**CAMS and ERA5 data**

**CAMS Data**

We take data from 2 sources:

1. CAMS global reanalysis (EAC4) Link: [CAMS global reanalysis (EAC4)](https://ads.atmosphere.copernicus.eu/datasets/cams-global-reanalysis-eac4?tab=overview)
2. CAMS global reanalysis (EAC4) monthly averaged fields Link: [CAMS global reanalysis (EAC4) monthly averaged fields](https://ads.atmosphere.copernicus.eu/datasets/cams-global-reanalysis-eac4-monthly?tab=overview)

These variables are available from the year 2003 to 2023.

Link 1 provides data every 3 hours. Link 2 provides data as a 1month average. Some variables are only available from link1, some variables are only available from link2, and some variables are available from both the links.

1. **CAMS GLOBAL REANALYSIS**

List of single level (surface level) and multi-level variables from CAMS

Asterisk shows that these variables are also available as monthly average.

If a short name and Unit are not available in these tables, then these variables while are mentioned on the website, but when downloaded contains no data.

Total column refers to the total amount of a selected variable in a column of air extending from surface of the Earth (model level 60) to the top of the atmosphere (model level 1). Total column can also be referred to as total <selected variable>, or vertically integrated <selected variable>.

List of Single level variables available

Documentation source: [CAMS: Reanalysis data documentation - Copernicus Knowledge Base - ECMWF Confluence Wiki](https://confluence.ecmwf.int/display/CKB/CAMS%3A+Reanalysis+data+documentation)

|  |  |  |  |
| --- | --- | --- | --- |
| **S.N.** | **Full name** | **Short name** | **Unit** |
| 1 | 10m u-component of wind | u10 | ms-1 |
| 2 | 10m v-component of wind | v10 | ms-1 |
| 3 | 2m dewpoint temperature\* | d2m | Kelvin |
| 4 | 2m temperature\* | t2m | Kelvin |
| 5 | Black carbon aerosol optical depth at 550 nm\* | bcaod550 | ~ |
| 6 | Dust aerosol optical depth at 550 nm\* | duaod550 | ~ |
| 7 | Land-sea mask | lsm | (0-1) |
| 8 | Mean sea level pressure\* | msl | Pa |
| 9 | Organic matter aerosol optical depth at 550 nm\* | omaod550 | ~ |
| 10 | Particulate matter d < 1 µm (PM1) | pm1 | kgm-3 |
| 11 | Particulate matter d < 2.5 µm (PM2.5)\* | pm2p5 | kgm-3 |
| 12 | Particulate matter d < 10 µm (PM10)\* | pm10 | kgm-3 |
| 13 | Sea salt aerosol optical depth at 550 nm\* | ssaod550 | ~ |
| 14 | Sulphate aerosol optical depth at 550 nm | suaod550 | ~ |
| 15 | Surface geopotential | z | m2s-2 |
| 16 | Surface pressure\* | sp | Pa |
| 17 | Total aerosol optical depth at 469 nm | aod469 | ~ |
| 18 | Total aerosol optical depth at 550 nm\* | aod550 | ~ |
| 19 | Total aerosol optical depth at 670 nm | aod670 | ~ |
| 20 | Total aerosol optical depth at 865 nm | aod865 | ~ |
| 21 | Total aerosol optical depth at 1240 nm | aod1240 | ~ |
| 22 | Total column carbon monoxide\* | tcco | kgm-2 |
| 23 | Total column ethane\* | tc\_c2h6 | kgm-2 |
| 24 | Total column formaldehyde\* | tchcho | kgm-2 |
| 25 | Total column hydrogen peroxide | tc\_h2o2 | kgm-2 |
| 26 | Total column hydroxyl radical\* | tc\_oh | kgm-2 |
| 27 | Total column isoprene\* | tc\_c5h8 | kgm-2 |
| 28 | Total column methane\* | tc\_ch4 | kgm-2 |
| 29 | Total column nitric aci d\* | tc\_hno3 | kgm-2 |
| 30 | Total column nitrogen dioxide\* | tcno2 | kgm-2 |
| 31 | Total column nitrogen monoxide\* | tc\_no | kgm-2 |
| 32 | Total column ozone\* | gtco3 | kgm-2 |
| 33 | Total column peroxyacetyl nitrate\* | tc\_pan | kgm-2 |
| 34 | Total column propane\* | tc\_c3h8 | kgm-2 |
| 35 | Total column sulphur dioxide\* | tcso2 | kgm-2 |
| 36 | Total column water vapour\* | tcwv | kgm-2 |

List of multi-level variables

These variables are expressed as mass mixing ratio at different model levels expressed in kgkg-1.

|  |  |  |  |
| --- | --- | --- | --- |
| S.N. | Full name | Short name | Unit |
| 1 | Carbon monoxide\* | co | kgkg-1 |
| 2 | Dust aerosol (0.03-0.55 µm) mixing ratio\* | aermr04 | kgkg-1 |
| 3 | Dust aerosol (0.55-0.9 µm) mixing ratio\* | aermr05 | kgkg-1 |
| 4 | Dust aerosol (0.9-20 µm) mixing ratio\* | aermr06 | kgkg-1 |
| 5 | Ethane\* | c2h6 | kgkg-1 |
| 6 | Formaldehyde\* | hcho | kgkg-1 |
| 7 | Hydrogen peroxide | h2o2 | kgkg-1 |
| 8 | Hydrophilic black carbon aerosol mixing ratio\* | aermr09 | kgkg-1 |
| 9 | Hydrophilic organic matter aerosol mixing ratio\* | aermr07 | kgkg-1 |
| 10 | Hydrophobic black carbon aerosol mixing ratio\* | aermr10 | kgkg-1 |
| 11 | Hydrophobic organic matter aerosol mixing ratio\* | aermr08 | kgkg-1 |
| 12 | Hydroxyl radical\* | oh | kgkg-1 |
| 13 | Isoprene\* | c5h8 | kgkg-1 |
| 14 | Nitric aci d\* | hno3 | kgkg-1 |
| 15 | Nitrogen dioxide\* | no2 | kgkg-1 |
| 16 | Nitrogen monoxide\* | no | kgkg-1 |
| 17 | Ozone\* | go3 | kgkg-1 |
| 18 | Peroxyacetyl nitrate\* | pan | kgkg-1 |
| 19 | Propane\* | c3h8 | kgkg-1 |
| 20 | Sea salt aerosol (0.03- 0.5 µm) mixing ratio\* | aermr01 | kgkg-1 |
| 21 | Sea salt aerosol (0.5- 5 µm) mixing ratio\* | aermr02 | kgkg-1 |
| 22 | Sea salt aerosol (5- 20 µm) mixing ratio\* | aermr03 | kgkg-1 |
| 23 | Specific humidity | q | kgkg-1 |
| 24 | Sulphate aerosol mixing ratio\* | aermr11 | kgkg-1 |
| 25 | Sulphur dioxide\* | so2 | kgkg-1 |
| 26 | Temperature | t | Kelvin |

1. **CAMS global reanalysis (EAC4) monthly averaged fields**

These variables are available as one month average.

Asterisk indicates data available every 3 hours as well.

List of single level variables

|  |  |  |  |
| --- | --- | --- | --- |
| **S.N.** | **Full name** | **Short name** | **Unit** |
| 1 | 2m dewpoint temperature\* | d2m | Kelvin |
| 2 | 2m temperature\* | t2m | Kelvin |
| 3 | Black carbon aerosol optical depth at 550 nm\* | bcaod550 | ~ |
| 4 | Charnock | chnk |  |
| 5 | Dust aerosol optical depth at 550 nm\* | duaod550 | ~ |
| 6 | Ice temperature layer 1 |  |  |
| 7 | Leaf area index, high vegetation | lai\_hv | m2m-2 |
| 8 | Leaf area index, low vegetation | lai\_lv | m2m-2 |
| 9 | Mean sea level pressure\* | msl | Pa |
| 10 | Organic matter aerosol optical depth at 550 nm\* | omaod550 | ~ |
| 11 | Particulate matter d < 2.5 µm (PM2.5)\* | pm2p5 | kgm-3 |
| 12 | Particulate matter d < 10 µm (PM10)\* | pm10 | kgm-3 |
| 13 | Sea salt aerosol optical depth at 550 nm\* | ssaod550 | ~ |
| 14 | Sea surface temperature | sst | Kelvin |
| 15 | Sea-ice cover | siconc | (0-1) |
| 16 | Snow albedo | asn | (0-1) |
| 17 | Snow density | rsn |  |
| 18 | Snow depth | sd | m of water equivalent |
| 19 | Soil temperature level 1 |  |  |
| 20 | Sulphate aerosol optical depth at 550 nm\* | suaod550 | ~ |
| 21 | Surface pressure\* | sp | Pa |
| 22 | Temperature of snow layer | tsn |  |
| 23 | Total aerosol optical depth at 550 nm\* | aod550 | ~ |
| 24 | Total column carbon monoxide\* | tcco | kgm-2 |
| 25 | Total column ethane\* | tc\_c2h6 | kgm-2 |
| 26 | Total column formaldehyde\* | tchcho | kgm-2 |
| 27 | Total column hydroxyl radical\* | tc\_oh | kgm-2 |
| 28 | Total column isoprene\* | tc\_c5h8 | kgm-2 |
| 29 | Total column methane\* | tc\_ch4 | kgm-2 |
| 30 | Total column nitric aci d\* | tc\_hno3 | kgm-2 |
| 31 | Total column nitrogen dioxide\* | tcno2 | kgm-2 |
| 32 | Total column nitrogen monoxide\* | tc\_no | kgm-2 |
| 33 | Total column ozone\* | gtco3 | kgm-2 |
| 34 | Total column peroxyacetyl nitrate\* | tc\_pan | kgm-2 |
| 35 | Total column propane\* | tc\_c3h8 | kgm-2 |
| 36 | Total column sulphur dioxide\* | tcso2 | kgm-2 |
| 37 | Total column water | tcw | kgm-2 |
| 38 | Total column water vapour\* | tcwv | kgm-2 |
| 39 | Vertically integrated mass of dust aerosol (0.03 -0.55 µm) | aernssdus | kgm-2 |
| 40 | Vertically integrated mass of dust aerosol (0.55 -9 µm) | aermssdum | kgm-2 |
| 41 | Vertically integrated mass of dust aerosol (9 - 20 µm) | aermssdul | kgm-2 |
| 42 | Vertically integrated mass of hydrophilic black carbon aerosol | aermssbchphil | kgm-2 |
| 43 | Vertically integrated mass of hydrophilic organic matter aerosol | aermssomhphil | kgm-2 |
| 44 | Vertically integrated mass of hydrophobic black carbon aerosol | aermssbchphob | kgm-2 |
| 45 | Vertically integrated mass of hydrophobic organic matter aerosol | aermssomhphob | kgm-2 |
| 46 | Vertically integrated mass of sea salt aerosol (0.03- 0.5 µm) | aermssss | kgm-2 |
| 47 | Vertically integrated mass of sea salt aerosol (0.5- 5µm) | aermssssm | kgm-2 |
| 48 | Vertically integrated mass of sea salt aerosol (5-20 µm) | aermssssl | kgm-2 |
| 49 | Vertically integrated mass of sulphate aerosol | aermsssu | kgm-2 |
| 50 | Vertically integrated mass of sulphur dioxide | aermssso2 | kgm-2 |

List of Multi-level variables

|  |  |  |  |
| --- | --- | --- | --- |
| S.N. | Full name | Short name | Unit |
| 1 | Carbon monoxide\* | co | kgkg-1 |
| 2 | Dust aerosol (0.03-0.55 µm) mixing ratio\* | aermr04 | kgkg-1 |
| 3 | Dust aerosol (0.55-0.9 µm) mixing ratio\* | aermr05 | kgkg-1 |
| 4 | Dust aerosol (0.9 - 20 µm) mixing ratio\* | aermr05 | kgkg-1 |
| 5 | Ethane\* | c2h6 | kgkg-1 |
| 6 | Formaldehyde\* | hcho | kgkg-1 |
| 7 | Geopotential |  |  |
| 8 | Hydrophilic black carbon aerosol mixing ratio\* | aermr09 | kgkg-1 |
| 9 | Hydrophilic organic matter aerosol mixing ratio\* | aermr07 | kgkg-1 |
| 10 | Hydrophobic black carbon aerosol mixing ratio\* | aermr10 | kgkg-1 |
| 11 | Hydrophobic organic matter aerosol mixing ratio\* | aermr08 | kgkg-1 |
| 12 | Hydroxyl radical\* | oh | kgkg-1 |
| 13 | Isoprene\* | c5h8 | kgkg-1 |
| 14 | Methane (chemistry) | ch4\_c | kgkg-1 |
| 15 | Nitric aci d\* | hno3 | kgkg-1 |
| 16 | Nitrogen dioxide\* | no2 | kgkg-1 |
| 17 | Nitrogen monoxide\* | no | kgkg-1 |
| 18 | Ozone\* | go3 | kgkg-1 |
| 19 | Peroxyacetyl nitrate\* | pan | kgkg-1 |
| 20 | Potential vorticity |  |  |
| 21 | Propane\* | c3h8 | kgkg-1 |
| 22 | Relative humidity |  |  |
| 23 | Sea salt aerosol (0.03-0.5 µm)\* | aermr01 | kgkg-1 |
| 24 | Sea salt aerosol (0.5-5 µm)\* | aermr02 | kgkg-1 |
| 25 | Sea salt aerosol (5-20 µm)\* | aermr03 | kgkg-1 |
| 26 | SO2 precursor mixing ratio | aermr12 | kgkg-1 |
| 27 | Specific humidity |  |  |
| 28 | Sulphate aerosol mixing ratio\* | aermr11 | kgkg-1 |
| 29 | Sulphur dioxide\* | so2 | kgkg-1 |
| 30 | Temperature |  |  |
| 31 | Vertical velocity |  |  |

A total of 82 unique variables.

1. **How to download CAMS data**

**Step 1**: Go to the link: <https://ads.atmosphere.copernicus.eu/datasets/cams-global-reanalysis-eac4-monthly?tab=overview>

**Step 2**: Select the tab DownloadA screenshot of a computer

AI-generated content may be incorrect.

**Step 3**: For single level data, select Single Level tab. Select the list of variables that you want to download. Only a partial list of variables is shown below.

A screenshot of a computer

AI-generated content may be incorrect.

**Step 4**: Select the Date tab and enter the start and end date of the data you want to download.

**Step 5**: Select the Time stamp you want to download. For data every 3 hours, Select all 8 timestamps. Picture below downloads data from 2023-01-01 to 2023-12-31 every 3 hours.

A screenshot of a computer

AI-generated content may be incorrect.

**Step 6**: You can either download the data for the entire Earth or for a particular region. Figure below shows the boundary for USA

**A screenshot of a computer

AI-generated content may be incorrect.**

**Step 6**: Select the Zipped netCDF as the data format to download.

**Step 7**: Select Submit form and the data download process will start.

For multi-level data, select the multi-level tab, select the variables that you want to download. Then select Model level 60 which is data at the surface level. Select date time, geographical area, data format and then select Submit form.

**Note**: There is a limit of 100,000 data points to download. So, data will need to be downloaded in a few steps and then combined. The pressure level is not required to be selected.

1. **How to download CAMS monthly averaged fields**

**Step 1:**  Go to the link: <https://ads.atmosphere.copernicus.eu/datasets/cams-global-reanalysis-eac4-monthly?tab=overview>

**Step 2**: Select tab Download

**Step 3**: For single level, Select Single level and the corresponding variables you want to download

**Step4**: Select Model Level 60

**Step 6**: Select the Year you want to download. For example: Year 2023

**Step 7**: Select Month. For example: select all the months to download one month for the Year 2023 of all the months.

**Step 8**: In the Product type tab, select monthly mean

**Step 9**: Select the sub-region extraction, Data format as mentioned before and click Submit form

For multi-level data. Follow the same steps as mentioned before. The pressure level need not be selected.

List of 82 unique features from CAMS. 58 features have been used. Features not used are in red color:

Single level variables

|  |  |  |  |
| --- | --- | --- | --- |
| **S.N.** | **Full name** | **Short name** | **Unit** |
| 1 | 10m u-component of wind | u10 | ms-1 |
| 2 | 10m v-component of wind | v10 | ms-1 |
| 3 | 2m dewpoint temperature | d2m | Kelvin |
| 4 | 2m temperature | t2m | Kelvin |
| 5 | Black carbon aerosol optical depth at 550 nm | bcaod550 | ~ |
| 6 | Dust aerosol optical depth at 550 nm | duaod550 | ~ |
|  | Land-sea mask | lsm | (0-1) |
| 7 | Mean sea level pressure | msl | Pa |
| 8 | Organic matter aerosol optical depth at 550 nm | omaod550 | ~ |
| 9 | Particulate matter d < 1 µm (PM1) | pm1 | kgm-3 |
| 10 | Particulate matter d < 2.5 µm (PM2.5) | pm2p5 | kgm-3 |
| 11 | Particulate matter d < 10 µm (PM10) | pm10 | kgm-3 |
| 12 | Sea salt aerosol optical depth at 550 nm | ssaod550 | ~ |
| 13 | Sulphate aerosol optical depth at 550 nm | suaod550 | ~ |
| 14 | Surface geopotential | z | m2s-2 |
| 15 | Surface pressure | sp | Pa |
| 16 | Total aerosol optical depth at 469 nm | aod469 | ~ |
|  | Total aerosol optical depth at 550 nm | aod550 | ~ |
|  | Total aerosol optical depth at 670 nm | aod670 | ~ |
|  | Total aerosol optical depth at 865 nm | aod865 | ~ |
| 17 | Total aerosol optical depth at 1240 nm | aod1240 | ~ |
| 18 | Total column carbon monoxide | tcco | kgm-2 |
| 19 | Total column ethane | tc\_c2h6 | kgm-2 |
| 20 | Total column formaldehyde | tchcho | kgm-2 |
| 21 | Total column hydrogen peroxide | tc\_h2o2 | kgm-2 |
| 22 | Total column hydroxyl radical | tc\_oh | kgm-2 |
| 23 | Total column isoprene | tc\_c5h8 | kgm-2 |
| 24 | Total column methane | tc\_ch4 | kgm-2 |
| 25 | Total column nitric aci d | tc\_hno3 | kgm-2 |
| 26 | Total column nitrogen dioxide | tcno2 | kgm-2 |
| 27 | Total column nitrogen monoxide | tc\_no | kgm-2 |
| 28 | Total column ozone | gtco3 | kgm-2 |
| 29 | Total column peroxyacetyl nitrate | tc\_pan | kgm-2 |
| 30 | Total column propane | tc\_c3h8 | kgm-2 |
| 31 | Total column sulphur dioxide | tcso2 | kgm-2 |
| 32 | Total column water vapour | tcwv | kgm-2 |

Multi-level variables

|  |  |  |  |
| --- | --- | --- | --- |
| **S.N.** | **Full name** | **Short name** | **Unit** |
| 33 | Carbon monoxide | co | kgkg-1 |
| 34 | Dust aerosol (0.03-0.55 µm) mixing ratio | aermr04 | kgkg-1 |
|  | Dust aerosol (0.55-0.9 µm) mixing ratio | aermr05 | kgkg-1 |
|  | Dust aerosol (0.9-20 µm) mixing ratio | aermr06 | kgkg-1 |
| 35 | Ethane | c2h6 | kgkg-1 |
| 36 | Formaldehyde | hcho | kgkg-1 |
| 37 | Hydrogen peroxide | h2o2 | kgkg-1 |
|  | Hydrophilic black carbon aerosol mixing ratio | aermr09 | kgkg-1 |
|  | Hydrophilic organic matter aerosol mixing ratio | aermr07 | kgkg-1 |
|  | Hydrophobic black carbon aerosol mixing ratio | aermr10 | kgkg-1 |
|  | Hydrophobic organic matter aerosol mixing ratio | aermr08 | kgkg-1 |
| 38 | Hydroxyl radical | oh | kgkg-1 |
| 39 | Isoprene | c5h8 | kgkg-1 |
| 40 | Nitric aci d | hno3 | kgkg-1 |
| 41 | Nitrogen dioxide | no2 | kgkg-1 |
| 42 | Nitrogen monoxide | no | kgkg-1 |
| 43 | Ozone | go3 | kgkg-1 |
| 44 | Peroxyacetyl nitrate | pan | kgkg-1 |
| 45 | Propane | c3h8 | kgkg-1 |
|  | Sea salt aerosol (0.03- 0.5 µm) mixing ratio\* | aermr01 | kgkg-1 |
|  | Sea salt aerosol (0.5- 5 µm) mixing ratio | aermr02 | kgkg-1 |
|  | Sea salt aerosol (5- 20 µm) mixing ratio | aermr03 | kgkg-1 |
| 46 | Specific humidity | q | kgkg-1 |
| 47 | Sulphate aerosol mixing ratio | aermr11 | kgkg-1 |
| 48 | Sulphur dioxide | so2 | kgkg-1 |
| 49 | Temperature | t | Kelvin |

Variables only available as monthly-averaged

|  |  |  |  |
| --- | --- | --- | --- |
| **S.N.** | **Full name** | **Short name** | **Unit** |
| 50 | Leaf area index, high vegetation | lai\_hv | m2m-2 |
| 51 | Leaf area index, low vegetation | lai\_lv | m2m-2 |
|  | Sea surface temperature1 | sst | Kelvin |
|  | Sea-ice cover1 | siconc | (0-1) |
| 52 | Snow albedo | asn | (0-1) |
| 53 | Snow depth | sd | m of water equivalent |
| 54 | Total column water | tcw | kgm-2 |
| 55 | Vertically integrated mass of dust aerosol (0.03 -0.55 µm) | aermssdus | kgm-2 |
|  | Vertically integrated mass of dust aerosol (0.55 -9 µm) | aermssdum | kgm-2 |
|  | Vertically integrated mass of dust aerosol (9 - 20 µm) | aermssdul | kgm-2 |
|  | Vertically integrated mass of hydrophilic black carbon aerosol | aermssbchphil | kgm-2 |
|  | Vertically integrated mass of hydrophilic organic matter aerosol | aermssomhphil | kgm-2 |
|  | Vertically integrated mass of hydrophobic black carbon aerosol | aermssbchphob | kgm-2 |
|  | Vertically integrated mass of hydrophobic organic matter aerosol | aermssomhphob | kgm-2 |
| 56 | Vertically integrated mass of sea salt aerosol (0.03- 0.5 µm) | aermssss | kgm-2 |
|  | Vertically integrated mass of sea salt aerosol (0.5- 5µm) | aermssssm | kgm-2 |
|  | Vertically integrated mass of sea salt aerosol (5-20 µm) | aermssssl | kgm-2 |
| 57 | Vertically integrated mass of sulphate aerosol | aermsssu | kgm-2 |
| 58 | Vertically integrated mass of sulphur dioxide | aermssso2 | kgm-2 |
|  | SO2 precursor mixing ratio | aermr12 | kgkg-1 |

1: These two variables have NaN in them.

**ERA5 Data**

Relative humidity is the only data downloaded from ERA5 hourly data on pressure levels from 1940 to present.

1. **How to download ERA5 hourly data on pressure levels from 1940 to present**

**Step 1:**  Go to the link: <https://cds.climate.copernicus.eu/datasets/reanalysis-era5-pressure-levels?tab=overview>

**Step 2**: Select tab Download

**Step 3**: Product tab: select the default Reanalysis

**Step4**: Select Variable Relative humidity

**Step 6**: Select the Year you want to download. For example: Year 2023

**Step 7**: Select Month. For example: select all the months to download one month for the Year 2023 of all the months.

**Step 8**: Select Day

**Step 9**: Select Time (I selected time interval every 3 hours even though the data is available every 1 hour).

**Step 10**: Select pressure level 1000hPa (that is surface level)

**Step 11**: Select whole available region or sub region as in Step 6 for CAMS data.