|  |
| --- |
| title: “Dendrochronolgy in R” |
| author: “Jeff Atkins” |
| date: ’ r format(Sys.time(), "%B %d, %Y) |
| output: |
| word\_document: default |
| pdf\_document: default |
| html\_document: default |

## Working with ring-width data

dplR version 1.7.2 is available on CRAN

Here we show how to import tree-ring data.

We are using data downloaded from the NOAA XXXX, specifically the Cook - Kelsey Tract TSCA-ITRDB NC005 [url - <https://www.ncdc.noaa.gov/paleo-search/study/2987?siteId=15463>]

### Installation of dplR

# install the package if not already installed and call it via library()  
if(!require(dplR)){install.packages("dplR")}

## Loading required package: dplR

## Warning: package 'dplR' was built under R version 4.0.5

library(dplR)  
library(tidyverse)

## Warning: package 'tidyverse' was built under R version 4.0.5

## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --

## v ggplot2 3.3.3 v purrr 0.3.4  
## v tibble 3.1.1 v dplyr 1.0.6  
## v tidyr 1.1.3 v stringr 1.4.0  
## v readr 1.4.0 v forcats 0.5.1

## Warning: package 'ggplot2' was built under R version 4.0.5

## Warning: package 'tibble' was built under R version 4.0.5

## Warning: package 'tidyr' was built under R version 4.0.5

## -- Conflicts ------------------------------------------ tidyverse\_conflicts() --  
## x dplyr::filter() masks stats::filter()  
## x dplyr::lag() masks stats::lag()

## Importing ring-width data

The vignette included with dplR provides a thorough walkthrough (<https://cran.r-project.org/web/packages/dplR/vignettes/intro-dplR.pdf>) here we show some highlights based on the independet dataset we have downloaded.

## Attempting to automatically detect format.  
## Assuming a Tucson format file.  
## There does not appear to be a header in the rwl file  
## There are 31 series  
## 1 102061 1653 1983 0.01  
## 2 102062 1649 1983 0.01  
## 3 102081 1707 1983 0.01  
## 4 102101 1634 1983 0.01  
## 5 102102 1637 1983 0.01  
## 6 102121 1675 1976 0.01  
## 7 102141 1638 1983 0.01  
## 8 102142 1665 1983 0.01  
## 9 102171 1623 1983 0.01  
## 10 102172 1654 1983 0.01  
## 11 102181 1695 1983 0.01  
## 12 102182 1684 1983 0.01  
## 13 102241 1654 1983 0.01  
## 14 102261 1694 1983 0.01  
## 15 102271 1737 1983 0.01  
## 16 102272 1678 1983 0.01  
## 17 102291 1594 1983 0.01  
## 18 102292 1594 1983 0.01  
## 19 102301 1673 1932 0.01  
## 20 102302 1628 1977 0.01  
## 21 102311 1623 1983 0.01  
## 22 102312 1645 1983 0.01  
## 23 102321 1689 1983 0.01  
## 24 102322 1738 1983 0.01  
## 25 102341 1560 1983 0.01  
## 26 102342 1573 1983 0.01  
## 27 102431 1692 1983 0.01  
## 28 102432 1663 1983 0.01  
## 29 102451 1617 1983 0.01  
## 30 102452 1581 1983 0.01  
## 31 102491 1612 1983 0.01

## [1] 424 31

## [1] "rwl" "data.frame"

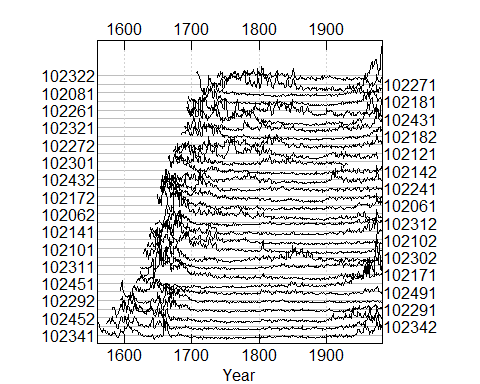
## Data descriptions

dplR has a function, rw.report() that provides a fairly detailed description of the data set(s) you are working with.

## Number of dated series: 31   
## Number of measurements: 10281   
## Avg series length: 331.6452   
## Range: 424   
## Span: 1560 - 1983   
## Mean (Std dev) series intercorrelation: 0.5316996 (0.05975429)  
## Mean (Std dev) AR1: 0.8697419 (0.04867715)  
## -------------  
## Years with absent rings listed by series   
## Series 102182 -- 1877 1888   
## Series 102291 -- 1644   
## Series 102292 -- 1756   
## Series 102311 -- 1752 1753   
## Series 102312 -- 1752 1753   
## Series 102321 -- 1876   
## Series 102341 -- 1716 1752   
## Series 102451 -- 1714 1715 1716 1717 1718   
## Series 102452 -- 1752   
## 17 absent rings (0.165%)  
## -------------  
## Years with internal NA values listed by series   
## None

## Plotting data (Spaghetti Plots)

We can now plot these data.

 Note that the echo = FALSE parameter was added to the code chunk to prevent printing of the R code that generated the plot.

## Detrending

## Detrending example, albeit brief.  
rw.detrend <- detrend(rwl = rw, method = "ModNegExp", verbose = TRUE)

## Verbose output: 102061  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 3.44413903  
## b: -0.03434367  
## k: 0.44902961  
## Verbose output: 102062  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 2.82001527  
## b: -0.01668015  
## k: 0.46014773  
## Verbose output: 102081  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 2.02801478  
## b: -0.04568062  
## k: 0.34733182  
## Verbose output: 102101  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 1.877257142  
## b: -0.007058882  
## k: 0.043304971  
## Verbose output: 102102  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 1.98975444  
## b: -0.01029991  
## k: 0.08925286  
## Verbose output: 102121  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 2.368258903  
## b: -0.001827476  
## k: -0.856734422  
## Verbose output: 102141  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 0.8676739  
## b: -0.0139668  
## k: 0.3768793  
## Verbose output: 102142  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 1.83194012  
## b: -0.02752817  
## k: 0.31690910  
## Verbose output: 102171  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 1.77511561  
## b: -0.01150277  
## k: 0.39930169  
## Verbose output: 102172  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 2.47420695  
## b: -0.02358822  
## k: 0.44310224  
## Verbose output: 102181  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 0.77170590  
## b: -0.02142554  
## k: 0.41657207  
## Verbose output: 102182  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Zero indices in input series:  
## 318 329  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 1.02193357  
## b: -0.01735269  
## k: 0.27466582  
## Verbose output: 102241  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 1.21881979  
## b: -0.01844401  
## k: 0.50931582  
## Verbose output: 102261  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls failed... fitting linear model... Linear model fit  
## Intercept: 1.510529  
## Slope: -0.003410913  
## Verbose output: 102271  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 1.12591921  
## b: -0.01085169  
## k: 0.83246748  
## Verbose output: 102272  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls failed... fitting linear model... Linear model fit  
## Intercept: 0.6787952  
## Slope: 0.0001062071  
## lm has a positive slope  
## pos.slope = FALSE  
## Detrend by mean.  
## Mean = 0.695098  
## Verbose output: 102291  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Zero indices in input series:  
## 85  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 0.98465235  
## b: -0.02122522  
## k: 0.34636554  
## Verbose output: 102292  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Zero indices in input series:  
## 197  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 0.89227265  
## b: -0.01100944  
## k: 0.18795069  
## Verbose output: 102301  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 0.98013439  
## b: -0.03880089  
## k: 0.57402812  
## Verbose output: 102302  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls failed... fitting linear model... Linear model fit  
## Intercept: 1.224673  
## Slope: -0.002383974  
## Verbose output: 102311  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Zero indices in input series:  
## 193 194  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls failed... fitting linear model... Linear model fit  
## Intercept: 0.2906381  
## Slope: 0.0008129911  
## lm has a positive slope  
## pos.slope = FALSE  
## Detrend by mean.  
## Mean = 0.4377895  
## Verbose output: 102312  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Zero indices in input series:  
## 193 194  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 0.81473188  
## b: -0.02042174  
## k: 0.28838224  
## Verbose output: 102321  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Zero indices in input series:  
## 317  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 0.38350175  
## b: -0.03208014  
## k: 0.52453774  
## Verbose output: 102322  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls failed... fitting linear model... Linear model fit  
## Intercept: 0.5473924  
## Slope: 0.00080779  
## lm has a positive slope  
## pos.slope = FALSE  
## Detrend by mean.  
## Mean = 0.6471545  
## Verbose output: 102341  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Zero indices in input series:  
## 157 193  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 0.87817024  
## b: -0.02076663  
## k: 0.38438272  
## Verbose output: 102342  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 1.008153  
## b: -0.020637  
## k: 0.398493  
## Verbose output: 102431  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 1.23895466  
## b: -0.02085683  
## k: 0.71092005  
## Verbose output: 102432  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 0.60218879  
## b: -0.01295955  
## k: 0.53169545  
## Verbose output: 102451  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Zero indices in input series:  
## 155 156 157 158 159  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 0.75585309  
## b: -0.06015716  
## k: 0.63053197  
## Verbose output: 102452  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Zero indices in input series:  
## 193  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls coefs  
## a: 1.83274980  
## b: -0.01756686  
## k: 0.43457031  
## Verbose output: 102491  
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Options  
## make.plot FALSE  
## method(s) "ModNegExp"  
## nyrs NULL  
## f 0.5  
## pos.slope FALSE  
## constrain.nls never  
## verbose TRUE  
## return.info FALSE  
## wt default  
## span cv  
## bass 0  
## difference FALSE  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## No zeros in input series.  
##   
## ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  
## Detrend by ModNegExp.  
## Trying to fit nls model...  
## nls failed... fitting linear model... Linear model fit  
## Intercept: 0.6962061  
## Slope: -0.001302699

# we can look at the col names of the new object  
names(rw.detrend)

## [1] "102061" "102062" "102081" "102101" "102102" "102121" "102141" "102142"  
## [9] "102171" "102172" "102181" "102182" "102241" "102261" "102271" "102272"  
## [17] "102291" "102292" "102301" "102302" "102311" "102312" "102321" "102322"  
## [25] "102341" "102342" "102431" "102432" "102451" "102452" "102491"

# and we can look at the means of those indviduals  
colMeans(rw.detrend, na.rm=TRUE)

## 102061 102062 102081 102101 102102 102121 102141 102142   
## 1.0046278 1.0021507 0.9977224 1.0407909 1.0610862 1.0023233 0.9996141 1.0014092   
## 102171 102172 102181 102182 102241 102261 102271 102272   
## 1.0108265 1.0001056 0.9977949 1.0038460 0.9997856 1.0000540 0.9998278 1.0000000   
## 102291 102292 102301 102302 102311 102312 102321 102322   
## 0.9979854 0.9990962 0.9996780 1.0112870 1.0000000 1.0007899 0.9996691 1.0000000   
## 102341 102342 102431 102432 102451 102452 102491   
## 0.9979342 0.9979640 0.9982441 0.9994659 0.9992464 1.0024558 1.0383337

## Building a Chronology

A chronology can be built from the detrended data.

rw.crn <- chron(rw.detrend, prefix = "CAM")  
  
# now we can plot these data  
plot(rw.crn, add.spline=TRUE, nyrs=20)

