Tracking Changes to the Local Climate

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Initial Words on Climate Change

Does a single event equate to a direct result of climate change?

Individual extreme events ***do not*** constitute climate change…

The ***frequency*** of these types of events and the ***seasonal shifts*** are an indicator of a warming climate though…

Think of a weather event as your mood, and climate as your personality.

Overview

- Overall Climate Tendencies
- NWS Heat Program Review
- WBGT and Heat Risk
- Heat / Climate Trends
- Precipitation Trends
- Historic Precipitation Information
- Excessive Precipitation Forecasts

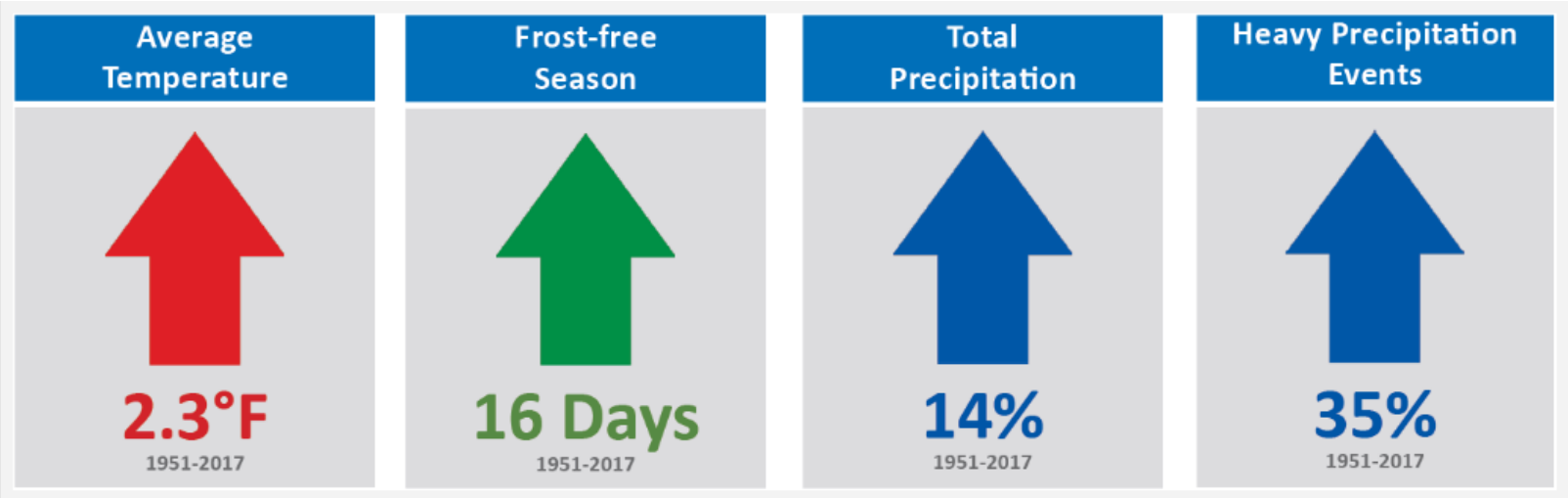
Intergovernmental Panel on Climate Change

Climate Change Considerations

- Temperature changes will not be even across the globe
- Great Lakes region will be affected
- More extreme events
  - Heat/cold
  - Heavy rain/snow
  - Stronger winds
- Global pattern disruption
- Deep ocean circulation changes

Great Lakes Region Impacts

- From GLISA (NOAA, University of Michigan, Michigan State University)

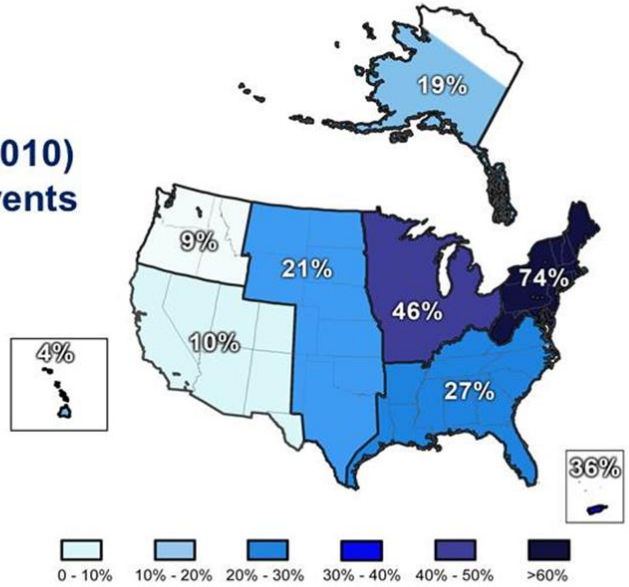


- Heavy precipitation events are the top 1% of events each year

Northeast Regional Trends

Regardless of Shifts in Total Annual Rain More of It Is Coming in Heavy Downpours

Percent Increase (1958-2010) in Heavy Precipitation Events (>2inch/48 hr)



NOAA, provided by A. DeGaetano, NERCC, Cornell

- **The Northeast U.S. leads the country with a 74% increase in heavy rain events over the past five decades**
- Heavy downpours are increasing nationally, especially over the last three to five decades, with the largest increases in the Northeast
- Increases in extreme precipitation are projected for all U.S. regions
- All reasons to consider flood insurance **both inside and outside flood plains**

Sources: A. DeGaetano, Global Change.gov

Recent Great Lakes Area Example

- July 2023
- Canandaigua, NY
- 3.81” of rain in 20 minutes
- 5.55” of rain in an hour

Recent Great Lakes Example Today

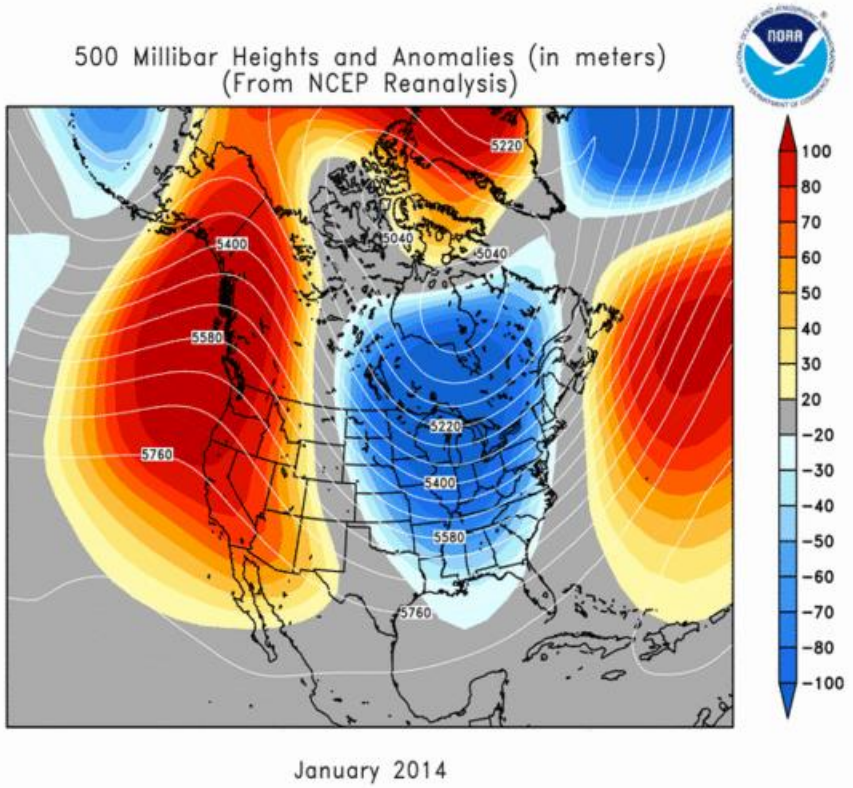
- Detroit Metropolitan Airport Today
- Services 1,100 flights a day
- 2.93” of rain in 3 hours
- Portions of the area saw 5.5” of rain
- Fully submerged cars
- Closed roads
  - I-94
  - I-275
- Thousands stranded

Great Lakes Future Scenarios

- More annual precipitation
  - Wetter winters, drier summers
  - Increases in sewage overflow, flood damage, erosion, transportation impacts
- Higher stratification in Great Lakes
  - Warmer surface waters
  - Increased lake effect precipitation
    - Initially will mean increased lake effect snowfall
  - More frequent and longer lasting algal blooms in the Great Lakes
    - Impacts to drinking water

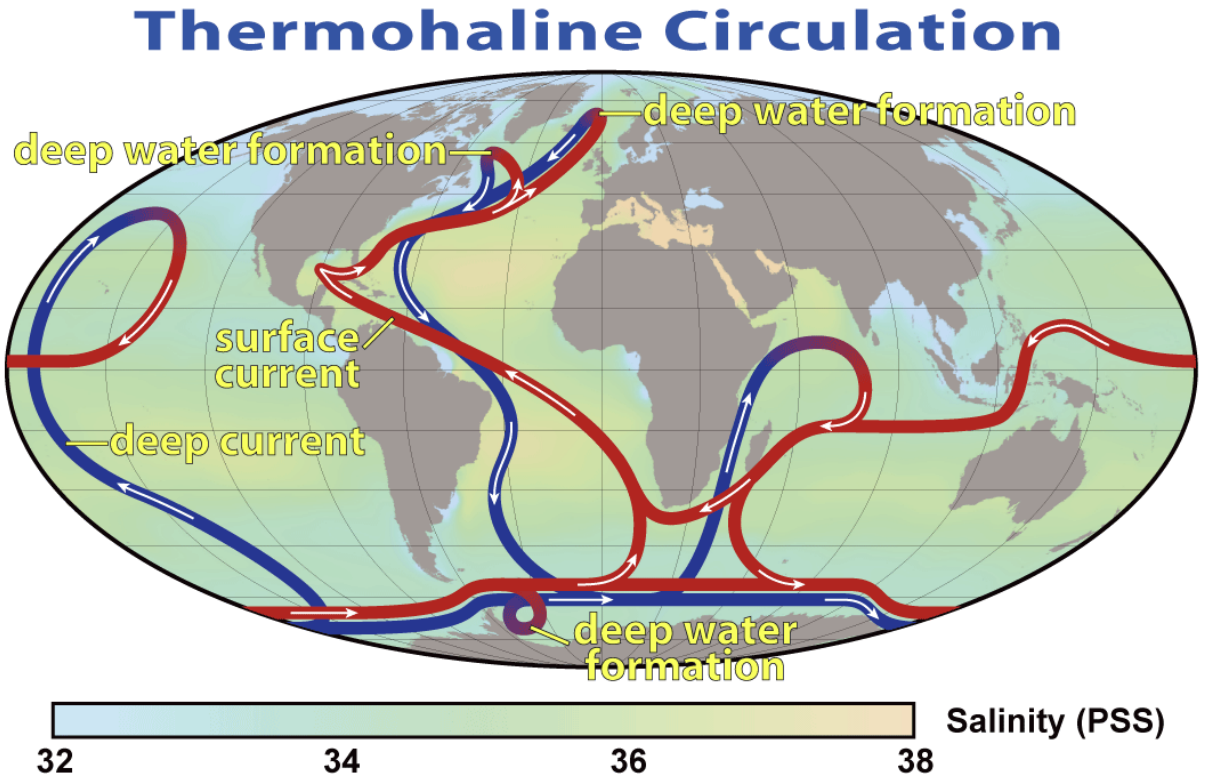
Global Circulation Pattern Disruptions

- Increase in global blocking patterns
- Longer lasting hot/cold spells
- Longer periods of consistent flow regimes…droughts/lake effect

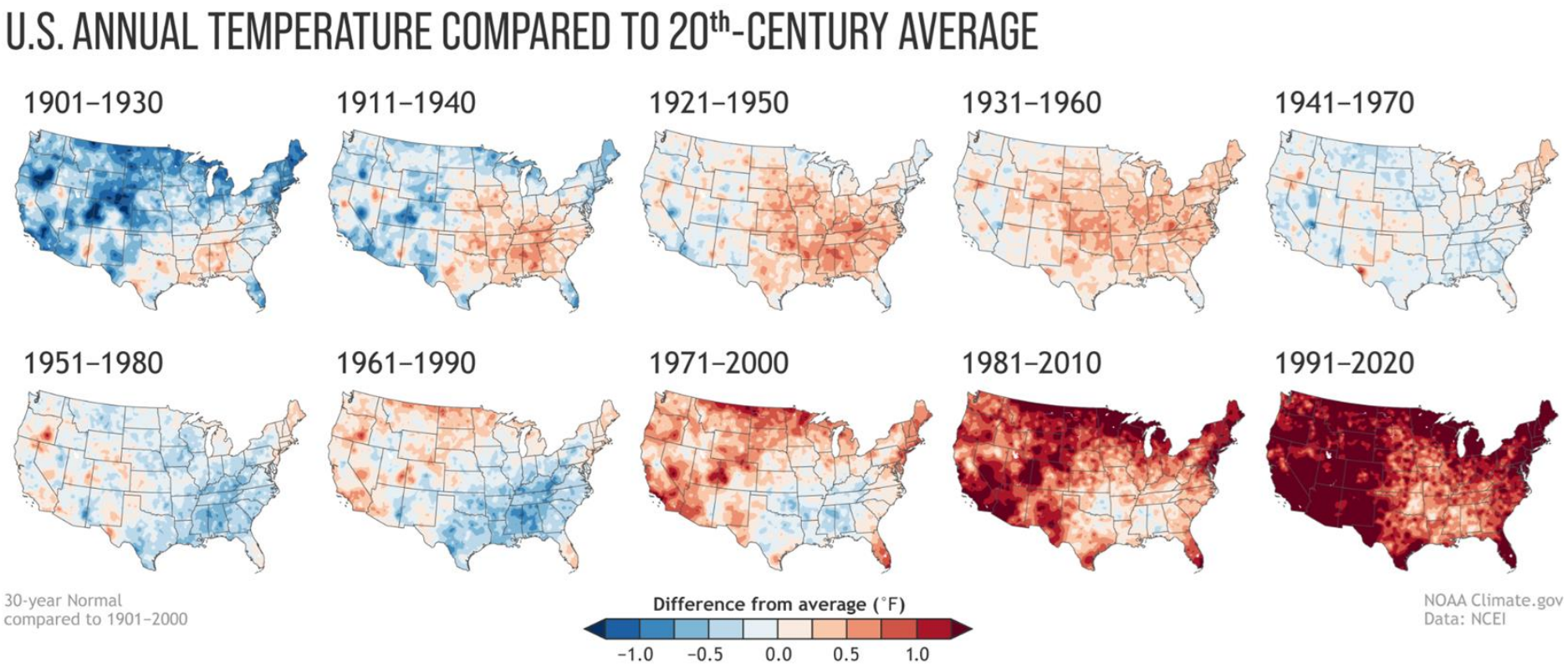


Deep Ocean Circulation

- Driven by ocean salinity and temperature
- Dissipates oceanic heat
- Changes to salinity from melting freshwater will affect this

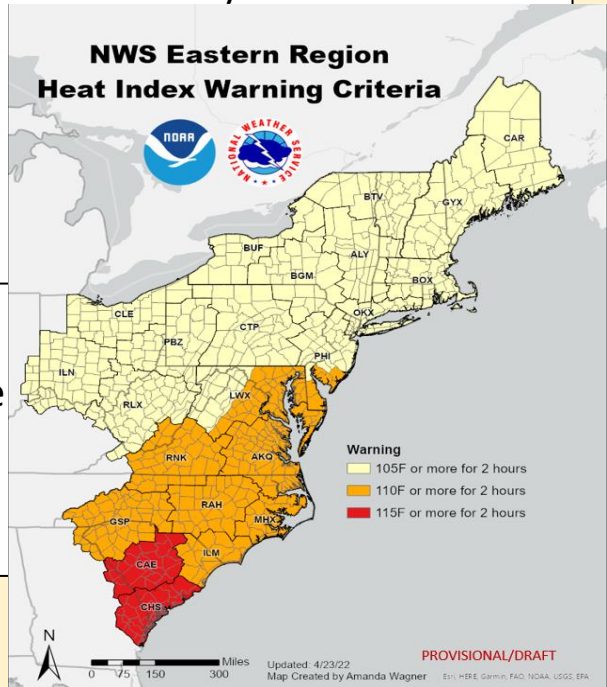


Trend for 30 Year Normals is Decidedly Up



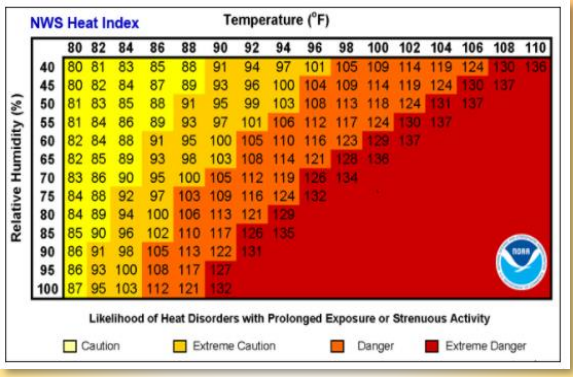
Excessive Heat Watch/Warning and Heat Advisory

Excessive Heat **Watch**	Conditions favorable for an excessive heat event to meet/exceed local heat warning criteria in the next 24 to 72 hrs
Heat **Advisory**	Heat Index values forecast to meet/exceed local heat advisory criteria for 2+ consecutive hours or > 100 for any hour. Issued 12 to 36 hours before event. **95 to 105 degrees**
Excessive Heat **Warning**	Heat Index values forecast to meet or exceed locally defined warning criteria for 2 consecutive hours. Issued 12 to 36 hours before event. **> 105 degrees**



NWS Forecast Tools to assess Heat

Heat Index

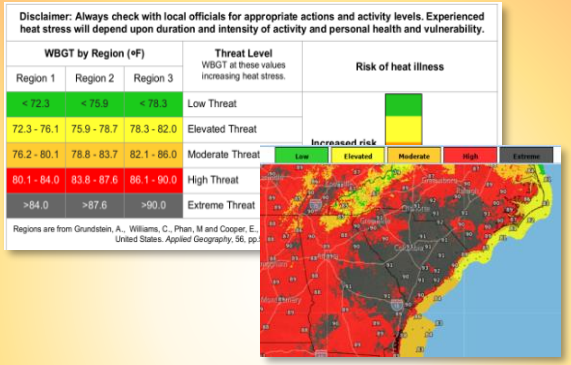


Heat stress in context for **general public.**

- Relatively simple: T + RH
- Light physical activity in shade

5'7" adult, 147.7 lbs, walking outside at 3.1 mph, wearing trousers and short sleeved shirt

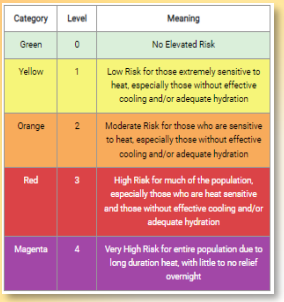
Wet Bulb Globe Temperature



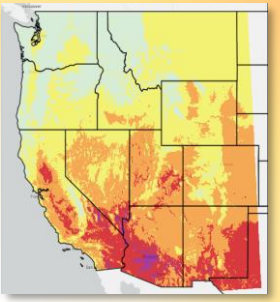
Heat stress in context for **healthy, active outdoor** communities.

- More Complex: T + RH + wind + solar radiation
- High levels of physical activity

Western Region HeatRisk Prototype



Category	Level	Meaning
Green	0	No Elevated Risk
Yellow	1	Low Risk for those extremely sensitive to heat, especially those without effective cooling and/or adequate hydration
Orange	2	Moderate Risk for those who are sensitive to heat, especially those without effective cooling and/or adequate hydration
Red	3	High Risk for much of the population, especially those who are heat senaitive and those without effective cooling and/or adequate hydration
Magenta	4	Very High Risk for entire population due to long duration heat, with little to no relief overnight

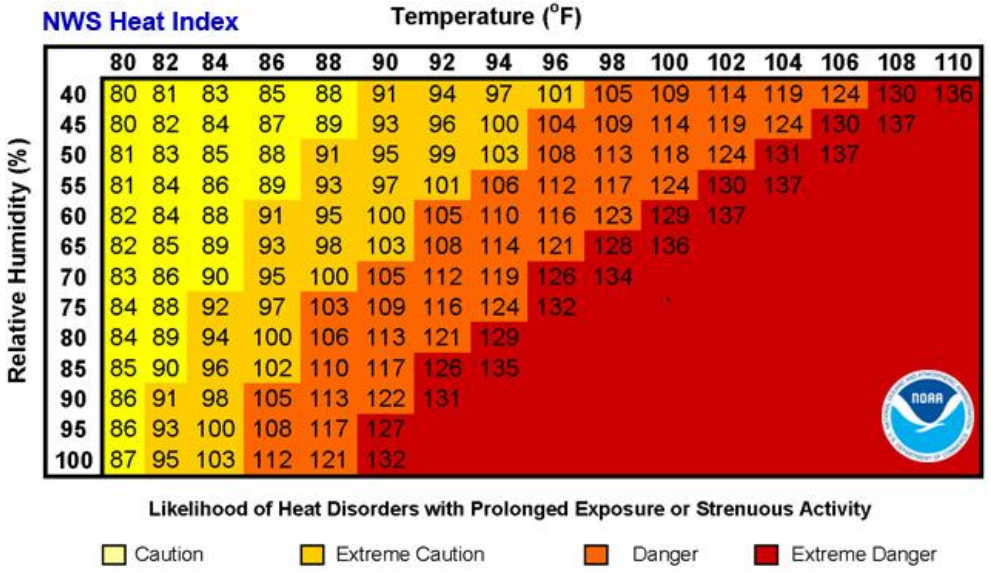


Heat forecasts in **climatological context** with CDC-based health impact messaging.

- How significantly above normal the temperatures are
- Messaging can target more sensitive/vulnerable groups

Heat Index

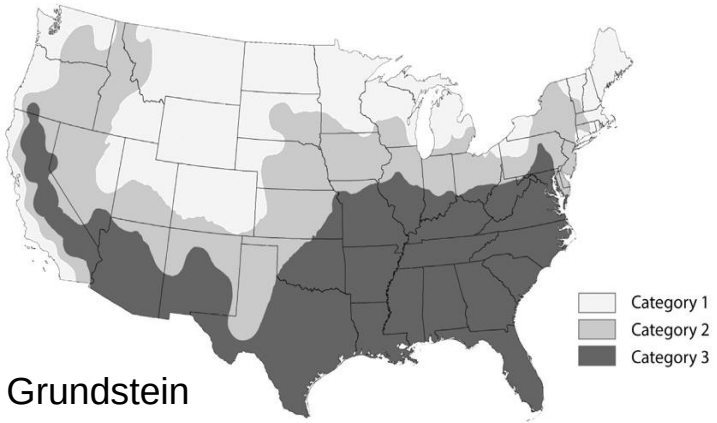
- Traditional measurement of heat stress due to high temperature and **high humidity**
- NWS Heat Headline Criteria



Wet Bulb Globe Temperature (WBGT)

- What is it?
  - Estimates the effect of temperature, humidity, wind and **solar radiation** on the human body
  - Effective indicator of heat stress for active populations
- What are the benefits?
  - Particularly useful for outdoor workers, athletes, outdoor recreation enthusiasts
  - Can help establish guidelines for activity modifications during exercise or outdoor work

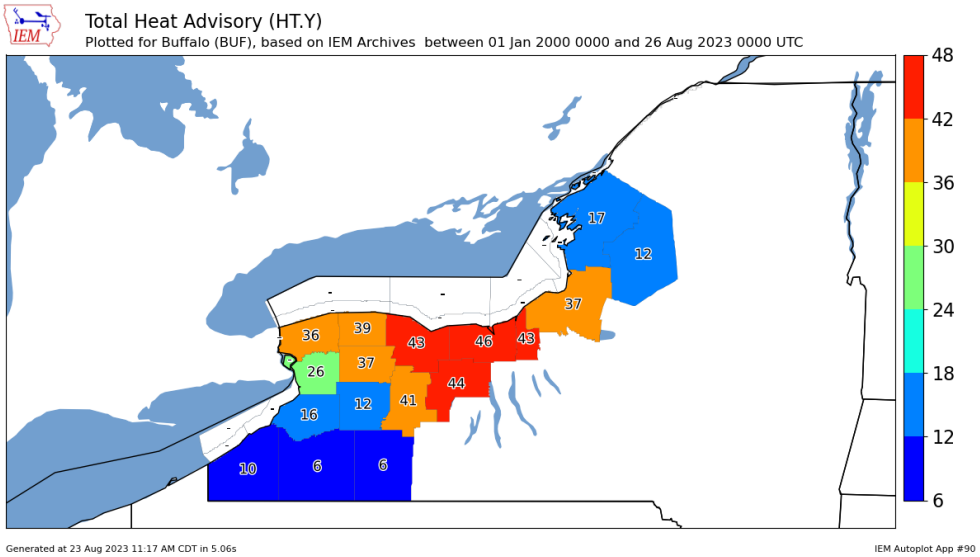
	WBGT	HEAT INDEX
Measured in the sun	●	○
Measured in the shade	○	●
Uses temperature	●	●
Uses relative humidity	●	●
Uses wind	●	○
Uses cloud cover	●	○
Uses sun angle	●	○

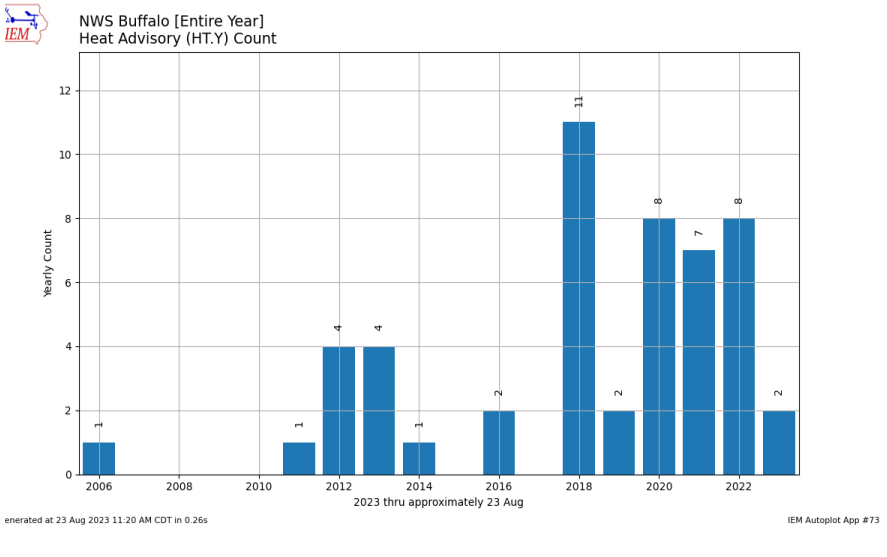


Grundstein

< 72.3	Low Threat	Increased risk for heat illness
72.3 - 76.1	Elevated Threat	
76.2 - 80.1	Moderate Threat	
80.1 - 84.0	High Threat	
>84.0	Extreme Threat	

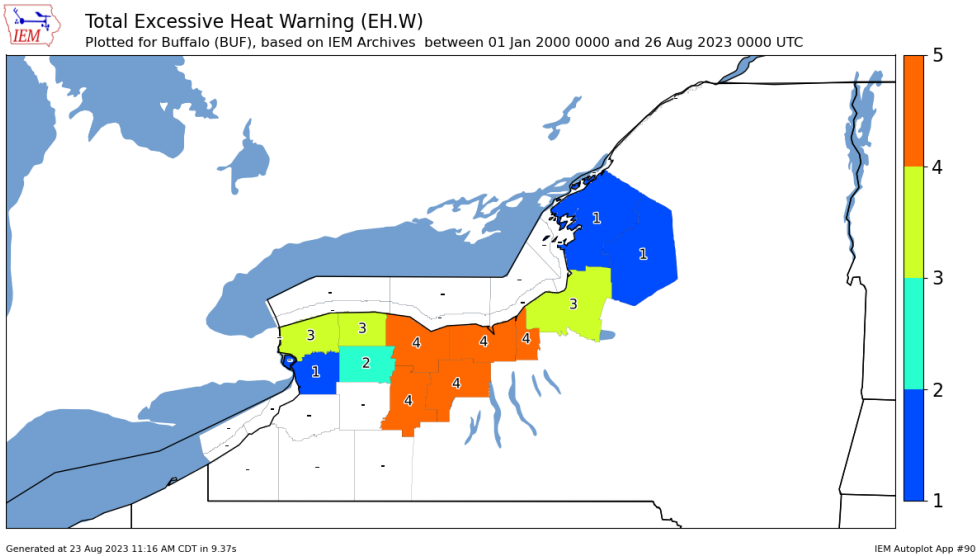
Heat Advisory Issuance

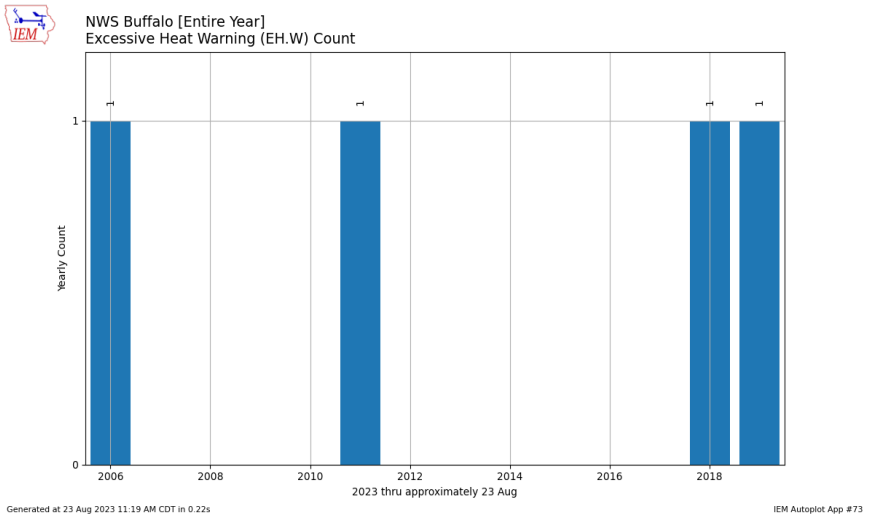




Criteria is 95 degree heat index or higher

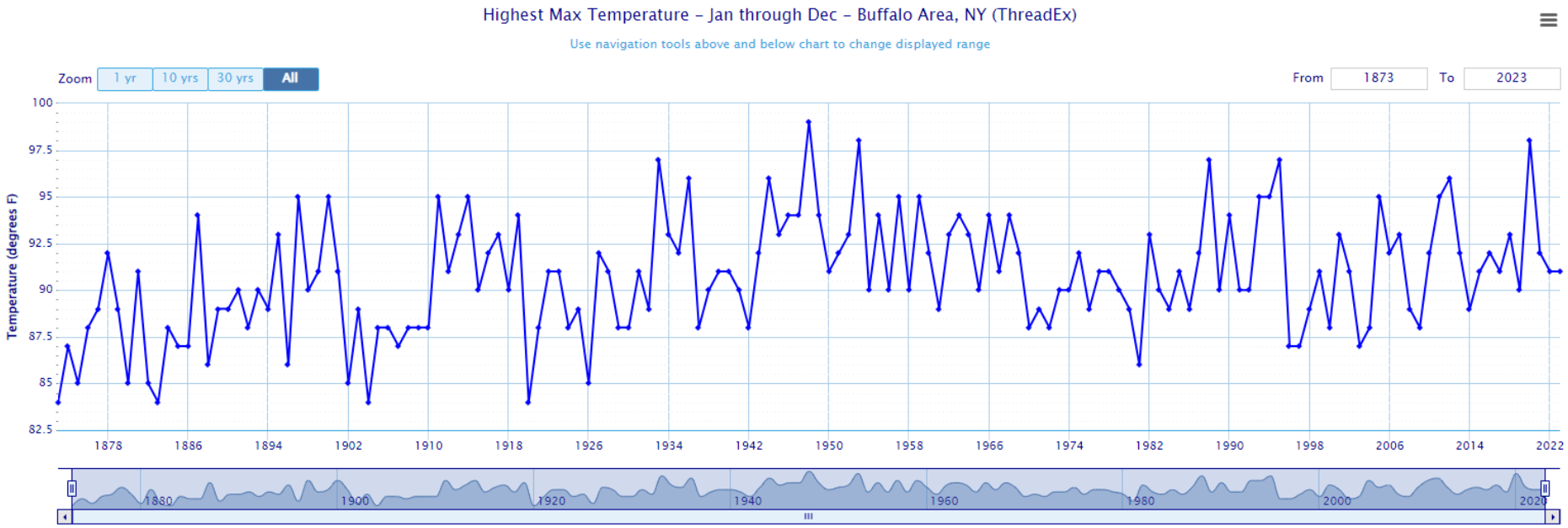
Excessive Heat Warning Issuance



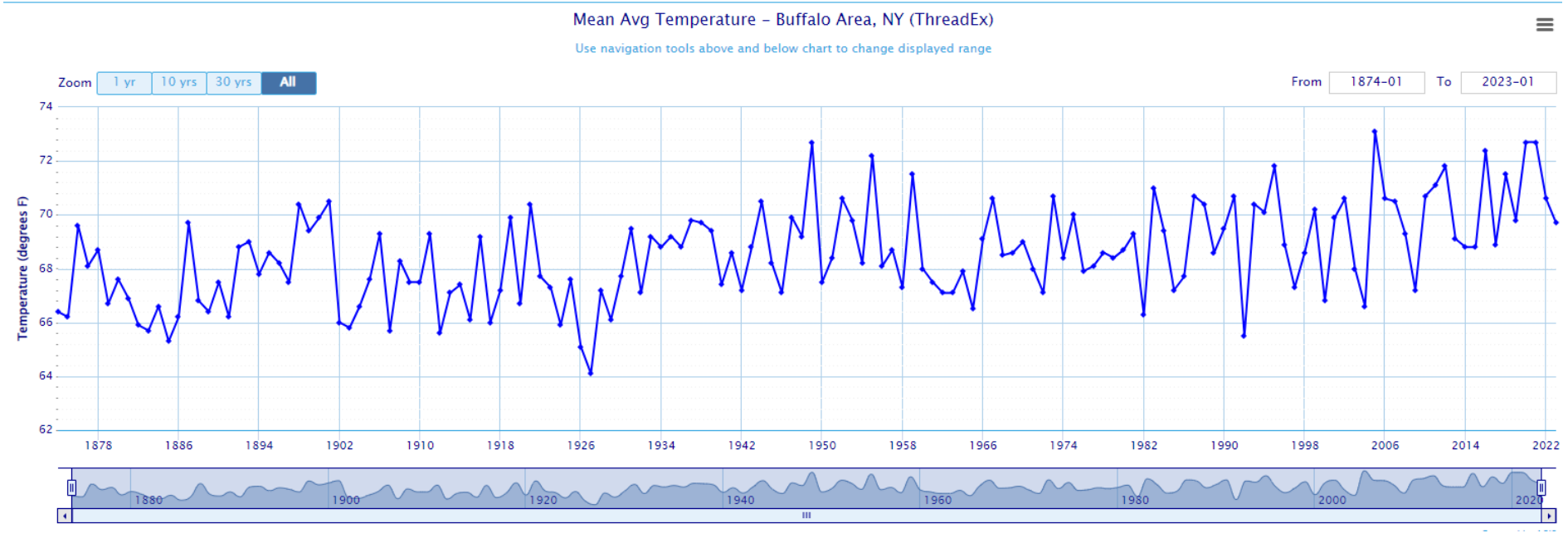


There was no update to the Excessive Heat Warning criteria in 2017

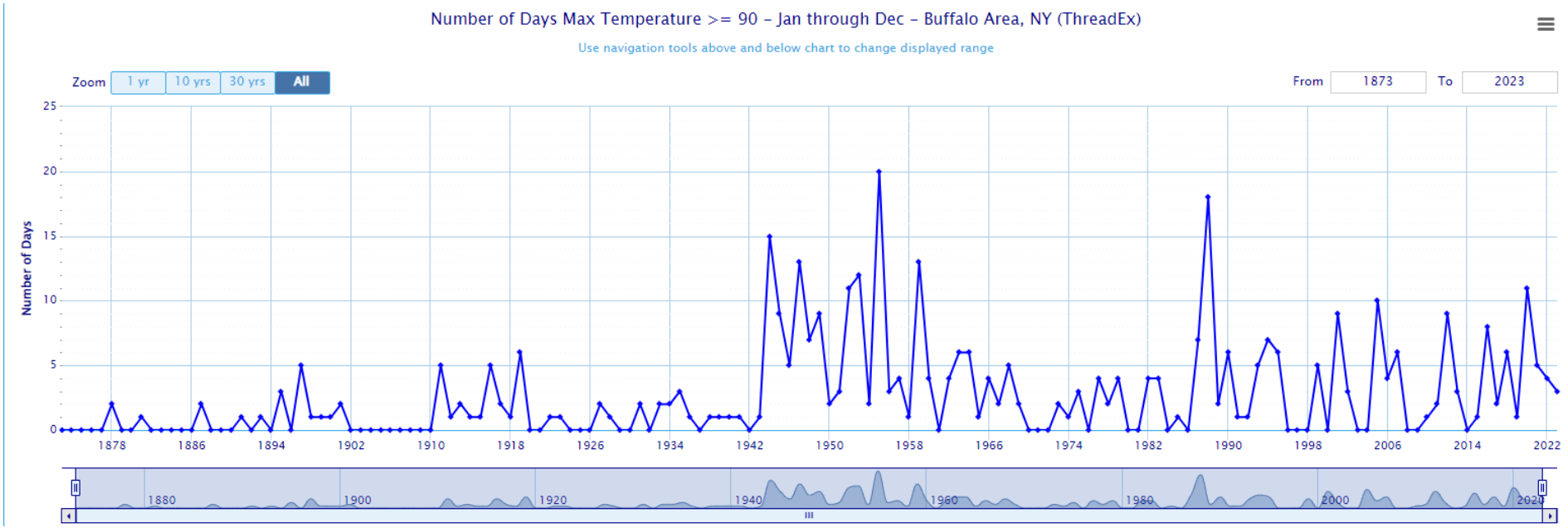
Maximum Annual Temperatures



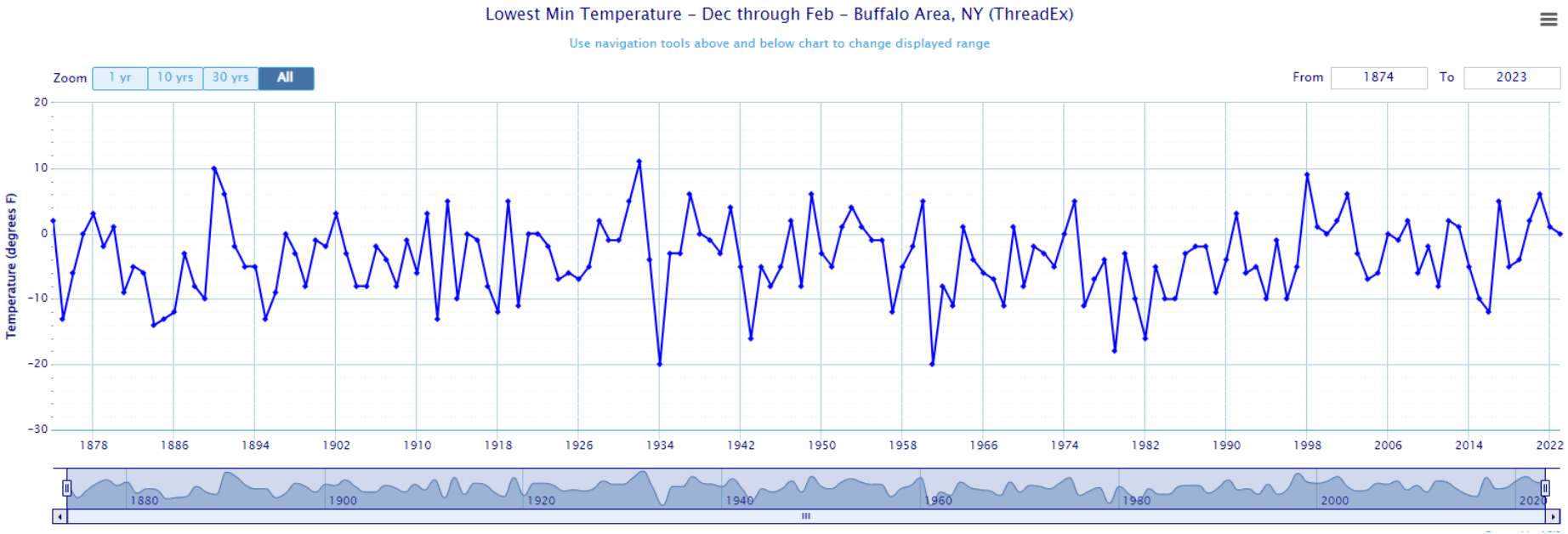
Mean Summertime Temperature Trend



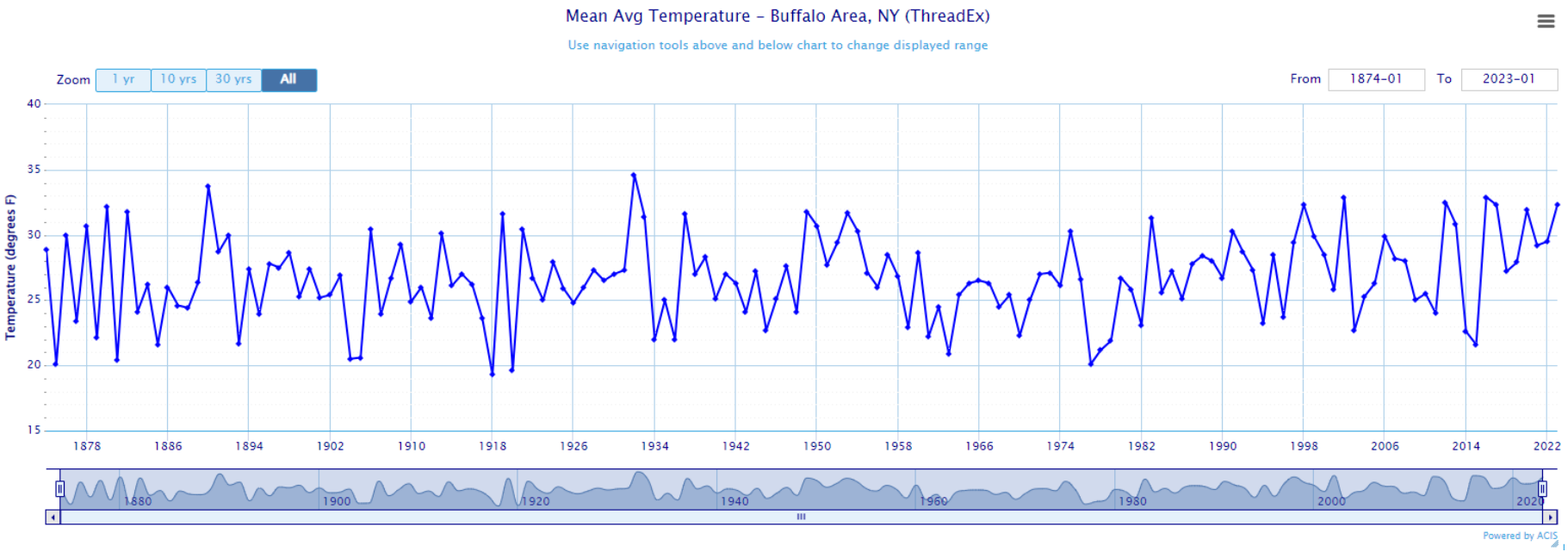
Number of Days Above 90 Degrees



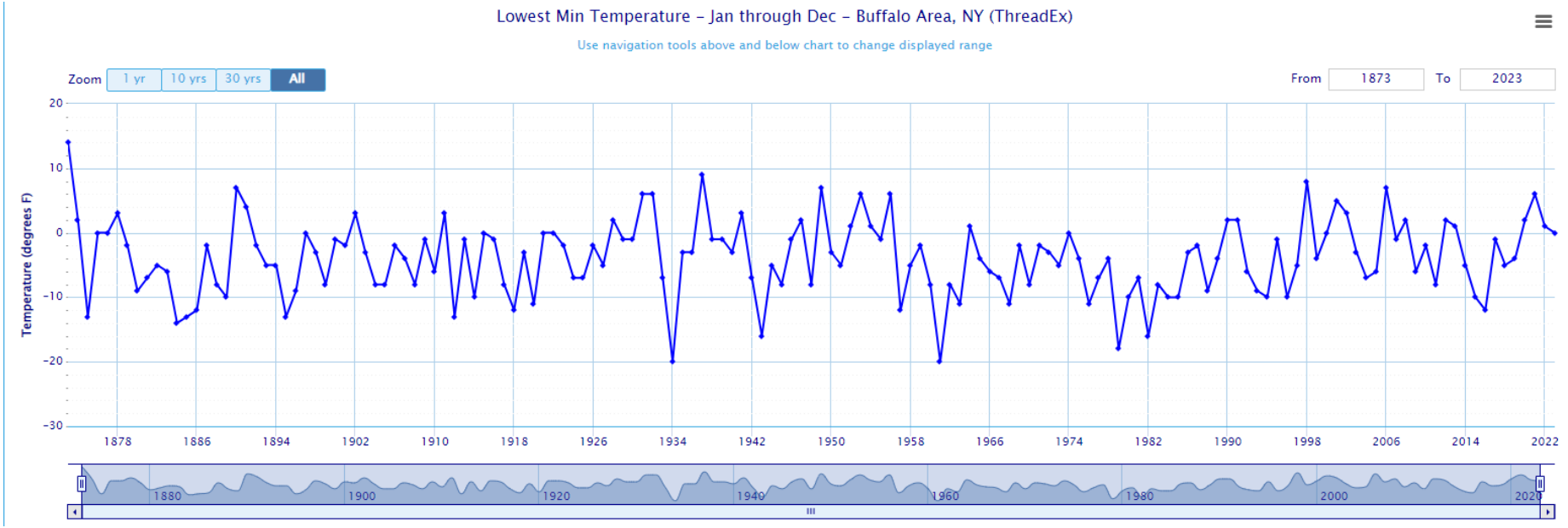
Minimum Winter Temperature Trend



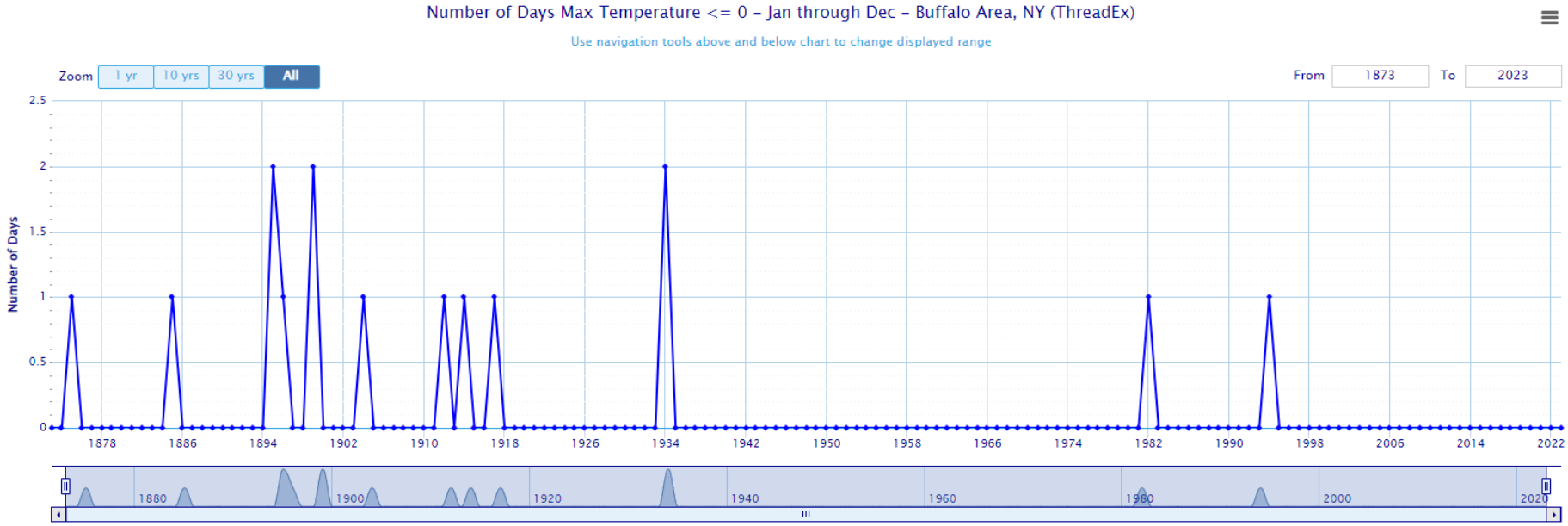
Mean Wintertime Temperature Trend



Lowest Minimum Temperature By Year

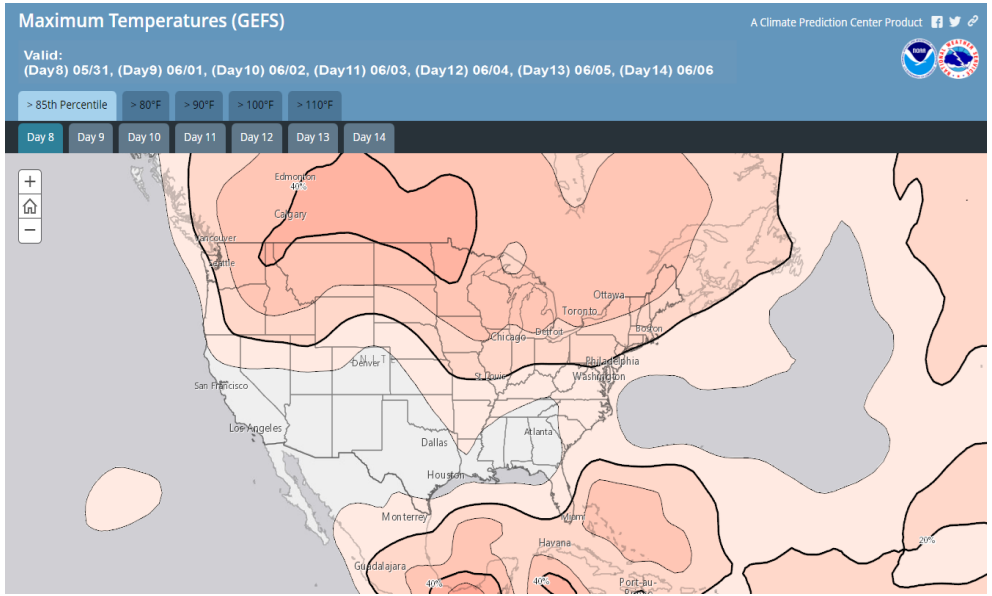


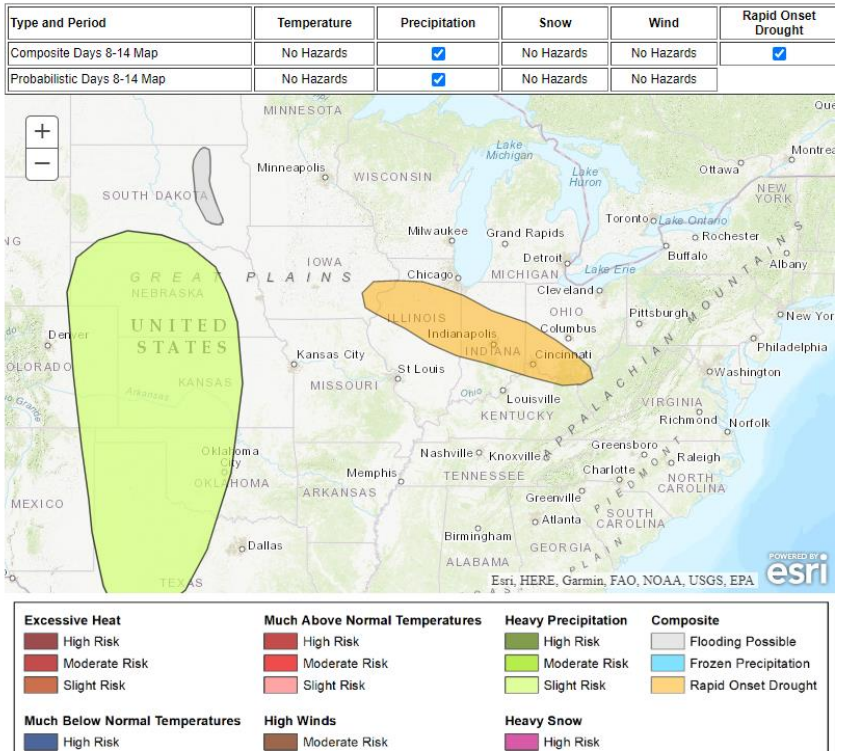
Days with Max Temps Below 0 Degrees Per Year



Resources

https://www.cpc.ncep.noaa.gov/products/predictions/threats/threats.php

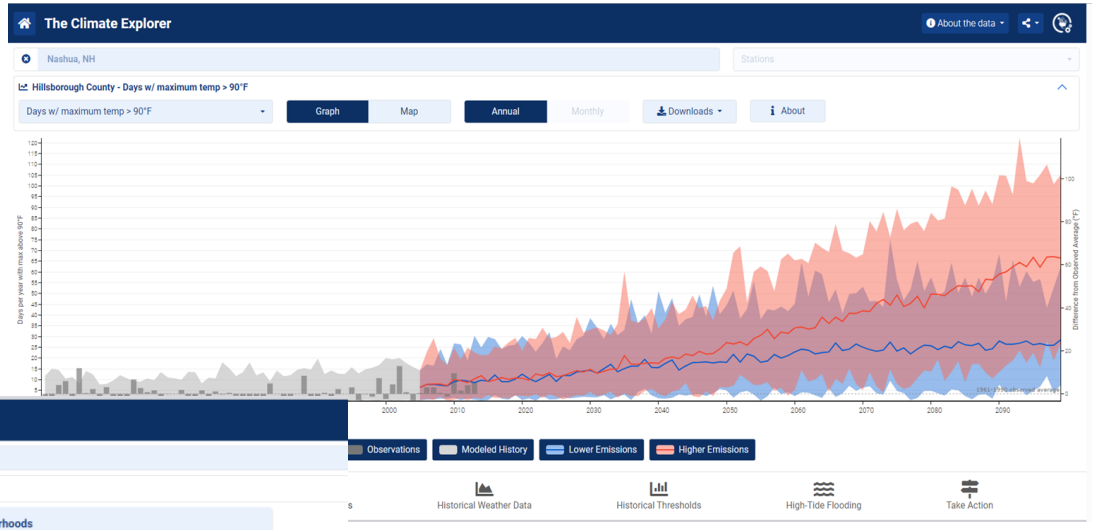


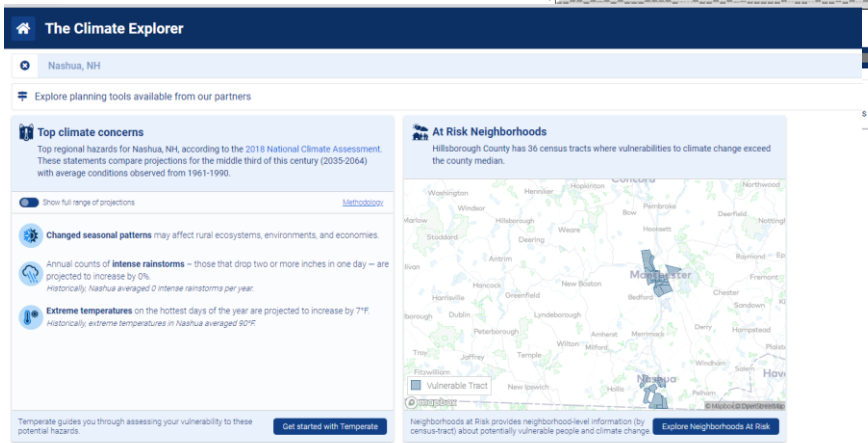


https://www.cpc.ncep.noaa.gov/products/predictions/threats/extremesTool.php

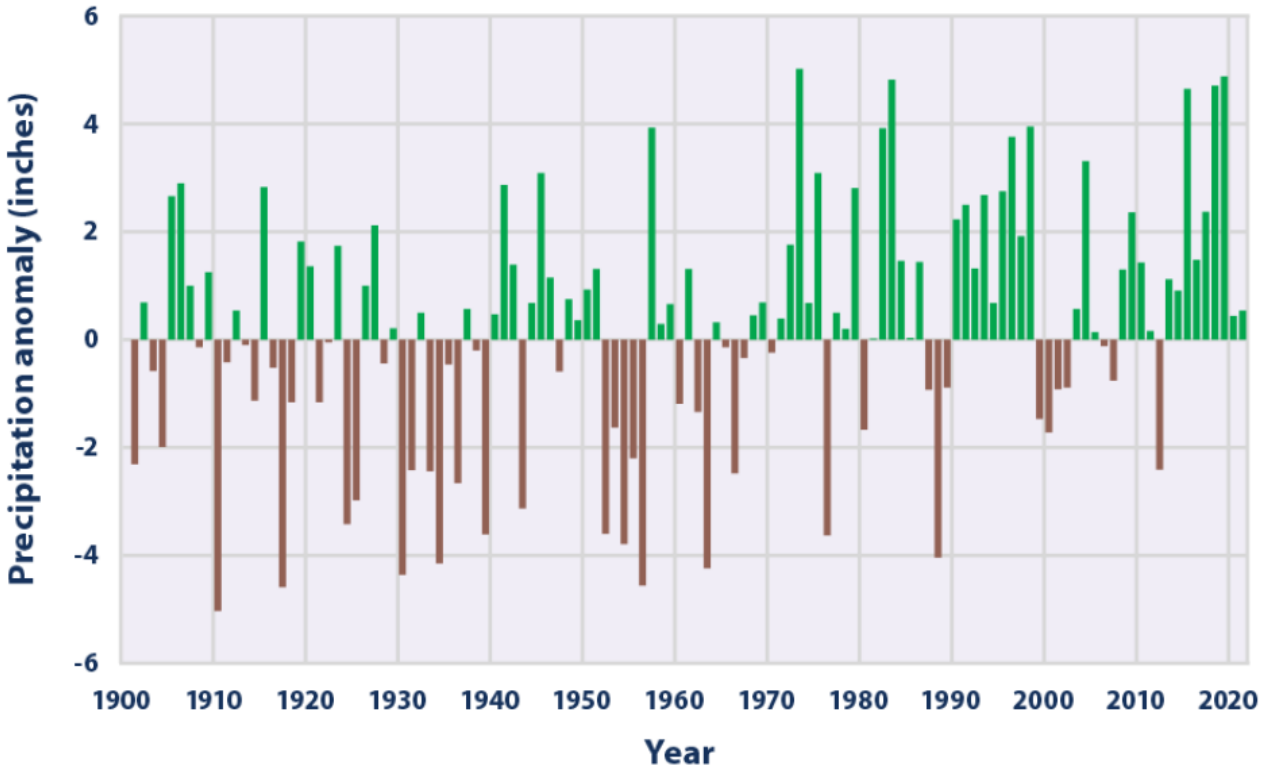
Planning Resources

- https://toolkit.climate.gov/
- Multi-Agency Resource Repository that focuses on planning resources and education for a changing climate



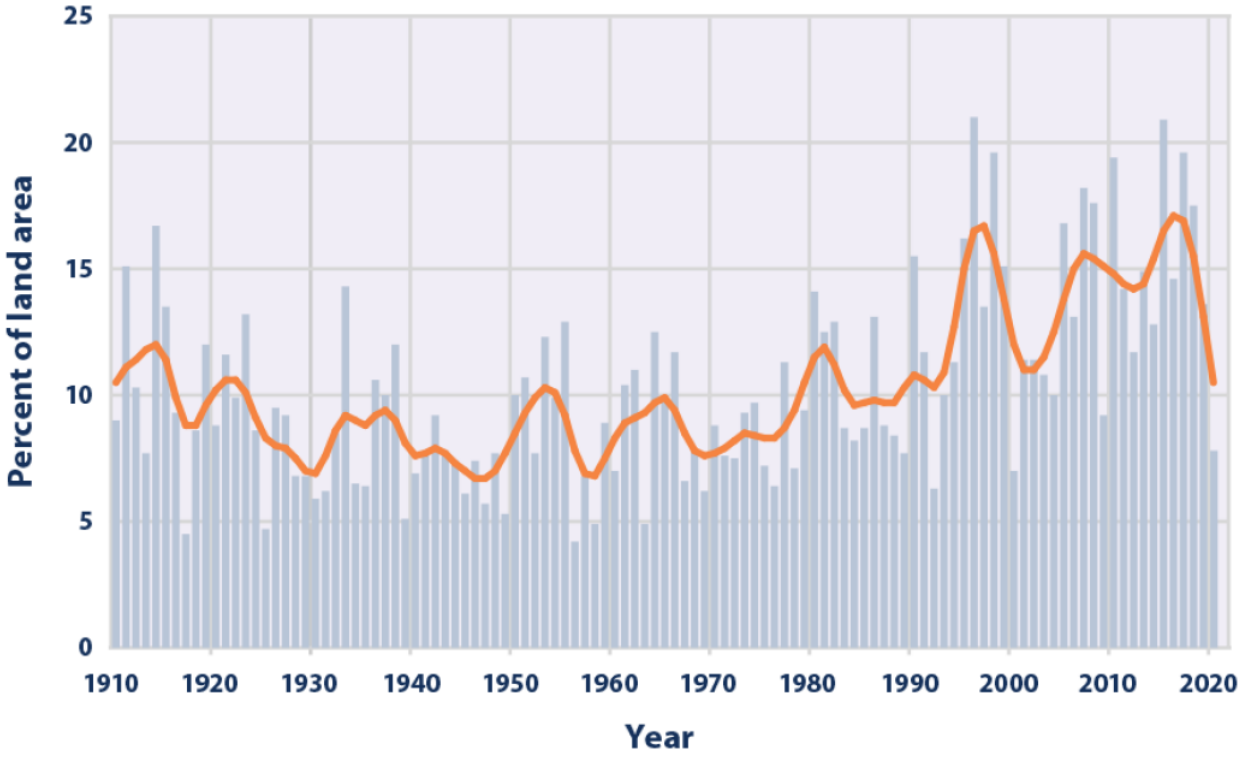


US Precipitation Trends



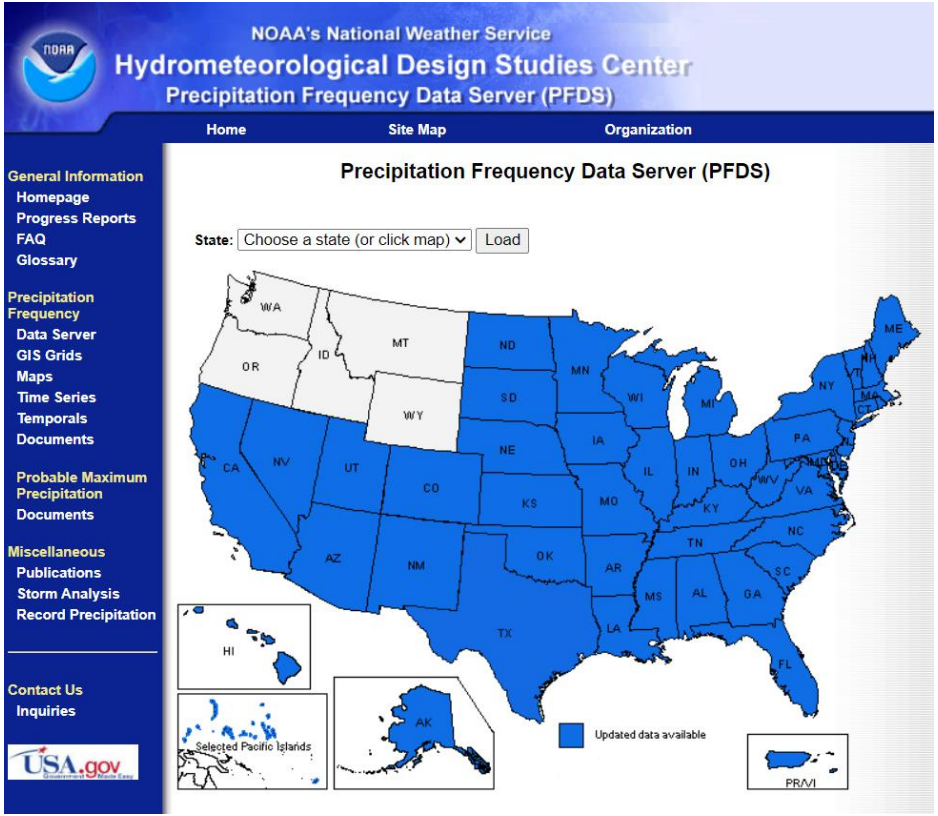
Frequency of Heavy Precipitation Events

- "Heavy precipitation" refers to instances during which the amount of rain or snow experienced in a location substantially exceeds what is normal. What constitutes a period of heavy precipitation varies according to location and season
- In recent years, a larger percentage of precipitation has come in the form of intense single day events.



Precipitation Frequency Data Server

- NOAA Atlas 14 Point Precipitation Frequency Estimates
  - https://hdsc.nws.noaa.gov/hdsc/pfds
- NOAA Atlas 15 is coming in the near future (already funded)



Local Precipitation Information

Orchard Park, NY

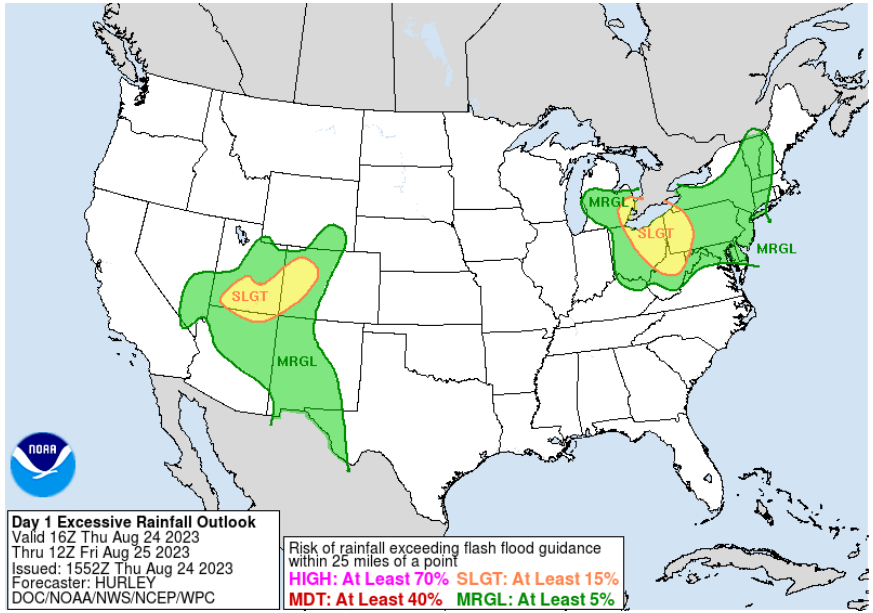
From NOAA Atlas 14

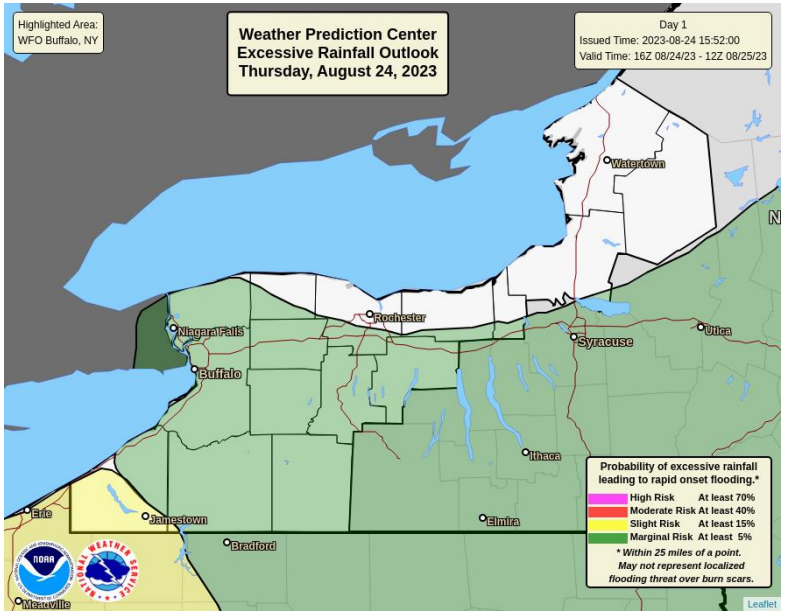
PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.286 (0.229-0.356)	0.344 (0.275-0.428)	0.439 (0.349-0.548)	0.518 (0.409-0.650)	0.626 (0.477-0.822)	0.707 (0.528-0.948)	0.793 (0.572-1.10)	0.891 (0.604-1.27)	1.03 (0.671-1.52)	1.15 (0.729-1.73)
10-min	0.405 (0.324-0.504)	0.488 (0.389-0.607)	0.623 (0.496-0.778)	0.734 (0.580-0.922)	0.887 (0.676-1.16)	1.00 (0.747-1.34)	1.12 (0.810-1.56)	1.26 (0.856-1.79)	1.46 (0.951-2.15)	1.63 (1.03-2.45)
15-min	0.477 (0.381-0.593)	0.574 (0.458-0.714)	0.732 (0.582-0.914)	0.863 (0.682-1.08)	1.04 (0.795-1.37)	1.18 (0.878-1.58)	1.32 (0.953-1.84)	1.49 (1.01-2.11)	1.72 (1.12-2.54)	1.92 (1.22-2.88)
30-min	0.656 (0.525-0.816)	0.790 (0.631-0.983)	1.01 (0.802-1.26)	1.19 (0.940-1.49)	1.44 (1.10-1.89)	1.62 (1.21-2.18)	1.82 (1.31-2.54)	2.05 (1.39-2.91)	2.38 (1.54-3.50)	2.65 (1.68-3.97)
60-min	0.836 (0.668-1.04)	1.01 (0.803-1.25)	1.28 (1.02-1.60)	1.52 (1.20-1.90)	1.83 (1.40-2.41)	2.07 (1.54-2.78)	2.32 (1.68-3.24)	2.61 (1.77-3.71)	3.03 (1.97-4.45)	3.37 (2.13-5.06)
2-hr	1.03 (0.826-1.27)	1.25 (1.00-1.54)	1.60 (1.28-1.99)	1.90 (1.51-2.37)	2.31 (1.77-3.02)	2.62 (1.96-3.50)	2.95 (2.14-4.08)	3.32 (2.26-4.69)	3.87 (2.52-5.66)	4.33 (2.75-6.46)
3-hr	1.14 (0.924-1.41)	1.40 (1.12-1.72)	1.80 (1.45-2.23)	2.14 (1.71-2.66)	2.61 (2.01-3.40)	2.96 (2.23-3.94)	3.33 (2.43-4.61)	3.77 (2.57-5.30)	4.40 (2.88-6.41)	4.94 (3.14-7.33)
6-hr	1.36 (1.11-1.66)	1.67 (1.35-2.04)	2.16 (1.75-2.66)	2.57 (2.07-3.18)	3.14 (2.43-4.06)	3.56 (2.70-4.72)	4.02 (2.95-5.53)	4.55 (3.12-6.36)	5.35 (3.51-7.74)	6.03 (3.85-8.88)
12-hr	1.61 (1.32-1.95)	1.96 (1.60-2.38)	2.54 (2.07-3.10)	3.02 (2.44-3.70)	3.68 (2.86-4.73)	4.16 (3.17-5.48)	4.69 (3.46-6.43)	5.32 (3.66-7.39)	6.28 (4.13-9.02)	7.10 (4.55-10.4)
24-hr	1.91 (1.58-2.31)	2.30 (1.89-2.78)	2.93 (2.40-3.55)	3.45 (2.81-4.20)	4.17 (3.27-5.32)	4.70 (3.60-6.15)	5.28 (3.92-7.19)	5.97 (4.12-8.23)	7.03 (4.64-10.0)	7.93 (5.10-11.5)
2-day	2.31 (1.91-2.76)	2.70 (2.24-3.24)	3.35 (2.76-4.03)	3.88 (3.18-4.70)	4.62 (3.65-5.85)	5.17 (3.98-6.69)	5.76 (4.29-7.76)	6.46 (4.49-8.84)	7.52 (4.99-10.6)	8.42 (5.43-12.2)
3-day	2.59 (2.16-3.09)	3.00 (2.49-3.58)	3.65 (3.02-4.37)	4.20 (3.45-5.06)	4.94 (3.91-6.22)	5.50 (4.25-7.08)	6.10 (4.55-8.17)	6.81 (4.74-9.27)	7.86 (5.23-11.1)	8.76 (5.66-12.6)
4-day	2.83 (2.36-3.37)	3.24 (2.70-3.86)	3.91 (3.24-4.67)	4.47 (3.68-5.36)	5.23 (4.15-6.56)	5.80 (4.49-7.44)	6.41 (4.79-8.54)	7.12 (4.97-9.67)	8.18 (5.45-11.5)	9.07 (5.87-13.0)
7-day	3.43 (2.88-4.06)	3.88 (3.25-4.59)	4.60 (3.84-5.46)	5.20 (4.30-6.21)	6.02 (4.80-7.49)	6.64 (5.15-8.44)	7.29 (5.45-9.62)	8.04 (5.63-10.8)	9.12 (6.10-12.7)	10.0 (6.49-14.3)
10-day	3.99 (3.36-4.71)	4.47 (3.76-5.28)	5.25 (4.39-6.22)	5.90 (4.90-7.02)	6.79 (5.42-8.40)	7.46 (5.80-9.43)	8.16 (6.10-10.7)	8.94 (6.29-12.0)	10.1 (6.74-14.0)	11.0 (7.13-15.6)
20-day	5.69 (4.82-6.66)	6.28 (5.31-7.35)	7.24 (6.10-8.51)	8.03 (6.72-9.50)	9.13 (7.33-11.2)	9.97 (7.78-12.5)	10.8 (8.10-14.0)	11.7 (8.30-15.6)	13.0 (8.75-17.9)	14.0 (9.12-19.7)
30-day	7.14 (6.08-8.33)	7.82 (6.65-9.13)	8.94 (7.56-10.5)	9.86 (8.28-11.6)	11.1 (8.96-13.6)	12.1 (9.47-15.0)	13.1 (9.80-16.8)	14.1 (10.0-18.7)	15.5 (10.4-21.2)	16.5 (10.8-23.2)
45-day	9.01 (7.70-10.5)	9.80 (8.36-11.4)	11.1 (9.42-12.9)	12.2 (10.3-14.3)	13.7 (11.0-16.6)	14.8 (11.6-18.3)	15.9 (11.9-20.3)	17.1 (12.1-22.5)	18.5 (12.6-25.4)	19.6 (12.9-27.5)
60-day	10.6 (9.09-12.3)	11.5 (9.84-13.3)	12.9 (11.0-15.1)	14.1 (12.0-16.5)	15.8 (12.8-19.1)	17.1 (13.4-21.0)	18.3 (13.8-23.2)	19.6 (13.9-25.7)	21.1 (14.3-28.8)	22.2 (14.6-31.0)

Excessive Precipitation Forecasts

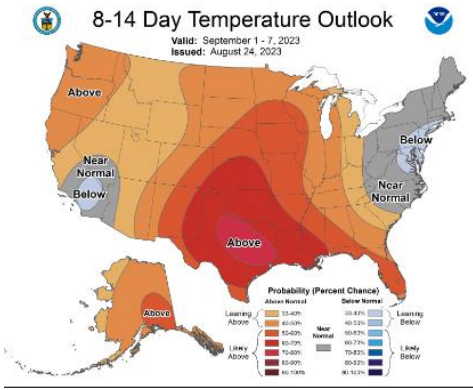
- Weather Prediction Center: https://wpc.ncep.noaa.gov/

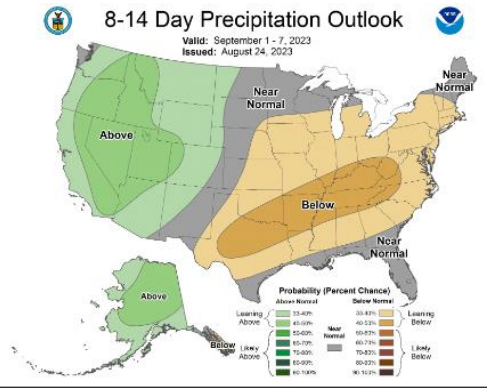




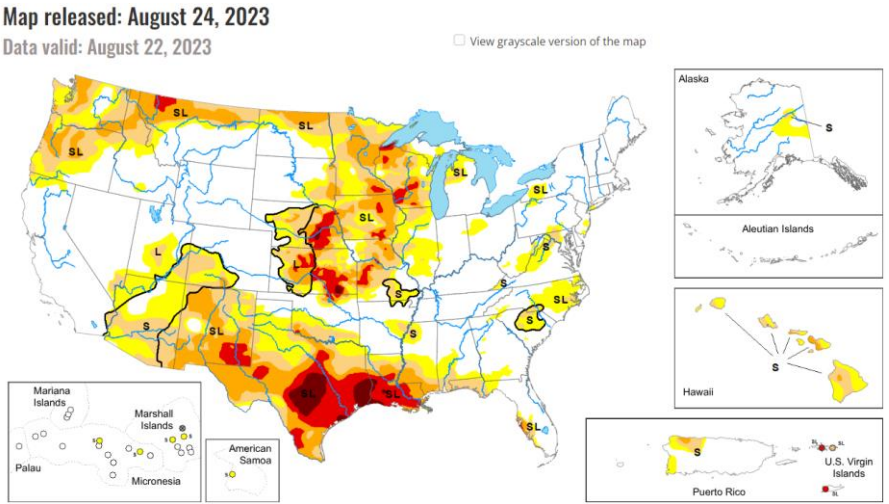
Climate Outlooks and Resources

- Climate Prediction Center: https://cpc.ncep.noaa.gov



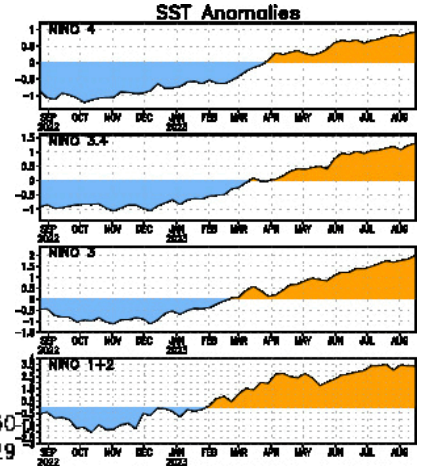


- Drought Monitor: https://droughtmonitor.unl.edu

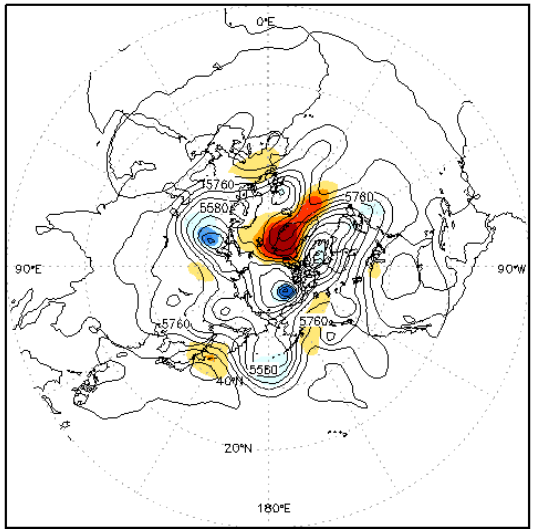


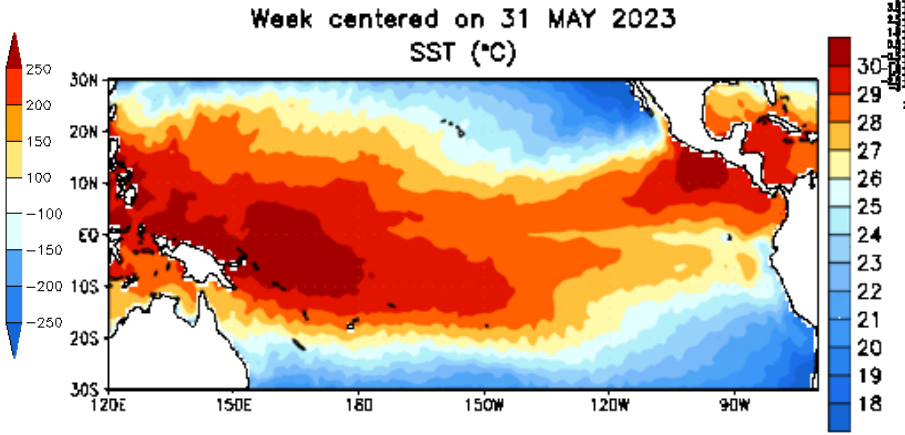
Climate Outlooks and Resources

- Climate Prediction Center (cont'd)
  - El Nino Outlooks
  - Blocking Patterns
  - Various oscillations that impact weather on a scale of week to months



500 hPa Geopotential Height and Anomalies 00Z24AUG2023





Dealing with a Changing Climate

- Preparedness Activities
- Impact Assessments
- Action Planning
- Resiliency and Mitigation

Weather-Ready Nation Ambassador

- Partnership between NWS, public, and private sector to build community resilience.
- Free program where you commit to:
  - Setting an example by becoming "Weather-Ready" yourself (*e.g.*, making employee preparedness a priority & having a disaster plan)
  - Promoting Weather-Ready Nation messages in outreach activities
  - Providing incentives to your constituents and stakeholders to become more resilient
  - Sharing success stories with NOAA

AMBASSADOR™ WRN WEATHER-READY NATION

Link: weather.gov/wrn/ambassadors

StormReady Program

- Proactive approach to show your community is prepared for storms
- Meet basic criteria:
  - Establish a 24-hour warning point and Emergency Operations Center
  - Have more than one way to receive severe weather warnings and forecasts and to alert the public
  - Create a system that monitors weather conditions locally
  - Promote the importance of public readiness through community seminars
  - Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises.

Link: weather.gov/stormready/

New York StormReady

- Erie County
- Amherst
- Cheektowaga
- Buffalo Bills

Questions?

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https://www.weather.gov/buf