



Weather of Eisenhower National Historic Site and Gettysburg National Military Park

Mid-Atlantic Network Summary Report for 2014

Natural Resource Report NPS/MIDN/NRR—2016/1111



ON THE COVER

Sunset at Gettysburg National Military Park
Photograph by: Nicolas Raymond.

Weather of Eisenhower National Historic Site and Gettysburg National Military Park

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Table of Contents

	Page
Figures.....	iv
Tables.....	v
List of Key Acronyms.....	vi
Introduction.....	1
Climate of the Lower Susquehanna	2
Observing Stations	3
Temperature Summary.....	8
Precipitation Summary.....	14
Drought Status	18
References.....	22
Appendix.....	23

Figures

	Page
Figure 1. Location of weather observing stations around Eisenhower National Historic Site and Gettysburg National Military Park selected as most representative of the parks in 2014.....	6
Figure 2. Maps showing departure from average monthly maximum temperature in 2014 compared to the 30-year normal (1981–2010).....	10
Figure 3. Maps showing departure from average monthly minimum temperature in 2014 compared to the 30-year normal (1981–2010).....	11
Figure 4. Maps showing percent of average monthly precipitation in 2014 compared to the 30-year normal (1981–2010).....	15
Figure 5. Palmer Drought Severity Index (PDSI) for the Lower Susquehanna, 2012–2014.....	19
Figure 6. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for Pennsylvania in 2014.	20
Figure 7. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for the Northeast in 2012.	21

Tables

	Page
Table 1. List of weather observing stations around Eisenhower NHS and Gettysburg NMP selected as most representative of the parks in 2014.....	7
Table 2. Status of 2014 temperature indicators compared to the 30-year normal (1981–2010) and the station period of record at the Biglerville (BGLP1) weather observing station.....	12
Table 3. Summary of 2014 monthly average temperatures for selected stations.....	13
Table 4. Summary of 2014 departure from normal temperature based on 30-year normal (1981–2010) for selected stations.	13
Table 5. Seasonal and annual temperature and precipitation rankings for 2014 over 120 years for the Lower Susquehanna (NOAA 2015).....	13
Table 6. Status of 2014 precipitation indicators compared to the 30-year normal (1981–2010) and the station period of record at the Biglerville (BGLP1) weather observing station.....	16
Table 7. Top five wettest days and top five dry spells (consecutive days with a trace or less of liquid precipitation) during 2014 from the weather observing station at Biglerville (BGLP1).....	16
Table 8. Summary of 2014 monthly total precipitation for selected stations.....	17
Table 9. Summary of 2014 percent of normal precipitation based on the 30-year normal (1981–2010) for selected stations.	17

List of Key Acronyms

ASOS	Automated Surface Observation System
CASTNET	Clean Air Status and Trends Network
COOP	National Weather Service Cooperative Observer Program
CWOP	Citizen Weather Observer Program
EISE	Eisenhower National Historic Site
FAA	Federal Aviation Administration
GETT	Gettysburg 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
NHS	National Historic Site
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, 2014, and to place current patterns and trends in an appropriate historical, regional, and global context (Marshall et al. 2012). It is our intention that this report will satisfy an inherent interest in meteorological phenomena and meet the Mid-Atlantic Network (MIDN) Weather and Climate Monitoring objective:

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

To accomplish this objective, a variety of atmospheric data streams were evaluated for their quality, longevity, and applicability to the MIDN parks. Since no single weather observing network contains all the pertinent measures of atmospheric phenomena to assess ecosystem health, an objective analysis of the data networks was developed and outlined in the Weather and Climate Monitoring Protocol for the Eastern Rivers and Mountains Network and Mid-Atlantic Network of the National Park Service (Marshall et al. 2012). Through this analysis, a select number of weather/climate observing stations were chosen as representative of each park; these are the primary data sources used in the profile of 2014'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. This report includes a summary of several of these indicators for the period of record of selected stations (ending on December 31, 2013). These key indicators are further described in the protocol (Marshall et al. 2012) and are summarized in the body of this report.

Climate of the Lower Susquehanna

Eisenhower National Historic Site (NHS) and Gettysburg National Military Park (NMP) are located in Pennsylvania Climate Division 4, known as the “Lower Susquehanna”. 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>). Pennsylvania is divided into ten climate divisions. The Lower Susquehanna River Valley 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 the valley. 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 the greatest effect within this portion of Pennsylvania, causing severe floods in some instances (Gelber 2002).

Temperatures are moderately continental with the tempering effects of the Great Lakes contributing to some cloud production in the winter and onshore winds 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 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 directs hot, humid air from the Gulf region into the Susquehanna Valley. The southwest winds gain additional warmth when descending the crest of the Appalachians. The last freeze and first frost typically occur in late April and late October, respectively.

Precipitation is fairly evenly distributed throughout the year. Annual amounts generally range between 34–52 in (864–1,321 mm), while the majority of places receive 38–46 in (965–1,168 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, although 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, but flash floods and damaging thunderstorm winds affect parts of the Valley 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, but are primarily confined to the months between December and March (Kocin and Uccellini 2004).

Observing Stations

A total of two weather observing stations comprised of two weather observing networks were selected as the most representative weather stations around Eisenhower NHS and Gettysburg NMP in 2014 (Figure 1). Representative stations within a 100-km range of each park were chosen based on several criteria, which include proximity to the parks, 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 two stations were ultimately used for this 2014 report: Arendtsville and Biglerville (Table 1, Figure 1).

One station, Biglerville (1972-current), was used for a long-term trend analysis using the period of record for the station ending December 31, 2013. Graphs of these long-term trends are shown in the Appendix section of this document. For temperatures, long-term means and the standard deviation above and below the long-term mean are computed for each indicator. Because precipitation distributions do not fall on a normal curve like temperature distributions do, standard deviations are not computed for the precipitation indicators.

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 2014) 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

Of the two stations, only Biglerville has a Period of Record (POR) sufficiently long for a 30-year normal (normal calculated from years 1981–2010). However, for Arendtsville, a normal was calculated based on a POR from 1988–2010. Monthly averages and deviations from normal are presented for all stations for precipitation and 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 selected 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>.

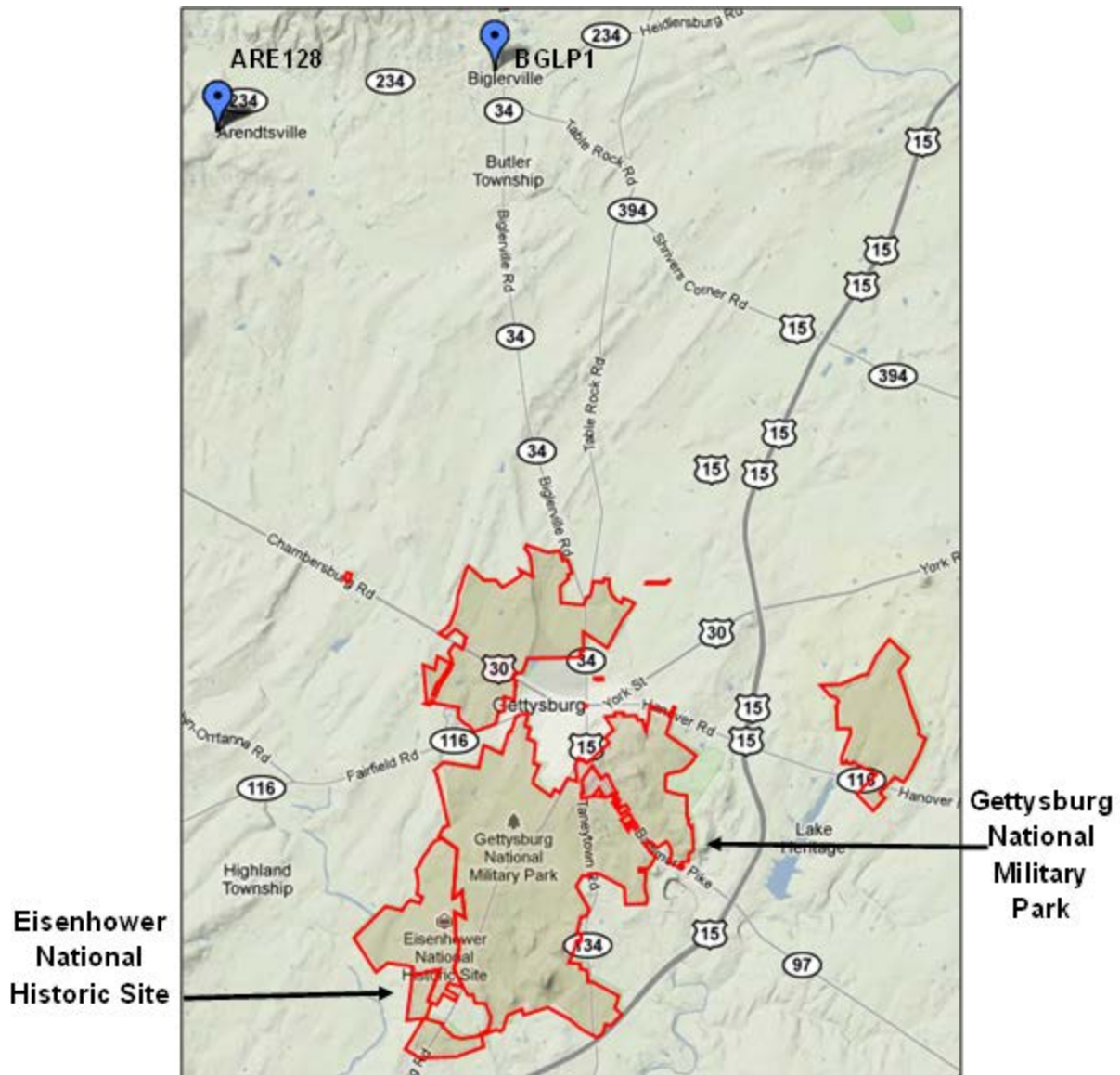


Figure 1. Location of weather observing stations around Eisenhower National Historic Site and Gettysburg National Military Park selected as most representative of the parks in 2014. See Table 1 for station names.

Table 1. List of weather observing stations around Eisenhower NHS and Gettysburg NMP selected as most representative of the parks in 2014.

Station	Observing Network ¹	Name	Period of Record (POR)		Percentage of time reporting temperature for 2014	Percentage of time reporting precipitation for 2014	Percentage of time reporting temperature for entire POR	Percentage of time reporting precipitation for entire POR
ARE128	CASTNET	Arendtsville	07/01/1988	Present	99.2	38.4	96.3	91.6
BGLP1	COOP	Biglerville	02/02/1972	Present	100.0	100.0	99.9	99.6

¹ Observing networks are: CASTNET — Clean Air Status and Trends Network, COOP — National Weather Service Cooperative Observer Program.

Temperature Summary

Temperatures were below normal more than half of the time during 2014 for the areas around Eisenhower NHS and Gettysburg NMP (Figures 2 and 3). The average annual maximum temperature was 1.8°F (1.3°C) below normal and the average annual minimum was 1.2°F (0.6°C) below normal, resulting in an overall 1.5°F (0.9°C) lower average annual temperature compared to normal (Table 2)¹.

The year began very cold with the year's lowest reading of -3°F (-19.4°C) on January 7-8th, which is just below the normal value of -2.5°F (-19.2°C) (Table 2). Accordingly the average temperatures for January were between 7.1°F to 7.3°F (3.9°C to 4.0°C) below the long-term normal (Tables 3 and 4). With the frigid start in January, February stayed quite cold with readings around -4.0°F to -4.4°F (-2.2°C to -2.4°C) below average (Table 4). The cold trend persisted into March, which averaged as much as 6.3°F (3.5°C) below the long-term average (Table 4) making it the 13th coldest March of record. The number of cold days in 2014 was about double the normal (Table 2). The winter, based on the Lower Susquehanna climate division, tied as 6th coldest in 120 years of records (Table 5).

Spring saw temperatures staying above seasonal levels in two of the three months, though April averaged as much as 1.5°F (0.8°C) below the long-term mean (Table 4). May was milder based on warmer nights (Figure 3). Above average conditions persisted in June with a monthly mean temperature around 70.9°F (21.6°C) (Table 3). As a result of the warmth, spring 2014 ranked as the 35th warmest on record for the Lower Susquehanna (Table 5).

The summer was noticeably cooler than previous years; it was tied as the 41th coolest in 120 years (Table 5). July was cool, with mean temperatures as much as 1.7°F (0.9°C) below the normal (Table 4). As a result, the highest readings of the year, 94.0°F (34.4°C), fell several degrees below the usual summer maximum (Table 2). Over the year, the number of days with maximum temperatures reaching 90°F (32.2°C) tallied 12, compared with a normal of 17 days (Table 2). August was even cooler, with readings averaging 2.5°F to 3.2°F (1.4°C to 1.8°C) below the normal temperatures (Table 4). September was milder, though there were some cool nights at mid-month (Figure 3).

Autumn featured a warm October and a very chilly November and a warm December (Figures 2 and 3). The season's first freeze occurred on November 8th and the number of sub-freezing days for the year was 122, which is more than the long-term mean of 113 days (Table 2). November was dominated by numerous days below normal (20 of 30 days) (Figure 2), which kept the mean temperatures from 4.1°F to 4.3°F (-2.3°C to -2.4°C) below normal (Table 4). A combination of warm nights and mild days in December kept the monthly mean temperatures for December well above

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 is at <http://www.prism.oregonstate.edu/>.

normal (Table 4).Autumn ranked as the 31st warmest due to the very mild December (Table 5). The growing season in 2014 was more than three weeks longer than the 30-year average (Table 2).

Eisenhower National Historic Site
and Gettysburg National Military Park
Departure from Average Monthly Maximum Temperature
2014 vs. 1981–2010

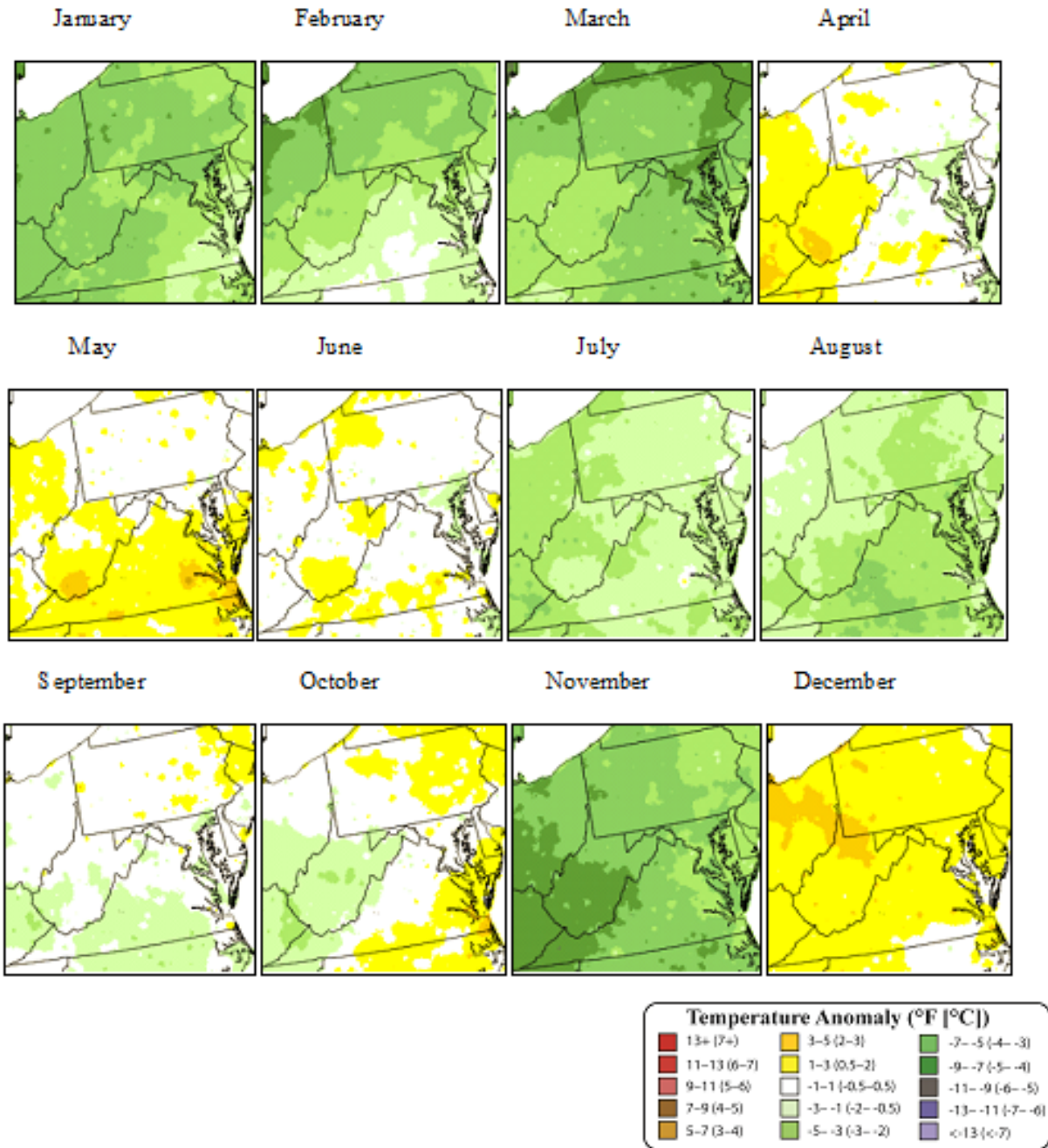


Figure 2. Maps showing departure from average monthly maximum temperature in 2014 compared to the 30-year normal (1981–2010).

Eisenhower National Historic Site
and Gettysburg National Military Park
Departure from Average Monthly Minimum Temperature
2014 vs. 1981–2010

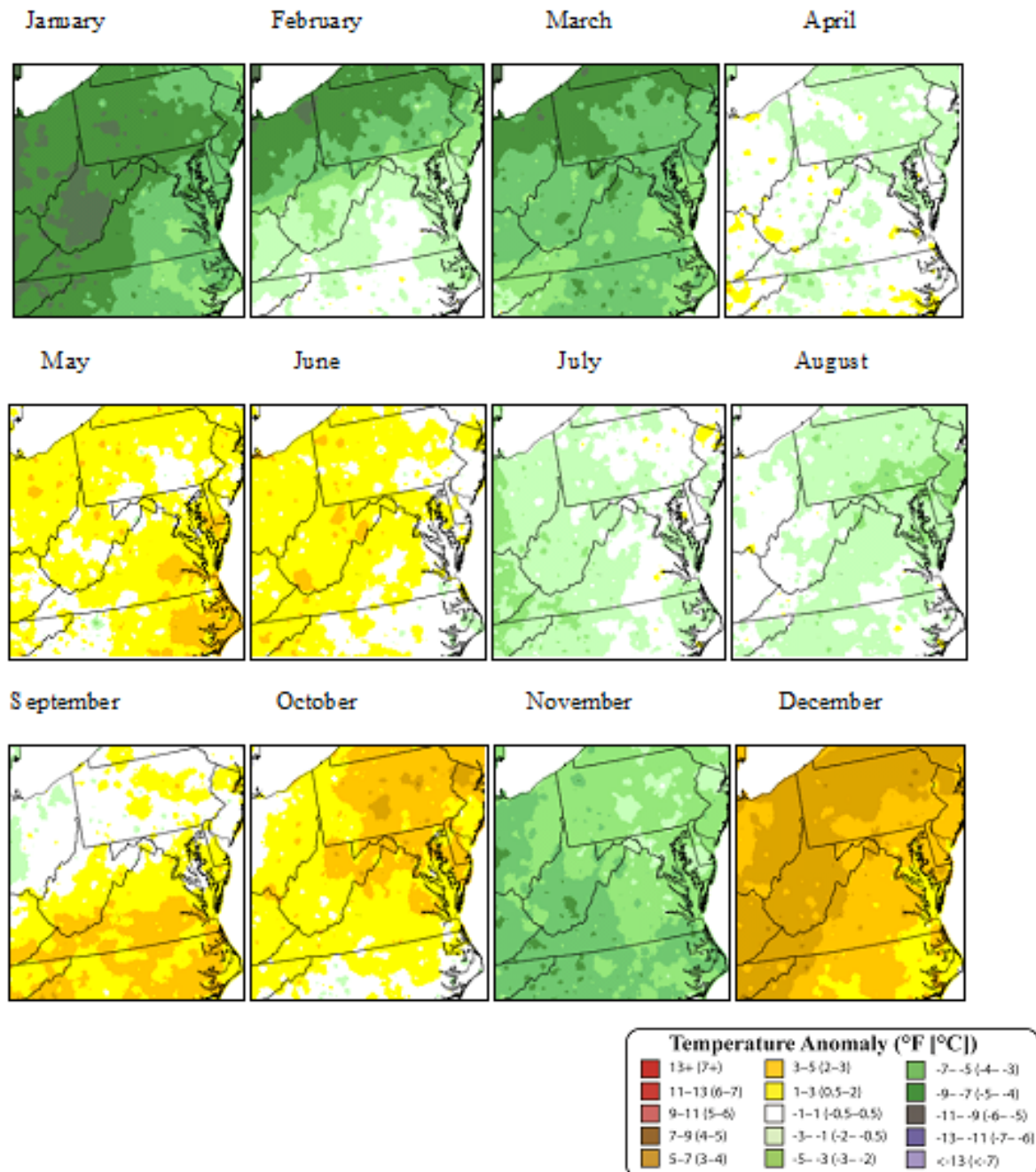


Figure 3. Maps showing departure from average monthly minimum temperature in 2014 compared to the 30-year normal (1981–2010).

Table 2. Status of 2014 temperature indicators compared to the 30-year normal (1981–2010) and the station period of record at the Biglerville (BGLP1) weather observing station.

Temperature Indicator	Biglerville, PA 2014	Biglerville, PA 1981–2010	Biglerville, PA 1972-2013 Mean (± 1 SD)
Average Annual Temperature	50.8°F 10.44°C	52.3°F 11.3°C	51.7 (50.2 – 53.3) °F 10.9 (10.1 – 11.8) °C
Average Annual Maximum Temperature	60.5°F 15.8 °C	62.3°F 17.1°C	NA
Maximum Temperature	94.0°F 34.4°C	97.5°F 36.4°C	95.7 (92.5 – 98.9) °F 35.4 (33.6 – 37.2) °C
Hot Days (days with Tmax $\geq$ 90°F/32°C)	12	17	17 (6 – 28)
Average Annual Minimum Temperature	41.1°F 5.1°C	42.3°F 5.7°C	NA
Minimum Temperature	-3.0°F -19.4°C	-2.5°F -19.2°C	-0.4 (-6.7 to 7.5) °F -18.0 (-14.1 to -21.9) °C
Cold Days (days with Tmax $\leq$ 32°F/0°C)	40	21	NA
Sub-freezing Days (days with Tmin $\leq$ 32°F/0°C)	122	113	120 (106 – 135)
Sub-zero Days (days with Tmin $\leq$ 0°F/-17.8°C)	6	1	NA
Growing Season Length (days between last spring Tmin 32°F/0°C and first fall Tmin 32°F/0°C)	203	180	178 (158 – 199)

Table 3. Summary of 2014 monthly average temperatures for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Biglerville	BGLP1	22.1°F	27.4°F	33.5°F	50.6°F	61.7°F	71.3°F	74.1°F	70.1°F	66.3°F	55.9°F	39.6°F	36.7°F	50.8°F
		-5.5°C	-2.6°C	0.8°C	10.3°C	16.5°C	21.8°C	23.4°C	21.2°C	19.1°C	13.3°C	4.2°C	2.6°C	10.4°C
Arendstville	ARE128	23.8°F	28.9°F	35.7°F	50.5°F	62.4°F	70.5°F	72.1°F	69.7°F	65.4°F	56.0°F	40.3°F	37.1°F	51.0°F
		-4.5°C	-1.7°C	2.1°C	10.3°C	16.9°C	21.4°C	22.3°C	20.9°C	18.6°C	13.3°C	4.6°C	2.8°C	10.6°C

Table 4. Summary of 2014 departure from normal temperature based on 30-year normal (1981–2010) for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Biglerville	BGLP1	-7.1°F	-4.4°F	-6.3°F	0.0°F	0.8°F	1.0°F	-0.8°F	-3.2°F	1.1°F	2.3°F	-4.1°F	3.3°F	-1.4°F
		-3.9°C	-2.4°C	-3.5°C	0.0°C	0.4°C	0.6°C	-0.4°C	-1.8°C	0.6°C	1.3°C	-2.3°C	1.8°C	-0.8°C
Arendstville ¹	ARE128	-7.3°F	-4.0°F	-5.2°F	-1.5°F	0.7°F	0.8°F	-1.7°F	-2.5°F	0.4°F	1.1°F	-4.3°F	3.0°F	-1.7°F
		-4.0°C	-2.2°C	-2.9°C	-0.8°C	0.4°C	0.5°C	-0.9°C	-1.4°C	0.2°C	0.6°C	-2.4°C	1.7°C	-0.9°C

¹Indicates a station's Period of Record is five or more years but 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 and annual temperature and precipitation rankings for 2014 over 120 years for the Lower Susquehanna (NOAA 2015).

	Climate Division 4 Rankings — Lower Susquehanna				
	Jan–Feb–Mar WINTER	Apr–May–Jun SPRING	Jul–Aug–Sep SUMMER	Oct–Nov–Dec AUTUMN	Jan–Dec YEAR
Temperature – 2014	115-T	35	80-T	31	89-T
Precipitation – 2014	46	22	88	59	49

1 = warmest/wettest year and 120 = coldest/driest year. T = Tie between multiple years.

Precipitation Summary

The year ending on December 31, 2014, was the 49th wettest on record for Eisenhower NHS and Gettysburg NMP (Figure 4, Table 5 and 6). It started with the 46th wettest winter in 120 years, followed by a very wet spring (Table 5). Though variable throughout the year, it was a year with six months above and six months below average.

While January averaged below normal precipitation (66-67 percent), February and March averaged mainly above-normal precipitation. In fact, February brought as much as 4.0 in (102 mm) of precipitation to Arendtsville, which is 143 percent of normal (Tables 8 and 9). Snowfall for the year tallied 39.8 in (101 cm), which was well above the long-term average of 25.9 in (Table 6). There were 16 days with measurable snow, compared with 11 days in a typical year (Table 6). Nevertheless, only one of the wettest days of 2014 occurred during the winter season, oddly on March 31st which is the last day of the season (Table 7). March was generally moist, with 87 percent of normal rain and snowfall in Biglerville, but 150 percent of normal in Arendtsville. Despite the generally moist conditions, there were three periods of seven days or more without measurable rain or snow, with one in each month (Table 7).

May was the 34th wettest on record for the Lower Susquehanna region, but then June turned a smidge drier and tied as the 41st wettest (Figure 4). June tallied 124-149 percent of normal rainfall (Table 9). The maximum monthly precipitation total during the spring was measured at Arendtsville in May with 8.2 in (207 mm). May had one of the top five wettest days in 2014 with 3.38in (86 mm) falling on May 16th (Table 7).

The region had below-average rainfall during 2 of the 3 summer months, with 2.1 in (53 mm) in July and 5.6 in (143 mm) during August (Table 8). There was no direct contribution to rainfall from tropical storms or hurricanes during this period. A total of only 1.6 in (40 mm) was tallied at Biglerville in September (Table 8). Two dry spells occurred during the summer of 2014. The period from June 28 to July 8 and August 25 to September 2 had no measurable rain (Table 7). This season ranked as the 33rd driest in 120 years for the Lower Susquehanna (Table 5), though one of the five wettest days in 2014 occurred on August 4th.

Autumn had an near-normal amount of precipitation with 10.4 in (264 mm) of rain and snow falling compared with a 10.3 in normal (262 mm) (Table 6). October had well above average rainfall. One of the wettest days in 2014 occurred on October 16th when 2.06 in (52 mm) fell (Table 7). No dry spells occurred during the autumn (Table 7). The autumn ranked virtually normal, ranking 59th in 120 years of record keeping (Table 5) , yet the annual precipitation total was surprisingly 0.72 in (18 mm) below the 30-year average from 1981–2010 (Table 6). Overall, there were 7 days when more than 1 in (25.4 mm) of rain was measured during 2014 (Table 6).

Eisenhower National Historic Site
and Gettysburg National Military Park
Percent of Average Monthly Precipitation

2014 vs. 1981–2010

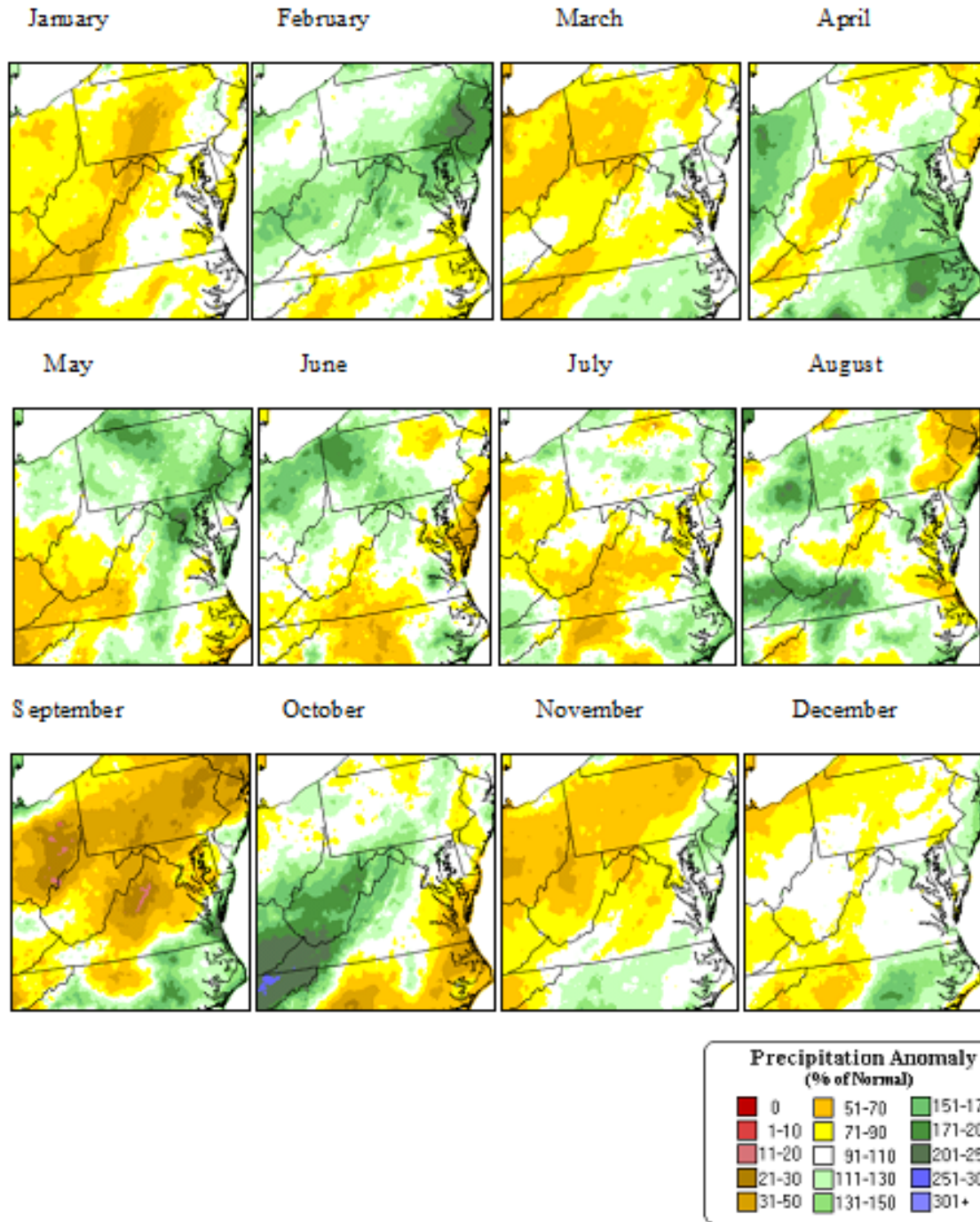


Figure 4. Maps showing percent of average monthly precipitation in 2014 compared to the 30-year normal (1981–2010).

Table 6. Status of 2014 precipitation indicators compared to the 30-year normal (1981–2010) and the station period of record at the Biglerville (BGLP1) weather observing station.

Precipitation Indicator	Biglerville, PA 2014	Biglerville, PA 1981–2010	Biglerville, PA 1972–2013 Mean (min – max)
Annual Precipitation	42.6 in 1,082 mm	43.3 in 1,100 mm	43.8 (29.8 – 65.4) in 1,113 (757 – 1,661) mm
Autumn (Oct, Nov, Dec) Precipitation	10.4 in 264 mm	10.3 in 262 mm	10.5 (3.6 – 16.7) in 267 (91 – 424) mm
Heavy Precipitation Days (days with ≥ 1.0 in [25 mm] rain)	7	11	NA
Extreme Precipitation Days (days with ≥ 2.0 in [51 mm] rain)	2	2	2 (0 – 6)
Micro-drought (periods of 7+ days without rain)	8	9	NA
Annual Snowfall	39.8 in 101.1 cm	25.9 in 65.8 cm	25.6 (6.4 – 62.0) in 65.0 (16.3 – 157.5) cm
Measurable Snow Days (days with ≥ 0.1 in [0.3 cm] snow)	16	11	NA
Moderate Snow Days (days with ≥ 3.0 in [7.6 cm] snow)	5	3	NA
Heavy Snow Days (days with ≥ 5.0 in [12.7 cm] snow)	2	1	NA

Table 7. Top five wettest days and top five dry spells (consecutive days with a trace or less of liquid precipitation) during 2014 from the weather observing station at Biglerville (BGLP1).

Wettest Days in 2014	Dry Spells in 2014
May 16: 3.38 in (85.9 mm)	June 28 - July 8
October 16: 2.06 in (52.3 mm)	January 23 - February 2
August 4: 1.84 in (46.7 mm)	August 25 - September 2
April 30: 1.38 in (35.1 mm)	March 4 - 12
March 31: 1.22 in (31 mm)	February 23 - March 2

Table 8. Summary of 2014 monthly total precipitation for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Biglerville	BGLP1	2.2 in	3.0 in	3.2 in	4.3 in	5.9 in	4.3 in	2.1 in	5.6 in	1.6in	5.0 in	2.7 in	2.7 in	42.6 in
		55 mm	77 mm	81 mm	108 mm	150 mm	110 mm	53 mm	143 mm	40 mm	127 mm	68 mm	69 mm	1082 mm
Arendtsville*	ARE128	2.0 in	4.0 in	5.4 in	3.5 in	8.2 in	5.9 in	M	M	M	M	M	M	M
		51 mm	102 mm	137 mm	89 mm	207 mm	149 mm	M	M	M	M	M	M	M

M = missing data (Monthly statistics are reported as ' M' if more than 7 days of data are missing).

*Arendtsville precipitation data for 2014 was taken from the NADP/NTN site co-located with the CASTNET site.

Table 9. Summary of 2014 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
Biglerville	BGLP1	67	105	87	118	135	124	59	161	53	129	75	83	101
Arendtsville ¹	ARE128	66	143	150	120	186	149	M	M	M	M	M	M	M

M = missing data (Monthly statistics are reported as ' M' if more than 7 days of data are missing).

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.

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 Lower Susquehanna in 2014 are shown in Figure 5.

According to the PDSI, January was near normal to start 2014 and then values hovered around moderately moist (near 2.0) for February through August. Values were closer to average conditions for September through December (near 0). When compared with the last two years, 2014 was noticeably wetter during the growing season, especially in the spring which had periods of below average conditions in recent years. However, the growing season ended drier when compared to previous seasons.

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 2014). 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 Pennsylvania (Figure 6) and the Northeast (Figure 7) are shown for 2014.

The DM – Drought Severity Index for Pennsylvania (Figure 6) and the Northeast (Figure 7) shows a pattern similar to the PDSI for the growing season (May through October); with mid September and October being the driest for the region when compared to the long-term average.

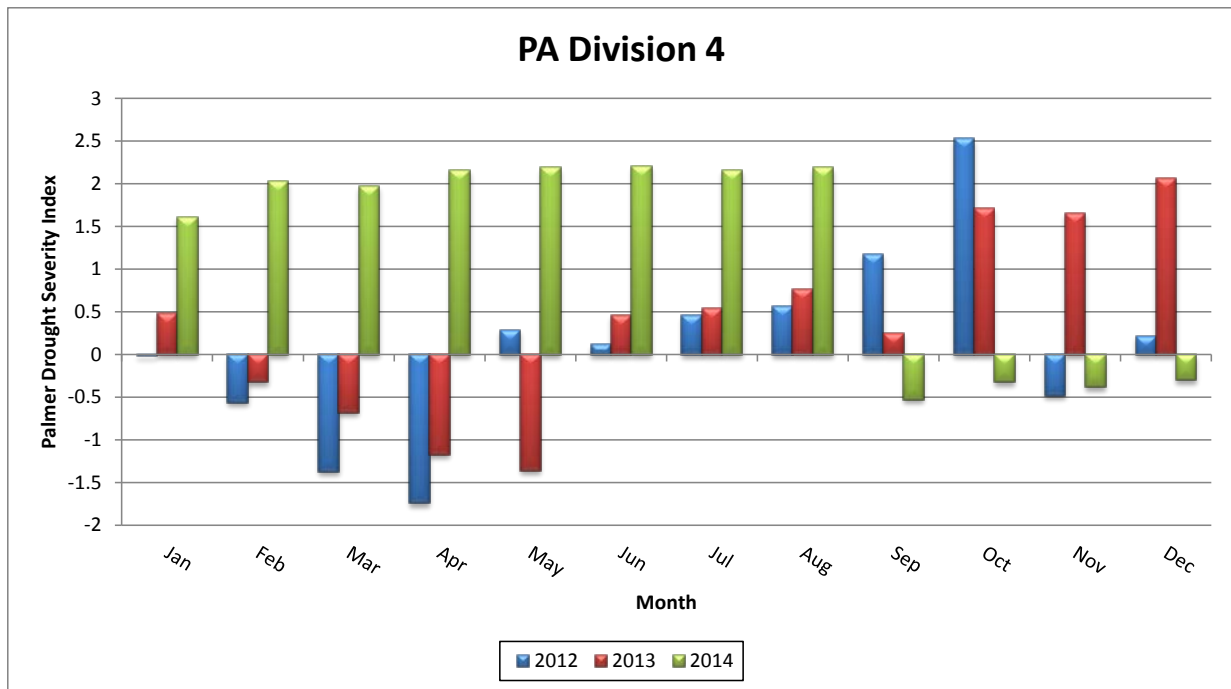


Figure 5. Palmer Drought Severity Index (PDSI) for the Lower Susquehanna, 2012–2014.

Drought Intensity in Pennsylvania During 2014

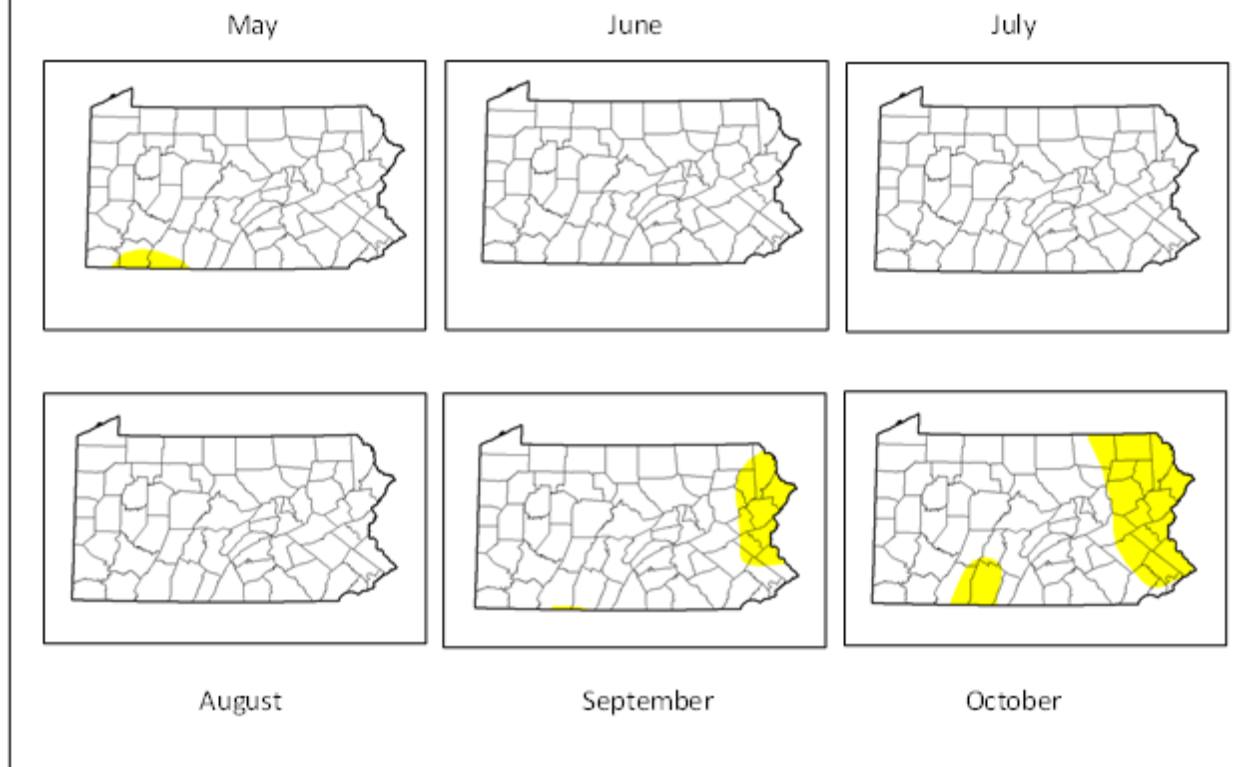


Figure 6. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for Pennsylvania in 2014.

Drought Intensity for the Northeast during 2014

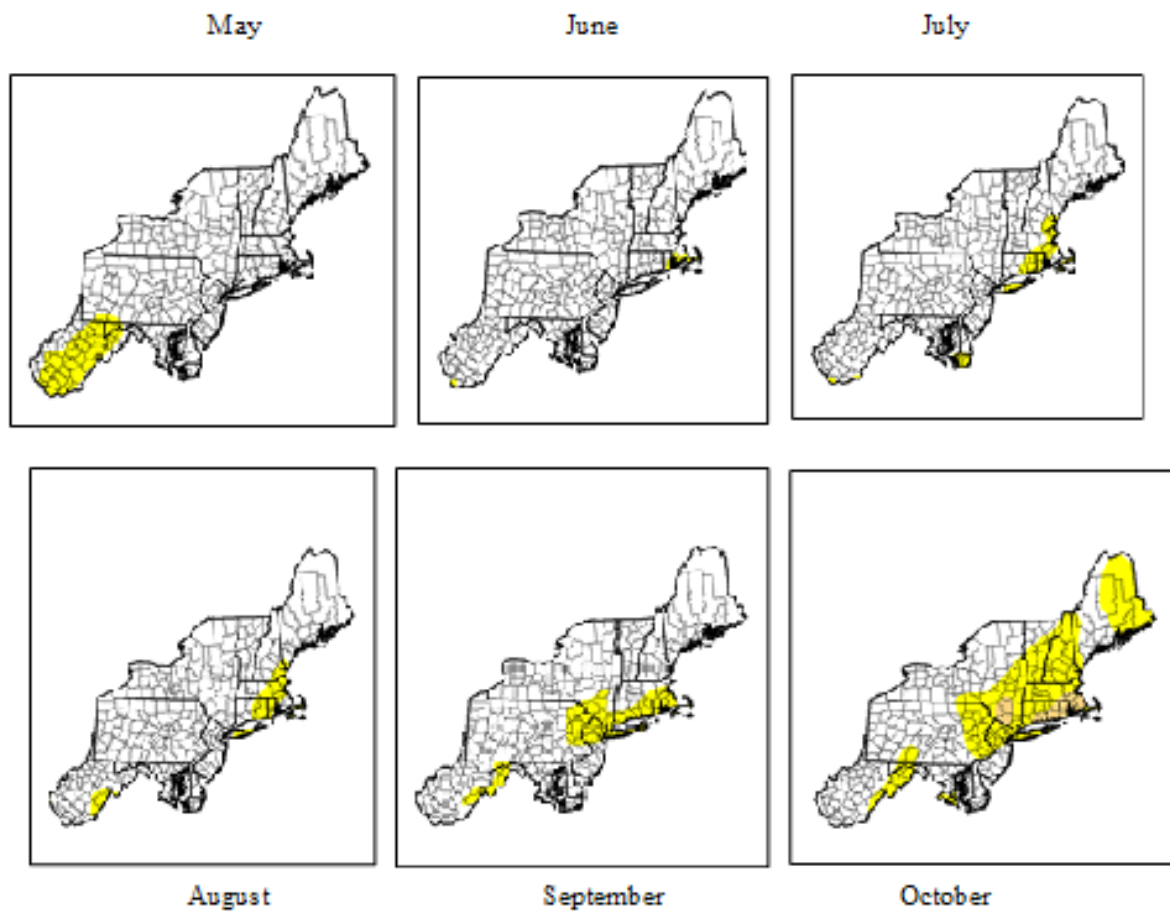


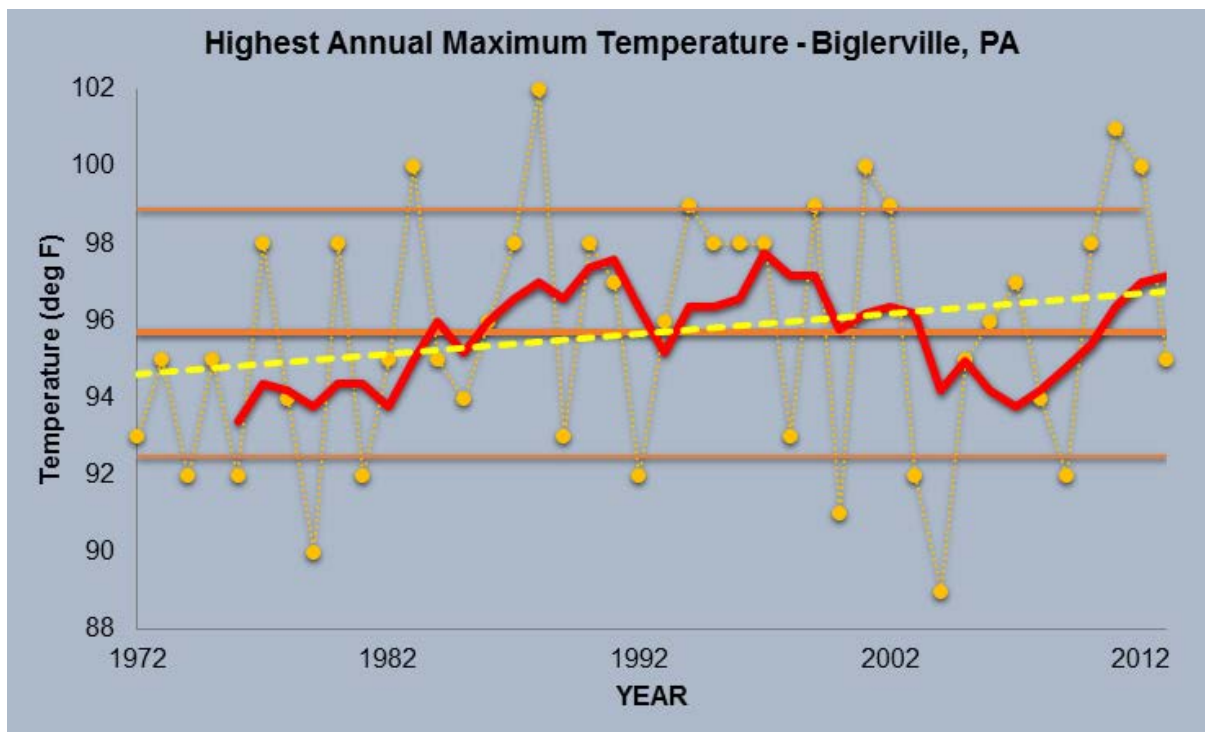
Figure 7. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for the Northeast in 2012.

References

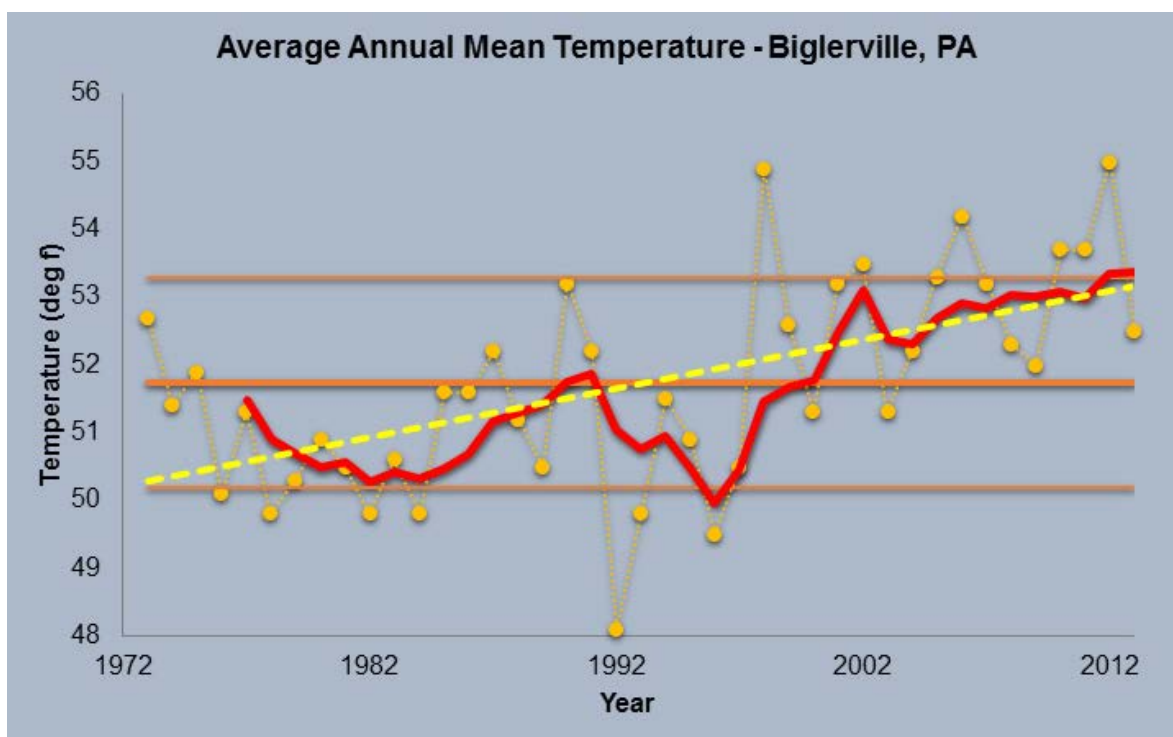
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Appendix

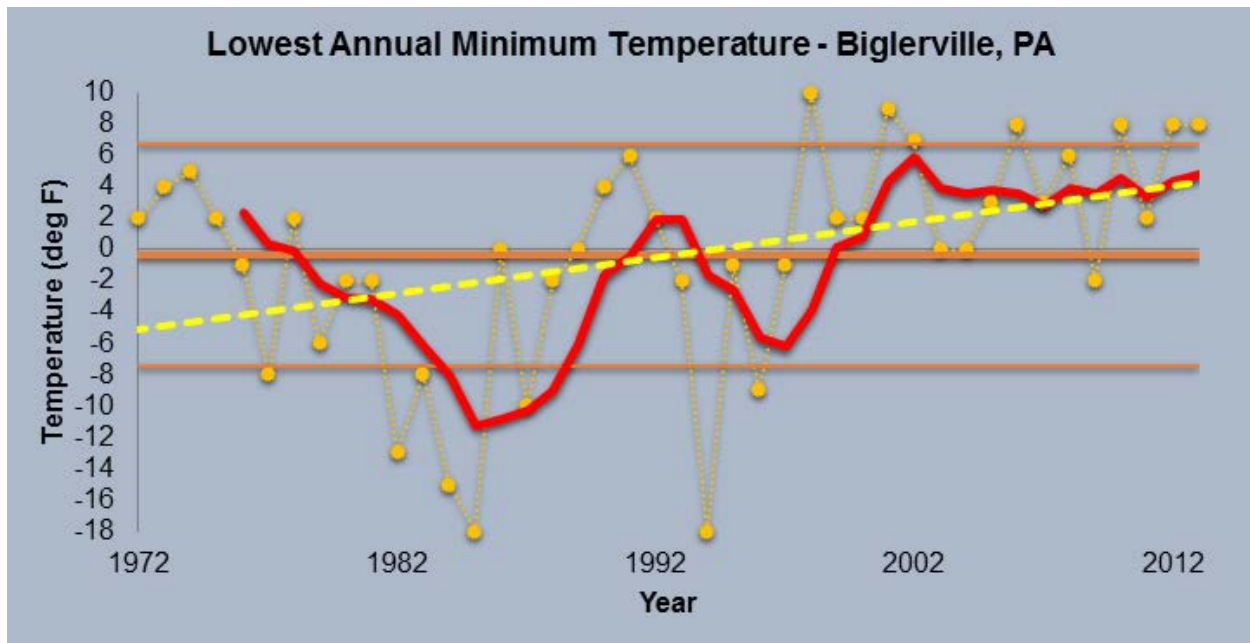
Below are graphs illustrating long-term trend analysis for multiple climate indicators at the Biglerville station. For temperature indicators, yearly values are marked by the dotted orange line, the 5-year moving average is indicated by the thick red line, the long-term linear trend is shown by the dotted yellow line, the long-term mean is marked by the thick orange line, and the first standard deviation above and below the long-term mean are delineated by the solid orange lines. Similarly for precipitation indicators, yearly values are marked by the dotted teal line, the 5-year moving average is indicated by the thick green line, the long-term linear trend is shown by the dotted yellow line, and the long-term mean is delineated by the thick light blue line.



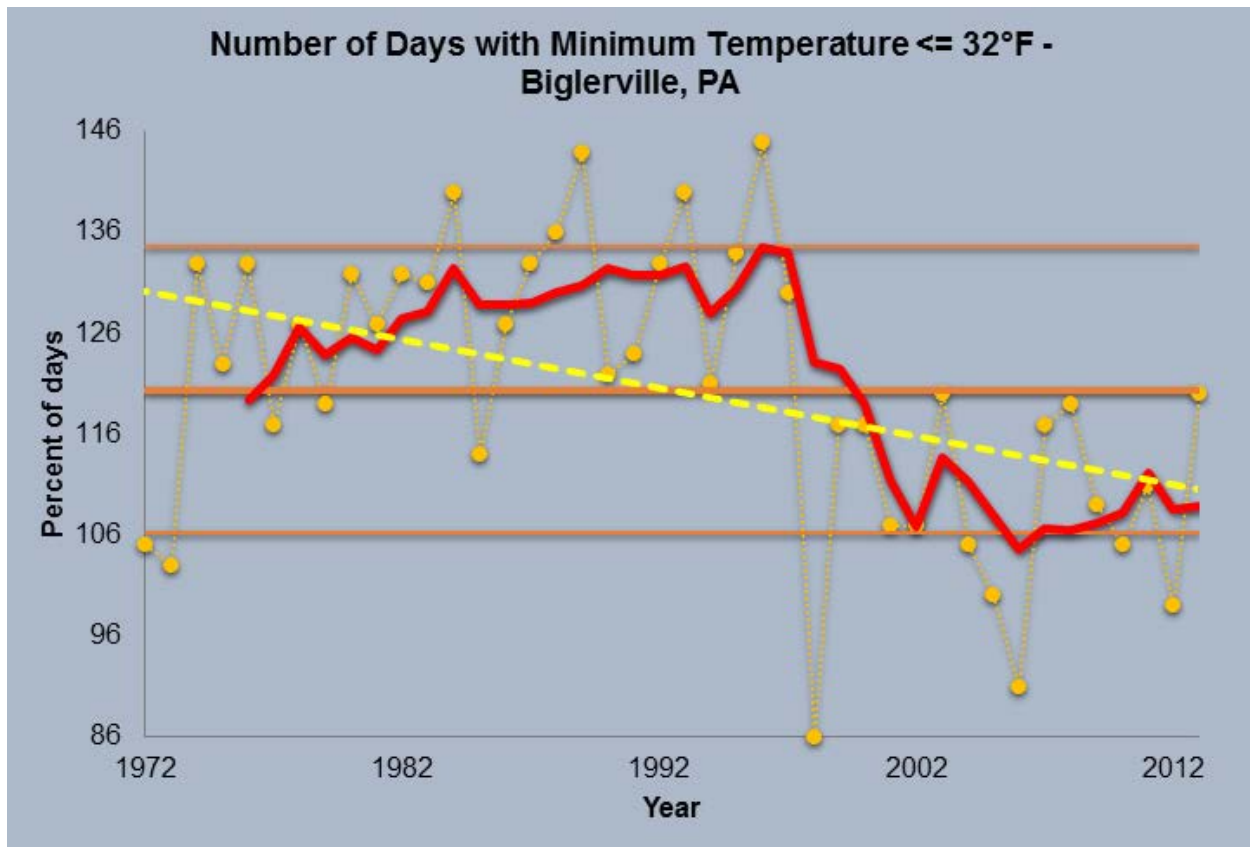
Annual Maximum Trends: There is an increasing trend during the last four decades. The average annual maximum temperature is 95.7°F (± 1 SD ranges from 92.5 - 98.9°F) (Table 2).



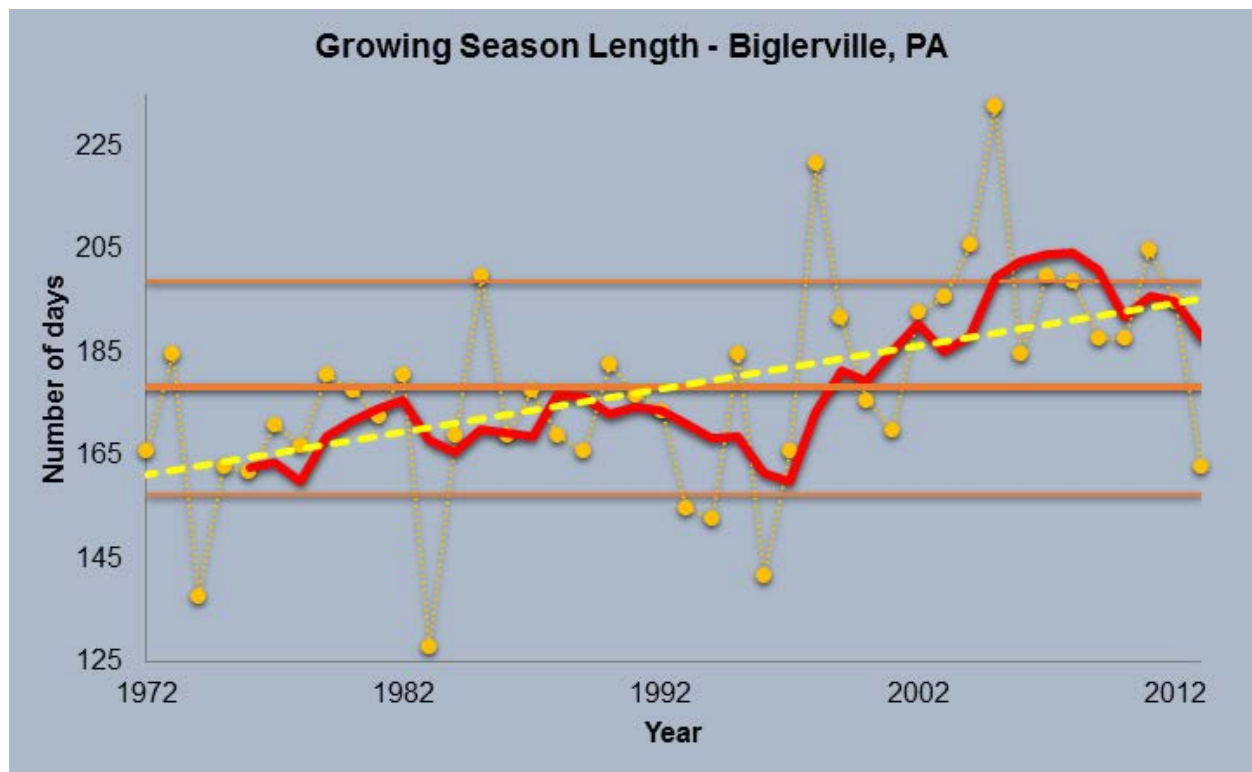
Annual Mean Trends: There is an increasing trend of around 0.7°F (0.4°C) per decade. The average annual mean temperature is 51.7°F (± 1 SD ranges from 50.2 - 53.3°F, Table 2).



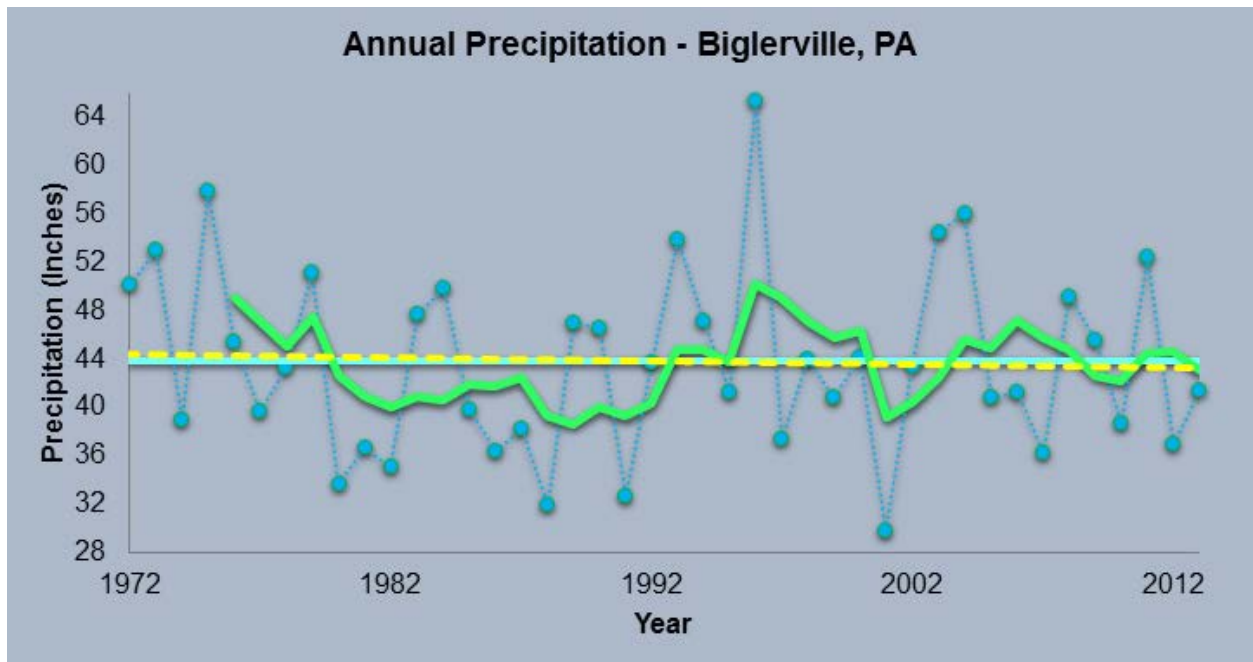
Annual Lowest Minimum Temperature: There is a rise in annual minimums with sub-zero readings a rarity in the last decade. The average annual minimum temperature is -0.4°F ($\pm 1\text{SD}$ ranges from -7.5 to 6.7°F , Table 2).



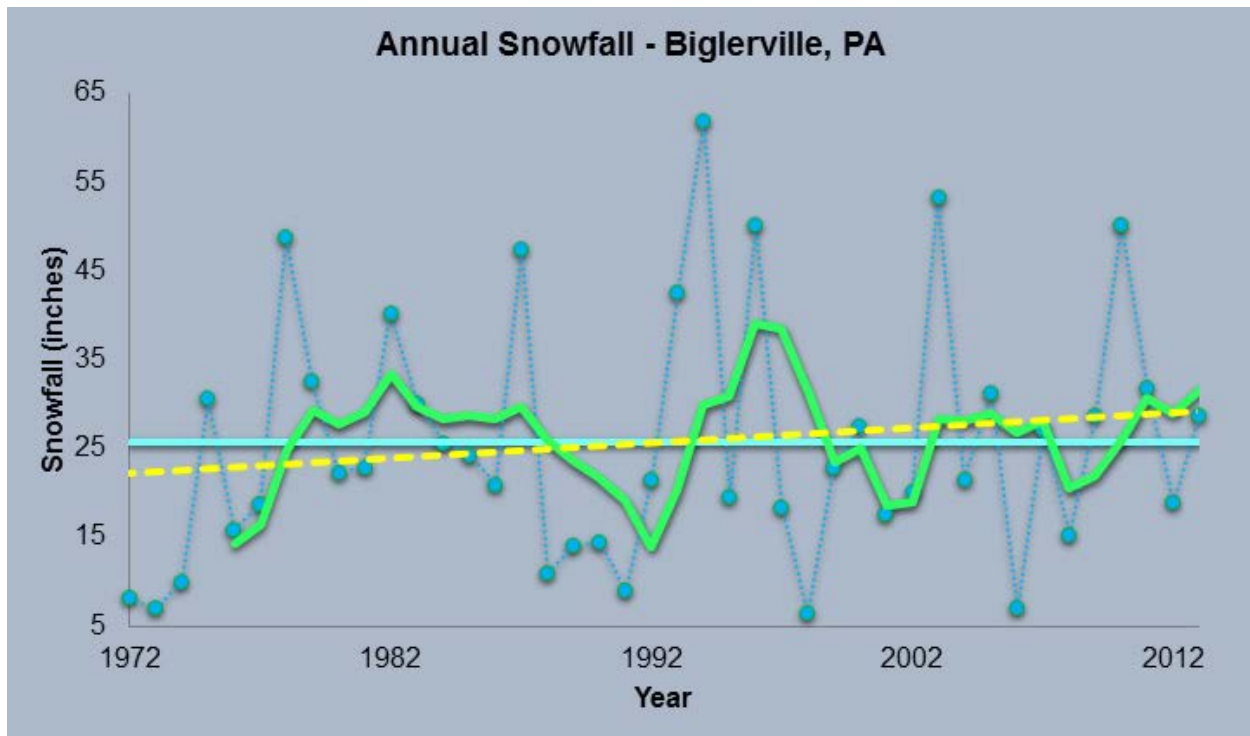
Annual Number of Days with Minimums at or below Freezing: There is a decreasing trend from more than 130 days in the 1970's to fewer than 110 days in the 2000's. The average number of nights is 120 ($\pm 1SD$ ranges from 106-135, Table 2).



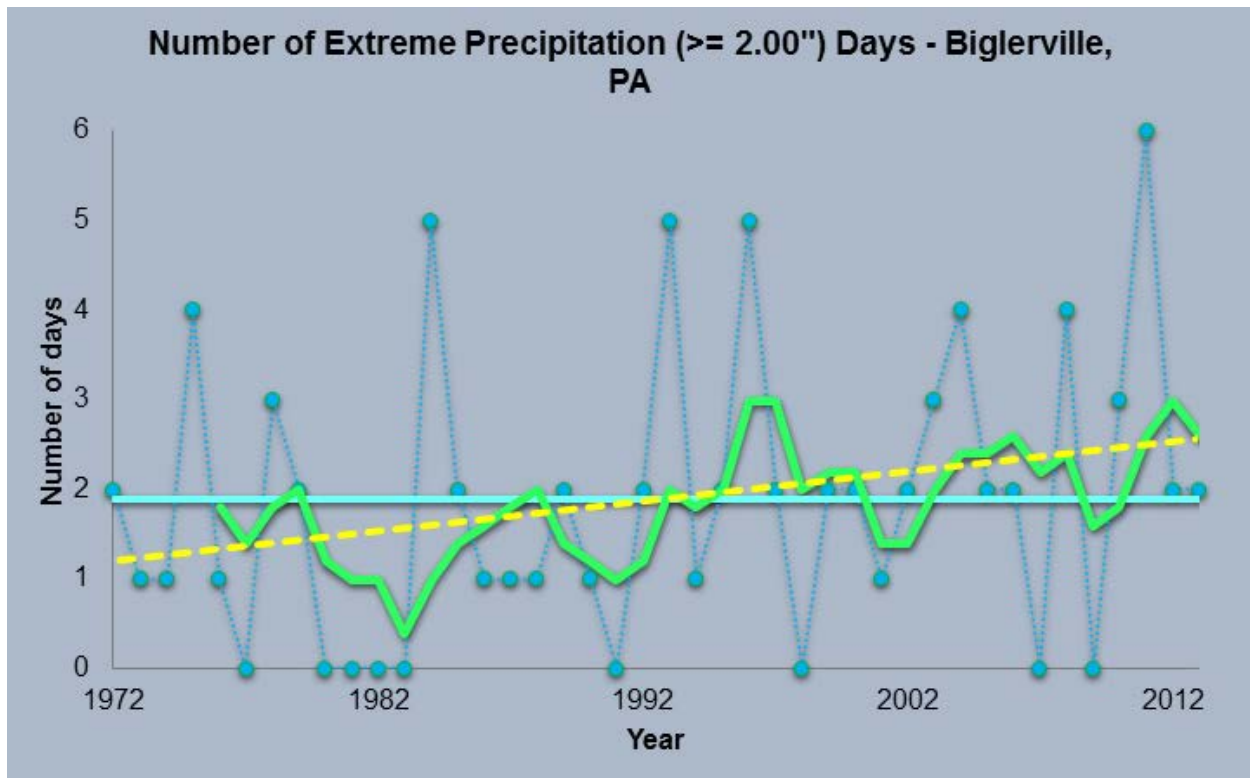
Growing Season Length Trends: The growing season, the period between the last freeze in the spring and the first freeze in the fall, has lengthened by more than three weeks during the last 40 years. The average annual number of days in the growing season is 178 ($\pm 1SD$ ranges from 158-199, Table 2).



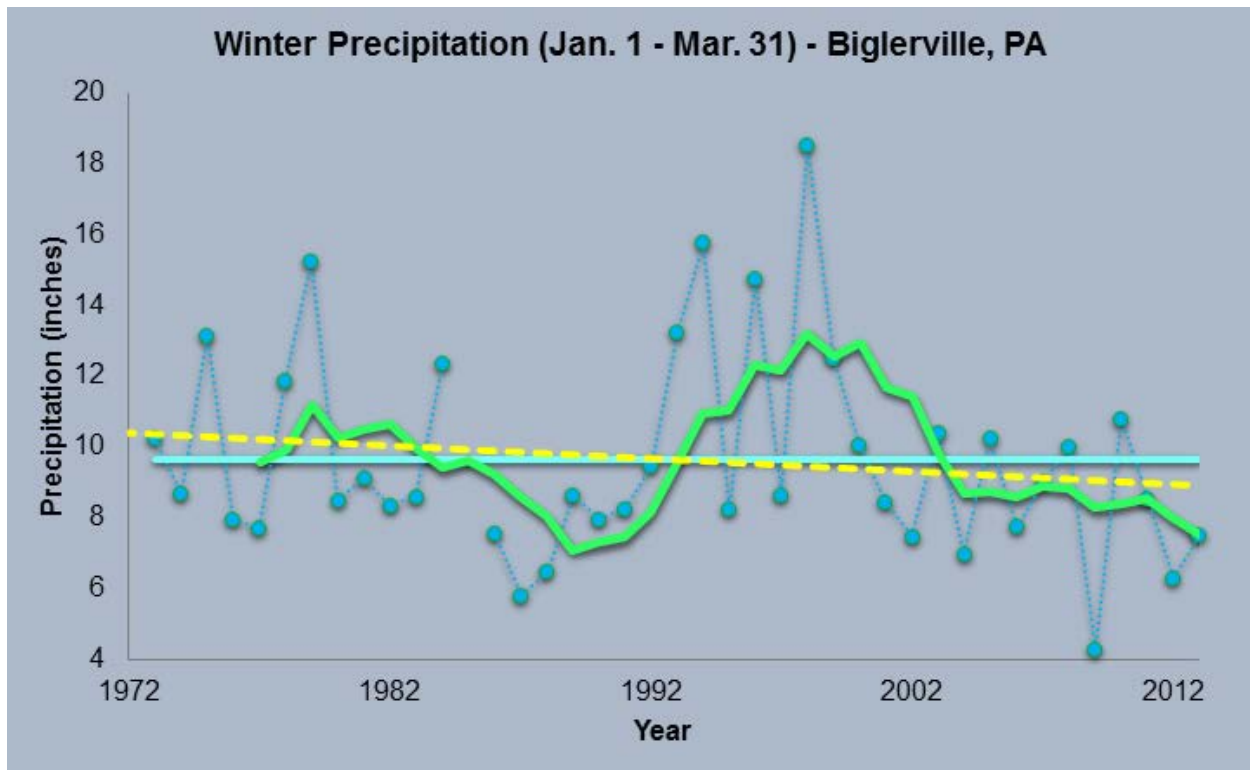
Annual Precipitation Trends: There is a no apparent trend. The average annual precipitation is 43.8 in. (min of 29.8 in and max of 65.4 in, Table 6).



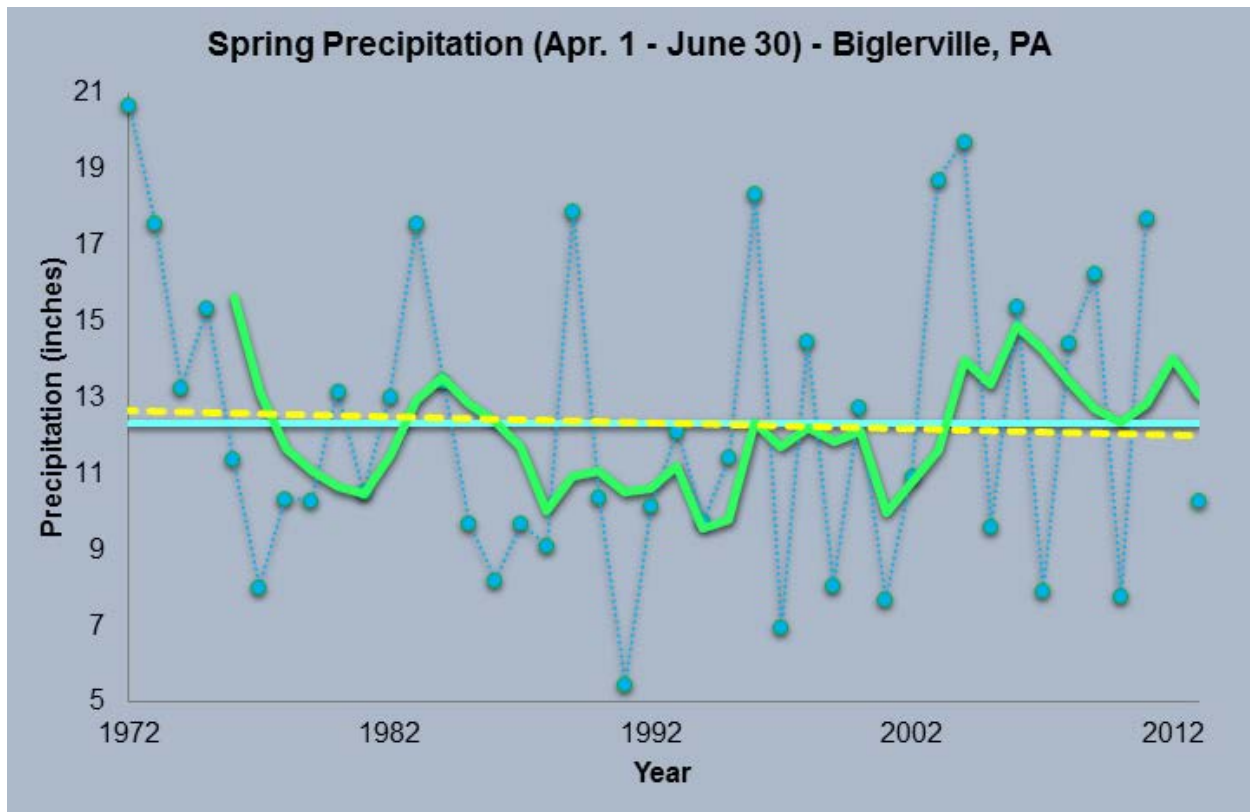
Annual Snowfall Trends: There has been a small rise of approximately 5 inches (13cm) during this period. The average annual snowfall amount is 25.6 in. (min of 6.4 in and max of 62.0 in, Table 6).



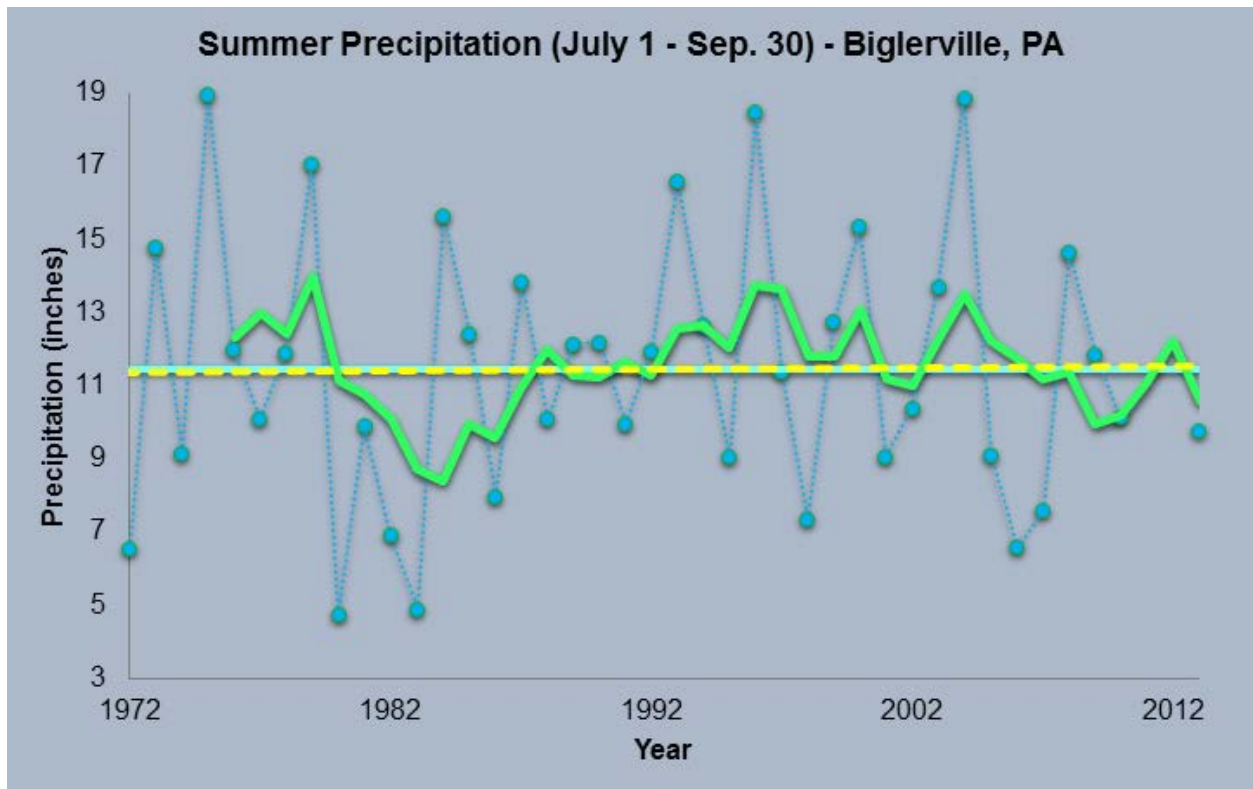
Annual Number of Extreme Precipitation Events: There has been a rise during the last four decades such that extreme wet days now occur twice as frequently. Nevertheless, this increase only results in approximately one more extremely wet day per year. The average number of days is 2 (min of 0 and max of 6, Table 6).



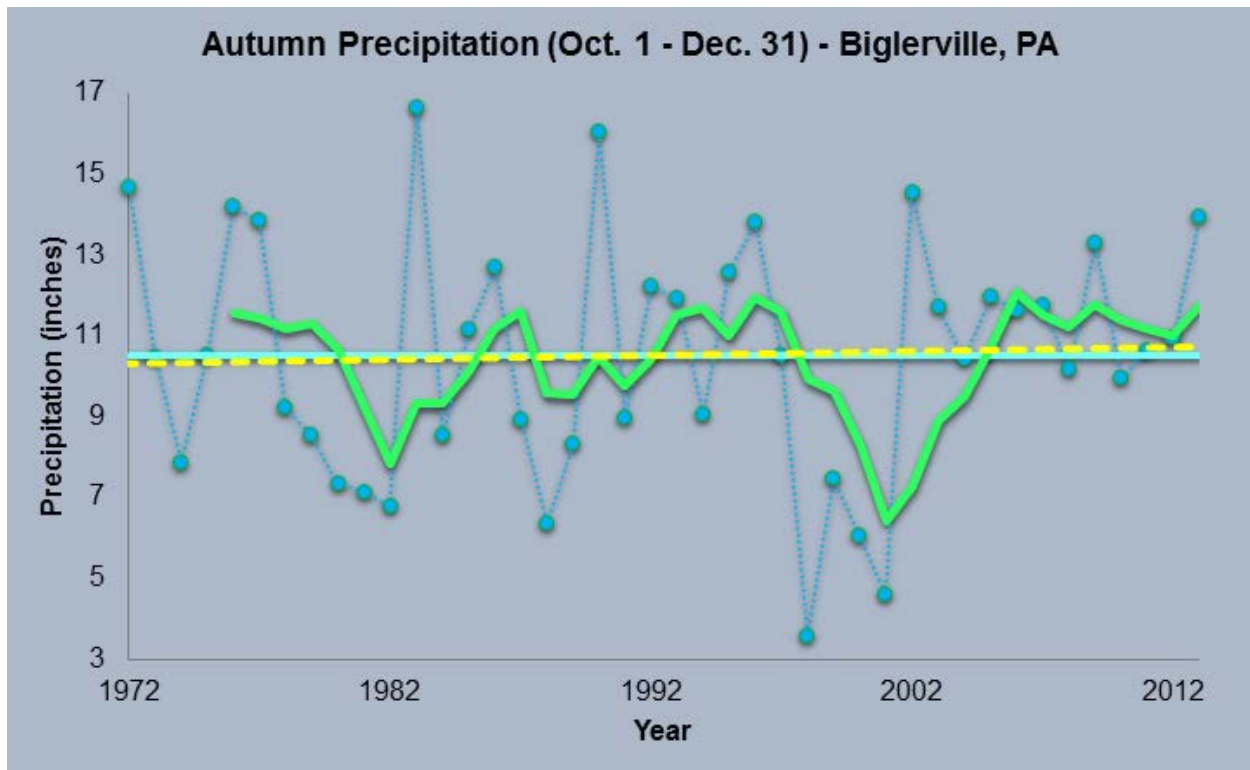
Winter Precipitation Trends: There has been a small decline of about one inch (25mm) for the winter season's precipitation total in the last 40 years. Winter precipitation has ranged between 4.3 in to as much as 18.6 in over the period of record.



Spring Precipitation Trends: There has been a very small decline of less than one inch (<25mm) for the spring season's precipitation total in the last 40 years. Biglerville has seen as much as 20.7 in and as little as 5.5 in or precipitation during the spring.



Summer Precipitation Trends: There has been virtually no change during the last 40 years. Summer precipitation has ranged between 4.7 to 19.0 in.



Autumn Precipitation Trends: There has been a small increase of less than one inch (25mm) for the autumn season's precipitation total in the last 40 years. This is much less than nearby stations. The average sum of precipitation during the autumn is 10.5 in (min of 3.6 and max of 16.7 in, Table 6).

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.

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