ABoVE: Ignitions, Burned Area, and Emissions of Fires in AK, YT, and NWT, 2001-2018

Get Data

Documentation Revision Date: 2021-06-22

Dataset Version: 2

Summary

This dataset provides estimates of daily burned area, carbon emissions, and uncertainty, and daily fire ignition locations for boreal fires in Alaska, U.S., and in the Yukon and Northwest Territories, Canada. The data are at 500 m resolution for the 18-year period from 2001-2018. Burned area was retrieved from combining fire perimeter data from the Alaskan and Canadian Large Fire Databases with surface reflectance and active fire data from the Moderate Resolution Imaging Spectroradiometer (MODIS) Collection 6. Per-pixel carbon consumption was estimated based on a statistical relationship between field estimates of pyrogenic consumption and several environmental variables. To derive the carbon consumption estimates, the approach from Alaskan Fire Emissions Database (AKFED) was updated and extended for the period 2001-2018. Fire weather variables, temperature, and the drought code complemented remotely sensed tree cover and burn severity as model predictors. Fire ignition location and timing were extracted from the daily burned area maps.

This Version 2 dataset is an improvement and extension of this previously archived Version 1 dataset. These data could be used in climate models and for predicting future fire regimes that will result from changes in fire weather, vegetation dynamics, and inherent landscape heterogeneity.

There are 108 data files in GeoTIFF format (*.tif): two files (one for each region) for each of 18 years spanning 2001–2018 and for each of the three burn estimates (i.e., carbon emissions, uncertainty, and daily fire ignition locations). Two shapefiles bundles in compressed (*.zip) format are also provided with daily fire ignition locations.

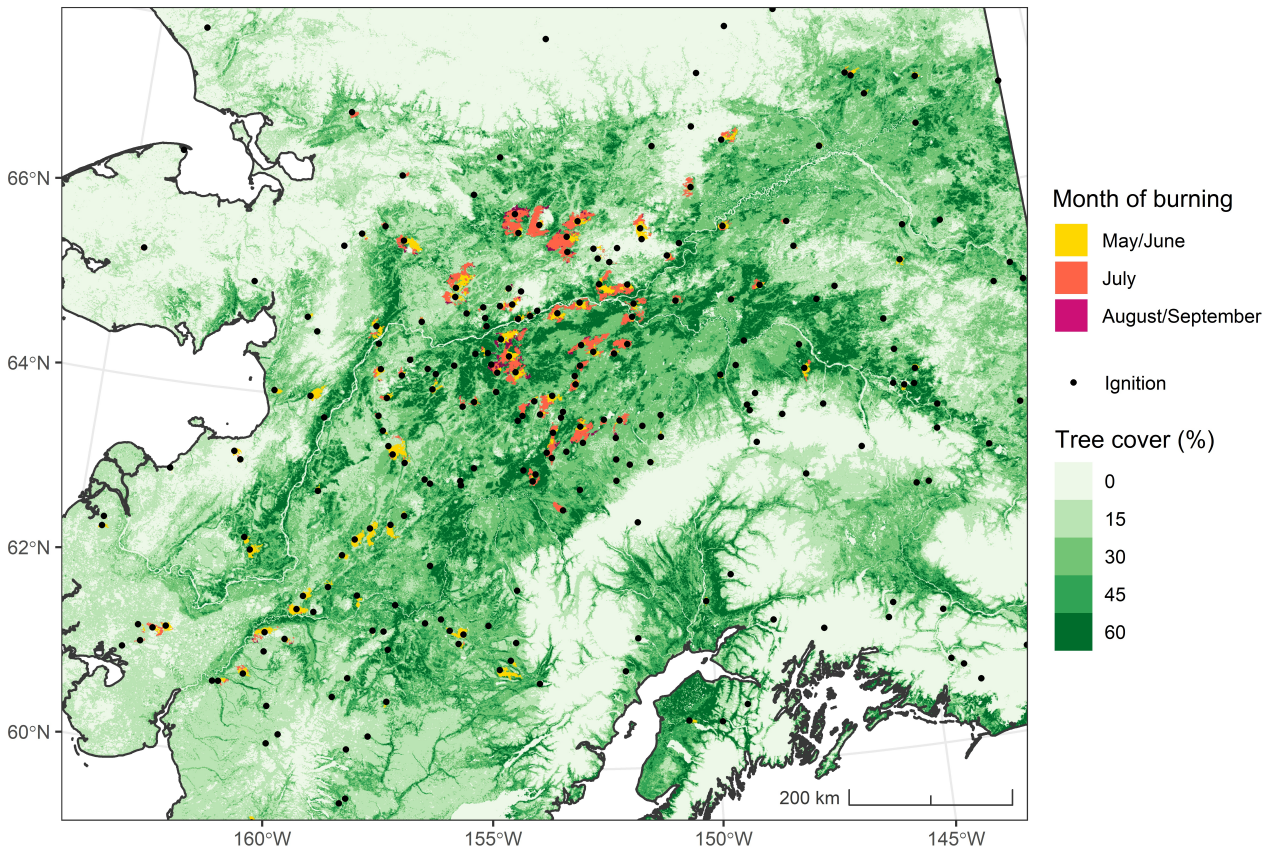

Figure 1. Ignition locations and burned area for Interior Alaska in 2015. Source: Scholten et al., 2021b

Citation

Scholten, R.C., S. Veraverbeke, R. Jandt, E.A. Miller, and B.M. Rogers. 2021. ABoVE: Ignitions, Burned Area, and Emissions of Fires in AK, YT, and NWT, 2001-2018. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1812

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 taking place in Alaska and western Canada between 2016 and 2021. Climate change in the Arctic and Boreal region is unfolding faster than anywhere else on Earth, resulting in reduced Arctic sea ice, thawing of permafrost soils, decomposition of long-frozen organic matter, widespread changes to lakes, rivers, coastlines, and alterations of ecosystem structure and function. ABoVE seeks a better understanding of the vulnerability and resilience of ecosystems and society to this changing environment.

Related Publications

Scholten, R.C., Jandt, R., Miller, E.A., Rogers, B.M. and Veraverbeke, S., 2021. Overwintering fires in boreal forests. *Nature*, *593*(7859), pp.399-404. https://doi.org/10.1038/s41586-021-03437-y

Veraverbeke, S., B.M. Rogers, M.L. Goulden, R.R. Jandt, C.E. Miller, E.B. Wiggins, and J.T. Randerson. 2017a. Lightning as a major driver of recent large fire years in North American boreal forests. Nature Climate Change 7:529–534. https://doi.org/10.1038/nclimate3329

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- The Version 2 dataset is an improvement and extension of this archived Version 1 dataset.

Veraverbeke, S., B.M. Rogers, and J.T. Randerson. 2015. CARVE: Alaskan Fire Emissions Database (AKFED), 2001-2013. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1282

2. Data Characteristics

Spatial Coverage: Alaska, U.S.; Yukon and the Northwest Territories, Canada

Spatial Resolution: 500 m

ABoVE Reference Locations

Domain: Core ABoVE

State/Territory: Alaska, Yukon, and the Northwest Territories

Grid cell(s): Ah0v0, Ah1v0, Ah1v1, Ah2v1

Temporal Resolution: Annual

Temporal Coverage: 2001-01-01 to 2018-12-31

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

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Full Extent	-167	-99.983819	79.26181	51.63464
Alaska	-167	-128	79.26181	51.63464
Yukon and Northwest Territories	-154.63	-99.9838	75.74841	54.30814

Data File Information

There are 108 data files in GeoTIFF format (*.tif): two files (one for each region) for each of 18 years spanning 2001–2018 and for each of the three burn estimates (i.e., carbon emissions, uncertainty, and daily fire ignition locations). Two shapefiles bundles in compressed (*.zip) format are also provided with daily fire ignition locations.

For all file names, the year (i.e., YYYY) is 2001–2018 and the region (i.e., X) is AK (Alaska) or YTNT (Yukon and the Northwest Territories).

Table 1. File names and descriptions.

File Name	Units	Description
Carbon_consumption_YYYY_X.tif	kg carbon / m^2	Carbon consumption (emissions) from burning. There are two files, one file for each region (i.e., AK and YTNT), for each year of the 18 year period from 2001–2018
Carbon_uncertainty_YYYY_X.tif	kg carbon / m^2	Carbon consumption (emissions) uncertainty files. There are two files, one file for each region, (i.e., AK and YTNT), for each year of the 18 year period from 2001–2018
fire_DOY_YYYY_X.tif	day of the year in local solar time	Day of burning. There are two files, one file for each region (i.e., AK and YTNT), for each year of the 18 year period from 2001–2018
Ignitions_20012018_AK.zip		When unzipped, the shapefile bundle provides daily fire ignition locations in Alaska
Ignitions_20012018_YTNT.zip		When unzipped, the shapefile bundle provides daily fire ignition locations in YTNT

Data File Details

For all GeoTIFF files,

- No Data Value: -9999
- Data Type: Float
- Number of bands: 1

For all files,

- CRS: ABoVE Standard Projection, EPSG:102001 (Canada Albers Equal Area Conic, North American Datum 1983)

Table 2. Attribute names and descriptions for Shapefiles.

Attribute Name	Description
Year	Year of ignition
doy	Day of year of ignition in local solar time
sE	Positional uncertainty of ignition point in meters

3. Application and Derivation

Databases of burned areas and emissions with high spatial and temporal resolution are a necessity to advance several related fields in biogeosciences. These data have applications in climate models and for predicting future fire regimes that will result from changes in fire weather, vegetation dynamics, and inherent landscape heterogeneity.

The data provided with this data set were derived from multiple sources including surface reflectance, active fire, and tree cover data derived from MODIS, weather data, fire perimeters, and tree species maps. The methods used are described in Section 5.

4. Quality Assessment

Uncertainties in carbon consumption within AKFED primarily originate from the unexplained model variance and the underlying land cover classifications. Uncertainties in burned area were propagated in the carbon consumption model to estimate uncertainties in carbon emissions.

Ignitions that were derived for Interior Alaska were compared with those from the Alaska Interagency Coordination Center (AICC) and 70% of the ignition points during 2001-2015 fell within three km and three days of the AICC ignition locations. The AICC ignition locations were estimated using local expert knowledge and may have larger temporal and location uncertainties.

5. Data Acquisition, Materials, and Methods

Data Sources

The data provided in this dataset were derived from multiple sources including surface reflectance, active fire, and tree cover data derived from MODIS, weather data, fire perimeters, and tree species maps.

Table 3. Data used to derive burned area and carbon consumption estimates, and lightning and ignition.

Data	Data Source
differenced Normalized Burn Ratio (dNBR)	Derived from MODIS surface reflectance (500 m)
Meteorological data	Regional Reanalysis (NARR) archived at the National Climatic Data Center (NCDC). Data obtained included wind speed, air temperature, relative humidity, and precipitation
Fractional tree species and non-treed	Vegetation cover data derived from Beaudoin et al. (2014) and the Fuel Characteristic Classification System
Tree cover in boreal forest and across the treeline ecotone	Terra MODIS Vegetation Continuous Fields Collection 6 product at 250 m resolution (MOD44B)
Fire perimeters	Alaskan and Canadian Large Fire Databases
Active fire	Derived from MODIS active fire product (http://modis-fire.umd.edu/index.php)

Fire and Burned Areas

Burned area and carbon emissions estimates (since 2001) were derived from an updated version of the AKFED (Veraverbeke et al., 2015a, 2015b, 2017a, 2017b) model. The data are at 500 m resolution and based on integrating field, fire perimeter, and remote sensing data. Daily burned area was determined by combining fire perimeter data with reflectance and active fire data from the Moderate Resolution Imaging Spectroradiometer (MODIS) (Veraverbeke et al., 2014). A threshold was applied to a burn-sensitive spectral index based on 1-year post-fire reflectance data, the differenced Normalized Burn Ratio (dNBR), within fire perimeters and outside perimeters, but within 1 km of active fire locations (Veraverbeke et al., 2015). The dNBR threshold for discriminating burned and unburned pixels was set at 0.15. AKFED, but was updated and extended for the period 2001–2018 by replacing the elevation and day of burning variables with weather variables from NARR. For each burned pixel, the weather variables were interpolated by applying the inverse distance weighting on the center coordinates from the four closest NARR grid cells. Subsequently, the fire weather indices were calculated from the Canadian Fire Weather Index (CFWI) system. The Version 2 dataset also ingests data from MODIS Collection 6.

Carbon Consumption

Carbon consumption was calibrated based on relationships between field observations of carbon consumption by fire in black spruce ecosystems and environmental variables. This approach was extended to include the Yukon and Northwest Territories. To do so, modifications were made to the original model. First, fractional tree species and non-treed vegetation cover data were used from Beaudoin et al. (2014) for the Canadian territories. Fractional cover data were aggregated for black spruce, white spruce, pine, deciduous, tundra-grass-shrubs, and non-vegetated. Second, the Consume 4.2 fuel consumption model was used to estimate consumption in black spruce, white spruce, pine, and deciduous ecosystems. As in Veraverbeke et al. (2015) and Veraverbeke et al. (2017), these consumption values were used to estimate consumption in ecosystems other than black spruce, by calculating their consumption relative to consumption in black spruce ecosystems. The consumption module of AKFED was originally driven by tree cover, burn severity, elevation, and day of burning in the year as environmental variables. For the non-treed cover classes, the same retrieval as for black spruce was applied since tree cover is accounted for in the model as a driving variable. Uncertainties in carbon consumption within AKFED primarily originate from the unexplained model variance and the underlying land cover classifications. Uncertainties in burned area were propagated in the carbon consumption model to estimate uncertainties in carbon emissions.

Ignition locations

For the period from 2001 to 2018, ignition location and timing were extracted from the daily burned area maps. A local minimum search was applied to the day of burning variable within a search radius of 5 km. The location and timing for each local minimum defined ignition points. Ignitions that were derived for Interior Alaska were compared with those from the Alaska Interagency Coordination Center (AICC) and 70% of the ignition points during 2001-2015 fell within three km and three days of the AICC ignition locations. The AICC ignition locations were estimated using local expert knowledge and may have larger temporal and location uncertainties.

6. Data Access

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

ABoVE: Ignitions, Burned Area, and Emissions of Fires in AK, YT, and NWT, 2001-2018

Contact for Data Center Access Information:

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

7. References

Beaudoin, A., P.Y. Bernier, L. Guindon, P. Villemaire, X.J. Guo, G. Stinson, T. Bergeron, S. Magnussen, and R.J. Hall. 2014. Mapping attributes of Canada's forests at moderate resolution through kNN and MODIS imagery. Canadian Journal of Forest Research 44:521–532. http://doi.org/10.1139/cjfr-2013-0401

Scholten, R.C., Jandt, R., Miller, E.A., Rogers, B.M. and Veraverbeke, S., 2021. Overwintering fires in boreal forests. *Nature*, *593*(7859), pp.399-404. https://doi.org/10.1038/s41586-021-03437-y

Veraverbeke, S., F. Sedano, S.J. Hook, J.T. Randerson, Y. Jin, and B.M. Rogers. 2014. Mapping the daily progression of large wildland fires using MODIS active fire data. International Journal of Wildland Fire 23:655. http://doi.org/10.1071/WF13015

Veraverbeke, S., B.M. Rogers, and J.T. Randerson. 2015a. Daily burned area and carbon emissions from boreal fires in Alaska. Biogeosciences 12:3579–3601. http://doi.org/10.5194/bg-12-3579-2015

Veraverbeke, S., B.M. Rogers, and J.T. Randerson. 2015b. CARVE: Alaskan Fire Emissions Database (AKFED), 2001-2013. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1282

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8. Dataset Revisions

Version	Release Date	Revision Notes	DOI
1	2017-06-21	The initial release. The data's date range is 2001–2015.	https://doi.org/10.3334/ORNLDAAC/1341
2	2021-06-22	MODIS 6 replaced MODIS 5, the ignitions algorithm was updated, and the data's date range was extended to 2001–2018.	https://doi.org/10.3334/ORNLDAAC/1812