MDSCO-2023-02

Maryland Climate Bulletin February 2023

Prepared by
Dr. Alfredo Ruiz-Barradas
Maryland State Climatologist

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DEPARTMENT OF ATMOSPHERIC & OCEANIC SCIENCE
Sumant Nigam, Chair

Maryland State Climatologist Office

Summary

February 2023 was considerably warmer and drier than normal (i.e., 1991-2020 averages). Monthly mean temperatures were above freezing everywhere; maximum temperatures were in the 46 to 58°F range, and minimum temperatures were between 25 to 37°F. Monthly total precipitation was in the 1.4 to 3.2 inches range.

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

- Mean temperature was warmer than normal everywhere by at least 5°F, notably in Garrett, Allegany, Carroll, Frederick, Montgomery, Anne Arundel, and Baltimore counties, and portions of Saint Mary's, Calvert, and Dorchester counties (above 7.2°F).

- Maximum temperature was also warmer than normal everywhere, by at least 6°F, especially over Garret County (above 9°F), to the west of Piedmont, and portions of Saint Mary's, Calvert, and Dorchester counties (above 8.1°F).

- Minimum temperature was warmer than normal everywhere, by at least 4°F, but notably in Garrett, portions of Frederick, Montgomery, Saint Mary's, Calvert, and Dorchester counties (above 6.3°F).

- Precipitation was below normal over most of the state, especially in Worcester, Somerset, Wicomico, Dorchester, Talbot, and Anne Arundel counties by more than 1 in, and western Garrett, northern Baltimore, Carroll, and Frederick counties by around 0.8 in.

- Abnormally dry conditions over Maryland continue over southern Garret and Saint Mary's counties. However, abnormally dry conditions in the northwest now extend east from Garret to northern Baltimore County.

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

- All eight climate divisions were warmer by at least 5.5°F and drier than normal. The Allegheny Plateau (i.e., Garrett County) had the largest departure from normal (7.6°F).

- Statewide warm and dry anomalies have changed very little in the past two months. Conditions went from anomalously cold and wet in December to warm and dry in January and February.

Historical Context (Figure 8, Tables A1 and A2)

- February's mean, maximum, and minimum statewide temperatures (43.0, 53.6, and 32.5°F) were all above the long-term (1895-2022) average, and very close to the historical records set in 2017. February's precipitation (1.95 in) was below the average, and as in January, within 25% of the smallest values.

- February 2023 was the 2nd warmest and 25th driest among the 129 Februaries in the 1895-2023 period. However, Calvert, Dorchester, and Saint Mary's had the warmest February on record.

Century-Plus Trends (Figures 9, 10)

- Statewide temperature showed a significant 4.3°F/century warming trend, and the heating degree-days a significant −124.36°F degree-days trend. On the other hand, statewide precipitation showed a non-significant decreasing trend (−0.18 in/century).
- Regionally, February temperatures showed a significant warming trend everywhere in the state. It varies from ~3°F/century over Garret County to ~4.8°F/century along the Montgomery−Frederick and Carroll−Howard boundaries, extending into Baltimore City.
- Regionally, Cecil and eastern Kent counties showed significant drying trends of around −0.5 in/century in February.

Contents

1. Introduction

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

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

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

The monthly surface climate conditions for February 2023 are presented via maps of key variables, such as average surface air temperature, maximum surface air temperature, minimum surface air temperature, total precipitation, and their anomalies (i.e., departures from normal); they are complemented by drought conditions for the state, as given by the U.S. Drought Monitor (Section 3). Statewide and climate division averages for the month are compared against each other via scatter plots (Section 4). The monthly statewide averages are placed in the context of the historical record via box and whisker plots in Section 5. Century-plus trends in statewide air temperature, heating degree-days, precipitation, and state maps of air temperature and precipitation are presented in Section 6. Ancillary statewide, climate division, and county-level information is provided via tables and plots in Appendices A-B; climatology and variability maps are in Appendices C-D.

2. Data

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

- NOAA Monthly U.S. Climate *Gridded* Dataset at 5-km horizontal resolution (NClimGrid – Vose et al. 2014), which is available in a preliminary status at:
  https://www.ncei.noaa.gov/data/nclimgrid-monthly/access/
  Data was downloaded on 3/10/2023.

- NOAA Monthly U.S. Climate *Divisional* Dataset (NClimDiv – Vose et al. 2014), which is available in a preliminary status (v1.0.0-20230308) at:
  https://www.ncei.noaa.gov/pub/data/cirs/climdiv/
  Data was downloaded on 3/13/2023.

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

Some definitions:

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

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

The eight climate divisions in Maryland are:

- Climate Division 1: Southeastern Shore. It includes the counties of Somerset, Wicomico, and Worcester.
- Climate Division 2: Central Eastern Shore. It includes the counties of Caroline, Dorchester, and Talbot.
- Climate Division 3: Lower Southern. It includes the counties of Calvert, Charles, and St. Mary's.
- Climate Division 4: Upper Southern. It includes the counties of Anne Arundel and Prince George's.
- Climate Division 5: Northeastern Shore. It includes the counties of Kent and Queen Anne's.
- Climate Division 6: North Central. It includes the counties of Baltimore, Carroll, Cecil, Frederick, Harford, Howard, 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 Plateau provinces*, Climate Divisions 3, 4, and a portion of 6 include the *Upper Coastal Plain Province*, and Climate Divisions 1, 2, 5, and a portion of 6 include the *Lower Coastal Plain (or Atlantic Continental Shelf) Province*.

3. February 2023 Maps

A. Mean Temperatures

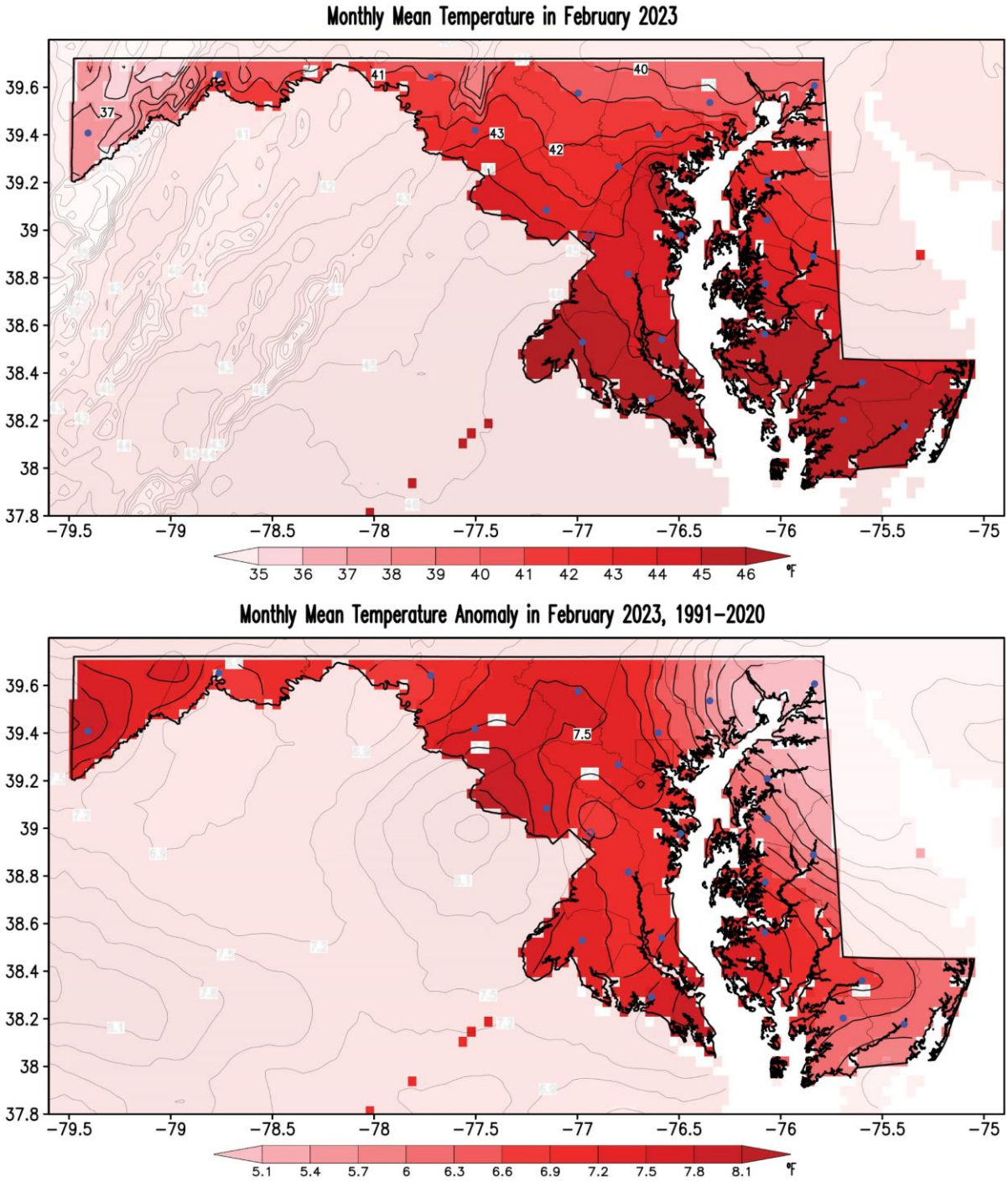

Figure 1. Monthly mean surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) for February 2023. Temperatures are in °F following the color bar. Red shading in the anomaly map marks warmer than normal conditions. Note shading outside the state has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

B. Maximum Temperatures

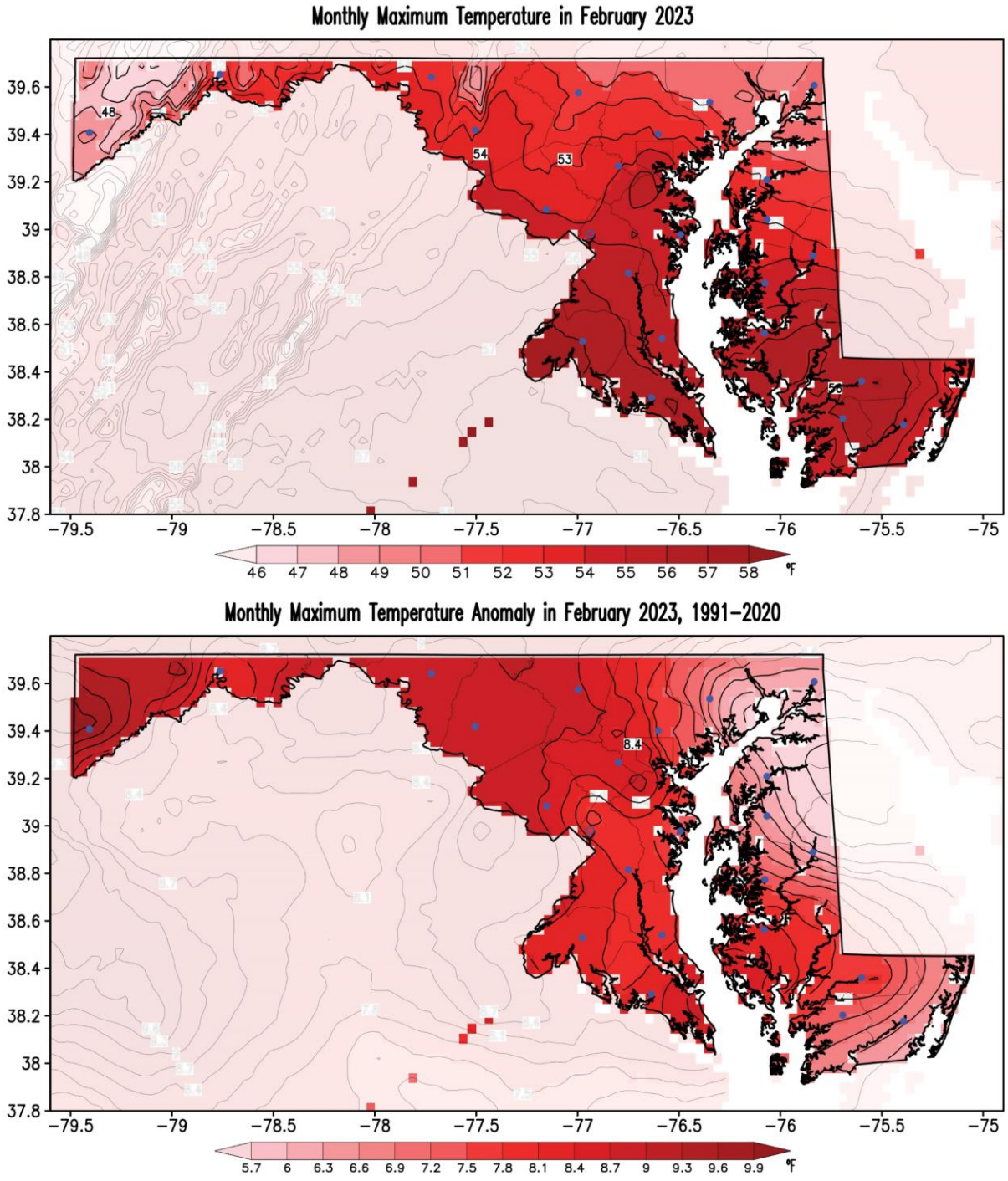

Figure 2. Monthly maximum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) for February 2023. Temperatures are in °F following the color bar. Red shading in the anomaly map marks warmer than normal conditions. Note shading outside the state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

C. Minimum Temperatures

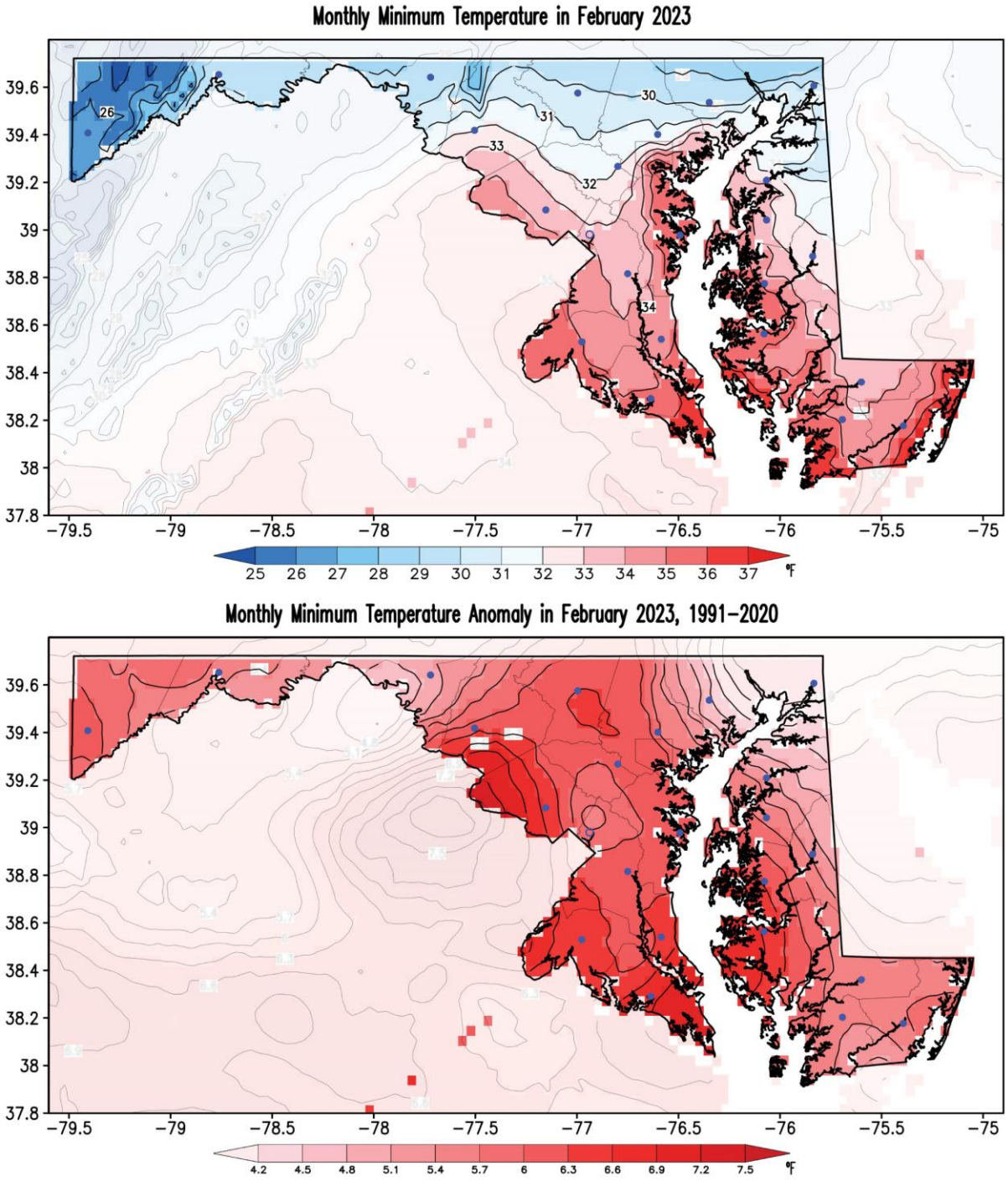

Figure 3. Monthly minimum surface air temperature (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) for February 2023. Temperatures are in °F following the color bar. Blue/red shading in the temperature map shows temperatures below/above 32°F, while red shading in the anomaly map marks warmer than normal conditions. Note shading outside the state has been washed out to facilitate focusing on Maryland. Filled blue circles mark the county seats.

D. Precipitation

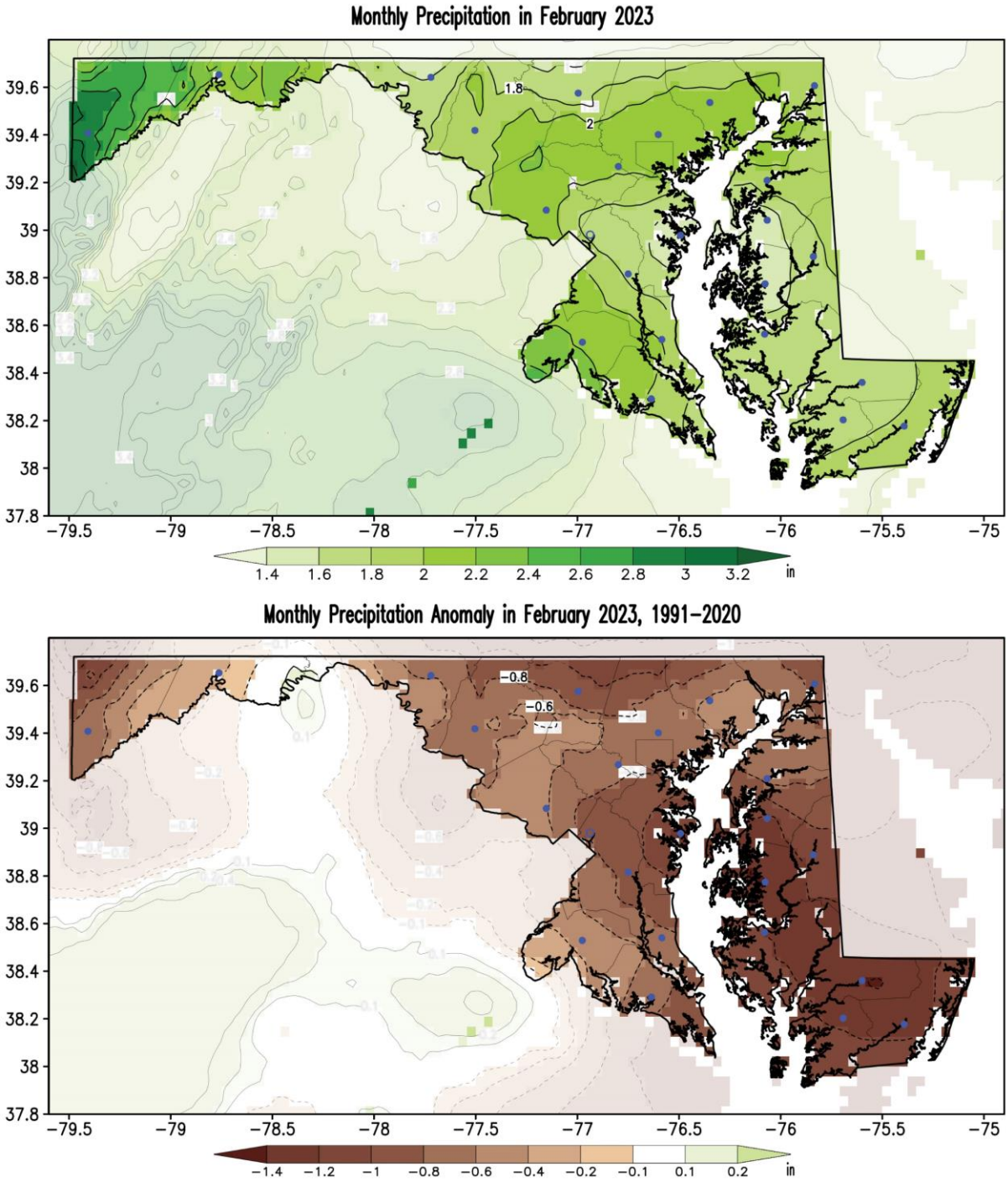

Figure 4. Monthly total precipitation (top panel) and its anomaly with respect to the 1991-2020 climatology (bottom panel) for February 2023. Precipitation is in inches following the color bar. Brown/green shading in the anomaly map marks drier/wetter than normal conditions. Note shading outside the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

E. Drought

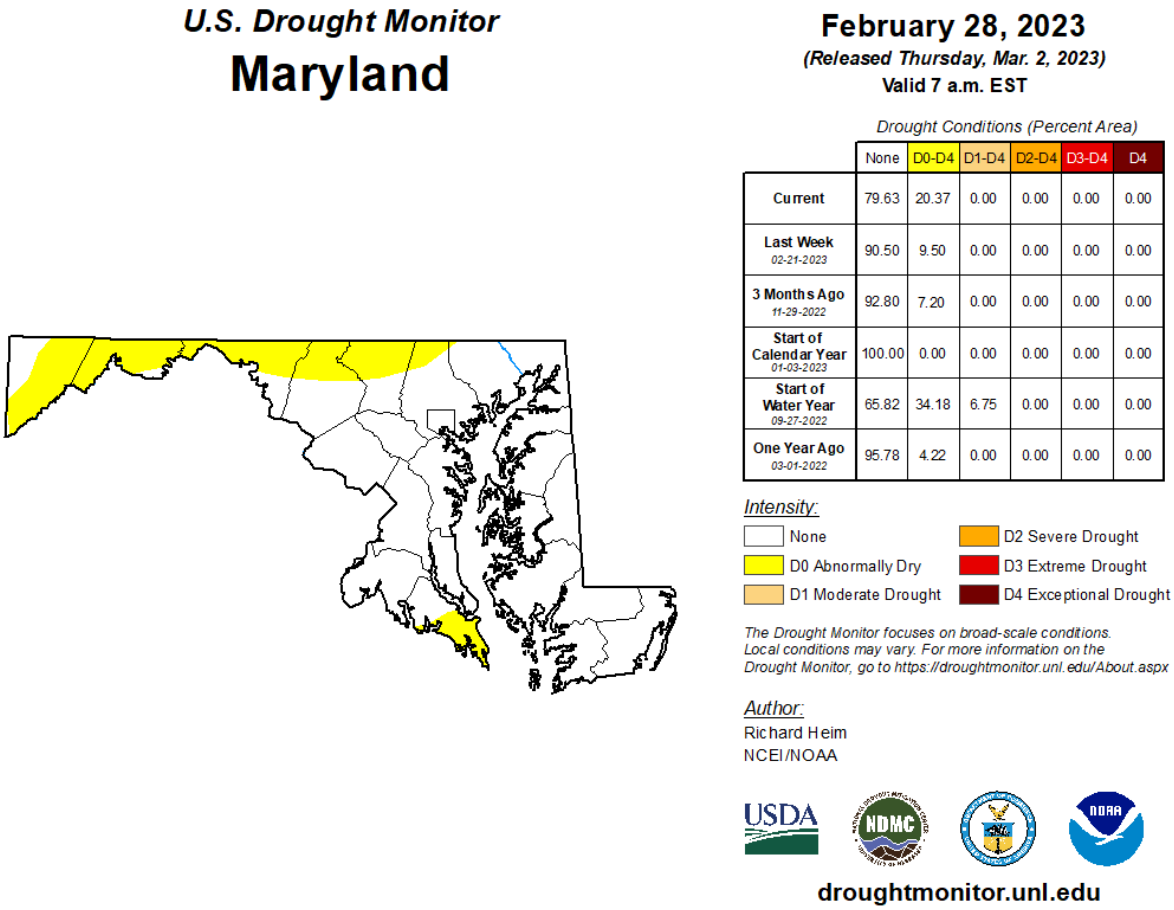

Figure 5. Drought conditions as reported by the U.S. Drought Monitor on February 28, 2023.

4. February and DJF 2022/2023 Climate Divisions Averages

A. February 2023 Scatter Plots

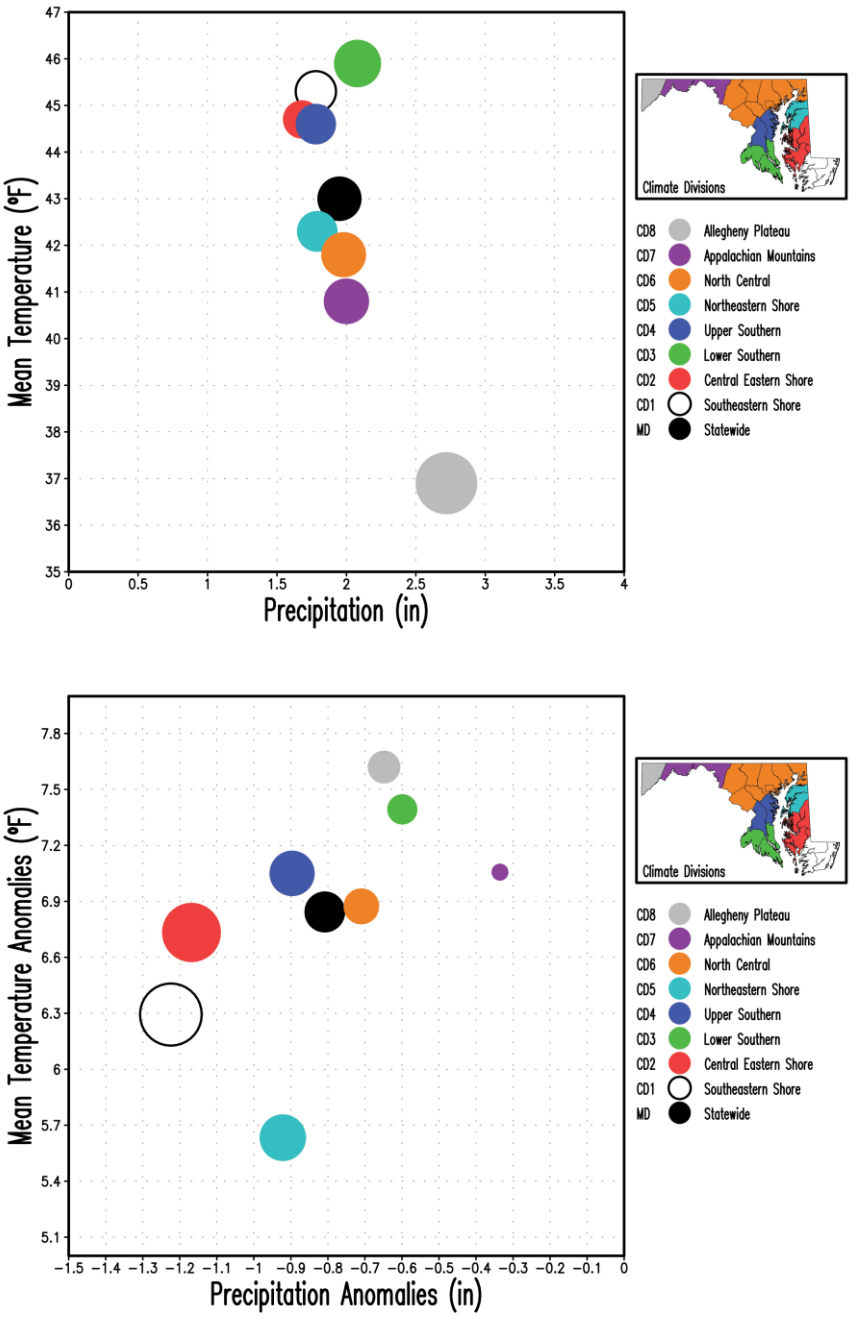

Figure 6. Scatter plots of Maryland (statewide) and Climate Divisions (CD#) monthly mean surface air temperature vs. total precipitation for February 2023. The upper panel shows the mean temperature and total precipitation, and the bottom panel displays their anomalies with respect to the 1991-2020 climatology. Temperatures are in °F and precipitation is in inches. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (2.72 inches in CD8, top panel) and by the maximum precipitation anomaly (|-1.22| inches in CD1, bottom panel) among the nine regions. Note that the color of the filled circles corresponds to the color in the Climate Divisions according to the inset map.

B. December, 2022-February, 2023 Scatter Plots

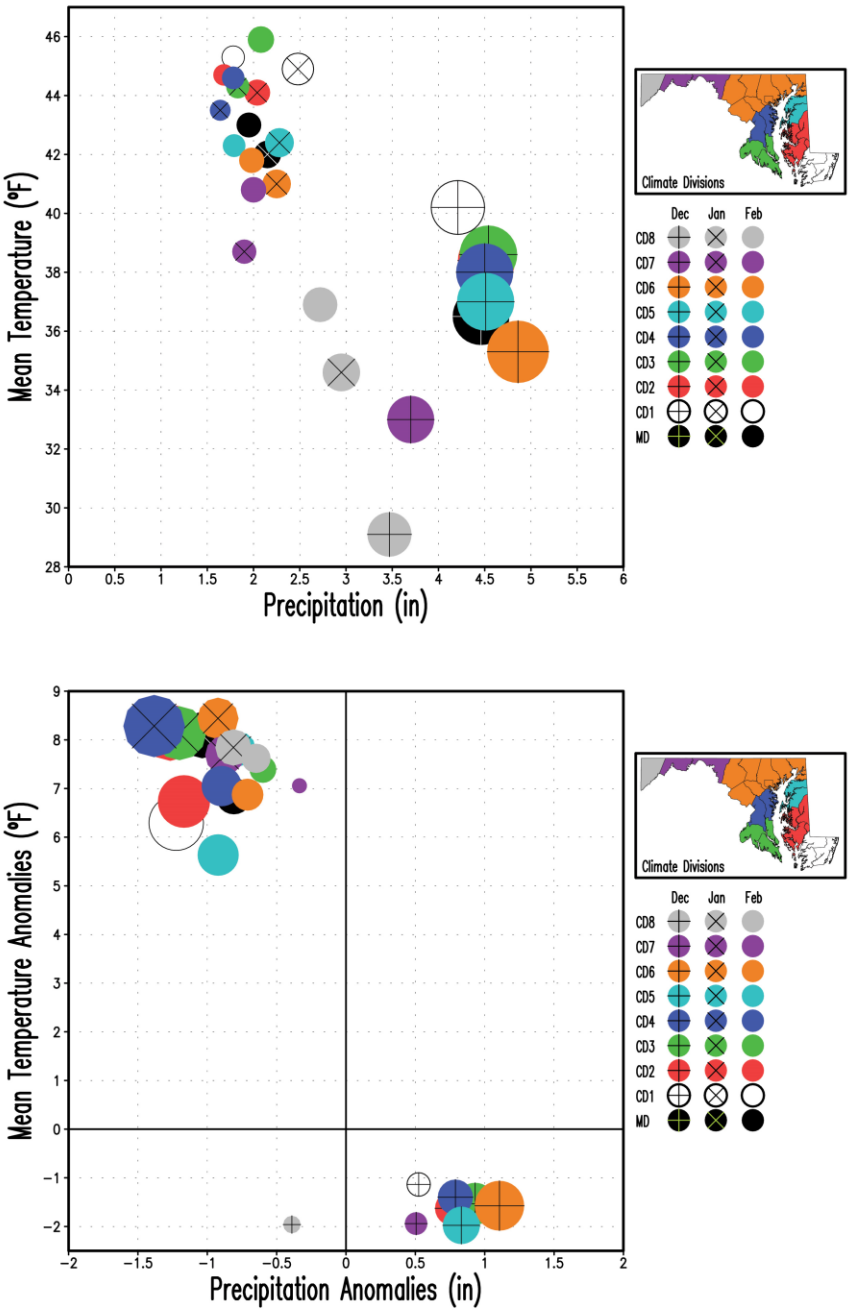

Figure 7. Scatter plots of Maryland (statewide) and Climate Divisions (CD#) monthly mean surface air temperature vs. total precipitation for December 2022, January and February 2023. The upper panel shows the mean temperature and total precipitation, and the bottom panel displays their anomalies with respect to the 1991-2020 climatology. Temperatures are in °F, and precipitation is in inches. The size of the circles is proportional to the total precipitation scaled down by the maximum precipitation (4.86 inches in CD6 in December, top panel) and by the maximum precipitation anomaly (|-1.38| inches in CD4 in January, bottom panel) among the nine regions and three months. February is displayed with filled circles only, while January and December are displayed with superposed multiplication and addition signs, respectively.

5. February 2023 Statewide Averages in the Historical Record

A. Box and Whisker Plots

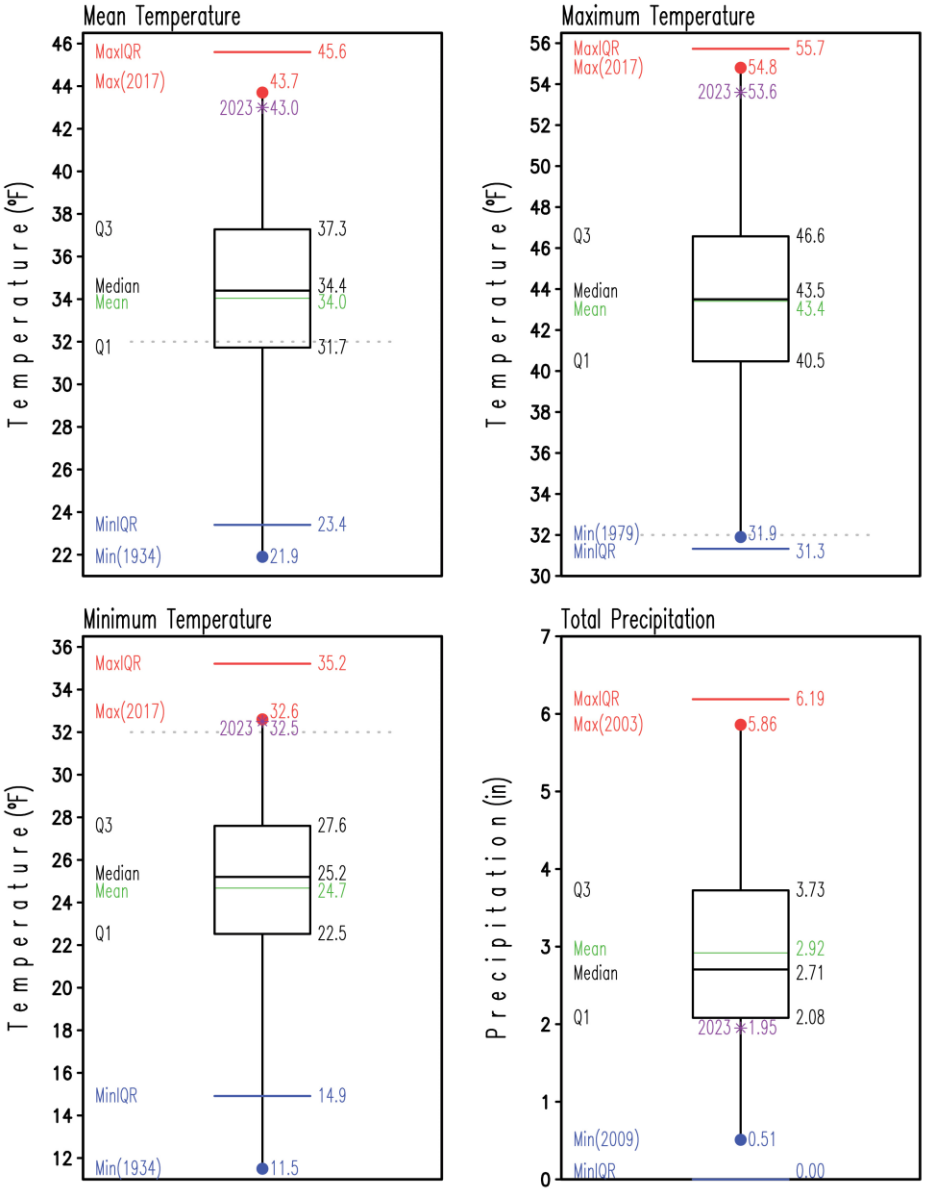

Figure 8. Box and Whisker plots of Maryland (statewide) monthly mean (upper left), maximum (upper right), minimum (lower left) surface air temperatures, and total precipitation (lower right) for February for the period 1895-2022. The label and asterisk in purple represent conditions for February 2023. Statistics for the period 1895-2022 are labeled at the left side of each box and whisker plot and their values at their right. Temperatures are in °F and precipitation is in inches. The mean is the green line within the box, while the median is the black line within the box. The lower (Q1) and upper (Q3) quartiles, indicating the values of the variable that separate 25% of the smaller and larger values are the lower and upper horizontal black lines of the box, respectively. The blue and red dots mark the minimum and maximum values in the period at the end of the whiskers; the year of occurrence is shown in parenthesis. The blue and red horizontal lines represent extreme values defined by Q1-1.5×(Q3-Q1) and Q3+1.5×(Q3-Q1), respectively. For reference, the 32° F temperature is displayed with a horizontal dotted line.

6. 1895-2023 Trends

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

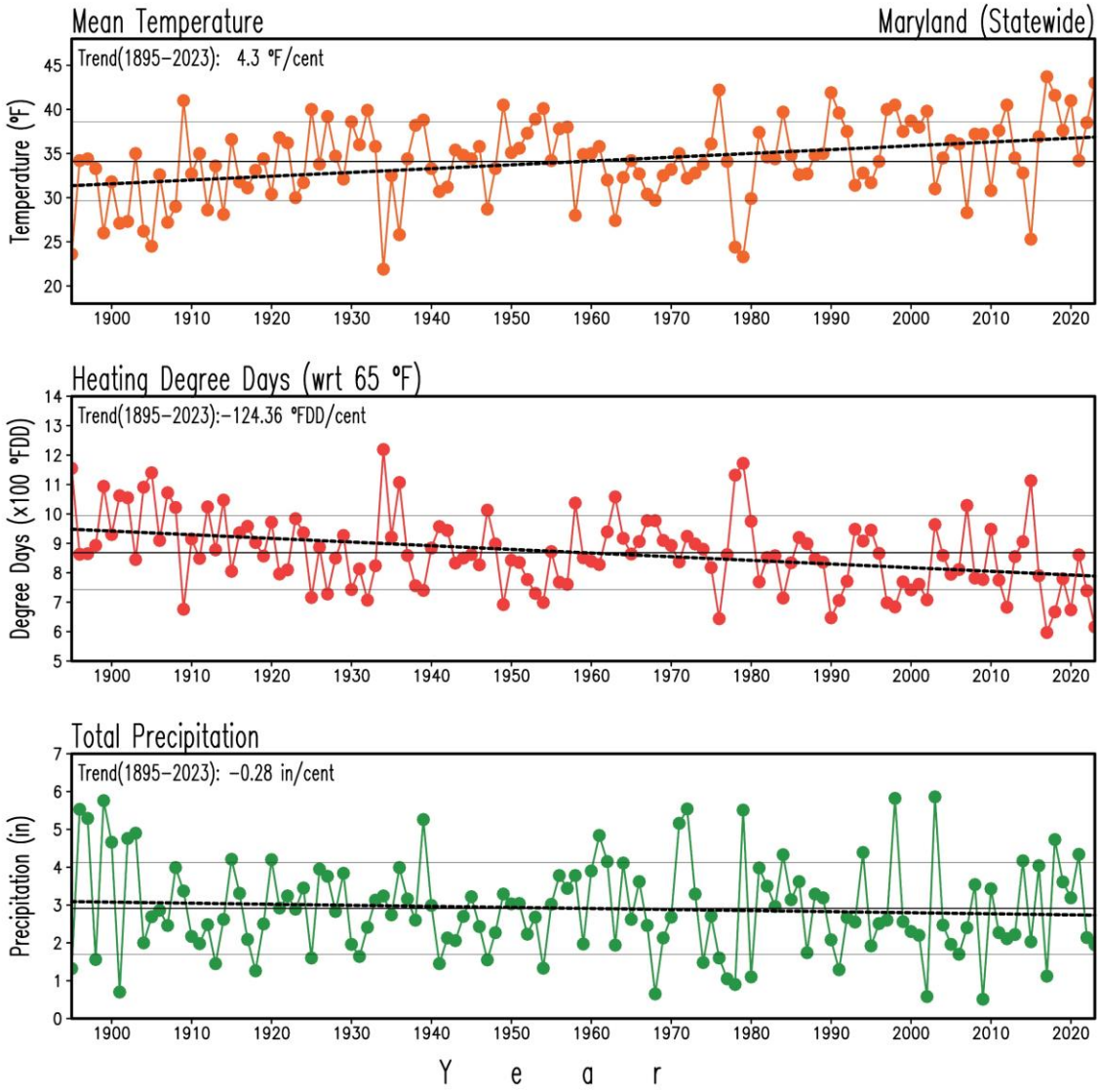

Figure 9. Maryland (statewide) mean surface air temperature, heating degree-days, and precipitation in February for the period 1895-2023. Temperature is in °F, heating degree-days is in °F degree-days (°FDD), and precipitation is in inches. The thin, continuous black lines in each panel display the long-term means (34.1°F, 868.43°FDD, and 2.91 in, 1895-2023), and the double thin, continuous gray lines indicate the standard deviation (4.5°F, 125.19°FDD, and 1.21 in) above/below the long-term mean. The thick dashed black lines show the long-term linear trend. Degree-days are the difference between the daily mean temperature (high temperature plus low temperature divided by two) and 65°F. It gives a general idea of how much energy is required to heat buildings; because energy demand is cumulative, degree-day totals for a month are the sum of each individual day's degree-day total (CPC, 2023). The warming temperature trend (4.3°F/century) and the decreasing heating degree-days (−124.36°FDD/century) trend are statistically significant at the 95% level (*Student's t-test* −Santer et al. 2000), but not the drying precipitation trend (−1.8 in/century).

B. Temperature and Precipitation Maps

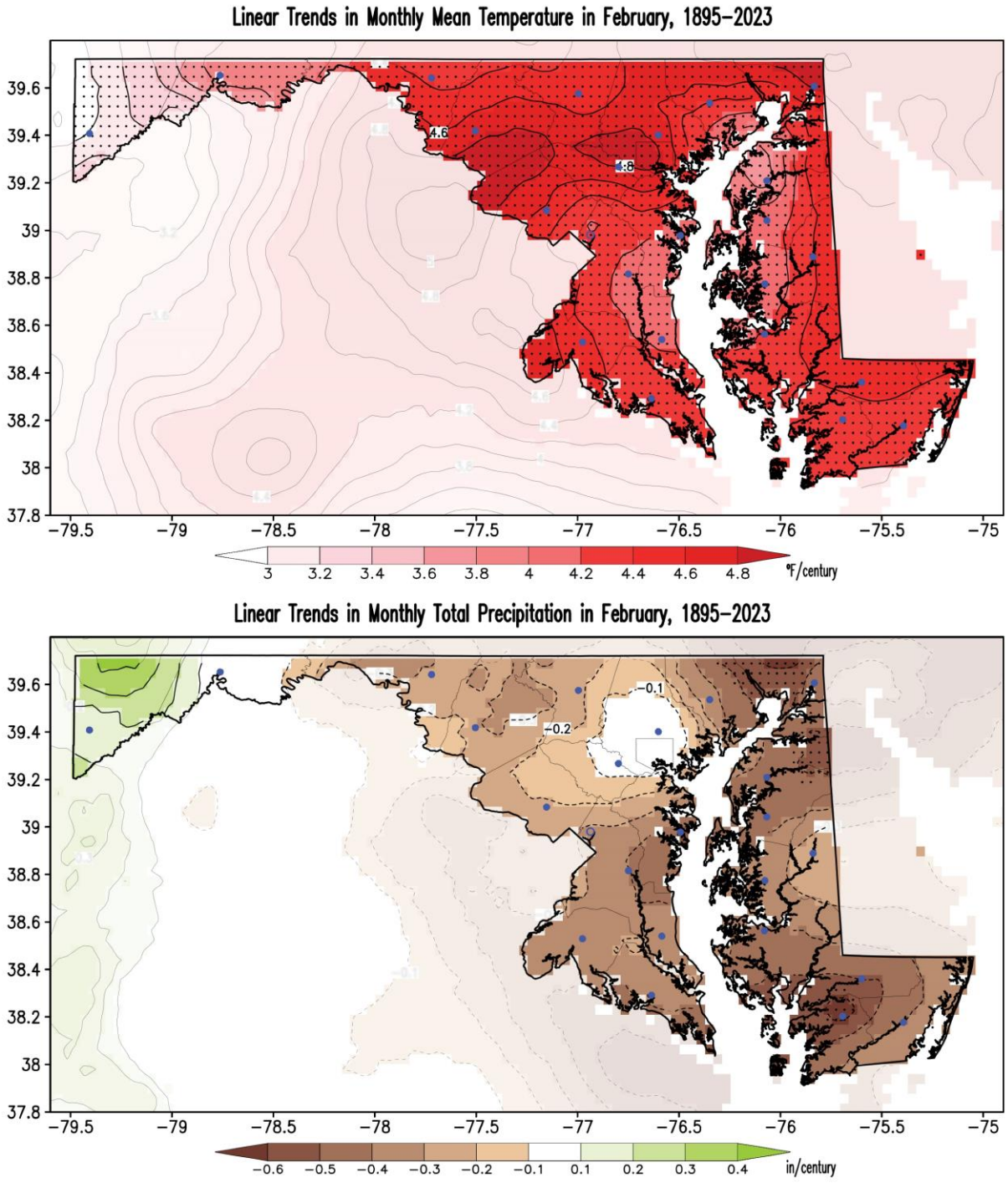

Figure 10. Linear trends in surface air mean temperature and precipitation for the period 1895-2023. Temperatures are in °F/century, and precipitation is in inches/century following the color bars. Red shading in the temperature map marks warming trends. Brown/green shading in the precipitation map shows drying/wetting trends. Stippling in the maps shows regions where trends are statistically significant at the 95% level (*Student's t-test* −Santer et al. 2000). Note that shading outside the state has been washed out to facilitate focusing on Maryland. Filled blue circles mark the county seats.

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

A. Mean Temperature and Precipitation

Region	Mean Air Temperature (°F)	Rank (#)
Statewide	43.0	128
Climate Division 1	45.3	128
Climate Division 2	44.7	128
Climate Division 3	45.9	129
Climate Division 4	44.6	128
Climate Division 5	42.3	125
Climate Division 6	41.8	128
Climate Division 7	40.8	128
Climate Division 8	36.9	128
Allegany	40.3	128
Anne Arundel	44.6	128
Baltimore	41.8	128
Baltimore City	44.0	128
Calvert	45.3	129
Caroline	43.3	126
Carroll	41.1	128
Cecil	40.1	123
Charles	46.0	128
Dorchester	45.6	129
Fredrick	42.0	128
Garrett	36.9	128
Harford	40.4	128
Howard	42.7	128
Kent	41.9	125
Montgomery	43.7	128
Prince George's	44.6	128
Queen Anne's	42.7	127
Saint Mary's	46.1	129
Somerset	45.5	127
Talbot	44.6	128
Washington	41.3	128
Wicomico	45.3	128
Worcester	45.2	128

Region	Total Precipitation (in)	Rank (#)
Statewide	1.95	25
Climate Division 1	1.78	21
Climate Division 2	1.68	19
Climate Division 3	2.08	38
Climate Division 4	1.78	24
Climate Division 5	1.79	22
Climate Division 6	1.98	38
Climate Division 7	2.00	52
Climate Division 8	2.72	51
Allegany	2.24	64
Anne Arundel	1.69	22
Baltimore	2.03	38
Baltimore City	2.12	40
Calvert	1.91	33
Caroline	1.74	22
Carroll	1.83	33
Cecil	1.96	28
Charles	2.22	44
Dorchester	1.68	19
Fredrick	1.93	42
Garrett	2.71	51
Harford	2.03	37
Howard	2.03	36
Kent	1.89	27
Montgomery	2.05	41
Prince George's	1.87	32
Queen Anne's	1.68	19
Saint Mary's	1.96	32
Somerset	1.76	22
Talbot	1.51	16
Washington	1.76	46
Wicomico	1.67	18
Worcester	1.87	21

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

B. Maximum and Minimum Temperatures

Region	Maximum Air Temperature (°F)	Rank (#)
Statewide	53.6	127
Climate Division 1	55.6	127
Climate Division 2	55.1	127
Climate Division 3	56.6	127
Climate Division 4	55.0	127
Climate Division 5	52.1	125
Climate Division 6	52.3	127
Climate Division 7	52.1	128
Climate Division 8	47.8	128
Allegany	51.4	127
Anne Arundel	54.8	127
Baltimore	52.4	127
Baltimore City	54.2	127
Calvert	55.6	126
Caroline	53.8	126
Carroll	51.9	128
Cecil	50.1	125
Charles	57.0	127
Dorchester	56.1	127
Fredrick	52.6	128
Garrett	47.8	128
Harford	50.7	126
Howard	53.5	128
Kent	51.6	125
Montgomery	53.9	127
Prince George's	55.4	127
Queen Anne's	52.5	125
Saint Mary's	56.6	127
Somerset	55.6	128
Talbot	54.5	127
Washington	52.8	128
Wicomico	56.3	128
Worcester	55.1	127

Region	Minimum Air Temperature (°F)	Rank (#)
Statewide	32.5	128
Climate Division 1	35.0	126
Climate Division 2	34.2	127
Climate Division 3	35.2	128
Climate Division 4	34.2	129
Climate Division 5	32.4	126
Climate Division 6	31.3	127
Climate Division 7	29.4	127
Climate Division 8	26.0	127
Allegany	29.1	127
Anne Arundel	34.4	129
Baltimore	31.2	128
Baltimore City	33.8	128
Calvert	34.9	128
Caroline	32.7	126
Carroll	30.3	128
Cecil	30.1	122
Charles	35.1	129
Dorchester	35.0	128
Fredrick	31.4	128
Garrett	26.0	127
Harford	30.1	124
Howard	31.8	128
Kent	32.2	128
Montgomery	33.4	129
Prince George's	33.8	128
Queen Anne's	32.8	126
Saint Mary's	35.6	128
Somerset	35.4	126
Talbot	34.8	127
Washington	29.7	126
Wicomico	34.2	127
Worcester	35.4	127

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

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

A. Temperatures and Precipitation

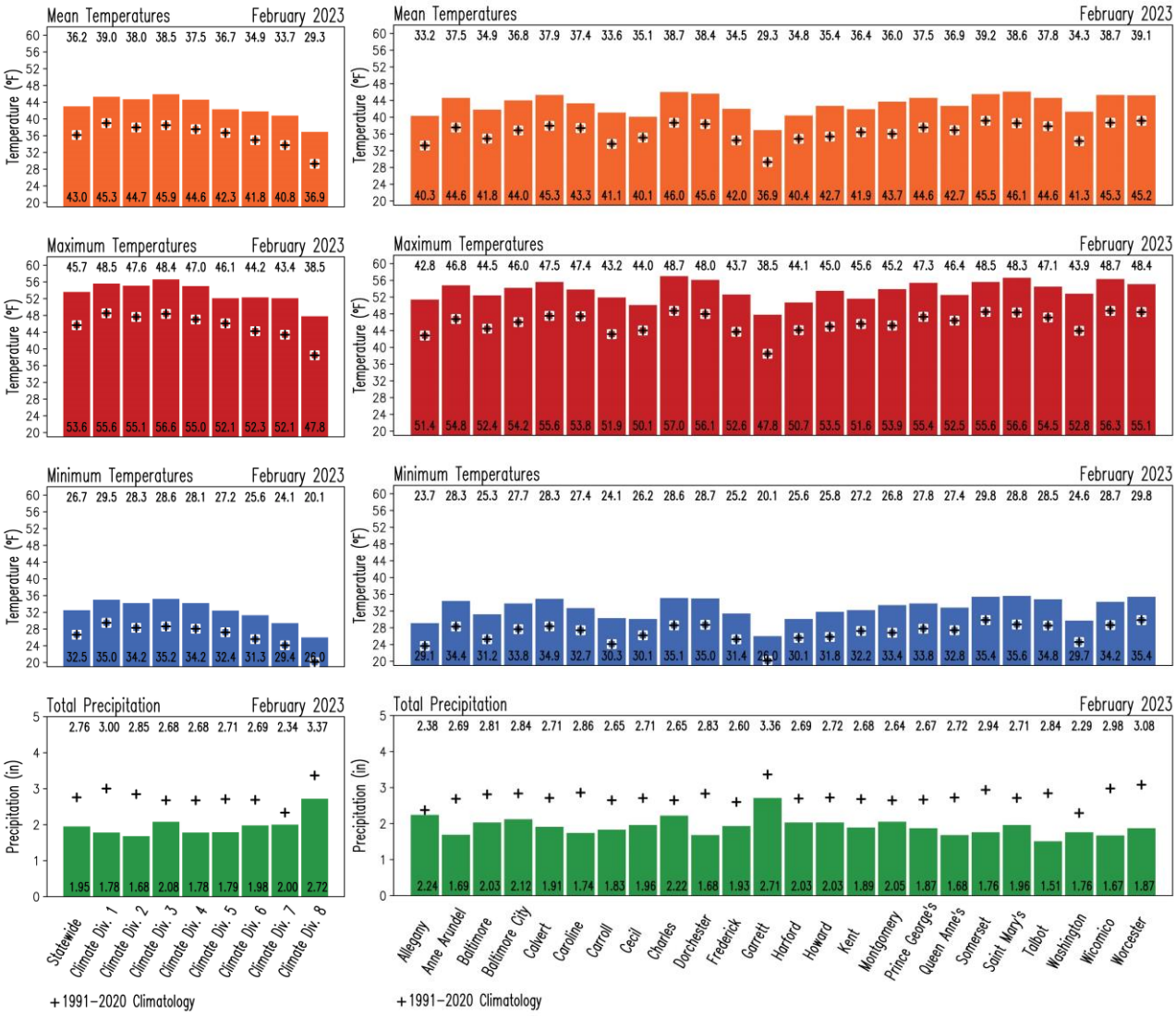

Figure B1. Monthly surface variables in Maryland for February 2023. Color bars represent the variables as follows: mean surface air temperature (orange), maximum surface air temperature (red), minimum surface air temperature (blue) and total precipitation (green) at statewide and climate division (left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

B. Temperature and Precipitation Anomalies

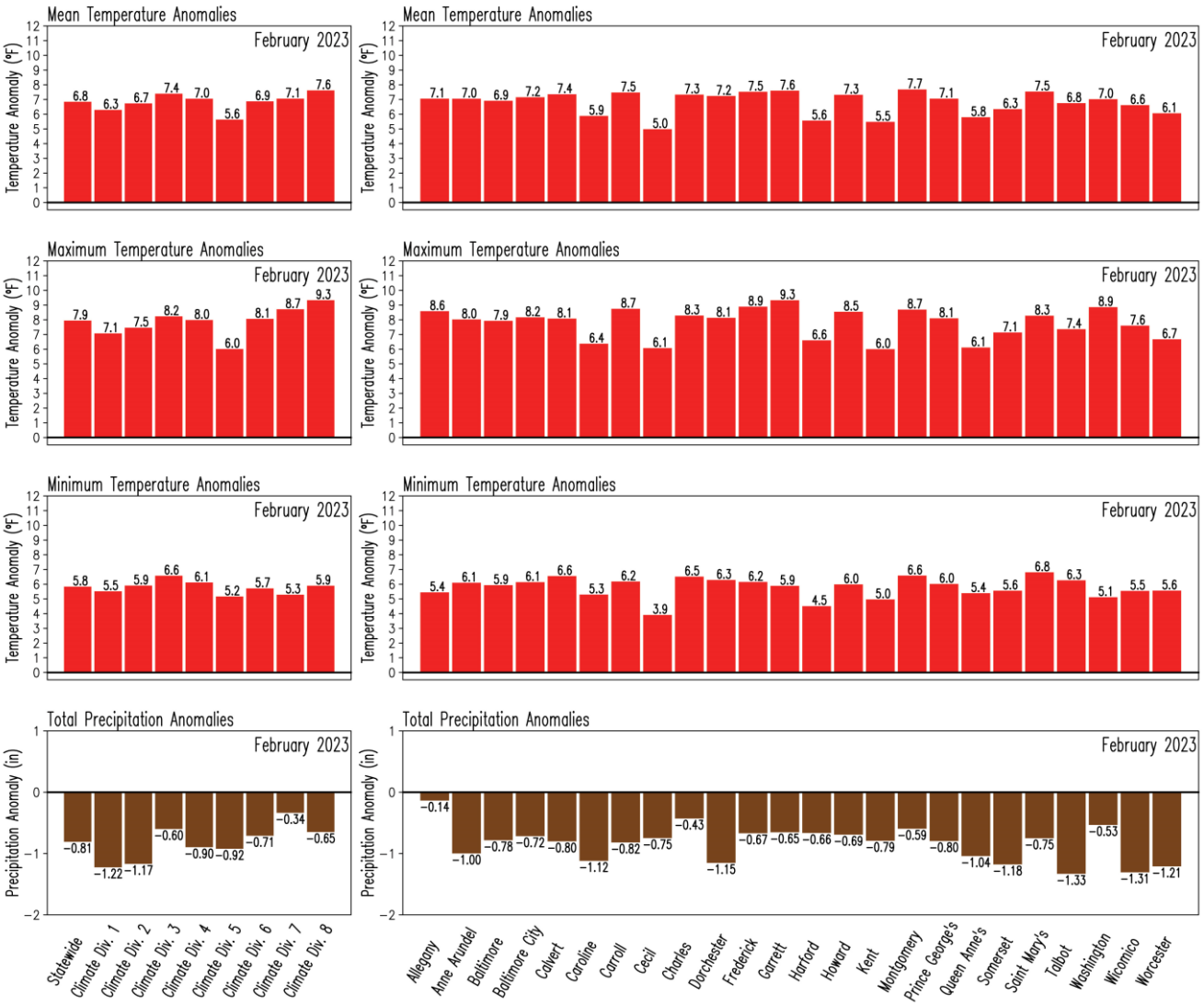

Figure B2. Anomalies of the monthly surface variables in Maryland for February 2023. Anomalies are with respect to the 1991-2020 climatology. Red color represents positive anomalies for mean surface air temperature (upper row), maximum surface air temperature (second row from top), and minimum surface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

Appendix C. February 1991-2020 Climatology Maps

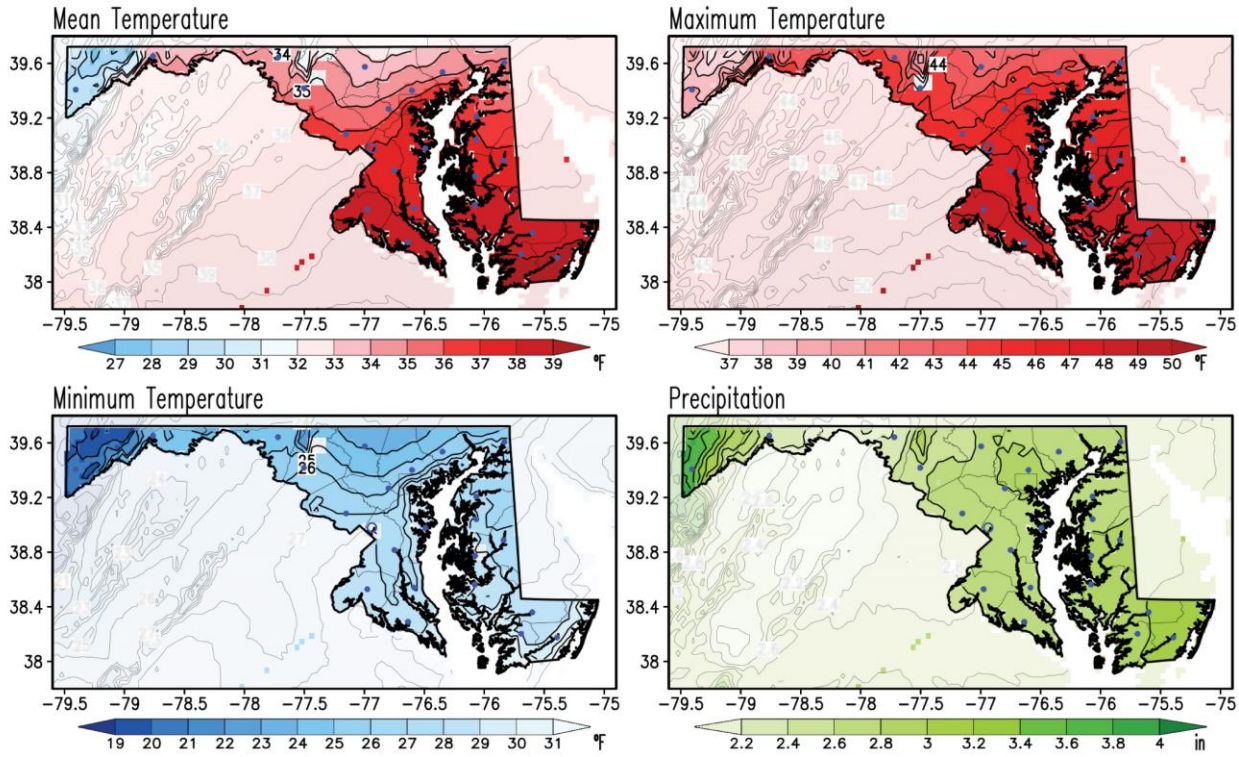

Figure C1. February climatology of the monthly mean, maximum and minimum surface air temperatures, and total precipitation for the period 1991-2020. Temperatures are in °F, and precipitation is in inches according to the color bars. This is the current climate normal against which the February 2023 conditions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

Weather and climate are closely related, but they are not the same. Weather represents the state of the atmosphere (temperature, precipitation, humidity, wind, sunshine, cloudiness, etc.) at any given time. On the other hand, climate refers to the time average of the weather elements when the average is over long periods. If the 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 30 years for the average. The 30-year averaged weather data is traditionally known as Climate Normal (Kunkel and Court 1990), which is updated every ten years (WMO 2017). Establishing a climate normal or climatology is important as it allows one to compare a specific day, month, season, or even another normal period with the current normal. Such comparisons characterize anomalous weather and climate conditions, climate variability and change, and help define extreme weather and climate events (Arguez et al. 2012).

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

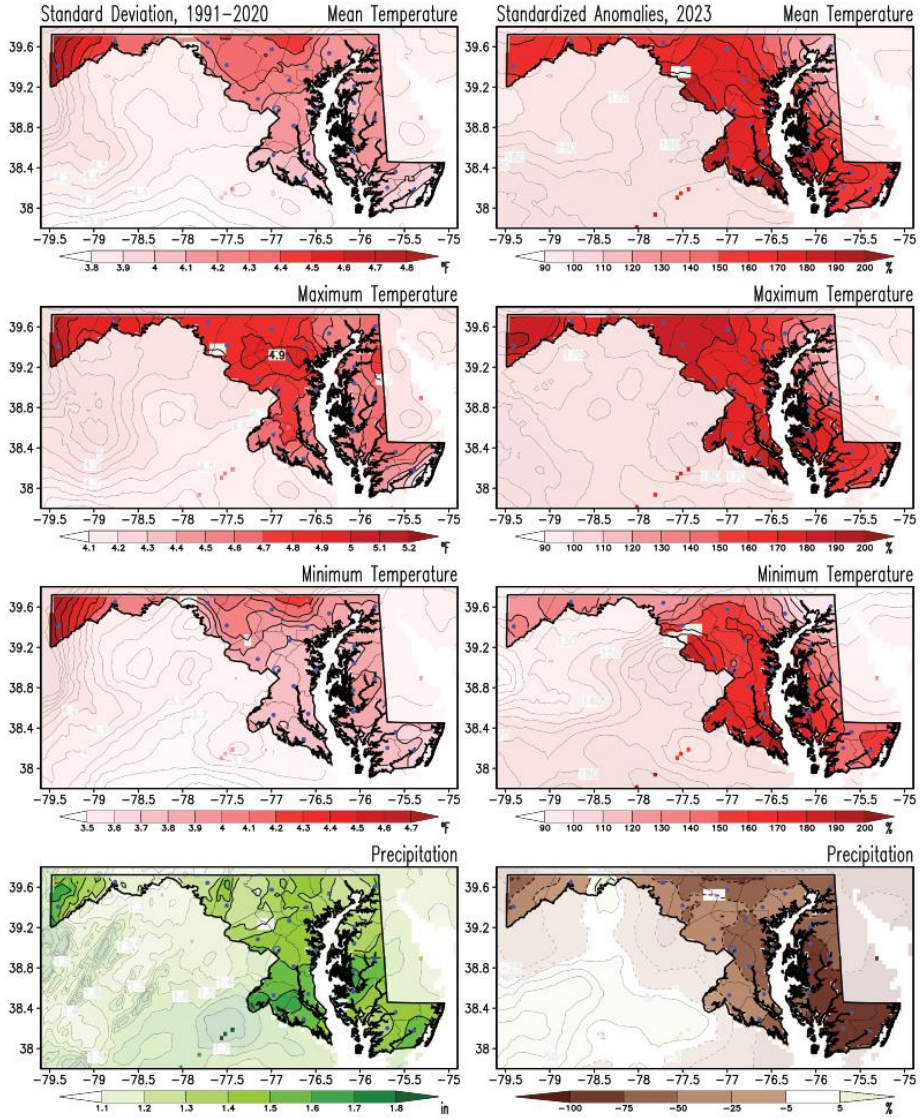

Figure D1. Standard deviation for February and standardized anomalies of temperatures and precipitation for February 2023. Standard deviations for monthly mean, maximum, and minimum surface air temperatures and total precipitation were obtained for the 1991-2020 period (left column). Anomalies for February 2023 (right column) are obtained as a percentage of the standard deviations. The standard deviations in temperatures are in °F, and those in precipitation are in inches according to the color bars. The standardized anomalies are obtained by dividing the raw anomalies (from Figures 1 to 4) by the standard deviation (from left column panels) and multiplying that ratio by 100; hence units are in percent (%). Note that shading outside the state has been washed out to facilitate focusing on Maryland. Filled blue circles mark the county seats.

The monthly standard deviation measures a climate variable's year-to-year, or interannual, variability. Anomalies are sometimes compared against that variability to identify extremes in the climate record. When the anomalies are divided by the standard deviation, they are named *standardized anomalies*.

References

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