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Maryland Climate Bulletin
June 2022

Prepared by
Alfredo Ruiz-Barradas
Maryland State Climatologist

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DEPARTMENT OF ATMOSPHERIC & OCEANIC SCIENCE

Maryland State Climatologist Office

Summary

June 2022 was slightly warmer and drier than normal in average, when compared with the 1991-2020 climatology. These conditions appeared after changing conditions from anomalously cold and wet April to an anomalously warm and wet May. Regional differences in June 2022 showed that except by a region in the middle of the state that had below normal temperatures, the northwestern counties of Garrett, Allegany and Washington, as well as the southern counties of Charles, Saint Mary's, Calvert and Wicomico had temperatures higher than normal. Regional differences in precipitation highlighted a region of above normal precipitation in the northeastern corner of the state over Kent and Harford counties and extreme below normal precipitation over Garrett and Allegany counties. In spite of the largely below normal precipitation along the majority of the state, drought conditions at the end of June largely remained nonexistent except by the abnormally dry conditions over Garrett and Allegany counties. Statewide temperature conditions in June were above the mean and median of the historical 1895-2021 record but precipitation conditions were below them.

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 June 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 June 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 7/12/2022.

- NOAA Monthly U.S. Climate Divisional Dataset (NClimDiv – Vose et al. 2014), which is available, in a *preliminary* status (v1.0.0-20220707), at:

  https://www.ncei.noaa.gov/data/climdiv/access/
  Data downloaded on 8/1/2022

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

A. Mean Temperatures

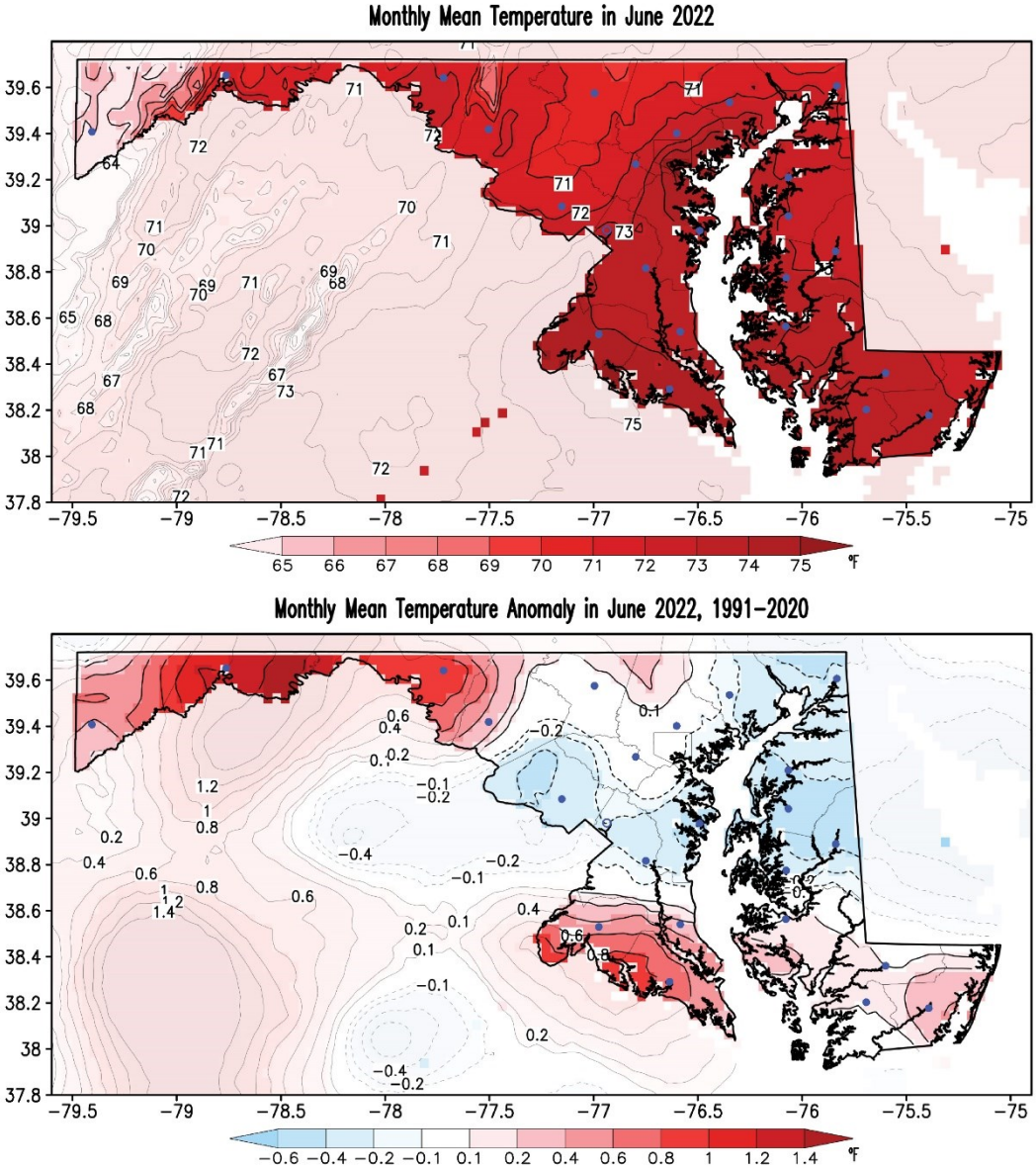

Figure 1. Mean surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in June 2022. Temperatures are given in °F according to the color bars. Red shading in the anomaly map shows above normal conditions. Note that shading outside the state has been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

Monthly mean temperatures in June 2022 were in the lower 70s except in western Garrett County. Temperatures along the coastal plains were warmer (~74-75°F) than over the North Central (~70-73°F) and Appalachian Mountains climate division (~71-72°F) and Garrett counties (~65°F). The mean temperatures over western (west of Frederick) and southern (south of Calvert and Dorchester) counties were warmer than normal while central Maryland had below normal conditions; appendices A and B show the area-averaged values. Maximum anomalies were below the regional year-to-year variability (Appendix D).

B. Maximum Temperatures

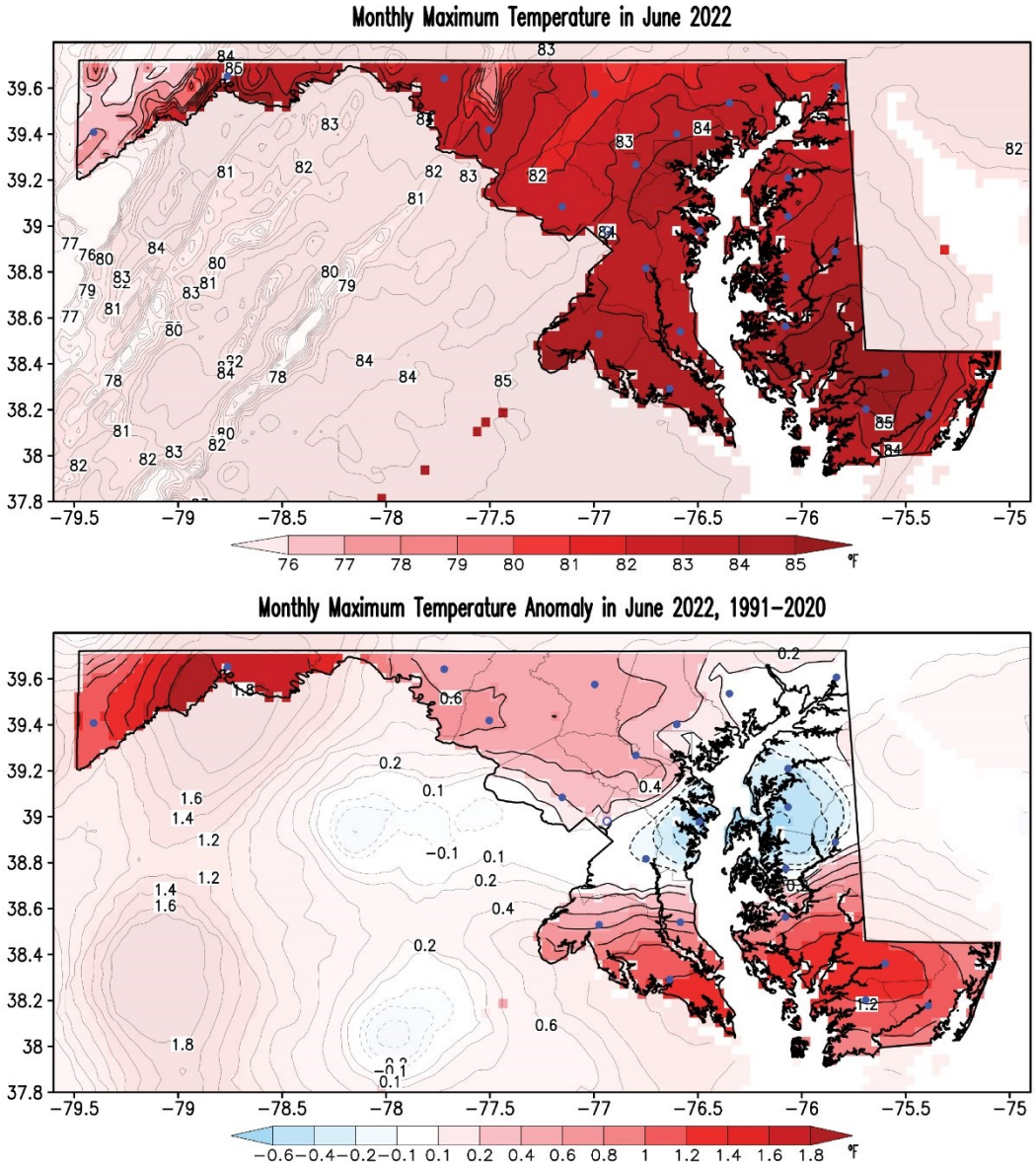

Figure 2. Maximum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in June 2022. Temperatures are given in °F according to the color bars. Red shading in the anomaly map shows above normal conditions. Note that shading outside the state has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

Monthly mean maximum temperatures in June 2022 had the same structure than the mean temperatures with maximum values over the coastal plains and Allegany County (~84-85°F) and minimum values over Garrett County (~76°F). Maximum temperatures were above normal along the northern and southern counties (~1.8°F over Allegany and ~1.2°F in the south), but they were below normal over Queen Anne's and Anne Arundel counties (~ -0.6°F); appendices A and B show the area-averaged values. Anomalies were inferior to the year-to-year variability (Appendix D).

C. Minimum Temperatures

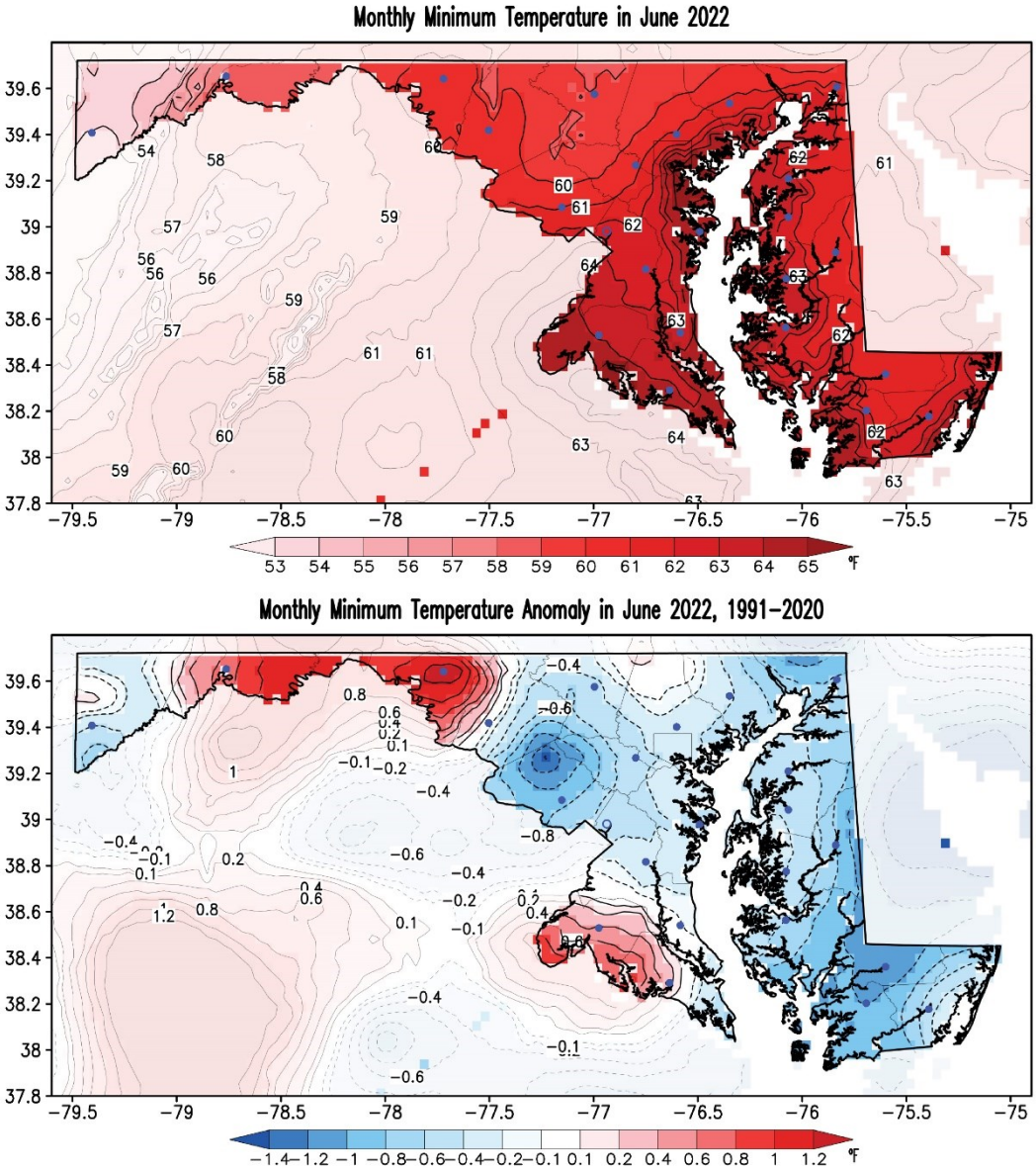

Figure 3. Minimum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in June 2022. Temperatures are given in °F according to the color bars. Blue/red shading in the anomaly map shows below/above normal conditions. Note that shading outside the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

Monthly mean minimum temperatures in June 2022 reached minimum values over Garrett County (~53°-54°F) and maximum values along the coasts of the Chesapeake Bay and Calvert and Saint Mary's counties (~64-65°F). The minimum temperatures over the majority of the state were colder than normal, especially over Montgomery (~ -1.2°F) and Wicomico (~ -1.0°F) counties. Anomalies over Allegany and Washington (1.0-1.2°F) counties, and Calvert and northern Saint Mary's (0.6-0.8 °F) counties were above normal; appendices A and B show the area-averaged values. Anomalies were smaller than the year-to-year variability (Appendix D).

D. Precipitation

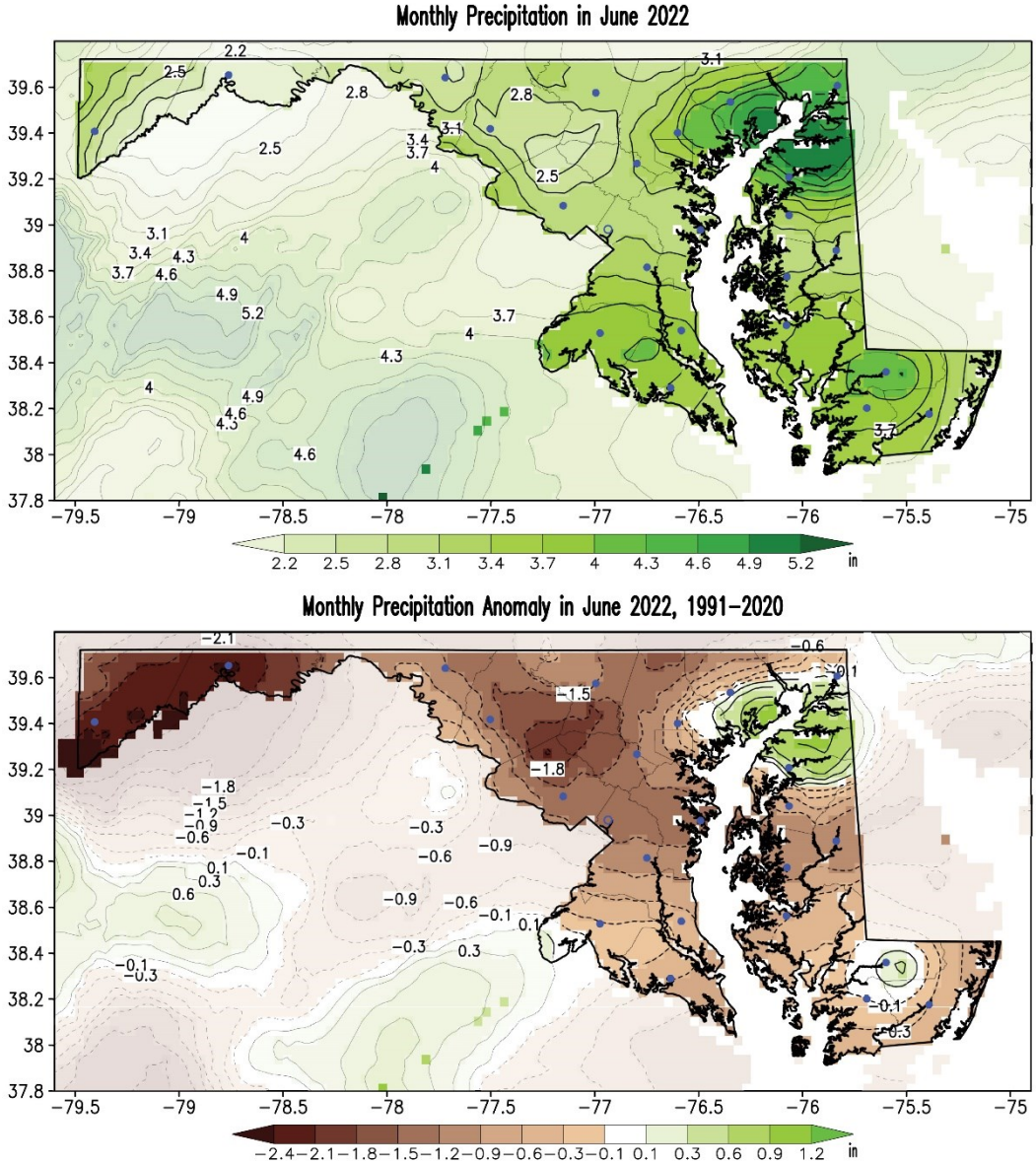

Figure 4. Precipitation (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in June 2022. Precipitation units are given as inches according to the color bars. Brown/green shading in the anomaly map shows below/above normal conditions. Note that shading outside the state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

Monthly total precipitation in June 2022 shows a distinctive structure with maximum precipitation over Kent and Harford counties (~4.9 in), and over Wicomico and Saint Mary's (~4 in) counties, and minimum amounts over Montgomery, Frederick, Howard and Carroll (~2.5 in) and Allegany counties (~2.8 in). This structure is partially highlighted in the anomalies with the largest positive values over Kent and Harford (~0.9 in) and Wicomico (~0.3 in) counties, and negative anomalies over Montgomery, Frederick, Howard and Carroll (~ -2.1 in) and Garrett and Allegany (~ - 2.4 in) counties; appendices A and B show the area-averaged values. The regions of maximum negative anomalies over Garrett and Allegany counties exceed the year-to-year variability (Appendix D).

E. Drought

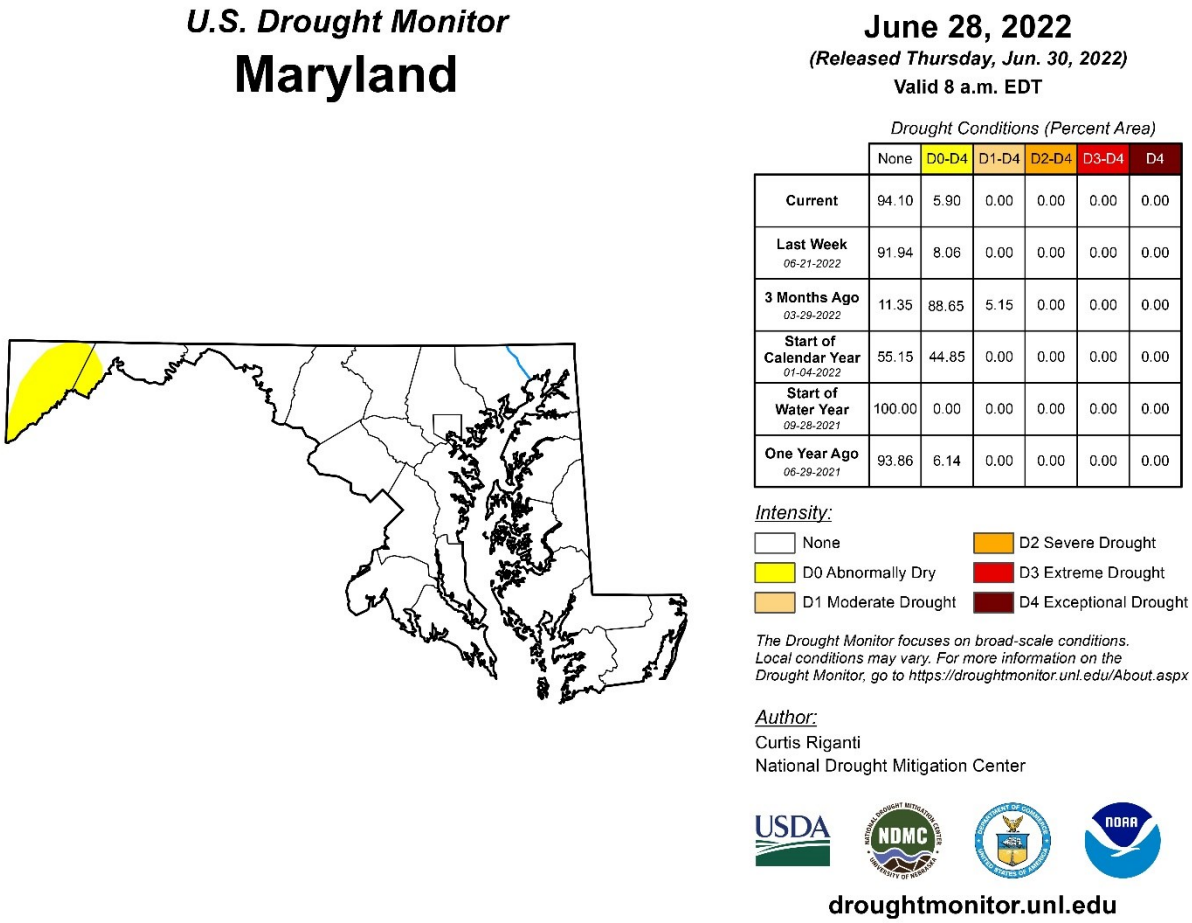

Figure 5. Drought conditions as reported by the U.S. Drought Monitor on June 28, 2022.

Drought conditions at the end of June 2022 only point to abnormally conditions over Garrett and Allegany counties. The large decrease in precipitation over Garrett and Allegany counties 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. June 2022 Statewide Averages in the Historical Record

A. Box and Whisker Plots

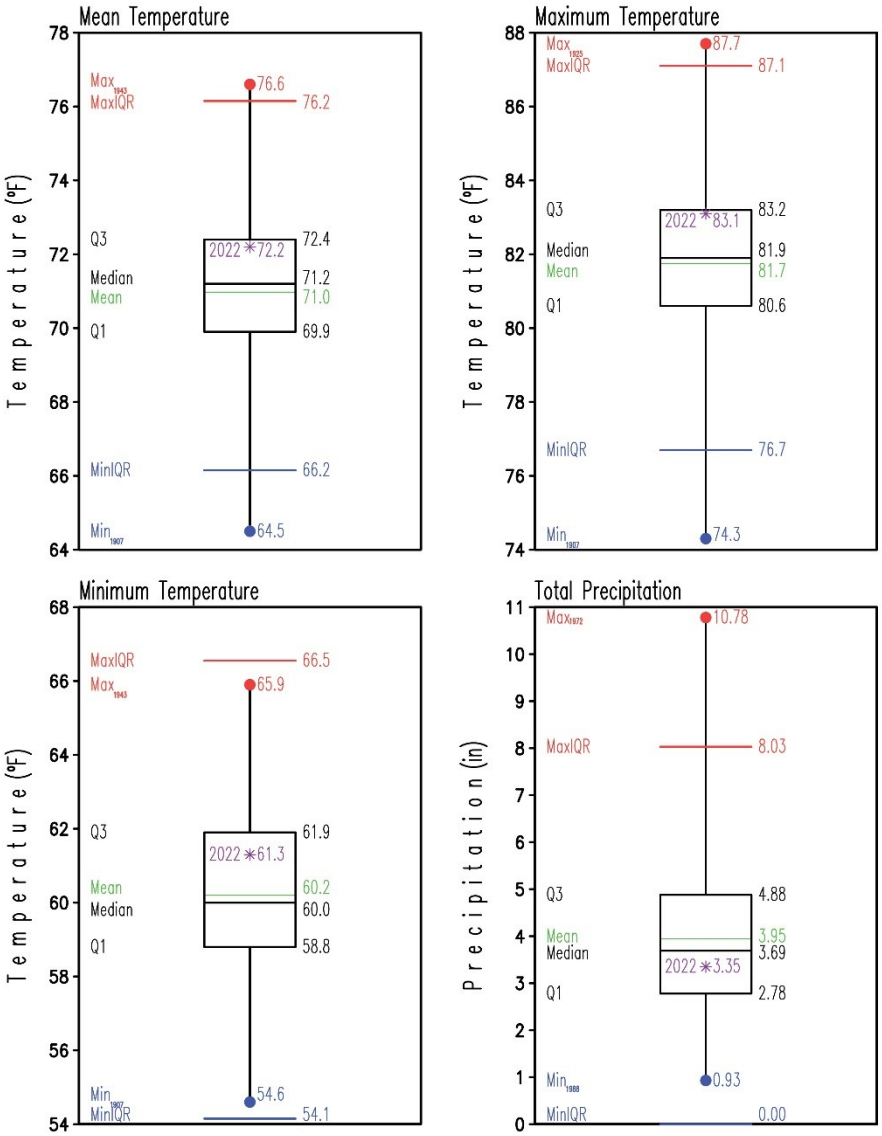

Figure 6. Box and Whisker plots of Maryland statewide mean (upper left), maximum (upper right), minimum (lower left) surface air temperatures and total precipitation (lower right) in June for the period 1895-2021. Conditions in June 2022 are represented by the label and asterisk in purple within the 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 temperature conditions in June 2022 are above the mean and median of the historical 1895-2021 record but total precipitation is under these central statistics. Thus, when put in context with the whole historical record, June 2022 was warmer and drier.

B. Scatter Plots

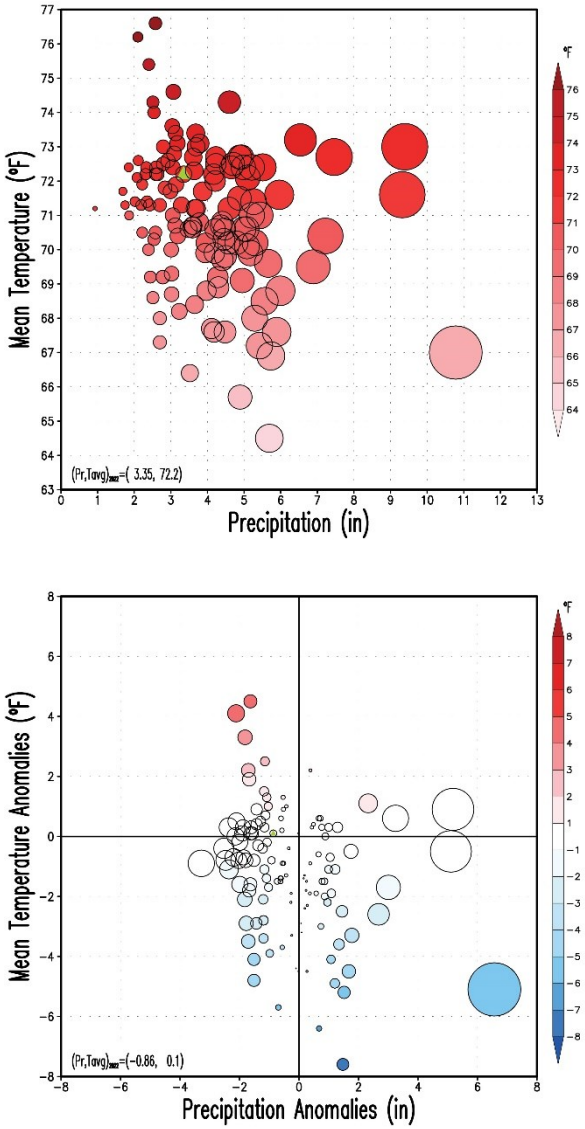

Figure 7. Scatter plot of averaged Maryland statewide mean surface air temperature vs total precipitation in June for the period 1895-2022. Upper panel shows the mean temperature and total precipitation in June, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation on record (10.78 in in 1972, top panel) and by the maximum precipitation anomaly (6.57 in in 1972, 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. June 2022 is marked by the yellow/green filled triangle.

The statewide total precipitation and mean temperature of 3.35 in and 72.2°F, as also indicated by the box and whisker plots, are within the upper left data cloud in the historical record of 128 years. The statewide anomalies, with respect to the current 1991-2020 climatology, of -0.86 in and 0.1 °F also indicate an anomalous dry and warm June 2022. The ranking of the temperatures and precipitation in June 2022 within the historical record at state, climate division and county level are displayed in the tables in Appendix A.

5. June and AMJ 2022 Climate Divisions Averages

A. June 2022 Scatter Plots

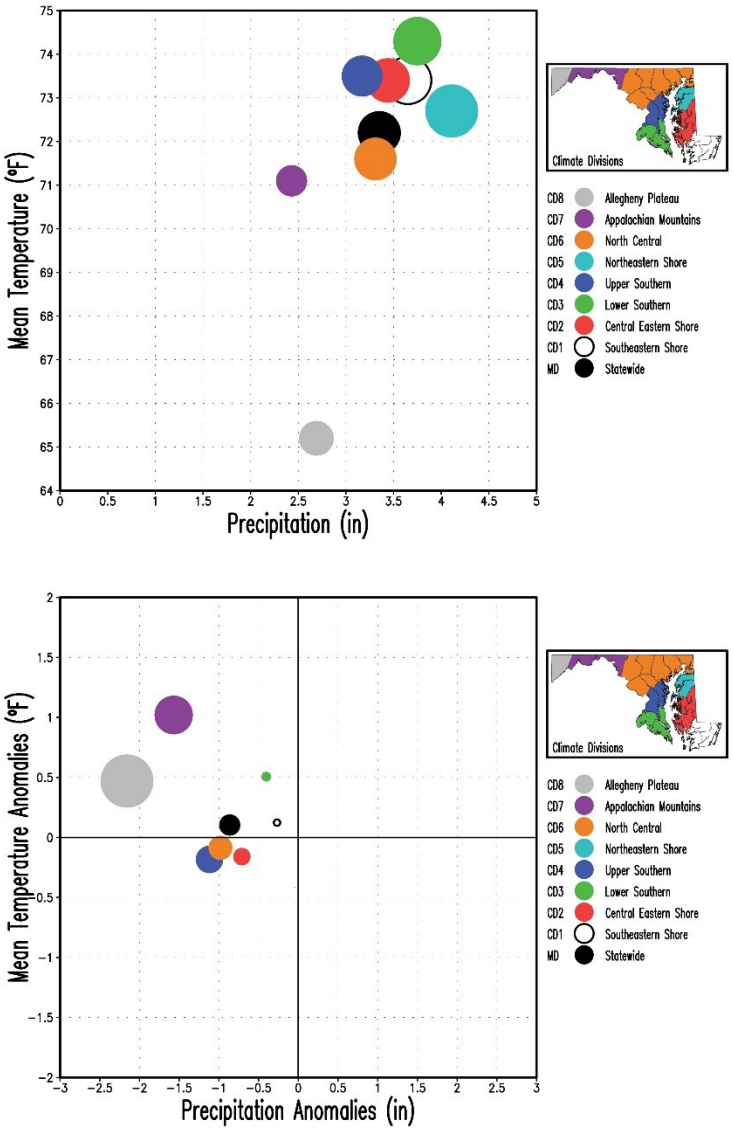

Figure 8. Scatter plot of averaged Maryland statewide and Climate Divisions (CD#) mean surface air temperature vs total precipitation for June 2022. Upper panel shows the mean temperature and total precipitation, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (4.11 in in CD5, top panel) and by the maximum precipitation anomaly (-2.16 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) are colder than the central and southern divisions (CD1-CD5), with CD8 been the coldest, and CD3 been the warmest among them. The driest division was CD7 while CD5 was the wettest. It is clear that all climate division experienced drier than normal conditions (with Garrett County been the driest, CD8), and the northern (CD7 and CD8) and southern (CD1 and CD3) divisions were warmer 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. April-May-June 2022 Scatter Plots

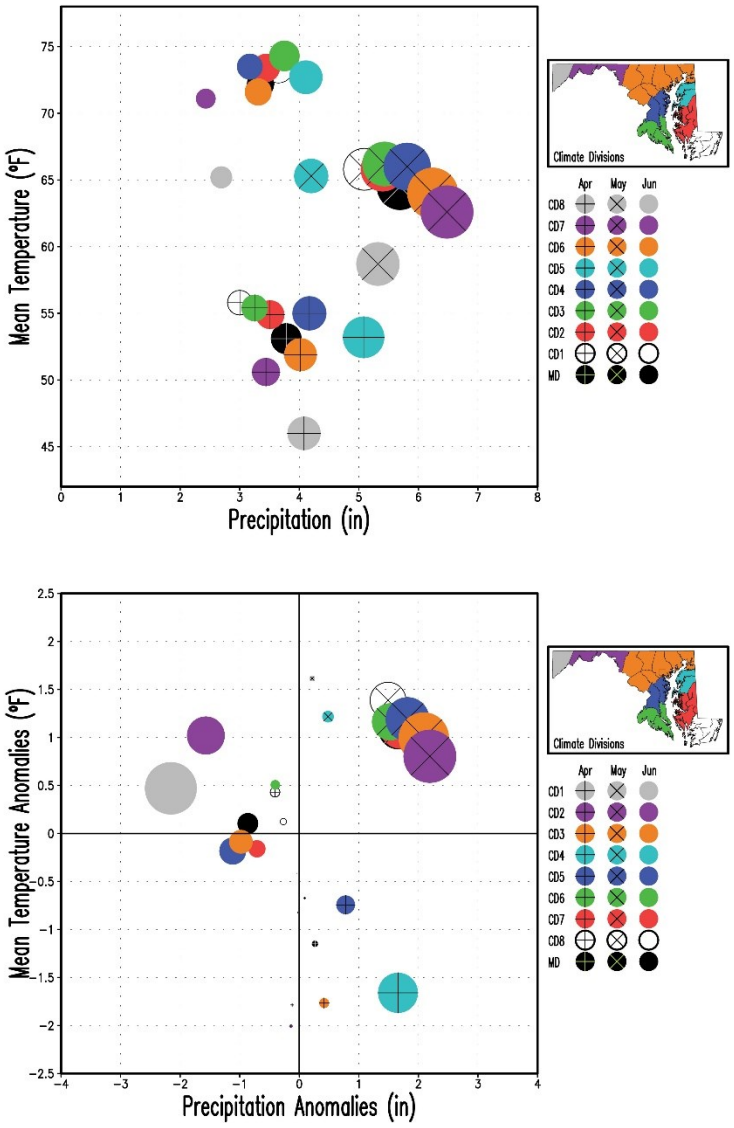

Figure 9. Scatter plot of averaged Maryland statewide and Climate Divisions (CD#) mean surface air temperature vs total precipitation for April, May and June 2022. Upper panel shows the mean temperature and total precipitation, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (6.48 in in CD7 in May, top panel) and by the maximum precipitation anomaly (2.19 in in CD7 in May, bottom panel) among the nine regions and months. Note that June is displayed with filled circles only, while May and April are displayed with superposed multiplication and addition signs respectively.

As expected, mean temperatures increased in general in the state from April to June in this 2022 but precipitation reached maximum values in May and minimum values in June. However, it is interesting to note the swing in conditions evident from the anomaly plot showing mostly below normal temperatures and above normal precipitation in April, to above normal temperatures and precipitation in May to largely above normal temperature and below normal precipitation in June.

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

A. Mean Temperature and Precipitation

Region	Mean Air Temperature (°F)	Rank (#)
Statewide	72.2	87
Climate Division 1	73.4	98
Climate Division 2	73.4	87
Climate Division 3	74.3	98
Climate Division 4	73.5	86
Climate Division 5	72.7	82
Climate Division 6	71.6	86
Climate Division 7	71.1	101
Climate Division 8	65.2	81
Allegany	70.5	101
Anne Arundel	73.7	83
Baltimore	72.0	93
Baltimore City	74.0	97
Calvert	73.8	92
Caroline	72.8	83
Carroll	70.6	86
Cecil	71.8	82
Charles	74.5	96
Dorchester	73.9	96
Fredrick	71.2	87
Garrett	65.3	83
Harford	72.1	87
Howard	71.6	88
Kent	72.8	83
Montgomery	71.6	80
Prince George's	73.3	86
Queen Anne's	72.7	80
Saint Mary's	74.4	103
Somerset	73.8	94
Talbot	73.5	84
Washington	71.7	106
Wicomico	73.4	94
Worcester	73.0	98

Region	Total Precipitation (in)	Rank (#)
Statewide	3.35	54
Climate Division 1	3.65	67
Climate Division 2	3.44	61
Climate Division 3	3.75	68
Climate Division 4	3.17	51
Climate Division 5	4.11	81
Climate Division 6	3.31	49
Climate Division 7	2.43	22
Climate Division 8	2.69	14
Allegany	2.00	10
Anne Arundel	3.00	46
Baltimore	3.40	51
Baltimore City	3.40	60
Calvert	3.60	63
Caroline	3.20	56
Carroll	2.80	33
Cecil	4.50	86
Charles	3.80	69
Dorchester	3.70	68
Fredrick	2.80	34
Garrett	2.60	14
Harford	4.10	74
Howard	2.70	34
Kent	4.50	90
Montgomery	2.90	37
Prince George's	3.30	54
Queen Anne's	3.70	75
Saint Mary's	3.60	60
Somerset	3.70	68
Talbot	3.10	55
Washington	2.70	36
Wicomico	3.90	73
Worcester	3.30	60

Tables A1. Mean surface air temperature (left) and total precipitation (right) at statewide, climate division and county levels in June 2022. Temperature is given in °F and precipitation in in. The rank is the order that the variable in June 2022 occupies among the 128 Junes 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	83.1	90
Climate Division 1	84.1	108
Climate Division 2	84.4	95
Climate Division 3	84.5	100
Climate Division 4	83.7	76
Climate Division 5	83.0	67
Climate Division 6	82.6	87
Climate Division 7	83.3	96
Climate Division 8	76.9	81
Allegany	83.3	98
Anne Arundel	83.8	78
Baltimore	83.1	90
Baltimore City	84.6	100
Calvert	83.8	94
Caroline	84.2	86
Carroll	82.1	89
Cecil	82.2	81
Charles	84.7	95
Dorchester	84.9	102
Fredrick	82.5	92
Garrett	76.9	80
Harford	82.8	84
Howard	83.0	93
Kent	82.8	66
Montgomery	82.5	89
Prince George's	83.8	79
Queen Anne's	83.0	63
Saint Mary's	84.6	106
Somerset	84.3	108
Talbot	83.5	74
Washington	83.3	92
Wicomico	85.0	110
Worcester	83.3	108

Region	Minimum Air Temperature (°F)	Rank (#)
Statewide	61.3	84
Climate Division 1	62.7	80
Climate Division 2	62.5	80
Climate Division 3	64.2	99
Climate Division 4	63.2	86
Climate Division 5	62.4	84
Climate Division 6	60.5	83
Climate Division 7	59.0	103
Climate Division 8	53.6	78
Allegany	57.8	92
Anne Arundel	63.7	87
Baltimore	60.9	89
Baltimore City	63.4	92
Calvert	63.8	90
Caroline	61.3	80
Carroll	59.1	84
Cecil	61.4	82
Charles	64.3	104
Dorchester	62.9	79
Fredrick	59.8	83
Garrett	53.6	78
Harford	61.4	85
Howard	60.1	82
Kent	62.7	84
Montgomery	60.6	75
Prince George's	62.7	87
Queen Anne's	62.4	84
Saint Mary's	64.3	94
Somerset	63.4	72
Talbot	63.4	83
Washington	60.1	105
Wicomico	61.8	75
Worcester	62.8	87

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

A. Temperatures and Precipitation

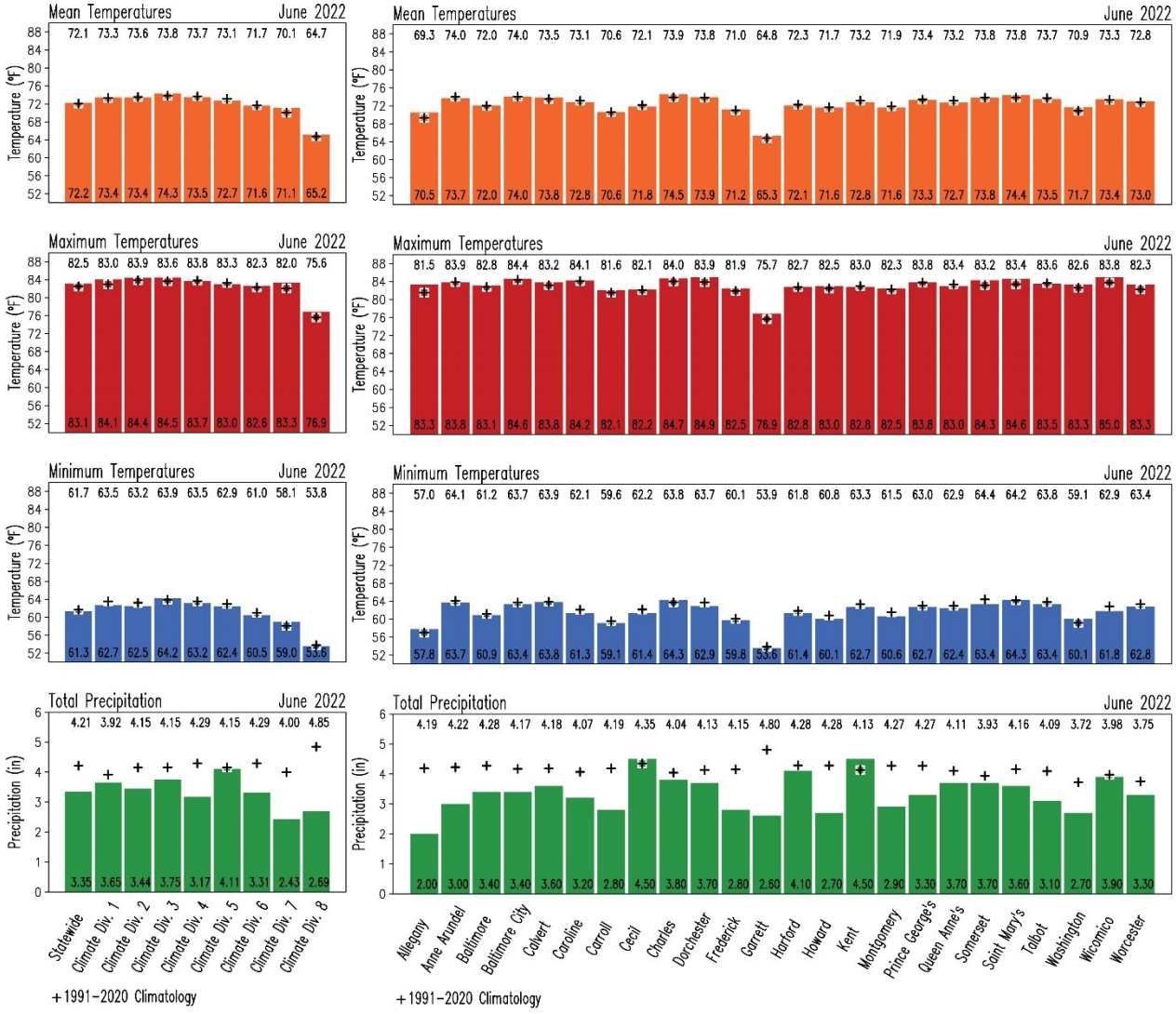

Figure B1. Area-averaged surface variables in Maryland in June 2022. Color bars represent the variables as follows: mean surface air temperature (orange, °F), maximum surface air temperature (red, °F), minimum surface air temperature (blue, °F) and total precipitation (green, in) at statewide and climate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

B. Temperature and Precipitation Anomalies

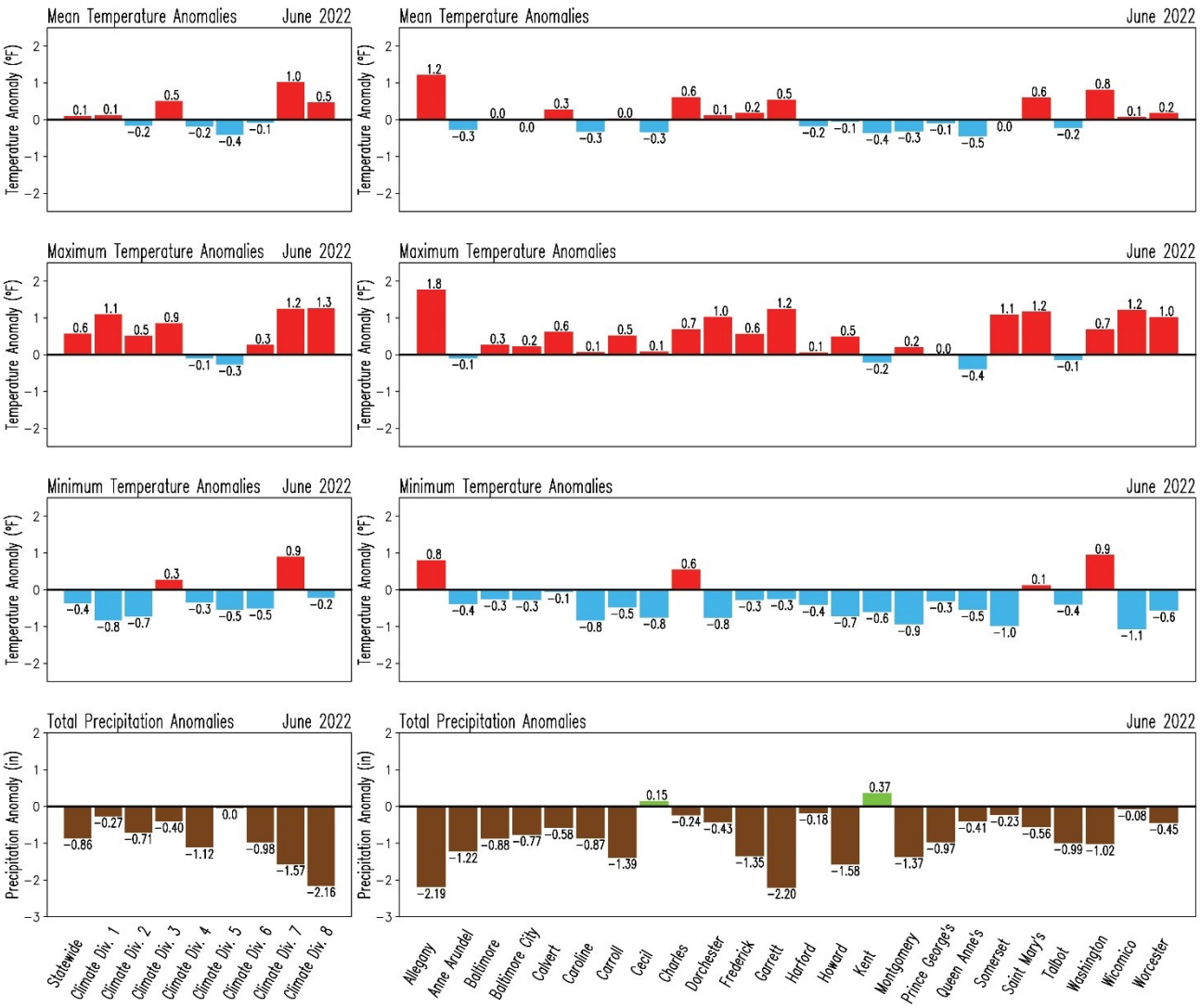

Figure B2. Area-averaged anomalies of the surface variables in Maryland in June 2022. Anomalies are with respect to the 1991-2020 climatology. Red and blue colors represent positive and negative anomalies for mean surface air temperature (upper row), maximum surface air temperature (second row from top),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

Appendix C. June 1991-2020 Climatology Maps

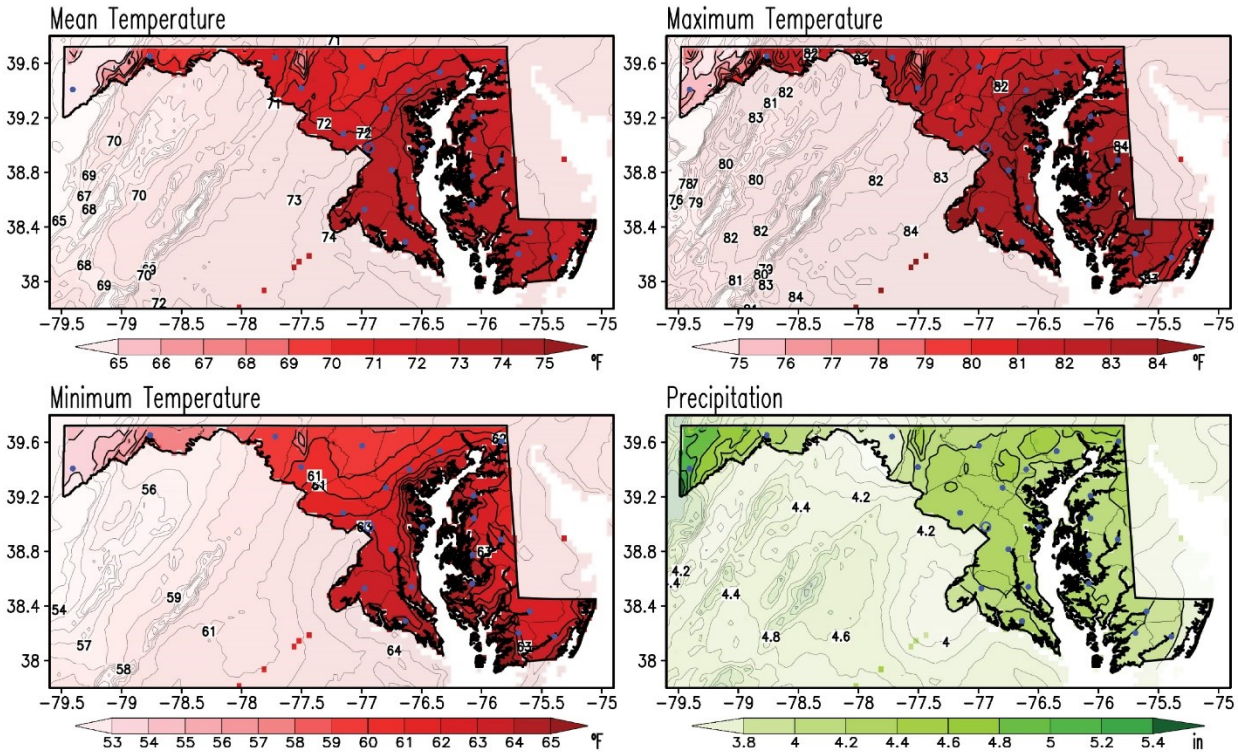

Figure C1. June climatology of the mean, maximum and minimum surface air temperatures and total precipitation for the period 1991-2020. Temperatures are given in °F and precipitation is in inches according to the color bars. This is the current climate normal against the June 2022 are compared with to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

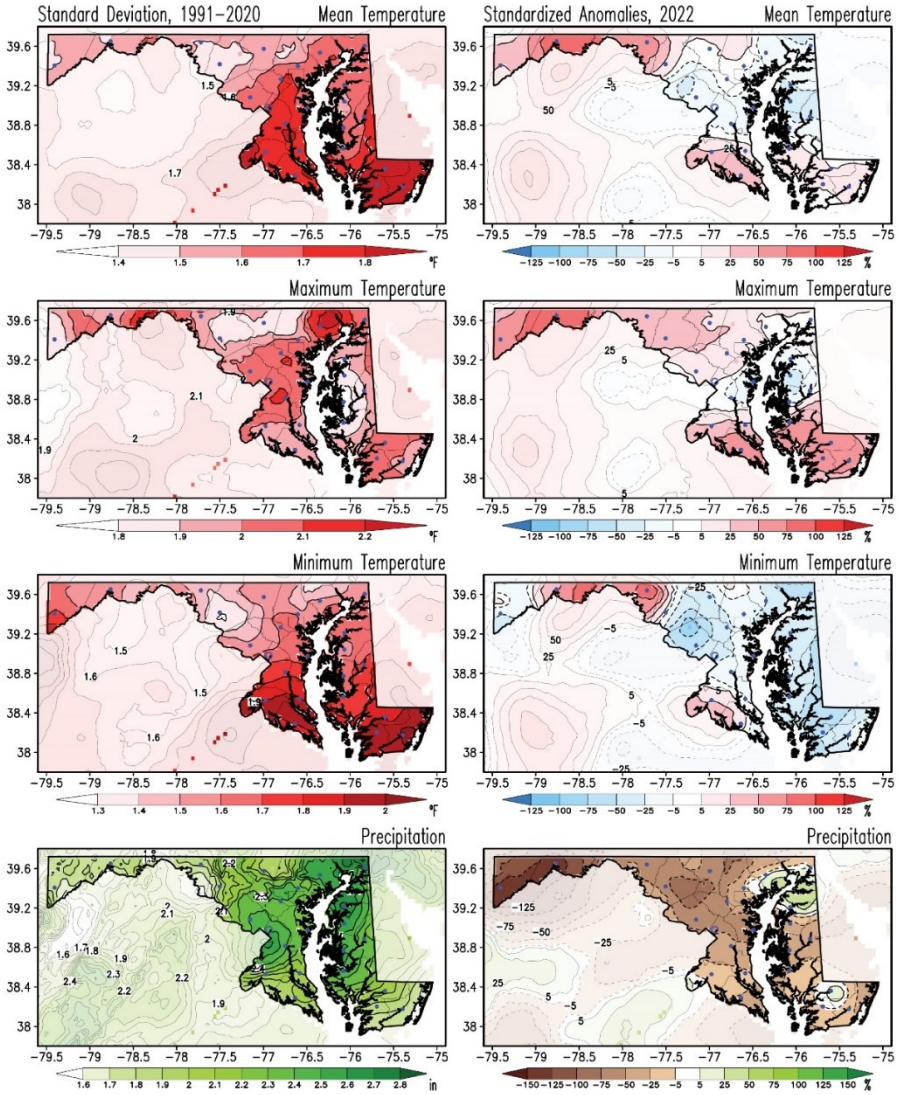

Figure D1. Standard deviation in June and standardized anomalies of temperatures and precipitation in June 2022. Standard deviations for mean, maximum and minimum surface air temperatures and precipitation are obtained for the period 1991-2020 (left column). Anomalies in June 2022 (right column) are 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. Standard deviation is a measure of the year-to-year variability. 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*.

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