

Heat Waves & Drought in Northeast

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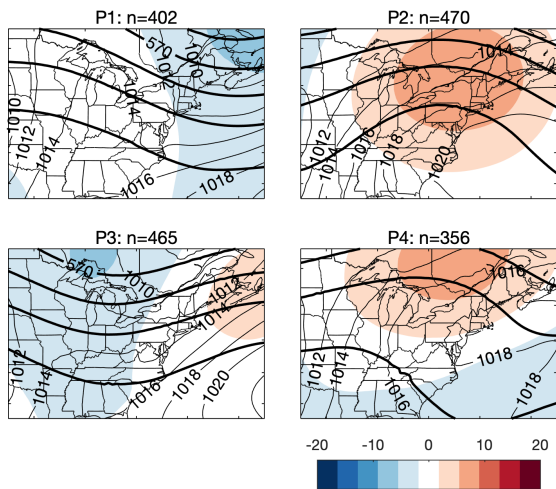
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Heat wave patterns 1980-2018

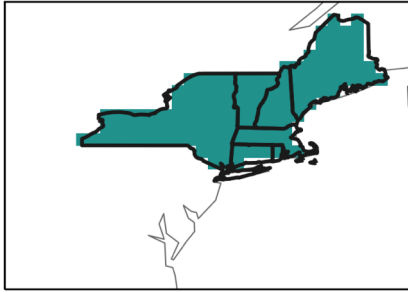


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Key Questions:

- How do these heat wave pattern days compare to all-days circulation patterns?
- Are these heat wave patterns particularly dry or wet?
- **What is the relationship between heat waves and drought in the Northeast?**
- **Do periods of drought have more heat wave days?**
- **Is the circulation different for drought vs heat waves?**

NE

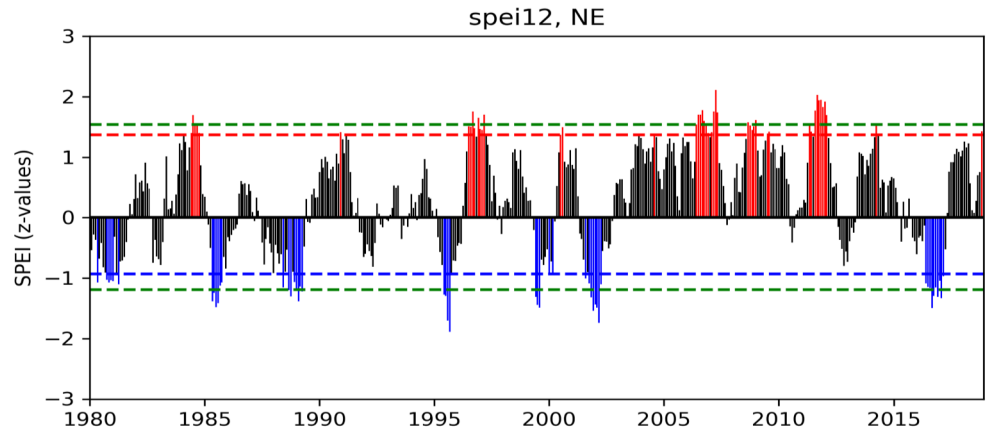
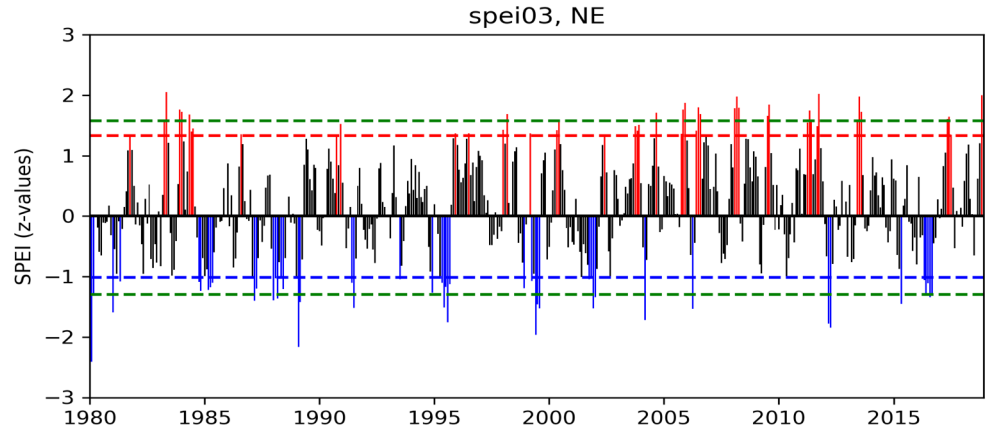


Standardized Precipitation-Evapotranspiration Index (SPEI)

Takes into account both precipitation and potential evapotranspiration (PET)

Gridded dataset, 0.5 degrees, global

Value for each month assessing relative wet vs dry conditions for the previous n months where n is 1,2,...,12,24 etc.



Dry periods:

Threshold=10%					
Interval	#months	Overall mean spei	#event	Mean duration of event (months)	Mean spei of event
Spei01	47	-1.436	41	1.1	-1.422
Spei03	47	-1.367	22	2.1	-1.369
Spei06	47	-1.309	18	2.6	-1.247
Spei12	47	-1.251	14	3.4	-1.184
Spei24	47	-0.895	13	3.6	-0.784

Wet periods:

Threshold=10%					
Interval	#months	Overall mean spei	#event	Mean duration of event (months)	Mean spei of event
Spei01	47	1.599	43	1.1	1.588
Spei03	47	1.612	25	1.9	1.571
Spei06	47	1.575	24	2.0	1.536
Spei12	47	1.595	14	3.4	1.537
Spei24	47	1.589	14	3.4	1.539

Upshot:

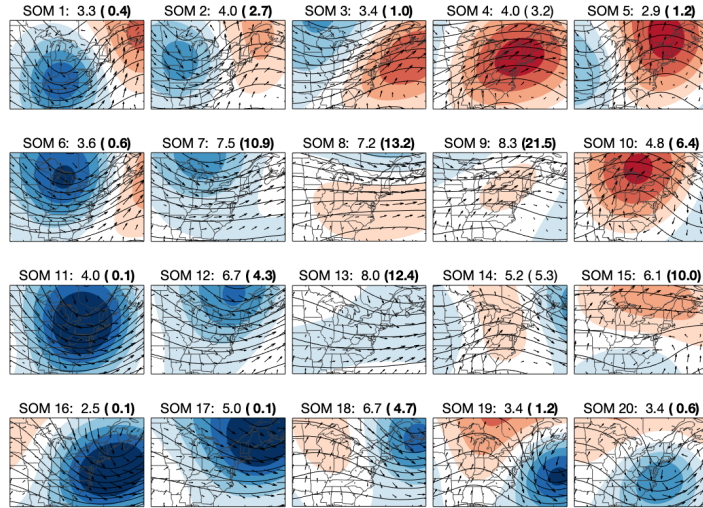
We have chosen to work with **3-month SPEI**, using a **top 10% threshold** for wet and dry periods

For dry 3-month periods in NE,

- Mean SPEI for top 10% dry periods is -1.369
- Mean duration of top 10% dry periods is 2.1 months (this means the dry event itself can be 5 months or more in duration)

Identified **22 top 10% dry events**, ranging from 1-5 months in duration (47 months total qualified as top 10% SPEI03)

How do heat waves and drought days fit into all-day circulation?



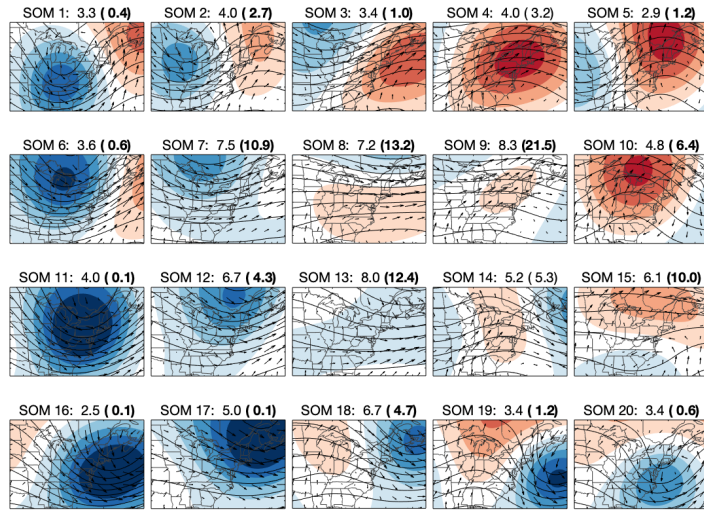
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These daily circulation patterns (SOMs) are based on 500-hPa geopotential height anomalies, and 900-hPa winds.

In this pattern-space:

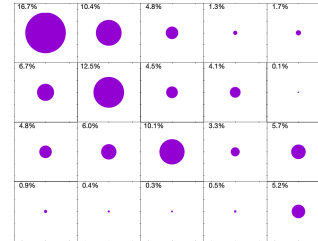
- Ridge patterns tend to cluster in the upper right
- Trough patterns tend to cluster in the lower left
- Zonal-flow patterns tend to cluster in the center

How do heat waves and drought days fit into all-day circulation?



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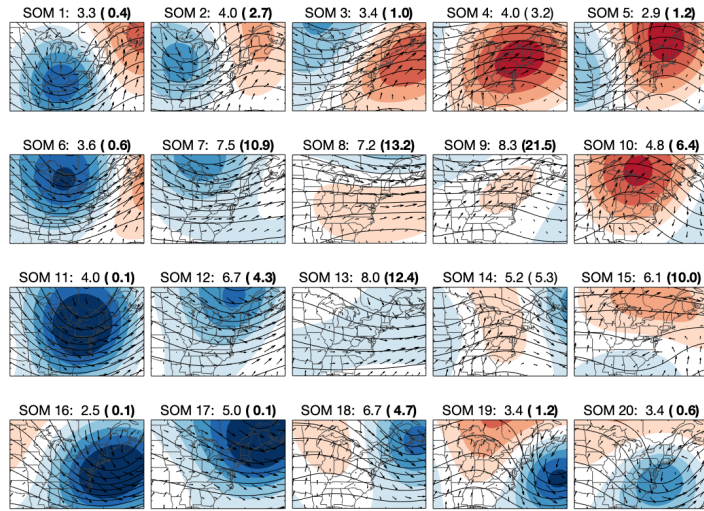
Extreme precipitation days



Heat wave days

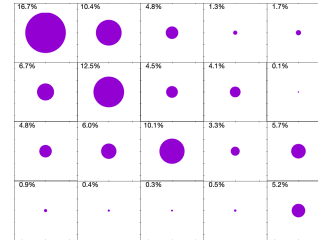


How do heat waves and drought days fit into all-day circulation?



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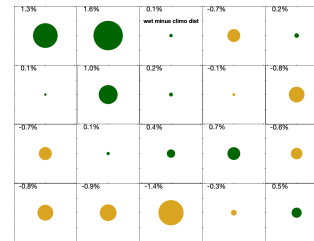
Extreme precipitation days



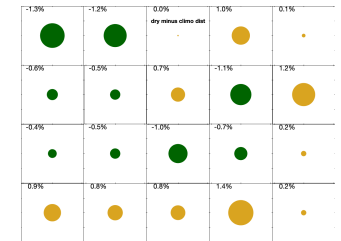
Heat wave days



Wettest (compared to climo)



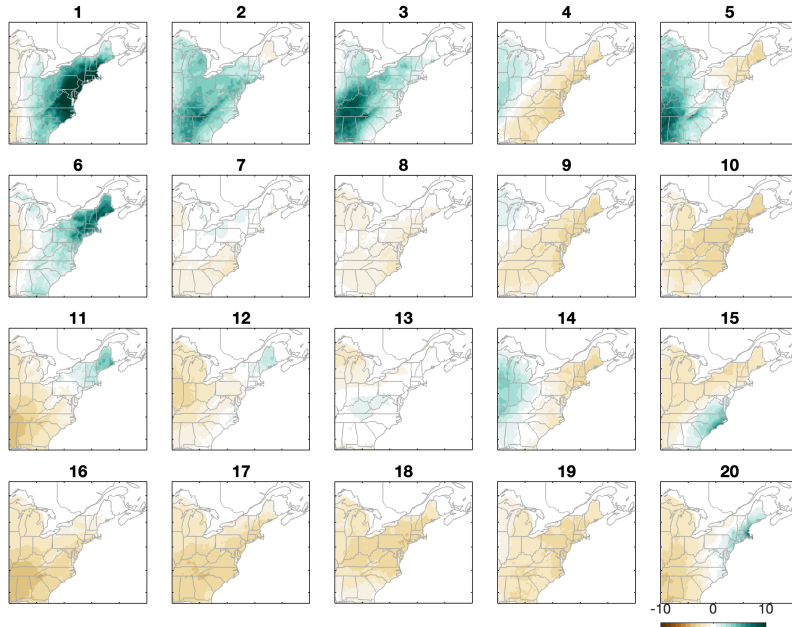
Driest (compared to climo)



This leads to interesting questions: Why do certain circulation patterns lend themselves to droughts? Can certain circulation patterns equally support drought and very wet days? **Within a SOM, what distinguishes drought/wet circulation?**

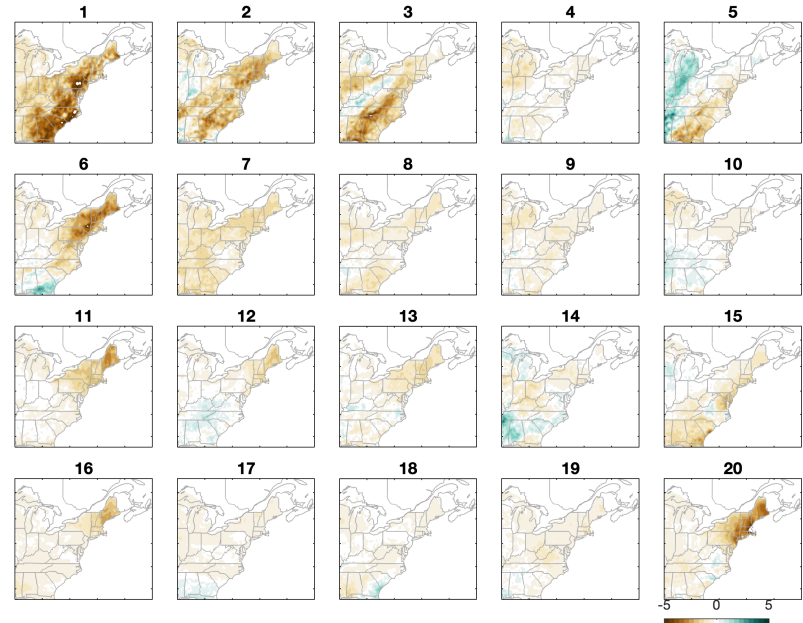
Precipitation: Is there some difference **within** a SOM for the wettest and driest days?

Climatological Precipitation Anomalies



Driest days minus climatology: anomalies relative to the SOM

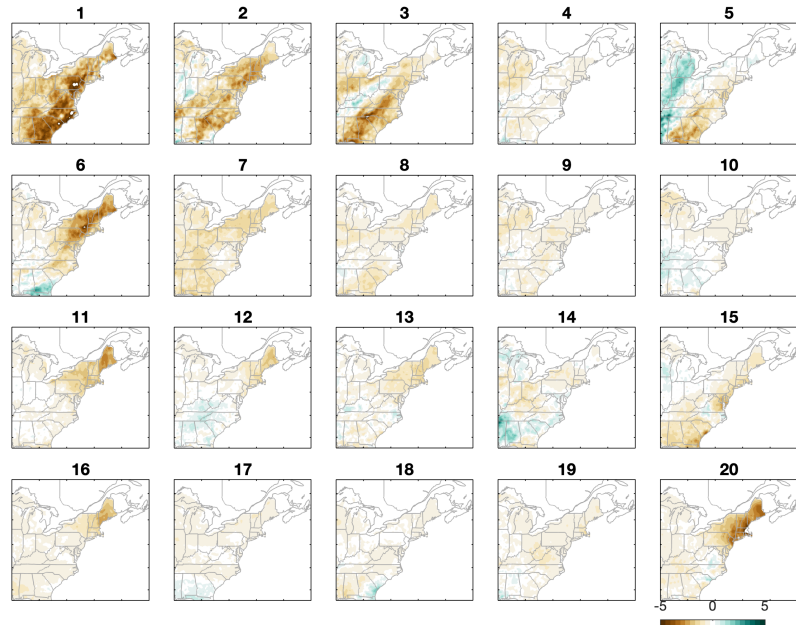
- For the driest patterns, the driest days are not much drier, except Maine in SOM 16
- For the wettest patterns, the driest days are significantly drier
- Interesting difference in SOMs 5, 14, and 30



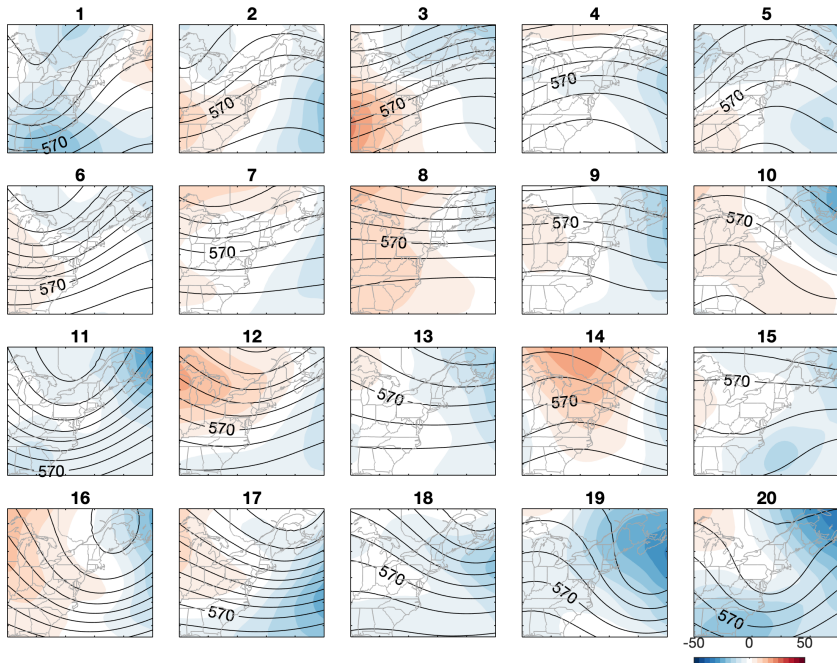
Why aren't dry days significantly drier than climatology within a SOM?

Maybe this is because extraordinary wet periods may be related to singular wet events (big events but spread out over the 3-month period, with lots of dry days in between), while extraordinary dry periods always involve lots of dry days strung together.

Equally, the "wet days" that fall into the dry SOMs may be relatively dry themselves, they just happen to fall into a wet 3-month period.



Circulation: How different is 10% driest day circulation within each SOM?

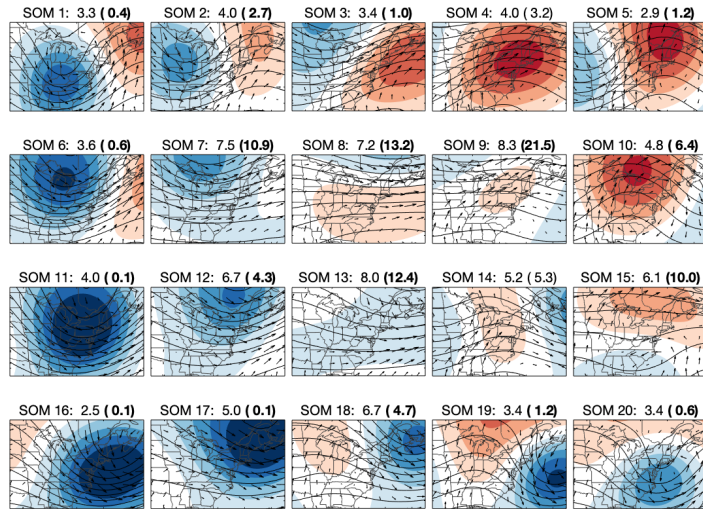


500-hPa heights

Driest days within SOM minus SOM mean

- Circulation on dry days is overall not too different from pattern itself
- Red areas show where the heights are larger values on the driest days (a tendency towards ridging or weakening a trough)
- Blue areas show where the heights are lower values on the driest days (a tendency towards troughing or weakening a ridge)

So for the driest SOMs (e.g. lower row), if the driest days are not too much drier, and the circulation is not too much different, what else can distinguish a drought period from a normal-dry period in these SOMs?



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- Is there a difference in the persistence of the circulation during a drought period? Do drought events last longer within the dry SOMs?
- Is there more information at the seasonal level? For example, in spring what percent of droughts are due to switching to drier patterns or to switching to wetter patterns that are anomalously dry?
- Is there a suppression mechanism for precipitation in the SOMs during drought?
- What do soil moisture or other surface variables look like for each dry spell within SOMs?