Last update: August 19, 2016

Soil Water Characteristics of Cores from Low- and High-Centered Polygons, Barrow, Alaska, 2012

Review and follow the current NGEE Data and Fair-Use Policies prior to using these data (http://ngee-arctic.ornl.gov/content/ngee-arctic-data-management-policies-and-plans).

Summary:

This dataset includes soil water characteristic curves for soil and permafrost in two representative frozen cores collected from a high-center polygon (HCP) and a low-center polygon (LCP) from the Barrow Environmental Observatory. Data include soil water content and soil water potential measured using the simple evaporation method for hydrological and biogeochemical simulations and experimental data analysis.

Data can be used to generate a soil moisture characteristic curve, which can be fit to a variety of hydrological functions to infer critical parameters for soil physics. Considering the measured the soil water properties, the van Genuchten model predicted well the HCP, in contrast, the Kosugi model well fitted LCP which had more saturated condition.

Two cores were collected on April 13, 2012.

- Core "NGADG0013" was collected in Intensive Site 1, Area A, from a low centered polygon (LCP) dissected into 2 layers.

- Core "NGADG0020" was collected in Intensive Site 1, Area B, from a high centered polygon (HCP) dissected into 6 layers.

There are eight *.zip files provided with this data set – one for each analyzed core layer/depth increment.

Please use this citation to reference the data.

Moon, J-W. and D.E. Graham. 2016. **Soil Water Characteristics of Cores from Low- and High-Centered Polygons, Barrow, Alaska, 2012**. Next Generation Ecosystem Experiments Arctic Data Collection, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA. Data set accessed at http://dx.doi.org/10.5440/1299259.

Data Characteristics

Locations:

Table 1. Core locations, field sampling characteristics, collection date, and contact information that apply to all respective core increments.

	CoreID	
Core Details	**NGADG0013**	**NGADG0020**
Locale	Barrow	Barrow
Site	Intensive Site 1	Intensive Site 1
Area	Area A	Area B
Location Description	Intensive Site 1_Area A	Intensive Site 1_Area B
Easting, meters	585572.98	585787.386
Northing, meters	7910489.195	7910247.311
Latitude, decimal degrees	71.281601	71.2792969
Longitude, decimal degrees	-156.6100006	-156.6049957
Elevation, meters amsl	5.1399999	5.5999999
Investigator	David Graham	David Graham
Contact	grahamde@ornl.gov	grahamde@ornl.gov
Last_Update	2015Jan7	2015Jan7
Collection date	2012-04-13	2012-04-13
Polygon type	LCP (low centered polygon)	HCP (high centered polygon)
Core hole depth, cm	75	96
Core length field, cm	65	80

Source: NGEE Arctic Core Locations, Sampling Characteristics, Collection, and Contacts, Barrow, Alaska, USA [NGEE_Core_Locations_Supplemental_Information_Barrow_Alaska_USA_20160502.xlsx]

* Values for these location fields have been standardized for NGEE Arctic and are required fields for all data dictionaries. (http://ngee-arctic.ornl.gov/content/metadata-entry-data-upload-and-data-management-help)

Data Files:

There are eight *.zip files provided with this data set – one for each analyzed core depth increment.

File naming convention: CoreID_(depth-increment)cm.zip

NGADG0013_0-19cm.zip
NGADG0013_19-49cm.zip

NGADG0020_0-10cm.zip
NGADG0020_10-20cm.zip
NGADG0020_20-35cm.zip
NGADG0020_35-50cm.zip
NGADG0020_50-65cm.zip
NGADG0020_65-80cm.zip

Each *.zip file contains:

1) The exported HYPROP file (*.bhdx),
2) The exported Excel workbook (*.xlsx) with individual worksheets (13) of water characteristics results, and
3) 13 (*.csv) files, that are the "saved as" individual results worksheets.

Data Dictionary:

Table 2 identifies the types of files and describes what is being reported in each type of file for the respective core depth-increment *.zip files.

Note that a <u>detailed data dictionary is not being provided</u> for each file type.

Details of the HYPROP measurement system and for parameter fitting with your own software, can be guided by HYPROP operational manual and HYPROP-FIT software manual, UMS (2015a) and UMS (2015b), respectively.

Table 2. Types of files and what is being reported in each type of file, for the respective core depth-increment *.zip files.

File Name / Type	Description
*.bhdx	Exported HYPROP file that can be re-import into HYPROP.
*.xlsx	Exported Excel workbook with individual worksheets (13) of water characteristics results.
13 individual results worksheets that are "saved as" (*.csv) files	
*_Information.csv	HYPROP settings and measurement conditions including duration (measurement date and time), soil volume, tensiometer position, fitting model, etc.
*_Measurements-Tension.csv	Bottom and top tensiometer readings over time
*_Measurements-Weight.csv	Weight change due to simple evaporation over time
*_Spline Points.csv	Spline data of tension and weight measurements over time
*_Evaluation-Retention theta(pF).csv	Variation of water retention (pF, $-\log_{10}$[tension in hPa]) depending on volumetric water content (θ)
*_Evaluation-Conductivity K(pF).csv	Variation of conductivity (K) depending on water retention
*_Evaluation-Conductivity K(theta).csv	Variation of conductivity (K) depending on volumetric water content
*_Fitting-Retention theta(pF).csv	Model-fitted water retention depending on volumetric water content (θ)
*_Fitting-Conductivity K(pF).csv	Model-fitted conductivity depending on water retention
*_Fitting-Conductivity K(theta).csv	Model-fitted conductivity depending on volumetric water content
*_Fitting-Parameter value.csv	Collection of fitting parameters including shape parameters (α and n), residual water content (θr), saturated water content (θs), saturated hydraulic conductivity (Ks), and tortuosity parameter (τ)
*_FittingCorrelationMatrix.csv	Correlation matrix of fitting parameters
*_Fitting-Statistical analysis.csv	Statistical fitting result using root-mean-square error (RMSE) on volumetric water content and conductivity, and Akaike information criterion (AIC)

Data Acquisition Materials and Methods

Measurement of soil water properties using HYPROP and WP4 System

Soil hydraulic properties were evaluated by simple evaporation method (SEM) that extends the measurement range. The SEM overcomes range limitations and extends the range for hydraulic function measurement to the medium to dry range using the air-entry pressure of the ceramic cups in a HYPROP tensiometer system (Decagon, Pullman, WA/UMS, Munich, Germany) measuring the water tension at two levels of soil with two tension shafts (Schindler, W., et al., 2010). Sections of core were placed in soil sampling rings, thawed, packed, and placed in a HYPROP system as shown in Figure 1 to collect a moisture characteristic curve.

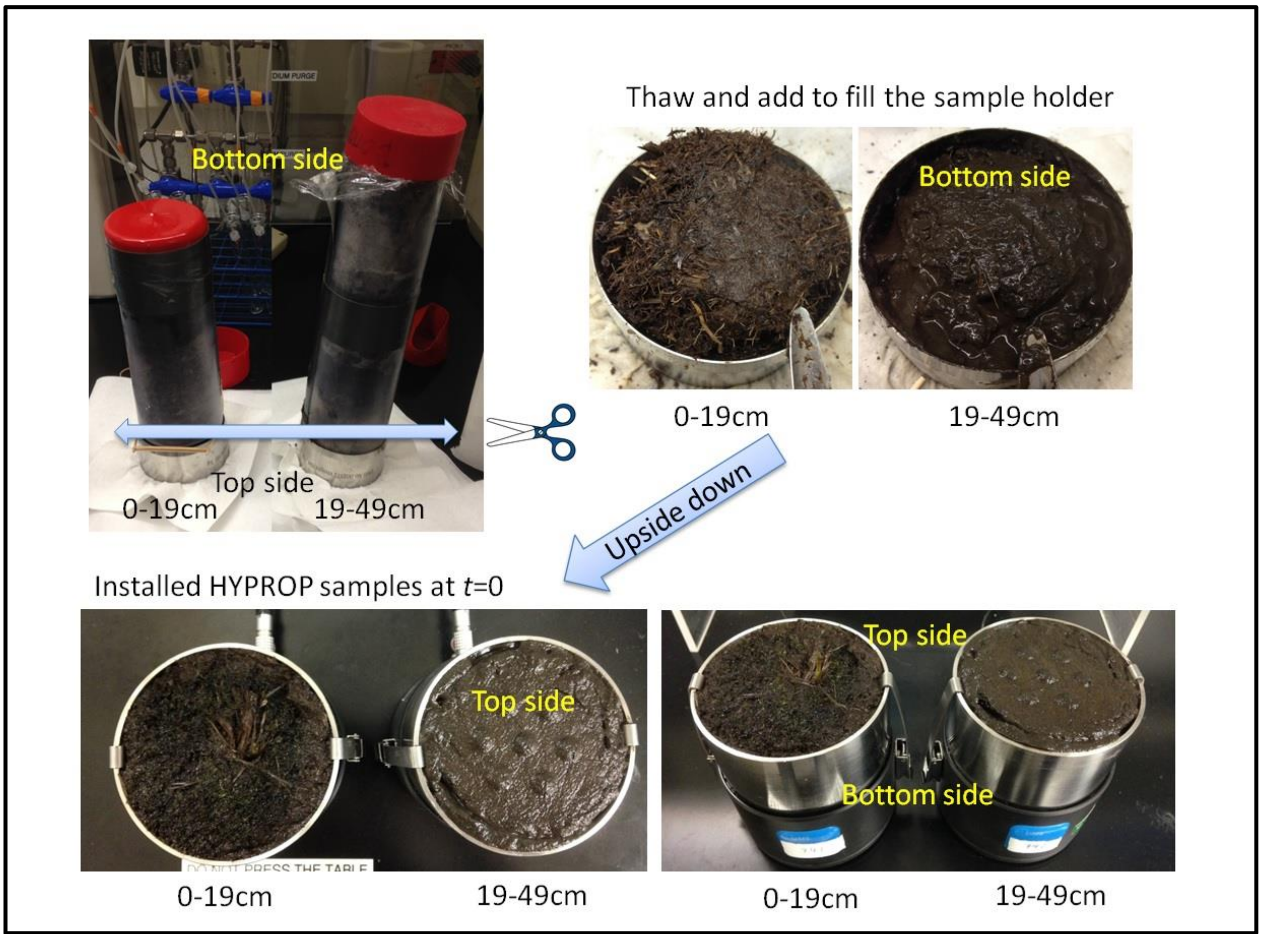

Figure 1. Sections of core were placed in soil sampling rings, thawed, packed, and placed in a HYPROP system to measure the moisture characteristic curve.

The location of the middle point between two tensiometers is in the center of the soil volume in 3-dimension. The topside of saturated sample exposed to atmosphere, therefore soil moisture simply evaporates. With the soil water tension, the average matric potential and the hydraulic gradient is calculated. The mass difference is used to calculate the volumetric water content and the flow rate. Detail procedure followed the manufacturer's instruction.

The curve was extended to air-dry condition beyond wilting point using WP-4 chilled mirror dew point instrument (Decagon) employing vapor pressure method (VPM) were done using room-temperature dried samples after HYPROP measurement or frozen core sample. Weight losses were intermittently measured until water potential dropped less than 65 MPa.

Hydraulic Modeling

Five different models were applied; Brooks-Corey (Brooks and Corey, 1964), Fredlund-Xing (Fredlund and Xing, 1994), Kosugi (Kosugi, 1996), van Genuchten (m=1-1/n, Mualem model), and van Genuchten (mnvar) (Van Genuchten, 1980) under 4 conditions including original, Peters-Durner-Iden (PDI) variant implying the water content matches zero at oven dry, bimodal, and bimodal+PDI. Each fitting were checked by the statistical analysis by root-mean-square error (RMSE) values of both water content data and log of conductivities and corrected Akaike Information Criterion. Processing using HYPROP FIT software (UMS GmbH) (https://www.decagon.com/en/data-loggers-main/software/hyprop-software/)

Based on the measured soil water properties, the van Genuchten model predicted well the HCP, in contrast, the Kosugi model well fitted LCP which had more saturated condition.

References

Brooks, R.H. and A.T. Corey. 1964. Hydraulic properties of porous media. Hydrology Papers. Colorado State University.

Decagon (2003) WP4-Operators-Manual. Accessed at http://manuals.decagon.com/Manuals/Discontinued/WP4-Operators-Manual-(discontinued).pdf

Fredlund, D.G. and A. Xing. 1994. Equations for the soil-water charateristic curve. Canadian Geotechnical Journal 31: 521-532.

Kosugi, K.I. 1996. Lognormal distribution model for unsaturated soil hydraulic properties. Water Resour. Res. 32: 2697-2703.

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UMS (2015a) Operational Manual HYPROP, Version 2015_01. Accessed at http://www.ums-muc.de/assets-ums/009VP.pdf

UMS (2015b) HYPROP-FIT User's Manual, Version 3.0. Accessed at http://www.ums-muc.de/assets-ums/009VP.pdf

van Genuchten, M.T. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. Soil Sci. Soc. Am. J. 44: 892-898.

Data Access:

Data Center Contact: support@ngee-arctic.ornl.gov

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