AmeriFlux Post-Processing Data QA/QC Activities

Gilberto Pastorello, Deb Agarwal, Dario Papale, Carlo Trotta, Eleonora Canfora, et al.

Berkeley, CA
2014-02-12
Eddy Covariance Method for Measuring Fluxes

Adapted from: Dario Papale (U. Tuscia)
The AmeriFlux Network and the AmeriFlux Management Project

http://ameriflux.lbl.gov/

168 registered sites

AMP
Funded by DOE

Coordinated at Berkeley Lab

Collaboration with institutions across the globe - FLUXNET

photo: D. Baldocchi Lab
Data Flow – Data Processing Pipeline for NEE

1. Data Collection (High Frequency and Meteorological Data)
2. Pre-Processing and Sensor Calibration
3. Processing into Fluxes
4. Post-Processing and Product Generation
5. QA / QC Flagging / Visual Checks
6. Ustar Calculation and Filtering
7. Gapfilling
8. Flux Partitioning
9. Generation of Data Products

Synthesis Studies, Models, Simulations
Data Processing Pipeline (carbon exchange)

1. Data Collection (High Frequency and Meteorological Data)
2. Pre-Processing and Sensor Calibration
3. Processing into Fluxes
4. Post-Processing and Product Generation
5. Synthesis Studies, Models, Simulations
6. QA / QC Flagging / Visual Checks
   - Ustar Calculation and Filtering
   - Gapfilling
   - Flux Partitioning
   - Generation of Data Products
Visual QA/QC – Precipitation

Time – 21 years (1991-2011)
Visual QA/QC – Precipitation

Time – 21 years (1991-2011)

½h accumulated

daily accumulated

Rainfall (mm)
Visual QA/QC – Precipitation

different sampling resolution
Visual QA/QC – Net Solar Radiation

Time – 14 years (1996-2009)
Visual QA/QC – Net Solar Radiation

Time – 14 years (1996-2009)

different levels for maximums and minimums
Visual QA/QC – Net Radiation
Visual QA/QC – Net Radiation

shifted lower and upper limits by different amounts
Visual QA/QC – Soil Heat Flux

Different ranges in ranges of values
Visual QA/QC – Air Pressure

different resolutions (number of digits?)
Visual QA/QC – Wind Speed

changes in sensors (model or height)
Visual QA/QC – Latent Heat

top and bottom cuts

modeled?
different instrument?
different filtering?
Visual QA/QC – Latent Heat

Varying maximums and minimums

different resolution due to fix number of digits
Visual QA/QC – CO$_2$ Turbulent Flux

variable threshold cuts
Visual QA/QC – Long Wave Radiation

Different ranges
Visual QA/QC – Precipitation

different sampling resolution

- diverging sampling
- consistent sampling

extreme points:
Visual QA/QC – Relative Humidity

smaller sampling resolution at upper part of sampling range

sensor failure
Visual QA/QC – Air Temperature

apparent small trend in maximums: real?
Visual QA/QC – PPFD vs SW_IN

Photosynthetically
Active Incoming
Radiation (μE/m²/s)

Short Wave
Incoming Radiation (W/m²)

Time – 1 year (2002)
Visual QA/QC – PPFD vs SW_IN

Photosynthetically Active Incoming Radiation (μE/m²/s)

Short Wave Incoming Radiation (W/m²)

Time – 1 year (2002)

Photosynthetically Active Incoming Radiation (μE/m²/s)
Visual QA/QC – PPFD vs SW_IN

Photosynthetically Active Incoming Radiation (μE/m²/s)

3 distinct trends

Time – 1 year (2002)
Visual QA/QC – PPFD vs SW_IN

SWin vs PPFD: JPTak 2000

PPFD

0 1464 2928 4392 5856 7320 8784 10248 11712 13176 14640 16104 17568

SWIn

0 200 400 600 800 1000 1200 1400 1600 1800 2000
Visual QA/QC – PPFD vs SW_IN

"perfect" match: derived data
Visual QA/QC – Wind Speed vs $U^*$
Visual QA/QC – Wind Speed vs $U^*$

two trends: leaf budding
Visual QA/QC – Wind Speed vs U*

WS vs USTAR: CHOe1 2005

regression Wind speed - Ustar
Visual QA/QC – Wind Speed vs U*

two trends: snow
Visual QA/QC – PPFD vs SW_IN
Visual QA/QC – PPFD vs SW_IN

The graph shows the comparison of PPFD and SW_IN over a period from 1996 to 2010. The data points indicate degradation in PPFD with a corresponding increase in SW_IN. A calibration phase is observed around the year 2002, where the PPFD degradation is slightly reduced.

Key points:
- **Slope PPFD vs SW_in**: The y-axis represents the slope of the PPFD vs SW_in relationship.
- **FRHes**: The x-axis represents the years from 1996 to 2010.
- **PPFD degradation**: The downward trend in PPFD from 1998 to 2003.
- **Calibration**: An improvement in PPFD degradation from 2002 to 2004.
Visual QA/QC – PPFD vs SW_IN

- **green**: monthly variation
- Seasonal variation on sun angle
- Sensor cosine response
Visual QA/QC – PPFD vs SW_IN

- dip in $r^2$
- phase shift between sensors
Visual QA/QC – PPFD vs SW_IN

![Graph showing PPFD degradation and calibration](image-url)
Visual QA/QC – PPFD vs SW_IN
Visual QA/QC – Timestamps through Radiation and Solar Noon

“ideal” incoming solar radiation (top of the atmosphere)

sensor 1 (short wave)
sensor 2 (PPFD)

Solar Radiation (W/m²)

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300

01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 00:00

Time of the Day
Visual QA/QC – Timestamps through Radiation and Solar Noon

- “ideal” incoming solar radiation (top of the atmosphere)
- Sensor 1 (short wave)
- Sensor 2 (PPFD)
- Timestamp shift
- Solar noon
- Timestamp noon
Visual QA/QC – Timestamps through Radiation and Solar Noon

“ideal” incoming solar radiation (top of the atmosphere)

Sensor 1 (short wave)

Sensor 2 (PPFD)

Possible shadow on sensor

Timestamp noon

Solar noon

Time of the Day
Visual QA/QC – Timestamps through Radiation and Solar Noon

“flat top” caused by partial shifts in timestamp
Visual QA/QC – Timestamps through Radiation and Solar Noon

higher than max

timestamp shift between two sensors
Visual QA/QC – Timestamps through Radiation and Solar Noon

shadow on both sensors in the afternoon
Visual QA/QC – Timestamps through Radiation and Solar Noon

ITRen 1999

looks like shift, but sunrise is correct: not horizontal PPFD sensor

shadow on PPFD only
Visual QA/QC

• Visual inspection to clarify (and potentially correct) data collection and processing issues
• Some tests can be automated to give more direct feedback, but many cannot be predicted beforehand
• Interaction with data managers for each site is essential: things that look like errors can be real and possibly the most interesting (extremes)
Thank You