ECMWF Copernicus Procurement

Invitation to Tender

Copernicus Atmosphere Monitoring Service

Volume II

Evaluation and Quality Control (EQC) of global products

ITT Ref: CAMS2_82
ISSUED BY: ECMWF Administration Department Procurement Section
Date: 6 July 2021
Version: Final

Funded by the European Union

Implemented by ECMWF

Table of Contents

1 Introduction

Some of today's most important environmental concerns relate to the composition of the atmosphere. Ozone distributions in the stratosphere influence the amount of ultraviolet radiation reaching the surface. In the troposphere, aerosols, ozone and other reactive gases such as nitrogen dioxide determine the quality of the air around us, affecting human health and life expectancy, the health of ecosystems and the fabric of the built environment. The variable abundance of the reactive gases change the oxidation capacity of the atmosphere and control therewith also the abundance of long-lived greenhouse gases. The composition of the troposphere and the associated deposition fluxes are major components of the biogeochemical cycles of carbon, nitrogen and sulphur and iron, which effect the land- and marine eco systems. Dust, smoke and volcanic aerosols affect the safe operation of transport systems and the availability of power from solar generation, the formation of clouds and rainfall, and the remote sensing by satellite of land, ocean and atmosphere.

The increasing concentration of the greenhouse gases and the various aerosol-weather feedbacks are prominent but often uncertain drivers of climate change. In the wake of the agreement signed in Paris at the UNFCCC's 21st Conference of the Parties (COP-21) in December 2015, the need to monitor and to inform about the effectiveness of mitigation efforts for anthropogenic emissions of key greenhouse gases has become more acute and prominent. With its global coverage (or regional in the case of geostationary platforms), Earth Observation has a decisive role to play within such a monitoring system, complementing ground-based observations, "bottom-up" estimates of the emissions (included in official reporting) and atmospheric transport modelling.

To address these environmental concerns there is a need for data and processed information. The Copernicus Atmosphere Monitoring Service (CAMS) has been developed to meet these needs, aiming at supporting policymakers, business and citizens with enhanced atmospheric environmental information.

Within its first phase (2015 – 2020), Cop1, the Service consolidated many years of preparatory research and development to deliver a range of operational services. In its second phase (2021 – 2027), Cop2, these services are further consolidated, improved and expanded to address all the existing and emerging societal needs related to the atmospheric environment. The CAMS service portfolio consists of the following service elements:

a) Daily production of real-time analyses and forecasts of global atmospheric composition;
b) Reanalyses providing consistent multi-annual global datasets of atmospheric composition with a stable model/assimilation system;
c) Daily production of real-time European air quality analyses and forecasts with a multi-model ensemble system;
d) Reanalyses providing consistent annual datasets of European air quality with a frozen model/assimilation system, supporting in particular policy applications;
e) Products to support policy users, adding value to "raw" data products in order to deliver information products in a form adapted to policy applications and policy-relevant work;
f) Solar and UV radiation products supporting the planning, monitoring, and efficiency improvements of solar energy production and providing quantitative information on UV irradiance for downstream applications related to health and ecosystems;
g) Greenhouse gas atmospheric inversions for CO_2, CH_4 and N_2O net surface fluxes, allowing the monitoring of the evolution in time of these fluxes;
h) Climate forcing from aerosols and long-lived (CO_2, CH_4) and shorter-lived (stratospheric and tropospheric ozone) agents;

i) Anthropogenic and natural emissions, based on inventory data and modelling, for the global and European domains;
j) Observation-based emission estimates of atmospheric pollutants for the global and European domains;
k) Observation-based anthropogenic emission estimates of CO_2 and CH_4 for the global domain and emission hotspots..

This Invitation to Tender (ITT) is mainly targeting the CAMS service elements described under items (a) and (b).

1.1 Definitions

Definitions specific for this ITT are defined below.

Global Service Provider: ECMWF is the provider of global products

Global Production System: the modelling and data assimilation infrastructure used to provide the CAMS global analyses and forecasts of atmospheric composition.

Real-Time Global Products: the operational real-time analyses and forecasts from the Global Production System, which is run by the Global Service Provider. These analyses and forecasts are produced at least daily and include 3-dimensional fields of aerosols, chemical species, and greenhouse gases with a temporal resolution of at least 6 hours.

Forecast-only Global Products: the outputs of a global CAMS forecasting system that is based on the Global Production System used to produce the Real-Time Global Products but without the assimilation of observations of atmospheric composition. The forecasts are produced at least daily and include 3-dimensional fields of aerosols, chemical species, and greenhouse gases with a temporal resolution of at least 6 hours.

Global Reanalysis Products: the outputs of reanalyses from the Global Production System, which is being run by the Global Service Provider. The reanalyses will cover the period between 2003 onwards and provide analyses and forecasts every 12 hours of 3-dimensional fields of aerosols, chemical species, and greenhouse gases with a temporal resolution of at least 6 hours.

2 Contract Summary

This ITT, entitled "Evaluation and Quality Control (EQC) of global products", is for evaluation and quality assurance (EQC) activities of the CAMS global production systems. The aim of the EQC activities is to provide information on the scientific and operational quality of Real-Time Global Products in the form of EQC reports and on-line evaluation graphics. Additionally, the ITT covers some support for EQC of system upgrades for the Real-Time Global Products and provides information on the scientific quality of reanalysis products produced by the Global Service Provider. The ITT is also for input to the CAMS EQC framework for the Global Products. In summary, the successful Tenderer shall deliver:

- EQC reports of CAMS Real-Time Global Products
- Evaluation of CAMS Real-Time Global Products through provision of routine monitoring graphics by maintaining the CAMS Global Evaluation Server https://global-evaluation.atmosphere.copernicus.eu/
- EQC reports for upgrades of the CAMS global production system
- EQC reports of the CAMS Global reanalysis Products
- Improvement of evaluation methodology and contribution to the Copernicus EQC framework.

- Exploration and acquisition of new observational datasets for validation of the CAMS Global Products and provision of these observational datasets to the Global Service Provider and other relevant CAMS contracts.

The ITT targets organisations with considerable experience in the field of atmospheric composition EQC activities and methodology as well as access to the relevant observational datasets.

3 Technical Specification

3.1 General Requirements

This ITT is for the provision of EQC activities for the CAMS global production system. EQC involves the assessment of the closeness of the data to the geophysical reality and of the sources of uncertainty of the data, over the geographic, vertical and temporal domains of relevance. Uncertainty estimates can include, but are not restricted to, estimates of the bias and precision of the data, and identification of the temporal and spatial domains over which those estimates are valid. Reference measurements used in the comparisons are supposed to represent the atmospheric "truth". A key aspect of any comparison performed for EQC purposes is the careful selection of this "truth". The quality, traceability and suitability of the latter are essential to allow proper, unbiased and independent quality assurance. Those reference data must be well documented and procedures must exist to ensure adequate quality assurance in the long term. EQC of CAMS atmospheric data products can rely on comparisons with accurate and well-documented independent observations from ground-, aircraft-, balloon- and satellite-based systems.

The central element of this ITT is the acquisition, interpretation and use of observational data sets that are independent (not used as input to the service production) to assess the quality of the products delivered by the Global Production System, as described in the work packages in sections 3.2 to 3.7. The successful Tenderer is therefore expected to bring together the relevant expertise and access to relevant data sets to fully exploit the existing knowledge base in Europe on EQC of atmospheric composition model outputs. In addition, the successful Tenderer shall make use, where meaningful, of the existing observational data streams under the CAMS2_2000 contracts (ACTRIS, EEA, EAN, GAW-EMEP, IAGOS, ICOS, and NDACC).

As a minimum requirement, EQC in the work packages described hereafter shall be provided for the following species:

- Aerosols (total and individual species, where possible)
- PM2.5, PM10
- Ozone
- Carbon monoxide
- Nitrogen dioxide
- Sulphur dioxide (anthropogenic and volcanic)
- Formaldehyde
- Carbon dioxide
- Methane

The EQC shall target the full 3-dimensional distribution of these species over time with additional emphasis on surface concentrations unless stated otherwise in the work package descriptions below. EQC of additional species shall be included if/when relevant independent observational data sets exist.

3.2 Work package 8210 – Evaluation of CAMS Real-Time Global Products

The Global Service Provider provides the CAMS Real-Time Global Products using ECMWF's Integrated Forecasting System (IFS). These products are produced by combining information from the global forecast model, which models aerosols, chemical species and greenhouse gases, with information from observations of both atmospheric composition and meteorology through a process called four-dimensional variational data assimilation (4D-Var). The analyses are used as initial conditions for the subsequent model forecast. Only a subset of the atmospheric composition species in these analyses and forecasts are directly constrained by observations, but all species are in principle available to users and therefore will need to be validated. The Real-Time Global Products cover both the troposphere and stratosphere. In parallel, the Global Service Provider produces Forecast-Only Global Products that act as a benchmark for the impact of the data assimilation on the forecast quality. These Forecast-Only Global Products can be based on different chemical schemes.

The successful Tenderer shall routinely (every three months) provide EQC reports for the Real-Time Global Products documenting the scientific quality relative to the independent validation data. The report shall also provide information on the impact of the assimilated observations through comparison of the Real-Time Global Products with the Forecast-Only Global Products. Each report shall document the 3-month period in terms of mean and variability of the product quality based on the individual analyses and forecasts and also the service evolution by inclusion of data from the Cop1 period. Each report shall be made available within 3 months after the end of each respective validation period. While the EQC reports shall describe the full global domain, particular focus shall be put on the European, North American, East Asian, Indian, Arctic and Mediterranean regions and effort shall be undertaken to increase the number of focus areas and acquire new observational datasets. The EQC reports will be used by service providers and users and shall therefore comprehensively and clearly document the various EQC comparisons and include a summary of the main findings. For the production of the EQC reports, the successful Tenderer shall use the software described in WP8220 and the software potentially developed as part of WP8250 as much as possible to harmonize the data processing and generation of the various graphics. The Tenderer shall outline a proposal for including in the EQC reports the evaluation of species currently not covered in the reports for which retrievals are or will be available from IASI, GOME-2, TROPOMI and future Sentinels as well as IASI-NG instruments.

The Real-Time Global Products provided by the Global Service Provider also contain forecasts of UV-Index values as well as the underlying spectrally resolved UV irradiances. The spectrally resolved UV irradiance is based on the Rapid Radiative Transfer Model adapted for Global Circulation Models (RRTMG) using prognostic ozone, aerosol optical thickness, cloud fraction and cloud mixing ratio as input. The code provides the down-welling spectral radiation for the lowest model level in the range 280 nm - 400 nm at 5 nm spectral resolutions. The successful Tenderer shall routinely evaluate the provided spectrally resolved UV irradiances and UV-index against independent observations worldwide and include the findings in the quarterly EQC reports, documenting the 3-month period in terms of mean and variability of the product quality based on the individual UV irradiance estimates.

The Global Service Provider plans to include a more comprehensive representation of stratospheric chemistry in the Global Production System during the duration of this ITT. Once such a chemistry module is in place, the EQC reports shall include an additional focus on the evaluation of stratospheric species, including the development of metrics that could allow support for the 2022 or 2026 WMO ozone assessments.

The EQC reports shall also include the greenhouse gas (GHG) products including the GHG analysis, GHG forecast, and the Forecast-Only GHG gas products produced by the Global Service Provider that are part of the operational service provision, but are currently produced in a parallel data assimilation and forecasting system.

Finally, the successful Tenderer shall include the monitoring of forecast model fields over time with a particular focus on individual aerosol species and the key atmospheric pollutants. This monitoring over time shall especially focus on changes in behaviour of the forecasts as a result of upgrades of the global forecasting system.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

WP8210 Deliverables			
#	*Type*	*Title*	*Due*
D1.Y.Z-yyyyQx[1]	Report	Quarterly EQC report	Quarterly
D1.Y.Z	Report/ Dataset		
…			

WP8210 Milestones			
#	*Title*	*Means of verification*	*Due*
M1.Y.Z			

3.3 Work package 8220 – Evaluation of CAMS Real-Time Global Products through provision of routine EQC graphics

To continuously monitor the scientific quality of the Real-Time Global Products the CAMS Global Evaluation Server https://global-evaluation.atmosphere.copernicus.eu/ was developed to produce on-line graphics on a routine basis comparing these products as well as the Forecast-Only Global Products with independent observations that are available within a few weeks of measurement. This Global Evaluation Server shall be maintained to routinely provide information to CAMS providers and users about how closely the CAMS global forecasts fit independent observations. The graphics shall be updated on a daily basis using the latest observations for each validation site, and particular effort shall be undertaken to keep the graphics as close to real-time as possible, providing more timely information than is available in the quarterly EQC reports. The successful Tenderer shall acquire the

[1] Deliverables (and Milestones) shall be numbered as per the following format DX.Y.Z (MX.Y.Z), where X is the WP number, Y is the task number and Z is the Deliverable (Milestone) number in this task. Deliverables delivered annually should be numbered DX.Y.Z-yyyy, where yyyy is the year the Deliverable refers to (e.g. DX.Y.Z-2016, DX.Y.Z-2017). Deliverables delivered quarterly should be numbered DX.Y.Z-yyyyQx, where yyyyQx is the quarter of the year the Deliverable refers to (e.g. DX.Y.Z-2016Q1, DX.Y.Z-2016Q2). The same numbering format shall be applied for Milestones. Continuous deliverables at higher frequency can be labelled in the same way as quarterly deliverables.

relevant validation data sets with a particular focus on data sets that are routinely updated (such as those acquired through the CAMS2_2000 contracts (see Section 3.1) and other international networks (e.g., AERONET, TCCON, ozone sondes).

The core of the developed software is formed by the CODE, HARP and MUNINN software, which is available through their GIT repositories at http://github.com/stcorp/coda, https://github.com/stcorp/harp, and https://github.com/stcorp/muninn. Documentation of HARP can be found at http://www.stcorp.nl/beat/documentation/harp/index.html. Technical documentation of the Global Evaluation Server can be found here: https://atmosphere.copernicus.eu/publication/27.

The successful Tenderer shall maintain the CAMS Global Evaluation Server including an operational implementation that generates and publishes the routine EQC graphics as part of the CAMS website. The EQC graphics shall be presented as daily updated time series comprising at least the last 3 months of data and the CAMS Global Evaluation Server shall include the same functionality as is available today.

The successful Tenderer shall also provide minor further development of the software, which will focus on further improving some of the functionality of the current evaluation server. This development will be agreed at the start of each annual Service Contract between ECMWF and the successful Tenderer.

The observations and co-located CAMS data shall also be made available to the Global Service Provider on a quarterly basis and the software of the Global Evaluation Server on an annual basis.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

WP8220 Deliverables			
#	*Type*	*Title*	*Due*
D2.Y.Z-yyyyQx	Website with graphics, short note	Up-to-date web site with EQC graphics	Quarterly on 15/01, 15/04, 15/07 and 15/10
D2.Y.Z-yyyy	Report	Development plan for EQC software including overview of previous 12 monthly developments	Annually in December
D2.Y.Z-yyyy	Code	Provision of EQC software to Global Service Provider	Annually
D2.Y.Z-yyyyQx	Data	Delivery of observational data used in Global Evaluation Server to Global Service Provider	Quarterly
…			

WP8220 Milestones			
#	*Title*	*Means of verification*	*Due*

M2.Y.Z			

3.4 Work package 8230 – EQC of upgrades of the CAMS global production system

EQC also plays an important role in the upgrade procedure of the CAMS operational Global Production System. The implementation of developments follows a model cycle approach. The Global Service Provider normally upgrades its Global Production System once or twice per year. These upgrades include improvements to the model and data assimilation system as well as changes in the input data sets and assimilated data sets. Because the Global Production System is based on the ECMWF numerical weather prediction system, new model cycles will also include meteorological developments and input data changes. These can also affect the assimilation and modelling of atmospheric composition. The Global Service Provider can also decide to implement significant changes in the input data sets, such as emissions, outside the normal cycle approach, if this is important to provide the best services to the CAMS users. The EQC of these changes shall also be taken into account as part of this work package.

Before replacing the operational system, the Global Service Provider performs extensive testing of the new cycle by setting up an experimental production suite that runs several months in catch-up mode (producing several days of analyses and forecasts per day) and finally in parallel with the operational suite. As part of this work package, the successful Tenderer shall evaluate the output of the final experimental suites against independent observations and compare them with the output of the then current operational suite. The successful Tenderer shall present the EQC findings in an evaluation report summarizing the results. This report will be used to inform CAMS users of the changes and how they affect the quality of the forecasts. The final decision to implement the experimental suite as the new operational suite will be taken by the Global Service Provider. The EQC report shall cover as full a period of the experimental suite as possible and be produced to a time schedule to be agreed by the successful Tenderer and ECMWF, on a case-by-case basis, ideally delivered one month before the planned implementation. ECMWF shall communicate the expected number and timing of experimental suites to be evaluated for each year at the start of the year.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

WP8230 Deliverables			
#	*Type*	*Title*	*Due*
D3.Y.Z-yyyy	Note	Agreed EQC plan for experimental suite(s) in yyyy	Annually (January)
D3.Y.Z-yyyyQx	Report	EQC report(s) for experimental suite(s) as defined in plan above	Annually
…			

WP8230 Milestones			
#	*Title*	*Means of verification*	*Due*
M3.Y.Z			

3.5 Work package 8240 – EQC of CAMS Global Reanalysis Products

The Global Service Provider is currently producing two global reanalyses, one covering aerosols and reactive gases (CAMS reanalysis EAC4) and one covering the main greenhouse gases (CAMS reanalysis EGG4), for the period 2003 - present, which are being extended in a so-called near-real-time mode within the time frame of this ITT. A new global reanalysis (again covering the period from 2003 onwards, and referred to as CAMS reanalysis EAC5) with an improved model and data assimilation system is scheduled to be produced from 2023 onwards. At this stage it is not decided yet if this new reanalysis will consist of one fully comprehensive data set covering aerosols and reactive gases as well as greenhouse gases or two separate data sets (as is currently the case with EAC4 and EGG4).

A reanalysis involves reprocessing observational data spanning an extended historical period using a consistent modern analysis system, to produce a dataset that can be used for various atmospheric composition studies. The same EQC principles apply as for the Real-Time Global Products but with a stronger focus on temporal stability of the output. The successful Tenderer will therefore use a range of relevant evaluation data sets and homogeneity tests to document the quality of the Global Reanalysis Products. The successful Tenderer shall present the EQC results in a series of reports based on the daily analyses.

For the current EAC4 and EGG4 reanalyses, two type of reports shall be provided. Quarterly “quick-look” reports shall cover the EQC results for each quarter of the reanalysis as it is being produced and shall be made available within two months after the end of each quarter. The “quick-look” reports shall consist of a set of standard evaluation graphics covering key atmospheric species and aerosols of the reanalysis (list to be agreed with ECMWF) and presented in the form of an up-to-date internal password-protected website displaying the graphics. This reanalysis monitoring website shall not be connected to the CAMS Global Evaluation Server, which is a public site. In addition, the successful Tenderer shall provide a comprehensive annual EQC report, documenting the quality of the CAMS reanalyses (EAC4 and EGG4) during the previous year, with particular focus on the long-term stability of the datasets, assessing the fitness of the data record for calculating spatial and temporal means as well as variability and trends.

For the upcoming EAC5 reanalysis (scheduled to be produced from 2023 onwards) the successful Tenderer shall provide every 6 months “quick-look” reports during the “catch-up” phase (the phase during which the reanalysis is produced at a rate that is higher than one day per day) with particular focus on the most recently produced period and display a set of standard evaluation graphics covering key atmospheric species and aerosols of the reanalysis (list to be agreed with ECMWF) in the form of an up-to-date internal password-protected website displaying the graphics. Also, two comprehensive reports documenting the quality of the recently produced periods (for periods chosen in discussion with the Global Service provider) shall be produced. Once the catch-up phase has finished, the successful Tenderer shall produce quarterly “quick-look” reports in the same way as described above and comprehensive annual EQC reports while the EAC5 reanalysis is being produced close to real-time. The evaluation shall include the troposphere and the stratosphere with particular focus on the long-term stability of the dataset, assessing the fitness of

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

WP8240 Deliverables			
#	*Type*	*Title*	*Due*
D4.Y.Z-yyyyQx	Website	Quarterly EQC quick-look report for the CAMS global reanalysis (EAC4 and EGG4)	Quarterly
D4.Y.Z-yyyy	Report	Comprehensive EQC assessment of the global reanalysis (EAC4 and EGG4) for the previous year	Annually
D4.Y.Z-yyyyQx	Website	6-monthly EQC quick-look reports for the EAC5 global reanalysis for the recently covered period while the reanalysis is running in catch-up mode	6-monthly
D4.Y.Z	Report	Comprehensive validation report for EAC5 reanalysis Period 1	3 months after the production of Period 1 of the reanalysis
D4.Y.Z	Report	Comprehensive validation report for EAC5 reanalysis Period 2	3 months after the production of Period 2 of the reanalysis
D4.Y.Z-yyyyQx	Website	Quarterly EQC quick-look report for the EAC5 global reanalysis once the reanalysis is running close to real-time	Quarterly
D4.Y.Z-yyyy	Report	Comprehensive assessment of the EAC5 global reanalysis for the previous year once the reanalysis is running close to real-time	Annually

WP8240 Milestones			
#	*Title*	*Means of verification*	*Due*
M4.y.z			

3.6 Work package 8250 – Improvement of evaluation methodology and contribution to EQC framework

As part of the general CAMS service evolution, ECMWF is setting up a comprehensive EQC framework for all data sets that are disseminated through the Atmosphere Data Store (ADS), similar to the EQC framework developed under the Copernicus Climate Change service (see, for example, https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-sea-ice?tab=eqc).

The successful Tenderer shall support ECMWF with the provision of EQC information for the products from the Global Production System through this online EQC framework. This will include the EQC reports as defined in the previous sections, but also documents directly related to the observations used for the evaluation, such as quality assurance of the EQC datasets as well as definitions of the EQC scores and methodologies used to evaluate the Global Production System. The successful Tenderer shall also contribute to points of User Documentation (e.g. Uncertainty quantification, Validation, Inter-comparison) and Independent Assessment (e.g. Expert evaluation, Key strengths and limitations) and will provide plans for this contribution on an annual basis in discussion with ECMWF as well as provide the resulting EQC documents to be displayed on the ADS.

The successful Tenderer shall also support the definition of new EQC metrics that will allow CAMS to support international efforts, such as the 2022 and 2026 WMO ozone assessments and intercomparisons of monitoring and forecasting results from various (operational) centres around the world.

In addition, the successful Tenderer shall support the monthly discussions between the Global Service Provider and the developers of the Global Production System based on the findings in the so-called CAMS Weather Room, an (currently) internal online platform that is used to monitor the daily CAMS forecasts.

Finally, the successful Tenderer shall explore innovative ways for the graphical representation of evaluation results. This activity shall support the production of the quarterly EQC reports as well as aim to address the requirements from the developers of the Global Production System. While the focus of the activity in WP8220 focuses on routine monitoring of the outputs from the Global Production System, the focus of this task shall be focused on flexibility of the interface. Examples of capabilities that have been developed so far can be found at https://policy.atmosphere.copernicus.eu/aeroval.php.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

WP8250 Deliverables			
#	*Type*	*Title*	*Due*
D5.Y.Z-yyyy	Report	Plan for EQC developments for inclusion on the ADS for the upcoming year	Annually in January
D5.Y.Z-yyyyQx	Report	Inclusion of EQC information and reports about the CAMS Global System and reanalysis on the ADS	6-monthly

WP8250 Milestones			
#	*Title*	*Means of verification*	*Due*
M5.y.z			

3.7 Work package 8260 – Acquisition of new observational data sets

Atmospheric composition observations are collected by a variety of different networks. Acquisition and quality control of the widest possible range of atmospheric composition observations is of crucial importance for the successful evaluation of the CAMS Global Production System. While many observational networks already routinely provide data to CAMS (with and without specific financial support), the successful Tenderer shall also actively search for new datasets that can be used for the evaluation of the CAMS Global Production System, especially in regions that are currently not sufficiently covered in the CAMS EQC activities (e.g., China, India, Korea, Japan, Australia, Africa). The successful Tenderer shall then acquire the data, assess the data quality and use them in the EQC reports of the CAMS global production system if the data quality allows this.

In this framework, the successful Tenderer shall explore the use of new data sets in addition to the existing data streams, such as (but not limited to) CASTNET, OpenAQ, AirBase and Airnow. If necessary, the successful Tenderer shall develop a classification system for the air quality data (e.g. urban, rural,…) that will allow them to apply quality control to the data sets.

The successful Tenderer shall make available the acquired observational data to the Global Service Provider and other relevant ITTs for the purpose of evaluating and improving the CAMS services.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables

WP8260 Deliverables			
#	*Type*	*Title*	*Due*
D6.Y.Z-yyyy	Report	Overview of newly acquired observations, data sources, data quality and classification system applied, including methods for accessing the data	Annually in November
…			

WP8260 Milestones			
#	*Title*	*Means of verification*	*Due*
M6.Y.Z	New data used in EQC report or Global Evaluation Server	Relevant graphics available in EQC reports and/or Global Evaluation Server	M18, M36

3.8 Work package 8270 – User support and documentation of service

The objective of this work package is to provide support to users of the delivered products and services.

ECMWF has established a centralised Copernicus Service Desk to provide multi-tiered technical support to all users of CAMS data, products, tools and services. The Service Desk handles user queries through a ticketing system and distributes these queries to specialists when needed. Dedicated staff

at ECMWF provide basic support in the form of self-help facilities (FAQs, Knowledge Base, online Forum, tutorials etc.) as well as individualised support on technical queries related to the Atmosphere Data Store (ADS), data formats, data access etc. In addition, ECMWF staff provide specialised scientific support to address questions related to its industrial contributions to CAMS, e.g. in the areas of global forecasting of atmospheric composition.

All CAMS contractors are expected to contribute to the delivery of multi-tiered technical support for the data and/or services they provide. Such specialised user support shall take the form of direct response to individual user queries via the Service Desk facility, as well as contributions to FAQs, Knowledge Base, and user guides. Contractors may also be requested by the CAMS Service Desk to contribute to support questions in the online Forum.

Tenderers shall describe the level of user support service on Service Desk tickets as a specific Key Performance Indicator (KPI) with a target value of 80% of the assigned specialised user queries being resolved within 15 days after being informed by the CAMS Service Desk.

Tenderers shall also address development of user guides. Documentation of the CAMS services is an integral part of the service provision and is directly linked to the Atmosphere Data Store. The technical and scientific specification of each service shall be documented in the CAMS Knowledge Base as linked from the Atmosphere Data Store (see example for the CAMS global reanalysis at https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-reanalysis-eac4?tab=doc), and, if more detail is required, in reports that will be available to users through the CAMS web site. The successful Tenderer shall therefore produce documentation describing in detail the methodologies and products they deliver for this ITT. The documentation in the Knowledge Base shall be targeted at the general external user community, while the additional detailed reports shall address the needs of expert users.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

WP8270 Deliverables			
#	*Type*	*Title*	*Due*
D7.Y.Z-yyyy	Other	Contribution to CAMS Knowledge Base to ensure up-to-date information about products and services covered under this contract	Annually
…			

WP8270 Milestones			
#	*Title*	*Means of verification*	*Due*
M7.Y.Z	…	…	…
…			

3.9 Work package 8200 – Management and coordination

The following management aspects shall be briefly described in the bid:

- Contractual obligations as described in the Framework Agreement Clause 2.3 on reporting and planning.
- Meetings (classified as tasks and listed in a separate table as part of the proposal):
  - ECMWF will organise annual CAMS General Assemblies. The successful Tenderer is required to attend these meetings with team members covering the various topics that are part of this ITT.
  - ECMWF will host monthly teleconference meetings to discuss CAMS service provision, service evolution and other topics. The Prime Investigator appointed by the successful Tenderer will represent the successful Tenderer in such meetings.
  - ECMWF will organise six-monthly project review meetings (linked to Payment milestones).
  - Tenderers can propose additional project internal meetings (kick-off meeting, annual face-to-face meeting and monthly teleconferences) as part of their response.
- Quality assurance and control: the quality of reports and Deliverables shall be equivalent to the standard of peer-reviewed publications. The final quality check of the deliverables should be made by the prime contractor (contents, use of ECMWF reporting templates for deliverables and reports (Microsoft Word), format, deliverable numbering and naming, typos…); all reports in this project shall be in English. Unless otherwise specified the specific contract Deliverables shall be made available to ECMWF in electronic format.
- Communication management (ECMWF, stakeholders, internal communication).
- Resources planning and tracking using the appropriate tools.
- Implementation of checks, controls and risk management tools for both the prime contractor and subcontractors.
- Subcontractor management, including conflict resolution, e.g. the prime contractor is responsible for settling disagreements, although advice/approval from ECMWF may be sought on the subject.
- A list of subcontractors describing their contribution and key personnel shall be provided, as well as back-up names for all key positions in the contract. The Tenderer shall describe how the Framework Agreement, in particular Clause 2.9 has been flowed down to all their subcontractors.
- Management of personal data and how this meets the requirements of Clause 2.8 and Annex 6 of the Volume V Framework Agreement.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

WP8200 Deliverables				
#	*Responsible*	*Nature*	*Title*	*Due*
D0.Y.Z-yyyyQx	Tenderer	Report	Quarterly Implementation Report QQ YYYY *QQ YYYY being the previous quarter*	Quarterly on 15/04, 15/07 and 15/10 (only at the above dates; QIR for Q4 will be part of the AIR)
D0.Y.Z-yyyy	Tenderer	Report	Annual Implementation Report (AIR) YYYY *YYYY being the Year n-1*	Annually on 28/02
D0.Y.Z-yyyy	Tenderer	Other	Preliminary financial form YYYY *YYYY being the Year n-1*	Annually on 15/01

D0.Y.Z	Tenderer	Report	Final report	60 days after end of contract (tenderer to include date based on Contract Notice)
D0.Y.Z-yyyy	Tenderer	Report	Finalised Implementation plan YYYY *YYYY being the Year n+1*	Annually on 30/09
D0.Y.Z-yyyy	Tenderer	Other	Copy of prime contractor's general financial statements and audit report YYYY *YYYY being the Year n-1*	Annually, in June
D0.Y.Z	Tenderer	Other	Updated KPIs (list, targets…) after review with ECMWF	One year after start of contract

WP8200 Milestones				
#	*Responsible*	*Title*	*Means of verification*	*Due*
M0.y.z-Px	Tenderer	Progress review meetings with ECMWF / Payment milestones	Minutes of meeting	~ Every 6 months

4 General Requirements

4.1 Implementation schedule

The Framework Agreement will run from 1 December 2021 to 31 May 2025. The Tenderer shall provide a detailed implementation plan of proposed activities for the full period.

4.2 Deliverables and milestones

Deliverables should be consistent with the technical requirements specified in section 3. A deliverable is a substantial, tangible or intangible good or service produced as a result of a project. In other words, a deliverable is an outcome produced in response to the specific objectives of the contract and is subject to acceptance by the technical contract officers at ECMWF. When defining deliverable please **consolidate their numbers** against a specific deadline where possible. All contract reports shall be produced in English. The quality of reports and deliverables shall be equivalent to the standard of peer-reviewed publications and practice. Unless otherwise specified in the specific contract, deliverables shall be made available to ECMWF in electronic format (PDF/Microsoft Word/Microsoft Excel or compatible) via the Copernicus Deliverables Repository portal.

In Volume IIIA (tab: “Deliverables List”) each Deliverable shall have an associated resource allocation (person-months and financial budget, resource type: payroll only). The total of these allocated resources shall amount to the requested budget associated with payroll. Milestones should not have the associated budget.

Milestones should be designed as markers of demonstrable progress in service development and/or quality of service delivery. They should not duplicate deliverables and shall not attract the budget under Annex IIIA, tab “Deliverables List”. Apart from the payment milestone review meetings, all foreseen meetings shall not be classified as milestones but listed in a separate overview table for each work package.

The Tenderer shall ensure that the proposed due dates of deliverables and milestones are realistic and achievable. Any dependencies on input data shall be accounted for in the risk table.

4.3 Acquisition of necessary data and observations

The Successful Tenderer is responsible for acquiring all the needed observational data sets, but shall closely interact with the Global Service Provider, the provider of the Regional Production contract, the provider of the regional EQC contract, and the providers of the relevant in situ support contracts (CAMS2_2000) for the exchange of relevant data sets related to this ITT. Particular emphasis should be paid to acquiring new data sets covering areas outside Europe, such as East-Asia and the Americas.

The Global Service Provider will provide the Real-Time Global Products, Forecast-Only Global Products and Global Reanalysis Products needed for carrying out the tasks of this ITT.

4.4 Communication

The successful Tenderer shall support ECMWF in its communication activities for the CAMS services, where they are related to the activities described in this ITT. Examples are contributions to the Copernicus State of the Climate report, CAMS web site news items, and CAMS brochures and flyers. All communication activity must be agreed with the ECMWF Copernicus Communication team in advance. This includes, but not exhaustively, communication planning, branding and visual style, media outreach, website and social media activity, externally facing written and graphic content and events. Agreed activity would also need to be evaluated and reported on, once complete, so that success measures and KPIs can be provided to the European Commission.

4.5 Support for user engagement and training activities

While user engagement and training activities are not part of the scope of this ITT, the Tenderer shall accommodate for eventual needs in providing technical and scientific expertise in support of these activities. The bidder shall specify in the bid the experts intended to be allocated to provide this support.

Requests to support activities may be raised on for example:

- Contribute with content specific input to training, education and capacity building material: development and/or review of learning resources in the domain of the contract, participation in train-the-trainer events and MOOCs;
- Contribute with content specific input to user-oriented communication material such as slides, story maps and user testimonials;
- Contribute and attend User Uptake workshops and stakeholder meetings. Presentations in your mother tongue may be asked to be provided;
- Input to the URDB with user requirements (cf. template as provided during the negotiation process) as well sharing needs and aspirations as raised by potential new user communities;

An indicative maximum budget of 5,000.- EUR shall be allocated in the pricing table to accommodate for these needs. This shall be paid as a fixed price. Details on the required activities shall be refined as part of the Annual Implementation Plans.

As part of the CAMS user interaction, user requirements are continually collected in a User Requirements Database (URDB) in a structured and traceable way. This URDB tracks all requirements emanating from a wide variety of user fora, surveys, user support and direct interactions between service providers and their users. The entries of the URDB are analysed on a regular basis in terms of

user requirements per domain, importance and feasibility. This analysis constitutes the basis for distilling, filtering and translating user requirements into technical specifications for the Service and its evolution.

The successful Tenderer shall provide input to the User Requirements Database (URDB) regarding user requirements that are directly related to activities covered by this ITT. The successful Tenderer shall also support ECMWF and the contractor for User Interaction activities with the analysis of relevant user requirements in the URDB.

The following deliverables are thus to be added to the WP8270 deliverable lists:

WP8270 Deliverables Template			
#	*Type*	*Title*	*Due*
D7.Y.Z-yyyy	Other	Input to CAMS URDB - YYYY	Checked by ECMWF annually in November
D7.Y.Z	Report	Summary of user engagement activities.	Due 1 month before contract end date

4.6 Data and IPR

It is a condition of EU funding for CAMS that ownership of any datasets developed with CAMS funding passes from the suppliers to the European Union via ECMWF. Ownership will pass from the date of creation of the datasets. Suppliers will be granted a non-exclusive licence to use the datasets which they have provided to CAMS for any purpose.

All software and products used by the successful Tenderer to produce the CAMS datasets will remain the property of the successful Tenderer, except for those components which are acquired or created specifically for CAMS purposes, with CAMS funding, and which are separable and useable in isolation from the rest of the successful Tenderers' production system. The identity and ownership of such exceptional components will be passed to the European Union via ECMWF annually The successful Tenderer will be granted a non-exclusive licence to use them for any purpose.

5 Tender Format and Content

General guidelines for the tender are described in Volume IIIB. Specific requirements to prepare the proposal for this particular tender are described in the next sub-sections.

5.1 Page Limits

As a guideline, it is expected that individual sections of the Tenderer's response do not exceed the page limits listed below. These are advisory limits and should be followed wherever possible, to avoid excessive or wordy responses.

Section	*Page Limit*
Executive Summary	2
Track Record	2 (for general) and 2 (per entity)
Quality of resources to be Deployed	2 (excluding Table 1 in Volume IIIB and CVs with a maximum length of 2 pages each)

Technical Solution Proposed	2 + 3 per Work package (Table 2 in Volume IIIB, the section on references, publications, patents and any pre-existing IPR is excluded from the page limit and has no page limit)
Management and Implementation	6 (excluding Table 3, Table 5, Table 6 and Table 7 in Volume IIIB) + 2 per each Work package description (Table 4 in Volume IIIB)
Pricing Table	No limitation

Table 1: *Page limits*

5.2 Specific additional instructions for the tenderer's response

The following is a guide to the minimum content expected to be included in each section, additional to the content described in the general guidelines of Volume IIIB. This is not an exhaustive description and additional information may be necessary depending on the Tenderer's response.

5.2.1 Executive Summary

The Tenderer shall provide an executive summary of the proposal, describing the objectives, team and service level.

5.2.2 Track Record

The Tenderer shall demonstrate for itself and for any proposed subcontractors that they have experience with relevant projects in the public or private sector at national or international level. ECMWF may ask for evidence of performance in the form of certificates issued or countersigned by the competent authority.

5.2.3 Quality of Resources to be Deployed

The Tenderer shall propose a team that meets at least the following requirements:

- A senior team member (Prime Investigator) with more than 5 years of experience in managing activities related to this ITT;
- At least two additional senior team members with more than 5 years of experience on performing activities related to the various aspects of this ITT.

These team members shall be involved in the activities of this ITT at a minimum level of 10% of their total working time. The successful Tenderer shall also appoint a Service Manager, which will be its primary contact for contractual delivery and performance aspects.

5.2.4 Technical Solution Proposed

The Tenderer is expected to provide a short background to the proposed technical solution to demonstrate understanding of the solution proposed. This should include background of the Tenderer's understanding of the Copernicus Atmosphere Monitoring Service, the global earth observing system, the current state of forecasting of global atmospheric composition and regional air quality, and how EQC plays a significant role in the service provision. Emphasis in the description should be given to general EQC principles of atmospheric composition products.

An exhaustive and detailed description of the proposed technical solution for all work packages described above shall be given. The Tenderer shall indicate which independent observational data sets it intends to use and how it will acquire the relevant data. The Tenderer shall describe the validation statistics it intends to use and how results shall be presented in the various EQC reports. The Tenderer shall also provide a detailed description of how it intends to generate the EQC graphics both for the validation reports and for the web-based evaluation. The description of the proposed technical solution shall be organized in individual tasks following the work package structure indicated above.