



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

Mid-Atlantic Network Summary Report for 2015

Natural Resource Report NPS/MIDN/NRR—2016/1321



ON THE COVER

Photograph of the Jones Law Office in Appomattox Court House National Historical Park.
Photograph courtesy of the National Park Service.

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

Mid-Atlantic Network Summary Report for 2015

Natural Resource Report NPS/MIDN/NRR—2016/1321

Kyle Imhoff and Arthur Person

Pennsylvania State Climate Office
503 Walker Building
Pennsylvania State University
University Park, Pennsylvania

October 2016

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are 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 Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

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.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the Mid-Atlantic Network website (<http://science.nature.nps.gov/im/units/MIDN>), and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

Please cite this publication as:

Imhoff, K., and A. Person. 2016. Weather of Appomattox Court House National Historical Park and Booker T. Washington National Monument: Mid-Atlantic Network summary report for 2015. Natural Resource Report NPS/MIDN/NRR—2016/1321. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	iv
Tables.....	v
Abstract.....	vi
List of Key Acronyms.....	vii
Introduction.....	1
Climate of the Western Piedmont Region of Virginia.....	2
Observing Stations and Climate Indicators.....	3
Temperature Summary.....	8
Precipitation Summary.....	14
Drought Status	18
References.....	21

Figures

	Page
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 2015.	5
Figure 2. Maps showing departure from average monthly maximum temperature in 2015 compared to the 30-year normal (1981–2010).....	12
Figure 3. Maps showing departure from average monthly minimum temperature in 2015 compared to the 30-year normal (1981–2010).....	13
Figure 4. Maps showing percent of average monthly precipitation in 2015 compared to the 30-year normal (1981–2010).....	15
Figure 5. Monthly Palmer Drought Severity Index (PDSI) for the Western Piedmont, 2013–2015.....	18
Figure 6. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for Virginia in 2015.	19
Figure 7. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for the Southeast in 2015.	20

Tables

	Page
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 2015.	6
Table 2. Status of 2015 temperature indicators compared to the 30-year normal (1981–2010) at the Lynchburg Airport (KLYH), Roanoke Airport (KROA), and Appomattox (APXV2) weather observing stations.	9
Table 3. Summary of 2015 departure from normal temperature based on the 30-year normal (1981–2010) for selected stations.....	10
Table 4. Summary of 2015 monthly average temperatures for selected stations.....	10
Table 5. Seasonal and annual temperature and precipitation rankings for 2015 over 121 years for the Western Piedmont (NOAA 2015).....	11
Table 6. Summary of 2015 percent of normal precipitation based on the 30-year normal (1981–2010) for selected stations.	16
Table 7. Status of 2015 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.	16
Table 8. Summary of 2015 monthly total precipitation for selected stations.....	17
Table 9. Top five wettest days and top five dry spells (consecutive days with a trace or less of liquid precipitation) during 2015 from weather observing stations at Lynchburg (KLYH), Roanoke (KROA), Rocky Mt (RYMV2), Appomattox (APXV2) and Huddleston (HUDV2).....	17

Abstract

The Mid-Atlantic Network (MIDN) weather and climate monitoring protocol supports the documentation of current status and long-term trends in air temperature and precipitation at multiple temporal and spatial scales in MIDN parks. The purpose of this report is to provide a concise weather and climate summary for Appomattox Court House National Historical Park (APCO) and Booker T. Washington National Monument (BOWA) for the time period of January 1 to December 31, 2015. APCO and BOWA are located in the Western Piedmont climate division of Virginia. In 2015, a total of five weather stations were selected to report park weather and climate conditions, and a large suite of precipitation and temperature metrics were summarized. Ultimately, 2015 was a very warm year and ranked as the 10th warmest on record for the Western Piedmont. In fact, the autumn of 2015 was the warmest autumn since 1895. The year was also very wet, being the 15th wettest on record. No drought conditions were reported during 2015.

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, 2015, and to place current patterns and trends in an appropriate historical and regional 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 2015's climate summary.

In addition to a suite of summary tables, graphs, and narratives, we specifically identify a series of key weather indicators to report climate status on an annual basis and climate trends periodically in separate and more thorough reports (for the most recent trend report, see Knight et al. 2016). These key indicators are further described in the protocol (Marshall et al. 2012) and are 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 (NM) 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/usclimdivs/data/map.html>). Virginia is divided into six climate divisions. The Western Piedmont 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 Western Piedmont. 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), though 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 and Climate Indicators

A total of five weather observing stations comprising two weather observing networks were selected as the most representative weather stations around Appomattox Court House NHP and Booker T. Washington NM (Figure 1). 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 2015 report: Lynchburg, Roanoke, Rocky Mt., Appomattox, and Huddleston (Figure 1, Table 1).

The following are the climate indicators selected for each of the parks:

- Average Annual Mean Temperature – A measure of the composite mean temperature (averaging the maximum and minimum on a daily basis) for an entire year
- Average Annual Maximum Temperature – A measure of the average of the daily maximum temperature for an entire year
- Highest Annual Maximum Temperature – A measure of the individual highest maximum temperature each year
- Annual Number of Hot Days (maximum temperature equal to or exceeding 90°F (32°C)) – A measure of warm season heat using a threshold of days with a 90°F (32°C) maxima
- Average Annual Minimum Temperature – A measure of the average of the daily minimum temperature for an entire year
- Lowest Annual Minimum Temperature – A measure of the individual lowest minimum temperature each year
- Annual Number of Cold Days (maximum temperature less than or equal to 32°F (0°C)) – A measure of cold season chill using a threshold of days with a 32°F (0°C) maxima
- Annual Number of Subfreezing Days (minimum temperature less than or equal to 32°F (0°C)) – A measure of cold season chill using a threshold of days with a 32°F (0°C) minima
- Annual Number of Subzero Days (minimum temperature less than or equal to 0°F (-17.8°C)) – A measure of cold season chill using a threshold of days with a 0°F (-17.8°C) minima
- Growing Season Length (number of days between last freeze in spring and first freeze in fall) – A measure of the local growing season as tallied by the total number of days between the last 32°F (0°C) in the spring and the first 32°F (0°C) in the fall
- Annual Precipitation – A measure of total liquid (and its equivalent melted snow) for all days

- Autumn Precipitation (October 1 – December 31) - The three month total precipitation including rain and melted snow
- Annual Number of Heavy Precipitation Days (liquid equal to or greater than 1.0 in (25mm) – A measure of the frequency of heavy precipitation events during each year
- Annual Number of Extreme Precipitation Days (liquid equal to or greater than 2.0 in (50mm)) – A measure of frequency of extreme precipitation events during each year
- Annual Number of Micro-droughts – A measure of micro-droughts for the year as the number of periods of 7+ days without rain
- Annual Snowfall – A measure of total solid precipitation (includes sleet and hail; does not include freezing rain)
- Annual Number of Measureable Snow Days – A measure of the severity of winter precipitation as the number of days receiving more than or equal to 0.1 in (0.3 cm) of solid precipitation (includes sleet and hail; does not include freezing rain)
- Annual Number of Moderate Snow Days– A measure of the severity of winter precipitation as the number of days receiving more than or equal to 3 in (7.6 cm) of solid precipitation (includes sleet and hail; does not include freezing rain)
- Annual Number of Heavy Snow Days– A measure of the severity of winter precipitation as the number of days receiving more than or equal to 5 in (12.7 cm) of solid precipitation (includes sleet and hail; does not include freezing rain)

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 2015) 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 are 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 is the 30-year normal or the pseudo-normal calculated on a shorter time frame.

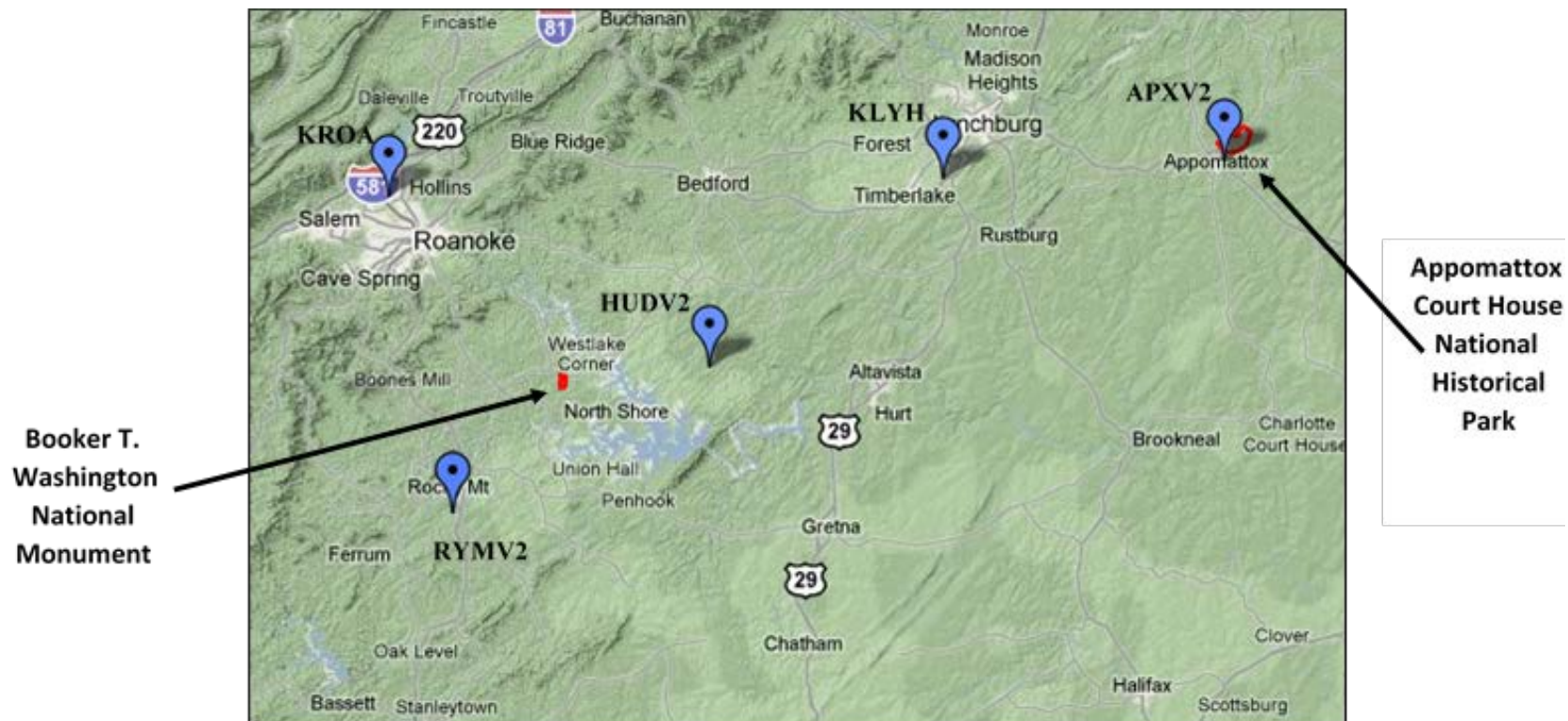


Figure 1. Location of weather observing stations around Appomattox Court House National Historical Park and Booker T. Washington National Monument selected as most representative of the parks in 2015. See Table 1 for station names.

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 2015.

Station	Observing Network ¹	Station Name	Period of Record (POR)		Percentage of Time Reporting Temperature for 2015	Percentage of Time Reporting Precipitation for 2015	Percentage of Time Reporting Temperature for entire POR ²	Percentage of Time Reporting Precipitation for entire POR
KLYH	ASOS	Lynchburg Regional Airport/Preston Glenn Field	02/01/1945	Present	100.0	100.0	96.3	96.3
KROA	ASOS	Roanoke Regional Airport/Woodrum Field	02/01/1948	Present	100.0	100.0	96.0	96.0
RYMV2	COOP	Rocky Mt.	01/01/1951	Present	100.0	100.0	94.6	94.5
APXV2	COOP	Appomattox	11/01/1937	Present	100.0	100.0	94.6	96.0
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.

All five stations have a Period of Record (POR) sufficiently long for a 30-year normal (normals calculated from years 1981–2010); however, Huddleston lacks temperature data. 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/NPS/interface.php>.

Temperature Summary

Average annual temperatures in 2015 were near, to slightly above, the 30-year normal for the area around Appomattox Court House NHP and Booker T. Washington NM (Table 2). Mean temperatures for the year were between 1.1°F (0.6°C) to 2.1°F (1.2°C) above normal (Tables 2 and 3; Figures 2 and 3)¹.

The winter months of January through March were cooler than normal for all observing stations, with February having the largest departures from normal. Average temperatures in February were 28.8°F (-1.8°C) at Lynchburg Airport, which is 9.4°F (5.2°C) below the 30-year normal (Tables 3 and 4). The lowest readings of the year occurred on February 20th, when temperatures dropped to between -11°F (-23.9°C) and 0°F (-17.8°C) across the observing stations (Table 2). As a result of the persistent chill, the winter tied as the 21st coolest in 121 years for the Western Piedmont.

Spring was much warmer than normal, with May having the most pronounced positive temperature anomalies (Table 3). May's departure from normal reached 5.1°F (2.8°C) at Appomattox (Table 3). Overall, the very mild weather resulted in the spring season ranking as the 3rd warmest on record for the Western Piedmont (Table 5).

The summer months, as a whole, was seasonal across Appomattox Court House NHP and Booker T. Washington NM. The season was bookended by slightly milder than normal temperatures in July and September, with August near to slightly below normal (Tables 3 and 4). The largest departure from normal was +2.6°F (+1.5°C) at Appomattox during the month of September. While the summer months were slightly milder than normal, the number of hot days for the year and average annual maximum temperatures were near-normal for most stations (Table 2). The summer of 2015 tied as the 36th warmest in the last 121 years for the Western Piedmont (Table 5).

With the exception of seasonal temperatures in October, the remainder of the autumn months was exceptionally warm across all observing stations (Tables 3 and 4). In fact, the month of December was the warmest in 121 years of records for the Western Piedmont climate division. December's positive departures from normal ranged from 10.9°F (6.1°C) at Roanoke to 11.5°F (6.4°C) at Lynchburg (Table 3). As a result of the exceptionally warm December, the entire autumn season was also the warmest on record for the Western Piedmont (Table 5). The length of the growing season was, on average, just a few days shorter than normal when compared to the 1981–2010 average (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 2015 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 2015	Lynchburg Airport 1981–2010	Roanoke Airport 2015	Roanoke Airport 1981–2010	Appomattox 2015	Appomattox 1981–2010
Average Annual Temperature	56.6°F 13.7°C	55.6°F 13.1°C	58.1°F 14.5°C	57.0°F 13.9°C	57.3°F 14.1°C	56.0°F 13.3°C
Average Annual Maximum Temperature	66.9°F 19.4°C	67.1°F 19.5°C	68.0°F 20.0°C	67.3°F 19.6°C	67.4°F 19.7°C	67.4°F 19.7°C
Maximum Temperature	92.0°F 33.3°C	95.9°F 35.5°C	94.0°F 34.4°C	96.7°F 35.9°C	94.0°F 34.4°C	96.0°F 35.6°C
Hot Days (days with Tmax≥90°F/32°C)	16	22	23	25	25	23
Average Annual Minimum Temperature	45.8°F 7.7°C	44.1°F 6.7°C	48.2°F 9.0°C	46.6°F 8.1°C	47.2°F 8.4°C	44.5°F 6.9°C
Minimum Temperature	-11.0°F -23.9 °C	3.7°F -15.7°C	0.0°F -17.8°C	6.0°F -14.4°C	-6.0°F -21.1°C	4.4°F -15.3°C
Cold Days (days with Tmax≤32°F/0°C)	13	6	11	7	11	6
Sub-freezing Days (days with Tmin≤32°F/0°C)	84	99	70	78	76	95
Sub-zero Days (days with Tmin≤0°F/-18°C)	1	0	1	0	2	1
Growing Season Length (days between last spring Tmin 32°F/0°C and first fall Tmin 32°F/0°C)	195	201	196	208	201	199

Table 3. Summary of 2015 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	-1.2°F	-9.4°F	-0.8°F	0.7°F	4.1°F	2.0°F	0.0°F	-0.7°F	2.3°F	-0.8°F	4.6°F	11.5°F	1.1°F
		-0.6°C	-5.2°C	-0.4°C	0.4°C	2.3°C	1.1°C	0.0°C	-0.4°C	1.3°C	-0.4°C	2.6°C	6.4°C	0.6°C
Roanoke Airport	KROA	-0.8°F	-9.0°F	-0.1°F	0.4°F	4.3°F	2.5°F	0.7°F	0.1°F	2.1°F	-0.4°F	4.2°F	10.9°F	1.2°F
		-0.4°C	-5.0°C	-0.1°C	0.2°C	2.4°C	1.4°C	0.4°C	0.1°C	1.2°C	-0.2°C	2.3°C	6.1°C	0.7°C
Rocky Mt ¹	RYMV2	-0.6°F	-6.5°F	-0.9°F	1.7°F	4.6°F	4.0°F	1.5°F	0.8°F	2.0°F	0.6°F	4.7°F	11.0°F	2.1°F
		-0.3°C	-3.6°C	-0.5°C	0.9°C	2.6°C	2.2°C	0.8°C	0.4°C	1.1°C	0.3°C	2.6°C	6.1°C	1.2°C
Appomattox	APXV2	-0.6°F	-9.3°F	-0.9°F	1.7°F	5.1°F	2.7°F	0.4°F	-0.2°F	2.6°F	0.1°F	4.5°F	11.1°F	1.4°F
		-0.3°C	5.1°C	-0.5°C	0.9°C	2.8°C	1.5°C	0.2°C	-0.1°C	1.5°C	0.1°C	2.5°C	6.1°C	0.8°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 departures from normal values were calculated with normals derived from data spanning the length of the station's Period of Record.

Table 4. Summary of 2015 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	33.9°F	28.8°F	45.1°F	56.1°F	67.2°F	73.6°F	75.3°F	73.4°F	69.3°F	55.4°F	51.4°F	49.1°F	56.6°F
		1.1°C	-1.8°C	7.3°C	13.4°C	19.6°C	23.1°C	24.1°C	23.0°C	20.7°C	13.0°C	10.8°C	9.5°C	13.7°C
Roanoke Airport	KROA	35.8°F	30.6°F	47.2°F	57.1°F	68.9°F	75.4°F	77.4°F	75.5°F	70.2°F	57.3°F	52.3°F	49.9°F	58.1°F
		2.1°C	-0.8°C	8.4°C	14.0°C	20.5°C	24.1°C	25.2°C	24.2°C	21.2°C	14.0°C	11.3°C	9.9°C	14.5°C
Rocky Mt	RYMV2	35.0°F	31.8°F	46.3°F	56.4°F	67.2°F	75.1°F	76.4°F	74.3°F	68.4°F	56.5°F	51.3°F	48.9°F	57.3°F
		1.7°C	-0.1°C	7.9°C	13.6°C	19.6°C	23.9°C	24.7°C	23.5°C	20.2°C	13.6°C	10.7°C	9.4°C	14.1°C
Appomattox	APXV2	34.5°F	29.3°F	44.8°F	57.1°F	68.4°F	74.9°F	76.3°F	74.5°F	70.2°F	56.9°F	51.7°F	49.4°F	57.3°F
		1.4°C	-1.5°C	7.1°C	13.9°C	20.2°C	23.8°C	24.6°C	23.6°C	21.2°C	13.8°C	10.9°C	9.7°C	14.1°C

Table 5. Seasonal and annual temperature and precipitation rankings for 2015 over 121 years for the Western Piedmont (NOAA 2015).

Parameter	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-2015	101-T	3	36-T	1	10
Precipitation-2015	95	44	26	6	15

1 = warmest/wettest year and 121 = coldest/driest year. T = Tie between multiple year

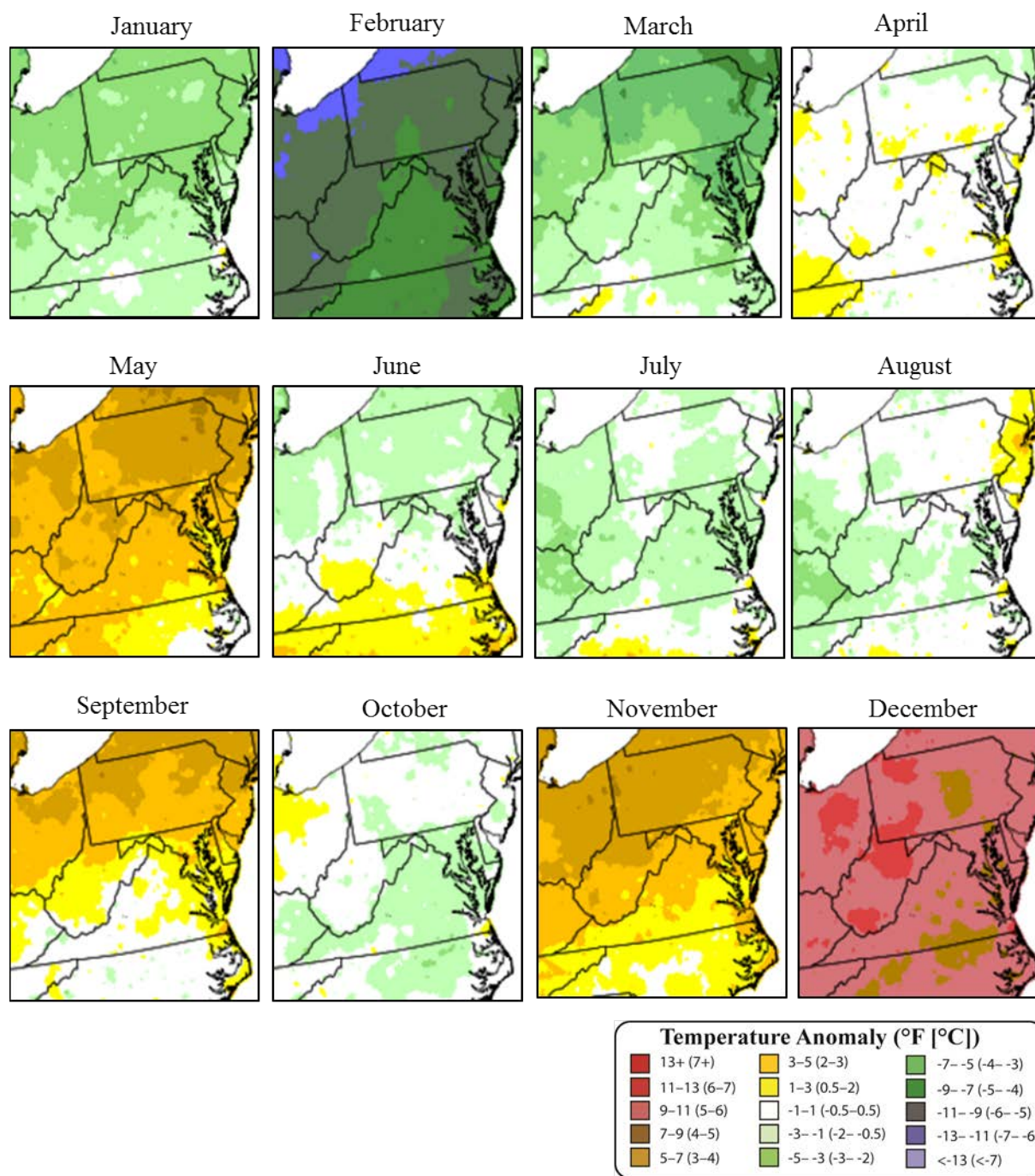


Figure 2. Maps showing departure from average monthly maximum temperature in 2015 compared to the 30-year normal (1981–2010).

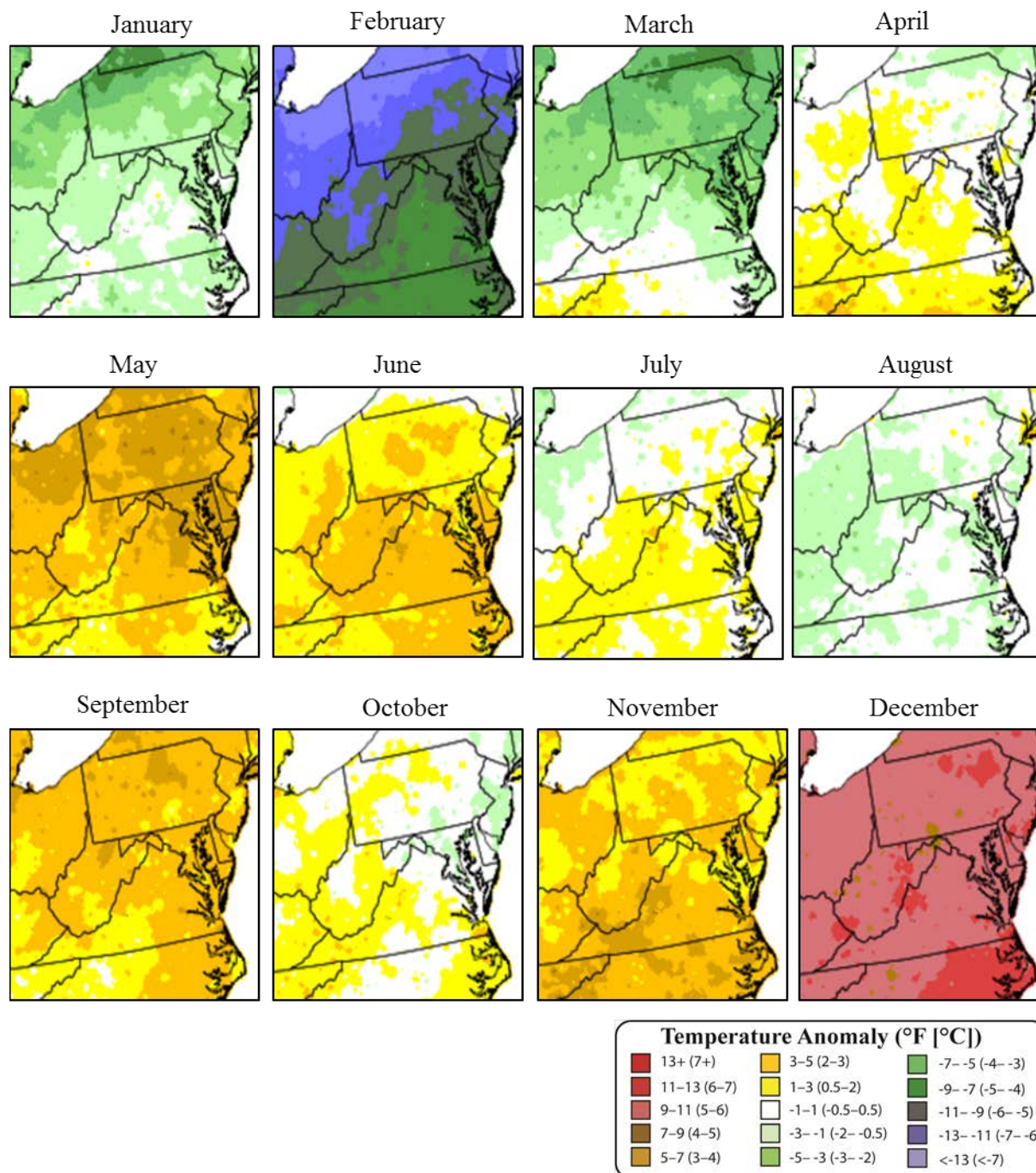


Figure 3. Maps showing departure from average monthly minimum temperature in 2015 compared to the 30-year normal (1981–2010).

Precipitation Summary

Precipitation at Appomattox Court House NHP and Booker T. Washington NM for the year varied greatly as 2015 started drier than normal and ended wetter than normal (Figure 4 and Table 6). Even with the wild swings in precipitation anomalies, annual precipitation totals were above normal across all observing stations (Tables 6 and 7). Annual precipitation ranged from 3.4 in (86 mm) above normal precipitation, or about a month's worth of rain and snow at Appomattox, to 13.3 in (338 mm), nearly a quarter of a year's precipitation, above normal at Roanoke (Table 7).

The beginning of the year was notably drier than normal, as January totals were just 45 to 67% of normal (Table 6). Precipitation totals were closer to seasonal levels for the month of February, with 2.0 in (51 mm) falling at Rocky Mt. and 3.2 in (81mm) at Appomattox (Table 8). March was, on average, the wettest month of the winter season with amounts as high as 124% of normal at Roanoke (Table 6). Overall, the winter months (January, February and March) were the 27th driest in the Western Piedmont since 1895 (Table 5).

Precipitation deficits for the first quarter of the year began to be erased during the month of April, as all stations observed above normal precipitation (Table 6). Nevertheless, dry weather returned for the month of May, with just 1.7 in (43 mm) falling at Lynchburg, less than half of their normal monthly rainfall. With the dry May, concerns of a drought over the summer began. The month of June relieved any concerns that arose, however, as precipitation tallied 5.6 in. (142 mm) to 9.4 in (239 mm) across the region (Table 8). The remnants of Tropical Storm Bill, along with a slow-moving frontal boundary, brought an extended period of wet weather to the region in the middle of June. Overall, the spring in the Western Piedmont ranked as the 44th wettest in 121 years of records (Table 5).

The first two months of the summer season, July and August, were drier than normal, on average, across the reporting stations (Tables 6 and 8). At Rocky Mt, just 1.4 in (36 mm) of rain fell in the month of August, which is less than one third of the 30-year normal total. September completely reversed the dry trend, as all stations reported above normal precipitation for the month. Huddleston measured 10.1 in (257mm) in September, 245% of normal monthly totals. Because of the very wet September, this season ranked as the 26th wettest in 121 years for the Western Piedmont (Table 5). Two of the wettest days of the year occurred during September with 2.8 in (71 mm) and 3.1 in (79 mm) falling on September 22nd and 29th, respectively (Table 9).

The last quarter of the year was the wettest of the year. All stations reported above normal precipitation during each month of the autumn season – October, November, and December (Tables 6 and 7). Both Roanoke and Rocky Mt observed more than twice their 30-year normal monthly rainfall totals during both October and November. In fact, the wettest day of the year occurred on November 10th with 3.2 in (81 mm, Table 9) of precipitation. Snowfall was above normal, with all stations measuring more than 15 in (38 cm, Table 7).

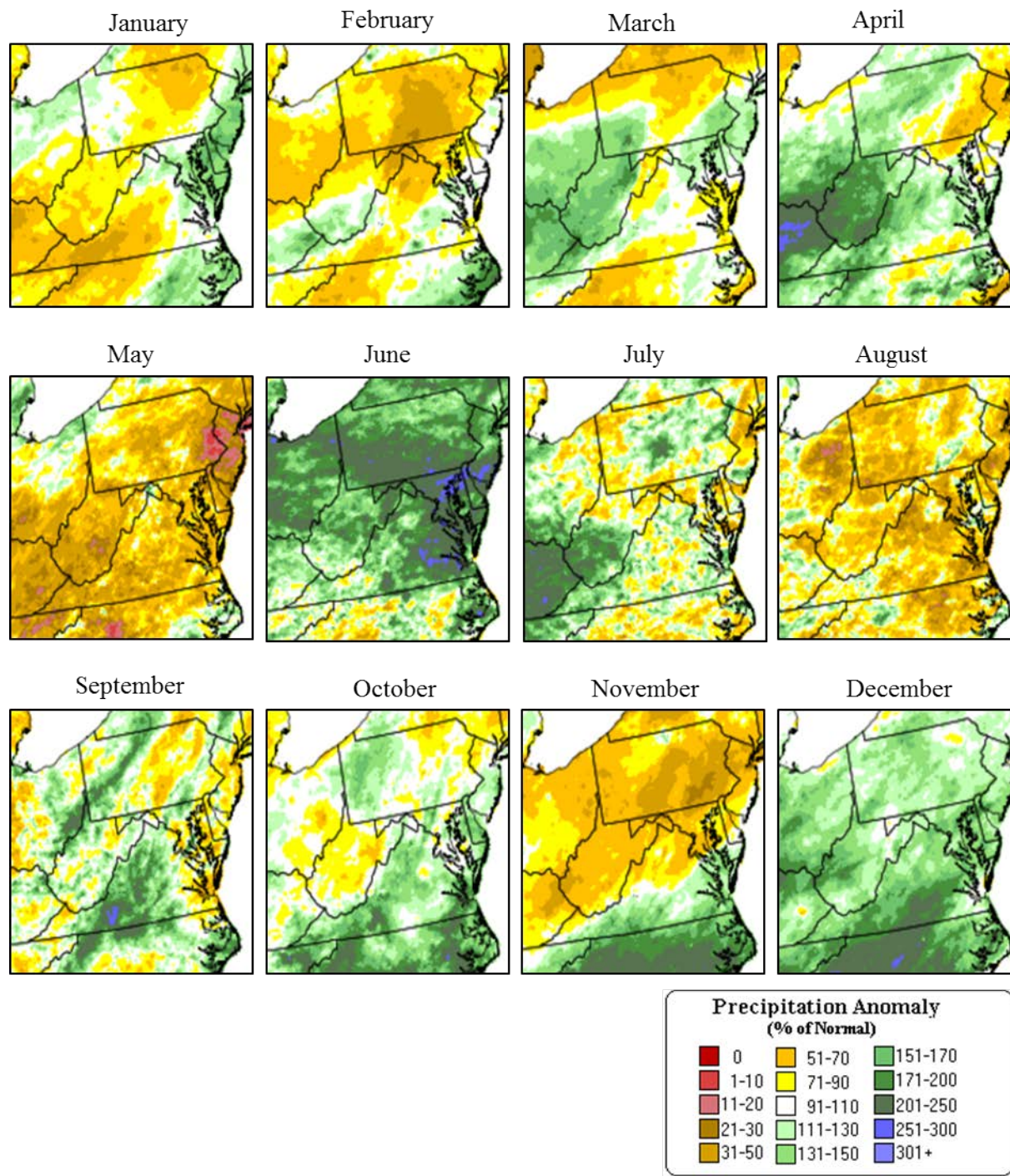


Figure 4. Maps showing percent of average monthly precipitation in 2015 compared to the 30-year normal (1981–2010).

Table 6. Summary of 2015 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	61	85	92	124	46	155	87	61	183	132	129	154	109
Roanoke Airport	KROA	45	90	124	148	44	238	106	87	219	211	118	156	132
Rocky Mt ¹	RYMV2	59	65	66	101	59	119	60	33	205	252	162	181	113
Appomattox	APXV2	67	104	96	114	67	109	89	48	147	133	101	233	109
Huddleston 4 SW	HUDV2	59	72	78	128	49	267	98	34	245	170	148	182	127

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 departures from normal values were calculated with normals derived from data spanning the length of the station's Period of Record.

Table 7. Status of 2015 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 2015	Lynchburg Airport 1981–2010	Roanoke Airport 2015	Roanoke Airport 1981–2010	Appomattox 2015	Appomattox 1981–2010	Huddleston 4 SW 2015	Huddleston 4 SW 1981–2010
Annual Precipitation	45.3 in 1,151 mm	41.6 in 1,057 mm	54.6 in 1,387mm	41.3 in 1,049 mm	50.0 in 1,270 mm	46.6 in 1,184 mm	54.6 in 1,387 mm	42.5 in 1,080 mm
Autumn (Oct, Nov, Dec) Precipitation	13.4 in 340 mm	9.8 in 249 mm	14.7 in 373 mm	9.2 in 234 mm	17.0 in 432 mm	11.2 in 284 mm	17.0 in 432 mm	10.3 in 262 mm
Heavy Precipitation Days (days with ≥ 1.0 in (25 mm) rain)	3	10	6	10	10	13	13	11
Extreme Precipitation Days (days with ≥ 2.0 in (51 mm) rain)	0	1	0	2	2	1	5	2
Micro-drought (periods of 7+ days without rain)	9	7	9	5	7	11	8	10
Annual Snowfall	22.9 in 51.0 cm	16.2 in 41.1 cm	21.2 in 53.8 cm	18.5 in 47.0 cm	15.4 in 39.1 cm	8.5 in 21.6 cm	15.0 in 38.1 cm	2.0 in 5.1 cm
Measurable Snow Days (days with ≥ 0.1 in (0.3 cm) snow)	7	8	8	9	6	3	3	1
Moderate Snow Days (days with ≥ 3.0 in (7.6 cm) snow)	3	2	3	2	2	1	3	0
Heavy Snow Days (days with ≥ 5.0 in (12.7 cm) snow)	3	1	2	1	2	1	2	0

Table 8. Summary of 2015 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	1.9 in	2.5 in	3.3 in	4.1 in	1.7 in	5.6 in	3.8 in	2.0 in	7.1 in	4.1 in	4.4 in	5.0 in	45.3 in
		48 mm	64 mm	84 mm	104 mm	43 mm	142 mm	97 mm	51 mm	180 mm	104 mm	112 mm	127 mm	1,151 mm
Roanoke Airport	KROA	1.3 in	2.6 in	4.3 in	5.0 in	1.8 in	9.1 in	4.3 in	3.1 in	8.5 in	6.1 in	4.0 in	4.6 in	54.6 in
		33 mm	66 mm	109 mm	127 mm	46 mm	231 mm	109 mm	79 mm	216 mm	155 mm	102 mm	117 mm	1,387 mm
Rocky Mt	RYMV2	2.0 in	2.0 in	2.8 in	3.8 in	2.4 in	5.4 in	2.9 in	1.4 in	9.4 in	8.0 in	5.8 in	6.3 in	51.9 in
		51 mm	51 mm	71 mm	97 mm	61 mm	137 mm	74 mm	36 mm	239 mm	203 mm	147 mm	160 mm	1,318 mm
Appomattox	APXV2	2.1 in	3.2 in	3.8 in	3.9 in	3.2 in	4.3 in	4.3 in	1.9 in	6.3 in	5.0 in	4.0 in	8.0 in	50.0 in
		53 mm	81 mm	97 mm	99 mm	81 mm	109 mm	109 mm	48 mm	160 mm	127 mm	102 mm	203 mm	1,270 mm
Huddleston 4 SW	HUDV2	2.0 in	2.1 in	2.9 in	4.3 in	1.8 in	9.4 in	3.9 in	1.2 in	10.1 in	5.8 in	5.3 in	6.0 in	54.6 in
		51 mm	53 mm	74 mm	109 mm	46 mm	239 mm	99 mm	30 mm	257 mm	147 mm	135 mm	152 mm	1,387 mm

Table 9. Top five wettest days and top five dry spells (consecutive days with a trace or less of liquid precipitation) during 2015 from weather observing stations at Lynchburg (KLYH), Roanoke (KROA), Rocky Mt (RYMV2), Appomattox (APXV2) and Huddleston (HUDV2).

Wettest Days in 2015	Dry Spells in 2015
Nov. 10: 3.2 in (81 mm)	Aug. 21–Sept. 11
Jun. 2: 3.1 in (79 mm)	Oct. 11 - 26
Sept. 29: 3.1 in (79 mm)	Jul. 15 - 25
Oct. 28: 2.9 in (74 mm)	Nov. 20 - 28
Sept. 22: 2.8 in (71 mm)	May 12 - 20

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 2015 are shown in Figure 5.

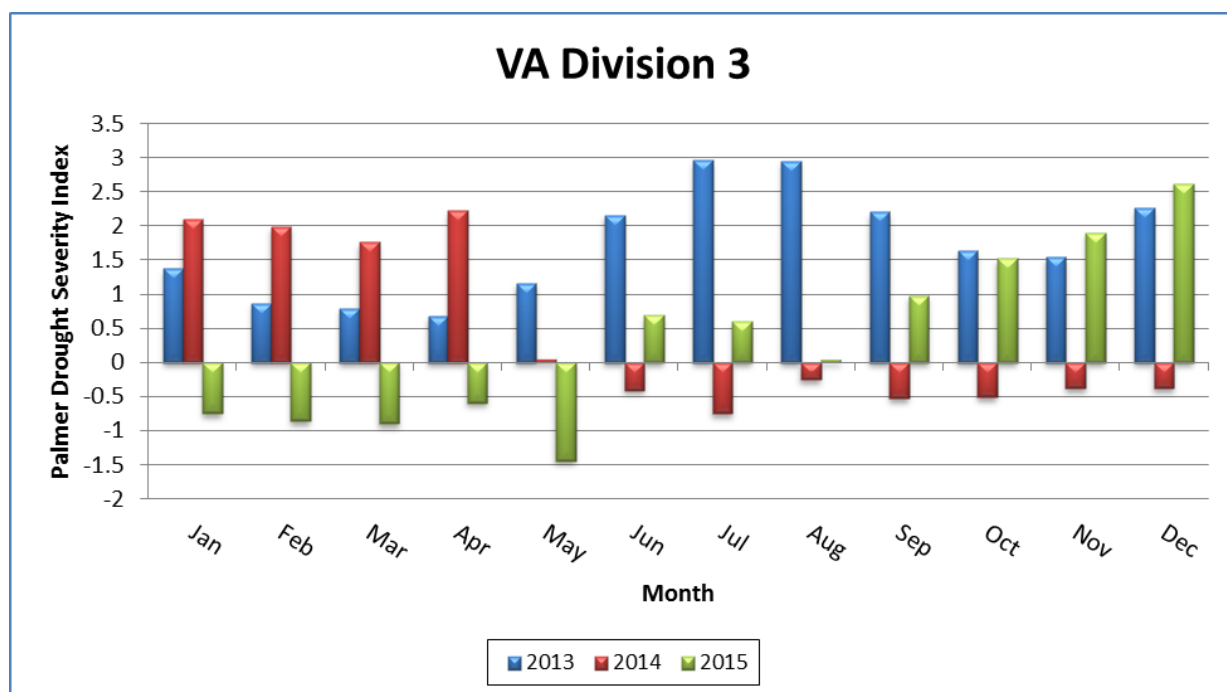


Figure 5. Monthly Palmer Drought Severity Index (PDSI) for the Western Piedmont, 2013–2015.

According to the PDSI, 2015 in the Western Piedmont started with slightly drier than normal conditions (below 0 PDSI values) through the end of May. Wetter weather returned in the summer and persisted until December (Figure 5). As a result of the persistent wet conditions, the PDSI remained at positive values through the remainder of the year, reaching the “moderately moist” category by December when index values exceeded $+2.0$. Compared with the previous two years, 2015 was considerably drier early in the year but wetter as the year came to a close.

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 2015). 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 2015.

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); no drought in the region during the warm season in the Western Piedmont.

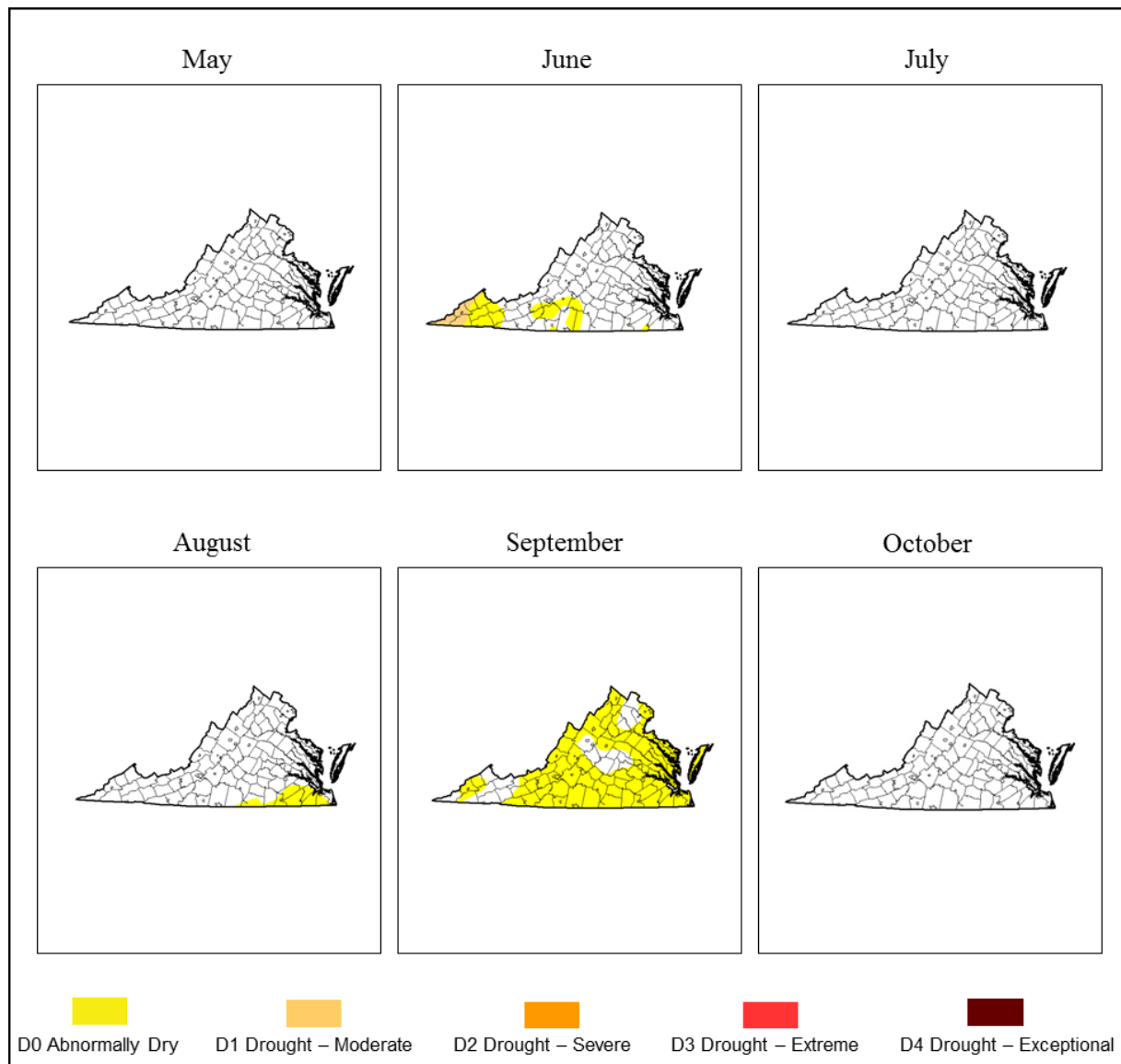


Figure 6. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for Virginia in 2015.

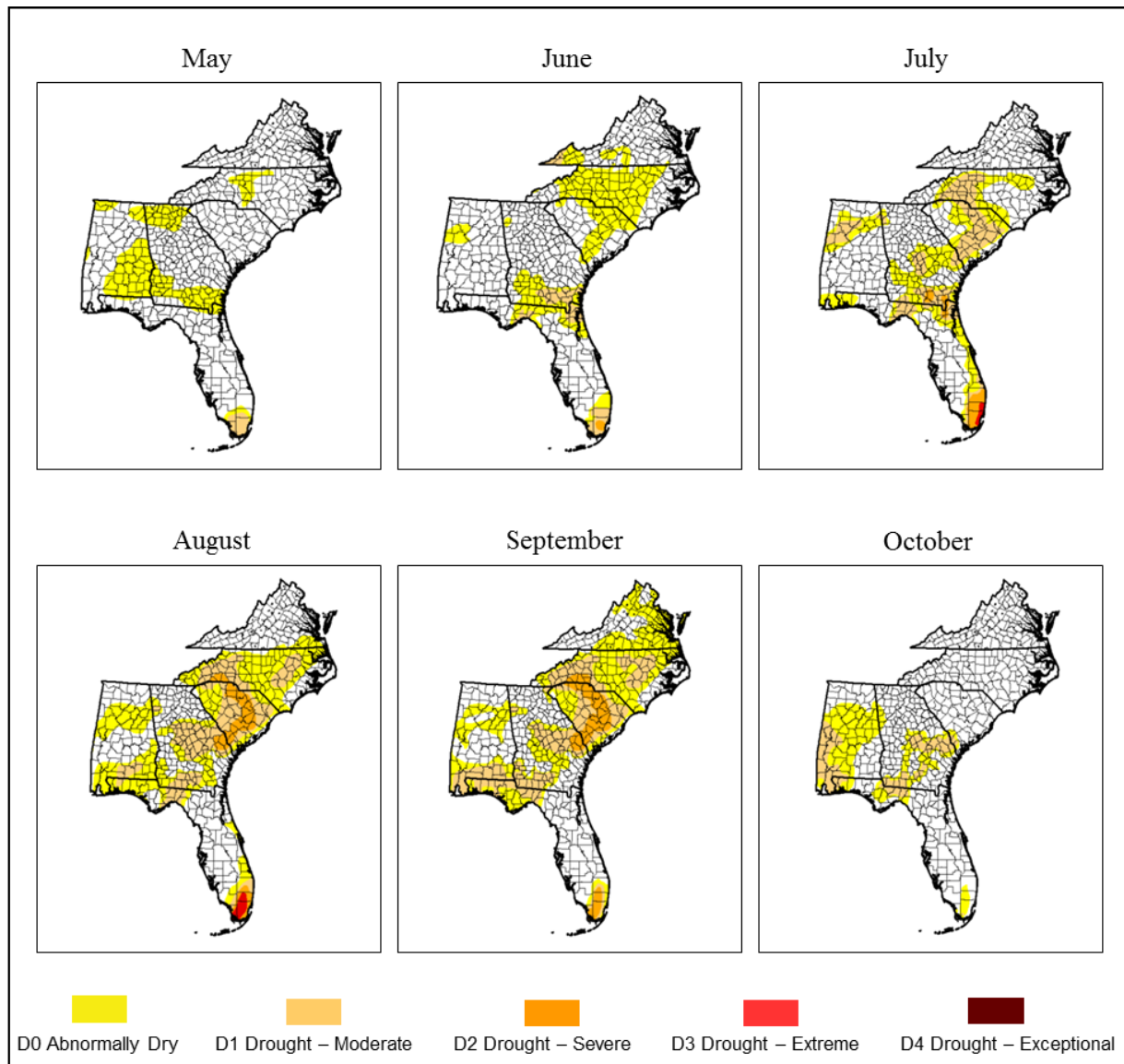


Figure 7. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for the Southeast in 2015.

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.
- Knight, P., K. Imhoff, and A. Person. 2016. Weather of Appomattox Court House National Historical Park and Booker T. Washington National Monument: Mid-Atlantic Network summary report for 2014. Natural Resource Data Series. NPS/MIDN/NRR—2016/1110. National Park Service. Fort Collins, Colorado.
- 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 Integrated Drought Information System (NIDIS). 2015. National Climate Data Center and United States Department of Agriculture. <http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx> (accessed 12 September 2016).
- National Oceanic and Atmospheric Administration (NOAA). 2015. National Centers for Environmental Information Climatological Rankings. Available at: <http://www.ncdc.noaa.gov/temp-and-precip/climatological-rankings/> (accessed 12 September 2016).

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 340/134791, 404/134791, October 2016

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

2016

NationalParkService.
CENTENNIAL

EXPERIENCE YOUR AMERICA™