ECMWF Copernicus Procurement

Invitation to Tender

Copernicus Climate Change Service

Volume II

Collection and Processing of *In Situ* Observations

ITT Ref: C3S2_311
ISSUED BY: ECMWF Administration Department Procurement Section
Date: 7 April 2021
Version: Final

Funded by the European Union

Implemented by ECMWF

Table of Contents

1 Introduction

ECMWF as the Entrusted Entity for the Copernicus Climate Change Service (C3S) invites tenders for services related to collection and processing of *in situ* observations in support of climate services development. The overall objective for these services is to improve access to available *in situ* instrumental data records and to data streams from observing networks, as needed for climate change monitoring and climate science. The technical work described in this document shall provide enhanced continuation of prior activities carried out in the first phase of the Copernicus programme (Cop1 hereafter), as described at https://climate.copernicus.eu/observations. All relevant results to date from Cop1 are available to bidders, including documentation, on request via ECMWF. Additional technical clarifications can be provided on request, and questions should be raised via the messaging board on the portal. To avoid duplication of work, synergies with other Copernicus services shall be exploited.

Goals to be addressed by the services described in this document include: improvement of the historical instrumental record by means of support to data rescue activities, quality control and homogenisation of *in situ* observations; harmonisation of access to data from major archives of climate observations as well as specialised networks of observing sites; development of merged collections of *in situ* observations suitable for climate reanalysis; development of high-resolution gridded datasets from *in situ* observations over Europe that are suitable for climate monitoring.

Central requirement is the open and free provision of *in situ* observations via the unified C3S Climate Data Store (CDS; *Raoult et al. 2017*). Scientific requirements on observations and derived information products for the CDS are based on the framework provided by the Global Climate Observing System (GCOS). The CDS provides information about the past, present and future climate in terms of Essential Climate Variables (ECVs; *Bojinski et al.* 2014) and derived climate indicators. The CDS also provides a comprehensive set of software (the CDS toolbox) which enables users to develop custom-made applications. These applications make use of the content of the CDS to analyse, monitor and predict the evolution of both climate drivers and impacts.

Following *Thorne et al. (*2017), the collection of *in situ* climate records can be grouped into three categories: from reference networks that provide metrologically traceable observations and are, though sparse, suitable for the absolute calibration of Climate Data Records (CDR) for ECVs, (2) from baseline-observing networks, which lack full traceability but do provide long-term records and (3) comprehensive; the much larger set of any observations that are not contained in the first two categories. The C3S2_311 service shall cover *in situ* observations from all these categories, as each has its own climate user base.

Contracts will be issued in three Lots, providing:

- Lot 1: Access to a comprehensive archive of historical surface observations, with support for data rescue;
- Lot 2: Access to observations from baseline and reference networks, and comprehensive upper-air observations;
- Lot 3: Access to high-resolution gridded datasets over Europe based on in situ observations.

Each of the Lots shall include efforts to improve the availability of observation datasets with open, unrestricted access through the CDS. This requires provision of the data in well-organized online repositories that can be queried directly by users via a simple CDS interface. Specific requirements are provided in section 3.3.2 and bidders should read those carefully since from year three onwards bidders shall migrate to solutions that will be developed in parallel elsewhere. Data services shall include a guarantee on uptime, provision of up-to-date documentation, expert user support and contribution to the C3S evaluation and quality control function (EQC). Successful bidders shall work with data providers as needed, liaise between network providers and ECMWF, and dedicate efforts to align existing data licences with the open and free principles of the Copernicus Licence. On the other hand, successful bidders shall ensure that Intellectual Property Rights (IPRs) are respected for all public-facing data on the CDS. In addition, contractors shall engage in outreach activities.

Although the in-situ observation datasets will serve a wide range of users and applications, a particular emphasis shall be on the support for climate reanalysis. This entails the selection of datasets in regions and periods where most value to reanalysis is added, emphasis on particular geophysical quantities and the provision of adequate metadata.

Specific objectives and technical requirements for each Lot are described in section 2 of this document. Crosslinks and synergies between Lots are listed there as well. General requirements common to all Lots are presented in section 3. Information about the tender format and content is given in section 4, and section 5 contains a list of reference documents and acronyms.

2 Technical requirements

2.1 Lot 1: Access to a comprehensive archive of historical surface observations, with support for data rescue.

ECMWF intends to award *a single multi-annual service contract (maximum 48 months)* for services in support to *in situ* data rescue activities and the provision of comprehensive marine and land surface observations. The objective is to facilitate and support (1) ongoing efforts to digitise documented instrumental data records extending back a century or more, to make these records easily accessible for further processing and analysis, (2) their ingestion and ingestion from other sources in well-maintained and harmonised data archives and (3) their public provision in the CDS. These activities shall provide enhanced continuity for the services developed by the C3S_311a Lot 1 and Lot 2 contracts in Cop1.

2.1.1 Scope of service

The value chain of data rescue from the search for original paper records to publicly available, well-maintained harmonised digital archives contains several steps. For the activities in this Lot most of these and are concentrated around these public-facing services and activities:

1. The C3S Data Rescue Service, which provides an overview of existing data rescue activities worldwide. This information is synchronised with the KNMI/WMO International Data Rescue Portal (I-DARE). The C3S Data Rescue Service also provides metadata inventories, supportive information, tutorials and tools for data rescue activities, including a job-dispatch system for data rescue projects.
2. The C3S Data Deposition Service, which is an upload service that allows providers from anywhere in the world to contribute to the C3S *in situ* databases. Behind the public eye, this part of the service includes the ingestion of such submitted records into future versions of consolidated archives and the improvement and harmonisation of such versions.
3. The CDS catalogue entries for the consolidated *in situ* surface marine and land archives. This part of the service sits at the backend of the CDS and includes all elements as specified in the introduction and shall follow requirements as stipulated in section 3.3.2.
4. Outreach to increase public awareness of the importance and urgency of the transcription of fast-degrading original records onto stable and machine-readable digital media.

Items (1) and (2) are in place, while the public access of (3) is in an advanced state of development. During this contract these activities shall be continued and evolved.

The selected Contractor for this Lot shall:

- Continue to work with existing international data rescue support initiatives such as the Atmospheric Circulation Reconstructions over the Earth (ACRE) and I-DARE;
- Seek continuation of the collaboration with the National Oceanic and Atmospheric Administration's National Centers for Environmental Information regarding the ICOADS archive of the marine component.

- Coordinate with other existing climate data initiatives in Europe or elsewhere, such as the WMO Observing Systems Capability Analysis and Review Tool (OSCAR).

2.1.2 Specification of work

The work includes the following four tasks.

Task 1: Support to data rescue activities.

1.1: Evolution of the C3S Data Rescue Service Portal. Currently its data rescue activity information is mirrored with I-DARE and the establishment of a joint WMO – Copernicus portal is envisaged. The portal aims to be the authoritative source of information on the state of play of data rescue activities. It provides an overview of existing data rescue projects, what data have been rescued so far, what is known to exist but has not yet been digitized, what records have been only imaged, etc. The inventories provide information on metadata, rather than access to the observations themselves. The portal allows users worldwide to register and add information on their projects and to upload metadata to the inventories. In addition, the portal provides access to tools and training material to prospective data rescuers. The bidder shall:

- Maintain the concept and web interface of the current portal;
- Merge the current portal with I-DARE to establish a joint WMO – Copernicus portal;
- Provide technical development work and provide a guarantee for a certain level of uptime;
- Provide user support and establish a code of conduct for users of the portal;
- Establish a maturity index that characterises the state of data rescue projects, starting from 'known to exist' to 'fully quality checked and available in consolidated well-maintained machine-readable archives';
- Improve functionality of the web interface to allow for a transparent global overview for each level of maturity at the click of a button;
- Evolve the tools for identifying opportunities, gaps and priorities in data rescue;
- Expand on facilities for submitting digitised data sets to international climate data archives;
- Promote community tools for imaging, digitizing and quality control;
- Enhance the promotion of best practices, data standards, in particular the C3S Station Exchange Format (SEF), and metadata requirements.

1.2: Provision of support for digitization activities on high-priority data records, to be selected in coordination with ECMWF. A prime candidate is the digitization of about 4 million images of the ACMAD dataset that will be delivered in 2021 by the Cop1 COP_062 contract. A maximum of 300,000 EURO can be allocated to such activities. All rescued data within the contract are to be submitted to the C3S data deposition service.

1.3: Collection and transfer of images of original records into secure repositories (desirable). Storing digital images of historical paper records are the most sustainable way of guaranteeing access to the 'ground truth'. The ability to go back to these allows for efficient reprocessing where errors, undocumented postprocessing or shortcuts (e.g., focussing on subsets of observables) had been made previously. In practice, images are an intermediate in the data rescue process and as such the curation of them is often not well organized. The scope of this Lot does not allow for a proper establishment of well-maintained comprehensive image repositories. However, it is optional to bidders to propose a proof of concept for the collection of images, the design of repositories and explore ways in which the data rescue community could gain access to these in an efficient manner.

Deliverables required: Joint WMO-C3S Data Rescue Service Portal including technical and user support; annual 'State of Data Rescue' assessments; metadata inventories; best practice guides; data rescue tools and facilities; selected digitized data sets.

Deliverables optional: Proof of concept for image repositories.

Task 2: Data ingestion and harmonisation.

The technical aspects of this part of the service as it is currently implemented can be found under https://github.com/glamod/.

2.1 Evolution of the C3S Data Deposition Service.

The data deposition server facility presents a web interface through which data providers can connect and upload new datasets for potential inclusion. Data can be pushed to the C3S data holdings by a range of transfer protocols before being manually assessed. It is an essential part of the *in situ* service as it allows for the harvesting of new sources of historical observations that will be included in future versions of public data releases. The bidder shall:

- Take over the implementation of the server and expand its functionality;
- Provide the ability to ingest any *in situ* observations, i.e., not limited to surface marine and land observations, including upper-air records that shall be passed on to Lot 2 for ingestion in the C3S comprehensive upper-air database;
- Improve the interconnection with the C3S Data Rescue Service Portal and work towards a seamless user experience;
- Provide adequate human resources for the processing of input observations.

2.2 Data ingestion and harmonisation in preparation for future releases.

This involves the preparing of data from multiple data archives, including those sourced via the C3S Data Deposition Service, retaining complete identification of data records with full traceability to data source and data set versions. The bidder shall process the data along the following steps:

1. Ingest and archive data from sources in their native formats;
2. Make an inventory for these sources;
3. Retain (and enrich where possible) metadata. This includes information about provenance, geo-location and timing, instrument characteristics, data quality, and any other attributes needed to facilitate processing and usage in reanalysis. Metadata is also to be enriched/validated against WMO OSCAR/Surface catalogue reporting major discrepancies (i.e., missing stations, conflicting coordinates/elevation or instruments heights) to data providers and NMHSs, where possible;
4. Convert to the common data model as described below in task 2.3;
5. Merge sources and take account for inter-source duplication;
6. Undertake quality assurance by application of baseline quality checks addressing completeness of record, physical plausibility, temporal consistency, etc;
7. Store regular back-ups which allow for the recreation of repositories in case of corruption or calamities.

Focus shall be on the comprehensive holdings of land and marine and surface observations as currently in place for this part of the service.

In Cop1 land data holdings originate from several hundreds of collections from land surface meteorological observations across the globe. Data are available at the observational level and also at daily and monthly aggregations. Data are collated and harmonised and quality control checks are performed. The bidder shall extend these collections and shall evolve this activity.

In Cop1 marine data holdings originate from a single source, Release 3.0.0 of the International Comprehensive Ocean Atmosphere Data Set (ICOADS) (*Freeman et al.,* 2017). This dataset is the most complete archive of surface marine observations and contains input data from many different sources in a harmonized format (the International Maritime Meteorological Archive (IMMA1) format). The processing includes limited quality flagging, duplicate elimination and merging of records. These tasks are particularly challenging given the fact that many stations (e.g., ships) move. These activities take place in collaboration

with NCEI. In cooperation with NCEI, the bidder shall continue to improve the consistency of the ICOADS dataset.

2.3 Maintenance and optimization of the common data model for *in situ* observations.

During Cop1 a Common Data Model for *in situ* observations was developed (CDM-OBS). Central requirement was the support of storing comprehensive metadata, which was established through the use of configuration tables. Amongst other things it sets standards for the naming and units of geophysical variables. The CDM-OBS follows the data model that is used to process observations at ECMWF (ODB) in the sense that its tables are structured on individual observation level, rather than on report level (see e.g., *Hersbach et al.* 2015). All *in-situ* data repositories of Cop1 use the CDM-OBS, while all public-facing observational datasets are compliant with its conventions (variable names, units, organised on single observation level). The latest version of the CDM-OBS can be found at https://github.com/glamod/common_data_model/blob/master/cdm_latest.pdf.

The bidder shall:

- Maintain the CDM-OBS and review its fitness for purpose (e.g., fast access to information, generic, scalable) on a regular basis, strive for some simplifications of the structure without losing functionality;
- Increase focus on the evolution of a subset of the CDM-OBS structure that is restricted to a subset of metadata, called CDM-light;
- Manage its governance structure and organize quarterly governance meetings to be attended by all C3S_311 Lots plus a representative from ECMWF;
- Develop a CDM-OBS checker that verifies that all prospective CDS non-gridded datasets from C3S_311 contracts adhere to its model.

Deliverables required: data deposition service including technical and user support; yearly updates plus inventories of the marine and land datasets; technical documents describing the harmonization methods, common data model; quarterly updates of the CDM-OBS, quarterly CDM-OBS governance meetings, software.

Task 3: Public provision of data services via the CDS.

During Cop1 preparations have been taking place for public release of the marine and land datasets. In the CDS, each dataset has its own catalogue entry, containing an overview, download and documentation tab. Internally the data are organized in a database structure that currently resides outside ECMWF and forms part of the backend of the CDS. Currently, the public release of these datasets is in a mature state. For technical reasons for this first release not all metadata will become available to users. Following the requirements as stated in section 3.3.2, the contractor shall:

- Provide a backend solution that is fit for purpose for at least the requirement of type (1) as stipulated in section 3.3.2. A solution based on flat files is preferred for the first two years of the contract that is able to provide efficient and fast access to observations for a particular data and time. As explained in section 3.3.2, from year three onwards the backend shall adopt solutions that will be put in place in parallel by a separate, dedicated contract;
- In coordination with ECMWF, extend the number of geophysical variables;
- Extend the backend with the objective that all metadata are publicly available rather than just a subset;
- Provide adequate human resources for development and technical support.

Deliverables required: Delivery of all data necessary for CDS ingestion, population of CDS catalogue entries for historical marine and land surface observations which includes access to all metadata rather than just a subset currently, fit-for-purpose online backend repositories, timely updates, delivery of regular versions over the length of the contract, capability to provide public access to at least the latest two versions,

guarantee for a certain level of uptime, up-to-date documentation, expert user support, contribution to the C3S EQC function.

Task 4: Outreach and improvement of data policies.

In coordination with the C3S Communication team this involves maintenance of C3S web pages, contribution to web articles, tweets and press releases. Central themes are (1) engagement with the data rescue community and (2) raising public awareness of the importance and urgency of data rescue.

In addition, the bidder is expected to lobby in favour of the adoption of data licences to be more closely aligned with the open and free principles of the Copernicus Licence. This includes coordination with the entrusted Copernicus entity for *in-situ* observations (currently the EEA) and participation in international forums. In addition, the bidder shall continue the efforts for ECMWF to be given the delegated authority by WMO to mint WIGOS Station Identifiers.

Deliverables required: Support the C3S Communication Team on the provision of web articles, tweets, press releases, relevant publications to the scientific and wider audience, measurable improvement of data policies such as reports and statements in writing.

Work packages

Work packages are to be organised along these four tasks. A separate work package WP0 shall be reserved for the overall management of the project.

2.1.3 Schedule

Activities shall be performed in the context of the service contract (with a maximum of 48 months). The start and kick-off (KO) of the first service contract shall take place in the third quarter of 2021. The successful Tenderer for Lot 1 is expected to provide a detailed time plan and schedule as part of the tender response for the duration of 48 Months.

2.2 Lot 2: Access to observations from baseline and reference networks, and comprehensive upper-air observations

ECMWF intends to award *a single multi-annual service contract (maximum 48 months)* for services providing consistent, reliable and unrestricted access to and redistribution of data from baseline and reference networks of observation sites (see section 2.4 in *GCOS* 2015 or *Thorne et al. (*2017) for a definition of baseline and reference networks). Observations from reference networks potentially allow for the absolute and independent calibration of gridded CDRs for ECVs. The objective for this Lot is to rationalise, harmonise and generally improve access to measurements provided by the large variety of existing networks, to facilitate climate monitoring, estimation of non-gridded ECVs and their uncertainty assessments. In addition, the service shall provide access to the comprehensive historical upper-air record, with a particular focus on their suitability for use in climate reanalysis. These activities shall provide enhanced continuity for the services as developed by the C3S_311a Lot 3 and C3S_311c Lot 2 contracts in Cop1.

2.2.1 Scope of service

Activities in this Lot include:

1. Continuous collaboration with network owners to enable redistribution of network observations via the CDS, aiming for unrestricted access where possible;
2. Collection and merging of comprehensive historical upper-air records;
3. Harmonization, homogenization and development of uncertainty estimates where possible.

Regarding collaboration and coordination, the selected Contractor for this Lot shall:

- Continue the close engagement with network providers, actively liaise their interaction with ECMWF to ensure continuation after the end of contract, ensure the integrity of their data and actively work

on terms and conditions for public release in the CDS with the purpose to align them to the open and free principles of the Copernicus Licence;
- Continue the engagement with data providers of historical upper-air observations, such as improved access to radiosonde intercomparison campaign data.

2.2.2 Specification of work

The work is split between the following four tasks.

Task 1: Access to baseline and reference networks and harmonization.

1.1 Access to network data

In Cop1, the C3S_311a Lot 3 has established links and access to baseline and reference quality measurement networks for the following ECVs: near-surface temperature, atmospheric temperature, humidity and wind (vertical profiles), ozone (partial column, total column and profiling concentrations), CO, CO_2 and CH_4 (column concentrations and vertical profile information), and water vapour content (columnar from GPS/GNSS only). Observations of those ECVs are provided by GRUAN, IGRA, NDACC, TCCON, SHADOZ, WOUDC, USCRN, IGS and additional networks such as ICOS and additional data sources provided by various National Meteorological and Hydrological Services (NMHS) and international initiatives.

In Cop2, the contractor shall:

- Build on these established links and expand on the ECV's that are currently offered;
- Expand on the activities on water vapour content. C3S has the objective to host the repository for Global Navigation Satellite System-Precipitable Water (GNSS-PW) observations on behalf of GCOS. In this respect the contractor shall actively approach observation networks from the geodesy community (International Association of Geodesy), work towards unified terms and conditions, collect such observations in the RINEX format for storage in C3S repositories, with the objective for a horizontal coverage of at least 100km.
- Expand on the governance structure and operating rules established for network data to allow for service operation continuity after the end of contract.

1.2 Harmonization, consistent quality control and uncertainty estimates

The goal of this sub task is the continuation of harmonization and application of consistent quality control algorithms for *in-situ* climate data arising from the baseline and reference networks under consideration. The merging of data shall retain complete identification of data records with full traceability to the data source and dataset versions. Whenever feasible, methods shall be developed and implemented to homogenize time series using unified data processing and quality checks, identifying issues such as instrumentation changes, calibration drifts or observing station relocations, and to quantify uncertainties in a consistent and metrologically rigorous manner. Solutions can build on the heritage from the H2020 projects GAIA-CLIM (www.gaia-clim.eu), QA4ECV (www.qa4ecv.eu), and ACTRIS (www.actris.eu).

Deliverables required: Access to network data, collection of GNSS-PW observations on behalf of GCOS, harmonized datasets with traceable uncertainties, governance structure and operating rules.

Task 2: Collection and homogenization of comprehensive upper-air observations

In Cop1, C3S_311a Lot 3 was tasked with the provision of access to the comprehensive IGRA upper-air data from 1979 onwards, while contract C3S_311c Lot 2 concentrated on comprehensive upper-air data from all available sources for both prior and beyond 1979. There is a large overlap in these datasets and each provides its own tailored estimates for bias corrections and error estimates. Bias estimates for the latter dataset are based on the RAOBCORE/RICH correction method (*Haimberger et al.* 2012) which aims for homogenized station time series that exploit information from comparison with (ERA5) reanalysis data and inter-comparison between neighbouring stations. Contract C3S_311c Lot 2 also works on the collection of

radiosonde intercomparison studies and their digitization. These enhance the ability to identify systematic differences in behavior between various types of instrumentation and for this reason facilitate homogenization of radiosonde time series.

2.1 Maintenance and updating the comprehensive upper air database

The contractor shall:

- Merge the comprehensive datasets as established in Cop1;
- Include new sources of data, such as to be provided via the data deposition service in Lot 1;
- Harmonize and convert observations to the CDM-OBS data model.

2.2 Provision of bias and uncertainty estimates

The contractor shall:

- Use the RAOBCORE/RICH method or a similar method that allows for an efficient and accurate homogenization of upper-air timeseries that updates bias estimates for upper-air temperature, upper-air humidity and wind;
- Use the method as developed by *Desrozier et al.* (2005) or similar method and provide error estimates for historical upper-air observations for temperature, humidity and wind;
- As specified in the introduction, dedicate a particular emphasis on the suitability of data usage for climate reanalysis.

2.3 Collection and evaluation of radiosonde intercomparison campaigns

The contractor shall:

- Collect additional sources of radiosonde intercomparison data;
- Convert such observations to the CDM-OBS data model;
- Establish systematic differences between different types of instrumentation to support homogeneity adjustments as applied in task 2.2.

Deliverables required: Regular versions of repositories for comprehensive upper-air and radiosonde intercomparison observations in the CDM-OBS format, provision of timely updates, inventory reports, ATBD for homogenization methods, bias and uncertainty estimates.

Task 3: Public provision of data services via the CDS.

In the CDS, each dataset has its own catalogue entry, containing an overview, download and documentation tab. Internally the data are organized in a database structure that currently reside at ECMWF using virtual machines as part of the backend of the CDS. An example of a baseline network is the GRUAN dataset (https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-observations-gruan-reference-network).
Following the requirements as stated in section 3.3.2, the contractor shall:

- Take over the current database structure and improve it such that it meets the requirements as set out in section 3.3.2;
- Provide human resources for development and technical support.

Deliverables required: Delivery of all data necessary for CDS ingestion, population of CDS catalogue entries for all reference, baseline and comprehensive datasets, provide and manage fit-for-purpose online backend repositories, timely updates and technical support, regular delivery of versions, capability to provide public access to at least the latest two versions, guarantee for a certain level of uptime, up-to-date documentation, user support, contribution to the C3S EQC function.

Task 4: Outreach and improvement of data policies.

In coordination with the C3S Communication team this involves maintenance of C3S web pages, contribution to web articles, tweets or press releases.

In addition, the bidder shall provide management of Intellectual Property Right (IPR) of the network providers. The bidder is expected to lobby in favour of the adoption of data licences to be more closely aligned with the open and free principles of the Copernicus Licence. This includes coordination with the entrusted Copernicus entity for in-situ observations (currently the EEA) and participation in international forums. The bidder shall act as an intermediate between network providers and ECMWF.

Deliverables required: Support the C3S Communication Team on the provision of web articles, tweets, press releases, relevant publications to the scientific and wider audience, measurable improvement of data policies such as reports and statements in writing.

Work packages

Work packages are to be organised along these four tasks. A separate work package WP0 shall be reserved for the overall management of the project.

2.2.3 Schedule

Activities shall be performed in the context of the service contract (with a maximum of 48 months). The start and kick-off meeting (KO) of the first service contract shall take place in the third quarter of 2021. The successful Tenderer for Lot 2 is expected to provide a detailed time plan and schedule as part of the tender response for the duration of 48 Months.

2.3 Lot 3: Access to high-resolution gridded datasets over Europe based on in situ observations

ECMWF intends to award *a single multi-annual service contract (maximum 48 months)* for services providing access to high-resolution gridded datasets of ECVs based on *in situ* observations within the European domain. The objective is to derive maximum benefit for climate services from existing European networks of observing sites managed by national meteorological, hydrological and environmental services. Goal is the provision of open access to gridded datasets.

In the context of this Lot "*in situ* observations" also include radar and other ground-based remote sensing or airborne data.

2.3.1 Scope of service

The work in this contract shall provide enhanced continuity for the data provision services as provided in Cop1 by contract C3S_311a Lot 4. The current activities within that contract embrace:

a) Collection and preparation of observations from high-density networks over Europe;
b) The provision of high-resolution gridded data sets of a number of ECVs over Europe;
c) The provision of derived climate indices via web services;
d) Contribution to monthly C3S climate bulletins, the annual European State of the Climate (ESOTC) and other outreach activities.

The new contract shall continue these activities. For (c), though, climate indices shall be provided via a CDS toolbox application, rather than through web services.

The European gridded dataset (E-OBS) is available in the CDS, while the Nordic Gridded Climate Dataset (NGCD) and the Long-term Alpine precipitation reconstruction (LAPrec) are in a mature state of preparation.

E-OBS is a daily gridded land-only observational dataset over Europe. It can be accessed at the CDS from: https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-gridded-observations-europe?tab=overview.

The E-OBS dataset is based on blended time series from the station network of the ECA&D project. All station data are sourced directly from the European National Meteorological and Hydrological Services (NMHSs) or other data holding institutions. For a considerable number of countries the number of stations used is the complete national network and therefore much denser than the station network that is routinely shared

among NMHSs (which is the basis of other gridded datasets). The density of stations gradually increases through collaborations with NMHSs within European research contracts.

Currently, E-OBS and LAPrec are strictly for use in non-commercial research and education projects only. Important goal of this follow-up contract is the relaxation of these limitations and to work towards open access (including commercial use).

Regarding collaboration and coordination, the selected Contractor for this Lot shall:

- Continue to work with stakeholders of ECA&D such as NMHSs in both EUMETNET and non EUMETNET member and partner countries.

2.3.2 Specification of work

The work is split between the following four tasks.

Task 1: Collection of input observations

The basis of the gridded E-OBS dataset is formed by the dense observational networks in Europe. In the current phase of Copernicus these are collected as part of the ECA&D project. ECA&D forms the backbone of the climate data node in the Regional Climate Centre (RCC) for WMO Region VI (Europe and the Middle East) since 2010. The data and information products contribute to the Global Framework for Climate Services (GFCS). The successful bidder shall:

- Make use of these activities and continue to collect observations from the ECA&D database;
- Explore the possibility to ingest observations from additional sources.

Deliverables required: Monthly updates of available datasets, provision of access to non-restricted observations, yearly status reports.

Task 2: Gridding of observations and provision of uncertainty estimate

In Cop1 the observational database as prepared in task 1, is gridded into the daily high-resolution E-OBS dataset on a 0.1 and 0.25-degree regular latitude-longitude grid. This involves several sub steps: (1) selection of observations based on quality control and license conditions, (2) homogenization of timeseries to resolve break points due to changes in instrumentation or station locations and (3) aggregation. This is performed for a range of meteorological quantities. Uncertainty estimates related to the representativity of observations within grid boxes are provided by ensembles of realizations. Depending on the variable, ensemble size ranges from 20 to 100 members. Details of the methodology can be found in *Cornes et al.* (2018).

The daily quantities currently range back to 1950, timely updates are provided with a delay of one month and new versions are released twice a year. The successful bidder shall:

- Make use of the ensemble methods (as described in *Cornes et al.* (2018)) and continue and evolve the E-OBS dataset or provide an alternative gridded dataset in case this improves error estimates;
- Deliver gridded ensembles that provide accurate estimates for sampling errors introduced by sub-grid variability for at least the following daily quantities: 2m temperature (minimum, average, maximum), amount of accumulated total precipitation, average mean sea level pressure, average surface downwelling shortwave radiation, average 2m relative humidity and average 10m wind speed;
- For each quantity, provide ensemble sizes of at least 20 members;
- Provide timely updates (as per deliverables required);
- Provide new versions twice a year that incorporate (a) any improvements in methodologies and (b) include more observations that have become available for usage in derived gridded products.

Deliverables required: E-OBS gridded ensemble dataset, monthly updates one month or less behind real time, bi-annual versions, ATBD on methodology.

Task 3: Public provision of gridded data services via the CDS.

3.1 Continuation and expansion of datasets in the CDS

As mentioned, in Cop1, E-OBS is publicly available in the CDS, while the NGCD and LAPrec are in an advanced state of development. The CDS backend of these datasets are hosted locally by the contractor (pull mode, see section 3.3.2 below for details and requirements). Access to individual ensemble members is not provided in the CDS and is limited to ensemble mean and spread only. The successful bidder shall:

- Maintain the provision of the E-OBS dataset in the CDS;
- Make available daily gridded products for all parameters as mentioned above;
- In addition to ensemble mean and spread, make available at least 20 individual ensemble members for each parameter;
- Maintain/introduce the provision of other gridded datasets, such as from NGCD and LAPrec;
- Provide all information in the CDS that is required for the calculation for climate indices as mentioned below in task 3.2;
- Provide fit-for-purpose and up-to-date comprehensive user documentation and ATBD (from task 2).

3.2 Provision of source code for the calculation of climate indices.

In Cop1, climate indicators from E-OBS data are provided via the following web service:

https://surfobs.climate.copernicus.eu/dataaccess/access_eobs_indices.php

The calculation of these indices is performed by the current contractor on individual E-OBS ensemble members and cannot be determined from the information in the CDS alone. The successful bidder shall:

- Continue the provision of such indices;
- Provide CDS toolbox source code (python-based), including tools to the CDS toolbox software library, for the calculation of all climate indices as listed in the above stated web service;
- Provide detailed guidance for a CDS application for the online calculation of all the climate indices in the above stated web services;
- Ensure that these purely act on data that will be publicly available from the CDS such that these can be reproduced by any C3S user.

An example of CDS toolbox source code is provided by the C3S European temperature statistics derived from ERA5 reanalysis:

https://cds.climate.copernicus.eu/cdsapp#!/software/app-health-temperature-exposure-current-climate?tab=appcode

Deliverables required: Delivery and maintenance of all data necessary for CDS ingestion, population of CDS catalogue entries for high-resolution gridded datasets, fit-for-purpose online backend datasets including timely updates, delivery of two new versions per year, capability to provide public access to an agreed number of previous versions, provide public access to at least 20 individual ensemble members for each parameter and for an agreed number of previous versions, guarantee for a certain level of uptime, up-to-date documentation (product user guide and for the datasets and the software tools), expert user support, contribution to the C3S EQC function, CDS toolbox source code for climate indices and detailed guidance for CDS a toolbox application.

Task 4: Outreach and improvement of data policies

In collaboration with the C3S Communication team this involves maintenance of C3S web pages, contribution to web articles, tweets or press releases.

C3S provides, within its Climate Intelligence activities, information and knowledge products based on the data held in the CDS. This includes, but is not limited to, the monthly and seasonal Climate Bulletins, the annual European State of the Climate, as well as a centralised provision to activities such as the WMO Statement on the state of the Climate. The three main regions considered are the globe, Europe and Arctic, as well as large sub-regions of the latter two. The timeliness required for finalisation of monthly and seasonal Climate Bulletins is a week, while for the annual State of the Climate it is 3 months.

The contractor is asked to provide products derived from the appropriate datasets with the timeliness required to be used by C3S in the above. Such products include derived indices, anomaly calculations etc. These products are to be accompanied by documentation of the method and the fitness-for-purpose of the product, as well as CDS toolbox-compatible processing tools. The contractor is further asked to provide interpretation of said product for the annual State of the Climate.

In addition, the bidder is expected to lobby in favour of the adoption of data licences that are more closely aligned with the open and free principles of the Copernicus Licence. This includes coordination with the entrusted Copernicus entity for in-situ observations (currently the EEA) and participation in international forums. The bidder shall actively engage with EUMETNET and other European network providers towards an open data licence (including commercial applications) for post-processed gridded products.

Deliverables required: Support the C3S Communication Team on the provision of web articles, tweets, press releases, relevant publications to the scientific and wider audience, input to the regular climate bulletins and reports issued by the C3S, measurable improvement of data policies such as reports and statements in writing.

Work packages

Work packages are to be organised along these four tasks. A separate work package WP0 shall be reserved for the overall management of the project.

2.3.3 Schedule

Activities shall be performed in the context of the service contract (with a maximum of 48 months). The start and kick-off meeting (KO) of the first service contract shall take place in the third quarter of 2021. The successful Tenderer for Lot 3 is expected to provide a detailed time plan and schedule as part of the tender response for the duration of 48 Months.

2.4 Cross cutting activities and synergies applicable to all Lots

2.4.1 Cross *in situ* meetings

Organized and led by ECMWF, each Lot shall participate in quarterly cross *in situ* teleconferences that address common denominators and improve interactions and collaboration.

2.4.2 Exchange of data collections

All Lots shall exchange observations and/or metadata where possible. In particular, Lot 1 will pass on any upper-air observations to Lot 2 that are acquired via their Data Deposition Service, and Lot 3 will provide observations from their underlying networks to Lot 1 where data licenses allow to do so.

2.4.3 Common Data Model for observations

All non-gridded observational data sets that are delivered to the service shall adhere to the CDM-OBS rules. In particular, for public facing datasets column names and units shall all follow the conventions in CDM-OBS, and a certain minimum set of attributes (such as date, time, latitude and longitude) are mandatory. Together with a representative from ECMWF, each Lot shall take membership in the CDM data governance body and shall participate in quarterly CDM governance teleconferences.

2.4.4 Coordination and synergies with other Copernicus services

Each Lot shall engage with the Copernicus In Situ Component (currently entrusted to the EEA) on request. This involves enhancement of data sharing, contribution to Copernicus-wide *in situ* communication activities and the provision of over-arching information to the EC.

To avoid duplication of work bidders shall seek synergies with other Copernicus services that operate similar activities on observations (e.g., in other physical domains). An example of this could be the exploration of synergies with the ITT for CEMS HYDRO & METEO observation collection (https://ted.europa.eu/udl?uri=TED:NOTICE:48764-2021:TEXT:EN:HTML).

Where bidders or subcontractors also participate in contracts on such activities in other Copernicus services, this shall be disclosed during negotiation and reflected in the tendered price.

3 General requirements

3.1 Schedule

The successful Tenderer for each Lot shall provide a detailed time plan and schedule as part of the tender response for the full period of 48 months. The proposed time plan and schedule shall address the main tasks, inputs, outputs, intermediate review steps, milestones, deliverables and dates. Regular progress meetings will be held with ECMWF during the contract to assess project status, risks and actions.

ECMWF has to prepare annual Implementation Plans, which must be approved by the European Commission before they can enter into force. The implementation plans will take full stock of service reviews, performed thoroughly on an annual basis, as well as of the continuously evolving user requirements and corresponding service specifications. The successful Tenderer shall therefore provide each year for ECMWF approval an updated detailed plan of proposed activities including Deliverables and Milestones, using the Work Package table template in Volume IIIB, which will form part of this Implementation Plan. The successful Tenderer has to report on a quarterly and annual basis (for more details please see Volume V Framework Agreement for this ITT).

3.2 Meetings

ECMWF organises annual meetings (General Assembly) to bring together all C3S service providers. At least one representative of the successful Tenderer shall attend these meetings. The Tenderer is also expected to attend monthly teleconference meetings to discuss C3S service provision, service evolution and other topics that cut across different aspects of C3S. The cost of attending these meetings shall be covered by each successful Tenderer and shall be included in the tendered price. The cost of organising and attending any additional meetings specific to each Lot shall also be covered by each successful Tenderer and shall be included in the tendered price.

3.3 Deliverables and milestones

Deliverables shall be consistent with the technical requirements as specified in section 2. These can be in the form of documents or reports, data sets or databases, software, web services and user support. A deliverable is a substantial, tangible or intangible good or service produced as a result of the 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 the technical contract officers at ECMWF. It will be good practice to organize deliverables along top-level objectives in order to limit their number.

Each Deliverable shall have an associated resource allocation (person-months and financial budget, resource type: payroll only). The total of these allocated resources shall amount to the requested budget associated with payroll.

Milestones shall be designed as markers of demonstrable progress in service development and/or quality of service delivery. They shall not duplicate deliverables. Apart from the payment milestone review meetings, all foreseen meetings shall not be classified as milestones but listed in a separate overview table for each work package.

Requirements for each type are described in the following subsections.

3.3.1 Documents and reports

All project 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). Public-facing reports (e.g., PUG, ATBD) may also be provided and maintained in HTML, where requested by ECMWF. Reports that need to be included into full-stock-of-service documents (Quarterly and Annual Implementation Reports, Draft and Final Implementation Plans) shall be provided in Microsoft Word.

3.3.2 Data sets

Data sets that are generated or acquired by the Tenderers shall be delivered via the Climate Data Store unless stated otherwise. The section below indicates generic requirements for these datasets in terms of standards and conformity.

Provision of data and products: Suppliers will make the output of their work available to C3S users via the CDS, by one of two methods:

a) uploading their data and products to a CDS virtual machine;
b) hosting them locally and providing them via web services (pull mode).

In the case of (a), suppliers will have to agree with ECMWF on the data formats to be used. ECMWF will only accept data in formats that follow internationally recognised standards. Such standards must be open (i.e. non-proprietary), managed by a recognised international standardisation body (e.g. ISO, WMO, OGC, etc.), or any de-facto standard.

All delivered non-gridded datasets shall be compliant with the CDM-OBS standard and in comma-separated values (CSV) form unless agreed otherwise with ECMWF. The delivery of database dumps is not accepted. This method of delivery has the preference for datasets that are relatively small (below several terabytes).

In the case of (b), suppliers will have to agree with ECMWF on the protocols to be used to invoke the web services. ECMWF will only accept protocols that follow internationally recognised standards. Such standards must be open (i.e. non-proprietary), managed by a recognised international standardisation process (e.g. ISO, WMO, OGC, etc), or be a de-facto standard. It should be noted that requests for these web services will 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 C3S. This method of delivery has the preference for larger datasets (exceeding several terabytes).

Every dataset and/or service provided shall be documented using the appropriate metadata standards (e.g. ISO 19115).

Non-gridded observational datasets: The provision of observations is inherently more complicated than access to gridded products due to their non-structured and unequal distribution in time and space. In addition, there is quite a variety of use cases, such as:

1. a user that requires all observations over the entire globe for one particular date and time;
2. a user that requires all observations in a local area, or single station, over the entire available period.

For both types of users, the CDS should provide efficient and easy access. Download speeds, including internal data gathering should be exceeding 1 megabyte per second. Currently, in Cop1, the technical

solutions mainly provide efficient access to requests of type (1); the solution followed by C3S_311c Lot 2, however, is also efficient for requests of type (2).

In addition, users are typically interested in subsets of observations, like a focus on particular variables, or subsets of metadata. To meet all these requirements, the contractors of Cop1 have provided database solutions that allow for bespoke data requests.

In the first two years of the Cop2 contracts, the successful Tenderers for Lot 1 and Lot 2 shall provide continuity of the current services and shall evolve these such that abovementioned requirements are met better. In parallel, C3S is planning the development of a generic solution for all non-gridded datasets that is to be tendered elsewhere. At the beginning of the third year, tenderers shall migrate towards that solution.

User applications or tutorials for CDS datasets shall build on the CDS toolbox.

Data and IPR: It is a condition of EU funding for C3S that ownership of any datasets developed with C3S 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 C3S for any purpose.

All software and products used by the successful Tenderer to produce the C3S datasets will remain the property of the successful Tenderer, except for those components which are acquired or created specifically for C3S purposes, with C3S funding, and which are separable and useable in isolation from the rest of the successful Tenderers' production system. The identity and ownership of such exceptional components will be passed to the European Union annually. The successful Tenderer will be granted a non-exclusive licence to use them for any purpose.

CDS catalogue entries: all public facing C3S datasets are represented in the CDS by dedicated catalogue entries. Each entry has an overview tab, a download tab and a documentation tab. The overview tab provides a short, clear overview of the dataset, gives information about coverage in space and time plus resolution. In addition, it provides a full list of all variables that are available to users. The download tab provides the interface to the user to access the data, while the documentation tab provides user guides, ATBDs and related relevant documents. In addition, a data licence provides information on terms and condition that users have to accept prior to usage. It is the responsibility for the successful Tenderer to populate all aspects of the catalogue entries and to provide and manage the backend of the CDS. The Tenderer shall work in close coordination with the CDS Team and the Technical Officer for the design, population and approval of catalogue entries.

3.3.3 Web services

Any web services and/or portals developed under contract with C3S shall be fully integrated in the C3S web portal following the guidance provided in the table below.

Activity	*Guidance*
Design	The existing templates and styles for the main service website (http://climate.copernicus.eu) must be used. The ECMWF Copernicus web officer will provide these on request.
Domain	Off-platform sites must be registered as a sub sub-domain of the main C3S sites (http://project.climate.copernicus.eu). The name will be agreed with the Copernicus web officer and registered by the European Commission once approved.
User journey	The user journey must start on the main C3S website via a dedicated landing page for the project. The sub sub-domain URL shall point to this page.
Content	All corporate and 'About us' project content will be published on the main service website and not duplicated on the microsite.
Navigation	A home button shall take users to the main websites' homepage.

Logos	Supplier logos shall not appear on the microsites. There will be a page on the service main website that reflects the contribution of suppliers.
Reporting	We require monthly Google Analytics reports for the microsites. These shall include at minimum: • Visits • Unique visits • Bounce rate • Traffic source • Document downloads There shall be an accompanying short explanation of the trends shown by the data.

Table 1: *Web services guidance*

3.4 Supporting activities

In addition to the dedicated core tasks of each Lot as described above, the Tenderer shall engage in a number of activities that are important to operate and support the service. These are typically intermittent and on request. For each Lot an indicative maximum budget of 12 PM can be allocated in the pricing table to accommodate all the needs as described in subsections 3.4.1 to 3.4.4. 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.

3.4.1 User support

ECMWF has established a centralised Service Desk to provide multi-tiered technical support to all users of C3S data, products, tools and services. The C3S Service Desk is used for ticketing user requests and distributing these requests to specialists as needed. Dedicated Copernicus User Support (CUS) staff at ECMWF provides basic support in the form of self-help facilities (Level-0; FAQs, knowledge base, tutorials, user forum, etc.) as well as individualised support on technical queries related to the CDS, data formats, data access etc (Level-1).

Each Tenderer shall provide in addition dedicated expert (Level-2) support. Support is provided to users through various channels and the contractor shall:

- Provide the Level-2 support through the Jira ticketing system with agreed KPIs (85% of Level-2 tickets should be resolved within 15-working days). The contractor shall provide an email address to the CUS Team which shall act as the single contact point;
- Transfer knowledge to user support by making contributions to the knowledge base. This may include user documentation and FAQs. Such documentation should be available in HTML format;
- Upon request, provide support to users through the user forum.

ECMWF may develop new channels for improvement of the user support function. The contractor will be communicated in advance where their involvement is required.

3.4.2 Contribution to the C3S Evaluation and Quality Control function

The successful bidder shall produce datasets/tools/applications following the quality assurance criteria set out by the C3S Evaluation and Quality Control (EQC) function and liaise with EQC (both C3S and its contractors) as appropriate. This includes (a) filling and updating the respective quality assurance templates (QAT) hosted in a Content Management System (CMS) to produce standardised quality assurance reports (QARs); (b) performing and documenting recommended data checks and tests ahead of publication; and (c) reviewing EQC material produced independently, in particular guidance to users.

3.4.3 Outreach activities

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 also need to be evaluated and reported on once complete so that success measures and KPIs can be provided to the European Commission.

3.4.4 User engagement and training activities

While user engagement and training activities are not part of the scope of this ITT as such, the bidder 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 Massive Open Online Courses (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 your mother tongue 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;
- Provide input to conceptional assessments and developments of specific user engagement plans and actions as launched by ECMWF.

The preferred bidder may be asked to fill out a table on user uptake relevant statistics during the negotiation/contract preparation phase. A template will be provided by ECMWF.

3.5 Provisions to allow for service continuity after the end of contract

The successful bidder shall develop a governance structure and operating rules together with the data custodians, to allow for continued operation of data services after the end of contract.

3.6 Key Performance Indicators

At the end of each year, a service readiness review shall take place that will include assessment of a set of Key Performance Indicators (KPIs). The KPIs shall be designed to quantify different aspects of quality of service against the requirements described in this document.

As part of the bid, the Tenderer shall specify a proposed set of KPIs appropriate for the service, e.g. relating to data access, user support, user satisfaction, etc. These initial specifications shall be refined together with ECMWF during the first 6 months of the contract.

Guidance can be found at https://op.europa.eu/en/publication-detail/-/publication/91e255c0-e5b2-11ea-ad25-01aa75ed71a1/language-en/format-PDF/source-172982372.

4 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.

4.1 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 must be followed wherever possible, to avoid excessive or wordy responses.

Section	*Page Limit*
Track Record	2 (for general) and 2 (per entity)
Quality of resources to be Deployed	2 (excluding Table 1 in Volume IIIB and CVs with a maximum length of 2 pages each)
Technical Solution Proposed	30 (Table 2 in Volume IIIB, the section on references, publications, patents and any pre-existing IPR is excluded from the page limit and has no page limit)
Management and Implementation	10 (excluding Table 4 and Table 5 in Volume IIIB) + 2 per each work package description (Table 3 in Volume IIIB)
Pricing Table	No limitation

Table 2: *Page limits*

4.2 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.

4.2.1 Executive summary

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

4.2.2 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.

4.2.3 Quality of Resources to be Deployed

The Tenderer shall propose a team providing the skills required for the provision of operational services that meet the technical requirements set out in section 2. The team shall include a Service Manager with at least 5 years of experience in management of large-scale projects. The Tenderer shall describe the experience of the Service Manager and the technical project team in performing activities related to the various aspects of this tender.

4.2.4 Technical Solution Proposed

The Tenderer shall give a short background to the proposed solution to demonstrate understanding of that solution and of the C3S context. This section shall also include information on any other third party suppliers that are used as part of the technical solution, and a statement of compliance for each requirement formulated throughout this document, describing how the proposed solution maps to the requirements.

4.2.5 Management and Implementation Plan

For each Lot, the Tenderer shall provide a detailed implementation plan of proposed activities for the duration of the framework agreement. Deliverables shall be consistent with the technical requirements specified in section 2. The number of milestones is not restricted, but they shall be designed as markers of demonstrable progress in service development and/or quality of service delivery. Adjustments to the proposed implementation plan can be made on a biennial basis depending on needs for service evolution,

changed user requirements, or other requirements as agreed between the European Commission and ECMWF.

As part of the general project management description the tenderer shall consider the following elements (this is not an exhaustive list):

- Monthly teleconferences with ECMWF and a proposal for involvement of ECMWF in major contract reviews shall be provided as part of the management plan.
- A proposed payment plan shall be provided as part of the proposal. The payment plan shall be based on payments for routine services and work packages and shall be based on milestones completion and associated deliverables for development related activities.
- The following management aspects shall be described: task and resources planning and tracking, quality assurance and control, communication management (ECMWF, stakeholders, internal communication), conflict resolution, subcontractor management, personal data management (i.e. how this meets the requirements of Clause 2.8 and Annex 6 of the Volume V Framework Agreement) and risk assessment and mitigation plans.
- A list of sub-contractors describing their contribution and key personnel, legal names and addresses shall be provided. The tenderer shall describe how the Framework Agreement, in particular Clause 2.9 has been flowed down to all their sub-contractors.

As part of the general contract management description, the Tenderer shall include the following elements in line with the reporting and planning requirements as laid down in the Terms and Conditions of the Framework Agreement. The table below provides the template to be used by the tenderer to describe the complete list of deliverables, milestones and schedules for the management work package (e.g. WP0, *cf*. template in Volume IIIB section 5.4). All milestones and deliverables shall be numbered as indicated and document deliverables shall be periodically updated and versioned as described in the table.

Deliverables for this work package shall include the following administrative and programmatic reports:

WP0 Contractual Obligations Template				
#	*Responsible*	*Nature*	*Title*	*Due*
D0.y.z-YYYYQQ	Tenderer	Report	Quarterly Implementation Report QQ YYYY *QQ YYYY being the previous quarter*	Quarterly on 15/01, 15/04, 15/07 and 15/10
D0.y.z-YYYY	Tenderer	Report	Annual Implementation Report YYYY *YYYY being the Year n-1*	Annually on 28/02
D0.y.z	Tenderer	Report	Final report	60 days after end of contract
D0.y.z-YYYY	Tenderer	Other	Preliminary financial information YYYY *YYYY being the Year n-1*	Annually on 15/01
D0.y.z-YYYY	Tenderer	Report	Draft Implementation plan YYYY *YYYY being the Year n+1*	60 days after signing of contract for Year N+1 Annually on 28/02
D0.y.z-YYYY	Tenderer	Report	Finalised Implementation plan YYYY *YYYY being the Year n+1*	Annually on 31/10
D0.y.z-YYYY	Tenderer	Other	Copy of prime contractor's general financial statements and audit report YYYY *YYYY being the Year n-1*	Annually

Table 3: Administrative and Programmatic Deliverables

Tenderers shall provide preliminary versions of the completed tables as part of their bid.

5 Additional information

5.1 References

Bojinski, S., M. Verstraete, T.C. Peterson, C. Richter, A. Simmons, and M. Zemp, 2014: The Concept of Essential Climate Variables in Support of Climate Research, Applications, and Policy. Bull. Amer. Meteor. Soc., 95, 1431–1443. Available at http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-13-00047.1

Cornes, R. C., van der Schrier, G., van den Besselaar, E. J., & Jones, P. D. (2018). An ensemble version of the E-OBS temperature and precipitation data sets. Journal of Geophysical Research: Atmospheres, 123(17), 9391-9409.

GCOS, 2015: Status of the Global Observing System for Climate. GCOS-195. Available at http://www.wmo.int/pages/prog/gcos/Publications/GCOS-195_en.pdf

Desroziers, G., Berre, L., Chapnik, B. and Poli, P., 2005. Diagnosis of observation, background and analysis-error statistics in observation space. Quarterly Journal of the Royal Meteorological Society: A journal of the atmospheric sciences, applied meteorology and physical oceanography, 131(613), pp.3385-3396.

Freeman, Eric, Scott D. Woodruff, Steven J. Worley, Sandra J. Lubker, Elizabeth C. Kent, William E. Angel, David I. Berry et al. "ICOADS Release 3.0: a major update to the historical marine climate record." International Journal of Climatology 37, no. 5 (2017): 2211-2232.

Haimberger, Leopold, Christina Tavolato, and Stefan Sperka. "Homogenization of the global radiosonde temperature dataset through combined comparison with reanalysis background series and neighboring stations." *Journal of Climate* 25.23 (2012): 8108-8131.

Hersbach, H., P. Poli, and D. Dee, 2015: The Observation Feedback Archive for the ICOADS and ISPD data sets. ERA Report Series, 18, ECMWF. Available at http://www.ecmwf.int/en/elibrary/9871-observation-feedback-archive-icoads-and-ispd-data-sets

Raoult, B., C. Bergeron, A. L. Alós, J-N. Thépaut, D. Dee, 2017: Climate service develops user-friendly data store, ECMWF Newsletter, 151, 22-27, Available at https://www.ecmwf.int/en/newsletter/151/meteorology/climate-service-develops-user-friendly-data-store.

Thorne PW, Madonna F, Schulz J, Oakley T, Ingleby B, Rosoldi M, Tramutola E, Arola A, Buschmann M, Mikalsen AC, Davy R. Making better sense of the mosaic of environmental measurement networks: a system-of-systems approach and quantitative assessment. Geoscientific Instrumentation, Methods and Data Systems. 2017 Nov 6;6(2):453-72.

5.2 Acronyms

ACMAD	African Centre of Meteorological Application for Development
ASCII	American Standard Code for Information Interchange
ACRE	Atmospheric Circulation Reconstructions over the Earth
ATBD	Algorithm Theoretical Basis Document
CAMS	Copernicus Atmosphere Monitoring Service
C3S	Copernicus Climate Change Service
CDM-OBS	C3S Common Data Model for OBServations
CDR	Climate Data Record
CDS	Climate Data Store
CH_4	Methane
CMS	Contents Management System
CO	Carbon monoxide

CO_2	Carbon dioxide
Cop1	Current phase; Copernicus Delegation Agreement until June 2021
Cop2	Next phase; Copernicus Contribution Agreement starting in July 2021
CSV	Comma-separated values ASCII format
CUS	ECMWF Copernicus User Support
ECMWF	European Centre for Medium-Range Weather Forecasts
ECA&D	European Climate Assessment and Dataset
EC	European Commission
ECA&D	European Climate Assessment and Dataset
ECV	Essential Climate Variable
EEA	European Environment Agency
ERA5	European ReAnalysis generation 5
E-OBS	European daily high-resolution gridded dataset
ESOTC	European State of the Climate
EQC	Evaluation and Quality Control function
EEA	European Environment Agency
EU	European Union
EUMETNET	European National Meteorological Services' network
E-OBS	European gridded dataset based on ECA&D information
FAQ	Frequently Asked Question
GAIA-CLIM	Gap Analysis for Integrated Atmospheric ECV CLImate Monitoring
GFCS	Global Framework for Climate Services
GCOS	Global Climate Observing System
GNSS	Global Navigation Satellite System
GNSS-PW	GNSS Precipitable Water
GPS	Global Positioning System
GRUAN	GCOS Reference Upper-Air Network
H2020	Horizon 2020
HTML	Hyper Text Markup Language
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
ICOS	Integrated Carbon Observation System
I-DARE	International Data Rescue Portal
IGRA	Integrated Global Radiosonde Archive
IGS	International GNSS Service
IMMA	International Maritime Meteorological Archive format
IPR	Intellectual Property Right
ISO	International Organization for Standardization
ITT	Invitation to tender
KNMI	Koninklijk Nederlands Meteorologisch Intituut
KO	Kick-Off meeting
KPI	Key Performance Indicator
LAPrec	Long-term Alpine precipitation reconstruction
Lot	One single contract within an ITT that embraces several contracts
MOOC	Massive Open Online Course
NCEI	National Centers for Environmental Information
NDACC	Network for the Detection of Atmospheric Composition Change
NGCD	Nordic Gridded Climate Dataset
NMHS	National Meteorological and Hydrological Service
ODB	Observation Data Base
OGC	Open Geospatial Consortium

ODB	ECMWF Observation DataBase
OSCAR	WMO Observing Systems Capability Analysis and Review Tool
PDF	Portable Document Format
PM	Person Month
PUG	Product User Guide
QA4ECV	Quality Assurance for Essential Climate Variables
QAR	Quality Assurance Report
QAT	Quality Assurance Template
RAOBCORE	RAdiosonde OBservation COrrection using Reanalyses
RCC	Regional Climate Centre
RICH	Radiosonde Innovation Composite Homogenization
RINEX	Receiver INdependent Exchange
SEF	C3S Station Exchange Format
SHADOZ	Southern Hemisphere ADditional OZonesondes
TCCON	Total Carbon Column Observing Network
URDB	User Requirement DataBase
USCRN	United States Climate Reference Network
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organisation
WOUDC	World Ozone and Ultraviolet Radiation Data Centre
WP	Contract Work Package