Package 'rintcal'

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Type Package

Title Radiocarbon Calibration Curves

Version 1.4.0

Maintainer Maarten Blaauw <maarten.blaauw@qub.ac.uk>

Description The IntCal20 radiocarbon calibration curves (Reimer et al. 2020 <doi:10.1017/RDC.2020.68>) are provided as a data package, together with previous IntCal curves (IntCal13, IntCal09, IntCal04, IntCal98), other curves (e.g., NOTCal04 [van der Plicht et al. 2004], Arnold & Libby 1951, Stuiver & Suess 1966, Pearson & Stuiver 1986) and postbomb curves. Also provided are functions to copy the curves into memory, and to read, query and plot the data underlying the IntCal20 curves.

License GPL (>= 2)

RoxygenNote 7.3.3

Suggests knitr, rmarkdown, utf8

VignetteBuilder knitr

Encoding UTF-8

NeedsCompilation no

Imports data.table, jsonlite

Language en-GB

Depends R (>= 3.5.0)

LazyData true

Author Maarten Blaauw [aut, cre] (ORCID:
<https://orcid.org/0000-0002-5680-1515>),
Christopher Bronk Ramsey [ctb] (ORCID:
<https://orcid.org/0000-0002-8641-9309>)

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Contents

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ccurve	*Copy a calibration curve*

Description

Copy one of the calibration curves into memory.

Usage

```
ccurve(
  cc = 1,
  postbomb = FALSE,
  cc.dir = NULL,
  resample = 0,
  glue = FALSE,
  as.F = FALSE,
  as.pMC = FALSE,
  as.Delta = FALSE,
  decimals = 8
)
```

Arguments

cc   Calibration curve for 14C dates: cc=1 for IntCal20 (northern hemisphere ter-
              restrial), cc=2 for Marine20 (marine), cc=3 for SHCal20 (southern hemisphere
              terrestrial). Alternatively, one can also write, e.g., "IntCal20", "Marine13". His-
              torical curves (Arnold & Libby 1951, Stuiver and Suess 1966, Pearson and Stu-
              iver 1986) are also provided. One can also make a custom-built calibration
              curve, e.g. using mix.ccurves(), and load this using cc=4. In this case, it is
              recommended to place the custom calibration curve in its own directory, using
              cc.dir (see below).

postbomb	Use postbomb=TRUE to get a postbomb calibration curve (default postbomb=FALSE). For monthly data, type e.g. ccurve("sh1-2_monthly")
cc.dir	Directory of the calibration curves. Defaults to where the package's files are stored (system.file), but can be set to, e.g., cc.dir="ccurves".
resample	The IntCal curves come at a range of 'bin sizes'; every year from 0 to 5 kcal BP, then every 5 yr until 15 kcal BP, then every 10 yr until 25 kcal BP, and every 20 year thereafter. The curves can be resampled to constant bin sizes, e.g. resample=5. Defaults to FALSE.
glue	If a postbomb curve is requested, it can be 'glued' to the pre-bomb curve. This feature is currently disabled - please use glue.ccurves instead
as.F	Return the F values, calculated from the C14 ages (columns 2 and 3). Defaults to as.F=FALSE.
as.pMC	Return the pMC values, calculated from the C14 ages (columns 2 and 3). Defaults to as.pMC=FALSE.
as.Delta	If loading a curve that contains 2 additional columns containing the D14C values, then these can be returned instead of the curve's C14 ages and errors. Defaults to as.Delta=FALSE.
decimals	Number of decimals to report when as.F=TRUE. Defaults to 8.

Details

Copy the radiocarbon calibration curve defined by cc into memory.

Value

The calibration curve (invisible).

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Examples

```
intcal20 <- ccurve(1)
marine20 <- ccurve(2)
shcal20 <- ccurve(3)
marine98 <- ccurve("Marine98")
pb.sh3 <- ccurve("sh3")
```

---

copyCalibrationCurve   *Copy a calibration curve*

Description

Copy one of the calibration curves into memory. Renamed to ccurve, and copyCalibrationCurve will become obsolete

Usage

```
copyCalibrationCurve(cc = 1, postbomb = FALSE)
```

Arguments

cc   Calibration curve for 14C dates: cc=1 for IntCal20 (northern hemisphere terrestrial), cc=2 for Marine20 (marine), cc=3 for SHCal20 (southern hemisphere terrestrial). Alternatively, one can also write, e.g., "IntCal20", "Marine13".

postbomb   Use postbomb=TRUE to get a postbomb calibration curve (default postbomb=FALSE).

Details

Copy the radiocarbon calibration curve defined by cc into memory.

Value

The calibration curve (invisible).

---

glue.ccurves   *Glue calibration curves*

Description

Produce a custom curve by merging two calibration curves, e.g. a prebomb and a postbomb one for dates which straddle both curves.

Usage

```
glue.ccurves(
  prebomb = "IntCal20",
  postbomb = "NH1",
  thisprebombcurve = c(),
  thispostbombcurve = c(),
  as.F = FALSE,
  as.pMC = FALSE,
  as.Delta = FALSE,
  cc.dir = c(),
  decimals = 8
)
```

Arguments

prebomb	The prebomb curve. Defaults to "IntCal20"
postbomb	The postbomb curve. Defaults to "NH1" (Hua et al. 2013)
thisprebombcurve	
	As an alternative to using existing curves, a tailor-made curve can be provided for the prebomb curve (as three columns: cal BP, C14 age, error)
thispostbombcurve	
	As an alternative to using existing curves, a tailor-made curve can be provided for the postbomb curve (as three columns: cal BP, C14 age, error)
as.F	The glued curve can be returned as F14C values instead of the default C14. Make sure that if as.F=TRUE and you are using thisprebombcurve and/or thispostbombcurve, that these curves are in F14C space already.
as.pMC	The curves can be returned as pMC values instead of the default C14. Make sure that if as.pMC=TRUE and you are using thiscurve1 and/or thiscurve2, that these curves are in pMC space already.
as.Delta	The curves can be returned as D14C values instead of the default C14. Make sure that if as.Delta=TRUE and you are using thiscurve1 and/or thiscurve2, that these curves are in Delta14C space already.
cc.dir	Directory of the calibration curves. Defaults to where the package's files are stored (system.file), but can be set to, e.g., cc.dir="ccurves".
decimals	Number of decimals to report when as.F=TRUE. Defaults to 5.

Value

The custom-made curve (invisibly)

Examples

```
my.cc <- glue.ccurves()
```

---

intcal *IntCal20 json file*

Description

The IntCal20 calibration curves and their underpinning data. This is based on a json file produced by Prof. Christopher Bronk Ramsey, University of Oxford.

Usage

```
intcal
```

Format

'intcal' A list with six main entries:

json_application IntChron project name

records a list with 139 entries for each IntCal dataset

project_series_list a list with 5 entries: IntCal20, Marine20, SHCal20, a list of the underlying datasets, and a GICC vs IntCal20 comparison

parameters an empty list

bibliography a list with 141 bibliography entries

options a list of 17 options (not used)

Source

<https://intchron.org/archive/IntCal/IntCal20/index.json>

---

intcal.data *plot the IntCal20 data*

Description

plot the C14 ages underpinning the IntCal20/Marine20/SHCal20 calibration curves

Usage

```
intcal.data(
  cal1,
  cal2,
  cc1 = "IntCal20",
  cc2 = NA,
  calcurve.data = "IntCal20",
  select.sets = c(),
```

```
        timescale = "C14",
        BCAD = FALSE,
        cal.lab = NA,
        cal.rev = FALSE,
        c14.lab = NA,
        c14.lim = NA,
        c14.rev = FALSE,
        ka = FALSE,
        cc1.col = rgb(0, 0, 1, 0.5),
        cc1.fill = rgb(0, 0, 1, 0.2),
        cc2.col = rgb(0, 0.5, 0, 0.5),
        cc2.fill = rgb(0, 0.5, 0, 0.2),
        data.cols = c(),
        data.pch = c(1, 2, 5, 6, 15:19),
        pch.cex = 0.5,
        legend.loc = "topleft",
        legend.ncol = 2,
        legend.cex = 0.7,
        cc.legend = "bottomright",
        bty = "l",
        ...
    )
```

Arguments

cal1	First calendar year for the plot
cal2	Last calendar year for the plot
cc1	Name of the calibration curve. Can be "IntCal20", "Marine20", "SHCal20", or for the previous curves "IntCal13", "Marine13" or "SHCal13".
cc2	Optional second calibration curve to plot. Can be "IntCal20", "Marine20", "SHCal20", or for the previous curves "IntCal13", "Marine13" or "SHCal13". Defaults to nothing, NA.
calcurve.data	Which dataset to use. Defaults to calcurve.data="IntCal20", but can also be calcurve.data="SHCal20". Note that Marine20 is based on IntCal20 and a marine carbon cycle model.
select.sets	Which datasets to plot. Defaults to all datasets within the selected period.
timescale	Which 'timescale' of radiocarbon to use. Defaults to timescale="C14" but can also be set to timescale="F14C", timescale="pMC" or timescale="D14C". Can be shorted to, respectively, "C", "F", "P" or "D" (or their lower-case equivalents).
BCAD	The calendar scale of graphs and age output-files is in cal BP (calendar or calibrated years before the present, where the present is AD 1950) by default, but can be changed to BC/AD using BCAD=TRUE.
cal.lab	The labels for the calendar axis (default age.lab="cal BP" or "BC/AD" if BCAD=TRUE), or to age.lab="kcal BP" etc. if ka=TRUE.
cal.rev	Reverse the calendar axis.

c14.lab	Label for the C-14 axis. Defaults to 14C BP (or 14C kBP if ka=TRUE).
c14.lim	Axis limits for the C-14 axis. Calculated automatically by default.
c14.rev	Reverse the C-14 axis.
ka	Use kcal BP (and C14 kBP).
cc1.col	Colour of the calibration curve (outline).
cc1.fill	Colour of the calibration curve (fill).
cc2.col	Colour of the calibration curve (outline), if activated (default cc2=NA).
cc2.fill	Colour of the calibration curve (fill), if activated (default cc2=NA).
data.cols	colours of the data points. Defaults to R's colours 1 to 8 (black, red, green, darkblue, lightblue, purple, orange, and grey)
data.pch	Symbols of the data points. Defaults to R's symbols 1, 2, 5, 6, and 15 to 19 (open circle, open upward triangle, open diamond, open downward triangle, closed square, closed circle, closed upward triangle, closed diamond)
pch.cex	Size of the data symbols. Defaults to 0.5.
legend.loc	Location of the data legend. Defaults to topleft. Set to NA for no plotting.
legend.ncol	Number of columns of the data legend.
legend.cex	Size of the legend. Defaults to 0.7.
cc.legend	Location of the legend for the calibration curve(s).
bty	Box type around the plot. Defaults to "l"-shaped.
...	Any additional optional plotting parameters.

Details

These datasets were downloaded from Intcal.org. All data have both uncertainties in C14 age and on the calendar scale. For trees this is the sample thickness (e.g., 10 years or 1 year). The name of each dataset starts with a lower-case letter which indicates their nature (t = tree-rings, l = lake sediment, c = coral, m = marine sediment, s = speleothem), followed by either the radiocarbon laboratory's placename or the lastname of the main author. Most of the tree-ring datasets are dated at calendar year precision; tSeattle (references 1-2), tBelfast (3-5), tWaikato (4-7), tGroningen (8-10), tHeidelberg (11-14), tPretoria (16), tIrvine (17-20), tGalimberti (21), tMannheim (22-25), tAix (26-27), tAarhus (22, 28-30), tManningKromer (31-32), tVienna (33-34), tTokyo (35-39), tArizona (40), tMiyake (41), tPearson (22, 41-45), and tZurich (22-23, 25, 41, 43, 46-49). Horizontal error bars for these series indicate the numbers of rings in the samples (e.g., 10 tree-rings; 1-yr samples do not have error bars). Additionally, there are some floating tree-ring datasets with imprecisely known calendar ages; tAdolphy (50) and tTurney (51-52). For these and the following datasets, horizontal error bars indicate their 1 sd calendar age uncertainties. Beside trees, other datasets include lake sediment (lSuigestu, 53-54), corals (cBard 55-56, cFairbanks 57, cCutler 58 and cDurand 61, marine sediment (mCariaco 59-60, 62-63, mBard 64-65) and speleothems (sSouthon 66-67, sHoffman 68, sBeck 69). The southern hemisphere calibration curve SHCal20 is mostly modelled on IntCal20, but it contains datasets from the southern hemisphere; tPretoria (70), tWaikato (72-75), tBelfast (76-67), tSydney (78-80), tLivermore (81), tArizona, tIrvineWaikato and tZurich (82-83).

Value

A plot of the IntCal curve and the underlying data, as well as (invisibly) the data themselves

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Examples

```
intcal.data(100, 200)
intcal.data(40e3, 55e3, ka=TRUE)
# plot Suigetsu and Cariaco data only
```

```
dat <- intcal.data(20e3, 25e3)
unique(dat$set) # ordered against their appearance in the plot's legend
dat <- intcal.data(20e3, 25e3, select.sets=c(109, 120), data.cols=c(1,2))
```

---

intcal.data.frames   *Extract from the intcal file*

Description

Extract items from the intcal json file.

Usage

```
intcal.data.frames(obj, ...)
```

Arguments

obj   Name of the object

...   Additional options can be provided, see examples

Examples

```
intcal <- intcal.read.data()
# all datasets from the Southern Hemisphere:
sh.data <- intcal.data.frames(intcal, intcal_set_type='SH')
head(sh.data)
Irish.oaks <- intcal.data.frames(intcal, intcal_set=3)
head(Irish.oaks[[2]]$data)
```

---

intcal.extract.record   *Extract an IntCal20 record*

Description

Extract one of the 140 records contributing to the IntCal20 calibration curves

Usage

```
intcal.extract.record(i)
```

Arguments

i   The IntCal record, in the order as they appear in the IntCal20 json file (140
                        entries). Must be a single integer between 1 and 140.

Value

The most relevant information for each record (where available, the record and site names, intcal series and division number, country, longitude, latitude, taxon, dois of publications, notes, calendar information (e.g., dendrochronology) and radiocarbon data)

Examples

```
record_1 <- intcal.extract.record(1)
```

---

intcal.plot.record   *Plot an IntCal20 record*

Description

Plot the calendar and radiocarbon data of an IntCal20 record

Usage

```
intcal.plot.record(
  i,
  col = rgb(0, 0, 1, 0.5),
  pch = 19,
  pch.cex = 0.3,
  lwd = 1,
  lty = 1,
  cal.lim = c(),
  C14.lim = c(),
  add = FALSE,
  cal.lab = c(),
  C14.lab = c(),
  ka = FALSE,
  as.F = FALSE,
  as.pMC = FALSE,
  as.Delta = FALSE,
  draw.z = TRUE,
  draw.calsigma = TRUE,
  grid = FALSE,
  grid.lty = 2,
  grid.col = rgb(0, 0, 0, 0.5),
  draw.cc = 1,
  cc.col = rgb(0, 0.5, 0, 0.5),
  legend.loc = "topleft",
  legend.cex = 0.5,
  mgp = c(2.5, 0.8, 0)
)
```

Arguments

i	The IntCal record, in the order as they appear in the IntCal20 json file (140 entries). Must be a single integer between 1 and 140.
col	Colour of the symbols. Defaults to semi-transparent blue, col=rgb(0,0,1,.5).
pch	Symbol of the dates. Defaults to a filled circle, pch=20.
pch.cex	Size of the symbol. Defaults to 0.3.
lwd	Line width of the error bars. Defaults to 1.
lty	Line type of the error bars. Defaults to continuous, 1.
cal.lim	Limits of the horizontal/calendar scale. Calculated automatically by default.
C14.lim	Limits of the C-14 scale. Calculated automatically by default
add	Make a new plot (default, add=FALSE). The alternative is to add to an existing plot.
cal.lab	Label of the calendar axis. Defaults to 'cal BP' or 'kcal BP'.
C14.lab	Label of the C-14 axis. Defaults to '14C BP' or '14C kBP'
ka	Whether or not to use ka (thousands of years). Defaults to FALSE (i.e., cal BP).
as.F	Return the F values, calculated from the C14 ages (columns 2 and 3). Defaults to as.F=FALSE.
as.pMC	Return the pMC values, calculated from the C14 ages (columns 2 and 3). Defaults to as.pMC=FALSE.
as.Delta	Return the Delta14C values, calculated from the C14 ages (columns 2 and 3). Defaults to as.Delta=FALSE.
draw.z	Whether or not to plot the spread in calendar years of blocks of (mostly) tree rings. This is for tree-ring datasets where individual dates were taken on blocks of rings covering e.g. 10 or 20 years.
draw.calsigma	Whether or not to plot the calendar age uncertainties where available.
grid	Whether or not to add a grid to the plot.
grid.lty	Line type of the grid.
grid.col	Colour of the grid.
draw.cc	Whether or not to also plot the calibration curve. Defaults to plotting the IntCal20 calibration curve, but can also be set to 2 (Marine20), 3 (SHCal20), or NA (none).
cc.col	Colour of the calibration curve. Defaults to semi-transparent darkgreen, cc.col=rgb(0,.5,0,.5).
legend.loc	Location of the legend. Defaults to top right. Set to NA if you don't want to plot the legend.
legend.cex	Relative size of the font of the legend. Defaults to 0.5.
mgp	White space around the plot. Defaults to giving a bit more than usual white space around the axis labels.

Value

A plot of the calendar and radiocarbon ages, indicating uncertainties (error bars) and age blocks where relevant (e.g., for trees where blocks of >1 rings were dated).

See Also

intcal.extract.record

Examples

```
 record_1 <- intcal.plot.record(1)
 record_10 <- intcal.plot.record(10, add=TRUE, col=rgb(1,0,0,.5), legend.loc="bottomright")
```

---

intcal.read.data   *Read data underlying the IntCal curves.*

Description

Download the json file that contains the IntCal20 radiocarbon calibration curves and the contributing data series.

Usage

```
intcal.read.data(from.intchron.org = FALSE, from.jsonfile = FALSE)
```

Arguments

from.intchron.org

> Download the IntCal20 json file the inchron.org server. Defaults to FALSE, and then the data will be loaded from within the rintcal package

from.jsonfile   The name and location of the json file (if used). Defaults to FALSE, and then the data will be loaded from within the rintcal package

Details

The intcal curves consist of the IntCal20, SHCal20 and Marine20 calibration curves. The details of these curves can be loaded, as well as the underlying data such as tree-ring records.

Examples

```
 intcal <- intcal.read.data()
```

---

intcal.write.data   *Write intcal data to a file.*

Description

Write the intcal.json file that comes with the rintcal package to somewhere local. This can be useful if you want to avoid repeatedly downloading the json file from intchron.org.

Usage

```
intcal.write.data(data, fname)
```

Arguments

data   intcal variable as obtained from intcal.read.data()

fname   Name of the file to be written

Examples

```
 intcal <- intcal.read.data()
myintcal <- tempfile()
 intcal.write.data(intcal, myintcal)
```

---

list.ccurves   *List the calibration curves*

Description

List the file names of the calibration curves available within the rintcal package.

Usage

```
list.ccurves()
```

Value

A list of the available calibration curves

---

mix.ccurves   *Build a custom-made, mixed calibration curve.*

Description

If two curves need to be 'mixed' to calibrate, e.g. for dates of mixed terrestrial and marine carbon sources, then this function can be used. The curve will be returned invisibly, or saved in a temporary directory together with the main calibration curves. This temporary directory then has to be specified in further commands, e.g. for rbacon: Bacon(, cc.dir=tmpdr) (see examples). It is advisable to make your own curves folder and have cc.dir point to that folder.

Usage

```
mix.ccurves(
  proportion = 0.5,
  cc1 = "IntCal20",
  cc2 = "Marine20",
  postbomb1 = FALSE,
  postbomb2 = FALSE,
  as.F = FALSE,
  as.pMC = FALSE,
  name = "mixed.14C",
  cc.dir = c(),
  thiscurve1 = c(),
  thiscurve2 = c(),
  save = FALSE,
  offset = cbind(0, 0),
  round = c(),
  sep = " ",
  decimals = 8
)
```

Arguments

proportion	Proportion of the first calibration curve required. e.g., change to proportion=0.7 if cc1 should contribute 70% (and cc2 30%) to the mixed curve.
cc1	The first calibration curve to be mixed. Defaults to the northern hemisphere terrestrial curve IntCal20.
cc2	The second calibration curve to be mixed. Defaults to the marine curve IntCal20.
postbomb1	Option to provide a postbomb curve for the first curve (defaults to FALSE).
postbomb2	Option to provide a postbomb curve for the second curve (defaults to FALSE).
as.F	The curves can be returned as F14C values instead of the default C14. Make sure that if as.F=TRUE and you are using thiscurve1 and/or thiscurve2, that these curves are in F14C space already.

as.pMC   The curves can be returned as pMC values instead of the default C14. Make
                  sure that if as.pMC=TRUE and you are using thiscurve1 and/or thiscurve2, that
                  these curves are in pMC space already.

name   Name of the new calibration curve.

cc.dir   Name of the directory where to save the file. Since R does not allow automatic
                  saving of files, this points to a temporary directory by default. Adapt to your
                  own folder, e.g., cc.dir="~/ccurves" or in your current working directory,
                  cc.dir=".".

thiscurve1   As an alternative to using curves that come with the package, a tailor-made curve
                  can be provided for the first curve (as three columns: cal BP, C14 age, error).

thiscurve2   As an alternative to using curves that come with the package, a tailor-made curve
                  can be provided for the second curve (as three columns: cal BP, C14 age, error).

save   Save the curve in the folder specified by dir. Defaults to FALSE.

offset   Any offset and error to be applied to cc2 (default 0 +- 0). Entered as two
                  columns (possibly of just one row), e.g. offset=cbind(100,0)

round   The entries can be rounded to a specified amount of decimals. Defaults to no
                  rounding.

sep   Separator between fields (tab by default, "\t")

decimals   Number of decimals to report when as.F=TRUE. Defaults to 8.

Details

The proportional contribution of each of both calibration curves has to be set.

Value

A file containing the custom-made calibration curve, based on calibration curves cc1 and cc2.

Examples

```
tmpdir <- tempdir()
new.ccdir(tmpdir)
mix.ccurves(cc.dir=tmpdir)
# now assume the offset is constant but its uncertainty increases over time:
cc <- ccurve()
offset <- cbind(rep(100, nrow(cc)),  seq(0, 1e3, length=nrow(cc)))
# clean up:
unlink(tmpdir)
```

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new.ccdir   *Make directory and fill with calibration curves*

Description

Make an alternative 'curves' directory and fill it with the calibration curves.

Usage

```
new.ccdir(cc.dir)
```

Arguments

cc.dir   Name and location of the new directory. For example, this could be a folder
                called 'ccurves', living within the current working directory, `cc.dir="./ccurves"`.

Details

Copies all calibration curves within the 'rintcal' package to the new directory.

Value

A message informing the user the name of the folder into which the calibration curves have been
copied.

Examples

```
new.ccdir(tempdir())
```

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