Package 'fluxible'

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Title Ecosystem Gas Fluxes Calculations for Closed Loop Chamber Setup

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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)

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`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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_n_conc Number of data point per flux.

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

f_flag_match 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_n_conc Number of data point per flux.

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

f_flag_match 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

f_fluxid Unique ID for each flux.

f_slope_tz Slope of C(t) at t zero.

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

f_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).

f_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
```

conc_poster *CO2 concentration*

Description

CO2 concentration used to make the plot in the poster

Usage

```
conc_poster
```

Format

A tibble with 530 rows and 11 variables

datetime Datetime at which CO2 concentration was recorded.

conc CO2 concentration in ppm.

f_fluxid Unique ID for each flux.

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

f_start Datetime at which the measurement was started.

f_RMSE RMSE of the exponential fit and the measured data

f_cor_coef coefficient of correlation between gas concentration and time

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

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

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.

Examples

```
conc_poster
```

`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,
  temp_air_col,
  chamber_volume,
  atm_pressure,
  plot_area,
  f_fluxid = f_fluxid,
  conc_unit,
  flux_unit,
  cols_keep = c(),
  cols_ave = c(),
  tube_volume,
  temp_air_unit = "celsius",
  f_cut = f_cut,
  keep_arg = "keep",
  cut = TRUE,
  fit_type = c()
)
```

Arguments

slopes_df	dataframe of flux slopes
slope_col	column containing the slope to calculate the flux (in ppm*s^(-1) or ppb*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.
temp_air_col	column containing the air temperature used to calculate fluxes. Will be averaged with NA removed.
chamber_volume	volume of the flux chamber in L, can also be a column in case it is a variable
atm_pressure	atmospheric pressure, can be a constant (numerical) or a variable (column name)
plot_area	area of the plot in m^2, can also be a column in case it is a variable
f_fluxid	column containing the flux IDs
conc_unit	unit in which the concentration of gas was measured ppm or ppb
flux_unit	unit in which the calculated flux will be mmol outputs fluxes in mmol * m^(-2)*h^(-1); micromol outputs fluxes in micromol * m^(-2)*h^(-1)
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.
tube_volume	volume of the tubing in L, can also be a column in case it is a variable
temp_air_unit	units in which air temperature was measured. Has to be either celsius (default), fahrenheit or kelvin.
f_cut	column containing cutting information
keep_arg	name in f_cut of data to keep
cut	if 'TRUE' (default), the measurements will be cut according to 'f_cut' before calculating fluxes. This has no influence on the flux itself since the slope is provided from flux_fitting, but it will influence the values of the columns in cols_ave.
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 flux IDs, datetime of measurements' starts, fluxes in mmol*m^(-2)*h^(-1)* or *micromol*m^(-2)*h^(-1) (f_flux) according to flux_unit, temperature average for each flux in Kelvin (f_temp_ave), the total volume of the setup for each measurement (f_volume_setup), the model used in flux_fitting, any column specified in cols_keep, any column specified in cols_ave with their value averaged over the measurement after cuts and discarding NA.

Examples

```
data(slopes0)
flux_calc(slopes0,
f_slope,
```

```
datetime,
temp_air,
conc_unit = "ppm",
flux_unit = "mmol",
chamber_volume = 24.5,
tube_volume = 0.075,
atm_pressure = 1,
plot_area = 0.0625)
```

`flux_check_item` *check the items inside* `flux_fun_check`

Description

check the items inside `flux_fun_check`

Usage

```
flux_check_item(arg, fn, msg, narg, df_name = NA)
```

Arguments

`arg`	argument to be checked by `fn`
`fn`	function to check `arg`
`msg`	message to display in case `arg` is the wrong class
`narg`	name of `arg`
`df_name`	name of `arg` in case it is a data frame

Author(s)

Adam Klimes

`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,
  conc_col,
  datetime_col,
  f_start = f_start,
  f_end = f_end,
  f_fluxid = f_fluxid,
  start_cut = 0,
  end_cut = 0,
  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
`conc_col`	column with gas concentration data
`datetime_col`	column with datetime of each concentration measurement Note that if there are duplicated datetime in the same f_fluxid only the first row will be kept
`f_start`	column with datetime when the measurement started
`f_end`	column with datetime when the measurement ended
`f_fluxid`	column with ID of each flux
`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)
`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 (f_slope), a datetime column of t zero (f_start_z), a factor column indicating the cuts (f_cut), the time in seconds since the start of the measurement (f_time), the modeled fit (f_fit), the modeled slope (f_fit_slope), the parameters of the fit depending on the model used, and any columns present in the input. The type of fit is added as an attribute for use by the other functions.

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, conc, datetime, fit_type = "exp")
flux_fitting(co2_conc, conc, datetime,  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,
  conc_col,
  datetime_col,
  f_start,
  f_end,
  f_fluxid,
  t_window,
  cz_window,
  b_window,
```

```
  a_window,
  roll_width,
  start_cut,
  end_cut
)
```

Arguments

conc_df	dataframe of gas concentration over time
conc_col	column with gas concentration
datetime_col	column with datetime of each concentration measurement Note that if there are duplicated datetime in the same f_fluxid only the first row will be kept
f_start	column with datetime when the measurement started
f_end	column with datetime when the measurement ended
f_fluxid	column with ID of each flux
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)

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,
  conc_col,
  datetime_col,
  f_start,
  f_end,
  f_fluxid,
  start_cut,
  end_cut
)
```

Arguments

conc_df	dataframe of gas concentration over time
conc_col	column with gas concentration
datetime_col	column with datetime of each concentration measurement Note that if there are duplicated datetime in the same f_fluxid only the first row will be kept
f_start	column with datetime when the measurement started
f_end	column with datetime when the measurement ended
f_fluxid	column with ID of each flux
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)

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,
  conc_col,
  datetime_col,
  f_start,
  f_end,
```

```
  f_fluxid,
  start_cut,
  end_cut,
  t_zero
)
```

Arguments

conc_df	dataframe of gas concentration over time
conc_col	column with gas concentration
datetime_col	column with datetime of each concentration measurement Note that if there are duplicated datetime in the same f_fluxid only the first row will be kept
f_start	column with datetime when the measurement started
f_end	column with datetime when the measurement ended
f_fluxid	column with ID of each flux
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)
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_fluxid = f_fluxid,
  f_quality_flag = f_quality_flag,
  f_cut = f_cut,
  f_flags = c("ok", "discard", "zero", "force_discard", "start_error", "no_data",
    "force_ok"),
  cut_arg = "cut"
)
```

Arguments

`slopes_df`	dataframe of flux slopes
`f_fluxid`	column containing fluxes unique ID
`f_quality_flag`	column containing the quality flags
`f_cut`	column indicating which part of the flux is being cut
`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).
`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_fun_check *checking that arguments and columns are in the correct class*

Description

checking that arguments and columns are in the correct class

Usage

```
flux_fun_check(args, fn, msg, name_df = NA)
```

Arguments

args	list of arguments or dataframe to check
fn	list of functions used to check (is.numeric, is.character, ...)
msg	list of messages to return in case of failed check
name_df	in case args is a df with selected columns to check origdf is the original df to take the name from for a more obvious error message

Author(s)

Adam Klimes

flux_gep *Calculates GEP*

Description

to calculate gross ecosystem production (GEP) from net ecosystem (NEE) exchange and ecosystem respiration (ER) as GEP = NEE - ER. Datetime and other variables to keep will be taken from the NEE measurement.

Usage

```
flux_gep(
  fluxes_df,
  type_col,
  datetime_col,
  f_flux = f_flux,
  id_cols,
  nee_arg = "NEE",
  er_arg = "ER",
  cols_keep = "none"
)
```

Arguments

fluxes_df	a dataframe containing NEE and ER
type_col	column containing type of flux (NEE or ER)
datetime_col	column containing start of measurement as datetime
f_flux	column containing flux values
id_cols	columns used to identify each pair of ER and NEE
nee_arg	argument designating NEE fluxes in type column
er_arg	argument designating ER fluxes in type column
cols_keep	columns to keep from fluxes_df. Values from NEE row will be filled in GEP row. none (default) keeps only the columns in id_cols, flux, type and datetime columns; all keeps all the columns; can also be a vector of column names.

Value

a dataframe with GEP as NEE - ER in long format with GEP, NEE, and ER as flux type, datetime, and any column specified in cols_keep. Values of datetime and columns in cols_keep for GEP row are taken from NEE measurements.

Examples

```
data(co2_fluxes)
flux_gep(co2_fluxes, type, f_start, id_cols = "turfID",
cols_keep = c("temp_soil"))
```

---

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,
  datetime_col,
  start_col,
  conc_col,
  startcrop,
  measurement_length,
  ratio_threshold = 0.5,
  time_diff = 0
)
```

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.
datetime_col	datetime column in raw_conc (dmy_hms format)
start_col	start column in field_record (dmy_hms format)
conc_col	concentration column in raw_conc
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.

Value

a dataframe with concentration measurements, corresponding datetime, flux ID (`f_fluxid`), measurements start (`f_start`) and end (`f_end`), flags in case of no data or low number of data (`f_flag_match`), the number of datapoints per measurement (`f_n_conc`), the ratio of number of datapoints over the length of each measurement in seconds (`f_ratio`), and any variables present in one of the inputs.

Examples

```
data(co2_df_short, record_short)
flux_match(co2_df_short, record_short, datetime, start, conc, startcrop = 10,
measurement_length = 180)
```

---

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, conc_col)
```

Arguments

slopes_df	the slopes_df that is being provided to flux_plot
conc_col	column with gas concentration

---

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, conc_col)
```

Arguments

slopes_df	the slopes_df that is being provided to flux_plot
conc_col	column with gas concentration

---

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. Note that 'flux_plot' is specific to the 'fluxible' package and will work best with datasets produced following a fluxible workflow.

Usage

```
flux_plot(
  slopes_df,
  conc_col,
  datetime_col,
  color_discard = "#D55E00",
  color_cut = "#D55E00",
  color_ok = "#009E73",
  color_zero = "#CC79A7",
  scale_x_datetime_args = list(date_breaks = "1 min", minor_breaks = "10 sec",
    date_labels = "%e/%m \n %H:%M"),
```

```
  f_ylim_upper = 800,
  f_ylim_lower = 400,
  f_plotname = "",
  facet_wrap_args = list(ncol = 4, nrow = 3, scales = "free"),
  y_text_position = 500,
  print_plot = "FALSE",
  output = "print_only",
  ggsave_args = list()
)
```

Arguments

`slopes_df`	dataset containing slopes, with flags produced by flux_quality
`conc_col`	column with gas concentration
`datetime_col`	column with datetime of each data point
`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
`scale_x_datetime_args`	list of arguments 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; if empty, the name of `slopes_df` will be used
`facet_wrap_args`	list of arguments for facet_wrap_paginate
`y_text_position`	position of the text box
`print_plot`	logical, if TRUE it prints the plot as a ggplot object 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"`)

Value

plots of fluxes, with raw concentration data points, fit, slope, and color code indicating quality flags and cuts. The plots are organized in facets according to flux ID, and a text box display the quality flag and diagnostics of each measurement. The plots are returned as a ggplot object if `print_plot = TRUE`; if `print_plot = FALSE` it will not return anything but will produce a file according to the `output` argument.

Examples

```
data(slopes0_flag)
flux_plot(slopes0_flag, conc, datetime)
data(slopes30lin_flag)
flux_plot(slopes30lin_flag, conc, datetime)
data(slopes30qua_flag)
flux_plot(slopes30qua_flag, conc, datetime)
```

---

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, conc_col, datetime_col, y_text_position)
```

Arguments

slopes_df	dataset containing slopes
conc_col	column with gas concentration
datetime_col	column with datetime of each data point
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)
```

Arguments

slopes_df	as provided in flux_plot
param_df	as provided by flux_param

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, conc_col, datetime_col, y_text_position)
```

Arguments

slopes_df	dataset containing slopes
conc_col	column with gas concentration
datetime_col	column with datetime of each data point
y_text_position	position of the text box

flux_plot_quadratic *plotting fluxes with a quadratic fit*

Description

specific part of flux_plot for quadratic fit

Usage

```
flux_plot_quadratic(slopes_df, conc_col, datetime_col, y_text_position)
```

Arguments

slopes_df	dataset containing slopes
conc_col	column with gas concentration
datetime_col	column with datetime of each data point
y_text_position	position of the text box

`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,
  conc_col,
  f_fluxid = f_fluxid,
  f_slope = f_slope,
  f_time = f_time,
  f_start = f_start,
  f_end = f_end,
  f_fit = f_fit,
  f_cut = f_cut,
  f_pvalue = f_pvalue,
  f_rsquared = f_rsquared,
  f_b = f_b,
  force_discard = c(),
  force_ok = c(),
  ratio_threshold = 0,
  fit_type = c(),
  ambient_conc = 421,
  error = 100,
  pvalue_threshold = 0.3,
  rsquared_threshold = 0.7,
  rmse_threshold = 25,
  cor_threshold = 0.5,
  b_threshold = 1,
  cut_arg = "cut"
)
```

Arguments

`slopes_df`	dataset containing slopes
`conc_col`	column containing the measured gas concentration (exponential fit)
`f_fluxid`	column containing unique IDs for each flux
`f_slope`	column containing the slope of each flux (as calculated by the flux_fitting function)
`f_time`	column containing the time of each measurement in seconds (exponential fit)
`f_start`	column with datetime of the start of the measurement (after cuts)

f_end	column with datetime of the end of the measurement (after cuts)
f_fit	column containing the modeled data (exponential fit)
f_cut	column containing the cutting information
f_pvalue	column containing the p-value of each flux (linear and quadratic fit)
f_rsquared	column containing the r squared of each flux (linear and quadratic fit)
f_b	column containing the b parameter of the exponential expression (exponential fit)
force_discard	vector of fluxIDs that should be discarded by the user's decision
force_ok	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
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
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)
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

a dataframe with added columns of quality flags (f_quality_flag), the slope corrected according to the quality flags (f_slope_corr), some diagnostics depending on the fit, and any columns present in the input.

Examples

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

`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,
  conc_col,
  f_fluxid,
  f_slope,
  f_time,
  f_fit,
  f_cut,
  f_b,
  force_discard,
  force_ok,
  rmse_threshold,
  cor_threshold,
  b_threshold
)
```

Arguments

`slopes_df`	dataset containing slopes, fluxID, and parameters of the exponential expression
`conc_col`	column with gas concentration
`f_fluxid`	column of ID for each measurement
`f_slope`	column containing the slope of each flux (as calculated by the flux_fitting function)
`f_time`	column containing the time of each measurement in seconds
`f_fit`	column containing the modeled data
`f_cut`	column containing the cutting information
`f_b`	column containing the b parameter of the exponential expression
`force_discard`	vector of fluxIDs that should be discarded by the user's decision
`force_ok`	vector of fluxIDs for which the user wants to keep the calculated slope despite a bad quality flag
`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,
  conc_col,
  f_fluxid,
  f_slope,
  f_cut,
  f_pvalue,
  f_rsquared,
  force_discard,
  force_ok,
  pvalue_threshold,
  rsquared_threshold,
  name_df
)
```

Arguments

`slopes_df`	dataset containing slopes, fluxID, p.value and r.squared
`conc_col`	column with gas concentration
`f_fluxid`	column of ID for each measurement
`f_slope`	column containing the slope of each flux (as calculated by the flux_fitting function)
`f_cut`	column containing the cutting information
`f_pvalue`	column containing the p-value of each flux
`f_rsquared`	column containing the r squared to be used for the quality assessment
`force_discard`	vector of fluxIDs that should be discarded by the user's decision
`force_ok`	vector of fluxIDs for which the user wants to keep the calculated slope despite a bad quality flag
`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

name_df
: name of slopes_df (used for error message)

Value

same dataframe with added flag and corrected slopes columns

---

raw_twogases *CO2 and CH4 concentration*

Description

CO2 and CH4 measured simultaneously

Usage

```
raw_twogases
```

Format

A tibble with 21681 rows and 4 variables

co2_conc CO2 concentration in ppm

ch4_conc CH4 concentration in ppb

datetime Datetime on the datapoint

temp_air Air temperature inside the chamber in Celsius

Examples

```
raw_twogases
```

---

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).

round Round of measurement.

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 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_flag_match Flags from flux_match.

f_time Time variable of the flux in seconds.

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

f_Cz Cz parameter of the C(t) function.

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

f_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.

f_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.

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

f_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 19 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_flag_match Flags from flux_match.

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 linear model of CO2 concentration over time.

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

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

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

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

f_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.

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.

f_flag_match Flags from flux_match.

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 linear model of CO2 concentration over time.

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

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

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

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

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

f_ratio Ratio of number of data points compared to length of measurement in seconds.

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 27 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_flag_match Flags from flux_match.

f_time Time variable of the flux in seconds.

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

f_Cz Cz parameter of the C(t) function.

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

f_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.

f_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.

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

f_start_z Datetime format of tz

f_ratio Ratio of number of data points compared to length of measurement in seconds.

f_cor_coef coefficient of correlation between gas concentration and time

f_RMSE RMSE of the exponential fit and the measured data

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 24 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_flag_match Flags from flux_match.

f_time Time variable of the flux in seconds.

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

f_Cz Cz parameter of the C(t) function.

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

f_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.

f_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.

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

f_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 23 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).
f_start Datetime at which the measurement was started.
f_end Datetime at which the measurement ended.
f_fluxid Unique ID for each flux.
f_flag_match Flags from flux_match.
f_time Time variable of the flux in seconds.
f_cut Indicating if the measurement should be kept (keep) or discarded (cut).
f_Cz Cz parameter of the C(t) function.
f_Cm Cm parameter of the C(t) function, calculated by optim() with Cm_est as starting point.
f_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.
f_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.
f_fit_slope Output of linear model of CO2 concentration passing by C(tz) and a slope of slope_tz.
f_start_z Datetime format of tz
volume volume of chamber in L

Examples

```
slopes0_vol
```

`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 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_flag_match Flags from flux_match.

f_time Time variable of the flux in seconds.

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

f_Cz Cz parameter of the C(t) function.

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

f_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.

f_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.

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

f_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 19 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_flag_match Flags from flux_match.

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 linear model of CO2 concentration over time.

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

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

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

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

f_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.

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.

f_flag_match Flags from flux_match.

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 linear model of CO2 concentration over time.

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

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

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

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

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

f_ratio Ratio of number of data points compared to length of measurement in seconds.

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 24 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

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

f_flag_match Flags from flux_match.

f_time Time variable of the flux in seconds.

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

f_param1 b parameter of C(t)

f_param2 c parameter of C(t)

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

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

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

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

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

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

f_fit_slope output of linear expression describing the slope at t_zero

f_start_z Datetime format of tz

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 26 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

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

f_flag_match Flags from flux_match.

f_time Time variable of the flux in seconds.

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

f_param1 b parameter of C(t)

f_param2 c parameter of C(t)

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

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

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

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

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

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

f_fit_slope output of linear expression describing the slope at t_zero

f_start_z Datetime format of tz

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 27 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_flag_match Flags from flux_match.

f_time Time variable of the flux in seconds.

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

f_Cz Cz parameter of the C(t) function.

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

f_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.

f_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.

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

f_start_z Datetime format of tz

f_ratio Ratio of number of data points compared to length of measurement in seconds.

f_cor_coef coefficient of correlation between gas concentration and time

f_RMSE RMSE of the exponential fit and the measured data

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 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_flag_match Flags from flux_match.

f_time Time variable of the flux in seconds.

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

f_Cz Cz parameter of the C(t) function.

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

f_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.

f_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.

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

f_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 19 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).

f_start Datetime at which the measurement was started.

f_end Datetime at which the measurement ended.

f_fluxid Unique ID for each flux.

f_flag_match Flags from flux_match.

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 linear model of CO2 concentration over time.

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

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

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

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

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

Examples

```
slopes60lin
```

`twogases_record` *Field record*

Description

Field record

Usage

```
twogases_record
```

Format

A tibble with 12 rows and 1 variable

start Start datetime of each flux measurement

Examples

```
twogases_record
```

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