# FluxnetLSM R package (v1.0): A community tool for processing FLUXNET data for use in land surface modelling

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## Supplementary Material

This supplementary material includes Supplementary Tables 1 and 2. An example script for processing a single site is provided in section S.1.

**Supplementary Table 1:** Default meteorological output variables. ALMA convention output names are indicated with an asterisk.

| Variable | FLUXNET variable | FLUXNET unit | Output variable | Output unit | ERA-Interim variable | QC flag | Essen-tial | Min. | Max. |
|---|---|---|---|---|---|---|---|---|---|
| Near surface air temperature | TA_F_MDS | C | Tair* | K | TA_ERA | Yes | Yes | 200 | 300 |
| Surface incident shortwave radiation | SW_IN_F_MDS | W $m^{-2}$ | SWdown* | W $m^{-2}$ | SW_IN_ERA | Yes | Yes | 0 | 1360 |
| Surface incident longwave radiation | LW_IN_F_MDS | W $m^{-2}$ | LWdown* | W $m^{-2}$ | LW_IN_ERA | Yes | No | 0 | 750 |
| Vapour pressure deficit | VPD_F_MDS | hPa | VPD | hPa | VPD_ERA | Yes | Yes | 0 | 100 |
| Surface air pressure | PA | kPa | Psurf* | Pa | PA_ERA | If gap-filled | No | 50000 | 110000 |
| Precipitation rate | P | mm | Precip* | mm $s^{-1}$ | P_ERA | If gap-filled | Yes | 0 | 0.05 |
| Scalar wind speed | WS | m $s^{-1}$ | Wind* | m $s^{-1}$ | WS_ERA | If gap-filled | Yes | 0 | 75 |
| Near surface relative humidity | RH | % | RH* | % | VPD_ERA | If gap-filled | No | 0 | 100 |
| Near surface specific humidity | RH | % | Qair* | kg/kg | VPD_ERA | If gap-filled | No | 0 | 0.1 |

**Supplementary Table 2:** Default evaluation output variables. ALMA convention output names are indicated with an asterisk.

| Variable | FLUXNET variable | FLUXNET unit | Output variable | Output unit | QC flag | Min | Max. |
|---|---|---|---|---|---|---|---|
| Reflected shortwave radiation | SW_OUT | W $m^{-2}$ | SWup* | W $m^{-2}$ | Yes | -100 | 1360 |
| Net absorbed radiation | NETRAD | W $m^{-2}$ | Rnet | W $m^{-2}$ | Yes | -1000 | 1360 |
| Near surface $CO_2$ concentration | CO2_F_MDS | µmol $CO_2$ $mol^{-1}$ | CO2air* | ppm | Yes | 200 | 600 |
| Ground heat flux | G_F_MDS | W $m^{-2}$ | Qg* | W $m^{-2}$ | Yes | -1000 | 1000 |
| Latent heat flux from surface | LE_F_MDS | W $m^{-2}$ | Qle* | W $m^{-2}$ | Yes | -1000 | 1000 |
| Latent heat flux from surface, corrected for energy balance closure | LE_CORR | W $m^{-2}$ | Qle_cor | W $m^{-2}$ | No | -1000 | 1200 |
| LE_CORR joint uncertainty | LE_CORR_JOINTUNC | W $m^{-2}$ | Qle_cor_uc | W $m^{-2}$ | No | -1000 | 1300 |
| Sensible heat flux from surface | H_F_MDS | W $m^{-2}$ | Qh* | W $m^{-2}$ | Yes | -1000 | 1000 |
| Sensible heat flux from surface, corrected for energy balance closure | H_CORR | W $m^{-2}$ | Qh_cor | W $m^{-2}$ | No | -1000 | 1000 |
| H_CORR joint uncertainty | H_CORR_JOINTUNC | W $m^{-2}$ | Qh_cor_uc | W $m^{-2}$ | No | -1000 | 1000 |
| Net ecosystem exchange of $CO_2$ (variable ustar) | NEE_VUT_REF | µmol $m^{-2}$ $s^{-1}$ | NEE* | µmol $m^{-2}$ $s^{-1}$ | No | -100 | 100 |

**Supplementary Table 3 continued.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| NEE_VUT_REF uncertainty (variable ustar) | NEE_VUT_REF_JOINTUNC | µmol $m^{-2}$ $s^{-1}$ | NEE_uc | µmol $m^{-2}$ $s^{-1}$ | No | -200 | 200 |
| Gross primary productivity of $CO_2$ (variable ustar, daytime partitioning) | GPP_DT_VUT_REF | µmol $m^{-2}$ $s^{-1}$ | GPP_DT | µmol $m^{-2}$ $s^{-1}$ | No | -200 | 200 |
| GPP_DT_VUT_REF standard error | GPP_DT_VUT_SE | µmol $m^{-2}$ $s^{-1}$ | GPP_DT_se | µmol $m^{-2}$ $s^{-1}$ | No | -200 | 200 |
| Gross primary productivity of $CO_2$ (variable ustar, nighttime partitioning) | GPP_NT_VUT_REF | µmol $m^{-2}$ $s^{-1}$ | GPP* | µmol $m^{-2}$ $s^{-1}$ | No | -200 | 200 |
| GPP_NT_VUT_REF standard error | GPP_NT_VUT_SE | µmol $m^{-2}$ $s^{-1}$ | GPP_se | µmol $m^{-2}$ $s^{-1}$ | No | -200 | 200 |

**S.1 Example usage of FluxnetLSM**

```
#' Example data conversion using the Howard Springs site.
#'
#' Converts useful variables from a Fluxnet 2015 spreatsheet format
#’ into two NetCDF files, one for fluxes, and one for met forcings.
#'
#' The user must provide the input file name (with full path),
#' output directory path and site code. All other settings
#' are optional and are set to their default values in this
#' example.
#'

library(FluxnetLSM)

##############################
###--- Required inputs ---###
##############################

#Fluxnet site ID (see http://fluxnet.fluxdata.org/sites/site-list-
#and-pages/)
site_code <- "AU-How"

# This directory should contain appropriate data from
# http://fluxnet.fluxdata.org/data/fluxnet2015-dataset/
in_path <- "~/FLUXNET2016_processing/Inputs"

#Outputs will be saved to this directory
out_path <- "~/FLUXNET2016_processing/Outputs"

# Name and version of dataset being processed (e.g. "FLUXNET2015")
datasetname="FLUXNET2015"

# Input Fluxnet data file (using FULLSET in this example, see
#R/Helpers.R for details)
infile <- get_fluxnet_files(in_path, site_code,
                            datasetname=datasetname)

#Retrieve dataset version
datasetversion <- get_fluxnet_version_no(infile)

################################
###--- Optional settings ---###
################################

# ERAinterim meteo file for gap-filling met data (set to FALSE if not
#desired)
ERA_gapfill  <- TRUE
ERA_file     <- get_fluxnet_erai_files(in_path, site_code,
                                       datasetname=datasetname,
                                       datasetversion=datasetversion)
```

```
#What percentage of time steps allowed to be missing
#or gap-filled in any given year? And minimum number of consecutive
#years to process. Note: Always checks for missing values. If no
#gapfilling thresholds are set, will not check for gap-filling.
missing      <- 15 #max. percent missing (must be set)
gapfill_all  <- 20 #max. percent gapfilled (optional)
gapfill_good <- NA #max. percent good-quality gapfilled (optional,
                   #ignored if gapfill_all set)
gapfill_med  <- NA #max. percent medium-quality gapfilled (optional,
                   #ignored if gapfill_all set)
gapfill_poor <- NA #max. percent poor-quality gapfilled (optional,
                   #ignored if gapfill_all set)
min_yrs      <- 2  #min. number of consecutive years

#Should code produce plots to visualise outputs? (set to NA if not
#desired)(annual: average monthly cycle; diurnal: average diurnal
#cycle by season; timeseries: 14-day running mean time series)
plot <- c("annual", "diurnal","timeseries")


##########################
###--- Run analysis ---###
##########################

convert_fluxnet_to_netcdf(infile=infile, site_code=site_code,
                          out_path=out_path, ERA_file=ERA_file,
                          ERA_gapfill=ERA_gapfill,
                          datasetname=datasetname,
                          datasetversion=datasetversion,
                          missing=missing, gapfill_all=gapfill_all,
                          gapfill_good=gapfill_good,
                          gapfill_med=gapfill_med,
                          gapfill_poor=gapfill_poor,
                          include_all_eval=TRUE, min_yrs=min_yrs,
                          plot=plot)
```