Queensland Future Climate Datasets

High Resolution Spatial Data Products

Introduction

This document provides a description of the Queensland High Resolution Climate Change Projection spatial datasets from the Queensland Department of Environment and Science on the Terrestrial Ecosystem Research Network (TERN). These datasets can be found on TERN here:

https://geonetwork.tern.org.au/geonetwork/srv/eng/catalog.search#/metadata/b587a6ee-cc1a-4849-bee4-58fec60f0e9f

Acknowledgements

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Modelling

The Queensland Future Climate Datasets are produced by dynamical downscaling of a range of General Circulation Models (GCMs) from the Coupled Inter-Model Comparison Project Phase 5 (CMIP5). The set of 11 CMIP5 GCMs selected for downscaling are shown in the table below.

Model ID	Model Description	Institution(s)	Country
ACCESS-1.0	Australian Community Climate and Earth-System Simulator, version 1.0	CSIRO-BOM	Australia
ACCESS-1.3	Australian Community Climate and Earth-System Simulator, version 1.3	CSIRO-BOM	Australia
CCSM4	Community Climate System Model, version 4	NCAR	USA
CNRM-CM5	Centre National de Recherches Météorologiques Coupled Global Climate Model, version 5	CNRM-CERFACS	France
CSIRO-Mk3.6.0	Commonwealth Scientific and Industrial Research Organisation Mark 3.6.0	CSIRO-QCCCE	Australia
GFDL-CM3	Geophysical Fluid Dynamics Laboratory Climate Model, version 3	NOAA-GFDL	USA
GFDL-ESM2M	Geophysical Fluid Dynamics Laboratory Earth System Model with Modular Ocean Model, version 4 component	NOAA-GFDL	USA
HadGEM2	Hadley Centre Global Environment Model, version 2 CC	MOHC	UK
MIROC5	Model for Interdisciplinary Research on Climate, version 5	JAMSTEC	Japan
MPI-ESM-LR	Max Planck Institute Earth System Model, low resolution	MPI	Germany
NorESM1-MQ	Norwegian Earth System Model, version 1 (intermediate resolution)	NCC	Norway

The high resolution dynamical downscaling of climate data from CMIP5 GCMs is performed in two stages using the Conformal-Cubic Atmospheric model (CCAM) developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia. During the first stage, an ensemble of CCAM models is run at 50km global

resolution with sea-surface temperatures from the corresponding CMIP5 GCMs. During the second stage, another ensemble of CCAM models is run on a stretched grid at 10km resolution over Queensland with six-hourly spectral nudging using data from the 50km resolution runs.

Bias Correction

Systematic errors such as temperature drifts are inherent in GCMs due to the discretisation of physical process, and could have large impacts on future climate projections. Therefore, the temperature and precipitation variables from the 10km CCAM model output are first bias-corrected against historical observation data from the Australian Water Availability Project (AWAP) before further analysis on extreme climate indices based on these variables are performed.

Data Format

All data files are provided in the NetCDF format, the standard for climate data. The Climate and Forecast (CF) conventions for data structure and metadata has been followed where feasible to maximise compatibility to third-party software accessing these data files.

Climate Variables

The tables in this section lists the climate projections data available for download. The file hierarchy is as follows:

<experiment_id>/<data_frequency>/<variable_group>/<variable_id>

Data are available for the following combinations:

- Experiment
  - rcp45
  - rcp85

- Data Frequency
  - daily (1980-01-01 to 2099-12-31)
  - monthly (1980-01 to 2099-12)
  - seasonal-changes (seasonal climatologies and changes)
    (Annual, DJF, MAM, JJA, SON, MJJASO and NDJFMA for all variables groups except heatwaves)
    (NDJFMA and July to June for heatwaves)
    - 1986-2005
    - 2020-2039 minus 1986-2005
    - 2040-2059 minus 1986-2005
    - 2060-2079 minus 1986-2005
    - 2080-2099 minus 1986-2005

- Variable Groups
  - mean-climate (daily, monthly, seasonal changes)
  - extremes (seasonal changes only)
  - heatwaves (seasonal changes only)
  - droughts (includes flood indices, seasonal changes only)

Details of variables from each variable group are shown in the tables below. Availability of climatological changes as absolute amounts (Absolute Change) or relative amounts (Percentage Change).

Mean Climate

The following climate variables from the 10km CCAM model have been selected to give an overall understanding of the future climate. These data are not bias-corrected.

Variable	Code	Units	Description	Absolute Change	Percentage Change
Mean Temperature	tscr_ave	K	The average temperature of air during a season	✓	x
Maximum Temperature	tmaxscr	K	The daily highest temperatures of air averaged over a season	✓	x
Minimum Temperature	tminscr	K	The daily lowest daily temperatures of air averaged over a season	✓	x
Precipitation	rnd24	mm	The daily amounts, expressed in millimetres of liquid water depth, of water substance fallen averaged over a season	✓	✓
Pan Evaporation	epan_ave	mm/day	Measured daily water losses from free water surface of class-A evaporation pan averaged over a season	✓	✓
Evaporation	evap	mm	The daily total amount of water transferred from the earth to the atmosphere (evapotranspiration) averaged over a season	✓	✓
Relative Humidity	rhscrn	%	The daily ratios, expressed in percent, of the vapour pressure to the saturation vapour pressure with respect of water averaged over a season	✓	✓
Surface Wind	u10	m/s	The daily horizontal wind speeds on the land surface averaged over a season	✓	✓
Solar Radiation	sgdn_ave	W/m	The daily electromagnetic radiation emitted received	✓	✓

Heatwave Indices

The heatwave indices are adapted from the NARCliM regional climate modelling project in NSW/ACT governments.

http://www.ccrc.unsw.edu.au/sites/default/files/NARCliM/publications/TechNote5.pdf

A heatwave occurs when certain atmospheric temperature conditions are met. These indices are used to analyse the frequency, severity and duration of heatwave conditions.

Bias-corrected temperature data are used in the calculation of these heatwave indices.

Variable	Code	Units	Description	Absolute Change	Percentage Change
Heatwave Amplitude	HWAt	°C	Amplitude of the hottest day in the hottest heatwave event	✓	✓
Heatwave Frequency	HWF	%	Frequency of heatwave days	✓	✓
Heatwave Duration	HWD	days	Duration of the longest heatwave	✓	✓
Heatwave Length	HWL	days	Mean duration of heatwaves	✓	✓

Extremes Temperature Indices

The Australian Bureau of Meteorology defined a selected set of extreme temperature indices suitable for Australian conditions. More information on these extreme indices can be found at:

http://www.bom.gov.au/climate/change/about/extremes.shtml

A few of these indices have been adapted for use here. Bias-corrected temperature data are used in the calculation of these indices.

Variable	Code	Units	Description	Absolute Change	Percentage Change
Very Hot Days	vhd	days	Count of days with maximum temperature > 40 °C	✓	✓
Hot Days	hd	days	Count of days with maximum temperature > 35 °C	✓	✓
Hot nights	hn	days	Count of days with maximum temperature > 20 °C	✓	✓
Warm Spell Duration	wsd	days	Count of days with at least 4 consecutive days when daily maximum temperature > 90th percentile	✓	✓
Cold Spell Duration	csd	days	Count of nights with at least 4 consecutive nights when daily minimum temperature < 10th percentile	✓	✓
Very Cold Nights (Frost Nights)	fn	days	Count of days with maximum temperature < 0 °C	✓	✓

Extreme Precipitation Indices

The Australian Bureau of Meteorology also defined a selected set of extreme precipitation indices suitable for Australian conditions. More information on these extreme indices can be found at:

http://www.bom.gov.au/climate/change/about/extremes.shtml

A few of these indices have been adapted for use here. Bias-corrected temperature data are used in the calculation of these indices.

Variable	Code	Units	Description	Absolute Change	Percentage Change
Maximum 1-day Precipitation	m1p	mm	Maximum 1-day precipitation total	✓	✓
Maximum 5-day Precipitation	m5p	mm	Maximum consecutive 5-day precipitation total	✓	✓
Extremely Wet Day Precipitation	ewdp	mm	Total precipitation when daily precipitation > 99th percentile	✓	✓
Simply Daily Intensity	sdi	mm	Total precipitation divided by the number of days where daily precipitation ≥ 1 mm	✓	✓
Consecutive Dry Days	cdd	days	Maximum number of consecutive days with daily precipitation < 1 mm	✓	✓
Consecutive Wet Days	cwd	days	Maximum number of consecutive days with daily precipitation ≥ 1 mm	✓	✓

Drought Indices based on the Standard Precipitation Index

The Standard Precipitation Index (SPI) is used to determine precipitation deficit over an assessment period compared to normal conditionals over a calibration period. It is widely used in the United States and globally for drought management. Monthly precipitation totals are used to calculate SPI values, which are in turn used for these indices. Bias-corrected precipitation data are used in the calculation of these heatwave indices.

Variable	Code	Units	Description	Absolute Change	Percentage Change
Frequency of Moderate Droughts	fmd	months	Number of months with SPI ranging from -1.00 to -1.49	✓	✓
Frequency of Severe Droughts	fsd	months	Number of months with SPI ranging from -1.50 to -1.99	✓	✓
Frequency of Extreme Droughts	fed	months	Number of months with SPI less than -2.00	✓	✓
Duration of Droughts	dd	months	Average number of consecutive months with SPI less than -1.00	✓	✓

Flood (Extreme Wet Climate) Indices based on the Standard Precipitation Index

Similar to the SPI-based drought indices above, the flood indices are calculated from the precipitation excess over an assessment period. Bias-corrected precipitation data are used in the calculation of these heatwave indices.

Variable	Code	Units	Description	Absolute Change	Percentage Change
Frequency of Moderate Floods	fmd	months	Number of months with SPI ranging from +1.00 to +1.49	✓	✓
Frequency of Severe Floods	fsd	months	Number of months with SPI ranging from +1.50 to +1.99	✓	✓
Frequency of Extreme Floods	fed	months	Number of months with SPI greater than +2.00	✓	✓
Duration of Floods	dd	months	Average number of consecutive months with SPI greater than +1.00	✓	✓

More Information

The LongPaddock website hosts the Future Climate Dashboard, which provides regional climate projections based on the same modelling data.

https://app.longpaddock.qld.gov.au/dashboard/

Contact the LongPaddock team for any questions on the TERN dataset and the Future Climate Dashboard.

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