# Package 'Bclim'

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**Type** Package

**Title** Bayesian Palaeoclimate Reconstruction from Pollen Data

**Version** 3.1.2

**Date** 2016-12-23

**Description** Takes pollen and chronology data from lake cores and produces a Bayesian posterior distribution of palaeoclimate from that location after fitting a non-linear non-Gaussian state-space model. For more details see the paper Parnell et al. (2015), Bayesian inference for palaeoclimate with time uncertainty and stochastic volatility. Journal of the Royal Statistical Society: Series C (Applied Statistics), 64: 115–138 <DOI:10.1111/rssc.12065>.

**Imports** MASS, mclust, graphics, statmod, ggplot2

**Suggests** Bchron, knitr

**Encoding** UTF-8

**License** GPL (>= 2)

**URL** https://github.com/andrewcparnell/Bclim

**BugReports** https://github.com/andrewcparnell/Bclim/issues

**LazyData** TRUE

**VignetteBuilder** knitr

**NeedsCompilation** yes

**RoxygenNote** 5.0.1

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**Repository** CRAN

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# R topics documented:



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`climate_histories` *Create Bclim climate_histories*

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## Description

Runs a number of algorithms to create climate histories for a given set of slice clouds (from `slice_clouds` and a set of chronologies. For examples why not see the wonderful Bclim vignette (available at https://cran.r-project.org/web/packages/Bclim/index.html) and the author's personal webpage (https://maths.ucd.ie/parnell)?

## Usage

```
climate_histories(slice_clouds, chronology, time_grid, n_mix = 10,
  mix_warnings = FALSE, n_chron = 2000, keep_parameters = TRUE,
  control_mcmc = list(iterations = 1e+05, burnin = 20000, thinby = 40, report
  = 100), control_chains = list(v_mh_sd = 2, phi1_mh_sd = 1, phi2_mh_sd = 10,
  v_start = statmod::rinvgauss(slice_clouds$n_slices - 1, 2, 1), Z_start =
  sample(1:n_mix, slice_clouds$n_slices, replace = TRUE), phi1_start = rep(3,
  slice_clouds$n_dimensions), phi2_start = rep(20, slice_clouds$n_dimensions)),
  control_priors = list(phi1_dl_mean = rep(1.275, slice_clouds$n_dimensions),
  phi1_dl_sd = rep(0.076, slice_clouds$n_dimensions), phi2_dl_mean = rep(4.231,
  slice_clouds$n_dimensions), phi2dl_sd = rep(0.271,
  slice_clouds$n_dimensions)))
```

## Arguments

| | |
|---|---|
| `slice_clouds` | An object of class `slice_clouds` obtained from `slice_clouds` |
| `chronology` | A set of chronologies given as a matrix. These should be provided in thousands of years before present. See details below |
| `time_grid` | The time grid on which to create the climate histories |
| `n_mix` | The number of mixture components for the Mclust mixture algorithm |
| `mix_warnings` | Whether to display warnings related to the mixture algorithm |
| `n_chron` | The number of chronologies to use |
| `keep_parameters` | Whether to keep latent parameters or not. Useful for convergence checking so default is TRUE |

`control_mcmc` A list containing elements that control the MCMC, including the number of iterations, the size of the burn-in period, the amount to thinby, and how often for the algorithm to report its progress

`control_chains` A list containing elements that control the starting values of the parameters (v_start, Z_start, phi1_start and phi2_start) and the Metropolis-Hastings proposal standard deviation for v, phi1 and phi2

`control_priors` A list containing the prior parameters for the volatilities, given by phi1 and phi2, both of which should be the log-mean and log-sd of the log-normal distribution. The values provided here are for the GISP2 ice core for the period 0 to 10k years BP

## Details

This function takes the slice_clouds produced by `slice_clouds` uses a set of algorithms to produce climate histories on the provided time grid. The full details are in the paper referenced below. The options listed above allow quite a detailed level of control over the behaviour of the algorithm, and convergence should be checked using suitable means (see e.g. the R package boa or coda).

One of the key inputs to this function is a chronology. This should be a matrix of n_chron by n_slices containing sample chronologies as produced by, e.g. the R package Bchron. These are used by the `climate_histories` function to take account of chronological uncertainty. In the (unlikely) event that there is no chronological uncertainty, the rows of the chronologies can be identical.

## Value

A list object with the following elements

- v.store Samples of the posterior estimated volatilities
- chron.store Samples of the used chronologies
- c.store Samples of the posterior estimated climates
- z.store Samples of the posterior mixture indices
- phi1 Values used for the IG prior on v for each climate dimension
- phi2 Values used for the IG prior on v for each climate dimension
- chron.loc A character string giving the location of the chronology file
- nchron The number of chronologies in the chronology file
- parameters A list containing further latent parameter values for convergence checking (only if `keep_parameters` is TRUE)

## References

Parnell, A. C., et al. (2015), Bayesian inference for palaeoclimate with time uncertainty and stochastic volatility. Journal of the Royal Statistical Society: Series C (Applied Statistics), 64: 115–138.

## See Also

`slice_clouds` for producing the input for this function. See `plot.climate_histories` and `summary.climate_histories` for plotting and summary details

plot.climate_histories

*Plots of posterior Bclim climate histories*

## Description

Create plots of climate histories from a Bclim run. For examples why not see the wonderful Bclim vignette (available at https://cran.r-project.org/web/packages/Bclim/index.html) and the author's personal webpage (https://maths.ucd.ie/parnell)?

## Usage

```
## S3 method for class 'climate_histories'
plot(x, dim = 1, slice_clouds = TRUE,
  chron = NULL, climate_ribbon = TRUE, most_representative = 1,
  conf = c(0.95, 0.75, 0.5), col_clouds = grDevices::rgb(0, 0, 1, 0.2),
  col_ribbon = grDevices::rgb(1, 0, 0, 0.4),
  col_representative = grDevices::rgb(0, 1, 0), present_left = TRUE, ...)
```

## Arguments

| | |
|---|---|
| x | The output of a Bclim run from climate_histories |
| dim | The chosen climate dimension. This could be GDD5 (dim=1), MTCO (dim=2) or AET/PET (dim=3) |
| slice_clouds | Whether to ploy the individual layer clouds (default TRUE) |
| chron | A chronology file (see climate_histories for details). Only required if layer_clouds=TRUE |
| climate_ribbon | Whether to plot the climate ribbon, i.e. the time slices quantiles (default=TRUE) |
| most_representative | The number of representative climate histories to plot. See Details section below. Can be set to zero if none are required |
| conf | The confidence levels of the layer clouds and the climate histories. Default is 95%, 75% and 50% shading |
| col_clouds | The colour of the climate clouds. Default is blue with 20% transparency |
| col_ribbon | The colour of the climate ribbon. Default is red with 40% transparency |
| col_representative | The colour of the representative climate histories. Default is green |
| present_left | Whether the present (i.e. 0 years before present) should be on the left or the right of the plot. Default is to put it on the left |
| ... | Other arguments to the plot function, such as axis labels, titles etc |

## Details

This function creates the default Bclim plots of climate histories and layer clouds from a Bclim run. Users can turn on or off the layer clouds and summaries of the the climate histories (the 'climate ribbon'), and change the confidence level shown on the plots. The function also allows for a number of 'representative histories' to be plotted. These are considered to be the climate histories that are the median distance away from the point-wise medians.

## Value

No output, just a plot

## See Also

The main Bclim functions are `slice_clouds` and `climate_histories`.

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`plot.slice_clouds` *Plots of Bclim slice clouds*

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## Description

Create bivariate climate plots of individual slices. For examples why not see the wonderful Bclim vignette (available at https://cran.r-project.org/web/packages/Bclim/index.html) and the author's personal webpage (https://maths.ucd.ie/parnell)?

## Usage

```
## S3 method for class 'slice_clouds'
plot(x, slice = 1, dims = 1:2, n = 50, ...)
```

## Arguments

| | |
|---|---|
| `x` | The output of a run from `slice_clouds` |
| `slice` | The chosen slice to plot |
| `dims` | A vector of length 2. dim=1 corresponds to GDD5, dim=2 to MTCO, and dim=3 to AET/PET |
| `n` | The resolution of the resulting plot. A higher value of n will yield finer plots but might require some colour adjustment |
| `...` | Other arguments to the plot function such as axis labels, titles, and colours |

## Details

This function creates a bivariate density plot of two climate dimensions (two of GDD5, MTCO and AET/PET) using the MASS library function `kde2d`

## Value

Just a plot

## See Also

The main Bclim functions are slice_clouds and climate_histories

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slice_clouds *Function to approximate pollen slices as climate clouds*

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## Description

This function takes a set of pollen data and turns it slice-by-slice into climate estimates. For examples why not see the wonderful Bclim vignette (available at https://cran.r-project.org/web/packages/Bclim/index.html) and the author's personal webpage (https://maths.ucd.ie/parnell)?

## Usage

```
slice_clouds(pollen, path_to_rs = "https://maths.ucd.ie/parnell/",
  n_samples = 1000)
```

## Arguments

| | |
|---|---|
| pollen | A matrix or data frame of pollen counts (they can be normalised or not) which contains an unspecified number of rows and precisely 28 columns. These columns should represent counts of the following taxa in order: Abies Alnus Betula Carpinus Castanea Cedrus Corylus Ephedra Fagus Juniperus Larix Olea Ostrya Phillyrea Picea Pinus.D Pinus.H Pistacia Quercus.D Quercus.E Salix Tilia Ulmus Artemisia Chenopodiaceae Cyperaceae Ericales Gramineae |
| path_to_rs | A web address which links to the file requireddata3D.RData which contains response surfaces. The default should work fine |
| n_samples | The number of samples taken for each slice cloud. Default is 1000 |

## Details

A slice cloud is a multivariate probability distribution of the three climate dimensions (Growing Degree Days above 5C, GDD5; Mean Temperature of Coldest Month, MTCO; the ratio of actual to potential evapotranspiration, AET/PET) given the pollen information at that slice only. This function loops through each slice in the core to produce slice clouds which represent the information about climate obtained only from that slice of pollen. See references below for the technical details of this technique

## Value

A list object the the following elements

- slice_cloudsThe slice clouds, an n_samples x n_slices x n_dimensions array
- n_samplesThe number of slices (i.e. the number of rows in the pollen file)
- n_dimensionsThe number of climate dimensions (currently always 3)

## References

Fore more detail on the algorithm see: Salter-Townshend, M. and J. Haslett (2012). Fast Inversion of a Flexible Regression Model for Multivariate, Zero-Inflated Pollen Counts. Environmetrics. Sweeney, J. (2012). Advances in Bayesian Model Development and Inversion in Multivariate Inverse Inference Problems with application to palaeoclimate reconstruction. Ph. D. thesis, Trinity College Dublin. Parnell, A. C., et al. (2015), Bayesian inference for palaeoclimate with time uncertainty and stochastic volatility. Journal of the Royal Statistical Society: Series C (Applied Statistics), 64: 115–138.

## See Also

`climate_histories`, `plot.slice_clouds`

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`summary.climate_histories`

*Summarises the output created by* `climate_histories`

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## Description

Produces estimated climate values for a chosen climate dimension for each of the values supplied to the `time_grid` argument to `climate_histories`. For examples why not see the wonderful Bclim vignette (available at https://cran.r-project.org/web/packages/Bclim/index.html) and the author's personal webpage (https://maths.ucd.ie/parnell)?

## Usage

```
## S3 method for class 'climate_histories'
summary(object, dim = 1, probs = c(0.05, 0.95),
  ...)
```

## Arguments

| | |
|---|---|
| `object` | An object of class `climate_histories` produced by the function `climate_histories` |
| `dim` | The chosen climate dimension. This could be GDD5 (dim=1), MTCO (dim=2) or AET/PET (dim=3) |
| `probs` | The chosen values at which to compute time-wise quantiles. The default is a 90% interval, i.e. from 5% to 95% |
| `...` | Not used |

## Details

The output is a table of time-wise confidence/credibility intervals for the climate histories at each time point given on the time grid for the specified climate dimension. The results can be saved in an object if required.

## Value

A data frame with the following columns:

- time_grid The provided time grid points
- quantiles The quantiles of the climate variable for the specified probabilities

Note that this object is reported silently so will be discarded unless the function is called with an object as in the vignette.

## See Also

See `climate_histories` for creating objects suitable for this function

# Index