**General information:**

aa\_fluxes\_plus\_GPP.csv :fluxes computed for the Eddy tower mounted in the alfalfa field

Location of the Eddy Covariance station:

|  |  |
| --- | --- |
|  | Alfalfa |
| Latitude | 42.82752 |
| Longitude | 11.07665 |
|  |  |

The aa\_fluxes\_plus\_GPP.csv file has cut to select only quantities actually used in our work. Specifically, the time information and the GPP with the corresponding error. Moreover, also the Ustar and NEE info have been considered.

OBS: In the original file, there were the starting and ending measurements time (for example, 9:00 and 9:30). The GPP values, then are referred to an average time, namely 9.15. Therefore, the correct time\_avg has been evaluated and put in the GPP table create for on purpose for our analysis.

**Quantities meaning in the table:**

* **GPP\_DT\_U95**: Gross primary production, i.e. influx to the land surface (μmol m-2 s-1 as NEE) estimated by day-time partitioning high estimate (95% quantile of the bootstrapped uncertainty distribution);
* **GPP\_DT\_U95\_SD**: Gross primary production, i.e. influx to the land surface (μmol m-2 s-1 as NEE) estimated by day-time partitioning high estimate (95% quantile of the bootstrapped uncertainty distribution) estimated standard deviation;
* **Ustar**: Friction velocity, in m/s;
* **NEE\_U95\_f**: Net ecosystem exchange (mmol/m^2/s^1) high estimate (95% quantile of the bootstrapped uncertainty distribution). Original values and gaps filled with mean of selected datapoints (condition depending on gap filling method)
* **NEE\_fsdu**: Net ecosystem exchange (mmol/m^2/s^1) standard deviation across uStar thresholds (uncertainty, bias)

**Other Information:**

All fluxes computations were made using ECpack (program to process eddy-covariance data stored in NetCDF files. and ec\_ncdf which were initially developed by Arjan van Dijk, and now maintained and further developed by Arnold Moene (arnold.moene@wur.nl). More information about the software and computations can be found at <http://www.met.wur.nl/projects/jep/>.

The main parameters are explained below.

|  |  |  |
| --- | --- | --- |
| Short name | Measurement Unit | Long name |
| DOY | - | Day of Year |
| Hr | - | Hour (start hour) |
| Mn | - | Minute (start) |
| DOY | - | Day of Year |
| Hr1 | - | Hour (end hour) |
| Mn1 | - | Minute (end) |
| Dir | [degr] | Original wind direction |
| WD\_corrected | [degr] | Corrected wind direction (Column FT in the alfalfa file - to be used in further calculations ie footprint prediction) |
| d(dir) | [degr] | Wind direction tolerance |
| Mean(vectorU) | [m/s] | Mean wind speed |
| dMean(vectorU) | [m/s] | Mean wind speed tolerance |
| Mean(TSon) | [K] | Mean Sonic Air Temperature |
| dMean(TSon) | [K] | Mean Sonic Air Temperature Tolerance |
| Mean(q) | [kg/kg] | Specific Humidity |
| dMean(q) | [kg/kg] | Specific Humidity Tolerance |
| H(Sonic) | [W/m^2] | Sensible heat flux |
| Tol(HSonic) | [W/m^2] | Sensible heat flux tolerance |
| LvE | [W/m^2] | Latent heat |
| dLvE | [W/m^2] | Latent heat tolerance |
| UStar | [m/s] | Friction velocity |
| dUStar | [m/s] | Friction velocity tolerance |
| FCO2 | [kg/m^2/s^1] | CO2 flux |
| dFCO2 | [kg/m^2/s^1] | CO2 flux tolerance |
| FCO2\_mmol | [mmol/ m^2/s^1] | CO2 flux in mmol |
| ET | [kg/m^2/s^1] | Evapotranspiration |
| d\_ET | [kg/m^2/s^1] | Evapotranspiration Tolerance |
| ET\_mm | [mm] | Evapotranspiration in mm |
| d\_ET\_mm | [mm] | Evapotranspiration in mm tolerance |

Evapotranspiration was computed as a function of latent heat and Air temperature using the LE.to.ET function from the “bigleaf” R package (<https://cran.r-project.org/web/packages/bigleaf/bigleaf.pdf>

The columns AE – AO are the input columns for the online REddyProc: Eddy covariance data processing tool (<https://www.bgc-jena.mpg.de/REddyProc/brew/REddyProc.rhtml>) and they correspond to

|  |  |  |
| --- | --- | --- |
| Short name | Measurement Unit | Long name |
| DoY | - | Day of Year |
| Hr | - | Decimal Hour |
| NEE | [mmol/ m^2/s^1] | Net ecosystem exchange |
| LE | [W/m^2] | Latent heat flux (same as column T) |
| H | [W/m^2] | Sensible heat flux (same as column R) |
| Rg | [W/m^2] | Global radiation |
| Tair | Degrees Celsius | Air temperature |
| Tsoil | Degrees Celsius | Soil temperature |
| rH | % | Relative humidity |
| UStar | [m/s] | Friction velocity (same as column V) |

The columns AP-FR are the output columns of the REddyProc tool and their explanation can be found at <https://www.bgc-jena.mpg.de/bgi/index.php/Services/REddyProcWebOutput>.

From this last link:

The default corresponds to the previous pvWave BGC online tool and few alternative options are provided with the web-service.

## Default: Online Tool

### Description of gap filling output variables

|  |  |  |
| --- | --- | --- |
| **Suffix** | **Description** | **Old suffix** |
| \_Thres | the threshold of uStar values used to mark insufficient conditions |  |
| \_orig | Original values used for gap filling | orig |
| \_f | Original values and gaps filled with mean of selected datapoints (condition depending on gap filling method) | \_f |
| \_fqc | Quality flag assigned depending on gap filling method and window length: 0 = original, 1 = most reliable, 2 = medium, 3 = least reliable | \_fqc |
| \_fall | All values considered as gaps (for uncertainty estimates) | \_f\_unc |
| \_fall\_qc | All values considered as gaps (for uncertainty estimates) | \_fqc\_unc |
| \_fnum | Number of datapoints used for gap filling | \_fn, \_fn\_unc |
| \_fsd | Standard deviation of datapoints used for gap filling (uncertainty) | \_fs, \_fs\_unc |
| \_fsdu | Standard deviation across uStar thresholds (uncertainty, bias) |  |
| \_fsdug | Combination of random uncertainty and uncertainty due to u\*: sqrt(fsd^2 + fsdu^2) |  |
| \_fmeth | Method used for gap filling: 1 = similar meteo condition (sFillLUT with Rg, VPD, Tair) 2 = similar meteo (sFillLUT with Rg only) 3 = mean diurnal course (sFillMDC)) | \_fmet, \_fmet\_unc |
| \_fwin | Full window length used for gap filling | \_fwin, \_fwin\_unc |

#### Bootstrapping the uStar-Threshold estimate

When bootstrapping was performed, several output columns are re-estimated with gap-Filling based on low, median, and high estimates of the uStar-Threshold.

|  |  |  |
| --- | --- | --- |
| **Suffix** | **Description** | **Old suffix** |
| \_uStar | estimate on the original unbootstrapped data | (empty) |
| \_U05 | low estimate (5% quantile of the bootstrapped uncertainty distribution) |  |
| \_U50 | median estimate (50% quantile of the bootstrapped uncertainty distribution) |  |
| \_U95 | high estimate (95% quantile of the bootstrapped uncertainty distribution) |  |

A missing '\_uStar' suffix in NEE, GPP, or Reco, it corresponds either to not performing uStar filtering or to uStar threshold of the non-bootstrapped data.

### Description of flux partitioning output variables

|  |  |  |
| --- | --- | --- |
| **Variable name** | **Description** | **Old name** |
| GPP\_f | Gross primary production, i.e. influx to the land surface (μmol m-2 s-1 as NEE) (nighttime-based) |  |
| Reco\_f | Ecosystem respiration, i.e. outflux from the land surface (μmol m-2 s-1 as NEE) (nighttime-based) |  |
| GPP\_DT | Gross primary production, i.e. influx to the land surface (μmol m-2 s-1 as NEE) estimated by day-time partitioning |  |
| Reco\_DT | Ecosystem respiration, i.e. outflux from the land surface (μmol m-2 s-1 as NEE) estimated by day-time partitioning |  |
| E0 | activation energy parameter (K) in relationship between temperature and nighttime NEE from night-time partitioning |  |
| R\_ref | respiration at reference temperature parameter (μmol m-2 s-1 as NEE) in relationship between temperature and nighttime NEE from night-time partitioning |  |
| FP\_alpha | canopy light utilization efficiency and represents the initial slope of the light–response curve (daytime partitioning) |  |
| FP\_beta | maximum CO2 uptake rate of the canopy at light saturation (μmol m-2 s-1) (daytime partitioning) |  |
| FP\_k | parameter controlling the VPD limitation of GPP (daytime partitioning) (daytime partitioning) |  |
| FP\_qc | quality flag of the estimated parameters: 0: good parameter fit, 1: some parameters out of range, required refit, 2: next parameter estimate is more than two weeks away (daytime partitioning) |  |
| FP\_dRecPar | records until or after closest record that has a parameter estimate associated (daytime partitioning) |  |
| FP\_GPP2000 | GPP at incoming radiation of 2000 Wm-2, more robust alternative to saturation FP\_k |  |
| FP\_E0 | activation energy parameter (K) in relationship between temperature and nighttime NEE from day-time partitioning |  |
| FP\_RRef | respiration at reference temperature parameter (μmol m-2 s-1 as NEE) in relationship between temperature and nighttime NEE from day-time partitioning |  |
| FP\_RRef\_Night | same as FP\_RRef using the same FP\_E0, but from intermedate step based on night-time data |  |
| FP\_<X>\_sd | estimated standard devation of X |  |
| FP\_qc | quality flag of day-time partitioning: 0: good parameter fit, 1: some parameters LRC parameters were out of range, required refit, 2: next parameter estimate is more than two weeks away |  |

## REddyProc 1.2

In difference to the Online-Tool-default,

* the \_uStar suffix is handled differently:
  + A missing '\_uStar' suffix it corresponds to not applying filtering for u\* threshold.
  + For filtering with the uStar threshold estimated on non-bootstrapped data, the suffix '\_uStar' is used.

## Fluxnet 2015

Provides data output similar to the formatting of the [2015 fluxnet data release](https://fluxnet.org/data/fluxnet2015-dataset/fullset-data-product/).

The following differences to default REddyProc 1.2. output:

* Formatted as comma-separated ASCII file.
* All rows after the first row contain data, i.e. no units in the second row
* Time (end of the measurement interval) is specified in column TIMESTAMP\_END in ISO timestamp format: YYYMMDDHHMM
* During export column names are translated.
  + Fluxes with suffix of used uStar threshold quantile
    - "^NEE\_U(\\d\\d)\_f$" -> "NEE\_VUT\_\\1", (the pattern corresponds to the two digits quantile of the uStar threshold distribution)
    - "^GPP\_U(\\d\\d)\_f$" -> "GPP\_NT\_VUT\_\\1"
    - "^GPP\_DT\_U(\\d\\d)$" -> "GPP\_DT\_VUT\_\\1"
    - "^Reco\_U(\\d\\d)$" -> "RECO\_NT\_VUT\_\\1"
    - "^Reco\_DT\_U(\\d\\d)$" -> "RECO\_DT\_VUT\_\\1", "GPP"
    - "^Ustar\_Thresh\_U(\\d\\d)$" -> "USTAR\_THRESHOLD\_VUT\_\\1"
    - "^NEE\_U50\_fqc$" -> "NEE\_VUT\_USTAR50\_QC"
    - "^NEE\_U50\_fsd$" -> "NEE\_VUT\_USTAR50\_RANDUNC"
    - "^NEE\_U50\_fnum$" -> "NEE\_VUT\_USTAR50\_RANDUNC\_N
  + further variables
    - "night" -> "NIGHT", "Rg\_f" -> "SW\_IN\_F\_MDS", "Rg\_fqc" -> "SW\_IN\_F\_MDS\_QC", "PotRad\_NEW" -> "SW\_IN\_POT", "Tair\_f" -> "TA\_F\_MDS", "Tair\_fqc" -> "TA\_F\_MDS\_QC", "VPD\_f" -> "VPD\_F\_MDS", "VPD\_fqc" -> "VPD\_F\_MDS\_QC"