Technical documentation

The Global Fire Atlas of individual fire size, duration, speed, and direction

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Summary. Natural and human-ignited fires affect all major biomes, altering ecosystem structure, biogeochemical cycles, and atmospheric composition. Satellite observations provide global data on spatiotemporal patterns of biomass burning and evidence for rapid changes in global fire activity in response to land management and climate. Satellite imagery also provides detailed information on the daily or sub-daily position of fires that can be used to understand the dynamics of individual fires. The Global Fire Atlas is a new global dataset that tracks the dynamics of individual fires to determine the timing and location of ignitions and fire size, duration, daily expansion, fire line length, speed, and direction of spread. The Global Fire Atlas algorithm identified 13.3 million individual fires over the 2003-2016 study period, based on moderate resolution (500 m) Collection 6 MCD64A1 burned area data. Individual fire information and summary data products provide new information for benchmarking fire models within ecosystem and Earth system models, understanding vegetation-fire feedbacks, improving global emissions estimates, and characterizing the changing role of fire in the Earth system.

Contents

1   Data Set Overview

The Global Fire Atlas dataset tracks the day-to-day dynamics of individual fires based on moderate resolution burned area data. During 2003 - 2016, we identified about 13.3 million individual fires globally. For each individual fire, the dataset provides information on the timing and location of the ignition, the fire size, perimeter, duration, daily fire line, daily expansion, speed and direction of spread. The methodology and validation are presented in Andela et al. (2018), while details on the underlying 500 m resolution daily burned area product (MCD64A1 collection 6) are described in Giglio et al. (2018). Data are available from 2003 to 2016 and will be updated annually while both Moderate Resolution Imaging Spectroradiometer (MODIS) instruments are operational. Data are produced in GIS file-formats (GeoTIFF and shape files) and are available as gridded 500 m global layers with corresponding vector shapefiles showing individual fire perimeters and ignition locations, as well as a monthly 0.25° aggregate product (Table 1).

Table 1: Overview of the Global Fire Atlas data-layers. The shapefiles of ignition locations (point) and fire perimeters (polygon) contain attribute tables with summary information for each individual fire, while the underlying 500 m gridded layers reflect the day-to-day behavior of the individual fires. In addition, we provide aggregate monthly layers at 0.25° resolution for regional and global analyses.

	Shapefile attributes*	500 m daily gridded	0.25° monthly gridded
Ignitions	location and timing	-	sum
Perimeter (km)	per fire	-	-
Size (km^2)	per fire	-	average
Duration (days)	per fire	-	average
Daily fire line (km)	average per fire	yes	average
Daily fire expansion (km^2 day^{-1})	average per fire	-	average
Speed (km day^{-1})	average per fire	yes	average
Direction of spread (-)	dominant per fire	yes	dominant
Day of burn	-	yes	-

* vector data are derived from the underlying 500 m MODIS data.

2   Data use and availability

These data are made freely available to the public and the scientific community in the belief that their wide dissemination will lead to greater understanding and new scientific insights. The quality of the dataset depends both on the Fire Atlas algorithm (Andela et al., 2018) as well as the underlying MCD64A1 collection 6 burned area dataset (Giglio et al., 2018), and we strongly recommend users to read these documents before using the data. Moreover, we are not responsible for the results and conclusions based on these data and may update the data based on new insights or data availability. In addition, we plan to provide annual updates based on the new availability of MCD64A1 collection 6 burned area data, as long as both

MODIS instruments are operational. Additional information may be obtained from the Global Fire Data website: http://www.globalfiredata.org, that also provides a basic online data-exploration tool.

3 File information

Global fire atlas data are both available at 500 m resolution as well as in a monthly 0.25° aggregate product.

3.1 Global shapefiles and 500 m gridded data

The 500 m resolution data layers contain shapefiles of ignition location (point) and fire perimeters (polygon), as well as gridded information on individual fire dynamics. The shape files and corresponding attribute tables provide summary information on each individual fire (Table 2). The annual global shape files and 500 m gridded layers are produced for each fire season, a 12-month period centered on the month of peak-fire activity in each 10° x 10° MODIS tile. Because each 500 m pixel rarely burns twice during a single fire season, this format allows for annual 500 m data layers with minimal loss of information. The shapefiles are projected in the World Geodetic System 1984 (WGS84, EPSG:4326).

Table 2: Overview shapefile attributes, providing individual fire summary information.

Attribute name	Description and units	Valid range
fire_ID	unique fire identifier number	≥ 1
latitude	ignition location latitude	90 to -90
longitude	ignition location longitude	-180 to 180
size	total area burnt (km^2)	≥ 0.21 (1 MODIS pixel)
perimeter	final perimeter (km)	≥ 1.85 (1 MODIS pixel)
start_date	ignition date (YYYY-MM-DD)	-
start_DOY	ignition day of year	$1 - 366$
end_date	extinction date (YYYY-MM-DD)	
end_DOY	extinction day of year	$1 - 366$
duration	fire duration (days)	≥ 1
expansion	average daily fire expansion (km^2 day^{-1})	≥ 0.21 (1 MODIS pixel)
fire_line	average daily fire line length (km)	≥ 0.46 (1 MODIS pixel)
speed	average speed of the fire (km day^{-1})	> 0
direction*	dominant direction of spread (numerical)	$0 - 8$
direction_s*	dominant direction of spread (string)	-
landcover**	dominant land cover type (numerical)	$0 - 16$
landcover_s**	dominant land cover type (string)	-
tile_ID	MODIS tile (h,v)	-

* Only provided for multiday fires, (0) indicates no data, (1) north, (2) northeast, (3) east, (4) southeast, (5) south, (6) southwest, (7) west, and (8) northwest.
** The dominant land cover type was derived from MODIS MCD12Q1 collection 5.1 data for 2012 using the University of Maryland (UMD) classification (Friedl et al., 2002).

In addition to the shape files, the dataset contains four global annual 500 m gridded layers (GeoTIFF), containing the day of burn, daily fire line, speed, and direction of spread. While the shapefile attribute tables contain per-fire average values on these aspects, the 500 m layers can be used to reconstruct time series of day-to-day fire behavior for each individual fire (Fig. 1). Both shapefiles and 500 m gridded layers can be easily imported in QGIS or Arc-GIS to explore global patterns of individual fires and their behavior. The 500 m gridded layers are projected in the MODIS sinusoidal projection, and on the fly coordinate reference system

(CRS) transformation may have to be enabled to correctly overlay gridded layers and shapefiles in GIS software.
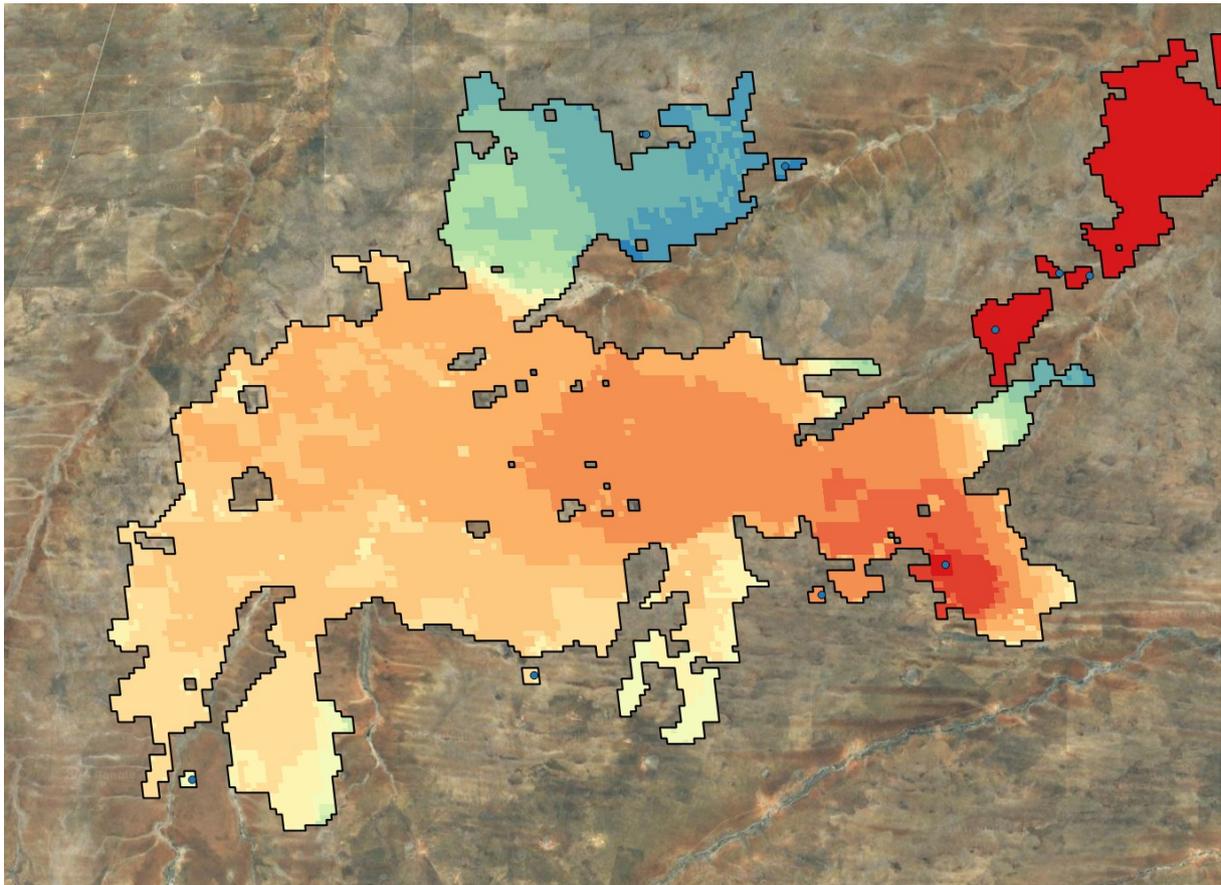

Figure 1: Example of a large fire burning in arid shrublands of Botswana, 2003. The blue points indicate ignition locations, colors indicate earlier (red) and later (blue) burn dates, and fire perimeters are marked by a black line. This particular fire burned an area of 2152 km^2 during 16 days with an average fire spread rate of 9 km day^{-1} and a dominant western spread direction.

3.2   0.25° gridded summary data

Data are summarized in a monthly 0.25° gridded product based on average values of individual fires (Table 1, GeoTIFF), projected in the World Geodetic System 1984 (WGS84, EPSG:4326). In contrast to the 500 m gridded layers and shapefiles, the 0.25° monthly layers are produced for each calendar year, with averages taken based on the fraction of burned area of each individual fire within the respective month and 0.25° grid cell. For example, a grid cell containing a 1 and 99 km^2 fire would have an average fire size of 50 km^2 [(1+99)/2] for that given month; in case half of the 99 km^2 fire occurred in a different month, the average fire size would become 33.7 km^2 [(1+99*0.5)/1.5]. For some applications, it may be useful to take averages weighted by the individual fire size, as that might be more representative for the typical impact of fire activity on the landscape.

4   References

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