

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

NOTE: There may be revised processes and documentation available.

**Check the NPScape methods webpage
(<http://science.nature.nps.gov/im/monitor/npscape/methods.cfm>)
for the most current version.**

Standard Operating Procedure: NPScape Climate Grid Analysis Toolset

Suggested Citation: National Park Service. 2012. NPScape Standard Operating Procedure: Climate Grid Analysis Toolset Measure – Tools for Assessing Regional Climatological Trends – CGAT Processing SOP. Version 2012-11-30. National Park Service, Natural Resource Stewardship and Science. Fort Collins, Colorado.

Contents

Overview.....	3
Software Requirements.....	3
Toolbox and Python Scripts	3
Data Sources	4
PRISM 4k and 30s	4
CRU CL20	7
SNAP	8
SNODAS.....	8
Statistics.....	9
Average.....	9
Water Year Average.....	10
Percentile	10
Zonal Statistics	10
Calculating Statistics Using the Available Datasets.....	11
Processing Steps and Tools	11
Refresh Archive	13
PRISM 4K	15
PRISM 30s.....	15
CRU CL 2.0	16
SNAP	17
SNODAS.....	18
Calculate Grid Statistics	19
Average.....	19
Water Year Average.....	21
Percentile	23
Zonal Statistics	24
Literature Cited.....	26

Overview

The goal of the NPScape Climate Grid Analysis Toolset (CGAT) is to provide landscape-scale climate monitoring support to I&M networks and parks, which is one of the top ranked vital signs among all of the NPS I&M networks ([Fancy & Bennetts 2012](#)). This standard operating procedure (SOP) provides guidance for the Climatic Grid Analysis Toolset (CGAT), which is designed to facilitate the efficient analysis of PRISM, CRU, SNAP, and SNODAS gridded climatic datasets. CGAT performs four statistical analyses over user defined areas of interest - average, water year average, percentile, and zonal statistics.

Software Requirements

CGAT requires the following software and installations:

- ArcGIS 10.1 with the Spatial Analyst License enabled
- Python 2.7 installed to work properly with ArcGIS. Note that stand-alone installations may have difficulty finding the ArcGIS arcpy library.
- Numpy (1.6.2+) for Python 2.7 - See <http://sourceforge.net/projects/numpy/files/NumPy/>. Note that installation and updating of Numpy will require administrative privileges.
- NetCDF4 (1.0+) for Python 2.7 – See <http://code.google.com/p/netcdf4-python/downloads/list> . Note that installation and updating of netCDF4 will require administrative privileges.

In addition, although not a requirement, this code has only been tested on a Windows operating system. Because there are some data conversions between unix and dos (especially for SNODAS), there may be compatibility issues if this module is with another operating system.

Toolbox and Python Scripts

Included with this SOP is a toolbox named NPScape Climate Grid Analysis Toolset, as well as the supporting python scripts. Data preparation and grid-statistic tools for each data source are included in the toolbox. NPScape Climate Grid Analysis Toolset can be found [here](#). For the tools to run without problem, it is crucial that all scripts are located in the same folder as the NPScape Climate Grid Analysis Toolset. There is no need to open or edit these files.

The following python scripts must be stored locally:

- The NPScape_CGAT_Module.py is the workhorse with all of the functionality.
- ArcGIS Refresh Archive Scripts – Each data source has its own script to refresh the respective archive (total of five). To run these tools without problem, they should be located in the same folder as the NPScape_CGAT_Module.py
- ArcGIS Statistics Scripts – There is a script for each of the statistics – percentile, average, water year average, and zonal statistics. To run these tools without problem, they should be located in the same folder as the NPScape_CGAT_Module.py.

More information about the tools can be found under the Processing Steps on page 13 of this SOP.

Data Sources

To meet the needs of the National Park Service, we have opted to focus on five datasets from four different sources.

Datasets	Geographic Extent	Spatial Resolution (km)	Temporal Resolution	Temporal Extent
PRISM 4k	Lower 48	4.0	Monthly	1895-Present
PRISM 30s	Lower 48	0.8	Monthly	Climatology (1960-1999; 1970-2009)
CRU	Global	8-17	Monthly	Climatology (1961-1990)
SNAP	Alaska, Western Canada, Northwestern U.S.	0.771 and 2.0	Monthly	1901-2009
SNODAS	Lower 48	1.0	Daily	10/1/2003-Present

Table 1. Temporal and Spatial Extent of the Supported Datasets.

Our decision to support these five was based on the following:

- Spatial Resolution – When possible, we opted for the highest spatial resolution data possible
- Geographic Extent – We wanted to ensure that each NPS unit was adequately represented
- Measured Variables- The measure variables should have clear application to ecological and physical issues faced by the parks
- Scientific Rigor – The methods to produce the datasets should be adequately documented and the use of the datasets should be accepted within the broader scientific community

Below are more detailed descriptions of each dataset. All of the figures are based off of Olympic National Park.

PRISM 4k and 30s

PRISM (Parameter-elevation Regressions on Independent Slopes Model) climatic data comes from the PRISM Climate Group at Oregon State University (<http://www.prism.oregonstate.edu/>). Using point-based observational data, PRISM is modeled using an advanced algorithm that factors in numerous regional controls including rain shadows, coastal effects, and temperature inversions. PRISM data is spatially continuous for the continental U.S., and has been modeled from the years 1895 to present. The spatial resolution of PRISM data is 2.5 arc-minutes (4km) or 30 arc-seconds (800m). The 4-km data is offered for free at a monthly time step; only the 800m 30 year climatology is free. More detailed information about the dataset is found [here](#).

Variable Code	Info
ppt	Total Precipitation (millimeters*100)
tmax	Average Maximum Temperature (degrees Celsius *100)
tmin	Average Minimum Temperature (degrees Celsius *100)
tdmean	Average Dewpoint Temperature (degrees Celsius *100)

Table 2. PRISM Variables and Related Information.

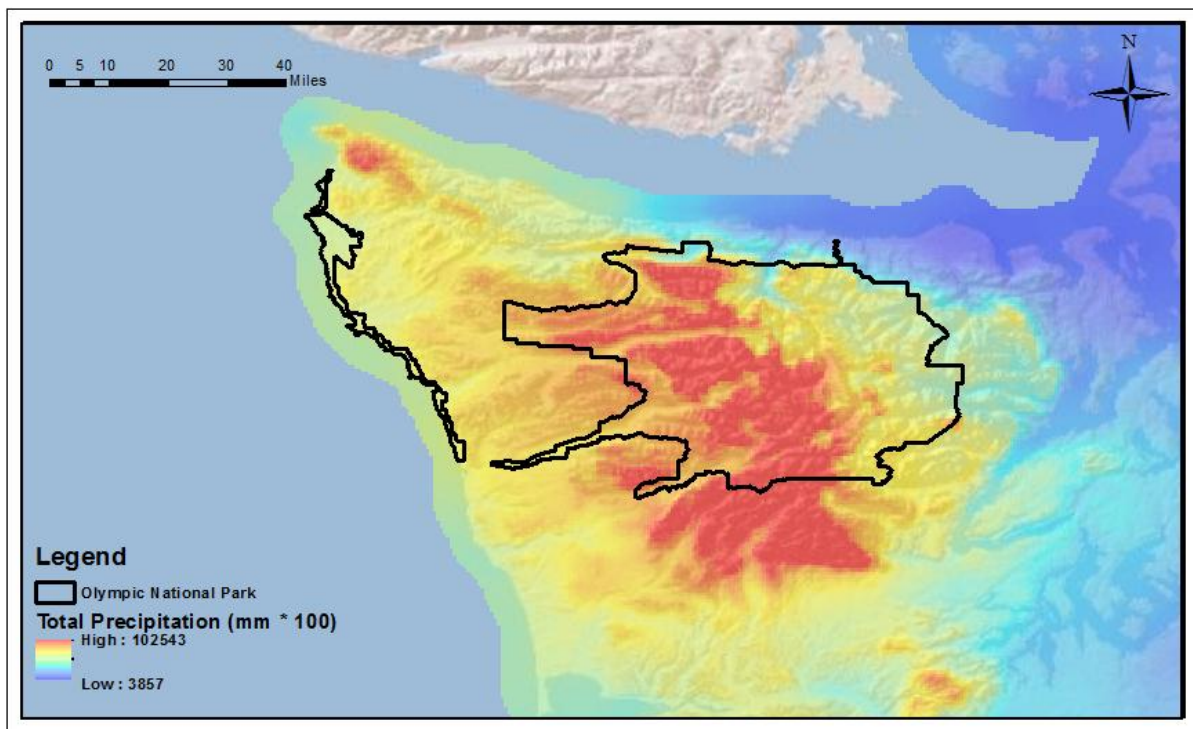


Figure 1. PRISM30s 30-year Averages, 1971-2010, in Olympic National Park.

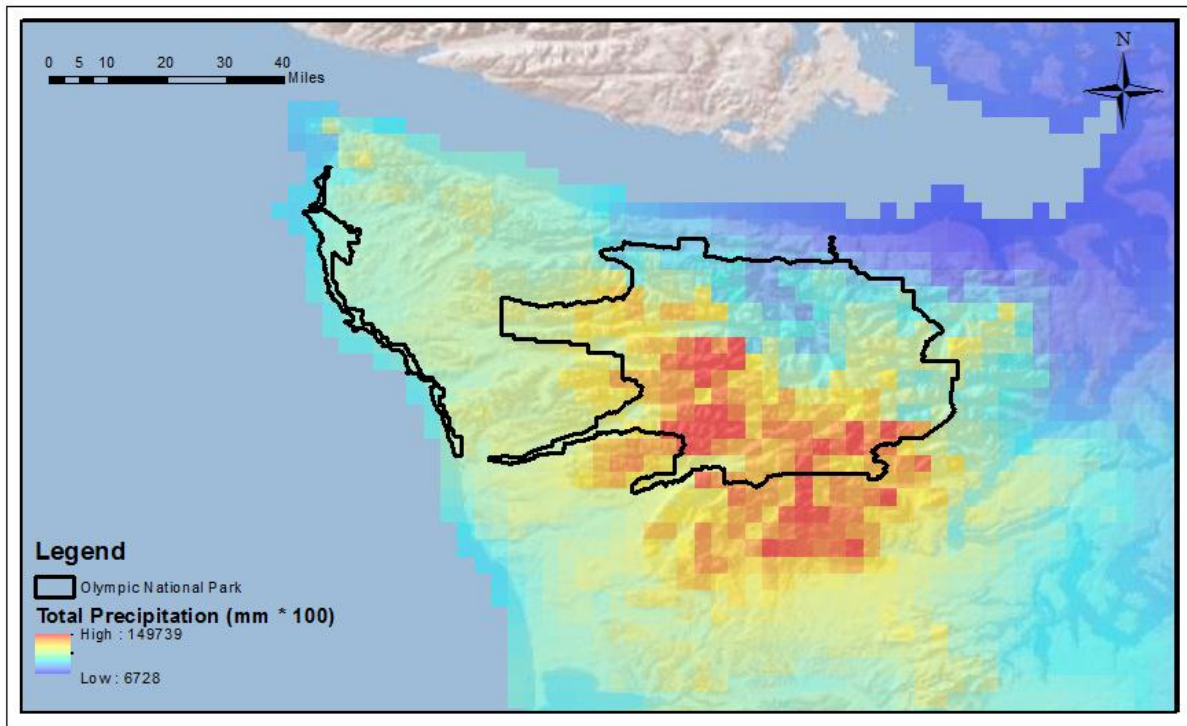


Figure 2. **PRISM4K Total Precipitation (mm *100) for January 1970 in Olympic National Park.**

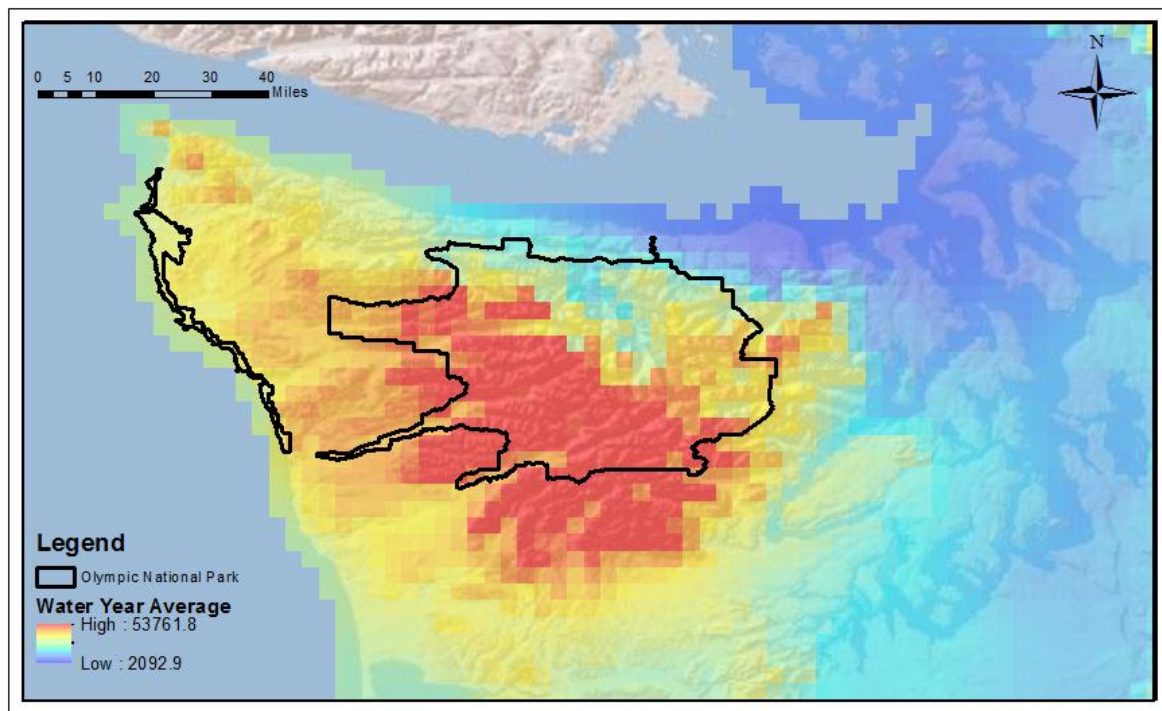


Figure 3. **PRISM4K 1970 Water Year Average Precipitation (mm *100) in Olympic National Park.**

CRU CL20

CRU CL2.0 is a ten-minute (approx. 8-17 km, depending on latitude) global-scale climatology for 1961-1990 reference period ([New et al, 2002](#); <http://www.cru.uea.ac.uk/cru/data/hrg/tmc/>). While CRU is coarser in scale than the other data sources and is only provided as a climatology, it offers a number of unique variables that have direct bioclimatic application. More detailed information about the variables can be found at <http://www.cru.uea.ac.uk/>.

Variable Code	Info
pre	Precipitation (mm/month)
rd0	Wet-days (number of days with >0.1mm rain per month)
tmp	Mean temperature (Degrees Celsius)
dtr	Mean diurnal temperature range (Degrees Celsius)
reh	Relative humidity (percent)
sunp	Sunshine (percent of maximum possible (percent of daylength))
frs	Ground-frost (number of days with ground-frost per month)
wnd	10m windspeed (meters/second)

Table 3. CRU CL20 variables and Related Information.

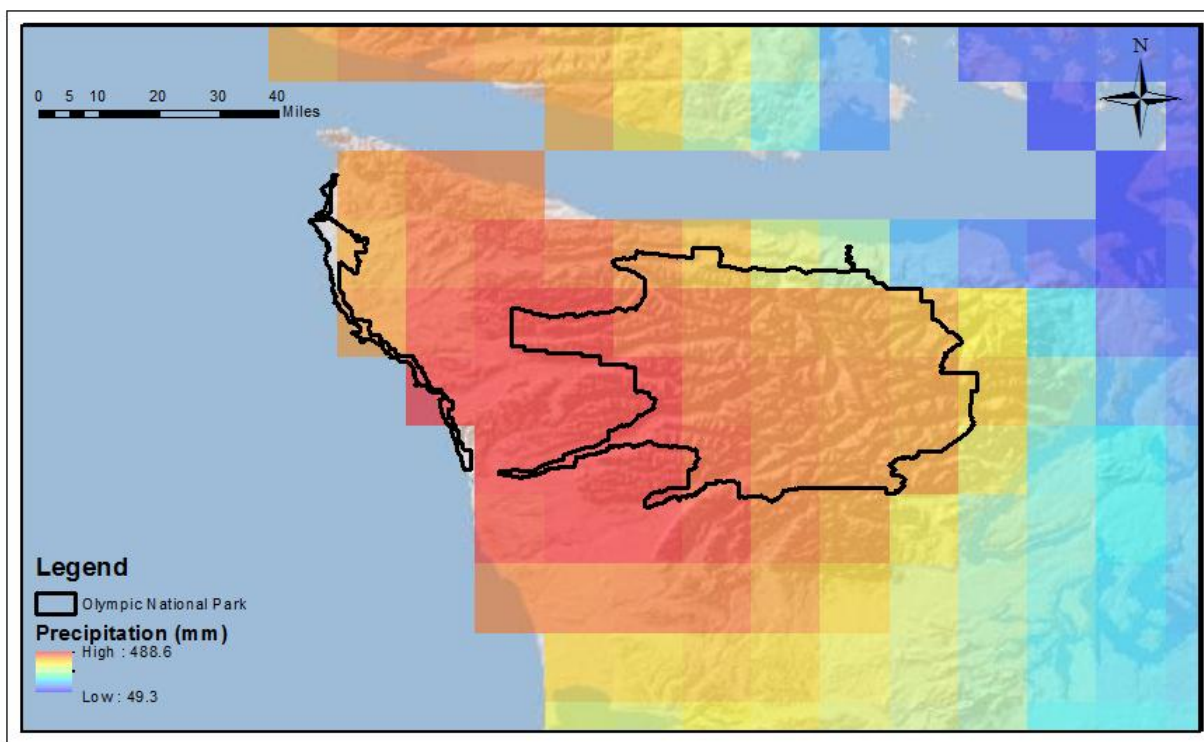


Figure 4. CRU Precipitation (mm) in January 1960 in Olympic National Park.

SNAP

SNAP (Scenarios Network for Alaska and Arctic Planning) products include historical and projected monthly climate data for temperate and precipitation across Alaska (771m) and Western Canada (2km data only) (<http://www.snap.uaf.edu/>).

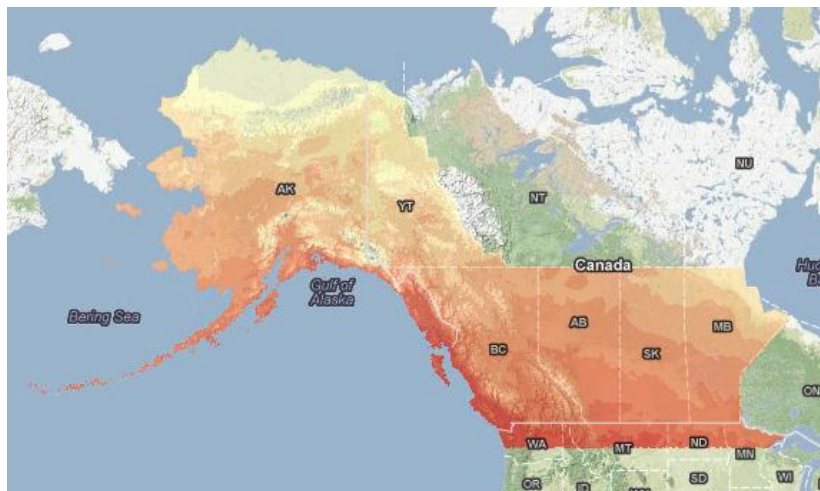


Figure 5. 2km CRU spatial extent includes Alaska, Canada (BC, AB, SK, MB), north regions of the United States (WA, MT, ND, MD).

Derived data products include potential evapotranspiration, vegetation, fire, permafrost, day of freeze, day of thaw, subsequent length of growing season, as well as decadal seasonal and annual averages. For detailed information on each of the datasets, please refer to the metadata in their respective sections.

Currently, the CGAT model has been tested to support the 771m and 2 km historical CRU TS 3.1 data for the following variables:

Variable Code	Info
tas	Mean air temperature (degrees Celsius)
pr	Total Precipitation (millimeters)
dof	Day of Freeze (Julian Day; 0 = Primarily Frozen and 365 = Rarely Freezes)
dot	Day of Thaw (Julian Day; 0 = Rarely Freezes and 365 = Primarily Frozen)

SNODAS

The National Weather Service's National Operational Hydrologic Remote Sensing Center (NOHRSC) offers SNOw Data Assimilation System (SNODAS), a daily 1-km gridded dataset for a number of hydrologically relevant variables (NOHRSC, 2012; <http://nsidc.org/data/g02158.html>). SNODAS is based on both point-based observations (e.g., SNOTEL) and also remotely-sensed imagery.

Variable Code	Info
1025S	Solid Precipitation (kg/m2). 24 hour total, 06:00 UTC-06:00 UTC

1025L	Liquid Precipitation (kg/m2). 24 hour total, 06:00 UTC-06:00 UTC
1034	Snow Water Equivalent (meters). Snapshot
1036	Snow Depth (meters). Snapshot
1038	Snow Pack Average Temperature (kelvin)
1039	Sublimation of Blowing Snow (meters). Total of 24 per hour sublimation rates, 06:00 UTC-06:00 UTC
1044	Snow Melt Runoff at the Base of the Snow Pack (meters). Total of 24 per hour melt rates, 06:00 UTC-06:00 UTC
1050	Sublimation from the Snow Pack (meters). Total of 24 per hour sublimation rates, 06:00 UTC-06:00 UTC

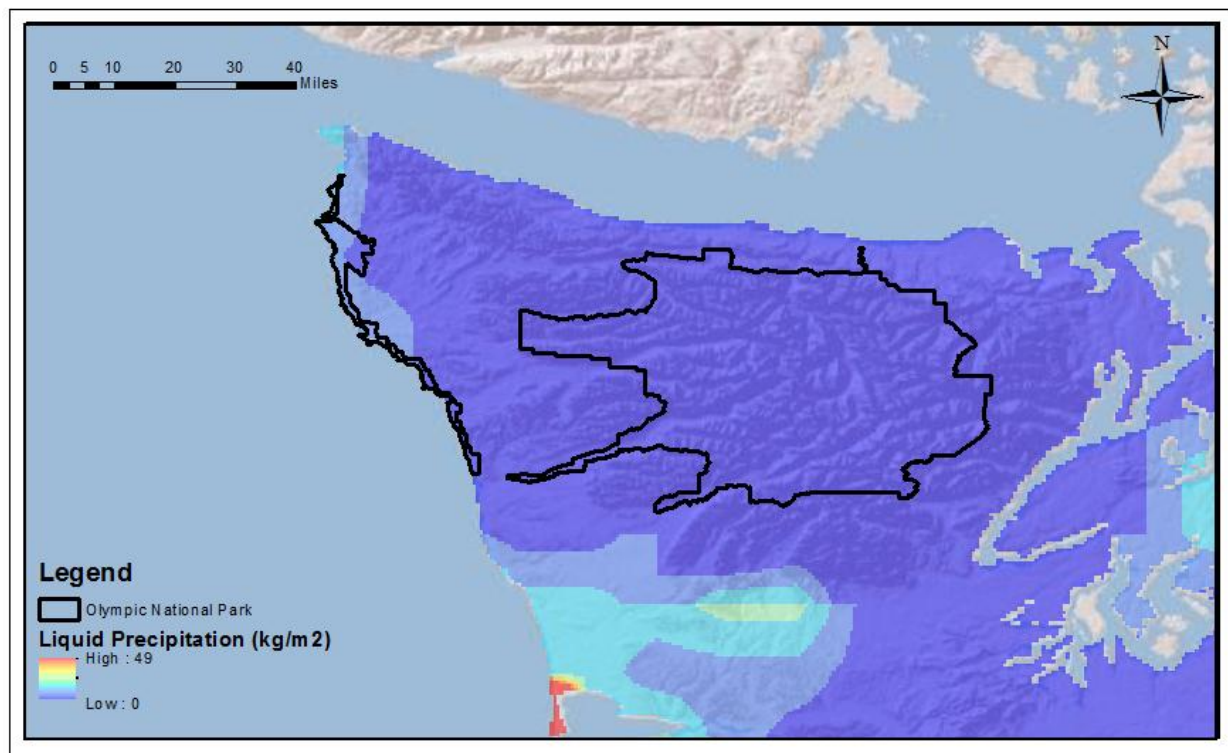


Figure 6. SNODAS Liquid Precipitation (kg/m2) January 1st 2004

Statistics

The CGAT tool provides four statistics for the purpose of summarizing the data.

Average

Averaging yields the central tendency value across one or more grids cells (Wikipedia 2012).

$$\frac{1}{n} \sum_{i=1}^n a_i$$

9

Averaging has the advantage of provided a simple and intuitive summary of information and is frequently used to summarize a regions climatology. Common uses include 30-year temperature averages and precipitation (i.e. 30-year normals). Averaging works well when data is normally distributed; bimodal and skewed data are poorly represented by this statistic. Averaging works best with larger samples, preferably at least 30.

Water Year Average

The water year average aggregates a series for values from October 1 of year one to September 30 of year two ([USGS 2012](#)). Aggregating climate data to the water year is most appropriate when relating it to hydrologic data that exhibits a model minimum during the months of September – October. This type of hydrologic behavior is most frequently found in the Northern Hemisphere mid-latitudes. Averaging relies entirely on the statistical methods defined above.

Percentile

Percentile is the value of a variable below which a certain percent of observations fall (Wikipedia, 2012). The advantage of percentile over other common means of representing departures from a common baseline (e.g., departure from normals) is that percentile does not depend on the underlying data being normally distributed. Furthermore, percentile is unit independent and bound by the range of 0 to 100%. Calculating percentile is recommended with at least 30 observations, including the comparison grid.

Zonal Statistics

The third CGAT analysis performs zonal statistics, which calculates summary statistics for specific areas of interest. Example areas could include fire boundaries, watersheds, park boundaries, etc. Output from zonal statistics is a .csv table with the zonal statistics by zone per climate grid. Statistical zones are defined by the specified field in either a feature class or grid layer zone dataset. ESRI provides thorough documentation on the zonal statistics method ([ESRI, 2012](#)).

Zonal statistics includes the calculation of the following statistics:

MIN
MAX
RANGE
MEAN
STD
SUM
VARIETY
MAJORITY
MINORITY
MEDIAN

Calculating Statistics Using the Available Datasets

The following table provides our recommendations on which statistics are valid/recommended for each particular dataset.

Dataset	Statistic			
	Average	Water Year Average	Percentile	Zonal Stats
PRISM4k				
PRISM30s				
SNAP				
CRU				
SNODAS				

Recommended	
Caution	
Not Recommended	

Processing Steps and Tools

Gridded climate data is notorious for the following:

- They are in different formats, making any type of standard analysis difficult; and
- File sizes are extremely large, making them slow to process

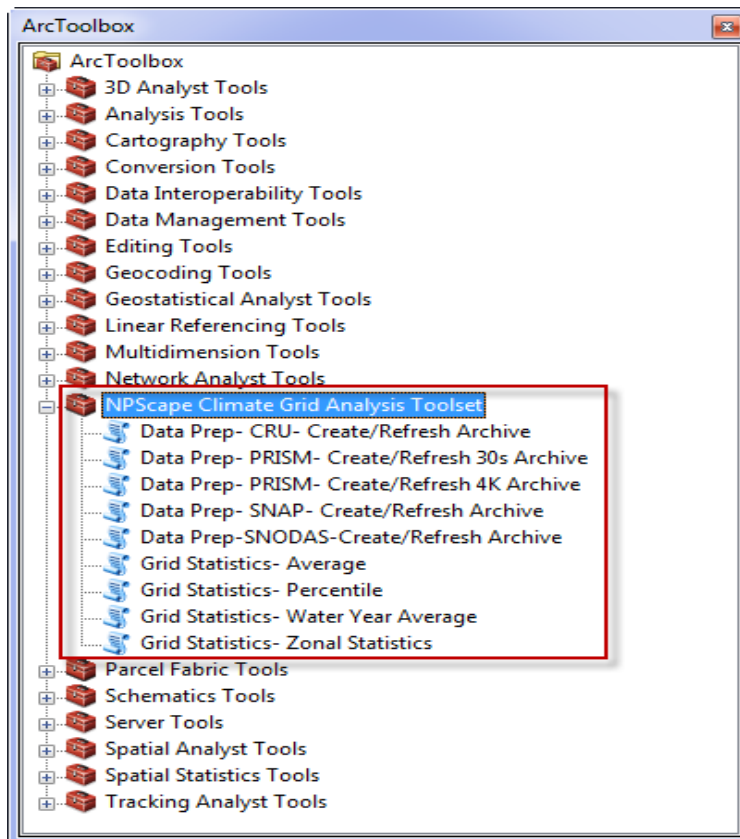
Therefore, one key component of the model is to generate a local archive of the climate data in a standard format for the desired geographic extent (Figure 7). Once in the standard format, statistical analyses are substantially faster, and data source independent. Furthermore, because netCDF is a non-proprietary and accepted data model, other statistics not covered by this module can be readily applied.



Figure 7. **Climate Grid Analysis Toolset- Analysis Flow Chart**

We provide a number of example workflows in the Appendix (see below).

To begin processing, open ArcGIS and add the NPSCape Climate Grid Analysis Toolset toolbox.



Refresh Archive

Except for SNAP, the Refresh Archive tools automatically pull the data directly from the source and save the files locally. Thus, the entire process is completely automated.

All tools will require the following:

- Working Directory – The folder where you intend to set up your data archive
- Feature Extent –The input feature class that includes the maximum area of the processed grids, or the maximum extent of the dataset.
- Geography Code – The geographic code given to the reformatted grids. If you choose the entire extent for the US, we recommend using 'US'. Otherwise, for park, network or regional extents, we recommend using the respective unit codes. Please note that **underscores are never allowed**.
- Parameters – Specify one or more of the climate variables. Note that the variable codes will differ among the climate sources.
- Dates (e.g., Years, months, and days depending on source).
- keepOriginalFiles – You can indicate whether to preserve or discard a local copy of the original files downloaded from the source. Unless space is a real issue, we recommend keeping a copy locally.
- Ignore Last Number of Months of Provisional Data - Indicates the last number of months to ignore of present year because they are provisional.

Defaults are set to retrieve the maximum data available. Please be aware that some data sources (e.g., SNODAS) will take a long time to process if you accept the defaults.

Once configured, begin the Refresh Archive process. Below are further notes specific to each data source.

Once any of the data sources are processed, they will be converted to a [netCDF](#) format (version 3). We chose to standardize on netCDF3 format and version because it is not proprietary, is frequently used by the climate community, and can be easily processed using a number of different tools used by the National Park Service, included ArcGIS, R, and Python.

All files are named according to our own naming convention:

geographyCode_dataSource_variable_statistic_YYYYMMDDHH.nc

Geography code represents the geographic extent of the processed data. For example, if PRISM data were clipped to the extent of Rocky Mountain National Park, an appropriate geography code might be 'ROMO' or 'RMNP'.

Data Source is the originating source of the processed data. The following table shows the codes that are used by CGAT:

Source Code	Data Source
PRISM4K	PRISM 4 kilometer monthly/annual grids
PRISM30s	PRISM 30-second (800m) grids
CRUCL20	CRU Version 2.0
SNAP	SNAP
SNODAS	SNODAS

Variable is the variable being measured (e.g., 'ppt' for PRISM precipitation). Variable codes are identical to those used by the respective data sources (see above).

Statistic represents analysis or aggregation of the variable. Currently, the following codes are used:

Statistic Code	Statistic Description
avg	average
obs	Instantaneous observation/snapshot
avg[time]	Average for a larger time step (e.g., 30 year avg)
tot	Total
wyAvg	The average for a water year (October-September)

The date is always represented by YYYYMMDDHH. If time divisions are irrelevant (e.g., for monthly data), the values are represented by '00'. In cases where there is a multi-year aggregation (e.g., 30 year averages), the begin date is represented here.

Below are examples of the Refresh Archive tool for each data source to get a better understanding of how the toolset works.

PRISM 4K

Figure 8 presents an example tool used to refresh the PRISM 4K archive.

The screenshot shows a Windows-style dialog box titled "Data Prep- PRISM- Create/Refresh 4K Archive". It contains several input fields and checkboxes. The "Working Directory" is set to "D:\CGAT\OLYM". The "Feature Extent (optional)" is "D:\Work\olympic.shp". The "Geography Code(text only- no underscores or special characters) (optional)" is "OLYM". Under "Parameters (optional)", the checkboxes for "ppt", "tmin", "tmax", and "tdmean" are all checked. Below this are "Select All" and "Unselect All" buttons, and an "Add Value" button. The "Begin Year(1895 or greater) (optional)" is "1895" and the "End Year (optional)" is "2012". The "Months (optional)" section has a list of months from 1 to 9, all of which are checked. There are also "Select All" and "Unselect All" buttons, and an "Add Value" button. At the bottom, there is a checkbox for "Keep Original PRISM Grids?" which is checked, and a field for "Ignore Last Number of Months of Provisional Data (optional)" set to "6". The dialog has "OK", "Cancel", "Environments...", and "Show Help >>" buttons at the bottom.

Figure 8. **Example Refresh Archive Script for the PRISM 4k Data**

Note:

- The month of 14 pertains to the annual average.

PRISM 30s

Figure 9 provides the example tool for PRISM 30s.

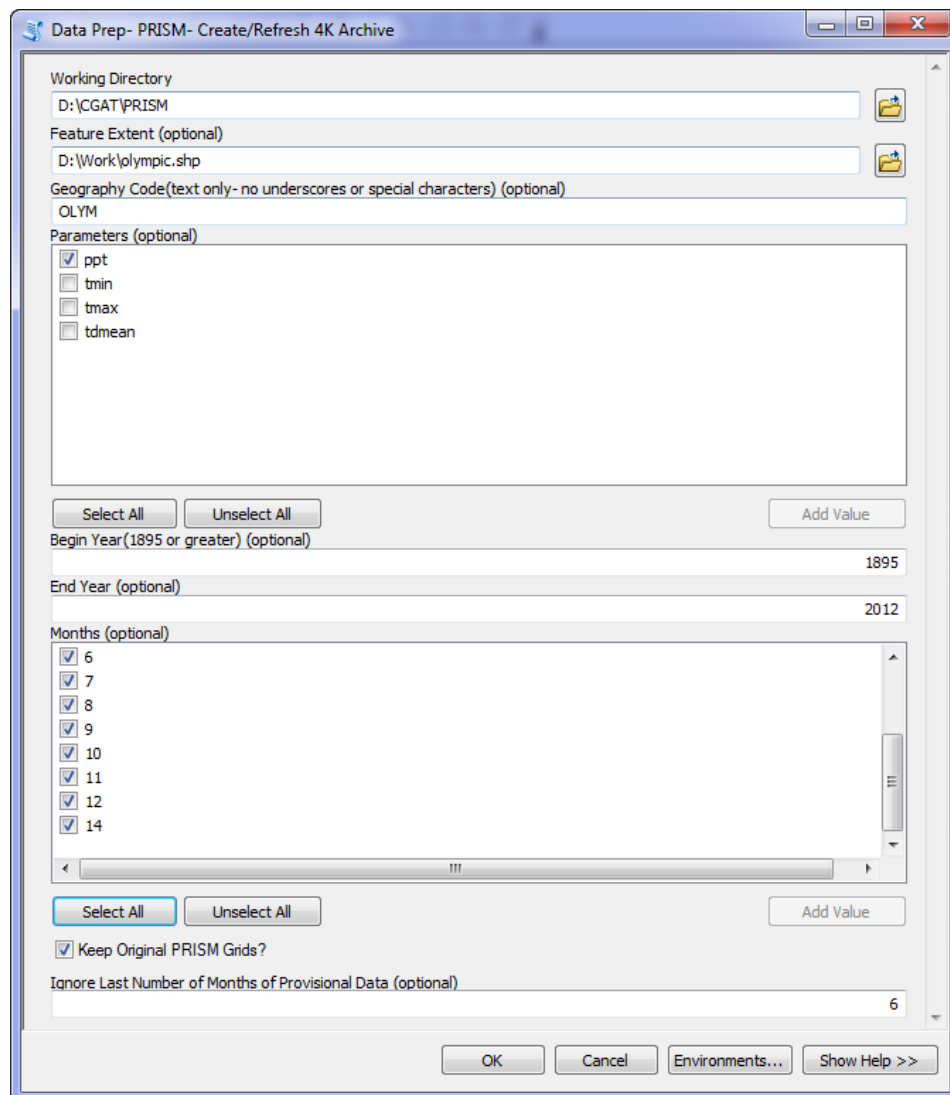


Figure 9. Example Refresh Archive Tool for the PRISM 30s data

Note:

- There are only two options for decade range: '1971_2000' and '1981_2010'.

CRU CL 2.0

Figure 10 is an example CRU tool.

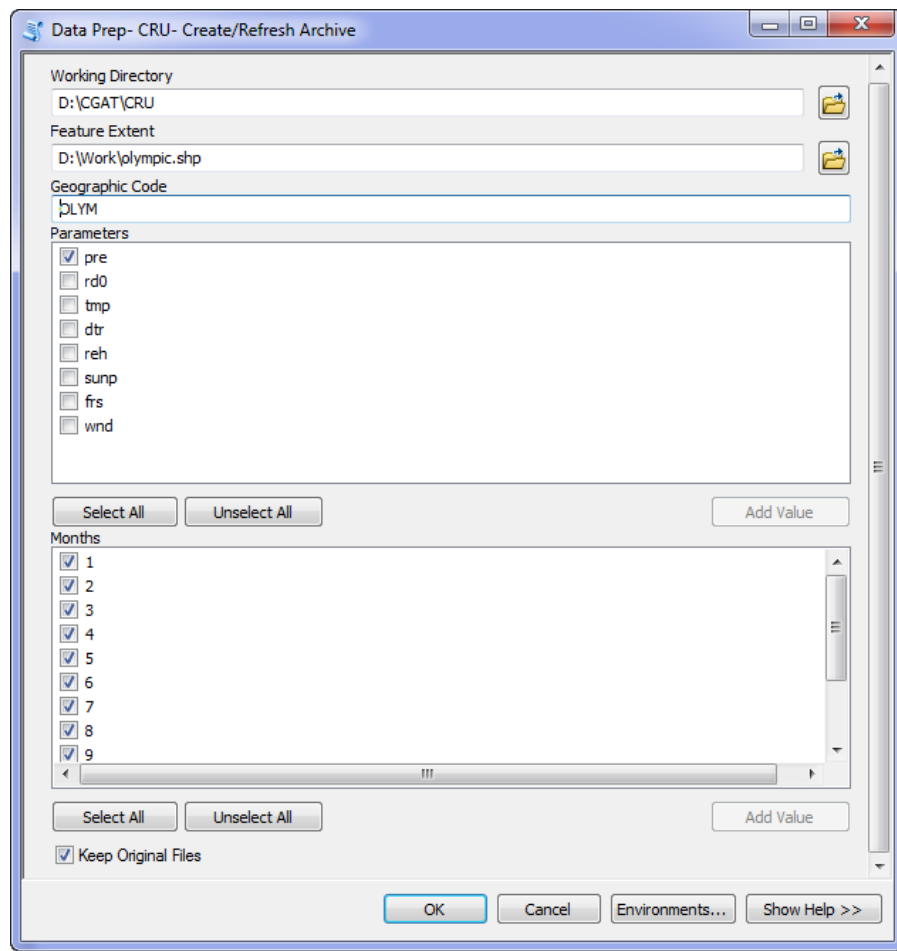


Figure 10. **Example Refresh Archive Tool for the CRU CL 2.0 data**

Note:

- Since CRU is a single 30-year climatology, there is no ability to specify a range of years.
- Although CRU is global in extent, we have set the default to cover the entire NPS domain

SNAP

The template for the SNAP archive is shown in Figure 11. Due to the extremely large file sizes, it is necessary to manually download the SNAP data files from the website <http://www.snap.uaf.edu/data.php>. Note that only the 771m historical CRU TS 3.1 data has been tested with the model, although others may work.

Once downloaded, the source files will need to be processed using the Refresh Archive tool.

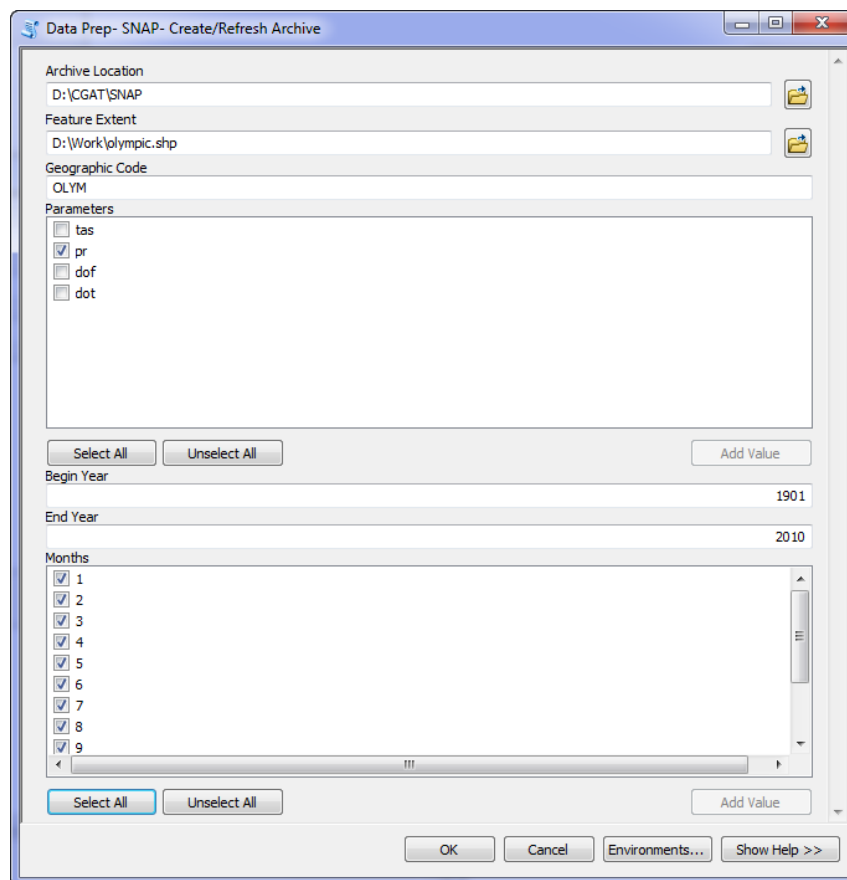


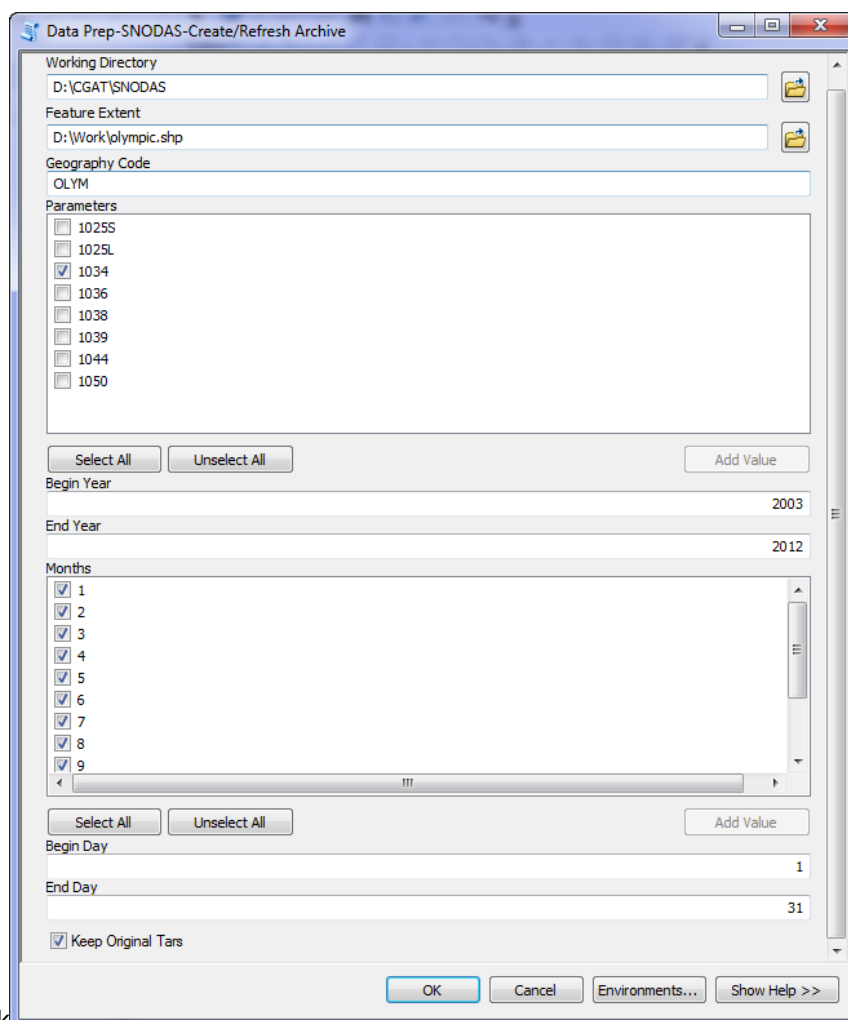
Figure 11. **Example Refresh Archive Script for the SNAP Data**

Note:

- There is no option in the script to automatically remove the downloaded files. If you want them removed after processing, you will need to delete them manually.

SNODAS

The largest of the archive tools is for SNODAS, which includes the daily observations (Figure 12).



That work
Figure 12. **Example Refresh Archive Script for the SNODAS data**

Note:

- Dates prior to October 2003 or later than the current date will be ignored.
- If you are processing numerous grids, be sure you have enough disk space. Each SNODAS archive is initially 22 mb in size. Because all archives are downloaded before processing, if you process all grids for all years, that is approximately 8.1 GB per year. The good news, however, is that once you process the grids and clip them to a smaller extent, the size will likely drop precipitously.

Calculate Grid Statistics

Average

As with the refresh tools, a few parameters will need to be specified to calculate the average (Figure 13).

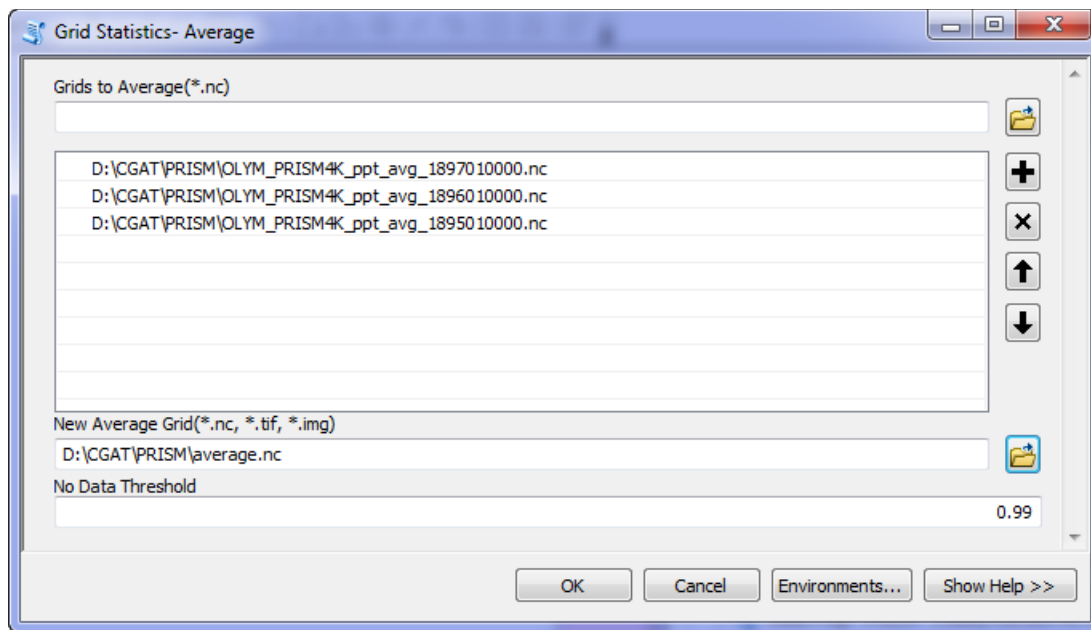


Figure 13. **Example Average Tool**

Note:

- Grids to Average - One or more netCDF formatted climate files.
- New Average Grid – The new netCDF grid which contains the average values for the files specified from Grids to Average.
- noDataThreshold – The percent of allowable missing values before “No Data” is returned for a particular grid cell. This threshold is a percentage represented between 0 and 1 (i.e, 0-100%).

The cell-based average tool creates a single grid in netCDF format (e.g., Figure 14).

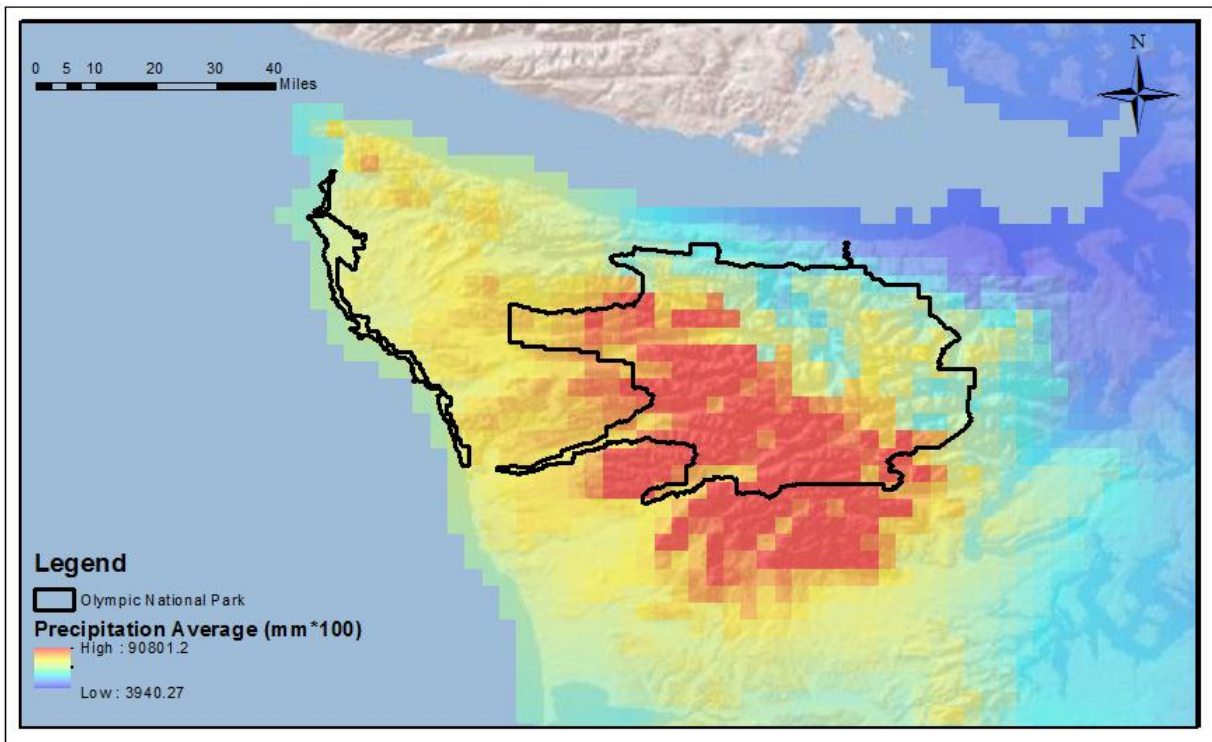


Figure 14. **PRISM4K January 1970-1980 Average Precipitation (mm*100) for Olympic National Park.**

Water Year Average

The Water Year Average tool must be modified before executing. Note that the parameters that are selected must match the correct Data Source.

Grid Statistics- Water Year Average

Archive Location
D:\CGAT\OLYM\python

Geographic Code
OLYM

Begin Year
1981

End Year
2012

Data Source
☒ PRISM4k
☐ SNAP
☐ SNODAS

Select All Unselect All Add Value

Parameter
☒ ppt
☐ tmin
☐ tmax
☐ tdmean
☐ tas
☐ pr
☐ dof
☐ dot
☐ 1025S

Select All Unselect All Add Value

Statistic
avg

No Data Threshold
1

OK Cancel Environments... Show Help >>

Figure 15. **Example Water Average Script**

Note:

- All months between October and September need to be locally archived in order to successfully calculate the water year average
- Parameters- It is necessary to choose the correct parameters that coorespond with the appropriate data source

The Water Year Average function produces a single grid for each Water Year. This example goes one step further to display the water year's total average precipitation during a 10 year time period in a single grid.

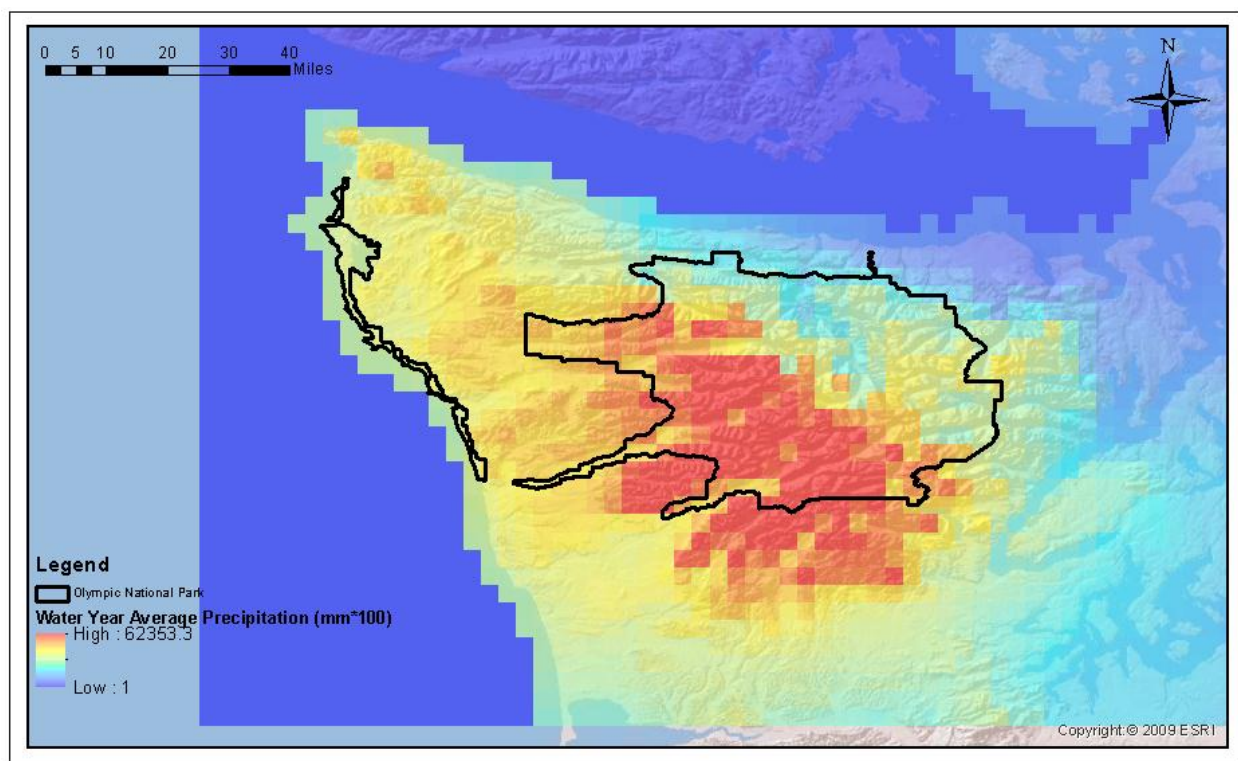


Figure 16. **PRISM4K Water Year (October- September) Average Total Precipitation (mm*100) for 1970-1980 for Olympic National Park.**

Percentile

Before running the Percentile tool, a few parameters must be specified.

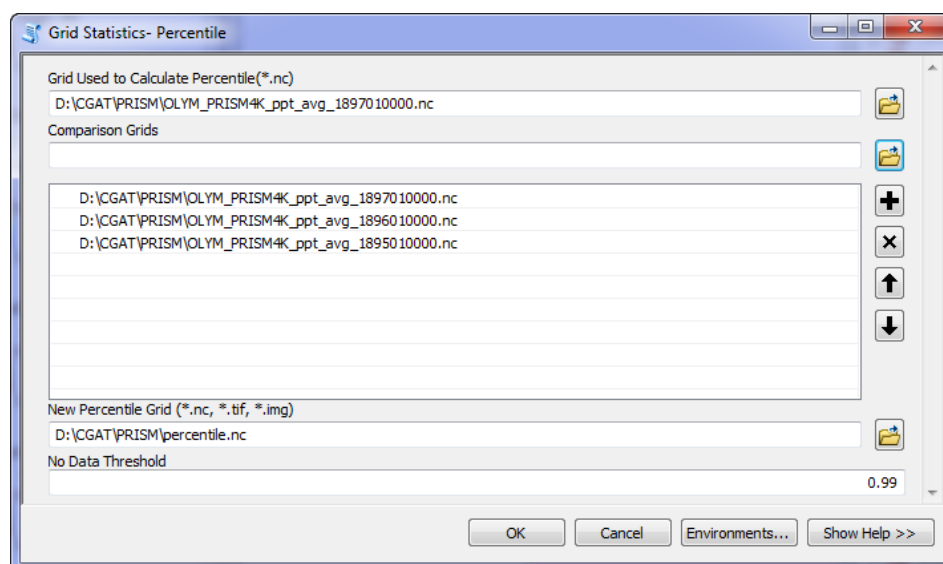


Figure 17. **Example Percentile Script**

- Grid Used to Calculate Percentile – The folder and file name of the single netCDF grid which is to be compared against a set of other grids

- Comparison Grids – The set of netCDF grids which are used for comparison. Folder names must be included.
- New Percentile Grid – The new grid which contains the grid percentiles.
- No DataThreshold – The percent of allowable missing values before “No Data” is returned for a particular grid cell. This threshold is a percentage represented between 0 and 1 (i.e, 0-100%).

The Percentile function creates a single grid.

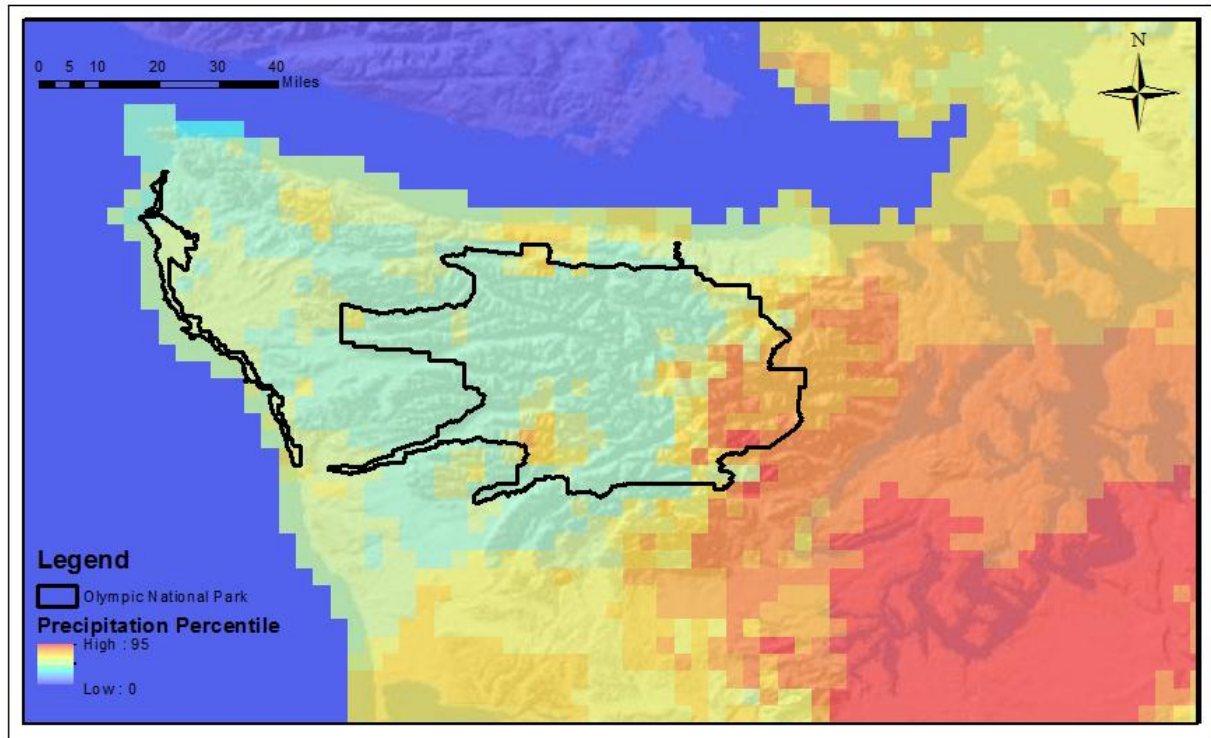
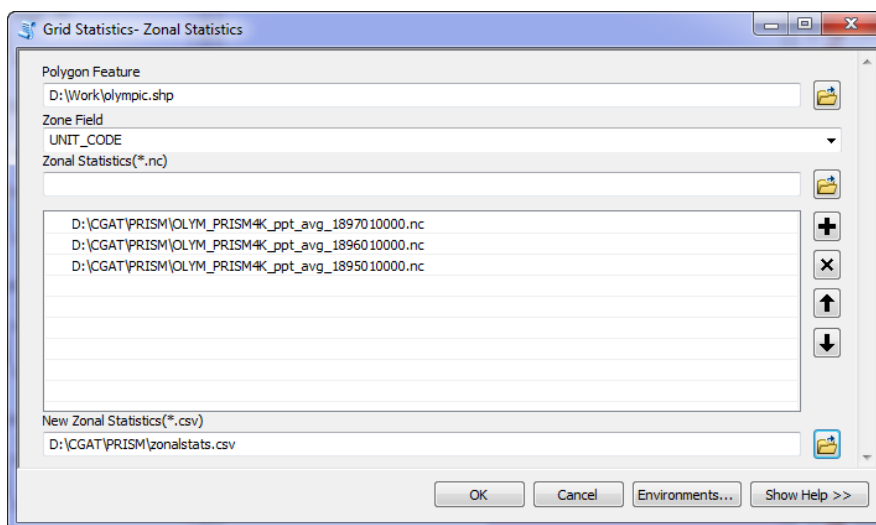


Figure 18. **PRISM4K Total Precipitation Percentiles** calculated from January 1970-1980 that is compared to January 1970 in Olympic National Park.

Zonal Statistics

To calculate zonal statistics, the Zonal Statistics tool will need to be opened and edited.



-
- Polygon Feature – The shapefile or feature class which defines one or more zones used to calculate the statistics. The extent polygon file must be encompassed by the geographic extent of the source data.
- Zone Field – The name of the column in the polygon file which uniquely identifies each region/zone
- Zonal Statistics – One or more netCDF formatted climate files. Folder names must be included.
- New Zonal Statistics – The resulting zonal statistics table that contains the summary for all grids.

This function creates a single comma-delimited text file containing the zonal statistics for all of the specified grids and the respective zones. To differentiate between the multiple grids, geography, data source, statistic (of the source grid), year, month, day and hour are included as separate fields.

Field	Description
UNIT_CODE	The name of this column is the same as the field defined in the shapefile or feature
ZONE_CODE	
COUNT	Number of cells intersecting the zone
AREA	The area of the zone
MIN	Minimum grid value found
MAX	Maximum grid value
RANGE	Range of grid values
MEAN	Average of grid values
STD	Standard deviation of grid values
SUM	Sum of grid values
VARIETY	Number of unique values for all cells
MAJORITY	Grid value that occurs most often
MINORITY	Grid value that occurs least often
MEDIAN	Median of grid values
Geography	Feature extent

Data Source	PRISM, CRU, SNAP, or SNODAS
Variable	Parameter that corresponds with specific data source
Statistic	Avg or wyAvg
Year	Year derived from filename
Month	Month derived from filename
Day	Day derived from filename
Hour	Hour derived from filename

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	
1	UNIT_CODE	ZONE_CODE	COUNT	AREA	MIN	MAX	RANGE	MEAN	STD	SUM	VARIETY	MAJORITY	MINORITY	MEDIAN	Geography	Data Source	Variable	Statistic	Year	Month	Day
2	OLYM	1	258	0.447917	19161	89571	70410	47191.7	15713.7	12175500	249	29340	19161	44205	OLYM	PRISM4K	ppt	avg	1970	1	
3	OLYM	1	258	0.447917	21210	132537	111327	57272.1	21069.9	14776200	247	27129	21210	56845	OLYM	PRISM4K	ppt	avg	1971	1	
4	OLYM	1	258	0.447917	18246	182195	163949	58303.2	27541.4	15042200	250	26453	18246	52107	OLYM	PRISM4K	ppt	avg	1972	1	
5	OLYM	1	258	0.447917	17912	113272	95360	54175.5	19899.4	13977300	254	43735	17912	50629	OLYM	PRISM4K	ppt	avg	1973	1	
6	OLYM	1	258	0.447917	34066	134835	100769	65294.1	16750.2	16845900	251	53275	34066	62886	OLYM	PRISM4K	ppt	avg	1974	1	
7	OLYM	1	258	0.447917	16736	146364	129628	49629.9	21655.7	12804500	251	24441	16736	45703	OLYM	PRISM4K	ppt	avg	1975	1	
8	OLYM	1	258	0.447917	15048	133596	118548	55862.5	24624.6	14412500	248	26320	15048	49993	OLYM	PRISM4K	ppt	avg	1976	1	
9	OLYM	1	258	0.447917	3769	42040	38271	20877.7	9393.88	5386450	250	7619	3769	20679	OLYM	PRISM4K	ppt	avg	1977	1	
10	OLYM	1	258	0.447917	10191	63282	53091	32343	12117.6	8344510	247	17625	10191	30500	OLYM	PRISM4K	ppt	avg	1978	1	
11	OLYM	1	258	0.447917	4476	40880	36404	14509.6	6342.1	3743470	250	7955	4476	13413	OLYM	PRISM4K	ppt	avg	1979	1	
12	OLYM	1	258	0.447917	11377	57578	46201	28638.3	9757.68	7388690	247	15308	11377	26631	OLYM	PRISM4K	ppt	avg	1980	1	
13																					

Literature Cited

National Operational Hydrologic Remote Sensing Center (NOHRSC). 2004. Snow Data Assimilation System (SNODAS) Data Products at NSIDC. Boulder, Colorado USA: National Snow and Ice Data Center. Digital media [<http://nsidc.org/data/g02158.html>].

New M and Others. 2002. A high-resolution data set of surface climate over global land areas. *Climate Research*. 21:1-25.