Maryland Climate Bulletin September 2023

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DEPARTMENT OF
ATMOSPHERIC &
OCEANIC SCIENCE
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Maryland
State
Climatologist
Office

Summary

Statewide averages show that September 2023 was warmer and slightly wetter than normal (i.e., 1991-2020 averages). Monthly mean temperatures were in the 61 to 74°F range; maximum temperatures were between 69 to 83°F, and minimum temperatures were in the 50 to 64°F range. Monthly total precipitation was between 3.0 to 6.4 inches.

Maryland Regional Features (Figures 1-5, C1, and D1)

- Mean temperature was warmer than normal everywhere, especially over Worcester, Somerset, Wicomico, Dorchester, Calvert, and Saint Mary's counties (above 2.4°F), and parts of Anne Arundel, Howard, Baltimore counties, and Baltimore City (above 1.8°F).

- Maximum temperature was warmer than normal in much of the state, particularly over Worcester, Somerset, Wicomico, Dorchester, Calvert, and Saint Mary's counties (above 2.4°F), and parts of Anne Arundel, Howard, Baltimore counties, and Baltimore City (above 1.8°F). Western Maryland was colder than normal, especially Allegany County (around –1.0°F).

- Minimum temperature was also warmer everywhere, especially over Worcester, Somerset, Wicomico, Dorchester, Talbot, Calvert, and Saint Mary's counties (above 2.2°F), and portions of Anne Arundel, Howard, Baltimore counties, and Baltimore City (above 1.8°F), and Garrett County (above 1.6°F).

- Precipitation was above normal over large areas of the Lower and Upper Coastal Plains, particularly over Caroline County (above 1.8 in) and the southwestern half of the Piedmont over parts of Montgomery, Howard, Frederick, and Carroll counties (above 1.2 in). However, below-normal precipitation was still present in the state, especially over the northern Lower Coastal Plain and eastern Piedmont over Harford, Cecil, and Kent counties (above 1.5 in), over Garrett County (above 0.6 in), northern Frederick and Carroll counties and southern Worcester and Somerset counties (around 0.6 in).

- The extent of the surface in the state under drought conditions increased from around 26% at the end of August to around 36% at the end of September. While the area of moderate drought conditions was reduced over the western Piedmont and the Blue Ridge provinces, severe drought conditions appeared over southern Frederick and Washington counties this month. The general increase in the extent of drought conditions this month was from an increase in abnormally dry conditions that showed over southern Worcester and Somerset counties, northern Kent, Cecil, and Carrol counties, and southern Garrett and Allegany counties, which had below-normal precipitation this month.

Maryland Climate Divisions (Figures 6-7, B1, and B2)

- All eight climate divisions were warmer than normal in September. However, except for the western and mountainous climate division 8 and the northeastern coastal climate division 5, which were drier than normal, the rest were wetter.

- The statewide temperature anomaly remained warmer than normal in September and reached a magnitude comparable to that in July (1.4°F). On the other hand, the statewide precipitation anomaly changed from drier than normal in August to slightly wetter than normal in September (0.17 in).

Historical Context (Figures 8 and 9, Tables A1 and A2)

- Mean, maximum, and minimum statewide temperatures in September (69.7, 79.6, and 59.7°F) were above the long-term (1895-2022) averages and within 25% of the highest values. September's precipitation (4.52 in) was above the long-term average but away from the record.
- So far this year, Maryland (statewide) has had 47 hot days (daily maximum temperature larger than 86°F) and 10 heat waves (two or more consecutive hot days), surpassing the annual mean of 44 hot days and 9 heat waves during 1951-2022. Similarly, Maryland (statewide) had 31 warm nights (daily minimum temperature larger than 68°F) and 7 spells of two or more consecutive warm nights; this is more than the annual mean of 22 warm nights and 5 warm spells during 1951-2022.

Century-Plus Trends, 1895-2023 (Figures 10, 11)

- Statewide temperature and cooling degree days in September showed significant trends: a warming trend (1.2°F/century) and an increasing trend (26.3°FDD/century), respectively. Statewide precipitation had a significant wetting trend (1.04 in/century).
- Regionally, September mean temperatures showed significant warming trends to the east and south of the Blue Ridge. Notably, the largest trend is in Baltimore City (2.2°F/century), as has been the case for the previous months since April. Trends of above 1.2°F/century are also evident along the counties of the eastern shore.
- Regionally, September precipitation had significant wetting trends almost everywhere. In particular, northern Frederick, Harford, and Cecil counties (1.4 in/century) and Charles, Saint Mary's, and Calvert counties (around 1.2 in/century).

Contents

1.   Introduction

The Maryland Climate Bulletin is issued by the Maryland State Climatologist Office (MDSCO), which resides in the Department of Atmospheric and Oceanic Science at the University of Maryland, College Park. It documents the surface climate conditions observed across the state in a calendar month and is issued in the second week of the following month.

Maryland's geography is challenging, with the Allegheny and Blue Ridge mountains to the west, Piedmont Plateau in the center, the Chesapeake Bay, and the Atlantic Coastal Plain to the east. The range of physiographic features and the eastern placement of the state within the expansive North American continent contribute to a comparatively wide range of climatic conditions.

The bulletin seeks to document and characterize monthly surface climate conditions statewide, and climate division and county-wise, placing them in the context of regional and continental climate variability and change to help Marylanders interpret and understand recent climate conditions.

The monthly surface climate conditions for September 2023 are presented via maps of key variables, such as average surface air temperature, maximum surface air temperature, minimum surface air temperature, total precipitation, and their anomalies (i.e., departures from normal); they are complemented by drought conditions for the state, as given by the U.S. Drought Monitor (Section 3). Statewide and climate division averages for the month are compared against each other via scatter plots (Section 4). The monthly statewide averages are placed in the context of the historical record via box and whisker plots in Section 5. Extreme heat, detrimental to crops without irrigation and population lacking air conditioning, is tracked by the count of hot days, warm nights, and their consecutive occurrence (identified from daily statewide-averaged temperatures – e.g., Tschurr et al. 2020, Barriopedro et al. 2023) and displayed in Section 6. Century-plus trends in statewide air temperature, cooling degree-days, precipitation, and state maps of air temperature and precipitation are presented in Section 7. Ancillary statewide, climate division, and county-level information is provided via tables and plots in Appendices A-B; climatology and variability maps are in Appendices C-D.

2.   Data

Surface air temperatures, total precipitation, and cooling degree-days data in this report are from the following sources:

- NOAA Monthly U.S. Climate *Gridded* Dataset at 5-km horizontal resolution (NClimGrid – Vose et al. 2014), which is available in a preliminary status at https://www.ncei.noaa.gov/data/nclimgrid-monthly/access/ Data was downloaded on 10/12/2023.

- NOAA Monthly U.S. Climate *Divisional* Dataset (NClimDiv – Vose et al. 2014), which is available in a preliminary status (v1.0.0-20231005) at: https://www.ncei.noaa.gov/pub/data/cirs/climdiv/ Data was downloaded on 10/12/2023.

- NOAA Area averages of daily temperatures and precipitation dataset (NClimGrid−Daily −Durre et al. 2022, 2022a), which is available in a preliminary status (v1.0.0) at: https://www.ncei.noaa.gov/pub/data/daily-grids/v1-0-0/ Data was downloaded on 10/12/2023.

The drought conditions are from the U.S. Drought Monitor website: https://droughtmonitor.unl.edu/Maps/MapArchive.aspx

Some definitions:

About the anomalies: Anomalies for a given month (e.g., September 2023) are the departures of the monthly value from the corresponding month's 30-year average (i.e., from the average of 30 Septembers) during 1991-2020; the 30-year average (or mean) is the climate normal, or just the climatology. When the observed monthly value exceeds its climatological value, it is referred to as above-normal (e.g., warmer than normal or wetter than normal) or a positive anomaly. In contrast, when this value is smaller than its climatological value, it is referred to as below-normal (e.g., colder than normal or drier than normal) or negative anomaly.

About NOAA's Climate Divisions. The term "climate division" refers to one of the eight divisions in the state that represent climatically homogeneous regions, as determined by NOAA: https://www.ncei.noaa.gov/access/monitoring/dyk/us-climate-divisions

The eight climate divisions in Maryland are:

- Climate Division 1: Southeastern Shore. It includes the counties of Somerset, Wicomico, and Worcester.
- Climate Division 2: Central Eastern Shore. It includes the counties of Caroline, Dorchester, and Talbot.
- Climate Division 3: Lower Southern. It includes the counties of Calvert, Charles, and St. Mary's.
- Climate Division 4: Upper Southern. It includes the counties of Anne Arundel and Prince George's.
- Climate Division 5: Northeastern Shore. It includes the counties of Kent and Queen Anne's.
- Climate Division 6: North Central. It includes the counties of Baltimore, Carroll, Cecil, Frederick, Harford, Howard, Montgomery, and the city of Baltimore.

- Climate Division 7: Appalachian Mountains. It includes the counties of Allegany and Washington.
- Climate Division 8: Allegheny Plateau. It includes Garrett County.

Note that these Climate Divisions do not correspond with the *Physiographic Provinces* in the state, as the former follow county lines. Climate Division 8 follows the *Appalachian Plateau Province*, Climate Division 7 follows the *Ridge and Valley Province*; however, Climate Division 6 includes the *Blue Ridge and the Piedmont Plateau provinces,* Climate Divisions 3, 4, and a portion of 6 include the *Upper Coastal Plain Province*, and Climate Divisions 1, 2, 5, and a portion of 6 include the *Lower Coastal Plain (or Atlantic Continental Shelf) Province*.

3.   September 2023 Maps
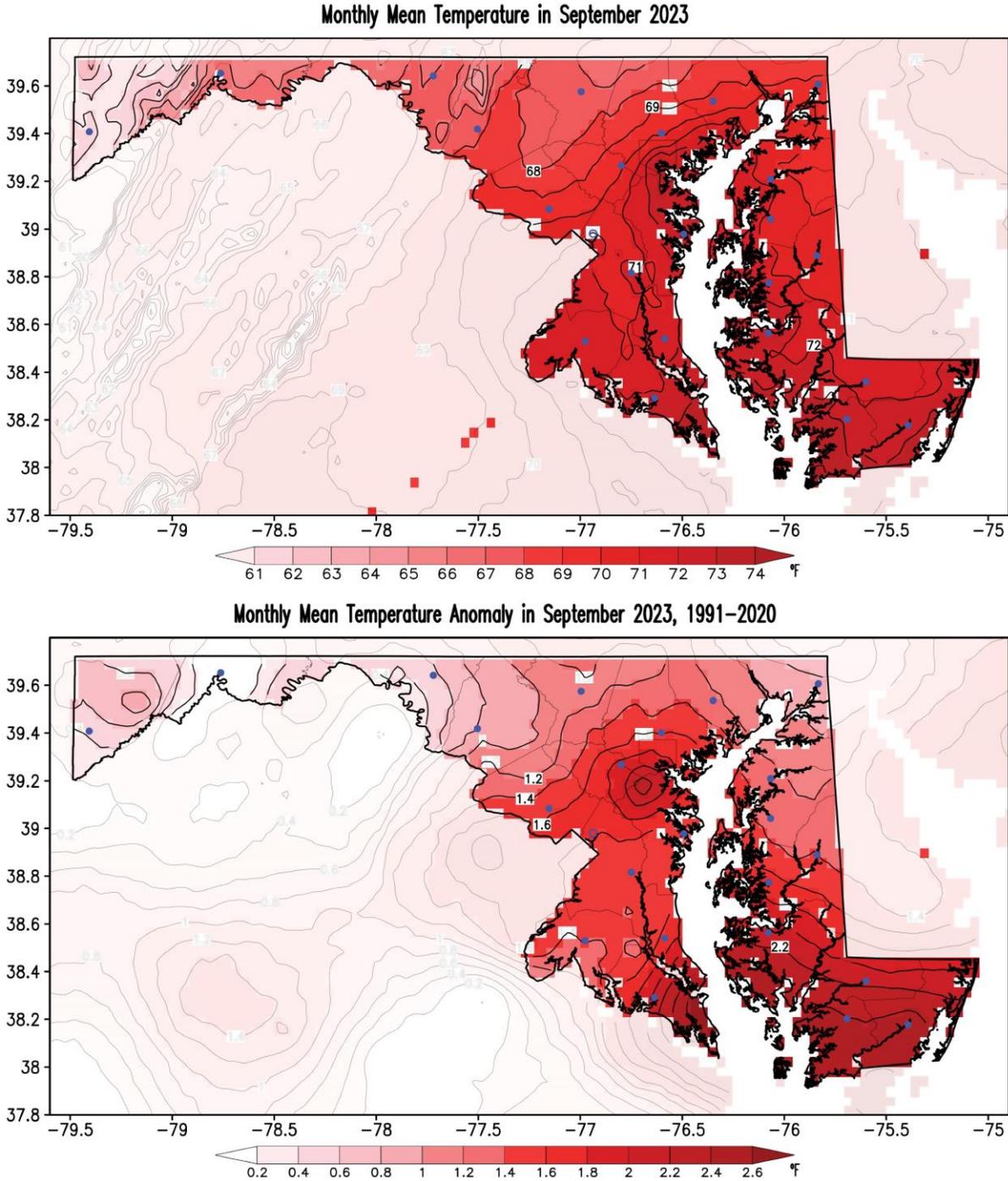
A.   Mean Temperatures

Figure 1. Monthly mean surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) for September 2023. Temperatures are in °F following the color bar. Red shading in the anomaly map marks warmer than normal conditions. Note shading outside the state has been washed out to facilitate focusing on Maryland. Filled blue circles mark the county seats.

B.   Maximum Temperatures

Figure 2. Monthly maximum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) for September 2023. Temperatures are in °F following the color bar. Blue/red shading in the anomaly map marks colder/warmer than normal conditions. Note shading outside the state has been washed out to facilitate focusing on Maryland. Filled blue circles mark the county seats.
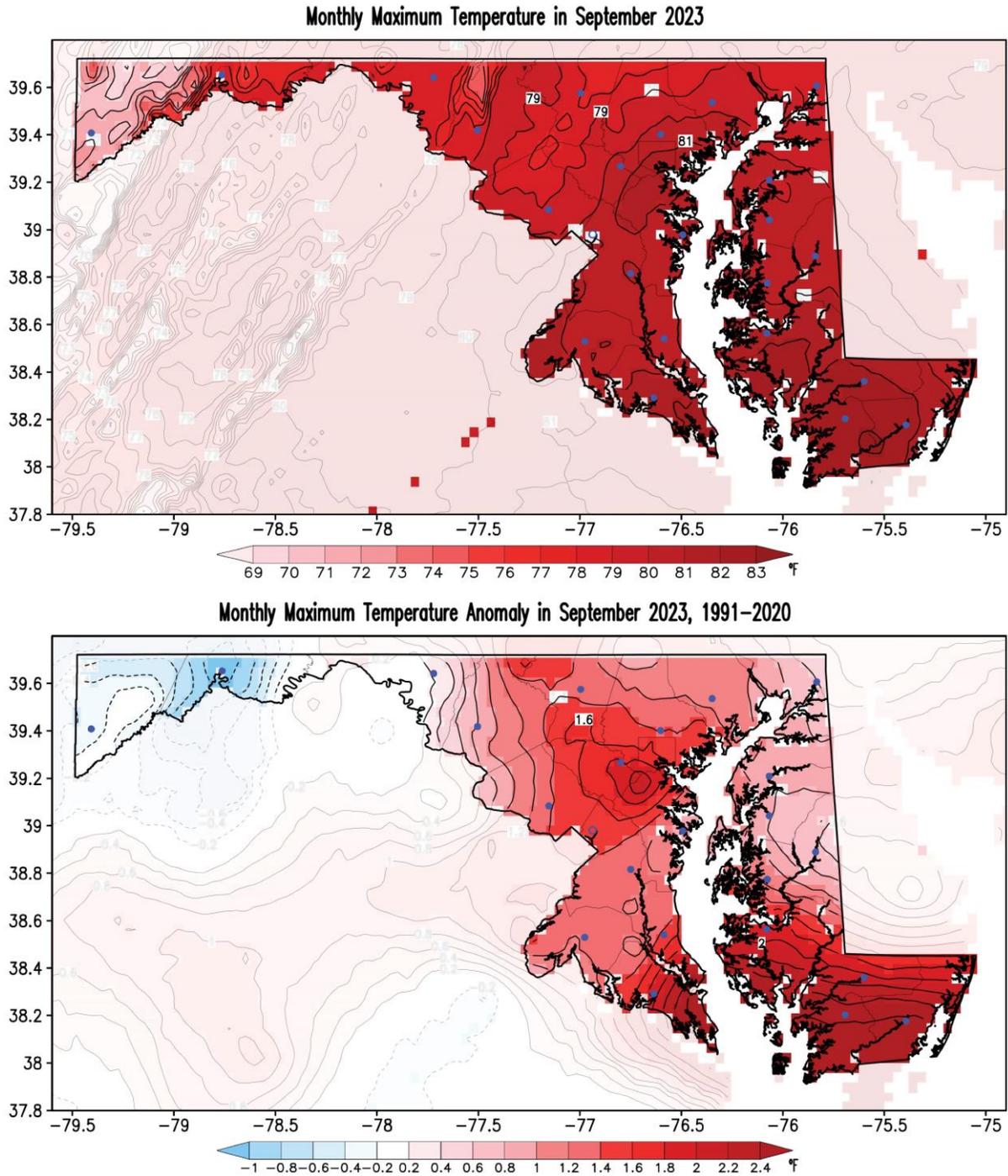
C.   Minimum Temperatures

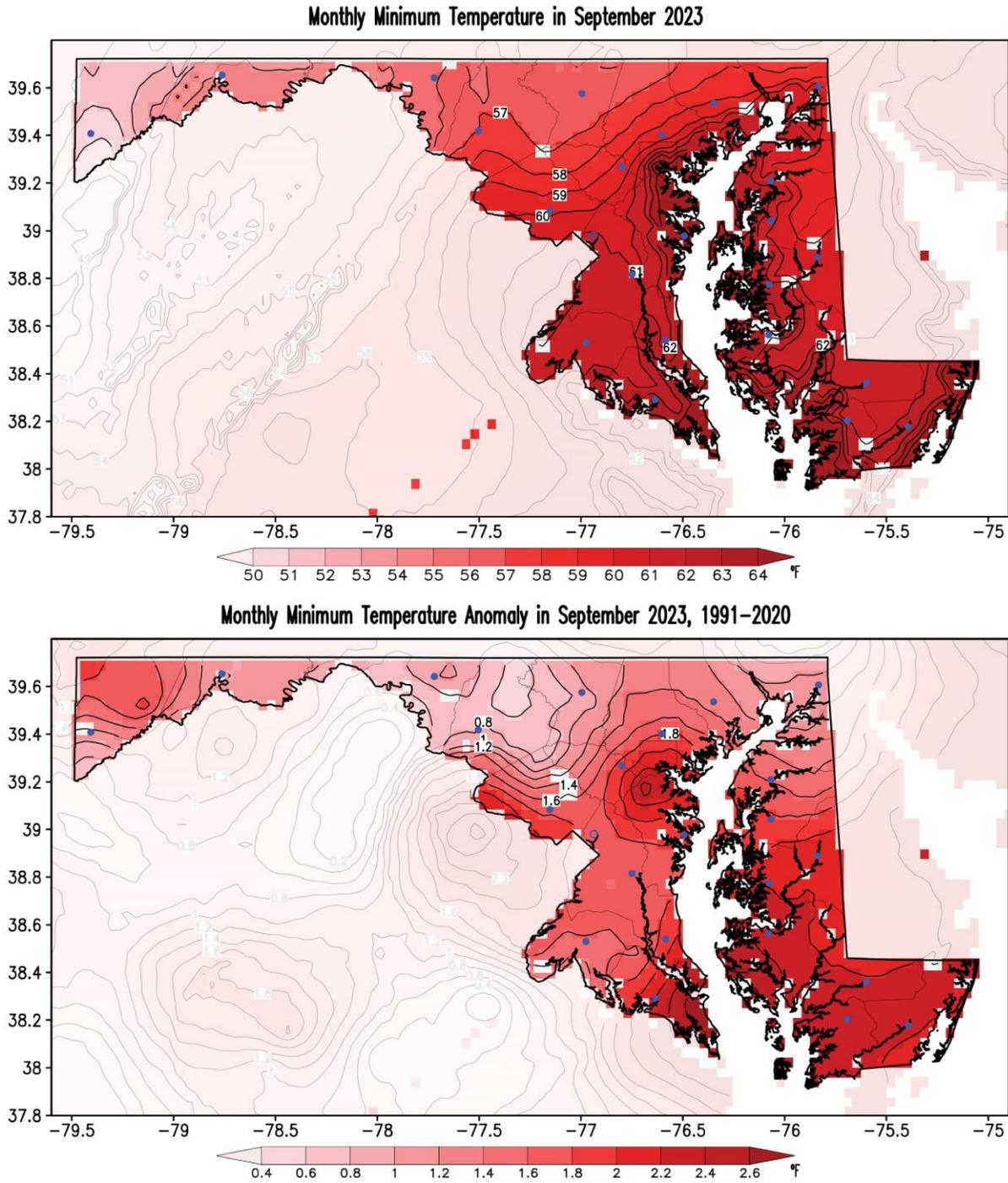**Figure 3.** Monthly minimum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) for September 2023. Temperatures are in °F following the color bar. Red shading in the anomaly map marks warmer than normal conditions. Note shading outside the state has been washed out to facilitate focusing on Maryland. Filled blue circles mark the county seats.

D.   Precipitation

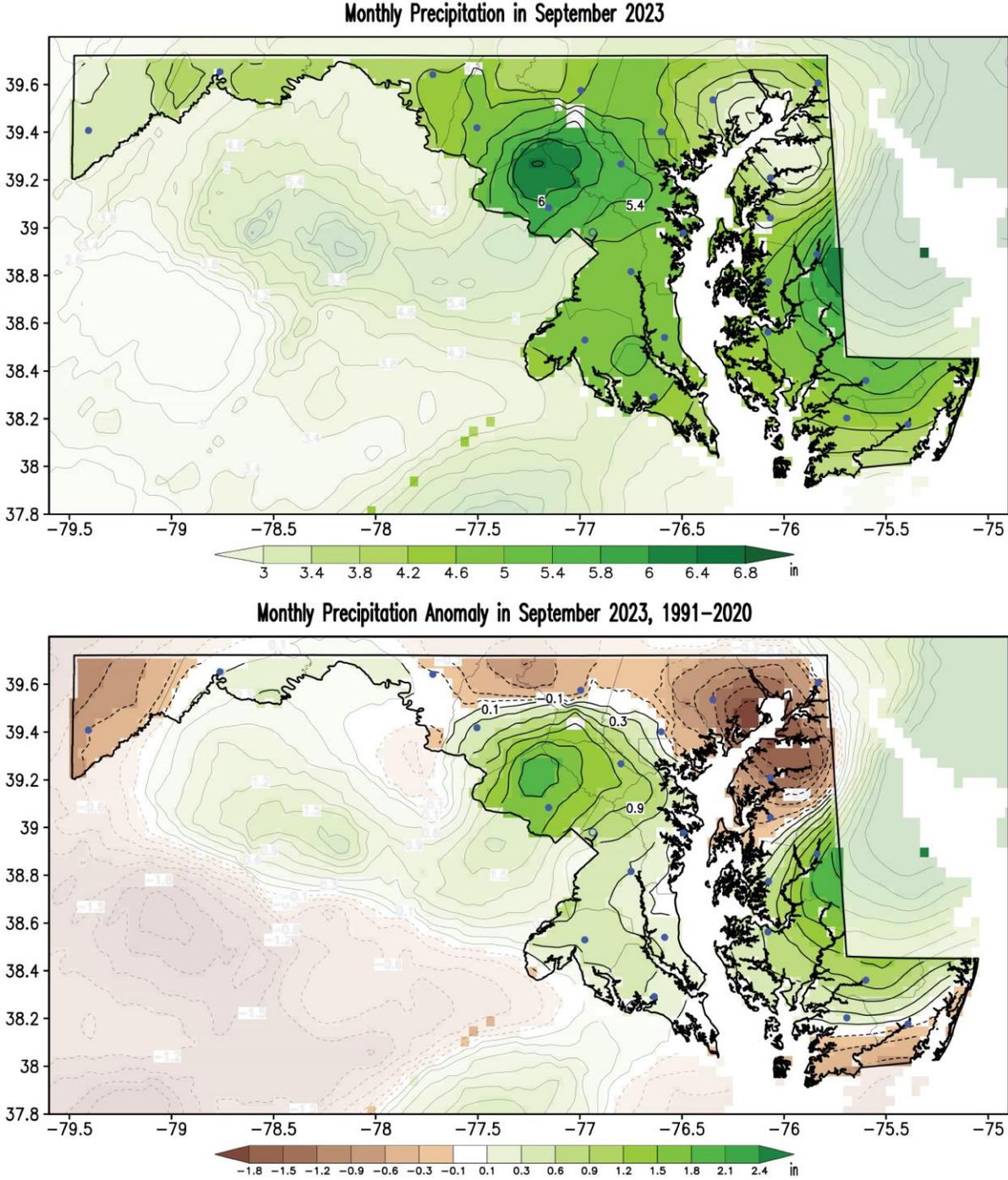**Figure 4.** Monthly total precipitation (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) for September 2023. Precipitation is in inches following the color bar. Brown/green shading in the anomaly map marks drier/wetter than normal conditions. Note shading outside the state has been washed out to facilitate focusing on Maryland. Filled blue circles mark the county seats.

E.   Drought

U.S. Drought Monitor
Maryland

October 3, 2023
(Released Thursday, Oct. 5, 2023)
Valid 8 a.m. EDT
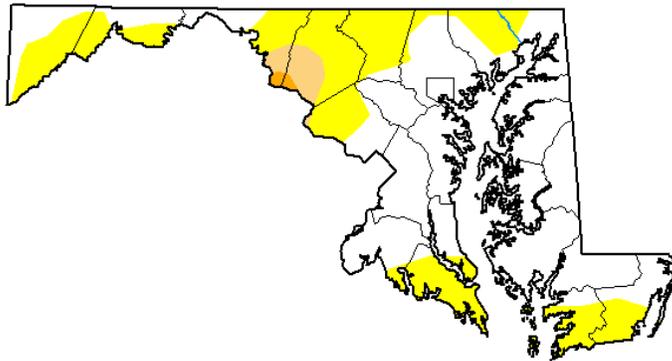
Drought Conditions (Percent Area)

	None	D0	D1	D2	D3	D4
Current	64.56	32.13	2.83	0.47	0.00	0.00
Last Week 09-26-2023	63.11	33.59	2.83	0.47	0.00	0.00
3 Months Ago 07-04-2023	15.41	30.38	36.73	17.49	0.00	0.00
Start of Calendar Year 01-03-2023	100.00	0.00	0.00	0.00	0.00	0.00
Start of Water Year 09-26-2023	63.11	33.59	2.83	0.47	0.00	0.00
One Year Ago 10-04-2022	93.24	6.76	0.00	0.00	0.00	0.00

Intensity:

None	D2 Severe Drought
D0 Abnormally Dry	D3 Extreme Drought
D1 Moderate Drought	D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions.
Local conditions may vary. For more information on the
Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

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droughtmonitor.unl.edu

Figure 5. Drought conditions as reported by the U.S. Drought Monitor on October 3, 2023. Yellow shading indicates abnormally dry regions, light orange shading shows regions under moderate drought, and darker orange shows areas under severe drought. Numbers in the table indicate the percentage of the state covered under the particular drought condition at the cited time in the left column. At this time, 35.43% of the state was under some drought category, which was an increase with respect to the 26.27% of the state under drought conditions at the end of August.

4. September and JAS 2023 Climate Divisions Averages

A. September 2023 Scatter Plots

Figure 6. Scatter plots of Maryland (statewide) and Climate Divisions (CD#) monthly mean surface air temperature vs. total precipitation for September 2023. The upper panel shows the mean temperature and total precipitation, and the bottom panel displays their anomalies with respect to the 1991-2020 climatology. Temperatures are in °F and precipitation is in inches. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (5.10 inches in CD2, top panel) and by the maximum precipitation anomaly (1.04 inches in CD2, bottom panel) among the nine regions. Note that the color of the filled circles corresponds to the color in the Climate Divisions according to the inset map.

B.   July-September 2023 Scatter Plots

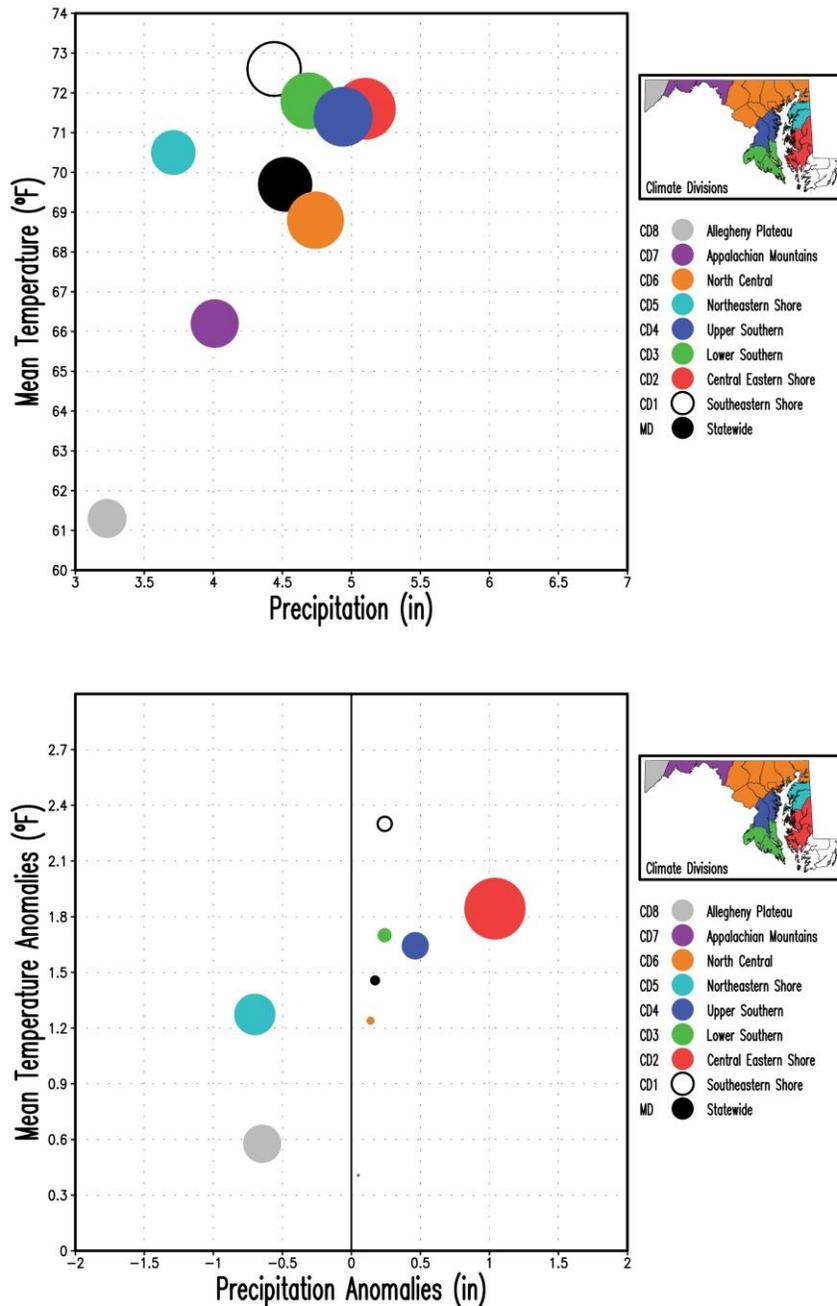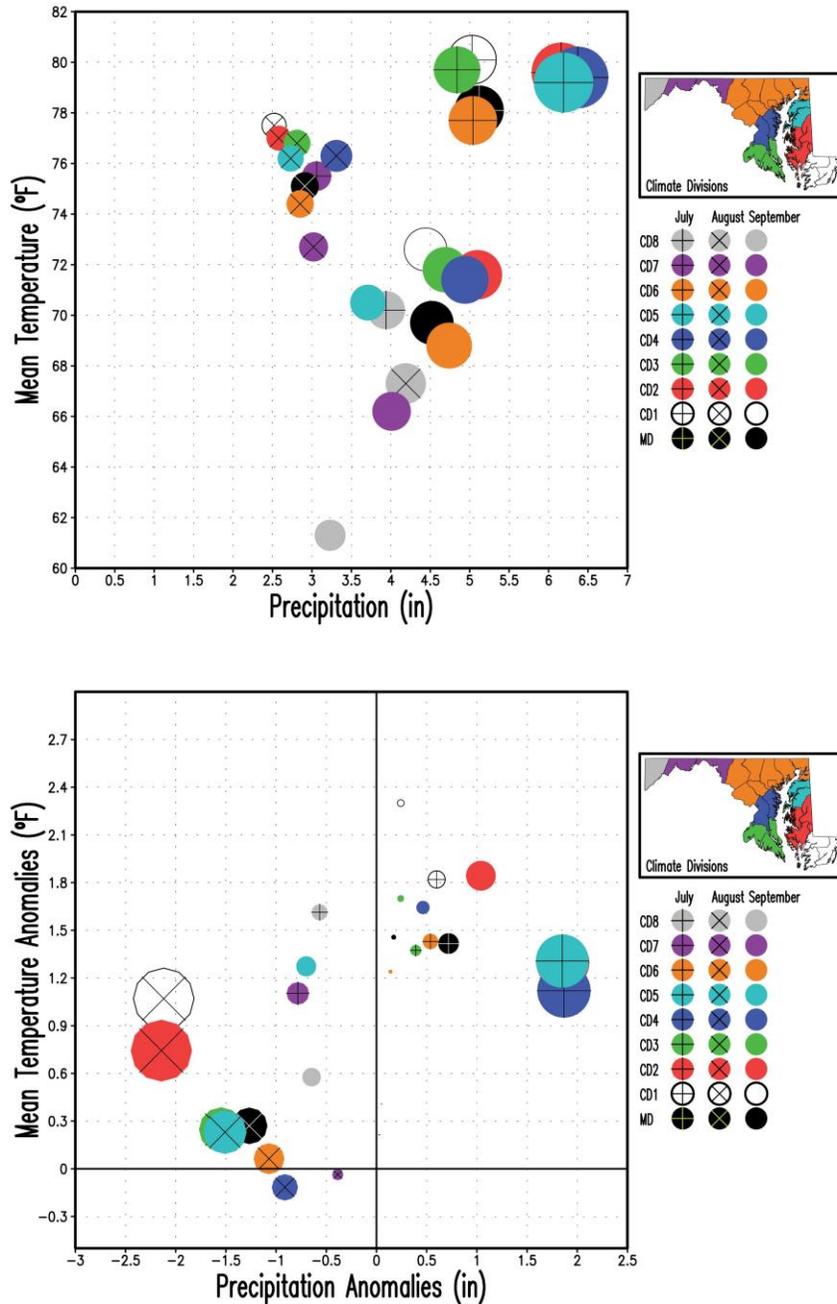**Figure 7**. Scatter plots of Maryland (statewide) and Climate Divisions (CD#) monthly mean surface air temperature vs. total precipitation for July, August, and September 2023. The upper panel shows the mean temperature and total precipitation, and the bottom panel displays their anomalies with respect to the 1991-2020 climatology. Temperatures are in °F, and precipitation is in inches. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (6.37 inches in CD4 in July, top panel) and by the maximum precipitation anomaly (|-2.14| inches in CD2 in August, bottom panel) among the nine regions and three months. September is displayed with filled circles only, while August and July are displayed with superposed multiplication and addition signs, respectively.

5. September 2023 Statewide Averages in the Historical Record

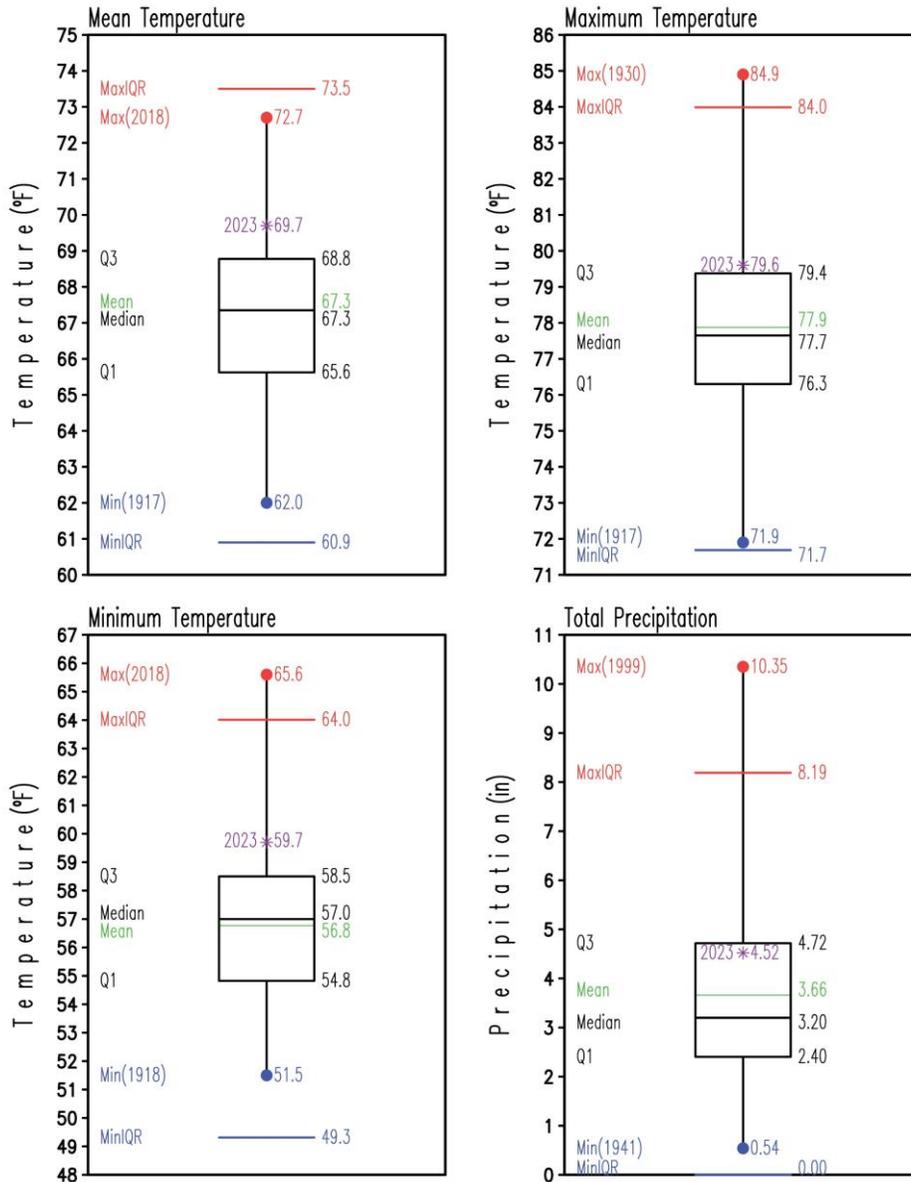## A. Box and Whisker Plots

Figure 8. Box and Whisker plots of Maryland (statewide) monthly mean (upper left), maximum (upper right), minimum (lower left) surface air temperatures, and total precipitation (lower right) for September for the period 1895-2022. The label and asterisk in purple represent conditions for September 2023. Statistics for the period 1895-2022 are labeled at the left side of each box and whisker plot and their values at their right. Temperatures are in °F and precipitation is in inches. The mean is the green line within the box, while the median is the black line within the box. The lower (Q1) and upper (Q3) quartiles, indicating the values of the variable that separate 25% of the smallest and largest values are the lower and upper horizontal black lines of the box, respectively. The blue and red dots mark the minimum and maximum values in the period at the end of the whiskers; the year of occurrence is shown in parenthesis. The blue and red horizontal lines represent extreme values defined by Q1-1.5×(Q3-Q1) and Q3+1.5×(Q3-Q1), respectively.
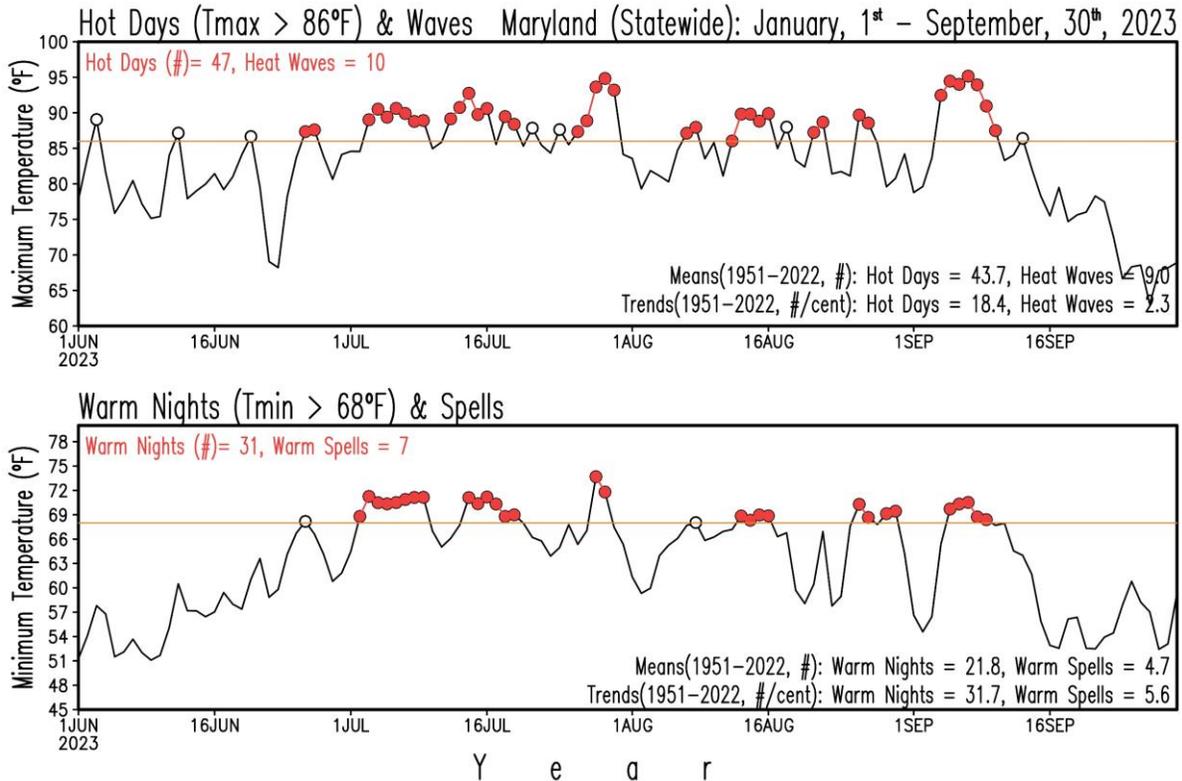
6. Hots Days and Warm Nights in 2023

Figure 9. Maryland (statewide) number of hot days, warm nights, and their consecutive occurrence for the period January 1 - September 30, 2023. A hot day is defined as one when the maximum temperature is greater than 86°F, while a warm night is when the minimum temperature is greater than 68°F. When these conditions persist for two or more days, they are called heat waves (daytime) and warm spells (nighttime). Upper panel shows hot days in open circles and heat waves in red-filled circles from daily maximum temperatures. Lower panel shows warm nights in open circles and warm spells in red-filled circles from daily minimum temperatures. The orange line in each panel marks the threshold temperatures of 86°F and 68°F for each case. By the end of September, the number of hot days and heat waves was 47 and 10, respectively; for reference, the annual means are 43.7 hot days and 9 heat waves, respectively, for the period 1951-2022. Similarly, by the end of September, the number of warm nights and warm spells was 31 and 7, respectively; for reference, the annual means are 21.8 warm nights and 4.7 warm spells, respectively, for the same 1951-2022 period. Linear trends obtained from the same period indicate increasing trends of 18.4 hot days/century, 2.3 heat waves/century, 31.7 warm nights/century, and 5.6 warm spells/century. Humans, animals, and plants are sensitive to extreme heat. Crops without irrigation and populations without air conditioning, especially pregnant women, children, the elderly, and the sick, are very vulnerable to heat waves and warm spells. The threshold temperatures are an attempt to track the extreme heat for crops and humans (e.g., Tschurr et al. 2020, Barriopedro et al. 2023). For reference, in July, the climatological (1991-2020) monthly maximum and minimum temperatures reach maximum values of 86.9°F and 66.5°F, respectively; the 90th-percentile values for the period 1951-2022 of the daily maximum and minimum temperatures are 86.9°F and 66.1°F, respectively.

7. 1895-2023 September Trends

A. Statewide Mean Temperature, Cooling Degree-Days, and Precipitation
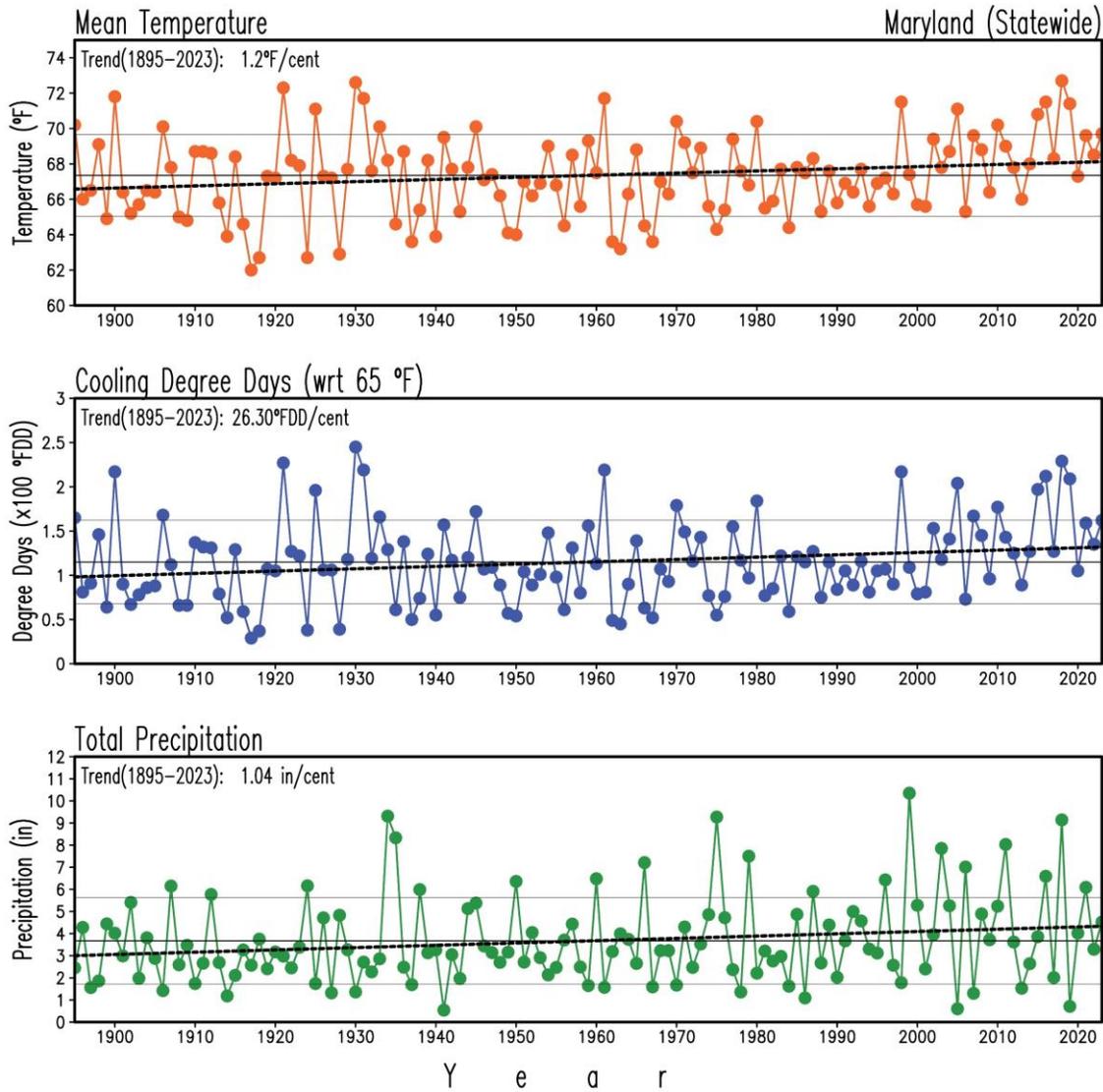

Figure 10. Maryland (statewide) mean surface air temperature, cooling degree-days, and precipitation in September for the period 1895-2023. Temperature is in °F, cooling degree-days is in °F degree-days (°FDD), and precipitation is in inches. The thin, continuous black lines in each panel display the long-term means (67.3°F, 115.01°FDD, and 3.67 in, 1895-2023), and the double thin, continuous gray lines indicate the standard deviation (2.3°F, 47.28°FDD, and 1.96 in) above/below the long-term mean. The thick dashed black lines show the long-term linear trend. Degree-days are the difference between the daily mean temperature (high temperature plus low temperature divided by two) and 65°F. It gives a general idea of how much energy is required to cool buildings; because energy demand is cumulative, degree-day totals for a month are the sum of each individual day's degree-day total (CPC, 2023). The warming temperature trend (1.2°F/century), and the increasing cooling degree-days trend (26.30°FDD/century) are statistically significant at the 95% level (*Student's t-test* −Santer et al. 2000) as well as the precipitation wetting trend (1.04 in/century).

B.   Temperature and Precipitation Maps

Linear Trends in Monthly Mean Temperature in September, 1895–2023

Linear Trends in Monthly Total Precipitation in September, 1895–2023
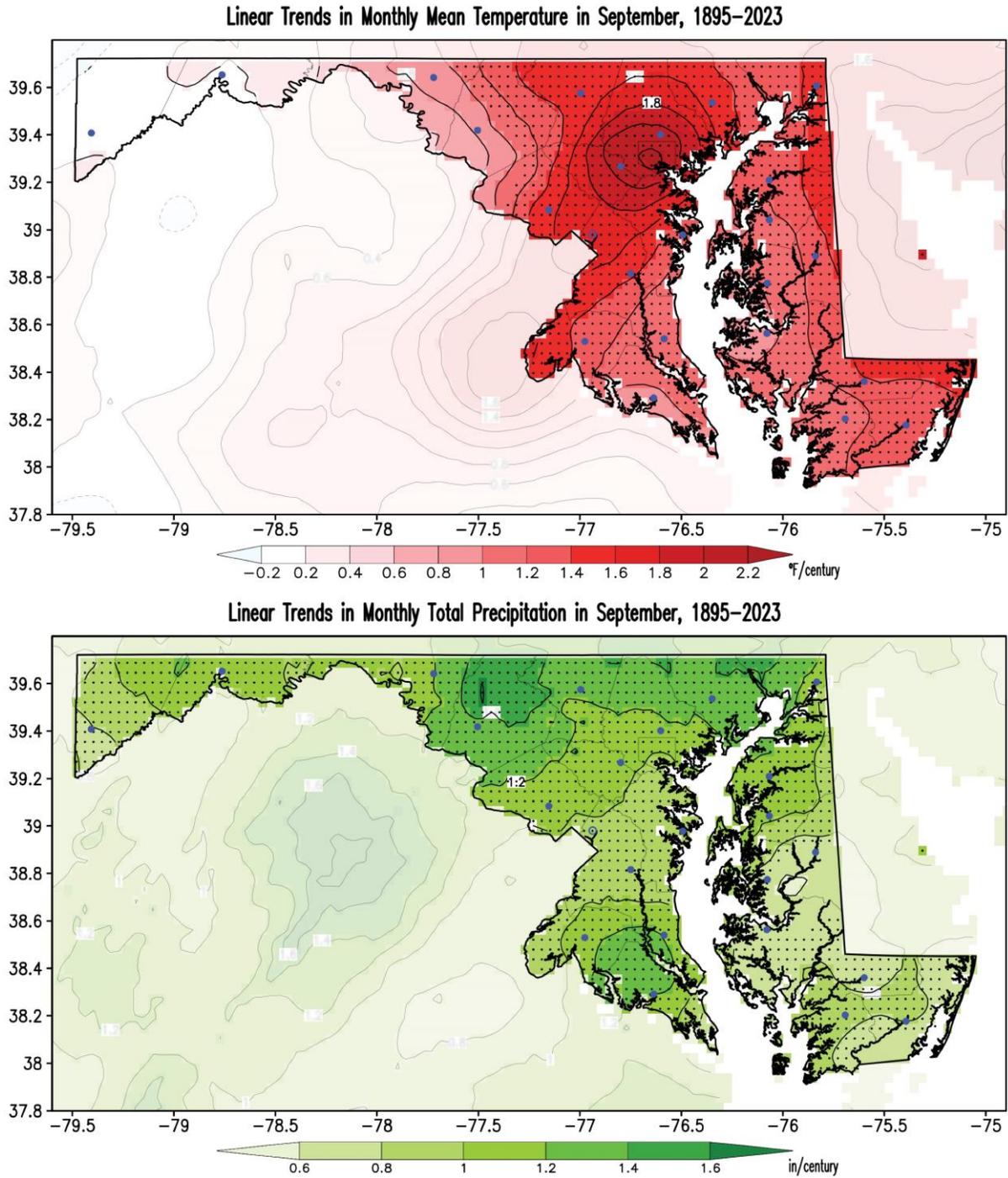
Figure 11. Linear trends in surface air mean temperature and precipitation in September for the period 1895-2023. Temperatures are in °F/century, and precipitation is in inches/century following the color bars. Blue/red shading in the temperature map marks cooling/warming trends. Green shading in the precipitation map shows wetting trends. Stippling in the maps shows regions where trends are statistically significant at the 95% level (*Student's t-test* −Santer et al. 2000). Note that shading outside the state has been washed out to facilitate focusing on Maryland. Filled blue circles mark the county seats.

Appendix A. September 2023 Data Tables: Statewide, Climate Divisions, and Counties

A. Mean Temperature and Precipitation

Region	Mean Air Temperature (°F)	Rank (#)	Region	Total Precipitation (in)	Rank (#)
Statewide	69.7	110	Statewide	4.52	95
Climate Division 1	72.6	116	Climate Division 1	4.44	98
Climate Division 2	71.6	110	Climate Division 2	5.10	104
Climate Division 3	71.8	110	Climate Division 3	4.69	96
Climate Division 4	71.4	112	Climate Division 4	4.94	96
Climate Division 5	70.5	105	Climate Division 5	3.71	76
Climate Division 6	68.8	106	Climate Division 6	4.74	94
Climate Division 7	66.2	87	Climate Division 7	4.01	97
Climate Division 8	61.3	83	Climate Division 8	3.23	71
Allegany	65.5	79	Allegany	3.84	95
Anne Arundel	71.8	113	Anne Arundel	4.99	97
Baltimore	69.3	110	Baltimore	4.69	88
Baltimore City	71.7	113	Baltimore City	4.90	91
Calvert	71.8	110	Calvert	4.71	96
Caroline	70.5	108	Caroline	5.57	108
Carroll	67.5	105	Carroll	4.79	92
Cecil	69.4	104	Cecil	3.68	73
Charles	71.4	106	Charles	4.79	94
Dorchester	72.3	114	Dorchester	4.79	103
Fredrick	67.7	99	Fredrick	4.80	100
Garrett	61.3	83	Garrett	3.24	72
Harford	69.4	103	Harford	3.59	69
Howard	69.1	111	Howard	5.82	107
Kent	70.6	105	Kent	3.33	68
Montgomery	69.2	110	Montgomery	5.84	110
Prince George's	71.0	110	Prince George's	4.94	95
Queen Anne's	70.6	107	Queen Anne's	3.92	79
Saint Mary's	72.3	111	Saint Mary's	4.57	98
Somerset	73.2	118	Somerset	4.05	90
Talbot	71.6	109	Talbot	4.72	96
Washington	66.9	92	Washington	4.17	96
Wicomico	72.0	116	Wicomico	5.05	107
Worcester	72.6	115	Worcester	4.31	92

Table A1. Monthly mean surface air temperature (left) and total precipitation (right) at Maryland (statewide), climate division, and county levels for September 2023. Temperatures are in °F, and precipitation is in inches. The rank is the order that the variable for September 2023 occupies among the 129 Septembers after the 129 values have been arranged from the lowest to the highest in the *standard competition ranking method*. The closer to 129 the rank is, the larger (i.e., the warmer/wetter) the value of the surface variable is in the record; similarly, the closer to 1 the rank is, the smaller (i.e., the colder/drier) the value of the surface variable is in the record.

B.   Maximum and Minimum Temperatures

Region	Maximum Air Temperature (°F)	Rank (#)	Region	Minimum Air Temperature (°F)	Rank (#)
Statewide	79.6	102	**Statewide**	59.7	113
Climate Division 1	82.1	115	**Climate Division 1**	63.1	115
Climate Division 2	81.3	106	**Climate Division 2**	61.9	118
Climate Division 3	81.1	103	**Climate Division 3**	62.4	113
Climate Division 4	80.8	103	**Climate Division 4**	61.9	115
Climate Division 5	80.1	90	**Climate Division 5**	60.8	113
Climate Division 6	79.1	105	**Climate Division 6**	58.5	108
Climate Division 7	77.5	67	**Climate Division 7**	54.8	94
Climate Division 8	71.3	52	**Climate Division 8**	51.3	103
Allegany	76.8	58	**Allegany**	54.1	98
Anne Arundel	80.8	103	**Anne Arundel**	62.7	117
Baltimore	79.6	104	**Baltimore**	59.0	111
Baltimore City	81.1	109	**Baltimore City**	62.3	119
Calvert	80.9	104	**Calvert**	62.6	114
Caroline	80.6	96	**Caroline**	60.4	116
Carroll	78.5	104	**Carroll**	56.5	106
Cecil	79.0	96	**Cecil**	59.7	107
Charles	81.0	99	**Charles**	61.8	112
Dorchester	81.9	110	**Dorchester**	62.6	119
Fredrick	78.5	97	**Fredrick**	56.9	96
Garrett	71.3	51	**Garrett**	51.3	103
Harford	79.4	98	**Harford**	59.4	108
Howard	79.6	109	**Howard**	58.7	113
Kent	80.0	91	**Kent**	61.2	115
Montgomery	79.2	102	**Montgomery**	59.3	112
Prince George's	80.8	103	**Prince George's**	61.2	114
Queen Anne's	80.2	92	**Queen Anne's**	60.9	115
Saint Mary's	81.5	108	**Saint Mary's**	63.2	116
Somerset	82.5	116	**Somerset**	63.9	116
Talbot	80.7	97	**Talbot**	62.4	114
Washington	78.2	83	**Washington**	55.5	93
Wicomico	82.0	111	**Wicomico**	62.0	116
Worcester	81.9	118	**Worcester**	63.3	113

Table A2. Monthly maximum (left) and minimum (right) surface air temperatures at Maryland (statewide), climate division, and county levels for September 2023. Temperatures are in °F. The rank is the order that the variable for September 2023 occupies among the 129 Septembers after the 129 values have been arranged from the lowest to the highest using the *standard competition ranking method*. The closer to 129 the rank is, the larger (i.e., the warmer) the value of the surface variable is in the record; similarly, the closer to 1 the rank is, the smaller (i.e., the colder) the value of the surface variable is in the record.

Appendix B. September 2023 Bar Graphs: Statewide, Climate Divisions, and Counties

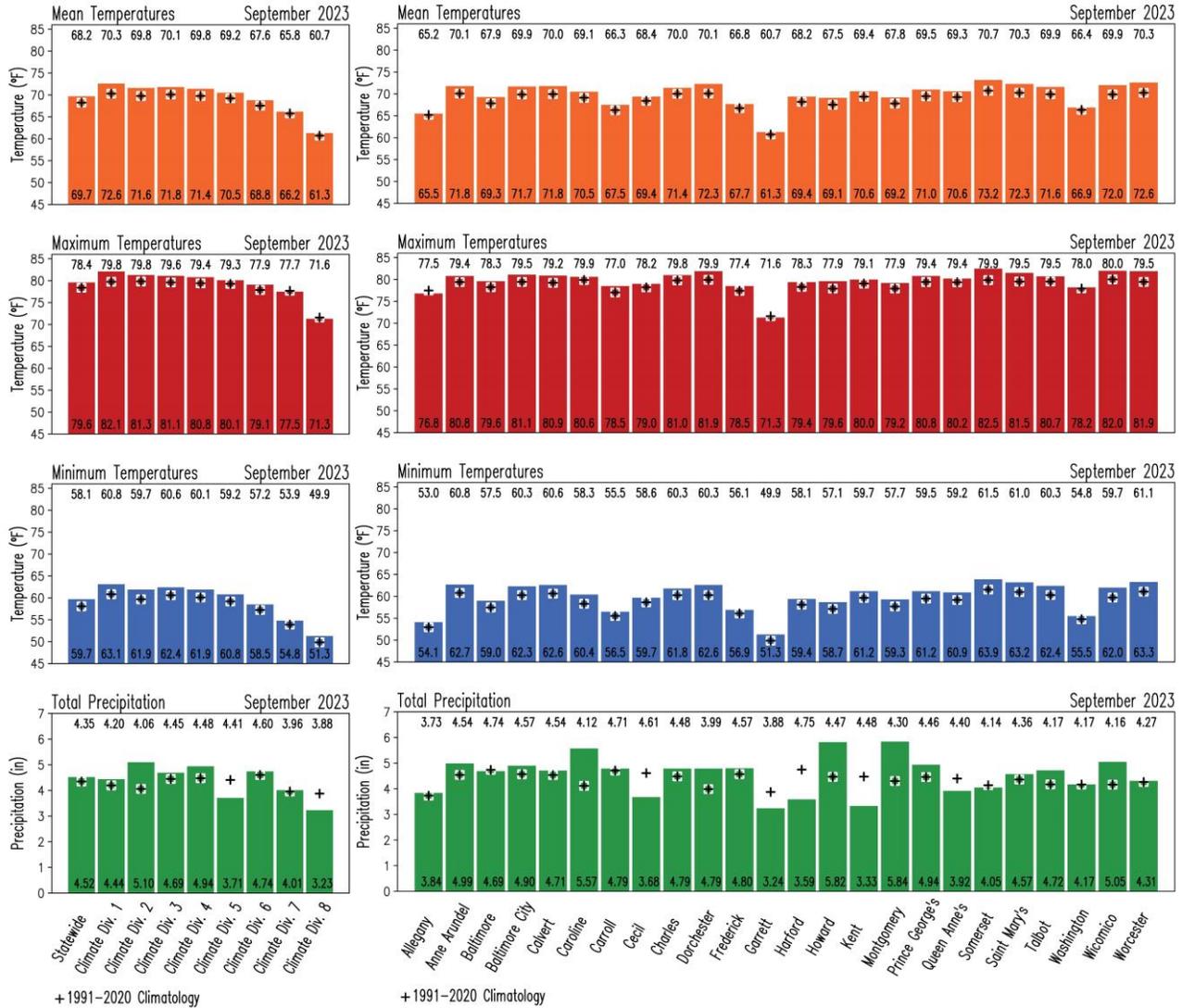A. Temperatures and Precipitation

Figure B1. Monthly surface variables in Maryland for September 2023. Color bars represent the variables as follows: mean surface air temperature (orange), maximum surface air temperature (red), minimum surface air temperature (blue) and total precipitation (green) at statewide and climate division (left column), and at county (right column) levels. Temperatures are in °F and precipitation is in inches. The numbers at the base of the bars indicate the magnitude of the variable for September 2023. For comparison, the corresponding 1991-2020 climatological values for September are displayed as black addition signs, and their magnitude are shown at the top of the panels.
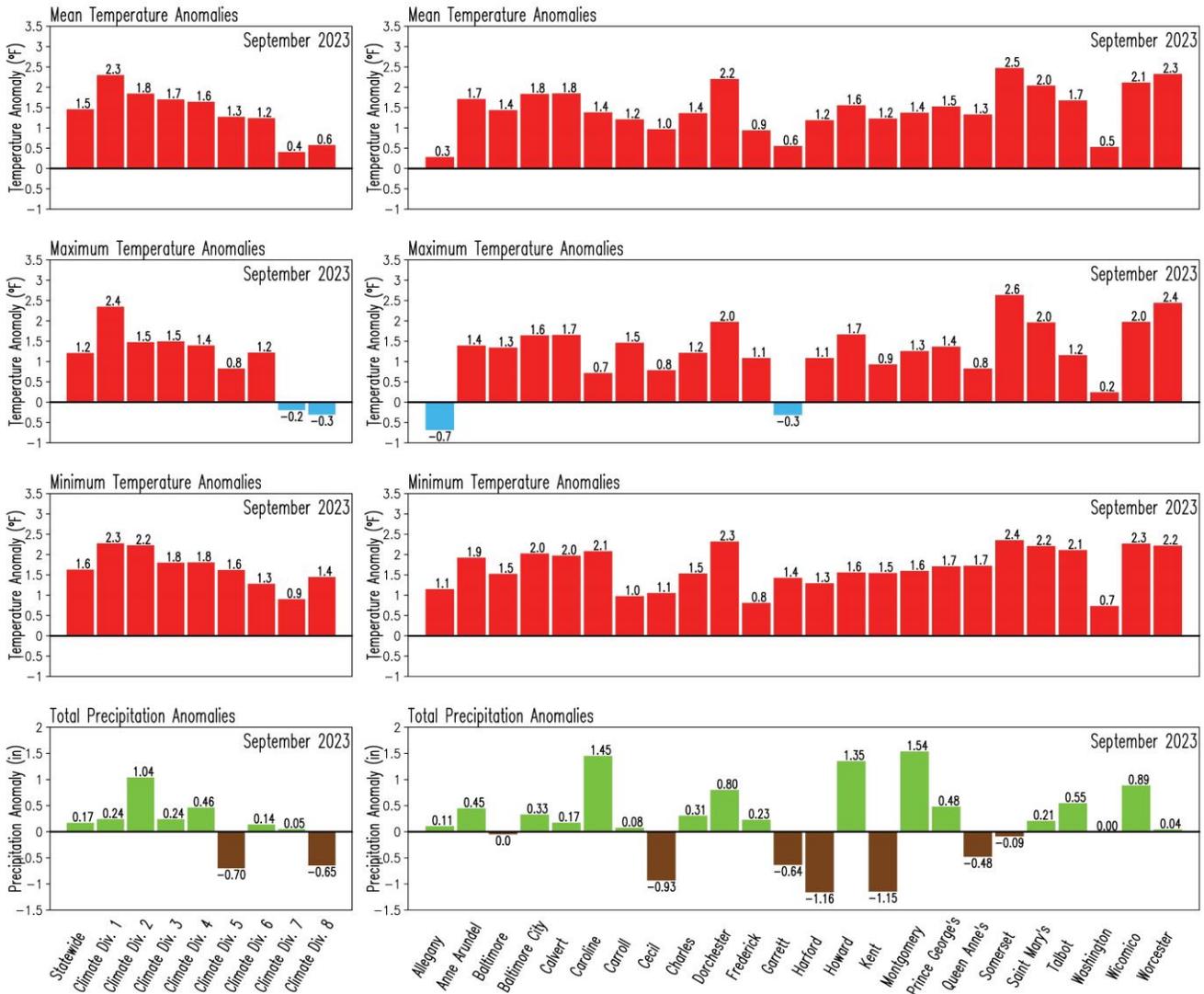
B.   Temperatures and Precipitation Anomalies

Figure B2. Anomalies of the monthly surface variables in Maryland for September 2023. Anomalies are with respect to the 1991-2020 climatology. Red/blue color represents positive/negative anomalies for mean surface air temperature (upper row), maximum surface air temperature (second row from top), and minimum surface air temperature (third row from top), while green/brown color indicates positive/negative anomalies in total precipitation (bottom row) at statewide and climate division (left column), and at county (right column) levels. Temperatures are in °F, and precipitation is in inches. The numbers outside of the bars indicate the magnitude of the anomaly for September 2023.

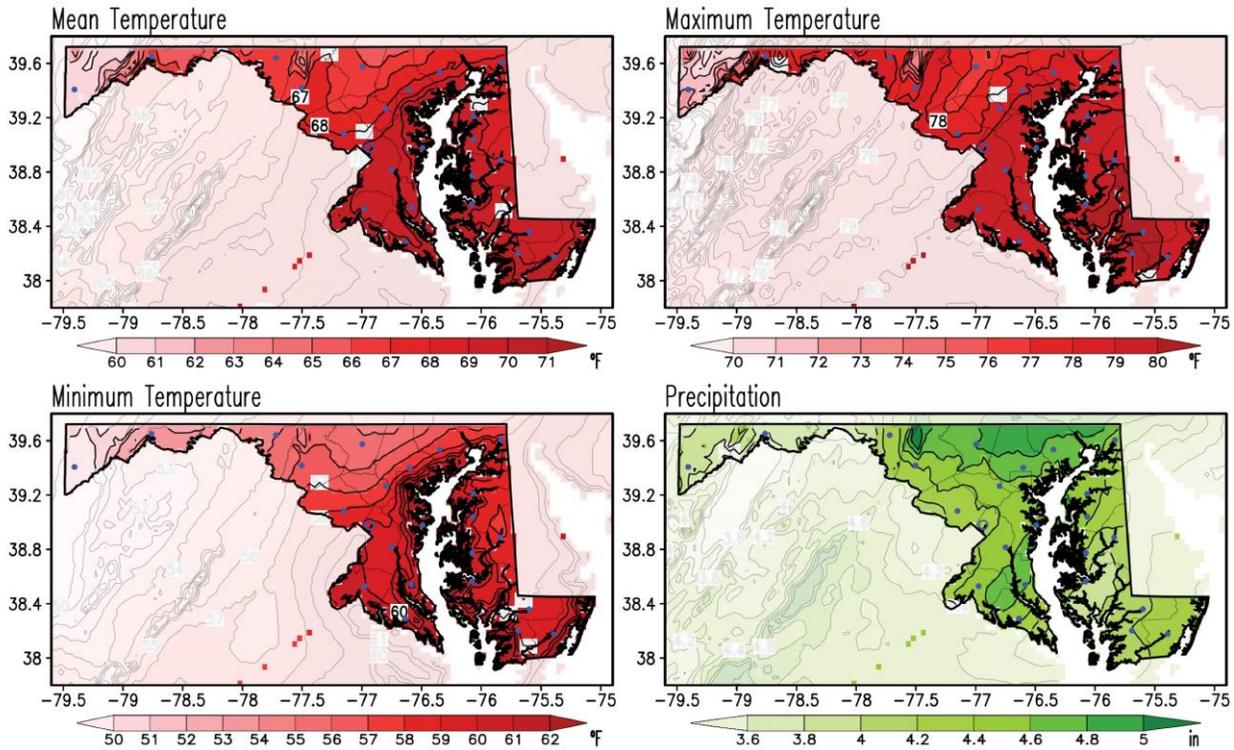# Appendix C. September 1991-2020 Climatology Maps

Figure C1. September climatology of the monthly mean, maximum and minimum surface air temperatures, and total precipitation for the period 1991-2020. Temperatures are in °F, and precipitation is in inches according to the color bars. This is the current climate normal against which the September 2023 conditions are compared to obtain the September 2023 anomalies. Note that shading outside the state has been washed out to facilitate focusing on Maryland. Filled blue circles mark the county seats.

Weather and climate are closely related, but they are not the same. Weather represents the state of the atmosphere (temperature, precipitation, humidity, wind, sunshine, cloudiness, etc.) at any given time. On the other hand, climate refers to the time average of the weather elements when the average is over long periods. If the average period is long enough, we can start to characterize the climate of a particular region.

It is customary to follow the World Meteorological Organization (WMO) recommendation and use 30 years for the average. The 30-year averaged weather data is traditionally known as Climate Normal (Kunkel and Court 1990), which is updated every ten years (WMO 2017). Establishing a climate normal or climatology is important as it allows one to compare a specific day, month, season, or even another normal period with the current normal. Such comparisons characterize anomalous weather and climate conditions, climate variability and change, and help define extreme weather and climate events (Arguez et al. 2012).

Appendix D. September Standard Deviation and September 2023 Standardized Anomalies Maps
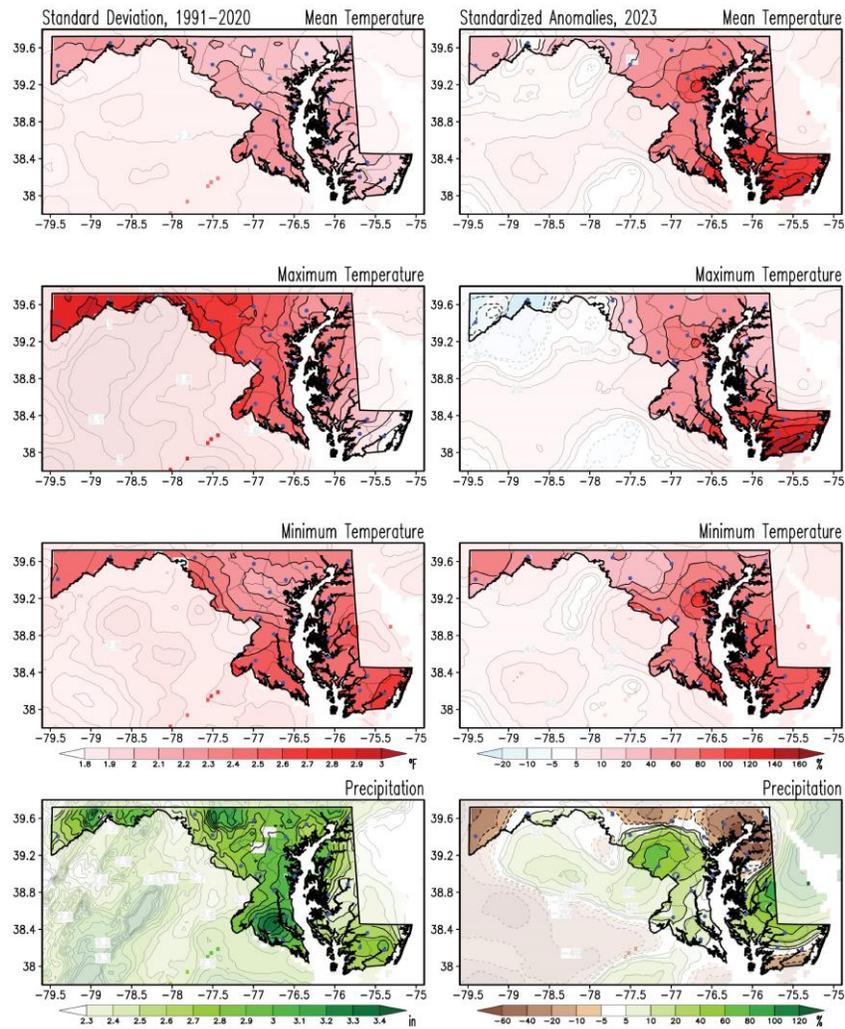

Figure D1. Standard deviation for September and standardized anomalies of temperatures and precipitation for September 2023. Standard deviations for monthly mean, maximum, and minimum surface air temperatures and total precipitation were obtained for the 1991-2020 period (left column). Anomalies for September 2023 (right column) are obtained as a percentage of the standard deviations. The standard deviations in temperatures are in °F, and those in precipitation are in inches according to the color bars. Blue/red shading in the anomaly temperature maps marks colder/warmer than normal conditions; brown/green shading in the anomaly precipitation map marks drier/wetter than normal conditions. The standardized anomalies are obtained by dividing the raw anomalies (from Figures 1 to 4) by the standard deviation (from left column panels) and multiplying that ratio by 100; hence, units are in percent (%). Note that shading outside the state has been washed out to facilitate focusing on Maryland. Filled blue circles The monthly standard deviation measures a climate variable's year-to-year, or interannual, variability. Anomalies are sometimes compared against that variability to identify extremes in the climate record. When the anomalies are divided by the standard deviation, they are named *standardized anomalies*.

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