



Climate Monitoring in the Northern Colorado Plateau Network

Annual Report 2011

Natural Resource Technical Report NPS/NCPN/NRTR—2013/664



ON THE COVER

Temperature sensor, Fossil Butte National Monument. National Park Service/Alice Wondrak Biel.

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Executive Summary

This report documents the 2011 monthly and annual climate summaries and climatic extremes for National Weather Service Cooperative Observer (Coop) and SNOTEL weather stations located within park units of the Northern Colorado Plateau Inventory and Monitoring Network (NCPN) and two stations located near park boundaries. In 2011, mean annual maximum temperature tended to be below average while mean annual minimum temperature and total snowfall were average to below average throughout much of the NCPN region. There were no clear patterns in total precipitation throughout the region. Differences between long-term means and this year's measures of average minimum and maximum temperature, total precipitation, and total snowfall were not related to the elevation gradient of stations. A general increase in the four-year composite moving mean for mean annual minimum temperature is evident for most of the Coop stations in the NCPN over the past 25–50 years. There is evidence for a declining trend in snowfall from the 1980s to the mid-2000s, but during many of the last few years, snowfall exceeded long-term averages. Historical records for NCPN Coop stations indicate that annual precipitation has been highly variable and that a strong unidirectional trend over the observation periods (8–84 years) is not readily evident.

1 Introduction

Climate is a key driver of ecosystem processes, and is one of the four interactive controls in the conceptual model of ecosystem sustainability (Chapin et al. 1996). Long-term patterns in rainfall and temperature provide first-order constraints on potential ecosystem structure and function (Whitford 2002). Secondary constraints are realized from the intensity and duration of individual weather events and, additionally, from seasonality and interannual variability. These constraints influence the fundamental properties of ecological systems, such as soil–water relationships, plant–soil processes, nutrient cycling, and disturbance rates and intensity. These properties, in turn, influence the life-history strategies supported by a climatic regime (Neilson 1987).

Understanding the role of climate as a forcing agent for other vital signs is critical to the efforts of the Northern Colorado Plateau Network (NCPN) Inventory & Monitoring program. Observed changes in other vital signs may occur in response to anthropogenic stressors or variation in climatic conditions. To ensure that management decisionmaking is properly informed, it is important to discern reasons for observed changes that are responsive to mitigation measures (e.g., anthropogenic vs. climate-driven). Moreover, distinguishing between intrinsic variation and climate-regime shifts provides useful insights into regional environmental change.

The overarching goal of the NCPN climate monitoring protocol is to compile and present climate data in a form that aids understanding of reasons for observed trends in other vital signs. Specific objectives of this protocol are:

- To provide monthly and annual summaries of climatic parameters in NCPN park units. Fundamental climate variables include air temperature and precipitation.
- To identify monthly and annual extremes for the fundamental climate variables.

The NCPN climate monitoring effort capitalizes on extant climate monitoring programs. Eight climate monitoring programs maintain a total of 36 weather stations within NCPN park units and 2 additional stations near park units (Table 1-1). These programs provide consistent monitoring of weather conditions and, in some cases, a long-term climatic record. The NCPN summarizes data from the National Weather Service Cooperative Observer (Coop) and SNOTEL (Snowpack Telemetry) networks, which maintain stations in or near all but one of the NCPN park units. The observation record for most of these stations dates back to the 1960s; the earliest record is from 1904 (Appendix A). Summaries of data from the other six climate monitoring programs are not included in this report due to the difficulty of processing data from multiple formats and because the data record for most of those stations covers less than 20 years (Appendix A).

Monitored parks include Arches National Park (NP; ARCH), Black Canyon of the Gunnison NP (BLCA), Bryce Canyon NP (BRCA), Canyonlands NP (CANY), Capitol Reef NP (CARE), Cedar Breaks National Monument (NM; CEBR), Colorado NM (COLM), Curecanti National Recreation Area (CURE), Dinosaur NM (DINO), Fossil Butte NM (FOBU), Hovenweep NM (HOVE), Natural Bridges NM (NABR), Pipe Spring NM (PISP), Timpanogos Cave NM (TICA), and Zion NP (ZION). Golden Spike National Historic Site has no nearby climate stations used in NCPN monitoring. The NCPN obtains weather observations from agency archives annually and stores data on the NCPN server for ease of access and use.

This report summarizes data from the same climate stations included in the 2010 NCPN climate report.

Table 1-1. Overview of climate monitoring programs, and number of weather stations by program in NCPN park units.

Climate monitoring program–Agency	Program synopsis	Number of weather stations												
		ARCH	BLCA	BRCA	CANY	CARE	CEBR	COLM	CURE	DINO	FOBU	GOSP	HOVE	NABR
NWS-Coop (National Weather Service Cooperative Observer Program)–National Oceanic and Atmospheric Administration (NOAA)	Observer-based program created in 1890 to define the climate of the United States and help measure extreme weather events, climate variability, and long-term climatic changes. Core observations include 24-hour minimum and maximum temperatures, and 24-hour rain precipitation and snowfall.	1	1	1	3	1		1	1	2	1	1	1	1
RAWS (Remote Automated Weather Stations)–National Interagency Wildfire Program (U.S. Forest Service, Bureau of Land Management, NPS, et al.)	An interagency network used by fire-management personnel to estimate a fire-danger rating in support of preventive measures, and to forecast the behavior of wildland fires. RAWS stations consist of automated sensors that record air temperature and relative humidity, precipitation, wind speed and direction, and measures of fuel moisture and temperature every 15–60 minutes.	1	2							1				2
SNOTEL (SNOWpack TELelemetry)–National Resources Conservation Service (NRCS)	A high-elevation network to provide real-time climate data using automated remote sensing from sites in the mountainous regions of the western U.S. Data include snow water equivalent, snow depth, precipitation, temperature, and other climatic elements at hourly intervals.		1				1							
Snow Course–NRCS	An observer-based program that manually measures snow depth and snow-water equivalent along a permanent transect.		1											
SNOWNET (including avalanche network)–MesoWest (University of Utah)	A collection of automated stations from various networks, used by the NWS Forecast Office. Data include air temperature and precipitation, and sometimes snow depth.				1									1
USCRN (U.S. Climate Reference Network)–NOAA	An initiative to provide long-term observations of temperature and precipitation that can be coupled to past long-term observations for the detection of climatic change. High-quality, automated stations record air temperature and precipitation, as well as measures of ground-surface temperature, solar radiation, wind speed, and sensor performance about every two seconds.	1				1				1		1		
USRCRN (U.S. Regional Climate Reference Network)–NOAA	These stations maintain the same level of quality measurements as the national-scale USCRN but are spaced more closely and focus solely on temperature and precipitation. USRCRN stations are deployed at a 130-km spatial resolution to provide for the detection of regional climate change signals.							1						1
CLIM-MET (Climate Impact Meteorological)–USGS Earth Surface Dynamics Program–SW Climate Impacts	A research program of USGS. Data on atmospheric and surficial processes are automatically recorded at regular intervals (about 5 minutes). Sensors and site locations are subject to change to accommodate research needs.				2									

All weather stations are located within park units, except for CEBR, which has one weather station located within 5 km of the park boundary, and CANY, which has one weather station located outside of the park boundary at the Hans Flat Ranger Station.

ARCH = Arches National Park; BLCA = Black Canyon of the Gunnison National Park; BRCA = Bryce Canyon National Park; CANY = Canyonlands National Park; CARE = Capitol Reef National Park; COLM = Colorado National Monument; CURE = Curecanti National Recreation Area; DINO = Dinosaur National Monument; FOBU = Fossil Butte National Monument; GOSP = Golden Spike National Historic Site; HOVE = Hovenweep National Monument; NABR = Natural Bridges National Monument; PISP = Pipe Spring National Monument; TICA = Timpanogos Cave National Monument; ZION = Zion National Park

2 Methods

2.1 Data acquisition and quality control

Details on the acquisition of weather-station observations and data processing are provided in the NCPN climate monitoring protocol (Garman et al. 2004). In short, Coop and SNOTEL observations are acquired from the Western Regional Climate Center (WRCC). The National Climate Data Center performs QA/QC (quality assurance/quality control) for Coop data. Data-quality codes indicate missing records or the use of estimation procedures. The WRCC performs QA/QC on SNOTEL data, and provides similar data-quality flags with the 24-hour data.

2.2 Analyses

2.2.1 Data completeness

An assessment of data completeness for the four fundamental climate variables (maximum and minimum temperature, total precipitation, and snowfall) is provided for each weather station. For purposes of this report, all 24-hour measures that were estimated or flagged as not valid (due to missing values or incomplete records) were excluded. For each station, the percentage of years with >95%, >85–95%, and <85% valid daily values were tallied for each climate variable. Reasons for noticeable data incompleteness were ascertained by general inspection of the data.

2.2.2 Parameters

All analyses used 24-hour measures. Station-level summaries used all valid daily data. Analyses using monthly or annual means or totals only used information based on 85% valid records. For monthly means, this required about ≥ 26 valid daily records. For annual means and totals, 310 valid daily records were required. Annual values were based on the calendar year. Monthly and annual summaries for consistently measured variables for each weather station in the NCPN park units are provided in the electronic appendix. See Section 4.2 of this report for a description of appendix contents.

2.2.2.1 Climatic extremes

Monthly means and totals were compared to the historical distribution of values using a variety of methods. Box-whisker plots show percentiles, minima, and maxima of monthly observations since the inception of each station. Overlaying 2011 observations on these plots highlighted extremes of the 2011 climate record where they occurred. Numerical deviation of a 2011 monthly mean or total from the corresponding long-term mean was further used to illustrate the historical context of 2011 climate attributes. Resulting graphics from this analysis are available for NCPN weather stations (the electronic appendix contains MS-Word versions of graphs).

For each NCPN weather station, annual means and totals for 2011 were differenced from station long-term means, and differences for stations were arrayed by elevation to assess topographic relationships. Data spanning the time of station inception up to the end of 2010 were the basis for long-term means.

2.2.2.2 Trend assessments

Annual means and totals for 2011 were combined with the historical record to evaluate trends. A moving mean based on the average of the three previous years plus the value of the year was generated to smooth trends. A cumulative or running mean illustrated the long-term mean at points in time. Temporal trends for the four fundamental climate variables were evaluated with least-squares regression using the corresponding moving mean for stations with at least 10 years of valid data. Trend graphs are available for NCPN weather stations (the electronic appendix contains MS-Word versions of graphs).

3 Results

3.1 Data completeness

National Weather Service Coop stations generally have more complete records for rain and snowfall than for temperature (Table 3-1; tables and figures start on page 7). Exact reasons for missing or invalid records are not obvious from the data-quality flags. However, it is likely that malfunction or misreading of instruments is more common with temperature than with precipitation levels, which use physical measurement. Numerous Coop stations have missing records in winter months—notably, BRCA, both DINO stations, and TICA. The SNOTEL stations at BRCA/Agua Canyon and CEBR/Midway Valley have many estimated precipitation values.

3.2 Climatic extremes

Winter and spring tended to be cooler than average compared to the historic record in 2011, with monthly maximum temperatures below average for around half of the climate stations in January, February, and April and for all stations in May (Figure 3-1). Minimum monthly temperatures followed a similar pattern. The late summer months tended to be hotter than average, with all but two stations recording above-average maximum monthly temperatures in August, and most stations recording above-average minimum monthly temperatures in August and September. Temperatures in fall and early winter were around the historic average for most climate stations.

January 2011 was an exceptionally dry month in the region, with all but two stations reporting below-average total precipitation. Most of these stations received little or no precipitation. This exceptionally dry period extended through March at many of southeast Utah Coop stations (ARCH, CANY/Neck, CANY/Needles, HOVE, and NABR). The TICA Coop station was the only one that received above-average precipitation during this time. Total precipitation was higher than average for most of the region in April and May, with exceptionally high precipitation at the TICA Coop station during these months. There were no clear regionwide patterns for the second half of the year, but June tended to be drier and July tended to be wetter for about half of the climate stations.

Differences between annual values for 2011 and long-term means along the elevation gradient are shown in Figure 3-2 for stations with valid observations for 2011 and an observational record of at least five years (supporting information for figures is in Table 3-1). Differences between 2011 and historical averages were unrelated to elevation gradient for temperature and precipitation. The majority of stations experienced lower-than-average mean annual maximum temperature (Figure 3-2A) and average-to-below average mean annual minimum temperatures (Figure 3-2B). The BRCA Coop station was an exception to this pattern, with mean annual minimum temperatures well above average. There was no clear regionwide pattern in total precipitation, with stations ranging from below the historical average to much higher than the average (Figure 3-3A). Total snowfall was below the historical average at the majority of stations (Figure 3-3B). Although the TICA Coop station reported total annual precipitation 20 inches higher than the historical average, it came mostly as rain, and total annual snowfall was more than 50 inches below the historical average.

3.3 Trend assessments

3.3.1 Average annual maximum temperature

Trends were evident for all of the fundamental climate attributes. Fifteen stations had a significant ($P < 0.05$) linear slope for average annual maximum temperature (Table 3-2). The majority of significant relationships indicated an increase in mean annual maximum temperature. Only the CEBR/Midway Valley SNOTEL station (Figure 3-4A) exhibited a strong linear trend ($\text{Adj}R^2 > 0.70$).

3.3.2 Mean annual minimum temperature

A trend in the four-year composite for mean annual minimum temperature was prevalent among NCPN climate stations, with all of the 13 significant relationships indicating an increase in temperature (e.g., Figure 3-4B). The four models that showed strong linear trends (Coop: BRCA, DINO/NM, PISP; SNOTEL: BRCA/Agua Canyon) indicated, on average, an annual increase over the past 30 years of 0.12°F in the four-year composite mean for

mean annual minimum temperature (see Table 3-2). A general increase in temperature has been noted in other western U.S. regions (e.g., Yellowstone River basin; Davey et al. 2006) since the 1970s, and, since the 1990s, in Alaska (Corell 2004). The BRCA Coop station had its highest mean minimum temperatures on record the last three years (Figure 3-4B).

3.3.3 Total precipitation

Only four stations exhibited a significant slope for total precipitation (see Table 3-2); however, the variance explained by three of the models was relatively low ($\text{AdjR}^2 < 0.2$) and the CEBR/Midway Valley SNOTEL station lacked adequate precipitation data for most of the last 10 years. In general, annual precipitation is variable through time, and there is no strong trend (negative or positive) in this attribute among the weather stations analyzed (e.g., Figure 3-4C).

3.3.4 Snowfall

Ten of the 16 stations with snowfall data had a significant negative slope, but none of the stations exhibited a strong linear trend (see Table 3-2). The DINO/NM Coop station exhibited the strongest trend in decreasing snowfall (Figure 3-4D). Closer inspection of snowfall records indicated a notable decline in snowfall at many NCPN stations from the 1980s to mid-2000s, but average to above-average snowfall for many of the last few years. At seven stations in southeast Utah, snowfall totals for 2011 were extremely low.

3.4 Limitations of the NCPN climate record

Inherent climatic oscillations operate over long time frames (e.g., 50–60 years; Mantua et al. 1997). The 25–50-year observation period characteristic of the majority of NCPN stations illustrates general, common trends among stations but is of insufficient length to begin to discern climatic-regime shifts. The 106-year observation period of the ZION Coop station, however, affords an informative perspective of climate variability and trends (Figure 3-5). Similar to the majority of Coop stations, the ZION station recorded increases in mean annual maximum and minimum temperatures over the past 2–3 decades, and in rainfall in the recent past. However, periods of similar increases are evident in this historical record, and recent temperature and precipitation values fail to exceed historical maxima. Trend assessments with the moving mean did indicate slightly increasing temperature and declining snowfall over this extended time period (see Table 3-2), but models generally explained much lower amounts of the variance than those based on a shorter duration.

Table 3-1. Summary of data completeness for weather stations in NCPN park units, and number of years the historical record comprises, by climate variable (for weather stations with valid 2011 annual averages and totals and an observational record of at least five years).

Station			Percentage of years with valid daily records														
			Mean maximum temp.		Mean minimum temp.		Precipitation		Snowfall								
			>95%	>85-95%	<85% No. of yrs. in record	>95%	>85-95%	<85% No. of yrs. in record	>95%	>85-95%	<85% No. of yrs. in record						
Station code	Observation period	NWS-COOP															
ARCH	6/1/80-12/31/11	94	3	3	31	69	28	3	31	94	3	3	31	78	9	13	28
BLCA	10/9/03-12/31/11	75	25	0	8	87	13	0	8	100	0	0	8	100	0	0	8
BRCA	6/1/59-12/31/11	77	17	6	50	66	26	8	49	85	9	6	50	76	15	1	48
CANY/Hans Flat	10/1/80-12/31/11	91	6	3	31	88	9	3	31	91	6	3	31	84	10	6	30
CANY/Neck	6/17/65-12/31/11	79	15	6	44	72	21	7	44	89	7	4	45	80	15	4	45
CANY/Needles	6/18/65-12/31/11	81	13	6	45	62	34	4	45	76	13	11	42	64	8	28	34
CARE	3/1/67-12/31/11	75	16	9	41	82	14	4	43	96	2	2	44	89	9	2	44
COLM	3/1/40-12/31/11	69	18	13	63	64	19	17	60	72	13	15	61	79	11	10	65
CURE (Blue Mesa) ¹	11/1/67-12/31/11	29	18	53	21	31	16	53	21	82	11	7	42	71	22	7	42
DINO/NM	6/1/65-12/31/11	70	24	6	44	79	15	6	44	81	11	8	43	79	15	6	44
DINO/Quarry ²	12/1/15-12/31/11	59	13	28	46	62	13	25	48	61	16	23	49	59	11	30	45
FOBU ³	8/1/90-12/31/11	63	23	14	19	55	36	9	20	73	4	23	17	73	4	23	17
HOVE	4/2/57-12/31/11	67	20	13	49	73	16	11	50	78	16	6	52	76	15	9	50
NABR	6/17/65-12/31/11	68	23	9	43	66	23	11	42	94	4	2	46	92	6	2	46
PISP	6/1/63-12/31/11	61	29	10	44	67	23	10	44	82	14	4	47	74	18	8	45
TICA	7/1/48-12/31/11	62	14	24	51	63	17	20	53	76	3	21	52	68	8	24	50
ZION	1/1/1904-12/31/11	84	8	8	99	77	13	10	97	78	0	22	84	68	8	24	82
SNOTEL																	
BRCA/Agua Canyon ⁴	10/7/94-12/31/11	72	17	11	16	83	6	11	16	17	44	39	12	-	-	-	na
CEBR/Midway Valley ⁵	10/1/81-12/31/11	58	10	32	20	61	3	36	19	55	13	32	-	-	-	-	na

¹Temperature observations not consistently recorded until 1990

²Numerous months in early years without valid records

³1-2 of the winter months tend to have a handful of missing or expert system-corrected temperature observations

⁴Numerous precipitation records have estimated values

⁵Numerous precipitation records have estimated values since 2002

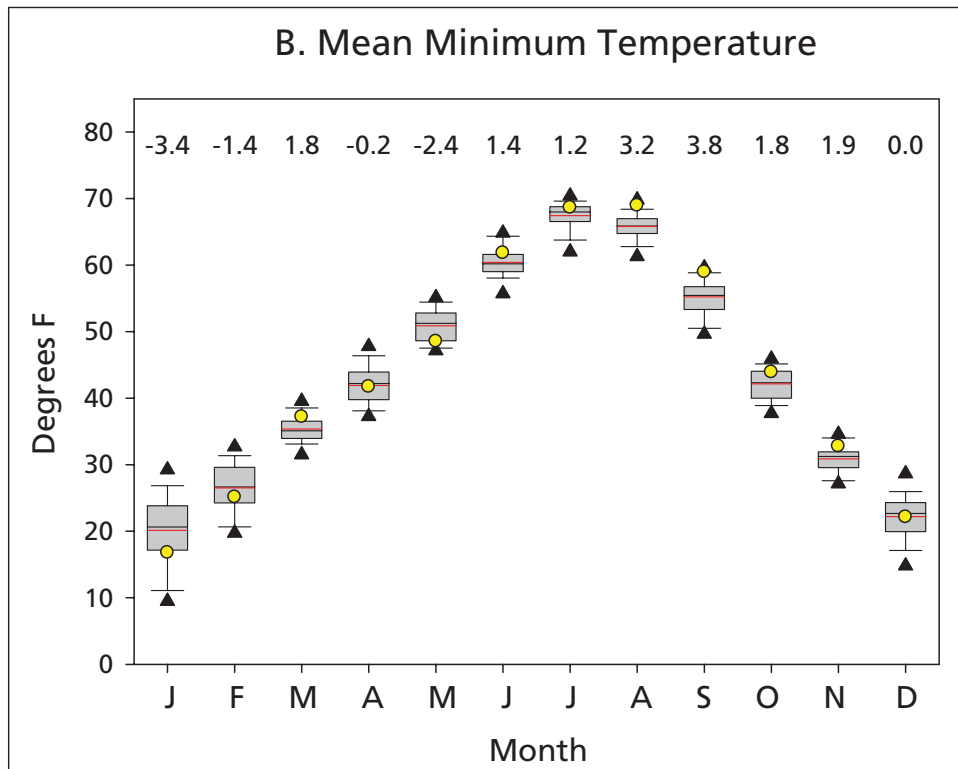
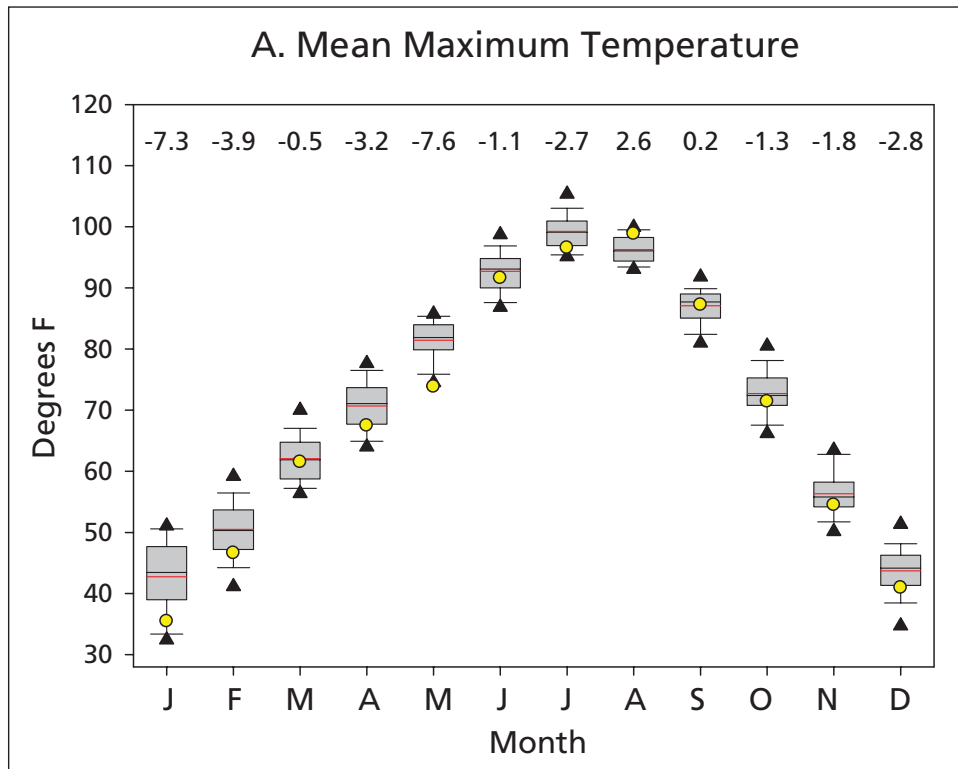
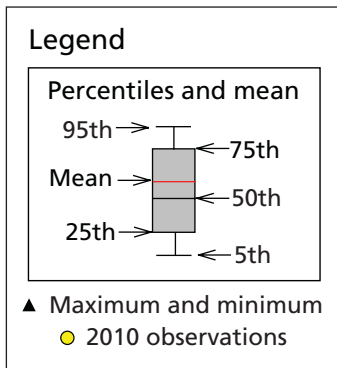


Figure 3-1. Comparison of 2011 monthly values with historical distributions (6/1/80–12/31/11) for ARCH Coop station. Numbers across top of graphs are the deviation between the monthly mean in 2011 and the historical monthly mean.

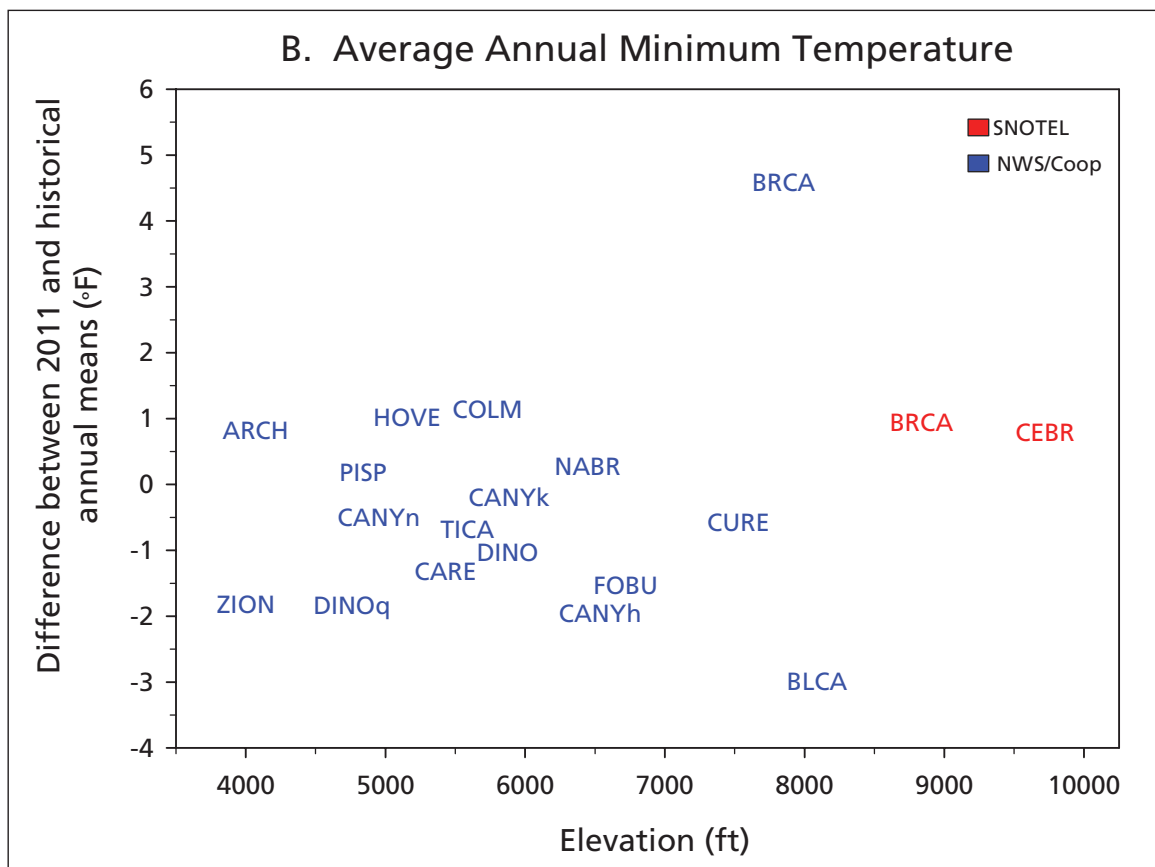
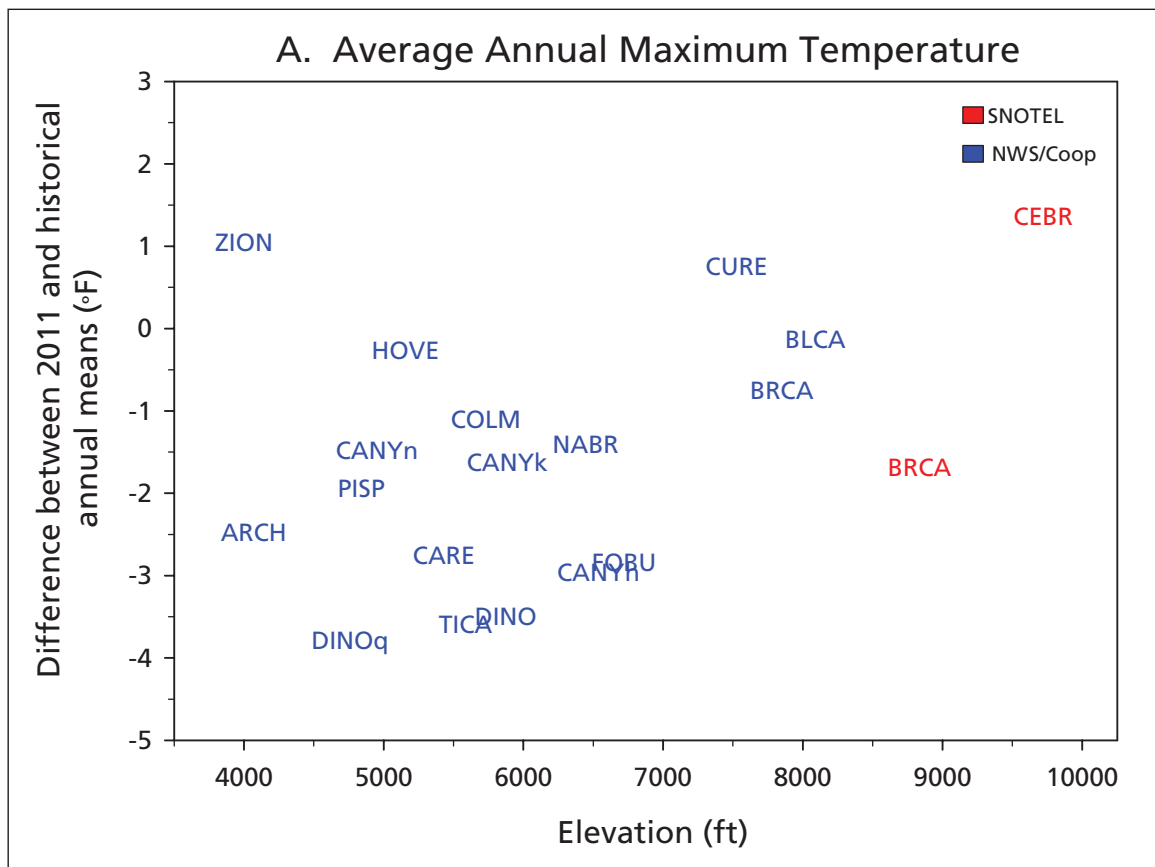


Figure 3-2. Differences between 2011 averages and long-term means for average maximum annual temperature (A) and minimum annual temperature (B), arrayed by elevation. See Table 3-1 for station codes.

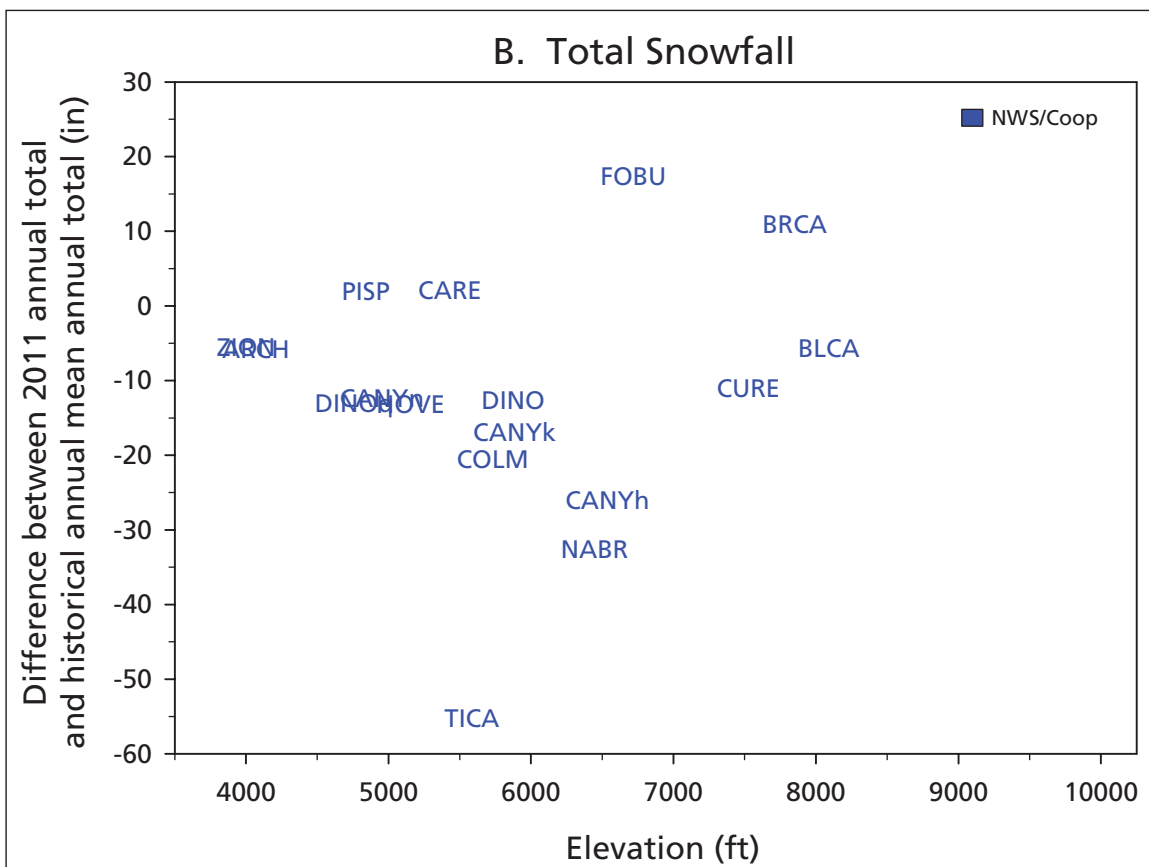
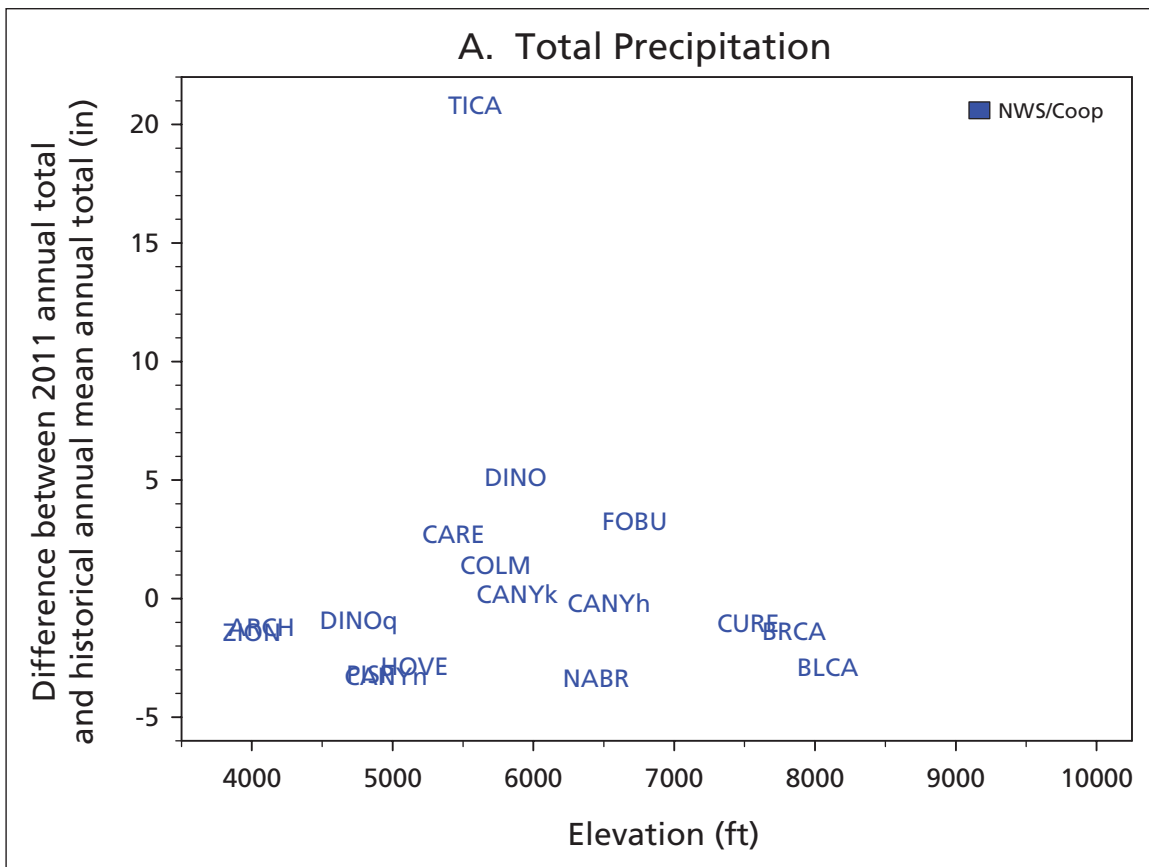


Figure 3-3. Differences between 2011 averages and long-term means for total annual precipitation (A) and total annual snowfall (B), arrayed by elevation. See Table 3-1 for station codes.

Table 3-2. Results of trend analyses of climatic variables based on a least-squares regression of the moving mean over time.

Station	Max. temp. (F)			Min. temp. (F)			Total precipitation (in)			Total snowfall (in)		
	df	P	AdjR ²	Slope	df	P	AdjR ²	Slope	df	P	AdjR ²	Slope
NWS-Coop Station												
ARCH	27	0.009	0.21	0.078	27	0.109	-	-	27	0.035	0.13	-0.056
BRCA	46	0.001	0.19	-0.026	45	<0.001	0.72	0.067	46	0.180	-	-
CANY/Hans Flat	27	0.038	0.12	0.056	27	<0.001	0.53	0.166	27	0.631	-	-
CANY/Neck	40	0.954	-	-	40	<0.001	0.39	0.064	41	0.327	-	-
CANY/Needles	41	<0.001	0.43	0.040	41	<0.001	0.58	0.094	38	0.796	-	-
CARE	37	<0.001	0.51	-0.050	39	<0.001	0.57	0.052	40	0.363	-	-
COLM	59	<0.001	0.24	0.031	56	0.469	-	-	57	0.776	-	-
CURE/Blue Mesa	17	0.020	0.25	0.069	17	0.690	-	-	38	0.044	0.08	-0.037
DINO/NM	40	<0.001	0.30	0.053	40	<0.001	0.72	0.110	39	0.499	-	-
DINO/Quarry	42	<0.001	0.25	0.055	44	<0.001	0.23	0.051	45	0.227	-	-
FOBU	15	0.148	-	-	16	0.890	-	-	13	0.875	-	-
HOVE	45	0.003	0.16	0.031	46	<0.001	0.39	0.053	48	0.485	-	-
NABR	39	0.004	0.18	-0.028	38	<0.001	0.62	0.061	42	0.341	-	-
PISP	40	<0.001	0.35	0.048	40	<0.001	0.76	0.064	43	0.508	-	-
TICA	47	0.005	0.14	0.026	49	0.076	-	-	48	0.402	-	-
ZION	95	<0.001	0.36	0.032	93	<0.001	0.20	0.020	80	0.044	0.04	0.022
SNOTEL Station												
BRCA/Agua Canyon	12	0.056	-	-	12	<0.001	0.85	0.238	8	0.062	-	-
CEBR/Midway Valley	16	<0.001	0.90	0.295	15	0.007	0.38	0.095	16	<0.001	0.57	-1.639

P-values correspond to the significance of the regression model and of the slope. AdjR² is the coefficient of determination. Bolded, shaded values are significant (P < 0.05) with a high (>0.70) AdjR². Only observational years with >85% valid records (days) were used in analyses.
df = degrees of freedom.

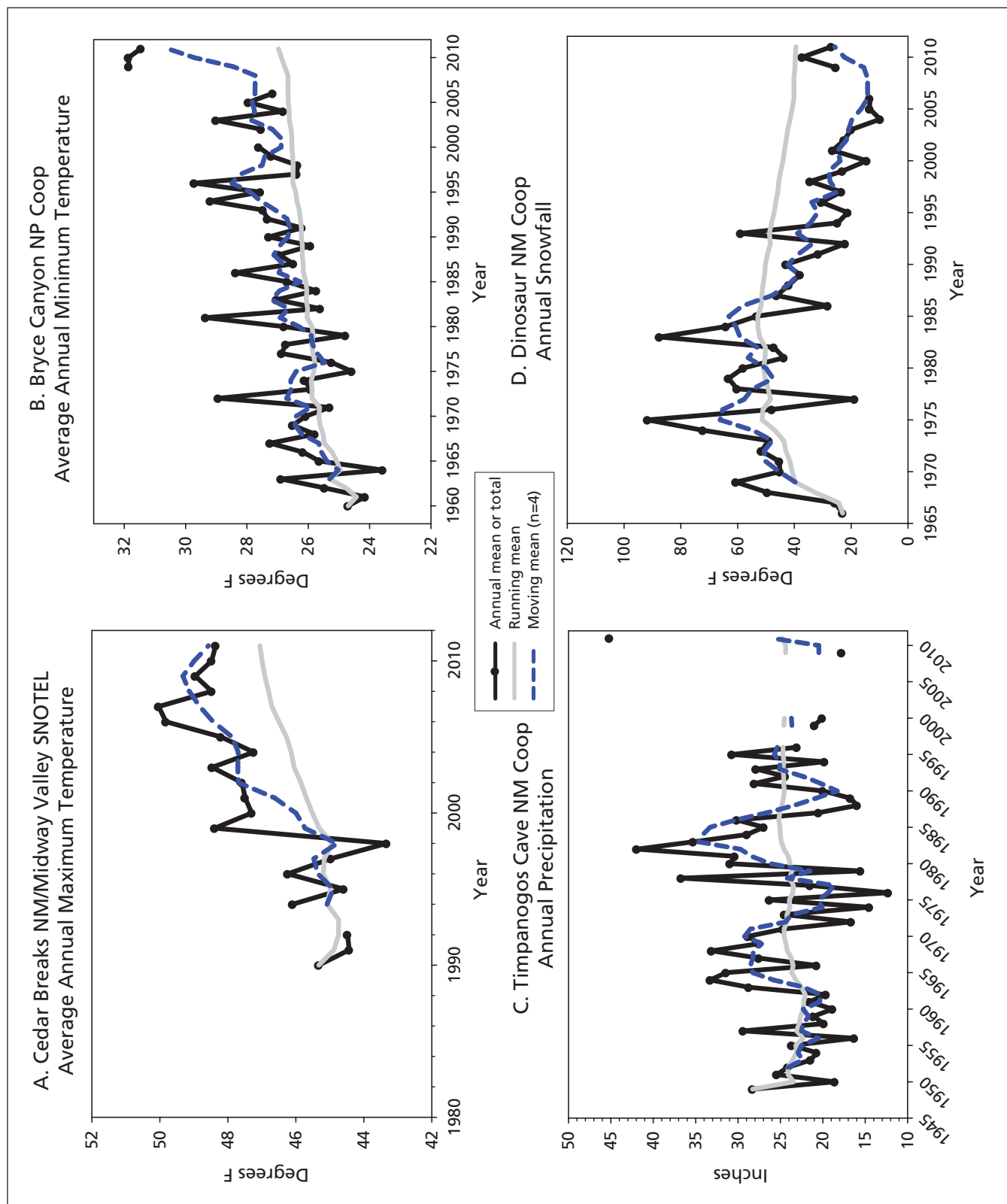


Figure 3-4. Long-term trends for selected stations and climate variables. Breaks in the annual line indicate years with limited or missing data. Moving mean is the average of valid values from the previous three years and the year of the estimate. The running mean is a cumulative mean.

ZION Coop Station Observational period 1/1/1904–12/31/2011

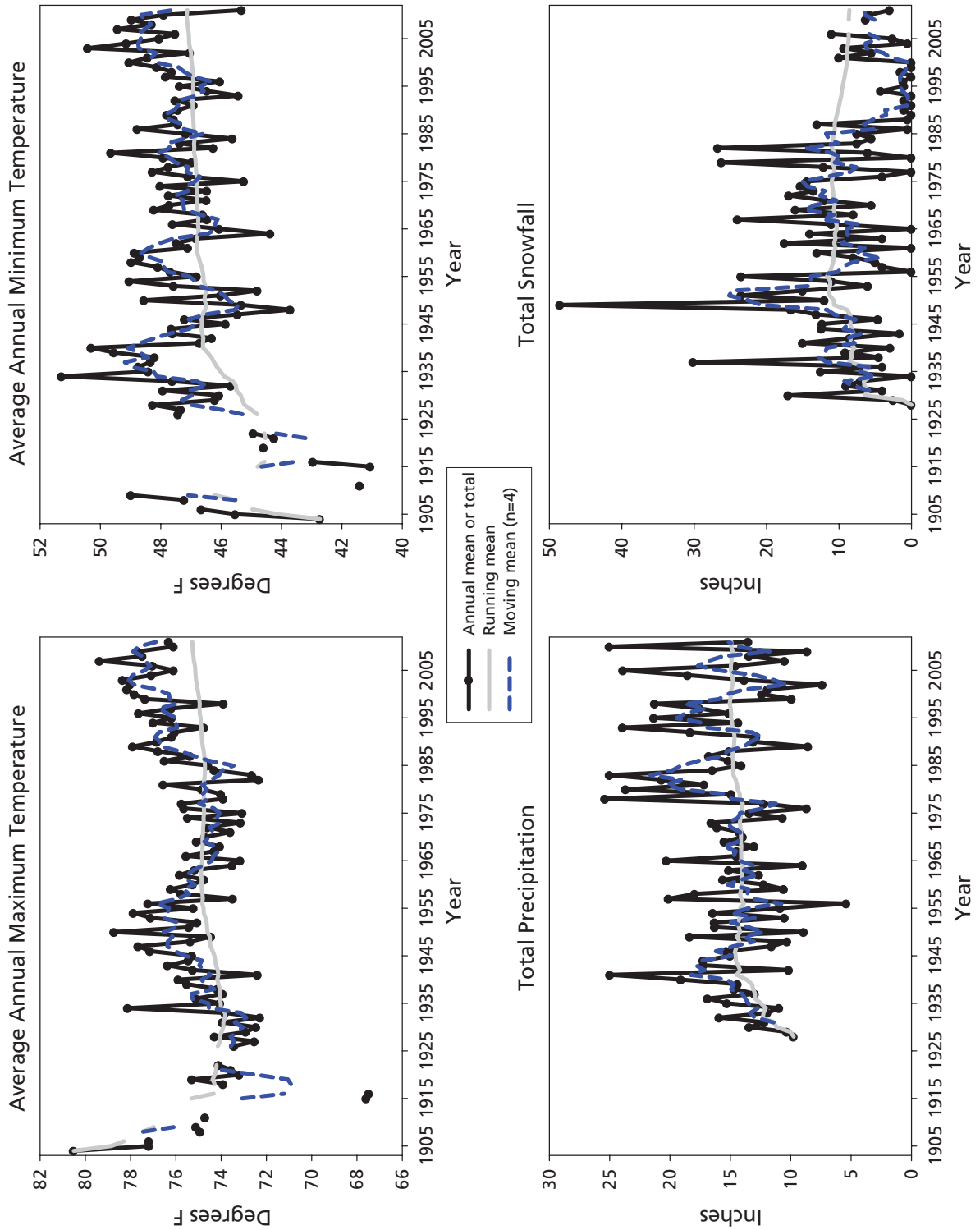


Figure 3-5. Long-term trends for the Zion Coop station. Breaks in the annual line indicate years with limited or missing data. The running mean is the average of valid values from the previous three years and the year of the estimate. The moving mean is a cumulative mean.

4 Discussion

In 2011, average annual maximum temperatures tended to be below average throughout much of the NCPN region, while average annual minimum temperatures tended to be average to below average. Differences between annual averages for maximum and minimum temperature, total precipitation, and total snowfall were not related to an elevation gradient when compared to long-term means. Total precipitation amounts in 2011 did not exhibit any regionwide patterns. However, snowfall tended to be below average, with more precipitation falling as rain for the majority of weather stations. This tendency was clearly shown at TICA, where patterns at the TICA Coop station differed dramatically from the historical record, with total annual precipitation 20 inches higher than average and total annual snowfall over 50 inches below average.

A general increase in the four-year, composite moving mean for average annual minimum temperature over the past 30–50 years is evident for most of the NCPN stations with long observation periods (i.e., Coop stations). Conversely, there is evidence for a declining trend in snowfall from the 1980s to the mid-2000s; however, during many of the last few years (not including 2011), snowfall has been higher than average. Historical records, especially for the NCPN Coop stations, indicate that annual precipitation has been highly variable and that a strong unidirectional trend over the observation periods (8–84 years) is not readily evident.

4.1 Cautionary note

NCPN station-level assessments of trends and average conditions should be viewed in the context of the available temporal and spatial record. The 25–50-year observation period characteristic of the majority of NCPN weather stations provides an adequate basis for delineating trends over the recent past, but this period is too short for discerning shifts in climatic regimes. Departures from historical averages are likely only meaningful for stations with longer (30+ years) observation periods. Additionally, the number of weather stations in any NCPN park is nominal, with generally only 1–3 stations, and stations do not span the full environmental range of a park. Especially for the larger units, station-level trends and extremes do not necessarily characterize climatic conditions of a park.

Assessments involving a spatially distributed network of weather stations in and around park lands are key to understanding climatic extremes, trends, and regimes of a park's environs. Ongoing efforts among the NPS Inventory & Monitoring Program's Washington-area Support Office, the WRCC, and the Wyoming State Climate Center are aimed at addressing how best to delineate such a network, and the nature of assessments to achieve this understanding. Approaches developed in these efforts will be employed in future NCPN climatic analyses and reports to provide a more comprehensive interpretation of climatic conditions of park units.

4.2 Summary reports and graphs

Summary reports (e.g., Figure 4-1), and monthly distributions and trend graphs for each NCPN weather station are included in the accompanying electronic appendix, and are labeled by park, climate-monitoring program, and report or graph type. Park acronyms are used to indicate the park unit. Monitoring programs are Coop and SNO-TEL. Monthly and annual summaries are MS-Excel spreadsheets with the term monthly or annual included in the file name. Monthly distributions and trend graphs are MS-Word documents with the term monthcomparison or trend included in the file name.

Monthly Climate Summary

FOBU COOP Station 483582 (FBMW4)–07/2011

Day	Air temperature (°F)			Precipitation (inches)		
	Minimum	Maximum	Average	Total	Snowfall	Snow depth
1	38	75	56.5	0	0	0
2	34	83	58.5	0	0	0
3	41	89	65	0	0	0
4	52	87	69.5	0.05	0	0
5	48	68	58	0.05	0	0
6	47	81	64	0	0	0
7	48	79	63.5	0.02	0	0

Annual Climate Summary

CURE (Blue Mesa) Coop, Station No. 50797 (BMKC2)–2011

Variable	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Minimum air temperature (F°)													
Min.	-28	-26	-3	17	17	28	37	39	29	16	6	-9	10.3
Max.	25	21	29	38	44	56	56	54	48	41	27	16	37.9
Average	-3.5	-0.1	16.3	25.2	30.1	38.1	48.4	47.5	38.7	27	14.8	3.5	23.8
# of days <0°F	20	12	2	0	0	0	0	0	0	0	0	9	43
# of days <32°F	28	25	29	26	19	4	0	0	3	21	24	24	203
% of days with valid records	90.3	89.3	93.5	96.7	100	100	96.8	100	100	96.8	80	77.4	93.4
Maximum air temperature (F°)													
Min.	-2	6	25	41	39	71	72	74	53	40	37	21	39.8

Figure 4-1. Example climate summary reports.

5 Literature Cited

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Appendix A. Location, Elevation, and Observational Period for the Major Weather Stations within NCPN Park Units

Climate monitoring program/Park	UTM location		Elevation ft (m)	Period of record
	Northing	Easting		
NWS-COOP				
ARCH	4275204	620212	4,130 (1,259)	6/1/80-present
BLCA	4270811	265847	8,150 (2,484)	10/9/03-present
BRCA	4166638	396948	7,915 (2,412)	6/1/59-present
CANY/Hans Flat	4234460	571744	6,581 (2,006)	10/1/80-present
CANY/Neck	4256408	603257	5,930 (1,807)	6/17/65-present
CANY/Needles	4223196	609524	4,998 (1,523)	6/18/65-present
CARE	4237285	476677	5,500 (1,676)	3/1/67-present
COLM	4330319	696008	7,600 (2,316)	3/1/40-present
CURE/Blue Mesa	4259937	311146	7,600 (2,316)	11/1/67-present
DINO/NM	4456830	672502	5,920 (1,804)	6/1/65-present
DINO/Quarry	4477485	643976	4,800 (1,463)	12/1/15-present
FOBU	4631297	519374	6,780 (2,066)	8/1/90-present
HOVE	4139559	669972	5,210 (1,588)	4/2/57-present
NABR	4163770	589724	6,500 (1,981)	6/17/65-present
PISP	4080598	345012	4,920 (1,500)	6/1/63-present
TICA	4477940	440642	5,640 (1,719)	7/1/48-present
ZION	4119827	323929	4,050 (1,234)	1/1/1904-present
RAWS				
BLCA	4269462	265823	8,560 (2,609)	6/4/97-present
BRCA/Agua Canyon	4153565	387677	8,000 (2,438)	6/4/90-present
BRCA	4166704	396581	7,855 (2,394)	1/6/03-present
DINO	4486307	677030	5,960 (1,816)	7/29/98-present
ZION/Lava Pt.	4140273	319512	7,700 (2,347)	7/31/95-present
ZION/HQ	4119415	324488	3,901 (1,189)	11/5/02-present
SNOTEL				
BRCA/Agua Canyon	4152946	387992	8,900 (2,712)	10/7/94-present
CEBR/Midway Valley	4159317	338088	9,800 (2,987)	10/1/81-present
Snow Course				
BRCA	4166517	396775	8,000 (2,438)	1/1/35-present
SNOWNET				
CARE	4238083	477085	5,500 (2,438)	12/15/97 -present
TICA	4476899	440086	7,999 (2,438)	12/28/97 -present
ZION/East Gate	4123976	333923	5,600 (1,707)	11/2/97-present

Appendix A. Location, Elevation, and Observational Period for the Major Weather Stations within NCPN Park Units, cont.

Climate monitoring program/Park	UTM location		Elevation ft (m)	Period of record
	Northing	Easting		
USCRN				
BLCA	4269509	265237	8,398 (2,559)	7/04–present
CARE	4239445	474333	6,211 (1,893)	10/07–present
DINO	4456876	672864	6,063 (1,848)	9/04–present
GOSP	4608354	371223	4,938 (1,505)	8/07–present
USRCRN				
COLM	4330515	695833	5806 (1770)	6/09–present
NABR	4162027	589278	6428 (1959)	8/10–present
ZION	4284769	624178	5096 (1553)	8/10–present
CLIM-MET				
CANY/Needles	4224489	608979	4,910 (1,497)	7/98–present
CANY/Virginia Park	4216970	601707	5,630 (1,716)	7/98–present

Stations in BLCA and CURE are UTM zone 13; otherwise, coordinates are UTM zone 12.
See Table 1-1 for acronym explanations.

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