

ECMWF Copernicus Procurement

Invitation to Tender



Copernicus Atmosphere Monitoring Service

Volume II

Development of regional air quality
modelling and data assimilation aspects

ITT Ref: CAMS_61
ISSUED BY: ECMWF Administration Department Procurement Section
Date: 29 May 2019
Version: Final



Funded by the European Union

Implemented by



Table of Contents

1	Introduction	3
1.1	Definitions	3
2	Contract Summary	4
3	Technical Specification.....	4
3.1	General Requirements	5
3.2	Work package 6100 – Management and coordination	5
3.3	Work package 6110 – In-depth assessment of the CAMS Regional Systems to identify future development needs	7
3.4	Work package 6120 – Coupling of regional forecasts and analyses.....	9
3.5	Work package 6130 – Towards assimilation of observations from geostationary satellite sensors (Sentinel-4) to constrain concentrations and emissions of main pollutants.....	10
4	General Requirements	12
4.1	Implementation schedule	12
4.2	Deliverables and milestones	12
4.3	Acquisition of necessary data and observations	12
4.4	Communication.....	12
4.5	Price and payment specifications	13
5	Tender Format and Content	13
5.1	Page Limits	13
5.2	Specific additional instructions for the tenderer’s response.....	13
5.2.1	Executive Summary.....	13
5.2.2	Track Record	13
5.2.3	Quality of Resources to be Deployed.....	14
5.2.4	Technical Solution Proposed.....	14

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 various aerosol-weather feedbacks are prominent but often uncertain drivers of climate change. 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-live green-house gases. The composition of the troposphere and the associated deposition fluxes are major components of the biogeochemical cycles of carbon, nitrogen and sulphur and iron, which effect the land- and marine eco systems. Dust, smoke and volcanic aerosols affect the safe operation of transport systems and the availability of power from solar generation, the formation of clouds and rainfall, and the remote sensing by satellite of land, ocean and atmosphere.

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
- i) Anthropogenic and natural emissions for the global and European domains and global emissions from wildfires and biomass burning

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 successful Tenderer of the present ITT CAMS_50, Regional Production (Météo-France, France).

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

Regional Products: the outputs of analyses and forecasts from the regional CAMS data assimilation and forecasting systems, which are run by the Regional Service Provider. The Regional Products consist in the first place of real-time analyses and forecasts. The regional CAMS data assimilation and forecasting systems comprise seven (nine from mid-2019) individual systems as well as their model ensemble products. These analyses and forecasts are 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 nine (seven until the end of May 2019) individual regional air quality modelling and data assimilation systems that contribute to the operational delivery of the Regional Products.

2 Contract Summary

This ITT is about activities to evaluate and support further development of the modelling and data assimilation aspects of the CAMS Regional Systems, which consist of a geographically distributed ensemble of nine (seven until the end of May 2019) individual operational systems. The successful Tenderer shall critically assess the outputs from the different systems and deliver (essentially) data, routines and pieces of numerical code as well as memoranda and reports. The successful Tenderer shall also advise the providers of the regional production of CAMS and help define the corresponding development plans. The ITT targets organisations with considerable experience in the field of air quality modelling and data assimilation, who will be able to provide the abovementioned contributions for the continuous upgrade of the Regional Systems delivering the CAMS regional production.

3 Technical Specification

The successful Tenderer shall provide studies and developments, which either build on top of the raw outputs from the operational ensemble of CAMS Regional Systems or are based on one or more air quality modelling systems operated in the same configuration as the CAMS Regional Systems, as outlined in the General Requirements section below. The focus of the developments shall be:

- In-depth assessment of the inter-model differences between the Regional Systems and their performance against observations;
- Based on this assessment, provide a list of priority Regional System-specific and general Research & Development activities;
- Evaluate the benefit of basing regional forecasts on analyses of surface observations;

- Deliver modular “model-agnostic” elements for performing data assimilation of future Sentinel-4 observations in the Regional Systems and test these with actual Sentinel-5P observations;
- Propose and evaluate strategy for combined or intermittent assimilation procedures with atmospheric concentrations and emissions as control variables in the Regional Systems.

3.1 General Requirements

For work package 6110 and 6120, the successful Tenderer will work on the outputs (analyses, forecasts and reanalyses) from the nine Regional Systems. The Regional Systems share the following configuration commonalities for their inputs and outputs:

- Output available in two formats, GRIB2 and NetCDF;
- Output available with hourly temporal resolution;
- Domain covered is (25°W-45°E, 30°N-72°N¹);
- Horizontal resolution is 0.1° by 0.1°;
- Output available at eight vertical levels: surface, 50m, 250m, 500m, 1000m, 2000m, 3000m and 5000m above ground;
- Output available for the following observed species NO, NO₂, CO, SO₂, PM2.5, PM10, Dust Aerosol², Secondary Inorganic Aerosol² and, during the relevant part of the year, birch, olive, grass and ragweed pollens;
- Advection transport and physical processes in the Regional Systems are driven by ECMWF’s high-resolution operational meteorological forecasts (using the most recent available forecast), either directly in the case of chemistry-transport models or by means of nudging or similar techniques;
- The systems use chemical boundary conditions from the Real-Time Global Products provided by the Global Service Provider (aerosol, reactive gases and greenhouse gases - if accounted for) using the most recent available products;
- The systems use the same regional anthropogenic emissions dataset provided by CAMS;
- The systems use fire emissions from the CAMS Global Fire Assimilation System provided by the CAMS Global Service Provider;
- In the case of analyses or reanalyses, the observations assimilated are identical in all the systems.

The variability between the Regional Systems therefore comes solely from the formulation of resolved and subgrid-scale transport, as well as physical and chemical processes.

For work package 6130 and 6140, the successful Tenderer shall use one or more air quality modelling and data assimilation systems that can be configured using the above-mentioned commonalities. It is not required that the systems used for these activities are already involved in the CAMS regional production. Any regional air quality system can be used, as long as there is clear published evidence that it is state-of-the-art.

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

3.2 Work package 6100 – Management and coordination

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

¹ Initially 70°N. The extension to 72°N has occurred at the end of May 2019.

² Available since the end of May 2019.

- 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 (contents, use of ECMWF reporting templates for deliverables and reports (Microsoft Word), format, deliverable numbering and naming, typos...) should be made by the prime contractor (the successful Tenderer); 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).

Tenderers shall complete Volume III C as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume III C will be used by the Tenderer 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.

WP6100 Deliverables				
#	Responsible	Nature	Title	Due
D0.y.z-YYYYQQ ³	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

³ Deliverables (and Milestones) shall be numbered as per the following format DX.Y.Z (MX.Y.Z), where X is the WP number, Y is the task number and Z is the Deliverable (Milestone) number in this task. Deliverables delivered annually should be numbered DX.Y.Z-yyyy, where yyyy is the year the Deliverable refers to (e.g. DX.Y.Z-2016, DX.Y.Z-2017). Deliverables delivered quarterly should be numbered DX.Y.Z-yyyyQx, where yyyyQx is the quarter of the year the Deliverable refers to (e.g. DX.Y.Z-2016Q1, DX.Y.Z-2016Q2). The same numbering format shall be applied for Milestones. Continuous deliverables at higher frequency can be labelled in the same way as quarterly deliverables.

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-YYYY	Tenderer	Other	Preliminary financial form YYYY <i>YYYY being the Year n-1</i>	Annually on 15/01
D0.y.z	Tenderer	Report	Final 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 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

WP6100 Milestones				
#	Responsible	Title	Means of verification	Due
M0.y.z-YYYY	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-Px	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-YYYY	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 6110 – In-depth assessment of the CAMS Regional Systems to identify future development needs

CAMS operates an ensemble of air quality forecast systems to provide its regional air quality services. Transport and physical processes in the Regional Systems are driven by ECMWF's high-resolution operational meteorological forecasts, either directly in the case of chemistry-transport models or by means of nudging or similar techniques. The Regional Systems also use the same regional anthropogenic emissions (provided through the CAMS_81 contract) and fire emissions from the CAMS Global Fire Assimilation System (GFAS). Chemical boundary conditions are provided by the CAMS

Global Service Provider (aerosol, reactive gases and greenhouse gases - if accounted for). This means, therefore, that the differences between the Regional Systems therefore comes solely from the formulation of resolved and subgrid-scale transport, as well as physical and chemical processes in the various modelling systems. These forecast differences are operationally used to provide a forecast uncertainty based on the ensemble spread, most notably in the daily EPSGRAMS available from the CAMS website (<https://www.regional.atmosphere.copernicus.eu>). However, these inter-model differences can also be analysed to better understand the impact of various approximations and assumptions in the Regional Systems. Such an analysis can then provide recommendations for specific developments of each of the Regional Systems in order to improve the individual forecast skill.

In this work package, the successful Tenderer shall perform a detailed analysis of the differences between the CAMS Regional Systems and air quality observations for all available pollutants except pollen taking different elements into account such as:

- daily profiles, e.g. daytime versus night-time concentrations;
- week-day versus weekend-day concentrations;
- lead time of the forecasts (e.g., 1-day forecast versus 4-day forecast);
- vertical and horizontal patterns;

The analysis shall focus on two areas:

1. Identifying significant systematic errors of the regional model ensemble against the observations. In other words, identify situations (meteorological situation, time, pollutant, location) for which the ensemble distribution is shifted away from the observations. This analysis shall be carried out to identify common developments for all models.
2. Identifying situations (meteorological situation, time, pollutant, location) for which the spread of the ensemble is significantly large for all Regional Systems or for which one specific Regional System is consistently significantly different from the other Regional Systems. This analysis shall be carried out to identify model specific developments and provide an overview of possible causes of these differences.

The assessment shall be based on operational archived forecast data for all available CAMS Regional Systems and all available pollutants. Archived data since September 2018 shall be used and the successful Tenderer shall take advantage of the system upgrade at the end of May 2019 to explore the potential impact of changes in anthropogenic emissions on any systematic errors of the regional ensemble compared to observations.

Using the full assessment and also taking into account relevant user requirements from the CAMS User Requirement Data Base (URDB), which will be provided by ECMWF, the successful Tenderer shall provide a prioritised list of recommended model developments for each individual Regional System as well as for cross-cutting activities that can be applied to all Regional Systems. These recommended model developments should have a maximum estimated duration of 6 to 12 months and shall take into account feedback from the CAMS_50 Regional Systems development teams, which are each in charge of one of the operational ensemble member system.

Tenderers shall complete Volume III C as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume III C will be used by the Tenderer 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.

WP6110 Deliverables

#	Type	Title	Due
D1.y.z	Report	First detailed report on the assessment of each Regional System and the inter-model differences	M6
D1.y.z	Report	Second detailed report on the assessment of each Regional System and the inter-model differences	M12
D1.y.z	Report	Report with prioritised list of development recommendations (model aspects).	M18

WP6110 Milestones			
#	Title	Means of verification	Due
M1.y.z	Meeting with ECMWF and the development teams of the CAMS Regional Systems to discuss first report	Minutes of meeting	M6
M1.y.z	Meeting with ECMWF and the development teams of the CAMS Regional Systems to discuss 2 nd report	Minutes of meeting	M12
M1.y.z	Meeting with ECMWF and the development teams of the CAMS Regional Systems to discuss final report	Minutes of meeting	M18

3.4 Work package 6120 – Coupling of regional forecasts and analyses

The CAMS regional service element provides daily analyses and forecasts from an ensemble of air quality forecast systems. Short-term forecasts are merged with air quality observations through data assimilation to obtain an analysis that is the best possible estimate of the full 3-dimensional distribution of the various atmospheric pollutants. Ideally, this analysis is then used to initialize the daily forecast, but due to the current timeliness of European air quality observations and the timeliness required by the users (CAMS forecasts need to be available before 09UTC), the CAMS regional analyses and forecasts are currently uncoupled. This is possible, because air quality forecasts of near-surface concentrations are to a large extent forced by the emissions of the various pollutants and therefore less sensitive to the initial conditions. However, there is a risk that the forecasts can drift away from the observed concentrations for several days due to a single incidental poor forecast. Routinely using a well-constrained analysis as the initial condition for each daily forecast will avoid this problem in most cases, and this coupling of analyses and forecasts is therefore one of the foreseen developments of the CAMS Regional Systems.

In this work package, the successful Tenderer shall describe through an initial literature review the current understanding of the methodologies and benefits of using analyses as initial conditions for regional air quality models. Subsequently, using one or more mature regional air quality data assimilation and forecasting system(s), configured as described in Section 3.1, the successful Tenderer shall assess the improvement in forecast skill against independent air quality observations, when an analysis is used as initial conditions for the forecast. The assessment shall look at all pollutants and consider various air quality regimes (summer/winter, good/poor air quality, rural/industrial areas) as well as different forecast start times (00, 06, 12, 18) and lead times.

Tenderers shall complete Volume III C as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume III C will be used by the Tenderer 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.

WP6120 Deliverables			
<i>#</i>	<i>Type</i>	<i>Title</i>	<i>Due</i>
D2.y.z	Report	Literature review on the methodologies and benefits of coupling air quality forecasts and analyses	M3
D2.y.z	Report	Impact of coupling air quality forecasts with analyses	M12

WP6120 Milestones			
<i>#</i>	<i>Title</i>	<i>Means of verification</i>	<i>Due</i>
M2.y.z	Meeting with ECMWF to agree on testing protocol	Minutes of meeting	M4
M2.y.z			

3.5 Work package 6130 – Towards assimilation of observations from geostationary satellite sensors (Sentinel-4) to constrain concentrations and emissions of main pollutants

All the CAMS Regional Systems operationally assimilate observations from the European air quality surface networks to provide the daily analyses. Some of these Regional Systems are also exploring the use of satellite data to constrain the analysis. However, current polar-orbiting satellites only provide observations once a day and in clear-sky conditions and are therefore limited in use for regional air quality assimilation systems. With the foreseen launch of the new geostationary Sentinel-4 mission, the satellite observation capability for air quality is expected to drastically change. Sentinel-4 will provide observations of O₃ (Ozone), NO₂ (Nitrogen dioxide), SO₂ (Sulfur dioxide), HCHO (Formaldehyde) and aerosol optical depth for the European domain at a temporal resolution of about an hour and spatial resolution of about 8 km. With an expected launch date of 2023, it is now critical to start preparing the CAMS Regional Systems for this new important observational data stream.

The Sentinel-4 data will provide an unprecedented view of air quality over Europe. However, this new data stream will also come with new challenges:

- For most observed pollutants, Sentinel-4 will measure total column amounts with a vertical sensitivity that is depending on the pollutant, the pollutant concentration, the observed scene, time of the day, etc. This is very different from surface observations, which directly sample the pollutant concentrations in the air we breathe.
- The amount of data measured per day will be several orders of magnitude larger than the amount of surface observations currently used. Making effective use of these large amounts of observations is not straightforward.

- Most data assimilation methods need a careful estimation of both the model errors and the observation errors. Adding a dominant observational data source to the data assimilation system will require a careful assessment and balancing of these error estimates.

Using one or more mature regional air quality data assimilation and forecasting system(s), configured as described in Section 3.1, the successful Tenderer shall develop specific elements for the data assimilation of satellite data, taking into account the range of methods already used in the current CAMS regional systems, to address the new challenges arising from using geostationary satellite data in regional air quality systems as mentioned above. These developments shall be general enough that they can be applied to at least three of the CAMS regional air quality systems.

The developments shall be tested using satellite data from the polar-orbiting Sentinel-5p mission. While this mission does not provide the expected temporal resolution of Sentinel-4 data, it is representative of the expected accuracy and spatial resolution (and therefore data density). The satellite data shall be tested on top of the use of existing surface air quality observations. The Tenderer shall also indicate how they envisage extrapolation of the Sentinel-5p results to the use of Sentinel-4. The testing shall be done relative to an independent subset of surface air quality observations and the impact of using satellite data on both the analysis and forecast shall be analysed.

In addition to the developments above, the successful Tenderer shall also investigate the use of satellite observations, with a focus on the future Sentinel-4 mission, to estimate emissions as part of the data assimilation process. This study shall provide guidelines for further development outside the scope of this contract and shall also be in collaboration with the Global Service Provider, who is investigating emission estimation for the CAMS global forecasting system. The Tenderer shall provide a realistic research & development plan to make some clear progress on this topic. This R&D plan shall include a literature review.

Tenderers shall complete Volume III C as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume III C will be used by the Tenderer 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.

WP6130 Deliverables			
<i>#</i>	<i>Type</i>	<i>Title</i>	<i>Due</i>
D3.y.z	Report	Development plan for WP6130 R&D activities	M4
D3.y.z	Report	Progress report of WP6130 R&D activities	M12
D3.y.z	Report	Final report of WP6130 R&D activities	M18
D3.y.z	Report	Computer code for Regional Systems resulting from WP6130 R&D activities	M18

WP6130 Milestones			
<i>#</i>	<i>Title</i>	<i>Means of verification</i>	<i>Due</i>
M3.y.z	Meeting with ECMWF to agree on	Minutes of meeting	M3

	testing protocol		
M3.y.z			

4 General Requirements

4.1 Implementation schedule

The Framework Agreement will run from 1 November 2019 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 Q3 2020 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.

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.

4.2 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.

4.3 Acquisition of necessary data and observations

The Global Service Provider will provide access to meteorological data, chemical boundary conditions and emissions that are needed to run the air quality systems as part of this contract. The successful Tenderer shall acquire the required surface air quality observations from the EEA UTD portal (<http://discomap.eea.europa.eu/map/fme/AirQualityUTDExport.htm>) and the required Sentinel-5p satellite data from the ESA Sentinel Datahub (<https://www.sentinel-hub.com/>).

4.4 Communication

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

4.5 Price and payment specifications

The tendered price shall not exceed the price as indicated in Contract Notice and shall include the personal costs, travel expenses and other costs for all Work packages.

Payments shall be conducted on a **cost-reimbursement** basis. Payment milestones shall be aligned with the implementation milestones as proposed in the implementation plan.

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>	20 (Table 2 in Volume IIIB, the section on references, publications, patents and any pre-existing IPR are excluded from the page limit and have no page limit)
<i>Management and Implementation</i>	5 (excluding Table 4 and Table 5 in Volume IIIB) + 2 per each Work package description (Table 3 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 successful Tenderer shall also appoint a Service Manager, which will be its primary contact for contractual delivery and performance aspects.

5.2.4 Technical Solution Proposed

The Tenderer is expected to provide a short background to the proposed technical solution to demonstrate understanding of the solution proposed. This should include background of the Tenderer's understanding of CAMS and more specifically of the CAMS Regional Products, their application areas and the different categories of users to be served. This part should also identify the main areas of development that will help to better meet 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 description of the proposed technical solution shall be organized in individual tasks following the work package structure indicated above.