SAFARI 2000 MODIS 500-m Burned Area Products, Southern Africa, Dry Season 2000

Abstract

The SAFARI 2000 dry season campaign was selected as the first test of a regional MODIS burned area product. The MODIS burned area product maps the 500 m location and approximate day of burning using a change detection algorithm based on a bi-directional reflectance model-based expectation method applied to the MODIS near-infrared and shortwave infrared bands. The algorithm was applied to recently reprocessed 500 m daily MODIS land surface reflectance data to produce burned area data sets for all of southern Africa for 2000 forward. This archived data set contains MODIS 500 m burned area products for two dry season months (July and September 2000).

Background Information

Investigator:
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Project: SAFARI 2000

Data Set Title: SAFARI 2000 MODIS 500-m Burned Area Products, Southern Africa, Dry Season 2000

Site: Southern Africa
Westernmost Longitude: 5° E
Easternmost Longitude: 56.7519° E
Northernmost Latitude: 0° N
Southernmost Latitude: 37.2249° S

Data Set Citation:
Roy, D. P. 2005. SAFARI 2000 MODIS 500-m Burned Area Products, Southern Africa, Dry Season 2000. Data set. Available on-line [http://daac.ornl.gov/] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Data Set Link: http://modis-fire.gsfc.nasa.gov/index.asp

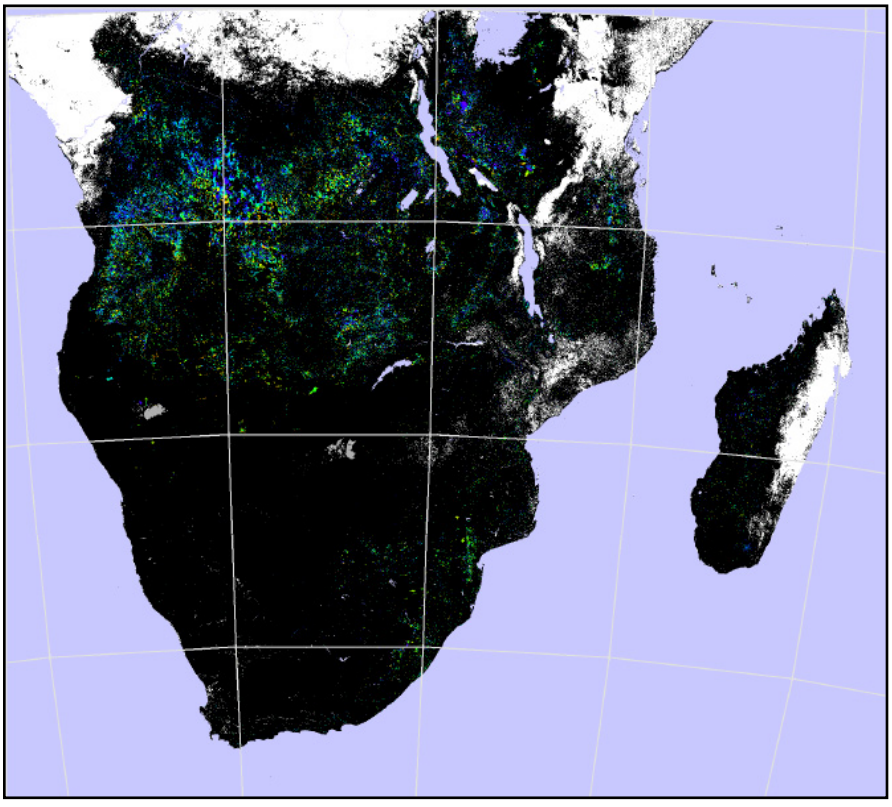
Data File Information

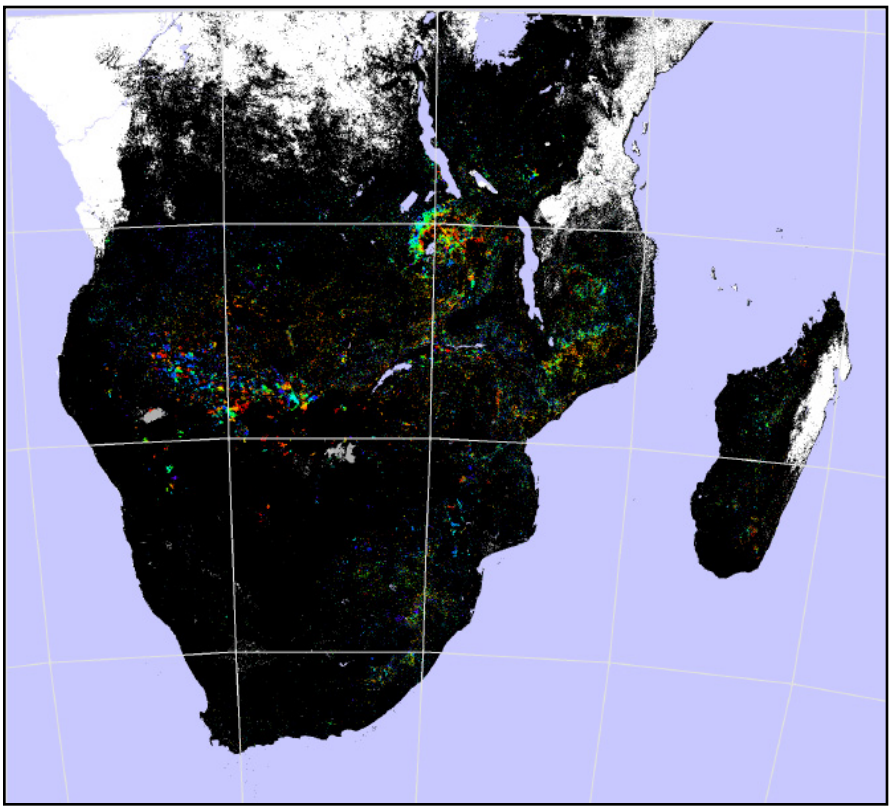
Burned area products are provided for the months of July and September 2000. These products are spatially explicit data sets that describe the approximate day of burning at 500 m resolution for all of southern Africa south of the Equator, including Madagascar.

The burned area maps are compressed GeoTiff files. Uncompressed, the burned area maps are named:

modis_ba_500m_2000-07.tif and
modis_ba_500m_2000-09.tif, where 07 refers to July and 09 to September.

July 2000 (top figure) and September 2000 (bottom figure) burn area products density sliced to illustrate the different days of burning.





The following three types of ENVI text files (i.e., *.hdr, *.dat, and *.dsr) are included to aid ENVI (Research Systems, Inc.) users, and each file type has been described in detail so that this information can be translated into any image processing software.

1. *.hdr
modis_ba_500m_2000-07.tif.hdr (ENVI header file)
modis_ba_500m_2000-09.tif.hdr (ENVI header file)

Definition of the contents of the ENVI header files, (*.hdr)

Lines 1 through 3: ENVI header file definition, a character string describing the image or processing performed:
"ENVI description = {GeoTIFF File Imported into ENVI [Mon Aug 4 11:44:11 2003] }"

Line 4: number of samples(pixels) per image line for each band
"samples = 9134"

Line 5: number of lines per image for each band
"lines = 8239"

Line 6: number of bands per image file
"bands = 1"

Line 7: the number of bytes of imbedded header information present in the file. These bytes are skipped when ENVI reads this file.
"header offset = 0"

Line 8: ENVI defined file type
"file type = TIFF"

Line 9: data type parameter identifying the type of data present. Type 2 = 16-bit signed integer
"data type = 2"

Line 10: band interleave type, BSQ = band sequential interleave
"interleave = bsq"

Line 11: specific instrument type, such as Landsat TM, SPOT, RadarSat, etc.
"sensor type = Unknown"

Line 12: order of the bites in integer, long integer, 64-bit integer, unsigned 64-bit integer, floating point, double percision, and complex data types; Byte order=0 is Least Significant Byte First (LSF)
"byte order = 0"

Line 13:
read procedures = {tiff_read_spatial, tiff_read_spectral}

Line 14: list of geographic coordinate information in the order of projection name, reference pixel x location in file coordinates, pixel y, pixel easting, pixel northing, x pixel size, y pixel size, projection zone, and unit of measure
"map info = {lam_15s_25e_nodatum_country, 1.0000, 1.0000, -1677263.4190, 1663163.9580, 500.00000000, 500.00000000, <none>, units=Meters}"

Line 15: parameters that describe the user-defined projection information. ENVI defines projection number 36 as Lambert Azimuthal Equal Area (sphere) with the following parameters, radious, 0 latitude, 0 longitude, 0 X, 0Y, [datum], name of projection, and unit of measure.

"projection info = {36, 6370997.0, -15.000000, 25.000000, 0.0, 0.0, <none>, lam_15s_25e_nodatum_country, units=Meters}"

2. *.dat (projection parameters)
modis_ba_500m_projection.dat (ENVI projection parameters)

Definition of the contents of the ENVI projection file (*.dat)

One line file listing each projection parameter delimited with a comma.
"36, 6370997.0, -15.000000, 25.000000, 0.0, 0.0, lam_15s_25e_nodatum_country"

These parameters are identical to the projection information listed in line 15 of the ENVI header file as described above. ENVI defines projection number 36 as Lambert Azimuthal Equal Area (sphere) with the following parameters, radious, 0 latitude, 0 longitude, 0 X, 0Y,[datum], name of projection, and unit of measure.

3. *.dsr
modis_ba_500m_2000-07.dsr (ENVI density slice file)
modis_ba_500m_2000-09.dsr (ENVI density slice file)

Definition of the contents of ENVI density slice files (*.dsr)

The file has five columns consisting of Start range, End range, and graphic colors used in ENVI (i.e., red, green, blue).

ENVI Density Slice Range File
-32768.000 -1.0000000 255 255 255
0.0000000 178.00000 0 0 0
179.00000 179.00000 124 0 255
180.00000 180.00000 102 0 255
181.00000 181.00000 75 0 255
182.00000 182.00000 43 0 255
183.00000 183.00000 12 0 255
184.00000 184.00000 0 20 255
185.00000 185.00000 0 47 255
186.00000 186.00000 0 78 255
187.00000 187.00000 0 110 255
188.00000 188.00000 0 141 255
189.00000 189.00000 0 168 255
190.00000 190.00000 0 200 255
191.00000 191.00000 0 231 255

192.00000 192.00000 0 255 247
193.00000 193.00000 0 255 220
194.00000 194.00000 0 255 188
195.00000 195.00000 0 255 157
196.00000 196.00000 0 255 125
197.00000 197.00000 0 255 98
198.00000 198.00000 0 255 35
199.00000 199.00000 0 255 8
200.00000 200.00000 23 255 0
201.00000 201.00000 55 255 0
202.00000 202.00000 86 255 0
203.00000 203.00000 113 255 0
204.00000 204.00000 145 255 0
205.00000 205.00000 177 255 0
206.00000 206.00000 208 255 0
207.00000 207.00000 235 255 0
208.00000 208.00000 255 243 0
209.00000 209.00000 255 212 0
210.00000 210.00000 255 180 0
211.00000 211.00000 255 153 0
212.00000 212.00000 255 122 0
213.00000 213.00000 255 90 0
214.00000 214.00000 255 59 0
215.00000 215.00000 255 32 0
216.00000 216.00000 255 16 0
217.00000 217.00000 255 0 0
218.00000 9997.0000 0 0 0
9998.0000 9998.0000 175 175 175
9999.0000 9999.0000 200 200 255
10000.000 10000.000 255 255 255

Image Data Format

Each product, uncompressed, occupies approximately 144 Mbytes and has the following characteristics:

file format	GeoTiff
data type	16-bit signed integer
image size	9134 columns by 8239 rows
geographic projection	Lambert Azimuthal Equal Area false Easting = 25.0 degrees, false Northing = 15.0 degrees
datum	none
sphere radius	6370997.0 m
upper left corner, x	10.006566° E
upper left corner, y	0.387092° N
x pixel size	500 m
y pixel size	500 m

Definition of Pixel Values (July 2000 product):

Pixel Values/Range	Definition
0	no burning detected over julian days 179-217, 2000
179-217	approximate day of burning (burning occurred on or up to 8 days prior to this day), where 179 corresponds to June 27, 180 corresponds to June 28, and 217 corresponds to August 4, 2000
9998	not considered (suspected ephemeral water & with NDVI < 0.1 on one or more days in July)
9999	not considered (water)
10000	insufficient MODIS data to establish burn status (persistent cloud and/or missing MODIS data)
-32768	not considered (outside mapping area)

The ENVI density slice file **modis_ba_500m_2000-07.dsr** defines a color map than can be used to display the July product in ENVI. The density slice file is composed of 5 columns, where columns one and two describe the pixel value

range, and columns three to five describe the corresponding red, green, and blue display values (range 0-255).

Definition of Pixel Values (September 2000 product):

Pixel Values/Range	Definition
0	no burning detected over julian days 241-278, 2000
241-278	approximate day of burning (burning occurred on or up to 8 days prior to this day), where 241 corresponds to August 28, 242 corresponds to August 29, and 278 corresponds to October 4, 2000
9998	not considered (suspected ephemeral water & with NDVI < 0.1 on one or more days in September)
9999	not considered (water)
10000	insufficient MODIS data to establish burn status (persistent cloud and/or missing MODIS data)
-32768	not considered (outside mapping area)

The ENVI density slice file **modis_ba_500m_2000-09.dsr** defines a color map than can be used to display the September product in ENVI. The density slice file is composed of 5 columns, where columns one and two describe the pixel value range, and columns three to five describe the corresponding red, green, and blue display values (range 0-255).

Background of the Burned Area Algorithm

Monitoring of biomass burning using satellite data has considerable heritage (Justice et al., 2002). Global active fire detection is provided using hotspot detection algorithms working on thermal channel data from a number of satellite sensors. The timing and spatial extent of burning cannot be estimated reliably from these orbital hot spot data, as the satellite may not overpass when burning occurs and because clouds may preclude active fire detection. Burned area mapping algorithms that examine spectral changes, rather than relying on hotspot detection, are generally insensitive to these effects as spectral changes induced by burning are temporally persistent (Roy et al., 2002a). The SAFARI 2000 project was selected as the first regional test for a prototype regional 500 m MODIS burned area product.

The MODIS burned area algorithm maps the approximate day of burning at 500 m using multitemporal daily MODIS data based on a method described by Roy et al., 2002a. The algorithm is applied independently to geolocated pixels over a long time-series of reflectance observations. A bi-directional reflectance model is inverted against multitemporal reflectance observations to provide predicted reflectances and uncertainties for subsequent observations. A statistical measure of the difference between the observed bi-directional surface reflectance (BRF) and the predicted BRF, at the viewing and illuminating angles of the observation, is used to quantify change from a previously observed state. Large discrepancies between predicted and measured values are attributed to change. A temporal consistency constraint is used to differentiate between temporary changes considered as noise and persistent changes of interest.

Regional MODIS burned area data sets produced for 2000, 2001 and 2002 are being validated using a methodology based upon the interpretation of multitemporal Landsat Enhanced Thematic Mapper plus (ETM+) data by members of the Southern Africa Fire Network (SAFNet http://safnet.umd.edu/) to derive maps of the location and approximate date of burning. This validation work is described in Roy et al. (in press).

Data Notes

1. The precise day of burning may not be certain because of cloudy and/or missing data. The detected burns may have occurred on, or up to 8 days before, the stored julian day. For this reason, the results for several days before and after the days in July and September have been included. A recommended conservative estimate of the area burned in July would be to consider only days 182-213 and for September would be to consider only days 244-274.

2. Pixels with codes 9998 & 10000 should not be considered as unburned. Rather, their burn status is unknown.

3. Although the July and September 2000 burned area data sets were produced from the latest reprocessed MODIS Collection 4 data, they are less reliable than burned area data sets produced for 2001 and later dry seasons. Missing burned areas and false detections occur due to noisy and poorly performing MODIS detectors in the period 25 February to 1 November 2000 (Guenther

et al., 2002) which had a deleterious impact on the MODIS land surface reflectance and cloud mask products (Roy et al., 2002b) used to make the burned area data sets.

4. It is unknown to what degree burns produced by low combustion completeness fires and produced by surface fires concealed by unburned overstory vegetation were mapped.

Additional Sources of Information

This work was supported by the National Aeronautics and Space Administration (NASA) Land Cover Land Use Change (LCLUC) and Applications programs (grant NAG511251).

Related Data Sets

More details of the MODIS burned area product will become available on the MODIS fire products web site at http://modis-fire.gsfc.nasa.gov/index.asp and eventually at http://firemaps.geog.umd.edu/ (which is a good resource for current fire data).

MODIS 1 km active fire detection data (MOD14 product suite) are available from the EROS Data Center (EDC) Land Processes DAAC at http://edcdaac.usgs.gov/order.html.

References

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