Online tool of a simple two-dimensional parameterisation for Flux Footprint Prediction (FFP)

For details of the derivation of the footprint parameterisation, see

Kljun, N., P. Calanca, M.W. Rotach, H.P. Schmid, 2015: A simple two-dimensional parameterisation for Flux Footprint Prediction (FFP). Geosci. Model Dev., 8, 3695-3713. doi:10.5194/gmd-8-3695-2015.

Please acknowledge the source of your footprint estimates by citing the above article. Thanks!

The FFPonline tool

To use the FFPonline tool, register or login at http://footprint.kljun.net → Online FFP 2D.
FFPonline allows you to upload a time series of input data. For each time step of the input data, an FFP footprint [1] is calculated (e.g., for each half-hour). All footprints of the uploaded time series are aggregated to a footprint climatology [1].

The tool then derives an unsupervised land cover classification [2, 3] based on an ESRI or a Google (RGB) map for the footprint area and overlays the footprint climatology with the classification, providing you with a simple estimate of what land cover contributes most to the measured fluxes. The unsupervised classification will derive five land cover classes. This is only a very simple approach for land cover classification that cannot substitute a detailed analysis.

Input data (Upload)

1) Flux tower information

Description: Provide a simulation name, for example site_yyyymm.
Please enter tower coordinates in decimal degrees latitude (-85° to 85°)/ longitude (-180° to 180°) in WGS84, with at least four decimals precision.
You can check the tower coordinates by clicking on “Check tower location”.

2) Upload Flux Data

To calculate a footprint climatology based on FFP, the input parameters listed below are needed. Upload a csv file with either information of a single time stamp or a time series of input data. The first row of the file is treated as header line. See FFPonline_template.csv for an example.

yyyy = Year
mm = Month [1-12]
day = Day of month [1-31]
HH = Hour [0-23] or [1-24] – has to be **in UTC**, NOT local time
MM = Minutes, for example [0 30]
zm = Measurement height above ground [m]
d = Displacement height [m]
z0 = Roughness length [m] - enter [-999] if not known
u_mean = Mean wind speed at zm [ms-1] - enter [-999] if not known
L = Obukhov length [m]
sigma_v = Standard deviation of lateral velocity fluctuations after rotation [ms^{-1}]
u_star = Friction velocity [ms^{-1}]
wind_dir = Wind direction in degrees (of 360) for rotation of the footprint
Note: Either z0 or u_mean is required. If both are given, z0 is selected to calculate the footprint.

The **error code for missing data is -999**. Only upload quality controlled data (e.g., u*-filtered). The measurement height should be above the roughness sublayer and within the planetary boundary layer. Further, the footprint parameterisation is restricted to -15.5 ≤ zm/L and u*>0.1 ms^{-1} (see Section 6.2 of Kljun et al. (2015) for more details on the limitations of FFP).

Please make sure that the input data is correctly arranged as shown in the template (the header line will not be read, a different order of input variables may hence result in erroneous footprints).
The time series does not necessarily need to be continuous. For daytime-only footprints, upload only daytime data. **Maximum file size is 10 Mb**. For processing of several years of data, it is suggested to upload one file per year.

The FFPOnline tool derives the planetary boundary layer height (*h*) for neutral and stable conditions according to Appendix B of Kljun et al. (2015). For convective conditions, *h* is set to 1500 m. Please see Kljun et al. (2015) for details on the derivation of *h* and for a description of the sensitivity of the footprint regarding estimates of *h*.

3) Run FFP

Click on "Process" to start the simulation.

Result files

Once you have started the simulation, the FFPonline calculation will enter a queue. Once ready, you will find the results listed at "MyProfile", for viewing or downloading. Please make sure to download the result files when they are ready. They will be kept until you delete them, or until we run out of space. Please note that we cannot guarantee that they are stored for more than a few days and we do not back up the results.

You will be able to download a zip-file with the following content:

FFPonline_Readme.pdf
: This file

fig_contour.png
: ESRI World Imagery or Google map of the flux tower area with footprint contour lines from 10 to 90%, in 10% steps

fig_lc.png
: ESRI World Imagery or Google map with land cover classification and footprint contour lines from 10 to 90%, in 10% steps. The contribution from each land cover class to the measured flux using footprint-weighting is annotated in the title of each panel.

fig_raster.png
: ESRI World Imagery or Google map of the flux tower area with footprint raster and contour lines from 10 to 90%, in 10% steps

footprint_classification_summary.csv
: Based on the footprint climatology: relative contribution of each land cover class to the measured flux depending on footprint source area (contribution per area only, no footprint-weighting). The map area is set as domain.

footprint_classification_weighted_summary.csv
: Based on the footprint climatology: relative contribution of each land cover class to the measured flux depending on footprint source area (applying footprint-weighting). The map area is set as domain.

footprint_fr.csv
: Footprint value at r (see below). These values can be used to draw contour lines of the footprint in a plot of footprint_raster_fclim2d.

footprint_r.csv

Percentage of contours in footprint_fr.csv, expressed in fractions of 1 (i.e. 0.1 to 0.9 for 10% to 90%)

footprint_raster_x2d.csv
: Raster with x-data of 2-dimensional footprint. Distance [m] from the flux tower, i.e. the tower is located at (0/0). The raster is a *m x n* two-dimensional array (matrix) where *m* corresponds to latitudinal distance and *n* to longitudinal distance. The x-coordinate of the lower left corner of the data raster / map corresponds to the very first number of the file.

footprint_raster_y2d.csv
: Raster with y-data of 2-dimensional footprint. Distance [m] from the flux tower, i.e. the tower is located at (0/0). The raster is a *m x n* two-dimensional array (matrix) where *m* corresponds to latitudinal distance and *n* to longitudinal distance. The y-coordinate of the lower left corner of the data raster / map corresponds to the very first number of the file.

footprint_raster_fclim2d.csv
: Raster with the footprint function values [m^{-2}] of the 2-dimensional footprint. The raster is a *m x n* two-dimensional array (matrix) where *m* corresponds to latitudinal distance and *n* to longitudinal distance. The first number of the file corresponds to the footprint value of the lower left corner.

log.txt
: Log file containing your simulation name, tower coordinates, and simulation details

For terms of use of ESRI World Imagery see https://www.esri.com/en-us/legal/terms/master-agreement, for terms of use of Google maps see https://developers.google.com/maps/terms.

Run your own FFP simulations

For customised simulations, for example for using your own maps or to design your own figures, you can download the FFP code (Matlab, Python, R) at http://footprint.kljun.net.

Acknowledgement

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References

[1] Kljun, N., P. Calanca, M.W. Rotach, H.P. Schmid, 2015: A simple two-dimensional parameterisation for Flux Footprint Prediction (FFP). *Geosci. Model Dev.*, 8, 3695-3713. doi:10.5194/gmd-8-3695-2015.

[2] Lloyd, Stuart P., 1982: Least Squares Quantization in PCM.*IEEE Transactions on Information Theory,* 28, 129–137.

[3] Seber, G. A. F., 1984: Multivariate Observations. Hoboken, NJ: John Wiley & Sons, Inc.