GeoCLIM Manual

by Tamuka Magadzire, Diego Pedreros, FEWS NET

Edited by Libby White

The GeoCLIM Manual is intended to be a reference guide for all users of the climatological analysis tool, be they climatologists, decision makers, researchers, etc. FEWS NET and the CHG are dedicated to providing tools to help mitigate or prevent humanitarian crises. The GeoCLIM, developed by Tamuka Magadzire and rigorously tested by his FEWS NET colleagues, is a user friendly yet powerful tool for climate data analysis.

U S G e o l o g i c a l S u r v e y

F a m i n e E a r l y W a r n i n g S y s t e m N e t w o r k

U C S a n t a B a r b a r a

C l i m a t e H a z a r d s G r o u p

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Chapter 1: Introduction and Overview

Summary

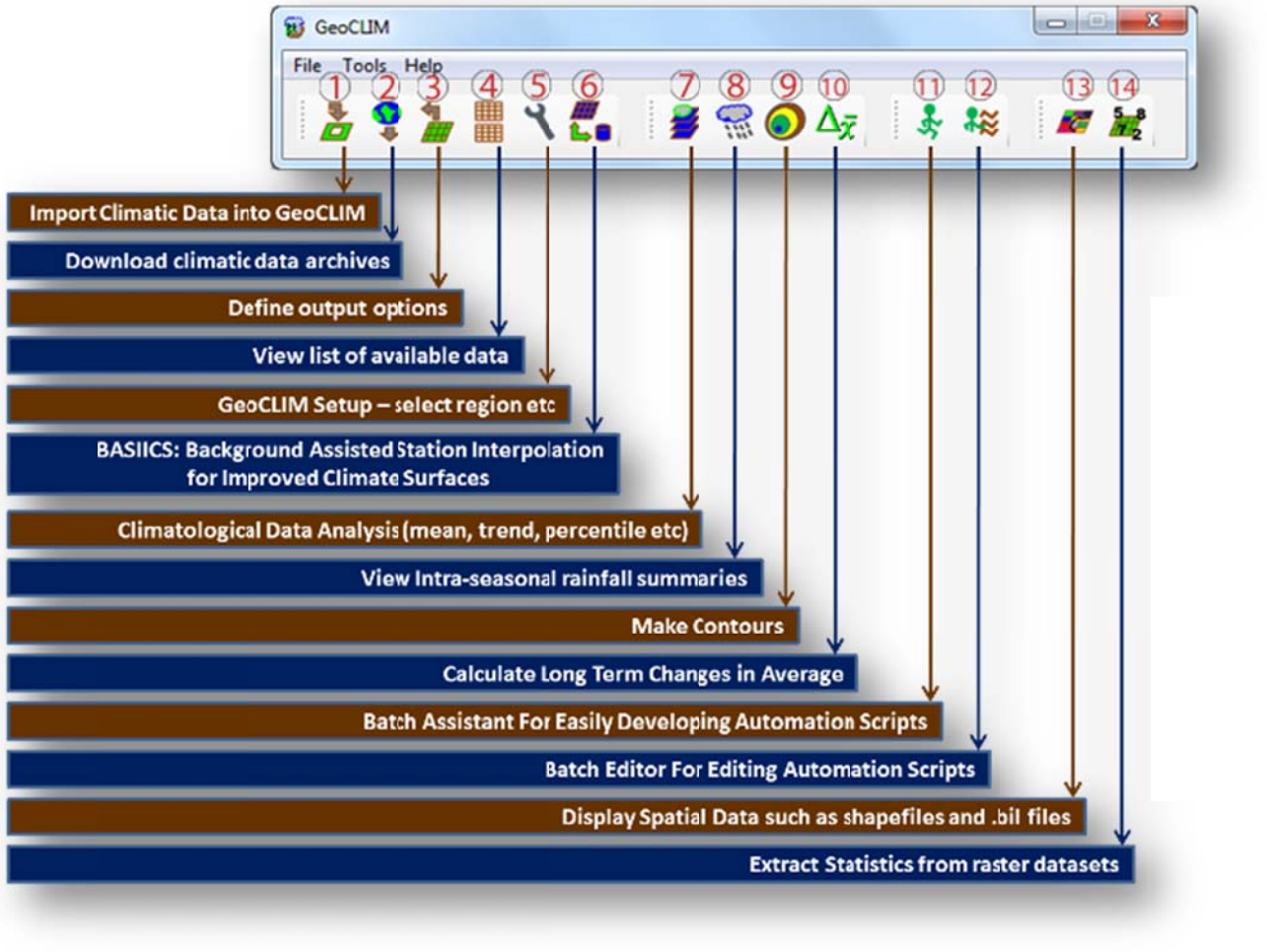
The GeoCLIM is a spatial analysis tool designed for climatological analysis of historical rainfall and temperature data. The GeoCLIM provides non-scientists with an array of accessible analysis tools for climate-smart agricultural development. These user friendly tools can be used to obtain and analyze climate data, blend station data with satellite data to create more accurate datasets, analyze seasonal trends and/or historical climate data, create visual representations of climate data, create scripts (batch files) to quickly and efficiently analyze similar "batches" of climate data, view and/or edit shapefiles and raster files, and extract statistics from raster datasets to create time series.

Using the Manual

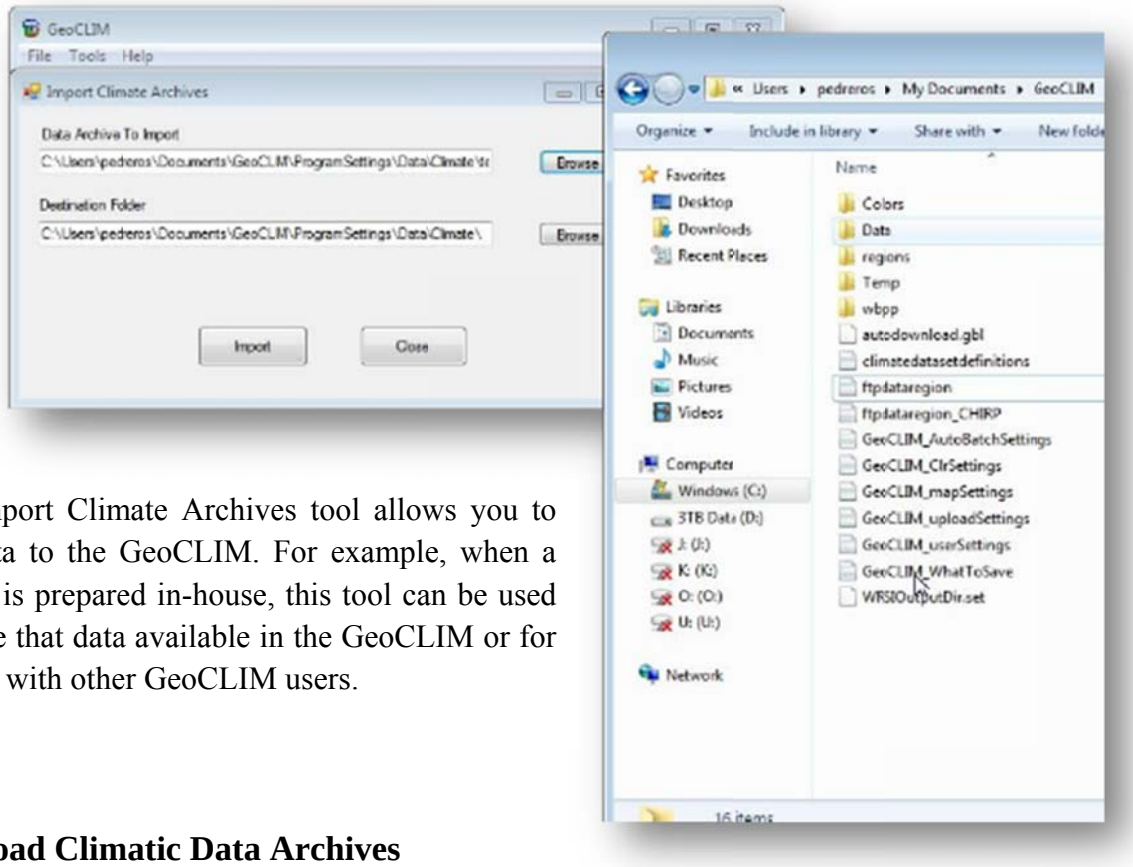
This manual presents examples and exercises to help you understand the different application of the tools of the GeoCLIM. The Introduction and Overview chapter is meant as a brief tour of the various options and tools available in the GeoCLIM. The Installation chapter will guide you through setting up the GeoCLIM and downloading data. The Data Types chapter provides a brief review of the different data types used in the GeoCLIM. The Spatial Data Viewer chapter is a general tutorial for the various uses of the Spatial Data Viewer. The Reclassifying Rasters chapter details the steps required to alter raster data. The Station Blending and BASIICS chapter is a walkthrough of the uses of station blending, how it can improve the data, and how to use the blending tools (including the BASIICS tool and its output). The Climatological Analysis chapter explains how to use the Climatological Analysis tool to make various calculations for rainfall, temperature, and evapotranspiration. The Contour Tool chapter briefly reviews how to delineate the amounts of rainfall for a certain area over specified periods for comparison. The Time Series chapter explains how to create summaries of historical rainfall for a given region. The Advanced Topics chapter gives a slightly more in depth review of the various tools and settings of the GeoCLIM.

The Main GeoCLIM Functions

This section presents the main tools available on the GeoCLIM toolbar. Although other tools are available on the menu, below we focus only on the most frequently used functions in the toolbar.

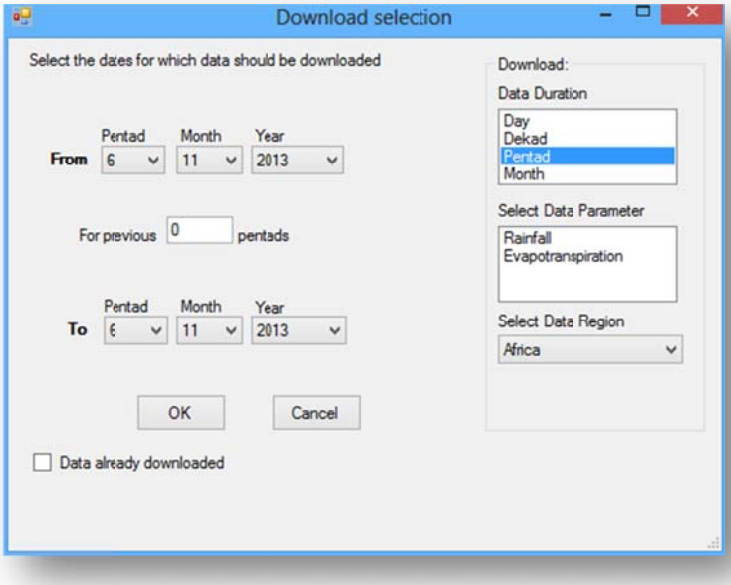


1) Import Climatic Data into GeoCLIM



The Import Climate Archives tool allows you to add data to the GeoCLIM. For example, when a dataset is prepared in-house, this tool can be used to make that data available in the GeoCLIM or for sharing with other GeoCLIM users.

2) Download Climatic Data Archives



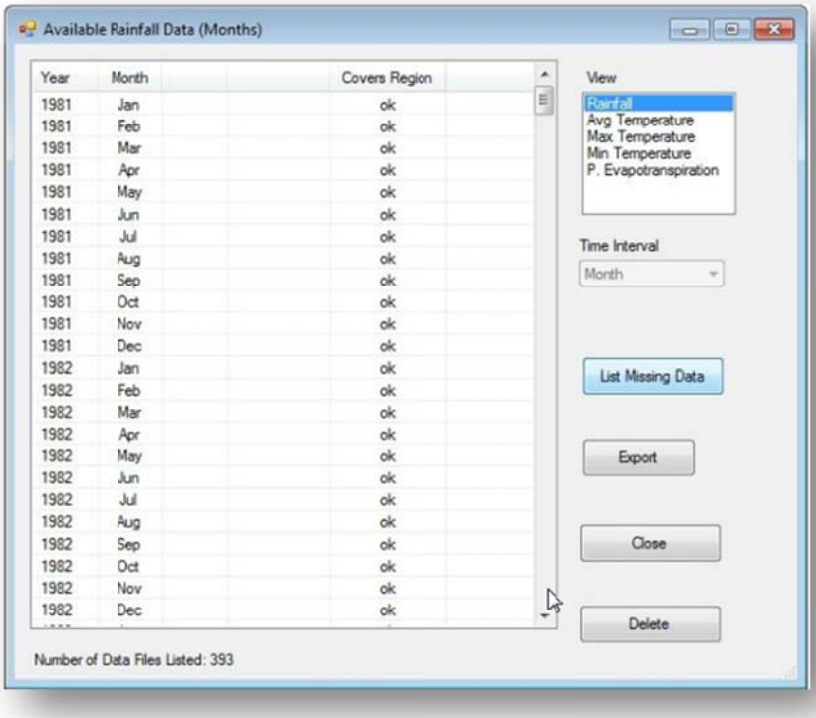
With the Download Selection tool, you can download data by date (From and To). You can also specify the Data Duration (daily, dekadal, pentadal, or monthly data), the Data Parameter(s), and the Data Region.

3) Define Output Options

The output options available in this tool allow you to define the directory where you want all your automatically-generated output to go. Additionally, you can add a prefix to each of the output files, change the font type and size, startup program size, and more. The defaults are as shown.

4) View List of Available Data

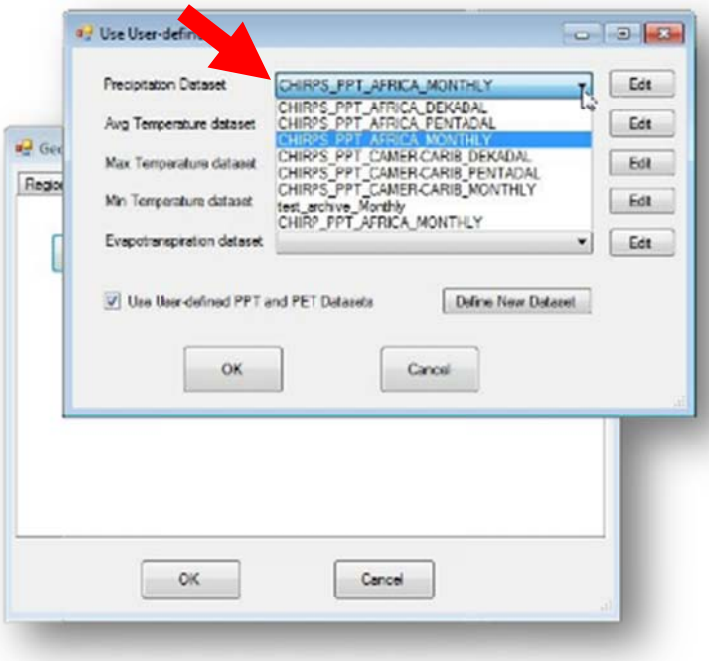
The Available Rainfall Data window allows you to list the data available for analysis among the different types of data (rainfall, temperature, etc.) that can be used in the GeoCLIM. For each data type, the data duration shown (Month, Dekad, Pentad, etc.) will match the currently selected dataset. The example shown here is a monthly dataset that starts in January 1981 and goes to September 2013. If the rainfall data did not cover the region selected in the GeoCLIM settings (see the Installation chapter), then these data would be highlighted yellow and the 'Covers Region' column would indicate that the rainfall data and region do not match. The 'List Missing Data' button will also show what months are missing during what years for the whole period (based on what data type you selected in the 'View' menu).



5) GeoCLIM Setup – Select Region, Etc.

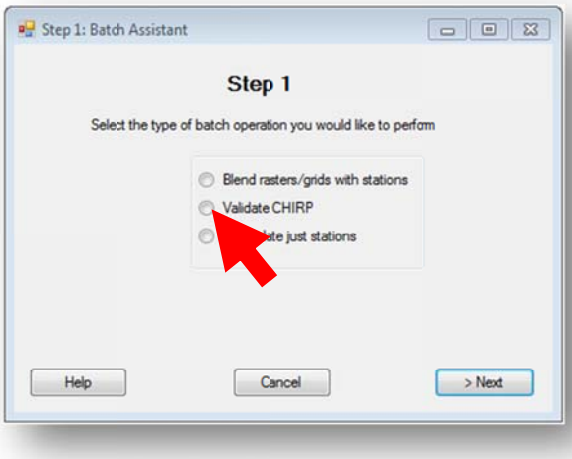
The GeoCLIM Settings window allows you to alter initial setup options. There are three main tabs for this:

1. **Region**
   - Select/revise region
2. **Mask**
   - Define specific mask or region for computation and display (e.g., land masses, non-desert regions).
3. **Data**
   - Click the 'Select Dataset' button to change the data to be used for analysis and select the desired dataset.



6) BASIICS: Background Assisted Station Interpolation for Improved Climate Surfaces

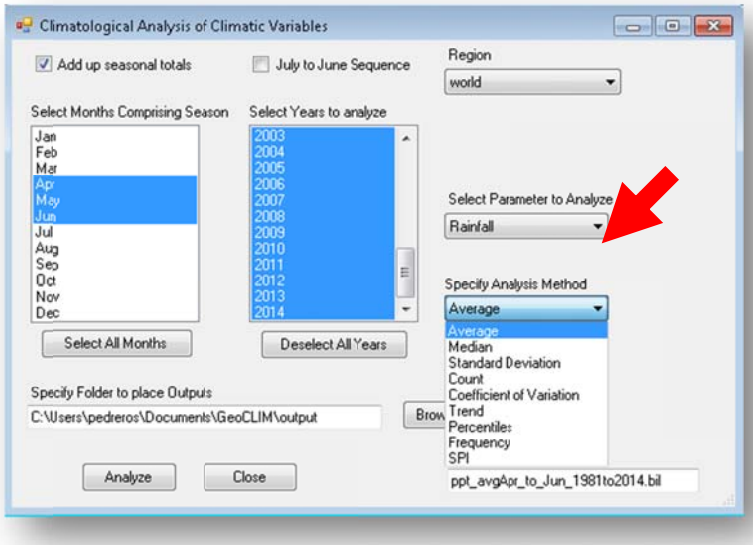
This tool allows you to select the type of process to be performed. The available processes are:



- **Blend rasters/grids with stations**: This takes the raster (e.g., satellite data, etc.), overlays the stations available for a specific period, and blends the two to create a new, improved dataset.
- **Validate CHIRP**: Validates a raster dataset using station data by taking the station value, extracting the value of the pixel where stations are, and compares the two. This indicates how much the station and the field values differ.
- **Interpolate just stations**: Uses inverse distance weighting interpolation process to interpolate the stations only.

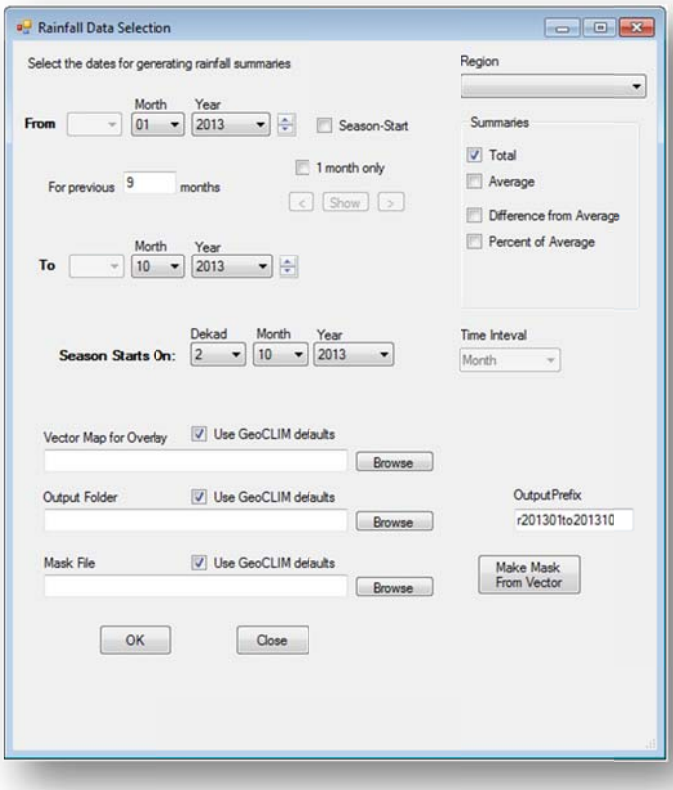
7) Climatological Data Analysis (mean, trend, percentile, etc.)

The Climatological Analysis of Climatic Variables tool is designed to analyze rainfall, evapotranspiration, and temperature information. All the years and months available are listed (such as from 1981 to 2013) in separate columns: months ('Select Months Comprising Season') and years ('Select Years to Analyze'). You can select the range of months and years desired, as well as the desired Analysis Method (such as Average), Parameter to Analyze (such as Rainfall), and the Region (such as EAC). You can also specify the output directory. Clicking the 'Analyze' button will produce a map representing your desired parameters. See the Climatological Analysis chapter for more in depth discussion of this tool, including a discussion of the Trend analysis method option.

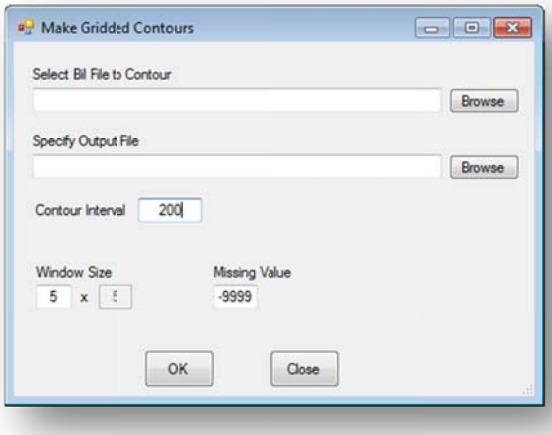


8) View Intra-seasonal Rainfall Summaries

The Rainfall Data Selection tool provides summaries of different periods. You can choose either the total, average, difference from average, or percent of average for a specific set of months, and select the output location. Make sure that the long term average is available in the same directory with the data.



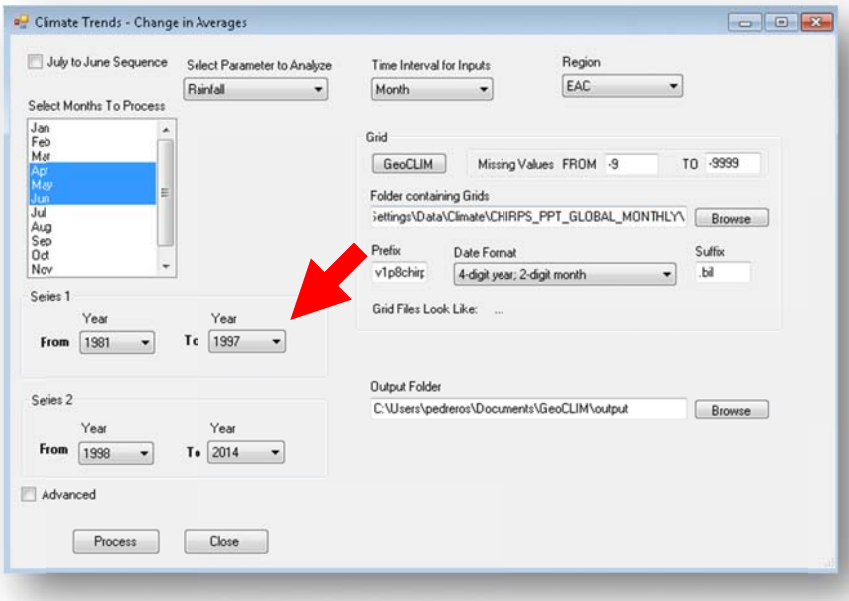
9) Make Contours



The 'Make Gridded Contours' tool allows you to specify a single interval on a selected map. To display contours for the specified interval, select the desired map (.bil file) and input a value (e.g., 200) into the Contour Interval field. The unit for this field is in millimeters for rainfall and Celsius for temperature. This tool is useful for comparing the change of contours from one period to another.

10) Calculate Long Term Changes in Average

The 'Climate Trends - Changes in Averages' tool compares the difference between averages for two specific periods. For example, you can select a set of months (season) and choose range of years (From to To) for Series 1 and Series 2 to ascertain how much the average rainfall or temperature has shifted over those two time periods.

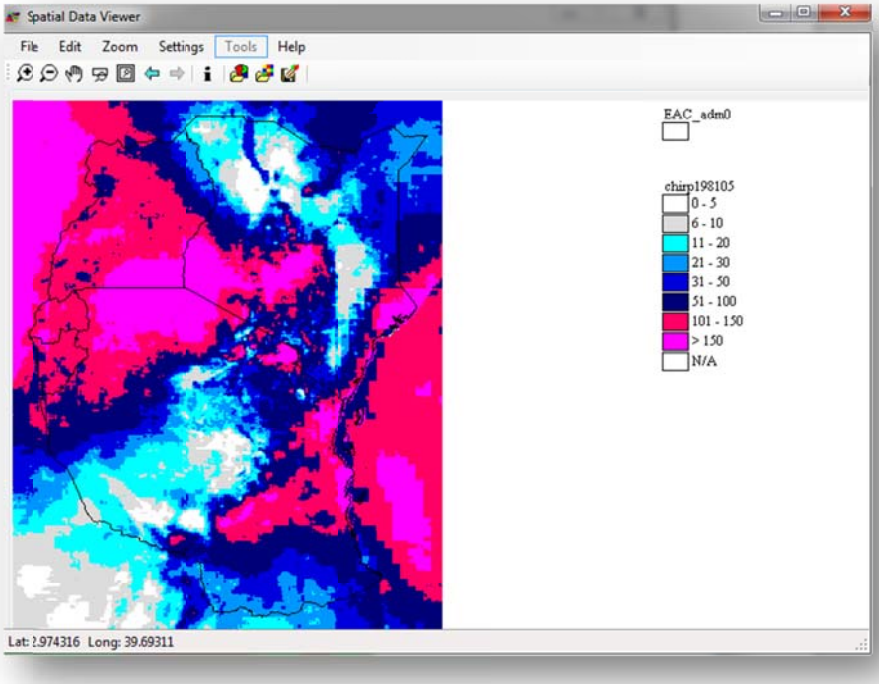


11) Batch Assistant for Easily Developing Automation Scripts and 12) Batch Editor for Editing Automation Scripts

The GeoCLIM contains a 'Batch Assistant' tool that helps create automated scripts for frequently run processes. The 'Batch Editor' allows you to manually change the code in the batch file without needing to go through all the steps of the 'Batch Assistant'.

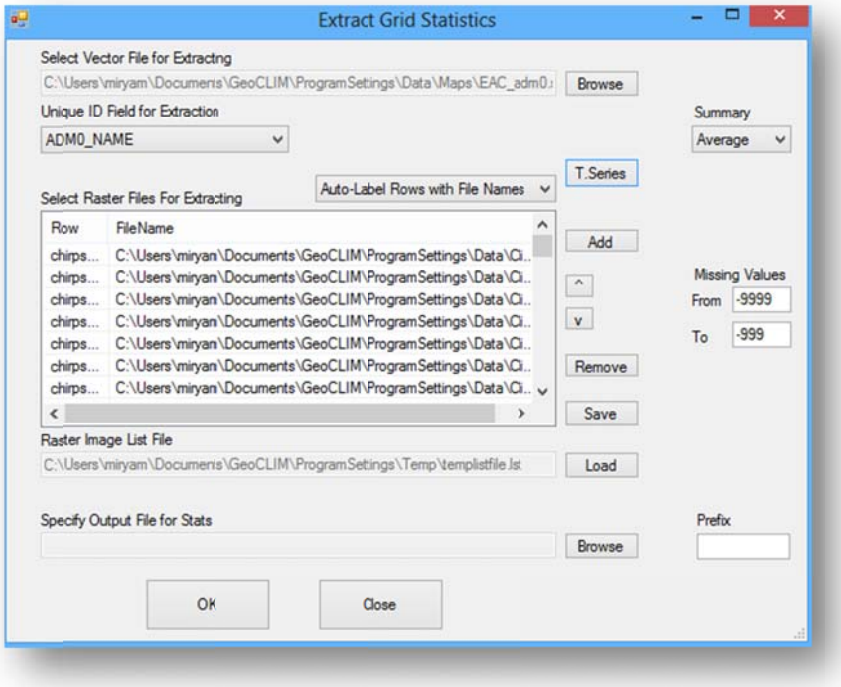
13) Display Spatial Data Such as Shapefiles and Raster Files

The Spatial Data Viewer allows you to view raster data, change the legend colors and ranges, bring in vector files, digitize over any region, and paint over a raster with a newly defined value. See the Spatial Data Viewer section for more details on this tool.



14) Extract Statistics from Raster Datasets

The Extract Grid Statistics tool allows you to calculate areal statistics such as areal averages, totals, and max for raster data over a given area (e.g. the average rainfall over District X in May 2007). You can use this to extract time series over a given area of interest, input a shapefile that defines the area or areas to analyze, and add any rasters required for that time series. For example, to analyze a hot spot as a possible problem area, you can digitize that region and use this tool to select all the historical rainfall data for the given polygon.



Chapter 2: Installation

System Requirements

- Microsoft Windows Operating System (XP or later)
- Microsoft .NET Framework v4.0. (Click here to download if needed).

Summary

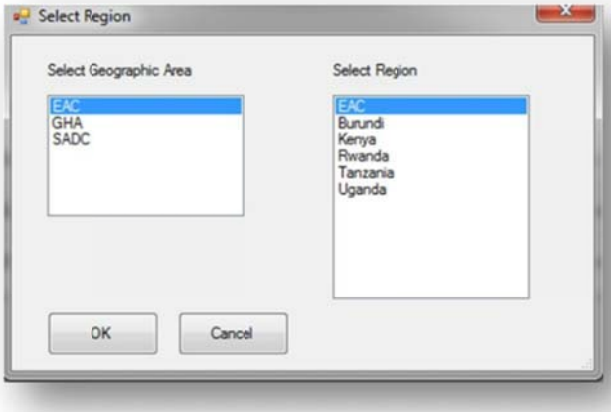
New versions of the GeoCLIM are released periodically as bugs are discovered and repaired or when performance improvements are implemented. This section will guide you through the process of downloading and installing the GeoCLIM. For video tutorials of this topic and more, please visit the CHG website at chg.geog.ucsb.edu/tools/geoclim/index.html.

Step 1: Download and Install the GeoCLIM

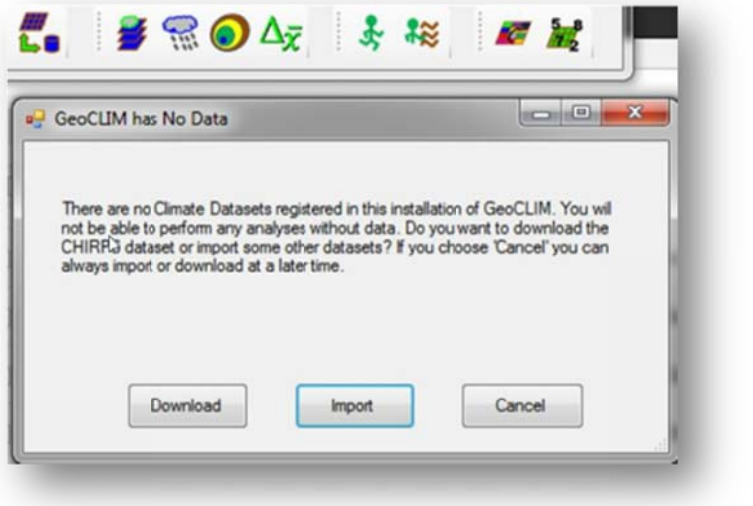
If an older version of the GeoCLIM is already installed, you will need to uninstall it in order to install the current version. To download the GeoCLIM application, go to the Climate Hazards Group's GeoCLIM wiki page (http://chg-wiki.geog.ucsb.edu/wiki/GeoCLIM) and select the latest GeoCLIM download. Once the file is downloaded, right click on the file and click 'Open', or double click on the file. If prompted, click 'Run' or 'Allow'. Follow the instructions on the subsequent dialogue boxes: click 'Next', accept the terms and click 'Next' again, click 'Next' to use the default installation directory or 'Browse' to change it, and then click 'Install'. Finally, click 'Finish' to close the installation window. The program can be run by navigating to the installation directory and double clicking on the GeoCLIM.exe (version names may differ), going to the Start Menu and selecting the program there, or double clicking on the desktop icon (if available).

Step 2: Select Geographic Area and Region

Once the GeoCLIM opens, choose a geographic area from the 'Select a Geographic Area' menu and a region or specific country from the 'Select Region' menu. Even if your region of interest is not available, you should still select one of the available regions. Adding regions of interest will be covered later on in the manual and creating a new region will be covered in the Advanced Topics chapter. Once the desired options are selected in the appropriate fields, click 'OK'.



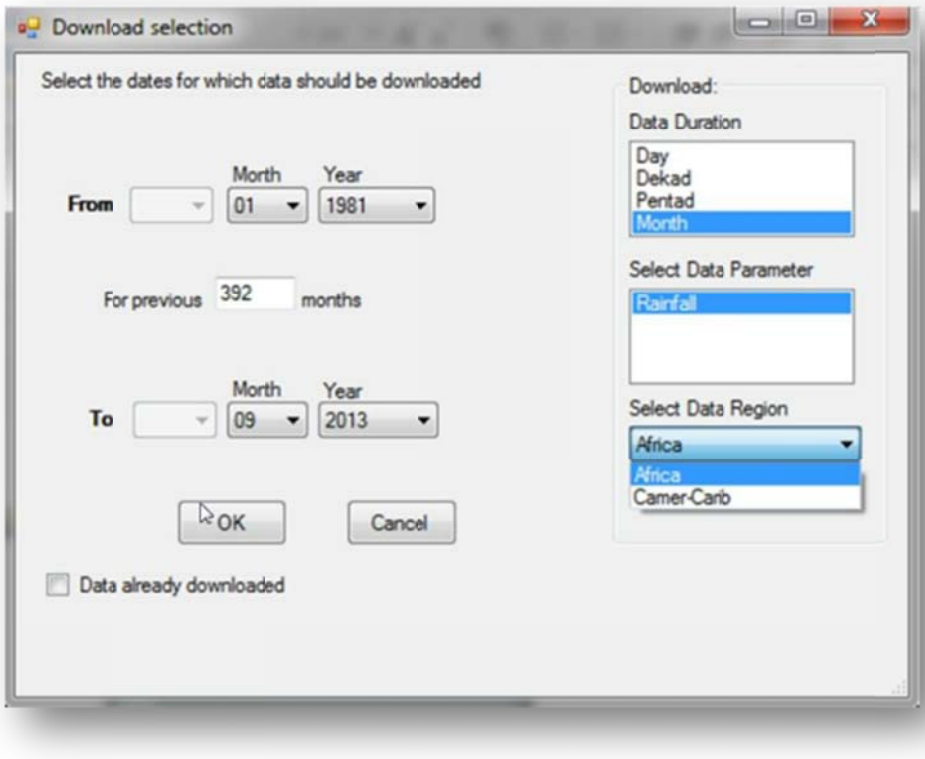
Step 3: Download or Import Data



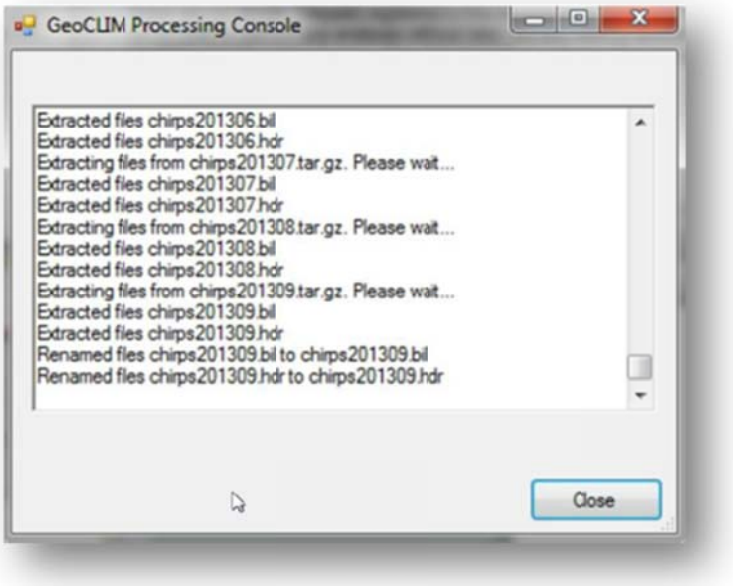
After the area selection window, you will see the "GeoCLIM has No Data" dialogue box. You can either (a) import existing archives (files created with an entire dataset - see ***Note 1*** below) into GeoCLIM by clicking 'Import' or (b) download the data by clicking 'Download'.

> ***Note 1:*** See the Creating Archives section for creating new archives. To download ready-to-install archives of CHIRPS, go to: ftp://chg-ftpout.geog.ucsb.edu/pub/org/chg/products/GeoCLIM/Geoclim_archives/

In the 'Download selection' window, select a period range for 'From' and 'To'. Select a duration segment from the 'Data Duration' menu (dekad, month, etc.). Selecting any data duration other than 'Month' will open up an additional option in the 'From' and 'To' sections. The user can also select a Data Parameter (Rainfall) and a Data Region. When all the desired options are chosen, click 'OK' to download the specified data.



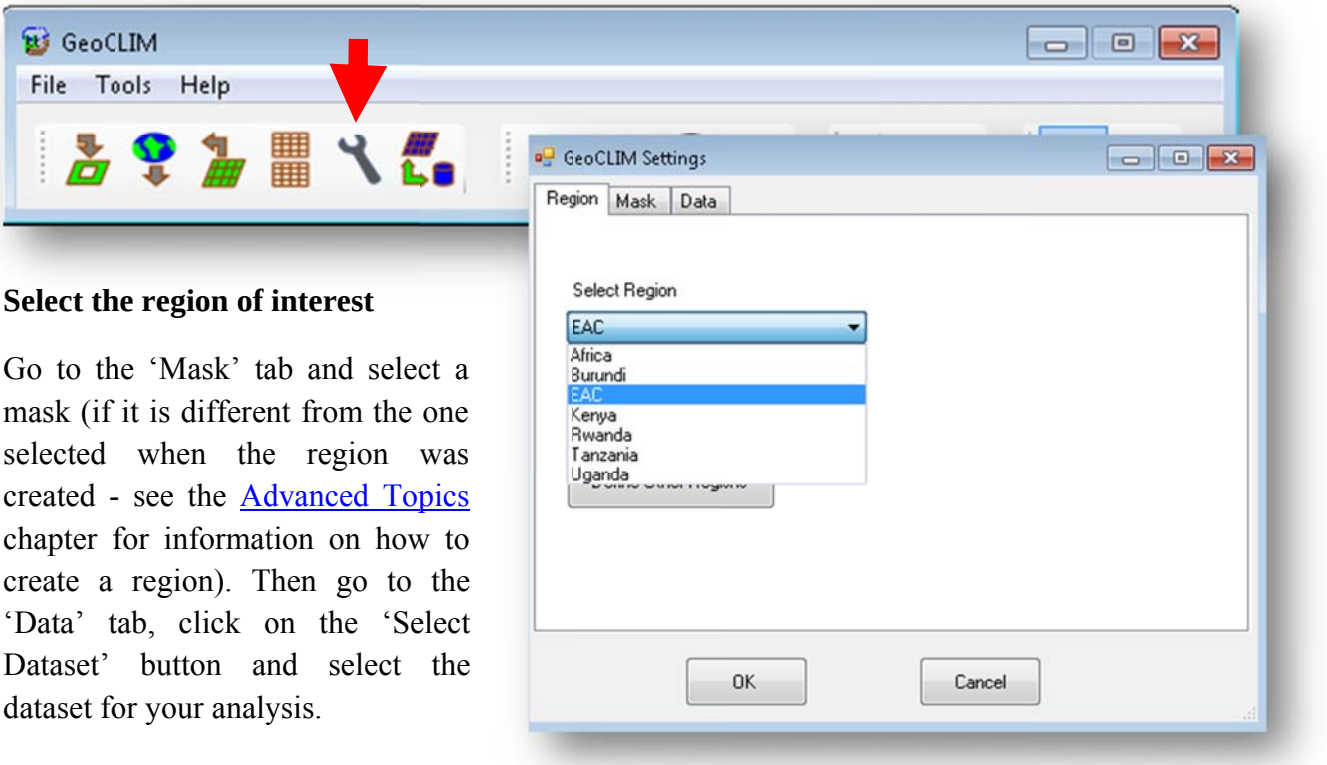
Note 2: At the time of this writing there are only two pre-defined regions, Africa and Central America.



Next you will see the 'GeoCLIM Processing Console' window, which shows the files downloading. When the download is complete, click 'Close'. Note that this may take a while depending on your computer or internet speed.

Setting up the GeoCLIM

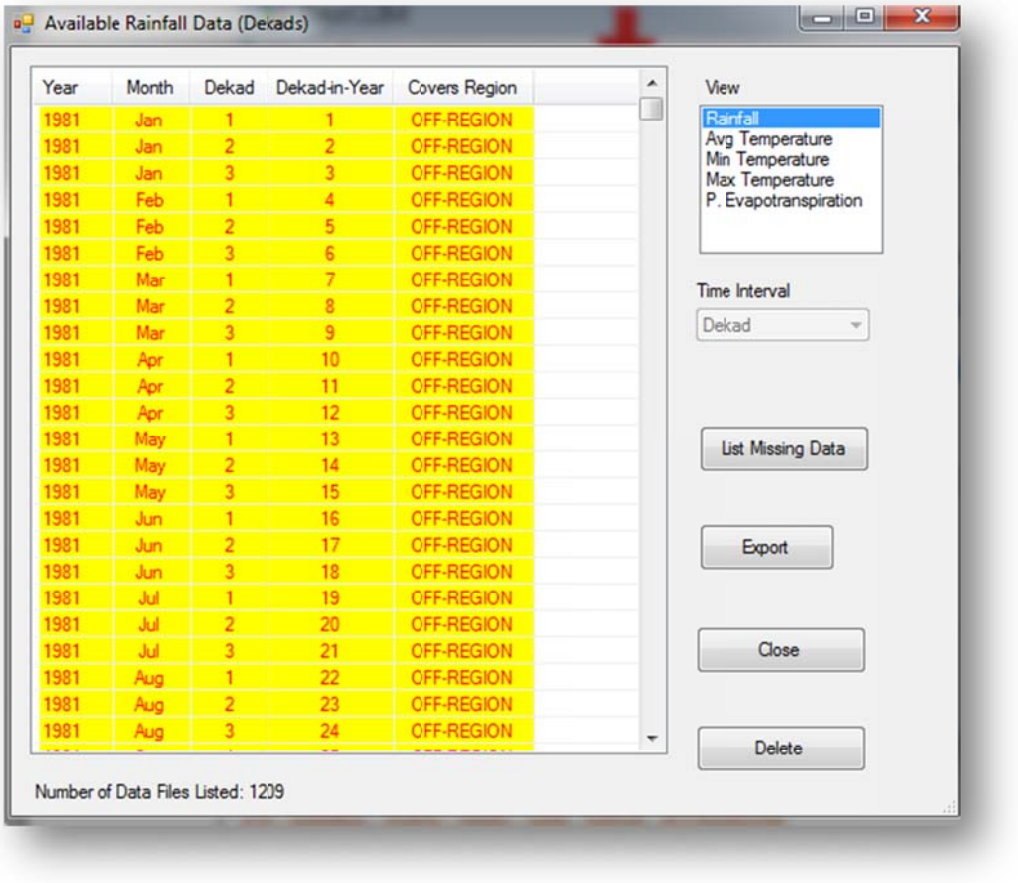
Once the dataset is installed, either by importing an archive or by downloading the files, you need to select the area of work. Click on the setup icon, as indicated below:



Select the region of interest

Go to the 'Mask' tab and select a mask (if it is different from the one selected when the region was created - see the Advanced Topics chapter for information on how to create a region). Then go to the 'Data' tab, click on the 'Select Dataset' button and select the dataset for your analysis.

To make sure that the data available covers the region selected, click on the icon and select the appropriate variable. If the table is filled and looks like the image below, the data and the region do not match. Make sure that the coordinates of the region are within the domain of the dataset (see the Advanced Topics chapter to learn how to create a new region).



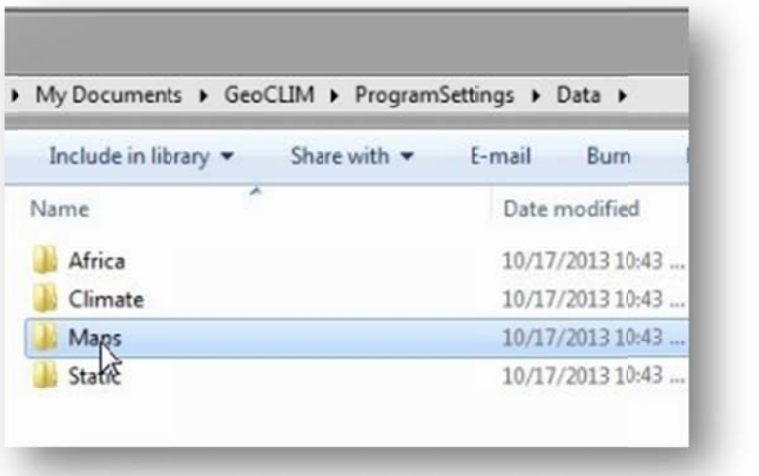
Step 4: Review Data

Now that all the data is downloaded, take a moment to review the directory structure and data paths. The main directory (in Windows Vista, 7, and 8) is

C:\Users\[USER]\Documents\GeoCLIM

where [USER] is the name of your home directory. There are two subdirectories in the GeoCLIM folder, 'Output' and 'ProgramSettings'. The 'Output' directory is where all the products or results will be saved. This default can be changed in the Output Options tool. Below is an outline of the contents of 'ProgramSettings':

- **Colors:** Default color files for legends and maps produced by the GeoCLIM.
- **Regions**: Files here define the different regions, or areas of work in the GeoCLIM. You can create new regions as needed (see the Advanced Topics chapter). GeoCLIM Regions are typically countries or regional groupings.



- **Data:**
  - ***Africa*** (Directory was created when we selected the African region during setup.)
  - ***Climate*** (All data downloaded are stored here. See the Creating Archives section for information on how to create a different directory to download another dataset.)
  - ***Maps*** (Contains all the shapefiles for the maps of the regions and countries required. Additional shapefiles/maps can be added to this directory.)
  - ***Static*** (This directory contains the masks. Masks are raster format maps that are used for keeping the area of work (region) in the analysis and blanking out everything else. Masks typically have a value of 1 over the area of work and values of 0 everywhere else, which makes computation faster and map display cleaner.
- **Temp:** Temporary files are stored here, such as the downloaded .tar.gz files.
- *Ftpdataregion.txt*: This file contains all the ftp addresses used to download data. The user can change ftp paths here as needed (see the Advanced Topics chapter).

Note 3: It is strongly recommended that you familiarize yourself with the structure of the 'ProgramSettings' directory.

Chapter 3: Data Types in the GeoCLIM

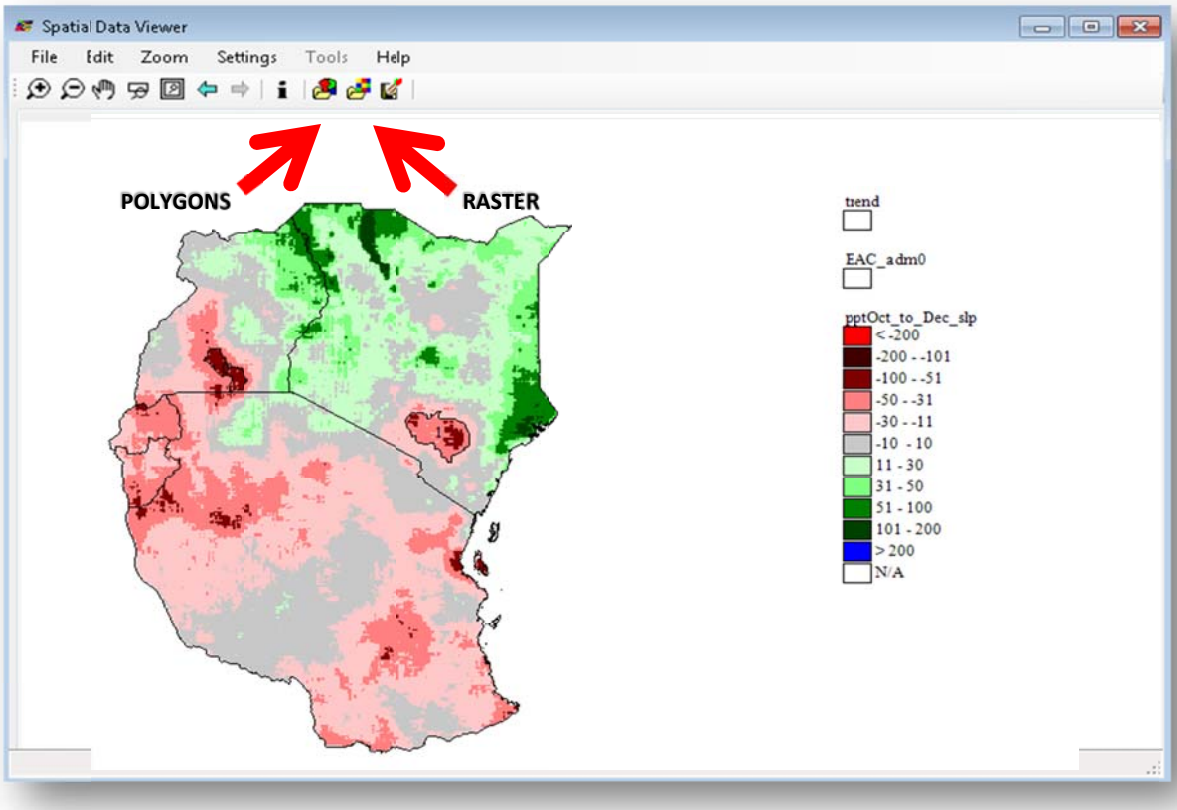
Summary

This section will examine the types of data that are used in the GeoCLIM. The GeoCLIM uses three main data types: rasters, shapefiles, and tables.

Examining Data Types

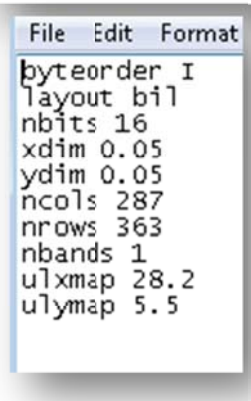
.bil and .hdr

To examine these data, open the Data Viewer via the icon indicated above and click the 'Open Raster Map' button (second to last icon, as indicated below, shaped like a colored grid going into a yellow folder), which will open the 'Select Raster Image' window. Once in the 'Select Raster Image' window, click the 'Browse' button next to the 'Select Raster File for Display' box to select a raster file (.bil). The file will open in Spatial Data Viewer (see Overview).



Opening a raster file is one way to find more information about it. For example, a raster file showing a value of positive 9999 (which in this case is the 'no data' value) is very important information to have. For more information on how to reclassify rasters using the GeoCLIM, see the Reclassifying Rasters section.

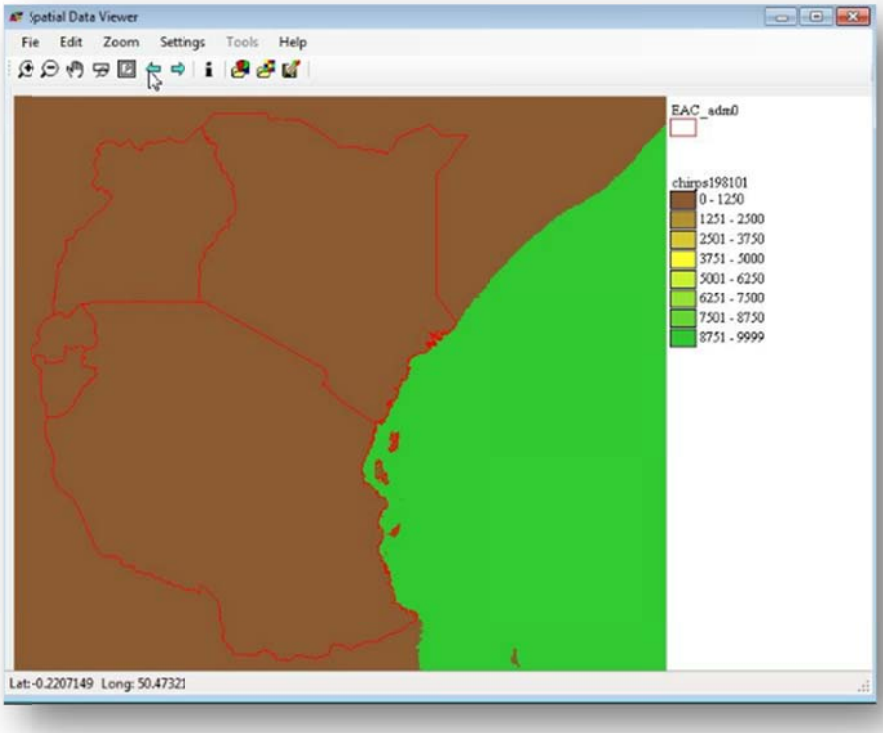
Delving deeper into the dataset, we find that a .bil file is made up of two main files: the .bil and its header file (.hdr). The .bil file is the file with the actual data (e.g. rainfall, temperature), while the .hdr file has geographic information pertaining to various location characteristics of the dataset. These two files have the same root name and make up the complete dataset. Changes to the name of the .bil file(s) need to be reflected in the .hdr file. The header can be shown in different formats (see below).



To take a closer look, open the HDR file in a text editor such as Notepad. The HDR file is fairly simple, but contains key information such as the number of columns, rows, bits, size of pixel, etc. The latitude and longitude values given indicate the upper left corner of our dataset. In this example, the pixel value is 0.05 (about five kilometers).

.shp

Another data type used by the GeoCLIM is shapefiles. To take a look at shapefiles, click the 'Open Vector Map' button (third to last icon, shown above labeled as "polygons", shaped like three colored shapes going into a yellow folder). Once in the 'Select Vector Map' window, click the 'Browse' button next to the 'Select Vector File for Display'

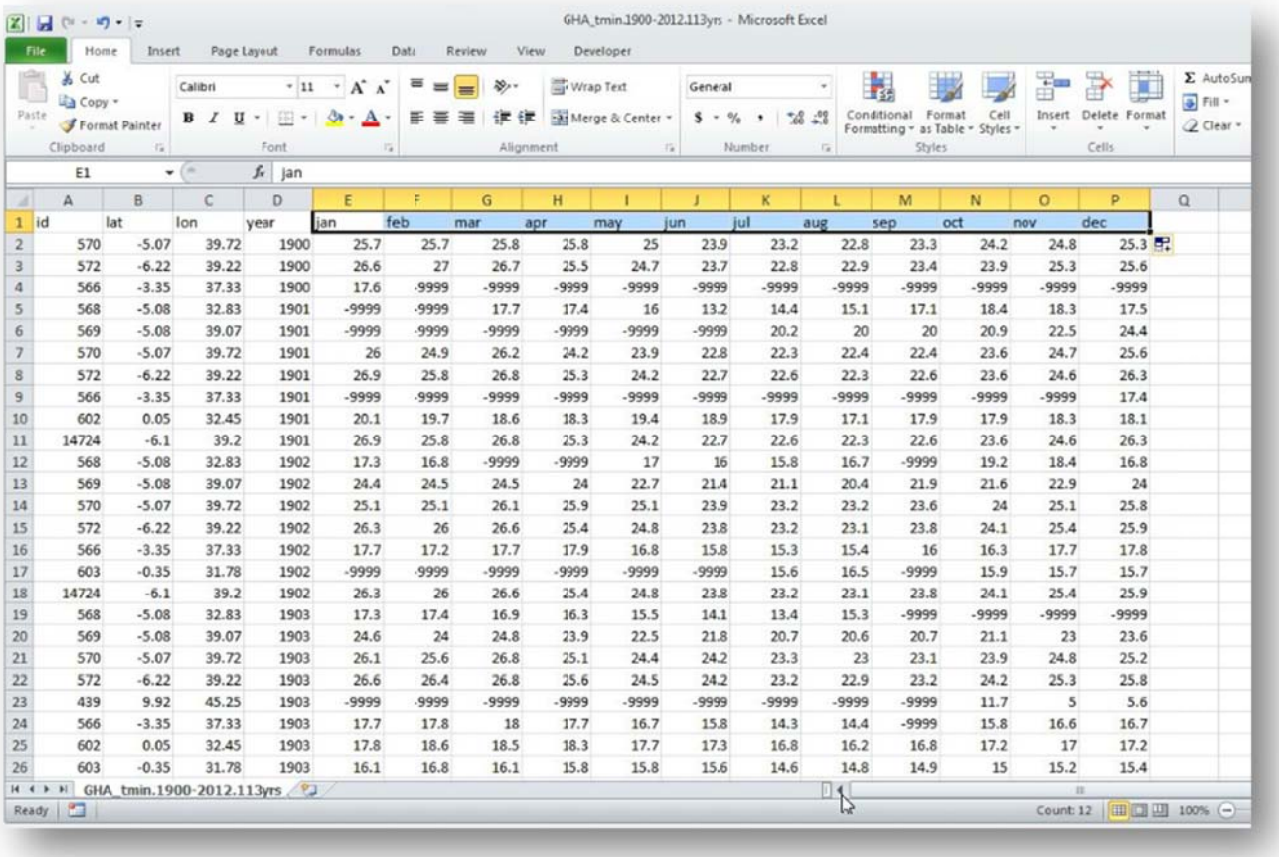


box to select a shapefile. Navigate to Data\Maps and choose the desired shapefile (.shp).

Once you have selected the desired shapefile, you have the option to change some presentational features, such as the color of the map outline. Click 'OK' to apply the shapefile. The result represents an area of focus within the larger area. For more information on how to create shapefiles using the Spatial Data Viewer, please see the Spatial Data Viewer section.

CSV Tables

Lastly, the GeoCLIM also uses CSV tables. These tables are used in the process of blending raster data with station values or to validate raster data. The CSV files are required to contain columns for ID, lat, long, year, and each period (in this case, the months January-December). The columns do not have to be in any particular order and additional metadata is permissible, but the time period columns listed must be present and chronologically arranged in the file in order for the tool to work.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	id	lat	lon	year	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	
2	570	-5.07	39.72	1900	25.7	25.7	25.8	25.8	25	23.9	23.2	22.8	23.3	24.2	24.8	25.3	
3	572	-6.22	39.22	1900	26.6	27	26.7	25.5	24.7	23.7	22.8	22.9	23.4	23.9	25.3	25.6	
4	566	-3.35	37.33	1900	17.6	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	
5	568	-5.08	32.83	1901	-9999	-9999	17.7	17.4	16	13.2	14.4	15.1	17.1	18.4	18.3	17.5	
6	569	-5.08	39.07	1901	-9999	-9999	-9999	-9999	-9999	-9999	20.2	20	20	20.9	22.5	24.4	
7	570	-5.07	39.72	1901	26	24.9	26.2	24.2	23.9	22.8	22.3	22.4	22.4	23.6	24.7	25.6	
8	572	-6.22	39.22	1901	26.9	25.8	26.8	25.3	24.2	22.7	22.6	22.3	22.6	23.6	24.6	26.3	
9	566	-3.35	37.33	1901	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	17.4	
10	602	0.05	32.45	1901	20.1	19.7	18.6	18.3	19.4	18.9	17.9	17.1	17.9	17.9	18.3	18.1	
11	14724	-6.1	39.2	1901	26.9	25.8	26.8	25.3	24.2	22.7	22.6	22.3	22.6	23.6	24.6	26.3	
12	568	-5.08	32.83	1902	17.3	16.8	-9999	-9999	17	16	15.8	16.7	-9999	19.2	18.4	16.8	
13	569	-5.08	39.07	1902	24.4	24.5	24.5	24	22.7	21.4	21.1	20.4	21.9	21.6	22.9	24	
14	570	-5.07	39.72	1902	25.1	25.1	26.1	25.9	25.1	23.9	23.2	23.2	23.6	24	25.1	25.8	
15	572	-6.22	39.22	1902	26.3	26	26.6	25.4	24.8	23.8	23.2	23.1	23.8	24.1	25.4	25.9	
16	566	-3.35	37.33	1902	17.7	17.2	17.7	17.9	16.8	15.8	15.3	15.4	16	16.3	17.7	17.8	
17	603	-0.35	31.78	1902	-9999	-9999	-9999	-9999	-9999	-9999	15.6	16.5	-9999	15.9	15.7	15.7	
18	14724	-6.1	39.2	1902	26.3	26	26.6	25.4	24.8	23.8	23.2	23.1	23.8	24.1	25.4	25.9	
19	568	-5.08	32.83	1903	17.3	17.4	16.9	16.3	15.5	14.1	13.4	15.3	-9999	-9999	-9999	-9999	
20	569	-5.08	39.07	1903	24.6	24	24.8	23.9	22.5	21.8	20.7	20.6	20.7	21.1	23	23.6	
21	570	-5.07	39.72	1903	26.1	25.6	26.8	25.1	24.4	24.2	23.3	23	23.1	23.9	24.8	25.2	
22	572	-6.22	39.22	1903	26.6	26.4	26.8	25.6	24.5	24.2	23.2	22.9	23.2	24.2	25.3	25.8	
23	439	9.92	45.25	1903	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	-9999	11.7	5	5.6	
24	566	-3.35	37.33	1903	17.7	17.8	18	17.7	16.7	15.8	14.3	14.4	-9999	15.8	16.6	16.7	
25	602	0.05	32.45	1903	17.8	18.6	18.5	18.3	17.7	17.3	16.8	16.2	16.8	17.2	17	17.2	
26	603	-0.35	31.78	1903	16.1	16.8	16.1	15.8	15.8	15.6	14.6	14.8	14.9	15	15.2	15.4	

Chapter 4: Creating Archives

Summary

The GeoCLIM recognizes only data that have been downloaded directly using the tool or imported from an archive. This chapter will go over how to create a data archive and import it into the GeoCLIM. For a brief review of GeoCLIM data settings, click the wrench/spanner ( ) icon on the main GeoCLIM toolbar to bring up the 'GeoCLIM Settings' window, then click the 'Data' tab followed by the 'Select Dataset' button. All the data listed here in the 'Use User-defined' window is data that have been imported, read, or otherwise recognized by the GeoCLIM. In order to introduce new data to the GeoCLIM, there is a series of simple but important steps that allow the GeoCLIM to see and use new data.

Create an Archive

Step 1: Data Directory

Create a new Data directory (e.g., 'test_archive_Monthly').

Step 2: File and Filename Format

Add all the rainfall files to this directory in .bil format. Make sure that the filenames use the following naming convention: xxxYYYYMM.bil and xxxYYYYMM.hdr. Where:

- YYYY is the year in 4 digits (e.g. 1981, 2008, etc.)
- MM is the month in 2 digits (e.g. 03 for March, 11 for November, etc.)
- xxx is the file prefix (e.g. "ppt", "mintmp", etc.)

So the filenames for "mintemperature" for September 1987 would be mintmp198709.bil and mintmp198709.hdr.

Step 3: Create the '_dataset' File

Using a text editor (like Notepad), create a file with the following information and include it in the newly created data directory:

```
BEGIN DATASET
 DATASETNAME test_archive_Monthly
 DATATYPE ppt
 DATAPREFIX xxx
 DATADATEFORMAT YYYYMM
 DATASUFFIX .bil
 DATAMISSINGFROM -99
 DATAMISSINGTO -99
END DATASET
```

This is the file that the GeoCLIM uses to "read" the archive. Name the file '_dataset'. Visit the GeoCLIM page on the CHG wiki for more details on how to make a '_dataset' file.

Step 4: Edit the '_dataset' File

Once you have copied this information into Notepad, you will need to alter the values of the variables to match the archive's contents. For example, if the archive directory is called 'test_archive_Monthly', the DATASETNAME value will need to match the archive directory name. The DATATYPE is ppt (which denotes precipitation). Verify that the DATAPREFIX value matches the prefix, or characters before the date, of all the files (e.g., if the files start with chg, then the DATAPREFIX value should be chg). The DATADATEFORMAT should be YYYYMM (four digits for the year and two digits for the month, in that order, such as 198101) for months, PT for pentads, and EK for dekads. The DATASUFFIX value should be every character after the DATAPREFIX and DATADATEFORMAT, including the .bil. For example, DATASUFFIX for the filename chirps198709v2.bil would be "v2.bil".

Finally, the values for DATAMISSINGFROM and DATAMISSINGTO must match the dataset's 'no-data' values (since different datasets have different values to represent 'no-data'). Once all the values have been verified as correct, save the Notepad file to the relevant archive directory. The _dataset file can be saved as a .txt, but saving the '_dataset' file with quotation marks (i.e., "_dataset") will prevent the Windows from adding the file extension.

Step 5: Compress the Data

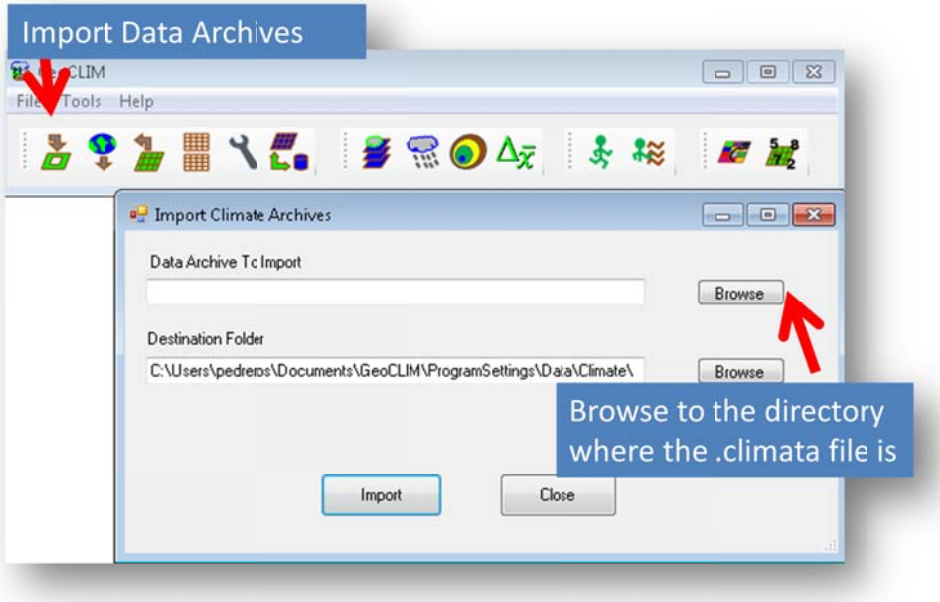
Once the _dataset file is correct and in place, compress the data directory by right clicking on the folder and selecting 'Send To' > 'Compressed (zipped) folder'. This will create a compressed .zip file with the same name as the dataset (e.g., 'test_archive_Monthly'). The file extension needs to be changed from .zip to .climdata, so right click on the newly created .zip file, select 'Properties', and change the .zip

extension to .climdata. If you cannot see the '.zip' extension on the archive file, see ***Note 4***.

> ***Note 4:*** If you cannot see extensions in your files like ".zip", you need to change the Windows settings. First, open up a file explorer window to the relevant directory. Then click the 'Organize' dropdown menu button in the top left corner and select 'Folder and Search Options'. In the Folder Options window, click the 'View' tab and uncheck the box for 'Hide extensions of known file types'. Click 'Okay' to exit the Folder Options window.

Step 6: Import the Newly Created Archive

Now that the actual archive is prepared (the .climdata file), click the 'Import Climate Data Archives' icon on the GeoCLIM main tool bar, which brings up the 'Import Climate Archives' window. Click the 'Browse' button next to the 'Data Archive To Import' field and navigate to the prepared .climdata file. Verify that the 'Destination Folder' is the GeoCLIM\ProgramSettings\Data\Climate directory and click the 'Import' button to import the data. Please note that importing can take a while. When the importing process is complete, the importing window will display a message to that effect.



Step 7: Verify Data

Once the importing is complete, verify that the new archive is available by clicking the wrench/spanner icon to go to 'GeoCLIM Settings', then click the 'Select Dataset' button in the Data tab. The new archive should be available in the 'Use User-defined' window. Clicking the 'View Available Data' icon (fourth icon from the left) will show all the data in 'Available Rainfall Data (Months)'. Finally, open Spatial Data Viewer to make sure the data is showing the same values as the source dataset. When you click on the legend for the raster, you will be able to see not only the latitude and longitude of the pixels you hover over in the raster, but also the pixel value.

Review

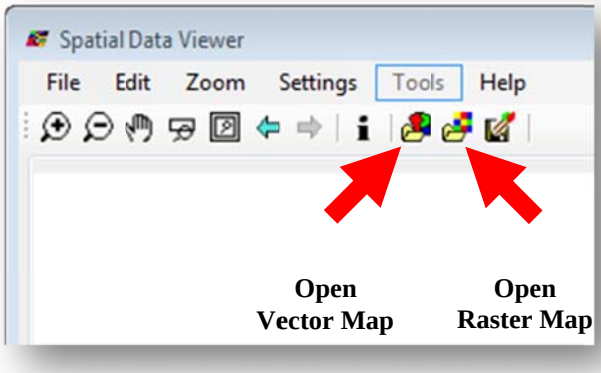
To create an archive file that the GeoCLIM can "read", create a directory with all the uncompressed .bil data files, then place within the directory a '_dataset' file which contains the required text with specific adjustments for the particular dataset. Then compress this dataset directory and change the resulting compressed file's file extension to .climdata. It is highly recommended that you verify the data using the tools in the GeoCLIM.

Chapter 5: Spatial Data Viewer

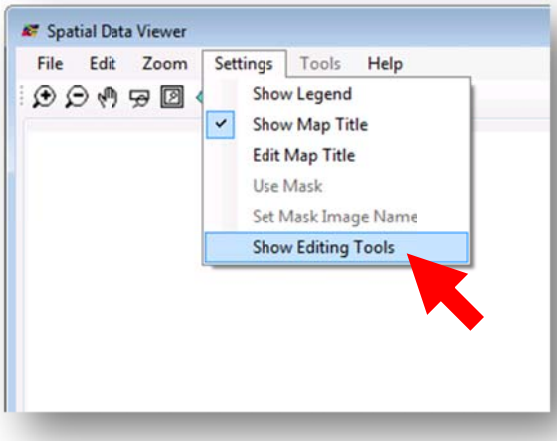
Summary

The spatial data viewer performs the following functions:

- **Edit spatial data**
  - Edit raster data values
  - Digitize polygons, create shapefiles
- **Display raster and vector data**



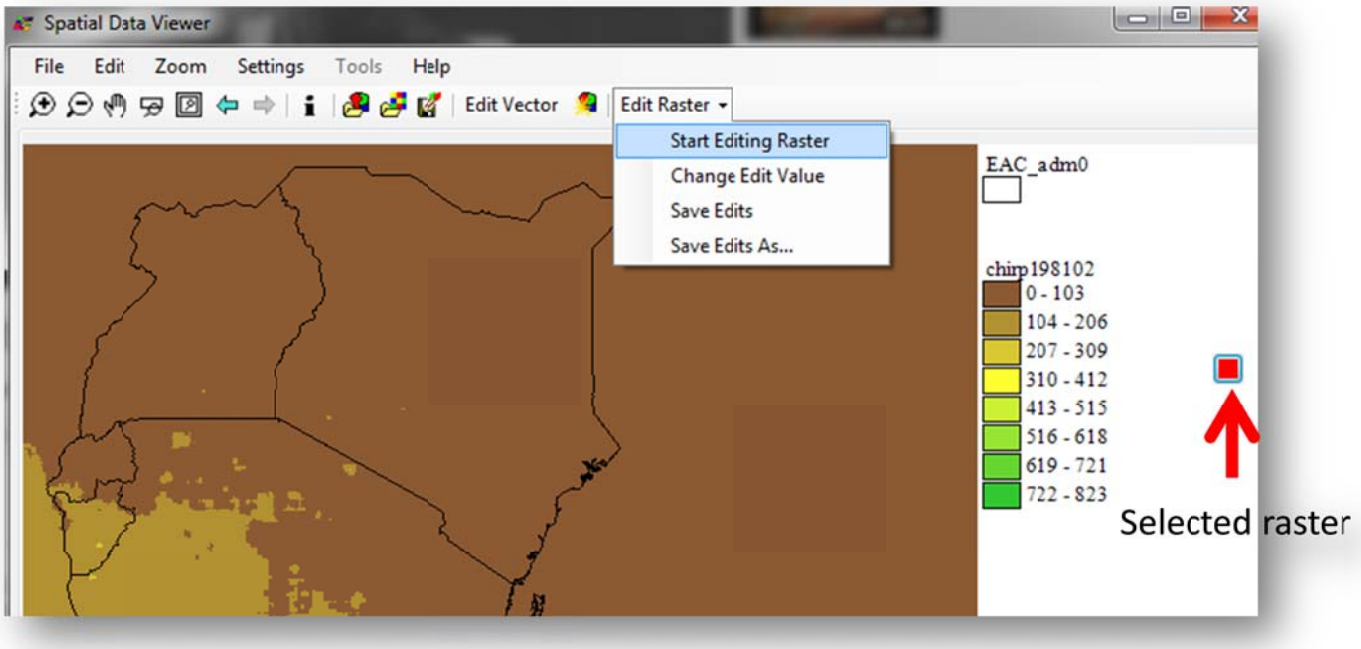
Editing Spatial Data



In order to edit spatial data, you must activate the Spatial Data Viewer's editing tools. To start editing, click the 'Settings' dropdown menu in the Spatial Data Viewer and select 'Show Editing Tools'. Two menus will appear - the 'Edit Vector' button and the 'Edit Raster' dropdown menu.

Editing Rasters

The Edit Raster tool enables you to change pixel values by painting over the raster. In order to do this, you must:

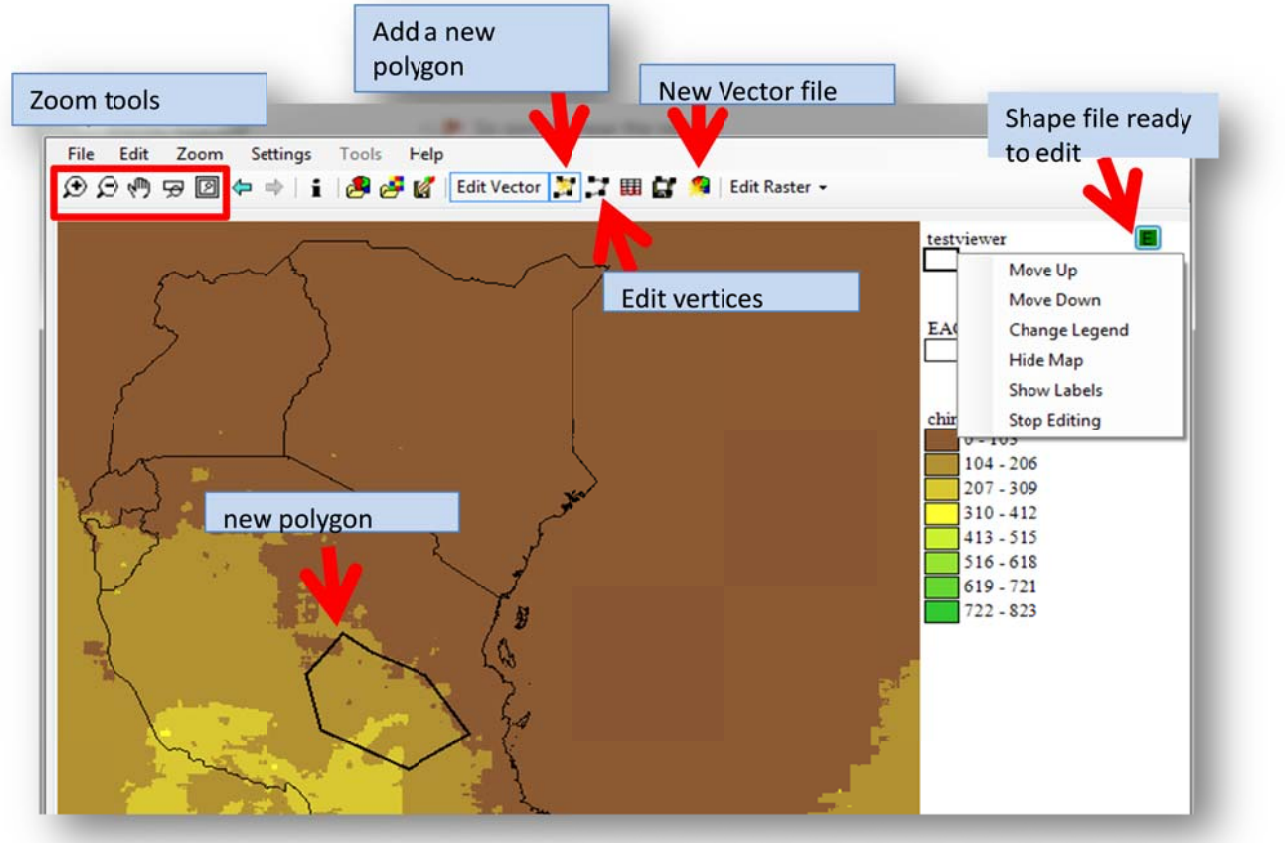


1. Select the raster to be edited by clicking on the legend for that raster. A red square will appear next to the legend, indicating that the raster is ready.
2. From the Edit Raster menu, select 'Start Editing Raster'.
3. Add the new value to be painted and select the size of the brush (between 1 and 10).
4. Start painting over the raster.
5. To finish, click on the 'Edit Raster' drop down menu again and select 'Save Edits'.

Note 5: Once the raster is selected, you can see information about the latitude (Lat), longitude (Long), and the value of the pixel in the bottom left corner of the Spatial Data Viewer.

Digitizing Polygons

Use this tool to create and edit polygons by following the instructions below.



1. Make sure that none of the zoom tools (first four tools from the left) are selected.
2. Click the 'Settings' dropdown menu and select 'Show Editing Tools'. Two menus will appear - the 'Edit Vector' button and the 'Edit Raster' dropdown menu.
3. Click the 'Edit Vector' button. Four additional tools will open. The tools are, respectively:
    a. Add a new polygon (*New Feature*)
    b. Edit Vertices
    c. Edit Attribute Table
    d. Save As Shapefile
    e. Create a new shape file/vector (*New Vector File* - this option exists before clicking 'Edit Vector').
4. Click the 'New Vector File' icon, browse to the directory where the new shapefile will be saved, and give the file a name.
5. Right click on the empty shapefile on the right side of the map viewer and select 'Start Editing'. A green box with an 'E' indicates that the file is ready to be edited.

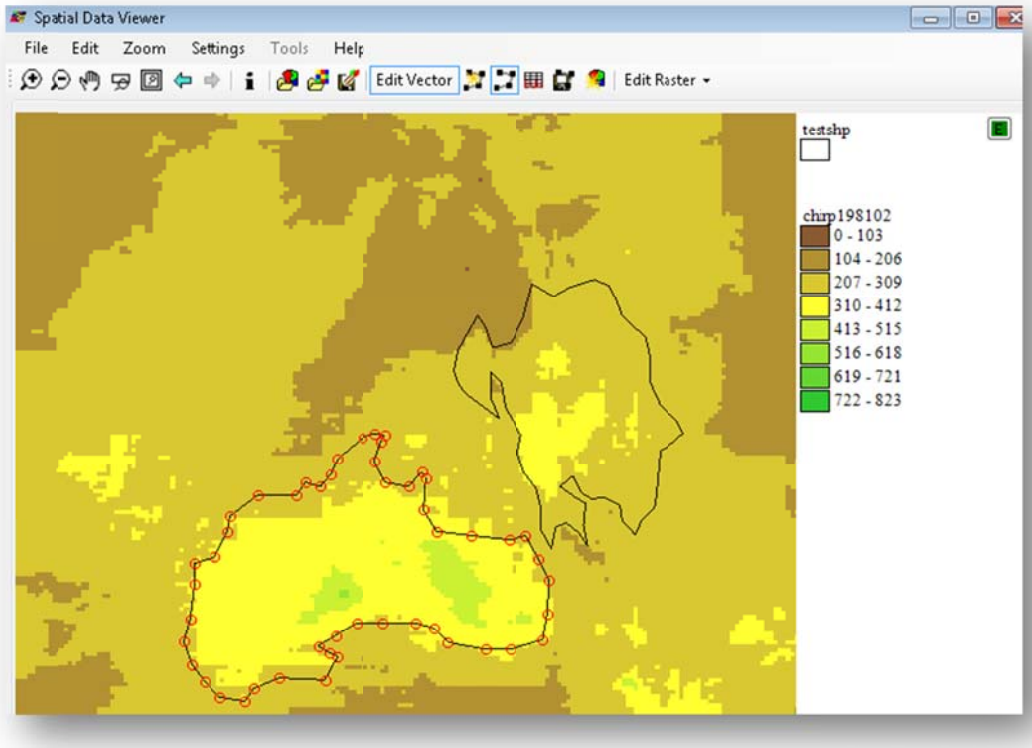
6. Make sure that the 'New Feature' icon is activated (indicated by a blue line around the icon) and start digitizing. Every click makes a new vertex. Right click to close a polygon. Once the polygon is closed, the user can start digitizing a new polygon.
7. To save the new polygons, click the fourth 'Edit Vector' icon (*Save As Shapefile*).
8. To stop editing, right click on the shapefile's legend and select 'Stop Editing'. Note that the 'E' (or green square) disappears.

Note 6: See The Spatial Data Viewer video tutorial on the CHG website for more details.

Note 7: It is important to remember that the GeoCLIM **is not** a full GIS tool. The GeoCLIM is missing some features common to full GIS tools, such as the ability to "undo". Therefore, if you make a mistake, you will have to start over. It is highly recommended that you save often (and, if practical, keep some older iterations as well).

Editing Vertices

If you need to edit polygons, you must do the following:



1. Right click on the legend of the shape file and select 'Start Editing'.
2. Click the 'Edit Vertices' button (second from the left of the 'Edit Vector' icons).

3. Click on the polygon to be edited until all vertexes show up as dots along the perimeter of the polygon.
4. To adjust the shape of the polygon, simply click on a vertex dot and move it to the desired location.

Note 8: It is highly recommended that you save the shapefile after finishing adjusting each polygon, as there is no undo function. Once all required changes are made, you should make sure to save the shapefile one final time. Also, remember to right click on the shapefile's legend and select 'Stop Editing'.

Note 9: If you are unable to make the necessary changes, one solution may be to close down the Spatial Data Viewer and reopen as detailed above.

Labels in Shapefiles

In order to display labels of polygons in the Spatial Data Viewer (if desired), you must:

1. Right click on the legend of the shapefile and select 'Show Labels'. This brings of the 'Define Labels' window.
2. Select the data field with the values you wish to be displayed as labels. For the shapefiles that come with GeoCLIM by default, this will be "PRIM_ID'.

Chapter 6: Station Blending and BASIICS

Summary

Satellite data provide very useful information on rainfall or temperature patterns, but sometimes the data contain some biases and inaccuracies due to incorrect or limited calibration with ground data. Also, sometimes raster data have low resolution, meaning that the size of the pixel is too large for the area of interest. These datasets could be improved by combining them with ground station values. The **B**ackground-**A**ssisted **S**tation **I**nterpolation for **I**mproved **C**limate **S**urfaces (BASIICS) tool blends gridded datasets, such as satellite data, with point datasets, particularly station. This blending is done using a modified Inverse Distance Weighting (IDW) approach that borrows some concepts from the kriging, particularly the use of the concepts of simple and ordinary kriging. The basic process uses two datasets: (1) a point dataset with values at discrete points in space (e.g., rain gages) and (2) a grid dataset with values varying continuously over space (e.g., a satellite-based rainfall estimate grid or a climatic average). For the algorithm to be used effectively, the two datasets need to be correlated. The first step in the algorithm is to extract values from the grid at all locations where the point data have valid values (missing values can be specified by the user). This produces a comparable dataset of grid values that can be directly compared to the point values. The program can also carry out a least squares regression between the collocated point and extracted grid values and output the R-squared value in a statistical diagnostic file.

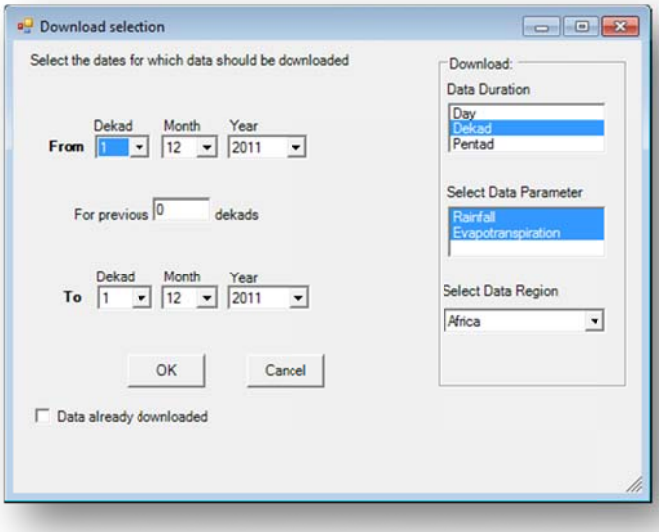
To produce the best possible gridded rainfall/temperature datasets using the GeoCLIM, we recommend a four step process:

1. Download or import the raster dataset to be improved into the GeoCLIM.
2. Validate the rainfall estimates.
3. Improve the rainfall estimate by blending the stations.
4. Edit batch files to run the algorithm for subsequent periods.

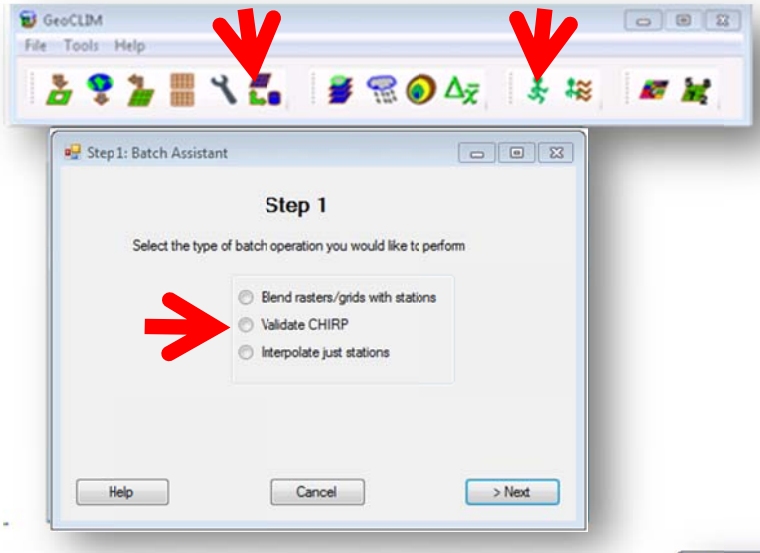
Step 1: Download or Import Rainfall Estimates

To download the rainfall estimates, click on the Downloading button on the toolbar. See the Creating Archives chapter for more information on how to create and import and archives.

This will open an input box which will allow you to choose the dates and type of data you want to download. By default, you are offered the most recent data (which is for the previous period). Enter the 'From' and 'To' dates and select the time period to download. Select the data type and region (Africa or Central America) and click 'OK' – this will download the data. For other regions you will need the global datasets. See the Advanced Topics chapter.

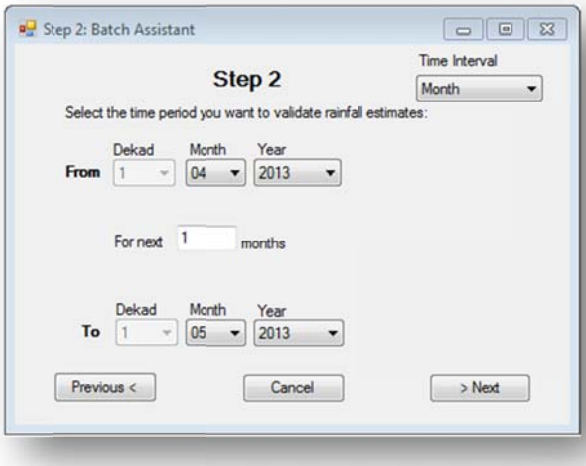


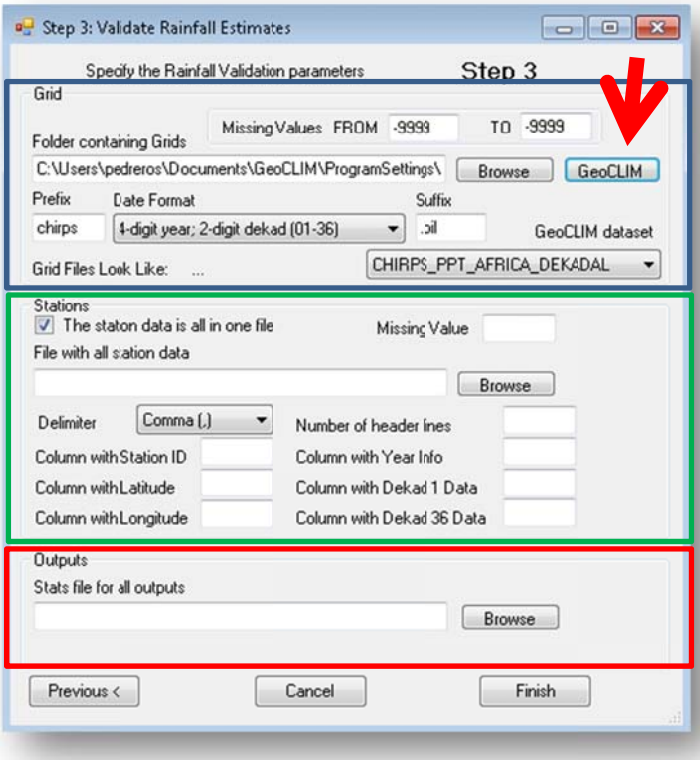
Step 2: Validating Rainfall Estimates



This tool allows you to validate the rainfall estimates and see how well they compare to the rain gauge data. Use the Batch Assistant or the BASIICS tool to open the Step 1 dialog box and select the 'Validate CHIRP' option, then click the '> Next' button.

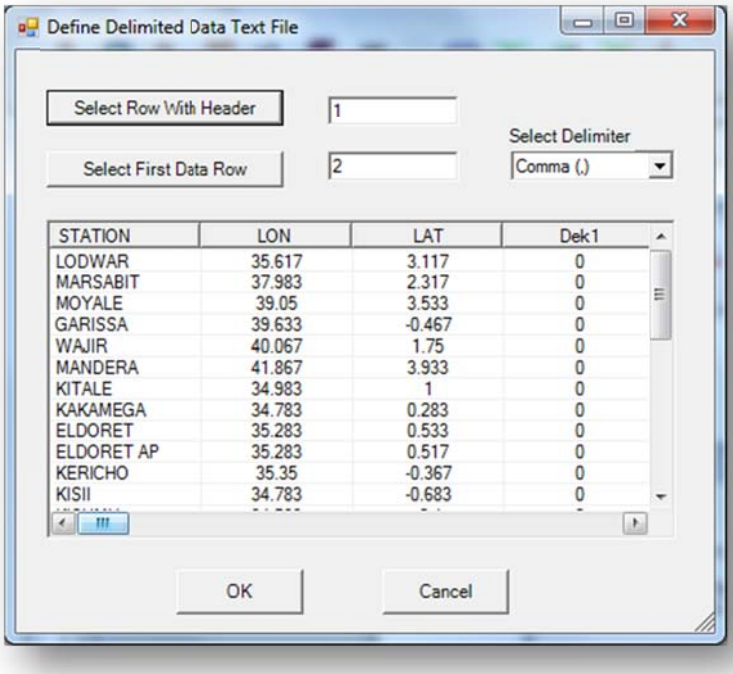
In the Step 2 dialogue box, select the date or dates of the rainfall estimate to be validated. Click next to proceed to Step 3 of the validation process.





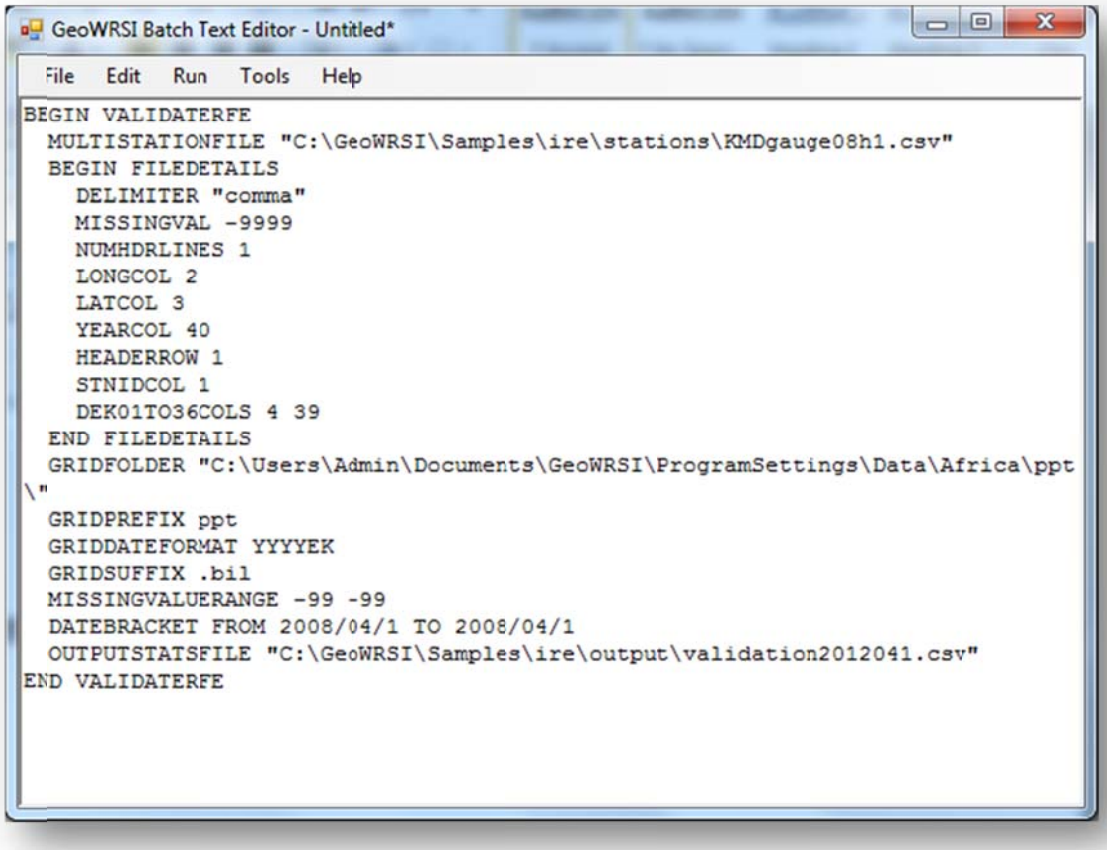
Step 3 has three sections. In the first section, specify the raster parameters. Here you will need to indicate the file path to the gridded data. If the data to be validated are the default dataset selected during the GeoCLIM setup, just click the GeoCLIM button and the fields will be populated. Otherwise, browse to the directory with the relevant data. In the stations section, click check the box for "The station data is all in one file", then select the file which contains the station data. Remember, a CSV file must be used. See the Data Types chapter for more information on the format of the table and other file types in the GeoCLIM.

After selecting the stations file, a dialog box will appear where you can define the format of the station file – the header row (usually row 1), the first row that contains actual data (usually row 2), and the delimiter (usually a comma). Make any necessary changes for the correct specifications. Click 'OK' when all the specifications are defined.



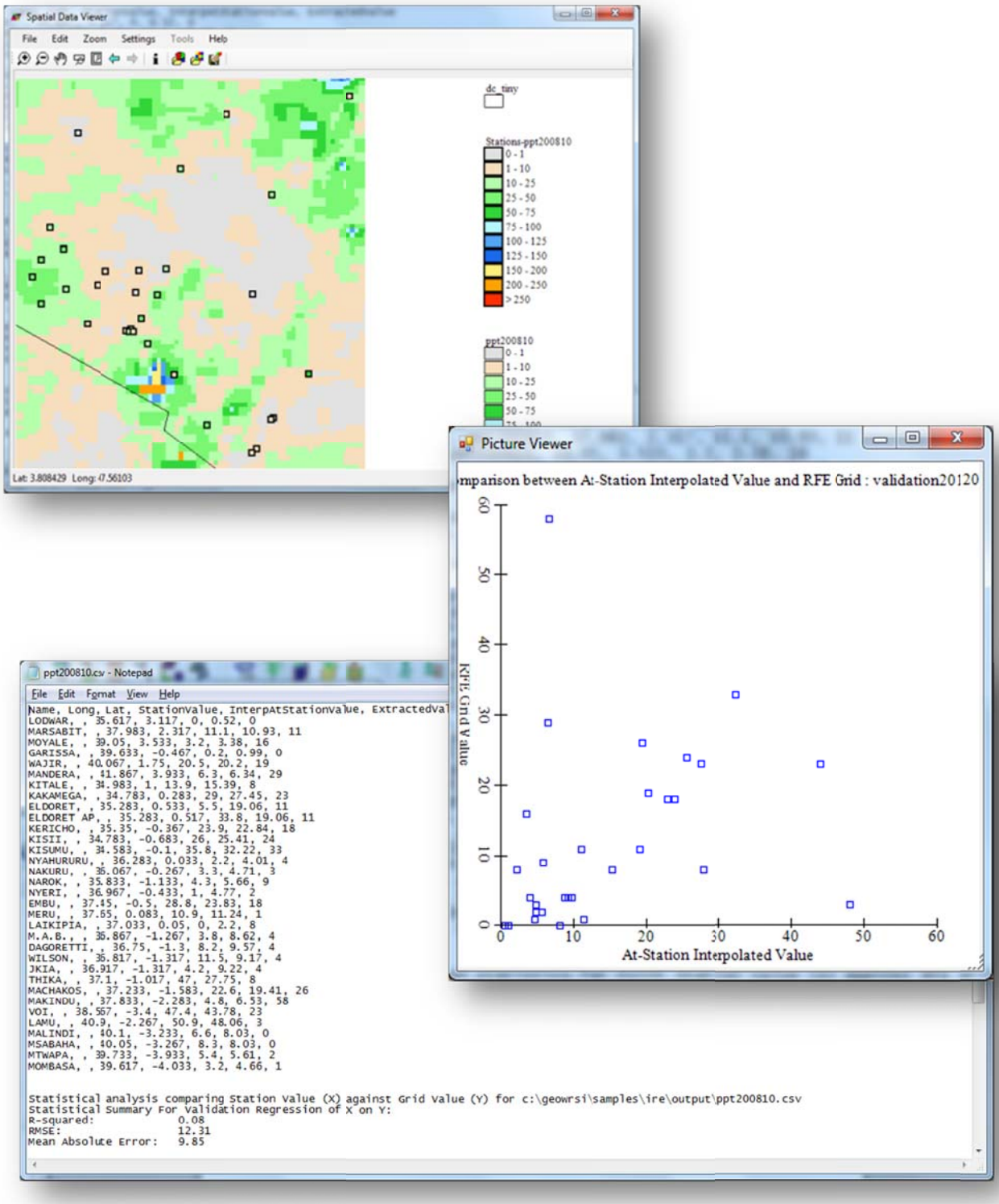
To finish off the station specifications, make sure that the columns with Station ID, Latitude, Longitude, Year Info, and the first and last period (the period could be pentad, dekad, or monthly), as well as the missing value, have all been specified. Click on any of the boxes to specify any given column. Finally, specify the file where the statistical outputs will be written. When all these items have been specified, click Finish.

You will be presented with a batch file which you can save for future reference.



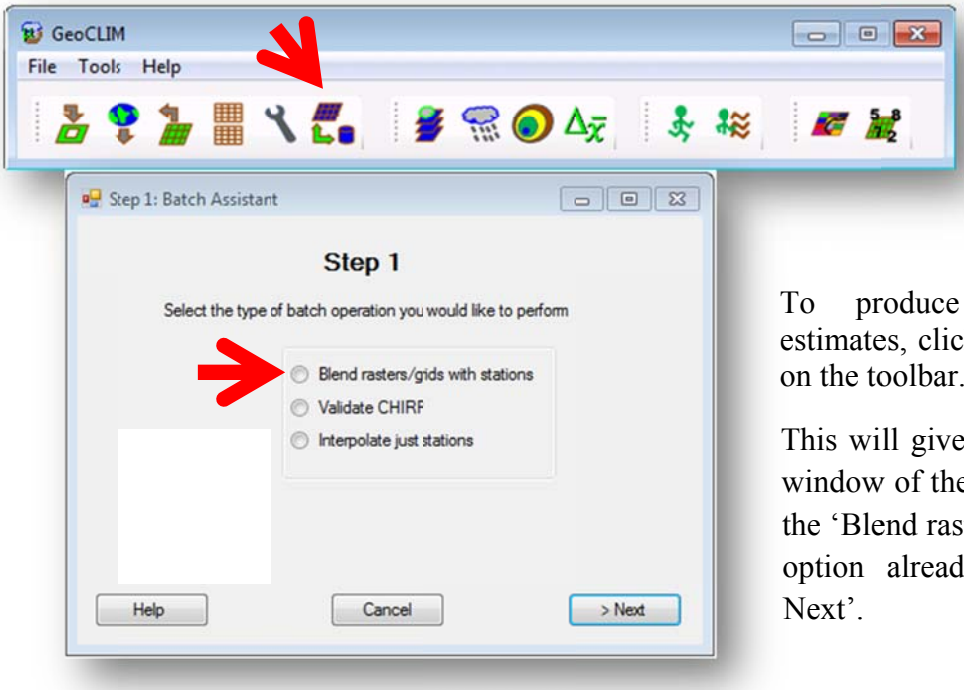
When the batch file is run, you will get the following output: (1) a map showing the stations used for validation as well as the rainfall field value, (2) a scatterplot showing the rainfall field values against the stations, and (3) statistics showing how well the rainfall field and station data are related.

Note 10: A map output will only be displayed if a single date is selected for validation. If multiple dates are selected, the map graphics will be written to hard disk (in the same folder as the output file) but will not be displayed.



These outputs give the basis for running the algorithm that combines the rainfall fields with the station data.

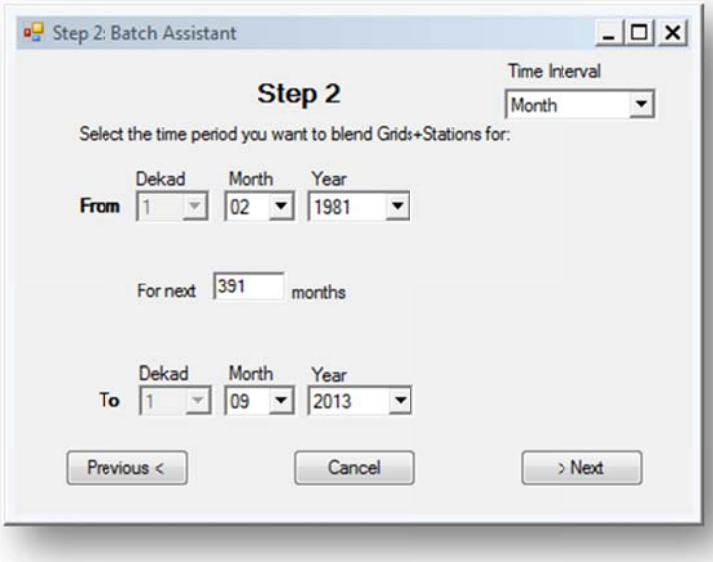
Step 3: Improving the Rainfall Estimate Using the GeoCLIM Blending Algorithm



To produce improved rainfall estimates, click the BASIICS button on the toolbar.

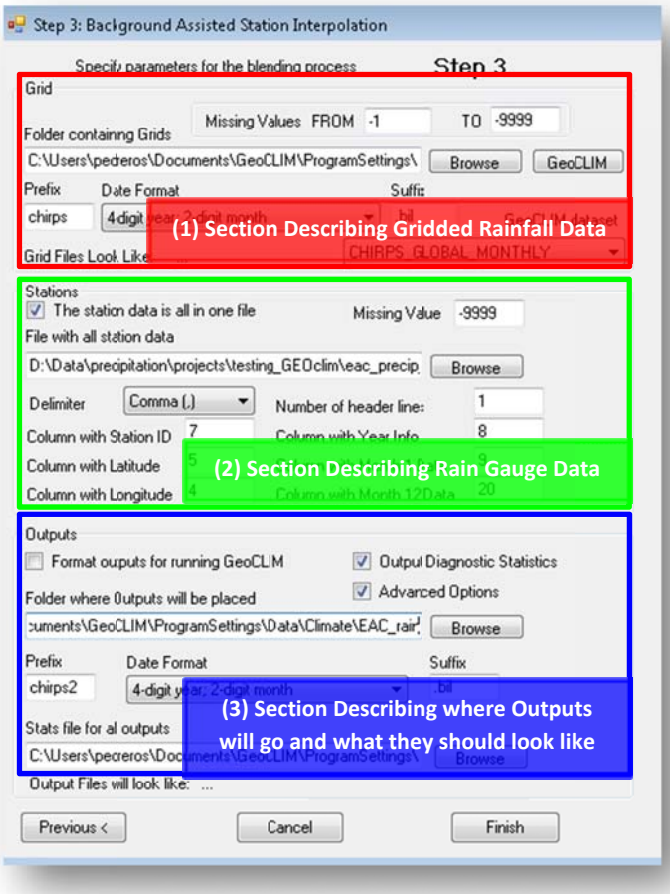
This will give bring up the 'Step 1' window of the Batch Assistant, with the 'Blend rasters/grids with stations' option already selected. Click '> Next'.

Note 12: If you want to run the IDW Interpolation instead of BASIICS, select the 'Interpolate just stations' option. This option interpolates the stations only and does not include the raster data.



In the 'Step 2' window, select the time period for which you want to improve the rainfall estimates. This should be the same for both the stations and the raster data.

Next, you will be presented with a dialog box in which you will input information into three sections: (1) the format of the gridded rainfall data, (2) the format of the rain gauge data, and (3) where the outputs should go.



(1) Section Describing Input Rainfall Grids

In the first section, simply click the 'GeoCLIM' button if the rainfall estimates for the BASIICS process are already in the GeoCLIM default settings; otherwise browse to the directory with the data and fill in the information. You must manually type in the range of the "Missing Values FROM" and "TO" fields.

(2) Section describing the rain gauge data.

In this section, specify the file containing the rain gauge station data, the missing value in the rain gauge data, and the column names/numbers for the different data types. GeoCLIM may try to estimate all these values automatically, but you should verify that the estimated values in the 'Stations' section are actually correct.

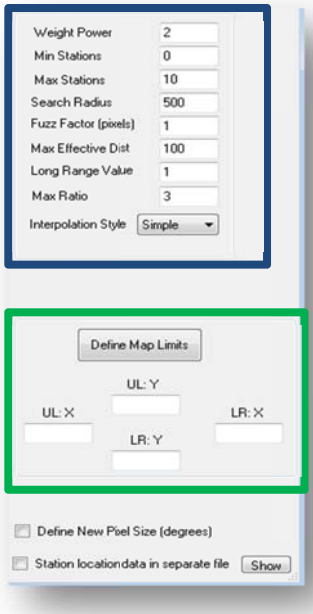
Note 13: The rain gauge data should have a .csv extension in the format described below. The order, names, and number of columns are not important, but must include:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	country	stat	source	lon	lat	elev	seq_ID	year	month01	month02	month03	month04	month05	month06	month07	month08	month09	month10	month11	month12
2	Burundi	MUYINGA	Met	30.33	-2.83	1755	114524	1981	0	72.4	156.6	127.7	82	0	0	101.3	62.6	88.2	92	59.4
3	Burundi	MUYINGA	Met	30.33	-2.83	1755	114524	1982	0	-9999	114.2	215.2	121	11.8	3.2	0.1	62.3	84.3	215.5	148.9
4	Burundi	MUYINGA	Met	30.33	-2.83	1755	114524	1983	0	167.1	148.1	228.8	68.2	0.1	0	57	74.8	101.7	97.7	81.4
5	Burundi	MUYINGA	Met	30.33	-2.83	1755	114524	1984	0	64.8	121.9	70.6	9.4	0	14.4	112.4	30	129	291.9	66.6
6	Burundi	MUYINGA	Met	30.33	-2.83	1755	114524	1985	-9999	209	151	248.5	78.6	0	0	5	162	219	196.7	147
7	Burundi	MUYINGA	Met	30.33	-2.83	1755	114524	1986	-9999	100.1	141	344	84	22	0	1.4	-9999	182.4	164	51.8

- A unique station identifier (in the example above, that is the column called 'STAT'
- A longitude column ("LON" in the example above)
- A latitude column ("LAT" in the example above)
- An unbroken series of columns from dekad 1 to dekad 36 (for dekads) or from January to December (for months - in the example above, the columns 'month01', 'month02', 'month03'..., 'month12')
- A year column that indicates the relevant data year

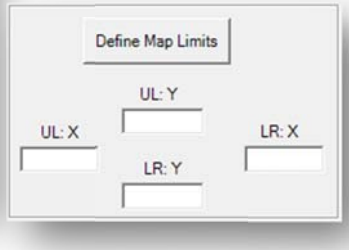
(3) Section describing the outputs

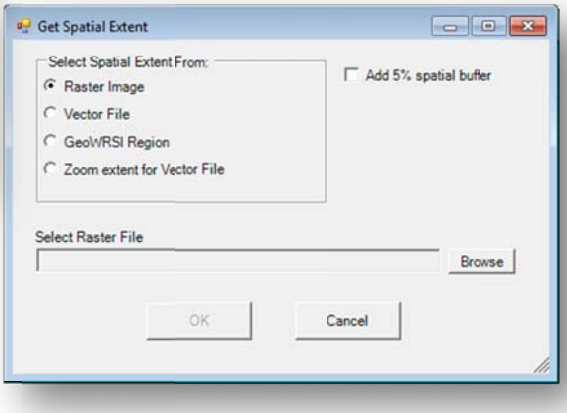
In the third section, specify where the outputs should go and what format they should be in. If you selected the "Output diagnostic statistics", then the last part of this section will ask for the path where the statistics file should be saved. This is a very important file since it gives an evaluation of how well the blending process performed.



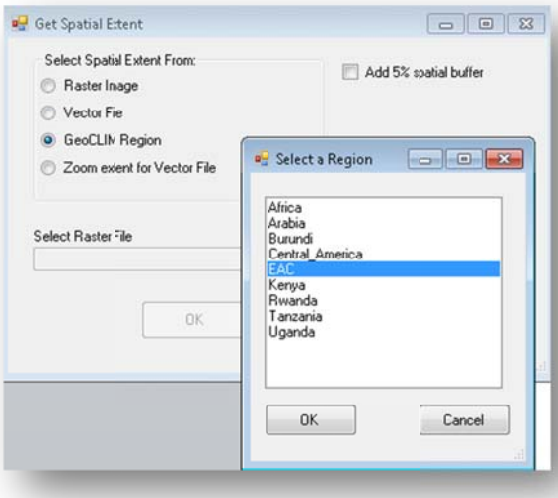
Advanced Options

Checking the 'Advanced Options' checkbox will open a set of options to the right. The upper section describes the interpolation parameters. Keep the default values for now. See the chapter on Advanced Topics in the GeoCLIM for a full description of the parameters. Click on the 'Define Map Limits' button to bring up the 'Get Spatial Extent' dialog box, which will prompt you to select the spatial extent.



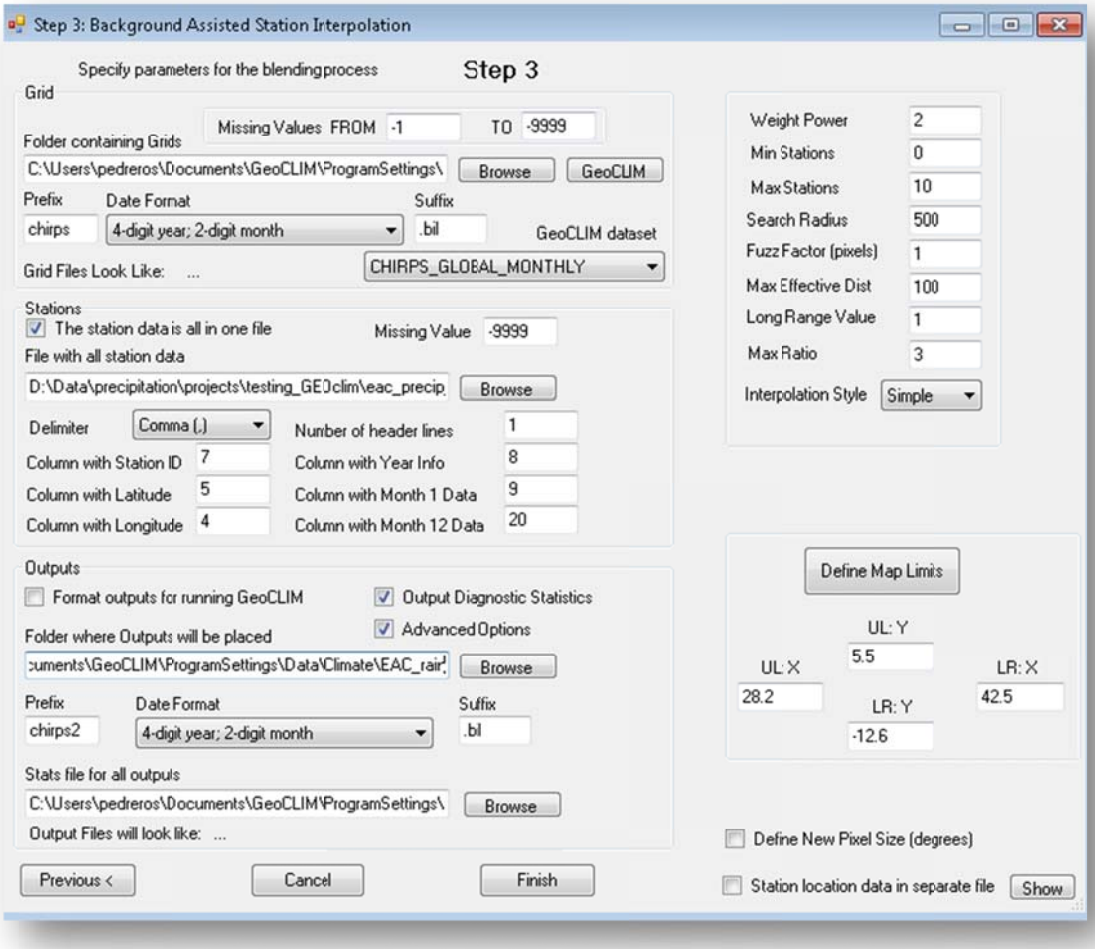


The 'Define Map Limits' option allows you to define a much smaller area for the interpolation than the extent of the complete gridded dataset. This helps speed up the interpolation considerably (i.e., by interpolating over a small area).



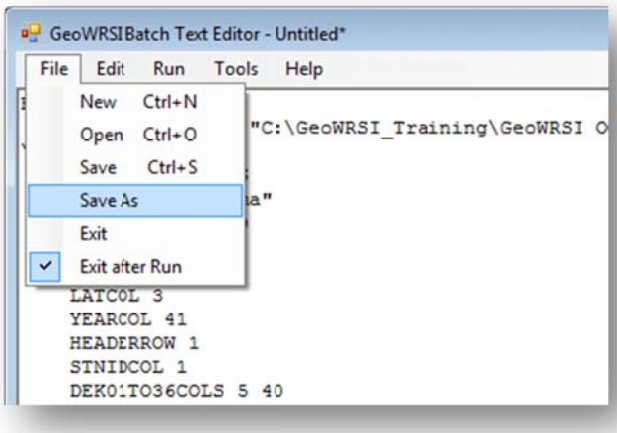
In this example, the BASIICS interpolation is running over EAC, which will define the spatial extent as covering the region. To do this, select the 'GeoCLIM Region' option in the 'Select Spatial Extent From:' menu. This brings up the 'Select a Region' window where you can choose the region that will define the extent of the output maps. That region's map limits will then be used as the new extent. Select the desired region and click 'OK', then click 'OK' on the 'Get Spatial Extent' window as well.

After everything, the BASIICS options should look something like this:



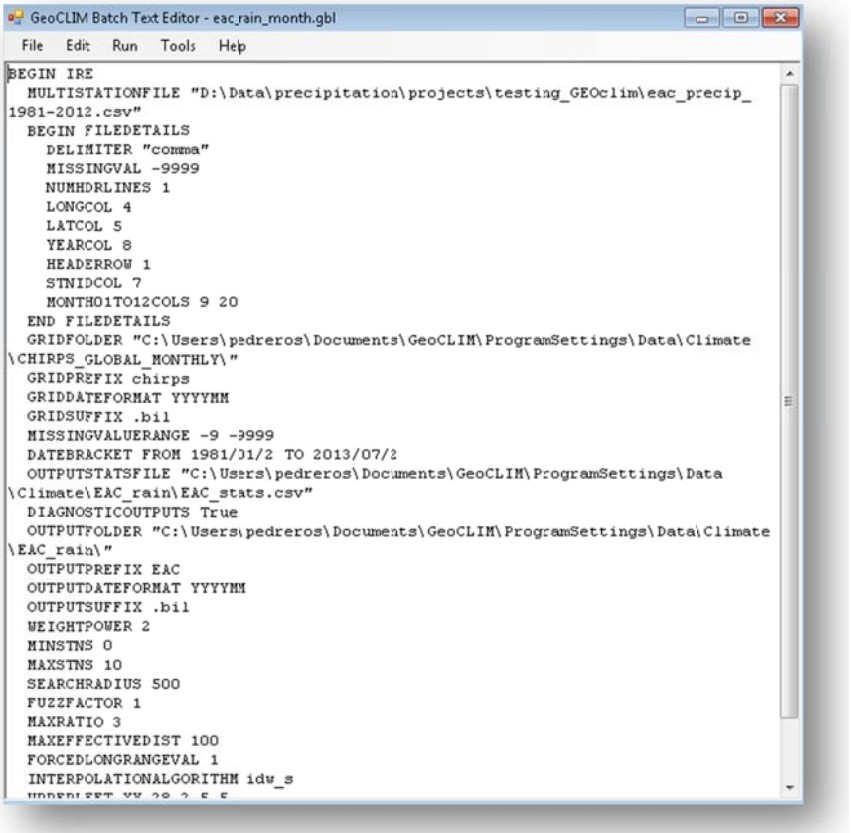
The text in the boxes may differ from the ones you see here based on the exact format of your station file and the region file you are interpolating for.

Click the 'Finish' button at the bottom of the Step 3 window when finished inputting specifications. This will generate a batch file which you can run as needed.



Before running the batch file you have just generated, it is strongly recommended that they save it. Press CTRL+S, or, in the GeoCLIM Batch Text Editor menu, click the 'File' dropdown menu and select 'Save As'. You should also take note of the file name the batch file was saved under, as well as the directory it was saved to. This will enable you to access and edit the file later (described in greater detail in the Creating Archives chapter).

To run the BASIICS batch file, either (a) Press the F5 key on the keyboard, or (b) Click the 'Run' dropdown menu of the GeoCLIM Batch Text Editor and then select 'Run'.



The batch file contains all the settings specified in the three steps of the batch assistant. The commands are somewhat self-descriptive, and most should be able to understand what the majority of the commands mean.

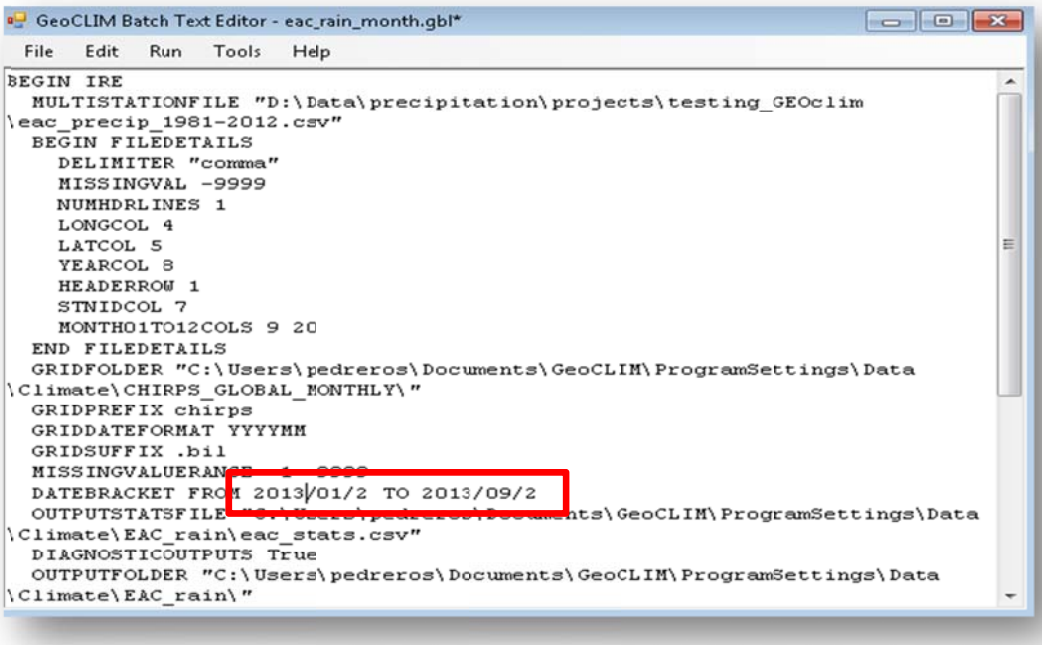
Step 4: Editing Batch Files to Run the BASIICS Algorithm for Ensuing Periods

Once the batch file has been saved and run, the same batch file can be used later to run the BASIICS module for ensuing periods for which the file was made (months in the case of the above example). For example, above we ran the BASIICS for month 1 to 12 of 1981 to 2012. Suppose, then, that you ran the BASIICS in real time, operational mode, and fast forwarded to a month later when you had new station data for that month.

To start, you would open up the GeoCLIM and click the 'Batch Text Editor' button on the main GeoCLIM toolbar. This will bring up a dialog box asking you to select a batch file. Navigate to the batch file you created for BASIICS, and double-click it, or select it and click 'Open'.

Once the file is open, edit it so that it can be run for the ensuing months. The part of the batch file that needs to be changed is the DATEBRACKET FROM … TO … This part indicates the months which are supposed to be BASIICS-interpolated.

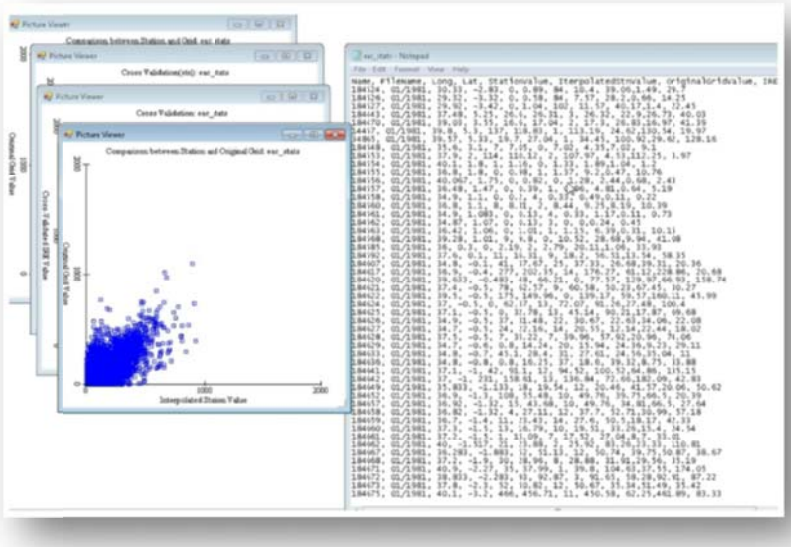
In this example, the code is changed to run the months 1 to 9 of 2013



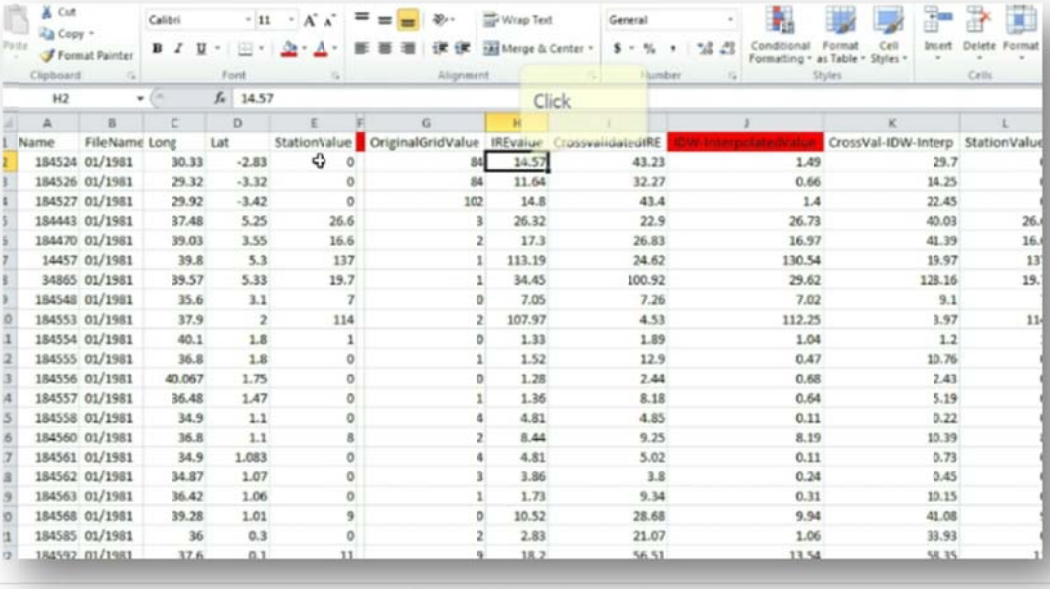
Then save and run the batch file. This change can be repeated as new station data comes in and as the GeoCLIM database is updated.

Analysis of the BASIICS results

Once run, the batch file will generate a table with a statistical analysis of the interpolation. The table shows five columns: (a) the original station value, (b) the value of the original grid (e.g. rainfall estimate) at the station's location, (c) the new blended grid value once the stations are blended with the raster data the Improved Rainfall Estimation (IRE) value, (d) a cross validated value (the blended grid value at the station's location when the station is not included in the process), and (e) the interpolated grid value we would have gotten at the station's location *if we had interpolated just the stations* (without blending in the background grid).



It is recommended that the user opens this file in Microsoft Excel to analyze the results.



Name	FileName	Long	Lat	StationValue	OriginalGridValue	IREvalue	CrossValidatedIRE	IDW-InterpolatedValue	CrossVal-IDW-Interp	StationValue
184524	01/1981	30.33	-2.83	0	84	14.57	43.23	1.49	29.7	
184526	01/1981	29.32	-3.32	0	84	11.64	32.27	0.66	14.25	
184527	01/1981	29.92	-3.42	0	102	14.8	43.4	1.4	22.45	
184443	01/1981	37.48	5.25	26.6	3	26.32	22.9	26.73	40.03	26.
184470	01/1981	39.03	3.55	16.6	2	17.3	26.83	16.97	41.39	16.
14457	01/1981	39.8	5.3	137	1	113.19	24.62	130.54	19.97	13
34865	01/1981	39.57	5.33	19.7	1	34.45	100.92	29.62	128.16	19.
184548	01/1981	35.6	3.1	7	0	7.05	7.26	7.02	9.1	
184553	01/1981	37.9	2	114	2	107.97	4.53	112.25	3.97	11
184554	01/1981	40.1	1.8	1	0	1.33	1.89	1.04	1.2	
184555	01/1981	36.8	1.8	0	1	1.52	12.9	0.47	10.76	
184556	01/1981	40.067	1.75	0	0	1.28	2.44	0.68	2.43	
184557	01/1981	36.48	1.47	0	1	1.36	8.18	0.64	5.19	
184558	01/1981	34.9	1.1	0	4	4.81	4.85	0.11	3.22	
184560	01/1981	36.8	1.1	8	2	8.44	9.25	8.19	10.39	
184561	01/1981	34.9	1.083	0	4	4.81	5.02	0.11	3.73	
184562	01/1981	34.87	1.07	0	3	3.86	3.8	0.24	3.45	
184563	01/1981	36.42	1.06	0	1	1.73	9.34	0.31	10.15	
184568	01/1981	39.28	1.01	9	0	10.52	28.68	9.94	41.08	
184585	01/1981	36	0.3	0	2	2.83	21.07	1.06	33.93	
184592	01/1981	37.6	0.1	11	9	18.2	56.51	13.54	58.35	1

Explanation of the code in the BASIICS batch file: The batch code statement

```
DATEBRACKET FROM 2011/12/2 TO 2011/12/2
```

This means that the BASIICS should be run from year 2011, December (/12) dekad 2 (/2) to 2011 December (/12) dekad 2 (/2). (ie, just run BASIICS for 1 dekad) If the code statement had been

```
DATEBRACKET FROM 1971/01/1 TO 2010/12/3
```

This means that the BASIICS should be run from year 1971, January (/01) dekad 1 (/1) to year 2012 December (/12) dekad 3 (/3)

To reiterate, the columns required to be in the stations CSV file are:

- A unique station identifier (in the example above, that is the column called "STAT"
- A longitude column ("LON" in the example above)
- A latitude column ("LAT" in the example above)
- An unbroken series of columns from dekad 1 to dekad 36 or months 1 to 12
- A year column that indicates the year the data are for

Chapter 7: Climatological Analysis

Summary

The Climatological analysis tool can calculate statistics, trends, and frequencies (among others) for rainfall, temperature, and evapotranspiration. This analysis can be done for the entire historical data or using just part of it, such as for El Niño years for the March-April-May season.

Climatological Analysis

Climatological analysis allows you to calculate statistics for each month or group of months. For example, you can calculate the average rainfall for February based on data from 1981 to 2013. In addition, the user is also able to calculate statistics for summations over various user-specified time periods, such as seasons (e.g., the standard deviation of total rainfall over the March-to-May season, from the years 1981 to 2000). When analyzing summations over various time periods, you have the option to sum across years, which is useful when a season starts in one year and ends in the following year (e.g., when the season starts in October of one year and end in March of the following year). Analysis can only be done for data that have already been downloaded or imported into GeoCLIM (see the Creating Archives chapter to learn more about importing data) and for regions that are completely covered by the available data.

The climatological analyses that can be done include:

- Average
- Median
- Standard deviation
- Count
- Coefficient of variation
- Trend
- Percentiles
- Frequency
- Standardized Precipitation Index (SPI)

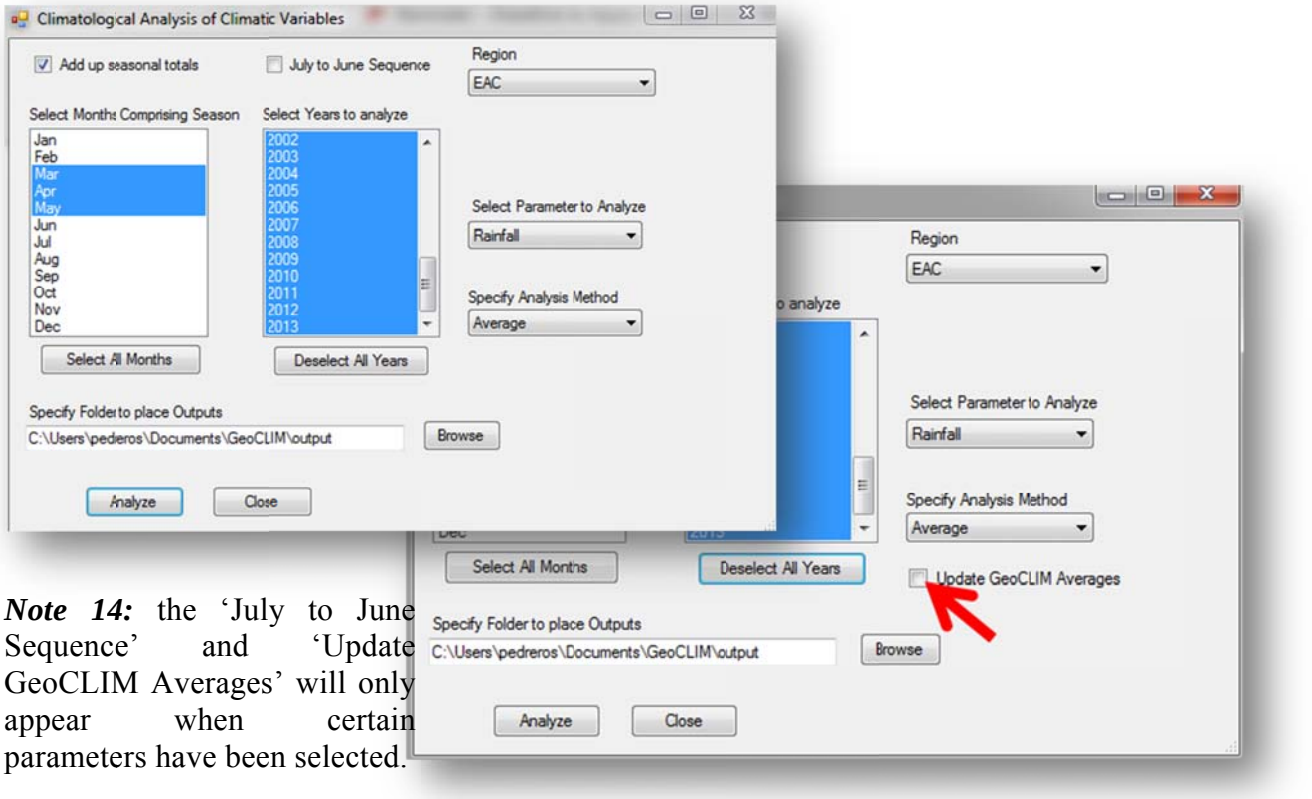
To access the climatological analysis module, click on the 'File' dropdown menu on the main GeoCLIM toolbar and select 'Rainfall Climatological Analysis', or click the Rainfall climatological Analysis tool bar button shown below.

Calculating Statistical Summaries

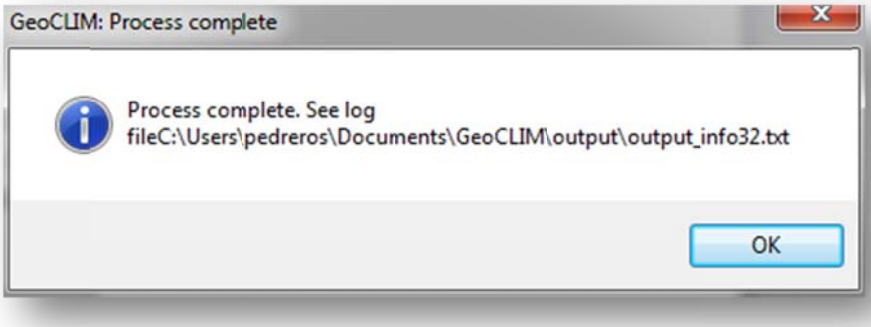
Follow these steps to calculate statistical summaries:

1. Open the Climatological Analysis tool
2. Make sure that the region of interest is selected; the default region is the region set during installation (see the Installation chapter) or with the GeoCLIM Settings tool (wrench/spanner icon).
3. Select the months of interest on the left panel.
4. Select the years of interest on the right panel.
5. To calculate the summary for the sum of the months selected, check the 'Add up seasonal totals' box in the upper left of the 'Climatological Analysis of Climatic Variables' window. Note that, if dealing with temperature datasets, seasonal averages rather than seasonal totals are calculated.
6. If the season goes from one year to another, for example Oct to Jan, check the 'July to June Sequence' checkbox.
7. Click 'Update GeoCLIM Averages' to make these averages to be the default used in the GeoCLIM dataset.

The following graphic shows a rainfall analysis for the EAC region that will calculate the average March-April-May seasonal rainfall for all years in the GeoCLIM dataset (1981 to 2012). A single output will be created.

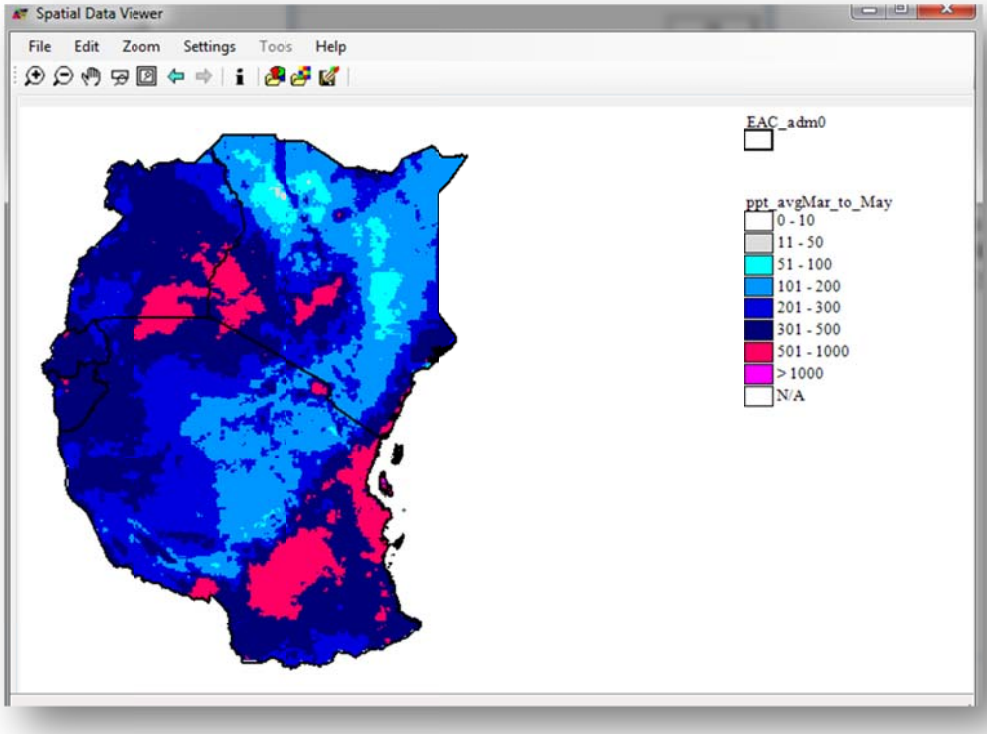


Note 14: the 'July to June Sequence' and 'Update GeoCLIM Averages' will only appear when certain parameters have been selected.



The data used to do the analysis is taken from the GeoCLIM data folder specified in the GeoCLIM settings (spanner/wrench icon on the GeoCLIM toolbar). The outputs will be placed in the folder specified in the 'Specify Folder to place Outputs' field above. A log file will also be generated specifying the location of the files generated. The location will be indicated in a dialogue box as shown above.

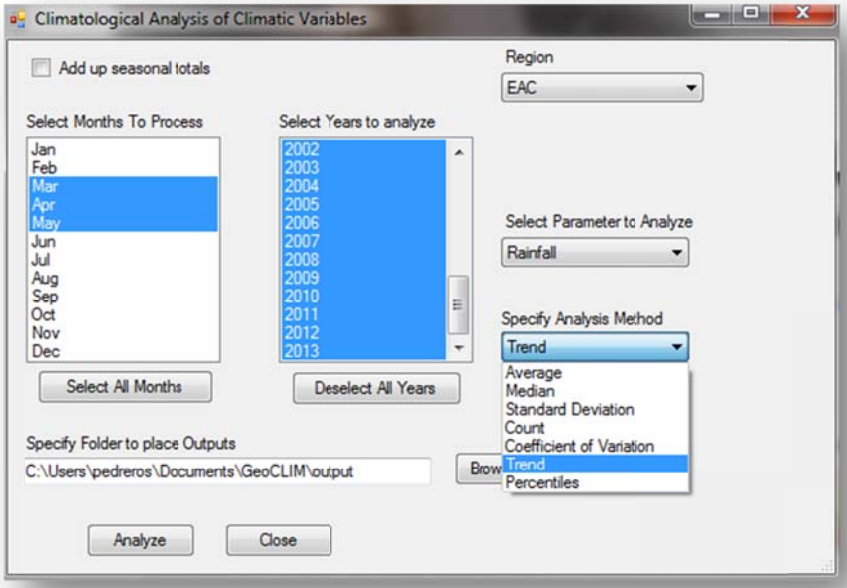
The output from this analysis is viewed as a map shown on the screen as well as saved to the output folder specified (in this case \GeoCLIM\output). The tool produces different outputs: one output will be for the statistic selected in the 'Specify Analysis Method' menu (in this case, the average) see image below, another will be the summations of each set of months for each of the years specified in the analysis. This set of seasonal totals can be used to create a time series for any given region of interest.

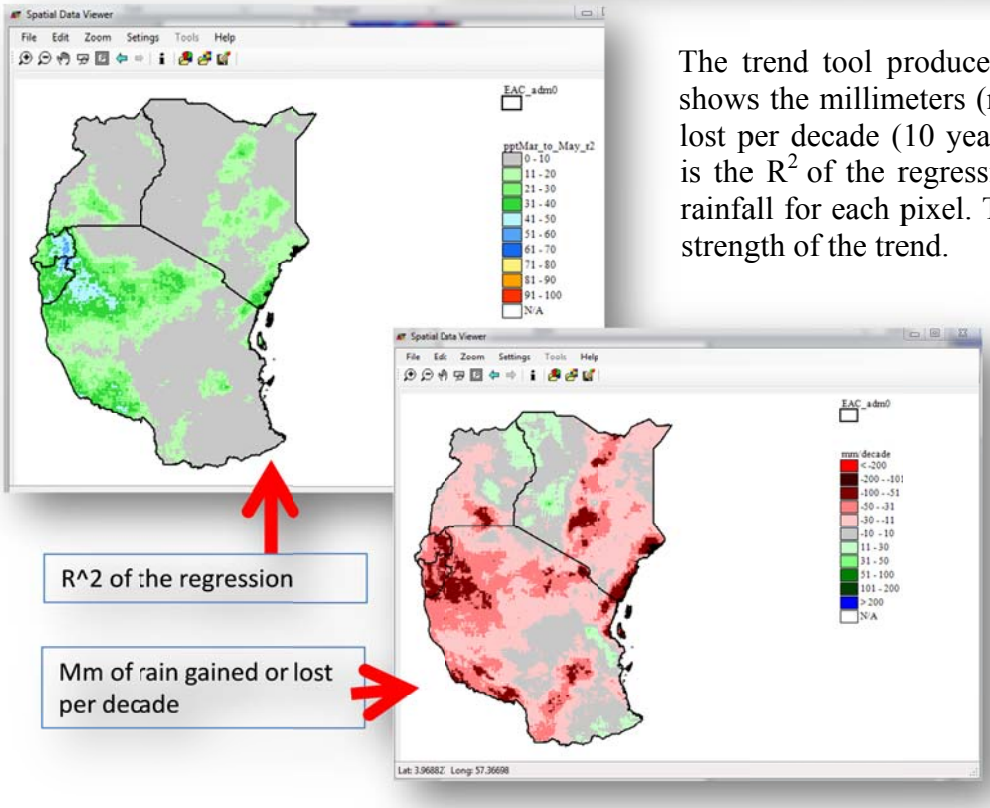


Calculate Trends

Another useful process in this tool is the trend analysis. The trend analysis method will calculate the sum of the selected months for every year and then calculate a linear trend using those values

1. Start the Climatological Analysis tool as described above.
2. Select the data to be analyzed.
3. Select 'Trend' as shown.





The trend tool produces two maps, one that shows the millimeters (mm) of rain gained or lost per decade (10 years) and the other map is the R^2 of the regression between time and rainfall for each pixel. This map indicates the strength of the trend.

Note 15: See The Climatological Analysis Tool tutorial video on this topic for further details.

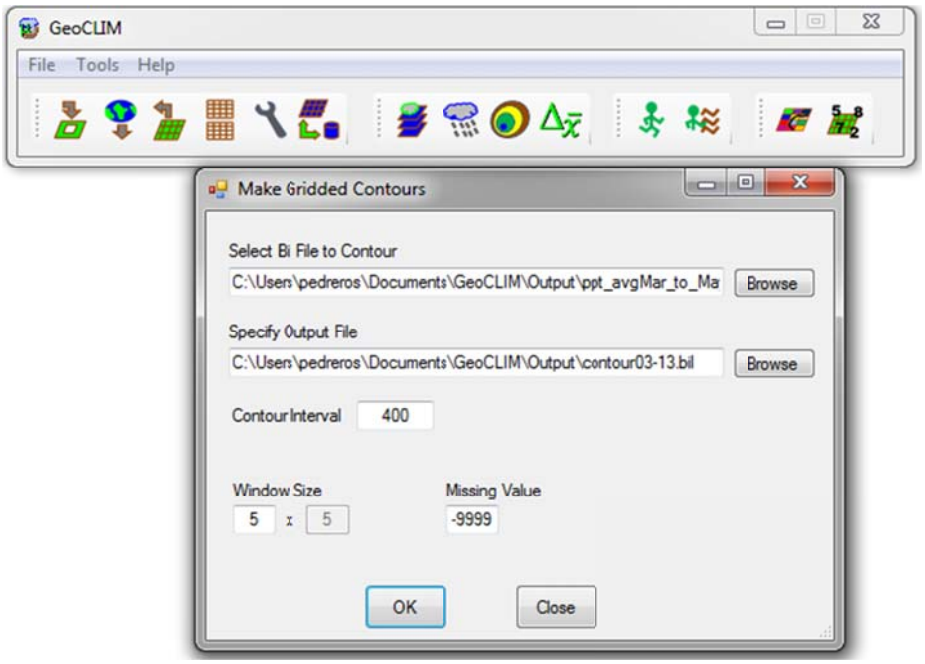
Chapter 8: Contour Tool

Summary

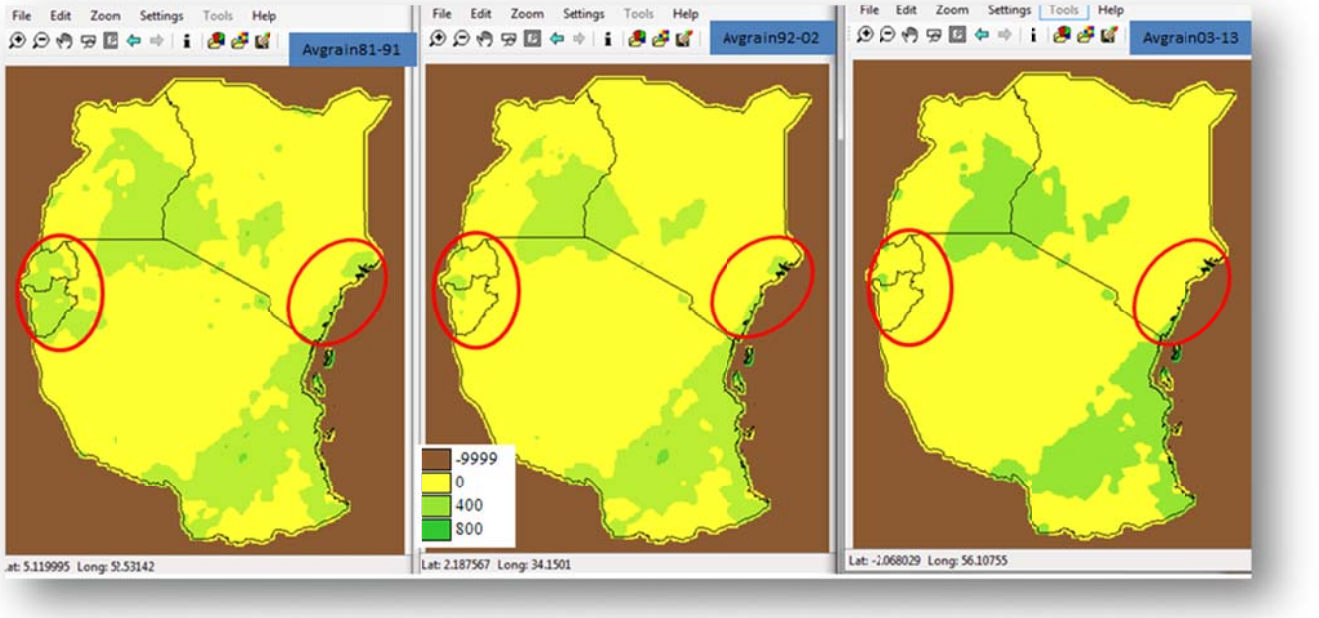
The contours tool is used to delineate areas with the same amounts of rainfall for a given period. Analyzing contours from different times could tell us how much change is there in rainfall patterns in a region.

Creating Contours

1. Open the contour tool from the GeoCLIM.
2. Fill out the form.
3. Select a contour value for your needs



For example, the user can calculate the average rainfall for the March-April-May season for the years 1981-1990, 1991-2000, and 2001-2010, run the contour tool for each map and compare the results.



The 400 mm interval for the average rainfall of the season March-April-May for the years 1981-1990, 1991-2000, and 2001-2010 show that the rainfall patterns in the SAC has changed in the coastal area of Kenya and the central West area.

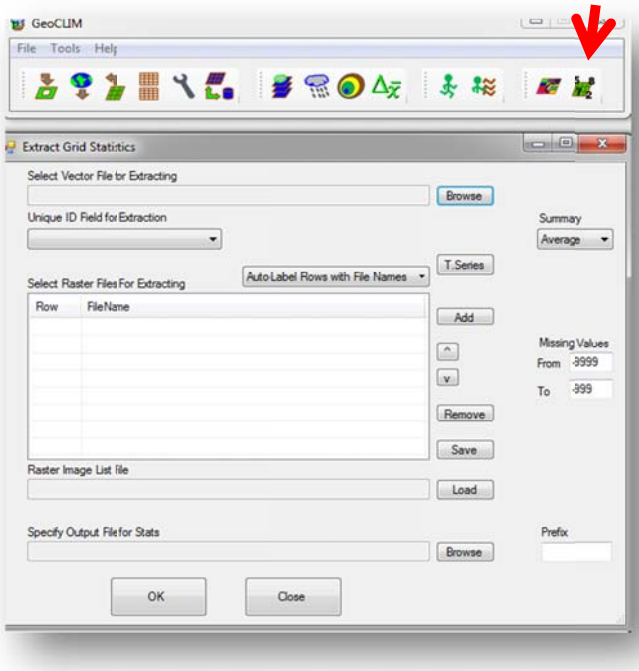
Chapter 9: Extracting Raster Statistics and Time Series

Summary

The Extract Raster Statistics tool calculates summary statistics from a raster file over polygons (such as districts) in a shapefile. For example, the tool can be used to calculate the district-average rainfall in January 2014 for each district in a country. The tool can further be used to summarize the historical rainfall and generate a time series for given polygons. For example, the district average rainfall of each district for rainfall each January from 1981 to 2014 can be calculated.. See the Spatial Data Viewer chapter to learn how to create shapefiles in the GeoCLIM.

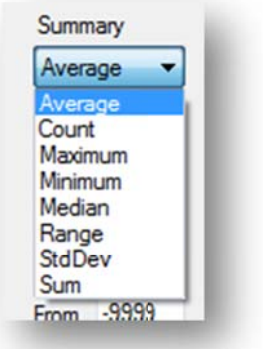
Creating a Time Series

1. Open the Extract Raster Statistics tool.

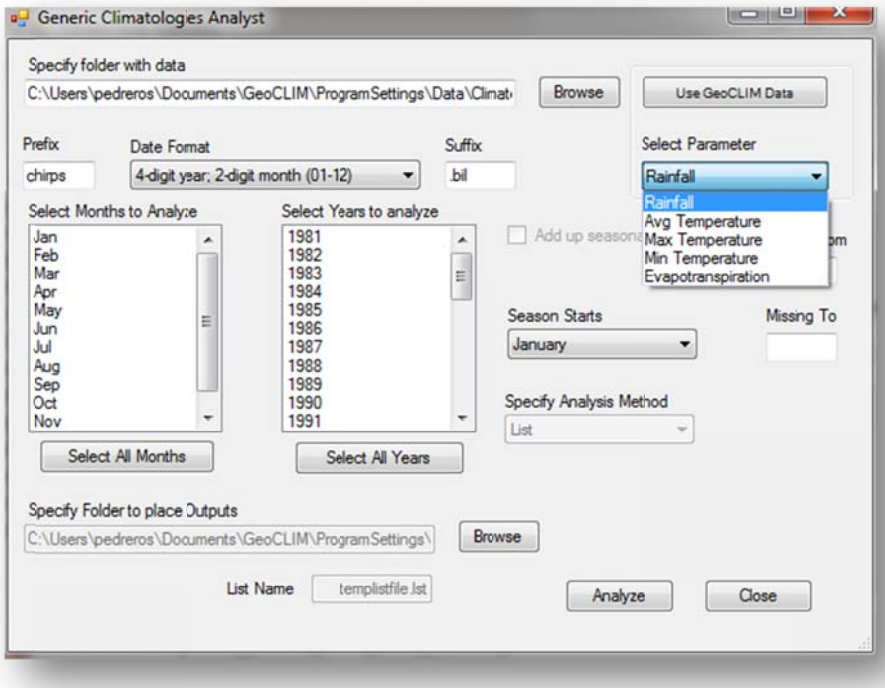


2. Select a shapefile containing the polygons of interest (e.g. districts) and select a unique ID (a data field in the shapefile that will uniquely identify each polygon, such as district names).

3. Select the type of summary needed. You can summarize the pixels within the polygon in different ways.

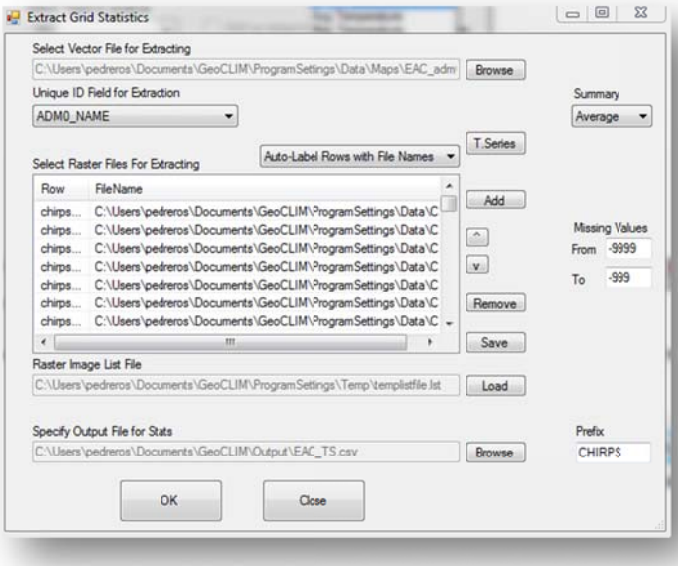


4. Click the 'T-series' button and then click 'Use GeoCLIM Data' to select files from the default database, or browse to a directory where the desired files are located and fill in the prefix, date format, and suffix to match the desired dataset. Alternatively, use the 'Add' button to select the raster files from which values will be extracted.



Once the required files are selected, click 'Analyze' to proceed. A message will appear, confirming the creation of a list file. The files previously selected by the user are compiled in a list file that populates the fields in the previous window. Close the 'Generic Climatologies Analyst' window by clicking 'Close'.

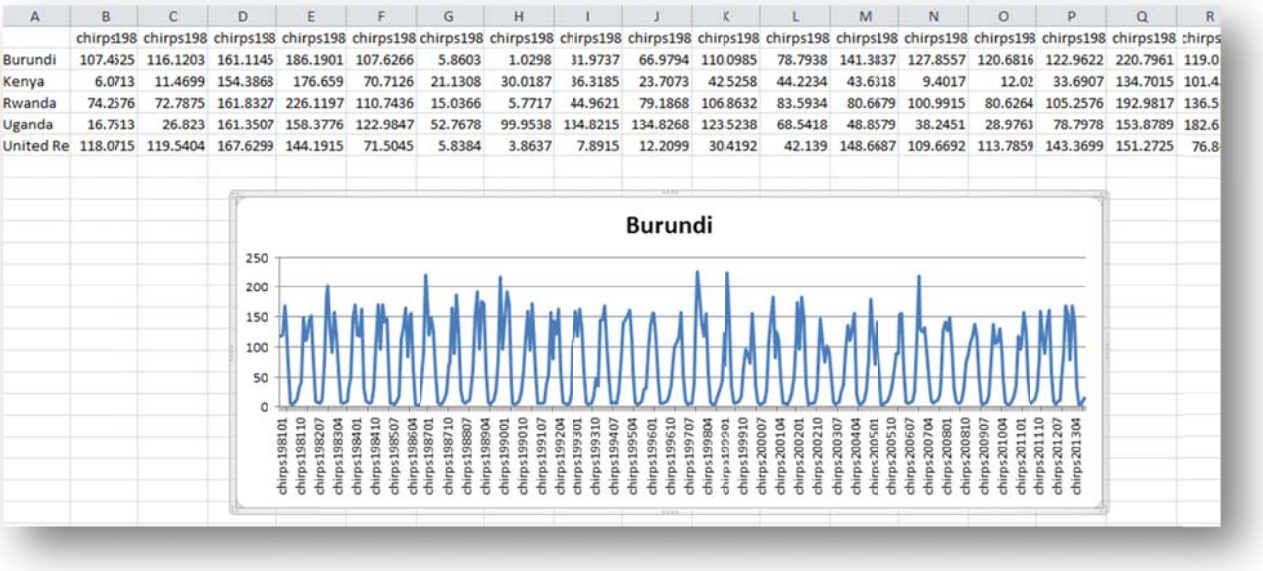
5. Back in the 'Extract Grid Statistics' window, the 'Select Raster Files for Extracting' field is now populated. Add the name and location of the output file and, if needed, a prefix. Once the form is completed, it should resemble the example shown here.



Click 'OK' to complete the process.

The Results

The time series tool produces a CSV file with as many rows as there are polygons in the input shapefile. Each column contains the summary value for each raster selected. Open the CSV file in Microsoft Excel or another similar program to produce the time series plots.



Chapter 10: Advanced Topics

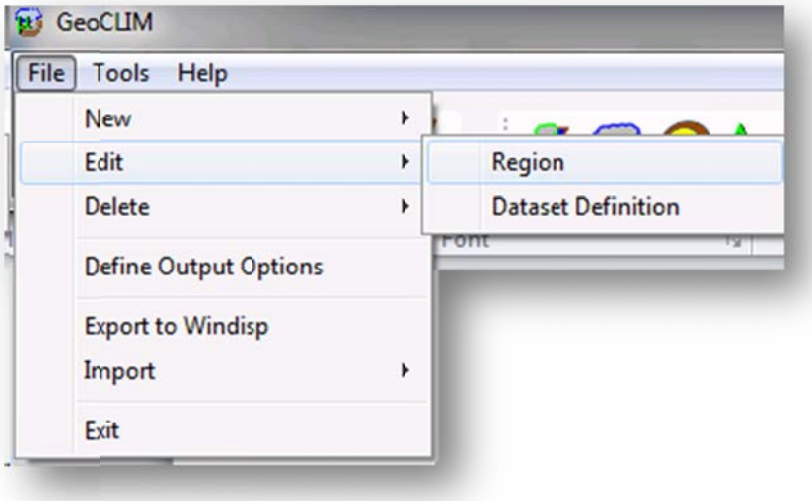
Summary

This chapter discusses the more advanced features of the GeoCLIM. The average user will not necessarily need to use the features described below.

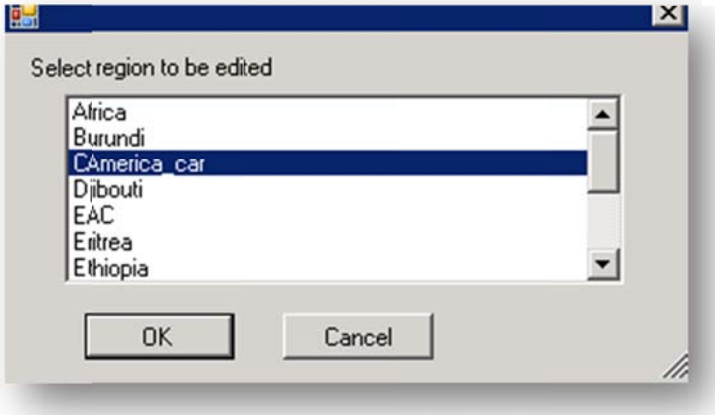
Create a New Region in the GeoCLIM

There are two ways of creating a new region in the GeoCLIM. One way to create a new region is to click on the 'File' menu of the GeoCLIM toolbar, then navigate to file/New > Region. The other way, which is recommended for beginners, is to modify an existing region. Using the second option is outlined below.

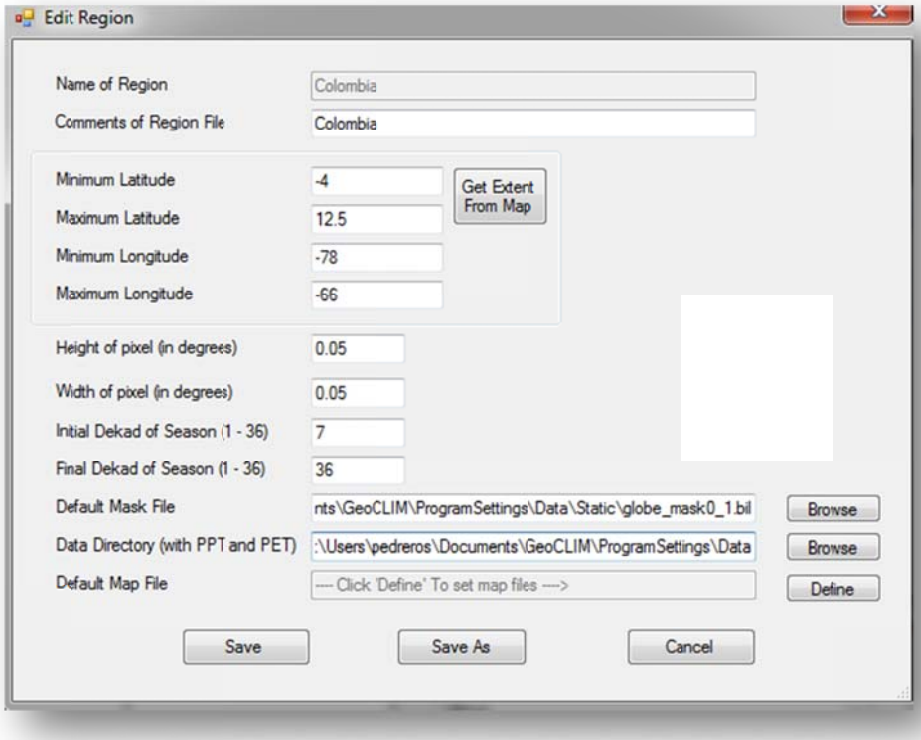
Step 1: Open an existing region by clicking the 'File' dropdown menu on the GeoCLIM toolbar and navigating to Edit > Region.



Step 2: Select an existing region, then save the region using a different name.

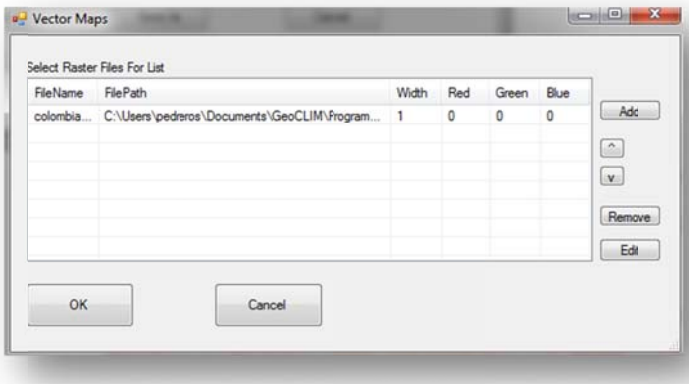


Step 3: Alter the parameters of the newly saved region to align with the parameters of the area of interest.

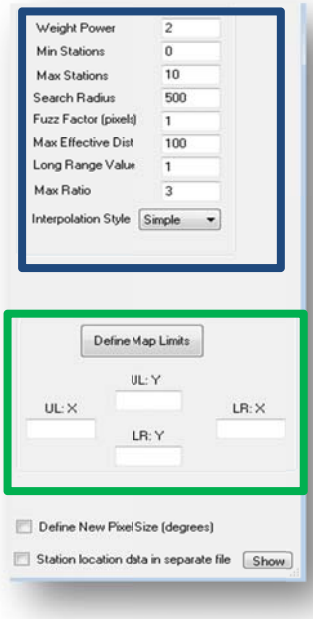


Step 4: Create a mask for the new region. As discussed in Step 4 of the Installation chapter, a mask is a raster dataset with a '0' value for outside the region of interest and a '1' for the area within the region. In the example 'Edit Region' window shown above, a global mask is used. The Height and Width of pixel refer to the pixel size of the rainfall or temperature fields. The Initial and Final Dekad of Season are fields borrowed from the GeoWRSI.

Step 5: Finally, add a map for the new region, bring a shape file of the region.



Advanced Parameters on Blending Stations and Gridded Data



□□WEIGHTPOWER: The power that will be applied to the inverse distance in calculating the weight. For example, a weight of 2 means that the inverse distance to each station will be squared (power of 2) to calculate the weight to that station.

□□MINSTNS: The minimum number of stations to be used in the interpolation. If there are less than MINSTNS available at a point, that pixel will not be interpolated, and a missing value will be put in the output grid at that pixel. Use a value of MINSTNS = 0 to produce a value everywhere in the output.

□□MAXSTNS: The maximum number of stations to be used in the interpolation. For example, if MAXSTNS = 10, and if there are more than 10 stations available at a point for the interpolation, only the nearest 10 stations will be used in the interpolation.

□□MAXEFFECTIVEDIST: This parameter only works with the "Simple IDW" (idw_s). It is the distance to which the stations would have an influence. Local knowledge is very important here.

□□MAXRATIO: The maximum station/grid value that is allowed in the interpolation. When the station/grid ratio is greater than MAXRATIO, then the MAXRATIO value is used.

□□INTERPOLATIONALGORITHM: The type of interpolation algorithm to use, namely idw_o or idw_s. idw_o is ordinary inverse distance weighting (IDW) interpolation, in which the interpolation weights are dependent only on the surrounding stations. idw_s is simple IDW, in which the background grid also contributes a weight to the interpolation routine, and the relative weight of the background grid increases increasing distance to surrounding stations.

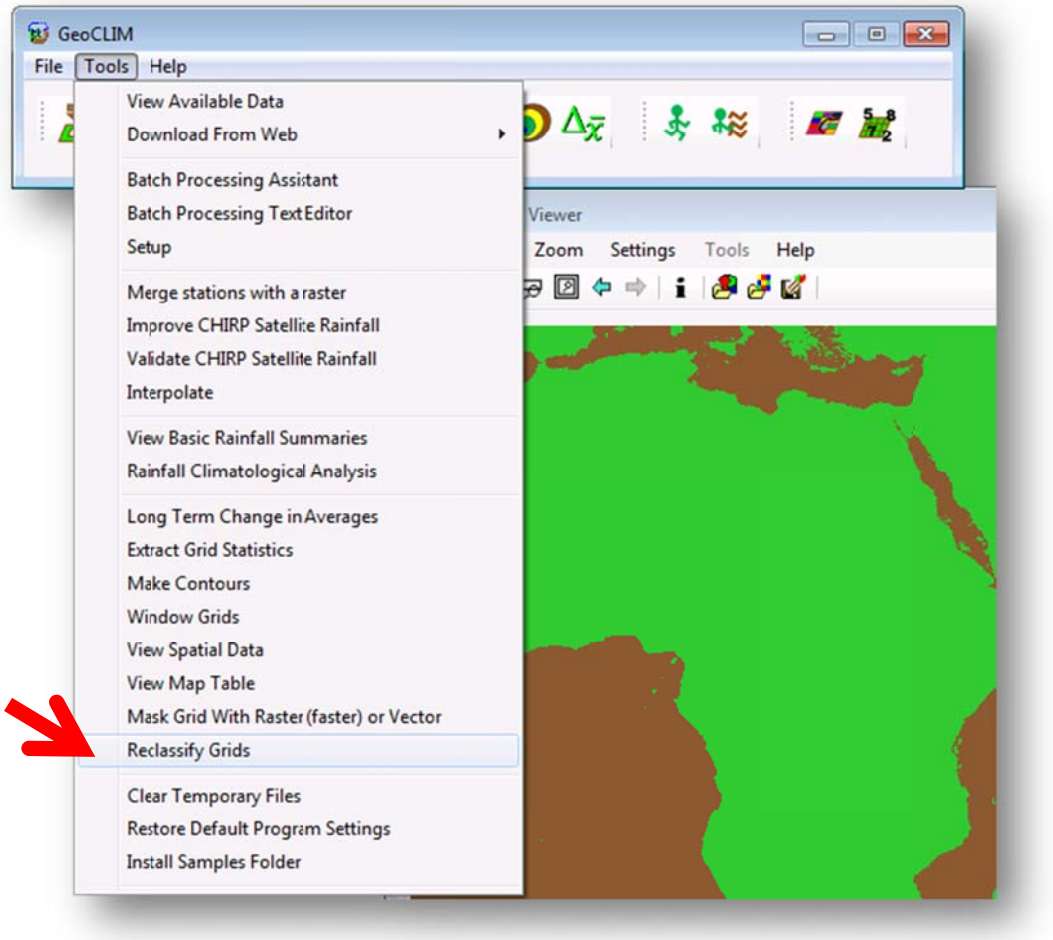
□□SEARCHRADIUS: The maximum radius (in km) over which to search for stations that will be used in the interpolation of each pixel. If, at a pixel, the distance to a station is larger than SEARCHRADIUS, then that station will not be used in the interpolation at that pixel.

Reclassifying Rasters

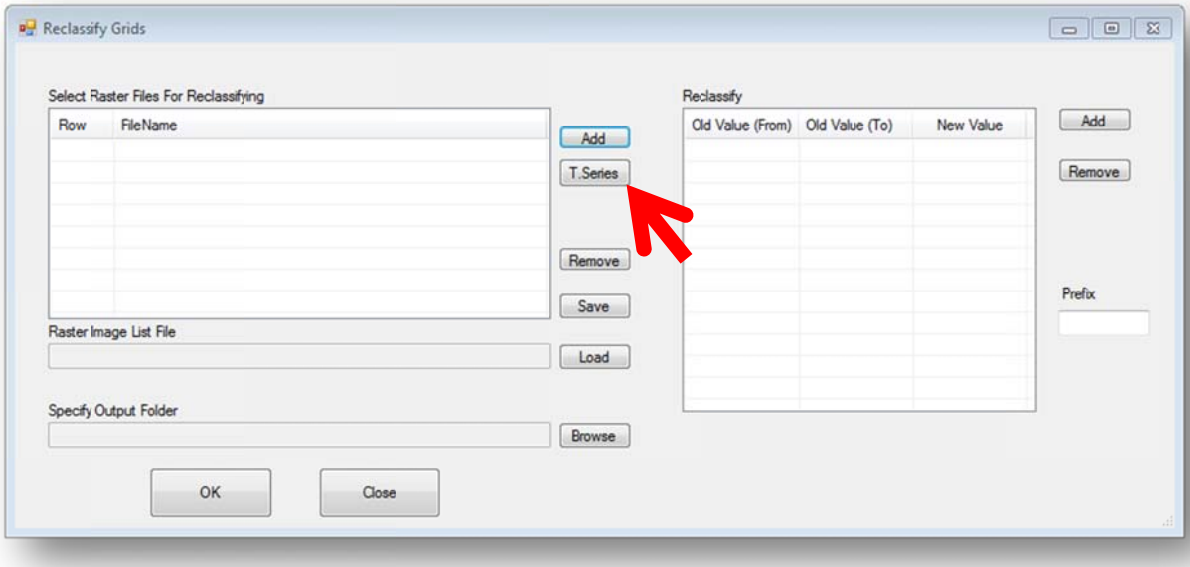
As demonstrated in the Editing Rasters section, changes in pixel values can be made using the Spatial Data Viewer. However, this method is only practical for changing a small number of pixels. The following outlines how to reclassify raster data for a large number of pixels at once.

Selecting Data

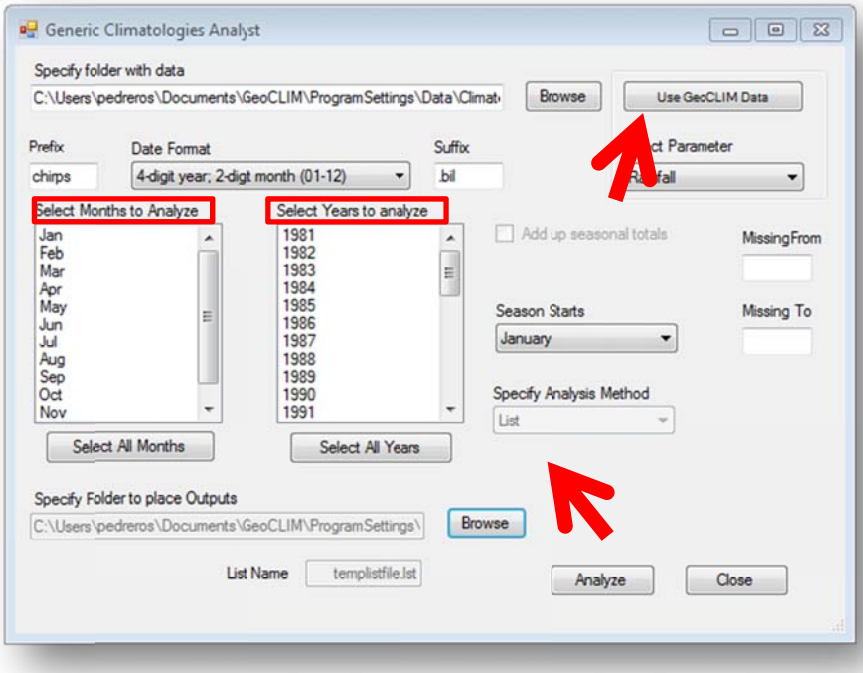
To begin, open the Spatial Data Viewer. Click the 'Open Raster Map' icon (second icon from the right) to open up the 'Select Raster Image' window. Click the 'Browse' button next to the 'Select Raster File For Display' field, navigate to GeoCLIM\ProgramSettings\Data\Climate, choose the appropriate dataset directory, select the desired .bil file and click 'Open', then 'OK'.



In this dataset, the 'no data' value is 9999, represented on the map as the brown color. To change the 'no data' value to -9999, go to the 'Tools' dropdown menu on the GeoCLIM toolbar and select 'Reclassify Grids'.



This will bring up the 'Reclassifying Grids' window (see image above). Click the 'T. Series' button in the middle of the window to bring up the 'Generic Climatologies Analyst' window. Click the 'Use GeoCLIM Data' button in the right hand corner of the 'Generic Climatologies Analyst' window to use the data already selected during setup (or via the "GeoCLIM Setup' icon). This default preset will automatically fill all the available fields (see image below).



This tool allows you to create a list of desired datasets that will be reclassified. When you select specific months and years from the 'Select Months to Analyze' and 'Select Years to analyze' menus, the tool creates a temporary list file in the directory specified in the 'Specify Folder to

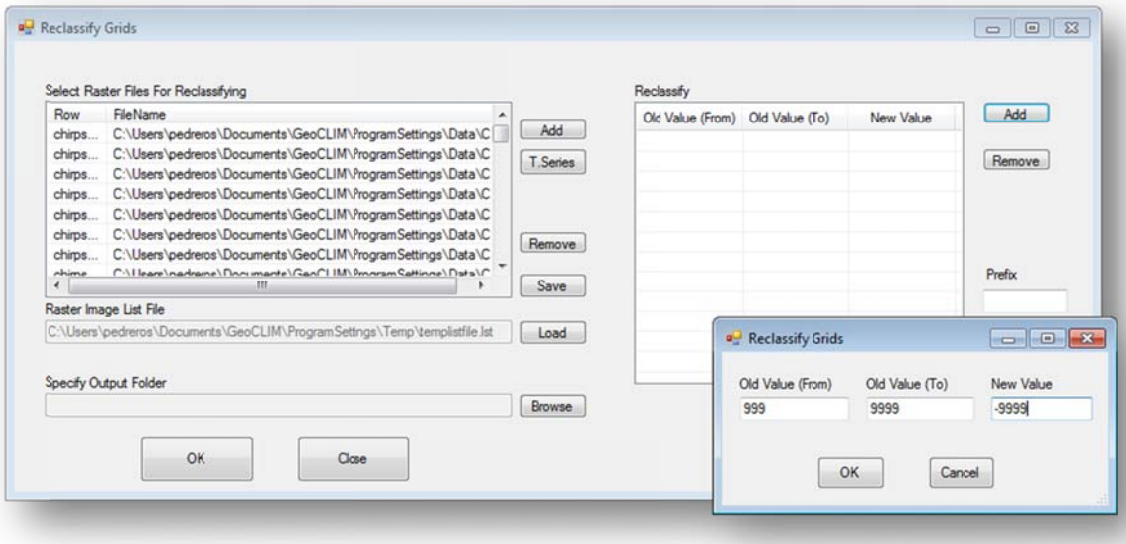
place Outputs' field (see image above). The temporary list in turn populates the 'Select Raster Files for Reclassifying' menu in the 'Reclassifying Grids' window with those specified datasets.

As an alternative to creating a list via the 'Generic Climatologies Analyst', you can click 'Add' in the 'Reclassifying Grids' window to add data, navigate to the folder containing the .bil files to be reclassified, and choose the desired .bil datasets.

Altering Data

For the purposes of this tutorial, all historical data will be used. In the 'Generic Climatologies Analyst' window, click the 'Use GeoCLIM Data' button to fill in the default data. Click the 'Select All Months' and 'Select All Years' buttons and then click 'Analyze'. Note the popup indicating the directory where the List File has been created and click 'OK'. Click the 'Close' button to go back to the 'Reclassifying Grids' window with all the datasets loaded.

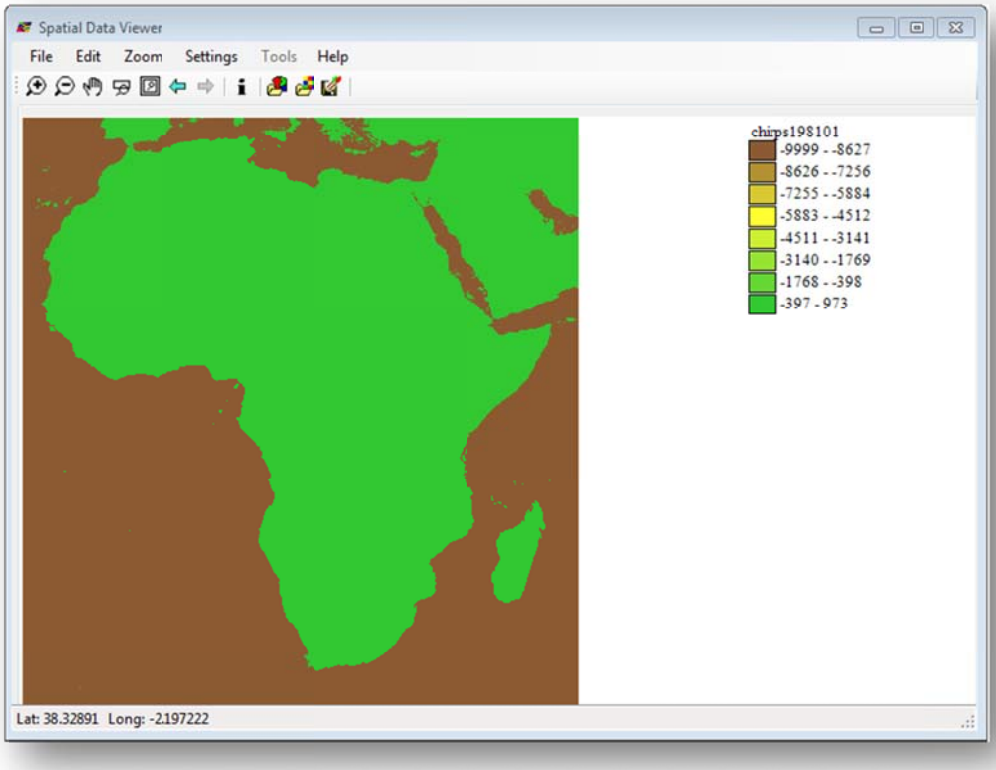
To begin reclassifying the data, click the 'Add' button next to the 'Reclassifying menu'. This will bring up a smaller 'Reclassify Grids' window with three fields. Enter the value range to be changed, starting with the 'Old Value (From)' field to the 'Old Value (To)' field (e.g. from 9996 to 9999). In the 'New Value' field, input the value that should be substituted for all values listed in the range (e.g. -9999). Click 'OK'. Now the values are listed in the 'Reclassify' menu.



Next, click 'Browse' next to the 'Specify Output Folder' field to select where to place all the new reclassified values. We recommend that you place the output in a new folder in the Climate directory. Click 'OK' to confirm and return to the 'Reclassifying Grids' window.

Click 'OK' on the 'Reclassifying Grids' window and click 'Close' to finish. Close the Spatial Data Viewer.

Reopen the Spatial Data Viewer and select the raster icon to navigate to the directory where the reclassified output was stored. Open a .bil file and observe that the lowest value is now -9999, and there are not 9999 values.



Additional Uses for the Time-Series tool

The Time-Series tool (as referenced in the Reclassifying Rasters section of this chapter) is useful in many other operations within the GeoCLIM. For example, the Time-Series tool can be used to generate a list file for analysis.

Chapter 11: Exercise

Summary

These exercises are available as a way to help users apply the knowledge gained from this manual.

Exercise

1) Install GeoCLIM (see the Installation chapter).
2) Set up the GeoCLIM (see the 'Setting up the GeoCLIM' section):
    a. Download the entire historical (1981-present) monthly data for Africa using the download tool.
    b. Set the GeoCLIM region to EAC.
        i. **Advanced Exercise**: Create a new region (see the Advanced Topics chapter).
    c. Obtain and import the CHIRPS_PPT_AFRICA_DEKADAL dataset.
    d. Set the output directory to \GeoCLIM\output\exercise1.
3) Review data (see Step 4 in the Installation chapter):
        i. Use the Spatial Data Viewer to open a raster dataset from the selected data imported in 2c.
        ii. Identify the no-data value (see the Reclassifying Rasters chapter).
        iii. Change the color palette of the legend by right clicking on the legend, selecting 'Change Legend', navigating to the color directory, and selecting RFE.CLR. Click 'Okay' to finish.
4) If local station data is available, use the BASIICS tools to blend the stations with CHIRPS (see the Station Blending and BASIICS chapter). If not station data is available, proceed to 5.
    a. Create a new archive with the product from the BASIICS process (see the Creating Archives chapter).
    b. Upload the new archive to the GeoCLIM and make sure that it is selected as the default dataset (see Step 3 of the Installation chapter).
5) Use the Climatological Analysis tool to analyze the April-May-June season of the EAC region for all years.
    a. Calculate the average and the standard deviation for the season.
    b. Calculate trend for the season for the years 1981-2013.

c. Calculate the difference in means 1981-1997 and 1998-2013 using the 'Calculate Long Term Changes in Average' tool. Observe how these results differ from the 'trend' results.

6) Identify "hot spots" (areas with strong decreasing/increasing rainfall), from the trend maps in 5b.
   a. Digitize polygons around the hot spots (see the Spatial Data Viewer chapter).
7) Extract time series for the spatial average value for each hot spot polygon (see the Time Series chapter). Make sure that to select the 'pptsum' files that were created with the trend process.
   a. Open the CSV table in Microsoft Excel and plot the time series to analyze it.
8) Calculate the average for each dekad in 1981-1990, 1991-2000, 2001-2013 using the Climatological Analysis tool. Then, use the contour tool to plot the 400mm contours. Compare these results to those from the time series.