

# ECMWF Copernicus Procurement

## Invitation to Tender



# Copernicus Atmosphere Monitoring Service

## Volume II

Provision of global inversion-optimised  
greenhouse gas fluxes and concentrations

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## 1 Introduction

Some of today's most important environmental concerns relate to the composition of the atmosphere. Ozone distributions in the stratosphere influence the amount of ultraviolet radiation reaching the surface. In the troposphere, aerosols, ozone and other reactive gases such as nitrogen dioxide determine the quality of the air around us, affecting human health and life expectancy, the health of ecosystems and the fabric of the built environment. The variable abundance of the reactive gases changes the oxidation capacity of the atmosphere and controls therewith also the abundance of long-lived greenhouse gases. The composition of the troposphere and the associated deposition fluxes are major components of the biogeochemical cycles of carbon, nitrogen and sulphur and iron, which affect the land and marine eco systems. Dust, smoke and volcanic aerosols affect the safe operation of transport systems and the availability of power from solar generation, the formation of clouds and rainfall, and the remote sensing by satellite of land, ocean and atmosphere.

The increasing concentration of the greenhouse gases and the various aerosol-weather feedbacks are prominent but often uncertain drivers of climate change. In the wake of the agreement signed in Paris at the UNFCCC's 21st Conference of the Parties (COP-21) in December 2015, the need to monitor and to inform about the effectiveness of mitigation efforts for anthropogenic emissions of key greenhouse gases has become more acute and prominent. With its global coverage (or regional in the case of geostationary platforms), Earth Observation has a decisive role to play within such a monitoring system, complementing ground-based observations, "bottom-up" estimates of the emissions (included in official reporting) and atmospheric transport modelling.

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

Within its first phase (2015 – 2020, Cop1), the Service consolidated many years of preparatory research and development to deliver a range of operational services. In its second phase (2021 – 2028, Cop2), these services are further consolidated, improved and expanded to address all the existing and emerging societal needs related to the atmospheric environment. The CAMS service portfolio consists of the following service elements:

- a) Daily production of real-time analyses and forecasts of global atmospheric composition;
- b) Reanalyses providing consistent multi-annual global datasets of atmospheric composition with a stable model/assimilation system;
- c) Daily production of real-time European air quality analyses and forecasts with a multi-model ensemble system;
- d) Reanalyses providing consistent annual datasets of European air quality with a frozen model/assimilation system, supporting in particular policy applications;
- e) Products to support policy users, adding value to "raw" data products in order to deliver information products in a form adapted to policy applications and policy-relevant work;
- f) Solar and UV radiation products supporting the planning, monitoring, and efficiency improvements of solar energy production and providing quantitative information on UV irradiance for downstream applications related to health and ecosystems;

- g) Greenhouse gas atmospheric inversions for CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O net surface fluxes, allowing the monitoring of the evolution in time of these fluxes;
- h) Climate forcing from aerosols and long-lived (CO<sub>2</sub>, CH<sub>4</sub>) and shorter-lived (stratospheric and tropospheric ozone) agents;
- i) Anthropogenic and natural emissions, based on inventory data and modelling, for the global and European domains;
- j) Observation-based emission estimates of atmospheric pollutants for the global and European domains;
- k) Observation-based anthropogenic emission estimates of CO<sub>2</sub> and CH<sub>4</sub> for the global domain and emission hotspots.

This Invitation to Tender (ITT) is mainly targeting the CAMS service element described under item g) above.

## 2 Contract Summary

This ITT, entitled “Provision of global inversion-optimised greenhouse gas fluxes and concentrations”, is for providing quantitative estimates of net surface fluxes of greenhouse gases, which are key drivers of the Earth's climate evolution. Ground-based and now satellite remote-sensing observations allow these fluxes to be monitored. The data provided so far by CAMS have delivered time-series of CH<sub>4</sub>, CO<sub>2</sub> and N<sub>2</sub>O surface flux fields of high quality. The successful Tenderer shall extend the time-series, both forwards and backwards (as far as possible) in time, while maintaining their quality at the highest international standard. Periodically, the successful Tenderer will reprocess the whole period in order to reflect improvements in spatial resolution as well as in modelling and data assimilation techniques used for the atmospheric inversions. The documentation of associated errors and comparison with independent observations as well as with similar products that are produced outside of CAMS will also form part of the activities. Finally, specific developments shall be included to further improve the data products.

## 3 Technical Specification

### 3.1 General Requirements

The successful Tenderer shall provide flux estimates of CH<sub>4</sub>, CO<sub>2</sub> and N<sub>2</sub>O using state-of-the-art atmospheric inversion systems to continue the current service provision<sup>1</sup>.

The Tenderer shall define the proposed spatial and temporal resolution for the atmospheric inversions defined in the work packages below with the constraint that the detail and accuracy of the flux estimates shall be at least reflecting the performance of the current CAMS products on greenhouse gas fluxes as described in the Evaluation and Quality Control documents for the Supplementary Services on Greenhouse Gas Fluxes on the CAMS website<sup>2</sup>.

The successful Tenderer shall validate the flux estimates with independent observations and also participate in international coordination and intercomparison projects, such as the Global Carbon

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<sup>1</sup> <https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-greenhouse-gas-inversion?tab=overview>

<sup>2</sup> <https://atmosphere.copernicus.eu/supplementary-services>

Project<sup>3</sup>, Transcom<sup>4</sup>, the Regional Carbon Cycle Assessment and Processes (RECCAP2) from the Global Carbon Project<sup>5</sup>, and the North American Carbon Program<sup>6</sup>, to ensure the produced estimates are of high quality.

### 3.2 Work package 1 – Flux estimates of CO<sub>2</sub>

The successful Tenderer shall provide at least annually updated global flux estimates of CO<sub>2</sub> at a horizontal resolution of as close to 1° by 1° as possible. The successful Tenderer shall use an atmospheric inversion system with a proven track record to provide the flux estimates. The flux estimates shall be based on observations from international ground-based networks (e.g., the NOAA Earth System Research Laboratory archive and the World Data Centre for Greenhouse Gases archive) and satellite observations (e.g., GOSAT and OCO-2) on the condition that the accuracy of the observations is sufficient for providing competitive flux estimates. In the case of using satellite data products, the Tenderer shall indicate if these will be used in a combined atmospheric inversion or in separate parallel atmospheric inversions. Within the first year covered by this ITT, the successful Tenderer shall provide an initial atmospheric inversion covering at least the period 1979 – 2023, showing equal or better performance than the current CAMS CO<sub>2</sub> flux estimates. The Tenderer shall further propose a strategy for providing at least annually updated flux estimates, either by reanalysing the whole period or by carefully extending the existing period to include the latest set of available observations. In the latter case, the Tenderer shall indicate potential issues with consistency of the whole data set. The successful Tenderer shall also provide uncertainty estimates of all flux estimates and provide an Evaluation & Quality Control (EQC) report (using independent observations of atmospheric CO<sub>2</sub> and/or CO<sub>2</sub> fluxes) with each new release of the flux estimates.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

<b>WP1 Deliverables</b>			
<i>#</i>	<i>Type</i>	<i>Title</i>	<i>Due</i>
D1.X.Z-yyyy <sup>7</sup>	Data set	Observation-based flux estimates for CO <sub>2</sub> – Period at least 1979-2023	During first year
D.1.X.Z-yyyy	Report	Evaluation and Quality Control document for observation-based CO <sub>2</sub> flux estimates for the period 1979 - 2023	During first year

<sup>3</sup> <https://www.globalcarbonproject.org/index.htm>

<sup>4</sup> <https://www.ggmt2022.online/transcom-2022/>

<sup>5</sup> <http://www.globalcarbonproject.org/reccap/>

<sup>6</sup> <http://www.nacarbon.org/nacp/index.html>

<sup>7</sup> Deliverables (and Milestones) shall be numbered as per the following format DX.Y.Z (MX.Y.Z), where X is the WP number, Y is the task number and Z is the Deliverable (Milestone) number in this task. Deliverables delivered annually should be numbered DX.Y.Z-yyyy, where yyyy is the year the Deliverable refers to (e.g. DX.Y.Z-2016, DX.Y.Z-2017). Deliverables delivered quarterly should be numbered DX.Y.Z-yyyyQx, where yyyyQx is the quarter of the year the Deliverable refers to (e.g. DX.Y.Z-2016Q1, DX.Y.Z-2016Q2). The same numbering format shall be applied for Milestones. Continuous deliverables at higher frequency can be labelled in the same way as quarterly deliverables.

D.1.X.Z-yyyy	Data	Observation-based flux estimates for CO <sub>2</sub> for YYYY or Observation-based flux estimates for CO <sub>2</sub> – Reprocessing of whole period 1979-YYYY (YYYY indicating incremental subsequent years)	Annually
D.1.X.Z-yyyy	Report	Evaluation and Quality Control document for observation-based CO <sub>2</sub> flux estimates for the period 1979 – YYYY (YYYY indicating incremental subsequent years)	Annually

<b>WP1 Milestones</b>			
#	Title	Means of verification	Due
M1.X.Y	...	...	...

### 3.3 Work package 2 – Flux estimates of CH<sub>4</sub>

The successful Tenderer shall provide annually updated global flux estimates of CH<sub>4</sub> at a resolution sufficient to characterize the main CH<sub>4</sub> source and sink patterns (e.g., wetlands, rice fields, cattle, atmospheric loss processes) and as close to a horizontal resolution of 1° by 1° as possible. The successful Tenderer shall use an atmospheric inversion system with a proven track record to provide the flux estimates. The flux estimates shall be based on observations from international ground-based networks (e.g., the NOAA Earth System Research Laboratory archive and the World Data Centre for Greenhouse Gases archive) and satellite observations (e.g., SCIAMACHY, GOSAT(-2), Sentinel-5p, IASI) on the condition that the accuracy of the observations is good enough for providing competitive flux estimates. In the case of using satellite data products, the Tenderer shall indicate if these will be used in an combined atmospheric inversion or in separate parallel atmospheric inversions. Within the first year covered by this ITT, the successful Tenderer shall provide an initial atmospheric inversion covering at least the period 1990 – 2023, showing equal or better performance than the current CAMS CH<sub>4</sub> flux estimates. The Tenderer shall further propose a strategy for providing at least annually updated flux estimates, either by reanalysing the whole period or by carefully extending the existing period to include the latest set of available observations. In the latter case, the Tenderer shall indicate potential issues with consistency of the whole data set. The successful Tenderer shall also provide uncertainty estimates of the fluxes and provide an Evaluation & Quality Control (EQC) report (using independent observations of atmospheric CH<sub>4</sub> and/or CH<sub>4</sub> fluxes) with each new release of the flux estimates.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

<b>WP2 Deliverables</b>			
#	Type	Title	Due
D2.X.Z-yyyy	Data set	Observation-based flux estimates for CH <sub>4</sub> – Period at least 1990 - 2023	During first year

D.2.X.Z-yyyy	Report	Evaluation and Quality Control document for observation-based CH <sub>4</sub> flux estimates for the period 1990 - 2023	During first year
D.2.X.Z-yyyy	Data	Observation-based flux estimates for CH <sub>4</sub> for YYYY or Observation-based flux estimates for CH <sub>4</sub> – Reprocessing of whole period 1990 – YYYY (YYYY indicating incremental subsequent years)	Annually
D.2.X.Z-yyyy	Report	Evaluation and Quality Control document for observation-based CH <sub>4</sub> flux estimates for the period 1990 – YYYY (YYYY indicating incremental subsequent years)	Annually

<b>WP2 Milestones</b>			
#	Title	Means of verification	Due
M2.X.Y	...	...	...

### 3.4 Work package 3 – Flux estimates of N<sub>2</sub>O

The successful Tenderer shall provide annually updated global flux estimates of N<sub>2</sub>O at a resolution sufficient to characterize the main N<sub>2</sub>O source and sink patterns (e.g., natural soils, agricultural soils, oceans, cattle) and as close to a horizontal resolution of 1° by 1° as possible. The successful Tenderer shall use an atmospheric inversion system with a proven track record to provide the flux estimates. The flux estimates shall be based on observations from international ground-based networks (e.g., the NOAA Earth System Research Laboratory archive) and satellite observations (e.g., IASI) on the condition that the accuracy of the observations is good enough for providing competitive flux estimates. In the case of using satellite data products, the Tenderer shall indicate if these will be used in an combined atmospheric inversion or in separate parallel atmospheric inversions. Within the first year covered by this ITT, the successful Tenderer shall provide an initial atmospheric inversion covering at least the period 1996 – 2022, showing equal or better performance than the current CAMS N<sub>2</sub>O flux estimates. The Tenderer shall further propose a strategy for providing at least annually updated flux estimates, either by reanalysing the whole period or by carefully extending the existing period to include the latest set of available observations. In the latter case, the Tenderer shall indicate potential issues with consistency of the whole data set. The successful Tenderer shall also provide uncertainty estimates of the fluxes and provide an Evaluation & Quality Control (EQC) report (using independent observations of atmospheric N<sub>2</sub>O and/or N<sub>2</sub>O fluxes) with each new release of the flux estimates.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

<b>WP3 Deliverables</b>			
#	Type	Title	Due
D3.X.Z-yyyy	Data set	Observation-based flux estimates for N <sub>2</sub> O – Period at least 1996 - 2022	During first year

D.3.X.Z-yyyy	Report	Evaluation and Quality Control document for observation-based N <sub>2</sub> O flux estimates for the period 1996 - 2022	During first year
D.3.X.Z-yyyy	Data	Observation-based flux estimates for N <sub>2</sub> O for YYYY or Observation-based flux estimates for N <sub>2</sub> O – Reprocessing of whole period 1996 – YYYY (YYYY indicating incremental subsequent years)	Annually
D.3.X.Z-yyyy	Report	Evaluation and Quality Control document for observation-based N <sub>2</sub> O flux estimates for the period 1996 – YYYY (YYYY indicating incremental subsequent years)	Annually

WP3 Milestones			
#	Title	Means of verification	Due
M3.X.Y	...	...	...

### 3.5 Work package 4 – Service evolution

Service evolution is a key aspect of all CAMS services and is therefore an important element of this ITT. Development aspects of the current CAMS2\_55 contract have focused on an increase in horizontal resolution to roughly 1° by 1°, including a significant improvement in computational efficiency, and the use of new satellite data, such as from Sentinel-5p and IASI. Further improvements to this part of the CAMS portfolio are expected to come from better prior flux estimates, especially for the land biosphere and the potential to extract more information about human-induced emissions.

The service evolution as part of this contract shall, where meaningful, take into account outcomes from current and future research projects in support of the development of the CAMS CO<sub>2</sub> and CH<sub>4</sub> emissions monitoring capacity (CO2MVS), such as CoCO<sub>2</sub><sup>8</sup>, CORSO<sup>9</sup>, and projects resulting from the Horizon Europe Call “HORIZON-CL4-2023-SPACE-01-31: Copernicus for Atmosphere and Climate Change, including CO<sub>2</sub>”<sup>10</sup>.

The Tenderer shall provide an outline of tasks to improve the service related to greenhouse gas flux estimates, as proposed under WP1, WP2, and WP3. This plan shall address at least the use of new satellite instruments (insofar they have not already been included in the service provision of the above work packages), the potential to extract more information about human-induced emissions (see for example current efforts under <https://atmosphere.copernicus.eu/ghg-services/putting-things-together>), and the improvement of the prior biosphere fluxes. The latter shall not solely rely on outcomes of other contracts and/or research projects, but be firmly embedded as part of this contract. Aspects to be considered are the generation and use of more timely prior information (compared to the use of climatological priors) based on the outputs from ECMWF’s Integrated Forecasting System<sup>11</sup>, offline Dynamic Global Vegetation Models (DVGMS), or satellite constrained empirical models<sup>12</sup>. The successful Tenderer shall also align their developments with other relevant CAMS activities, especially

<sup>8</sup> <https://coco2-project.eu>

<sup>9</sup> <https://corso-project.eu>

<sup>10</sup> <https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl4-2023-space-01-31>

<sup>11</sup> <https://www.mdpi.com/2073-4433/12/6/723>

<sup>12</sup> For example, <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021JG006290>



in the framework of the ramping up of the CO2MVS, where meaningful for the provision of the services of this contract. Main examples are the harmonisation of prior flux and emission data sets, the estimation of product uncertainties, and the Evaluation and Quality Control activities for CO<sub>2</sub> and other emissions.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

<b>WP4 Deliverables</b>			
#	Type	Title	Due
D4.Y.Z.yyyy	Report	Annual development plan for the Year YYYY	Annually
D4.Y.Z.yyyy	Report	Annual report on the developments achieved during the Year YYYY	Annually

<b>WP4 Milestones</b>			
#	Title	Means of verification	Due
M4.Y.Z	...	...	...

### 3.6 Work package 5 – User support and documentation of service

The objective of this work package is to provide support to users of the delivered products and services.

ECMWF has established a centralised Copernicus Service Desk to provide multi-tiered technical support to all users of CAMS data, products, tools and services. The Service Desk handles user queries through a ticketing system and distributes these queries to specialists when needed. Dedicated staff at ECMWF provide basic support in the form of self-help facilities (FAQs, Knowledge Base, online Forum, tutorials etc.) as well as individualised support on technical queries related to the Atmosphere Data Store (ADS), data formats, data access, etc. In addition, ECMWF staff provide specialised scientific support to address questions related to its industrial contributions to CAMS, e.g. in the areas of global forecasting of atmospheric composition.

All CAMS contractors are 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 Service Desk facility, as well as contributions to FAQs, Knowledge Base, and user guides. Contractors may also be requested by the CAMS Service Desk to contribute to support questions in the online Forum.

Tenderers shall describe the level of user support service on Service Desk tickets as a specific Key Performance Indicator (KPI) with a target value of 80% of the assigned specialised user queries being resolved within 15 days after being informed by the CAMS Service Desk.

Tenderers shall also address development of user guides. Documentation of the CAMS services is an integral part of the service provision and is directly linked to the Atmosphere Data Store. The technical and scientific specification of each service shall be documented in the CAMS Knowledge Base as linked from the Atmosphere Data Store (see example for the CAMS global reanalysis at

<https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-reanalysis-eac4?tab=doc>),

and, if more detail is required, in reports that will be available to users through the CAMS website. The successful Tenderer shall therefore produce documentation describing in detail the methodologies and products they deliver for this ITT. The documentation in the Knowledge Base shall be targeted at the general external user community, while the additional detailed reports shall address the needs of expert users.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

WP5 Deliverables*			
#	Type	Title	Due
D5.y.z-YYYY	Other	Contribution to CAMS Knowledge Base to document products and services as provided within the scope of this contract	Annually
D5.y.z-YYYY	Report	Contribution to documentation of products and services as provided within the scope of this contract	Annually
...			

WP5 Milestones			
#	Title	Means of verification	Due
M5.y.z	...	...	...

(\*) See also sub-section 4.5 of this ITT which details some additional deliverables for WP5 in what regards the support for user engagement and training activities.

### 3.7 Work package 0 – Management and coordination

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

- Contractual obligations as described in the Framework Agreement Clause 2.3 on reporting and planning.
- Meetings (classified as tasks and listed in a separate table as part of the proposal):
  - ECMWF will organise annual CAMS General Assemblies. The successful Tenderer is required to attend these meetings with team members covering the various topics that are part of this ITT.
  - ECMWF will host monthly teleconference meetings to discuss CAMS service provision, service evolution and other topics. The Prime Investigator appointed by the successful Tenderer will represent the successful Tenderer in such meetings.
  - ECMWF and the successful Tenderer will organise six-monthly Progress Review Meetings (linked to Payment Milestones, unless agreed otherwise).
  - ECMWF and the successful Tenderer will organise a Kick-Off Meeting.
  - Tenderers can propose additional project internal meetings (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 sub-contractors.

- Sub-contractor 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 sub-contractors 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 sub-contractors.
- Management of personal data and how this meets the requirements of Clause 2.8 and Annex 6 of the Volume V Framework Agreement.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for this work package already indicated in the tables below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

<b>WPO Deliverables</b>				
#	Responsible	Nature	Title	Due
D0.Y.Z-yyyyQx	Tenderer	Report	Quarterly Implementation Report (QIR) QX YYYY <i>QX YYYY being the previous quarter</i>	Quarterly on 15/04, 15/07 and 15/10 <i>(only at the above dates since QIR for Q4 will be part of the AIR Part 1)</i>
D0.Y.Z-yyyy	Tenderer	Report / Other	Annual Implementation Report (AIR) Part 1 YYYY, including: # Quarterly Implementation Report (QIR) Q4 YYYY <i>Q4 YYYY being the previous quarter</i> # Preliminary financial form YYYY <i>YYYY being the Year n-1</i>	Annually on 15/01
D0.Y.Z-yyyy	Tenderer	Report	Annual Implementation Report (AIR) Part 2 YYYY <i>YYYY being the Year n-1</i>	Annually on 28/02
D0.Y.Z	Tenderer	Report	Final Implementation Report	60 days after end of contract <i>(Tenderer to include date based on Contract Notice)</i>
D0.Y.Z-yyyy	Tenderer	Report	Annual Implementation plan YYYY <i>YYYY being the Year n+1</i>	Annually on 30/09
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, in June
D0.Y.Z	Tenderer	Other	Updated KPIs (list, targets, etc.) after review with ECMWF	One year after start of contract

<b>WPO Milestones</b>				
#	Responsible	Title	Means of verification	Due
M0.y.z-KOM	Tenderer	Kick-Off Meeting and associated MoM	Minutes of Meeting	30 days after start of contract
M0.y.z-PRMx	Tenderer	Progress Review Meetings / Payment	Minutes of Meeting	~ Every 6

		Milestone SC1-PMx and associated MoM		months
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## 4 General Requirements

### 4.1 Implementation schedule

The Framework Agreement will run from 1 November 2023 to 31 October 2026. The Tenderer shall provide a detailed implementation plan of proposed activities for the full period.

### 4.2 Deliverables and milestones

A deliverable is a substantial, tangible or intangible good or service produced as a result of a project. In other words, a deliverable is an outcome produced in response to the specific objectives of the contract and is subject to acceptance by both ECMWF's Technical Officer (TO) and Contract Management Officer (CMO).

The following shall apply to the deliverables:

- Deliverables should be consistent with the technical requirements specified in Section 0.
- When defining deliverables, please consolidate their numbers against a specific deadline where possible.
- 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.

Please note that in Volume IIIA "Pricing and deliverables" (cf. Excel sheet "Deliverables List"):

- Each deliverable shall have an associated resource allocation (person-months in column I "Nb of PM allocated", and financial budget - resource type to be considered is payroll only – in column J "Estimated price"). Therefore, the total of these allocated resources shall amount to the requested budget associated with payroll.
- Milestones should not have any associated budget.

Milestones should be designed as markers of demonstrable progress in service development and/or quality of service delivery. They should not duplicate deliverables and shall not attract the budget under Volume IIIA "Pricing and deliverables", Excel sheet "Deliverables List".

The Tenderer shall ensure that the proposed due dates of deliverables and milestones are realistic and achievable.

- o Any dependencies on input data (whose origin must be specified) shall be detailed and also accounted for in the risk table.

### 4.3 Acquisition of necessary data and observations

The successful Tenderer shall acquire the relevant observational data sets needed for the provision of the services of this ITT. Where possible, use shall be made of the observational data sets provided by the Copernicus Climate Change Service (C3S), CAMS, and the Climate Change Initiative programme from the European Space Agency (ESA-CCI). The successful Tenderer shall also acquire the relevant

observational data sets needed for the optimisation and evaluation of the developments of this ITT. Where possible, use shall be made of the observational data sets under the CAMS2\_2000 in situ support contracts.

#### 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 (<https://climate.copernicus.eu/esotc/2021/globe-in-2021>), CAMS website news items, and CAMS brochures and flyers. All communication activity must be agreed with the ECMWF Copernicus Communication team in advance. This includes, but not exhaustively, communication planning, branding and visual style, media outreach, website and social media activity, externally facing written and graphic content and events. Agreed activity would also need to be evaluated and reported on, once complete, so that success measures and KPIs can be provided to the European Commission.

#### 4.5 Support for user engagement and training activities

While user engagement and training activities are not part of the scope of this ITT, the Tenderer shall accommodate for eventual needs in providing technical and scientific expertise in support of these activities. The bidder shall specify in the bid the experts intended to be allocated to provide this support.

Requests to support activities may be raised on for example:

- Contribute with content specific input to training, education and capacity building material: development and/or review of learning resources in the domain of the contract, participation in train-the-trainer events and MOOCs;
- Contribute with content specific input to user-oriented communication material such as slides, story maps and user testimonials;
- Contribute and attend User Uptake workshops and stakeholder meetings. Presentations in the mother tongue of participating staff may be asked to be provided;
- Input to the URDB with user requirements (cf. template as provided during the negotiation process) as well sharing needs and aspirations as raised by potential new user communities.

An indicative maximum budget of 5,000.- EUR shall be allocated in the pricing table to accommodate for these needs. This shall be paid as a cost-reimbursement against a fixed fee rate/day. Details on the expected activities and the budget shall be refined during the negotiation/contract preparation phase.

As part of the CAMS user interaction, user requirements are continually collected in a User Requirements Database (URDB) in a structured and traceable way. This URDB tracks all requirements emanating from a wide variety of user fora, surveys, user support and direct interactions between service providers and their users. The entries of the URDB are analysed on a regular basis in terms of user requirements per domain, importance and feasibility. This analysis constitutes the basis for distilling, filtering and translating user requirements into technical specifications for the Service and its evolution.

The successful Tenderer 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 of User Interaction activities with the analysis of relevant user requirements in the URDB.

The following deliverables are thus to be added to the WP5 deliverable list:

<b>WP5 Deliverables</b>			
#	Type	Title	Due
D5.Y.Z-yyyy	Other	Input to CAMS URDB - YYYY	Checked by ECMWF annually in November
D5.Y.Z	Report	Summary of user engagement activities	Due 1 month before contract end date

#### 4.6 Data provision and IPR

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

##### *Data access via the CADS*

The CADS 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). The Successful Tenderer shall provide the data in a way that is compatible with the working practice of the CADS, but this is not limited to the data format and standard but covers also metadata and documentation.

##### *Dataset registration*

Dataset suppliers to the CADS shall provide a comprehensive description of their datasets at least two months prior to delivery, using a dataset registration process established by ECMWF. Successful Tenderers will be required to submit details of the products to be generated, including the temporal scope, input data to be used and summary metadata for the products, as well as to maintain details of the scientific documentation related to the products. Exact details of the registration process, which serves to collect all CADS relevant information (to define metadata, landing page user forms and necessary adaptors), will be provided to the preferred bidder during negotiation.

##### *Access methods*

Data access can be implemented in the CADS distributed infrastructure either by:

- (a) Push mode: uploading datasets to a designated ECMWF CADS server.
- (b) Pull mode: providing datasets via web services.

ECMWF has a strong preference for push mode. In case pull mode is implemented, the contractor shall ensure that the data products are stored in one or more EU members countries. The contractor is responsible for storing the data for at least 6 years after the contract has come to an end.

The bidder is encouraged to distribute the data in non-proprietary file format (NetCDF, csv, shape files, etc.) provided through a web service and accessible by simple commands like wget. The “ECMWF metadata recommendations for NetCDF” document, available at <https://confluence.ecmwf.int/x/9IsjDQ>, provides recommendations for encoding the datasets in NetCDF. Requests for access to those web services will originate from the CADS, 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, nevertheless it will collect usage statistics for all aspects of CAMS

### *Publication of Data Catalogue Entries*

The main result of the data integration and data publication processes is a Data Catalogue Entry. Data suppliers shall contribute to those processes. A Data Catalogue Entry is a hypertext document providing access to a collection of data or datasets. Typically, the entry has its own Digital Object Identifier (DOI) and citation (which can differ from the DOIs and citations associated with the underlying data or datasets).

**Data Integration Process:** The data integration process is a machine-oriented process designed to automatically produce Data Catalogue Entries. This requires that the information about the data and the associated documentation is described using machine parseable files provided in json, yaml, csv, or other machine parseable format enabling CADS scripts to automatically generate a Data Catalogue Entry. Therefore, in addition to data and associated documentation, the contractor shall also provide a machine parseable description of the data and associated documents. This could, for instance, be through a manifest file which lists of all web addresses to the files of the dataset that will be used to fetch the data.

**Data Publication Process:** The data publication process is a human-oriented process designed to assess, verify and control whether the result of the data integration process matches, a) what was contractually defined to be delivered in terms of data and documentation through the CADS at a specific time (this requires human readable information about deliveries of data and documentation), b) the CADS policies and the agreements made between the data providers and ECMWF concerning the final look and feel of the catalogue entries. The data publication process follows a procedure similar (but not identical) to the publication of an article in a scientific journal.

Therefore, to publish a dataset in the CADS the successful Tenderer shall supply information and collaborate with the CADS team with three different types of contributions:

1. delivering the data and the documents to be served through the catalogue;
2. providing the information needed to describe the product characteristics (dataset metadata, information to complete the catalogue entry, etc.). The contribution (DR) will be carried out either in document format or in an evolving CMS provided by ECMWF;
3. collaborating with the CADS to run the integration and publication processes.

The following link provides more detailed information on the integration of a dataset in the CADS catalogue:

<https://confluence.ecmwf.int/display/COPSRV/How+to+integrate+a+dataset+into+the+CDS+Catalogue>

### *Deprecation and replacement of datasets*

During the course of the contract, some data published in a catalogue entry may have to be deprecated and replaced, for instance due to the identification of an anomaly in a data product. The CADS will tag the data as deprecated. However, the CADS and the contractor will ensure access to the deprecated data during a certain period (deprecation period), typically one year, alongside the new data replacing the deprecated one. The deprecation period will provide users the chance to manage the implications of such modifications and to keep the most important scientific imperatives of traceability, reproducibility and accountability for as long as possible. Therefore, data suppliers shall reserve enough resources to keep deprecated data alongside the replacement data that can be a single file, or all files concerning a variable, or even the whole dataset



## Data and IPR

It is a condition of EU funding for CAMS that ownership of any datasets developed with CAMS funding passes from the suppliers to the European Union via ECMWF. Ownership will pass from the date of creation of the datasets. Suppliers will be granted a non-exclusive licence to use the datasets which they have provided to the European Union via ECMWF for any purpose.

All software and products used by the successful Tenderer to produce the CAMS datasets will remain the property of the successful Tenderer, except for those components which are acquired or created specifically for CAMS purposes, with CAMS funding, and which are separable and useable in isolation from the rest of the successful Tenderer's production system. The identity and ownership of such exceptional components will be passed to the European Union annually. The successful Tenderer will be granted a non-exclusive licence to use them for any purpose.

A distinction ought to be made between those datasets (or relating documentation) specifically created as a result of this ITT, which, as Deliverables, will be fully owned by the EU and on the other hand, if pre-existing datasets (or documentation), which are simply brokered / made accessible as part of the services. Such brokered datasets (or documentation) will continue to be owned by their original owner. The successful Tenderer will licence the relevant brokered data/documentation to ECMWF/EU or will procure on behalf of ECMWF a licence directly from the owner. Such licence will ensure the best available terms of accessibility and redistribution, bearing in mind the purpose of the Copernicus Programme and the free and open terms of accessibility and redistribution, established for Copernicus products in the Copernicus Data Regulation. At a minimum, the successful Tenderer shall grant, or procure on behalf of ECMWF, the right for the brokered datasets (or documentation) to be made available via the Climate and Atmosphere Data Store (CADS) on terms consistent with any applicable specifications of ECMWF and the Copernicus Data Regulation. The successful Tenderer will be responsible to provide the license terms to ECMWF in a suitable format in order for ECMWF to make the brokered datasets (or documentation) available via the CADS. The successful Tenderer will inform ECMWF of any updates to such terms. In this case, ECMWF is procuring a service, rather than the datasets (or the documentation) themselves.

The proposal shall thus provide a clear distinction between both cases by setting the nature of:

- the datasets (or relating documentation) specifically created as a result of this ITT to "Dataset" or "Report",
- the brokered datasets (or relating documentation) made accessible as part of the service to "Brokerage Dataset" or "Brokered Report".

Please note that, in both cases, the bidder shall warrant that it has all necessary rights to either pass on ownership to the ECMWF/EU or, alternatively, that it has all necessary rights to grant the required license to ECMWF and the EU in respect of brokered datasets (or documentation), as described above. Please refer to the Framework Agreement for further details of the license required.

## 4.7 Key performance indicators

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

The table below provides the template to be used by the 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_1	Quality of the CO <sub>2</sub> product - bias	...	For each product release	Mean absolute bias between the posterior simulation and a large set of independent aircraft measurements in the free troposphere
KPI_2	Quality of the CO <sub>2</sub> product – standard deviation	...	For each product release	Mean standard deviation between the posterior simulation and a large set of independent aircraft measurements in the free troposphere
KPI_3	Quality of the CH <sub>4</sub> product - bias	...	For each product release	Mean absolute bias between the posterior simulation and a large set of independent aircraft measurements in the free troposphere
KPI_4	Quality of the CH <sub>4</sub> product – standard deviation	...	For each product release	Mean standard deviation between the posterior simulation and a large set of independent aircraft measurements in the free troposphere
KPI_5	Quality of the N <sub>2</sub> O product - bias	...	For each product release	Mean absolute bias between the posterior simulation and a large set of independent aircraft measurements in the free troposphere
KPI_6	Quality of the N <sub>2</sub> O product – standard deviation	...	For each product release	Mean standard deviation between the posterior simulation and a large set of independent aircraft measurements in the free troposphere

## 5 Tender Format and Content

General guidelines for the tender are described in Volume IIIB. Specific requirements to prepare the proposal for this particular tender are described in the next sub-sections.

### 5.1 Page Limits

As a guideline, it is expected that individual sections of the Tenderer's response do not exceed the page limits listed below. These are advisory limits and should be followed wherever possible, to avoid excessive or wordy responses.

<i>Section</i>	<i>Page Limit</i>
<i>Executive Summary</i>	2
<i>Track Record</i>	2 (for general) and 2 (per entity)
<i>Quality of Resources to be Deployed</i>	2 (excluding Table 1 in Volume IIIB and CVs with a maximum length of 2 pages each)
<i>Technical Solution Proposed</i>	2 + 3 per Work package (Table 2 in Volume IIIB, the section on references, publications, patents and any pre-existing IPR is excluded from the page limit and has no page limit)
<i>Management and Implementation</i>	6 (excluding Table 3, Table 5, Table 6 and Table 7 in Volume IIIB) + 2 per each Work Package description (Table 4 in Volume IIIB)
<i>Pricing Table</i>	No limitation

*Table 1: Page limits*

### 5.2 Specific additional instructions for the Tenderer's response

The following is a guide to the minimum content expected to be included in each section, additional to the content described in the general guidelines of Volume IIIB. This is not an exhaustive description and additional information may be necessary depending on the Tenderer's response.

#### 5.2.1 Executive Summary

The Tenderer shall provide an executive summary of the proposal, describing the objectives, team and service level.

#### 5.2.2 Track Record

The Tenderer shall demonstrate for itself and for any proposed sub-contractors 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 the Copernicus Atmosphere Monitoring Service and the current state of atmospheric inversions to estimate greenhouse gas fluxes.

An exhaustive and detailed description of the proposed technical solution for all work packages described above, including any ramp-up or mobilization phase, shall be given. The Tenderer shall indicate which observational data sets it intends to use and how it will acquire the relevant data. The Tenderer shall describe the proposed method for producing the flux estimates outlining in some detail the proposed atmospheric inversion system(s). The Tenderer shall indicate the spatial and temporal resolution of the flux estimates and how their accuracy will be competitive within existing international collaboration frameworks. The Tenderer shall also describe its intended procedure for annually updating the data products. Finally, the Tenderer shall clearly describe their plans for service evolution as part of this proposal.