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Maryland Climate Bulletin
October 2022

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DEPARTMENT OF ATMOSPHERIC & OCEANIC SCIENCE

Maryland State Climatologist Office

Summary

October 2022 was colder and drier than normal in average, when compared with the 1991-2020 climatology. While the colder anomalies arose after August and September were warmer than normal, the drier anomalies have persisted since August. Regional differences showed that the largest cold mean anomalies over Garrett and Allegany counties followed the largest minimum temperature anomalies, and the largest cold mean anomalies over Harford, Kent and Queen Anne's counties followed those from the largest maximum temperature anomalies. Regional differences indicated that precipitation was above normal only over the northeastern counties of Harford, Cecil, and Kent, and largely below normal in the rest of the state with the maximum dry anomalies over western Charles County, Garrett, Montgomery and Baltimore counties. The persistence of below normal precipitation for three consecutive months didn't set or worsened drought conditions, especially over the southern tips of Somerset and Worcester counties that were under moderate drought in September. Statewide temperature conditions were below the mean and median but precipitation was, however, above the mean and median of the historical 1895-2021 record; in both cases, October 2022 was far from the records of the month.

Contents

1. Introduction

This bulletin is issued by the Maryland State Climate Office once per month in order to indicate in a brief format the most recent monthly surface climatic conditions in the state. Maryland is a state of great geographic diversity with miles of streams and rivers, beaches, coastal flatlands and wetlands, hills, valleys and mountains. This range of physiographic features, together with the land and water distribution and the placement of the state within the continental U.S., contribute to a comparatively wide range of climatic conditions thus the importance of their monitoring. This bulletin is addressed to all Marylanders so they can stay current with the latest climate conditions impacting their lives.

The monthly surface climate conditions for October 2022 are presented via maps of a set of variables such as mean surface air temperature, maximum surface air temperature, minimum surface air temperature, total precipitation, and their anomalies, that are complemented with drought conditions for the state, as given by the U.S. Drought Monitor (Sections 3). Statewide averages in October 2022 are contrasted against the historical record via box and whisker plots and scatter plots (Sections 4). Then statewide and climate division averages for the month are contrasted against each other via scatter plots (Section 5). Ancillary information at statewide, climate divisions and county levels are given via tables and plots, and via maps in Appendices A-D.

2. Data

Surface air temperature and total precipitation data in this report are from the following sources:

- NOAA Monthly U.S. Climate Gridded Dataset at 5km horizontal resolution (NClimGrid – Vose et al. 2014), which are given in a *preliminary* status, and available at:

  https://www.ncei.noaa.gov/data/nclimgrid-monthly/access/
  Data downloaded on 11/10/2022.

- NOAA Monthly U.S. Climate Divisional Dataset (NClimDiv – Vose et al. 2014), which is available, in a *preliminary* status (v1.0.0-20221104), at:

  https://www.ncei.noaa.gov/data/climdiv/access/
  Data downloaded on 11/10/2022

The drought conditions map is from the U.S. Drought Monitor site and available at:

https://droughtmonitor.unl.edu/Maps/MapArchive.aspx

Some useful notes are the following.

About the anomalies. Anomalies for a given month (i.e. October 2022) are the difference of the monthly values with respect to the long-term mean of the 30 months (i.e. Octobers) in the period 1991-2020; this 30-year mean is known as the climate normal, or just the climatology for short. When a value exceeds its climatological value, it is usually referred as an above normal (e.g., warmer than normal or wetter than normal) anomaly, or positive anomaly, while when the value is smaller than its climatological value, it is referred as a below normal (e.g., colder than normal or dryer than normal) anomaly, or negative anomaly.

About NOAA's Climate Divisions. The term "climate division" refers to one of the 8 divisions in the state that represent climatically homogeneous regions, as determined by NOAA:

https://www.ncei.noaa.gov/access/monitoring/dyk/us-climate-divisions

These regions are the following:

- 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, and Montgomery, as well as 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 Provinces,* Climate Divisions 3, 4 and a portion of 7 include the *Upper Coastal Plain Province*, and Climate Divisions 1, 2, 5 and a portion of 7 include the *Lower Coastal Plain Province*.

3. October 2022 Maps

A. Mean Temperatures

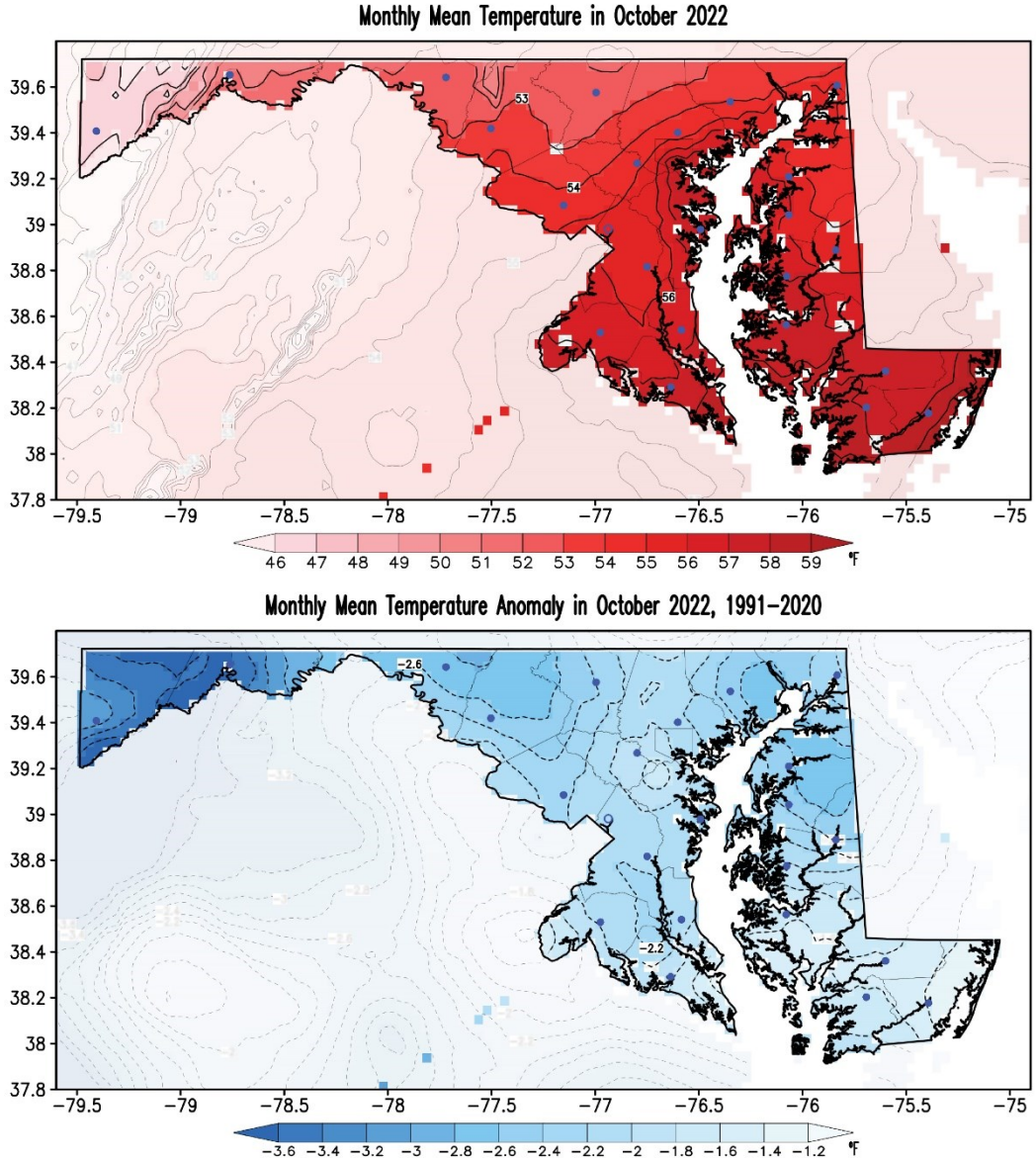

Figure 1. Mean surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in October 2022. Temperatures are given in °F according to the color bars. Red/blue shading in the anomaly map shows above/below normal conditions. Note that shading outside the state has been washed out for clarity purposes. Filled blue circles mark the county seats.

Monthly mean temperatures keep on decreasing in October 2022. Temperatures along the coastal plains were warmer (~56-59°F) than over the North Central and Appalachian Mountains climate divisions (~51-53°F) and Garrett County (~46-48°F). The mean temperatures over the state were colder than normal throughout the state. Anomalies over Garrett and Allegany counties were colder than -3°F, and those over southern Saint Mary's and Dorchester counties and Wicomico, Somerset and Worcester counties were in the -1.6 to -1.2°F; appendices A and B show the area-averaged values. Anomalies were equal or above the regional year-to-year variability in the majority of the northern counties and northeastern shore climate division (Appendix D).

B. Maximum Temperatures

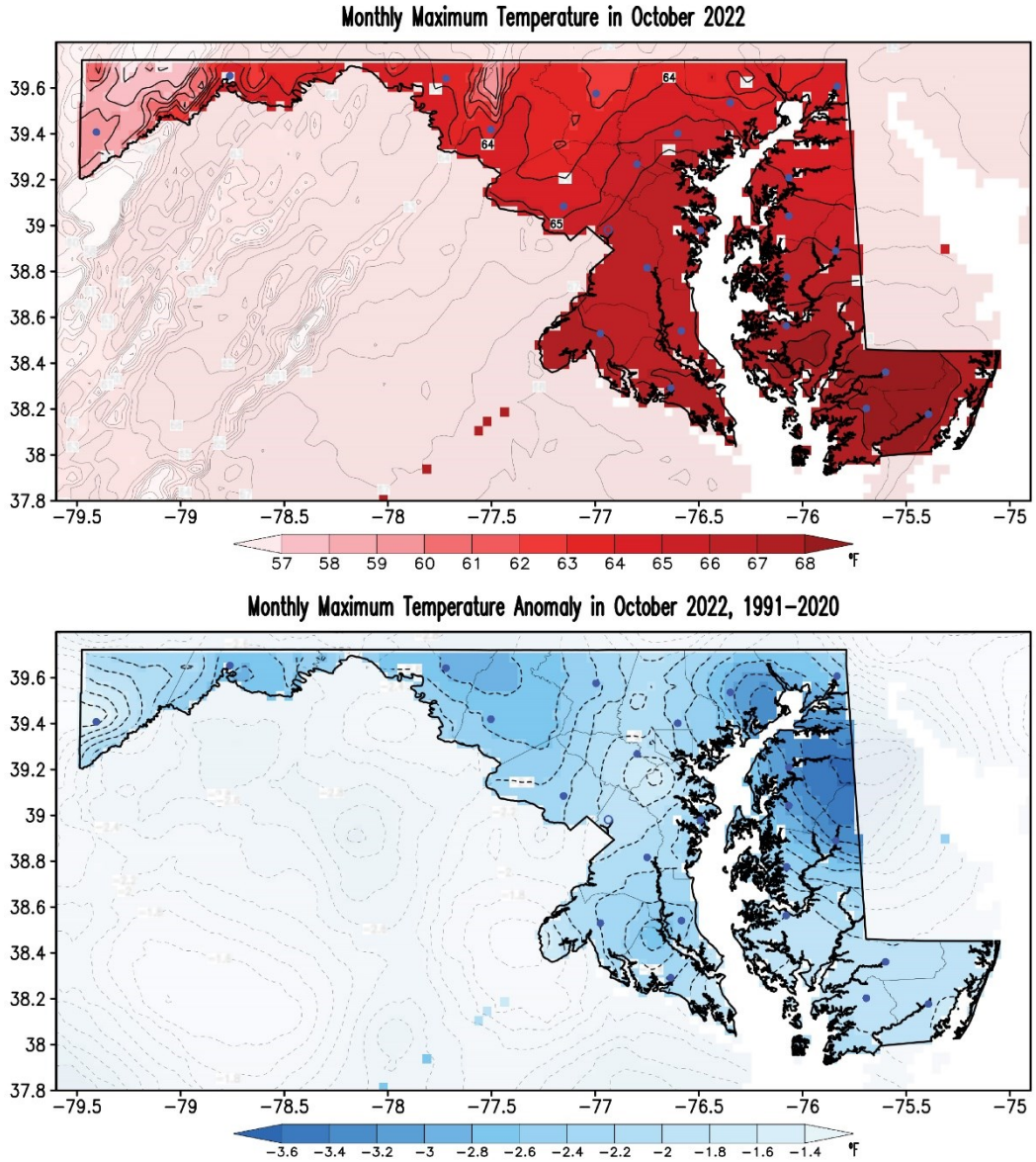

Figure 2. Maximum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in October 2022. Temperatures are given in °F according to the color bars. Red shading in the anomaly map shows above normal conditions. Note that shading outside the state has been washed out for clarity purposes. Filled blue circles mark the county seats.

Monthly mean maximum temperatures in October 2022 reached the upper 60s. Maximum values were reached over the coastal plains (~66-68°F) and minimum values over Frederick County's Blue Ridge (~60°F) and Garrett County (~57-60°F). Maximum temperatures were below normal also in the entire state. Negative anomalies reached -3.6°F over eastern Kent County and between -3 and -3.4F over western Kent, Queen Anne's and Harford counties, and -1.6°F over western Garrett and northern Anne Arundel counties; appendices A and B show the area-averaged values. The largest negative anomalies in the northeastern shore climate division surpassed the regional year-to-year variability (Appendix D).

C. Minimum Temperatures

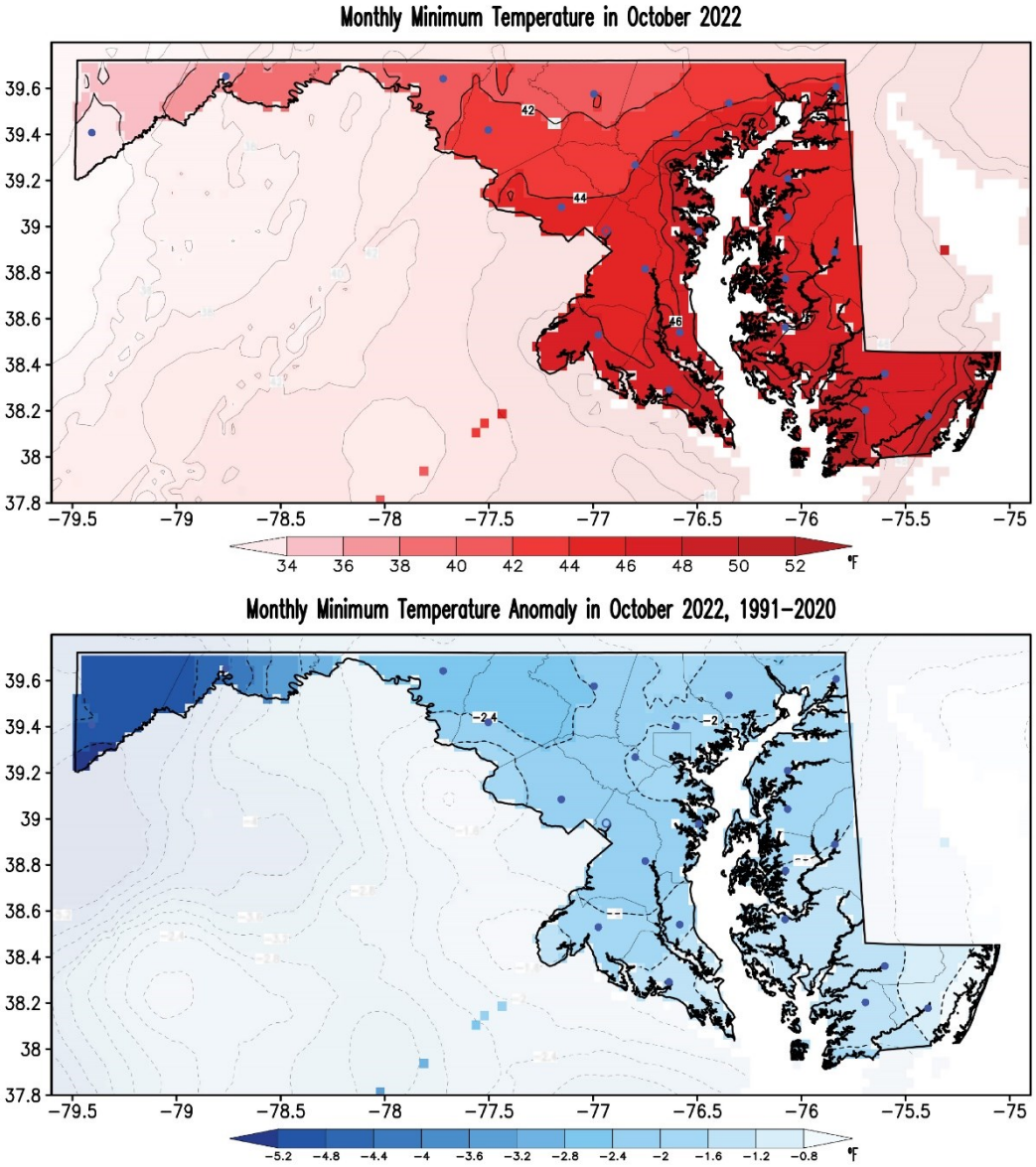

Figure 3. Minimum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in October 2022. Temperatures are given in °F according to the color bars. Blue/red shading in the anomaly map shows below/above normal conditions. Note that shading outside the state has been washed out for clarity purposes. Filled blue circles mark the county seats.

Monthly mean minimum temperatures in October 2022 reached the mid-30s. Minimum values over Garrett County (~34-36°F) and maximum values along the coasts of the Chesapeake Bay (~46-52°F). The minimum temperatures were also colder than normal in the whole state. Negative anomalies over Garret reached the largest values (~ -5.2°F) and minimum values (-1.6 to -0.8°F) over southern Saint Mary's county and Dorchester, Wicomico, Somerset and Worcester counties; appendices A and B show the area-averaged values. Anomalies were larger than the year-to-year variability over Allegany and Garrett counties (Appendix D).

D. Precipitation

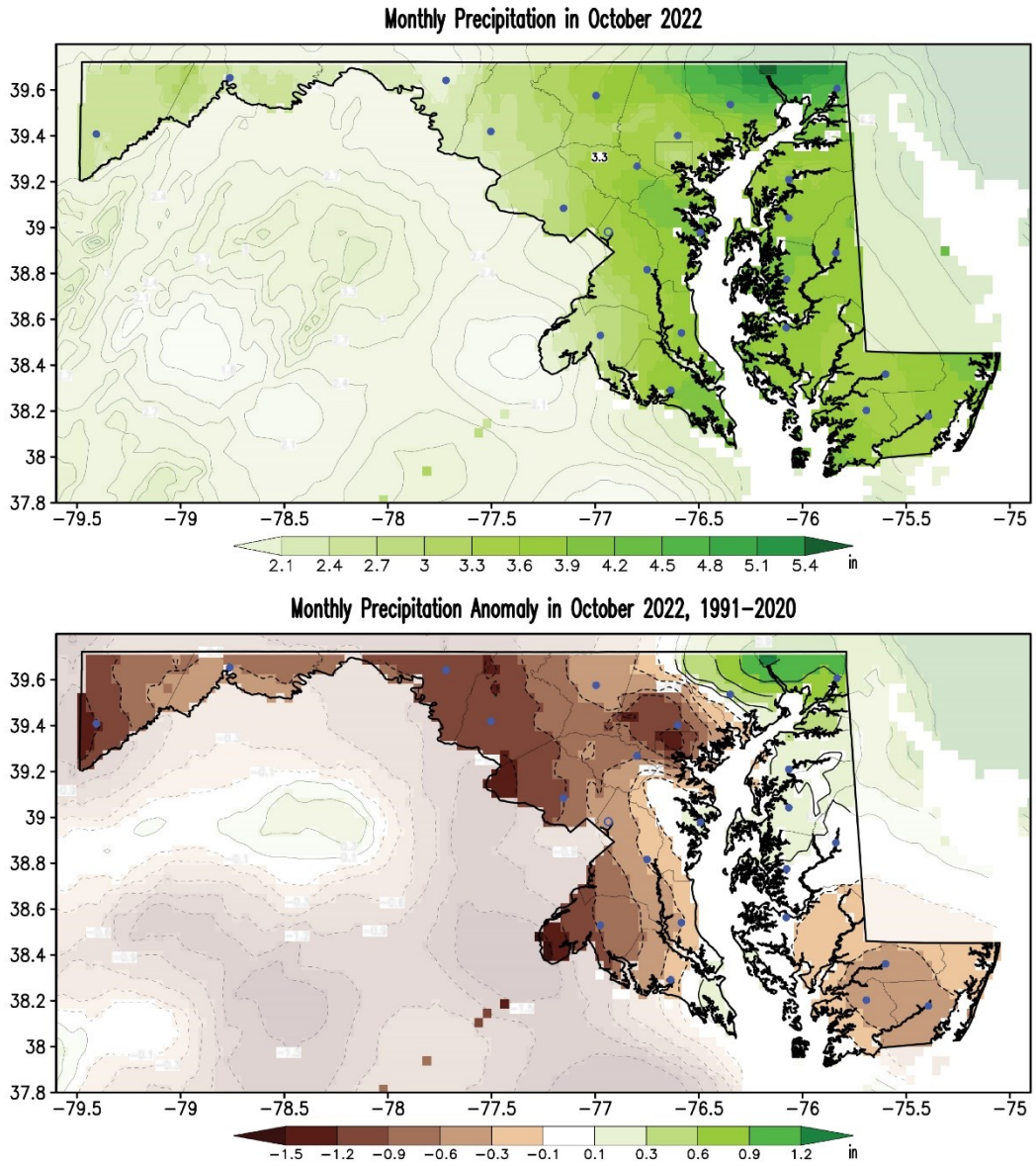

Figure 4. Precipitation (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in October 2022. Precipitation units are given as inches according to the color bars. Brown/green shading in the anomaly map shows below/above normal conditions. Note that shading outside the state has been washed out for clarity purposes. Filled blue circles mark the county seats.

Monthly total precipitation in October 2022 reached maximum values over some northeastern counties. Precipitation was maximum over Harford and Cecil counties (~ 5.1-5.4 in), and it was minimum over Garrett and Washington counties (2.1 in). Precipitation was largely below normal over the state except by the northeastern counties that had the largest precipitation. The largest positive anomalies were over the cited Harford and Cecil counties (1.2 in) and were smaller over Kent and Queen Anne's (0.1-0.3 in), however the maximum negative anomalies reached the largest values over western Charles County (-1.5 in) and over Garrett, Montgomery and Baltimore (0.9-1.2 in); appendices A and B show the area-averaged values. Anomalies were below the year-to-year variability (Appendix D).

E. Drought

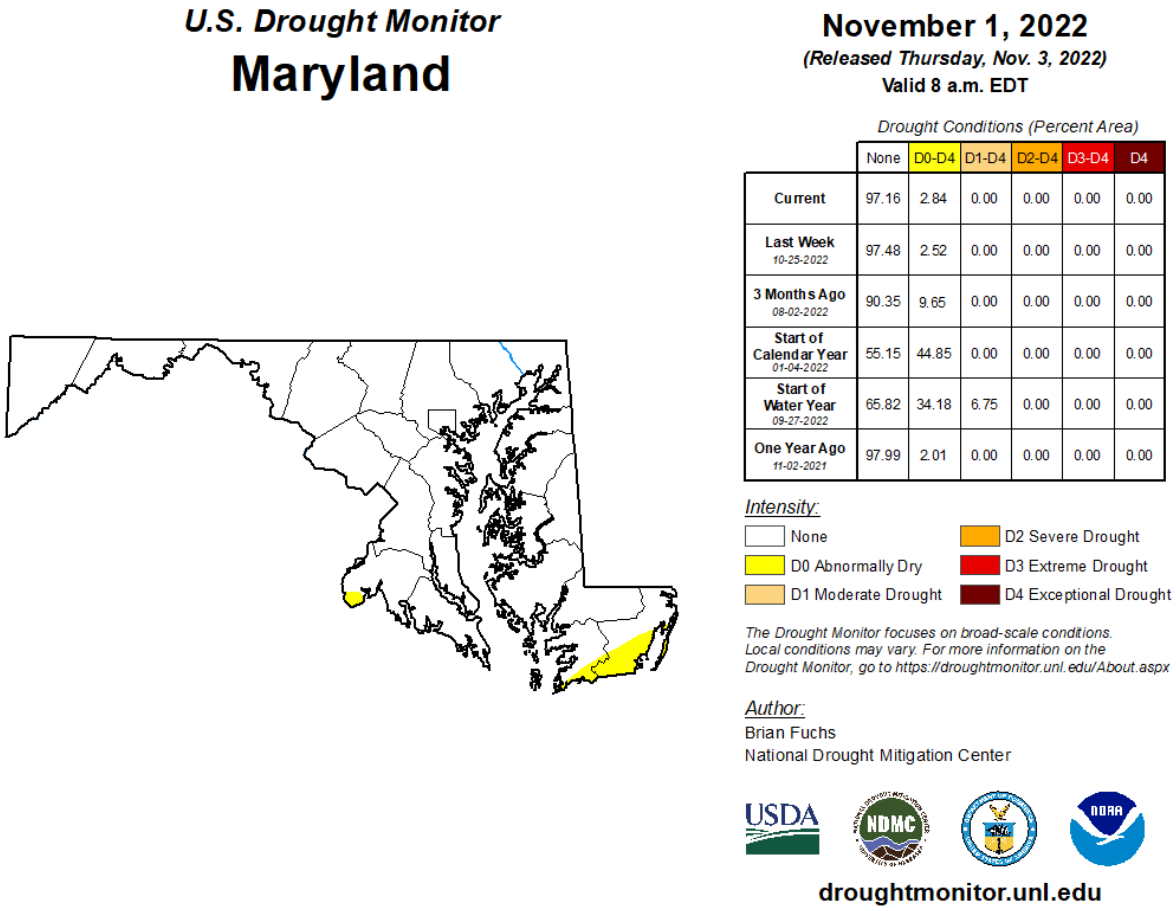

Figure 5. Drought conditions as reported by the U.S. Drought Monitor on November 1, 2022.

Drought conditions in October 2022, indicated by the conditions given by the November 1 map, show a reduction in the areas affected by drought from the previous month. The persistence of below normal precipitation since August in the state has not worsened drought conditions, maybe because the below normal temperatures. The southern counties under abnormally dry conditions improved from the moderate drought conditions in the previous month; a region under abnormally dry conditions has a decline in water levels, crops are stunted, gardens begin to wilt and fire danger is elevated.

4. October 2022 Statewide Averages in the Historical Record

A. Box and Whisker Plots

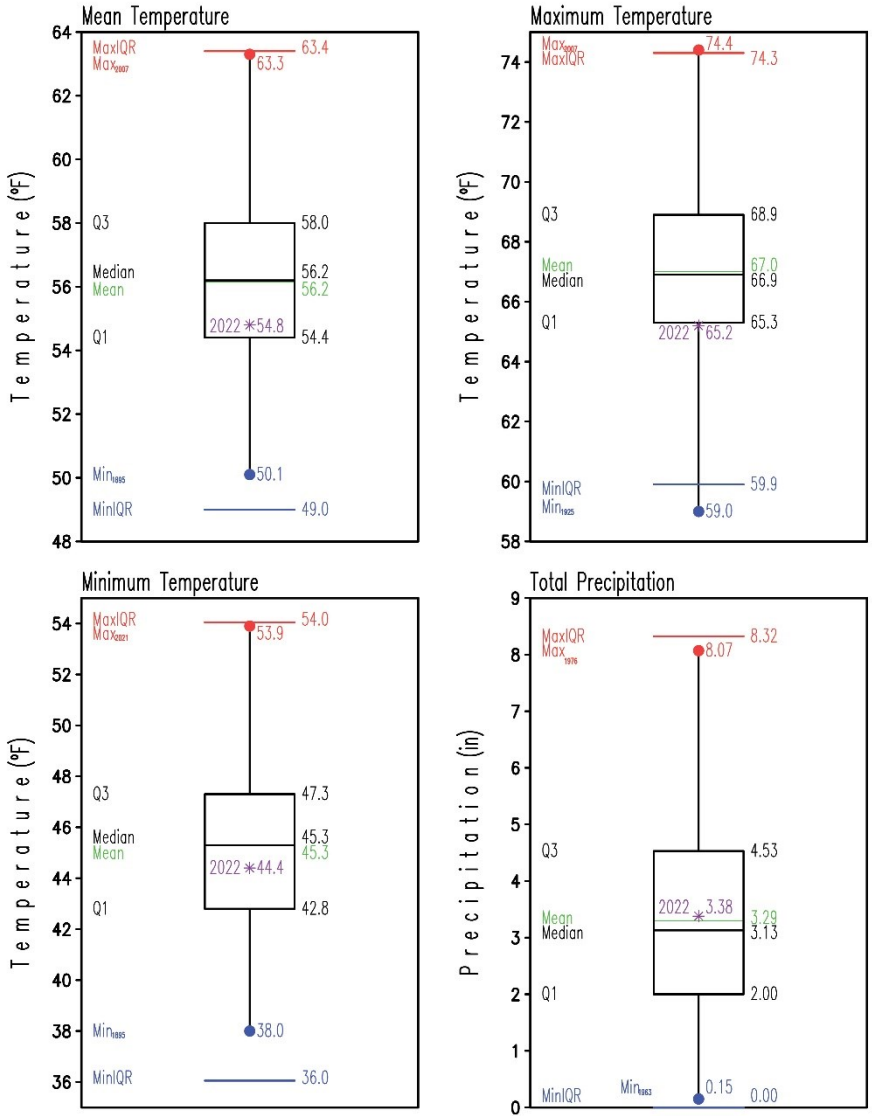

Figure 6. Box and Whisker plots of Maryland statewide mean (upper left), maximum (upper right), minimum (lower left) surface air temperatures and total precipitation (lower right) in October for the period 1895-2021. Conditions in October 2022 are represented by the label and asterisk in purple within the boxes. Statistics for the period 1895-2021 are labeled at the left side of each box and whisker plot and their values at their right. 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 smaller and larger values respectively, are the lower and upper horizontal black lines of the box respectively. The minimum and maximum values in the period are marked by the blue and red dots at the end of the whiskers; the year of occurrence is shown as a subscript to their labels. The blue and red horizontal lines represent extreme values defined by Q1-1.5×(Q3-Q1) and Q3+1.5×(Q3-Q1), respectively.

Statewide temperatures (54.8, 65.2, 44.4°F) in October 2022 were below the mean and median of the 1895-2021 historical record, while precipitation (3.38 in) was above them. In the historical context, October 2022 was colder and barely wetter than normal but far of the extremes.

B. Scatter Plots

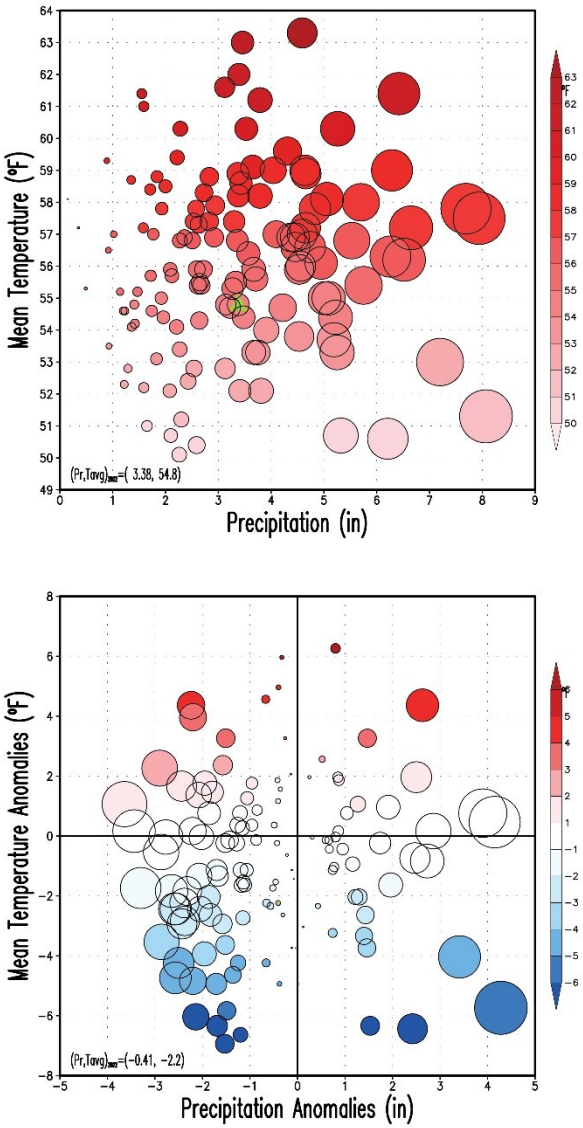

Figure 7. Scatter plot of averaged Maryland statewide mean surface air temperature vs total precipitation in October for the period 1895-2022. Upper panel shows the mean temperature and total precipitation in October, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation on record (8.07 in in 1976, top panel) and by the maximum precipitation anomaly (4.28 in in 1976, bottom panel). The red shading of the circles in the top panel denotes temperatures above 32°F, and the blue/red shading of the circles in the bottom panel denotes below/above climatology. October 2022 is marked by the yellow/green filled triangle.

The statewide total precipitation and mean temperature of 3.38 in and 54.8°F are within the lower and left side of the data cloud in the historical record of 128 years. The statewide anomalies, with respect to the current 1991-2020 climatology, of -0.41 in and -2.2 °F indicate an anomalous dry and cold October 2022. The ranking of the temperatures and precipitation in October 2022 within the historical record at state, climate division and county level are displayed in the tables in Appendix A.

5. October and ASO 2022 Climate Divisions Averages

A. October 2022 Scatter Plots

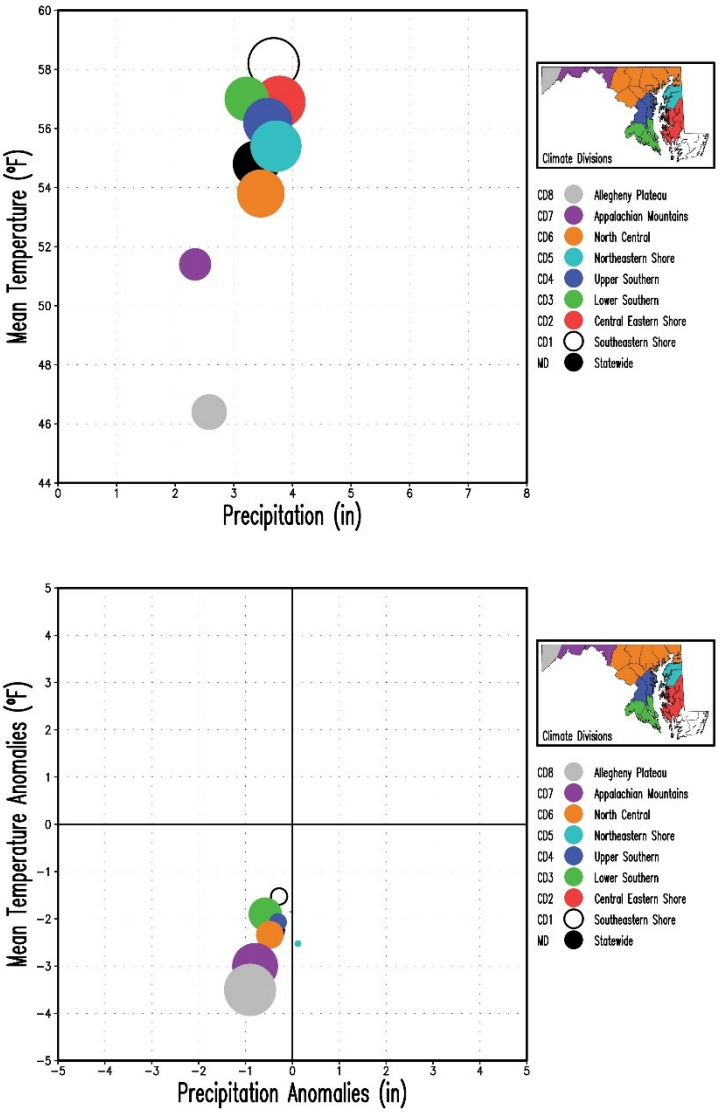

Figure 8. Scatter plot of averaged Maryland statewide and Climate Divisions (CD#) mean surface air temperature vs total precipitation for October 2022. Upper panel shows the mean temperature and total precipitation, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (3.78 in in CD2, top panel) and by the maximum precipitation anomaly (|-0.90| in in CD8, 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.

The northern climate divisions (CD6-CD8) were colder than the central and southern divisions (CD1-CD5) and the statewide mean, with CD8 been the coldest and CD1 been the warmest. The driest division was CD7, followed by division CD8, while CD2 was the wettest. All the climate divisions were colder than normal, and except by CD5 that was wetter than normal, the rest of divisions were drier than normal. The values of the surface variables and their anomalies at state, climate division and county level are displayed in Appendix B bar graphs.

B. August-September-October 2022 Scatter Plots

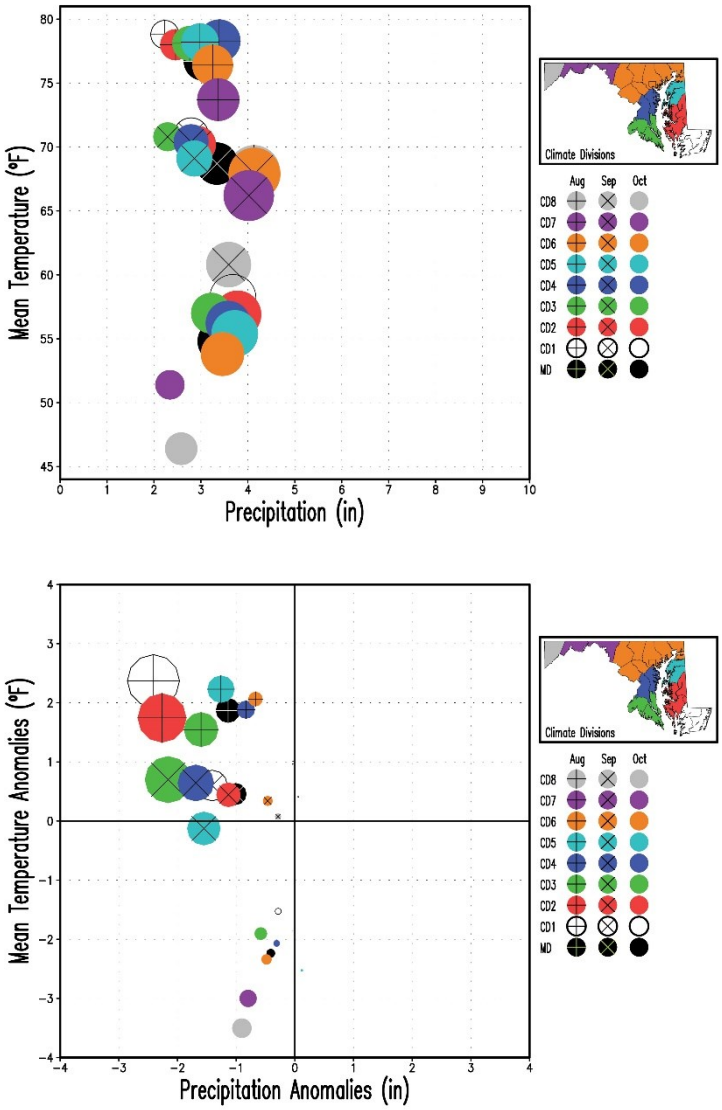

Figure 9. Scatter plot of averaged Maryland statewide and Climate Divisions (CD#) mean surface air temperature vs total precipitation for August, September and October 2022. Upper panel shows the mean temperature and total precipitation, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (4.14 in in CD6 in September, top panel) and by the maximum precipitation anomaly (|-2.41| in in CD1 in August, bottom panel) among the nine regions and months. Note that October is displayed with filled circles only, while September and August are displayed with superposed multiplication and addition signs respectively.

Mean temperatures have decreased statewide from August to October 2022 but precipitation remained about the same in the last two months. Temperatures decreased the most from September to October (~ -13°F) than from August to September (~ -8°F). Except by CD5 in October and CD7 in September the divisions were drier than normal during the three months, while the mean temperatures were above normal in August and September but below normal in CD5 in September and all the divisions in October.

Appendix A. October 2022 Tables: Statewide, Climate Divisions and Counties

A. Mean Temperature and Precipitation

Region	Mean Air Temperature (°F)	Rank (#)
Statewide	54.8	40
Climate Division 1	58.2	57
Climate Division 2	56.9	49
Climate Division 3	57.0	44
Climate Division 4	56.2	44
Climate Division 5	55.4	35
Climate Division 6	53.8	40
Climate Division 7	51.4	27
Climate Division 8	46.4	19
Allegany	50.5	20
Anne Arundel	56.6	43
Baltimore	54.2	43
Baltimore City	56.3	47
Calvert	56.8	44
Caroline	55.7	41
Carroll	52.5	40
Cecil	54.5	39
Charles	56.8	45
Dorchester	57.6	54
Fredrick	52.9	34
Garrett	46.5	20
Harford	54.2	37
Howard	54.1	45
Kent	55.4	35
Montgomery	54.3	40
Prince George's	55.8	44
Queen Anne's	55.5	35
Saint Mary's	57.4	44
Somerset	58.4	53
Talbot	56.9	44
Washington	52.4	37
Wicomico	57.6	57
Worcester	58.4	58

Region	Total Precipitation (in)	Rank (#)
Statewide	3.38	72
Climate Division 1	3.68	76
Climate Division 2	3.78	81
Climate Division 3	3.22	72
Climate Division 4	3.58	83
Climate Division 5	3.72	88
Climate Division 6	3.46	79
Climate Division 7	2.34	55
Climate Division 8	2.58	54
Allegany	2.40	57
Anne Arundel	3.80	88
Baltimore	3.50	78
Baltimore City	3.00	66
Calvert	3.70	85
Caroline	3.80	83
Carroll	3.30	73
Cecil	4.60	99
Charles	2.60	54
Dorchester	3.70	80
Fredrick	2.60	54
Garrett	2.50	52
Harford	4.40	96
Howard	3.40	77
Kent	3.60	87
Montgomery	2.80	58
Prince George's	3.30	76
Queen Anne's	3.70	86
Saint Mary's	3.70	84
Somerset	3.70	77
Talbot	3.80	84
Washington	2.10	49
Wicomico	3.50	75
Worcester	3.70	76

Table A1. Mean surface air temperature (left) and total precipitation (right) at statewide, climate division and county levels in October 2022. Temperature is given in °F and precipitation in in. The rank is the order that the variable in October 2022 occupies among the 128 Octobers after the 128 values have been arranged from the lowest to the highest value by using the standard competition ranking method. The closer to 128 is the rank, the larger the value of the surface variable is in the record.

B. Maximum and Minimum Temperatures

Region	Maximum Air Temperature (°F)	Rank (#)
Statewide	65.2	32
Climate Division 1	68.0	43
Climate Division 2	67.0	36
Climate Division 3	67.0	30
Climate Division 4	66.4	37
Climate Division 5	65.1	22
Climate Division 6	64.2	31
Climate Division 7	63.5	26
Climate Division 8	58.8	33
Allegany	63.2	24
Anne Arundel	66.4	37
Baltimore	64.8	36
Baltimore City	66.1	40
Calvert	66.5	30
Caroline	66.2	29
Carroll	63.3	30
Cecil	64.1	29
Charles	67.1	32
Dorchester	67.7	42
Fredrick	63.4	29
Garrett	58.8	32
Harford	64.1	28
Howard	64.9	42
Kent	64.8	20
Montgomery	64.6	33
Prince George's	66.4	32
Queen Anne's	65.3	22
Saint Mary's	67.1	32
Somerset	68.0	45
Talbot	66.5	31
Washington	63.9	32
Wicomico	68.2	49
Worcester	68.1	51

Region	Minimum Air Temperature (°F)	Rank (#)
Statewide	44.4	52
Climate Division 1	48.3	64
Climate Division 2	46.7	60
Climate Division 3	47.0	57
Climate Division 4	46.0	54
Climate Division 5	45.7	56
Climate Division 6	43.4	50
Climate Division 7	39.3	31
Climate Division 8	34.2	13
Allegany	37.8	24
Anne Arundel	46.8	53
Baltimore	43.6	51
Baltimore City	46.5	57
Calvert	47.1	56
Caroline	45.1	57
Carroll	41.7	52
Cecil	44.9	53
Charles	46.4	60
Dorchester	47.4	61
Fredrick	42.4	48
Garrett	34.2	13
Harford	44.2	48
Howard	43.3	53
Kent	46.1	54
Montgomery	44.0	51
Prince George's	45.1	54
Queen Anne's	45.7	55
Saint Mary's	47.7	56
Somerset	48.8	59
Talbot	47.2	52
Washington	40.8	44
Wicomico	46.9	66
Worcester	48.8	66

Table A2. Maximum (left) and minimum (right) surface air temperatures at statewide, climate division and county levels in October 2022. Temperature is given in °F. The rank is the order that the variable in October 2022 occupies among the 128 Octobers after the 128 values have been arranged from the lowest to the highest value by using the standard competition ranking method. The closer to 128 is the rank, the larger the value of the surface variable is in the record.

Appendix B. October 2022 Bar Graphs: Statewide, Climate Divisions and Counties

A. Temperatures and Precipitation

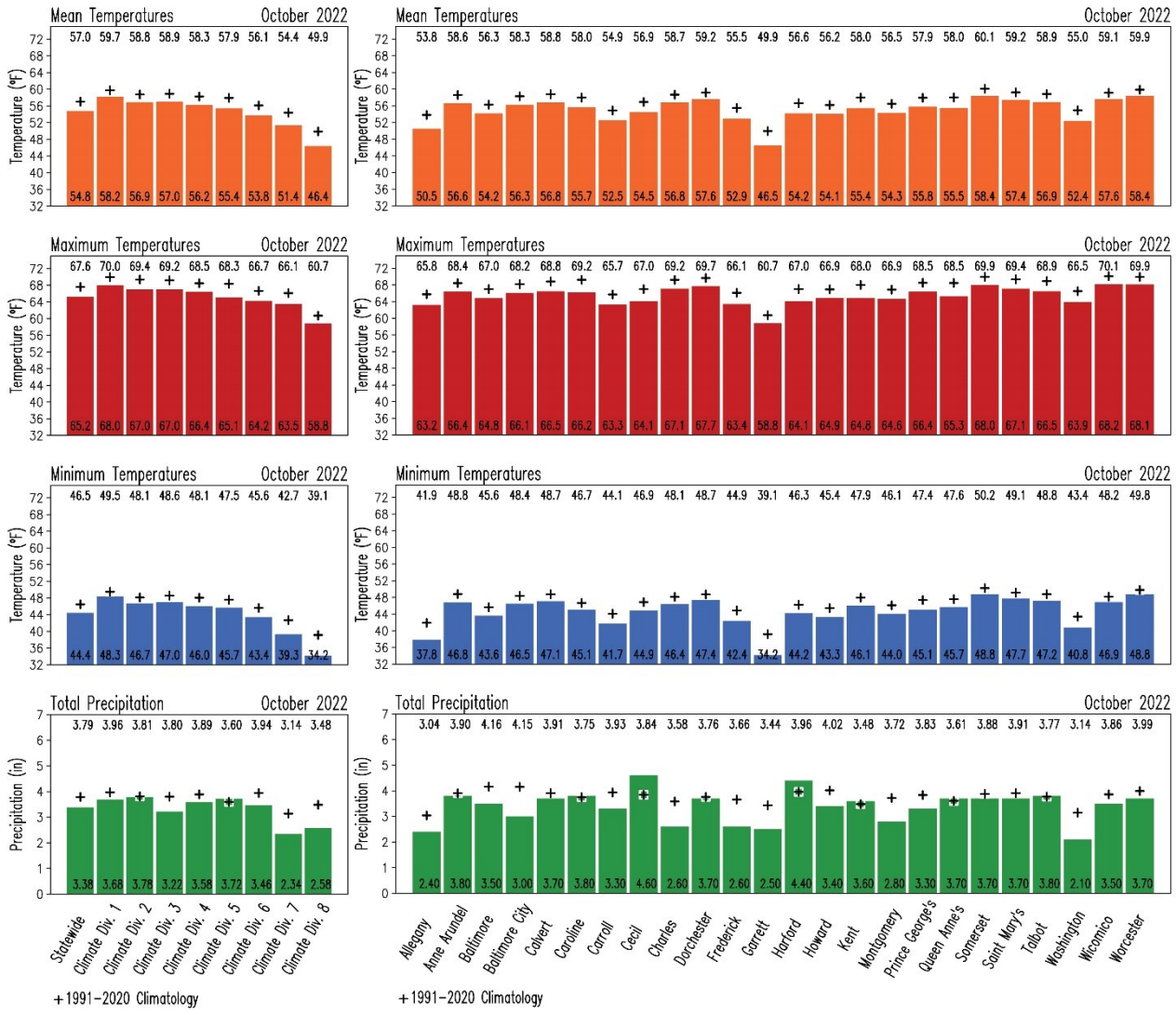

Figure B1. Area-averaged surface variables in Maryland in October 2022. Color bars represent the variables as follows: mean surface air temperature (orange, °F), maximum surface air temperature (red, °F), minimum surface air temperature (blue, °F) and total precipitation (green, in) at statewide and climate divisions (left column), and at county (right column) level. The numbers at the base of the bars indicate the magnitude of the variable in October 2022. For comparison, the corresponding 1991-2020 climatological values for October are displayed as black addition signs, and their magnitude are shown at the top of the panels.

B. Temperature and Precipitation Anomalies

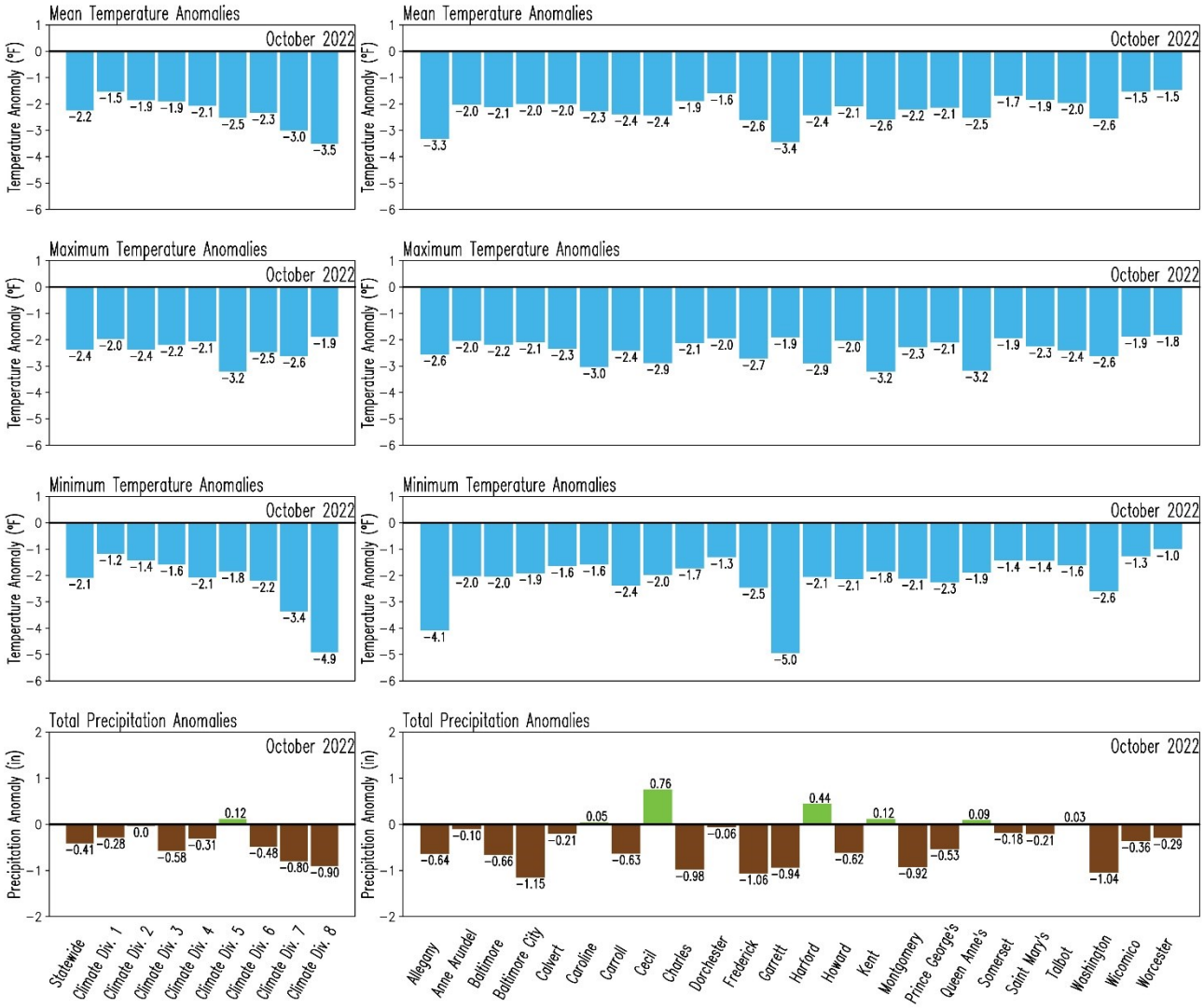

Figure B2. Area-averaged anomalies of the surface variables in Maryland in October 2022. Anomalies are with respect to the 1991-2020 climatology. Red and blue colors represent positive and negative anomalies for mean surface air temperature (upper row), maximum surface air temperature (second row from top), and minimum surface air temperature (third row from top) while green and brown colors indicate positive and negative anomalies in total precipitation (bottom row) at statewide and climate divisions (left column), and at county (right column) level. The numbers outside of the bars indicate the magnitude of the anomaly in October 2022. Units are °F for the temperatures and in for precipitation.

Appendix C. October 1991-2020 Climatology Maps

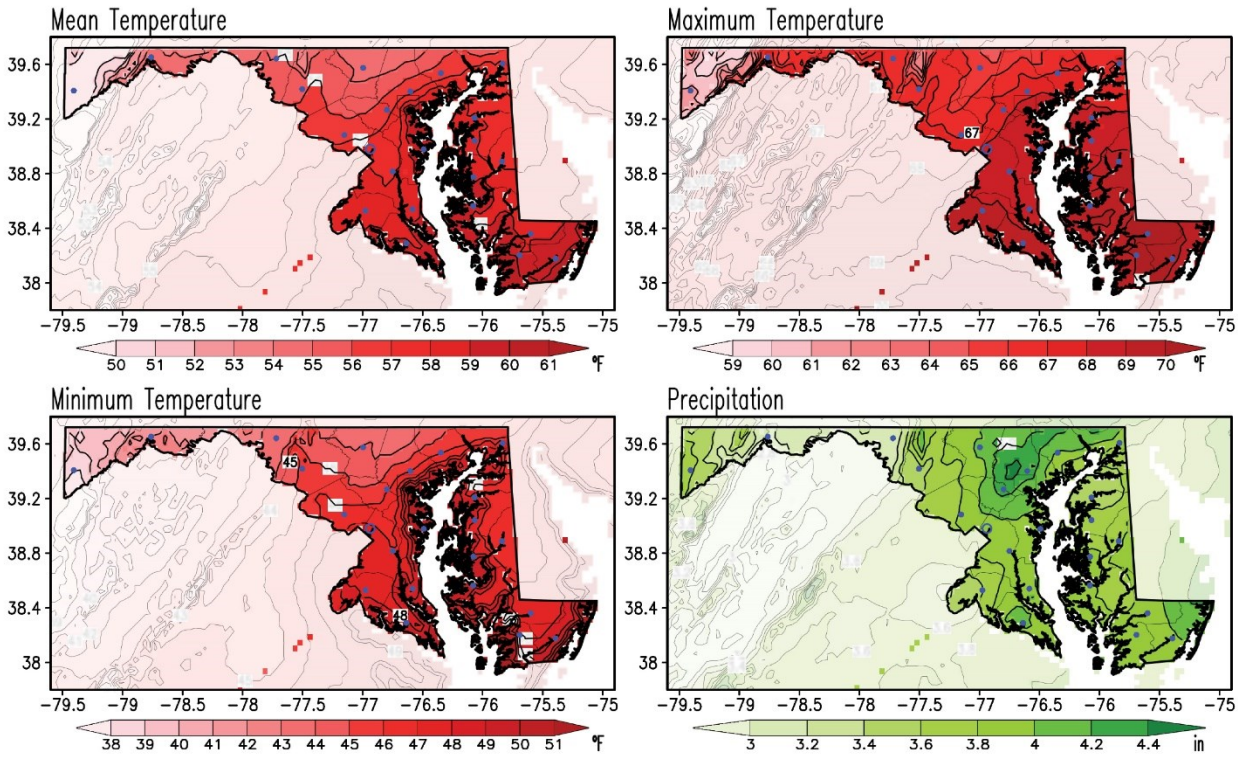

Figure C1. October climatology of the mean, maximum and minimum surface air temperatures and total precipitation for the period 1991-2020. Temperatures are given in °F and precipitation is in inches according to the color bars. This is the current climate normal against which the October 2022 conditions are compared with to obtain the October 2022 anomalies. Note that shading outside the state has been washed out for clarity purposes. 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.) and ocean (sea-level, sea surface temperature, etc.) at any given time, while climate refers to the time-average of the weather elements when the average is over long periods. If the averaging 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 a 30-year period 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). The establishment of a climate normal or climatology is important as it allows one to compare a specific day, month, season, or even another period normal 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. October Standard Deviation and October 2022 Standardized Anomalies Maps

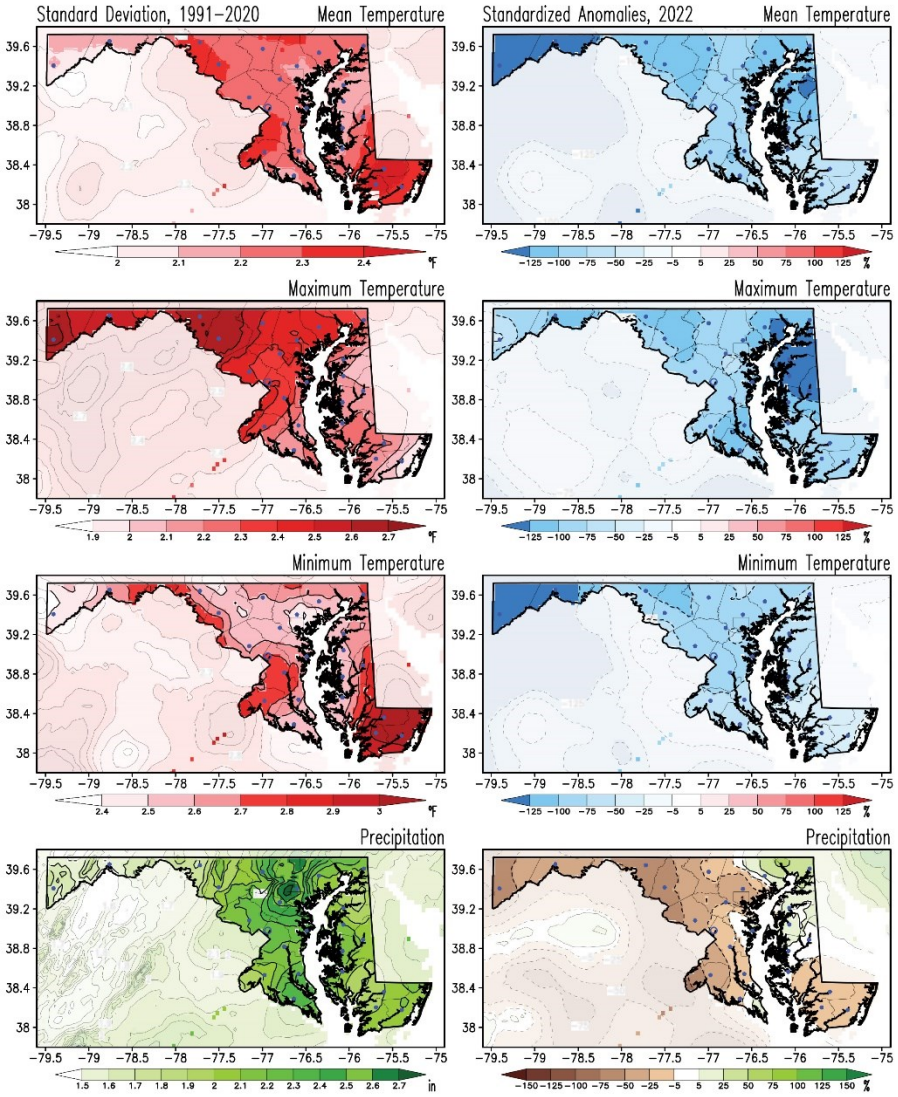

Figure D1. Standard deviation in October and standardized anomalies of temperatures and precipitation in October 2022. Standard deviations for mean, maximum and minimum surface air temperatures and precipitation are obtained for the period 1991-2020 (left column). Anomalies in October 2022 (right column) are obtained as percentage of the standard deviations. The standard deviations in temperatures are given in °F and those in precipitation are in inches according to the color bars. 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, so units are in percent (%). Note that shading outside the state has been washed out for clarity purposes. Filled blue circles mark the county seats.

The standard deviation is a measure of the year-to-year, or interannual, variability of a climate variable. In this case the standard deviation is calculated for the same period as the climatology. Anomalies sometimes are compared against that variability in order to identity extremes in the climate record. When the anomalies are divided by the standard deviation they are named *standardized anomalies*.

References

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