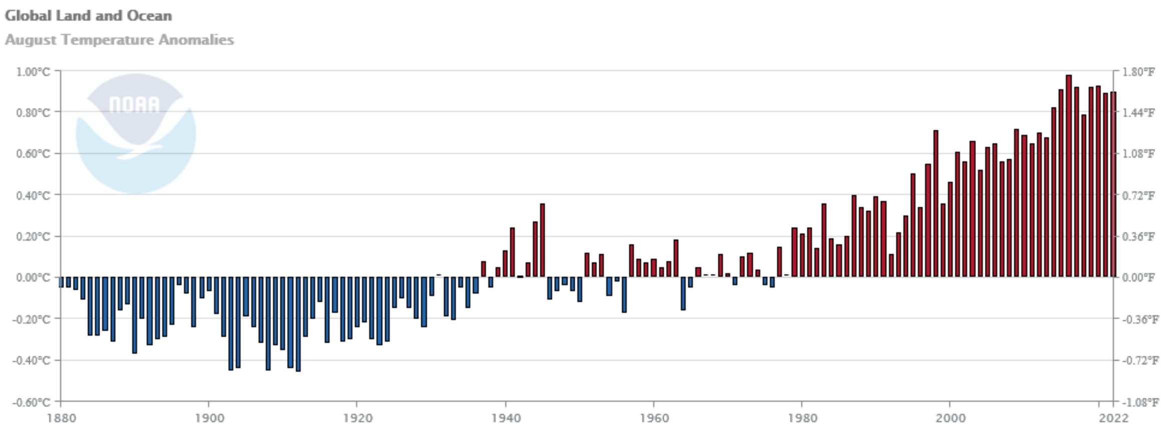
Ohio Precipitation Tool: An Overview

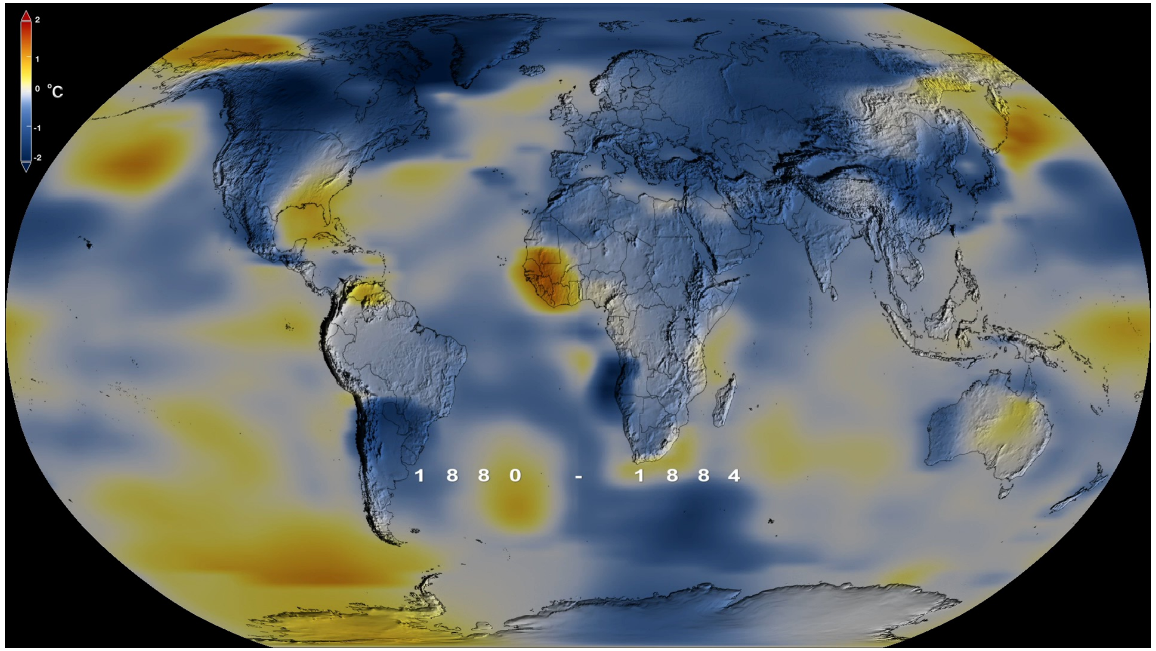
Geddy Davis
Byrd Center & SCOO
25 May 2023

Introduction

- Geddy Davis – Weather & Climate Services Program Coordinator (Byrd Polar & Climate Research Center).
  - B.S. Atmospheric Science – Ohio State University (May '22)
  - Cert. Of Weather Forecasting – Penn State University (Dec '20)
- Partner with State Climate Office of Ohio (SCOO) in sharing weather and climate information to Ohioans
- Science and records (SCOO) + education/outreach (Byrd) = fruitful connections, programs, and partnerships

Global Assessment

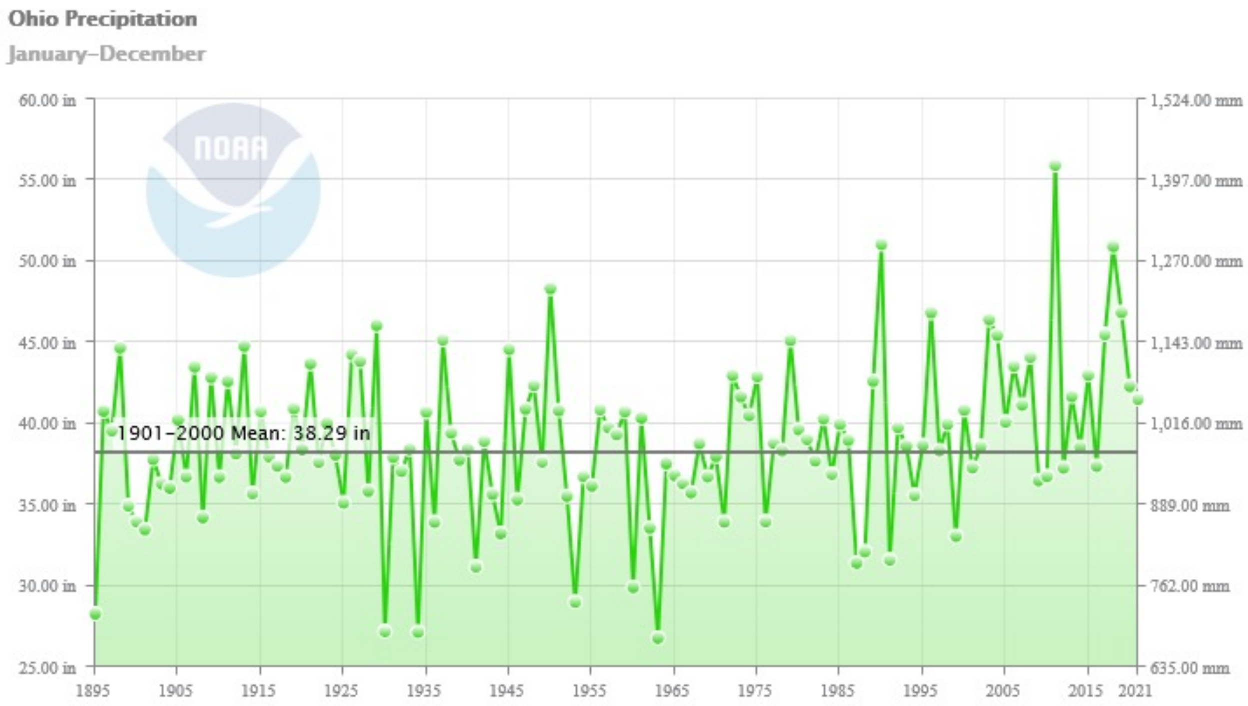


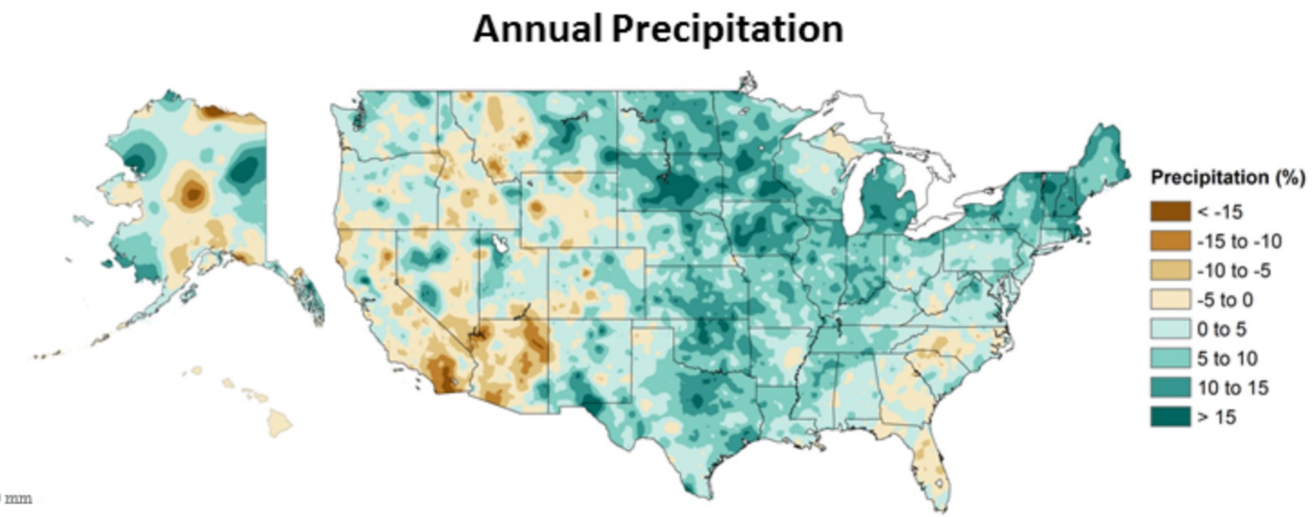


https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series

- 2022 is the 6th warmest year since 1880
- Top 10 warmest years have occurred since 2005; Last 8 years are top 8 warmest (since 2015)
- If you were born after February 1985, you have never experienced a cooler than average month for the planet!

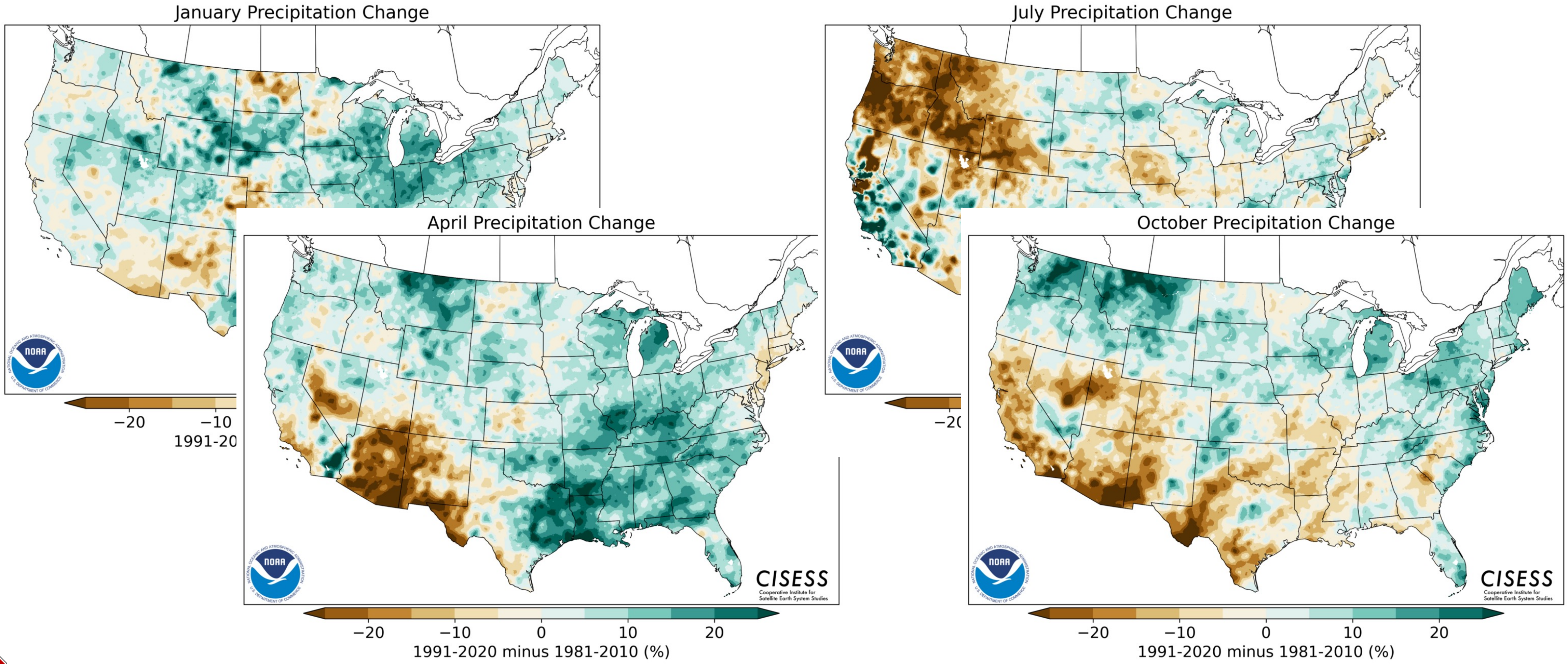
Ohio Precipitation Assessment





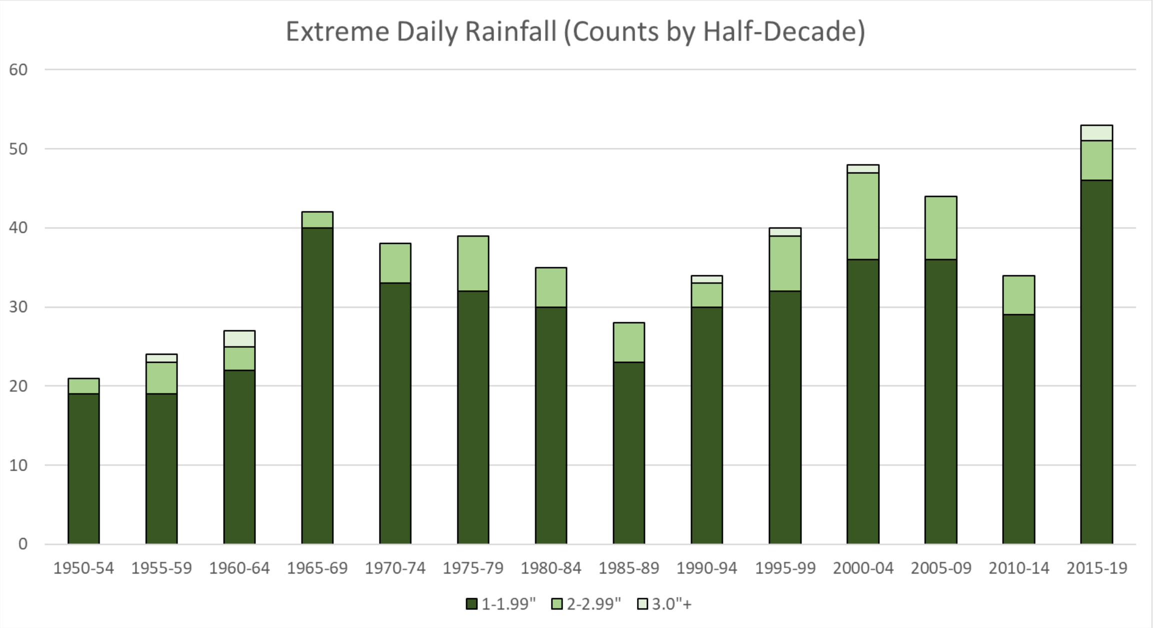
- National average increase of 4% since 1901
- Trend in Ohio is 0.31” per decade 1895-2020
- Includes changes to seasonal trends and intensity

Recent Seasonal Precipitation Changes

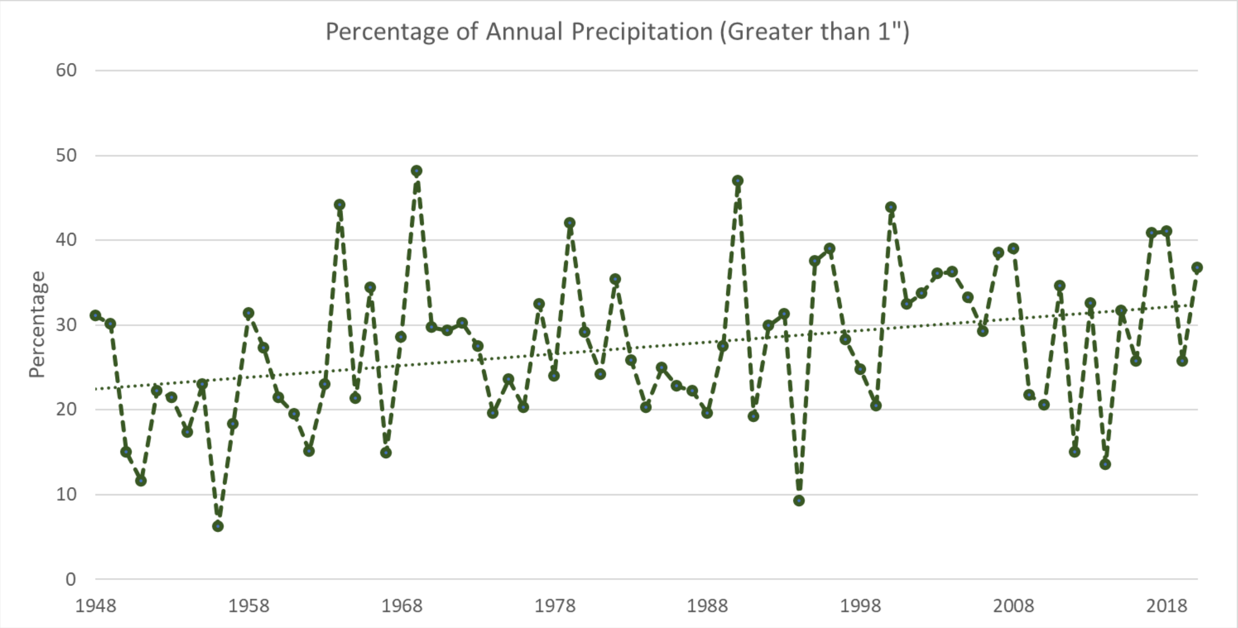


https://www.ncei.noaa.gov/products/us-climate-normals

Precipitation Intensity Changes in Columbus



Number of 1” or greater events per 5-yr increments from 1950-2019



1” or greater events expressed as a percentage of the total number of rain events by year between 1948 and 2020

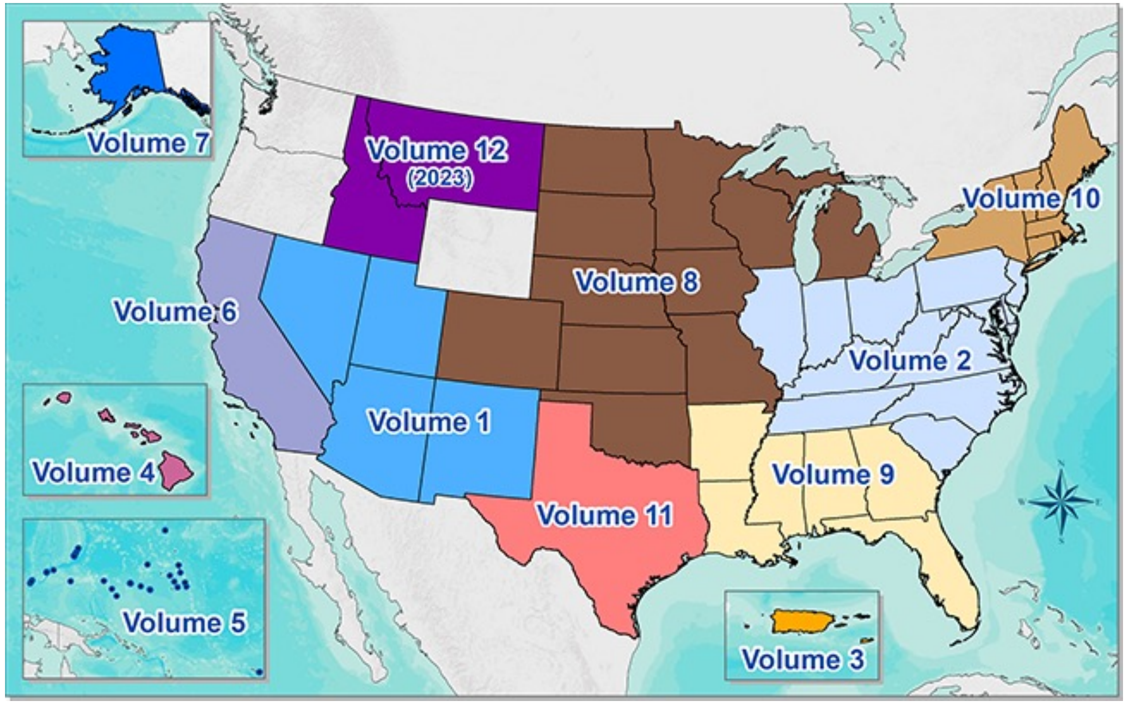
Top 10 Warmest & Wettest Years in Ohio

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
5	2021	53.2	1.6
7	1991	53.1	1.5
8	2020	53.0	1.4
9	1931	52.9	1.3
10	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

NOAA-Atlas 14 Review

- NOAA-Atlas 14: The official peer-reviewed record of precipitation frequency estimates for the United States and affiliated territories is produced by the NWS Office of Water Prediction.
- Information quantifies the precipitation amount, at a particular location and for a given duration
- Currently, not funded by Congressional appropriations, but rather by affected states and other users on a cost-reimbursable basis.
- ***Volume 2 – Released in 2004. The records of these stations extend through December 2000 and average 63 data years in length for daily stations and 40 data years for hourly.***
- Need to update precipitation guidance for development, infrastructure design, etc.



https://repository.library.noaa.gov/view/noaa/37601

National Effort Summary

- NOAA Atlas-14 based on a concept of temporal stationarity which assumes that the extreme precipitation events do not change significantly over time (https://hdsc.nws.noaa.gov/hdsc/files25/NA14_Assessment_report_202201v1.pdf)
- Assessment recommendations
  - Timely updating of Atlas 14 or its equivalent;
  - Incorporating nonstationarity using observational data;
  - Considering future climate change and conducting risk assessments for planning long-lived infrastructure;
  - Improving accuracy of climate models for precipitation predictions.

https://repository.library.noaa.gov/view/noaa/37601

National Effort Summary

- States, water utilities, and engineering firms want NOAA to continue to be an authoritative source by improving availability and use of precipitation statistics
- Floods Act/PRECIP ACT:
  - Update NOAA Atlas 14 (or its successor) nationwide at least every 5–10 years using the most updated observations
  - Update NOAA Atlas 14 methodology to incorporate nonstationarity; and
  - Provide guidance on evaluating future statistics under climate change, for mid-century and end-of century.

Check 1: Questions?

Ohio Precipitation Estimate Tool

- Ohio State partnered with Franklin Soil and Water Conservation District to create a “stop-gap” measure and improve precipitation estimates
- Goal: create outputs that ***mirror*** those available via NOAA Atlas 14. ***Not*** replacing or supplementing.
- This will assess the potential impacts of updating the information. Knowledge gained via this analysis will be shared with both local practitioners and other communities interested in replicating the process and getting a head start in a similar capacity.
- Share information via an intuitive website and code repository.

Methods

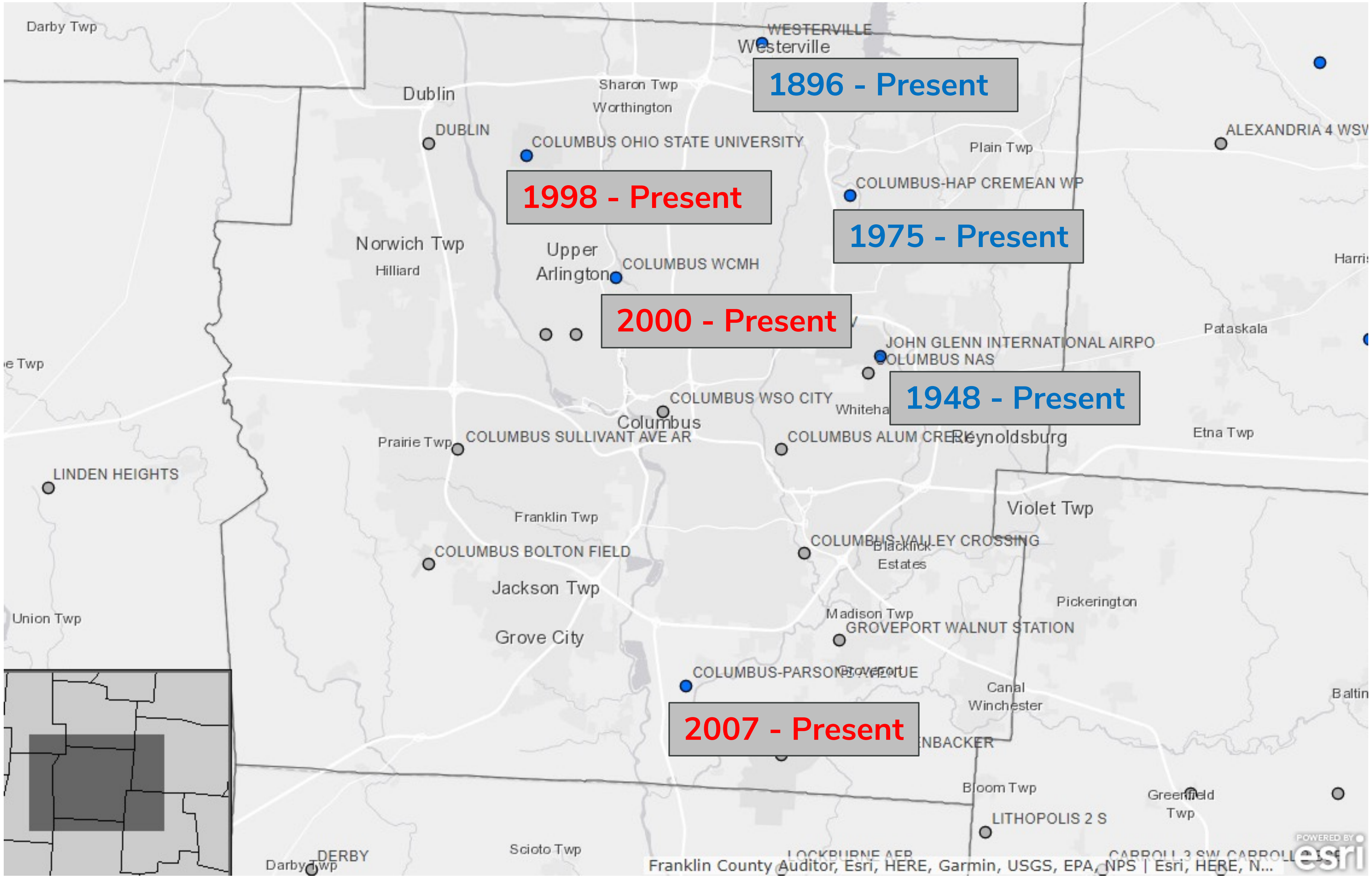
ATLAS 14

- Uses Daily & Hourly station data
- Utilizes Generalized Extreme Value (GEV) + L Regions to fit a distribution function to the precipitation data and calculate precipitation frequency estimates (often used as an approximation to model the maxima of long sequences of variables)
- Little variability considered regarding extreme/changing precipitation events
- MULTIPLE consistency adjustments, most notably in daily and hourly station data quantiles and their confidence intervals

OPE Tool

- Uses mainly Daily station data + PRISM 4km Interpolated Precipitation Data
- Utilizes Generalized Pareto (GP) distribution, a method for fitting the data and analyzing excess precipitation in the right tail (extreme) of the distribution
- Encompasses more variability of extreme precipitation. This however can also mean increased spatial variability and more variability in the confidence intervals surrounding the return level estimates.
- There have yet to be consistency adjustments

Station Comparisons in Franklin County



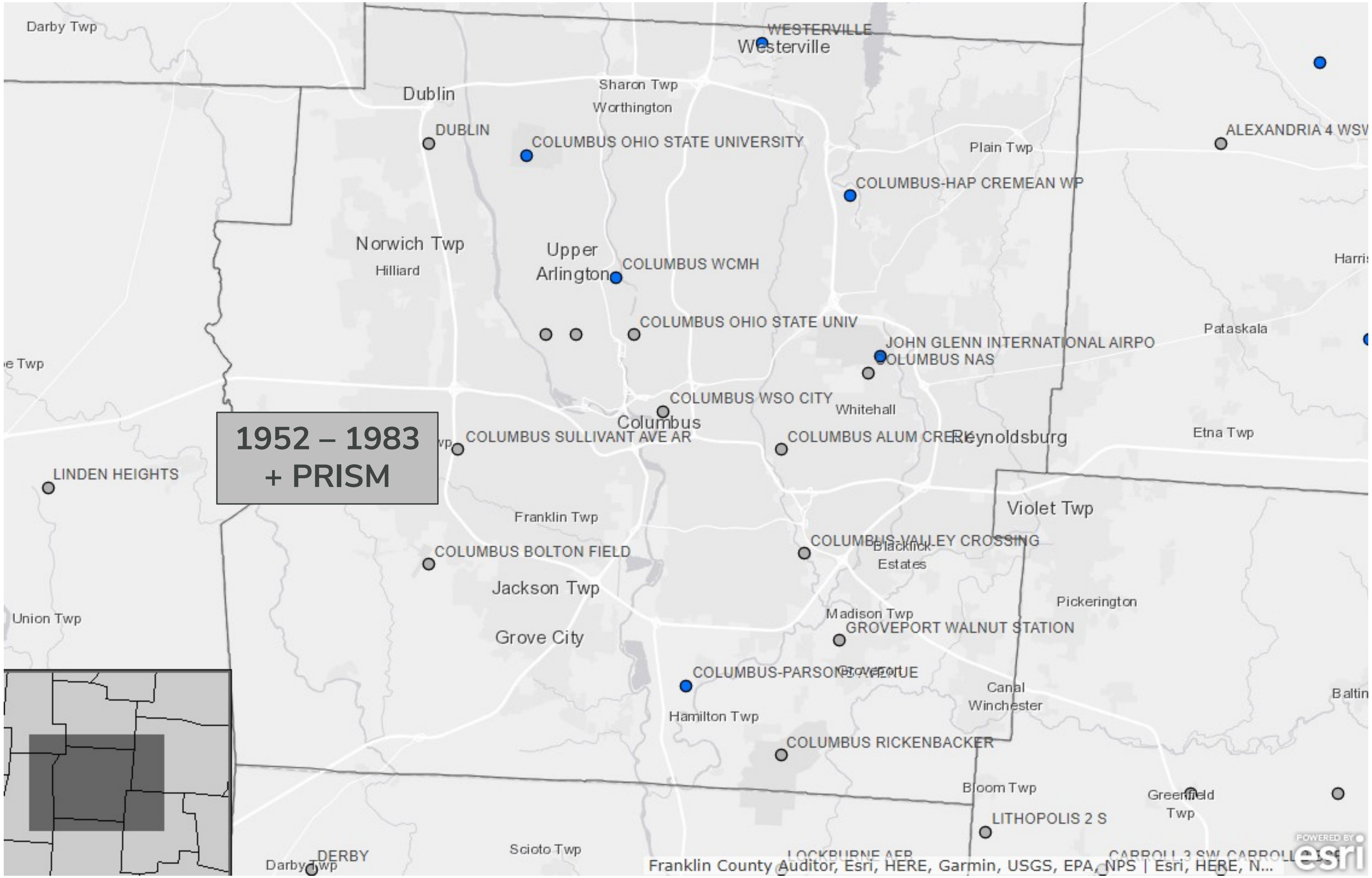
- Active stations
- Stations no longer operating

Trace data replaced as 0.00" daily rainfall

Days w/ Missing Data:

1/1/1981 – 12/31/2022

CMH:	0
Westerville:	14
Easton:	775

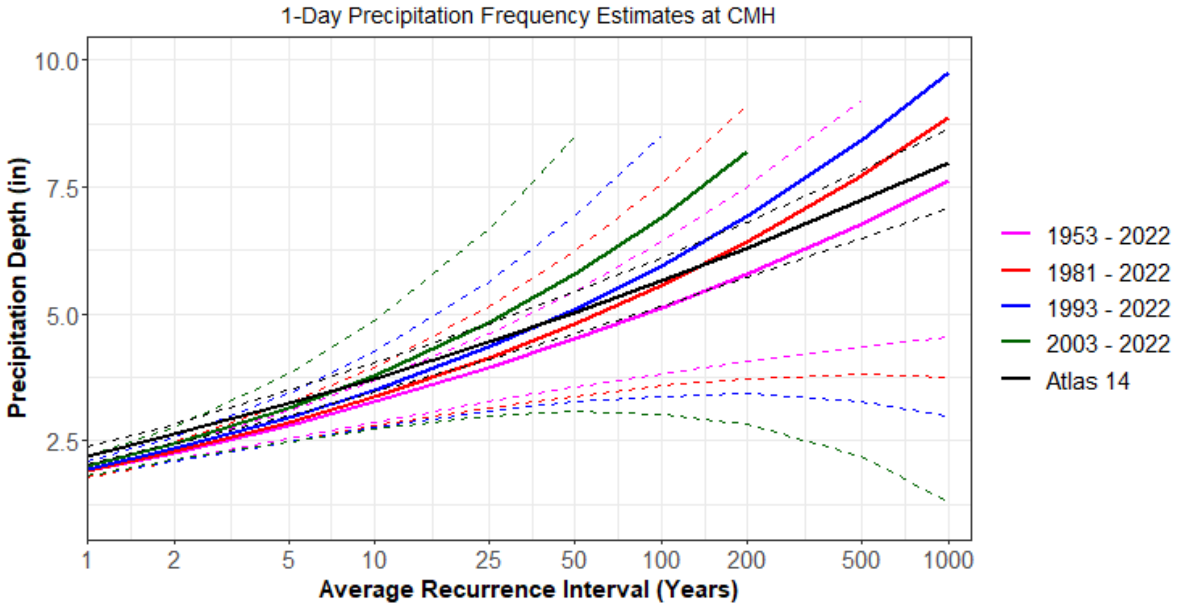


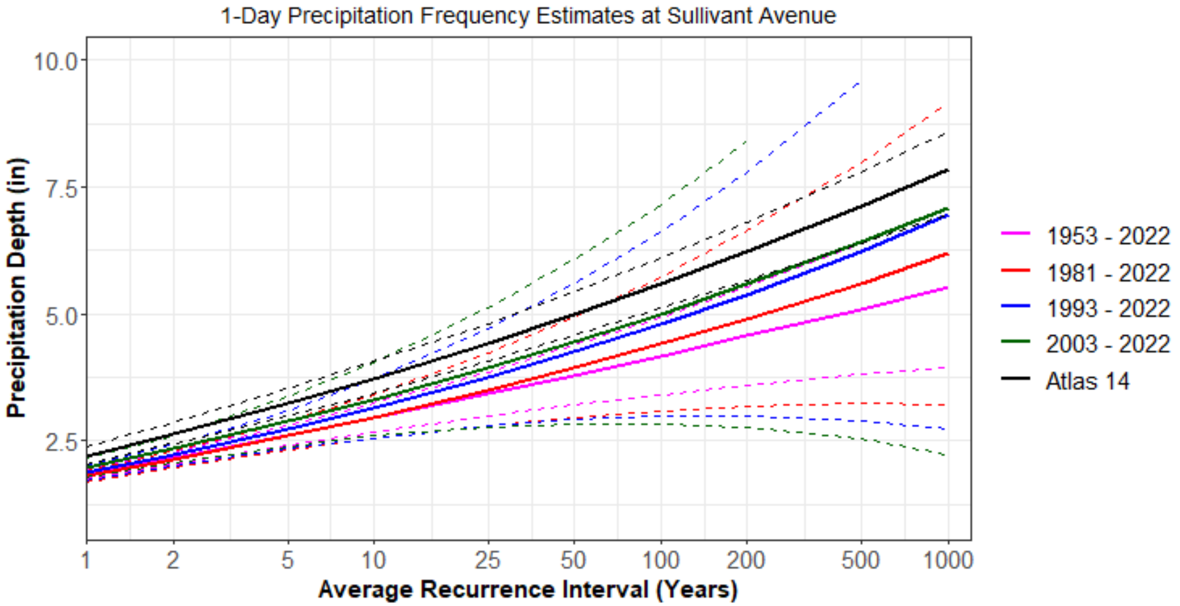
- Active stations
- Stations no longer operating

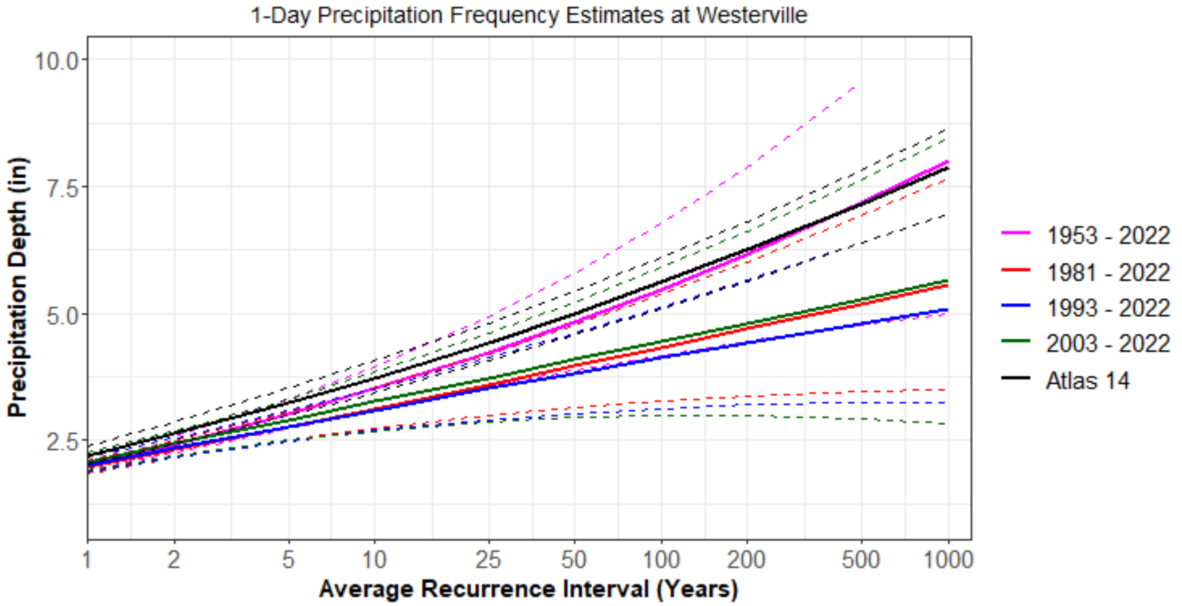
Attach the current (1981-2022) PRISM record to Sullivant Avenue historical station to quantify the value added.

This exhibits flexibility of using PRISM. Three final stations in analysis 1: CMH, Westerville, and Sullivent

Ohio Precipitation Estimate (OPE) Tool Phase 1







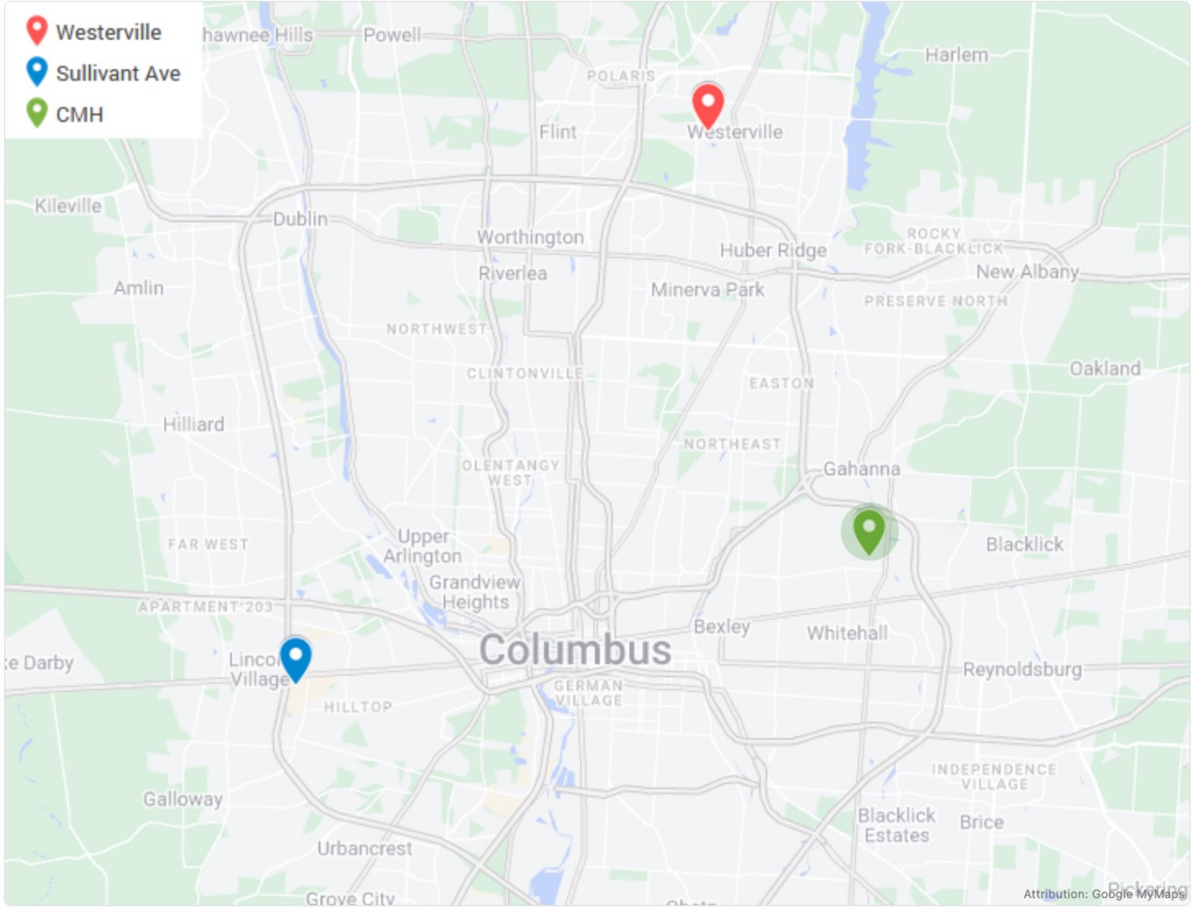
- Return levels calculated using a blend of station (prior to 1981) and PRISM (1981 – 2022) precipitation data
- The period of record has a significant impact on return levels, but there is not clear evidence that there are more frequent extreme daily rainfall events over the past 20 years
- This analysis provides a proof-of-concept for how PRISM precipitation data can be used to develop a more flexible and responsive tool for monitoring precipitation extremes

Ohio Precipitation Tool

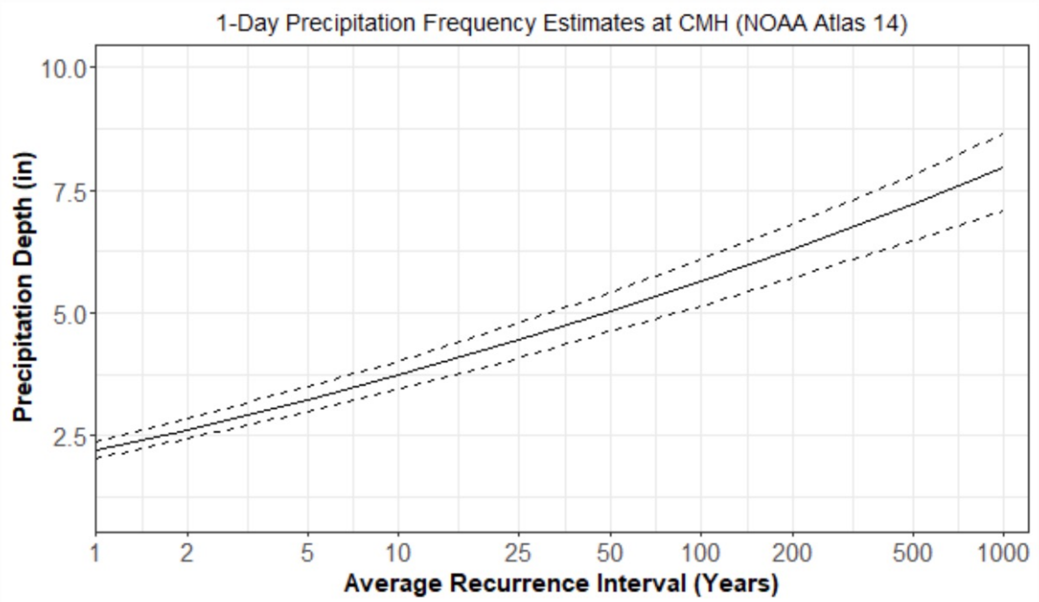
The Ohio State University
Byrd Polar and Climate Research Center
OSU Extension
OSU Department of Geography
Franklin Soil and Water Conservation District
Creating Conservation Solutions for Over 70 Years

Location CMH **Period/Source** NOAA Atlas-14

Download data as: CSV Plot PDF Auto Reload Search



Return Period (years)	95% Lower CI	Estimate	95% Upper CI
1	2.04	2.19	2.37
2	2.44	2.62	2.84
5	3	3.23	3.49
10	3.46	3.73	4.02
25	4.09	4.44	4.79
50	4.61	5.03	5.42
100	5.15	5.65	6.09
200	5.71	6.3	6.8
500	6.48	7.23	7.81
1000	7.09	7.98	8.65



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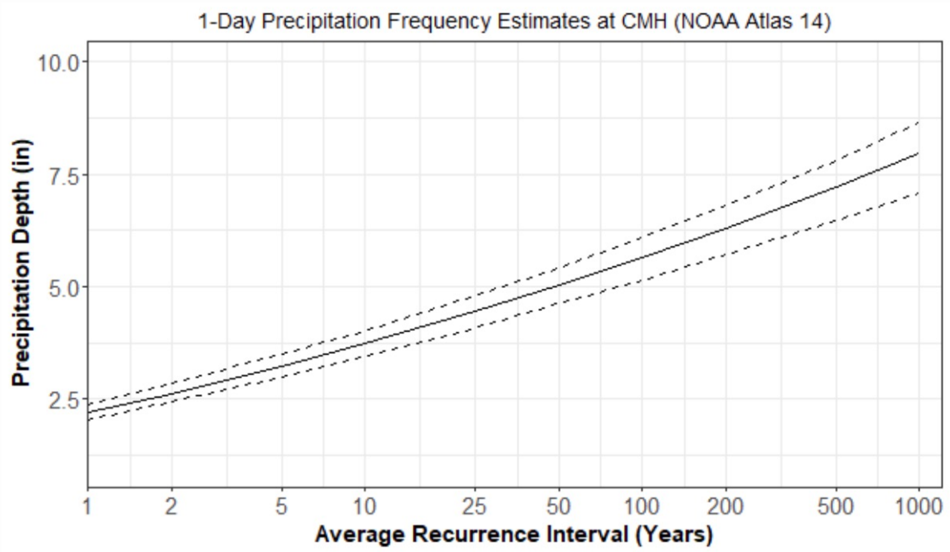
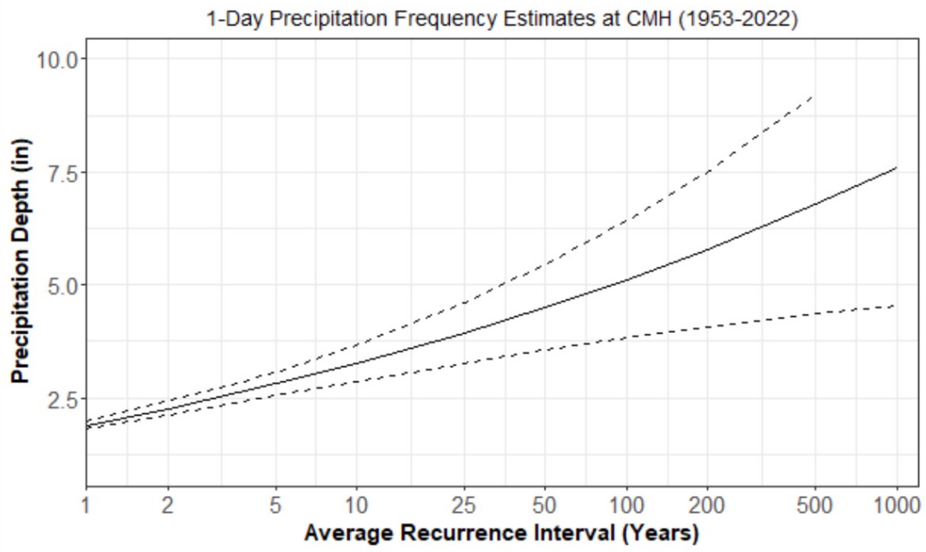
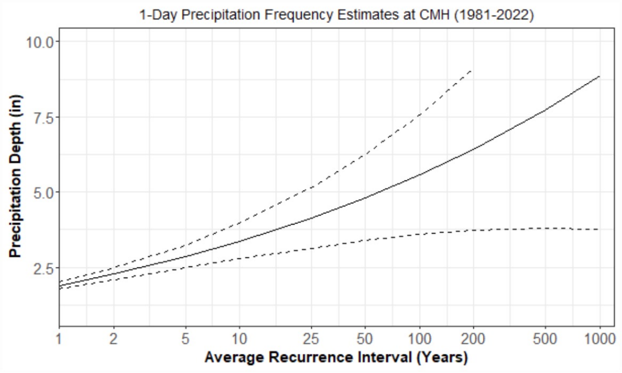
100	5.15	5.65	6.09
200	5.71	6.3	6.8
500	6.48	7.23	7.81
1000	7.09	7.98	8.65

Return Period (years)	95% Lower CI	Estimate	95% Upper CI
1	1.805	1.896	1.988
2	2.124	2.266	2.409
5	2.546	2.81	3.074
10	2.86	3.266	3.672
25	3.263	3.936	4.61
50	3.553	4.499	5.445
100	3.826	5.115	6.403
200	4.076	5.789	7.502
500	4.359	6.779	9.198
1000	4.528	7.61	10.692

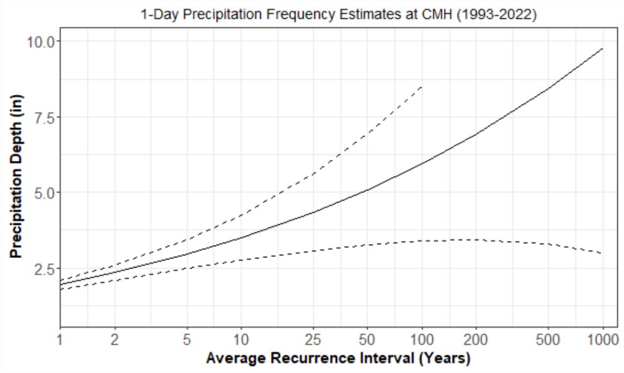




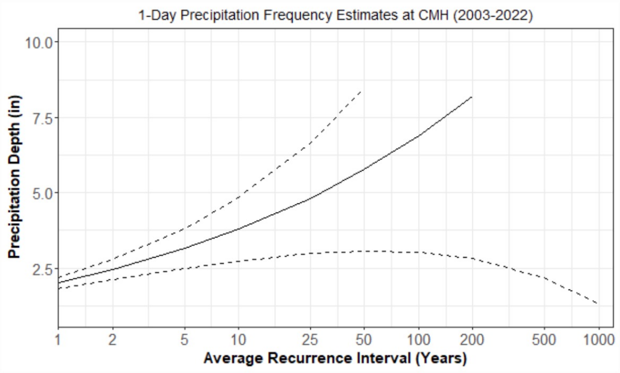
Return Period (years)	95% Lower CI	Estimate	95% Upper CI
1	1.778	1.897	2.015
2	2.084	2.278	2.472
5	2.486	2.86	3.233
10	2.78	3.366	3.952
25	3.14	4.137	5.133
50	3.38	4.807	6.235
100	3.58	5.565	7.55
200	3.726	6.42	9.114
500	3.806	7.722	11.638
1000	3.754	8.856	13.958



Return Period (years)	95% Lower CI	Estimate	95% Upper CI
1	1.795	1.94	2.086
2	2.097	2.339	2.581
5	2.485	2.956	3.426
10	2.758	3.501	4.243
25	3.073	4.344	5.615
50	3.259	5.09	6.92
100	3.38	5.943	8.506
200	3.414	6.92	10.425
500	3.278	8.43	13.582
1000	2.994	9.766	16.537



Return Period (years)	95% Lower CI	Estimate	95% Upper CI
1	1.815	2.007	2.199
2	2.113	2.444	2.775
5	2.487	3.146	3.805
10	2.735	3.79	4.844
25	2.98	4.822	6.665
50	3.067	5.769	8.47
100	3.031	6.887	10.743
200	2.823	8.207	13.591
500	2.18	10.325	18.471
1000	1.312	12.267	23.223

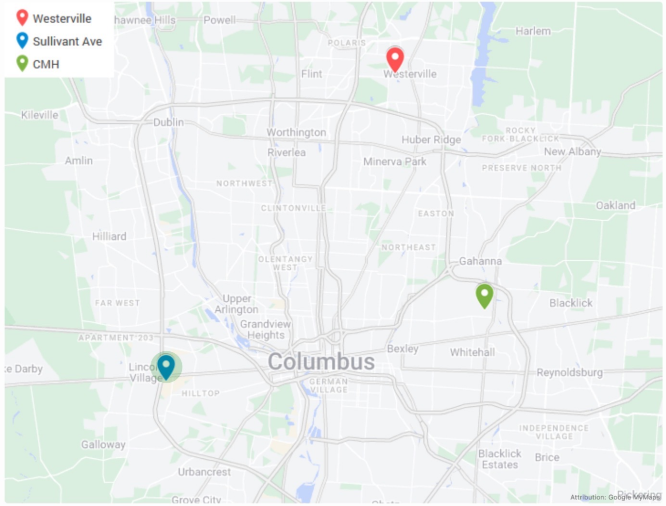


Ohio Precipitation Tool

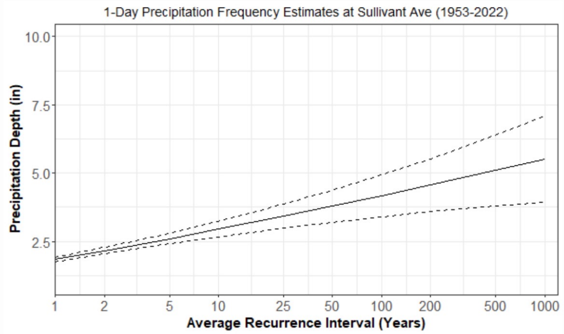
The Ohio State University · Byrd Polar and Climate Research Center · OSU Extension · OSU Department of Geography · Franklin Soil and Water Conservation District

Location: Sullivant Ave · Period/Source: 1953 - 2022

Download data as: CSV · Plot · PDF · Auto Reload · Search



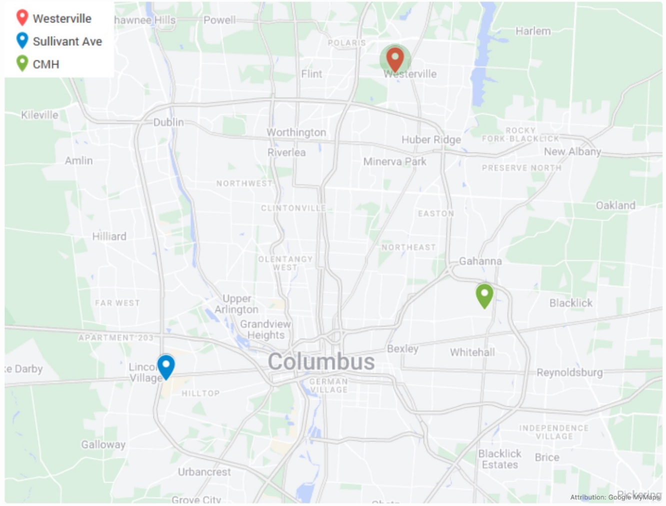
Return Period (years)	95% Lower CI	Estimate	95% Upper CI
1	1.755	1.841	1.927
2	2.042	2.163	2.283
5	2.406	2.603	2.799
10	2.665	2.947	3.229
25	2.983	3.418	3.854
50	3.204	3.788	4.372
100	3.407	4.168	4.929
200	3.591	4.559	5.528
500	3.804	5.095	6.386
1000	3.94	5.515	7.09



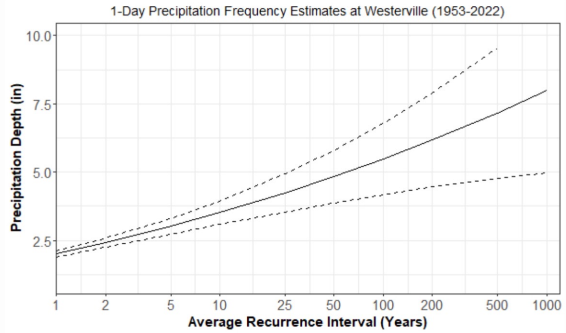
Ohio Precipitation Tool

Location: Westerville · Period/Source: 1953 - 2022

Download data as: CSV · Plot · PDF · Auto Reload · Search



Return Period (years)	95% Lower CI	Estimate	95% Upper CI
1	1.895	2.001	2.106
2	2.259	2.417	2.576
5	2.738	3.02	3.302
10	3.092	3.518	3.944
25	3.543	4.237	4.931
50	3.867	4.832	5.797
100	4.172	5.474	6.776
200	4.453	6.167	7.882
500	4.778	7.169	9.561
1000	4.98	7.997	11.015



Data and Code Repository for Analysis

This project has resulted in:

- A PRISM database with code to download, update, and subset data to any location based on lat/lon
- Code to interpret which distribution fit can be used to model precipitation frequency estimates
- Code to create graphical and tabular output and compare different configurations
- Draft summary of all back-end data analysis

Name	Last commit	Last update
Analysis.R	Upload New File	2 minutes ago
ExploratoryAnalysis.R	Replace ExploratoryAnalysis.R	36 seconds ago
LocationComparisonPlots.R	Upload New File	2 minutes ago
PRISM_extract_gridcell.py	Update PRISM_extract_gridcell.py, PRISM_ex...	2 months ago
PRISM_extract_local_1_6_23.py	Update PRISM_extract_gridcell.py, PRISM_ex...	2 months ago
PRISM_extract_missingdays.py	Update PRISM_extract_gridcell.py, PRISM_ex...	2 months ago
PRISM_extract_point_location.py	Update PRISM_extract_gridcell.py, PRISM_ex...	2 months ago
PRISM_extract_soil_moisture2_lo...	Update PRISM_extract_gridcell.py, PRISM_ex...	2 months ago
TimePeriod_Analysis.R	Upload New File	just now
returnperiodcalculation.R	Upload New File	3 minutes ago

*All materials stored on Microsoft OneDrive and BPCRC code repository (**code.osu.edu**)*

Check 2: Questions?

Strengths and Weaknesses

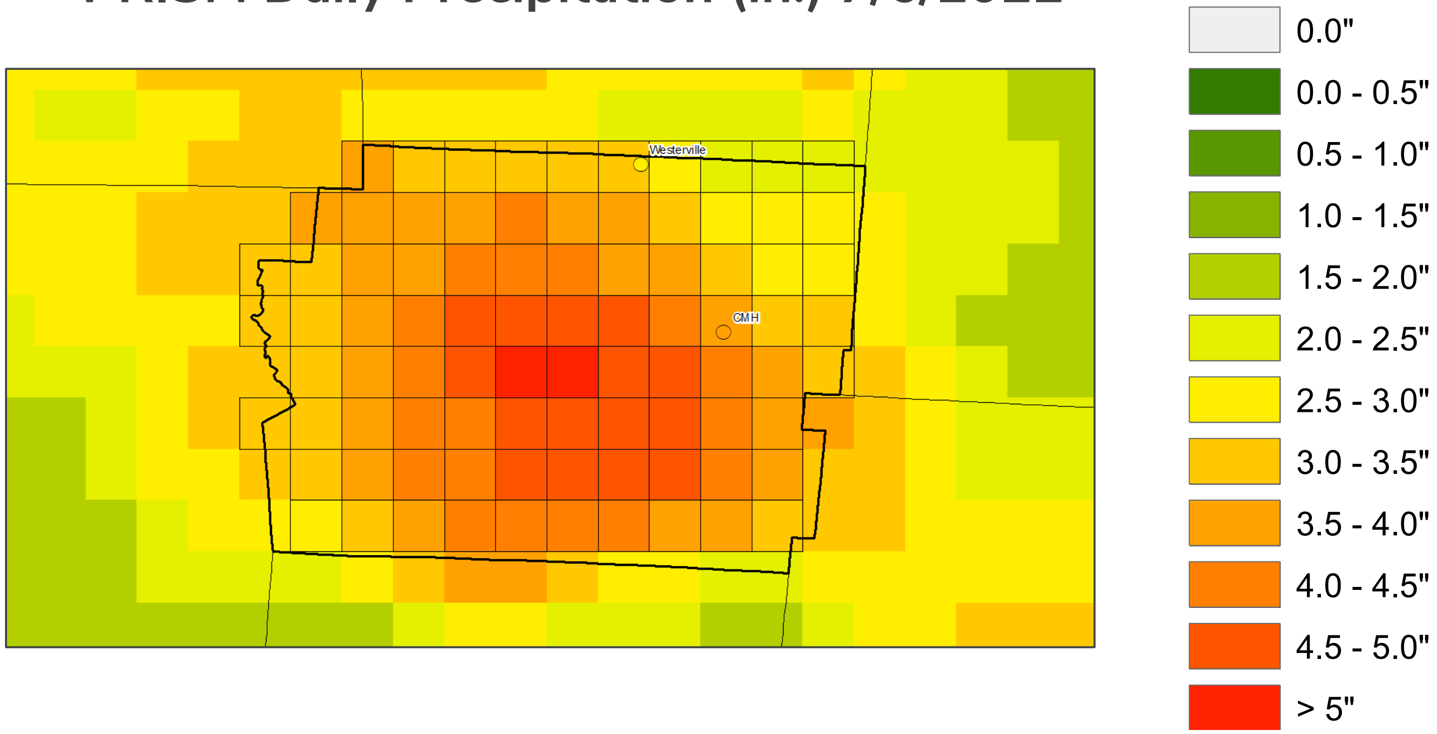
- Website is robust and easily adaptable
- Code and framework in place to expand or adjust project efficiently
- Precipitation data is easily accessible via the repository

- Can decision makers be accurately informed with only 3 stations? Especially with inconsistent results?
- What do we need to do to make results consistent?
- Is data useful to practitioners in the meantime? Are we presenting the right types of data?

Future Research

What is the optimal method & spatial scale for characterizing extreme precipitation characteristics in Franklin County (and Ohio)?

PRISM Daily Precipitation (in.) 7/6/2022



- Expand analysis to additional locations in Franklin County and central Ohio. Concurrently refine methods to provide consistent, clear results & messaging.
- Supplement more station data with PRISM so that precipitation frequency estimates are based on complete and up to date historical data
- Use results to recommend an optimal method and historical record for characterizing present-day precipitation extremes

Summary

- Phase 1 (completed):
  - Update the historical data through present day and expand the number of point-based flood and precipitation estimates in Franklin County.
  - Create point-based precipitation recurrence intervals based on updated data.
  - Create end-user interface designed to closely emulate the function of the current Atlas-14 interface.
  - Share with internal and county stakeholders to evaluate use and design.
  - Initial publication of findings and results
- Phase 2 (not yet funded):
  - Expand scope of project beyond Franklin County, revise methodology
  - Utilize updated precipitation projections to update other aspects of physical modeling space
  - With these updated physical projections, re-evaluate key stakeholder decisions such as design, planning, etc.

Steps to Resilience

https://toolkit.climate.gov/

- **Local issues → Need local solutions and decision-making**
- Final step is Action → Need actionable items
- Monitor for Change → Are actions achieving Desirable Results

https://toolkit.climate.gov/case-studies/pittsburgh-unifies-its-approach-updating-stormwater-management

"The primary lesson learned from the reevaluation of Pittsburgh's stormwater management system was that *all* of the observed water quality and quantity issues—including combined sewer overflows, sanitary sewer overflows, stream bank erosion, surface flooding, basement backups, and water quality degradation—were symptoms of a single root cause: ineffective or outdated stormwater management."

Final Check: Questions?

Thank You

Questions? Email:
Geddy Davis (davis.5694@osu.edu)