

ECMWF Copernicus Procurement

Invitation to Tender



Copernicus Climate Change Service Volume II

Provisions to environmental forecasting applications: Surface Global Forcing (Lot 1), Surface Global Land Information Mapping (Lot 2) and Multi-Model Hydrological Seasonal Predictions (Lot 3)

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1 Introduction

ECMWF as the Entrusted Entity for the Copernicus Climate Change Service (C3S) invites tenders for services related to operational service provision.

The C3S combines observations of the climate system with the latest science to develop authoritative, quality-assured information about the past, current and future states of the climate and the environmental impacts in Europe and worldwide. The C3S builds upon and complements capabilities existing at national level and being developed through many climate-change research initiatives.

The C3S aims to provide information to support the development of a climate resilient society. Through the Sectoral Information System (SIS), C3S has already procured 7 Proof of Concept elements (POCs), addressing the needs of sectoral users in water, energy, insurance, agriculture and urban-management sectors in Europe. In addition, in 2017 ECMWF built upon the experience gained from the POC contracts, and supported a further 7 operational activities. The existing SIS contracts are developing datasets and tools based on the Climate Data Store (CDS) infrastructure. Outputs include Global, European and regional CII (Climate Impact Indicators), ECVs (essential climate variables) tools, and Python scripts built using the CDS python libraries that run on the CDS Toolbox, to develop user driven, sector specific services.

To help achieving the best outcomes of the SIS activities, the C3S aims to provide as much information as possible to improve any sectoral and environmental prediction applications. This includes deriving high resolution (in space and time) data records covering a wide range of components of the earth system for past, present and future timescales.

This Invitation to Tender (ITT) focuses on developing prototype tools for global near present (i.e. with 2-3 days latency) / high frequency dataset of surface climate forcing variables (**Lot 1**) and global near-term (i.e. representative of last season/year) surface land information mapping (**Lot 2**), and on procuring seasonal hydrological predictions at a global level (**Lot 3**).

The three contracted activities together will maximize the use of past, current (and future) Earth Observation (EO) data from satellites (in particular from Copernicus missions) and *in situ* data and information coming from other Copernicus services, in conjunction with climate modelling and reanalysis. This will produce a consistent, comprehensive and credible description of the near-past, present and future boundary condition information specifically tailored for state-of-the art environmental prediction and sectoral climate applications, and of a number of land ECVs not yet served by the ECV contract. The C3S is complementary to research activities, such as the ESA Climate Change Initiative (CCI) and H2020 climate projects (e.g. IMPREX, BINGO). These address mainly the R&D needs for development of algorithms for generating prototype Surface Forcing Data Records (SFDRs) and Surface Land Information Mapping (SLIMs), while the C3S addresses the sustained production of SFDRs and LIMs with the state-of-the-art algorithms.

With a growing demand for global environmental forecasts (both at the medium range of up to a couple of weeks, and the seasonal range of several months) for downstream applications such as natural disaster prevention, water resources management, agriculture, energy production, tourism, international humanitarian aid etc., it is important to develop tools and information that will contribute to the quality of the forecasts. An operational system producing surface forcing and land mapping variables, as well as seasonal hydrological outlooks is an essential step towards the vision of global environmental forecasts of Copernicus.

This Invitation to Tender (ITT) is designed to procure a set of global surface climate variables and surface mapping that can be used as forcing and input data by global environmental prediction models, and the forecast output of a set of global seasonal hydrological prediction models. For the surface climate forcing (Lot 1), given the requirements for very localised information with short delay, the Tenderer shall develop and deliver generic methodologies as well as detailed datasets to be used directly in operational applications. For the surface mapping (Lot 2), the Tenderer shall consider the existing data sources, including from the Copernicus Land Monitoring Service. For the forecast output (Lot 3), the Tenderer shall define a mechanism to gradually incorporate the outputs generated by the other contracts (Lot 1 and Lot 2) in the operational production chain

Specific objectives and technical requirements are described in section 2 and 3 of this document. General implementation requirements are presented in section 4 and information about the tender format and content is in section 5.

2 Background

2.1 Global surface climate forcing and surface mapping datasets up to present

The purpose of this section is to provide background context of this ITT for Lot 1 and Lot 2.

Environmental applications (e.g. water, fire, energy etc.) require an accurate knowledge of the state of key variables describing the environment. For forecasting applications, this means access to surface climate forcing variables as close to the time of the forecast as possible (defined here as near-present or 2-3 days latency) to define as accurately as possible the initial conditions of the forecast, and surface mapping variables that describe the latest seasonal evolution of the land surface (defined as here near-term or 1-2 years latency).

In the context of environmental applications, precipitation and temperature are two critical surface forcing variable necessary for balancing the surface energy budget, and present some of the most challenging aspects of climate modelling. Other surface climate forcing variables, such as wind speed, solar radiation and humidity, are also important components of both energy and water budgets, and are directly or indirectly key elements of environmental modelling. As the diurnal cycle and short-term temporal variations in the surface climate forcings influence water and energy exchanges, information at sub-daily time scales is necessary to simulate the key processes of environment. Making these fields available through the CDS to a wide audience is expected to empower intermediate users and further enhance the downstream service markets.

The constant increase in model resolution means a good characterisation of the land surface is becoming increasingly important as changes in the land surface can affect local conditions as much if not more than the changes in the global climate. Surface mapping variables critical to environmental applications include land use cover, soil texture and orography, generally referred to Land Information Mapping, and require sustained production and regular updates for environmental models to accurately simulate land surface processes.

The C3S is providing records of Essential Climate Variables for historical periods; however, the information in its present form (e.g. spatial resolution, temporal resolution, latency) is not sufficient to make the high-resolution environmental seasonal predictions required by a range of sectoral applications. For specific applications including impact monitoring and prediction, the availability of near-present high quality data (as truthful a representation of reality as possible) is critical. This can be used to provide up-to-date initial states to be used as the starting point of future simulations. For earth system and environmental applications, this means knowledge of the state of near-surface

forcing and surface boundary conditions. In order to appropriately capture critical surface environmental dynamics, such as the simulation of river discharge at scales appropriate for energy production, simulation of agricultural yield, carbon balance in urban areas, etc., there is now a need for kilometre-scale resolution data which could be used as input to run latest generation environmental models, and deliver environment forecasts appropriate for a wide range of sectoral applications.

In the context of an operational service, this data must be delivered reliably (i.e. with limited risk of failure in the acquisition chain), at a frequency consistent with the operational update needs, and with temporal and horizontal resolutions appropriate for downstream applications. This means to keep the delay between data acquisition, data processing and delivery as short as possible, especially for fast evolving variables such as precipitation.

2.2 Seasonal hydrological simulations

The purpose of this section is to provide background context of this ITT for Lot 3.

C3S aims at facilitating the emergence of a downstream market of climate services with the ultimate goal of supporting the development of a climate smart society. Central to this vision is the free and unrestricted distribution of high-quality climate data through the Climate Data Store. Two of the most popular datasets are the seasonal predictions and the reanalyses.

A number of recent papers (e.g. Wanders et al. 2019, Greuell et al. 2018, Arnal et al. 2018) have shown that whilst seasonal predictions of atmospheric variables have limited skill especially over Europe, the long-memory processes (snow cover and melt, soil moisture, groundwater recharge, etc.) associated to surface hydrology may add extra predictability for a number of land ECVs of great user relevance (e.g. discharge, ET, ..). However, the way land surface and hydrological processes are represented differs with models, resulting in uncertainty in the hydrological simulations due to hydrological models. Whilst the impact of hydrological modelling uncertainty has been demonstrated for climate change impact projections, the importance of using a multi-(hydrological) modelling approach to produce hydrological outlooks, and how the differing ensemble influence decision making has not yet been fully evaluated. This is partly because robust skill assessments require the generation/ availability of comprehensive sets of hydrological hindcasts (or reforecasts) - which at a global scale require heavy computational and archiving resources. In addition, existing operational hydrological seasonal forecasts systems rely on models with different spatial and temporal resolutions, based on different surface climate and land forcing, hence making any combination or comparison of results challenging.

Currently at the global scale, C3S offers a multi-model operational seasonal forecasting system but only for surface climate variables. The creation of a multi-model hydrological seasonal forecasting system generating in a consistent manner, at the same resolution, comparable operationally monthly hydrological outlooks would enable for robust assessment of hydrological modelling uncertainty in hydrological seasonal forecasting and how this could help more robust downstream applications and decision making.

In the context of an operational service, this data must be delivered reliably (i.e. with limited risk of failure in the acquisition chain), at a frequency consistent with the operational update needs (i.e. monthly at this stage in time). This means to keep the delay between data processing and delivery as short as possible.

The Tender is part of the implementation of the C3S. For this reason the Tenderer is expected to liaise and interface with the other components of the programme (e.g. user-support, training,

communication etc.) as well as with other relevant C3S contracts (e.g. EQC, CDR, ECVs, Reanalysis, ...) and other Copernicus services (e.g. CEMS, CAMS, CLMS,...) and to attend the C3S General Assembly (Warsaw, 28/10-01/11 2019).

3 Technical requirements

The technical requirements for all three Lots are specified in this chapter.

One contract is expected to be signed for each Lot.

3.1 Lot 1: Up to present global surface climate forcing datasets

3.1.1 Scope of service

The service shall deliver algorithms, acquisition and modelling chains to produce a set of near-present, kilometre-scale hourly surface climate forcing dataset products, generate associated hourly Surface Forcing Data Records (SFDRs) and make them available through the CDS. This is expected to support the delivery of environmental forecasts for downstream applications across various sectors, including water, food, energy and transport.

To reach these resolutions, interpolation beyond the scale at which the information exist will be required; therefore, the tendered shall characterise the additional error/uncertainty introduced by the algorithm and included in the dataset. The ITT shall also apply the same algorithms that will be developed to generate a multi-year global Surface Forcing Data Records extending to present, in order to complement, build upon and enhance the Climate Data Records already procured by C3S.

There are challenges involved in obtaining good quality, reliable and frequent surface climate forcing data in near-present, including:

- the spatial coverage and density of in-situ networks (especially for global systems), their maintenance and the quality of their measurements;
- the relevance and horizontal resolution of indirectly measured variables, typically from Earth Observation systems (e.g. radar, satellite, Cosmic probes etc...);
- the long-term sustainability of the service;
- data licensing terms and conditions can be a barrier in transferring and using data to new entities, especially when the measurements are under strict intellectual properties rights.

The tenderer should explicitly describe in the proposal their strategy to address those challenges.

Despite those challenges, new continental or global scale datasets have emerged in the recent years from research and development projects (see review by Sun et al., 2017¹). Examples of catalogues of existing datasets include the UCAR 'Climate Data Guide'², the ERSI 'Gridded climate Datasets'³. For precipitation those can be derived from single source (in-situ, e.g. CRU TS, GPCC, WFDEI, APHRODITE, PREC/L; or satellite, e.g. CHOMPS) and merged sources (i.e. satellite-gauge products, e.g. GPCP, CMAP,

¹ Sun, Q., Miao, C., Duan, Q., Ashouri, H., Sorooshian, S., & Hsu, K.-L. (2018). A review of global precipitation data sets: Data sources, estimation, and inter-comparisons. *Reviews of Geophysics*, 56, 79–107. <https://doi.org/10.1002/2017RG000574>

² <https://climatedataguide.ucar.edu/climate-data>

³ <https://www.esrl.noaa.gov/psd/data/gridded/tables/subdaily.html>

TRMM 3B42) or reanalysis (i.e. modelled with observation assimilation, e.g. ERA5). Datasets that exploit state-of-the-art hourly reanalysis opportunely combined with in-situ observations and other satellite-based information can be particularly adapted to the service. However, the quality, resolution and update frequency of diverse observational datasets vary largely, with only a fraction providing a near-present service.

SFDRs are expected to be derived from a mixture of data sources to achieve global coverage to the maximum extent possible with the finest time step and update frequency possible; this includes in-situ data, earth observations including satellite, and re-analysis. The table below specifies the SFDRs to be addressed and the associated target requirements.

A number of global data sources have already been identified and catalogued by various agencies including Copernicus⁴ and NOAA⁵.

The successful Tenderer shall deliver:

- 1) **all ‘priority 1’ variables and**
- 2) **at least 3 ‘priority 2’ variables.**

All data should be compliant with the common data model of the CDS (e.g. GCOS ECVs and follow CF conventions). They should be provided at a spatial resolution of 0.01° degree and an hourly temporal resolution, as close as possible to instantaneous values.

	Flux Variables (over an hour)	State Variables (at valid time)
Priority 1	Total precipitation	2-m air temperature
		2-m air relative humidity
Priority 2	Downwelling short-wave incoming radiation	Surface pressure and associated elevation
	Downwelling long-wave incoming radiation	10-m wind speed (or wind components)
	Rainfall / snowfall partitioning	10-m wind direction (or wind components)

Table 1: Surface Forcing Data Records (SFDRs) and associated target requirements

Whenever appropriate and practical, the contract shall also contribute to the C3S activities, e.g. climate monitoring (e.g. GCOS and policy implementation), other Copernicus services (e.g. CEMS, CAMS, CLMS,..) and other initiatives (e.g. EUMETSAT SAFs, and ESA-CCI).

The scope of contract shall be based on following specifications:

- Focus on the definition of SFDR characteristics (record length, consistency, and continuity to determine climate variability and change);
- Focus on the *routine* and *timely (near-present)* production and delivery of state-of-the-art SFDRs of ECVs based on observations, including estimates of uncertainty/ accuracy (time step, update frequency, latency);
- Focus on using data streams that are suitable for operational services;

⁴ <https://land.copernicus.eu/global/products/>

⁵ <https://www.ncdc.noaa.gov/gosic/gcos-essential-climate-variable-ecv-data-access-matrix>

- Focus on using data streams that are fully traceable to source, with preference given to data with full and unrestricted access;
- Focus on the *sustained* delivery of global products at the *planetary scale*, using an agile re-processing system delivering the global SFDR products with existing algorithms;
- Enable *brokering* of existing data sets if already available;
- Capitalize on state-of-the-art algorithms to harmonize existing data sources to produce the SFDRs, using either multiple or single sources according to requirements (see table above)
- Follow ECMWF guidelines on how to coordinate the activity with key European data providers, such as EUMETSAT and its SAFs, ESA and its CCI, and other Copernicus services (e.g. CEMS, CAMS, CLMS).

As a minimum, the successful tenderer shall implement the specifications through following activities:

- Review existing surface climate forcing datasets and associated methods, and provide a critical evaluation of their transferability to a reliable, sustainable daily operation in near-present to produce global kilometre-scale products conducted within the initial 3 months of the contract, and propose an algorithm, workflow and data sources envisaged for the operational implementation
- Define and document the productions protocols and standards, dataset formats, metadata information, quality assurance methods and licencing agreement to ensure compliance with the EQC framework developed by C3S. Following an agile methodology, production protocols might evolve to reflect feedback from quality checks of data, with a first draft delivered within 6 months of the start of the contract, and final methodology delivered at the end of the contract.
- Develop a prototype multi-source surface climate forcing modelling chain including data acquisition, data processing, quality assurance and delivery within the initial 9 months of the contract. This shall be designed to a high standard with the assumption that could be used by third parties as a methodology of reference.
- Generate a kilometre-scale global hourly surface climate forcing dataset of minimum two years and extending up to 5 years back in the past
- Initiate the operational production of kilometre-scale global hourly surface climate forcing dataset in near-present as a demonstration dataset.
- Develop a method to quantify the uncertainty/ attribute data quality flags to the generated surface climate forcing, e.g. accounting for the number of different data types used, distance (for in-situ data) to interpolated value, latency time of latest observation for each time step.
- Define quality flags and KPI indicating possible breaks in the acquisition process
- Ensure the demonstration dataset is ready to be made available in the C3S Climate Data Store (e.g. manifest file, compliance with C3S Common Data Model, ...) by the end of the contract
- Prepare a road-map to operation summarising the key steps necessary for a smooth transition to an operational service
- Document the procedure followed and develop appropriate training and supporting material.

A number of independent C3S activities, which are not part of this ITT, are being implemented to complement the scope of this tendered service. In particular:

- An Evaluation and Quality Control (EQC) function, which will assess the quality and suitability (fitness-for-purpose) of C3S products and services from a user perspective;
- A Climate Data Store (CDS) to provide access to ECV products, including those delivered by this service, as well as climate model output, reanalysis products;

- Outreach and dissemination activities to promote uptake of C3S data by various user communities.

The successful Tenderer shall put in place all necessary mechanisms to ensure the outputs of this contract will be fully compliant with the activities above. Furthermore, the successful Tenderer is expected to liaise and interface with other Copernicus services (e.g. CEMS, CAMS, CLMS, etc.).

Therefore, the scope of this tendered service does not include:

- **Development and assessment of new algorithms performed in existing R&D activities such as the CCI, H2020 projects, etc.;**
- **Development of data portals and data dissemination systems not based on the CDS/Tool box.**

The service shall be primarily designed to support monitoring and seasonal predictions for application sectors (e.g. water, agriculture, infrastructure) including operational service. It is expected that business and entrepreneurs developing climate services (e.g. GFCS, Small-Medium Enterprises) will benefit directly from this activity.

3.1.2 Specification of work

C3S_432_Lot1 Work package 0: Management and coordination activities

This work package will focus on contract management, including internal controls and coordination of subcontractors, links with other Copernicus services, organisation of workshops/meetings, risk management and tracking of the key performance indicators.

Deliverables expected:

Deliverables covering the contractual and financial reporting obligations towards ECMWF in line with the Terms and Conditions of the Framework Agreement shall be covered under WP0:

- Quarterly Implementation Reports, due 15 days after the end of each calendar quarter;
- Annual Implementation Reports, due annually on 28 February;
- Preliminary financial information, due annually on 15 January;
- Draft and final Implementation Plans for the year N+1, due respectively in February and October of the year N;
- Letter from the auditors referred to in Clause 2.3.1.4 of the Framework Agreement;
- Final report, due 60 days after the end of the Framework Agreement.

C3S_432_Lot1 Work package 1: Data source analysis and definition of the scope (Month 1-6)

After a review of existing surface climate forcing datasets and associated methods and the possible applicability to a reliable, sustainable hourly operation in near-present on the CDS, the successful Tenderer will produce a document describing the different existing methods used for production of global kilometre-scale products conducted within the initial 3 months of the contract, and propose an algorithm, workflow and data sources envisaged for the operational implementation.

This WP will also define and document the productions protocols and standards, dataset formats, metadata information, quality assurance methods and licencing agreement to ensure compliance with the EQC framework developed by C3S. Finally, it will include a methodology to quantify the uncertainty/ attribute data quality flags to the generated surface forcing for each time step, and definition of quality flags and KPI indicating possible breaks in the acquisition process.

Deliverables expected:

- A document describing the different existing methods used to produce global kilometre-scale surface climate forcing datasets (T0+3);
- A document describing the setup (algorithms, workflows, and output data streams) that will be used during the operational implementation (T0+ 6).

C3S_432_Lot1 Work package 2: Prototyping (Month 3-9)

WP2 will take care of developing a prototype multi-source surface climate forcing modelling chain including data acquisition, data processing, quality assurance and delivery within the initial 9 months of the contract, with delivery of a first prototype for review at month 6. It is expected for the modelling chain to be implemented in a programming environment compatible with those supported at ECMWF (e.g. Python, Fortran, ..)

Deliverables expected:

- An initial (T0+6) and fully working (T0+9) prototype;
- A sample dataset –inclusive quality assurance information- generated through the prototype and covering at least 2 months;
- A set of files (called pseudo-manifest files in the C3S jargon) describing in detail the characteristic of the data (including naming convention, directory structure, metadata structure, etc. ...) to facilitate the integration of the data onto the CDS;
- Full documentation and user manual for the prototype.

C3S_432_Lot1 Work package 3: Data production (Month 6 - 12)

This WP will be devoted to the operational production of the data. This include both the near-present generation of the data and the Climate Data Record extending as minimum 2 years back in time.

Deliverables expected:

- A short climate record extending 2 years back in time (T0+11);
- An operational stream of near-present data ready to be integrated on the CDS (T0+12).

C3S_432_Lot1 Work package 4: Support and help development (Month 9-12)

This WP focuses on the preparation for the future operational transition.

Deliverables expected:

- A document summarising the key steps towards the integration of the methodology into operation (T0+12);
- A knowledge-based document for C3S User Support purposes (T0+12).

3.2 Lot 2: Up to present surface land information mapping datasets

3.2.1 Scope of service

The service shall deliver algorithms, acquisition and/or modelling chains able to produce a set of near-term kilometre-scale global Surface Land Information Mapping (SLIM) which shall then be made available through the CDS.

SLIMs are expected to be derived from a mixture of data sources to achieve global coverage to the maximum extent possible with the finest time step and update frequency possible; this includes in-

situ data, earth observations including satellite, and re-analysis. Table 2 specifies the SLIMs to be addressed and the associated target requirements.

A number of global data sources have already been identified and catalogued by various agencies including Copernicus (<https://land.copernicus.eu/global/products/>). It is expected that the contractor will build on these datasets and adapt them to facilitate their use/ingestion into an operational environmental modelling chain.

The successful Tenderer shall deliver:

- 1) **all ‘priority 1’ variables;**
- 2) **at least 1 variable of ‘priority 2’.**

Priority	Annual/Monthly Maps	Static Maps
Priority 1	Land Use Land Cover	Orography
	Surface Water Bodies	Soil Texture
	Vegetation state indicators	
Priority 2	Human settlement morphology	Soil depth
	Permafrost	

Table 2: Portfolio of the SLIMs addressed by the C3S

The service shall be primarily designed to support monitoring and seasonal predictions for environmental applications (e.g. water, agriculture, infrastructure) including operational services. It is expected that Business and entrepreneurs developing climate services (e.g. GFCS, Small-Medium Enterprises) will benefit directly from this activity.

Whenever appropriate and practical the contract shall also contribute to other C3S activities (e.g. climate monitoring), other Copernicus services (e.g. CEMS, CAMS, CLMS,..) and other international initiatives (e.g. EUMETSAT SAFs, and ESA-CCI).

The scope of contract shall be based on following specifications:

- Focus on the definition of SLIM characteristics (record length, consistency, and continuity to determine climate variability and change);
- Focus on the routine and timely (near-term climate) production and delivery of state-of-the-art SLIMs that is EO-based, including estimates of uncertainty/ accuracy (number of EO-data considered);
- Focus on using data streams that are suitable for operational services;
- Focus on using data streams that are fully traceable to source, with preference given to data with full and unrestricted access;
- Focus on the sustained delivery of global products at the planetary scale, using an agile re-processing system delivering the global SLIM products with existing algorithms;
- Enable brokering of existing data sets if already available and meeting the Terms of Reference;
- Capitalize on state-of-the-art algorithms to harmonize existing data sources to produce the SLIMs, using either multiple or single sources according to requirements of the table above;
- Follow ECMWF guidelines on how to coordinate the activity with key European data providers, such as EUMETSAT and its SAFs, ESA and its CCIs, and other Copernicus services (e.g. CEMS, CAMS, CLMS). It is expected that the Tenderer will take full advantage of the products developed by other Copernicus services and will maximise the use of Copernicus Land Monitoring Services.

The successful tenderer shall implement the specifications through following activities:

- Review of existing boundary conditions datasets and associated methods, and critic of their transferability to a reliable, sustainable yearly updated operation for Global Surface Mapping for global kilometre-scale maps products conducted within the initial 3 months of the contract, and propose an algorithm, workflow and data sources envisaged for the operational implementation
- Define productions protocols and standards, dataset formats, metadata information, quality assurance methods, licensing agreements to put in place etc... all described in a report. Following an agile methodology, production protocols might evolve to reflect feedback from quality checks of data, with a first draft delivered within 6 months of the start of the contract, and final methodology delivered at the end of the contract.
- Develop a prototype multi-source land-use mapping for modelling chain including data acquisition, data processing, quality assurance and delivery within the initial 9 months of the contract. This shall be designed to a high standard with the assumption that could be used by third parties as a methodology of reference.
- Generate kilometre-scale global maps from a Near-Term-Climate period (based on EO-data within the last 10 years), as close as possible to real time as a demonstration dataset. It should be delivered in a NetCDF standard format and be associated with complete metadata between month 3 and month 9.
- Initiate the operational production of kilometre-scale global surface mapping dataset as a demonstration dataset.
- Develop a method to quantify the uncertainty/attribute data quality flags to the generated land-use-land-cover map, e.g. comparing 2-different sources and differences with the currently use data sources in C3S and that could guide uncertainty modelling.
- Define quality flags and KPI indicating possible breaks in the acquisition process
- Ensure the demonstration dataset is ready to be made available in the C3S Climate Data Store (e.g. manifest file, compliance with C3S Common Data Model, ...) by the end of the contract
- Prepare a road-map summarising the key steps necessary for a smooth transition to an operational service
- Document the procedure followed and develop appropriate training and supporting material.

The Tenderer is expected to develop new algorithm, acquisition and modelling chains to produce Near Term Climate Mapping at kilometre-scale for Surface Mapping Data Record and make them available in the CDS as an operational service. This is expected to support the delivery of environmental forecasts for downstream applications across various sectors, including water, food, energy and transport.

Therefore, the scope of this tendered service does not include:

- **Development and assessment of new algorithms performed in existing R&D activities such as the CCI, H2020 projects, etc.;**
- **Development of data portals and data dissemination systems not based on the CDS/Tool box.**

There are challenges involved in obtaining good quality, reliable and frequent surface mapping data, including:

- the spatial coverage and classification of information (especially for global systems);
- the relevance and horizontal resolution of indirectly measured variables, typically from Earth Observation systems (e.g. radar, satellite, etc...);
- and the long-term sustainability of the service.

In addition, data licensing terms and conditions can be a barrier in transferring and using data to new entities, especially when the measurements are under strict intellectual properties rights.

A number of independent C3S activities, which are not part of this ITT, are being implemented to complement the scope of this tendered service. In particular:

- An Evaluation and Quality Control (EQC) function, which will assess the quality and suitability (fitness-for-purpose) of C3S products and services from a user perspective;
- A Climate Data Store (CDS) to provide access to ECV products, including those delivered by this service, as well as climate model output, reanalysis products;
- Outreach and dissemination activities to promote uptake of C3S data by various user communities.

The Tenderer shall put in place all necessary mechanisms to ensure the outputs of this contract will be fully compliant with the activities above.

3.2.2 Specification of work

C3S_432_Lot2 Work package 0: Management and coordination activities

This work package will focus on contract management, including internal controls and coordination of subcontractors, links with other Copernicus services, organisation of workshops/meetings, risk management and tracking of the key performance indicators.

Deliverables expected:

Deliverables covering the contractual and financial reporting obligations towards ECMWF in line with the Terms and Conditions of the Framework Agreement shall be covered under WP0:

- Quarterly Implementation Reports, due 15 days after the end of each calendar quarter;
- Annual Implementation Reports, due annually on 28 February;
- Preliminary financial information, due annually on 15 January;
- Draft and final Implementation Plans for the year N+1, due respectively in February and October of the year N;
- Letter from the auditors referred to in Clause 2.3.1.4 of the Framework Agreement;
- Final report, due 60 days after the end of the Framework Agreement.

C3S_432_Lot2 Work package 1: Data source analysis and definition of the scope (Month 1-6)

After a review of the existing surface land mapping information datasets and associated methods and the possible applicability to a reliable, sustainable annual update on the CDS, the successful Tenderer will produce a document describing the different existing methods used for production of global kilometre-scale products conducted within the initial 3 months of the contract and propose an algorithm, workflow and data sources envisaged for the operational implementation.

This WP will also define and document the productions protocols and standards, dataset formats, metadata information, quality assurance methods and licencing agreement to ensure compliance with the EQC framework developed by C3S. Finally, it will include a methodology to quantify the uncertainty/ attribute data quality flags to the surface land information mapping so generated, for each time step, and definition of quality flags and KPI indicating possible breaks in the acquisition process.

Deliverables expected:

- A review document highlighting pros and cons of different datasets and methodologies (T0+3);

- A document describing the setup (workflow and data production) that will be implemented (T0+6).

C3S_432_Lot2 Work package 2: Prototyping (Month 3-9)

WP2 will take care of developing a prototype multi-source surface mapping modelling chain including data acquisition, data processing, quality assurance and delivery within the initial 9 months of the contract. It is expected that, for the modelling chain to be implemented, the programming environment will be compatible with those supported at ECMWF (e.g. Python, Fortran).

Deliverables expected:

- A fully working prototype;
- A sample dataset –inclusive quality assurance information- generated through the prototype and covering at least two different years (T0+6);
- A set of files (called pseudo-manifest files in the C3S jargon) describing in details the characteristic of the data (including naming convention, directory structure, metadata structure, etc. ...) to facilitate the integration of the data onto the CDS;
- Full documentation and user manual for the prototype.

C3S_432_Lot2 Work package 3: Data production

This WP will be devoted to the operational production of the data. This includes both the operational generation of the data and the surface land information mapping records extending as minimum 2 years back in time.

Deliverables expected:

- A short near-term surface land information mapping extending over 2 different years in previous decade;
- An operational stream of SLIM ready to be integrated on the CDS.

C3S_432_Lot2 Work package 4: Support and help development

This WP focuses on the preparation for the future operational transition.

Deliverables expected:

- A document summarising the key steps towards the integration of the methodology into operations;
- A knowledge-based document for C3S User Support purposes.

3.3 Lot 3: Operational Multi-model hydrological seasonal forecasts

3.3.1 Scope of service

The main goal of this Lot of the ITT is to procure the outputs of a set of global operational seasonal predictions of hydrological variables (a full list is defined in Table 3). The primary output of the contract will be data which shall be available on the CDS.

The approach intends to build upon the experience of previous multi-model ensemble projects Earth2Observe (Schellekens et al., 2016), ISI-MIP (Warszawski et al., 2014), Water-MIP/WATCH (Hadelland et al., 2011), GSWP3 (<http://hydro.iis.u-tokyo.ac.jp/GSWP3/>), and extends and adapt it for the seasonal operational production.

The forcing will be constituted by C3S seasonal predictions and hindcasts ensembles with focus on the period 1993-2019. For simplicity the simulations shall all initially use ECMWF S5 ensemble as forcing but should gradually incorporate the forcing from the other models which constitute the C3S seasonal prediction ensemble. As in Earth2Observe the forcing shall be bilinearly interpolated to 0.25° in higher resolution including a topographic adjustment for temperature using an appropriated environmental lapse rate. Global simulations can be performed at 0.25° or higher resolution and their outputs, for all variables excluding discharge, shall be provided on a standard regular latitude-longitude grid at 0.25° (equal to the seasonal forcing data) to simplify multi-model post-processing tasks. Discharge shall be provided on a standard regular latitude-longitude grid at 0.1° grid as well as for a list of 50 pre-defined locations (to be provided by ECMWF at the inception of the contract). The grid-points not represented by the model (e.g. ocean or lakes) should be set to missing value in the output. The simulations shall be provided at daily frequency. For models that run a sub-daily time-step, the daily means shall be computed from all model time-steps. The Tenderer shall provide the raw outputs from all ensemble members.

The simulations shall be performed each month as soon as the seasonal prediction becomes available (13th of the month to become 10th in the months to come), as a minimum for the following 3 months.

The decision on how to initialise the hydrological simulation will be initially left entirely to the Tenderer. Successful Tenderer is expected to progressively take advantage of the new datasets that will be produced by Lot1 and include those datasets into the initialisation of their models.

Similarly to the initialisation, the static fields (e.g. land cover) will be initially defined by the Tenderer and are expected to progressively take advantage of the new datasets that will be produced by Lot 2.

Name	Long name	Standard name	Units	Def.	Positive direction
AvgSurfT	Average surface temperature -	surface_temperature	K	Average of all vegetation, bare soil and snow skin temperatures	
Total Precip	total precipitation	precipitation_flux	kg m-2 s-1	Average of total precipitation (Rainf+Snowf)	downwards
Actual Evap	Total evapotranspiration	water_evaporation_flux	kg m-2 s-1	Sum of all evaporation sources, averaged over a grid cell	downwards
PotEvap	potential evapotranspiration	water_potential_evaporation_flux	kg m-2 s-1	The flux as computed for evapotranspiration but will all resistances set to zero, except the aerodynamic resistance.	downwards
SWE	Snow water equivalent	Snow_water_equivalent	Kg m-2	The amount of liquid water contained within the snow pack	Into grid cell
Qsm	snowmelt	surface_snow_melt_flux	kg m-2 s-1	Average liquid water generated from solid to liquid phase change in the snow	solid to liquid

TotVolISM	Percentage of water wrt the available volume	Total volumetric soil moisture	%	Volumetric soil moisture content in the soil layers at the end of each model time step	Into grid cell
Runoff	Total runoff	runoff_flux	kg m ⁻² s ⁻¹	Average total liquid water draining from land	into grid cell
DisPoint	Discharge (gauge level)	N.A	m ³ s ⁻¹	Water volume leaving the cell	downstream
Dis	Gridded river discharge	N.A	m ³ s ⁻¹	Water volume leaving the cell	downstream

Table 3: List of deliverable variables and conventions (attribute) standard_name

The Tenderer should also provide additional ancillary data descriptions that will enable the interpretation of the variables described in table, at the relevant resolution (e.g. 0.25° and at the discharge routing resolution). This includes, but should not be restricted to, upstream catchment area, soil information (type of soil and soil depth), land cover (including vegetation type) and the Digital Elevation Model.

Whenever appropriate and practical, the contract shall also contribute to the C3S activities such as for example climate monitoring, and their interface with other Copernicus services (e.g. CEMS, CAMS, CLMS,..) and other international initiatives (e.g. EUMETSAT SAFs, and ESA-CCI).

The tendered service shall:

- Focus on the routine and timely production and delivery of the forecast for the variables above; it will be their responsibility to make the data available on the CDS on a regular basis;
- Deliver the initialisation simulations for the period 1993-2019 using ERA5 forcing. The 1979-1993 period is suggested for testing/spin-up time;
- Deliver the hindcast hydrological simulations for the period 1993-2019 and ensure they are fully consistent with the SEAS5 forecasts provided;
- Focus on the sustained delivery of global products at the planetary scale; the data shall be made available to ECMWF no later than the 15th of the month;
- Follow ECMWF guidelines on how to coordinate the activity with key Copernicus data providers, such as CEMS GloFAS system.

The aim of Lot 3 is to generate a global forecast dataset at a daily resolution updated every month, that could be used for a number of applications related to water. It is expected that the outputs of this Lot of the ITT will constitute the inputs that downstream users can use to develop their own value-added services (e.g. services for agriculture, water supplies, hydropower etc.). Note that the current call is designed to cover only the operational implementation and running of the models. The Tender shall not include any model development activity that is not strictly functional to the transition into operation.

Therefore, the scope of this tendered service does not include:

- ‘Blue-sky’ hydrological research
- Development and assessment of new model configurations unless the development is strictly necessary to comply with the requirements of this ITT

- **Development and assessment of new algorithms performed in existing R&D activities such as the CCI, H2020 projects, etc.;**
- **Development of data portals and data dissemination systems not based on the CDS/Tool box.**

The successful tenderer shall:

- Define and document the productions protocols and standards, dataset formats, metadata information, quality assurance methods and licencing agreement to ensure compliance with the EQC framework developed by C3S⁶.
- Develop an operational modelling chain including data acquisition, data processing, quality assurance within the initial 6 months of the contract.
- Push the data generated onto the CDS in a way that is compliant with C3S requirements (e.g. Common Data Format, harmonised table, manifest file, ...)
- Develop a method to quantify the uncertainty/ attribute data quality flags to the generated hydrological variables.
- Define quality flags and KPI indicating possible breaks in the data production process
- Make suggestions for a possible evolution of the service, this shall include information on how to take advantage from the data generated by the other relevant ITT.
- Document the procedure followed and develop appropriate training and supporting material.

In addition, data licensing terms and conditions can be a barrier in transferring and using data to new entities, especially when the measurements are under strict intellectual properties rights.

A number of independent C3S activities, which are not part of this ITT, are being implemented to complement the scope of this tendered service. In particular:

- An Evaluation and Quality Control (EQC) function, which will assess the quality and suitability (fitness-for-purpose) of C3S products and services from a user perspective;
- A Climate Data Store (CDS) to provide access to ECV products, including those delivered by this service, as well as climate model output, reanalysis products;
- Outreach and dissemination activities to promote uptake of C3S data by various user communities.

The Tenderer shall put in place all necessary mechanisms to ensure the outputs of this contract will be fully compliant with the activities above.

3.3.2 Specification of work

C3S_432_Lot3 Work package 0: Management and coordination activities (Month 1-15)

This work package will focus on contract management, including internal controls and coordination of subcontractors, links with other Copernicus services, organisation of workshops/meetings, risk management and tracking of the key performance indicators.

Deliverables expected:

Deliverables covering the contractual and financial reporting obligations towards ECMWF in line with the Terms and Conditions of the Framework Agreement shall be covered under WP0:

⁶ Following an agile methodology, production protocols might evolve to reflect feedback from quality checks of data, with a first draft delivered within 3 months of the start of the contract, and final methodology delivered at the end of the contract

- Quarterly Implementation Reports, due 15 days after the end of each calendar quarter;
- Annual Implementation Reports, due annually on 28 February;
- Preliminary financial information, due annually on 15 January;
- Draft and final Implementation Plans for the year N+1, due respectively in February and October of the year N;
- Letter from the auditors referred to in Clause 2.3.1.4 of the Framework Agreement;
- Final report, due 60 days after the end of the Framework Agreement.

C3S_432_Lot3 Work package 1: Production chain design (Month 1-3)

After a review of the existing hydrological modelling chains the Tenderer shall produce a document describing the operational setup that would be needed to fulfil the requirements of this Lot. Such a document should explain and justify any hydrological system development should this be required.

This WP will also define and document the productions protocols and standards, dataset formats, metadata information, quality assurance methods and licencing agreement to ensure compliance with the EQC framework developed by C3S. Finally, it will include methodology to quantify the uncertainty/attribute data quality flags to the generated surface forcing for each time step, including quality flags and KPIs indicating possible breaks in the acquisition process. ITT respondents planning to make use of the ensemble forcing capability in ERA5/SEAS5 will be favoured.

Deliverables expected:

- A document describing the production setup (algorithms, workflows, and output data streams). This will be a revised version of the proposal to account for the interaction with ECMWF (month 1)

C3S_432_Lot3 Work package 2: Prototyping (Month 1-3)

WP2 will take care of developing a working prototype of the production chain. This will be used to conduct a series of tests and ensure the overall quality of the indicators generated is compliant with C3S expectations. It is expected that this prototype phase shall take no longer than 3 months.

Deliverables expected:

- A fully working production chain
- A sample dataset –inclusive quality assurance information- generated through the prototype and covering at least 2 months.
- A set of files (called pseudo-manifest files in the C3S jargon) describing in detail the characteristic of the data (including naming convention, directory structure, metadata structure, etc. ...) to facilitate the integration of the data onto the CDS.
- Full documentation on the production chain, dataset and the files with the characteristic of the data.

C3S_432_Lot3 Work package 3: Data production (Month 4-15)

This WP will be devoted to the operational production of the data. This include both the forecast and the hindcast generation

Deliverables expected:

- The full hindcast extending back to 1993. ERA5 forcing period 1979-1993 can be used for testing and initialisation/spin-up
- A series of real-time forecast to be delivered to ECMWF no later than the 15th of the month.

In both cases the datasets should be provided in a way that would allow C3S to incorporate them directly onto the CDS catalogue.

C3S_432_Lot3 Work package 4: Support and help development (Month 4-15)

This WP focuses on the provision of an operational support to the service (e.g. user support, communication, manual) as well as the suggestions for a service evolution.

Deliverables expected:

- A document summarising the key steps towards the integration of the products generated by the other lots (e.g. SGFRs, and SLIM) into the operational production chain
- A knowledge-based document for C3S User Support purposes
- Training material linked to the products developed.
- Contribution to C3S web content (videos, FAQs, web stories) to support communication on the contract.

4 General requirements for Lot 1, Lot 2 and Lot 3

4.1 Implementation Schedule

The contracts for Lot 1 and Lot 2 will run for a **period of maximum 12 months and must be delivered by 30th October 2020 at the latest**. The contract for Lot 3 will run for a **period of maximum 15 months and must be delivered by 31st January 2021 at the latest**.

The contracts for all three lots will be implemented in two phases:

- **Phase 1** will be completed within 3 months, and will define the scope overall approach.
- **Phase 2** will be of no more than 9 months (Lot 1 and Lot 2) or 12 months (Lot 3) in duration and will implement and demonstrate the prototype service.

The Tenderer shall provide in their bid a detailed schedule with the duration of each activity and their interactions, as well as all contractual milestones and deliverables, which will be refined during contract negotiations.

For all three lots, activities shall be performed in the context of one service contract covering the whole duration.

The successful Tenderer is expected to provide a detailed time plan and schedule as part of the tender response. 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 will report on a quarterly and annual basis (for more details please see Volume V Framework Agreement for this ITT).

4.2 Service Target Requirements

The successful tenderer will be expected to *meet* or preferably *exceed* all the following Target Requirements (TRs), or if not possible explain in detail *to which extent they can be met with existing capability*. The TRs described in table 2 are expected to *evolve* during the lifetime of the service to adjust to new sensors (e.g. upcoming Copernicus missions), new capabilities (e.g. algorithms, cloud-based platforms), emerging needs of C3S and feedback from the EQC. As such the service shall be supported by an *agile* production system, which shall continuously evolve to rapidly take account of these new needs.

TR1	Set-up a flexible, agile, scalable, and iterative production system capitalizing on existing e-infrastructures and enabling new software and new data streams to be integrated easily and incrementally. In particular, if a production chain already exists for other purposes, the successful tenderer shall if possible upgrade the existing chains (rather than re-inventing another system) to meet the necessary climate quality requirements.
TR2	Ensure traceability of provenance of data and workflows, through data collection management tools, linked data principles, and configuration system control
TR3	Develop and implement a system to monitor routinely the performance of the system through a series of benchmarking metrics, covering both the <i>quality</i> of the data (e.g. validation), the <i>performance</i> of the system, and the quality of the service. In particular, for the C3S, the successful tenderer shall take account of the feedback of the EQC to improve iteratively its products and processing chain.

Table 4: Target Requirements

4.3 Meetings

A kick-off and closure meeting shall be organised at ECMWF (Reading, U.K.). The successful Tenderer is also expected to organise monthly teleconference meetings to discuss the contractual aspects and service provision, service evolution and other topics that cut across different aspects of C3S. All key experts involved in the contract shall attend these meetings.

ECMWF will organise annual meetings to bring together all C3S service providers. The successful Tenderer is expected to attend this meeting.

The cost of attending these meetings shall be covered by the successful Tenderer and shall be included in the tendered price. The cost of organising and attending any additional meetings specific to the service provision shall also be covered by the successful Tenderer and shall be included in the tendered price.

4.4 Deliverables

Expected top level deliverables are outlined in Section 3. These can be in the form of documents or reports, data sets or databases, services and user support. Requirements for each type are described in the following subsections. Where needed, additional deliverables should be mentioned by the tenderer.

4.4.1 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).

4.4.2 Data sets

It is expected that data sets (including databases) generated or acquired by the successful Tenderer will be delivered via the Climate Data Store. 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 designated server,
- b) providing them via web services.

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

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

In the case of (b), suppliers will have to agree with ECMWF on the protocols to be used to invoke the web services. ECMWF will only accept protocols that follow internationally recognised standards. Such standards must be open (i.e. non-proprietary), managed by a recognised international standardisation process (e.g. ISO, WMO, OGC, etc), or be a de-facto standard such as OpenDAP. ECMWF will consider using bespoke web-based APIs to access the data and products if they implement very simple protocols (e.g. REST), as long as the results returned by these APIs are compatible with (a). It should be noted that requests for these web services will mostly originate from the Climate Data Store 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.

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

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

Provision of processing capabilities:

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

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

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

Data and IPR:

It is a condition of EU funding for C3S that ownership of any datasets developed with C3S funding passes from the suppliers to the EC, via ECMWF. Ownership will pass on delivery of the datasets. In return, the suppliers will be granted a non-exclusive licence to use the datasets which they have provided to C3S for any purpose except one which conflicts with the aims of C3S.

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 EC via ECMWF annually, but in return the successful Tenderer will be granted a non-exclusive licence to use them for any purpose except one which conflicts with the aims of C3S.

4.4.3 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 staff at ECMWF provide basic support in the form of self-help facilities (FAQs, knowledge bases, tutorials etc.) as well as individualised support on technical queries related to the CDS, data formats, data access etc. In addition, ECMWF staff will provide specialised scientific support to address questions related to its industrial contributions to C3S, e.g. in the areas of global reanalysis and seasonal forecasting.

The tenderer is expected to provide enough documentation regarding the produced dataset and associated methodology that could be used during the operationalisation phase by the user support service.

4.5 Key Performance Indicators

As part of the bid, the Tenderer shall specify a proposed set of Key Performance Indicators (KPIs) appropriate for the service. The KPIs shall be designed to quantify different aspects of quality of service against the requirements described in this document. These initial specifications shall be refined together with ECMWF during the first 3 months of the contract. Contractors shall report to ECMWF on a set of KPIs suitable for monitoring various aspect of service performance, including (but not limited to):

- Data quality
- Service delivery
- Contract management
- User support

The KPIs will be reported in the Quarterly and Annual reports. At the end of each year, a service readiness review shall take place that will include assessment of performance against the set of KPIs.

5 Tender format and content

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

5.1 Page limits

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

<i>Section</i>	<i>Page Limit</i>
<i>Executive Summary</i>	2
<i>Track Record</i>	2 (for general) and 2 (per entity)
<i>Quality of resources to be Deployed</i>	2 (excluding Table 1 in Volume IIIB and CVs with a maximum length of 2 pages each)
<i>Technical Solution Proposed</i>	20 (Table 2 in Volume IIIB, the section on references, publications, patents and any pre-existing IPR are excluded from the page limit and have no page limit)
<i>Management and Implementation</i>	5 (excluding Table 4 and Table 5 in Volume IIIB) + 2 per each Work package description (Table 3 in Volume IIIB)
<i>Pricing Table</i>	No limitation

Table 5: Page limits

5.2 Specific additional instructions for the Tenderer's response

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

5.2.1 Executive summary

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

5.2.2 Track record

The Tenderer shall demonstrate for itself and for any proposed subcontractors that they have experience with relevant projects in the public or private sector at national or international level. ECMWF may ask for evidence of performance in the form of certificates issued or countersigned by the competent authority.

5.2.3 Quality of resources to be deployed

The Tenderer shall propose a team providing the skills required for providing operational services that meet the technical requirements set out in section 3. 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.

5.2.4 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.

5.2.5 Management and implementation plan

The Tenderer shall provide a detailed implementation plan of proposed activities for the duration of the framework agreement. Deliverables should be consistent with the technical requirements specified in section 3.

The Tenderer is requested to include management and implementation activities within a dedicated work package (WP0). The number of milestones is not restricted, but they should 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 an annual 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):

- Quarterly, annual and final reports shall be provided in accordance with the Framework Agreement Article 2.3.
- An implementation plan for the year N+1 shall be provided in February of the year N for ECMWF approval.
- Monthly teleconferences with ECMWF and a bid for involvement of ECMWF in major project reviews shall be provided as part of the management plan.
- A proposed payment plan shall be provided as part of the bid. The payment plan shall be based on quarterly payments for routine services work packages and shall be based on milestones completion and associated deliverables for development related activities.
- If relevant, a list of sub-contractors and details of their contribution, key personnel, legal names and addresses shall be provided. The Tenderer shall describe how the Framework Agreement, in particular Clause 2.9, has been communicated down to all their sub-contractors.

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

Deliverables for this work package shall include the following reports:

WP0 Contractual Obligations Template				
#	Responsible	Nature	Title	Due
D0.y.z-YYYYQQ	Tenderer	Report	Quarterly Implementation Report QQ YYYY <i>QQ YYYY being the previous quarter</i>	Quarterly on 15/01, 15/04, 15/07 and 15/10
D0.y.z-YYYY	Tenderer	Report	Annual Implementation Report YYYY <i>YYYY being the Year n-1</i>	Annually on 28/02
D0.y.z	Tenderer	Report	Final report	60 days after end of contract
D0.y.z-YYYY	Tenderer	Other	Preliminary financial information YYYY <i>YYYY being the Year n-1</i>	Annually on 15/01
D0.y.z-YYYY	Tenderer	Report	Draft Implementation plan YYYY <i>YYYY being the Year n+1</i>	Annually on 28/02
D0.y.z-YYYY	Tenderer	Report	Finalised Implementation plan YYYY <i>YYYY being the Year n+1</i>	Annually on 31/10
D0.y.z-YYYY	Tenderer	Other	Copy of prime contractor's general financial statements and audit report YYYY <i>YYYY being the Year n-1</i>	Annually
D0.y.z-YYYY	Tenderer	Other	Letter from auditor specific to C3S contract YYYY <i>YYYY being the Year n-1</i>	Annually

Table 6: List of contractual deliverables in line with the Terms and Conditions (Volume V)

5.3 Price and payment specifications

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

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