Package ‘seasonalclumped’

January 14, 2021

Title Toolbox for Clumped Isotope Seasonality Reconstructions
Version 0.3.2
Description Compiles a set of functions and dummy data that simplify reconstructions of seasonal temperature variability in the geological past from stable isotope and clumped isotope records in sub-annually resolved carbonate archives (e.g. mollusk shells, corals and speleothems). For more information, see de Winter et al., 2020 (Climate of the Past Discussions, <doi:10.5194/cp-2020-118>).
Imports ggplot2, gridExtra, TTR, magrittr
License GPL-3
URL https://github.com/nielsjdewinter/seasonalclumped
BugReports https://github.com/nielsjdewinter/seasonalclumped/issues
Encoding UTF-8
LazyData true
RoxygenNote 7.1.1
Depends R (>= 3.5.0)
Suggests knitr, rmarkdown
NeedsCompilation no
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Repository CRAN
Date/Publication 2021-01-14 10:20:02 UTC

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binning_seasonality

Function for monthly binning based clumped isotope seasonality reconstruction.

Description

Combines records of stable oxygen isotope ratios ($\delta^{18}O$) and clumped isotope ratios ($\Delta_{47}$) through subannually resolved carbonate archives (e.g., mollusk shells or corals) to reconstruct monthly variability in temperature and salinity (through the $\delta^{18}O$ composition of the precipitation fluid), using the monthly binning method detailed in de Winter et al., 2020 (Climate of the Past).
Usage

```r
binning_seasonality(
  d18Oc,
  D47,
  ages,
  SD_d18Oc = 0.1,
  SD_D47 = 0.04,
  N = 1000,
  binsize = "month",
  d18O_fun = "KimONeil97",
  D47_fun = "Bernasconi18",
  export = FALSE
)
```

Arguments

- **d18Oc** Vector containing subannually resolved $\delta^{18}O_c$ data
- **D47** Vector containing subannually resolved $\Delta_{47}$ data
- **ages** Vector containing ages for of all samples in years relative to the shell chronology
- **SD_d18Oc** Error on the $\delta^{18}O_c$ measurements. Either a single value (constant uncertainty) or a vector of length equal to the period in SST data (365 days by default) containing information about the error of each datapoint (1 standard deviation; default = 0.1 permille).
- **SD_D47** Error on the $\Delta_{47}$ measurements. Either a single value (constant uncertainty) or a vector of length equal to the period in SST data (365 days by default) containing information about the error of each datapoint (1 standard deviation; default = 0.04 permille).
- **N** Number of datapoints for Monte Carlo simulation (defaults to 1000)
- **binsize** Size of the bins in which records are subdivided. month and season (period of three months) is currently supported.
- **d18O_fun** String containing the name of the transfer function used to convert temperature and $\delta^{18}O_w$ to $\delta^{18}O_c$ data (for example: "KimONeil97" or "GrossmanKu86"). Defaults to Kim and O’Neil (1997).
- **D47_fun** String containing the name of the transfer function used to convert temperature to $\Delta_{47}$ data (for example: "Bernasconi18" or "Jautzy20"). Defaults to Bernasconi et al., 2018).
- **export** Export table summary of result (CSV format)? TRUE/FALSE

Value

A data frame containing monthly reconstructions of $\Delta_{47}$, temperature, $\delta^{18}O$ of the precipitation fluid and $\delta^{18}O_c$. 

References


de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high–resolution paleoclimate records, *Climate of the Past Discussions* **2020**, *1*, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)

Examples

```r
# find attached dummy data
Case1 <- seasonalclumped::Case1
d18Oc <- Case1[, 29]
d18Oc <- d18Oc[!is.na(d18Oc)]
D47 <- Case1[, 30]
D47 <- D47[!is.na(D47)]
ages <- Case1[, 27]
ages <- ages[!is.na(ages)]

# Run function
binned <- binning_seasonality(d18Oc, D47, ages)
```
carbmodel

Function that produces $\delta^{18}O$ and $\Delta_{47}$ records

Description
Takes vectors of time, temperature, growth rate and $\delta^{18}O$ of the fluid and converts them into a $\delta^{18}O$ and $\Delta_{47}$ record. The $\delta^{18}O$ and $\Delta_{47}$ values are calculated for every depth value provided in the D vector. By default, the empirical transfer function by Kim and O’Neil (1997) is used to produce the $\delta^{18}O$ record, but other transfer functions (e.g. Grossman and Ku, 1986) are also supported. The default transfer function for converting temperature data to $\Delta_{47}$ data is based on Bernasconi et al. (2018), but other transfer functions (e.g. Jautzy et al., 2020) are also supported.

Usage
carbmodel(
  time,
  SST,
  GR,
  d18Ow,
  D,
  d18O_fun = "KimONeil97",
  D47_fun = "Bernasconi18",
  AV = FALSE,
  plot = FALSE
)

Arguments

- **time**: Time vector (values in years)
- **SST**: A vector containing temperature data (values in degrees C; length must be equal to that of time)
- **GR**: Growth rate vector (values in same time unit as time (years); length must be equal to that of time)
- **d18Ow**: A vector containing data on the $\delta^{18}O$ value of the precipitation fluid (values in permille VSMOW; length must be equal to that of time)
- **D**: Depth vector (values in same depth unit as GR)
- **d18O_fun**: String containing the name of the transfer function used to convert temperature and $\delta^{18}O_w$ to $\delta^{18}O_c$ data (for example: “KimONeil97” or “GrossmanKu86”). Defaults to Kim and O’Neil (1997).
D47_fun  String containing the name of the transfer function used to convert temperature to $\Delta_{47}$ data (for example: "Bernasconi18" or "Jautzy20"). Defaults to Bernasconi et al., 2018).

AV  Should the subsampling take into account the mean value within the sample interval? TRUE/FALSE If FALSE, the interpolated value corresponding to the exact position is used instead of the mean of the interval

plot  Should the result be plotted? TRUE/FALSE

Value

A matrix containing subsampled time, depth, $\delta^{18}O_c$ and $\Delta_{47}$ values: "Tnew"): New time vector after subsampling "D"): New depth vector after subsampling "d18Oc"): Vector listing $\delta^{18}O_c$ values for each sample "D47"): Vector listing $\Delta_{47}$ values for each sample

References

package dependencies: ggplot2, gridExtra function dependencies: subsample, subsample_mean
## Examples

```r
# Create test data (= ideal case)
# Set boundary conditions
Td <- seq(1, 12 * 365, 1) # Create timeline of 12 years in days
Ty <- Td / 365 # Convert to years
MAT <- 20 # Set mean annual temperature
Amp <- 10 # Set seasonal amplitude
Sext <- 2 * Amp # Calculate extent of seasonal variability
TSD <- 1.5 # Set the degree of random non-seasonal noise on the SST curve

# Set SST
SST <- rnorm(length(Ty), MAT + Amp * sin(2 * pi * Ty), TSD) # Create virtual daily SST data

# Set GR
GR <- rep(10 / 365, length(Ty)) # Set growth rate to 10 mm/yr and create daily GR vector

# Set d18Osw
DSD <- 0.6 # Set the degree of random non-seasonal noise on the d18Osw curve

d18Osw <- rnorm(length(Ty), rep(0, length(Ty)), DSD) # Set d18Osw to 0 permille VSMOW, create daily d18Osw vector

# Create vector for all samples along entire shell length by applying constant sampling resolution
D <- seq(SR, sum(GR), SR)

# Calculate virtual data
newdata <- carbmodel(Ty, SST, GR, d18Osw, D, AV = TRUE)
```

### Description

A dataset containing ages ($T_{new}$), depth values ($D$), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 1 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

### Usage

`Case1`

### Format

A data frame with 1200 rows and 30 variables:

- **SR_0.1**: Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew**: Age, in years relative to the start of the record
- **D**: Depth, in mm along the virtual record
- **d18Oc**: Stable oxygen isotope value, in permille VPDB
- **D47**: Clumped isotope value, in permille
<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR_0.2</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_0.45</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_0.75</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_1.55</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_3.25</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
</tbody>
</table>
| D47    | Clumped isotope value, in permille ...

Details

Case 1 describes an ideal temperature sinusoid without distortion by either changes in growth rate or changes in $\delta^{18}O_w$.

Generated using the code in "Generate_Case1.r" in dataraw

Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* **2020**, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)
Virtual dataset Case 10

Description
A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values (δ¹⁸O) and clumped isotope values ∆⁴⁷ of a simulated carbonate record based on environmental parameters following Case 10 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage
Case10

Format
A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d¹⁸O** Stable oxygen isotope value, in permille VPDB
- **D⁴⁷** Clumped isotope value, in permille

- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d¹⁸O** Stable oxygen isotope value, in permille VPDB
- **D⁴⁷** Clumped isotope value, in permille

- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d¹⁸O** Stable oxygen isotope value, in permille VPDB
- **D⁴⁷** Clumped isotope value, in permille

- **SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d¹⁸O** Stable oxygen isotope value, in permille VPDB
- **D⁴⁷** Clumped isotope value, in permille

- **SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
### Case 11

**Description**

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values (δ¹⁸O) and clumped isotope values (Δ₄₇) of a simulated carbonate record based on environmental parameters following Case 11 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

**Usage**

Case11
Format

A data frame with 1200 rows and 30 variables:

- **SR_0.1**: Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew**: Age, in years relative to the start of the record
- **D**: Depth, in mm along the virtual record
- **d18Oc**: Stable oxygen isotope value, in permille VPDB
- **D47**: Clumped isotope value, in permille

- **SR_0.2**: Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew**: Age, in years relative to the start of the record
- **D**: Depth, in mm along the virtual record
- **d18Oc**: Stable oxygen isotope value, in permille VPDB
- **D47**: Clumped isotope value, in permille

- **SR_0.45**: Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **Tnew**: Age, in years relative to the start of the record
- **D**: Depth, in mm along the virtual record
- **d18Oc**: Stable oxygen isotope value, in permille VPDB
- **D47**: Clumped isotope value, in permille

- **SR_0.75**: Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **Tnew**: Age, in years relative to the start of the record
- **D**: Depth, in mm along the virtual record
- **d18Oc**: Stable oxygen isotope value, in permille VPDB
- **D47**: Clumped isotope value, in permille

- **SR_1.55**: Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
- **Tnew**: Age, in years relative to the start of the record
- **D**: Depth, in mm along the virtual record
- **d18Oc**: Stable oxygen isotope value, in permille VPDB
- **D47**: Clumped isotope value, in permille

- **SR_3.25**: Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm
- **Tnew**: Age, in years relative to the start of the record
- **D**: Depth, in mm along the virtual record
- **d18Oc**: Stable oxygen isotope value, in permille VPDB
- **D47**: Clumped isotope value, in permille
Details

Case 11 describes an ideal temperature sinusoid without distortion by changes in growth rate, but a positive peak in $\delta^{18}O_w$ during the warm season.

Generated using the code in "Generate_Case11.r" in dataraw

Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high–resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

Case12

Virtual dataset Case 12

Description

A dataset containing ages ($T_{new}$), depth values ($D$), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 12 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case12

Format

A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm

- **Tnew** Age, in years relative to the start of the record
Case 12 describes a temperature sinusoid without distortion by changes in growth rate or $\delta^{18}O_w$, but with a multi-annual trend in temperature superimposed on the seasonality.

Generated using the code in "Generate_Case12.r" in dataraw

Details

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4
Virtual dataset Case 13

Description

A dataset containing ages (T\textsubscript{new}), depth values (D), stable oxygen isotope values (\(\delta^{18}O\)) and clumped isotope values \(\Delta_{47}\) of a simulated carbonate record based on environmental parameters following Case 13 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case13

Format

A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **T\textsubscript{new}** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d\textsubscript{18}Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **T\textsubscript{new}** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d\textsubscript{18}Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **T\textsubscript{new}** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d\textsubscript{18}Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **T\textsubscript{new}** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d\textsubscript{18}Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
**Case14**

**Virtual dataset Case 14**

**Description**

A dataset containing ages ($T_{new}$), depth values ($D$), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 14 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

**Usage**

Case14
Format

A data frame with 1200 rows and 30 variables:

**SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_3.25** Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille ...
Details

Virtual case simulating open marine conditions: Seasonal change in growth rate in phase with temperature with linear growth decrease and dynamic growth threshold. Multi–annual cyclicity in $\delta^{18}O_w$ (NAO–style).

Generated using the code in "Generate_Case14.r" in dataraw

Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high–resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4
Example of natural NAO oscillation:


Case15  Virtual dataset Case 15

Description

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 15 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case15

Format

A data frame with 1200 rows and 30 variables:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR_ 0.1</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_ 0.2</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>stable oxygen isotope value, in permille VPDB</td>
</tr>
</tbody>
</table>
**Details**

Case simulating a coastal ecosystem: Seasonal change in growth rate with fast growth in spring and linear growth decrease. Pulse of light $\delta^{18}O_w$ in spring and multi-annual cyclicity in SST.

Generated using the code in "Generate_Case15.r" in `dataraw`

**Source**

See code to generate data in `dataraw`

Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* **2020**, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)
**Case16**

**Virtual dataset Case 16**

**Description**

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 16 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

**Usage**

Case16

**Format**

A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille
- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille
- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille
- **SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille
- **SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
Details

Case simulating a lagoonal ecosystem – Seasonal change in growth rate with slower growth in summer and linear growth decrease. Pulse of increased $\delta^{18}O_w$ in summer (evaporation).

Generated using the code in "Generate_Case16.r" in dataraw

Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

Description

A dataset containing ages ($T_{new}$), depth values ($D$), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 17 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case17
**Format**

A data frame with 1200 rows and 30 variables:

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR_0.1</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_0.2</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_0.45</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_0.75</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_1.55</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_3.25</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille ...</td>
</tr>
</tbody>
</table>
Details
Case simulating a tropical ecosystem – Slight seasonal change in growth rate with slower growth in summer and linear growth decrease. Confined temperature seasonality, relatively strong multi-annual trend. Strong $\delta^{18}O_{w}$ seasonality, light in summer, multi-annual trend in antiphase with multi-annual SST (ENSO-style).
Generated using the code in "Generate_Case17.r" in dataraw

Source
See code to generate data in dataraw Details on how these example cases are defined is provided in:
de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

Case 18 Virtual dataset Case 18

Description
A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 18 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage
Case 18

Format
A data frame with 1200 rows and 30 variables:

| SR_0.1  | Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm |
| Tnew    | Age, in years relative to the start of the record |
| D       | Depth, in mm along the virtual record |
| d18Oc   | stable oxygen isotope value, in permille VPDB |
| D47     | clumped isotope value, in permille |

| SR_0.2  | Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm |
| Tnew    | Age, in years relative to the start of the record |
| D       | Depth, in mm along the virtual record |
| d18Oc   | stable oxygen isotope value, in permille VPDB |
**Case 18**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_0.45</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_0.75</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_1.55</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_3.25</td>
<td>Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm</td>
</tr>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
</tbody>
</table>

**Details**

Case simulating a high-latitude shallow marine ecosystem: Spring freshening and growth only during summer half of season

Generated using the code in "Generate_Case18.r" in dataraw

**Source**

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* **2020**, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)
Virtual dataset Case 19

**Description**

A dataset containing ages (\(T_{\text{new}}\)), depth values (\(D\)), stable oxygen isotope values (\(\delta^{18}O\)) and clumped isotope values \(\Delta_{47}\) of a simulated carbonate record based on environmental parameters following Case 19 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

**Usage**

Case19

**Format**

A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
Case2

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_3.25** Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille...

**Details**

Case 19 describes an ideal temperature sinusoid without distortion by either changes in growth rate or changes in $\delta^{18}O_w$, but with a smaller temperature amplitude.

Generated using the code in "Generate_Case19.r" in da.tar.aw

**Source**

See code to generate data in da.tar.aw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* 2020, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)

**Case2**

*Virtual dataset Case 2*

**Description**

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 2 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

**Usage**

Case2
Format

A data frame with 1200 rows and 30 variables:

**SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_3.25** Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille ...
Details

Case 2 describes an ideal temperature sinusoid without distortion by changes in $\delta^{18}O_w$, but with a growth stop in the cold season.

Generated using the code in "Generate_Case2.r" in dataraw.

Source

See code to generate data in dataraw. Details on how these example cases are defined is provided in:

dewinter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

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Case20 Virtual dataset Case 20

Description

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 20 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case20

Format

A data frame with 1200 rows and 30 variables:

**SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm

**Tnew** Age, in years relative to the start of the record
**Details**

Case 20 describes an ideal temperature sinusoid without distortion by either changes in growth rate or changes in δ¹⁸Ow but with an even smaller temperature amplitude.

Generated using the code in "Generate_Case20.r" in dataraw

**Source**

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* 2020, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)
Virtual dataset Case 21

Description

A dataset containing ages (T_{new}), depth values (D), stable oxygen isotope values (\delta^{18}O) and clumped isotope values \Delta_{47} of a simulated carbonate record based on environmental parameters following Case 21 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case21

Format

A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **T_{new}** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d_{18}O_c** stable oxygen isotope value, in permille VPDB
- **D_{47}** clumped isotope value, in permille

- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **T_{new}** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d_{18}O_c** stable oxygen isotope value, in permille VPDB
- **D_{47}** clumped isotope value, in permille

- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **T_{new}** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d_{18}O_c** stable oxygen isotope value, in permille VPDB
- **D_{47}** clumped isotope value, in permille

- **SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **T_{new}** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d_{18}O_c** stable oxygen isotope value, in permille VPDB
- **D_{47}** clumped isotope value, in permille

- **SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
Case 22

Virtual dataset Case 22

Description

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values (δ¹⁸O) and clumped isotope values Δ₄⁷ of a simulated carbonate record based on environmental parameters following Case 22 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case22
Format

A data frame with 1200 rows and 30 variables:

**SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_3.25** Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille...
Details

Case 22 describes an natural environment with temperature and $\delta^{18}O_w$ records from a tidal inlet (Texel harbor). data from inst/extdata/Texel_data.csv.
Generated using the code in "Generate_Case22.r" in dataraw

Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:
de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high–resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

Virtual dataset Case 23

Description

A dataset containing ages ($T_{new}$), depth values ($D$), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 23 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case23

Format

A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **Tnew** Age, in years relative to the start of the record
### Details

Case 23 describes an natural environment with temperature and $\delta^{18}O_w$ records from a tropical sea (Great Barrier Reef). data from inst/extdata/GBR_data.csv.

Generated using the code in "Generate_Case23.r" in dataraw

### Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* **2020**, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)
Virtual dataset Case 24

Description

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values (δ\textsubscript{18}O) and clumped isotope values Δ\textsubscript{47} of a simulated carbonate record based on environmental parameters following Case 24 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case24

Format

A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
Case 25

**Description**

A dataset containing ages (T\textsubscript{new}), depth values (D), stable oxygen isotope values (\(\delta^{18}O\)) and clumped isotope values \(\Delta_{47}\) of a simulated carbonate record based on environmental parameters following Case 25 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

**Usage**

Case 25
Format

A data frame with 1200 rows and 30 variables:

SR_0.1 Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille

SR_0.2 Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille

SR_0.45 Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille

SR_0.75 Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille

SR_1.55 Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille

SR_3.25 Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille ...
Case 26

Details

Case 25 describes a natural environment with temperature and $\delta^{18}O_w$ records from a high-latitude marine site (Iceland). Data from inst/extdata/Iceland_data.csv.

Generated using the code in "Generate_Case25.r" in dataraw.

Source

See code to generate data in dataraw. Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* **2020**, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)

---

**Case26**

**Virtual dataset Case 26**

Description

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 26 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case26

Format

A data frame with 1200 rows and 30 variables:

**SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** Stable oxygen isotope value, in permille VPDB

**D47** Clumped isotope value, in permille

**SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm

**Tnew** Age, in years relative to the start of the record
Details

Case 26 describes an ideal temperature sinusoid without distortion by either changes in growth rate or changes in $\delta^{18}O_w$ but with a shorter (6 yr) record length.

Generated using the code in "Generate_Case26.r" in dataraw

Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

**Description**

A dataset containing ages (\(T_{\text{new}}\)), depth values (\(D\)), stable oxygen isotope values (\(\delta^{18}O\)) and clumped isotope values \(\Delta_{47}\) of a simulated carbonate record based on environmental parameters following Case 27 and employing a sampling resolution of \(0.1\) mm, \(0.2\) mm, \(0.45\) mm, \(0.75\) mm, \(1.55\) mm and \(3.25\) mm.

**Usage**

Case27

**Format**

A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille
- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille
- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille
- **SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille
- **SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
**Case28**

*Description*

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 28 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

*Usage*

Case28
**Format**

A data frame with 1200 rows and 30 variables:

<table>
<thead>
<tr>
<th>SR_0.1</th>
<th>Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SR_0.2</th>
<th>Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SR_0.45</th>
<th>Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SR_0.75</th>
<th>Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SR_1.55</th>
<th>Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SR_3.25</th>
<th>Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tnew</td>
<td>Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D</td>
<td>Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc</td>
<td>Stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47</td>
<td>Clumped isotope value, in permille</td>
</tr>
</tbody>
</table>
Details

Case 28 describes an ideal temperature sinusoid without distortion by either changes in growth rate or changes in δ^{18}O_{w} but with a shorter (1 yr) record length.

Generated using the code in "Generate_Case28.r" in dataraw

Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

Virtual dataset Case 29

Description

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values (δ^{18}O) and clumped isotope values Δ_{47} of a simulated carbonate record based on environmental parameters following Case 29 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case29

Format

A data frame with 1200 rows and 30 variables:

**SR_ 0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_ 0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_ 0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm

**Tnew** Age, in years relative to the start of the record
Case 29 describes an ideal temperature sinusoid without distortion by changes in growth rate, but with seasonal variability in $\delta^{18}O_w$ with a minimum in spring season and a tiny (1 days SD) error on age model.

Generated using the code in "Generate_Case29.r" in dataraw.

Source

See code to generate data in dataraw. Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high–resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4
Virtual dataset Case 3

Description

A dataset containing ages ($T_{\text{new}}$), depth values ($D$), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 3 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case3

Format

A data frame with 1200 rows and 30 variables:

- **SR_0.1**: Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **$T_{\text{new}}$**: Age, in years relative to the start of the record
- **$D$**: Depth, in mm along the virtual record
- **$d^{18}O_{\text{c}}$**: Stable oxygen isotope value, in permille VPDB
- **$D_{47}$**: Clumped isotope value, in permille

- **SR_0.2**: Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **$T_{\text{new}}$**: Age, in years relative to the start of the record
- **$D$**: Depth, in mm along the virtual record
- **$d^{18}O_{\text{c}}$**: Stable oxygen isotope value, in permille VPDB
- **$D_{47}$**: Clumped isotope value, in permille

- **SR_0.45**: Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **$T_{\text{new}}$**: Age, in years relative to the start of the record
- **$D$**: Depth, in mm along the virtual record
- **$d^{18}O_{\text{c}}$**: Stable oxygen isotope value, in permille VPDB
- **$D_{47}$**: Clumped isotope value, in permille

- **SR_0.75**: Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **$T_{\text{new}}$**: Age, in years relative to the start of the record
- **$D$**: Depth, in mm along the virtual record
- **$d^{18}O_{\text{c}}$**: Stable oxygen isotope value, in permille VPDB
- **$D_{47}$**: Clumped isotope value, in permille

- **SR_1.55**: Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
Case30

Tnew  Age, in years relative to the start of the record
D  Depth, in mm along the virtual record
d18Oc  stable oxygen isotope value, in permille VPDB
D47  clumped isotope value, in permille
SR_3.25  Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm

Details
Case 3 describes an ideal temperature sinusoid without distortion by changes in $\delta^{18}O_w$, but with a growth stop in the warm season.

Generated using the code in "Generate_Case3.r" in dataraw

Source
See code to generate data in dataraw
Details on how these example cases are defined is provided in:
de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high–resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

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Case30  Virtual dataset Case 30

Description
A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 30 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage
Case30
Format

A data frame with 1200 rows and 30 variables:

**SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_3.25** Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille ...
Details
Case 30 describes an ideal temperature sinusoid without distortion by changes in growth rate, but with seasonal variability in $\delta^{18}O_w$ with a minimum in spring season and a small (5 days SD) error on age model (roughly +/- one week).

Generated using the code in "Generate_Case30.r" in dataraw.

Source
See code to generate data in dataraw. Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

Description
A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta^{47}$ of a simulated carbonate record based on environmental parameters following Case 31 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage
Case31

Format
A data frame with 1200 rows and 30 variables:

**SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
**Tnew** Age, in years relative to the start of the record
**D** Depth, in mm along the virtual record
**d18Oc** stable oxygen isotope value, in permille VPDB
**D47** clumped isotope value, in permille

**SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
**Tnew** Age, in years relative to the start of the record
**D** Depth, in mm along the virtual record
**d18Oc** stable oxygen isotope value, in permille VPDB
**D47** clumped isotope value, in permille

**SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
**Tnew**  Age, in years relative to the start of the record

**D**  Depth, in mm along the virtual record

**d18Oc**  stable oxygen isotope value, in permille VPDB

**D47**  clumped isotope value, in permille

**SR_0.75**  Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm

**Tnew**  Age, in years relative to the start of the record

**D**  Depth, in mm along the virtual record

**d18Oc**  stable oxygen isotope value, in permille VPDB

**D47**  clumped isotope value, in permille

**SR_1.55**  Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm

**Tnew**  Age, in years relative to the start of the record

**D**  Depth, in mm along the virtual record

**d18Oc**  stable oxygen isotope value, in permille VPDB

**D47**  clumped isotope value, in permille

**SR_3.25**  Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm

**Tnew**  Age, in years relative to the start of the record

**D**  Depth, in mm along the virtual record

**d18Oc**  stable oxygen isotope value, in permille VPDB

**D47**  clumped isotope value, in permille ...

**Details**

Case 31 describes an ideal temperature sinusoid without distortion by changes in growth rate, but with seasonal variability in $\delta^{18}O_w$ with a minimum in spring season and a larger (15 days SD) error on age model (roughly +/- one month)

Generated using the code in "Generate_Case31.r" in dataraw

**Source**

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* 2020, 1–52. https://doi.org/fpc4
Virtual dataset Case 32

Description
A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values (δ^{18}O) and clumped isotope values Δ_{47} of a simulated carbonate record based on environmental parameters following Case 32 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage
Case32

Format
A data frame with 1200 rows and 30 variables:
- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** Stable oxygen isotope value, in permille VPDB
- **D47** Clumped isotope value, in permille
- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** Stable oxygen isotope value, in permille VPDB
- **D47** Clumped isotope value, in permille
- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** Stable oxygen isotope value, in permille VPDB
- **D47** Clumped isotope value, in permille
- **SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** Stable oxygen isotope value, in permille VPDB
- **D47** Clumped isotope value, in permille
- **SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
**Tnew**  Age, in years relative to the start of the record

**D**  Depth, in mm along the virtual record

**d18Oc**  stable oxygen isotope value, in permille VPDB

**D47**  clumped isotope value, in permille

**SR_ 3.25**  Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm

**Tnew**  Age, in years relative to the start of the record

**D**  Depth, in mm along the virtual record

**d18Oc**  stable oxygen isotope value, in permille VPDB

**D47**  clumped isotope value, in permille

**Details**

Case 32 describes an ideal temperature sinusoid without distortion by changes in growth rate, but with seasonal variability in $\delta^{18}O_w$ with a minimum in spring season and a large (45 days SD) error on age model (roughly +/- three months)

Generated using the code in "Generate_Case32.r" in data raw

**Source**

See code to generate data in data raw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* 2020, 1–52. https://doi.org/fpc4

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**Case33**  

**Virtual dataset Case 33**

**Description**

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 33 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

**Usage**

Case33
Format

A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** Stable oxygen isotope value, in permille VPDB
- **D47** Clumped isotope value, in permille

- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** Stable oxygen isotope value, in permille VPDB
- **D47** Clumped isotope value, in permille

- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** Stable oxygen isotope value, in permille VPDB
- **D47** Clumped isotope value, in permille

- **SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** Stable oxygen isotope value, in permille VPDB
- **D47** Clumped isotope value, in permille

- **SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** Stable oxygen isotope value, in permille VPDB
- **D47** Clumped isotope value, in permille

- **SR_3.25** Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** Stable oxygen isotope value, in permille VPDB
- **D47** Clumped isotope value, in permille ...
Details

Case 33 describes an ideal temperature sinusoid without distortion by changes in growth rate, but with seasonal variability in $\delta^{18}O_w$ with a minimum in spring season and a enormous (90 days SD) error on age model (roughly +/- half year).

Generated using the code in "Generate_Case33.r" in dataraw

Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

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Virtual dataset Case 4

Description

A dataset containing ages ($T_{new}$), depth values ($D$), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta^{47}$ of a simulated carbonate record based on environmental parameters following Case 4 and employing a sampling resolution of $0.1 \text{ mm}$, $0.2 \text{ mm}$, $0.45 \text{ mm}$, $0.75 \text{ mm}$, $1.55 \text{ mm}$ and $3.25 \text{ mm}$.

Usage

Case4

Format

A data frame with 1200 rows and 30 variables:

**SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of $0.1 \text{ mm}$

$T_{new}$ Age, in years relative to the start of the record

$D$ Depth, in mm along the virtual record

$\delta^{18}O_c$ stable oxygen isotope value, in permille VPDB

$\Delta^{47}$ clumped isotope value, in permille

**SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of $0.2 \text{ mm}$

$T_{new}$ Age, in years relative to the start of the record

$D$ Depth, in mm along the virtual record

$\delta^{18}O_c$ stable oxygen isotope value, in permille VPDB

$\Delta^{47}$ clumped isotope value, in permille

**SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of $0.45 \text{ mm}$
Case 4 describes an ideal temperature sinusoid without distortion by changes in δ^{18}O_w, but with a linearly decreasing growth rate.

Generated using the code in "Generate_Case4.r" in dataraw

Details

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* 2020, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)
Virtual dataset Case 5

Description
A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 5 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage
Case5

Format
A data frame with 1200 rows and 30 variables:

- **SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- **Tnew** Age, in years relative to the start of the record
- **D** Depth, in mm along the virtual record
- **d18Oc** stable oxygen isotope value, in permille VPDB
- **D47** clumped isotope value, in permille

- **SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
Case 5 describes an ideal temperature sinusoid without distortion by changes in $\delta^{18}O_w$, but with seasonal variability in growth rate which is in phase with the temperature seasonality.

Generated using the code in "Generate_Case5.r" in dataraw

Details

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 6 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case6
Format

A data frame with 1200 rows and 30 variables:

SR_ 0.1 Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille

SR_ 0.2 Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille

SR_ 0.45 Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille

SR_ 0.75 Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille

SR_ 1.55 Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille

SR_ 3.25 Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm
Tnew Age, in years relative to the start of the record
D Depth, in mm along the virtual record
d18Oc stable oxygen isotope value, in permille VPDB
D47 clumped isotope value, in permille ...
Details

Case 6 describes an ideal temperature sinusoid without distortion by changes in $\delta^{18}O_w$, but with seasonal variability in growth rate which is in phase with maxima in the spring season.

Generated using the code in "Generate_Case6.r" in dataraw

Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

Case7 Virtual dataset Case 7

Description

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 7 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case7

Format

A data frame with 1200 rows and 30 variables:

<table>
<thead>
<tr>
<th>SR_0.1 Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tnew Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47 clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_0.2 Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm</td>
</tr>
<tr>
<td>Tnew Age, in years relative to the start of the record</td>
</tr>
<tr>
<td>D Depth, in mm along the virtual record</td>
</tr>
<tr>
<td>d18Oc stable oxygen isotope value, in permille VPDB</td>
</tr>
<tr>
<td>D47 clumped isotope value, in permille</td>
</tr>
<tr>
<td>SR_0.45 Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm</td>
</tr>
<tr>
<td>Tnew Age, in years relative to the start of the record</td>
</tr>
</tbody>
</table>
### Details

Case 7 describes an ideal temperature sinusoid without distortion by changes in growth rate, but with seasonal variability in $\delta^{18}O_w$ in phase with temperature seasonality.

Generated using the code in "Generate_Case7.r" in dataraw

### Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, *Climate of the Past Discussions* **2020**, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)
Virtual dataset Case 8

Description

A dataset containing ages (Tnew), depth values (D), stable oxygen isotope values ($\delta^{18}O$) and clumped isotope values $\Delta_{47}$ of a simulated carbonate record based on environmental parameters following Case 8 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

Usage

Case8

Format

A data frame with 1200 rows and 30 variables:

- SR_ 0.1 Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm
- Tnew Age, in years relative to the start of the record
- D Depth, in mm along the virtual record
- d$18$Oc stable oxygen isotope value, in permille VPDB
- D$47$ clumped isotope value, in permille

- SR_ 0.2 Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm
- Tnew Age, in years relative to the start of the record
- D Depth, in mm along the virtual record
- d$18$Oc stable oxygen isotope value, in permille VPDB
- D$47$ clumped isotope value, in permille

- SR_ 0.45 Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm
- Tnew Age, in years relative to the start of the record
- D Depth, in mm along the virtual record
- d$18$Oc stable oxygen isotope value, in permille VPDB
- D$47$ clumped isotope value, in permille

- SR_ 0.75 Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm
- Tnew Age, in years relative to the start of the record
- D Depth, in mm along the virtual record
- d$18$Oc stable oxygen isotope value, in permille VPDB
- D$47$ clumped isotope value, in permille

- SR_ 1.55 Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm
## Description

A dataset containing ages (\(T_{\text{new}}\)), depth values (\(D\)), stable oxygen isotope values (\(\delta^{18}O\)) and clumped isotope values \(\Delta_{47}\) of a simulated carbonate record based on environmental parameters following Case 9 and employing a sampling resolution of 0.1 mm, 0.2 mm, 0.45 mm, 0.75 mm, 1.55 mm and 3.25 mm.

### Usage

Case9
Format

A data frame with 1200 rows and 30 variables:

**SR_0.1** Empty column denoting the start of the record sampled at a sampling resolution of 0.1 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.2** Empty column denoting the start of the record sampled at a sampling resolution of 0.2 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.45** Empty column denoting the start of the record sampled at a sampling resolution of 0.45 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_0.75** Empty column denoting the start of the record sampled at a sampling resolution of 0.75 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_1.55** Empty column denoting the start of the record sampled at a sampling resolution of 1.55 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille

**SR_3.25** Empty column denoting the start of the record sampled at a sampling resolution of 3.25 mm

**Tnew** Age, in years relative to the start of the record

**D** Depth, in mm along the virtual record

**d18Oc** stable oxygen isotope value, in permille VPDB

**D47** clumped isotope value, in permille ...
Details

Case 9 describes an ideal temperature sinusoid without distortion by changes in growth rate, but with seasonal variability in $\delta^{18}O_w$ with a minimum in spring season.

Generated using the code in "Generate_Case9.r" in dataraw

Source

See code to generate data in dataraw Details on how these example cases are defined is provided in:

dele, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high-resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4

optimization_seasonality

Function for sample size optimization based clumped isotope seasonality reconstruction.

Description

Combines records of stable oxygen isotope ratios ($\delta^{18}O_c$) and clumped isotope ratios ($\Delta_{47}$) through subannually resolved carbonate archives (e.g. mollusk shells or corals) to reconstruct monthly variability in temperature and salinity (through the $\delta^{18}O$ composition of the precipitation fluid), using the sample size optimization method detailed in de Winter et al., 2020 (Climate of the Past).

Usage

optimization_seasonality(
  d180c,
  D47,
  ages,
  SD_d180c = 0.1,
  SD_D47 = 0.04,
  N = 1000,
  p = 0.05,
  d180_fun = "KimONeil97",
  D47_fun = "Bernasconi18",
  export = FALSE,
  export_raw = FALSE
)

Arguments

d180c Vector containing subannually resolved $\delta^{18}O_c$ data
D47 Vector containing subannually resolved $\Delta_{47}$ data
ages Vector containing ages for of all samples in years relative to the shell chronology
Error on the $\delta^{18}O_c$ measurements. Either a single value (constant uncertainty) or a vector of length equal to the period in SST data (365 days by default) containing information about the error of each datapoint (1 standard deviation; default = 0.1 permille).

Error on the $\Delta_{47}$ measurements. Either a single value (constant uncertainty) or a vector of length equal to the period in SST data (365 days by default) containing information about the error of each datapoint (1 standard deviation; default = 0.04 permille).

Number of datapoints for Monte Carlo simulation (defaults to 1000)

Threshold value for the p value of separating summer from winter reconstructions. Defaults to 0.05 (95% confidence level)

String containing the name of the transfer function used to convert temperature and $\delta^{18}O_w$ to $\delta^{18}O_c$ data (for example: "KimONeil97" or "GrossmanKu86"). Defaults to Kim and O’Neil (1997).

String containing the name of the transfer function used to convert temperature to $\Delta_{47}$ data (for example: "Bernasconi18" or "Jautzy20"). Defaults to Bernasconi et al., 2018).

Export table summary of result (CSV format)? TRUE/FALSE

Export tables containing all raw model results before being merged into tidy tables? TRUE/FALSE

A data frame containing monthly reconstructions of $\Delta_{47}$, temperature, $\delta^{18}O$ of the precipitation fluid and $\delta^{18}O_c$.

References


**Examples**

# find attached dummy data
case1 <- seasonalclumped::case1
d18oc <- case1[, 29]
d18oc <- d18oc[!which(is.na(d18oc))]
d47 <- case1[, 30]
d47 <- d47[!which(is.na(d47))]
ages <- case1[, 27]
ages <- ages[!which(is.na(ages))]

# Run function
monthly <- optimization_seasonality(d18oc = d18oc,
    d47 = d47,
    ages = ages,
    SD_d18oc = 0.1,
    SD_d47 = 0.04,
    N = 100, # Use small amount of samples for quick testing (recommended N = 1000)
    p = 0.05,
    d18o_fun = "KimONeil97",
    d47_fun = "Bernasconi18",
    export = FALSE,
    export_raw = FALSE)

**oxygen_isotope_seasonality**

*Function for oxygen isotope based seasonality reconstructions.*

**Description**

Uses records of stable oxygen isotope ratios (δ18O) through subannually resolved carbonate archives (e.g. mollusk shells or corals) to reconstruct monthly variability in temperature and salinity (assuming user provided variability in δ18O composition of the precipitation fluid).
Usage

```r
doxygen_isotope_seasonality(
  d180c,
  ages,
  SD_d180c = 0.1,
  d180w = 0,
  d180_fun = "KimONeil97",
  export = FALSE
)
```

Arguments

- `d180c` Vector containing subannually resolved $\delta^{18}O_c$ data
- `ages` Vector containing ages for of all samples in years relative to the shell chronology
- `SD_d180c` Error on the $\delta^{18}O_c$ measurements. Either a single value (constant uncertainty) or a vector of length equal to the period in SST data (365 days by default) containing information about the error of each datapoint (1 standard deviation; default = 0.1 permille).
- `d180w` Vector containing $\delta^{18}O$ values (in permille VSMOW) of the precipitation fluid used to calculate temperatures. If only a single value is provided, the $\delta^{18}O$ of the fluid is presumed constant at this value. Default = 0 permille VSMOW.
- `d180_fun` String containing the name of the transfer function used to convert temperature and $\delta^{18}O_w$ to $\delta^{18}O_c$ data (for example: "KimONeil97" or "GrossmanKu86"). Defaults to Kim and O’Neil (1997).
- `export` Export table summary of result (CSV format)? TRUE/FALSE

Value

A data frame containing monthly reconstructions of temperature, $\delta^{18}O$ of the precipitation fluid and $\delta^{18}O_c$.

References


de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high–resolution paleoclimate records, Climate of the Past Discussions 2020, 1–52. https://doi.org/fpc4
smoothing_seasonality  

Function for sample size optimization based clumped isotope seasonality reconstruction.

Description

Combines records of stable oxygen isotope ratios ($\delta^{18}O_w$) and clumped isotope ratios (D47) through subannually resolved carbonate archives (e.g. mollusk shells or corals) to reconstruct monthly variability in temperature and salinity (through the $\delta^{18}O$ composition of the precipitation fluid), using the moving average method detailed in de Winter et al., 2020 (Climate of the Past).

Usage

```
smoothing_seasonality(  
d18Oc,  
D47,  
ages,  
SD_d18Oc = 0.1,  
SD_D47 = 0.04,  
window = "optimize",  
N = 1000,  
p = 0.05,  
d18O_fun = "KimONeil97",  
D47_fun = "Bernasconi18",  
export = FALSE,  
export_raw = FALSE  
)
```

Arguments

- `d18Oc` Vector containing subannually resolved $\delta^{18}O_w$ data
- `D47` Vector containing subannually resolved D47 data

Examples

```r
# find attached dummy data
Case1 <- seasonalclumped::Case1
d18Oc <- Case1[, 29]
d18Oc <- d18Oc[!is.na(d18Oc)]
ages <- Case1[, 27]
ages <- ages[!is.na(ages)]
# Run function
monthly <- oxygen_isotope_seasonality(d18Oc,  
ages,  
0.1,  
0,  
"KimONeil97",  
FALSE)
```
**smoothing_seasonality**

- **ages** Vector containing ages for all samples in years relative to the shell chronology.

- **SD_d18Oc** Error on the $\delta^{18}O_w$ measurements. Either a single value (constant uncertainty) or a vector of length equal to the period in SST data (365 days by default) containing information about the error of each datapoint (1 standard deviation; default = 0.1 permille).

- **SD_D47** Error on the D47 measurements. Either a single value (constant uncertainty) or a vector of length equal to the period in SST data (365 days by default) containing information about the error of each datapoint (1 standard deviation; default = 0.04 permille).

- **window** Either supply the size of the window used for moving average calculation (integer with values between 2 and the length of the record), or enter the term "optimize" to let the function find the optimum window size for the record through a Monte Carlo approach.

- **N** Number of datapoints for Monte Carlo simulation (defaults to 1000)

- **p** Threshold value for the p value of separating summer from winter reconstructions. Defaults to 0.05 (95% confidence level)

- **d18O_fun** String containing the name of the transfer function used to convert temperature and $\delta^{18}O_w$ to $\delta^{18}O_w$ data (for example: "KimONeil97" or "GrossmanKu86"). Defaults to Kim and O’Neil (1997).

- **D47_fun** String containing the name of the transfer function used to convert temperature to D47 data (for example: "Bernasconi18" or "Jautzy20"). Defaults to Bernasconi et al., 2018).

- **export** Export table summary of result (CSV format)? TRUE/FALSE

- **export_raw** Export tables containing all raw model results before being merged into tidy tables? TRUE/FALSE

**Value**

A data frame containing monthly reconstructions of D47, temperature, $\delta^{18}O$ of the precipitation fluid and $\delta^{18}O_w$.

**References**


de Winter, N. J., Agterhuis, T., Ziegler, M., Optimizing sampling strategies in high–resolution paleoclimate records, *Climate of the Past Discussions* 2020, 1–52. [https://doi.org/fpc4](https://doi.org/fpc4)

Examples

```r
# find attached dummy data
Case1 <- seasonalclumped::Case1
d18Oc <- Case1[, 29]
d18Oc <- d18Oc[!which(is.na(d18Oc))]
D47 <- Case1[, 30]
D47 <- D47[!which(is.na(D47))]
ages <- Case1[, 27]
ages <- ages[!which(is.na(ages))]

# Run function
monthly <- smoothing_seasonality(d18Oc, D47, ages, 0.1, 0.04, "optimize", 100, # Use small amount of samples for quick testing (recommended N = 1000) 0.05, "KimONeil97", "Bernasconi18", FALSE, FALSE)
```
subsample

*Function used to linearly subsample data at new depth values*

**Description**

Function used to linearly subsample data at new depth values

**Usage**

`subsample(data, old_depth, new_depth, AV = FALSE, plot = FALSE)`

**Arguments**

- `data`: A vector of data to be interpolated
- `old_depth`: A vector containing the depth values belonging to `data`
- `new_depth`: A vector containing depth values at which the data should be interpolated.
- `AV`: Should the subsampling take into account the mean value within the sample interval? TRUE/FALSE If FALSE, the interpolated value corresponding to the exact position is used instead of the mean of the interval
- `plot`: Should the result be plotted? TRUE/FALSE

**Value**

A vector listing the values interpolated from `data` at the positions of `new_depth`

**Examples**

```r
# Create test data (= ideal case)
# Set boundary conditions
Td <- seq(1, 12 * 365, 1) # Create timeline of 12 years in days
Ty <- Td / 365 # Convert to years
MAT <- 20 # Set mean annual temperature
Amp <- 10 # Set seasonal amplitude
Sext <- 2 * Amp # Calculate extent of seasonal variability
TSD <- 1.5 # Set the degree of random non-seasonal noise on the SST curve

# Set the type of seasonal noise on the SST curve
"weather"
SST <- rnorm(length(Ty), MAT + Amp * sin(2 * pi * Ty), TSD) # Create virtual
# daily SST data
GR <- rep(10 / 365, length(Ty)) # Set growth rate to 10 mm/yr and create daily
# GR vector
SR <- 0.75 # Set sampling resolution to 0.75 mm

# Create vector for all samples along entire shell length by applying constant
# sampling resolution
D <- seq(SR, sum(GR), SR)
D_cum <- cumsum(GR) # Create cumulative depth vector for all values

new_data <- subsample(SST, D_cum, D, AV = TRUE, plot = FALSE) # Interpolate
# SST values at the positions of D while calculating sample averages
```
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