



Weather of Appomattox Court House National Historical Park and Booker T. Washington National Monument

Mid-Atlantic Network Summary Report for 2011

Natural Resource Data Series NPS/MIDN/NRDS—2012/337



ON THE COVER

New County Jail, Appomattox Court House National Historical Park .
Photograph by: Karen Peterson.

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Natural Resource Data Series NPS/MIDN/NRDS—2012/337

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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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List of Key Acronyms

APCO Appomattox Court House National Historical Park

ASOS Automated Surface Observation System

BOWA Booker T. Washington National Monument

CASTNet Clean Air Status and Trends Network

COOP National Weather Service Cooperative Observer Program

CWOP Citizen Weather Observer Program

FAA Federal Aviation Administration

IFLOWS Integrated Flood Observing and Warning System

MIDN Mid-Atlantic Network

NADP National Atmospheric Deposition Program

NARR North American Regional Reanalysis

NCDC National Climatic Data Center

NHP National Historical Park

NM National Monument

NOAA National Oceanic and Atmospheric Administration

NWS National Weather Service

PASC Pennsylvania State Climatologist

PDSI Palmer Drought Severity Index

POR Period of Record

PRISM Parameter-elevation Regressions on Independent Slopes Model

RAWS Remote Automated Weather Stations

USDM United States Drought Monitor

USEPA United States Environmental Protection Agency

USGS United States Geological Survey

Introduction

Weather and climate are widely recognized as key drivers of terrestrial and aquatic ecosystems, affecting biotic as well as abiotic ecosystem characteristics and processes. Global and regional scale climatic patterns, trends, and variations are critical to the cycling of elements, nutrients, and minerals through ecosystems and can deliver pollutants from regional and even global sources (National Assessment Synthesis Team 2001). These variations and trends influence the fundamental properties of ecologic systems such as soil-water relationships and plant-soil processes and their disturbance rates and intensity. Information obtained from meteorological monitoring will be useful to interpreting and understanding changes in species composition, community structure, water and soil chemistry, and related landscape processes (Comiskey and Callahan 2008).

The purpose of this report is to provide a concise weather and climate summary for January 1 to December 31, 2011, and to place current patterns and trends in an appropriate historical, regional, and global context (Marshall et al. 2012). It is our intention that this report will satisfy an inherent interest in meteorological phenomena and meet the Mid-Atlantic Network (MIDN) Weather and Climate Monitoring objective:

- Document current status and long-term trends in air temperature and precipitation at multiple temporal scales (e.g., daily, monthly, seasonal, annual, and decadal) and spatial scales (e.g., individual stations and aggregated stations such as climate divisions) utilizing existing weather and climate monitoring programs and datasets.

To accomplish this objective, a variety of atmospheric data streams were evaluated for their quality, longevity, and applicability to the MIDN parks. Since no single weather observing network contains all the pertinent measures of atmospheric phenomena to assess ecosystem health, an objective analysis of the data networks was developed and outlined in the Weather and Climate Monitoring Protocol for the Eastern Rivers and Mountains Network and Mid-Atlantic Network of the National Park Service (Marshall et al. 2012). Through this analysis, a select number of weather/climate observing stations were chosen as representative of each park; these are the primary data sources used in the profile of 2011's climate summary and trends.

In addition to a suite of summary tables, graphs, and narratives, we specifically identify a series of key weather indicators to report status and trends on an annual basis and periodically in separate and more thorough reports. These key indicators are further described in the protocol (Marshall et al. 2012) and summarized in this report.

Climate of the Western Piedmont Region of Virginia

Appomattox Court House National Historical Park (NHP) and Booker T. Washington National Monument (NHP) lie in Virginia Climate Division 3, known as the “Western Piedmont.” A climate division is a region that is reasonably homogenous with respect to climatic and hydrologic characteristics and is frequently used for compiling climate statistics (<http://www.esrl.noaa.gov/psd/data/usclimate/map.html>). Virginia is divided into six climate divisions. This division is generally considered to have a humid, continental type of climate, but the varied physiographic features have a marked effect on the weather and climate of the various parts of this region. The prevailing westerly winds carry most of the weather disturbances that affect the region from the interior of the continent through the Ohio Valley, so that the Atlantic Ocean has only some influence on the climate of the area (Davey et al. 2006, Gawtry and Stenger 2007). Coastal storms do, at times, affect the day-to-day weather, especially in the winter. Infrequently, storms of tropical origin can have a significant effect, causing severe floods in some instances.

Temperatures are moderately continental, with the tempering effects of the nearby mountains contributing to cloud production in the winter and mountain-valley circulation clouds reducing the heat at times during the summer. The lowest readings in the winter occur with polar air masses of Canadian origin settling over the region after a fresh snowfall. On average, Appomattox Court House NHP tends to have a greater number of sub-freezing nights than Booker T. Washington NM (~92 to ~75). The highest readings of the summer happen when the sub-tropical fair weather system, the Bermuda high, pushes westward into the Carolinas; its clockwise circulation will direct hot, humid air from the Gulf region into the region. The humid southwest winds descending the crest of the Appalachians will raise the temperature several more degrees. The last freeze and first frost typically occur in mid-April and late October, respectively.

Precipitation is fairly evenly distributed throughout the year. Annual amounts generally range between 36–52 in (914–1,321 mm), while the majority of places receive 38–44 in (965–1,118 mm). Greatest amounts usually occur in the late spring and summer months, while February is the driest month, having about 2 in (51 mm) less than the wettest months. Precipitation is somewhat greater in the mountains. During the warm season, the uneven heating over the irregular terrain leads to thunderstorms which typically form over the mountains and dissipate as they reach the Piedmont.

Surface winds blow from the west and northwest in the cold season and from the southwest during the warm half of the year. Thunderstorms follow a frequency that matches the solar cycle, occurring between the equinoxes and reaching a peak near the solstice. Hail is relatively infrequent, but flash floods and damaging thunderstorm winds affect parts of the region each summer. On average, tornadoes pass through the area about once every three years. The direct effects of an Atlantic hurricane are uncommon, though remnant rains from hurricanes and tropical storms occur most years and some have contributed to the region’s worst floods. Ice storms, which can cause significant disruption, occur at irregular intervals but are primarily confined to the months between December and March (Kocin and Uccellini 2004).

Observing Stations

A total of five weather observing stations comprising two weather observing networks were selected around Appomattox Court House NHP and Booker T. Washington NM. Representative stations within a 100-km range of each park were chosen based on several criteria, which include proximity to the park, the representativeness of the station to the park elevation profile, the type and frequency of observations, the period of record of the data, and data availability (Marshall et al. 2012). Moreover, the percentage of time a station reports a particular parameter (e.g., temperature) can influence data inclusion. A total of five stations were ultimately used for this 2011 report: Lynchburg, Roanoke, Rocky Mt., Appomattox, and Huddleston (Figure 1, Table 1).

The average value of a climate element over 30 years is defined as a climatological normal, which is calculated and established by NOAA's National Climatic Data Center (NCDC). Every ten years, NCDC computes new thirty-year climate normals for selected temperature and precipitation elements for a large number of U.S. climate and weather stations. The current (as of 2011) normals cover the period 1981–2010. In this report, the 30-year normals established by NCDC are used as the baseline for comparisons (e.g., departures from normal). In cases where data for the 30-year normal period are not available, we use alternative comparisons such as the new pseudo-normal from NCDC or a recent 10-year period. In some cases, sufficient data may simply not be available to calculate normals. For metrics that NCDC may not routinely calculate a normal, such as the number of days with more than 2 in (55 mm) of rain or liquid equivalent, normals will be calculated using the same time period (e.g., 1981–2010) as the current NCDC standard. Throughout the report, descriptions of a station's values as compared to the normals are described as a difference from the "average", "mean", "typical", "long-term value", as well as "normal", to improve the readability of the document. However, all of these terms are comparing a value from one year at that station to that station's normal, whether it be the 30-year normal or the pseudo-normal calculated on a shorter time frame.

Of the five stations, four have a Period of Record (POR) sufficiently long for a 30-year normal (1981–2010); however, Huddleston lacks temperature data. The normal for Rocky Mt. is based on a POR from 1994–2011. Monthly averages and deviations from normal are presented for all five stations for precipitation, and for all except Huddleston for temperature.

In addition to the summary information available in this report, a near real-time data stream has been made available to the MIDN through a Web interface for the weather observing stations, along with monthly, seasonal, and annual summaries. The Web interface is accessible through the following link: http://climate.met.psu.edu/gmaps/NPS_DEVELOPMENT/interface.php.

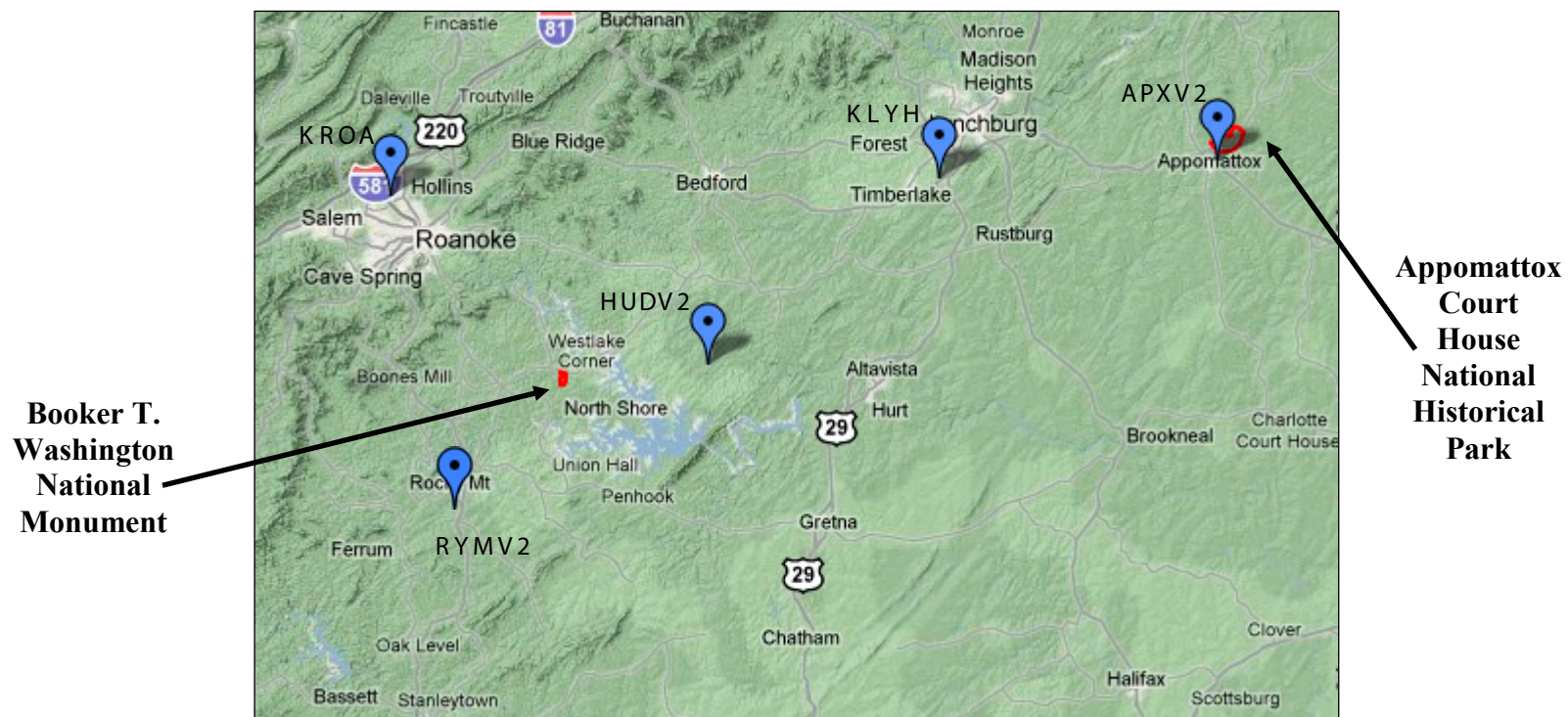


Figure 1. Location of weather observing stations around Appomattox Court House National Historical Park and Booker T. Washington National Monument selected as most representative of the parks in 2011. See Table 1 for station names.

Table 1. List of weather observing stations around Appomattox Court House National Historical Park and Booker T. Washington National Monument selected as most representative of the parks in 2011.

Station	Observing Network ¹	Station Name	Period of Record (POR)	Percentage of Time Reporting Temperature for 2011	Percentage of Time Reporting Precipitation for 2011	Percentage of Time Reporting Temperature for entire POR	Percentage of Time Reporting Precipitation for entire POR
KLYH	ASOS	Lynchburg Regional Airport/Preston Glenn Field	02/01/1948 Present	100.0	100.0	96.0	96.0
KROA	ASOS	Roanoke Regional Airport/Woodrum Field	02/01/1948 Present	100.0	100.0	95.7	95.7
RYMV2	COOP	Rocky Mt.	01/01/1951 Present	99.7	99.7	94.4	94.2
APXV2	COOP	Appomattox	11/01/1937 Present	98.1	98.1	95.4 ²	96.1
HUDV2	COOP	Huddleston 4 SW	01/01/1960 Present	-	100.0	-	99.2

¹ Observing networks are: ASOS — Automated Surface Observation System, COOP — National Weather Service Cooperative Observer Program.

² Percentage of time reporting temperature for Appomattox Court House NHP is based upon a Period of Record beginning on 11/01/1961. The station did not report temperature prior to this date.

Temperature Summary

Average annual temperatures in 2011 were significantly above the 30-year normal for the area around Appomattox Court House NHP and Booker T. Washington NM (Table 2) despite a cold January and a chilly October (Tables 3 and 4). Average monthly temperatures were continuously above normal from February through September (Figures 2 and 3)¹.

January was colder than average, with mean temperatures ranging from -1.6 to -2.2°F (-0.9 to -1.2°C) from the long-term values (Tables 3 and 4). The lowest readings of the year occurred on January 9th and 23rd with values as low as 12.0°F (-11.1°C), much higher than the typical annual minimums (Table 2). February turned much milder with mean temperatures varying from 40.1°F (4.5°C) at Rocky Mt. to 43.2°F (6.3°C) at Roanoke (Table 3). There was a return to normal temperatures in March, leading to a winter that ranked the 53rd coolest in 117 years for the Western Piedmont (Table 5; 59 is the mid-point). There were also a below-normal number of cold days during the winter (Table 2).

Spring was much milder than normal, as all three months noted significant positive anomalies at each of the representative weather stations (Table 4). April had the largest positive departures from normal, with Rocky Mt. registering 3.8°F (2.1°C) above normal (Table 4). Much of the warmth was due to very mild nights, particularly during May and June (Figure 3). Overall, this spring season ranked as the 14th warmest on record for the Western Piedmont (Table 5).

The summer months featured consistently warmer-than-average weather from July through much of September. In fact, the positive anomalies ranged from +3.0 to +3.5°F (1.7 to 1.9°C) during July (Table 4). The number of hot days was well above normal. Between 33 and 42 days reached or exceeded 90°F (32.2°C) compared with normal numbers around 25 days (Table 2). Accordingly, the highest readings of 2011 exceeded the normal values of around 96°F (36.5°C), topping out at 100°F (37.8°C) (Table 2). The summer of 2011 ranked as the 29th warmest in the last 117 years for the Western Piedmont (Table 5).

After a cool October, the next two autumn months had increasingly large positive departures from normal. The number of sub-freezing days was exactly or very close to normal (Table 2). December's departure from normal varied from +4.0°F (2.2°C) at Rocky Mt. to +5.2°F (2.9°C) at Lynchburg (Table 4). The autumn ranked as the 28th warmest in 117 years for the Western Piedmont (Table 5). The length of the growing season was about a week longer when compared to the 1981–2010 average and first freeze of the autumn occurred on October 29-30, very close to the average dates (Table 2).

¹ The maps in Figures 2 and 3 were created using estimates from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). PRISM uses an interpolation scheme for temperature between actual observations and corrects these estimates for changes in topography across the region (Daly et al. 2002). More information can be found at <http://www.prism.oregonstate.edu/>.

Table 2. Status of 2011 temperature indicators compared to the 30-year normal (1981–2010) at the Lynchburg Airport (KLYH), Roanoke Airport (KROA), and Appomattox (APXV2) weather observing stations.

Temperature Indicator	Lynchburg Airport 2011	Lynchburg Airport 1981–2000	Roanoke Airport 2011	Roanoke Airport 1981–2010	Appomattox 2011	Appomattox 1981–2010
Average Annual Temperature	57.6°F 14.2°C	55.6°F 13.1°C	58.9°F 14.9°C	57.0°F 13.9°C	57.7°F 14.3°C	56.0°F 13.3°C
Average Annual Maximum Temperature	69.0°F 20.6°C	67.1°F 19.5°C	69.1°F 20.6°C	67.3°F 19.6°C	68.6°F 20.3°C	67.4°F 19.7°C
Maximum Temperature	100°F 37.8°C	95.9°F 35.5°C	99°F 37.2°C	96.7°F 35.9°C	100°F 37.8°C	96.0°F 35.6°C
Hot Days (days with Tmax≥90°F/32°C)	42	22	42	25	33	23
Average Annual Minimum Temperature	46.1°F 7.8°C	44.1°F 6.7°C	48.6°F 9.2°C	46.6°F 8.1°C	46.8°F 8.2°C	44.5°F 6.9°C
Minimum Temperature	12.0°F -11.1°C	3.7°F -15.7°C	15.0°F -9.4°C	6.0°F -14.4°C	14.0°F -10.0°C	4.4°F -15.3°C
Cold Days (days with Tmax≤32°F/0°F)	3	6	4	7	1	6
Sub-freezing Days (days with Tmin≤32°F/0°C)	99	99	74	78	96	95
Sub-zero Days (days with Tmin≤0°F/-18°C)	0	0	0	0	0	1
Growing Season Length (days between last spring Tmin 32°F/0°C and first fall Tmin 32°F/0°C)	211	201	207	208	206	199

Table 3. Summary of 2011 monthly average temperatures for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Lynchburg Airport	KLYH	32.9°F	41.0°F	46.7°F	59.1°F	65.5°F	74.1°F	78.5°F	76.1°F	68.4°F	55.6°F	49.1°F	42.8°F	57.5°F
		0.5°C	5.0°C	8.2°C	15.1°C	18.6°C	23.4°C	25.8°C	24.5°C	20.2°C	13.1°C	9.5°C	6.0°C	14.2°C
Roanoke Airport	KROA	34.7°F	43.2°F	47.5°F	60.1°F	66.0°F	75.8°F	80.2°F	77.8°F	68.8°F	56.9°F	50.5°F	43.9°F	58.8°F
		1.5°C	6.2°C	8.6°C	15.6°C	18.9°C	24.3°C	26.8°C	25.4°C	20.4°C	13.8°C	10.3°C	6.6°C	14.9°C
Rocky Mt	RYMV2	33.4°F	40.1°F	46.4°F	58.5°F	64.4°F	74.5°F	78.1°F	75.3°F	67.3°F	55.5°F	48.4°F	41.9°F	57.0°F
		0.8°C	4.5°C	8.0°C	14.7°C	18.0°C	23.6°C	25.6°C	24.1°C	19.6°C	13.1°C	9.1°C	5.5°C	13.9°C
Appomattox	APXV2	33.5°F	41.2°F	45.9°F	58.5°F	64.4°F	74.5°F	78.9°F	75.5°F	68.5°F	56.5°F	49.5°F	42.9°F	56.5 °F
		0.8°C	5.1°C	7.7°C	14.7°C	18.0°C	23.6°C	26.1°C	24.2°C	20.3°C	13.6°C	9.7°C	6.1°C	13.6 °C

Table 4. Summary of 2011 departure from normal temperature based on the 30-year normal (1981–2010) for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Lynchburg Airport	KLYH	-2.2°F	2.8°F	0.8°F	3.7°F	2.4°F	2.5°F	3.2°F	2.0°F	1.4°F	-0.6°F	2.3°F	5.2°F	2.0°F
		-1.2°C	1.6°C	0.4°C	2.1°C	1.3°C	1.4°C	1.8°C	1.1°C	0.8°C	-0.3°C	1.3°C	2.9°C	1.1°C
Roanoke Airport	KROA	-1.9°F	3.6°F	0.2°F	3.4°F	1.4°F	2.9°F	3.5°F	2.4°F	0.7°F	-0.8°F	2.4°F	4.9°F	1.9°F
		-1.1°C	2.0°C	0.1°C	1.9°C	0.8°C	1.6°C	1.9°C	1.3°C	0.4°C	-0.4°C	1.3°C	2.7°C	1.1°C
Rocky Mt ¹	RYMV2	-2.2°F	1.8°F	1.0°F	3.8°F	1.8°F	3.4°F	3.2°F	1.8°F	0.9°F	-0.4°F	1.8°F	4.0°F	1.7°F
		-1.2°C	1.0°C	0.6°C	2.1°C	1.0°C	1.9°C	1.8°C	1.0°C	0.5°C	-0.2°C	1.0°C	2.2°C	1.0°C
Appomattox	APXV2	-1.6°F	2.6°F	0.2°F	3.1°F	1.1°F	2.3°F	3.0°F	0.8°F	0.9°F	-0.3°F	2.3°F	4.6°F	1.6°F
		-0.9°C	1.4°C	0.1°C	1.7°C	0.6°C	1.3°C	1.7°C	0.4°C	0.5°C	-0.2°C	1.3°C	2.6°C	0.9°C

¹Indicates a station's Period of Record does not cover the period of 1981-2010 but is five or more years. In these cases the departure from normal values were calculated with normals derived from data spanning the length of the station's Period of Record.

Table 5. Seasonal and annual temperature and precipitation rankings for 2011 over 117 years for the Western Piedmont (NOAA 2011).

	Climate Division 3 Rankings — Western Piedmont				
	Jan–Feb–Mar WINTER	Apr–May–Jun SPRING	Jul–Aug–Sep SUMMER	Oct–Nov–Dec AUTUMN	Jan–Dec YEAR
Temperature-2011	64	14	T-29	22	T-25
Precipitation-2011	90	45	50	17	36

1 = warmest/wettest year and 117 = coldest/driest year. T = Tie between two years.

Appomattox Court House National Historical Park
and Booker T. Washington National Monument
Departure from Average Monthly Maximum Temperature
2011 vs. 1981–2010

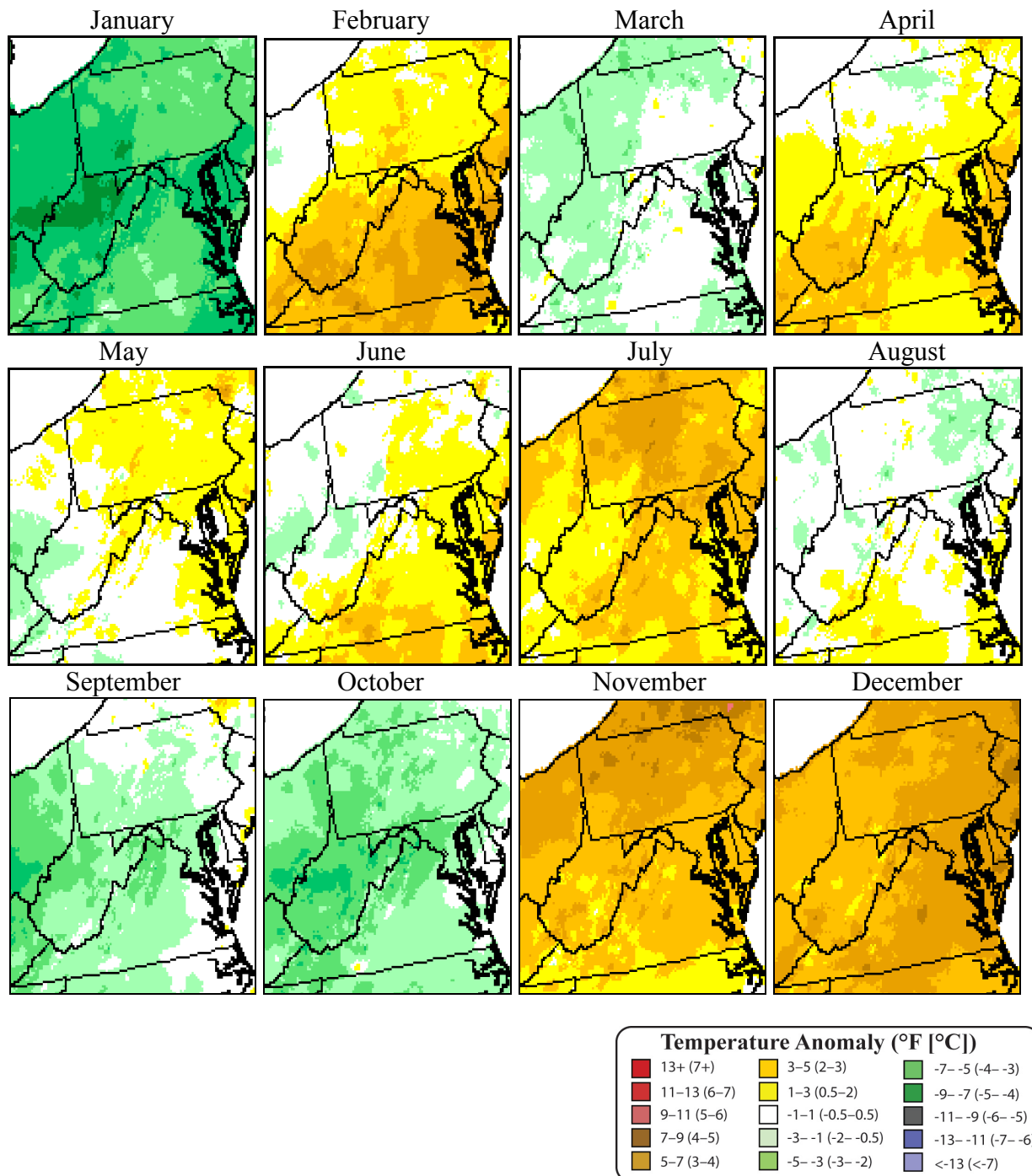


Figure 2. Maps showing departure from average monthly maximum temperature compared to the 30-year normal (1981–2010).

Appomattox Court House National Historical Park
and Booker T. Washington National Monument
Departure from Average Monthly Minimum Temperature
2011 vs. 1981–2010

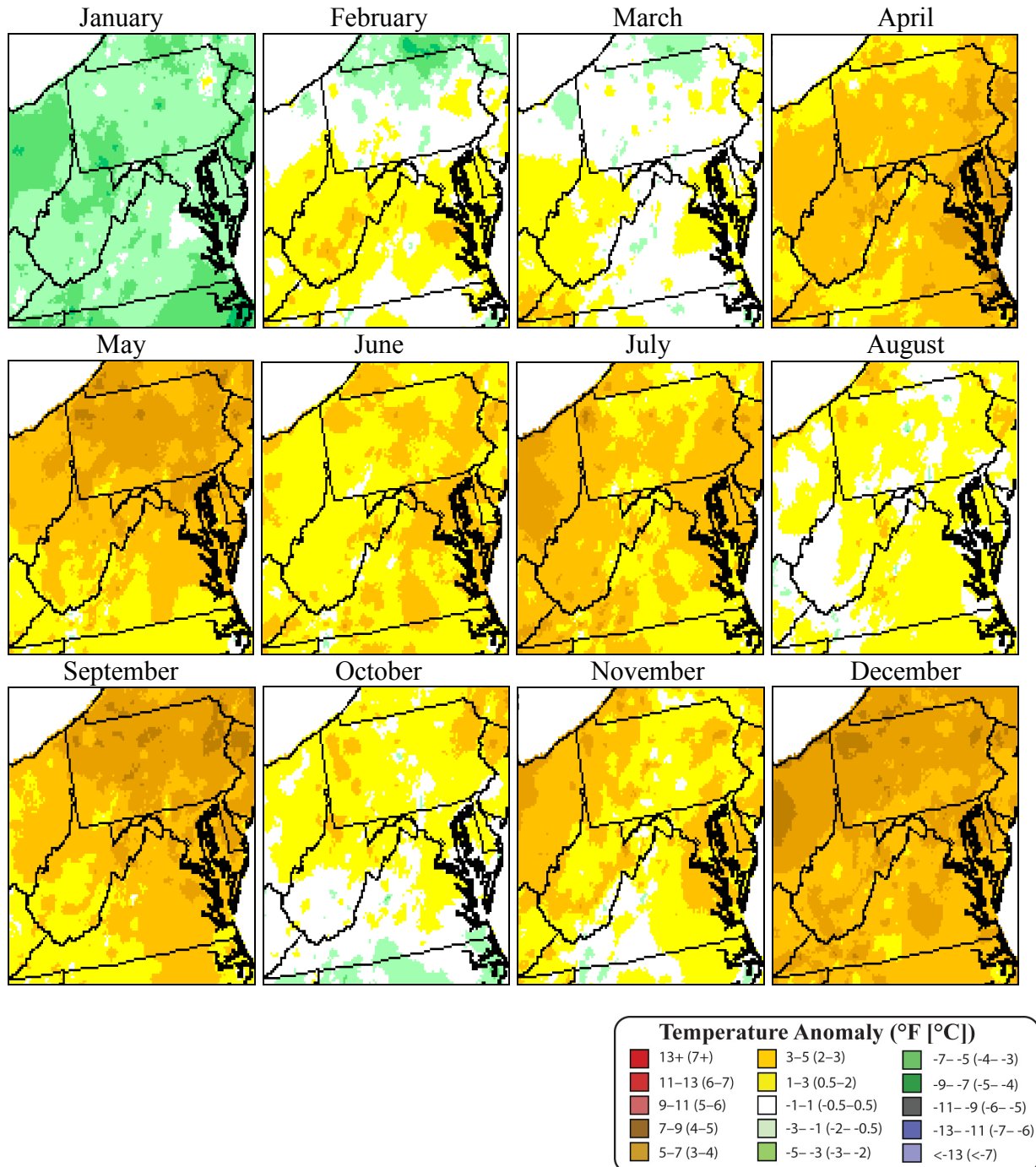


Figure 3. Maps showing departure from average monthly minimum temperature compared to the 30-year normal (1981–2010).

Precipitation Summary

The year began with a very dry month at Appomattox Court House NHP and Booker T. Washington NM. Oddly, the seasons alternated with a dry winter, wet spring, moist summer, and a very wet autumn (Table 5). Annual precipitation ranged from 3.7 in (96 mm) above normal precipitation, or about an average month of rain and snow at Roanoke, to 5.9 in (150 mm) below normal at Huddleston (Table 6). The number of heavy precipitation days was the same or slightly above the long-term average at three of the four stations (Table 6).

January was noted by little precipitation: a total of 0.80 in (20 mm) fell the entire month at Roanoke (Tables 7 and 8). It was dry also in February with no measurable precipitation during February 7-21st, followed by a wetter March (Figure 4). Precipitation in February was measured at 41-76 percent of normal (Tables 8 and 9). March brought closer to average precipitation, as 2.7 in (69 mm) was tallied at Lynchburg and 6.0 in (152 mm) was measured at Rocky Mt. (Table 8). Overall, the winter months (January, February and March) were the 27th driest in the Western Piedmont since 1895 (Table 5).

The spring months of April, May and June were significantly wetter, aided by an anomalously moist April, with 6.6 in (168 mm) in Rocky Mt., 175 percent of normal precipitation for the month (Tables 8 and 9). A long dry spell was noted from May 29 to June 9 during which no measurable precipitation was reported (Table 7). Overall, the spring in the Western Piedmont ranked as the 45th wettest in 117 years of records (Table 5).

Summer rainfall varied across the region, as evidenced by the range of precipitation during July. This month brought only 0.9 in (23 mm) at Huddleston and an overabundance of 11.0 in (279 mm) at Rocky Mt. (Table 8). There were indirect effects from Hurricane Irene in late August and the direct effects of tropical storm Lee in early September. Overall, this season averaged on the wet side, and ranked as the 50th wettest in 117 years for the Western Piedmont (Table 5). Four of the five notably wet days occurred during this season with 4.1 in (104 mm) on July 26, 2.40 in (61 mm) the day before on July 25, 2.52 in (64 mm) on September 6 and 1.97 in (50 mm) on September 24 (Table 7).

The last quarter of the year was notably wet. October had relatively uniform precipitation totals ranging from 95 to 140 percent of normal (Table 9). November and December had increasingly higher amounts at the majority of weather stations (Table 9). The autumn precipitation totals were around 120 percent of the 1981–2010 normal amounts (Table 6). Snowfall was well below normal, with most stations measuring less than 2 in (5 cm), compared with long-term averages of 12 in (30 cm) (Table 6; several stations had missing snow data). Much of the snow for 2011 fell in January and the number of snowy days at Lynchburg was half the normal (Table 6).

Appomattox Court House National Historical Park
and Booker T. Washington National Monument
Percent of Average Monthly Precipitation
2011 vs. 1981–2010

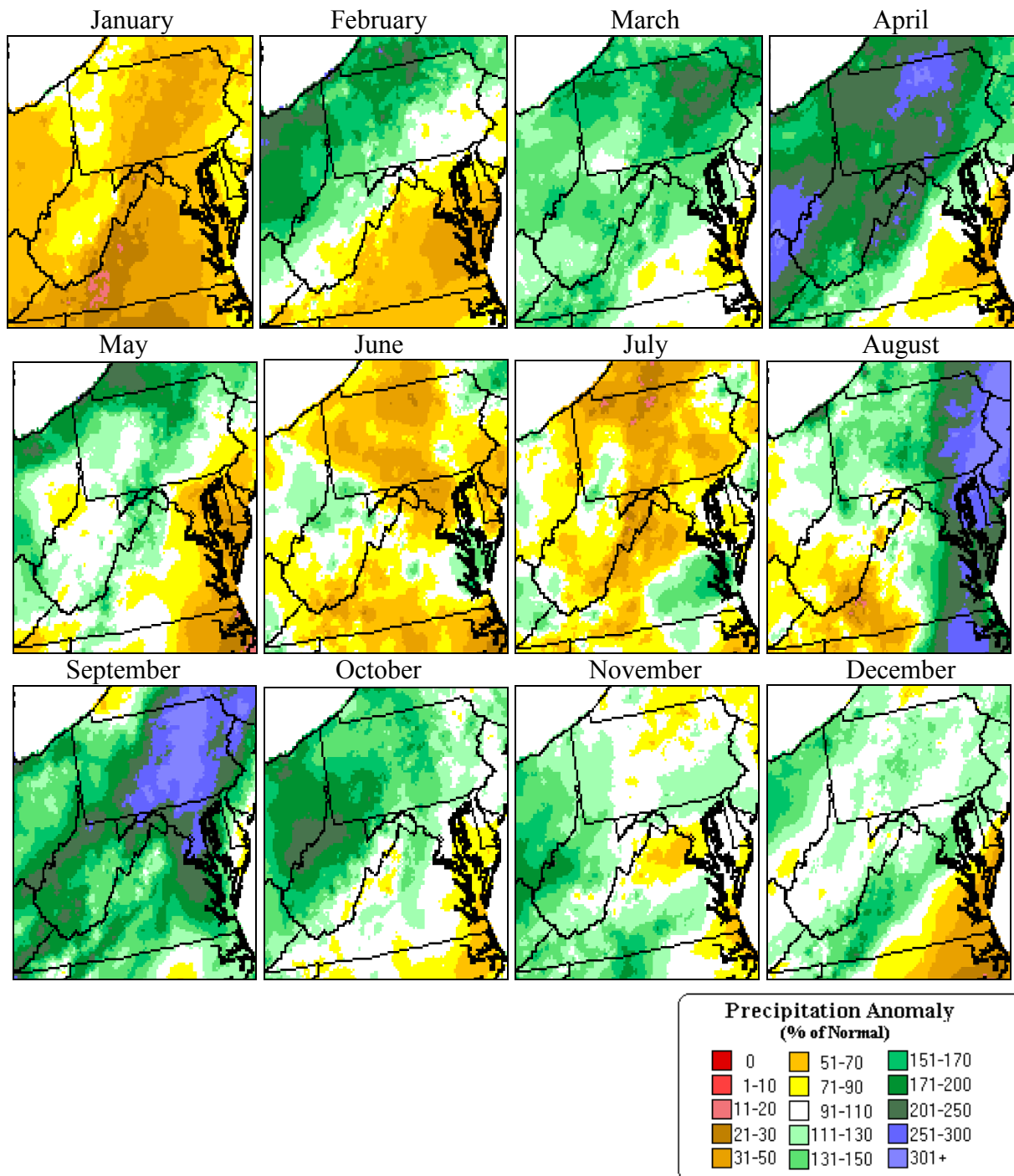


Figure 4. Maps showing percent of average monthly precipitation compared to the 30-year normal (1981–2010).

Table 6. Status of 2011 precipitation indicators compared to the 30-year normal (1981–2010) at the Lynchburg Airport (KLYH), Roanoke Airport (KROA), Appomattox (APXV2), and Huddleston 4 SW (HUDV2) weather observing stations.

Precipitation Indicator	Lynchburg Airport 2011	Lynchburg Airport 1981–2010	Roanoke Airport 2011	Roanoke Airport 1981–2010	Appomattox 2011	Appomattox 1981–2010	Huddleston 4 SW 2011	Huddleston 4 SW 1981–2010
Annual Precipitation	39.0 in 991 mm	41.6 in 1,057 mm	45.0 in 1,143 mm	41.3 in 1,049 mm	44.6 in 1,133 mm	46.6 in 1,184 mm	36.6 in 930mm	42.5 in 1,080 mm
Autumn (Oct, Nov, Dec) Precipitation	10.8 in 274 mm	9.8 in 249 mm	12.6 in 320 mm	9.2 in 234 mm	12.2 in 310mm	11.2 in 284 mm	12.8 in 325 mm	10.3 in 262 mm
Heavy Precipitation Days (days with ≥ 1.0 in (25 mm) rain)	10	10	11	10	15	13	7	11
Extreme Precipitation Days (days with ≥ 2.0 in (51 mm) rain)	0	1	1	2	0	1	0	2
Micro-drought (strings of 7+ days without rain)	4	7	3	5	7	11	6	10
Annual Snowfall	2.1 in 5.3 cm	16.2 in 41.1 cm	3.2 in 8.1 cm	18.5 in 47.0 cm	1.5in ¹ 3.8 cm ¹	8.5 in 21.6 cm	0.1 in ² 0.3 cm ²	2.0 in 5.1 cm
Measurable Snow Days (days with ≥ 0.1 in (0.3 cm) snow)	4	8	7	9	2 ¹	3	1 ²	1
Moderate Snow Days (days with ≥ 3.0 in (7.6 cm) snow)	0	2	0	2	0 ¹	1	0 ²	0
Heavy Snow Days (days with ≥ 5.0 in (12.7 cm) snow)	0	1	0	1	0 ¹	1	0 ²	0

¹Appomattox had 105 days with missing snowfall data in 2011, thus annual snowfall data will reflect this.

²Huddleston 4 SW had 188 days with missing snowfall data in 2011, thus annual snowfall data will reflect this.

Table 7. Top five wettest days and top five dry spells (consecutive days with a trace or less of liquid precipitation) during 2011 from weather observing stations at Lynchburg (KLYH), Roanoke (KROA), Rocky Mt (RYMV2), Appomattox (APXV2) and Huddleston (HUDV2).

Wettest Days in 2011	Dry Spells in 2011
Jul. 26: 4.10 in (104 mm)	Jul. 10–25
Sep. 6: 2.52 in (64 mm) ¹	Feb. 7–21
Jul. 25: 2.40 in (61 mm)	Sep. 8–20
Sep. 24: 1.97 in (50 mm)	May 29–Jun. 9
Apr 16: 1.95 in (50 mm)	Nov. 6–15

¹ Tropical Storm Lee

Table 8. Summary of 2011 monthly total precipitation for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Lynchburg Airport	KLYH	1.3 in	2.1 in	2.7 in	5.4 in	3.3 in	3.8 in	3.0 in	2.1 in	4.5 in	3.0 in	3.3 in	4.6 in	39.1 in
		33 mm	53 mm	69 mm	137 mm	84 mm	97 mm	76 mm	53 mm	114 mm	76 mm	84 mm	117 mm	993 mm
Roanoke Airport	KROA	0.8 in	2.2 in	4.2 in	5.3 in	3.8 in	3.5 in	3.8 in	1.5 in	7.4 in	4.1 in	4.3 in	4.2 in	45.1 in
		20 mm	56 mm	107 mm	135 mm	97 mm	89 mm	97 mm	38 mm	188 mm	104 mm	109 mm	107 mm	1,147 mm
Rocky Mt	RYMV2	1.1 in	1.4 in	6.0 in	6.6 in	4.9 in	1.4 in	11.0 in	1.6 in	7.1 in	4.1 in	6.0 in	6.3 in	57.5 in
		28 mm	36 mm	152 mm	168 mm	124 mm	36 mm	279 mm	41 mm	180 mm	104 mm	152 mm	160 mm	1,460 mm
Appomattox	APXV2	1.2 in	1.4 in	4.2 in	4.0 in	3.9 in	2.6 in	4.0 in	5.7 in	5.4 in	3.7 in	3.5 in	5.0 in	44.6 in
		30 mm	36 mm	107 mm	102 mm	99 mm	66 mm	102 mm	145 mm	137 mm	94 mm	89 mm	127 mm	1,134 mm
Huddleston 4 SW	HUDV2	1.0 in	1.2 in	4.4 in	4.2 in	3.2 in	1.9 in	0.9 in	1.9 in	5.2 in	4.5 in	3.7 in	4.6 in	36.7 in
		25 mm	30 mm	112 mm	107 mm	81 mm	48 mm	23 mm	48 mm	132 mm	114 mm	94 mm	117 mm	931 mm

M = missing data (Monthly statistics are reported as 'M' if more than 4 days of data are missing).

Table 9. Summary of 2011 percent of normal precipitation based on the 30-year normal (1981–2010) for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Lynchburg Airport	KLYH	41	72	75	162	89	105	69	63	116	95	96	142	94
Roanoke Airport	KROA	28	76	122	158	93	92	93	41	190	140	126	143	109
Rocky Mt ¹	RYMV2	34	44	140	175	121	31	225	38	154	130	167	179	120
Appomattox	APXV2	37	46	105	117	82	67	83	143	125	99	88	146	95
Huddleston 4 SW	HUDV2	29	41	118	127	88	53	24	53	126	131	102	141	86

¹Indicates a station's Period of Record does not cover the period of 1981-2010 but is five years or more. In these cases the departure from normal values were calculated with normals derived from data spanning the length of the station's Period of Record.

Drought Status

There are a number of drought indices used to estimate the severity of drought in an area using algorithms that incorporate recent temperatures, rainfall, soil moisture, and other information (<http://www.drought.gov>). The main indices we report are the Palmer Drought Severity Index (PDSI) and the United States Drought Monitor (DM) – Drought Intensity Index. While both indices provide excellent summary information on broad-scale conditions, local conditions (such as at the park scale) may vary.

The PDSI is a soil moisture algorithm calibrated for relatively homogeneous regions and is calculated on a monthly basis using precipitation and temperature data, as well as the water content of the soil. The values vary between extremely moist (>4.0) and extreme drought (<-4.0) with “normal” values ranging between -1.9 and 1.9 . The long-term average is “zero”. Monthly PDSI values for the Western Piedmont in 2011 are shown in Figure 5.

The DM – Drought Intensity Index is a synthesis of multiple indices (including the PDSI) and impacts, which represents a consensus of federal and academic scientists (NIDIS 2011). The DM produces a summary map of drought intensity for the nation and all states each week. It is on a scale ranging from abnormally dry (D0) to exceptional drought (D4). Mid-month (i.e., the second or third week) values for Virginia (Figure 6) and the Southeast (Figure 7) are shown for 2011.

According to the PDSI, 2011 in the Western Piedmont started with near normal to moderate drought conditions, with wetter conditions returning during spring. Dry weather returned in the early summer and persisted until September (Figure 5). The wet conditions at the end of September into December restored the PDSI to positive values. However, only February was sufficiently dry to send the PDSI outside the normally dry levels. Compared with the previous two years, 2011 was more similar to 2009 during the colder seasons. The PDSI value was only above /below ± 2 for one month, unlike four months in 2010.

The DM – Drought Severity Index for Virginia (Figure 6) and the Southeast (Figure 7) shows a pattern similar to the PDSI for the growing season (May through October); abnormally dry (D0) in some of July and August in the Western Piedmont.

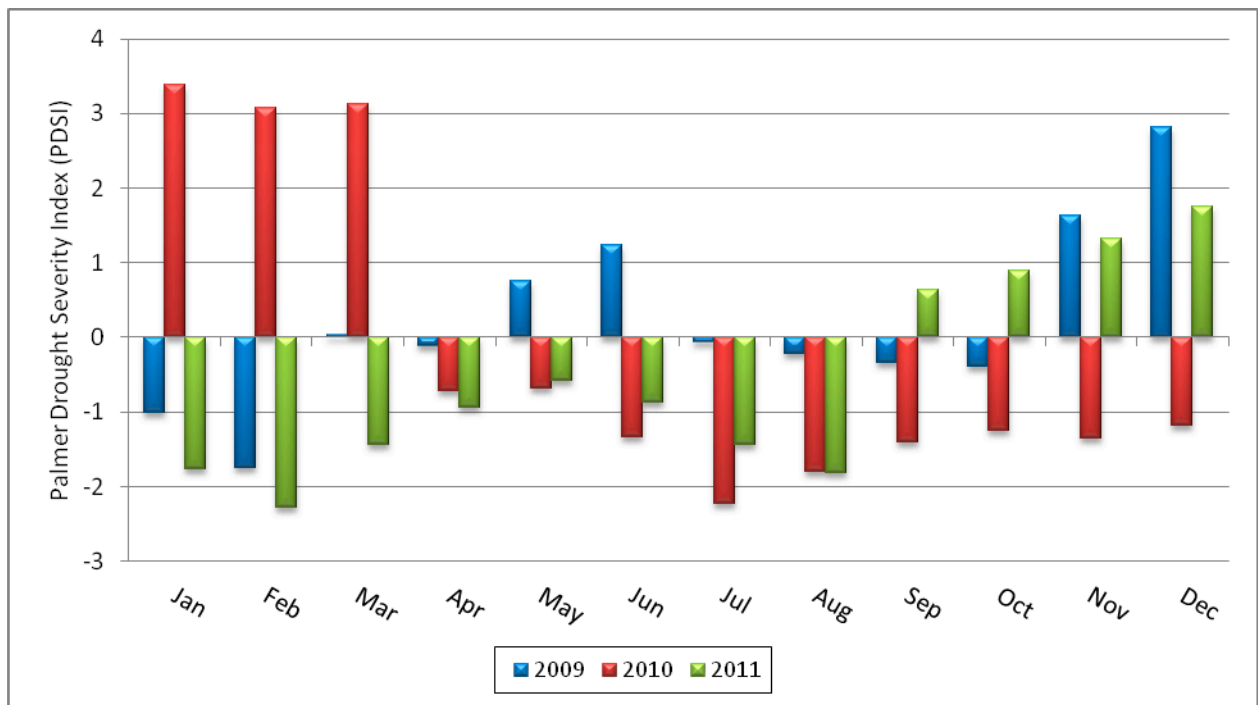


Figure 5. Palmer Drought Severity Index (PDSI) for the Western Piedmont, 2009–2011.

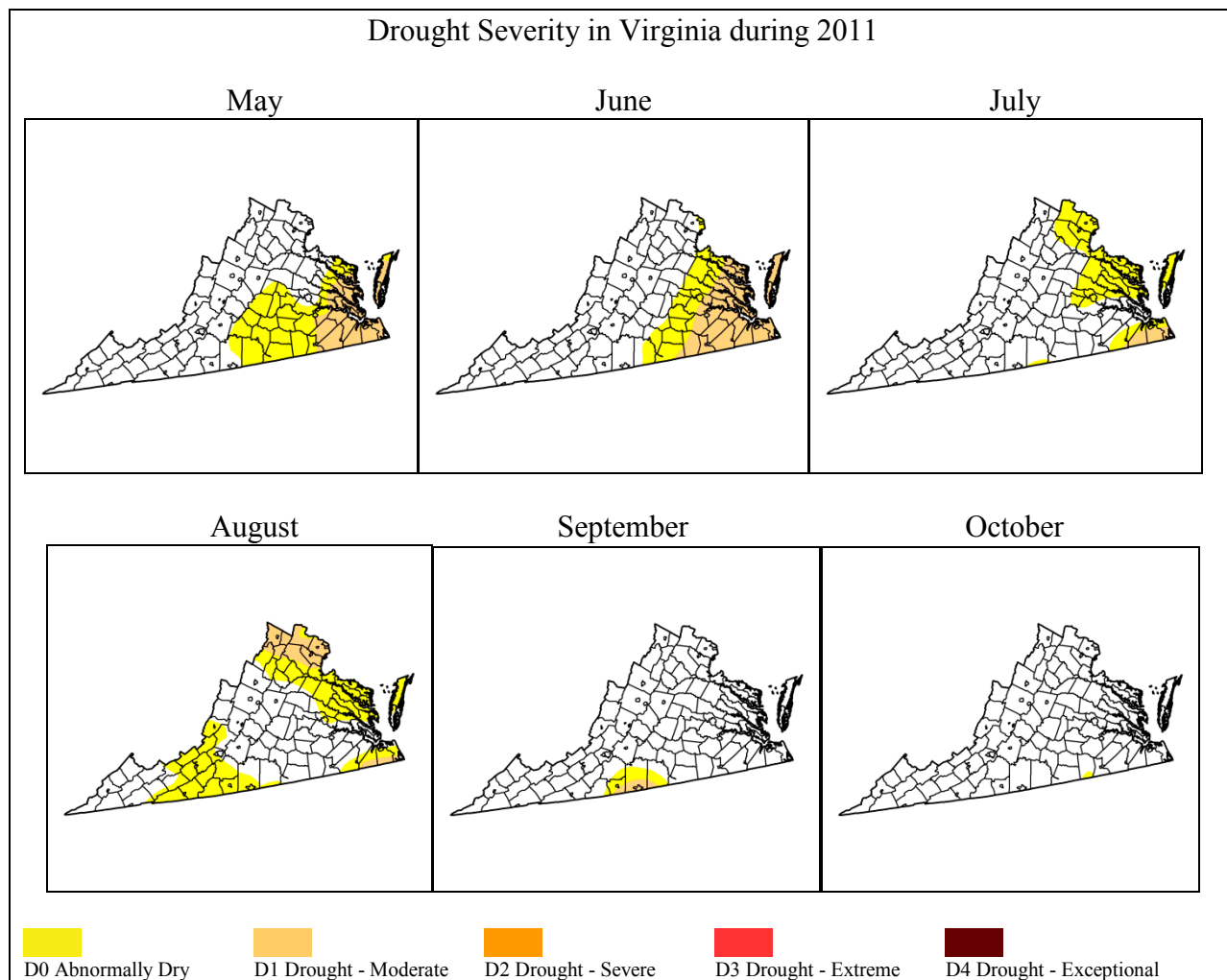


Figure 6. Mid-month values of the United States Drought Monitor (DM) – Drought Intensity Index for Virginia in 2011.

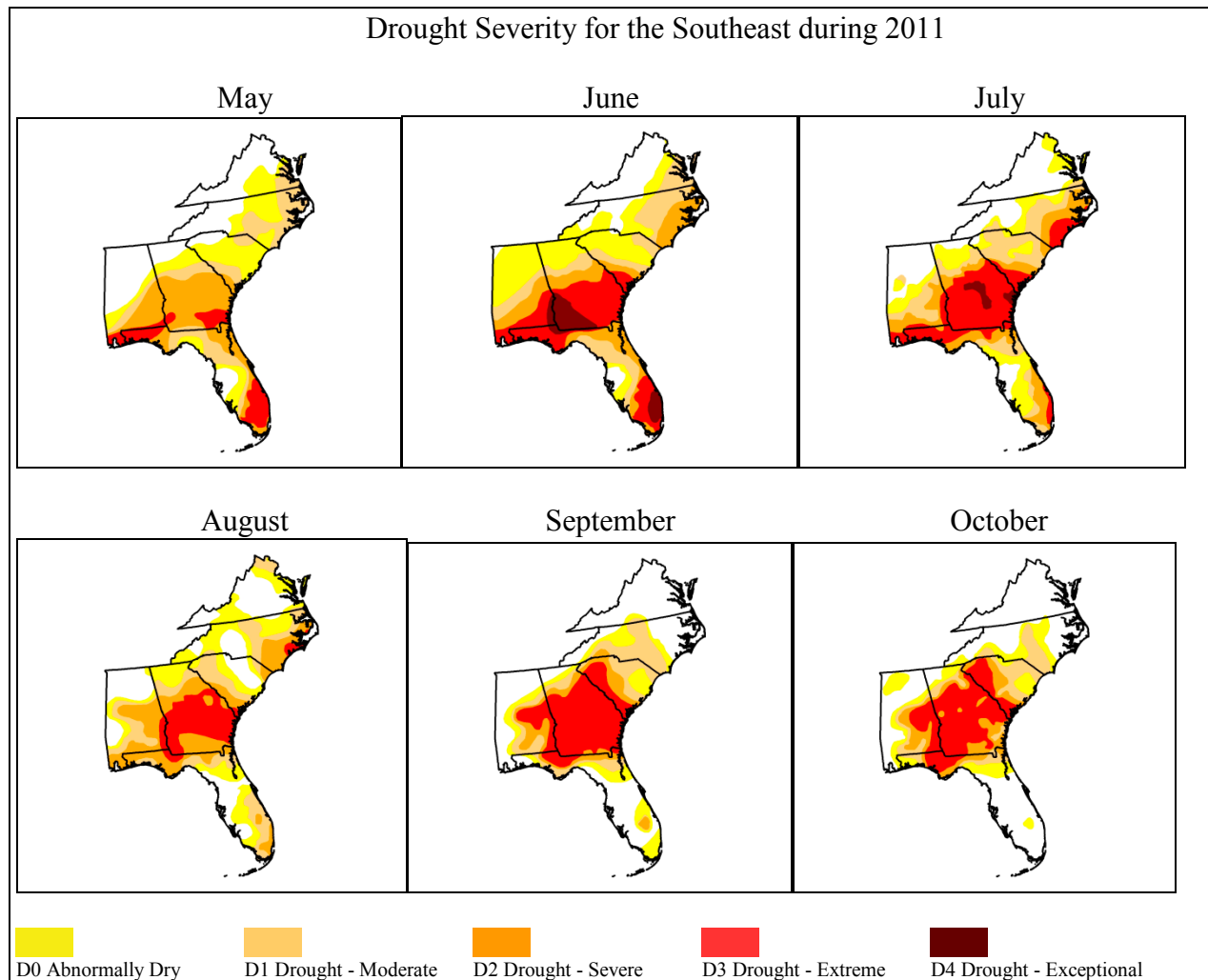


Figure 7. Mid-month values of the United States Drought Monitor (DM) – Drought Intensity Index for the Southeast in 2011.

References

- Comiskey, J. A., and K. K. Callahan. 2008. Mid-Atlantic Network vital signs monitoring plan. Natural Resource Report NPS/MIDN/NRR—2008/071. National Park Service, Fort Collins, CO.
- Daly, C., W. P. Gibson, G. H. Taylor, G. L. Johnson, and P. Pasteris. 2002. A knowledge-based approach to the statistical mapping of climate. *Climate Research* 22:99–113.
- Davey, C. A., K. T. Redmond, and D. B. Simeral. 2006. Weather and Climate Inventory, National Park Service, Mid-Atlantic Network. Natural Resource Technical Report NPS/MIDN/NRTR—2006/013. National Park Service, Fort Collins, Colorado.
- Gawtry, S., and J. Stenger. 2007. Climate Summary, Shenandoah National Park. Natural Resources Report NPS/NER/NRR—2007/017. National Park Service, Philadelphia, PA.
- Kocin, P. J., and L. W. Uccellini. 2004. Northeast Snowstorms Volume 1: Overview. Meteorological Monographs. Vol 32. No 54. American Meteorological Society. Boston, MA.
- Marshall, M., P. Knight, and J. Comiskey. 2012. Weather and climate monitoring protocol: Eastern Rivers and Mountains Network and Mid-Atlantic Network. Natural Resource Report NPS/ERMN-MIDN/NRR—2012/498. National Park Service, Fort Collins, Colorado.
- National Assessment Synthesis Team. 2001. Climate Change Impacts on United States: The Potential Consequences of Climate Variability and Change. Report for the U.S. Global Change Research Program. Cambridge University Press, Cambridge, UK.
- National Oceanic and Atmospheric Administration (NOAA). 2011. National Climatic Data Center. Climate of 2011 – Annual Review, Global and U.S. Summary. <http://lwf.ncdc.noaa.gov/oa/climate/research/2011/ann/us-summary.html>.
- National Integrated Drought Information System (NIDIS). 2011. National Climate Data Center and United States Department of Agriculture. <http://drought.unl.edu/dm/archive.html>.

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