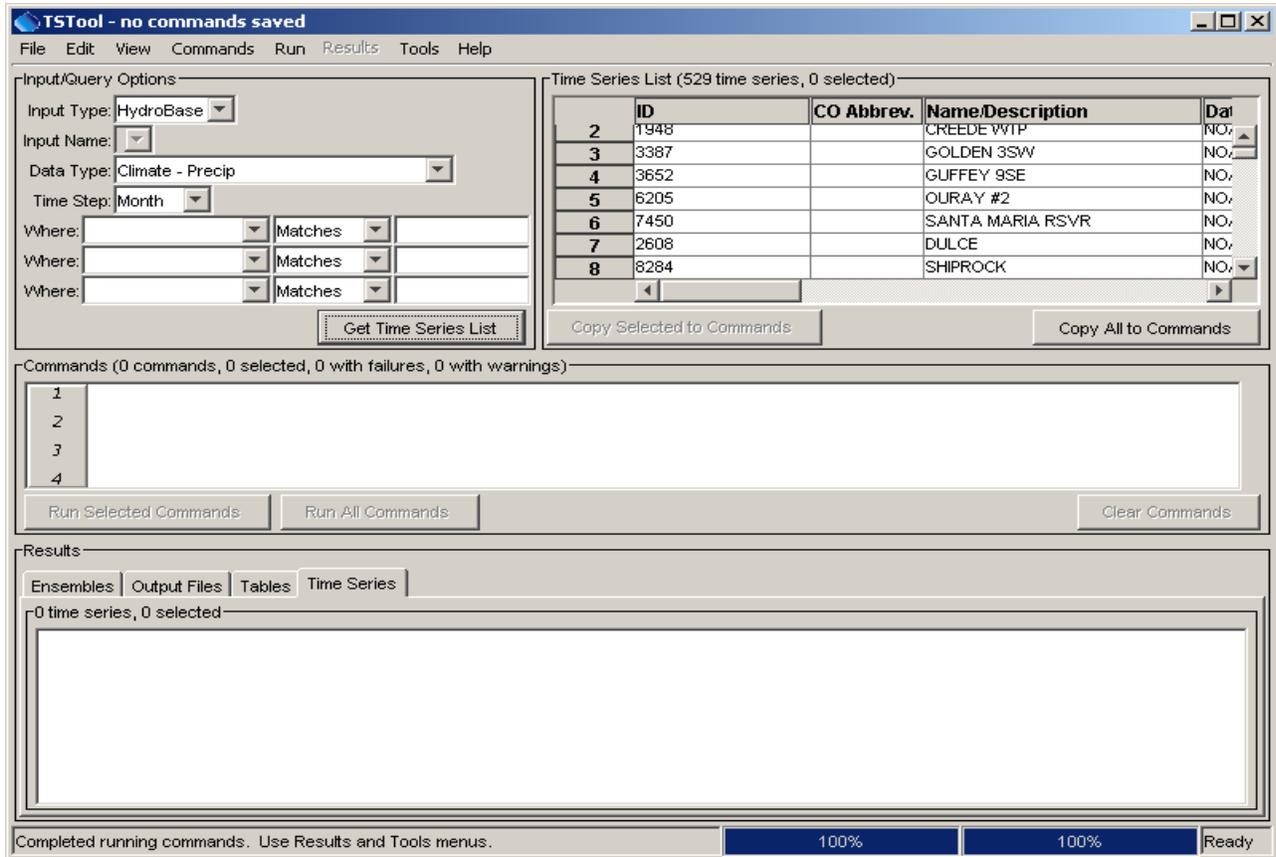


TSTOOL – TIME SERIES TOOL



Quick Start Manual for Regression Fill of Climate Data

March 2012

Introduction

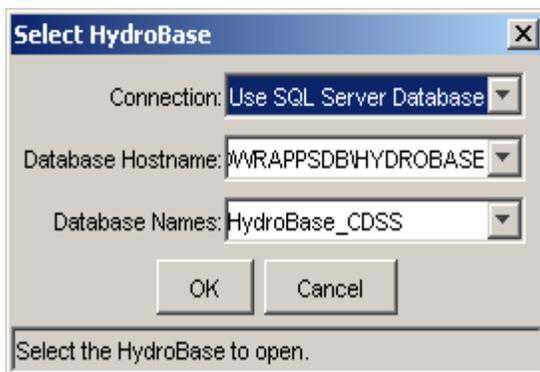
This Quick Start Manual is a very shortened and step-by-step description of what the model can perform. Should you desire to learn how to develop further complex analysis, the TSTool Documentation manual is far more extensive than this manual.

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

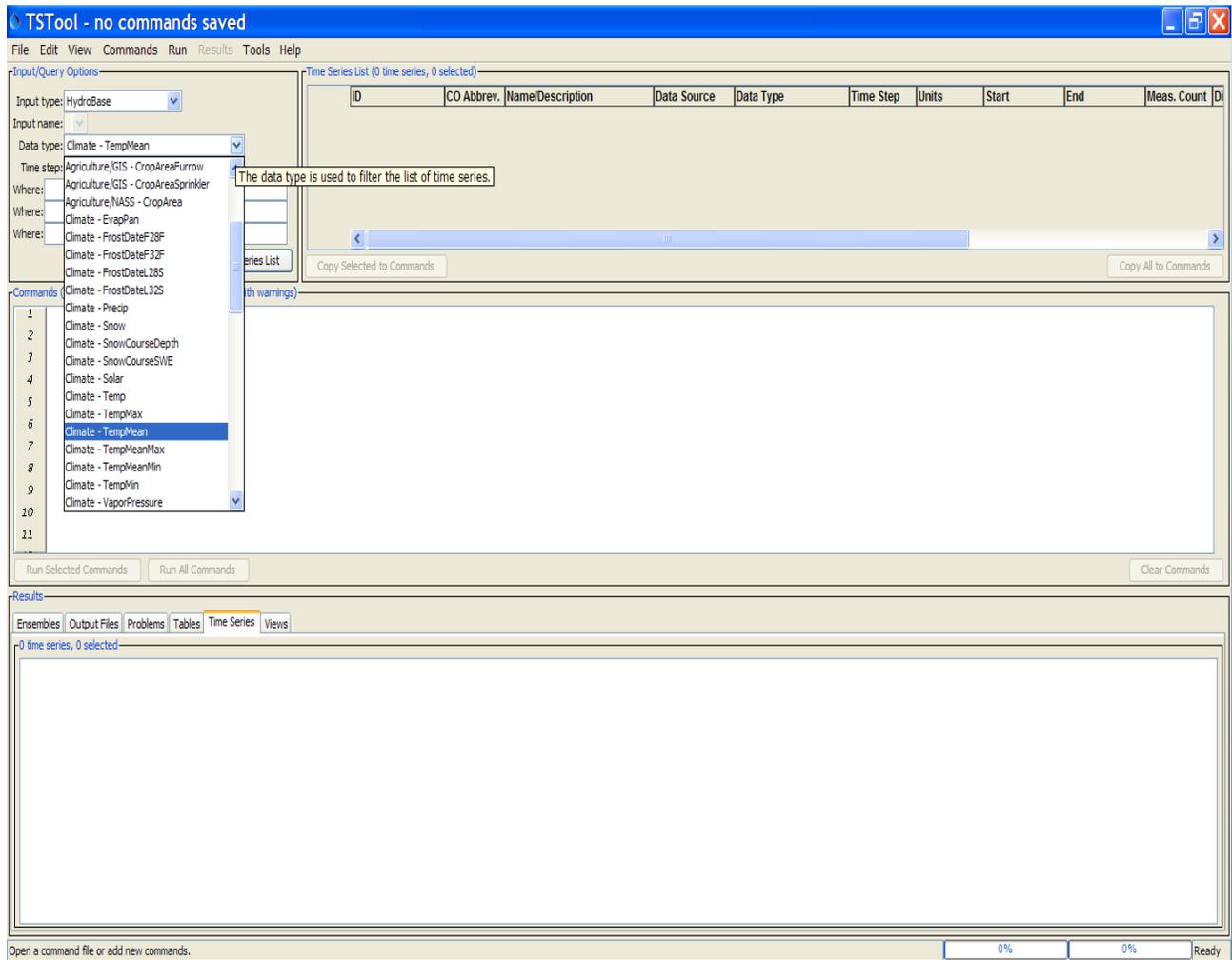
TSTools can be downloaded by going to <http://cdss.state.co.us/Pages/CDSSHome.aspx>. The program will take a minute to open up. Once open, the table on the front page of this manual and an overlapping table should be shown.



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

The screenshot shows the TSTool software interface. The 'Input/Query Options' panel is on the left, and the 'Time Series List' panel is on the right. The 'Where' dropdown is set to 'Division' and the second dropdown is set to '2 - Arkansas'. The 'Time Series List' table shows 7 entries with columns for CO Abbrev., Name/Description, Data Source, and Data Type. The 'Get Time Series List' button is highlighted with an arrow.

	CO Abbrev.	Name/Description	Data Source	Data Type
1		COLORADO SPRINGS MUNI AP	NOAA	TempMean
2		FORT CARSON BUTTS AAF	NOAA	TempMean
3		AYER RANCH	NOAA	TempMean
4		LAKE MORAIN	NOAA	TempMean
5		MONUMENT 2 WSW	NOAA	TempMean
6		MONUMENT	NOAA	TempMean
7		PALMER LAKE	NOAA	TempMean

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	Sort Ascending	Mea
1	1778	COLORADO SPRINGS MUNI AP	NOAA	TempMean	Month		1948	Sort Ascending	753
2	3002	FORT CARSON BUTTS AAF	NOAA	TempMean	Month		1967	Sort Descending	271
3	3063	FOUNTAIN	NOAA	TempMean	Month		1947	Original Order	2
4	3068	FOUNTAIN 6 NNE	NOAA	TempMean	Month		1943		3
5	0437	AYER RANCH	NOAA	TempMean	Month		1953		1
6	4750	LAKE MORANE	NOAA	TempMean	Month		1894		779
7	5730	MONUMENT 2 WSW	NOAA	TempMean	Month		1911		631

Copy Selected to Commands Copy All to Commands

Commands (0 commands, 0 selected, 0 with failures, 0 with warnings)

1
2
3
4
5
6
7
8
9
10
11

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

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 MORANE	NOAA	TempMean	Month		1894	1959
6	1660	CLIMAX	NOAA	TempMean	Month		1895	2010
7	8931	WESTCLFFE	NOAA	TempMean	Month		1895	2010

Copy Selected to Commands Copy All to Commands

Commands (0 commands, 0 selected, 0 with failures, 0 with warnings)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

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.

The screenshot shows the TSTool software interface. The main window is titled "TSTool - no commands saved". The menu bar includes File, Edit, View, Commands, Run, Results, Tools, and Help. The "Commands" menu is open, showing a list of commands. The "Read Time Series" command is selected, and its sub-menu is also open, showing "SetInputPeriod()... <for reading data>" as the selected option.

The "Time Series List" table is visible, showing 107 time series. The table has the following columns: ID, CO Abbrev., Name/Description, Data Source, Data Type, Time Step, Units, Start, and End. The data is as follows:

ID	CO Abbrev.	Name/Description	Data Source	Data Type	Time Step	Units	Start	End
		SetIncludeMissingTS()... <create empty time series if no data>		empMean	Month		1893	2010
		SetInputPeriod()... <for reading data>		empMean	Month		1893	2010
		ReadDateValue()... <read 1(+) time series from a DateValue file>		empMean	Month		1893	2010
		ReadDelimitedFile()... <read 1(+) time series from a delimited file (under development)>		empMean	Month		1894	1959
		ReadHydroBase()... <read 1(+) time series from HydroBase>		empMean	Month		1895	2010
		ReadMODSIM()... <read 1(+) time series from a MODSIM output file>		empMean	Month		1895	2010
		ReadStateCU()... <read 1(+) time series from a StateCU file>		empMean	Month		1895	2010
		ReadStateCUR()... <read 1(+) time series from a StateCU binary output file>		empMean	Month		1895	2010
		ReadStateMod()... <read 1(+) time series from a StateMod file>		empMean	Month		1895	2010
		ReadStateModB()... <read 1(+) time series from a StateMod binary output file>		empMean	Month		1895	2010
		StateModMax()... <generate 1(+) time series as Max() of TS in two StateMod files>		empMean	Month		1895	2010
		TS Alias = ReadDateValue()... <read 1 time series from a DateValue file>		empMean	Month		1895	2010
		TS Alias = ReadHydroBase()... <read 1 time series from HydroBase>		empMean	Month		1895	2010
		TS Alias = ReadMODSIM()... <read 1 time series from a MODSIM output file>		empMean	Month		1895	2010
		TS Alias = ReadRiverWare()... <read 1 time series from a RiverWare file>		empMean	Month		1895	2010
		TS Alias = ReadTimeSeries()... <read 1 time series given a full TSD>		empMean	Month		1895	2010
		TS Alias = ReadUsgrlwis()... <read 1 time series from a USGS NWIS file>		empMean	Month		1895	2010

The "Results" section at the bottom shows "0 time series, 0 selected". The status bar at the bottom indicates "Open a command file or add new commands." and "Ready".

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.

Edit SetInputPeriod() Command

The input period constrains the period when reading data from files and databases. Use this command only if a limited data period is necessary (e.g., to improve performance). Using a SetInputPeriod() command may result in incomplete data being available for data filling. Enter date/times to a precision appropriate for time series being read. For example:

Year data: YYYY
Month data: MM/YYYY or YYYY-MM
Day data: MM/DD/YYYY or YYYY-MM-DD
Hour data: MM/DD/YYYY HH or YYYY-MM-DD HH
Minute data: MM/DD/YYYY HH:mm or YYYY-MM-DD HH:mm

Special values are also recognized (for all precisions):
CurrentToYear = the current date to year precision
CurrentToMinute = the current date/time to minute precision
CurrentToMinute - 7Day = current date/time minus 7 days
CurrentToMinute + 7Day = current date/time plus 7 days

Leave blank to read all available data (default if SetInputPeriod() command is not used).

Input period start:

Input period end:

Command:

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.

The screenshot shows the TSTool software interface. The window title is "TSTool - no commands saved". The menu bar includes File, Edit, View, Commands, Run, Results, Tools, and Help.

The "Input/Query Options" panel on the left has the following settings:

- Input type: HydroBase
- Input name: (empty)
- Data type: Climate - TempMean
- Time step: Month
- Where: Division: Equals, 2 - Arkansas
- Where: (empty)
- Where: (empty)

The "Time Series List (107 time series, 1 selected)" table is as follows:

ID	CO Abbrev.	Name/Description	Data Source	Data Type	Time Step	Units	Start	End
49	8434	TRINIDAD LAS ANIMAS COUNTY ...	NOAA	TempMean	Month		1948	2011
50	7867	SPRINGFIELD 8 S	NOAA	TempMean	Month		1948	1964
51	5017	LIMON	NOAA	TempMean	Month		1948	1971
52	8574	UTLEYVILLE	NOAA	TempMean	Month		1951	1956
53	0437	AVER RANCH	NOAA	TempMean	Month		1953	1953
54	6740	PUEBLO MEMORIAL AP	NOAA	TempMean	Month		1954	2011
55	8157	TACONY 10 SE	NOAA	TempMean	Month		1955	2010

The "Commands (3 commands, 0 selected, 0 with failures, 0 with warnings)" list contains:

```

1 SetInputPeriod(InputStart="1911", InputEnd="2010")
2 # 6740 - PUEBLO MEMORIAL AP
3 6740.NOA.TempMean.Month-HydroBase
4
5
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```

The "Results" panel shows "0 time series, 0 selected". The status bar at the bottom indicates "Open a command file or add new commands." and "Ready".

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.

The screenshot shows the TSTool software interface. The main window is titled "TSTool - no commands saved". The interface is divided into several sections:

- Input/Query Options:** Contains dropdown menus for "Input type" (HydroBase), "Input name", "Data type" (Climate - TempMean), "Time step" (Month), and "Where" (Division: Equals, 2 - Arkansas).
- Time Series List (107 time series, 3 selected):** A table with columns: ID, CO Abbrev., Name/Description, Data Source, Data Type, Time Step, Units, and Start. The selected rows are:

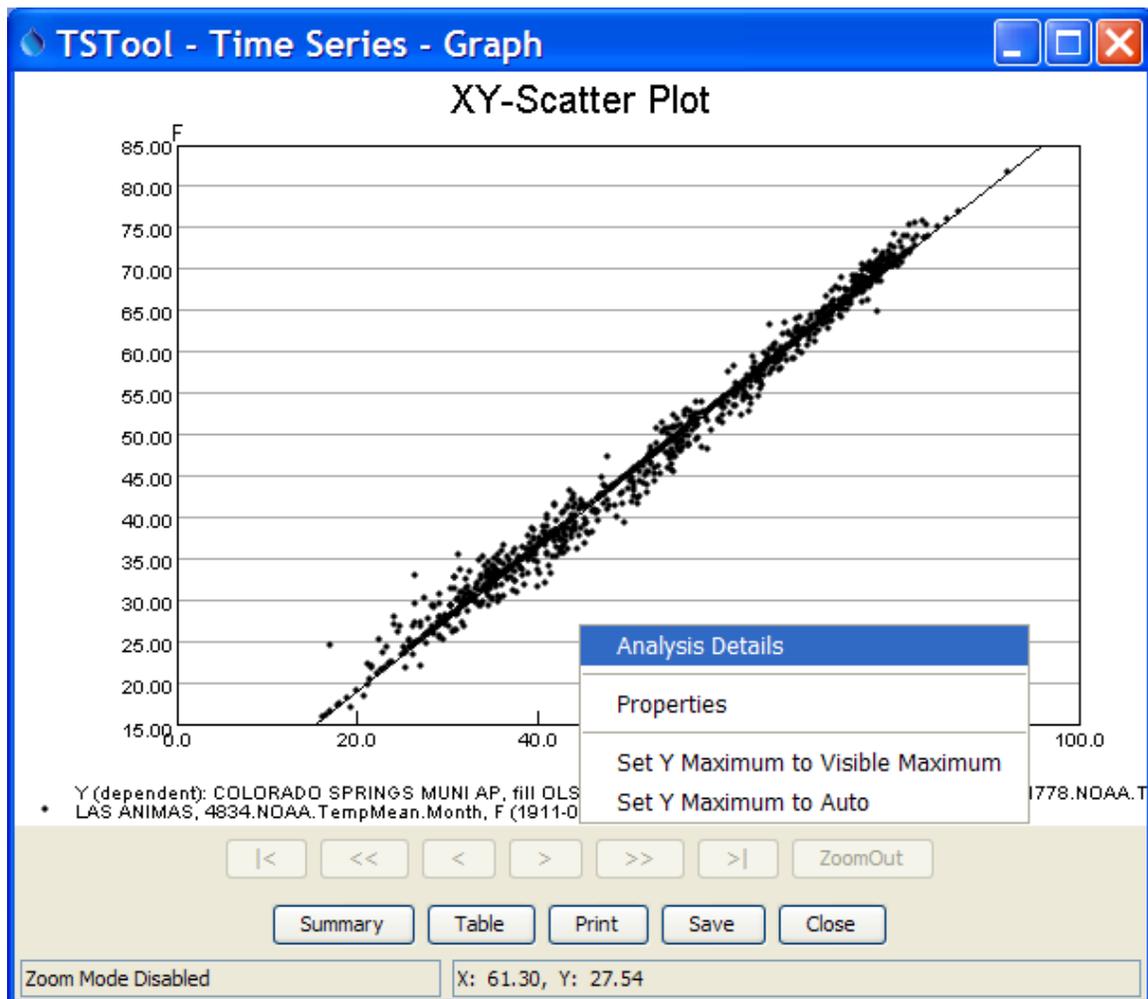
ID	CO Abbrev.	Name/Description	Data Source	Data Type	Time Step	Units	Start
1	1294	CANON CITY	NOAA	TempMean	Month		1893
2	4834	LAS ANIMAS	NOAA	TempMean	Month		1893
3	7167	ROCKY FORD 2 SE	NOAA	TempMean	Month		1893
4	4770	LAMAR	NOAA	TempMean	Month		1893
5	4750	LAKE MORAINE	NOAA	TempMean	Month		1894
6	1660	CLIMAX	NOAA	TempMean	Month		1895
7	8931	WESTCLIFFE	NOAA	TempMean	Month		1895
- Commands (8 commands, 0 selected, 0 with failures, 0 with warnings):** A list of commands generated from the selected stations, including station IDs and names.
- Results:** A section with tabs for "Ensembles", "Output Files", "Problems", "Tables", "Time Series", and "Views". The "Time Series" tab is active, showing 4 time series selected:
 - COLORADO SPRINGS MUNI AP - 1778.NOAA.TempMean.Month (1948-08 to 2011-05)
 - LAS ANIMAS - 4834.NOAA.TempMean.Month (1893-01 to 2010-12)
 - ROCKY FORD 2 SE - 7167.NOAA.TempMean.Month (1893-01 to 2010-12)
 - LAMAR - 4770.NOAA.TempMean.Month (1893-01 to 2010-12)

The status bar at the bottom indicates "Completed running commands. Use Results and Tools menus." and shows "100%" zoom levels and a "Ready" status.

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.

TSTool - Analysis Details

Independent time series (X, 1911-01 - 2010-01): 4834.NOAA.TempMean.Month (LAS ANIMAS) F
 Dependent time series (Y, 1911-01 - 2010-01): 1778.NOAA.TempMean.Month (COLORADO SPRINGS MUNI AP, fill OLSRegression using 4834.N
 Analysis period: 1911-01 to 2010-01
 Analysis method: Ordinary Least Squares Regression
 Data transformation: None
 Number of equations: 1

Independent (X)									
Mon	N1	MeanX1	SX1	N2	MeanX2	SX2	MeanX	SX	
All	1152	53.95	17.46	0	0.00	0.00	53.95	17.46	

Dependent (Y)				Line Fit Results						
Mon	MeanY1	SY1	MeanY	SY	A	B	R	R ²	RMSE	
All	48.52	15.23	0.00	0.00	1.66	0.87	0.9955	0.9910	6.08	

N1 indicates analysis period where X and Y are non-missing. N2 indicates analysis period where only X is non-missing. The N2 and full period values are provided as information but are not considered in the regression analysis. MeanX and SX are for the dependent available period (may be different than the analysis period). RMSE = sqrt(sum((Y1 - X1)^2)/N1), where Y1 is dependent and X1 is independent.

Independent time series (X, 1911-01 - 2010-01): 4834.NOAA.TempMean.Month (LAS ANIMAS) F
 Dependent time series (Y, 1911-01 - 2010-01): 1778.NOAA.TempMean.Month (COLORADO SPRINGS MUNI AP, fill OLSRegression using 4834.N
 Analysis period: 1911-01 to 2010-01
 Analysis method: Ordinary Least Squares Regression
 Data transformation: None
 Number of equations: 1

Search Print Save Close

Ready

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

Input/Query Options Create Time Series
 Input type: HydroBase Convert TS Identifier to Read Command
 Input name: Read Time Series
 Data type: Climate Fill Time Series Missing Data
 Time step: Month Set Time Series Contents
 Where: Division Manipulate Time Series
 Where: Analyze Time Series
 Where: Models - Routing
 Output Time Series

Time Series List (107 time series, 3 selected)

ID	CO Abbrev.	Name/Description	Data Source	Data Type	Time Step	Units	Start	End
1	1294	CANON CITY	NOAA	TempMean	Month		1893	2010
				TempMean	Month		1893	2010
				TempMean	Month		1893	2010
				TempMean	Month		1894	1959
				TempMean	Month		1895	2010
				TempMean	Month		1895	2010

Copy All to Commands

Commands (9 commands)

- 1 SetInput
- 2 # 1778 -
- 3 1778. NOAA
- 4 # 4834 -
- 5 4834. NOAA
- 6 # 7167 -
- 7 7167. NOAA
- 8 # 4770 -
- 9 4770. NOAA
- 10
- 11

Run Selected Commands

Results

Ensembles Output

0 time series, 0 selected

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

Fill Constant()... <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>

Clear Commands

Open a command file or add new commands. 0% 0% 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.

Edit FillRegression() command

Fill missing data using ordinary least squares (OLS) regression.
 The analysis period is used to determine relationships used for filling.
 Use a SetOutputPeriod() command before reading to extend the dependent time series, if necessary.
 Specify dates with precision appropriate for the data, use blank for all available data, OutputStart, or OutputEnd.

Time series to fill (dependent): 6740.NOAA.TempMean.Month

Independent time series: 7167.NOAA.TempMean.Month

Number of equations: OneEquation Optional - number of equations (default=OneEquation).

Analysis month: Optional - use with monthly equations (default=process all months).

Transformation: Optional - how to transform data before analysis (blank=None).

Intercept: Optional - blank or 0.0 are allowed with no transformation.

Analysis period: to

Fill Period: to

Fill flag: Optional - 1-character flag to indicate fill.

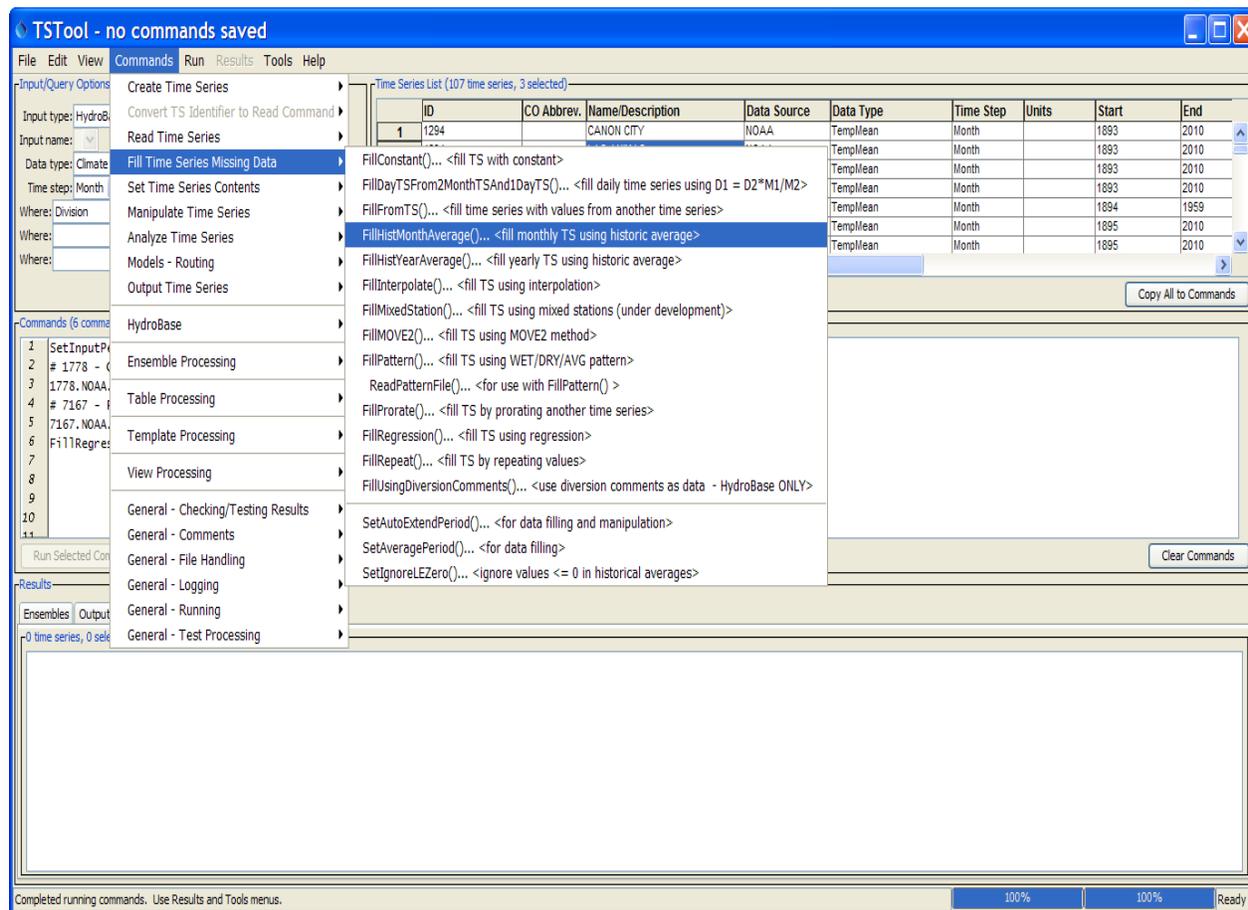
Command:
`FillRegression (TSID="6740.NOAA.TempMean.Month", IndependentTSID="7167.NOAA.TempMean.Month", NumberOfEquations=OneEquation)`

Cancel OK

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.

The screenshot shows the TSTool software interface. The main window is titled "TSTool - no commands saved". The "Commands" menu is open, and the "Manipulate Time Series" option is selected. The "Free()" option is highlighted in the submenu. The "Time Series List" table is visible in the background, showing 107 time series with 3 selected. The table has columns for ID, CO Abbrev., Name/Description, Data Source, Data Type, Time Step, Units, Start, and End.

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
			NOAA	TempMean	Month		1894	1959
			NOAA	TempMean	Month		1895	2010
			NOAA	TempMean	Month		1895	2010

The "Commands" menu is open, showing the following options:

- 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

The "Manipulate Time Series" submenu is open, showing the following options:

- Add()... <add one or more TS to another>
- AddConstant()... <add a constant value to a TS>
- AdjustExtremes()... <adjust extreme values>
- ARMA()... <lag/attenuate a time series using ARMA>
- Blend()... <blend one TS with another>
- ChangePeriod()... <change the period of record>
- ConvertDataUnits()... <convert data units>
- Cumulate()... <cumulate values over time>
- Divide()... <divide one TS by another TS>
- Free()... <free time series>
- Multiply()... <multiply one TS by another TS>
- RunningAverage()... <convert TS to running average>
- Scale()... <scale TS by a constant>
- ShiftTimeByInterval()... <shift TS by an even interval>
- Subtract()... <subtract one or more TS from another>

The "Results" panel is empty. The status bar at the bottom shows "Completed running commands. Use Results and Tools menus." and "Ready".

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.

Edit Free() Command ✖

This command frees (removes) time series, which is useful to remove unneeded or temporary time series.
 The list of time series to be removed can be indicated in several ways.
 Time series identifiers follow the pattern:
 Location.Source.DataType.Interval.Scenario
 Examples of wildcard use when TSList=AllMatchingTSID are shown below:
 * - matches all time series
 ABC* - matches locations starting with ABC
 ABC*. *.Type.Month - matches locations starting with ABC, with data type Type and interval Month.
 Time series that are in an ensemble will be removed from the ensemble.

TS list: Optional - indicates the time series to process (default=AllTS).

TSID (for TSList=matching TSID):

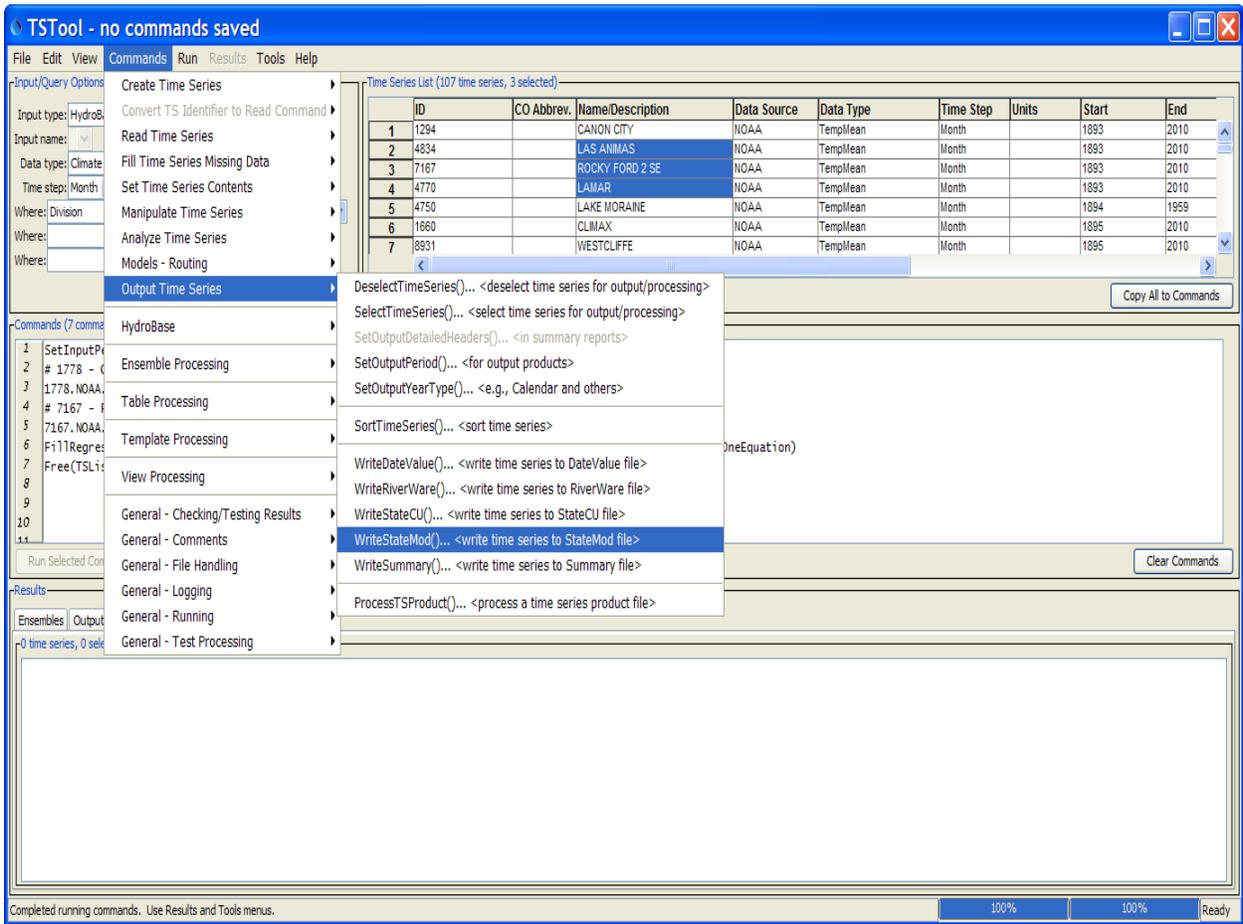
EnsembleID (for TSList=EnsembleID):

Time series position(s) (for TSList=TSPosition):

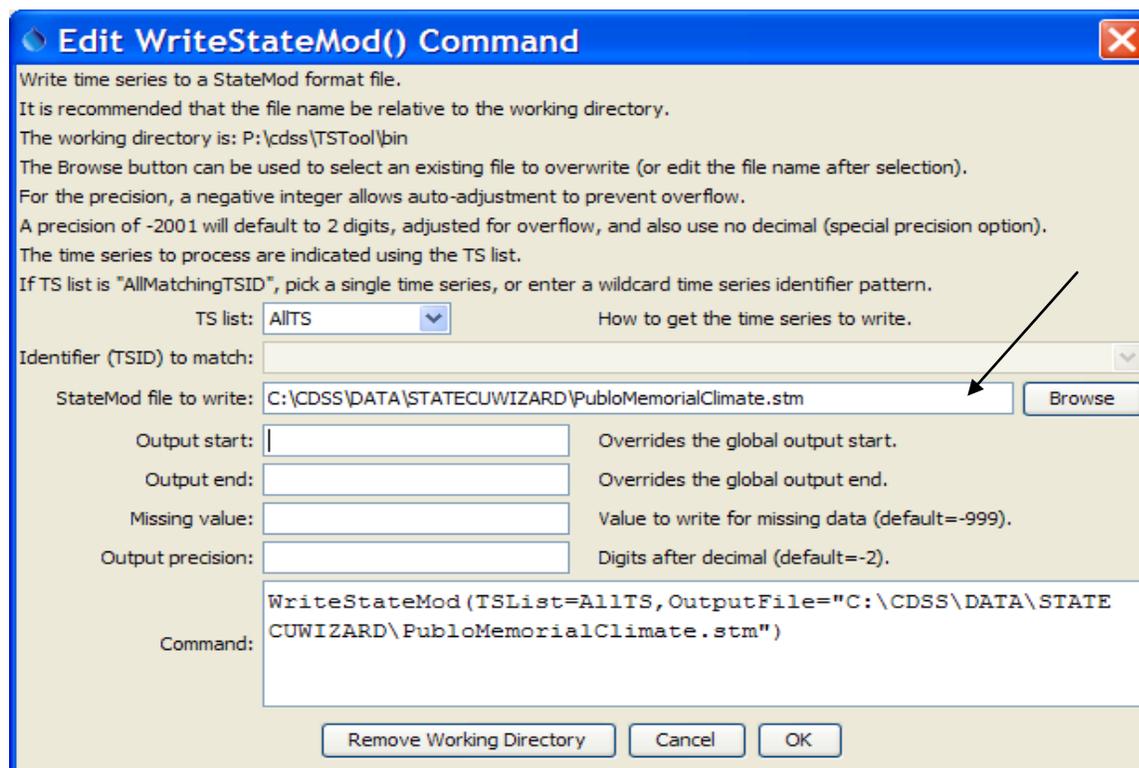
Free ensemble if empty?

Command:

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 output formats available that may suit your purposes.



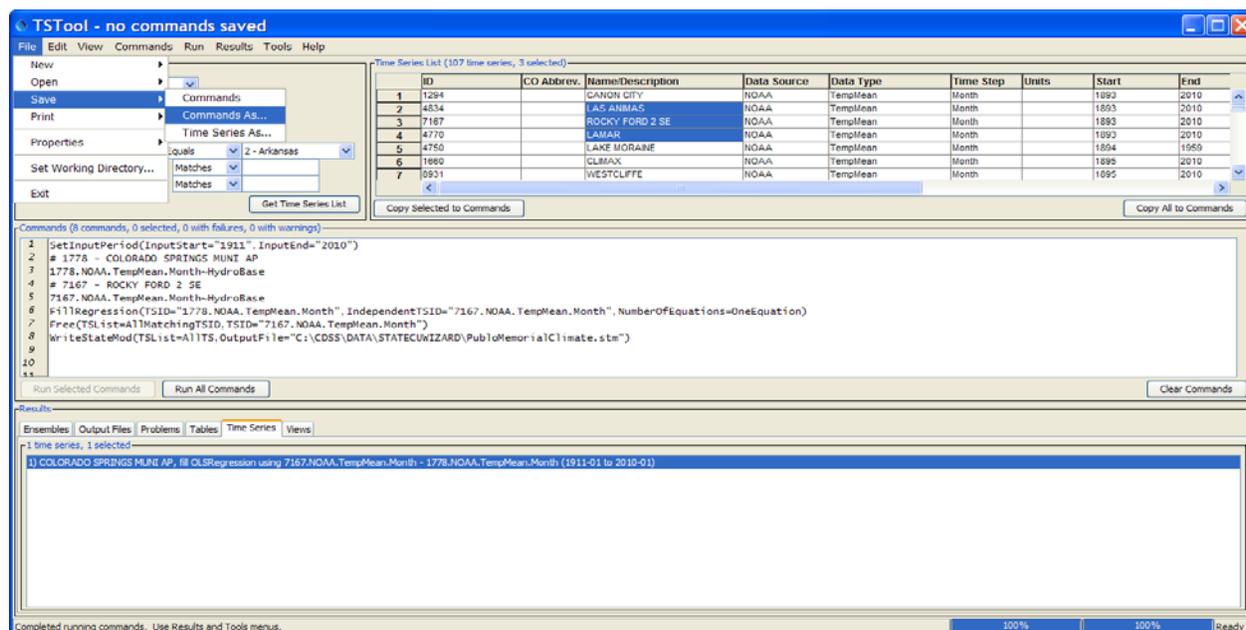
On this table you will write to the directory that you wish to file to go. The Browse button makes this easier.



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.



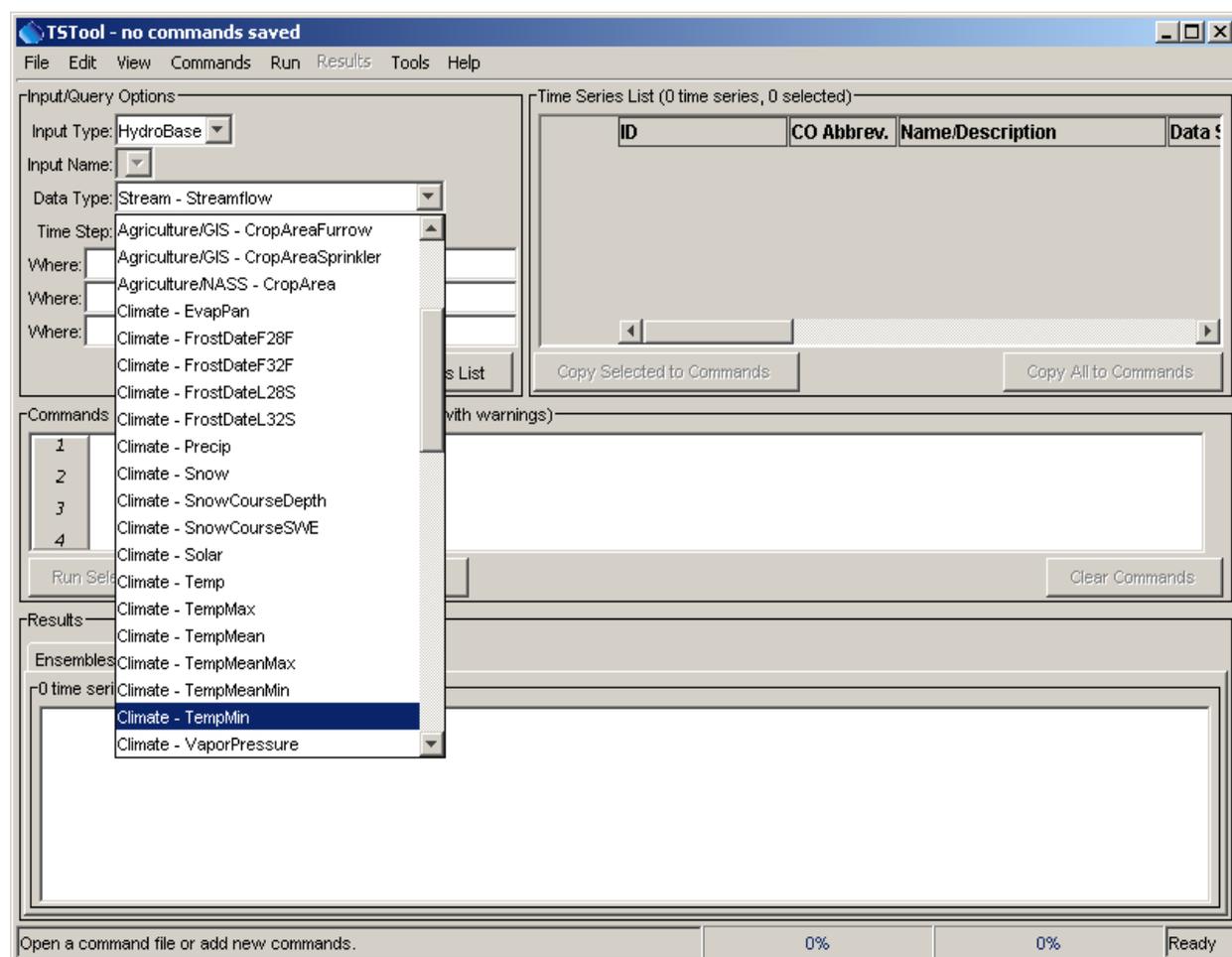
The data for precipitation can be filled the same way or averages for your station can be used. Your engineering judgment should determine which method is appropriate for your situation. Now that you know which climate station to work your regression from, many of the steps presented can be deleted. 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:

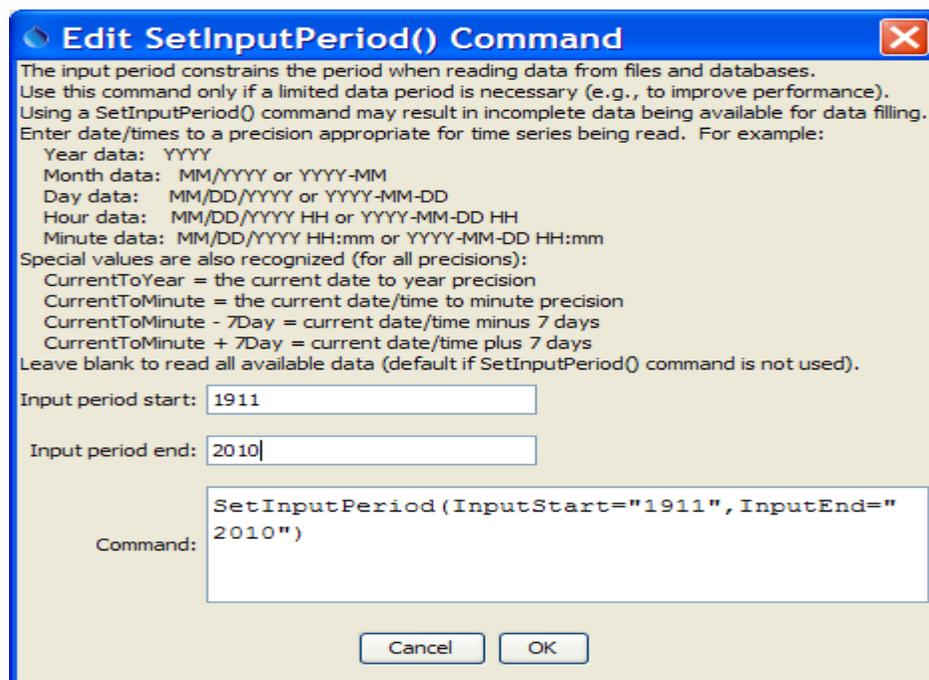
```
# SetInputPeriod(InputStart="1911",InputEnd="2008")
## 6740 - PUEBLO MEMORIAL AP
# 6740.NOAA.Precip.Month~HydroBase
## 7167 - ROCKY FORD 2 SE
# 7167.NOAA.Precip.Month~HydroBase
# FillRegression(TSID="6740.NOAA.Precip.Month",IndependentTSID="7167.NOAA.Precip.Month",NumberOfEquations=OneEquation)
#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

Frost Dates

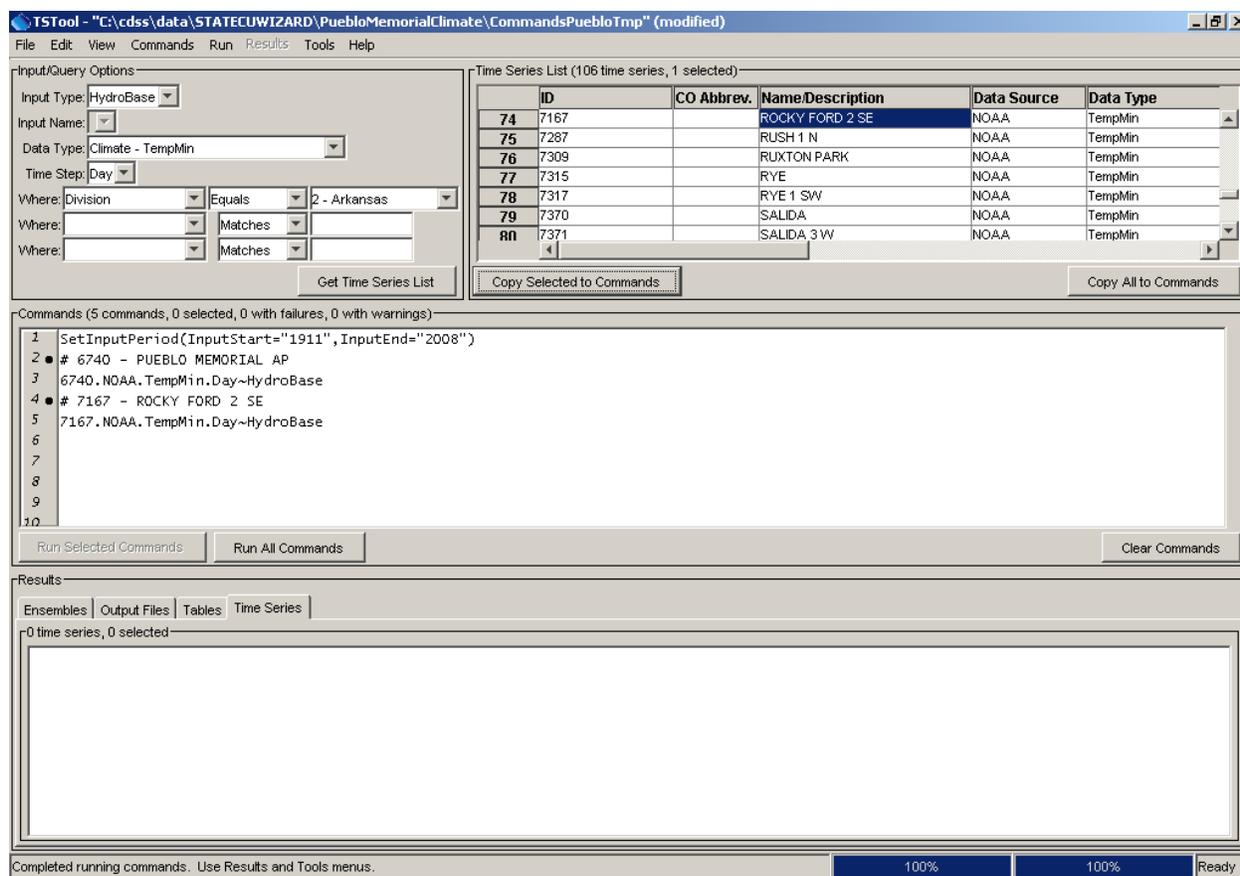
Determining Frost Dates is a little more complex. Here you will begin by using the TempMin.Day from the HydroBase drop down.



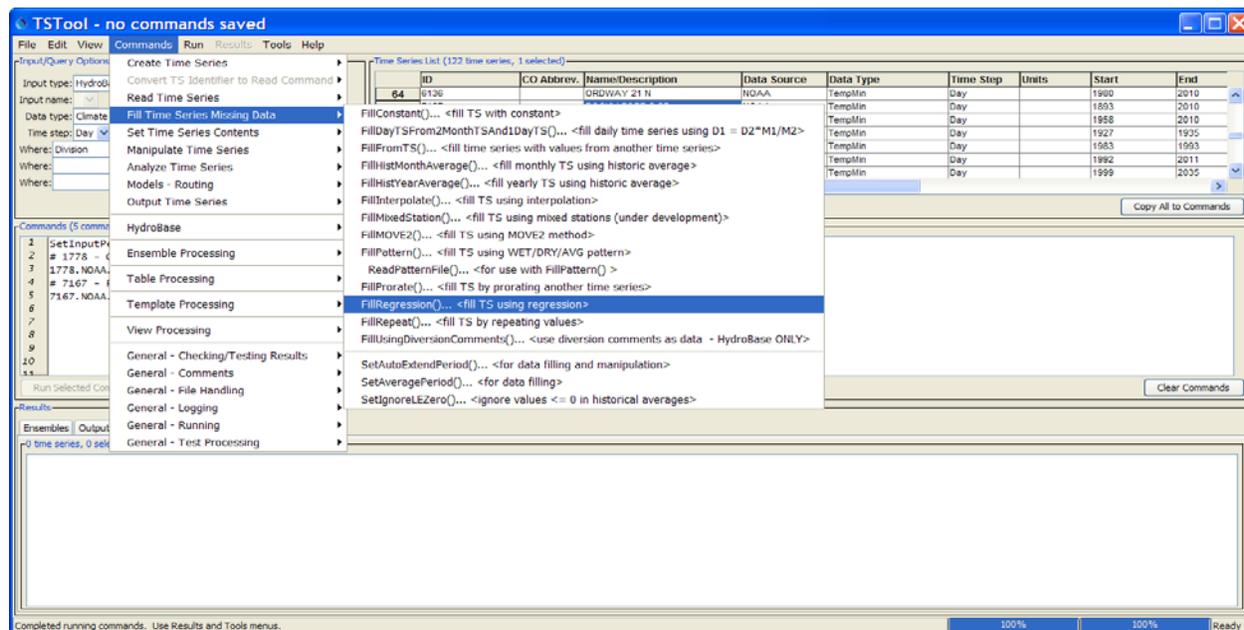
Once again, set your input period.



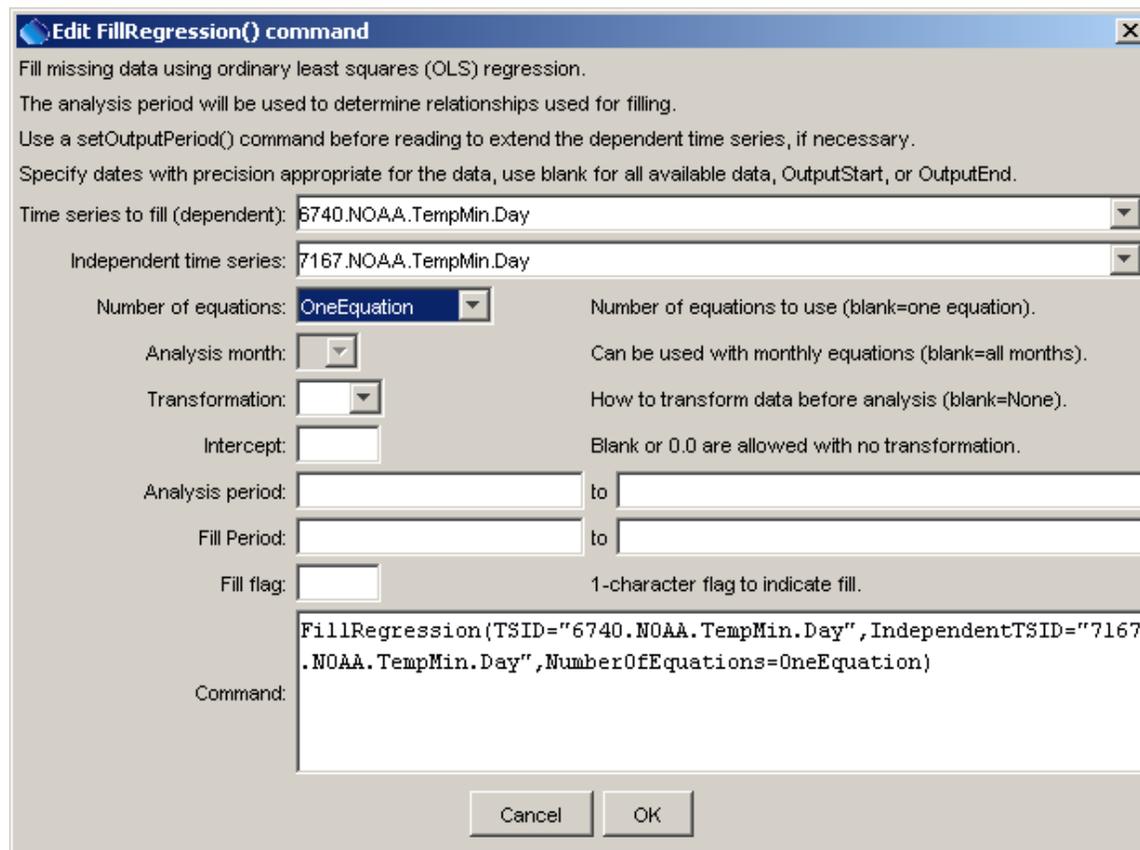
Under “Where” put in Division, then Arkansas and press the Get Time Series List. Copy down Pueblo Memorial and then Rocky Ford.



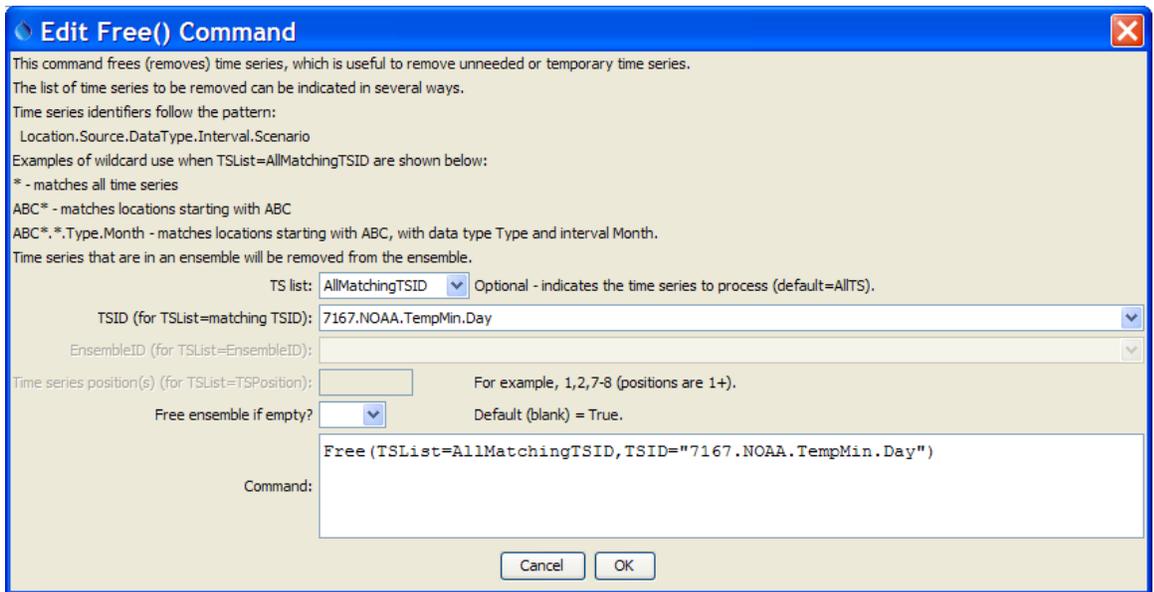
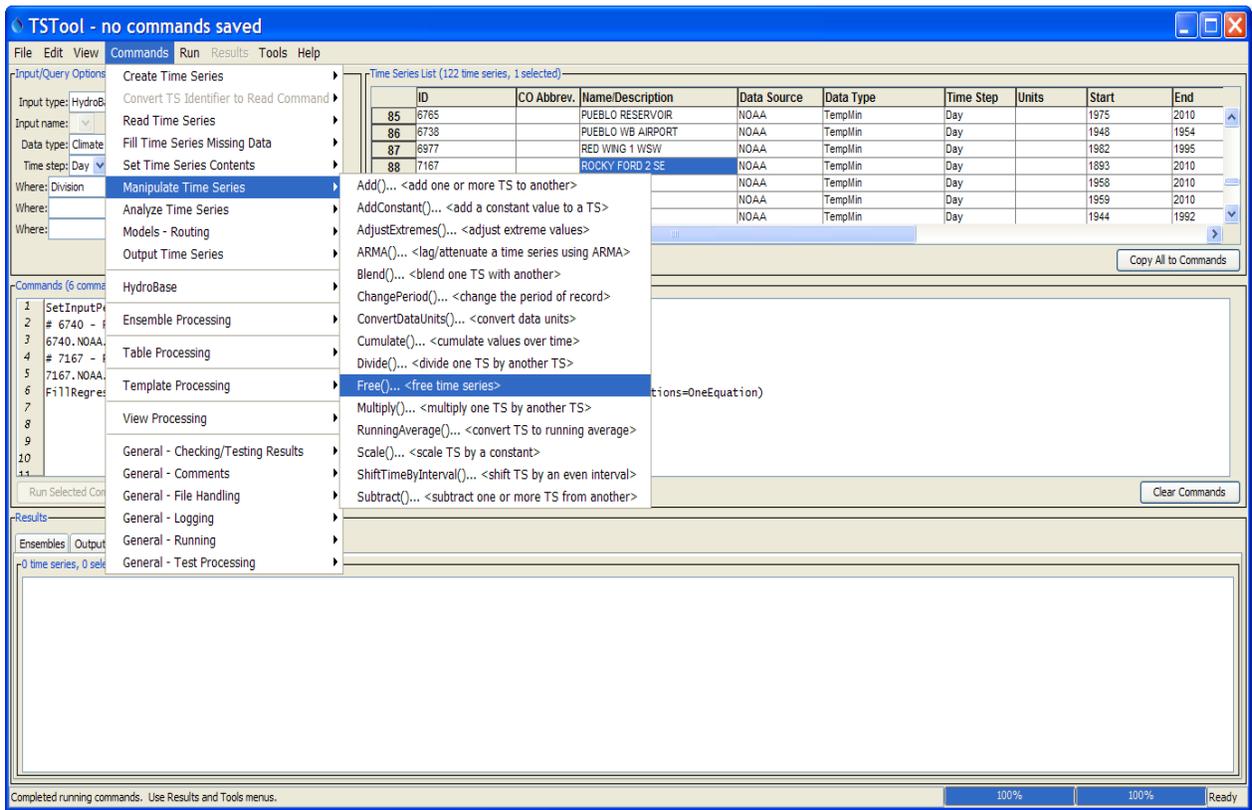
Under Commands pull down the FillRegression.



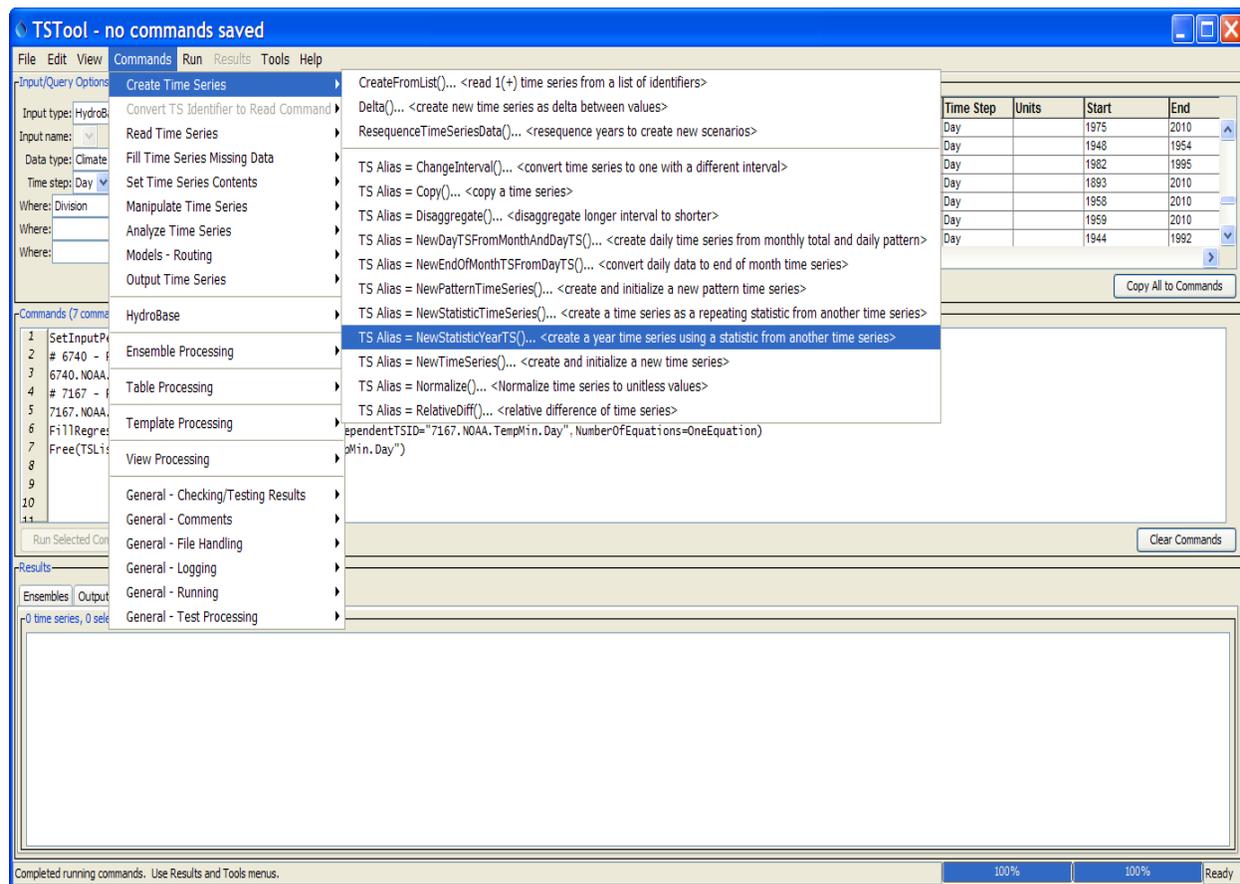
Fill this table in much the same way as was done for the mean temp.



Free up the station that was filled from.



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



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.

Edit TS Alias = NewStatisticYearTS() Command

Create a year time series as a statistic extracted from another time series, giving the result an alias.
 A statistic is a yearly quantity computed from a sample, where in this case the sample is values in the time series.
 Optionally, specify a new time series identifier (TSID) information for the output time series.
 This is highly recommended if there is any chance that the new time series will be mistaken for the original.

Time series alias: Often the location from the TSID, or a short string.

Time series to analyze (TSID):

New time series ID: Specify to avoid confusion with TSID from original TS.

Statistic: Statistic to generate.

Test value: Test value (needed for some statistics).

Allow missing count: Number of missing values allowed in analysis interval.

Analysis period: to

Analysis window (in a year):
 Analysis Window Start: Month: Day: Hour:
 to
 Analysis Window End: Month: Day: Hour:

Search start: Search start (needed for some statistics).

Command:
 TS Alias = NewStatisticYearTS(TSID="6740.NOAA.TempMin.Day",Statistic=CountGE)

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 \leq TestValue.
- DayOfLastLE is the Julian day of the year (1 – 366) for the last data value for values \leq 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.

Edit TS Alias = NewStatisticYearTS() Command

Create a year time series as a statistic extracted from another time series, giving the result an alias.
 A statistic is a yearly quantity computed from a sample, where in this case the sample is values in the time series.
 Optionally, specify a new time series identifier (TSID) information for the output time series.
 This is highly recommended if there is any chance that the new time series will be mistaken for the original.

Time series alias: Often the location from the TSID, or a short string.

Time series to analyze (TSID):

New time series ID: Specify to avoid confusion with TSID from original TS.

Statistic: Statistic to generate.

Test value: Test value (needed for some statistics).

Allow missing count: Number of missing values allowed in analysis interval.

Analysis period: to

Analysis window (in a year):
 Analysis Window Start: Month: Day: Hour:
 Analysis Window End: Month: Day: Hour:

Search start: Search start (needed for some statistics).

Command:

```
TS 6740L28S =
NewStatisticYearTS (TSID='6740.NOAA.TempMin.Day',NewTSID='6740.NOAA.FrostDateL28S.
Year',Statistic=DayOfLastLE,TestValue=28,AllowMissingCount=0,SearchStart='06/30')
```

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

Edit the Time Series Identifier (TSID)

The time series identifier (TSID) uniquely identifies a time series, and conforms to the standard:
Location.DataSource.DataType.Interval.Scenario

For example:
XYZ.USGS.Streamflow.24Hour
123.NOAA.MeanTemp.Month

The input type and name indicate the format and storage location of data.
Specify TSID parts below and the full TSID will automatically be created.

Location:	<input type="text" value="6740"/>	For example, a station or sensor identifier.
Data source:	<input type="text" value="NOAA"/>	Optional. The source of the data (e.g., agency abbreviation).
Data type:	<input type="text" value="FrostDateL28S"/>	Optional. A data type abbreviation.
Data interval:	<input type="text" value="Year"/>	Data interval.
Scenario:	<input type="text"/>	Optional string (e.g., "Hist", "Test1").
Input type:	<input type="text"/>	Optional input type (e.g., database, file format).
Input name:	<input type="text"/>	Optional file or database name, for input type.

Time series identified (TSID):
6740.NOAA.FrostDateL28S.Year

OK Cancel

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

Edit TS Alias = NewStatisticYearTS() Command

Create a time series where each value is a statistic calculated from a year of data from the input time series. The output time series has an interval of year.
It is recommended that new time series identifier (TSID) information be specified for the output time series to avoid confusing the output with the original.

Time series alias: Required - for output, typically the location from the TSID, or a short string.

Time series to analyze (TSID):

New time series ID: Recommended - to avoid confusion with TSID from original time series.
Edit Clear

Statistic: Required - statistic to calculate.

Test value: Optional - test value (required for comparison statistics).

Allow missing count: Optional - number of missing values allowed in analysis interval (default=allow missing).

Minimum sample size:

Output year type:

Analysis start:

Analysis end:

Analysis window: Optional - analysis window within input year (default=full year).

Search start: Optional - search start (needed for some statistics, default=full year).

Command:
`TS 6740L32S =
NewStatisticYearTS (TSID="6740.NOAA.TempMin.Day", NewTSID="6740.NOAA.FrostDateL32S.Year",
Statistic=DayOfLastLE, TestValue=32, AllowMissingCount=0, SearchStart="06/30")`

Cancel OK

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

Edit TS Alias = NewStatisticYearTS() Command

Create a time series where each value is a statistic calculated from a year of data from the input time series. The output time series has an interval of year. It is recommended that new time series identifier (TSID) information be specified for the output time series to avoid confusing the output with the original.

Time series alias: 6740F32F Required - for output, typically the location from the TSID, or a short string.

Time series to analyze (TSID): 6740.NOAA.TempMin.Day

New time series ID: 6740.NOAA.FrostDateF32F.Year Recommended - to avoid confusion with TSID from original time series.

Statistic: DayOfFirstLE Required - statistic to calculate.

Test value: 32 Optional - test value (required for comparison statistics).

Allow missing count: 0 Optional - number of missing values allowed in analysis interval (default=allow missing).

Minimum sample size: Optional - minimum required sample size (default=determined by statistic).

Output year type: Optional - to define year span (default=Calendar).

Analysis start: Optional - analysis start date/time (default=full time series period).

Analysis end: Optional - analysis end date/time (default=full time series period).

Analysis window: Optional - analysis window within input year (default=full year).

Search start: 07/01 Optional - search start (needed for some statistics, default=full year).

Command:

```
TS 6740F32F =
NewStatisticYearTS (TSID="6740.NOAA.TempMin.Day", NewTSID="6740.NOAA.FrostDateF32F.Year
",Statistic=DayOfFirstLE,TestValue=32,AllowMissingCount=0,SearchStart="07/01")
```

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

Edit TS Alias = NewStatisticYearTS() Command

Create a time series where each value is a statistic calculated from a year of data from the input time series. The output time series has an interval of year. It is recommended that new time series identifier (TSID) information be specified for the output time series to avoid confusing the output with the original.

Time series alias: 6740F28F Required - for output, typically the location from the TSID, or a short string.

Time series to analyze (TSID): 6740.NOAA.TempMin.Day

New time series ID: 6740.NOAA.FrostDateF28F.Year Recommended - to avoid confusion with TSID from original time series.

Statistic: DayOfFirstLE Required - statistic to calculate.

Test value: 28 Optional - test value (required for comparison statistics).

Allow missing count: 0 Optional - number of missing values allowed in analysis interval (default=allow missing).

Minimum sample size: Optional - minimum required sample size (default=determined by statistic).

Output year type: Optional - to define year span (default=Calendar).

Analysis start: Optional - analysis start date/time (default=full time series period).

Analysis end: Optional - analysis end date/time (default=full time series period).

Analysis window: Optional - analysis window within input year (default=full year).

Search start: 07/01 Optional - search start (needed for some statistics, default=full year).

Command:

```
TS 6740F28F =
NewStatisticYearTS (TSID="6740.NOAA.TempMin.Day", Statistic=DayOfFirstLE,TestValue=28,A
llowMissingCount=0,SearchStart="07/01")
```

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

TSTool - "C:\cdss\data\STATECUWIZARD\PuebloMemorialClimate\PuebloMemFD.tstool"

File Edit View Commands Run Results Tools Help

Input/Query Options

Input Type: **HydroBase**

Input Name:

Data Type: **Climate - TempMin**

Time Step: **Day**

Where: **Division** **Equals** **2 - Arkansas**

Where: **Matches**

Where: **Matches**

Time Series List (106 time series, 1 selected)

ID	CO Abbrev.	Name/Description	Data Source	Data Type
1	7167	ROCKY FORD 2 SE	NOAA	TempMin
2	2446	EADS	NOAA	TempMin
3	4076	HOLLY	NOAA	TempMin
4	4770	LAMAR	NOAA	TempMin
5	5015	LIMON 10 SSW	NOAA	TempMin
6	8510	TWO BUTTES	NOAA	TempMin
7	4834	LAS ANIMAS	NOAA	TempMin

Commands (13 commands, 0 selected, 0 with failures, 0 with warnings)

```

4
5
6 ,IndependentTSID="7167.NOAA.TempMin.Day",NumberOfEquations=OneEquation)
7 .TempMin.Day")
8 .NOAA.TempMin.Day",NewTSID="6740.NOAA.FrostDateL28S.Year",Statistic=DayOfLastLE,TestValue=28,AllowMissingCount=0,SearchStart="06/30")
9 .NOAA.TempMin.Day",NewTSID="6740.NOAA.FrostDateL32S.year",Statistic=DayOfLastLE,TestValue=32,AllowMissingCount=0,SearchStart="06/30")
10 .NOAA.TempMin.Day",NewTSID="6740.NOAA.FrostDateF32F.Year",Statistic=DayOfFirstLE,TestValue=32,AllowMissingCount=0,SearchStart="07/01")
11 .NOAA.TempMin.Day",NewTSID="6740.NOAA.FrostDateF28F.Year",Statistic=DayOfFirstLE,TestValue=28,AllowMissingCount=0,SearchStart="07/01")
--

```

Results

Ensembles Output Files Tables Time Series

0 time series, 0 selected

Use the Run menubuttons to run the commands. 0% 0% Ready

You will need to write a new Free command.

TSTool - "C:\cdss\data\STATECUWIZARD\PuebloMemorialClimate\PuebloMemFD.tstool"

File Edit View Commands Run Results Tools Help

Input/Query Options

Input Type: **Hydro**

Input Name:

Data Type: **Climate**

Time Step: **Day**

Where: **Division**

Where:

Where:

Time Series List (106 time series, 1 selected)

ID	CO Abbrev.	Name/Description	Data Source	Data Type
1	7167	ROCKY FORD 2 SE	NOAA	TempMin
2	2446	EADS	NOAA	TempMin
3	4076	HOLLY	NOAA	TempMin
4	4770	LAMAR	NOAA	TempMin
5	5015	LIMON 10 SSW	NOAA	TempMin
6	8510	TWO BUTTES	NOAA	TempMin
7	4834	LAS ANIMAS	NOAA	TempMin

Commands (13 commands, 0 selected, 0 with failures, 0 with warnings)

```

6 FillRec
7 Free(TS
8 TS 6740
9 TS 6740
10 TS 6740
11 TS 6740
12 Free(TS
13 WriteStateCU(OutputFile='C:\cdss\data\...')

```

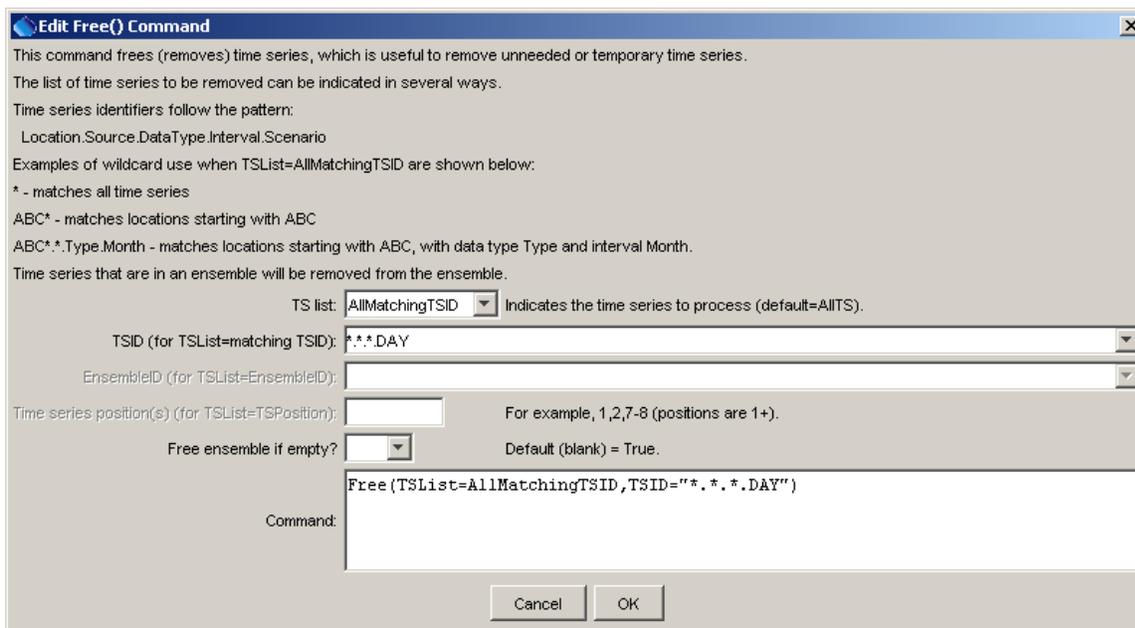
Results

Ensembles Output Files Tables Time Series

0 time series, 0 selected

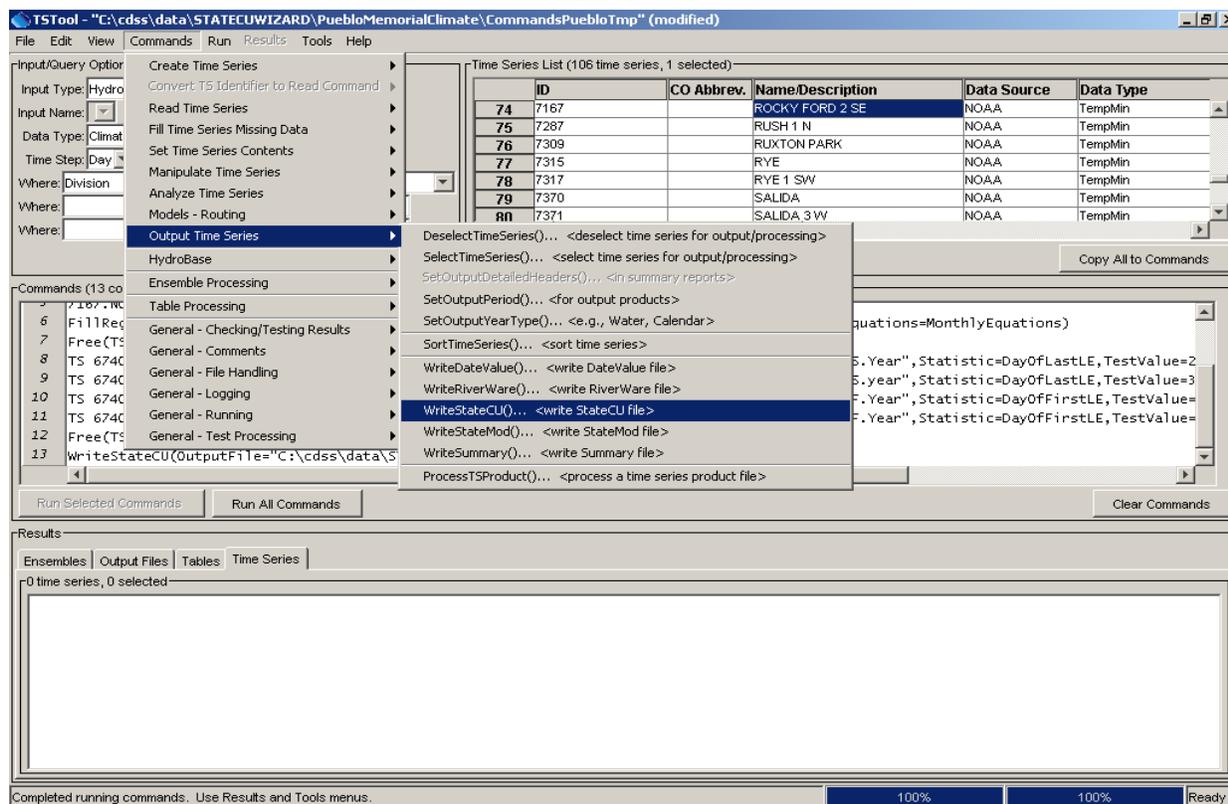
Use the Run menubuttons to run the commands. 0% 0% Ready

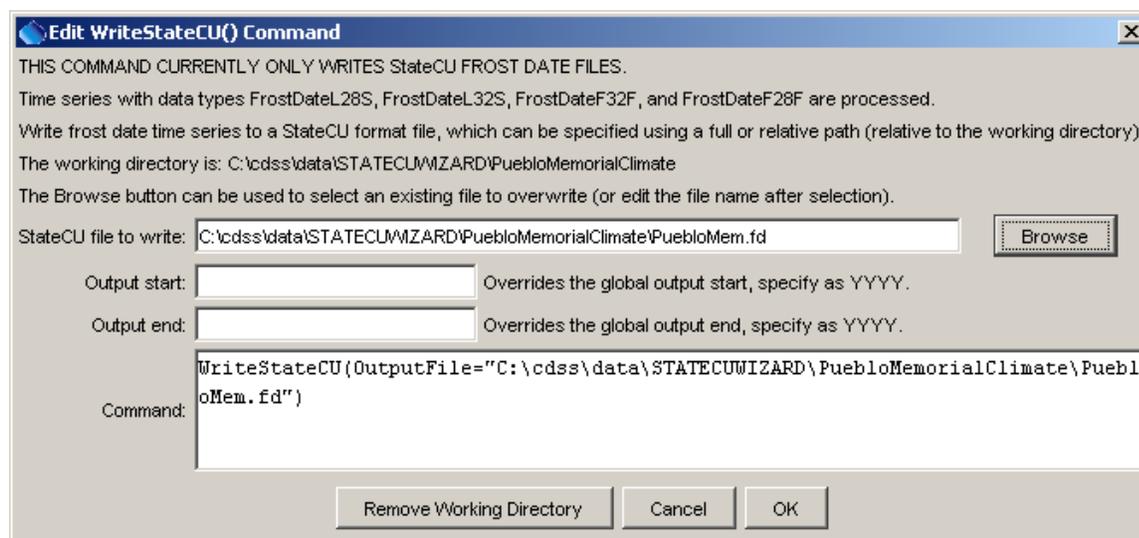
This is under the Commands drop down, highlight Manipulate Time Series and then click on the Free.



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.

The screenshot shows the TSTool software interface. At the top, the title bar reads "TSTool - no commands saved". Below the title bar is a menu bar with "File", "Edit", "View", "Commands", "Run", "Results", "Tools", and "Help".

The "Input/Query Options" panel on the left includes:

- Input type: HydroBase
- Input name: (dropdown)
- Data type: Climate - TempMin
- Time step: Day
- Where: Division (dropdown), Equals (dropdown), 2 - Arkansas (dropdown)
- Where: (dropdown), Matches (dropdown)
- Where: (dropdown), Matches (dropdown)
- Buttons: "Get Time Series List", "Copy Selected to Commands", "Copy All to Commands"

The "Time Series List (122 time series, 1 selected)" table is as follows:

ID	CO Abbrev.	Name/Description	Data Source	Data Type	Time Step	Units	Start
83	6743						
84	6740	PUEBLO CITY RESERVOI	NOAA	TempMin	Day		1941
85	6765	PUEBLO MEMORIAL AP	NOAA	TempMin	Day		1954
86	6738	PUEBLO RESERVOIR	NOAA	TempMin	Day		1975
87	6977	PUEBLO WB AIRPORT	NOAA	TempMin	Day		1948
88	7167	RED WING 1 WSW	NOAA	TempMin	Day		1982
89	7287	ROCKY FORD 2 SE	NOAA	TempMin	Day		1893
		RUSH 1 N	NOAA	TempMin	Day		1958

The "Commands (12 commands, 0 selected, 0 with failures, 0 with warnings)" panel contains:

```
6 FillRegression(TSID="6740.NOAA.TempMin.Day", IndependentTSID="7167.NOAA.TempMin.Day", NumberOfEquations=OneEquation)
7 Free(TSList=AllMatchingTSID, TSID="7167.NOAA.TempMin.Day")
8 TS 6740L285 = NewStatisticYearTS(TSID="6740.NOAA.TempMin.Day", NewTSID="6740.NOAA.FrostDateL285.Year", Statistic=DayOfLastLE, TestValue=28, AllowMissingCount=0, SearchStart=
9 TS 6740L325 = NewStatisticYearTS(TSID="6740.NOAA.TempMin.Day", NewTSID="6740.NOAA.FrostDateL325.Year", Statistic=DayOfLastLE, TestValue=32, AllowMissingCount=0, SearchStart=
10 TS 6740F32F = NewStatisticYearTS(TSID="6740.NOAA.TempMin.Day", NewTSID="6740.NOAA.FrostDateF32F.Year", Statistic=DayOfFirstLE, TestValue=32, AllowMissingCount=0, SearchStart
11 TS 6740F28F = NewStatisticYearTS(TSID="6740.NOAA.TempMin.Day", NewTSID="6740.NOAA.FrostDateF28F.Year", Statistic=DayOfFirstLE, TestValue=28, AllowMissingCount=0, SearchStart
12 Free(TSList=AllMatchingTSID, TSID="*. *. *. DAY")
```

The "Results" panel shows "4 time series, 4 selected":

- 6740L285 - Day of year for last value <= 28.000000 - 6740.NOAA.FrostDateL285.Year (1911 to 2010)
- 6740L325 - Day of year for last value <= 32.000000 - 6740.NOAA.FrostDateL325.Year (1911 to 2010)
- 6740F32F - Day of year for first value <= 32.000000 - 6740.NOAA.FrostDateF32F.Year (1911 to 2010)
- 6740F28F - Day of year for first value <= 28.000000 - 6740.NOAA.FrostDateF28F.Year (1911 to 2010)

At the bottom, the status bar shows "Completed running commands. Use Results and Tools menus." and "Ready".

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.

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	10/6				
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				

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

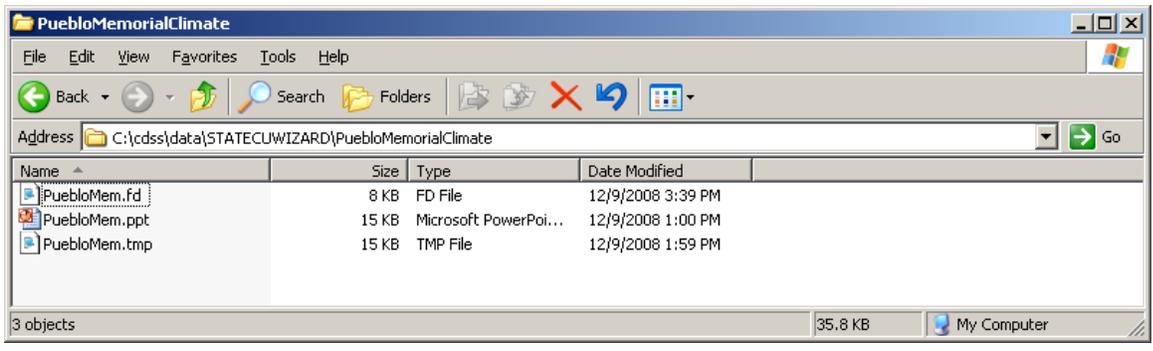
File Edit Help

Historical frost dates for station: 6740 PUEBLO MEMORIAL AP

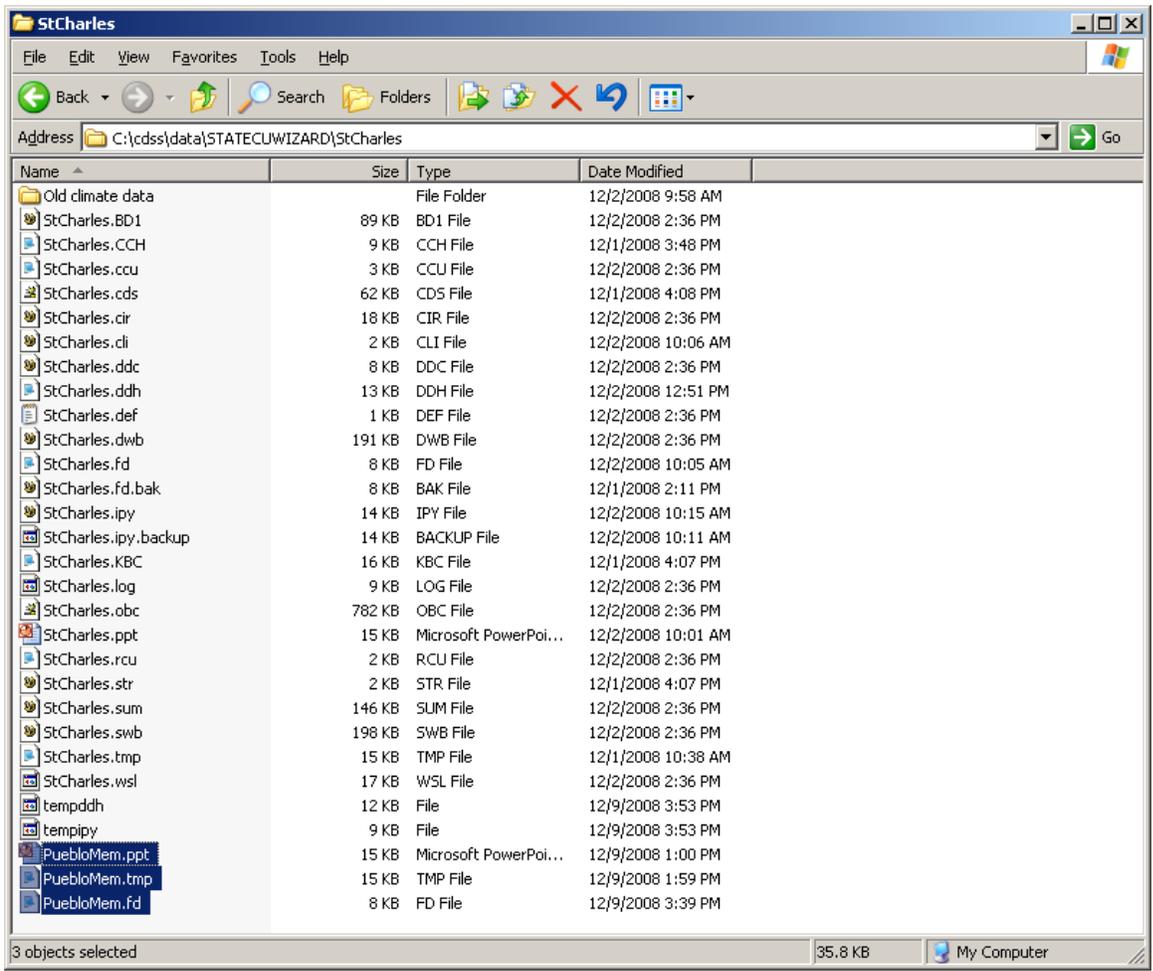
Year	Last spring 28 deg F day	Last spring 32 deg F day	First fall 28 deg F day	First fall 32 deg F day
1911	April 16	April 25	October 09	October 17
1912	April 16	April 25	October 09	October 17
1913	April 16	April 25	October 09	October 17
1914	April 16	April 25	October 09	October 17
1915	April 16	April 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.



HCF/word/TSTool Climate