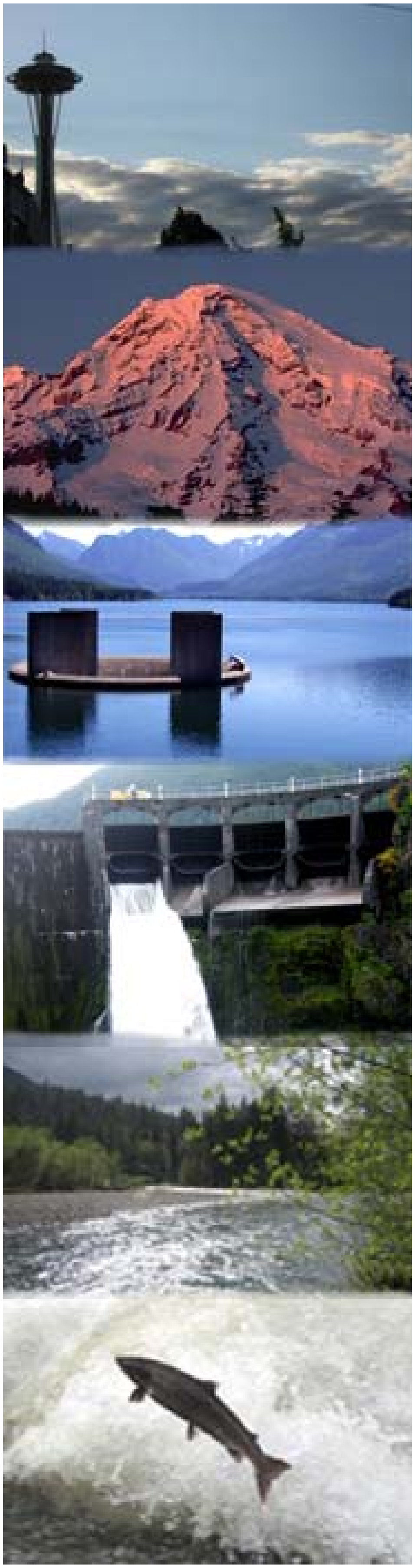

Technical Memorandum #3: Online Database Functionality and Design for Climate Impacted Data

Prepared for:

Climate Change Technical Committee

12/13/2007

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The report benefited from the committee members, including:

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Technical Memorandum #3
Online Database Functionality and Design for Climate Impacted Data

Background

A web-accessible database, denoted as the Online Climate Variables Database (www.climate.tag.washington.edu) was created to provide access to meteorological and hydrological forecasts of the impacts of climate change. This database provides access to the climate change forecasts that were produced as part of the Regional Water Supply Planning Process. Users have the ability to view and download climate change forecasts and access documents and technical memos that were produced by the Climate Change Technical Committee.

Introduction

This document details the website functions, as well as the website design and organization. It provides guidance on accessing and using the climate variables database. Four types of functions are provided for the user through four unique interfaces: informational pages, data download pages, spatial plot generation pages and graphical trends generation pages.

Website Overview

Climate change forecasts were produced for four "water resources index areas" (WRIAs) including WRIAs 7, 8, 9, and 10 in the Puget Sound region of Washington (Figure 1). The WRIAs lie in three counties of interest- King, Snohomish, and Pierce (Figure 2).

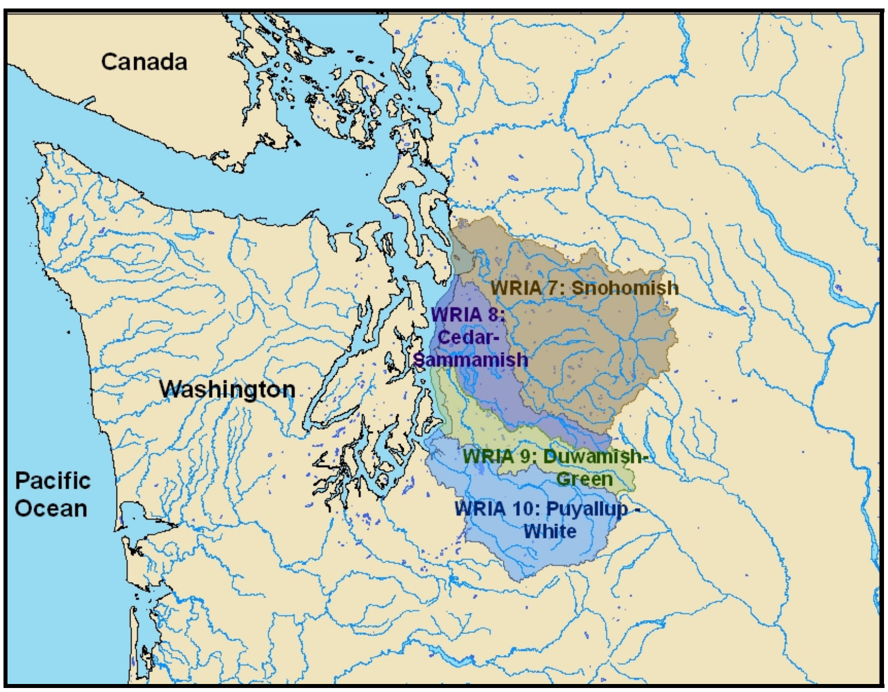

Figure 1: Regional map of the WRIAs in the database

The website provides several ways to access and display the data contained in the database. Users can view graphical trends and spatial plots of the data, download the data, and review the data generation process. All technical memos produced by the subcommittee related to the data generation process are available from the website. The homepage provides a brief overview of the website and its functions.

Website Data

Climate change forecasts were generated using three different General Circulation Models (GCMs) for the periods 2000, 2025, 2050, and 2075. The GCMs are coupled with two emissions scenarios, A2 and B1, which are narrative storylines that describe potential economic and social conditions in the future and their associated productions of greenhouse gases and emissions (IPCC, 2001). The models and scenarios chosen were all included in the IPCC Fourth Assessment Report. More information on GCMs and emission scenarios can be found in Technical Memorandum #4 (Polebitski et al., 2007).

The data within the database includes outputs from the following GCM/emission scenarios:

- IPSL A2
- GISS B1
- ECHAM A2

On an annual scale, the three models and scenarios result in different futures. The IPSL A2 characterizes an extremely warm and wet future, the GISS B1 characterizes a colder and drier future, and the ECHAM A2 characterizes a moderately warmer and wetter future. There are also seasonal differences between the models, and much of the impacts on water resources will be felt from late spring to summer and during the winter.

Meteorological Data

Daily temperature and precipitation forecasts were generated for 15 stations located in four WRIAs (one station is located outside of the WRIAs) in the Puget Sound region (Figure 2).

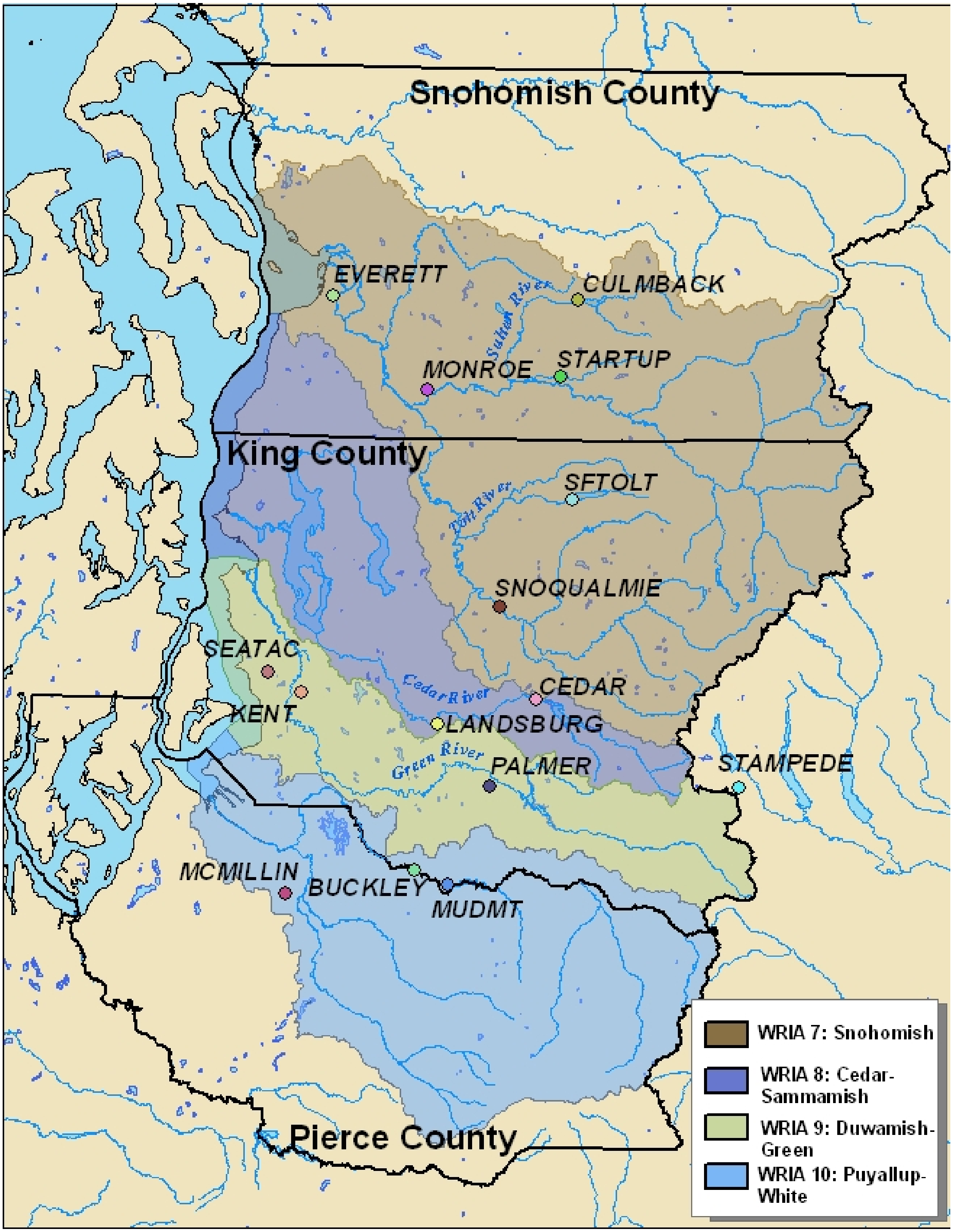

Figure 2: Geographical map of WRIAs 7-10 and the 15 meteorological stations used to create the database and the counties they fall in.

Historical daily temperature and precipitation data, dating back to 1927, are available for each station in the database. Outputs from the GCMs were downscaled to the historic meteorological data. More information on the downscaling process can be found in Technical Memorandum #2 (Polebitski et al., 2007). Table 1 lists the stations in each WRIA, and details background station information along with historic climatic averages, maximums and minimums.

Table 1: Meteorological stations in the database and historical averages for 77 years of meteorological data for each station

	Station	COOP	Latitude	Longitude	Elevation (m)	Average Daily Temperature (°C)	Minimum Daily Temperature (°C)	Maximum Daily Temperature (°C)	Average Daily Precipitation (mm)
WRIA 7	Culmback	---------	47°58'N	121°41'W	442	8.03	-23.57	34.57	11.30
	Everett	452675	47°59'N	122°12'W	18	10.46	-17.78	36.67	2.51
	Monroe	455525	47°51'N	122°00'W	37	10.76	-19.44	38.33	3.29
	SFTolt	458508	47°42'N	121°41'W	609	7.65	-22.48	35.56	7.54
	Snoqualmie	457773	47°32'N	121°50'W	134	10.20	-19.44	38.89	4.21
	Startup	458034	47°52'N	121°43'W	52	10.71	-22.22	39.44	4.51
WRIA 8	Cedar	451233	47°25'N	121°45'W	476	8.60	-23.89	38.33	6.98
	Landsburg	454486	47°23'N	121°58'W	163	9.69	-17.78	38.89	3.91
WRIA 9	Kent	454169	47°25'N	122°15'W	9	11.04	-23.33	37.78	2.75
	Palmer	456295	47°18'N	121°51'W	280	9.68	-19.44	38.33	6.24
	Seatac	457473	47°27'N	122°19'W	122	11.05	-17.78	37.78	2.62
WRIA 10	Buckley	450945	47°10'N	122°00'W	209	10.31	-19.44	39.44	3.35
	McMillin	455224	47°08'N	122°15'W	177	10.04	-18.33	37.78	2.86
	Mudmt	455704	47°08'N	121°56'W	399	9.18	-18.89	37.22	3.90
Other Stations	Stampede	458009	47°18'N	121°20'W	1206.4	4.30	-29.44	38.89	5.95
					Average All Stations:	**9.45**	**-20.88**	**37.86**	**4.80**

Statistical analysis of the data is also available for downloaded for each station. This includes the yearly average temperature in August, the number of days above 90°F and 100°F, the first frost day of the fall and the last day of frost in the spring.

Streamflow Data

Streamflow data includes daily streamflow values, in cubic feet per second (cfs), for five naturalized streamflows in the Puget Sound region; the Sultan, Tolt, Cedar, Green, and White Rivers. Simulated historic streamflows and forecasts using the same GCMs and emission scenarios that were used for the meteorological forecasts will be available for download.

The streamflows that are available for download are not specifically USGS gauging stations, but are often derived from system models that have been used by different utilities and agencies in the region. These users have different models that require alternative points along the rivers. The data in the website database is organized by the systems model annotations. However, for explanation purposes in this technical memo, streamflow reference points are created with a simple naming scheme. The USGS Station number (if available), a description of the location, and the latitude and longitude of each station reference point are listed in Table 2.

Table 2: Streamflow reference points annotation and background information

		Streamflow Reference Point	Latitude	Longitude	USGS Station Number	Description
WRIA 7	Sultan	Sultan A	47°58'28"	121°41'4"	--------	SULTAN RIVER INFLOW FROM SPADA LAKE
		Sultan B	47°57'34"	121°47'46"	12137800	SULTAN RIVER BELOW DIVERSION DAM NEAR SULTAN, WA
		Sultan C	47°56'31"	121°49'46"	--------	LAKE CHAPLAIN OUTFLOW
		Sultan D	47°54'27"	121°48'51"	12138160	SULTAN RIVER BELOW POWERPLANT NEAR SULTAN, WA
		Sultan E	47°54'27"	121°49'0"	--------	SULTAN RIVER NEAR SULTAN, WA
	Tolt	Tolt A	47°42'25"	121°35'56"	12147600	SOUTH FORK TOLT RIVER NEAR INDEX, WA
		Tolt B	47°41'40"	121°41'12"	--------	TOLT RIVER INFLOW FROM SO.FK.TOLT RESERVOIR
		Tolt C	47°41'22"	121°42'44"	12148000	SOUTH FORK TOLT RIVER NEAR CARNATION, WA
WRIA 8	Cedar	Cedar A	47°22'13"	121°37'26"	12115000	CEDAR RIVER NEAR CEDAR FALLS, WA
		Cedar B	47°24'52"	121°45'35"	--------	CEDAR RIVER INFLOW FROM CHESTER MORSE LAKE
		Cedar C	47°23'28"	121°57'12"	12117500	CEDAR RIVER NEAR LANDSBURG, WA
		Cedar D	47°27'52"	122°6'5"	--------	CEDAR RIVER NEAR MAPLEWOOD, WA
		Cedar E	47°28'58"	122°12'08"	12119000	CEDAR RIVER AT RENTON, WA
WRIA 9	Green	Green A	47°17'02"	121°47'48"	12105900	GREEN RIVER BELOW HOWARD A HANSON DAM, WA
		Green B	47°18'19"	121°50'58"	12106700	GREEN RIVER AT PURIFICATION PLANT NEAR PALMER, WA
		Green C	47°18'45"	122°12'10"	12113000	GREEN RIVER NEAR AUBURN, WA
WRIA 10	White	White A	47°09'05"	121°56'55"	12098500	WHITE RIVER NEAR BUCKLEY, WA
		White B	47°10'10"	122°00'20"	12099100	WHITE RIVER CANAL AT BUCKLEY, WA
	Carbon	Carbon A	47°01'41"	122°01'53"	12094000	CARBON RIVER NEAR FAIRFAX, WA
	Puyallup	Puyallup A	47°02'22"	122°12'24"	12093500	PUYALLUP RIVER NEAR ORTING, WA

WRIA 7

The Sultan and the Tolt River, located in WRIA 7, were evaluated for impacts of climate change on their streamflow. The Sultan has five streamflows available for download on the website, which are called Q1, Q2, Q3, Q4, and Q5 from the systems model. The streamflow reference points, Sultan A-E, are illustrated in Figure 3. Q1 is the flow at the streamflow reference point Sultan A, which describes all the flows into the Spada Lake Reservoir. Q2 is the streamflow at Sultan C, also known as all the inflows to Lake Chaplain. Q3 is the streamflow between Sultan B and Sultan A, which means Q3 is all of the local inflows between Chapman Dam and the Old Diversion. Q4 is the local inflows between the Old Diversion and the Powerhouse, including Chaplin Creek inflows, which corresponds to the flow between our streamflow reference points Sultan D and B, plus Sultan C (Chaplain Creek Inflows). Lastly, Q5 is the flow between Sultan D and Sultan E, which represent the local inflows below the confluence of Chaplain Creek and Sultan River and above the Powerhouse. .

The Tolt River has different annotations, because it uses a different system model. The Tolt stations in our database are called 7, 8, 20 and "Add." 7 is equal to the flow at the streamflow reference point Tolt A, 8 is all the inflows between Tolt C and Tolt B, 20 is the streamflow between Tolt B and Tolt A. Add is the addition of 7 and 20, which is really the flow at Tolt B, which is the Tolt inflow from the South Fork Tolt Reservoir.

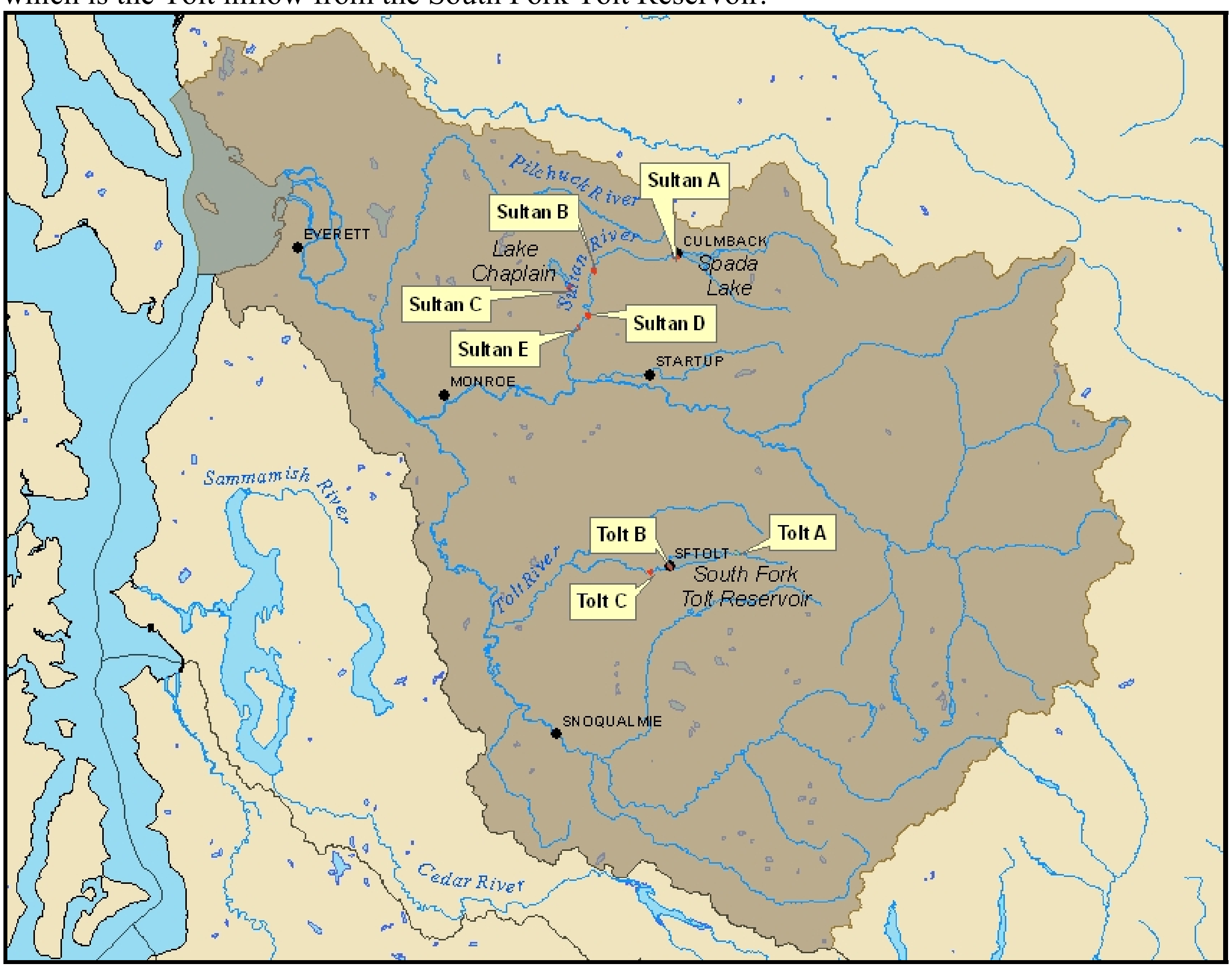

Figure 3: The streamflow reference points on the Sultan and Tolt River in WRIA 7

WRIA 8

The streamflow in WRIA 8 is referred to as Cedar1, Cedar18, Cedar2, Cedar3, and Cedar 5 in the systems model. Figure 4 illustrates the streamflow reference points that are used on the Cedar River. Cedar1 is equal to the flow at the streamflow reference point Cedar A, which is called CRY05 in the model. Cedar18 is the difference between the flow at Cedar A and Cedar B (CRY01 in the model). Cedar2 represents the flows between Cedar C (CRY09) and Cedar B. Cedar3 represents the inflows between Cedar C and Cedar D (CRY07). Cedar5 is the flows between Cedar D and Cedar E (CRY06).

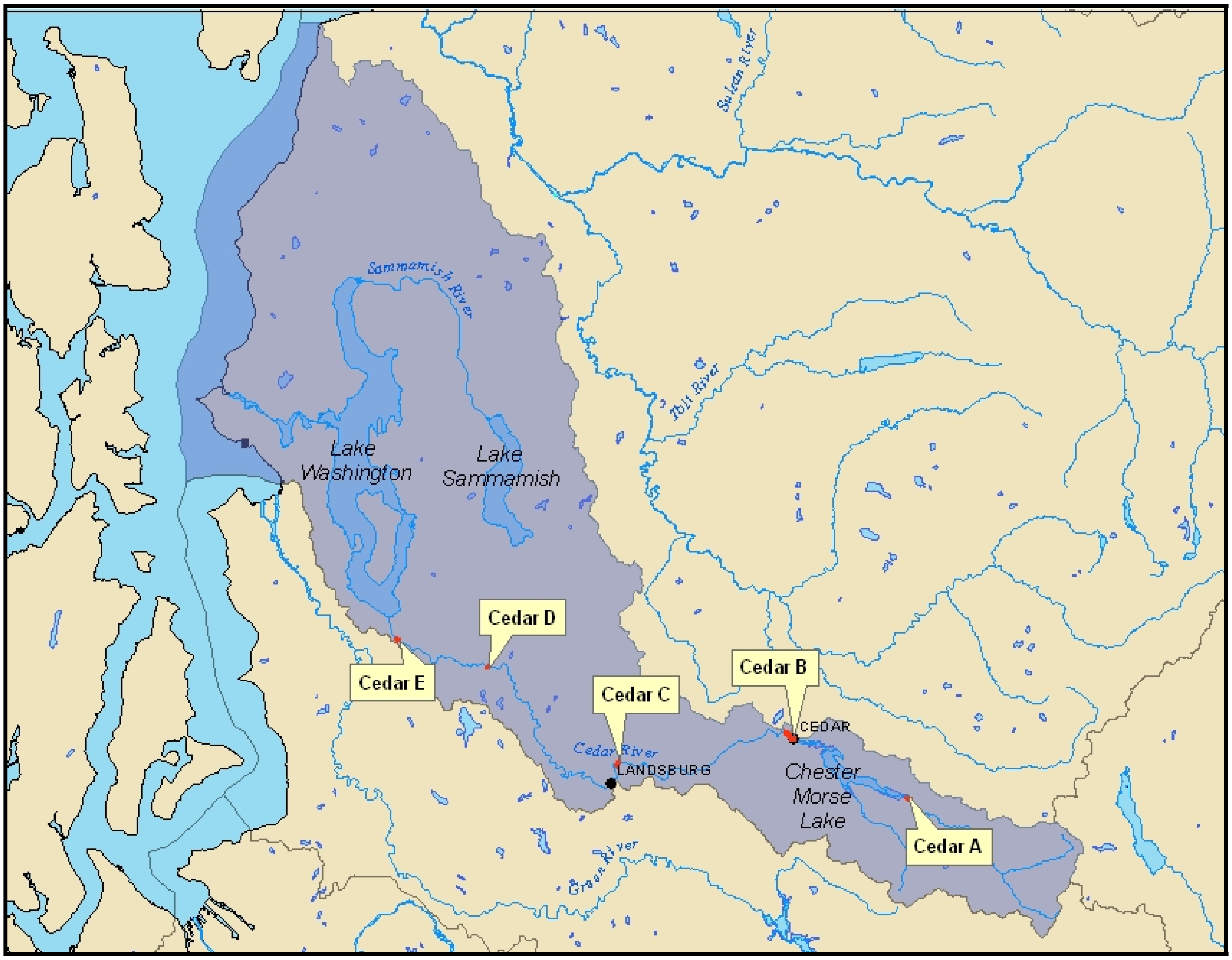

Figure 4: The streamflow reference points on the Cedar River in WRIA 8

WRIA 9

WRIA 9 only has two streamflow forecasts available for download for the Green River. These are referred to as "HH_Inflow" and "FlowBetween" in our website and in the system models. HH_Inflow is represented in Figure 5 by the flows at Green A, the inflow to the Green River from the Howard Hanson Reservoir. FlowBetween is the inflows between the streamflow reference points Green B and Green C.

Figure 5: The streamflow reference points on the Green River in WRIA 9

WRIA 10

There are four streamflow forecasts generated for WRIA 10, two on the White River, one on the Carbon River, and one on the Puyallup River. The flows on our website are annotated as the USGS gages that they correspond with. The flow at the point White A from Figure 6, the inflow from Mud Mountain Lake to the White River, is annotated as q12098500, and the flow at the streamflow reference point White B is annotated as q12099100. The streamflow reference point Carbon A is annotated as q12094000 and the streamflow reference point Puyallup A is called q12093500.

Figure 6: The streamflow reference points on the White River in WRIA 10

Table 3 explains the Systems Model annotations that are used in our website and the streamflow equivalent, using the streamflow reference points from Figure 3-Figure 6.

Table 3: System Model Annotation and actual streamflow from our streamflow reference points

		System's Model Annotation	Streamflow Reference Point Equivalent
WRIA 7	Sultan	Q1	Sultan A
		Q2	Sultan C
		Q3	Sultan B –Sultan A
		Q4	Sultan D – Sultan C – Sultan B
		Q5	Sultan E – Sultan D
	Tolt	7	Tolt A
		8	Tolt B - Tolt C
		20	Tolt B - Tolt A
		Add	Tolt B
WRIA 8	Cedar	Cedar1	Cedar A
		Cedar18	Cedar A - Cedar B
		Cedar2	Cedar C - Cedar B
		Cedar3	Cedar D - Cedar C
		Cedar5	Cedar E - Cedar D
WRIA 9	Green	HH_Inflows	Green A
		FlowBetween	Green B - Green C
WRIA 10	White	Q12098500	White A
		q12099100	White B
	Carbon	Q12094000	Carbon A
	Puyallup	Q12093500	Puyallup A

Evaluating the Website

During the design process, and through interactions with the Climate Change Technical Subcommittee, the researchers considered ways in which the website's utility could be evaluated. This includes, but is not limited to:

- Clarity of site's purpose,
- User's ability to interact with the site easily,
- Educational value of site,
- General website layout, and
- Ease of obtaining desired information.

Website Deliverables

The purpose of the website is to:

- Familiarize the user with the potential impacts of climate change,
- Provide access to technical memorandums and documents produced by the Climate Change Technical Committee,
- Provide access to precipitation and temperature data at meteorological stations for climate impacted periods, including 2000, 2025, 2050, 2075,
- Provide access to streamflow data at pseudo stream stations for climate impacted periods, including 2000, 2025, 2050, 2075, and
- Provide interactive graphic and analysis tools for illustrating the trends of Climate Change for precipitation, temperature, and streamflow at specific stations.

Website Design

The website contains of a series of web pages that provide the user access to the functions. The pages can be can be classified as:

1. **Informational pages *('Technical Memos', 'Regional Map', 'What Is This?')***
   The user obtains background on the committee, issues related to climate change, and access to technical documents from these pages.

2. **Data download pages *('Download Data')***
   The users can download the raw climate and streamflow data files from these pages. These data are provided in flat ASCII files that are easily converted to Excel, MySql, or other type of database that the user may use to evaluate the data (Appendix A).

3. **Graphical generation pages *('View Meteorological Trends, 'View Streamflow Trends'')***
   The user obtains access to visual display of the data and of the trends associated with the climate variables from these pages. These pages are interactive and produce line graphs, bar graphs, box and whisker plots, and cumulative distribution functions (CDFs) of the climate forecast data.

4. **Spatial display pages *('View Spatial Plots')***
   The user obtains access to spatial plots of all of the WRIAs together illustrating the climate changes spatially from these pages. This page is not WRIA specific, but instead provides insight into the impacts of climate change for the entire Eastern Puget Sound region.

Website Access

The website is principally organized by watershed, but it also gives users the flexibility to navigate though the website by function as well. The homepage of the website provides a brief overview of the website and its functions. From there, the user can select the appropriate WRIA (7, 8, 9,10, or other) or they can select a function, both of which are on the left menu of the page

(Figure 7). Functions are the different options that a user has to evaluate the impacts of climate change with this website. The left menu includes the following options:

- Home
- Technical Memos
- Regional Map
- Download Data
- View Meteorological Trends
- View Spatial Plots
- View Streamflow Trends
- Contact
- Back to TAG
- Go to a Specific WRIA

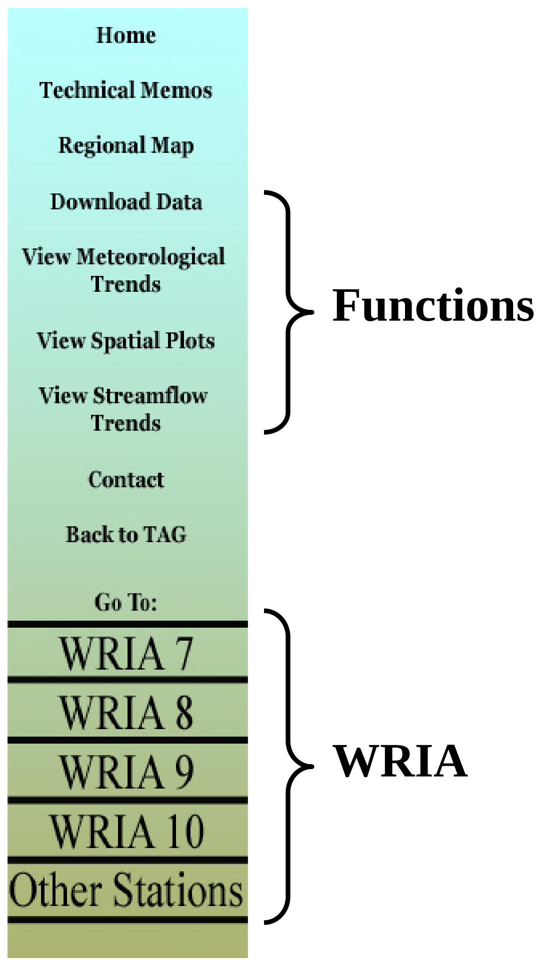

Figure 7: Website menu frame located on the left hand side of the webpage

If a specific WRIA is chosen, then the user is directed to an index page specific to the WRIA, where they can select any function on the left menu. Alternatively, if a function is selected from the menu on the home page, the user is directed to a page that describes the function, and then directs the user to select a WRIA to evaluate that function. The difference is that when a function within a specific WRIA page is selected, the user is directed to a WRIA specific function page, instead of a function overview page. This process is illustrated in Figure 8.

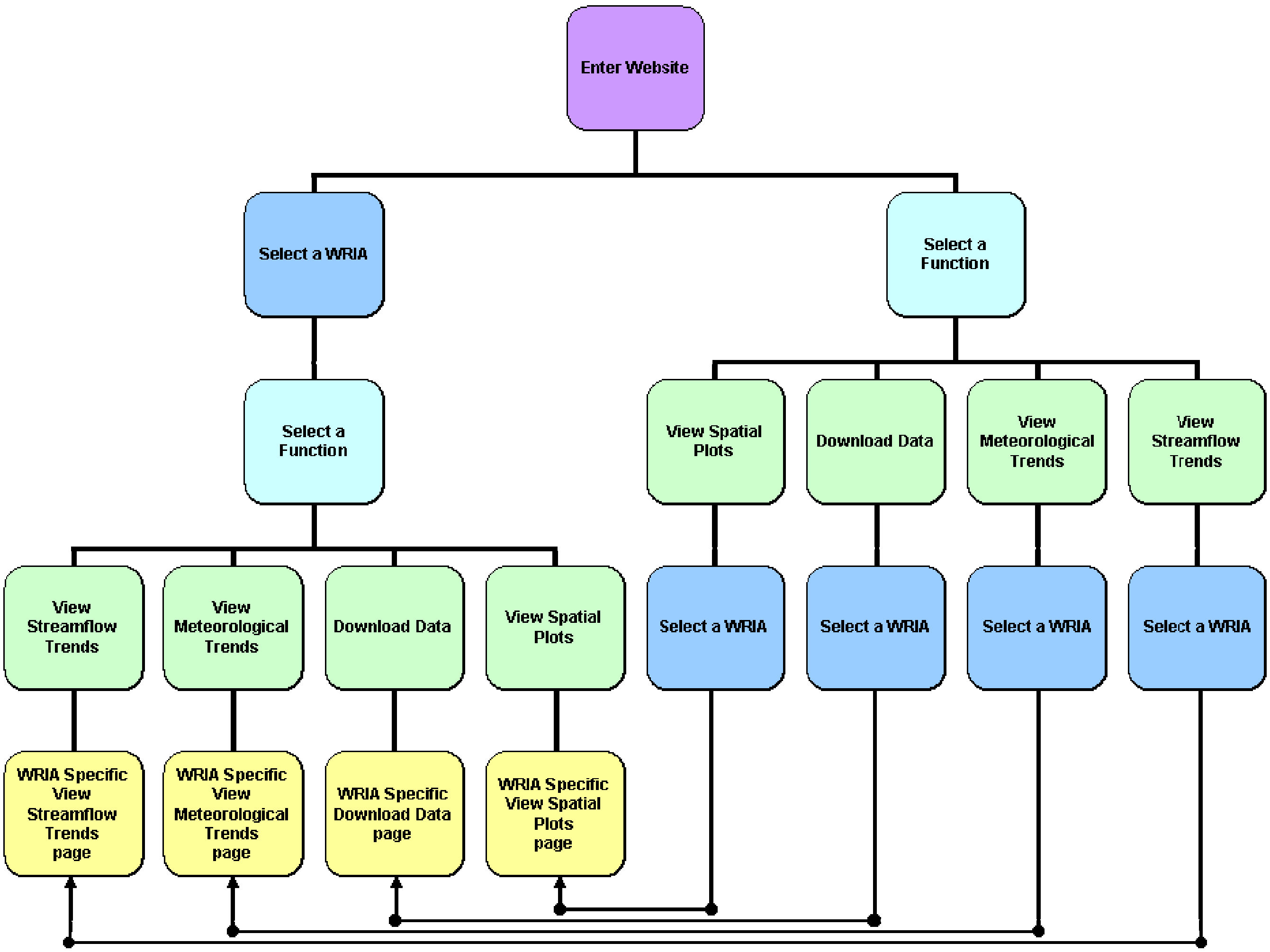

Figure 8: Simple flow chart to illustrate website organization. The user can get to the desired information from several different paths.

The index page for every WRIA has a detailed map of the WRIA that contains major rivers, streamflow stations, and the meteorological stations in that WRIA. From an individual WRIA page, the user must select one of the functions (listed above) from the left menu to proceed.

Website Functions

The following sections detail each specific function and activity of the website.

Home

The homepage of the website provides a brief overview of the history of the website and describes how information can be obtained. It provides access to the Regional Water Supply

Planning Process page and the Climate Change Technical Committee page. It also contains an interactive map and provides navigation to specific WRIAs from the interactive map. From the homepage, the user can select a function or go to an individual WRIA from the menu on the left of the page.

Technical Memos

This page provides access to the Technical Memos and supporting documents that have been produced by the Climate Change Technical Committee. The documents provide technical information on data generation and processing.

Regional Map

The regional map page illustrates the WRIAs on a regional level, much like Figure 1. This page is interactive, and when the user clicks on an individual WRIA on this page, they will be directed to the index page of that specific WRIA.

Download Data

The files include data generated from 15 stations located in four WRIAs in the Puget Sound region. Daily streamflow, temperature and precipitation forecasts were generated using three GCM scenarios for the years 2025, 2050, and 2075. The following files can be downloaded for each station:

- Maximum and Minimum Daily Temperature Data (Forecasted and Historic)
- Total Daily Precipitation Data (Forecasted and Historic)
- Statistical Analysis of Meteorological Data
- Average Daily Streamflows

View Meteorological Trends

This function generates graphs after parameters are chosen from the selection criteria. The graphs illustrate the trends associated with the meteorological and streamflow data.

The selection criteria for the meteorological data include:

1. **Station**

   There are between 2 and 6 meteorological stations located in each WRIA (Table 1). Background for the individual stations is provided, including the station's latitude and longitude, historic meteorological averages, and the source of the data. This information can be accessed by clicking on the "What is this?" link next to the stations title.

2. **GCM/Scenario**

   The forecasts were generated using three different General Circulation Models (GCMs) that include two emission scenarios, A2 and B1. The data within the database will include outputs from the following GCM/emission scenarios: IPSL A2, GISS B1, and ECHAM A2.

3. Period

Four future periods of interest were used to generate the data. These periods are three decades in length and are centered on a year of investigation: 2000, 2025, 2050, and 2075.

4. Climate Parameter

The climate parameters that can be evaluated include temperature (◦C) and precipitation (mm). When temperature data is graphed for comparison, the median is used, while the precipitation data uses the average precipitation for comparisons.

5. Type of Graph

Four different types of graphs are available for viewing the trends in the dataset: 1) Line graphs, 2) Cumulative Distribution Functions (CDFs), 3) Bar graphs, and 4) Composite Bar and Line graphs. The availability of these graph types will be dictated by the previous selection of parameters. CDFs can only be produced when “All GCMs” or “All Periods” is selected. The type of graph available for specific parameter selections is detailed below in the Graphical Outputs section.

6. Time Step

Data on the website can be visually analyzed on a daily or monthly timestep. Due to computational limitations and presentation preferences, not all options will be available for each timestep. The timestep available for specific parameter selections is detailed below in the Graphical Outputs selection.

Meteorological Graphical Outputs

A series of graphic options are available for temperature and precipitation on the website. They include:

1. Data from one station, for a specified GCM/emissions scenario and period, compared to the historic data on a *daily* time step.

Presented as a:
- Line graph (Figure 9)

2. Data from one station, for a specified GCM/emissions scenario, and all periods in the future on a daily time step.

Presented as a:
- Line graph (Figure 10)
- CDF (Figure 11)

3. Data from one station, for a specified period, and all GCM/emissions scenarios, compared to the historic data on a daily time step.

Presented as a:
- Line graph (Figure 12)
- CDF (Figure 13)

4. Data from one station, for a specified GCM/emissions scenario and period, compared to the historic data on a monthly time step.

   Presented as a:
   - Line graph (Figure 14)
   - Bar graph (Figure 15)

5. Data from one station, for a specified GCM/emissions scenario, and all periods in the future on a monthly time step.

   Presented as a:
   - Line graph (Figure 16)
   - Bar graph (Figure 17)

6. Data from one station, for a specified period, and all GCM/emissions scenarios, compared to the historic data on a monthly time step.

   Presented as a:
   - Line graph (Figure 18)
   - Bar graph (Figure 19)

7. Temperature and precipitation data from one station, for a specified GCM/emissions scenario and period on a monthly time step.

   Presented as a:
   - Composite plot (Line and Bar graph) (Figure 20)

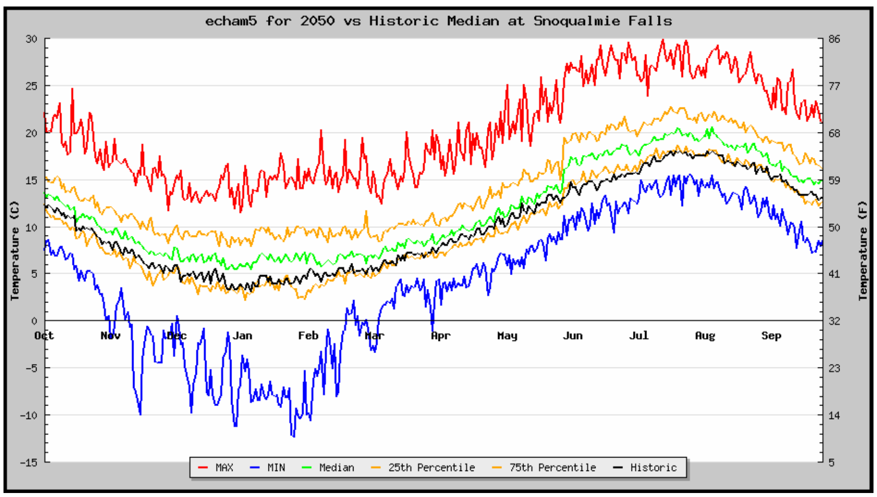

Figure 9: Line graph of one station, for one future GCM/scenario and one period compared to the historic data for that station on a daily time step

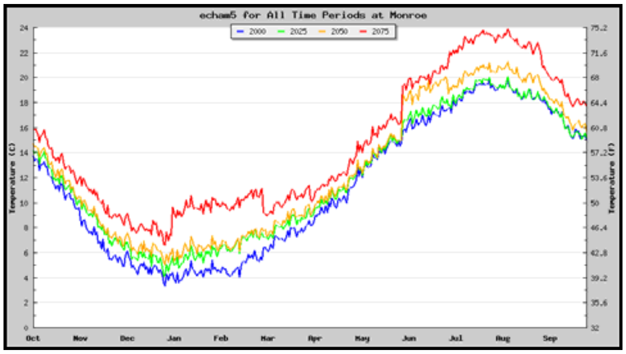

Figure 10: Line graph of a single GCM and all time periods at a single station on a daily time step

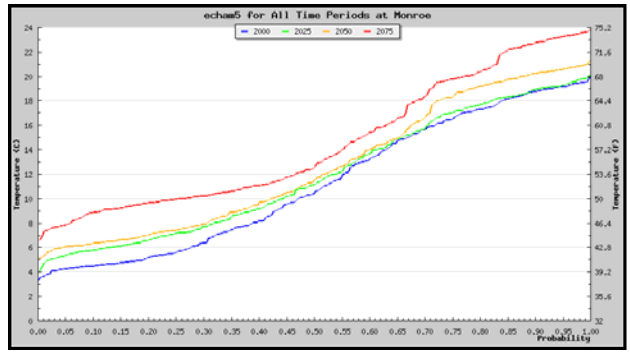

Figure 11: CDF of a single GCM and all time periods at a single station on a daily time step

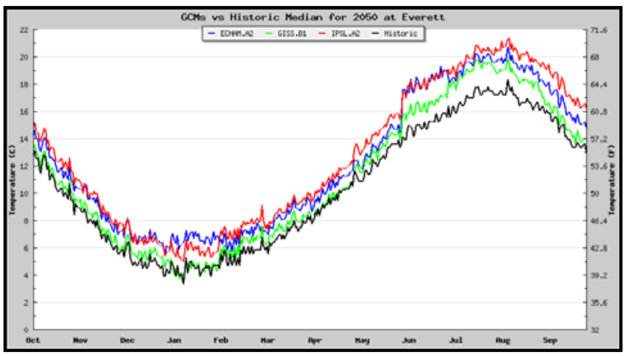

Figure 12: Line graph of all GCMs at a single time period compared to the historic data for a single station on a daily time step

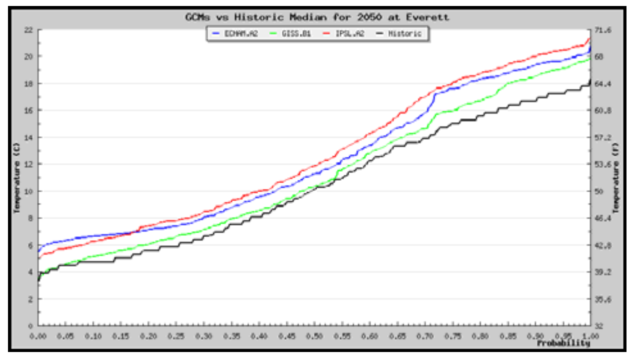

Figure 13: CDF of all GCMs at a single time period compared to the historic data for a single station on a daily time step

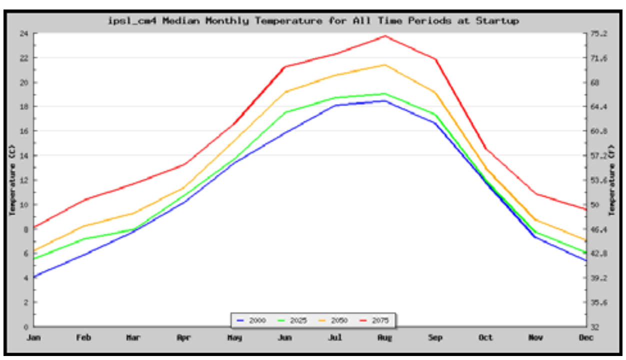

Figure 14: Line graph for a single GCM at all time periods for a single station at a monthly time step

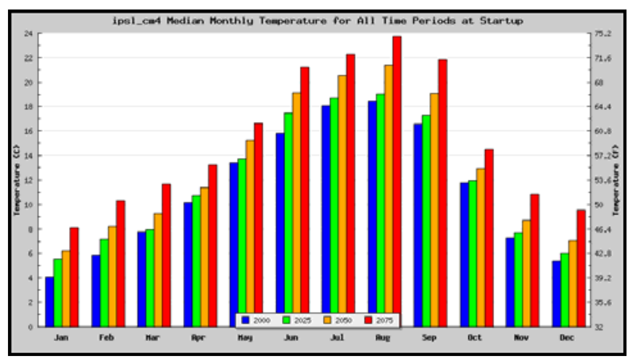

Figure 15: Bar graph for a single GCM at all time periods for a single station at a monthly time step

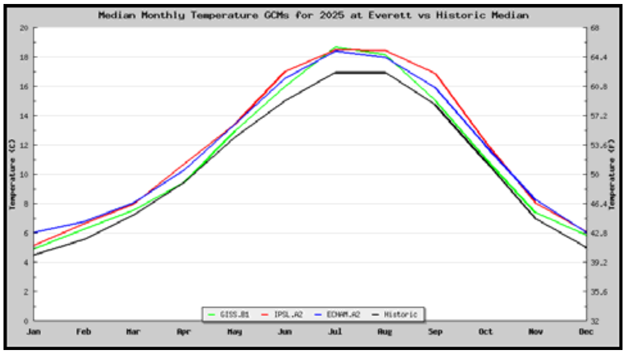

Figure 16: Line graph for all GCMs and a single time period for a single station compared to the historic data on a monthly time step

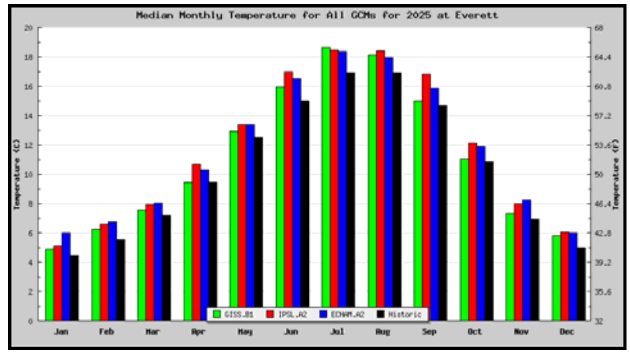

Figure 17: Bar graph for all GCMs and a single time period for a single station compared to the historic data on a monthly time step

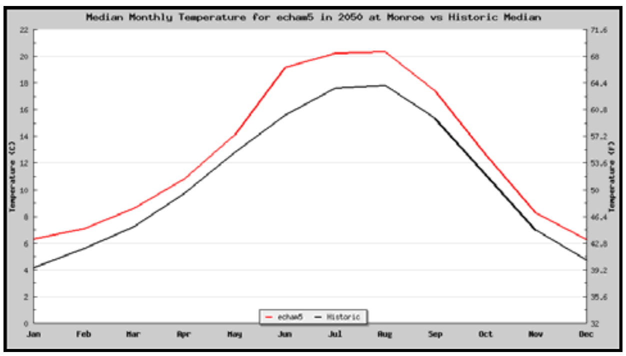

Figure 18: Line graph for a single GCM and time period at a single station compared to the historic data on a monthly time step

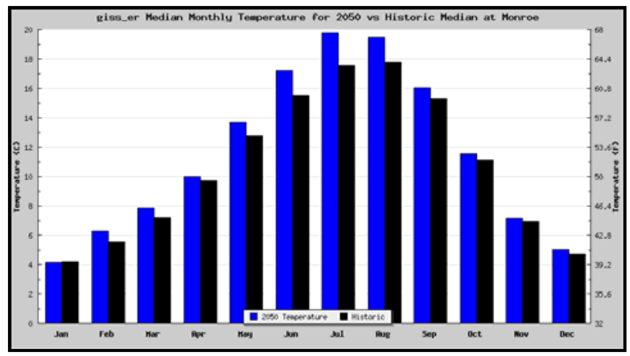

Figure 19: Bar graph for a single GCM and time period at a single station compared to the historic data on a monthly time step

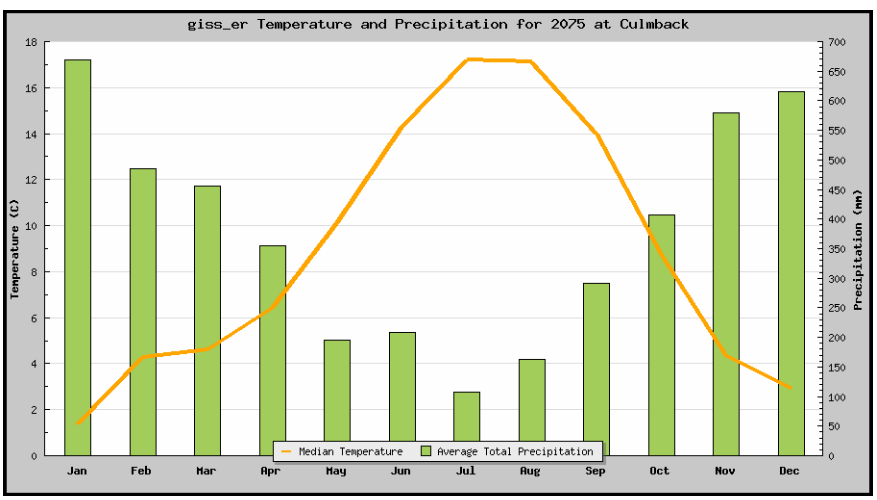

Figure 20: Composite Line and Bar graph comparing temperature and precipitation for a single GCM and time period at a single station on a monthly time step

View Streamflow Trends

The selection criteria for the streamflow data include:

1. Station
There are at least one and typically multiple streamflow stations in each WRIA. Background for the individual stations is provided, including the station's latitude and longitude, historic streamflow averages, and the source of the data. This information can be accessed by clicking on the "What is this?" link next to the stations title.

2. GCM/Scenario
The forecasts were generated using three different General Circulation Models (GCMs) that include two emission scenarios, A2 and B1. The data within the database will include outputs from the following GCM/emission scenarios: IPSL A2, GISS B1, and ECHAM A2.

3. Period
Four future periods of interest were used to generate the data. These periods are three decades in length and are centered on a year of investigation: 2000, 2025, 2050, and 2075.

4. Type of Graph
Three different types of graphs are available for viewing the trends in the dataset: 1) Line graphs, 2) Cumulative Distribution Functions (CDFs), and 3) Bar graphs. The availability of these graph types will be dictated by the previous selection of parameters. CDFs can only be produced when "All GCMs" or "All Periods" is selected. The type of graph available for specific parameter selections is detailed below in the Graphical Outputs section.

5. Time Step
Data on the website can be visually analyzed on a daily or monthly timestep. Due to computational limitations and presentation preferences, not all options will be available for each timestep. The timestep available for specific parameter selections is detailed below in the Graphical Outputs selection.

Streamflow Graphical Outputs

A series of graphic options are available for the streamflow data on the website. They include:

1. Data from one station, for a specified GCM/emissions scenario and period, compared to the simulated historic streamflow on a *weekly* time step.

Presented as a:
- Line graph (Figure 21)

2. Data from one station, for a specified GCM/emissions scenario, and all periods in the future on a *weekly* time step.

Presented as a:

- Line graph Figure 22)
- CDF (Figure 23)

3. Data from one station, for a specified period, and all GCM/emissions scenarios, compared to the simulated historic streamflow on a *weekly* time step.

   Presented as a:

   - Line graph (Figure 24)
   - CDF (Figure 25)

4. Data from one station, for a specified GCM/emissions scenario and period, compared to the simulated historic streamflow on a *monthly* time step.

   Presented as a:

   - Line graph (Figure 26)
   - Bar graph (Figure 27)

5. Data from one station, for a specified GCM/emissions scenario, and all periods in the future on a *monthly* time step.

   Presented as a:

   - Line graph (Figure 28)
   - Bar graph (Figure 29)

6. Data from one station, for a specified period, and all GCM/emissions scenarios, compared to the simulated historic streamflow on a *monthly* time step.

   Presented as a:

   - Line graph (Figure 30)
   - Bar graph (Figure 31)

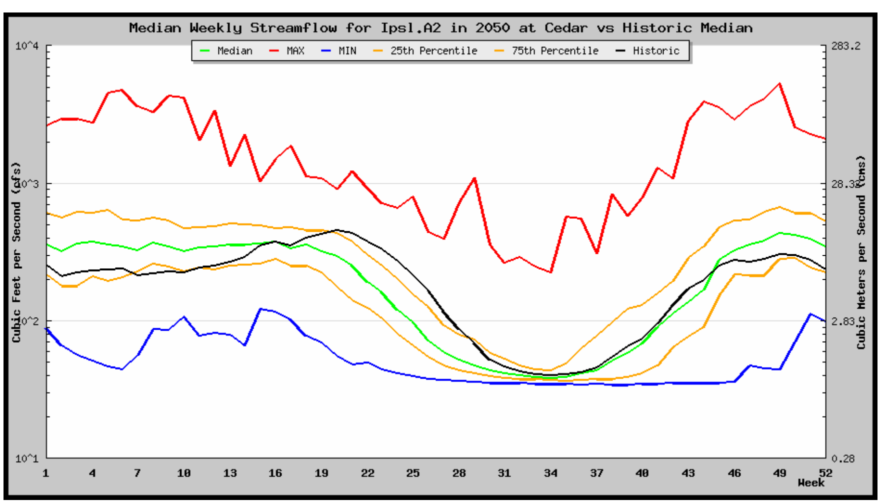

Figure 21: Line graph of one station, for one future GCM/scenario and one period compared to the simulated historic streamflow on a weekly timestep

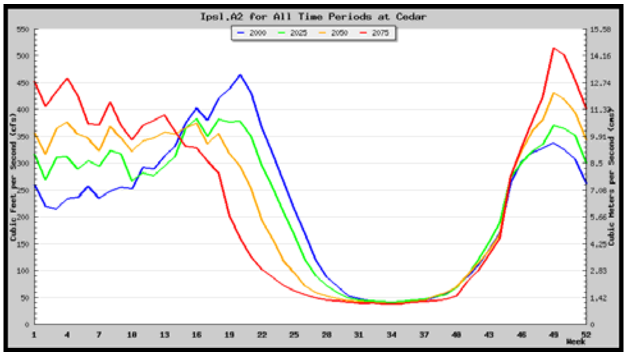

Figure 22: Line graph of a single GCM and all time periods at a single station on a weekly time step

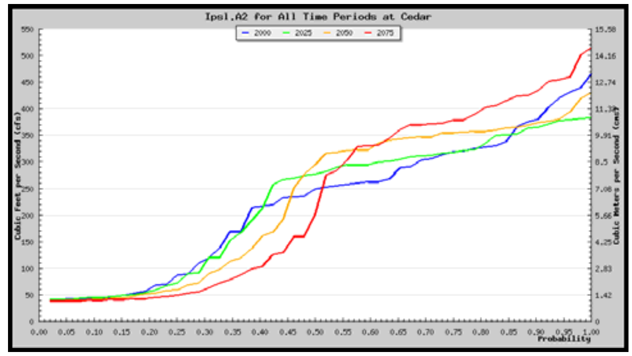

Figure 23: CDF of a single GCM and all time periods at a single station on a weekly time step

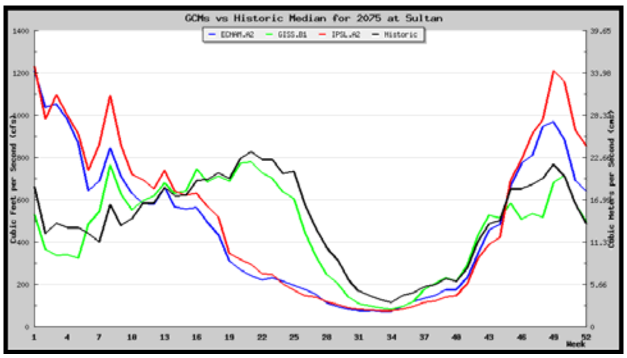

Figure 24: Line graph of all GCMs at a single time period compared to the simulated historic streamflow for a single station on a weekly time step

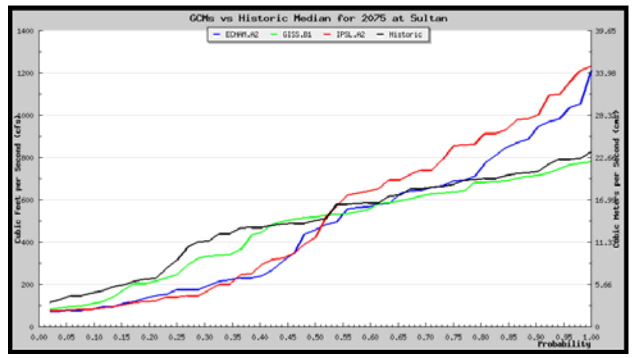

Figure 25: CDF of all GCMs at a single time period compared to the simulated historic streamflow for a single station on a weekly time step

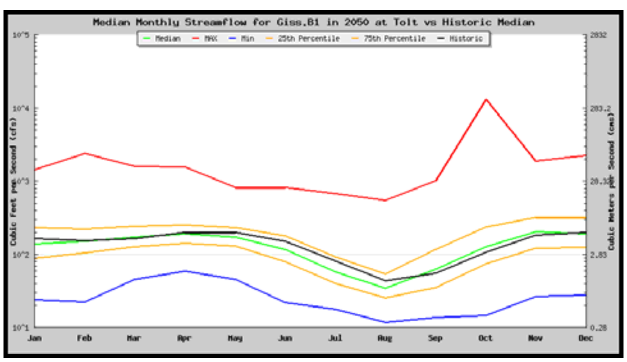

Figure 26: Line graph of one station, for one future GCM/scenario and one period compared to the simulated historic streamflow on a monthly timestep

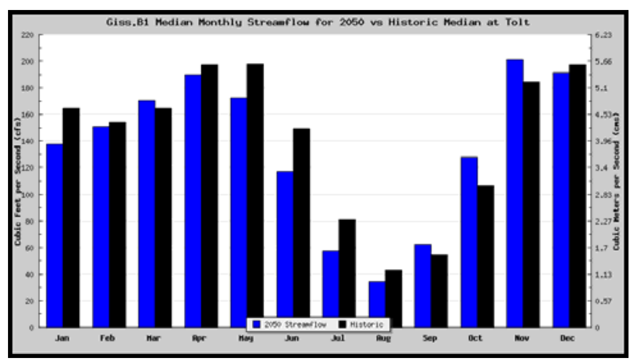

Figure 27: Bar graph of one station, for one future GCM/scenario and one period compared to the simulated historic streamflow on a monthly timestep

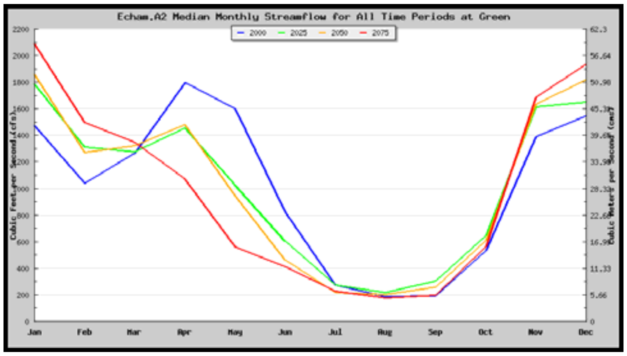

Figure 28: Line graph of a single GCM and all time periods at a single station on a monthly time step

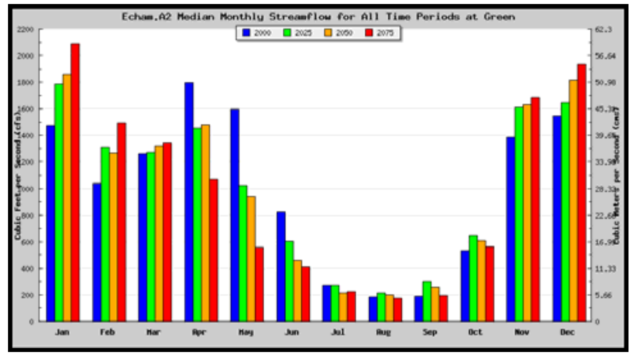

Figure 29: Bar graph of a single GCM and all time periods at a single station on a monthly time step

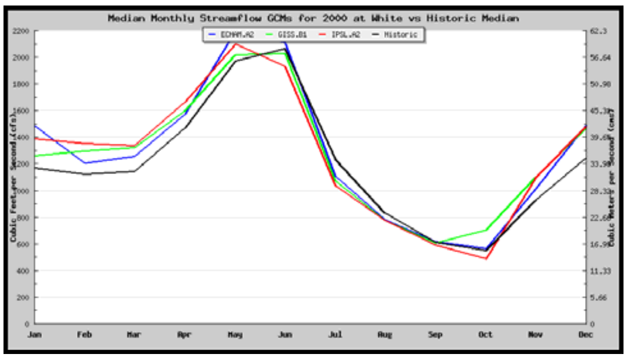

Figure 30: Line graph of all GCMs at a single time period compared to the simulated historic streamflow for a single station on a monthly time step

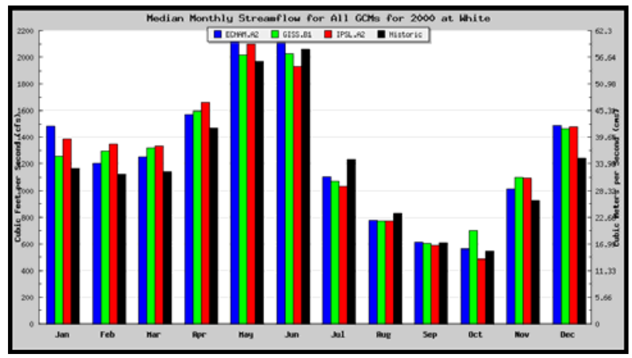

Figure 31: Bar graph of all GCMs at a single time period compared to the simulated historic streamflow for a single station on a monthly time step

View Spatial Plots

Spatial plots are figures that can be generated on the website that illustrate the predicted changes in temperature and precipitation over the entire region spatially (Figure 32). The plots can be viewed after selecting a climate parameter (average daily temperature and precipitation), a season (winter, spring, summer or fall), and a GCM/scenario. Each graph represents each period simultaneously, to make comparisons spatially over time easier.

Projected Average Winter (DJF)
Temperature (°C) - ECHAM GCM

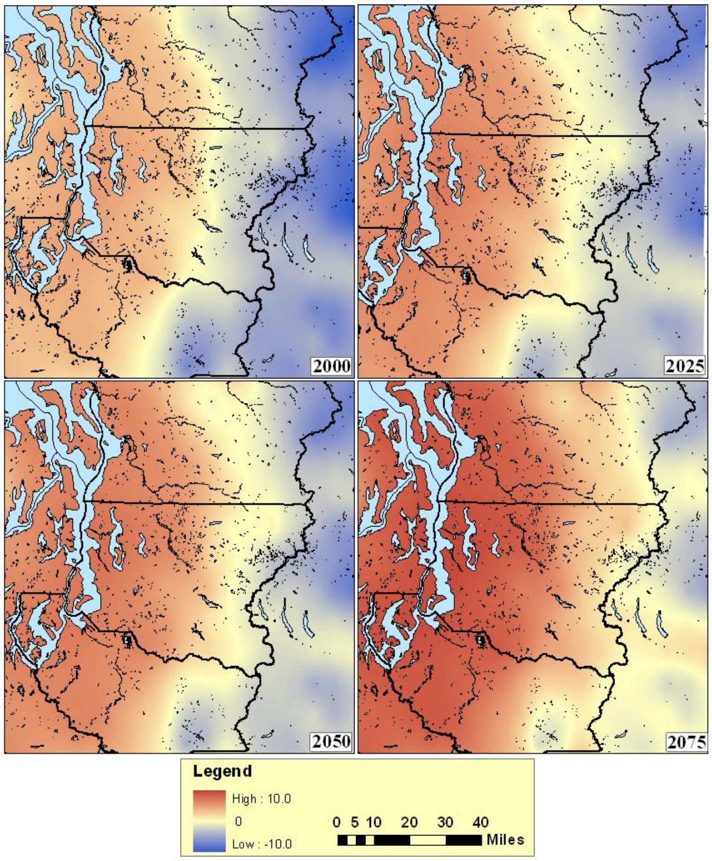

Figure 32: This spatial plot example was generated after the user selected "temperature" from the climate parameter, "winter" from the season, and "Echam.A2" from the GCM/Scenario selection criteria.

Contact

The contact page can be accessed from any WRIA and from any function. If users have questions about any of the data or the processes, they can ask questions as needed.

Back to TAG

This provides a link to the researcher's main webpage: www.tag.washington.edu

Conclusion

This website was created to make climate change forecasts in a format that can be used by many users and that are easily accessible. The website is organized by WRIAs and by functions in order to accommodate a multitude of users.

References

Intergovernmental Panel on Climate Change, World Meteorological Organization, & United Nations Environment Programme. (2007). *IPCC fourth assessment climate change 2007.* Geneva: WMO.

Polebitski, A., M.W. Wiley, and R.N. Palmer. 2007. "Technical Memorandum #2: Methodology for Downscaling Meteorological Data for Evaluating Climate Change." A report prepared by the Climate Change Technical Subcommittee of the Regional Water Supply Planning Process, Seattle, WA.

Polebitski, A., L. Traynham, and R.N. Palmer. 2007. "Technical Memorandum #4: Approach for Developing Climate Impacted Meteorological Data and its Quality Assurance/Quality Control." A report prepared by the Climate Change Technical Subcommittee of the Regional Water Supply Planning Process, Seattle, WA.

APPENDIX A

How to convert ASCII files to Excel:

1. Save the zipped file
2. Unzip the folder
3. Select a station file within the folder*
4. Open the station file with Excel
5. Highlight column A
6. Select "Data" from the menu bar
7. Select "Text to Columns…"
8. Make sure the "Delimited" radio button is selected
9. Click Next
10. Check the "tab" and "comma" boxes
11. Click Finish
12. Your Excel file should now be sorted into 4 columns.**

***The station file names are as follows:** aaaaa.bbbbb.cccc.d.e.fffff.g.h

a: is the GCM used for the run (*Echam, Ipsl, Giss*)
b: is the SRES scenario used (*A2, B1*)
c: is the Year of Interest (*2000, 2025, 2050, 2075*)
d: (not applicable)
e: (not applicable)
f: is the station name
g: (not applicable)
h: (not applicable)

Each file contains columns of date, temperature (T_Min, T_Max), and precipitation (Prcp). T_Min and T_Max are in degrees Celcius and Prcp is in total mm.

****Column Headings:**

Column A: Date
Column B: T min (◦C)
Colum C: T max (◦C)
Column D: Prcp (mm)