

# Package: CMIP6VisR (via r-universe)

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**Type** Package

**Title** Visualization and Analysis of Coupled Model Intercomparison  
Project, Phase-6 (CMIP6) Hydroclimatic Data

**Version** 1.1.0

**Date** 2025-03-14

**Description** Data manipulation for Coupled Model Intercomparison  
Project, Phase-6 (CMIP6) hydroclimatic data. The files are  
archived in the Federated Research Data Repository (FRDR)  
(Rajulapati et al, 2024, <[doi:10.20383/103.0829](https://doi.org/10.20383/103.0829)>). The data set  
is described in Abdelmoaty et al. (2025,  
<[doi:10.1038/s41597-025-04396-z](https://doi.org/10.1038/s41597-025-04396-z)>).

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scales, magrittr

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**VignetteBuilder** knitr

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**Maintainer** Kevin Shook <[kshook@kshook.ca](mailto:kshook@kshook.ca)>

**License** GPL-3

**URL** <https://github.com/TycheLab/CMIP6VisR>

**Config/pak/sysreqs**  
cmake libgdal-dev gdal-bin libgeos-dev make libicu-dev libproj-dev libsqlite3-dev

**Repository** <https://tychelab.r-universe.dev>

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|                   |                                                               |
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| CMIP6VisR-package | <i>Visualization and Analysis of CMIP6 Hydroclimatic Data</i> |
|-------------------|---------------------------------------------------------------|

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**Description**

Provides data manipulation, analyses and visualization for Coupled Model Intercomparison Project, Phase-6 (CMIP6) hydroclimatic data. The files are archived in the Federated Research Data Repository (FRDR) (Rajulapati et al., 2024)

**Author(s)**

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Authors:

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- Heba Abdelmoaty
- Konstantinos Andreadis

**References**

Rajulapati, C., Abdelmoaty, H., Nerantzaki, S., Papalexiou, S. (2024). High-resolution future temperature and precipitation dataset for Canada, 2015 - 2100. Federated Research Data Repository. <https://doi.org/10.20383/103.0829>

**See Also**

Useful links:

- <https://github.com/TycheLab/CMIP6VisR>

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cv\_clip\_basin

*Get zones and areas that clip rasters from a given basin polygon*


---

**Description**

Takes the SpatRaster that represents zones and areas and clips them from polygon basin.

**Usage**

```
cv_clip_basin(za_rast, basin)
```

**Arguments**

|         |                                     |
|---------|-------------------------------------|
| za_rast | SpatRaster of the zones and areas.  |
| basin   | SpatVector of the basin to clip to. |

**Value**

Returns a list with 3 elements:

- raster (rasters of cell areas for each zone).
- area (total area of each zone in the basin).
- zone (zone numbers).

**Author(s)**

Kostas Andreadis

**See Also**

[cv\\_extract\\_mean\\_basin\\_daily](#) [cv\\_extract\\_all\\_basin\\_daily](#)

**Examples**

```
## Not run:
library(terra)
az_raster <- cv_zone_area_raster()
fpath <- system.file("extdata", "07BF001.shp", package = "CMIP6VisR")
basin_vector <- vect(fpath)
basin_areas <- cv_clip_basin(az_raster, basin_vector)

## End(Not run)
```

---

cv\_extract\_all\_basin\_daily

*Extracts daily precipitation or temperatures for all locations in a basin*


---

## Description

Extracts the daily precipitation or temperature values from CMIP6 NetCDF files for all locations in a specified basin.

The CMIP6 data are arranged by zone in 9 files. As a given basin may lie over more than one zone, it may necessary to read in data from more than one NetCDF file when computing the basin mean precipitation.

## Usage

```
cv_extract_all_basin_daily(
  netcdf_directory = ".",
  scenario = "pr_day_ACCESS-CM2_ssp126_r2i1p1f1_gn_20150101-21001231_cannnc_SPQM_",
  basin_zone_area = NULL,
  temp_file = TRUE,
  output_file_name = NULL
)
```

## Arguments

|                  |                                                                                                                                                                                                                                                                                                                                   |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| netcdf_directory | Required. Directory containing NetCDF files.                                                                                                                                                                                                                                                                                      |
| scenario         | Required. Full name of scenario to be used. This is the file name omitting the zone number. The first character of the scenario name is used to determine the name of the variable returned.                                                                                                                                      |
| basin_zone_area  | Required. A list object returned by cv_clip_basin() which contains the zone numbers to be used, the basin area within each zone, and rasters of each zone containing the area of each element.                                                                                                                                    |
| temp_file        | If TRUE (the default) then temporary files will be used when extracting the values from the NetCDF files. This option is slower than keeping all the values in memory (which is what occurs if temp_file = TRUE), <i>but</i> allows the function to work with very large basins, which may require more memory than is available. |
| output_file_name | If NULL, then the precipitation values will not be written to a file. If a file name is specified, then the values <i>will</i> be written to a file. Note that if the filename exists, then the values will be overwritten.                                                                                                       |

## Value

Returns a SpatRaster object of the daily precipitation for all locations in the specified basin. Optionally writes the precipitation values to a specified NetCDF file.

**Author(s)**

Kevin Shook

**See Also**[cv\\_clip\\_basin](#) [cv\\_extract\\_mean\\_basin\\_daily](#)**Examples**

```
# This function is marked to not be tested as it requires local copies of the CMIP6 data files
# which are many GB in size
library(terra)
az_raster <- cv_zone_area_raster()
fpath <- system.file("extdata", "07BF001.shp", package = "CMIP6VisR")
basin_vector <- vect(fpath)
basin_areas <- cv_clip_basin(az_raster, basin_vector)
netcdf_directory <- "."
all_precip <- cv_extract_all_basin_daily(netcdf_directory = netcdf_directory,
                                       basin_zone_area = basin_areas,
                                       temp_file = FALSE)
```

---

cv\_extract\_mean\_basin\_daily

*Calculates basin-averaged daily precipitation or air temperature*


---

**Description**

Extracts daily precipitation or temperature values from CMIP6 NetCDF files, and calculates the mean for a given basin for each time interval. The original files are in longitude-latitude projection, so the areas of the cells varies. The cell areas are used to weight the values when computing the basin mean.

The CMIP6 data are arranged by zone in 9 files. As a given basin may lie over more than one zone, it may necessary to read in data from more than one NetCDF file when computing the basin mean daily values.

**Usage**

```
cv_extract_mean_basin_daily(
  netcdf_directory = ".",
  scenario = "pr_day_ACCESS-CM2_ssp126_r2i1p1f1_gn_20150101-21001231_cannnc_SPQM_",
  basin_zone_area = NULL,
  temp_file = TRUE
)
```



---

`cv_extract_point_daily`*Extracts daily precipitation or temperature for a specific location*

---

### Description

Extracts a daily time series from a single CMIP6 raster location, which can be used to compare the CMIP6 values against station values. The location of the data in the CMIP6 data (its zone and raster location) is found using `cv_find_point`.

### Usage

```
cv_extract_point_daily(  
  variable_file_name = NULL,  
  grid_lon = NULL,  
  grid_lat = NULL  
)
```

### Arguments

|                                 |                                                                                                                                     |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <code>variable_file_name</code> | Required. String containing the name of the NetCDF file with the CMIP6 daily precipitation or temperature, including the file path. |
| <code>grid_lon</code>           | Required. Longitude of the grid cell containing the location, as returned by <code>cv_find_point</code> .                           |
| <code>grid_lat</code>           | Required. Latitude of grid cell containing the location, as returned by <code>cv_find_point</code> .                                |

### Value

Returns a data frame with 2 columns: date and either precipitation or temperature, depending on the file name. The date is a standard R date over the interval 2015-01-01 to 2100-12-31, and the precipitation or temperature is the value at the specified grid location. The returned time series can be plotted using `cv_plot_TS`, `cv_plot_prob`, and `cv_plot_season`.

### Author(s)

Kevin Shook

### See Also

[cv\\_find\\_point](#) [cv\\_extract\\_all\\_basin\\_daily](#) [cv\\_extract\\_mean\\_basin\\_daily](#)

## Examples

```
## Not run:
point_long <- -110.456
point_lat <- 52.19
point_loc <- cv_find_point(point_long, point_lat)
point_loc
precip_file <- "pr_day_ACCESS-CM2_ssp126_r2i1p1f1_gn_20150101-21001231_cannnc_SPQM_07.nc"
grid_lon <- point_loc[1]
grid_lat <- point_loc[2]
point_precip <- cv_extract_point_daily(precip_file, grid_lon, grid_lat)

## End(Not run)
```

---

cv\_find\_point

Locates a specific point in the CMIP6 data rasters

---

## Description

Finds the closest CMIP6 raster location (zone and raster longitude and latitude) to a point specified by its longitude and latitude. The distances from the raster centres are found using functions from **geosphere**.

## Usage

```
cv_find_point(longitude, latitude, fast = TRUE)
```

## Arguments

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| longitude | Required. Longitude (decimal degrees) of the point                                                                                                                                                                                                                                                                                                                                                                               |
| latitude  | Required. Latitude (decimal degrees) of the point                                                                                                                                                                                                                                                                                                                                                                                |
| fast      | Optional. If TRUE (the default), the faster, but slightly less accurate <code>distVincentySphere</code> method will be used to determine the distance between the coordinates of the specified point and that of all the CMIP6 raster points. If FALSE, then the more accurate <code>distVincentyEllipsoid</code> method is used. The difference between the distances of the two methods is very small, typically a few metres. |

## Value

Returns a vector containing the raster cell coordinates ('grid\_lon', 'grid\_lat'), zone number ('zone'), cell area ('area') in km<sup>2</sup> and the distance ('distance') between the point and cell centre (m).

## Author(s)

Kevin Shook

**Examples**

```
{
  point_long <- -110.456
  point_lat <- 52.195
  point_loc <- cv_find_point(point_long, point_lat)
  point_loc
}
```

---

cv\_plot\_prob*Plot probability of exceedance for precipitation*

---

**Description**

Plots the exceedance probabilities of non-zero values in a precipitation time series as returned by `cv_extract_mean_basin_daily()`, vs the precipitation value. Uses a logarithmic scale for the y-axis.

**Usage**

```
cv_plot_prob(data)
```

**Arguments**

|      |                                                                                                                                        |
|------|----------------------------------------------------------------------------------------------------------------------------------------|
| data | A data frame with two columns: date (date or datetime) and precipitation (numeric) as returned by <code>cv_mean_basin_daily()</code> . |
|------|----------------------------------------------------------------------------------------------------------------------------------------|

**Value**

A ggplot object displaying the probability of exceedance of nonzero precipitation. The returned plots look best when saved at the size 16.5 x 12 cm. You can easily change the font sizes using `theme()`.

**See Also**

[cv\\_extract\\_mean\\_basin\\_daily](#) [cv\\_plot\\_TS](#) [cv\\_plot\\_season](#)

**Examples**

```
cv_plot_prob(eg_TS)
```

---

|                |                                                 |
|----------------|-------------------------------------------------|
| cv_plot_season | <i>Plot seasonal precipitation distribution</i> |
|----------------|-------------------------------------------------|

---

### Description

Creates seasonal plots of a precipitation time series, as returned by `cv_basin_daily_precip()`. Assigns seasons based on the month, computes the proportion of zero precipitation values (P0) and seasonal means for nonzero precipitation, and generates a violin plot showing the seasonal distribution of precipitation.

### Usage

```
cv_plot_season(data)
```

### Arguments

|      |                                                                                                                                                |
|------|------------------------------------------------------------------------------------------------------------------------------------------------|
| data | A data frame with two columns: date (date or datetime) and precipitation (numeric) as returned by <code>cv_extract_mean_basin_daily()</code> . |
|------|------------------------------------------------------------------------------------------------------------------------------------------------|

### Value

A ggplot object displaying the seasonal distribution of nonzero precipitation, with mean values and P0 labelled. The returned plots look best when saved at the size 16.5 x 14 cm. You can easily change the font sizes using `theme()`.

### See Also

[cv\\_extract\\_mean\\_basin\\_daily](#) [cv\\_plot\\_TS](#) [cv\\_plot\\_prob](#)

### Examples

```
cv_plot_season(eg_TS)
```

---

|            |                                       |
|------------|---------------------------------------|
| cv_plot_TS | <i>Plot precipitation time series</i> |
|------------|---------------------------------------|

---

### Description

Creates a time series plot from a data frame of precipitation data as returned by `cv_extract_mean_basin_daily()`. Basic statistics (mean, standard deviation, and proportion of zero values), are added to the title of the plot.

### Usage

```
cv_plot_TS(data)
```

**Arguments**

**data** A data frame with two columns: date (date or datetime) and precipitation (numeric) as returned by `cv_mean_basin_daily()`.

**Value**

A ggplot object displaying the precipitation time series with summary statistics in the title. The returned plots look best when saved at the size 16.5 x 6 cm You can easily change the font sizes using `theme()`.

**See Also**

[cv\\_extract\\_mean\\_basin\\_daily](#) [cv\\_plot\\_prob](#) [cv\\_plot\\_season](#)

**Examples**

```
cv_plot_TS(eg_TS)
```

---

`cv_zone_area_raster` *Gets zones and areas for all grid locations*

---

**Description**

Uses the data frame `zone_grid_df`. Returns a raster containing two layers, the zone (1-9) and the area (km<sup>2</sup>) for each grid location in the CMIP6 files. The raster returned has 415 rows (latitudes in 0.1 degrees) and 883 columns (longitudes in 0.1 degrees). The zone number is used to determine the file(s) to read in for computing the basin mean precipitation statistics for a given Canadian hydrometric basin. The

**Usage**

```
cv_zone_area_raster()
```

**Value**

Returns a **terra** `SpatRaster` object (415 rows x 883 columns x 2 layers) of all Canadian grid locations.

**Author(s)**

Heba Abdelmoaty Kevin Shook

**Examples**

```
zone_area_grid <- cv_zone_area_raster()
library(terra)
plot(zone_area_grid)
```

---

|       |       |
|-------|-------|
| eg_TS | eg_TS |
|-------|-------|

---

**Description**

A dataframe containing daily precipitation time series for a basin.

**Usage**

eg\_TS

**Format**

A dataframe with 31,411 rows and 2 columns.

**Details**

This timeseries represents a weighted average daily precipitation time series over the basin given in the package. It comes from one simulation of the CMIP6 model ACCESS-CM2 under the SSP1-2.6 scenario.

Variables:

**date** Date of the observation (YYYY-MM-DD format)

**precipitation** Daily precipitation amount (mm)

**Source**

CMIP6 simulation: "\_ACCESS-CM2\_ssp126\_r2i1p1f1\_gn\_20150101-21001231"

---

|              |              |
|--------------|--------------|
| zone_grid_df | zone_grid_df |
|--------------|--------------|

---

**Description**

A dataframe of zone values and areas for all CMIP6 grid cells

**Usage**

zone\_grid\_df

**Format**

A dataframe with 169584 rows and 4 columns.

### **Details**

Variables:

**long** Longitude

**lat** Latitude

**zone** Zone (0-9)

**area** Grid cell area km<sup>2</sup>

### **Source**

<https://doi.org/10.20383/103.0829>

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