



Presentation to Carroll County Environmental Advisory Council

Wednesday, May 15, 2024

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Program Manager

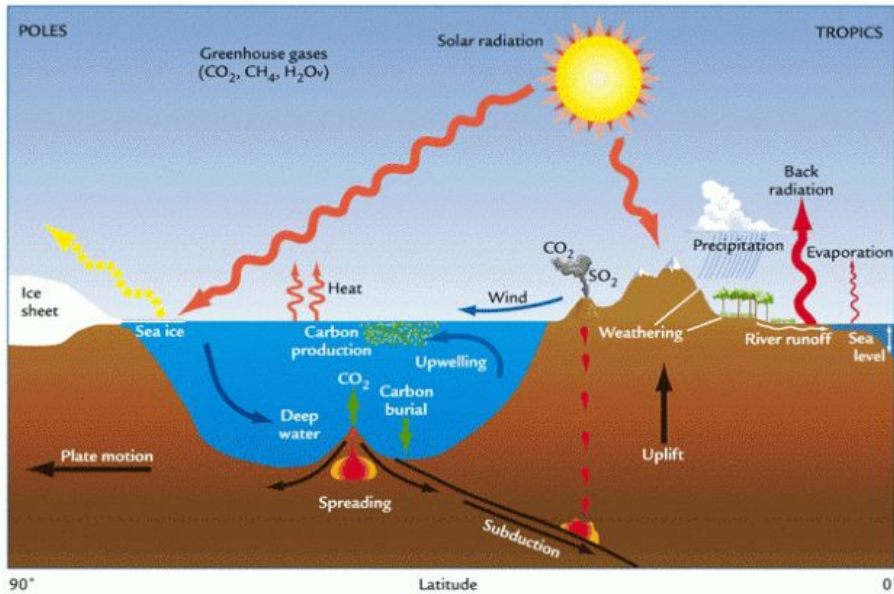
Modeling, Analysis, Predictions, and Projections Program

Climate Program Office

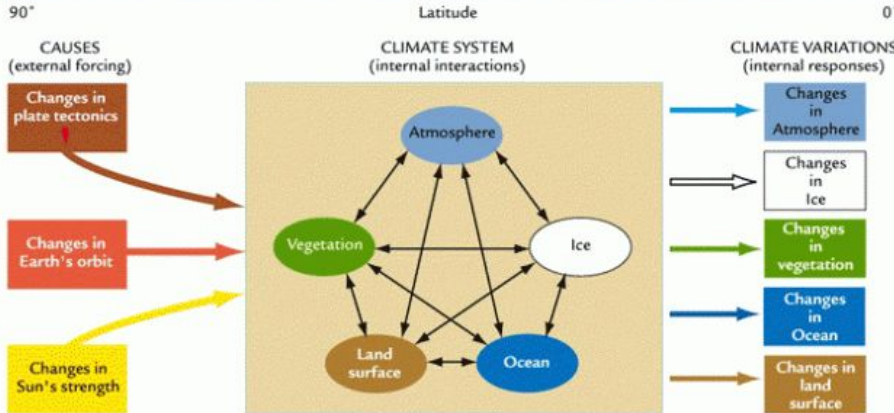
Office of Atmospheric and Oceanic Research

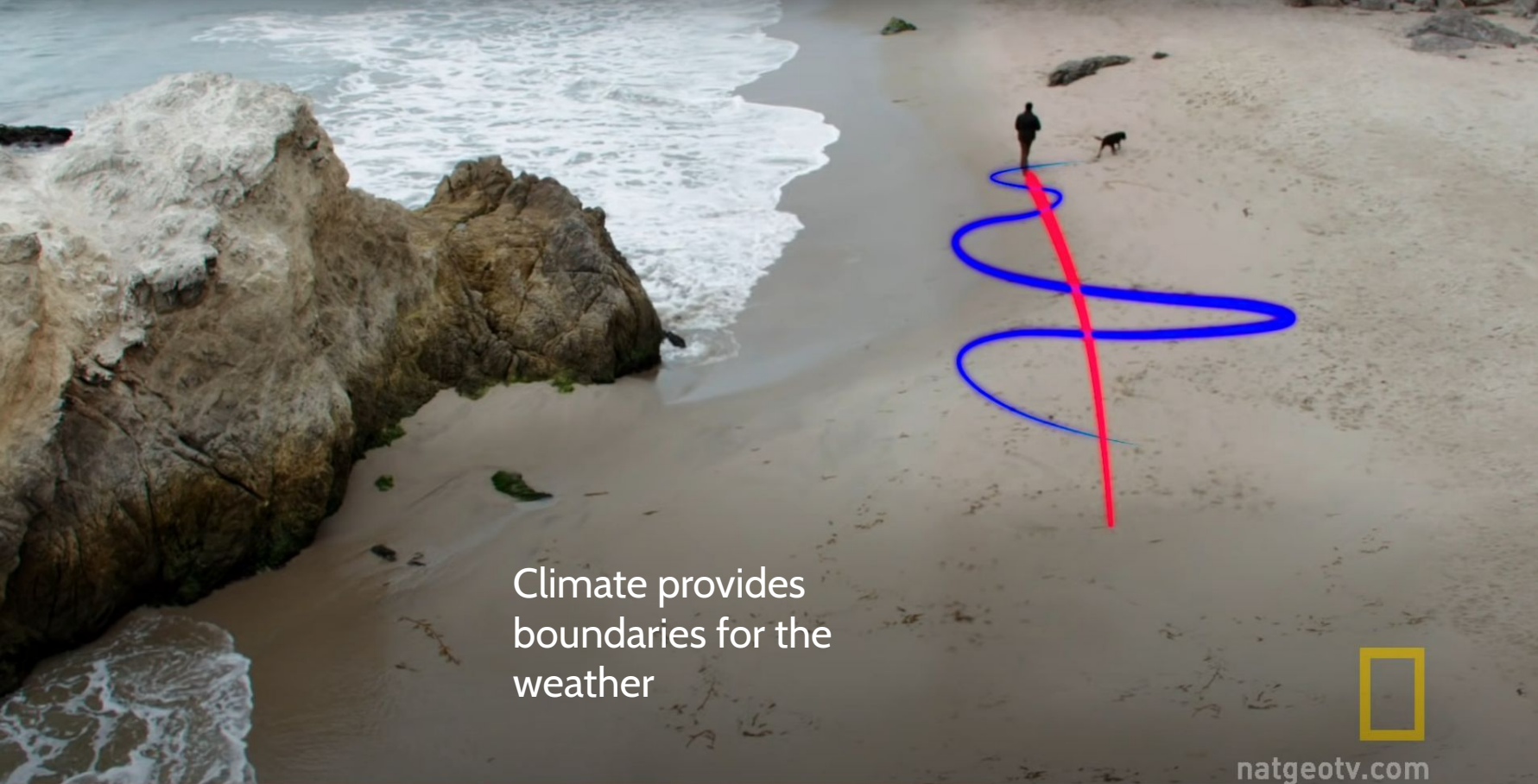
National Oceanic and Atmospheric Administration

Department of Commerce



The Climate System: Interactions between the “fast”-moving systems of the Earth





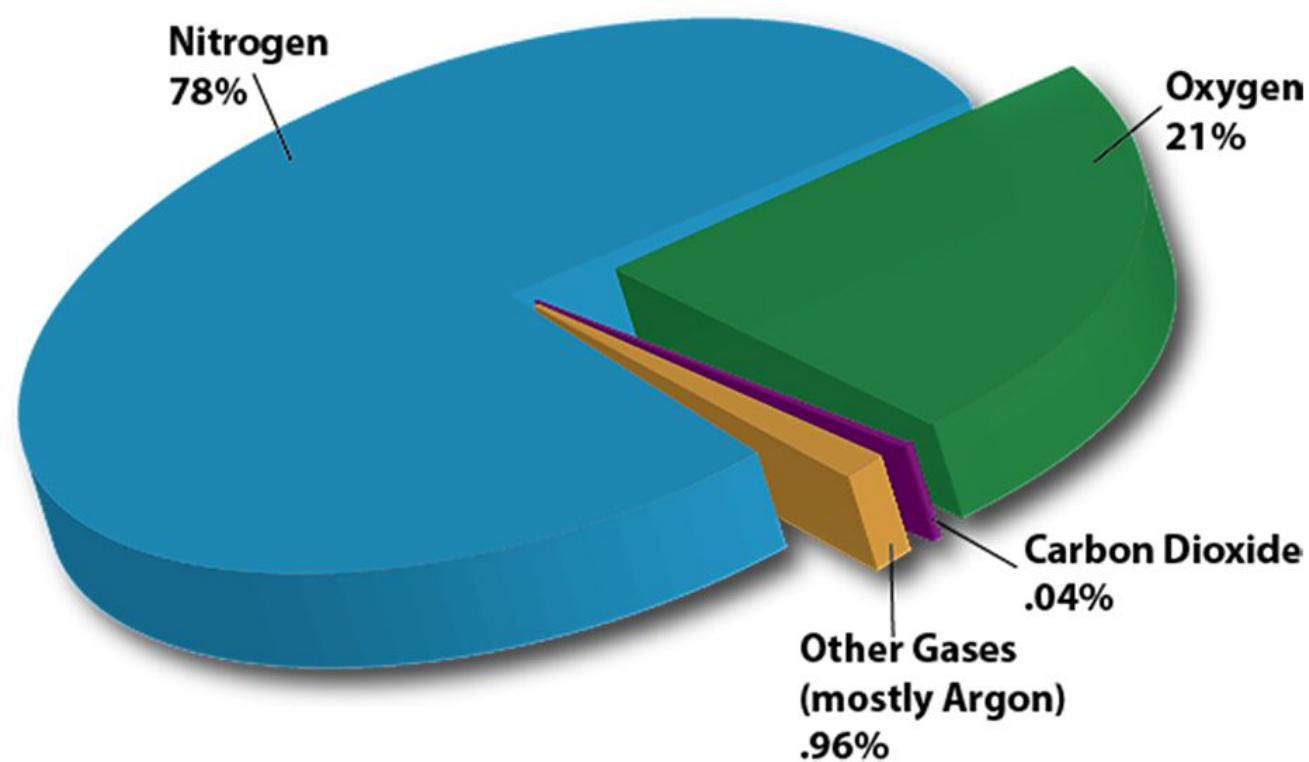
Climate provides
boundaries for the
weather



natgeotv.com

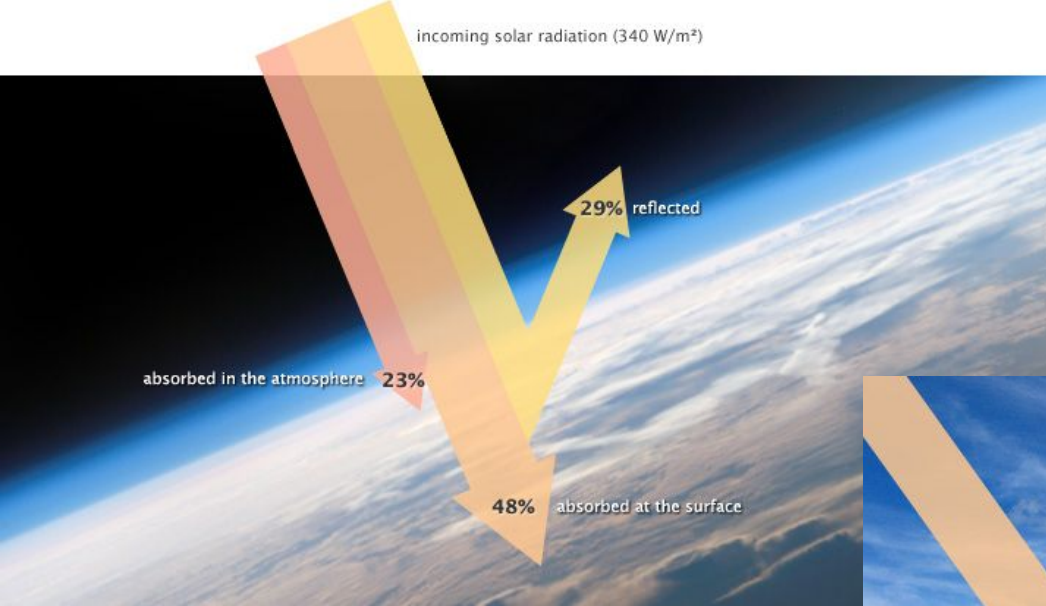
“Keep your eye on the dog walker, not the dog”





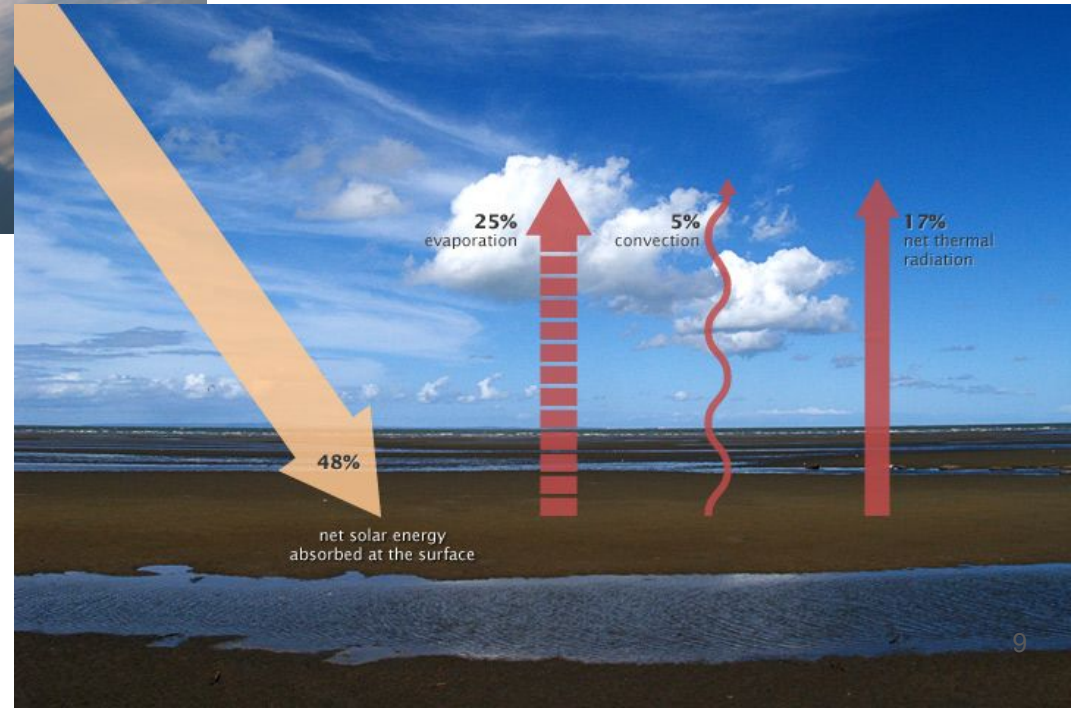
A very small portion of the atmosphere is greenhouse gases

But those gases have a particular affinity for absorbing energy



About half of the sun's energy reaches the Earth's surface

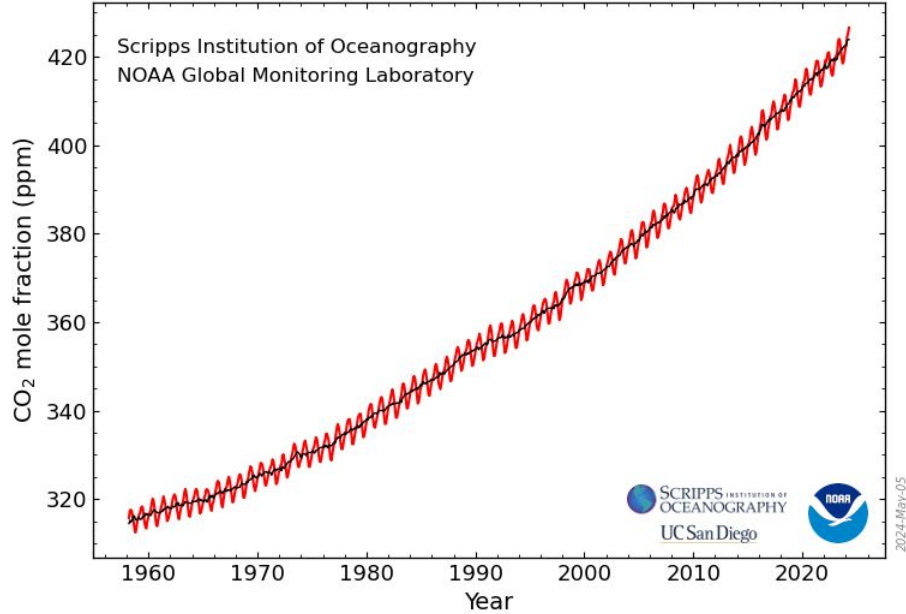
A lot of that energy goes into evaporating water



Some energy is emitted from the surface

The portion of that energy absorbed by the atmosphere goes into the greenhouse effect

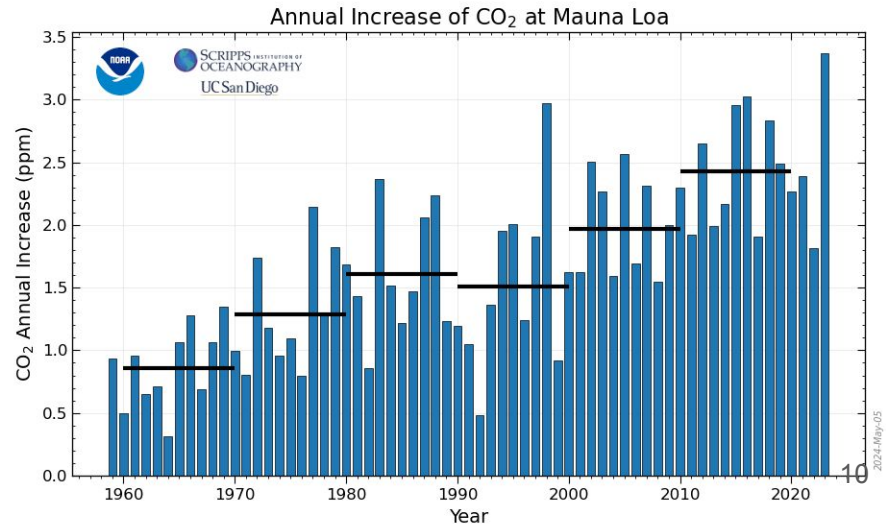
Atmospheric CO₂ at Mauna Loa Observatory



Carbon Dioxide has been increasing since roughly the mid 1800s

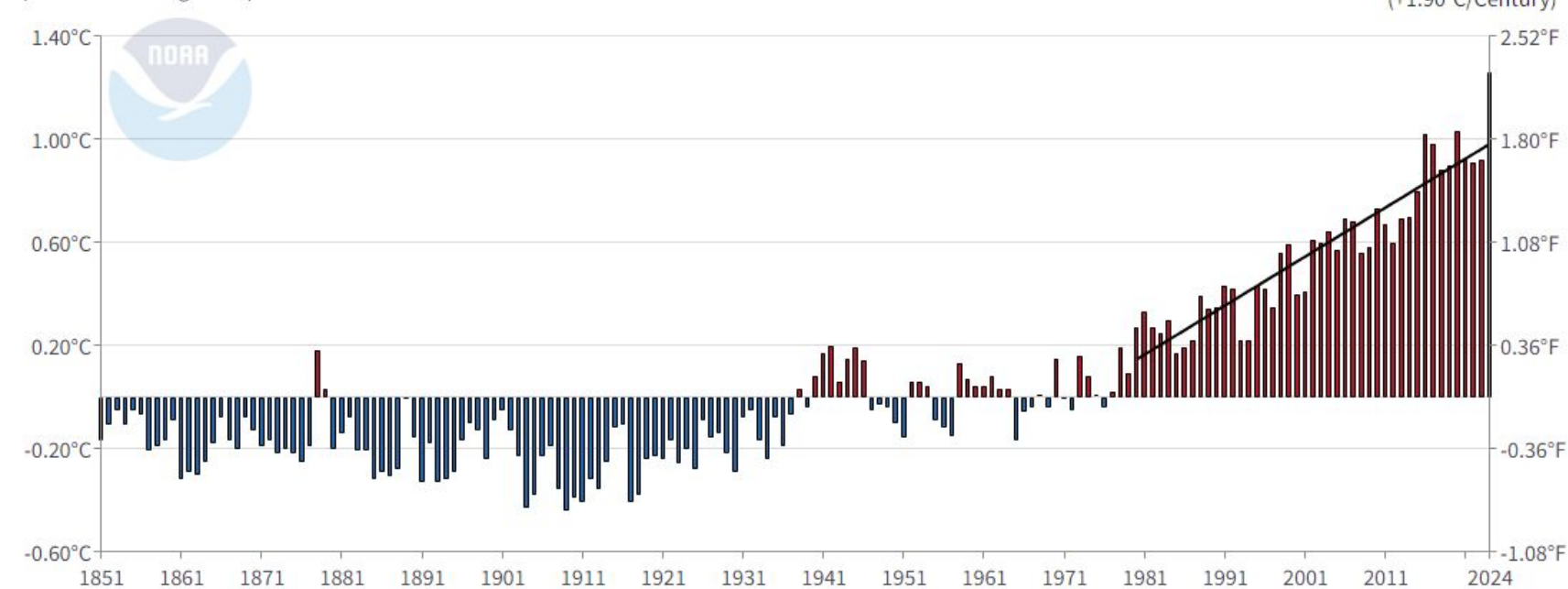
The rate of increase since 1980 (~2.01 ppm/year) is nearly four times that of the rate from 1900-1980 (~0.54 ppm/year)

The following figures focus on climate changes since 1980



Global Land and Ocean

April-March Average Temperature Anomalies

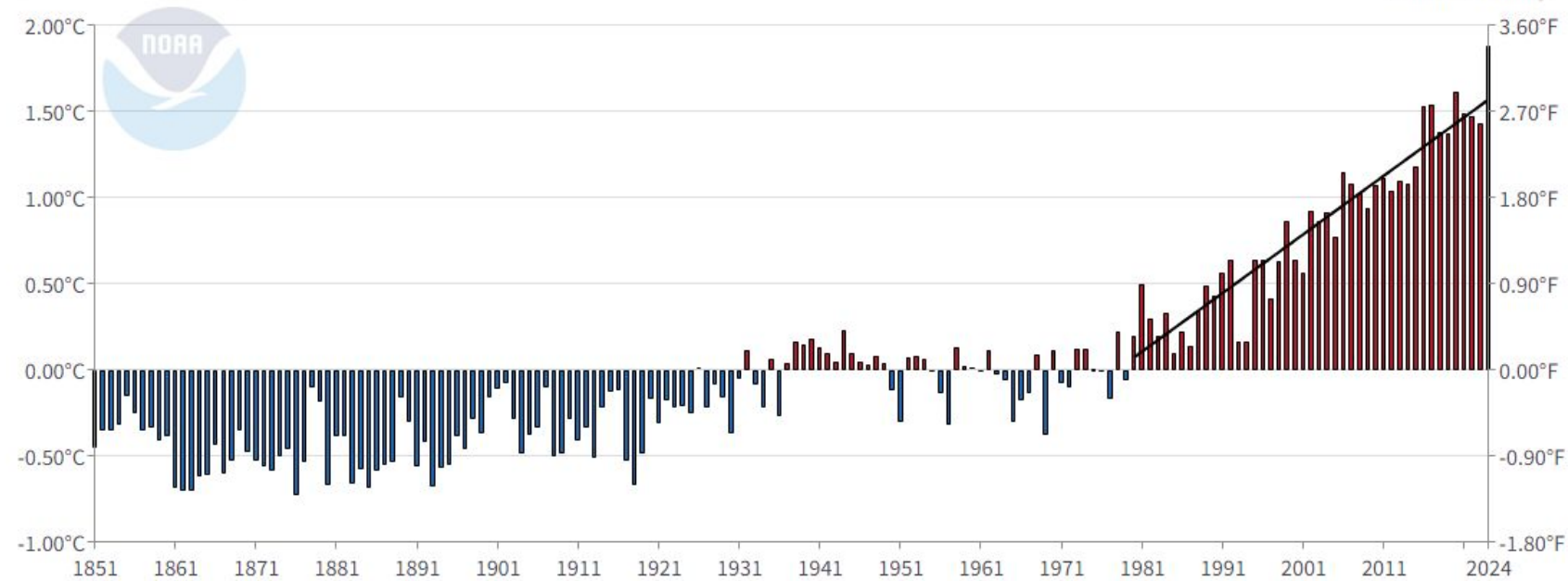


Global temperatures have increased about 1.2 °c (2.2 °F) over the past century.

The rate of change since 1980 is closer to 1.9 °c (3.4 °F) per century.

Global Land

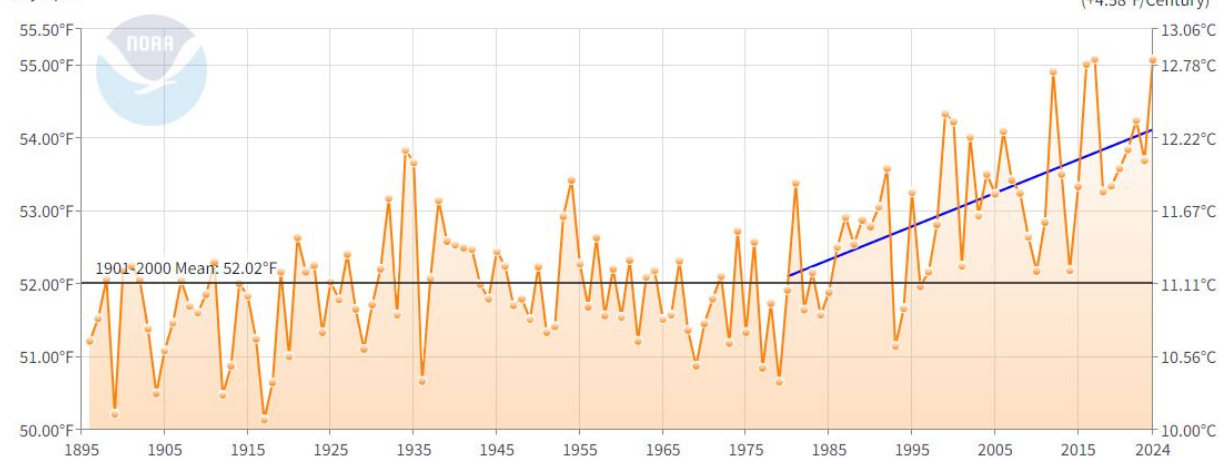
April-March Average Temperature Anomalies



The rate at which temperatures are changing over land (3.4 °c or 6.1 °F per century) is much higher than the global rate including oceans (1.9°c/3.4°F)

Contiguous U.S. Average Temperature

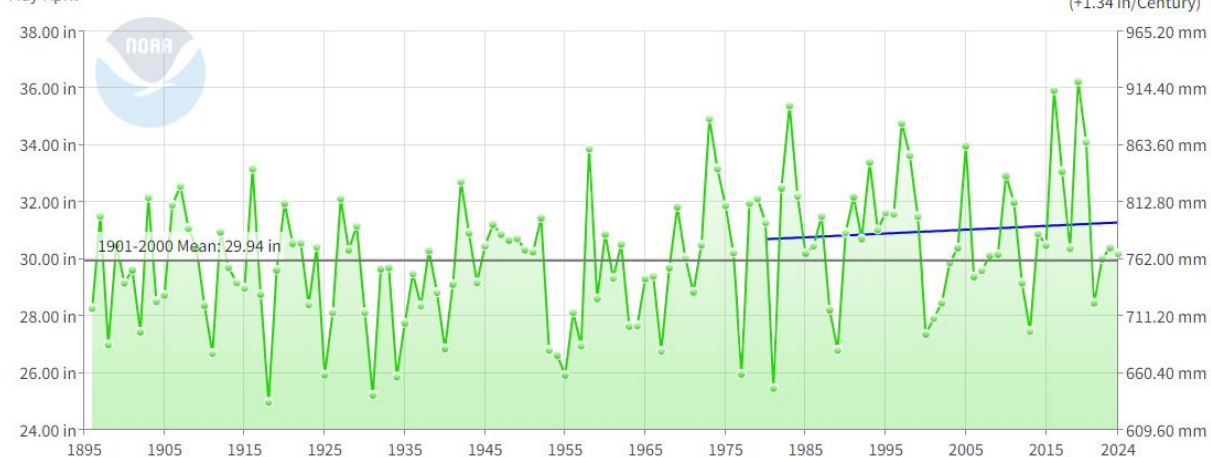
May-April



The rate of change ($\sim 4.6^{\circ}$ F/century) in the Contiguous US is a bit lower than the rate of change over the global land surface.

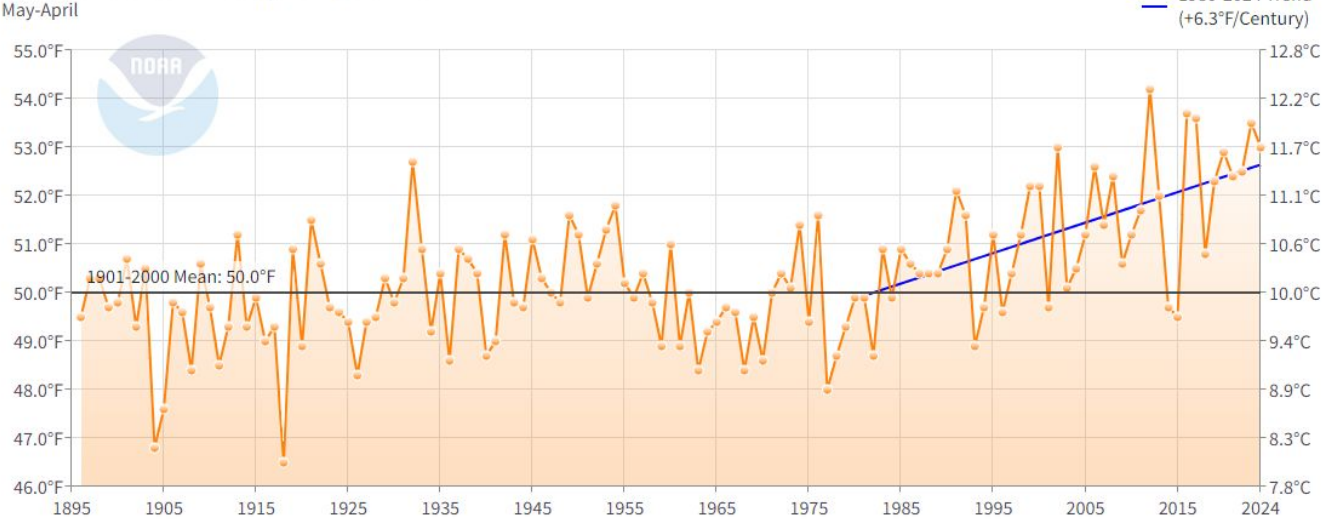
Contiguous U.S. Precipitation

May-April



Precipitation has increased a marginal amount over the Contiguous US

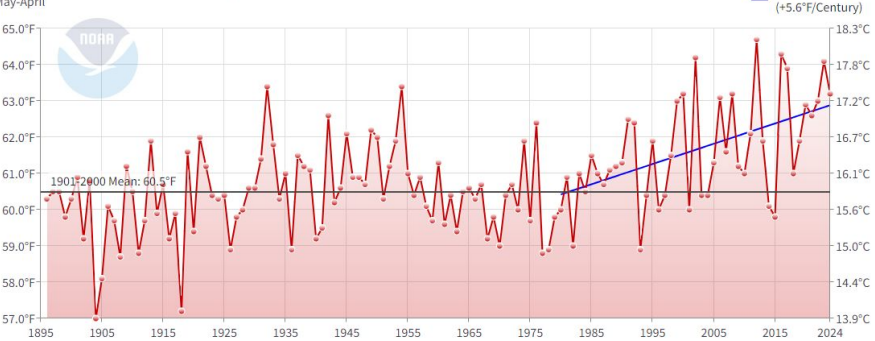
Mid-Atlantic Basin Average Temperature



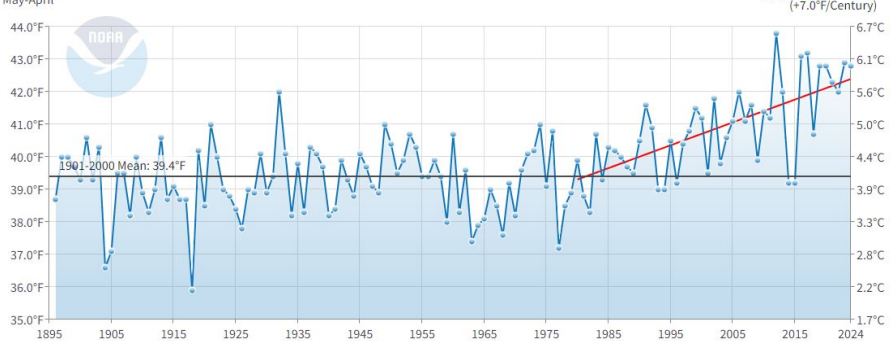
In the Mid-Atlantic, the rate of temperature increase is closer to the global temperature increase.

Minimum daily temperatures have increased faster than Maximum daily temperatures

Mid-Atlantic Basin Maximum Temperature

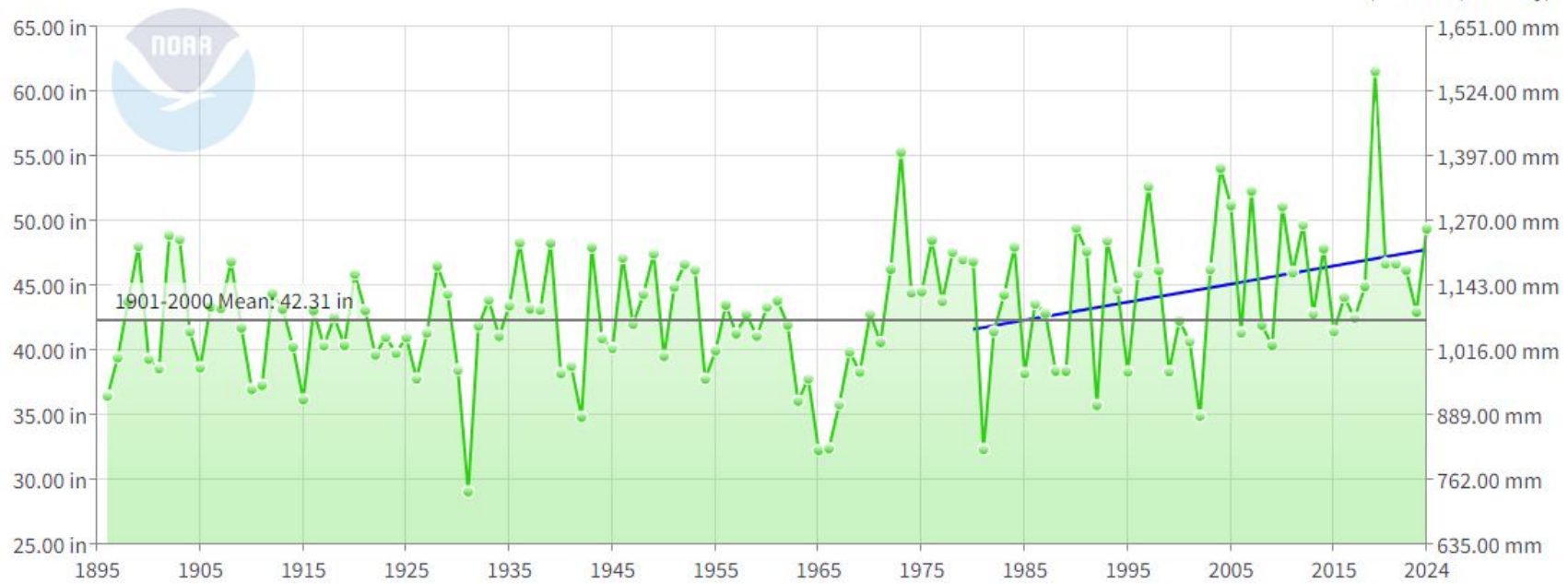


Mid-Atlantic Basin Minimum Temperature



Mid-Atlantic Basin Precipitation

May-April

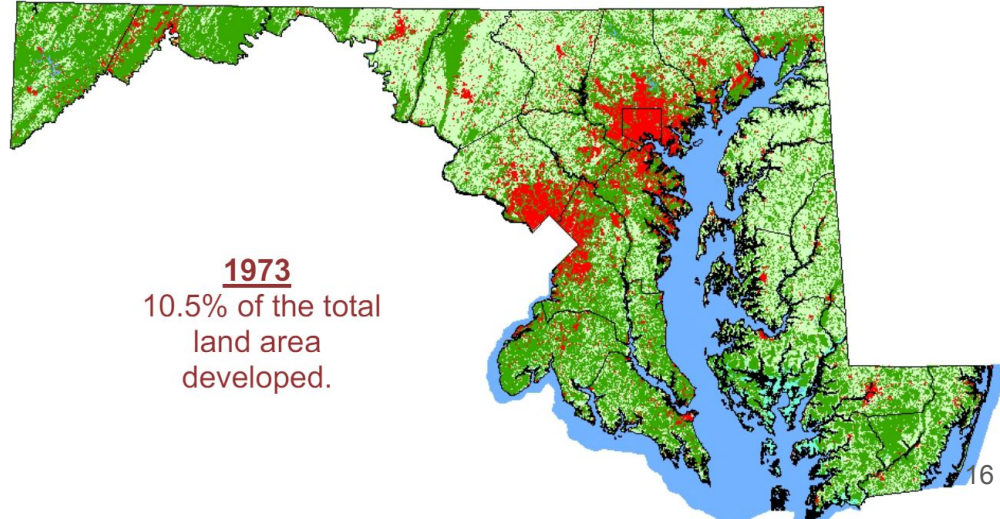
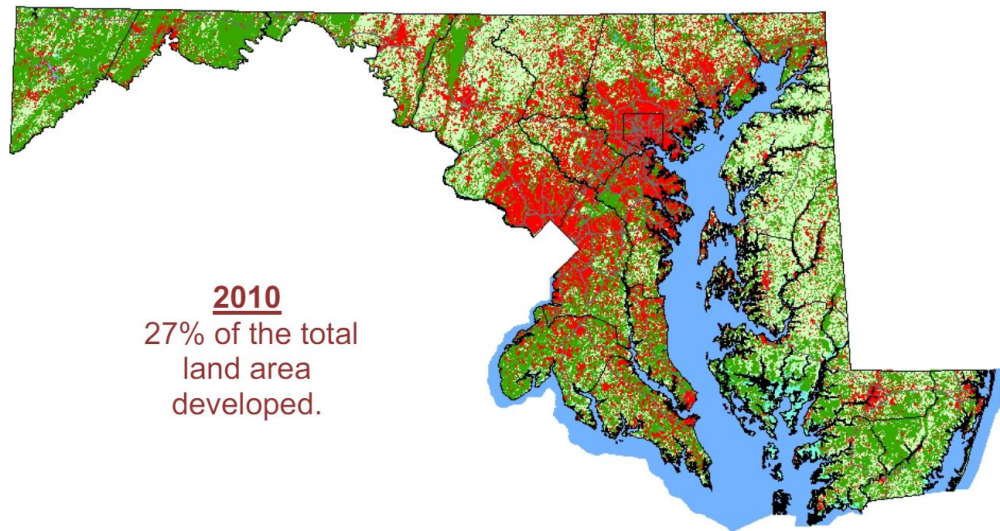
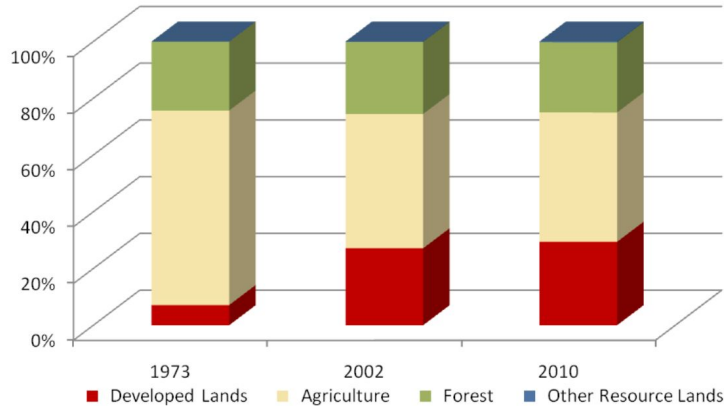


Annual total precipitation has generally increased in the Mid-Atlantic region

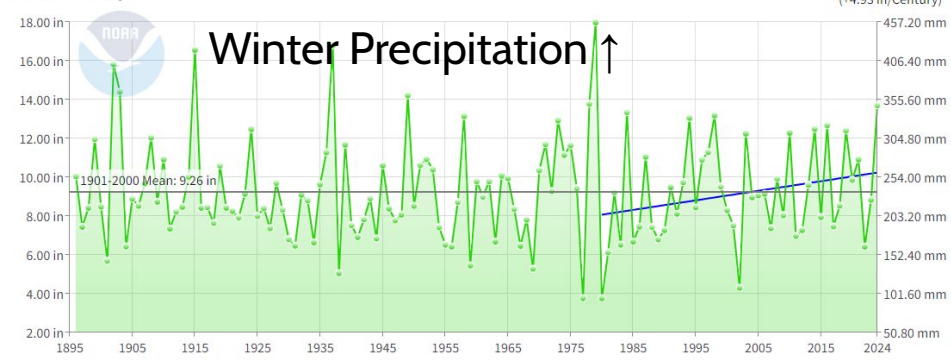
Carroll County Population:

1970	69,006	30.7%
1980	96,356	39.6%
1990	123,372	28.0%
2000	150,897	22.3%
2010	167,134	10.8%
2020	172,891	3.4%

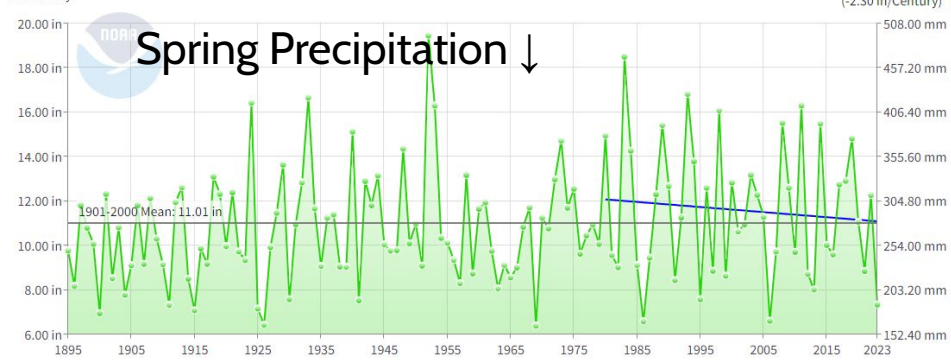
Land Use Change 1973 - 2010



Carroll County, Maryland Precipitation
December-February

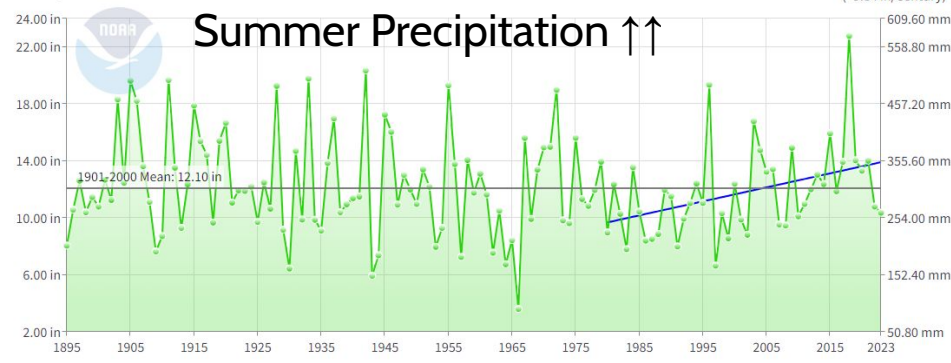


Carroll County, Maryland Precipitation
March-May

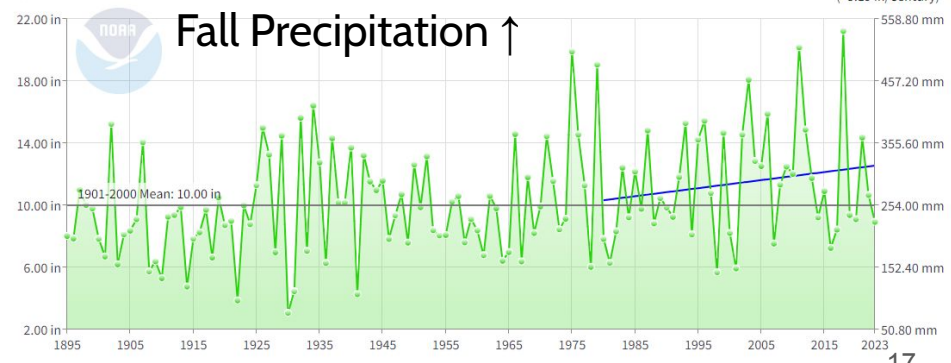


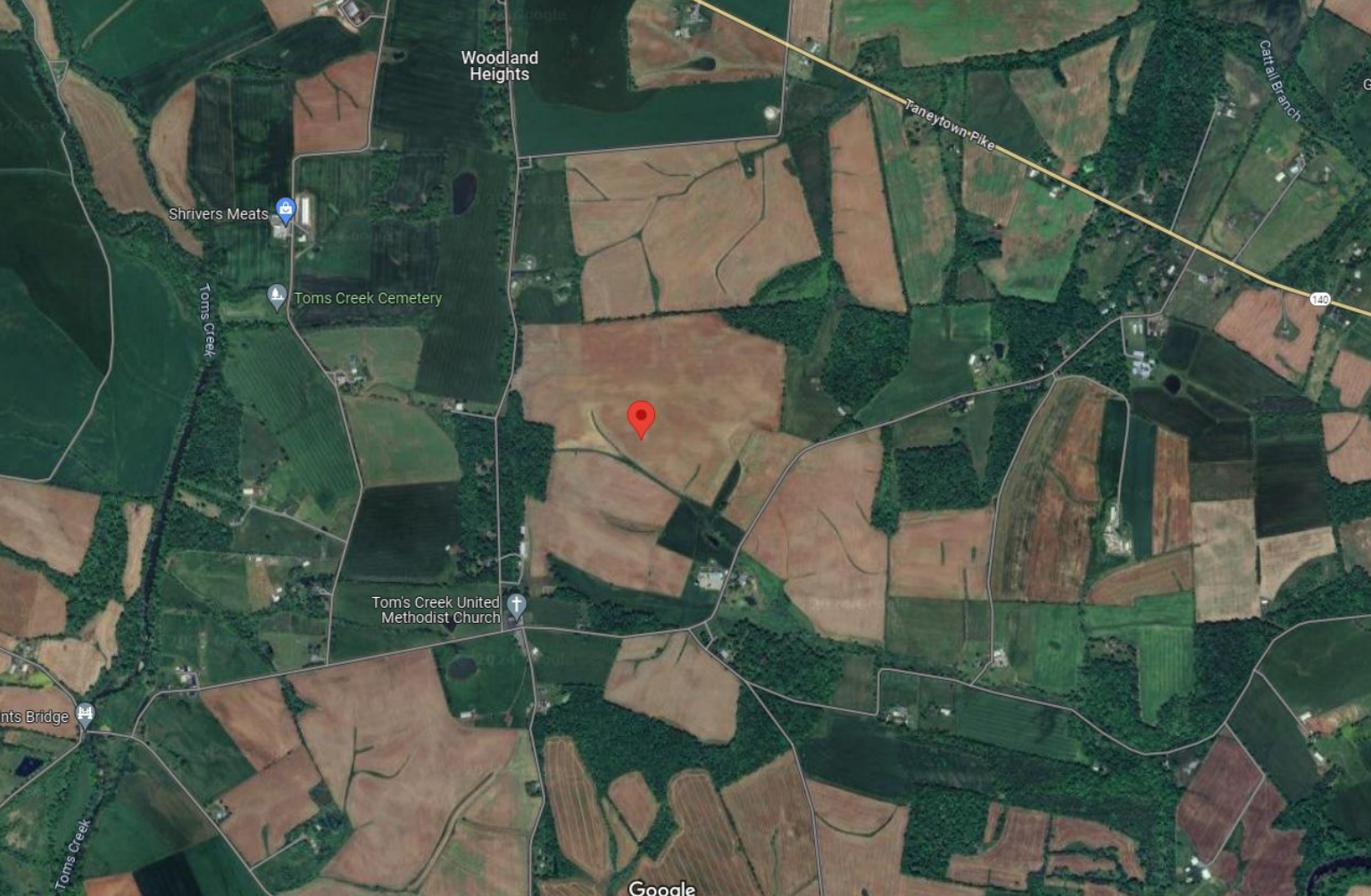
Precipitation in Carroll County is highly variable from year to year, but there are some significant trends the past few decades.

Carroll County, Maryland Precipitation
June-August



Carroll County, Maryland Precipitation
September-November

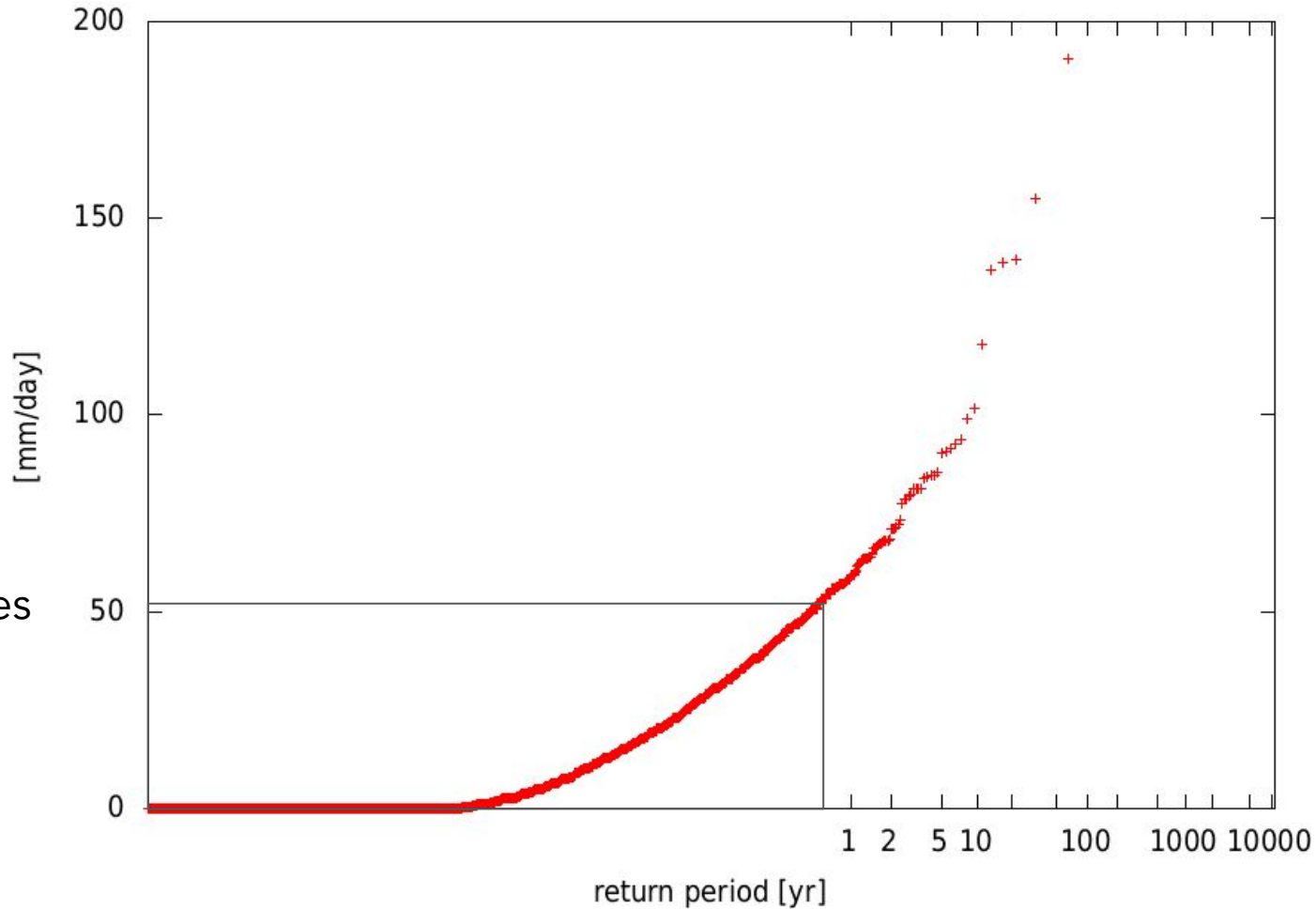




The following graphs are based on weather data from the nearest weather station to Carroll County, in Emmitsburg, MD.

The station is about 16 miles northwest of Westminster and has data from 1956 through 2024.

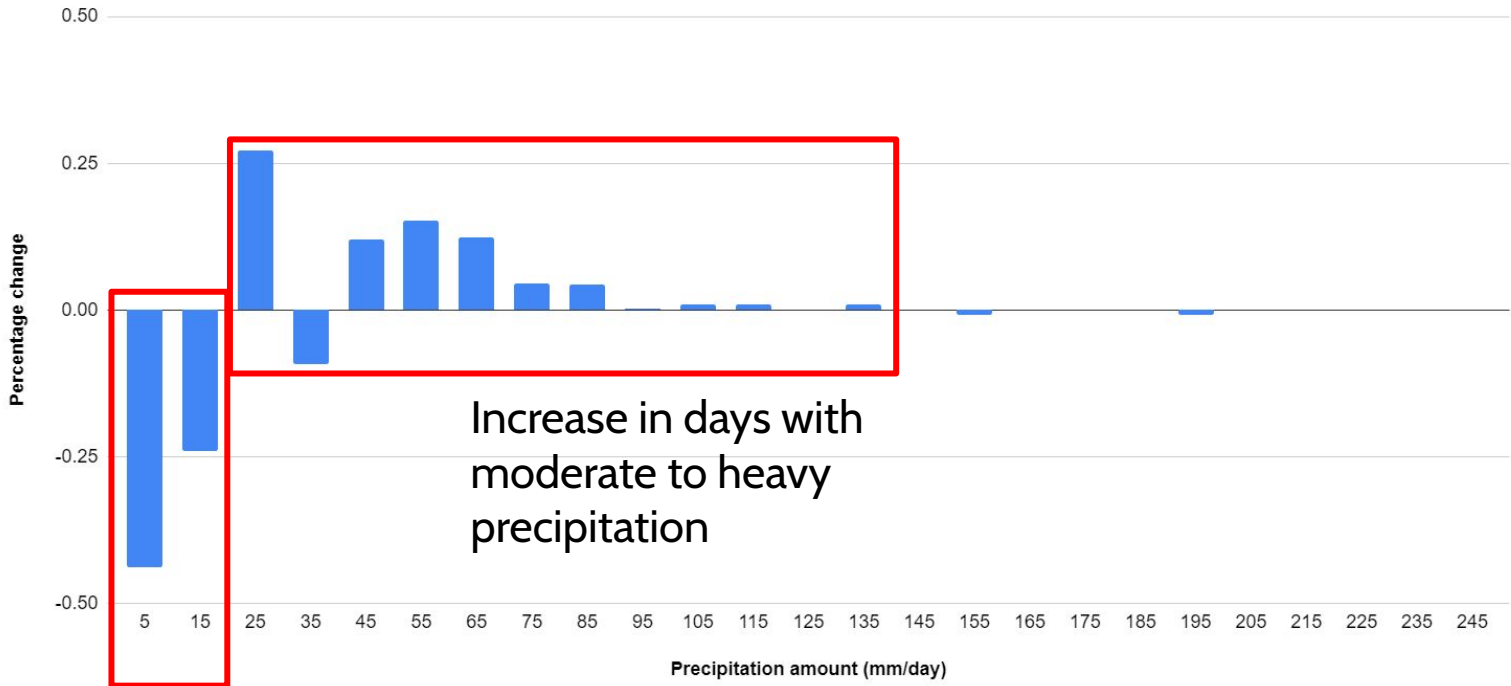
Jan-Dec precipitation EMMITSBURG 2 SE, MD 1956:2024 (95% CI)



2 inches

This graph shows how frequently (horizontal axis) precipitation events of a certain magnitude (vertical axis) happen

Percentage change in days with particular precipitation amounts



Increase in days with moderate to heavy precipitation

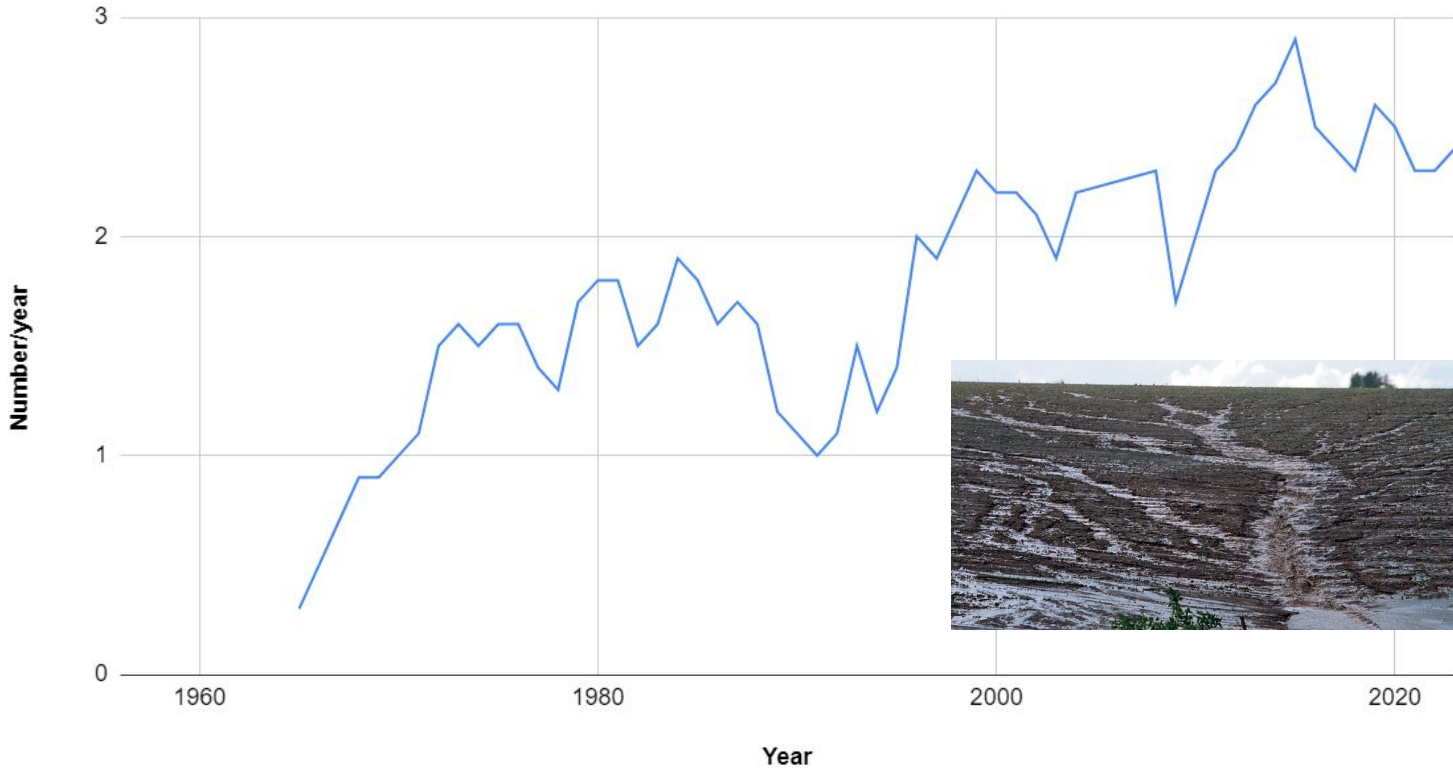
Decrease in days with light or no precipitation

Fewer days with light or no precipitation

More days with heavier precipitation

Number of Days with Rainfall >2in per year

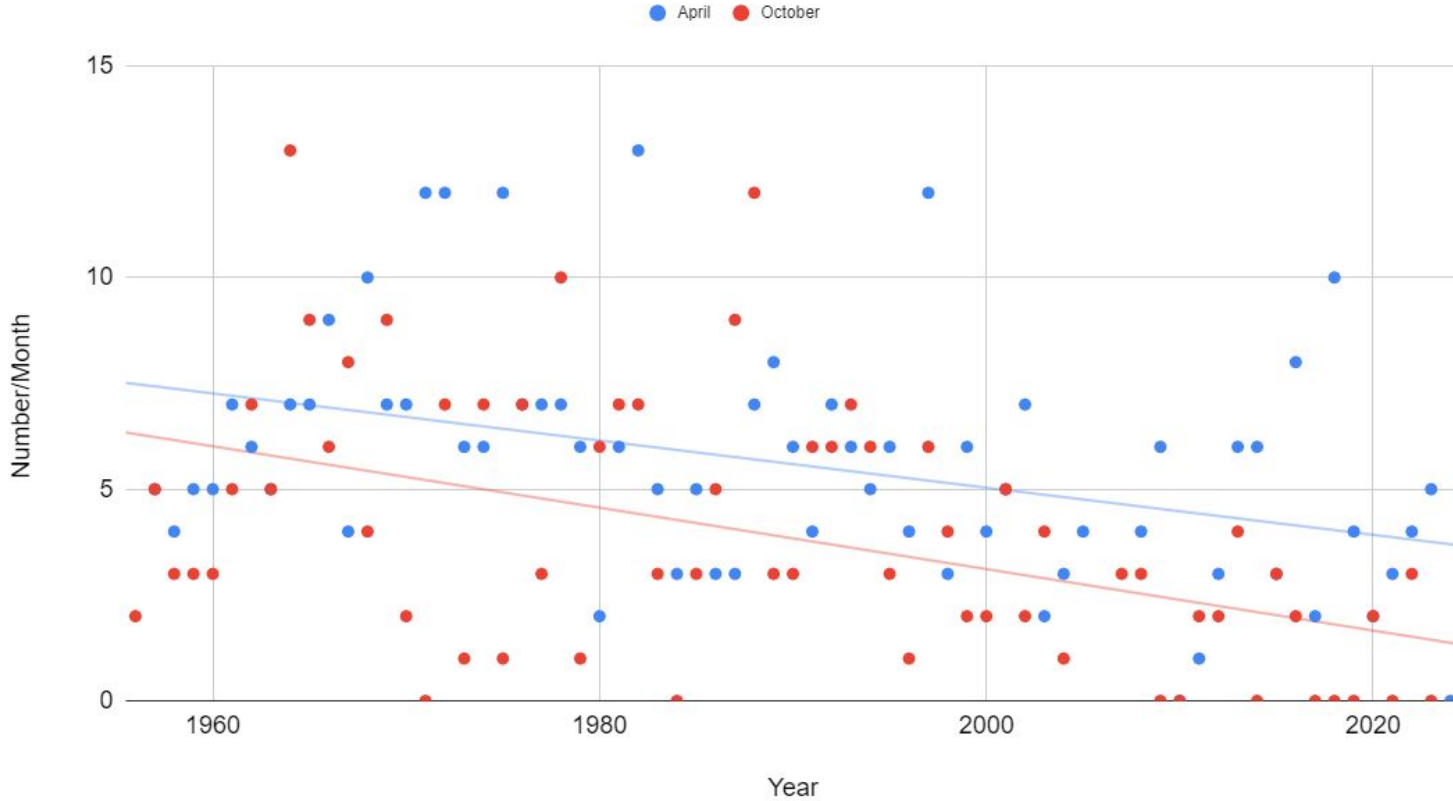
10-year running average



The number of days with rainfall >2 inches per year has gone from about 1 to 2-3



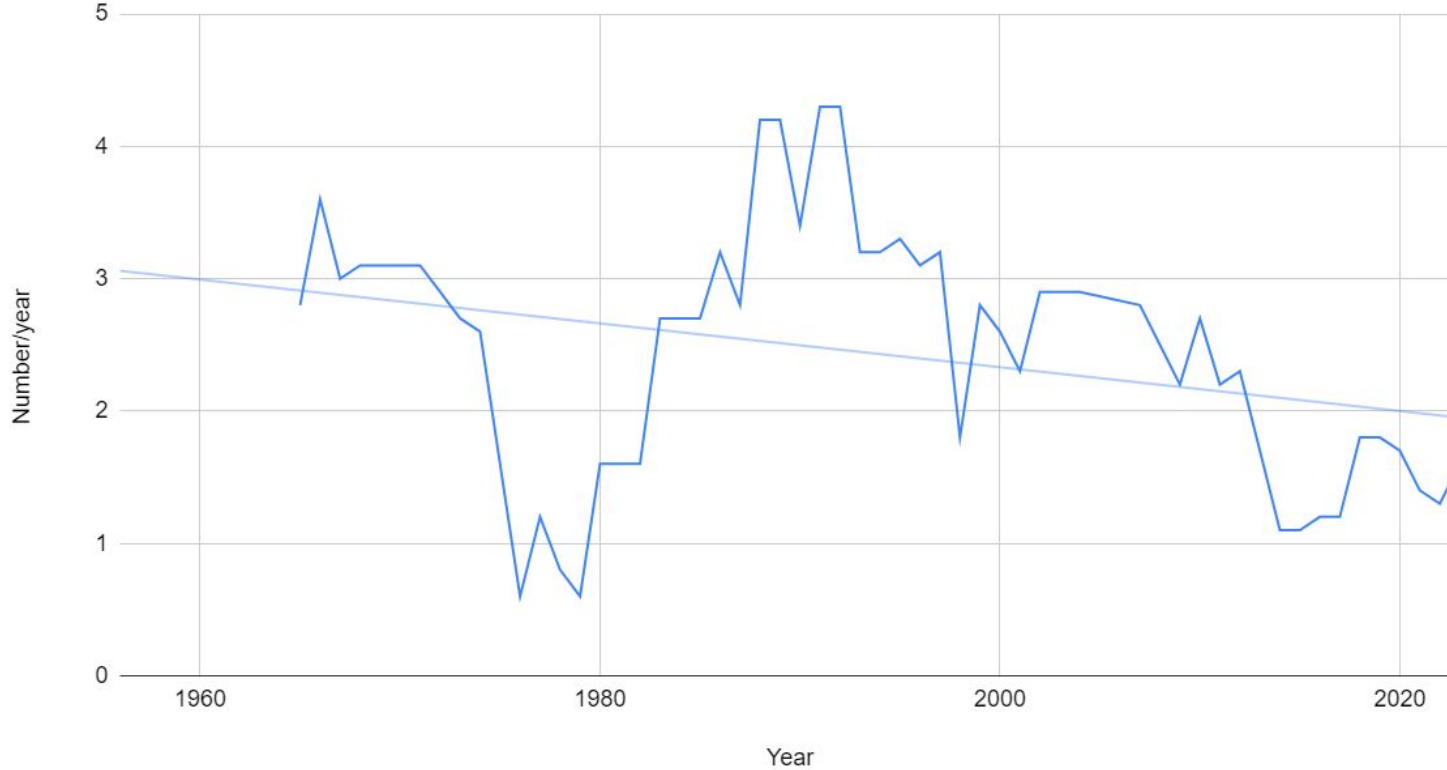
Number of frost days in April and October



The number of frost days during the beginning and end of the growing season has decreased

Days per year with Temperature >95 degrees Fahrenheit

10 year running average

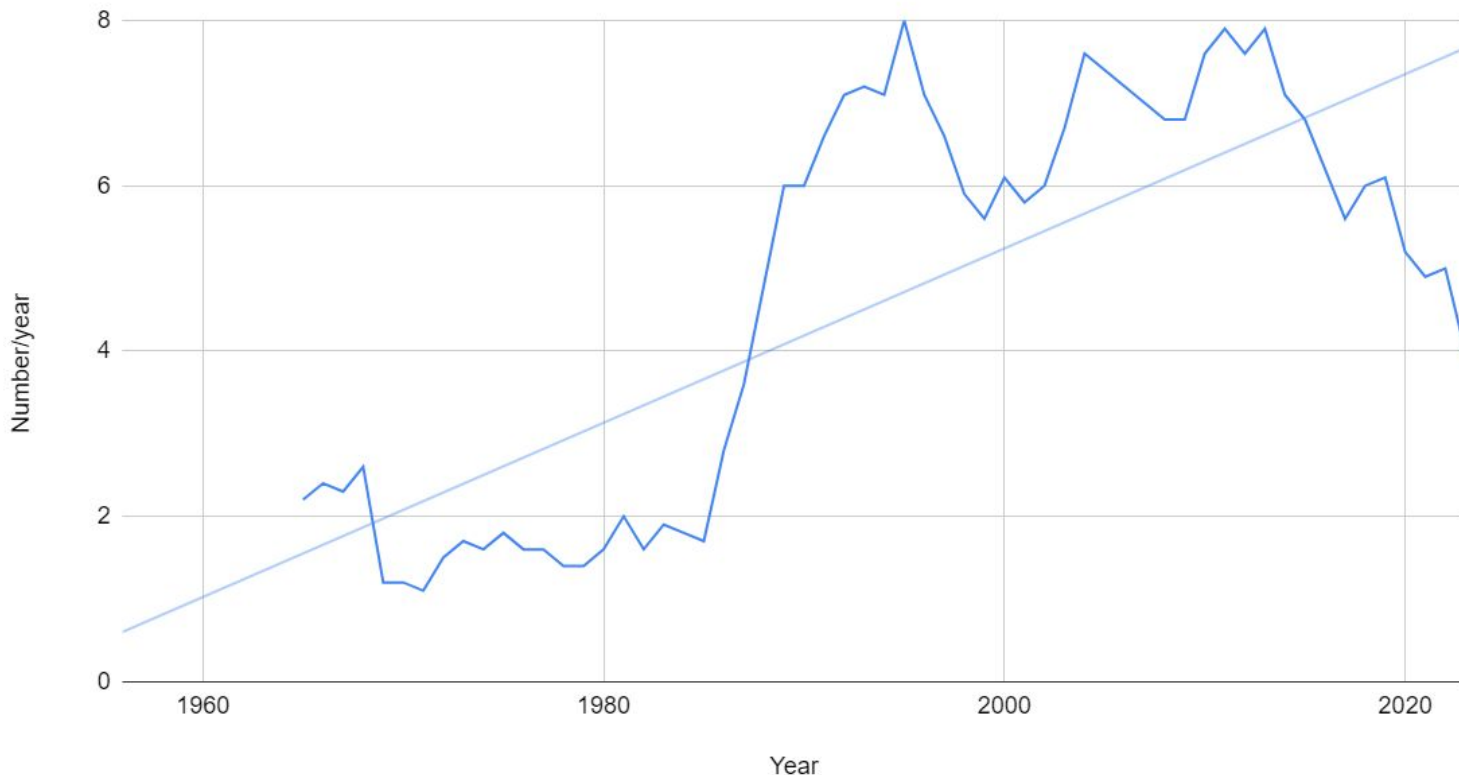


The number of days where the high temperature spikes about 95 °F has decreased

This is likely due to the increase in precipitation over the region

Number of nights where temperature stays > 70 degrees Fahrenheit

10-year running average

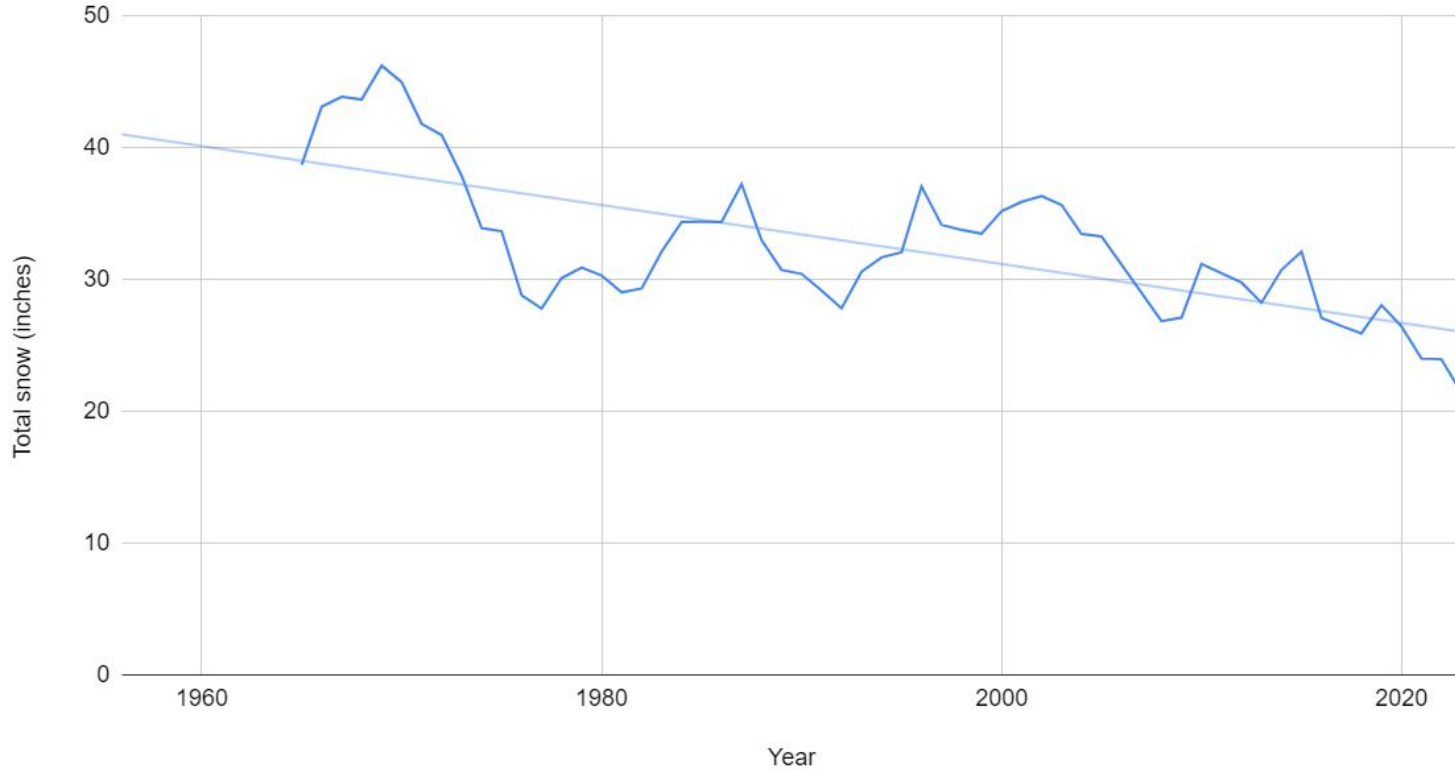


The number of nights where the temperature fails to fall below 70°F has increased from 1-2 to 5-7.

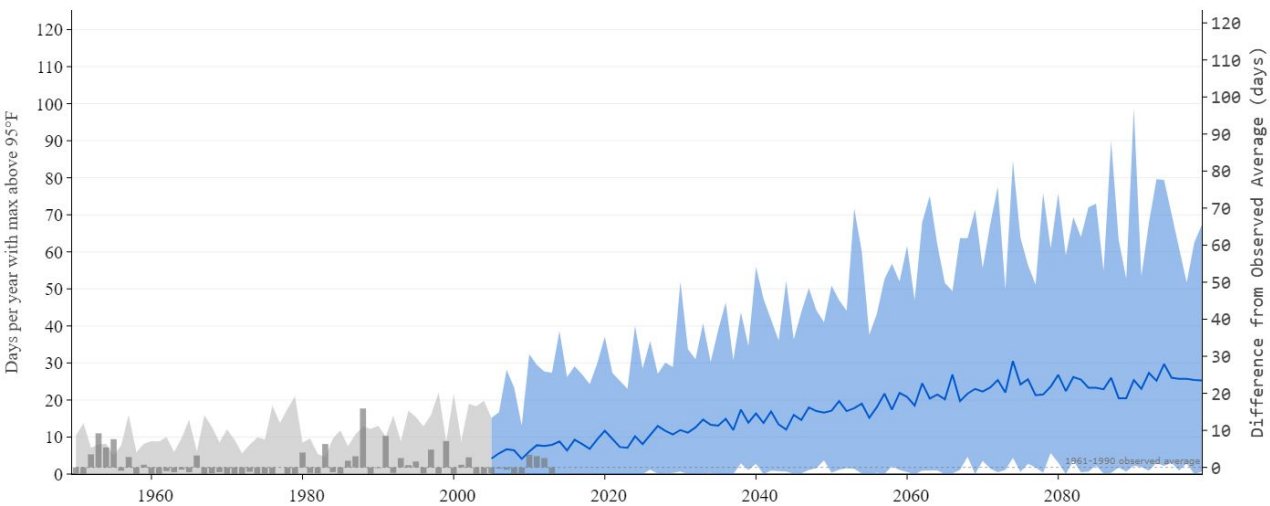
This is due to the increase in greenhouse gases (including water vapor) which prevent nighttime cooling

Snow (inches) vs. Year

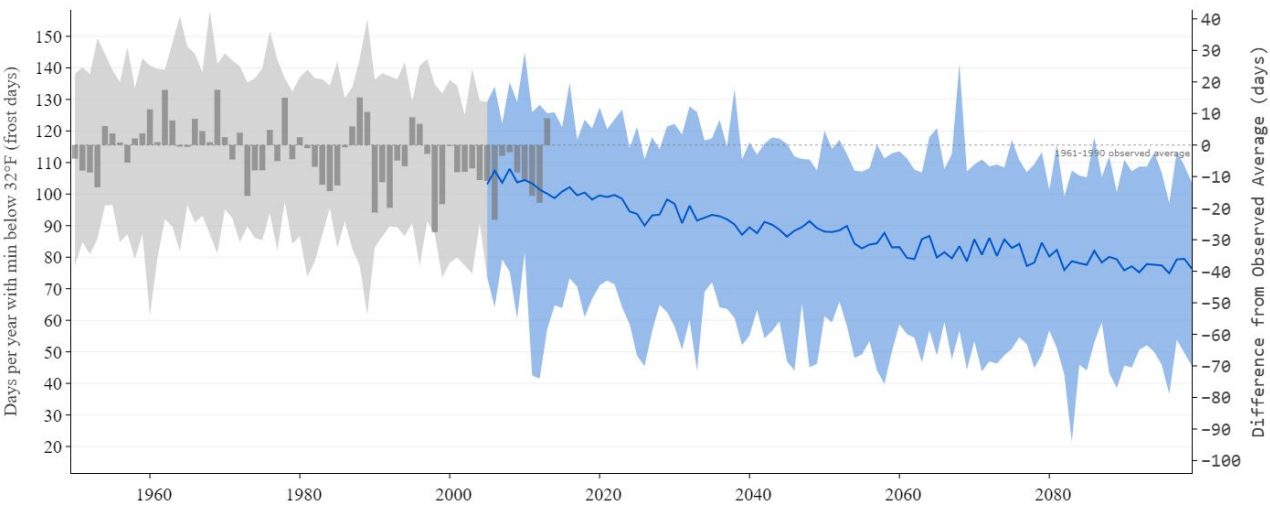
10-year running average



Annual snowfall has fallen from ~40 inches to ~25 inches.



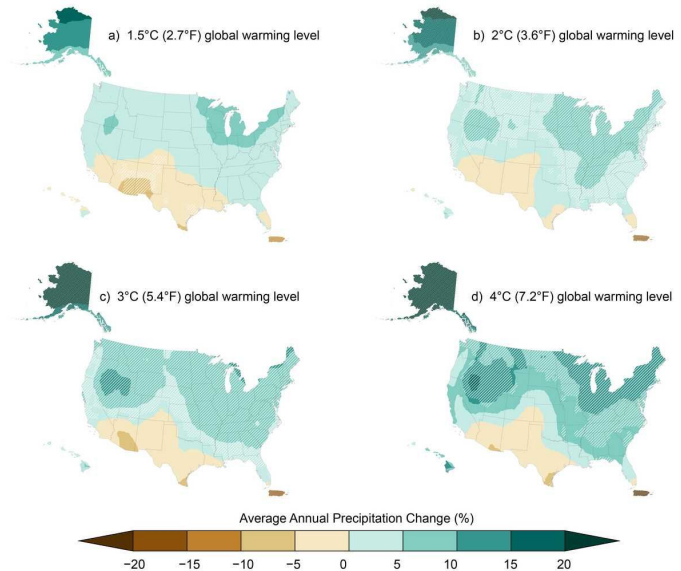
The number of days with temperatures above 95 °F is projected to increase to 20-25 (top left)



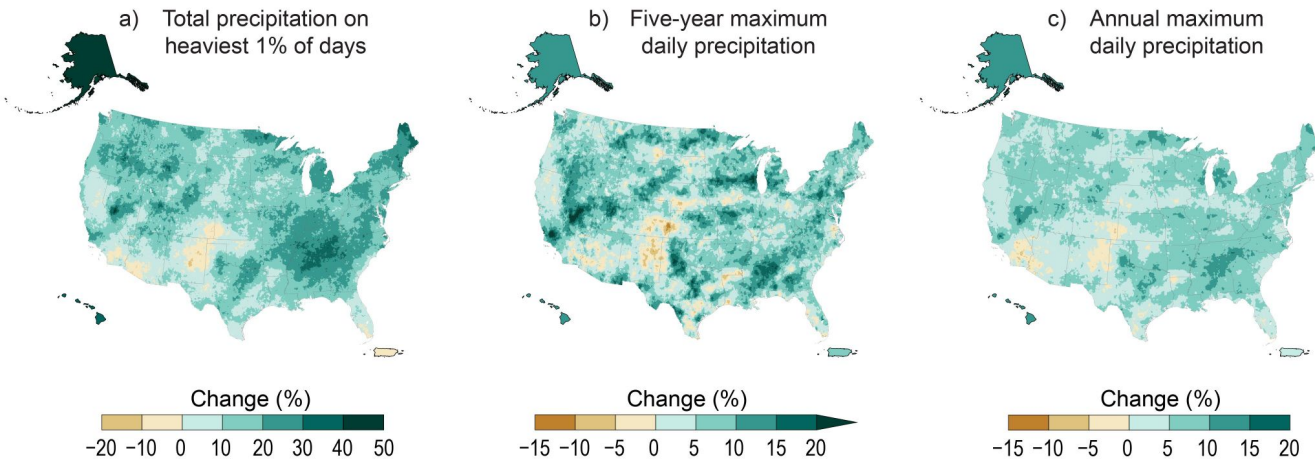
The number of frost days is projected to increase from around 115 to 80 (bottom right)

Precipitation is expected to continue to increase in the mid-Atlantic (right) including extremes measured in a variety of ways (bottom).

Projected US Precipitation Changes at 1.5°C, 2°C, 3°C, and 4°C of Global Warming



Projected Changes to Precipitation Extremes at 2°C of Global Warming



Tools and Further Information

<https://nca2023.globalchange.gov/>




CMRA <https://resilience.climate.gov/>



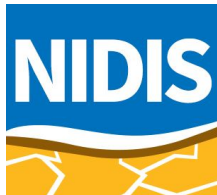
<https://www.heat.gov/>

<https://www.climate.gov/>



 Climate and Economic Justice
Screening Tool

<https://screeningtool.geoplatform.gov>



<https://www.drought.gov/>

<https://toolkit.climate.gov/>



(b) Time evolution of effective radiative forcing 1750-2022

