ABoVE: Active Layer Thickness from Airborne L- and P- band SAR, Alaska, 2017, Ver. 3

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Documentation Revision Date: 2022-09-15

Dataset Version: 3

Summary

This dataset provides estimates of seasonal subsidence, active layer thickness (ALT), the vertical soil moisture profile, and uncertainties at a 30 m resolution for 51 sites across the ABoVE domain, including 39 sites in Alaska and 12 sites in Northwest Canada. The ALT and soil moisture profile retrievals simultaneously use L- and P-band synthetic aperture radar (SAR) data acquired by the NASA/JPL Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) instruments during the 2017 Arctic Boreal Vulnerability Experiment (ABoVE) airborne campaign. The data are provided in NetCDF Version 4 format along with a python script for estimating soil volumetric water content from data.

This product was created by the Permafrost Dynamics Observatory (PDO) project to estimate the seasonal subsidence owing to active layer thaw from the L-band interferometric SAR (InSAR) pair acquired in June and September 2017. It also estimates the vertical profile of soil volumetric water content (VWC) from the P-band polarimetric SAR (PolSAR) backscatter acquired in August by Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS). The joint retrieval uses seasonal subsidence derived from L-band and P-band backscatter simultaneously to estimate the ALT and vertical soil moisture profile, along with uncertainties.

There are 51 data files in NetCDF Version 4 (*.nc4) format, one for each site, and a python script for estimating soil volumetric water content from data.

Figure 1. Sites of the Permafrost Dynamics Observatory Project product.

Citation

Chen, R.H., R.J. Michaelides, J. Chen, A.C. Chen, L.K. Clayton, K. Bakian-Dogaheh, L. Huang, E. Jafarov, L. Liu, M. Moghaddam, A.D. Parsekian, T.D. Sullivan, A. Tabatabaeenejad, E. Wig, H.A. Zebker, and Y. Zhao. 2022. ABoVE: Active Layer Thickness from Airborne L- and P- band SAR, Alaska, 2017, Ver. 3. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2004

Table of Contents

1. Dataset Overview

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Project: Arctic-Boreal Vulnerability Experiment

The Arctic-Boreal Vulnerability Experiment (ABoVE) is a NASA Terrestrial Ecology Program field campaign being conducted in Alaska and western Canada, for 8 to 10 years, starting in 2015. 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 to, and societal implications of, climate change in the Arctic and Boreal regions.

Related Publications

Chen, A.C., A.D. Parsekian, K. Schaefer, E.E. Jafarov, S. Panda, L. Liu, T. Zhang, and H.A. Zebker. 2016. Ground-Penetrating Radar Measurements of Active Layer Thickness on the Alaska North Slope. Geophysics, 81:H1–H11. https://doi.org/10.1190/GEO2015-0124.1

Chen, R.H., A. Tabatabaeenejad, and M. Moghaddam. 2018. P-Band Radar Retrieval of Permafrost Active Layer Properties: Time-Series Approach and Validation with In-Situ Observations. IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium. https://doi.org/10.1109/IGARSS.2018.8518179

Jafarov, E.E., A.D. Parsekian, K. Schaefer, L. Liu, A.C. Chen, S.K. Panda, and T. Zhang. 2018. Estimating active layer thickness and volumetric water content from ground penetrating radar measurements in Barrow, Alaska. Geoscience Data Journal 4:72-79. https://doi.org/10.1002/gdj3.49

Schaefer, K., L. Liu, A.D. Parsekian, E.E. Jafarov, A.C. Chen, T. Zhang, A. Gusmeroli, S.K. Panda, H.A. Zebker, T. Schaefer. 2015. Remotely Sensed Active Layer Thickness (ReSALT) at Barrow Alaska using Interferometric Synthetic Aperture Radar. Journal of Remote Sensing, 7:3735-3759. https://doi.org/10.3390/rs70403735

Related Datasets

Schaefer, K., R.J. Michaelides, R.H. Chen, T.D. Sullivan, A.D. Parsekian, Y. Zhao, K. Bakian-Dogaheh, A. Tabatabaeenejad, M. Moghaddam, J. Chen, A.C. Chen, L. Liu, and H.A. Zebker. 2021. ABoVE: Active Layer Thickness Derived from Airborne L- and P-band SAR, Alaska, 2017. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1796

- Version 2 of this dataset. See the “Summary of Changes between Version 2 & Version 3” section to find out the updates in Version 3.

Chen, A., A. Parsekian, K. Schaefer, E. Jafarov, S.K. Panda, L. Liu, T. Zhang, and H.A. Zebker. 2015. Pre-ABoVE: Ground-penetrating Radar Measurements of ALT on the Alaska North Slope. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1265

Jafarov, E.,A.D. Parsekian, K. Schaefer, L. Liu, A. Chen, S.K. Panda, and T. Zhang. 2016. Pre-ABoVE: Active Layer Thickness and Soil Water Content, Barrow, Alaska, 2013. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1355

Liu, L., K. Schaefer, A. Chen, A. Gusmeroli, E. Jafarov, S. Panda, A. Parsekian, T. Schaefer, H. A. Zebker, T. Zhang. 2015. Pre-ABoVE: Remotely Sensed Active Layer Thickness, Barrow, Alaska, 2006-2011. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1266

Liu, L., K. Schaefer, A. Chen, A. Gusmeroli, E. Jafarov, S. Panda, A. Parsekian, T. Schaefer, H. A. Zebker, T. Zhang. 2015. Pre-ABoVE: Remotely Sensed Active Layer Thickness, Prudhoe Bay, Alaska, 1992-2000. ORNL DAAC, Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1267

Acknowledgments

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2. Data Characteristics

Spatial Coverage: 51 sites across the ABoVE Domain, including 39 in Alaska and 12 in Canada

ABoVE Reference Locations

Domain: Core and Extended ABoVE Regions

State/Territory: Alaska, Yukon, Northwest Territories

Grid Cells: See Table 1

Spatial Resolution: 30 m

Temporal Coverage: 2017-06-19 to 2017-09-16

Temporal Resolution: The estimates are one-time estimates. The surface deformation estimates are considered to represent the subsidence that occurred during the thawing season in 2017. The thaw depth and soil moisture estimates are considered to represent the active layer soil profile at maximum thaw, in which case the thaw depth is equivalent to ALT for the year 2017.

Table 1. Study Area. Latitude and longitude are given in decimal degrees.

Site	Site Code	UAVSAR Flight Lines	ABoVE Grid Cells	North Latitude	South Latitude	East Longitude	West Longitude
Alaska							
Ambler	ambler	ambler	Bh005v002, Bh006v002	67.25	66.33	-157.82	-159.41
Anaktuvuk	anaktu			70.27	68.38	-148.04	-153.49
Atqasuk	atqasu	atqasu	Bh007v001, Bh008v001	71.05	69.67	-156.79	-158.30
Barrow	barrow	barrow	Bh008v001	71.49	70.25	-154.44	-156.86
Bonanza Creek	bonanz			65.63	64.40	-146.12	-149.14
Chevak	chevak			62.00	61.07	-164.63	-166.27
Coldfoot	coldfo	coldfo	Bh007v003, Bh006v004, Bh007v004	67.43	66.20	-149.67	-151.12
Council	counci	counci	Bh003v002, Bh004v002, Bh004v001	65.55	64.51	-163.25	-165.15
Delta Junction	deltaj	deltjA, deltjB, deltjC, djNEON	Bh006v005, Bh006v006, Bh006v007, Bh007v006, Bh007v007	64.50	62.85	-142.08	-147.61
Denali	denali			64.70	62.97	-148.36	-152.40
Deadhorse	dhorse			70.52	68.69	-145.97	-151.23
Fort Smith N	fsmitN			61.66	59.77	-111.92	-113.91
Fort Smith S	fsmitS			60.27	59.50	-111.20	-112.28
	ftreso			61.75	60.91	-112.37	-114.33
Good Hope	gdhope			67.98	65.98	-128.20	-131.92
Huslia	huslia	huslia	Bh005v003	65.54	65.18	-154.82	-156.80
Inigok	inigok	inigok	Bh007v002, Bh008v002	70.68	69.71	-151.23	-154.20
Ivotuk	ivotuk			69.02	67.91	-154.52	-157.26
Katmai National Park	katmai	katmaA, katmaB	Bh001v006, Bh002v006	58.49	58.12	-154.58	-157.06
Kluane A	kluanA			61.58	60.24	-136.78	-139.26
Kluane B	kluanB			61.77	60.70	-137.21	-139.58
Kougarok	kougar	kougar	Bh004v002, Bh005v002	65.71	65.45	-159.96	-163.03
Koyuk	koyukk	koyukk	Bh004v002, Bh004v003	65.06	64.71	-159.19	-161.12
Lake Clark	lclark			61.44	59.70	-152.19	-155.72
Mcpherson	mcpher			67.74	66.85	-133.81	-136.87
Noatak	noatak			68.54	67.34	-159.39	-163.10
Norman Wells	nwells			66.43	64.26	-124.92	-129.59
Poorman	poorma	poorma	Bh004v004, Bh005v004	64.42	64.26	-153.12	-156.23
Scoaoi	scoaoi			60.91	59.91	-119.78	-121.83
Scotty	scotty			61.78	60.44	-120.21	-122.00
SnagyK	snagyk			63.06	62.00	-139.88	-142.01
Snake River	sriver	sriver	Bh003v004, Bh003v005	61.68	60.77	-156.05	-157.48
Teller	teller			65.98	64.25	-163.37	-166.73
Toolik	toolik	toolik	Bh008v003	68.84	68.51	-148.97	-150.03
Watson	watson			60.84	59.22	-127.26	-130.91
Wolf Creek	wolfcr			60.75	60.25	-134.47	-135.74
WrigLN	wrigLN			63.71	62.85	-122.73	-123.96

Yukon Flats	yflats	yflatE, yflatW	Bh007v004, Bh008v004, Bh007v005, Bh008v005	67.21	65.73	-144.74	-147.42
Yukon-Kuskokwin Delta	ykdelt	ykdelA, ykdelB	Bh002v003	61.32	61.05	-161.86	-163.89
Canada							
Aklavik Highway	aklavi	aklavi	Bh010v005	68.37	68.01	-133.11	-135.55
Behchoko	behcho	behcho	Bh013v011, Bh013v010	62.67	62.08	-116.41	-116.88
Daring Lake	daring	daring	Bh014v009, Bh015v009, Bh014v010	65.00	63.65	-111.09	-113.33
Faber Lake	faberl	faberl	Bh013v009, Bh013v010	64.39	63.86	-116.95	-118.21
Kakisa Lake A	kakisA	kakisA	Bh012v011, Bh012v012	61.30	60.80	-116.42	-118.02
Kakisa Lake B	kakisB	kakisB	Bh012v011	61.40	60.67	-117.38	-117.99
Old Crow Airport	oldcrB	oldcrB	Bh008v005, Bh009v005	67.63	66.85	-139.58	-143.17
Old Crow Flats	oldcrA	oldcrA	Bh009v005	68.22	67.66	-139.05	-140.05
Fort Providence	provid	provid	Bh013v011, Bh012v011	62.20	61.29	-116.21	-117.90
Snare River	snarer	snarer	Bh012v010, Bh013v010	63.96	62.72	-116.56	-118.30
Inuvik to Tuk Highway	tukhwy	tukhwy	Bh010v005, Bh011v005	69.51	68.18	-132.92	-134.41
Yellowknife	yellow	yellow	Bh010v005, Bh011v005	62.58	61.94	-112.34	-113.82

Data File Information

There are 51 files in netCDF version 4 (*.nc4) format, one for each site, and a python script for estimating soil volumetric water content from data..

The netCDF files are named PDO_ReSALT_ **site**_2017_03.nc4 (e.g., PDO_ReSALT_aklavi_2017_03.nc4), where **site** is provided as a Site Code in Table 1.

The Python script file *generate_pdo_soil_vwc.py* is provided for users to generate the soil volumetric water content (VWC) averaged to the depth of interest. The script requires the numpy and gdal libraries. Execute the script as follows:

python generate_pdo_soil_vwc.py -s **site_code** -a **depth_avg_in_cm**

where **site_code** is one listed in Table 1 and **depth_avg_in_cm** is the averaging depth in centimeters.

Data File Details

Missing values are represented by -9999.

The projection used is “Canada_Albers_Equal_Area_Conic" (EPSG:102001); Proj.4 string: “+proj=aea +lat_1=50 +lat_2=70 +lat_0=40 +lon_0=-96 +x_0=0 +y_0=0 +ellps=GRS80 +datum=NAD83 +units=m no_defs”.

Table 2. Variable names and descriptions in netCDFs. Note that files *PDO_ReSALT_bonanz_2017_03.nc4* and *PDO_ReSALT_denali_2017_03.nc4* do not contain all variables listed. See Section 5 for details.

Variable	Units	Description
lat	degrees_north	Latitude coordinate
lon	degrees_east	Longitude coordinate
x	m	x coordinate of projection
y	m	y coordinate of projection
crs		coordinate reference system (CRS)
alt	m	Active layer thickness (ALT)
alt_unc	m	Uncertainty of ALT estimates
sub	m	Seasonal subsidence from L-band InSAR
sub_unc	m	Uncertainty of seasonal subsidence
Sw0	vol/vol	Soil water saturation fraction at the surface (z=0)
Sw0_unc	vol/vol	Uncertainty of surface water saturation
wtd	m	Water table depth
wtd_unc	m	Uncertainty of water table depth

Variable	Units	Description
mv_6cm	vol/vol	Soil volumetric water content averaged over 0 to 6 cm
mv_12cm	vol/vol	Soil volumetric water content averaged over 0 to 12 cm
mv_20cm	vol/vol	Soil volumetric water content averaged over 0 to 20 cm
mv_alt	vol/vol	Soil volumetric water content averaged over the active layer thickness
qa		quality attributes

3. Application and Derivation

Soil moisture and active layer thickness (ALT) are critical variables in understanding how permafrost and active layer dynamics respond to climate warming in high-latitude regions. Remote sensing technologies such as InSAR provide a means to measure ALT (Liu et al., 2012).

4. Quality Assessment

InSAR correlation data was used for both the masking of poor data and uncertainty quantification. Poorly correlated pixels with coherence <0.35 were masked because they do not provide reliable phase estimates. Uncertainties were estimated in phase from InSAR correlation using the Cramer-Rao bound (Tough et al., 1995) converted to centimeters of uncertainties in subsidence. Owing to a lack of repeat temporal airborne observations within a single thaw season, the Cramer-Rao bound estimates are considered lower-bound estimates with actual uncertainties likely larger than those we report. Nonetheless, empirical estimates of uncertainty of phase calibration yield point values of approximately 0.5–1.0 cm. The plausible range of uncertainty values lies between the Cramer-Rao bound and 1.0–2.0 cm.

The uncertainty in P-band PolSAR backscatter was assumed to be 0.5 dB based on absolute radiometric calibration (Chapin et al., 2015). A data cube of all possible solutions was constructed based on the forward model. All solutions were identified with a cost function value less than the P-band backscatter uncertainty. The mean of these solutions is reported as the best estimate for the desired geophysical variables and the standard deviation as uncertainty.

5. Data Acquisition, Materials, and Methods

InSAR Processing

InSAR uses phase differences between SAR images acquired at different times to produce interferograms of surface deformation in the radar line-of-sight direction. The interferometric phase provided by the NASA/JPL UAVSAR (https://uavsar.jpl.nasa.gov) was unwrapped using the SNAPHU algorithm (Chen and Zebker, 2002). The unwrapped interferometric phase from the line-of-sight (LOS) viewing geometry was converted to vertical motions (Chen et al., 2016). Variations in atmospheric and tropospheric water content can introduce biases into interferometric phase values (Jolivet et al., 2011). For swaths with noticeable atmospheric noise, a high pass filter was applied to remove signals at length scales on the order of atmospheric correlation (Lohman and Simons, 2005).

Daymet temperature data (Thornton et al., 2016) was to generate a time series of accumulated degree days of thaw (ADDT) for each site. The measured subsidence was adjusted using the ADDT time series to estimate the total seasonal subsidence of the active layer over the course of the thaw season. The Schaefer et al. (2015) technique was modified to scale the measured subsidence with the difference in ADDT between the full thaw season and the L-band SAR image acquisition dates. Some sites did not include the ADDT correction, which was added during Version 3 processing.

Known subsidence values at reference sites were used to convert the relative phase to absolute seasonal subsidence. Where available, reliable in-situ field measurements of ALT were used and converted to seasonal subsidence using the soil expansion model (Schaefer et al., 2015, Michaelides et al., 2019). For sites without reliable in situ data, the 5th percentile of deformation was chosen as zero-based on scene-wide histograms of relative deformation values. All estimates of seasonal deformation, correlation, and deformation uncertainties were projected onto the 30-m ABoVE reference grid.

Table 3. Summary of the InSAR processing steps applied to each site.

Site Code	UAVSAR Flight Line	Calibrated to Reference Pixel	Referenced to 5th Percentile of Deformation	Atmospheric Noise Correction: PyAPS (Jolivet et al., 2011)	ADDT (Schaefer et al., 2015)
Alaska					
ambler	ambler	X			
anaktu					
atqasu	atqasu	X			
barrow	barrow	X			X
bonanz					
chevak					
coldfo	coldfo		X	X	
counci	counci	X			X
deltaj (referenced to deltjC)	deltjA		X	X	
	deltjB		X	X	
	deltjC	X			
	djNEON		X	X	

Site Code	UAVSAR Flight Line	Calibrated to Reference Pixel	Referenced to 5th Percentile of Deformation	Atmospheric Noise Correction: PyAPS (Jolivet et al., 2011)	ADDT (Schaefer et al., 2015)
denali					
dhorse					
fsmitN					
fsmitS					
ftreso					
gdhope					
huslia	huslia		X	X	
inigok	inigok	X			
ivotik					
katmai	katmaA				
katmai	katmaB		X	X	X
kluanA					
kluanB					
kougar	kougar		X	X	
koyukk	koyukk		X	X	
lclark					
mcpher					
noatak					
nwells					
poorma	poorma		X	X	X
scoaoi					
scotty					
snagyk					
sriver	sriver		X	X	X
teller					
toolik	toolik		X	X	X
watson					
wolfcr					
wriglN					
yflats (referenced to yflatW)	yflatE		X	X	X
	yflatW		X	X	X
ykdelt	ykdelA	X			X
	ykdelB	X			X
Canada					
aklavi	aklavi		X	X	X
behcho	behcho		X	X	X
daring	daring		X	X	X
faberl	faberl		X	X	X
kakisA	kakisA		X	X	X
kakisB	kakisB		X	X	X
oldcrB	oldcrB		X	X	X
oldcrA	oldcrA		X	X	X
provid	provid		X	X	X

Site Code	UAVSAR Flight Line	Calibrated to Reference Pixel	Referenced to 5th Percentile of Deformation	Atmospheric Noise Correction: PyAPS (Jolivet et al., 2011)	ADDT (Schaefer et al., 2015)
snarer	snarer		X	X	X
tukhwy	tukhwy		X	X	X
yellow	yellow		X	X	X

Forward Models

The ground surface settles as the active layer thaws in summer mainly because groundwater takes up about 9% less volume than ground ice. Therefore, the seasonal subsidence directly relates to the volume of melted water in the active layer. The subsidence model integrates the soil VWC profile from the surface to thaw depth, multiplied by a factor accounting for the change in volume of water phase changes.

The vertical profile of VWC profile in the active layer is soil porosity times water saturation fraction. Soil porosity depends on soil composition, mineral texture, and organic matter content. The saturation fraction is the fraction of pore space filled with water. The organic matter profile is assumed to be a generalized logistic function, which can be parametrized by the surface organic matter content (OM_0) and organic layer thickness (OLT). Nominal values for OM_0 and OLT over the ABoVE domain are chosen to be 0.8 g g^{-1} and 0.15 m, respectively (Chen et al., 2019).

The forward model of P-band PolSAR backscatter includes a radar backscattering model that calculates the radar backscattering coefficients from a multilayer dielectric structure with a rough surface atop, and a soil parametrization model that translates soil physical parameters (soil organic matter, soil texture, soil moisture) to soil dielectric constant (Chen et al., 2019). The subsidence and backscatter models share the same set of parameters that characterize the active layer soils, which enables the simultaneous retrieval of ALT and soil VWC profiles using L-band InSAR and P-band PolSAR.

Joint Retrieval of ALT and Soil VWC Profile

The retrieval process is an inversion of both subsidence and backscatter models, which can be formulated as an optimization problem minimizing their cost function (L2 norm of the observation-model differences). There are four unknowns: ALT (alt), surface water saturation (S_{w0}), water table depth (wtd), and surface roughness (h) (Eq. 1). In order to facilitate the inversion process, which is to find the solution points that meet the cost function criteria (L2 norm smaller than the uncertainties in the measured subsidence and P-band backscatter), the data cubes of subsidence and P-band HH and VV backscatter were pre-computed with dimensions of the unknown variables. The mean and standard deviation of all solution points that met the cost function criteria are reported as the retrieved value and associated uncertainty for the unknowns. After the retrieval, soil porosity and water saturation profiles can be calculated from the retrieved profile parameters (S_{w0} and wtd) and the assumed organic matter profile, which then be used to calculate the soil VWC profile (Eq. 2).

$$S_w(z) = \begin{cases} \frac{S_{w0} - 1}{wtd^2}(z - wtd)^2 + 1, & z \leq wtd \\ 1, & z > wtd \end{cases} \qquad (1)$$

$$VWC(z) = S_w(z) \cdot porosity(z) \qquad (2)$$

The python script (*generate_pdo_soil_vwc.py*) can be used to generate the soil VWC averaged to the depth of the user's interest. The soil VWC values averaged over the first 6, 12, and 20 cm from the surface and over the entire active layer are provided.

Summary of Changes between Version 2 & Version 3

New lines. The dataset was expanded to include all 66 eligible flight lines collected during the 2017 airborne ABoVE campaign.

Updated Reference Points. Calibration using a reference point of known subsidence converts the relative subsidence after phase unwrapping to absolute subsidence. Many flight lines did not have reference points, so a multi-point calibration was developed from available measurements and used to calibrate all flight lines.

New Seasonal Calibration. The two SAR scenes for the interferograms for each flight line do not bracket the entire thaw season, resulting in an underestimate of the seasonal subsidence. The measured subsidence was calibrated by applying an Accumulated Degree Days of Thaw (ADDT) correction to the seasonal subsidence (Michaelides et al., 2021). Differences in calibration and convergence might change the length of dimensions for a particular file between Versions 2 and 3.

Atmospheric Noise. Differences in atmospheric humidity between the two SAR scenes introduce a false, large-scale subsidence signal in the resulting interferogram. A boxcar filter was applied to remove large-scale atmospheric noise while keeping small-scale variability on subsidence.

Uncertainty. Uncertainty owing to interferometric phase noise from stochastic, non-ergodic surface scatterers and uncertainty owing to native instrument resolution were quantified.

Discontinuities. Phase unwrapping assumes a continuous land surface, but lakes and rivers in the flight lines often violated this assumption, resulting in spatial discontinuities in subsidence. An algorithm was developed to detect and correct these.

Numerical Noise. The radiative transfer model approximated continuously varying soil properties with homogeneous horizontal slabs, introducing noise in the estimates of soil moisture. A Gaussian filter was used to remove this.

Inconsistent Number of Variables. The files *PDO_ReSALT_bonanz_2017_03.nc4* and *PDO_ReSALT_denali_2017_03.nc4* do not have all of the variables present in the other files (i.e., Sw0, Sw0_unc, mv_6cm, mv_12cm, mv_20cm, mv_alt). The retrieval requires both P-band and L-band SAR. An Air Force base in Fairbanks restricts P-band SAR, so the lines included in these files have only L-band.

6. Data Access

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

ABoVE: Active Layer Thickness from Airborne L- and P- band SAR, Alaska, 2017, Ver. 3

Contact for Data Center Access Information:

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7. References

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8. Dataset Revisions

Version	Release Date	Revision Notes
3	2022-08-31	Current dataset. For this version, new flight lines were added, reference points were updated, a new seasonal calibration was used, atmospheric and numerical noise was removed, additional uncertainty was quantified, and discontinuities were corrected. See Section 5 for details.
2	2021-04-01	In Version 2, retrieval of P- and L-band data was performed in tandem. For this version, the seasonal subsidence model and the radar backscattering model were integrated using a joint inversion process. Additional sites across the ABoVE domain were added. This version is now superseded and available only upon request. https://doi.org/10.3334/ORNLDAAC/1796
1	2019-05-08	Version 1 of this dataset. This version is now superseded and available only upon request. https://doi.org/10.3334/ORNLDAAC/1676