Introductory Guide to the Climate Change Projection Maps and Data

Introduction

Climate data for different regions, time periods and global climate models are available in the "Maps and Data" section of Ecoshare (http://climatechange.ecoshare.info/maps-and-data). For more information about the specifics of this project, please go to the Climate Impacts Group (CIG) report "*Regional Climate and Hydrologic Change in the Northern US Rockies and Pacific Northwest: Internally Consistent Projections of Future Climate for Resource Management*" by Littell et al found at: http://cses.washington.edu/picea/USFS/pub/Littell_etal_2010

Both static maps (for use in presentations or documents) and gridded data (for use in GIS software) are available for download on the Ecoshare website. The maps are intended for people who merely want to see general expected changes, or who want to illustrate to others where changes may occur. The gridded data are intended for people who use GIS software and want to pull data out for specific areas of interest. Both are intended to be used by resource managers to understand anticipated climatic change in the Region and may be used in documents and publications.

Static maps are currently available for the entire CIG study area, which covers most of the western United States (W US), as well as for those portions of the full study area that fall within USDA Forest Service Region 1 (R1) and Region 6 (R6). R6 covers Oregon and Washington; R1 covers NE Washington, N Idaho, Montana, North Dakota, and NW South Dakota; and W US covers Washington, Oregon, Idaho, Montana, Wyoming, Nevada, Utah, Arizona and parts of Colorado and New Mexico.

There are currently three time periods available for maps: 1) historic climate data for the time period 1916-2006, derived from weather station records; 2) projected climate data for mid-century (2030-2059); and 3) projected climate data for late century (2070-2099).

The Climate Impacts Group chose to use the A1B emissions scenario, described in the Intergovernmental Panel on Climate Change (IPCC) document "*Special Report on Emissions Scenarios*" (Nakicenovic et al 2000). The A1 scenario envisions a future world of very rapid economic growth, a global population that peaks in midcentury, and the rapid introduction of new and more efficient technologies. There are several sub-groups in the A1 scenario, where A1B represents a balance across all energy sources.

The Climate Impacts Group then selected global climate models (GCM) created by other researchers, choosing Miroc3.2 which predicts a large amount of warming in the region, and PCM1 which predicts less warming (Meehl et al. 2007). They also took a mean of 10 GCMs which they called "Ensemble Mean." Miroc3.2 and PCM1 give a range, while the ensemble mean is a possible average.

In the future, the Climate Impacts Group may add more time periods, more regions, and more computer models. Please continue to check the Maps and Data sections for additions.

How to Acknowledge and Cite

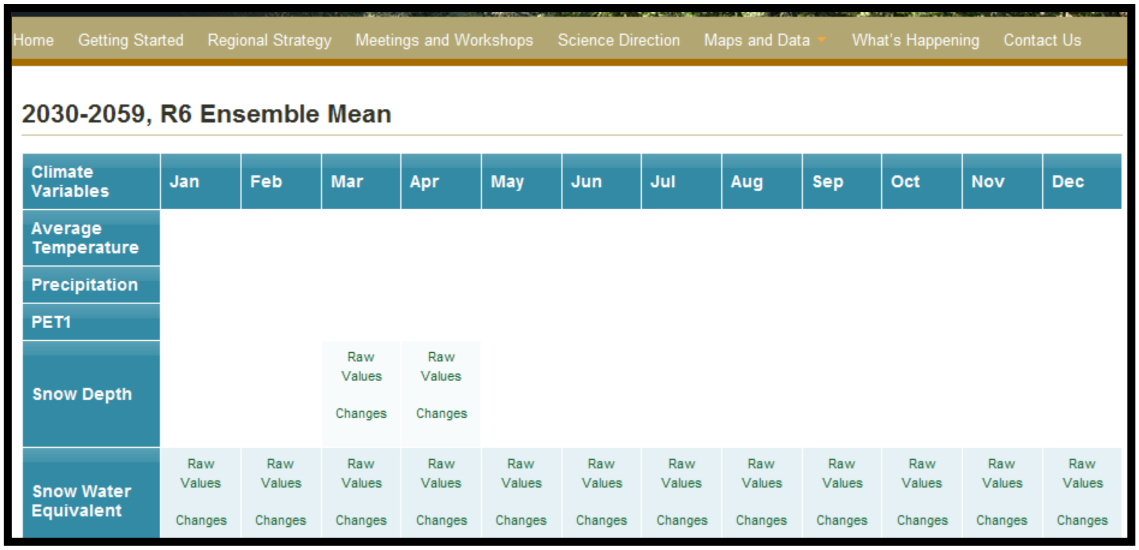
Whenever you produce documents based on model output from the databases, you should include the following acknowledgement: "We acknowledge the University of Washington Climate Impacts Group for making the Regional climate and hydrologic projections for the Pacific Northwest and northern US Rockies publicly available. Support of this dataset was provided by the United States Forest Service Region 1, United States Fish and Wildlife Service Region 6, and United States Forest Service Region 6."

Please use this citation: Littell, J.S., M.M. Elsner, G. S. Mauger, E. Lutz, A.F. Hamlet, and E. Salathe. 2011. Regional Climate and Hydrologic Change in the Northern US Rockies and Pacific Northwest: Internally Consistent Projections of Future Climate for Resource Management. Available online at: http://cses.washington.edu/picea/USFS/pub/Littell_etal_2010/

Find and Download Maps

From Ecoshare's "Climate Change" page, select the "Maps and Data" tab. In the menu on the right hand side of the page, choose a region. Users are routed to a page where a time period and global climate model (please read the introduction for an explanation of GCMs) can be selected for either maps or data. As of the writing of this guide, maps are not available for the western US. Please check back, because they may be added soon.

Once the region, time period and GCM have been selected, the climate variables can be selected. For example, selecting 2030-2059, R6 Ensemble Mean would bring up a table showing a list of climate variables (excerpt of the screen-capture is shown below).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2030-2059, R6 Ensemble Mean

Climate Variables	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Temperature												
Precipitation												
PET1												
Snow Depth			Raw Values Changes	Raw Values Changes								
Snow Water Equivalent	Raw Values Changes	Raw Values Changes	Raw Values Changes	Raw Values Changes	Raw Values Changes	Raw Values Changes	Raw Values Changes	Raw Values Changes	Raw Values Changes	Raw Values Changes	Raw Values Changes	Raw Values Changes

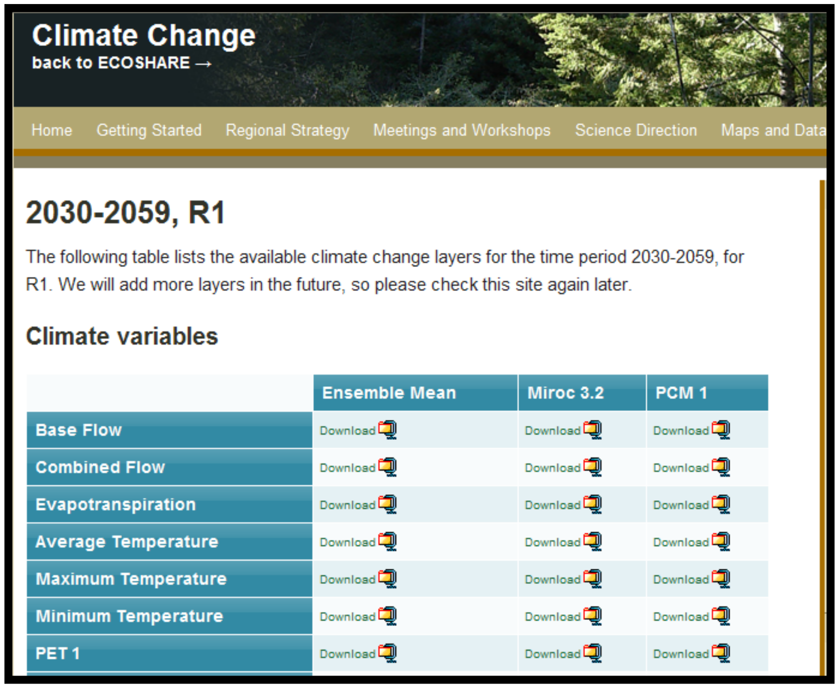
If you click on “Raw Values” or “Changes” a map will pop up. The map available under “Raw Values” will show predicted values, whereas the map available under “Changes” will show the predicted change from historic values (in the example provided, this would be the change from 1916-2006 values to the 2030-2059 predicted values). This can be downloaded by placing your cursor on the map and right-clicking with your mouse. A drop-down menu will appear, and you can select “Save picture as”. When the pop-up window “Save Window” appears, the user can save the map onto their computer. The maps come as “.PNG” files (Portable Network Graphics).

In the near future, it will also be possible to download all the maps for a climate variable as a single zip file.

Find and Download Gridded Data

From Ecoshare’s “Climate Change” page, select the “Maps and Data” tab. In the menu on the right hand side of the page, choose a region. Users are routed to a page where a time period and global climate model (please read the introduction for an explanation of GCMs) can be selected for either maps or data. As of the writing of this guide, data is available for each of the regions, although maps are not available for the western US.

For example, selecting “2030-2059, R1” would bring up a table showing a list of climate variables for three climate models (excerpt of screen-capture is shown below).



2030-2059, R1

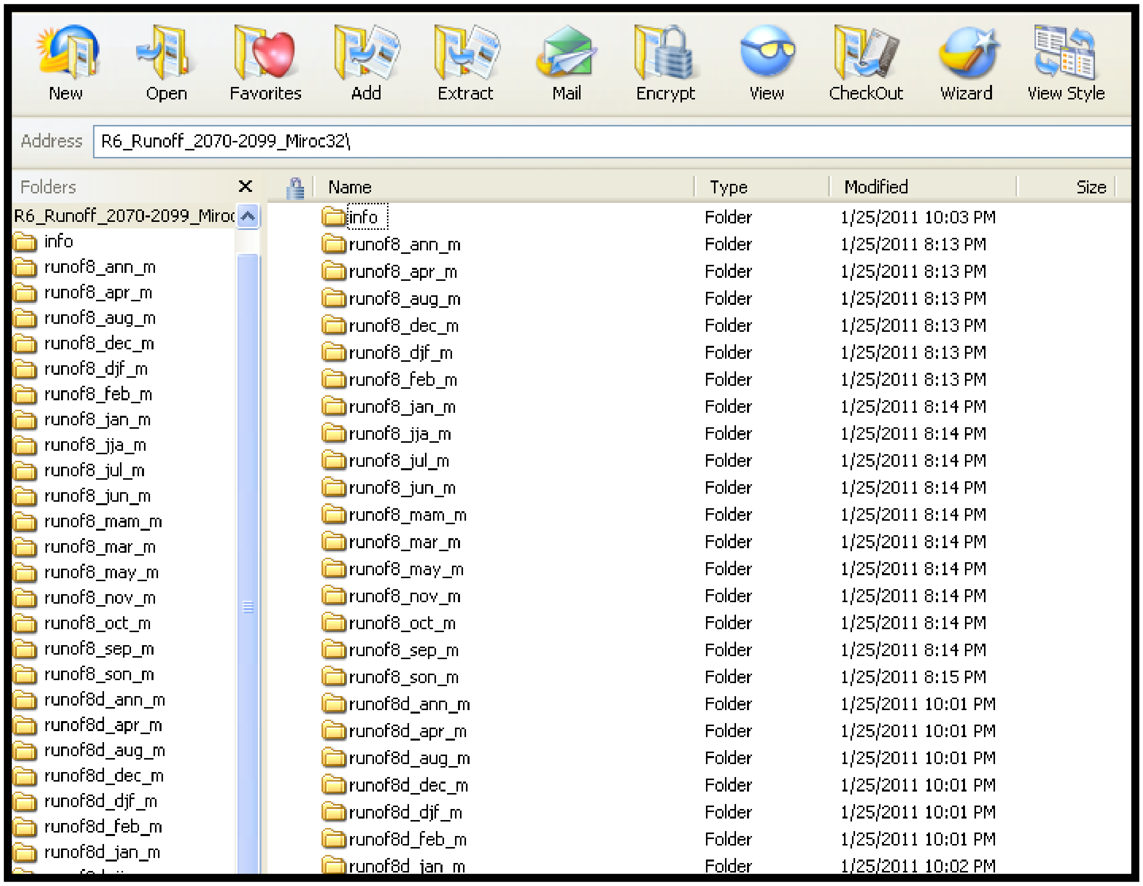
The following table lists the available climate change layers for the time period 2030-2059, for R1. We will add more layers in the future, so please check this site again later.

Climate variables

	Ensemble Mean	Miroc 3.2	PCM 1
Base Flow	Download	Download	Download
Combined Flow	Download	Download	Download
Evapotranspiration	Download	Download	Download
Average Temperature	Download	Download	Download
Maximum Temperature	Download	Download	Download
Minimum Temperature	Download	Download	Download
PET 1	Download	Download	Download

Currently, both the raw values and the changes from historic data for the monthly, seasonal, and annual means are packaged together in each zip file.

Users can double click on the zip file for a particular climate variable and climate model. Double clicking will generate a pop-up box and give the user the option of saving the zipped file directly onto their computer's hard drive or opening the zipped file to view the contents. Metadata is included in each of the climate variable folders.



The names of the folders are descriptive. For example, the folder "runof8_sep_m" is for the climate variable "run off" and is the average for the month September. Folder names with a "d", such as "runof8d_sep_m" designates the predicted change (delta) from historic values, whereas names without the "d" designates the straight predicted values.

These gridded raster data can be brought into GIS software such as ArcMap. Users should review the metadata to be sure of the projection and extent (NAD_1983_Albers, unless otherwise noted).

Climate Variables Defined:

If you cannot find the climate variable you are seeking in a map or as data, please check back soon.

Base Flow: This is the portion of the stream-flow that would be present even during periods of drought. Monthly and seasonal totals averaged over various time periods are available.

Combined Flow: This is base flow plus runoff. Monthly and seasonal totals averaged over various time periods are available.

Evapotranspiration: This is the loss of water to the atmosphere as a result of evaporation and the transpiration of plants. Summer monthly and seasonal totals averaged over various time periods are available.

Average Temperature: This is the average temperature for the month, season or year for the time period. For example, an average temperature for “Jan” would be an average of the high and low temperatures for every day in January for each year in the time period.

Maximum Temperature: This is the average of the daily maximum temperatures. For example, a maximum temperature for “Jan” would be an average of the high temperatures for every day in January for each year in the time period.

Minimum Temperature: This is the average of the daily minimum temperatures. For example, a minimum temperature for “Jan” would be an average of the low temperatures for every day in January for each year in the time period.

PET1: This is the potential evapotranspiration for natural vegetation, no water limit. Summer monthly and seasonal totals averaged over various time periods are available.

PET5: This is the potential evapotranspiration for a short reference crop (short grass). Summer monthly and seasonal totals averaged over various time periods are available.

Precipitation: This is the monthly and annual totals averaged over various time periods, and monthly totals averaged over seasons and various time periods. For example, precipitation for “Jan” would be an average of the rainfall or snow water equivalent for the entire month for each January in the time period; precipitation for winter would be the average monthly precipitation for every December, January and February in the time period.

Relative Humidity: This is the ratio of the amount of moisture actually in the air to the maximum amount of moisture which the air could hold at the same temperature, expressed as a percent. Summer monthly and seasonal averages are available.

Runoff: This is the water that moves across the surface, or just beneath the surface, coming from precipitation or the melting of ice and snow. Monthly and seasonal totals averaged over various time periods are available.

Snow Depth: This is snow depth measured on the 1st of the month, averaged over various time periods.

Snow Water Equivalent: This is the amount of water contained within the snowpack. It can be thought of as the depth of water that would theoretically result if you melted the entire snowpack. Snow water equivalent is measured on the 1st of the month, averaged over various time periods.

Soil Moisture: This is the portion of water in a soil that can be readily absorbed by plant roots, in other words, the total column soil moisture, which is the sum of layers 1, 2 and 3. Summer monthly (measured on the 1st of the month) and seasonal average soil moisture, averaged over various time periods, are available.

Soil Moisture Deficit: This is an experimental variable, calculated as the difference between the potential evapotranspiration (PET1) and the total column soil moisture. Its intended use is as a possible indicator of drought stress.

Water Balance Deficit: This is calculated as the potential evapotranspiration (PET1) minus the actual evapotranspiration. It is intended as a measure of the difference between the atmospheric demand for moisture and the ability of the land/plant surface to supply it. Monthly and seasonal totals averaged over various time periods are available.

Scales and Guidance for Use

Climate Impacts Group report "*Regional Climate and Hydrologic Change in the Northern US Rockies and Pacific Northwest: Internally Consistent Projections of Future Climate for Resource Management*" by Littell et al gives guidance regarding use. It suggests that planning for the effects of climate change on natural resources requires detailed projections of future climate at scales consistent with the processes managers typically consider. While it is possible to produce downscaled climate at very fine scales (<5km), several factors make accurate estimation at these scales difficult and less tractable without very detailed local information.

Downscaled projections can be developed that maximize climatic information from the coarser scales of global climate models to more local scales. This project was designed to provide climate information that meets those needs and creates a basis for more detailed work or for a more comprehensive approach to downscaling and regional climate modeling.

The capability of global climate models relative to each other or some benchmark depends greatly on the study objectives, and the result of any such ranking exercise will therefore vary – in other words, no "best" subset of climate models exists. Moreover, fidelity to the observed record does not guarantee that a model or multi-model ensemble has the greatest possible skill for future projection. In this study, CIG developed a process to select 10 global climate models that perform similarly well in the Pacific NW / Columbia Basin, the Northern Rockies / Upper Missouri Basin, and the Central Rockies / Upper Colorado Basin. The result is an internally consistent set of projections, downscaled to about 6km, and run through a hydrologic model to develop plausible estimates of climate and hydroclimate variables in the future over much of the western U.S.

A memorandum from Joel D. Holtrop, Deputy Chief, National Forest System, entitled "Considering Climate Change in Land Management Planning" and dated March 2, 2010 includes a document entitled "Climate Change Considerations in Land Management Plan Revisions" dated January 20, 2010 (available at http://www.fs.fed.us/emc/nepa/climate_change/index.htm). This document states that:

> "At this time, the following is a list of minimum items recommended to be addressed when revising land management plans:

Principles:

- The focus of NFS land management is multiple use management with ecological, social, and economic sustainability. Climate change is a factor to be considered in the delivery of our overall mission.

- Use the best available science on climate change that is relevant to the planning unit and the issues being considered in planning.

- Where necessary to make informed decisions and provide planning direction responsive to changing climate, use climate change science and projections of change in temperature and precipitation patterns at the lowest geographic level (national, broad, mid-, base) that is scientifically defensible. Given the uncertainty involved and limits to modeling capability, this is most likely at much broader scales than appropriate for the planning unit.

- Address climate change during land management plan (LMP) revision in terms of "need for change" from current LMP direction so that the unit will continue contributing to social, economic, and ecological sustainability.

- Place increased value on monitoring and trend data to understand actual climate change implications to local natural resource management.

Forest Service guidance on climate change considerations for project level NEPA analysis is also available at http://www.fs.fed.us/emc/nepa/climate_change/index.htm

References

Littell, J.S., M.M. Elsner, G. S. Mauger, E. Lutz, A.F. Hamlet,, and E. Salathé. 2010. Regional Climate and Hydrologic Change in the Northern US Rockies and Pacific Northwest: Internally Consistent Projections of Future Climate for Resource Management.

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Please note: This guide was created by Sara Lovtang of the USDA Forest Service Pacific Northwest Region Ecology technical team, with input from Chris Ringo and Tom DeMeo, also on the team. Please contact us with any suggestions for additional material or improvements. For further clarification on specific data, please refer to the Climate Impacts Group.