NACP Soil Organic Matter of Burned Boreal Black Spruce Forests, Alaska, 2009-2011

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Documentation Revision Date: 2018-04-18

Data Set Version: 1

Summary

This data set provides organic soil layer characteristics, estimated carbon content, and soil depth measurements made at four black spruce stands in interior Alaska that had burned twice in the last 37-52 years (intermediate-interval fire events). The most recent fires occurred in 2004, 2005, and 2010. Measurements of soil depth and distance from the adventitious roots to the soil, and total organic matter are also included for unburned black spruce sites adjacent to the burned sites dominated by live, intermediate-aged (~37-52 years) black spruce trees.

Samples were collected from 39 burned plots between 2009-08-03 to 2011-08-02, and from seven unburned plots between 2009-08-01 to 2011-07-22.

There are four data files with this data set: a shapefile (.shp) and a comma-separated (.csv) file each for burned and unburned sites (two files for each site). The data contained in the shapefiles are identical to the corresponding comma-separated files. There are also four companion files: two files provide the data from the shapefiles in .kmz format for viewing in Google Earth, one file provides 179 photos of the study plots, and one file is a pdf of this document.

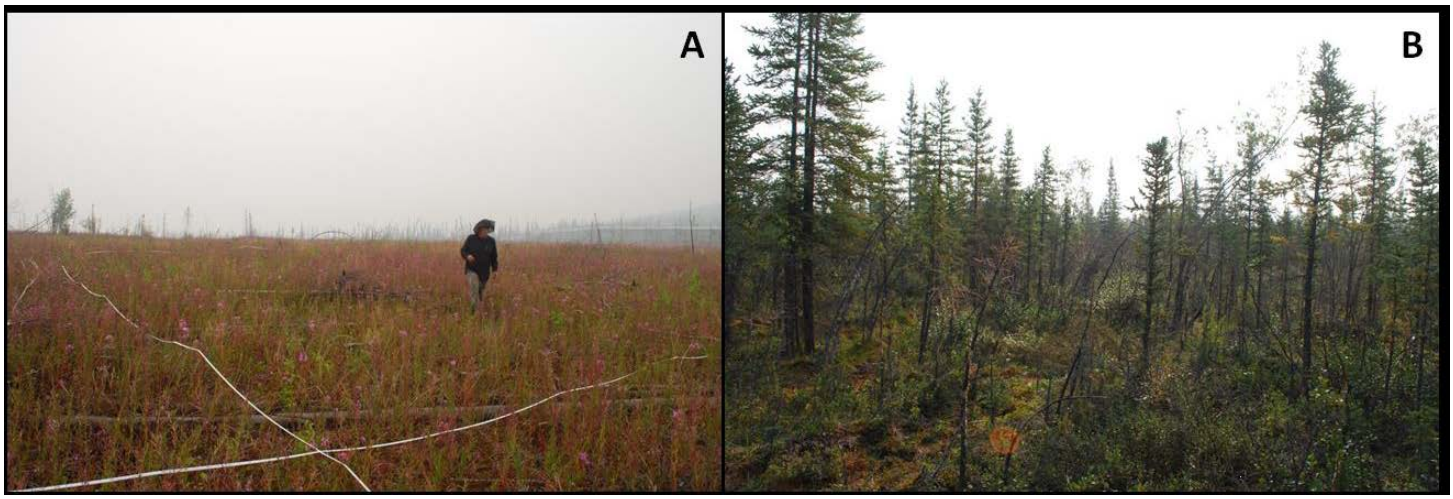

Figure 1. Field site photos: (A) stand that burned during the summer of 2005; (B) unburned stand that had previously burned in 1966 (Hoy et al., 2016).

Citation

Hoy, E.E., M.R. Turetsky, and E.S. Kasischke. 2018. NACP Soil Organic Matter of Burned Boreal Black Spruce Forests, Alaska, 2009-2011. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1331

Table of Contents

1. Data Set Overview

Project: North American Carbon Program (NACP)

The North American Carbon Program (NACP) is a multidisciplinary research program designed to improve scientific understanding of North America's carbon sources and sinks and of changes in carbon stocks needed to meet societal concerns and to provide tools for decision makers.

This data set provides organic soil layer characteristics, estimated carbon content, and soil depth measurements made at four black spruce stands in interior Alaska that had burned twice in the last 37-52 years (intermediate-interval fire events). The most recent fires occurred in 2004, 2005, and 2010. Measurements of soil depth and distance from the adventitious roots to the soil, and total organic matter are also included for unburned black spruce sites adjacent to the burned sites dominated by live, intermediate-aged (~37-52 years) black spruce trees.

Samples were collected from 39 burned plots between 2009-08-03 to 2011-08-02, and from seven unburned plots between 2009-08-01 to 2011-07-22. Individual plots consisted of an area at least 30 by 40 m on the same topographic position with similar fire severity. Sample sites (burned and unburned) were located across different topographic positions (also referred to as landscape classes) representing a gradient of well-drained to poorly-drained areas. Soil depth was measured from the top of the remaining soil organic layer (SOL) following fire to the mineral soil layer, and a breakdown of soil type was noted (including the char, fibric, mesic and humic soil layers). The adventitious root (AR) measurements were collected by measuring the distance from the top AR to the mineral soil of black spruce trees ≥ 2 meters tall and believed to have burned during the most recent fire event (during the 2000s). Soil organic carbon (SOC) storage and losses were estimated using empirical relationships between organic horizon depth (cm) and SOC (kg m-2) developed by Turetsky et al. (2011) from published soil data for Alaskan black spruce forests stratified by landscape (topographic) class.

2. Data Characteristics

Spatial Coverage: Interior boreal forest of Alaska, USA.

Spatial Resolution: Individual plots consisted of an area at least 30 by 40 m; entire plot was approximately 90 m^2.

Temporal Coverage: 2009-08-01 to 2011-08-02.

Temporal Resolution: Samples were collected one time at each plot.

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

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Interior boreal forest of Alaska, USA	-153.41953125	-143.839453125	66.464613611549	64.306111033025

Data File Information

There are four data files with this data set. This includes a shapefile (.shp) and a comma-separated (.csv) file for burned and unburned sites (two files for each site). The data provide the location of soil organic layer measurements and ancillary plot data. The data contained in the shapefiles are identical to the corresponding comma-separated files. There are also photos of the burned and unburned plots provided in companion files, refer to the end of this section for details.

Burned Site Files

File: Alaskan_Black_Spruce_burned_soil_samples.csv

Samples were collected from 39 plots between 2009-08-03 to 2011-08-02. Note that this is just a date range -- samples were not collected from each site in each year.

There are no missing values.

Column Name	Units/format	Description

Plot_name		Name of plot -- combination of fire event, burn status, and plot number. See description below.
Plot_type		Either a burned or unburned plot
Sampling_date	YYYY-MM-DD	Sampling date
Plot_elevation	m	Elevation of the plot (in meters)
Latitude	decimal degrees	Latitude in decimal degrees
Longitude	decimal degrees	Longitude in decimal degrees
Topographic_position		One of 5 topographic positions (Flat upland, South facing slope, East or West facing slope, North facing slope, Flat lowland)
Fire_event		Name of reburn event (the second of the two events occurring to create the intermediate-interval burned stand)
Burn_period		Either an early (between May and July) or late season (after July 31st) burn
Julian_date		Julian date the plot burned during the more recent of the two fire events which occurred to create the intermediate-interval burned stand
Burn_year		Year of the more recent burn event of the two fire events which occurred to create the intermediate-interval burned stand
Char_layer_thickness	cm	Thickness of the char layer (in cm)
Fibric_layer_thickness	cm	Thickness of the fibric soil layer (in cm)
Mesic_layer_thickness	cm	Thickness of the mesic soil layer (in cm)
Humic_layer_thickness	cm	Thickness of the humic soil layer (in cm)
Prefire_number		Number of prefire samples collected at the plot location
Prefire_depth	cm	Estimated prefire depth at the plot (in cm)
Prefire_SE	cm	Standard Error (SE) of the prefire depth (in cm)
Postfire_number	cm	Number of postfire samples collected at the plot location
Postfire_depth	cm	Postfire depth, including the char layer
Postfire_SE	cm	Standard error (SE) of the Postfire depth including the char layer
Burn_depth	cm	Estimated depth of burn (in cm)
Burn_depth_SE	cm	Standard Error of the depth of burn
Depth_reduction	%	Percent depth reduction
Carbon_loss	kg/m^2	Estimated carbon loss due to the burn (in kg m^{-2}). SOC storage and losses were estimated using empirical relationships between organic horizon depth (cm) and SOC (kg m-2) developed by Turetsky et al. (2011) from published soil data for Alaskan black spruce forests stratified by landscape (topographic) class
Carbon_storage_prefire	kg/m^2	Estimated prefire carbon storage (in kg m^{-2}).
Carbon_storage_postfire	kg/m^2	Estimated postfire carbon storage (in kg m^{-2}).

File: Alaskan_Black_Spruce_burned_soil_samples.shp: When unzipped, the shapefile contains six files (*.shx, *.dbf, *.prj, *.sbn, *.sbx, and *.shp).

This file represents the location of soil organic layer measurements and other ancillary plot data at burned sites. The data contained within are identical to the corresponding *.csv.

Parameters of the shapefile:

Geometry Type: Point

Geographic Coordinate System: GCS_WGS_1984

Datum: D_WGS_1984

Prime Meridian: Greenwich

Angular Unit: Degree

Extent in file's coordinate system (same as geographic lat/lon):

North: 65.7018

South: 63.8201

West: -149.1933

East: -141.4182

Attributes (The corresponding *.csv field names are provided after the colons):

FID: Internal feature number; sequential unique whole numbers that are automatically generated

Shape: Feature geometry

PlotName: Plot_name

PlotType: PlotType

samp_date: Sampling_date (YYYY_MM_DD)

Elevation: Plot_elevation (m)

N_Latitude: Latitude (decimal degrees)

W_Longitud: Longitude (decimal degrees)

Topographi: Topographic_position

FireEvent: Fire_event

BurnPeriod: Burn_period

JulianDate: Julian_date

BurnYear: Burn_year

Char__cm_: Char_layer_thickness (cm)

Fibric__cm: Fibric_layer_thickness (cm)

Mesic__cm_: Mesic_layer_thickness (cm)

Humic__cm_: Humic_layer_thickness (cm)

PrefireN: Prefire_number

PrefireDep: Prefire_depth (cm)

PrefireSE: Prefire_SE (cm)

PostfireN: Postfire_number (cm)

PostfireDe: Postfire_depth (cm)

PostfireSE: Postfire_SE (cm)

DepthOfBur: Burn_depth (cm)

DepthOfB_1: Burn_depth_SE(cm)

DepthReduc: Depth_reduction (%)

Carbon_los: Carbon_loss (kg/m^2)

Carbon_sto: Carbon_storage_prefire (kg/m^2)

Carbon_s_1: Carbon_storage_postfire (kg/m^2)

Unburned Site Files

File: Alaskan_Black_Spruce_unburned_soil_samples.csv

Samples were collected from seven plots adjacent to, and similar in age, to the burned plots between 2009-08-01 to 2011-07-22. Note that this is just a date range-samples were not collected from each site in each year.

There are no missing values.

Column Name	Units/format	Description
Plot_name		Name of plot -- combination of fire event, burn status, and plot number. See description below.
Plot_type		Either a burned or unburned plot
Sampling_date	YYYY-MM-DD	Date samples were taken at plot
Plot_elevation	m	Elevation of the plot (in meters)
Topographic_position		One of 5 topographic positions (Flat upland, South facing slope, East or West facing slope, North facing slope, Flat lowland)
Latitude	degrees	Latitude in decimal degrees
Longitude	degrees	Longitude in decimal degrees
Moss_layer_thickness	cm	Thickness of the moss layer (in cm)
Fibric_layer_thickness	cm	Thickness of the fibric soil layer (in cm)
Mesic_layer_thickness	cm	Thickness of the mesic soil layer (in cm)
Humic_layer_thickness	cm	Thickness of the humic soil layer (in cm)
OM_AR_depth	cm	The distance from the top of the soil layer (organic matter) to the adventitious root (in cm)
AR_mineral_soil_depth	cm	The distance from the adventitious root to the mineral soil (in cm)
Total_OM_depth	cm	The average total organic layer depth recorded for the plot
Moss_SE	cm	Standard Error (SE) of the moss layer depth (in cm)
Fibric_SE	cm	Standard Error (SE) of the thickness of the fibric soil layer (in cm)
Mesic_SE	cm	Standard Error (SE) of the thickness of the mesic soil layer (in cm)
Humic_SE	cm	Standard Error (SE) of the thickness of the humic soil layer (in cm)
OM_AR_depth_SE	cm	Standard Error (SE) of the distance from the top of the soil layer to the adventitious root (in cm)
AR_mineral_soil_depth_SE	cm	Standard Error (SE) of the distance from the adventitious root to the mineral soil (in cm)
Total_OM_SE	cm	Standard Error (SE) of the average total organic layer depth recorded for the plot

File: Alaskan_Black_Spruce_unburned_soil_samples.shp: When unzipped, the shapefile contains six files (*.shx, *.dbf, *.prj, *.sbn, *.sbx, and *.shp).

This file represents the location of soil organic layer measurements and other ancillary plot data at unburned sites. The data contained within is identical to the corresponding *.csv.

Parameters of the shapefile:

Geometry Type: Point

Geographic Coordinate System: GCS_WGS_1984

Datum: D_WGS_1984

Prime Meridian: Greenwich

Angular Unit: Degree

Extent in file's coordinate system (same as geographic lat/lon):

North: 65.699549

South: 63.85444

West: -150.275306

East: -142.189006

Attributes (The corresponding *.csv field names are provided after the colons):

FID: Internal feature number; sequential unique whole numbers that are automatically generated

Shape: Feature geometry

PlotName: Plot_name

PlotType: Plot_type

samp_date: Sampling_date (YYYY_MM_DD)

Elevation: Plot_elevation (m)

Topographi: Topographic_position

N_Latitude: Latitude (decimal degrees)

W_Longitud: Longitude (decimal degrees)

Moss__cm_: Moss_layer_thickness (cm)

Fibric__cm: Fibric_layer_thickness (cm)

Mesic__cm_: Mesic_layer_thickness (cm)

Humic__cm_: Humic_layer_thickness (cm)

Organic_Ma: OM_AR_depth (cm)

Adventitio: AR_mineral_soil_depth (cm)

Total_Orga: Total_OM_depth (cm)

Moss_SE__c: Moss_SE (cm)

Fibric_SE: Fibric_SE (cm)

Mesic_SE__: Mesic_SE (cm)

Humic_SE__: Humic_SE (cm)

Organic__1: OM_AR_depth_SE (cm)

Adventit_1: AR_mineral_soil_depth_SE (cm)

Total_Or_1: Total_OM_SE (cm)

Companion files

There are four companion files with this data set:

1. NACP_BlackSpruce_Burn-Severity.pdf: A pdf of this document.

2. Alaskan_Black_Spruce_unburned_soil_samples.kmz: Provides data from the corresponding shapefile described above for viewing in Google Earth.

3. Alaskan_Black_Spruce_burned_soil_samples.kmz: Provides data from the corresponding shapefile described above for viewing in Google Earth.

4. Alaskan_Black_Spruce_Field_Research_Plot_Photos.zip: Contains 179 photos (*.jpg) of the study plots.

Plot_name and Photo file (*.jpg) naming conventions:

Plot_name syntax:

The name of a study plot was constructed by concatenating the code for the specific Fire Event (Table 1), with Burn Status and Plot Number (Table 2). Plot_name(s) are listed in Table 2.

For example: **FCB01, where:**

FC = Fish Creek, Fire Event Code;

B = Burned, Burn Status for the Plot; and

01 = Plot Number

Photo file (*.jpg) name syntax:

The individual photo files are identified by Plot_name and a Letter (A, B, C, D) for the series of photos for each Plot (Table 2).

For example: **CKUB04_C, where:**

Plot_name = CKUB04 (as above, **CK =** Chicken, Fire Event Code; **UB** = Unburned, Burn Status for the Plot; and **04** = Plot Number); and

Letter = C, the third photo taken at the Plot

Table 1. Burn-fire event codes and characteristics.

Code	Historic Burn-Fire Event	Historic Burn-Discovery Date	Recent Burn-Fire Event	Recent Burn-Discovery Date	Intermed.ageSites-Burned	Intermed.age Sites-Unburned	Intermed.ageSites-FFI (yrs)
FC	Rogers	1967-06-16	Fish Creek	2005-06-16	14	2	38
KC	King Creek	1969-06-22	King Creek	2004-06-22	6	6	37
LD	Livengood	1958-06-04	Cascaden Rdg.	2010-06-03	3	--	52
CK	West Fork	1966-07-23	Chicken	2004-06-15	16	--	38
BD	Big Denver	1969-06-16	--	--	--	1	--

Table 2. Index of fire events, burn status, plot names, with photo designations and sampling dates.

Fire Event	Burned/Unburned Plot Status	Plot Name	Photos	Sampling Date
West Fork/Chicken	Burned	CKB01	A, B, C, D	2009-08-03
West Fork/Chicken	Burned	CKB02	A, B, C, D	2009-08-03
West Fork/Chicken	Burned	CKB03	A, B, C, D	2009-08-03
West Fork/Chicken	Burned	CKB04	A, B, C, D	2010-07-23
West Fork/Chicken	Burned	CKB05	A, B, C, D	2010-07-23
West Fork/Chicken	Burned	CKB06	A, B, C, D	2010-07-23
West Fork/Chicken	Burned	CKB07	A, B, C, D	2010-07-24
West Fork/Chicken	Burned	CKB08	A, B, C, D	2010-07-24

West Fork/Chicken	Burned	CKB09	A, B, C, D	2010-07-24
West Fork/Chicken	Burned	CKB10	A, B, C, D	2010-07-25
West Fork/Chicken	Burned	CKB11	A, B, C, D	2010-07-27
West Fork/Chicken	Burned	CKB12	A, B, C, D	2010-07-27
West Fork/Chicken	Burned	CKB13	A, B, C, D	2011-07-28
West Fork/Chicken	Burned	CKB14	A, B, C, D	2011-07-28
West Fork/Chicken	Burned	CKB15	A, B, C, D	2011-07-28
West Fork/Chicken	Burned	CKB16	A, B, C, D	2011-07-28
West Fork/Chicken	Unburned	CKUB01	A, B, C, D	2009-08-01
West Fork/Chicken	Unburned	CKUB02	A, B, C, D	2009-08-03
West Fork/Chicken	Unburned	CKUB03	A, B, C, D	2010-07-24
West Fork/Chicken	Unburned	CKUB04	A, B, C, D	2010-07-25
Rogers/Fish Creek	Burned	FCB01	A, B, C, D	2009-08-06
Rogers/Fish Creek	Burned	FCB02	A, B, C, D	2009-08-06
Rogers/Fish Creek	Burned	FCB03	A, B, C, D	2010-08-03
Rogers/Fish Creek	Burned	FCB04	A, B, C, D	2010-08-03
Rogers/Fish Creek	Burned	FCB05	A, B, C, D	2010-08-03
Rogers/Fish Creek	Burned	FCB06	A, B, C, D	2010-08-03
Rogers/Fish Creek	Burned	FCB07	A, B, C, D	2010-08-03
Rogers/Fish Creek	Burned	FCB08	A, B, C, D	2010-08-03
Rogers/Fish Creek	Burned	FCB09	A, B, C, D	2010-08-03
Rogers/Fish Creek	Burned	FCB10	A, B, C, D	2010-08-03
Rogers/Fish Creek	Burned	FCB11	A, B, C, D	2010-08-03
Rogers/Fish Creek	Burned	FCB12	A, B, C, D	2010-08-03
Rogers/Fish Creek	Burned	FCB13	A, B, C, D	2010-08-04
Rogers/Fish Creek	Burned	FCB14	A, B, C, D	2010-08-04
Rogers/Fish Creek	Unburned	FCUB01	A, B, C, D	2009-08-06
Rogers/Fish Creek	Unburned	FCUB02	A, B, C, D	2010-08-04
King Creek	Burned	KCB01	A, B, C, D	08/01/2011
King Creek	Burned	KCB02	A, B, C, D	08/01/2011
King Creek	Burned	KCB03	A, B, C, D	2011-08-02
King Creek	Burned	KCB04	A, B, C, D	2011-08-02
King Creek	Burned	KCB05	A, B, C, D	2011-08-02
King Creek	Burned	KCB06	A, B, C, D	2011-08-02
Livengood/Cascaden Rdg.	Burned	LDB01	A, B, C, D	2011-07-31
Livengood/Cascaden Rdg.	Burned	LDB02	A, B, C, D	2011-07-31
Livengood/Cascaden Rdg.	Burned	LDB03	A, B, C, *no 4^{th} photo	2011-07-31
Big Denver	Unburned	BDUB01	not available	2011-07-22

3. Application and Derivation

These data are useful to climate change studies. The largest carbon sink present in North America is in forests and the boreal forest biome is one of the largest terrestrial carbon stores across North America, mainly due to the large carbon pool stored in the soils of peatlands and forests of this region (Hoy et al., 2016).

4. Quality Assessment

The standard error has been included in the burned plot data for prefire depth, postfire depth, and depth of burn, and in the unburned data, for the thickness of the fibric, mesic, humic, and moss layers, adventitious root depth to organic matter and mineral soil, and also for total organic matter layer depth.

An initial relationship was developed between the organic layer depth and the AR depth to mineral soil using only the sample points from the seven intermediate-aged unburned Black Spruce sites. Based on overlapping confidence intervals for the slope and intercept of each equation, this relationship did not vary significantly from the relationship published in Turetsky et al. (2011) to relate AR data with total organic matter depth in mature Black Spruce stands.

5. Data Acquisition, Materials, and Methods

Site Description

This study was conducted in interior Alaska, which stretches from the Brooks Range in the north to the Alaska Range in the south and encompasses multiple topographic and permafrost gradients. Black Spruce forests represent 45% of the land cover in the interior of Alaska and are the prevailing forest type in Alaskan (66% of Alaskan forests) and Canadian boreal forests. These forests occur primarily in areas with discontinuous permafrost, which can greatly influence site drainage conditions and the organic soil layer thickness (Hoy et al., 2016).

Methods

Samples were collected from 39 plots established in four Black Spruce stands which burned twice in the last 37-52 years (considered to be intermediate-interval fire events). In each of the intermediate-interval fire events, a fire first occurred in the 1950s or 1960s, with the sites burning again in the 2000s.There were no live trees in these stands. Samples were also collected from seven plots in unburned stands adjacent to the burned stands of similar ages (across multiple topographic positions and dominated by live, intermediate-aged (~37-52 years) Black Spruce trees).

Individual plots consisted of an area at least 30 by 40 m on the same topographic position with similar fire severity. Sample sites were located across different topographic positions (also referred to as landscape classes) representing a gradient of well-drained to poorly-drained areas including flat uplands (FU); south (S) facing backslopes; east and west facing backslopes (EW); north (N) facing backslopes; and flat lowlands (FL).

Figure 2. The Fish Creek burned site, Plot 13 (also a companion photo file: FCB13_A.jpg).

Figure 3. The Fish Creek unburned site, Plot 1 (also a companion photo file: FCUB01_B.jpg).

Measurement of Organic Layer Characteristics in Burned and Unburned Stands

Date of burn from the most recent fire event was established for each plot using MODIS hotspot data (Giglio et al. 2006). The organic layer sampling methods followed Kane et al. (2007) and Kasischke et al. (2008). In the intermediate-interval burned plots, the soil depth measurements consisted of a measurement from the top of the remaining soil SOL following fire to the mineral soil layer, and a breakdown of soil type was noted (including the char, fibric, mesic and humic soil layers). The AR measurements were collected by measuring the distance from the top AR to the mineral soil using black spruce trees ≥ 2 meters tall and believed to have burned during the most recent fire event (during the 2000s).

Samples were also collected in plots located in seven unburned stands adjacent to the burned stands of similar ages in order to estimate pre-fire depth using adventitious roots. Similar to the design used to make depth measurements in burned stands, SOL measurements were made in unburned stands from the top of the SOL to the mineral soil including a breakdown of soil type (moss, fibric, mesic and humic soil). AR measurements were also collected and included the measurement of the top of the organic layer to the top AR, and from the top of the AR to the mineral soil. Using the relationship between the AR depth above the mineral soil and total organic layer depth in unburned stands, pre-fire organic layer depths in burned stands were estimated (Hoy et al., 2016).

Changes in Soil Carbon

SOC storage and losses were estimated using empirical relationships between organic horizon depth (cm) and SOC (kg m-2) developed by Turetsky et al. (2011) from published soil data for Alaskan black spruce forests stratified by landscape (topographic) class. In burned stands, the estimated depth of burn derived from AR measurements less the char layer was used in the analysis to account for ecosystem carbon retained in the soil as char or charcoal (Turetsky et al. 2011).

Data Analysis

Organic layer depths in intermediate-interval burned sites were analyzed using three measures of fire severity: 1) depth of burn (or absolute depth reduction), the amount of organic matter which burned during the fire, 2) percent depth reduction (or relative depth reduction), the relative amount of organic matter removed during the fire when compared to pre-fire organic layer levels, and 3) the post-fire depth at the site following the intermediate interval burn. The characteristics of the organic layer depths found in intermediate-interval burned sites were compared with the long-interval sites previously sampled by Turetsky et al. (2011) using linear mixed effects models, which can account for any non-normality in the data set as well as random variables. Fixed effects included in the models were fire-free interval (Interval), landscape class (the five topographic positions described above), Julian date, and the interaction between interval and landscape class, while the random effect of fire identity was used to account for differences among fire events used in the analysis.

6. Data Access

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

NACP Soil Organic Matter of Burned Boreal Black Spruce Forests, Alaska, 2009-2011

Contact for Data Center Access Information:

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

7. References

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8. Data Set Revisions

Revision 1.1 - The data file Alaskan_Black_Spruce_burned_soil_samples.csv has been revised on April 18, 2018. The values for CKB15, CKB16, LDB01, LDB02, LDB03, KCB01, KCB02, and KCB03 in column Z (Carbon Storage Prefire) has been updated.