# ESA Climate Change Initiative – Fire_cci
# D4.2.2 Product User Guide - AVHRR-Long Term Data Record (PUG-LTDR)

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## Summary

This document is the version 1.0 of the deliverable 4.2.2 corresponding to the Product User Guide for the LTDR Fire_cci v1.1 product (FireCCILT11). It provides practical information about the use of the Fire_cci global burned area products based on the LTDR product.

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# 1. General overview

The ESA CCI Programme comprises the generation and provision of Essential Climate Variables (ECV) on a global scale based on long-term satellite data time series. "Fire Disturbance" is deemed as one of these ECVs and is tackled through the Fire_cci project. Burned area (BA) is considered as the primary variable for the Fire Disturbance ECV.

This document contains practical information on how to use the LTDR Fire_cci BA v1.1 products (also called FireCCILT11 for short), which are based on the AVH09 product of the Land Long-Term Data Record (LTDR, Pedelty et al. 2007) project developed using images acquired by the Advanced Very High Resolution Radiometer (AVHRR 2-3) sensors on board the National Oceanic and Atmospheric Administration (NOAA 7-19) satellites.

## 1.1. Introduction

The LTDR Fire_cci version 1.1 products (FireCCILT11) comprise maps of global burned area developed and tailored for use by climate, vegetation and atmospheric modellers, as well as by fire researchers or fire managers interested in historical burned patterns. That product (1982-2018) double the time series of the previous BA product developed by the Fire_cci product: MODIS Fire_cci v 5.0 (Chuvieco et al. 2018) and MODIS Fire_cci v 5.1 (Lizundia-Loiola et al. 2020), which comprised the 2001-2017 period. FireCCILT11 also adds an extra year of coverage (2018) to the previous Beta version FireCCILT10, using an improved algorithm that tackles many of the issues found in that version.

The Fire_cci project produces two burned area products available at different spatial resolutions, the PIXEL product and the GRID product, which is derived from the pixel one.

## 1.2. Input data and BA algorithm

The structure and some steps of the FireCCILT10 algorithm have been adapted from the FireCCILT10 algorithm (Otón and Chuvieco 2018; Otón et al. 2019), but the new algorithm has many novelties and improvements. Three inputs are still required to start the process:

- The AVHRR-LTDR product (AVH09 version 5, Pedelty et al. 2007) are the global images degraded to 0.05° (≈5 km) from 1981 to date; the AVH09 product offers daily surface reflectance information in the RED, near infrared (NIR) and Mid-wave infrared (MWIR) bands, as well as TOA brightness temperature in the MWIR and two thermal channels in the Long-wave infrared (LWIR). Furthermore, the daily product offers information on the quality of the data (Quality Assessment Field), Solar zenith angle, View zenith angle and Relative azimuth.
- Land cover data (CCI and C3S Land Cover products) per year is used to achieve better adaptability to Land cover changes (burnable-unburnable).
- FireCCI51 (Lizundia-Loiola et al. 2020) is used to train the algorithm.

The algorithm is described in the Algorithm Theoretical Basis Document of the product (ATBD, Otón and Chuvieco 2020, in preparation).

The LTDR product is daily but it presents noise, artefacts, BRDF effects or may have incorrect observations. For this reason, temporal composites have been used to improve the utility and quality of daily data in the time series (Roy 1997). The maximum temperature criterion offers robustness and increases the atmospheric attenuation and the sensitivity to detect burned pixels, decreases the presence of clouds and cloud shadows, high satellite zenith angles and off-nadir pixels (Cihlar et al. 1994; Chuvieco et al. 2005; Roy 1997). Therefore, the date of the pixel is the date got in the composite.

The LTDR data used as input for the algorithm is in geographic coordinates (GCS_Unknown_datum_based_upon_the_Clarke_1866_ellipsoid). All the processing was done in these coordinates, with the other inputs reprojected to the Clarke ellipsoid. The final pixel and grid products, however, were reprojected to geographical coordinates (WGS84) to keep consistency with other CCI products.

# 2. Pixel BA product

The pixel BA product is comprised of four GeoTIFF files indicating the date of detection, the confidence level, the burned area (Figure 2.1) and the number of observations.

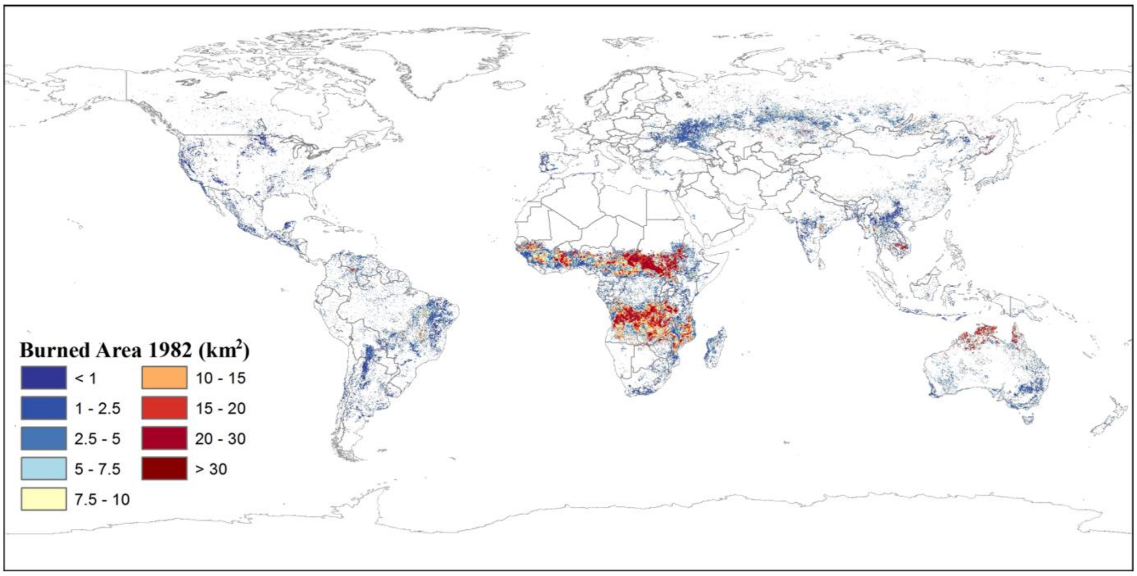


**Figure 2.1: Total burned area for the year 1982 at a 0.05-degree spatial resolution (pixel product).**

## 2.1. Temporal compositing

The pixel products are released as monthly composites so that they can tackle those pixels that can burn more than once during a calendar year. This is most commonly the case in the northern Tropical areas, since the dry season commonly occurs between December and February.

Since the pixel resolution is coarse, and several proportions of the pixel can be burned in consecutive months, the pixels are partially allowed to burn in consecutive months, but the algorithm restricts the total accumulated BA to the size of the pixel (≈25 km$^2$) within a six-month period.

## 2.2. Spatial Resolution

The Spatial resolution of this BA product is 0.05 degrees (approximately 5 km at the Equator), which is the original resolution of LTDR product.

## 2.3. Product projection system

The Coordinate Reference System (CRS) used for the global BA products is a geographic coordinate system (GCS) based on the World Geodetic System 84 (WGS84) reference ellipsoid and using a Plate Carrée projection with geographical coordinates of equal pixel size. The coordinates are specified in decimal degrees. Information on product projection, ellipsoid and pixel size is included in the GeoTIFF file header, so every pixel in the file can be geographically referenced without the need of adding specific pixel indicators of geographical position.

## 2.4. Pixel attributes

The following sub-sections describe each of the layers of the pixel product, including the name of the attributes in the GeoTIFF file, the units of the attributes and the data type, and some information useful for the correct use of the product.

They also include examples of the pixel product layers.

### 2.4.1. Layer 1: Dates

| Attribute | Units | Data Type | Notes |
|---|---|---|---|
| Date of the first detection (JD) | Day of the year, from 1 to 365 (or 366) | Float | Possible values:<br>• 0 (zero): when the pixel is not burned.<br>• 1 to 366: The date of the burned pixel according to the composite.<br>• -1: when the pixel is not observed in the month.<br>• -2: used for pixels that are not burnable: continuous water, bare land, urban, permanent ice-snow. |

This layer corresponds to the day assigned to the pixel by the monthly composite, also commonly called Julian Day. Unlike many other existing BA products, since the area of each pixel is large, it is not assumed that the whole pixel is burned, but instead an proportion of burn is calculated (see Section 2.4.3).

The date of the burned pixel may not be coincident with the actual burning date, but most probably taken from one to several days afterwards, depending on image availability and cloud coverage. For areas with low cloud coverage, the detected date of burn should be very close to the actual date of burn, while for areas with high cloud coverage the date may be from several days or even weeks after the fire is over.

An example of this layer corresponding to August 1982 is shown in Figure 2.2.

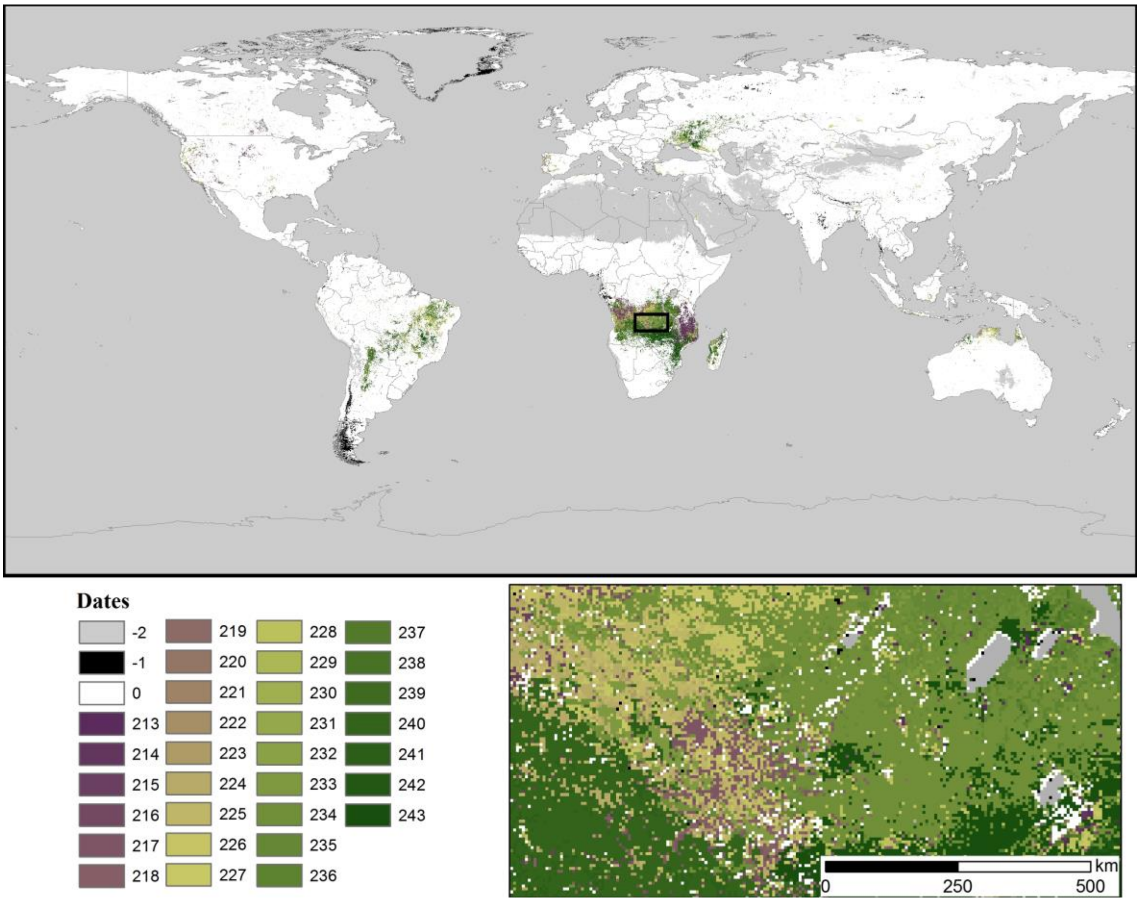


**Figure 2.2: Example of the Dates for August 1982 (19820801-ESACCI-L3S_FIRE-BA-AVHRR-LTDR-fv1.1-JD.tif file).**

### 2.4.2. Layer 2: Confidence level

| Attribute | Units | Data Type | Notes |
|---|---|---|---|
| Confidence level (CL) | 0 to 100 | Float | Probability of detecting a pixel as burned. Possible values:<br>• 0: when the probability is so close to 0 that the classifier rounds the value to it.<br>• 1 to 100: Probability values. When the pixel is closer to 100, that pixel has higher confidence that the pixel is actually burned. This value expresses the uncertainty of the detection for all pixels, even if they are classified as unburned.<br>• -1: when the pixel is not observed in the month.<br>• -2: used for pixels that are not burnable: continuous water, bare land, urban, permanent ice-snow. |

The confidence level is the probability that the pixel is actually burned. A pixel with a confidence level of 80 means that it is burned with a probability of 80%, which implies that the input data and the algorithm result in a fairly high belief of the pixel being burned. A low value (for instance, 5) would indicate a strong belief of the pixel not being burned. These values can also be called “per pixel” uncertainty (*pb*). *pb* was modelled from the output of Random Forest (RF), being the proportion of times that decision trees classify the pixel as burned in the FireCCILT11-BA algorithm (Otón and Chuvieco 2020). It should be noted that this uncertainty is just a description of how much one can trust the interpretation of the burned/unburned state of a pixel given the uncertainty of the data, the choices done in modelling, etc. Lewis et al. (2017) do not give an indication about whether the estimates of BA are close to the truth, as that is really the role of validation

(Padilla et al. 2018). An example of this layer corresponding to August 1982 is shown in Figure 2.3. All pixels with a burnable land cover include a confidence level, both if they are classified as burned or as not burned.

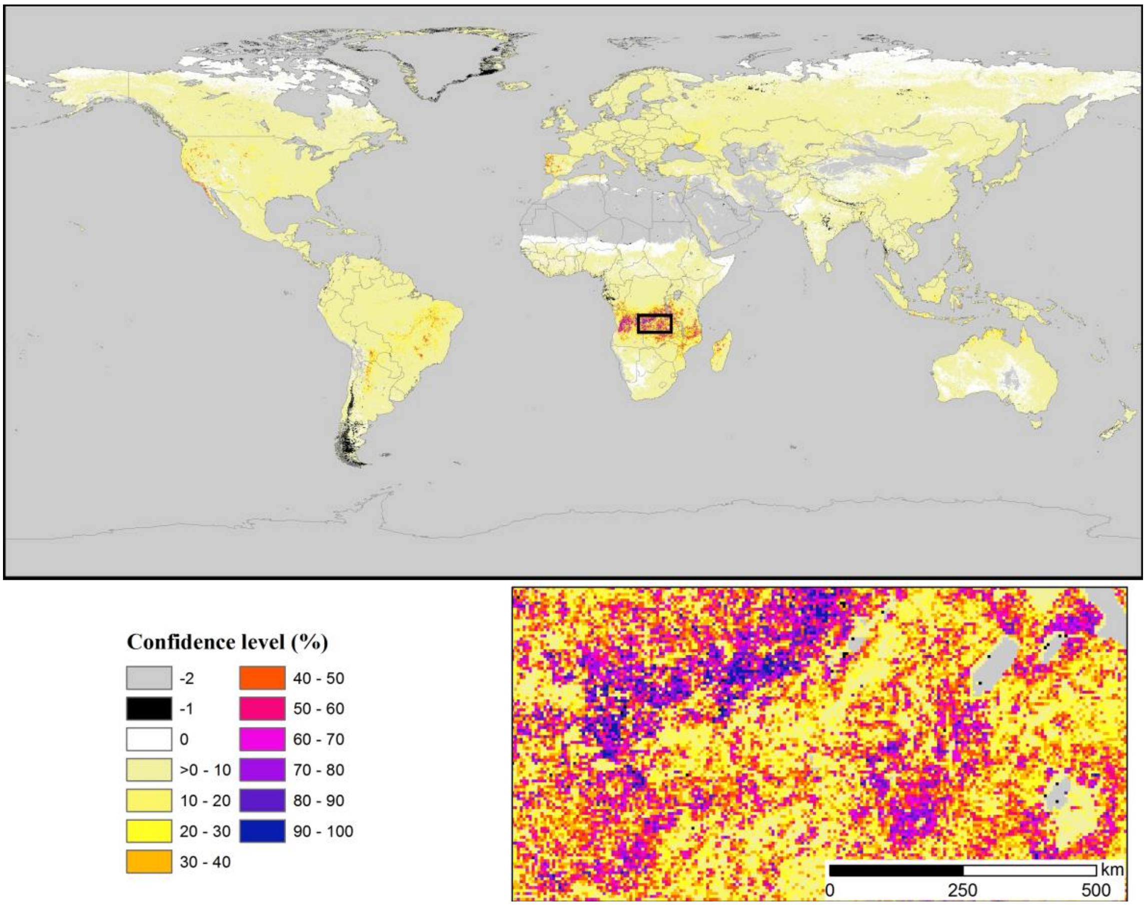


**Figure 2.3: Example of the Confidence Level for August 1982 (19820801-ESACCI-L3S_FIRE-BA-AVHRR-LTDR-fv1.1-CL.tif file).**

### 2.4.3. Layer 3: Burned Area

| Attribute | Units | Data Type | Notes |
|---|---|---|---|
| Burned Area (BA) | Square metres | Float | • 0 to N: Area in $m^2$ detected as burned within each pixel cell.<br>• -1: when the pixel is not observed in the month.<br>• -2: used for pixels that are not burnable: continuous water, bare land, urban, permanent ice-snow |

Burned Area is the proportion of the pixel that is burned. Unlike other global BA products, a pixel can be partially or totally burned. The pixel detected as burned in the binary classification, according to Random Forest probabilities and the thresholding method, is assigned a proportion of area burned. That proportion is obtained using the statistical distribution of BA at 0.25º between the time series of the FireCCI51 and the binary classification, and extrapolated to the early years of the temporal series prior to the MODIS era. Further description on the methodology to obtain the burned area from the BA detections is included in the Algorithm Theoretical Basis Document of the product (Otón and Chuvieco 2020).

An example of this layer corresponding to August 1982 is shown in Figure 2.4.

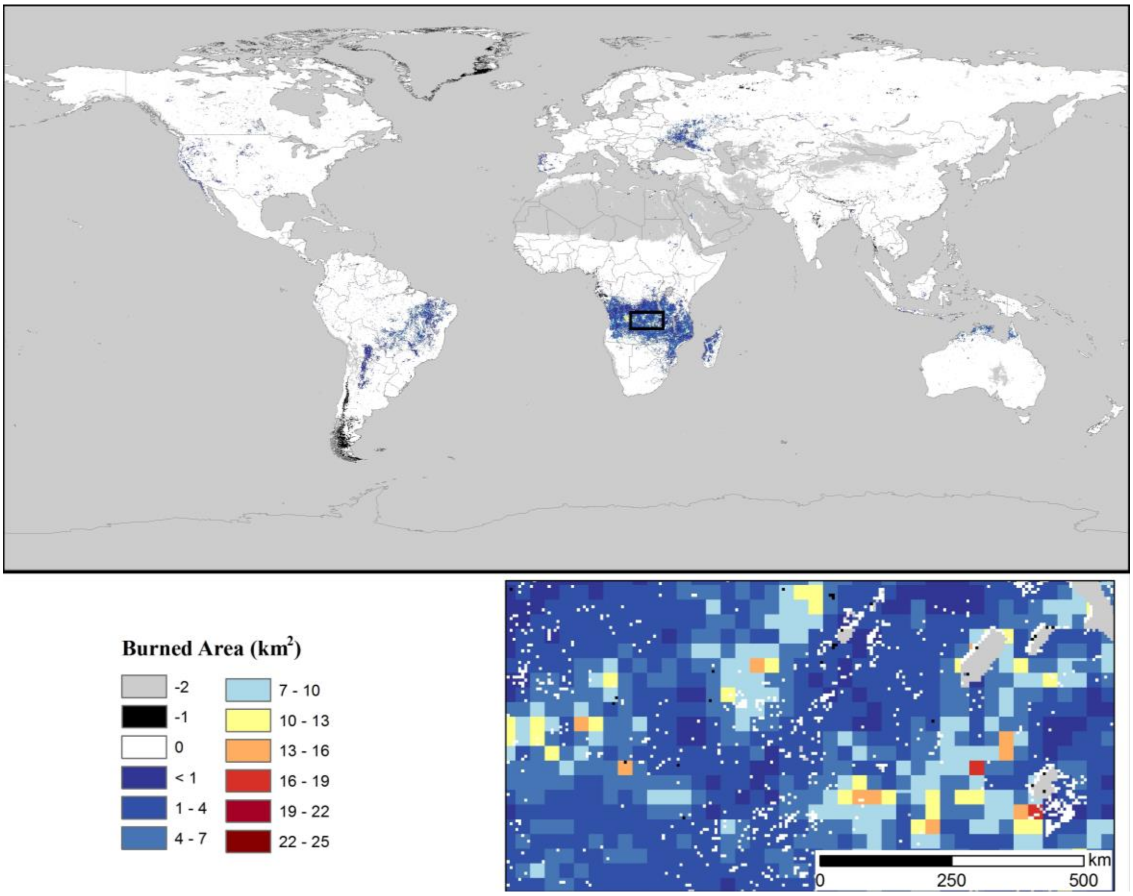


**Figure 2.4: Example of the Burned Area for August 1982 (19820801-ESACCI-L3S_FIRE-BA-AVHRR-LTDR-fv1.1-BA.tif file).**

### 2.4.4. Layer 4: Number of observations

| Attribute | Units | Data Type | Notes |
|---|---|---|---|
| Number of observations (OB) | 0 to 31 | Int16 | Possible values:<br>• 0 to 31: Number of observations that are classified as No-cloud in the Cloud mask within each pixel cell. When the pixel is not observed is 0 (zero).<br>• -2: used for pixels that are not burnable: continuous water, bare land, urban, permanent ice-snow. |

The Number of Observations is the number of different times that this pixel has been observed in the month and does not have no data values, noise or clouds.

**Important note**: The number of observations varies according to the month (28 – 31 days) and the number of NOAA-AVHRR satellites (1 or 2) that are active that day. If there are superposition of satellites that obtained images in a day, there may be two observations per day. In those cases, the total observations in these months are divided by the number of satellites that are active, to keep the coherence throughout the time series

An example of this layer corresponding to August 1982 is shown in Figure 2.5.

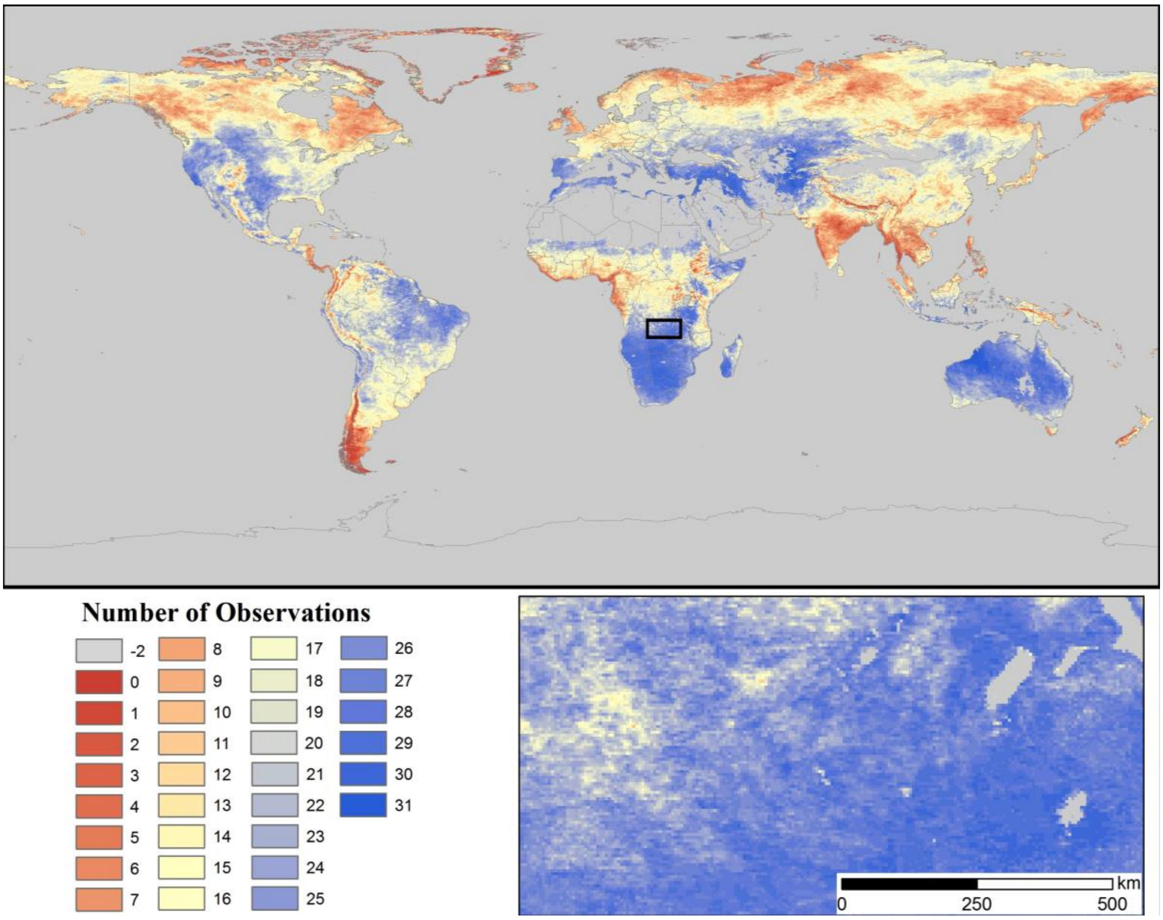


**Figure 2.5: Example of the Number of Observations for August 1982 (19820801-ESACCI-L3S_FIRE-BA-AVHRR-LTDR-fv1.1-OB.tif file).**

## 2.5. File format

The product is delivered in GeoTIFF format, with each layer as an individual file, and together compressed yearly into tar.gz files to reduce downloading file sizes.

## 2.6. Product file naming conventions

The files for each sensor and month are named as follows:

**<Indicative_Date>-ESACCI-L3S_FIRE-BA-<Indicative_sensor>-fv<xx.x>-<Layer>.tiff**

**<Indicative_Date>**

The identifying date for this data set:

Format is YYYYMMDD, where YYYY is the four-digit year, MM is the two-digit month from 01 to 12 and DD is the two-digit day of the month from 01 to 31. For monthly products DD=01.

**<Indicative_sensor>**

In this version of the product it is AVHRR-LTDR.

**fv<File_Version>**

File version number in the form n{1,}[.n{1,}] (That is 1 or more digits followed by optional "." and another 1 or more digits). This version is fv1.1.

**<Layer>**

As each layer is provided as an individual GeoTIFF file, the code of each layer is:

- JD: layer 1, corresponding to the Julian day, or day of the year of detection of the BA.
- CL: layer 2, corresponding to the confidence level
- BA: layer 3, corresponding to the burned area
- OB: layer 4, corresponding to the number of observations.

Example:

19820801-ESACCI-L3S_FIRE-BA-AVHRR-LTDR-fv1.1-JD.tif

19820801-ESACCI-L3S_FIRE-BA-AVHRR-LTDR-fv1.1.xml

## 2.7. File metadata

For each BA product, an additional xml file with the same name is created. This file holds the metadata information following the ISO 19115 standard. The description of the populated fields is included in Annex 1.

# 3. Grid BA product

The grid product is the result of summing up the burned area of the pixels (0.05 degrees) within each cell of 0.25 degrees in a regular grid covering the whole Earth in monthly composites. In addition to this variable, other attributes are stored in NetCDF file format: standard error of the estimations, fraction of burnable area and fraction of observed area. Figure 3.1 shows the total BA from this product for 1982. This product is derived from the final pixel product in geographical coordinates (WGS84) to avoid differences due to reprojection. In this way, pixel and grid products are consistent between them.

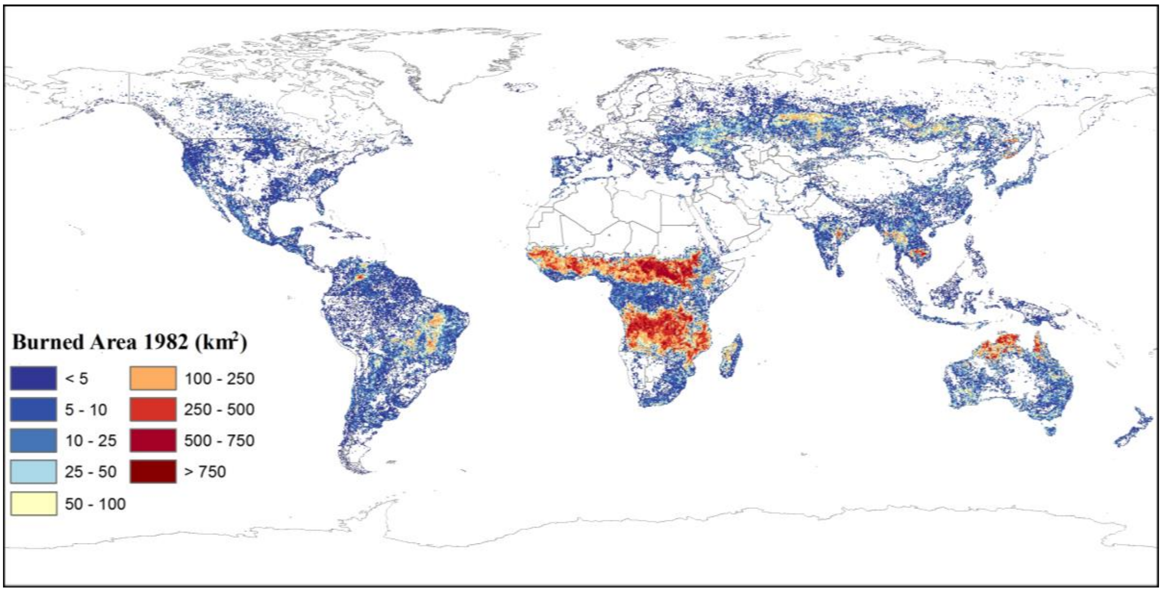


**Figure 3.1: Total burned area for the year 1982 at a 0.25-degree spatial resolution (grid product).**

## 3.1. Temporal compositing

Grid products are released in monthly files covering from the start to the end of the month. They are named assigning the day 1 of the month in the naming convention (see Section 3.6).

## 3.2. Spatial Resolution

The spatial resolution of the grid product is 0.25 x 0.25 degrees. Grid attributes are computed from all pixels included in each cell of that size within the time period previously indicated.

## 3.3. Product projection system

The grid product is stored in geographical coordinates. Each cell has a latitude and longitude assignment which is tied to the centre of the grid cell. For example, a series of adjacent grid cells have longitude references of -67.625°, -67.375°, -67.125° and -66.875°. Similarly, a series of latitude references are 0.125°, -0.125°, -0.375° and -0.625°.

## 3.4. Grid attributes

The following sub-sections describe each of the grid attributes, including the name of the variables (attributes) in the NetCDF file, the unit of the attributes and the data type, and some information useful for the correct use of the product. They also include an example of the grid product attributes.

### 3.4.1. Attribute 1: Sum of burned area

| | Attribute | Units | Data Type | Notes |
|---|---|---|---|---|
| 1 | Sum of BA | Square metres | Float | Sum of area detected as burned in all the pixels within each grid cell and month. |

Sum of burned area assigned to all the pixels detected as burned within each grid cell and period. An example of this layer corresponding to August 1982 is shown in Figure 3.2.

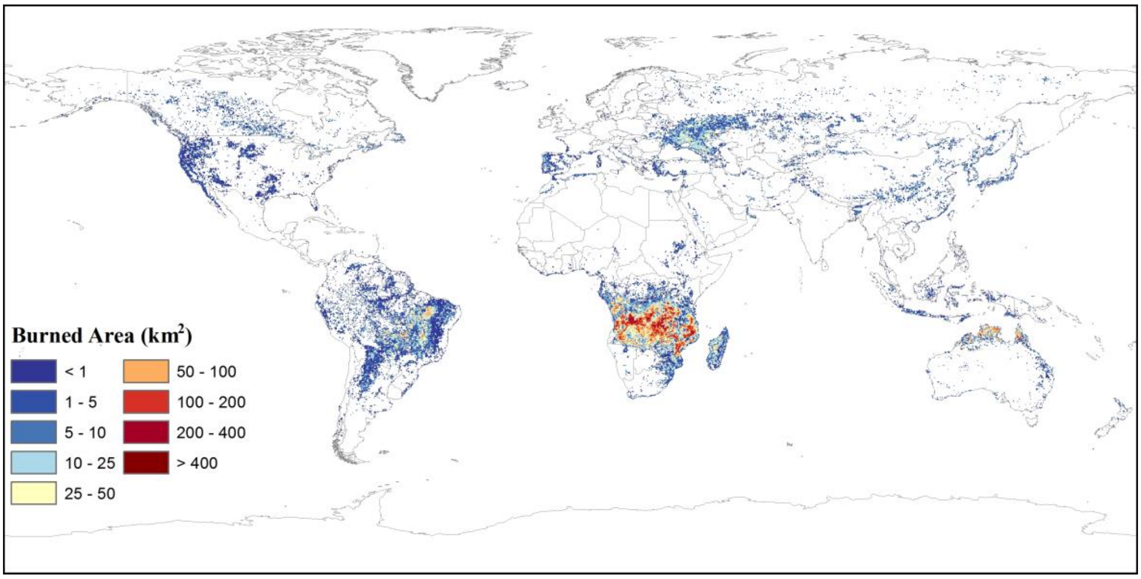


**Figure 3.2: Example of the Burned Area attribute in August 1982 (19820801-ESACCI-L4_FIRE-BA-AVHRR-LTDR-fv1.1.nc file).**

### 3.4.2. Attribute 2: Standard error

| | Attribute | Units | Data Type | Notes |
|---|---|---|---|---|
| 2 | Standard Error | Square metres | Float | This value is the standard error of the estimation of BA in each grid cell and month. |

The standard error describes the hypothetic error according to the sensitivity of the data to the observed fire phenomenon, the ability of the algorithm to detect burn area and the quality of the observations that have been used to label pixels (Lewis et al. 2017). The standard error is modelled from the estimation of the probability ($p_b$) of each pixel being burned. The calculation is made using the pixel confidence level as input. More detail on the statistical models can be found in the ATBD (Otón and Chuvieco 2020).

An example of this layer corresponding to August 1982 is shown in Figure 3.3.

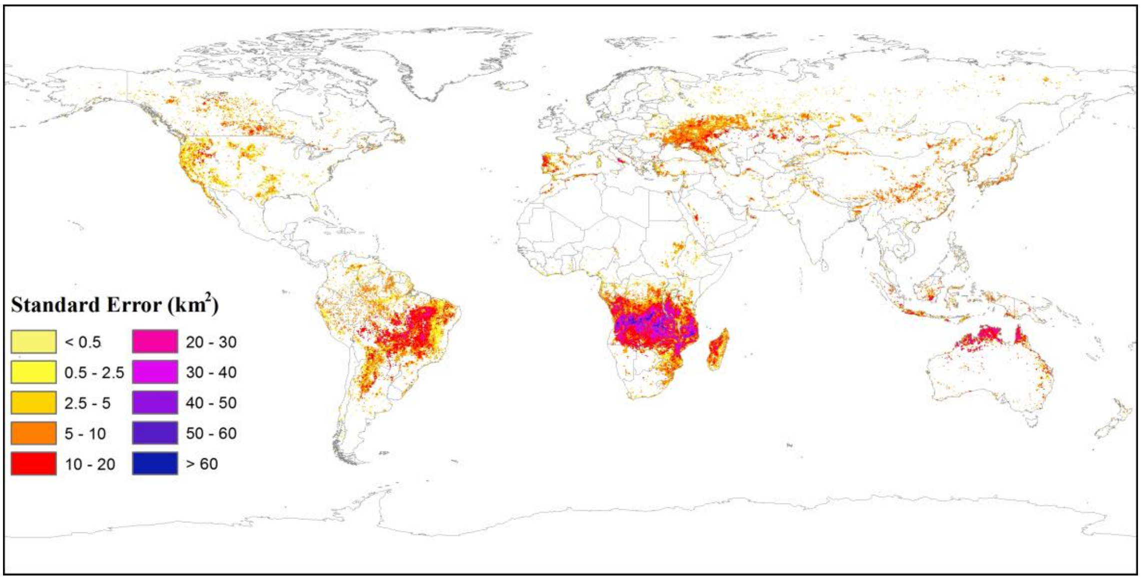


**Figure 3.3: Example of the Standard Error attribute in August 1982 (19820801-ESACCI-L4_FIRE-BA-AVHRR-LTDR-fv1.1.nc file).**

### 3.4.3. Attribute 3: Fraction of burnable area

| | Attribute | Units | Data Type | Notes |
|---|---|---|---|---|
| 3 | Fraction of burnable area | 0 to 100 | Float | The fraction of area in the grid that corresponds to vegetated land covers that could be affected by fire. |

It includes all land cover categories that can be burned. That means that it excludes water bodies, permanent snow and ice, urban areas and bare areas. Land cover information was extracted from the LC_cci project (Defourny et al. 2019; ESA 2017).

An example of this layer corresponding to August 1982 is shown in Figure 3.4. This layer does not change monthly, but only when a new yearly land cover is considered.

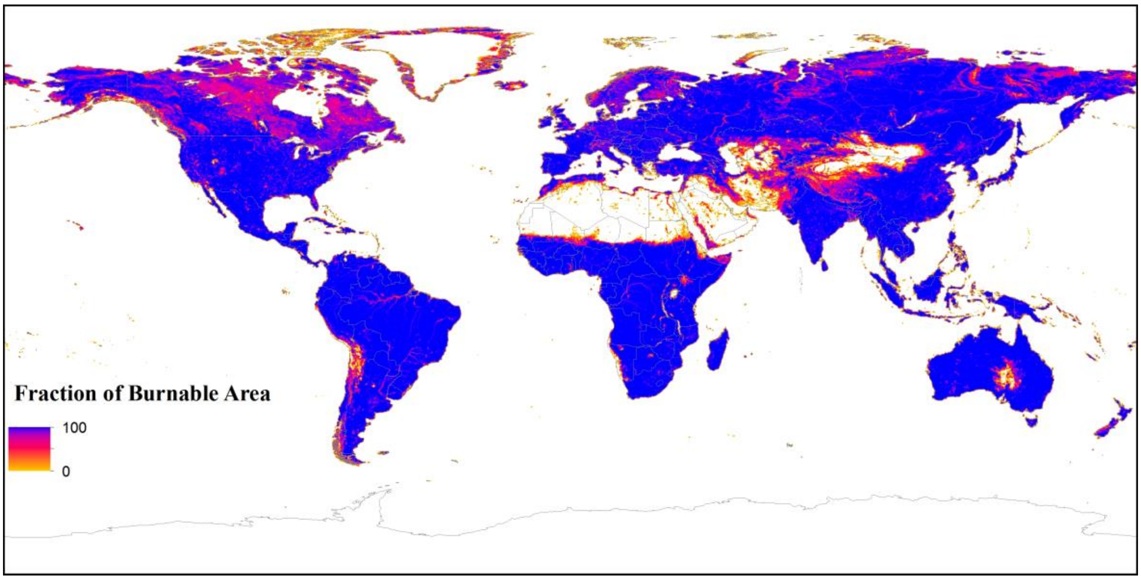


**Figure 3.4: Example of the Fraction of Burnable area in August 1982 (19820801-ESACCI-L4_FIRE-BA-AVHRR-LTDR-fv1.1.nc file).**

### 3.4.4. Attribute 4: Fraction of observed area

| | Attribute | Units | Data Type | Notes |
|---|---|---|---|---|
| 4 | Fraction of observed area | 0 to 100 | Float | Fraction of the total burnable area in the grid that was observed during the month (without cloud cover / haze or low quality pixels). |

The observed area fraction is included as a layer in the grid product with the particular aim of providing information on the incomplete observation of the Earth surface by the input sensor. This may be caused by a sensor failure, high solar zenith angles or by persistent cloud coverage.

**Recommendation on product use**: this is a very important attribute to consider, as it shows the proportion of each cell that was not observed in a particular monthly product and therefore it identifies the regions where the product may miss burned area. Grid cells with low fraction of observed area should be used with care.

An example of this layer corresponding to August 1982 is shown in Figure 3.5.

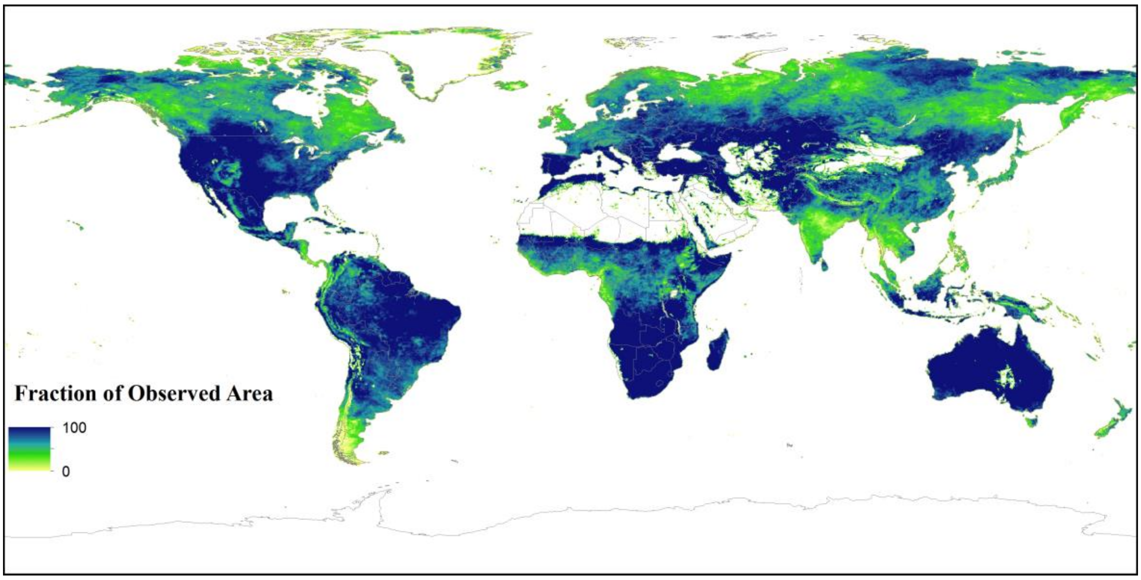


**Figure 3.5: Example of the Observed Area Fraction attribute in August 1982 (19820801-ESACCI-L4_FIRE-BA-AVHRR-LTDR-fv1.1.nc file).**

## 3.5. File formats

The product is delivered in raster format, on a regular geographical grid. The product format is NetCDF-CF (see http://www.unidata.ucar.edu/software/netcdf/docs for detailed information about this format).

## 3.6. Product file naming conventions

The files are named as follows:

**<Indicative_Date>-ESACCI-L4_FIRE-BA-<Indicative_sensor>-fv<xx.x>.nc**

**<Indicative_Date>**

The identifying date for this data set:

Format is YYYYMMDD, where YYYY is the four-digit year, MM is the two-digit month from 01 to 12 and DD is the two-digit day of the month from 01 to 31. For monthly files the day is set to 01.

**<Indicative_sensor>**

In this version of the product it is AVHRR-LTDR.

**fv<File_version>**

Version number of the Fire_cci BA algorithm. It is in the form n{1,}[.n{1,}] (That is 1 or more digits followed by optional "." and another 1 or more digits.). Current version is fv1.1.

<u>Example:</u>

19820801-ESACCI-L4_FIRE-BA-AVHRR-LTDR-fv1.1.nc

### 3.7. File metadata

The grid files follow the NetCDF Climate and Forecast (CF) Metadata Convention (http://cfconventions.org/). Annex 2 describes the fields included in the .nc files.

## 4. Product validation

The validation and comparison of the global long-term low-resolution product is a hard work but is needed to assess the accuracy of the product. The creation of Landsat dataset to validate according to protocols (Boschetti et al. 2006; Padilla et al. 2017; Padilla et al. 2015) or CEOS-LPVS (http://lpvs.gsfc.nasa.gov, accessed October 2020) is unrealistic since the human effort will be too high and the obtained images could be unavailable (Wulder et al. 2016). Thereby, a small but long-term Landsat dataset was created in the most affected fire regions. Moreover, the spatial and temporal consistency of the product was checked using available global BA products (but with a shorter time series), official perimeters (regional but long-term) and regional studies (literature). The validation and comparison results are detailed in the Algorithm Theoretical Basis Document ATBD (Otón and Chuvieco 2020).

## 5. Changes and improvements since last version

The FireCCILT11 product introduced several changes from the previous FireCCILT10 product. The most important are:

- The pixel product is now delivered as a standard product.
- The improvement of the BA detection algorithm has allowed to obtain a consistent product with coherent trends and more burned area compared to FireCCILT10 (see Otón and Chuvieco (2020) for more information).
    - FireCCI51 product is used for training in the algorithm instead of MCD64A1 because the former has more global and regional accuracy and detects more BA and small fires.
    - New No-Cloud Mask is generated to select free-cloud pixels.
    - Land Cover is annual instead an only using a single Land Cover in the time series.
    - Yearly profiles to train RF are regressive and progressive to contiguous years instead of months within a single year.
    - Some RF parameters have been modified to obtain more variability of data.
    - Two RF models (global and boreal) per month were run to keep regional variabilities.
    - Thresholding methods have been improved per month and region, adapting better to each image and correcting the solar angle.
    - BA proportions have been improved.
- The land cover information has been updated, and now uses ESA's CCI Land Cover v2.0.7 (CCI-LC, ESA 2017) product and Copernicus Climate Change Service (C3S) Global Land Cover (C3S-LC, Defourny et al. 2019) products v2.1.1
- One more year of data (2018) have been processed.

## 6. Known issues

The LTDR product (AVH09) has some problems in 1994 and also starting in 2019. In the year 1994 from day 1 to 71 the bands of the images have gaps but they are useful, from day 72 to 256 the bands of the images have gaps and they are useless, from day 257 to

365 there is no information inside the files (days 271, 272, 274 to 279 and 281 to 365 inclusive) or there is noise (days 257 to 270 inclusive, 273 and 280). Those problems are due to a satellite (NOAA-11) degradation (Otón et al. 2019; Riaño et al. 2007; Tucker et al. 2005) and lack of NOAA-13 (failed, Carmona-Moreno et al. 2005), replaced by NOAA-14 (Ignatov et al. 2004).

From 2018 onwards the data quality has been degrading for the satellite (NOAA-19), with important gaps in the images and noise, which makes the data unusable to obtain acceptable results (https://www.usgs.gov/centers/eros/science/usgs-eros-archive-advanced-very-high-resolution-radiometer-avhrr?qt-science_center_objects=0#qt-science_center_objects, last accessed on October 2020). Consequently, 1994, 2019 and 2020 were not used (Hansen et al. 2018; Tian et al. 2015) in the development of the FireCCILT11 product, and the time series ends in 2018, with a yearly gap in 1994.

## 7. Data dissemination

The LTDR Fire_cci BA products are available to the public through the Fire_cci website https://climate.esa.int/en/projects/fire/data/.

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## Annex 1: Metadata of the pixel product (XML file)

In each XML file corresponding to the pixel product, the following fields are populated:

- Universal Unique Identifier
- Language
- Contact
- Date stamp
- Metadata Standard Name
- Reference System
- Citation
  - Title
  - Creation date
  - Publication date
  - DOI
  - Abstract (contains information about each layer)
- Point of Contact
  - Resource provider
  - Distributor
  - Principal investigator
  - Processor
- Keywords
- Resource constraints
- Spatial resolution
- Extent:
  - Geographical extent
  - Temporal extent

## Annex 2: Metadata of the grid product (NetCDF file)

This is an example of the metadata of the file 19820801-ESACCI-L4_FIRE-BA-AVHRR-LTDR-fv1.1.nc, as extracted using Python's netCDF4 library:

<class 'netCDF4._netCDF4.Dataset'>
root group (NETCDF4 data model, file format HDF5):
    title: Fire_cci Gridded LTDR Burned Area product
    institution: University of Alcala
    source: LTDR AVH09 Surface Reflectance Product (Version 5), ESA CCI Land Cover dataset v2.0.7 and Copernicus Climate Change Service (C3S) Global Land Cover dataset v2.1.1
    history: Created on 2020-11-11 16:44:07
    references: See https://climate.esa.int/en/projects/fire/
    tracking_id: b3e445f4-a336-4fa4-8b62-585994adfc72
    Conventions: CF-1.6
    product_version: 1.1
    summary: The grid product is the result of summing up burned area within each cell of 0.25 degrees in a regular grid covering the whole Earth in monthly composites. The attributes stored are sum of burned area, standard error, fraction of burnable area and fraction of observed area.
    keywords: Burned Area, Fire Disturbance, Climate Change, ESA, GCOS
    id: 19820801-ESACCI-L4_FIRE-BA-AVHRR-LTDR-fv1.1.nc

naming_authority: int.esa.climate
doi: 10.5285/62866635ab074e07b93f17fbf87a2c1a
keywords_vocabulary: burned area, fire
cdm_data_type: Grid
comment: These data were produced as part of the ESA Fire_cci project.
date_created: 20201111T164407Z
creator_name: University of Alcala
creator_url: https://climate.esa.int/en/projects/fire/
creator_email: emilio.chuvieco@uah.es
project: Climate Change Initiative - European Space Agency
geospatial_lat_min: -90
geospatial_lat_max: 90
geospatial_lon_min: -180
geospatial_lon_max: 180
geospatial_vertical_min: 0
geospatial_vertical_max: 0
time_coverage_start: 19820801T000000Z
time_coverage_end: 19820831T235959Z
time_coverage_duration: P1M
time_coverage_resolution: P1M
standard_name_vocabulary: NetCDF Climate and Forecast (CF) Metadata Convention
license: ESA CCI Data Policy: free and open access
platform: NOAA-7, NOAA-9, NOAA-11, NOAA-14, NOAA-16, NOAA-18 and NOAA-19
sensor: AVHRR
spatial_resolution: 0.25 degrees
geospatial_lon_units: degrees_east
geospatial_lat_units: degrees_north
geospatial_lon_resolution: 0.25
geospatial_lat_resolution: 0.25
dimensions(sizes): lat(720), lon(1440), nv(2), strlen(150), time(1)
variables(dimensions): float32 lat(lat), float32 lat_bnds(lat, nv), float32 lon(lon), float32 lon_bnds(lon, nv), float64 time(time), float32 time_bnds(time, nv), float32 burned_area(time, lat, lon), float32 standard_error(time, lat, lon), float32 fraction_of_burnable_area(time, lat, lon), float32 fraction_of_observed_area(time, lat, lon)
groups:
OrderedDict([('lat', <class 'netCDF4._netCDF4.Variable'>
float32 lat(lat)
units: degree_north
standard_name: latitude
long_name: latitude
bounds: lat_bnds
unlimited dimensions:
current shape = (720,)
filling on, default _FillValue of 9.969209968386869e+36 used), ('lat_bnds', <class 'netCDF4._netCDF4.Variable'>
float32 lat_bnds(lat, nv)
unlimited dimensions:
current shape = (720, 2)
filling on, default _FillValue of 9.969209968386869e+36 used), ('lon', <class 'netCDF4._netCDF4.Variable'>
float32 lon(lon)
units: degree_east
standard_name: longitude
long_name: longitude
bounds: lon_bnds
unlimited dimensions:
current shape = (1440,)
filling on, default _FillValue of 9.969209968386869e+36 used), ('lon_bnds', <class 'netCDF4._netCDF4.Variable'>
float32 lon_bnds(lon, nv)
unlimited dimensions:

current shape = (1440, 2)
filling on, default _FillValue of 9.969209968386869e+36 used), ('time', <class 'netCDF4._netCDF4.Variable'>
float64 time(time)
    units: days since 1970-01-01 00:00:00
    standard_name: time
    long_name: time
    bounds: time_bnds
    calendar: standard
unlimited dimensions: time
current shape = (1,)
filling on, default _FillValue of 9.969209968386869e+36 used), ('time_bnds', <class 'netCDF4._netCDF4.Variable'>
float32 time_bnds(time, nv)
unlimited dimensions: time
current shape = (1, 2)
filling on, default _FillValue of 9.969209968386869e+36 used), ('burned_area', <class 'netCDF4._netCDF4.Variable'>
float32 burned_area(time, lat, lon)
    units: m2
    standard_name: burned_area
    long_name: total burned_area
    cell_methods: time: sum
unlimited dimensions: time
current shape = (1, 720, 1440)
filling on, default _FillValue of 9.969209968386869e+36 used), ('standard_error', <class 'netCDF4._netCDF4.Variable'>
float32 standard_error(time, lat, lon)
    units: m2
    long_name: standard error of the estimation of burned area
unlimited dimensions: time
current shape = (1, 720, 1440)
filling on, default _FillValue of 9.969209968386869e+36 used), ('fraction_of_burnable_area', <class 'netCDF4._netCDF4.Variable'>
float32 fraction_of_burnable_area(time, lat, lon)
    units: 1
    long_name: fraction of burnable area
    comment: The fraction of burnable area is the fraction of the cell that corresponds to vegetated land covers that could burn. The land cover classes are those from CCI Land Cover (https://climate.esa.int/en/projects/land-cover/), and their extension to the C3S Land cover (https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover?tab=overview)
unlimited dimensions: time
current shape = (1, 720, 1440)
filling on, default _FillValue of 9.969209968386869e+36 used), ('fraction_of_observed_area', <class 'netCDF4._netCDF4.Variable'>
float32 fraction_of_observed_area(time, lat, lon)
    units: 1
    long_name: fraction of observed area
    comment: The fraction of observed area is the fraction of the total burnable area in the cell (fraction_of_burnable_area variable of this file) that was observed during the time interval, and was not marked as unsuitable/not observable. The latter refers to the area where it was not possible to obtain observational burned area information for the whole time interval because of lack of input data (non-existing images for that location and period), cloud cover or sensor failure.
unlimited dimensions: time
current shape = (1, 720, 1440)
filling on, default _FillValue of 9.969209968386869e+36 used)])

# Annex 3: Acronyms and abbreviations

| | |
|---|---|
| ATBD | Algorithm Theoretical Basis Document |
| AVHRR | Advanced Very High Resolution Radiometer |
| BA | Burned Area |
| BRDF | Bidirectional reflectance distribution function |
| C3S | Copernicus Climate Change Service |
| C3S-LC | C3S Global Land Cover project |
| CCI | Climate Change Initiative |
| CEOS | Committee on Earth Observation Satellites |
| CRS | Coordinate Reference System |
| CF | Climate and Forecast Metadata Convention |
| CL | Confidence Level |
| ECV | Essential Climate Variables |
| ESA | European Space Agency |
| FireCCI51 | MODIS Fire_cci burned area product, version 5.1 |
| FireCCILT10 | LTDR Fire_cci burned area product, version 1.0 |
| FireCCILT11 | LTDR Fire_cci burned area product, version 1.1 |

| | |
|---|---|
| fv | File version |
| GCS | Geographic Coordinate System |
| JD | Julian Day |
| LC | Land Cover |
| LC_cci | CCI Land Cover project |
| LPVS | Land Product Validation Subgroup |
| LTDR | Land Long-Term Data Record |
| LWIR | Long-wave infrared |
| MCD64A1 | MODIS Burned Area product |
| MODIS | Moderate Resolution Imaging Spectrometer |
| MWIR | Mid-wave infrared |
| NIR | Near Infrared |
| NOAA | National Oceanic and Atmospheric Administration |
| OB | Number of observations |
| pb | Per pixel uncertainty |
| PUG | Product User Guide |
| RF | Random Forest |
| TOA | Top of Atmosphere |
| WGS84 | World Geodetic System 1984 |