Package 'paleofire'

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Type Package

Title Analysis of Charcoal Records from the Global Charcoal Database

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Description Tools to extract and analyse charcoal sedimentary data stored in the Global Charcoal Database. Main functionalities includes data extraction and sites selection, transformation and interpolation of the charcoal records as well as compositing.

URL http://gpwg.paleofire.org

License GPL (>= 2)

Imports locfit, raster, ggplot2, plyr, rgdal, lattice

Suggests gtools,caTools,pscl,agricolae,Imap,sp,rworldmap,RColorBrewer

Depends R(>= 2.10.0), methods, GCD

LazyLoad yes

LazyData no

Encoding UTF-8

RoxygenNote 5.0.1

NeedsCompilation no

Repository CRAN

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R topics documented:

`paleofire-package` *paleofire: A package for the Global Charcoal Database*

Description

The paleofire package provides tools to extract and analyse charcoal sedimentary data stored in the Global Charcoal Database. Main functionalities includes data extraction and sites selection, transformation and homogenization of the charcoal records as well as regional to global compositing.

Details

Package:	paleofire
Type:	Package
Version:	1.1.9
Date:	2016-09-19
License:	GPL (>=2)

Author(s)

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Maintainer

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References

Blarquez, O., Vannière, B., Marlon, J. R., Daniau, A. L., Power, M. J., Brewer, S., & Bartlein, P. J. (2014). paleofire: an R package to analyse sedimentary charcoal records from the Global Charcoal Database to reconstruct past biomass burning. Computers & Geosciences, 72, 255-261.

See Also

http://gpwg.paleofire.org

Examples

```
## Not run:
## Interactive sites selection:
# ID=pfInteractive()

## Site selection using criterions
# Boreal Eastern North American sites with at least one
# dating point each 2500 year

ID=pfSiteSel(lat>50, lat<70, long>-90, long<(-50), date_int<=2500, l12==1)
plot(ID,zoom="world")

## Modify plot
plot(ID,zoom="sites")

## Simple test for transforming data
# Select site 1 (Cygnet Lake)

ID1=pfSiteSel(id_site==1)
plot(ID1)
```

```
# Transformation of data
TR=pfTransform(ID1,method=c("MinMax", "Box-Cox", "Z-Score"))

# Plot Transformed and raw data
# First retrieve raw data for Cygnet using pfExtract

RAW=pfExtract(ID=1)

dev.off()
par(mfrow=(c(2,1)))

plot(RAW[,3],RAW[,4],type="l")
plot(TR$Age,TR$TransData,type="l")

## Transforming and Compositing
## Example 1: Usage as in Power et al. 2008
## Data transformation

TR1=pfTransform(ID, method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,2000))

## Diagnostic pdf file with transformed series:
# pfDiagnostic(ID, method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,2000),
# FileName = "Diagnostic.pdf")

## Compositing: basic binning procedure
COMP=pfComposite(TR1, binning=TRUE, bins=seq(0,8000,500))
plot(COMP)

## The result matrix can be saved
# write.csv(COMP$Result,file="temp.csv")

## Compositing: Using the locfit package equivalent procedure to Daniau et al. 2012

COMP2=pfCompositeLF(TR1, tarAge=seq(-50,8000,20), binhw=20, hw=500,nboot=100)
plot(COMP2)

## And save
write.csv(COMP2$Result,file="temp2.csv")

## End(Not run)
```

---

checkGCDversion *Check GCD package install*

Description

Check if GCD package is installed and up to date to ensure always using the most up to date GCD version. devtools package is required: on Windows install Rtools.exe depending on your R version http://cran.r-project.org/bin/windows/Rtools/

Usage

```
checkGCDversion()
```

Details

Last GCD database version is donwloaded and installed using:

```
library(devtools)
install_github("GCD",username="paleofire",ref="master")
```

Author(s)

O. Blarquez

Examples

```
## Not run: checkGCDversion()
```

`coast` *coast*

Description

World coastlines

Usage

```
data(coast)
```

Format

A data frame with 9865 observations on the following 2 variables.

`Y` Latitude

`X` Longitude

Source

http://www.naturalearthdata.com/downloads/10m-physical-vectors/

Examples

```
data(coast)
```

contiguous *Are cores sampled contiguously?*

Description

The function checks wether cores have been sampled contiguously or with a depth resolution <1cm.

Usage

```
contiguous(x, threshold = 1)
```

Arguments

x	An object of the class "pfSiteSel"
threshold	Numeric, threshold for considering two samples as contiguous (default=1cm)

Value

Summary table of sites with the added contiguous logical column (TRUE–FALSE)

Author(s)

O. Blarquez

See Also

pfResolution

Examples

```
x=pfSiteSel(lat>12,lat<60,long<(-50),long>-140)
contiguous(x)
```

contrib.pfCompositeLF *contrib.pfCompositeLF*

Description

Calculates the number of prebinned samples contributing to the composite curve. The number is calculated by counting the number on non null charcoal values at each tarAge from the prebinned charcoal series.

Usage

```
## S3 method for class 'pfCompositeLF'
contrib(x, ...)
```

Arguments

x	A "pfCompositeLF" object.
...	...

Author(s)

O. Blarquez

Examples

```
ID=pfSiteSel(id_region=="WNA0",l12==1,long>=-160,long<=-140)

TR=pfTransform(ID, method=c("MinMax","Box-Cox","MinMax","Z-Score"),
               BasePeriod=c(200,2000),QuantType="INFL")

COMP1=pfCompositeLF(TR, tarAge=seq(-50,4000,10), hw=200, nboot=100)

a=contrib(COMP1)
plot(COMP1$BinCentres,a)
```

---

kdffreq *Fire frequency using kernel density*

Description

Computes paleo-fire frequency for a set of fire events (or frequency from other events types, see examples) using a gaussian kernel density estimation procedure based on a defined bandwidth (see Mudelsee 2004 for details). Pseudo-replicated values are used to correct for edge bias, equivalent to "minimum slope" correction in Mann (2004).

Usage

```
kdffreq(fevent, up = NULL, lo = NULL, interval = 10, bandwidth = NULL,
  nbboot = NULL, alpha = NULL, pseudo = FALSE)
```

Arguments

fevent	Numeric vector, set of dates
up	Numeric, upper age for fire frequency calculus
lo	Numeric, lower age for fire frequency calculus
interval	Numeric, interval between two points for fire frequency calculus (default 10 years)
bandwidth	Numeric, bandwidth in years, or character for automatic bandwidth calculation (e.g. "bw.ucv" for unbiased cross validation) see bandwidth for details
nbboot	Numeric, number of bootstrap replicates
alpha	Numeric, confidence interval (default 0.01)
pseudo	Logical, apply (TRUE) or not (FALSE) Mann (2004) correction (default=FALSE)

Value

ff data.frame, with fire frequency, bandwidth and CIs

Author(s)

O. Blarquez

References

Mann, M. E. (2004). On smoothing potentially non-stationary climate time series. Geophysical Research Letters, 31(7).

Mudelsee, M., Börngen, M., Tetzlaff, G., & Grünewald, U. (2004). Extreme floods in central Europe over the past 500 years: Role of cyclone pathway "Zugstrasse Vb". Journal of Geophysical Research: Atmospheres (1984–2012), 109(D23).

See Also

plot.kdffreq

Examples

```
set.seed(123)
fevent=c(round(abs(rnorm(20,mean=7,sd=5))*1000),round(abs(rnorm(10,mean=8,sd=1))*1000))
ff=kdffreq(fevent,bandwidth = 1000, nbboot=10)

## Not run:
# Estimate the frequency of armed conflicts from 1946 to 2014
# Data from the The Uppsala Conflict Data Program (UCDP) available at: https://www.prio.org

dat=read.csv('http://ucdp.uu.se/downloads/ucdpprio/ucdp-prio-acd-4-2016.csv')
res=kdffreq(dat$Year,bandwidth = "bw.ucv", nbboot=1000, up = 1946, lo = 2014, interval=1, pseudo=T)
plot(res, ylab="# armed conflict/year")

## End(Not run)
```

paleofire-internal *Internal paleofire functions*

Description

Internal paleofire functions and functions waiting for man.

pfAddData *Add user defined charcoal data series to paleofire*

Description

This function is used to create a "pfAddData" object, from user defined csv files containing charcoal data, to be passed to pfTransform. csv files must contain three columns with Depth, Age, Charcoal quantity in this same order (for type="NONE" argument). A metadata csv file could also be specified with sites location information (three columns with: SITE_NAME, LATITUDE, LONGITUDE). CharAnalysis data files could also be used, in this case the file must include the following columns: DepthTop, DepthBottom, AgeTop, AgeBottom, Volume and Charcoal value in this exact order. Then the files are passed to the pretreatment function in order to calculate Charcoal Accumulation Rates (see pretreatment for details).

Usage

```
pfAddData(files, metadata = NULL, type = "NULL", Int = TRUE,
  first = NULL, last = NULL, yrInterp = NULL, sep = ",", dec = ".")
```

Arguments

files	Character, names and path to csv files.
metadata	Character, name and path to the (unique) metadata csv file.
type	Character, "NONE": user defined csv (default), "CharAnalysis": CharAnalysis data file.
Int	Logical specifying whether the pretreatment function interpolates particle zero counts, default TRUE.
first, last	Numeric, date of the first, last sample for accumulation rate calculation, if NULL first, last are automatically specified as the the minimum and maximum ages of the record respectively.
yrInterp	Numeric, temporal resolution of the interpolated accumulation rates, if NULL, yrInterp is automatically specified as the median resolution of the record.
sep	char, column separator for csv, "," by default
dec	char, decimal "." by default

Value

out	A list with merged data files that can be passed to pfTransform

Author(s)

O. Blarquez

See Also

pretreatment

Examples

```
## Not run:
# Ad user own data from CharAnalysis file (csv)
# In this example we will use data from:
# Senici, D., A. Lucas, H. Y. H. Chen, Y. Bergeron, A. Larouche, B. Brossier, O.
# Blarquez, and A. A. Ali. 2013. Multi-millennial fire frequency and tree abundance
# differ between xeric and mesic boreal forests in central Canada. Journal of Ecology:
# 101, 356-367.

files=c("http://blarquez.com/public/data//Ben.csv",
       "http://blarquez.com/public/data/Small.csv")
metadata=c("http://blarquez.com/public/data/metadata.csv")

mydata=pfAddData(files=files,metadata=metadata,type="CharAnalysis")

# Transform and compositing:
TR1=pfTransform(add=mydata, method=c("MinMax","Box-Cox","Z-Score"),
                BasePeriod=c(200,2000))
COMP2=pfCompositeLF(TR1, tarAge=seq(-50,8000,20), hw=500, nboot=100)
plot(COMP2)

# Three columns example (with semicolon csv files):
files=c("http://blarquez.com/public/data/Ben_area.csv",
       "http://blarquez.com/public/data/Small_area.csv")
mydata=pfAddData(files=files, sep=";")
# Transform and compositing:
TR1=pfTransform(add=mydata, method=c("MinMax","Box-Cox","Z-Score"),
               BasePeriod=c(200,2000))
COMP2=pfCompositeLF(TR1, tarAge=seq(-50,8000,20), hw=500, nboot=100)
plot(COMP2)

## End(Not run)
```

`pfBoxCox` *Box-Cox transformation of Charcoal series*

Description

Box-Cox transformation of charcoal series, the maximum likelihood estimation of lambda is derived from the boxcox.R function in the Venables and Ripley MASS library included in R 2.6.1

Usage

```
pfBoxCox(serie, alpha = 0.01, type = "BoxCox1964")
```

Arguments

`serie`	A vector of charcoal values.
`alpha`	Numeric, the "shift" parameter, default=0.01.
`type`	Character, the Box-Cox transformation formulation, can be either "BoxCox1964" (default) for the original Box & Cox (1964) formulation, or "JohnDraper" for the John & Draper (1980) modulus transformation.

Value

`X`	Vector of transformed charcoal values

Author(s)

P. Bartlein

References

Venables, W. N., Ripley, B. D., & Venables, W. N. (1994). Modern applied statistics with S-PLUS (Vol. 250). New York: Springer-verlag.

Box, G.E.P. & Cox, D. R.(1964) An analysis of transformations, Journal of the Royal Statistical Society, Series B, 26, 211-252.

John, J. A. & Draper N. R. (1980) Analternative family of transformations, Applied Statistics, 29, 190-197.

See Also

`pfTransform`

Examples

```
# Select a site
ID=pfSiteSel(site_name=="Pas-de-Fond")

# Extract data
A=pfExtract(ID)

B=pfBoxCox(A[,4],0.1)
plot(B,type="l")
```

`pfCircular` *Circular block bootstrap procedure applied to charcoal records compositing results*

Description

Block bootstrap has been proposed to test the significances of changes in stationary time series (Kunsch 1989). This procedure consists of splitting each charcoal series into n-b+1 overlapping blocks of data, where n is sample size and b the block size. These blocks are used to reconstruct resampled individual charcoal series that are in turn used to estimate the confidence intervals around the charcoal series composite mean.

Usage

```
pfCircular(comp, b = NULL, conf = c(0.05, 0.95), nboot = 1000,
  AgeLim = NULL)
```

Arguments

`comp`	A "pfComposite" object
`b`	A numeric giving block size, if NULL the optimal block size for a given series is given by: b= 2x(-1 /log(p)), where p is the lag one autocorrelation coefficient of that series (Adams, Mann & Ammann 2003).
`conf`	Numeric, calculated confidence intervals.
`nboot`	Numeric, number of bootstrap replicates.
`AgeLim`	Numeric, years defining a period to restrict the analysis to.

Value

`out`	A "pfCircular" object with estimated confidence intervals.

Author(s)

O. Blarquez

References

Kunsch, H. R. 1989. The jackknife and the bootstrap for general stationary observation s. The Annals of Statistics 17:1217-1241.

Adams, J. B., M. E. Mann, and C. M. Ammann. 2003. Proxy evidence for an El Nino-like response to volcanic forcing. Nature 426:274-278.

Examples

```
ID=pfSiteSel(lat>49, lat<75, long>6, long<50)
plot(ID,zoom="world")
TR1=pfTransform(ID, method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,2000))

## Circular block bootstrapp

COMP=pfComposite(TR1, binning=TRUE, bins=seq(0,2000,100))
circ=pfCircular(COMP,conf=c(0.005,0.025,0.975,0.995),nboot=100)
plot(circ)
```

---

pfComposite *Produce a composite serie from multiple charcoal records*

Description

Produce a composite serie from multiple charcoal records using bootstrap resampling, the sites charcoal values are binned and the mean in each bin is calculated prior the bootstrap procedure. This procedure is equivalent to Power et al. 2008.

Usage

```
pfComposite(TR, bins = NULL, nboot = 1000, binning = TRUE,
  conf = c(0.05, 0.95))
```

Arguments

TR	An object returned by pfTransform
bins	Numeric, the sequence for binning given in years (e.g. bins=seq(from=0, to=10000, by=200)). If unspecified the sequence is defined as bins=seq(from=min age, to=max age, by=median resolution).
nboot	Numeric, a number specifying the number of bootstrap replicates.
binning	Logical, set to TRUE (default) for binning, if transformed data are first interpolated this argument can be set to FALSE (no binning).
conf	Numeric, define confidence levels.

Value

Object of the class "pfComposite"

Author(s)

O.Blarquez

References

Power, M., J. Marlon, N. Ortiz, P. Bartlein, S. Harrison, F. Mayle, A. Ballouche, R. Bradshaw, C. Carcaillet, C. Cordova, S. Mooney, P. Moreno, I. Prentice, K. Thonicke, W. Tinner, C. Whitlock, Y. Zhang, Y. Zhao, A. Ali, R. Anderson, R. Beer, H. Behling, C. Briles, K. Brown, A. Brunelle, M. Bush, P. Camill, G. Chu, J. Clark, D. Colombaroli, S. Connor, A. L. Daniau, M. Daniels, J. Dodson, E. Doughty, M. Edwards, W. Finsinger, D. Foster, J. Frechette, M. J. Gaillard, D. Gavin, E. Gobet, S. Haberle, D. Hallett, P. Higuera, G. Hope, S. Horn, J. Inoue, P. Kaltenrieder, L. Kennedy, Z. Kong, C. Larsen, C. Long, J. Lynch, E. Lynch, M. McGlone, S. Meeks, S. Mensing, G. Meyer, T. Minckley, J. Mohr, D. Nelson, J. New, R. Newnham, R. Noti, W. Oswald, J. Pierce, P. Richard, C. Rowe, M. Sanchez Goni, B. Shuman, H. Takahara, J. Toney, C. Turney, D. Urrego-Sanchez, C. Umbanhowar, M. Vandergoes, B. Vanniere, E. Vescovi, M. Walsh, X. Wang, N. Williams, J. Wilmshurst, and J. Zhang. 2008. Changes in fire regimes since the Last Glacial Maximum: an assessment based on a global synthesis and analysis of charcoal data. Climate Dynamics 30:887-907.

Examples

```
## Composite charcoal record for North America:
ID=pfSiteSel(id_region=="WNA0" & l12==1)
plot(ID)
## Transform data
res3=pfTransform(ID,method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,4000))

## Composite
comp=pfComposite(res3,bins=seq(from=0,to=12000,by=200))
plot(comp)
```

---

pfCompositeLF *Produce a composite serie from multiple charcoal records using a local regression procedure (from the locfit package)*

Description

Produces a composite series from multiple charcoal records by using a robust locally weighted scatterplot smoother (LOWESS). The robust LOWESS uses the locfit function from the locfit package and is applied repeatedly (nboot times) on bootstrapped charcoal sites samples. The records charcoal values are pre-binned prior to sites resampling. This procedure is equivalent to Daniau et al. (2012).

Usage

```
pfCompositeLF(TR, hw = 250, tarAge = NULL, binhw = NULL, nboot = 1000,
  conf = c(0.05, 0.95), pseudodata = FALSE, verbose = TRUE)
```

Arguments

TR	An object returned by pfTransform
hw	Numeric, the half window width for the locfit procedure (in years).
tarAge	Numeric, the target ages for prebinning given in years (e.g. tarAge = seq(0, 10000, 20)). If unspecified the sequence is defined as tarAge=seq(from=min age, to=max Age, by=median resolution).
binhw	Numeric, bin half width for the prebinning procedure (use the same value as tarAge intervals for overlapping bins or tarAge intervals/2 for non-overlapping bins, default).
nboot	Numeric, a number specifying the number of bootstrap replicates.
conf	Numeric, define confidence levels.
pseudodata	Logical, if TRUE 10 percent of the data is reflected at the top and the bottom of the resampled serie prior of each locfit regression in order to correct for the edge effect introduced by the local regression, see Cowling & Hall (1996). Equivalent to "minimum slope" correction in Mann(2004).
verbose	Logical: verbose or not...

Value

out	A "pfCompositeLF" object.

Author(s)

O.Blarquez

References

Daniau, A. L., P. J. Bartlein, S. P. Harrison, I. C. Prentice, S. Brewer, P. Friedlingstein, T. I. Harrison-Prentice, J. Inoue, K. Izumi, J. R. Marlon, S. Mooney, M. J. Power, J. Stevenson, W. Tinner, Andri, M., J. Atanassova, H. Behling, M. Black, O. Blarquez, K. J. Brown, C. Carcaillet, E. A. Colhoun, D. Colombaroli, B. A. S. Davis, D. D'Costa, J. Dodson, L. Dupont, Z. Eshetu, D. G. Gavin, A. Genries, S. Haberle, D. J. Hallett, G. Hope, S. P. Horn, T. G. Kassa, F. Katamura, L. M. Kennedy, P. Kershaw, S. Krivonogov, C. Long, D. Magri, E. Marinova, G. M. McKenzie, P. I. Moreno, P. Moss, F. H. Neumann, E. Norstrom, C. Paitre, D. Rius, N. Roberts, G. S. Robinson, N. Sasaki, L. Scott, H. Takahara, V. Terwilliger, F. Thevenon, R. Turner, V. G. Valsecchi, B. Vanniere, M. Walsh, N. Williams, and Y. Zhang. 2012. Predictability of biomass burning in response to climate changes. Global Biogeochem. Cycles 26:GB4007.

Cowling A, Hall P (1996) On pseudodata methods for removing boundary effects in kernel density estimation. Journal of the Royal Statistical Society, Series B 58(3): 551-563.

Mann, M. E. (2004). On smoothing potentially non-stationary climate time series. Geophysical Research Letters, 31(7).

Examples

```
ID=pfSiteSel(id_region=="WNA0", l12==1, long>=-160 & long<=-140)
plot(ID, xlim=c(-180, -130), ylim=c(40,80))
TR=pfTransform(ID, method=c("MinMax","Box-Cox","MinMax","Z-Score"),
               BasePeriod=c(200,2000),QuantType="INFL")

COMP1=pfCompositeLF(TR, tarAge=seq(-50,4000,10), hw=200, nboot=100)

plot(COMP1)

## Note: comparing confidence intervals based on 100 replicates is not recommended
# (100 is used to decrease analysis time)
```

`pfDiagnostic` *Print diagnostic pdf for individual transformed series*

Description

Print diagnostic pdf for individual transformed series, successive transformations could be specified (see example)

Usage

```
pfDiagnostic(ID, add = NULL, Age = 0, Interpolate = FALSE,
  method = "Box-Cox", BasePeriod = c(-100, 1e+09), span = 0.3,
  RunWidth = 500, RunQParam = 0.5, stlYears = 500, alpha = 0.01,
  type = "BoxCox1964", FileName = "Diagnostic.pdf", QuantType = "ALL")
```

Arguments

`ID`	An object returned by `pfSiteSel` or `pfTransform`
`add`	An object returned by `pfAddData`
`Age`	Numeric, if Interpolate=TRUE, Age is used to specified the ages where the interpolation took place, If Age=0 the interpolated ages are automatically specified using the median resolution of the record(s) If Age is specified as a vector (e.g. Age=(from=0,to=10000, by=10)) the interpolation took place at specified ages
`Interpolate`	Logical, indicates wether data should be interpolated or not, default=FALSE
`method`	A character indicating the transformation method: "Z-Score", Z-Score, "LOESS", Locally weighted regression, "SmoothSpline", Smoothing spline, "Box-Cox", Box-Cox transformation, "MinMax", Minimax transformation, "RunMed", Running median, "RunMean", Running mean, "RunQuantile", Running quantile, "RunMin", Running min, "RunMax", Running max, "stl", Decompose a time series into seasonal, trend and irregular components using loess, based on `stl` function.

BasePeriod	Numeric, a parameter specifying the base period for calculating Z-score given in years BP (e.g. BasePeriod=c(0, 4000)), if empty or unspecified the base period corresponds to record length.
span	Numeric, the span parameter for the LOESS or Smoothing spline methods
RunWidth	Numeric, the width of the window for the"RunMed", "RunMean", "RunQuantile", "RunMin", and "RunMax" methods in years.
RunQParam	Numeric, the parameter specifying which quantile should be calculated for the method "RunQuantile" (default=0.5 i.e. median).
stlYears	Numeric, the bandwith for stl decomposition, default=500 years.
alpha	Numeric, alpha value to add before BoxCox calculation, see pfBoxCox.
type	Character, the type of Box-Cox transformation, see pfBoxCox for details
FileName	Character, define output pdf file name e.g. FileName="mydata.pdf"
QuantType	Character, by default QuantType="INFL" and influx are automatically calculated, otherwise use QuantType="NONE" (not recommended).

Value

Filename.pdf	A diagnostic file is printed, each sites being printed on separate pages (specified using FileName="myfile.pdf"")

Author(s)

O. Blarquez

Examples

```
# Select boreal sites from Levavasseur 2012 PNV in Western North America
ID=pfSiteSel(id_region=="WNA0", l12==1, long>=-160 & long<=-140)

# Print a diagnostic pdf for Box-Cox, Smoothed and Z-score tranformed data
# (base period = 200-2000 BP)
pfDiagnostic(ID,method=c("Box-Cox", "SmoothSpline","Z-Score"),
             span=0.3,BasePeriod=c(200,4000))
```

---

pfDotMap *Produce maps of paleofire data*

Description

Produce map graphics representing spatial variability in charcoal data from the Global Charcoal Database.

Usage

```
pfDotMap(TR, tarAge, hw, binhw = 0.5 * mean(diff(tarAge)),
  fig.base.name = NULL, base.map = "coasts", grd.res = 5,
  grd.ext = c(-180, 180, -90, 90), grd.lonlat = NULL,
  proj4 = "+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs", n.boot = 1000,
  cx.minsize = 0.3, cx.mult = 1)
```

Arguments

TR	An object returned by pfTransform
tarAge	Numeric, the target ages for prebinning given in years (e.g. tarAge = seq(0, 10000, 20)). If unspecified the sequence is defined as tarAge=seq(from=min age, to=max Age, by=median resolution).
hw	Numeric, the half window width for the locfit procedure (in years).
binhw	Numeric, bin half width for the prebinning procedure (use the same value as tarAge intervals for overlapping bins or tarAge intervals/2 for non-overlapping bins).
fig.base.name	Character sequence representing the base name for the figures. Can be preceded by a path as long as all directories in the path exist. One figure will be produced for each time bin, with years (and file suffix) appended to the base name automatically. A value of NULL (default) causes figures to be plotted to the current device in sequence.
base.map	Currently, either 'coasts' or 'countries' to choose which base map (from required library 'rworldmap') to be plotted as the base map for all plots. Could easily be modified to accept any SpatialPolygons object.
grd.res, grd.ext	Desired grid resolution and extent in degrees. If grd.res is a single number, the grid will be defined with equal lon/lat resolution; a two-element vector (lon,lat) can also be supplied for unequal resolution. grd.ext is specified as a vector of the form c(min-lon,max-lon,min-lat,max-lat).
grd.lonlat	A data frame of coordinates for every grid cell center, to be used in cases where an irregular grid is desired. Columns must be named 'lon' and 'lat'. If specified, grd.res and grd.ext are ignored. Note that this option could have undesirable results for unusual grid definitions. In particular, the maximum radius for including sites in a grid cell is always calculated at the equator. For a regular lon/lat grid, this guarantees all sites will be included in at least one cell, because equatorial cells are largest at the equator. If an irregular grid is specified such that this is not true, the maximum radius calculated could lead to sites excluded from all cells. In this case a warning is printed but the function proceeds anyway.
proj4	proj.4 string representing the desired projection for plotted maps. Default is unprojected. See http://www.spatialreference.org to look up the string for your favorite projections.
n.boot	Number of bootstrap replicates to use when creating confidence intervals around each grid-cell mean. In each time bin X grid cell combination, replicates consist of composite z-score values for that bin, randomly sampled (with replacement) from sites within the grid cell (see 'Details' for precise description of

sites included in each cell). I.e., no temporal bootstrapping is done here, so that bootstrap CI reflect only spatial variability.

`cx.minsize, cx.mult`
: Parameters that crudely adjust plotted dot size. cx.minsize defines the minimum cex applied to any point in any map, cx.mult scales all points by an equivalent factor.

Details

Takes any pfTransform object as input, and allows any set of one or more time bins to be specified for plotting (one plot per bin). Time bins are specified as for pfCompositeLF (which is called by pfSimpleGrid. The extent, resolution, and projection of the desired grid are also user-specified.

Results will be plotted on a regular lon/lat grid. To determine which sites contribute to each grid cell value, the code searches within a specified great circle distance (i.e. on the surface of the globe) around each grid cell center. To avoid missing any sites, the distance is set equal to the greatest distance from a grid cell center to its most distant corner, which occurs at the equator where grid cells are largest. This conservative approach will result in many sites falling within multiple grid boxes. At all latitudes, the defined radii will overlap near the edges of the grid boxes. At higher latitudes, the lon/lat grid cells are physically much smaller, so overlap will be considerably greater. There are alternatives, like using a grid that is irregular in terms of lon/laton, or changing the area of grid cells depending on latitude. But all have their tradeoffs, and this one is simple.

Current version produces plots of mean CHAR, number of sites per grid cell, and number of grid cells contributed to by each site (due to overlapping radii described above). The mean plot additionally shows points in two sizes, representing those mean values whose 95"%" confidence intervals do (small dots) or do not (large dots) contain zero. Finally, a time series is plotted in each figure with the current time bin highlighted.

Value

Plots are produced on the current device or in pdf files defined by `fig.base.name`. In addition, a named list of useful objects is returned:

`COMP`
: The binned composite generated for plotting.

`bins`
: The list of bin endpoints.

`sp.grd`
: A `SpatialPointsDataFrame-class` object containing all the grid-level statistics produced and plotted (mean influx value, bootstrap confidence interval, and number of sites per grid cell).

`sp.sites`
: A `SpatialPointsDataFrame-class` object representing the number of grid cells influenced by each site.

`plots`
: A list with one element for each bin. These elements are themselves named lists of trellis objects representing each of the plots produced ("mean", "sitesPerCell", "cellsPerSite", "timeSeries"). Note that these objects can be edited to some degree with the `update.trellis` function, and plotted or used in layouts as any other trellis graphics can.

Author(s)

R. Kelly

References

Power, M., J. Marlon, N. Ortiz, P. Bartlein, S. Harrison, F. Mayle, A. Ballouche, R. Bradshaw, C. Carcaillet, C. Cordova, S. Mooney, P. Moreno, I. Prentice, K. Thonicke, W. Tinner, C. Whitlock, Y. Zhang, Y. Zhao, A. Ali, R. Anderson, R. Beer, H. Behling, C. Briles, K. Brown, A. Brunelle, M. Bush, P. Camill, G. Chu, J. Clark, D. Colombaroli, S. Connor, A. L. Daniau, M. Daniels, J. Dodson, E. Doughty, M. Edwards, W. Finsinger, D. Foster, J. Frechette, M. J. Gaillard, D. Gavin, E. Gobet, S. Haberle, D. Hallett, P. Higuera, G. Hope, S. Horn, J. Inoue, P. Kaltenrieder, L. Kennedy, Z. Kong, C. Larsen, C. Long, J. Lynch, E. Lynch, M. McGlone, S. Meeks, S. Mensing, G. Meyer, T. Minckley, J. Mohr, D. Nelson, J. New, R. Newnham, R. Noti, W. Oswald, J. Pierce, P. Richard, C. Rowe, M. Sanchez Goni, B. Shuman, H. Takahara, J. Toney, C. Turney, D. Urrego-Sanchez, C. Umbanhowar, M. Vandergoes, B. Vanniere, E. Vescovi, M. Walsh, X. Wang, N. Williams, J. Wilmshurst, and J. Zhang. 2008. Changes in fire regimes since the Last Glacial Maximum: an assessment based on a global synthesis and analysis of charcoal data. Climate Dynamics 30:887-907.

Examples

```
## Not run:
## Composite charcoal record for North America:
ID=pfSiteSel(id_region==c("WNA0"), l12==1 & long<(-130))
plot(ID)

## Transform data
res3=pfTransform(ID,method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,4000))

## Plot maps for 1000-yr bins spanning 3-0 kBP
# dev.new(width=10,height=10) # A big plot area helps.
dotmap = pfDotMap( TR=res3, tarAge=seq(0,2000,1000), hw=500, grd.ext=c(-170,-80,40,80),
                   cx.minsize=2,cx.mult=3)
summary(dotmap)

# Plot the mean map from the first time bin
# newmap = update(dotmap$plots[[1]]$mean, main="A relabeled map")
# newmap

## End(Not run)
```

`pfExtract` *Extract charcoal data for a list of sites*

Description

Extract charcoal data from an object returned by `pfSiteSel`

Usage

```
pfExtract(ID)
```

Arguments

ID	An object returned by pfSiteSel.

Value

out	A matrix of charcoal data with the following structure: out[,1]=Site identifiers, out[,2]=Depths, out[,3]=Estimated ages, out[,4]=Charcoal data.

Author(s)

O. Blarquez

Examples

```
## Retrieve a site
ID=pfSiteSel(site_name=="Pas-de-Fond")
## Or a group of sites (Western North America)
ID=pfSiteSel(id_region==c("WNA0"))

## Extract data
A=pfExtract(ID)

# Plot the first site raw charcoal data
plot(A[A[,1]==ID$id_site[1],3],A[A[,1]==ID$id_site[1],4],type="l",main=ID$site_name[1],
     xlab="Age",ylab="raw Char")
```

---

pfGridding *Produce gridded maps of transformed charcoal values.*

Description

The function uses weighted spatio-temporal interpolation to produce gridded maps of transformed charcoal values. Spatial grids are used to interpolate transformed charcoal values for a key period defined by Age. For each grid cell the function search charcoal sites located in a radius defined by distance_buffer from the grid centre and at an elevation within a range defined by elevation_buffer from the mean elevation of the cell. Then the function search for charcoal samples within a temporal range from the key date defined by time_buffer. Finally a tricube distance weighting function is applied to each sample by considering it spatial distance to the grid centre and it temporal distance to the key date. This approach that weight samples according to their spatio-temporal location also down-weight charcoal sites that are poorly sampled.

Usage

```
pfGridding(data, cell_sizex = NULL, cell_sizey = NULL, age = 0,
  cell_size = NULL, time_buffer = NULL, distance_buffer = NULL,
  raster_extent = NULL, elevation_buffer = NULL, proj4 = NULL,
  sea_mask = TRUE, other_mask = NULL, verbose = TRUE)
```

Arguments

data	An object returned by pfTransform.
cell_sizex	Numeric, grid cell width (m).
cell_sizey	Numeric, grid cell height (m).
age	Numeric, key date (years BP).
cell_size	Numeric, grid cell size (bypass cell_sizex and cell_sizey and produce square cells).
time_buffer	Numeric, temporal distance (years) from the key date to search for charcoal samples.
distance_buffer	Numeric, spatial distance from the grid centres to search for charcoal samples (m).
raster_extent	Numeric, define custom extent for the analysis such as raster_extent = c(xmin, xmax, ymin, ymax)
elevation_buffer	Numeric, elevation range from the mean grid cell elevation to search for charcoal sites.
proj4	String, proj.4 string representing the desired projection for plotted maps. Default is Robinson ("+proj=robin +lon_0=0 +x_0=0 +y_0=0 +ellps=WGS84 +datum=WGS84 +units=m +no_defs"). See http://www.spatialreference.org to look up the string for your favorite projections.
sea_mask	Logical, mask cells falling in the sea.
other_mask	A sp object (SpatialPolygonsDataFrame) used to mask data i.e. for not interpollating pixels under the mask (classical usage: ice extent mask). Note that the SpatialPolygonsDataFrame projection must be used in the analysis and defined using proj4 argument, otherwise the mask should be reprojected (e.g. using rgdal::spTransform).
verbose	Logical, verbose or not...

Value

A "pfGridding" object (list) that could be plotted using plot.pfGridding.

Author(s)

O.Blarquez

See Also

plot.pfGridding, pfTransform, pfDotMap

Examples

```
ID=pfSiteSel(id_region=="ENA0", l12==1, long>-85)

TR=pfTransform(ID,method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,4000))

p=pfGridding(TR,age=1000)
summary(p)

## Not run:
require(raster)
plot(p$raster)

## Example of other_mask usage: we will use here Dyke 2003 ice extent map for North
 America
require(maptools)
ID=pfSiteSel(id_region=="ENA0", long>-100,lat>40)
TR=pfTransform(ID,method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,4000))

## Define projection (same as Dyke 2003)
proj4="+proj=lcc +lat_1=49 +lat_2=77 +lat_0=49
 +lon_0=-95 +x_0=0 +y_0=0 +ellps=clrk66 +datum=NAD27 +units=m +no_defs"

## Download the shapefile
where=getwd()
download.file("http://blarquez.com/public/data/ice_9500_calBP_lcc.shp",
               paste0(where,"/ice_9500_calBP_lcc.shp"))
download.file("http://blarquez.com/public/data/ice_9500_calBP_lcc.dbf",
               paste0(where,"/ice_9500_calBP_lcc.dbf"))
download.file("http://blarquez.com/public/data/ice_9500_calBP_lcc.shx",
               paste0(where,"/ice_9500_calBP_lcc.shx"))

ice_shp=readShapePoly(paste0(where,"/ice_9500_calBP_lcc.shp"),
                      proj4string=CRS(proj4))
plot(ice_shp)

p=pfGridding(TR,age=9500,cell_size=100000,distance_buffer=300000,
             proj4=proj4,other_mask=ice_shp)
plot(p,add=ice_shp)

# Citation: Dyke, A.S., Moore, A. And Robertson, L. 2003 :
# Deglaciation of North America, Geological Survey of Canada Open File 1574.

## End(Not run)
```

---

pfInteractive *GCD sites interactive selection*

Description

Interactive selection of GCD sites by drawing a polygon on a map.

Usage

```
pfInteractive(addata = NULL)
```

Arguments

addata	An optional XY matrix of coordinates to specify a polygon to be drawn on the map.

Value

An object of the class "pfSiteSel".

Author(s)

O. Blarquez

See Also

pfSiteSel

Examples

```
## Not run:
# Type:
ID=pfInteractive()
# And follow text instructions
## End(Not run)
```

---

pfKruskal *Analyse composite records by a Kruskal-Wallis ANOVA*

Description

The function applies a Kruskal-Wallis ANOVA on binned data issued from a "pfComposite" object (of directly on "pfTransform" objects), in order to test the difference in biomass burning activity between different time periods.

Usage

```
pfKruskal(data, p.adj = "none", alpha = 0.05, bins = NULL,
  verbose = TRUE)
```

Arguments

data	An object returned by pfComposite or pfTransform.
p.adj	Method for adjusting p values (see p.adjust). Includes: "holm", "hochberg", "hommel", "bonferroni", "BH", "BY", "fdr" and "none" (default).
alpha	Numeric, confidence level.
bins	Numeric, bins to use if a "pfTransform" object is provided.
verbose	Logical, verbose or not...

Value

A "pfKruskal" object containing multiple comparison results.

Author(s)

O. Blarquez

See Also

plot.pfKruskal,kruskal

Examples

```
## Composite charcoal record for Western Boreal North America:
ID=pfSiteSel(id_region=="WNA0" & l12==1)
plot(ID)
## Transform data
res3=pfTransform(ID,method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,4000))

## Composite
comp=pfComposite(res3,bins=seq(from=-500,to=12500,by=1000))
plot(comp)

## Kruskal Wallis Anova
comparison=pfKruskal(comp)
```

---

pfMinMax *MiniMax transformation of a charcoal serie*

Description

MiniMax transformation of a charcoal serie

Usage

```
pfMinMax(serie)
```

Arguments

serie	Numeric, a vector of charcoal values.

Value

out	A vector of minimax transformed values.

Author(s)

O. Blarquez

See Also

pfTransform

Examples

```
## Retrieve a site
ID=pfSiteSel(site_name=="Pas-de-Fond")
## Or a group of sites (Western North America)
ID=pfSiteSel(id_region==c("WNA0"))

## Extract data
A=pfExtract(ID)

## Plot the first site raw charcoal data
par(mfrow=c(1,2))
plot(A[A[,1]==ID$id_site[1],3],A[A[,1]==ID$id_site[1],4],type="l",main=ID$site_name[1],
     xlab="Age",ylab="raw Char")
## Minimax transformation
B=pfMinMax(A[A[,1]==ID$id_site[1],4])
## Plot the first site Minimax transformed charcoal data
plot(A[A[,1]==ID$id_site[1],3],B,type="l",main=ID$site_name[1],
     xlab="Age",ylab="Minimax")
```

---

pfPublication *Get citations for charcoal sites*

Description

Get citations for charcoal sites

Usage

```
pfPublication(x, output = "data.frame")
```

Arguments

x	A "pfSiteSel" object
output	Defines the output as a "list" or a "data.frame" (default).

Value

A list or data frame with citation informations related to charcoal sites.

Author(s)

O. Blarquez

Examples

```
x=pfSiteSel(id_site %in% c(1:4))
pfPublication(x,output="list")
```

---

pfResolution *Calculates age resolution indicators for charcoal records*

Description

Calculates age resolution indicators for charcoal records selected using pfSiteSel or pfInteractive functions.

Usage

```
pfResolution(ID, AgeLim = NULL)
```

Arguments

ID	An object of the class "pfSiteSel"
AgeLim	Numeric, defines age limits for age resolution calculations (e.g. AgeLim=c(-50,6000))

Value

data.frame	A data frame with the following informations: ID_SITE, SITE_NAME, Median Resolution of the record, Mean Resolution and Standard deviation

Author(s)

O. Blarquez

Examples

```
ID=pfSiteSel(lat>40, lat<90, long>-100, long<=-50)
Res=pfResolution(ID,AgeLim=c(-50,8000))
head(Res)
```

---

pfSimpleGrid *Produce simple gridded maps of paleofire data*

Description

Produce gridded map graphics representing spatial variability in charcoal data from the Global Charcoal Database.

Usage

```
pfSimpleGrid(TR, tarAge, hw, binhw = 0.5 * mean(diff(tarAge)), fun = mean,
  n.boot = 0, prob.CI = c(0.025, 0.975), test.val = 0,
  proj4 = "+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs", res = 5,
  ext = c(-180, 180, -90, 90), fig.file.name = NULL, show.plots = TRUE,
  title.text = "", cols = NULL, cuts = NULL, zlim = NULL,
  base.map = "coasts", base.map.col = grey(0.7), base.map.lwd = 0.5)
```

Arguments

TR	An object returned by pfTransform
tarAge	Numeric, the target ages for prebinning given in years (e.g. tarAge = seq(0, 10000, 20)). If unspecified the sequence is defined as tarAge=seq(from=min age, to=max Age, by=median resolution).
hw	Numeric, the half window width for the locfit procedure (in years).
binhw	Numeric, bin half width for the prebinning procedure (use the same value as tarAge intervals for overlapping bins or tarAge intervals/2 for non-overlapping bins).
fun	Function to be used for aggregating across sites.
n.boot	Number of bootstrap replicates to use when creating confidence intervals around each grid-cell value.
prob.CI	Vector of two quantiles to define the bootstrap CI for significance testing
test.val	Test value for bootstrap significance test.
proj4	proj.4 string representing the desired projection for plotted maps. Default is unprojected. See http://www.spatialreference.org to look up the string for your favorite projections.

res, ext	Desired grid resolution and extent. If grd.res is a single number, the grid will be defined with equal x/y resolution; a two-element vector (x,y) can also be supplied for unequal resolution. grd.ext is specified as a vector, matrix, or Extent object, as for the function raster::extent.
fig.file.name	Character sequence representing the file name for the output figures. Can be preceded by a path as long as all directories in the path exist. The file will be a PDF with one figure per time bin, each on a separate page.
show.plots	Logical indicating whether plots will be printed to the screen.
title.text	Character sequence for labeling figures. Time bin bounds will be added automatically.
cols,	cuts Vectors of color specifications and values defining the plot legend. Grid-cell values will be binned by cuts and assigned the colors in cols. If either are NULL, the function tries to guess at a good scheme. cuts may also be a single value specifying the number of bins.
cuts	Defines range and resolution of color scale
zlim	Two-element vector representing the bounds of the color scale. Ignored if cuts is fully specified, but otherwise used in defining the color bins.
base.map	Currently, either 'coasts' or 'countries' to choose which base map (from required library 'rworldmap') to be plotted as the base map for all plots. Could easily be modified to accept any SpatialPolygons object.
base.map.col,	Color specifications for plotting the basemap.
base.map.lwd	Line width specifications for plotting the basemap.

Details

Takes any pfTransform object as input, and allows any set of one or more time bins to be specified for plotting (one plot per bin). Time bins are specified as for pfCompositeLF (which is called by pfSimpleGrid. The extent, resolution, and projection of the desired grid are also user-specified.

Records are first composited, and then aggregated with other sites falling in the same grid cell according to the specified function 'fun' (defauts to mean). This is a considerably simpler approach than the distance-based spatial binning used by pfDotMap, although it has its own tradeoffs (e.g. grid cells are unlikely to represent equal area).

A flexible bootstrapped significance test is implemented. Within each time bin X grid cell combination, composite z-score values are randomly sampled (with replacement) from sites within the grid cell. The function is applied to the sampled values. Quantiles of all bootstrap function evaluations are computed, and significance is reported if a user-specified test value is outside of these bootstrap CI. Note that bootstrap CI calculated here reflect only spatial variability, as no temporal resampling is performed.

Value

Plots are produced on the current device and/or in pdf files according to input arguments. In addition, a named list of useful objects is returned:

COMP	The binned composite generated for plotting.
tarAge	The list of target ages used for temporal binning.

sg.rast	A Raster-class object containing the gridded output data
sg.plots	A list of trellis objects representing the composed plots. Note that these objects can be edited to some degree with the update.trellis function, and plotted or used in layouts as any other trellis graphics can.

Author(s)

R. Kelly

References

Power, M., J. Marlon, N. Ortiz, P. Bartlein, S. Harrison, F. Mayle, A. Ballouche, R. Bradshaw, C. Carcaillet, C. Cordova, S. Mooney, P. Moreno, I. Prentice, K. Thonicke, W. Tinner, C. Whitlock, Y. Zhang, Y. Zhao, A. Ali, R. Anderson, R. Beer, H. Behling, C. Briles, K. Brown, A. Brunelle, M. Bush, P. Camill, G. Chu, J. Clark, D. Colombaroli, S. Connor, A. L. Daniau, M. Daniels, J. Dodson, E. Doughty, M. Edwards, W. Finsinger, D. Foster, J. Frechette, M. J. Gaillard, D. Gavin, E. Gobet, S. Haberle, D. Hallett, P. Higuera, G. Hope, S. Horn, J. Inoue, P. Kaltenrieder, L. Kennedy, Z. Kong, C. Larsen, C. Long, J. Lynch, E. Lynch, M. McGlone, S. Meeks, S. Mensing, G. Meyer, T. Minckley, J. Mohr, D. Nelson, J. New, R. Newnham, R. Noti, W. Oswald, J. Pierce, P. Richard, C. Rowe, M. Sanchez Goni, B. Shuman, H. Takahara, J. Toney, C. Turney, D. Urrego-Sanchez, C. Umbanhowar, M. Vandergoes, B. Vanniere, E. Vescovi, M. Walsh, X. Wang, N. Williams, J. Wilmshurst, and J. Zhang. 2008. Changes in fire regimes since the Last Glacial Maximum: an assessment based on a global synthesis and analysis of charcoal data. Climate Dynamics 30:887-907.

See Also

pfGridding

Examples

```
## Not run:
ID=pfSiteSel(id_region==c("WNA0"), l12==1 & long<(-130))
plot(ID)

## Transform data
res3=pfTransform(ID,method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,4000))

## Plot maps for 1000-yr bins spanning 3-0 kBP
# dev.new(width=10,height=10) # A big plot area helps.
gridmap = pfSimpleGrid( TR=res3, tarAge=seq(0,2000,1000), hw=500, ext=c(-170,-80,40,80))
summary(gridmap)

# Plot the mean map from the first time bin
newmap = update(gridmap$sg.plots[[1]], main="A relabeled map")
newmap

## End(Not run)
```

pfSiteSel *GCD sites selection methods*

Description

Main function used for site selection, uses data strored in data(paleofiresites) to perform site selection according to multiple criterion, those criterions could be either geographic, based on series attributes (e.g. # of datings), or on sites attributes (e.g. biome).

Usage

```
pfSiteSel(...)
```

Arguments

...	Any combination of conditions defined by relational operators and or logical operators that are applied on the "paleofiresites" dataset. See examples below:

Details

Use data(paleofiresites);names(paleofiresites) to retrieve the conditions that could be used to select sites i.e.: id_site, site_name, lat, long, elev, pref_units, biome, id_region, id_country, id_site_type, water_depth, id_basin_size, id_catch_size, id_land_desc, dating_type, min_est_age, max_est_age, num_dating, age_model, data_source, qtype, rf99, l12, num_samp, date_int.

Value

An object of the class "pfSiteSel" (list) with "id_site" and "site_name" components.

Author(s)

O. Blarquez

See Also

paleofiresites

Examples

```
## Sites selection examples

## Select all sites
ID=pfSiteSel()

## Site in the Biome #8
ID=pfSiteSel(biome==8)
plot(ID,zoom="world")
```

```
## Site in the biome #8 or in the biome #6
ID=pfSiteSel(biome==8 | biome==6)

## Sites in North America by geographic location
ID=pfSiteSel(lat>25, lat<75, long<(-45), long>-150)
plot(ID,zoom="world")

## is equivalent to:
ID=pfSiteSel(lat>25 & lat<75 & long<(-45) & long>-150)
plot(ID,zoom="world")

## By region criterion
ID=pfSiteSel(id_region==c("ENA0","WNA0"))
plot(ID,zoom="world")

## WRONG, use the %in% operator when concatenating two characters
# ID=pfSiteSel(id_region %in% c("ENA0","WNA0"))
# plot(ID,zoom="world")

## Pas-de-Fond site
pfSiteSel(site_name=="Pas-de-Fond")

## All sites in  eastern North America that are not Pas-de-Fond
pfSiteSel(site_name!="Pas-de-Fond", id_region=="ENA0")

## Sites with on average one dating point every 250 to 300 yrs
pfSiteSel(date_int>=250 & date_int<=300)

## Sites between 0, 100 m elevation in Asia
ID=pfSiteSel(elev>0 & elev<100, id_region=="ASIA")

## All sites that are not marine nor fluvial
ID=pfSiteSel(id_land_desc!="MARI" , id_site_type!="FLUV" & id_site_type!="LFLU")
plot(ID)
```

---

pfToKml *Export selected site to Google Earth kml format*

Description

Export sites selected using pfSiteSel function to Google Earth kml format.

Usage

```
pfToKml(x, file = "NULL")
```

Arguments

x	An object of the class "pfSiteSel"
file	File location and name with kml extension e.g. file="/Users/Olivier/Desktop/truc.kml"

Value

No value returned.

Author(s)

O. Blarquez

Examples

```
## Not run:
x=pfSiteSel(id_site==222)
pfToKml(x,file="site222.kml")

## End(Not run)
```

---

pfTransform *Transform charcoal data for unique to multiple series*

Description

Charcoal data transformation, background estimation and homogenization for unique to multiple series, accepts objects returned by pfSiteSel.

Usage

```
pfTransform(ID = NULL, add = NULL, Interpolate = FALSE, Age = NULL,
  method = "Z-Score", BasePeriod = c(-100, 1e+09), span = 0.3,
  RunWidth = 500, RunQParam = 0.5, stlYears = 500, type = "BoxCox1964",
  alpha = 0.01, QuantType = "INFL", MethodType = NULL, verbose = TRUE)
```

Arguments

ID	An object returned by pfSiteSel or pfTransform
add	An object returned by pfAddData
Interpolate	Logical, idicates wether data should be interpolated or not, default=FALSE
Age	Numeric, If Interpolate=TRUE, Age is used to specified the ages where the interpolation took place, If Age=NULL (default) the interpolated ages are automatically specified using the median resolution of the record(s). If Age is specified as a vector (e.g. Age=(from=0,to=10000, by=10)) the interpolation took place at specified ages.

method	A character indicating the transformation method: "Z-Score", Z-Score, "LOESS", Locally weighted regression, "SmoothSpline", Smoothing spline, "Box-Cox", Box-Cox transformation, "MinMax", Minimax transformation, "RunMed", Running median, "RunMean", Running mean, "RunQuantile", Running quantile, "RunMin", Running min, "RunMax", Running max, "stl", Decompose a time series into seasonal, trend and irregular components using loess, based on stl function.
BasePeriod	Numeric, a parameter specifying the base period for calculating Z-score given in years BP (e.g. BasePeriod=c(0, 4000)), if empty or unspecified the base period corresponds to record length.
span	Numeric, the span parameter for the LOESS or Smoothing spline methods
RunWidth	Numeric, the width of the window for the"RunMed", "RunMean", "RunQuantile", "RunMin", and "RunMax" methods in years.
RunQParam	Numeric, the parameter specifying which quantile should be calculated for the method "RunQuantile" (default=0.5 i.e. median).
stlYears	Numeric, the bandwidth for stl decomposition, default=500 years.
type	Character, the type of Box-Cox transformation, see pfBoxCox for details.
alpha	Numeric, alpha value to add before BoxCox calculation, see pfBoxCox.
QuantType	Character, by default QuantType="INFL" and influx are automatically calculated, otherwise use QuantType="NONE" (not recommended).
MethodType	Character, by default (MethodType=NULL) imply that when for a specific site two charcoal unit exist the function pick the one define by pref_unit. By passing different arguments to MethodType user can modify the analysis to pick non preferred units by referring to more general methods for instance MethodType = "POLS" will choose charcoal records from pollen slides, or MethodType = "SIEV" sieved macro charcoal series. Type (paleofiredata); levels(paleofiredata$METHOD) for available methods.
verbose	Logical, verbose or not...

Value

An object of the class "pfTransform".

Author(s)

O. Blarquez

Examples

```
## Select the site Pas-de-Fond
ID=pfSiteSel(site_name=="Pas-de-Fond")

# Transform data sequentially using pfTransform function
tr=pfTransform(ID,method=c("MinMax","Box-Cox"))

## Plot transformed data for the first site
```

```
plot(tr$Age[,1],tr$TransData[,1],type="l")
```

`plot.CHAR` *Plot CHAR*

Description

Plot an object of the class "CHAR" returned by the pretreatment function. Original accumulation rates are presented using grey bars, accumulation rates interpolated at equal time steps are presented by a black curve.

Usage

```
## S3 method for class 'CHAR'
plot(x, ...)
```

Arguments

`x`	An object of the class "CHAR".
`...`	...

Author(s)

O. Blarquez

Examples

```
## In this example we will use the charcoal record of the Lac du Loup (Blarquez et al. 2010)
## Load raw charcoal data in mm^2
A=read.csv("http://blarquez.com/public/code/loupchar.csv")
C_=A[,6] # charcoal areas
P_=A[,1:5] # CmTop, CmBot, AgeTop, AgeBot, Volume


## Calculates charcoal accumulation rate (CHAR, mm2.cm-2.yr-1)
CHAR=pretreatment(params=P_,serie=C_,Int=TRUE)
plot(CHAR)
```

`plot.contiguous` *Plot "contiguous" object*

Description

Plot an object returned by contiguous, plot contiguous cores (or sites) in green (T) and non-contiguous cores in red (F).

Usage

```
## S3 method for class 'contiguous'
plot(x, ylim = NULL, xlim = NULL, ...)
```

Arguments

`x`	An object returned by contiguous
`ylim`	Numeric, ylim for the graph
`xlim`	Numeric, xlim for the graph
`...`	...

Value

A plot.

Author(s)

O. Blarquez

See Also

`contiguous`

Examples

```
x=pfSiteSel(lat>12,lat<60,long<(-50),long>-140)
cont=contiguous(x)
plot(cont)
```

plot.kdffreq *plot.kdffreq*

Description

Plot fire frequency calculated using the kdffreq function

Usage

```
## S3 method for class 'kdffreq'
plot(x, ylim = NULL, xlim = NULL, main = NULL,
  xlab = "Age", ylab = "FF (#.yr-1)", ...)
```

Arguments

x	Object returned by kdffreq
ylim	Numeric, y axis limits
xlim	Numeric x axis limits
main	char, title of plot
xlab	char, x axis legend
ylab	char, y axis legend
...	other arguments

See Also

kdffreq @examples

set.seed(123) fevent=c(round(abs(rnorm(20,mean=7,sd=5))*1000),round(abs(rnorm(10,mean=8,sd=1))*1000))

ff=kdffreq(fevent,bandwidth = 1000, nbboot=10) plot(ff)

plot.pfCircular *plot.pfCircular*

Description

Plot circular block bootstrap percentiles.

Usage

```
## S3 method for class 'pfCircular'
plot(x, ylim = NULL, xlim = NULL, ylab = NULL,
  xlab = NULL, main = NULL, text = FALSE, ...)
```

Arguments

x	A "pfCircular" object.
ylim	Numeric, x axis limits.
xlim	Numeric, y axis limits.
ylab	Character, y axis label.
xlab	Character, x axis label.
main	Character, title of the plot.
text	Logical, text options.
...	...

Author(s)

O. Blarquez

Examples

```
ID=pfSiteSel(lat>49,lat<75,long>6,long<50)
TR1=pfTransform(ID, method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,2000))

## Circular block bootstrapp
COMP=pfComposite(TR1, binning=TRUE, bins=seq(0,2000,100))
circ=pfCircular(COMP,conf=c(0.005,0.025,0.975,0.995),nboot=100)
plot(circ)
```

---

plot.pfComposite *plot.pfComposite*

Description

Plot a pfComposite object

Usage

```
## S3 method for class 'pfComposite'
plot(x, type = "ci", conf = c(0.05, 0.95),
  palette = "jet", add = "NONE", text = FALSE, main = NULL, ...)
```

Arguments

x	A "pfComposite" object.
type	Character, type of plot among "ci", "prctile", "density"
conf	Numeric, confidence levels.
palette	Character, color palette used with type=c("prctile", "density") among "jet" and "BW".
add	Character, add="NONE" by default, add="sitenum" could be specified to plot the sites number in eah bin along with the composite curve.
text	Logical, text options.
main	Character, title of the plot.
...	...

Author(s)

O. Blarquez

Examples

```
## Composite charcoal record for North America:
ID=pfSiteSel(id_region=="WNA0",l12=1)
## Transform data
res3=pfTransform(ID,method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,4000))

## Composite
comp=pfComposite(res3,bins=seq(0,5000,200))
plot(comp,type="density",smoothing=TRUE,spar=0.3)
```

---

plot.pfCompositeLF *plot.pfCompositeLF*

Description

Plot pfCompositeLF object

Usage

```
## S3 method for class 'pfCompositeLF'
plot(x, type = "ci", add = "NULL", conf = c(0.05,
  0.95), palette = "jet", xlim = NULL, ylim = NULL, main = "Composite",
  text = FALSE, what = "locfit", ...)
```

Arguments

x	A "pfCompositeLF" object.
type	Character, type of plot among "ci", "prctile", "density"
add	Character, add=NULL by default, add="sitenum" could be specified to plot the sites number in eah bin along with the composite curve.
conf	Numeric, confidence levels.
palette	Character, color palette used with type=c("prctile", "density") among "jet" and "BW".
xlim	Numeric, x axis limits.
ylim	Numeric, y axis limits.
main	Character, title of the plot.
text	Logical, text options.
what	Character, indicates which transformed charcoal trend is used for the plot (type="ci"), default "locfit" indicates that the trend is the locfit applied to All binned data, use "mean" or "median" to plot the mean or median of the locfit relplicates given by the bootstrap procedure.
...	...

Author(s)

O. Blarquez

Examples

```
ID=pfSiteSel(id_region=="WNA0",l12==1,long>=-160,long<=-140)

TR=pfTransform(ID, method=c("MinMax","Box-Cox","MinMax","Z-Score"),
               BasePeriod=c(200,2000),QuantType="INFL")

COMP1=pfCompositeLF(TR, tarAge=seq(-50,4000,10), hw=200, nboot=100)

plot(COMP1, type="density")

## Note: comparing confidence intervals based on 100 replicates is not recommended
# (100 is used to decrease analysis time)
```

plot.pfGridding *Plot a "pfGridding" object.*

Description

Plot maps presenting gridded and transformed charcoal values obtained from the pfGridding function.

Usage

```
## S3 method for class 'pfGridding'
plot(x, continuous = TRUE, col_class = NULL,
  col_lim = NULL, xlim = NULL, ylim = NULL, empty_space = 10,
  cpal = "YlGn", anomalies = TRUE, file = NULL, points = FALSE,
  add = NULL, add_color = "white", plot_countries = FALSE, ...)
```

Arguments

x	An object returned by pfGridding.
continuous	Logical, plot continuous (TRUE) or discrete (FALSE) colors on the map.
col_class	Numeric, if continuous is false define here color classes (single values: col_class=5, or sequences col_class=seq(-15,15,5) are accepted.)
col_lim	Numeric, limits for plotting grid cells values, grid cells with values beyond col_lim are not plotted.
xlim	Numeric, map limits.
ylim	Numeric, map limits.
empty_space	Percentage, define empty space around the map.
cpal	String, color palette to use see brewer.pal
anomalies	Logical, adapt output for plotting anomalies or not (color classes, etc..)
file	Path/Filename.tiff, the function can output a GeoTiff file if desired.
points	Logical, plot charcoal sites on the map?
add	An object of the class "SpatialPolygonsDataFrame" (sp) to be ploted on the map.
add_color	Color of the added SpatialPolygonsDataFrame.
plot_countries	Logical, default FALSE (if TRUE plot countries borderlines and coastlines)
...	...

Value

A ggplot2 "gg" object that could be further manipulated.

Author(s)

O. Blarquez

See Also

pfGridding

Examples

```
## Not run:
ID=pfSiteSel(id_region=="ENA0", l12==1, long>-85)

TR=pfTransform(ID,method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,4000))

p=pfGridding(TR,age=1000)

plot(p,empty_space=100)

# require(ggplot2)
# pp=plot(p,empty_space=100)
# pp+ggtitle("my title..")

## End(Not run)
```

---

plot.pfKruskal *Plot a "pfKruskal" object.*

Description

Plot a "pfKruskal" object using boxplots and showing significant differences between the periods using letters.

Usage

```
## S3 method for class 'pfKruskal'
plot(x, trend = FALSE, outliers = FALSE, xlim = NULL,
  ylim = NULL, ...)
```

Arguments

x	An object returned by pfKruskal.
trend	Logical, show trend using linear regression?
outliers	Logical, show outliers?
xlim	Numeric, x axis limits.
ylim	Numeric, y axis limits.
...	...

Details

If two periods share the same letter their rank (median) is not significantly different at the confidence level specified by alpha. If not, equality could be rejected at the confidence level specified by alpha.

Value

Return a ggplot2 "gg" object.

Author(s)

O. Blarquez

See Also

pfKruskal

Examples

```
## Composite charcoal record for Western Boreal North America:
ID=pfSiteSel(id_region=="WNA0" & l12==1)
plot(ID)
## Transform data
res3=pfTransform(ID,method=c("MinMax","Box-Cox","Z-Score"),BasePeriod=c(200,4000))

## Composite
comp=pfComposite(res3,bins=seq(from=-500,to=12500,by=1000))
plot(comp)

## Kruskal Wallis Anova
comparison=pfKruskal(comp)

plot(comparison)

# p=plot(comparison)
# require(ggplot2)
# p+ggtitle("my title")
```

---

plot.pfSiteSel *plot.pfSiteSel*

Description

Plot an object of the class "pfSiteSel"

Usage

```
## S3 method for class 'pfSiteSel'
plot(x, add = NULL, type = "Map", zoom = "Sites",
  pch = "|", xlim = NULL, ylim = NULL, cex = 1,
  plot_countries = FALSE, ...)
```

Arguments

x	An object of the class "pfSiteSel".
add	An object returned by pfAddData (optional).
type	Character, type of plot among "Map" or "Chronology".
zoom	Character, zooming factor for type="Map": "Sites" or "World"
pch	Pointer type see plot.
xlim	Numeric, x axis limits.
ylim	Numeric, y axis limits.
cex	Numeric, size of points.
plot_countries	Logical, default FALSE (if TRUE plot countries borderlines and coastlines)
...	...

Author(s)

O. Blarquez

Examples

```
ID=pfSiteSel(id_region=="ENA0", long>-100)
plot(ID,zoom="world")
```

---

plot.potveg *plot.potveg*

Description

Plot "potveg" object i.e. produce a map by overlaying charcoal sites on potential vegetation maps. Uses ggplot2 syntax.

Usage

```
## S3 method for class 'potveg'
plot(x, size = 4, palette = NULL, alpha = 0.5,
  text = FALSE, points = TRUE, ...)
```

Arguments

x	A "potveg object."
size	Size of the dots on the map.
palette	A custom color palette can be specified.
alpha	Transparency of charcoal sites dots
text	Logical: plot sites as numbers referring to potential vegetation index (text=TRUE) or as points (text=FALSE, default).
points	Logical: plot sites (TRUE, default)
...	...

Value

A ggplot2 ("gg") object that can be further modified (see example)

Author(s)

O. Blarquez

See Also

potveg

Examples

```
# #not run
# require(paleofire)
# ID=pfSiteSel(c(1:10))
# obj=potveg(ID,classif="l12")
# plot(obj)
#
# #Return a ggplot object
# require(ggplot2)
# p=plot(obj,text=TRUE,alpha=1)
# p+ggtitle("My title")
```

---

potveg *potveg*

Description

Retrieve potential vegetation types based on charcoal sites location

Usage

```
potveg(ID, classif = "rf99", buffer = NULL)
```

Arguments

ID	An object of the class "pfSiteSel"
classif	Potential vegetation to be used: "rf99" in reference to Ramankutty and Foley (1999) or "l12" in reference to Levavasseur et al. 2012.
buffer	Distance in m that defines a radius around each site to calculate the dominant vegetation type by kernel density estimation.

Value

An object of the class "potveg" i.e. a list contaning two data frames: "site_data" for charcoal sites and associated potential vegetation type, "map" data frame used for mapping data. See plot.potveg for details.

Author(s)

O. Blarquez

References

Ramankutty, N., and J.A. Foley (1999). Estimating historical changes in global land cover: croplands from 1700 to 1992, Global Biogeochemical Cycles 13(4), 997-1027.

Levavasseur, G., M. Vrac, D. M. Roche, and D. Paillard. 2012. Statistical modelling of a new global potential vegetation distribution. Environmental Research Letters 7:044019.

See Also

plot.potveg

Examples

```
 ## Not run:
require(paleofire)
ID=pfSiteSel(c(1:10))
obj=potveg(ID,classif="l12")
head(obj$site_data)

## End(Not run)
```

pretreatment *Calculate particules accumulation rates for sediment records*

Description

This is the R version of the CharAnalysis CharPretreatment.m function originally develloped by P. Higuera and available at https://sites.google.com/site/charanalysis

Usage

```
pretreatment(params, serie, Int = TRUE, first = NULL, last = NULL,
  yrInterp = NULL)
```

Arguments

params	A matrix with the following colums: CmTop, CmBot, AgeTop, AgeBot, Volume, in the same order.
serie	A proxy record to be transformed in accumulation rates, could be particule counts, surfaces, volumes, etc.
Int	Logical specifying whether the function interpolates particle zero counts, default TRUE
first, last	Date of the first, last sample for accumulation rate calculation, if NULL first, last are automatically specified as the the minimum and maximum ages of the record respectively
yrInterp	Temporal resolution of the interpolated accumulation rates, if NULL, yrInterp is automatically specified as the median resolution of the record

Value

Return an output structure with the following:

cmI	interpolated depths
ybpI	interpolated ages
accI	accumulation rates

Author(s)

O. Blarquez translated from P. Higuera CharPretreatment.m function

Examples

```
## Not run:
# In this example we will use the charcoal record of the Lac du Loup from Blarquez et al. (2010).
# Blarquez, O., C. Carcaillet, B. Mourier, L. Bremond, and O. Radakovitch. 2010. Trees in the
# subalpine belt since 11 700 cal. BP: origin, expansion and alteration of the modern forest.
# The Holocene 20:139-146.
```

```
# Load raw charcoal data in mm^2
A=read.csv("http://blarquez.com/public/code/loupchar.csv")
C_=A[,6] # charcoal areas
P_=A[,1:5] # CmTop, CmBot, AgeTop, AgeBot, Volume

# Calculates charcoal accumulation rate (CHAR, mm2.cm-2.yr-1)
CHAR=pretreatment(params=P_,serie=C_,Int=TRUE)
plot(CHAR)

## End(Not run)
```

`rbind.pfAddData` *rbind.pfAddData*

Description

rbind two or more pfAddData objects, this enable to add charcoal series stored using multiple types, see type argument of `pfAddData` for details.

Usage

```
## S3 method for class 'pfAddData'
rbind(...)
```

Arguments

...	two or more objects returned by pfAddData

Value

An object of the class "pfAddData" (list)

Author(s)

O. Blarquez

See Also

`pfAddData`

Examples

```
## Not run:
files=c("http://blarquez.com/public/data//Ben.csv",
       "http://blarquez.com/public/data/Small.csv")
metadata=c("http://blarquez.com/public/data/metadata.csv")

mydata1=pfAddData(files=files,type="CharAnalysis")
mydata2=pfAddData(files=files,metadata=metadata,type="CharAnalysis")
mydata=rbind(mydata1,mydata2)

TR1=pfTransform(add=mydata, method=c("MinMax","Box-Cox","Z-Score"),
               BasePeriod=c(200,2000))
COMP2=pfCompositeLF(TR1, tarAge=seq(-50,8000,20), hw=500, nboot=100)
plot(COMP2)

## End(Not run)
```

---

summary.pfSiteSel *summary.pfSiteSel*

Description

Return a summary table for an object of the class "pfSiteSel"

Usage

```
## S3 method for class 'pfSiteSel'
summary(object, ...)
```

Arguments

object	An object of the class "pfSiteSel".
...	...

Value

Data.frame, returns the following informations: "id_site", "lat", "long" "elev", "min_est_age", "max_est_age", "num_dating", "date_int", "num_samp", "l12", "rf99".

Author(s)

O. Blarquez

Examples

```
ID=pfSiteSel(id_site==2)
summary(ID)
```

`triCube` *Tukey's Tricube weight function*

Description

From the EGRET package http://usgs-r.github.io/EGRET/ Robert Hirsch and Laura De Cicco

Usage

```
triCube(d, h)
```

Arguments

d	numeric vector of distances from the point of estimation to the given sample value
h	numeric value, the half-window width, measured in the same units as d

Details

Computes the tricube weight function on a vector of distance values (d), based on a half-window width of h, and returns a vector of weights that range from zero to 1.

Value

w numeric vector of weights, all 0<=w<=1

Examples

```
h<-10
 d<-c(-11,-10,-5,-1,-0.01,0,5,9.9,10,20)
 triCube(d,h)
```

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