Intermountain Gas Company

Historical Temperature Climate Report

Integrated Resource Plan 2021 – 2026

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Exhibit No. 3

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Prepared for
Intermountain Gas Company

January 26, 2021

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Climate Consultant

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INTRODUCTION

This report provides estimates of design air temperature values that are likely to be equaled or exceeded (in a "colder than" sense) in a year, with specified probabilities of occurrence and with specified average return periods. The estimates are made for monthly and annual daily-average temperatures, and for annual minimum daily average temperatures, at seven locations in Southern Idaho used by Intermountain Gas Company (IGC) in its gas supply and storage calculations. The estimated values are intended to assist IGC in developing its Integrated Resource Plan (IRP).

This report arose out of discussions with representatives of IGC regarding what information was most needed for development of the IRPs, and provides an update to similar earlier reports (Qualls, 2007, 2017; Molnau, 1994). Each of these reports relied upon probability distributions generated from historical temperature values measured at or near the seven Southern Idaho IGC calculation locations, and included the Normal Distribution ("NORM"; symmetric bell-shaped distribution) and the Pearson Type III Distribution ("PIII"; a skewed distribution which can represent asymmetric data and converges to the Normal distribution for symmetric data). Selecting design temperatures from values generated by these probability distributions is preferable over using individual observations, such as the coldest observed daily average temperature, because exceedance probabilities corresponding to values obtained from the probability distributions are known. This enables IGC to choose a design temperature, from among a range of values, which corresponds to an exceedance probability that IGC considers appropriate for the intended use.

Each successive report incorporates temperature data which occurred and was measured after the completion of the earlier reports. In addition, this report includes temperature data from as much of the entire Period Of Record (POR) at each location as was deemed reliable. This extends the data pool for each location backward in time, making each dataset much larger (i.e., covering a longer time period) than in the preceding reports. This has some statistical advantages. First, it allows one to assess with greater confidence how well a particular distribution represents the observed data, and secondly, it generally narrows the range of uncertainty associated with a given probabilistic temperature value. This report includes analyses introduced in the 2017 report, which quantify the goodness-of-fit of each probability distribution and the range of uncertainty of each estimated value. These additional analyses include:

1) Running hypothesis tests on each probability distribution fitted, to assess whether it should be accepted as a good descriptor of the data (Chi-Squared Test)
2) Calculation of the 90% confidence interval for each probabilistic temperature estimate. There is a 90% probability that the endpoints of the confidence interval, known as upper and lower confidence limits, encompass the true probabilistic temperature value.

Further discussion of these additional analyses is provided in Appendix B.

The contents of this report may be compared with Intermountain Gas Company's Integrated Resource Plan (IRP) to estimate probabilities associated with design values presented there.

DATA

The data used in this report were either provided by Lori Blattner or Landon Barber of IGC, or obtained directly from the National Centers for Environmental Information (NCEI, formerly National Climate Data Center, NCDC). The data consist of daily observed maximum and minimum temperatures, and/or daily averages calculated as the mean of the daily maximum and minimum values. Table 1 provides the IGC Zone ID, location name, and starting Water Year for the data. A Water Year (WY) begins on October 1st, and ends on September 30^{th} of the following year, and is numbered by the year in which it ends. That is, the 1905 Water Year for Caldwell begins on October 1, 1904 and ends on September 30, 1905. A Water Year groups all winter months of a particular season together. The analysis for each station extends to the end of the 2020 Water Year (September 30, 2020).

Table 1: Weather Station Zones, Locations, and Starting Water Year (WY)

Zone ID	Location	Starting WY
350	Caldwell	1905
450	Boise	1941
500	Hailey	1909
600	Twin Falls	1906
700	Rexburg	1908
750	Idaho Falls	1949
800	Pocatello	1939

Most long-term weather stations include occasional changes such as instrument replacements or changes, or station moves. The data used in this analysis span these changes. Some of these changes have occurred in the past 30 years, so the Molnau (1994) and Qualls (2007, 2017) reports, and the data currently used by IGC have some of these changes embedded in them, as would the current analysis even if it was limited to the past 30 years.

RESULTS

For each IGC location, results calculated over the POR at each station from data aggregated at the annual time scale are presented in this section, and results with greater detail including monthly analyses and additional figures are presented in the appendices. “Annual” in this report refers to a Water Year. Table 2 presents POR summaries and statistics of station data and values of exceedance temperatures for annual mean daily average temperatures and annual minimum daily average temperatures. Exceedance temperatures are presented for a range of return periods (T=2, 5, 10, 20, 50 and 100 years) and their corresponding exceedance probabilities, calculated by fitting both Normal (NORM) and Pearson Type III (PIII) distributions to observed data from each IGC location. With the addition of only 5 years’ data since the previous report, the resulting values do not change substantially.

Table 2: Annual Station data and exceedance temperatures based on NORM and PIII Distributions (°F)

		Annual Mean Daily Average Temperature							Annual Minimum Daily Average Temperature						
Station		350	450	500	600	700	750	800	350	450	500	600	700	750	800
Mean		51	52	43	49	43	44	47	10	10	-1	6	-6	-5	0
Std Dev		1.6	1.7	1.6	1.7	1.8	1.7	1.4	9.7	8.8	7.3	8.3	8.0	7.8	8.0
Skew		0.1	-0.1	0.2	0.3	0.0	-0.4	-0.1	-0.5	-0.6	-0.3	-0.3	-0.2	-0.3	-0.3
Max		55	56	49	54	48	48	50	28	27	13	24	16	10	15
Min		48	48	39	45	38	39	43	-18	-16	-23	-15	-27	-23	-18
No Years		116	80	111	115	113	72	82	116	80	111	115	113	72	82
T	P	Normally Distributed Exceedance Temperatures							Normally Distributed Exceedance Temperatures						
2	0.5	51	52	43	49	43	44	47	10	10	-1	6	-6	-5	0
5	0.2	50	50	42	47	41	43	46	2	3	-7	-1	-13	-11	-7
10	0.1	49	50	41	47	40	42	45	-3	-1	-10	-4	-16	-15	-10
20	0.05	49	49	41	46	40	41	45	-6	-4	-13	-7	-19	-17	-13
50	0.02	48	48	40	45	39	41	44	-10	-8	-16	-11	-22	-21	-16
100	0.01	48	48	40	45	39	40	44	-13	-10	-18	-13	-25	-23	-18
T	P	PIII Distributed Exceedance Temperatures							PIII Distributed Exceedance Temperatures						
2	0.5	51	52	43	49	43	44	47	11	11	-1	7	-6	-4	1
5	0.2	50	50	42	47	41	43	46	2	3	-7	0	-13	-11	-6
10	0.1	49	50	41	47	40	42	45	-3	-1	-11	-5	-16	-15	-10
20	0.05	49	49	41	46	40	41	45	-7	-5	-14	-8	-20	-18	-13
50	0.02	48	48	40	46	39	40	44	-13	-10	-17	-12	-23	-22	-17
100	0.01	48	48	40	45	39	40	43	-16	-14	-20	-15	-26	-24	-20

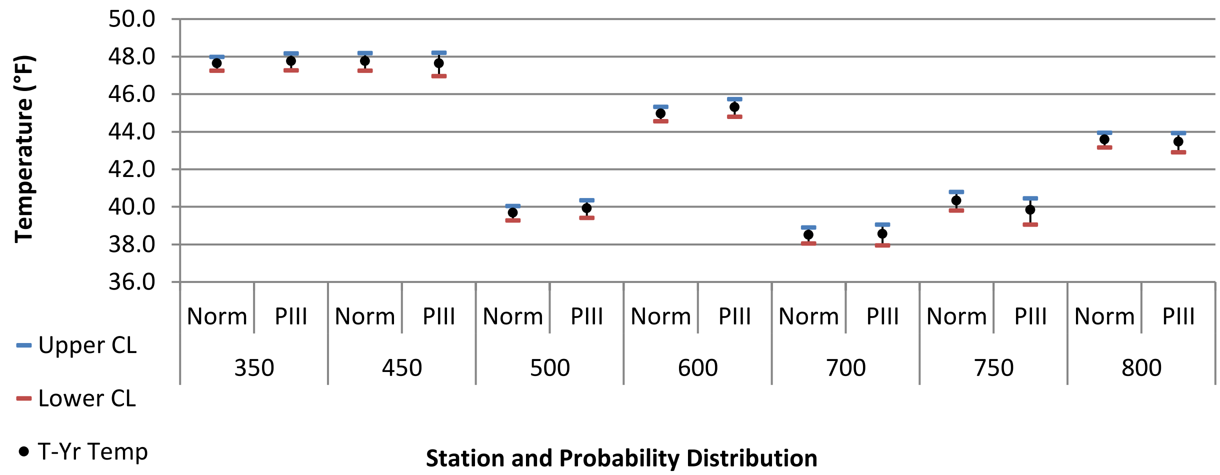
POR summaries and statistics of the data are presented in the top third of Table 2. In this section, the statistics are calculated from the annual values at a given station over the number of years available for that station. For the annual mean daily average temperature shown in the left half of Table 2, the POR mean at each station ranges from a low value of 43 °F (Station 700) to high value of 52 °F (Station 450) across the different locations. This is shown in the first row below the station number, labeled “Mean”. In the second row below the station number, the relatively small standard deviation shows that the collection of annual mean temperatures do not spread out very far around the POR mean at each station. This can also be seen in the relatively small difference between the Max and Min values in the fourth and fifth rows below the station numbers, which represent the largest and smallest annual mean daily average temperature for each station. The Max and Min values differ by no more than 10 °F at any of the stations.

Because the spread of the annual mean daily average temperatures is small at each station, the exceedance temperatures for different return periods also fall within a fairly narrow range, as shown for the normal distribution in the left half of the middle third of Table 2. For example, at station 350, the two-year return period exceedance temperature is 51 °F and the 100-year return period exceedance temperature is only 3 °F colder at 48 °F. Furthermore, the asymmetry is small as shown by the small value of the skew coefficients for the annual mean daily average temperatures, in the third row below the station numbers in Table 2. As a result, the PIII distribution nearly converges to the normal distribution and in most cases they give the same result for each return period (e.g., the 100-year return period event is the same or only slightly different between the NORM and PIII distributions for a given station; compare left half of middle and lower thirds of Table 2).

In addition, the small spread of the annual mean daily average temperatures indicates that the calculated exceedance values can be accepted with high certainty. Ninety percent confidence intervals have been calculated for the different return period exceedance temperatures at each station and for both the Norm and PIII distributions. Upper and lower Confidence Limits (CL values) are given in tables in Appendix A. For the annual mean daily average temperatures, Figure 1 shows the values of the 100-year exceedance temperature and their upper and lower CLs for the NORM and PIII distributions at each station.

The range of the CLs around the 100-year return period value at each station is small, less than 1 °F at most stations, and the results are similar between the Norm and PIII distributions for a given station. The CLs are even smaller for exceedance temperatures with shorter return periods than 100 years. Thus, the exceedance temperatures for the annual mean daily temperatures given in Table 2 can be accepted with a high degree of confidence. The annual minimum daily average temperatures, summarized in the right half of Table 2, have a much higher degree of variability. This is expected because these data and statistics come from the single lowest daily average temperature observation from each year, in contrast to the annual mean daily average temperatures discussed above which are comprised of the mean of a full year’s worth of daily values. Averaging, as in the case of the annual mean temperatures, centralizes the results and reduces variability. The difference between the behavior of the annual *minimum* and annual *mean* daily average temperatures is clearly visible in the time series plots of each of these variables for each station shown in Appendix A. The upper line is the annual mean and the lower line is the annual minimum over the POR for a given station. The greater variability of the annual minimums is readily apparent.

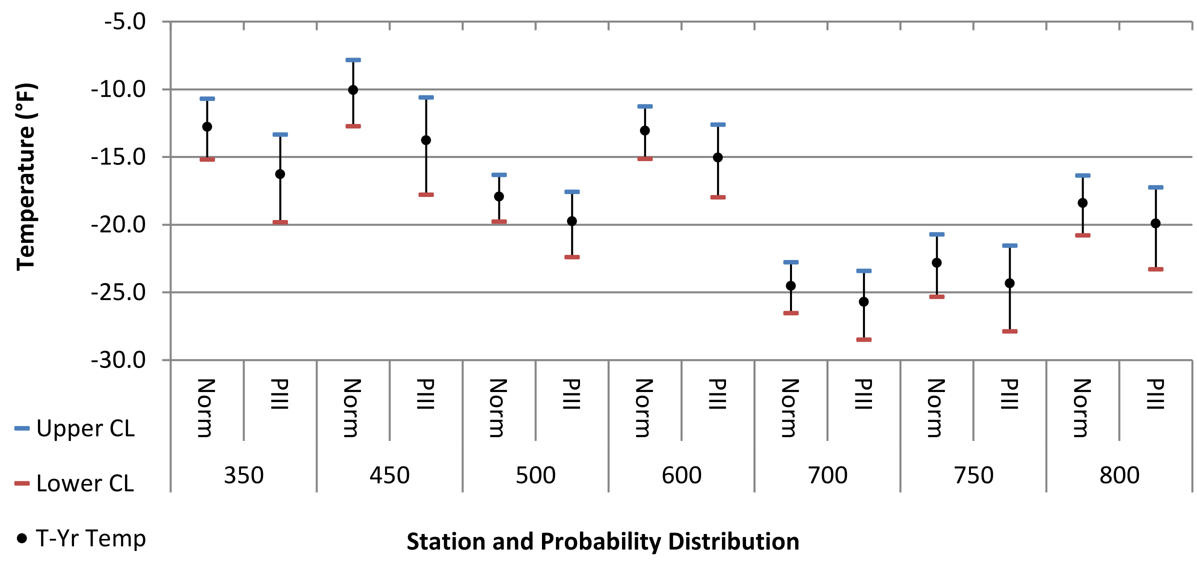
Figure 1. 100-Year Annual Mean Daily Average Temperature



Summary statistics for the annual minimum daily average temperatures given in the left half of Table 2 reflect its greater variability. The standard deviation of the annual minimums is much larger than that for the annual means, and many of the stations exhibit large negative skew. The large standard deviation indicates that the uncertainty of the exceedance values of annual minimum temperatures is larger than it was for the annual mean temperatures, consequently the range of the confidence limits for the minimum temperatures is much wider. This is shown in Figure 2 for the 100-year return period minimum temperatures, where the CLs span a range from 3.5 to 7.2 ˚F. The large negative skew suggests that the PIII distribution should provide a more realistic estimate of the minimum annual daily average exceedance temperatures than would the NORM distribution. Results of Chi-Square tests of the “goodness-of-fit” of the NORM and PIII distributions for each station generally confirm this as discussed in Appendix B.

For the T-year return period exceedance values of annual minimum daily average temperature, the PIII distribution provides better estimates than the NORM distribution, and the true values of the exceedance temperatures could be several degrees larger or smaller than the values provided in Table 2 owing to the inherent uncertainty of this variable.

Figure 2. 100-Year Annual Minimum Daily Average Temperature



Although estimated annual Tavg exceedance temperatures are very similar between the Norm and PIII distribution, for monthly Tavg and annual minTavg exceedance temperatures there are a number of cases where the PIII distribution represents the data better than does the Norm distribution and where the exceedance temperatures and confidence limits differ between the two distributions. For this reason, to simplify the selection process, it is recommended that the PIII exceedance temperatures be used in general. Where both distributions provide similar results it doesn't matter, and where they differ, PIII is usually more representative of the data. Routinely using the PIII values will avoid accidentally using the Norm exceedance temperatures when they are not representative of the observations. Further explanation is provided in Appendix B.

Multi-Year Time Horizon Probabilities

Probabilities of equaling or exceeding an event at least once during a multi-year period can be calculated based on the return period, T. Average Return Period T and annual exceedance probability have a reciprocal relationship, $P=1/T$. The exceedance probabilities, P, correspond to the likelihood of observing temperatures less than or equal to the indicated value *in any single year*. In order to apply these numbers over a *multi-year time horizon*, one should calculate the probability P_J that the temperature will be less than the specified threshold at least once during the J-year period. P_J may be calculated as $P_J = (1-(1-P)^J)$. Values of P_J for J equal to 5, 10, and 15 years are given in Table 3.

The single-year exceedance probability of 0.033 which appears in the third row up from the bottom is the approximate exceedance probability corresponding to using the coldest day observed in a T=thirty-year period as the peak design day. Thus, the likelihood that a temperature colder than the 0.033 or 3.3% exceedance temperature will be observed at least once in the next five years is 0.16 or 16%, as shown in the 5-year (J=5) column. Similarly, there is only a 5% chance of having a temperature occur at least once that is colder than the P=0.01 exceedance temperature (i.e., the T=100-year event) within a 5-year span.

Table 3. Multi-Year Exceedance Probabilities corresponding to different time horizons (J=5, 10, and 15 years) for different values of single-year exceedance probability.

Single-Year		Multi-Year Exceedance Probabilities, PJ		
T	P	J=5	J=10	J=15
2	0.5	0.97	0.999	0.99997
5	0.2	0.67	0.89	0.96
10	0.1	0.41	0.65	0.79
20	0.05	0.23	0.40	0.54
30	0.033	0.16	0.29	0.40
50	0.02	0.10	0.18	0.26
100	0.01	0.05	0.10	0.14

SUMMARY

T-year exceedance temperature values for monthly and annual daily average Temperatures (Tavg) and annual minimum daily average temperatures (minTavg) have been estimated for seven stations across Southern Idaho by fitting Normal and PIII distributions to long-term observations from the stations. Results for annual Tavg and minTavg are presented in Table 2 and Figures 1 and 2 above and in Appendix A, which also includes results for monthly Tavg.

For annual Tavg exceedance temperatures, results are similar between the Norm and PIII distribution estimates. For monthly Tavg and annual minTavg, results are often substantially different owing primarily to skew in the distribution of the data so that the PIII distribution provides a superior estimate of exceedance temperatures. The χ^2 (Chi-Squared) test applied to the results generally confirms that PIII is as good as or better than the Norm distribution. Because PIII usually provides a better estimate when results differ between the Norm and PIII distributions, it is recommended to use the PIII results from this report. When the Norm and PIII estimates are similar, this produces no negative consequences. However, when they differ, routinely using the PIII results avoids accidentally using the less accurate results from the Norm distribution.

A measure of uncertainty of the exceedance temperatures is given by 90% confidence limits in Figures 1 and 2 above, and in tables given for each station in Appendix A.

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Appendix A

Detailed Station Results

Detailed data and statistics for each station are presented in both tabular and graphic form in this appendix. Information for each station is grouped together on a series of four pages in order of station number. Each page lists the station number and name at the top. The first page for each station lists the starting and ending water year, followed by a table similar to the top one-third of Table 2 in the main body of the report, except that it contains data for one station only, and contains monthly results for the mean daily average temperature, in addition to annual results. In these pages T_{avg} refers to the monthly or annual mean daily average temperature; $minT_{avg}$ refers to annual minimum daily average temperature. The results in the last two columns are identical to those in Table 2 for the respective station. The left figure shows time series over the period of record (POR) of annual values of T_{avg} and $minT_{avg}$. These time series plots illustrate how the data vary from year to year throughout the period of record, and the difference in variability between T_{avg} and $minT_{avg}$. The two figures on the right present the annual data sorted by magnitude for T_{avg} (upper) and $minT_{avg}$ (lower).

The second and third pages for each station give tables of exceedance temperatures and Upper and Lower Confidence Limits (CLs) for the Norm and PIII distributions, respectively. As in the tables at the top of the first page for each station, monthly and annual values are included for T_{avg}, and annual values for $minT_{avg}$. The exceedance temperature values for *annual* T_{avg} and $minT_{avg}$ given in these tables are the same as those given in Table 2 in the main body of this report.

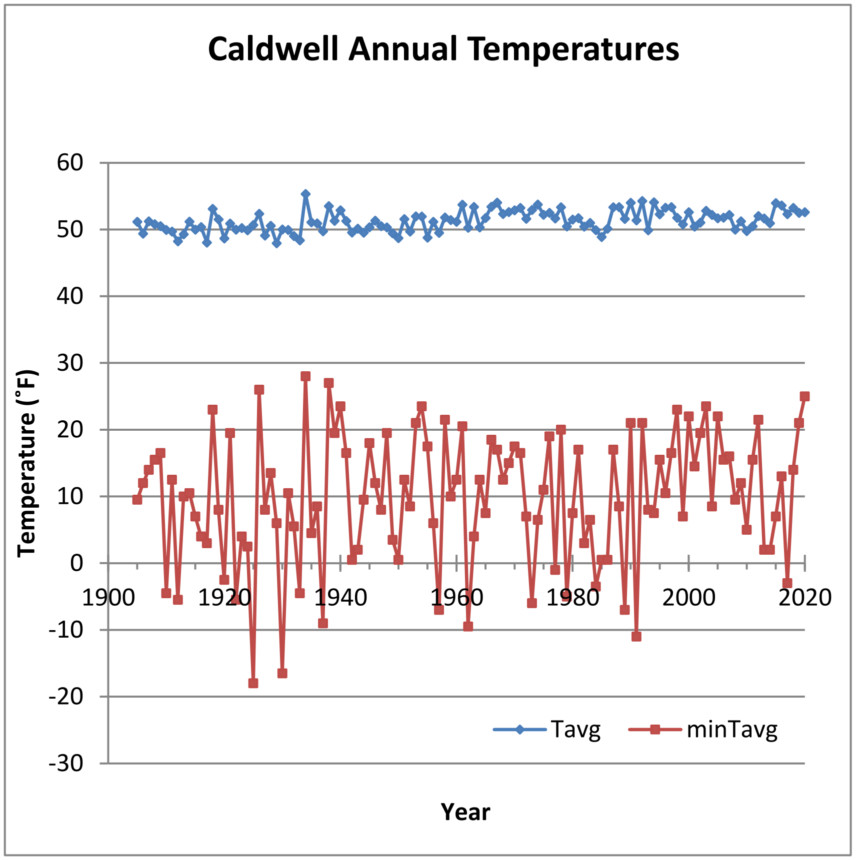
The fourth page for each station shows the exceedance temperatures and CLs graphically for annual values of T_{avg} and $minT_{avg}$ for the Norm and PIII distributions. Each graph presents results for the full range of return periods analyzed in this report, that is, 2, 5, 10, 20, 50 and 100 years. Each left/right pair of figures can be compared to see the influence of fitting a Normal versus PIII distribution to the data. T_{avg} is presented in the top pair of figures, and $minT_{avg}$ is presented in the bottom pair.

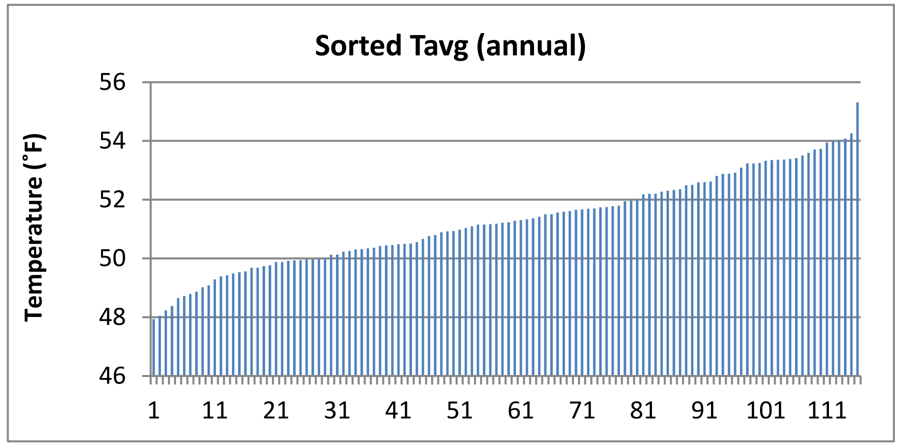
Weather Station Zones, Locations, and Starting Water Year (WY)		
Zone ID	Location	Starting WY
350	Caldwell	1905
450	Boise	1941
500	Hailey	1909
600	Twin Falls	1906
700	Rexburg	1908
750	Idaho Falls	1949
800	Pocatello	1939

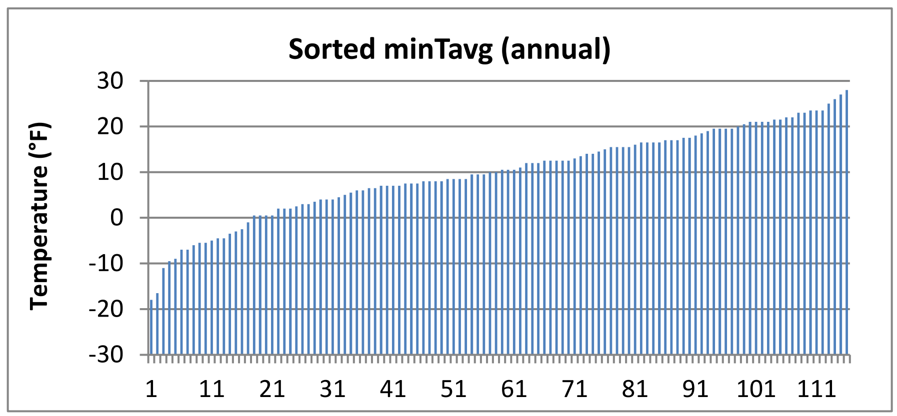
Station:	350 Caldwell		
Water Years (WY)	Starting: 1905	Ending: 2020	

Tavg (˚F)													
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
Mean	51.0	39.1	30.9	29.3	35.8	43.7	51.0	58.9	66.5	74.4	71.8	62.2	51.3
Sx	2.6	3.2	4.7	5.7	4.4	2.9	3.0	3.2	3.1	2.7	2.8	2.9	1.6
Skew	0.13	-0.30	-0.76	-0.62	-0.79	-0.15	0.17	0.03	0.41	0.01	0.29	0.15	0.10
Max	59.5	45.3	41.7	42.1	43.6	49.8	58.9	66.2	75.3	80.4	79.9	70.7	55.3
Min	44.6	29.0	12.5	13.1	20.5	34.7	44.6	51.8	60.5	66.7	66.1	55.4	47.9
n (years)	116	116	116	116	116	116	116	116	116	115	116	116	116

minTavg
Annual
9.8
9.7
-0.50
28.0
-18.0
116







Station:	350 Caldwell

NORMAL DISTRIBUTION

Exceedance Temperatures															
T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	51.0	39.1	30.9	29.3	35.8	43.7	51.0	58.9	66.5	74.4	71.8	62.2	51.3	9.8
5	0.2	48.8	36.4	26.9	24.5	32.1	41.2	48.5	56.3	63.9	72.1	69.5	59.8	50.0	1.7
10	0.1	47.7	35.1	24.9	22.0	30.1	39.9	47.2	54.9	62.5	71.0	68.2	58.5	49.3	-2.6
20	0.05	46.7	33.9	23.2	19.9	28.5	38.9	46.2	53.7	61.3	70.0	67.2	57.4	48.7	-6.1
50	0.02	45.6	32.6	21.3	17.6	26.7	37.7	45.0	52.4	60.1	68.9	66.0	56.2	48.1	-10.1
100	0.01	44.9	31.7	20.0	16.1	25.5	36.9	44.1	51.6	59.2	68.2	65.3	55.4	47.6	-12.8

Upper Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	51.4	39.5	31.4	30.0	36.3	44.0	51.4	59.3	66.9	74.7	72.2	62.6	51.5	11.0
5	0.2	49.2	36.9	27.6	25.3	32.7	41.6	48.9	56.7	64.3	72.5	69.8	60.2	50.2	2.9
10	0.1	48.1	35.5	25.6	22.9	30.8	40.4	47.7	55.4	63.0	71.4	68.6	58.9	49.5	-1.1
20	0.05	47.2	34.4	24.0	20.9	29.3	39.4	46.7	54.3	61.9	70.5	67.7	57.9	49.0	-4.5
50	0.02	46.2	33.2	22.2	18.7	27.6	38.2	45.5	53.1	60.7	69.4	66.6	56.8	48.4	-8.2
100	0.01	45.5	32.4	21.0	17.3	26.4	37.5	44.8	52.3	59.9	68.7	65.9	56.1	48.0	-10.7

Lower Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	50.7	38.7	30.3	28.7	35.3	43.3	50.7	58.6	66.1	74.1	71.5	61.9	51.1	8.7
5	0.2	48.4	36.0	26.3	23.7	31.4	40.8	48.1	55.8	63.4	71.8	69.0	59.4	49.7	0.2
10	0.1	47.2	34.5	24.1	21.0	29.4	39.4	46.7	54.3	61.9	70.5	67.7	58.0	49.0	-4.3
20	0.05	46.2	33.3	22.3	18.8	27.6	38.3	45.6	53.1	60.7	69.5	66.6	56.9	48.4	-8.1
50	0.02	45.0	31.9	20.2	16.3	25.7	37.0	44.3	51.7	59.4	68.3	65.4	55.6	47.7	-12.3
100	0.01	44.3	31.0	18.8	14.6	24.4	36.1	43.4	50.8	58.4	67.5	64.5	54.7	47.3	-15.2

Station: 350 Caldwell

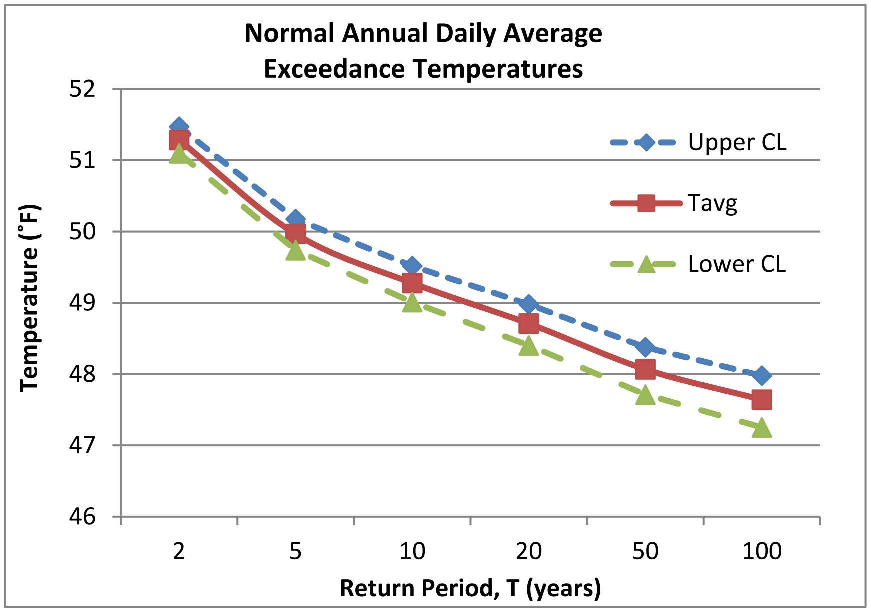
PIII DISTRIBUTION

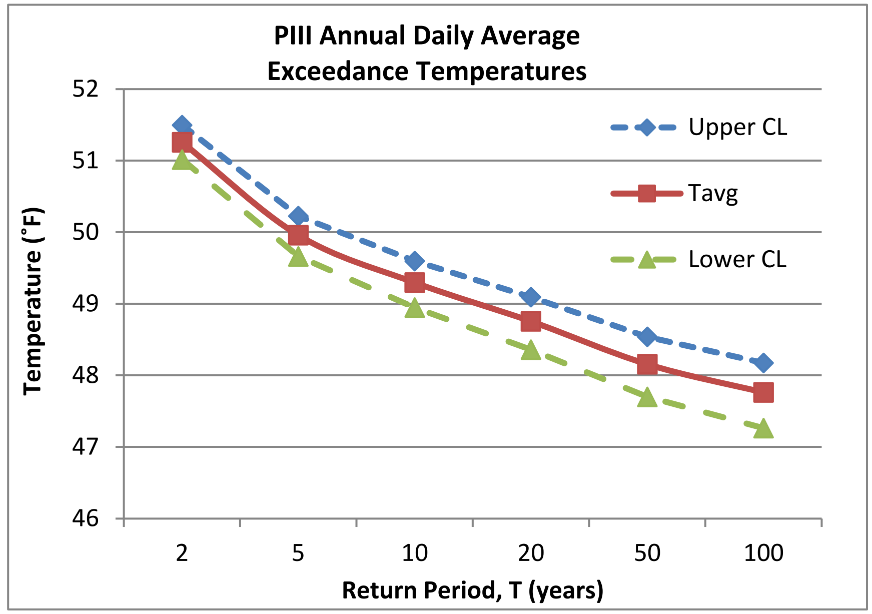
Exceedance Temperatures															
T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	51.0	39.3	31.5	29.9	36.4	43.7	51.0	58.9	66.3	74.4	71.7	62.2	51.3	10.6
5	0.2	48.8	36.5	27.2	24.8	32.3	41.2	48.5	56.3	63.8	72.1	69.4	59.8	50.0	2.0
10	0.1	47.7	35.0	24.6	21.8	29.9	39.9	47.3	54.9	62.6	71.0	68.3	58.5	49.3	-3.0
20	0.05	46.8	33.6	22.3	19.1	27.7	38.7	46.3	53.8	61.7	70.0	67.4	57.6	48.8	-7.4
50	0.02	45.8	32.1	19.5	15.8	25.0	37.4	45.2	52.5	60.8	68.9	66.5	56.5	48.2	-12.6
100	0.01	45.2	31.0	17.4	13.5	23.0	36.6	44.5	51.7	60.1	68.2	65.9	55.8	47.8	-16.3

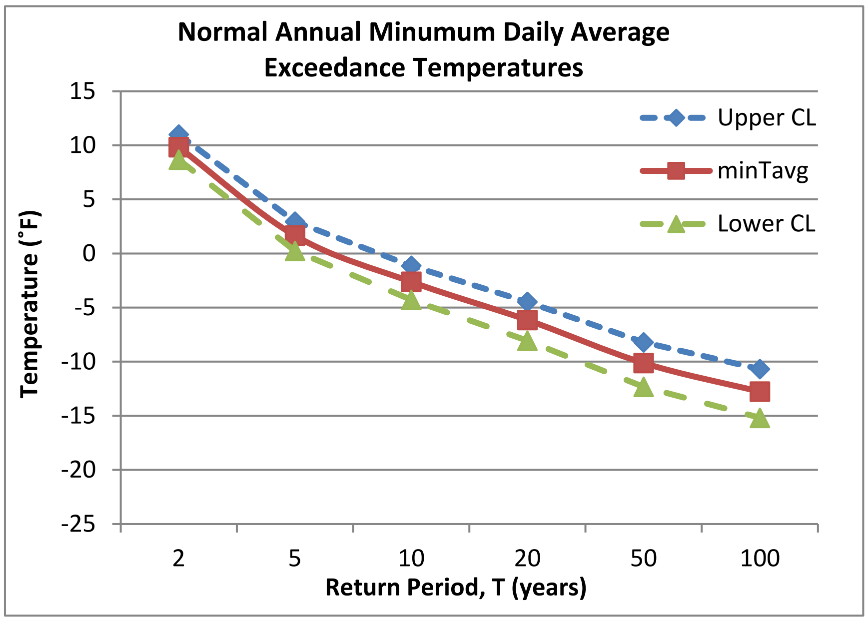
Upper Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	51.4	39.8	32.2	30.8	37.0	44.2	51.4	59.4	66.8	74.8	72.1	62.6	51.5	12.1
5	0.2	49.3	37.0	28.0	25.8	33.1	41.7	49.0	56.8	64.4	72.6	69.9	60.3	50.2	3.6
10	0.1	48.2	35.6	25.6	22.9	30.8	40.4	47.9	55.5	63.2	71.5	68.8	59.1	49.6	-1.1
20	0.05	47.4	34.3	23.4	20.4	28.7	39.4	46.9	54.5	62.4	70.6	68.0	58.2	49.1	-5.2
50	0.02	46.5	32.9	20.8	17.4	26.2	38.2	45.9	53.3	61.5	69.6	67.1	57.2	48.5	-10.0
100	0.01	45.9	31.9	18.9	15.3	24.4	37.4	45.3	52.5	60.9	68.9	66.6	56.5	48.2	-13.4

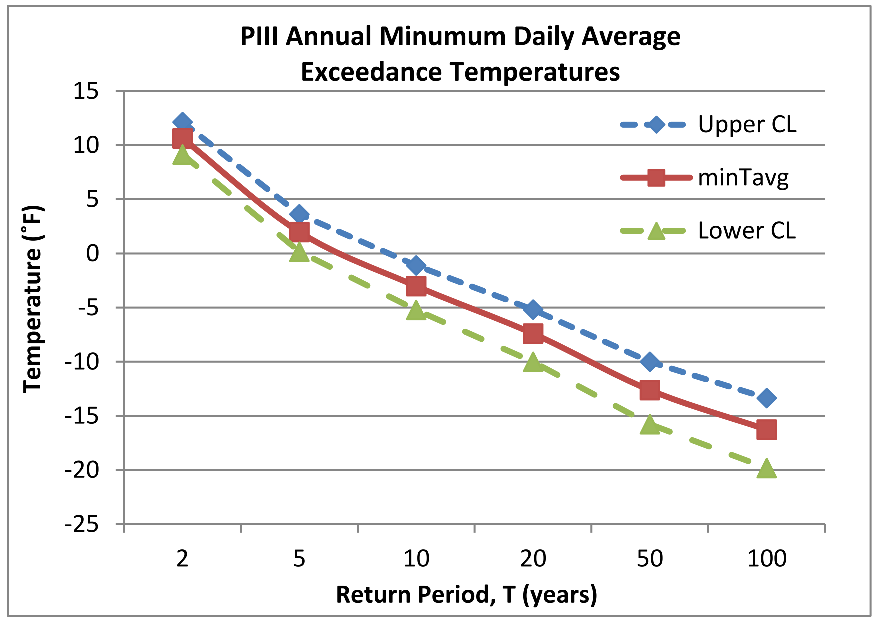
Lower Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	50.6	38.8	30.8	29.1	35.7	43.3	50.5	58.4	65.8	74.0	71.3	61.7	51.0	9.1
5	0.2	48.3	35.9	26.4	23.7	31.5	40.7	48.0	55.7	63.2	71.6	68.9	59.2	49.7	0.2
10	0.1	47.1	34.2	23.6	20.5	28.9	39.2	46.6	54.2	62.0	70.4	67.7	57.9	48.9	-5.2
20	0.05	46.1	32.8	21.0	17.5	26.5	38.0	45.6	53.0	61.0	69.3	66.7	56.8	48.4	-10.0
50	0.02	45.0	31.1	17.9	13.9	23.5	36.5	44.4	51.6	59.9	68.1	65.7	55.6	47.7	-15.8
100	0.01	44.3	29.9	15.6	11.4	21.3	35.6	43.6	50.6	59.2	67.3	65.0	54.8	47.3	-19.8

Station: 350 Caldwell



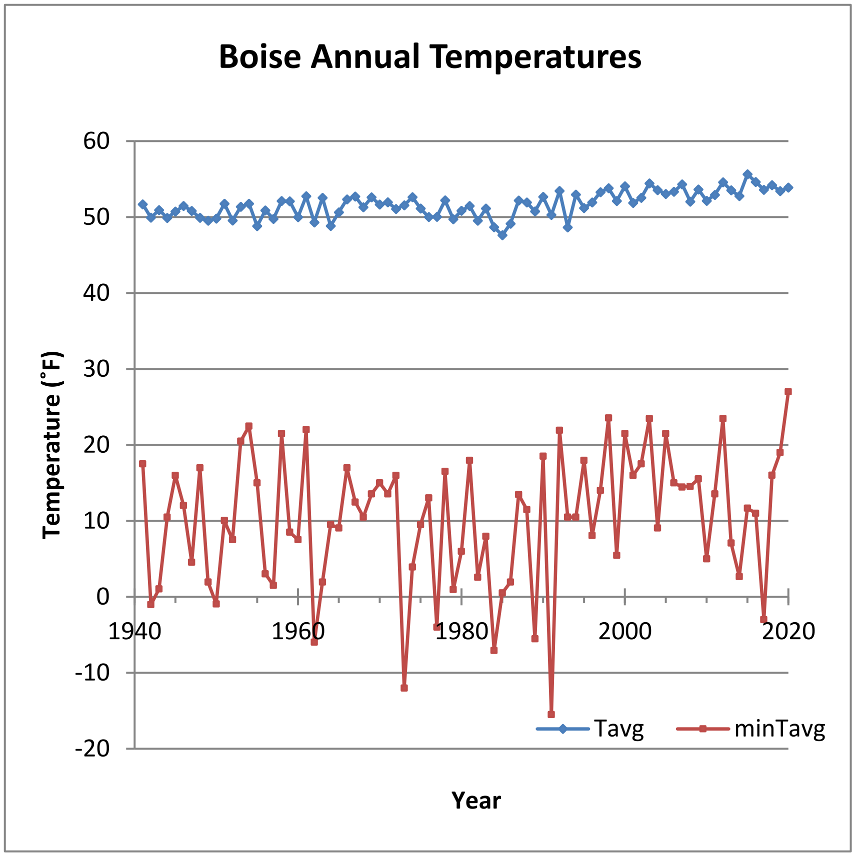


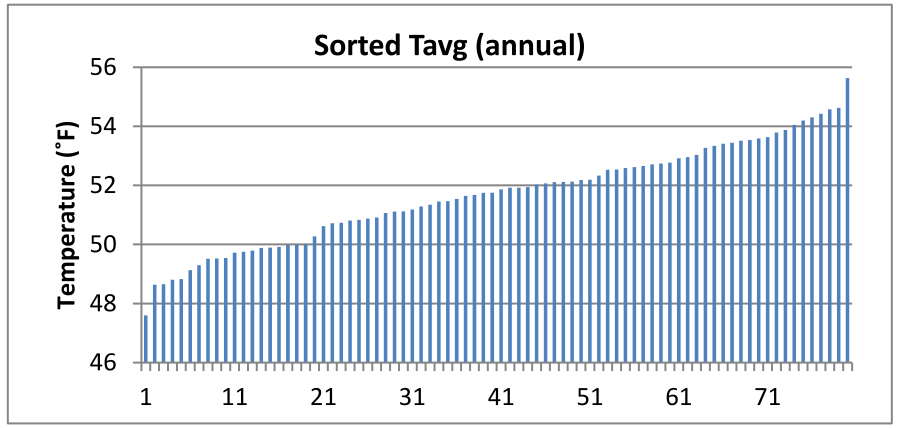


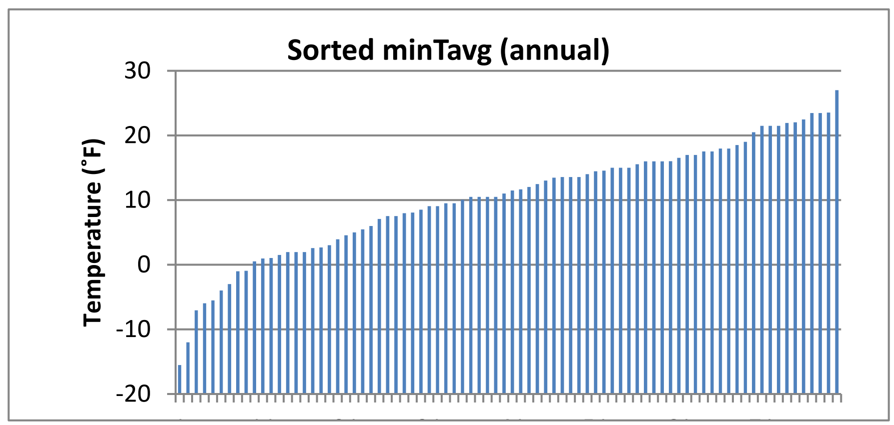


Station:	450 Boise		
Water Years (WY)	Starting: 1941	Ending: 2020	

	Tavg (˚F)													minTavg
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
Mean	52.4	39.8	31.3	29.9	36.1	43.0	49.8	58.2	66.3	75.3	73.5	64.0	51.7	10.3
Sx	3.1	3.6	4.5	5.9	4.2	3.2	2.9	3.0	3.3	3.3	3.0	3.4	1.7	8.8
Skew	0.14	-0.54	-1.36	-0.73	-0.75	-0.11	0.07	0.01	0.24	0.05	-0.08	-0.18	-0.09	-0.59
Max	59.8	47.2	38.4	41.0	43.9	49.7	56.7	64.3	75.9	83.1	78.7	71.4	55.6	27.0
Min	45.1	27.6	12.6	10.3	23.2	35.9	43.8	52.1	59.3	65.0	67.2	56.2	47.6	-15.5
n (years)	80	80	80	80	80	80	80	80	80	80	80	80	80	80







Station: 450 Boise	NORMAL DISTRIBUTION

Exceedance Temperatures

T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	52.4	39.8	31.3	29.9	36.1	43.0	49.8	58.2	66.3	75.3	73.5	64.0	51.7	10.3
5	0.2	49.7	36.7	27.6	24.9	32.6	40.3	47.4	55.7	63.5	72.5	70.9	61.2	50.3	2.9
10	0.1	48.3	35.2	25.6	22.3	30.7	38.9	46.1	54.3	62.1	71.1	69.6	59.7	49.5	-0.9
20	0.05	47.2	33.9	24.0	20.2	29.2	37.7	45.0	53.2	60.9	69.9	68.5	58.4	48.9	-4.1
50	0.02	45.9	32.4	22.2	17.8	27.5	36.4	43.8	52.0	59.6	68.6	67.3	57.0	48.2	-7.7
100	0.01	45.1	31.4	20.9	16.1	26.3	35.5	43.0	51.2	58.7	67.7	66.5	56.1	47.8	-10.1

Upper Confidence Limit

T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	52.8	40.3	32.0	30.8	36.8	43.4	50.2	58.6	66.7	75.7	73.9	64.5	51.9	11.6
5	0.2	50.2	37.3	28.3	25.9	33.3	40.8	47.8	56.1	64.0	73.0	71.4	61.7	50.5	4.3
10	0.1	48.9	35.8	26.4	23.4	31.5	39.4	46.6	54.9	62.7	71.7	70.2	60.3	49.8	0.7
20	0.05	47.8	34.6	24.9	21.4	30.1	38.4	45.6	53.9	61.6	70.6	69.1	59.1	49.3	-2.3
50	0.02	46.7	33.3	23.2	19.1	28.5	37.1	44.5	52.7	60.3	69.3	68.0	57.8	48.6	-5.6
100	0.01	45.9	32.4	22.1	17.6	27.4	36.3	43.8	52.0	59.5	68.5	67.2	57.0	48.2	-7.8

Lower Confidence Limit

T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	51.9	39.2	30.7	29.1	35.5	42.5	49.4	57.8	65.8	74.8	73.1	63.5	51.4	9.0
5	0.2	49.2	36.1	26.8	23.9	31.9	39.7	46.9	55.1	63.0	72.0	70.4	60.6	50.0	1.4
10	0.1	47.7	34.4	24.7	21.1	29.9	38.2	45.5	53.7	61.4	70.4	69.0	59.0	49.2	-2.7
20	0.05	46.5	33.0	22.9	18.8	28.2	36.9	44.3	52.5	60.1	69.1	67.8	57.6	48.5	-6.2
50	0.02	45.1	31.4	20.9	16.1	26.3	35.5	43.0	51.2	58.7	67.7	66.4	56.1	47.8	-10.1
100	0.01	44.1	30.4	19.6	14.3	25.1	34.6	42.2	50.3	57.7	66.7	65.5	55.1	47.3	-12.7

Station: 450 Boise

PIII DISTRIBUTION

Exceedance Temperatures

T	Exceed.	Tavg														minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual		Annual
2	0.5	52.3	40.1	32.3	30.6	36.7	43.0	49.8	58.2	66.1	75.2	73.5	64.1	51.7		11.2
5	0.2	49.7	36.9	28.2	25.3	32.8	40.3	47.4	55.7	63.5	72.5	71.0	61.2	50.3		3.3
10	0.1	48.4	35.0	25.4	22.0	30.5	38.8	46.1	54.3	62.2	71.1	69.6	59.6	49.5		-1.3
20	0.05	47.3	33.4	22.7	19.1	28.4	37.6	45.1	53.3	61.1	70.0	68.4	58.3	48.9		-5.4
50	0.02	46.2	31.4	19.3	15.6	25.9	36.2	44.0	52.0	60.0	68.7	67.1	56.7	48.1		-10.3
100	0.01	45.4	30.0	16.8	13.0	24.1	35.3	43.2	51.2	59.3	67.8	66.3	55.6	47.6		-13.8

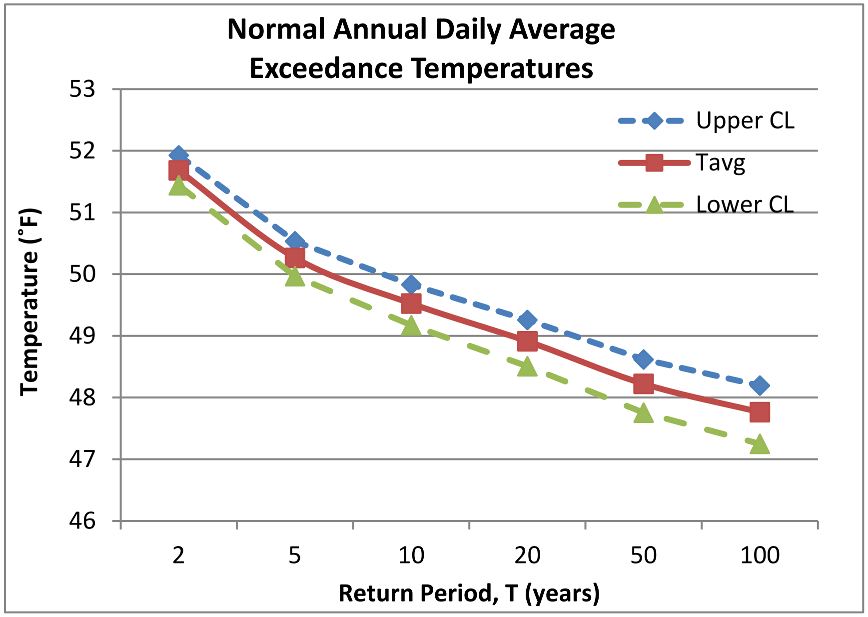
Upper Confidence Limit

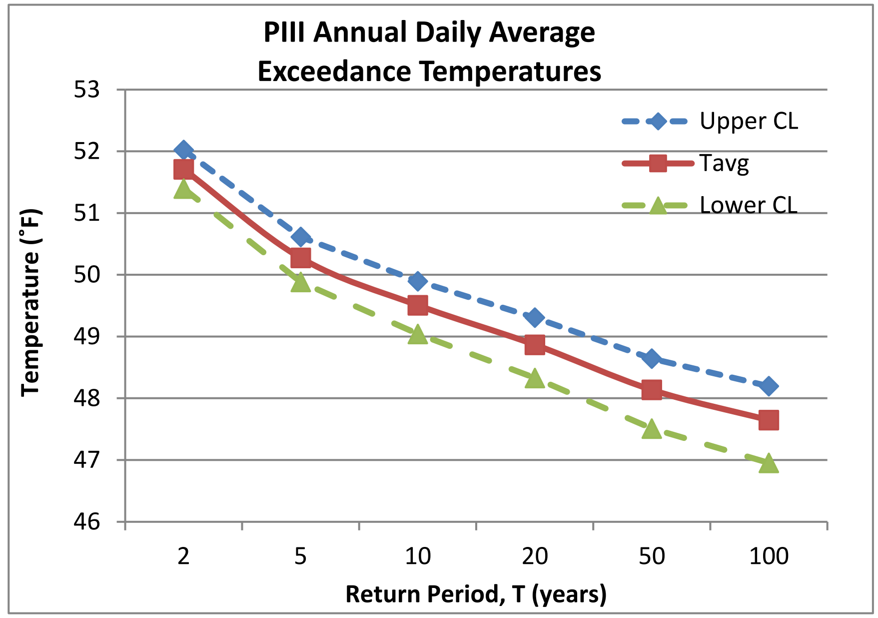
T	P	Tavg														minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual		Annual
2	0.5	52.9	40.7	33.1	31.8	37.5	43.6	50.3	58.7	66.7	75.8	74.1	64.8	52.0		12.8
5	0.2	50.3	37.6	29.0	26.5	33.7	40.9	47.9	56.3	64.2	73.2	71.6	61.9	50.6		5.1
10	0.1	49.1	35.9	26.4	23.4	31.5	39.6	46.8	55.0	62.9	71.9	70.3	60.4	49.9		0.7
20	0.05	48.1	34.3	24.0	20.7	29.6	38.4	45.8	54.0	62.0	70.8	69.2	59.2	49.3		-3.0
50	0.02	47.1	32.6	20.9	17.5	27.3	37.2	44.8	52.9	60.9	69.6	68.0	57.7	48.6		-7.5
100	0.01	46.4	31.3	18.6	15.2	25.7	36.3	44.1	52.2	60.3	68.8	67.3	56.8	48.2		-10.6

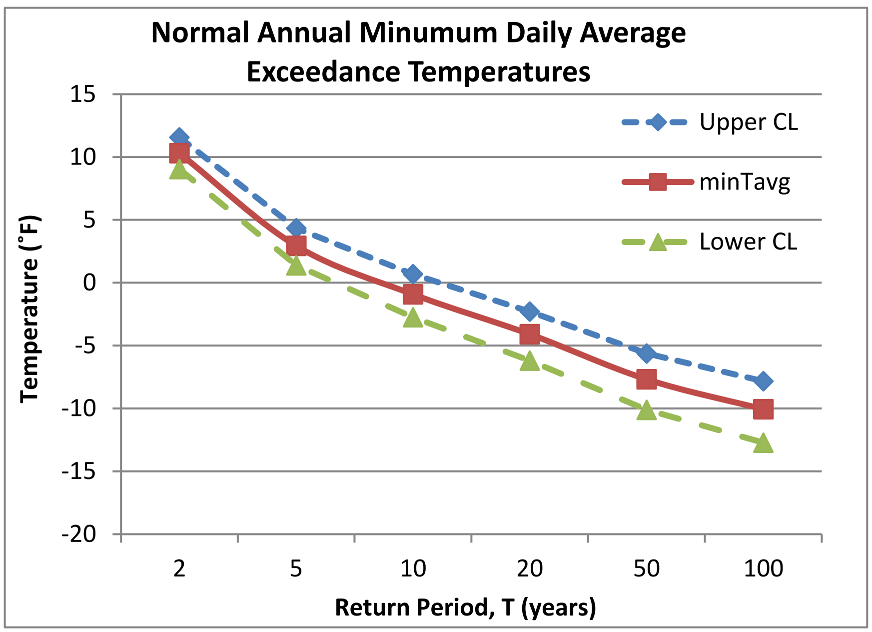
Lower Confidence Limit

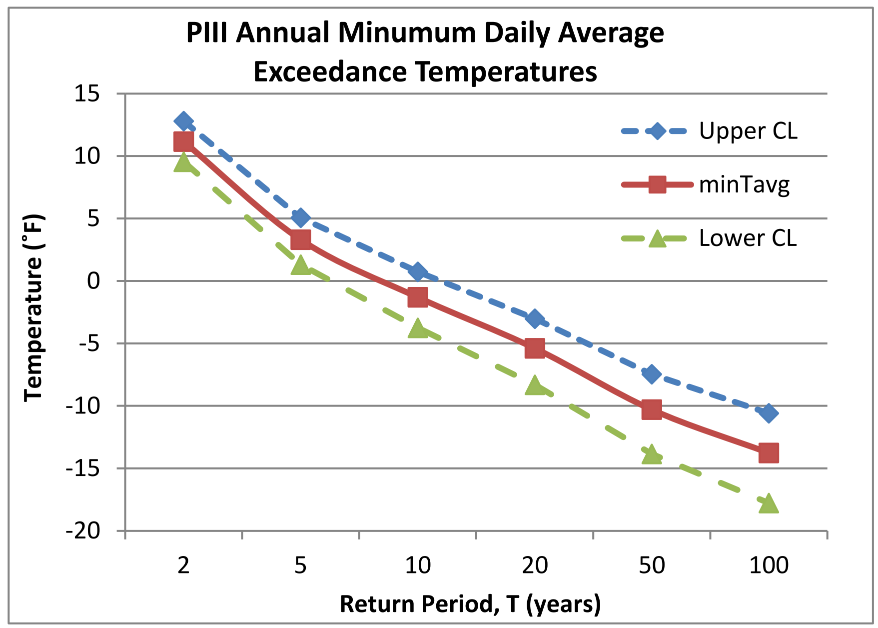
T	P	Tavg														minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual		Annual
2	0.5	51.7	39.4	31.5	29.5	35.9	42.4	49.2	57.6	65.5	74.6	73.0	63.5	51.4		9.5
5	0.2	49.0	36.1	27.2	23.9	31.9	39.6	46.7	55.0	62.7	71.8	70.3	60.4	49.9		1.3
10	0.1	47.5	34.0	24.1	20.4	29.3	38.0	45.3	53.5	61.3	70.2	68.8	58.7	49.0		-3.7
20	0.05	46.4	32.2	21.2	17.1	27.0	36.6	44.2	52.3	60.1	68.9	67.5	57.2	48.3		-8.3
50	0.02	45.0	30.0	17.3	13.1	24.2	35.0	42.9	50.9	58.9	67.5	66.0	55.4	47.5		-13.8
100	0.01	44.2	28.4	14.4	10.2	22.1	34.0	42.0	50.0	58.0	66.5	65.0	54.2	47.0		-17.8

Station: 450 Boise



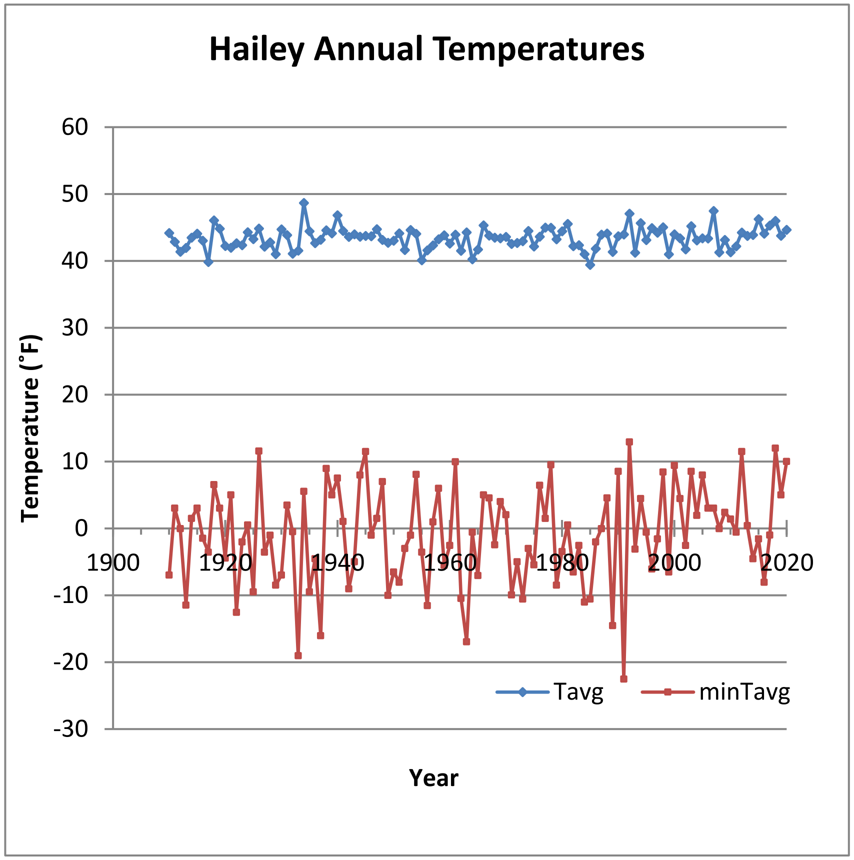


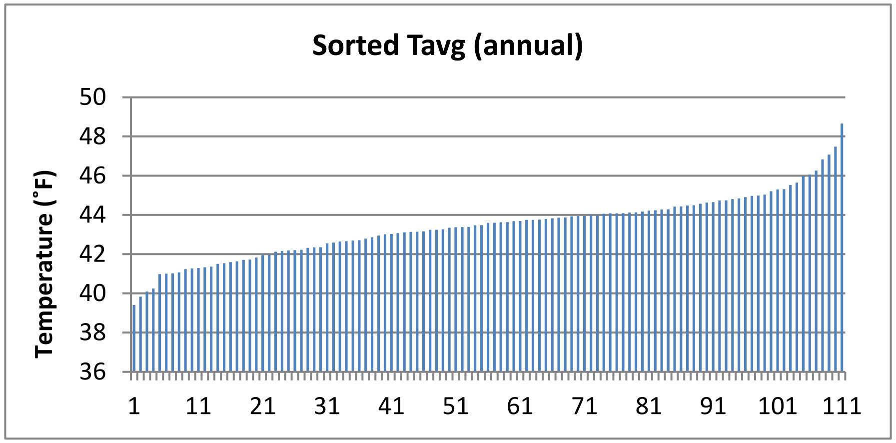


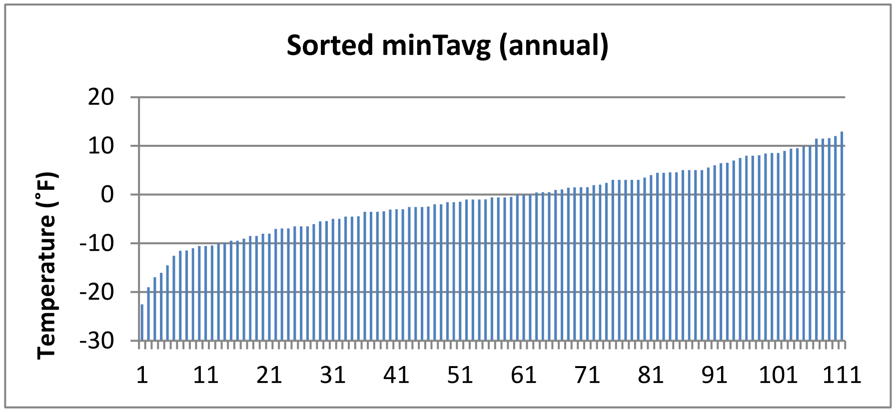


Station:	500 Hailey		
Water Years (WY)	Starting: 1910	Ending: 2020	

	Tavg (˚F)														minTavg
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual		Annual
Mean	46.0	32.7	22.0	19.6	24.1	32.2	42.6	51.5	58.9	67.6	65.9	56.9	43.4		-1.0
Sx	3.0	3.9	4.4	4.7	5.0	4.3	3.5	3.0	2.7	2.5	2.5	3.1	1.6		7.3
Skew	-0.04	-0.2	-0.1	-0.4	-0.1	0.0	0.0	0.2	0.5	-0.3	-0.2	-0.4	0.2		-0.3
Max	53.4	41.3	32.6	30.1	36.6	43.4	51.6	58.8	66.4	76.1	71.2	62.4	48.7		12.9
Min	37.8	22.1	9.4	6.0	10.4	20.3	34.3	44.7	54.4	58.3	60.4	49.4	39.4		-22.5
n (years)	111	111	111	111	111	111	111	111	111	111	111	111	111		111







Station: 500 Hailey

NORMAL DISTRIBUTION

Exceedance Temperatures															
T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	46.0	32.7	22.0	19.6	24.1	32.2	42.6	51.5	58.9	67.6	65.9	56.9	43.4	-1.0
5	0.2	43.5	29.4	18.3	15.6	19.9	28.6	39.7	49.0	56.6	65.5	63.8	54.3	42.1	-7.1
10	0.1	42.1	27.7	16.3	13.5	17.7	26.8	38.2	47.7	55.4	64.4	62.7	53.0	41.4	-10.3
20	0.05	41.0	26.3	14.7	11.8	15.9	25.2	36.9	46.6	54.4	63.5	61.8	51.8	40.8	-13.0
50	0.02	39.8	24.7	12.9	9.9	13.8	23.5	35.5	45.4	53.3	62.4	60.8	50.6	40.1	-15.9
100	0.01	39.0	23.6	11.7	8.6	12.4	22.3	34.6	44.6	52.5	61.7	60.1	49.7	39.7	-17.9

Upper Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	46.4	33.1	22.6	20.1	24.7	32.8	43.1	51.9	59.3	67.9	66.2	57.3	43.6	-0.1
5	0.2	43.9	29.9	18.9	16.3	20.6	29.2	40.2	49.4	57.0	65.8	64.2	54.7	42.3	-6.1
10	0.1	42.6	28.3	17.0	14.3	18.5	27.4	38.7	48.1	55.8	64.8	63.1	53.4	41.6	-9.2
20	0.05	41.6	26.9	15.5	12.7	16.7	26.0	37.5	47.1	54.9	63.9	62.3	52.4	41.1	-11.7
50	0.02	40.4	25.4	13.8	10.9	14.8	24.3	36.2	46.0	53.8	62.9	61.3	51.2	40.4	-14.5
100	0.01	39.6	24.5	12.7	9.7	13.5	23.2	35.3	45.2	53.1	62.3	60.7	50.4	40.0	-16.3

Lower Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	45.7	32.2	21.5	19.0	23.5	31.7	42.2	51.1	58.6	67.3	65.6	56.5	43.2	-1.8
5	0.2	43.0	28.8	17.6	14.9	19.1	28.0	39.2	48.5	56.2	65.1	63.5	53.9	41.8	-8.2
10	0.1	41.6	27.0	15.6	12.7	16.8	26.0	37.6	47.2	54.9	63.9	62.3	52.4	41.1	-11.6
20	0.05	40.4	25.5	13.8	10.9	14.9	24.3	36.2	46.0	53.9	63.0	61.3	51.2	40.5	-14.4
50	0.02	39.1	23.8	11.9	8.8	12.6	22.5	34.7	44.7	52.7	61.8	60.2	49.9	39.8	-17.6
100	0.01	38.2	22.6	10.6	7.4	11.2	21.2	33.7	43.8	51.8	61.1	59.5	49.0	39.3	-19.8

Station:	500 Hailey

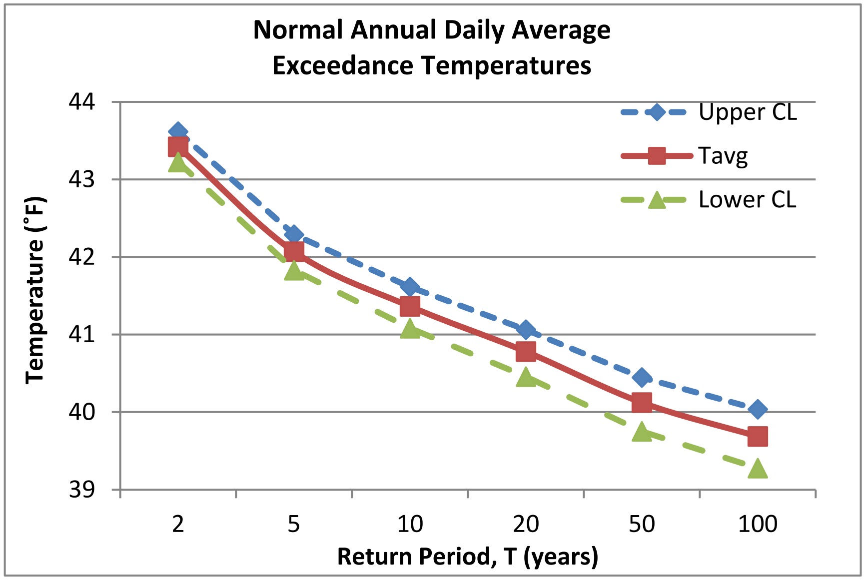
PIII DISTRIBUTION

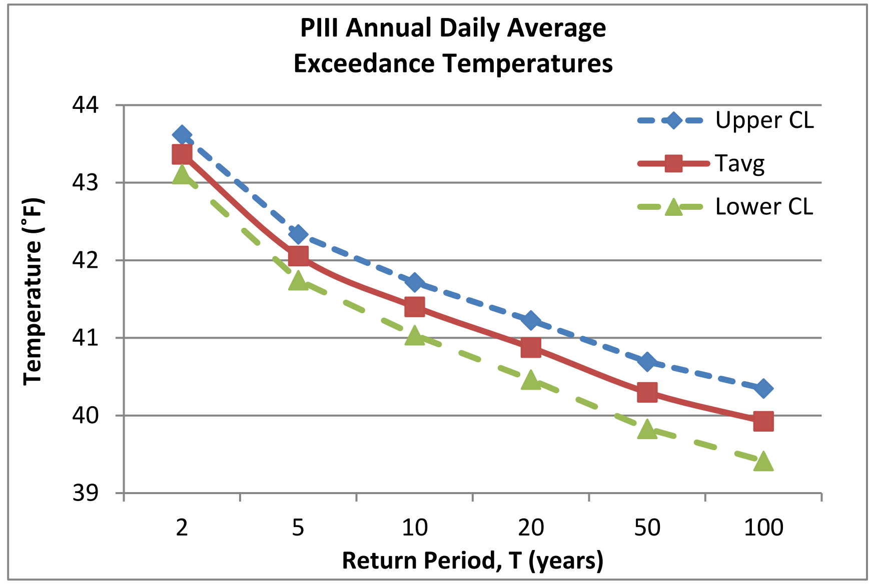
Exceedance Temperatures															
T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	46.0	32.8	22.1	19.9	24.2	32.2	42.6	51.4	58.7	67.7	66.0	57.1	43.4	-0.5
5	0.2	43.5	29.4	18.3	15.7	19.9	28.6	39.7	49.0	56.6	65.5	63.9	54.4	42.1	-6.9
10	0.1	42.1	27.6	16.3	13.4	17.7	26.8	38.2	47.8	55.6	64.3	62.7	52.8	41.4	-10.5
20	0.05	41.0	26.0	14.6	11.4	15.8	25.2	37.0	46.8	54.8	63.2	61.7	51.5	40.9	-13.6
50	0.02	39.7	24.2	12.6	9.0	13.7	23.5	35.6	45.8	54.0	62.0	60.6	49.9	40.3	-17.2
100	0.01	38.9	23.0	11.3	7.3	12.2	22.4	34.7	45.1	53.5	61.1	59.8	48.8	39.9	-19.7

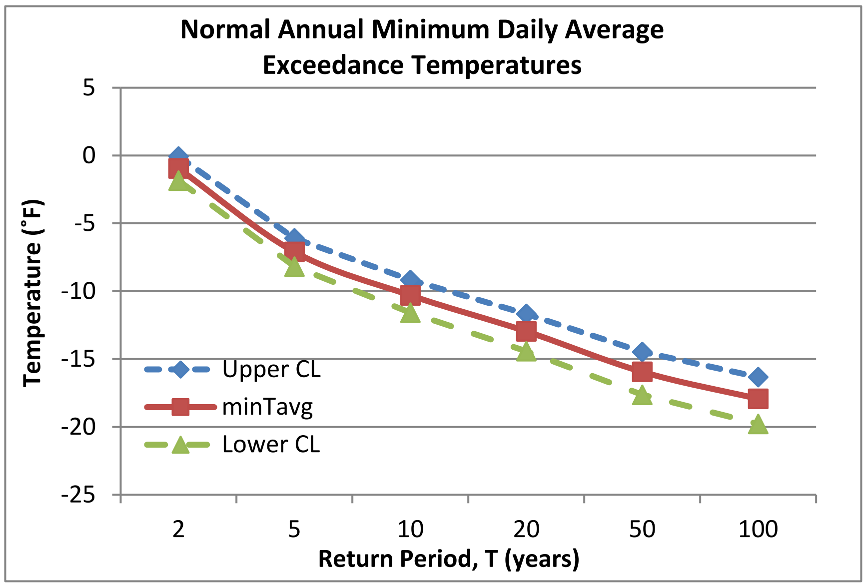
Upper Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	46.5	33.4	22.8	20.6	24.9	32.9	43.2	51.9	59.2	68.1	66.4	57.6	43.6	0.6
5	0.2	44.0	30.1	19.1	16.5	20.8	29.4	40.3	49.5	57.1	66.0	64.3	54.9	42.3	-5.7
10	0.1	42.7	28.4	17.2	14.3	18.6	27.6	38.9	48.3	56.1	64.8	63.2	53.5	41.7	-9.1
20	0.05	41.7	26.9	15.6	12.4	16.9	26.2	37.7	47.5	55.4	63.8	62.3	52.2	41.2	-12.0
50	0.02	40.5	25.3	13.8	10.3	14.9	24.6	36.5	46.5	54.6	62.7	61.2	50.7	40.7	-15.3
100	0.01	39.7	24.1	12.6	8.8	13.6	23.6	35.6	45.9	54.1	61.9	60.5	49.7	40.3	-17.6

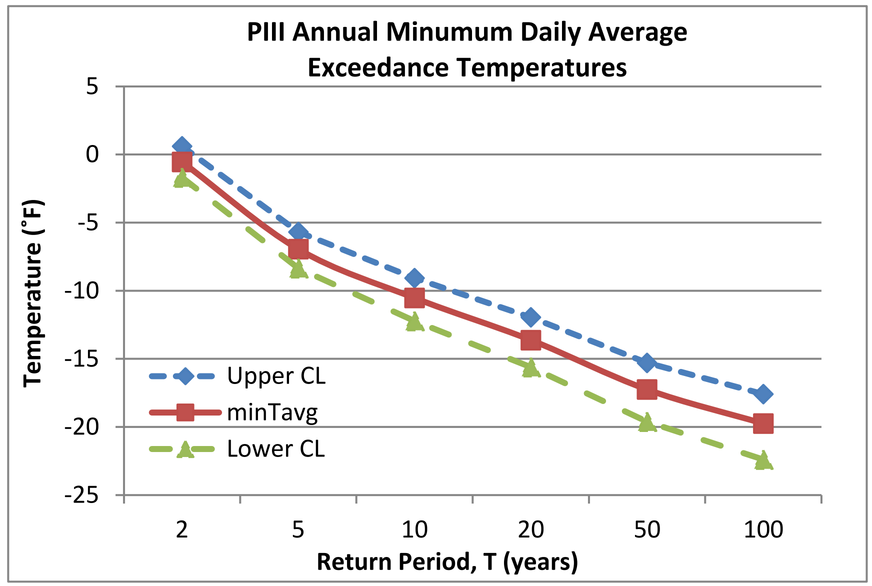
Lower Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	45.6	32.2	21.4	19.1	23.4	31.6	42.1	50.9	58.3	67.3	65.6	56.6	43.1	-1.7
5	0.2	42.9	28.7	17.5	14.8	18.9	27.8	39.0	48.4	56.0	65.0	63.4	53.8	41.7	-8.3
10	0.1	41.4	26.7	15.3	12.3	16.5	25.8	37.4	47.1	55.0	63.7	62.1	52.1	41.0	-12.2
20	0.05	40.2	25.0	13.4	10.1	14.4	24.1	36.1	46.0	54.1	62.6	61.0	50.6	40.5	-15.6
50	0.02	38.8	23.0	11.3	7.5	12.1	22.2	34.6	44.9	53.2	61.2	59.8	48.9	39.8	-19.6
100	0.01	37.9	21.7	9.8	5.6	10.5	21.0	33.5	44.2	52.6	60.2	58.9	47.6	39.4	-22.4

Station: 500 Hailey



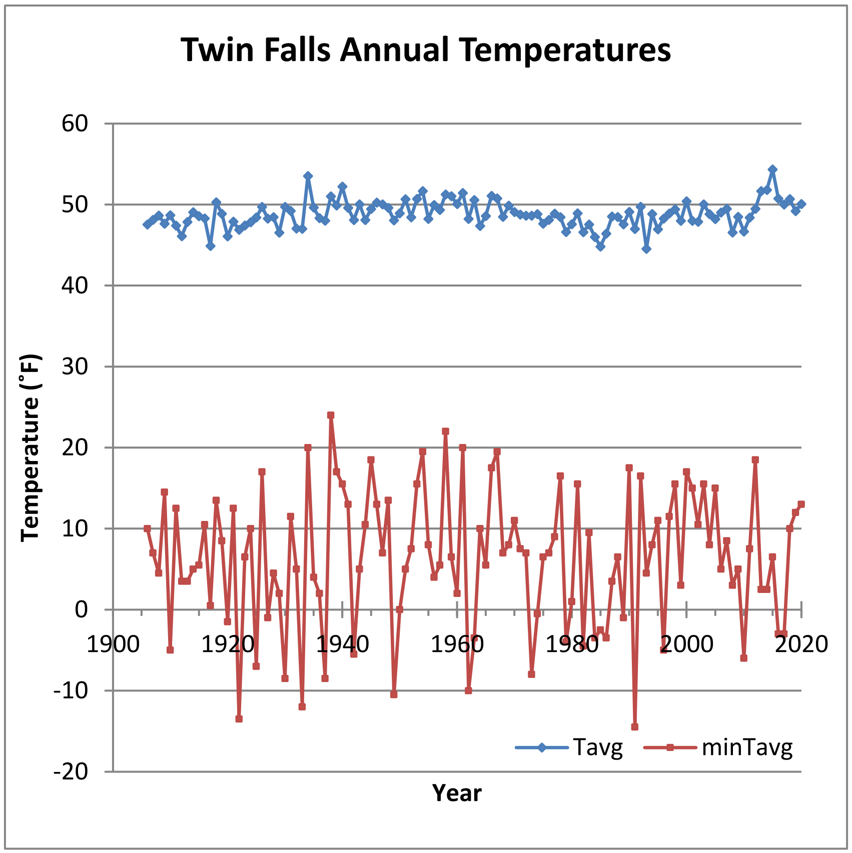


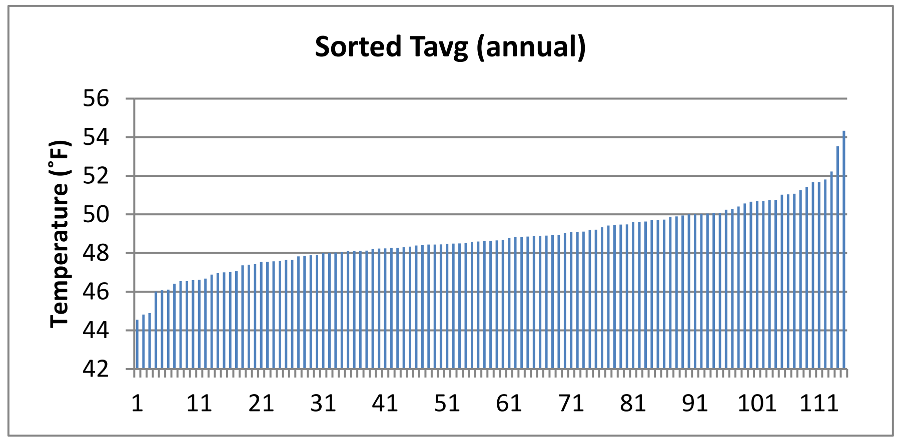


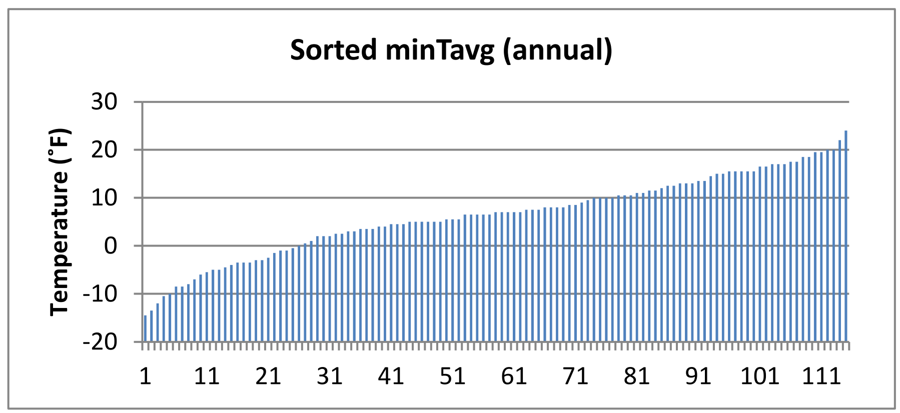


Station:	600 Twin Falls		
Water Years (WY)	Starting: 1906	Ending: 2020	

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	minTavg Annual
	Tavg (˚F)													
Mean	49.5	37.8	29.3	27.7	32.9	40.2	47.6	55.8	63.5	71.5	69.2	60.0	48.8	6.4
Sx	3.0	3.4	4.5	5.3	4.7	3.2	3.1	3.0	3.0	2.9	2.7	2.9	1.7	8.3
Skew	0.1	-0.5	-0.6	-0.7	-0.3	-0.1	0.0	0.2	0.5	-0.3	0.1	-0.1	0.3	-0.3
Max	58.5	44.7	40.0	40.3	42.6	48.9	55.4	63.8	73.5	79.5	77.1	66.6	54.3	24.0
Min	41.8	26.8	12.8	7.8	19.4	30.8	40.4	49.6	57.0	60.9	63.6	53.1	44.6	-14.5
n (years)	114	115	114	115	115	115	113	114	114	115	115	115	115	115







Station:	600 Twin Falls

NORMAL DISTRIBUTION

Exceedance Temperatures

T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	49.5	37.8	29.3	27.7	32.9	40.2	47.6	55.8	63.5	71.5	69.2	60.0	48.8	6.4
5	0.2	47.0	35.0	25.5	23.2	28.9	37.4	44.9	53.2	61.0	69.1	67.0	57.5	47.4	-0.7
10	0.1	45.7	33.5	23.5	20.8	26.8	36.0	43.5	51.9	59.7	67.8	65.8	56.2	46.7	-4.3
20	0.05	44.6	32.3	21.9	18.9	25.1	34.9	42.4	50.8	58.6	66.8	64.8	55.2	46.1	-7.4
50	0.02	43.4	30.9	20.0	16.7	23.2	33.5	41.1	49.5	57.4	65.6	63.7	54.0	45.4	-10.8
100	0.01	42.6	30.0	18.8	15.3	21.9	32.7	40.3	48.7	56.6	64.8	63.0	53.2	45.0	-13.0

Upper Confidence Limit

T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	49.9	38.2	29.9	28.3	33.5	40.5	47.9	56.1	63.9	71.8	69.5	60.4	49.0	7.4
5	0.2	47.4	35.4	26.1	23.9	29.5	37.9	45.3	53.6	61.4	69.5	67.3	57.9	47.6	0.5
10	0.1	46.2	34.0	24.2	21.7	27.6	36.5	44.0	52.3	60.2	68.3	66.2	56.7	46.9	-3.1
20	0.05	45.1	32.9	22.7	19.8	25.9	35.4	42.9	51.3	59.2	67.3	65.3	55.7	46.4	-5.9
50	0.02	44.0	31.6	20.9	17.8	24.1	34.2	41.7	50.1	58.0	66.2	64.3	54.5	45.7	-9.1
100	0.01	43.2	30.7	19.8	16.4	22.9	33.4	40.9	49.3	57.3	65.4	63.6	53.8	45.3	-11.3

Lower Confidence Limit

T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	49.2	37.4	28.8	27.0	32.3	39.8	47.2	55.4	63.2	71.2	68.9	59.6	48.6	5.4
5	0.2	46.6	34.5	24.9	22.4	28.2	37.0	44.5	52.7	60.6	68.7	66.6	57.1	47.2	-1.9
10	0.1	45.2	32.9	22.8	19.9	26.0	35.5	43.0	51.3	59.2	67.3	65.3	55.7	46.4	-5.8
20	0.05	44.0	31.6	21.0	17.9	24.2	34.2	41.8	50.1	58.0	66.2	64.3	54.6	45.8	-9.0
50	0.02	42.7	30.1	19.0	15.5	22.1	32.8	40.4	48.8	56.7	65.0	63.1	53.3	45.0	-12.7
100	0.01	41.8	29.1	17.7	14.0	20.7	31.9	39.5	47.9	55.9	64.1	62.3	52.4	44.5	-15.1

Station:	600 Twin Falls

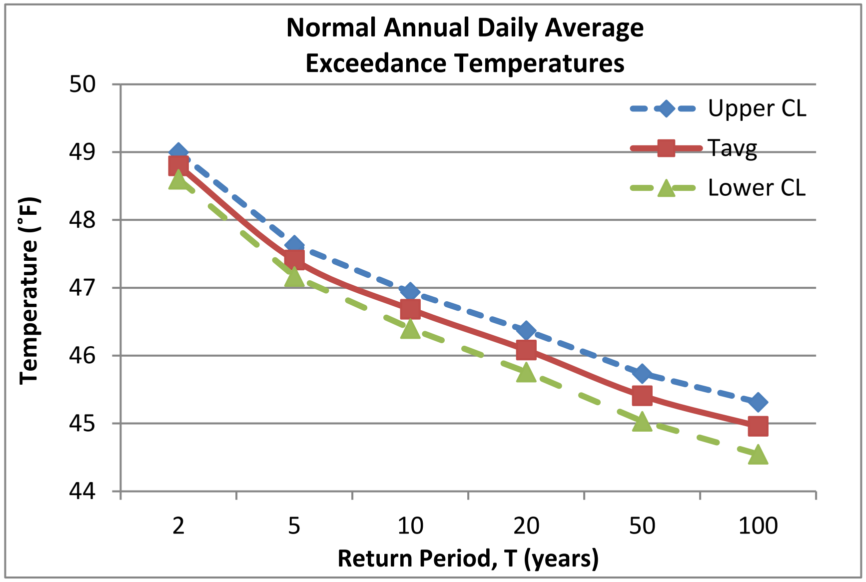
PIII DISTRIBUTION

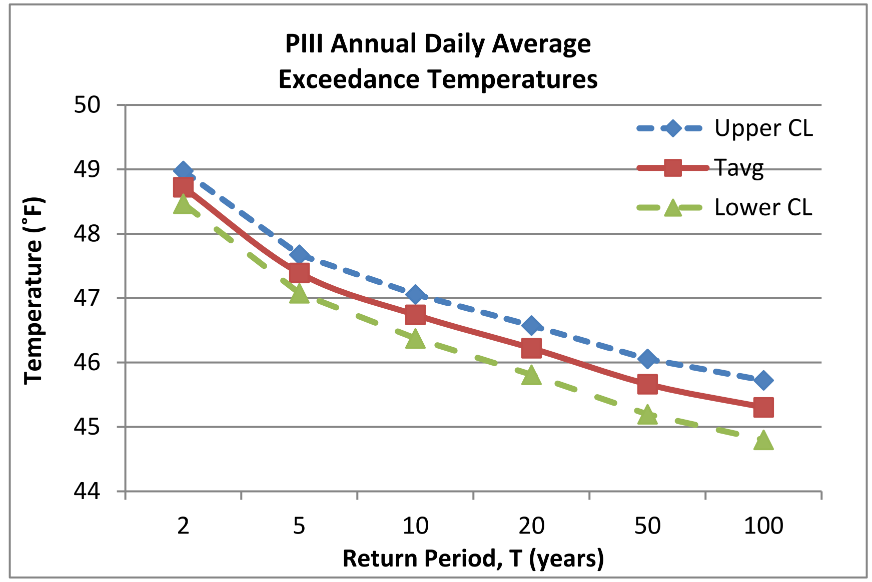
Exceedance Temperatures															
T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	49.5	38.1	29.8	28.3	33.1	40.2	47.5	55.6	63.3	71.7	69.2	60.1	48.7	6.8
5	0.2	47.0	35.1	25.7	23.5	29.0	37.5	44.9	53.2	61.0	69.1	67.0	57.5	47.4	-0.5
10	0.1	45.7	33.4	23.3	20.6	26.7	36.0	43.6	51.9	59.9	67.7	65.8	56.2	46.7	-4.6
20	0.05	44.7	31.9	21.3	18.0	24.7	34.8	42.4	51.0	59.1	66.5	64.9	55.1	46.2	-8.1
50	0.02	43.5	30.1	18.8	14.9	22.4	33.4	41.2	49.9	58.3	65.1	63.9	53.8	45.7	-12.2
100	0.01	42.7	28.8	17.0	12.7	20.8	32.5	40.4	49.2	57.8	64.2	63.3	52.9	45.3	-15.0

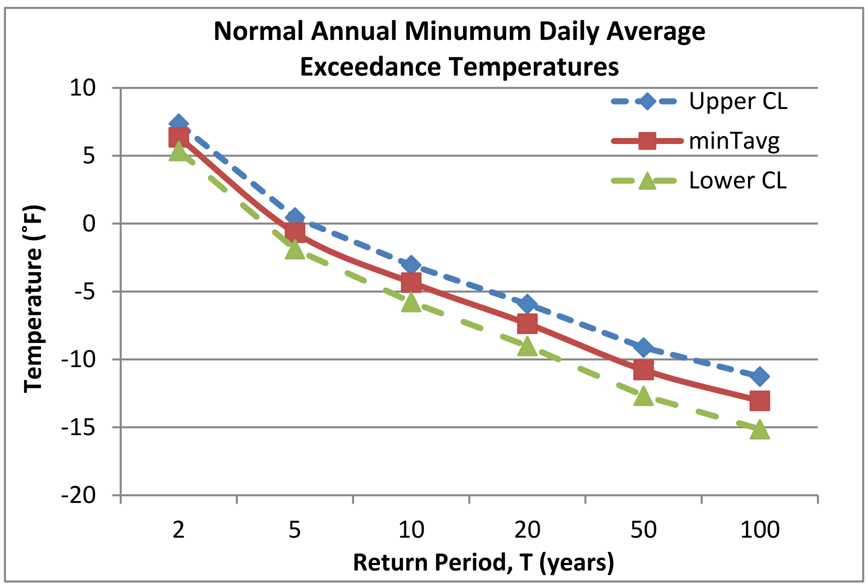
Upper Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	50.0	38.6	30.5	29.1	33.9	40.7	48.0	56.1	63.7	72.1	69.6	60.5	49.0	8.1
5	0.2	47.5	35.7	26.5	24.4	29.8	38.0	45.4	53.7	61.5	69.6	67.4	58.0	47.7	0.9
10	0.1	46.3	34.0	24.2	21.6	27.6	36.6	44.2	52.5	60.5	68.3	66.4	56.8	47.1	-2.9
20	0.05	45.3	32.6	22.3	19.2	25.8	35.5	43.1	51.6	59.7	67.2	65.5	55.7	46.6	-6.2
50	0.02	44.2	31.0	20.0	16.4	23.7	34.2	42.0	50.6	59.0	65.9	64.6	54.5	46.1	-10.0
100	0.01	43.5	29.8	18.4	14.3	22.2	33.4	41.2	50.0	58.5	65.0	64.0	53.7	45.7	-12.6

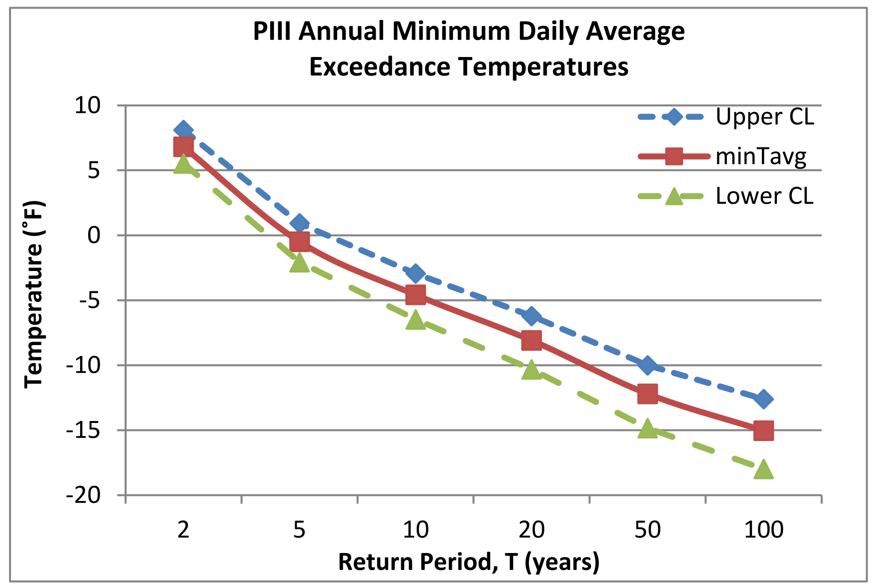
Lower Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	49.0	37.6	29.1	27.4	32.4	39.7	47.0	55.2	62.8	71.2	68.7	59.6	48.5	5.5
5	0.2	46.4	34.5	24.9	22.5	28.1	36.8	44.3	52.6	60.4	68.6	66.4	57.0	47.1	-2.1
10	0.1	45.0	32.6	22.3	19.4	25.6	35.3	42.8	51.3	59.3	67.1	65.2	55.5	46.4	-6.5
20	0.05	43.9	30.9	20.0	16.6	23.5	34.0	41.6	50.2	58.4	65.8	64.3	54.3	45.8	-10.3
50	0.02	42.6	29.0	17.3	13.1	20.9	32.5	40.3	49.0	57.5	64.2	63.2	52.9	45.2	-14.8
100	0.01	41.8	27.6	15.3	10.6	19.2	31.4	39.3	48.3	56.9	63.2	62.4	51.9	44.8	-18.0

Station: 600 Twin Falls



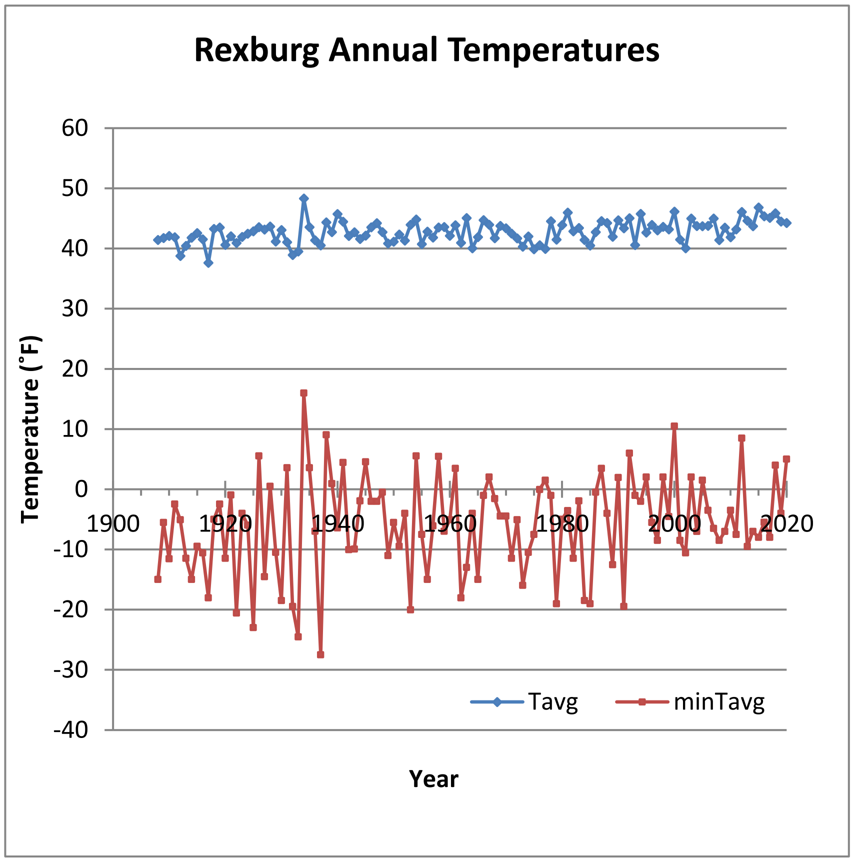


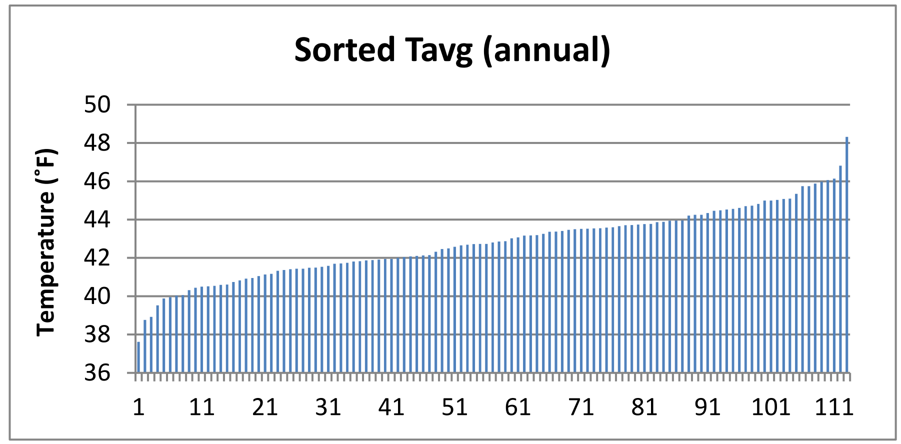


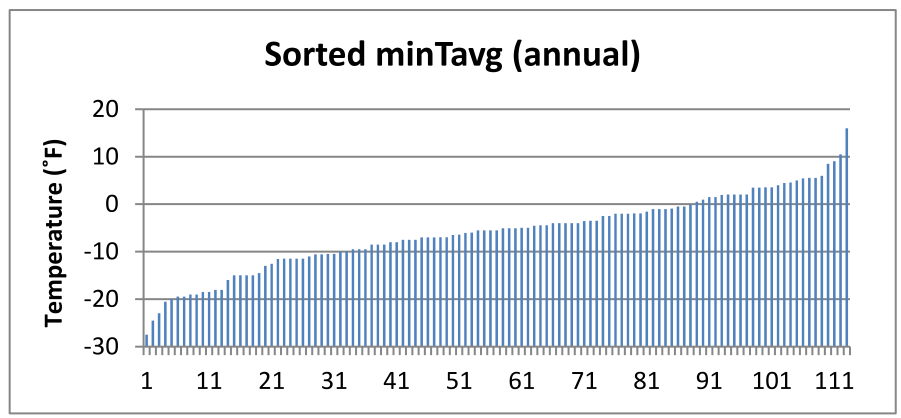


Station:	700 Rexburg		
Water Years (WY)	Starting: 1908	Ending: 2020	

	Tavg (˚F)														minTavg
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual		Annual
Mean	44.9	31.9	21.0	18.4	22.5	31.8	42.9	52.1	59.5	66.9	64.7	55.9	42.8		-5.9
Sx	3.1	4.1	4.8	5.5	5.9	5.0	3.4	2.9	2.7	2.4	2.6	2.9	1.8		8.0
Skew	-0.2	-0.1	0.0	-0.4	-0.3	-0.3	-0.1	0.0	0.1	-0.1	0.0	-0.3	0.0		-0.2
Max	51.8	42.5	33.7	32.3	36.0	42.4	50.7	58.3	66.5	73.3	70.3	62.2	48.3		16.0
Min	36.7	21.7	11.8	-0.1	6.2	17.7	33.1	46.0	52.5	58.4	58.9	47.5	37.6		-27.5
n (years)	112	111	112	113	113	113	113	113	113	112	112	112	113		113







Station:	700 Rexburg

NORMAL DISTRIBUTION

Exceedance Temperatures

T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	44.9	31.9	21.0	18.4	22.5	31.8	42.9	52.1	59.5	66.9	64.7	55.9	42.8	-5.9
5	0.2	42.3	28.4	17.0	13.7	17.5	27.6	40.1	49.6	57.2	64.8	62.6	53.4	41.2	-12.6
10	0.1	40.9	26.6	14.9	11.3	14.9	25.4	38.6	48.3	56.0	63.8	61.4	52.1	40.4	-16.1
20	0.05	39.8	25.2	13.1	9.3	12.8	23.6	37.3	47.3	55.0	62.9	60.5	51.1	39.8	-19.1
50	0.02	38.5	23.5	11.2	7.1	10.4	21.5	35.9	46.1	53.9	61.9	59.4	49.9	39.0	-22.3
100	0.01	37.7	22.4	9.9	5.6	8.8	20.1	35.0	45.3	53.2	61.2	58.7	49.1	38.5	-24.5

Upper Confidence Limit

T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	45.2	32.4	21.6	19.0	23.2	32.4	43.3	52.4	59.8	67.2	65.0	56.2	43.0	-4.9
5	0.2	42.7	29.0	17.6	14.5	18.3	28.3	40.5	50.0	57.6	65.2	62.9	53.8	41.5	-11.5
10	0.1	41.4	27.3	15.6	12.2	15.9	26.2	39.1	48.8	56.4	64.1	61.8	52.6	40.7	-14.9
20	0.05	40.3	25.9	14.0	10.3	13.8	24.4	37.9	47.8	55.5	63.3	60.9	51.6	40.1	-17.7
50	0.02	39.2	24.3	12.1	8.2	11.6	22.5	36.6	46.7	54.5	62.4	59.9	50.5	39.4	-20.7
100	0.01	38.4	23.3	10.9	6.8	10.1	21.2	35.7	45.9	53.8	61.7	59.3	49.7	38.9	-22.8

Lower Confidence Limit

T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	44.5	31.4	20.4	17.7	21.8	31.2	42.5	51.7	59.2	66.6	64.4	55.5	42.6	-6.8
5	0.2	41.8	27.8	16.3	12.9	16.7	26.8	39.6	49.2	56.8	64.5	62.2	53.0	41.0	-13.8
10	0.1	40.4	25.9	14.0	10.4	13.9	24.5	38.0	47.8	55.5	63.3	61.0	51.6	40.1	-17.5
20	0.05	39.2	24.3	12.2	8.2	11.6	22.6	36.6	46.7	54.5	62.4	60.0	50.5	39.4	-20.6
50	0.02	37.8	22.5	10.1	5.8	9.1	20.4	35.1	45.4	53.3	61.3	58.8	49.2	38.6	-24.2
100	0.01	36.9	21.3	8.7	4.2	7.3	18.9	34.1	44.6	52.5	60.6	58.1	48.4	38.0	-26.5

Station:	700 Rexburg

PIII DISTRIBUTION

Exceedance Temperatures

T	Exceed.	Tavg														minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual		Annual
2	0.5	45.0	32.0	21.0	18.8	22.8	32.0	43.0	52.1	59.4	66.9	64.7	56.0	42.8		-5.6
5	0.2	42.3	28.5	17.0	13.9	17.6	27.7	40.1	49.6	57.2	64.8	62.6	53.5	41.2		-12.5
10	0.1	40.9	26.6	14.9	11.1	14.8	25.3	38.5	48.3	56.1	63.7	61.4	52.0	40.4		-16.3
20	0.05	39.6	25.0	13.2	8.7	12.3	23.2	37.2	47.2	55.1	62.8	60.5	50.8	39.8		-19.5
50	0.02	38.2	23.2	11.3	5.8	9.4	20.8	35.7	46.0	54.1	61.7	59.4	49.4	39.0		-23.2
100	0.01	37.3	22.0	10.1	3.8	7.4	19.2	34.7	45.2	53.5	61.0	58.7	48.4	38.6		-25.7

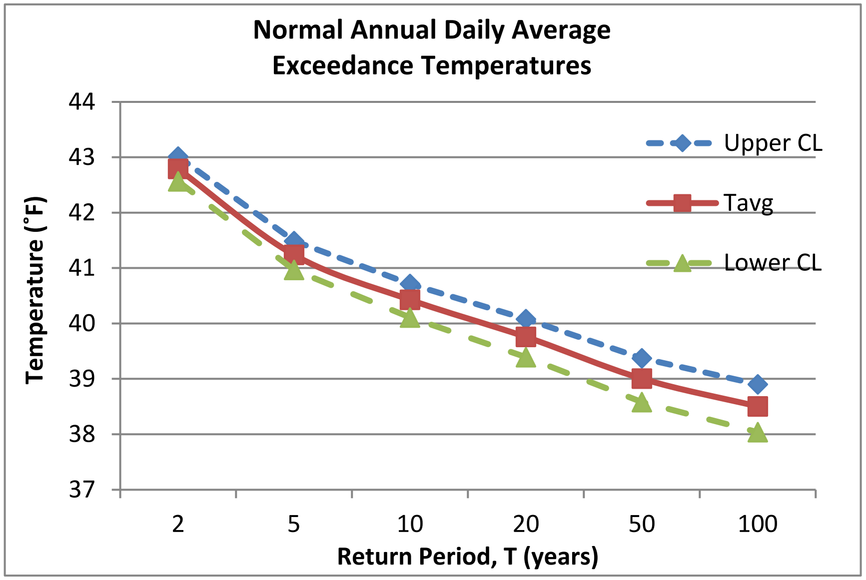
Upper Confidence Limit

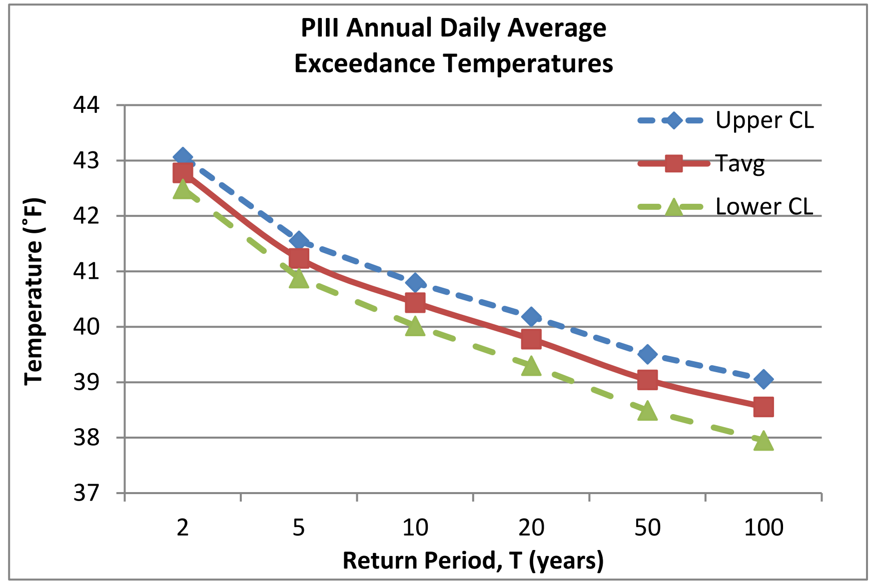
T	P	Tavg														minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual		Annual
2	0.5	45.4	32.6	21.7	19.6	23.7	32.8	43.5	52.6	59.9	67.3	65.1	56.5	43.1		-4.4
5	0.2	42.8	29.2	17.8	14.8	18.7	28.5	40.7	50.1	57.7	65.3	63.0	54.0	41.6		-11.2
10	0.1	41.5	27.4	15.8	12.2	15.9	26.2	39.2	48.9	56.6	64.2	61.9	52.6	40.8		-14.7
20	0.05	40.3	25.9	14.3	9.9	13.6	24.3	38.0	47.9	55.7	63.3	61.0	51.5	40.2		-17.7
50	0.02	39.0	24.3	12.5	7.3	10.9	22.1	36.6	46.8	54.8	62.3	60.1	50.2	39.5		-21.1
100	0.01	38.2	23.2	11.3	5.4	9.1	20.6	35.7	46.0	54.2	61.7	59.4	49.2	39.1		-23.4

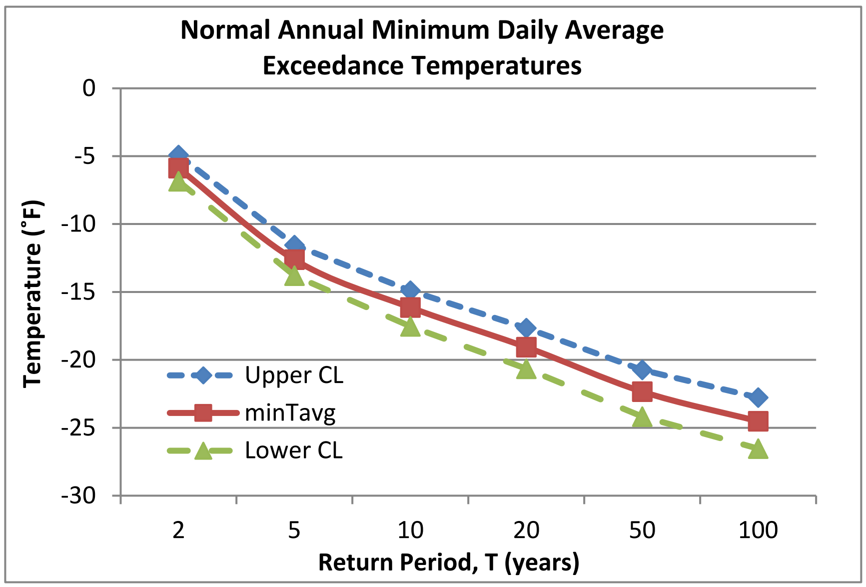
Lower Confidence Limit

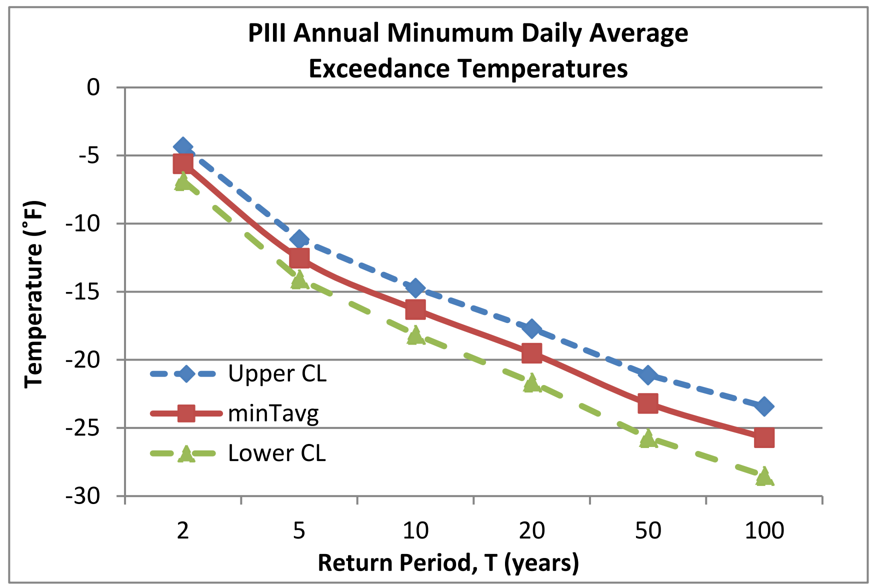
T	P	Tavg														minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual		Annual
2	0.5	44.5	31.3	20.2	17.9	21.9	31.3	42.5	51.7	59.0	66.5	64.3	55.6	42.5		-6.9
5	0.2	41.7	27.7	16.0	12.8	16.5	26.7	39.4	49.1	56.7	64.4	62.1	52.9	40.9		-14.1
10	0.1	40.2	25.7	13.8	9.8	13.4	24.1	37.7	47.7	55.5	63.2	60.8	51.4	40.0		-18.1
20	0.05	38.8	23.9	12.0	7.2	10.7	21.9	36.3	46.5	54.4	62.1	59.8	50.0	39.3		-21.6
50	0.02	37.3	22.0	9.9	4.0	7.5	19.2	34.7	45.1	53.3	61.0	58.6	48.4	38.5		-25.7
100	0.01	36.2	20.6	8.5	1.8	5.3	17.4	33.6	44.2	52.6	60.2	57.9	47.3	38.0		-28.5

Station: 700 Rexburg



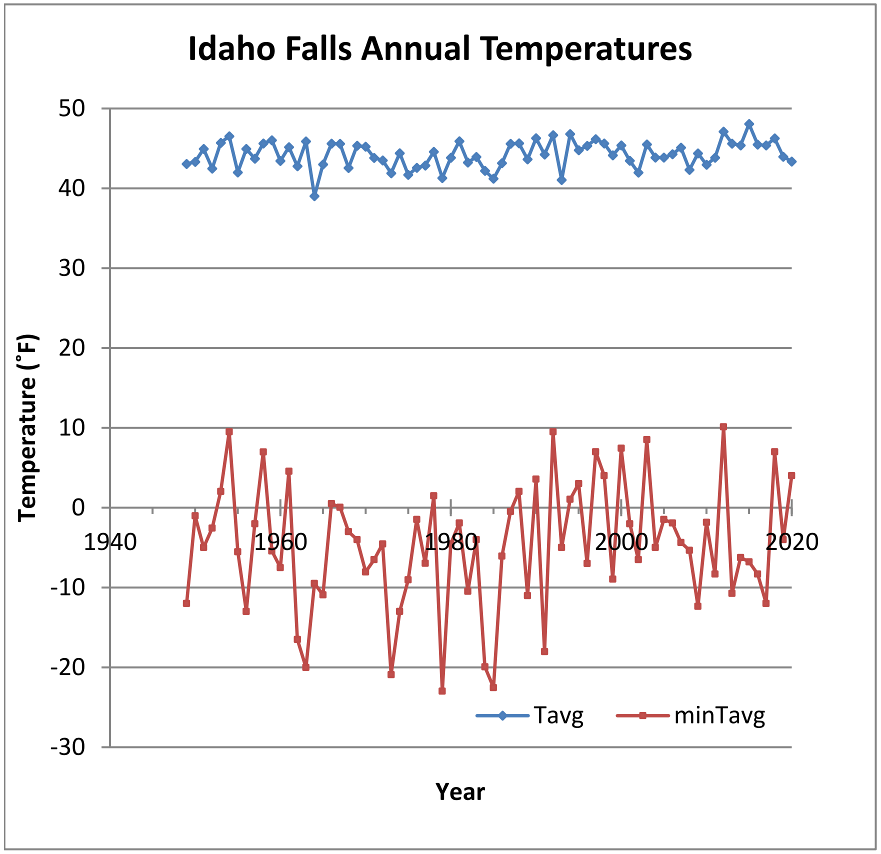


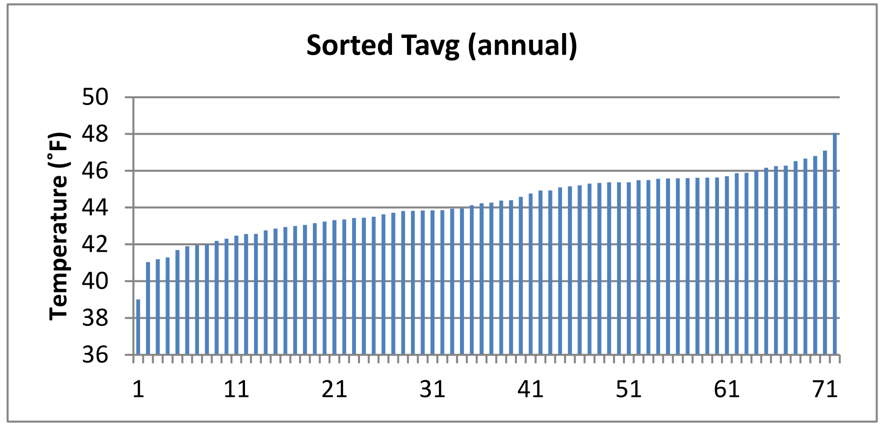


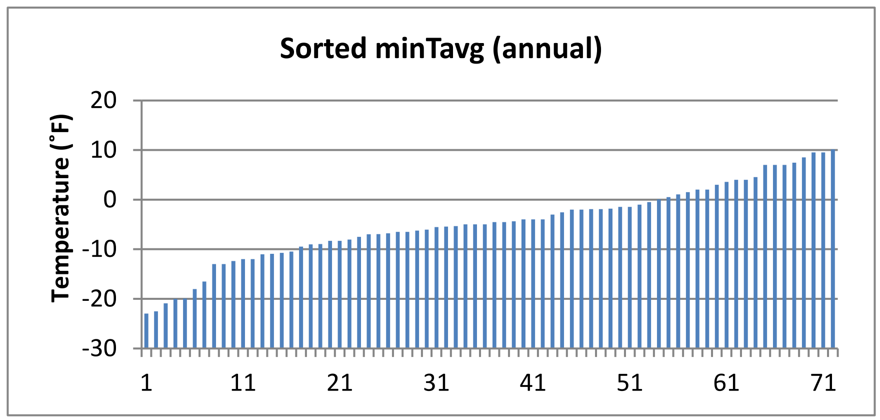


Station:	750 Idaho Falls	
Water Years (WY)	Starting: 1949	Ending: 2020

	Tavg (˚F)														minTavg
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual		Annual
Mean	45.5	32.7	21.7	19.4	24.5	34.7	44.2	53.1	61.0	68.6	66.9	57.5	44.2		-4.7
Sx	2.9	3.8	4.7	6.2	6.4	4.7	2.9	2.6	2.5	2.2	2.3	3.0	1.7		7.8
Skew	-0.2	-0.2	-0.4	-0.1	-0.3	-0.9	-0.1	0.2	0.5	-0.9	0.0	-0.4	-0.4		-0.3
Max	52.6	40.0	30.0	32.8	36.9	42.9	50.1	59.9	67.5	72.4	71.6	64.2	48.1		10.1
Min	36.9	23.7	10.0	4.2	7.1	17.7	37.5	47.5	56.6	59.8	62.6	49.8	39.0		-23.0
n (years)	72	72	72	72	72	72	72	72	72	72	72	72	72		72







Station:	750 Idaho Falls

NORMAL DISTRIBUTION

Exceedance Temperatures

T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	45.5	32.7	21.7	19.4	24.5	34.7	44.2	53.1	61.0	68.6	66.9	57.5	44.2	-4.7
5	0.2	43.1	29.5	17.8	14.3	19.2	30.7	41.8	50.9	58.8	66.8	65.0	55.1	42.8	-11.2
10	0.1	41.9	27.8	15.7	11.5	16.4	28.7	40.6	49.7	57.7	65.8	64.0	53.8	42.1	-14.7
20	0.05	40.8	26.5	14.0	9.3	14.0	27.0	39.5	48.8	56.8	65.1	63.2	52.7	41.5	-17.5
50	0.02	39.6	24.9	12.1	6.8	11.4	25.0	38.4	47.7	55.8	64.2	62.2	51.5	40.8	-20.7
100	0.01	38.9	23.9	10.9	5.1	9.7	23.8	37.6	47.0	55.1	63.6	61.6	50.7	40.3	-22.8

Upper Confidence Limit

T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	46.0	33.2	22.4	20.4	25.5	35.4	44.7	53.5	61.4	68.9	67.2	58.0	44.5	-3.5
5	0.2	43.6	30.1	18.6	15.3	20.2	31.5	42.3	51.3	59.3	67.2	65.3	55.5	43.1	-9.9
10	0.1	42.4	28.6	16.6	12.7	17.6	29.6	41.1	50.2	58.2	66.3	64.4	54.3	42.4	-13.2
20	0.05	41.4	27.3	15.0	10.6	15.4	28.0	40.1	49.3	57.3	65.5	63.6	53.3	41.8	-15.8
50	0.02	40.3	25.9	13.3	8.3	13.0	26.2	39.1	48.3	56.4	64.7	62.8	52.2	41.2	-18.8
100	0.01	39.6	24.9	12.1	6.8	11.4	25.0	38.4	47.7	55.8	64.2	62.2	51.5	40.8	-20.7

Lower Confidence Limit

T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	45.1	32.1	21.0	18.5	23.6	34.0	43.8	52.7	60.6	68.3	66.5	57.1	44.0	-5.9
5	0.2	42.6	28.8	16.9	13.1	18.0	29.9	41.3	50.4	58.4	66.4	64.5	54.5	42.5	-12.7
10	0.1	41.2	27.0	14.7	10.2	14.9	27.6	39.9	49.1	57.2	65.4	63.5	53.1	41.7	-16.4
20	0.05	40.1	25.5	12.9	7.7	12.4	25.8	38.8	48.1	56.2	64.5	62.6	51.9	41.1	-19.5
50	0.02	38.8	23.8	10.8	5.0	9.5	23.6	37.5	46.9	55.0	63.5	61.6	50.6	40.3	-23.0
100	0.01	37.9	22.7	9.4	3.1	7.6	22.2	36.7	46.1	54.3	62.9	60.9	49.7	39.8	-25.3

Station: 750 Idaho Falls

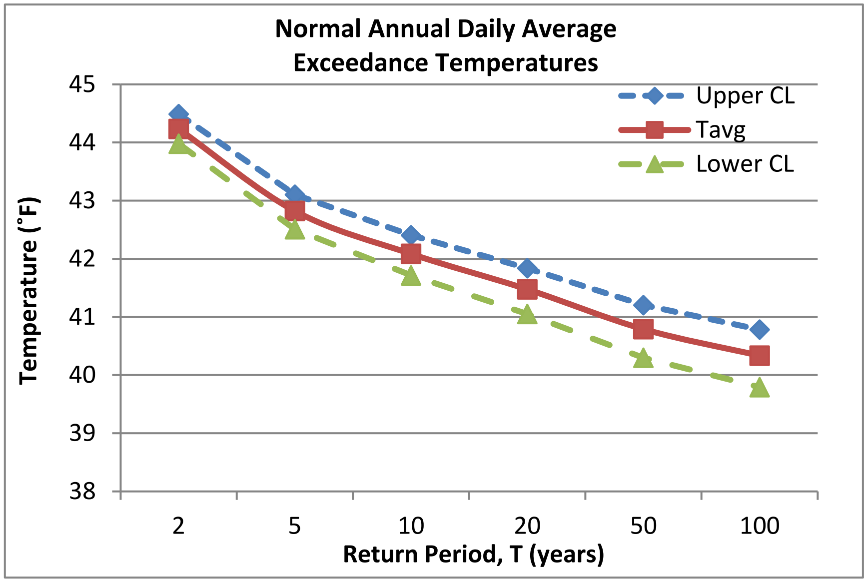
PIII DISTRIBUTION

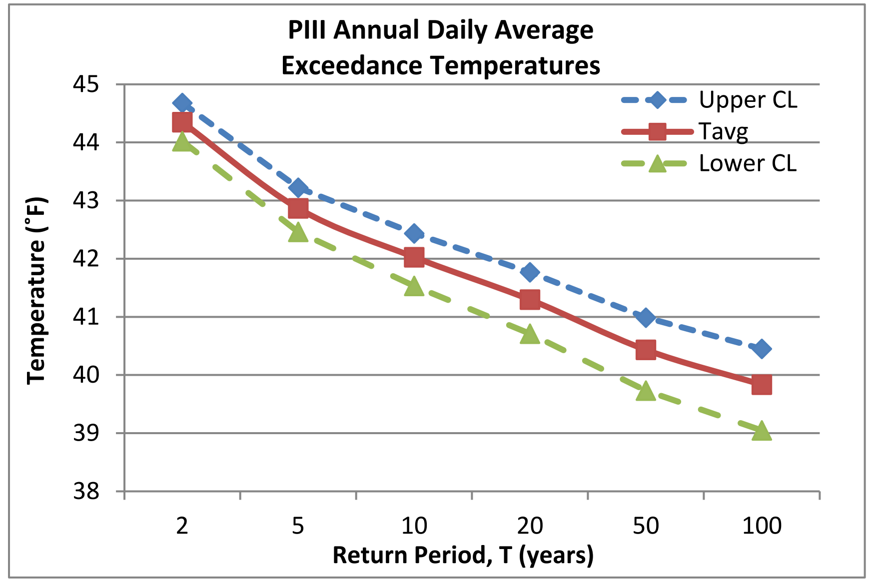
Exceedance Temperatures															
T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	45.6	32.8	22.0	19.6	24.9	35.4	44.3	53.0	60.8	68.9	66.9	57.7	44.3	-4.3
5	0.2	43.1	29.5	17.9	14.3	19.3	31.1	41.8	50.8	58.8	67.0	65.0	55.1	42.9	-11.1
10	0.1	41.8	27.8	15.6	11.5	16.2	28.4	40.5	49.8	57.9	65.7	64.0	53.7	42.0	-14.9
20	0.05	40.7	26.3	13.5	9.1	13.5	26.0	39.5	48.9	57.2	64.6	63.2	52.4	41.3	-18.1
50	0.02	39.4	24.5	11.1	6.4	10.3	23.0	38.2	48.0	56.5	63.2	62.2	50.9	40.4	-21.8
100	0.01	38.5	23.4	9.5	4.5	8.1	20.8	37.4	47.3	56.0	62.2	61.6	49.8	39.8	-24.3

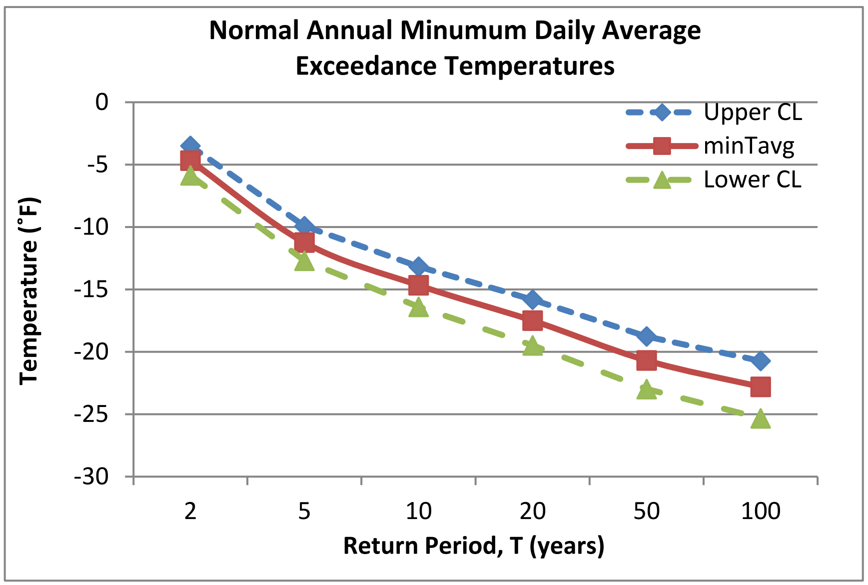
Upper Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	46.2	33.5	22.9	20.8	26.2	36.3	44.8	53.5	61.3	69.3	67.3	58.3	44.7	-2.8
5	0.2	43.7	30.3	18.9	15.6	20.6	32.1	42.4	51.4	59.3	67.4	65.5	55.7	43.2	-9.5
10	0.1	42.5	28.7	16.7	13.0	17.7	29.6	41.2	50.4	58.5	66.3	64.5	54.4	42.4	-13.0
20	0.05	41.5	27.3	14.8	10.8	15.2	27.3	40.2	49.6	57.8	65.2	63.8	53.2	41.8	-15.9
50	0.02	40.3	25.8	12.7	8.3	12.4	24.6	39.1	48.7	57.2	64.0	62.9	51.9	41.0	-19.3
100	0.01	39.5	24.7	11.2	6.6	10.4	22.7	38.4	48.2	56.8	63.1	62.4	50.9	40.4	-21.5

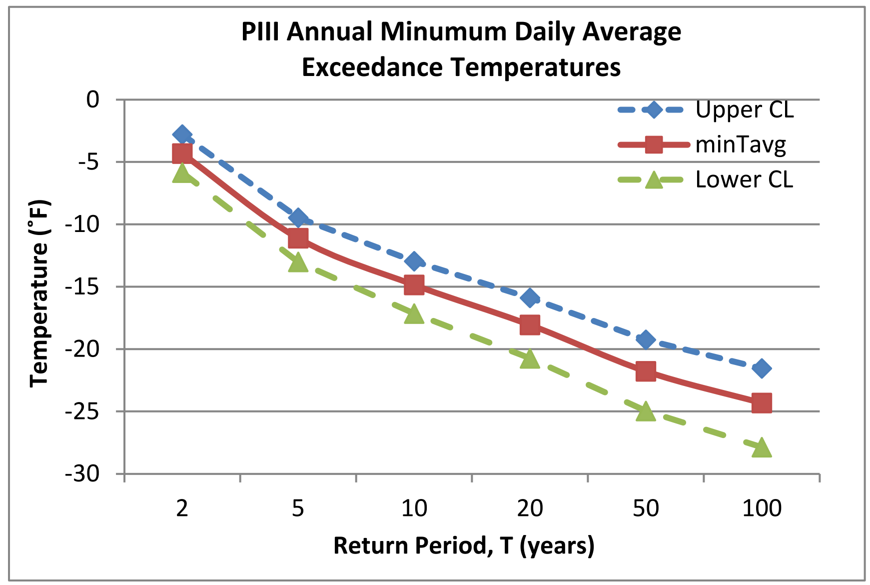
Lower Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	45.0	32.1	21.1	18.4	23.7	34.5	43.7	52.5	60.3	68.5	66.4	57.1	44.0	-5.8
5	0.2	42.4	28.6	16.8	12.8	17.7	30.0	41.1	50.2	58.2	66.4	64.4	54.4	42.5	-13.0
10	0.1	41.0	26.7	14.2	9.7	14.3	27.0	39.7	49.0	57.2	65.1	63.3	52.8	41.5	-17.1
20	0.05	39.7	25.0	11.9	7.0	11.2	24.3	38.5	48.0	56.4	63.8	62.4	51.4	40.7	-20.7
50	0.02	38.2	23.0	9.2	3.9	7.7	20.8	37.1	47.0	55.6	62.3	61.3	49.7	39.7	-25.0
100	0.01	37.2	21.7	7.3	1.8	5.2	18.3	36.1	46.3	55.1	61.1	60.6	48.5	39.0	-27.9

Station: 750 Idaho Falls



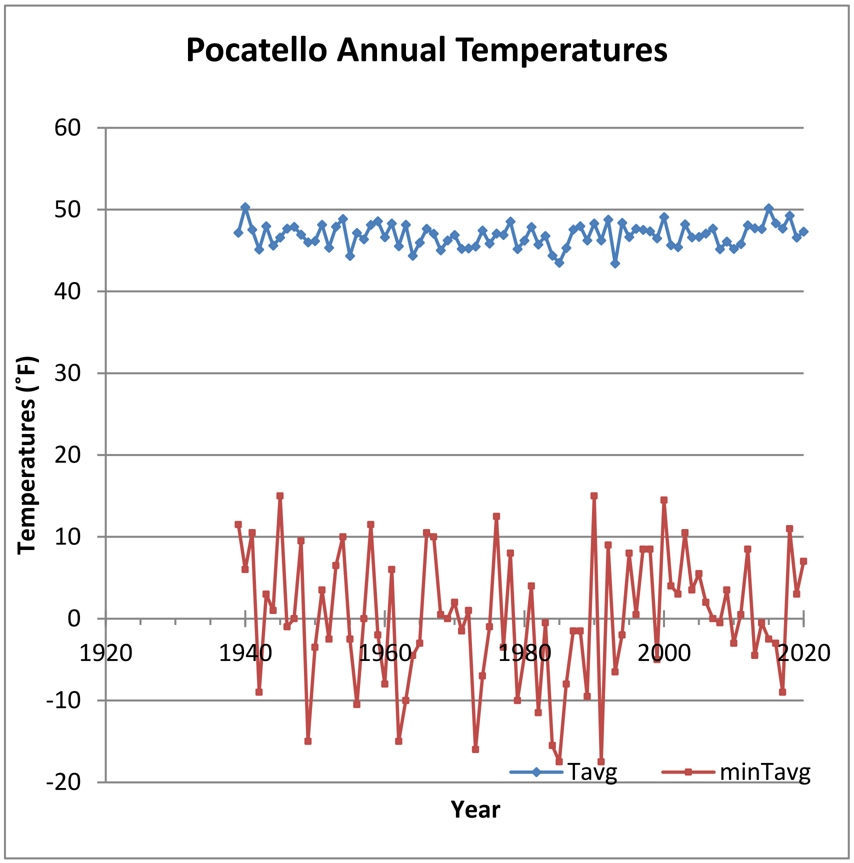


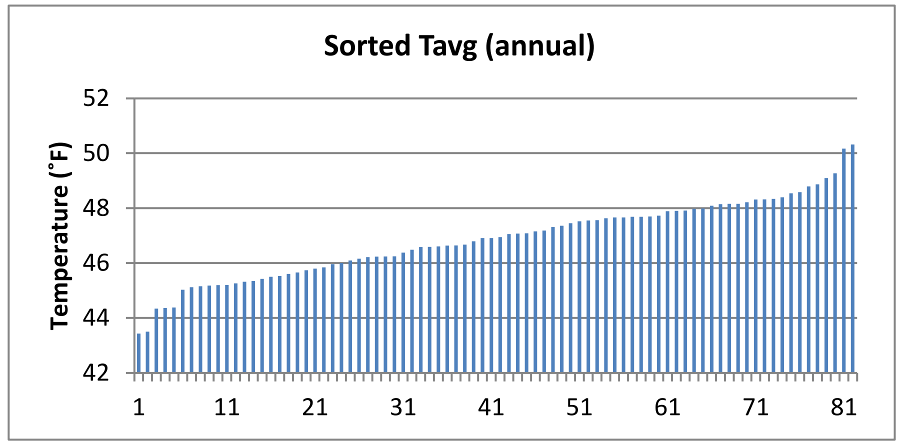


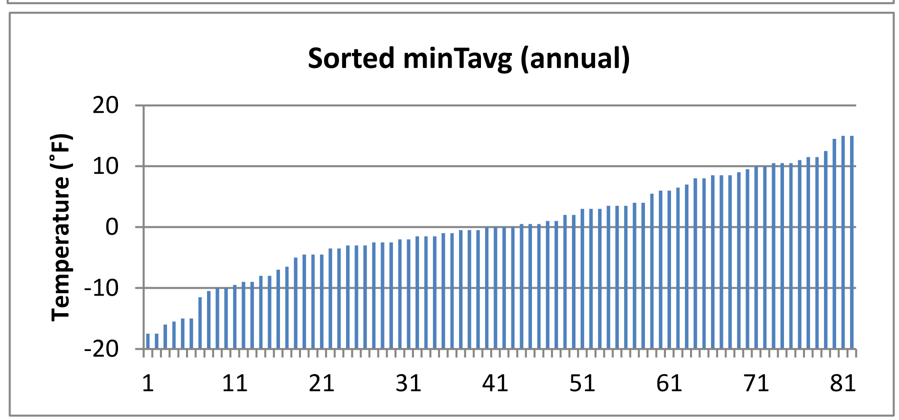


Station:	800 Pocatello	
Water Years (WY)	Starting: 1939	Ending: 2020

	Tavg (˚F)														minTavg
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual		Annual
Mean	47.9	35.2	26.1	24.0	29.2	37.3	45.6	54.2	62.4	71.0	69.3	59.4	46.9		0.2
Sx	3.1	3.6	4.5	5.9	5.3	3.7	2.9	2.8	2.8	2.3	2.2	2.7	1.4		8.0
Skew	-0.04	-0.33	-0.47	-0.42	-0.44	-0.53	0.14	0.18	0.58	-0.93	-0.32	-0.53	-0.10		-0.26
Max	55.3	42.4	34.5	36.2	38.6	44.2	52.4	61.4	69.6	75.1	73.5	65.6	50.3		15.0
Min	39.2	25.8	11.4	5.1	16.9	27.5	39.0	48.5	57.3	61.1	62.9	51.8	43.4		-17.5
n (years)	81	81	81	82	82	82	82	82	82	82	82	82	82		82







Station:	800 Pocatello

NORMAL DISTRIBUTION

Exceedance Temperatures															
T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	47.9	35.2	26.1	24.0	29.2	37.3	45.6	54.2	62.4	71.0	69.3	59.4	46.9	0.2
5	0.2	45.3	32.1	22.3	19.0	24.8	34.2	43.1	51.9	60.0	69.0	67.4	57.1	45.7	-6.5
10	0.1	44.0	30.6	20.3	16.4	22.4	32.5	41.8	50.7	58.8	68.0	66.5	55.9	45.1	-10.0
20	0.05	42.9	29.2	18.7	14.2	20.5	31.2	40.8	49.7	57.8	67.1	65.7	54.9	44.5	-12.9
50	0.02	41.6	27.8	16.9	11.8	18.3	29.7	39.6	48.5	56.7	66.2	64.8	53.8	44.0	-16.2
100	0.01	40.8	26.8	15.6	10.2	16.9	28.6	38.8	47.8	55.9	65.5	64.2	53.1	43.6	-18.4

Upper Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	48.3	35.7	26.7	24.8	30.0	37.8	46.0	54.6	62.8	71.3	69.6	59.8	47.1	1.4
5	0.2	45.8	32.7	23.0	19.9	25.6	34.8	43.6	52.3	60.5	69.4	67.8	57.6	45.9	-5.2
10	0.1	44.5	31.2	21.1	17.5	23.4	33.2	42.4	51.2	59.3	68.4	66.9	56.4	45.3	-8.6
20	0.05	43.5	30.0	19.6	15.5	21.6	31.9	41.4	50.2	58.4	67.6	66.1	55.5	44.8	-11.3
50	0.02	42.3	28.6	17.9	13.2	19.6	30.5	40.3	49.2	57.3	66.7	65.3	54.5	44.3	-14.4
100	0.01	41.5	27.7	16.8	11.7	18.2	29.6	39.5	48.5	56.6	66.1	64.7	53.8	43.9	-16.4

Lower Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	47.4	34.7	25.4	23.2	28.5	36.8	45.2	53.8	62.0	70.6	69.0	59.0	46.7	-0.9
5	0.2	44.8	31.5	21.5	18.0	23.8	33.5	42.6	51.4	59.5	68.6	67.0	56.7	45.4	-7.9
10	0.1	43.3	29.8	19.4	15.2	21.3	31.8	41.2	50.1	58.2	67.5	66.0	55.4	44.8	-11.7
20	0.05	42.1	28.4	17.6	12.8	19.3	30.3	40.1	49.0	57.1	66.6	65.2	54.3	44.2	-14.8
50	0.02	40.8	26.8	15.6	10.2	16.9	28.6	38.8	47.8	55.9	65.5	64.2	53.1	43.6	-18.4
100	0.01	39.8	25.7	14.3	8.4	15.3	27.5	37.9	46.9	55.1	64.8	63.5	52.3	43.2	-20.8

Station: 800 Pocatello

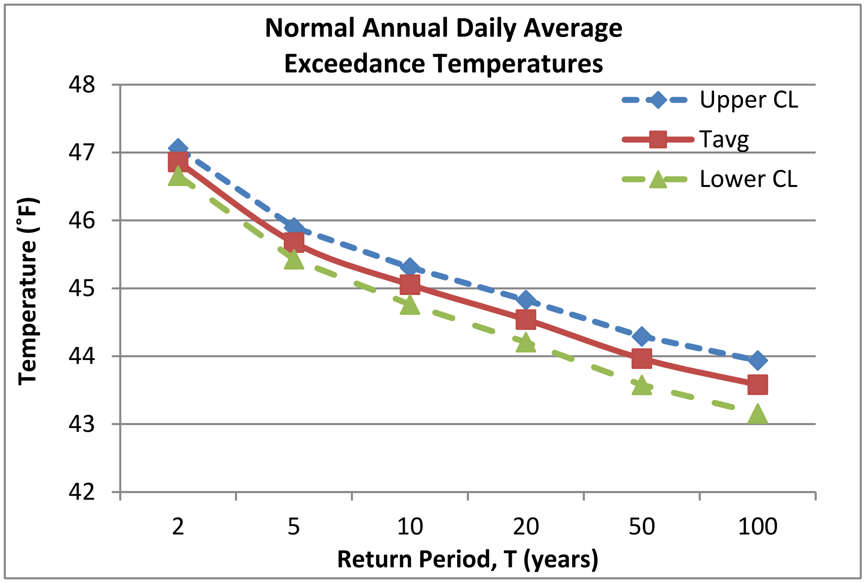
PIII DISTRIBUTION

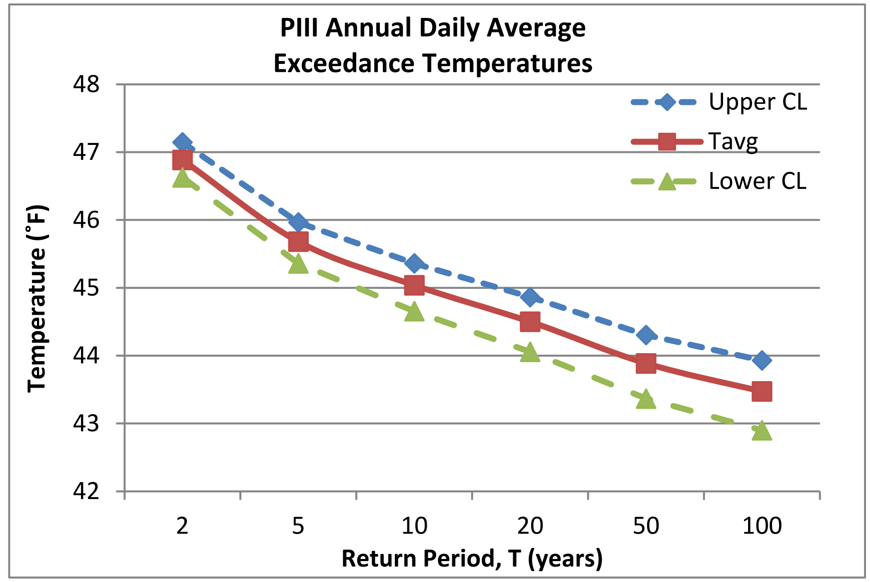
Exceedance Temperatures															
T	Exceed.	Tavg													minTavg
years	Prob. (P)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	47.9	35.4	26.4	24.4	29.6	37.6	45.5	54.2	62.1	71.3	69.4	59.7	46.9	0.6
5	0.2	45.3	32.2	22.4	19.2	24.9	34.3	43.1	51.9	60.0	69.2	67.5	57.2	45.7	-6.4
10	0.1	44.0	30.4	20.1	16.2	22.2	32.4	41.9	50.7	59.0	67.9	66.4	55.8	45.0	-10.2
20	0.05	42.8	28.9	18.1	13.6	19.9	30.7	40.9	49.8	58.3	66.6	65.5	54.6	44.5	-13.5
50	0.02	41.5	27.1	15.8	10.5	17.1	28.7	39.8	48.8	57.5	65.1	64.4	53.1	43.9	-17.3
100	0.01	40.7	25.9	14.1	8.4	15.2	27.2	39.1	48.1	57.1	64.0	63.7	52.0	43.5	-19.9

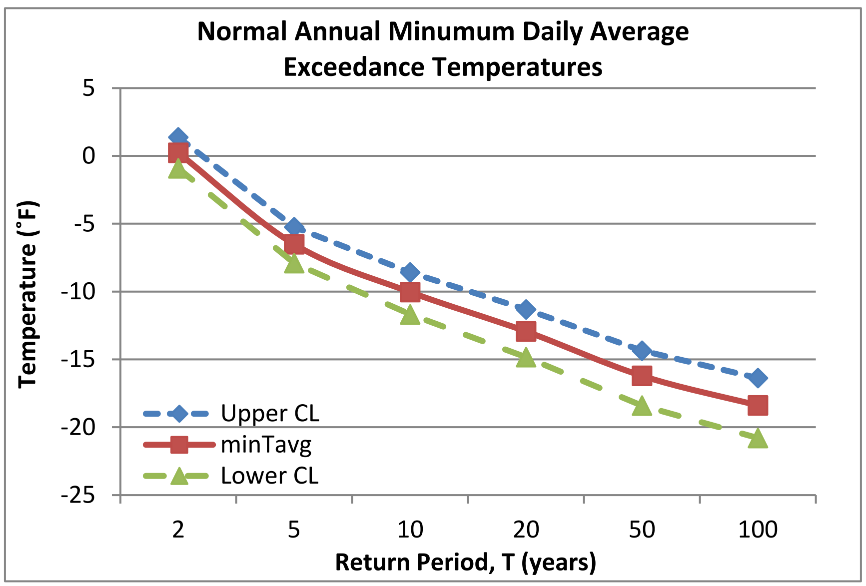
Upper Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	48.5	36.0	27.2	25.5	30.6	38.3	46.1	54.7	62.6	71.8	69.8	60.2	47.1	2.1
5	0.2	45.9	32.9	23.3	20.4	26.0	35.0	43.7	52.4	60.5	69.6	67.9	57.8	46.0	-4.8
10	0.1	44.7	31.3	21.2	17.6	23.5	33.2	42.5	51.4	59.6	68.4	66.9	56.5	45.4	-8.4
20	0.05	43.6	29.9	19.3	15.2	21.3	31.7	41.6	50.5	59.0	67.3	66.1	55.3	44.9	-11.4
50	0.02	42.4	28.3	17.2	12.4	18.8	29.8	40.6	49.6	58.3	65.9	65.1	53.9	44.3	-14.9
100	0.01	41.7	27.1	15.7	10.4	17.0	28.5	40.0	49.0	57.8	64.9	64.4	53.0	43.9	-17.2

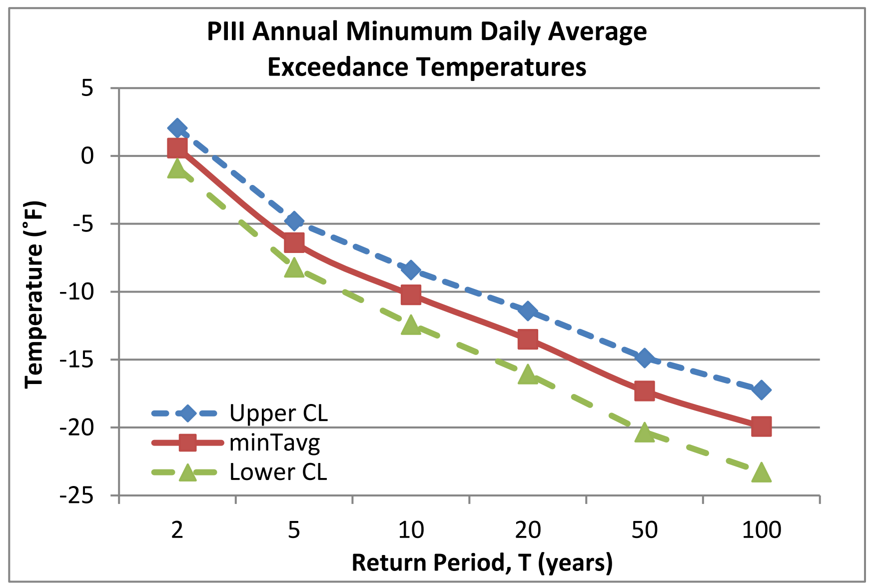
Lower Confidence Limit															
T	P	Tavg													minTavg
years	prob.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual	Annual
2	0.5	47.3	34.7	25.6	23.3	28.7	37.0	45.0	53.7	61.6	70.9	69.0	59.2	46.6	-0.9
5	0.2	44.6	31.4	21.4	17.8	23.7	33.5	42.4	51.2	59.3	68.7	67.0	56.6	45.4	-8.2
10	0.1	43.1	29.5	18.9	14.6	20.8	31.4	41.1	50.0	58.3	67.2	65.8	55.1	44.7	-12.4
20	0.05	41.9	27.8	16.7	11.7	18.2	29.5	40.0	49.0	57.5	65.8	64.8	53.7	44.1	-16.1
50	0.02	40.4	25.7	14.0	8.2	15.1	27.2	38.8	47.8	56.6	64.1	63.6	52.0	43.4	-20.3
100	0.01	39.4	24.4	12.1	5.8	12.9	25.6	37.9	47.1	56.1	62.9	62.7	50.8	42.9	-23.3

Station: 800 Pocatello









Appendix B

Analysis Details

This appendix presents information about the methods used to analyze the data in this report.

The T-year exceedance temperatures presented in this report are statistical estimates based on NORM and PIII probability distributions fitted using sets of sample observations. Exceedance temperatures were calculated using the Frequency Factor method applied to the Norm and PIII distributions (Chow *et al*., 1988).

At least two sources of uncertainty are involved in these T-year exceedance temperature estimates. One source is the selection of an appropriate probability distribution to represent the sample observations; a second source is associated with how well the random sample of observations collected represents the underlying population. The χ^2 (Chi-Squared) test is used to determine if either the NORM or PIII distribution is more appropriate than the other to represent the observations, and confidence intervals are calculated to provide a measure of uncertainty in the estimated exceedance temperatures relative to their unknown population values based on the fact that they are derived from a random sample of observations.

Selection of Distribution-χ^2 (Chi-Squared) test

Assuming the sample observations adequately represent the underlying population, selection of an unsuitable probability distribution will yield erroneous exceedance temperatures wherever the fitted distribution deviates from the trend of the sample observations. For example, application of the Normal distribution to observations with significant real skew will induce errors in the estimated exceedance temperatures. One way this may be assessed is by testing the “goodness of fit” of the NORM and PIII distributions to each set of sample observations using a χ^2 (Chi-Squared) test (Chow *et al*., 1988). The χ^2-test is a hypothesis test in which the null hypothesis, H_o, is that a proposed distribution together with its parameters fit the observations well. The alternative hypothesis, H_a, is that the distribution and/or the particular parameters are inadequate.

In the χ^2 test, the range of n sample observations is divided into k intervals, and the number of observations n_i occurring in each interval is compared with the theoretical number of observations expected within each interval based on the fitted distribution, given by $np(x_i)$. Here, $p(x_i)$ is the theoretical probability of the random variable with cumulative distribution function $F(x)$ falling within the ith interval bounded between x_i and x_{i-1}. That is, $p(x_i) = F(x_i) - F(x_{i-1})$ It essentially compares the number of observations occurring in each bin of a histogram of the data, with the number of occurrences expected within the range of each histogram bin based on the fitted probability distribution. The squared differences of the observed minus expected number of occurrences in each interval are normalized by the expected number of occurrences and summed over all the intervals to give the test statistic χ^2_c

$$\chi_c^2 = \sum_{i=1}^{k} \frac{[n_i - np(x_i)]^2}{np(x_i)}$$

The sum χ^2_c is the test statistic which is compared with a χ^2 distribution limiting value. The null hypothesis is accepted if the test statistic, χ^2_c is lower than the χ^2 distribution limiting value.

A χ2 distribution is the distribution of the sum of squares of ν standard normal random variables, z. The number of degrees of freedom, ν, is given by ν=k-m-1, where k is the number of intervals, and m the number of parameters fitted for a particular distribution (m=2 for the Normal distribution, and m=3 for PIII). The effect of m is that the limiting value for the PIII distribution is smaller than that for the Normal distribution, so that the test is a little more stringent for PIII to account for the fact that PIII has three parameters which allows greater flexibility in the distribution to fit the observations. The $\chi^2_{\nu,1-\alpha}$ limiting value has cumulative probability 1- α, where α is the significance level. A typical value is α=0.05; it gives the likelihood of rejecting the null hypothesis when it is true. Tables of the $\chi^2_{\nu,1-\alpha}$ distribution function are available in many statistics texts (e.g., Benjamin and Cornell, 1970; Devore, 1987; Haan, 1977; Lapin, 1983; Pearson and Hartley, 1966).

Histograms are usually set up using uniformly sized increments of the variable for each interval so that the histogram shape is similar to the shape of the probability density function fitted to the data. However, for the χ^2 test, it is desirable to select the range of values for each interval such that each interval has the same number of expected occurrences of the random variable within it based on the fitted distribution (e.g., 20 intervals might be selected each with 1/20th or 5% probability of occurrence), and the commonly recommended smallest number of expected occurrences in each interval is 5 (Benjamin and Cornell, 1970). For any fitted distribution other than a uniform distribution, this requires that the span or range of the values defining each interval will vary. In the analysis performed here, each dataset was divided into a number of intervals, k, sized so that the expected number of occurrences in each interval was at least 5, that is, k≤n/5. For example, with Caldwell there were n=116 years of data. The number of intervals was limited by k≤n/5=23. Thus, 23 intervals were used, each having probability p=1/k=0.0435 (4.35%).

The χ^2 test was applied to all the observations from each station, both on an annual basis for Tavg and minTavg, and on a monthly basis for Tavg. On a WY basis, both the NORM and PIII distributions passed the χ^2 test applied to Tavg and minTavg at each station, except for one failure by the NORM distribution at Station 800 (Pocatello) for minTavg. Generally, the PIII distribution passed the χ^2 test as well as or by a greater margin than did the Normal distribution, especially when the observations contained significant skew. It is recommended to use the PIII distribution values: When the skew is significant, as it often is for minTavg, PIII likely provides more accurate results; when the skew is near zero, as commonly occurs with WY Tavg, the Normal and PIII return period values are not very different, so selection of PIII to be consistent induces no penalty and simplifies the selection process. Following this recommendation avoids the use of the one NORM failure with minTavg.

For the T_{avg} monthly data, both the Normal and PIII distributions passed the χ^2 test for most months at most stations. Across twelve months at the seven stations, there were 84 station-months tested (ie., 7 stations x 12months) for each distribution. For the Normal distribution, 83 station-months passed the χ^2 test, and 1 failed (December at Station 450, Boise). For the PIII distribution, 83 passed and 1 failed (July at Station 750, Idaho Falls). From a gas demand viewpoint, the PIII July failure is unimportant. Furthermore, since the recommendation is to use PIII, the NORM December failure at Station 450 also does not matter. The remaining five stations passed the χ^2 test for all station-months for both distributions.

Confidence Limits

The temperature data collected at each station constitute a random sample of the underlying populations of temperatures and these samples have been used to estimate the true frequency curves of the corresponding populations. If a random sample consisting of the same number of observations could be selected from a different period of time, they would probably produce a different estimate of the population frequency curve. How well the observations represent the underlying temperature population depends on the number of observations (sample size), its accuracy, and whether or not the underlying distribution is known.

Confidence limits provide a measure of the uncertainty of the exceedance temperature at a selected probability or return period. A range or confidence interval which brackets the true exceedance temperature with a specified probability or confidence level, β, can be calculated. That is, for a two-sided confidence interval with an upper and lower confidence limit, and confidence level β=0.9, there is a 90% probability that the limits span or encompass the true exceedance temperature. The significance level, α, corresponding to the confidence level is given by $\alpha=(1- \beta)/2$, or 0.05 for the selected β=0.9.

Approximate confidence limits for the T-year exceedance temperatures for the NORM and PIII distributions were calculated using the Interagency Advisory Committee on Water Data (1981) method, also described in Chow, et al. (1988). Confidence limit values are reported in Figures 1 and 2 in the main body of this report, and in Appendix A.