Does Climate Change Really Impact Ohio Ag?



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Snapshots of My Background











The Power of Weather Impacts Us All



"Ohio's greatest weather disaster."

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

Flood of 1913





The Power of Weather Impacts Us All



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Blizzard of 1978

January 26-27; 51 lives lost

Sample of NWS recorded peak wind gusts:

- 69 mph Dayton & Columbus
- 75 mph Akron
- 82 mph Cleveland Hopkins Airport
- 86 mph sustained with gusts to 111 mph on Lake Erie (reported by ore carrier J. Burton Ayers)

https://www.weather.gov/iln/19780126

The Power of Weather Impacts Us All

June 29, 2012 Midwest to East Coast Derecho Radar Imagery Composite Summary 18-04 UTC ~600 miles in 10 hours / Average Speed ~60 mph

Derecho of 2012



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Weather & Climate Are Related – **But Different Climate**: Slower-varying aspects; Averages over longer periods. **Weather**: High-frequency; seconds to days variations CFAES

Weather & Perception



Average Temperature (°F): Departure from 1981-2010 Normals

Midwestern Regional Climate Center cli-MATE: MRCC Application Tools Environment Generated at: 7/17/2018 8:11:01 AM CDT





Statewide Average Temperature Ranks May 2018 Period: 1895-2018



Detecting Weather Extremes and Asking the "Right" Questions



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"Did climate change cause a particular event to occur?"

Bad Question!

"Are events of this severity becoming more or less likely because of climate change?"

"To what extent was the storm intensified or weakened, or its precipitation increased or decreased, because of climate change?"

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

Observing the Modern Day Climate











2.8110





Global Perspective



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Global annually averaged temperature (land and oceans) has increased by about 1.8°F (1.0°C; linear trend from 1901 to 2016) and by 1.2°F (0.65°C) for the period 1986–2015 as compared to 1901–1960.

Sixteen of the last 17
years have been the
warmest ever recorded
by human observations.

Global Temps: A Historical Perspective



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Temperature Difference Relative to 1961-1990 average.

U.S. Temperature Trends

- Increased until ~1940, decreased until ~1970, and increased rapidly through 2016
- Surface and satellite data show accelerated warming from 1979 to 2016





HowGlobalWarmingWorks.org, 2014

How the Atmosphere Warms



HowGlobalWarmingWorks.org, 2014

How the Atmosphere Warms





Contemporary Greenhouse Gas Concentrations

Water Vapor (humidity):

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Contributes about 40°F to current Earth's temperature: (Increased 5-10% in last 50 years)

Carbon Dioxide: Contributes 20°F to current temperature: (Increased 25-30% in last 50 years)



Historical Greenhouse Gas Concentrations





Warming Temperatures Have Feedbacks Ten Indicators of a Warming World Air Temperature Near Surface (Troposphere) Water Vapor **Glaciers and Ice Sheets Temperature Over Oceans** Snow Cover Sea Surface Temperature Sea Level Sea Ice **Temperature Over Land Ocean Heat Content CFAES**

Impact: Record Warmth



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Record Highs Outpacing Record Lows



Period	High Max	High Min	Low Max	Low Min
Last 7 Days	4	3	7	1
Last 30 Days	292	481	1210	756
Last 365 Days	24086	37196	22678	14779

Impact: Water Vapor

On July 30 in Bandar Mahshahr, at 4:30pm, the temperature was 111°F and the dew point 88°F, making the heat index value a whopping 155°F, an unfathomably high number. The next day, July 31, at 4:30pm, the heat index soared to 165°F, after a temperature of 115°F was reached while the dew point was 90°F.

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top) Annual specific humidity over land (orange) and ocean (green) compared to the 1979-2003 average. (bottom) Relative humidity over land areas compared to the 1979-2003 average from two different data sets. While the exact values form the the different sources vary from year to year, most show similar trends over time. Graph by NOAA Climate.gov, adapted from Figure 2.12 in State of the Climate in 2013.

Hurricane Harvey (2017) for Perspective



Blake and Zelinsky (National Hurricane Center): Update 9 May 2018 https://www.nhc.noaa.gov/data/tcr/AL092017_Harvey.pdf



U.S. Regional Climate Trend Impacts



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

U.S. Temperature Trends



- 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



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: <u>https://science2017.globalchange.gov/</u>



What is Happening in Summer?

https://science2017.globalchange.gov/chapter/6/

• The 1930s Dust Bowl era

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 Agricultural intensification may have suppressed the hottest extremes in the Midwest. (Muller et al, 2016: Nature Climate Change; Science http://www.sciencemag.org/news/2018/02/america-scorn-belt-making-its-own-weather)

NCA Region	Change in Coldest Day of the Year	Change in Warmest Day of the Year
Northeast	2.83°F	–0.92°F
Southeast	1.13°F	-1.49°F
Midwest	2.93°F	–2.22°F
Great Plains North	4.40°F	-1.08°F
Great Plains South	3.25°F	-1.07°F
Southwest	3.99°F	0.50°F
Northwest	4.78°F	–0.17°F

Local Impacts from Increasing Temperatures

- Additional (sustained) stress on humans and livestock; Increased need for adequate cooling
- Accelerated pace of GDD accumulation; Changes in regional crop rotations and field management options (double-cropping use of cover crops)
- Pollination and grain, fiber, or fruit production sensitive to high temperatures lower productivity and reduced quality
- Seasonal ice in/out changes impact fisheries and ecosystems

Local Impacts from Increasing Temperatures



U.S. Precipitation Trends



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

- Annual precipitation has decreased in much of the West, Southwest, and Southeast
- Increased in most of the Northern and Southern Plains, Midwest, and Northeast.
- National average increase of 4% in annual precipitation since 1901

Seasonal Precipitation Changes

- National trends driven strongly by fall trends (10-15% in some locations)
- Spring trends in our region focused across SW Ohio, Southern Indiana and Illinois, into Missouri then across the rest of the Midwest



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

Summer and Fall trends shift a bit northward



Observed changes in extreme precipitation

- Extreme precipitation events are generally observed to increase in intensity by about 6% to 7% for each degree Celsius of temperature increase.
- Change in seasonal maximum 1day precipitation (1948-2015)



Other Heavy Precipitation Metrics

- Maximum daily precipitation totals were calculated for consecutive 5year blocks from 1901
- The total precipitation falling in the top 1% of all days with precipitation





Extreme Precipitation Changes in Ohio

Observed Annual Precipitation



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Observed Number of Extreme Precipitation Events



https://statesummaries.ncics.org/oh

Impacts from Intense Rainfall





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

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



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.



Change in Annual Number of Days > 90°F

Lower Emissions

Change in annual #days Tmax > 90F by mid 21st century



Higher Emissions

Change in annual #days Tmax > 90F by mid 21st century



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

Change in Mean Annual Days with Precipitation > 2"

Lower Emissions

Change (%) in annual #days > 2 inches by mid 21st century



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Higher Emissions

Change (%) in annual #days > 2 inches by mid 21st century



Ohio (1976-2005): < 1 day

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

Summarize and Ask: What Can We Do?



Based on temperature, humidity, and precipitation, future summers in Ohio might resemble those in Arkansas, and winters may become similar to those in Virginia.

STEPS TO RESILIENCE



Understand the Threats and Have Conversations

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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THANK YOU!

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http://u.osu.edu/wilson.1010/