# ECMWF Copernicus Procurement

Invitation to Tender



# Copernicus Atmosphere Monitoring Service Volume II

Global and regional a posteriori evaluation and quality assurance (EQA)

ITT Ref: CAMS\_84

ISSUED BY: ECMWF

Administration Department

**Procurement Section** 

Date: 16 March 2018

Version: Final





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#### 1 Introduction

Some of today's most important environmental concerns relate to the composition of the atmosphere. The increasing concentration of the greenhouse gases and the cooling effect of aerosol are prominent drivers of a changing climate, but the extent of their impact is often still uncertain.

At the Earth's surface, 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. Ozone distributions in the stratosphere influence the amount of ultraviolet radiation reaching the surface. Dust, sand, 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.

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.

The Service consolidates many years of preparatory research and development and delivers the following operational services:

- 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 surface flux inversions for CO2, CH4 and N2O, allowing the monitoring of the evolution in time of these fluxes
- h) Climate forcing from aerosols and long-lived (CO2, CH4) and shorter-lived (stratospheric and tropospheric ozone) agents

This Invitation to Tender (ITT) is targeting the evaluation and quality assurance of CAMS service elements described under items a, b, c and d above.

#### 1.1 Definitions

Definitions specific for this ITT are provided as follows:

Global Service Provider: ECMWF is the provider of global products

**Regional Service Provider:** The regional service provider will be selected through another ITT, CAMS\_50, Regional Production.

**Real-Time Global Products:** The operational real-time analyses and forecasts from the global CAMS data assimilation and forecasting 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 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 a reanalysis from the global CAMS data assimilation and forecasting system, which is being run by the Global Service Provider. The reanalysis 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.

Regional Products: the outputs of analyses and forecasts from the regional CAMS data assimilation and forecasting systems, which are run by the Regional Service Provider. The Regional Products consist in the first place of real-time analyses and forecasts. The regional CAMS data assimilation and forecasting systems will comprise at least seven individual systems as well as their model ensemble products. These analyses and forecasts will be produced every 24 hours and include 3-dimensional fields of aerosols and chemical species with a temporal resolution of 1 hour. The Regional Products also include the outputs from interim re-analyses based on fast-track in-situ observations and reanalyses based on fully validated in-situ observations. Outputs from these reanalyses consist of analyses of chemical species and aerosols with a temporal resolution of 1 hour and will be provided on an annual basis by the Regional Service Provider.

### 2 Contract Summary

This ITT, entitled "Global and regional a posteriori evaluation and quality assurance (EQA)", is for EQA activities of the CAMS global, and to some extent regional, production systems. The aim of the EQA activities is to provide information on the scientific and operational quality of Real-Time Global Products in the form of EQA reports and on-line evaluation graphics. Additionally, EQA of Regional Products in the free troposphere are covered by this ITT together with EQA of system upgrades for the Real-Time Global Products. In summary, the successful Tenderer shall deliver:

- EQA of CAMS Real-Time Global Products
- Evaluation of CAMS Real-Time Global Products through provision of routine monitoring graphics
- Provision of software for validation tools as well as the observational data to the Global Service Provider
- EQA and assessment of developments in and upgrades of the CAMS global production system
- EQA of CAMS Regional Products in the free troposphere
- EQA of the interface between CAMS global and regional production systems
- Improvement of EQA methodology.

### 3 Technical Specification

EQA 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 EQA 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. EQA of CAMS atmospheric data products can rely on comparisons with accurate and well-documented independent observations from ground-, aircraft-, balloon- and satellite-based systems.

#### 3.1 General Requirements

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 global and regional service products as described in the work packages in sections 3.2 to 3.6. 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 EQA of atmospheric composition model outputs.

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

Global products	<ul> <li>Aerosols (total and individual species, where possible)</li> <li>Ozone</li> <li>Carbon monoxide</li> <li>Nitrogen dioxide</li> </ul>	<ul><li>Sulphur dioxide</li><li>Formaldehyde</li><li>Carbon dioxide</li><li>Methane</li></ul>
Regional products (free troposphere only)	<ul><li>Aerosol</li><li>Ozone</li><li>Carbon monoxide</li><li>Nitrogen oxides</li></ul>	

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

#### 3.2 Work package 8410 – EQA of CAMS Real-Time Global Products

The Global Service Provider provides the CAMS Real-Time Global Products using the 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 fourdimensional 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 will act as a benchmark for the impact of the data assimilation on the forecast quality. The successful Tenderer shall routinely (every three months) provide EQA 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 3month period in terms of mean and variability of the product quality based on the individual analyses and forecasts and shall be made available within 3 months after the end of each respective validation period. While the EQA reports shall describe the full global domain, particular focus shall be put on the European, Arctic and Mediterranean regions. The EQA reports will be used by service providers and users and shall therefore comprehensively and clearly document the various EQA comparisons and include a summary of the main findings. For the production of the EQA reports, the successful Tenderer shall use the software described in section 3.3 as much as possible to harmonize the data processing and generation of the various graphics.

The EQA reports shall also include the greenhouse gas (GHG) 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.

In addition, the successful Tenderer shall reserve resources to assess the quality of additional Forecast-Only Global Products that are produced with additional chemical schemes (MOZART, MOCAGE, BASCOE) as far as they form part of the operational service provision by the Global Service Provider.

Finally, the successful Tenderer shall include the monitoring of key atmospheric species for which insufficient independent observations exist, such as, for instance, individual aerosol species and PM10. This monitoring over time shall especially focus on changes in behaviour of the forecasts as a result of upgrades of the global forecasting system.

The tables below provide templates to be used by the contractor to describe the complete list of deliverables, milestones and schedules for this work package (WP). All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables. Tenderers shall provide preliminary versions of the completed tables, which include the deliverables and milestones already indicated in the tables below, as part of their bid.

WP8410 Delive	erables Te	mplate	
# Type Title		Title	Due
D1.y.z <sup>1</sup> - YYYYQx	Report	Quarterly EQA report	Quarterly

WP8410 Milestones Template				
#	Title	Means of verification	Due	
M1.y.z	IFI IA PANOPTS	Availability of draft EQA report two weeks before publishing	Quarterly	

# 3.3 Work package 8420 - EQA of CAMS Real-Time Global Products through provision of routine EQA graphics

To continuously monitor the scientific quality of the Real-Time Global Products, on-line graphics shall

<sup>&</sup>lt;sup>1</sup> 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.

be routinely produced on a daily basis comparing these products as well as the Forecast-Only Global Products with independent observations that are available within a few weeks of measurement. The graphics shall be produced within one day of the acquisition of each new observation for a specific validation site. The successful Tenderer will put in place a system to acquire the relevant validation data sets (see also section 4.3) and to produce the comparisons between the Real-Time Global Products and Forecast-Only Global Products and individual validation datasets.

As part of the first phase of CAMS, open-source software has been developed in CAMS 84-I to harmonize the data processing and generation of EQA graphics. While the software does not cover all aspects of a full EQA system, it shall form the basis for providing the EQA comparisons and their graphical display. Examples of the current functionality can be seen at https://cams-dev.stcorp.nl and a pre-operational version based on a limited subset of independent observations can be found at http://cams-bira.stcorp.nl. The software is still being further developed as part of the current CAMS 84-I contract, which means that the technical documentation of the software will only become available by the end of September 2018. However, the core of the developed software is formed by the CODE, HARP and MUNINN software, which is available through their GIT repositories at https://github.com/stcorp/harp, http://github.com/stcorp/coda, and https://github.com/stcorp/muninn. Documentation **HARP** of can be found at http://www.stcorp.nl/beat/documentation/harp/index.html.

The successful Tenderer shall further develop the software to include additional observation data sets as well as provide an operational implementation that generates the routine EQA graphics. The software development shall also include further requirements for the functionality from ECMWF, which will be agreed at the start of each annual Service Contract between ECMWF and the successful Tenderer. This includes, but is not restricted to, the use of the software to generate graphics for all relevant EQA reports and the use of independent satellite data as EQA observations. The Tenderer shall therefore reserve a reasonable budget for further development of the processing and plotting software and also to support the Global Service Provider in running the software at ECMWF for use in the development of the CAMS global forecasting system.

The EQA graphics shall at a minimum be presented as daily updated time series comprising the last 3 months of data for EQA data representing individual geographic locations or daily updated profiles for EQA data providing profile information from ground-based or aircraft measurements. The graphics shall be hosted in a single comprehensive web-based system, which can be embedded in the CAMS web site, producing daily EQA graphics with technical support on a next-working-day basis.

WP8420 Delive	WP8420 Deliverables Template				
#	Туре	Title	Due		
D2.y.z-YYYY	Web site, graphics	Initial set of verification website(s) with up-to-date content.	M2		
D2.y.z- YYYYQx	Web site, graphics	Up-to-date web site with EQA graphics	Quarterly		
D2.y.z-YYYY	Docume nt	Development plan for EQA software	Annually		

D2.y.z-YYYY	Docume nt	Overview of developments for EQA software as specified in annual development plan	Annually
D2.y.z-YYYY	Code	Developments of EQA software as specified in annual development plan	Annually

WP8420 Milestones Template				
#	Title	Means of verification	Due	
M2.y.z				

#### 3.4 Work package 8430 - EQA of upgrades of the CAMS global production system

EQA 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 approximately twice per year. These upgrades include improvements to the model and data assimilation system as well as changes in the assimilated data sets. Because the CAMS global assimilation and forecasting 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. 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 validate the output of the experimental suites against independent observations and compare them with the output of the then current operational suite. The successful Tenderer shall present the EQA in an evaluation report summarizing the results. This report will be used to adjust the experimental suite, if necessary, and to assess if the experimental suite is ready to replace the operational suite. The final decision to implement the experimental suite as the new operational suite will be taken by Global Service Provider. The Global Service Provider shall give the successful Tenderer one month's notice of the start and expected schedule of the experimental suite. The EQA 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.

In addition, the Tenderer shall allocate resources to support the assessment of the testing of new developments in the global production system in the lead-up to the experimental production suites for each cycle. The support shall consist of the production and interpretation of EQA graphics for specific global production experiments, as requested by the Global Service Provider.

Note that due to the relocation of the ECMWF data centre to Bologna, there will be a reduced number of new model cycles in the period 2019 - 2020. Therefore, the exact balance between the production of full EQA reports for experimental suites and the above-mentioned support for development experimentation shall be defined at the start of each annual Service Contract.

The tables below provide templates to be used by the contractor to describe the complete list of deliverables, milestones and schedules for this 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. Tenderers shall provide preliminary versions of the completed tables, which include the deliverables and milestones already indicated in the tables below, as part of their bid.

WP8430 Deliverables Template				
#	Туре	Title	Due	
D3.y.z-YYYY	Report	EQA plan 2019 for experimental suite(s) and global development experimentation	Annually	
D3.y.z-YYYY	Report	EQA report for experimental suite(s) as defined in plan above		
D3.y.z-YYYY	Note	EQA note for global development experimentation as defined in plan above		

WP8430 Milestones Template				
#	Title	Means of verification	Due	
M3.y.z				

# 3.5 Work package 8440 - EQA of CAMS Regional Products in the free troposphere and the interface between CAMS global and regional production systems

The CAMS Regional Products will be provided by an ensemble of air quality models (between seven and ten members) for the European domain, which is the subject of another ITT, CAMS\_50 (Regional Production). The Regional Service Provider will provide EQA of the Regional Products at the surface. The successful Tenderer for this ITT shall therefore provide supplementary EQA of the Regional Products focusing on concentrations of chemical species above the surface. The successful Tenderer shall routinely (every three months) provide EQA reports for the daily produced Regional Products documenting the scientific quality relative to the independent validation data. Each report shall document a 3-month period in terms of mean and variability of the product quality and shall be made available within 3 months after the end of each respective validation period. The EQA reports will be used by service providers and users and shall therefore comprehensively and clearly document the various EQA comparisons and include a summary of the main findings. The summary will also be used in the regional EQA reports provided by the Regional Service Provider. For the Regional Products from the interim reanalyses and full reanalysis validation reports based on the daily analyses shall be provided on an annual basis within 3 months of the delivery of the full annual data set. Above-surface data from these regional reanalysis data sets are expected to become available from 2020 onwards.

A central element of CAMS is the link between the global production system and the regional production system. The CAMS regional air quality models run on a European geographical domain and therefore need boundary conditions of the relevant aerosol and chemical species for this domain as input to their assimilation and forecast runs. The CAMS global production system provides these boundary conditions. The successful Tenderer shall monitor and evaluate the boundary conditions for the CAMS regional geographical domain from the CAMS global model as well as the response of the regional models to these boundary conditions. This shall also include comparisons between the global and regional forecasts over the European domain. Inconsistencies between the global and regional systems shall be flagged and communicated directly to the Global Service Provider and Regional

Service Provider for further investigation. Focus shall be on longer-lived species, such as carbon monoxide, ozone and aerosols. The results of the monitoring and evaluation shall be part of the quarterly reports mentioned in the paragraph above.

The tables below provide templates to be used by the contractor to describe the complete list of deliverables, milestones and schedules for this 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. Tenderers shall provide preliminary versions of the completed tables, which include the deliverables and milestones already indicated in the tables below, as part of their bid.

WP8440 Deliverables Template				
# Type Title		Title	Due	
D4.y.z- YYYYQx	Report	Quarterly EQA report	Quarterly	
D4.y.z-YYYY	Report	EQA report for the interim regional reanalysis	Annually	
D4.y.z-YYYY	Report	EQA report for the validated regional reanalysis	Annually	

WP8440 Milestones Template				
#	Title	Means of verification	Due	
M4.y.z	Quarterly EQA report	Availability of draft EQA report two weeks before publishing	Quarterly	

#### 3.6 Work package 8450 - Validation of CAMS Global Reanalysis Products

The Global Service Provider is currently producing a global reanalysis for the period 2003 - 2016, which will then be extended in a so-called near-real-time mode within the time frame of this ITT. 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 EQA 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 validation data sets and homogeneity tests to document quality of the Global Reanalysis Products. The successful Tenderer shall present the validation results in a series of EQA reports based on the daily analyses. The annual reports shall include the validation results for each additional year of the reanalysis as being produced and shall be made available within a period of three months after the end of each year. In addition, the successful Tenderer shall provide initial feedback on the reanalysis production half-way through each year by providing a short note including relevant EQA graphics and their interpretation. This note will be used by the Global Service Provider to detect any potential issues with the reanalysis production for that year.

WP8450 Deliverables Template			
#	Type Title		Due
D5.y.z-YYYY	Report	Annual EQA report for the global reanalysis 2017	December 2018
D5.y.z-YYYY	Note	Initial assessment of the global reanalysis 2018	December 2018
D5.y.z-YYYY	Report	Annual EQA report for the global reanalysis 2018	March 2019
D5.y.z-YYYY	Note	Initial assessment of the global reanalysis 2019	June 2019
D5.y.z-YYYY	Report	Annual EQA report for the global reanalysis 2019	March 2020
D5.y.z-YYYY	Note	Initial assessment of the global reanalysis 2020	June 2020
D5.y.z-YYY	Report	Annual EQA report for the global reanalysis 2020	March 2021

WP8450 Milestones Template			
#	Title	Means of verification	Due
M5.y.z			

#### 3.7 Work package 8460 - Improvement of validation methodology

Improvement of the EQA methodology involves aspects directly related to the validating observations, such as quality assurance of the EQA datasets, identification of outliers, better characterisation of the observation errors, site classification, representativity error estimates, as well as aspects related to EQA procedures. The latter includes improved or new definitions of EQA scores and development of advanced skill scores documenting the model performance in a more intuitive way and targeting the different application areas of CAMS. The successful Tenderer shall document progress on these aspects in annual reports and implement mature developments in the various EQA tasks defined above in consultation with ECMWF.

WP8460 Deliverables Template			
#	Туре	Title	Due
D6.y.z-YYYY	Report	Observations characterisation document for validation	Annually
D6.y.z-YYYY	Report	Validation scoring methods document	Annually

WP8460 Milestones Template			
#	Title	Means of verification	Due
M6.y.z			

#### 3.8 Work package 8400 - Management and coordination

The following management and coordination aspects shall be briefly described in the proposal:

- Contractual obligations as described in the Framework Agreement Clause 2.3 on Reporting and Planning.
- Meetings:
  - ECMWF will organise annual CAMS General Assemblies in EU member states. The successful Tenderer is expected 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.
  - o ECMWF will organise six-monthly project review meetings (linked to Payment milestones).
  - Tenderers should propose additional project internal meetings (kick-off meeting, annual faceto-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.
- Personal data management (name, ID and contact details of prime contractor's data controller in line with Clause 2.8).

WP8400 Deliverables Template				
#	Responsible	Nature	Title	Due
D0.y.z-YYYYQQ	Tenderer	Report	Quarterly Implementation Report QQ YYYY QQ YYYY being the previous quarter	Quarterly on 15/01, 15/04, 15/07 and 15/10
D0.y.z-YYYY	Tenderer	Report	Annual Implementation Report YYYY YYYY being the Year n-1	Annually on 28/02
D0.y.z	Tenderer	Report	Final implementation Report, including letter from auditor specific to CAMS contract YYYY  YYYY being the last year of the contract	60 days after end of the last service contract
D0.y.z-YYYY	Tenderer	Report	Draft Implementation Plan YYYY YYYY being the Year n+1	Annually on 28/02
D0.y.z-YYYY	Tenderer	Report	Finalised Implementation Plan YYYY YYYY being the Year n+1	Annually on 31/10
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
D0.y.z-YYYY	Tenderer	Other	Letter auditor's opinion specific to CAMS most recent Annual Implementation Report YYYY YYYY being the Year n-1	Annually
D0.y.z	Tenderer	Other	Updated KPIs (list, targets) after review with ECMWF	One year after start of contract

WP8400 Milestones Template				
#	Responsible	Title	Means of verification	Due
M0.y.z	Tenderer	CAMS General Assembly	Participation to the meeting	Annually
M0.y.z	Tenderer	Monthly teleconference meetings with ECMWF	Participation to meeting	Monthly
M0.y.z	Tenderer	Progress review meetings with ECMWF / Payment milestones		~ Every 6 months
M0.y.z	Tenderer	Kick-Off meeting	Minutes of meeting	Month 1
M0.y.z	Tenderer	project meetings	Minutes of meeting	Annually
M0.y.z	Tenderer	Internal project monthly teleconferences	Meetings happened	Monthly

## 4 General Requirements

#### 4.1 Implementation schedule

The Framework Agreement will run from 1 October 2018 until 31 December 2021. The Tenderer shall provide a detailed implementation plan of proposed activities for the period until 30 June 2021. However, note that by Q4 2019 the level and duration of activities for the full year of 2021 will be

communicated by ECMWF to the successful Tenderer based on the Copernicus programme review by the European Commission.

#### 4.2 Deliverables and milestones

Deliverables should be consistent with the technical requirements specified in section 3.

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.

Each Deliverable shall have an associated resource allocation (person-months and financial budget). The total of these allocated resources shall amount to the entire requested budget.

Milestones should be designed as markers of demonstrable progress in service development and/or quality of service delivery. They should not duplicate deliverables.

Adjustments to the proposed implementation plan can be made on an annual basis depending on needs for service evolution, changed user requirements, or other requirements as agreed between the European Commission and ECMWF.

#### 4.3 Acquisition of necessary data and observations

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. Similarly, the Regional Service Provider will provide the needed Regional Products. The Global Service Provider will also provide access to observations from the networks, for which CAMS has agreed a support contract (ICOS, NDACC, ACTRIS, GAW, EMEP, and IAGOS). The successful Tenderer itself shall acquire all other relevant observational data sets and make them available for use in all CAMS activities related to assessment of operational and experimental CAMS products. Particular emphasis should be paid to acquiring data sets covering areas outside Europe, such as East-Asia and the Americas. The successful Tenderer shall provide all observations to the Global Service Provider every 3 months for use in the assessment of the development of the global production system, including information about the respective data policies of these data sets.

#### 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.

#### 4.5 User requirements

As part of CAMS, the database and three documents described below will be maintained. 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 CAMS\_94 (User Interaction) with the analysis of relevant user requirements in the URDB. Finally, in case the successful Tenderer provides service elements that are listed in the Service Product Portfolio (SPP), the successful Tenderer shall provide input on product lines and their metadata to ECMWF to ensure the SPP is up-to-date.

#### User Requirements Database (URDB) and Requirement Analysis Document (RAD)

User requirements are collected in this database in a structured and traceable way, and links to entries in the Service Product Portfolio (see below) are provided, when appropriate. The URDB, which tracks all requirements emanating from a wide variety of user fora, surveys, and support panels, is complemented by a Requirements Analysis Document (RAD) which captures the stratification of user requirements per domain, importance and feasibility. The RAD constitutes the basis for distilling, filtering and translating user requirements into technical specifications for the Service. The URDB and RAD are maintained and continually updated by ECMWF and its contractor for CAMS\_94 (User Interaction).

#### Service Product Portfolio (SPP)

Both data and value-added products are presented in this document in a structured way, providing key technical aspects, when appropriate, such as geophysical parameter, temporal resolution and coverage, spatial resolution and coverage, data formats, time availability, expected quality, data format together with a direct link to detailed information on methodology and quality monitoring for each specific product or services.

#### Service Evolution Strategy (SES)

The appropriateness of the list of emerging and existing user requirements, the routinely updated Requirement Analysis Document and the existing Service Product Portfolio, are continually monitored by ECMWF and feed into a Service Evolution Strategy (SES) document. The SES document is produced on an annual basis and provides, in addition to the annual implementation plan focussing on year n+1 service Deliverables, a proposed longer term (typically 4 years) perspective for forthcoming service upgrades and extensions, the expected benefits and costs, together with recommendations for potential research needs outside Copernicus operations. This document allows informed discussions to be opened on specific proposed service upgrades and extensions with the stakeholders.

The following deliverables are thus to be added to the WP8400 deliverable list:

WP8400 Deliverables Template			
#	Туре	Title	Due
D0.y.z-YYYY	Report	Input to CAMS SPP - YYYY	Annually in September
D0.y.z-YYYY	Other	Input to CAMS URDB - YYYY	Continuous

#### 4.6 Key performance indicators

Contractors shall report to ECMWF on a set of Key Performance Indicators (KPIs) suitable for monitoring various aspect of service performance. These will be used in the overall monitoring of the CAMS programme for which the following KPI categories have been identified:

- KPI1 Service availability
- KPI2 Products usage
- KPI3 Products quality
- KPI4 User support
- KPI5 User statistics
- KPI6 Service audience
- KPI7 User engagement

- KPI8 User satisfaction
- KPI9 Contracts
- KPI10 Deliverables
- KPI11 data usage

The table below provides the template to be used by the Tenderer to describe the KPIs, relevant for this ITT, together with performance targets, delivery schedules and explanations if needed. Please note that the listed KPIs form part of the overall set of KPIs comprising the full CAMS service portfolio; the successful Tenderer therefore might have to provide KPI values for a KPI in support of services outside this ITT.

All KPIs shall be labelled and numbered as indicated. All KPIs shall be periodically updated as described in the tables. Tenderers shall provide preliminary versions of the completed tables as part of their bid.

The list of KPIs shall be reviewed with ECMWF in the second year of the contract and updated if necessary.

Service availability KPI#	KPI Title	Performance Target and Unit of Measure	Frequency of Delivery	Explanations / Comments
KPI_84.1.1	Website uptime	95%	Quarterly	
KPI_84.2.1	Number of validation reports downloaded during the quarter		Quarterly	
KPI_84.3.1	Availability of global analyses and forecasts quarterly validation reports	Yes	Quarterly	
KPI_84.3.2	Common Area Fraction for the Neumayer site in Antarctica	> 0.9	Quarterly	
KPI_84.3.3	MNMB of the d+1 Aerosol Optical Depth global forecasts against AERONET sites for East Asia, Europe, North Africa and North America	Between +/- 40%	Quarterly	
KPI_84.10.1	Deliverables delivered on time during last Quarter	Guideline 100%	Quarterly	

#### 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	2 (excluding Table 1 in Volume IIIB and CVs with a maximum
Deployed	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	6 (excluding Table 3, Table 5, Table 6 and Table 7 in Volume IIIB) +
Implementation	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 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 validation plays a significant role in the service provision. Emphasis in the description should be given to general validation 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 validation reports. The Tenderer shall also provide a detailed description of how it intends to generate the validation graphics both for the validation reports and for the web-based verification. In case the Tenderer intends to provide a comprehensive web-based system to produce these graphics, it shall describe this system. The description of the proposed technical solution shall be organized in individual tasks following the work package structure indicated above.