Package 'AgeBandDecomposition'

February 4, 2026

Title Age Band Decomposition Method for Tree Ring Standardization

Version 2.0.0

Description Implements the Age Band Decomposition (ABD) method for standardizing tree ring width data while preserving both low and high frequency variability. Unlike traditional detrending approaches that can distort long term growth trends, ABD decomposes ring width series into multiple age classes, detrends each class separately, and then recombines them to create standardized chronologies. This approach improves the detection of growth signals linked to past climatic and environmental factors, making it particularly valuable for dendroecological and dendroclimatological studies. The package provides functions to perform ABD-based standardization, compare results with other common methods (e.g., BAI, C method, RCS), and facilitate the interpretation of growth patterns under current and future climate variability.

URL https://gitlab.com/Puletti/agebanddecomposition_rpackage

Language en-US

License GPL (>= 3)

Encoding UTF-8

RoxygenNote 7.3.2

LazyData true

Imports dplyr, tidyr, tibble, readxl, ggplot2, dplR, patchwork

Suggests testthat (>= 3.0.0)

Config/testthat/edition 3

Depends R (>= 4.1.0)

NeedsCompilation no

Author Nicola Puletti [aut, cre] (ORCID: <https://orcid.org/0000-0002-2142-959X>), Gianluigi Mazza [aut] (ORCID: <https://orcid.org/0000-0002-2744-2330>), Dimitrios Sarris [ctb] (ORCID: <https://orcid.org/0000-0003-1379-1465>)

Maintainer Nicola Puletti <nicola.puletti@crea.gov.it>

Repository CRAN

Date/Publication 2026-02-04 15:20:08 UTC

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ABD *ABD - Age Band Decomposition*

Description

ABD - Age Band Decomposition. This function calculates standardized tree-ring width chronologies by decomposing tree-ring width (stdTRW) data into age bands, detrending each age band separately, and then recombining them to produce the mean standardized chronology. Specifically, ABD standardizes each series within its age band (e.g., each ring width is divided by the corresponding age-specific expected value from the stdTRW). Then, standardized values from all age bands are merged and averaged to produce a composite chronology, preserving both inter-annual and low-frequency climate signals.

Usage

```
ABD(inTRW, min_nTrees_year = 3, pct_stdTRW_th = 0.5, pct_Trees_th = 0.3)
```

Arguments

`inTRW`	tibble. A tibble. The input dataset obtained from the `import_rwl()` function.
`min_nTrees_year`	Numeric. Sets the minimum number of trees per year required within each age class to be included in the analysis. The default is 3. Using less than three trees may result in poor representation of within-class variability and is not recommended unless data availability is limited.
`pct_stdTRW_th`	Numeric. Sets the threshold for the minimum proportion of standardized tree-ring width values required within a given age class. The default is set to 0.5, meaning that at least 50% of the possible values must be present (e.g., 6 out of 10 values for 10-year age bands, or 11 out of 20 for 20-year bands). For instance, the final age band of a 94-year-old tree (i.e., the 91–100-year band) includes only 4 years of growth. Since this number of years below the threshold, we recommend excluding that tree from the corresponding age band group.

pct_Trees_th — Numeric. Sets the minimum number of samples (i.e., trees) required to compute the mean standardized tree-ring widths within each age band. The default value is 0.3. However, when working with small sample sizes (approximately 20 trees or fewer), increasing the threshold to 0.5 is recommended to ensure that more trees are included in the analysis.

Details

The function performs age-band decomposition on stdTRW data by filtering out age classes with insufficient observations (`min_nTrees_year`) or excessive within-class variation.

The `stdTRW_th` value is particularly important in small datasets: too strict a threshold may exclude valid data. If working with approximately 20 trees or fewer, a threshold of 0.5 is suggested.

Please, see the `Examples` section below for a demonstration using a typical input tibble obtained with `import_rwl()`.

Value

A tibble with the following columns: year, N_ageBands, ABD, and ABDsd.

See Also

`import_rwl`, `stdTRW`, `plotABD`

Other ABD functions: `import_rwl()`, `stdTRW()`

Examples

```
ABD(inTRW)
```

`import_rwl` *import_rwl*

Description

This function imports tree-ring width data from RWL (Tucson format) files and pith offset information, then arranges the dataset for ABD analysis.

Usage

```
import_rwl(
  rwl_path,
  po_path,
  ageBands,
  first_age_class = NULL,
  zero_as_na = TRUE,
  verbose = TRUE
)
```

Arguments

rwl_path	Path to the RWL file (Tucson format).
po_path	Path to the pith offset file (tab-delimited text file with columns 'tree_code' and 'pith.offset').
ageBands	character. Setting the age band window. It must be set to '1010' if all the age classes have the same size (10 years). It must be '1020' if the age classes have different sizes: 10 years till 100 and then 20 years size.
first_age_class	numeric. is numeric and specifies the first age band from which the analysis begins. If NULL (default), no filtering is applied. For example, first_age_class = 3 excludes the first 20 years of growth (age classes 1 and 2 in '1010' mode).
zero_as_na	logical. If TRUE (default), zero values in TRW are converted to NA. If FALSE, zero values are kept as is.
verbose	logical. If TRUE, prints additional information during import.

Details

The RWL file must be in Tucson format (readable by dplR::read.rwl). The pith offset file must be a tab-delimited text file with header containing columns 'tree_code' and 'pith.offset', where pith.offset indicates the number of missing rings between the pith and the first measured ring. are available on the package's GitLab page. https://gitlab.com/Puletti/agebanddecomposition_rpackage and can be used to test the package's functions.

Value

A list of two objects. The first object is a tibble representing the imported dataset in long format. In this tibble the last two columns are an identification number (id_by_years) and two grouping variables (age_class and ageBands). The second object in the list is a lookup table (tibble), useful for further steps.

See Also

stdTRW, ABD

Other ABD functions: ABD(), stdTRW()

Examples

```
# Download example files from the package's GitLab page
package_gitlab_site <- 'https://gitlab.com/Puletti/agebanddecomposition_rpackage'
rwl_url <- "/-/raw/main/studio/dati/TRW_example.rwl"
po_url <- "/-/raw/main/studio/dati/pith.offset.txt"

# Create temporary files
tmpfile_rwl <- tempfile(fileext = ".rwl")
tmpfile_po <- tempfile(fileext = ".txt")

# Download the files
download.file(paste0(package_gitlab_site, rwl_url),
```

```
              tmpfile_rwl,
              mode = "wb")

download.file(paste0(package_gitlab_site, po_url),
              tmpfile_po,
              mode = "wb")

# Import the data
inData <- import_rwl(rwl_path = tmpfile_rwl,
                             po_path = tmpfile_po,
                             ageBands = '1010',
                             first_age_class = 3,
                             zero_as_na = TRUE,
                             verbose = TRUE)

# View the result
inData
```

`inTRW` *AgeBandDecomposition test data*

Description

A tiny test dataset including example, the basic reference for AgeBandDecomposition package.

A list of two test datasets derived from TRW_readExcel function. The first list-object is a `tibble` that can be used as the argument of `stdTRW` function.

Usage

```
inTRW

inTRW
```

Format

A tibble with 85 rows and 16 variables, as derived from the Excel file.

A list of two tibbles

`plotABD` *plotABD*

Description

Function for plotting ABD values from `inTRW` object using the two `tibble` objects produced by the function `import_rwl`.

Usage

```
plotABD(
  inTRW,
  min_nTrees_year = 3,
  pct_stdTRW_th = 0.5,
  pct_Trees_th = 0.3,
  linewidth_TRW = 0.7,
  linewidth_Ntrees = 1,
  byYears = 20,
  xlim = NULL,
  ylimABD = NULL,
  ...
)
```

Arguments

inTRW	tibble. A tibble. The input dataset obtained from the `import_rwl()` function.
min_nTrees_year	Numeric. The minimum number of trees per year required within each age class to be included in the analysis. The default is 3. Using less than three trees may result in poor representation of within-class variability and is not recommended unless data availability is limited.
pct_stdTRW_th	Numeric. It defines the threshold for the minimum proportion of standardized tree-ring width values required within a given age class. The default is set to 0.5, meaning that at least 50% of the possible values must be present (e.g., 6 out of 10 values for 10-year age bands, or 11 out of 20 for 20-year bands). For instance, the final age band of a 94-year-old tree (i.e., the 91–100-year band) includes only 4 years of growth. Since this number of years below the threshold, we recommend excluding that tree from the corresponding age band group.
pct_Trees_th	Numeric. It defines the threshold used to calculate the mean standardized tree-ring widths within each age band. The default value is 0.3. However, when working with small sample sizes (approximately 20 trees or fewer), it is advisable to increase the threshold to 0.5. This adjustment helps retain more trees in the analysis while still accounting for natural growth variability.
linewidth_TRW	numeric. line size for TRW.
linewidth_Ntrees	numeric. line size for Ntrees.
byYears	numeric. Spacing (in years) between tick marks on the x-axis of time-related plots.
xlim	Optional numeric vector of length 2 specifying the limits of the x-axis. If `NULL` the limits are automatically determined.
ylimABD	Optional numeric vector of length 2 specifying the limits of the y-axis for the ABD panel. If `NULL` the limits are automatically determined.
...	Other arguments passed on to methods. Not currently used.

Details

This function produces a multi-panel plot with three graphs: the first displays standardized values by age band; the second shows the final mean chronology (ABD), adjusted for age-related effects; and the third depicts the corresponding number of trees.

Value

None. A multipanel plot.

See Also

plotBAI, plotTRW, ABD

Other tree ring plotting: plotBAI(), plotTRW()

Examples

```
plotABD(inTRW,
   min_nTrees_year = 3,
   pct_stdTRW_th = .5,
   pct_Trees_th = .3,
   byYears = 50)
```

---

plotBAI *plotBAI*

Description

Function for plotting basal area increment (BAI) values derived from `inTRW` object using the first `tibble` produced by the function `import_rwl`.

Usage

```
plotBAI(
  inTRW,
  linewidth_BAI = 1,
  linewidth_Ntrees = 1,
  byYears = 20,
  xlim = NULL,
  ylim = NULL,
  ...
)
```

Arguments

inTRW	tibble. The first object resulting from the import_rwl function.
linewidth_BAI	numeric. line size for BAI.
linewidth_Ntrees	numeric. line size for Ntrees.
byYears	numeric. Spacing (in years) between tick marks on the x-axis of time-related plots.
xlim	Optional numeric vector of length 2 specifying the limits of the x-axis. If NULL the limits are automatically determined.
ylim	Optional numeric vector of length 2 specifying the limits of the y-axis for the ABD panel. If NULL the limits are automatically determined.
...	Other arguments passed on to methods. Not currently used.

Details

This function generates a basic plot displaying the mean chronology +/- standard error of raw basal area increments (in squared cm) alongside the corresponding number of trees.

Value

None. A plot is produced.

See Also

plotTRW, plotABD

Other tree ring plotting: plotABD(), plotTRW()

Examples

```
plotBAI(inTRW
    , linewidth_BAI = .5
    , linewidth_Ntrees = 1
    )
```

---

plotTRW *plotTRW*

Description

Function for plotting TRW values from inTRW object using the first tibble produced by the function import_rwl.

Usage

```
plotTRW(
  inTRW,
  linewidth_TRW = 1,
  linewidth_Ntrees = 1,
  byYears = 20,
  xlim = NULL,
  ylim = NULL,
  ...
)
```

Arguments

inTRW	tibble. The first object resulting from the import_rwl function.
linewidth_TRW	numeric. line size for TRW.
linewidth_Ntrees	numeric. line size for Ntrees.
byYears	numeric. Spacing (in years) between tick marks on the x-axis of time-related plots.
xlim	Optional numeric vector of length 2 specifying the limits of the x-axis. If NULL the limits are automatically determined.
ylim	Optional numeric vector of length 2 specifying the limits of the y-axis for the ABD panel. If NULL the limits are automatically determined.
...	Other arguments passed on to methods. Not currently used.

Details

This function generates a basic plot displaying the mean chronology +/- standard error of raw tree-ring widths (in mm) alongside the corresponding number of trees.

Value

None. A plot is produced.

See Also

plotBAI, plotABD

Other tree ring plotting: plotABD(), plotBAI()

Examples

```
plotTRW(inTRW)
```

stdTRW *stdTRW*

Description

To remove the influences of local site characteristics on tree growth, this function standardizes the tree-ring width series by dividing each tree-ring width of a particular series by the mean width of that series. In dendroclimatic studies, it is advisable to exclude the initial years or decades of growth (the first "age bands", i.e., 1-10 and 11-20) as they are less likely to contain climatic signals rather than the influence of strong early-year growth competition within the tree stand (Mazza and Sarris, 2021; Sarris et al., 2007).

Usage

```
stdTRW(inTRW)
```

Arguments

inTRW	tibble. The first object resulting from the `import_rwl` function.

Details

To export a tibble like the one below to an `.xlsx` file, you can use the `writexl` package:

```
mytibble <- stdTRW_df |>
  dplyr::group_by(year) |>
  dplyr::summarise(
    N_trees = dplyr::n(),
    mean_stdTRW = mean(stdTRW, na.rm = TRUE)
  )

writexl::write_xlsx(mytibble, path = "my_stdTRW_df.xlsx")
```

This will create an Excel file named `my_stdTRW_df.xlsx` in your current working directory. Please, check also the **Examples** section below for how to obtain `stdTRW_df` object.

Value

A tibble with the following columns: year, tree_code, TRW, meanTRW, and stdTRW. Together with additional columns of grouping variables based on age class.

References

Mazza, G., Sarris, D., 2021. Identifying the full spectrum of climatic signals controlling a tree species' growth and adaptation to climate change. Ecol. Indic. 130, 108109. https://doi.org/10.1016/j.ecolind.2021.108109.

Sarris, D., Christodoulakis, D., Körner, C., 2007. Recent decline in precipitation and tree growth in the eastern Mediterranean. Glob. Chang. Biol. 13 (6), 1187–1200. https://doi.org/10.1111/j.1365-2486.2007.01348.x.

See Also

import_rwl, ABD

Other ABD functions: ABD(), import_rwl()

Examples

```
inTRW_1 <- inTRW[[1]]

stdTRW_df <- stdTRW(inTRW_1)

stdTRW_df |>
dplyr::group_by(year) |>
dplyr::summarise(N_trees = dplyr::n(),
       mean_stdTRW = mean(stdTRW, na.rm = TRUE)) |>
       ggplot2::ggplot(ggplot2::aes(year, N_trees)) +
       ggplot2::geom_line()
```

TRW_readExcel *TRW_readExcel (Deprecated)*

Description

This function is deprecated and will be removed in a future version. Please use import_rwl instead after converting your data to RWL format.

Usage

```
TRW_readExcel(path, sheet, ageBands, limitFirst20y = FALSE, verbose = TRUE)
```

Arguments

path	Path to the xls/xlsx file.
sheet	Sheet to read.
ageBands	character. Age band window setting.
limitFirst20y	logical. Remove first 20 years from each tree.
verbose	logical. Print additional information.

Value

A list of two objects (see original documentation).

See Also

import_rwl

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