**DATA META FILE 2016**

This file describes the instrumentation, field setup, and quality control procedures

associated with the climate and flux data collected for AMERIFLUX Site US\_Ro4 during 2016 at the University of

Minnesota, Rosemount Research Experiment Station (UMORE Park) located near St.

Paul Minnesota.

Metafile Created: **February 6, 2017**

Metafile Updated: **February 6, 2017**

Climate Data Files First Posting: **February 2, 2017**

Flux Raw Data Files First Posting: **February 2, 2017**

**Investigators**

Please direct all questions, comments, or errors related to these data to:

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**Site Location and Description**

Rosemount Research and Outreach Center (RROC), Upper Midwest, St. Paul, Minnesota

Flux stations in restored tallgrass Prairie

Site US\_Ro4 Prairie

**RROC Station Coordinates**

Site US\_Ro4: 44.404131 N, -93.42014 W, Elevation: 274m

**Last Ameriflux Site Visits: August 2013 (G21), August 2009 (G19), August 2006 (G21), August 2004 (G21)**

**Relevant Reference Papers (complete list at www.biometeorology.umn.edu)**

Baker, J.M., Ochsner, T.E., Venterea, R.T., and Griffis, T.J. 2006. Tillage and Soil Carbon Sequestration –

What Do We Really Know?, Agriculture, Ecosystems, and Environment, 118: 1-5

Baker, J.M. and Griffis T.J. 2005. Examining strategies to improve the carbon balance of corn/soybean

agriculture using eddy covariance and mass balance techniques. Agricultural and Forest Meteorology*,*

128 (3-4), 163-177.

Griffis, T.J., Sargent S.D., Baker J.M., Lee X., Tanner B.D., Greene J., Swiatek E., and Billmark K. 2007.

Direct measurement of biosphere-atmosphere Isotopic CO2 exchange using the eddy covariance

technique. In prep.

Griffis, T.J., Zhang J., Baker, J.M., Kljun, N., and Billmark, K. 2007. Determining carbon isotope signature

from micrometeorological measurements: Implications for studying biosphere-atmosphere exchange

processes. Boundary-Layer Meteorology, 123 (2): 201-218, doi: 10.1007/s10546-006-9143-8

Griffis, T.J., Baker, J.M., and Zhang, J. 2005. Seasonal dynamics of isotopic CO2 exchange in a C3/C4

managed ecosystem. Agricultural and Forest Meteorology, 132, 1-19.

Griffis, T.J. Lee, X., Baker J.M., King J.Y., and Sargent S.D. 2005. Feasibility of quantifying ecosystem atmosphere

C18O16O fluxes and discrimination mechanisms using laser spectroscopy, Agricultural

and Forest Meteorology, 135, 44-60.

Zhang, J., Griffis T.J., and Baker J.M. 2006. Using continuous stable isotope measurements to partition net

ecosystem CO2 exchange. Plant Cell and Environment, doi:10.1111/j.1365-3040.2005.01425.x.

**Climate Variables and Data Structure**

There are currently 23 variables contained within a [17568 x 23] comma delineated array.

This array represents our best measure/quality control of the climate variables to date and

are subject to revision. See dates above for recent updates concerning the data file and

metadata.

The following data are provided without headers for field sites **Prairie (US\_Ro4)**:

**Column Variable Units Instrument \*Notes**

1 Timestamp Start (ISO8601)

2 Timestamp End (ISO8601

3 Air temperature (oC) Vaisala HMP155A 3.0m

4 Soil heat flux at 10 cm depth W/m2 (2X Huskeflux HFP01SC)

5 Soil temperature (oC) at 2.5cm depth using Type T Thermocouples

6 Soil temperature (oC) at 5cm depth using Type T Thermocouples

7 Soil temperature (oC) at 7.5cm depth using Type T Thermocouples

8 Soil temperature (oC) at 10 cm depth using Type T Thermocouples

9 Net radiation (Rn) W/m2 Kipp and Zonen CNR4 3.7 m

10 Relative humidity (%) - Vaisala HMP155A 3.0 m

11 Precipitation (mm) using Geonor T200B Weighing Gauge

12 Vapor Pressure Deficit (hPa)

13 Wind Speed (m/s) Campbell Scientific CSAT-3 Sonic Anaemometer

14 Incoming shortwave radiation (K↓) W/m2 Kipp and Zonen CNR4 3.7m

15 Outgoing (reflected) shortwave W/m2 Kipp and Zonen CNR4 3.7 m

16 Incoming longwave radiation W/m2 Kipp and Zonen CNR4 3.7m

17 Outgoing longwave radiation W/m2 Kipp and Zonen CNR4 3.7m

18 Wind direction (degrees) Campbell Scientific CSAT-3 Sonic Anaemometer

19 Photosynthetic Photon Flux Density (µmolPhoton m-2 s-1) Apogee Instruments SQ-311

20 Air Pressure (kPa) measured using Vaisala PTB-110 barometer

21 Surface Temperature (degrees Celsius) using Apogee Infrared Radiometer

22 Albedo (%)

23 Soil Volumetric Water Content at 10cm (SWC, %) Campbell Scientific TDR100

**Instrumentation and Calculations**

\*All heights provided above are relative to the ground surface

Soil heat flux is measured at a soil depth of 10 cm and corrected using the calorimetric

method with thermocouples position above (but offset from) the HFP01SC self

calibrating heat flux plates.

Net radiation is a composite variable consisting of the best component fluxes (upward

and downward facing pyranometers and pyregeometers, Kipp and Zonen 4 Component Net Radiometer, CNR4)

**Gapfilling of Meteorological Data**

Where possible, gaps have been filled by linear interpolation (temperatures, relative humidity, soil heat flux, gaps <=2hrs), or by pulling data from other Rosemount Cluster sites (US\_Ro2 and US\_Ro1) for incoming short and longwave radiation, soil and air temperatures, relative humidity or if these are not possible from ASOS Automated weather station at KLVN Airport Lakeville for air temperature and relative humidity (12 mi distance).

**Data Files Recently Posted (Feb 02, 2017)**

US\_Ro4\_AmerifluxAnnualMeteorologyFile\_2016.xlsx

**Eddy Covariance Flux Measurements**

**Basic System Information**

All eddy covariance data collection and calculations were performed on a CR5000

Campbell Scientific Data Logger. All signals were acquired at 10 Hz and half-hourly

fluxes calculated and stored internally. Post processing of these data is done at the

University of Minnesota using custom Matlab software.

The eddy covariance system consists of a 2-dimensional sonic-anemometer-thermometer

(CSAT3, Campbell Scientific Inc.) and an open-path infrared gas analyzer (LI-7500, LI-COR Biosciences, Inc.).

**Basic Post-Processing**

1. Raw covariances are determined from 30 minute block averaging

2. Two-dimensional coordinate rotation is applied following Baldocchi et al.,

(1988)

3. Webb-Pearman-Leuning (WPL) & Schotanus simultaneous solution

4. As this site uses 2 flux towers to account for inadequate fetch in all directions (North and South Tower) an R script is used to import processed flux data for each tower and stitch them together based on prevailing wind direction. The result is a single flux timeseries for each variable where values are used based on wind direction. Briefly, for simplicity, roughly north winds use fluxes from the south tower, roughly south winds from the north tower, and roughly East/West winds use averages of both towers. Details and a download of this script can be found at the U of MN Biometeorology group website: (biometeorology.umn.edu/research/matlab-tools)

5. De-spiking of NEE, LE and H using method described by Papale et al. (2006; Biogeosciences, 3:571-583). Briefly, the time series is despiked by comparing the double differenced timeseries (2nd derivative) with the median absolute deviation computed over some defined window, *n* (in this case 13 days).

6. Basic QA/QC is performed on raw data removing suspect observations due to instrument failure, optical window obstructions, site power loss, etc.

**Please Note:** These Eddy Flux Files are considered “RAW” and have not been filtered

using final assessment of the co-spectra/stationarity/statistical properties, friction velocity filters or empirical gapfilling.

**Flux Variables and Data Structure**

There are currently 13 variables contained within a [17568 x 13] comma delimited array.

These data are subject to revision. See dates above for recent updates concerning the

flux data file and metadata.

**Column Variable Units**

1 Timestamp Start (ISO8601)

2 Timestamp End (ISO8601)

3 U-star (friction velocity, m/s)

4 Net ecosystem CO2 exchange (NEE) μmol m-2 s-1 (storage corrected)

5 Carbon dioxide (CO2) flux, FC μmol m-2 s-1

6 CO2 storage flux (SC) μmol m-2 s-1

7 Sensible heat flux (H) W m-2

8 Sensible heat (SH) storage flux W m-2

9 Latent heat flux (LE) W m-2

10 Latent heat storage flux (SLE) W m-2

11 CO2 Concentration (mixing ratio umol/mol)

12 H20 Concentration (mixing ratio mmol/mol)

13 Z/L Atmospheric Stability parameter

**Data Files Recently Posted (Feb 02, 2017)**

US\_Ro4\_AmerifluxAnnualFluxFile\_not\_gapfilled\_2016.xlsx

**Biomass DATA**

Leaf area index was measured with an AccuPAR handheld sensor (AccuPAR, Model

PAR-80, Decagon Devices Inc., Pullman, WA, USA).

The leaf area indexes are currently stored as 8 variables within a comma delimited array.

The variables include: Year, DOY, Time, Field ID, Crop Type, LAI, Latitude, Longitude

**Biomass Files Posted**

**Gapfilling of Eddy Covariance Flux Measurements**

Processed flux data are further filtered for periods of insufficient nighttime turbulence using site specific friction velocity thresholds for the growing season and non-growing season. These thresholds are as follows: Prairie, 0.1 m/s. Processed flux data are filtered and removed below these thresholds after despiking and before gapfilling. For these purposes, nighttime observations are included those where incoming solar radiation is <10 W/m^2.

Gap-filling net ecosystem carbon dioxide (CO2) exchange (NEE) and partitioning into gross primary production (GPP) and ecosystem respiration (*R*E) is accomplished using a variation on the light-response-curve analyses described in Reichstein et al., [2005]. Here we estimate RE during the growing season from daily light-response curves to NEP (net ecosystem production) in daytime, and separately for night as the mean of measured NEE, while during the non-growing season, the mean 24 h *R*E is taken. These three different samples of RE are then used separately to fit unique temperature functions (5cm soil temperature. These models are then used to model RE as a function of temperature for each averaging interval during the respective time periods. Daytime NEP is filled using the light-response curves using PPFD. GPP is then taken as the sum of NEP and RE.The assumption here is that we can reasonably capture the *R*E-temperature relation using these mean data. All functions were written using MATLAB (R2015a).

**Gapfilled Flux Variables and Data Structure**

There are currently 6 variables contained within a [17568 x 6] comma delimited array.

These data are subject to revision. See dates above for recent updates concerning the

flux data file and metadata.

**Column Variable Units**

1 Timestamp Start (ISO8601)

2 Timestamp End (ISO8601)

3 Gapfilled Net ecosystem CO2 exchange (NEE\_F) μmol m-2 s-1 (storage corrected)

4 Ecosystem Respiration (RECO), μmol m-2 s-1, from flux partitioning algorithm

5 Gross primary productivity (GPP), μmol m-2 s-1, from flux partitioning algorithm

6 Gapfilled Latent Heat Flux (LE\_F), W m-2

**Data Files Recently Posted (Feb 02, 2017)**

US\_Ro4\_AmerifluxAnnualFluxFile\_gapfilled\_2016.xlsx