



## Fully Corrected Fluxes

Data logger program that computes fully corrected fluxes of CO<sub>2</sub>, latent heat, and sensible heat

### Overview

EasyFlux™ DL is a free CRBasic program that enables a data logger to report fully corrected fluxes of CO<sub>2</sub>, latent heat (H<sub>2</sub>O), sensible heat, and momentum from a Campbell Scientific open-path and closed-path eddy-covariance (EC) system. Final fluxes are processed from raw high frequency time series data by applying commonly used corrections found in scientific literature.

In the past, Campbell Scientific's data logger EC programs roughly estimated fluxes, and PC post-processing software was used to fully correct the flux measurements. Now with

the EasyFlux™ DL program, fully corrected fluxes are processed by the data logger and reported at the end of each EC averaging interval.

EasyFlux™ DL has been tested at several stations in various environments, including irrigated alfalfa, grassland, maize, open water, forest, and desert. The results have shown good agreement with fluxes processed using traditional PC-based software applications.

To download EasyFlux™ DL, refer to the Downloads section.

### Benefits and Features

- ▶ Accesses final fluxes quickly without the burden of post-processing
- ▶ Produces flux output tables that are smaller than time series tables, which allows flux data to be frequently collected using cellular, radio, or other lower-bandwidth telemetry options
- ▶ Available at no charge; see Downloads section on web page
- ▶ Matches the fluxes provided by PC post-processing software packages (assuming same filtering of raw data and same selection of correction procedures)
- ▶ Saves high frequency time series to removable media in case reprocessing is later needed
- ▶ Includes data quality and footprint characteristics
- ▶ Reports uncorrected and intermediate values in an auxiliary output table for more detailed data inspection
- ▶ Provides for CR6 program fully processed data output in AmeriFlux format

### Technical Description

Provides fully corrected outputs of CO<sub>2</sub> flux, latent heat flux, and sensible heat flux at a user-defined interval (e.g., 30 minutes). Also provides many other variables of atmospheric

properties, instrument diagnostics, intermediate corrections, and other energy balance or biomet sensors. Comparisons of flux outputs have shown good agreement with other

common post-processing software packages when applying the same set of corrections.

#### Main correction and processing procedures:

- ▶ Despiking and filter high frequency time series data using sonic anemometer and gas analyzer diagnostic codes, signal strengths, and measurement output range thresholds.
- ▶ Apply coordinate rotations with an option to use the double rotation method (Tanner and Thurtell, 1969) or planar fit method (Wilczak et al., 2001).
- ▶ Lag CO<sub>2</sub> and H<sub>2</sub>O measurements against sonic wind measurements for maximization of CO<sub>2</sub> and H<sub>2</sub>O fluxes (Horst and Lenschow, 2009; Foken et al., 2012), with additional constraints to ensure lags are physically possible.
- ▶ Apply frequency corrections using commonly used cospectra (Moore, 1986; van Dijk, 2002; Moncrieff et al., 1997) and transfer functions for block averaging (Kaimal et al., 1989), line/volume averaging (Moore, 1986; Moncrieff et al., 1997; Foken et al., 2012; van Dijk, 2002), time constants (Montgomery, 1947; Shapland et al., 2014; Geankoplis, 1993), and sensor separation (Horst and Lenschow, 2009; Foken et al., 2012).
- ▶ Apply a modified SND correction (Schotanus et al., 1983) to derive sensible heat flux from sonic sensible heat flux following the implementation as outlined in van Dijk (2002). Additionally, fully corrected sensible heat flux computed from a fine-wire thermocouple is provided if our FW05, FW1, or FW3 is used.
- ▶ Apply correction for air density fluctuations using Webb et al., 1980.
- ▶ Assign data quality classifications (QC) based on steady state conditions and surface layer turbulence characteristics following Foken et al., 2002 to conform to AmeriFlux format. In addition, Foken et al., (2012) is also followed to include wind direction. An additional set of QC is provided.
- ▶ Calculate footprint characteristics using Kljun et al., 2004 or Kormann and Meixner, 2001.
- ▶ If energy balance sensors are used, calculate energy closure based on energy balance measurements and corrected sensible and latent heat fluxes.
- ▶ Sonic shadow correction is optional.
- ▶ CO<sub>2</sub> spectroscopic correction using air temperature at high frequency nature as default and at convention as an option. CO<sub>2</sub> values corrected using different air temperature are all stored at the measured frequency.

For comprehensive details, visit: [www.campbellsci.eu/easyflux-dl](http://www.campbellsci.eu/easyflux-dl) 



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