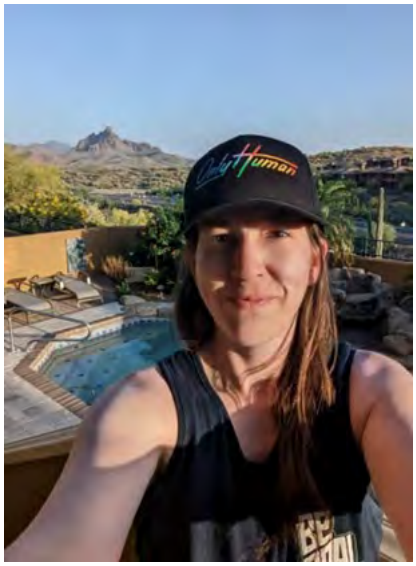
Discovering Datasets at a Regional Level, ABoVE Domain

Meet the Interns

Behind the Pages:

Beverly Bolster is a senior at the University of Maryland, College Park. She is pursuing a dual degree in Geospatial Data Science and Sociology, with minors in Spanish and Sustainability Studies. She is passionate about community engagement to promote sustainability and address the impacts of climate change, and she started this booklet during her internship with NASA's Arctic-Boreal Vulnerability Experiment (ABoVE). After she graduates in May, she will be working at a summer program for children with severe emotional and behavior challenges, before pursuing additional experience working with children, families, and communities and ultimately, graduate school for developmental psychology or social work.



Mary Banner is Ponca and an enrolled member of the Mille Lacs Band of Ojibwe. She is kahu to four rescued pups and eight years sober. She will soon graduate with a Master of Science in Environmental Science from SUNY ESF with a focus on ecosystems: land, air, and water. This booklet completes her internship with NASA's Arctic-Boreal Vulnerability Experiment (ABoVE), and her hope is that these one-pagers that show complex data are more accessible to communities. After graduation, she plans to test for an ESRI GIS certificate, take a much-needed road trip to explore the East Coast, and pursue opportunities to work with Tribal Nations, the private sector, or look for a fellowship. Hy'shqe (Thank you).

ABoVE

ARCTIC – BOREAL VULNERABILITY EXPERIMENT

NASA ORNL DAAC

Table of Contents

Introduction

This booklet presents a variety of datasets created through NASA's Arctic-Boreal Vulnerability Experiment (ABoVE). ABoVE is a NASA Terrestrial Ecology Program field campaign being conducted in Alaska and western Canada which began in 2015. It is a diverse large-scale study of the impacts of environmental change on arctic and boreal terrestrial and freshwater ecosystems, and the implications of these changes for social and ecological systems. It encompasses the variability in the key types of ecosystems that are both unique to Arctic and boreal regions in North America as well as being representative of the larger Northern High Latitude region.

We aim to make the data more widely available and accessible to communities, governments, and other organizations.

For each type of data, there is a page with general explanation and a map of the full extent that the data covers. We also provide the following information:

What do the data show?

This section explains the importance of the dataset, as well as the type of information that can be interpreted from the maps provided.

How were the data produced?

This section explains the methods for capturing the data. This may include whether the data were collected through airborne campaigns (in which sensors attached to aircraft gather information about the earth's surface) or satellites (which contain instruments to collect images as they orbit the earth). Additionally, this may explain models or algorithms that were used to produce data.

Spatial Resolution:

This includes a value that tells the distance between each measurement that is recorded. Smaller distances lead to a higher level of detail, but less area can be covered in the same amount of time.

Spatial Coverage:

This details the regional extent that the dataset includes.

Temporal Resolution:

This tells how often the data were measured, whether this occurred only once or how frequently measurements recurred.

Temporal Coverage:

This includes a data range that tells the time period that the dataset covers.

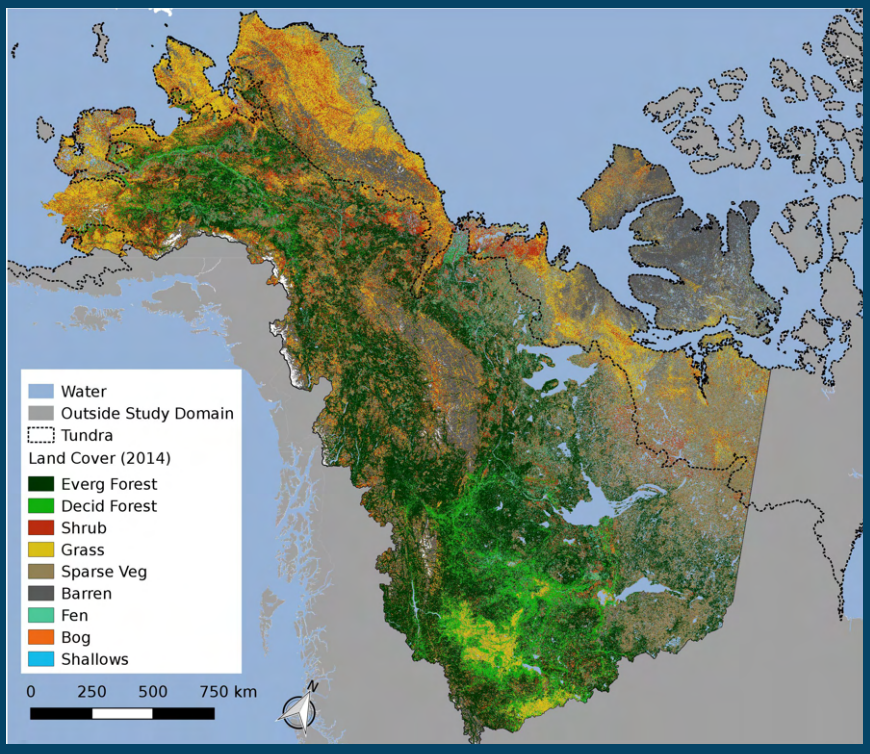
Citation

There is also a citation with a link to further information and a platform to download each dataset.

Regional Example Maps

Where applicable, additional regional maps for regions in Alaska and Canada are provided. These show how the data can be visualized at a community or local level.

ABoVE: Landsat-derived Annual Dominant Land Cover Across ABoVE Core Domain, 1984-2014



Land cover across ABoVE core domain 2014

What do the data show?

These data include land cover classifications over Alaska and western Canada from 1984-2014. One dataset classifies land cover into fifteen classes of forest and shrub types, and the other simplifies this classification into ten categories.

How were the data produced?

The datasets were produced by determining the dominant plant type in each 30 meter by 30 meter pixel (square). Thus, each square is classified according to which plant type covered the largest area.

Spatial Resolution: 30 m

Spatial Coverage: Alaska and Canada

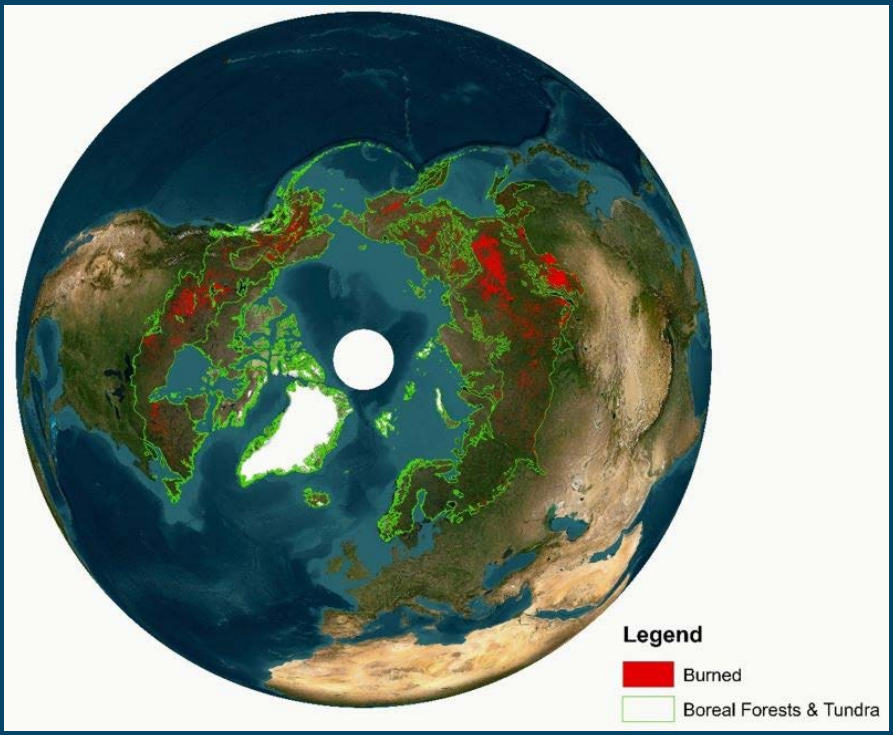
Temporal Coverage: 01-01-1984 to 12-31-2014

Temporal Resolution: Annual

Citation:

Wang, J.A., D. Sulla-Menashe, C.E. Woodcock, O. Sonnentag, R.F. Keeling, and M.A. Friedl. 2019. ABoVE: Landsat-derived Annual Dominant Land Cover Across ABoVE Core Domain, 1984-2014. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1691

Arctic Boreal Annual Burned Area, Circumpolar Boreal Forest and Tundra, V2, 2002-2022



Burned area between 2002 and 2022

What do the data show?

The dataset provides the amount of area that was burned in boreal forests and tundra in the northern latitudes (areas above 50 degrees north latitude) each year from 2002 to 2022.

How were the data produced?

The data were produced using satellite data at 500m spatial resolution (MODIS data) through an algorithm that captures the difference before and after a fire to assess the amount of area burned. In particular, this algorithm was intended to capture fires that occur late in the season (near the end of the northern hemisphere summer months) and unburned areas within fire perimeters.

Spatial Resolution: 463 m

Spatial Coverage: High northern latitudes (circumpolar above 50 degrees N)

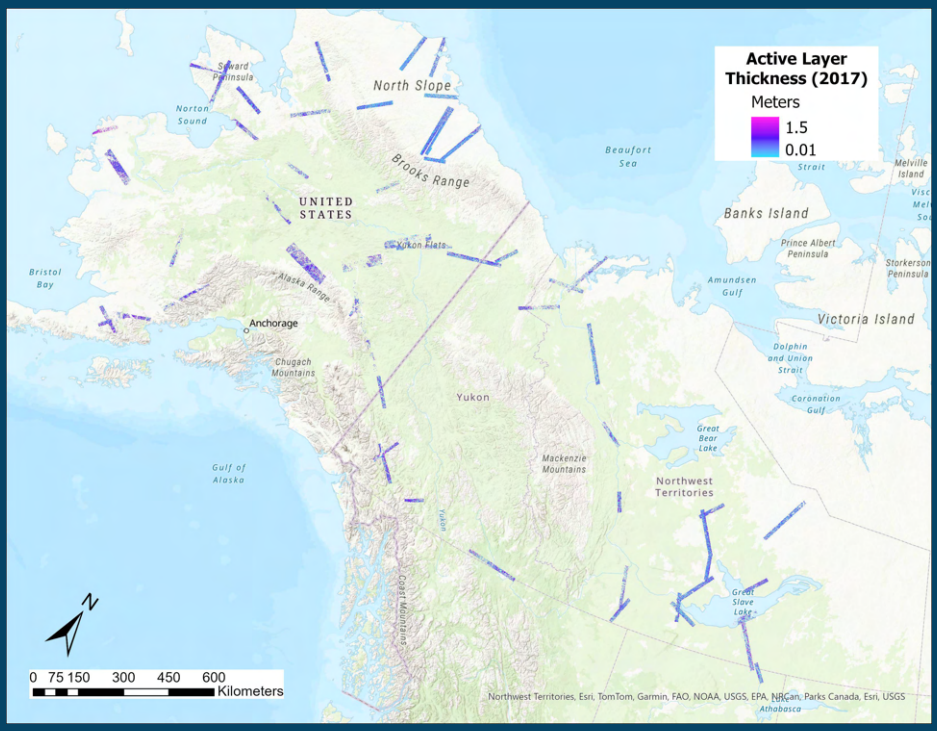
Temporal Coverage: 2002 to 2022

Temporal Resolution: Annual

Citation:

Loboda, T.V., J.V. Hall, D. Chen, A. Hoffman-Hall, V.S. Shevade, F. Argueta, and X. Liang. 2024. Arctic Boreal Annual Burned Area, Circumpolar Boreal Forest and Tundra, V2, 2002-2022. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2328

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



Active layer thickness from ABoVE flightpaths 2017

What do the data show?

This dataset estimates changes in the presence of permafrost and soil moisture by calculating active layer thickness, seasonal subsidence, and the vertical soil moisture profile at the time of predicted maximum thaw in 2017. The active layer thickness is the depth of the ground that thaws each summer. The seasonal subsidence is how much the Earth's surface moves downward each year due to the ground becoming drier. The vertical soil moisture profile is how much the quantity of water in the soil changes as the depth of the soil changes, which impacts how quickly water can pass through soil and how quickly soil will dry out.

How were the data produced?

These data were produced through NASA's ABoVE airborne campaign. Sensors attached to aircraft gathered images of the earth's surface above Alaska and Canada. The data product was created by the Permafrost Dynamics Observatory (PDO) project.

Spatial Resolution: 30 m

Spatial Coverage: 51 sites across the ABoVE domain, including 39 in Alaska and 12 in Canada; Alaska, Yukon, Northwest Territories Yukon, Northwest Territories

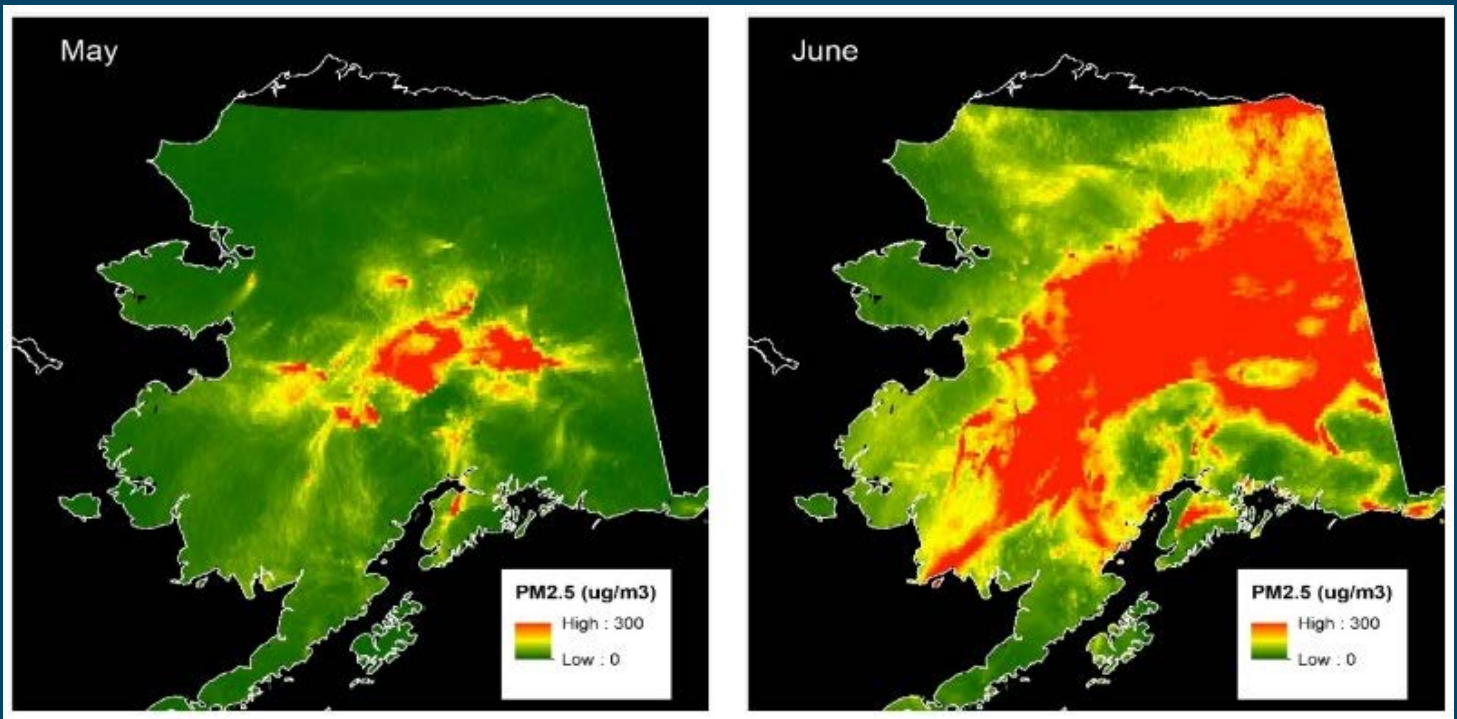
Temporal Resolution: One time estimates in 2017

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

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

Simulated Fine Particulate Matter (PM2.5) Estimates over Alaska, 2001-2015



Maximum PM2.5 concentration maps for May and June of 2001-2015

What do the data show?

This dataset estimates the concentration of PM2.5 over Alaska, U.S from May to September between 2001 to 2015. PM2.5 is particulate matter (PM) with a diameter less than or equal to 2.5 microns. PM refers to solid or liquid particles in the air that are too small to see but can cause health problems for people and organisms that inhale them.

How were the data produced?

The dataset was produced using fire emissions and burning data over Alaska. These data were inputted into multiple models to map the amount of particulate matter over Alaska at a given time. These models use data that is available to make informed predictions for locations or times where data is unavailable.

Spatial Resolution: 0.10 degree (near 1 kilometer)

Spatial Coverage: Alaska, U.S.

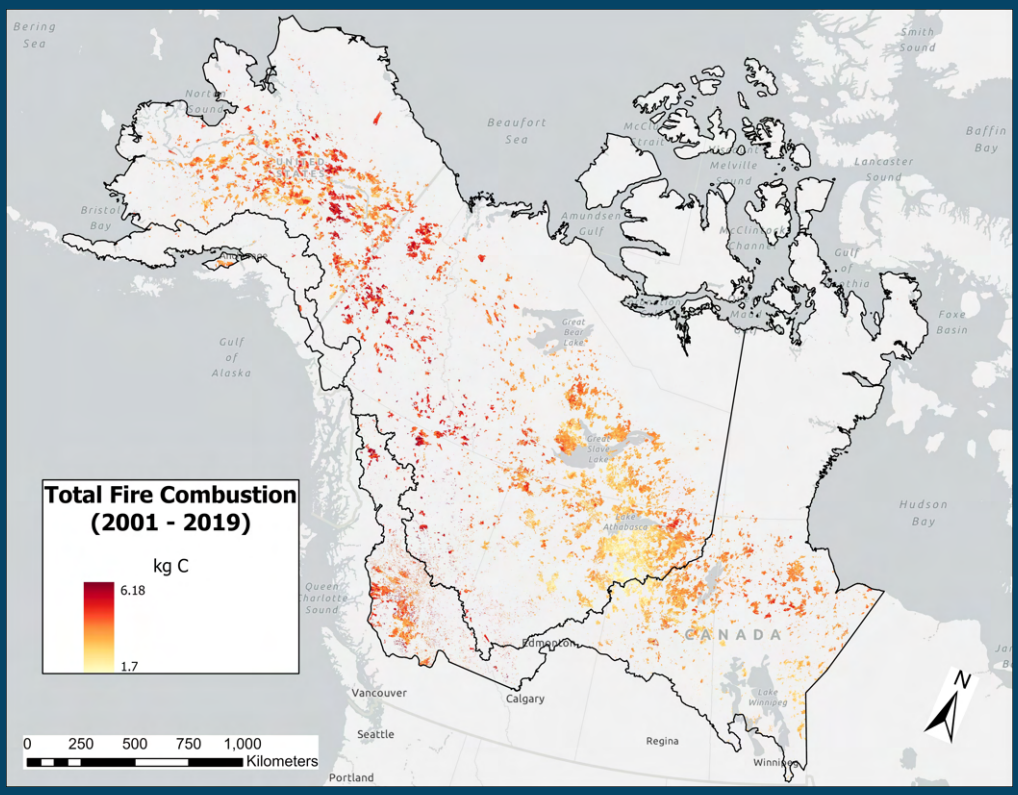
Temporal Coverage: 05-10-2001 to 09-28-2015

Temporal Resolution: Daily

Citation:

Chen, D., M. Billmire, N.H.F. French, T.V. Loboda, and A.E. Bredder. 2023. Simulated Fine Particulate Matter (PM2.5) Estimates over Alaska, 2001-2015. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2157

ABoVE: Total Burned Area, Depth, and Combustion for Alaska and Canada, 2001-2019



Total carbon emissions combustion between 2001-2019 aggregated to a 70 km grid

What do the data show?

This dataset shows fire activity in Alaska and Canada from 2001 to 2019, showing where and when fires occurred, how much area burned, and the amount of carbon released into the atmosphere. It uses satellite data, field observations, and advanced modeling to help understand the impacts of wildfires on boreal ecosystems, including carbon emissions and ecosystem disturbances.

How were the data produced?

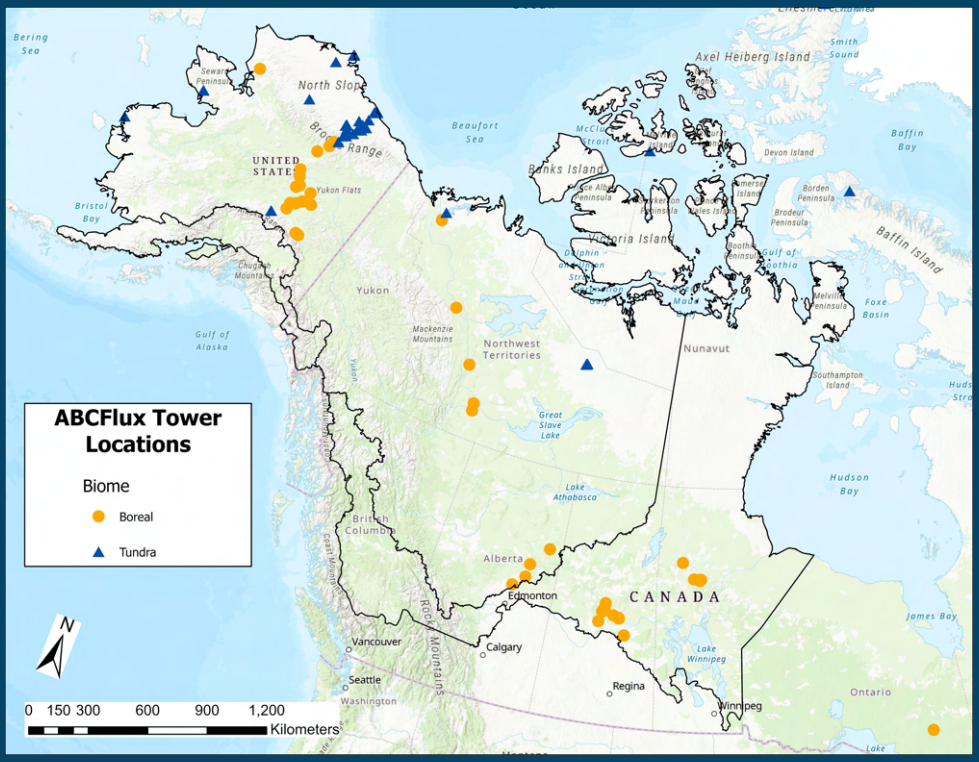
The data were produced using MODIS and Landsat satellite imagery to detect fire locations and burned areas, combined with statistical modeling of carbon combustion and burn depth based on field observations and environmental variables like fire severity, topography, and climate.

Spatial Resolution: 500 m
Spatial Coverage: Alaska and Canada
Temporal Resolution: 01-01-2001 to 12-31-2019
Temporal Coverage: Annual

Citation:

Potter, S., S. Veraverbeke, X.J. Walker, M.C. Mack, S.J. Goetz, J.L. Baltzer, C. Dieleman, N.H.F. French, E.S. Kane, M.R. Turetsky, E.B. Wiggins, and B.M. Rogers. 2022. ABoVE: Burned Area, Depth, and Combustion for Alaska and Canada, 2001-2019. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2063

ABCFlux Database: Arctic-Boreal CO_2 Flux and Environment Site, 1989-2000



Flux tower locations from the ABCFlux Database (1989-2020) to highlight CO_2 flux monitoring, categorized by biome across tundra and boreal ecosystems

What do the data show?

This dataset shows the levels of carbon dioxide (CO_2). absorbed and released each month from 1989 to 2020 in selected locations across Arctic and boreal ecosystems, helping to track CO_2 dynamics in these regions.

How were the data produced?

The dataset was collected using special sensors and measurement tools to track the gas levels in the air and soil. Then, information from 244 different locations were combined and standardized into a single database.

Spatial Resolution: Point- resolution

Spatial Coverage: Arctic boreal sites in Alaska, Canada, Finland, Greenland, Iceland, Mongolia, Norway, Russia, and Sweden

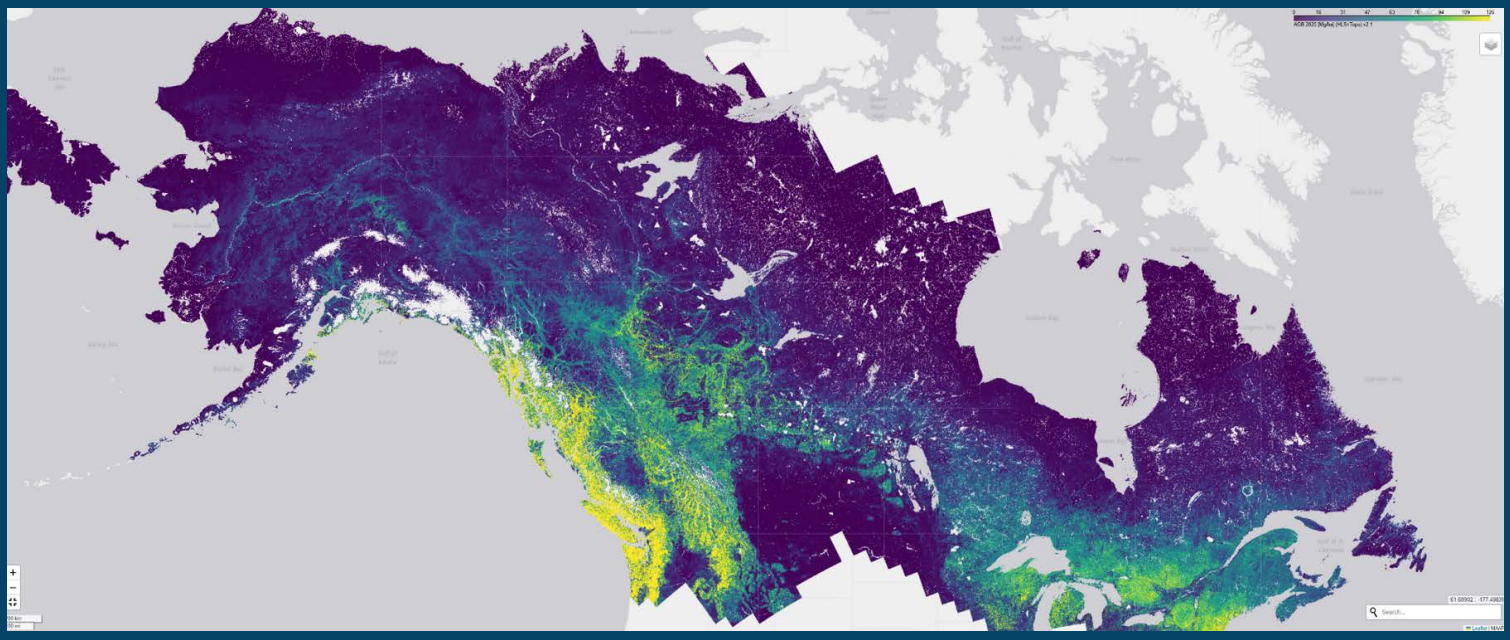
Temporal Coverage: 12-01-1989 to 09-30-2020

Temporal Resolution: Monthly

Citation:

Virkkala, A-M., et. al. 2021. The ABCflux Database: Arctic-Boreal CO2 Flux and Site Environmental Data, 1989-2020. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1934

Aboveground Biomass Density for High Latitude Forests from Ice SAT2



Aboveground biomass (Mg ha^{-1}) for boreal forest estimated from ICESat-2 imagery

What do the data show?

This dataset shows how much woody biomass is stored in Northern forests, helping to map and monitor forest carbon stocks.

How were the data produced?

The data were created by combining ground measurements with satellite laser data and advanced models to estimate biomass across these forests from 2019 to 2021.

Spatial Resolution: 30 m

Spatial Coverage: Boreal forest zone in the Northern Hemisphere, covering areas above 44 degrees latitude where these forests thrive

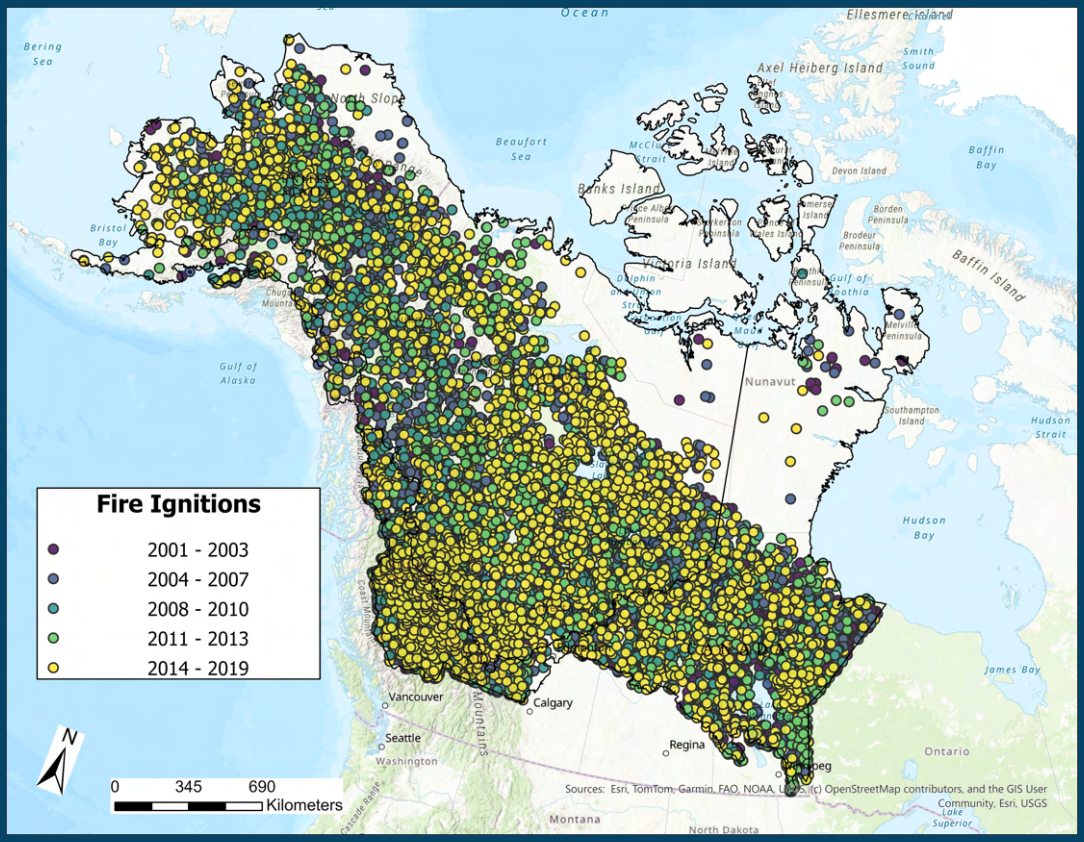
Temporal Coverage: One-time measurements

Temporal Resolution: Circa 2000 (06-01-2029 to 09-30-3021)

Citation:

Duncanson, L., P.M. Montesano, A. Neuenschwander, N. Thomas, A. Mandel, D. Minor, E. Guenther, S. Hancock, T. Feng, A. Barciauskas, G.W. Chang, S. Shah, and B.P. Satorius. 2023. Aboveground Biomass Density for High Latitude Forests from ICESat-2, 2020. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2186

ABoVE: Ignitions of ABoVE Fire Emission Database Fires in Alaska and Canada



Fire Ignition locations across Canada and Alaska, U.S., for 2001 - 2019

What do the data show?

The dataset shows where and when wildfires started in boreal forests across Alaska and Canada from 2001 to 2019.

How were the data produced?

The data was produced by analyzing satellite images to detect fire activity, using specialized methods to identify ignition points and determine their timing within a single day.

Spatial Resolution: Points with 463 location precision

Spatial Coverage: Alaska and Canada

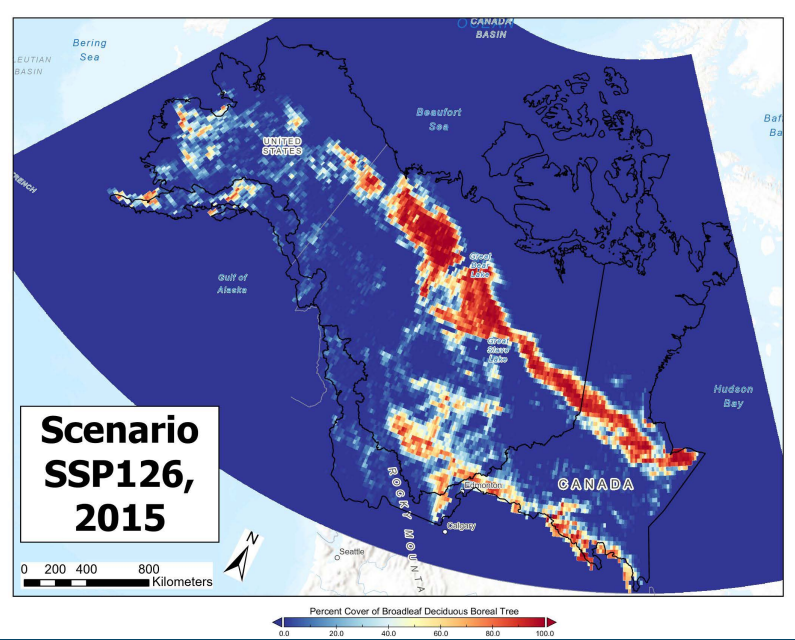
Temporal Coverage: 01-01-2001 to 12-31-2019

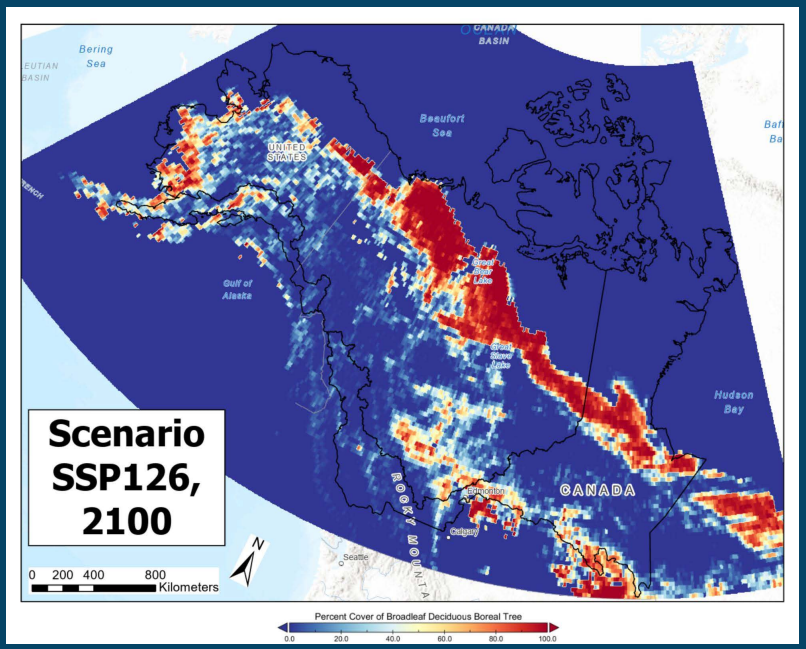
Temporal Resolution: Daily

Citation:

Hessilt, T.D., B.M. Rogers, R.C. Scholten, S. Potter, T.A.J. Janssen, and S. Veraverbeke. 2023. ABoVE: Ignitions of ABoVE-FED Fires in Alaska and Canada. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2316

Land Use and Land Cover Change Projection in the ABoVE Domain





Percentage Cover of Broadleaf Deciduous Boreal Tree predicted under scenario SSP 1 - 2.6 in 2015 and 2100

What do the data show?

The data shows predicted changes in land use and land cover in the Arctic region from 2015 to 2100, including shifts in forests, shrubs, grasses, and crops. The maps above specifically highlight percent cover of deciduous boreal trees under climate scenario SSP 1 - 2.6 in 2015 and 2100.

How were the data produced?

The data was produced by combining a global landuse model with satellite data and to create detailed annual maps under two different climate and socioeconomic scenarios (Shared Socioeconomic Pathways, SSP) which model differences in human-driven land use changes and diverse land cover.

Spatial Resolution: 0.25 degrees

Spatial Coverage: ABoVE domain Alaska and Canada

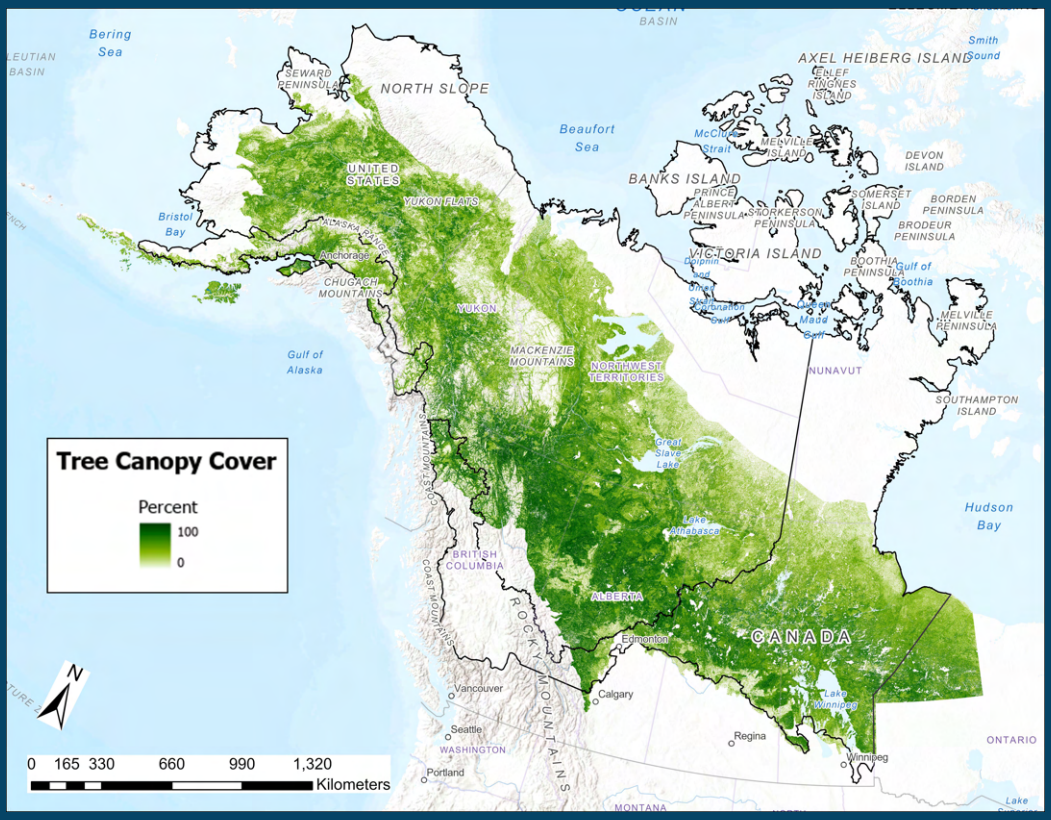
Temporal Coverage: 01-01-2015 to 12-31-2100

Temporal Resolution: Annual

Citation:

Luo, M., F. Li, D. Hao, Q. Zhu, H. Dashti, and M. Chen. 2024. Land Use and Land Cover Change Projection in the ABoVE Domain. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2353

ABoVE: Tree Canopy Cover and Stand Age from Landsat, Boreal Forest Biome, 1984-2020



Tree Canopy Cover in the ABoVE Domain, 2020

What do the data show?

This dataset shows the amount of the circumpolar boreal forest covered by tree canopy and the age of the forests. Using this information, forest change estimates of stand age were made using data from 1984 to 2020.

How were the data produced?

The data were produced using satellite images from Landsat and machine learning to estimate tree canopy cover, then changes were tracked over time to determin changes in forest age.

Spatial Resolution: 30 m

Spatial Coverage: Pan-boreal including all boreal forest or taiga ecoregion, as well as temperate conifer forests or tundra regions predominantly surrounded by boreal forest or taiga

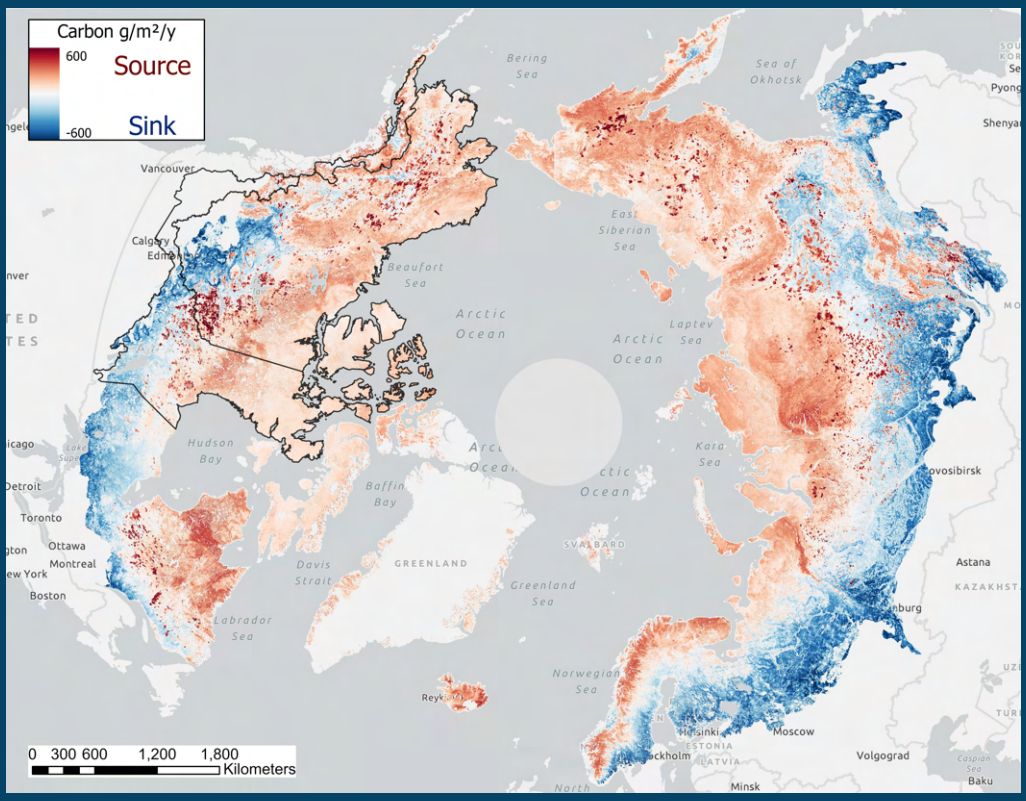
Temporal Coverage: 01-01-1984 to 12-31-2014

Temporal Resolution: Annual

Citation:

Feng, M., J.O. Sexton, P. Wang, S. Channan, P.M. Montesano, W. Wagner, M.R. Wooten, and C.S. Neigh. 2022. ABoVE: Tree Canopy Cover and Stand Age from Landsat, Boreal Forest Biome, 1984-2020. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2012

Machine learning-based Arctic-boreal terrestrial ecosystem CO_2 fluxes, 2001-2020



ABoVE Domain CO_2 Fluxes showing the Net Ecosystem Exchange and Net Ecosystem Fire from 2001-2020

What do the data show?

The dataset show how Arctic and boreal ecosystems acted as carbon sinks-absorbing more CO_2 than they released- or as carbon sources- releasing more CO_2 than they absorbed- between 2001 and 2020.

How were the data produced?

The dataset was created by combining ground-based CO_2 measurements with satellite, weather, soil, and landscape data, into machine learning models to estimate carbon flux across the region.

Spatial Resolution: 1 km

Spatial Coverage: Circumpolar Arctic and boreal regions (tundra and boreal biomes) >49 degrees north latitude

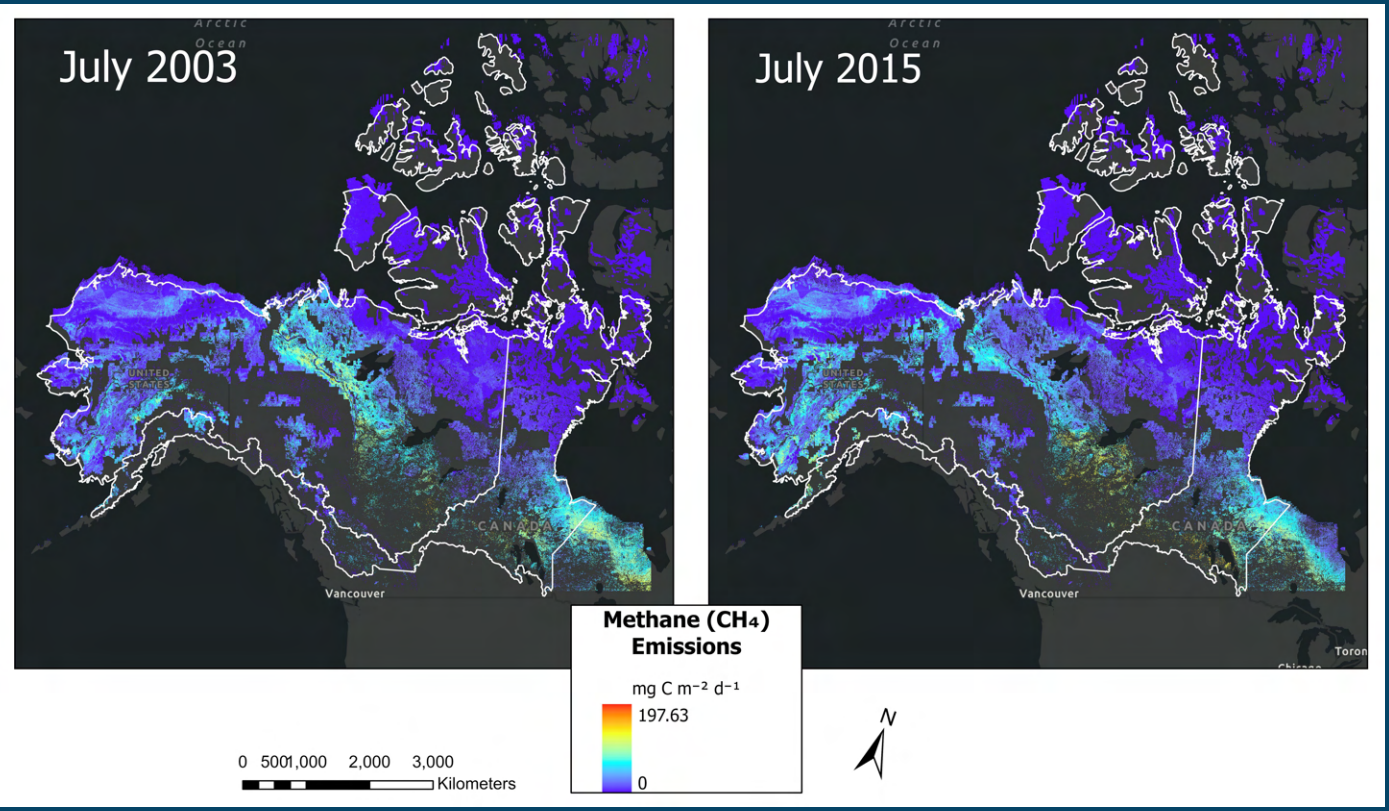
Temporal Coverage: 01-01-2001 to 12-31-2020

Temporal Resolution: Monthly

Citation:

Virkkala, A-M., B.M. Rogers, J.D. Watts, K. Arndt, S. Potter, I. Wargowsky, and S. Natali. 2024. Machine learning-based Arctic-boreal terrestrial ecosystem CO2 fluxes, 2001-2020. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2377

Gridded CO_2 and CH_4 Flux Estimates for pan-Arctic and Boreal Regions, 2003-2015



Tracking Methane Emissions Across Arctic Wetlands in the ABoVE Domain showing July in 2003 and 2015

What do the data show?

The data comes from a computer model that estimates plant growth, soil breakdown, and greenhouse gas emissions. It uses satellite images and environmental data collected from over 60 monitoring sites.

How were the data produced?

The data was created using a computer model that estimates plant growth, how soil breaks down, and greenhouse gas emissions. This model is based on satellite images and environmental data from the monitoring sites.

Spatial Resolution: 1 km

Spatial Coverage: Pan-Arctic and Boreal Zone (>49 Deg N)

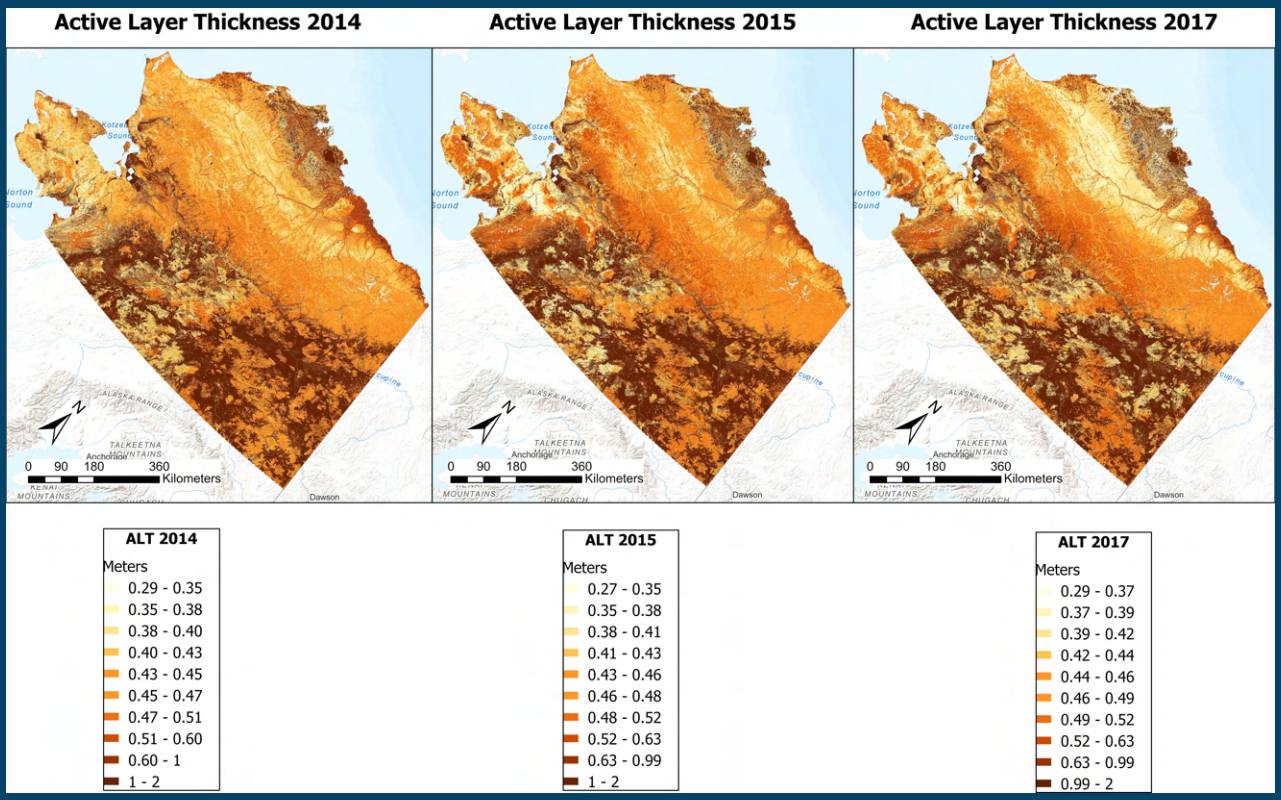
Temporal Coverage: 01-01-2001 to 12-31-2015

Temporal Resolution: Daily

Citation:

Farina, M.K., and J.D. Watts. 2022. Gridded CO2 and CH4 Flux Estimates for pan-Arctic and Boreal Regions, 2003-2015. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2121

ABoVE: Upscaled Active Layer Thickness in Northern Alaska, 2014-2017



Comparison of Active Layer Thickness Over Time, 2014, 2015, and 2017

What do the data show?

The dataset consists of maps of estimated Active Layer Thickness (ALT) throughout the northern half of Alaska for the years 2014, 2015, and 2017. ALT is the depth of soil that thaws and freezes each year in areas with permafrost.

How were the data produced?

The data was produced using machine learning-based regression to upscale ALT measurements derived from high-resolution NASA airborne imagery (P-band Polarimetric Synthetic Aperture Radar, PolSAR).

Spatial Resolution: 30 m

Spatial Coverage: Northern Alaska

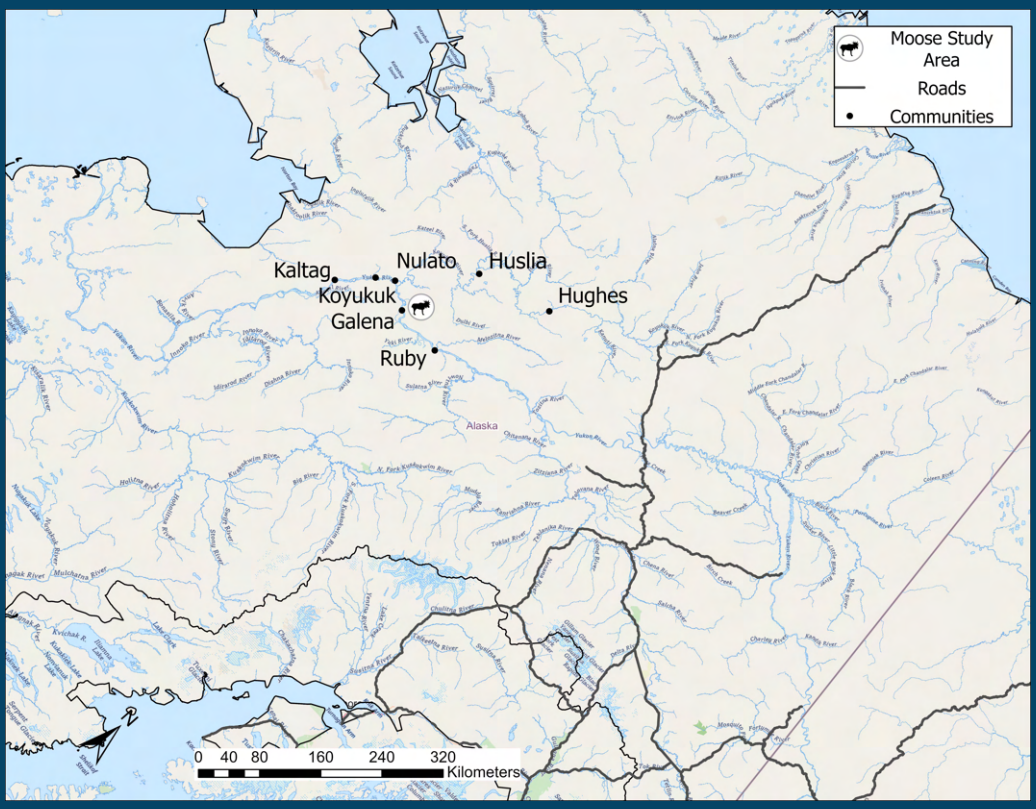
Temporal Coverage: 2014, 2015, and 2017

Temporal Resolution: Annual

Citation:

Whitcomb, J., R.H. Chen, D. Clewley, J. Kimball, N.J. Pastick, Y. Yi, and M. Moghaddam. 2024. ABoVE: Upscaled Active Layer Thickness in Northern Alaska, 2014-2017. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/23322012

ABoVE: Environmental Conditions During Fall Moose Hunting Seasons, Alaska, 2000-2016



Location of Moose Study Area, Communities, and Nearest Roads

What do the data show?

The data show how air temperature, river water levels, and the timing of leaf fall changed during the fall moose hunting season at the Moose Study Area from 2000 to 2016.

How were the data produced?

The data was produced using temperature and water level data was developed from National Oceanic Atmospheric Administration (NOAA) and United States Geological Survey (USGS) weather and water gauge stations in Galena, Alaska. Leaf drop dates were estimated using satellite imagery.

Spatial Resolution: Data are considered representative of the entire study area

Spatial Coverage: Areas surrounding the rural communities of Nulato, Koyukuk, Kaltag, Galena, Ruby, Huslia, and Hughes in interior Alaska

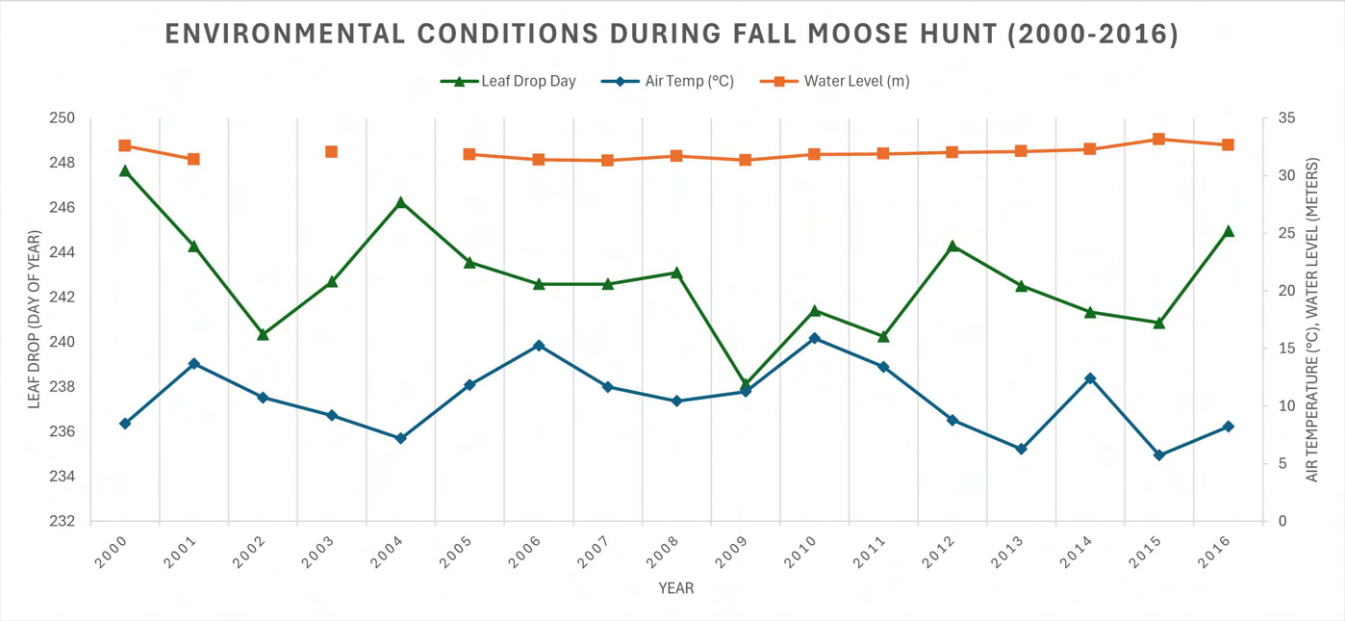
Temporal Coverage: 01-01-2000 to 12-31-2016

Temporal Resolution: Daily and annual

Citation:

Hasbrouck, T., T.J. Brinkman, G. Stout, K. Kielland, and E. Trochim. 2019. ABoVE: Environmental Conditions During Fall Moose Hunting Seasons, Alaska, 2000-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1739

Environmental Conditions During Fall Moose Hunting Season Table



Conclusion

Over the past decade, the Arctic-Boreal Vulnerability Experiment (ABoVE) has brought together scientists, data analysts, government and community leaders, and Traditional and Indigenous knowledge holders to better understand the profound environmental changes unfolding across the Arctic and boreal regions. These collaborations have generated invaluable datasets spanning multiple science themes, including:

Carbon dynamics and fluxes, fire regimes and post-fire recovery, vegetation structure and aboveground biomass, permafrost thaw and soil carbon dynamics, subsistence resources and environmental conditions, hydrology and watershed dynamics, remote sensing and spectroscopy, land use and cover change, ecosystem disturbance and recovery, cryosphere dynamics and ice monitoring, human-environment interactions and climate impacts, ecosystem health and biodiversity.

These themes not only advance scientific understanding but also support planning and decision-making by local and Indigenous communities whose lands and livelihoods are directly impacted by these changes, as well as state/territorial and federal land managers with regional and national priorities. Each region within the ABoVE domain tells a unique story - a story of changing landscapes, shifting ecosystems, and community resilience. Through the creation of regional one-pagers, we have distilled some of ABoVE's complex scientific findings into accessible formats that can help residents make informed decisions. These region-specific summaries provide a bridge between cutting-edge science and the lived experiences of local and Indigenous peoples, ensuring that knowledge generated over the last decade serves those most affected by environmental change.

As we look to the future, the legacy of ABoVE extends beyond datasets and maps created. It lives in the relationships built, the knowledge shared, and the commitment to ensuring that data generated in the Arctic and boreal regions serves the communities who call these lands home. Moving forward, we remain committed to upholding principles of Indigenous data sovereignty, fostering open-access science, and cultivating deeper partnerships that respect and honor the knowledge and perspectives of governments, rightsholders, and residents of the Arctic and boreal regions.

This work would not have been possible without the dedicated efforts of the ABoVE science teams, data analysts, and field researchers who have contributed their expertise to this endeavor. We also extend our deepest gratitude to the Indigenous communities across the Arctic and boreal regions who have generously shared their knowledge, experiences, and perspectives to ensure that these datasets reflect the realities of the land. Special thanks to the Sahtu Region, Vuntut Gwitchin Traditional Territory, Bristol Bay, Bonanza Creek, Dehcho, and all other communities who have guided and enriched this work.

Explore ABoVE Information and Products
ABoVE Project Website: https://above.nasa.gov
NASA Earthdata ABoVE Search: https://search.earthdata.nasa.gov/search?portal=above
NASA Earthdata Search (all NASA Earth data products): https://search.earthdata.nasa.gov
NASA Oak Ridge National Laboratory Distributed Active Archive Center for Biogeochemical Dynamics (ORNL DAAC): https://daac.ornl.gov/cgi-bin/dataset_lister.pl?p=34