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Maryland Climate Bulletin
May 2022

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DEPARTMENT OF ATMOSPHERIC & OCEANIC SCIENCE

Maryland State Climatologist Office

Summary

May 2022 was slightly warmer and wetter than normal in average, when compared with the 1991-2020 climatology. These conditions appeared after changing conditions from anomalously warm and dry March to an anomalously cold and wet April. Regional differences showed that except by a region centered at the boundary of Montgomery and Frederick counties that had below normal temperatures, the state had temperatures higher than normal, especially over Garret County and counties over the northeastern corner of the state and along the western and eastern shores. Regional differences in precipitation highlighted a region of below normal precipitation in the northeastern corner of the state over Harford, Cecil, Kent and Queen Anne's counties and regions of above normal precipitation over Montgomery, Frederick, Washington and Allegany counties and over Saint Mary's, Calvert and Dorchester counties. Drought conditions at the end of May continued to improve due to the largely above normal precipitation in this month and only the southern half of Saint Mary's county was under abnormally dry conditions. Statewide conditions in June were above the mean and median of the historical 1895-2021 record.

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 May 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 May 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 6/9/2022.

- NOAA Monthly U.S. Climate Divisional Dataset (NClimDiv – Vose et al. 2014), which is available, in a *preliminary* status (v1.0.0-20220606), at:

  https://www.ncei.noaa.gov/data/climdiv/access/
  Data downloaded on 6/9/2022

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

A. Mean Temperatures

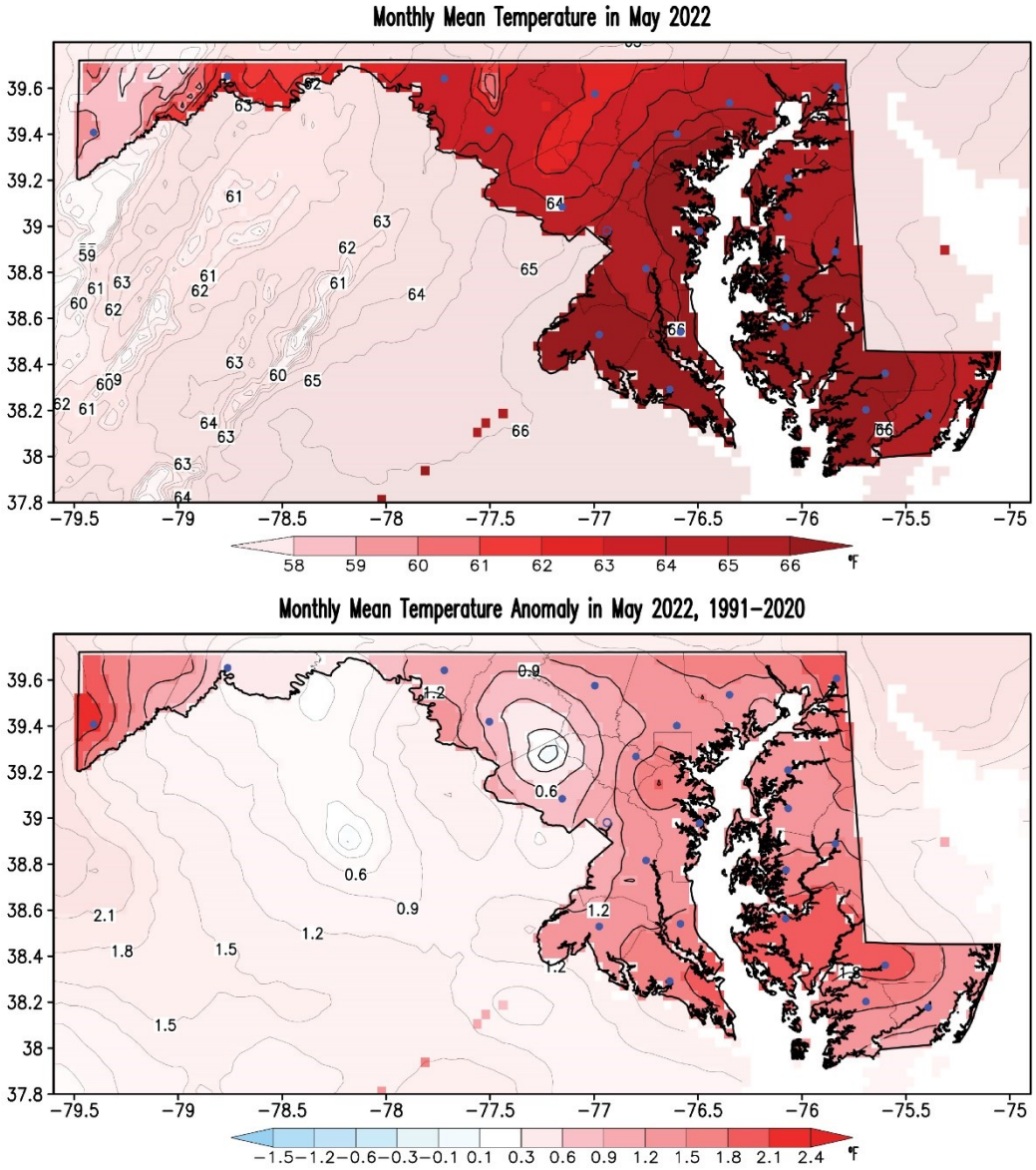

Figure 1. Mean surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in May 2022. Temperatures are given in °F according to the color bars. Red shading in the anomaly map shows above normal conditions. Note that shading outside the state has been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

Monthly mean temperatures in May 2022 increased from south to north. Temperatures along the coastal plains of the eastern and western shores were warmer (~65-66°F) than over the North Central climate division (~63-64°F), Frederick (~61°F) and Garrett counties (~58°F). However, the mean temperatures over the majority of the state were warmer than normal, especially over the northwestern Garret County (~1.5°F) and Dorchester and Wicomico counties (~1.8°F). Below normal conditions appeared over northern Montgomery County (~-0.1°F); appendices A and B show the area-averaged values. Maximum anomalies were below the regional year-to-year variability (Appendix D).

B. Maximum Temperatures

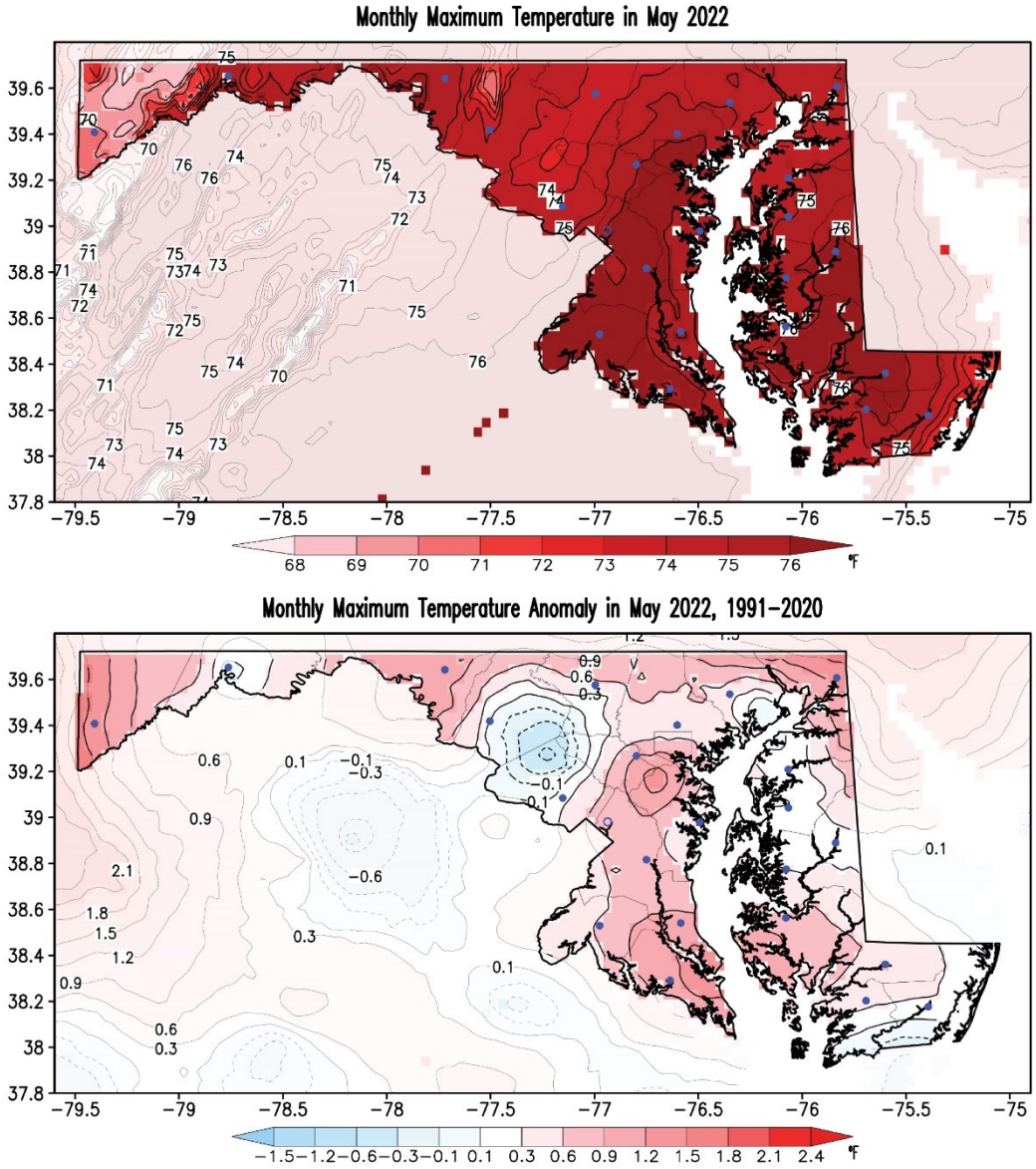

Figure 2. Maximum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in May 2022. Temperatures are given in °F according to the color bars. Red shading in the anomaly map shows above normal conditions. Note that shading outside the state has been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

Monthly mean maximum temperatures in May 2022 had the same structure than the mean temperatures with maximum values over the coastal plains (~75-76°F) and minimum values over Garrett (~68°F) and Frederick counties (~71°F). However, while maximum temperatures over the Garrett, Cecil, Anne Arundel, Saint Mary's counties were above normal (~1.2°F), maximum temperatures over Montgomery and Frederick counties were smaller than normal (~-0.3°F*)*. Anomalies are inferior to the year-to-year variability (Appendix D).

C. Minimum Temperatures

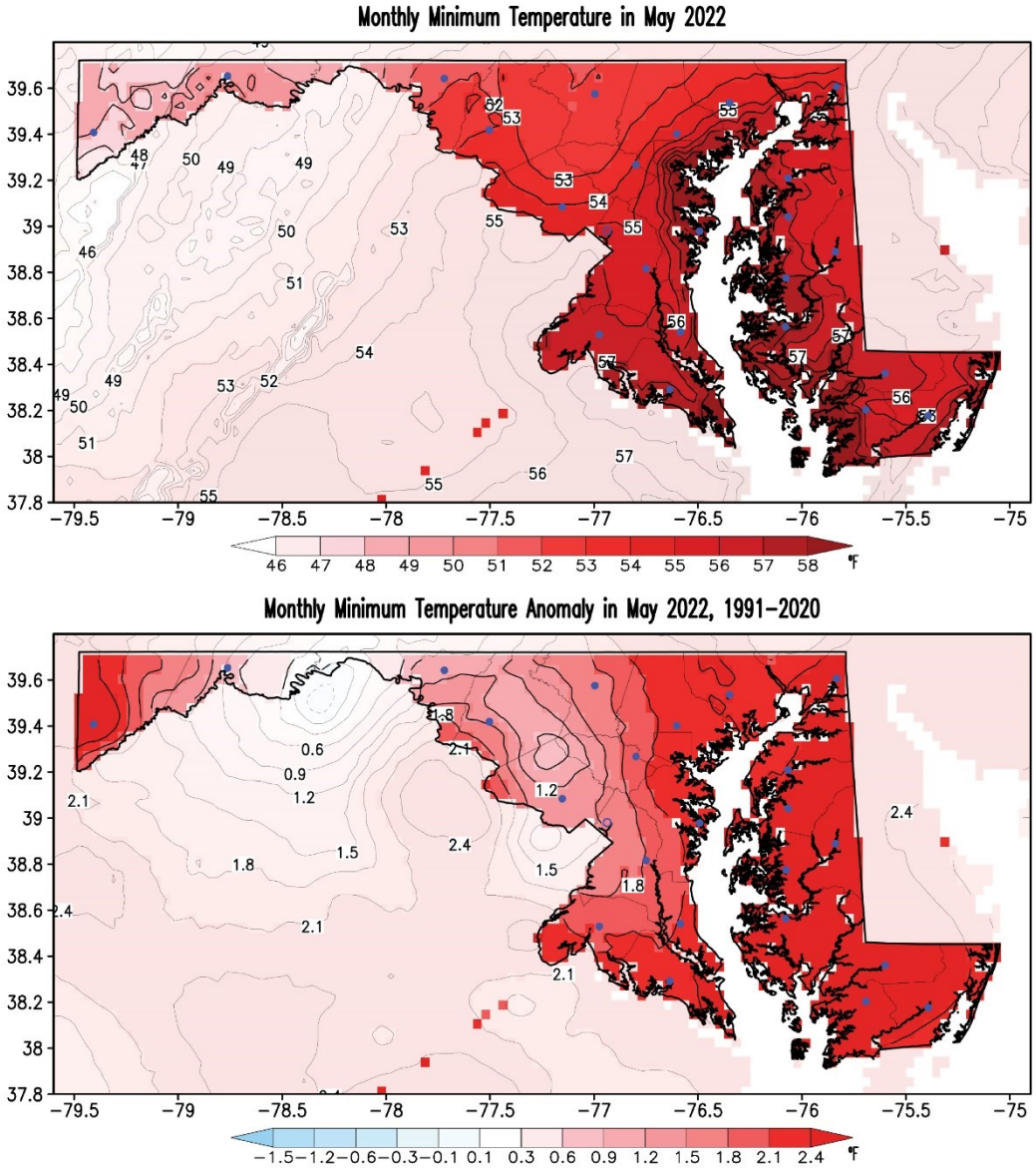

Figure 3. Minimum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in May 2022. Temperatures are given in °F according to the color bars. Blue/red shading in the anomaly map shows below/above normal conditions. Note that shading outside the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

Monthly mean minimum temperatures in May 2022 reached minimum values over Garrett County (~46°-47°F) and maximum values along the coasts of the Chesapeake Bay (~57-58°F). The minimum temperatures over the majority of the state were warmer than normal, especially over the northwestern Garret County (~2.1°F) and the western and eastern shores and northeastern counties (~2.1°F). Very close to normal conditions appeared over Allegany and Washington counties. Anomalies over small portions of Dorchester and Wicomico counties were comparable to the year-to-year variability (Appendix D).

D. Precipitation

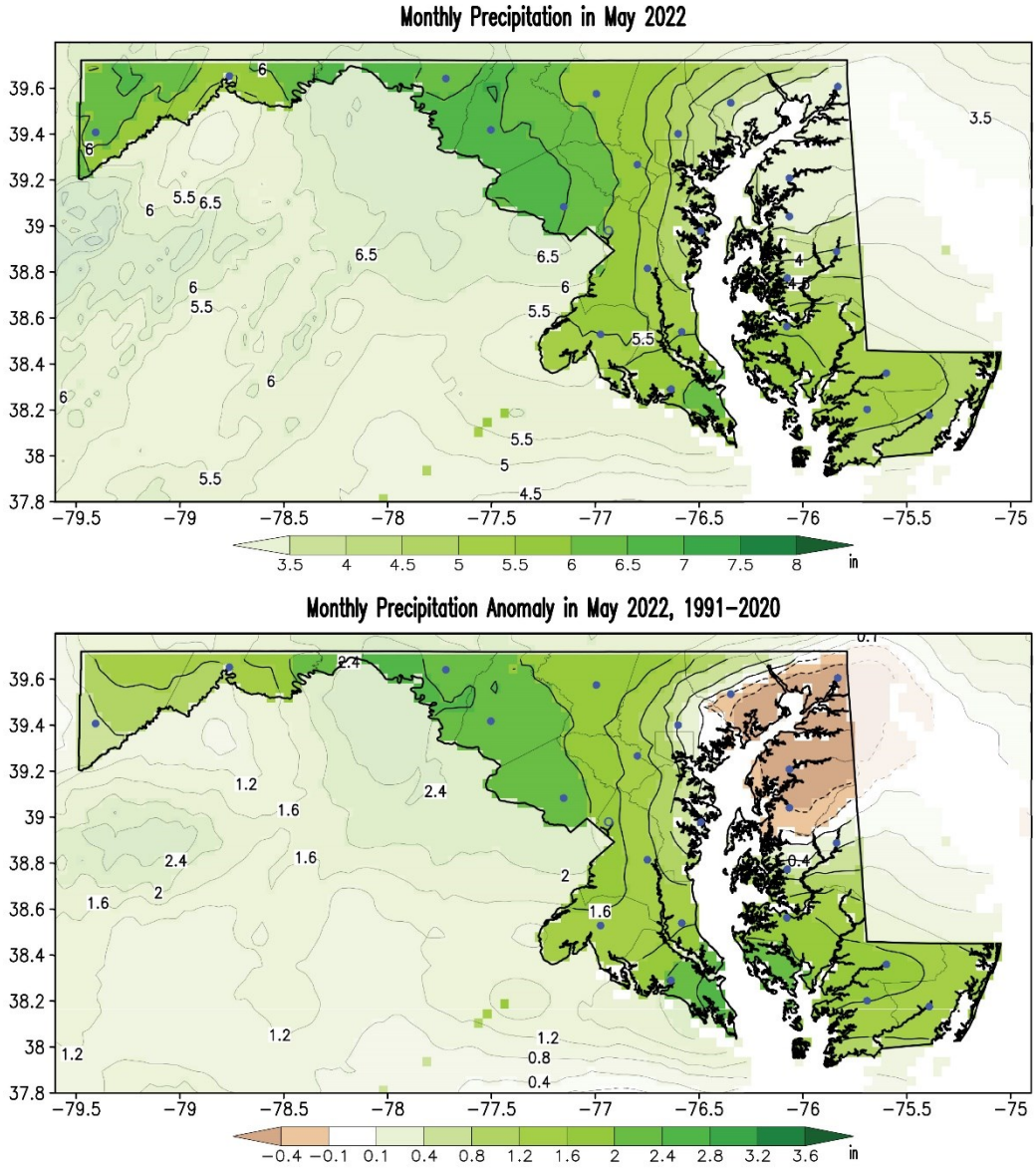

Figure 4. Precipitation (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) in May 2022. Precipitation units are given as inches according to the color bars. Brown/green shading in the anomaly map shows below/above normal conditions. Note that shading outside the state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

Monthly total precipitation in May 2022 shows a distinctive structure with maximum precipitation over Garrett, Montgomery, Frederick, Washington and Allegany counties (~6.0 in) and minimum amounts over Harford, Cecil, Kent and Queen Anne's counties (~3.5 in). This structure is highlighted in the anomalies with the largest positive anomalies over Montgomery, Frederick, Washington and Allegany counties (2.0-2.4 in), and negative anomalies to the east over Harford, Cecil, Kent and Queen Anne's counties (-0.4 in); it is also evident a secondary maximum in positive precipitation anomalies over Saint Mary's, Calvert and Dorchester counties (~2.4 in). The regions of maximum positive anomalies exceed the year-to-year variability (Appendix D).

E. Drought

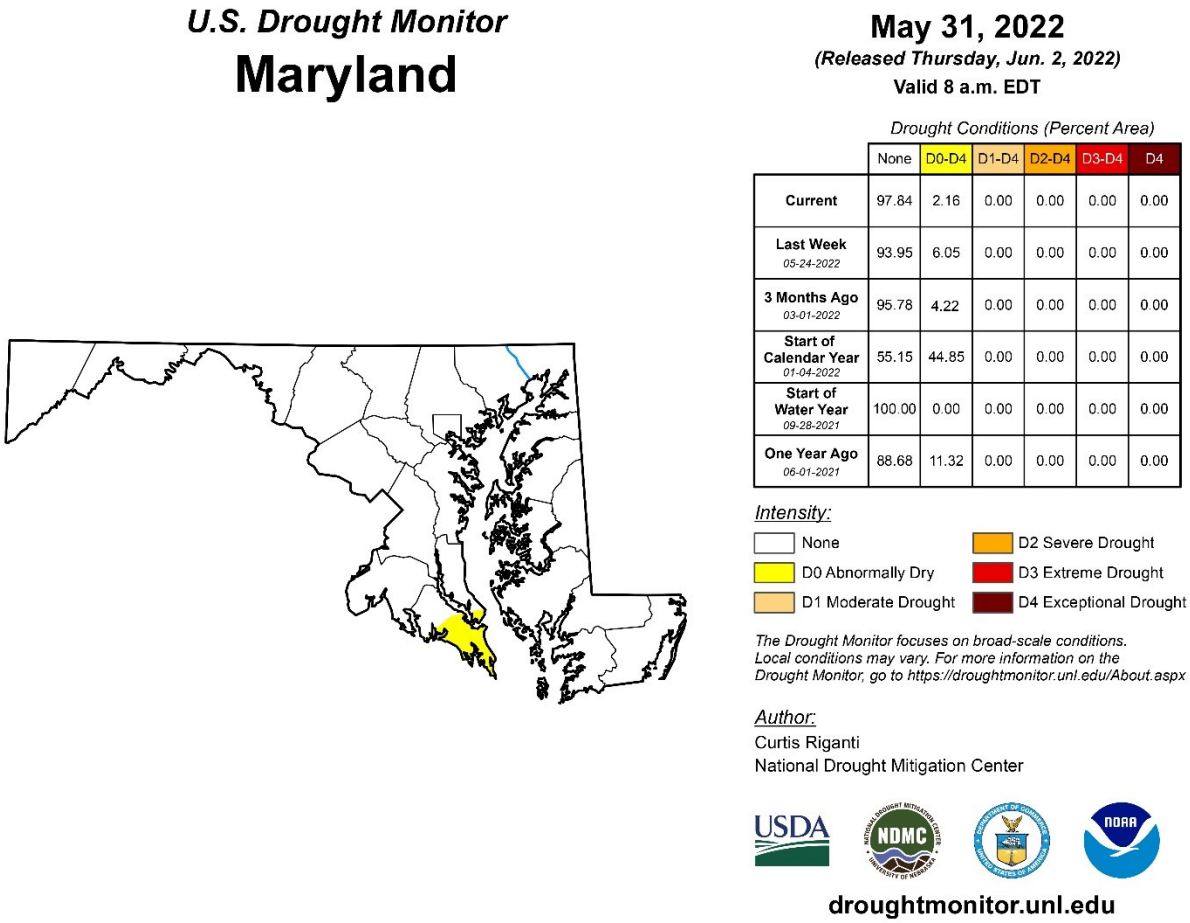

Figure 5. Drought conditions as reported by the U.S. Drought Monitor on May 31, 2022.

Drought conditions at the end of May 2022 continue to improve due to the largely above normal precipitation in this month. Only the southern half of Saint Mary's county is under abnormally dry conditions now while the rest of the state is no longer experiencing drought conditions. The anomalous increase in precipitation over Saint Mary's has moved out the county from moderate drought conditions at the end of April to abnormally dry conditions at the end of May.

4. May 2022 Statewide Averages in the Historical Record

A. Box and Whisker Plots

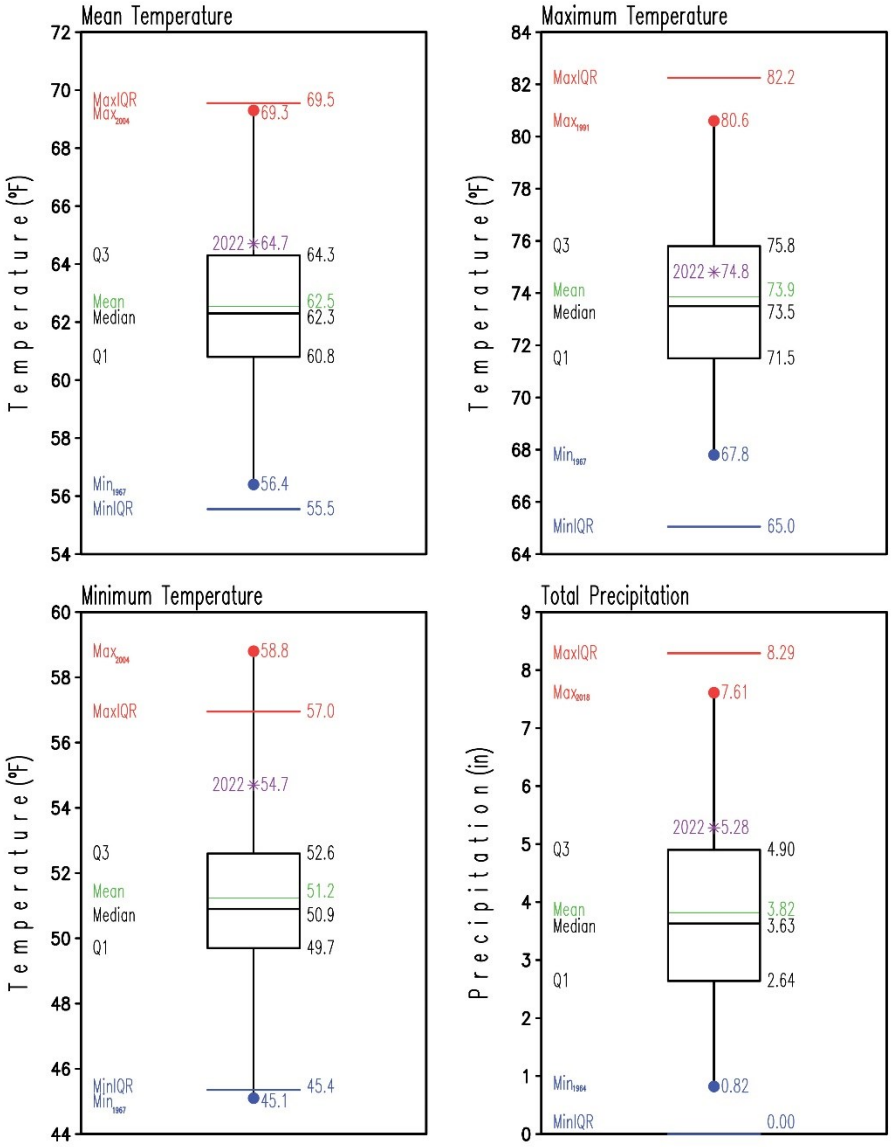

Figure 6. Box and Whisker plots of Maryland statewide mean (upper left), maximum (upper right), minimum (lower left) surface air temperatures and total precipitation (lower right) in May for the period 1895-2021. Conditions in May 2022 are represented by the label and asterisk in purple within the boxes. 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 conditions in May 2022 are above the mean and median of the historical 1895-2021 record. Except by the maximum temperature, mean and minimum temperatures and precipitation in May 2022 are among the 25% of the largest values in the record.

B. Scatter Plots

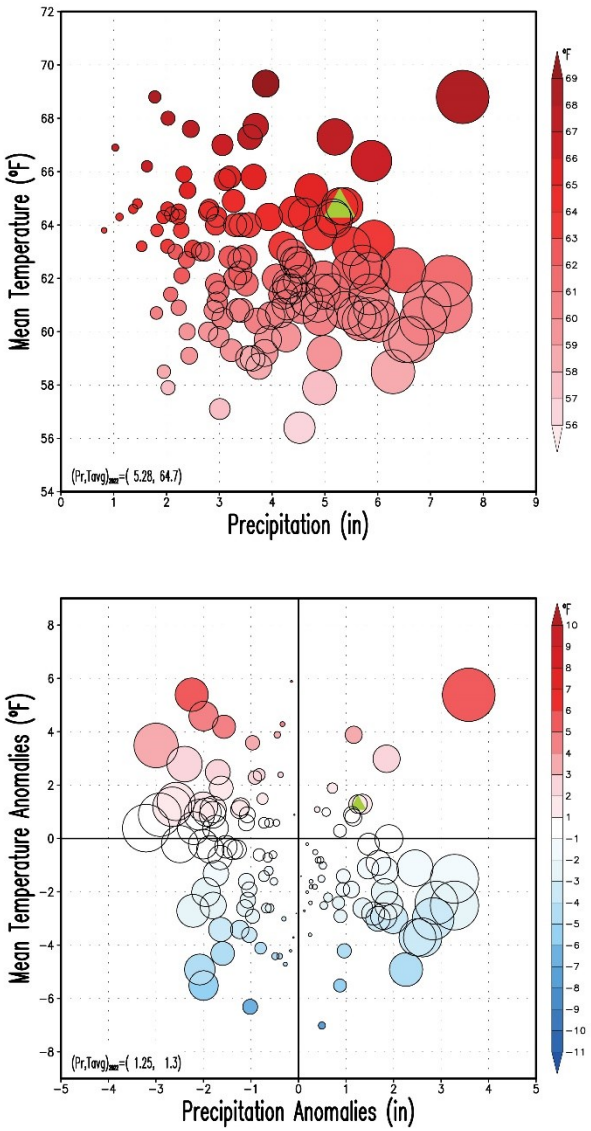

Figure 7. Scatter plot of averaged Maryland statewide mean surface air temperature vs total precipitation in May for the period 1895-2022. Upper panel shows the mean temperature and total precipitation in May, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation on record (7.61 in in 2018, top panel) and by the maximum precipitation anomaly (3.58 in in 2018, 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. May 2022 is marked by the yellow/green filled triangle.

The statewide total precipitation and mean temperature of 5.28 in and 64.7°F, as also indicated by the box and whisker plots, are within the data cloud of the large values in the historical record of 128 years. The statewide anomalies of 1.25 in and 1.3 °F indicate an anomalous wet and warm May 2022. The ranking of the temperatures and precipitation in May 2022 within the historical record at state, climate division and county level are displayed in the tables in Appendix A.

5. May and MAM 2022 Climate Divisions Averages

A. May 2022 Scatter Plots

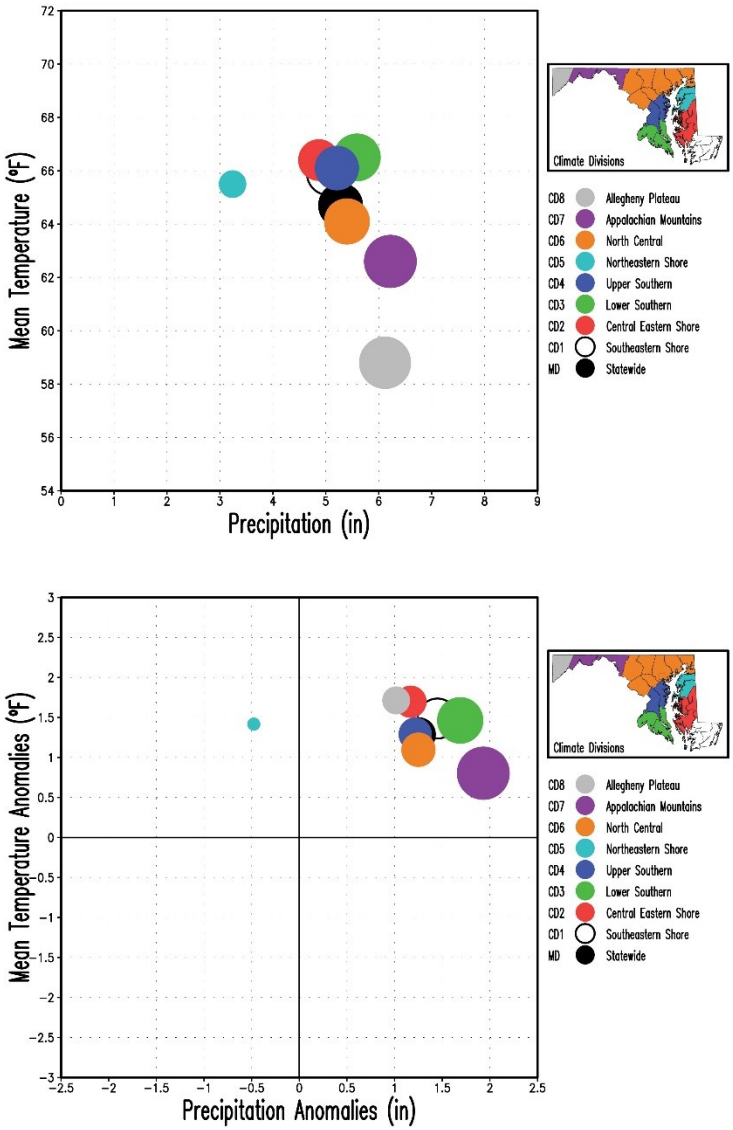

Figure 8. Scatter plot of averaged Maryland statewide and Climate Divisions (CD#) mean surface air temperature vs total precipitation for May 2022. Upper panel shows the mean temperature and total precipitation, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (6.22 in in CD7, top panel) and by the maximum precipitation anomaly (1.93 in in CD7, 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.

It stands out that the northwestern climate divisions (CD7 and CD8, including Garrett, Allegany and Washington counties) were the coldest and wettest. However, the climate divisions along the western and eastern shores (CD1-CD4) were the warmest and the Northeastern Shore climate division (CD5) was the driest. Except by the latter climate division (CD5) the rest were wetter than normal and all of them 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. March-April-May 2022 Scatter Plots

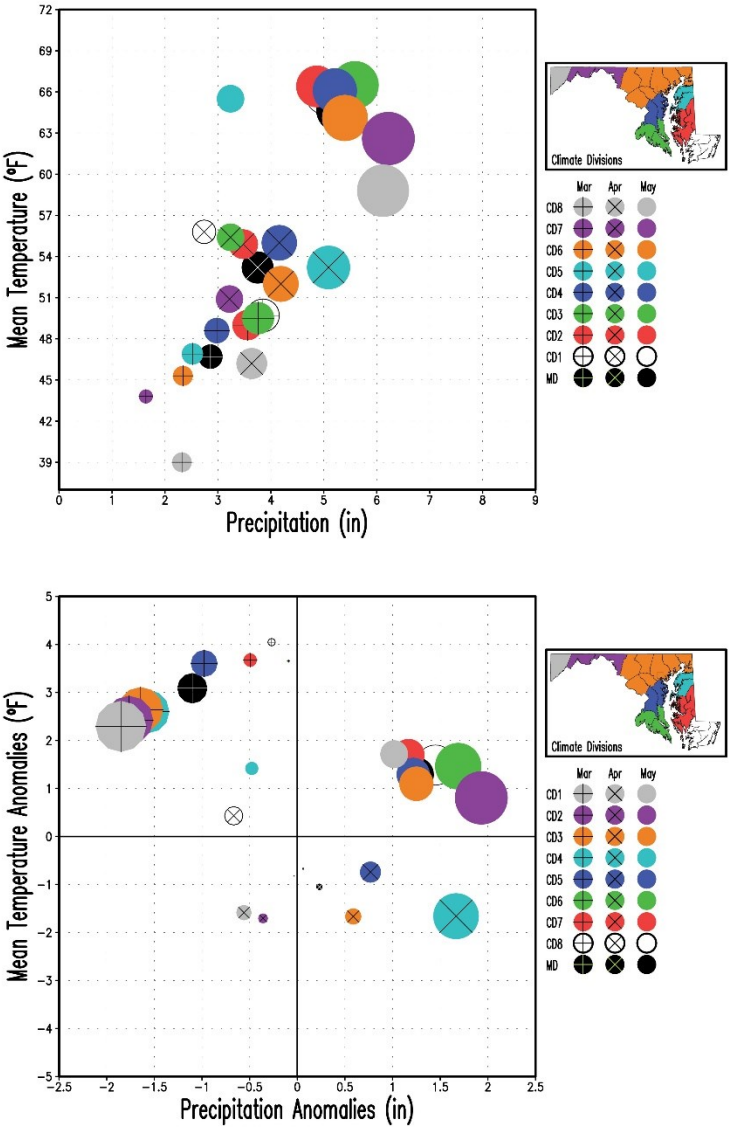

Figure 9. Scatter plot of averaged Maryland statewide and Climate Divisions (CD#) mean surface air temperature vs total precipitation for March, April and May 2022. Upper panel shows the mean temperature and total precipitation, and bottom panel displays their anomalies with respect to the 1991-2020 climatology. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (6.22 in in CD7 in May, top panel) and by the maximum precipitation anomaly (1.93 in in CD7 in May, bottom panel) among the nine regions and months. Note that May is displayed with filled circles only, while April and March are displayed with superposed multiplication and addition signs respectively.

Mean temperatures and precipitation increased in general in the state from March to May in this 2022. However, it is interesting to note the swing in conditions evident from the anomaly plot showing mostly above normal temperatures and below normal precipitation in March, to below normal temperatures and above normal precipitation in April to largely above normal temperature and precipitation in May.

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

A. Mean Temperature and Precipitation

Region	Mean Air Temperature (°F)	Rank (#)
Statewide	64.7	107
Climate Division 1	65.9	111
Climate Division 2	66.4	111
Climate Division 3	66.5	106
Climate Division 4	66.1	106
Climate Division 5	65.5	109
Climate Division 6	64.1	96
Climate Division 7	62.6	87
Climate Division 8	58.8	99
Allegany	61.8	81
Anne Arundel	66.5	109
Baltimore	64.7	108
Baltimore City	66.6	109
Calvert	66.3	109
Caroline	65.9	111
Carroll	63.1	96
Cecil	64.8	110
Charles	66.5	105
Dorchester	66.9	112
Fredrick	63.3	90
Garrett	58.8	99
Harford	64.7	103
Howard	64.2	102
Kent	65.5	109
Montgomery	64.1	91
Prince George's	65.9	104
Queen Anne's	65.6	109
Saint Mary's	66.7	109
Somerset	66.4	110
Talbot	66.4	108
Washington	63.3	91
Wicomico	66.3	111
Worcester	65.2	110

Region	Total Precipitation (in)	Rank (#)
Statewide	5.28	105
Climate Division 1	5.05	107
Climate Division 2	4.87	99
Climate Division 3	5.59	108
Climate Division 4	5.21	100
Climate Division 5	3.24	55
Climate Division 6	5.40	98
Climate Division 7	6.22	116
Climate Division 8	6.12	102
Allegany	5.80	110
Anne Arundel	4.70	93
Baltimore	5.00	98
Baltimore City	4.80	97
Calvert	5.50	107
Caroline	4.10	78
Carroll	5.90	107
Cecil	3.20	57
Charles	5.40	105
Dorchester	5.40	110
Fredrick	6.50	115
Garrett	6.10	99
Harford	3.80	69
Howard	5.90	106
Kent	3.10	50
Montgomery	6.40	118
Prince George's	5.60	107
Queen Anne's	3.30	59
Saint Mary's	5.80	114
Somerset	5.00	107
Talbot	4.40	89
Washington	6.50	119
Wicomico	5.20	107
Worcester	4.80	103

Tables A1. Mean surface air temperature (left) and total precipitation (right) at statewide, climate division and county levels in May 2022. Temperature is given in °F and precipitation in in. The rank is the order that the variable in May 2022 occupies among the 128 Mays 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	74.8	74
Climate Division 1	75.0	86
Climate Division 2	76.0	82
Climate Division 3	76.2	81
Climate Division 4	76.0	75
Climate Division 5	75.0	70
Climate Division 6	74.4	74
Climate Division 7	74.7	75
Climate Division 8	69.6	74
Allegany	74.3	71
Anne Arundel	76.0	76
Baltimore	75.1	78
Baltimore City	76.4	84
Calvert	75.7	86
Caroline	76.1	77
Carroll	73.9	74
Cecil	74.4	83
Charles	76.4	74
Dorchester	76.3	91
Fredrick	73.8	75
Garrett	69.7	74
Harford	74.6	78
Howard	74.9	77
Kent	74.7	70
Montgomery	74.2	73
Prince George's	76.2	74
Queen Anne's	75.1	70
Saint Mary's	76.1	91
Somerset	75.2	85
Talbot	75.5	79
Washington	75.2	78
Wicomico	76.0	89
Worcester	74.0	84

Region	Minimum Air Temperature (°F)	Rank (#)
Statewide	54.7	115
Climate Division 1	56.9	119
Climate Division 2	56.8	119
Climate Division 3	56.9	116
Climate Division 4	56.2	114
Climate Division 5	56.0	118
Climate Division 6	53.8	114
Climate Division 7	50.4	100
Climate Division 8	47.8	112
Allegany	49.4	97
Anne Arundel	57.0	115
Baltimore	54.3	115
Baltimore City	56.8	116
Calvert	56.8	113
Caroline	55.6	119
Carroll	52.2	112
Cecil	55.1	116
Charles	56.6	116
Dorchester	57.4	119
Fredrick	52.7	108
Garrett	47.9	112
Harford	54.8	116
Howard	53.4	111
Kent	56.3	120
Montgomery	53.9	110
Prince George's	55.6	112
Queen Anne's	56.0	117
Saint Mary's	57.3	116
Somerset	57.6	119
Talbot	57.3	117
Washington	51.5	105
Wicomico	56.6	120
Worcester	56.5	118

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

A. Temperatures and Precipitation

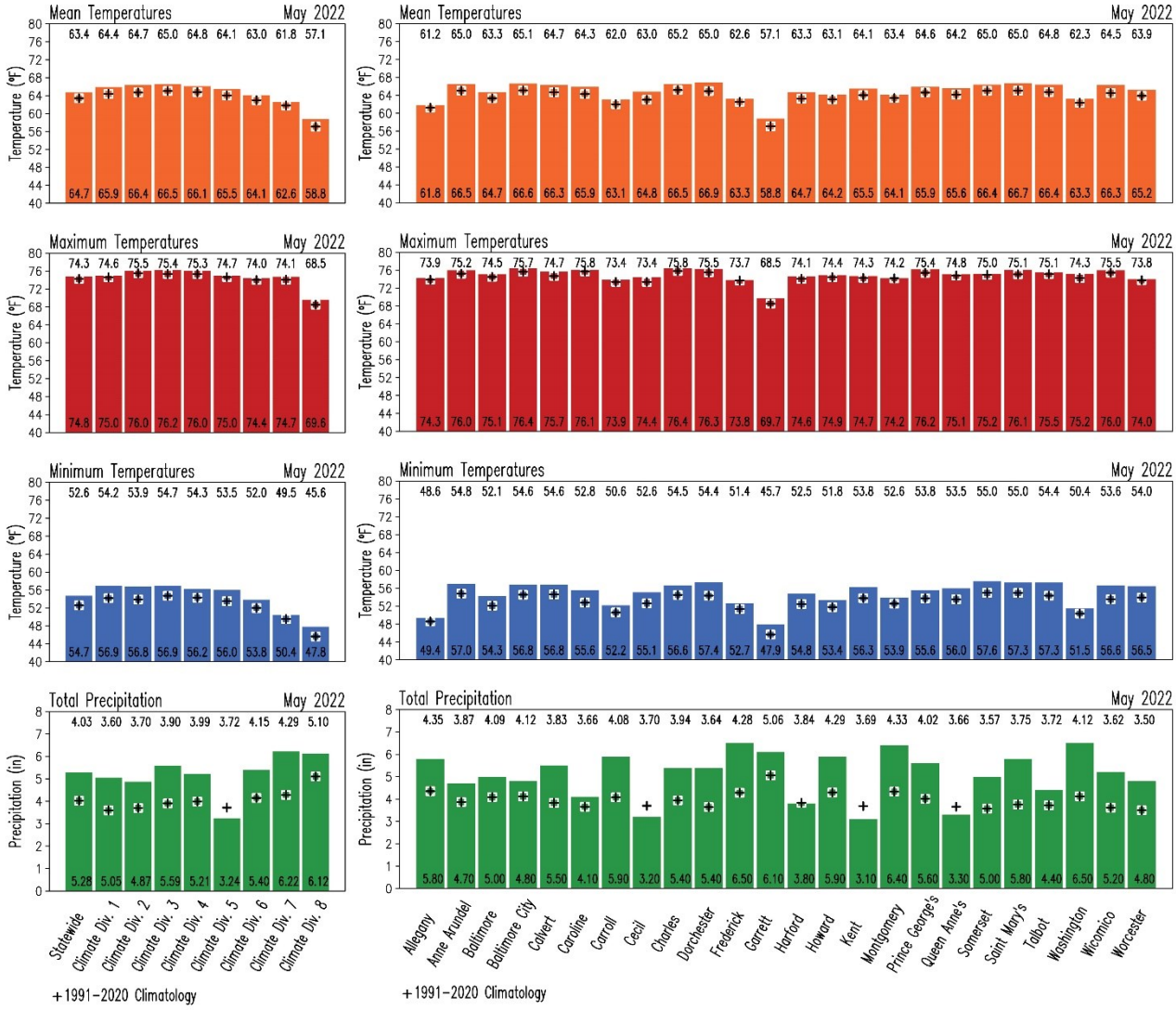

Figure B1. Area-averaged surface variables in Maryland in May 2022. Color bars represent the variables as follows: mean surface air temperature (orange, °F), maximum surface air temperature (red, °F), minimum surface air temperature (blue, °F) and total precipitation (green, in) at statewide and climate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

B. Temperature and Precipitation Anomalies

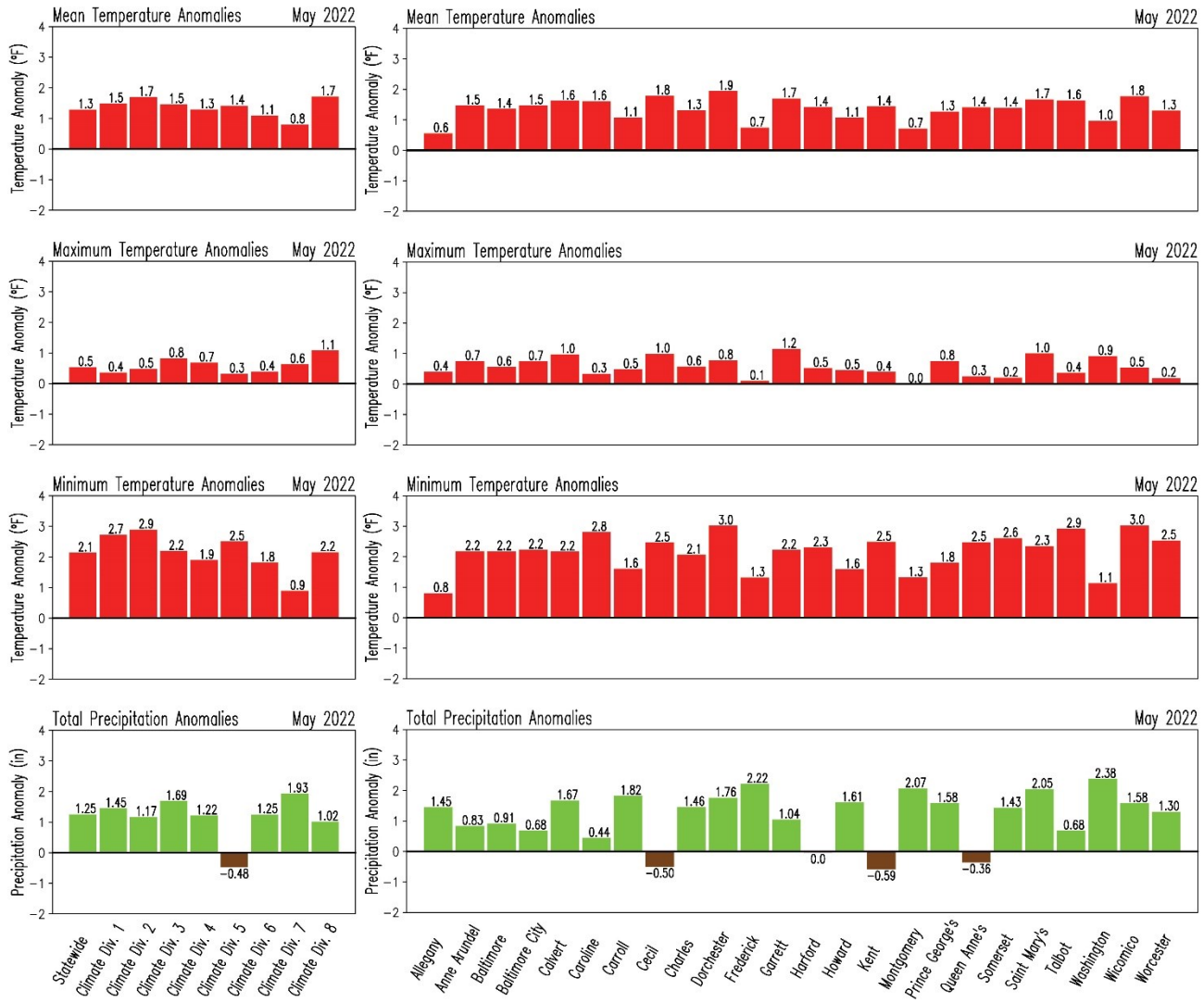

Figure B2. Area-averaged anomalies of the surface variables in Maryland in May 2022. Anomalies are with respect to the 1991-2020 climatology. Red and blue colors represent positive and negative anomalies for mean surface air temperature (upper row), maximum surface air temperature (second row from top),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

Appendix C. May 1991-2020 Climatology Maps

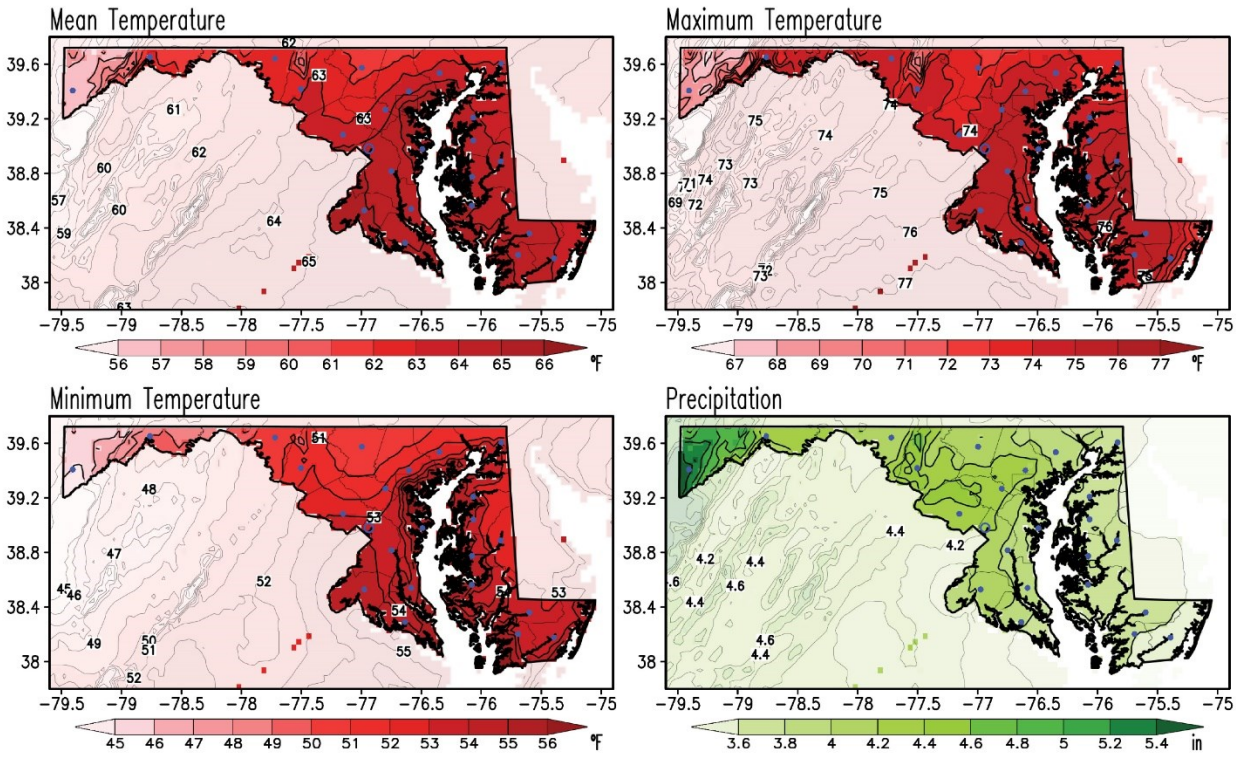

Figure C1. May climatology of the mean, maximum and minimum surface air temperatures and total precipitation for the period 1991-2020. Temperatures are given in °F and precipitation is in inches according to the color bars. This is the current climate normal against the May 2022 are compared with to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

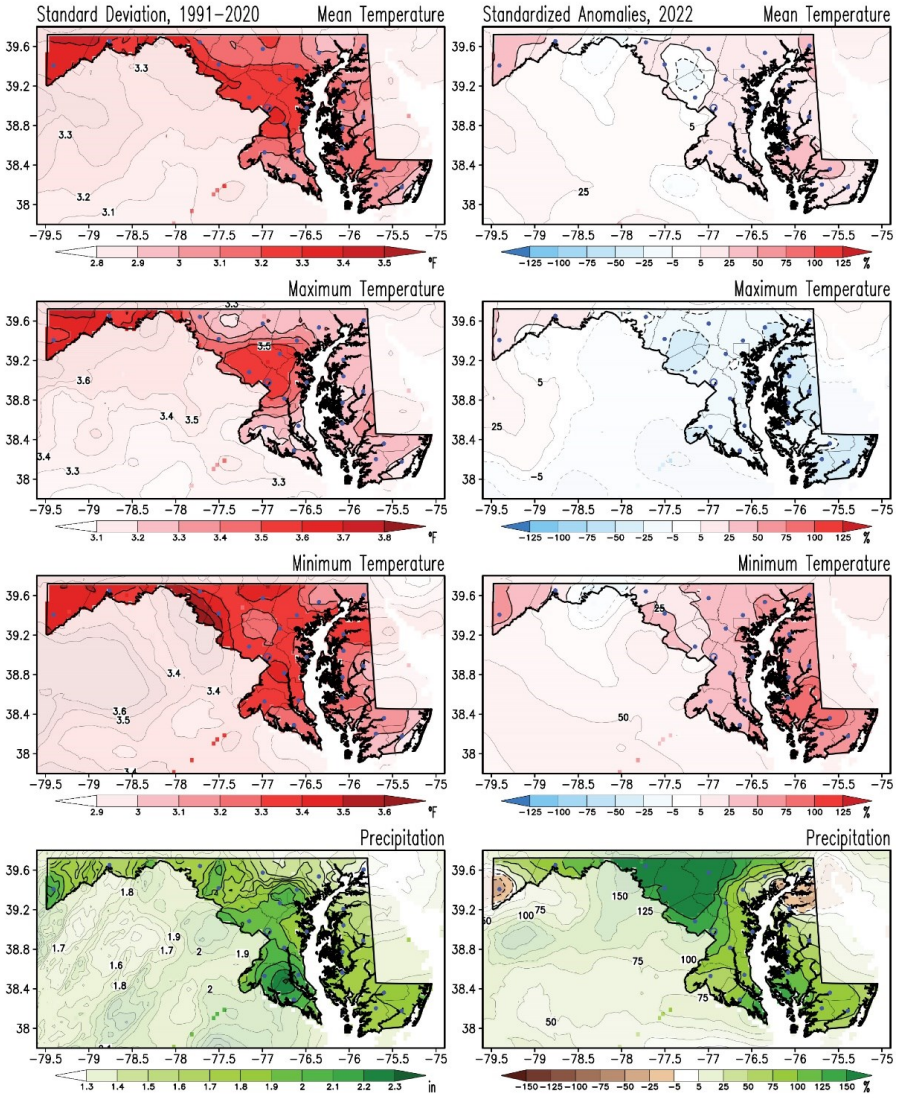

Figure D1. Standard deviation in May and standardized anomalies of temperatures and precipitation in May 2022. Standard deviations for mean, maximum and minimum surface air temperatures and precipitation are obtained for the period 1991-2020 (left column). Anomalies in May 2022 (right column) are obtained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