ESA Climate Change Initiative – Fire_cci
D4.2.5 Product User Guide – Sentinel-3 SYN (PUG)

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Summary

This document is the version 1.1 of the deliverable 4.2.5, corresponding to the Product User Guide for the Sentinel-3 Synergy (SYN) Fire_cci v1.1 product (FireCCIS311). It provides practical information about the use of the Fire_cci global burned area products based on the Sentinel-3 SYN dataset, which is currently available for the period 2019-2022.

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1. General overview

The ESA CCI Programme comprises the generation and provision of Essential Climate Variables (ECV) on 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 Sentinel-3 SYN Fire_cci BA v1.1 products (FireCCIS311), which are based on the Synergy dataset developed from the OLCI and SLSTR sensors onboard the Sentinel-3 satellites. This product version replaces the previous v1.0, which was processed only for 2019.

1.1. Introduction

The S3 SYN Fire_cci version 1.1 products (FireCCIS311) 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. These products currently cover the period 2019 to 2022.

The Fire_cci project produces two burned area products available at different spatial resolutions, the PIXEL product and the GRID product, both derived from the original algorithm pixel outputs.

1.2. Input data and BA algorithm

Two main inputs are used by the algorithm for this BA Fire_cci product. The first is the Level-2 Synergy surface reflectance (SY_2_SYN, https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-3-synergy/level-2/syn-level-2-product, accessed on October 2023), based on data obtained from the OLCI and SLSTR sensors onboard the Sentinel-3 satellites. From this product, bands SDR-S5N and SRD_S6N, corresponding to the short and long SWIR, were used. The second input is the VIIRS active fire information provided by the VNP14IMGML product (Schroeder and Giglio 2018). As auxiliary variable, land cover information from the Copernicus Climate Change Service (C3S) Land Cover (LC) product version 2.1.1 (https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover, accessed on October 2023) was used as a burnable mask, and to provide information of the burned vegetation. The description of the algorithm can be found in the Algorithm Theoretical Basis Document (Lizundia-Loiola et al., 2022b) and in Lizundia-Loiola et al. (2022a).

2. Pixel BA product

The pixel BA product is a GeoTIFF file with three layers indicating the date of detection (Figure 1), the confidence level and the land cover in the pixel detected as burned (see Section 2.4 for further detail).

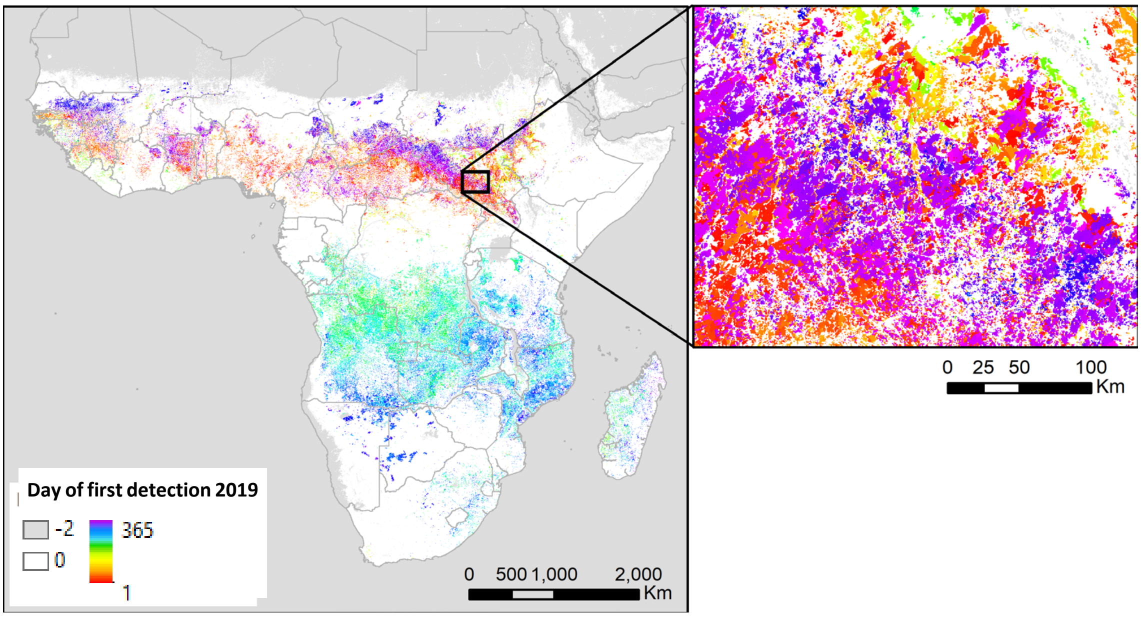

Figure 1: Day of detection for Area 5 (Sub-Saharan Africa) for the year 2020, derived from the pixel product. See Figure 5 for the geographic distribution of subsets.

2.1. Temporal compositing

The pixel products are released as monthly composites such that those pixels that burn more than once during a calendar year can be encompassed. This may occur in the Northern Tropical areas, where the dry season commonly occurs between December and February.

2.2. Spatial Resolution

The Spatial resolution of this BA product is 0.002777778 degrees (approximately 300 m at the Equator), which is the resolution of the SYN bands.

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: Date of the first detection

Layer	Attribute	Units	Data Type	Notes
1	Date of the first detection (JD)	Day of the year, from 1 to 365 (or 366)	Integer	Possible values: • 0 (zero): when the pixel is not burned. • 1 to 366: day of the first detection when the pixel is burned. • -1: when the pixel is not observed in the month. • -2: used for pixels that are not burnable: water bodies, bare areas, urban areas, permanent snow and ice.

This layer corresponds to the day in which the fire was first detected, also commonly called Julian Day. When the pixel is characterized as burned, it is assumed that the complete pixel was burned, as for all burned area products.

The date of the burned pixel may not be coincident with the actual burning date, 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 several days after the fire is over.

An example of this layer corresponding to December 2020 for Area 5 is shown in Figure 2.

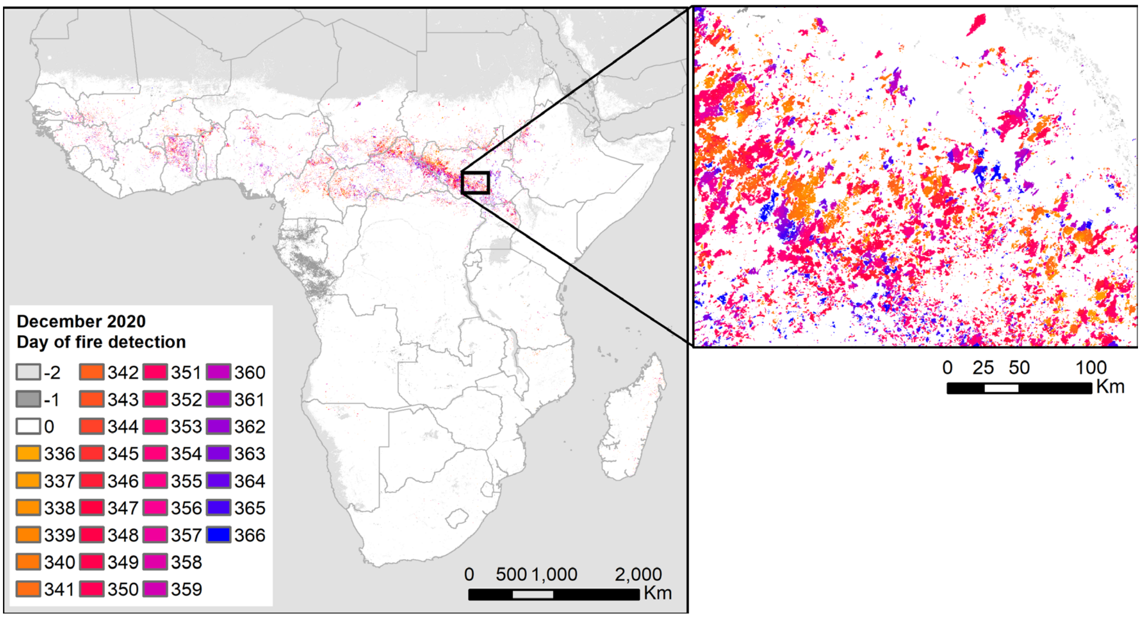

Figure 2: Example of the date of the first detection layer for Africa December 2020 (20201201-ESACCI-L3S_FIRE-BA-SYN-AREA_5-fv1.1-JD.tif file).

2.4.2. Layer 2: Confidence level

Layer	Attribute	Units	Data Type	Notes
2	Confidence level (CL)	0 to 100	Byte	Probability of detecting a pixel as burned. Possible values: - 0 (zero): when the pixel is not observed in the month, or it is not burnable (not vegetated). - 1 to 100: Probability values. The closer to 100, the higher the 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.

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. 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. It does 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 December 2020 for Area 5 is shown in Figure 3. All pixels with a burnable land cover include a confidence level, both if they are classified as burned or as not burned.

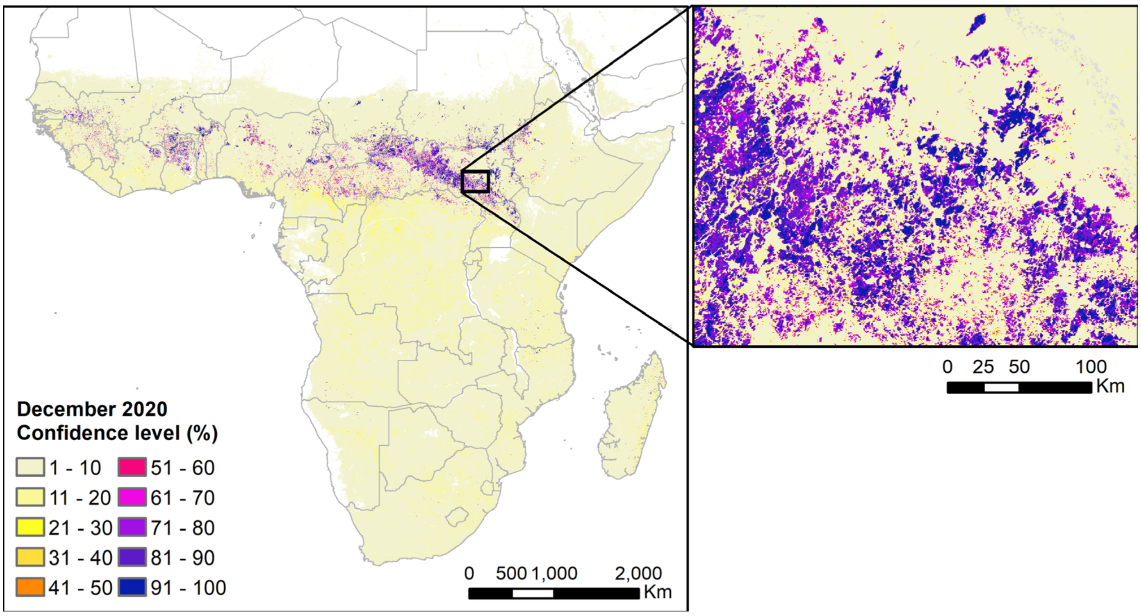

Figure 3: Example of the Confidence Level layer for Africa December 2020 (20201201-ESACCI-L3S_FIRE-BA-SYN-AREA_5-fv1.1-CL.tif file). Values: 0: not observed or not burnable, 1 to 100: confidence level.

2.4.3. Layer 3: Land cover of burned pixels

Layer	Attribute	Units	Data Type	Notes
3	Land cover of burned pixels (LC)	0 to N	Byte	Possible values: • 0 (zero): when the pixel is not burned in the month, either because it was observed and not classified as burned, or because it is non burnable or was not observed. • 10 to 180: land cover code when the pixel is burned (codes listed in Annex 1). Land cover of the pixel detected as burned, extracted from the C3S Land Cover maps (see Section 2.8).

It is assumed that there is only one land cover within the pixel, as in most land cover maps. This is a reasonable estimation for homogenous land cover areas, but it may imply errors for heterogeneous landscapes. The basic land cover map is the C3S Land Cover map (see Section 2.8). Errors included in this map will also affect the information contained in the BA product and hence the calculation of emissions using land-cover-based emissions factors would be affected. The resolution of the land cover and BA products is the same (approx. 300 m at the Equator).

An example of this layer corresponding to December 2020 for Area 5 is shown in Figure 4.

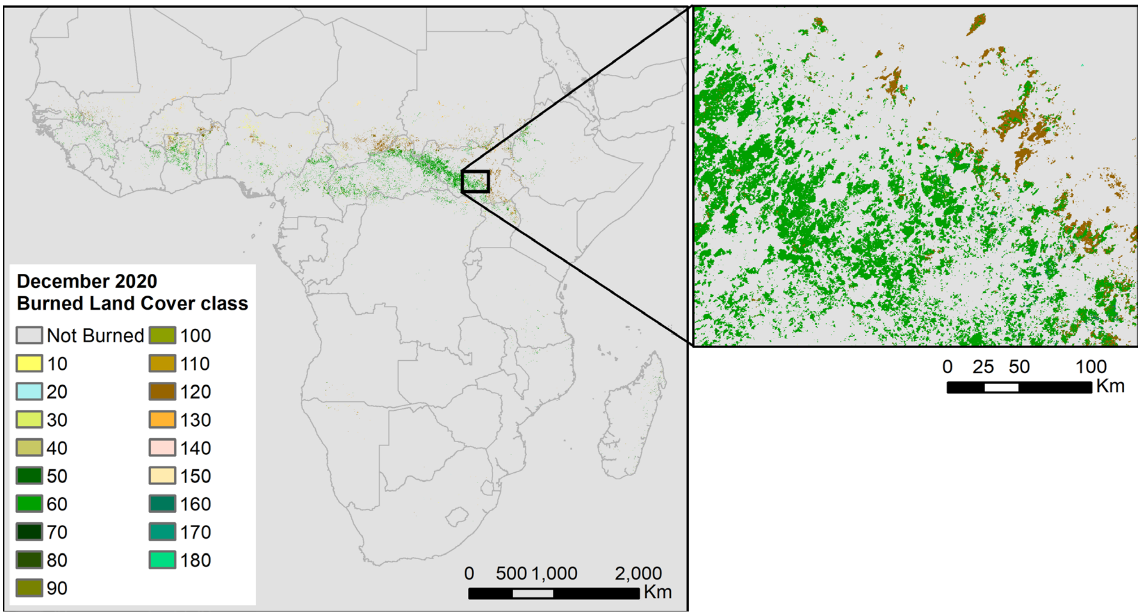

Figure 4: Example of the Land Cover of burned pixels layer for Africa December 2020 (20201201-ESACCI-L3S_FIRE-BA-SYN-AREA_5-fv1.1-LC.tif file). The description of the land cover categories is in Annex 1. Main classes in the zoomed map: 60: Tree cover, broadleaved, deciduous, closed to open (>15%), 120: Shrubland.

2.5. File formats

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

2.6. Geographical subsets

The BA product is distributed in continental tiles. All subsets are non-overlapping regions. They cover mostly continental tiles, excluding areas that do not burn or are very small and surrounded by large proportions of water. Figure 5 shows the extent of these tiles, which are referenced in Table 1.

Table 1: Geographical distribution of BA tiles for the pixel product

Areas	Name	Upper left		Lower right	
1	North America	180°W	83°N	26°W	19°N
2	South America	105°W	19°N	34°W	57°S
3	Europe –North Africa	26°W	83°N	53°E	25°N
4	Asia	53°E	83°N	180°E	0°N
5	Sub-Saharan Africa	26°W	25°N	53°E	40°S
6	Australia & New Zealand	95°E	0°N	180°E	53°S

Coordinates correspond to the centres of the border pixels.

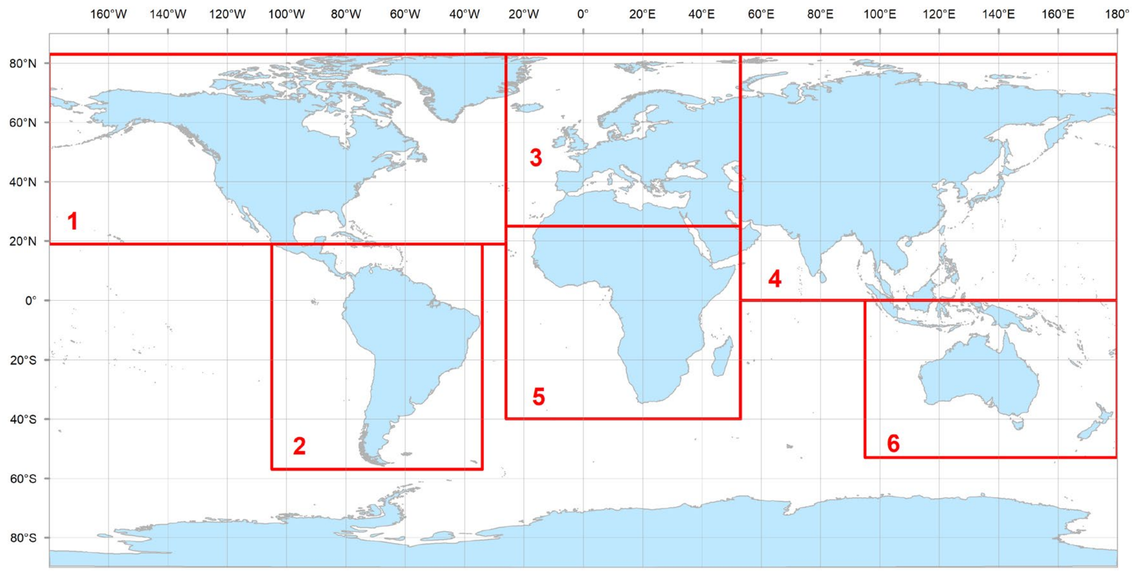

Figure 5: Geographical distribution of subsets for the global pixel BA product

2.7. Product file naming conventions

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

<Indicative_Date>-ESACCI-L3S_FIRE-BA-<Indicative_sensor>-<Additional_Segregator>-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 SYN.

<Additional_Segregator>

This is AREA_<TILE_NUMBER> being the tile number the subset index described in 2.6. (see Table 1 for more information).

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.
- LC: layer 3, corresponding to the land cover.

Example:

20201201-ESACCI-L3S_FIRE-BA-SYN-AREA_5-fv1.1-JD.tif

20201201-ESACCI-L3S_FIRE-BA-SYN-AREA_5-fv1.1.xml

2.8. Land Cover information

The land cover information was selected to provide information about the pre-fire land cover category, and for this reason the reference land cover used is the closest available product prior to the year being processed. The land cover assigned to the pixel detected as burned was extracted from the Copernicus Climate Change Service (C3S) land cover (LC) product (https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover, accessed on October 2023).

For the FireCCIS311 products, C3S Land Cover v2.1.1 has been used. This product offers annual land cover files that cover the period 2016-2021, and it is the continuation of the CCI Land Cover product v2.0.7 corresponding to 1992 – 2015. For each processed year, previous year information was used. The land cover categories included in the BA product are listed in Annex 1.

2.9. 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 2.

3. Grid BA product

The grid product is the result of adding the area of the burned area pixels 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 the NetCDF file: standard error of the estimations, fraction of burnable area, fraction of observed area, and the burned area for 18 land cover classes of C3S Land Cover. Figure 6 shows the total BA from this product for 2020.

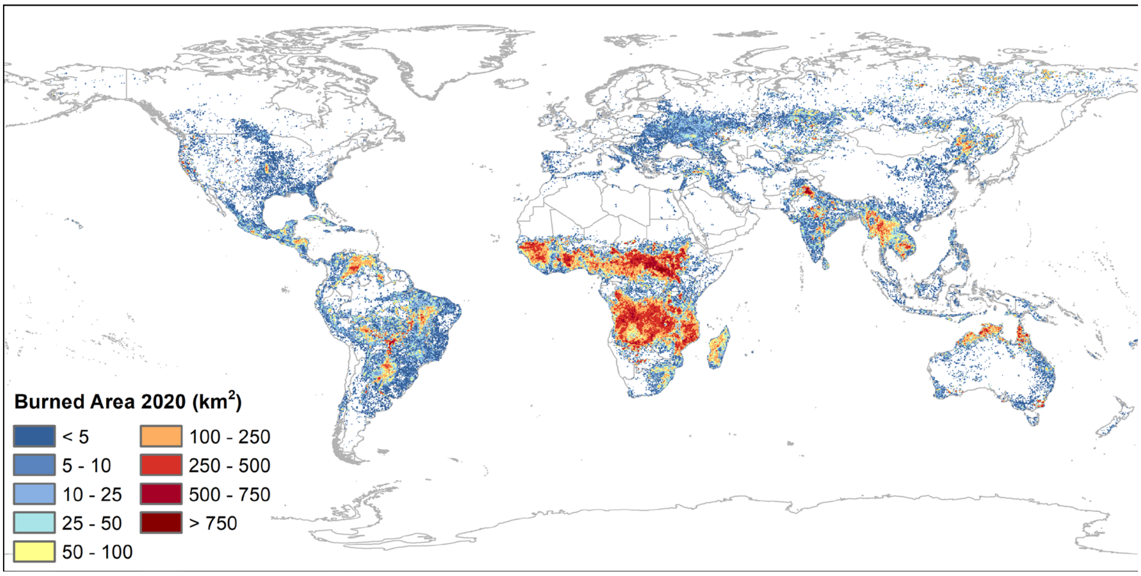

Figure 6: Total burned area for the year 2020.

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	burned_area	Square metres	Float	Sum of area of all pixels detected as burned within each grid cell and period.

In common with other global BA products, it is assumed that a pixel at the native spatial resolution of the input surface reflectance product (300 m) was totally burned. Further description on the methodology to obtain the burned area from the BA detections is included in the Algorithm Theoretical Basis Document (Lizundia-Loiola et al., 2022b) and in Lizundia-Loiola et al. (2022a).

An example of this layer corresponding to August 2020 is shown in Figure 7.

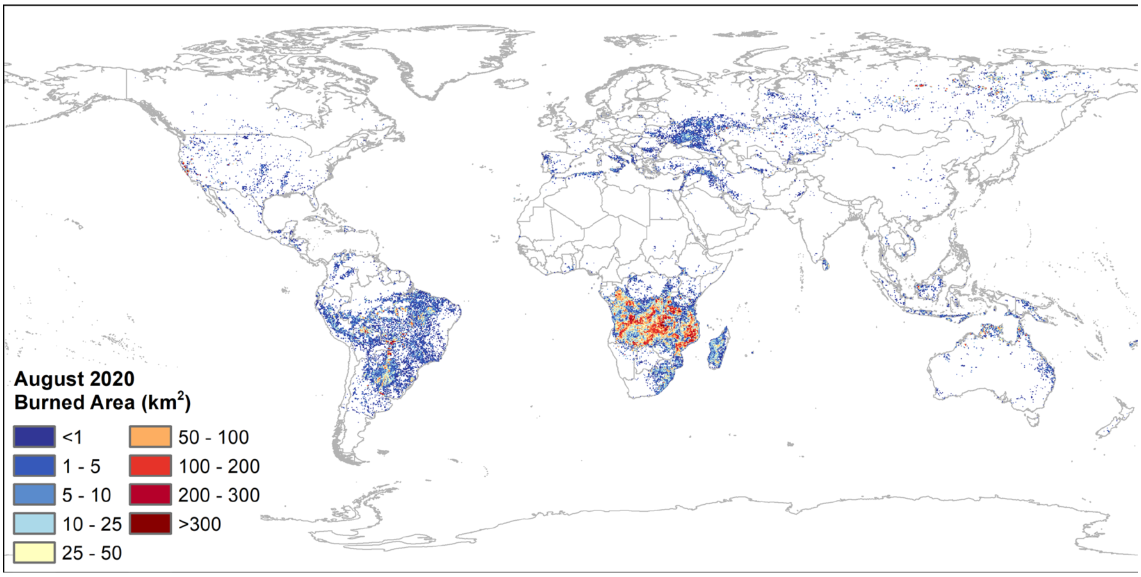

Figure 7: Example of the Burned Area attribute of the 20200801-ESACCI-L4_FIRE-BA-SYN-fv1.1.nc file

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, based on the aggregation of the confidence level of the pixel product.

The standard error is modelled from the confidence level (p_b) of the pixel product. The rationale of the calculation is the following: the aggregation of the burned pixels into the grid cells implies adding up the area of each pixel. But that does not take into account that some pixels appear very clearly burned (high p_b), whereas others have lower p_b values. Some pixels have intermediate values which, in case a certain p_b threshold was used to determine a pixel being burned or not, could imply its belonging to either class if only e.g. the noise in the observations was marginally different, so the sum of burned pixels would be variable if only the input data had slightly different noise added to it. Clearly, if all pixels are either burned or unburned with very strong evidence (p_b equal to 1 or 0, respectively), then small changes in the data would not really change the aggregation, but if there are a lot of "not sure pixels" (where the data is insufficient to make a very clear distinction), this could have a major impact.

This spread of possible values is what is quantified by the uncertainty. If BAr was defined as a random variable of the number of burned pixels within a grid cell, and for simplicity it could be assumed that BAr is normal with a mean and standard deviation, an epistemic view on probability suggests that the distribution of BAr describes the strength of belief in the value of BAr lying in a particular "bin". So the belief would be maximum at the mean of the distribution of BAr, but will be very weak say 3 standard deviations away from the mean. So in this case, the standard deviation of the distribution gives a way to calculate the interval where the true mean might be based on the observed data and choice of algorithm. Note that in this case the standard deviation is saying nothing about how precisely the mean can be estimated, as the information is really contained in the shape of the distribution. Uncertainty in the case described earlier informs the user about the sensitivity of the data to the observed fire phenomenon, the ability of the algorithm and the quality of the observations that have been used to label pixels (Lewis et al. 2017).

Since the Attribute 1 was calculated as the sum of the individual burned pixel areas and not directly as BAr, the p_b was rescaled so that the mean was made equal to the sum of burned area of Attribute 1. More information about the method for the uncertainty characterization can be found in Khaïroun et al. (2022).

An example of this layer corresponding to August 2020 is shown in Figure 8.

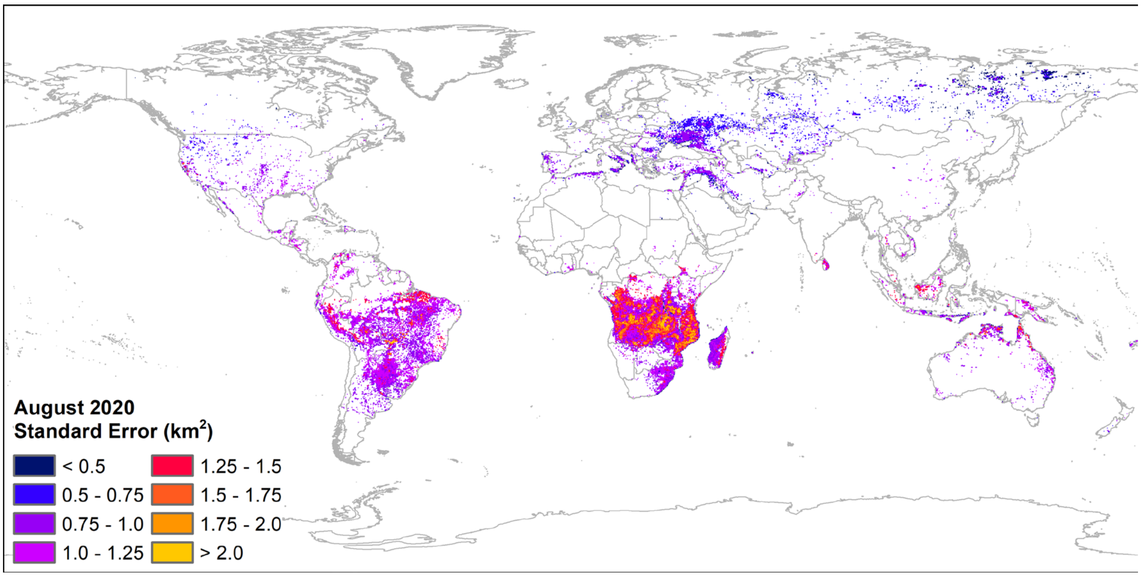

Figure 8: Example of the Standard Error attribute of the 20200801-ESACCI-L4_FIRE-BA-SYN-fv1.1.nc file

3.4.3. Attribute 3: Fraction of burnable area

	Attribute	Units	Data Type	Notes
3	Fraction of burnable area	0 to 1	Float	Fraction of area in the grid that corresponds to land covers that could be affected by fire.

The fraction of burnable area 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 C3S Land Cover product (see section 2.8).

An example of this layer corresponding to August 2020 is shown in Figure 9. This layer does not change monthly, but only when a new land cover year is considered (see section 2.8).

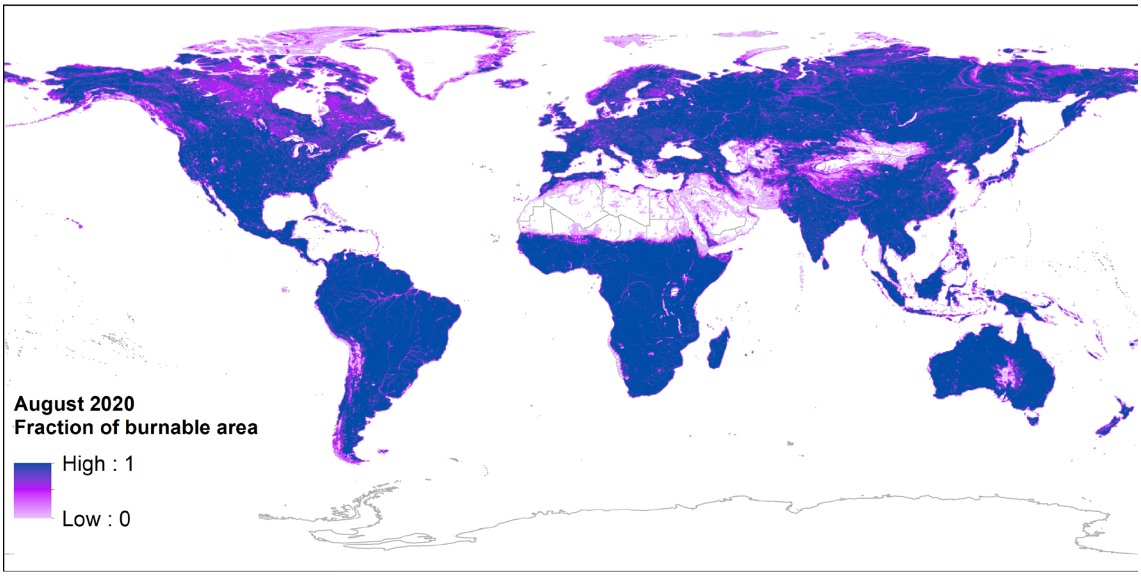

Figure 9: Example of the Fraction of Burnable Area attribute of the 20200801-ESACCI-L4_FIRE-BA-SYN-fv1.1.nc file

3.4.4. Attribute 4: Fraction of observed area

	Attribute	Units	Data Type	Notes
4	Fraction of observed area	0 to 1	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 fraction of observed area 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 or by persistent cloud coverage. An example of this layer corresponding to August 2020 is shown in Figure 10.

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 month and therefore it identifies the regions where the product may miss burned pixels. All grid cells with fraction of observed area lower than 80% should be used with care.

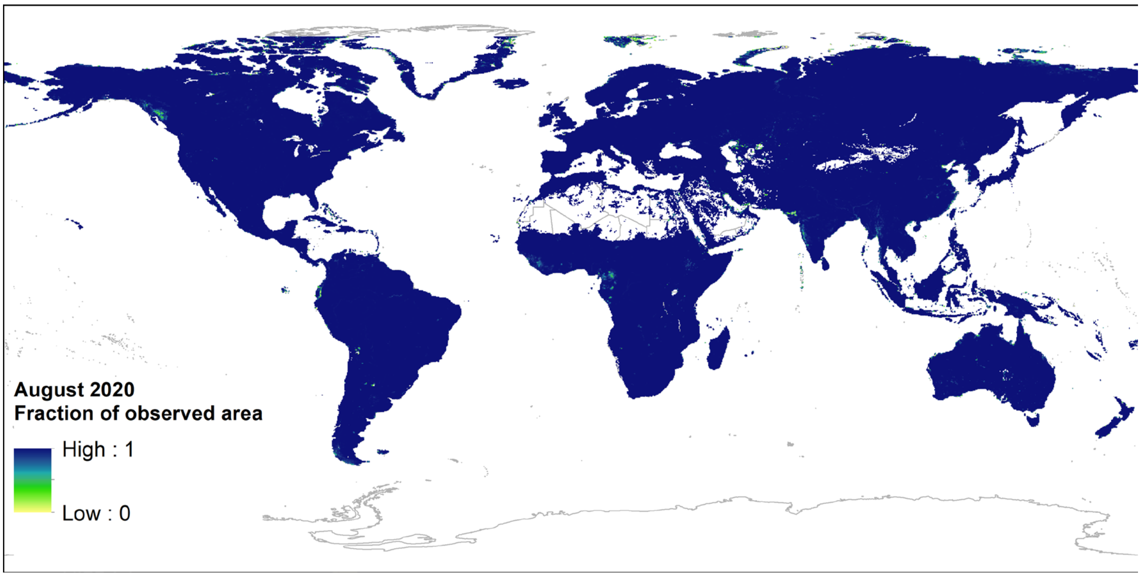

Figure 10: Example of the Fraction of Observed Area attribute of the 20200801-ESACCI-L4_FIRE-BA-SYN-fv1.1.nc file

3.4.5. Attributes 5-22: Sum of burned area for each land cover category

	Attribute	Units	Data Type	Notes
6 to 23	burned_area_in_vegetation_class*	Square metres	Float	Sum of all burned pixels of each land cover as defined by the C3S Land Cover map.

*The vegetation_class categories are those described in Annex 1.

As in the case of the pixel product, it is assumed that each burned pixel that adds to the total burned area in a grid cell corresponds to only one land cover, as in most land cover maps. This is a reasonable estimation for homogenous land cover areas, but it may imply errors for heterogeneous landscapes. The basic land cover map is the C3S Land Cover (see Section 2.8). Obviously, the errors of this map affect the estimation provided by the FireCCIS311 product.

It is assumed that the land cover source has accurately described the land cover type and is spatially consistent. We aim to provide readily available information for users on the type of vegetation that has burned. This information could be used, for example, with the vegetation type dependent fuel load data for calculation of the carbon emissions and other trace gas emissions due to fires, or could be used to apply vegetation type relevant combustion completeness and emission factor information in climate modelling research.

Two examples of these types of layers corresponding to August 2020 are shown in the following figures. Figure 11 shows the sum of the burned area of croplands (LC class 10), while Figure 12 shows the sum of BA in broadleaf deciduous trees (LC class 60) for the same period.

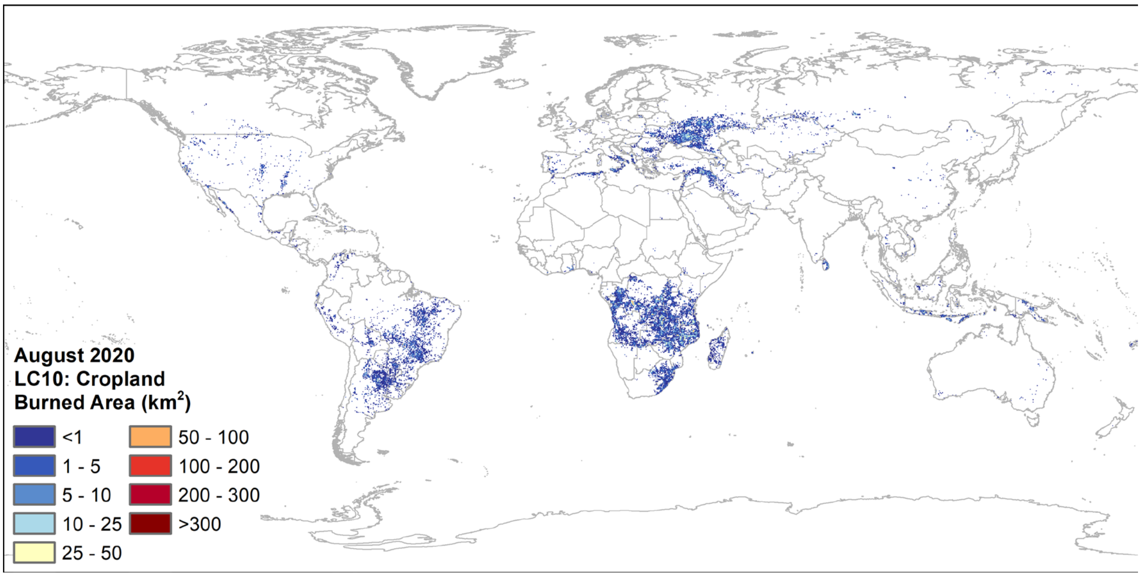

Figure 11: Example of the Burned Area in Vegetation Class attribute, for land cover class 10, corresponding to croplands, of the 20200801-ESACCI-L4_FIRE-BA-SYN-fv1.1.nc file

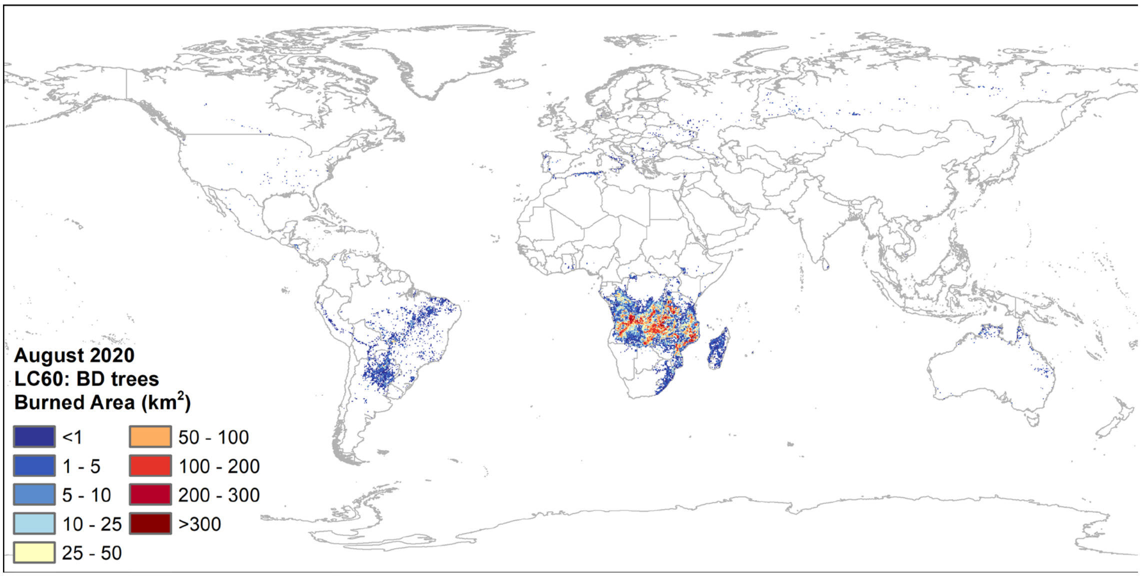

Figure 12: Example of the Burned Area in Vegetation Class attribute, for land cover class 60, corresponding to broadleaf deciduous tree cover, of the 20200801-ESACCI-L4_FIRE-BA-SYN-fv1.1.nc file

3.5. File format

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, accessed on October 2023, for detailed information about this format).

3.6. Product file naming conventions

The grid files are named as following:

<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 SYN.

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.

Example:

20200801-ESACCI-L4_FIRE-BA-SYN-fv1.1.nc

3.7. File metadata

The grid files follow the NetCDF Climate and Forecast (CF) Metadata Convention (http://cfconventions.org/, accessed on October 2023). Annex 3 describes the fields included in the .nc files.

4. Product validation

The final products generated in the FireCCI project have been validated at global scale using a probability sampling design that takes into account both the spatial and temporal dimension, using multi-temporal pairs of Landsat TM-ETM-OLI images. The validation results are detailed in the Product Validation and Intercomparison Report (Stroppiana et al. 2022).

5. Changes and improvements since last version

The FireCCIS311 product solves an issue found in the FireCCIS310 version. An error in the previous algorithm caused some pixels to appear as burned in a month but with a date corresponding to two months later, due to the way the compositing of the algorithm works (see Lizundia-Loiola 2022a). The area affected was quite low, accounting to about 125 km^2 in total globally. These pixels were removed from the final product because they had a low likelihood of being actually burned, as they should have appeared as burned again in the processing of the next 3 months at least once if they would have had a good burned signal.

6. Data dissemination

The FireCCIS311 products are available to the public through the ESA Climate Office https://climate.esa.int/en/projects/fire/about/ (accessed on October 2023), and its Open Data Portal: https://climate.esa.int/en/odp/#/dashboard (accessed on October 2023).

7. References

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Annex 1: Land cover categories

LC number		Class name	Fire_cci number
1st level	**2nd level**		
0		No data	**0**
10		Cropland, rainfed	**10**
	11	*Herbaceous cover*	***10***
	12	*Tree or shrub cover*	***10***
20		Cropland, irrigated or post-flooding	**20**
30		Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)	**30**
40		Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)	**40**
50		Tree cover, broadleaved, evergreen, closed to open (>15%)	**50**
60		Tree cover, broadleaved, deciduous, closed to open (>15%)	**60**
	61	*Tree cover, broadleaved, deciduous, closed (>40%)*	**60**
	62	*Tree cover, broadleaved, deciduous, open (15-40%)*	**60**
70		Tree cover, needleleaved, evergreen, closed to open (>15%)	**70**
	71	*Tree cover, needleleaved, evergreen, closed (>40%)*	***70***
	72	*Tree cover, needleleaved, evergreen, open (15-40%)*	***70***
80		Tree cover, needleleaved, deciduous, closed to open (>15%)	**80**
	81	*Tree cover, needleleaved, deciduous, closed (>40%)*	***80***
	82	*Tree cover, needleleaved, deciduous, open (15-40%)*	***80***
90		Tree cover, mixed leaf type (broadleaved and needleleaved)	**90**
100		Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	**100**
110		Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	**110**
120		Shrubland	**120**
	121	*Shrubland evergreen*	***120***
	122	*Shrubland deciduous*	***120***
130		Grassland	**130**
140		Lichens and mosses	**140**
150		Sparse vegetation (tree, shrub, herbaceous cover) (<15%)	**150**
	152	*Sparse shrub (<15%)*	***150***
	153	*Sparse herbaceous cover (<15%)*	***150***
160		Tree cover, flooded, fresh or brackish water	**160**
170		Tree cover, flooded, saline water	**170**
180		Shrub or herbaceous cover, flooded, fresh/saline/brackish water	**180**

Note: Only the level 1 classes are considered, so the subdivisions have the number of broader categories. Only vegetated LC classes have been considered.

Annex 2: 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 3: Metadata of the grid product

This is an example of the metadata of the file 20200801-ESACCI-L4_FIRE-BA-SYN-fv1.1.nc, as extracted using Python's netCDF4 library.

```
<class 'netCDF4._netCDF4.Dataset'>
root group (NETCDF4_CLASSIC data model, file format HDF5):
    title: Sentinel-3 SYN Burned Area Grid product, version 1.1
    institution: University of Alcala
    source: Sentinel-3 Synergy (SYN) product, derived from OLCI+SLSTR Surface Reflectance, VIIRS VNP14IMGML thermal anomalies, C3S Land Cover dataset v2.1.1
    history: Created on 2023-03-22 18:04:32
    references: See https://climate.esa.int/en/projects/fire/
    tracking_id: 168a8561-cb00-4a6a-8476-b42a1ea71447
    Conventions: CF-1.7
    product_version: v1.1
    format_version: CCI Data Standards v2.3
    summary: The grid product is the result of summing burned area pixels and their attributes within each cell of 0.25x0.25 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, fraction of observed area, and the burned area for 18 land cover classes of C3S Land Cover.
    keywords: Burned Area, Fire Disturbance, Climate Change, ESA, GCOS
    id: 20200801-ESACCI-L4_FIRE-BA-SYN-fv1.1.nc
    naming_authority: int.esa.climate
    doi: 10.5285/da8e669a74334c82a56e0b470bc4ef04
    keywords_vocabulary: none
    cdm_data_type: Grid
```

comment: These data were produced as part of the Climate Change Initiative Programme, Fire Disturbance ECV.
date_created: 20230322T180432Z
creator_name: University of Alcala
creator_url: https://geogra.uah.es/gita/en/
creator_email: emilio.chuvieco@uah.es
contact: mlucrecia.pettinari@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: 20200801T000000Z
time_coverage_end: 20200831T235959Z
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: Sentinel-3A, Sentinel-3B
sensor: OLCI, SLSTR
spatial_resolution: 0.25 degrees
key_variables: burned_area
geospatial_lon_units: degrees_east
geospatial_lat_units: degrees_north
geospatial_lon_resolution: 0.25
geospatial_lat_resolution: 0.25
dimensions(sizes): vegetation_class(18), lat(720), lon(1440), bounds(2), strlen(150), time(1)
variables(dimensions): float64 lat(lat), float64 lat_bounds(lat, bounds), float64 lon(lon), float64 lon_bounds(lon, bounds), float64 time(time), float32 time_bounds(time, bounds), int32 vegetation_class(vegetation_class), |S1 vegetation_class_name(vegetation_class, strlen), 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), float32 burned_area_in_vegetation_class(time, vegetation_class, lat, lon), int32 crs()
groups:
OrderedDict([('lat', <class 'netCDF4._netCDF4.Variable'>
float64 lat(lat)
units: degree_north
standard_name: latitude
long_name: latitude
bounds: lat_bounds
unlimited dimensions:
current shape = (720,)
filling on, default _FillValue of 9.969209968386869e+36 used), ('lat_bounds', <class 'netCDF4._netCDF4.Variable'>
float64 lat_bounds(lat, bounds)
unlimited dimensions:
current shape = (720, 2)
filling on, default _FillValue of 9.969209968386869e+36 used), ('lon', <class 'netCDF4._netCDF4.Variable'>
float64 lon(lon)
units: degree_east
standard_name: longitude
long_name: longitude
bounds: lon_bounds
unlimited dimensions:
current shape = (1440,)
filling on, default _FillValue of 9.969209968386869e+36 used), ('lon_bounds', <class 'netCDF4._netCDF4.Variable'>
float64 lon_bounds(lon, bounds)

```
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_bounds
    calendar: standard
unlimited dimensions: time
current shape = (1,)
filling on, default _FillValue of 9.969209968386869e+36 used), ('time_bounds', <class
'netCDF4._netCDF4.Variable'>
float32 time_bounds(time, bounds)
unlimited dimensions: time
current shape = (1, 2)
filling on, default _FillValue of 9.969209968386869e+36 used), ('vegetation_class', <class
'netCDF4._netCDF4.Variable'>
int32 vegetation_class(vegetation_class)
    units: 1
    long_name: vegetation class number
unlimited dimensions:
current shape = (18,)
filling on, default _FillValue of -2147483647 used), ('vegetation_class_name', <class
'netCDF4._netCDF4.Variable'>
|S1 vegetation_class_name(vegetation_class, strlen)
    units: 1
    long_name: vegetation class name
unlimited dimensions:
current shape = (18, 150)
filling on, default _FillValue of   used), ('burned_area', <class 'netCDF4._netCDF4.Variable'>
float32 burned_area(time, lat, lon)
    units: m2
    standard_name: burned_area
    long_name: total burned_area
    valid_range: [0.000000e+00 7.693146e+08]
    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
    valid_range: [0.000000e+00 7.693146e+08]
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 C3S Land Cover,
https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover?tab=overview
    valid_range: [0. 1.]
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 the lack of input data (non-existing data for that location and period).
    valid_range: [0. 1.]
unlimited dimensions: time
current shape = (1, 720, 1440)
filling on, default _FillValue of 9.969209968386869e+36 used), ('burned_area_in_vegetation_class', <class 'netCDF4._netCDF4.Variable'>
float32 burned_area_in_vegetation_class(time, vegetation_class, lat, lon)
    units: m2
    long_name: burned area in vegetation class
    cell_methods: time: sum
    comment: Burned area by land cover classes; land cover classes are from C3S Land Cover, https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-land-cover?tab=overview
    valid_range: [0.000000e+00 7.693146e+08]
unlimited dimensions: time
current shape = (1, 18, 720, 1440)
filling on, default _FillValue of 9.969209968386869e+36 used), ('crs', <class 'netCDF4._netCDF4.Variable'>
int32 crs()
    wkt: GEOGCS["WGS84(DD)",
  DATUM["WGS84",
    SPHEROID["WGS84", 6378137.0, 298.257223563]],
  PRIMEM["Greenwich", 0.0],
  UNIT["degree", 0.017453292519943295],
  AXIS["Geodetic longitude", EAST],
  AXIS["Geodetic latitude", NORTH]]
    i2m: 0.25,0.0,0.0,-0.25,-180.0,90.0
unlimited dimensions:
current shape = ()
filling on, default _FillValue of -2147483647 used)])

Annex 4: Acronyms and abbreviations

C3S	Copernicus Climate Change Service
CCI	Climate Change Initiative
CRS	Coordinate Reference System
ECV	Essential Climate Variables
ESA	European Space Agency
FireCCIS310	Sentinel-3 SYN Fire_cci v1.0
FireCCIS311	Sentinel-3 SYN Fire_cci v1.1
GCS	Geographic Coordinate System
LC	Land Cover
OLCI	Ocean and Land Colour Instrument
p_b	Per pixel uncertainty
S3	Sentinel-3
SLSTR	Sea and Land Surface Temperature Radiometer
SYN	Synergy
SWIR	Short wave infrared
VIIRS	Visible Infrared Imaging Radiometer Suite
WGS84	World Geodetic System 84