Water Weirding in a Time of Rapidly Changing Climate

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OSU Extension | Byrd Polar and Climate Research Center

State Climate Office of Ohio

48th Annual WMAO Conference

November 13 , 2019

CFAES

THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Opening Questions

- In your lifetime, have weather patterns changed?
- What have you noticed? How do you know?
- Have you experienced impacts on water, soil, transportation, or agriculture?

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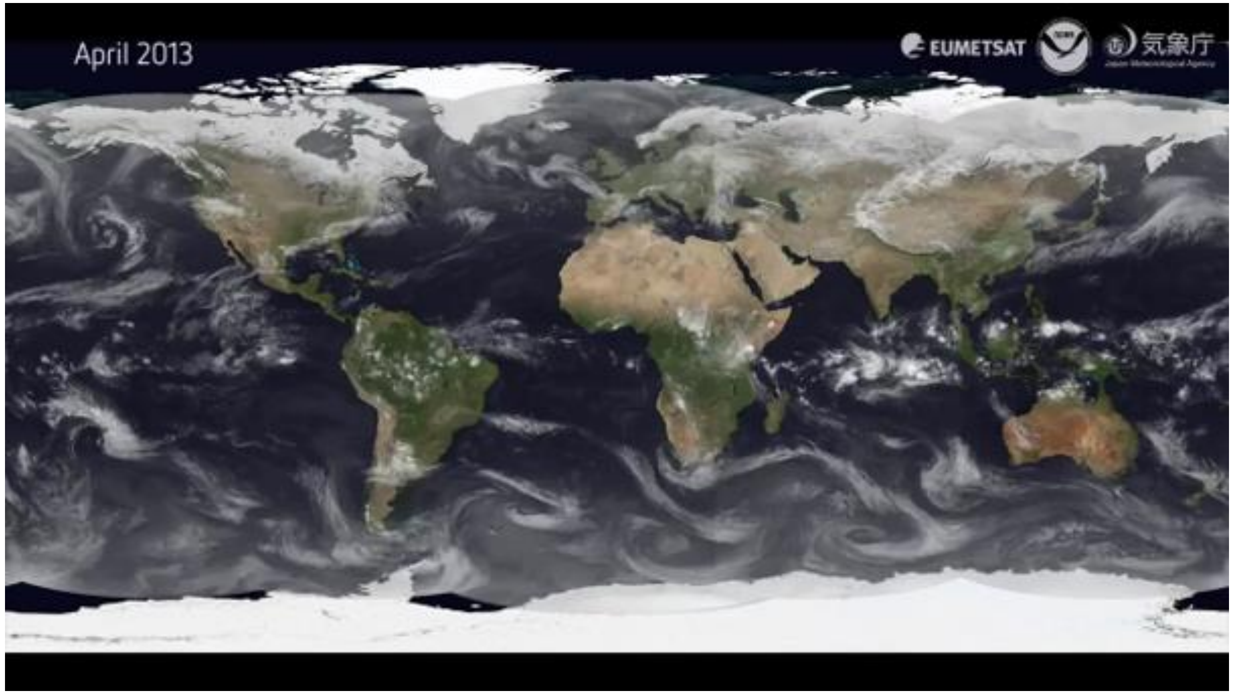
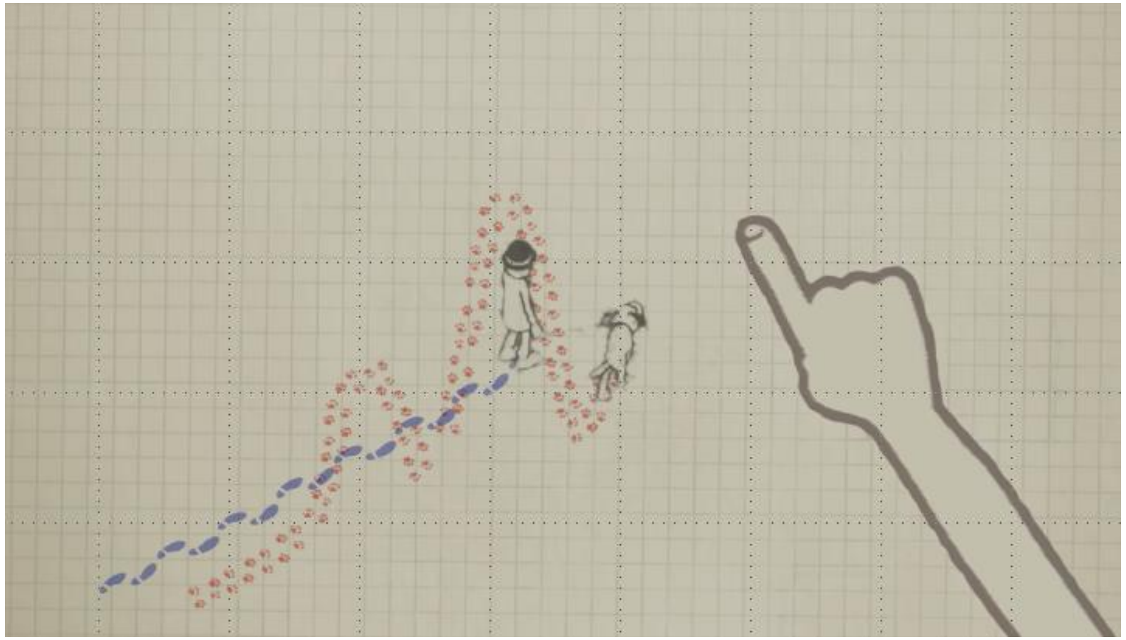
Weather and Climate



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.



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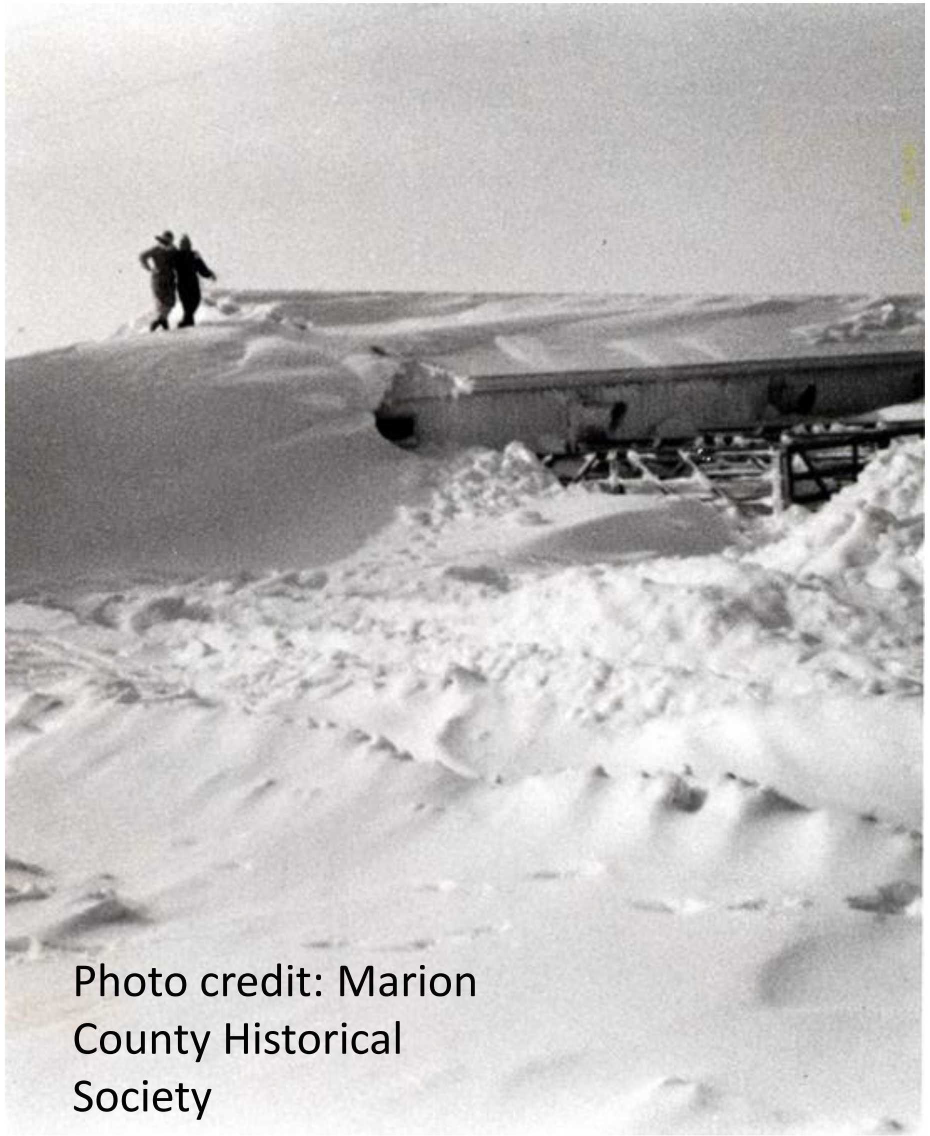
The Power of Weather Impacts Us All

1913 Flood: “Ohio’s greatest weather disaster.”

- 6-11” of rain; 467 deaths; Over 40,000 homes destroyed

Blizzard of 1978:

- January 26-27; 51 lives lost



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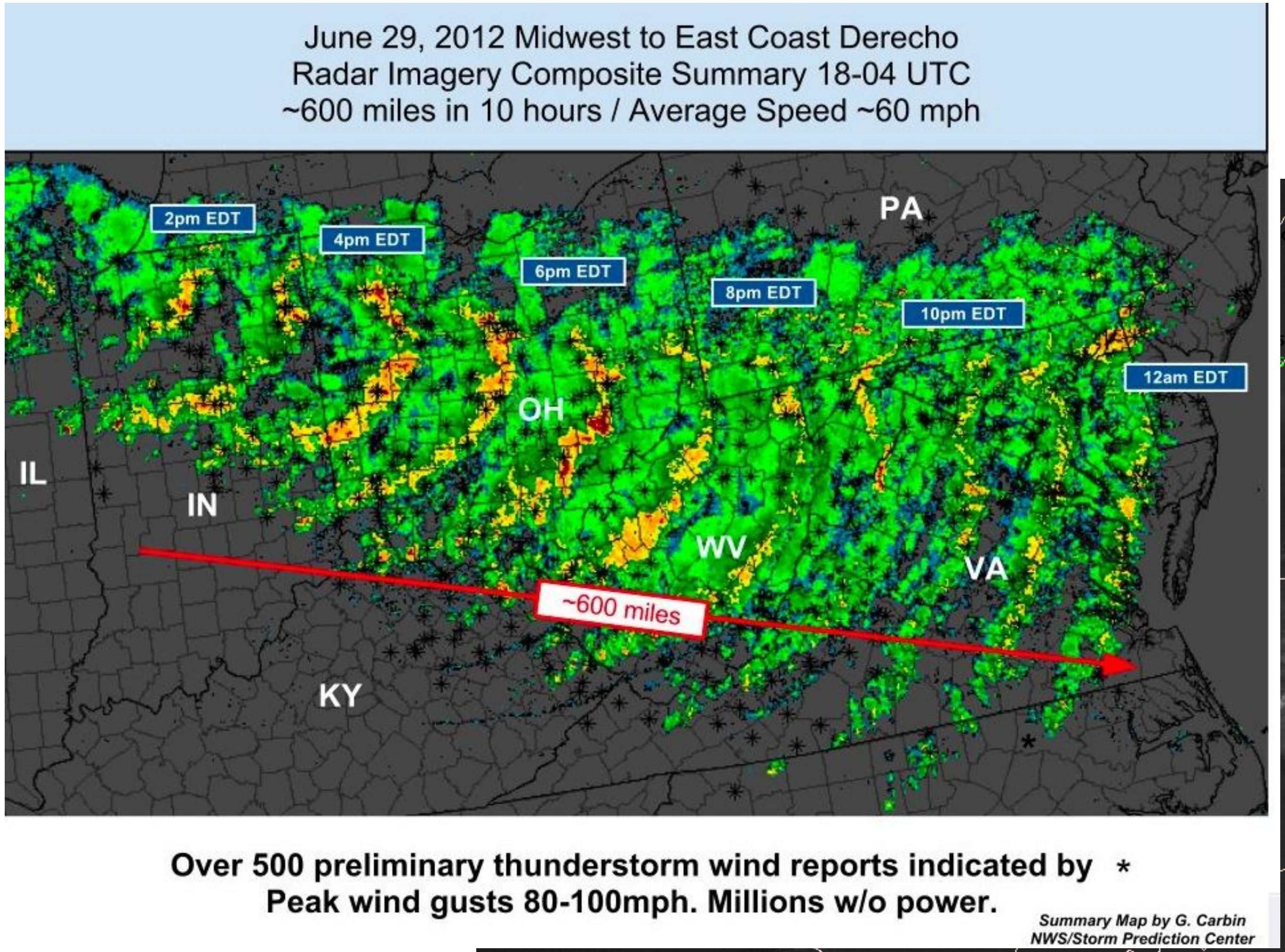
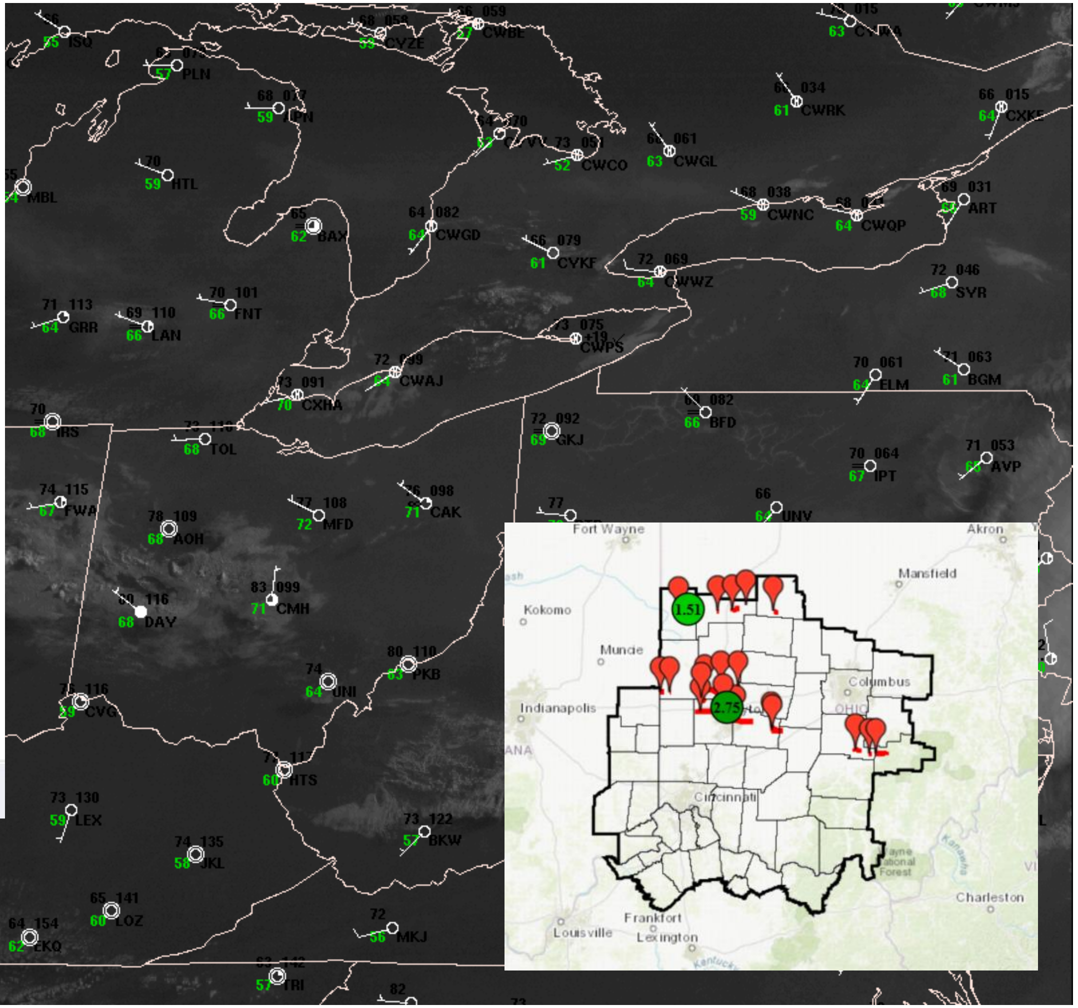
Severe Weather in Ohio

Derecho of 2012





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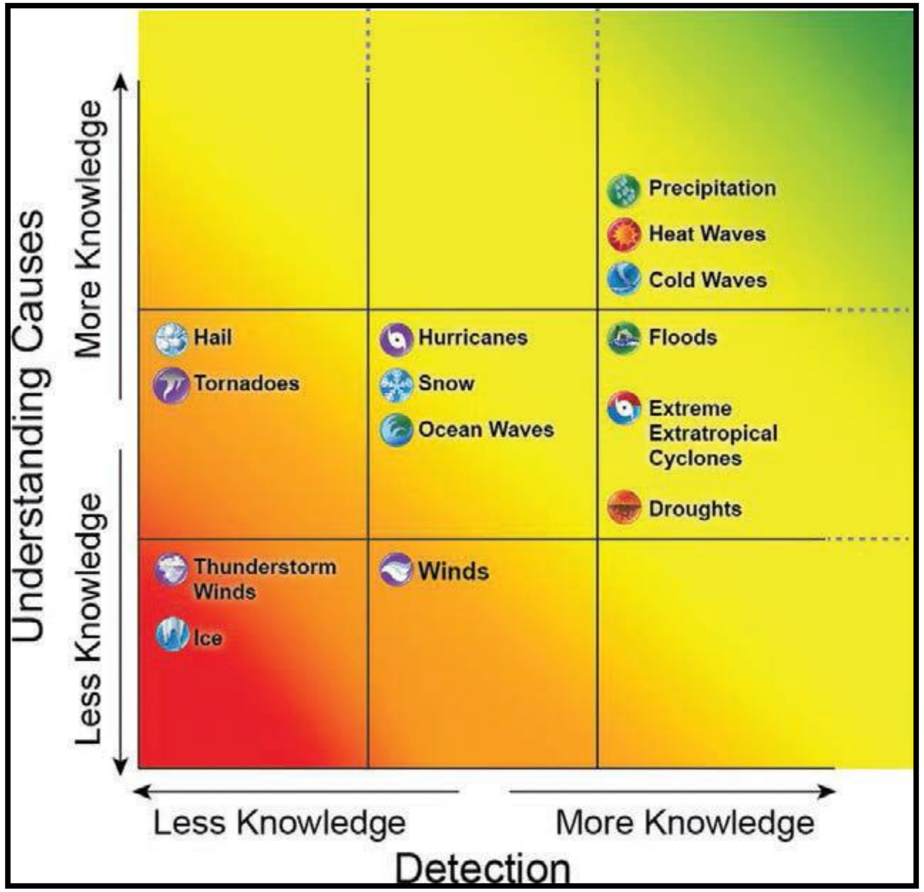
Ohio's Costliest Weather Disasters are Water-Related



Flood Warning Services in a Wetter World
(Sarah Jamison, National Oceanic and Atmospheric Administration) Thursday November 14th, 11:15-11:45am, Ballroom 3

D Wuebbles et al. , 2014: CMIP5 Climate Model Analyses: Climate Extremes in the United States. *Bull. Amer. Meteor. Soc.*, **95**, 571–583, doi: 10.1175/BAMS-D-12-00172.1

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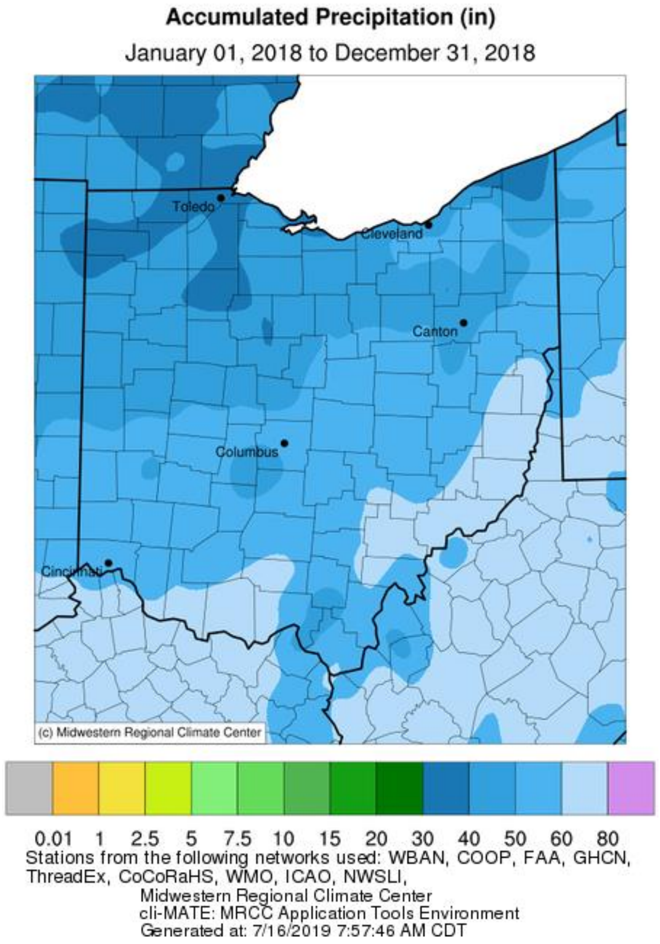
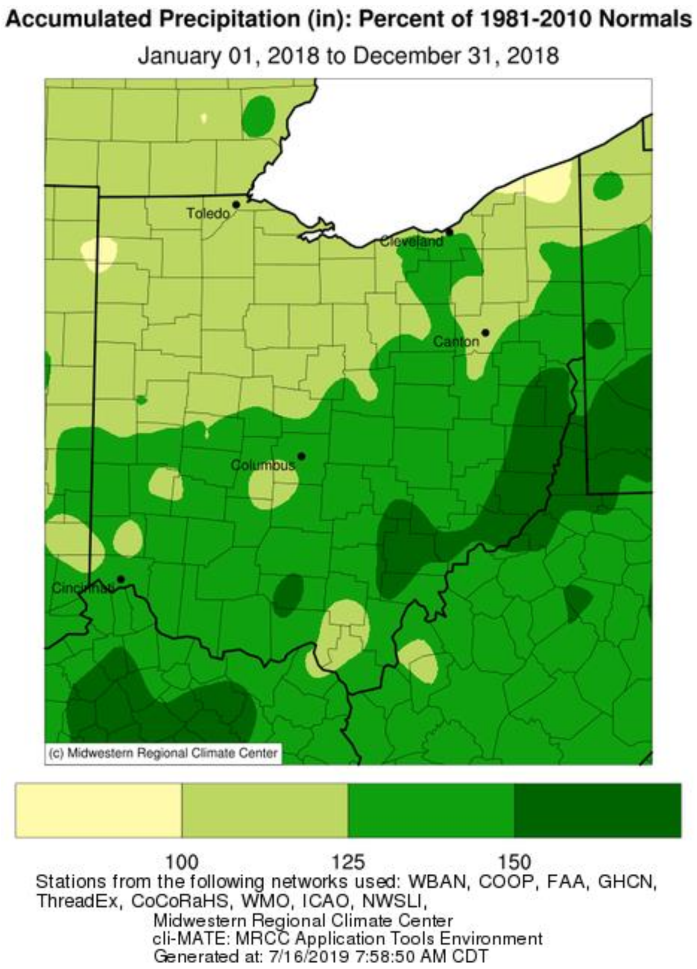
2018 for the State of Ohio





RANK	YEAR	AVERAGE	DIFFERENCE
1	2011	55.95	16.50
2	1990	51.07	11.62
3	2018	50.83	11.38
4	1950	48.34	8.89
5	1996	46.85	7.40
6	2003	46.42	6.97
7	1929	46.42	6.62
8	2017	45.51	6.06
9	2004	45.45	6.00
10	1937	45.18	5.73

- 19th Warmest
- 3rd Wettest
- Modern Period (1895 – 2018)

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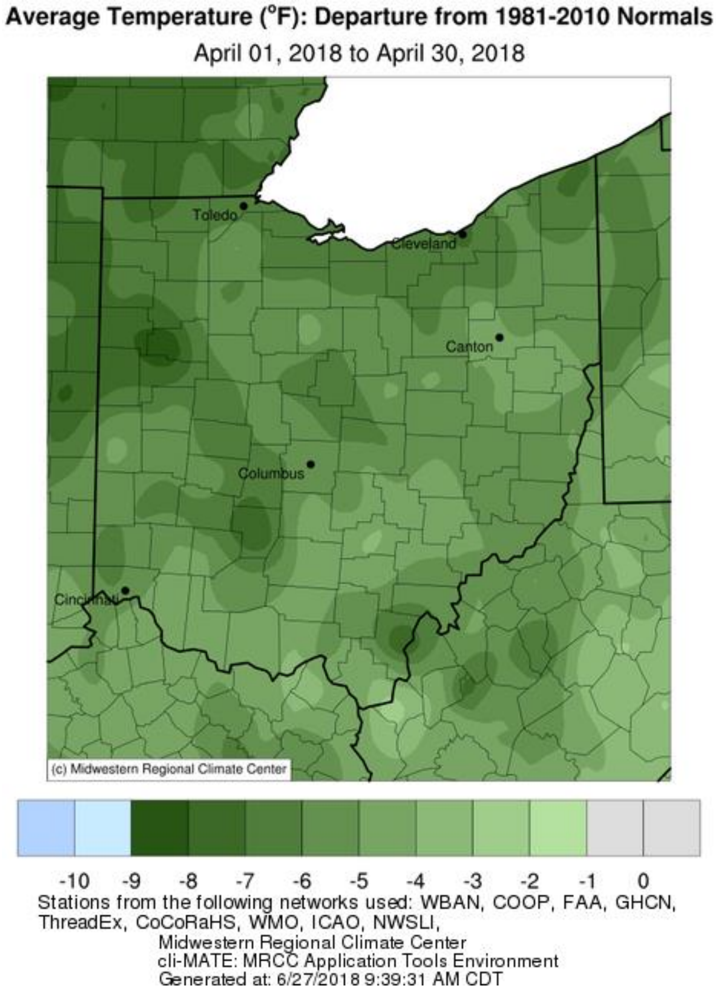
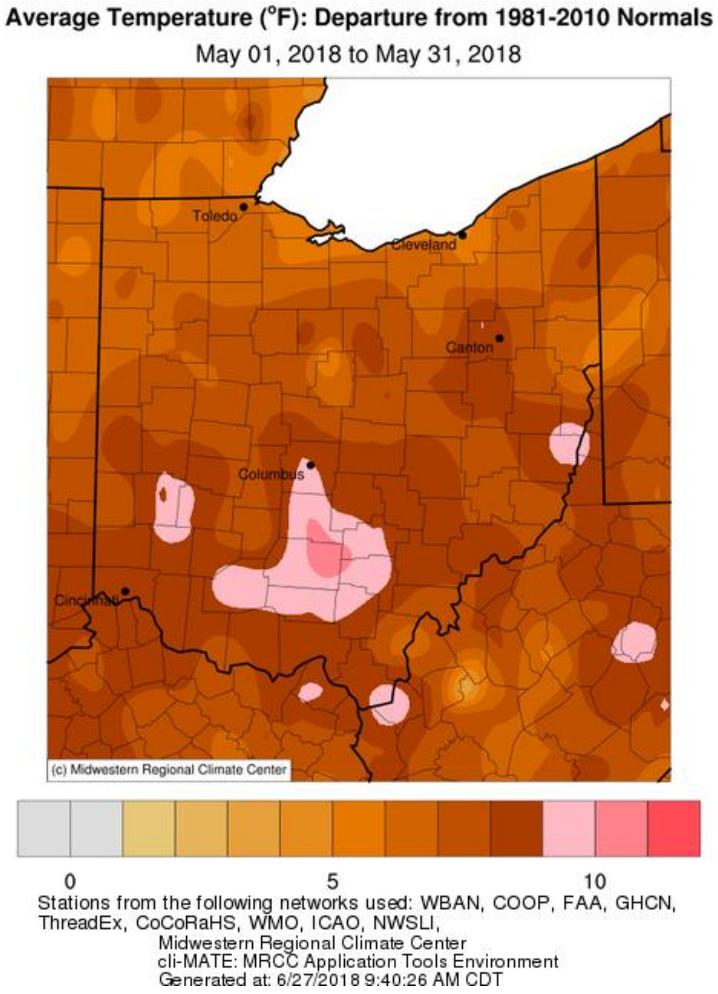
Recall the Variability of Spring 2018





- MAM 2018 ranks as the 49th warmest – close to average
- **Extreme monthly variability**
- 9th coldest April on record (1895-present)
- Warmest May (1895-present)
- Stayed wet and cool across northern Ohio through about mid-May

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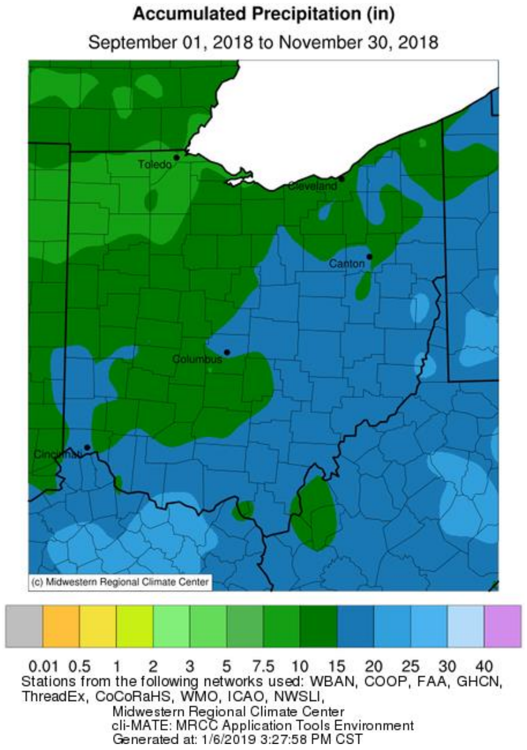
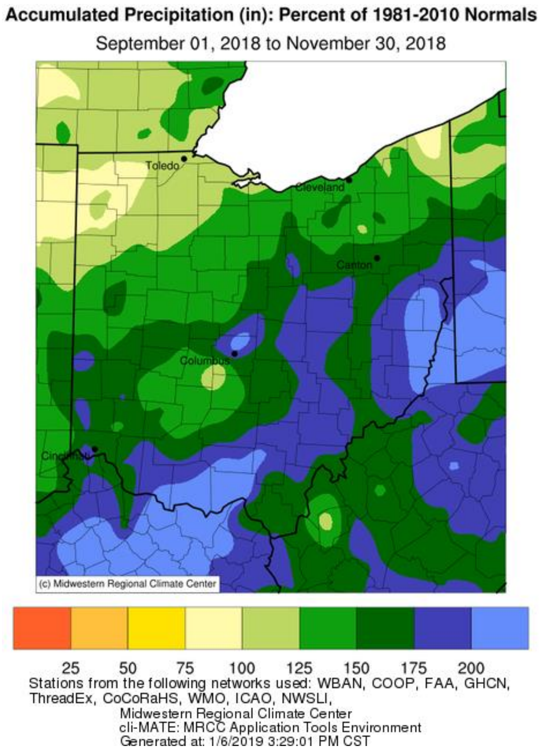
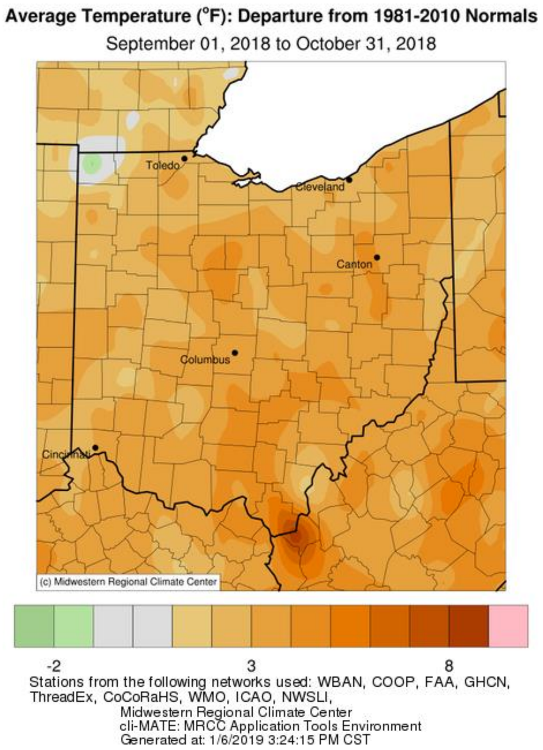
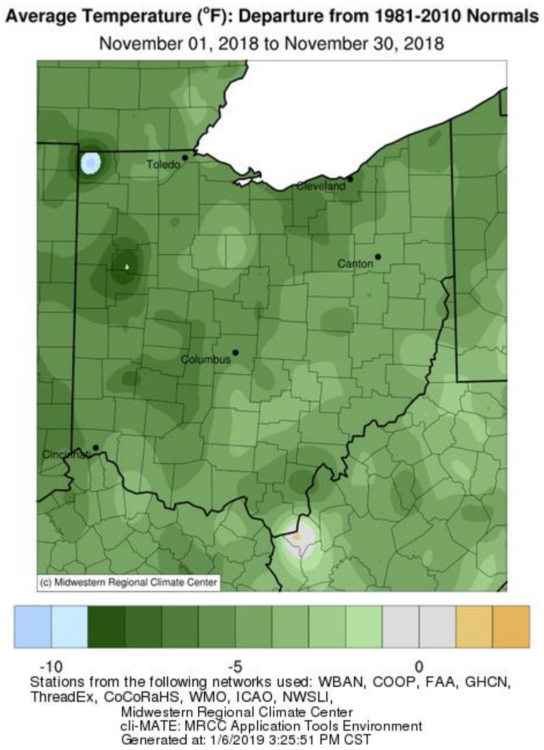
A Crazy Fall in Ohio



Fall 2018: Extreme Variability







- 3rd wettest on record since 1895.
- Sep. 2018 ranks as 2nd wettest.
- Driven largely by tropical activity

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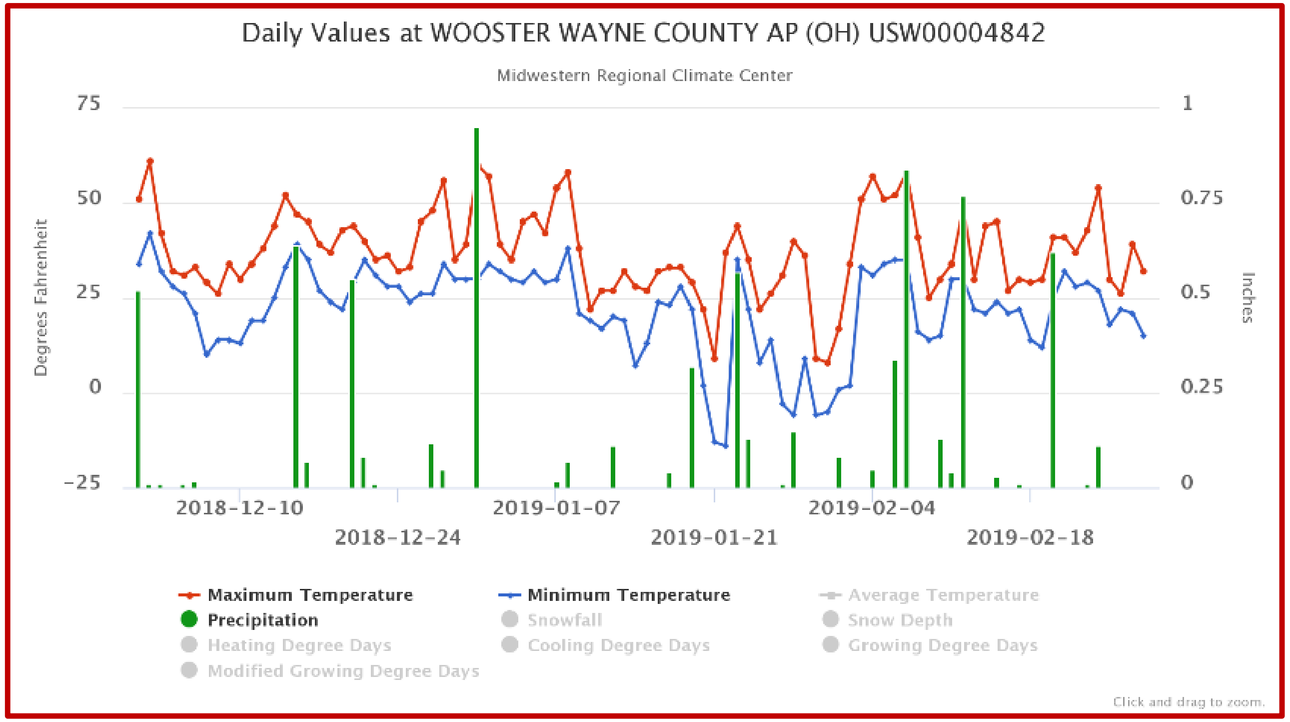
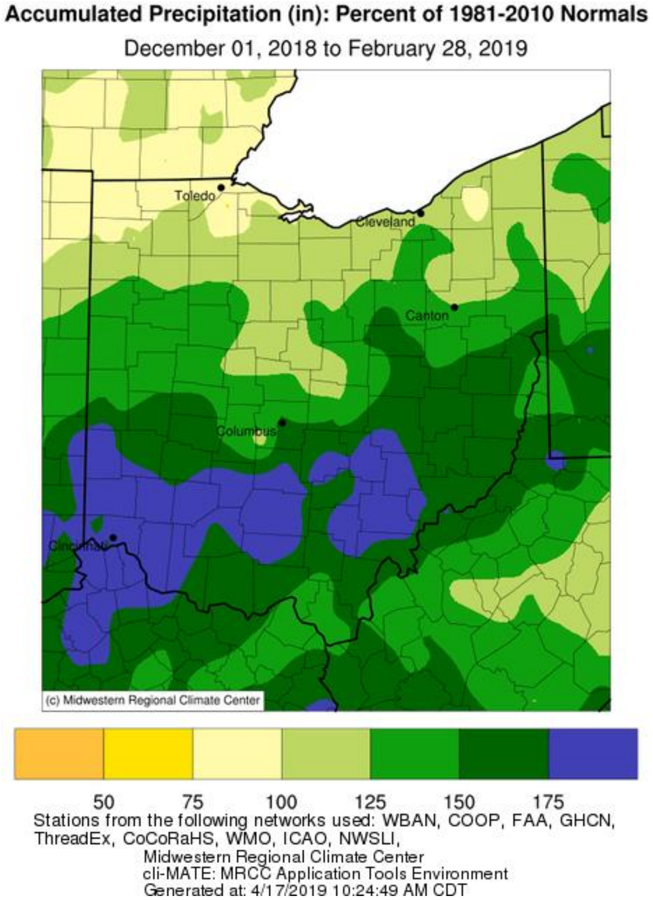
No Relief During Winter





- Winter 2019 ranks as the 11th wettest on record for Ohio, with precipitation 150-200% above average along and south of about I-70.

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- A short period of intense cold occurred during January, with frequent freeze-thaw cycles led to extreme heaving.

Spring: Rinse & Repeat

- March-May 2019 rank as the 36^{th} warmest and 32^{nd} wettest for the state
- West-central and northwest Ohio ranked 7^{th} and 3^{rd} wettest on record, respectively.
- St. Marys, Ohio (Auglaize County), CoCoRaHS observer reported over 20 inches of precipitation between March 1 and May 31 - ***that's over half of their normal yearly rainfall in just three months.***
- Multiple observers in excess of 15 inches
- Reports of 20-26 days of at least a trace of precipitation during the month of May
- Only 7 days suitable for fieldwork during May

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Consequences of All That Water

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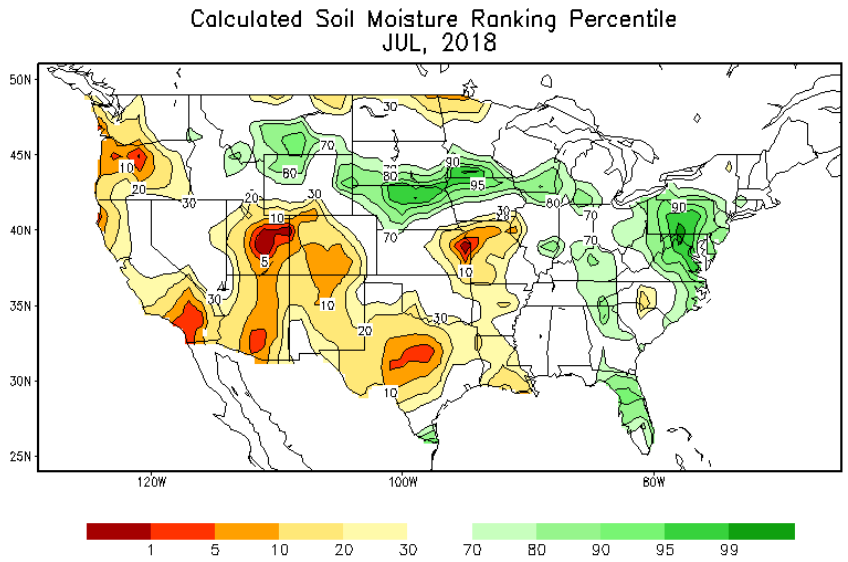
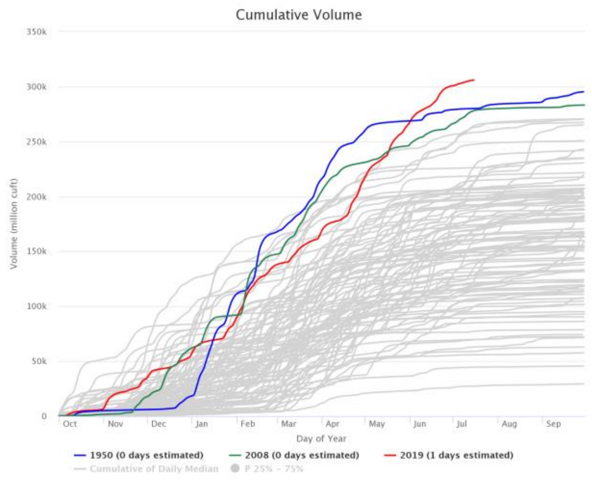


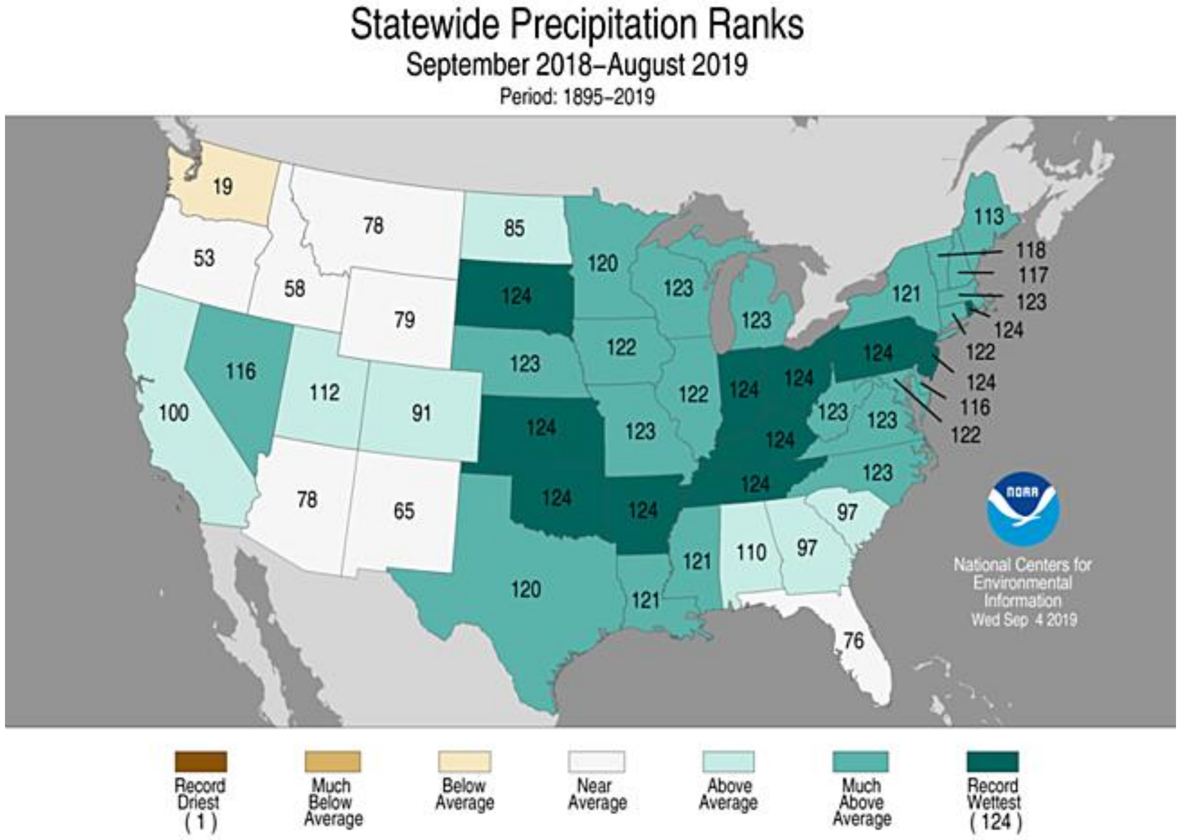
https://www.cpc.ncep.noaa.gov/products/Soilmst_Monitoring/US/Soilmst/Soilmst.shtml

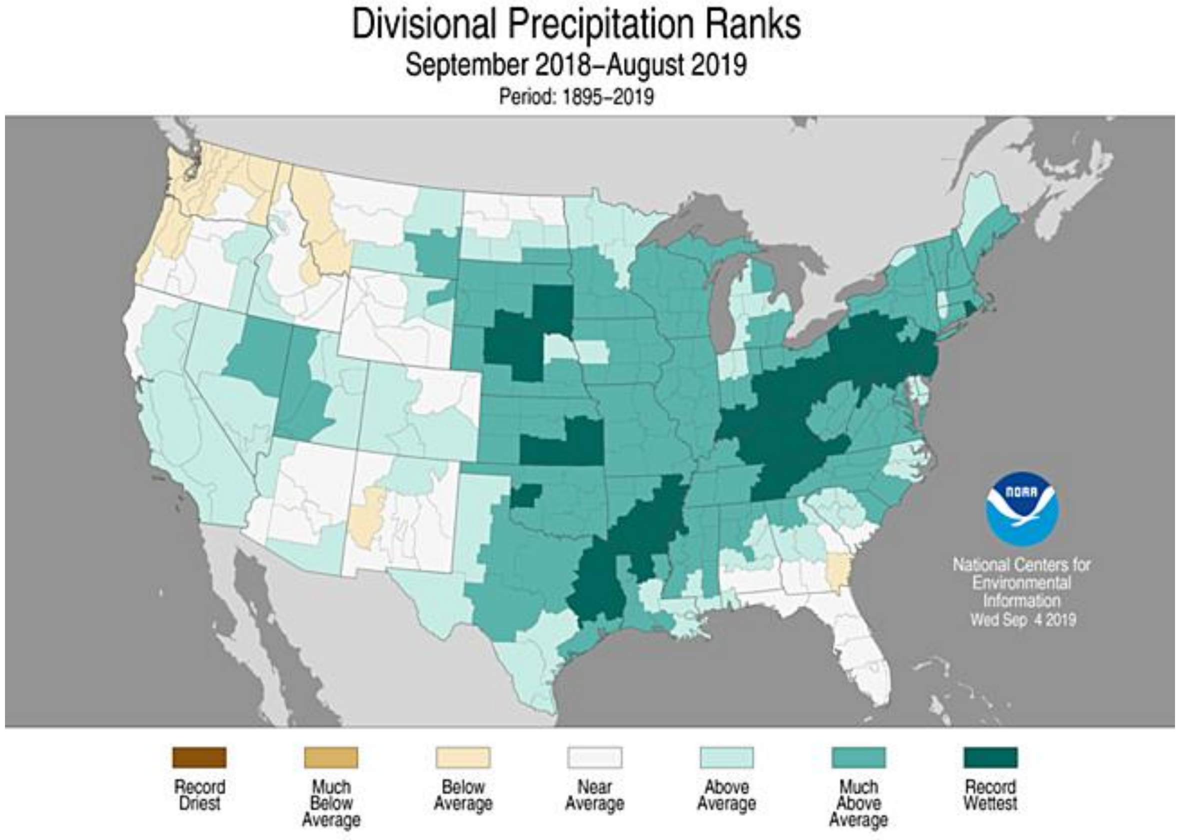


NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Maumee River at Waterville

Has it been a wet year?





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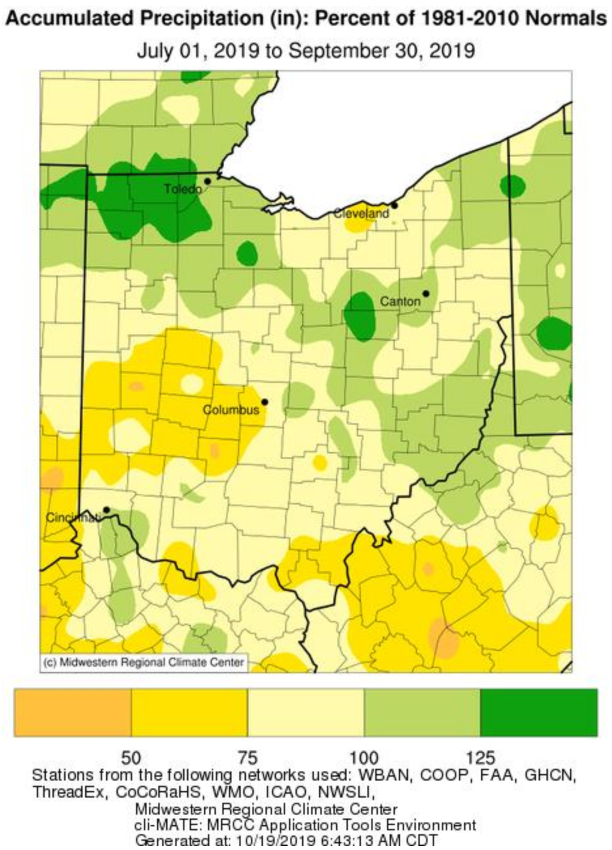
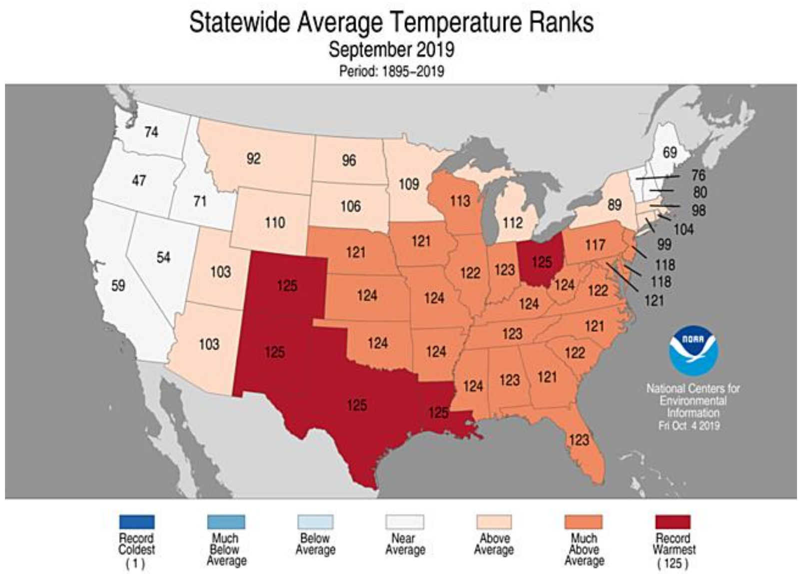
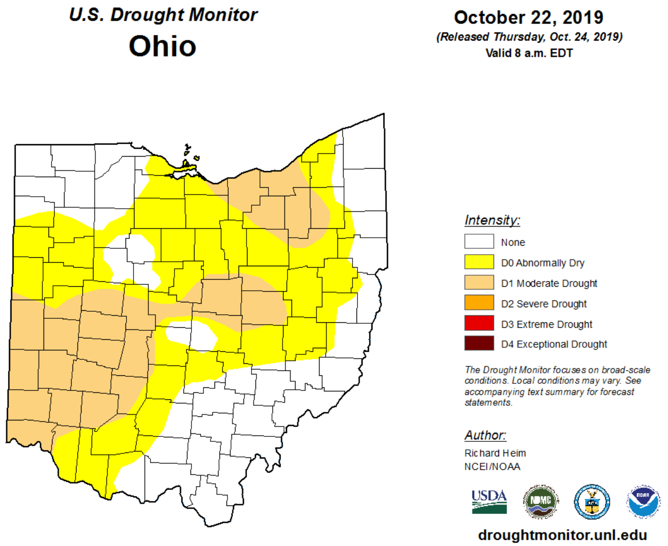


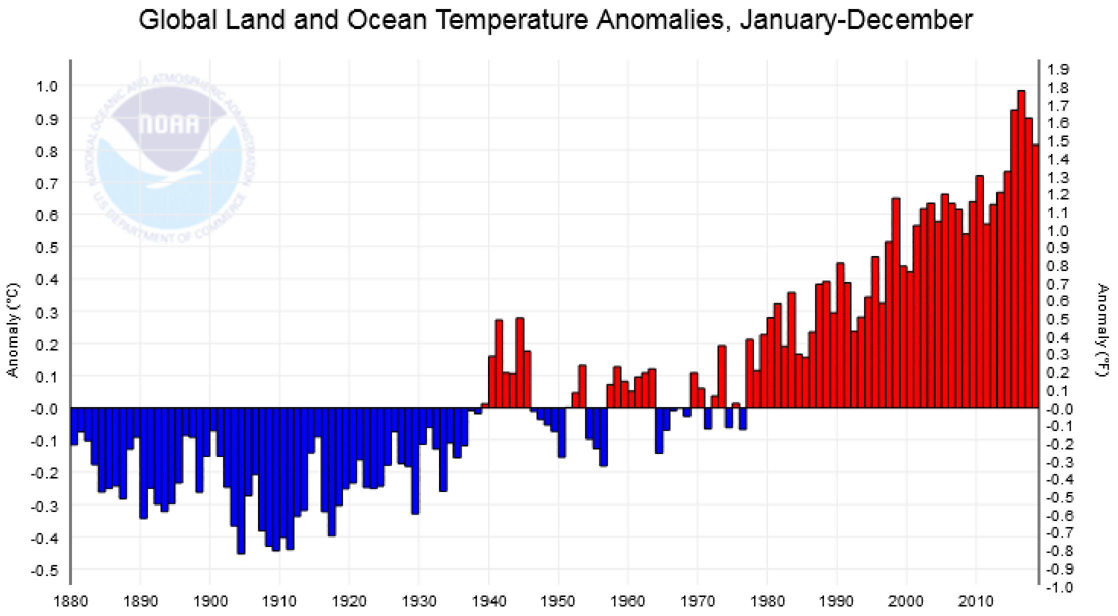




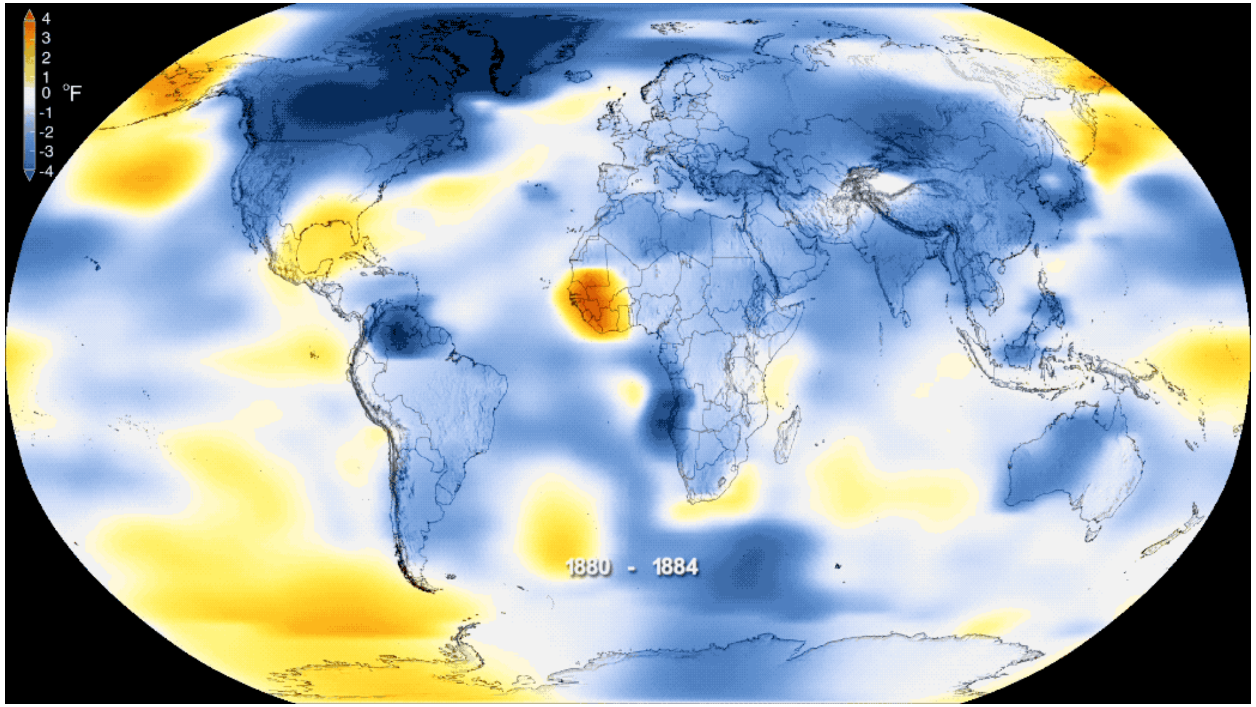
A Rapid Summer Transition

Photo courtesy of Amanda Douridas

Global Temperatures Have Warmed



- 2018 Ranks as the 4th Warmest since 1880
- 9 out of the top 10 warmest years have occurred since 2005



January – September 2019

35th warmest U.S.; Tied for 2nd warmest for the globe; 15th warmest for Ohio

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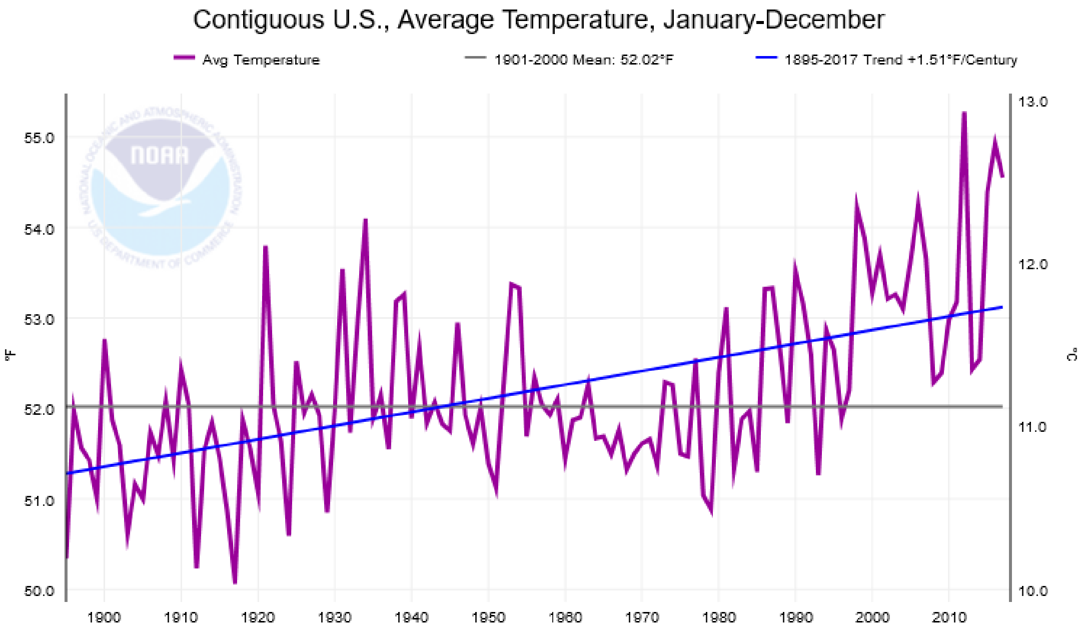
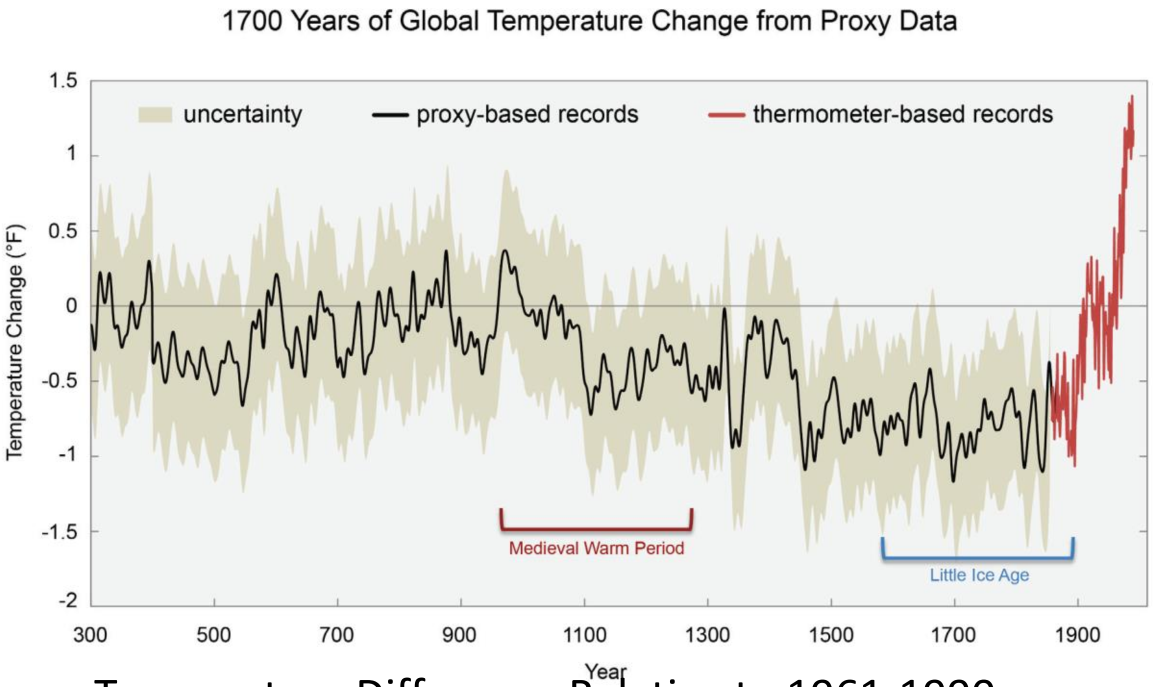
Dog and Walker: US and Global Temperatures



NCA 3: Walsh and Wuebbles 2014



Temperature Difference Relative to 1961-1990 average.

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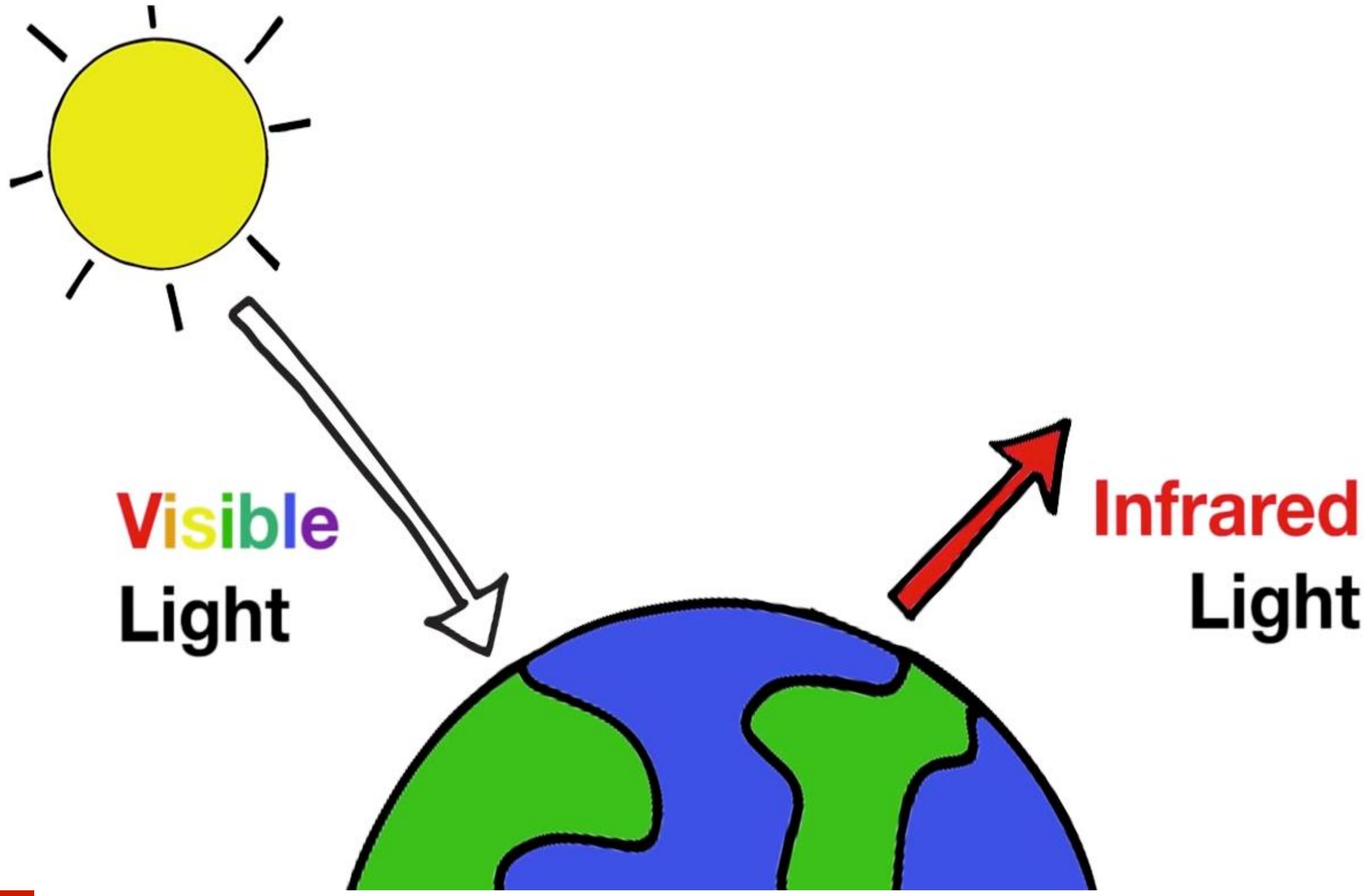
How the Atmosphere Warms



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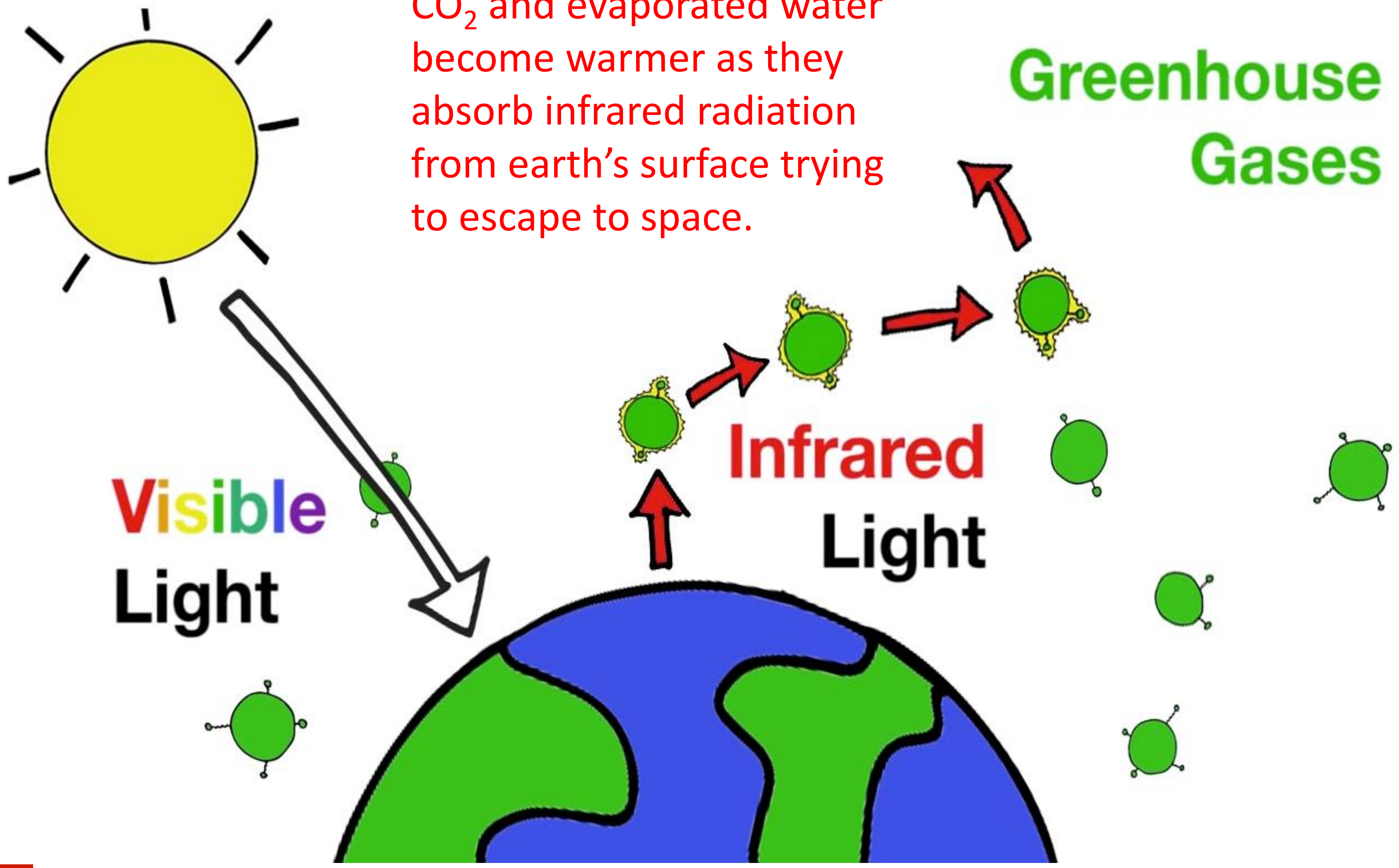
HowGlobalWarmingWorks.org, 2014

How the Atmosphere Warms

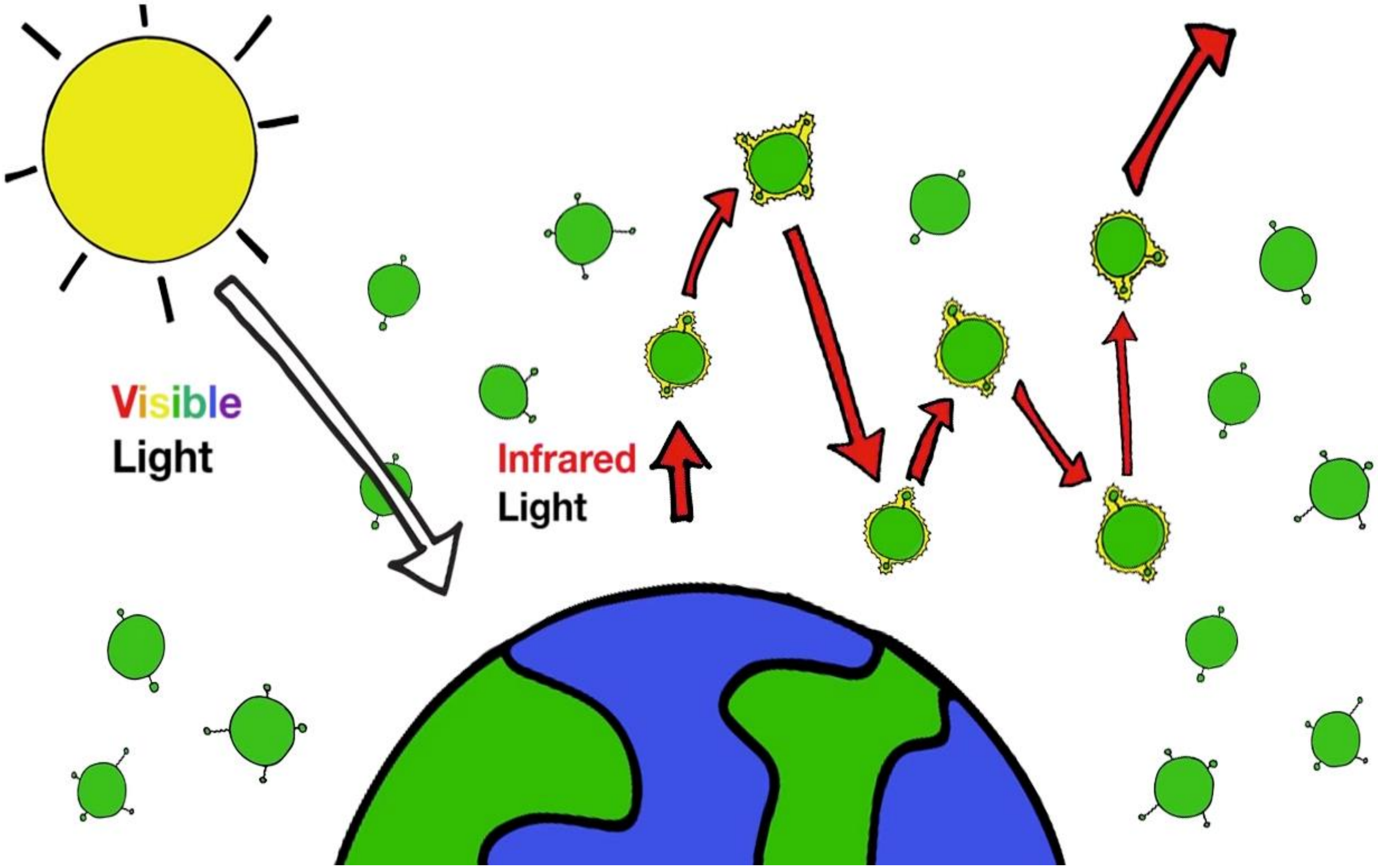
CO_2 and evaporated water become warmer as they absorb infrared radiation from earth's surface trying to escape to space.



CFAES

HowGlobalWarmingWorks.org, 2014

How the Atmosphere Warms



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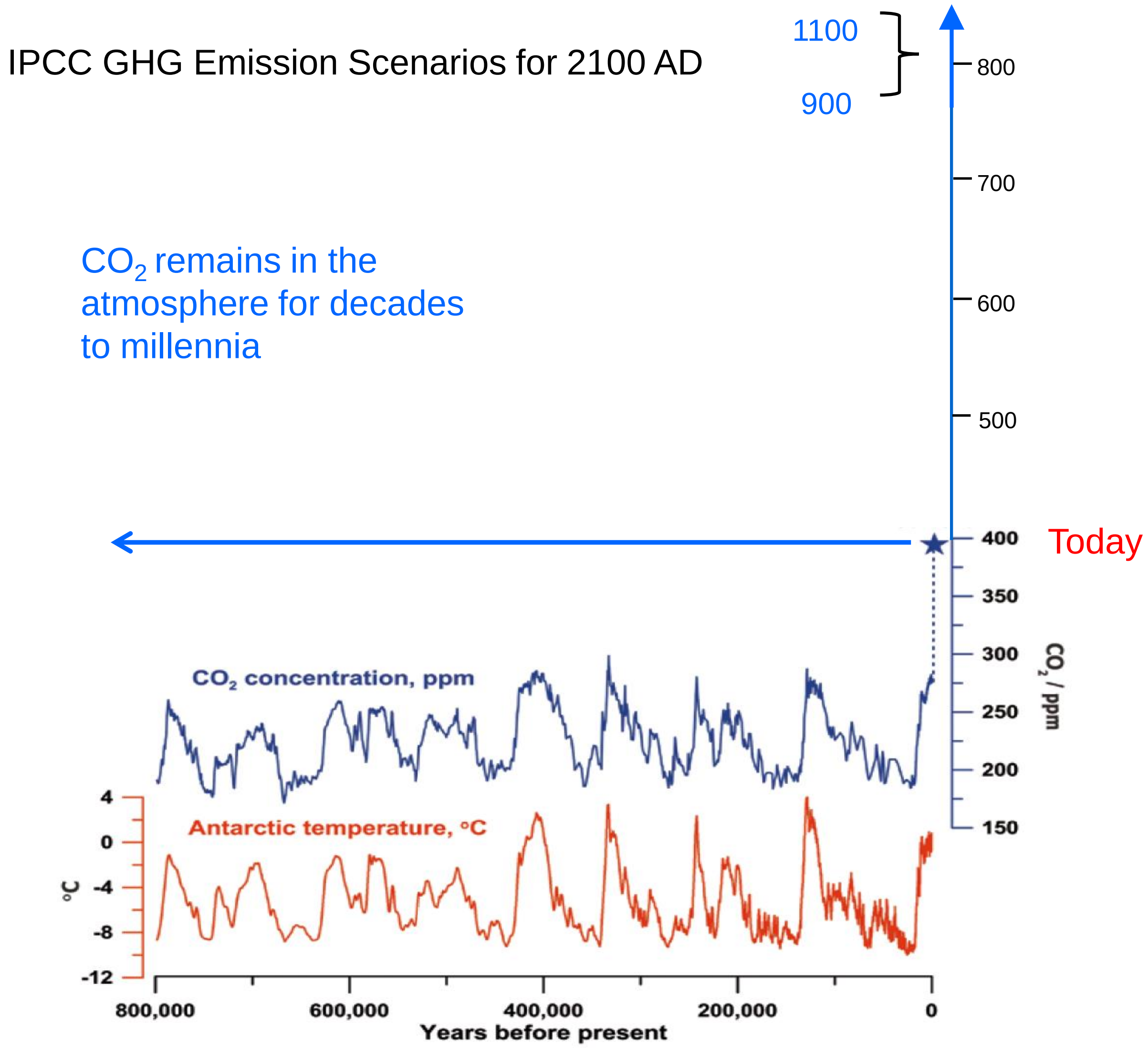
HowGlobalWarmingWorks.org, 2014

Historical Greenhouse Gas Concentrations



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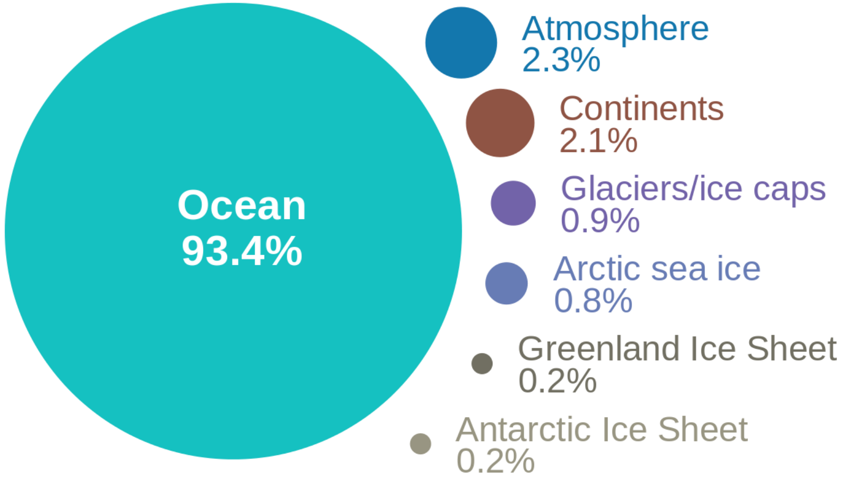
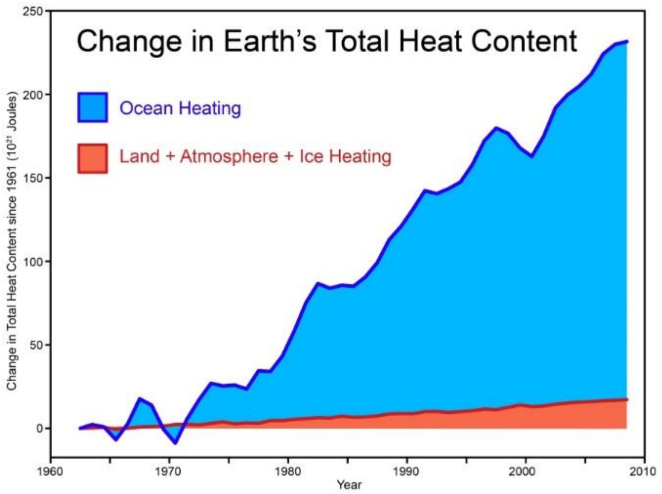
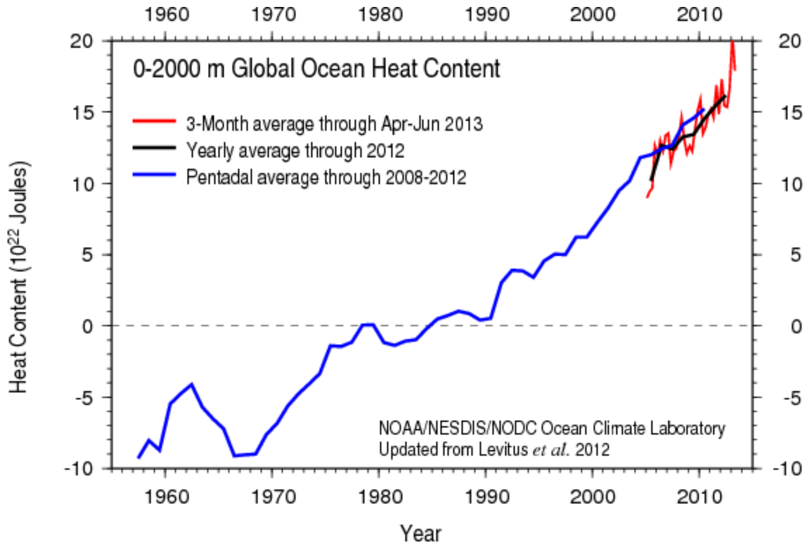
Where is the additional heat going?







In the past, El Niño, the periodic heating of the equatorial Pacific, has been very effective in transferring heat from the ocean into the atmosphere.

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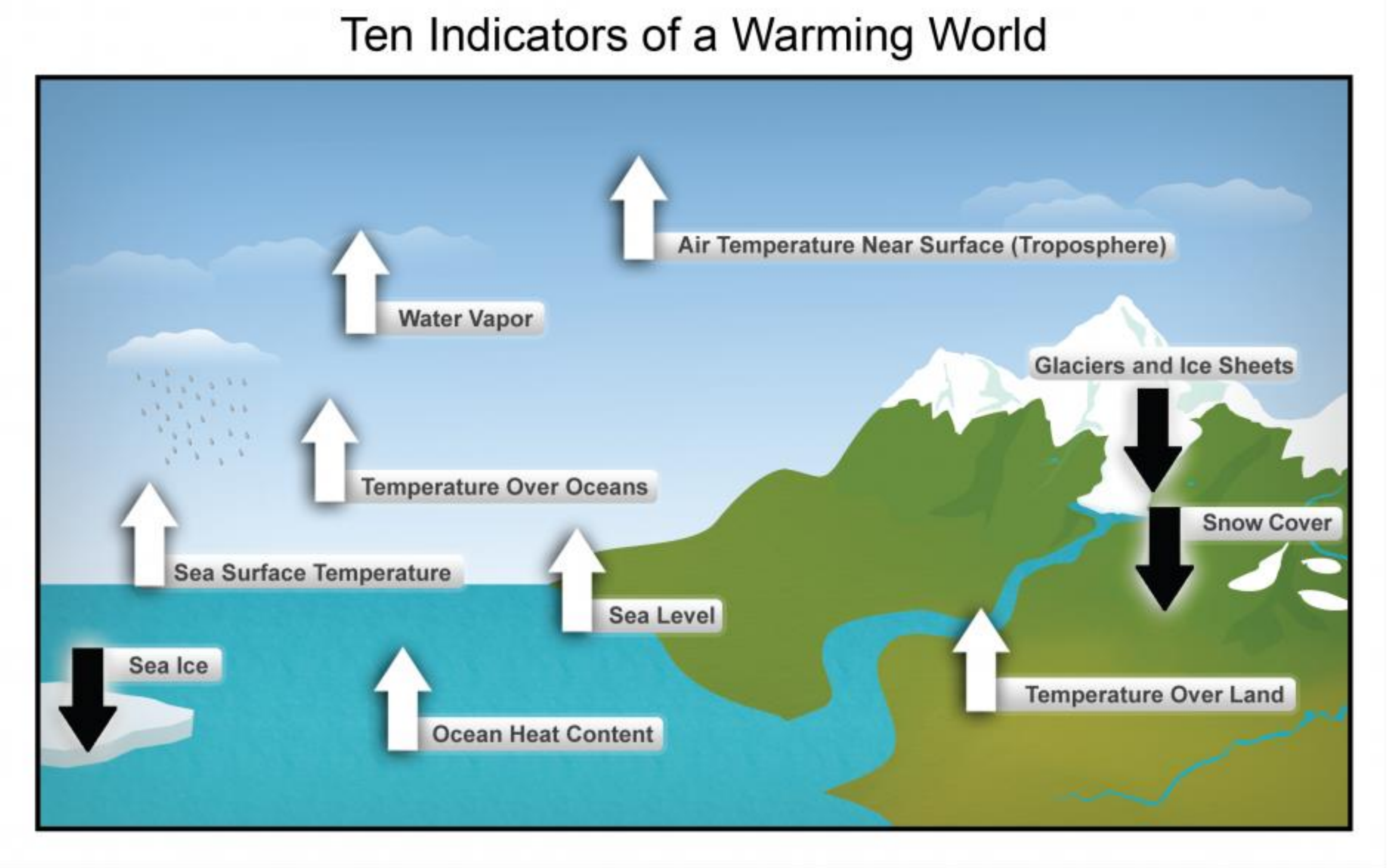
Warming Temperatures Have Feedbacks



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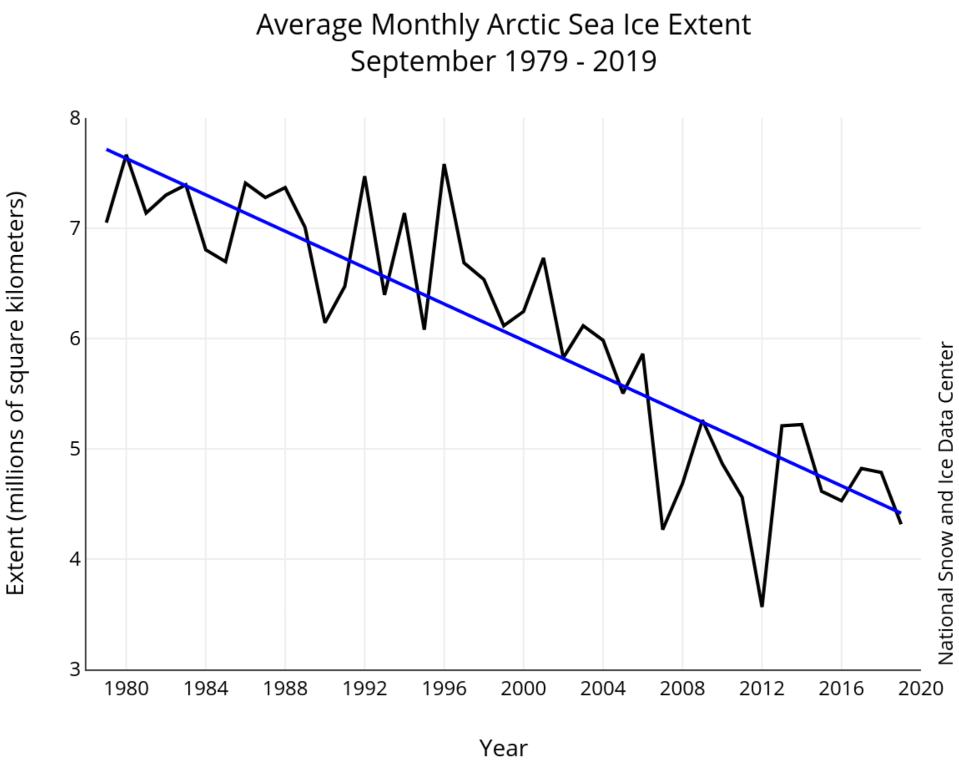
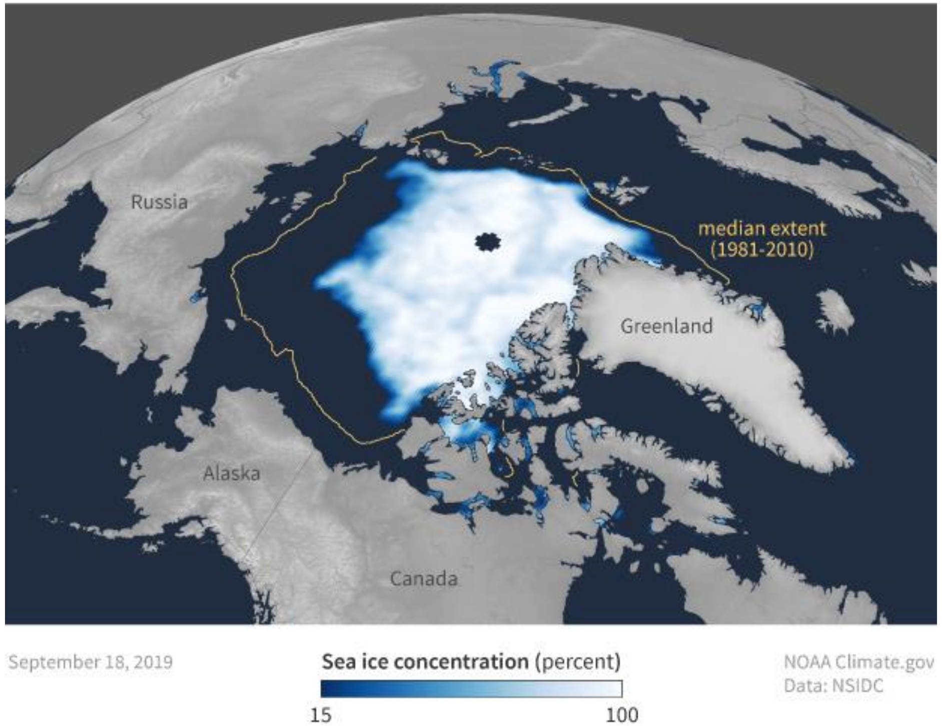
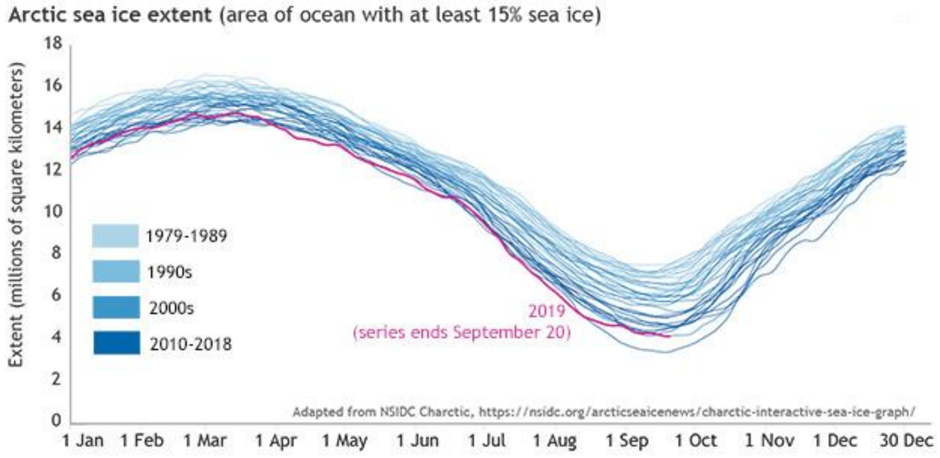
Loss of Arctic Sea Ice



2019 SUMMER MINIMUM





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Loss of Tropical Glaciers

Courtesy of
Lonnie Thompson

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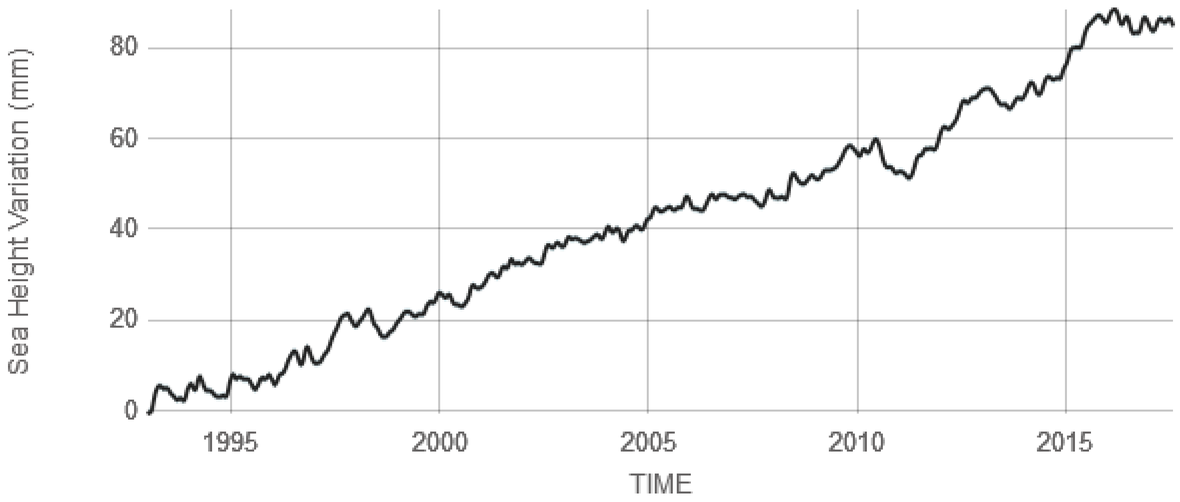
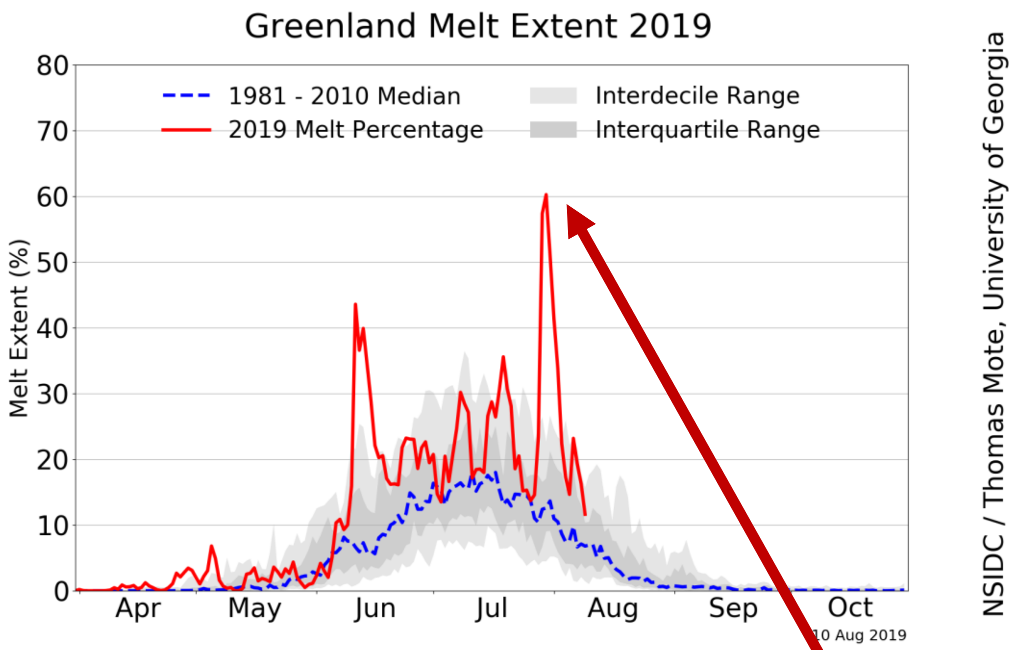
Global Evidence: Sea Level Rise

https://climate.nasa.gov/vital-signs/sea-level/



Source: climate.nasa.gov



4.4 Million Olympic-sized swimming pools!

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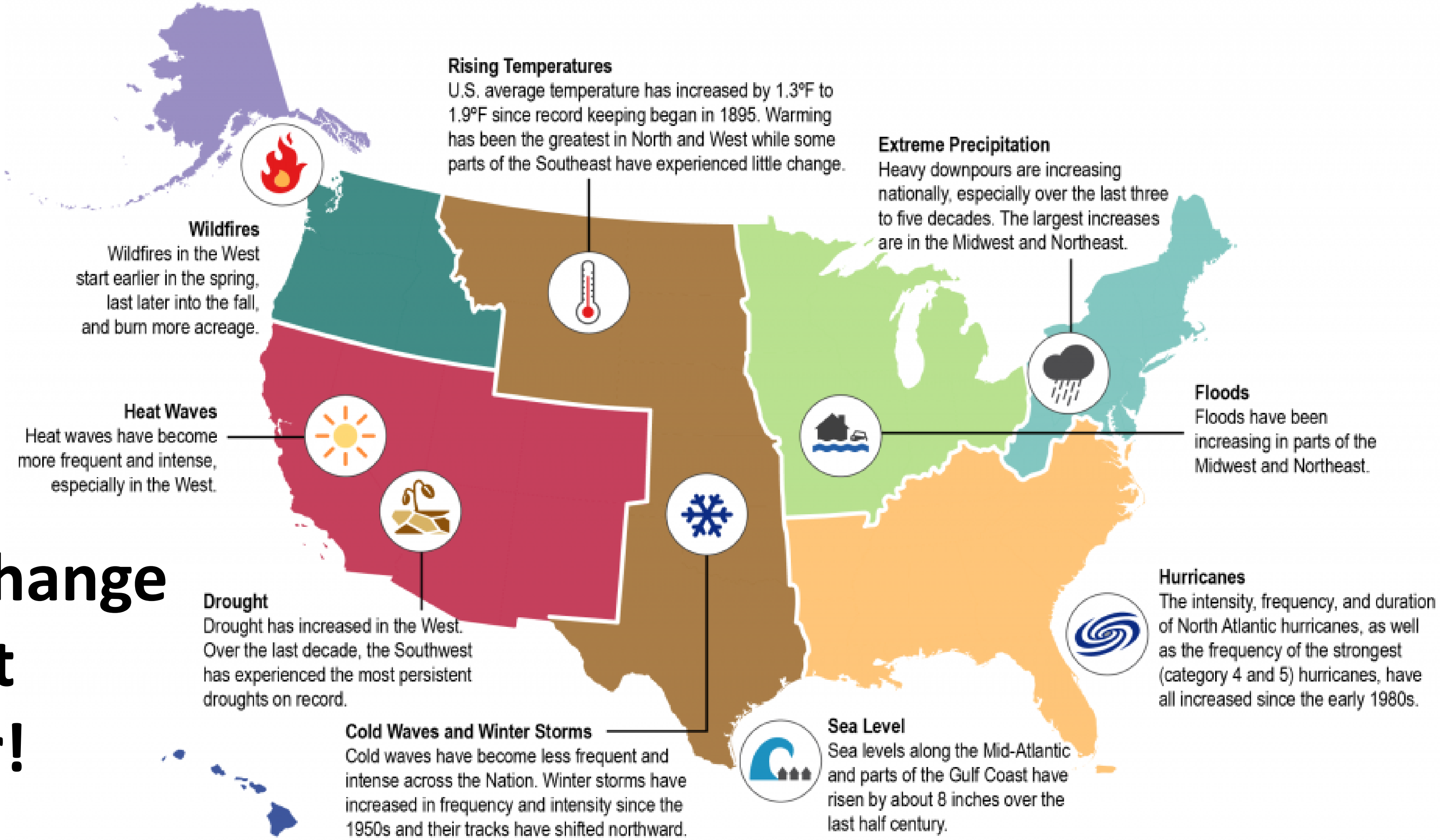
U.S. Regional Climate Trend Impacts



Climate Change is a Threat Multiplier!

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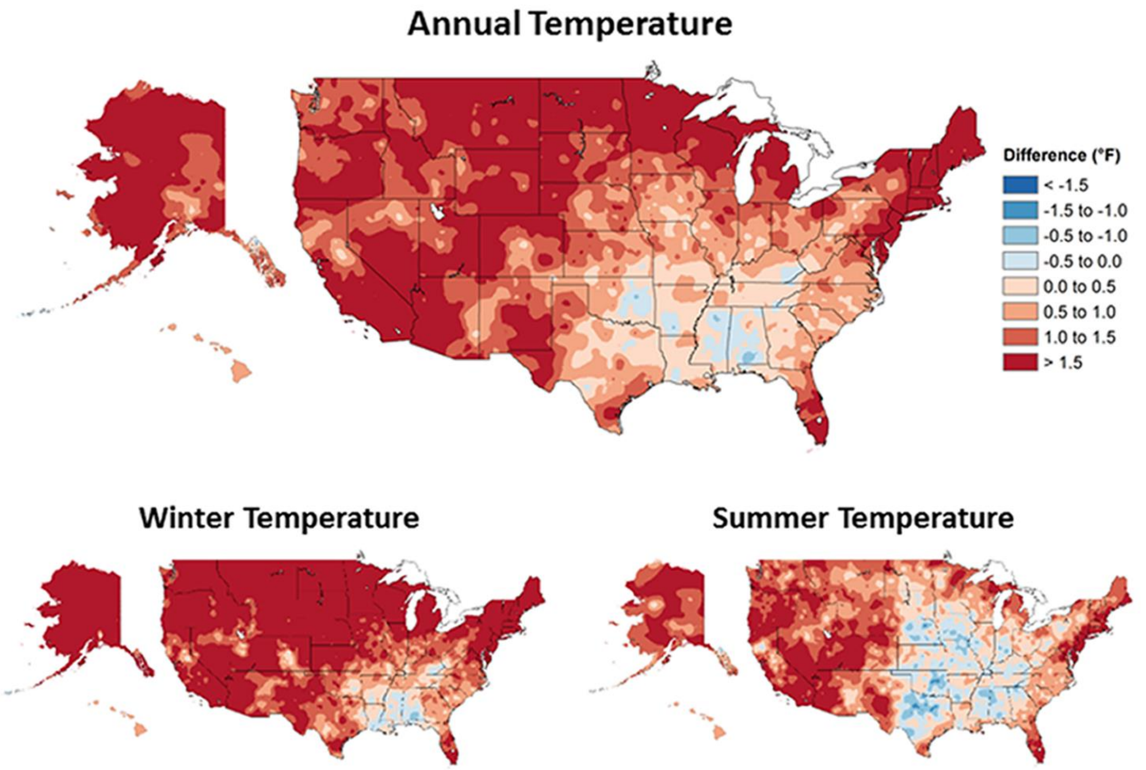
https://health2016.globalchange.gov/climate-change-and-human-health

Seasonal Differences in Warming



- More than 95% of the land surface demonstrated an increase in annual average temperature
- Paleoclimate records suggest recent period the warmest in at least the past 1,500 years
- Greatest and most widespread in winter

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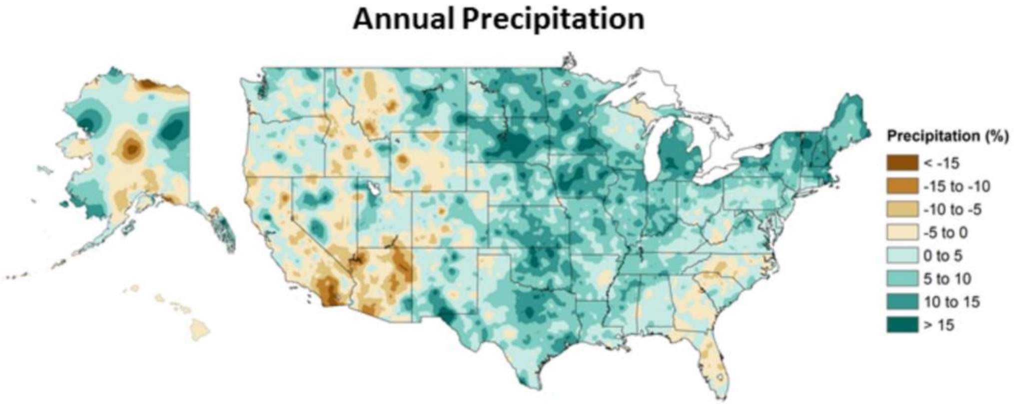
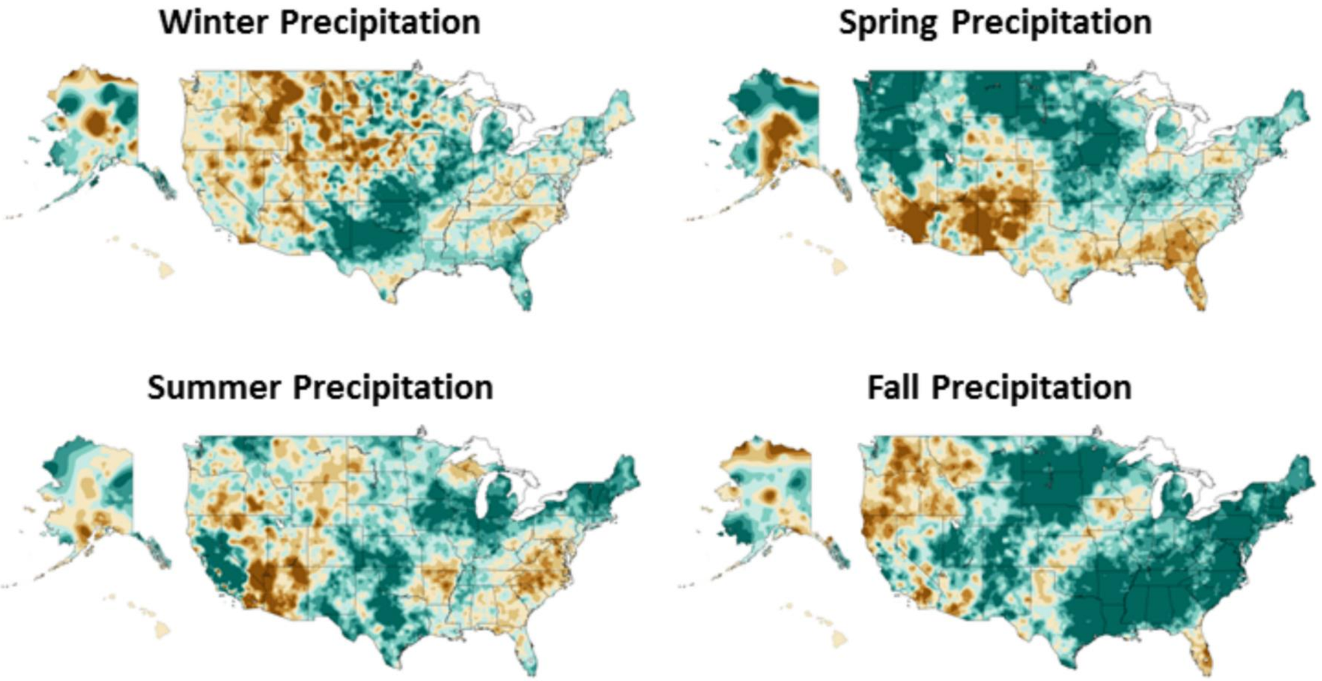
Annual average temperature over the contiguous United States has increased by 1.2°F (0.7°C) for the period 1986–2016 relative to 1901–1960 and by 1.8°F (1.0°C) based on a linear regression for the period 1895–2016: National Climate Assessment CCSR: https://science2017.globalchange.gov/

Annual and Seasonal Changes in Precipitation

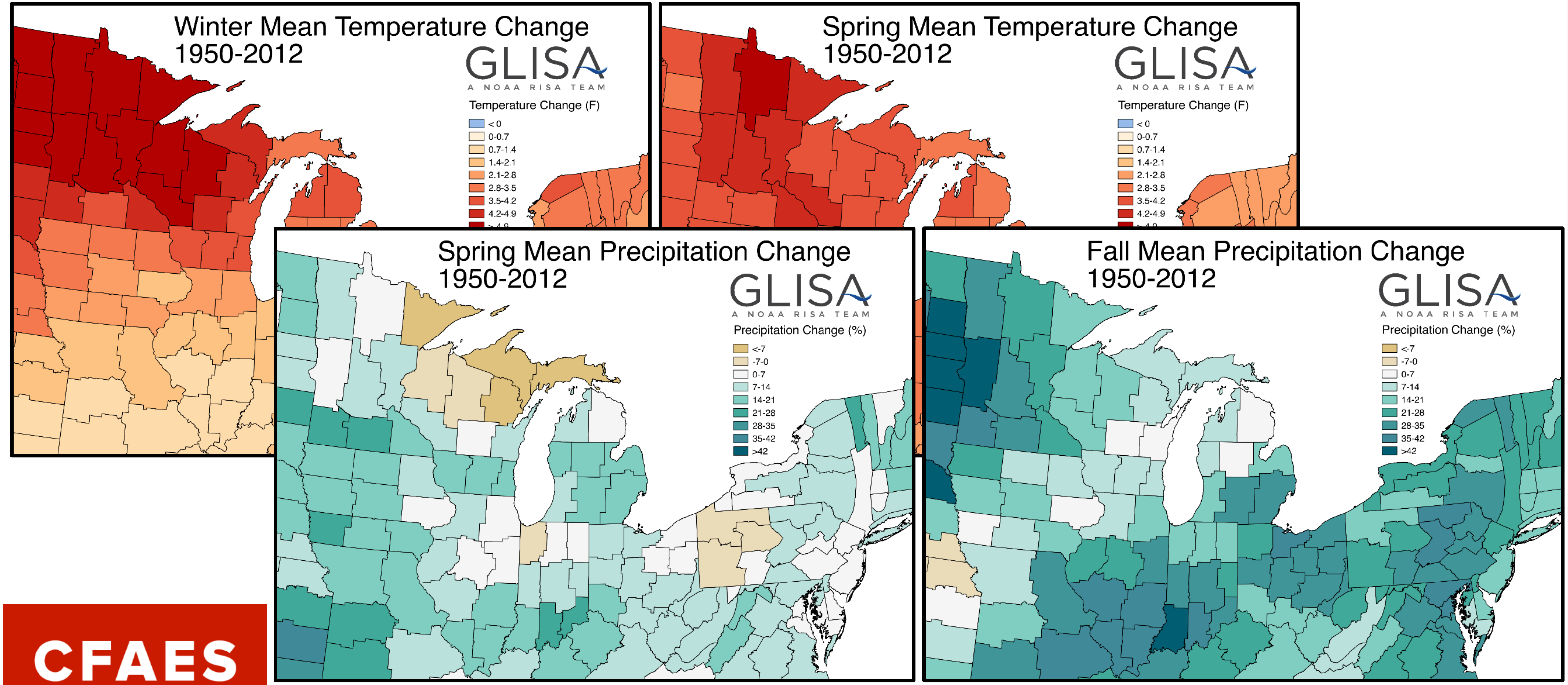




National Climate Assessment CCSR:
https://science2017.globalchange.gov/

- National average increase of 4% in annual precipitation since 1901: Ohio: 5-15%
- Driven strongly by fall trends (10-15% in some locations)
  - Regional Spring, Summer, and Fall Trends across Ohio
  - Increased Intensity of rainfall events

Seasonal Changes Across the Great Lakes



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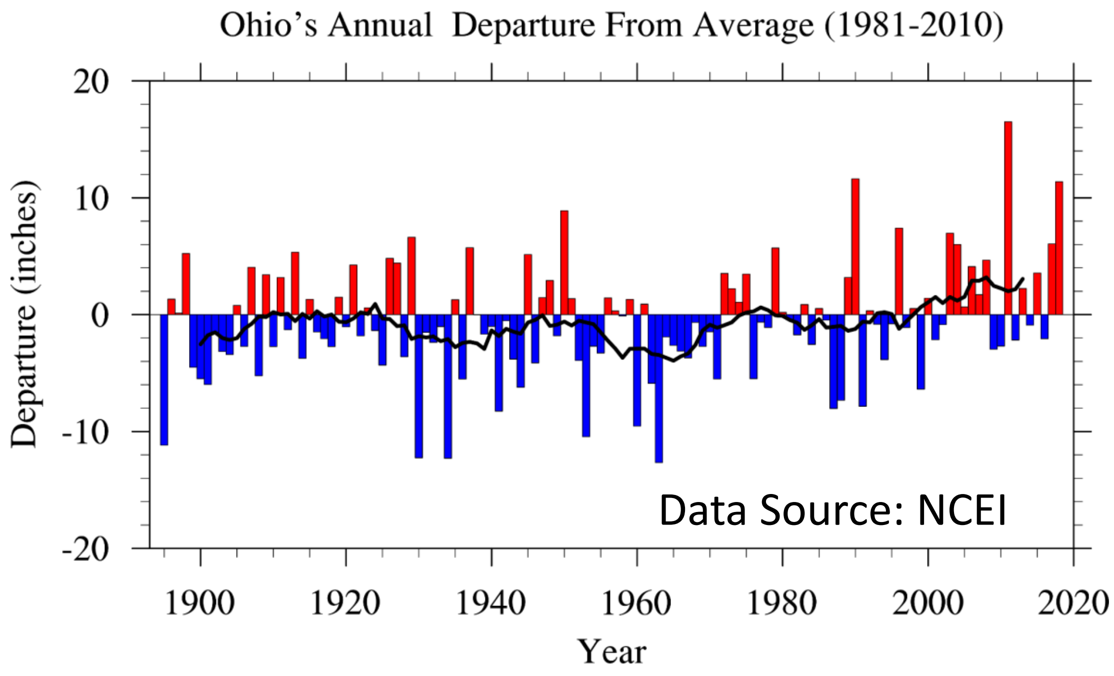
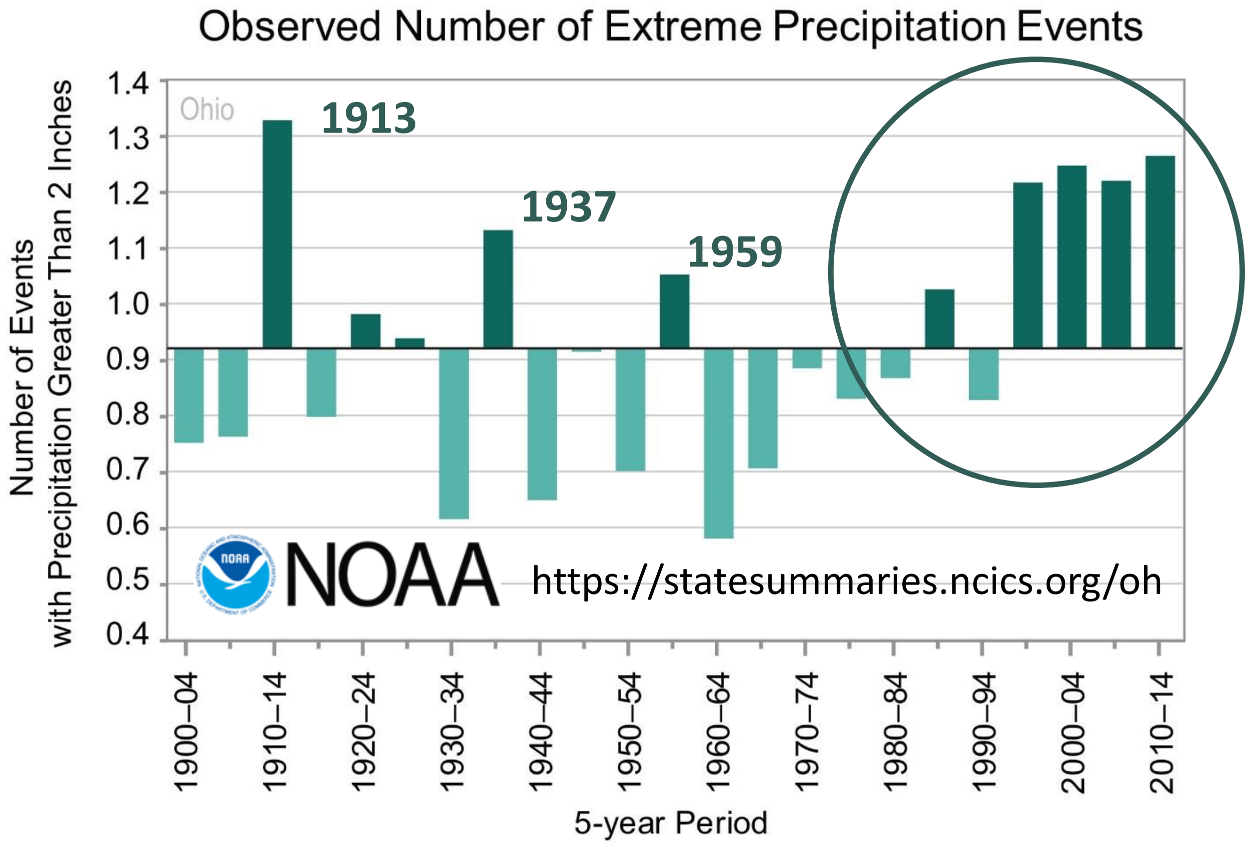
Long-term Precipitation Trends in Ohio





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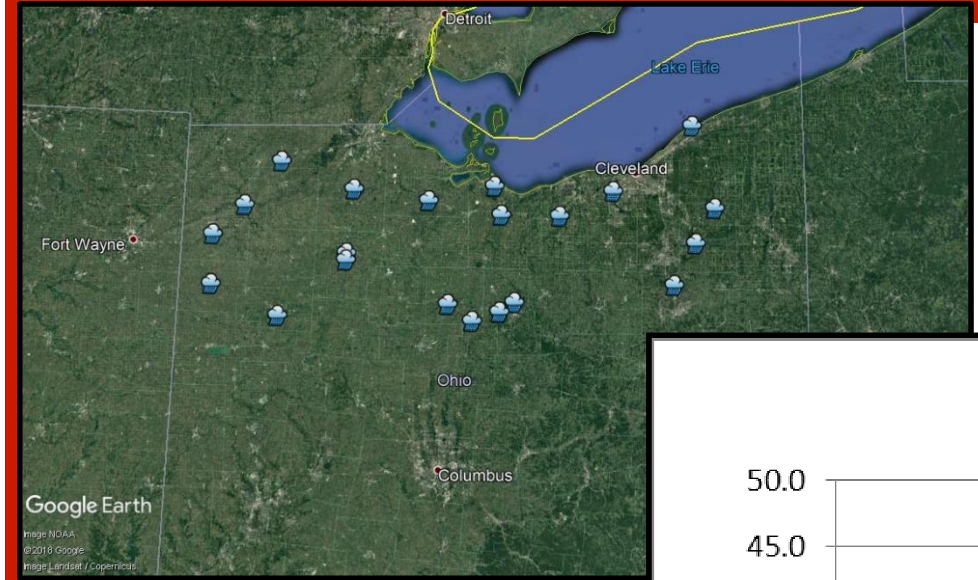
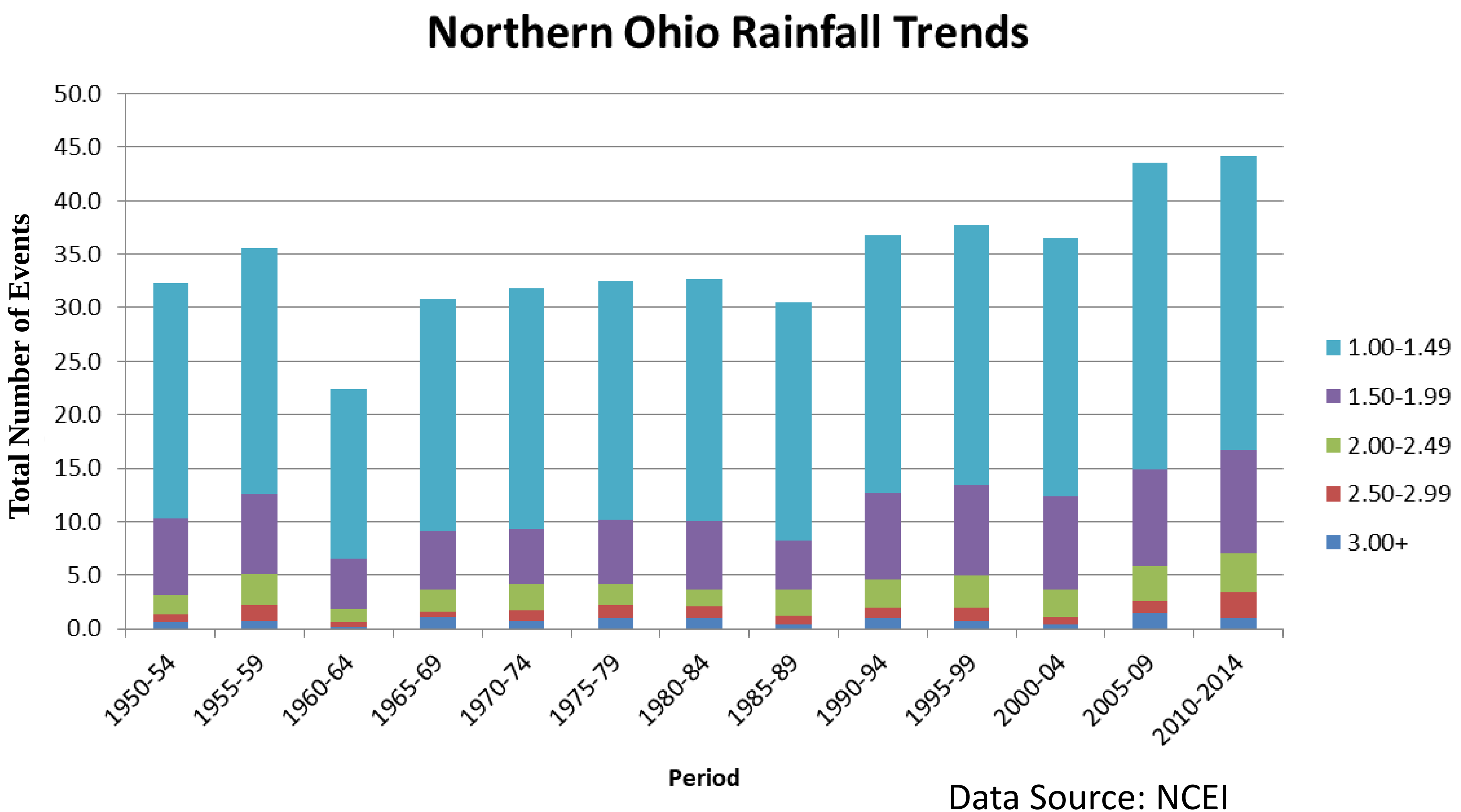
Flood Warning Services in a Wetter World **(Sarah Jamison, National Oceanic and Atmospheric Administration) Thursday November 14th, 11:15-11:45am, Ballroom 3**

Intensity of Rainfall





Data Source: NCEI

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North Edge of Arcanum: July 6, 2017
Photos Courtesy of Sam Custer/Janelle Brinksneader

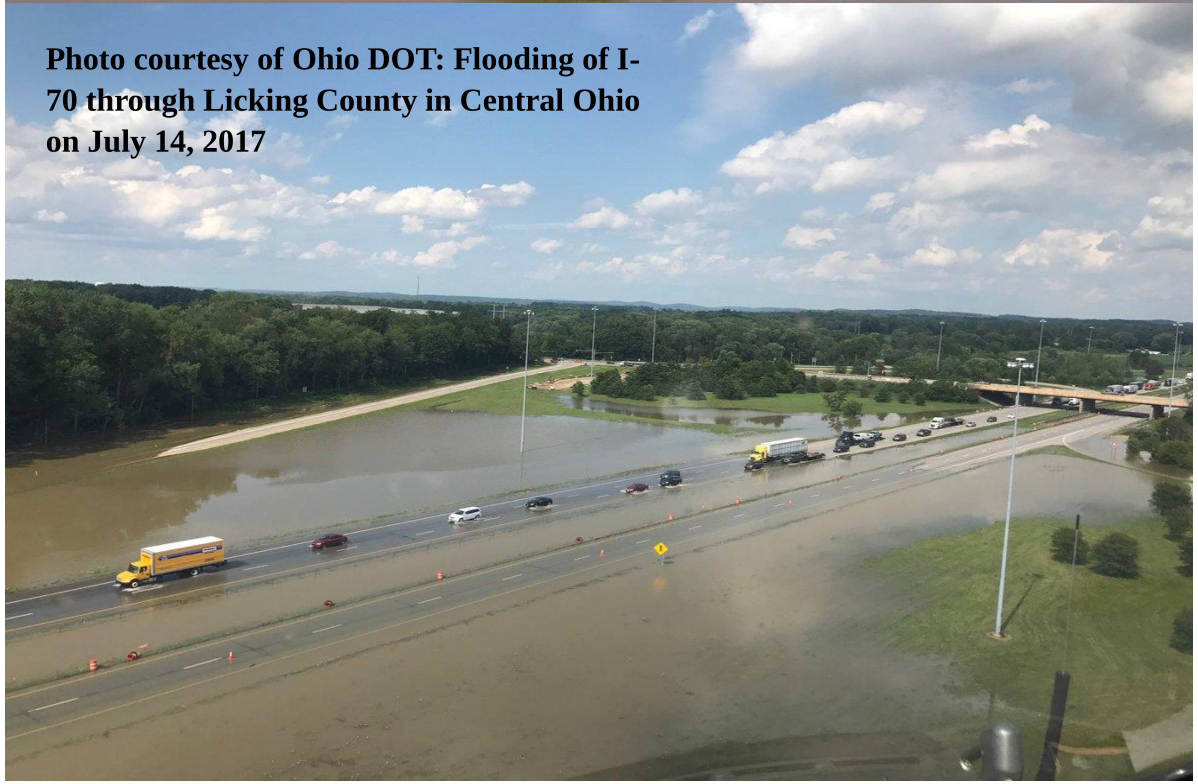
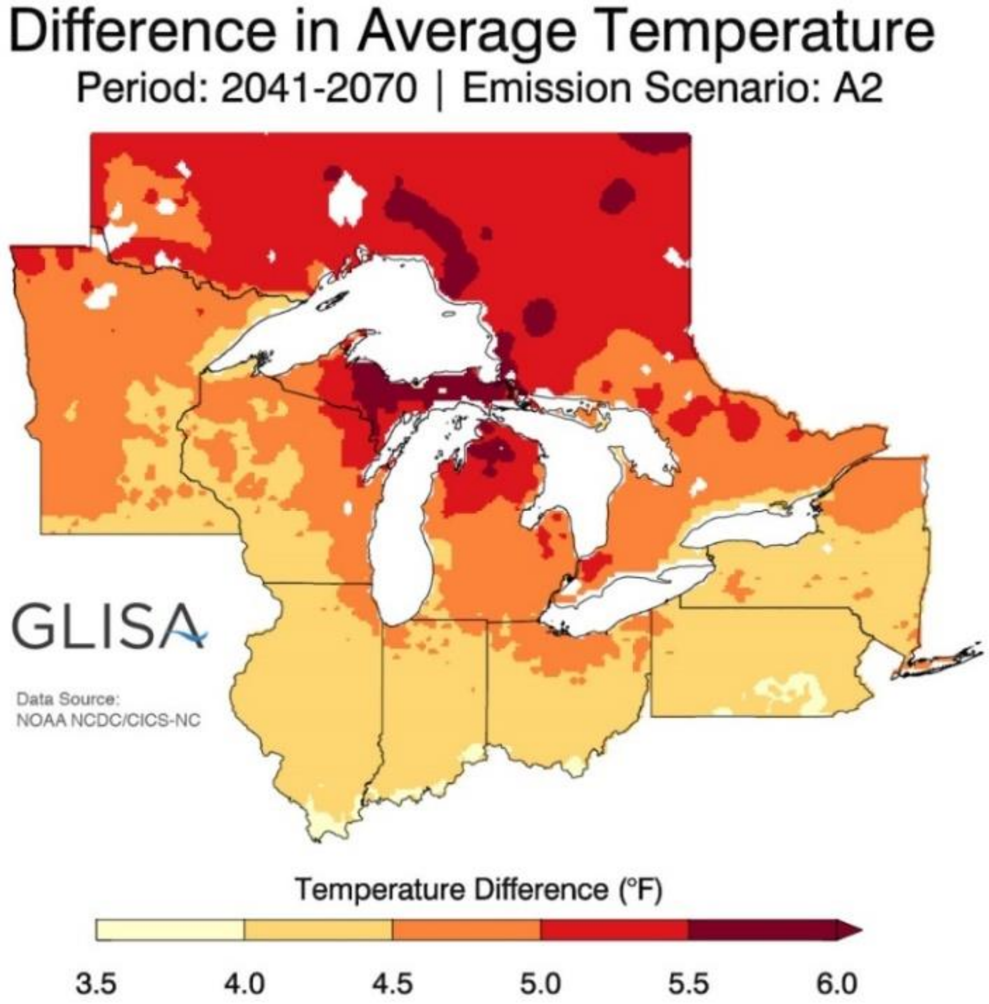
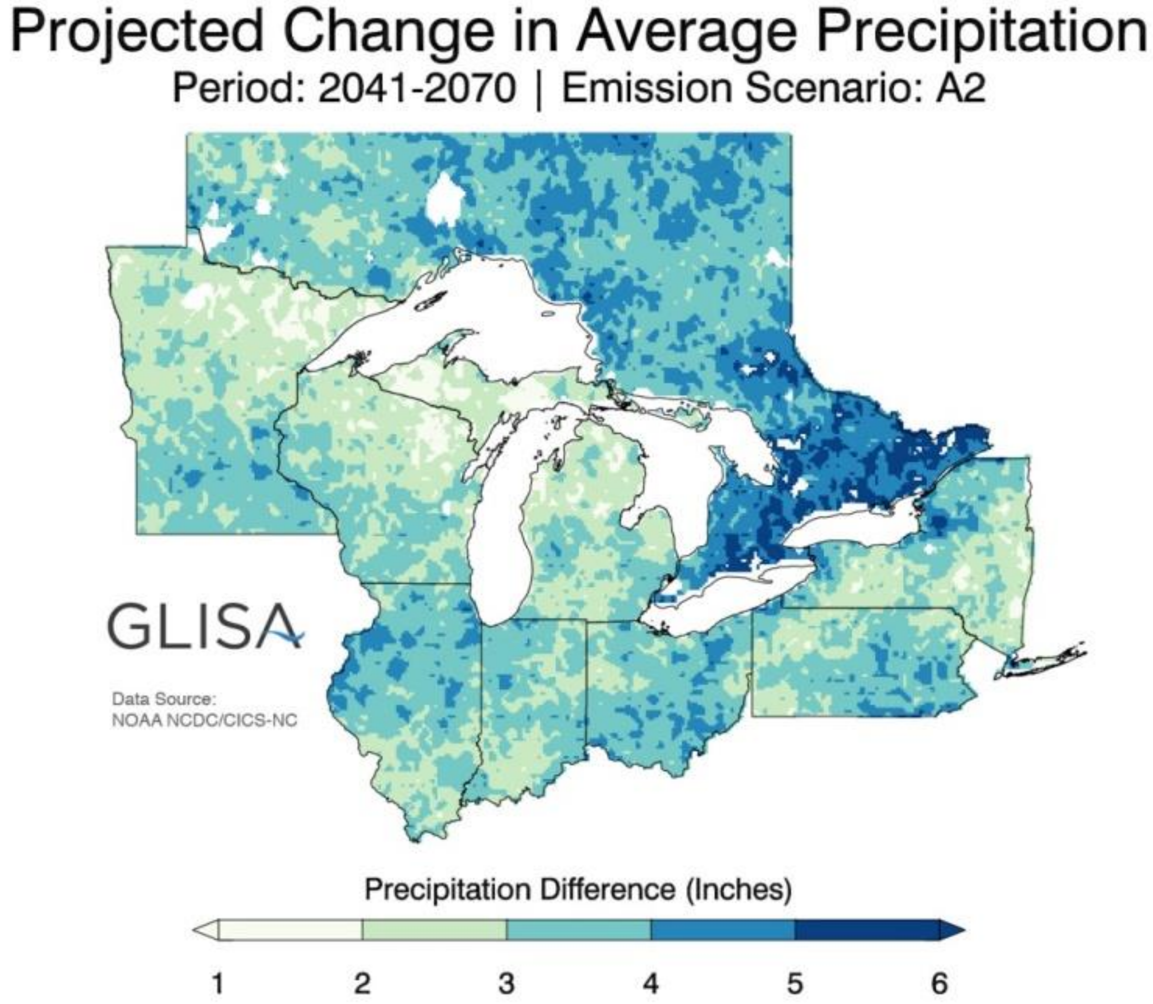


Photo courtesy of Ohio DOT: Flooding of I-70 through Licking County in Central Ohio on July 14, 2017





Future Climate

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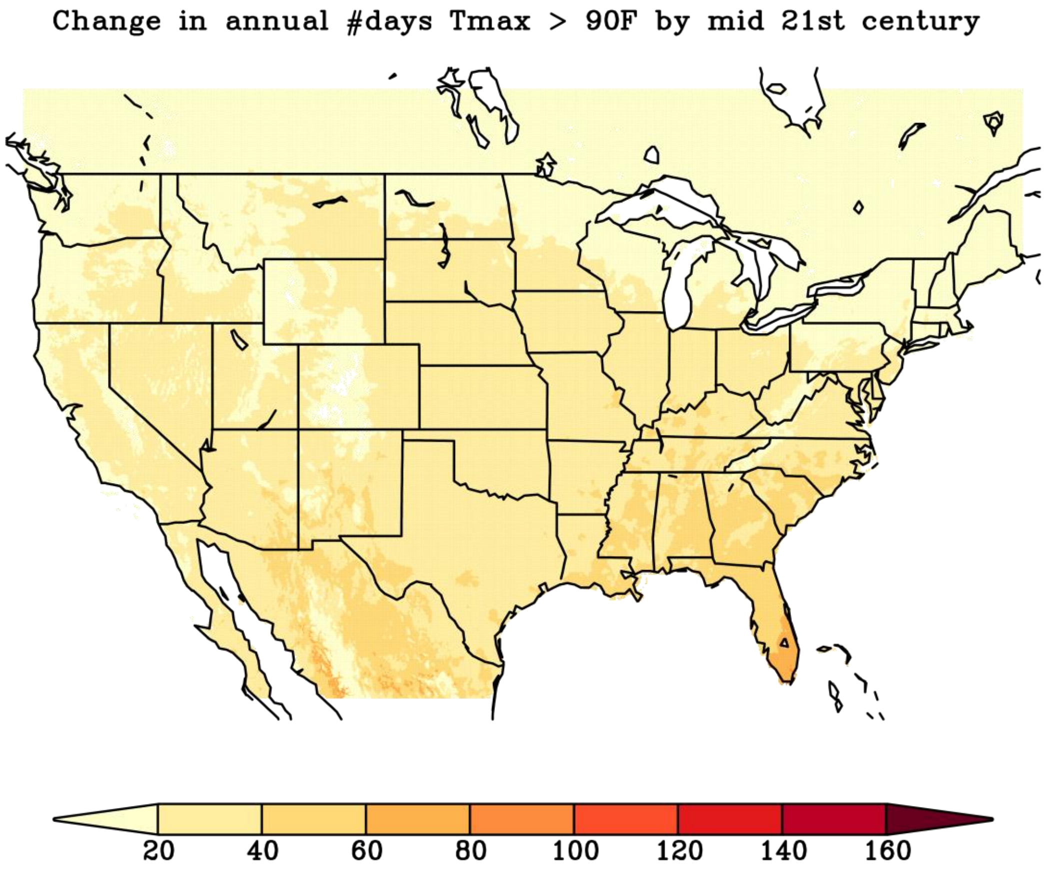
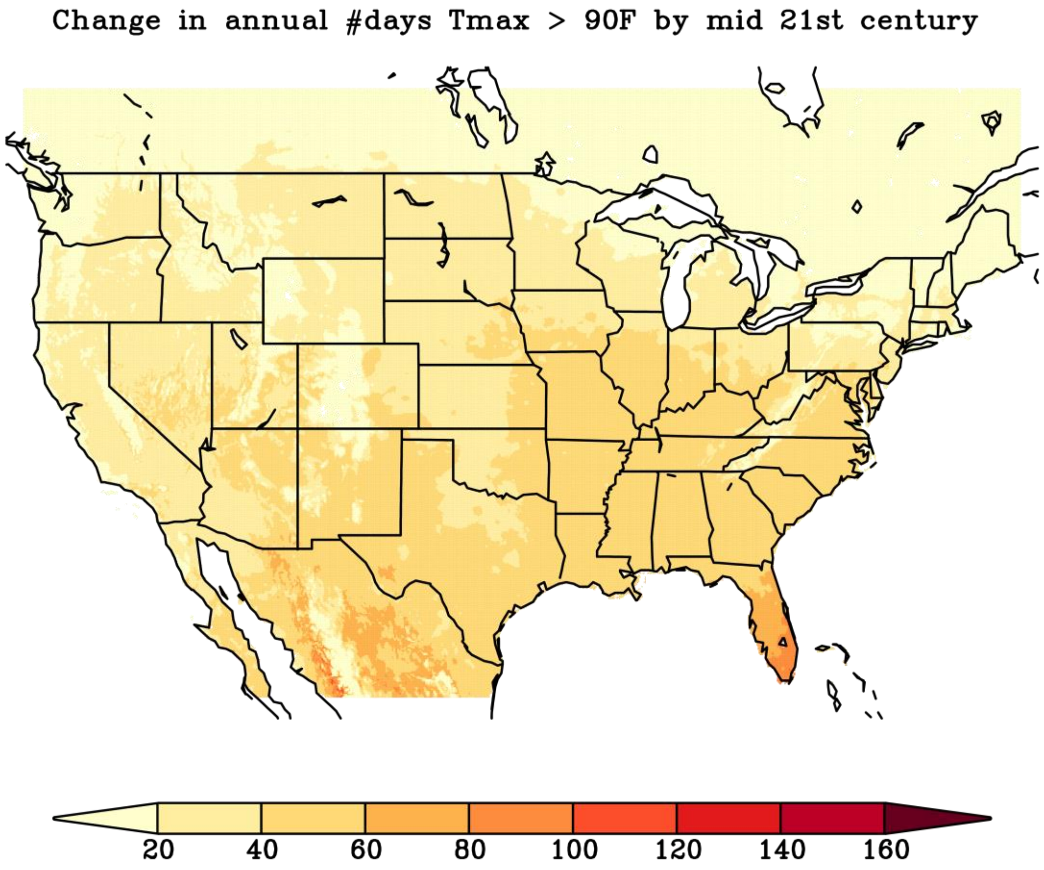
Change in Annual Number of Days > 90°F

Lower Emissions



Higher Emissions



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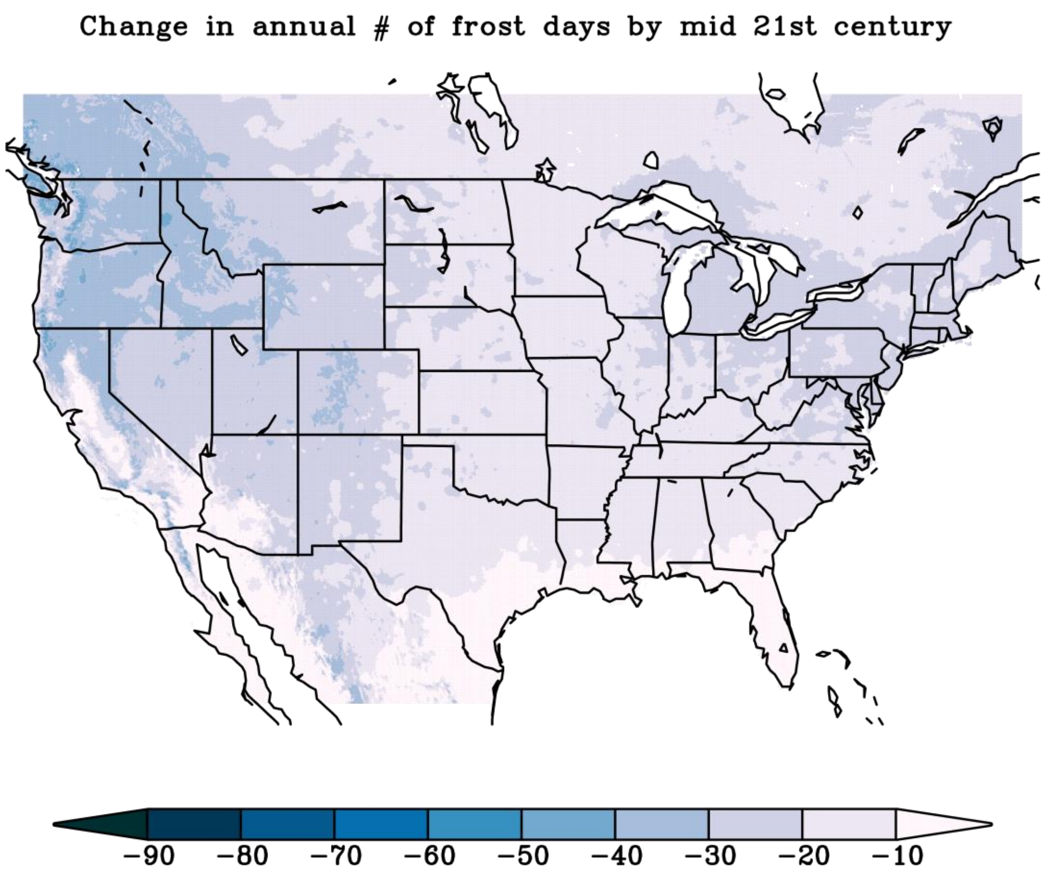
(1976-2005): 20-40 days per year

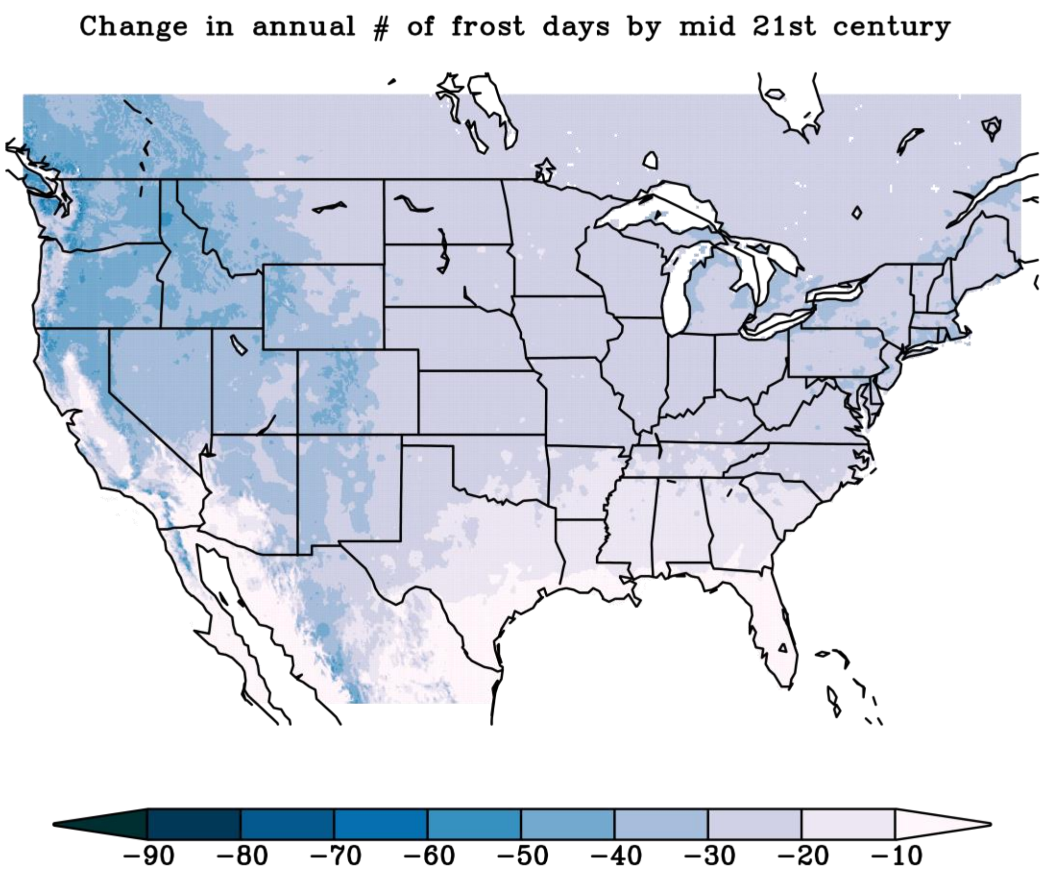
https://scenarios.globalchange.gov/loca-viewer/

Change in Annual Number of Days < 32°F

Lower Emissions



Higher Emissions



Ohio (1976-2005): 80-160 days per year

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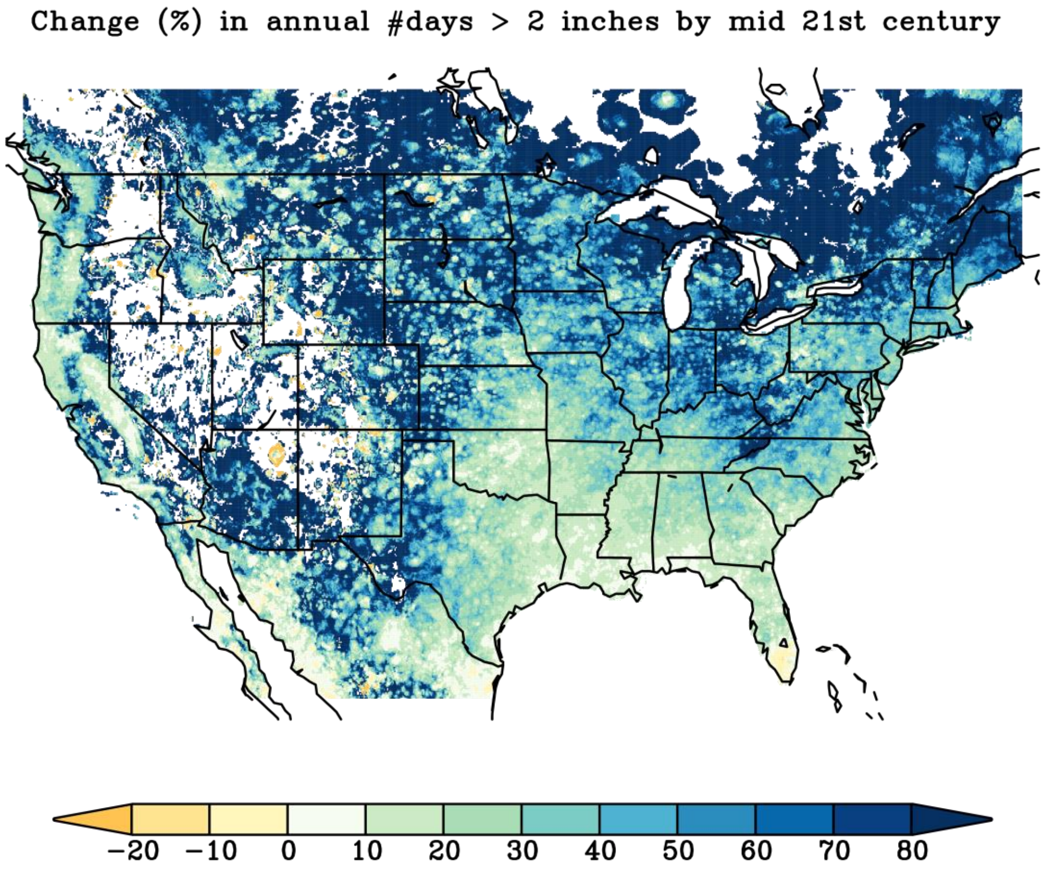
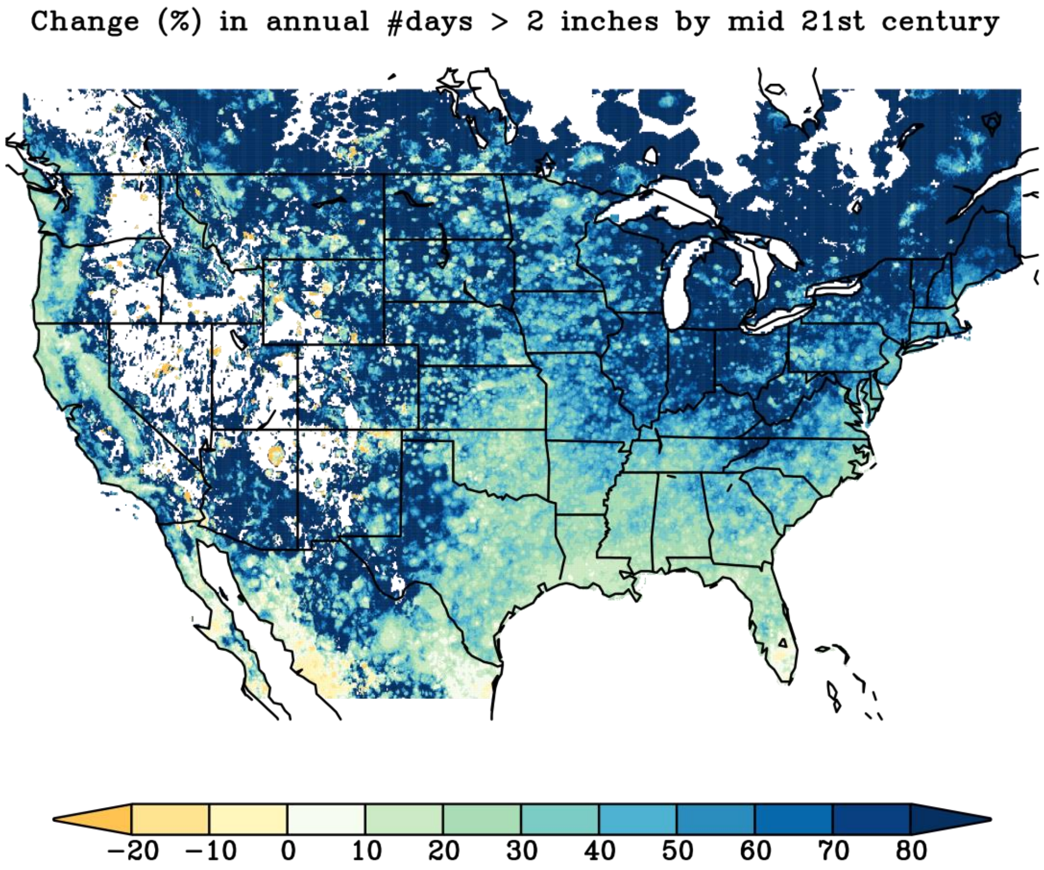
https://scenarios.globalchange.gov/loca-viewer/

Change in Mean Annual Days with Precipitation > 2”

Lower Emissions



Higher Emissions



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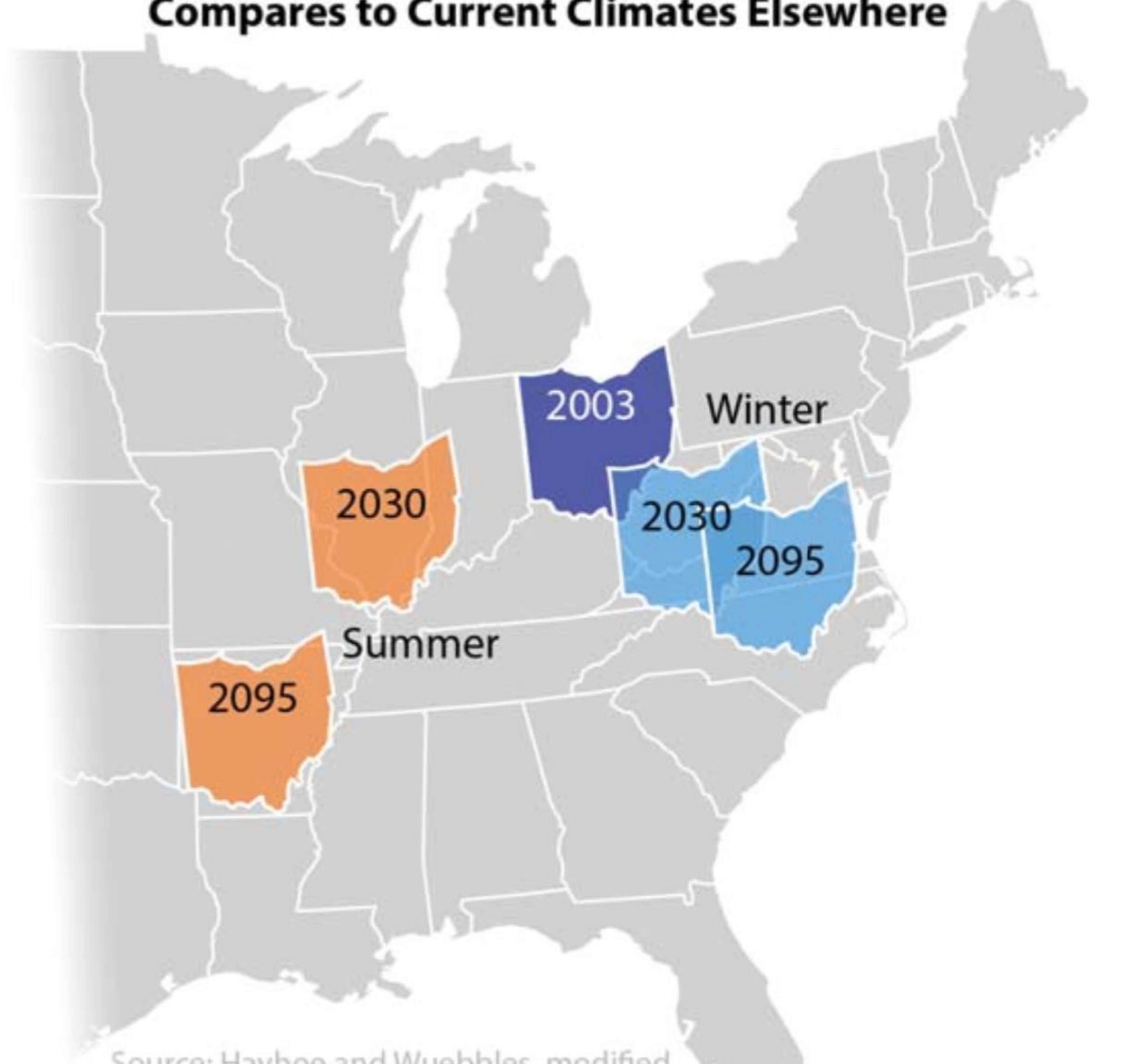
(1976-2005): < 1 day

https://scenarios.globalchange.gov/loca-viewer/

So what if I told you 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



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Extreme Precipitation Risks

Greater Flood Risk (Increased Frequency of Flooding)

- Increased risk (damage to water infrastructure and changing floodplains (roads, floodwalls, dams, electric grid, water intakes, etc.)

- Health risks associated with floods (mold, exposure to chemicals and waterborne pathogens, vector control, drinking water and food contamination)

- Increased transportation issues (major disruptions to local economy, difficult for police and ambulances to respond to emergencies when areas are flooded).

Reduced Water Quality

- Intensity means more runoff and potential contamination

- Increased need for water treatment due to deteriorated water quality.

- Potential for summer droughts and seasonal water shortages, particularly for agricultural and industrial use.

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Ecosystem Concerns

- Higher average temperatures and shifting precipitation patterns are causing plants to bloom earlier, creating unpredictable growing seasons.
- Invasive, non-native plants and animals' ranges are expanding and making them more apt to take advantage of weakened ecosystems and outcompete native species. (e.g., kudzu, garlic mustard, and purple loosestrife).
- Native and iconic plants may no longer be able to survive in portions of their historic range. (e.g., Ohio without the Ohio buckeye)
- Important connections between pollinators, breeding birds, insects, and other wildlife and the plants they depend on will be disrupted. Pollinators such as hummingbirds and bees may arrive either too early or too late to feed on the flowers on which they normally rely.

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NWF: https://www.nwf.org/Our-Work/Environmental-Threats/Climate-Change/Greenhouse-Gases/Gardening-for-Climate-Change

Ag-Water Management

Manage higher temperatures

•crop regulation and canopy management, such as using temperature data loggers to optimize temperatures; greenhouse modifications

•using irrigation to ameliorate temperature extremes; sprinkler irrigation can reduce canopy temperatures.

•Vegetable/Fruit hybrids with greater heat tolerance

https://www.agric.wa.gov.au/climate-change/climate-change-and-horticulture

Improve water harvesting and storage

- dams and catchments to cope with projected rainfall and evaporation rates
- use in-row water harvesting for grapes and tree crops
- harvest water run-off from greenhouses
- increase investment in tanks and dam storages.

Improve irrigation efficiency

- watering at night; drip irrigation; subsurface drip irrigation
- reduced evaporation of soil water through mulching with organic materials, mulching with plastic, rapid crop canopy development/closure
- reducing run-off by using appropriate irrigation rates, mulches, contour sowing, minimum tillage, claying.

Grow crops under shelters or greenhouses

- use netting to provide shade (reduced canopy temperature and evaporation) and reduce risk of hail and bird damage
- grow crops in greenhouses to increase productivity by using plastic tunnels, plastic structures with computerized temperature control and shading systems; glass structures with computerized temperature control and shading systems

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Soil & Water Health

- Seasonal precipitation changes and impacts on water availability for crop production

- Healthy soils impacted by erosion, compaction, and loss of organic matter.
  - Organic material impacted by soil temperature & water availability
  - Increased erosion from intense extreme rainfall events
  - Increased potential for associated, off-site, non-point-source pollution.
  - Tillage intensity, crop selection, as well as planting and harvest dates can significantly affect runoff and soil loss.

- Surface and groundwater systems impacted over time through changes in evapotranspiration and recharge

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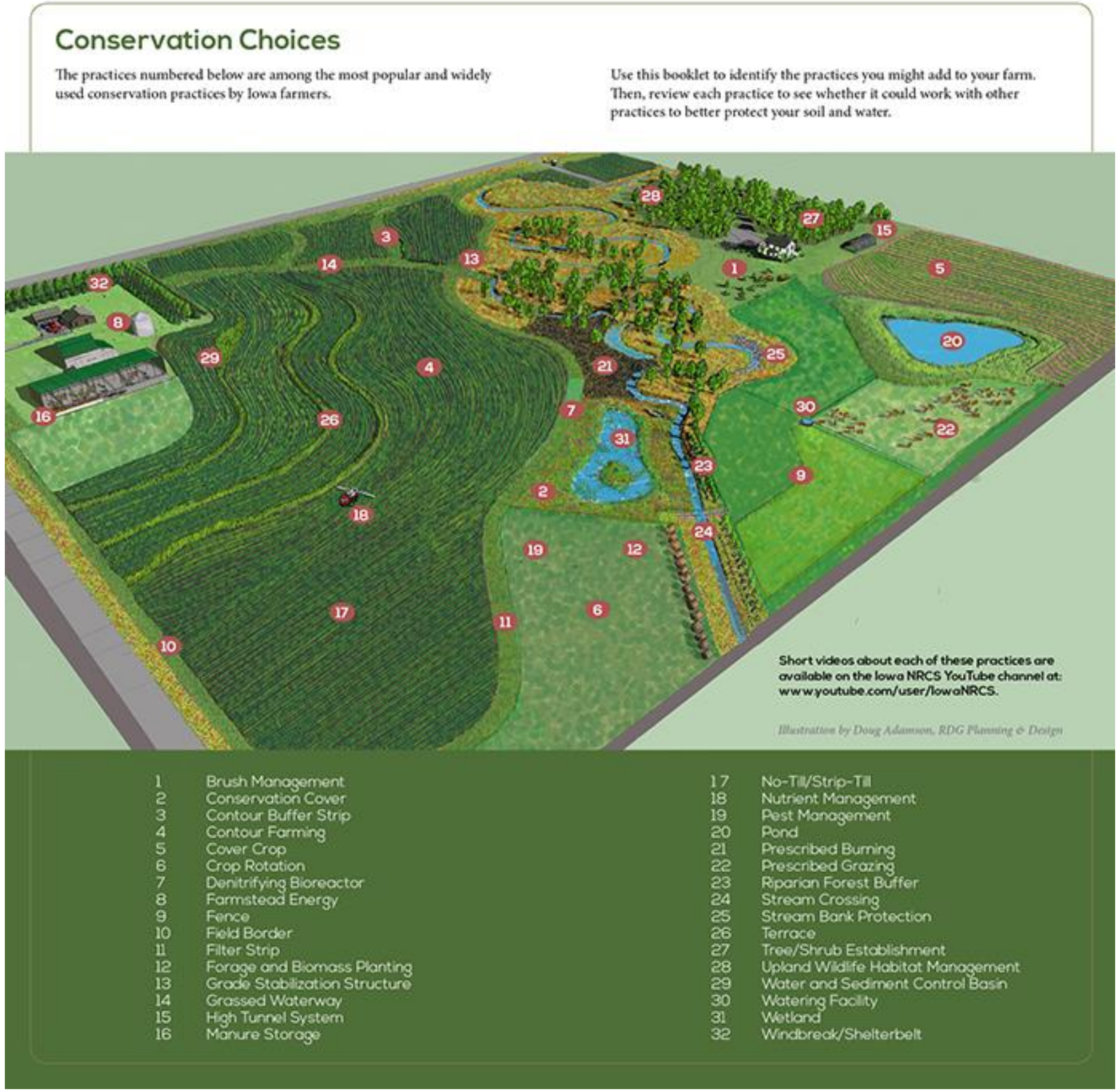
Conservation Practices for Discussion

- What strategies slow the progress of water from fields to streams?

- What strategies improve the quality of the soil, thereby improving plant health and water storage capacity?



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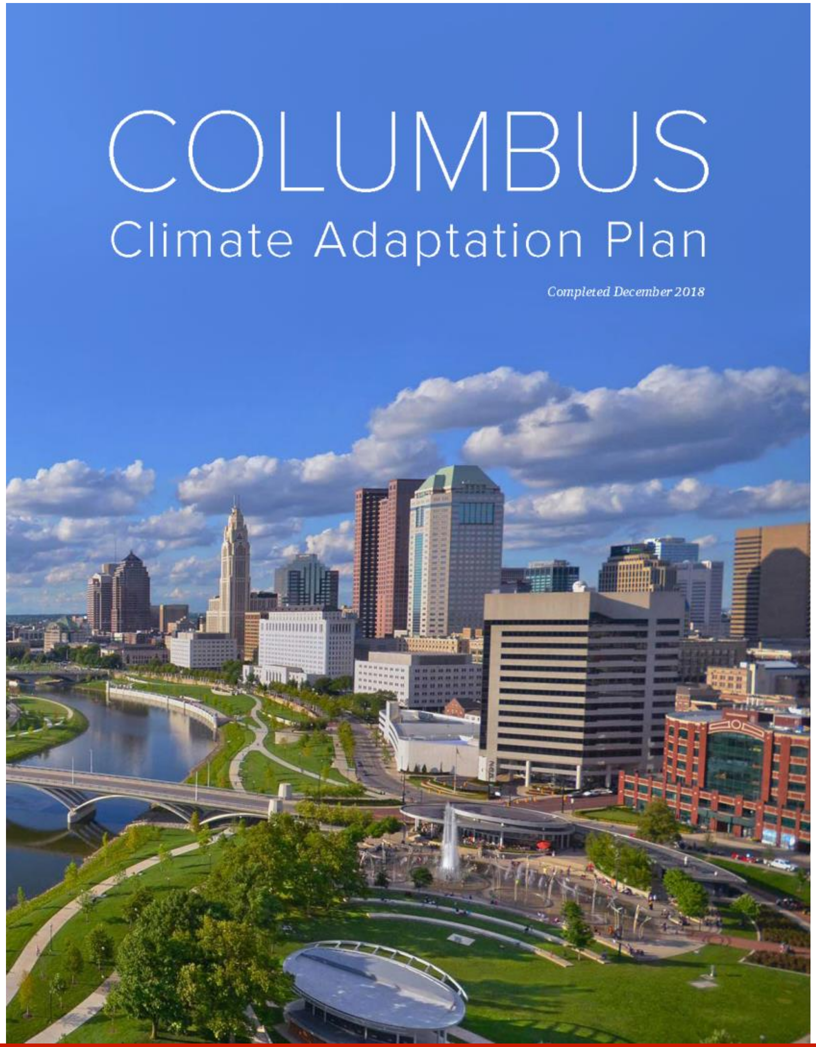
Columbus Climate Adaptation Plan



Contents

https://byrd.osu.edu/columbus

Recommended Climate Adaptations for Columbus

Extreme Heat: N1, N2, A1, A2

Establish a larger, better coordinated, more responsive network of cooling center and draft clear guidelines for network members.

Air Quality & Energy: N3, N4, A3, A4, A5

Modernize electric grid for greater resilience and more efficient energy distribution.

conveys risks to and responsibilities of property owners.

Flooding: N5, N6, N7, N8, A6

Develop an emergency plan that can be implemented during a flood to ensure adequate transportation and logistics for critical resources.

runoff and promote infiltration.

Water Quality: N9, N10, N11, N12, A7, A8

Continue upgrades to sewer system and sewage treatment infrastructure to reduce contamination of waterways.

Continue upgrades to water and sewage treatment infrastructure to reduce harmful alagal bloom (HAB) toxins in drinking water.

Water Use: N13, A9, A10, A11, A12

Educational campaign on reducing water use.

Improve efficiency of water use in city fountains, pools, splash pads, and ponds.

Ecosystems: N14, A13, A14, A15, A16

Promote sustainable landscaping practices for residential, commercial, and industrial properties.

additional green space, urban tree canopy, and urban farms.

Emergency Preparedness: N15, N16, A17, A18, A19, A20

Use geographic information systems (GIS) to map fixed critical assets and vulnerable

Use GPS to map fixed critical assets and vulnerable populations susceptible to environmental hazards.

Identify representative advocacy organizations for diverse and vulnerable populations.

Vulnerable Populations: N17, N18, N19, N20, N21, N21, A22

Identify advocacy organizations end ensure diverse modes of communication during hazard emergencies.

Require or incentivize that monthly utility costs for rental properties be reported to potential tenants.

https://climate.osu.edu/ohio-climate-change-resources

Adaptation Process

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https://www.globalchange.gov/nca4

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