

ECMWF Copernicus Procurement

Invitation to Tender



Copernicus Atmosphere Monitoring Service

Volume II

Regional Air Quality Products

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Table of Contents

1	Introduction	3
1.1	Definitions	4
2	Contract Summary	4
3	Technical Specification.....	5
3.1	General Requirements	6
3.2	Work package 4010 – Observational data acquisition	6
3.3	Work package 4020 – Provision of near-real-time (NRT) European analyses and forecasts .	7
3.3.1	Task 4021: Daily Near-Real-Time (NRT) European air quality analyses.....	9
3.3.2	Task 4022: Daily European air quality forecasts	10
3.4	Work package 4030 – Maintenance and system upgrades of the operational forecasting systems	11
3.5	Work package 4040 – Provision of European reanalyses	12
3.5.1	Task 4041: European air quality interim re-analyses.....	13
3.5.2	Task 4042: European air quality validated re-analyses.....	13
3.6	Work package 4050 - User support and documentation of service	14
3.7	Work package 4060 – Forecasting system development	16
3.8	Work package 4000 - Management and coordination	18
4	General Requirements	20
4.1	Implementation schedule	20
4.2	Deliverables and milestones	20
4.3	Acquisition of necessary data and observations	21
4.4	Communication.....	21
4.5	Data provision and IPR.....	21
4.6	Key performance indicators.....	23
5	Tender Format and Content	24
5.1	Page Limits	24
5.2	Specific additional instructions for the tenderer’s response.....	24
5.2.1	Executive Summary.....	24
5.2.2	Track Record	24
5.2.3	Quality of Resources to be Deployed.....	24
5.2.4	Technical Solution Proposed.....	25

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 affect 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 CO₂, CH₄ and N₂O net surface fluxes, 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;

- 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 CO₂ and CH₄ for the global domain and emission hotspots.

This Invitation to Tender (ITT) is mainly targeting the CAMS service elements described under items (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 current contractor of CAMS2_40, 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 will comprise eleven 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 ten or more regional air quality modelling and data assimilation systems that contribute to the operational delivery of the Regional Products.

2 Contract Summary

This ITT, entitled “Regional air quality products” is for the operational delivery of the European-scale air quality component of CAMS. It consists of a set of services, which are further detailed in the technical specification below. The production must be based upon a geographically distributed ensemble of more than ten individual models and a central processing function to deliver three numerical data streams:

- on a daily basis, analyses for the previous day and forecasts for key air pollutants up to +96h with a temporal resolution of one hour;
- with a delay of a few weeks (in order to maximise the number of observations), interim reanalyses shall be produced daily with systems frozen in their configuration of January 1st every year;
- with a delay of up to two years (due to the delay in getting fully validated observational data), reanalyses shall be produced with frozen systems, which are only updated every few years.

All the individual Regional Systems must be mature, well-validated and operated by their main developers. This aspect is essential so that the operators can directly maintain a continuous workflow of changes to the numerical systems, in order to include new research developments, to make corrections reflecting findings from verification and validation activities, as well as to implement changes to better meet user requirements. Acquisition of data, production of analyses, reanalyses and forecasts, data dissemination services and support to the users form the bulk of the operational delivery and development activities that are procured within this ITT.

Finally, it is important to note that the daily productions of air quality forecasts and analyses which is currently run by the regional service provider should not be interrupted since users download these datasets as boundary conditions of their own regional modelling systems. Consequently, continuity of the daily production should be ensured between both services.

The ITT is divided into two distinct Lots:

- **Lot1: operational components** of the service, including users support and management of both Lots to simplify management and reporting activities and to rationalise the number of deliverables. Therefore, Lot1 will cover Work Packages WP4000, WP4010, WP4020, WP4030, WP4040, WP4050;
- **Lot2: development components** dedicated to the coordination and evaluation of the preparatory work carried out for the service evolution during the contract period. Lot2 will cover WP4060 and is expected to contribute to the other Work Packages according to the general requirements expressed in Section 3.1.

Tenderers may respond to one or both Lots, considering that the following requirements should be fulfilled:

- The successful Tenderer for Lot1 shall oversee reporting activities of both Lots. Therefore, they will deliver the required management reports (WP4000) which shall cover both Lot1 and Lot2 workplans. The successful Tenderer of Lot2 (if different than Lot1) is expected to provide input to the reporting activities run by the successful Tenderer of Lot1.
- The successful Tenderer for Lot2 shall develop and run a regional air quality assimilation and forecast system as a contribution to the regional multi-model system implemented in Lot1.

3 Technical Specification

The aim of this ITT is to bring together a group of organisations which shall continuously develop and operate ten or more regional air quality assimilation and forecast systems (Regional Systems), which support the delivery of the Regional Products.

3.1 General Requirements

The successful Tenderer(s) will bring evidence that the following conditions are met for each of the individual Regional Systems involved in the operational and development activities:

- the domain covered shall be at least (25°W-45°E, 30°N-72°N);
- the system's horizontal resolution shall be finer than or equal to 0.1° by 0.1°, or the equivalent resolution in kilometres;
- transport and physical processes shall be 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 system shall use the regional emissions dataset (other than fire) provided by the CAMS contract for regional emission inventories and possibly using refinements from observation-based emission estimates provided by ECMWF to the successful Tenderer, if these estimates become available within the duration of this contract;
- the system shall 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;
- the system shall have the capability to forecast atmospheric pollutants regulated at the European and national levels in Europe, gases and particulate, as well as pollens (if the source term is externally provided);
- the system shall have a documented data assimilation capability for surface Air Quality observations (at the minimum);
- the system shall have an existing track record of providing daily forecasts with evidence of performance (quality, timeliness/completeness of the output...) as documented in peer-reviewed publications, reports or technical notes.

3.2 Work package 4010 – Observational data acquisition

The successful Tenderer shall acquire observational data for data assimilation purposes and shall ensure that identical datasets are made available to and used by all the individual Regional Systems.

Surface observations of air pollutants measured from regulatory networks in Europe will be primarily acquired from the European Environment Agency (EEA). CAMS has a dedicated contract with EEA and its contractors to support the operational data provision. Additional surface air quality data may be obtained directly from European countries, in particular in order to reduce data gaps or mitigate issues with the primary data feed. Finally, the use of advanced chemical surface observations from the ACTRIS and EMEP programmes, the provision of which will be supported by separate CAMS contracts, shall be also considered to use for improving robustness and reliability of the service.

The successful Tenderer shall acquire directly three streams of observational data:

- Near-Real-Time ("NRT data") or Up-to-Data ("UTD data") unvalidated data shall be acquired daily as they are made available by the EEA according to the provisions of the air quality e-reporting process;
- "Interim data" shall be gathered routinely with a delay of between 2 and 4 weeks. Such data is up-to-date data that has undergone certain automatic validation processes but is not reported as validated data by the European Countries.
- "Validated data" shall be gathered within a month after it has been made available in EEA's air quality database, following the official reporting process defined in the implementation provisions of the air quality directive. Over the past years, the EEA has significantly shortened the time between reporting and validated data delivery. Validated data of a given year is reported by the Member States by the 30th September of the year after. The EEA now considers that validated

datasets are available on their download e-reporting service no later than two months after the official reporting deadline.

The successful Tenderer shall organise together with ECMWF the liaison with the EEA regarding feedback on NRT data integrity, quality, acquisition and format aspects. ECMWF and EEA have an ongoing contract, which is dedicated to the improvement of the infrastructure as well as to visit individual European countries for the purpose of solving specific issues and of advocating for increasing the amount of data submitted on a NRT routine basis. Finally, the successful Tenderer shall make all acquired observations available to ECMWF in a timely but non-operational fashion agreed with ECMWF.

Other types of observations (satellite, data from research infrastructures and networks) will be acquired by ECMWF and made available to the successful Tenderer for activities directly related to this ITT. The successful Tenderer shall acquire, process (formatting, black-listing...) and filter observations according to their representativeness and suitability for assimilation and verification purposes at the resolution of the Regional Systems. The successful Tenderer shall interact with the provider for Regional Evaluation and Quality Control (EQC) services to set aside some observations for the purpose of independent verification and quality control of analyses, re-analyses and forecasts.

The successful Tenderer shall report data acquisition activities on a quarterly basis. At the minimum, information will be stratified by country, by parameter and by hour in the day. Indications will be given whether the data flow is steady, improving or deteriorating for the different entries.

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.

Tenderers are required to limit the number of deliverables to only those that are essential and strictly necessary to fulfil the core objectives of the contract.

WP4010 Required Core Deliverables			
<i>#</i>	<i>Type</i>	<i>Title</i>	<i>Due</i>
D1.Y.Z- yyyyQx	Data & Report	Daily data acquisition and quarterly status report of NRT and interim data from the EEA and the ACTRIS and EMEP programmes	Quarterly
D1.Y.Z-yyyy	Report	Annual data acquisition and status report of validated data from the EEA	Annually (no later than 4 months after they are released)

3.3 Work package 4020 – Provision of near-real-time (NRT) European analyses and forecasts

For the provision of daily near-real-time European air quality analyses and forecasts, the Regional Systems selected by the successful Tenderer shall deliver numerical outputs to the Central Regional Production Unit (CRPU) that shall process the input from each individual Regional System and prepare ensemble products based on that input. Output data from all individual Regional Systems as well as the ensemble products shall be made available to the users via the Atmosphere Data Store (ADS). It is

also ECMWF's intention to provide the data through a mechanism suitable for supporting time-critical applications, which will be separate from ADS. The data shall have the following characteristics:

- Delivery done in GRIB2 formats;
- model outputs are made available over the area defined in section 3.1;
- ensemble products shall have a horizontal resolution of 0.1°;
- model outputs are provided for at least ten vertical levels: surface, 50m, 100m, 250m, 500m, 750m, 1000m, 2000m, 3000m and 5000m above ground;
- at the start of the contract, the model variables will include at least O₃, NO, NO₂, CO, SO₂, PM_{2.5}, PM₁₀, NH₃, total Non-Methane Volatile Organic Compounds (NMVOC), total Peroxy-Acetyl Nitrates (PANs), formaldehyde (HCHO), glyoxal (OCHCHO), PM₁₀ from wildfires, PM₁₀ from dust, PM₁₀ from sea salt, PM_{2.5} secondary inorganic aerosols, ammonium, nitrate, sulfate, PM_{2.5} residential elementary carbon, PM_{2.5} total elementary carbon, PM_{2.5} total organic matter and birch, olive, grass, alder, mugwort, and ragweed pollens. .

The methodology employed for the centralised regional production shall develop upon two methodological approaches:

- An ensemble based on the median of the individual systems for each geographical location, vertical level and parameter. The median ensemble approach is the one currently operationally implemented in the CAMS regional system
- A weighted Ensemble that allows to combine individual models results in a way that best performing models for each given location and time could drive the final result. Artificial intelligence algorithms can be proposed. A similar approach is currently tested in the CAMS regional system.

Both methodologies should allow to build up Ensemble results not only for ground level concentrations but also for the vertical distribution. They should apply at least on the list of regulatory pollutants (O₃, NO₂, CO, SO₂, PM₁₀ and PM_{2.5}). The Tenderers will detail how they can be expanded to the other species targeted by NRT delivery (see above) or justify the reasons why it may not be possible or relevant. Performances of each method should be thoroughly assessed by the Evaluation and Quality Control (EQC) service (see below).

The regional ensemble products delivered at the beginning of the contract will be based **on the median ensemble, as currently done**. More time will be needed for the weighted ensemble process assuming that some developments/adjustments of the methodology could be necessary to ensure robustness and accuracy of this approach compared to the median ensemble and to fulfil the requirements expressed in 3.3. Once quality and operational maturity of the weighted ensemble approach will be demonstrated by the successful contractor, this approach will be implemented in the operational suite to replace the median ensemble. The Tenderers will provide a realistic timeline for such a transition, that will include the demonstration that the weighted ensemble performances overpass those of the median ensemble according to criteria that he will define. By the end of the contract, the weighted ensemble approach should run.

The outputs from the different ensemble members shall be used to estimate uncertainties, which are required by the users, and the Ensemble spread will be delivered as an output data of the regional system. Particular attention shall be paid to adequate routine quality control for any significant outliers in the model ensemble. The successful Tenderer shall also take into account any feedback provided by the CAMS contract on regional Evaluation and Quality Control on the quality of the provided services.

3.3.1 Task 4021: Daily Near-Real-Time (NRT) European air quality analyses

The successful Tenderer shall provide daily analyses with a temporal resolution of one hour for the previous day (0h to 24h) for each of the individual Regional Systems using the NRT observations compiled under Work package 4010 (see section 3.2). The successful Tenderer shall also provide the equivalent ensemble products. All the variables mentioned in section 3.3 shall be provided, even if no observations are assimilated for a certain variable or if the impact of the assimilation of other chemically related species on that variable is marginal. These cases must be documented.

The analyses shall be made available daily to ECMWF through an agreed data-serving mechanism by the CRPU not later than 12 UTC. The successful Tenderer must make the necessary arrangements so that individual production of the analyses, dissemination to the CRPU, ensemble processing, and availability of final data products on the data server meets this target.

The Ensemble analyses will be delivered in a full operational way, according to the KPIs defined for this service, and with respect to the timeline detailed above since the beginning of the contract. The same will apply to the weighted ensemble when it replaces the median in operational workflows, assuming it performs better than the median ensemble. The Tenderers will provide a tentative timeline for the operational implementation of the weighted ensemble approach, consistent with the upgrading plans (see WP 4030) and will report on a half-year basis on the progress of work carried out to achieve operations.

For each of the individual regional systems, a detailed record will be kept of the data effectively assimilated each day as well as the time of delivery of the analyses. This information will be synthesised by the main contractors and related statistics delivered as annexes in the quarterly service reports.

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.

Tenderers are required to limit the number of deliverables to only those that are essential and strictly necessary to fulfil the core objectives of the contract.

WP4021 Required Core Deliverables			
<i>#</i>	<i>Type</i>	<i>Title</i>	<i>Due</i>
D2.1.Z- yyyyQx	Data	Provision of individual NRT analyses from each of the operational systems plus the ENSEMBLE.	Daily
D2.1.Z- yyyyQx	Report	Report providing the uptime statistics of data servers, explanations of major issues, volumes and number of files served.	Quarterly

3.3.2 Task 4022: Daily European air quality forecasts

The successful Tenderer shall provide daily 96-hour air quality forecasts with a temporal resolution of one hour based from 00 UTC for each of the individual Regional Systems. The successful Tenderer shall also provide the equivalent ensemble products. The forecasts for chemical variables will be initialised by the 24-hour forecast of the previous day for the same system. Initialisation of the forecasts with the analyses of the previous days is a straightforward development that should be considered in the present contract. The successful tenderer will propose requirements regarding the timeliness of observation data and analyses to support initialisation of the forecasting suite with analyses.

Forecasts will be made available daily to ECMWF through the same agreed data-serving mechanism as that used for the analyses by the CRPU not later than 08 UTC (0-48h) and 10 UTC (49-96h). The successful Tenderer must make the necessary arrangements so that individual production of the forecasts, dissemination to the CRPU, ensemble processing, and availability of the final data products on the data server meet this target.

The Ensemble forecasts will be delivered in a full operational way, according to the KPIs defined for this service, and with respect to the timeline detailed above since the beginning of the contract. The same will apply to the weighted ensemble when it replaces the median in operational workflows, assuming it performs better than the median ensemble. The Tenderers will provide a tentative timeline for the operational implementation of the weighted ensemble approach, consistent with the upgrading plans (see WP 4030) and will report on a half-year basis on the progress of work carried out to achieve operations.

In addition, the current regional services include since February 2024 the delivery of European “Air Quality Forecasts Optimised at Observation Sites” which rely on an AI approach to use observations from the air quality monitoring networks set-up by countries across Europe to correct inherent biases of model results and improve the quality of the forecasts at the station locations. This product is shortly referred as “CAMS-MOS,” although it is based on further sophisticated algorithms that improve the Model Output Statistics method used as a basic approach. This new product is fully documented in the framework of the current contract and operationally implemented and should be part of the operational deliveries of this task. Quality and robustness of this delivery is strongly dependant on the quality and the consistency of observation datasets at the monitoring stations. The Tenderers will document potential limits and drawbacks that could hampered operational workflows and requirements to deliver the service.

For each of the individual regional systems, a detailed record will be kept of the data effectively delivered each day and the timeliness of the delivery for the four forecast days. This information will be synthesised by the main contractors and related statistics delivered as annexes in the quarterly service reports.

For both tasks, 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.

Tenderers are required to limit the number of deliverables to only those that are essential and strictly necessary to fulfil the core objectives of the contract.

WP4022 Required Core Deliverables			
#	Type	Title	Due
D2.2.Z-yyyyQx	Data	Provision of individual forecasts (up to 96h) from each of the operational systems plus the ENSEMBLE.	Daily
D2.2.Z-yyyyQx	Report	Report providing the uptime statistics of data servers, explanations of major issues, volume and number of files served.	Quarterly

3.4 Work package 4030 – Maintenance and system upgrades of the operational forecasting systems

The Regional Systems shall be operated by organisations that have demonstrated capability of bringing changes to the corresponding numerical codes. For each one of the Regional Systems a multi-year development plan will be maintained and will form part of the CAMS Service Evolution Strategy document. The implementation development plans of the Regional Systems will especially focus on implementing items that will be finalized and validated by the long-term development work package (4060) comprising modelling, data assimilation and post-processing aspects. Two specific short-term developments shall be included:

- Implementation of the operational production of observation-adjusted (Model Output Statistics) point forecasts for all stations in Europe that report regularly to the Up-To-Date (UTD) observations system of the European Environment Agency (EEA), including urban stations.
- Implementation and assessment of the performance of the new weighted ensemble approach, in parallel to the median ensemble in an e-suite.

The successful Tenderer shall report on continual development activities for all Regional Systems as well as the Ensemble processing on a yearly basis. The operational configuration of each of the Regional Systems shall be changed only once a year and simultaneously, in principle during the month of November each year. The successful Tenderer shall inform the users at least two months in advance of the main changes. If the contents or format of the outputs is changed, sample files shall be made available also at least two months in advance through a parallel, but otherwise identical, data feed as the products they will replace or augment. In the case that another change is proposed by the successful Tenderer (either for fixing an issue in one or the Regional Systems or for making a general change to all the Regional Systems), it will have to be formally approved by ECMWF before implementation and information of the users. Each change shall be described by updating the documentation of the relevant Regional Systems in the centralized CAMS Knowledge Base (see also WP4060).

In principle, most developments will be phased in with the planned upgrades of the systems. However, the successful Tenderer shall keep the possibility for interim ad hoc upgrades to correct issues that affect the quality of the operational data provision, subject to discussion with and approval from ECMWF. This shall take into account the feedback provided by the CAMS contract on regional Evaluation and Quality Control. The successful Tenderer shall inform the users at least two months in advance of the main changes; in case the contents or format of the outputs is changed, sample files will be made available also at least two months in advance in the same manner as for planned upgrades. Each change will be described by updating the documentation of the relevant Regional System(s): the main body of the text should describe the current version, while annexes should

describe the changes compared to previous operational versions (indicating periods when these were in operations).

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.

Tenderers are required to limit the number of deliverables to only those that are essential and strictly necessary to fulfil the core objectives of the contract.

WP4030 Required Core Deliverables			
<i>#</i>	<i>Type</i>	<i>Title</i>	<i>Due</i>
D3.Y.Z-yyyy	Report	Annual plan for short-term maintenance and development activities for all Regional Systems and the ENSEMBLE processing	End of November
D3.Y.Z-yyyy	Report	Annual report on the short-term maintenance and development activities for all the Regional Systems and the ENSEMBLE processing	End of December

WP4030 Required Core Milestones			
<i>#</i>	<i>Title</i>	<i>Means of verification</i>	<i>Due</i>
M3.Y.Z	Operational upgrade of the Regional Systems and ENSEMBLE processing	Email sent via the CAMS Service Desk to the users informing of completion of the operational upgrade	At each operational upgrade*

* The Tenderer shall indicate in the proposal the planned approximate implementation dates of the main system upgrades.

3.5 Work package 4040 – Provision of European reanalyses

For the provision of annual European air quality reanalyses, the Regional Systems selected by the successful Tenderer shall deliver numerical outputs to the Central Regional Production Unit (CRPU) that shall process the input from each individual Regional System and prepare ensemble products based on that input. Output data from all individual Regional Systems as well as the ensemble products shall be made available to the users via the Atmosphere Data Store (ADS) and shall have the following characteristics:

- Delivery done in NetCDF formats;
- model outputs are made available over the area defined in section 3.1;
- ensemble products shall have a horizontal resolution of 0.1°;
- model outputs are provided for at least ten vertical levels: surface, 50m, 100m, 250m, 500m, 750m, 1000m, 2000m, 3000m and 5000m above the ground;
- The model variables will include at least O₃, NO, NO₂, CO, SO₂, PM_{2.5}, PM₁₀, NH₃, total Non-Methane Volatile Organic Compounds (NMVOC), total Peroxy-Acetyl Nitrates (PANs), formaldehyde (HCHO), glyoxal (OCHCHO), PM₁₀ from wildfires, PM₁₀ from dust, PM_{2.5} secondary

inorganic aerosols, ammonium, nitrate, sulphate, Secondary Organic Aerosols (SOA), PM_{2.5} residential elementary carbon, PM_{2.5} total elementary carbon, PM_{2.5} total organic matter.

The methodology employed for the centralised regional production shall be based on the median value of the ensemble of the individual systems for each geographical location, vertical level and parameter. The outputs from the different ensemble members shall be used to estimate uncertainties, which are required by the users.

3.5.1 Task 4041: European air quality interim re-analyses

The successful Tenderer shall provide annual interim reanalyses with a temporal resolution of one hour for the past year and for each of the individual Regional Systems, using the “Interim data” compiled under work package 4010. The successful Tenderer shall also provide the equivalent ensemble products. All the above-mentioned parameters shall be provided, even if no observation is assimilated for a certain parameter or if the impact of the assimilation of other chemical-related species on that parameter is marginal. The first year to be provided shall be 2024.

Interim reanalyses based on “Interim data” shall be made available to the users by the CRPU not later than at the end of February each year for the entire previous year. The successful Tenderer has to make the necessary arrangements so that individual production of the analyses, dissemination to the CRPU and ensemble processing allows for meeting this target.

For each of the individual Regional Systems, a record shall be kept of the data effectively assimilated for each day of the year.

3.5.2 Task 4042: European air quality validated re-analyses

The successful Tenderer shall provide annual reanalyses with a temporal resolution of one hour for each past year and for each of the individual regional systems, using the “Validated data” compiled under Work package 4010. The successful Tenderer shall also provide the equivalent ensemble products. All the above-mentioned parameters shall be provided, even if no observation is assimilated for a certain parameter or if the impact of the assimilation of other chemical species on that parameter is marginal. The first year to be provided shall be 2023.

Reanalyses based on “Validated data” shall be made available to the users by the CRPU not later than four months after data has been made available by the EEA in the e-reporting database for a given past year.

The successful Tenderer has to make the necessary arrangements so that individual production of the analyses, dissemination to the CRPU and ensemble processing allows for meeting this target.

For each of the individual Regional Systems, a record shall be kept of the data effectively assimilated for each day of the year.

For both tasks, 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 below.

Tenderers are required to limit the number of deliverables to only those that are essential and strictly necessary to fulfil the core objectives of the contract.

WP4040 Required Core Deliverables			
#	Type	Title	Due
D4.Y.Z-yyyy	Data	Provision of the annual interim reanalysis for Year N from each of the operational systems plus ENSEMBLE	End of February of Year N+1
D4.Y.Z-yyyy	Data	Provision of the annual reanalysis for Year N-1 from each of the operational systems plus ENSEMBLE	During Year N+1, no later than 4 months after 'validated' observations for Year N-1 have been released by the EEA

3.6 Work package 4050 - 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 required 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(s) 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.

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(s) 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.

Finally, while user engagement and training activities are not part of the scope of this ITT, the Tenderers shall accommodate for eventual needs in providing technical and scientific expertise in support of these activities. The Tenderers 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.

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.

Tenderers are required to limit the number of deliverables to only those that are essential and strictly necessary to fulfil the core objectives of the contract.

WP4050 Required Core Deliverables			
<i>#</i>	<i>Type</i>	<i>Title</i>	<i>Due</i>
D5.Y.Z-yyyy	Other	Contribution to CAMS Knowledge Base to ensure up-to-date information about products and services covered under this contract	Annually
D5.Y.Z-yyyy	Other	Contribution to CAMS Knowledge Base about system upgrades of Regional Production	At each system upgrade
D5.Y.Z-yyyy	Other	Contribution to CAMS Knowledge Base about new release of (interim) reanalysis products	At each annual release of Regional (interim) reanalysis
D5.y.z-YYYY	Other	Input to CAMS URDB - YYYY	Checked by ECMWF annually in November

3.7 Work package 4060 – Forecasting system development

The successful Tenderer shall further develop the methods and tools used to deliver the products from the model and data assimilation systems and the ensemble products. A multi-year development plan for longer-term developments shall be maintained and will form part of the CAMS Service Evolution Strategy document. Additionally, the plans may cover other aspects to address specific shortcomings that have not necessarily been identified in the context of CAMS operations. The successful Tenderer shall report on continual development activities for the regional central processing system on a half-yearly basis.

The development plan shall include two major aspects in support of the implementation of the CAMS mid- and long-term strategy (beyond 2027):

- Further harmonization of the individual models with special focus on:
 - o Land-use data
 - o Vertical discretisation
 - o Boundary conditions
 - o Altitude profiles to inject emissions
- Improvement of the horizontal resolution: to comply with user requirements and to benefit from the expected spatial resolution of Earth observations that will be delivered by the upcoming Copernicus satellite missions (about 4-5km), the CAMS regional products are expected to be delivered at 3 – 5 km resolution during the third phase of the Copernicus Programme starting in 2028. Therefore, the Tenderer shall include a plan for ramping-up developments that will support the achievement of this objective. The tenderer will propose downscaling methodologies and is free to propose physics-based or data-driven and machine learning or a combination of both. It shall include preparatory work on the individual models, regarding model parametrisations, HPC infrastructure and data management and data flows. Pilot studies to demonstrate the feasibility and the performance of the high-resolution systems for a selection of models that can deal with the high-resolution requirements shall be included as well.

Beyond the short-term developments mentioned above, the developments shall include:

- Implementation of deposition fluxes for key pollutants in the Regional Systems that have potential impacts on ecosystems and materials: nitrogen compounds, sulphur compounds, ozone, and elemental carbon. This action is a follow-up of activities started in the current CAMS2_40 contract, and shall take stock of the lessons learnt from this initial phase and from on-going research projects (e.g. CAMEO). Outputs from the Regional Systems shall be compared with each other, but also with equivalent outputs from the global CAMS data assimilation and forecasting system. Where possible, observations of the deposition fluxes shall be used to support an evaluation process.
- Activities on satellite data assimilation to prepare for the launch of the Sentinel-4 satellite that will provide up to hourly measurements at 4km resolution over the entire European domain. Preliminary data assimilation tests shall be conducted using the Sentinel-5p satellite with a selection of models. This work shall take into account the outcomes of on-going research activities carried out in the Horizon Europe framework. Sentinel-4 is expected to be launched in summer 2025, and a commissioning phase of at least 12 months is foreseen. Therefore, operational assimilation of Sentinel-4 data is not expected to be implemented in the first half of the contract, but preparatory actions shall be planned.

- Further develop the capability to produce timely forecasts initialized by the analyses elaborated on updated data assimilation modelling systems. This will require benchmarking and showing the added value of including the analyses as initial conditions (potentially delayed) for the ensemble forecast scores.
- Introduction of two new pollen species that will be determined with ECMWF after user consultation and in collaboration with the contractor in charge of pollen data acquisition (contract CAMS2_23).
- Development of an alternative data-serving API that is better suited to the needs of the ADS. This API will completely hide from the ADS any differences in backend storage solutions, such as between older and newer data, satisfy multi-field requests and allow optimal download performance to be achieved by multiple concurrent ADS requests without them being aware of each other's existence. (In these respects its API will be similar to ECMWF's MARS service.) It may well necessitate a server-side queuing system, in which case the API will offer the ability to observe the queue state.
- Generalisation of the CAMS_MOS forecasts to the whole modelling domain with appropriate methodologies to ensure consistency of the corrections made at the monitoring station locations over the whole domain. The Tenderers will propose a development plan including assessment of the performance of the proposed generalised-MOS forecasts and comparison for ground level surface data, to other ensemble forecasts implemented in this contract.

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.

Tenderers are required to limit the number of deliverables to only those that are essential and strictly necessary to fulfil the core objectives of the contract.

WP4060 Required Core Deliverables			
<i>#</i>	<i>Type</i>	<i>Title</i>	<i>Due</i>
D6.Y.Z-yyyy	Report	Annual plan for long-term development activities for all Regional Systems and the ENSEMBLE processing	End of November
D6.Y.Z-yyyy	Report	Annual report on the long-term development activities for all the Regional Systems and the ENSEMBLE processing	End of December
D6.Y.Z-yyyy	Note	For each new development achieved synthesis note that summarises the outcomes and the performance of the new development	1 month after the development review meeting

WP4060 Required Core Milestones			
<i>#</i>	<i>Title</i>	<i>Means of verification</i>	<i>Due</i>
M6.Y.Z	Review meeting with ECMWF to present achievement of new developments	Ppt presentation for the meeting	Once a new development is achieved

3.8 Work package 4000 - Management and coordination

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

- 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 (or in intervals as otherwise agreed during the negotiation) 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.

WP4000 Required Core Deliverables				
#	Responsible	Nature	Title	Due
D0.Y.Z-yyyyyQx	Tenderer	Report	Quarterly Implementation Report (QIR) yyyyQx	Quarterly on 15/04,

			yyyyQx being the previous quarter (e.g. 2024Q3 due on 15/10/2024)	15/07 and 15/10
D0.Y.Z-yyyy-Part1	Tenderer	Report / Other	Annual Implementation Report (AIR) for year yyyy - Part 1 including: <ul style="list-style-type: none"> the Quarterly Implementation Report (QIR) yyyyQ4, and the preliminary financial information yyyy being the Year n-1 	Annually on 15/01
D0.Y.Z-yyyy-Part2	Tenderer	Report	Annual Implementation Report (AIR) for year yyyy - Part 2 yyyy being the Year n-1	Annually on 28/02
D0.Y.Z	Tenderer	Report	Final Report	By the end of contract
D0.Y.Z-yyyy	Tenderer	Report	Annual Implementation Plan for year 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 for year YYYY YYYY being the Year n-1	Annually, not later than on 15/12 ⁽¹⁾
D0.Y.Z	Tenderer	Other	Updated KPIs (list, targets, etc.) after review with ECMWF	1 year after start of contract

WP4000 Required Core Milestones				
#	Responsible	Title	Means of verification	Due
M0.Y.Z-KOM	Tenderer	Kick-Off Meeting	Minutes of Meeting	30 days after start of contract
M0.Y.Z-PMxqqYY	Tenderer	Progress Review Meeting #PMx being the Payment milestone number, #qq - the quarter and #YY - a year during which the Payment Milestone is due xx being the iteration number of the PRM	Minutes of Meeting	~ as a minimum linked to the Payment Milestone.
M0Y.Z-SLB ⁽²⁾	Tenderer	CAMS Service Level Board meeting	Attendance	Every month
M0.y.z-CAMSGA-YYYY	Tenderer	CAMS General Assembly YYYY	Attendance	Annually, not later than on 15/12 ⁽¹⁾

⁽¹⁾ These due dates are indicated to frame the corresponding deliverables and milestones schedule only, consequently the following shall be considered by the Tenderer:

- the general financial statements shall be sent by the contractor as soon as available,
- the schedule of the Progress Review Meetings shall be aligned with the different Payment Milestones during the contract negotiation,
- depending on the year, the CAMS General Assembly may take place at a different period of the year.

- ⁽²⁾ All iterations for this recurring SLB meeting do not need to be listed by the Tenderer, i.e., only one row shall be added in Volume IIIA “Pricing and deliverables” Excel sheet “Deliverables List”.

4 General Requirements

4.1 Implementation schedule

The Framework Agreement is expected to be implemented by a single Service Contract of 36 months. The Tenderer shall provide a detailed implementation plan of proposed activities for the full period.

4.2 Deliverables and milestones

The Tenderers shall provide the list of deliverables and milestones (cf. ITT Volume IIIA “Pricing and deliverables”, Excel spreadsheet “Deliverables List”) for each Work Package. All deliverables and milestones must be consistent with the activities and objectives described in Section 3 of this ITT Volume II:

- A deliverable is a substantial, tangible or intangible good or service produced as a result of a project (see also the deliverable definition in this ITT Volume V Clause 1.2 and Clause 3.2). In other words, a deliverable is an outcome produced in response to the specific objectives of the contract and is subject to acceptance by both ECMWF’s Technical Officer (TO) and Contract Management Officer (CMO).
- Milestones should be designed as markers of demonstrable progress in service development and/or quality of service delivery (see also the milestone definition in this ITT Volume V Clause 1.2). They should not duplicate deliverables and shall not attract the budget under Volume IIIA “Pricing and deliverables”, Excel sheet “Deliverables List”.

The following shall apply to the deliverables and milestones:

- The deliverables and milestones should be consistent with the technical requirements specified in Section 3.
- When defining deliverables, please **consolidate their number** and assign the precise dates (DD/MM/YYYY) to each of them.
- All contract reports and deliverables 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. See also Section 4.6 in what regards the data provision.

Volume IIIA “Pricing and deliverables” (cf. Excel sheet “Deliverables List”) of this ITT shall be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package (due dates). Please note that:

- All deliverables and milestones shall be numbered as per the following format DX.Y.Z (for deliverables) and MX.Y.Z (for milestones), where X is the WP number, Y is the task number and Z is the deliverable or 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). 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 the milestones. Continuous deliverables at higher frequency can be labelled in the same way as quarterly deliverables.

- Each deliverable shall have an associated resource allocation and price (cf. column I “Nb of PM allocated” and column J “Estimated price”), while the only resource type to be considered is “payroll” (the total of these allocated resources and prices shall therefore amount to the total price associated with payroll in Volume IIIA spreadsheet “Costs and Prices”). Milestones should not have such associated resource allocation, unless otherwise agreed.
- The Tenderers shall provide a due date for each proposed deliverable and milestone (in accordance with those indicated in Section 3):
 - o The Tenderers shall ensure that the proposed due dates of deliverables and milestones are realistic and achievable. **Any dependencies on input data (whose origin must be specified) shall be detailed and also accounted for in the risk table.**
 - o It is advised to schedule the submission/completion of the last deliverables and/or milestones associated with a Payment Milestone not later than 15 days before the expected date of completion of the said Payment Milestone (i.e. when all deliverables have been submitted by the contractor and all milestones have been completed by the concerned parties).

4.3 Acquisition of necessary data and observations

The Successful Tenderer(s) shall closely interact with the Global Service Provider and the providers of the relevant in situ support contracts for the exchange of relevant data sets related to this ITT. The Successful Tenderer(s) shall also closely interact with the provider(s) for the Global and regional emissions activities, who are responsible for delivering the emission data sets that form an input to the Regional Systems, to ensure appropriate use of these emissions.

4.4 Communication

The successful Tenderer(s) 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 Data provision and IPR

It is expected that data sets (including databases) generated or acquired by the successful Tenderer will be delivered to the users via the Atmosphere Data Store (ADS). The section below indicates generic requirements for these datasets in terms of standards and conformity.

Provision of data and products:

Suppliers will make the output of their work available to CAMS users via the ADS, by one of two methods:

- a) uploading their data and products to a designated server,
- b) providing them via web services.

Note that it is also ECMWF's intention to provide the data through a mechanism suitable for supporting time-critical applications, which will be separate from ADS.

In the case of (a), suppliers will have to agree with ECMWF on the data formats to be used. ECMWF will only accept data in formats that follow internationally recognised standards. Such standards must be open (i.e. non-proprietary), managed by a recognised international standardisation body (e.g. ISO, WMO, OGC, etc.), or any de-facto standard. Open source software should also exist that can read and write files of these standards. Serialisation formats (e.g. NetCDF, XML, JSON) should be supported by standard schemas and conventions. All text-based formats should be encoded in UTF-8. ECMWF will implement tools to check the compliance of the provided data and products to the agreed standards before they are added to the ADS.

Examples of case (a) are data uploaded to the ADS in WMO GRIB edition 1 and 2, NetCDF files conforming to CF-1.6, or greater.

Special care will be accorded to the speed of the server and clear commitments should be taken by the Tenderers considering the evolution of the service and datasets foreseen in the proposal. ECMWF must be able to transfer the complete output of one model forecast run / one analysis cycle in a time that will be proposed by the Tenderers. An agreed life-cycle management plan for the data on the server, and requirements on informing of any major maintenance, disruption or future (agreed) changes to the interface to the server within an agreed time period (2 months) will be established.

In the case of (b), suppliers will have to agree with ECMWF on the protocols to be used to invoke the web services. ECMWF will only accept protocols that follow internationally recognised standards. Such standards must be open (i.e. non-proprietary), managed by a recognised international standardisation process (e.g. ISO, WMO, OGC, etc), or be a de-facto standard such as OpenDAP. ECMWF will consider using bespoke web-based APIs to access the data and products if they implement very simple protocols (e.g. REST), as long as the results returned by these APIs are compatible with (a). It should be noted that requests for these web services will mostly originate from the ADS itself, as part of a workflow run on behalf of an end-user; ECMWF will therefore need to have the necessary credentials to invoke these services. ECMWF will not provide information on the end user's identity when invoking the web services. ECMWF will nevertheless collect usage statistics for all aspects of CAMS.

Examples of case (b) are OGC standards (WMS, WCS, WFS, etc), OpenDAP, etc. Other protocols could be considered as the system evolves.

Every dataset and/or service provided shall be documented using the appropriate metadata standards (e.g. ISO 19115, INSPIRE Directive 2007/2/EC).

Provision of processing capabilities:

Successful tenderer will (when appropriate) implement specific web-service-based data manipulation facilities. These will make it possible to run some agreed reduction and/or analysis algorithms directly on the data and products located on the suppliers' systems, and to return the results of said algorithms.

As for data retrievals, invocation of these web services will originate from the ADS itself as part of a workflow run on behalf of an end user, and ECMWF will need to have the necessary end-user credentials to invoke these services. ECMWF will not provide information on the end user's identity when invoking the web services. ECMWF will nevertheless collect usage statistics.

ECMWF will ensure that these services are invoked in a controlled fashion, to prevent any misuse of the system. This web services will be implemented with OGC's WPS standards or will be based on simple web-based REST API or equivalent. The results returned by these services will have to be in formats compatible with options (a) or (b) described above.

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 from the suppliers to the European Union via ECMWF. The successful Tenderer will be granted a non-exclusive licence to use them for any purpose

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.

The table below provides the template to be used by the Tenderers 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
KPI_40.1	Data server uptime in latest Quarter	95%	Quarterly
KPI_40.1a	Percentage of requests for recent data, catalogue data & tokens successfully served	99%	Quarterly
KPI_40.1b	Percentage of requests for archived data successfully served	95%	Quarterly
KPI_40.2	Production on time of NRT analyses and forecasts with all N operational models / with N-2 models in latest Quarter	90% / 98%	Quarterly
KPI_40.2b	Production on time of Ensemble NRT analyses and forecasts	99%	Quarterly

KPI_40.3	User Support ticket acknowledgement in latest Quarter	100% within 3 working days	Quarterly
KPI_40.4	User Support ticket response in latest Quarter	80% within 15 days	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.

<i>Section</i>	<i>Page Limit</i>
<i>Executive Summary</i>	2
<i>Track Record</i>	2 (for general) and 2 (per entity)
<i>Quality of resources to be Deployed</i>	2 (excluding Table 1 in Volume IIIB and CVs with a maximum length of 2 pages each)
<i>Technical Solution Proposed</i>	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)
<i>Management and Implementation</i>	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)
<i>Pricing Table</i>	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 make their way to the users and damage the Service's reputation. The description of the proposed technical solution shall be organized in individual tasks following the work package structure indicated above.