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ABOVE: Active Layer Soil Characterization of Permafrost Sites, Northern Alaska, 2018

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Summary

This dataset provides in situ soil measurements including soil dielectric properties, temperature, and moisture profiles, active layer thickness (ALT), and measurements of soil organic matter, bulk density, porosity, texture, and coarse root biomass. Samples were collected from the surface to permafrost table in soil pits at selected sites along the Dalton Highway in Northern Alaska. From North to South, the study sites include Franklin Bluffs, Sagwon, Happy Valley, Ice Cut, and Imnavait Creek. Measurements were made from August 22 to August 26, 2018. The purpose of the field campaign was to characterize the dielectric properties of permafrost active layer soils in support of the NASA Arctic and Boreal Vulnerability Experiment (ABOVE) Airborne Campaign.

There are six data files in comma separated value (*.csv) format provided with this dataset: two files with soil characterization data for five sites and four files with active layer thickness data for four sites.

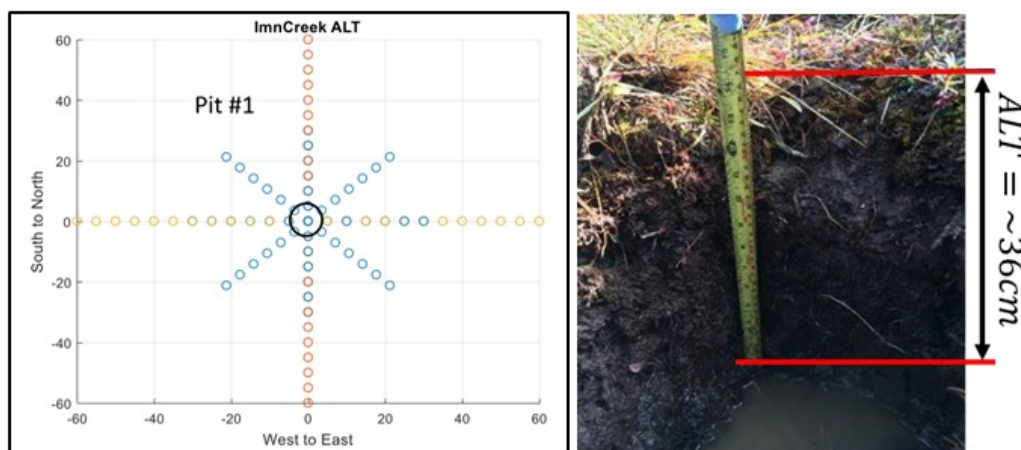


Figure 1. Site sampling plan used for characterizing active layer soils (left). Axes are in meters. At Imnavait Creek, active layer thickness (ALT) was measured on transects intersecting a central soil pit. Soil dielectric properties, in situ moisture and temperature profiles were measured, and soil samples were collected for analyses from the soil pit (right).

Citation

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1. Dataset Overview

This dataset provides in situ soil measurements including soil dielectric properties, temperature, and moisture profiles, active layer thickness (ALT), and measurements of soil organic matter, bulk density, porosity, texture, and coarse root biomass. Samples were collected from the surface to permafrost table in soil pits at selected sites along the Dalton Highway in Northern Alaska. From North to South, the study sites include Franklin Bluffs, Sagwon, Happy Valley, Ice Cut, and Imnavait Creek. Measurements were made from August 22 to August 26, 2018. The purpose of the field campaign was to characterize the dielectric properties of permafrost active layer soils in support of the NASA Arctic and Boreal Vulnerability Experiment (ABOVE) Airborne Campaign.

The Arctic-Boreal Vulnerability Experiment (ABoVE) is a NASA Terrestrial Ecology Program field campaign based in Alaska and western Canada between 2016 and 2021. Research for ABoVE links field-based, process-level studies with geospatial data products derived from airborne and satellite sensors, providing a foundation for improving the analysis and modeling capabilities needed to understand and predict ecosystem responses and societal implications.

Related Datasets

Additional [Hydrology](#) and [Permafrost](#) ABoVE datasets archived at the ORNL DAAC provide similar observations at other sites.

Acknowledgments

Funding was provided by Terrestrial Ecology Grant NNX17AC65A and NASA Earth and Space Science Fellowship Grant 80NSSC18K1410.

2. Data Characteristics

Spatial Coverage: Five sites in Northern Alaska along the Dalton Highway: Franklin Bluffs, Sagwon, Happy Valley, Ice Cut, and Imnaviat Creek.

ABOVE Reference Locations

Domain: Core

State/Territory: Alaska

Grid cells: Ah01Av00.Bh08Bv03.Ch48Cv21, Ah01Av00.Bh08Bv03.Ch50Cv20, Ah01Av00.Bh08Bv03.Ch51Cv19, Ah01Av00.Bh08Bv03.Ch52Cv18

Spatial Resolution: Point locations

Temporal Coverage: 2018-08-22 to 2018-08-26

Temporal Resolution: Daily one time measurements

Study Area: Latitude and longitude are given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Northern Alaska, USA	-149.5	-148.4	69.9	68.5
Franklin Bluffs	-148.766	-148.766	69.81237	69.81237
Sagwon	-148.564	-148.564	69.47958	69.47958
Happy Valley	-148.509	-148.509	69.18333	69.18333
Ice Cut	-148.827	-148.825	69.04193	69.04189
Imnavait Creek	-149.306	-149.306	68.60497	68.60497

Data File Information

There are six data files in comma-separated value (*.csv) format provided with this dataset: two files with soil characterization data for five sites and four files with active layer thickness data for four sites. The companion file **Data_Descriptions_with_Equations.pdf** provides data descriptions and equations used to derive the soil physical and dielectric properties.

Table 1. File names and descriptions

File Name	Description
soil_physical_properties.csv	This file provides soil characterization data for 102 samples collected from eight soil pits at five study sites.
soil_dielectric_profiles.csv	This file provides 144 soil electric conductivity, temperature, and dielectric permittivity measurements made at eight soil pits in five study sites.
active layer thickness (ALT) <ul style="list-style-type: none"> franklin_bluffs_alt.csv ice_cut_alt.csv imnavait_creek_alt.csv sagwon_alt.csv 	These files provide active layer thickness measured along transects at four sites. See site-specific plans in Section 5. No ALT measurements were collected at Happy Valley.

Table 2. Variables in the file **soil_physical_properties.csv**. Equations used to derive the soil physical properties are included in the companion file **Data_Descriptions_with_Equations.pdf**.

Column Name	Units	Description
soil_pit_number		Soil pit number, where the soil sample was collected. Includes Site abbreviation: FB = Franklin Bluffs, SGW = Sagwon, HV = Happy Valley, ICC = Ice Cut, and IMN = Imnaviat Creek
pit_sample_id		Samples were collected adjacent together at each depth. Sample ID denotes two adjacent samples.
sampling_date	YYYY-MM-DD	Date samples were collected

latitude	decimal degrees	Latitude in decimal degrees of the site
longitude	decimal degrees	Longitude in decimal degrees of the site
min_depth	cm	Minimum sampling depth
max_depth	cm	Maximum sampling depth
field_wet_mass	g	Weight of the wet soil samples in the field
dry_mass	g	Weight of the soil sample after 48 hours of oven-drying at 65 °C
moisture_mass	g	Difference of Field_Wet_Mass and Dry_Mass
sample_volume	cm3	Volume of the sampling container
sample_volumetric_water_content	cm3/ cm3	Volumetric water content of the soil sample
field_bulk_density	g/ cm3	Bulk density of the soil sample in the field
porosity	cm3/ cm3	Porosity of the soil sample
saturation_water_fraction		Fraction of saturation of the sample
coarse_root_biomass_fraction	g/g (%)	Gravimetric fraction of the sample with dimension > 2mm over the entire dry sample
fine_organic_mineral_fraction	g/g (%)	Gravimetric fraction of the sample with 0.15mm < dimension < 2 mm over the entire dry sample
soil_fraction	g/g (%)	Gravimetric Fraction of the sample with 0.15mm > dimension over the entire dry sample
soil_organic_matter_fraction	g/g (%)	Soil organic matter content, loss on ignition over the samples < 2mm
total_organic_matter_fraction	g/g (%)	Total organic matter content
gravel	g/g (%)	Gravel fraction (>2mm)
sand	g/g (%)	Sand fraction, analyzed through hydrometer method
silt	g/g (%)	Silt fraction, analyzed through hydrometer method
clay	g/g (%)	Clay fraction, analyzed through hydrometer method
soil_type		Type of mineral soil according to soil classification

Table 3. Variables in the file **soil_dielectric_profiles.csv**. Equations used to derive the soil dielectric properties are included in the companion file **Data_Descriptions_with_Equations.pdf**.

Column Name	Units	Description
soil_pit_number		Soil pit number, where the soil sample was collected. Includes Site abbreviation: FB = Franklin Bluffs, SGW = Sagwon, HV = Happy Valley, ICC = Ice Cut, and IMN = Imnaviat Creek
sampling_date	YYYY-MM-DD	Date samples were collected
latitude	decimal degrees	Latitude in decimal degrees of the site
longitude	decimal degrees	Longitude in decimal degrees of the site
sampling_depth	cm	Sampling depth
adc_count		The analog-to-digital converter (ADC) count to measure the permittivity as provided by the (ProCheck) data logger. Sometimes referred to as Raw ADC count. Manual included as a companion file.
electrical conductivity	mS/cm	Electrical Conductivity measured using the (TEROS 12) sensor and (ProCheck) data logger
temperature	Deg C	Temperature as measure by the (TEROS 12) sensor
permittivity_70 mhz		Dielectric permittivity as derived by equation 8 from the TEROS11-12 manual to transfer Raw ADC count to dielectric permittivity. Equation 8: $\epsilon = (2.887 \times 10^{-9} \times \text{RAW}^3 - 2.080 \times 10^{-5} \times \text{RAW}^2 + 5.276 \times 10^{-2} \times \text{RAW} - 43.39)^2$ where RAW = raw sensor output. The TEROS11-12 manual is included as a companion file.
loss_70mhz		Effective loss factor at 70MHZ

Table 4. Variables in the site active layer thickness data files: **franklin_bluffs_alt.csv**, **ice_cut_alt.csv**, **imnavait_creek_alt.csv**, and **sagwon_alt.csv**. See the site plan figures in Section 5 to visualize how the transects and soil pits intersect at a given site. No ALT measurements were collected at Happy Valley.

Column Name	Units	Description
site		Measurement Site. Abbreviations: FB = Franklin Bluffs, SGW = Sagwon, ICC = Ice Cut, and IMN = Imnaviat Creek
sample_date	YYYY-MM-DD	Date samples were collected
latitude	decimal degrees	Latitude in decimal degrees of the site and measurement points. Mostly the same value because site is small.
longitude	decimal degrees	Longitude in decimal degrees of the site and measurement points. Mostly the same value because site is small.
transect		Transect as defined for each site, e.g., N-S, E-W, NE-SW, NW-SE, etc. See site-specific figures in Section 5.
measurement_traverse		Direction taken by investigator along a transect to make measurements, e.g., N to S, E to W, NE to SW, NW to SE, etc. See site-specific figures in Section 5.
measurement_order		Sequential measurement number along each transect. See site-specific figures in Section 5.
measurement_purpose		Purpose of each measurement, either general plot characterization or for characterizing a soil pit (soil pit focus, i.e., at six measurement locations along a transect closest to a soil pit). See site-specific figures in Section 5.
alt	cm	Active layer thickness. Note that ALT values for site soil pits are repeated. That is, the ALT measurement for a given soil pit is repeated when a transect intersects the soil pit. See site-specific figures in Section 5.
alt_fl		Identifies the locations that are soil pit measurements or may have been covered by water (e.g., Soil pit FB-1 or water). See site-specific figures in Section 5.

3. Application and Derivation

Soil dielectric properties, soil moisture, organic matter content, root biomass, and other soil physical properties, along with active layer thickness (ALT), are key variables for understanding the dynamics of the permafrost active layer under the regional warming trends in the Arctic area. Remote sensing modeling initially starts and is developed based on field (in situ) observations. This dataset provides a unique and comprehensive characterization of soil properties that can be utilized in support of NASA Arctic and Boreal Vulnerability Experiment (ABoVE) Airborne Campaign (AAC). The site locations were carefully selected to capture different landscapes within two benchmarks AAC legacy flight lines known as Deadhorse and Toolik. Furthermore, the parameters from Franklin Bluffs were concurrent with an August 2018 ABoVE L-band flight and can be used for calibration activities.

4. Quality Assessment

Two adjacent samples (Fig. 3, a and b) were collected at each horizon to make sure the measurement procedures were reliable. This is based on the assumption that two separate samples collected at the same horizon will have similar properties.

Field instruments were calibrated according to manufacturers' recommendations. Soil texture analysis and soil organic matter measurement followed standard methods for the characterization of soils (Ward Laboratories). Other soil physical properties have been measured according to well-established procedures with necessary modifications for some variables. A journal article is under preparation for further analysis of the measured data and quality assessment.

5. Data Acquisition, Materials, and Methods

Geo-physical characterization of northern Alaska arctic permafrost active layer soils was conducted at site locations in August of 2018. Measurements included in situ profiles of soil moisture and temperature parameters and lab analyses of soil samples for organic matter content, bulk density, and other physical soil characteristics. Selected sites are along the Dalton Highway in Northern Alaska. From North to South, the study sites included Franklin Bluffs, Sagwon, Happy Valley, Ice Cut, and Imnavait Creek. The parameters from Franklin Bluffs were concurrent with an August 2018 ABoVE L-band flight.



Figure 2. Map of sites along the Dalton Highway.

Table 5. Site sampling and measurement details.

Site Name	Number of Soil Pits	Date of Sampling	Latitude	Longitude	Pit Sample ID		Number of Samples per Pit		Active Layer Thaw Depth (cm)
					a	b			
Franklin Bluffs (FB)	1	2018-08-26	69.812372	-148.76648	a	b	8	8	58
Sagwon (SGW)	1	2018-08-22	69.479578	-148.56442	a	b	6	6	51
	2	2018-08-22	69.476578	-148.56443	>a	b	8	8	54
Happy Valley (HV)	1	2018-08-25	69.155356	-148.83878	a	b	8	8	47
	2	2018-08-25	69.155358	-148.8418	a	b	5	5	36
Ice Cut (ICC)	1	2018-08-23	69.041894	-148.82703	a	b	6	6	55
	2	2018-08-23	69.041928	-148.82538	a	b	5	5	38
Imnavait Creek (IMN)	1	2018-08-24	68.604972	-149.30635	a	>b	5	5	57



Figure 3. Two adjacent samples, a and b, were collected from each depth interval starting from the surface down to the permafrost table in each soil pit. A TEROS 12 dielectric probe was inserted horizontally into the side of the soil pit to measure a soil dielectric properties profile.

Site Sampling Protocol

The general site sampling protocol follows. Owing to each site's conditions and permitted areas, the length of each transect and the number of soil pits might differ (see site-specific plans below).

1. ALT measurements were made along two long transects: north to south (N-S) and east to west (E-W). Priority was given to establishing the N-S transect.
2. Soil pit locations were identified.
3. ALT measurements were made along 4 short transects intersecting each soil pit: northeast to southwest (NE-SW), north to south (N-S), northwest to southeast (NW-SE), east to west (E-W).
4. Dielectric profiles were measured from surface to the permafrost table in soil pits.
5. Soil samples were collected from each soil pit using 8 oz tin containers. Two samples were collected from each selected depth to the permafrost table. The samples were then shipped to the University of Southern California for further texture and physical property analysis (Combs et al., 1998; Foth, 1978; Gee and Bauder, 1986). Figure 3 shows the two adjacent sample containers and horizontal soil dielectric probing.

Site Sampling Plan: Franklin Bluff

ALT was measured on four transects intersecting a central soil pit:

- N-S transect: 180 m with 5 m interval
- E-W transect: 180 m with 5 m interval
- Center: Soil pit #1 location
- NE-SW transect: 60 m with 5 m interval
- NW-SE transect: 60 m with 5 m interval

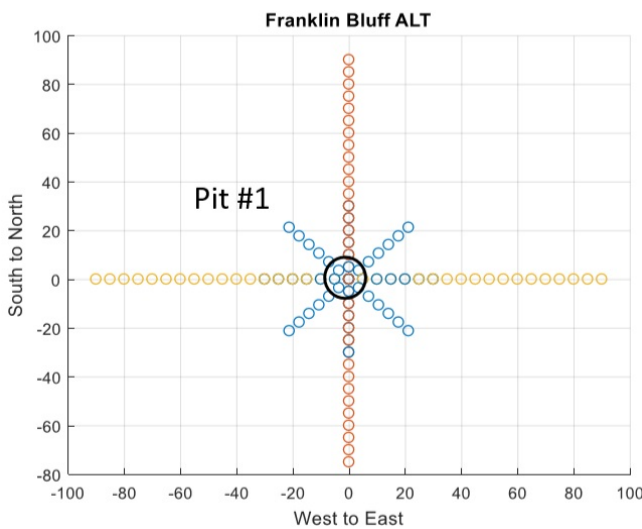


Figure 4. Site sampling plan used for characterizing ALT at the Franklin Bluff site. Axes are in meters.

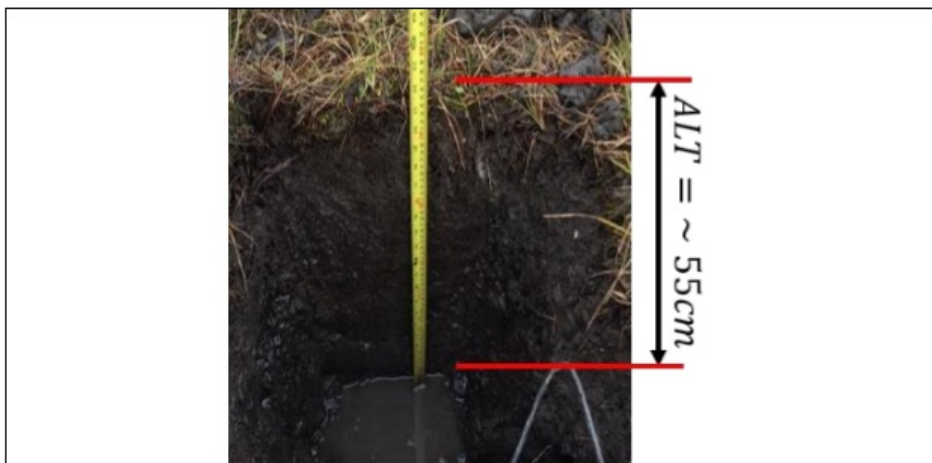


Figure 5. Physical and dielectric soil properties were measured in one soil pit at the Franklin Bluff site.

Site Sampling Plan: Sagwon

ALT was measured on seven transects intersecting two soil pits:

- N-S transect: 480 m with 5 m interval; no measurement at the missing points at approximately 125 m along the N-S axes due to surface water.
- Blue: Measurement across soil pit #1 location
 - NE-SW transect: 60 m with 5 m interval
 - NW-SE transect: 60 m with 5 m interval
 - E-W transect: 60 m with 5 m interval
- Red: Measurement across soil pit #2 location
 - NE-SW transect: 60 m with 5 m interval
 - NW-SE transect: 60 m with 5 m interval
 - E-W transect: 60 m with 5 m interval

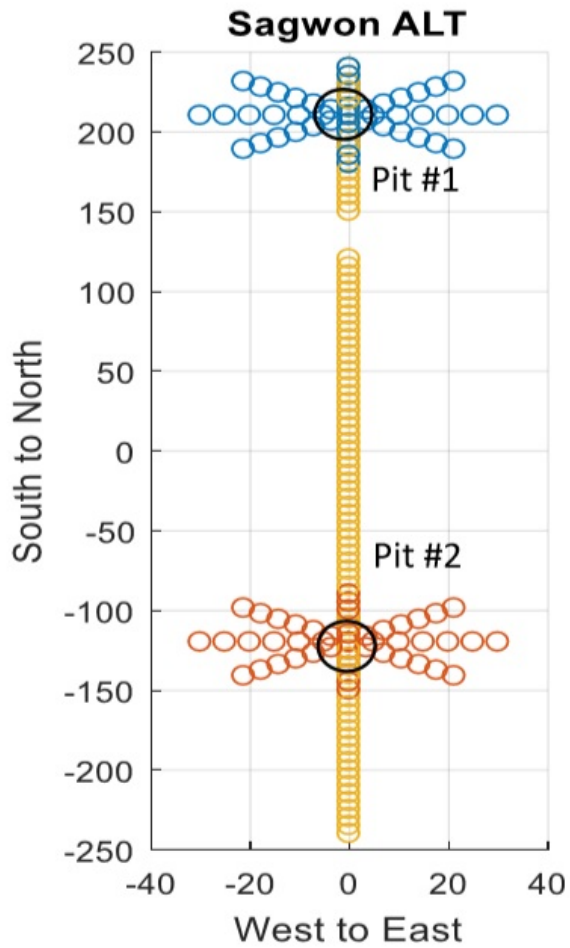


Figure 6. Site sampling plan used for characterizing ALT at the Sagwon site. Axes are in meters.

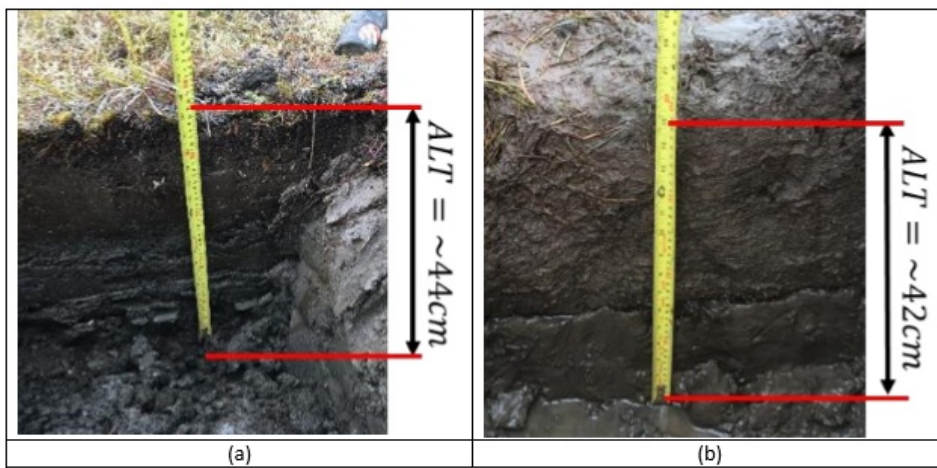


Figure 7. Physical and dielectric soil properties were measured in the Sagwon soil pit #1 (a) and Sagwon soil pit #2 (b).

Site Sampling Plan: Happy Valley

No transect ALT measurements were collected at the Happy Valley site.

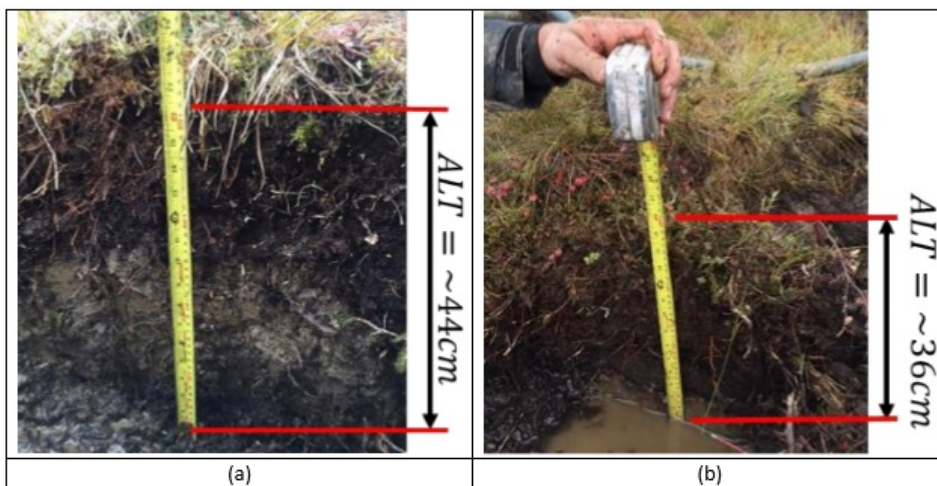


Figure 8. Physical and dielectric soil properties were measured in two soil pits, #1 (a) and #2 (b), at the Happy Valley site.

Site Sampling Plan: Ice Cut

ALT was measured on eight transects intersecting two soil pits:

- N-S transect: 180 m with 5 m interval
- E-W transect: 180 m with 5 m interval
- Blue: Measurement across soil pit #1 location
 - NE-SW transect: 60 m with 5 m interval
 - NW-SE transect: 60 m with 5 m interval
 - E-W transect: 60 m with 5 m interval
- Red: Measurement across soil pit #2 location
 - NE-SW transect: 60 m with 5 m interval
 - NW-SE transect: 60 m with 5 m interval
 - N-S transect: 60 m with 5 m interval

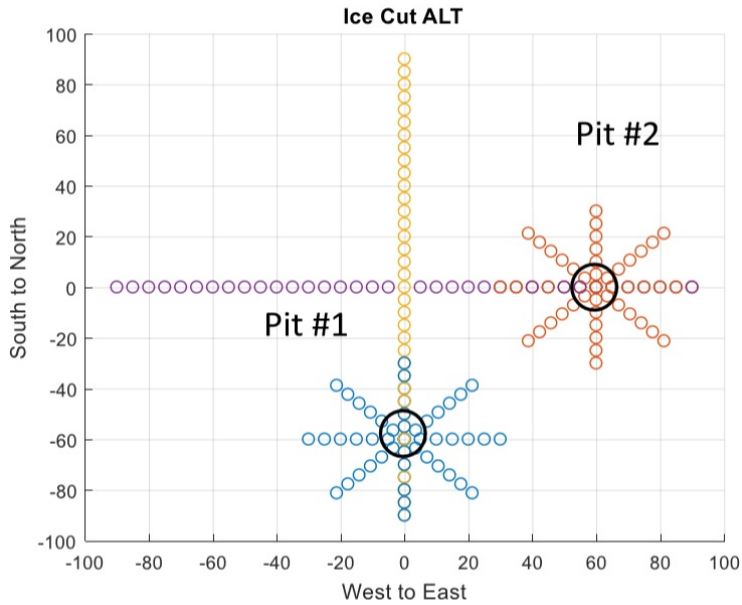


Figure 9. Site sampling plan used for characterizing ALT at the Ice Cut site. Axes are in meters.

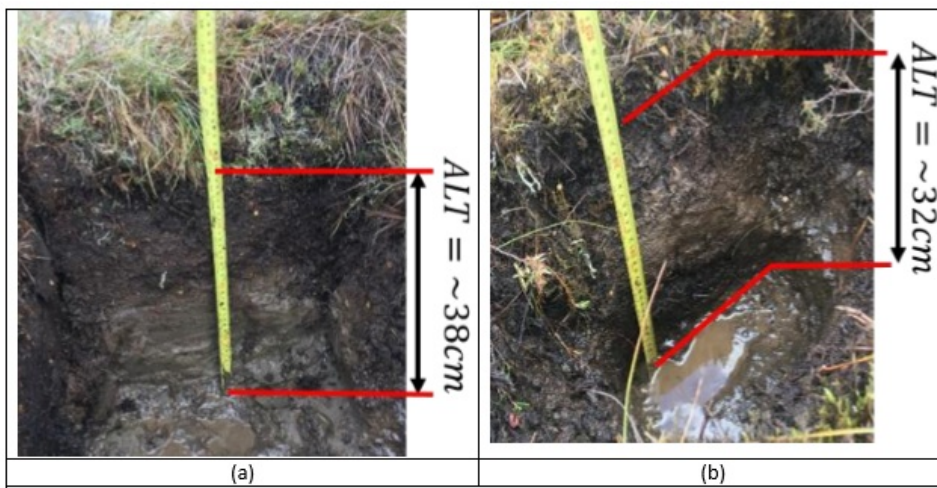


Figure 10. Physical and dielectric soil properties were measured in the Ice Cut soil pit #1 (a) and Ice Cut soil pit #2 (b).

Site Sampling Plan: Imnavait Creek

ALT was measured on four transects intersecting a central soil pit:

- N-S transect: 120 m with 5 m interval
- E-W transect: 120 m with 5 m interval
- Center: Soil pit #1 location
- NE-SW transect: 60 m with 5 m interval
- NW-SE transect: 60 m with 5 m interval

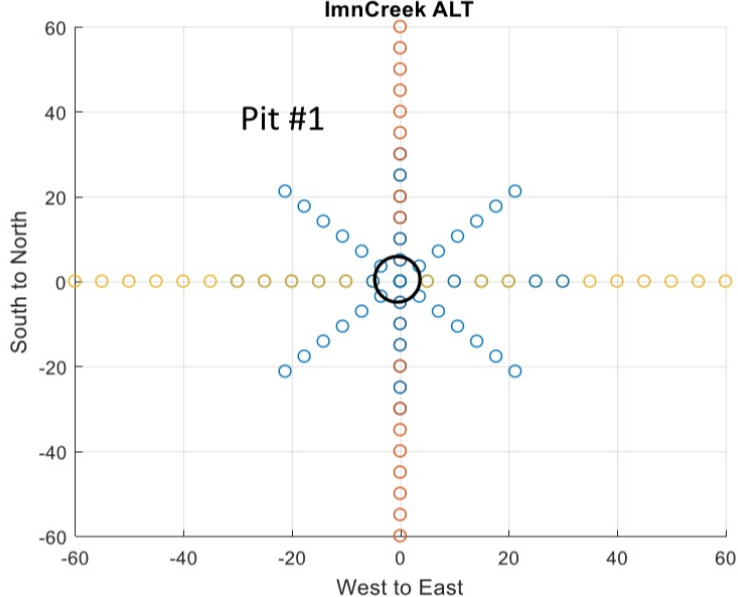


Figure 11. Site sampling plan used for characterizing ALT at the Imnavait Creek site. Axes are in meters.

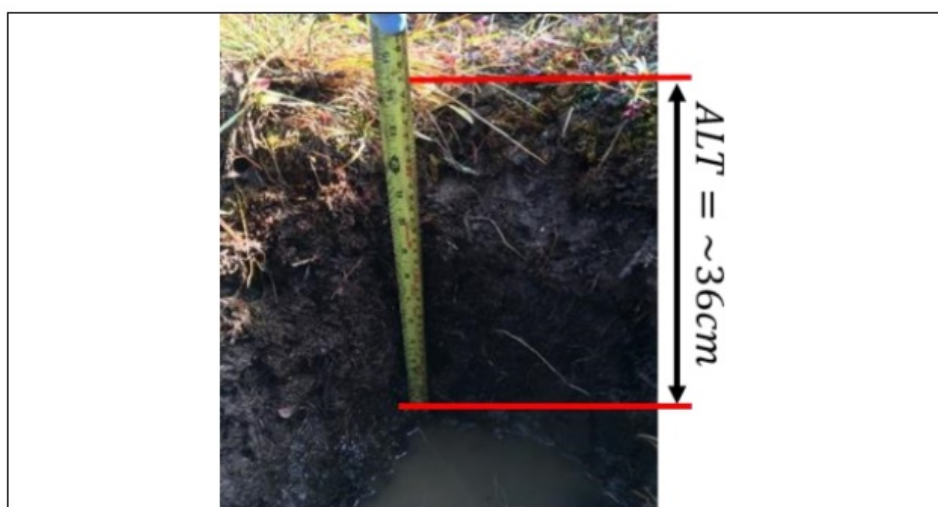


Figure 12. Physical and dielectric soil properties were measured in one soil pit at the Imnavait Creek site. Physical and dielectric soil properties were measured in one soil pit at the Imnavait Creek site.

6. Data Access

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

[ABoVE: Active Layer Soil Characterization of Permafrost Sites, Northern Alaska, 2018](#)

Contact for Data Center Access Information:

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

7. References

Combs, S. M. and M. V. Nathan. 1998. Soil Organic Matter. p. 53-58. *In* J. R. Brown (ed.) Recommended Chemical Soil Test Procedures for the North Central Region. North Central Regional Publication No. 221 (revised). University of Missouri Ag. Exp. Station, Columbia, MO 65211.

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