

Tutorial #1 - Selecting and Extracting BCCAQv2 Data

Introduction

Three of the Pacific Climate Impact Consortium's (PCIC's) websites are helpful to hydrologic modellers:

- 1) The Statistical Downscaled Climate Scenarios data portal:
<https://www.pacificclimate.org/data/statistically-downscaled-climate-scenarios>
- 2) The Daily Gridded Meteorological Datasets data portal:
<https://pacificclimate.org/data/daily-gridded-meteorological-datasets>
- 3) The PCIC Climate Explorer:
<https://www.pacificclimate.org/analysis-tools/pcic-climate-explorer>

In this exercise, we are going to learn how to use a combination of these tools to select and extract gridded precipitation, minimum and maximum temperature projections for an area of interest. We focus on results from the fifth Coupled Model Intercomparison Project (CMIP5) that were downscaled with BCCAQv2 (Bias Correction/Constructed Analogues with Quantile delta mapping reordering), which is a hybrid method developed at PCIC that combines results from Bias Corrected Constructed Analogs (BCCA; Maurer et al. 2010) and Quantile Delta Mapping (QDM; Cannon et al. 2015). BCCA uses spatial aggregation from a linear combination of historical analogues for daily large-scale fields. QDM applies a form of quantile mapping where relative changes in GCM quantiles are preserved to avoid inflationary effects that can occur with standard quantile mapping. This technique has been shown to be successful in downscaling such that changes in hydrologic extremes can be well simulated (Werner and Cannon 2016). BCCAQv2 is an updated version of BCCAQ (version 1), which employed standard quantile mapping. CMIP5 GCMs were downscaled using [NRCANmet](#) as a target. NRCANmet + CMIP5 + BCCAQv2 = CanDCS-U5. CanDCS-U5 is available over all of Canada at ~10 km a side, on a daily time step, for 23 Global Climate Models (GCMs) and 3 Representative Concentration Pathways (RCPs) (Figure 1).

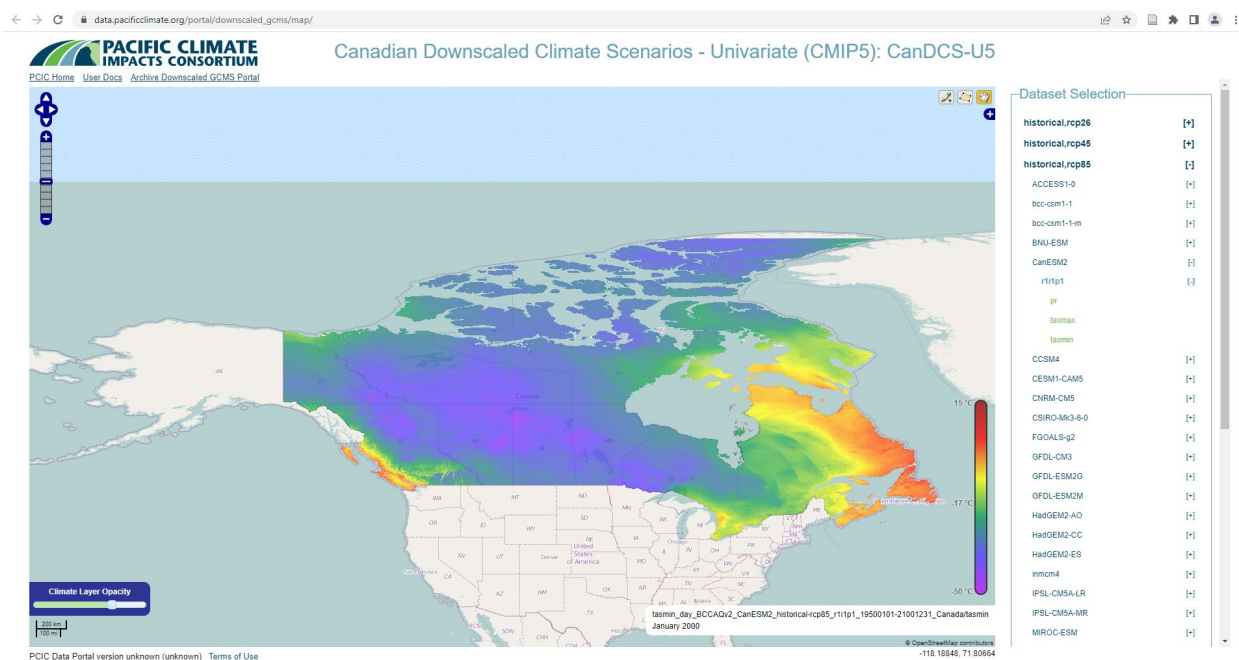


Figure 1 - Screen shot COUPLED MODEL INTERCOMPARISON PROJECT PHASE 5 (CMIP5) data portal

Running and analyzing multiple hydrologic simulations can be quite onerous and computationally challenging. PCIC proposes a set of 12 GCMs that represent 90% of the range in several climate extremes by Giorgi region (Figure 2). In the case of our recent work with VICGL in BC, we chose a subset of six models and compared the response of each of these models under RCP 4.5 and RCP 8.5. In addition, to including the top three models for Western North America (WNA): CNRM-CM5-r1, CanESM2-r1 and ACCESS1-0-r1 based on the ranking by Cannon 2015, we also included CCSM4, HadGEM2-ES and MPI-ESM-LR because they were in the PCIC12 and matched those used by other institutes in Canada we collaborate with, such as Ouranos.

MODEL SELECTION (CMIP5 ONLY)

Analysis and storage of the full ensemble is often not feasible. For the CMIP5 ensemble, users are encouraged to select models according to the Table below. The 12 model runs listed capture 90% of the range of projected changes in temperature and precipitation in all seasons for a suite of indices of extremes under RCP4.5 (Cannon, 2015). Recommended subsets of models are provided for a number of geographic sub-regions of North America, known as Giorgi regions (Giorgi and Francisco, 2000), shown in the map below the Table. Note, however, that data are only available for the parts of the Giorgi regions that lie within Canada. If fewer than 12 GCM runs are desired, they should be chosen following the order listed for each sub-region in the Table. Note that only 9 of the 12 GCM runs are available for RCP2.6.

The 12 GCM runs listed under the WNA region are used in PCIC's [Plan2Adapt](#) and [PCIC's Climate Explorer](#) online tools (PCEx).

Model Ensembles and Giorgi Regions					
Order	WNA	ALA	CNA	ENA	GRL
1	CNRM-CM5-r1	CSIRO-Mk3-6-0-r1	CanESM2-r1	MPI-ESM-LR-r3	MPI-ESM-LR-r3
2	CanESM2-r1	HadGEM2-ES-r1	ACCESS1-0-r1	Inmcm4-r1	Inmcm4-r1
3	ACCESS1-0-r1	Inmcm4-r1	Inmcm4-r1	CNRM-CM5-r1	CanESM2-r1
4	Inmcm4-r1	CanESM2-r1	CSIRO-Mk3-6-0-r1	CSIRO-Mk3-6-0-r1	CNRM-CM5-r1
5	CSIRO-Mk3-6-0-r1	ACCESS1-0-r1	MIROC5-r3	HadGEM2-ES-r1	ACCESS1-0-r1
6	CCSM4-r2	MIROC5-r3	HadGEM2-ES-r1	CanESM2-r1	CSIRO-Mk3-6-0-r1

Exercise

- 1) Find the top three CMIP5 GCMs in your Giorgi region.
- 2) Compare temperature and precipitation changes in the 2050s from these CMIP5 models for a region or watershed of interest using the PCIC Climate Explorer.
<https://www.pacificclimate.org/analysis-tools/pcic-climate-explorer>
- 3) Download one of the CMIP5 GCMs as netCDF that is in the top six in your region of interest. On the Statistical Downscaling Climate Scenario data portal:
<https://www.pacificclimate.org/data/statistically-downscaled-climate-scenarios>
Go to the “A. COUPLED MODEL INTERCOMPARISON PROJECT PHASE 5 (CMIP5)” → ACCESS AND DOWNLOAD CANCS-U5, which takes you to:
https://data.pacificclimate.org/portal/downscaled_gcms/map/
- 4) When does the netCDF start and when does it end? (hint the cdo infov in cdo can help)
- 5) What are the variable names of the files you have downloaded? (hint the ncdump -h in nco can help)

- 6) What is the Daily Gridded Meteorological Dataset or the Downscaling Target Dataset for the Canadian Downscaled Climate Scenarios - Univariate (CMIP5): CanDCS-U5 or BCCAQv2 Statistically Downscaled Climate Scenarios? See the documentation here:
<https://www.pacificclimate.org/data/statistically-downscaled-climate-scenarios>
- 7) Where can you download that Daily Gridded Meteorological Dataset for your region or watershed of interest? (<https://pacificclimate.org/data/daily-gridded-meteorological-datasets>).

Working ahead

Downloading multiple models from the server using 'wget' statements. This is possible with a point (specified in array indices) or a bbox (a range of indices):

<https://data.pacificclimate.org/portal/docs/raster.html#power-user-howto>

Tools and packages for working with NetCDFs

- R ncdf4:
<https://cran.r-project.org/web/packages/ncdf4/index.html>
- R gdal:
<https://cran.r-project.org/web/packages/rgdal/index.html>
- R raster:
<https://cran.r-project.org/web/packages/raster/index.html>
- NetCDF Operators (NCO):
<http://nco.sourceforge.net/>
http://research.jisao.washington.edu/data_sets/nco/
- Climate Data Operators (CDO):
<http://www.idris.fr/media/ada/cdo.pdf>
<https://code.mpimet.mpg.de/projects/cdo/wiki/Tutorial>
- ncview:
http://meteora.ucsd.edu/~pierce/ncview_home_page.html

References and Resources

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PCIC - CSHS Webinar July 21st, 2022 10:00 AM to 12:00 PM PST
Selecting, Applying and Interpreting Climate Projections for Hydrologic Modelling

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