

CAMS Regional: European air quality reanalyses data documentation

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Introduction

The regional air quality production of the Copernicus Atmosphere Monitoring Service (CAMS) is based on an ensemble of 11 state-of-the-art numerical air quality models developed in Europe : CHIMERE from INERIS (France), EMEP from MET Norway (Norway), EURAD-IM from Jülich IEK (Germany), LOTOS-EUROS from KNMI and TNO (Netherlands), MATCH from SMHI (Sweden), MOCAGE from METEO-FRANCE (France), SILAM from FMI (Finland), DEHM from AARHUS UNIVERSITY (Denmark), GEM-AQ from IEP-NRI (Poland), MONARCH from BSC (Spain) and MINNI from ENEA (Italy).

The regional air quality models provide two streams of regional reanalyses every year of the main atmospheric pollutants concentrations, in the lowest layers of the atmosphere for the European domain (east boundary=25.0° W, west=45.0° E, south=30.0° N, north=72.0°). Their horizontal resolution is 0.1° approximately from 3 km (at 72.0°N) to 10 km (at 30°N), allowing background air pollution levels and medium-range atmospheric composition to be monitored. To get insight into your local area, please liaise with your national or local air quality agency.

Two streams of regional European reanalyses are produced every year:

1) "interim" re-analyses are data assimilated fields of air pollutant concentrations, based on up-to-date observation data. Since October 1st, 2015, according to EU Decision 2011/850/EU *on reciprocal exchange of information and reporting on ambient air quality*, EU Member States must report to the European Environment Agency (EEA) observation data as soon as it is produced, even if the necessary validation process is not completed. Such data is thus flagged as "non-validated" or "non- verified" data. Up-to-Date (UTD) data should be considered as provisional or "interim" data, until they are flagged as "validated" by the Member States, which can formally happen more than one year after their production.

2) 'validated' reanalyses are data assimilated fields of air pollutant concentrations based on observation data rigorously validated according to the air quality reporting principles set in EU Decision 2011/850/EU *on reciprocal exchange of information and reporting on ambient air quality*. These data are reported by the Member States to the European Environment Agency (EEA) in autumn, every year for the previous year.

The same post-processing are operated on these two streams.

Reanalyses from all partner models are combined in calculating the median value of the individual outputs, which currently gives the best estimate from the ensemble. In that case the median value is designated as the [ENSEMBLE](#) output.

Please note that access to the numerical data produced by the production chains of the individual models and the [ENSEMBLE](#) output is subject to your prior acceptance of the Licence agreement and registration (read more [here](#) for licence and [here](#) for registration).

Air quality models and data assimilation system

The nine air quality models use the meteorological parameters settings coming from operational ECMWF IFS, the boundary conditions for chemical species coming from IFS global production, the emissions coming from CAMS emission (for anthropic emissions over Europe and for biomass burning).

Table 1: Air quality models (Source: [Regional Production, Updated documentation covering all Regional operational systems and the ENSEMBLE \(01-2021\) document](#))

Model	Institution
CHIMERE	INERIS (France)

DEHM	AARHUS UNIVERSITY (Denmark)
EMEP	MET Norway (Norway)
EURAD-IM	Jülich IEK (Germany)
GEM-AQ	IEP-NRI (Poland)
LOTOS-EUROS	KNMI and TNO (Netherlands)
MATCH	SMHI (Sweden)
MINNI	ENEA (Italy)
MOCAGE	METEO-FRANCE (France)
MONARCH	BSC (Spain)
SILAM	FMI (Finland)

Data access

Data is available for download from the [CAMS Atmosphere Data Store \(ADS\)](#). CAMS ADS registered users can access the available data interactively through the [CAMS European air quality reanalyses ADS download web interface](#) and/or programmatically using the API as per instructions detailed [here](#).

Data availability

The CAMS European air quality reanalyses is available for recent years.

Interim reanalyses become available for whole year Y on May of year Y+1.

Validated reanalyses become available for whole year Y in November year Y+2.

Table 2: Next release dates (last update 04 Sep 2023)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
IRA									Published on ADS	Published on ADS	Published on ADS ***
VRA	Published on ADS *	Published on ADS *	Published on ADS *	Published on ADS **	Published on ADS **	Published on ADS	Published on ADS	Published on ADS	Published on ADS ***	expected in 2024	expected in 2025

*for surface O₃, NO₂, PM_{2.5} and PM₁₀ concentrations from the ENSEMBLE only.

**for surface O₃, NO₂, CO, SO₂, PM_{2.5} and PM₁₀ concentrations from the ENSEMBLE only.

***Two more species are provided: Formaldehyde(HCHO) and Glyoxal(CHOCHO)



MATCH data are available for some type and years. Please check on the [ADS](#) for availability.

Spatial grid

Horizontal resolution of ENSEMBLE reanalyses is on a 0.1°× 0.1° regular latitude-longitude grid.

The eleven individual models have different native spatial grids (for details see [Regional Production, Updated documentation covering all Regional operational systems and the ENSEMBLE \(01-2021\) document](#)) and they are interpolated on the ensemble common regular grid for each time step of the hourly reanalyses.



It's worth noting that it was decided to harmonize grid definitions between the NRT production and the reanalyses production in 2022.

From VRA2020 and IRA2022, the grid definition is:

700 x 420 gridpoints:
 – from -24.95°E to 44.95°E
 – from 30.05°N to 71.95°N
 – Resolution 0.1° x 0.1°

For all previous productions (to VRA2020 and IRA2022) the grid definition is :

701 x 421 gridpoints:
– from -25°E to 45°E
– from 30.0°N to 72°N
– Resolution 0.1° x 0.1°

Temporal frequency

The yearly ensemble reanalyses is available with a Time resolution of 1 hour from step 1st January to the 31st of December.

Data format

Data are available in NetCDF format for the individual models outputs and for the ENSEMBLE outputs.

Level listings

Vertical levels: Surface, 50m,100m, 250m, 500m, 750m, 1000m, 2000m, 3000m, 5000m



100m and 750m were added up from VRA2020 and IRA2022.

Product listings

The following species could be considered experimental and without assessment and to be used with caution:

- SIA
- PANs
- NMVOC
- PM10_WF
- PM25_tot
- PM25_res
- NH3
- PM10 DUST

The land-sea mask field used to produce the regional air quality data is attached here below, already interpolated to a regular lat/lon grid of 0.1°x0.1°:

name	units
land-sea mask (netCDF4)	(0-1)

Table 3: List of parameters

Variable Name	NetCDF Units	Variable name in ADS	Note
Ammonia	µg m ⁻³	ammonia	
Carbon monoxide	µg m ⁻³	carbon_monoxide	
PM 10 Dust fraction	µg m ⁻³	dust	Dust is fraction in PM10
Formaldehyde	µg m ⁻³	formaldehyde	available from IRA 2023 and VRA2021
Glyoxal	µg m ⁻³	glyoxal	available from IRA 2023 and VRA2021
Nitrogen dioxide	µg m ⁻³	nitrogen_dioxide	
Nitrogen monoxide	µg m ⁻³	nitrogen_monoxide	
Non-methane volatile compounds (VOCs)	µg m ⁻³	non_methane_vocs	
Ozone	µg m ⁻³	ozone	
Particulate matter d < 10 µm (PM10)	µg m ⁻³	particulate_matter_10um	
Particulate matter d < 10 µm, wildfires only (PM10_WF)	µg m ⁻³	pm10_wildfires	available from IRA 2021 and VRA2019
Particulate matter d < 2.5 µm (PM2.5)	µg m ⁻³	particulate_matter_2.5um	

Particulate matter d < 2.5 µm, anthropogenic total carbon (PM2.5_tot)	µg m ⁻³	pm2.5_anthropogenic_total_carbon	available from IRA2022 and VRA2020
Particulate matter d < 2.5 µm, anthropogenic residential carbon only (PM2.5_res)	µg m ⁻³	pm2.5_anthropogenic_residential_carbon	available from IRA2022 and VRA2020
Peroxyacyl nitrates (PANs)	µg m ⁻³	peroxyacyl_nitrates	
PM 2.5 Secondary inorganic aerosol (SIA)	µg m ⁻³	secondary_inorganic_aerosol	
Sulphur dioxide	µg m ⁻³	sulphur_dioxide	

In Situ Observations

In situ observations used as input into the CAMS regional services to *constrain* the regional forecast models. In situ observations are also used in the evaluation and quality assurance (EQA) of all CAMS products.

Application in CAMS	Measured species	Networks
Input for regional services	O ₃ , NO ₂ , SO ₂ , CO, PM2.5, PM10	EEA/EIONET
EQA of regional services	O ₃ , NO ₂ , SO ₂ , CO, PM2.5, PM10	EEA/EIONET , EMEP

Validation reports

Validation Reports for the CAMS reanalysis can be found on the [CAMS Quality Assurance website](#).

How to acknowledge, cite and refer to the data

All users of data uploaded on the Atmosphere Data Store (ADS) must provide clear and visible attribution to the Copernicus programme and are asked to cite and reference the dataset provider.

(1) Acknowledge according to the [licence to use Copernicus Products](#).

(2) Cite each dataset used:

- Institut national de l'environnement industriel et des risques (Ineris), Aarhus University, Norwegian Meteorological Institute (MET Norway), Jülich Institut für Energie- und Klimaforschung (IEK), Institute of Environmental Protection – National Research Institute (IEP-NRI), Koninklijk Nederlands Meteorologisch Instituut (KNMI), METEO FRANCE, Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO), Swedish Meteorological and Hydrological Institute (SMHI), Finnish Meteorological Institute (FMI), Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) and Barcelona Supercomputing Center (BSC) (2022): CAMS European air quality forecasts, ENSEMBLE data. Copernicus Atmosphere Monitoring Service (CAMS) Atmosphere Data Store (ADS). (Accessed on <DD-MMM-YYYY>), <https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-europe-air-quality-reanalyses?tab=overview>
- Institut national de l'environnement industriel et des risques (Ineris) (2020): CAMS European air quality forecasts, CHIMERE model data. Copernicus Atmosphere Monitoring Service (CAMS) Atmosphere Data Store (ADS). (Accessed on <DD-MMM-YYYY>), <https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-europe-air-quality-reanalyses?tab=overview>
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- Koninklijk Nederlands Meteorologisch Instituut (KNMI) and Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO) (2020): CAMS European air quality forecasts, LOTOS-EUROS model data. Copernicus Atmosphere Monitoring Service (CAMS) Atmosphere Data Store (ADS). (Accessed on <DD-MMM-YYYY>), <https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-europe-air-quality-reanalyses?tab=overview>
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(3) Throughout the content of your publication, the dataset used is referred to as Author (YYYY) e.g. for Ensemble data: INERIS et. al (2020)

References

- [A regional air quality forecasting system over Europe: the MACC-II daily ensemble production.\(11 Mar 2015\)](#)
- [Regional Production, Updated documentation covering all Regional operational systems and the ENSEMBLE \(01-2021\) document](#)

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Related articles

- [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](#)
- [CAMS User Support Journey](#)