

Implementation of IFS cycle 46r1

Description of upgrade

The CAMS IFS cycle 46R1 is based on ECMWF's [IFS cycle 46R1](#) . IFS Cycle 46r1 is an upgrade with many scientific contributions, including changes in the use of observations and in modelling. The new cycle also includes an upgrade of the vertical resolution from [60 model levels](#) to [137 model levels](#).

The page will be updated as required. It was last changed on 05.07.2019.

For a record of changes made to this page please refer to [Document versions](#) .

Further information and advice regarding the upgrade can be obtained from the [Copernicus User Support](#).

-
- [Timetable for implementation](#)
 - [Current Status](#)
 - [Meteorological content of the new cycle](#)
 - [Atmospheric composition content of the new cycle](#)
 - [Impact of the new cycle](#)
 - [Technical details of the new cycle](#)
 - [Changes to GRIB encoding](#)
 - [New model output parameters](#)
 - [Discontinued model parameters](#)
 - [Software](#)
 - [Availability of test data from the cycle 46r1 test suites](#)
 - [Document versions](#)
-

Timetable for implementation

The planned timetable for the implementation of the cycle 46r1 is as follows:

Date	Event
08-05-2019	Announcement of expected implementation date
09-07-2019	Implementation

The timetable represents current expectations and may change in light of actual progress made.

Current Status

IFS cycle 46r1 is going through its final testing phase.

Meteorological content of the new cycle

The meteorological changes can be found on the ECMWF [IFS CY46R1 page](#) .

Atmospheric composition content of the new cycle

Assimilation

- **New model-error covariance matrices for aerosol and chemistry at 137 levels.**

Observations

- No new atmospheric composition observations compared to Cycle 45r1.

Emissions

- **New emissions inventories:** CAMS_GLOB_ANT v2.1 (anthropogenic) and CAMS_GLOB_BIO v1.1 (biogenic), in place of previous MACCity and MEGAN_MACC inventories.
- **Biomass-burning injection heights from GFAS, and updated diurnal cycle.** In particular, this reduces the overestimation of near-surface $PM_{2.5}$ during fire events.
- **Anthropogenic SOA production updated with a diurnal cycle and regionally-varying ratio to CO emissions.** This has a small impact on AOD, but significantly reduces night-time overestimation of near-surface $PM_{2.5}$ in polluted regions.

- **New online dust emission scheme (Nabat et al., 2012).** This increases total dust emissions and shifts them towards larger particle sizes, in line with recent literature. An updated dust source function improves the selection of source regions, reducing "gaps" in dust emissions.
- **Sea-salt production over freshwater lakes eliminated.** This corrects an issue that was particularly noticeable over the Great Lakes.

Other model changes

- **Vertical resolution increased from 60 levels to 137 levels,** matching that used at ECMWF for NWP. This includes moving the model top from 0.1 hPa to 0.01 hPa.
- **New nitrate and ammonium aerosol species, coupled to the gas-phase nitrogen chemistry.** See new model parameters below. This is a major expansion of the aerosol species represented in the model, giving a more complete representation of the species which contribute to e.g. PM_{2.5} over Europe.
- **Sulfur species (SO₂ and SO₄) coupled between chemistry and aerosol schemes.** See discontinued parameters below. This brings a greater consistency between the chemistry and aerosol products related to the sulfur cycle.
- **Online calculation of dry deposition velocities for trace gases.** This was already in place for aerosols in 45r1, and allows the deposition scheme to better account for variations in surface properties..
- **Updates to wet deposition parameterisations.** This brings improvements in the distinction between scavenging by liquid and ice, and harmonises the treatment for aerosols and trace gases.
- **Updates to chemical reaction rates** following latest recommendations by JPL/IUPAC.

Impact of the new cycle

This upgrade introduces some significant changes that will allow better evolution of the CAMS forecasting system products and their quality on the long term. The main direct impact seen for this upgrade is a significant improvement of the Particulate Matter (PM) values and some degradation of the stratospheric ozone profile, although total column ozone values have not been changed. For all other species we confirm very similar performance to the previous forecasting system. In summary:

- Pronounced improvement of surface PM2.5 and PM10 forecasts, especially during night time, by changes to the diurnal cycle of emissions and the introduction of injection heights for biomass burning emissions .
- The changes in composition of aerosols (adding nitrate and ammonium aerosol) create a small increase or no increase in the total Aerosol Optical Depth (AOD) depending on the season. An increase of sulphate aerosol is seen in particular at high latitudes of the northern hemisphere, but less in highly polluted areas in East Asia. There is less organic aerosol, especially at high latitudes. Globally there is less sea salt AOD. Mean dust AOD is slightly increased, and there is in particular more dust in North Africa and less in East Asia.
- Tropospheric ozone shows generally higher correlations with surface and airborne observations, but the bias is slightly increased near the surface. The change in the upper troposphere is neutral.
- CO results are somewhat mixed with slightly increased biases in some areas and slightly decreased biases in other areas.
- Tropospheric NO2 values have not significantly changed.
- Stratospheric O3 column values show a slight decrease in bias, but the vertical profile has generally changed with a marked positive bias between 25 and 32 km altitude and a negative bias between 30 and 40 km altitude.

The new cycle has been validated by the CAMS Validation team and the results are presented in their [validation report](#).

Technical details of the new cycle

Changes to GRIB encoding

paramId	shortName	name	units	GRIB edition	Components	Test data available
Model levels						
210247	aermr16	Nitrate fine mode aerosol mass mixing ratio	kg kg ⁻¹	2	CAMS aerosol model	yes
210248	aermr17	Nitrate coarse mode aerosol mass mixing ratio	kg kg ⁻¹	2	CAMS aerosol model	yes
210249	aermr18	Ammonium aerosol mass mixing ratio	kg kg ⁻¹	2	CAMS aerosol model	yes
Pressure levels						
210247	aermr16	Nitrate fine mode aerosol mass mixing ratio	kg kg ⁻¹	1	CAMS aerosol model	yes
210248	aermr17	Nitrate coarse mode aerosol mass mixing ratio	kg kg ⁻¹	1	CAMS aerosol model	yes
210249	aermr18	Ammonium aerosol mass mixing ratio	kg kg ⁻¹	1	CAMS aerosol model	yes
Surface level						
210250	niaod550	Nitrate aerosol optical depth at 550 nm	<i>dimensionless</i>	1	CAMS aerosol model	yes
210251	amaod550	Ammonium aerosol optical depth at 550 nm	<i>dimensionless</i>	1	CAMS aerosol model	yes

New model output parameters

Discontinued model parameters

The "SO₂ aerosol precursor" (aermr12/210012 and related diagnostics 215168–215175) have been discontinued, as the aerosol scheme now uses the same SO₂ tracer as the chemistry (so2/210122).

Similarly, the sulfate tracer in the chemistry scheme (so4/217020 and related diagnostic tcso4/218020) is no longer used, as the chemistry now uses the same sulfate tracer as the aerosol (aermr11/210011).

Old grib name	Old grib short name	Old grib parameter ID		New grib name	New grib short name	New grib parameter ID
SO2 precursor mixing ratio	aermr12	210012		Sulphur dioxide	so2	210122
Sulfate	so4	217020		Sulphate Aerosol Mixing Ratio	aermr11	210011

Software

ecCodes

[ecCodes](#) version 2.12.1 provides full support for the new CAMS model output parameters introduced in IFS Cycle 46r1.

Availability of test data from the cycle 46r1 test suites

The CAMS operational FTP server (ECPDS) currently serves one day of test data (17 March 2019) in the directory "/DATA/CAMS_GLOBAL_TEST" and "/DATA/CAMS_EUROPE_BC_TEST" for global and regional boundary condition data, respectively. More details can be found [here](#).

Document versions

Date	Reason for update
11.04.2019	Initial version
30.04.2019	Listing of all changes and their expected impact.
20.06.2019	Decision on expected implementation date
04-07-2019	Summary of validation results added.
05-07-2019	Link to validation report added