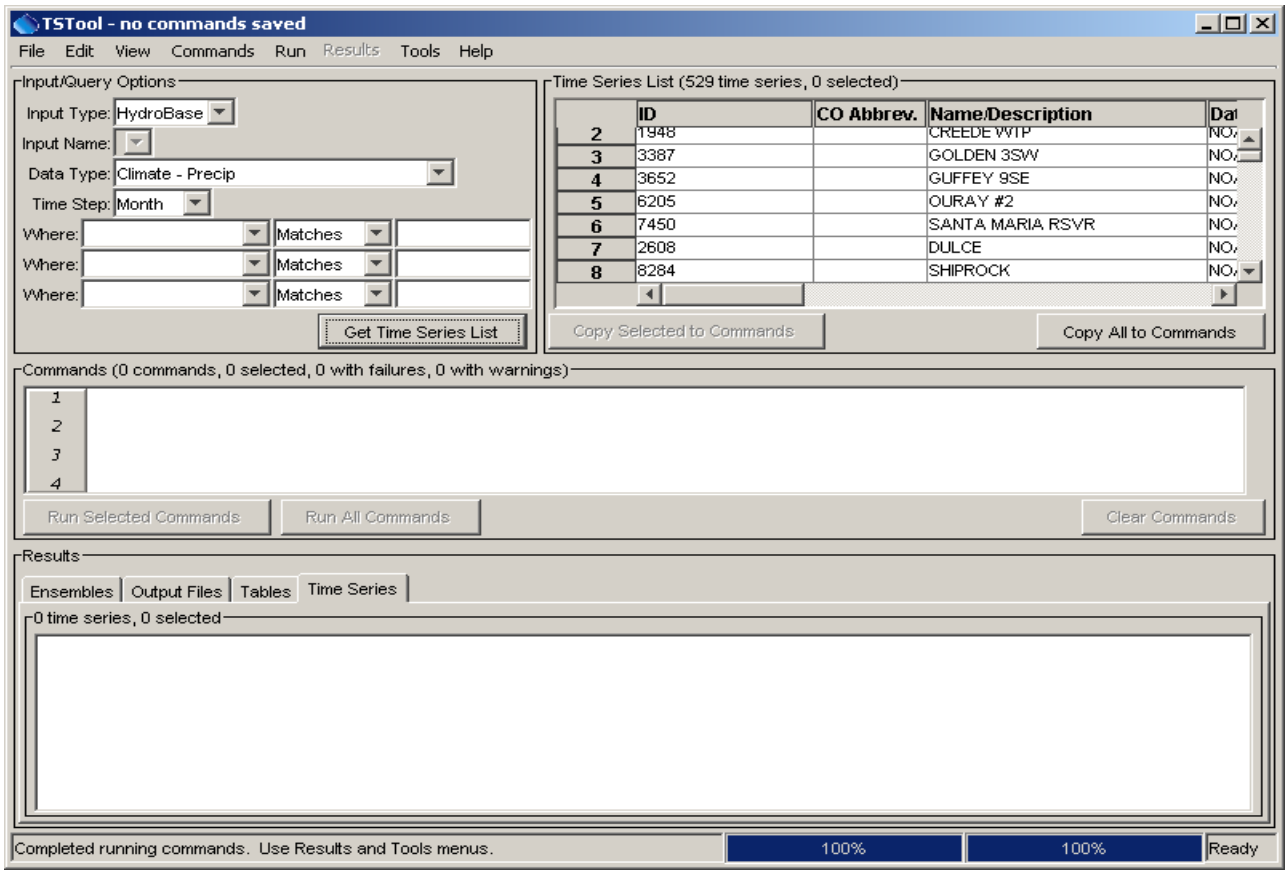
TSTOOL – TIME SERIES TOOL



Quick Start Manual for Regression Fill of Climate Data

March 2012

Introduction

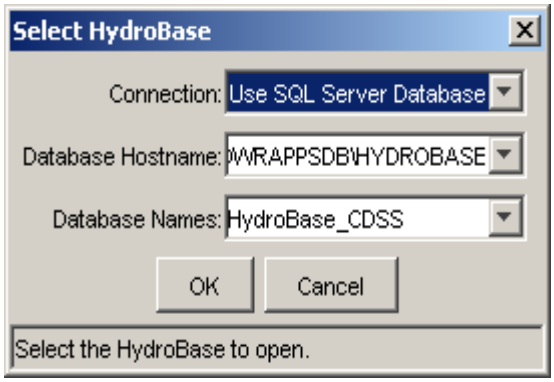
This Quick Start Manual is a very shortened and step-by-step description of what the model can perform. Should you desire to learn how to develop further complex analysis, the TSTool Documentation manual is far more extensive than this manual.

For many climate stations within HydroBase, the data may only go back to around 1950, however, diversion records may go back to around 1900. Where a year-by-year analysis is to be conducted for the full period of record of the structure diversions, this tool will provide an avenue to back fill the data for precipitation, temperature, and frost date.

Users outside of the state system will need to obtain a copy of HydroBase from the Division of Water Resources Records Section and install that data on their system to use TSTool.

Getting Started

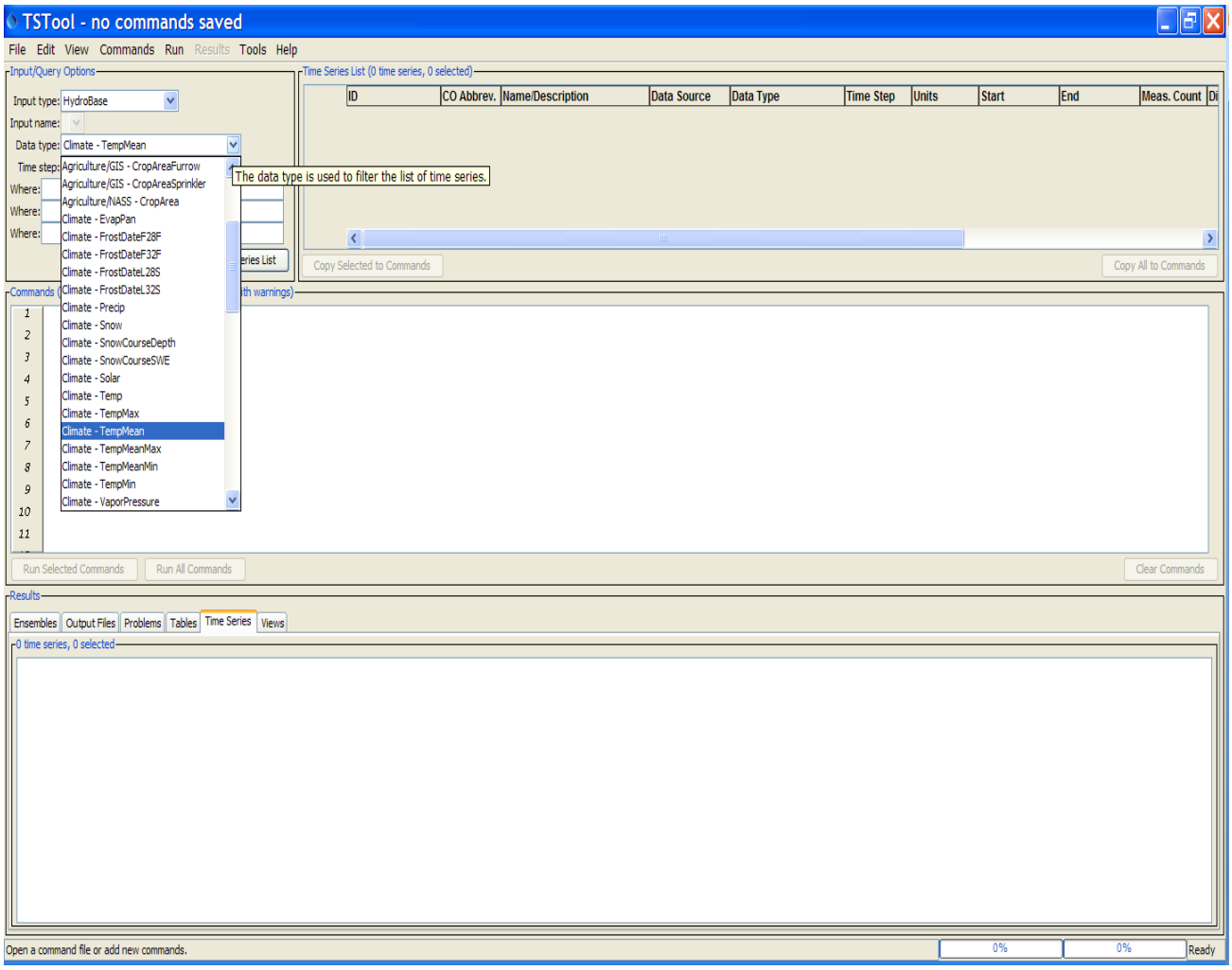
TSTools can be downloaded by going to http://cdss.state.co.us/Pages/CDSSHome.aspx
The program will take a minute to open up. Once open, the table on the front page of this manual and an overlapping table should be shown.



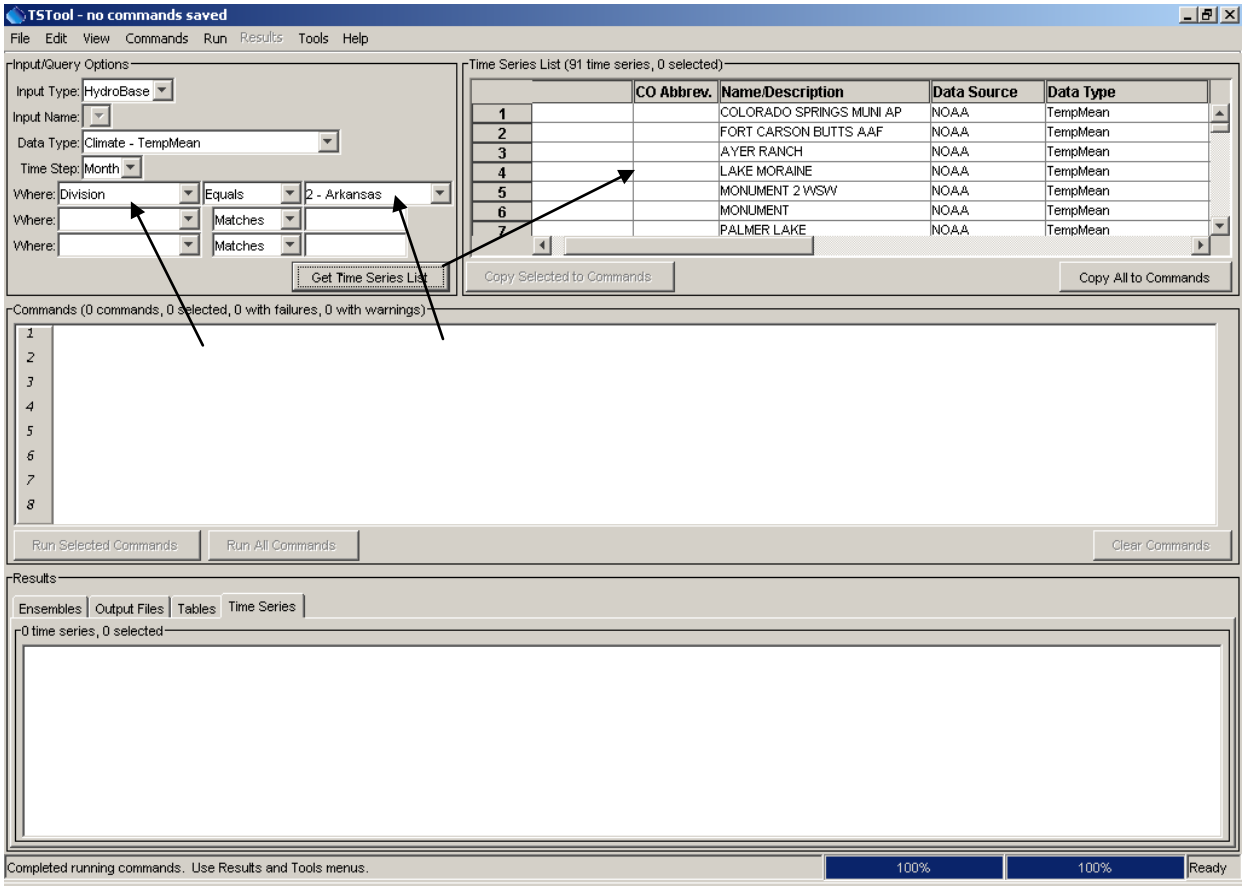
Press OK.

Temperature and Precipitation Regression

On the main table, click the drop down menu and scroll to Climate – TempMean and highlight it. Climate - TempMean should now be within the Data Type box. It is best to use the TempMean to find a climate station that is statistically similar to the station you want to fill. It is best to find a fill from station that has a long period of record and is somewhat close in proximity; however, this is not always the case.

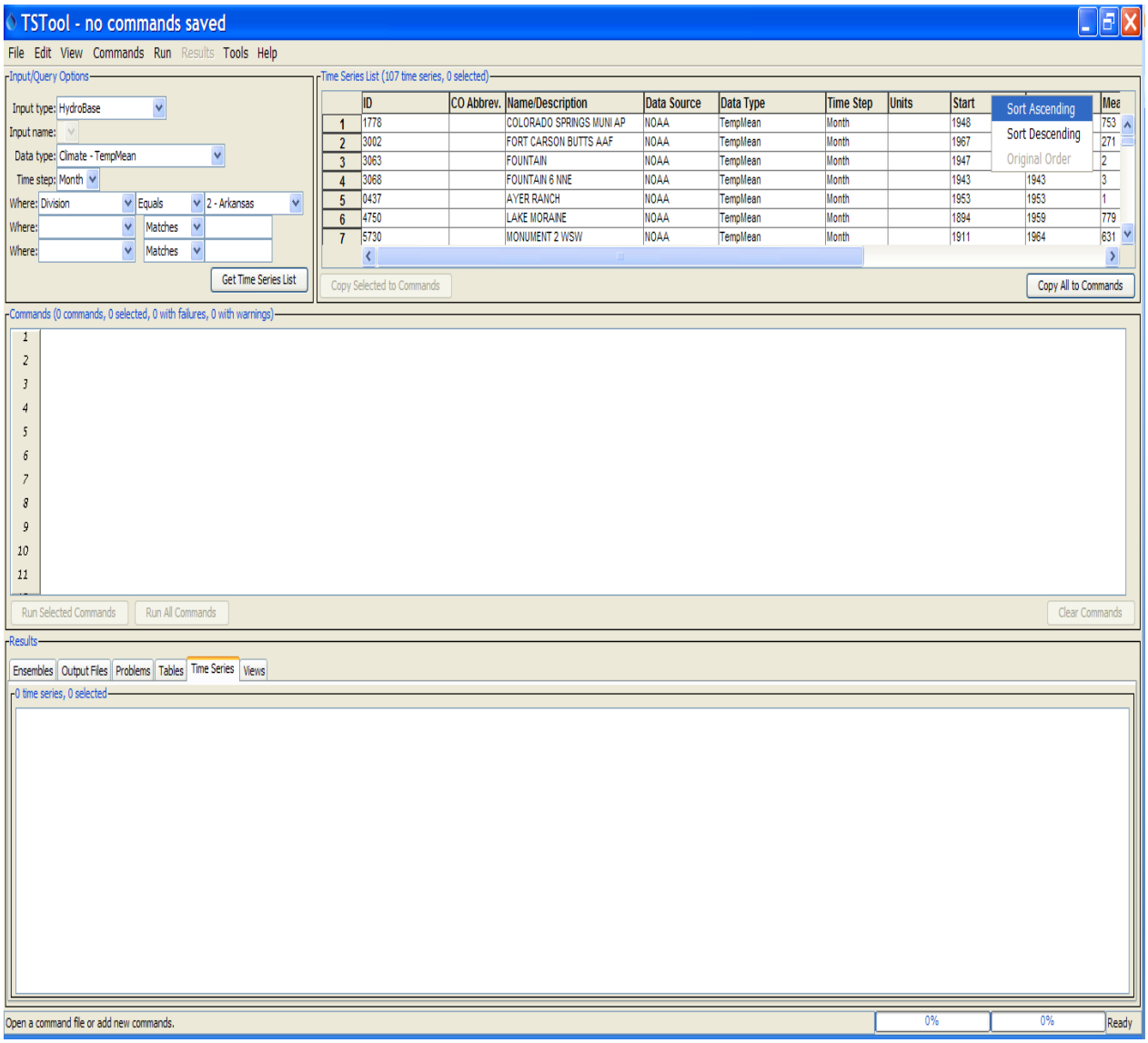


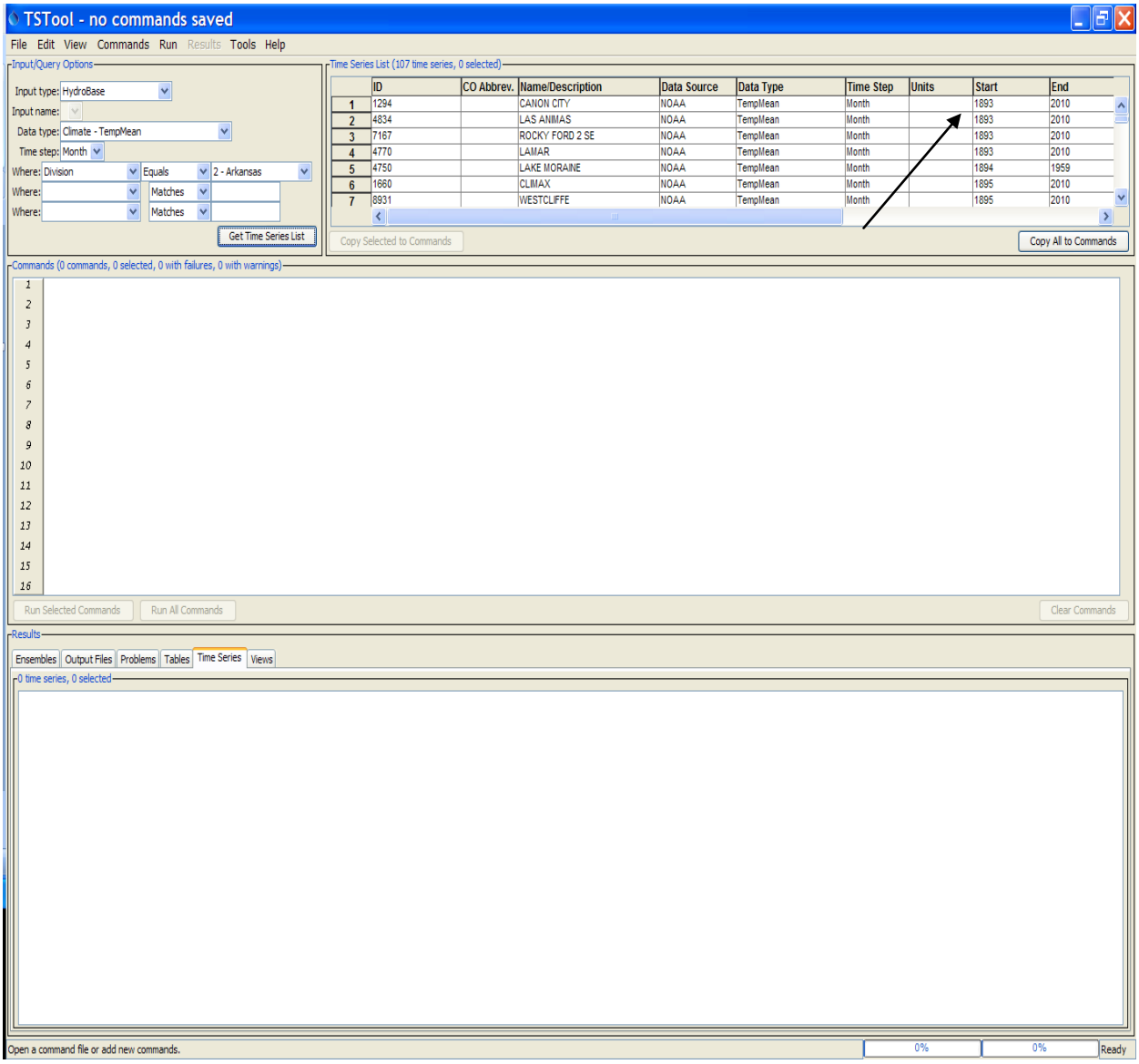
To find climate stations with long periods of records, it may be best to pull down all the climate stations in the Division. For this example, the first drop down for “Where”, highlight Division, then to the right highlight Arkansas in that drop down. Press the “Get Time Series List” and the climate stations in Division 2 should show up under the Time Series List



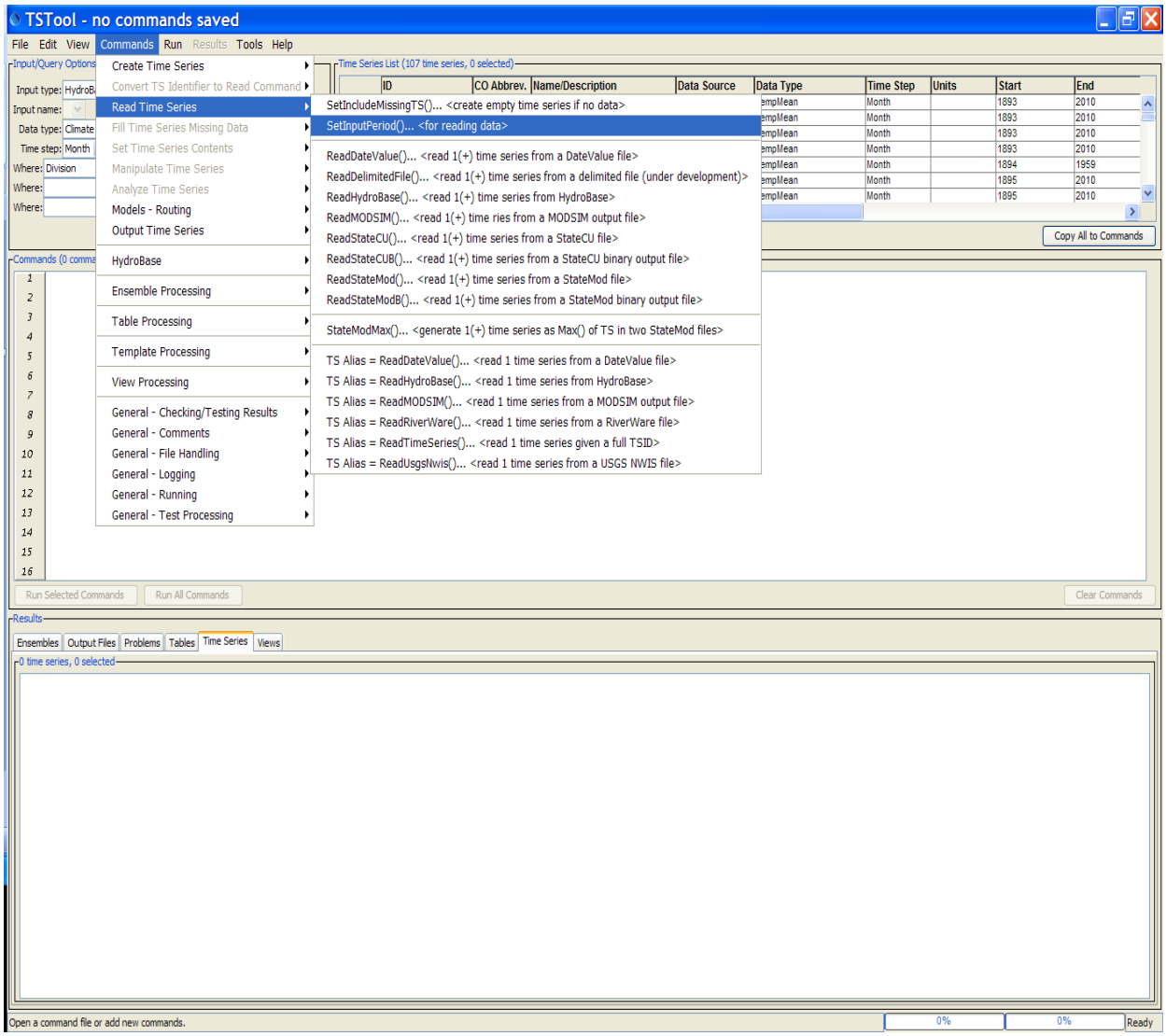
You will want to scroll to the right on the “Time Series List” and find the start dates.

For this example, Pueblo Memorial will be the station to regression fill. Right click on the start date then click on Sort Ascending. This will put the stations in order of first date. There should be about 4 stations that have a period of record of 1893 - 2010. One of these stations will be used for a regression fill for Pueblo Memorial

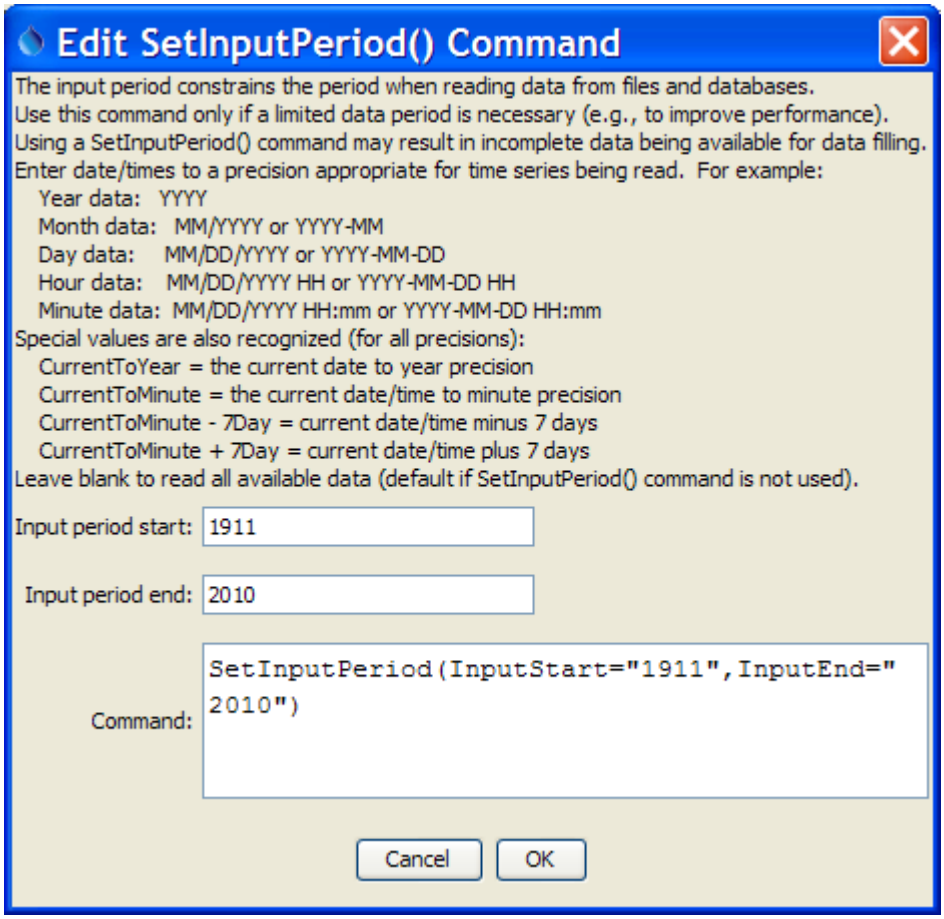



TSTool - no commands saved
File Edit View Commands Run Results Tools Help
Input/Query Options
Input type: HydroBase
Input name:
Data type: Climate - TempMean
Time step: Month
Where: Division Equals 2 - Arkansas
Where: Matches
Where: Matches
Get Time Series List
Time Series List (107 time series, 0 selected)
ID CO Abbrev. Name/Description Data Source Data Type Time Step Units Start End
1 1294 CANON CITY NOAA TempMean Month 1893 2010
2 4834 LAS ANIMAS NOAA TempMean Month 1893 2010
3 7167 ROCKY FORD 2 SE NOAA TempMean Month 1893 2010
4 4770 LAMAR NOAA TempMean Month 1893 2010
5 4750 LAKE MORAINE NOAA TempMean Month 1894 1959
6 1660 CLIMAX NOAA TempMean Month 1895 2010
7 8931 WESTCLIFFE NOAA TempMean Month 1895 2010
Copy Selected to Commands
Copy All to Commands
Commands (0 commands, 0 selected, 0 with failures, 0 with warnings)
Run Selected Commands
Run All Commands
Clear Commands
Results
Ensembles Output Files Problems Tables Time Series Views
0 time series, 0 selected
Open a command file or add new commands.
0%
0%
Ready

It is easiest to set the input period up front, saving time by not having to input the data on following tables. Under Commands, click on Read Time Series, then on the right, click on SetInputPeriod.

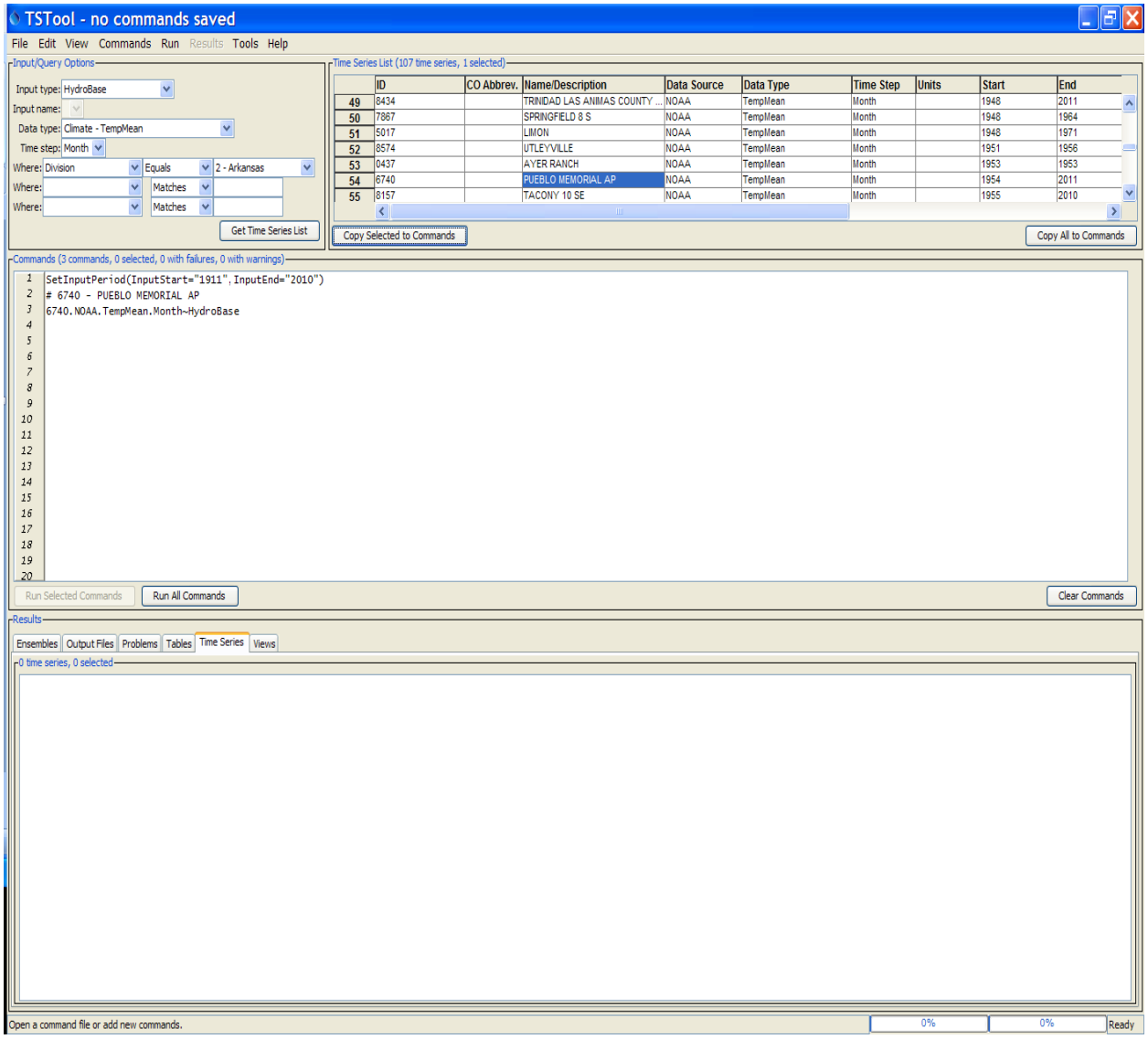


Enter your period of record for the analysis and be sure to follow the format. You need to only enter the start and end date, the program will write the command for you in the command box. The period of record for this analysis is set for 1911 through 2010. StateCU will not run an analysis that is longer than 100 years.

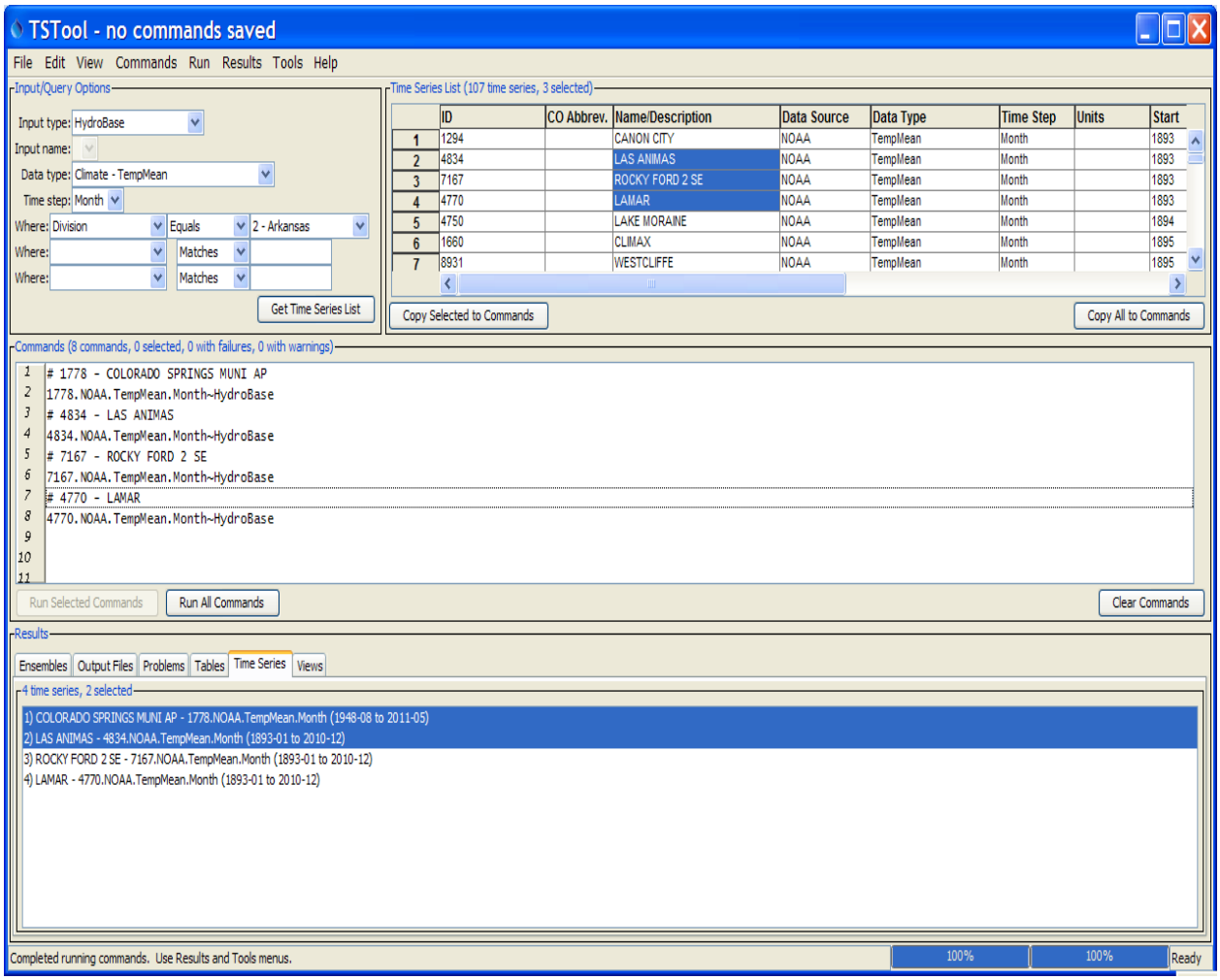


Once you press OK, the command will show up as the first command in the main table.

Scroll down on the Time Series List till you find Pueblo Memorial. Highlight it and then press the Copy to Selected Commands. This will bring the Pueblo Memorial station down into your commands list. You always want the station to be filled listed first, then the station to fill from.



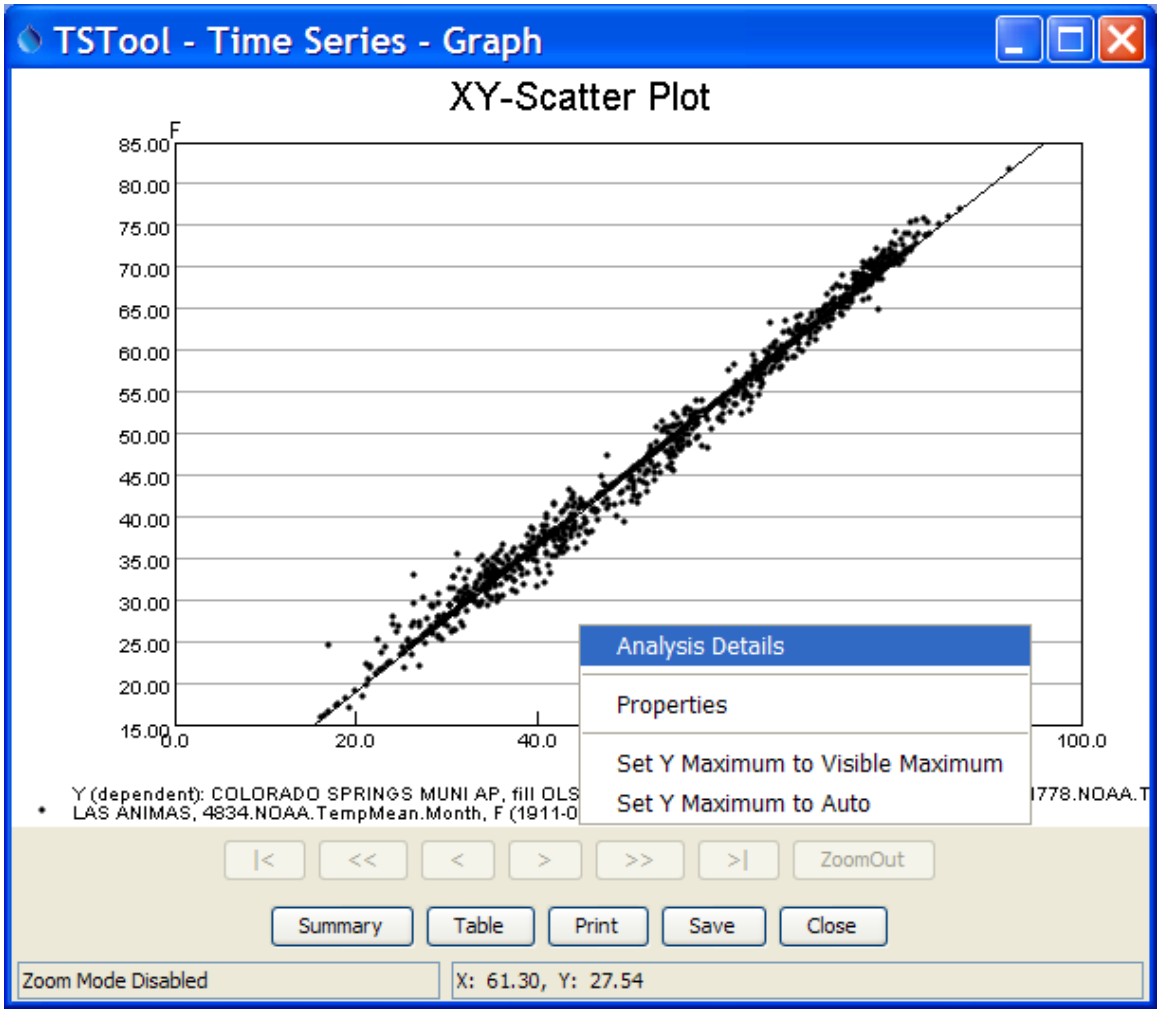
Next, back to the top of the Time Series List, highlight the stations with the long periods of record and copy them down to the commands list. Use your best judgment in deciding which stations to pick. For this example, Las Animas, Rocky Ford 2 SE, and Lamar were chosen. Copy the selected 4 stations down.



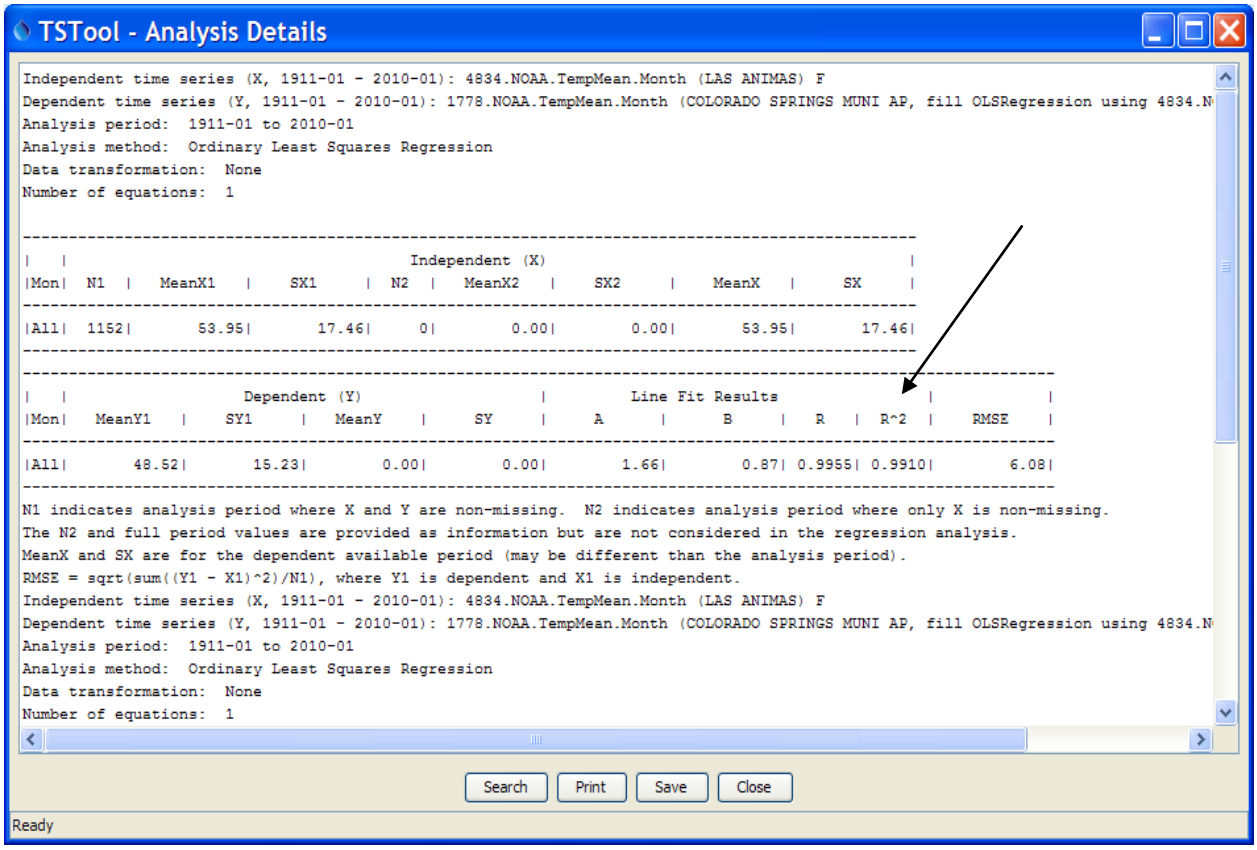
To determine which of the 3 stations should be used for the fill, see which station is statistically similar.

Press the Run All Commands button and 4 lines of results shows in the bottom window. Highlight the Pueblo Memorial line and the Las Animas line, right click on your mouse, and a pop up window will open, click on the Graph – XY Scatter and a graph will open up.

Right click your mouse on the table, then click Analysis Details.



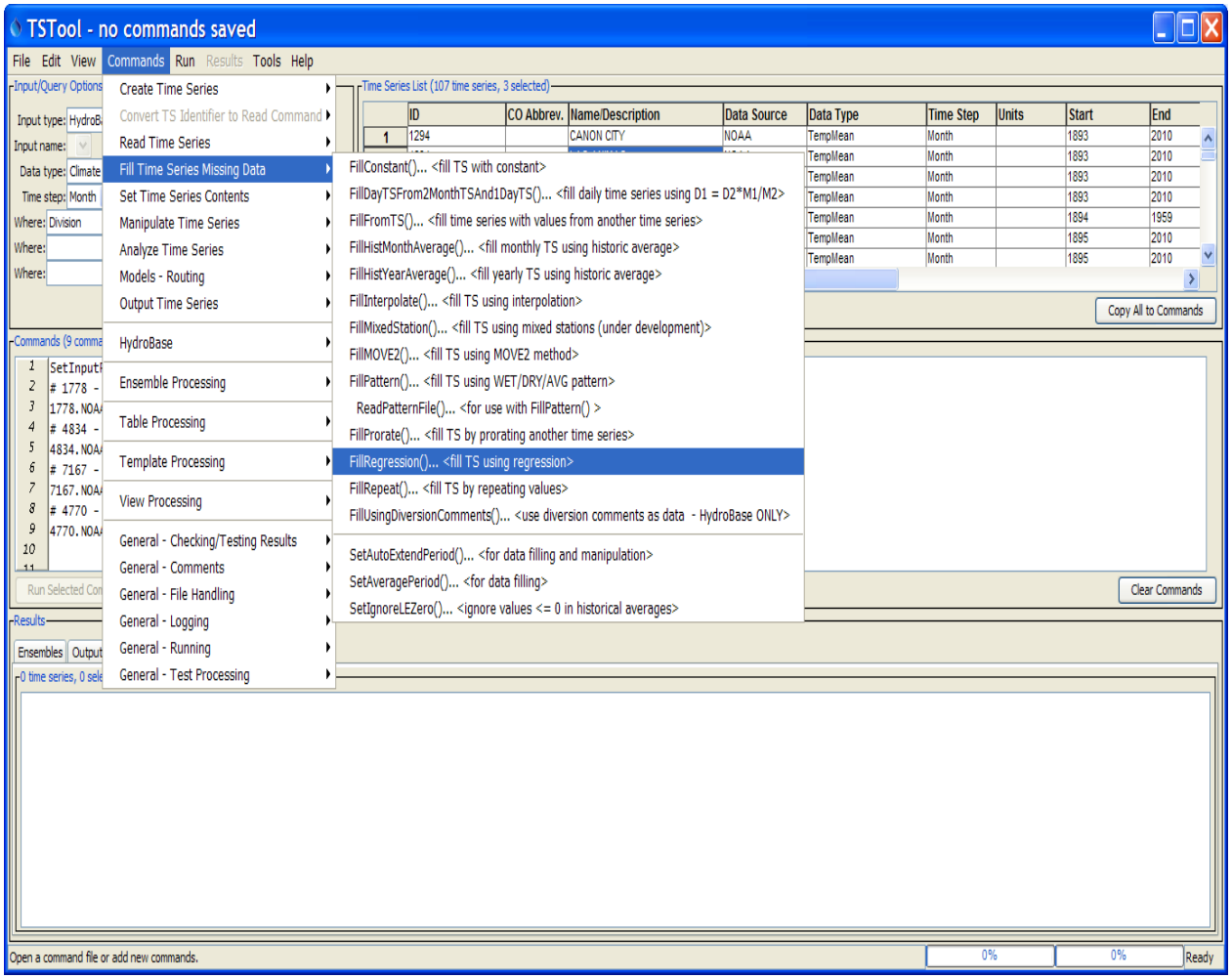
On this table the R^2 value is 0.9910. The closer the value is to 1.0, the better.



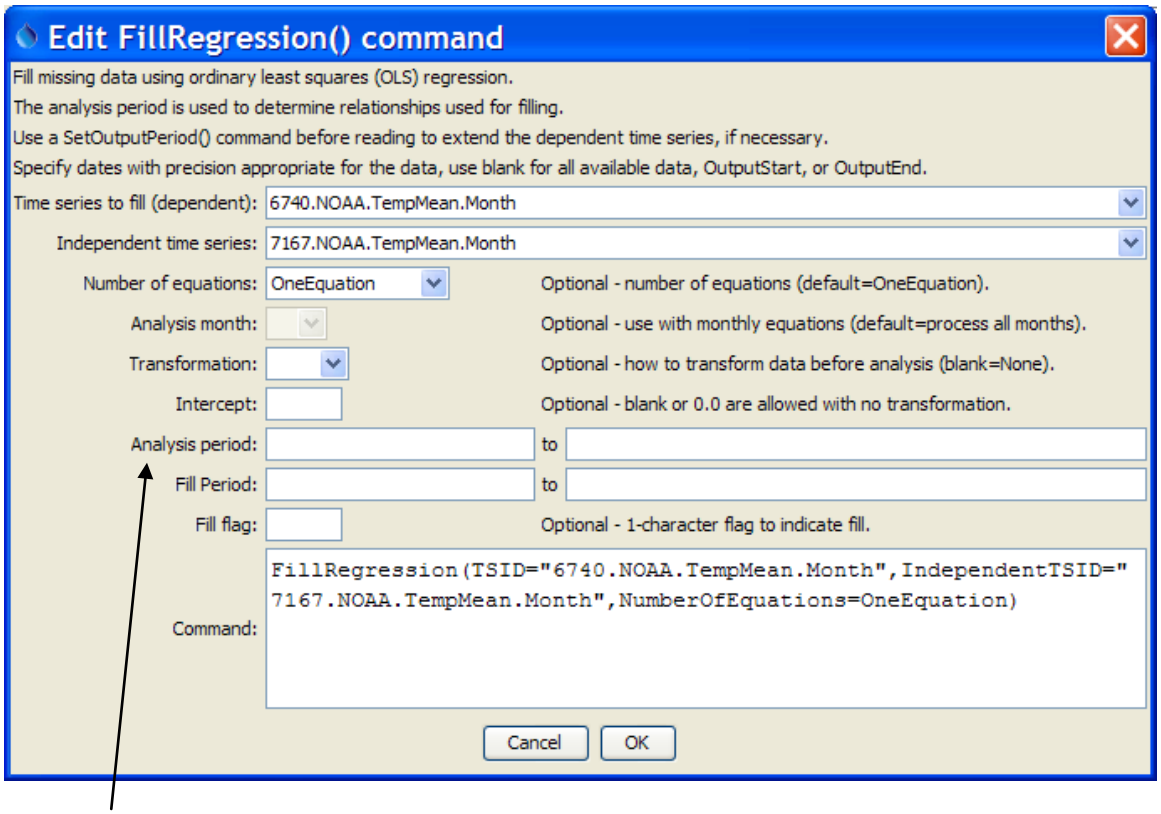
Repeat this analysis for the other 2 stations. For this analysis, it appears that Rocky Ford is the best climate station to use.

Return back to the main table and highlight the commands for the 2 stations that are not going to be used, you can either right click and cut them out or “comment” them out, so it could be shown what stations were originally reviewed but not used.)

Under Commands, highlight the Fill Time Series Missing Data, and then click on the FillRegression


TSTool - no commands saved
File Edit View Commands Run Results Tools Help
Create Time Series
Convert TS Identifier to Read Command
Read Time Series
Fill Time Series Missing Data
Set Time Series Contents
Manipulate Time Series
Analyze Time Series
Models - Routing
Output Time Series
HydroBase
Ensemble Processing
Table Processing
Template Processing
View Processing
General - Checking/Testing Results
General - Comments
General - File Handling
General - Logging
General - Running
General - Test Processing
FillConstant()... <fill TS with constant>
FillDayTSFrom2MonthTSAnd1DayTS()... <fill daily time series using D1 = D2*M1/M2>
FillFromTS()... <fill time series with values from another time series>
FillHistMonthAverage()... <fill monthly TS using historic average>
FillHistYearAverage()... <fill yearly TS using historic average>
FillInterpolate()... <fill TS using interpolation>
FillMixedStation()... <fill TS using mixed stations (under development)>
FillMOVE2()... <fill TS using MOVE2 method>
FillPattern()... <fill TS using WET/DRY/AVG pattern>
ReadPatternFile()... <for use with FillPattern() >
FillProrate()... <fill TS by prorating another time series>
FillRegression()... <fill TS using regression>
FillRepeat()... <fill TS by repeating values>
FillUsingDiversionComments()... <use diversion comments as data - HydroBase ONLY>
SetAutoExtendPeriod()... <for data filling and manipulation>
SetAveragePeriod()... <for data filling>
SetIgnoreLEZero()... <ignore values <= 0 in historical averages>
Time Series List (107 time series, 3 selected)
Copy All to Commands
Clear Commands
Open a command file or add new commands.
Ready

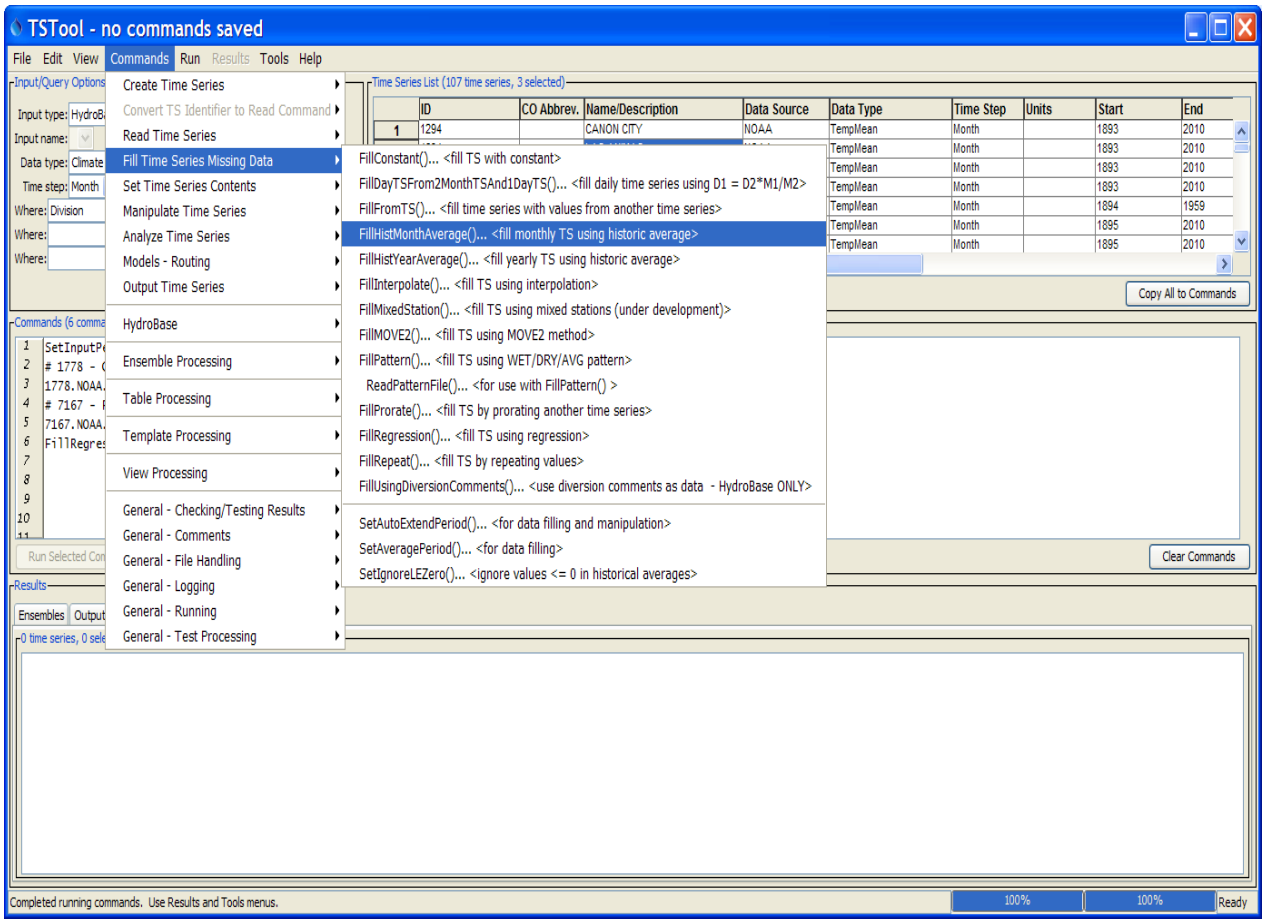
This table will open up and show the time series to be filled and the independent time series to be filled from. The drop down for the independent will show the other stations to be filled from. For the Number of equations, choose OneEquation.



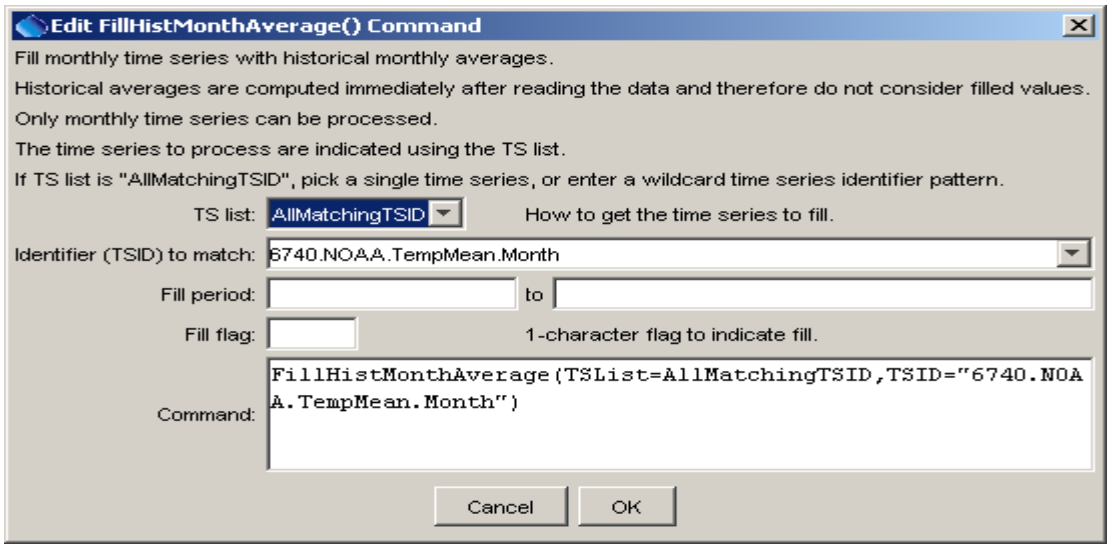
If the SetInputPeriod is not set up as the first command in the beginning, then the analysis period will need to be filled in for remaining tables.

Press OK and the following command above should be written in the command box of the main table.

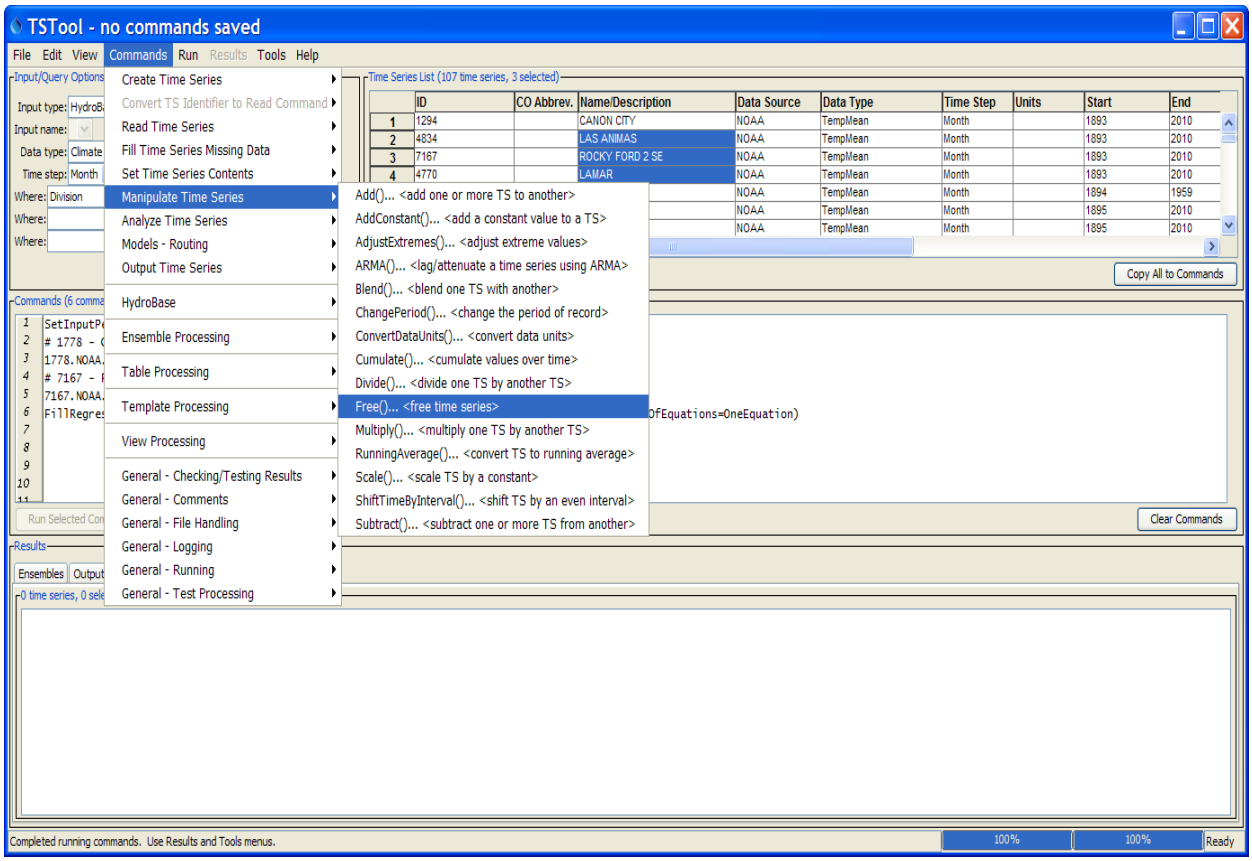
Now that you have your command files for a regression fill from the Rocky Ford Station, you can either fill any additional missing data with another climate station or write an additional command to fill any missing data with average historic monthly data.



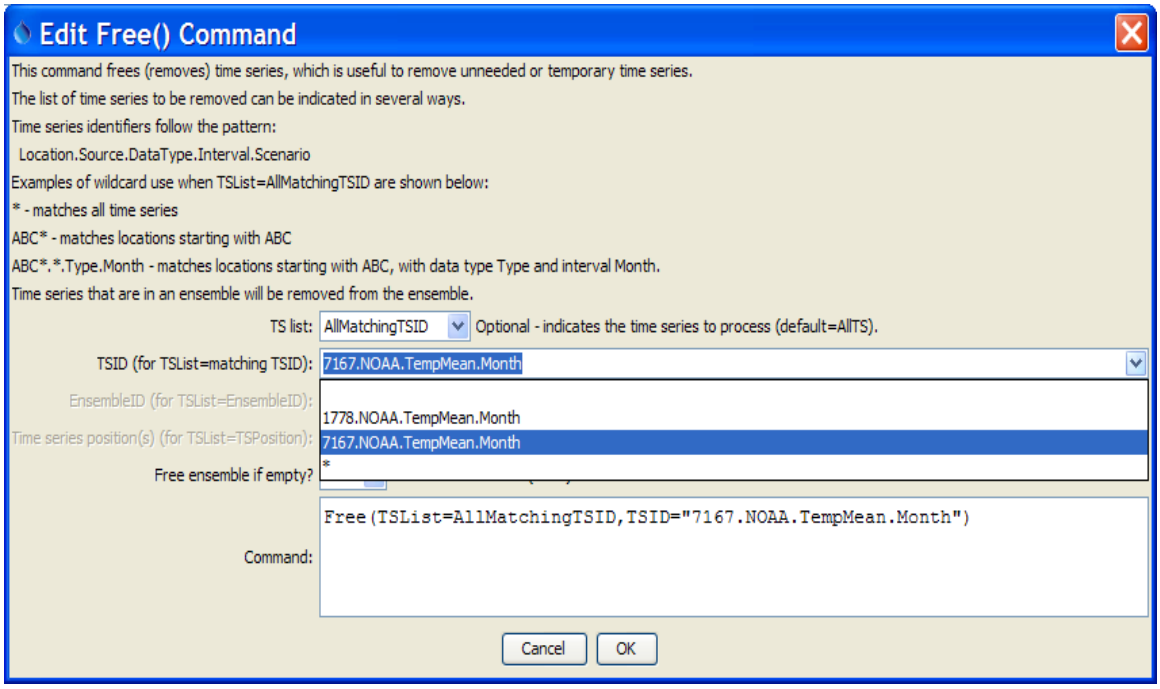
Under Commands, highlight the Fill Time Series and then click on FillHistMonthAverage. Set the TS list to AllMatchingTSID, then for the Identifier highlight the station to fill, which here is the Pueblo Memorial station. Press OK.



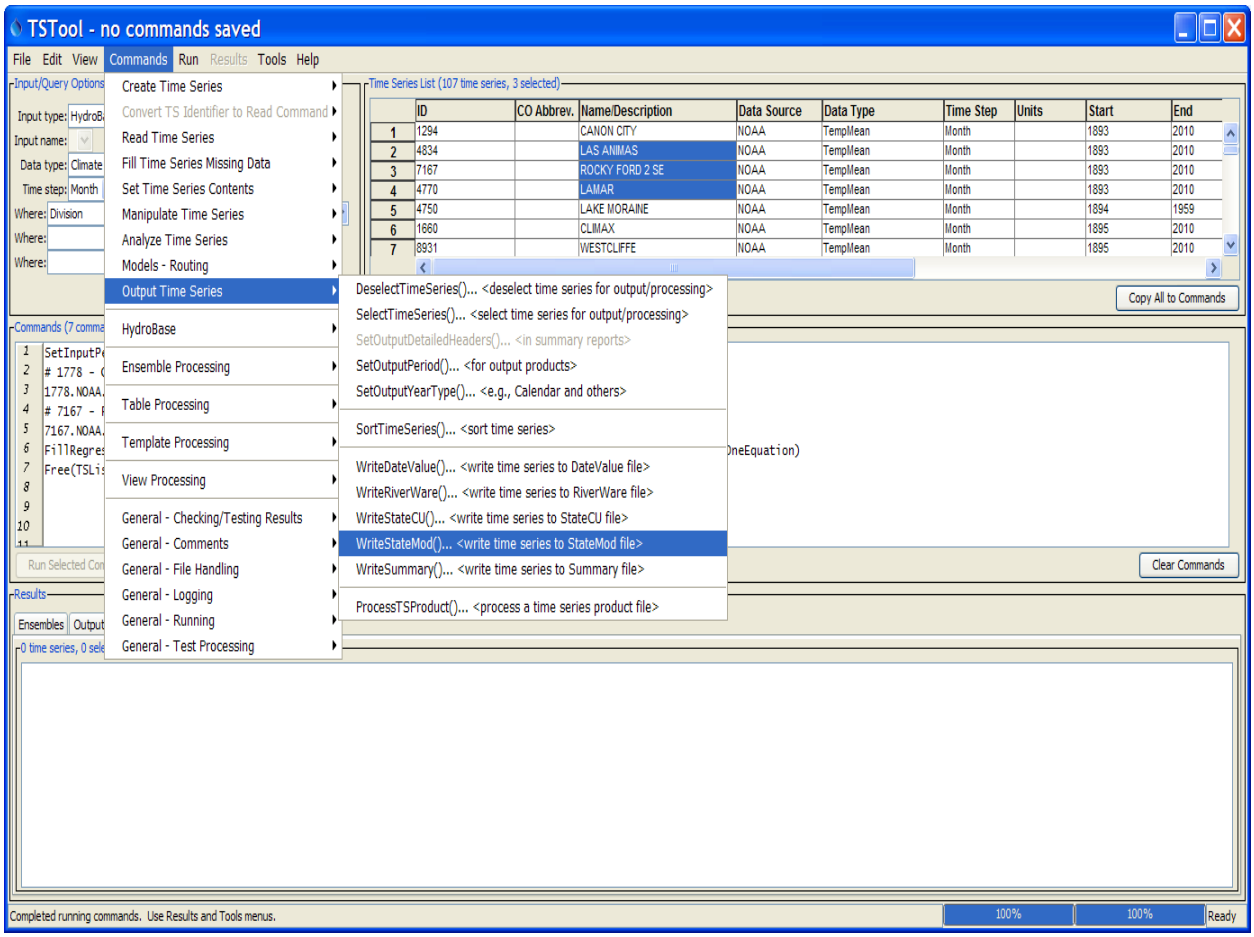
Back under Commands, highlight Manipulate Time Series and then click on Free.



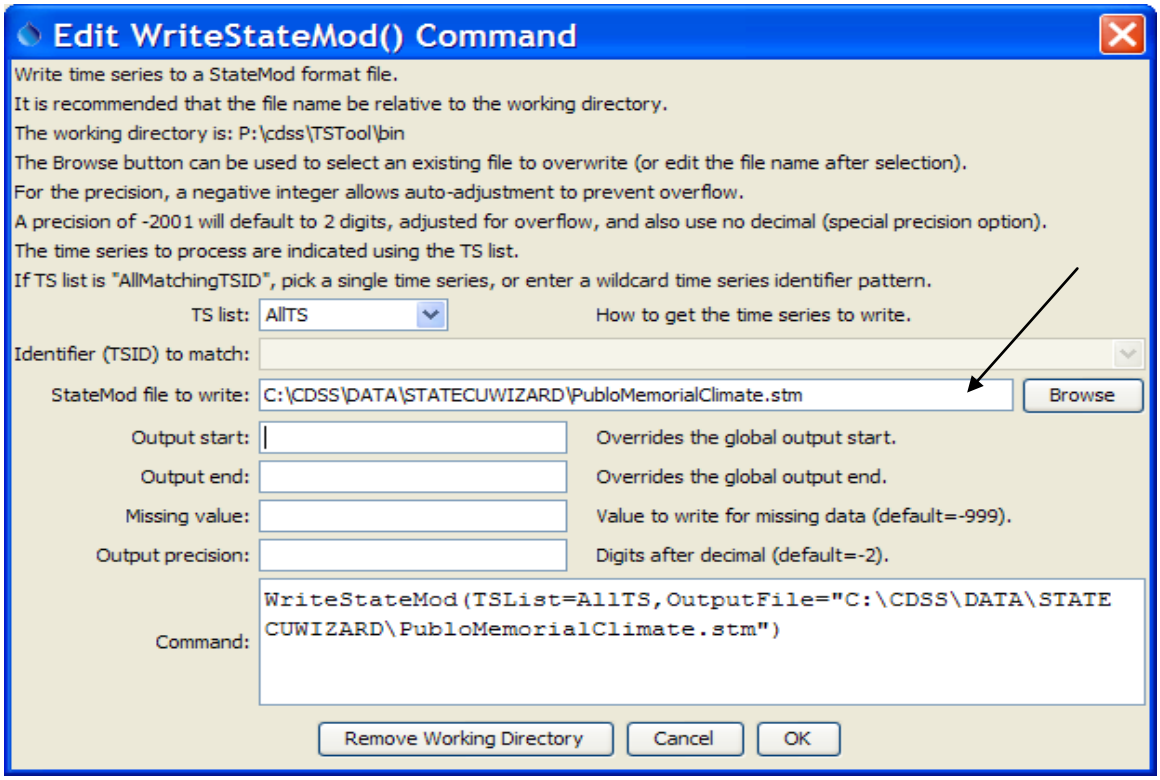
You now want to write a command to free the Rocky Ford station from further analysis. The Free() command frees (removes) the selected time series from memory. The time series will therefore not be available for use after that line in the command file. This command is useful for discarding temporary time series needed for data manipulation (e.g., so that they are not written in output and are not available for interactive plots). Freed time series are also removed from any ensembles that reference the time series.



To write the commands to a file, click on Commands, scroll down to Output Time Series, then click on WriteStateMod. There are also other types of ouput formats available that may suit your purposes.

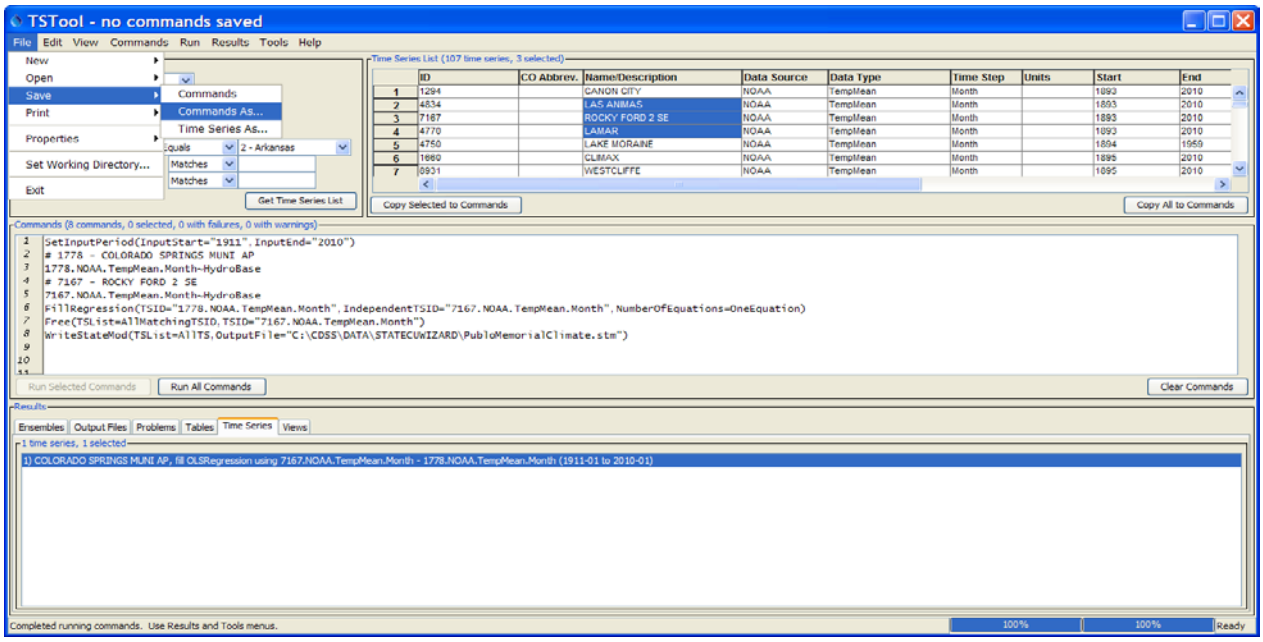


On this table you will write to the directory that you wish to file to go. The Browse button makes this easier.



Press OK and this command should have been added to your list.

Press Run All Commands. You should now have written a command file to your directory. To see the results, click on the Report Summary under the Results tab.
You may also want to save the command file for later use or modification in a Command File. Under file, click on save, then Commands As.



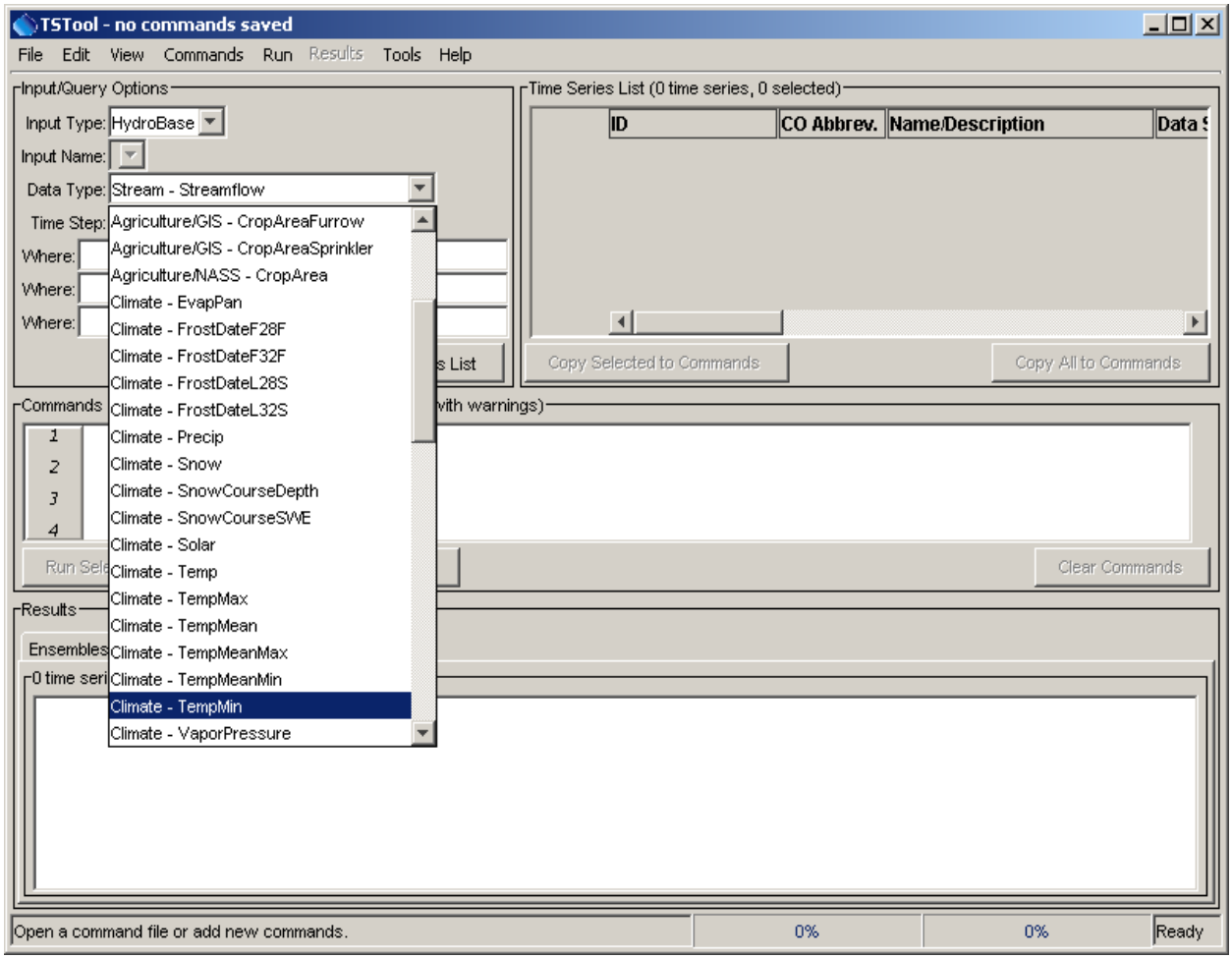
The data for precipitation can be filled the same way or averages for your station can be used. Your engineering judgment should determine which method is appropriate for your situation. Now that you know which climate station to work your regression from, many of the steps presented can be deleted. If you find a precipitation station that is closer and complete, use that station for the regression. Here again you can save your command files for future use or modification.

The commands are as follows:

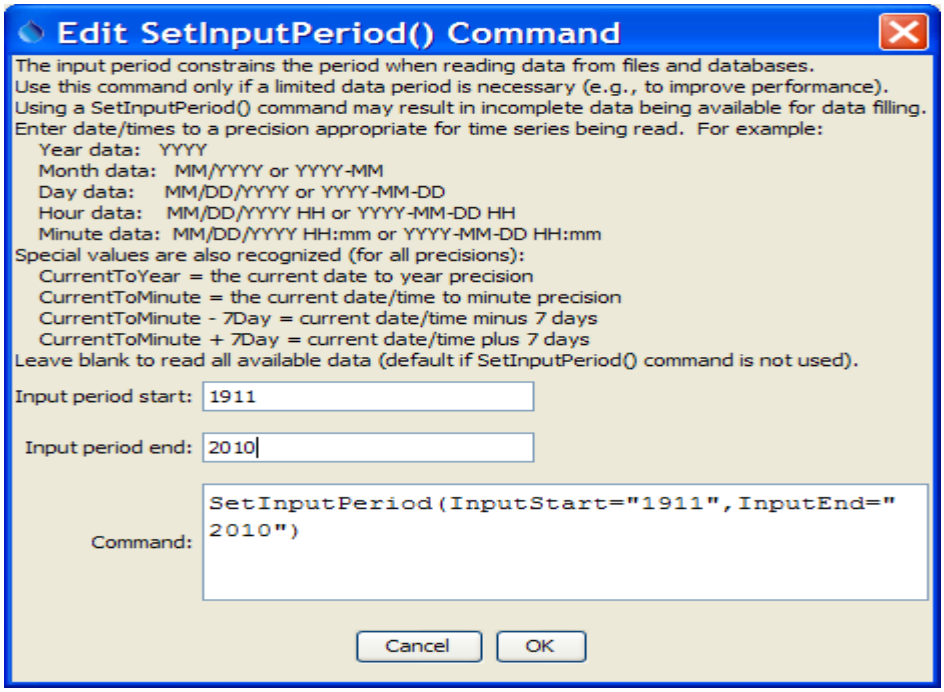
```
# SetInputPeriod(InputStart="1911",InputEnd="2008")
# # 6740 - PUEBLO MEMORIAL AP
# 6740.NOAA.Precip.Month~HydroBase
# # 7167 - ROCKY FORD 2 SE
# 7167.NOAA.Precip.Month~HydroBase
#FillRegression(TSID="6740.NOAA.Precip.Month",IndependentTSID="7167.NOAA.Precip.Month",NumberOfEquations=OneEquation)
# FillHistMonthAverage(TSList=AllMatchingTSID,TSID="6740.NOAA.Precip.Month")
# Free(TSList=AllMatchingTSID,TSID="7167.NOAA.Precip.Month")
#WriteStateMod(TSList=AllTS,OutputFile="C:\cdss\data\STATECUWIZARD\PuebloMemorialClimate\PuebloMem.ppt")
```

Frost Dates

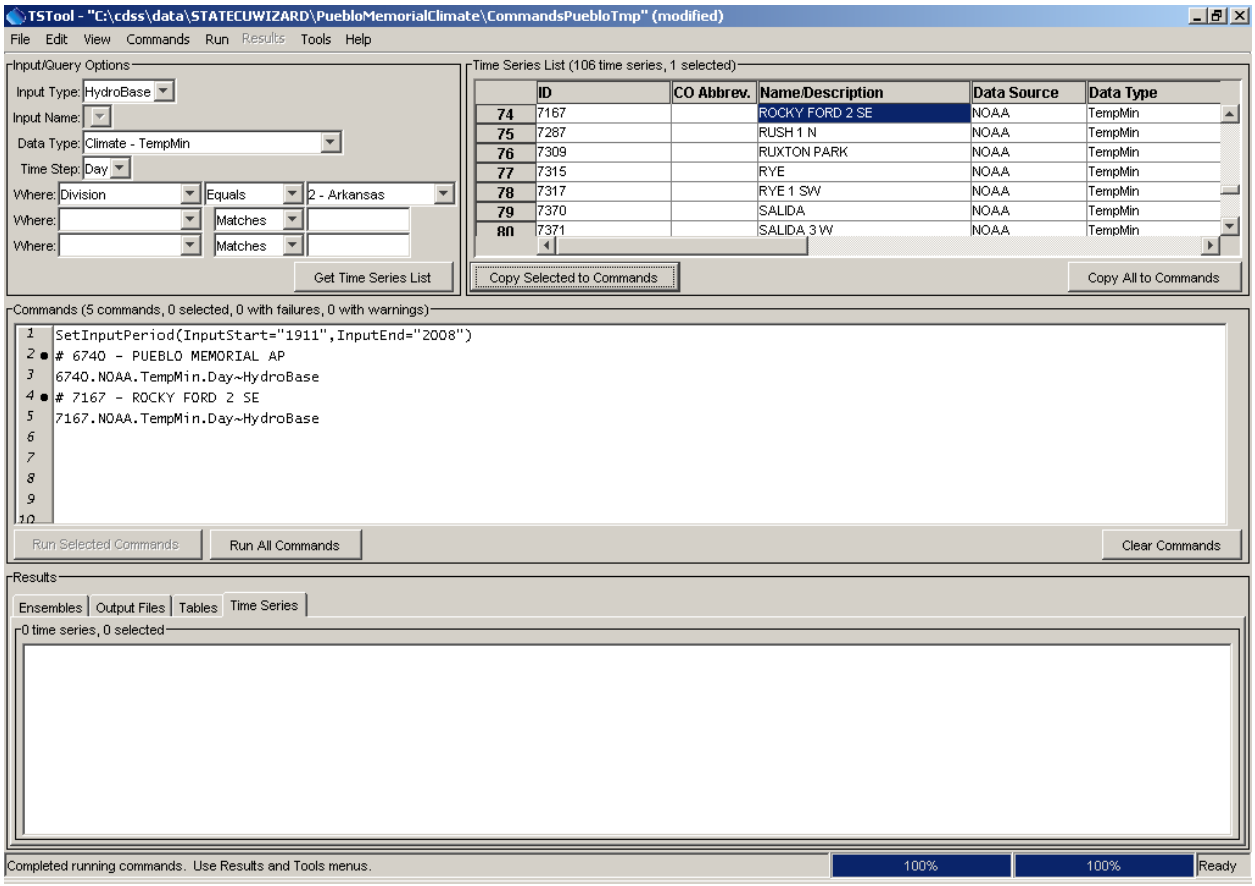
Determining Frost Dates is a little more complex. Here you will begin by using the TempMin.Day from the HydroBase drop down.



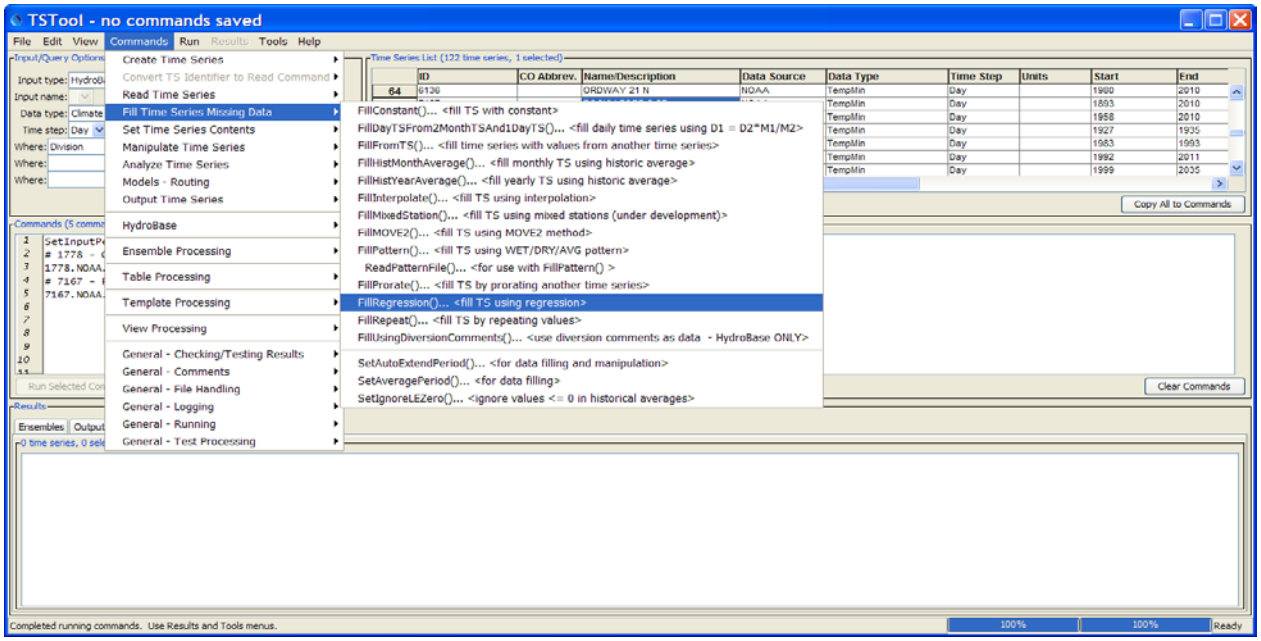
Once again, set your input period.



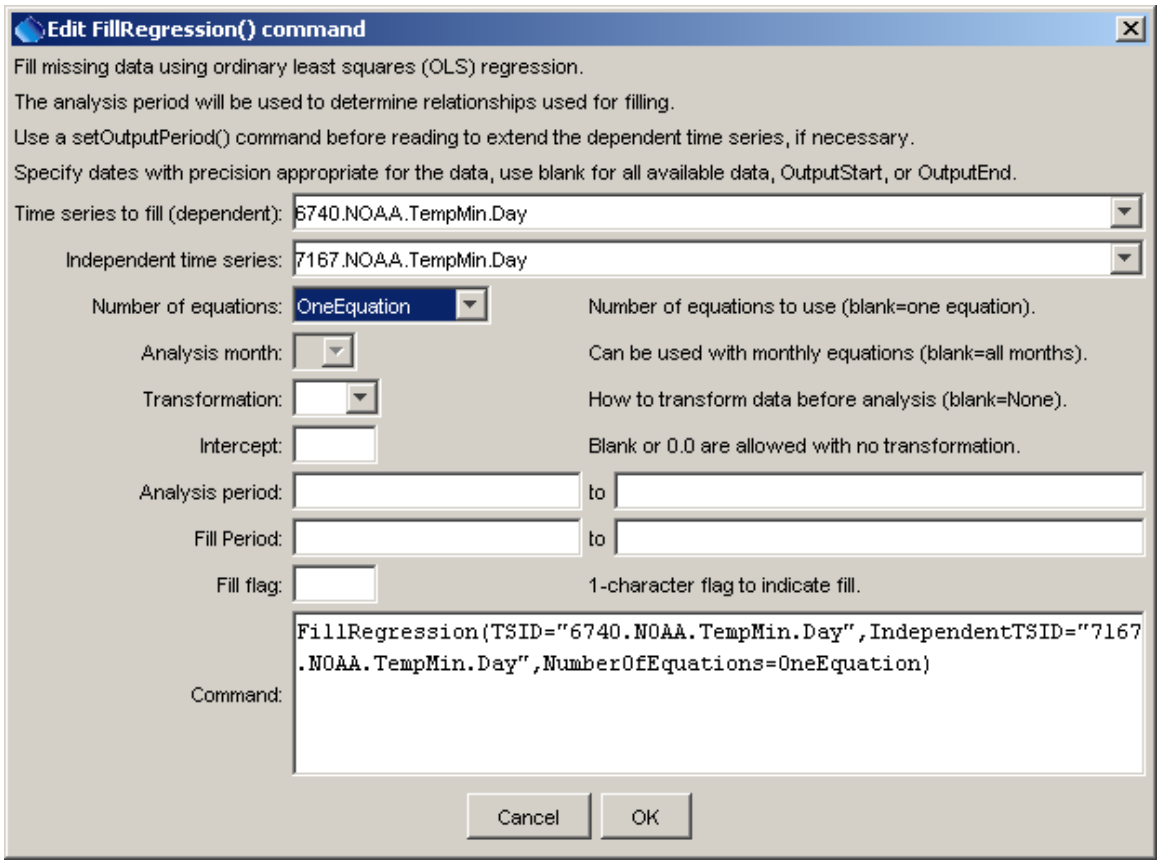
Under “Where” put in Division, then Arkansas and press the Get Time Series List. Copy down Pueblo Memorial and then Rocky Ford.



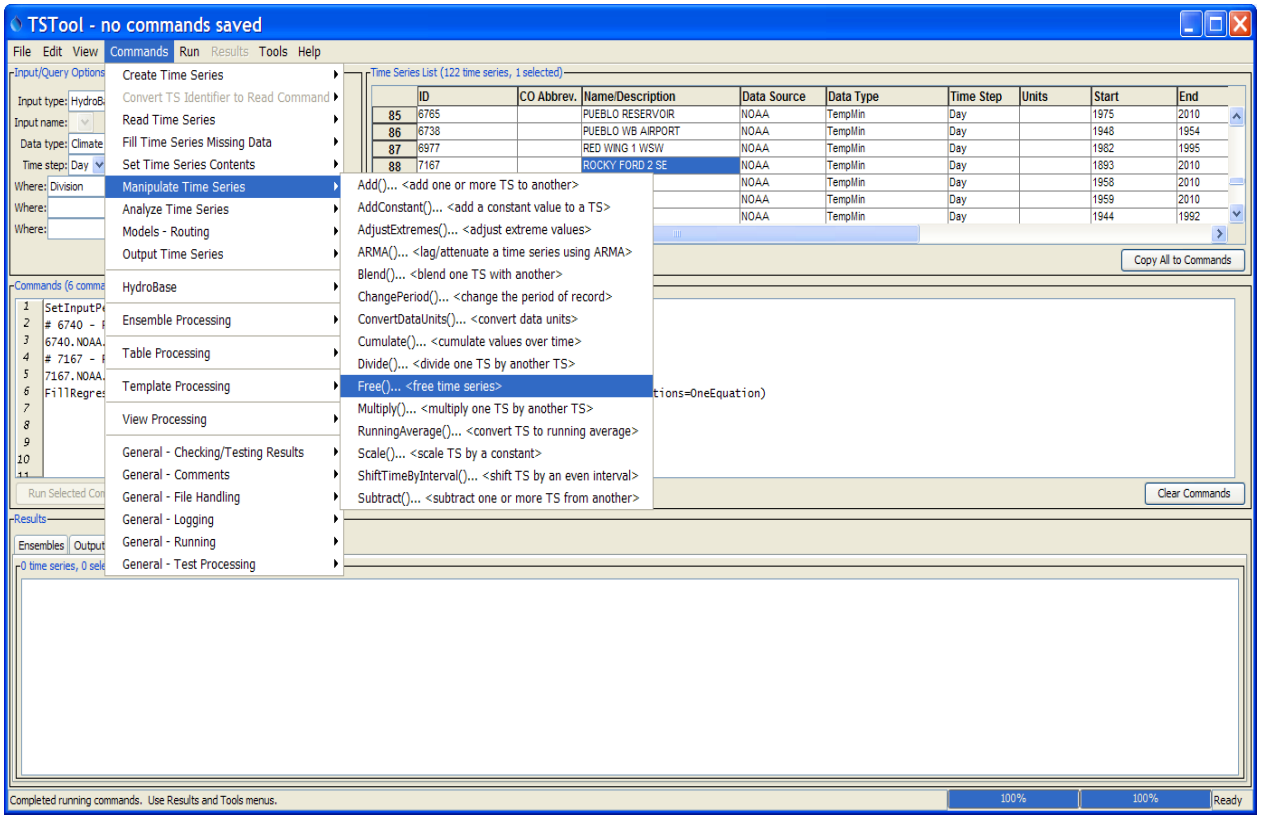
Under Commands pull down the FillRegression.

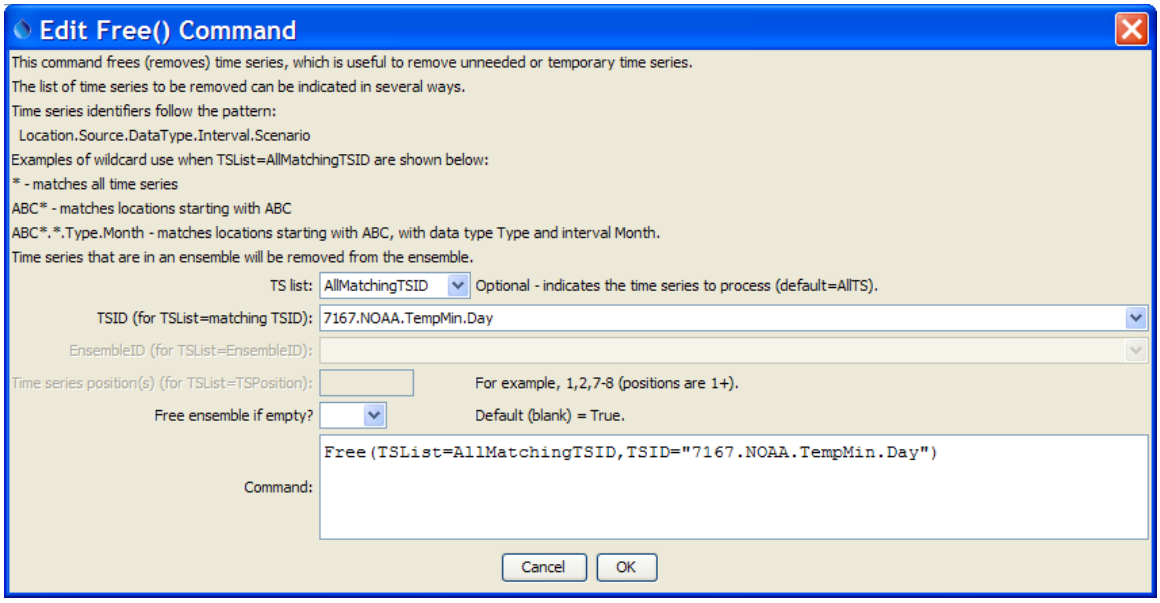


Fill this table in much the same way as was done for the mean temp.

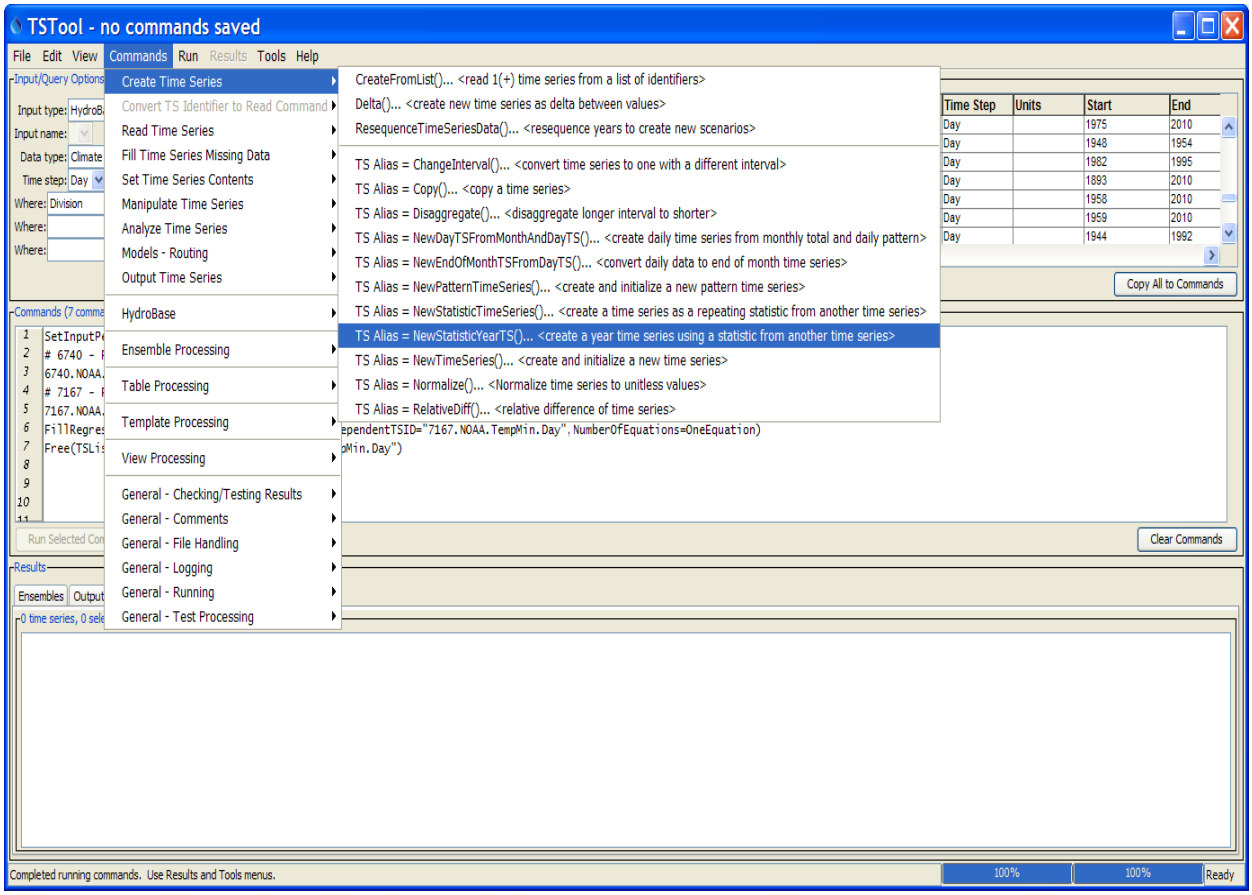


Free up the station that was filled from.



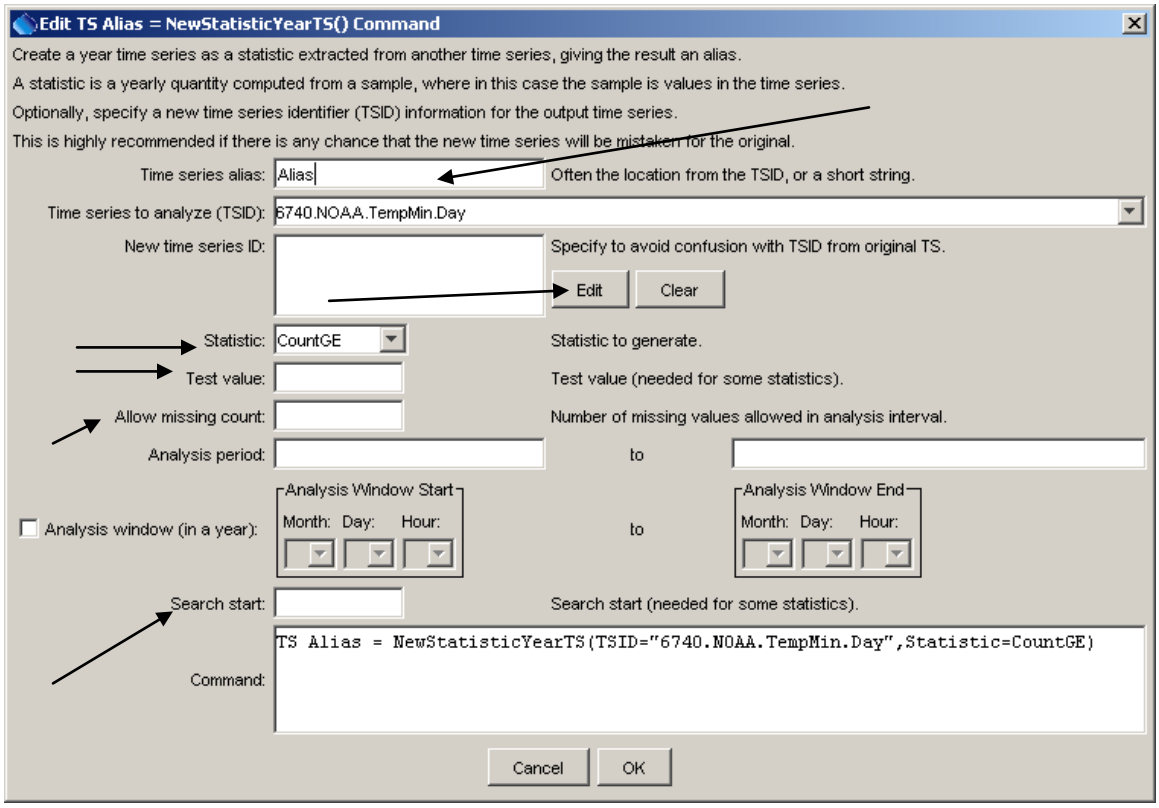


You will now be developing 4 individual long strings of commands The fist string will be for a spring frost date of 28º, then one for 32º, then for a fall frost date of 32º and one for 28º.



Click on the Commands tab, then the Create Time Series tab, and finally on the NewStatisticYearTS to begin. This is the table that will open up. The TS Alias = NewStatisticYearTS() command processes a time series and creates a new yearly time series, assigning the result an alias so that it can be more easily manipulated. This command operates on the raw time series data.

The areas that require information are marked by the arrows.



The alias of the new time series, which can be used instead of the TSID in other commands, must be specified.

The TSID is the time series identifier of the time series to analyze.

The NewTSID is the time series identifier to be assigned to the new time series, which is useful to avoid confusion with the original time series.

The statistics used for determining the frost dates are:

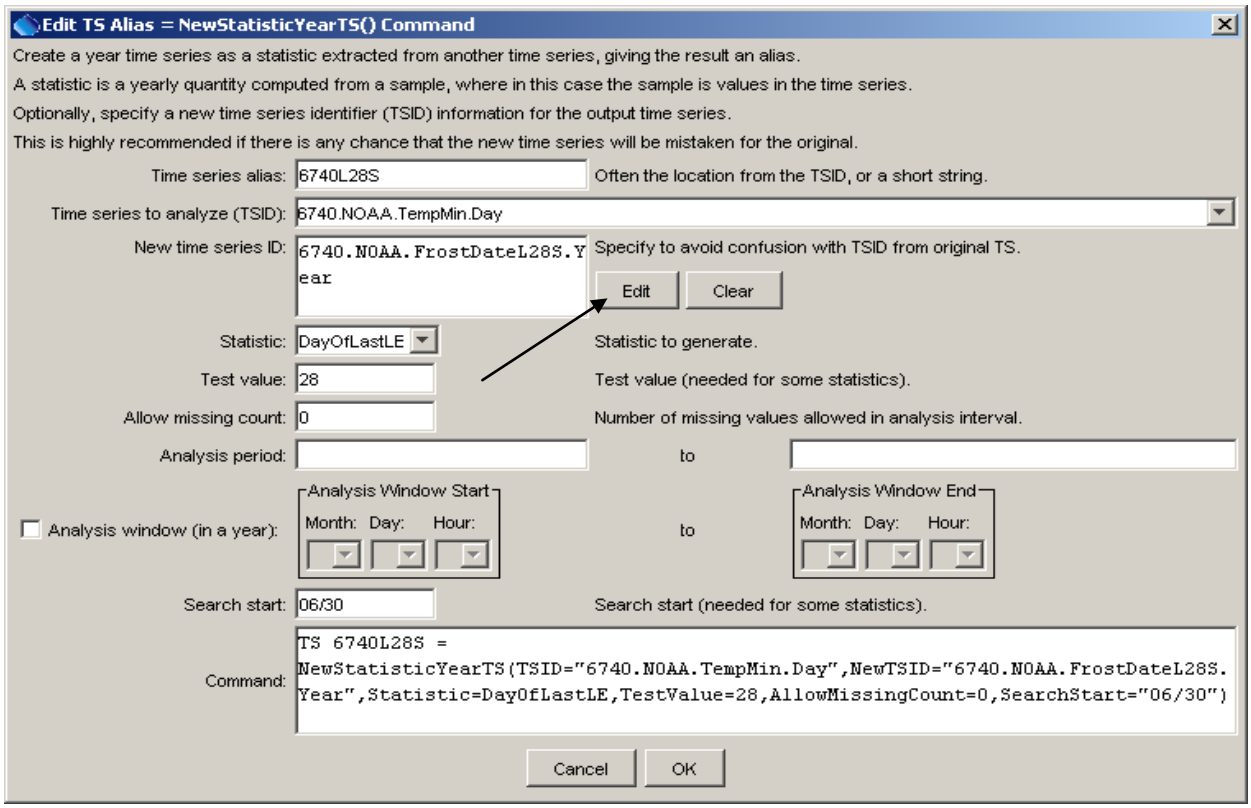
- DayOfFirstLE is the Julian day of the year (1 – 366) for the first data value for values < = TestValue.
- DayOfLastLE is the Julian day of the year (1 – 366) for the last data value for values < = TestValue.

The TestValue is a value used when analyzing the statistic.

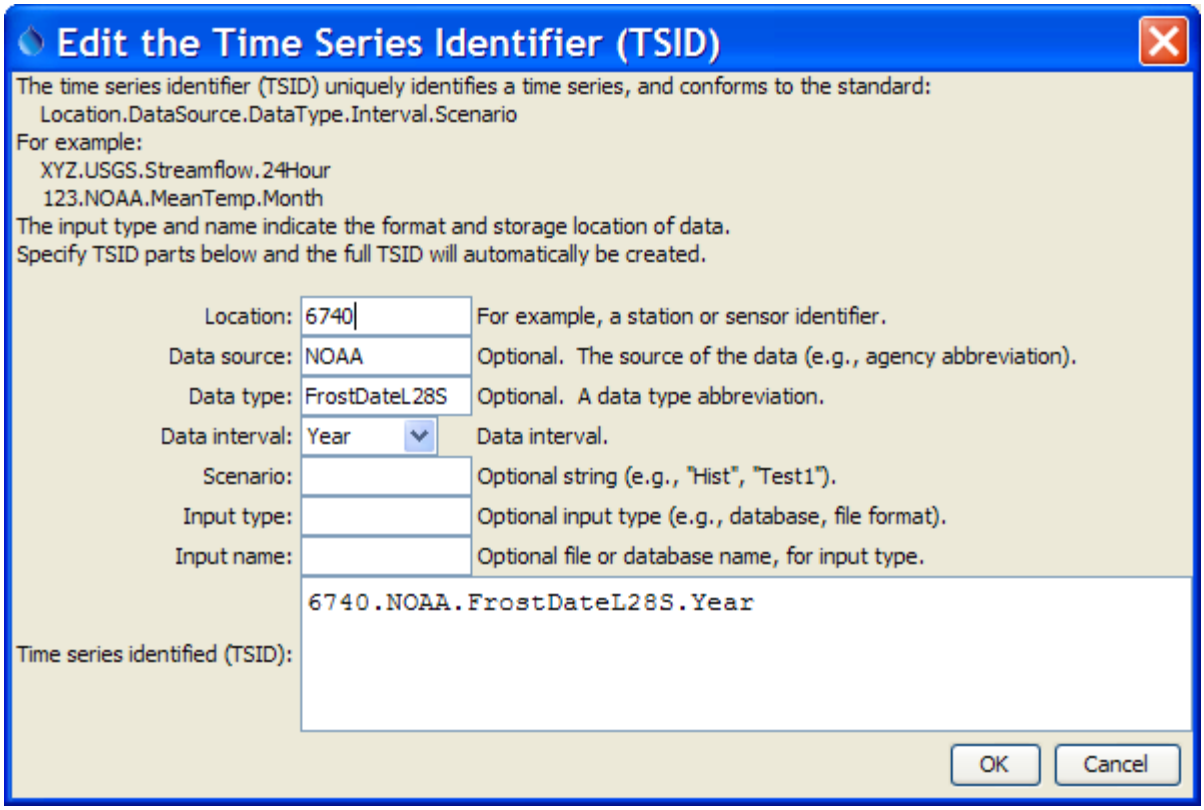
The Allow Missing Count is the number of missing values allowed in the source interval(s) in order to produce a result. This capability should be used with care because it may result in data that are not representative of actual conditions.

Search Start is the date/time to begin a data search when processing the statistic.

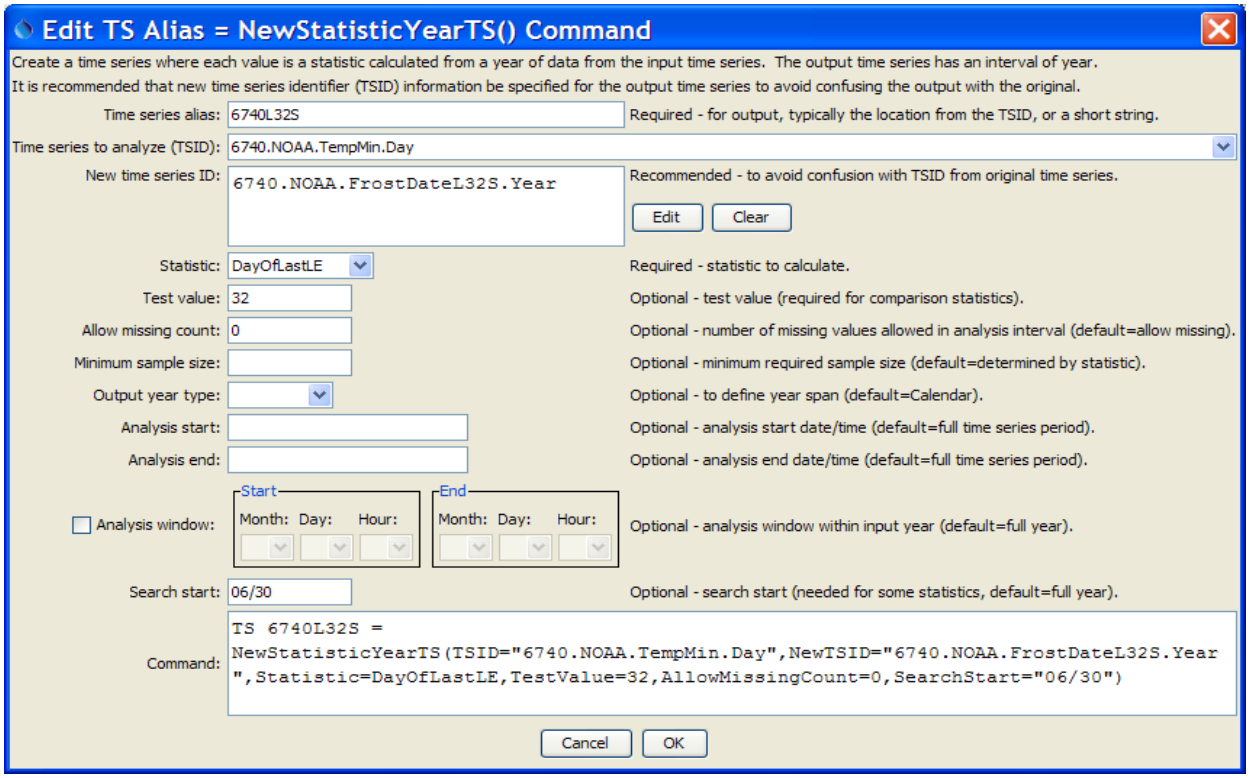
The next table shows how this table should be filled in. The alias provided is just an example.



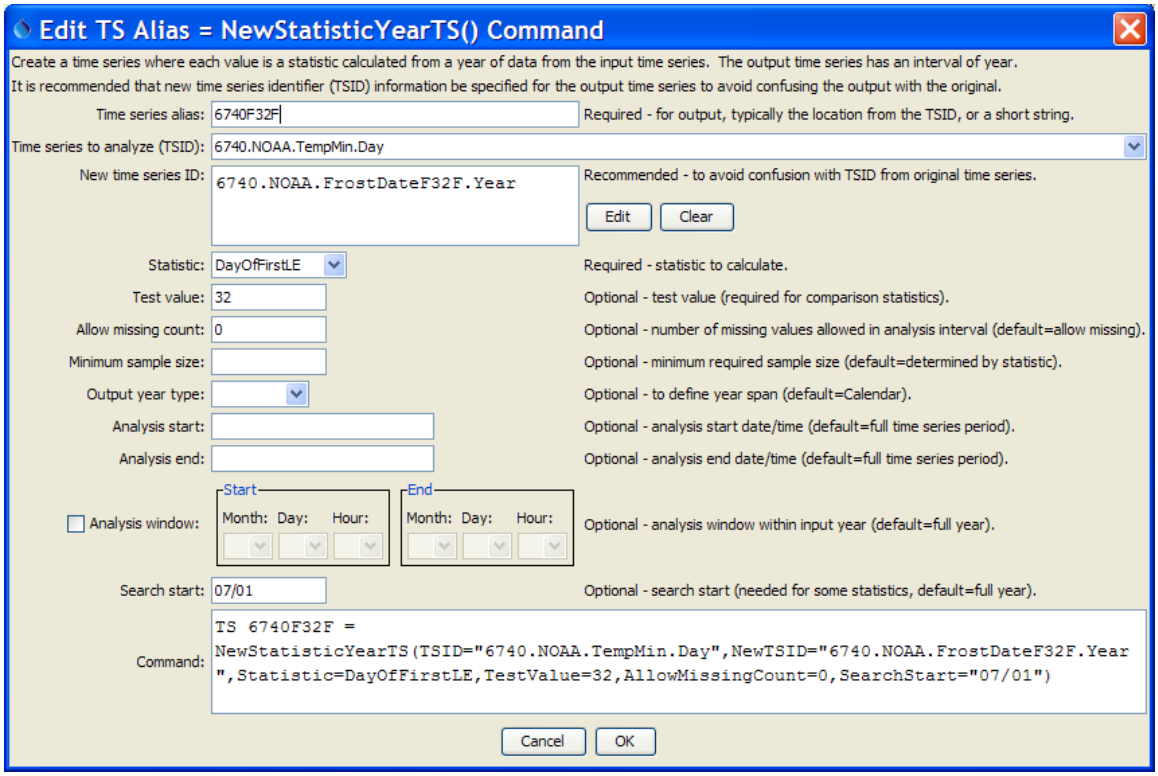
In pressing the Edit button, the following table will open and the data should be entered to describe the new time series.



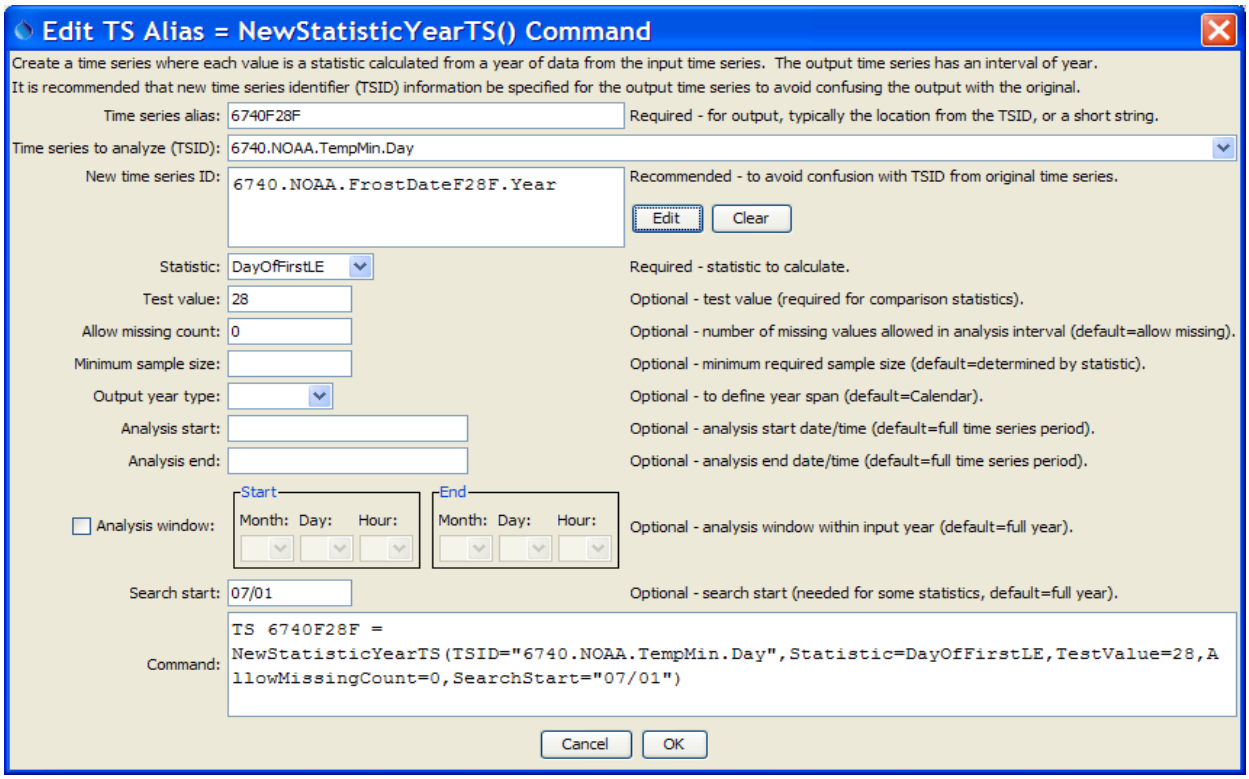
Run the same command again and adjust the alias and test value to 32.



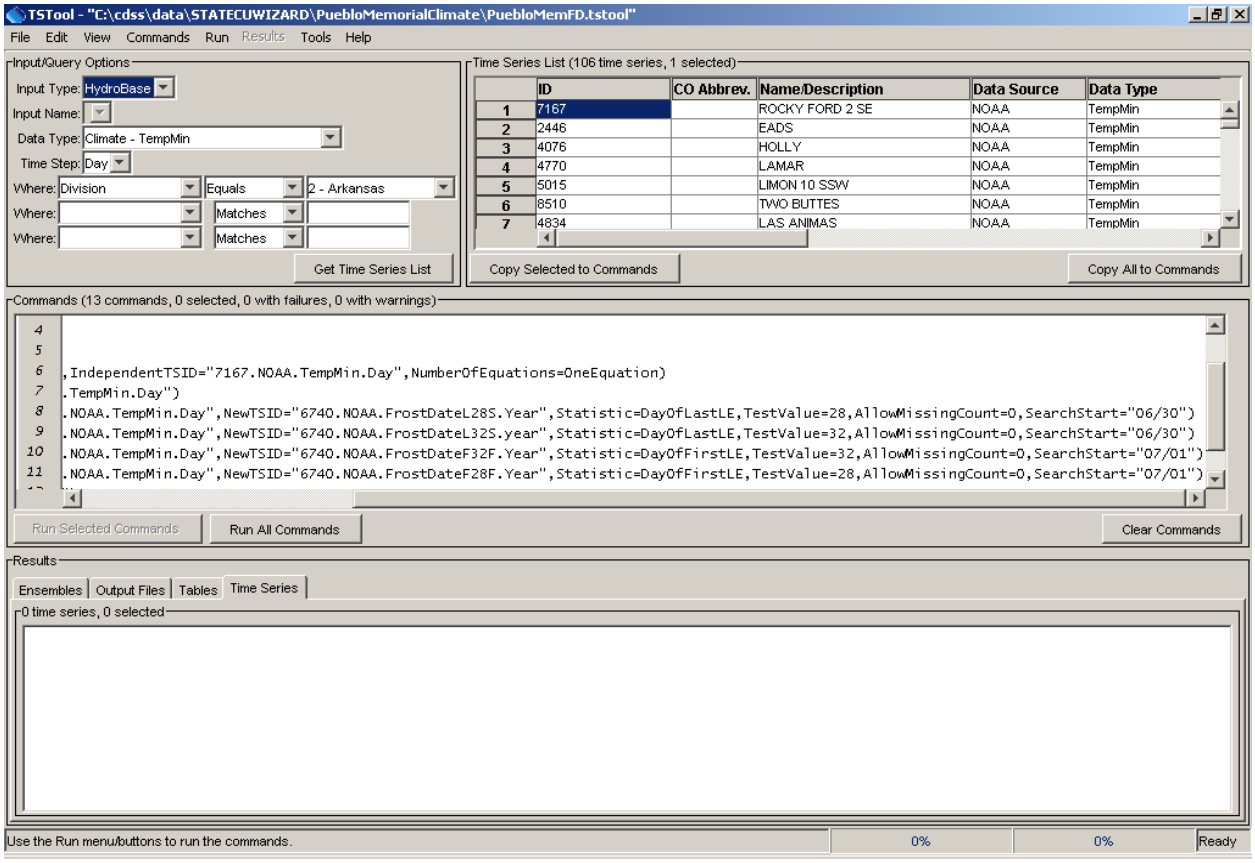
Run the same command for the fall frost date of 32. The statistic will need to be changed to DayOfFirstLE.



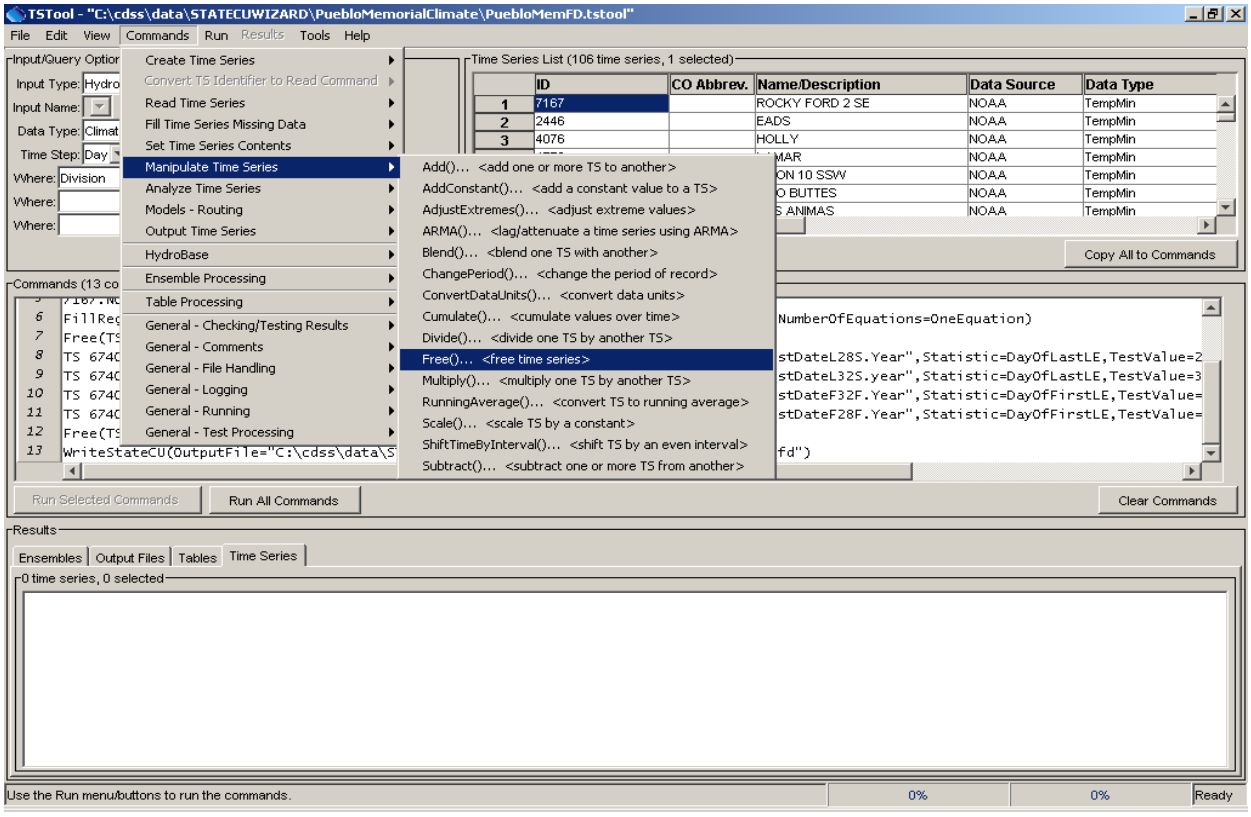
Run the same command for the fall frost date of 28.



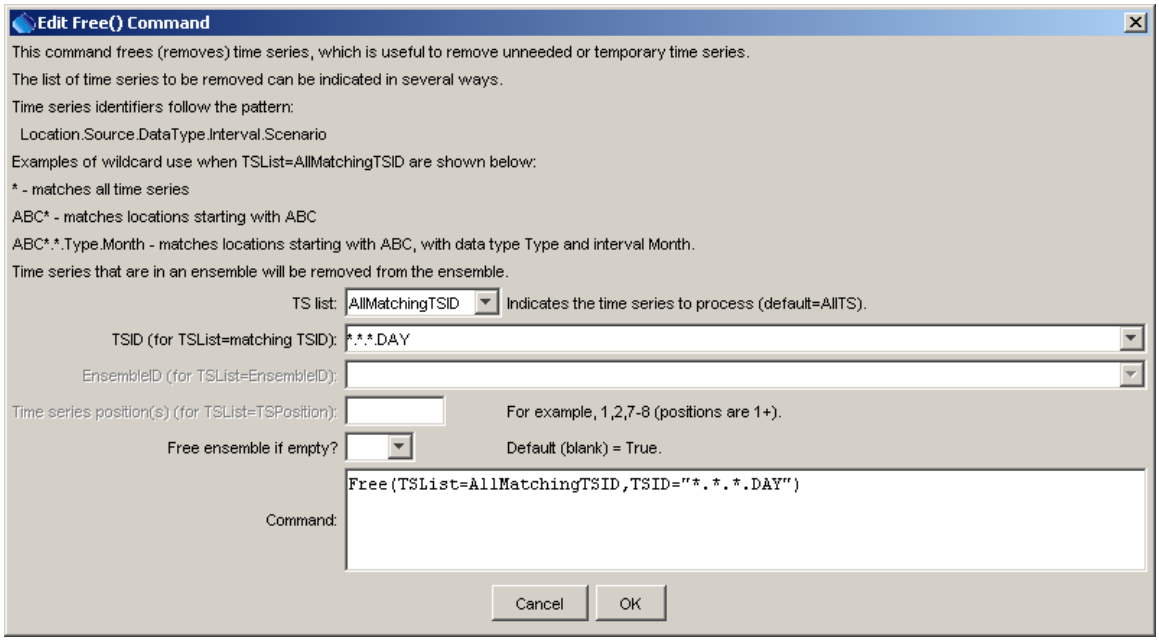
The table has been scrolled all the way to the right to see the meat of the command.



You will need to write a new Free command.

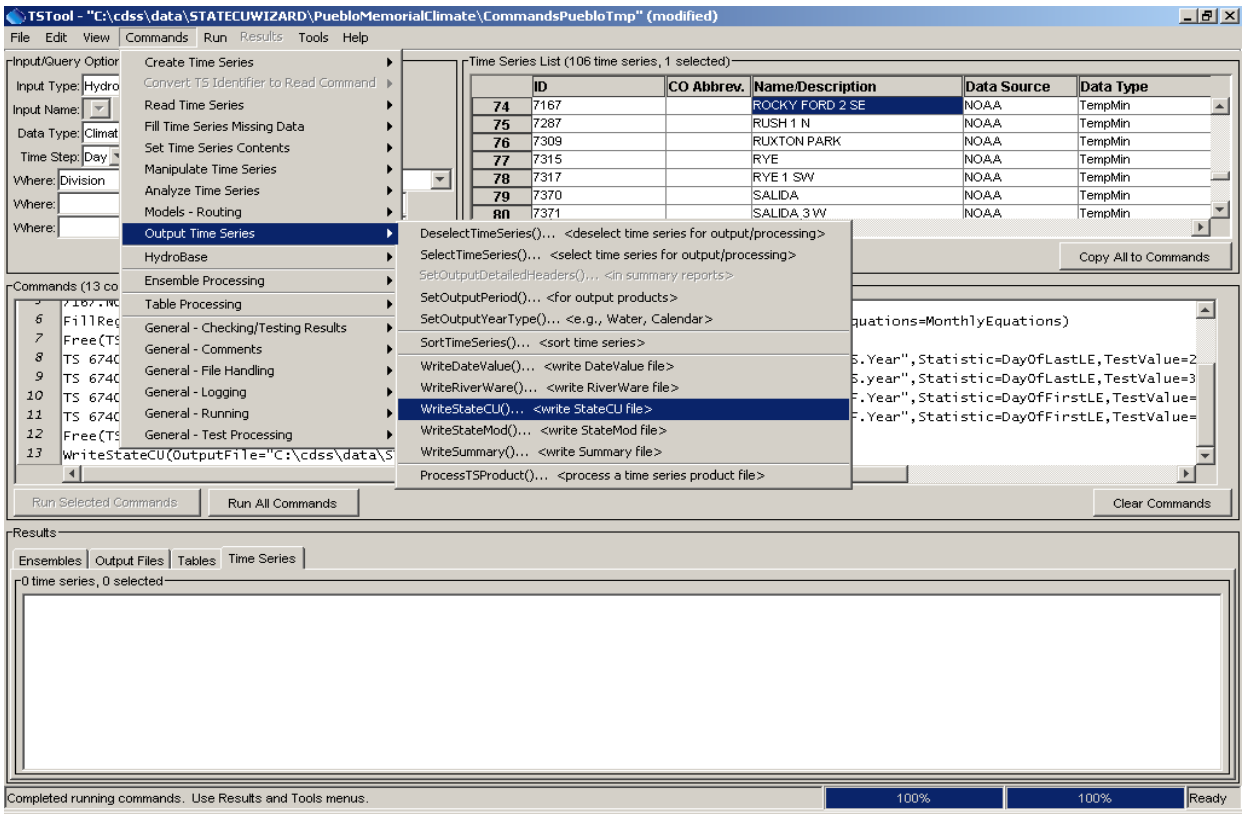


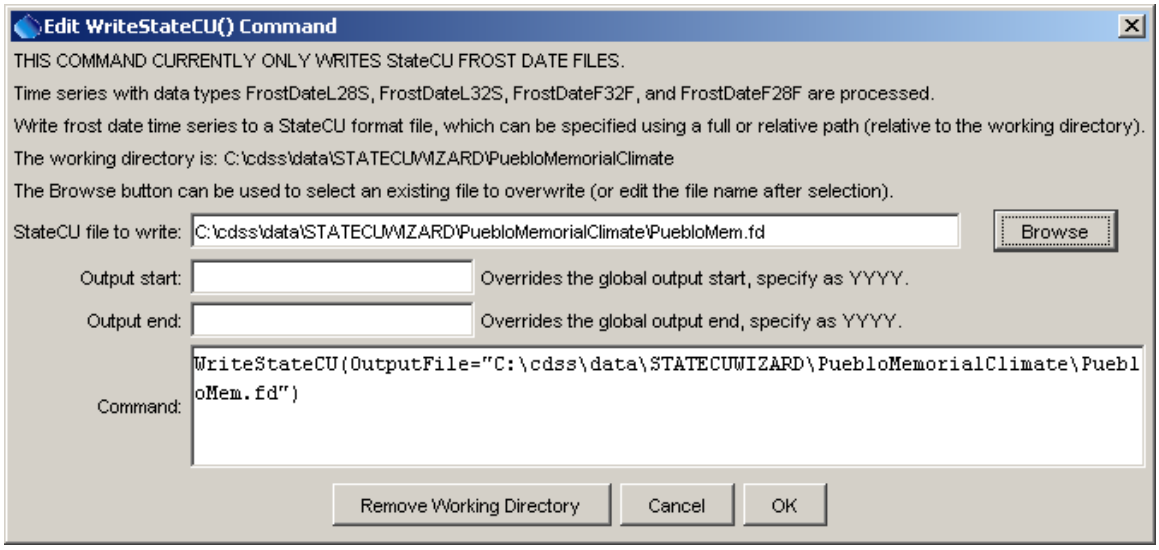
This is under the Commands drop down, highlight Manipulate Time Series and then click on the Free.



On this table the *.*.*.Day will need to be typed in.

You will now need to write your commands to a file.

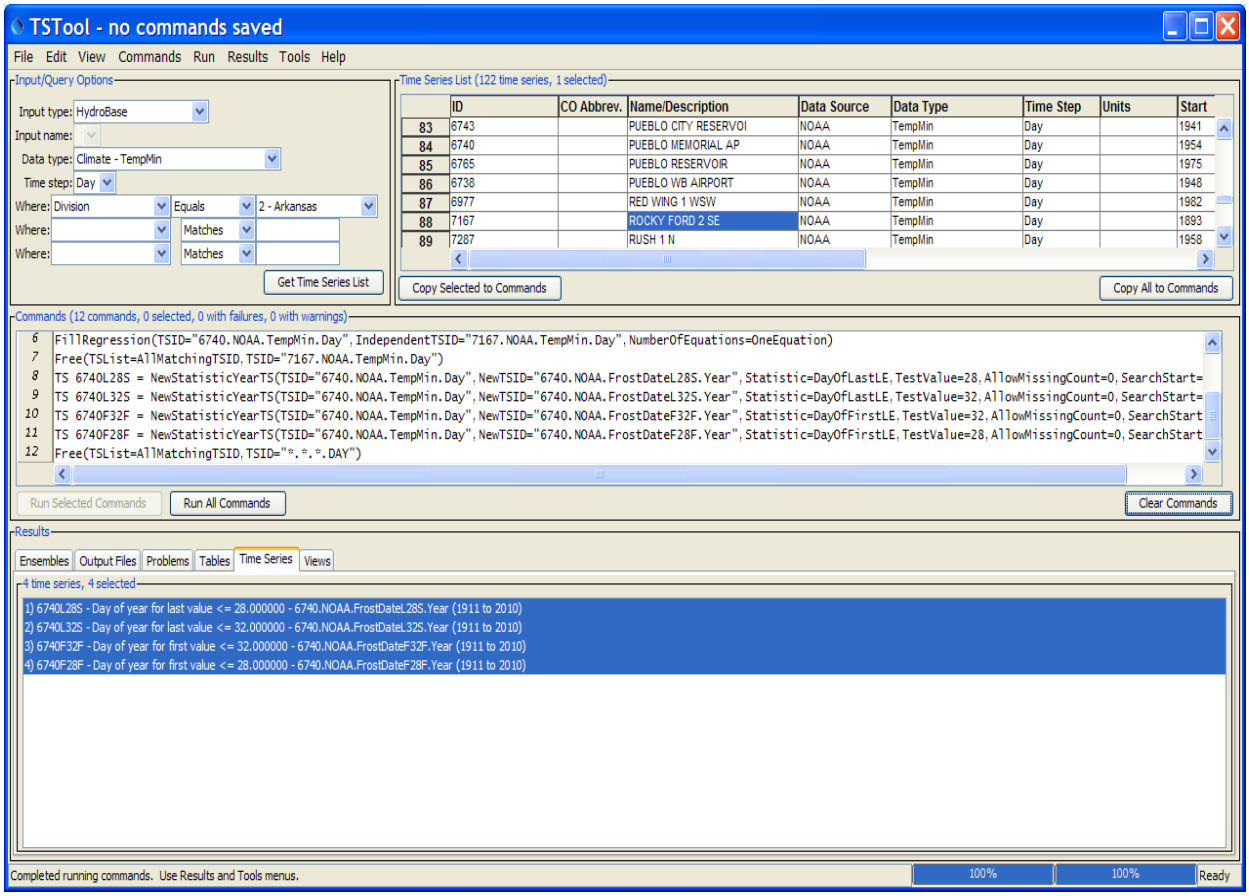




If you notice, the Frost Date commands must be written to a StateCU output file where temp and precip are written to StateMod files.

Press OK.

Run all commands.



Under the Results menu click on Table.

This table displays the frost dates as number of days. These values can be copied into excel to average the frost dates and fill the missing data with the averages.

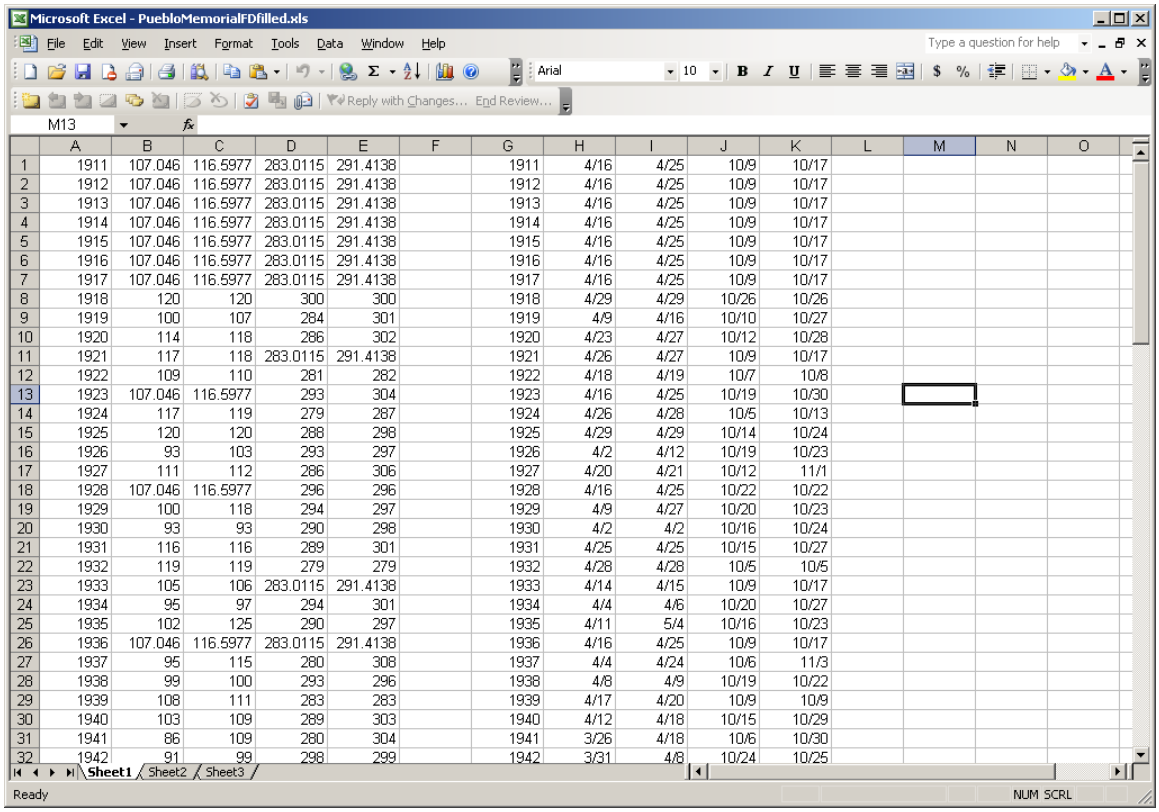
TSTool - Time Series - Table

DATE	6740L28S, FrostDateL28S, DayOfYear	6740L32S, FrostDateL32S, DayOfYear	6740F32F, FrostDateF32F, DayOfYear	6740F28F, FrostDateF28F, DayOfYear
1911				
1912				
1913				
1914				
1915				
1916				
1917				
1918	120.00	120.00	300.00	300.00
1919	100.00	107.00	284.00	301.00
1920	114.00	118.00	286.00	302.00
1921	117.00	118.00		
1922	109.00	110.00	281.00	282.00
1923			293.00	304.00
1924	117.00	119.00	279.00	287.00
1925	120.00	120.00	288.00	298.00
1926	93.00	103.00	293.00	297.00
1927	111.00	112.00	286.00	306.00
1928			296.00	296.00
1929	100.00	118.00	294.00	297.00
1930	93.00	93.00	290.00	298.00
1931	116.00	116.00	289.00	301.00
1932	119.00	119.00	279.00	279.00
1933	105.00	106.00		

Graph Summary Save Close

Currently-selected worksheet interval: Year

Excel can convert this format into the format associated with StateCU frost dates.



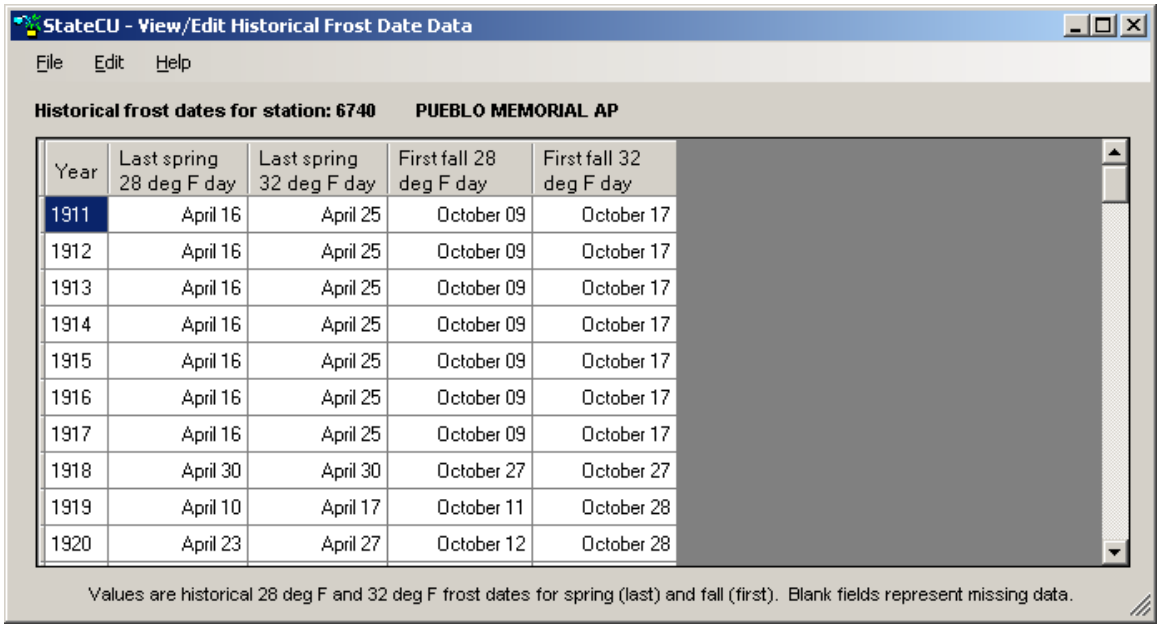
Microsoft Excel - PuebloMemorialFDfilled.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	1911	107.046	116.5977	283.0115	291.4138		1911	4/16	4/25	10/9	10/17				
2	1912	107.046	116.5977	283.0115	291.4138		1912	4/16	4/25	10/9	10/17				
3	1913	107.046	116.5977	283.0115	291.4138		1913	4/16	4/25	10/9	10/17				
4	1914	107.046	116.5977	283.0115	291.4138		1914	4/16	4/25	10/9	10/17				
5	1915	107.046	116.5977	283.0115	291.4138		1915	4/16	4/25	10/9	10/17				
6	1916	107.046	116.5977	283.0115	291.4138		1916	4/16	4/25	10/9	10/17				
7	1917	107.046	116.5977	283.0115	291.4138		1917	4/16	4/25	10/9	10/17				
8	1918	120	120	300	300		1918	4/29	4/29	10/26	10/26				
9	1919	100	107	284	301		1919	4/9	4/16	10/10	10/27				
10	1920	114	118	286	302		1920	4/23	4/27	10/12	10/28				
11	1921	117	118	283.0115	291.4138		1921	4/26	4/27	10/9	10/17				
12	1922	109	110	281	282		1922	4/18	4/19	10/7	10/8				
13	1923	107.046	116.5977	293	304		1923	4/16	4/25	10/19	10/30				
14	1924	117	119	279	287		1924	4/26	4/28	10/5	10/13				
15	1925	120	120	288	298		1925	4/29	4/29	10/14	10/24				
16	1926	93	103	293	297		1926	4/2	4/12	10/19	10/23				
17	1927	111	112	286	306		1927	4/20	4/21	10/12	11/1				
18	1928	107.046	116.5977	296	296		1928	4/16	4/25	10/22	10/22				
19	1929	100	118	294	297		1929	4/9	4/27	10/20	10/23				
20	1930	93	93	290	298		1930	4/2	4/2	10/16	10/24				
21	1931	116	116	289	301		1931	4/25	4/25	10/15	10/27				
22	1932	119	119	279	279		1932	4/28	4/28	10/5	10/5				
23	1933	105	106	283.0115	291.4138		1933	4/14	4/15	10/9	10/17				
24	1934	95	97	294	301		1934	4/4	4/6	10/20	10/27				
25	1935	102	125	290	297		1935	4/11	5/4	10/16	10/23				
26	1936	107.046	116.5977	283.0115	291.4138		1936	4/16	4/25	10/9	10/17				
27	1937	95	115	280	308		1937	4/4	4/24	10/6	11/3				
28	1938	99	100	293	296		1938	4/8	4/9	10/19	10/22				
29	1939	108	111	283	283		1939	4/17	4/20	10/9	10/9				
30	1940	103	109	289	303		1940	4/12	4/18	10/15	10/29				
31	1941	86	109	280	304		1941	3/26	4/18	10/6	10/30				
32	1942	91	99	298	299		1942	3/31	4/8	10/24	10/25				

Sheet1 Sheet2 Sheet3

Ready NUM SCRL

Cut and past into StateCU frost date table and the table will automatically convert dates from 04/16 to April 16.



StateCU - View/Edit Historical Frost Date Data

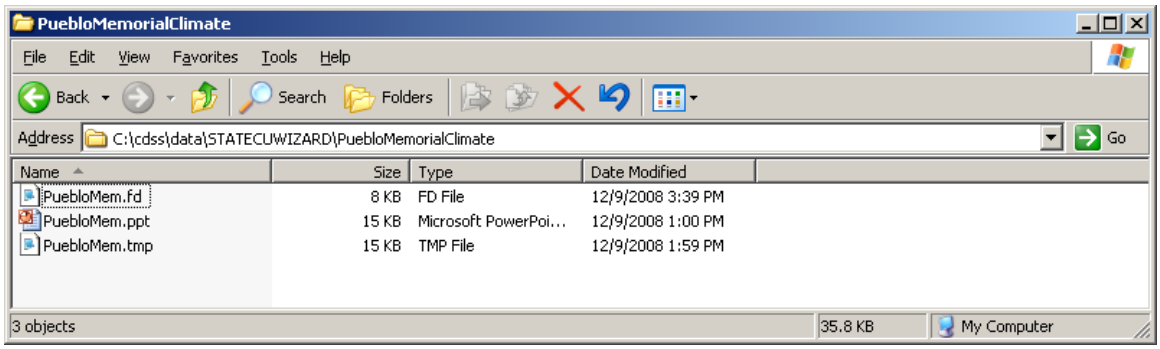
File Edit Help

Historical frost dates for station: 6740 PUEBLO MEMORIAL AP

Year	Last spring 28 deg F day	Last spring 32 deg F day	First fall 28 deg F day	First fall 32 deg F day
1911	April 16	April 25	October 09	October 17
1912	April 16	April 25	October 09	October 17
1913	April 16	April 25	October 09	October 17
1914	April 16	April 25	October 09	October 17
1915	April 16	April 25	October 09	October 17
1916	April 16	April 25	October 09	October 17
1917	April 16	April 25	October 09	October 17
1918	April 30	April 30	October 27	October 27
1919	April 10	April 17	October 11	October 28
1920	April 23	April 27	October 12	October 28

Values are historical 28 deg F and 32 deg F frost dates for spring (last) and fall (first). Blank fields represent missing data.

Once you create extended climate files, it's a good idea to save them to a directory to be used at a later date.



These files can be copied into your Scenario analysis in StateCU. You will need to direct StateCU in the Input File List to your newly created frost date data.