CAMS: Global atmospheric composition forecast data documentation

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Introduction

The global production system is used to produce the daily forecasts of pollutants, aerosols and greenhouse gases across the globe. Satellite observations of atmospheric composition are merged with a detailed computer simulation of the atmosphere using a method called data assimilation. The resulting analyses, i.e. maps of atmospheric composition, are used as initial conditions for the daily forecasts of atmospheric composition. Analyses and forecasts for aerosols and chemical species are produced twice a day.

A global production system is also used to assimilate re-processed observations from many satellites for the last few decades, using the same data assimilation process. The result is called reanalysis and it provides a consistent data set that can be used for scientific studies and trend analyses. The current atmospheric composition reanalysis produced by the Copernicus Atmosphere Monitoring Service is the CAMS: Reanalysis data documentation (EAC4).

The IFS model and data assimilation system configurations (48r1)

The model used in the CAMS Global atmospheric composition forecast is the Integrated Forecasting System (IFS) that also produces ECMWF weather forecasts, but with additional modules enabled for aerosols, reactive gases and greenhouse gases that have been developed within CAMS and precursor projects GEMS and MACC. The following processes of atmospheric composition are considered:

- transport of trace gases and aerosols
- injection of emissions
- uptake and release by vegetation and the land and sea surface
- removal by dry deposition at the surface
- removal by scavenging in precipitation
- chemical conversion in the troposphere (CB05) and stratosphere (BASCOE)
- aerosol microphysics

Emissions and surface fluxes of the trace gases and aerosols used in the global CAMS productions are:

- anthropogenic emissions from the CAMS_GLOB_ANT v5.3 with sectoral diurnal cycles and injection heights
- natural and biogenic emissions from the CAMS_GLOB_BIO v3.1 climatologies
- ocean fluxes of DMS from the CAMS_GLOB_OCE v.3.1 climatology
- aircraft emissions of CO_2 and NO_x from the CAMS_GLOB_AIR v3.1 data set
- biomass burning emissions inferred from satellite observations of fire activity from the CAMS GFAS v1.4 system
- using IS4FIRES injection heights from the CAMS GFAS v1.4 system

For details about simulations and assimilation of chemistry, carbon dioxide, methane and aerosols please see References.

The IFS uses a four-dimensional variational data assimilation method (4D-VAR) for the assimilation of a wide range of meteorological observations as well as satellite retrievals of atmospheric composition.

The IFS model documentation for various model cycles can be found on https://www.ecmwf.int/en/publications/ifs-documentation, including a new section on atmospheric composition aspects. Please note that the IFS cycle changes during the years, and this page documents the current operational cycle (48r1); please have a look at the table below for details of changes from previous cycles.

Configuration for CAMS Global atmospheric composition global forecasts (daily)

Twice a day (at 00:00 and 12:00 UTC), CAMS issues a five-day forecast of global atmospheric composition. The forecast consists of 56 reactive traces gases in the troposphere, stratospheric ozone and seven different types of aerosol: desert dust, sea salt, organic matter, black carbon, sulphate, and (since 9 July 2019) nitrate and ammonium.

The initial conditions of the forecast are obtained by combining a previous forecast with satellite observations of aerosol optical depth, ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2) , and sulfur dioxide (SO_2) through the 4D-VAR data assimilation process.

Satellite observations of fire radiative power (GFAS) from the day before the forecast start are used to derive timely biomass burning emissions for the forecast.

The forecasts are evaluated at quarterly intervals by an external team lead by KNMI and evaluation reports can be found here: https://atmosphere.copernicus.eu/eqa-reports-global-services.

Evolution of the CAMS global forecasting system

The IFS undergoes changes regularly in order to improve the forecast. Changes are listed below with their identifier (Cycle 46r1 for instance) or a specific title when the cycle number did not change.

Implementation date	Cycle	Summary of changes	Resolution /Resolution change	New species
27 June 2023	48r1	Atmospheric composition, Meteorology, GRIB encoding	Horizontal: 40km, Vertical: 137 levels	See parameters in green in tables below
1 Feb 2023	47r3	Assimilation of AOD from VIIRS		none
15 Dec 2022	47r3	Update of the T159 background error covariance wavelet file to use the correct NWP background errors. The update leads to considerably improved NWP forecast scores. As a consequence, smaller changes to AOD and upper tropospheric and lower stratospheric ozone are also expected.	Horizontal: 40km, Vertical: 137 levels	none
22 Feb 2022	47r3	A fix of low-level T/q in fog conditions was introduced with the 12 UTC cycle on 22 Feb 2022	Horizontal: 40km, Vertical: 137 levels	none
12 October 2021	47r3	Atmospheric composition, Meteorology	Horizontal: 40km, Vertical: 137 levels	none
18 May 2021 (12UTC cycle)	47r2	Atmospheric composition, Meteorology	Horizontal: 40km, Vertical: 137 levels	none
6 October 2020	47r1	Atmospheric composition, Meteorology	Horizontal: 40km, Vertical: 137 levels	none
9 July 2019	46r1	Atmospheric composition, Meteorology	Horizontal: 40km, **Vertical: from 60 to 137 l evels**	Aerosols: nitrate and ammonium
26 June 2018	45r1	Atmospheric composition, Meteorology	Horizontal: 40km, Vertical: 60 levels	See Table 1 and 2
26 September 2017	43r3	Atmospheric composition, Meteorology	Horizontal: 40km, Vertical: 60 levels	none
24 January 2017	43r1	Atmospheric composition, Meteorology	Horizontal: 40km, Vertical: 60 levels	none
21 June 2016	41r1	Atmospheric composition, Meteorology	**Horizontal: from 80km to 40km**, Vertical: 60 levels	none

Data access

The data is now available from the Atmosphere Data Store (ADS), either interactively through its download web form or programmatically using the CDS API service:

CAMS global atmospheric composition forecasts

Currently only strings should be used as keyword values in a CDS API request for ADS data.

Analysis data are not available on the ADS webform but they can be downloaded using the CDS API service. In the request, the keyword 'type' and 'leadtime_hour' have to be set as 'analysis' and '0' respectively. Please have see the following example:

Example to download analysis data

```
import cdsapi

c = cdsapi.Client()

c.retrieve(
    'cams-global-atmospheric-composition-forecasts',
    {
        'date': '2021-03-24',
        'time': [
            '00:00', '06:00', '12:00',
            '18:00',
        ],
        'leadtime_hour': '0',
        'area': [           #North, West, South, East
            70, -18, 69,
            -17,
        ],
        'type':'analysis',
        'variable': 'total_aerosol_optical_depth_670nm',
        'format': 'netcdf_zip',
    },
    'download.netcdf_zip')
```

A **subset** of the CAMS Global atmospheric composition forecast data for the latest three days can also be accessed through the FTP service. **For a list of variables available on the FTP please see** here.

Access to CAMS global air quality forecast and analysis data through the ECMWF public Web API service ended on 30 June 2021.

To move to the ADS service, please follow our **guidelines** on How to migrate to CDS API on the Atmosphere Data Store (ADS).

Users with direct access to MARS can browse the data on the MARS catalogue under class=mc and expver= 0001.

Data availability (HH:MM)

CAMS Global analyses and forecasts:

00 UTC forecast data availability guaranteed by **10:00 UTC**

12 UTC forecast data availability guaranteed by **22:00 UTC**

It is possible that the data will be available earlier but without guarantee.

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

CAMS Global atmospheric composition forecasts data currently has a resolution of approximately 40 km (approximately 0.35 degrees). The data are archived either as spectral coefficients with a triangular truncation of T511 or on a reduced Gaussian grid with a resolution of N256. These grids are so called "linear grids", sometimes referred to as T_L511.

PLEASE NOTE: CAMS Global atmospheric composition forecasts data available from the ADS **has been pre-interpolated** to a regular 0.4° x 0.4° latitude/longitude grid. The keyword 'grid' is not supported in CDS API requests on the ADS.

Temporal frequency

The CAMS Global 5-day forecasts run twice daily from 00 and 12 UTC and the data are available every hour (for surface fields) and every 3 hours (for model- and pressure-level fields). The analyses are available every 6 hours at 00 UTC, 06 UTC, 12 UTC and 18 UTC.

From 21 June 2016 CAMS Global data is produced twice daily, with basetime 00:00 and 12:00 UTC.

Until 21 June 2016 CAMS Global data was produced only once a day, with basetime 00:00 UTC.

Data format

Model level fields are in GRIB2 format. All other fields are in GRIB1, unless otherwise indicated. NetCDF format is available on ADS but it is experimental.

From cycle 48R1, there are important changes to the GRIB encoding for model levels fields, relating to packing and GRIB tables. Please see this page for full details: Implementation of IFS cycle 48r1 for CAMS#ChangetoGRIBencoding

The 'packingType' can be changed using ECMWF's ecCodes:

```
# CCSDS -> simple

grib_set -r -s packingType=grid_simple in.grib2 out.grib

# Simple -> CCSDS

grib_set -r -s packingType=grid_ccsds in.grib out.grib2
```


Users are advised to use data in GRIB format. If this is not possible, users should download the data in GRIB and convert them to NetCDF with sufficient precision such that data values are correctly represented.

Level listings

Pressure levels: 1000/950/925/900/850/800/700/600/500/400/300/250/200/150/100/70/50/30/20/10/7/5/3/2/1

Model levels: 1/to/137, which are described at https://confluence.ecmwf.int/display/UDOC/L137+model+level+definitions. Before 9 July 2019, the vertical levels were 60, which are described at https://confluence.ecmwf.int/display/UDOC/L60+model+level+definitions.

Parameter listings

Physical characteristics of the different types of aerosols (i.e mass density, the radius mode and geometric standard deviation of the lognormal size distribution and the bin limits and hygroscopic factor), are available in Rémy et al. (2019).

The suggested reference for the IFS aerosol optical properties and hygroscopic growth tables is Bozzo at al (2020) and the new CY48R1 documentation: https://www.ecmwf.int/en/elibrary/81374-ifs-documentation-cy48r1-part-viii-atmospheric-composition, chapter 5.

Fast access	Parameters labelled as "Fast access" are stored on disk while parameters labelled as "slow access" are stored on tape. Retrieval of this data will be MUCH SLOWER than disk-resident data.
	Parameters highlighted in green were introduced with the new upgrade (48R1).

PLEASE NOTE: *Total column (in kg m^{-2}) is available at the surface (model level 137 for MARS users; before 9 July 2019, model level 60). Total column refers to the total amount of the selected variable in a column of air extending from the surface of the Earth to the top of the atmosphere (model level 1 for MARS users). Total column can also be referred to as **total** <selected variable>, or **vertically integrated** <selected variable>.

PLEASE NOTE: Multi levels data are only available at 3-hourly intervals.

Table 1: Single level Fast access parameters (last reviewed on 02 Aug 2023)

Name	Units	Variable name in CDS API	Shortname	Param ID	Access type	fc	an	Note

10 metre U wind component	m s^{-1}	10m_u_component_of_wind	10u	165	Fast access	X	X	
10 metre V wind component	m s^{-1}	10m_v_component_of_wind	10v	166	Fast access	X	X	
2 metre dewpoint temperature	K	2m_dewpoint_temperature	2d	168	Fast access	X	X	
2 metre temperature	K	2m_temperature	2t	167	Fast access	X	X	
Ammonium aerosol optical depth at 550 nm	dimensionless	ammonium_aerosol_optical_depth_550nm	amaod550	210251	Fast access		X	Only available from 9 July 2019 00UTC
Black Carbon Aerosol Optical Depth at 550nm	dimensionless	black_carbon_aerosol_optical_depth_550nm	bcaod550	210211	Fast access	X	X	
Dust Aerosol Optical Depth at 550nm	dimensionless	dust_aerosol_optical_depth_550nm	duaod550	210209	Fast access	X	X	
Land-sea mask	(0 - 1)	land_sea_mask	lsm	172	Fast access	X	X	
Mean sea level pressure	Pa	mean_sea_level_pressure	msl	151	Fast access	X	X	
Nitrate aerosol optical depth at 550 nm	dimensionless	nitrate_aerosol_optical_depth_550nm	niaod550	210250	Fast access	X	X	Only available from 9 July 2019 00UTC
Organic Matter Aerosol Optical Depth at 550nm	dimensionless	organic_matter_aerosol_optical_depth_550nm	omaod550	210210	Fast access	X	X	
Particulate matter d < 10 um	kg m^{-3}	particulate_matter_10um	pm10	210074	Fast access	X	X	PM10 and PM25 global products
Particulate matter d < 2.5 um	kg m^{-3}	particulate_matter_2.5um	pm2p5	210073	Fast access	X	X	PM10 and PM25 global products
Particulate matter d < 1 um	kg m^{-3}	particulate_matter_1um	pm1	210072	Fast access	X	X	
Sea Salt Aerosol Optical Depth at 550nm	dimensionless	sea_salt_aerosol_optical_depth_550nm	ssaod550	210208	Fast access		X	Only available from 26 June 2018 12UTC
Sulphate aerosol optical depth at 550 nm	dimensionless	sulphate_aerosol_optical_depth_550nm	suaod550	210212	Fast access		X	
Surface geopotential	m^2 s^{-2}	surface_geopotential	z	129	Fast access		X	
Surface pressure	Pa	surface_pressure	sp	134	Fast access	X	X	Only available from 21 June 2016 00UTC
Total aerosol optical depth at 1240nm	dimensionless	total_aerosol_optical_depth_1240nm	aod1240	210216	Fast access	X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 469nm	dimensionless	total_aerosol_optical_depth_469nm	aod469	210213	Fast access	X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 550nm	dimensionless	total_aerosol_optical_depth_550nm	aod550	210207	Fast access	X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 670nm	dimensionless	total_aerosol_optical_depth_670nm	aod670	210214	Fast access	X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 865nm	dimensionless	total_aerosol_optical_depth_865nm	aod865	210215	Fast access	X	X	Only available from 26 June 2018 12UTC
Total column Carbon monoxide	kg m^{-2}	total_column_carbon_monoxide	tcco	210127	Fast access	X	X	
Total column of chlorine monoxide	kg m^{-2}	total_column_chlorine_monoxide	tc_clo	218174	Fast access	X	X	Available from 28 June 2023
Total column of chlorine nitrate	kg m^{-2}	total_column_chlorine_nitrate	tc_clono2	218064	Fast access	X	X	Available from 28 June 2023
Total column ethane	kg m^{-2}	total_column_ethane	tc_c2h6	218045	Fast access	X	X	
Total column Formaldehyde	kg m^{-2}	total_column_formaldehyde	tchcho	210128	Fast access	X	X	
Total column hydrogen chloride	kg m^{-2}	total_column_hydrogen_chloride	tc_hcl	218200	Fast access	X	X	Available from 28 June 2023
Total column hydrogen cyanide	kg m^{-2}	total_column_hydrogen_cyanide	tc_HCN	218226	Fast access	X	X	Available from 28 June 2023
Total column hydrogen peroxide	kg m^{-2}	total_column_hydrogen_peroxide	tc_h2o2	218003	Fast access	X	X	Only available from 26 June 2018 12UTC
Total column hydroxyl radical	kg m^{-2}	total_column_hydroxyl_radical	tc_oh	218030	Fast access	X	X	
Total column isoprene	kg m^{-2}	total_column_isoprene	tc_c5h8	218016	Fast access	X	X	
Total column methane	kg m^{-2}	total_column_methane	tc_ch4	218004	Fast access	X	X	
Total column nitric acid	kg m^{-2}	total_column_nitric_acid	tc_hno3	218006	Fast access	X	X	

Total column Nitrogen dioxide	kg m^{-2}	total_column_nitrogen_dioxide	tcno2	210125	Fast access	X	X	
Total column nitrogen monoxide	kg m^{-2}	total_column_nitrogen_monoxide	tc_no	218027	Fast access	X	X	
GEMS Total column ozone	kg m^{-2}	total_column_ozone	gtco3	210206	Fast access	X	X	
Total column peroxyacetyl nitrate	kg m^{-2}	total_column_peroxyacetyl_nitrate	tc_pan	218013	Fast access	X	X	
Total column propane	kg m^{-2}	total_column_propane	tc_c3h8	218047	Fast access	X	X	
Total column Sulphur dioxide	kg m^{-2}	total_column_sulphur_dioxide	tcso2	210126	Fast access	X	X	
Total column water vapour	kg m^{-2}	total_column_water_vapour	tcwv	137	Fast access	X	X	
UV biologically effective dose	dimensionless	uv_biologically_effective_dose	uvbed	214002	Fast access	X	X	Only available from 03 September 2015 00UTC
UV biologically effective dose clear-sky	dimensionless	uv_biologically_effective_dose_clear_sky	uvbedcs	214003	Fast access	X	X	Only available from 03 September 2015 00UTC

Table 2: Single level Slow access parameters (last reviewed on 02 Aug 2023)

Name	Units	Variable name in CDS API	Shortname	Param ID	Access type	fc	an	Note
10 metre wind gust in the last 3 hours	m s^{-1}	10m_wind_gust_in_the_last_3_hours	10fg3	228028			X	Only available from 21 June 2016 00UTC
Asymmetry factor at 1020 nm	dimensionless	asymmetry_factor_1020nm	asymmetry1020	215164		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 1064 nm	dimensionless	asymmetry_factor_1064nm	asymmetry1064	215165		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 1240 nm	dimensionless	asymmetry_factor_1240nm	asymmetry1240	215166		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 1640 nm	dimensionless	asymmetry_factor_1640nm	asymmetry1640	215167		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 2130 nm	dimensionless	asymmetry_factor_2130nm	asymmetry2130	215179		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 340 nm	dimensionless	asymmetry_factor_340nm	asymmetry340	215150		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 355 nm	dimensionless	asymmetry_factor_355nm	asymmetry355	215151		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 380 nm	dimensionless	asymmetry_factor_380nm	asymmetry380	215152		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 400 nm	dimensionless	asymmetry_factor_400nm	asymmetry400	215153		X	X	Only available from 27 June 2018 00UTC
Asymmetry factor at 440 nm	dimensionless	asymmetry_factor_440nm	asymmetry440	215154		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 469 nm	dimensionless	asymmetry_factor_469nm	asymmetry469	215155		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 500 nm	dimensionless	asymmetry_factor_500nm	asymmetry500	215156		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 532 nm	dimensionless	asymmetry_factor_532nm	asymmetry532	215157		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 550 nm	dimensionless	asymmetry_factor_550nm	asymmetry550	215158		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 645 nm	dimensionless	asymmetry_factor_645nm	asymmetry645	215159		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 670 nm	dimensionless	asymmetry_factor_670nm	asymmetry670	215160		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 800 nm	dimensionless	asymmetry_factor_800nm	asymmetry800	215161		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 858 nm	dimensionless	asymmetry_factor_858nm	asymmetry858	215162		X	X	Only available from 26 June 2018 12UTC
Asymmetry factor at 865 nm	dimensionless	asymmetry_factor_865nm	asymmetry865	215163		X	X	Only available from 26 June 2018 12UTC
Boundary layer height	m	boundary_layer_height	blh	159		X		
Clear-sky direct solar radiation at surface	J m^{-2}	clear_sky_direct_solar_radiation_at_surface	cdir	228022		X		
Clear sky surface photosynthetically active radiation	J m^{-2}	clear_sky_surface_photosynthetically_active_radiation	parcs	20		X		Only available from 24 January 2017 12UTC
Cloud base height	m	cloud_base_height	cbh	228023		X		

Convective available potential energy	J kg^{-1}	convective_available_potential_energy	cape	59		X		
Convective inhibition	J kg^{-1}	convective_inhibition	cin	228001		X	X	
Convective precipitation	m	convective_precipitation	cp	143		X	X	
Direct solar radiation	J m^{-2}	direct_solar_radiation	dsrp	47		X		Only available from 24 January 2017 12UTC
Downward UV radiation at the surface	J m^{-2}	downward_uv_radiation_at_the_surface	uvb	57		X		
Dry deposition of ammonium aerosol	kg m^{-2} s^{-1}	dry_deposition_of_ammonium_aerosol	aerddpam	215206		X		Only available from 9 July 2019 00UTC
Dry deposition of coarse-mode nitrate aerosol	kg m^{-2} s^{-1}	dry_deposition_of_coarse_mode_nitrate_aerosol	aerddpnic	215192		X		Only available from 9 July 2019 00UTC
Dry deposition of dust aerosol (0.03 - 0.55 um)	kg m^{-2} s^{-1}	dry_deposition_of_dust_aerosol_0.03-0.55um	aerddpdus	215028		X		Only available from 26 June 2018 12UTC
Dry deposition of dust aerosol (0.55 - 9 um)	kg m^{-2} s^{-1}	dry_deposition_of_dust_aerosol_0.55-9um	aerddpdum	215029		X		Only available from 26 June 2018 12UTC
Dry deposition of dust aerosol (9 - 20 um)	kg m^{-2} s^{-1}	dry_deposition_of_dust_aerosol_9-20um	aerddpdul	215030		X		Only available from 26 June 2018 12UTC
Dry deposition of fine-mode nitrate aerosol	kg m^{-2} s^{-1}	dry_deposition_of_fine_mode_nitrate_aerosol	aerddpnif	215191		X		Only available from 9 July 2019 00UTC
Dry deposition of hydrophilic black carbon aerosol	kg m^{-2} s^{-1}	dry_deposition_of_hydrophilic_black_carbon_aerosol	aerddpbchphil	215068		X		Only available from 26 June 2018 12UTC
Dry deposition of hydrophilic organic matter aerosol	kg m^{-2} s^{-1}	dry_deposition_of_hydrophilic_organic_matter_aerosol	aerddpomhphil	215052		X		Only available from 26 June 2018 12UTC
Dry deposition of hydrophobic black carbon aerosol	kg m^{-2} s^{-1}	dry_deposition_of_hydrophobic_black_carbon_aerosol	aerddpbchphob	215067		X		Only available from 26 June 2018 12UTC
Dry deposition of hydrophobic organic matter aerosol	kg m^{-2} s^{-1}	dry_deposition_of_hydrophobic_organic_matter_aerosol	aerddpomhphob	215051		X		Only available from 26 June 2018 12UTC
Dry deposition of sea salt aerosol (0.03 - 0.5 um)	kg m^{-2} s^{-1}	dry_deposition_of_sea_salt_aerosol_0.03-0.5um	aerddpsss	215004		X		Only available from 26 June 2018 12UTC
Dry deposition of sea salt aerosol (0.5 - 5 um)	kg m^{-2} s^{-1}	dry_deposition_of_sea_salt_aerosol_0.5-5um	aerddpssm	215005		X		Only available from 26 June 2018 12UTC
Dry deposition of sea salt aerosol (5 - 20 um)	kg m^{-2} s^{-1}	dry_deposition_of_sea_salt_aerosol_5-20um	aerddpssl	215006		X		Only available from 26 June 2018 12UTC
Dry deposition of sulphate aerosol	kg m^{-2} s^{-1}	dry_deposition_of_sulphate_aerosol	aerddpsu	215082		X		Only available from 26 June 2018 12UTC
Dust aerosol (0.03 - 0.55 um) optical depth	dimensionless	dust_aerosol_0.03-0.55um_optical_depth_550nm	aeroddus	215046		X	X	
Dust aerosol (0.55 - 9 um) optical depth	dimensionless	dust_aerosol_0.55-9um_optical_depth_550nm	aeroddum	215047		X	X	
Dust aerosol (9 - 20 um) optical depth	dimensionless	dust_aerosol_9-20um_optical_depth_550nm	aeroddul	215048		X	X	
Evaporation	m of water equivalent	evaporation	e	182		X		
Forecast albedo	(0 - 1)	forecast_albedo	fal	243		X		
Friction velocity	m s^{-1}	friction_velocity	zust	228003		X		
Height of convective cloud top	m	height_of_convective_cloud_top	hcct	228046		X		Only available from 24 January 2017 12UTC
High cloud cover	(0 - 1)	high_cloud_cover	hcc	188		X	X	
Hydrophilic black carbon aerosol optical depth	dimensionless	hydrophilic_black_carbon_aerosol_optical_depth_550nm	aerodbchphil	215080		X	X	
Hydrophilic organic matter aerosol optical depth	dimensionless	hydrophilic_organic_matter_aerosol_optical_depth_550nm	aerodomhphil	215064		X	X	
Hydrophobic black carbon aerosol optical depth	dimensionless	hydrophobic_black_carbon_aerosol_optical_depth_550nm	aerodbchphob	215079		X	X	
Hydrophobic organic matter aerosol optical depth	dimensionless	hydrophobic_organic_matter_aerosol_optical_depth_550nm	aerodomhphob	215063		X	X	
Lake cover	(0 - 1)	lake_cover	cl	26		X	X	Only available from 03 September 2015 00UTC
Large-scale precipitation	m	large_scale_precipitation	lsp	142		X		
Leaf area index, high vegetation	m^2 m^{-2}	leaf_area_index_high_vegetation	lai_hv	67		X	X	
Leaf area index, low vegetation	m^2 m^{-2}	leaf_area_index_low_vegetation	lai_lv	66		X	X	
Lifting threshold speed	m s^{-1}	lifting_threshold_speed	aerlts	210053			X	
Low cloud cover	(0 - 1)	low_cloud_cover	lcc	186		X	X	
Medium cloud cover	(0 - 1)	medium_cloud_cover	mcc	187		X	X	
Coarse-mode nitrate aerosol optical depth at 550 nm	dimensionless	nitrate_coarse_mode_aerosol_optical_depth_550nm	aerodnic	215204		X	X	Only available from 9 July 2019 00UTC

Fine-mode nitrate aerosol optical depth at 550 nm	dimensionless	nitrate_fine_mode_aerosol_optical_depth_550nm	aerodnif	215203		X	X	Only available from 9 July 2019 00UTC
Photosynthetically active radiation at the surface	J m^{-2}	photosynthetically_active_radiation_at_the_surface	par	58		X		
Potential evaporation	m	potential_evaporation	pev	228251		X		Only available from 21 June 2016 00UTC
Precipitation type	code table (4.201)	precipitation_type	ptype	260015		X		Only available from 21 June 2016 00UTC
Sea ice area fraction	(0 - 1)	sea_ice_cover	ci	31		X	X	
Sea salt aerosol (0.03 - 0.5 um) optical depth	dimensionless	sea_salt_aerosol_0.03-0.5um_optical_depth_550nm	aerodsss	215022		X	X	Only available from 26 June 2018 12UTC
Sea salt aerosol (0.5 - 5 um) optical depth	dimensionless	sea_salt_aerosol_0.5-5um_optical_depth_550nm	aerodssm	215023		X	X	Only available from 26 June 2018 12UTC
Sea salt aerosol (5 - 20 um) optical depth	dimensionless	sea_salt_aerosol_5-20um_optical_depth_550nm	aerodssl	215024		X	X	Only available from 26 June 2018 12UTC
Sea surface temperature	K	sea_surface_temperature	sst	34			X	
Secondary organic aerosol optical depth at 550 nm	dimensionless	secondary_organic_aerosol_optical_depth_550nm	soaod550	215226		X	X	Available from 28 June 2023
Sedimentation of ammonium aerosol	kg m^{-2} s^{-1}	sedimentation_of_ammonium_aerosol	aersdmam	215207		X		Only available from 9 July 2019 00UTC
Sedimentation of coarse-mode nitrate aerosol	kg m^{-2} s^{-1}	sedimentation_of_coarse_mode_nitrate_aerosol	aersdmnic	215194		X		Only available from 9 July 2019 00UTC
Sedimentation of dust aerosol (0.03 - 0.55 um)	kg m^{-2} s^{-1}	sedimentation_of_dust_aerosol_0.03-0.55um	aersdmdus	215031		X		Only available from 26 June 2018 12UTC
Sedimentation of dust aerosol (0.55 - 9 um)	kg m^{-2} s^{-1}	sedimentation_of_dust_aerosol_0.55-9um	aersdmdum	215032		X		Only available from 26 June 2018 12UTC
Sedimentation of dust aerosol (9 - 20 um)	kg m^{-2} s^{-1}	sedimentation_of_dust_aerosol_9-20um	aersdmdul	215033		X		Only available from 26 June 2018 12UTC
Sedimentation of fine-mode nitrate aerosol	kg m^{-2} s^{-1}	sedimentation_of_fine_mode_nitrate_aerosol	aersdmnif	215193		X		Only available from 9 July 2019 00UTC
Sedimentation of hydrophilic black carbon aerosol	kg m^{-2} s^{-1}	sedimentation_of_hydrophilic_black_carbon_aerosol	aersdmbchphil	215070		X		Only available from 26 June 2018 12UTC
Sedimentation of hydrophilic organic matter aerosol	kg m^{-2} s^{-1}	sedimentation_of_hydrophilic_organic_matter_aerosol	aersdmomhphil	215054		X		Only available from 26 June 2018 12UTC
Sedimentation of hydrophobic black carbon aerosol	kg m^{-2} s^{-1}	sedimentation_of_hydrophobic_black_carbon_aerosol	aersdmbchphob	215069		X		Only available from 26 June 2018 12UTC
Sedimentation of hydrophobic organic matter aerosol	kg m^{-2} s^{-1}	sedimentation_of_hydrophobic_organic_matter_aerosol	aersdmomhphob	215053		X		Only available from 26 June 2018 12UTC
Sedimentation of sea salt aerosol (0.03 - 0.5 um)	kg m^{-2} s^{-1}	sedimentation_of_sea_salt_aerosol_0.03-0.5um	aersdmsss	215007		X		Only available from 26 June 2018 12UTC
Sedimentation of sea salt aerosol (0.5 - 5 um)	kg m^{-2} s^{-1}	sedimentation_of_sea_salt_aerosol_0.5-5um	aersdmssm	215008		X		Only available from 26 June 2018 12UTC
Sedimentation of sea salt aerosol (5 - 20 um)	kg m^{-2} s^{-1}	sedimentation_of_sea_salt_aerosol_5-20um	aersdmssl	215009		X		Only available from 26 June 2018 12UTC
Sedimentation of sulphate aerosol	kg m^{-2} s^{-1}	sedimentation_of_sulphate_aerosol	aersdmsu	215083		X		Only available from 26 June 2018 12UTC
Single scattering albedo at 1020 nm	(0 - 1)	single_scattering_albedo_1020nm	ssa1020	215146		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 1064 nm	(0 - 1)	single_scattering_albedo_1064nm	ssa1064	215147		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 1240 nm	(0 - 1)	single_scattering_albedo_1240nm	ssa1240	215148		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 1640 nm	(0 - 1)	single_scattering_albedo_1640nm	ssa1640	215149		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 2130 nm	(0 - 1)	single_scattering_albedo_2130nm	ssa2130	215178		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 340 nm	(0 - 1)	single_scattering_albedo_340nm	ssa340	215132		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 355 nm	(0 - 1)	single_scattering_albedo_355nm	ssa355	215133		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 380 nm	(0 - 1)	single_scattering_albedo_380nm	ssa380	215134		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 400 nm	(0 - 1)	single_scattering_albedo_400nm	ssa400	215135		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 440 nm	(0 - 1)	single_scattering_albedo_440nm	ssa440	215136		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 469 nm	(0 - 1)	single_scattering_albedo_469nm	ssa469	215137		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 500 nm	(0 - 1)	single_scattering_albedo_500nm	ssa500	215138		X	X	Only available from 26 June 2018 12UTC

Single scattering albedo at 532 nm	(0 - 1)	single_scattering_albedo_532nm	ssa532	215139		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 550 nm	(0 - 1)	single_scattering_albedo_550nm	ssa550	215140		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 645 nm	(0 - 1)	single_scattering_albedo_645nm	ssa645	215141		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 670 nm	(0 - 1)	single_scattering_albedo_670nm	ssa670	215142		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 800 nm	(0 - 1)	single_scattering_albedo_800nm	ssa800	215143		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 858 nm	(0 - 1)	single_scattering_albedo_858nm	ssa858	215144		X	X	Only available from 26 June 2018 12UTC
Single scattering albedo at 865 nm	(0 - 1)	single_scattering_albedo_865nm	ssa865	215145		X	X	Only available from 26 June 2018 12UTC
Skin reservoir content	m of water equivalent	skin_reservoir_content	src	198		X	X	
Skin temperature	K	skin_temperature	skt	235		X	X	
Snow albedo	(0 - 1)	snow_albedo	asn	32		X	X	
Snow depth	m of water equivalent	snow_depth	sd	141		X	X	
Sulphate Aerosol Optical Depth at 550nm	dimensionless	sulphate_aerosol_optical_depth_550nm	suaod550	210212			X	
Sunshine duration	s	sunshine_duration	sund	189		X		
Surface latent heat flux	J m^{-2}	surface_latent_heat_flux	slhf	147		X		
Surface net solar radiation	J m^{-2}	surface_net_solar_radiation	ssr	176		X		
Surface net solar radiation, clear sky	J m^{-2}	surface_net_solar_radiation_clear_sky	ssrc	210		X		
Surface net thermal radiation	J m^{-2}	surface_net_thermal_radiation	str	177		X		
Surface net thermal radiation, clear sky	J m^{-2}	surface_net_thermal_radiation_clear_sky	strc	211		X		
Surface sensible heat flux	J m^{-2}	surface_sensible_heat_flux	sshf	146		X	X	
Surface solar radiation downward clear-sky	J m-2	surface_solar_radiation_downward_clear_sky	ssrdc	228129		X		
Surface solar radiation downwards	J m^{-2}	surface_solar_radiation_downwards	ssrd	169		X		
Surface thermal radiation downward clear-sky	J m^{-2}	surface_thermal_radiation_downward_clear_sky	strdc	228130		X		
Surface thermal radiation downwards	J m^{-2}	surface_thermal_radiation_downwards	strd	175		X		
Time-integrated dry deposition mass flux of Ammonia	kg m^{-2}	time_integrated_dry_deposition_mass_flux_of_ammonia	acc_dry_dep m_NH3	222019		X	X	Available from 28 June 2023
Time-integrated dry deposition mass flux of Dinitrogen pentoxide	kg m^{-2}	time_integrated_dry_deposition_mass_flux_of_dinitrogen_pentoxide	acc_dry_dep m_N2O5	222033		X	X	Available from 28 June 2023
Time-integrated dry deposition mass flux of Nitric acid	kg m^{-2}	time_integrated_dry_deposition_mass_flux_of_nitric_acid	acc_dry_dep m_HNO3	222006		X	X	Available from 28 June 2023
Time-integrated dry deposition mass flux of Nitrogen dioxide	kg m^{-2}	time_integrated_dry_deposition_mass_flux_of_nitrogen_dioxide	acc_dry_dep m_NO2	222031		X	X	Available from 28 June 2023
Time-integrated dry deposition mass flux of Nitrogen monoxide	kg m^{-2}	time_integrated_dry_deposition_mass_flux_of_nitrogen_monoxide	acc_dry_dep m_NO	222027		X	X	Available from 28 June 2023
Time-integrated dry deposition mass flux of Organic nitrates	kg m^{-2}	time_integrated_dry_deposition_mass_flux_of_organic_nitrates	acc_dry_dep m_ONIT	222015		X	X	Available from 28 June 2023
Time-integrated dry deposition mass flux of Ozone	kg m^{-2}	time_integrated_dry_deposition_mass_flux_of_ozone	acc_dry_dep m_O3	222001		X	X	Available from 28 June 2023
Time-integrated dry deposition mass flux of Peroxyacetyl nitrate	kg m^{-2}	time_integrated_dry_deposition_mass_flux_of_peroxyacetyl_nitrate	acc_dry_dep m_PAN	222013		X	X	Available from 28 June 2023
Time-integrated dry deposition mass flux of Sulphur dioxide	kg m^{-2}	time_integrated_dry_deposition_mass_flux_of_sulphur_dioxide	acc_dry_dep m_SO2	222017		X	X	Available from 28 June 2023
Time-integrated wet deposition mass flux of Ammonia	kg m^{-2}	time_integrated_wet_deposition_mass_flux_of_ammonia	acc_wet_dep m_NH3	223019		X	X	Available from 28 June 2023
Time-integrated wet deposition mass flux of Dinitrogen pentoxide	kg m^{-2}	time_integrated_wet_deposition_mass_flux_of_dinitrogen_pentoxide	acc_wet_dep m_N2O5	223033		X	X	Available from 28 June 2023
Time-integrated wet deposition mass flux of Nitric acid	kg m^{-2}	time_integrated_wet_deposition_mass_flux_of_nitric_acid	acc_wet_dep m_HNO3	223006		X	X	Available from 28 June 2023
Time-integrated wet deposition mass flux of Nitrogen dioxide	kg m^{-2}	time_integrated_wet_deposition_mass_flux_of_nitrogen_dioxide	acc_wet_dep m_NO2	223031		X	X	Available from 28 June 2023
Time-integrated wet deposition mass flux of Nitrogen monoxide	kg m^{-2}	time_integrated_wet_deposition_mass_flux_of_nitrogen_monoxide	acc_wet_dep m_NO	223027		X	X	Available from 28 June 2023
Time-integrated wet deposition mass flux of Organic nitrates	kg m^{-2}	time_integrated_wet_deposition_mass_flux_of_organic_nitrates	acc_wet_dep m_ONIT	223015		X	X	Available from 28 June 2023
Time-integrated wet deposition mass flux of Peroxyacetyl nitrate	kg m^{-2}	time_integrated_wet_deposition_mass_flux_of_peroxyacetyl_nitrate	acc_wet_dep m_PAN	223013		X	X	Available from 28 June 2023

Time-integrated wet deposition mass flux of Sulphur dioxide	kg m^{-2}	time_integrated_wet_deposition_mass_flux_of_sulphur_dioxide	acc_wet_dep m_SO2	223017		X	X	Available from 28 June 2023
TOA incident solar radiation	J m^{-2}	toa_incident_solar_radiation	tisr	212		X		
Top net solar radiation	J m^{-2}	top_net_solar_radiation	tsr	178		X		
Top net solar radiation, clear sky	J m^{-2}	top_net_solar_radiation_clear_sky	tsrc	208		X		
Top net thermal radiation	J m^{-2}	top_net_thermal_radiation	ttr	179		X		
Top net thermal radiation, clear sky	J m^{-2}	top_net_thermal_radiation_clear_sky	ttrc	209		X		
Total absorption aerosol optical depth at 1020 nm	dimensionless	total_absorption_aerosol_optical_depth_1020nm	aodabs1020	215110		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 1064 nm	dimensionless	total_absorption_aerosol_optical_depth_1064nm	aodabs1064	215111		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 1240 nm	dimensionless	total_absorption_aerosol_optical_depth_1240nm	aodabs1240	215112		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 1640 nm	dimensionless	total_absorption_aerosol_optical_depth_1640nm	aodabs1640	215113		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 2130 nm	dimensionless	total_absorption_aerosol_optical_depth_2130nm	aodabs2130	215176		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 340 nm	dimensionless	total_absorption_aerosol_optical_depth_340nm	aodabs340	215096		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 355 nm	dimensionless	total_absorption_aerosol_optical_depth_355nm	aodabs355	215097		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 380 nm	dimensionless	total_absorption_aerosol_optical_depth_380nm	aodabs380	215098		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 400 nm	dimensionless	total_absorption_aerosol_optical_depth_400nm	aodabs400	215099		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 440 nm	dimensionless	total_absorption_aerosol_optical_depth_440nm	aodabs440	215100		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 469 nm	dimensionless	total_absorption_aerosol_optical_depth_469nm	aodabs469	215101		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 500 nm	dimensionless	total_absorption_aerosol_optical_depth_500nm	aodabs500	215102		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 532 nm	dimensionless	total_absorption_aerosol_optical_depth_532nm	aodabs532	215103		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 550 nm	dimensionless	total_absorption_aerosol_optical_depth_550nm	aodabs550	215104		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 645 nm	dimensionless	total_absorption_aerosol_optical_depth_645nm	aodabs645	215105		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 670 nm	dimensionless	total_absorption_aerosol_optical_depth_670nm	aodabs670	215106		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 800 nm	dimensionless	total_absorption_aerosol_optical_depth_800nm	aodabs800	215107		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 858 nm	dimensionless	total_absorption_aerosol_optical_depth_858nm	aodabs858	215108		X	X	Only available from 26 June 2018 12UTC
Total absorption aerosol optical depth at 865 nm	dimensionless	total_absorption_aerosol_optical_depth_865nm	aodabs865	215109		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 1020 nm	dimensionless	total_aerosol_optical_depth_1020nm	aod1020	210227		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 1064 nm	dimensionless	total_aerosol_optical_depth_1064nm	aod1064	210228		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 1640 nm	dimensionless	total_aerosol_optical_depth_1640nm	aod1640	210229		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 2130 nm	dimensionless	total_aerosol_optical_depth_2130nm	aod2130	210230		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 340 nm	dimensionless	total_aerosol_optical_depth_340nm	aod340	210217		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 355 nm	dimensionless	total_aerosol_optical_depth_355nm	aod355	210218		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 380 nm	dimensionless	total_aerosol_optical_depth_380nm	aod380	210219		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 400 nm	dimensionless	total_aerosol_optical_depth_400nm	aod400	210220		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 440 nm	dimensionless	total_aerosol_optical_depth_440nm	aod440	210221		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 500 nm	dimensionless	total_aerosol_optical_depth_500nm	aod500	210222		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 532 nm	dimensionless	total_aerosol_optical_depth_532nm	aod532	210223		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 645 nm	dimensionless	total_aerosol_optical_depth_645nm	aod645	210224		X	X	Only available from 26 June 2018 12UTC

Total aerosol optical depth at 800 nm	dimensionless	total_aerosol_optical_depth_800nm	aod800	210225		X	X	Only available from 26 June 2018 12UTC
Total aerosol optical depth at 858 nm	dimensionless	total_aerosol_optical_depth_858nm	aod858	210226		X	X	Only available from 26 June 2018 12UTC
Total cloud cover	(0 - 1)	total_cloud_cover	tcc	164		X	X	
Total column acetone	kg m^{-2}	total_column_acetone	tc_ch3coch3	218052		X	X	Only available from 26 June 2018 12UTC
Total column acetone product	kg m^{-2}	total_column_acetone_product	tc_aco2	218053		X	X	Only available from 06 October 2020 00UTC
Total column acetonitrile	kg m^{-2}	total_column_acetonitrile	tc_CH3CN	218224		X	X	Available from 28 June 2023
Total column aldehydes	kg m^{-2}	total_column_aldehydes	tc_ald2	218012		X	X	Only available from 26 June 2018 12UTC
Total column amine	kg m^{-2}	total_column_amine	tc_nh2	218040		X	X	Only available from 06 October 2020 00UTC
Total column ammonia	kg m^{-2}	total_column_ammonia	tc_nh3	218019		X	X	Only available from 06 October 2020 00UTC
Total column ammonium	kg m^{-2}	total_column_ammonium	tc_nh4	218021		X	X	Only available from 9 July 2019 00UTC
Total column asymmetric chlorine dioxide radical	kg m^{-2}	total_column_asymmetric_chlorine_dioxide_radical	tc_cloo	218198		X	X	Available from 28 June 2023
Total column bromine	kg m^{-2}	total_column_bromine	tc_br2	218192		X	X	Available from 28 June 2023
Total column bromine atom	kg m^{-2}	total_column_bromine_atom	tc_br	218191		X	X	Available from 28 June 2023
Total column bromine monochloride	kg m^{-2}	total_column_bromine_monochloride	tc_brcl	218193		X	X	Available from 28 June 2023
Total column bromine monoxide	kg m^{-2}	total_column_bromine_monoxide	tc_bro	218176		X	X	Available from 28 June 2023
Total column bromine nitrate	kg m^{-2}	total_column_bromine_nitrate	tc_brono2	218194		X	X	Available from 28 June 2023
Total column bromochlorodifluoromethane	kg m^{-2}	total_column_bromochlorodifluoromethane	tc_ha1211	218082		X	X	Available from 28 June 2023
Total column chlorine	kg m^{-2}	total_column_chlorine	tc_cl2	218066		X	X	Available from 28 June 2023
Total column chlorine atom	kg m^{-2}	total_column_chlorine_atom	tc_cl_c	218175		X	X	Available from 28 June 2023
Total column chlorine dioxide	kg m^{-2}	total_column_chlorine_dioxide	tc_oclo	218063		X	X	Available from 28 June 2023
Total column chlorodifluoromethane	kg m^{-2}	total_column_chlorodifluoromethane	tc_hcfc22	218079		X	X	Available from 28 June 2023
Total column chloropentafluoroethane	kg m^{-2}	total_column_chloropentafluoroethane	tc_cfc115	218075		X	X	Available from 28 June 2023
Total column cloud ice water	kg m^{-2}	total_column_cloud_ice_water	tciw	79		X	X	
Total column cloud liquid water	kg m^{-2}	total_column_cloud_liquid_water	tclw	78		X	X	
Total column dibromomethane	kg m^{-2}	total_column_dibromomethane	tc_ch2br2	218195		X	X	Available from 28 June 2023
Total column dichlorine dioxide	kg m^{-2}	total_column_dichlorine_dioxide	tc_cl2o2	218069		X	X	Available from 28 June 2023
Total column dichlorodifluoromethane	kg m^{-2}	total_column_dichlorodifluoromethane	tc_cfc12	218072		X	X	Available from 28 June 2023
Total column dichlorotetrafluoroethane	kg m^{-2}	total_column_dichlorotetrafluoroethane	tc_cfc114	218074		X	X	Available from 28 June 2023
Total column dimethyl sulfide	kg m^{-2}	total_column_dimethyl_sulfide	tc_dms	218018		X	X	Only available from 06 October 2020 00UTC
Total column dinitrogen pentoxide	kg m^{-2}	total_column_dinitrogen_pentoxide	tc_n2o5	218033		X	X	Only available from 06 October 2020 00UTC
Total column ethanol	kg m^{-2}	total_column_ethanol	tc_c2h5oh	218046		X	X	Only available from 26 June 2018 12UTC
Total column ethene	kg m^{-2}	total_column_ethene	tc_c2h4	218010		X	X	Only available from 26 June 2018 12UTC
Total column formic acid	kg m^{-2}	total_column_formic_acid	tc_hcooh	218043		X	X	Only available from 26 June 2018 12UTC
Total column Glyoxal	kg m^{-2}	total_column_glyoxal	tc_glyoxal	218107		X	X	Available from 28 June 2023
Total column hydrogen bromide	kg m^{-2}	total_column_hydrogen_bromide	tc_hbr	218068		X	X	Available from 28 June 2023
Total column hydrogen fluoride	kg m^{-2}	total_column_hydrogen_fluoride	tc_hf	218202		X	X	Available from 28 June 2023

Total column hydroperoxy radical	kg m^{-2}	total_column_hydroperoxy_radical	tc_ho2	218028		X	X	Only available from 20 June 2017 00UTC
Total column of hypobromous acid	kg m^{-2}	total_column_hypobromous_acid	tc_hobr	218070		X	X	Available from 28 June 2023
Total column of hypochlorous acid	kg m^{-2}	total_column_hypochlorous_acid	tc_hocl	218065		X	X	Available from 28 June 2023
Total column HYPROPO2	kg m^{-2}	total_column_hypropo2	tc_hypropo2	218055		X	X	Only available from 06 October 2020 00UTC
Total column IC3H7O2	kg m^{-2}	total_column_ic3h7o2	tc_ic3h7o2	218054		X	X	Only available from 06 October 2020 00UTC
Total column lead	kg m^{-2}	total_column_lead	tc_pb	218026		X	X	Only available from 06 October 2020 00UTC
Total column methacrolein MVK	kg m^{-2}	total_column_methacrolein_mvk	tc_ispd	218050		X	X	Only available from 06 October 2020 00UTC
Total column methacrylic acid	kg m^{-2}	total_column_methacrylic_acid	tc_mcooh	218044		X	X	Only available from 06 October 2020 00UTC
Total column methane sulfonic acid	kg m^{-2}	total_column_methane_sulfonic_acid	tc_msa	218022		X	X	Only available from 06 October 2020 00UTC
Total column methanol	kg m^{-2}	total_column_methanol	tc_ch3oh	218042		X	X	Only available from 26 June 2018 12UTC
Total column of methyl bromide	kg m^{-2}	total_column_methyl_bromide	tc_ch3br	218080		X	X	Available from 28 June 2023
Total column of methyl chloride	kg m^{-2}	total_column_methyl_chloride	tc_ch3cl	218078		X	X	Available from 28 June 2023
Total column of methyl chloroform	kg m^{-2}	total_column_methyl_chloroform	tc_ch3ccl3	218077		X	X	Available from 28 June 2023
Total column methyl glyoxal	kg m^{-2}	total_column_methyl_glyoxal	tc_ch3cocho	218023		X	X	Only available from 06 October 2020 00UTC
Total column methyl peroxide	kg m^{-2}	total_column_methyl_peroxide	tc_ch3ooh	218007		X	X	Only available from 26 June 2018 12UTC
Total column methylperoxy radical	kg m^{-2}	total_column_methylperoxy_radical	tc_ch3o2	218029		X	X	Only available from 06 October 2020 00UTC
Total column nitrate	kg m^{-2}	total_column_nitrate	tc_no3_a	218051		X	X	Only available from 06 October 2020 00UTC
Total column nitrate radical	kg m^{-2}	total_column_nitrate_radical	tc_no3	218032		X	X	Only available from 06 October 2020 00UTC
Total column nitrogen oxides Transp	kg m^{-2}	total_column_nitrogen_oxides_transp	tc_noxa	218056		X	X	Only available from 06 October 2020 00UTC
Total column of nitryl chloride	kg m^{-2}	total_column_nitryl_chloride	tc_clno2	218067		X	X	Available from 28 June 2023
Total column NO to alkyl nitrate operator	kg m^{-2}	total_column_no_to_alkyl_nitrate_operator	tc_xo2n	218039		X	X	Only available from 06 October 2020 00UTC
Total column NO to NO2 operator	kg m^{-2}	total_column_no_to_no2_operator	tc_xo2	218038		X	X	Only available from 06 October 2020 00UTC
Total column olefins	kg m^{-2}	total_column_olefins	tc_ole	218011		X	X	Only available from 26 June 2018 12UTC
Total column organic ethers	kg m^{-2}	total_column_organic_ethers	tc_ror	218036		X	X	Only available from 06 October 2020 00UTC
Total column organic nitrates	kg m^{-2}	total_column_organic_nitrates	tc_onit	218015		X	X	Only available from 26 June 2018 12UTC
Total column paraffins	kg m^{-2}	total_column_paraffins	tc_par	218009		X	X	Only available from 26 June 2018 12UTC
Total column pernitric acid	kg m^{-2}	total_column_pernitric_acid	tc_ho2no2	218034		X	X	Only available from 06 October 2020 00UTC
Total column peroxides	kg m^{-2}	total_column_peroxides	tc_rooh	218014		X	X	Only available from 06 October 2020 00UTC
Total column peroxy acetyl radical	kg m^{-2}	total_column_peroxy_acetyl_radical	tc_c2o3	218035		X	X	Only available from 06 October 2020 00UTC
Total column polar stratospheric cloud	kg m^{-2}	total_column_polar_stratospheric_cloud	tc_psc	218041		X	X	Only available from 06 October 2020 00UTC
Total column propene	kg m^{-2}	total_column_propene	tc_c3h6	218048		X	X	Only available from 06 October 2020 00UTC
Total column Radon	kg m^{-2}	total_column_radon	tcra	210183		X	X	Only available from 06 October 2020 00UTC
Total column rain water	kg m^{-2}	total_column_rain_water	tcrw	228089		X	X	Only available from 21 June 2016 00UTC
Total column snow water	kg m^{-2}	total_column_snow_water	tcsw	228090		X	X	Only available from 21 June 2016 00UTC
Source/gain of ammonium aerosol	kg m^{-2} s^{-1}	total_column_source_of_ammonium_aerosol	aersrcam	215205		X		Only available from 9 July 2019 00UTC

Source/gain of coarse-mode nitrate aerosol	kg m^{-2} s^{-1}	total_column_source_of_coarse_mode_nitrate_aerosol	aersrcnic	215190		X		Only available from 9 July 2019 00UTC
Source/gain of dust aerosol (0.03 - 0.55 um)	kg m^{-2} s^{-1}	total_column_source_of_dust_aerosol_0.03-0.55um	aersrcdus	215025		X		Only available from 26 June 2018 12UTC
Source/gain of dust aerosol (0.55 - 9 um)	kg m^{-2} s^{-1}	total_column_source_of_dust_aerosol_0.55-9um	aersrcdum	215026		X		Only available from 26 June 2018 12UTC
Source/gain of dust aerosol (9 - 20 um)	kg m^{-2} s^{-1}	total_column_source_of_dust_aerosol_9-20um	aersrcdul	215027		X		Only available from 26 June 2018 12UTC
Source/gain of fine-mode nitrate aerosol	kg m^{-2} s^{-1}	total_column_source_of_fine_mode_nitrate_aerosol	aersrcnif	215189		X		Only available from 26 June 2018 12UTC
Source/gain of hydrophilic black carbon aerosol	kg m^{-2} s^{-1}	total_column_source_of_hydrophilic_black_carbon_aerosol	aersrcbchphil	215066		X		Only available from 26 June 2018 12UTC
Source/gain of hydrophilic organic matter aerosol	kg m^{-2} s^{-1}	total_column_source_of_hydrophilic_organic_matter_aerosol	aersrcomhphil	215050		X		Only available from 26 June 2018 12UTC
Source/gain of hydrophobic black carbon aerosol	kg m^{-2} s^{-1}	total_column_source_of_hydrophobic_black_carbon_aerosol	aersrcbchphob	215065		X		Only available from 26 June 2018 12UTC
Source/gain of hydrophobic organic matter aerosol	kg m^{-2} s^{-1}	total_column_source_of_hydrophobic_organic_matter_aerosol	aersrcomhphob	215049		X		Only available from 26 June 2018 12UTC
Source/gain of sea salt aerosol (0.03 - 0.5 um)	kg m^{-2} s^{-1}	total_column_source_of_sea_salt_aerosol_0.03-0.5um	aersrcsss	215001		X		Only available from 26 June 2018 12UTC
Source/gain of sea salt aerosol (0.5 - 5 um)	kg m^{-2} s^{-1}	total_column_source_of_sea_salt_aerosol_0.5-5um	aersrcssm	215002		X		Only available from 26 June 2018 12UTC
Source/gain of sea salt aerosol (5 - 20 um)	kg m^{-2} s^{-1}	total_column_source_of_sea_salt_aerosol_5-20um	aersrcssl	215003		X		Only available from 26 June 2018 12UTC
Source/gain of sulphate aerosol	kg m^{-2} s^{-1}	total_column_source_of_sulphate_aerosol	aersrcsu	215081		X		Only available from 26 June 2018 12UTC
Total column stratospheric ozone	kg m^{-2}	total_column_stratospheric_ozone	tc_o3s	218024		X	X	Only available from 20 June 2017 00UTC
Total column supercooled liquid water	kg m^{-2}	total_column_supercooled_liquid_water	tcslw	228088		X		Only available from 21 June 2016 00UTC
Total column terpenes	kg m^{-2}	total_column_terpenes	tc_c10h16	218049		X	X	Only available from 06 October 2020 00UTC
Total column of tetrachloromethane	kg m^{-2}	total_column_tetrachloromethane	tc_ccl4	218076		X	X	Available from 28 June 2023
Total column of tribromomethane	kg m^{-2}	total_column_tribromomethane	tc_chbr3	218197		X	X	Available from 28 June 2023
Total column of trichlorofluoromethane	kg m^{-2}	total_column_trichlorofluoromethane	tc_cfc11	218071		X	X	Available from 28 June 2023
Total column of trichlorotrifluoroethane	kg m^{-2}	total_column_trichlorotrifluoroethane	tc_cfc113	218073		X	X	Available from 28 June 2023
Total column of trifluorobromomethane	kg m^{-2}	total_column_trifluorobromomethane	tc_ha1301	218083		X	X	Available from 28 June 2023
Total column water	kg m^{-2}	total_column_water	tcw	136		X	X	
Total column of water vapour (chemistry)	kg m^{-2}	total_column_water_vapour_chemistry	tc_h2o	218059		X	X	Available from 28 June 2023
Total fine mode (r < 0.5 um) aerosol optical depth at 1020 nm	dimensionless	total_fine_mode_aerosol_optical_depth_1020nm	aodfm1020	215128		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 1064 nm	dimensionless	total_fine_mode_aerosol_optical_depth_1064nm	aodfm1064	215129		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 1240 nm	dimensionless	total_fine_mode_aerosol_optical_depth_1240nm	aodfm1240	215130		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 1640 nm	dimensionless	total_fine_mode_aerosol_optical_depth_1640nm	aodfm1640	215131		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 2130 nm	dimensionless	total_fine_mode_aerosol_optical_depth_2130nm	aodfm2130	215177		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 340 nm	dimensionless	total_fine_mode_aerosol_optical_depth_340nm	aodfm340	215114		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 355 nm	dimensionless	total_fine_mode_aerosol_optical_depth_355nm	aodfm355	215115		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 380 nm	dimensionless	total_fine_mode_aerosol_optical_depth_380nm	aodfm380	215116		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 400 nm	dimensionless	total_fine_mode_aerosol_optical_depth_400nm	aodfm400	215117		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 440 nm	dimensionless	total_fine_mode_aerosol_optical_depth_440nm	aodfm440	215118		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 469 nm	dimensionless	total_fine_mode_aerosol_optical_depth_469nm	aodfm469	215119		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 500 nm	dimensionless	total_fine_mode_aerosol_optical_depth_500nm	aodfm500	215120		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 532 nm	dimensionless	total_fine_mode_aerosol_optical_depth_532nm	aodfm532	215121		X	X	Only available from 26 June 2018 12UTC

Total fine mode (r < 0.5 um) aerosol optical depth at 550 nm	dimensionless	total_fine_mode_aerosol_optical_depth_550nm	aodfm550	215122		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 645 nm	dimensionless	total_fine_mode_aerosol_optical_depth_645nm	aodfm645	215123		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 670 nm	dimensionless	total_fine_mode_aerosol_optical_depth_670nm	aodfm670	215124		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 800 nm	dimensionless	total_fine_mode_aerosol_optical_depth_800nm	aodfm800	215125		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 858 nm	dimensionless	total_fine_mode_aerosol_optical_depth_858nm	aodfm858	215126		X	X	Only available from 26 June 2018 12UTC
Total fine mode (r < 0.5 um) aerosol optical depth at 865 nm	dimensionless	total_fine_mode_aerosol_optical_depth_865nm	aodfm865	215127		X	X	Only available from 26 June 2018 12UTC
Total precipitation	m	total_precipitation	tp	228		X		
Total sky direct solar radiation at surface	J m^{-2}	total_sky_direct_solar_radiation_at_surface	fdir	228021		X		
Vertically integrated mass of ammonium aerosol	kg m^{-2}	vertically_integrated_mass_of_ammonium_aerosol	aermssam	215211		X	X	Only available from 9 July 2019 00UTC
Vertically integrated mass of coarse-mode nitrate aerosol	kg m^{-2}	vertically_integrated_mass_of_coarse_mode_nitrate_aerosol	aermssnic	215202		X	X	Only available from 9 July 2019 00UTC
Vertically integrated mass of dust aerosol (0.03 - 0.55 um)	kg m^{-2}	vertically_integrated_mass_of_dust_aerosol_0.03-0.55um	aermssdus	215043		X	X	Only available from 26 September 2017 00UTC
Vertically integrated mass of dust aerosol (0.55 - 9 um)	kg m^{-2}	vertically_integrated_mass_of_dust_aerosol_0.55-9um	aermssdum	215044		X	X	Only available from 26 September 2017 00UTC
Vertically integrated mass of dust aerosol (9 - 20 um)	kg m^{-2}	vertically_integrated_mass_of_dust_aerosol_9-20um	aermssdul	215045		X	X	Only available from 26 September 2017 00UTC
Vertically integrated mass of fine-mode nitrate aerosol	kg m^{-2}	vertically_integrated_mass_of_fine_mode_nitrate_aerosol	aermssnif	215201		X	X	Only available from 9 July 2019 00UTC
Vertically integrated mass of hydrophilic black carbon aerosol	kg m^{-2}	vertically_integrated_mass_of_hydrophilic_black_carbon_aerosol	aermssbchphil	215078		X	X	Only available from 26 September 2017 00UTC
Vertically integrated mass of hydrophilic organic matter aerosol	kg m^{-2}	vertically_integrated_mass_of_hydrophilic_organic_matter_aerosol	aermssomhphil	215062		X	X	Only available from 26 September 2017 00UTC
Vertically integrated mass of hydrophobic black carbon aerosol	kg m^{-2}	vertically_integrated_mass_of_hydrophobic_black_carbon_aerosol	aermssbchphob	215077		X	X	Only available from 26 September 2017 00UTC
Vertically integrated mass of hydrophobic organic matter aerosol	kg m^{-2}	vertically_integrated_mass_of_hydrophobic_organic_matter_aerosol	aermssomhphob	215061		X	X	Only available from 26 September 2017 00UTC
Vertically integrated mass of sea salt aerosol (0.03 - 0.5 um)	kg m^{-2}	vertically_integrated_mass_of_sea_salt_aerosol_0.03-0.5um	aermssssss	215019		X	X	Only available from 26 September 2017 00UTC
Vertically integrated mass of sea salt aerosol (0.5 - 5 um)	kg m^{-2}	vertically_integrated_mass_of_sea_salt_aerosol_0.5-5um	aermssssm	215020		X	X	Only available from 26 September 2017 00UTC
Vertically integrated mass of sea salt aerosol (5 - 20 um)	kg m^{-2}	vertically_integrated_mass_of_sea_salt_aerosol_5-20um	aermssssl	215021		X	X	Only available from 26 September 2017 00UTC
Vertically integrated mass of sulphate aerosol	kg m^{-2}	vertically_integrated_mass_of_sulphate_aerosol	aermsssu	215087		X	X	Only available from 26 September 2017 00UTC
Vertically integrated moisture divergence	kg m^{-2}	vertically_integrated_moisture_divergence	vimd	213		X		Only available from 21 June 2016 00UTC
Visibility	km	visibility	vis	3020		X		Only available from 21 June 2016 00UTC
Wet deposition of ammonium aerosol by convective precipitation	kg m^{-2} s^{-1}	wet_deposition_of_ammonium_aerosol_by_convective_precipitation	aerwdcam	215209		X		Only available from 9 July 2019 00UTC
Wet deposition of ammonium aerosol by large-scale precipitation	kg m^{-2} s^{-1}	wet_deposition_of_ammonium_aerosol_by_large_scale_precipitation	aerwdlam	215208		X		Only available from 9 July 2019 00UTC
Wet deposition of coarse-mode nitrate aerosol by convective precipitation	kg m^{-2} s^{-1}	wet_deposition_of_coarse_mode_nitrate_aerosol_by_convective_precipitation	aerwdcnic	215198		X		Only available from 9 July 2019 00UTC
Wet deposition of coarse-mode nitrate aerosol by large-scale precipitation	kg m^{-2} s^{-1}	wet_deposition_of_coarse_mode_nitrate_aerosol_by_large_scale_precipitation	aerwdlnic	215196		X		Only available from 9 July 2019 00UTC
Wet deposition of dust aerosol (0.03 - 0.55 um) by convective precipitation	kg m^{-2} s^{-1}	wet_deposition_of_dust_aerosol_0.03-0.55um_by_convective_precipitation	aerwdccdus	215037		X		Only available from 26 June 2018 12UTC
Wet deposition of dust aerosol (0.03 - 0.55 um) by large-scale precipitation	kg m^{-2} s^{-1}	wet_deposition_of_dust_aerosol_0.03-0.55um_by_large_scale_precipitation	aerwdlsdus	215034		X		Only available from 26 June 2018 12UTC
Wet deposition of dust aerosol (0.55 - 9 um) by convective precipitation	kg m^{-2} s^{-1}	wet_deposition_of_dust_aerosol_0.55-9um_by_convective_precipitation	aerwdccdum	215038		X		Only available from 26 June 2018 12UTC
Wet deposition of dust aerosol (0.55 - 9 um) by large-scale precipitation	kg m^{-2} s^{-1}	wet_deposition_of_dust_aerosol_0.55-9um_by_large_scale_precipitation	aerwdlsdum	215035		X		Only available from 26 June 2018 12UTC
Wet deposition of dust aerosol (9 - 20 um) by convective precipitation	kg m^{-2} s^{-1}	wet_deposition_of_dust_aerosol_9-20um_by_convective_precipitation	aerwdccdul	215039		X		Only available from 26 June 2018 12UTC
Wet deposition of dust aerosol (9 - 20 um) by large-scale precipitation	kg m-2 s-1	wet_deposition_of_dust_aerosol_9-20um_by_large_scale_precipitation	aerwdlsdul	215036		X		Only available from 26 June 2018 12UTC
Wet deposition of fine-mode nitrate aerosol by convective precipitation	kg m-2 s-1	wet_deposition_of_fine_mode_nitrate_aerosol_by_convective_precipitation	aerwdcnif	215197		X		Only available from 26 June 2018 12UTC
Wet deposition of fine-mode nitrate aerosol by large-scale precipitation	kg m-2 s-1	wet_deposition_of_fine_mode_nitrate_aerosol_by_large_scale_precipitation	aerwdlnif	215195		X		Only available from 26 June 2018 12UTC

Wet deposition of hydrophilic black carbon aerosol by convective precipitation	kg m-2 s-1	wet_deposition_of_hydrophilic_black_carbon_aerosol_by_convective_precipitation	aerwdccbchphil	215074		X		Only available from 26 June 2018 12UTC
Wet deposition of hydrophilic black carbon aerosol by large-scale precipitation	kg m-2 s-1	wet_deposition_of_hydrophilic_black_carbon_aerosol_by_large_scale_precipitation	aerwdlsbchphil	215072		X		Only available from 26 June 2018 12UTC
Wet deposition of hydrophilic organic matter aerosol by convective precipitation	kg m-2 s-1	wet_deposition_of_hydrophilic_organic_matter_aerosol_by_convective_precipitation	aerwdccomhphil	215058		X		Only available from 26 June 2018 12UTC
Wet deposition of hydrophilic organic matter aerosol by large-scale precipitation	kg m-2 s-1	wet_deposition_of_hydrophilic_organic_matter_aerosol_by_large_scale_precipitation	aerwdlsomhphil	215056		X		Only available from 26 June 2018 12UTC
Wet deposition of hydrophobic black carbon aerosol by convective precipitation	kg m-2 s-1	wet_deposition_of_hydrophobic_black_carbon_aerosol_by_convective_precipitation	aerwdccbchphob	215073		X		Only available from 26 June 2018 12UTC
Wet deposition of hydrophobic black carbon aerosol by large-scale precipitation	kg m-2 s-1	wet_deposition_of_hydrophobic_black_carbon_aerosol_by_large_scale_precipitation	aerwdlsbchphob	215071		X		Only available from 26 June 2018 12UTC
Wet deposition of hydrophobic organic matter aerosol by convective precipitation	kg m-2 s-1	wet_deposition_of_hydrophobic_organic_matter_aerosol_by_convective_precipitation	aerwdccomhphob	215057		X		Only available from 26 June 2018 12UTC
Wet deposition of hydrophobic organic matter aerosol by large-scale precipitation	kg m-2 s-1	wet_deposition_of_hydrophobic_organic_matter_aerosol_by_large_scale_precipitation	aerwdlsomhphob	215055		X		Only available from 26 June 2018 12UTC
Wet deposition of sea salt aerosol (0.03 - 0.5 um) by convective precipitation	kg m-2 s-1	wet_deposition_of_sea_salt_aerosol_0.03-0.5um_by_convective_precipitation	aerwdccsss	215013		X		Only available from 26 June 2018 12UTC
Wet deposition of sea salt aerosol (0.03 - 0.5 um) by large-scale precipitation	kg m-2 s-1	wet_deposition_of_sea_salt_aerosol_0.03-0.5um_by_large_scale_precipitation	aerwdlssss	215010		X		Only available from 26 June 2018 12UTC
Wet deposition of sea salt aerosol (0.5 - 5 um) by convective precipitation	kg m-2 s-1	wet_deposition_of_sea_salt_aerosol_0.5-5um_by_convective_precipitation	aerwdccssm	215014		X		Only available from 26 June 2018 12UTC
Wet deposition of sea salt aerosol (0.5 - 5 um) by large-scale precipitation	kg m-2 s-1	wet_deposition_of_sea_salt_aerosol_0.5-5um_by_large_scale_precipitation	aerwdlsssm	215011		X		Only available from 26 June 2018 12UTC
Wet deposition of sea salt aerosol (5 - 20 um) by convective precipitation	kg m-2 s-1	wet_deposition_of_sea_salt_aerosol_5-20um_by_convective_precipitation	aerwdccssl	215015		X		Only available from 26 June 2018 12UTC
Wet deposition of sea salt aerosol (5 - 20 um) by large-scale precipitation	kg m-2 s-1	wet_deposition_of_sea_salt_aerosol_5-20um_by_large_scale_precipitation	aerwdlsssl	215012		X		Only available from 26 June 2018 12UTC
Wet deposition of sulphate aerosol by convective precipitation	kg m-2 s-1	wet_deposition_of_sulphate_aerosol_by_convective_precipitation	aerwdccsu	215085		X		Only available from 26 June 2018 12UTC
Wet deposition of sulphate aerosol by large-scale precipitation	kg m-2 s-1	wet_deposition_of_sulphate_aerosol_by_large_scale_precipitation	aerwdlssu	215084		X		Only available from 26 June 2018 12UTC

Table 3: Multi-level Fast access parameters (last reviewed on 02 Aug 2023)

Name	Units	Variable name in CDS API	Shortname	Param ID	Access type	fc	an	Note
Ammonium aerosol mass mixing ratio	kg kg-1	ammonium_aerosol_mass_mixing_ratio	aermr18	210249	Fast access	X	X	
Anthropogenic secondary organic aerosol mass mixing ratio	kg kg-1	anthropogenic_secondary_organic_aerosol_mixing_ratio	aermr20	210253	Fast access			Available from 28 June 2023
Biogenic secondary organic aerosol mass mixing ratio	kg kg-1	biogenic_secondary_organic_aerosol_mixing_ratio	aermr19	210252	Fast access			Available from 28 June 2023
Carbon monoxide	kg kg-1	carbon_monoxide	co	210123	Fast access	X	X	
Chlorine monoxide	kg kg-1	chlorine_monoxide	clo	217174	Fast access	X	X	Available from 28 June 2023
Chlorine nitrate	kg kg-1	chlorine_nitrate	clono2	217064	Fast access	X	X	Available from 28 June 2023
Dust Aerosol (0.03 - 0.55 um) Mixing Ratio	kg kg-1	dust_aerosol_0.03-0.55um_mixing_ratio	aermr04	210004	Fast access	X	X	
Dust Aerosol (0.55 - 0.9 um) Mixing Ratio	kg kg-1	dust_aerosol_0.55-0.9um_mixing_ratio	aermr05	210005	Fast access	X	X	
Dust Aerosol (0.9 - 20 um) Mixing Ratio	kg kg-1	dust_aerosol_0.9-20um_mixing_ratio	aermr06	210006	Fast access	X	X	
Ethane	kg kg-1	ethane	c2h6	217045	Fast access	X	X	
Formaldehyde	kg kg-1	formaldehyde	hcho	210124	Fast access	X	X	
Hydrogen chloride	kg kg-1	hydrogen_chloride	hcl	217200		X	X	Available from 28 June 2023
Hydrogen cyanide	kg kg-1	hydrogen_cyanide	HCN	217226		X	X	Available from 28 June 2023
Hydrogen peroxide	kg kg-1	hydrogen_peroxide	h2o2	217003	Fast access	X	X	
Hydrophilic Black Carbon Aerosol Mixing Ratio	kg kg-1	hydrophilic_black_carbon_aerosol_mixing_ratio	aermr09	210009	Fast access	X	X	
Hydrophilic Organic Matter Aerosol Mixing Ratio	kg kg-1	hydrophilic_organic_matter_aerosol_mixing_ratio	aermr07	210007	Fast access	X	X	
Hydrophobic Black Carbon Aerosol Mixing Ratio	kg kg-1	hydrophobic_black_carbon_aerosol_mixing_ratio	aermr10	210010	Fast access	X	X	

Hydrophobic Organic Matter Aerosol Mixing Ratio	kg kg-1	hydrophobic_organic_matter_aerosol_mixing_ratio	aermr08	210008	Fast access	X	X	
Hydroxyl radical	kg kg-1	hydroxyl_radical	oh	217030	Fast access	X	X	
Isoprene	kg kg-1	isoprene	c5h8	217016	Fast access	X	X	
Logarithm of surface pressure	~	logarithm_of_surface_pressure	lnsp	152	Fast access	X	X	Available only at level=1
Methane	kg kg-1	methane	ch4_c	217004	Fast access	X	X	Differences between CH4 and CH4_C
Nitrate coarse mode aerosol mass mixing ratio	kg kg-1	nitrate_coarse_mode_aerosol_mass_mixing_ratio	aermr17	210248	Fast access	X	X	
Nitrate fine mode aerosol mass mixing ratio	kg kg-1	nitrate_fine_mode_aerosol_mass_mixing_ratio	aermr16	210247	Fast access	X	X	
Nitric acid	kg kg-1	nitric_acid	hno3	217006	Fast access	X	X	
Nitrogen dioxide	kg kg-1	nitrogen_dioxide	no2	210121	Fast access	X	X	
Nitrogen monoxide	kg kg-1	nitrogen_monoxide	no	217027	Fast access	X	X	
Ozone	kg kg-1	ozone	go3	210203	Fast access	X	X	
Peroxyacetyl nitrate	kg kg-1	peroxyacetyl_nitrate	pan	217013	Fast access	X	X	
Propane	kg kg-1	propane	c3h8	217047	Fast access	X	X	
Sea Salt Aerosol (0.03 - 0.5 um) Mixing Ratio	kg kg-1	sea_salt_aerosol_0.03-0.5um_mixing_ratio	aermr01	210001	Fast access	X	X	CAMS global sea salt aerosol mixing ratios
Sea Salt Aerosol (0.5 - 5 um) Mixing Ratio	kg kg-1	sea_salt_aerosol_0.5-5um_mixing_ratio	aermr02	210002	Fast access	X	X	CAMS global sea salt aerosol mixing ratios
Sea Salt Aerosol (5 - 20 um) Mixing Ratio	kg kg-1	sea_salt_aerosol_5-20um_mixing_ratio	aermr03	210003	Fast access	X	X	CAMS global sea salt aerosol mixing ratios
Specific humidity	kg kg-1	specific_humidity	q	133	Fast access	X	X	
Sulphate Aerosol Mixing Ratio	kg kg-1	sulphate_aerosol_mixing_ratio	aermr11	210011	Fast access	X	X	
Sulphur dioxide	kg kg-1	sulphur_dioxide	so2	210122	Fast access	X	X	
Temperature	K	temperature	t	130	Fast access	X	X	
U component of wind	m s-1	u_component_of_wind	u	131	Fast access	X	X	
V component of wind	m s-1	v_component_of_wind	v	132	Fast access	X	X	

Table 4: Multi-level Slow access parameters (last reviewed on 02 Aug 2023)

Name	Units	Variable name in CDS API	Shortname	Param ID	Access type	fc	an	Note
Acetone	kg kg-1	acetone	ch3coch3	217052		X	X	
Acetone product	kg kg-1	acetone_product	aco2	217053		X	X	
Acetonitrile	kg kg-1		CH3CN	217224		X	X	Available from 28 June 2023
Aerosol extinction coefficient at 1064 nm	m-1	aerosol_extinction_coefficient_1064nm	aerext1064	215182		X		Only available from 26 September 2017 00UTC
Aerosol extinction coefficient at 355 nm	m-1	aerosol_extinction_coefficient_355nm	aerext355	215180		X		Only available from 26 September 2017 00UTC
Aerosol extinction coefficient at 532 nm	m-1	aerosol_extinction_coefficient_532nm	aerext532	215181		X		Only available from 26 September 2017 00UTC
Aldehydes	kg kg-1	aldehydes	ald2	217012		X	X	
Amine	kg kg-1	amine	nh2	217040		X	X	
Ammonia	kg kg-1	ammonia	nh3	217019		X	X	
Ammonium	kg kg-1	ammonium	nh4	217021		X	X	
Aerosol backscatter coefficient at 1064 nm (from ground)	m-1 sr-1	attenuated_backscatter_due_to_aerosol_1064nm_from_ground	aerbackscatgnd1064	215188		X		Only available from 26 September 2017 00UTC
Aerosol backscatter coefficient at 1064 nm (from top of atmosphere)	m-1 sr-1	attenuated_backscatter_due_to_aerosol_1064nm_from_top_of_atmosphere	aerbackscattoa1064	215185		X		Only available from 26 September 2017 00UTC
Aerosol backscatter coefficient at 355 nm (from ground)	m-1 sr-1	attenuated_backscatter_due_to_aerosol_355nm_from_ground	aerbackscatgnd355	215186		X		Only available from 26 September 2017 00UTC

Aerosol backscatter coefficient at 355 nm (from top of atmosphere)	m-1 sr-1	attenuated_backscatter_due_to_aerosol_355nm_from_top_of_atmosphere	aerbackscattoa355	215183		X		Only available from 26 September 2017 00UTC
Aerosol backscatter coefficient at 532 nm (from ground)	m-1 sr-1	attenuated_backscatter_due_to_aerosol_532nm_from_ground	aerbackscatgnd532	215187		X		Only available from 26 September 2017 00UTC
Aerosol backscatter coefficient at 532 nm (from top of atmosphere)	m-1 sr-1	attenuated_backscatter_due_to_aerosol_532nm_from_top_of_atmosphere	aerbackscattoa532	215184		X		Only available from 26 September 2017 00UTC
Anthropogenic secondary organic aerosol mass mixing ratio	kg kg-1	anthropogenic_secondary_organic_aerosol_mixing_ratio	aermr20	210253		X	X	Available from 28 June 2023
Asymmetric chlorine dioxide radical								
Biogenic secondary organic aerosol mass mixing ratio	kg kg-1	biogenic_secondary_organic_aerosol_mixing_ratio	aermr19	210252		X	X	Available from 28 June 2023
Bromine	kg kg-1	bromine	br2	217192		X	X	Available from 28 June 2023
Bromine atom	kg kg-1	bromine_atom	br	217191		X	X	Available from 28 June 2023
Bromine monochloride	kg kg-1	bromine_monochloride	brcl	217193		X	X	Available from 28 June 2023
Bromine monoxide	kg kg-1	bromine_monoxide	bro	217176		X	X	Available from 28 June 2023
Bromine nitrate	kg kg-1	bromine_nitrate	brono2	217194		X	X	Available from 28 June 2023
Bromochlorodifluoromethane	kg kg-1	bromochlorodifluoromethane	ha1211	217082		X	X	Available from 28 June 2023
Chlorine	kg kg-1	chlorine	cl2	217066		X	X	Available from 28 June 2023
Chlorine atom	kg kg-1	chlorine_atom	cl_c	217175		X	X	Available from 28 June 2023
Chlorine dioxide	kg kg-1	chlorine_dioxide	oclo	217063		X	X	Available from 28 June 2023
Chlorodifluoromethane	kg kg-1	chlorodifluoromethane	hcfc22	217079		X	X	Available from 28 June 2023
Chloropentafluoroethane	kg kg-1	chloropentafluoroethane	cfc115	217075		X	X	Available from 28 June 2023
Dibromomethane	kg kg-1	dibromomethane	ch2br2	217195		X	X	Available from 28 June 2023
Dichlorine dioxide	kg kg-1	dichlorine_dioxide	cl2o2	217069		X	X	Available from 28 June 2023
Dichlorodifluoromethane	kg kg-1	dichlorodifluoromethane	cfc12	217072		X	X	Available from 28 June 2023
Dichlorotetrafluoroethane	kg kg-1	dichlorotetrafluoroethane	cfc114	217074		X	X	Available from 28 June 2023
Dimethyl sulfide	kg kg-1	dimethyl_sulfide	dms	217018		X	X	
Dinitrogen pentoxide	kg kg-1	dinitrogen_pentoxide	n2o5	217033		X	X	
Ethanol	kg kg-1	ethanol	c2h5oh	217046		X	X	
Ethene	kg kg-1	ethene	c2h4	217010		X	X	
Formic acid	kg kg-1	formic_acid	hcooh	217043		X	X	
Fraction of cloud cover	(0 - 1)	fraction_of_cloud_cover	cc	248		X	X	
Geopotential	$m^2 s^{-2}$	geopotential	z	129		X	X	
Glyoxal	kg kg-1	glyoxal	glyoxal	217107		X	X	Available from 28 June 2023
Hydrogen bromide	kg kg-1	hydrogen_bromide	hbr	217068		X	X	Available from 28 June 2023
Hydrogen fluoride	kg kg-1	hydrogen_fluoride	hf	217202		X	X	Available from 28 June 2023
Hydroperoxy radical	kg kg-1	hydroperoxy_radical	ho2	217028		X	X	
Hypobromous acid	kg kg-1	hypobromous_acid	hobr	217070		X	X	Available from 28 June 2023
Hypochlorous acid	kg kg-1	hypochlorous_acid	hocl	217065		X	X	Available from 28 June 2023
Logarithm of surface pressure	Numeric	logarithm_of_surface_pressure	lnsp	152		X	X	
Lead	kg kg-1	lead	pb	217026		X	X	
Methacrolein MVK	kg kg-1	methacrolein_mvk	ispd	217050			X	
Methacrylic acid	kg kg-1	methacrylic_acid	mcooh	217044		X	X	
Methane sulfonic acid	kg kg-1	methane_sulfonic_acid	msa	217022		X	X	
Methanol	kg kg-1	methanol	ch3oh	217042		X	X	
Methyl bromide	kg kg-1	methyl_bromide	ch3br	217080		X	X	Available from 28 June 2023
Methyl chloride	kg kg-1	methyl_chloride	ch3cl	217078		X	X	Available from 28 June 2023
Methyl chloroform	kg kg-1	methyl_chloroform	ch3ccl3	217077		X	X	Available from 28 June 2023
Methyl glyoxal	kg kg-1	methyl_glyoxal	ch3cocho	217023		X	X	
Methyl peroxide	kg kg-1	methyl_peroxide	ch3ooh	217007		X	X	
Methylperoxy radical	kg kg-1	methylperoxy_radical	ch3o2	217029		X	X	
Nitrate	kg kg-1	nitrate	no3_a	217051		X	X	
Nitrate radical	kg kg-1	nitrate_radical	no3	217032		X	X	
Nitryl chloride	kg kg-1	nitryl_chloride	clno2	217067		X	X	Available from 28 June 2023
Olefins	kg kg-1	olefins	ole	217011		X	X	
Organic ethers	kg kg-1	organic_ethers	ror	217036		X	X	
Organic nitrates	kg kg-1	organic_nitrates	onit	217015		X	X	

Paraffins	kg kg-1	paraffins	par	217009		X	X	
Pernitric acid	kg kg-1	pernitric_acid	ho2no2	217034		X	X	
Peroxides	kg kg-1	peroxides	rooh	217014		X	X	
Peroxy acetyl radical	kg kg-1	peroxy_acetyl_radical	c2o3	217035		X	X	
Potential vorticity	K m2 kg-1 s-1	potential_vorticity	pv	60		X	X	
Propene	kg kg-1	propene	c3h6	217048		X	X	
Radon	kg kg-1	radon	ra	210181		X	X	
Relative humidity	%	relative_humidity	r	157		X	X	
Specific cloud ice water content	kg kg-1	specific_cloud_ice_water_content	ciwc	247		X	X	
Specific cloud liquid water content	kg kg-1	specific_cloud_liquid_water_content	clwc	246		X	X	
Specific rain water content	kg kg-1	specific_rain_water_content	crwc	75		X	X	
Specific snow water content	kg kg-1	specific_snow_water_content	cswc	76		X	X	
Stratospheric ozone	kg kg-1	stratospheric_ozone_tracer	o3s	217024		X	X	
Terpenes	kg kg-1	terpenes	c10h16	217049		X	X	
Tetrachloromethane	kg kg-1	tetrachloromethane	ccl4	217076		X	X	Available from 28 June 2023
Tribromomethane	kg kg-1	tribromomethane	chbr3	217197		X	X	Available from 28 June 2023
Trichlorofluoromethane	kg kg-1	trichlorofluoromethane	cfc11	217071		X	X	Available from 28 June 2023
Trichlorotrifluoroethane	kg kg-1	trichlorotrifluoroethane	cfc113	217073		X	X	Available from 28 June 2023
Trifluorobromomethane	kg kg-1	trifluorobromomethane	ha1301	217083		X	X	Available from 28 June 2023
Vertical velocity	Pa s-1	vertical_velocity	w	135		X	X	
Water vapour (chemistry)	kg kg-1	water_vapour_chemistry	h2o	217059		X	X	Available from 28 June 2023

Satellite observations

Satellite observations are used by CAMS to *constrain* the global forecast model, ensuring the forecasts are as accurate as possible. The process of merging the numerical forecast model with the observations is called data assimilation.

The CAMS Global production system uses satellite data in its 4-dimensional variational (4D-Var) data assimilation system to constrain the initial atmospheric state that is used for the 5-day forecast. Apart from all the meteorological observations that form part of the ECMWF numerical weather prediction system, CAMS uses additional observations on atmospheric composition. Three categories of observations are listed below. The **assimilated observations** are the observations that are currently used to constrain the model; the **monitored observations** are the observations that are being tested for future implementation; and the **planned observations** are observations that are being considered for future implementation in the CAMS system.

Satellite data monitoring statistics are available here.

Instrument	Satellite	Space Agency	Data Provider	Species
MODIS	EOS-Aqua, EOS-Terra	NASA	NASA	AOD
MLS	EOS-Aura	NASA	NASA	O_3 profile
OMI	EOS-Aura	NASA	KNMI	O_3
OMI	EOS-Aura	NASA	NASA	SO_2
OMPS	NOAA-20*, Suomi NPP	NOAA	EUMESAT	O_3 layers
IASI	METOP-B, METOP-C	EUMETSAT/CNES	AC-SAF	CO
MOPITT	EOS-Terra	NASA	NCAR	CO
GOME-2	METOP-B, METOP-C	EUMETSAT/ESA	AC-SAF	O_3, NO_2, SO_2
PMAp	METOP-B, METOP-C	EUMETSAT	EUMETSAT	AOD
TROPOMI	Sentinel-5p	ESA/NSO	ESA/KNMI/DLR	O_3, SO_2, CO
VIIRS	S-NPP and NOAA20	NOAA	NOAA/Eumetsat	AOD

Instrument	Satellite	Space Agency	Data Provider	Species
GOME-2	METOP-B, METOP-C	EUMETSAT/ESA	AC-SAF	HCHO
GOME-2	METOP-A	EUMETSAT/ESA	AC-SAF	O_3, NO_2, SO_2, HCHO
IASI	METOP-A	EUMETSAT/CNES	AC-SAF	CO
TROPOMI	Sentinel-5p	ESA/NSO	ESA/KNMI/DLR	HCHO
SBUV-2	NOAA-19	NOAA	NOAA	O_3

Instrument	Satellite	Space Agency	Data Provider	Species
SLSTR	Sentinel-3	ESA/EUMETSAT	EUMETSAT	AOD
IASI	METOP-A, -B, -C	EUMETSAT/CNES	ULB/LATMOS	O_3, SO_2
SEVIRI	MSG	EUMETSAT	ICARE	AOD

Evaluation and Quality Assurance reports

The global forecasting system is continually being evaluated to ensure the output meets the expected requirements. Comprehensive Evaluation and Quality Assurance (EQA) reports are provided on a quarterly basis. Before each upgrade of the global forecasting system, the new system is tested and evaluated, and a so-called "e-suite EQA report" is produced. **All reports are available** here.

Quality monitoring graphics

CAMS uses a multitude of independent data sets to routinely monitor its global forecasts. It works with various data providers, acquiring the observations with appropriate timeliness and generating graphics that show the differences between the forecasts and the independent observations. See at https://atmosphere.copernicus.eu/global-services

Guidelines

1. Convert mass mixing ratio (MMR) to mass concentration or to volume mixing ratio (VMR)
2. Representations of SO2 and SO4 in CAMS reanalysis
3. CAMS global sea salt aerosol mixing ratios
4. For details on how convert from mixing ratio (kg per kg dry air) to concentration (kg/m3): CAMS Surface concentration of a given species
5. CAMS provides a global solar UV index forecast (from the ADS), conforming to the WHO definition.

   UV Index data is available as:

   - UV biologically effective dose rate, uvbed, 214002, in W/m2
   - UV biologically effective dose rate clear-sky, uvbedcs, 214003, in W/m2

   To generate this data, we compute the surface down-welling spectral solar irradiance in the range 280-340nm at 5nm resolution taking into account local surface albedo, aerosol, clouds and ozone in the model profile. This is then convoluted with the erythema spectrum, resulting in the biologically active UV radiation. For more details please have a look here.

   UV Index plots are available showing:

   - total UV index
   - clear sky UV index

   corresponding to the two UV index parameters described above. To create the plots we divide the UV biologically effective dose rate by 0.025 W /m2 (i.e. multiplied by 40), resulting in the dimensionless UV index where one unit of measurement (ie the difference between UV Index X and X+1) represents 25mW/m2 of UVA and UVB radiation absorbed by the human skin.

   UV Index values are instantaneous, not cumulated.
6. The actual aerosol species represented in the model are defined more according to their chemical composition (e.g. sulphate, black carbon, organic matter) rather than their source type (e.g. biomass burning or fossil fuels).

   What is presented on the web charts as "biomass-burning AOD" is the sum of organic matter AOD (omaod550) and black carbon AOD (bcaod550). Organic matter is almost always the dominant component out of these.

   Historically, biomass-burning was the main source of such aerosols in the model, apart from a much lower background of primary OM+BC from fossil fuels and of OM from biogenic secondary organic aerosol (SOA).

   However, since a representation of anthropogenic SOA as a source of OM was added (in cycle 43r1, implemented in January 2017), the model also captures the relatively high levels of this OM around polluted cities.

   To sum up, if you want the data used for those web charts, take omaod550+bcaod550 (which will usually be fairly close to omaod550 alone). However, note that this will also show significant aerosol plumes from anthropogenic pollution as well as biomass burning.

Known issues

Issue type	Description	Cycle	Note
High SO2 values over north-eastern Brazil	High SO2 values over north-eastern Brazil on 18 January 2020 and 16 June 2020 at 06:00:00 are artificial and are due to the assimilation of some spurious satellite observations of SO2 in one of the datasets used by CAMS.	47r1	

BC concentrations in the mid/upper troposphere tend to be too high	Some of the low background BC concentrations in the mid/upper troposphere tend to be too high as an artefact of the data assimilation as it improves the total AOD. (They're still very low compared to polluted areas, but can be somewhat higher than they should.) This aspect of the impact of data assimilation on aerosol speciation is something that we're continuing to look into. (The accompanying "control run", a model-only product with no AOD assimilation, can often has a more realistic speciation and vertical profile in this regard, but at the cost of a poorer agreement with observations of total AOD.)	47r1 or 46r1	
Dust emissions are too high in cycle 46r1	See details here: Dust emissions are too high in Cycle 46r1	46r1	
AOD and PM data are zero at forecast step 0	Aerosol optical depth (AOD) and particulate matter (PM10, PM2.5) at forecast step 0: all values are zero	41r1 and 43r1	

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Related articles

- CAMS: Reanalysis data documentation
- CAMS: Global atmospheric composition forecast data documentation
- CAMS Regional: European air quality reanalyses data documentation
- CAMS global biomass burning emissions based on fire radiative power (GFAS): data documentation
- CAMS solar radiation time-series: data documentation