NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Calculating Extreme Cold Weather Temperature

RELIABILITY | RESILIENCE | SECURITY




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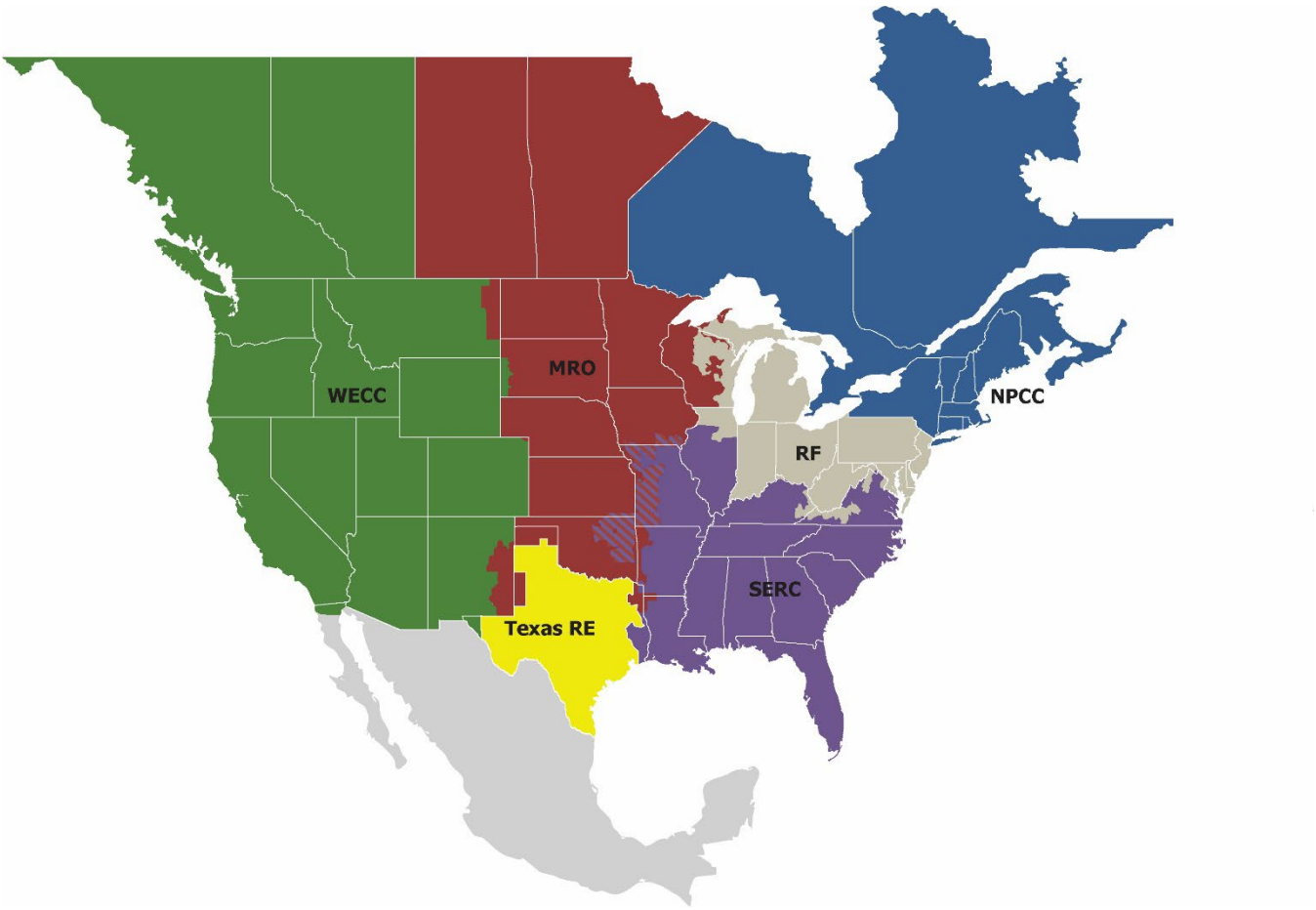
Preface

Electricity is a key component of the fabric of modern society and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable, resilient, and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

Reliability | Resilience | Security
Because nearly 400 million citizens in North America are counting on us

The North American BPS is made up of six Regional Entity boundaries as shown in the map and corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Regional Entity while associated Transmission Owners/Operators participate in another.



MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	WECC

Introduction

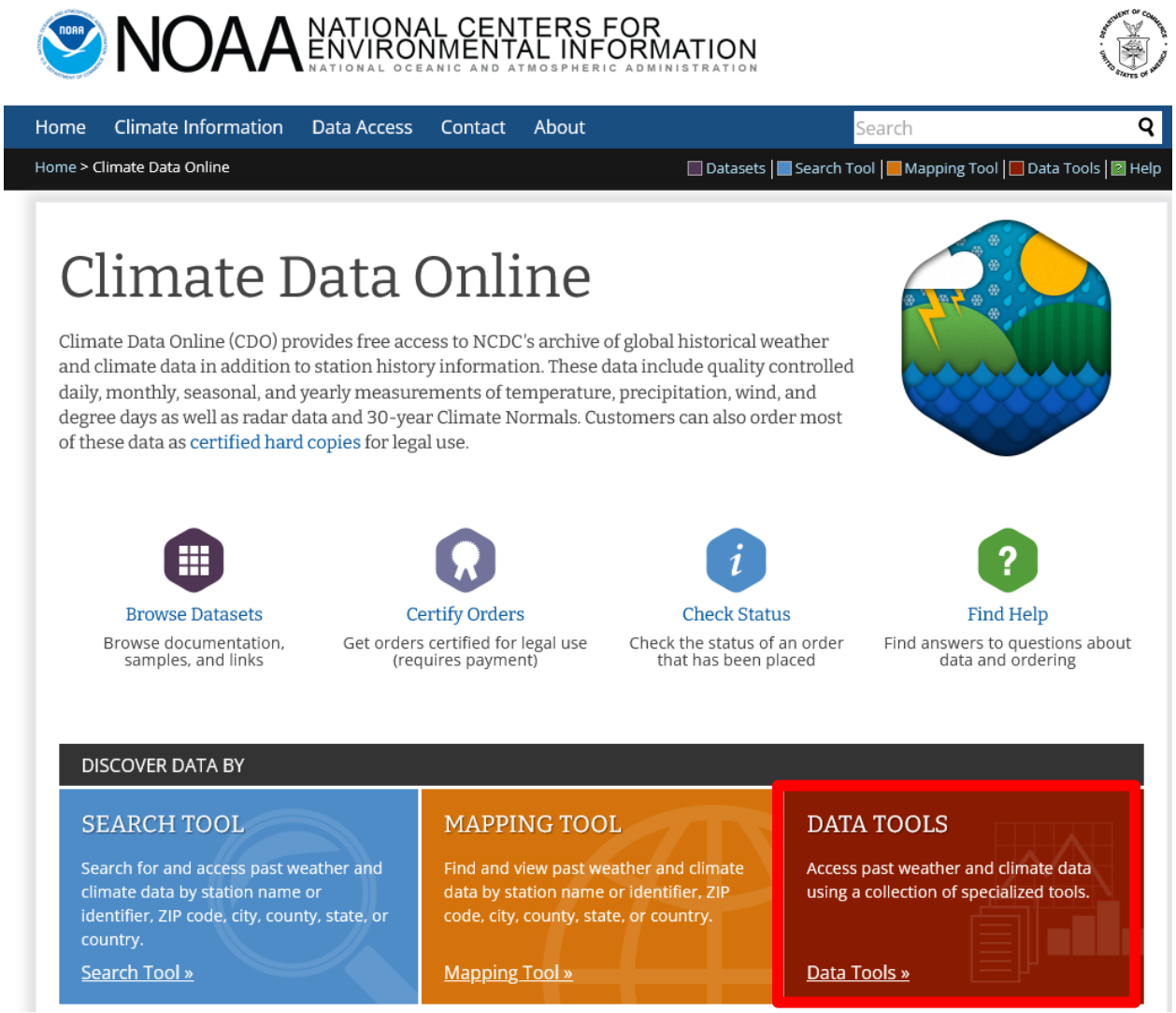
This document demonstrates two methods for acquiring data for a given location and a method of performing the statistical analysis of the data to determine the Extreme Cold Weather Temperature for a given location. These examples are focused on United States and will use data obtained from NOAA's Climate Data Online database and Automated Surface Observing Systems (ASOS). Performance of the statistical analysis with Microsoft Excel is demonstrated as well. The method shown in this document only shows the collection of data and two methods of analyzing this data, both using Microsoft Excel. Note that other data sources may be available for use. Although not addressed here, offshore installations may be able to use National Data Buoy Center (noaa.gov) but data is limited. It is understood that a complete single source data set may not always be available due to a variety of reasons. There may be ways to gather a more complete data set than described below. Document your approach when identifying and addressing suspect data.

Determination of Location's Extreme Cold Weather Temperature

Gathering the Data From NOAA

Navigate to https://www.ncdc.noaa.gov/cdo-web/

1. Select **Data Tools.**



2. Scroll down if necessary and select **Local Climatological Data (LCD).**

Find a Station

Locate weather observing stations using a variety of parameters such as address, ZIP code, date, and data type with filters by observation type

Select a Location

Order data by weather observing stations or by geographic locations using a simplified drill-down interface with data from U.S. and other countries

Search Within a Single Dataset

The following search tools access data from within a specific dataset. Use these tools to view or order data from within each respectiv dataset. Data will be in a more standard format across stations or locations.

Climate Normals

View temperature and precipitation Climate Normals for over 9,800 stations across the United States and a selection of other territories

Daily Weather Records

Access summaries of recent global and U.S. daily weather records with options to view monthly, annual, all-time or selected records

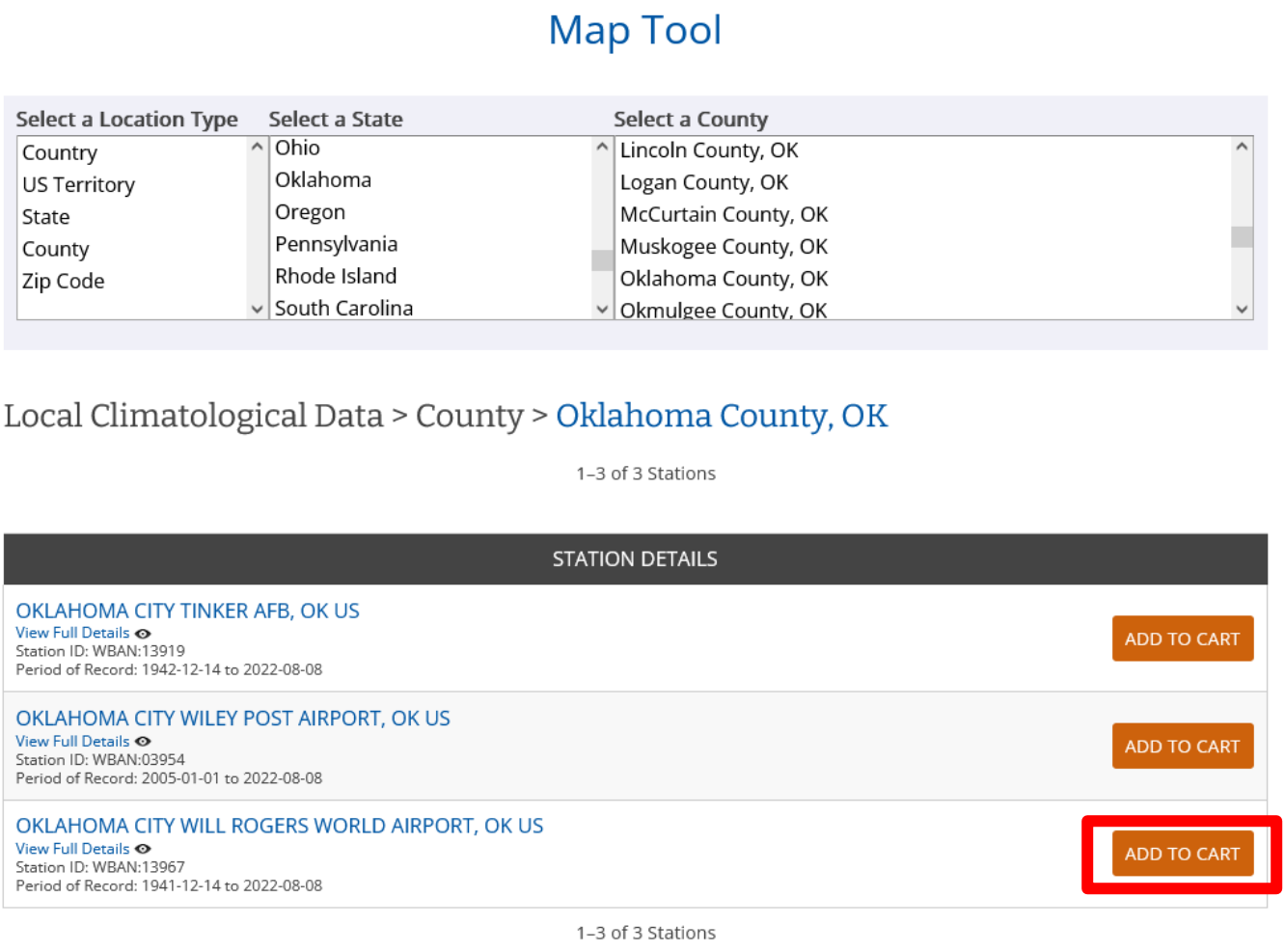
Local Climatological Data (LCD)

View and order hourly, daily, and monthly data from nearly 2400 locations within the U.S., surrounding territories, and other selected areas

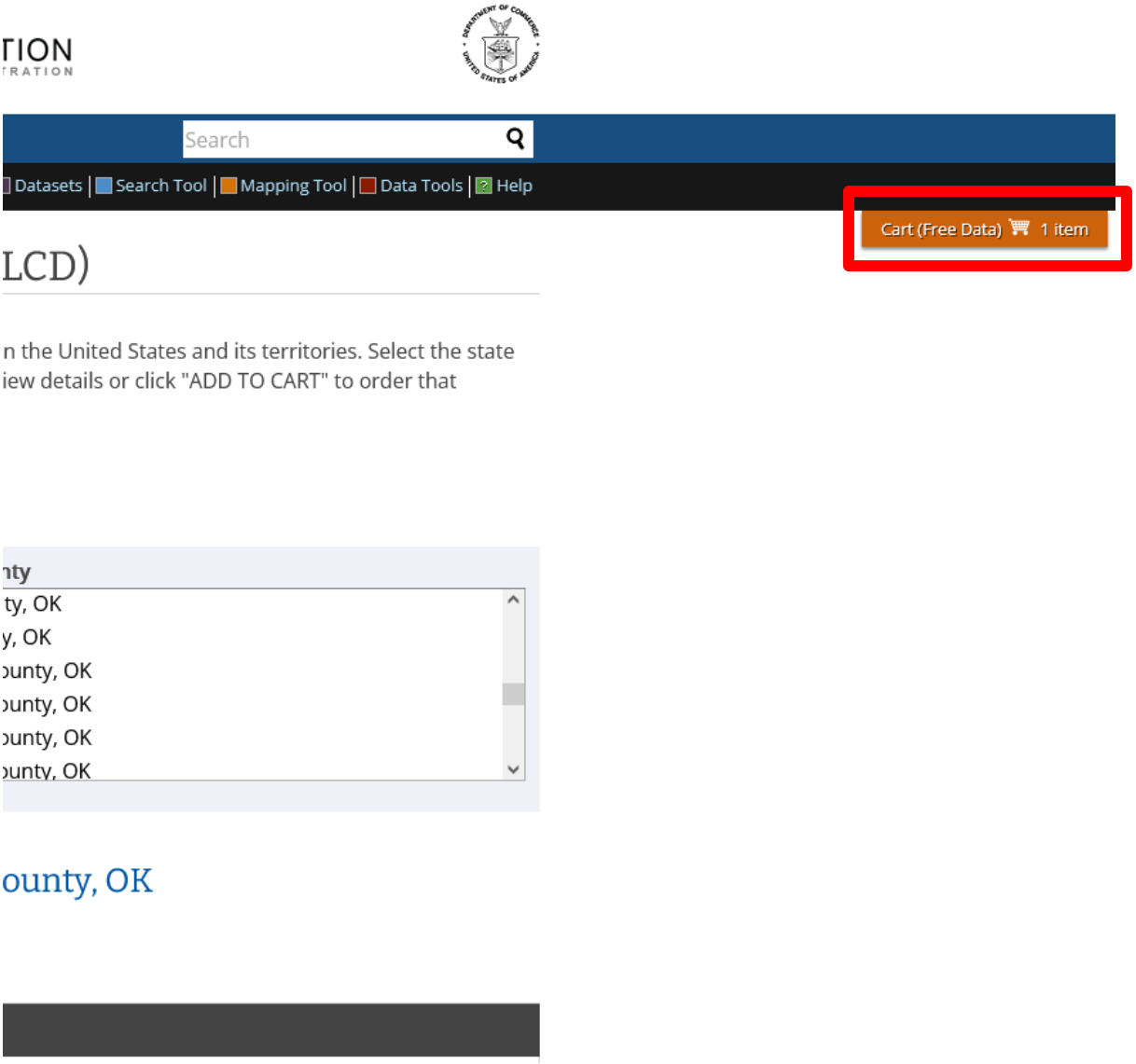
Marine Data

View and order historical marine data which is comprised of ship, buoy, and platform observations from 1662 to present.

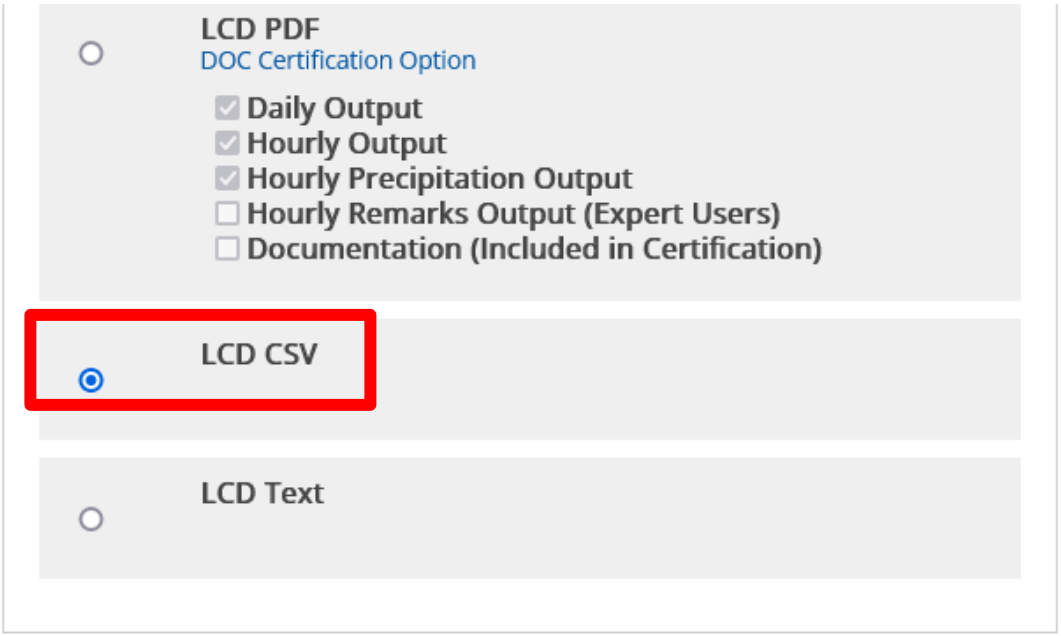
3. Use the selection tool to find a weather station appropriate for your location and click ADD TO CART.

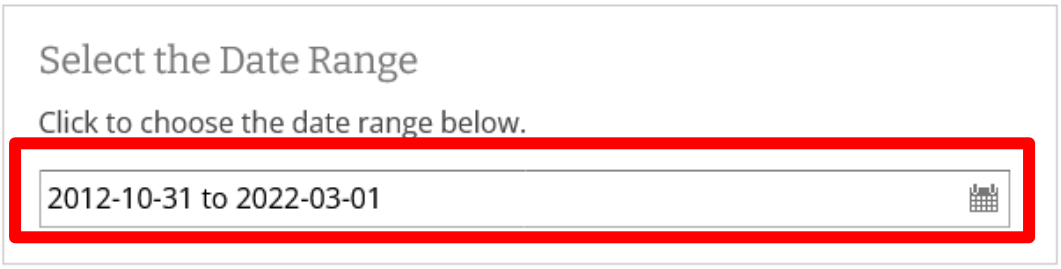


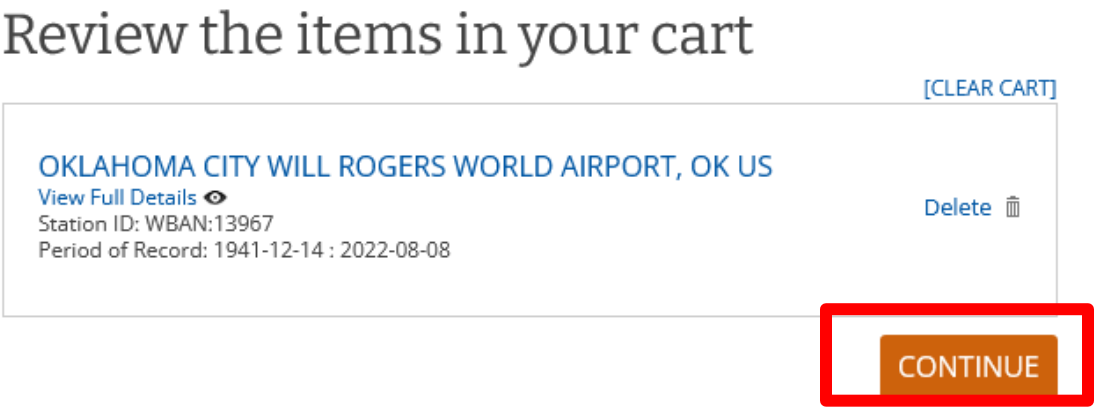
4. Click on the **cart icon** in the upper right-hand portion of the page.



5. Select LCD CSV, your desired date range, and then click continue. (Note: date ranges must be less than 10 years, so this process might have to be repeated several times and multiple files combined into one in order to get all data necessary to perform the analysis to determine the Extreme Cold Weather Temperature)







6. Enter and verify your email address and click **Submit Order.** You will receive an email when your request has been processed and is ready to download.

REQUESTED DATA REVIEW	
Dataset	Local Climatological Data
Order Start Date	2012-10-31 00:00
Order End Date	2022-03-01 23:59
Output Format	LCD CSV
Stations/Locations	OKLAHOMA CITY WILL ROGERS WORLD AIRPORT, OK US (Station ID: WBAN:13967)

Enter email address

Please enter your email address. This is the address to which your data links and information regarding this order will be sent. Please read NOAA's Privacy Policy if you have any concerns.

Email Address

email@address.com

Verify Email Address

email@address.com

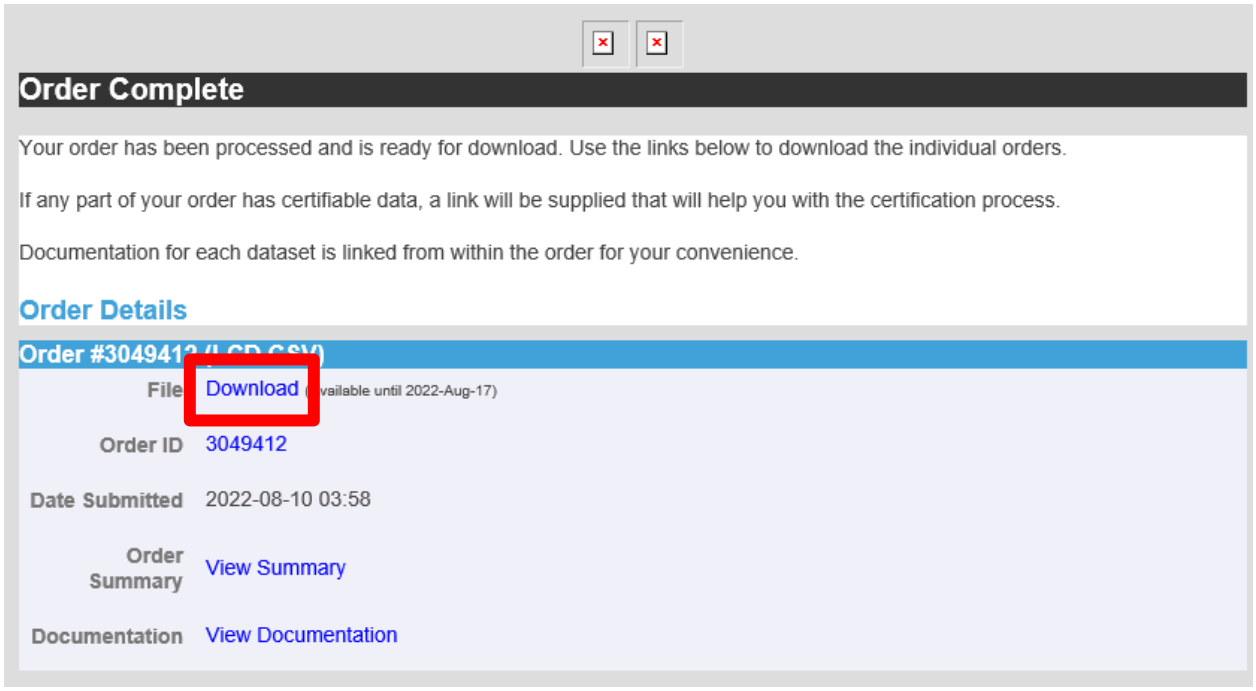
Remember my email address

[Uncheck to forget]

NOAA will not share your email address with anyone. The email address will not be used for any purpose other than communicating the order status.

EDIT ORDER SUBMIT ORDER

7. Click **Download** in the email that you will receive from NOAA to download your dataset.



Analyzing the Data

Option 1

1. Open the .csv file that was downloaded using the previous steps (and combine with other .csv files as necessary to cover the required date range).

2. Add filters to the first row and filter on "Report Type", column C, to only show report type FM-15, this is the standard METAR data.

STATION	DATE	REPOR	SOURC	AWND	Backup	Backup	Backup	Backup	Backup	Backup	Backup	Backup
72353013967	2012-10-31T00:52:00	FM-15	7									
72353013967	2012-10-31T01:52:00	FM-15	7									
72353013967	2012-10-31T02:52:00	FM-15	7									
72353013967	2012-10-31T03:52:00	FM-15	7									
72353013967	2012-10-31T04:52:00	FM-15	7									
72353013967	2012-10-31T05:52:00	FM-15	7									
72353013967	2012-10-31T06:52:00	FM-15	7									
72353013967	2012-10-31T07:52:00	FM-15	7									
72353013967	2012-10-31T08:52:00	FM-15	7									
72353013967	2012-10-31T09:52:00	FM-15	7									
72353013967	2012-10-31T10:52:00	FM-15	7									
72353013967	2012-10-31T11:52:00	FM-15	7									
72353013967	2012-10-31T12:52:00	FM-15	7									
72353013967	2012-10-31T13:52:00	FM-15	7									
72353013967	2012-10-31T14:52:00	FM-15	7									
72353013967	2012-10-31T15:52:00	FM-15	7									
72353013967	2012-10-31T16:52:00	FM-15	7									
72353013967	2012-10-31T17:52:00	FM-15	7									
72353013967	2012-10-31T18:52:00	FM-15	7									
72353013967	2012-10-31T19:52:00	FM-15	7									
72353013967	2012-10-31T20:52:00	FM-15	7									
72353013967	2012-10-31T21:52:00	FM-15	7									
72353013967	2012-10-31T22:52:00	FM-15	7									
72353013967	2012-10-31T23:52:00	FM-15	7									
72353013967	2012-11-01T00:52:00	FM-15	7									
72353013967	2012-11-01T01:52:00	FM-15	7									
72353013967	2012-11-01T02:52:00	FM-15	7									
72353013967	2012-11-01T03:52:00	FM-15	7									
72353013967	2012-11-01T04:52:00	FM-15	7									
72353013967	2012-11-01T05:52:00	FM-15	7									

3. Select the Date column, column B, by clicking on the column, scroll over to the Hourly Dry Bulb Temperature column, column AS, and holding down the CTRL key, select that column. Copy and paste both columns into a new sheet named "Clean and Filter".

DATE	HourlyDryBulbTemperature		
2012-10-31T00:52:00	52		
2012-10-31T01:52:00	51		
2012-10-31T02:52:00	50		
2012-10-31T03:52:00	47		
2012-10-31T04:52:00	46		
2012-10-31T05:52:00	46		
2012-10-31T06:52:00	44		
2012-10-31T07:52:00	48		
2012-10-31T08:52:00	52		
2012-10-31T09:52:00	57		
2012-10-31T10:52:00	61		
2012-10-31T11:52:00	65		
2012-10-31T12:52:00	67		
2012-10-31T13:52:00	68		
2012-10-31T14:52:00	71		
2012-10-31T15:52:00	71		
2012-10-31T16:52:00	70		
2012-10-31T17:52:00	66		
2012-10-31T18:52:00	62		
2012-10-31T19:52:00	59		
2012-10-31T20:52:00	54		
2012-10-31T21:52:00	51		
2012-10-31T22:52:00	52		
2012-10-31T23:52:00	52		
2012-11-01T00:52:00	53		

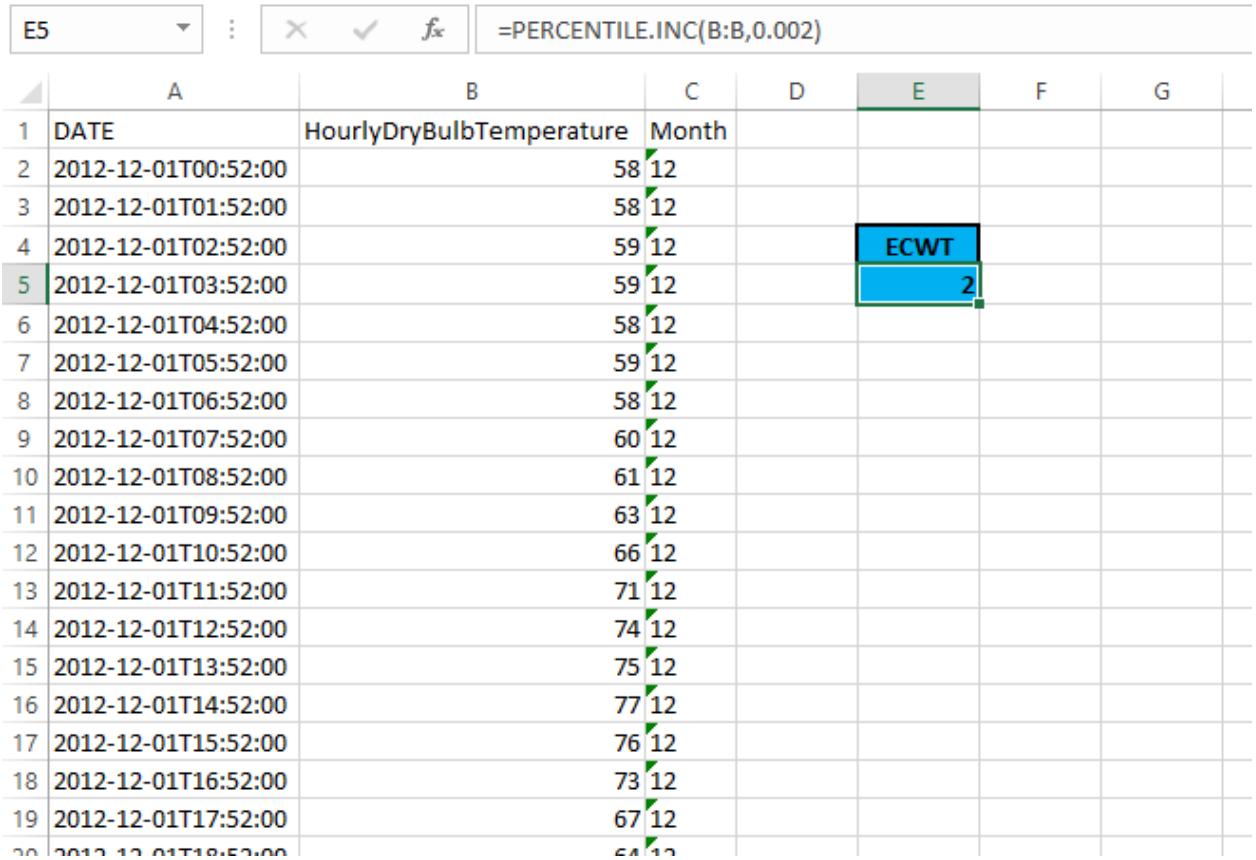
4. Using the data on the "Clean and Filter" sheet, type **Month** in column C1, type the formula "=mid(A2,6,2)" in cell C2, and copy that formula in column C to the last row of the data set. Then Filter month to only show months 1, 2, 12 (January, February, and December).

5. You can then filter by Hourly Dry Bulb Temperature (Column B) to find and address bad data as appropriate. Bad data may consist of corrupt or missing values. It is beneficial to document information about the bad data to support the calculation of ECWT. If there are other sources that are similar to the source selected that has more complete data or the data can be used, consider that option and document accordingly. It is understood that complete single source data sets may not be the norm due to a variety of reasons- technology, maintenance on monitoring devices, failure to record, instrument failure, instrument testing, etc. You may not have the reason for the corrupt or missing data and documenting the raw data and its source is recommended. Now Select, Copy, and Paste the remaining data to a new sheet named ECWT

	A	B	C	D
1	DATE	HourlyDryBulbTemperatur	Month	
747	2012-12-01T00:52:00	58	12	
748	2012-12-01T01:52:00	58	12	
749	2012-12-01T02:52:00	59	12	
750	2012-12-01T03:52:00	59	12	
751	2012-12-01T04:52:00	58	12	
752	2012-12-01T05:52:00	59	12	
753	2012-12-01T06:52:00	58	12	
754	2012-12-01T07:52:00	60	12	
755	2012-12-01T08:52:00	61	12	
756	2012-12-01T09:52:00	63	12	
757	2012-12-01T10:52:00	66	12	
758	2012-12-01T11:52:00	71	12	
759	2012-12-01T12:52:00	74	12	
760	2012-12-01T13:52:00	75	12	
761	2012-12-01T14:52:00	77	12	
762	2012-12-01T15:52:00	76	12	
763	2012-12-01T16:52:00	73	12	
764	2012-12-01T17:52:00	67	12	
765	2012-12-01T18:52:00	64	12	
766	2012-12-01T19:52:00	63	12	
767	2012-12-01T20:52:00	58	12	
768	2012-12-01T21:52:00	61	12	
769	2012-12-01T22:52:00	52	12	
770	2012-12-01T23:52:00	50	12	
771	2012-12-02T00:52:00	48	12	
772	2012-12-02T01:52:00	46	12	
773	2012-12-02T02:52:00	45	12	
774	2012-12-02T03:52:00	43	12	
775	2012-12-02T04:52:00	44	12	
776	2012-12-02T05:52:00	43	12	

6. Using Excel's built in Percentile function, the Extreme Cold Weather Temperature (ECWT) can now be determined. While on the ECWT sheet, in a blank cell use the function "=PERCENTILE.INC()" and select all temperature data in Column B (Hourly Dry Bulb Temperature) on the "ECWT" sheet and use 0.002 for the percentile value. The formula will look similar to this, "=PERCENTILE.INC(B:B,0.002)" (using 0.002 for the second argument in this function returns the two-tenths percentile temperature of the hourly temperatures measured in the dataset used).

   <u>This value should be representative of the Extreme Cold Weather Temperature based on the given dataset.</u>



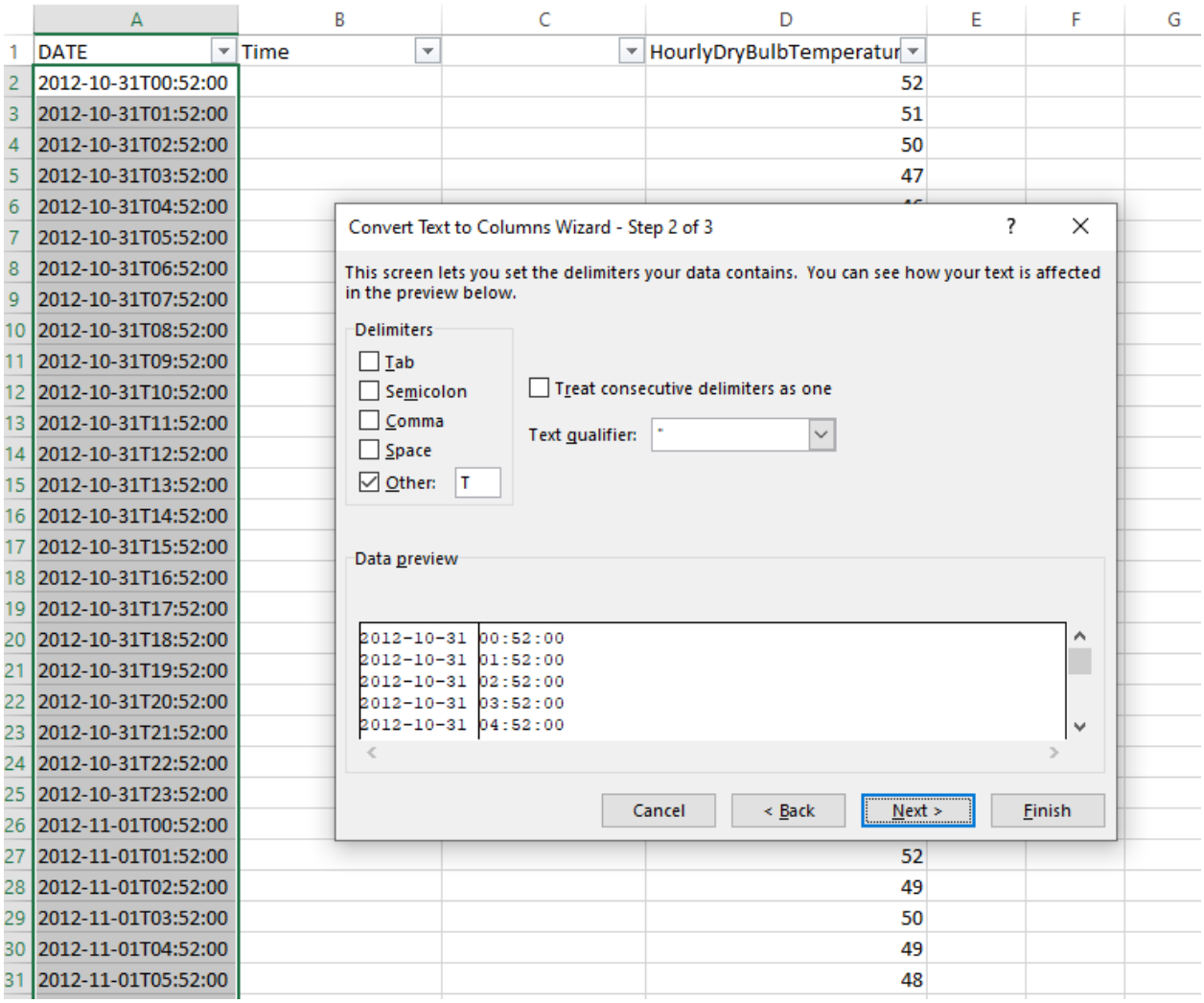
E5 =PERCENTILE.INC(B:B,0.002)

	A	B	C	D	E	F	G
1	DATE	HourlyDryBulbTemperature	Month				
2	2012-12-01T00:52:00	58	12				
3	2012-12-01T01:52:00	58	12				
4	2012-12-01T02:52:00	59	12		ECWT		
5	2012-12-01T03:52:00	59	12		2		
6	2012-12-01T04:52:00	58	12				
7	2012-12-01T05:52:00	59	12				
8	2012-12-01T06:52:00	58	12				
9	2012-12-01T07:52:00	60	12				
10	2012-12-01T08:52:00	61	12				
11	2012-12-01T09:52:00	63	12				
12	2012-12-01T10:52:00	66	12				
13	2012-12-01T11:52:00	71	12				
14	2012-12-01T12:52:00	74	12				
15	2012-12-01T13:52:00	75	12				
16	2012-12-01T14:52:00	77	12				
17	2012-12-01T15:52:00	76	12				
18	2012-12-01T16:52:00	73	12				
19	2012-12-01T17:52:00	67	12				

Option 2

These next few steps demonstrate how to view the distribution of temperatures from the data set and obtain the Extreme Cold Weather Temperature by a slightly different method.

1. On the "Clean and Filter" sheet, insert two new columns between column A and column B. Select column A and use Excel's *Text to Columns* feature and selected the delimited option and use the letter "T" to split the date data into a date component and a time component by hitting "Next" and "Finish". (Note: You can also do a "Find and Replace, finding the letter T and replacing it with a space to change the information in the Date column to a numerical value that can then be used for calculations.)

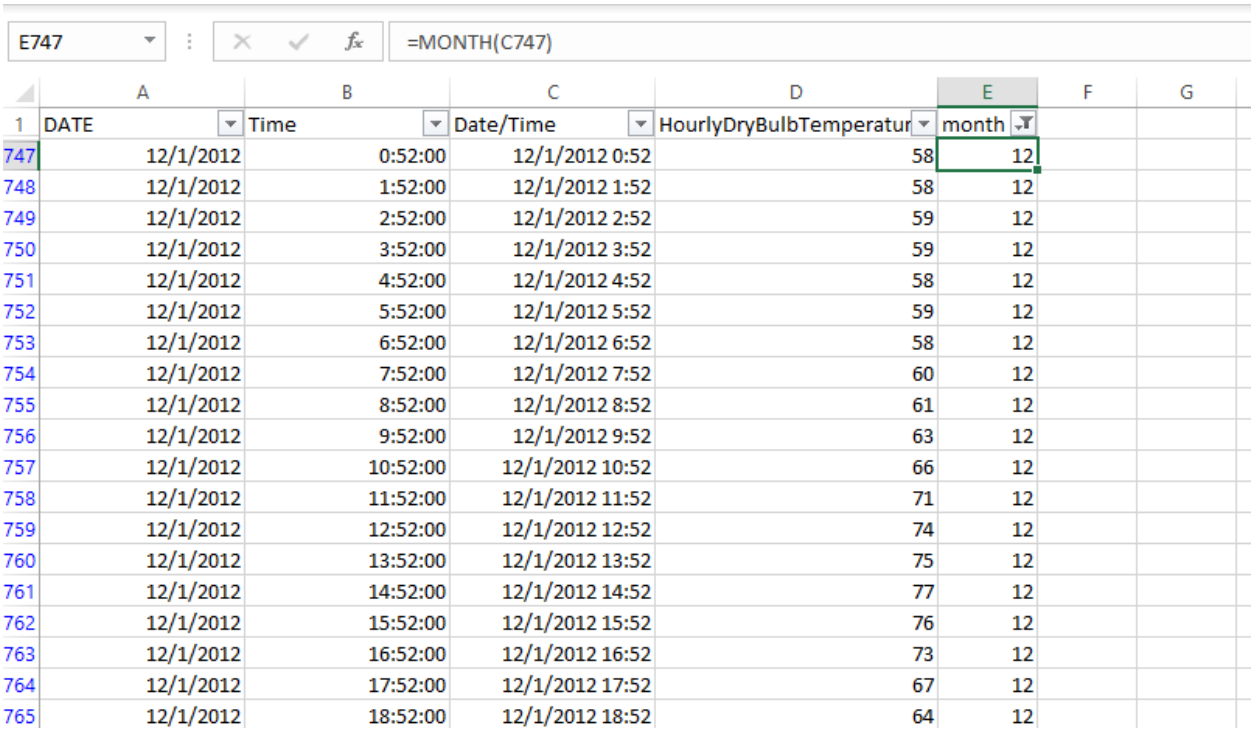


2. Add in column C, add the date in column A to time in column B, and copy this formula for all rows of the data set.

C2 =A2+B2

	A	B	C	D
1	DATE	Time	Date/Time	HourlyDryBulbTemperatur
2	10/31/2012	0:52:00	10/31/2012 0:52	52
3	10/31/2012	1:52:00	10/31/2012 1:52	51
4	10/31/2012	2:52:00	10/31/2012 2:52	50
5	10/31/2012	3:52:00	10/31/2012 3:52	47
6	10/31/2012	4:52:00	10/31/2012 4:52	46
7	10/31/2012	5:52:00	10/31/2012 5:52	46
8	10/31/2012	6:52:00	10/31/2012 6:52	44
9	10/31/2012	7:52:00	10/31/2012 7:52	48
10	10/31/2012	8:52:00	10/31/2012 8:52	52
11	10/31/2012	9:52:00	10/31/2012 9:52	57
12	10/31/2012	10:52:00	10/31/2012 10:52	61
13	10/31/2012	11:52:00	10/31/2012 11:52	65
14	10/31/2012	12:52:00	10/31/2012 12:52	67
15	10/31/2012	13:52:00	10/31/2012 13:52	68
16	10/31/2012	14:52:00	10/31/2012 14:52	71
17	10/31/2012	15:52:00	10/31/2012 15:52	71
18	10/31/2012	16:52:00	10/31/2012 16:52	70
19	10/31/2012	17:52:00	10/31/2012 17:52	66
20	10/31/2012	18:52:00	10/31/2012 18:52	62
21	10/31/2012	19:52:00	10/31/2012 19:52	59
22	10/31/2012	20:52:00	10/31/2012 20:52	54
23	10/31/2012	21:52:00	10/31/2012 21:52	51

3. Type Month in cell E1, and in cell E2 use the formula "=month(C2)". Copy the formula for all rows of the data set, then filter based on month, only selecting 1,2,12 for the desired months. Then copy remaining data from column C and column D to a sheet named Histogram.



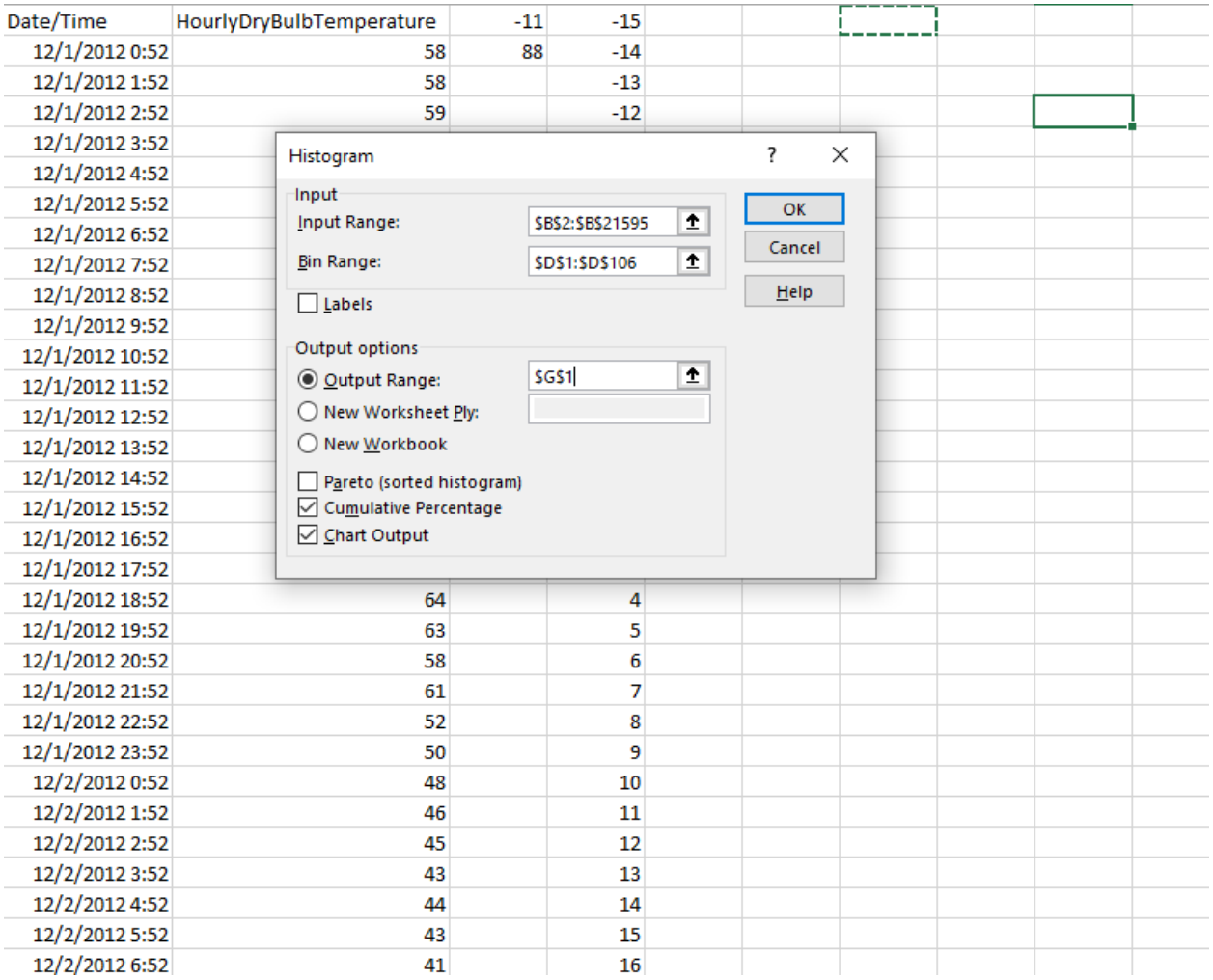
E747 =MONTH(C747)

	A	B	C	D	E	F	G
1	DATE	Time	Date/Time	HourlyDryBulbTemperatur	month		
747	12/1/2012	0:52:00	12/1/2012 0:52	58	12		
748	12/1/2012	1:52:00	12/1/2012 1:52	58	12		
749	12/1/2012	2:52:00	12/1/2012 2:52	59	12		
750	12/1/2012	3:52:00	12/1/2012 3:52	59	12		
751	12/1/2012	4:52:00	12/1/2012 4:52	58	12		
752	12/1/2012	5:52:00	12/1/2012 5:52	59	12		
753	12/1/2012	6:52:00	12/1/2012 6:52	58	12		
754	12/1/2012	7:52:00	12/1/2012 7:52	60	12		
755	12/1/2012	8:52:00	12/1/2012 8:52	61	12		
756	12/1/2012	9:52:00	12/1/2012 9:52	63	12		
757	12/1/2012	10:52:00	12/1/2012 10:52	66	12		
758	12/1/2012	11:52:00	12/1/2012 11:52	71	12		
759	12/1/2012	12:52:00	12/1/2012 12:52	74	12		
760	12/1/2012	13:52:00	12/1/2012 13:52	75	12		
761	12/1/2012	14:52:00	12/1/2012 14:52	77	12		
762	12/1/2012	15:52:00	12/1/2012 15:52	76	12		
763	12/1/2012	16:52:00	12/1/2012 16:52	73	12		
764	12/1/2012	17:52:00	12/1/2012 17:52	67	12		
765	12/1/2012	18:52:00	12/1/2012 18:52	64	12		

4. On the Histogram sheet, enter "=min(B:B)" in cell C1, and "=max(B:B)" in cell C2. This will give you the minimum and maximum temperatures in the dataset. We will use the temperatures to set range for this histogram. In Column D start with a value, a few degrees below the min, then list every degree to a few degrees above the max.

Date/Time	HourlyDryBulbTemperature	-11	-15	
12/1/2012 0:52	58	88	-14	
12/1/2012 1:52	58		-13	
12/1/2012 2:52	59		-12	
12/1/2012 3:52	59		-11	
12/1/2012 4:52	58		-10	
12/1/2012 5:52	59		-9	
12/1/2012 6:52	58		-8	
12/1/2012 7:52	60		-7	
12/1/2012 8:52	61		-6	
12/1/2012 9:52	63		-5	
12/1/2012 10:52	66		-4	
12/1/2012 11:52	71		-3	
12/1/2012 12:52	74		-2	
12/1/2012 13:52	75		-1	
12/1/2012 14:52	77		0	
12/1/2012 15:52	76		1	
12/1/2012 16:52	73		2	
12/1/2012 17:52	67		3	
12/1/2012 18:52	64		4	
12/1/2012 19:52	63		5	
12/1/2012 20:52	58		6	
12/1/2012 21:52	61		7	
12/1/2012 22:52	52		8	
12/1/2012 23:52	50		9	
12/2/2012 0:52	48		10	
12/2/2012 1:52	46		11	
12/2/2012 2:52	45		12	
12/2/2012 3:52	43		13	
12/2/2012 4:52	44		14	
12/2/2012 5:52	43		15	
12/2/2012 6:52	41		16	
12/2/2012 7:52	38		17	
12/2/2012 8:52	44		18	

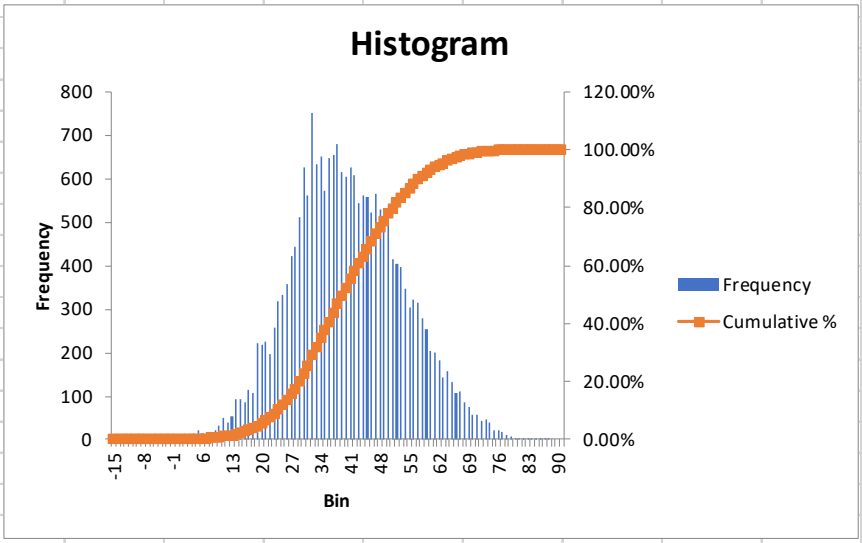
5. In the Data Analysis ToolPak in excel, select histogram. Select all dry bulb temperatures for your Input Range. Select all the Temperatures in column D for our Bin Range. Select an empty cell for your Output Range. Check the Cumulative Percentage and Chart Output boxes.



Date/Time	HourlyDryBulbTemperature	-11	-15
12/1/2012 0:52	58	88	-14
12/1/2012 1:52	58		-13
12/1/2012 2:52	59		-12
12/1/2012 3:52			
12/1/2012 4:52			
12/1/2012 5:52			
12/1/2012 6:52			
12/1/2012 7:52			
12/1/2012 8:52			
12/1/2012 9:52			
12/1/2012 10:52			
12/1/2012 11:52			
12/1/2012 12:52			
12/1/2012 13:52			
12/1/2012 14:52			
12/1/2012 15:52			
12/1/2012 16:52			
12/1/2012 17:52			
12/1/2012 18:52	64		4
12/1/2012 19:52	63		5
12/1/2012 20:52	58		6
12/1/2012 21:52	61		7
12/1/2012 22:52	52		8
12/1/2012 23:52	50		9
12/2/2012 0:52	48		10
12/2/2012 1:52	46		11
12/2/2012 2:52	45		12
12/2/2012 3:52	43		13
12/2/2012 4:52	44		14
12/2/2012 5:52	43		15
12/2/2012 6:52	41		16

6. The output from this will provide a listing of percentile rankings for the listed temperatures, as well as a graph output of the distribution of temperatures contained in this dataset. The "Bin" column shows the temperature, "Frequency" shows how many times that temperature occurred within the dataset, and "Cumulative %" shows the percentile ranking for each temperature. Choose the temperature at or closest to the 0.2 percentile level.

Bin	Frequency	Cumulative %
-15	0	0.00%
-14	0	0.00%
-13	0	0.00%
-12	0	0.00%
-11	1	0.00%
-10	0	0.00%
-9	2	0.01%
-8	0	0.01%
-7	1	0.02%
-6	4	0.04%
-5	4	0.06%
-4	4	0.07%
-3	1	0.08%
-2	4	0.10%
-1	6	0.13%
0	5	0.15%
1	3	0.16%
2	11	**0.21%**
3	5	0.24%
4	13	0.30%
5	22	0.40%
6	14	0.46%
7	12	0.52%
8	17	0.60%
9	23	0.70%
10	32	0.85%
11	50	1.08%
12	39	1.26%
13	53	1.51%
14	93	1.94%
15	92	2.37%
16	86	2.76%

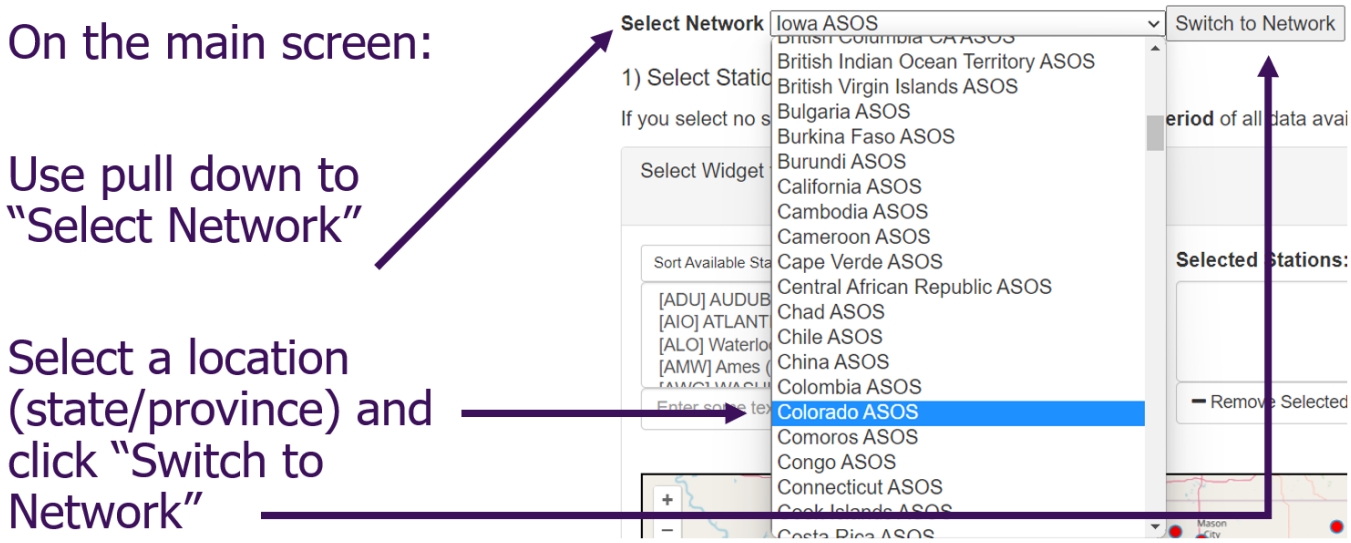


Gathering Data From ASOS

The Automated Surface Observing System (ASOS) program is a joint effort between the National Weather Service (NWS), the Federal Aviation Administration (FAA), and the Department of Defense (DOD). The primary function of ASOS stations is to take minute-by-minute observations and generate weather reports for use. The National Center for Environmental Information (NCEI) provides an archive of one-minute internal observations for many US ASOS sites back to the year 2000. Data is not available for all sites back to the year 2000.

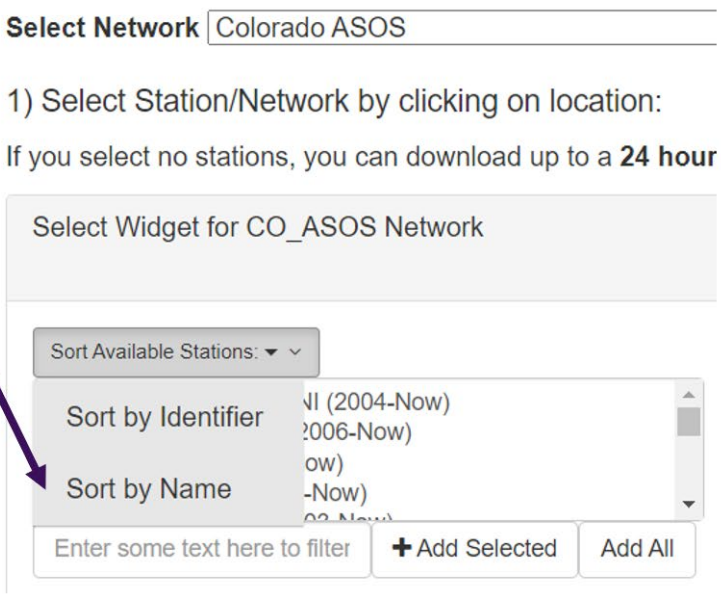
Each ASOS station is designed to provide observations every minute of every hour of every day. In general, ASOS stations are located at airports so may limit some use for ECWT calculations depending upon the Generator Owner selection process. Sensors measure wind speed and direction, dew point, air temperature, and station pressure. The vast majority also measure precipitation type and amount, visibility, and cloud height and thickness. Data is available for Canadian airports. More information is available at IEM :: ASOS/AWOS Network (iastate.edu) and https://mesonet.agron.iastate.edu/request/download.phtml where the example graphics were gathered. Additional information is available at ASOS (weather.gov).

1. Selecting Data
   ASOS uses "Network" to describe particular locations. From the main screen you would use the pulldown for "Select Network" and then select a particular location.



Sorting the data is available by an "identifier" (the airport code) or "name" (city or airport name normally) with "name" probably providing the easier way to identify the location needed to facilitate ECWT calculation efforts. This is needed to support the weather station selection. When downloading the information, the "identifier" will be included in the data set, so it is recommended that you ensure you are getting the correct location by both name and identifier.

Select "Sort by Identifier" or "Sort by Name" on the "Sort Available Stations" drop down.



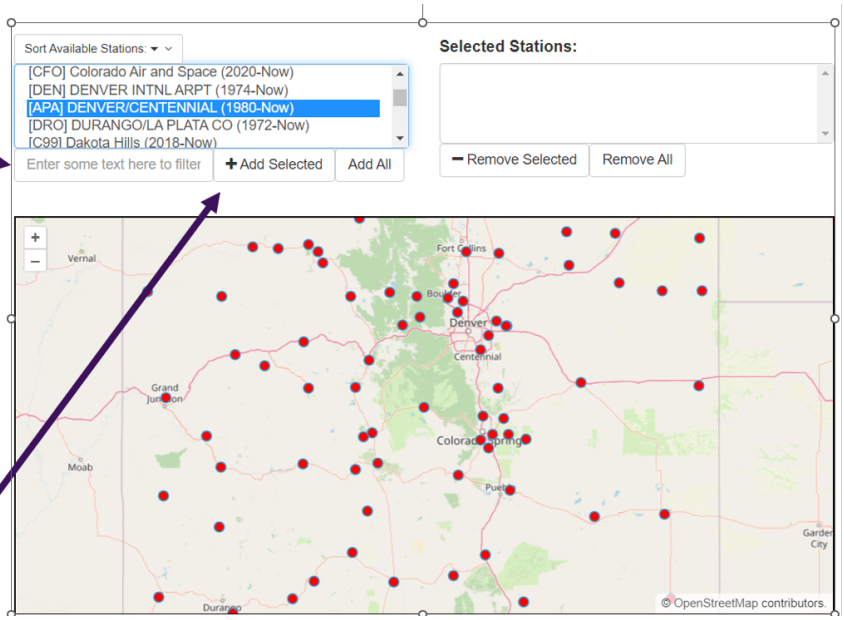
A map of available weather stations is provided along with options to select a particular weather station. Make sure you select "+ADD Selected" toggle button to capture the weather station.

Text search

Or can use the map to find a station name/ID

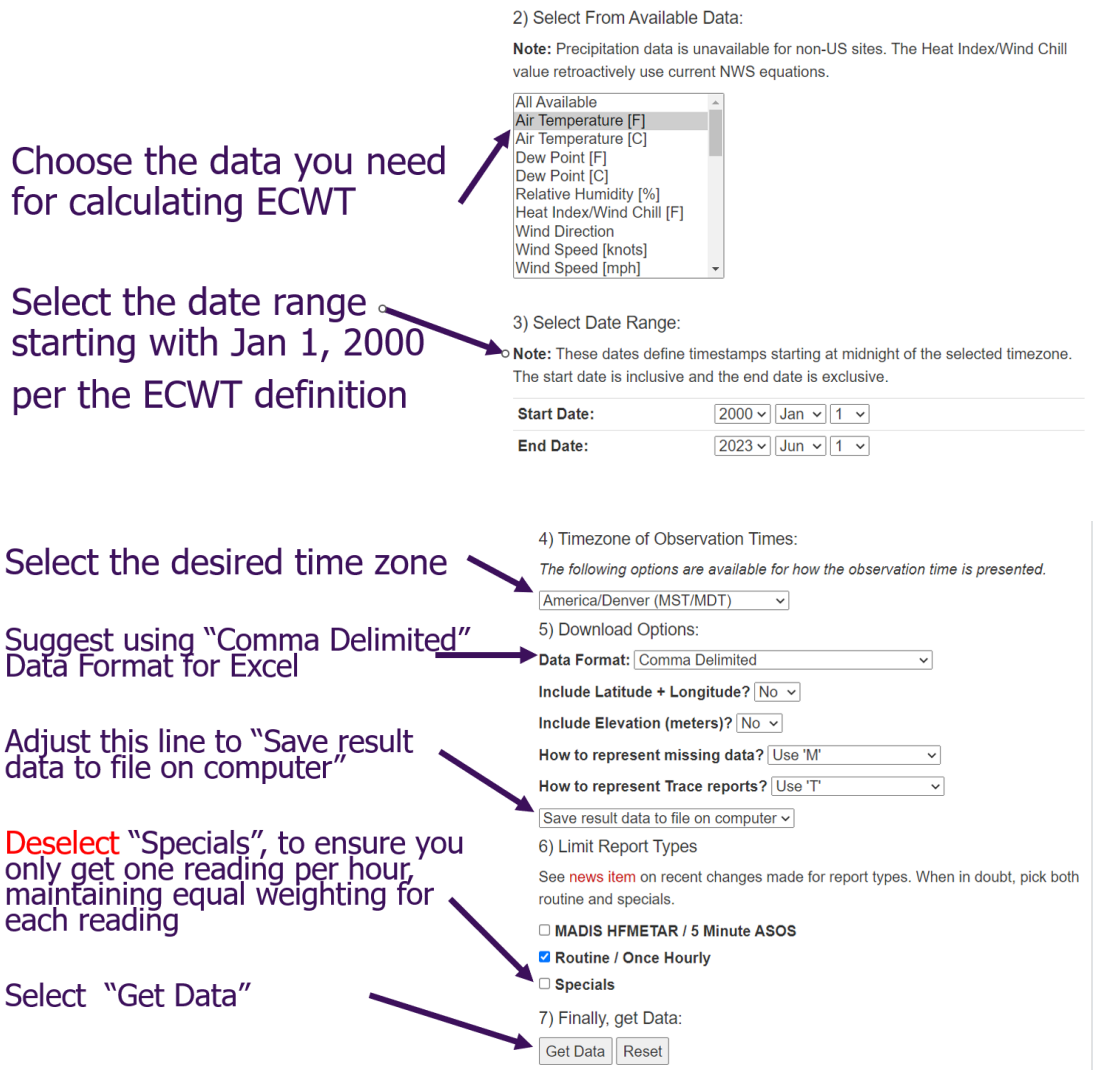
Or can just scroll and choose the station desired.

Select "+Add Selected"



At this point you can select data types, date ranges, time zones, data formats, download options, and report types. Note that some data types may not be available for the location. As discussed with the NOAA example, if hourly values for temperature are not available, document in your methodology or support documents how that is managed. It is important to note what may be missing/corrupt and how you approach that condition. As of yet, no criteria has been set to indicate how much can be missing (or present) to be considered an appropriate calculation of ECWT. Use professional judgement and present it in the best way possible if asked.

Make sure you understand the "Notes" ASOS provides when selecting data.

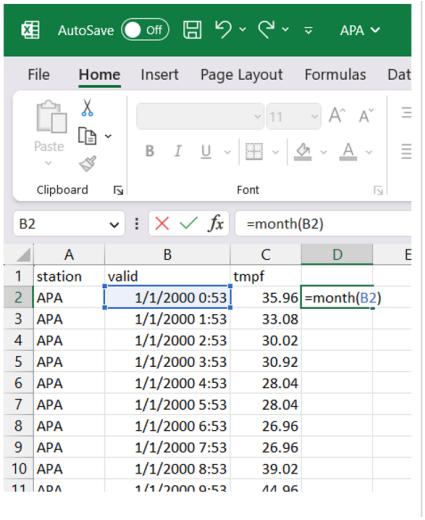


Note the "Deselection" verbiage as this could lead to possible erroneous ECWT calculations if left selected. By removing the Specials, the data set will have fewer duplicate readings in the data set.

After selecting "Get Data" you should receive a download with the filtered data. It is important to retain this raw file. The file should conatin every hour for every month for the Date Range selected. This helps preserve the documentation to demonstrate the means by which you arrived at the ECWT you determine.
The ECWT definition only requires the months of December, January, and February to be selected. Once you have the comma delimited file, save it as an Excel worksheet. Then use the "MONTH" function to provie a simple numeric value (e.g., January = 1, February = 2, etc) and then filter on 1, 2, and 12 to get the three months required by the ECWT definition.

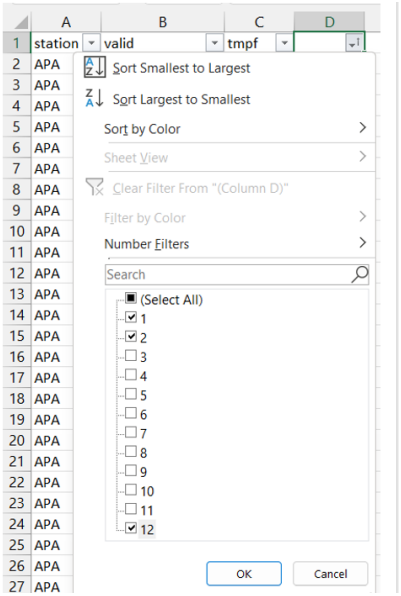
ECWT only uses the months of January, February and December.

Use the MONTH function to get a numeric value in an empty column and then copy that formula down through the end of the data set. Other filtering options can be used.



	A	B	C	D
1	station	valid	tmpf	
2	APA	1/1/2000 0:53	35.96	=month(B2)
3	APA	1/1/2000 1:53	33.08	
4	APA	1/1/2000 2:53	30.02	
5	APA	1/1/2000 3:53	30.92	
6	APA	1/1/2000 4:53	28.04	
7	APA	1/1/2000 5:53	28.04	
8	APA	1/1/2000 6:53	26.96	
9	APA	1/1/2000 7:53	26.96	
10	APA	1/1/2000 8:53	39.02	

Once a numeric value is produced you can simply use excel filters.



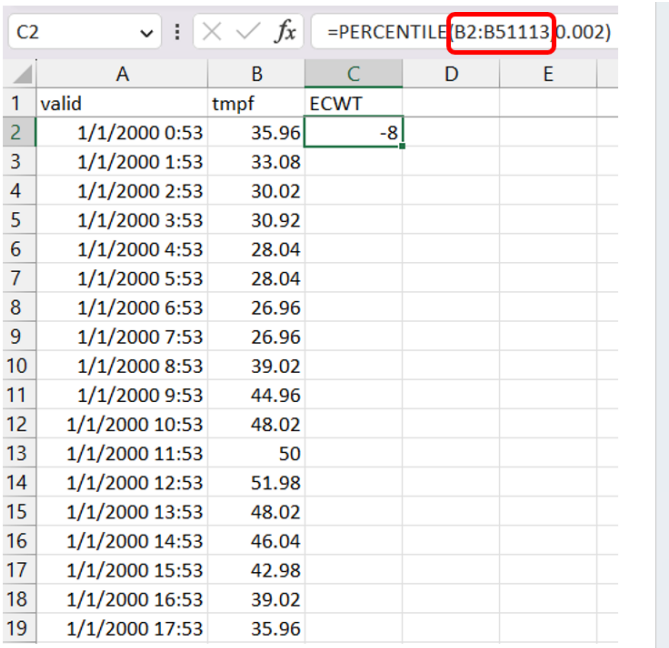
It is suggested that you highlight and copy the filtered data to another worksheet or file. Again, if moving the data to a separate spreadsheet be sure to maintain this original file for documentation.

When you paste the data into the new worksheet, you will have the the data from December, Janauary and February from all years needed to caculate ECWT. Add the Microsoft Excel function "PERCENTILE" to a new cell with the proper percentile value from the ECWT definition (i.e. "0.2 percentile" which for Excel is .002)). Make sure you capture your complete data set. (Example: =PERCENTILE(B:B,.002))

Compute the ECWT using the PERCENTILE function in Excel:

=PERCENTILE(range,0.002)

Ensure your range includes all the data points (e.g., B2:B51113 in the example)



	A	B	C
1	valid	tmpf	ECWT
2	1/1/2000 0:53	35.96	-8
3	1/1/2000 1:53	33.08	
4	1/1/2000 2:53	30.02	
5	1/1/2000 3:53	30.92	
6	1/1/2000 4:53	28.04	
7	1/1/2000 5:53	28.04	
8	1/1/2000 6:53	26.96	
9	1/1/2000 7:53	26.96	
10	1/1/2000 8:53	39.02	
11	1/1/2000 9:53	44.96	
12	1/1/2000 10:53	48.02	
13	1/1/2000 11:53	50	
14	1/1/2000 12:53	51.98	
15	1/1/2000 13:53	48.02	
16	1/1/2000 14:53	46.04	
17	1/1/2000 15:53	42.98	
18	1/1/2000 16:53	39.02	
19	1/1/2000 17:53	35.96	

In the above example, the ECWT is -8 (cell C1) based on the data in column B. Essentially you have completed your ECWT at this point, but it is important to do a quality check or other validation effort. You want to make sure you have the most complete set of data that is as free of errors as possible to determine the ECWT.

To help ensure data quality assurance you should evaluate how many hours of data you might expect for the given year an ECWT is being calculated. Using the "COUNTA" Excel function and the data range will provide a value but a check on that value is encouraged. The basic premise is to calculate the number of "full" years by 90 (the number of days i.e., January and December have 31 and February has 28) by 24 (number of hours in a day) plus the number of past leap years (years with 29 days in February) by 24 (number of hours in a day) plus the number of days in January and February for the current year by 24 (number of hours in a day). Note: "Full" years is inclusive of 2000. It is not stated in the Standard but when recalculating the ECWT, you are encouraged to recalculate ***after*** February has passed and before December of the year in which you are recalculating to provide the most up to date information.

Effectively, if this example is used, the calculation for March 2024 would look like:

(24X90X24) + (6X24) + (60X24) = 53424 data points where "full" years is 24 for 2000-2023, leap years included in the calculation is 7 (2000, 20004, 2008, 2012, 2016, 2020 and 2024), and days in the current year is 59 (January is 31 and February is 28 with February 29 accounted for in the leap years). Other methods can be used of course but make sure you retain how you came up with the value.

If you noticed ASOS provides filters for missing data but may not capture missing hours. You can use Excel in a variety of ways to verify if the number of hours accounted for in the data range selected. To the point made earlier, all hours may not be available for an ECWT calculation due to a variety of issues. If a large number of hours are missing, consider using other weather stations within close proximity or the combination of NWS/NOAA and ASOS data (regardless of what your primary data source is) in an attempt to capture a fuller data set. The key is

documenting what is missing and what you did with your approach. To date there has not been an approach to determine the statistical significance "margin" for ECWT.

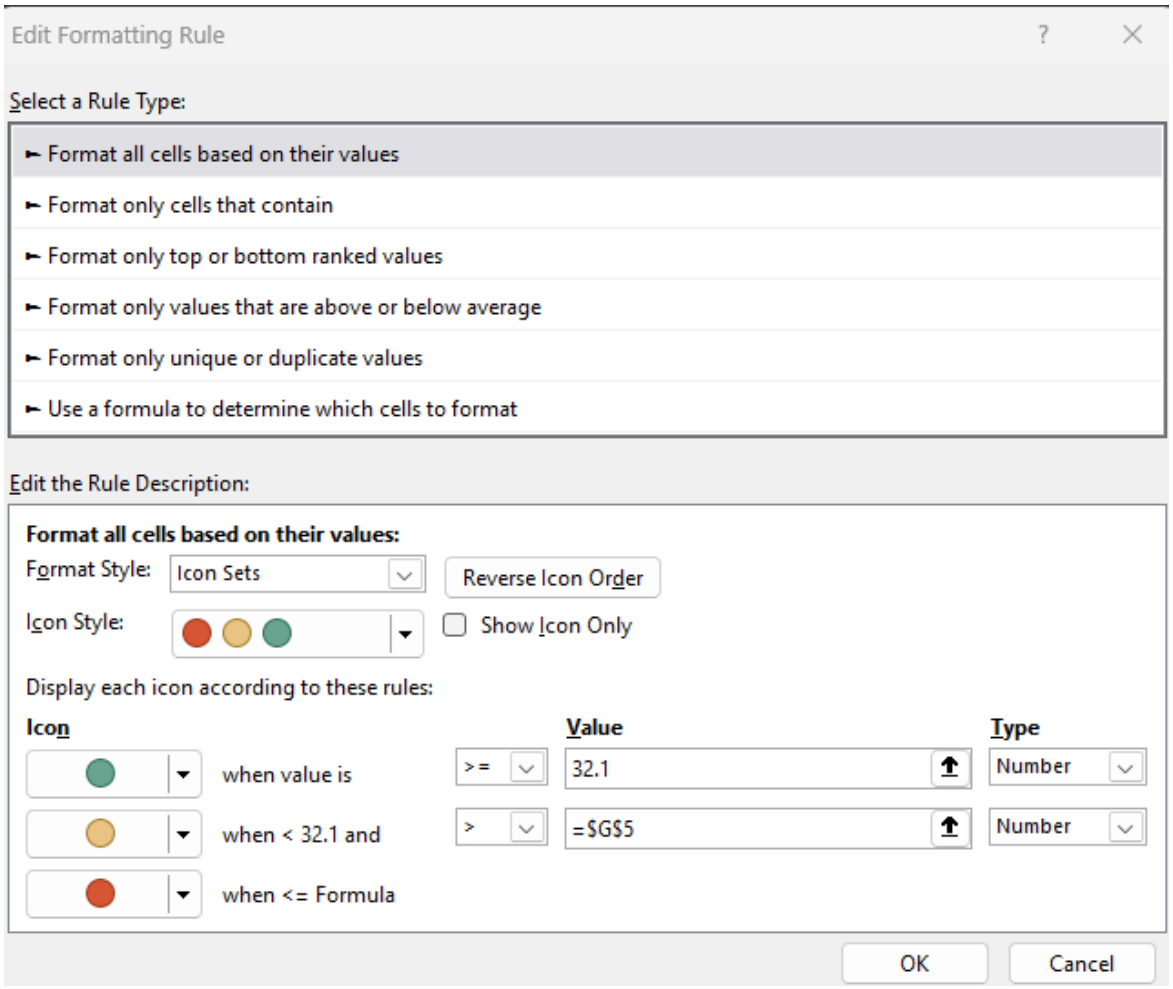
Excel also provides the ability to visualize when temperatures drop below ECWT, hover around ECWT, or exceed ECWT if more analysis is needed. This visualization, in conjunction with your efforts to find missing hours may provide insight for your approach to missing data. In any case, document what you have done.

valid	Month	tmpf	Time Check	ECWT	Data Points	Missing Data Points
1/1/2000 8:56	1	42.8		**6.000**	53247	177
1/1/2000 9:56	1	46	1.00			
1/1/2000 10:56	1	57	1.00	Reord low temp		-17
1/1/2000 11:56	1	68	1.00	Maximum		
1/1/2000 12:56	1	72	1.00	6,603.00		
1/1/2000 13:56	1	72	1.00	Minimum		
1/1/2000 14:56	1	72	1.00	0.05		
1/1/2000 15:56	1	71	1.00			
1/1/2000 16:56	1	69	1.00			
1/1/2000 17:56	1	65	1.00			

This picture shows one way that can be used to verify the data is reasonably complete. The Data Points of 53,247 is compared to the total number of hours that are included from January 1, 2000 through February 29, 2024 of 53, 424. The Data Points number is found by using the =COUNT function and highlighting the data in the "tmpf" column.

To evaluate the missing data points, the Time Check column compares the time shown on the row above with the time on that row. The formula for this is =(B6-B5)*24. If the results of this formula is less than 1, there is possibly duplicate readings for that hour. If the result is 2 or more, it indicates that there are missing data points. Note that the first hour each December will be 6601 or greater since we do not use any hours March through November. Use Conditional Formatting in the Time Check column to highlight cells with numbers less than 0.9 and greater than 1.1 to quickly identify missing or duplicate data points.

You can also use Conditional Formatting to identify hours that are above freezing, below freezing but above the ECWT and temperatures equal to or below the ECWT. This can help determine if the missing data points are likely to cause a change in the ECWT. This shows the Conditional Formatting rule assuming the ECWT is shown in cell G5:


Edit Formatting Rule
Select a Rule Type:
Format all cells based on their values
Format only cells that contain
Format only top or bottom ranked values
Format only values that are above or below average
Format only unique or duplicate values
Use a formula to determine which cells to format
Edit the Rule Description:
Format all cells based on their values:
Format Style:
Icon Sets
Reverse Icon Order
Icon Style:
Show Icon Only
Display each icon according to these rules:
Icon
Value
Type
when value is
>=
32.1
Number
when < 32.1 and
>
=G5
Number
when <= Formula
OK
Cancel