

ECMWF Copernicus Procurement

Invitation to Tender



Copernicus Atmosphere Monitoring Service Volume II

Regional production

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1 Introduction

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

At the Earth's surface, aerosols, ozone and other reactive gases such as nitrogen dioxide determine the quality of the air around us, affecting human health and life expectancy, the health of ecosystems and the fabric of the built environment. Ozone distributions in the stratosphere influence the amount of ultraviolet radiation reaching the surface. Dust, sand, smoke and volcanic aerosols affect the safe operation of transport systems and the availability of power from solar generation, the formation of clouds and rainfall, and the remote sensing by satellite of land, ocean and atmosphere.

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

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

- a) Daily production of real-time analyses and forecasts of global atmospheric composition
- b) Reanalyses providing consistent multi-annual global datasets of atmospheric composition with a stable model/assimilation system
- c) Daily production of real-time European air quality analyses and forecasts with a multi-model ensemble system
- d) Reanalyses providing consistent annual datasets of European air quality with a frozen model/assimilation system, supporting in particular policy applications
- e) Products to support policy users, adding value to "raw" data products in order to deliver information products in a form adapted to policy applications and policy-relevant work
- f) Solar and UV radiation products supporting the planning, monitoring, and efficiency improvements of solar energy production and providing quantitative information on UV irradiance for downstream applications related to health and ecosystems
- g) Greenhouse gas surface flux inversions for CO₂, CH₄ and N₂O, allowing the monitoring of the evolution in time of these fluxes
- h) Climate forcing from aerosols and long-lived (CO₂, CH₄) and shorter-lived (stratospheric and tropospheric ozone) agents

This Invitation to Tender (ITT) is targeting the 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 will comprise between eight and ten 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 eight to ten individual 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 production” 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 between eight and 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 re-analyses 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 data), re-analyses shall be processed with frozen systems, which are only updated every few years.

All the individual assimilation and forecast 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, re-analyses and forecasts, verification of the outputs, data dissemination services and support to the users form the bulk of the activities that are procured within this ITT.

3 Technical Specification

The successful Tenderer shall bring together a group of organisations which will continuously develop and operate eight to ten regional air quality assimilation and forecast systems, which support the delivery of the Regional Products.

3.1 General Requirements

The successful Tenderer will bring evidence that the following conditions are met for each of the eight to ten individual Regional Systems that it has selected:

- the domain covered must be at least (25°W-45°E, 30°N-72°N*);
- the system horizontal resolution shall be finer than or equal to 0.2° by 0.2°, or the equivalent resolution in kilometres;
- transport and physical processes must 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 will use the regional emissions dataset (other than fire) provided by the CAMS_81 contract;
- the system will 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 must 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 must have a documented data assimilation capability for surface Air Quality observations (at the minimum);
- the system must 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.

* Some Member States have required that the CAMS domain for Regional Products is extended from the current value of 70°N in order to cover entirely mainland Europe up to Cape Nordkinn (71°8'2"N). Pragmatic solutions, such as using outputs from the CAMS Global Products north of 70° (given the limited extent of local sources so far north) are acceptable.

3.2 Work package 5000 - 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);
 - 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 templates to be used by the contractor to describe the complete list of deliverables, milestones and schedules for this work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables. Tenderers shall provide preliminary versions of the completed tables, which include the deliverables and milestones already indicated in the tables below, as part of their bid.

WP5000 Deliverables Template				
#	Responsible	Nature	Title	Due
D0.y.z-YYYYQQ	Tenderer	Report	Quarterly Implementation Report QQ YYYY <i>QQ YYYY being the previous quarter</i>	Quarterly on 15/01, 15/04, 15/07 and 15/10
D0.y.z-YYYY	Tenderer	Report	Annual Implementation Report YYYY <i>YYYY being the Year n-1</i>	Annually on 28/02
D0.y.z	Tenderer	Report	Final Implementation Report, including letter from auditor specific to CAMS contract YYYY <i>YYYY being the last year of the contract</i>	60 days after end of the last service contract
D0.y.z-YYYY	Tenderer	Report	Draft Implementation Plan YYYY <i>YYYY being the Year n+1</i>	Annually on 28/02
D0.y.z-YYYY	Tenderer	Report	Finalised Implementation Plan YYYY <i>YYYY being the Year n+1</i>	Annually on 31/10
D0.y.z-YYYY	Tenderer	Other	Copy of prime contractor's general financial statements and audit report YYYY <i>YYYY being the Year n-1</i>	Annually
D0.y.z-YYYY	Tenderer	Other	Letter auditor's opinion specific to CAMS most recent Annual Implementation Report YYYY <i>YYYY being the Year n-1</i>	Annually
D0.y.z	Tenderer	Other	Updated KPIs (list, targets...) after review with ECMWF	One year after start of contract

WP5000 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 5010 – Observational data acquisition

The successful Tenderer will acquire observational data for data assimilation and verification purposes and will 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). 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 acquisition of advanced chemical surface observations from the ACTRIS and EMEP programmes will be supported by two CAMS contracts (CAMS_21a and CAMS_24b respectively).

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

- Near-Real-Time un-validated data (“NRT data”) will be acquired daily.
- “Interim data” will be gathered routinely with a delay of between 2 and 4 weeks. Such data may have undergone certain validation processes but are not officially reported by the European Countries.
- “Validated data” will be gathered within a month after they have been made available in EEA’s Airbase, following the official reporting process of the European Countries, which currently takes up to two years.

The successful Tenderer will 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 (CAMS_22), 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 routine basis.

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 will 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 will set aside some observations for the purpose of independent verification and quality control of analyses, re-analyses and forecasts: it will also flag whether data must or must not be taken into account in the preparation of Regional Products.

The successful Tenderer will 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.

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

WP5010 Deliverables Template			
#	Type	Title	Due
D1.y.z	Data	Provision of NRT surface observations to the Regional operational systems	Daily
D1.y.z-YYYYMMM	Report	Quarterly reports on the acquisition of NRT data from the EEA and the ACTRIS and EMEP programmes	2 months after each production quarter
D1.y.z	Data	Provision of interim surface observations to the Regional operational systems	Daily
D1.y.z-YYYYMMM	Report	Quarterly reports on the acquisition of interim data from the EEA and the ACTRIS and EMEP programmes	2 months after each production quarter
D1.y.z-YYYY	Data	Provision of validated surface observations to the Regional operational systems	Annually (3 months after release of Airbase by the EEA)
D1.y.z-YYYY	Report	Annual report on the acquisition of interim data from EEA and the ACTRIS and EMEP programmes	Annually (3 months after release of Airbase by the EEA)
...			

WP5010 Milestones Template			
#	Title	Means of verification	Due
M1.y.z		List here the milestones	
...			

3.4 Work package 5020 - Continuous model development

The Regional Systems must 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 short and medium-term development plans of the Regional Systems will especially focus on addressing items that will be provided by the successful Tenderer for the regional Research & Development component of CAMS (CAMS_61 ITT, comprising both modelling and data assimilation aspects) and by the successful Tenderer in charge of validation activities (CAMS_84 ITT). 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 will report on continual development activities for each single Regional System on a half-yearly basis.

The operational configuration of each of the Regional Systems will be changed only once a year and simultaneously, in principle during the month of November each year. The successful Tenderer will 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 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 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).

Besides the Regional Systems delivering the Regional Products operationally, it is encouraged to include activities in this workpackage that will target the qualification of up to two new candidate systems for operational use in CAMS. These optional activities will aim at extending the pool of European models that could be included in the future in the CAMS operational ensemble. In order to be eligible, the new candidate systems must be mature, well validated and operated by their main developers. The activities should cover mainly the adaptation of the new candidate systems to meet the general requirements described in section 3.1 and demonstrate - offline and then in real conditions - that performance (quality of the outputs and operational reliability) is comparable with the current Regional Systems.

Similarly, the CRPU will operate and further develop the methods and tools used to deliver the ensemble products. A multi-year development plan for central regional processing will be maintained and will form part of the CAMS Service Evolution Strategy document. For the short and medium-term horizons, the plan will especially integrate the elements provided by the successful Tenderer of ITT CAMS_63 (ensemble methods). 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 will report on continual development activities for the regional central processing system on a half-yearly basis.

The operational configuration of CAMS Regional ensemble processing will be changed on an ad hoc basis and in any case less frequently than once a year and subject to approval by ECMWF. The successful Tenderer will 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. 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).

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

WP5020 Deliverables Template			
#	Type	Title	Due
D2.y.z.{model}-YYYYS1/S2	Report	Half-yearly reports on the development activities of each of the operational Regional Systems, {model} being one of the 8 to 10 operational models	End of February and end of August each year
D2.y.z.{model}-YYYYS2	Note	Note confirming the status of the development milestones planned for YYYYS2 for each of the operational Regional Systems, {model} being one of the 8 to 10 operational models	End of December each year
D2.y.z.{model}	Report	Update of the documentation of each the Regional Systems, {model} being one of the 8 to 10 operational models	With each change of operational configuration

D2.y.z.{new_model}-YYYYS1/S2	Report	(Optional) Half-yearly reports on the development activities of each of the candidate Regional Systems, {new_model} being one of the new model(s)	End of February and end of August each year
D2.y.z.{new_model}-YYYYS2	Note	Note confirming the status of the development milestones planned for YYYYS2 for each of the candidate Regional Systems, {new_model} being one of the new model(s)	End of December each year
D2.y.z.ENSEMBLE-YYYYS1/S2	Report	Half-yearly reports on the development activities of the ENSEMBLE Regional System	End of February and end of August each year
D2.y.z.ENSEMBLE-YYYYS2	Note	Note confirming the status of the development milestones planned for YYYYS2 for the ENSEMBLE Regional System	End of December each year
D2.y.z.ENSEMBLE	Report	Update of the documentation of the CAMS Regional ENSEMBLE	With each change of operational configuration of the CAMS Regional ENSEMBLE
...			

WP5020 Milestones Template			
#	Title	Means of verification	Due
M2.y.z		List here the development milestones for the first calendar year of the contract	
M2.y.z.{model}	Operational upgrade of the Regional System {model}	Email sent to the users informing of completion of the operational upgrade	At each operational upgrade
M2.y.z.ENSEMBLE	Operational upgrade of the Regional System {model}	Email sent to the users informing of completion of the operational upgrade	At each operational upgrade
...			

3.5 Work package 5030 - Distributed regional production

The eight to ten Regional Systems selected by the successful Tenderer will deliver numerical outputs to the CRPU. For each, the data streams will have the following characteristics:

- 2 formats available: GRIB2 and NetCDF;
- model outputs are made available over the area defined in section 3.1;
- model outputs are provided for at least eight vertical levels: surface, 50m, 250m, 500m, 1000m, 2000m, 3000m and 5000m above ground;
- at the start of the contract, the model parameters 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) and, during the relevant part of the year, birch, olive, grass and ragweed pollens;
- 12 months after the start of the contract, add the five following aerosol parameters: total mineral dust, total biomass burning, PM₁₀ fraction of anthropogenic combustion primary production, PM_{2.5} fraction of anthropogenic combustion primary production, PM_{2.5} fraction of secondary organic production.

3.5.1 Task 5031: Daily Near-Real-Time (NRT) European air quality analyses

The successful Tenderer will provide analyses with a temporal resolution of one hour for the past day (0h to 24h) and for each of the individual regional systems, using the “NRT data” compiled under Work package 5010 (see 3.3). 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 chemically-related species on that parameter is marginal.

Analyses based on “NRT data” will be made available daily to the users by the CRPU not later than 12 UTC. The successful Tenderer has to make the necessary arrangements so that individual production of the analyses, dissemination to the CRPU and ensemble processing (see 3.5) allows for meeting this target.

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 will be used to produce a short note with the time of delivery of the daily analyses two weeks after the end of each quarter. This record will also be used for the quarterly Evaluation and Quality Assurance (EQA) dossiers (see Workpackage 5050) in order to inform the users about the production of the analyses (percentages, reasons for delays or failures) and about the NRT data that has been assimilated in the different individual Regional Systems.

3.5.2 Task 5032: Daily European air quality forecasts

The successful Tenderer will provide daily 96-hour air quality forecasts with a temporal resolution of one hour based from 00 UTC for the above-mentioned pollutants and for each of the individual Regional Systems. Initially, the forecasts for chemical variables are allowed to be initialised by the 24-hour forecast of the previous day for the same system and not from analyses because of challenging timeliness requirements. Should timeliness of NRT data acquisition permit, it is encouraged that the Regional Systems use analyses to initialise the forecasts as long as it is the case for all the individual systems.

Forecasts will be made available daily to the users by the CRPU not later than 08 UTC (0-48h) and 10 UTC (49-96h). The successful Tenderer has to make the necessary arrangements so that individual production of the forecasts, dissemination to the CRPU and ensemble processing allows for meeting this target.

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. It will be used to produce a short note with the time of delivery of the daily forecasts two weeks after the end of each quarter. This record will also be used for the quarterly Evaluation and Quality Assurance (EQA) dossiers (see Workpackage 5050) in order to inform the users about the production of the forecasts (percentages, reasons for delays or failures...).

3.5.3 Task 5033: European air quality interim re-analyses

The successful Tenderer will provide interim re-analyses 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 Workpackage 5010. 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 chemically-related species on that parameter is marginal.

Interim re-analyses based on “Interim data” will 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 will be kept of the data effectively assimilated for each day of the year. The successful Tenderer will use it to produce a detailed analysis of the interim data effectively assimilated in each of the operational systems in the Evaluation and Quality Assurance (EQA) report associated with each year's interim reanalysis (see Workpackage 5050).

It is emphasised here that the complete numerical datasets (all species and all vertical levels as defined in the introduction of section 3.5) are required by the users. By exception, it is acceptable to deliver only surface values for the interim reanalysis for 2018 (to be delivered in 2019). For the interim reanalysis for 2019 and subsequent years, all the vertical levels must be provided; in particular, provision for the production during 2019 must be organised by the successful Tenderer in order to be able to deliver the full dataset of the interim reanalysis for 2019 (in 2020).

3.5.4 Task 5034: European air quality re-analyses

The successful Tenderer will provide re-analyses 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 5010. 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 chemically-related species on that parameter is marginal.

Re-analyses based on "Validated data" will be made available to the users by the CRPU not later than four months after data has been made available by the EEA in Airbase 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 will be kept of the data effectively assimilated for each day of the year. The successful Tenderer will use it to produce a detailed analysis of the validated data effectively assimilated in each of the operational systems in the Evaluation and Quality Assurance (EQA) report associated with each year's reanalysis (see Workpackage 5050).

It is emphasised here that the complete numerical datasets (all species and all vertical levels as defined in the introduction of section 3.5) are required by the users. In particular, provision for the production during 2019 must be organised by the successful Tenderer in order to be able to deliver the full dataset of the reanalysis of 2017 (and similarly in subsequent years).

3.5.5 Deliverables and milestones

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

WP5030 Deliverables Template			
#	Type	Title	Due
D3.y.z.{model}	Data	Provision of individual NRT analyses from each of the operational systems	Daily (before 12 UTC)
D3.y.z-YYYYQX	Note	Log of daily provision of NRT analyses covering all the operational systems (and including time stamps)	Quarterly, 2 weeks after the end of each quarter

D3.y.z.{model }	Data	Provision of individual forecasts (up to 96h) from each of the operational systems	Daily (before 08 UTC for D and D+1; before 10 UTC for D+2 and D+3)
D3.y.z.-YYYYQX	Note	Log of daily provision of forecasts for all the operational systems (including time stamps for D, D+1, D+2 and D+3)	Quarterly, 2 weeks after the end of each quarter
D3.y.z.{model }-YYYY	Data	Provision of the annual interim reanalysis for Year N from each of the operational systems	End of February of Year N+1
D3.y.z.-YYYY	Note	Log of the delivery of the interim reanalysis for Year N for all the operational systems	End of February of Year N+1
D3.y.z.{model }-YYYY	Data	Provision of the annual reanalysis for Year N-1 from each of the operational systems	During Year N+1, no later than 4 months after 'validated' observations for Year N-1 have been released by the EEA
D3.y.z.-YYYY	Note	Log of the delivery of the annual reanalysis for Year N-1 for all the operational systems	During Year N+1, no later than 4 months after 'validated' observations for Year N-1 have been released by the EEA
...			

WP5030 Milestones Template			
#	Title	Means of verification	Due
M3.y.z		List here the milestones	
...			

3.6 Work package 5040 - Centralised regional production

The Central Regional Production Unit will process the input from individual Regional Systems and prepare ensemble products based on that input (Workpackage 5030). Output data will be made available to the users and will have the following characteristics:

- 2 formats available: GRIB2 and NetCDF;
- outputs are made available over the area defined in section 3.1, with a horizontal resolution of 0.1°;
- outputs are provided for at least eight vertical levels: surface; 50m, 250m, 500m, 1000m, 2000m, 3000m and 5000m above ground;
- at the start of the contract, the model parameters 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) and, during the relevant part of the year, birch, olive, grass and ragweed pollens;
- 12 months after the start of the contract, add the five following aerosol parameters: total mineral dust, total biomass burning, PM₁₀ fraction of anthropogenic combustion primary production, PM_{2.5} fraction of anthropogenic combustion primary production, PM_{2.5} fraction of secondary organic production.

3.6.1 Task 5041: Daily European air quality ensemble analyses

The successful Tenderer, through the CRPU, will process (acquisition, quality control, re-gridding to output grid, formatting) the individual NRT analyses produced by Task 5031 and provide ensemble NRT analyses with a temporal resolution of one hour for the past day (0h to 24h). All parameters shall be provided, even if no observation is assimilated for a certain parameter or if the impact of the assimilation of other chemically-related species on that parameter is marginal. The methodology employed initially will 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 will be used to estimate uncertainties, which are required by the users. This methodology might be changed later based on activities of the dedicated contract CAMS_63 and in Workpackage 5020.

Individual and ensemble analyses based on “NRT data” will be made available daily to the users by the CRPU not later than 12 UTC.

A detailed record will be kept of the completeness and time of delivery of the ENSEMBLE NRT analyses. It will be used to produce a short note with the time of delivery of the daily ENSEMBLE NRT analyses two weeks after the end of each quarter. This record will also be used for the quarterly Evaluation and Quality Assurance (EQA) dossiers (see Workpackage 5050) in order to inform the users about the production of the ENSEMBLE NRT analyses (percentages, reasons for delays or failures...).

3.6.2 Task 5042: Daily European air quality ensemble forecasts

The successful Tenderer, through the CRPU, will process (acquisition, quality control, re-gridding to output grid, formatting) the individual forecasts produced by Task 5032 and provide daily 96-hour air quality forecasts with a temporal resolution of one hour for all the above-mentioned parameters. The methodology employed initially will 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 will be used to estimate uncertainties, which are required by the users. This methodology might be changed later based on activities of the dedicated contract CAMS_63 and in Workpackage 5020.

A detailed record will be kept of the data effectively delivered each day and the timeliness of the delivery for the four forecast days. It will be used to produce a short note with the time of delivery of the daily ENSEMBLE forecasts two weeks after the end of each quarter. This record will also be used for the quarterly Evaluation and Quality Assurance (EQA) dossiers (see Workpackage 5050) in order to inform the users about the production of the ENSEMBLE forecasts (percentages, reasons for delays or failures...).

3.6.3 Task 5043: European air quality ensemble interim re-analyses

The successful Tenderer, through the CRPU, will process (acquisition, quality control, re-gridding to output grid, formatting) the individual interim re-analyses produced by Task 5033 and provide ensemble interim re-analyses for the past year with a temporal resolution of one hour. The methodology employed initially will 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 will be used to estimate uncertainties, which are required by the users. This methodology might be changed later based on activities of the dedicated contract CAMS_63 and in Workpackage 5020.

Individual and ensemble interim re-analyses based on “Interim data” will be made available to the users by the CRPU not later than at the end of February each year for the entire previous year.

A record of the data effectively delivered regarding each annual ENSEMBLE interim reanalysis will be kept. The successful Tenderer will use it to produce the Evaluation and Quality Assurance (EQA) report associated with each year's interim reanalysis (see Workpackage 5050).

It is emphasised here that the complete numerical datasets (all species and all vertical levels as defined in the introduction of section 3.5) are required by the users. All the parameters shall be provided, even if no observation is assimilated for a certain parameter or if the impact of the assimilation of other chemically-related species on that parameter is marginal. By exception, it is acceptable to deliver only surface values for the interim reanalysis for 2018 (to be delivered in 2019). For the interim reanalysis for 2019 and subsequent years, all the vertical levels must be provided; in particular, provision for the production during 2019 must be organised by the successful Tenderer in order to be able to deliver the full dataset of the interim reanalysis for 2019 (in 2020).

3.6.4 Task 5044: European air quality ensemble re-analyses

The successful Tenderer, through the CRPU, will process (acquisition, quality control, re-gridding to output grid, formatting) the individual re-analyses produced by Task 5034 and provide ensemble re-analyses for each past year based with a temporal resolution of one hour. The methodology employed initially will 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 will be used to estimate uncertainties, which are required by the users. This methodology might be changed later based on activities of the dedicated contract CAMS_63 and in Workpackage 5020.

Individual and ensemble re-analyses based on "Validated data" will be made available to the users by the CRPU not later than four months after data has been made available by the EEA in Airbase for a given past year.

A record of the data effectively delivered regarding each annual ENSEMBLE reanalysis will be kept. The successful Tenderer will use it to produce the Evaluation and Quality Assurance (EQA) report associated with each year's reanalysis (see Workpackage 5050).

It is emphasised here that the complete numerical datasets (all species and all vertical levels as defined in the introduction of section 3.5) are required by the users. All the parameters shall be provided, even if no observation is assimilated for a certain parameter or if the impact of the assimilation of other chemically-related species on that parameter is marginal. In particular, provision for the production during 2019 must be organised by the successful Tenderer in order to be able to deliver the full dataset of the ENSEMBLE reanalysis of 2017 (and similarly in subsequent years).

3.6.5 Deliverables and milestones

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

WP5040 Deliverables Template			
#	Type	Title	Due
D4.y.z	Data	Provision of ENSEMBLE NRT analyses	Daily (before 12 UTC)

D4.y.z-YYYYQX	Note	Log of daily provision of ENSEMBLE NRT analyses (and including time stamps)	Quarterly, 2 weeks after the end of each quarter
D4.y.z	Data	Provision of ENSEMBLE forecasts (up to 96h)	Daily (before 08 UTC for D and D+1; before 10 UTC for D+2 and D+3)
D4.y.z-YYYYQX	Note	Log of daily provision of ENSEMBLE forecasts (including time stamps for D, D+1, D+2 and D+3)	Quarterly, 2 weeks after the end of each quarter
D4.y.z-YYYY	Data	Provision of the annual ENSEMBLE interim reanalysis for Year N	End of February of Year N+1
D4.y.z-YYYY	Note	Log of the delivery of the annual ENSEMBLE interim reanalysis for Year N	End of February of Year N+1
D4.y.z-YYYY	Data	Provision of the annual ENSEMBLE reanalysis for Year N-1	During Year N+1, no later than 4 months after 'validated' observations for Year N-1 have been released by the EEA
D4.y.z-YYYY	Note	Log of the delivery of the annual ENSEMBLE reanalysis for Year N-1	During Year N+1, no later than 4 months after 'validated' observations for Year N-1 have been released by the EEA
...			

WP5040 Milestones Template			
#	Title	Means of verification	Due
M4.y.z		List here the milestones	
...			

3.7 Work package 5050 - Evaluation and Quality Assessment (EQA)

EQA activities as part of this ITT correspond to the systematic evaluation of the quality of the Regional Products against independent surface air quality observations using a set of defined metrics. The successful Tenderer will set up verification procedures for the Regional Products (forecasts, analyses and reanalyses) for which there are observations available to compare with.

These procedures will initially follow the ones that have been set up in CAMS and for which Table 1 synthesises the main characteristics. Additional metrics defined by the FAIRMODE programme led by the JRC will be added during 2019, with detailed implementation to be discussed between ECMWF and the successful Tenderer during the negotiations.

Metrics	Bias, Normalized Modified Mean Bias (NMMB), Root Mean Square Error (RMSE), Correlation (CORR) and Fractional Gross Error (FGE)
Species (surface concentrations)	O ₃ , NO ₂ , SO ₂ , CO, PM ₁₀ and PM _{2.5}
Data streams (surface)	Individual and ensemble NRT analyses (see 3.5.1 and 3.6.1), individual and ensemble forecasts (see 3.5.2 and 3.6.2), individual and ensemble interim re-analyses (see 3.5.3 and 3.6.3) and individual and ensemble re-analyses (see 3.5.4 and 3.6.4)

Table 1: Main characteristics of the initial regional EQA

The successful Tenderer will compute the statistical skill scores by comparing the above-mentioned data streams interpolated at each measurement site with corresponding observational data acquired as part of Work package 5010:

- Individual and ensemble NRT analyses and forecasts will be verified against “NRT data”;
- Individual and ensemble interim re-analyses will be verified against “Interim data”;
- Individual and ensemble re-analyses will be verified against “Validated data”.

The successful Tenderer will make clear if the observational data is fully independent (not been used in data assimilation) or not.

The successful Tenderer will develop a strategy to present all these statistical scores in a meaningful, comprehensive and user-friendly way. The successful Tenderer will consider especially evolving user requirements as well as user feedback to further develop the verification products.

For the four data streams, results will be presented in the form of verification reports.

In the case of the NRT analyses and forecasts, verification reports will be delivered quarterly and will cover the periods, called hereafter “Production Quarters”: September-October-November (SON); December-January-February (DJF); March-April-May (MAM); June-July-August (JJA). They will be made available not later than two months after the end of each period.

In the case of the interim re-analyses and of the re-analyses, verification reports will be made available for each year not later than two months after the numerical product has been delivered. A companion numerical dataset will also be provided every quarter with the reports, detailing the corresponding quarterly statistics for all the pollutants and all the observational sites used.

In the case of the NRT analyses and forecasts, the successful Tenderer will develop specific daily-updated statistics and graphics for the past day, the past week and the past 3 months. This will be targeted at giving insight into the difference in performance between the individual members and the ensemble, the different European geographical areas as well as a function of the forecast horizon and of local time. These graphics shall either be hosted on the CAMS web site or in a single comprehensive web-based system, which can be embedded in the CAMS web site, producing daily verification graphics.

In addition, the successful Tenderer will develop a web-based visualisation tool for giving insight on the ensemble and individual Regional Systems’ performance over past quarters (at least the 8 last quarters) for all the observed pollutants and for all the sites considered in the corresponding verification reports. This system should be based on the same statistics as the published quarterly verification reports (and their companion numerical datasets). It should be presented in the form of a zoom-able geographical map, allowing users selecting sites and obtaining the statistics and/or graphics corresponding to their selection.

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

WP5050 Deliverables Template			
#	Type	Title	Due
D5.y.z.{model}-YYYYMMM	Report	Quarterly reports on the verification of NRT forecasts and analyses, for each of the operational systems ({model})	2 months after each production quarter
D5.y.z.ENSEMBLE-YYYYMMM	Report	Quarterly reports on the verification of NRT forecasts and analyses, for the ENSEMBLE	2 months after each production quarter
D5.y.z-YYYYMMM	Data	Companion numerical dataset (detailed performance statistics) of the quarterly reports on the verification of NRT forecasts and analyses, for each operational model and the ENSEMBLE	2 months after each production quarter
D5.y.z-YYYY	Report	Annual report on the verification of the interim reanalysis for Year N (ENSEMBLE and individual operational systems)	At the end of May of Year N+1
D5.y.z-YYYY	Data	Companion numerical dataset (detailed performance statistics) of the verification of the interim reanalysis for Year N (ENSEMBLE and individual operational systems)	At the end of May of Year N+1
D5.y.z-YYYY	Report	Annual report on the verification of the reanalysis for Year N-1 (ENSEMBLE and individual operational systems)	During Year N+1, no later than 7 months after 'validated' observations for Year N-1 have been released by the EEA
D5.y.z-YYYY	Data	Companion numerical dataset (detailed performance statistics) of the verification of the reanalysis for Year N-1 (ENSEMBLE and individual operational systems)	During Year N+1, no later than 7 months after 'validated' observations for Year N-1 have been released by the EEA
D5.y.z	Online graphics	Verification plots for the past day, past week and past 3 months	Updated daily
D5.y.z	Online system	Presentation of NRT analyses and forecasts site-level verification statistics for the past 8 quarters (ENSEMBLE and individual operational systems)	01/10/2019
...			

WP5050 Milestones Template			
#	Title	Means of verification	Due
M5.y.z		List here the milestones	
...			

3.8 Work package 5060 - Data services for Regional Products

It is required that the Regional Products will be delivered to the ECMWF Copernicus Data Store (CDS). It is expected that the transition to the CDS will take place in 2018 and first half of 2019. While the CDS is under development, ECMWF and the successful Tenderer will agree during negotiations on an interim solution to continue seamless delivery of all the Regional Products to the users. Note that the requirements in the remainder of section 3.8 will strictly apply only when the CDS is fully implemented.

The CDS has been designed as a distributed system that provides access to datasets and tools through a unified web interface. A general description of the design and functionality can be found in Raoult et al. (2017)¹.

The successful Tenderer will make the Regional Products available through:

- a dedicated data server, which will form part of the CAMS CDS (see 3.8.2).
- a single comprehensive web-based system that will present a range of maps and graphics (including verification results produced by workpackage 5050) covering a selection of the products; special focus is expected to be put on the daily NRT analyses and forecasts.

The successful Tenderer will describe the technical solution proposed. It is encouraged that the web-based system presenting graphical outputs and the data server solution are as integrated as possible for ease-of-use for the users.

All Regional Products delivered as part of CAMS (NRT analyses, forecasts, interim reanalyses and reanalyses) shall be made available to the users, although it is acceptable that the graphics and numerical data available online only cover a selection of them based especially on most recent and most used criteria. The successful Tenderer will describe the archival strategy and the level of service offered for elements which are not available online and must be retrieved from archive.

3.8.1 Dataset registration

Dataset suppliers to the CDS shall provide a comprehensive description of their datasets at least two months prior to delivery, using a dataset registration process established by ECMWF. Details of the registration process, which serves to collect all CDS relevant information (to define metadata, user forms and necessary adaptors) will be provided to the preferred bidder during negotiation.

3.8.2 Access methods

Data access to CAMS data products, ancillary data and metadata, can be implemented in the CDS distributed infrastructure either by:

- (a) **Push mode:** uploading datasets to a designated ECMWF CDS server.

ECMWF will not accept data in push mode if the initial volume exceeds 1 TB or if the annual increase in volume exceeds 0.5 TB. Upper bounds on data volume are subject to change and may be negotiable in exceptional circumstances.

- (b) **Pull mode:** providing datasets via web services.

ECMWF has a strong preference for pull mode, which is consistent with the distributed architecture of the CDS and simplifies management of access, traceability and updates of an evolving data collection. However, the master copies of the Deliverables must be stored and archived only in places where the Copernicus Regulation and related delegation legislation such as the Copernicus Data Policy can be enforced during the full duration of the Framework Agreement.

ECMWF strongly recommends use of the OPeNDAP protocol to implement pull mode. Tenderers who are not able to do so are requested to explain this in their bids.

¹ Raoult, B., C. Bergeron, A. López Alós, J-N. Thépaut, D. Dee, 2017: Climate service develops user-friendly data store. ECMWF Newsletter No. 151, 22-27. Available at <https://www.ecmwf.int/sites/default/files/elibrary/2017/17181-newsletter-no-151-spring-2017.pdf>

3.8.3 Use of standards

ECMWF will only accept service protocols that follow internationally recognised standards. Such standards must be open (i.e. non-proprietary), managed by a recognised international standardization 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 data and products if they implement very simple protocols (e.g. REST), as long as the results returned by these APIs are compatible with the results of a dataset upload via push mode. It should be noted that requests for these web services will mostly originate from the CDS 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.

3.8.4 Data formats

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 standardization body (e.g. ISO, WMO, OGC, etc.), or any de-facto standard. Open source software that can read and write files following these standards must be available. Serialization 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 CDS catalogue.

ECMWF strongly recommends that datasets be encoded in NetCDF according to the recommendations described in the “*ECMWF metadata recommendations for NetCDF*” document, available at <https://software.ecmwf.int/wiki/display/DGOV/ECMWF+Convention>. Tenderers who are not able to do so are requested to explain this in their bids.

3.8.5 Data ownership

It is a condition of EU funding for CAMS that ownership of any Deliverable (including datasets and their documentation) developed with CAMS funding passes from the suppliers to the EC, via ECMWF. Ownership will pass on delivery of the Deliverable. In return, the suppliers will be granted a non-exclusive licence to use the Deliverable which they have provided to CAMS for any purpose except one which conflicts with the aims of CAMS.

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 Tenderer's production system. The identity and ownership of such exceptional components will be passed to the EC via ECMWF annually, but in return the successful Tenderer will be granted a non-exclusive licence to use them for any purpose except one which conflicts with the aims of CAMS.

Pre-existing Technology, foreseen Assets, and Integrated Technology (as defined in Framework Agreement Clause 3) shall also be described in the proposal, following the template below

Pre-existing Technology		
Title	Type	Description
...		
Assets (tangible and intangible)		

<i>Title</i>	<i>Type</i>	<i>Description</i>
...		
Integrated Technology		
<i>Title</i>	<i>Type</i>	<i>Description</i>
...		

3.8.6 Deliverables and milestones

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

WP5060 Deliverables Template			
<i>#</i>	<i>Type</i>	<i>Title</i>	<i>Due</i>
D6.y.z-analyses	Service	NRT analyses (Regional Systems and CAMS ensemble) available in CDS	Start as early as possible and not later than June 2019, then continuous
D6.y.z-forecasts	Service	Forecasts (Regional Systems and CAMS ensemble) available in CDS	Start as early as possible and not later than June 2019, then continuous
D6.y.z-interimreanalyses	Service	Annual Interim reanalyses for the last 3 years (Regional Systems and CAMS ensemble) available in CDS	Start as early as possible and not later than June 2019, then continuous
D6.y.z-reanalyses	Service	Annual Reanalyses since 2010 (Regional Systems and CAMS ensemble) available in CDS	Start as early as possible and not later than June 2019, then continuous
D6.y.z-YYYYQX	Report	Quarterly report on the delivery of CAMS Regional Products (uptime statistics of data servers, explanations for issues, volume and number of files served...)	Quarterly
D6.y.z-web	Web pages	Web-based graphics on Regional Products and their verification	From the start of the contract, continuous
D6.y.z-YYYYQX	Report	Quarterly report on the delivery of web-based graphics on Regional Products and their verification (delivery statistics, explanations for issues, if applicable number of visits and unique visits...)	Quarterly
...			

WP5060 Milestones Template			
<i>#</i>	<i>Title</i>	<i>Means of verification</i>	<i>Due</i>
M6.y.z		List here the milestones	
M6.y.z-analyses	NRT analyses (Regional Systems and CAMS ensemble) start being available in CDS	Users can discover, plot, process and retrieve corresponding data in the CDS infrastructure	Before end of June 2019

M6.y.z-forecasts	Forecasts (Regional Systems and CAMS ensemble) start being available in CDS	Users can discover, plot and retrieve corresponding data in the CDS infrastructure	Before end of June 2019
M6.y.z-interimreanalyses	Interim reanalyses (Regional Systems and CAMS ensemble) start being available in CDS	Users can discover, plot and retrieve corresponding data in the CDS infrastructure	Before end of June 2019
M6.y.z-reanalyses	NRT analyses (Regional Systems and CAMS ensemble) start being available in CDS	Users can discover, plot and retrieve corresponding data in the CDS infrastructure	Before end of June 2019
...			

3.9 Work package 5070 - User support

The objective of this work package is to provide specialised support to users of the Regional Products.

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 CAMS Service Desk is used for ticketing user requests and distributing these requests to specialists as needed. Dedicated staff at ECMWF provide basic support in the form of self-help facilities (FAQs, knowledge bases, tutorials etc.) as well as individualised support on technical queries related to the CDS, data formats, data access etc. In addition, ECMWF staff provide specialised scientific support to address questions related to its industrial contributions to CAMS, e.g. in the areas of global forecasting of atmospheric composition.

All CAMS contractors are expected to contribute to the delivery of multi-tiered technical support for the data and/or services they provide. Such specialised user support shall take the form of direct response to individual user queries via the CAMS Service Desk facility, as well as contributions to FAQs, user guides and knowledge bases.

As part of the bid, Tenderers shall describe the level of user support service on CAMS Service Desk tickets they can provide. Tenderers shall also address development of user guides. Documentation of the CAMS services is an integral part of the service provision. The technical and scientific specification of each service shall be documented in reports that will be available to users through the CAMS web site. The successful Tenderer shall therefore produce documentation reports describing in detail the methodologies and products it delivers for this ITT.

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

WP5070 Deliverables Template			
#	Type	Title	Due
D7.y.z-YYYY	Other	Specialised user support via the CAMS Service Desk (Respond to user support queries requiring expertise specific to the Greenhouse gas flux products provided)	Continuous
D7.y.z-v1	Report	Report on Specialised User Support during Period 1	At Payment milestone 1
D7.y.z-v2	Report	Report on Specialised User Support during Period 2	At Payment milestone 2
...			

WP5070 Milestones Template			
#	Title	Means of verification	Due
M7.y.z	Link with CAMS User Support team established; service desk set-up completed	Specialised Service Desk up and running	Month 2
...			

4 General Requirements

4.1 Implementation schedule

The Framework Agreement will run from 1 October 2018 to 31 December 2021. The Tenderer shall provide a detailed implementation plan of proposed activities for the period until 30 June 2021. However, note that by Q4 2019 the level and duration of activities for the full year of 2021 will be communicated by ECMWF to the successful Tenderer based on the Copernicus programme review by the European Commission.

4.2 Deliverables and milestones

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

All contract reports shall be produced in English. The quality of reports and deliverables shall be equivalent to the standard of peer-reviewed publications and practice. Unless otherwise specified in the specific contract, deliverables shall be made available to ECMWF in electronic format (PDF/Microsoft Word/Microsoft Excel or compatible) via the Copernicus Deliverables Repository portal.

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

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

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

4.3 Communication

The successful Tenderer shall support ECMWF in its communication activities for the CAMS services, where they are related to the activities described in this ITT. Examples are contributions to the Copernicus State of the Climate report, CAMS web site news items, and CAMS brochures and flyers.

4.4 User Requirements

As part of CAMS, the four documents described below will be maintained. The successful Tenderer shall provide input to the User Requirements Database (URDB) regarding user requirements that are directly related to activities covered by this ITT. The successful Tenderer shall also support ECMWF and the contractor for CAMS_94 (User Interaction) with the analysis of relevant user requirements in the URDB. Finally, in case the successful Tenderer provides service elements that are listed in the

Service Product Portfolio (SPP), the successful Tenderer shall provide input on product lines and their metadata to ECMWF to ensure the SPP is up-to-date.

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

User requirements are collected in this database in a structured and traceable way, and links to entries in the Service Product Portfolio (see below) are provided, when appropriate. The URDB, which tracks all requirements emanating from a wide variety of user fora, surveys, and support panels, is complemented by a Requirements Analysis Document (RAD) which captures the stratification of user requirements per domain, importance and feasibility. The RAD constitutes the basis for distilling, filtering and translating user requirements into technical specifications for the Service. The URDB and RAD are maintained and continually updated by ECMWF and its contractor for CAMS_94 (User Interaction).

Service Product Portfolio (SPP)

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

Service Evolution Strategy (SES)

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

The following deliverables are thus to be added to the WP5000 and WP5070 deliverable lists:

WP5000 Deliverables Template			
#	Type	Title	Due
D0.y.z-YYYY	Report	Input to CAMS SPP - YYYY	Annually in September
...			

WP5070 Deliverables Template			
#	Type	Title	Due
D7.y.z-YYYY	Other	Input to CAMS URDB - YYYY	Checked by ECMWF annually in December
...			

4.5 Key performance indicators

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

- KPI1: Service availability
- KPI2: Products usage
- KPI3: Products quality
- KPI4: User support
- KPI5: User statistics
- KPI6: Service audience
- KPI7: User engagement
- KPI8: User satisfaction
- KPI9: Contracts
- KPI10: Deliverables
- KPI11: data usage

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

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

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

KPI #	KPI Title	Performance Target and Unit of Measure	Frequency of Delivery	Explanations / Comments
KPI_50.1.1	Data server uptime in latest Quarter	95%	Quarterly	
KPI_50.1.2	Web pages uptime in latest Quarter	95%	Quarterly	If applicable (in the case the successful Tenderer hosts webpages for presenting main outputs and their verification)
KPI_50.2.1	Volume of data downloaded by users in latest Quarter	(increase)	Quarterly	And/or similar metrics (number of files or of queries...)
KPI_50.2.2	Number of Regional Systems and Ensemble verification reports downloaded during the latest quarter	(increase)	Quarterly	

KPI_50.3.1	Production on time of NRT analyses and forecasts with all N operational models / with N-2 models in latest Quarter	90% / 98%	Quarterly	
KPI_50.3.2	Root-Mean Square Error of the daily maximum of the O ₃ concentration for NRT 1-day ENSEMBLE analyses / forecasts in latest Quarter	<16 / 18 µg.m ⁻³	Quarterly	
KPI_50.3.3	Root-Mean Square Error of the daily maximum of the NO ₂ concentration for NRT 1-day ENSEMBLE analyses / forecasts in latest Quarter	<22 / 25 µg.m ⁻³	Quarterly	
KPI_50.3.4	Root-Mean Square Error of the daily mean of the PM10 concentration for NRT 1-day analyses / forecasts in latest Quarter	<16 / 18 µg.m ⁻³	Quarterly	
KPI_50.3.5	Root-Mean Square Error of the daily mean of the PM2.5 concentration for NRT 1-day analyses / forecasts in latest Quarter	<16 / 18 µg.m ⁻³	Quarterly	
KPI_50.4.1	User Support ticket acknowledgement in latest Quarter	100% within 3 working days	Quarterly	
KPI_50.4.2	User Support ticket response in latest Quarter	85% within 3 working weeks	Quarterly	
KPI_50.4.3	Number of tickets in latest Quarter	(for information)	Quarterly	
KPI_50.5.1	Number of active unique users of the Regional Products during the quarter	(increasing)	Quarterly	
KPI_50.5.2	Number of active unique visitors to the web pages	(increasing)	Quarterly	If applicable (in the case the successful Tenderer hosts webpages for presenting main outputs and their verification)
KPI_50.8.1	User satisfaction regarding support	90% score 3/5 or above	Quarterly	

	brought or Regional Products in latest Quarter			
KPI_50.10.1	Deliverables delivered on time during last Quarter	100%	Quarterly	
KPI_50.11.1	Number of surface sites used for NRT production and verification of ozone / NO2 / PM10 / PM2.5	.../.../.../... (for information)	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 2: 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.