

Climate Trends and Challenges in the Miami Valley

Aaron B. Wilson

2022 Climate Change Seminar: Making the
Business Case for Climate Action
26 April 2022



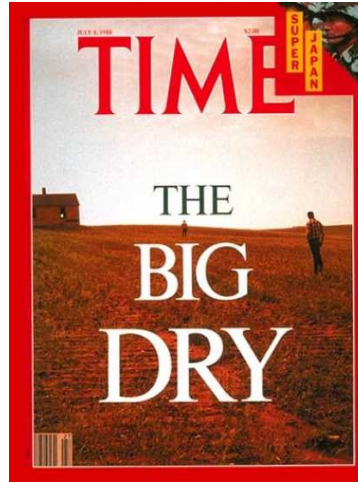
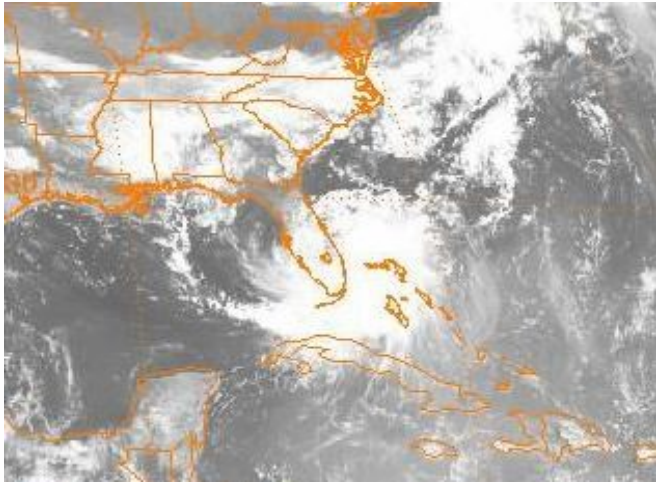
THE OHIO STATE
UNIVERSITY

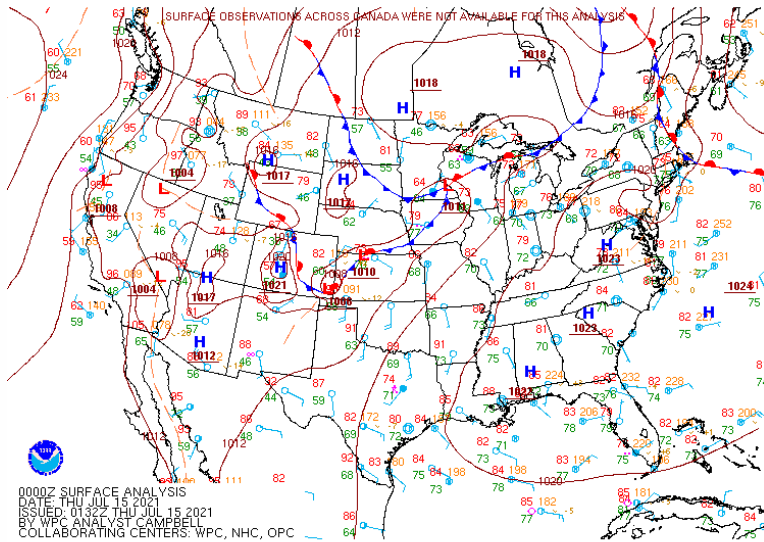
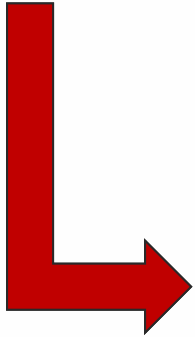
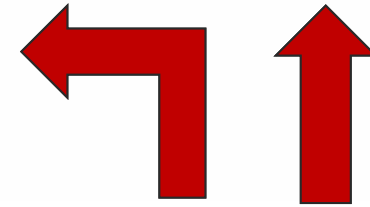
COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



Cox Media Group

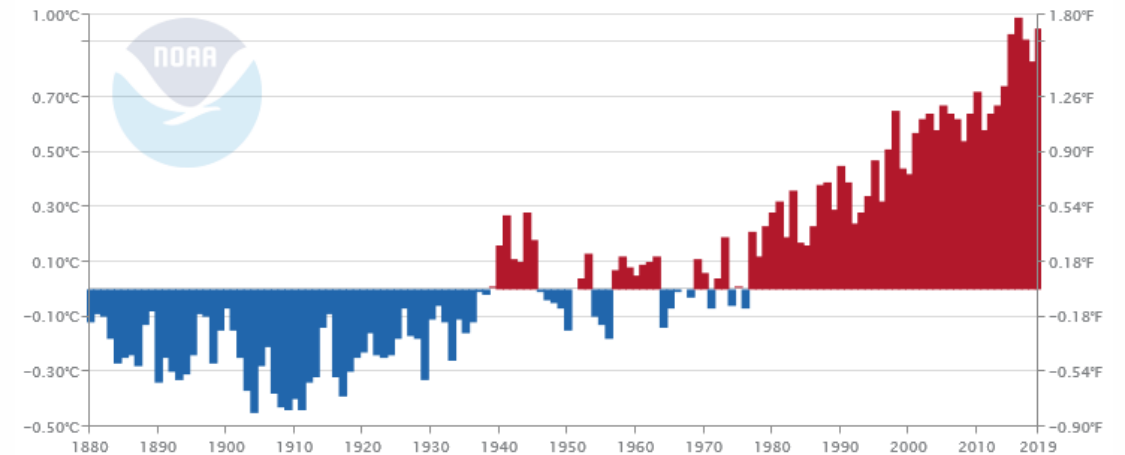
MY BACKGROUND





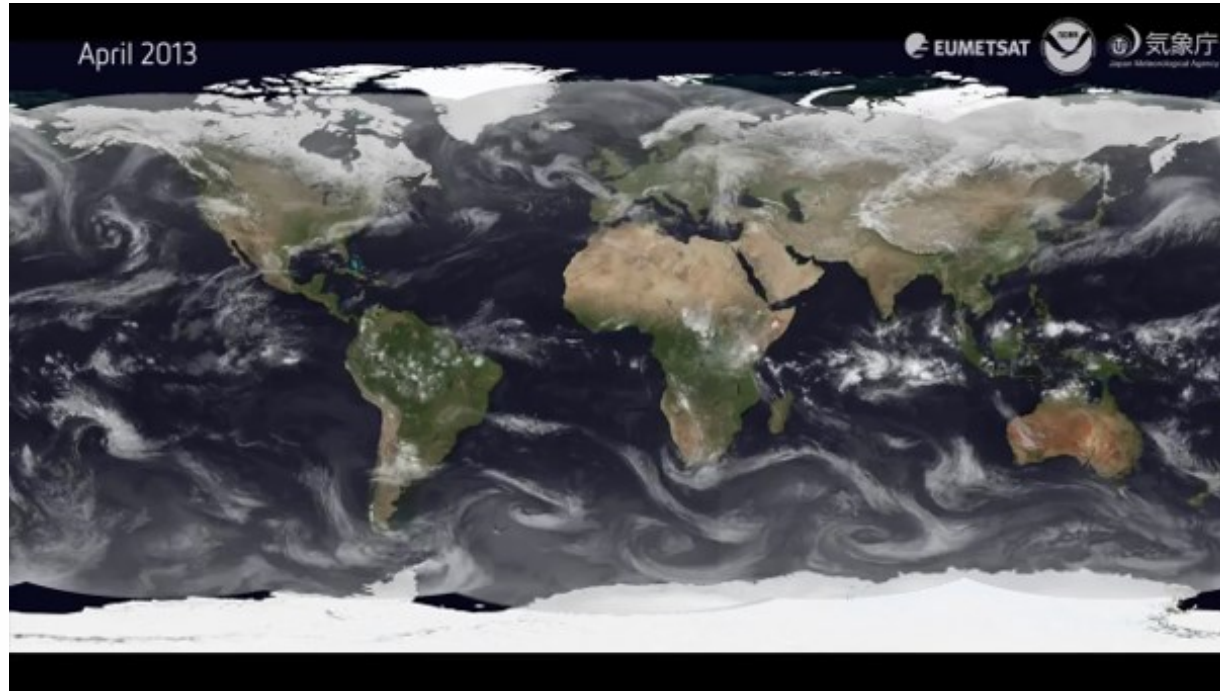
Global Land and Ocean

January–December Temperature Anomalies



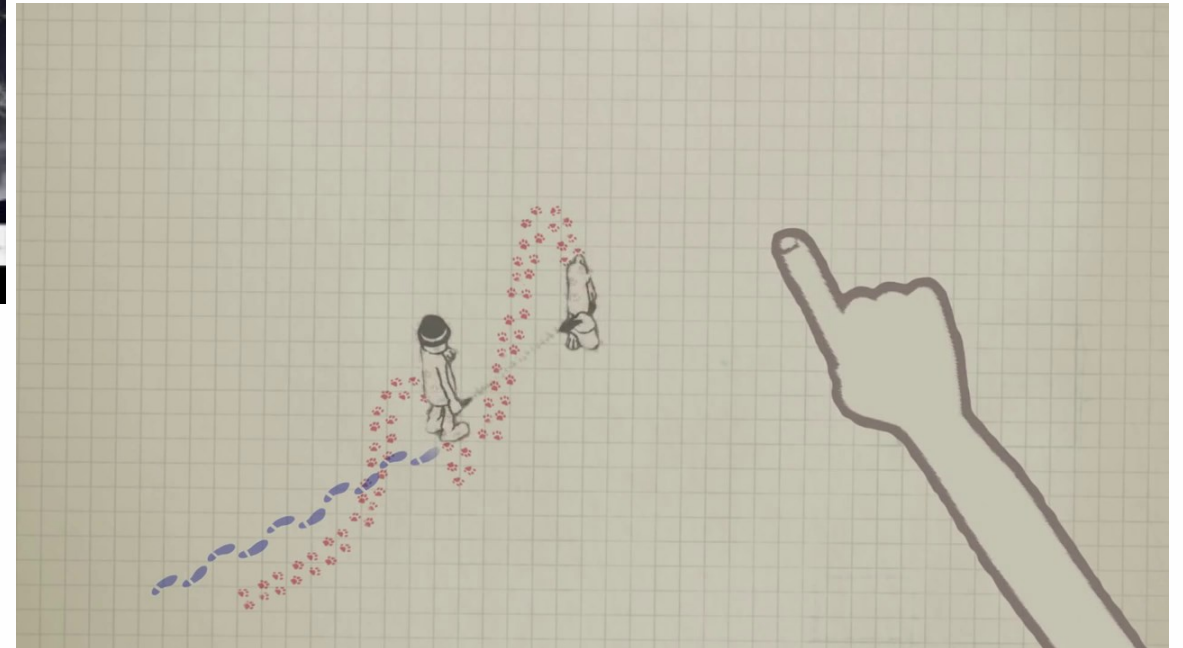
WEATHER AND CLIMATE

Video from UCAR: Center for Science Education -
<https://scied.ucar.edu/dog-walking-weather-and-climate>



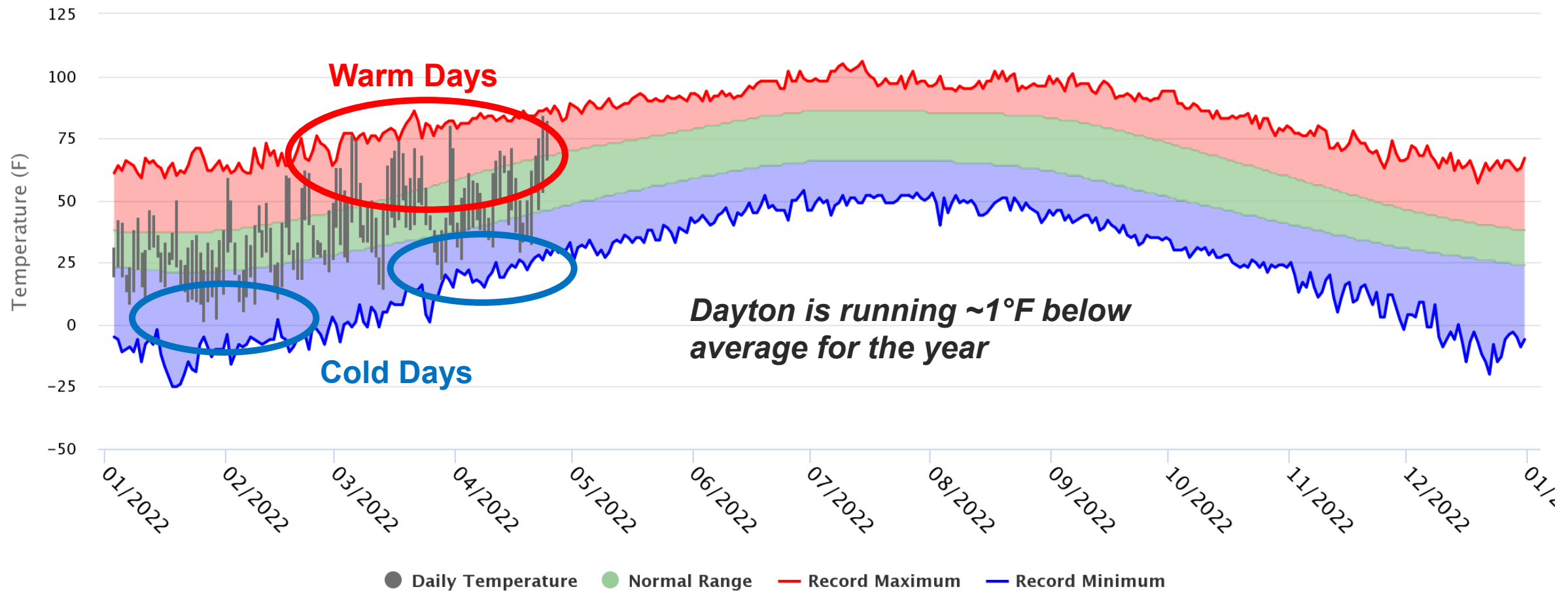
Weather: High-frequency changes in temperature, wind speed, etc; Caused by imbalance of energy across the globe.

Climate: Slower-varying aspects; Averages over longer periods.



2022 TEMPERATURE SUMMARY: Dayton, Ohio

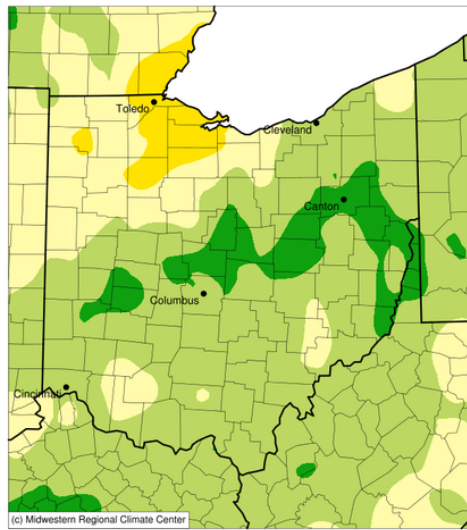
Midwestern Regional Climate Center



Click and drag to zoom

Accumulated Precipitation (in): Percent of 1991-2020 Normals

January 01, 2022 to April 25, 2022

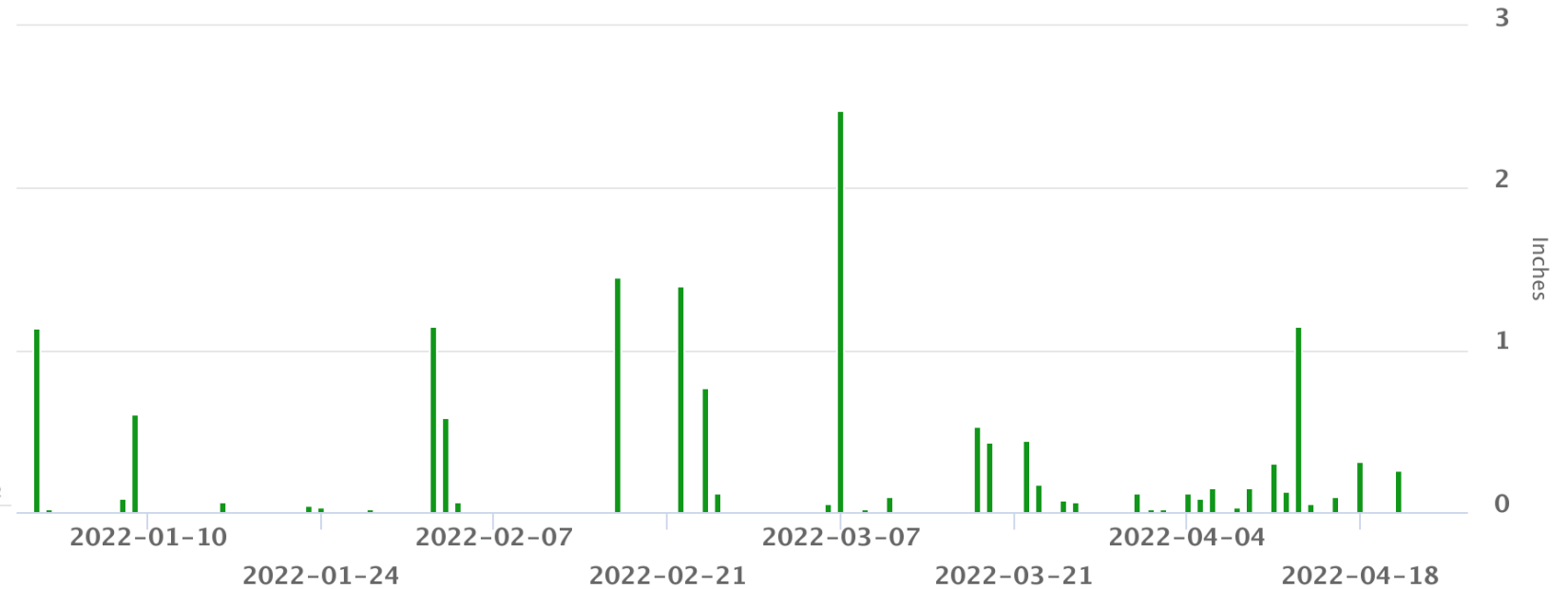


25 50 75 100 125

Stations from the following networks used: WBAN, COOP, FAA, GHCN, ThreadEx, CoCoRaHS, WMO, ICAO, NWSLI, Midwest Regional Climate Center
cli-MATE: MRCC Application Tools Environment
Generated at: 4/25/2022 9:51:44 AM CDT

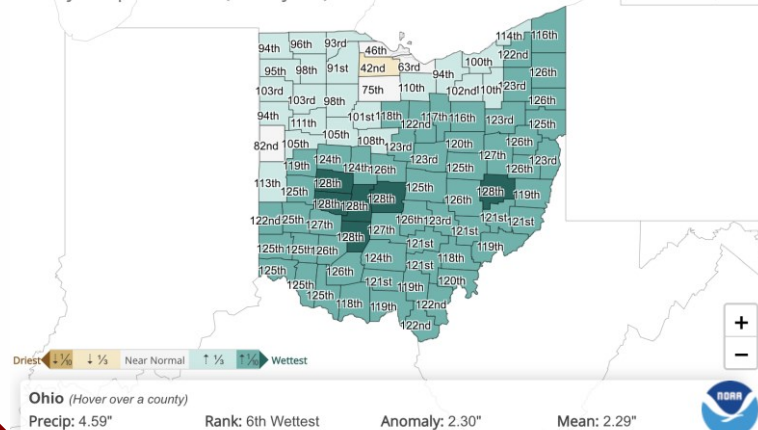
2022 PRECIPITATION SUMMARY: Dayton, Ohio

Midwestern Regional Climate Center



County Precipitation Rank (of 128 years)

February 2022



- Maximum Temperature
- Precipitation
- Heating Degree Days
- Modified Growing Degree Days

- Minimum Temperature
- Snowfall
- Cooling Degree Days

6 events over 1.0" (~28%)
14 days = ~46% of
precipitation (47.79")

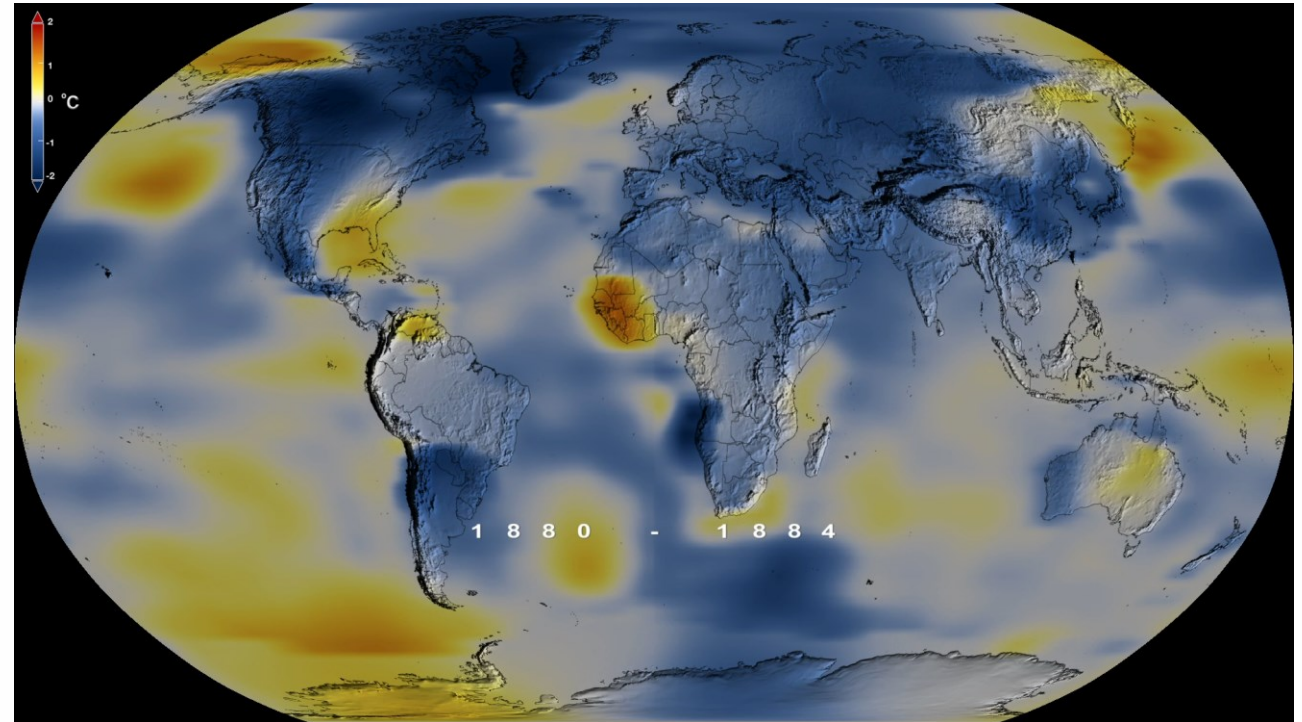
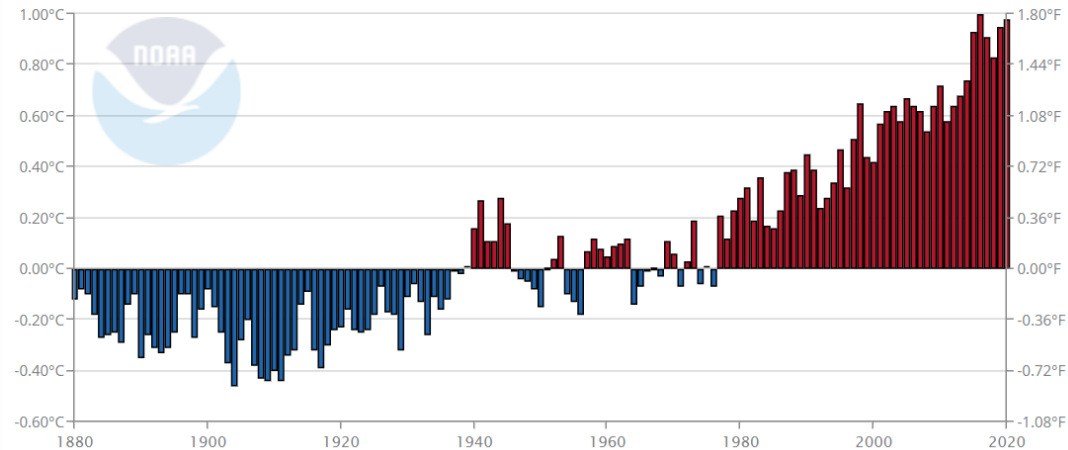


FIRST TWO TAKEAWAYS

- Weather and Climate are related but describe different scales of events.
- What happens in your backyard or at your place of business matters and may vary significantly from neighboring counties and states.

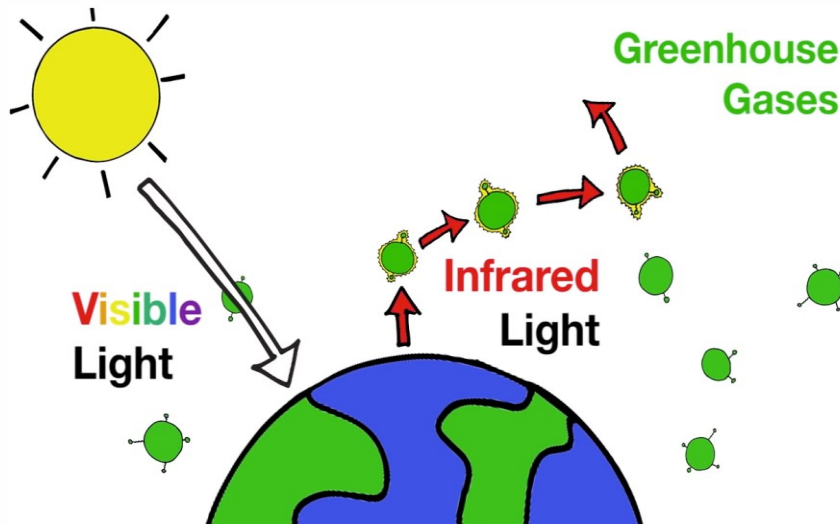
GLOBAL ASSESSMENT

Global Land and Ocean
January–December Temperature Anomalies



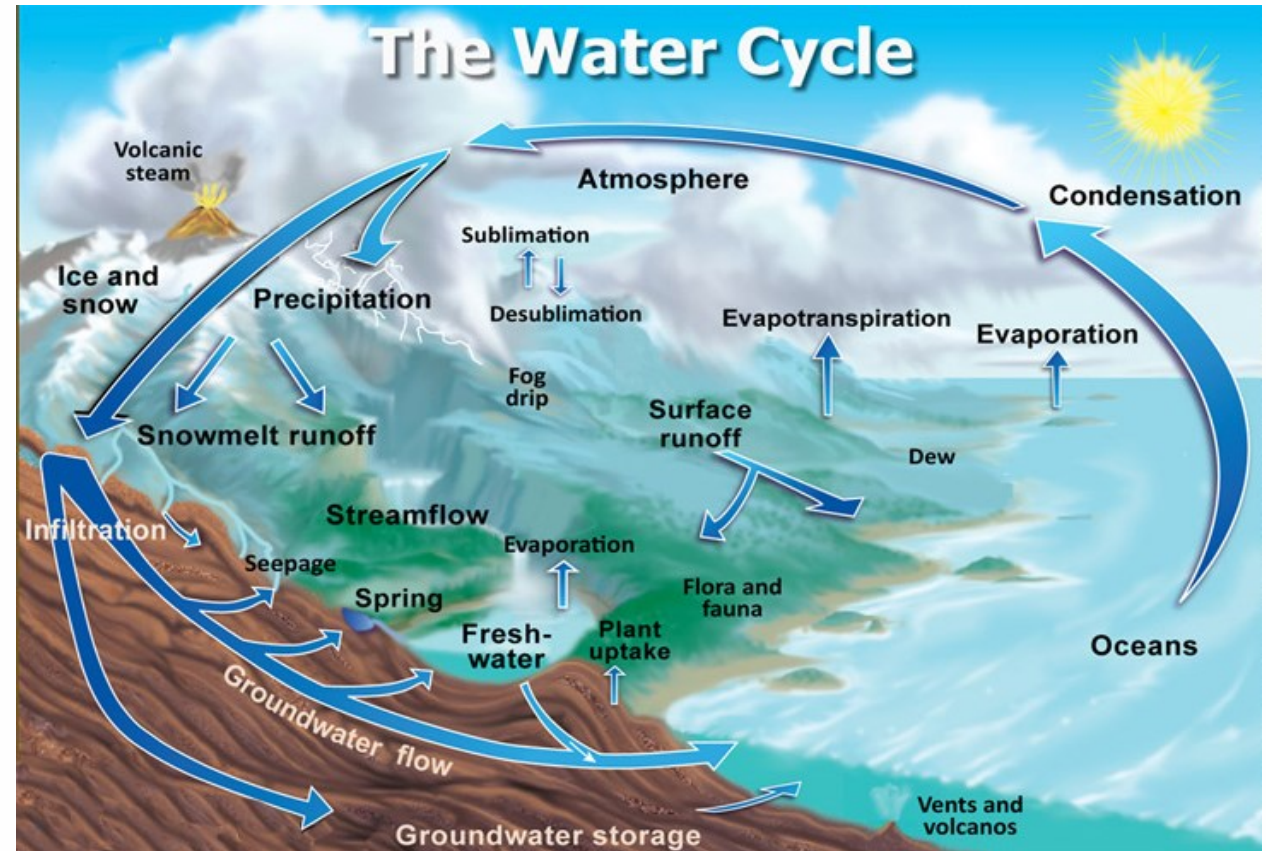
- 2021 is the 6th warmest year since 1880
- Top 10 warmest years have occurred since 2005
- Last 7 years (since 2015) are top 7 warmest
- If you were born after February 1985, you have never experienced a cooler than average month for the planet!

HOW THE ATMOSPHERE WARMS & WHY IT MATTERS



HowGlobalWarmingWorks.org, 2014

- Greenhouse Gases (Water Vapor, Carbon Dioxide, Methane, Nitrous Oxide) absorb energy from the Earth's Surface = Sustained Human Life
- Increase Water Vapor increasing is a function of temperature; Feedback loop → Warmer atmosphere intensifies Evaporation

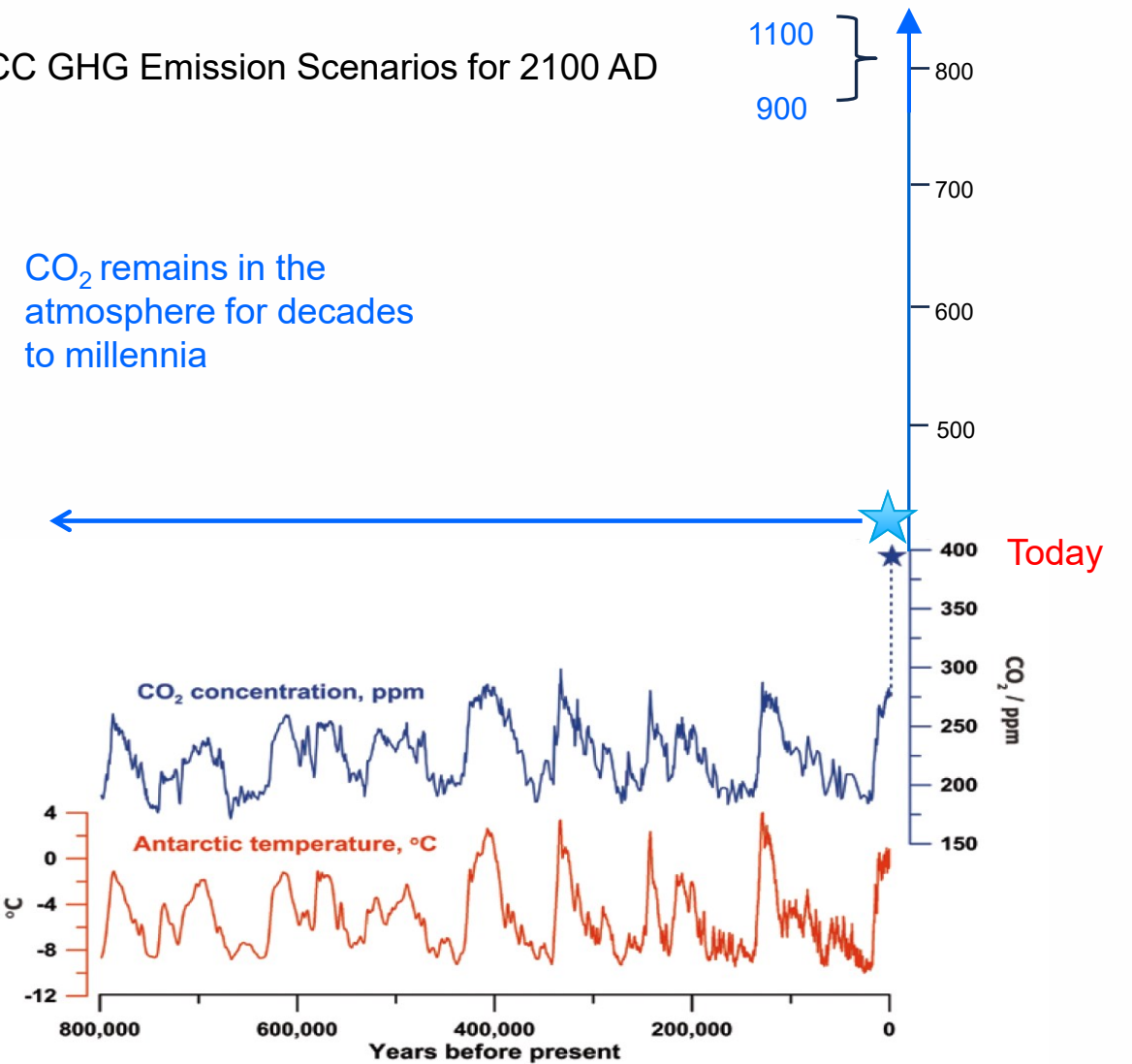


John Evans and Howard Periman, USGS - <http://ga.water.usgs.gov/edu/watercycle.html>

CO₂ AND TEMPERATURE

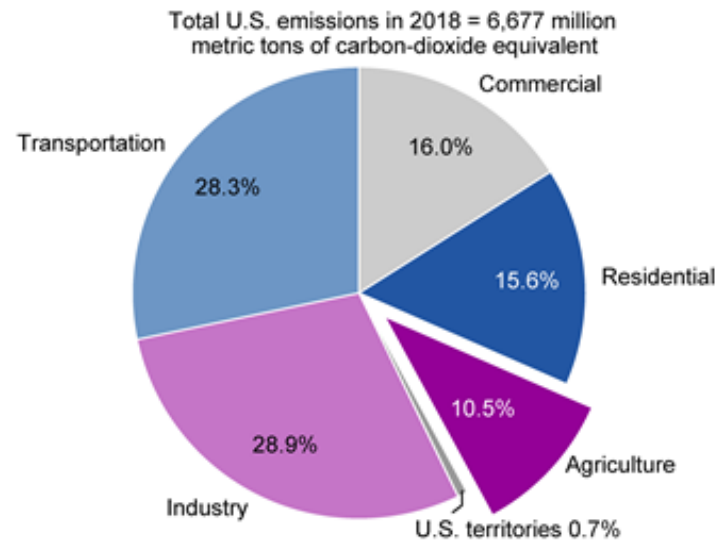


IPCC GHG Emission Scenarios for 2100 AD



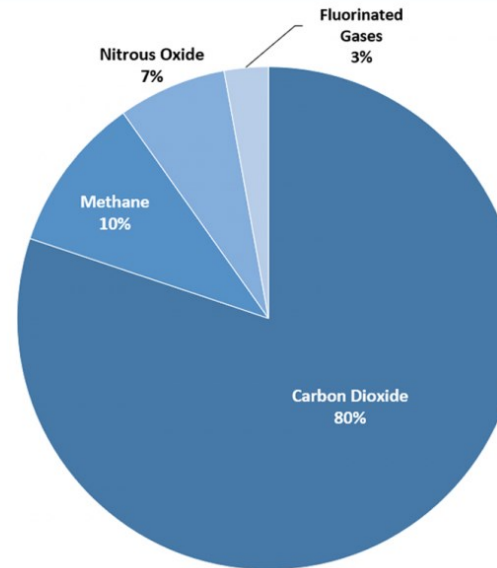
GHGs Emissions by Economic Sector

Estimated U.S. greenhouse gas emissions by economic sector, 2018

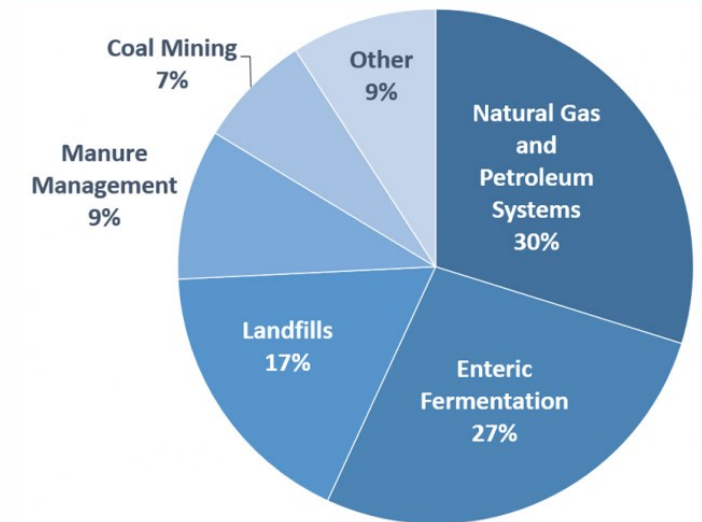


Note: Carbon dioxide emissions associated with electricity consumption are allocated to each end-use sector.
Source: USDA, Economic Research Service using data from U.S. Environmental Protection Agency, April 2020: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018*, Table ES-7.

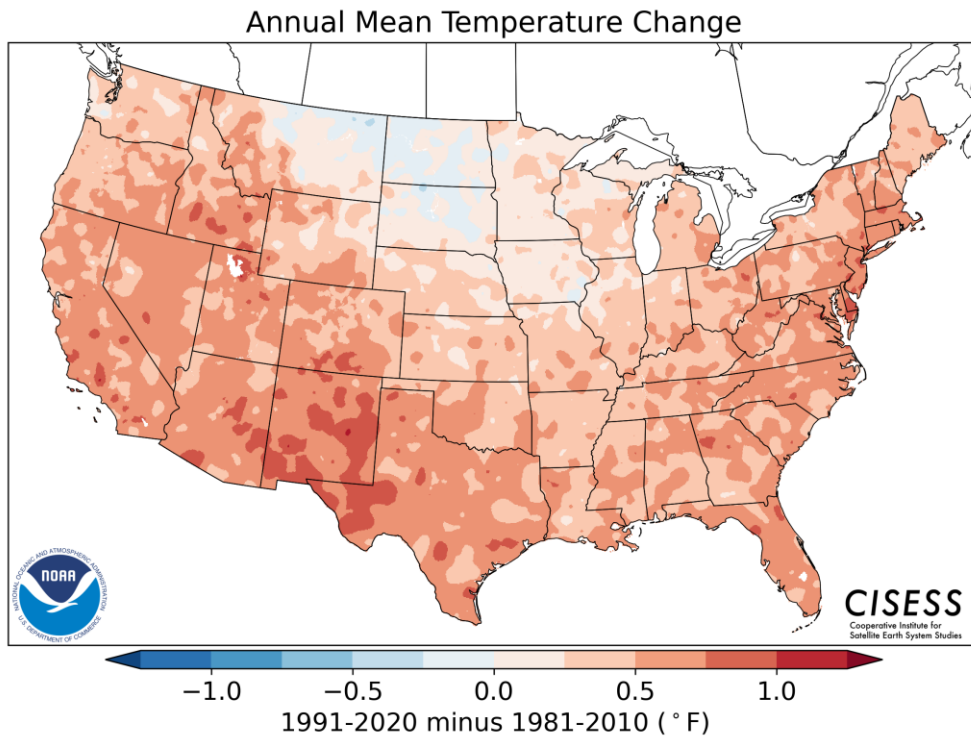
Overview of U.S. Greenhouse Gas Emissions in 2019



2019 U.S. Methane Emissions, By Source

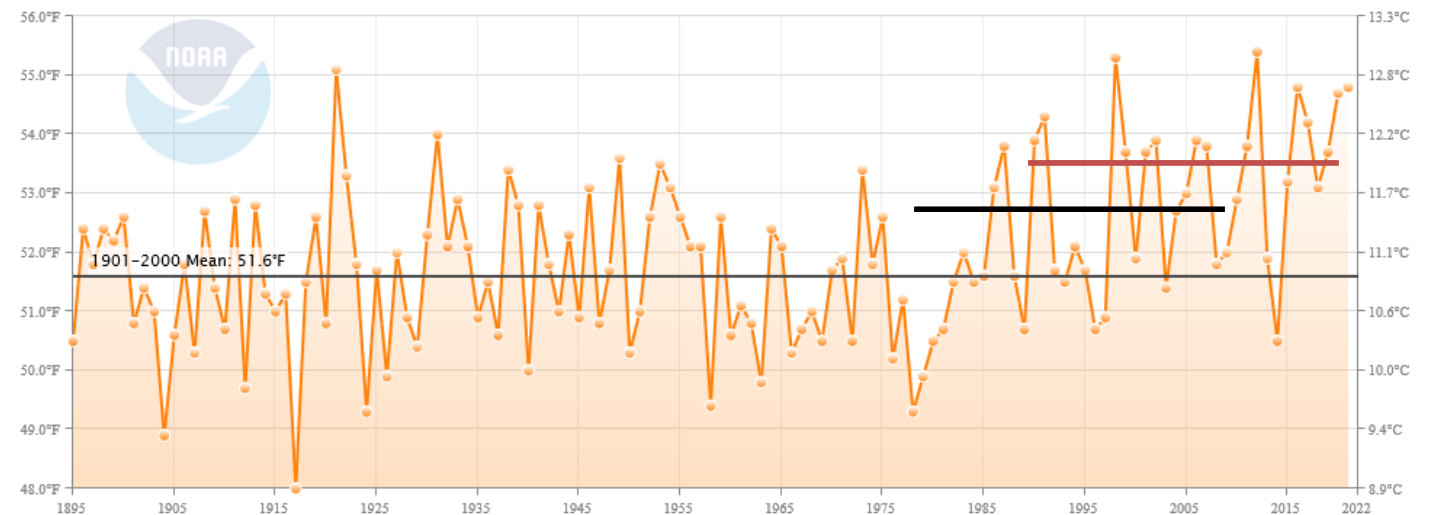


NWS NEW NORMALS: Temperature



<https://www.ncei.noaa.gov/products/us-climate-normals>

Montgomery County, Ohio Average Temperature
January–December

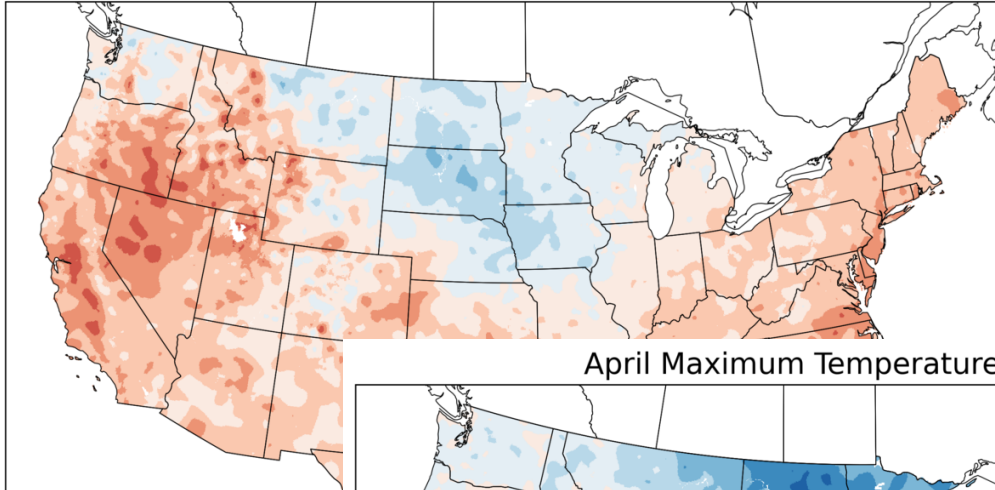


NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published January 2022, retrieved on January 11, 2022 from <https://www.ncdc.noaa.gov/cag/>

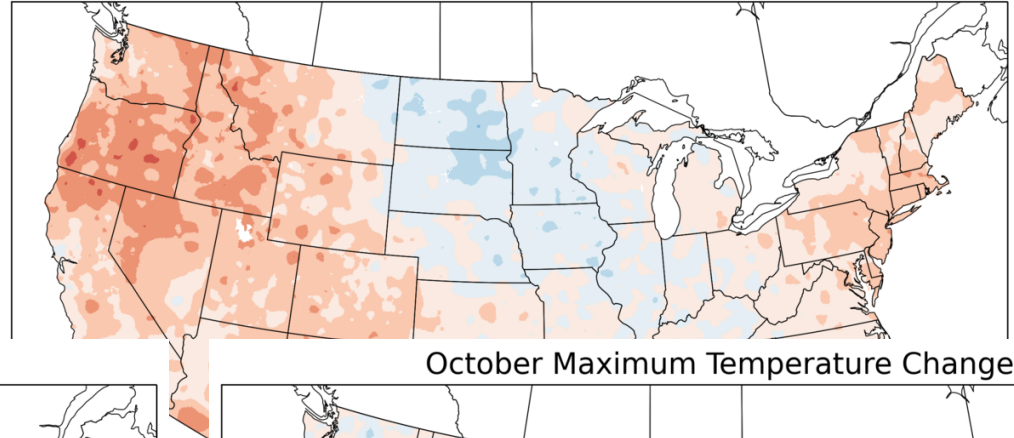
Seasonal Changes

<https://www.ncei.noaa.gov/products/us-climate-normals>

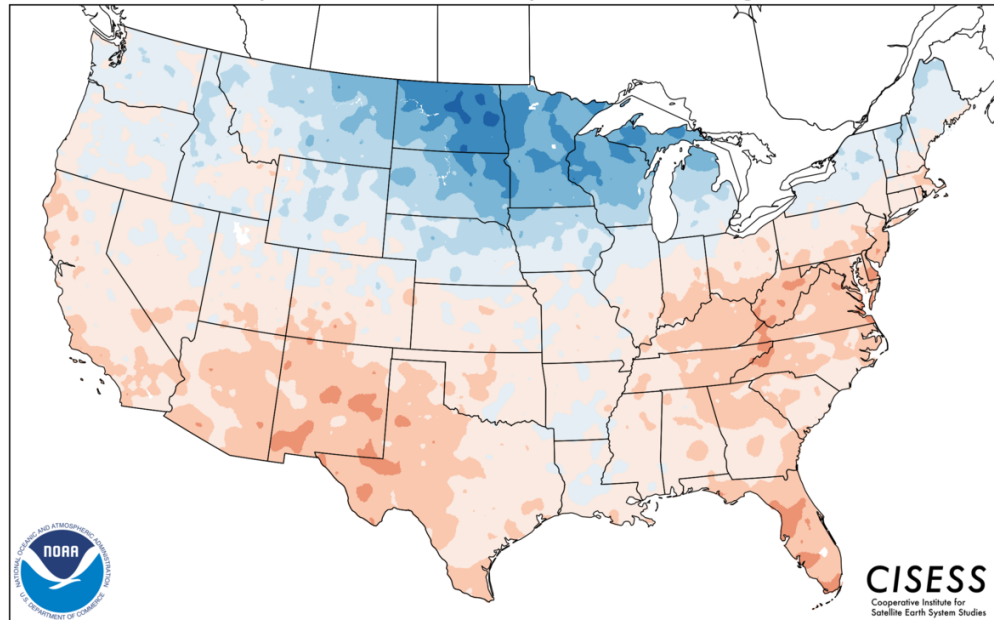
January Maximum Temperature Change



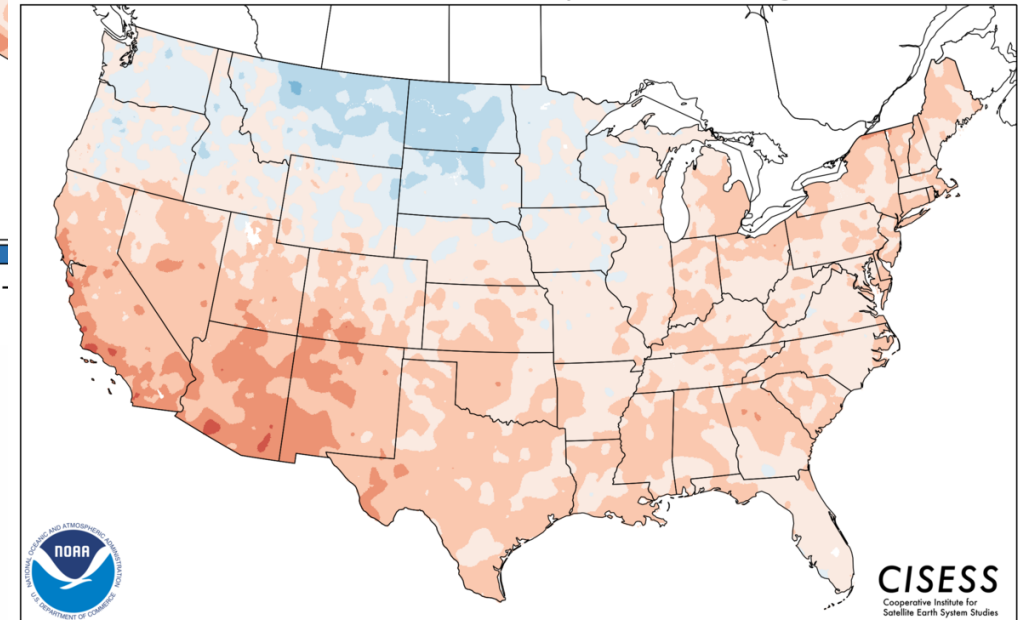
July Maximum Temperature Change



April Maximum Temperature Change



October Maximum Temperature Change



-2

1991



CISESS
Cooperative Institute for
Satellite Earth System Studies

-2

-1

0

1

2

1991-2020 minus 1981-2010 (°F)

TH

-2

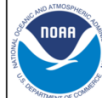
-1

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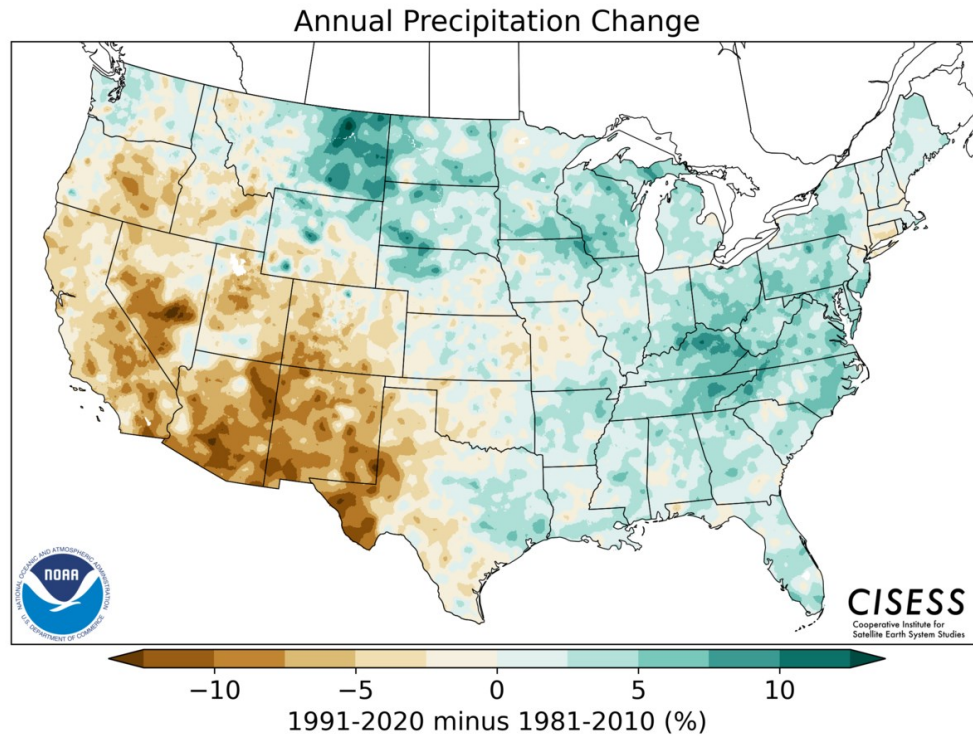
1991-2020 minus 1981-2010 (°F)



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Satellite Earth System Studies

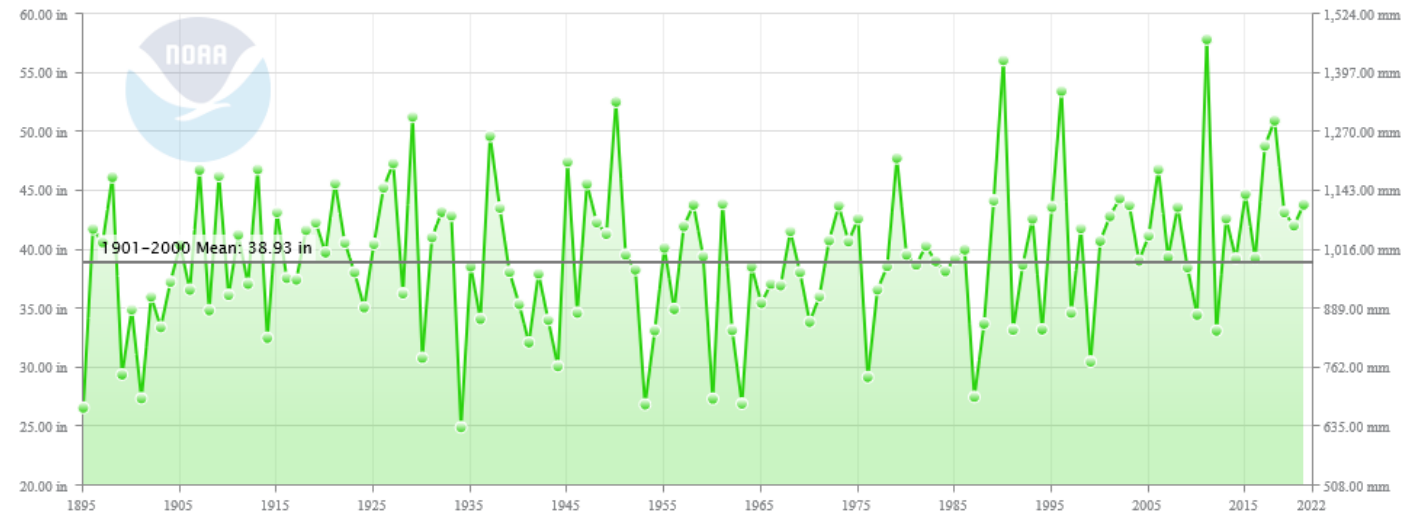
CFAES

NWS NEW NORMALS: Precipitation



<https://www.ncei.noaa.gov/products/us-climate-normals>

Montgomery County, Ohio Precipitation
January–December

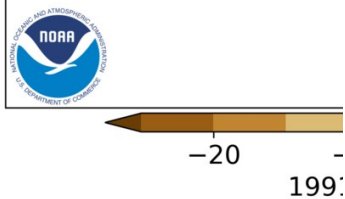
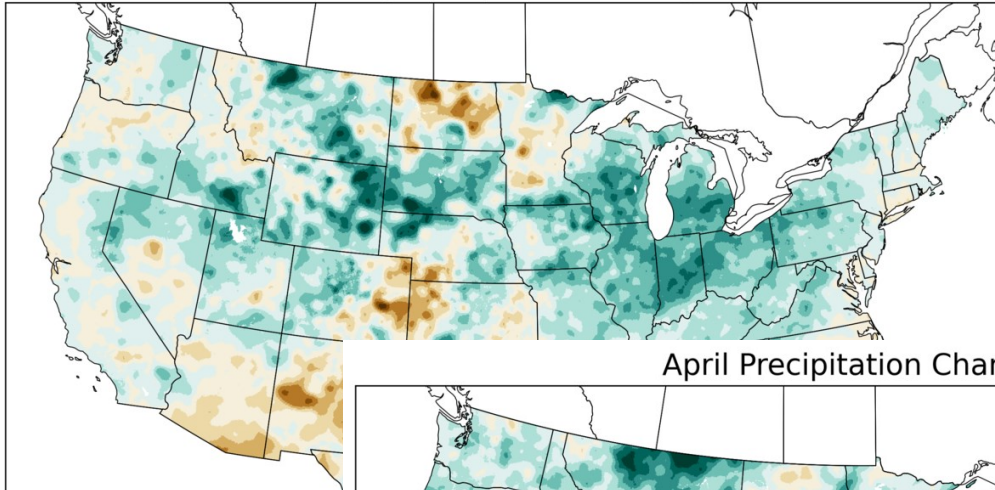


NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published January 2022, retrieved on January 11, 2022 from <https://www.ncdc.noaa.gov/caq/>

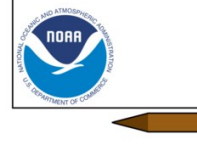
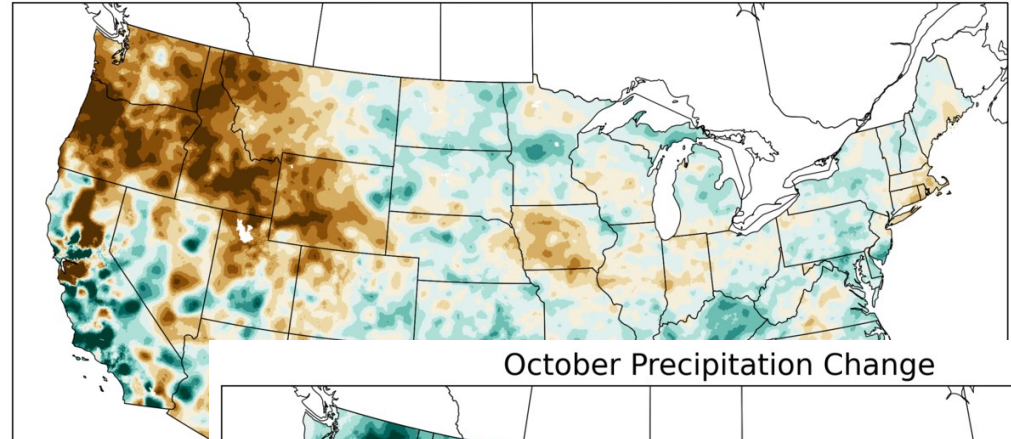
NWS New Normals

<https://www.ncei.noaa.gov/products/us-climate-normals>

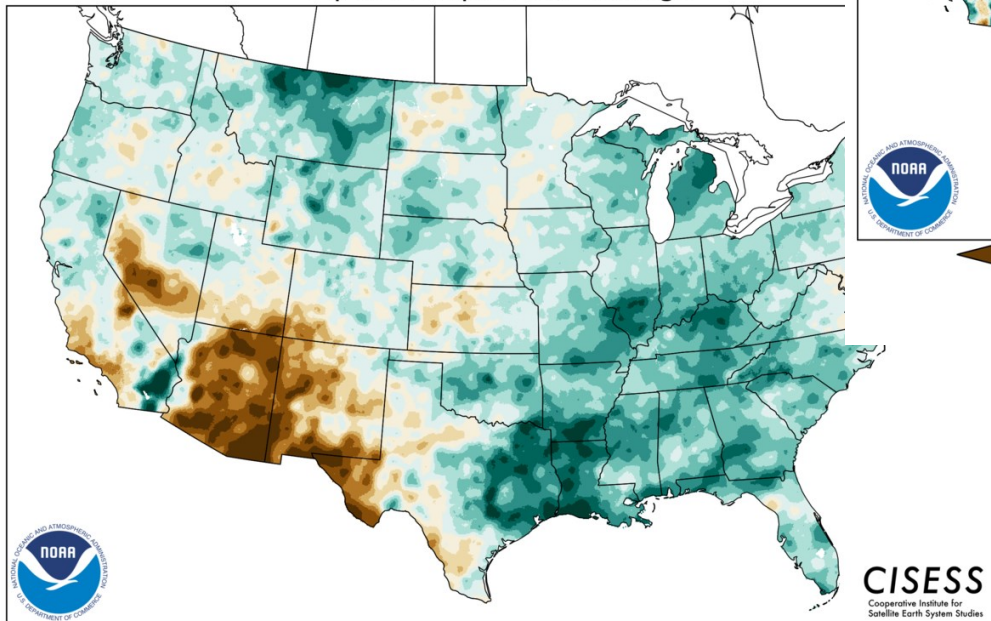
January Precipitation Change



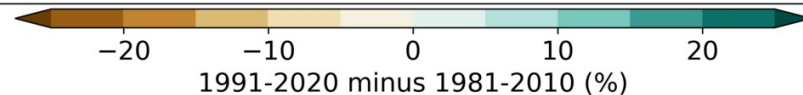
July Precipitation Change



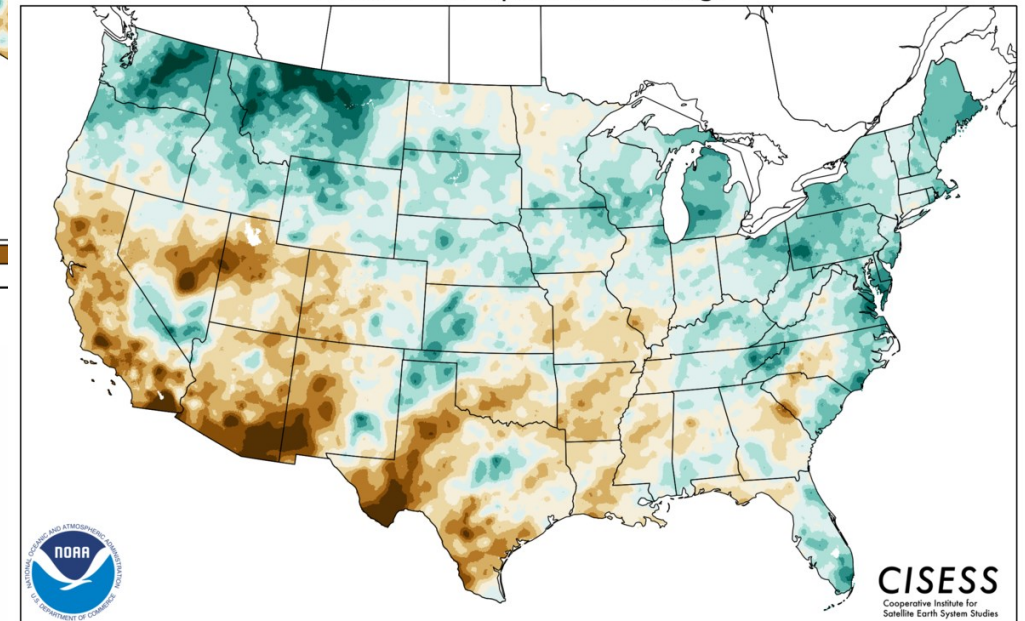
April Precipitation Change



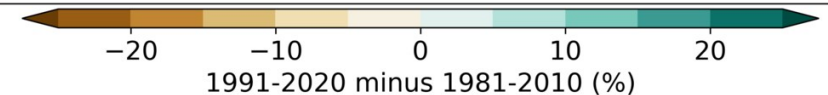
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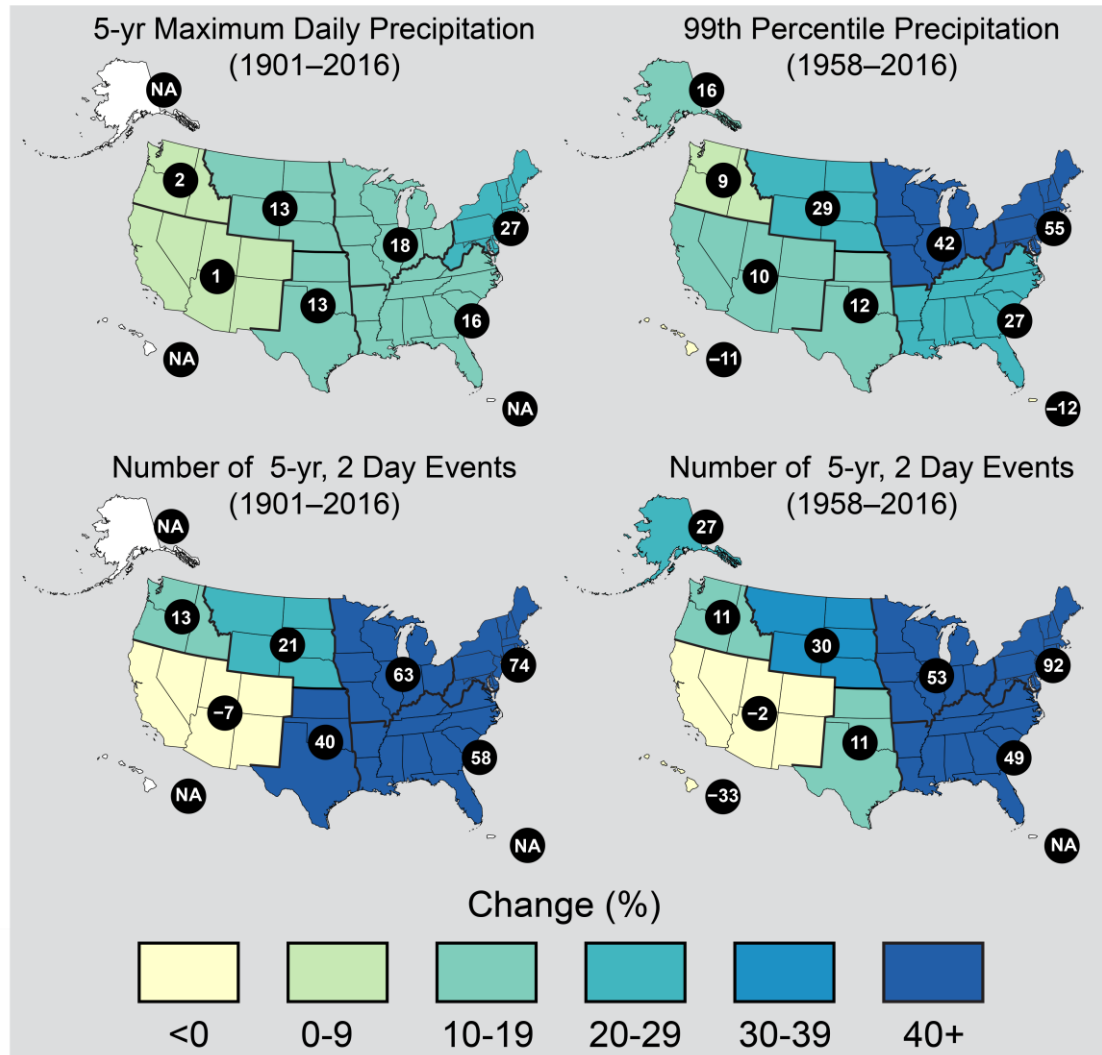
October Precipitation Change



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Observed Change in Heavy Precipitation



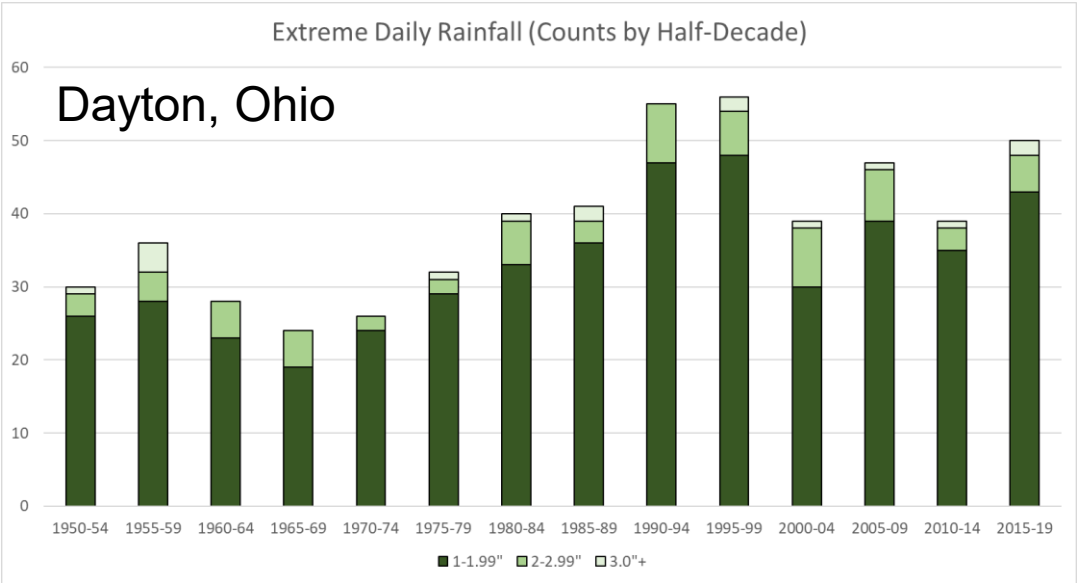
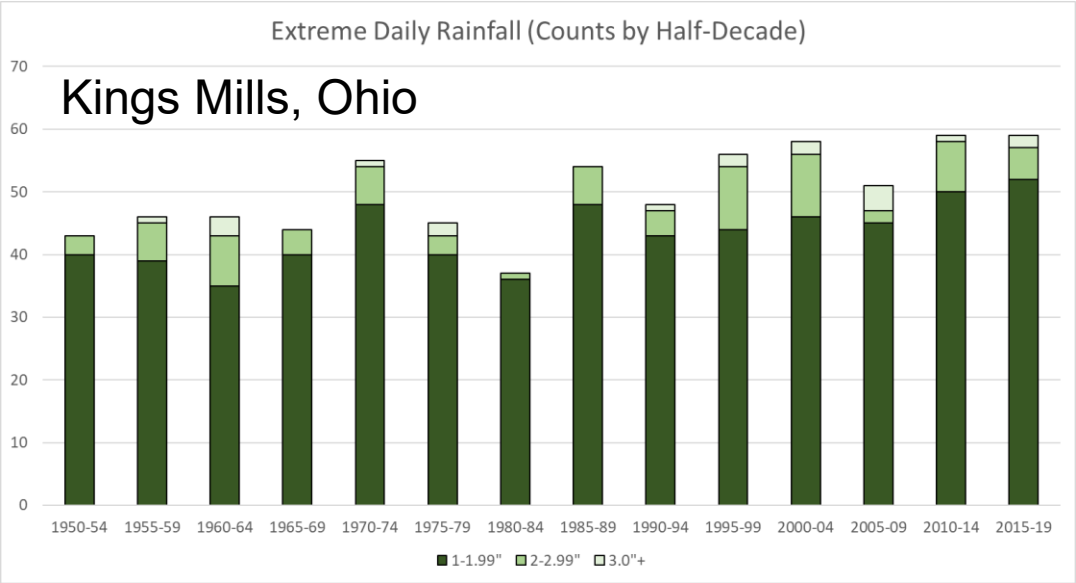
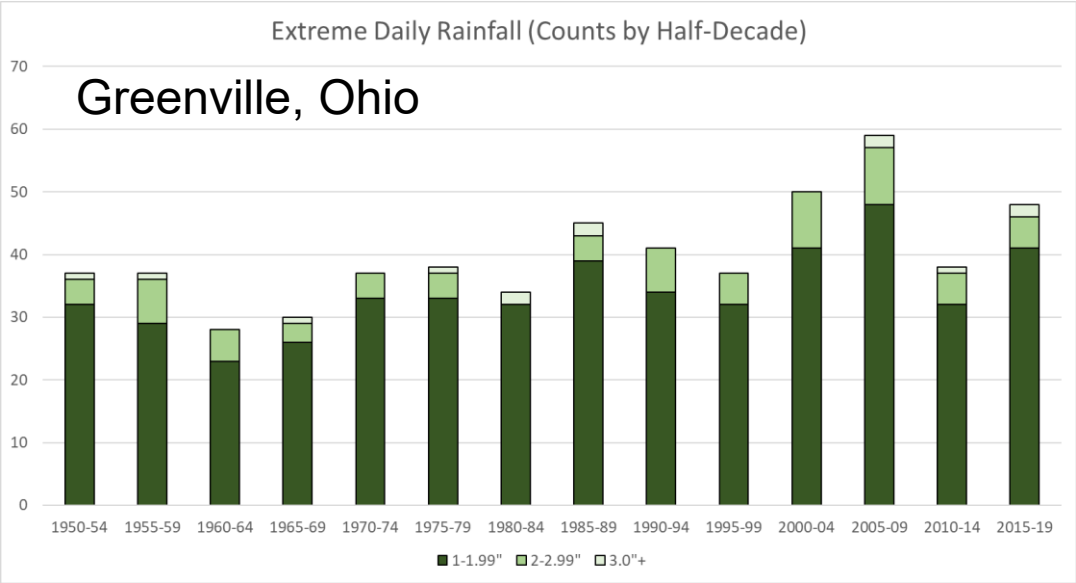
HEAVY PRECIPITATION

- Maximum daily precipitation totals were calculated for consecutive 5-year blocks from 1901
- The total precipitation falling in the top 1% of all days with precipitation
- Strongest events have a 42% higher probability of occurrence across the Midwest

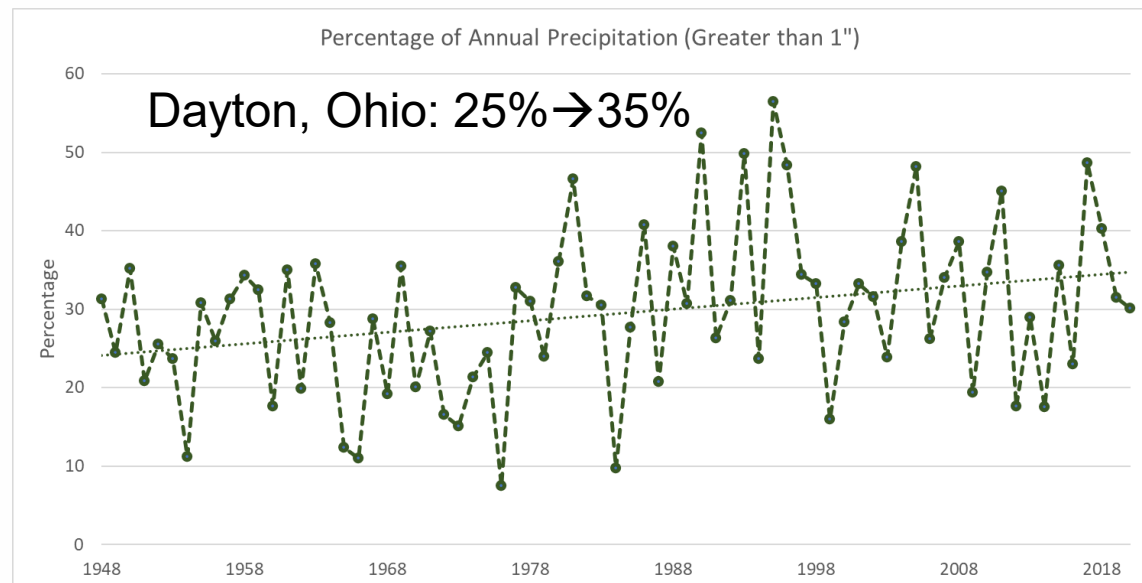
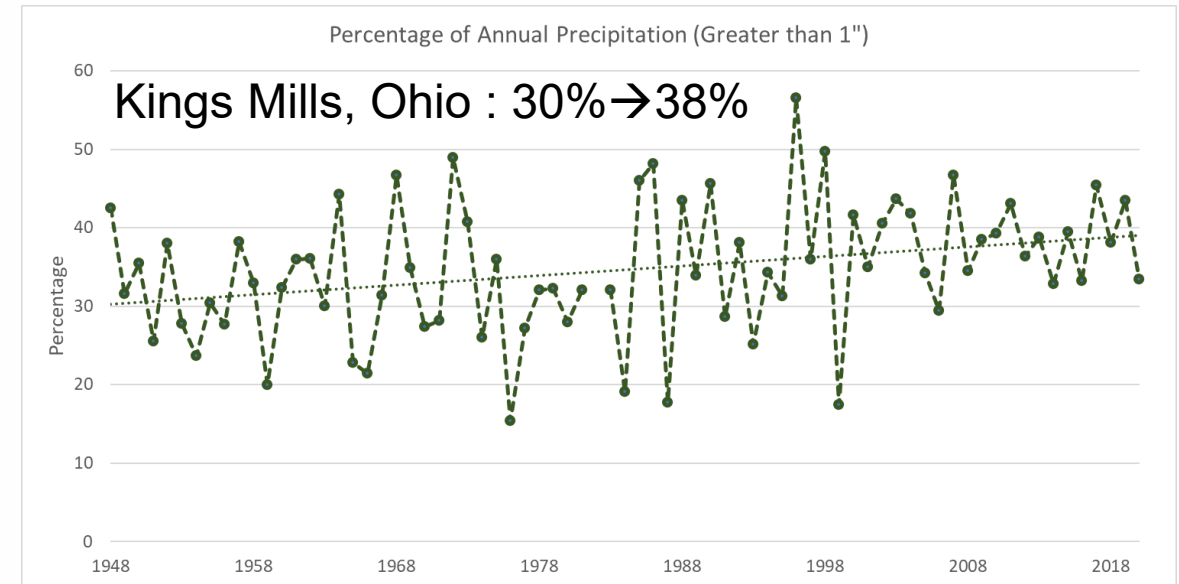
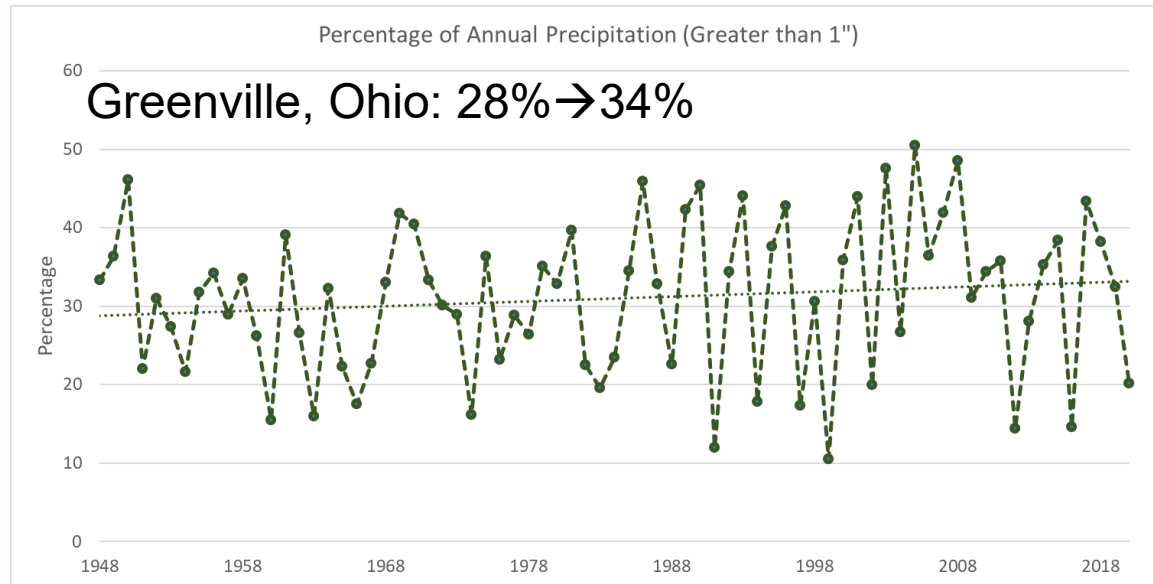
National Climate Assessment CCSR: <https://science2017.globalchange.gov/>

Easterling, D.R., K.E. Kunkel, J.R. Arnold, T. Knutson, A.N. LeGrande, L.R. Leung, R.S. Vose, D.E. Waliser, and M.F. Wehner, 2017: Precipitation change in the United States. In: *Climate Science Special Report: Fourth National Climate Assessment, Volume I* [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 207-230, doi: [10.7930/J0H993CC](https://doi.org/10.7930/J0H993CC).

Extreme Daily Event (Pentad) Trends



Portion of Rainfall Falling as Heavier Events

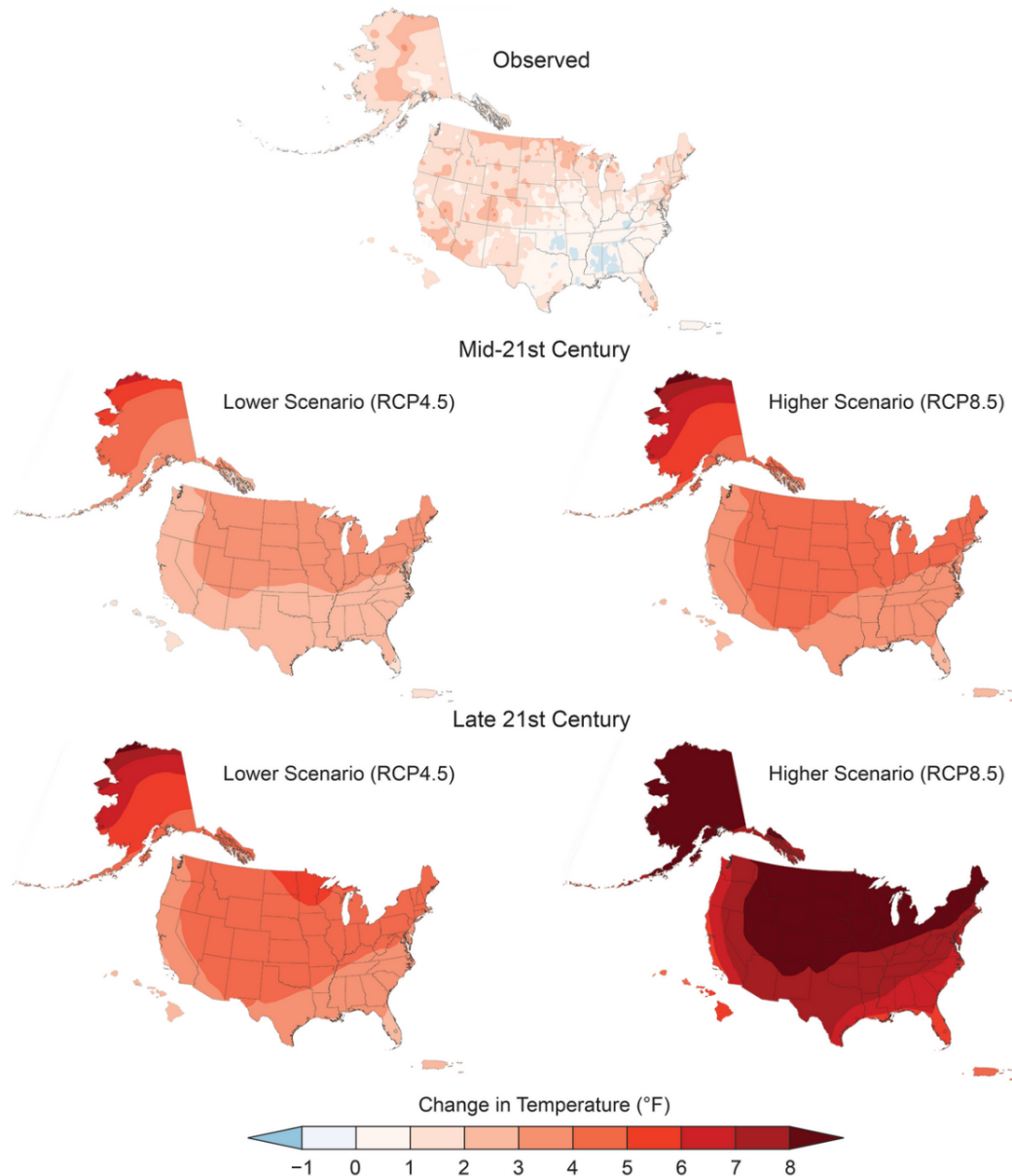


TEMPERATURE			
RANK	YEAR	AVERAGE	DIFFERENCE
1	1998	54.1	2.4
2	2012	54.0	2.4
3	2016	53.6	1.9
4	1921	53.5	1.8
5	2017	53.2	1.6
6	2021	53.2	1.5
7	1991	53.1	1.5
8	2020	53.0	1.4
9	1931	52.9	1.3
9	2006/1990	52.7	1.0

PRECIPITATION			
RANK	YEAR	TOTAL	DIFFERENCE
1	2011	55.95	14.85
2	1990	51.07	9.97
3	2018	50.93	9.83
4	1950	48.34	7.24
5	2019	46.87	5.77
6	1996	46.85	5.75
7	2003	46.42	5.32
8	1929	46.07	4.97
9	2017	45.51	4.41
10	2004	45.45	4.35

- 5 of the top 10 warmest/ 6 of the top 10 wettest have occurred since 2003
- 9 of the top 10 warmest/ 8 of the top 10 wettest since 1990

OHIO'S TOP 10

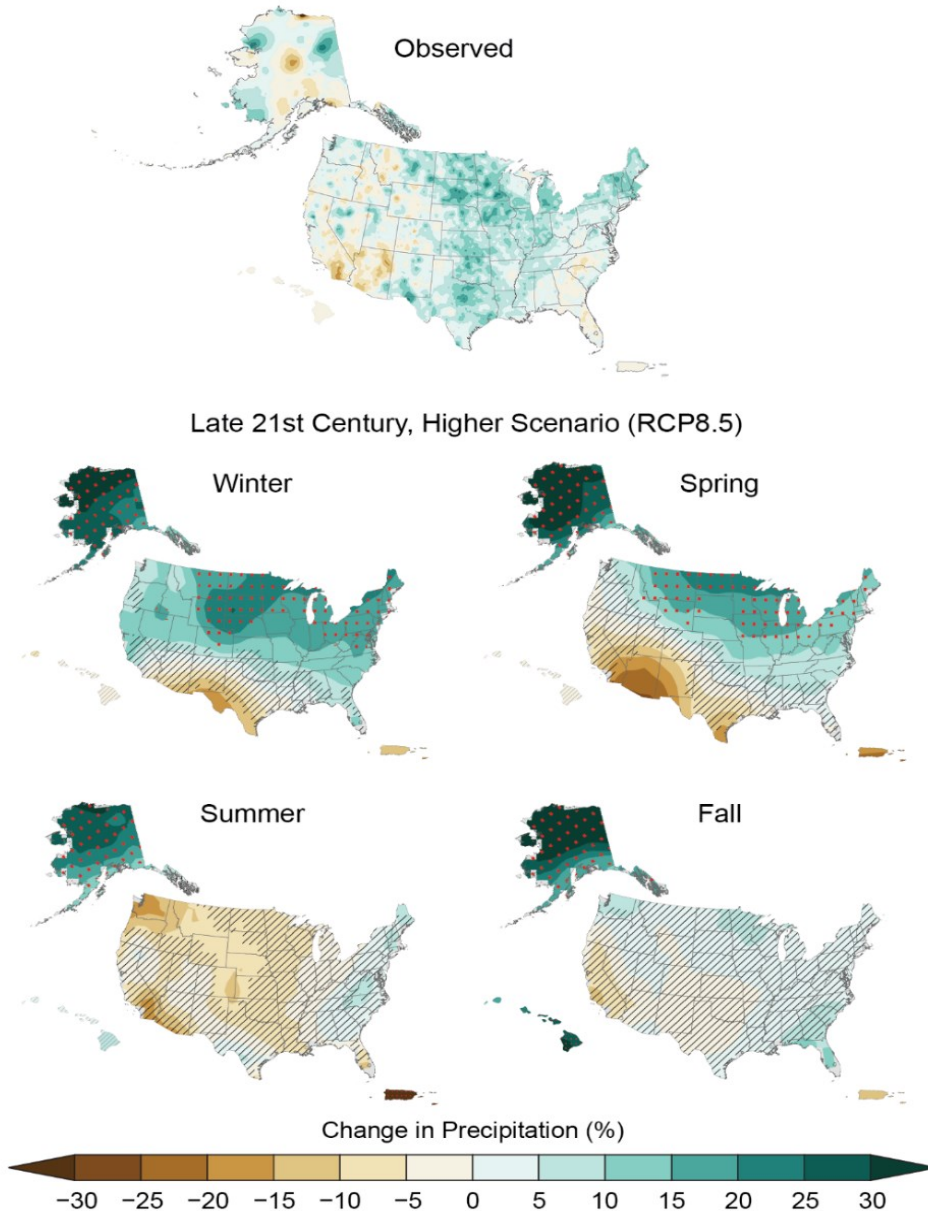


OUR FUTURE CLIMATE: TEMPERATURE

- Driven by winter warming and warmer nighttime temperatures
- Mid-Century Change: 3-5°F warmer
- Late-Century Change: 4-8°F warmer

Fourth National Climate Assessment CCSR: <https://nca2018.globalchange.gov/>

USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018.



OUR FUTURE CLIMATE: PRECIPITATION

- Driven by increased water vapor (humidity)
- Seasonal changes atmospheric circulation
- Wetter cool season; drier summer season = could mean intensified drought

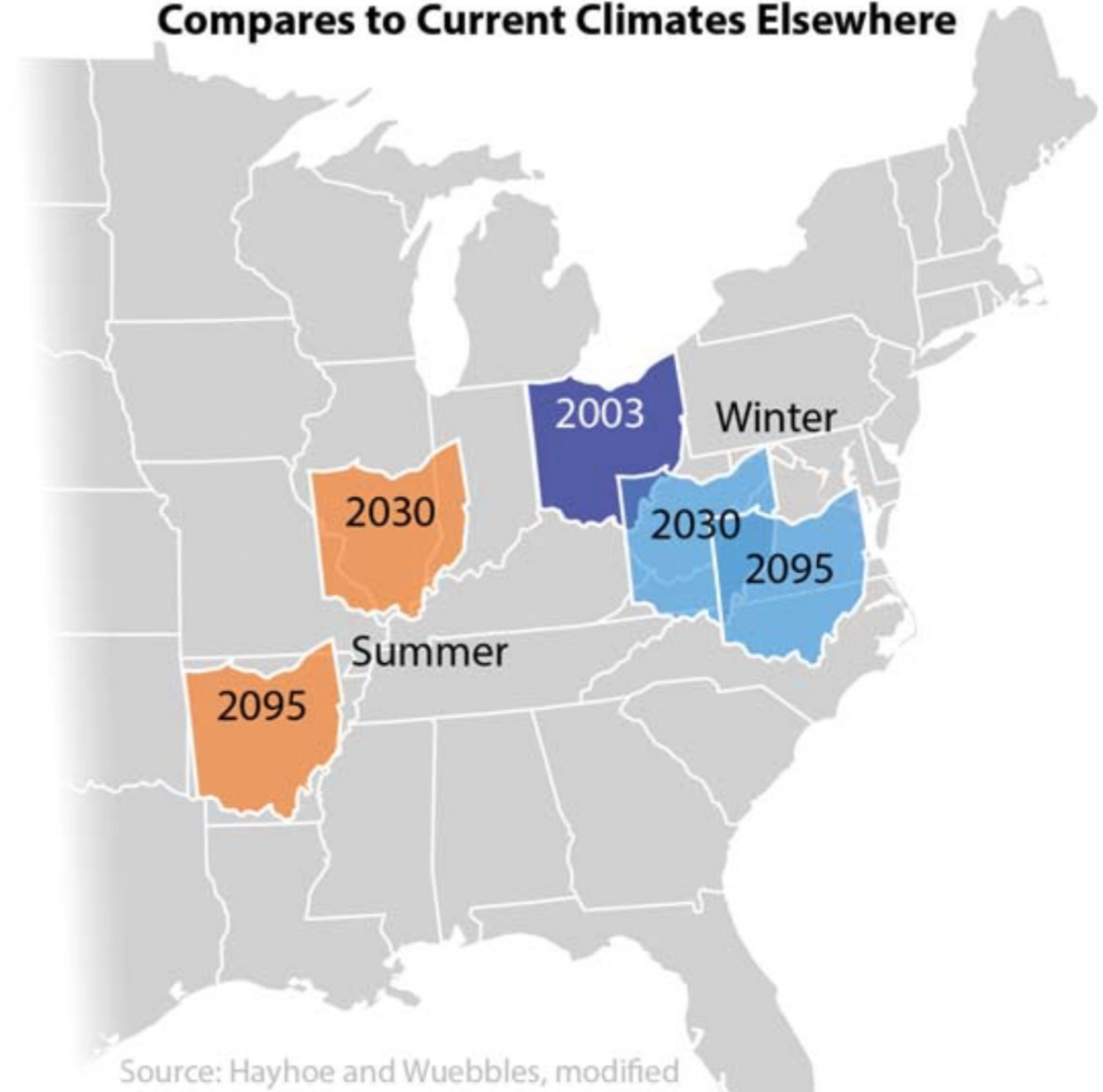
Fourth National Climate Assessment CCSR: <https://nca2018.globalchange.gov/>

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WHAT IF THIS IS OUR NEW NORMAL?

- Longer Growing Season
- Warmer Temperatures (Winter and at Night)
- Higher Humidity
- More Rainfall
- More Intense Rainfall Events
- More Autumn Precipitation

How the Future Climate of Ohio
Compares to Current Climates Elsewhere



CLIMATE TAKEAWAYS

- It is getting warmer and wetter in the Miami Valley.
- Distinct seasonal trends (e.g., warmer cool season)
- Intense rainfall increasing in intensity and frequency along with seasonal distribution changes
- Future looks even warmer with swings between extreme hydro extremes likely

Leiserowitz Big Five – Yale Climate Project

1. Climate change is happening.
2. We are currently experiencing the effects.
3. Humans are the cause.
4. The scientific evidence is overwhelming.
5. We can do something about it.

Mitigate

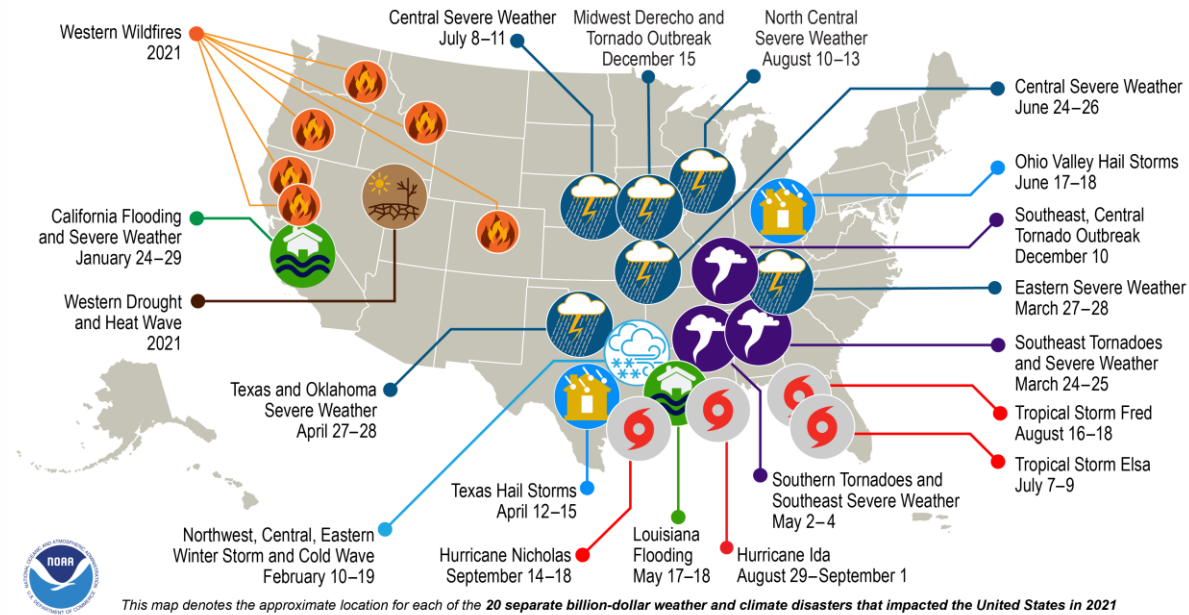
Adapt

Suffer

**WE NEED EVERYONE TALKING ABOUT CLIMATE CHANGE
(No matter what we call it)!**

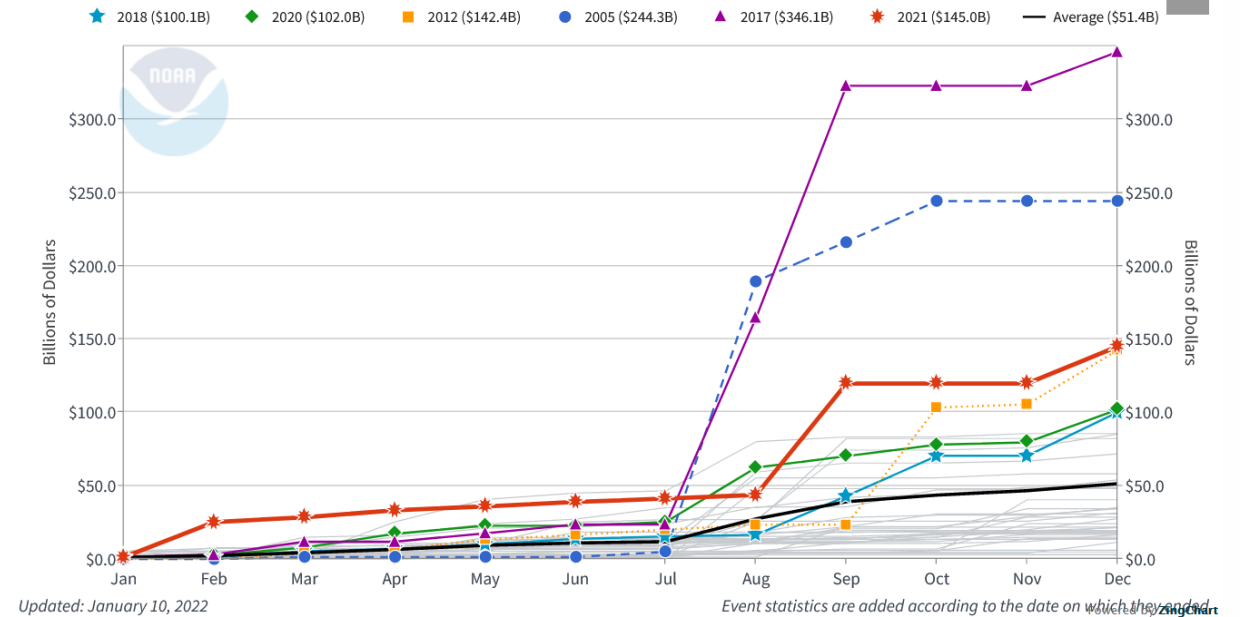
Photo Credit: Amanda Douridas

U.S. 2021 Billion-Dollar Weather and Climate Disasters



BILLION DOLLAR DISASTERS

1980-2021 United States Billion-Dollar Disaster Event Cost (CPI-Adjusted)



National Weather Service Mission

2008-2017 Natural Disasters in Ohio

- Flash flooding: \$178,548,000
- Flooding: \$54,551,000
- Hurricanes: \$0
- Heavy rain: \$126,000
- Heavy snow: \$4,860,000
- Tornadoes: \$196,559,000
- Tsunamis: \$0
- Wildfires: \$0
- >\$200 million on rain related disasters

<https://www.ncdc.noaa.gov/billions/>

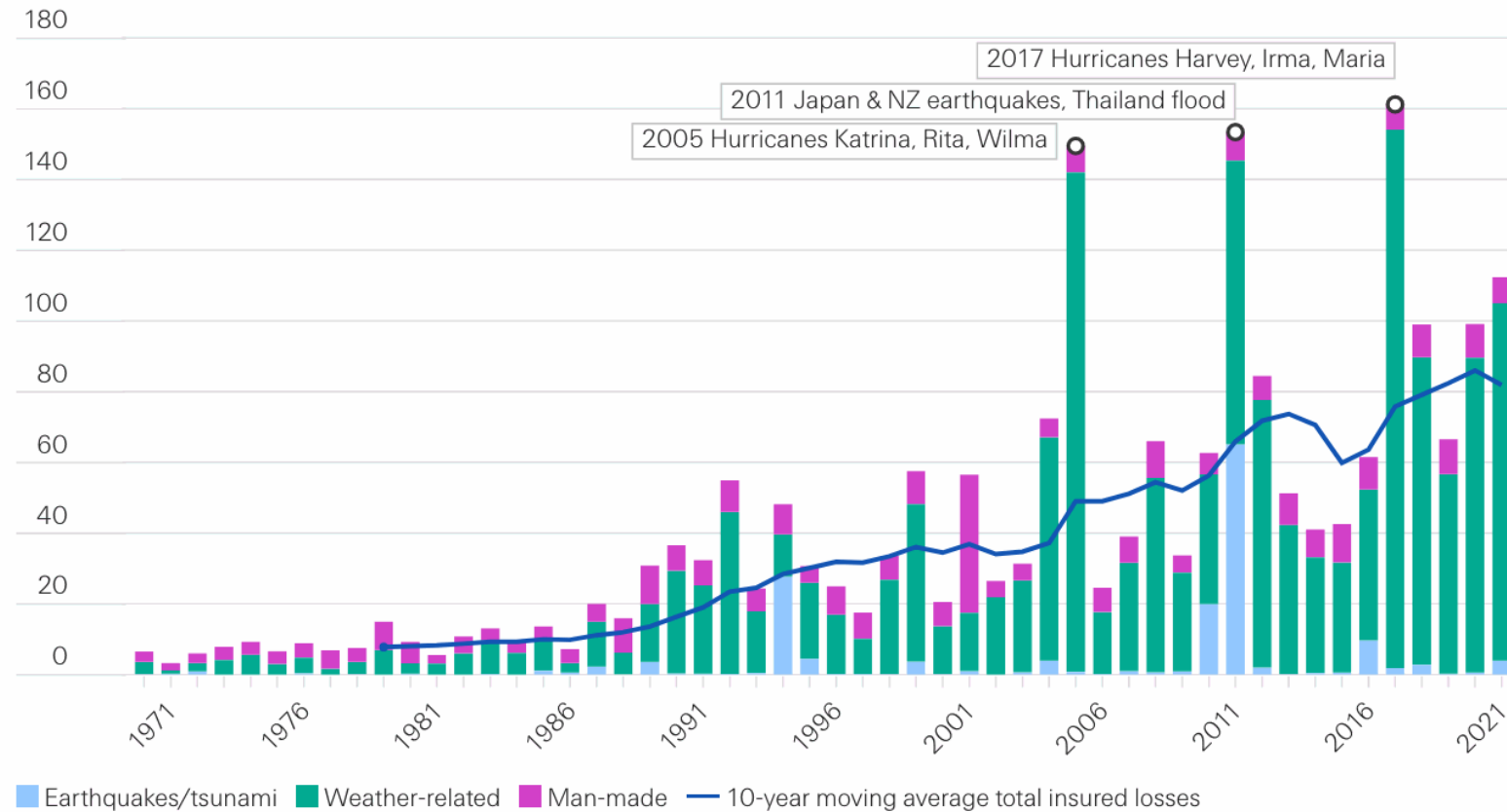
Building a Weather-Ready Nation

Losses are Increasing

Insured losses since 1970

USD billion (in 2021 prices)

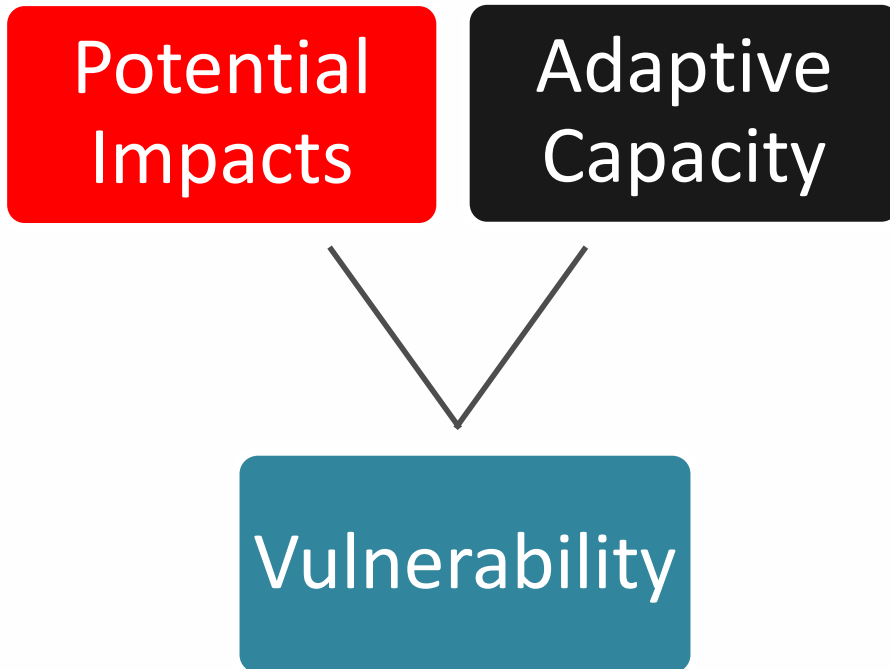
Rollover/touch chart for details



Source: Swiss Re Institute

Adaptation: There is no single answer

Every business owner is different



Each decision is unique and will vary based upon:

People: Values, Culture, & Resources

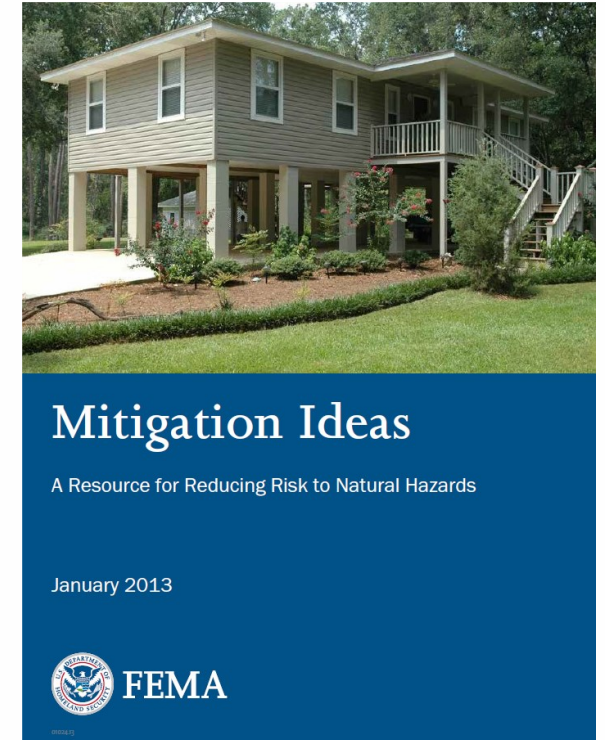
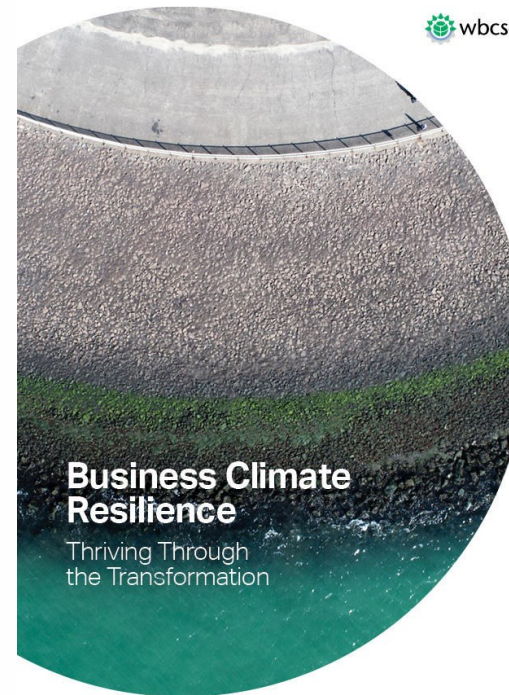
Place: Location & Site Conditions

Purpose: Goals & Objectives

Practices: Equipment, Procedures, & Methods

Resources Available for Businesses

- C2ES (Center for Climate and Energy Solutions), 2013: Weather the Storm: Building Business Resilience to Climate Change.
- FEMA, 2013: Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards
- U.S. Federal Government, 2014: U.S. Climate Resilience Toolkit.
<http://toolkit.climate.gov>
- WBCSD, 2019: Business Climate Resilience: Thriving Through the Transformation



“Businesses to prepare for both the physical risks that are associated with climate change, as well as the associated transitional risks on the path towards a net-zero economy.”

One Approach to Building Internal Resilience

- Survey Instrument designed to evaluate and prioritize actions that the company thinks are important to build resilience to the increasing precipitation extremes and potential flood inundation
- What is the company's will to act?
- What are the costs associated with actions?
- What is the current level of expertise in the company?

Potential Solutions to Increased Flood Risk

Raise susceptible buildings to prevent flood inundation

Build higher levels on buildings and designate lower levels for parking or storage

Transform surfaces from impervious to pervious to allow increased water infiltration and less runoff (parking lots and walkways)

Implement additional water retention and water collection sites on campus to draw water away from key assets – preserve natural water systems (e.g., wetland restoration)

Move highly susceptible assets and/or buildings – turn these areas into greenspace (mitigation measures)

Elevate heating/cooling systems, wiring, and access

Construct flood walls to prevent inundation

Review and update flood emergency evacuation plans – ties steps of prevention into key threshold or flood markers

Review company communication plans associated with flooding and emergency response

Waterproofing structures (walls/floors, electrical sockets)

Have temporary flood barriers on-hand

Ensure adequate stock of key inputs or raw materials, back-up or self-generated electric power

Diversify sources of key inputs

Engage suppliers of key inputs in resilience planning

Survey In Action

Solution: Build higher levels on buildings (or specifically, Building 'A') and designate lower levels for parking or storage



Hypothetical: Company has decided that it will evaluate adaptation strategies based on the following criteria:

potential positive impact of each proposed statement

feasibility of implementing each proposed statement (costs, local technical knowledge, company will/support)



Use focus groups and/or survey

Ask participants to mark answers from “strongly disagree” to “strongly agree”

Ask them to self-report their expertise pertaining to the potential action for the expertise question ranging from “no expertise” to “significant expertise”

Solicit additional comments for each statement.

Weight impact and feasibility by expertise reporting



Repeat for all potential solutions and rank according to scores



Use this ranking to prioritize company actions

Energy and Low Carbon Alternatives



An aerial photograph of a town, likely Columbus, Ohio, showing a mix of residential and commercial buildings, streets, and green spaces. The text 'Thank You!' is overlaid in large yellow letters at the top center.

Thank You!

Aaron B. Wilson, PhD

CFAES-OSU Extension | Climate Specialist

Byrd Polar & Climate Research Center | Research Scientist

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