ABoVE: Cumulative Annual Burned Area, Circumpolar High Northern Latitudes, 2001-2015

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Documentation Revision Date: 2017-08-30

Data Set Version: 1

Summary

This dataset provides annual cumulative end-of-season burned area in circumpolar high northern latitudes (HNL) above 60 degrees for the years 2001-2015. The data were generated using the Arctic Boreal Burned Area (ABBA) product (a MODIS-based algorithm). The product is delivered in two spatial domains: circumpolar and a North American subset for areas above 60 degree north.

The algorithm is based on Normalized Burned Ratio differencing (dNBR) and is designed specifically to capture late season fires. The annual MODIS Vegetation Continuous Fields (VCF) 250 m Collection 5.1 (MOD44B) product allowed for additional vegetation-dependent dNBR thresholds within the algorithm's processing steps.

There are 30 data files in shapefile format (.shp files compressed into .zip files) with this data set. This includes 15 files for annual burned area, one file for each year 2001-2015, for the circumpolar high northern latitudes and 15 files for the North American subset. The data are also provided in .kmz format for viewing in Google Earth.

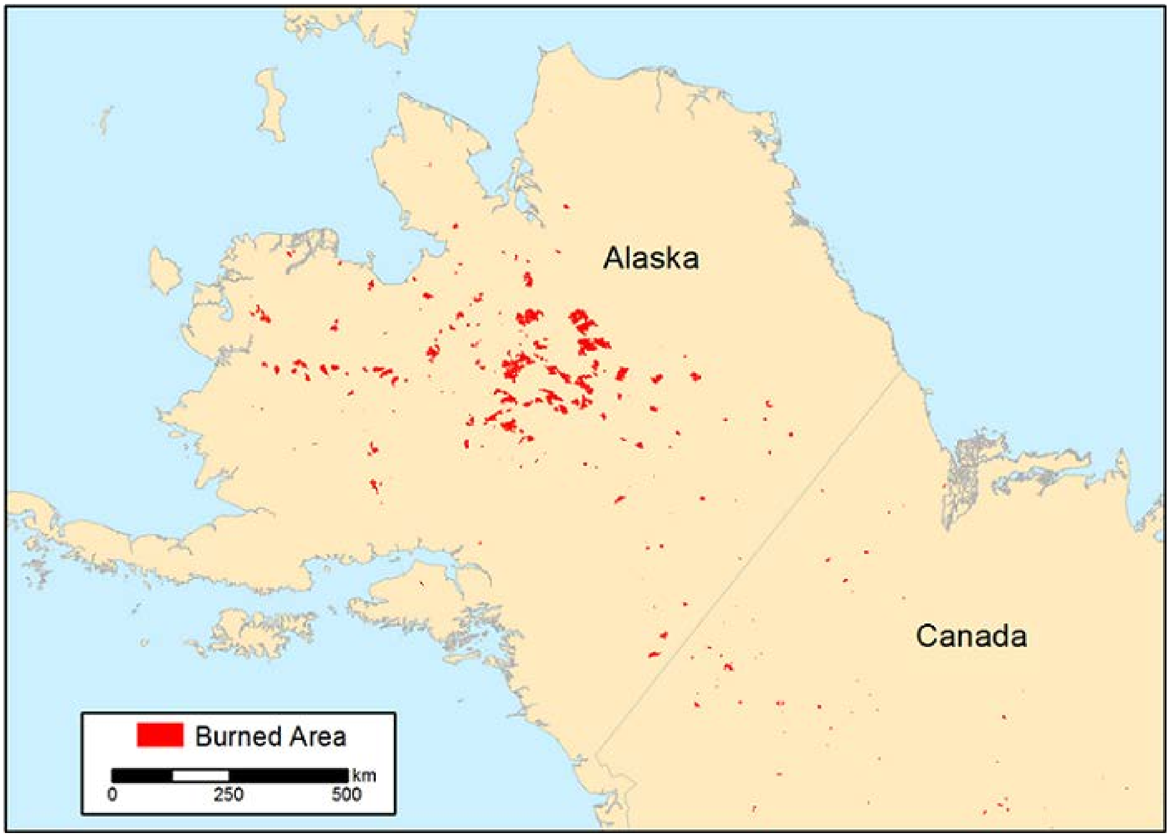

Figure 1. Cumulative end-of-season burned area for the year 2015 within a subset region of North America above 60 degrees N.

Citation

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Table of Contents

1. Data Set Overview

The Arctic Boreal Burned Area (ABBA) dataset provides annual cumulative end-of-season burned area in circumpolar high northern latitudes (HNL) above 60 degrees north for the years 2001-2015. The ABBA product (a MODIS-based algorithm) is an updated version of the algorithm developed in a previous study (Loboda et al., 2011). The algorithm is based on Normalized Burned Ratio differencing (dNBR) and is designed specifically to capture late season fires. The product is delivered in two spatial domains: circumpolar and a North American subset for areas above 60 degree north with a focus on the NASA Arctic - Boreal Vulnerability Experiment (ABoVE) study area.

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. ABoVE seeks a better understanding of the vulnerability and resilience of ecosystems and society to this changing environment.

2. Data Characteristics

Data Characteristics

Spatial Coverage: High northern latitudes (circumpolar above 60 degrees N)

ABoVE Site Designation:

Domain: Core ABoVE

Spatial Resolution: The input data were from several MODIS products at resolutions ranging from 250m to 500m

Temporal Coverage: 20010101 to 20151231

Temporal Resolution: Annual

Study Area (All latitude and longitude given in decimal degrees)

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Circumpolar above 60°N	-179.814	179.1537	72.59167	60
North America above 60°N	-179.814	-96.4412	69.675	60

Data file information

There are 30 compressed shapefiles (.shp contained in .zip files) in this data set. This includes 15 files for annual burned area, one file for each year 2001-2015, for the circumpolar higher latitudes, and 15 files for the North American subset. These data are also provided as companion files in .kmz format for viewing in Google Earth.

Table 1. File names and descriptions

File names	Descriptions
ABBA_HNL_YYYY.zip	Fifteen shapefiles (.shp) provided in compressed .zip files of burned area data in the high northern latitudes above 60 degrees N for the years 2001-2015. In the filenames, "HNL" refers to high northern latitudes and "YYYY" to the year of data.
ABBA_NA_YYYY.zip	Fifteen shapefiles (.shp) provided in compressed .zip files of burned area data in North America above 60 degrees N for the years 2001-2015. In the filenames, "NA" refers to North America and "YYYY" to the year of data.

Properties of the Shapefiles

Table 2. The attributes in the shapefiles are the cumulative end-of-season burned area.

Attribute	Description
Area_ha	Area of burn in hectares
Area_ac	Area of burn in acres

Table 3. Extents of the shapefiles

File names	North	South	East	West
ABBA_2001_HNL.shp	70.88333	60	173.5488	-151.935
ABBA_2002_HNL.shp	70.525	60	179.1537	-179.814
ABBA_2003_HNL.shp	71.22083	60	177.6474	-159.701
ABBA_2004_HNL.shp	69.4375	60	177.6209	-164.992
ABBA_2005_HNL.shp	72.08333	60	176.7187	-162.211
ABBA_2006_HNL.shp	70.63333	60	173.7454	-161.838
ABBA_2007_HNL.shp	69.48333	60	178.2328	-164.397
ABBA_2008_HNL.shp	70.83333	60	178.3079	-163.21
ABBA_2009_HNL.shp	70.225	60	173.083	-161.968

ABBA_2010_HNL.shp	72.59167	60	175.7491	-164.398
ABBA_2011_HNL.shp	69.73333	60	172.751	-162
ABBA_2012_HNL.shp	69.96667	60	175.8905	-162.583
ABBA_2013_HNL.shp	71.95833	60	165.5284	-161.619
ABBA_2014_HNL.shp	70.59167	60	172.0258	-161.721
ABBA_2015_HNL.shp	69.60833	60	173.9583	-164.611
ABBA_2001_NA.shp	67.03334	60.09168	-103.923	-151.935
ABBA_2002_NA.shp	68.20417	60	-104.027	-179.814
ABBA_2003_NA.shp	68.47917	60	-99.5461	-159.701
ABBA_2004_NA.shp	68.55	60	-100.797	-164.992
ABBA_2005_NA.shp	68.2625	60	-107.281	-162.211
ABBA_2006_NA.shp	68.12083	60	-96.4563	-161.838
ABBA_2007_NA.shp	69.48333	60	-104.421	-164.397
ABBA_2008_NA.shp	67.43333	60	-100.266	-163.21
ABBA_2009_NA.shp	69.3125	60	-116.273	-161.968
ABBA_2010_NA.shp	68.3625	60	-99.0457	-164.398
ABBA_2011_NA.shp	68.0875	60	-102.088	-162
ABBA_2012_NA.shp	69.675	60	-109.668	-162.583
ABBA_2013_NA.shp	69.0875	60	-102.992	-161.619
ABBA_2014_NA.shp	68.03333	60.0125	-96.4412	-161.721
ABBA_2015_NA.shp	68.32083	60	-106.748	-164.611

3. Application and Derivation

These data could be of use to fire management, fire mapping, and land use/land cover change studies.

4. Quality Assessment

An intercomparison of burned area (km^2) between the ABBA product, MODIS MCD64A1 Collection 6 Burned Area product (Giglio, 2015), and fire perimeter data obtained from the Alaskan Interagency Coordination Center (AICC) and the Natural Resources Canada (NRC) was carried out to assess the performance of the ABBA algorithm. Yearly comparisons between the mapped burned area from ABBA and MCD64A1 and the fire perimeters were undertaken between 2001 and 2014. Results (refer to Table 4; Fig 2 has an example for 2014) indicate that while area burned estimates from both MODIS-based products show strong statistical relationships with the estimates from the auxiliary burned area perimeters, ABBA estimates match the AICC and NRC estimates much more closely and with a greater consistency over the entire time period. Only estimates from the 2001 fire season diverge from this general pattern with very poor estimates delivered by the MODIS-based products. The poor performance during the 2001 season was mostly due to the fact that the MODIS instrument was turned off for substantial periods of time during the growing season. While the instrument was off, no active fire detections were acquired and since those represent an integral part for both ABBA and MCD64A1 products, even larger scars detectable on the surface later during the growing season were not reliably mapped.

Table 4. Intercomparison between ABBA and MCD64A1 burned area products (2001 – 2014) and the AICC and NRC fire perimeter datasets. Small fire years (annual cumulative area < 10,000 km^2 are denoted with *) and large fire years (annual cumulative area ≥ 10,000 km^2 are denoted with **).

Year	Cumulative Fire Database Area (km^2)	ABBA R^2 (slope)	MCD64A1 R^2 (slope)
2001*	2009	-0.175 (-0.01)	0.747 (0.17)
2002*	9074	0.975 (0.97)	0.842 (0.66)
2003*	4044	0.998 (1.04)	0.975 (0.62)

2004 **	49362	0.997 (0.96)	0.981 (0.71)
2005 **	22915	0.993 (1.04)	0.979 (0.73)
2006*	2578	0.977 (0.87)	0.738 (0.40)
2007*	7448	0.984 (0.91)	0.947 (0.60)
2008*	4669	0.982 (0.92)	0.982 (0.79)
2009 **	14248	0.997 (0.99)	0.970 (0.57)
2010*	9618	0.980 (0.85)	0.689 (0.25)
2011*	4631	0.985 (0.95)	0.907 (0.49)
2012*	4721	0.962 (0.87)	0.872 (0.61)
2013 **	11760	0.986 (0.94)	0.813 (0.45)
2014 **	36423	0.999 (0.94)	0.991 (0.66)

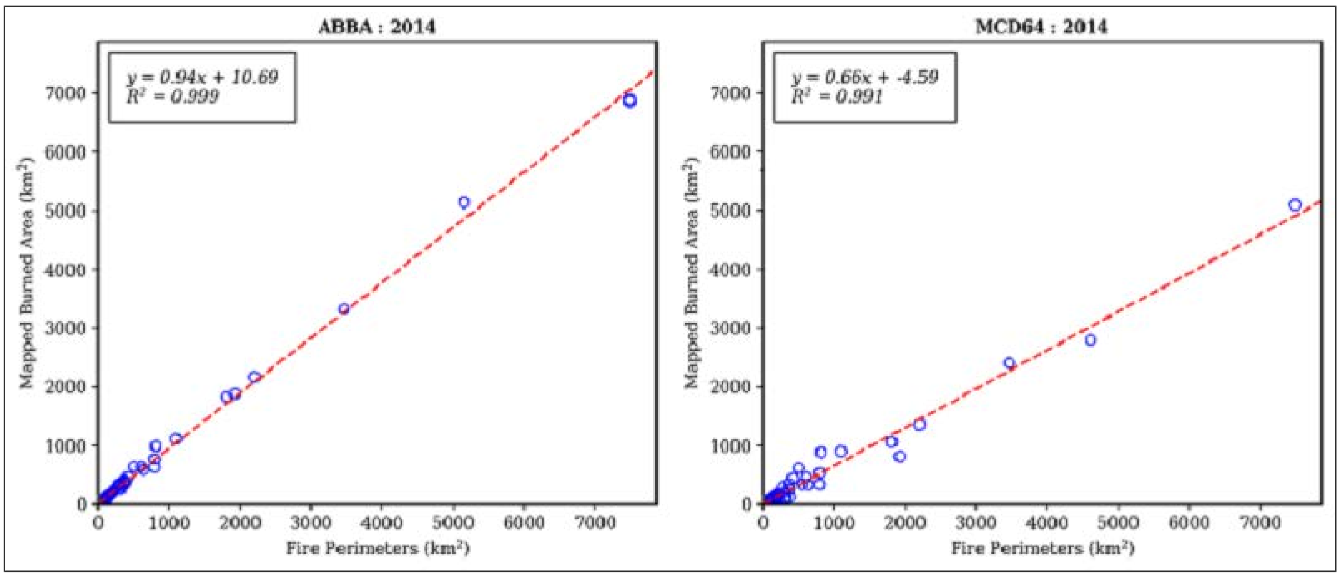

Figure 2. 2014 burned area (km^2) comparison between the fire perimeters from AICC and NRC and the ABBA (left) and MCD64A1 (right) burned area products. ABBA mapped an additional 298 km^2 of cumulative burned area (non-overlapping the AICC and NRC fire perimeters), while MCD64A1 mapped an additional 523 km^2. These values were excluded from the analysis.

5. Data Acquisition, Materials, and Methods

Annual maps of the cumulative end-of-season burned area in the circumpolar high northern latitudes (HNL) above 60 degrees N were developed in a previous study using the ABBA algorithm with MODIS data from collection 5 (Loboda et al., 2011). The data in this dataset were derived with MODIS collection 6 products and are for the years 2001-2015, generated using ABBA.

The ABBA algorithm is based on Normalized Burned Ratio differencing (dNBR) and is designed specifically to capture late season fires. The algorithm inputs the MODIS Surface Reflectance 8-Day Composite product (MOD09A1; Vermote, 2015), the MODIS Active Fire product (MOD14ML; Giglio, 2015), the MODIS Vegetation Continuous Fields (VCF) 250 m Collection 5.1 (MOD44B; Hansen et al., 2003) product and the MODIS 250 m land-water mask (MOD44W; Carroll et al., 2009). The algorithm development follows the methodology published in Loboda et al. (2007) and Loboda et al. (2011).

Table 5. Summary of data products used in the study.

Satellite-based fire monitoring programs and products	Purpose
MODIS active fire detections (MCD14ML) Collection 6 (Giglio, 2015)	Assessment of observed fire activity (fire location). This is a change introduced to the inputs for the burned area production since the publication of the algorithm (Loboda et al., 2007 and 2011)

MODIS 8-day Level 3 500m MOD09A1 Surface Reflectance Collection 6 (Vermote, 2015)	Used to create surface reflectance composites for dNBR. This is a change introduced to the inputs for the burned area production since the publication of the algorithm (Loboda et al., 2007 and 2011)
MODIS 250 m land-water mask (MOD44W; Carroll et al., 2009)	Used for the identification of water bodies. Only larger water bodies with a minimum area of ~ 21ha (~ 53 ac) – corresponding to four 231.65 m grid cells – were mapped as water. Due to the preponderance of very small waterbodies in the HNL, a relaxed aggregation rule was used to reduce the omission of large amounts of land area and thus reduce the patchy appearance of burn scars. This is a change introduced to the inputs for the burned area production since the publication of the algorithm (Loboda et al., 2007 and 2011)
MODIS Vegetation Continuous Fields (VCF) 250 m Collection 5.1 (MOD44B; Hansen et al., 2003)	Allowed for additional vegetation-dependent dNBR thresholds within the algorithm's processing steps
Alaskan Interagency Coordination Center (AICC) and the Natural Resources Canada (NRC) fire perimeters	Used to assess reported burned area estimates per individual fire scar (2001 – 2015)

ABBA algorithm modifications and methodology

In order to optimize the mapping accuracy of the ABBA algorithm, the original Loboda et al. (2007) methodology was modified to include pre-season and post-season spring composites:

- First, burned areas were mapped following the original methodology of Loboda et al. (2007). This methodology is based on semi-automated processing of standard MODIS land products into burned area maps using information about changes in surface reflectance due to fire and the record of fire activity. The algorithm ingests the MODIS 500m 8-day surface reflectance composites (MOD09A1) collected during the year of interest and the year before, masks out poor-quality data using MOD09A1 quality bits, and produces 8-day dNBR grids.
- A set of vegetation-dependent dNBR thresholds was then developed by an analyst to reflect ecosystem-specific changes in surface reflectance due to fire. These masks of potential burning, created by separating the dNBR grids into 'potentially burned' and 'unburned' categories, were further compared with the observed fire activity recorded by the MODIS active fire detections (Giglio et al., 2003) to eliminate instances of surface reflectance change due to reasons other than fire. At this stage, two thresholds are set for active fire detections included in the analysis: (1) the area threshold that defines a minimum of active fires detections per unit burned area, and (2) the temporal threshold, which is defined by the longevity of a burn scar, the possible length of a fire-event occurrence, and the possible length of a period of persistent cloud cover impeding surface observations.
- The resultant 8-day burn masks were merged into an end-of season burned area product.

Regional dNBR thresholds and updates to define burned area pixels

With the changes introduced in the MODIS Collection 6, new updates to acceptability of pixels for burned area mapping were defined. Regional dNBR thresholds were established at 0.25 and 0.2 for areas with tree cover >10% and ≤10% respectively. MODIS pixels with values above those thresholds were considered potentially burned. The potentially burned pixels were further compared with the active fire detection to ensure that the observed change in surface reflectance occurred owing to burning. The active fire detection thresholds, designed to limit the selection of appropriate samples of active fires from the MODIS active fire product, were set at three times the area mapped by active fires for the area threshold and 64 days before the date of the given composite for the temporal threshold. For a more complete description of threshold identification, see Loboda et al. (2007).

Spring composites

The spring composite was automatically created from the MODIS 8-day composite files acquired during late April–May (composite Julian Dates (JD) 121–153) to develop a pre-fire season clear surface view. Analysis of active fire detections showed that few fires occurred during this time and they were easily separated from the fire scars of the previous year. The JD 153 MODIS 8-day composite was then modified using the information contained in the quality layer to mask out pixels of low quality. The masked-out pixels from the base composite were filled with acceptable-quality pixels from the composite of the previous date (JD 8). The process was repeated until the JD reached 121, the cut-off date based on snow-melt trajectories, after which the remaining poor-quality pixels were permanently masked out.

Visual analysis of multiyear burned area mapping using the original regional burned area algorithm showed that new burn scars were frequently found to be adjacent to the burns from the previous year. To eliminate the potential confusion in the year of burning, a pre-fire season spring composite was created to exclude previously burned areas. MOD09A1 composites between JD 121 and 153 were combined in a single clear surface pre-burn composite for year i and year i-1 with preferential selection of later dates in the compositing time-window. The subsequent processing included analysis of three spring composites: the spring pre-fire season composite (year i), the spring post-fire season composite of the following year (year i+1), and the spring pre-fire-season composite of the previous year (year i-1). dNBR images were calculated for composites from (1) year i-1 and year i, and (2) year i and year i+1. The dNBR images were further processed using the regional thresholds and using cumulative fire detections from the previous year for the pre-fire season dNBR composite and from the current fire season for the post-fire dNBR composite. The resultant burned area masks from the post-fire season were merged with the burns mapped using the original algorithm. Finally, the pre-fire season masks were erased from the resultant product.

For a more complete description, see Loboda et al. (2011).

6. Data Access

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

ABoVE: Cumulative Annual Burned Area, Circumpolar High Northern Latitudes, 2001-2015

Contact for Data Center Access Information:

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- Telephone: +1 (865) 241-3952

7. References

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