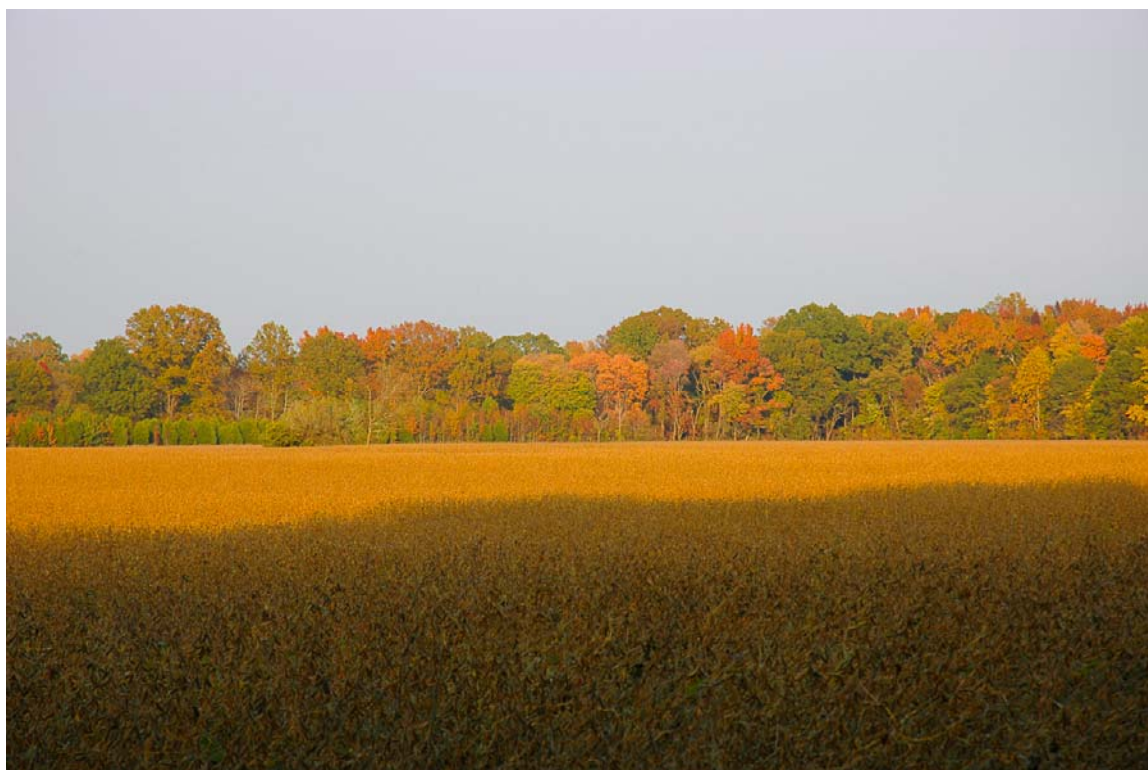




Fredericksburg and Spotsylvania National Military Park

Weather of 2009

Natural Resource Data Series NPS/MIDN/NRDS—2010/091



ON THE COVER

Fredericksburg Battlefield, Fredericksburg and Spotsylvania National Military Park.
Photograph by: James A. Comiskey, National Park Service.

Fredericksburg and Spotsylvania National Military Park

Weather of 2009

Natural Resource Data Series NPS/MIDN/NRDS—2010/091

Paul Knight, Tiffany Wisniewski, Chad Bahrmann, and Sonya Miller

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

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National Park Service
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The National Park Service, Natural Resource Program Center 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 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.

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.

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List of Key Acronyms

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
NADP	National Atmospheric Deposition Program
NARR	North American Regional Reanalysis
NCDC	National Climatic Data Center
NMP	National Military Park
NWS	National Weather Service
PDSI	Palmer Drought Severity Index
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RAWS	Remote Automated Weather Stations
USDM	United States Drought Monitor
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 the 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, 2009, and to place current patterns and trends in an appropriate historical, regional, and global context (Knight et al., in preparation). 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 long-term trends in weather and climate through seasonal and annual summaries of selected parameters (e.g., multiple forms of precipitation, temperature).
- Identify and document extremes and averages of climatic conditions for common parameters (e.g., precipitation, air temperature) and other parameters where sufficient data are available (e.g., wind speed and direction, solar radiation).
- Provide information on near real-time weather parameters, historical climate patterns, and climate station metadata from a single, easy-to-use Internet portal.

To accomplish these objectives, 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 (Knight et al., in preparation). 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 2009's climate summary and trends.

In addition to a suite of summary tables, graphs, and narratives, we specifically identify a series of key climatological 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 (Knight et al., in preparation) 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 (the 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/usclimate/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 typically occurs in mid-April and the first frosts appear in October.

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 reaches 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 17 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 (Knight et al., in preparation). A subset of these weather observing networks (CWOP; six total stations) are not yet utilized for these reports due to limited data availability and/or lack of data quality assurance (Bureau of Land Management 1997). Moreover, the percentage of time a station reports a particular parameter (e.g., temperature) can influence data inclusion. Therefore, a total of six stations were ultimately used for this 2009 report: Culpepper, Shannon, Orange County, Corbin, Fredericksburg Sewage Plant, and Louisa (Table 1, Figure 1).

Two stations, Corbin and Louisa, have a long-term record and are used to create a 30-year normal (mean values for 1971–2000) for temperature and precipitation. Orange County also has a long-term record, but the 30-year normal can only be created for temperature; precipitation over the Period of Record (POR) has only been reported 6.7% of the time (Table 1). Temperature indicators for 2009 are compared to the normals for three stations, while precipitation indicators are compared for only two stations. All six 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, and Louisa are used to calculate monthly summaries and 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.

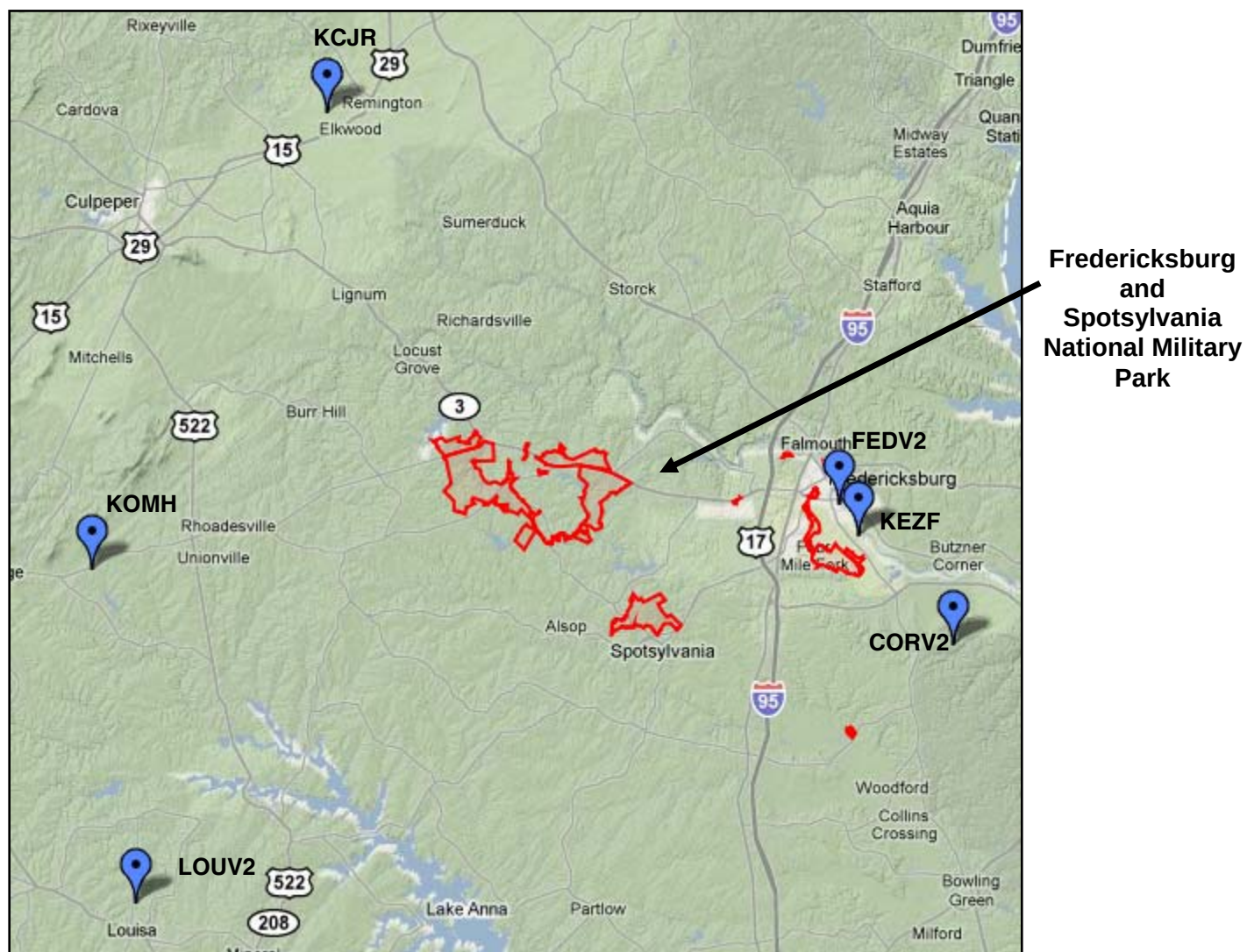


Figure 1. Location of weather observing stations around Fredericksburg and Spotsylvania National Military Park selected as most representative of the park in 2009.

Table 1. List of weather observing stations around Fredericksburg and Spotsylvania National Military Park selected as most representative of the parks in 2009.

Weather Station	Weather Network	Station Name	Period of Record (POR)		Percentage of Time Reporting Temperature for 2009	Percentage of Time Reporting Precipitation for 2009	Percentage of Time Reporting Temperature for entire POR	Percentage of Time Reporting Precipitation for entire POR
KCJR	FAA	Culpepper	05/11/1998	Present	95.6	56.4	94.1	20.4
KEZF	FAA	Shannon	01/01/1996	Present	96.4	63.6	90.1	4.8
KOMH	FAA	Orange County	07/01/1951	Present	96.7	66.7	84.8	6.7
CORV2	COOP	Corbin	01/01/1959	Present	97.0	99.2	98.4	98.8
FEDV2	COOP	Fredericksburg Sewage Plant	01/01/1995	Present	99.2	93.4	95.3	96.3
LOUV2	COOP	Louisa	05/01/1916	Present	100.0	100.0	97.6	96.7

Temperature Summary

Near average temperatures were common in Fredericksburg and Spotsylvania NMP throughout the year, with pronounced negative anomalies in January, July, and December and positive anomalies in February, August, and November (Figures 2 and 3)¹. Annual temperatures were cool with daytime maximums averaging more than 1.0°F (0.6°C) below normal, though nighttime readings were slightly above normal (Table 2).

January brought the lowest readings of the year with values as low as -3°F (-19.4°C) mid-month (Tables 3 and 4). Above-average temperatures dominated February, and March turned cooler than average (Table 4). Winter, as a whole, ranked as 60th in 115 years, or virtually normal (Table 5).

Temperatures during April continued to climb above average, reaching as much as 2.1°F (1.1°C) above normal at Louisa, VA (Table 4). The warmth continued with mild nights into May (Figure 3). The warmth faded in June as maximum temperatures averaged below seasonal levels (Figure 2). Overall, spring 2009 ranked as the 20th warmest for the Eastern Piedmont (Table 5). The length of the growing season was approximately three weeks longer than the 30-year average due, in large part, to the mild spring nights (Table 2 and Figure 3).

The summer months were below average, with July and September being cooler than normal at all reporting stations. August was the outlier, with a warm anomaly (Figures 2 and 3). Maximum temperatures for the year rose to normal levels, but the number of hot days were well below normal (Table 5). In fact, Corbin typically reaches 90°F (32.2°C) on 29 occasions, but only hit this level 15 times during 2009. August was the warmest month of the year, as the monthly average temperature in Fredericksburg was 3.0°F (1.7°C) above normal (Table 4). The summer months ranked as the 52nd coolest in 115 years of records (Table 5).

Autumn ranked the 64th coldest in 115 years (Table 5). The cool weather arrived in October with chillier than average daytime temperatures (Figure 2). November brought a reversal with the largest positive departures measured this month. Louisa was 3.6°F (2.0°C) above the 30-year average (Table 4). The calendar year ended cold, as December brought anomalies ranging from -2.0 to -3.5°F (-1.1 to -1.9°C) (Table 4). Overall, 2009 featured a near-normal number of sub-freezing nights (93–103) and near average 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
2009 vs. 1971–2000

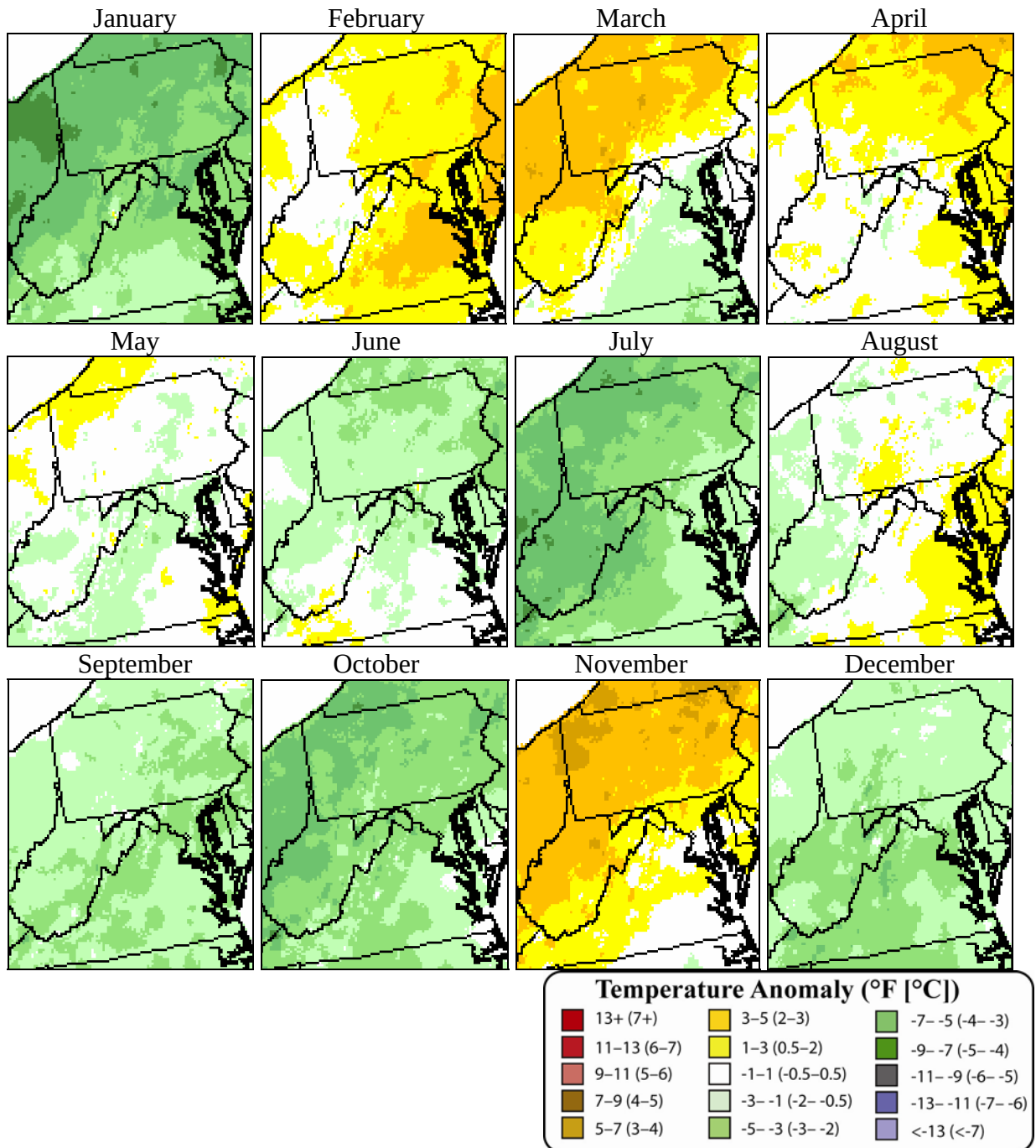


Figure 2. Maps showing departure from average monthly maximum temperature compared to the 30-year normal (1971–2000).

Fredericksburg and Spotsylvania National Military Park
Departure from Average Monthly Minimum Temperature
2009 vs. 1971–2000

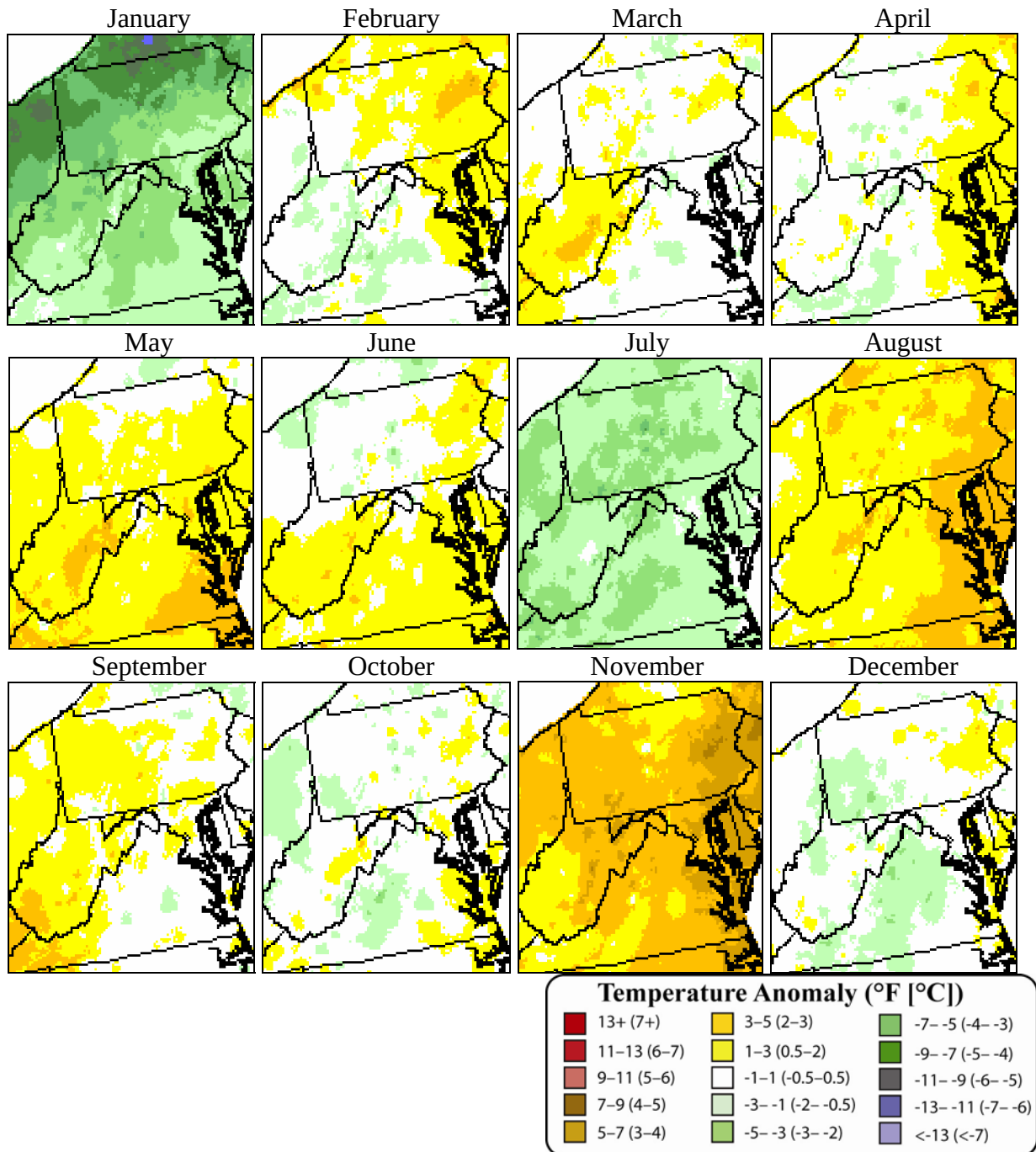


Figure 3. Maps showing departure from average monthly minimum temperature compared to the 30-year normal (1971–2000).

Table 2. Status of 2009 temperature indicators compared to the 30-year normal (1971-2000) at the Corbin (CORV2), Louisa (LOUV2) and Orange County (KOMH) weather observing stations.

Temperature Indicator	Corbin, VA 2009	Corbin, VA 1971-2000	Louisa, VA 2009	Louisa, VA 1971-2000	Orange County, VA 2009	Orange County, VA 1971-2000
Average Annual Temperature	55.5°F 13.1°C	56.5°F 13.6°C	56.2°F 13.4°C	56°F 13.3°C	54.5°F 12.5°C	55.3°F 12.9°C
Average Annual Maximum Temperature	65.3°F 18.5°C	67°F 19.4°C	68.1°F 20.1°C	68.5°F 20.3°C	65°F 18.3°C	66.9°F 19.4°C
Summer Maximum (highest temperature)	95°F 35°C	97.3°F 36.3°C	96°F 35.6°C	96.5°F 35.8°C	95°F 35°C	95.7°F 35.4°C
Hot Days (days with Tmax≥90°F/32°C)	15	29	23	27	10	31
Average Annual Minimum Temperature	45.7°F 7.6°C	46°F 7.8°C	44.3°F 6.8°C	43.6°F 6.4°C	44.3°F 6.8°C	43.7°F 6.5°C
Winter Minimum (lowest temperature)	6.0°F -14.4°C	1.3°F -17.1°C	-3.0°F -19.4°C	-1.0°F -18.3°C	-1.0°F -18.3°C	2.3°F -16.5°C
Cold Days (days with Tmax≤32°F/0°F)	10	10	4	8	11	5
Sub-freezing Nights (days with Tmin≤32°F/0°C)	93	100	103	106	97	101
Cold Winter Nights (days with Tmin≤0°F/-17.8°C)	0	1	2	1	1	1
Growing Season Length (days between last spring 32°F/0°C and first fall 32°F/0°C)	209	186	189	169	190	172

Table 3. Summary of 2009 monthly average temperatures for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Culpepper	KCJR	30.1°F	39.0°F	45.2°F	56.9°F	63.5°F	73.1°F	72.4°F	72.3°F	65.5°F	54.3°F	45.8°F	31.9°F	54.2°F
		-1.1°C	3.9°C	7.3°C	13.8°C	17.5°C	22.8°C	22.5°C	22.4°C	18.6°C	12.4°C	7.6°C	-0.1°C	12.3°C
Shannon	KEZF	32.3°F	41.2°F	46.0°F	58.2°F	68.0°F	76.0°F	76.8°F	78.8°F	69.6°F	58.7°F	52.0°F	38.4°F	58.0°F
		0.2°C	5.1°C	7.8°C	14.6°C	20.0°C	24.4°C	24.9°C	26.1°C	20.9°C	14.9°C	11.1°C	3.5°C	14.5°C
Orange County	KOMH	31.1°F	38.9°F	44.4°F	55.7°F	63.9°F	73.0°F	73.0°F	75.4°F	66.3°F	55.4°F	49.1°F	34.5°F	54.5°F
		-0.5°C	3.8°C	6.9°C	13.1°C	17.7°C	22.8°C	22.8°C	24.1°C	19.1°C	13.0°C	9.5°C	1.4°C	12.5°C
Corbin	CORV2	32.1°F	40.3°F	43.7°F	57.4°F	64.7°F	72.3°F	72.1°F	77.3°F	67.2°F	56.5°F	51.1°F	35.7°F	55.5°F
		0.1°C	4.6°C	6.5°C	14.1°C	18.1°C	22.4°C	22.3°C	25.2°C	19.6°C	13.6°C	10.6°C	2.1°C	13.0°C
Fredericksburg Sewage Plant	FEDV2	31.1°F	39.0°F	42.8°F	55.7°F	64.6°F	72.6°F	75.0°F	78.4°F	68.0°F	55.7°F	49.8°F	35.6°F	55.9°F
		-0.5°C	3.9°C	6.0°C	13.1°C	18.1°C	22.6°C	23.9°C	25.8°C	20.0°C	13.0°C	9.9°C	2.0°C	13.3°C
Louisa	LOUV2	31.3°F	39.7°F	45.1°F	56.8°F	65.5°F	73.1°F	73.7°F	77.3°F	67.7°F	57.1°F	50.2°F	36.0°F	56.2°F
		-0.4°C	4.3°C	7.3°C	13.8°C	18.6°C	22.8°C	23.1°C	25.2°C	19.8°C	13.9°C	10.1°C	2.2°C	14.6°C

Table 4. Summary of 2009 departure from normal temperature based on 30-year normal (1971–2000) for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Orange County	KOMH	-2.6°F	-0.1°F	-2.0°F	0.0°F	-0.7°F	0.4°F	-3.0°F	2.0°F	-1.7°F	-0.3°F	0.9°F	-2.6°F	-0.8°F
		-1.4°C	-0.1°C	-1.1°C	0.0°C	-0.4°C	0.2°C	-1.7°C	1.1°C	-0.9°C	-0.2°C	0.5°C	-1.4°C	-0.4°C
Corbin	CORV2	-2.7°F	2.2°F	-2.6°F	1.8°F	0.4°F	-0.2°F	-4.7°F	2.0°F	-1.7°F	-0.8°F	2.9°F	-3.5°F	-1.0°F
		-1.5°C	1.2°C	-1.5°C	1.0°C	0.2°C	-0.1°C	-2.6°C	1.1°C	-0.9°C	-0.4°C	1.6°C	-1.9°C	-0.6°C
Fredericksburg Sewage Plant *	FEDV2	-2.9°F	1.8°F	-2.9°F	1.0°F	0.5°F	-0.2°F	-2.6°F	3.0°F	-0.6°F	-1.0°F	3.2°F	-2.4°F	-0.3°F
		-1.6°C	1.0°C	-1.6°C	0.5°C	0.3°C	-0.1°C	-1.4°C	1.7°C	-0.4°C	-0.6°C	1.8°C	-1.3°C	-0.2°C
Louisa	LOUV2	-2.7°F	2.5°F	-0.6°F	2.1°F	1.4°F	0.3°F	-3.9°F	1.9°F	-0.9°F	0.4°F	3.6°F	-2.0°F	0.2°F
		-1.5°C	1.4°C	-0.4°C	1.1°C	0.8°C	0.1°C	-2.1°C	1.1°C	-0.5°C	0.2°C	2.0°C	-1.1°C	0.1°C

*Indicates a station's Period of Record is less than 30 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 5. Seasonal temperature and precipitation rankings over 115 years for the Eastern Piedmont (NOAA 2010).

Climate Division 2 Rankings Eastern Piedmont	Jan–Feb–Mar WINTER	Apr–May–Jun SPRING	Jul–Aug–Sep SUMMER	Oct–Nov–Dec AUTUMN
Temperature-2009	60	20	62	50
Precipitation-2009	95	30	91	1

1 = warmest/wettest year and 115 = coldest/driest year

Precipitation Summary

The equivalent of 13 months of rain and snow fell during 2009 in Fredericksburg and Spotsylvania NMP (Table 6). The year became progressively wetter, such that by late December between 2.7–4.5 in (67–138 mm) of excessive precipitation was tallied, or at least one month's worth of rain and snow (Table 6). Overall, 2009 had a well above-average number of days with heavy rain (greater than 1.0 in [25 mm]) and more than double the number of days with excessive rain (greater than 2.0 in [51 mm], Table 6).

The year began very dry with 20 consecutive days without any measurable precipitation from January 8–27 (Table 7). January had between 51–84 percent of the normal rain and snow (Table 8 and 9). February was one of the driest on record with total precipitation ranging between 0.1–0.5 in (3–14 mm) (Table 8). Another dry spell lasting 16 consecutive days without rain or snow occurred from March 3–18. As a result, the first three months of the year were the 20th driest ever for the Eastern Piedmont (Table 5).

In sharp contrast to the dry winter, the spring months for Fredericksburg and Spotsylvania NMP were quite wet (Figure 4). April, though, was exactly normal with the average of the three stations departure equal to 100 percent (Table 9). The spring months also had two of the wettest days of the year, including 2.5 in (64 mm) of rain on both June 3 and 4 (Table 7). June was the soggiest month of the year as 7–10.9 in (177–277 mm) was tallied around the region (Table 8). Overall, the spring months (April, May, and June) ranked as the 30th wettest in 115 years of records for the Eastern Piedmont (Table 5).

The lack of tropical moisture throughout the region due to no direct effect from any tropical storms or hurricanes in 2009 led to the 24th driest summer in 115 years (Table 5). Three of the dry spells took place during this period. From July 22–August 5 and then from August 7–19 had no measurable rainfall. Another mini-drought occurred from September 28–October 14 (Table 7). In August, only Fredericksburg had slightly above-normal rainfall (Table 9).

The final three months of the year were the wettest in recent memory. October's precipitation total ranged from 3.1–4.4 in (78–113 mm), and this was the driest of the three (Table 8). Despite a long dry spell at the start of October, the period from October 21 until December 9 produced three excessively wet days which contributed 9.2 in (233 mm) of rain (Table 7), or more than half of the autumn's precipitation of 17.4 in (442 mm) (Table 6). December stayed quite moist as rain and snow reached 162–220 percent of normal (Table 9). A blizzard dropped heavy snow in the area December 19–20, leading to above-average snowfall for 2009. Oddly, the number of days with measurable snow was below normal (three compared with eight), so snow was heavy on snow days (Table 6).

Table 6. Status of 2009 precipitation indicators compared to the 30-year normal (1971-2000) at Corbin (CORV2) and Louisa (LOUV2) weather observing stations.

Precipitation Indicator	Corbin, VA 2009	Corbin, VA 1971–2000	Louisa, VA 2009	Louisa, VA 1971–2000
Annual Precipitation	49.0 in 1245 mm	44.5 in 1130 mm	46.7 in 1186 mm	44 in 1118 mm
Autumn (Oct, Nov, Dec) Precipitation	17.4 in 442 mm	10.5 in 267 mm	17.3 in 439 mm	10.8 in 274 mm
Heavy Rain (days with ≥ 1.0 in (25 mm) rain)	19	11	13	12
Extreme Rain (days with ≥ 2.0 in (51 mm) rain)	5	2	2	2
Micro-drought (strings of 7+ days without rain)	17	10	10	10
Annual Snowfall	23.3 in 59.2 cm	16.7 in 42.4 cm	31.6 in 80.3 cm	19.8 in 50.3 cm
Snow (days with ≥ 0.1 in (0.3 cm) snow)	3	8	6	7
Moderate Snow (days with ≥ 2.0 in (5.0 cm) snow)	2	2	3	4
Heavy Snow (days with ≥ 5.0 in (15.2 cm) snow)	2	1	2	1

Table 7. Top five wettest days and top five dry spells (consecutive days with a trace or less of rainfall) during 2009 from weather observing stations at Corbin (CORV2) and Louisa (LOUV2).

Wettest Days in 2009	Dry Spells in 2009
Nov. 13: 4.2 in (107 mm)	Jan. 8–27
Dec. 9: 2.6 in (66 mm)	Sep. 28–Oct. 14
Jun. 4: 2.5 in (64 mm)	Mar. 3–18
Jun. 3: 2.5 in (64 mm)	Jul. 22–Aug. 5
Oct. 28: 2.4 in (61 mm)	Aug. 7–Aug. 19

Table 8. Summary of 2009 monthly total rainfall for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Corbin	CORV2	3.1 in	0.2 in	0.5 in	3.3 in	5.6 in	10.9 in	2.9 in	2.9 in	2.3 in	4.4 in	7.6 in	5.4 in	49.0 in
		80 mm	6 mm	11 mm	83 mm	142 mm	277 mm	73 mm	73 mm	58 mm	113 mm	193 mm	137 mm	1,245 mm
Fredericksburg Sewage Plant	FEDV2	2.6 in	0.1 in	2.0 in	3.2 in	5.1 in	8.0 in	2.3 in	4.1 in	1.9 in	4.1 in	7.1 in	5.4 in	45.8 in
		66 mm	3 mm	52 mm	82 mm	130 mm	202 mm	58 mm	104 mm	49 mm	104 mm	180 mm	137 mm	1,163 mm
Louisa	LOUV2	1.8 in	0.5 in	2.8 in	3.0 in	6.5 in	7.0 in	2.6 in	2.6 in	2.5 in	3.1 in	7.1 in	7.2 in	46.7 in
		46 mm	14 mm	71 mm	77 mm	165 mm	177 mm	66 mm	66 mm	64 mm	78 mm	180 mm	182 mm	1,186 mm

Table 9. Summary of 2009 percent of normal rainfall based on 30-year normal (1971–2000) for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Corbin, VA	CORV2	84	7	11	100	139	303	66	78	58	114	228	162	110
Fredericksburg Sewage Plant, VA*	FEDV2	74	3	51	103	131	232	54	117	50	111	211	165	110
Louisa, VA	LOUV2	51	19	71	97	165	203	62	74	65	83	212	220	110

*Indicates a station's Period of Record is less than 30 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. Stations with an insufficient percentage of time reporting precipitation for 2009 were not included in this table.

Fredericksburg and Spotsylvania National Military Park
Percent of Average Monthly Precipitation
2009 vs. 1971–2000

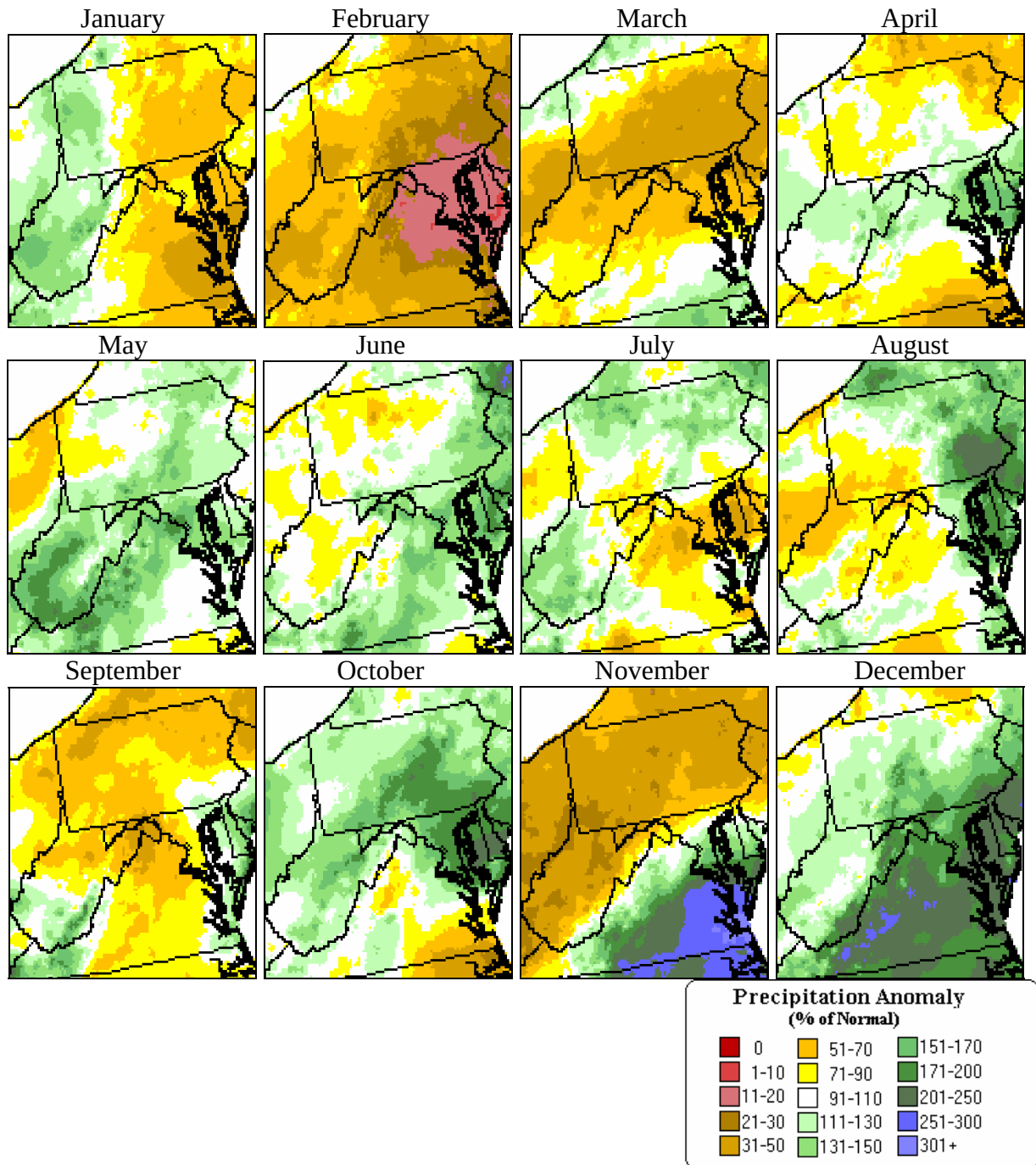


Figure 4. Maps showing percent of average monthly precipitation compared to the 30-year normal (1971-2000).

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 2009 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 2010). 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 2009.

According to the PDSI, dry conditions finally ended in March after 27 consecutive months of PDSI below 0. Wetter weather returned during the spring, allowing the drought index to return to normal conditions. Drier conditions developed during the summer and early autumn causing the PDSI to fall below normal; however, November and December erased any drought, and by the end of the year the region was very moist. Comparing 2009 with previous years shows that the long-term dry conditions were replaced by more normal precipitation. Only two months, January and February, were slightly drier than 2007. The remaining ten months showed improvement from the last two years.

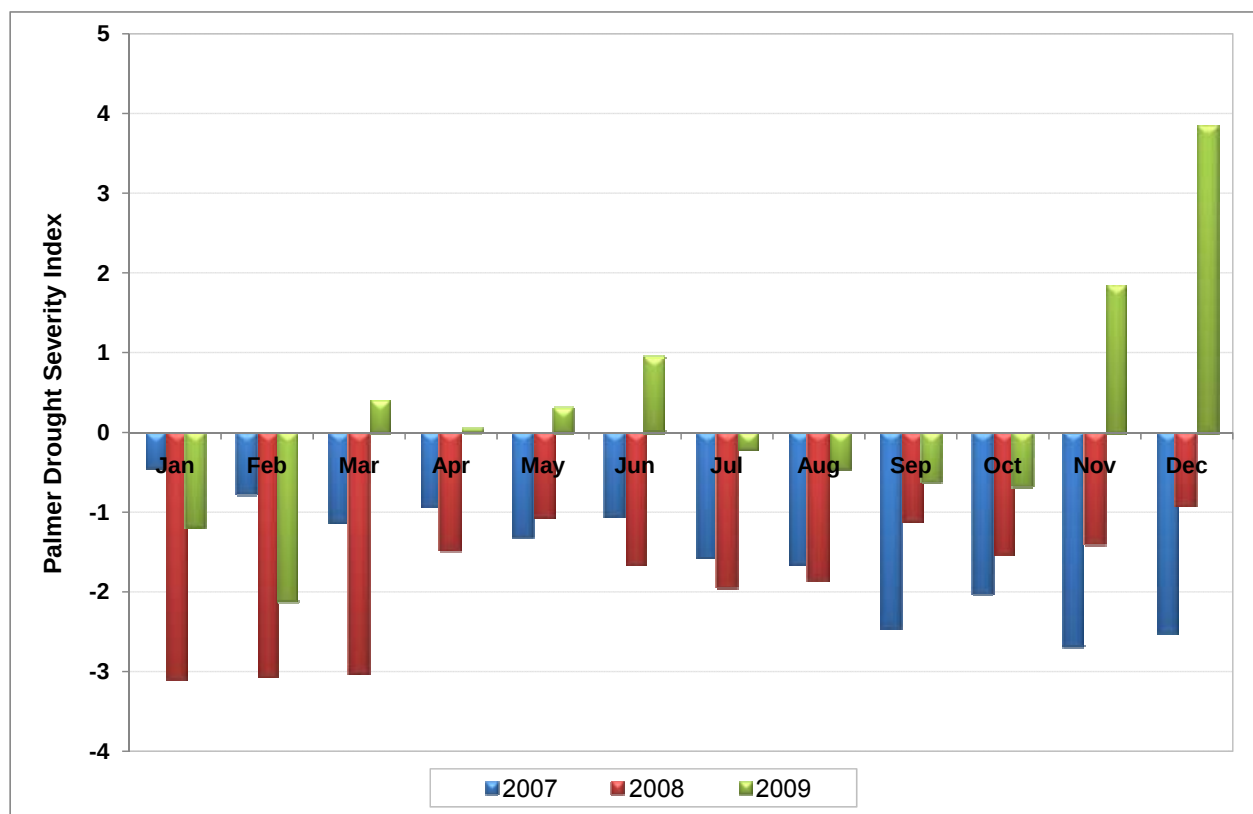


Figure 5. Palmer Drought Severity Index (PDSI) for the Eastern Piedmont, 2007–2009.

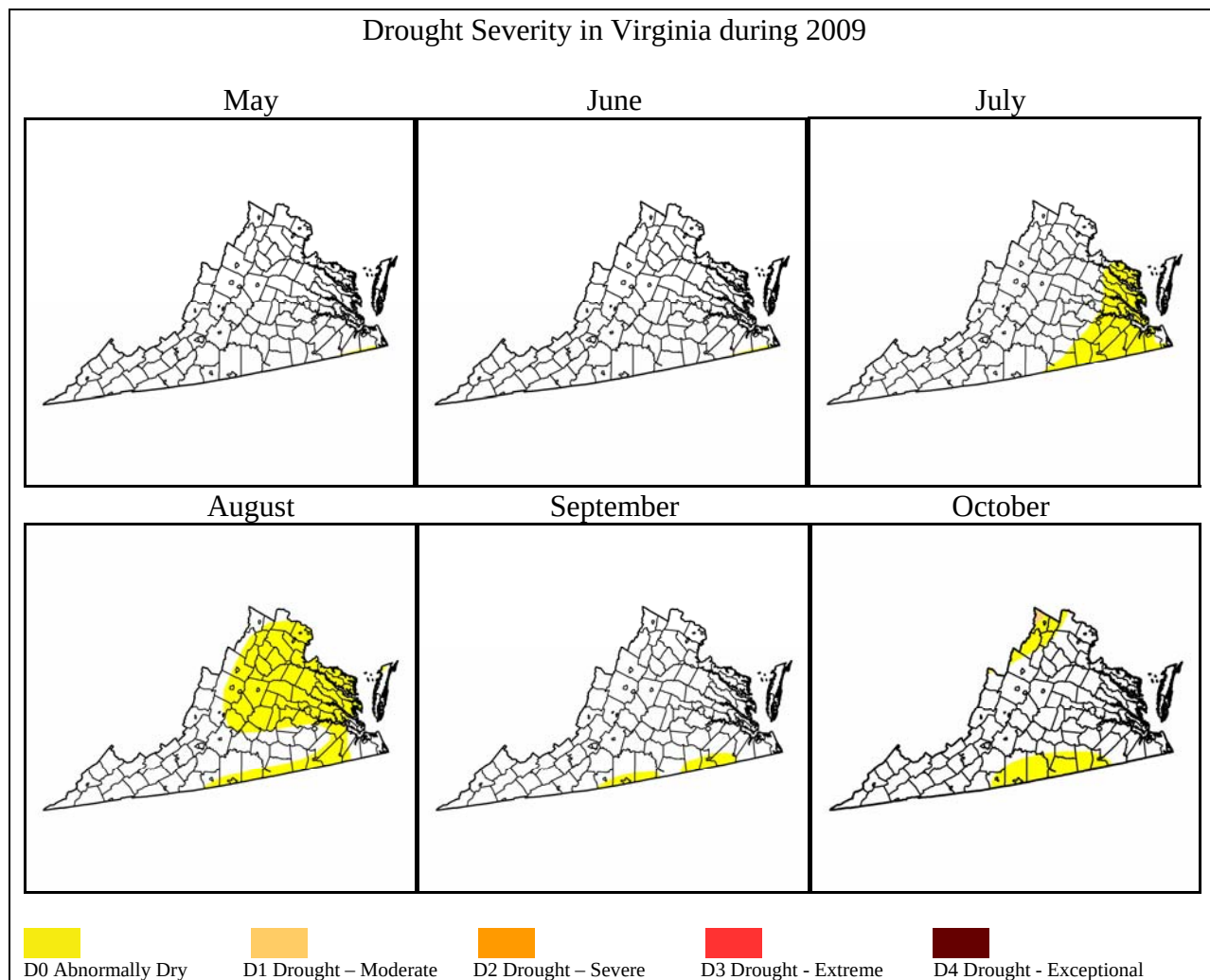


Figure 6. Mid-month values of the Palmer Drought Severity Index for Virginia in 2009.

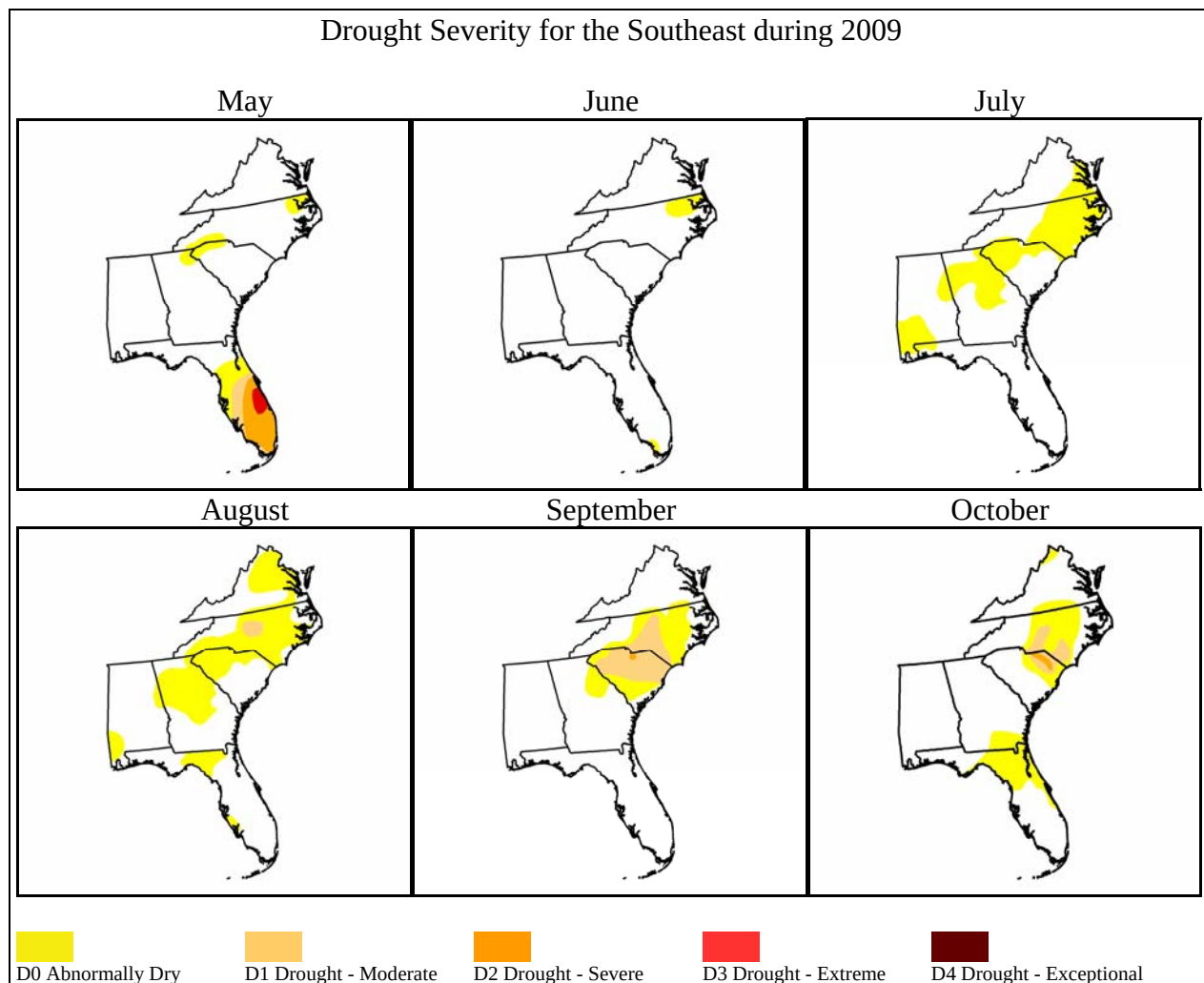


Figure 7. Mid-month values of the Palmer Drought Severity Index for the Southeast in 2009.

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Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

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