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FLUXNET Canada Research Network - Canadian Carbon Program Data Collection, 1993-2014

Get Data

Documentation Revision Date: 2016-12-06

Data Set Version: V1

Summary

FLUXNET Canada is a Fluxnet research network comprised of the Fluxnet-Canada Research Network (FCRN) and the Canadian Carbon Program (CCP) operating from 1993 through 2014. It was a national research network of university and government scientists studying the influence of climate and disturbance on carbon cycling along an east-west transect of Canadian forest and peat land ecosystems. The data provided are measured and modeled results as obtained from the site investigators. They were not standardized and quality-controlled. Data include: atmospheric carbon dioxide (CO₂) and water vapor fluxes and many ancillary meteorological variables; soil CO₂ efflux and soil moisture; stable carbon isotopes; site soil and vegetation characteristics, plus documentation and descriptions for the 32 tower sites across 12 flux research stations. The time period is from 1993 - 2014; most reported data for a site does not cover the entire period.

This data set contains the contents of the Fluxnet-Canada/Canadian Carbon Program Data Information System (DIS) which was previously distributed as an internet based warehouse for all FLUXNET Canada and the CCP until the website was closed in 2014.

The eddy covariance method was used at individual network tower sites to measure mass and energy exchange across a horizontal plane between vegetation and the free atmosphere. The spatial scales of observations at each tower extended through the flux footprint around the tower (ranging between 100 and 1000 m). Ground plots were studied to gain an overview of the state of ecological and site variables and were established and surveyed according to Canada's National Forest Inventory ground plot protocols (NFI 2004 A-F).

There are 35 files with this data set. This includes 33 compressed files (*.zip), one for each tower site (when opened these directories contain a total of 21,494 files in various formats). There is also one compressed shapefile (.zip) which contains spatial information about these sites, and one comma-separated file (.csv) which provides the site locations, FLUXNET identifiers, and investigator contact information from the shapefile.

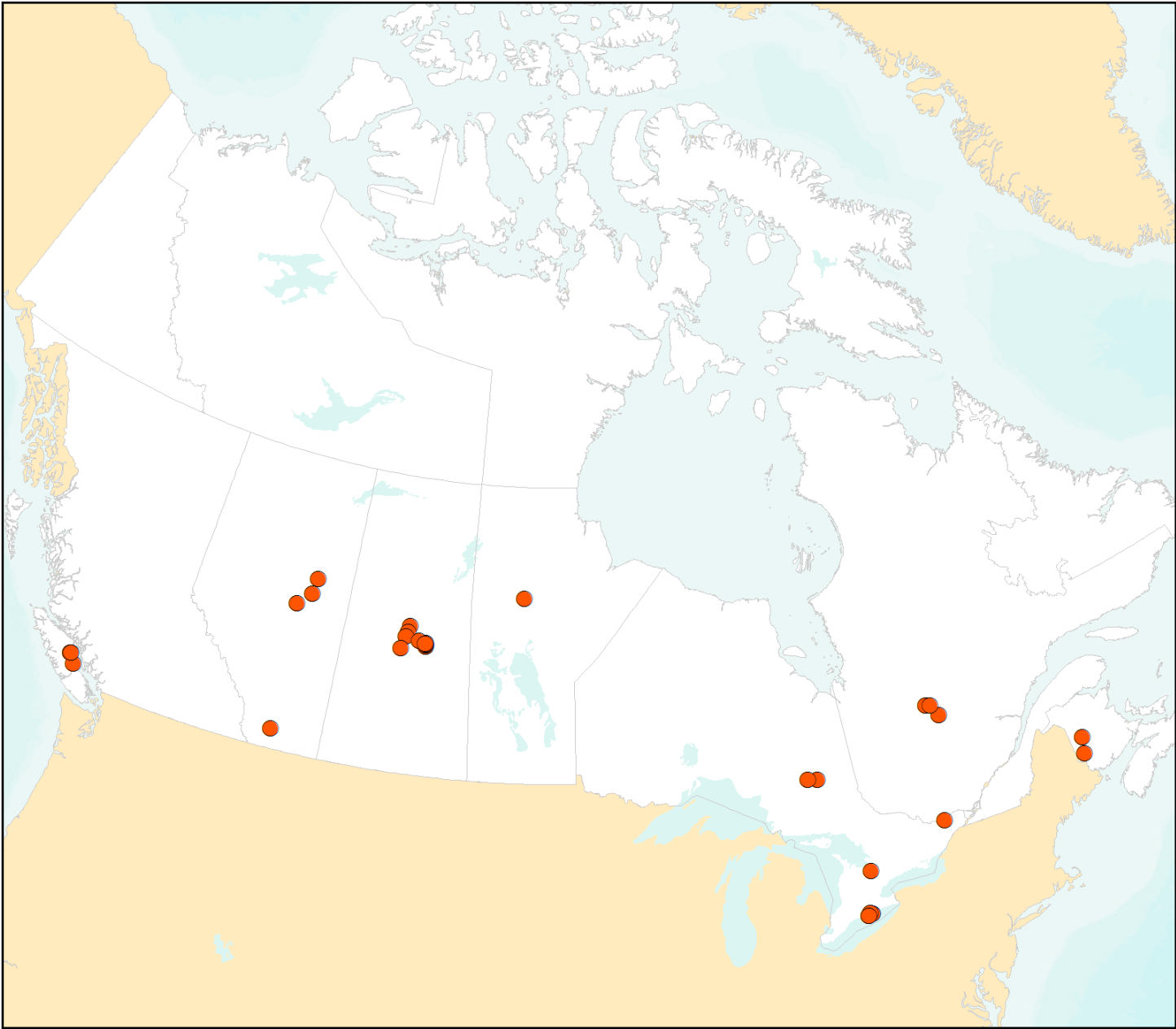


Figure 1. Locations of the 32 Eddy-Covariance towers of FLUXNET Canada included in this data set.

Citation

FLUXNET CANADA TEAM. 2016. FLUXNET Canada Research Network - Canadian Carbon Program Data Collection, 1993-2014. ORNL DAAC, Oak Ridge, Tennessee, USA. <http://dx.doi.org/10.3334/ORNLDAAC/1335>

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1. Data Set Overview

FLUXNET Canada is comprised of the Fluxnet-Canada Research Network (FCRN) and the Canadian Carbon Program (CCP). It was a national research

network of university and government scientists studying the influence of climate and disturbance on carbon cycling along an east-west transect of Canadian forest and peat land ecosystems.

The data provided are measured and modeled results as obtained from the site investigators. They were not standardized and quality-controlled. Data include: atmospheric carbon dioxide (CO2) and water vapor fluxes, and many ancillary meteorological variables; soil CO2 efflux and soil moisture; stable carbon isotopes; site soil and vegetation characteristics surface water, plus documentation and descriptions for the 32 tower sites across 12 flux research stations. The time period is from 1993 - 2014; most reported data for a site does not cover the entire period.

The eddy covariance method was used at individual network sites to measure mass and energy exchange across a horizontal plane between vegetation and the free atmosphere. Information collected at a site encompassed sensor measurements, field observations, laboratory analysis of field samples, as well as anecdotal descriptions. Ground Plots were studied to gain an overview of the state of ecological and site variables and included measurements of trees, understory, woody debris, forest floor, vegetation dominant species, leaf characteristics, carbon, biomass, and soil measurements within each plot (Baldocchi, 2008).

This data set contains the contents of the Fluxnet-Canada/Canadian Carbon Program Data Information System (DIS) which was previously distributed as an internet based warehouse for all FLUXNET Canada and the CCP until the website was closed in 2014. The data are presented in a structure that mirrors that of the FLUXNET Canada Web Site and are provided in their original distribution format. They have been repackaged as zip files for distribution purposes.

Related Data:

Updated standardized and quality-controlled data from many of the Fluxnet-Canada sites is available from the Ameriflux group at <http://ameriflux.lbl.gov/>

User Note:

Please acknowledge the appropriate **Site Contact** when using these data; this information is provided in the shapefile (**FLUXNET-Canada_file_site_investigators.zip**), as well as in the text and Word files associated with site-specific data.

Table 1. Fluxnet Canada Tower Site Contacts for Acknowledgement

Tower Sites	Site Contact
AB-Grassland	Larry Flanagan
AB-WPeatland-TreedFen	Larry Flanagan
AB-WPeatland-MayPoorFen	Larry Flanagan
AB-WPeatland-TonysRichFen	Larry Flanagan
BC-DFir1949	Andy Black
BC-HarvestDFir1988	Andy Black
BC-HarvestDFir2000	Andy Black
MB-NOldBlackSpruce	Allison Dunn (1994-2006), Brian Amiro (2007-2008)
NB-BFir1967-NashwL01	Charles Bourque
NB-BFir1975-CharlieL01	Charles Bourque
ON-BordenMixedWood	Ralf Staebler
ON-Deciduous-TP	M. Altaf Arain
ON-EPeatland-MerBleue	Peter Lafleur
On-HarvestMixedWood1989	Harry McCaughey
ON-OldMixedWood-GhogR	Harry McCaughey
ON-PlantnWPine1939-TP	Altaf Arain
ON-PlantnWPine1974-TP	Altaf Arain
ON-PlantnWPine1989-TP	Altaf Arain
ON-PlantnWPine2002-TP	Altaf Arain
QC-BSpruceJPineCut	Hank Margolis
QC-MatureBSpruce	Hank Margolis
QC-HarvestBS1975	Hank Margolis
SK-Fen	Andy Black and Alan Barr
SK-Fire1977	Brian Amiro

SK-Fire1989	Brian Amiro
SK-Fire1998	Brian Amiro
SK-HarvestJP1975	Alan Barr
SK-HarvestJP1994	Shohei Murayama (2001-2003, Alan Barr (2004-2012)
SK-HarvestJP2002	Andy Black and Alan Barr
SK-OldAspen	Andy Black and Alan Barr
SK-OldBlackSpruce	Andy Black and Alan Barr
SK-OldJackPine	Harry McCaughey, Andy Black, and Alan Barr

2. Data Characteristics

Spatial Coverage: Fluxnet Canada tower sites on an east-west transect of Canadian forest and peat land ecosystems.

Spatial Resolution: Point data

Temporal Coverage: Data covers 1993 to 2014

Temporal Resolution: Varies from 30-minute meteorological and flux measurements to one-time synoptic soil and biological site characterization data.

Study Area (All latitudes and longitudes are given in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Fluxnet Canada - various sites	-125.3336	-67.0993	55.8800	42.6609

Table 2. Fluxnet Canada Tower Site Locations

Tower Site	Description	Lat	Long
AB-Grassland	Alberta - Mixed Grass Prairie	49.70919	-112.9403
AB-WPeatland-TreedFen	Alberta - Western Peatland - LaBiche River, Black Spruce/Larch Fen	55.5375	-112.4470
AB-WPeatland-MayPoorFen	Alberta - Western Peatland - Poor Fen (Sphagnum moss)	55.5375	-112.3343
AB-WPeatland-TonysRichFen	Alberta - Western Peatland - Rich Fen (Carex)	54.4700	-113.3200
BC-DFir1949	British Columbia - 1948 Douglas-fir Stand	49.8673	-125.3336
BC-HarvestDFir1988	British Columbia - Pole sapling Douglas-fir Stand	49.5346	-124.9004
BC-HarvestDFir2000	British Columbia - Clearcut Douglas-fir Stand (harvested winter 1999/2000)	49.8705	-125.2909
MB-NOldBlackSpruce	Manitoba - Northern Old Black Spruce (former BOREAS Northern Study Area)	55.8800	-98.4810
NB-BFir1967-NashwL01	New Brunswick - 1967 Balsam Fir - Nashwaak Lake Site 01 (Mature Balsam fir forest)	46.4738	-67.0993
NB-BFir1975-CharlieL01	New Brunswick - Charlie Lake site 01 (immature balsam fir forest to be thinned in year 3)	45.8850	-67.3570
ON-BordenMixedWood	Ontario - Mixed Deciduous, Borden Forest Site	44.3185	-79.9342
ON-Deciduous-TP	Ontario - Turkey Point Deciduous Forest Site	42.6353	-80.55757
ON-EPeatland-MerBleue	Ontario - Eastern Peatland, Mer Bleue	45.4094	-75.5187
On-HarvestMixedWood1989	Ontario - Childerhose Juvenile Boreal Mixedwood Forest harvested in 1989	48.1330	-81.6280
ON-OldMixedWood-GhogR	Ontario - Groundhog River, Boreal Mixedwood Forest	48.2173	-82.1555
ON-PlantnWPine1939-TP	Ontairo - Turkey Point 1939 Plantation White Pine	42.7098	-80.3574
ON-PlantnWPine1974-TP	Ontario - Turkey Point 1974 Plantation White Pine	42.7068	-80.3483

ON-PlantnWPine1989-TP	Ontario - Turkey Point 1989 Plantation White Pine	42.7744	-80.4588
ON-PlantnWPine2002-TP	Ontario - Turkey Point 2002 Plantation White Pine	42.6609	-80.5595
QC-BSpruceJPineCut	Quebec - Eastern Boreal, Black Spruce / Jack Pine Cutover	49.2671	-74.0365
QC-MatureBSpruce	Quebec - Eastern Boreal, Mature Black Spruce	49.6925	-74.3420
QC-HarvestBS1975	Quebec - Eastern Boreal, Black Spruce forest harvested in 1975	49.7598	-74.5711
SK-Fen	Saskatchewan - Western Boreal, wetland	53.8021	-104.6180
SK-Fire1977	Saskatchewan - Western Boreal, forest burned in 1977	54.4850	-105.8176
SK-Fire1989	Saskatchewan - Western Boreal, forest burned in 1989	54.2539	-105.8775
SK-Fire1998	Saskatchewan - Western Boreal, forest burned in 1998	54.0916	-106.0053
SK-HarvestJP1975	Saskatchewan - Western Boreal, Jack Pine forest harvested in 1975 (BOREAS Young Jack Pine)	53.8758	-104.6453
SK-HarvestJP1994	Saskatchewan - Western Boreal, Jack Pine forest harvested in 1994	53.9084	-104.6559
SK-HarvestJP2002	Saskatchewan - Western Boreal, Jack Pine forest harvested in 2002	53.9447	-104.6493
SK-OldAspen	Saskatchewan - Western Boreal, Mature Aspen	53.6289	-106.1978
SK-OldBlackSpruce	Saskatchewan - Western Boreal, Mature Black Spruce	53.9872	-105.1178
SK-OldJackPine	Saskatchewan - Western Boreal, mature Jack Pine forest	53.9163	-104.692

Data file information

There are 35 total data files provided with this data set, 34 (*.zip) files and one comma-separated (.csv) file.

- There are 32 files (*.zip) with site-specific data and documentation which when uncompressed contain the original data as distributed by the FLUXNET Canada web site.
- The **0-Fluxnet-Canada.zip** file contains a complete description of the Fluxnet Canada data management plan, standard measurements, metadata documentation guidelines, plus multi-site data compilations, plant nutrients, and stable isotope data for plants and air samples.
- There is one compressed shapefile (provided in **FLUXNET-Canada_file_site_investigators.zip**) that contains spatial information about each of the 32 research sites, including FLUXNET network identifiers.
- One comma-separated (**FLUXNET-Canada_file_site_investigators.csv**) file which provides site and investigator information for each of the compressed directories.

The total file count is 21,494 data and documentation files when all directories are uncompressed.

The data are presented in a structure that mirrors that of the FLUXNET Canada Web Site and are provided in their original distribution format. They have been repackaged as zip files for distribution purposes.

Note that this section does not describe the contents of each specific file, but the descriptions below provide a good overview of all zip file contents. Data dictionaries and site descriptions are provided in text and/or MS Word files with each compressed directory.

Data files (*.zip)

Each zip file, when opened, contains one or more text or Word document files and data file folders. Many of the data files are in comma-separated (.csv) format; the first row in the files have the variable names and the second row provides the units under the variable name. There are also files in xls, .txt, .doc, .html, .pdf, and .rar formats.

Measured and modeled data are included. The data provided include carbon dioxide and water vapor fluxes, ancillary meteorological, soil, groundwater, surface water, vegetation, file documentation, and site descriptions. Most data are monthly or annual and the time periods vary from 1993 - 2014.

Coded values

Missing and no data values: -999 and NaN represent missing and no data values--there are files where all values are -999 or NaN except for the site information There are not a large number of these files and they are generally at the beginning of a time series, for example, the first month or year.

Quality assurance: The last two columns in the data files are for Certification and Revision information. Certification Code will either be "CPI" or "PRE". "CPI" means that data have been checked by the principal investigator and "PRE" means that the data are preliminary. "RevisionDate" is

the date when the data were last revised by the principal investigator.

Data file names and descriptions.

Note: The time periods listed are for general reference; within each year listed, there may or may not be data provided for the entire year. The periods do not reflect the year of any revisions made to the data. Consult the associated metadata documents (.txt and/or .doc) files for additional information on data revisions and known errors.

Table 3. Fluxnet Canada Tower Site Data Files

*.ZIP file name	Number of files	Time period
0-Fluxnet-Canada	147	1994-2014
AB-Grassland	129	1998-2008
AB-WPeatland-TreedFen	259	2003-2009
AB-WPeatland-MayPoorFen	54	2004-2006
AB-WPeatland-TonysRichFen	52	2004-2006
BC-DFir1949	1,452	1997-2010
BC-HarvestDFir1988	1,033	1995-2010
BC-HarvestDFir2000	1,078	2000-2010
MB-NOldBlackSpruce	18	1994-2008
NB-BFir1967-NashwL01	109	2002-2005
NB-BFir1975-CharlieL01	41	2004-2005
ON-BordenMixedWood	91	1995-2012
ON-Deciduous-TP	253	2012-2014
ON-EPeatland-MerBleue	1,533	1998-2010
On-HarvestMixedWood1989	248	2006-2010
ON-OldMixedWood-GhogR	1,337	2002-2010
ON-PlantnWPine1939-TP	1,305	2002-2014
ON-PlantnWPine1974-TP	1,106	2002-2014
ON-PlantnWPine1989-TP	602	2002-2008
ON-PlantnWPine2002-TP	1,106	2002-2014
QC-BSpruceJPineCut	1,032	2001-2010
QC-MatureBSpruce	866	2003-2010
QC-HarvestBS1975	392	2007-2010
SK-Fen	373	2002-2010
SK-Fire1977	22	2002-2006
SK-Fire1989	23	2001-2006
SK-Fire1998	22	1993-2006
SK-HarvestJP1975	598	1993-2010
SK-HarvestJP1994	804	2001-2010
SK-HarvestJP2002	795	2002-2010
SK-OldAspen	1,629	1993-2010
SK-OldBlackSpruce	1,553	1993-2010
SK-OldJackPine	1,432	1993-2010

Feedback

Data file naming conventions for individual files in the site-level *.zip files.

There are text and Word files which describe the data file naming conventions for the files within the *.zip files. The following are general data file naming conventions.

Flux data files

Most files are named by **site_FlxTwr_Flx_YYYY_MM_DD**

Example file name: AB-WPL_FlxTwr_Flx3_2005-06-00.csv

Where:

- AB-WPL: is the Alberta Western Peatland Treed Fen Flux Tower site.
- FlxTwr: is subsite where data was collected, in this case the main fluxtower.
- Flx3: files include NEE, R and GPP.
- 2005-06-00: year, month, day.

Soil moisture and soil CO2 efflux data files

Soil moisture and soil CO2 efflux data are included for many sites. These file names contain additional abbreviations such as _SMx (soil moisture files) or SR2 (soil CO2 efflux files) .

Example file name: ON-WPP39_FlxTwr_SM2_2002-01-00.csv

Site Characteristics data file

Folders named X__Site_Characteristics contain a file named NACP_X__Ameriflux_Biological_Data_X.xls. These are excel files that provide site characteristics, vegetation data, biomass, carbon, data, etc. The files include the site name (represented as X).

Readme files and Word doc files provide data dictionaries, vegetation information, and additional information on file naming structure as well as related publications.

Data file aggregation and quality assessment

There are three levels of data aggregation and quality assessment for the flux and meteorological data.

Flux data:

1. **Ancillary:** contains raw data used to derive Carbon, Water and Energy fluxes and ultimately Net Ecosystem Productivity information. Includes profile, tree bole and soil heat flux data.
2. **Computed Fluxes:** contains Carbon, Water and Energy flux data.
3. **NEP:** contains Net Ecosystem Productivity, Gross Ecosystem Productivity and Respiration information.

Meteorology data:

1. **Ancillary:** contains a subset of Meteorological variables that were used to derive and quality assure some variables in the Main directory. These are "extra" variables that may be useful to only a few people.
2. **Main:** contains the most complete sub set of meteorological variables where most have been corrected and some have been derived, but none have been gap-filled.
3. **Summarized:** contains data that have been summarized from the Main subset. Variables have been aggregated (eg., 4 tower top temperature measurements have become one) and gaps have been filled. This summarized subset is to be **standard** for all sites.

Shapefile and comma-separated file

The shapefile (.shp) is provided in **FLUXNET-Canada_file_site_investigators.zip**. The following information is provided in the file. Site-specific information was obtained from the FLUXNET database at <https://fluxnetweb.ornl.gov/>.

Table 4. Shapefile contents

Field Name	Description
file_name	File name-corresponds to each of the zip files listed in Table 1.
num_files	Number of zip files
siteid	FLUXNET site id
fluxnetid	FLUXNET id
sitename	FLUXNET site name
Desc	Description of the site

Lat	Latitude
Lon	Longitude
Start_Year	First year of data
End_Year	Last year of data
PI	Lead investigator
PI_Email	Lead investigator email

Table 5. File contents of FLUXNET-Canada_file_site_investigators.csv.

Field Name	Description
file_name	File name-corresponds to each of the zip files listed in Table 1.
num_files	Total number of files provided in the zip file when unzipped.
siteid	FLUXNET site id (https://fluxnetweb.ornl.gov/)
fluxnetid	FLUXNET id (https://fluxnetweb.ornl.gov/)
sitename	FLUXNET site name (https://fluxnetweb.ornl.gov/)
site_desc	Description of the site
lat	Latitude
lon	Longitude
start_Year	First year of data
end_Year	Last year of data
pi	Lead investigator
pi_email	Lead investigator email

3. Application and Derivation

FLUXNET data could be used in climate models.

4. Quality Assessment

The data from the FLUXNET sites are quality assessed and gap-filled using techniques described in (Papale et al., 2006, Reichstein et al., 2005, Moffat et al., 2007, and Papale and Valentini 2003).

The equipment and methodology were standardized among sites by using common software and instrumentation.

5. Data Acquisition, Materials, and Methods

These are examples of the sampling and analysis methods employed by the investigators. The numerous Readme files and Word documentation files provided with the data contain detailed method and data descriptions and reference related publications.

Flux and Meteorology Data

Information collected at a site encompassed sensor measurements, field observations, laboratory analysis of field samples, as well as anecdotal descriptions. Each network site deploys a number of sensors measuring micro-meteorology such as precipitation or wind speed and carbon flux. The field data were processed to generate 1/2 hourly flux-met data files. The other, ancillary data include relatively infrequent measurements. An important aspect of the ancillary data is that each measurement is often annotated. For more information about ancillary data and related reporting protocol see (Law et al., 2008).

The eddy covariance method was used at individual network sites to measure mass and energy exchange across a horizontal plane between vegetation and the free atmosphere. Fluxes of carbon dioxide, water vapor and heat were determined by measuring the covariance between fluctuations in vertical velocity (w) and the mixing ratio of trace gases of interest (c) (Aubinet et al., 2000; Baldocchi, 2003); negative covariance values of net ecosystem CO2 exchange (FN) represent a loss of CO2 from the atmosphere and a gain by the surface. The temporal information produced at each network site varied. The spatial scales of observations at each tower extends through the flux footprint around the tower (ranging between 100 and 1000 m) (Gockede et al., 2004).

The 1/2 hourly flux-met data was passed from the sites to their regional networks and then on to FLUXNET. It was then quality assessed and gap-filled using techniques described in (Papale et al., 2006, Reichstein et al., 2005, Moffat et al., 2007, and Papale and Valentini 2003). The goal of gap filling is the reproduction of the NEE time series.



Figure 2. The QC-2000 harvested Black Spruce/Jack Pine site, Quebec, Canada. Image is from the <https://fluxnet.ornl.gov/> site gallery.

CCP Flux Stations

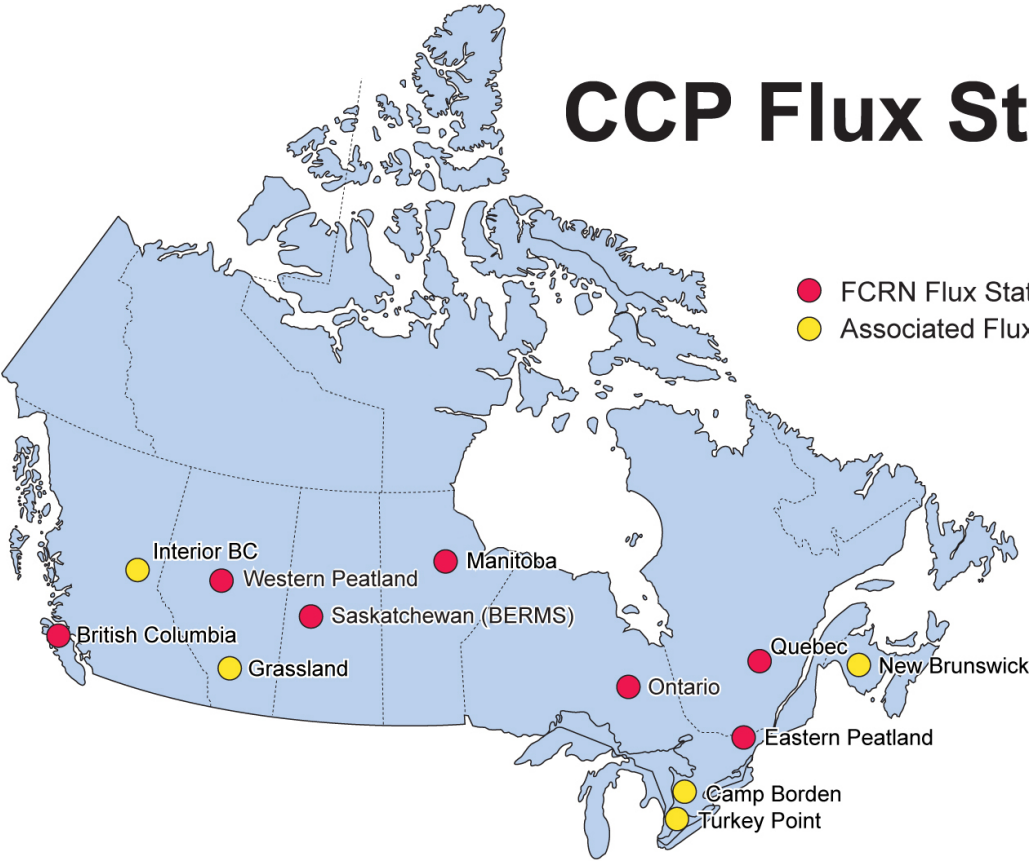


Figure 3. Canadian Carbon Program (CCP) FLUXNET Stations in 2008.

Ground Data

Ground Plots were studied to gain an overview of the state of ecological and site variables. Plots were established and surveyed according to Canada's National Forest Inventory ground plot protocols (NFI 2004), which were adopted by FRCN for these measurements. These protocols call for the establishment of 400-m2 circular plots and measurement of trees, understory, woody debris, forest floor, vegetation dominant species, leaf characteristics, carbon, biomass, and soil measurements within each plot. The individual files contain the documentation for site measurements (Baldocchi 2008).

Leaf Sample Nutrient Content and Carbon Isotope Composition

Leaves from each dominant tree species were sampled for nutrient content and carbon isotope composition. The leaf samples were collected in late August or early September 2005, from live, green leaves that were near the top of the trees and exposed to full sunlight. For conifer trees only current year's needles were collected. Leaf samples were collected from 6 individuals of each tree species. After collection the leaves were placed in paper bags, dried at 60°C, and then ground to a fine powder in a coffee grinder and/or in a mortar and pestle. The total nitrogen and total carbon contents were analyzed on N₂ and CO₂ gases, respectively, that were generated from combustion/reduction of the dried leaf tissue in an elemental analyzer and quantified using a gas isotope ratio mass spectrometer. The other nutrient analysis (Ca, P, K, Mg, S) was conducted on tissue that was dry-ashed and then digested using a dilute HNO₃ and HCl mixture and then quantified using an Inductively Coupled Plasma (ICP) spectroscopic analysis technique at Norwest Labs, Lethbridge.

δ¹³C Measurements

The dried and ground leaf samples were prepared for measurements of carbon isotopic composition by combustion. A 3-4 mg subsample of ground organic material was sealed in a tin capsule and loaded into an elemental analyzer for combustion (Carla Erba). The carbon dioxide generated from the combustion was purified in a gas chromatographic column and passed directly to the inlet of a gas isotope ratio mass spectrometer (Delta Plus, Finnigan Mat, San Jose, CA, USA).

Atmospheric CO₂ – Flask Samples

The data files contain information on the concentration of CO₂ and the stable carbon (¹³C/¹²C) isotope composition of CO₂ in flask samples of air collected at different Fluxnet-Canada Carbon Cycle Stations during 2003-2005. Most atmospheric CO₂ samples were collected during nighttime sample periods. Air samples were collected in order to use a modified Keeling plot technique to calculate the isotope composition of CO₂ respired by the ecosystem.

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

[FLUXNET Canada Research Network - Canadian Carbon Program Data Collection, 1993-2014](#)

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

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