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Maryland Climate Bulletin
July 2022

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DEPARTMENT OF ATMOSPHERIC & OCEANIC SCIENCE

Maryland State Climatologist Office

Summary

July 2022 was slightly warmer and wetter than normal in average, when compared with the 1991-2020 climatology. These conditions appeared after an anomalously warm and dry June. Regional differences in July 2022 showed that except by a small region over Washington and Frederick counties with below normal maximum temperatures, Garrett County, the southern counties of Charles, Saint Mary's, Calvert Dorchester and Wicomico, and the northeastern coastal counties of Anne Arundel, Baltimore, Harford, Cecil, Kent and Queen Anne's had the largest temperature anomalies (i.e., higher than normal). Regional differences in precipitation highlighted a tongue of above normal precipitation along all counties that share the Chesapeake Bay, with the highest values over southern counties of Saint Mary's, Calvert and Dorchester, and maximum negative anomalies over Montgomery and Frederick counties that diminished toward Garrett and Allegany and Washington counties. The continuation of below normal precipitation over Garrett, Allegany and Washington counties from the previous June had expanded the abnormally dry conditions over Garrett and Allegany counties toward western Washington County. Statewide temperature conditions in July were well above the mean and median of the historical 1895-2021 record and within the upper quarter of the largest of the historical data; precipitation was also above the mean and median of the historical 1895-2021 record but was short of making into to the upper 25% of the largest precipitation data.

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 July 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 July 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 8/15/2022.

- NOAA Monthly U.S. Climate Divisional Dataset (NClimDiv – Vose et al. 2014), which is available, in a *preliminary* status (v1.0.0-20220804), at:

  https://www.ncei.noaa.gov/data/climdiv/access/
  Data downloaded on 8/15/2022

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. July 2022) are the difference of the monthly values with respect to the long-term mean of the 30 months (i.e. Julys) 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.

3. July 2022 Maps

A. Mean Temperatures

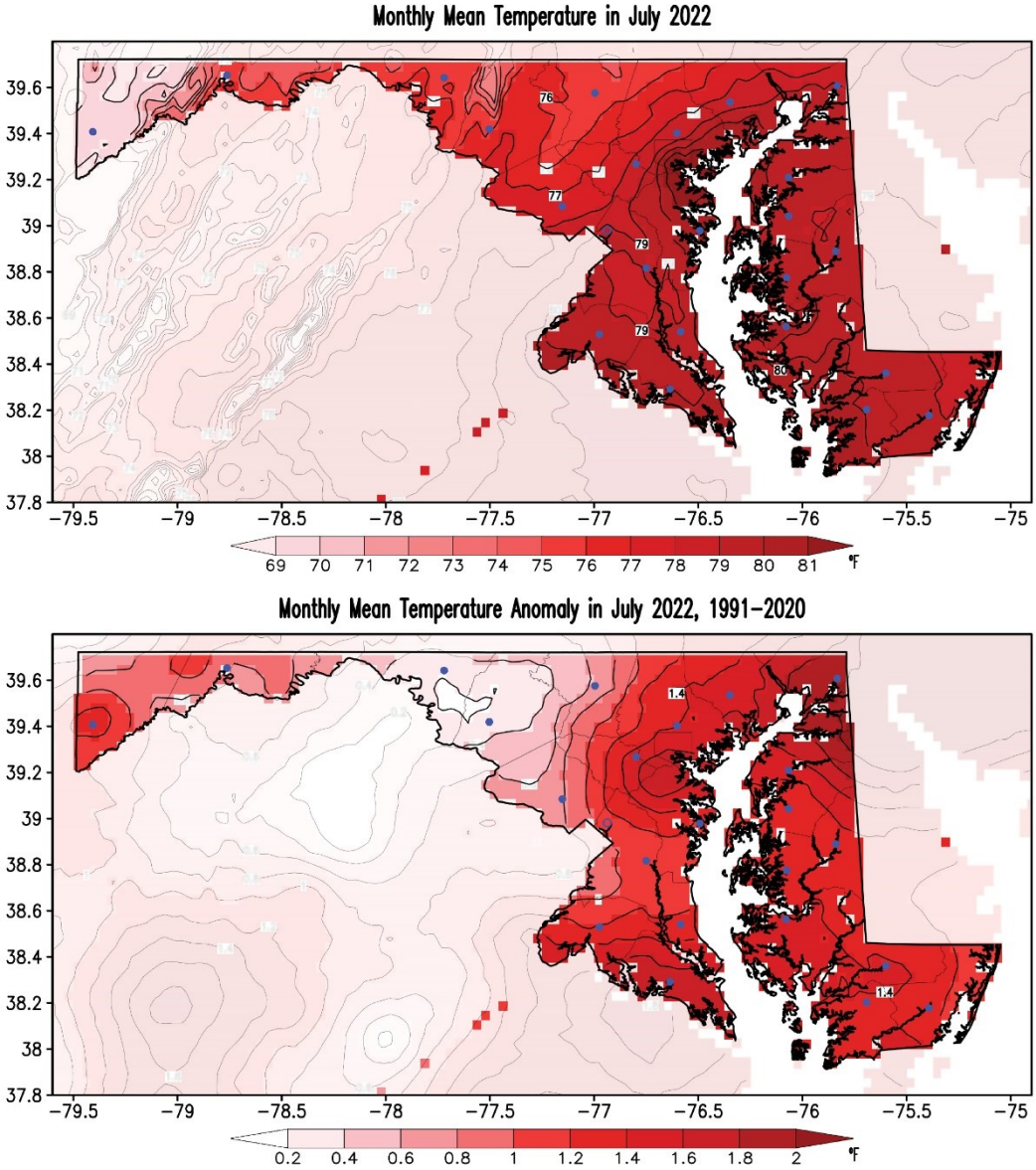

Figure 1. Mean surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in July 2022. Temperatures are given in °F according to the color bars. Red shading in the anomaly map shows above normal conditions. Note that shading outside the state has been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

Monthly mean temperatures kept increasing in July 2022. Temperatures along the coastal plains were warmer (~79-81°F) than over the North Central and Appalachian Mountains climate divisions (~73-77°F) and Garrett County (~69-71°F). The mean temperatures over the state were warmer than normal. Anomalies over eastern Cecil and Kent counties exceeded 1.8°F, and over southern and northern shore counties and Garrett County exceeded 1.2°F while very close to normal anomalies (0.2°F) appeared over Frederick and Washington counties; appendices A and B show the area-averaged values. Maximum anomalies were below the regional year-to-year variability (Appendix D).

B. Maximum Temperatures

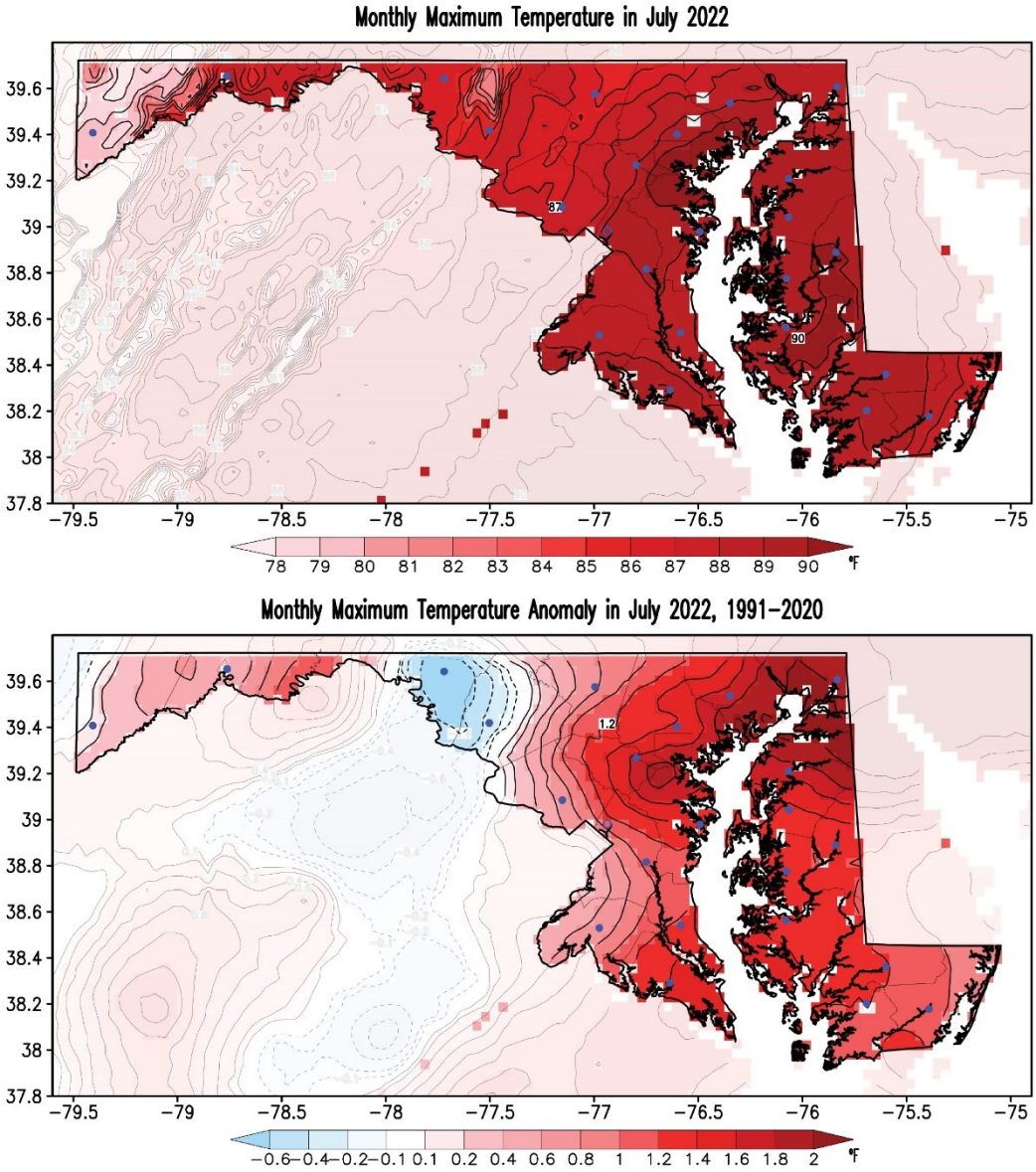

Figure 2. Maximum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in July 2022. Temperatures are given in °F according to the color bars. Red shading in the anomaly map shows above normal conditions. Note that shading outside the state has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

Monthly mean maximum temperatures in July 2022 had the same structure than the mean temperatures with maximum values over the coastal plains (~89-90°F) and minimum values over the North Central counties (~83-87°F) and Garrett County (~78-80°F). Maximum temperatures were above normal along the northern coastal plain counties (~1.8-2.0°F) and southern coastal plain counties ~1.2°F in the south, but they were below normal over Frederick and Washington counties (~ -0.6°F) and western Garret County (~-0.2°F); appendices A and B show the area-averaged values. Anomalies were inferior to the year-to-year variability (Appendix D).

C. Minimum Temperatures

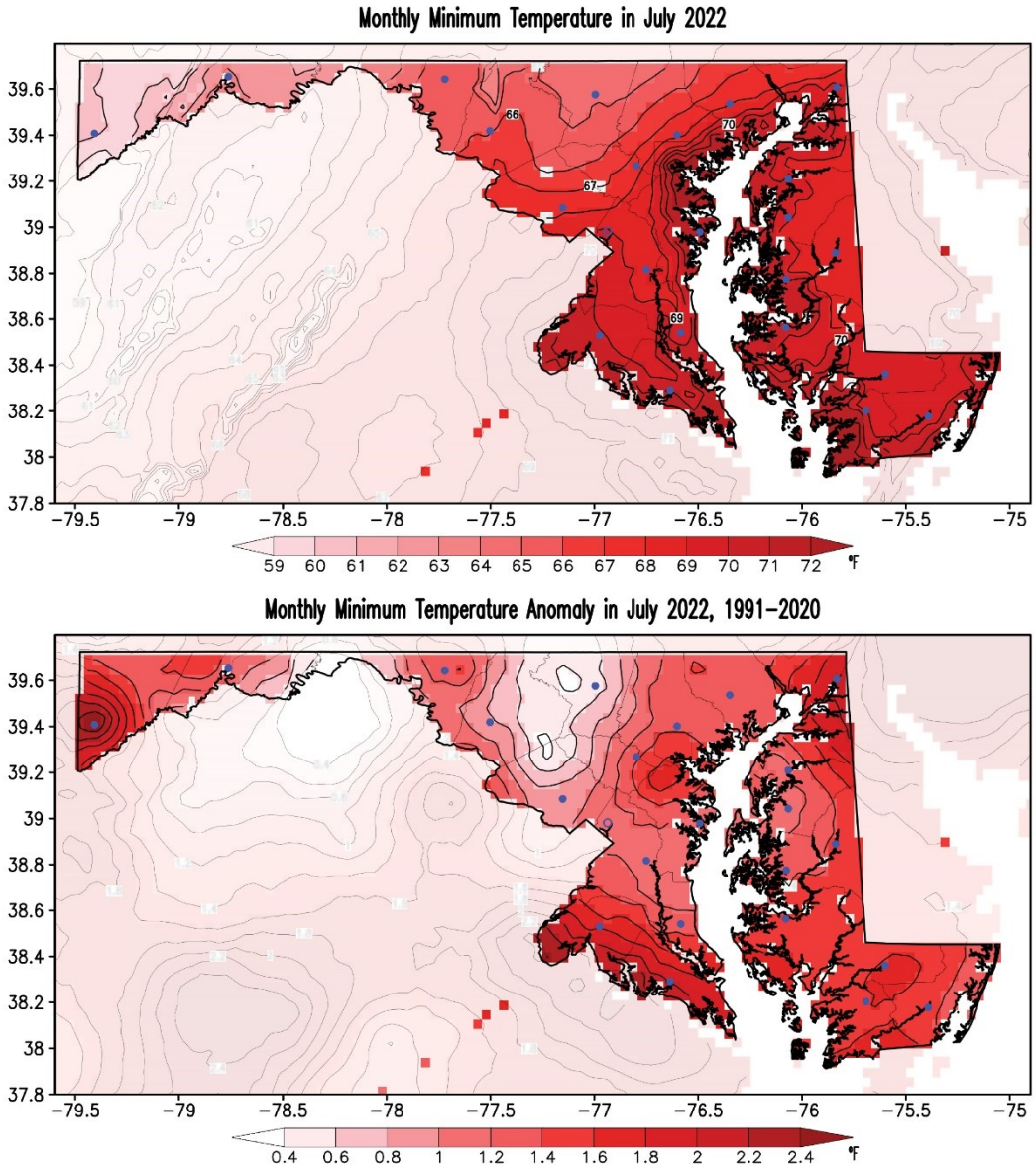

Figure 3. Minimum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in July 2022. Temperatures are given in °F according to the color bars. Blue/red shading in the anomaly map shows below/above normal conditions. Note that shading outside the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

Monthly mean minimum temperatures in July 2022 reached minimum values over Garrett County (~59°-60°F) and maximum values along the coasts of the Chesapeake Bay (~70-72°F). The minimum temperatures over the majority of the state were warmer than normal, especially over Garrett County (~ 2.6°F) and southern Charles, Saint Mary's, Kent and Cecil counties (~ 1.8°F). Anomalies over Frederick and Carroll counties were close to normal (~0.4°F); appendices A and B show the area-averaged values. Anomalies were smaller than the year-to-year variability (Appendix D).

D. Precipitation

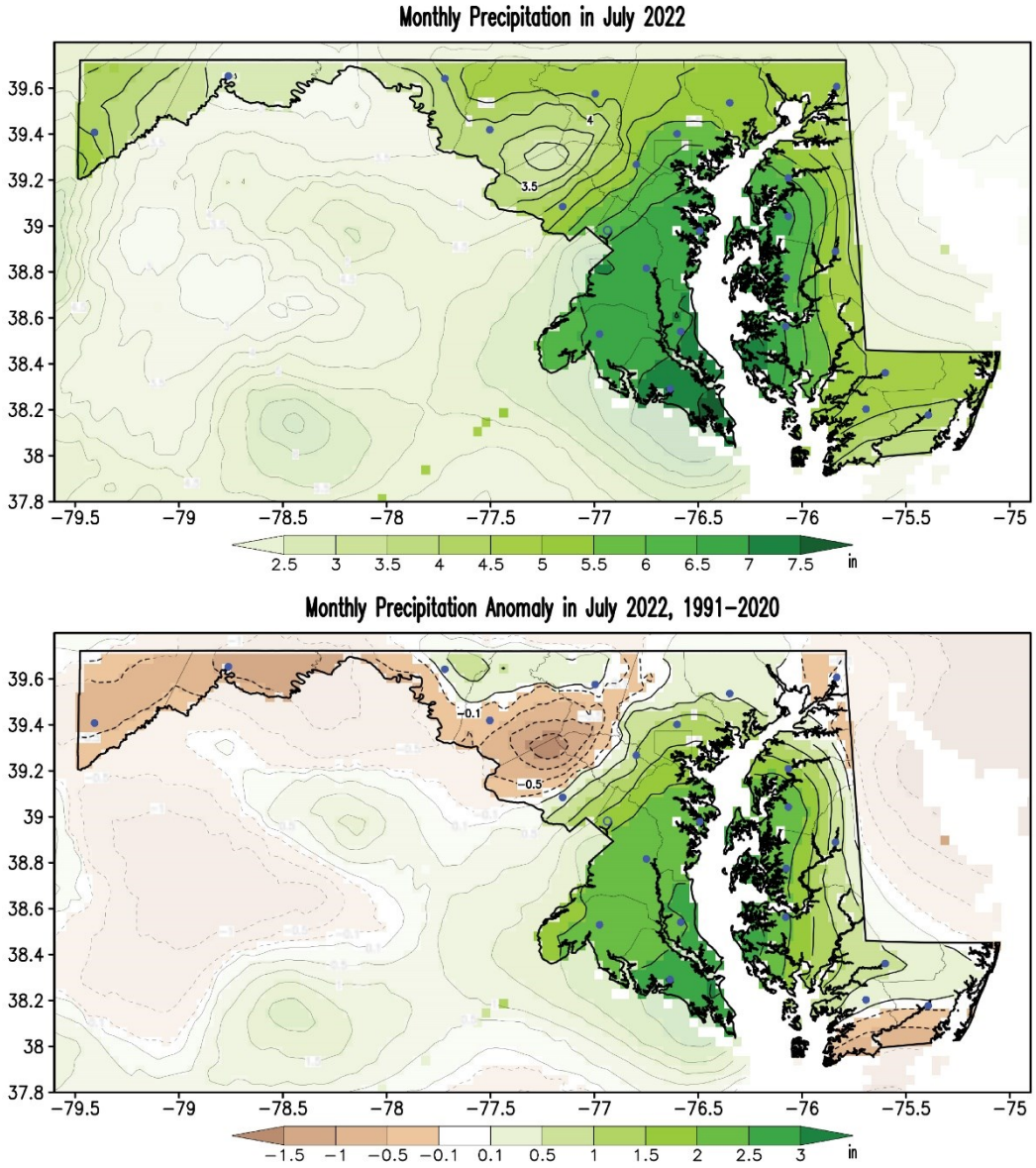

Figure 4. Precipitation (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in July 2022. Precipitation units are given as inches according to the color bars. Brown/green shading in the anomaly map shows below/above normal conditions. Note that shading outside the state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

Monthly total precipitation in July 2022 shows a distinctive structure with a tongue of maximum precipitation along the coastal plains. Maximum precipitation is over Saint Mary's, Calvert and Dorchester counties (~7-7.5 in), and minimum amounts are over Montgomery, Frederick, and Allegany counties (~3.0 in). This structure is partially highlighted in the anomalies with the largest positive values along the Bay over Saint Mary's, Calvert and Dorchester counties (~2.5-3.0 in), and negative anomalies over Montgomery, Frederick (~ -1.5 in), Garrett, Allegany counties (~ -0.5 in) and portions of Montgomery, Frederick, and Carroll counties; appendices A and B show the area-averaged values. The regions of negative anomalies over Garrett and Allegany counties exceed the year-to-year variability (Appendix D).

E. Drought

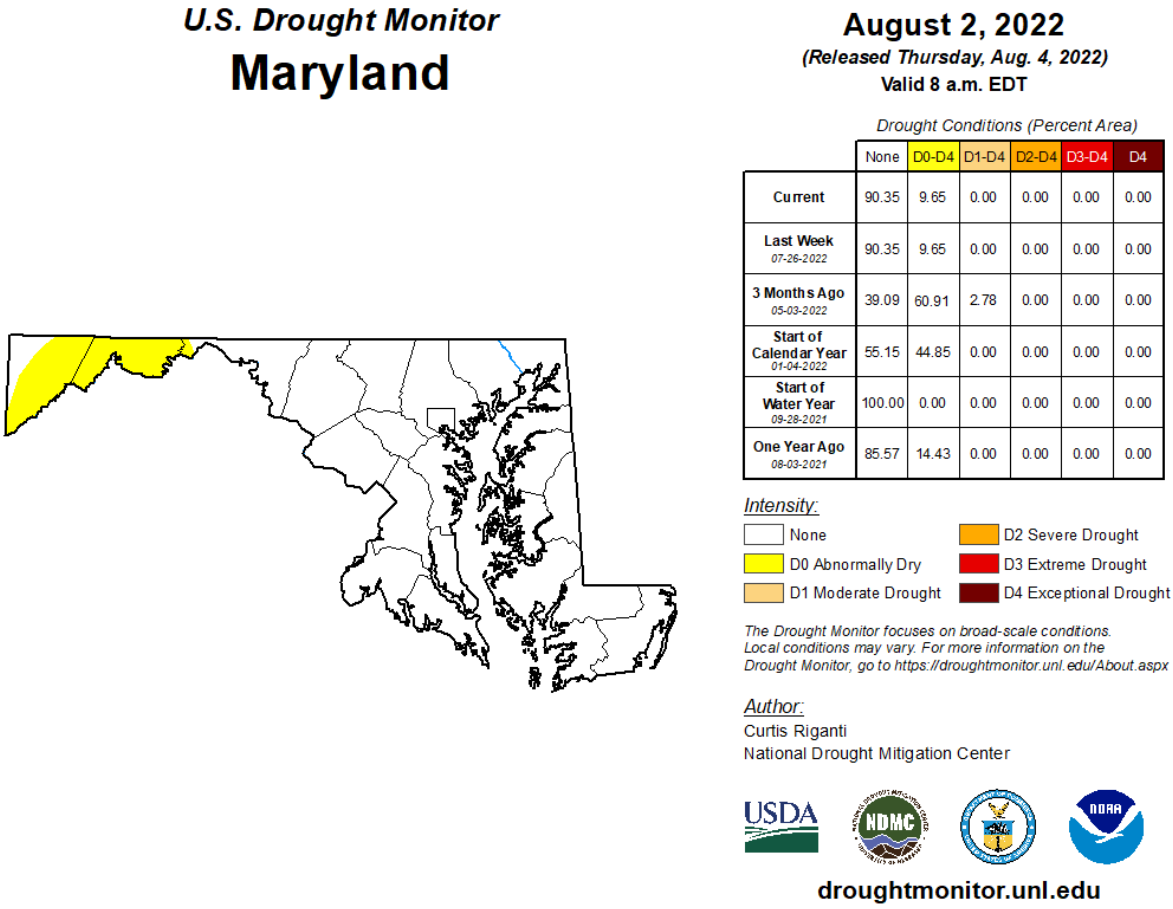

Figure 5. Drought conditions as reported by the U.S. Drought Monitor on August 2, 2022.

Drought conditions at the end of July 2022 indicate that the abnormally conditions over Garrett and Allegany counties seen in June have expanded eastward and reached western Washington County now. The continued decrease in precipitation over these western counties from the previous June seem to be behind the observed abnormally dry conditions at the end of this month. Under these abnormally dry conditions surface water levels decline, crops are stunted, gardens begin to wilt and fire danger is elevated.

4. July 2022 Statewide Averages in the Historical Record

A. Box and Whisker Plots

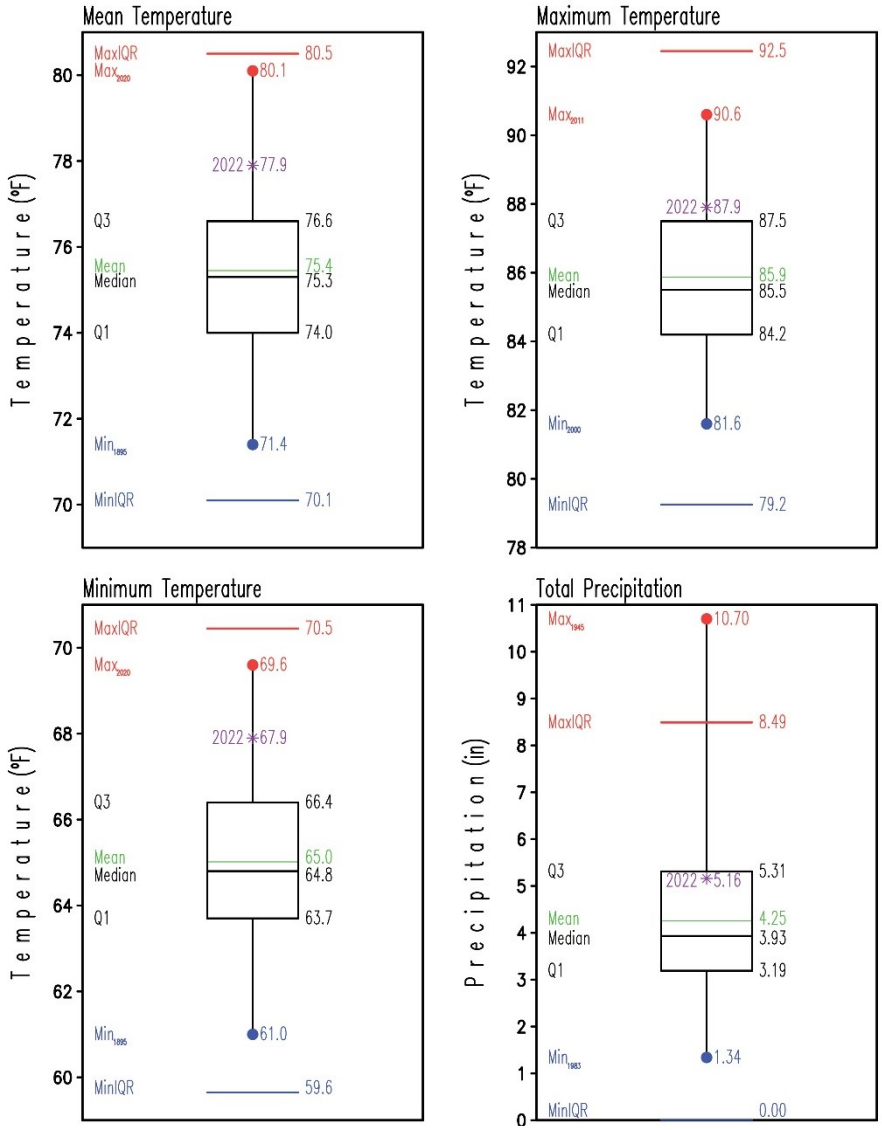

Figure 6. Box and Whisker plots of Maryland statewide mean (upper left), maximum (upper right), minimum (lower left) surface air temperatures and total precipitation (lower right) in July for the period 1895-2021. Conditions in July 2022 are represented by the label and asterisk in purple within the 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 (77.9, 87.9, 67.9°F) and precipitation (5.11 in) in July 2022 are above the mean and median of the 1895-2021 historical record, in the upper 25% of the concentration of the data for the temperatures. Thus, in the historical context, July 2022 was warmer and wetter.

B. Scatter Plots

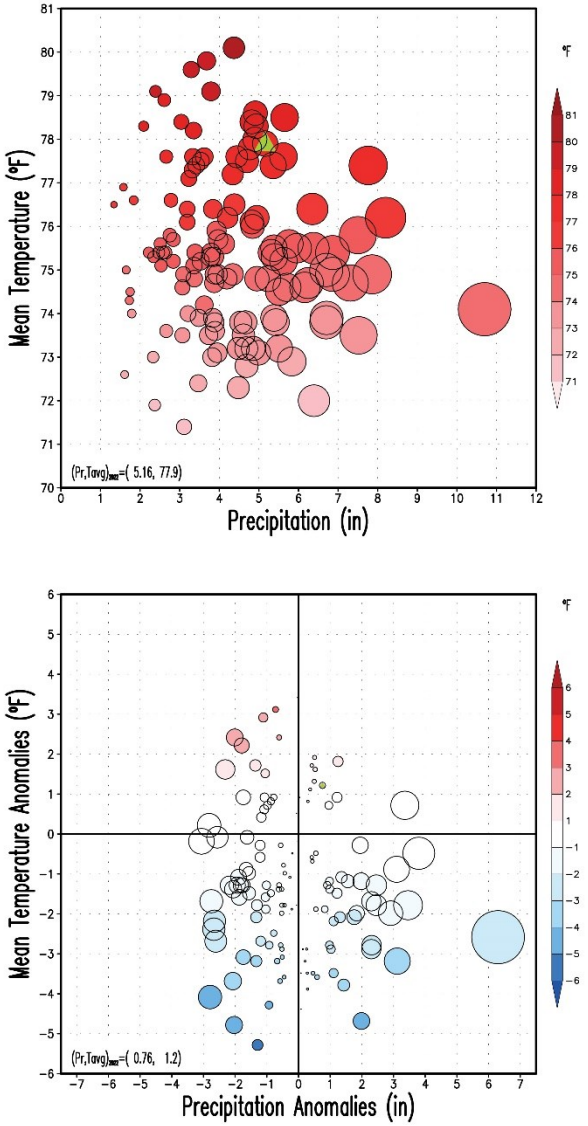

Figure 7. Scatter plot of averaged Maryland statewide mean surface air temperature vs total precipitation in July for the period 1895-2022. Upper panel shows the mean temperature and total precipitation in July, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation on record (10.70 in in 1945, top panel) and by the maximum precipitation anomaly (6.30 in in 1945, 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. July 2022 is marked by the yellow/green filled triangle.

The statewide total precipitation and mean temperature of 5.11 in and 77.9°F, as also indicated by the box and whisker plots, are within the upper and middle data cloud in the historical record of 128 years. The statewide anomalies, with respect to the current 1991-2020 climatology, of -0.76 in and 1.2 °F also indicate an anomalous wet and warm July 2022. The ranking of the temperatures and precipitation in July 2022 within the historical record at state, climate division and county level are displayed in the tables in Appendix A.

5. July and MJJ 2022 Climate Divisions Averages

A. July 2022 Scatter Plots

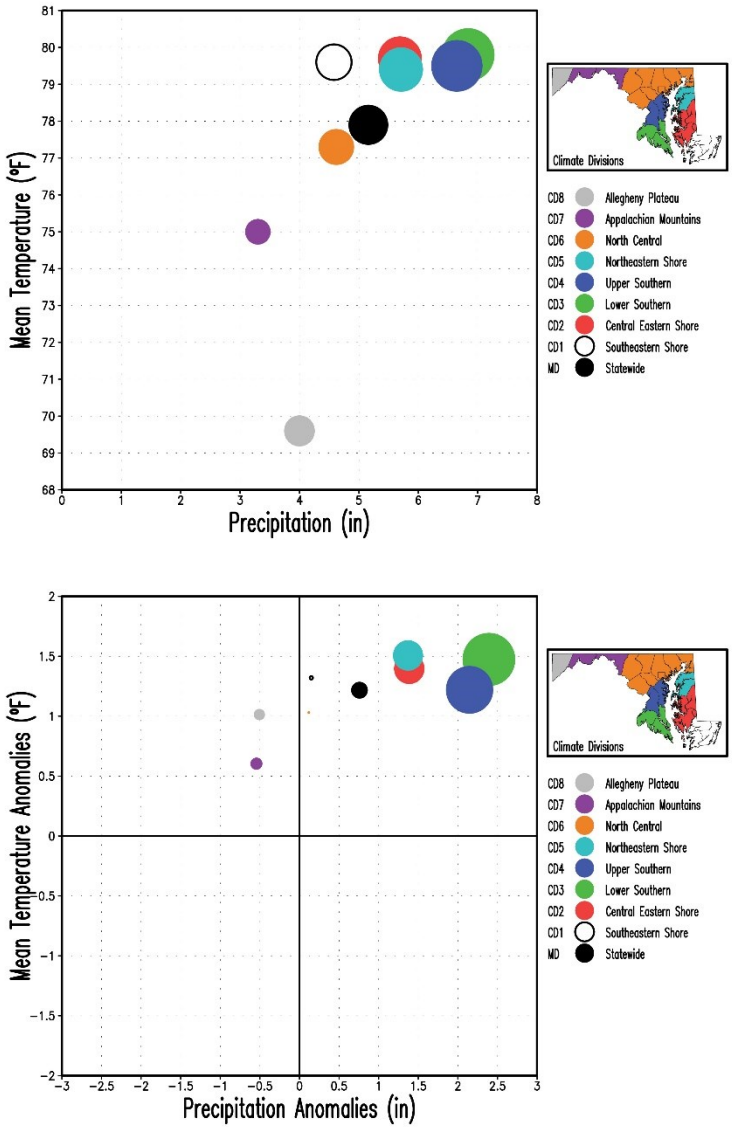

Figure 8. Scatter plot of averaged Maryland statewide and Climate Divisions (CD#) mean surface air temperature vs total precipitation for July 2022. Upper panel shows the mean temperature and total precipitation, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (6.84 in in CD3, top panel) and by the maximum precipitation anomaly (2.39 in in CD3, 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) are colder than the central and southern divisions (CD1-CD5) and the statewide mean, with CD8 been the coldest, and CD3 been the warmest among them. The driest division was CD7 and closely CD8, while CD3 was the wettest. It is clear that all climate divisions experienced warmer than normal conditions but the northwestern climate divisions CD7 and CD8 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. May-June-July 2022 Scatter Plots

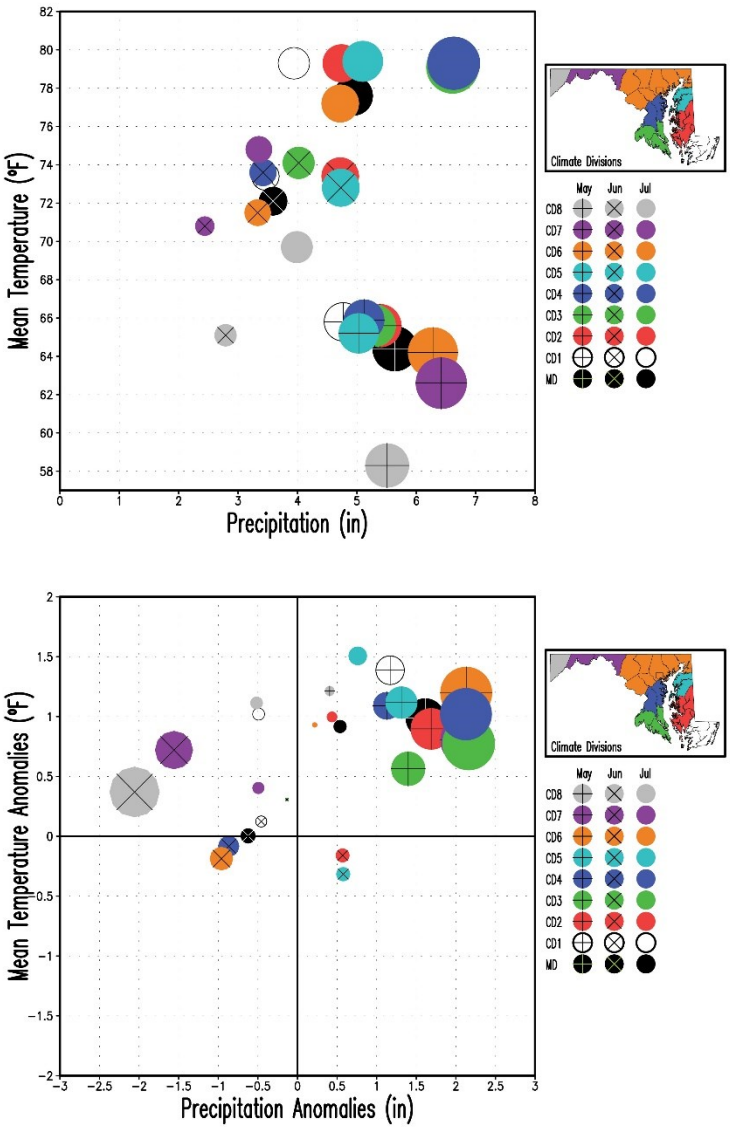

Figure 9. Scatter plot of averaged Maryland statewide and Climate Divisions (CD#) mean surface air temperature vs total precipitation for May, June and July 2022. Upper panel shows the mean temperature and total precipitation, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (6.84 in in CD3 in July, top panel) and by the maximum precipitation anomaly (2.39 in in CD3 in July, bottom panel) among the nine regions and months. Note that July is displayed with filled circles only, while June and May are displayed with superposed multiplication and addition signs respectively.

As expected, mean temperatures increased in general in the state from May to July in this 2022 but precipitation, with comparable values in May and July, reached minimum values in June. While the state in general experienced above normal mean temperatures in the past three months, the state was drier than normal in the preceding June and the northwestern climate divisions CD7 and CD8 kept this tendency in July which may explain the observed abnormal dryness in these climate divisions.

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

A. Mean Temperature and Precipitation

Region	Mean Air Temperature (°F)	Rank (#)
Statewide	77.9	114
Climate Division 1	79.6	117
Climate Division 2	79.7	115
Climate Division 3	79.8	116
Climate Division 4	79.5	115
Climate Division 5	79.4	118
Climate Division 6	77.3	108
Climate Division 7	75.0	97
Climate Division 8	69.6	102
Allegany	74.3	98
Anne Arundel	80.0	117
Baltimore	78.0	114
Baltimore City	80.3	117
Calvert	79.4	114
Caroline	79.2	114
Carroll	75.8	100
Cecil	78.8	122
Charles	79.7	115
Dorchester	80.0	117
Fredrick	75.9	97
Garrett	69.6	102
Harford	78.5	117
Howard	77.4	111
Kent	79.6	120
Montgomery	77.2	104
Prince George's	79.0	113
Queen Anne's	79.3	114
Saint Mary's	80.0	117
Somerset	80.2	118
Talbot	79.7	113
Washington	75.6	94
Wicomico	79.6	117
Worcester	79.1	116

Region	Total Precipitation (in)	Rank(#)
Statewide	5.16	95
Climate Division 1	4.58	75
Climate Division 2	5.69	105
Climate Division 3	6.84	112
Climate Division 4	6.65	116
Climate Division 5	5.71	102
Climate Division 6	4.62	79
Climate Division 7	3.30	53
Climate Division 8	4.00	54
Allegany	2.80	29
Anne Arundel	6.60	115
Baltimore	5.30	96
Baltimore City	6.00	105
Calvert	7.00	109
Caroline	4.90	84
Carroll	4.30	79
Cecil	4.60	74
Charles	6.50	109
Dorchester	6.00	107
Fredrick	3.90	68
Garrett	3.90	52
Harford	5.10	86
Howard	4.60	82
Kent	5.50	95
Montgomery	4.20	72
Prince George's	6.60	116
Queen Anne's	5.90	103
Saint Mary's	7.20	113
Somerset	4.50	70
Talbot	6.30	108
Washington	3.70	66
Wicomico	4.90	82
Worcester	4.30	73

Tables A1. Mean surface air temperature (left) and total precipitation (right) at statewide, climate division and county levels in July 2022. Temperature is given in °F and precipitation in in. The rank is the order that the variable in July 2022 occupies among the 128 Julies 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	87.9	102
Climate Division 1	88.9	116
Climate Division 2	89.7	113
Climate Division 3	89.0	101
Climate Division 4	89.2	103
Climate Division 5	89.6	115
Climate Division 6	87.7	98
Climate Division 7	86.3	80
Climate Division 8	79.3	70
Allegany	86.3	86
Anne Arundel	89.6	111
Baltimore	88.5	108
Baltimore City	90.3	115
Calvert	88.7	103
Caroline	89.9	113
Carroll	86.6	91
Cecil	88.8	118
Charles	89.0	99
Dorchester	89.8	112
Fredrick	86.2	81
Garrett	79.3	70
Harford	88.8	110
Howard	88.0	107
Kent	89.5	115
Montgomery	87.2	95
Prince George's	88.9	100
Queen Anne's	89.6	113
Saint Mary's	89.2	107
Somerset	89.2	115
Talbot	89.5	112
Washington	86.4	72
Wicomico	89.6	116
Worcester	88.2	113

Region	Minimum Air Temperature (°F)	Rank (#)
Statewide	67.9	117
Climate Division 1	70.3	120
Climate Division 2	69.6	116
Climate Division 3	70.5	121
Climate Division 4	69.8	116
Climate Division 5	69.2	118
Climate Division 6	67.0	112
Climate Division 7	63.6	107
Climate Division 8	59.8	117
Allegany	62.3	102
Anne Arundel	70.4	114
Baltimore	67.4	114
Baltimore City	70.4	118
Calvert	70.0	112
Caroline	68.4	115
Carroll	64.9	106
Cecil	68.9	121
Charles	70.5	122
Dorchester	70.2	119
Fredrick	65.6	103
Garrett	59.8	117
Harford	68.2	115
Howard	66.8	112
Kent	69.8	119
Montgomery	67.3	107
Prince George's	69.1	115
Queen Anne's	69.1	118
Saint Mary's	70.8	121
Somerset	71.3	122
Talbot	70.0	114
Washington	64.8	108
Wicomico	69.7	119
Worcester	70.1	119

Tables A2. Maximum (left) and minimum (right) surface air temperatures at statewide, climate division and county levels in July 2022. Temperature is given in °F. The rank is the order that the variable in July 2022 occupies among the 128 Julies 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. July 2022 Bar Graphs: Statewide, Climate Divisions and Counties

A. Temperatures and Precipitation

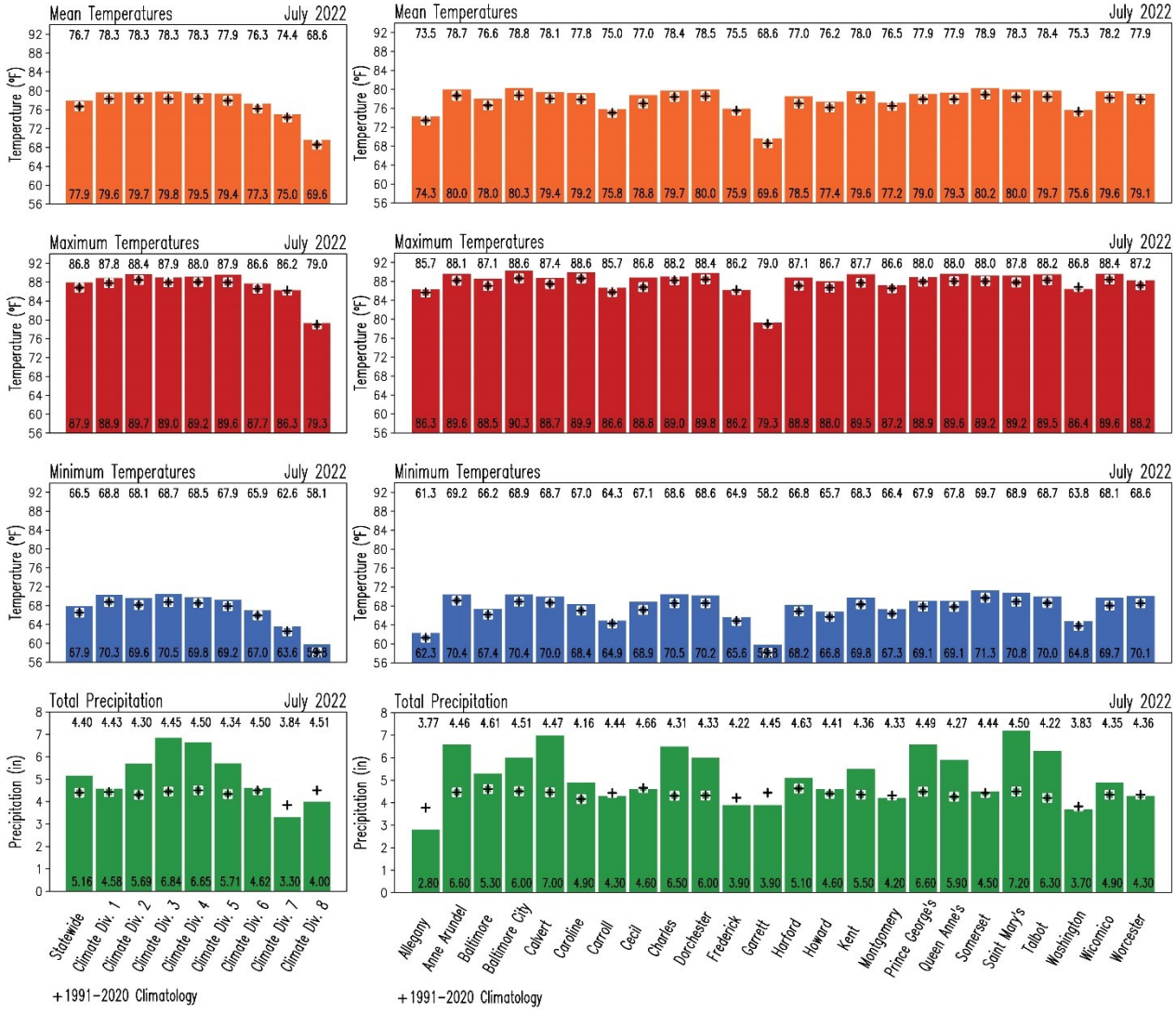

Figure B1. Area-averaged surface variables in Maryland in July 2022. Color bars represent the variables as follows: mean surface air temperature (orange, °F), maximum surface air temperature (red, °F), minimum surface air temperature (blue, °F) and total precipitation (green, in) at statewide and climate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

B. Temperature and Precipitation Anomalies

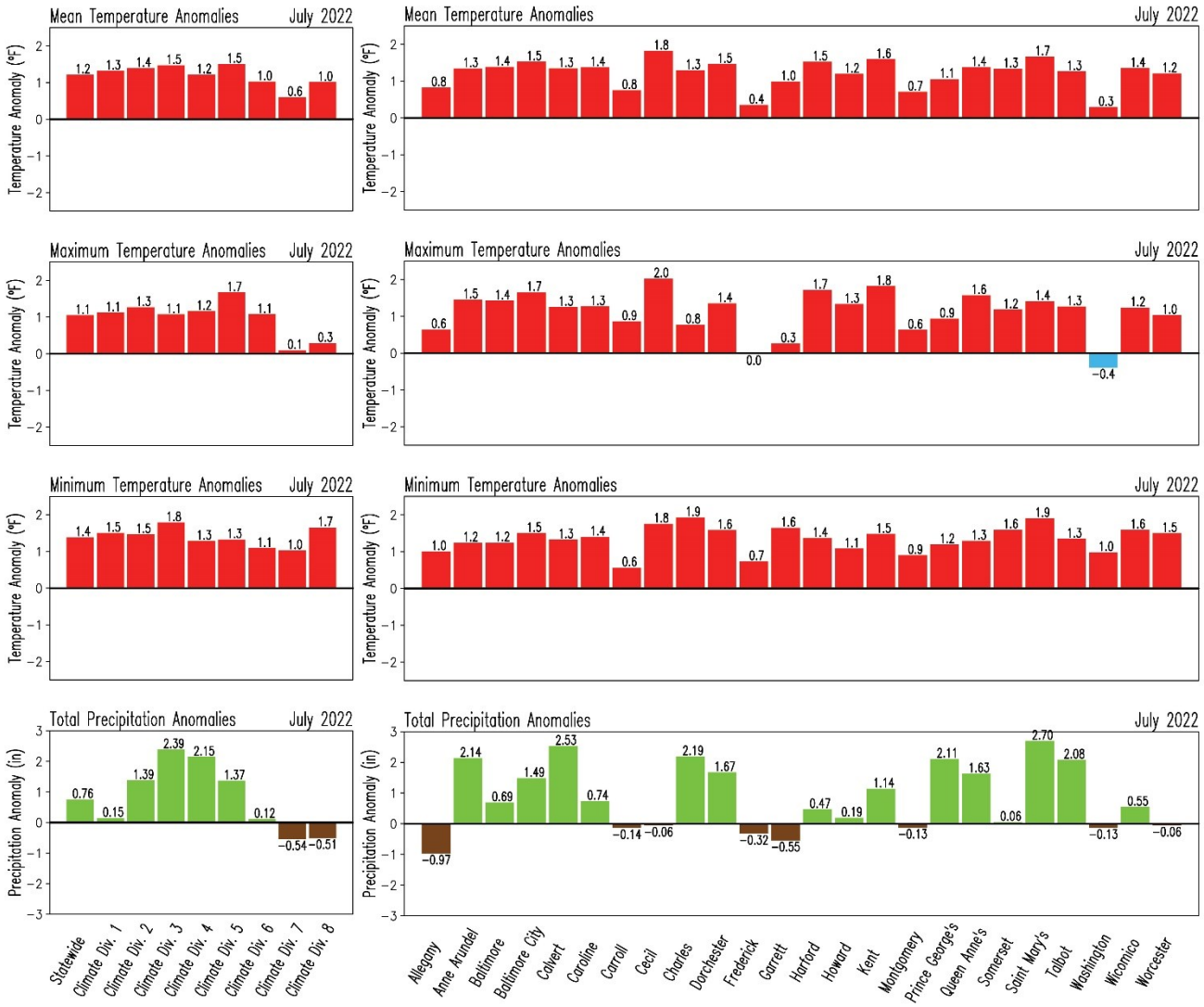

Figure B2. Area-averaged anomalies of the surface variables in Maryland in July 2022. Anomalies are with respect to the 1991-2020 climatology. Red and blue colors represent positive and negative anomalies for mean surface air temperature (upper row), maximum surface air temperature (second row from top), 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 July 2022. Units are °F for the temperatures and in for precipitation.

Appendix C. July 1991-2020 Climatology Maps

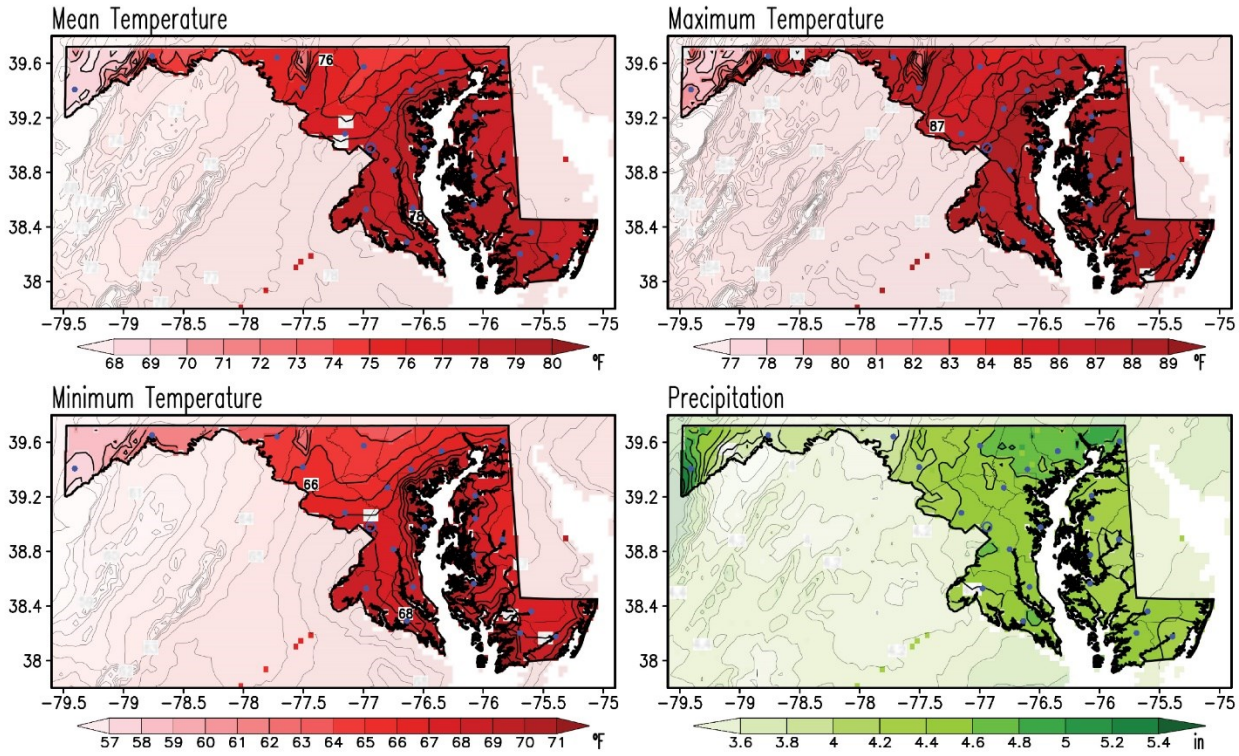

Figure C1. July climatology of the mean, maximum and minimum surface air temperatures and total precipitation for the period 1991-2020. Temperatures are given in °F and precipitation is in inches according to the color bars. This is the current climate normal against which the July 2022 conditions are compared with to obtain the July 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. July Standard Deviation and July 2022 Standardized Anomalies Maps

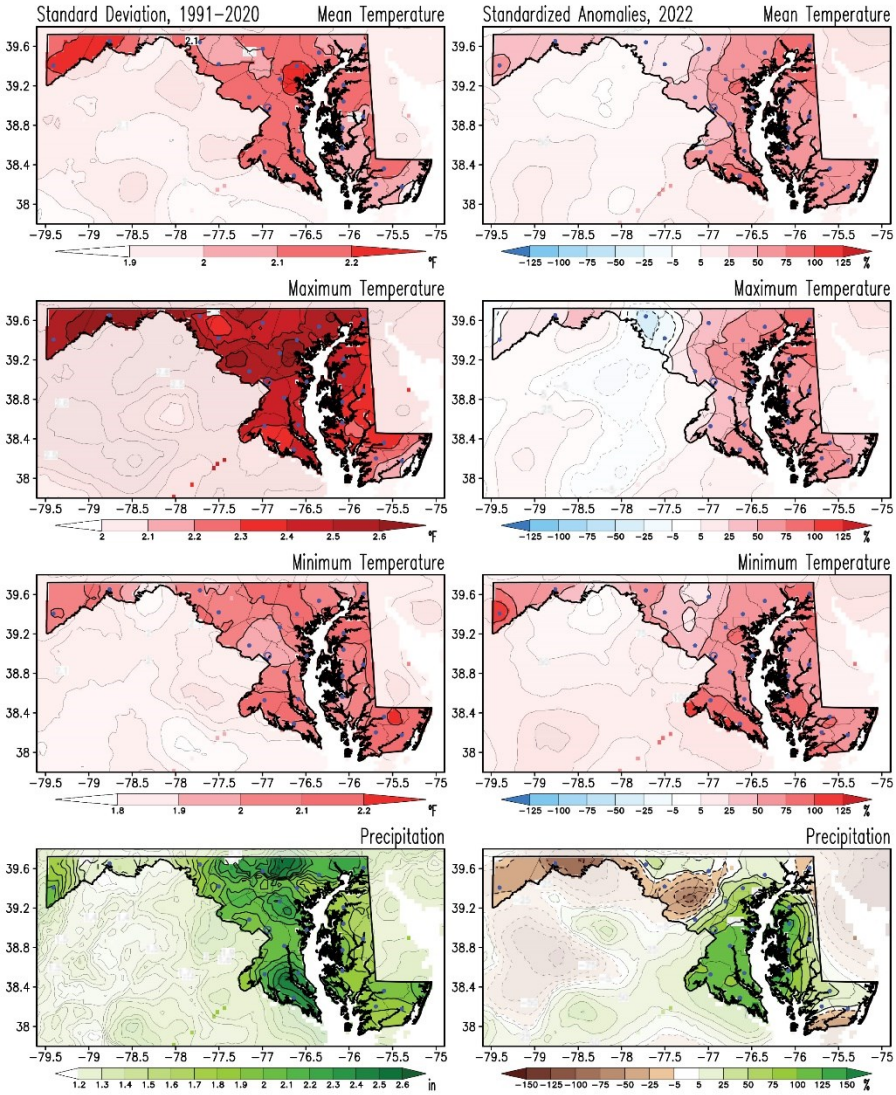

Figure D1. Standard deviation in July and standardized anomalies of temperatures and precipitation in July 2022. Standard deviations for mean, maximum and minimum surface air temperatures and precipitation are obtained for the period 1991-2020 (left column). Anomalies in July 2022 (right column) are 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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