Metadata for: [California Basin Characterization Model (BCM) downscaled climate and hydrology](http://climate.calcommons.org/dataset/10)

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# Identification Information

## Citation Information

### Originator

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Ryan Boynton

Lorraine Flint

Alan Flint

Thuy-N’goc Le

### Publication date

2012

### Title

California Basin Characterization Model (BCM) downscaled climate and hydrology

### Geospatial Data Presentation Form

Raster digital data

### Publication Information

United States Geological Survey and University of California, Davis

### Online linkage:

<http://climate.calcommons.org/dataset/10>

## Description

### Abstract

The California Basin Characterization Model (BCM) dataset provides historical and projected climate and hydrologic surfaces for the region that encompasses the state of California and all the streams that flow into it at a 270 meter resolution. The historical data is based on 4 kilometer PRISM data, and the projected climate surfaces are based on the A2 and B1 scenarios of the PCM and GFDL GCMs. The BCM approach uses a regional water balance model based on high resolution downscaled precipitation and temperature as well as elevation, geology, and soils to produce surfaces for a wide range of variables. These variables include maximum temperature, minimum temperature, precipitation, potential evapotranspiration, runoff, recharge, climatic water deficit, actual evapotranspiration, sublimation, soil water storage, snowfall, snowpack, snowmelt, and excess water. Data is distributed as 30-year monthly summaries and 30-year water year summaries, with month-by-month data for each year available by special request.

The paper “Development and Application of Downscaled Hydroclimatic Predictor Variables for Use in Climate Vulnerability and Assessment Studies” (available at <http://climate.calcommons.org/bib/development-and-application-downscaled-hydroclimatic-predictor-variables-use-climate>) describes the Basin Characterization Model (BCM), a map-based, mechanistic model used to process the hydrological variables. Three historic and three future time periods of 30 years (1911–1940, 1941–1970, 1971–2000, 2010–2039, 2040–2069, and 2070–2099) were developed that summarize 180 years of monthly historic and future climate values.

For more information:

This data is cataloged on the California Climate Commons at <http://climate.calcommons.org/dataset/10>. The discussion forum found at <http://climate.calcommons.org/forums/about-california-basin-characterization-model-bcm-downscaled-climate-surfaces> may be utilized to ask questions of the data originators, and to review the questions and answers posted to date.

There is a Climate Commons article “Featured Dataset: The California Basin Characterization Model” at <http://climate.calcommons.org/article/featured-dataset-california-basin-characterization-model> introducing the dataset and highlighting a project that used it to explore climate impacts for the North San Francisco bay area.

Please refer to the following publications for detailed information about the model:

Thorne, James, Ryan Boynton, Lorraine Flint, Alan Flint, and Thuy, N’goc Le (University of California, Davis and U.S. Geological Survey). 2012. Development and Application of Downscaled Hydroclimatic Predictor Variables for Use in Climate Vulnerability and Assessment Studies. California Energy Commission. Publication number: CEC-500-2012-010. Available at:

<http://climate.calcommons.org/bib/development-and-application-downscaled-hydroclimatic-predictor-variables-use-climate>

Flint, L. E., and A. L. Flint. 2012. Downscaling future climate scenarios to fine scales for hydrologic and ecological modeling and analysis. Ecological Processes 1. Available at: <http://climate.calcommons.org/bib/downscaling-future-climate-scenarios-fine-scales-hydrologic-and-ecological-modeling-and-analysis>

Cayan, D. R., M. Tyree, M. D. Dettinger, H. Hidalgo, and T. Das. 2009. California climate change scenarios and sea level rise estimates for the California 2009 Climate Change Scenarios Assessment. California Energy Commission report CEC‐500‐2009‐014‐F. Available at: <http://climate.calcommons.org/bib/climate-change-scenarios-and-sea-level-rise-estimates-california-2009-climate-change-scenarios>

Cayan, D. R., E. P. Mauer, M. D. Dettinger, M. Tyree, and K. Hayhoe. 2008. “Climate change scenarios for the California region.” Climactic Change 87 (suppl 1): S21–S42. DOI: 10.1007/s10584‐007‐9377‐6. Available at: <http://climate.calcommons.org/bib/climate-change-scenarios-california-region>

### Purpose

This dataset is part of the library of datasets developed in a project sponsored by the California Energy Commission (Energy Commission) Public Interest Energy Research (PIER) 2010 Climate Change Vulnerability and Adaptation (V&A) study. Since its release the BCM dataset has been used by others for research on the nature of climate change impacts on biodiversity, watershed health, and human communities.

The Thorne 2012 paper referenced above presents three analyses done with the outputs from the Basin Characterization Model: trends in hydrologic variables over baseline, the most recent 30-year period; a calibration and validation effort that uses measured discharge values from 139 streamgages and compares those to Basin Characterization Model derived projections of discharge for the same basins; and an assessment of the trends of specific hydrological variables that links historical trend to projected future change under four future climate projections. Overall, increases in potential evapotranspiration dominate other influences in future hydrologic cycles. Increased potential evapotranspiration drives decreasing runoff even under forecasts with increased precipitation, and drives increased climatic water deficit, which may lead to conversion of dominant vegetation types across large parts of the study region, as well as have implications for rain-fed agriculture. The potential evapotranspiration is driven by air temperatures, and the Basin Characterization Model permits it to be integrated with a water balance model that can be derived for landscapes and summarized by watershed. These results show the utility of using a process based model with modules representing different hydrological pathways that can be interlinked.

This standardized set of fine-scale climate data were shared with 14 research groups, including the U.S. National Park Service and several University of California groups as part of the PIER V&A project. The advantage in using them is that results will be cross-comparable with other studies that also use them.

Due to large number of datasets in this library, please see abstract and supplemental information sections for specifics on this dataset.

### Supplemental Information

The 14 climate variables (four BCM inputs and 10 BCM outputs) are:

Variable: Maximum Temperature

Code: tmax

Creation Method: downscaled

Units: degree C

Equation/Model: Model input

Description: The maximum monthly temperature averaged annually

Variable: Minimum Temperature

Code: tmin

Creation Method: downscaled

Units: degree C

Equation/Model: Model input

Description: The minimum monthly temperature averaged annually

Variable: Precipitation

Code: ppt

Creation Method: downscaled

Units: degree C

Equation/Model: Model input

Description: Total monthly precipitation (rain or snow) summed annually

Variable: Potential Evapotranspiration

Code: pet

Creation Method: Modeled in preprocessing step to BCM

Units: mm

Equation/Model: Modeled\* on an hourly basis from solar radiation that is modeled using topographic shading, corrected for cloudiness, and partitioned on the basis of vegetation cover to represent bare-soil evaporation and evapotranspiration due to vegetation

Description: Total amount of water that can evaporate from the ground surface or be transpired by plants summed annually

Variable: Runoff

Code: run

Creation Method: BCM

Units: mm

Equation/Model: Amount of water that exceeds total soil storage + rejected recharge

Description: Amount of water that becomes stream flow, summed annually

Variable: Recharge

Code: rch

Creation Method: BCM

Units: mm

Equation/Model: Amount of water exceeding field capacity that enters bedrock, occurs at a rate determined by the hydraulic conductivity of the underlying materials, excess water (rejected recharge) is added to runoff

Description: Amount of water that penetrates below the root zone, summed annually

Variable: Climatic Water Deficit

Code: cwd

Creation Method: BCM

Units: mm

Equation/Model: cwd = pet - aet

Description: Annual evaporative demand that exceeds available water, summed annually

Variable: Actual Evapotranspiration

Code: aet

Creation Method: BCM

Units: mm

Equation/Model: pet calculated\* when soil water content is above wilting point

Description: Amount of water that evaporates from the surface and is transpired by plants if the total amount of water is not limited, summed annually

Variable: Sublimation

Code: subl

Creation Method: BCM

Units: mm

Equation/Model: Calculated\*, applied to pck

Description: Amount of snow lost to sublimation (snow to water vapor), summed annually

Variable: Soil Water Storage

Code: stor

Creation Method: BCM

Units: mm

Equation/Model: stor = ppt + melt – aet - rch - run

Description: Average amount of water stored in soil annually

Variable: Snowfall

Code: snow

Creation Method: BCM

Units: mm

Equation/Model: Precipitation if air temperature below 1.5 degree C (calibrated)

Description: Amount of snow that fell summed annually

Variable: Snowpack

Code: pck

Creation Method: BCM

Units: mm

Equation/Model: pck = prior month pck + snow - subl - melt

Description: Amount of snow that accumulated per month summed annually (if divided by 12 would be the average monthly snowpack)

Variable: Snowmelt

Code: melt

Creation Method: BCM

Units: mm

Equation/Model: Calculated\*, applied to pck

Description: Amount of snow that melted (snow to liquid water) summed annually

Variable: Excess Water

Code: exc

Creation Method: BCM

Units: mm

Equation/Model: ppt - pet

Description: Amount of water that remains in the system, assuming evapotranspiration consumes the maximum possible amount of water, summed annually for positive months only

\* The equation or model for these variables is available in the following publication:

Flint, A.L., and Flint, L.E., 2007, Application of the basin characterization model to estimate in‐place recharge and runoff potential in the Basin and Range carbonate‐rock aquifer system, White Pine County, Nevada, and adjacent areas in Nevada and Utah: U.S. Geological Survey Scientific Investigations Report 2007‐5099, 20 p. <http://pubs.usgs.gov/sir/2007/5099/>. Available at: <http://climate.calcommons.org/bib/application-basin-characterization-model-estimate-in%E2%80%90place-recharge-and-runoff-potential-basin>

There are seven derived statistics for each variable (Equations for these statistics were from: Zar, Jerrold H,, 1999 Biostatistical Analysis –4th Edition, Prentice-Hall, New Jersey):

ave = average,

cov = coefficient of variation,

int = intercept,

rsq = coefficient of determination,

slp = slope,

std = standard deviation,

var = variance.

Naming conventions:

Each variable’s dataset name is a series of concatenated codes that fully describe its characteristics.

Using this dataset name as an example: ppt1911-1940jan\_ave\_HST.tif, specific characteristics are determined as follows:

Characters 1-3 are the variable code, e.g. ‘ppt’ is the code for precipitation. See table in Abstract section for full list of variables, their codes and other pertinent information.

Characters 4-12 are the time range in this file.

Time ranges available are the following 30-year summaries.

 1911-1940, 1941-1970, 1971-2000 (for the historical scenario ONLY),

2010-2039, 2040-2069, 2070-2099 (for the four future scenarios ONLY).

Characters 13-15 are the code for the time unit. If this dataset is for a specific month there will be a 3 character abbreviation for the month. If there is no month abbreviation present then the dataset is for the Water Year. The time units available are:

Individual months: January, February, March, April, May, June, July, August, September, October, November, December. For the 30-year monthly summary, summaries of monthly values were calculated for 30 year intervals. For each month, all 30 years in the sequence were fed into a linear regression model.

Water Year: For the 30-year Water Year summary, a summary for each water year is done by either averaging (tmax and tmin) or summing (all other variables) the values from all 12 months for each water year. Water year starts in October and ends in September, therefore water year 2000 begins in October 1999 and ends in September 2000. Then the sequence of 30 water years is run thru a linear regression model.

Characters 17-19 are the code for the statistic. There are seven derived statistics for each variable (Equations for these statistics were from: Zar, Jerrold H,, 1999 Biostatistical Analysis –4th Edition, Prentice-Hall, New Jersey):

ave = average,

cov = coefficient of variation,

int = intercept,

rsq = coefficient of determination,

slp = slope,

std = standard deviation,

var = variance.

Characters 21-23 are the code for the climate scenario.

Climate Scenarios available:

HST = Historical,

PA2 = PCM global climate model and A2 SRES emissions scenario,

GA2 = GFDL global climate model and A2 SRES emissions scenario,

PB1 = PCM global climate model and B1 SRES emissions scenario,

GB1 = GFDL global climate model and B1 SRES emissions scenario.

## Time Period of Content

### Currentness Reference

Publication date

## Status

### Progress

Complete

### Update

Irregular

## Spatial domain

### Bounding box

#### West bounding coordinate

125.455399

#### East bounding coordinate

112.450323

#### North bounding coordinate

44.292218

#### South bounding coordinate

31.045345

## Keywords

### Theme

#### Theme keyword thesaurus

None

#### Theme keyword

temperature

evapotranspiration

snowfall

groundwater

water budget

climatic water deficit

### Place

#### Place keyword thesaurus

None

#### Place keyword

California watersheds

### Temporal

#### Temporal keyword thesaurus

None

#### Temporal keyword

1911 - 2099

## Access constraints

Due to large file sizes, only the 30-year summaries have been made available online on the California Climate Commons. To obtain monthly data please contact Jim

Thorne (jhthorne@ucdavis.edu) 530-752-4389.

## Use constraints

This data is in the public domain.

Limitations of use:

The user of this data should be aware that these model outputs are intended for watershed-scale evaluation. Use of the data for analyses at a scale smaller than the HUC or planning watershed is not intended.

Data Disclaimer:
The data are released on the condition that neither the USGS nor the United States Government may be held liable for any damages resulting from their authorized or unauthorized use. Although the data have been subjected to rigorous review and are substantially complete, the USGS reserves the right to revise the data pursuant to further analysis and review. Furthermore, the data are released on the condition that neither the USGS nor the United States Government may be held liable for any damages resulting from their authorized or unauthorized use.
Source and Authority: U.S. Geological Survey Manual, Section 500.24.

## Point of contact

### Contact information

For inquiries regarding the Climate Commons online access point for the data:

Zhahai Stewart or Deanne DiPietro

California Landscape Conservation Cooperative

Data Manager

3820 Cypress Drive, Suite 11

Petaluma, CA 94954

United States

707-781-2555, ext. 322

zstewart@pointblue.org

ddipietro@pointblue.org

For inquiries regarding the content, processing, and appropriate usage of the data:

Lorraine and Alan Flint

lflint@usgs.gov

# Data Quality Information

## Lineage

### Process step

#### Process Description

Overview of inputs, BCM processing, and outputs:

Historical climate data came from the PRISM Climate Group at the Oregon State University. It was spatially downscaled from 4 km grid cell size through a method developed by Drs. Lorraine and Alan Flint, USGS, to 270m grid cell size. These data, plus others, were input to a regional water budget model, the Basin Characterization Model (BCM). Other key temporal inputs were potential evapotranspiration (modeled separately using the Priestley-Taylor equation) and four ‘standard’ climate scenarios provided by Dan Cayan, et al. Climate scenarios chosen were the A2 and B1 SRES emissions scenario outputs of the PCM and GFDL Global Climate Models. These future climate scenarios were downscaled from 12km to 4km and bias corrected (J. Thorne, L. Flint, et. al.), then downscaled again along with the (4km) PRISM historical climate data (L. & A. Flint) to a 270m horizontal resolution covering the state of California and its connecting watersheds. Three variables, ppt, tmax and tmin, were input to a preprocessing modeling step based on the Priestley-Taylor equation to generate the variable potential evapotranspiration (pet). These four temporal variables were then input to the BCM.

Other static inputs to the BCM were DEM, geology, soil water content at field capacity, soil porosity, bulk bedrock permeability soil thickness and soil water content at wilting point. Driven by high resolution downscaled precipitation and temperature, the Flints developed a program (BCM) to calculate and portray several other derivative measures, which are associated with the water balance at the land surface. The combined input to and output of the BCM provide a suite of 14 climate variables with multiple time ranges, time units and derived statistics about each variable.

For detailed information about the calculation of each of the variables, please see the individual metadata records for each variable, as well as the publications referenced above.

Due to large, unwieldy file sizes, results were summarized to 30 year means. Historical time ranges are 1911-1940, 1941-1970 and 1971-2000. Future climate values, based on 100 year simulations, are available in 2010-2039, 2040-2069 and 2070-2099 time ranges.

# Spatial Data Organization Information

## Direct Spatial Reference Method

Raster

## Raster Object Information

### Raster Object Type

Grid Cell

### Row Count

4649

### Column Count

3726

# Spatial Reference Information

Projection: California Teale Albers

Datum: NAD 83

# Distribution Information

## Distributor

California Climate Commons

<http://climate.calcommons.org>

## Resource Description

California Basin Characterization Model (BCM) downscaled climate and hydrology

## Standard Order Process

### Digital Form

The data has been made available on the California Climate Commons at <http://climate.calcommons.org/dataset/10> (See the Commons Hosting section, log in with a Commons account. Click on “View Map and Download Geodata” for access to the datasets using an intuitive interface that allows the user to choose from the variables, GCMs and emission scenarios, and other options. Data is downloaded immediately and comes with a read-me file to assist with interpretation of the products received.

# Metadata reference information

## Metadata date

20130724, updated 20131231

## Metadata contact

Zhahai Stewart or Deanne DiPietro

California Landscape Conservation Cooperative

Data Manager

3820 Cypress Drive, Suite 11

Petaluma, CA 94954

United States

707-781-2555, ext. 322

zstewart@pointblue.org

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## Metadata standard

This metadata record is based on the FGDC Content Standards for Digital Geospatial Metadata, version FGDC-STD-001-1998. For validated FGDC standard compliant metadata for each variable, please see the individual variable catalog records in the Climate Commons at <http://climate.calcommons.org/dataset/10>