomalies



SOMs vs Clusters





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Act II

1. Heatwave circulation patterns in the Northeast US
2. **Connecting heatwaves and droughts**
3. Predictability of heatwaves (preliminary)

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Act III

1. Heatwave circulation patterns in the Northeast US
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3. **Predictability of heatwaves (preliminary)**

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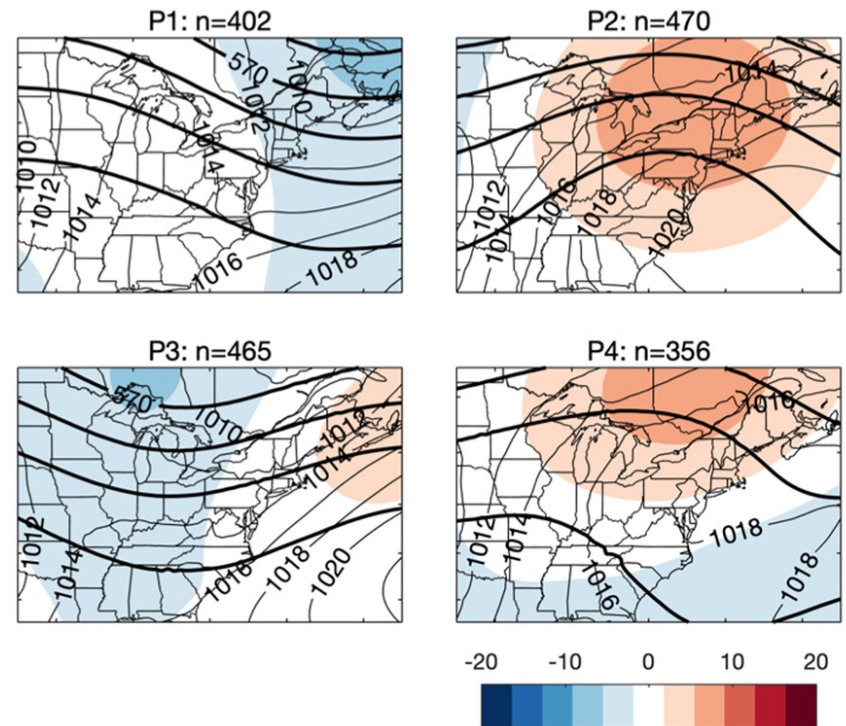
Predictability Questions

Are some types of heatwaves more predictable than others?

Are circulation patterns more predictable than surface temperatures?

Can we make better 3-10 day predictions of heatwaves by considering circulation patterns?

a 500-hPa geopotential height



Predictability Questions

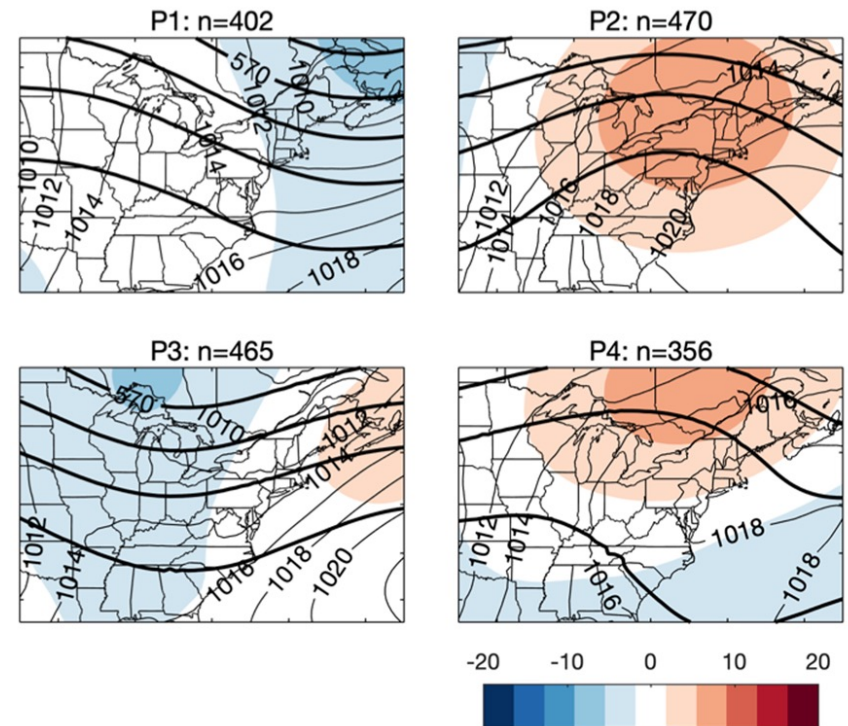
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(Also applies to our work on extreme precipitation patterns, & flash drought)

a 500-hPa geopotential height

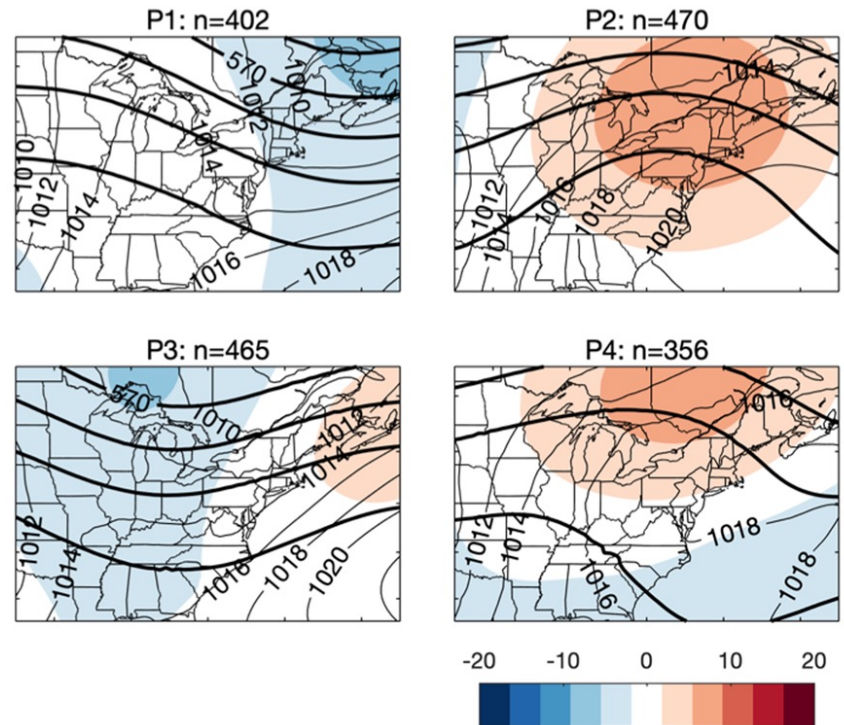


Initial Assessment of Predictability

Spatial correlation of observed fields with 72-hour forecast (GEFSV12), for first day of heat waves

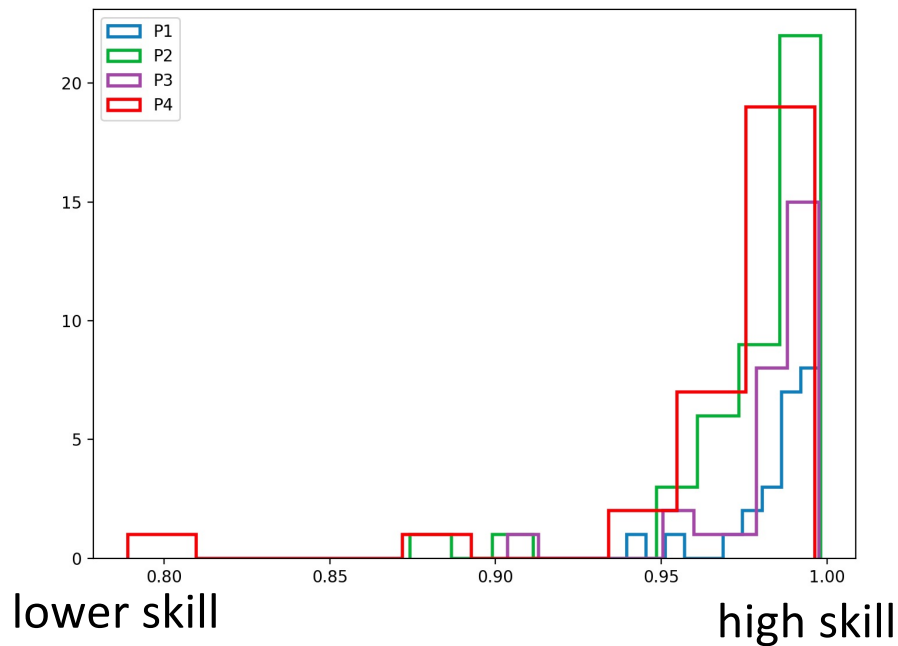
Expect high correlations for 500 hPa heights.

a 500-hPa geopotential height

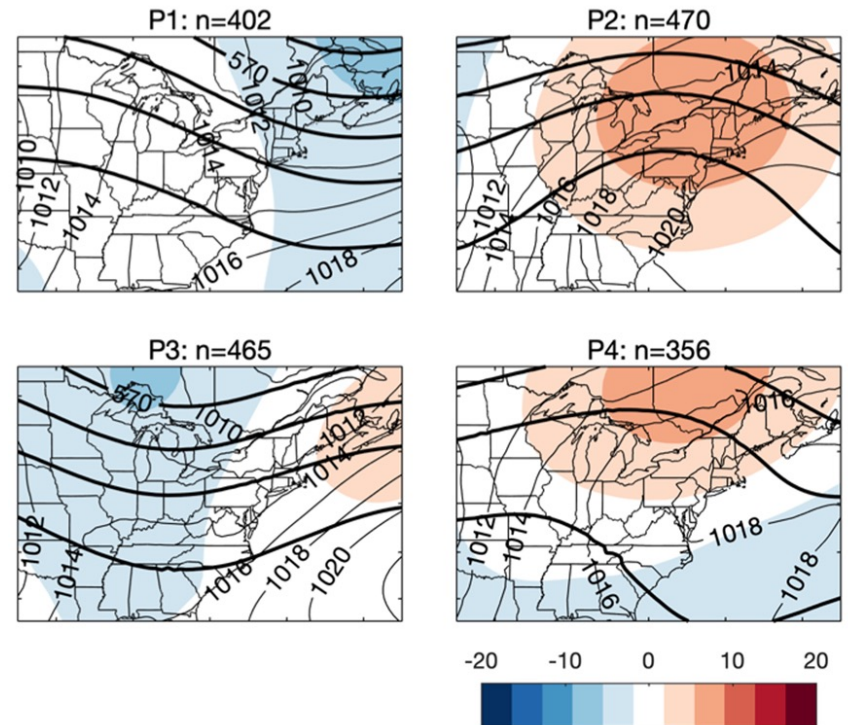


Initial Assessment of Predictability

Histogram of 72-HR Predictability of 500 hPa Heights

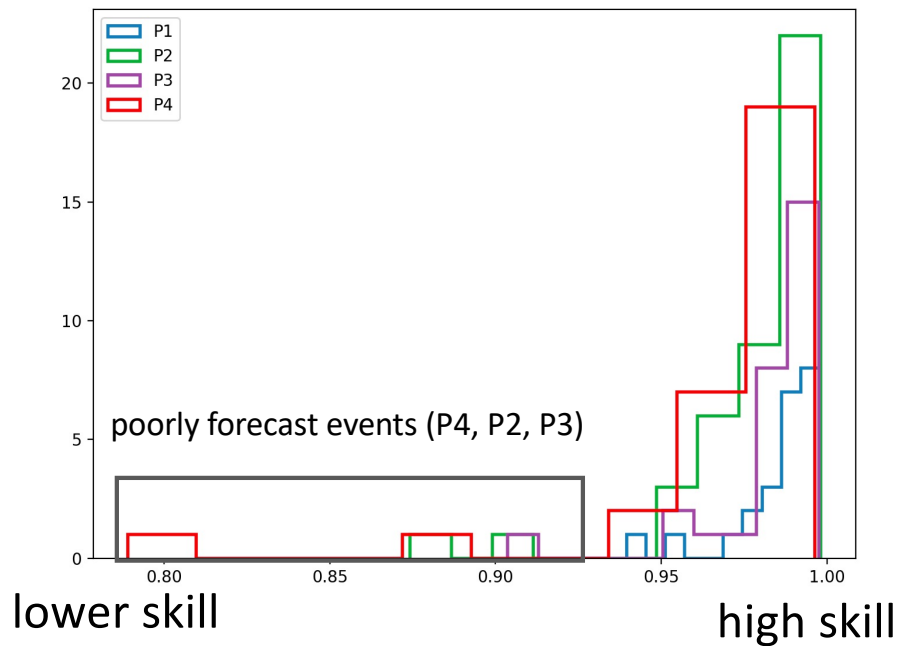


a 500-hPa geopotential height

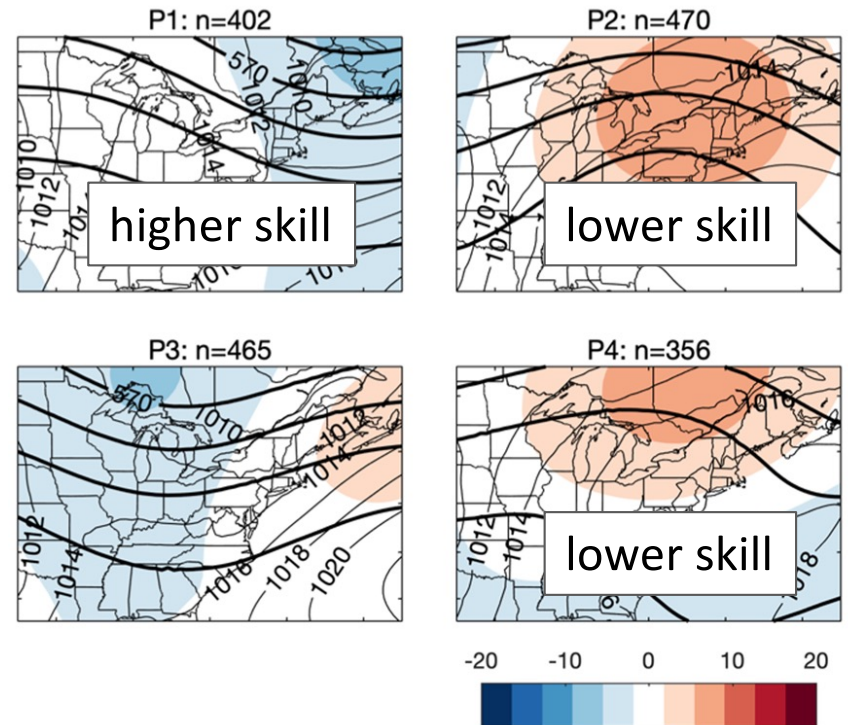


Initial Assessment of Predictability

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a 500-hPa geopotential height



Predictability Questions

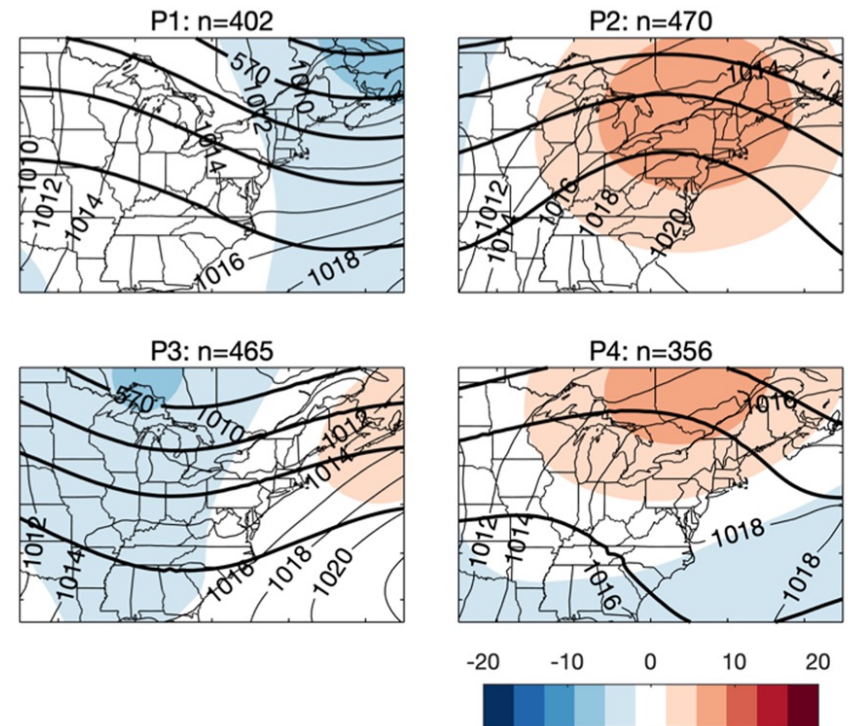
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[Exit, pursued by a bear.]

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