



Weather of Fredericksburg and Spotsylvania National Military Park

Mid-Atlantic Network Summary Report for 2012

Natural Resource Data Series NPS/MIDN/NRDS—2013/501



ON THE COVER

Fredericksburg and Spotsylvania National Military Park.
Photograph by: David Quinalty.

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Natural Resource Data Series NPS/MIDN/NRDS—2013/501

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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. 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 Data Series is intended for 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

ASOS	Automated Surface Observation System
COOP	National Weather Service Cooperative Observer Program
CWOP	Citizen Weather Observer Program
FAA	Federal Aviation Administration
FRSP	Fredericksburg and Spotsylvania National Military Park
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
NMP	National Military Park
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, 2012, 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 objectives:

- 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 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 2012'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 Eastern Piedmont of Virginia

Fredericksburg and Spotsylvania National Military Park (NMP) lies in VA Climate Division 2 (Eastern 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. This section of Virginia is generally considered to have a humid continental type of climate, but the rolling hills and valleys have a marked effect on the weather and climate of the parks. The prevailing westerly winds carry most of the weather disturbances that affect the region from the interior of the continent, with the Atlantic Ocean having only an occasional 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. Also, storms of tropical origin can have significant effect within this part of Virginia, causing severe floods in some instances.

Temperatures are moderately continental with the tempering effects due to the nearby mountains that contribute to cloud production in the summer and onshore winds modifying the chill at times during the winter. The lowest readings in the winter occur with polar air masses of Canadian origin settling over the Northeast after a fresh snowfall. 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 area. The southwest winds gain additional warmth when descending the crest of the Appalachians. The last freeze and first frost typically occur in mid-April and October, respectively.

Precipitation is fairly evenly distributed throughout the year. Annual amounts generally range between 38–48 in (965–1,219 mm), while the majority of places receive 40–45 in (1,016–1,150 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 tends to be somewhat greater in the mountains, due primarily to coastal storms which occasionally frequent the area. During the warm season, these storms can bring heavy rain, while in winter, heavy snow or a mixture of rain and snow may be produced.

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, occurring about once every other year, but flash floods and damaging thunderstorm winds affect parts of the park 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 tropical storms have contributed to the region's worst floods. Ice storms, which can cause significant disruption, occur at irregular intervals and are primarily confined to the months between December and March (Kocin and Uccellini 2004).

Observing Stations

A total of seven weather observing stations comprising three weather observing networks were selected around Fredericksburg and Spotsylvania NMP (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. Therefore, a total of seven stations were ultimately used for this 2012 report: Culpepper Regional Airport, Shannon Airport, Piedmont Research Station, Corbin, Fredericksburg Sewage Plant, Louisa, and Fredericksburg Battlefield (Table 1, Figure 1).

The average value of a climate element over 30 years is defined as a climatological normal, which are 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-normals 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 be the 30-year normal or the pseudo-normal calculated on a shorter time frame

Two stations, Piedmont Research Station and Louisa, have a long-term record and are used to create a 30-year normal (mean values for 1981–2010) for temperature and precipitation. Temperature indicators for 2012 are compared to the normals for two stations, while precipitation indicators are compared for only one station (Louisa); Piedmont was excluded due to missing records in 2012. Corbin was not used as an indicator station for temperature due to inconsistent data during 2010. All seven stations are used to provide monthly summaries for temperature, and four are used to show departures from normal. Fredericksburg Sewage Plant has a shorter reporting period, but departures from normal are compared to the longer term record for that station (1995–2007). For precipitation, Corbin, Fredericksburg Sewage Plant, Louisa, Piedmont Research Station and Fredericksburg Battlefield are used to calculate monthly summaries. These stations, with the exception of Fredericksburg Battlefield due to a short Period of Record, are used to calculate monthly departures from normal.

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.

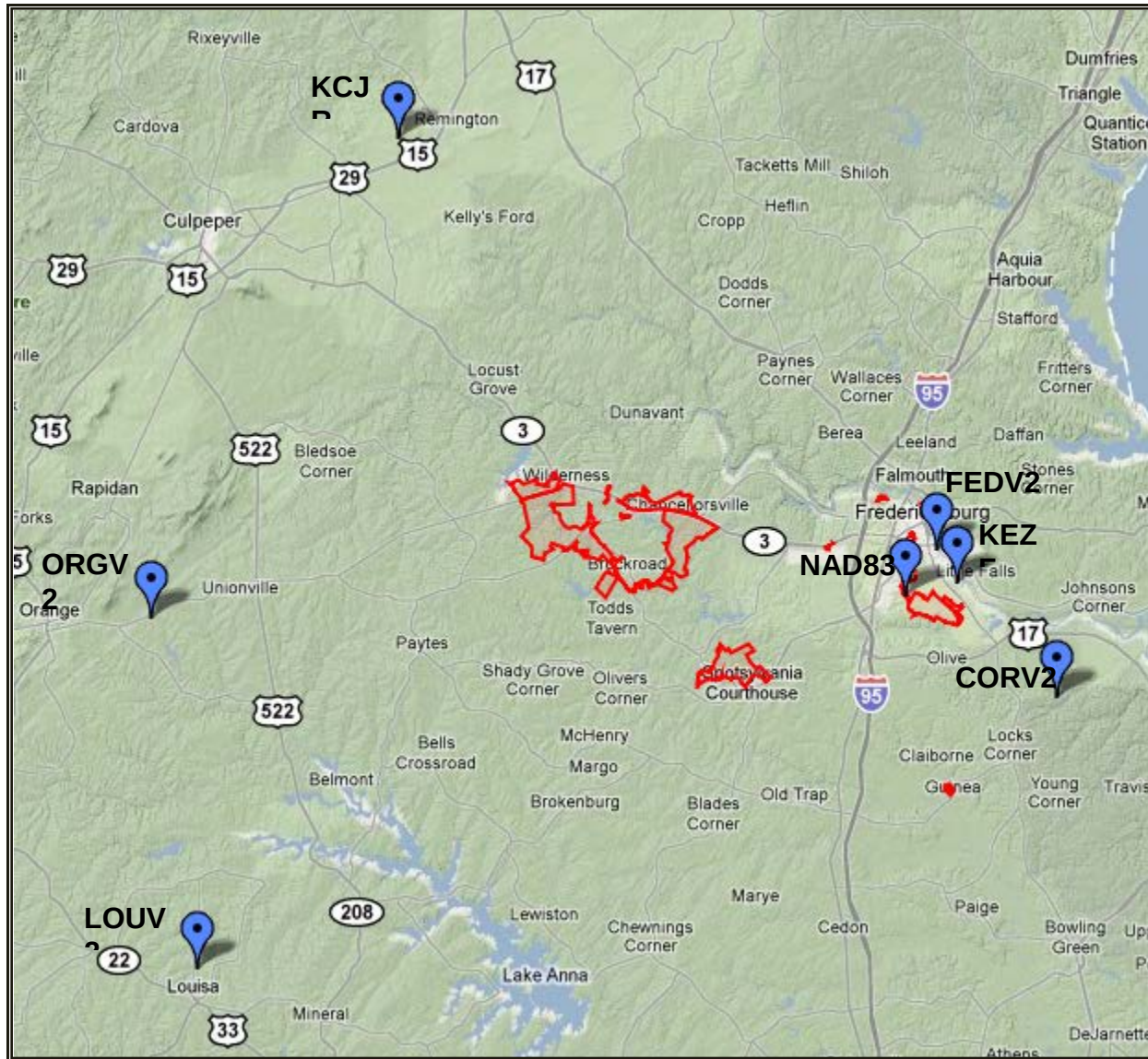


Figure 1. Location of weather observing stations around Fredericksburg and Spotsylvania National Military Park selected as most representative of the park in 2012. See Table 1 for station names.

Table 1. List of weather observing stations around Fredericksburg and Spotsylvania National Military Park selected as most representative of the parks in 2012.

Station	Observing Network ¹	Name	Period of Record (POR)		Percentage of Time Reporting Temperature for 2012	Percentage of Time Reporting Precipitation for 2012	Percentage of Time Reporting Temperature for entire POR	Percentage of Time Reporting Precipitation for entire POR
KCJR	ASOS	Culpepper Regional Airport	05/11/1998	Present	100.0	100.0	97.4	32.3
KEZF	ASOS	Shannon Airport	01/01/1996	Present	100.0	100.0	91.9	18.7
ORGV2	COOP	Piedmont Research Station	11/01/1946	Present	100.0	94.5	99.8	99.6
CORV2	COOP	Corbin	01/01/1959	Present	100.0	100.0	97.8	98.4
FEDV2	COOP	Fredericksburg Sewage Plant	01/01/1995	Present	96.7	95.9	95.7	95.1
LOUV2	COOP	Louisa	05/01/1916	Present	100.0	100.0	97.9	97.1
NAD83	NPS	Fredericksburg Battlefield	01/01/2009	Present	100.0	100.0	99.6	99.6

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

Temperature Summary

Above-average temperatures were the rule for the region around Fredericksburg and Spotsylvania NMP for the majority (eight of twelve months) of 2012 (Table 2), ranking as the warmest on record (Table 3), with pronounced negative anomalies only in November, and high positive anomalies from January through March and in May, July and December (Figures 2 and 3)¹. Annual temperatures were very mild with daytime maximums averaging as much as 2.3°F (1.3°C) above normal and nighttime readings were between 1.3°F to 1.8°F (0.8°C to 1.0°C) above normal (Table 2).

January brought a very mild start to the year. The lowest readings of 2012 with values as low as 12°F (-11.1°C) occurred on January 4 (Tables 4 and 5). Above-average temperatures continued in February with departures ranging from 3.5°F to 5.3°F (1.9°C to 2.9°C) above normal (Table 5). As a result of an exceptionally warm March, the last freeze of the winter took place on April 12th. Readings in March averaged as much as 11.4°F (6.3°C) above the long-term mean. Winter, as a whole, ranked as the 2nd warmest in 118 years in the Eastern Piedmont, which set the pace for the remainder of the year (Table 3).

Temperatures during April were much closer to average, reaching only 1.4°F (0.8°C) above normal at Corbin, VA (Table 5). Warm conditions returned with very mild nights in May (Figure 3). The warmth was tempered in June as temperatures averaged from 1.0°F to 2.0°F (0.6°C to 1.1°C) below seasonal levels (Table 5). Overall, spring 2012 ranked as the 17th warmest for the Eastern Piedmont (Table 3). The length of the growing season was as much as two weeks longer than the 30-year average due to the mild early spring nights (Table 2 and Figure 3).

The summer months stayed above average, with each month showing warmer than normal readings at a few reporting stations. July was very warm with anomalies from 3.0°F to 4.0°F (1.7°C to 2.2°C) above normal (Figures 2 and 3). Maximum temperatures for the year rose to 101°F (38.3°C), several degrees above normal levels, and the number of hot days was above normal with as many as 38 days compared to an average of 31 days (Table 5). The summer months ranked as the 12th warmest in 118 years of records in the Eastern Piedmont (Table 3).

Autumn continued the temperature trend and was ranked the 21st warmest in 118 years (Table 3). Mild weather persisted during October with seasonable nighttime temperatures, but cooler than average daytime temperatures (Figure 2). November brought the largest negative departures ranging from -3.7°F to -4.9°F (-2.1°C to -2.7°C) (Table 5). The first freeze of the fall occurred on October 13th. The calendar year ended very mild, as December brought anomalies ranging from 4.3°F to 5.8°F (2.4°C to 3.2°C) (Table 5). Overall, 2012 had somewhat below-normal number of sub-freezing days (77 to 95) and fewer than normal number of cold days (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/>.

Fredericksburg and Spotsylvania National Military Park
Departure from Average Monthly Maximum Temperature
2012 vs. 1981–2010

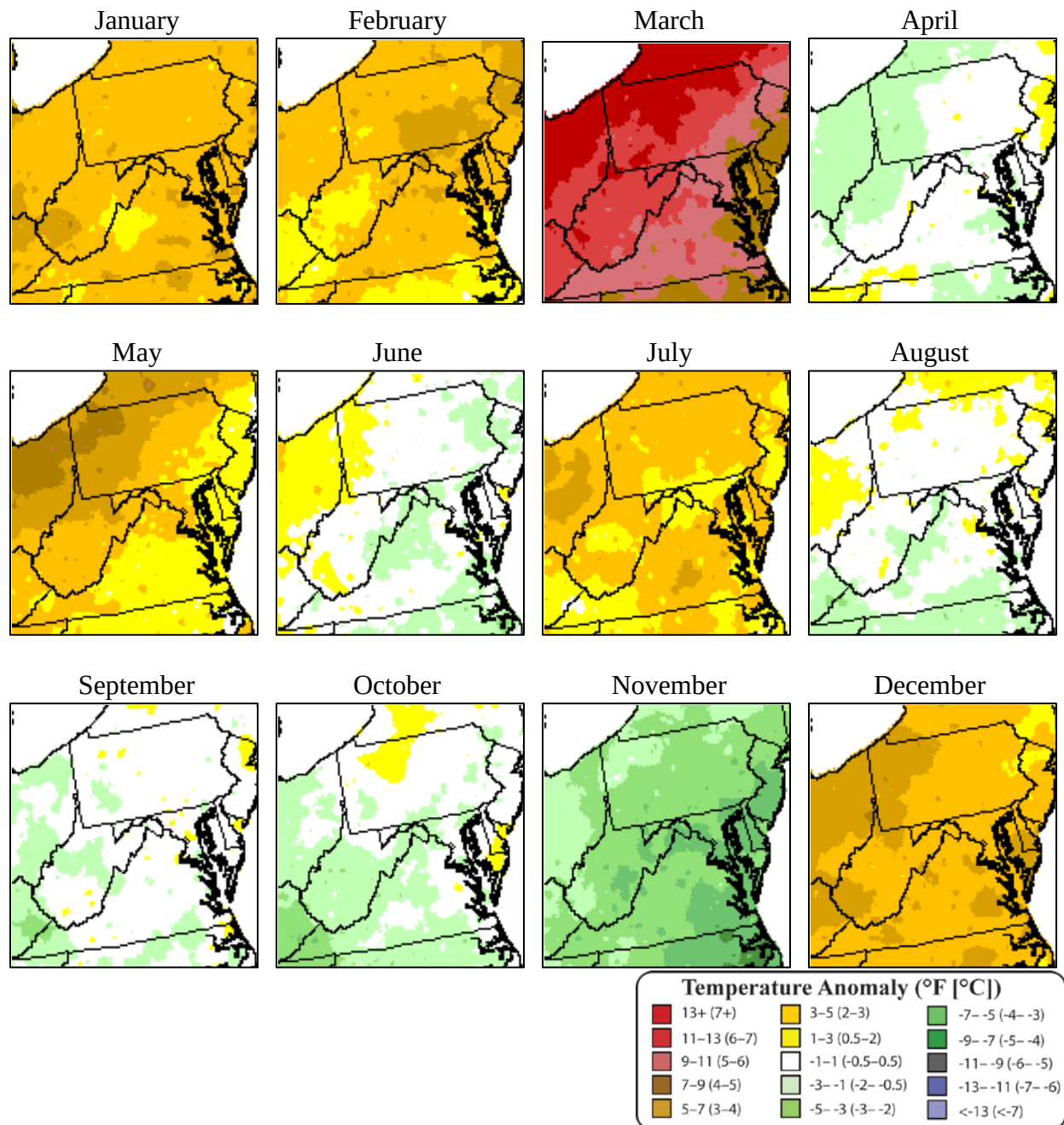


Figure 2. Maps showing departure from average monthly maximum temperature compared to the 30-year normal (1981–2010).

Fredericksburg and Spotsylvania National Military Park
Departure from Average Monthly Minimum Temperature
2012 vs. 1981–2010

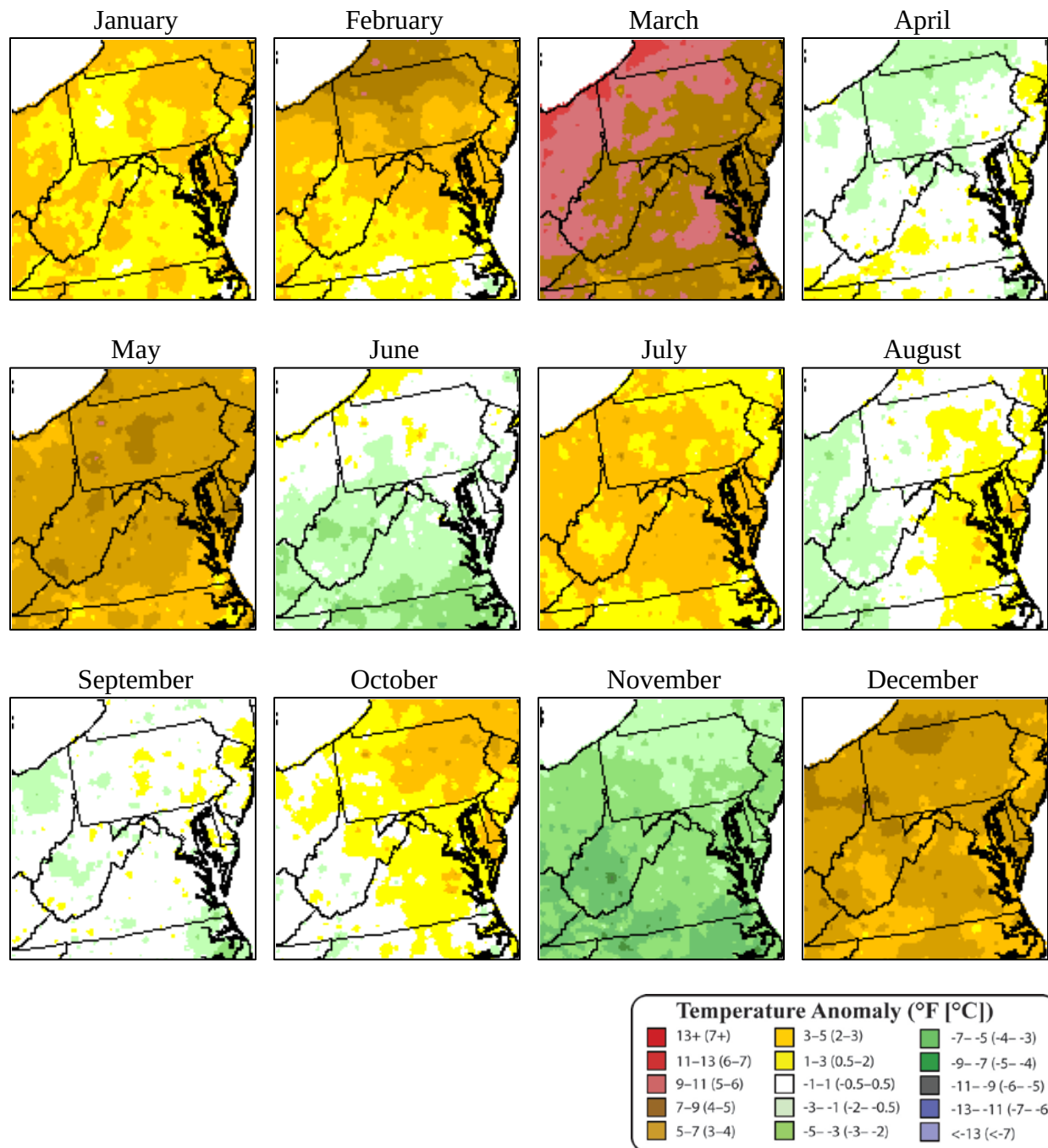


Figure 3. Maps showing departure from average monthly minimum temperature compared to the 30-year normal (1981–2010).

Table 2. Status of 2012 temperature indicators compared to the 30-year normal (1981-2010) Louisa (LOUV2) and Piedmont Research Station (ORGV2) weather observing stations¹.

Temperature Indicator	Louisa, VA 2012	Louisa, VA 1981–2010	Piedmont Research Station, VA 2012	Piedmont Research Station, VA 1981-2010
Average Annual Temperature	58.6°F 14.8°C	56.8°F 13.8°C	57.5°F 14.2°C	55.8°F 13.2°C
Average Annual Maximum Temperature	71.0°F 21.7°C	68.7°F 20.4°C	67.7°F 19.8°C	66.2°F 19.0°C
Maximum Temperature	101.0°F 38.3°C	96.5°F 35.8°C	99.0°F 37.2°C	97.0°F 36.1°C
Hot Days (days with Tmax≥90°F/32°C)	38	31	23	22
Average Annual Minimum Temperature	46.2°F 7.9°C	44.9°F 7.2°C	47.3°F 8.5°C	45.5°F 7.5°C
Minimum Temperature	12.0°F -11.1°C	0.5°F -17.5°C	13.0°F -10.6°C	3.5°F -15.8°C
Cold Days (days with Tmax≤32°F/0°F)	0	5	3	9
Sub-freezing Days (days with Tmin≤32°F/0°C)	95	100	77	92
Sub-zero Days (days with Tmin≤-0°F/-18°C)	0	1	0	0
Growing Season Length (days between last spring Tmin 32°F/0°C and first fall Tmin 32°F/0°C)	183	169	219	210

¹Prior temperature indicator, Corbin, was not used due to inconsistent data during 2010.

Table 3. Seasonal and annual temperature and precipitation rankings for 2012 over 118 years for the Eastern Piedmont (NOAA 2012).

	Climate Division 2 Rankings — Eastern Piedmont				
	Jan–Feb–Mar WINTER	Apr–May–Jun SPRING	Jul–Aug–Sep SUMMER	Oct–Nov–Dec AUTUMN	Jan–Dec YEAR
Temperature-2012	2	18	T-13	T-22	1
Precipitation-2012	90	95	T-57	95	107

1 = warmest/wettest year and 118 = coldest/driest year. T = tie between two or more year

Table 4. Summary of 2012 monthly average temperatures for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Culpepper Airport	KCJR	38.9°F	42.0°F	55.9°F	54.4°F	68.6°F	71.1°F	80.0°F	76.5°F	67.9°F	57.3°F	43.1°F	42.2°F	58.2°F
		3.8°C	5.6°C	13.3°C	12.4°C	20.3°C	21.7°C	26.7°C	24.7°C	19.9°C	14.1°C	6.2°C	5.7°C	14.6°C
Shannon Airport	KEZF	41.5°F	44.4°F	57.8°F	58.3°F	71.3°F	73.1°F	82.1°F	78.2°F	69.9°F	60.0°F	46.3°F	46.0°F	60.7°F
		5.3°C	6.9°C	14.3°C	14.6°C	21.8°C	22.8°C	27.8°C	25.7°C	21.1°C	15.6°C	7.9°C	7.8°C	15.9°C
Piedmont Research Station	ORGV2	37.3°F	41.4°F	54.7°F	55.0°F	67.4°F	71.0°F	79.5°F	74.6°F	67.2°F	56.7°F	43.1°F	41.8°F	57.5°F
		2.9°C	5.2°C	12.6°C	12.8°C	19.7°C	21.7°C	26.4°C	23.7°C	19.6°C	13.7°C	6.2°C	5.4°C	14.2°C
Corbin	CORV2	40.6°F	43.2°F	56.9°F	56.9°F	68.9°F	71.7°F	80.3°F	76.8°F	68.8°F	58.4°F	44.2°F	44.1°F	59.2°F
		4.8°C	6.2°C	13.8°C	13.8°C	20.5°C	22.1°C	26.8°C	24.9°C	20.4°C	14.7°C	6.8°C	6.7°C	15.1°C
Fredericksburg Sewage Plant	FEDV2	38.2°F	42.1°F	54.6°F	56.0°F	68.6°F	72.0°F	81.4°F	77.0°F	69.2°F	58.0°F	43.2°F	43.6°F	58.7°F
		3.4°C	5.6°C	12.6°C	13.3°C	20.3°C	22.2°C	27.4°C	25.0°C	20.7°C	14.4°C	6.2°C	6.4°C	14.8°C
Louisa	LOUV2	39.5°F	42.6°F	56.6°F	56.8°F	68.8°F	71.2°F	80.1°F	76.2°F	67.8°F	57.6°F	42.8°F	43.2°F	58.6°F
		4.2°C	5.9°C	13.7°C	13.8°C	20.4°C	21.8°C	26.7°C	24.6°C	19.9°C	14.2°C	6.0°C	6.2°C	14.8°C
Fredericksburg Battlefield	NAD83	40.4°F	42.9°F	56.8°F	57.1°F	69.1°F	72.8°F	80.2°F	76.3°F	68.5°F	58.0°F	44.0°F	43.9°F	59.2°F
		4.7°C	6.1°C	13.8°C	13.9°C	20.6°C	22.7°C	26.8°C	24.6°C	20.3°C	14.4°C	6.7°C	6.6°C	15.1°C

Table 5. Summary of 2012 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
Piedmont Research Station	ORGV2	3.0°F	4.1°F	9.7°F	-0.3°F	3.7°F	-1.6°F	3.1°F	-0.3°F	-0.8°F	0.0°F	-4.4°F	4.3°F	1.7°F
		1.7°C	2.3°C	5.4°C	-0.2°C	2.1°C	-0.9°C	1.7°C	-0.2°C	-0.4°C	0.0°C	-2.4°C	2.4°C	0.9°C
Corbin	CORV2	5.9°F	5.3°F	11.4°F	1.4°F	5.1°F	-1.0°F	3.5°F	1.5°F	0.5°F	1.2°F	-3.7°F	5.8°F	3.1°F
		3.3°C	2.9°C	6.3°C	0.8°C	2.8°C	-0.6°C	1.9°C	0.8°C	0.3°C	0.7°C	-2.1°C	3.2°C	1.7°C
Fredericksburg Sewage Plant ¹	FEDV2	3.4°F	4.7°F	9.6°F	0.8°F	4.4°F	-1.5°F	4.0°F	0.9°F	0.2°F	0.6°F	-4.3°F	5.4°F	2.4°F
		1.9°C	2.6°C	5.3°C	0.4°C	2.4°C	-0.8°C	2.2°C	0.5°C	0.1°C	0.3°C	-2.4°C	3.0°C	1.3°C
Louisa	LOUV2	3.5°F	3.5°F	9.9°F	0.2°F	4.0°F	-2.0°F	3.0°F	0.7°F	-0.6°F	0.2°F	-4.9°F	4.8°F	1.9°F
		1.9°C	1.9°C	5.5°C	0.1°C	2.2°C	-1.1°C	1.7°C	0.4°C	-0.3°C	0.1°C	-2.7°C	2.7°C	1.1°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.

Precipitation Summary

The equivalent of only about 10 months of rain and snow fell during 2012 in Fredericksburg and Spotsylvania NMP (Table 6) resulting in the 12th driest year on record (Table 3). After a rather dry first third with dry spells in January and March (Table 7), it turned moist in May, the rest of the warm season averaged only slightly drier than normal, such that by the end of July about 3.0 in (78 mm) of precipitation deficit was tallied, or approximately one month's worth of rain (Table 8 and 9). Overall, 2012 had only half the number of days with heavy rain (greater than 1.0 in [25 mm]) and near normal number of days with extreme rain (greater than 2.0 in (51 mm), Table 6).

The first month ended dry with ten consecutive days without any measurable precipitation from January 22-February 1 (Table 7). January had between 61 and 77 percent of the normal rain and snow (Tables 8 and 9). February also had generally below normal precipitation ranging from 54 to 110 percent of normal (Table 9). Another notable dry spell occurred during the early spring from March 30-April 17, a 19 day period without measurable precipitation (Table 7). As a result, March and April tallied liquid equivalent ranging from 2.6 to 5.5 in (66 to 140 mm). The first three months of the year were the 29th driest for the Eastern Piedmont (Table 5).

In step with the dry winter, the spring months for Fredericksburg and Spotsylvania NMP were dry (Figure 4). April was below normal with the average of the four stations departure equal to 59 percent (Table 9). The spring months also had one of the wettest days of the year with 1.65 in (42mm) on May 23rd (Table 7). May and June were a bit wetter with as much as 5.8 in (147 mm) at Fredericksburg Sewage Plant during May (Tables 8 and 9). Overall, the spring months (April, May, and June) ranked 24th driest in 118 years of records for the Eastern Piedmont (Table 5).

The summer had two faces with dry weather in the first half of July and much of September and then several bouts of heavy rain in August such that the summer as a whole ranked as the 57th wettest since records began in 1895 (Table 5). One of the dry spells took place during this period. From September 9-17 saw no rainfall. In addition, two of the wettest days of 2012 were recorded during the summer months (Table 7). The rainfall on July 15th of 3.12 in (79 mm) was associated with a cluster of thunderstorms and the wet day on August 26th was associated with a stalled front (Table 7). Piedmont Research Station tallied 6.1 in (155 mm) during August, 191 percent above average (Table 8).

The final three months of the year saw a return to drier than normal as 6.6 in (168 mm) of precipitation fell compared to a normal of 10.9 in (277 mm) (Table 6). October's precipitation total ranged from 3.9 in to 5.6 in (99 mm to 140 mm), with the effects of Hurricane Sandy being noticed in the area, and this was the wettest of the three months (Table 8). November and December showed a wide range of variability (more typical of summer) with as much as 118 percent of normal rainfall in December at Corbin to as little as 12 percent at Louisa during November (Table 9). Despite being a somewhat drier than average year, the number of days with measurable snow was near normal (5 compared with 6), and the annual snowfall was 14.8 in (37.6 cm) compared with a normal amount of 17.7 in (45.0 cm) (Table 6).

Table 6. Status of 2012 precipitation indicators compared to the 30-year normal (1981-2010) at Louisa (LOUV2) weather observing station.

Precipitation Indicator	Louisa, VA 2012	Louisa, VA 1981–2010
Annual Precipitation	35.8 in 909 mm	44.2 in 1,123 mm
Autumn (Oct, Nov, Dec) Precipitation	6.6 in 168 mm	10.9 in 277 mm
Heavy Precipitation Days (days with ≥ 1.0 in (25 mm) rain)	6	12
Extreme Precipitation Days (days with ≥ 2.0 in (51 mm) rain)	1	2
Micro-drought (strings of 7+ days without rain)	10	8
Annual Snowfall	14.8 in 37.6 cm	17.7 in 45.0 cm
Measurable Snow Days (days with ≥ 0.1 in (0.3 cm) snow)	5	6
Moderate Snow Days (days with ≥ 3.0 in (7.6 cm) snow)	2	2
Heavy Snow Days (days with ≥ 5.0 in (15.2 cm) snow)	1	1

Table 7. Top five wettest days and top five dry spells (consecutive days with a trace or less of liquid precipitation) during 2012 from weather observing stations at Fredericksburg Sewage Plant (FEDV2) and Louisa (LOUV2).

Wettest Days in 2012	Dry Spells in 2012
Oct. 30: 3.65 in (93 mm) ¹	Nov. 14–Dec. 4
Jul. 15: 3.12 in (79 mm)	Mar. 30–Apr. 17
May 23: 1.65 in (42 mm)	Oct. 31–Nov. 12
Dec. 27: 1.63 in (41 mm)	Jan. 22–Feb. 1
Aug. 26: 1.61 in (41 mm)	Sep. 9–17

¹ Hurricane Sandy

Table 8. Summary of 2012 monthly total rainfall for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Corbin	CORV2	2.4 in	2.3 in	3.1 in	2.4 in	3.5 in	4.1 in	1.7 in	3.1 in	3.7 in	5.5 in	0.6 in	3.9 in	36.3 in
		61 mm	58 mm	79 mm	61 mm	89 mm	104 mm	43 mm	79 mm	94 mm	140 mm	15 mm	99 mm	922 mm
Fredericksburg Sewage Plant	FEDV2	2.0 in	M in	3.0 in	2.2 in	5.8 in	2.1 in	5.0 in	3.0 in	2.0 in	5.1 in	0.6 in	3.6 in	M in
		51 mm	M mm	76 mm	56 mm	147 mm	53 mm	127 mm	76 mm	51 mm	130 mm	15 mm	91 mm	M mm
Louisa	LOUV2	1.9 in	3.2 in	2.6 in	2.1 in	4.5 in	5.0 in	2.0 in	4.8 in	3.1 in	3.9 in	0.5 in	2.2 in	35.8 in
		48 mm	81 mm	66 mm	53 mm	114 mm	127 mm	51 mm	122 mm	79 mm	99 mm	13 mm	56 mm	909 mm
Fredericksburg Battlefield	NAD83	2.0 in	3.5 in	1.5 in	2.0 in	4.6 in	2.1 in	2.6 in	3.1 in	2.5 in	4.7 in	0.6 in	3.5 in	32.7 in
		51 mm	89 mm	38 mm	51 mm	117 mm	53 mm	66 mm	79 mm	64 mm	119 mm	15 mm	89 mm	831 mm
Piedmont Research Station	ORGV2	1.7 in	1.5 in	2.1 in	1.1 in	4.5 in	3.7 in	3.3 in	6.1 in	3.6 in	5.6 in	0.6 in	1.4 in	35.2 in
		43 mm	38 mm	53 mm	28 mm	114 mm	94 mm	84 mm	155 mm	91 mm	142 mm	15 mm	36 mm	894 mm

M = missing data (Monthly statistics are reported as 'M' if more than 4 days of data are missing). An exception was made for FEDV2 (September) and CORV2 (November). Five days of data are missing, but they were determined to have no substantial impact on the monthly totals.

Table 9. Summary of 2012 percent of normal rainfall 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
Corbin	CORV2	77	74	78	73	88	111	43	91	90	149	17	118	84
Fredericksburg Sewage Plant ¹	FEDV2	69	M	75	65	141	53	111	88	47	150	16	113	M
Louisa	LOUV2	61	110	68	66	110	139	43	133	74	108	12	69	81
Piedmont Research Station	ORGV2	61	54	60	32	110	88	70	191	90	165	16	45	82

¹Indicates a station's Period of Record does not cover the period of 1981-2010 but is more than five 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.

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

Fredericksburg and Spotsylvania National Military Park
Percent of Average Monthly Precipitation
2012 vs. 1981–2010

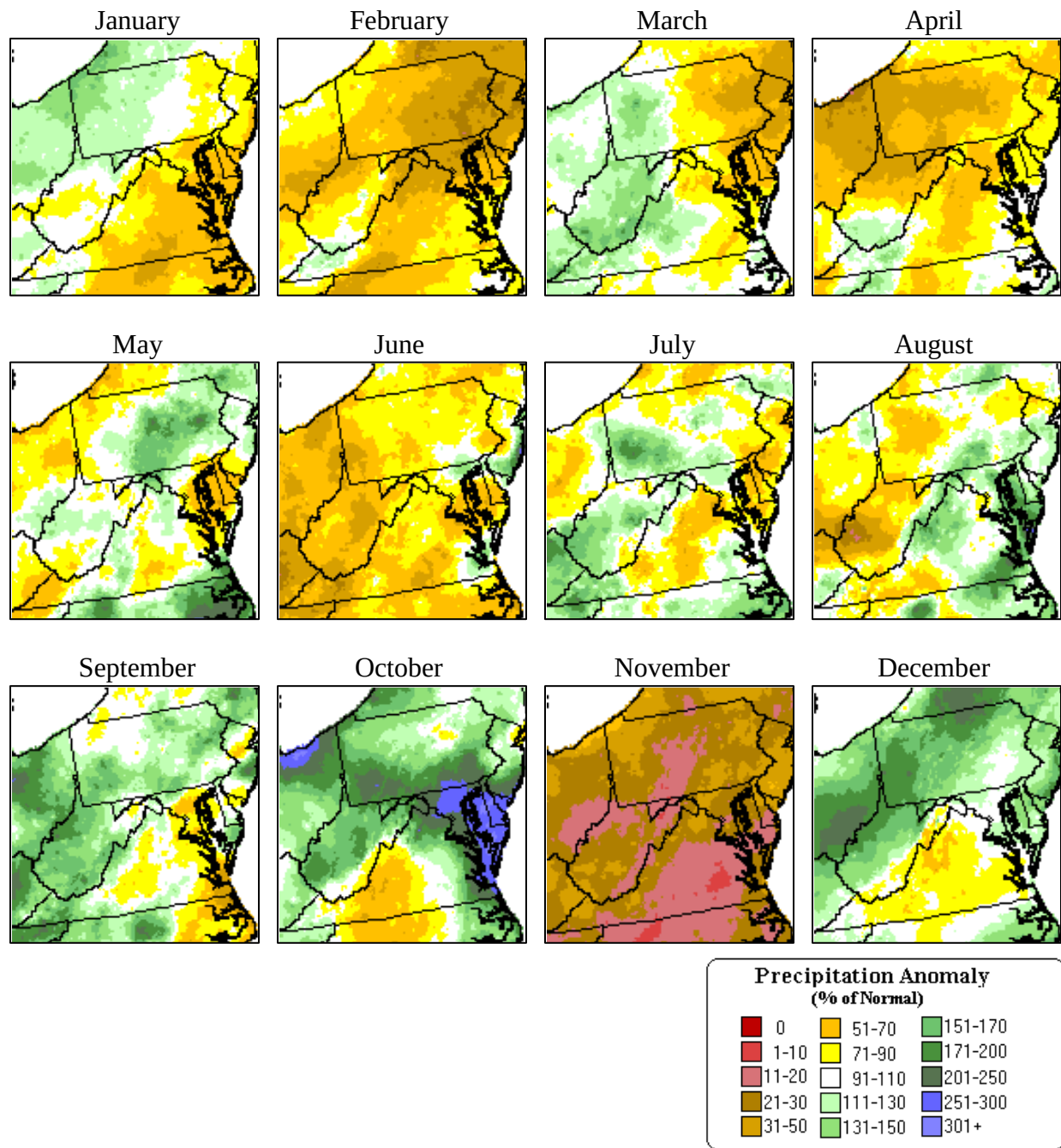


Figure 4. Maps showing percent of average monthly precipitation compared to the 30-year normal (1981–2010).

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 Eastern Piedmont in 2012 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 2012). 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 2012.

According to the PDSI, all of 2012 was much drier than normal with values in the Normal to Moderate Drought range and reaching close to Severe in December. Moist weather during May and October allowed the drought index to stay steady for a month. The dry weather returned in earnest during November causing a drop in the drought index at the end of the year. Comparing 2012 with the previous year shows that the growing season trend of dry conditions mimicked the pattern through July. This past year marks the third consecutive spring and summer with drought conditions in central and northern Virginia. The latter part of 2012 were quite similar to 2010.

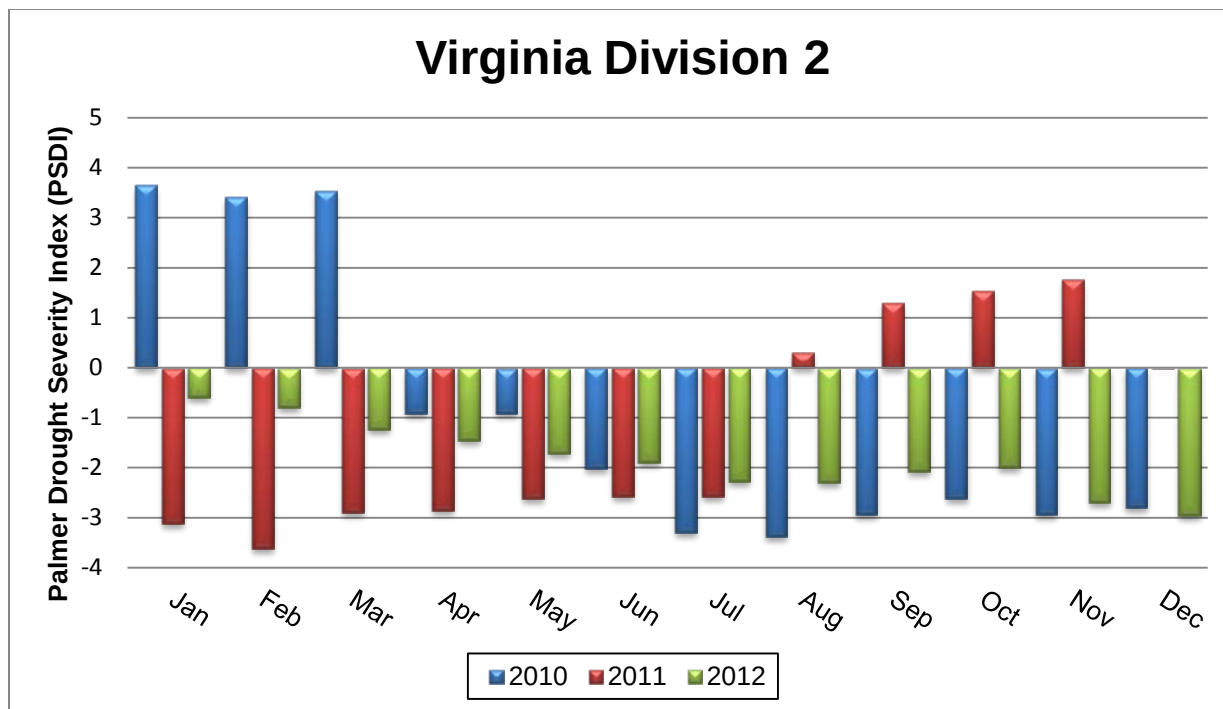


Figure 5. Palmer Drought Severity Index (PDSI) for the Eastern Piedmont, 2010–2012.

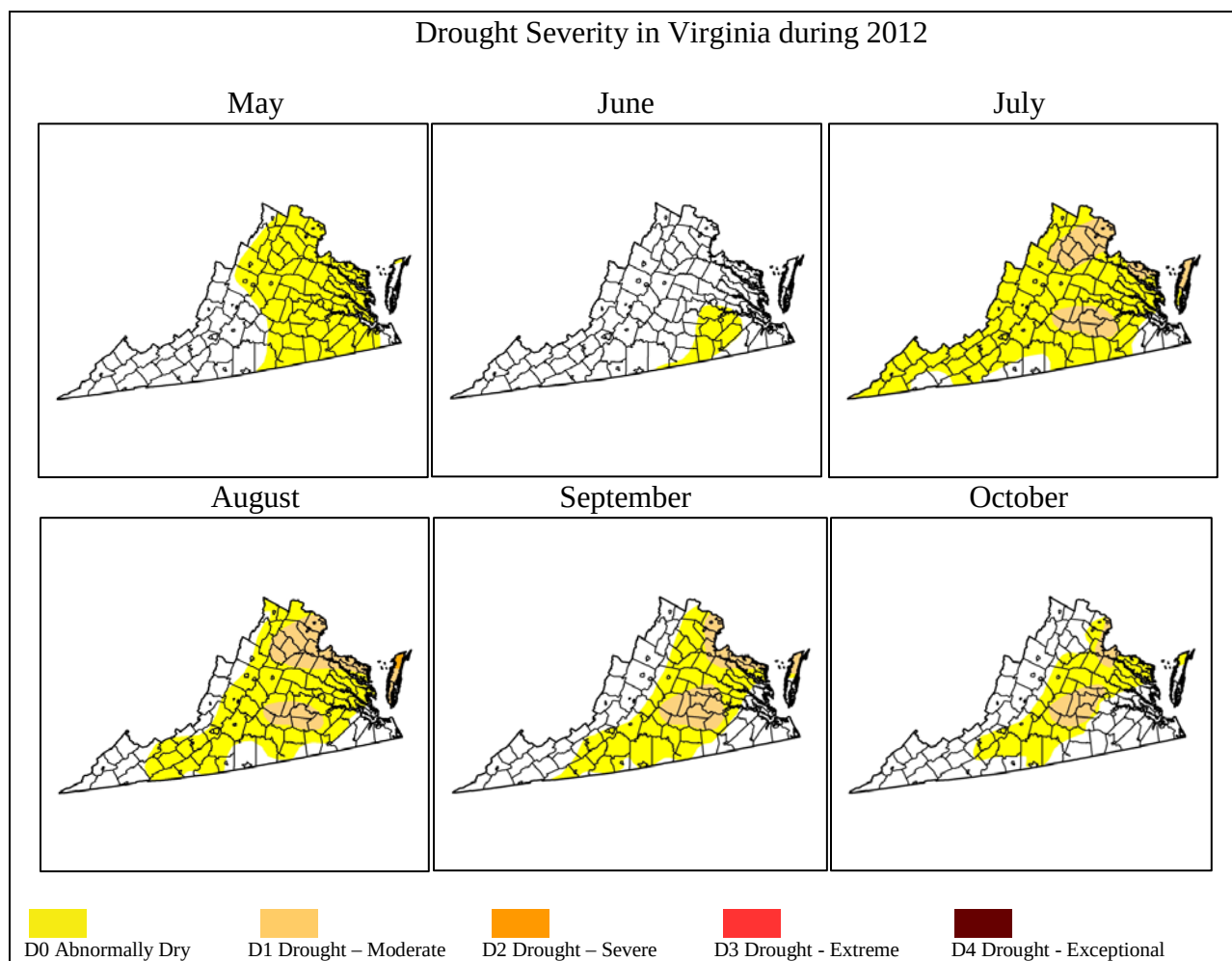


Figure 6. Mid-month values of the United States Drought Monitor (DM) – Drought Intensity Index for Virginia in 2012.

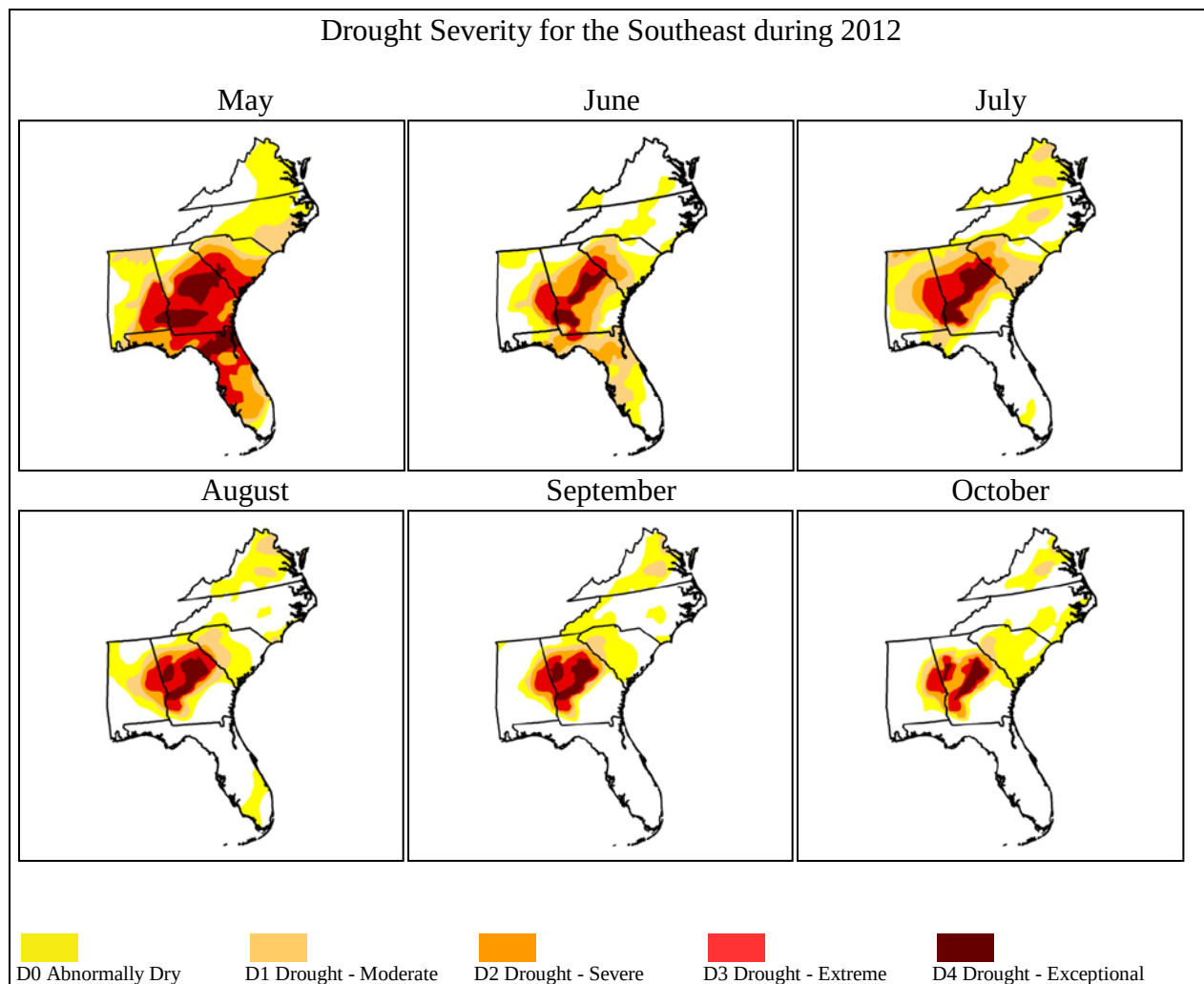


Figure 7. Mid-month values of the United States Drought Monitor (DM) – Drought Intensity Index for the Southeast in 2012.

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