CAMS global biomass burning emissions based on fire radiative power (GFAS): data documentation

Last modified on Apr 08, 2024 08:34

Table of Contents

Overview

The CAMS Global Fire Assimilation System (GFAS) assimilates fire radiative power (FRP) observations from satellite-based sensors to produce daily estimates of biomass burning emissions. It has been extended to include information about injection heights derived from the same FRP observations combined with meteorological information from the ECMWF operational weather forecast.

FRP observations currently assimilated in CAMS GFAS are the NASA Terra MODIS and Aqua MODIS active fire products (http://modis-fire.umd.edu/).

CAMS GFAS data covers the period from 2003 to present, and includes: FRP, dry matter burnt and biomass burning emissions.

The features of the current version of CAMS GFAS (GFAS v1.2) are:

- Injection height daily data (Mean altitude of maximum injection and Altitude of plume top) as provided by the Plume Rise Model and IS4FIRES
- Pixel based quality control for the MODIS instruments on Aqua and Terra
- Statistical regression of the output when assimilating only Aqua or Terra observations so as to preserve consistency with data obtained assimilating Aqua and Terra observations

CAMS GFAS fire data is based on satellite observations of thermal anomalies at the surface which are most commonly associated with vegetation fires, however, detections from other heat sources (such as active volcanos and gas flaring) and reflective surfaces may also be possible. GFAS tries to minimise these spurious detections to ensure that the data is largely based on vegetation fires.

Iceland and Hawai'i are considered as special cases due to volcanic activity and any thermal anomaly detections there are filtered out to mitigate against any spurious signals.

MODIS observations may be limited by smaller fires being below the detection threshold of the instruments or in the presence of cloud when the instruments are not able to observe the surface.

Data access

The data is now available from the Atmosphere Data Store (ADS), as the dataset:

CAMS global biomass burning emissions based on fire radiative power (GFAS)

This data can be accessed either interactively through its download web form or programmatically using the CDS API service.

It's strongly suggested to construct CDS API requests by using the web form of the relevant dataset and using the 'Show API request' button to get the code. Please note, currently only strings should be used as keyword values in a CDS API request for ADS data.

CAMS GFAS data for the latest seven days can also be accessed through the FTP service. For a list of variables available on the FTP please see here.

Access to CAMS GFAS data through the ECMWF public Web API service ended on 07 Sept 2022 . To move to the ADS service, please follow our **guidelines** on How to migrate to CDS API on the Atmosphere Data Store (ADS).

Before downloading data, users must accept the Copernicus CAMS data licence.

Data availability (HH:MM)

CAMS GFAS data guaranteed by 07:00 UTC.

It is possible that the data will be available earlier but it is not guaranteed.

Variations in delivery times may occur due to the non-operational nature of this ADS service, as issues may arise which cause delays. For any time-critical work, users should rely on ECMWF FTP service dissemination system instead.

Spatial grid

Data are available globally on a regular latitude-longitude grid with a horizontal resolution of 0.1 degrees.

Temporal frequency

The Global Fire Assimilation System v1.2 runs once a day from 00 UTC based on the last complete day of MODIS observations. The GFAS analysis provides a 24-hour average of the last whole day valid for 00-23 UTC.

Data format

The GFAS File format is GRIB1. See What are GRIB files and how can I read them for more information.

Injection height parameters

Injection height parameters (see Table 1) provide information on the height at which a fire releases emissions into the atmosphere due to the convection related to the high intensity of the fire. GFAS uses two different models (the Plume Rise Model, or PRM, and the Integrated Monitoring and Modelling System for wildland fires, or IS4FIRES) to calculate the injection height, based on satellite observed FRP and the ECMWF forecast of key atmospheric parameters. More information on the injection height calculations in GFAS can be found in Remy et al. (2017).

Analysis surface parameters

The analysis surface parameters (see Table 2) provided by GFAS are daily averages of fire radiative power and emissions fluxes of pyrogenic atmospheric species based on a combination of the available satellite FRP observations and the GFAS analysis of the previous day. The assimilation is performed applying a Kalman filter to fill in any observational gaps (due to, e.g., cloud cover) and to propagate the previous day's analysis forwards in time and take into account the new FRP observations. More information on the GFAS technical details can be found in Kaiser et al. (2012).

Parameter listing

Table 1 below provides the injection height parameters and Table 2 provides analysis surface parameters.

Table1: Gridded injection height parameters (last reviewed on 21 Jul 2022)

Name	Units	Variable name in CDS API	Short name	Parameter ID	Note
Mean altitude of maximum injection	m (above sea level)	mean_altitude_of_maximum_injection	mami	119.210	
Altitude of plume top	m (above sea level)	altitude_of_plume_top	apt	120.210	The parameters describe the top and bottom altitude of the smoke plume and are provided on the 10 degree longitude by 10 degree latitude output grid of GFAS.
Altitude of plume bottom*	m (above sea level)	altitude_of_plume_bottom	apb	242.210	The parameters describe the top and bottom altitude of the smoke plume and are provided on the 10 degree longitude by 10 degree latitude output grid of GFAS.
Injection height (from IS4FIRES)*	m	injection_height	injh	60.210	

*since 1 July 2018

Table 2: CAMS GFAS analysis surface parameters (last reviewed on 21 Jul 2022)

Name	Units	Variable name in CDS API	Short name	Parameter ID
Wildfire flux of acetaldehyde (C2H4O)	kg m^{-2} s^{-1}	wildfire_flux_of_acetaldehyde	c2h4ofire	114.210
Wildfire flux of acetone (C3H6O)	kg m^{-2} s^{-1}	wildfire_flux_of_acetone	c3h6ofire	115.210
Wildfire flux of ammonia (NH3)	kg m^{-2} s^{-1}	wildfire_flux_of_ammonia	nh3fire	116.210
Wildfire flux of benzene (C6H6)	kg m^{-2} s^{-1}	wildfire_flux_of_benzene	c6h6fire	232.210
Wildfire flux of black carbon	kg m^{-2} s^{-1}	wildfire_flux_of_black_carbon	bcfire	91.210
Wildfire flux of butanes (C4H10)	kg m^{-2} s^{-1}	wildfire_flux_of_butanes	c4h10fire	238.210
Wildfire flux of butenes (C4H8)	kg m^{-2} s^{-1}	wildfire_flux_of_butenes	c4h8fire	234.210
Wildfire flux of carbon dioxide (CO2)	kg m^{-2} s^{-1}	wildfire_flux_of_carbon_dioxide	co2fire	80.210
Wildfire flux of carbon monoxide (CO)	kg m^{-2} s^{-1}	wildfire_flux_of_carbon_monoxide	cofire	81.210
Wildfire flux of dimethyl sulfide (DMS) (C2H6S)	kg m^{-2} s^{-1}	wildfire_flux_of_dimethyl_sulfide	c2h6sfire	117.210
Wildfire flux of ethane (C2H6)	kg m^{-2} s^{-1}	wildfire_flux_of_ethane	c2h6fire	118.210
Wildfire flux of ethanol (C2H5OH)	kg m^{-2} s^{-1}	wildfire_flux_of_ethanol	c2h5ohfire	104.210
Wildfire flux of ethene (C2H4)	kg m^{-2} s^{-1}	wildfire_flux_of_ethene	c2h4fire	106.210
Wildfire flux of formaldehyde (CH2O)	kg m^{-2} s^{-1}	wildfire_flux_of_formaldehyde	ch2ofire	113.210
Wildfire flux of heptane (C7H16)	kg m^{-2} s^{-1}	wildfire_flux_of_heptane	c7h16fire	241.210
Wildfire flux of hexanes (C6H14)	kg m^{-2} s^{-1}	wildfire_flux_of_hexanes	c6h14fire	240.210
Wildfire flux of hexene (C6H12)	kg m^{-2} s^{-1}	wildfire_flux_of_hexene	c6h12fire	236.210
Wildfire flux of higher alkanes (CnH2n+2, c>=4)	kg m^{-2} s^{-1}	wildfire_flux_of_higher_alkanes	hialkanesfire	112.210
Wildfire flux of higher alkenes (CnH2n, c>=4)	kg m^{-2} s^{-1}	wildfire_flux_of_higher_alkenes	hialkenesfire	111.210
Wildfire flux of hydrogen (H)	kg m^{-2} s^{-1}	wildfire_flux_of_hydrogen	h2fire	84.210
Wildfire flux of isoprene (C5H8)	kg m^{-2} s^{-1}	wildfire_flux_of_isoprene	c5h8fire	108.210
Wildfire flux of methane (CH4)	kg m^{-2} s^{-1}	wildfire_flux_of_methane	ch4fire	82.210
Wildfire flux of methanol (CH3OH)	kg m^{-2} s^{-1}	wildfire_flux_of_methanol	ch3ohfire	103.210
Wildfire flux of nitrogen oxides (NOx)	kg m^{-2} s^{-1}	wildfire_flux_of_nitrogen_oxides	noxfire	85.210
Wildfire flux of nitrous oxide (N20)	kg m^{-2} s^{-1}	wildfire_flux_of_nitrous_oxide	n2ofire	86.210
Wildfire flux of non-methane hydrocarbons	kg m^{-2} s^{-1}	wildfire_flux_of_non_methane_hydrocarbons	nmhcfire	83.210
Wildfire flux of octene (C8H16)	kg m-2 s-1	wildfire_flux_of_octene	c8h16fire	237.210
Wildfire flux of organic carbon	kg m^{-2} s^{-1}	wildfire_flux_of_organic_carbon	ocfire	90.210
Wildfire flux of particulate matter d < 2.5 µm (PM2.5)	kg m-2 s-1	wildfire_flux_of_particulate_matter_d_2_5_µm	pm2p5fire	87.210
Wildfire flux of pentanes (C5H12)	kg m^{-2} s^{-1}	wildfire_flux_of_pentanes	c5h12fire	239.210
Wildfire flux of pentenes (C5H10)	kg m^{-2} s^{-1}	wildfire_flux_of_pentenes	c5h10fire	235.210
Wildfire flux of propane (C3H8)	kg m^{-2} s^{-1}	wildfire_flux_of_propane	c3h8fire	105.210
Wildfire flux of propene (C3H6)	kg m^{-2} s^{-1}	wildfire_flux_of_propene	c3h6fire	107.210
Wildfire flux of sulphur dioxide (SO2)	kg m^{-2} s^{-1}	wildfire_flux_of_sulphur_dioxide	so2fire	102.210
Wildfire flux of terpenes ((C5H8)n)	kg m^{-2} s^{-1}	wildfire_flux_of_terpenes	terpenesfire	109.210
Wildfire flux of toluene (C7H8)	kg m^{-2} s^{-1}	wildfire_flux_of_toluene	c7h8fire	231.210
Wildfire flux of toluene_lump (C7H8+ C6H6 + C8H10)	kg m^{-2} s^{-1}	wildfire_flux_of_toluene_lump	toluenefire	110.210
Wildfire flux of total carbon in aerosols	kg m^{-2} s^{-1}	wildfire_flux_of_total_carbon_in_aerosols	tcfire	89.210
Wildfire flux of total particulate matter	kg m-2 s-1	wildfire_flux_of_total_particulate_matter	tpmfire	88.210
Wildfire flux of xylene (C8H10)	kg m-2 s-1	wildfire_flux_of_xylene	c8h10fire	233.210
Wildfire fraction of area observed	dimensionless	wildfire_fraction_of_area_observed		
Wildfire overall flux of burnt carbon	kg m-2 s-1	wildfire_overall_flux_of_burnt_carbon	cfire	92.210

Wildfire radiative power	W m^{-2}	wildfire_radiative_power		

Satellites and instruments

The table below presents the observations used in GFASv1.2. FRP observations are from the MODIS instruments on the NASA Terra and Aqua satellites which were launched in December 1999 and June 2002 respectively.

(last reviewed on 21 Jul 2022)

Parameter	Instrument	Satellite	Period	Data Provider/version
FRP	MODIS	Terra	2000-present	NASA LANCE-MODIS, collection 6
FRP	MODIS	Aqua	2003-present	NASA LANCE-MODIS, collection 6

GFAS Maps

The **latest daily Fire Radiative Power (FRP) analysis from GFAS** is available here. The map represents the thermal radiation measured from space-borne sensors and detected as coming from actively burning vegetation and other open fires. It is expressed as the daily average of the fire radiative power (FRP) observations made in 125 km grid cells and expressed in the units of [mW/m^2]. The rate of release of thermal radiation by a fire is believed to be related to the rate at which fuel is being consumed and smoke produced. Therefore, these daily averaged FRP areal intensity data are used in the global estimation of open vegetation fire trace gas and particulate emissions.

Known issues

- 31 March - 17 April 2022: No Aqua MODIS FRP data due to known issues with the satellite.
- 22 February 2021: Aqua and Terra MODIS FRP data changed from collection 6 to collection 6.1
- 18 November 2020: Aqua MODIS FRP data reintroduced to GFAS processing
- 19 August 2020: No Aqua MODIS FRP data available since 17 August (limited coverage on 16th) due to known issue with the satellite as documented at https://ladsweb.modaps.eosdis.nasa.gov/alerts-and-issues/?id=44995.
- 3 July 2018: GFAS production moved to ECMWF operations; standard output updated to include altitude of plume bottom and injection height from IS4FIRES.
- 23-27 June 2018: Limited MODIS FRP observations being used in daily NRT GFAS processing.
- 19 December 2016: Aqua and Terra MODIS FRP data changed from collection 5 to collection 6.
- 8-9 August 2016: no Aqua MODIS data available leading to reduced GFAS emissions over Africa and South America - all other regions seem to be unaffected.
- 22 April 2016: Terra MODIS data reintroduced to GFAS processing.
- 1 March 2016: Terra MODIS removed from GFAS processing.
- 24 February - 4 March 2016: anomalous FRP values associated with degraded Terra MODIS data being used in GFAS.
    - *Updated 20 September 2016: GFAS FRP values for these dates have been recalculated using Aqua MODIS data only and have replaced the anomalous values in the GFAS catalogue. For users that have downloaded the GFAS data for these dates, we recommend to download them again.*

How to cite the CAMS GFAS data

Please acknowledge the use of the CAMS GFAS data as stated in the Copernicus CAMS License agreement:

- "Where the Licensee communicates to the public or distributes or publishes CAMS Information, the Licensee shall inform the recipients of the source of that information by using the following or any similar notice:

  'Generated using Copernicus Atmosphere Monitoring Service Information [Year]'.

- Where the Licensee makes or contributes to a publication or distribution containing adapted or modified CAMS Information, the Licensee shall provide the following or any similar notice:

  'Contains modified Copernicus Atmosphere Monitoring Service Information [Year]';

Any such publication or distribution shall state that "neither the European Commission nor ECMWF is responsible for any use that may be made of the information it contains."

Q&A

Users can find the Q&A for wildfires here.

References

Kaiser, J. W., Heil, A., Andreae, M. O., Benedetti, A., Chubarova, N., Jones, L., Morcrette, J.-J., Razinger, M., Schultz, M. G., Suttie, M., and van der Werf, G. R. (2012). Biomass burning emissions estimated with a global fire assimilation system based on observed fire radiative power. BG, 9:527-554. [PDF]

Di Giuseppe, F, Remy, S, Pappenberger, F, Wetterhall, F (2016): Improving GFAS and CAMS biomass burning estimations by means of the Global ECMWF Fire Forecast system (GEFF), *ECMWF Tech. Memo No.* 790 [PDF]

Di Giuseppe, F, Remy, S, Pappenberger, F, Wetterhall, F, 2018: Combining fire radiative power observations with the fire weather index improves the estimation of fire emissions, *Atmos. Chem. Phys. Discuss.*, **18**, 5359–5370, https://doi.org/10.5194/acp-2017-790

Heil et al. (2010) Assessment of the Real-Time Fire Emissions (GFASv0) by MACC, *ECMWF Tech. Memo No.* 628 [PDF]

N. Andela (VUA), J.W. Kaiser (ECMWF, KCL), A. Heil (FZ Jülich), T.T. van Leeuwen (VUA), G.R. van der Werf (VUA), M.J. Wooster (KCL), S. Remy (ECMWF) and M.G. Schultz (FZ Jülich), Assessment of the Global Fire Assimilation System (GFASv1). [PDF]

Rémy, S., A. Veira, R. Paugam, M. Sofiev, J. W. Kaiser, F. Marenco, S. P. Burton, A. Benedetti, R. J. Engelen, R. Ferrare, and J. W. Hair, 2017: Two global data sets of daily fire emission injection heights since 2003, *Atmos. Chem. Phys*., **17**, 2921-2942, https://doi.org/10.5194/acp-17-2921-2017.

Xu et al. (2010) New GOES imager algorithms for cloud and active fire detection and fire radiative power assessment across North, South and Central America. *RSE Vol. 114*

This document has been produced in the context of the Copernicus Atmosphere Monitoring Service (CAMS).

The activities leading to these results have been contracted by the European Centre for Medium-Range Weather Forecasts, operator of CAMS on behalf of the European Union (Delegation Agreement signed on 11/11/2014 and Contribution Agreement signed on 22/07/2021). All information in this document is provided "as is" and no guarantee or warranty is given that the information is fit for any particular purpose.

Related articles

- How to run the WRF-Chem model using CAMS data as initial and boundary conditions (BC)?
- CAMS: Reanalysis data documentation
- Please read: CDS and ADS migrating to new infrastructure: Common Data Store (CDS) Engine
- CAMS Regional: European air quality analysis and forecast data documentation
- How to install and use CDS API on Windows