Package 'fluxible'

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Title Ecosystem Gas Fluxes Calculations for Closed Loop Chamber Setup

Version 0.0.1

Description Processes the raw data from closed loop flux chamber (or tent) setups into ecosystem gas fluxes usable for analysis. It goes from a data frame of gas concentration over time (which can contain several measurements) and a meta data file indicating which measurement was done when, to a data frame of ecosystem gas fluxes including quality diagnostics. Functions provided include different models (exponential as described in Zhao et al (2018) <doi:10.1016/j.agrformet.2018.08.022>, quadratic and linear) to estimate the fluxes from the raw data, quality assessment, plotting for visual check and calculation of fluxes based on the setup specific parameters (chamber size, plot area, ...).

License GPL (>= 3)

Encoding UTF-8

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Suggests knitr, rmarkdown, testthat (>= 3.0.0), vdiffr

Config/testthat/edition 3

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LazyData true

URL https://plant-functional-trait-course.github.io/fluxible/

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Contents

co2_conc *CO2 concentration*

Description

CO2 concentration with measurements meta data

Usage

```
co2_conc
```

Format

A tibble with 1251 rows and 13 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

Examples

```
co2_conc
```

`co2_conc_missing` *CO2 concentration*

Description

CO2 concentration with measurements meta data, with missing data.

Usage

```
co2_conc_missing
```

Format

A tibble with 668 rows and 13 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

Examples

```
co2_conc_missing
```

co2_df_missing *CO2 concentration with missing data*

Description

Continuous CO2 concentration as measured on the field, with missing data.

Usage

```
co2_df_missing
```

Format

A tibble with 1148 rows and 5 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

Examples

```
co2_df_missing
```

co2_df_short *CO2 concentration*

Description

Continuous CO2 concentration as measured on the field

Usage

```
co2_df_short
```

Format

A tibble with 1801 rows and 5 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

Examples

```
co2_df_short
```

`co2_fluxes` *CO2 fluxes*

Description

Calculated CO2 fluxes

Usage

```
co2_fluxes
```

Format

A tibble with 6 rows and 11 variables

fluxID Unique ID for each flux.

slope_tz Slope of C(t) at t zero.

temp_air_ave Air temperature inside the flux chamber in Celsius averaged over the flux measurement.

flux CO2 flux in mmol/sqm/hour.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm averaged over the flux measurement.

temp_soil Ground temperature inside the flux chamber in Celsius averaged over the flux measurement.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement started.

temp_fahr Air temperature inside the flux chamber in Fahrenheit averaged over the flux measurement.

temp_kelvin Air temperature inside the flux chamber in Kelvin averaged over the flux measurement.

Examples

```
co2_fluxes
```

co2_liahovden *CO2 concentration at Liahovden*

Description

CO2 concentration at Liahovden site, used in example in readme file

Usage

```
co2_liahovden
```

Format

A tibble with 89692 rows and 5 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

Examples

```
co2_liahovden
```

flux_calc *calculates ecosystem gas fluxes*

Description

calculates a flux based on the rate of change of gas concentration over time

Usage

```
flux_calc(
  slopes_df,
  slope_col,
  datetime_col = "f_datetime",
  cut_col = c(),
  keep_arg = c(),
  chamber_volume = 24.5,
  tube_volume = 0.075,
  atm_pressure = 1,
  plot_area = 0.0625,
  cols_keep = c(),
```

```
  cols_ave = c(),
  fluxid_col = "f_fluxID",
  temp_air_col = "temp_air",
  temp_air_unit = "celsius",
  fit_type = c()
)
```

Arguments

slopes_df	dataframe of flux slopes
slope_col	column containing the slope to calculate the flux (in ppm*s^(-1))
datetime_col	column containing the datetime of each gas concentration measurements in slopes_df. The first one after cutting will be kept as datetime of each flux in the output.
cut_col	column containing cutting information
keep_arg	name in cut_col of data to keep
chamber_volume	volume of the flux chamber in L, default for Three-D project chamber (25x24.5x40cm), can also be a column in case it is a variable
tube_volume	volume of the tubing in L, default for summer 2020 setup, can also be a column in case it is a variable
atm_pressure	atmospheric pressure, assumed 1 atm, can be a constant (numerical) or a variable (column name)
plot_area	area of the plot in m^2, default for Three-D
cols_keep	columns to keep from the input to the output. Those columns need to have unique values for each flux, as distinct() is applied.
cols_ave	columns with values that should be averaged for each flux in the output. Note that NA are removed in mean calculation.
fluxid_col	column containing the fluxID
temp_air_col	column containing the air temperature used to calculate fluxes. Will be averaged with NA removed.
temp_air_unit	units in which air temperature was measured. Has to be either Celsius, Fahrenheit or Kelvin.
fit_type	(optional) model used in flux_fitting, exponential, quadratic or linear. Will be automatically filled if slopes_df was produced using flux_quality().

Value

a dataframe containing fluxID, fluxes (in mmol*m^(-2)*h^(-1)), temperature average for each flux, slope used for each flux calculation, the model used in `flux_fitting`, and any columns specified in cols_keep and cols_ave.

Examples

```
data(slopes0)
flux_calc(slopes0, slope_col = "f_slope")
```

flux_cut *filter cut data before calculating fluxes*

Description

filter cut data before calculating fluxes

Usage

```
flux_cut(slopes_df, cut_col, keep_arg)
```

Arguments

slopes_df	dataset containing slopes and cut column
cut_col	column containing cutting information
keep_arg	name in cut_col of data to keep

flux_fitting *Fitting a model to concentration data and estimating the slope*

Description

fits gas concentration over time data with a model (exponential, quadratic or linear) and provides the slope later used to calculate gas fluxes with flux_calc

Usage

```
flux_fitting(
  conc_df,
  start_cut = 0,
  end_cut = 0,
  start_col = "f_start",
  end_col = "f_end",
  datetime_col = "f_datetime",
  conc_col = "f_conc",
  fluxid_col = "f_fluxID",
  t_window = 20,
  cz_window = 15,
  b_window = 10,
  a_window = 10,
  roll_width = 15,
  t_zero = 0,
  fit_type
)
```

Arguments

conc_df	dataframe of gas concentration over time
start_cut	time to discard at the start of the measurements (in seconds)
end_cut	time to discard at the end of the measurements (in seconds)
start_col	column with datetime when the measurement started
end_col	column with datetime when the measurement ended
datetime_col	column with datetime of each concentration measurement
conc_col	column with gas concentration data
fluxid_col	column with ID of each flux
t_window	enlarge focus window before and after tmin and tmax (exponential fit)
cz_window	window used to calculate Cz, at the beginning of cut window (exponential fit)
b_window	window to estimate b. It is an interval after tz where it is assumed that the model fits the data perfectly (exponential fit)
a_window	window at the end of the flux to estimate a (exponential fit)
roll_width	width of the rolling mean for CO2 when looking for tz, ideally same as cz_window (exponential fit)
t_zero	time at which the slope should be calculated (for quadratic fit)
fit_type	exponential, quadratic or linear. Exponential is using the exponential model from Zhao et al (2018)

Value

a dataframe with the slope at t zero, and parameters of a model of gas concentration over time

References

Zhao, P., Hammerle, A., Zeeman, M., Wohlfahrt, G., 2018. On the calculation of daytime CO2 fluxes measured by automated closed transparent chambers. Agricultural and Forest Meteorology 263, 267–275. https://doi.org/10.1016/j.agrformet.2018.08.022

Examples

```
data(co2_conc)
flux_fitting(co2_conc, fit_type = "exp")
flux_fitting(co2_conc, fit_type = "quadratic", t_zero = 10, end_cut = 30)
```

`flux_fitting_exp` *Fitting a model to the gas concentration curve and estimating the slope over time, using the exponential model from Zhao et al (2018)*

Description

Fits an exponential expression to the concentration evolution

Usage

```
flux_fitting_exp(
  conc_df,
  t_window = 20,
  cz_window = 15,
  b_window = 10,
  a_window = 10,
  roll_width = 15,
  start_cut = 0,
  end_cut = 0,
  start_col = "f_start",
  end_col = "f_end",
  datetime_col = "f_datetime",
  conc_col = "f_conc",
  fluxid_col = "f_fluxID"
)
```

Arguments

`conc_df`	dataframe of gas concentration over time
`t_window`	enlarge focus window before and after tmin and tmax
`cz_window`	window used to calculate Cz, at the beginning of cut window
`b_window`	window to estimate b. It is an interval after tz where it is assumed that C fits the data perfectly
`a_window`	window at the end of the flux to estimate a
`roll_width`	width of the rolling mean for CO2 when looking for tz, ideally same as cz_window
`start_cut`	time to discard at the start of the measurements (in seconds)
`end_cut`	time to discard at the end of the measurements (in seconds)
`start_col`	column with datetime when the measurement started
`end_col`	column with datetime when the measurement ended
`datetime_col`	column with datetime of each concentration measurement
`conc_col`	column with gas concentration data
`fluxid_col`	column with ID of each flux

Value

a dataframe with the slope at t zero, modeled concentration over time and exponential expression parameters

References

Zhao, P., Hammerle, A., Zeeman, M., Wohlfahrt, G., 2018. On the calculation of daytime CO2 fluxes measured by automated closed transparent chambers. Agricultural and Forest Meteorology 263, 267–275. https://doi.org/10.1016/j.agrformet.2018.08.022

`flux_fitting_lin` *linear fit to gas concentration over time*

Description

fits a linear model to the gas concentration over time

Usage

```
flux_fitting_lin(
  conc_df,
  start_cut = 0,
  end_cut = 0,
  start_col = "f_start",
  end_col = "f_end",
  datetime_col = "f_datetime",
  conc_col = "f_conc",
  fluxid_col = "f_fluxID"
)
```

Arguments

`conc_df`	dataframe of gas concentration over time
`start_cut`	time to discard at the start of the measurements (in seconds)
`end_cut`	time to discard at the end of the measurements (in seconds)
`start_col`	column with datetime when the measurement started
`end_col`	column with datetime when the measurement ended
`datetime_col`	column with datetime of each concentration measurement
`conc_col`	column with gas concentration data
`fluxid_col`	column with ID of each flux

Value

a df with the modeled gas concentration, slope, intercept, std error, r square and p value of the linear model

`flux_fitting_quadratic` *quadratic fit to gas concentration over time*

Description

fits a quadratic model to the gas concentration over time

Usage

```
flux_fitting_quadratic(
  conc_df,
  start_cut = 0,
  end_cut = 0,
  start_col = "f_start",
  end_col = "f_end",
  datetime_col = "f_datetime",
  conc_col = "f_conc",
  fluxid_col = "f_fluxID",
  t_zero = 0
)
```

Arguments

`conc_df`	dataframe of gas concentration over time
`start_cut`	time to discard at the start of the measurements (in seconds)
`end_cut`	time to discard at the end of the measurements (in seconds)
`start_col`	column with datetime when the measurement started
`end_col`	column with datetime when the measurement ended
`datetime_col`	column with datetime of each concentration measurement
`conc_col`	column with gas concentration data
`fluxid_col`	column with ID of each flux
`t_zero`	time at which the slope should be calculated

Value

a df with the modeled gas concentration, slope, intercept, std error, r square and p value of the quadratic model

flux_fit_type *to check the type of fit*

Description

extracts the type of fit that was applied in flux_fitting or checks that the fit_type provided by the user is compatible with Fluxible

Usage

```
flux_fit_type(
  df,
  fit_type = c(),
  fit_type_list = c("exponential", "linear", "quadratic")
)
```

Arguments

df	any dataframe
fit_type	type of fit that was applied in flux_fitting. Needs to be filled only if the df was produced outside of the Fluxible workflow.
fit_type_list	list of fit types in use with Fluxible.

flux_flag_count *counts quality flags*

Description

provides a table of how many fluxes were attributed which quality flag. This function is incorporated in flux_quality (output as a message) but can be used alone to extract a dataframe with the flag count.

Usage

```
flux_flag_count(
  slopes_df,
  f_flags = c("ok", "discard", "zero", "weird_flux", "start_error", "no_data",
    "force_ok"),
  fluxid_col = "f_fluxID",
  flags_col = "f_quality_flag",
  cut_col = "f_cut",
  cut_arg = "cut"
)
```

Arguments

slopes_df	dataframe of flux slopes
f_flags	list of flags used in the dataset (if different from default from flux_quality). If not provided, it will list only the flags that are present in the dataset (no showing 0).
fluxid_col	column containing fluxes unique ID
flags_col	column containing the quality flags
cut_col	column indicating which part of the flux is being cut
cut_arg	argument defining that the data point should be cut out

Value

a dataframe with the number of fluxes for each quality flags and their proportion to the total

Author(s)

Vincent Belde

Examples

```
data(slopes30qua_flag)
flux_flag_count(slopes30qua_flag)
```

---

flux_match *Matching continuously measured fluxes with measurement IDs and meta data*

Description

Matching a dataframe of continuously measured gas concentration data with measurement metadata from another dataframe. Measurements are paired with their metadata based on datetime. Extra variables in both dataframes are kept in the output.

Usage

```
flux_match(
  raw_conc,
  field_record,
  startcrop = 10,
  measurement_length = 220,
  ratio_threshold = 0.5,
  time_diff = 0,
  datetime_col = "datetime",
  conc_col = "conc",
  start_col = "start"
)
```

Arguments

raw_conc	dataframe of CO2 concentration measured continuously. Has to contain at least a datetime column in ymd_hms format and a gas concentration column as double.
field_record	dataframe recording which measurement happened when. Has to contain at least a column containing the start of each measurement, and any other column identifying the measurements.
startcrop	how many seconds should be discarded at the beginning of the measurement
measurement_length	length of the measurement (in seconds) from the start specified in the field_record
ratio_threshold	ratio (number of concentration measurement compared to length of measurement in seconds) below which the data should be flagged as too little
time_diff	time difference (in seconds) between the two datasets. Will be added to the datetime column of the raw_conc dataset. For situations where the time was not synchronized correctly.
datetime_col	datetime column in raw_conc (dmy_hms format)
conc_col	concentration column in raw_conc
start_col	start column in field_record (dmy_hms format)

Value

a dataframe with concentration measurements, corresponding datetime, flux ID, measurements start and end, flags in case of no data or low number of data, and any variables present in one of the inputs.

Examples

```
data(co2_df_short, record_short)
flux_match(co2_df_short, record_short)
```

---

flux_param_exp *prepares text to print for flux_plot function*

Description

creates a df with quality flags and quality diagnostics to print on the plots produced by flux_plot. flux_param_lm is for fit in the lm family (linear and quadratic) flux_param_exp is for the exponential fit

Usage

```
flux_param_exp(slopes_df, cut_arg = "cut")
```

Arguments

slopes_df	the slopes_df that is being provided to flux_plot
cut_arg	argument pointing rows to be cut from the measurements

flux_param_lm *prepares text to print in flux_plot*

Description

creates a df with quality flags and quality diagnostics to print on the plots produced by flux_plot. flux_param_lm is for fit in the lm family (linear and quadratic) flux_param_exp is for the exponential fit

Usage

```
flux_param_lm(slopes_df, cut_arg = "cut")
```

Arguments

slopes_df	the slopes_df that is being provided to flux_plot
cut_arg	argument pointing rows to be cut from the measurements

flux_plot *plotting fluxes for visual evaluation*

Description

plots the fluxes, fit and slope in facets with color code indicating quality flags This function takes time to run and is optional in the workflow, but it is still highly recommended to use it to visually check the measurements.

Usage

```
flux_plot(
  slopes_df,
  color_discard = "#D55E00",
  color_cut = "#D55E00",
  color_ok = "#009E73",
  color_zero = "#CC79A7",
  f_date_breaks = "1 min",
  f_minor_breaks = "10 sec",
  f_date_labels = "%e/%m \n %H:%M",
  f_ylim_upper = 800,
  f_ylim_lower = 400,
  f_plotname = "plot_quality",
  facet_wrap_args = list(ncol = 4, nrow = 3, scales = "free"),
  y_text_position = 500,
  print_plot = "FALSE",
  output = "print_only",
```

```
  ggsave_args = list(),
  cut_arg = "cut",
  no_data_flag = "no_data"
)
```

Arguments

slopes_df	dataset containing slopes, with flags produced by flux_quality
color_discard	color for fits with a discard quality flag
color_cut	color for the part of the flux that is cut
color_ok	color for fits with an ok quality flag
color_zero	color for fits with a zero quality flag
f_date_breaks	date_breaks argument for scale_x_datetime
f_minor_breaks	minor breaks argument for scale_x_datetime
f_date_labels	date_labels argument for scale_x_datetime
f_ylim_upper	y axis upper limit
f_ylim_lower	y axis lower limit
f_plotname	filename for the extracted pdf file
facet_wrap_args	list of arguments for facet_wrap_paginate
y_text_position	position of the text box
print_plot	FALSE or TRUE, if TRUE it prints the plot in R but will take time depending on the size of the dataset
output	"pdfpages", the plots are saved as A4 landscape pdf pages; "ggsave", the plots can be saved with the ggsave function; "print_only" (default) prints the plot without creating a file (independently from 'print_plot' being TRUE or FALSE)
ggsave_args	list of arguments for ggsave (in case output = "ggsave")
cut_arg	argument pointing rows to be cut from the measurements
no_data_flag	flag marking fluxID without data in f_quality_flag

Value

a ggplot object if print_plot = TRUE, if print_plot = FALSE it will not return anything but will produce a file depending on output

Examples

```
data(slopes0_flag)
flux_plot(slopes0_flag, output = "print_only")
data(slopes30lin_flag)
flux_plot(slopes30lin_flag, output = "print_only")
flux_plot(slopes30qua_flag, output = "print_only")
```

flux_plot_exp *plotting fluxes with exponential fit*

Description

plots the fluxes that were fitted with an exponential model

Usage

```
flux_plot_exp(slopes_df, cut_arg = "cut", y_text_position = 500)
```

Arguments

slopes_df	dataset containing slopes
cut_arg	argument pointing rows to be cut from the measurements
y_text_position	position of the text box

flux_plot_flag *creates the flag column to be used by flux_plot*

Description

creates a column with quality flags (from flux_quality) for the part of the rows to be kept, and cut flag for rows to be discarded

Usage

```
flux_plot_flag(slopes_df, param_df, cut_arg = "cut")
```

Arguments

slopes_df	as provided in flux_plot
param_df	as provided by flux_param
cut_arg	argument pointing rows to be cut from the measurements

flux_plot_lin *plotting fluxes with linear fit*

Description

plots the fluxes that were fitted with a linear model

Usage

```
flux_plot_lin(slopes_df, y_text_position = 500, cut_arg = "cut")
```

Arguments

slopes_df	dataset containing slopes
y_text_position	position of the text box
cut_arg	argument pointing rows to be cut from the measurements

flux_plot_quadratic *plotting fluxes with a quadratic fit*

Description

specific part of flux_plot for quadratic fit

Usage

```
flux_plot_quadratic(slopes_df, y_text_position = 500, cut_arg = "cut")
```

Arguments

slopes_df	dataset containing slopes
y_text_position	position of the text box
cut_arg	argument pointing rows to be cut from the measurements

flux_quality *assessing quality of slopes calculated with flux_fitting*

Description

indicates if slopes should be discarded or replaced by 0 according to quality thresholds set by user

Usage

```
flux_quality(
  slopes_df,
  fit_type = c(),
  ambient_conc = 421,
  error = 100,
  fluxid_col = "f_fluxID",
  slope_col = "f_slope",
  weird_fluxes_id = c(),
  force_ok_id = c(),
  ratio_threshold = 0,
  pvalue_col = "f_pvalue",
  rsquared_col = "f_rsquared",
  pvalue_threshold = 0.3,
  rsquared_threshold = 0.7,
  conc_col = "f_conc",
  b_col = "f_b",
  time_col = "f_time",
  fit_col = "f_fit",
  cut_col = "f_cut",
  rmse_threshold = 25,
  cor_threshold = 0.5,
  b_threshold = 1,
  cut_arg = "cut"
)
```

Arguments

slopes_df	dataset containing slopes
fit_type	model fitted to the data, linear, quadratic or exponential. Will be automatically filled if slopes_df was produced using flux_fitting()
ambient_conc	ambient gas concentration in ppm at the site of measurement (used to detect measurement that started with a polluted setup)
error	error of the setup, defines a window outside of which the starting values indicate a polluted setup
fluxid_col	column containing unique IDs for each flux
slope_col	column containing the slope of each flux (as calculated by the flux_fitting function)

`weird_fluxes_id`
: vector of fluxIDs that should be discarded by the user's decision

`force_ok_id`
: vector of fluxIDs for which the user wants to keep the calculated slope despite a bad quality flag

`ratio_threshold`
: ratio of gas concentration data points over length of measurement (in seconds) below which the measurement will be considered as not having enough data points to be considered for calculations

`pvalue_col`
: column containing the p-value of each flux (linear and quadratic fit)

`rsquared_col`
: column containing the r squared of each flux (linear and quadratic fit)

`pvalue_threshold`
: threshold of p-value below which the change of gas concentration over time is considered not significant (linear and quadratic fit)

`rsquared_threshold`
: threshold of r squared value below which the linear model is considered an unsatisfactory fit (linear and quadratic fit)

`conc_col`
: column containing the measured gas concentration (exponential fit)

`b_col`
: column containing the b parameter of the exponential expression (exponential fit)

`time_col`
: column containing the time of each measurement in seconds (exponential fit)

`fit_col`
: column containing the modeled data (exponential fit)

`cut_col`
: column containing the cutting information

`rmse_threshold`
: threshold for the RMSE of each flux above which the fit is considered unsatisfactory (exponential fit)

`cor_threshold`
: threshold for the correlation coefficient of gas concentration with time below which the correlation is considered not significant (exponential fit)

`b_threshold`
: threshold for the b parameter. Defines a window with its opposite inside which the fit is considered good enough (exponential fit)

`cut_arg`
: argument defining that the data point should be cut out

Value

same dataframe with added quality flags and corrected slope column

Examples

```
data(slopes0lin)
flux_quality(slopes0lin, fit_type = "li")
data(slopes30)
flux_quality(slopes30, fit_type = "expo", slope_col = "f_slope")
```

flux_quality_exp *quality assessment for the slopes estimated by flux_fitting*

Description

indicates if fluxes should be discarded or replaced by 0 according to parameters set by user. flux_quality_lm is for the model of the lm family. flux_quality_exp is for the exponential model.

Usage

```
flux_quality_exp(
  slopes_df,
  weird_fluxes_id = c(),
  force_ok_id = c(),
  b_col = "f_b",
  rmse_threshold = 25,
  cor_threshold = 0.5,
  b_threshold = 1
)
```

Arguments

slopes_df	dataset containing slopes, fluxID, and parameters of the exponential expression
weird_fluxes_id	vector of fluxIDs that should be discarded by the user's decision
force_ok_id	vector of fluxIDs for which the user wants to keep the calculated slope despite a bad quality flag
b_col	column containing the b parameter of the exponential expression
rmse_threshold	threshold for the RMSE of each flux above which the fit is considered unsatisfactory
cor_threshold	threshold for the correlation coefficient of gas concentration with time below which the correlation is considered non significant
b_threshold	threshold for the b parameter. Defines a window with its opposite inside which the fit is considered good enough.

Value

same dataframe with added flag and corrected slopes columns

`flux_quality_lm` *quality assessment for the slopes estimated by flux_fitting*

Description

indicates if fluxes should be discarded or replaced by 0 according to parameters set by user. flux_quality_lm is for the model of the lm family. flux_quality_exp is for the exponential model.

Usage

```
flux_quality_lm(
  slopes_df,
  weird_fluxes_id = c(),
  force_ok_id = c(),
  pvalue_col = "f_pvalue",
  rsquared_col = "f_rsquared",
  pvalue_threshold = 0.3,
  rsquared_threshold = 0.7
)
```

Arguments

`slopes_df`	dataset containing slopes, fluxID, p.value and r.squared
`weird_fluxes_id`	vector of fluxIDs that should be discarded by the user's decision
`force_ok_id`	vector of fluxIDs for which the user wants to keep the calculated slope despite a bad quality flag
`pvalue_col`	column containing the p-value of each flux
`rsquared_col`	column containing the r squared to be used for the quality assessment
`pvalue_threshold`	threshold of p-value below which the change of gas concentration over time is considered not significant (user decided)
`rsquared_threshold`	threshold of r squared value below which the linear model is considered an unsatisfactory fit

Value

same dataframe with added flag and corrected slopes columns

record_liahovden *Measurements meta data at Liahovden*

Description

Measurements meta data as recorded on the field at site Liahovden

Usage

```
record_liahovden
```

Format

A tibble with 138 rows and 3 variables

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

Examples

```
record_liahovden
```

record_short *Measurements meta data*

Description

Measurements meta data as recorded on the field

Usage

```
record_short
```

Format

A tibble with 6 rows and 3 variables

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

Examples

```
record_short
```

`slopes0` *Slopes for each flux*

Description

Slopes of C(t) for each flux without cut.

Usage

```
slopes0
```

Format

A tibble with 1251 rows and 28 variables

datetime Datetime at which CO2 concentration was recorded.
temp_air Air temperature inside the flux chamber in Celsius.
temp_soil Ground temperature inside the flux chamber in Celsius.
conc CO2 concentration in ppm.
PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.
turfID Unique ID of the turf in which the measurement took place.
type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).
start Datetime at which the measurement was started.
end Datetime at which the measurement ended.
fluxID Unique ID for each flux.
n_conc Number of data point per flux.
ratio Ratio of n_conc over length of the measurement (in seconds).
flag Data quality flags.
time Time variable of the flux in seconds.
cut Indicating if the measurement should be kept (keep) or discarded (cut).
Cm_est Estimation of the Cm parameter.
a_est Estimation of the a parameter.
b_est Estimation of the b parameter.
tz_est Estimation of the tz parameter.
Cz Cz parameter of the C(t) function.
Cm Cm parameter of the C(t) function, calculated by optim() with Cm_est as starting point.
a a parameter of the C(t) function, calculated by optim() with a_est as starting point.
b b parameter of the C(t) function, calculated by optim() with b_est as starting point.
tz tz parameter of the C(t) function, calculated by optim() with tz_est as starting point.
slope_tz Slope of C(t) at tz
fit C(t), modeled CO2 concentration as a function of time.
fit_slope Output of linear model of CO2 concentration passing by C(tz) and a slope of slope_tz.
start_z Datetime format of tz

Examples

```
slopes0
```

`slopes0lin` *Slopes for each flux*

Description

Slopes of linear fit for each flux without cut.

Usage

```
slopes0lin
```

Format

A tibble with 1251 rows and 22 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

time Time variable of the flux in seconds.

cut Indicating if the measurement should be kept (keep) or discarded (cut).

p.value P-value of the linear model of CO2 concentration over time.

r.squared R squared of the linear model of CO2 concentration over time.

adj.r.squared Adjusted R squared of the linear model of CO2 concentration over time.

intercept Intercept of the linear model of CO2 concentration over time.

slope Slope of the linear model of CO2 concentration over time.

fit Output of the linear model of CO2 concentration over time.

Examples

```
slopes0lin
```

`slopes0lin_flag` *Slopes for each flux*

Description

Slopes of linear fit for each flux without cut, with quality flags.

Usage

```
slopes0lin_flag
```

Format

A tibble with 1251 rows and 22 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

f_conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

f_fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

time Time variable of the flux in seconds.

cut Indicating if the measurement should be kept (keep) or discarded (cut).

f_pvalue P-value of the linear model of CO2 concentration over time.

f_rsquared R squared of the linear model of CO2 concentration over time.

adj.r.squared Adjusted R squared of the linear model of CO2 concentration over time.

intercept Intercept of the linear model of CO2 concentration over time.

f_slope Slope of the linear model of CO2 concentration over time.

fit Output of the linear model of CO2 concentration over time.

f_start_error flagging if measurement started outside of the possible ambient concentration

f_quality_flag quality flag advising if the slope has to be replaced by 0 or NA

f_slope_corr slope corrected according to quality flag

Examples

```
slopes0lin_flag
```

`slopes0_flag` *Slopes for each flux*

Description

Slopes of C(t) for each flux with 0 second cut, with quality flags.

Usage

```
slopes0_flag
```

Format

A tibble with 1251 rows and 36 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

f_conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

f_fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

f_time Time variable of the flux in seconds.

f_cut Indicating if the measurement should be kept (keep) or discarded (cut).

Cm_est Estimation of the Cm parameter.

a_est Estimation of the a parameter.

b_est Estimation of the b parameter.

tz_est Estimation of the tz parameter.

Cz Cz parameter of the C(t) function.

Cm Cm parameter of the C(t) function, calculated by optim() with Cm_est as starting point.

a a parameter of the C(t) function, calculated by optim() with a_est as starting point.

f_b b parameter of the C(t) function, calculated by optim() with b_est as starting point.

tz tz parameter of the C(t) function, calculated by optim() with tz_est as starting point.

f_slope Slope of C(t) at tz

f_fit C(t), modeled CO2 concentration as a function of time.

fit_slope Output of linear model of CO2 concentration passing by C(tz) and a slope of slope_tz.

start_z Datetime format of tz

f_cor_coef coefficient of correlation between gas concentration and time

f_RMSE RMSE of the exponential fit and the measured data

f_start_error flagging if measurement started outside of the possible ambient concentration

f_fit_quality flagging bad fit

f_correlation flagging if there is a correlation between gas concentration and time

f_quality_flag quality flag advising if the slope has to be replaced by 0 or NA

f_slope_corr slope corrected according to quality flag

Examples

```
slopes0_flag
```

`slopes0_temp` *Slopes for each flux*

Description

Slopes of C(t) for each flux with air temperature in various units.

Usage

```
slopes0_temp
```

Format

A tibble with 1251 rows and 30 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

time Time variable of the flux in seconds.

cut Indicating if the measurement should be kept (keep) or discarded (cut).

Cm_est Estimation of the Cm parameter.

a_est Estimation of the a parameter.

b_est Estimation of the b parameter.

tz_est Estimation of the tz parameter.

Cz Cz parameter of the C(t) function.

Cm Cm parameter of the C(t) function, calculated by optim() with Cm_est as starting point.

a a parameter of the C(t) function, calculated by optim() with a_est as starting point.

b b parameter of the C(t) function, calculated by optim() with b_est as starting point.

tz tz parameter of the C(t) function, calculated by optim() with tz_est as starting point.

slope_tz Slope of C(t) at tz

fit C(t), modeled CO2 concentration as a function of time.

fit_slope Output of linear model of CO2 concentration passing by C(tz) and a slope of slope_tz.

start_z Datetime format of tz

temp_fahr Air temperature inside the flux chamber in Fahrenheit averaged over the flux measurement.

temp_kelvin Air temperature inside the flux chamber in Kelvin averaged over the flux measurement.

Examples

```
slopes0_temp
```

`slopes0_vol` *Slopes for each flux*

Description

Slopes of C(t) for each flux without cut.

Usage

```
slopes0_vol
```

Format

A tibble with 1251 rows and 28 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

time Time variable of the flux in seconds.

cut Indicating if the measurement should be kept (keep) or discarded (cut).

Cm_est Estimation of the Cm parameter.

a_est Estimation of the a parameter.

b_est Estimation of the b parameter.

tz_est Estimation of the tz parameter.

Cz Cz parameter of the C(t) function.

Cm Cm parameter of the C(t) function, calculated by optim() with Cm_est as starting point.

a a parameter of the C(t) function, calculated by optim() with a_est as starting point.

b b parameter of the C(t) function, calculated by optim() with b_est as starting point.

tz tz parameter of the C(t) function, calculated by optim() with tz_est as starting point.

slope_tz Slope of C(t) at tz

fit C(t), modeled CO2 concentration as a function of time.

fit_slope Output of linear model of CO2 concentration passing by C(tz) and a slope of slope_tz.

start_z Datetime format of tz

volume volume of chamber in L

Examples

```
slopes0_vol
```

`slopes0_vol_tube` *Slopes for each flux*

Description

Slopes of C(t) for each flux without cut.

Usage

```
slopes0_vol_tube
```

Format

A tibble with 1251 rows and 28 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

time Time variable of the flux in seconds.

cut Indicating if the measurement should be kept (keep) or discarded (cut).

Cm_est Estimation of the Cm parameter.

a_est Estimation of the a parameter.

b_est Estimation of the b parameter.

tz_est Estimation of the tz parameter.

Cz Cz parameter of the C(t) function.

Cm Cm parameter of the C(t) function, calculated by optim() with Cm_est as starting point.

a a parameter of the C(t) function, calculated by optim() with a_est as starting point.

b b parameter of the C(t) function, calculated by optim() with b_est as starting point.

tz tz parameter of the C(t) function, calculated by optim() with tz_est as starting point.

slope_tz Slope of C(t) at tz

fit C(t), modeled CO2 concentration as a function of time.

fit_slope Output of linear model of CO2 concentration passing by C(tz) and a slope of slope_tz.

start_z Datetime format of tz

volume volume of chamber in L

tube_vol volume of tubes in L

Examples

```
slopes0_vol_tube
```

`slopes30` *Slopes for each flux*

Description

Slopes of C(t) for each flux with a 30 seconds cut at the end of each flux.

Usage

```
slopes30
```

Format

A tibble with 1251 rows and 28 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

time Time variable of the flux in seconds.

cut Indicating if the measurement should be kept (keep) or discarded (cut).

Cm_est Estimation of the Cm parameter.

a_est Estimation of the a parameter.

b_est Estimation of the b parameter.

tz_est Estimation of the tz parameter.

Cz Cz parameter of the C(t) function.

Cm Cm parameter of the C(t) function, calculated by optim() with Cm_est as starting point.

a a parameter of the C(t) function, calculated by optim() with a_est as starting point.

b b parameter of the C(t) function, calculated by optim() with b_est as starting point.

tz tz parameter of the C(t) function, calculated by optim() with tz_est as starting point.

slope_tz Slope of C(t) at tz

fit C(t), modeled CO2 concentration as a function of time.

fit_slope Output of linear model of CO2 concentration passing by C(tz) and a slope of slope_tz.

start_z Datetime format of tz

Examples

```
slopes30
```

`slopes30lin` *Slopes for each flux*

Description

Slopes of linear fit for each flux with a 30 seconds cut at the end of each flux.

Usage

```
slopes30lin
```

Format

A tibble with 1251 rows and 22 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

time Time variable of the flux in seconds.

cut Indicating if the measurement should be kept (keep) or discarded (cut).

p.value P-value of the linear model of CO2 concentration over time.

r.squared R squared of the linear model of CO2 concentration over time.

adj.r.squared Adjusted R squared of the linear model of CO2 concentration over time.

intercept Intercept of the linear model of CO2 concentration over time.

slope Slope of the linear model of CO2 concentration over time.

fit Output of the linear model of CO2 concentration over time.

Examples

```
slopes30lin
```

`slopes30lin_flag` *Slopes for each flux*

Description

Slopes of linear fit for each flux with 30 seconds end cut, with quality flags.

Usage

```
slopes30lin_flag
```

Format

A tibble with 1251 rows and 22 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

f_conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

f_fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

time Time variable of the flux in seconds.

cut Indicating if the measurement should be kept (keep) or discarded (cut).

f_pvalue P-value of the linear model of CO2 concentration over time.

f_rsquared R squared of the linear model of CO2 concentration over time.

adj.r.squared Adjusted R squared of the linear model of CO2 concentration over time.

intercept Intercept of the linear model of CO2 concentration over time.

f_slope Slope of the linear model of CO2 concentration over time.

fit Output of the linear model of CO2 concentration over time.

f_start_error flagging if measurement started outside of the possible ambient concentration

f_quality_flag quality flag advising if the slope has to be replaced by 0 or NA

f_slope_corr slope corrected according to quality flag

Examples

```
slopes30lin_flag
```

`slopes30qua` *Slopes for each flux*

Description

Slopes of quadratic fit for each flux with 30 seconds end cut and t_zero of 10 seconds, without quality flags. C(t) = a + b*t* + *c*t^2

Usage

```
slopes30qua
```

Format

A tibble with 1251 rows and 27 variables

f_datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

f_conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

f_time Time variable of the flux in seconds.

f_cut Indicating if the measurement should be kept (keep) or discarded (cut).

f_pvalue P-value of the quadratic model of gas concentration over time.

f_rsquared R squared of the quadratic model of gas concentration over time.

f_adj_rsquared Adjusted R squared of the quadratic model of gas concentration over time.

f_intercept Intercept of the quadratic model of gas concentration over time.

f_param1 b parameter of C(t)

f_param2 c parameter of C(t)

f_slope Slope of the quadratic model of gas concentration over time at t_zero.

f_fit Output of the quadratic model of gas concentration over time.

f_fit_slope output of linear expression describing the slope at t_zero

Examples

```
slopes30qua
```

`slopes30qua_flag` *Slopes for each flux*

Description

Slopes of quadratic fit for each flux with 30 seconds end cut and t_zero of 10 seconds, with quality flags. C(t) = a + b*t* + *c*t^2

Usage

```
slopes30qua_flag
```

Format

A tibble with 1251 rows and 27 variables

f_datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

f_conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

f_time Time variable of the flux in seconds.

f_cut Indicating if the measurement should be kept (keep) or discarded (cut).

f_pvalue P-value of the quadratic model of gas concentration over time.

f_rsquared R squared of the quadratic model of gas concentration over time.

f_adj_rsquared Adjusted R squared of the quadratic model of gas concentration over time.

f_intercept Intercept of the quadratic model of gas concentration over time.

f_param1 b parameter of C(t)

f_param2 c parameter of C(t)

f_slope Slope of the quadratic model of gas concentration over time at t_zero.

f_fit Output of the quadratic model of gas concentration over time.

f_fit_slope output of linear expression describing the slope at t_zero

f_start_error flagging if measurement started outside of the possible ambient concentration

f_quality_flag quality flag advising if the slope has to be replaced by 0 or NA

f_slope_corr slope corrected according to quality flag

Examples

```
slopes30qua_flag
```

`slopes30_flag` *Slopes for each flux*

Description

Slopes of C(t) for each flux with 30 seconds end cut, with quality flags.

Usage

```
slopes30_flag
```

Format

A tibble with 1251 rows and 36 variables

datetime Datetime at which CO2 concentration was recorded.
temp_air Air temperature inside the flux chamber in Celsius.
temp_soil Ground temperature inside the flux chamber in Celsius.
f_conc CO2 concentration in ppm.
PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.
turfID Unique ID of the turf in which the measurement took place.
type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).
start Datetime at which the measurement was started.
end Datetime at which the measurement ended.
f_fluxID Unique ID for each flux.
n_conc Number of data point per flux.
ratio Ratio of n_conc over length of the measurement (in seconds).
flag Data quality flags.
f_time Time variable of the flux in seconds.
f_cut Indicating if the measurement should be kept (keep) or discarded (cut).
Cm_est Estimation of the Cm parameter.
a_est Estimation of the a parameter.
b_est Estimation of the b parameter.
tz_est Estimation of the tz parameter.
Cz Cz parameter of the C(t) function.
Cm Cm parameter of the C(t) function, calculated by optim() with Cm_est as starting point.
a a parameter of the C(t) function, calculated by optim() with a_est as starting point.
f_b b parameter of the C(t) function, calculated by optim() with b_est as starting point.
tz tz parameter of the C(t) function, calculated by optim() with tz_est as starting point.
f_slope Slope of C(t) at tz
f_fit C(t), modeled CO2 concentration as a function of time.
fit_slope Output of linear model of CO2 concentration passing by C(tz) and a slope of slope_tz.
start_z Datetime format of tz
f_cor_coef coefficient of correlation between gas concentration and time
f_RMSE RMSE of the exponential fit and the measured data
f_start_error flagging if measurement started outside of the possible ambient concentration
f_fit_quality flagging bad fit
f_correlation flagging if there is a correlation between gas concentration and time
f_quality_flag quality flag advising if the slope has to be replaced by 0 or NA
f_slope_corr slope corrected according to quality flag

Examples

```
slopes30_flag
```

`slopes60` *Slopes for each flux*

Description

Slopes of C(t) for each flux with a cut of 60 seconds at the end of each flux.

Usage

```
slopes60
```

Format

A tibble with 1251 rows and 28 variables

datetime Datetime at which CO2 concentration was recorded.
temp_air Air temperature inside the flux chamber in Celsius.
temp_soil Ground temperature inside the flux chamber in Celsius.
conc CO2 concentration in ppm.
PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.
turfID Unique ID of the turf in which the measurement took place.
type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).
start Datetime at which the measurement was started.
end Datetime at which the measurement ended.
fluxID Unique ID for each flux.
n_conc Number of data point per flux.
ratio Ratio of n_conc over length of the measurement (in seconds).
flag Data quality flags.
time Time variable of the flux in seconds.
cut Indicating if the measurement should be kept (keep) or discarded (cut).
Cm_est Estimation of the Cm parameter.
a_est Estimation of the a parameter.
b_est Estimation of the b parameter.
tz_est Estimation of the tz parameter.
Cz Cz parameter of the C(t) function.
Cm Cm parameter of the C(t) function, calculated by optim() with Cm_est as starting point.
a a parameter of the C(t) function, calculated by optim() with a_est as starting point.
b b parameter of the C(t) function, calculated by optim() with b_est as starting point.
tz tz parameter of the C(t) function, calculated by optim() with tz_est as starting point.
slope_tz Slope of C(t) at tz
fit C(t), modeled CO2 concentration as a function of time.
fit_slope Output of linear model of CO2 concentration passing by C(tz) and a slope of slope_tz.
start_z Datetime format of tz

Examples

```
slopes60
```

`slopes60lin` *Slopes for each flux*

Description

Slopes of linear fit for each flux with a 60 seconds cut at the end of each flux.

Usage

```
slopes60lin
```

Format

A tibble with 1251 rows and 22 variables

datetime Datetime at which CO2 concentration was recorded.

temp_air Air temperature inside the flux chamber in Celsius.

temp_soil Ground temperature inside the flux chamber in Celsius.

conc CO2 concentration in ppm.

PAR Photosynthetically active radiation inside the chamber in micromol/s/sqm.

turfID Unique ID of the turf in which the measurement took place.

type Type of measurement: ecosystems respiration (ER) or net ecosystem exchange (NEE).

start Datetime at which the measurement was started.

end Datetime at which the measurement ended.

fluxID Unique ID for each flux.

n_conc Number of data point per flux.

ratio Ratio of n_conc over length of the measurement (in seconds).

flag Data quality flags.

time Time variable of the flux in seconds.

cut Indicating if the measurement should be kept (keep) or discarded (cut).

p.value P-value of the linear model of CO2 concentration over time.

r.squared R squared of the linear model of CO2 concentration over time.

adj.r.squared Adjusted R squared of the linear model of CO2 concentration over time.

intercept Intercept of the linear model of CO2 concentration over time.

slope Slope of the linear model of CO2 concentration over time.

fit Output of the linear model of CO2 concentration over time.

Examples

```
slopes60lin
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