ECMWF Copernicus Procurement

Invitation to Tender

Copernicus Atmosphere Monitoring Service
Volume II

Development of post-processing methods and tools for the CAMS regional air quality ensemble

ITT Ref: CAMS_63
ISSUED BY: ECMWF Administration Department Procurement Section
Date: 10 December 2018
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. 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 users in the policy domain, 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 CO_2, CH_4 and N_2O, 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

This Invitation to Tender (ITT) is targeting developments that will underpin evolution of the CAMS service elements described under item c and d.

1.1 Definitions

Definitions specific for this ITT are defined below.

Global Service Provider: ECMWF is the provider of global products

Regional Service Provider: the successful Tenderer of the present 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 twice- daily and include 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 comprise seven (nine from mid-2019) 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 in-situ observations in an interim stage of validation and re-analyses 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.

Central Regional Production Unit (CRPU): the organisation in charge of ensemble processing and of delivering the Regional Products to the users on behalf of the Regional Service Provider.

Regional Systems: the seven (nine from mid-2019) individual regional air quality modelling and data assimilation systems that contribute to the operational delivery of the Regional Products.

Model Output Statistics: Model Output Statistics (MOS) is a type of statisitical post-processing, a class of techniques used to improve numerical models' ability to forecast by relating model outputs to observational or additional model data (see for instance http://www.weather.gov/mdl/mos_home).

2 Contract Summary

This ITT is about activities to develop post-processing methods and tools for the CAMS Regional Products, which are based upon a distributed ensemble of seven individual operational regional air quality systems (the number of systems will be extended to nine in the course of 2019). The successful Tenderer will be expected to deliver (essentially) computer scripts, routines and pieces of numerical code as well as reports. The ITT targets Tenderers with relevant experience, who will be able to provide the above-mentioned contributions for supporting the continuous upgrade of the post-processing of CAMS regional outputs. The ITT does not include daily operational production but may include routine experimental processing (without guaranteed level of service). The bids shall not involve actually running regional air quality system(s).

Scientific track record in the areas of ensemble methods, of model output statistics and/or of forecasts evaluation is expected and relevant expertise for the developments included in this ITT will be among the selection criteria.

3 Technical Specification

The successful Tenderer shall provide some studies and developments, which build on top of the raw outputs from the operational ensemble of CAMS Regional Systems. The focus of these developments shall be:

- to assess the relationship between the spread between ensemble members and the skill of the analyses or forecasts according to a range of metrics, in view of being able to provide calibrated uncertainty estimates;
- to develop post-processing methods using latest or past forecasts, past analyses and/or past observations to propose ensemble products that outperform significantly the median, while being compatible with operational time-critical implementation;

- to develop and test Model Output Statistics methods that could be used for providing forecasts on sites where timeseries of observations are available even if the raw model outputs are biased;
- to develop innovative ways of conveying uncertainty information associated with the Regional Products in graphical form (maps, charts...) for presentation on the web and targeting non-expert audiences.

3.1 General Requirements

The successful Tenderer will work on the outputs (analyses, forecasts and reanalyses) from the seven (increasing to nine in 2019) operational air quality systems. These outputs share the following commonalities:

- available in two formats, GRIB2 and NetCDF;
- hourly values;
- domain covered is (25°W-45°E, 30°N-72°N[1]);
- horizontal resolution is 0.1° by 0.1°;
- eight vertical levels: surface, 50m, 250m, 500m, 1000m, 2000m, 3000m and 5000m above ground;
- The list of parameters includes the following observed species NO, NO_2, CO, SO_2, PM2.5, PM10 and, during the relevant part of the year, birch, olive, grass and ragweed pollens;
- transport and physical processes in the systems are driven by ECMWF's high-resolution operational meteorological forecasts (using the most recent available forecast), either directly in the case of chemistry-transport models or by means of nudging or similar techniques;
- the systems use the same regional anthropogenic emissions dataset provided by CAMS;
- the systems use fire emissions as well as chemical boundary conditions provided by the CAMS Global Service Provider (aerosol, reactive gases and greenhouse gases -if accounted for) using the most recent available products;
- in the case of analyses or reanalyses, the observations assimilated are identical in all the systems.

The variability between the models comes solely from the formulation of transport, physical as well as chemical processes. Nevertheless, it is observed that the spread obtained is generally significant.

The successful Tenderer shall demonstrate that a suitable computing infrastructure is available (including storage) for performing the development tasks.

3.2 Work package 6300 - Management and coordination

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

- Contractual obligations as described in the Framework Agreement Clause 2.3 on reporting and planning.
- Meetings:
    - ECMWF will organise annual CAMS General Assemblies within 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;
    - ECMWF will organise six-monthly project review meetings (linked to Payment milestones);

[1] Initially 70°N. The extension to 72°N will occur during 2019.

- Tenderers should 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.
- Personal data management (name, ID and contact details of prime contractor's data controller in line with Clause 2.8).

The tables below provide the deliverables and milestones for the work package. Tenderers shall complete Volume IIIC as part of their bid, which should include the deliverables and milestones already indicated in the tables below and will constitute a preliminary version of such. Volume IIIC will 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.

WP6300 Deliverables Template				
#	*Responsible*	*Nature*	*Title*	*Due*
D0.y.z[2]-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	Annually

[2] 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.

			YYYY *YYYY being the Year n-1*	
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

WP6300 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	Minutes of meeting	~ Every 6 months
M0.y.z	Tenderer	Kick-Off meeting	Minutes of meeting	Month 1
M0.y.z	Tenderer	Internal face to face project meetings	Minutes of meeting	Annually
M0.y.z	Tenderer	Internal project monthly teleconferences	Meetings happened	Monthly

3.3 Work package 6310 – Post-processing of ensemble outputs

A key objective of CAMS is to provide products of highest quality together with an estimate of the associated uncertainty. This chiefly applies to Regional Products, which are now used daily by several hundred of users. This workpackage is about the investigation and development of methods that will significantly outperform the current operational ensemble post-processing approach, which is the median of uncalibrated individual model outputs.

There are four main requirements:

- these new methods shall be applicable for the post-processing of all the Regional Products (analyses, forecasts and annual reanalyses), though possibly with slightly different settings or parametric values;
- the computational burden on standard unix/linux machines shall be compatible with operational time-critical implementation by the CRPU (contract CAMS_50), an absolute maximum being one hour of elapsed time for processing 24 hourly steps/values (non-time-critical pre-calculations are acceptable and are not included in the one hour);
- the methods shall be resilient regarding model changes: there are generally one or two version upgrades per year of the CAMS individual regional systems (with a few weeks of parallel running of the old and new systems) and methods need to include an update/tuning process in order to make sure that post-processing remains optimally applicable (or only very temporarily degraded);
- while observations are only available at the surface and don't cover all the species which are made available to the users, ensemble products shall be produced for all vertical levels, all species and covering the entire CAMS regional geographical domain.

Within these constraints, the successful Tenderer is expected to describe in the proposal a few approaches to be tested: weighted (fixed or dynamical) and calibrated ensemble, analogues, Artificial Intelligence…

It is acceptable to make the hypothesis that surface observations of the past day (00h to 23h) are available at the time of post-processing ensemble products (species and distributions corresponding to the UTD data stream the European Environment Agency for the processing of daily time-critical products as well as of interim reanalyses, and corresponding to AirBase for reanalyses), which allows taking into account persistence information in the methods tested. It is preferred but not essential that the methods proposed are already documented in the international peer-reviewed literature.

The proposal shall describe how ensemble products uncertainty information will be estimated and will be provided as far as possible on the same 3D grid as the ensemble products.

The proposal shall set-up a protocol for verification of the ensemble products relying on the same approach and metrics as implemented by the contractors of CAMS_50 (Regional Production). At the beginning of the contract, the successful Tenderer is expected to liaise with the contractor of CAMS_50 for making sure that metrics and site selection are aligned. The successful Tenderer shall use the current operational approach (median of individual outputs) as reference for evaluating the different methods that will be tested. The successful Tenderer shall also study the ensemble outputs for making sure that fields are realistic and chemically balanced: one use of CAMS ensemble products being indeed to serve as boundary conditions for local air quality applications.

In principle, studies and experiments shall be conducted over March-April-May 2018, June-July-August 2018, September-October-November 2018 and December 2018-January-February 2019. It is essential indeed to consider a recent period and all four seasons in order to reach overall conclusions that will be sufficiently robust. While it is expected that there will be an interannual variability of model performance, it is accepted that this is neglected in the present contract.

Activities within this workpackage shall be organised into four successive phases with a decision meeting/workshop with ECMWF (and possibly relevant experts appointed by ECMWF) between these for agreeing to move to the next one:

- phase 1: detailed description of the candidate methods and experimental set-up;
- phase 2: experimentation over one year and comparison of the different candidate methods;
- phase 3: second experimentation over one year with revised/additional methods;
- phase 4: experimentation of the selected method in routine processing mode (but no time-critical/operational requirement);

Phase 1 is expected to run for up to 3 months; phase 2 is expected to run for up to 12 months; phase 3 is expected to run for up to 6 months; phase 4 is expected to run for up to 3 months.

The different candidate methods shall be implemented using only freely available open-source software/libraries. The scripts and pieces of code for the method that will be selected shall be provided to ECMWF; IPR will be passed on to the European Commission, which will enforce a non-restrictive license of use. The concept of Integrated Technology will not be accepted for this specific development. Scientific publication about the methods and inter-comparisons performed will be possible (with due acknowledgement of Copernicus and CAMS).

The tables below provide the deliverables and milestones for the work package. Tenderers shall complete Volume IIIC as part of their bid, which should include the deliverables and milestones already indicated in the tables below and will constitute a preliminary version of such. Volume IIIC will 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.

WP6310 Deliverables Template			
#	*Type*	*Title*	*Due*
D1.y.z	Report	Phase 1 report: candidate methods and experimental set-up	Month 3
D1.y.z	Report	Phase 2 report: experimentation over one year and analysis of results	Month 15 at the latest
D1.y.z	Report	Phase 3 report: second experimentation over one year and analysis of results	Month 21 at the latest
D1.y.z	Report	Phase 4 report: routine experimentation report for the selected ensemble post-processing method	Month 24 at the latest
D1.y.z	Script, code	Scripts and numerical code for implementation of the selected ensemble post-processing method	Month 24
D1.y.z	Report	Description of the selected ensemble post-processing method	Month 24
…			

WP6310 Milestones Template			
#	*Title*	*Means of verification*	*Due*
M1.y.z		List here the milestones	
…			

3.4 Work package 6320 – Model Output Statistics for forecasts

The objective of this workpackage is to provide statistically adapted forecasts for all European sites where a suitably representative observed timeseries can be obtained. This corresponds to the sites reporting through the UTD stream of the European Environment Agency (EEA) and to Airbase. Detailed information about the list of sites will be provided to the successful Tenderer by the contractor of CAMS_22 (European air quality observations). The list covers well over a thousand sites and most countries of the EU and Member States of the EEA.

As indicated in Section 3.1, the horizontal resolution of the Regional Systems is 0.1° by 0.1°. Such a resolution is in particular insufficient to represent local effects in the vicinity of emissions sources. The models used for the forecasts also have systematic biases and errors. The use of MOS or other statistical methodologies or machine-learning techniques is expected to greatly improve the forecasts on specific sites and alleviate some shortcomings for the raw forecasts. For this work, only the operational ensemble forecasts (median of the regional systems) shall be considered.

The proposal shall include a description of the proposed MOS method(s) that will be tested and of the evaluation protocol that will be carried out. Tests should be performed over at least one year worth of observations and forecast data, covering all the meteorological seasons. It is preferred but not essential that the method(s) proposed are already documented in the international peer-reviewed literature. Uncertainty estimates shall form part of the outputs.

The successful Tenderer shall set-up a protocol for verification of the MOS products relying on the same approach and metrics as implemented by the contractors of CAMS_50 (Regional Production). At the beginning of the contract, the successful Tenderer is expected to liaise with the contractor of CAMS_50 for making sure that metrics and site selection are aligned.

The MOS method(s) shall be implemented using only freely available open-source software/libraries. The scripts and pieces of code for the method that will be selected shall be provided to ECMWF; IPR will be passed on to the European Commission. The concept of Integrated Technology will not be accepted for this specific development. Scientific publication about the method(s) and inter-comparisons performed will be possible (with due acknowledgement of Copernicus and CAMS).

The tables below provide the deliverables and milestones for the work package. Tenderers shall complete Volume IIIC as part of their bid, which should include the deliverables and milestones already indicated in the tables below and will constitute a preliminary version of such. Volume IIIC will 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.

WP6320 Deliverables Template			
#	*Type*	*Title*	*Due*
D2.y.z	Report	Description of MOS method(s) and experimental set-up	Month 3 at the latest
D2.y.z	Report	Report on the experimentation of MOS method(s) for providing CAMS forecasts on point sites	Month 15 at the latest
D2.y.z	Script, code	Scripts and numerical code for implementation of the selected MOS method	Month 15
D2.y.z	Report	Description of the selected MOS method	Month 15
…			

WP6320 Milestones Template			
#	*Title*	*Means of verification*	*Due*
M2.y.z		List here the milestones	
…			

3.5 Work package 6330 – Presentation of uncertainty information

The objective of this work package is to investigate ways for conveying uncertainty information for map and point forecasts, analyses or reanalyses. This should be done in the form of maps, graphics and charts and targeting especially a non-specialist audience. It must be taken into account that these maps, graphics and charts will eventually be presented on the web as well as in quarterly evaluation and quality control reports.

The successful Tenderer shall develop a package of graphical outputs for presenting the uncertainty information (as will be eventually provided by workpackages 6310 and 6320) associated with maps and point values for all the CAMS products: analyses, forecasts and reanalyses. It is acceptable to use synthetic (not actual) uncertainty information so that the work in this workpackage can be carried out in parallel with the other tasks of the contract.

It is essential that these developments are actually user-driven. At the beginning of the contract, the successful Tenderer will appoint with the help of ECMWF a dozen committed users or stakeholders of CAMS regional products to serve as “beta-testers” and provide feedback on the proposed products down to a fairly detailed level (choice of colours, banding for uncertainty ranges…).

It is expected that three rounds of consultation with these selected users will be carried out:

- on the basis of a scoping document that will describe the proposed range of graphical products;

- on the basis of a report or demo web platform showcasing the implementation of the range of products discussed and agreed;
- on the basis of a report or demo web platform showcasing the revised implementation of the range of products.

It is not expected that this contract will implement routine production of such graphics but rather that it will deliver detailed specifications and demonstration of all the products resulting from the consultation with the cohort of beta users.

The consultation with beta-users will be made using videoconferencing. ECMWF will provide the facility to do so.

The tables below provide the deliverables and milestones for the work package. Tenderers shall complete Volume IIIC as part of their bid, which should include the deliverables and milestones already indicated in the tables below and will constitute a preliminary version of such. Volume IIIC will 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.

WP6330 Deliverables Template			
#	*Type*	*Title*	*Due*
D3.y.z-v0	Report	Range of graphical products to present uncertainty information associated with CAMS Regional Products (proposed/draft), version 0	Month 4
D3.y.z-v1	Report	Range of graphical products to present uncertainty information associated with CAMS Regional Products, version 1	Month 6
D3.y.x-v1	Report / Web-based	Demonstration of the range of graphical products to present uncertainty information associated with CAMS Regional Products	Month 12
D3.y.x-v2	Report / Web-based	Updated demonstration of the range of graphical products to present uncertainty information associated with CAMS Regional Products	Month 15
D3.y.w	Report	Detailed specifications of the range of graphical products to present uncertainty information associated with CAMS Regional Products	Month 18
…			

WP6330 Milestones Template			
#	*Title*	*Means of verification*	*Due*
M3.y.z.1	Videoconference 1 with the appointed beta-testers	Minutes are available	Month 5
M3.y.z.2	Videoconference 2 with the appointed beta-testers	Minutes are available	Month 13
M3.y.z.3	Videoconference 3 with the appointed beta-testers	Minutes are available	Month 16
…			

4 General Requirements

4.1 Implementation schedule

The Framework Agreement will run for a duration of two years. The Tenderer shall provide a detailed implementation plan of proposed activities for the period. However, note that by Q4 2019 the level and duration of activities for 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.

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 Communication

The activities within this contract will not be directly facing the users of the CAMS Regional Products, but rather providing developments supporting ECMWF and the CAMS Regional Provider. However, 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.

4.4 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

Due to the specific nature of the CAMS_63 ITT, few KPI categories are relevant: KPI3, KPI7 and KPI10.

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.

KPI #	KPI Title	Performance Target and Unit of Measure	Frequency of Delivery	Explanations / Comments
KPI_63.3.1	Improvement of the skill of CAMS regional ensemble products for a range of metrics against surface observations of key air pollutants	To be defined in the proposal	Month 15, Month 21 and Month 24	Improvements are compared to the median approach
KPI_63.3.2	Improvement of the skill of CAMS air quality forecasts on point sites for a range of metrics against surface observations of key air pollutants	To be defined in the proposal	Month 15	Improvements are compared to the median of the ensemble bi-linearly interpolated at each site's location
KPI_63.7.1	User satisfaction regarding demonstration of the range of graphical products to present uncertainty information associated with CAMS Regional Products	At least 3/5 (Month 13) and 4/5 (Month 16)	Month 13, Month 16	Survey among the selected beta-testers after videoconference 2 and videoconference 3 (see section 3.5)
KPI_63.10.1	Deliverables delivered on time during last Quarter	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 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 & Volume IIIC	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 CAMS and more specifically of the CAMS Regional Products, their applications areas and the different categories of users to be served. This part should also identify the main areas of development that will help meet better the users' requirements and expectations.

An exhaustive and detailed description of the proposed technical solution for all work packages described above shall be given. The Tenderer shall describe how service provision will be organised in order to meet the stringent timeliness and completeness requirements. Some emphasis shall be put on the quality assurance and quality control strategy and, in particular, on the measures taken to ensure detection of issues in order to avoid that erroneous or uncomplete products or graphics make their way to the users and damage the Service's reputation. The Tenderer shall also provide a detailed description of how it intends to generate the different sets of graphics required and how it is intended to make them available. The description of the proposed technical solution shall be organized in individual tasks following the work package structure indicated above.