

ECMWF Copernicus Procurement

Invitation to Tender



Copernicus Climate Change Service Volume II

Quality Assurance for Datasets in the Climate Data Store

ITT Ref: C3S2_520
ISSUED BY: ECMWF Administration Department Procurement Section
Date: 25 August 2021
Version: Final



Funded by the European Union

Implemented by



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1 Introduction

The Copernicus Climate Change Service (C3S) implemented by ECMWF on behalf of the European Union develops and delivers authoritative, quality-assured information about the past, current and future states of the climate in Europe and worldwide. It aims to a) inform policy development to protect citizens from climate-related hazards such as high-impact weather events, b) improve the planning of mitigation and adaptation practices for key human and societal activities, and c) promote the development of new applications and services for the benefit of society.

Within its first phase (2015 – 2020), Cop1, the Service consolidated many years of preparatory research and development to deliver a range of operational services. In its second phase (2021 – 2027), Cop2, these services are further consolidated, improved and expanded to address all the existing and emerging societal needs related to climate services.

Quality assurance (in the following also: Evaluation and Quality Control or EQC) is a central component of C3S to establish the service as a trusted source of climate information, delivering quality-assured and authoritative service outputs such as datasets and applications that are traceable and reproducible. The EQC function ensures transparency of the service outputs including their quality attributes and builds the basis for a true operationalisation of climate services and the inclusion of climate data into policies and standards. Quality is a key element to build trust between users and providers.

ECMWF, as the Entrusted Entity for the Copernicus Climate Change Service, invites tenders for the implementation of the Evaluation and Quality Control function for datasets in the C3S Climate Data Store (CDS). The successful Tenderer shall be responsible for the management and execution of quality assessments for C3S datasets as served via the CDS infrastructure. For information, a separate invitation to tender will be issued for the EQC function for tools and applications, while another one will address broader quality management aspects of C3S such as the management and analysis of user requirements and the performance of the service overall.

2 Background Information

The purpose of this section is to clarify the context of this tender and to describe the relevant outcomes of EQC activities undertaken by C3S so far. Specific technical requirements for the work to be carried out under this tender are described in Section 3 of this document.

2.1 The C3S Climate Data Store

2.1.1 Current CDS Infrastructure

The Climate Data Store (CDS) is a core infrastructure supporting the implementation of C3S (Fig. 1). It is designed as a distributed system and an open framework, providing web-based and API-based retrieve facilities to a wide catalogue of datasets, applications and other digital information. It also provides a development platform (Toolbox) which allows the creation of web-based applications operating on the datasets and products available in the catalogues. These applications can subsequently be made available to end-users. All Toolbox computations are executed within the infrastructure in a distributed, service-oriented architecture.

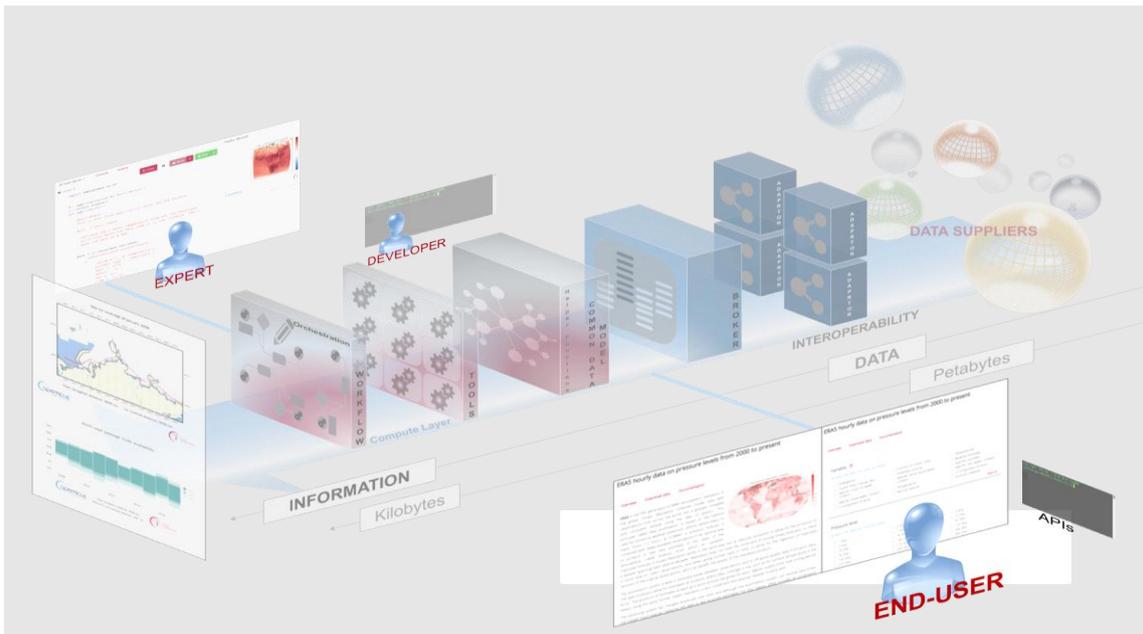


Figure 1: Data Store conceptual framework infrastructure diagram (refer to CJS2_211 Vol II Section 1 for a more detailed explanation of the components depicted in this figure).

The main interface between the CDS and the users is a web portal, serving as a single point of entry for the discovery and post-processing of data and products available in the CDS catalogue. The web portal provides access to content pages, user support and quality assurance information.

Reference	Link
Climate Data Store	https://cds.climate.copernicus.eu/
EQC tab (example)	https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels-monthly-means?tab=egc
User Support	https://cds.climate.copernicus.eu/cdsapp#!/usersupport

The CDS catalogue contains a wide variety of datasets. These datasets are distributed and located at different data suppliers and are accessible via adaptors using a range of protocols. Available datasets are encoded in files using various formats, such as WMO GRIB or NetCDF-CF. The data types range from single point observations or time series at a given location, to multi-dimensional global fields. The main dataset categories are:

Category	Example
Reanalysis (global)	https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels-monthly-means
Reanalysis (regional)	https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-uerra-europe-pressure-levels
Climate projections (global)	https://cds.climate.copernicus.eu/cdsapp#!/dataset/projections-cmip6
Climate projections (regional)	https://cds.climate.copernicus.eu/cdsapp#!/dataset/projections-cordex-domains-single-levels
Seasonal forecasts	https://cds.climate.copernicus.eu/cdsapp#!/dataset/seasonal-monthly-single-levels
Satellite observations	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-albedo

In situ observations	https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-observations-gruan-reference-network
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2.1.2 CDS Modernisation

The vision for the next phase of Copernicus is to enhance and upgrade both C3S and CAMS services with a modern, more usable, scalable and interoperable Data Store & Toolbox infrastructure (hereafter referred to as CopDS) that will engage with a broader user community and will facilitate interoperability and synergies with external projects and platforms. Products aimed to be accessible through the CopDS catalogue will follow an iterative integration process.

The modernised infrastructure will include a Content Integration Manager (CIM) component that will be the main tool for gathering quality assurance information via the EQC function and publishing this information on the CDS. The CIM will also provide the entry point for the integration of new datasets and applications into the system facilitating the collection and management of deliverables provided by third parties. Products are provided together with (high-level) discovery metadata, full user documentation, independent quality assessments, outreach material, licenses and references. Provided material will serve as basis for the final content exposed to users, as well as for internal contractual reporting. The CIM component will serve as the central repository for metadata and documents associated with datasets and applications acquired by ECMWF for provision through the CopDS. Principal aim of this component is to facilitate information gathering and sharing between different actors, including the EQC function, throughout the dataset life cycle on the CopDS.

In particular, it will ease the collaborative development and content management of Quality Assurance Reports (QARs). The QARs will be stored, documented and published as part of the CopDS EQC functionality. This will include the management of workflows to produce QARs in a collaborative fashion. It will be the tool for the successful bidder to store, document and publish QARs.

For a more detailed description of the planned modernisation of the CopDS and the integration of the EQC infrastructure, please refer to CJS2_211 Vol II Section 2: https://climate.copernicus.eu/sites/default/files/2021-06/CJS2_211_Volume_II_final.pdf.

Whilst the development of the EQC-relevant components of the CopDS infrastructure (i.e. CIM and related EQC workflows) is not part of this tender, the successful bidder shall provide requirements for these components and coordinate with the CopDS team and the third parties responsible for their implementation.

2.2 The Current Operational EQC Framework

According to ISO standard 9000:2015, the EQC framework considers several parts of quality management, including quality control, quality assurance and quality improvement. In the context of C3S, these activities aim to assure the technical and scientific quality of the service outputs. The EQC process scrutinises service outputs including their documentation to ensure usability and reliability. While the main focus of the EQC function for datasets is on their reliability and usability, it also addresses aspects of fitness-for-purpose. However, since information about the intended purpose is often limited, the focus of the fitness-for-purpose aspect is to provide value-added information, including metadata, documentation and guidance to enable users to assess the respective suitability and fitness themselves (Whitfield 2012).

The purpose of the EQC for CDS datasets function is as follows:

- Provide quality assurance for service outputs including technical and scientific assessments of datasets in the CDS.
- Ensure reliability and usability of datasets including the correctness of metadata.
- Enable users to assess fitness for purpose of datasets.

- Report to ECMWF on shortcomings and gaps to be addressed in order to improve the quality of products and services.

An overview of the quality assurance framework can be found here: <https://climate.copernicus.eu/quality-assurance-copernicus-climate-change-service>.

2.2.1 Previous EQC Contracts

C3S has made significant investments in the development of the EQC function for the CDS. Four contracts were awarded during the first phase of C3S (Cop1) to develop the EQC framework and proofs of concept, followed by three additional contracts dedicated to the operational implementation of EQC (Fig. 2).

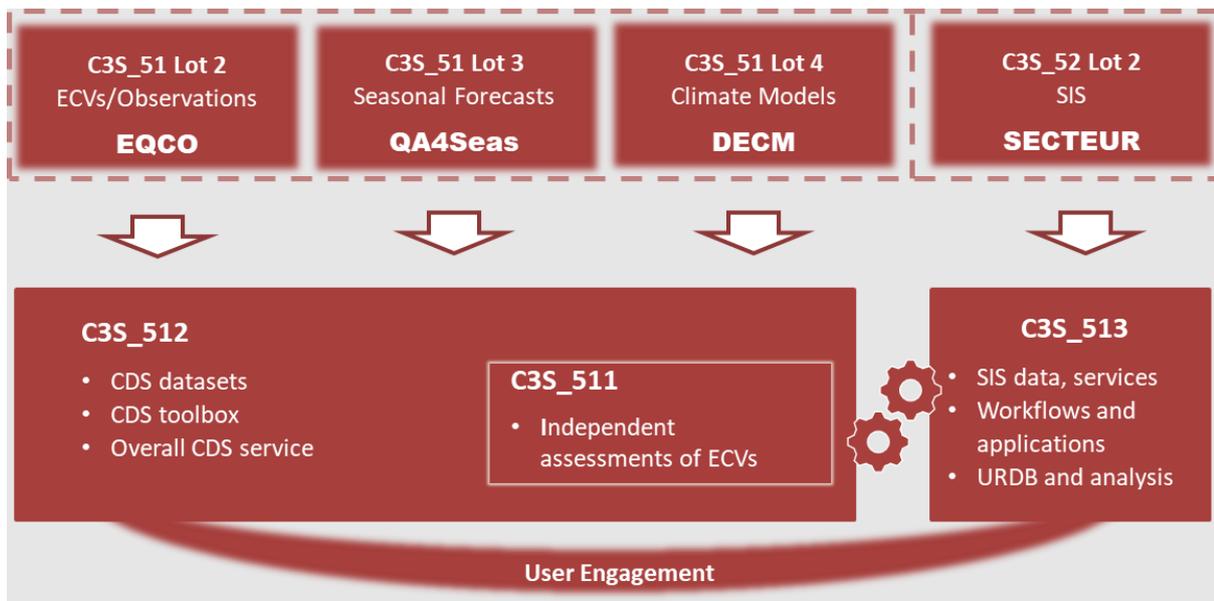


Figure 2. Contractual set-up in the proof-of-concept and first operational phase of EQC.

2.2.2 An EQC Framework for CDS

An operational EQC framework for the CDS was implemented under Cop1, and is guided by:

- A modular, flexible and scalable approach that can accommodate new data/information sources and new roles in the EQC workflow.
- Automation of information management workflows in order to reduce human error and make the system sustainable in the long-term.
- An iterative and reproducible approach suitable for continuous improvement.
- A user-friendly presentation of the EQC quality information on the CDS.
- Homogeneous and consistent presentation of CDS data quality information, whilst recognizing inherent differences across the dataset categories.
- Transparency and traceability of quality assessment workflows.
- Best practices in data management and stewardship in accordance with FAIR (Wilkinson et al. 2016) and TRUST principles (Lin et al. 2020) and widely adopted data quality standards such as ISO 19157:2013.

C3S_512 established a firm methodological framework for quality assessment of all CDS dataset categories. It developed standards, procedures, and infrastructure for generating and presenting the outcomes of quality assessments. C3S_511 developed a framework for the independent scientific assessment of Essential Climate Variables data products derived from satellite and gridded ground-based observations as well as reanalysis data. C3S_513 put in place a framework for quality assurance of outputs from the Sectoral Information Systems (SIS) including datasets. All contract activities were continuously informed by user feedback.

The main features of the framework and its current implementation for CDS data are described in the following subsections.

This invitation to tender aims to combine the quality assessment efforts addressed under C3S_511 and C3S_512. Tenderers are expected to further evolve the existing concepts and infrastructure already put in place, while further consolidating, harmonising and streamlining the framework, including its methodologies, procedures and outputs.

2.2.3 Quality Assurance Reports for CDS Datasets

The general strategy for assessing CDS datasets consists of five steps:

- 1) Designing quality assurance templates (QAT) representing the quality assessment criteria for the different dataset categories listed in Section 2.1.1.
- 2) Liaising with data providers to gather content for the QATs.
- 3) Scrutinizing the information provided to ensure its correctness.
- 4) Performing technical and scientific quality assessments of the CDS datasets.
- 5) Publishing all information on the CDS once approved by C3S.

These steps lead to the creation of QARs, which provide users with comprehensive information about quality attributes including the technical and scientific quality of the datasets. The different sections of the QARs are made accessible to users in the CDS web portal, currently through a synthesis table in a dedicated quality assessment tab. The synthesis table is devised as a tool to organise and homogenise the EQC information, which is made of atomic elements corresponding to the different entries of this table. These entries lead to the respective subsection of the QAR, where the users can find the EQC information of interest. An example of the current structure of a QAT for datasets is given in Annex 6.2.

The following table shows how the EQC assessments are currently being presented.

Category	Example of EQC assessment
Reanalysis (global)	https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels-monthly-means?tab=eqc
Reanalysis (regional)	https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-uerra-europe-pressure-levels?tab=eqc
Climate projections (global)	https://cds.climate.copernicus.eu/cdsapp#!/dataset/projections-cmip5-monthly-pressure-levels?tab=eqc
Climate projections (regional)	https://cds.climate.copernicus.eu/cdsapp#!/dataset/projections-cordex-domains-single-levels?tab=eqc
Seasonal forecasts	https://cds.climate.copernicus.eu/cdsapp#!/dataset/seasonal-monthly-single-levels?tab=eqc
Satellite observations	https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-albedo?tab=eqc
In situ observations	https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-observations-gruan-reference-network?tab=eqc

Orchestrating the different elements of a QAR requires considerable coordination efforts and a continuous improvement approach to integrate the inputs from data providers. Quality assessments are produced in a collaborative framework that requires iteration across different actors to solve new aspects continuously emerging during its implementation. The respective EQC workflows are currently supported by a dedicated Content Management System (CMS) that facilitates the cooperation and co-production of the QARs.

Reference	Link
Content Management System	http://136.156.132.55/

The general EQC workflow currently includes the following roles:

Role	Responsibility
QAR Manager	Responsible for managing the review process. Selects the team involved in the QAR production and creates the empty QAR. Coordinates with data providers and C3S technical officers. Role covered by EQC team member (contractor).
Data provider	Enters the required quality information by completing the sections of the QAT (mandatory fields at least). Role covered by representative of the data provider.
Evaluator	Checks, reviews and evaluates the content provided by the provider, filling in additional sections of the form, including independent assessment fields. No altering of content without agreement by provider. Role covered by one EQC team member.
Reviewer	Scrutinizes the QAR content for accuracy, completeness and understandability. Ensures accuracy and correctness of the provided information. Role covered by EQC team member with high expertise on the respective dataset category or independent expert called upon by the EQC team.
Approver	Approves or rejects the QAR. Obtains final approval for publication of the QAR from C3S Technical Officers or Review Board. Role covered by one C3S staff member of ECMWF.

An iteration loop between the different roles allows for refinement of the content. Fig. 3 shows the sequential workflow.

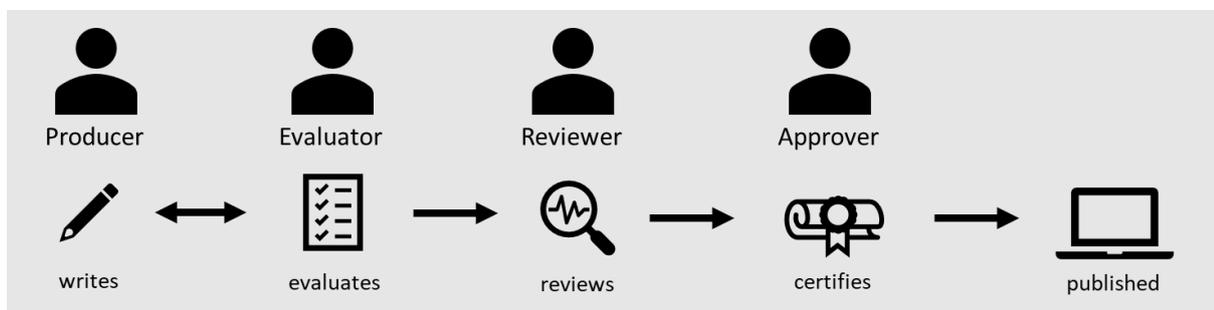


Figure 3. The main roles in the EQC workflow for the production of QARs.

The EQC workflow is split into two assessment cycles according to the lifecycle of CDS datasets:

Before publication of dataset

- Fast assessment: producing EQC information in relatively short time and ahead of publication of data; checking for fulfilment of minimum requirements; focuses on data stewardship in terms of documentation, metadata and accessibility.

After publication of dataset

- In-depth assessment: scientific assessments, focusing on the technical, scientific and maturity evaluation of the data; triggered after approval of the fast-assessment and publication of the dataset.

An example of how QARs are currently presented in the CDS catalogue after having passed both phases can be found here: <https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-sea-surface-temperature?tab=eqc>.

Scientific, in-depth assessments are carried out to provide users with guidance on suitability, quality and reliability of the data. Independent evaluation of the data is an important aspect for data users and hence the QATs include the results from an independent assessment of the data quality appropriate for the specific dataset type. The independent analyses show the fitness and usability of the CDS data and ensure that data are robust and sufficient for users to judge the fitness of such dataset for the specific application they want to use it for. Fig. 4 shows the basic approach for the scientific assessment applied in the current phase.

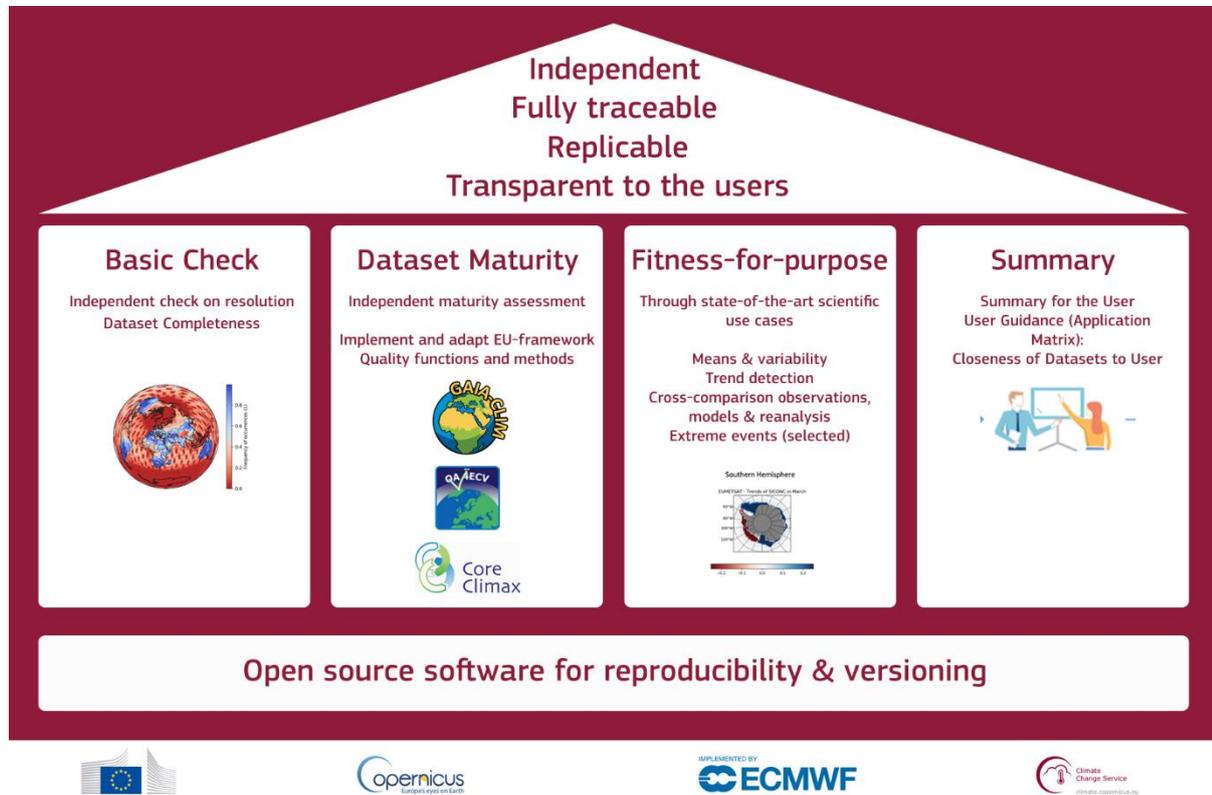


Figure 4. Independent assessment framework used in the first operational phase of EQC.

2.3 Continuity and Evolution of the EQC function

Whilst the current EQC framework has successfully brought various quality assurance concepts proposed over the last few years into operational practice, several lessons learned from this first operational phase, due mainly to external dependencies, shall guide the continuity and evolution of the EQC function, as follows:

- QAR production as a result of the EQC workflow is a multi-actor process, involving data providers, EQC evaluators, reviewers and C3S approvers. Although roles and responsibilities are clearly defined, the workflow is fragile in the event of one actor not fulfilling their role. This holds in particular true for the data provider/producer who are generally considered as the best source to fully describe the dataset and hence are the preferential choice to contribute to the QARs. However, data provider/producer input has sometimes been sparse or non-existent due to lack of commitment/resources. In the next phase, contractual commitment of data providers will be ensured to support the EQC process by filling the QATs in the CMS. The respective technical officers will have to be involved in the interaction between the EQC team and the data providers to accompany the process of filling the QATs.
- A large number of QARs has been produced due to high level of granularity of the QARs. For example, for climate projections, a QAR is a combination of model, experiment and parameter. This leads to a massive amount of QARs which makes the review and approval process cumbersome and also difficult for the data provider to fill all respective QATs in the CMS. Thus, the level of granularity shall

be reduced, and the catalogue entry shall be regarded as the baseline for a dataset. For most dataset categories, common QARs have already been introduced for shared fields across large sets of QARs. This approach shall be applied to all dataset categories as it will greatly reduce the overall number of individual QATs to be filled and QARs to be reviewed. Moreover, the QARs need to become less dependent from the way the download tab is being structured.

- Currently, the information required from EQC in the CMS is already partly being gathered during the data ingestion process using a multitude of independent sources (e.g. excel sheets, word documents, Jira tickets and personal communication). This complicates the integration and maintenance of the data in the CDS catalogue and provides redundancies with EQC. Having the EQC workflow at the end of the data ingestion process has shown problematic. A central repository for metadata and documentation is therefore needed, which can be accessed by all relevant stakeholders including the CDS catalogue, data providers, technical officers and EQC. The EQC workflow shall start earlier in the data ingestion process, rather than in the end. The CIM is expected to offer a sustainable solution. Such a repository will also help synchronizing the catalogue entry with fields in the EQC tab (currently perceived as duplication in some cases).
- The readiness/maturity of the QATs is not satisfactory yet for at least some dataset categories, in particular seasonal forecasts. Since the QAT concept is a heritage from the satellite community, more work is needed to fully apply the idea to model-based data. Discussion with respective stakeholders need to continue and the QATs modified accordingly. While maintaining general consistency across all QATs, the content may be further tailored for individual dataset types.
- So far, datasets were not necessarily produced with standardised quality assurance criteria in mind. These criteria have only been recently established by the EQC function. Hence, not all service outputs are meeting the minimum requirements as defined by EQC. The data checker functionality as implemented by EQC has shown problematic as it requires a large amount of (computational) resources to download the data and run the checks. Data providers shall therefore be asked to run a minimum set of tests before delivery in order to assure a minimum level of quality. The data checker could be introduced earlier in the processing chain (on the producer side), with EQC only doing some random sampling to verify that checks have been done. This would also solve the issue of EQC taking quite a lot of the download bandwidths at times.
- The QARs need to be reviewed before publication, which requires the involvement of several subject matter experts. Respective technical officers and external experts need to be involved in the review process (and appropriate resources ensured), at least in the ongoing ramp-up phase of EQC.
- The QAR release calendar had to be created by the EQC contractor without having the benefit of full visibility on the CDS data publication roadmap. This lack of transparency has led to some problems in the QAR production. The QAR release calendar should therefore be developed in close coordination with C3S, according to the dataset roadmap. The production of the QARs needs to be triggered by C3S. This holds true also for the independent assessments.
- Scientific assessments have been produced for most ECVs but maintaining this level across all dataset categories and parameters is virtually impossible. Even for satellite observations and reanalysis there are gaps as a full scientific assessment requires quite some effort. Standard metrics and diagnostics considered most relevant for the users have been proposed but more work needs to be done to identify the common baseline metrics. Prioritization of certain variables and specific products for which a standard level of scientific assessments needs to be maintained is necessary. Automatization of certain diagnostics (ideally being performed with the Toolbox) and automatic generation of text and reports is sought to the greatest extent possible.
- Updates of the QARs may be necessary more frequently than the scheduled six-month interval, in particular when documentation is being replaced. Given the amount and frequency of changes, updating the QARs accordingly and keeping the content synchronous provides a challenge for EQC. Automatic synchronization of content (facilitated by a global repository) should be envisaged.

- The usability of the synthesis table in the EQC tab needs to be improved as it currently starts only at the level of a specific parameter (see point on granularity above). Important EQC information is often perceived as hidden. Also, a lot of information has to be accessed by further clicks, opening pdf documents, and the results of the data checker are not presented in an appealing way. Lastly, there is overlapping information in the Introduction column with what is presented in the Overview tab. Therefore, key information on a dataset (e.g. strengths and weaknesses, usability) shall be made accessible at a higher level on top of the synthesis table. More visual elements are needed to display the information.
- While the internal value of EQC is widely acknowledged, increased emphasis needs to be given to the demonstration of external value and hence, uptake of the EQC function by users.

The next chapter describes the technical requirements for the next phase of EQC, as a result of the lessons learned from the first operational phase.

3 Technical Requirements

ECMWF intends to award a single framework contract (for a maximum duration of 48 months), implemented via Service Contracts, for the management and implementation of the Evaluation and Quality Control function for the C3S Climate Data Store, addressing quality assurance for datasets.

The scope of this contract is on carrying out the operational tasks associated with the EQC function to deliver and update quality assurance information in a timely fashion. While the focus of the work will be on continuation of service and routine activities, some further conceptual evolution of the EQC framework will be required and shall therefore be included in the proposal. New technical developments of the CDS infrastructure components required to support the EQC function will be carried out under a separate tender (CJS2_211) addressing modernisation of the CDS. The successful Tenderer will be a user of the provided software platform and have the opportunity to participate in the definition of functional requirements. A close and dynamic interaction between the two contractors is required in order to co-design the EQC component of the new CopDS infrastructure.

The successful Tenderer shall:

- Take overall responsibility for providing quality assurance information to CDS users, using proven methods, metrics and techniques.
- Assess the technical and scientific quality of the CDS and provide means to facilitate fitness-for-purpose assessments by users.
- Provide requirements for the new CopDS EQC infrastructure, liaising closely with its developers and support the migration and integration of current EQC content.
- Consider relevant outcomes of previous EQC activities contracted by C3S, but propose new ideas to further develop the approach.
- Make use of any applicable international standards and best practices related to quality assurance and quality control wherever possible.
- Make use of relevant work performed by international scientific bodies and initiatives.
- Interact closely with the CDS data providers and the CDS development and data management team at ECMWF, in order to ensure that agreed protocols and processes are in place and adhered to, to enable timely and accurate updating of content in the QATs.
- Report quarterly to ECMWF on the outcomes of these activities.

Fig. 5 shows the expected timeline of activities needed to ensure continuation of routine EQC tasks and support the definition of the EQC component for the new CopDS infrastructure as well as the migration of EQC content.

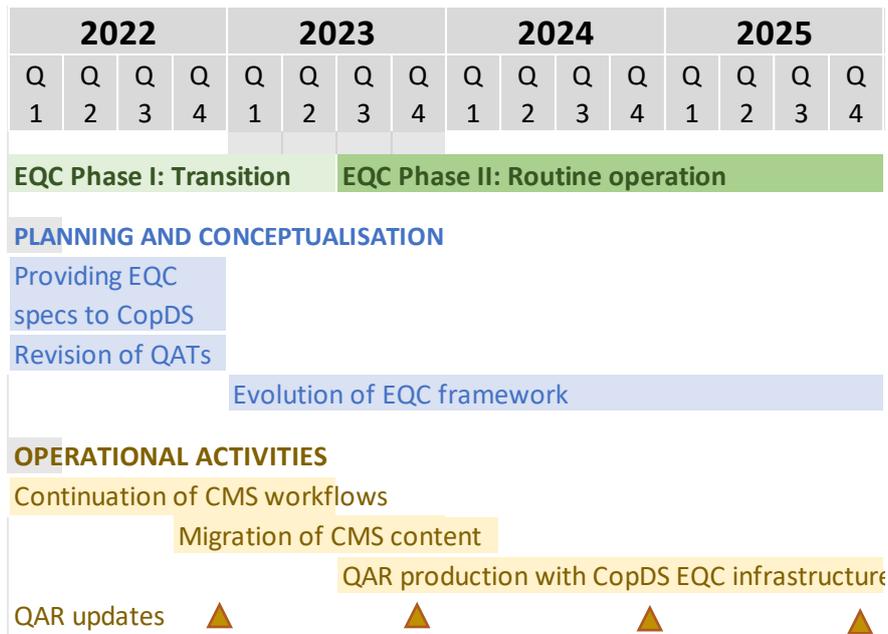


Figure 5. Expected timeline for the next phase of EQC

The following subsections list specific technical requirements for areas of work related to quality of CDS data, tools and applications.

3.1 Definition of EQC Requirements for CopDS and Content Migration

As described above, the modernisation of the new CopDS foresees the integration of EQC infrastructure components. To ensure a seamless integration of EQC components into the new infrastructure, the successful Tenderer shall:

- Actively participate in the analysis phase for the modernisation of the CopDS.
- Act as a key user for the CIM development and provide expertise and guidance.
- Provide specific EQC requirements.
- Monitor the content migration of existing QARs from a Drupal-based Content Management System to the CIM in the new infrastructure operated by the CopDS contractor and provide expertise where necessary.
- Act as beta tester for the CIM.

Deliverables expected:

- Monthly reports on liaison with CopDS modernisation team.
- List of EQC requirements for the CopDS infrastructure (to be updated monthly).
- Weekly logs of QARs migrated to CopDS infrastructure.

3.2 Management of QAR Production and Reporting

The contractor shall be responsible for the production of QARs in the CDS and the management of the respective protocols and workflows for initiating, developing and updating QARs, including definitions of minimum requirements and procedures for publication of new datasets in the CDS. The production and regular updating of the QARs requires close coordination with C3S and third parties delivering datasets. QAR production shall follow a production calendar to be agreed with C3S.

The complexity of the expected tasks, in particular the management of the QAR production calendar and liaison with various stakeholders will require the successful bidder to propose personnel with high project management and excellent inter-personal communication skills.

To support C3S management in overseeing the status of all QARs, including availability of documentation and results of data checker, compliance with Toolbox, standards etc., a dashboard or similar to monitor the QAR status shall be produced. This shall cover all catalogue entries subject to EQC and for which QARs are being produced. The dashboard is expected to increase visibility on the EQC status of datasets, facilitate the comparison among those and inform management decisions.

The successful Tenderer shall also produce regular reports on the quality of CDS datasets focusing on shortcomings and gaps. Tangible recommendations based on the outcomes of the QARs should be submitted to ECMWF via an already established Jira system on a regular basis. Urgent issues such as the presence of corrupt data or the failure of workflows should be immediately reported to ECMWF via a dedicated fast-track channel.

The successful Tenderer shall:

- Manage and coordinate the workflows for the production of QARs.
- Define and maintain a QAR production calendar/roadmap with input/support from C3S.
- Regularly liaise with all actors involved in the QAR production workflow, in particular with data providers to facilitate their input.
- Provide reviewers involved in the EQC workflow who have the necessary high-level skills and expertise for this service.
- Monitor and document the status and progress of QAR production via a dashboard or similar.
- Report urgent issues and submit regular data quality recommendations via Jira.

Deliverables expected:

- Quarterly reports on QAR production status and progress.
- Record of revision history for QARs.
- Description and regular update of consolidated EQC framework.
- Monitoring tool for status of QARs.
- Quarterly reports to ECMWF on overall quality of the CDS datasets including quality shortcomings and recommendations.

3.3 Quality Assurance for CDS Datasets

The successful Tenderer shall implement a hierarchical structure for users to access quality assurance information associated with each dataset in the CDS catalogue, offering various entry points, ranging from high-level to more detailed. The information shall be organised in tiers as shown in Table 1. The expected EQC content to be developed in each Tier is further explained in Section 3.3.1 below.

Level	EQC Content	Current implementation	Example of level
Tier 1	Overviews of QA attributes for catalogue entries containing visual clues and high-level information	N/A	CMIP5 monthly data on single levels (catalogue entry level)
Tier 2	Basic content of the QARs providing access to metadata and documentation	Synthesis table – common fields of the QAR	MPI-ESM-LR (model for which most fields in the QAR share the same information)

Tier 3	Detailed results of scientific quality assessments	Synthesis table – non-common fields of the QAR / scientific assessment	RCP4.5/2m temperature (scenario and variable; level at which scientific assessments operate)
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Table 1: Expected hierarchy of EQC information (with an example for global climate projections).

The CDS catalogue dataset landing pages shall provide the entry point to the EQC information, with appealing and easy-to-comprehend information as Tier 1, which shall be informed by Tier 2 and Tier 3 assessments, while more detailed information can be accessed by the users at lower levels as needed. The integration and design of the EQC content shall be closely coordinated with the contractor in charge of the web portal component of the CDS.

The successful bidder is expected to maintain and regularly update the EQC information for the upper two tiers. Technical and scientific assessments at Tier 3 shall be produced with a high level of automation while detailed scientific assessments will be requested by C3S as required. Selection of datasets/variables will depend on expected popularity and user relevance and the production of selected scientific assessments will be in the order of 10-15 reports per year (refer to Section 3.3.2).

Based on the currently published datasets in the CDS, EQC content is expected to be maintained and regularly updated for the following numbers of catalogue entries, listed per dataset category: seasonal forecasts (6), satellite observations (30), global reanalyses (7), regional reanalyses (8), in situ observations (2), global climate projections (1), regional climate projection (1). This number will increase with new datasets being ingested into the CDS, in the order of ca. 10-15 new catalogue entries per year. Annex 1 lists all current catalogue entries subject to EQC, including their expected granularity at Tier 2.

The proposal shall include indicative cost estimates for the individual content to be produced under each tier.

3.3.1 Operational Quality Assurance Reports

The EQC function for datasets shall operate for each of the tiers described in the previous section. At the catalogue entry level (Tier 1), the successful bidder shall review the catalogue entry as a whole and provide summaries of the EQC activities and high-level information on the respective datasets, including strengths and weaknesses. This shall be supported by visual clues, developed in coordination with the CopDS team and third parties.

In the first phase of the new contract, a consultative process between the EQC team and data provider representatives as well as selected experts shall take place to revisit and further evolve the QATs for each dataset category. Consultations shall also be held with the CopDS team and third parties to harmonise the QAT sections with the structure of the CDS catalogue entries (e.g. CDS “Overview” tab vs “Introduction” column in the current synthesis table or CDS “Documentation” tab vs. “User Documentation” column in current EQC synthesis table).

The QAR production corresponds to Tier 2 and shall be following the 5-step strategy explained in Section 2. Before the start of QAR production, consultations with the respective data providers shall take place to agree on a) the number and granularity of QARs to be produced, b) the required workload from the data provider (who have contractual obligations to support the EQC function by filling the QAT) and c) a list of metrics/diagnostics to be used in the scientific assessment (as described in the next section). The QAR filling by data providers will mainly cover the parts which are currently presented in the first three columns of the synthesis table (i.e. introduction, user documentation, access).

Minimum Requirements for New Datasets

As part of the evaluation of the QAR content, the successful Tenderer shall perform operational checks of minimum requirements (MRs) for new datasets to inform the decision on inclusion of the dataset into the CDS. The list of MRs shall facilitate a timely publication of a dataset, ensuring, at the same time, a sufficient quality and maturity. The MRs cover a wide range of aspects from the dataset documentation to the compliance of metadata with community standards. They shall be revisited at the beginning of the contract.

Basic data checks of aspects such as space and time completeness, temporal and spatial consistency with metadata, as well as physical plausibility ranges shall be documented in the QARs. Data checker software to perform those technical checks about data and metadata is already in place for reanalysis and seasonal forecasts and will be made available, together with the related documentation.

In order to rationalise use of resources and better integrate with quality control protocols on the provider side, the EQC contractor shall take advantage of the data checks performed and documented by the data provider who shall add the respective logs and documentation to the QARs. Wherever such data check logs from data providers are available, EQC shall only perform random checks to verify correctness. The results of these independent data checks shall be documented in the QAR as well (i.e. certification of provider checks). The ultimate goal is for data providers to perform all data checks recommended by EQC on their end ahead of submission.

QAR updates for existing datasets

The update interval for QARs shall follow a specific set of rules, as follows. Regular updates of the QAR assessments that do not require human intervention include the results from the data checker and Toolbox compatibility software. This is particularly valuable for datasets that are regularly extended in time, such as seasonal forecasts, reanalysis and satellite ICDRs. The appropriate parts of the QARs shall be automatically updated once a month, considering the last month of data available.

Regular updates that require manual intervention (e.g. to take into account possible novelties in the documentation) depend on QAT field and dataset type:

- Annual updates for all QAR common fields (manually).
- Updates triggered by changes in the catalogue entry (e.g. change in variable description, new documentation available etc.).
- Seasonal forecasts QARs need a more frequent manual update because of the high number of systems considered in the seasonal forecasts catalogue entry, each spanning a different lifecycle of operability. The update shall be done by restarting the common fields once every six months focusing on a few QAT fields selected.

Requirements for Tier 3 will be described in the next section.

The successful Tenderer shall:

- Review existing and new catalogue entry landing pages and report required edits.
- Provide high-level quality assurance summaries at catalogue level, supported by visual clues in coordination with CopDS and third parties implementing the web portal.
- Revisit existing QATs and consult with key stakeholders and experts for further improvement.
- Create QARs for new datasets and advise on their readiness for publication according to minimum requirements set by the EQC function.
- Update existing QARs according to updating strategy.
- Operate a data checker to complement and verify checks performed by data providers.
- Ensure participation of subject matter experts for each dataset category (either as part of the contract team or external experts).

Deliverables expected:

- Tier 1 summaries at catalogue entry level for all catalogue entries listed in Annex 6.1 plus future catalogue entries (10-15 new entries per year).
- Tier 2 QARs for all catalogue entries and their respective granularity listed in Annex 6.1 plus future catalogue entries (10-15 new entries per year).
- Consolidated set of QATs per dataset category.
- Technical documentation and instruction manual for data checker.
- Review of existing catalogue entries including list of suggested improvements.

3.3.2 Scientific Assessments

3.3.2.1 Tier 3 Assessments

Scientific assessments of CDS datasets fall under Tier 3 as described above. Given the high level of granularity for these types of assessments (variable level) and the continuously growing number of datasets in the CDS, automated procedures shall be introduced to the greatest extent possible to ensure manageability and sustainability of the QAR production for Tier 3.

The proposal shall outline the minimum level of non-automated efforts required and include innovative ideas for automated procedures that would produce valuable information for users.

A list of agreed metrics and diagnostics shall be established for each dataset category building on those defined in the first phase of C3S (Cop1). This shall be based on consultations with data providers and subject matter experts. The diagnostics shall support evaluators and users alike in taking objective decisions on the quality of the data including their strengths and weaknesses and thus facilitating assessments by users on the specific fitness-for purpose. These standardised assessments shall be produced on a routine basis and with a software suite that ensures reproducibility of the results as well as customisation by users. The CDS Toolbox shall be used to the greatest extent possible for performing the diagnostics and producing the respective plots, graphs and statistics. The bid shall foresee respective coordination efforts with the Toolbox developers.

The successful Tenderer shall:

- Agree on a set of metrics and diagnostics for each dataset category after consultation with data providers and subject matter experts.
- Introduce automated procedures for applying the identified metrics and diagnostics, and liaise with the Toolbox developers to implement a solution with the CDS Toolbox.
- Carry out and maintain standardised scientific assessments for all dataset categories.
- Explore means and tools to facilitate self-assessments by users on the fitness-for-purpose of datasets.

Deliverables expected:

- List of agreed metrics and diagnostics for each dataset category.
- Plotting suite for the generation of reproducible plots and graphs used in the scientific assessments based on the CDS Toolbox.
- Tier 3 production of standardised diagnostics for all variables covered by catalogue entries listed in annex 6.1 plus future catalogue entries (10-15 new entries per year).
- Concept to facilitate self-assessment of fitness-for-purpose of datasets.

3.3.2.2 Selected ECV Assessments

In addition to that, and separate from the QAR productions, a series of in-depth scientific assessment reports shall be produced for each of a pre-defined set of Essential Climate Variables (ECVs) across multiple observation-based datasets (e.g. reanalysis and satellite observations). The reports shall be independently

reviewed within the contract team. These ECV assessments shall address key features and maturity of the relevant datasets as well as intercomparisons for the ECV in question, allowing users to comprehend individual strengths and weaknesses of the different datasets. Each ECV assessment shall take the form of a report, containing direct links to CDS data and tools as appropriate, and be optimized for display on the C3S website. Bidders are encouraged to explore tools enabling users to self-assess fitness-for-purpose of ECVs from multiple available datasets and hence supporting decisions on which data to choose (e.g. via a search tool to identify datasets close to specific requirements).

The selection of ECVs to be assessed shall depend on a) availability in the CDS (e.g. where both reanalysis and satellite observations exist), b) actual or expected user uptake and c) relevance for downstream users. Proposals shall include a flexible workplan to allow the activation of dedicated ECV reports on demand. An estimate of 10-15 reports per year shall be produced covering atmospheric, oceanic and terrestrial ECVs.

Thematic assessments about fitness-for purpose of CDS datasets with regard to larger-scale climate studies involving multiple ECVs (e.g. addressing the energy budget, hydrological cycle etc.) are not subject to this tender.

The successful Tenderer shall:

- Perform in-depth assessments for a selected set of ECVs (based on satellite observations and reanalysis) including maturity assessments, intercomparisons between different datasets, as well as assessments of strengths and weaknesses.

Deliverables expected:

- Scientific in-depth assessments for selected ECVs as agreed (10-15 ECVs per year).

3.4 User Experience

The following sections describe the interfaces and interactions with users as a key driver of the EQC framework.

3.4.1 Integration with CDS Catalogue

While the current phase of EQC was focused on the foundation and baseline of quality assurance information, there is a need for reducing barriers for users to access the EQC content by introducing easy-to-comprehend information according to Tier 1 as described above.

The successful Tenderer is expected to closely collaborate with the CopDS web portal component managed by third parties and advise on means to display simplified EQC information. To this end, the bidder is expected to develop concepts to convey QA outcomes in a comprehensive way, such as visual clues, scoring schemes, comprehensive diagrams etc.

A concept for quality indicators shall be explored based on recommended practices from the metrological community. Quality indicators can be supported by a scoring scheme with a ranking system of datasets depending on the detail of information provided. The scoring scheme shall reflect the methods used and quality information provided with the data.

The successful Tenderer shall:

- Devise means to translate the QAR content for datasets, tools and applications into simplified information.
- Liaise with the web portal component managed by the CopDS contractor to implement these means, as well as with Comms, CUE and CUS.
- Develop a scoring scheme building on recommendations from the first operational phase and proof-of concept phase to inform quality indicators.
- Provide a definition of standard terminologies based on previous efforts.

Deliverables expected:

- Recommendations to simplify the display of EQC information.
- Set of proposed diagrams and icons to be introduced in the CopDS web portal.
- Conceptual design for quality indicators / scoring scheme.

3.4.2 Consultations with Users

Under the auspices of the Copernicus User Engagement (CUE) team, consultations with users are expected to ensure user relevance of the quality assurance information offered. The successful Tenderer shall liaise with CUE to organise a series of user consultations and surveys. This will be an opportunity to present the EQC framework and gather new requirements and feedback.

User engagement outcomes are the basis to perform a gap analysis of the EQC information made available to users and to steer the EQC design in terms of framework and dissemination activities. User requirements help to refine the QATs and will inform the user demand for quality assurance information.

The successful Tenderer shall:

- Liaise with CUE and CUS on user consultations and surveys to learn about necessary improvements of the EQC function for the CDS.
- Work with a dedicated User Focus Group to gain feedback on how to further evolve the quality assurance information.
- Study user requirements (made available as analyses such as the URAD) to identify gaps and required updates of the QARs.

Deliverables expected:

- Reports on user feedback with regard to EQC content.
- Recommendations from User Focus Group.
- List of gaps and shortcomings of the EQC function based on existing user requirements and results from user surveys.

4 Tender Format and Content

General guidelines for the tender are described in Volume IIIB. This section describes specific requirements to prepare the proposal for this particular tender, along with guidelines for minimum content expected to be included in the proposal, 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.

4.1 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 is excluded from the page limit and has no page limit)

<i>Management and Implementation</i>	6 (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 2: Page limits

4.2 Executive Summary

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

4.3 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.

4.4 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 five 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.

4.5 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.

4.6 Management and Implementation

The Tenderer shall provide a detailed implementation plan of proposed activities for the duration of the framework agreement. The Tenderer is requested to include management and implementation activities within a dedicated work package (WPO).

Deliverables should be consistent with the technical requirements specified in Section 3. When defining deliverables please consolidate their numbers ideally against one deadline aligned with the proposed payment milestone, where possible.

All contract reports shall be produced in English. The quality of reports and deliverables shall be equivalent to the standard of peer-reviewed publications and practice. Unless otherwise specified in the contract, deliverables in WPO shall be made available to ECMWF in Word or Excel (for Financial Tables) format to help during the review process and PDF the latest approved document via the Copernicus Deliverables Repository system or if explicitly requested via email.

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 (Please see Volume IIIA Template - Pricing and deliverables).

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

updated and versioned as described in the tables. Tenderers shall provide list of Deliverables and Milestones as part of their bid.

Minor 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.

The C3S EQC function has now entered an operational phase and timely delivery of services is essential.

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

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

- Reporting shall be provided in accordance with the Framework Agreement Clause 2.3.
- An implementation plan for the year N+1 shall be provided in September of the year N for ECMWF approval.
- Monthly teleconferences with ECMWF and a proposal 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 proposal. The payment plan shall be based on payments at intervals of preferably six-months for routine services work packages and shall be based on milestones completion and associated deliverables for development related activities.
- Communication management (ECMWF, stakeholders, internal communication).
- Resources planning and tracking using the appropriate tools.
- Implementation of checks, controls and risk management tools for both the prime contractor and subcontractors.
- Subcontractor management, including conflict resolution, e.g. the prime contractor is responsible for settling disagreements, although advice/approval from ECMWF may be sought on the subject.
- A list of 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.
- Management of personal data and how this meets the requirements of Clause 2.8 and Annex 6 of the Volume V Framework Agreement.

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which shall include the deliverables and milestones for Work Package 0 already indicated in the table below. Volume IIIA will be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for each work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the tables.

WPO Deliverables				
#	Responsible	Nature	Title	Due
D0.y.z-YYYYQQ	Tenderer	Report	Quarterly Implementation Report QQ YYYY <i>QQ YYYY being the previous quarter</i>	On 15/04, 15/07 and 15/10
D0.y.z-YYYY	Tenderer	Report	Annual Implementation Report [PART 1] YYYY <i>YYYY being the Year n-1</i>	Annually on 15/01
D0.y.z-YYYY	Tenderer	Report	Annual Implementation Report [PART 2] 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	Report	Annual Implementation Plan YYYY <i>YYYY being the Year n+1</i>	Annually on 30/09
D0.y.z-YYYY	Tenderer	Other	Copy of prime contractor's general financial statements and audit report YYYY <i>YYYY being the Year n-1</i>	Annually
D0.y.z	Tenderer	Other	Updated KPIs (list, targets...) after review with ECMWF	One year after start of contract

WPO Milestones				
#	Responsible	Title	Means of verification	Due
M0.y.z	Tenderer	Kick-Off meeting	Minutes of meeting	Month 1
M0.y.z-Px	Tenderer	Progress review meetings with ECMWF / Payment milestones	Minutes of meeting	~ Every 6 months

5 Additional Information

5.1 Recommended literature

Lin, D., Crabtree, J., Dillo, I. et al. (2020) The TRUST Principles for digital repositories. *Sci Data* 7, 144. <https://doi.org/10.1038/s41597-020-0486-7>

Nightingale, J., Mittaz, J.P.D., Douglas, S., Dee, D., Ryder, J., Taylor, M., Old, C., Dieval, C., Fouron, C., Duveau, G., Merchant, C. (2019). Ten Priority Science Gaps in Assessing Climate Data Record Quality. *Remote Sensing*, 11(8):986. <https://doi.org/10.3390/rs11080986>

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

Whitfield, P.H. (2012): Why the Provenance of Data Matters: Assessing Fitness for Purpose for Environmental Data, *Canadian Water Resources Journal / Revue canadienne des ressources hydriques*, 37:1, 23-36, DOI: 10.4296/cwrj3701866

Wilkinson, M., Dumontier, M., Aalbersberg, I. et al. (2016): The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* 3, 160018. <https://doi.org/10.1038/sdata.2016.18>

5.2 Acronyms

C3S	Copernicus Climate Change Service
CDS	Climate Data Store
CMS	Content Management System
ECV	Essential Climate Variable
EQC	Evaluation and Quality Control
ITT	Invitation To Tender
PQAD	Product Quality Assurance Document
PQAR	Product Quality Assessment Report
QAR	Quality Assurance Report
QAT	Quality Assurance Template

SIS Sectoral Information System
URDB User Requirements Database
URAD User Requirements Analysis Document

6 Appendices

6.1 List of current catalogue entries to be addressed by the EQC function

Dataset at catalogue entry level (tier 1)	QAR production level (tier 2)	EQC tab available
Seasonal forecasts		
Seasonal forecast daily and subdaily data on single levels	per forecast model	Yes
Seasonal forecast monthly statistics on single levels		Yes
Seasonal forecast subdaily data on pressure levels		Yes
Seasonal forecast monthly statistics on pressure levels		Yes
Seasonal forecast anomalies on pressure levels		Yes
Seasonal forecast anomalies on single levels		Yes
Climate projections		
CMIP6 climate projections	per global model	No
CORDEX regional climate model data on single levels	per regional model	Yes
Reanalysis		
ERA5 monthly averaged data on pressure levels from 1979 to present	per catalogue entry	Yes
ERA5 hourly data on pressure levels from 1979 to present		Yes
ERA5 monthly averaged data on pressure levels from 1950 to 1978 (preliminary version)		No
ERA5 hourly data on pressure levels from 1950 to 1978 (preliminary version)		No
ERA5-Land monthly averaged data from 1981 to present		Yes
ERA5-Land hourly data from 1981 to present		Yes
UERRA regional reanalysis for Europe on height levels		Yes
UERRA regional reanalysis for Europe on pressure levels		Yes
UERRA regional reanalysis for Europe on single levels		Yes
UERRA regional reanalysis for Europe on soil levels		Yes
Arctic regional reanalysis on height levels from 1998 to 2019		No
Arctic regional reanalysis on pressure levels from 1998 to 2019		No
Arctic regional reanalysis on model levels from 1998 to 2019		No
Arctic regional reanalysis on single levels from 1998 to 2019		No
Near surface meteorological variables from 1979 to 2019 derived from bias-corrected reanalysis		No
In situ observations		
GRUAN reference network	per catalogue entry	Yes
E-OBS daily gridded meteorological data	per grid/version	Yes
Satellite observations		
Glaciers elevation and mass change data from 1850 to present from the Fluctuations of Glaciers Database	per Climate Data Record	Yes
Glaciers distribution data from the Randolph Glacier Inventory for year 2000		Yes
Greenland ice sheet annual gridded velocity data from 2017 to present derived from satellite observations		No

Aerosol properties gridded data from 1995 to present derived from satellite observations	Yes
Surface albedo 10-daily gridded data from 1981 to present	Yes
Leaf area index and fraction absorbed of photosynthetically active radiation 10-daily gridded data from 1981 to present	Yes
Ice sheet surface elevation change rate for Greenland and Antarctica from 1992 to present derived from satellite observations	No
Lake water levels from 1992 to present derived from satellite observations	No
Ocean colour daily data from 1997 to present derived from satellite observations	Yes
Tropospheric humidity profiles averaged monthly and zonally from 2006 to present derived from satellite observations	Yes
Lake surface water temperature from 1995 to present derived from satellite observations	No
Land cover classification gridded maps from 1992 to present derived from satellite observations	Yes
Sea ice thickness monthly gridded data for the Arctic from 2002 to present derived from satellite observations	Yes
Sea level daily gridded data from satellite observations for the global ocean from 1993 to present	Yes
Ozone monthly gridded data from 1970 to present derived from satellite observations	Yes
Sea level daily gridded data from satellite observations for the Mediterranean Sea from 1993 to present	Yes
Sea level daily gridded data from satellite observations for the Black Sea from 1993 to present	Yes
Precipitation monthly and daily gridded data from 1979 to present derived from satellite measurements	No
Sea surface temperature daily gridded data from 1981 to 2016 derived from a multi-product satellite-based ensemble	Yes
Soil moisture gridded data from 1978 to present	Yes
Upper tropospheric humidity gridded data from 1999 to present derived from satellite observations	Yes
Surface radiation budget from 1982 to present derived from satellite observations	Yes
Carbon dioxide data from 2002 to present derived from satellite observations	Yes
Methane data from 2002 to present derived from satellite observations	Yes
Sea surface temperature daily data from 1981 to present derived from satellite observations	Yes
Sea ice edge and type daily gridded data from 1979 to present derived from satellite observations	Yes
Sea ice concentration daily gridded data from 1979 to present derived from satellite observations	No
Fire burned area from 2001 to present derived from satellite observations	Yes
Earth's radiation budget from 1979 to present derived from satellite observations	No
Gravimetric mass balance data for the Antarctic and Greenland ice sheets from 2003 to 2017 derived from satellite observations	No

6.2 Current QAT for Datasets (example for satellite observations)

INTRODUCTION

A quick overview of the data characteristics (e.g. name, provider, time resolution)

DATASET OVERVIEW

Basic information about the data (e.g. format, name)

Catalogue entry name* (not shown publicly) (appadmin)	Drop down box: according to the Catalogue url	According to selection in CDS catalogue
Catalogue entry category	Drop-down menu: climate projections, reanalysis, satellite observations, seasonal forecasts, in-situ observations, sectoral climate indices	e.g Satellite observations
Description of the catalogue entry category	Free text	
Data format*	Drop-down box of: GRIB, NetCDF, ASCII, csv, txt, HDF, other (with area to write their other option) (Allow multiple options to be selected, data can come in a few formats)	
Dataset name and version*	Free text	Product name and version as identified and traceable by the data producer
Summary description of the dataset	Free text	Provide a concise summary describing the dataset specifically for the data record evaluated in this form. Please provide here general information on the dataset, its production, and how it can be used.
Variable domain	Drop-down list of: Atmosphere (composition), Atmosphere, Land Land (cryosphere), Ocean, Ocean (cryosphere), Ocean (biogeochemistry), Other(with area to write their other option)	If data already in the CDS, possibly take it automatically from the CDS portal left bar

Physical Quantity Name* (UNCOMMON) (appadmin)	Free text	There is a table on the CDS website overview tab containing this information, if possible, feed automatically here with value reported there, otherwise it will be free text
Physical Quantity Unit* (UNCOMMON)	Free text	There is a table on the CDS website overview tab containing this information, if possible, feed automatically here with value reported there, otherwise it will be free text
Definition of physical quantity* (UNCOMMON)	Free text	There is a table on the CDS website overview tab containing this information, if possible, feed automatically here with value reported there, otherwise it will be free text
How to cite this dataset ? (reference style)	Free text	Provide a standard format to be used for dataset citation. Citation should include the following information: Creator, Year of publication, Title of the dataset, Version of the dataset, Publisher (if applicable), Identifier (e.g. DOI). E.g. "WGMS (2018): Fluctuations of Glaciers Database. World Glacier Monitoring Service, Zurich, Switzerland. Digital Media. DOI:10.5904/wgms-fog-2018-11. Online access: http://dx.doi.org/10.5904/wgms-fog-2018-11 "
Are there licence conditions or terms of agreement which regulate the use of this dataset ?	Y/N	
If yes -> Licence	Link(s)	Description of conditions or terms of agreement for any use of the dataset.

if Yes	Is the licence a Creative Commons licence?	<p>Drop-down list of:</p> <p>No: all rights reserved licence</p> <p>Yes: CC0 (Freeing content globally without restrictions)</p> <p>Yes: CC BY (only attribution requested)</p> <p>Yes: CC BY-SA (Attribution + ShareAlike)</p> <p>Yes: CC BY-ND (Attribution + no Derivatives)</p> <p>Yes: CC BY-NC (attribution + non commercial)</p> <p>Yes: CC BY-NC-SA (attribution + non commercial + share alike)</p> <p>Yes: CC BY-NC-ND (attribution + non commercial +no derivatives)</p>	Guidance on which type of licence should be considered is available at https://creativecommons.org/share-your-work/
Main spectral regions of interest	Free text	Microwave, Infrared, Near-infrared, Thermal infrared, Visible, UV, Other...	
Spectral band covered	Free text	Describe the spectral band used to perform the retrieval and provide the associated wavelength or wavenumbers	
Remote sensing technique	Drop down list of : Active, Passive or Combined		
Platform	Free text	Specify the satellite platform on which the instrument is located (examples: Metop-A, Metop-B, SPOT, NOAA 17, Sentinel-3A, Sentinel-3B, AQUA)	
Orbit type	Drop down list of : LEO, GEO or other (with free text option)	Orbit type (LEO, GEO, other...)	
Sensors*	Free text or drop-down menu, depending on the Catalogue entry	Specify the instrument / sensor name	

Sensor type*	Free text	Specify the instrument type (e.g, radiometer, spectrometer, SAR...)
TEMPORAL AND SPATIAL COVERAGE AND RESOLUTION		
Time and space characteristics of the data		
Temporal coverage	Drop-down list of: past, present, future (Allow multiple options to be selected)	If data already in the CDS, possibly take it automatically from the CDS portal left bar
Record start date*	Date	start date (YYYY-MM)
Record end date*	Date (Also tick-box option for “ongoing”)	end date (YYYY-MM) (if ongoing - no date to be given)
Geographical coverage*	Drop-down list of: Global, Europe, North America, South America, Australasia, Asia, Africa, Global land mass, Global oceans, Global except polar regions, Polar regions, Northern Hemisphere, Southern Hemisphere, other (with area to write their other option)	If dataset already in the CDS, possibly take it automatically from the CDS portal left bar. Indicate also lat/lon in degrees when “other”, e.g. Other (180°W - 180°E, 30°S - 30°N)
Vertical coverage*	Free text	E.g. surface, troposphere, stratosphere, total column, vertical profile.
Temporal resolution*	Free text	Add a tooltip for “E.g. monthly, daily, hourly.” It will become a drop-down list in future
Horizontal resolution*	Free text (when possible in degrees)	Specify the geospatial resolution with units (if possible in degrees)
Vertical resolution*	Drop-down box with “Single level” and “Other: free text”	When variable at surface select “single levels”, when variable on vertical levels, select “other” for having access to the free text option. Specify with units (meters, kilometers, hPa, etc.)
Grid description*	Free text	Only for gridded data products, specify method and degree of horizontal gridding. For not gridded product: “N/A”

Coordinate system	Free text	If known provide the geographical coordinate system of the data (e.g Mercator, Equidistant cylindrical...)
Description of any gaps in spatial and temporal coverage	Free text	Describe temporal or spatial gaps in the dataset
PROVIDERS		
Data provider and contact points		
Organisation* of the producer	Free text	Name of the organisation producing the dataset
Point of contact*	Free text	Copernicus User Support (copernicus-support@ecmwf.int)
Is the dataset brokered?	Y/N	A brokered dataset is a pre-existing dataset, not subject to the Copernicus licence, to which C3S only acquires a licence for the purpose of including it in the CDS. Such licence is either provided by a C3S contractor directly or brokered from a third party, who has the right to grant such licence. In other words, C3S acquires access to the relevant dataset as a service rather than the dataset itself, as it would normally happen if the dataset had been created as a Deliverable from Copernicus funds
if yes -> Brokering approach	Free text	e.g. how the producer sends the files to CDS
DATASET VERSION		
Current version of the data and associated DOI		
Version*	Free text or drop-down menu, depending on the Catalogue entry	Dataset version
Has the dataset DOI associated?	Y/N	
<small>If yes -></small>	Report DOI	Free text
		Specify the datasetDOI
Processing level*	Free text	The description of processing level is provided in the common vocabulary (e.g. level 2, level 3 or level 4 data)
DATA UPDATE		
Data status and next releases		

Dataset status*		Drop-down box with these fields: operational, completed, experimental, in development or OTHER (with area to write their other option)	
If operational ->	Date/frequency new data is made available in the CDS*	Free text	When is expected the ICDR to be extended in the Catalogue
Is there a future update planned?		Y/N	When a new version of the dataset is meant to be issued, like a new bunch of variables associated with a new algorithm version
If yes ->	Please define future update plan	Free text	Specify the regularity of updates planned or just an indication on the year / semester of the next planned update
If no ->	Please state why no future update planned	Free text	i.e there is no planned reprocessing of the product...

USER DOCUMENTATION

Essential documentation for the effective use and understanding of the dataset

USER GUIDE

Overview of input data and methods, general guidelines for the data usage, etc

Is there a product user guide (PUG)?*			
If yes ->	Link to PUG:*	Link(s)	
If no->	Specify the reason	Free text	
Is there a user forum provided for the catalogue entry ?		Y/N	
If yes ->	Link to user forum	Link	e.g.: https://confluence.ecmwf.int/display/CUSF/forum
Does the dataset have a 'known issues' register?		Y/N	
If yes ->	Provide a description	Free text	
	Key references	Link(s)	
Quality Flags available for dataset?*		Y/N	
If no ->	Specify the reason	Free text	Please describe why no quality flag is available
If yes ->	Flag names*	Free text	Provide the flag names
If yes ->	Flag descriptions*	Free text	Describe the purpose of the flag, how it was derived and how it should be used
	Flag derivation justifications and references	Free text	
	Link to documentation of Quality Flags	Link(s)	
Is cloud masking applied to measurement (input) data?		Y/N	
If yes ->	Describe method used	Free text	

	Give justification for method used	Free text	
SCIENTIFIC METHODOLOGY			
Description of the physical basis, the algorithm or model used to produce the data record, etc			
Is there documentation describing processing of data?*	Y/N	E.g. Algorithm Theoretical Basis Document (ATBD), or any equivalent document describing the product generation	
<i>if no -></i>	Specify the reason	Free text	Please describe why no documentation describing the processing of data is available
<i>if yes -></i>	Link to documentation*	Link(s)	
Short description of the algorithm	Free text	Short description of processing algorithm used in the product retrieval, including key assumptions and main processing steps	

Can the dataset be considered as a reference?*		Y/N	<p>A dataset of satellite observations is considered as a reference when the related measurements are metrologically traceable to SI units or community accepted standards and a comprehensive characterization of uncertainty is provided for each data point. Moreover, full metadata and the description of measurement procedures and retrieval algorithms are also provided, which allows the full reprocessing of measurements starting from the raw data. Finally, measurements and their uncertainties are verified through complementary, redundant, observations of the same measurand on a routine basis.</p>	
If yes->	Is there a product Traceability Chain (TC)?*	Y/N		
	If no>	Specify the reason	Free text	Please describe why no product TC is available
	If yes->	Link to documentation*	Link	Provide a link to documentation with the product traceability chain

UNCERTAINTY QUANTIFICATION

General practices and findings used to characterize and represent uncertainty in the data record

Has an uncertainty characterization been completed?*		Y/N		
<i>If yes -></i>	Uncertainty characterization report*	Link(s)	Provide a link to the uncertainty characterization report	
	Description of uncertainty analysis*	Free text	Please describe the overall uncertainty analysis. How are the different uncertainties (random uncertainties, systematic uncertainties..) taken into account. This description is an overview for the user of the type of information he may find further details in the documentation linked as “uncertainty characterization report”	
	Global Uncertainty*	Free text	Include values/ranges and units of total uncertainty, resulting from the characterization of all estimated uncertainty contributions, with spatial and temporal ranges to which total uncertainty refers.	

VALIDATION
 Details on the validation activities performed to assess the fidelity of the data record

Is there a validation report?*		Y/N	
<i>If yes -></i>	Short description of the validation methodology, including how uncertainties are dealt with and results*	Free text	Describe how data uncertainties and observation reference uncertainties have been taken into account in the validation process. Also include regions used for validation, metrics and variables involved.

	Global and regional bias summary*	Free text	Summary of all validation activities, including bias value(s), their standard deviation values, as well as spatial and temporal ranges over which the above biases and standard deviations apply
	Any validation material publicly available	Link(s)	Any general documentation, not necessarily peer review publication
	Key references*	Link(s) (multiple links can be added)	validation reports or scientific papers about the product validation

INTER-COMPARISON

Description of the comparison activities performed against peer datasets

Has a known inter-comparison activity been completed for this dataset?		Y/N	For this product version are there inter-comparison activities that have been performed ?
<small>If yes -></small>	+	Click '+' to add/access inter-comparison activities	
	Inter-comparison activity	Free text	
	Description of methods	Free text	List the variables compared and describe how uncertainties are the observational reference were considered
	One-off or routine inter-comparison activity	Drop-box list: one-off, routine, TBD	Specify if one-off or routine inter-comparison; if routine, provide information or link to documentation on the long term inter-comparison strategy
	Results of inter-comparison	Free text	
	Key references	Link(s)	

ACCESS

Toolbox compatibility and archiving practices

TOOLBOX COMPATIBILITY *(provider does not fill it in)*

Get to know whether the variable can be served through the Toolbox

Is (are) the data file(s) compatible with the toolbox? (monthly update)		Y/N	This test verifies whether the data can be retrieved and manipulated with a predefined set of tools.
If yes or no ->	Details (monthly) (monthly update)	pdf	
	Details (daily/sub-daily) (monthly update)		

ARCHIVE *(common field)*

Archiving is associated with the capability to preserve and access CDS data, i.e. data are safeguarded against loss and kept accessible and usable for current and future applications

Description of the archiving and recovery functions and capabilities	Free text	Describe how the repository for archiving ensures continuity to ongoing access and usability. Evidence shall clarify how data archiving and recovery mechanisms are implemented.
Duration of the archiving period	Free text	Describe how long data are stored on readable and durable carriers. E.g. 10 years
Are archived data duplicated?	Free text	Is there more than one copy of the same operational dataset? Are the data kept at different geographical locations?

INDEPENDENT ASSESSMENT

Basic technical and scientific assessment of the data quality, performed by the quality control function of C3S independently of the data provider

DATA CHECK *(monthly update, when operational)*

Data and metadata checks performed

File(s) format(s) *	Drop-down menu, more selections possible	e.g. grib1, grib2, netcdf3, netcdf4, csv, txt, zip, shp (the same formats given in entry "data format" of the other QATs).
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Standard identified for the dataset category*		Drop-down menu: CMIP5 standard, CORDEX standard, GRIB2 standard for C3S (under development), CF V1.7, C3S-0.1 NetCDF seasonal standards, ESA-CCI Data Standards V2.1, C3S_311a_CDM	e.g. CF conventions v1.8, ESA-CCI v1.2
	Is(are) the data file(s) compliant with the standard identified above?*	monthly: Y/N	This test verifies whether the data comply with the identified standard.
		daily/sub-daily: Y/N	
	If yes/no ->	Details (monthly)* Details (daily/sub-daily)*	Free text and/or link to graphs/tables/CDS documents
+		Click '+' to add more standards identified for the dataset type [it implies repeating the previous 3 entries above]	
Space and time completeness	monthly	pdfs	This test verifies whether the data are complete in space (no unexpected missing values) and in time (all expected time steps are present).
	daily/sub-daily		
Is (are) the data file(s) temporally consistent with the metadata?	monthly	Y/N	This test verifies whether the data are temporally consistent with their metadata.
	daily/sub-daily		
If yes/no ->	Details (monthly)	pdfs	
	Details (daily/sub-daily)		
	monthly		

Is (are) the data file(s) spatially consistent with the metadata?	daily/sub-daily	Y/N	This test verifies whether the data are spatially consistent with their metadata.
	Details (monthly)	pdfs	
Physical plausibility ranges	Details (daily/sub-daily)	html	This test computes and displays the distribution of the data to detect any obvious issues in the values and illustrates their statistical properties.
	monthly		
	daily/sub-daily		

EXPERT EVALUATION

Scientific soundness of the data through standard diagnostics, as evaluated by field experts in the quality control function of C3S independently of the data provider

If satellite->	Scientific use cases	General description (invariant text+pdf)	Presentation of the methodology and set of metrics applied for the independent assessment. This assessment is an external and basic revision of the data, which is independent of the provider
		Means and variability (invariant text+pdf)	Describe the fitness of the data record for calculating spatial and temporal means and variability
		Trends and their limits (invariant text+pdf)	Describe the fitness of the data record for calculating trends and their limits

	Inter-comparison	Applicability for Earth System Models (ESMs) evaluation (invariant text+pdf)	Describe the fitness of the data record for Earth System Models (ESMs) evaluation
		Click '+' to add more entries [the new entry is structured like "Means and variability", the name of the new entry is "Additional scientific use case"] (invariant text+pdf)	Additional scientific use case
		General description (invariant text+pdf)	Presentation of the methodology and set of metrics applied for the independent assessment. This assessment is an external and basic revision of the data, which is independent of the provider
		Inter-comparison analysis (invariant text+pdf)	Comparison of the same variable across different data records
if reanalysis->	Performance metrics	(invariant text+pdf)	Presentation of the methodology and set of metrics applied for the independent assessment. This assessment is an external and basic revision of the data, which is independent of the provider

	Scientific use cases	Climatological mean, linear trends, etc	
		General description (invariant text+pdf)	Presentation of the methodology and set of metrics applied for the independent assessment. This assessment is an external and basic revision of the data, which is independent of the provider
		Means and variability (invariant text+pdf)	Describe the fitness of the data record for calculating spatial and temporal means and variability
		Trends and their limits (invariant text+pdf)	Describe the fitness of the data record for calculating trends and their limits
		Applicability for Earth System Models (ESMs) evaluation (invariant text+pdf)	Describe the fitness of the data record for Earth System Models (ESMs) evaluation
	Click '+' to add more entries [the new entry is structured like "Means and variability", the name of the new entry is "Additional scientific use case"] (invariant text+pdf)	Additional scientific use case	
	Inter-comparison	General description (invariant text+pdf)	Presentation of the methodology and set of metrics applied for the independent assessment. This

			assessment is an external and basic revision of the data, which is independent of the provider
		Inter-comparison analysis (invariant text+pdf)	Comparison of the same variable across different data records
If seasonal ->	Performance metrics	(invariant text+pdf)	<p>Presentation of the methodology and set of metrics applied for the independent assessment. This assessment is an external and basic revision of the data, which is independent of the provider</p> <p>[It includes general description and operations performed in pdf]</p>
		Bias, Correlation, fRPSS, fCRPSS	
If projections ->	Performance metrics	(invariant text+pdf)	<p>Presentation of the methodology and set of metrics applied for the independent assessment. This assessment is an external and basic revision of the data, which is independent of the provider</p> <p>[It includes general description and operations performed in pdf]</p>

If in-situ ->	Performance metrics	Bias, global mean, model ensemble global mean, temporal standard deviation	
		(invariant text+pdf)	<p>Presentation of the methodology and set of metrics applied for the independent assessment. This assessment is an external and basic revision of the data, which is independent of the provider</p> <p>[It includes general description and operations performed in pdf]</p>
		Statistical properties (mean, standard deviation, min, max, percentiles,...), anomalies and trends, etc	

DATASET MATURITY

The maturity assessment of the dataset variable is performed in the following six categories: metadata, user documentation, uncertainty characterization, public access/feedback/update, usage. This entry is still under development because there is not an agreed methodology to score the maturity of all dataset types available in the CDS.

Maturity matrix	invariant text + pdf	<p>The maturity assessment of the dataset variable is performed in the following six categories: metadata, user documentation, uncertainty characterization, public access/feedback/update, usage. This assessment establishes to what extent the production of a data record follows best practices, based on</p>
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		accumulated experience by the scientific and engineering communities.
Maturity matrix inter-comparison	invariant text + pdf	Maturity assessment of the same variable for different dataset sources
Guidance document on applying the maturity matrix	invariant text + link	This is the guidance document used to assess the maturity matrix of the dataset

KEY STRENGTHS AND LIMITATIONS
 Concluding remarks and highlights arising from a basic assessment performed independently of the data provider

	invariant field (automatically filled in by CMS)	The independent assessment is an external and basic revision of the data, which is independent of the provider and is performed by the Evaluation and Quality Control (EQC) function of C3S. The assessment seeks to determine compliance of metadata against community standards, data consistency and unexpected gaps in space and time, data physical plausibility, dataset performance through standard diagnostics and whether the data producer follows good practices. All the details are available in the table cells above. The
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		<p>resulting concluding remarks are reported below and identify key strengths and limitations associated with the dataset that further guide its usage.</p>
<p>Key strengths and limitations</p>	<p>invariant text + pdf</p>	<p>Main conclusions of the independent assessment and dataset variable highlights.</p>
<p>Recommendations to C3S(*) (not shown publicly)</p>	<p>Drop-down menu, options:</p> <ol style="list-style-type: none"> 1. All minimum requirements met → publish 2. Some minimum requirements not fulfilled, see details -> carefully consider publication 3. Significant issues found, see details --> do not publish 	<p>Anything that is worth mentioning to C3S (and not to the users) to make an informed decision about the publishing of the QAR and dataset. C3S needs an overview, the rest of the QAR are the details needed to give support to the main C3S' concern.</p> <p>Some guidance questions, do not need to answer them all, these just give an idea of what C3S may be interested in: any specific disagreement with the provider? did the provider contribute to the QAR? should the dataset be served at different granularity level? Are all the minimum requirements been answered satisfactorily (e.g. all the necessary documentation is available, it is clear what the data relate to, no metadata</p>

		issues). Is the overview in the Catalogue complete and coherent? Are there issues in the download page? Is the licensing clear? What shall be improved?
If 1 or 2 or 3->	Specify details(*) (not shown publicly)	
Evaluator names	pdf	Main names of the EQC team providing this specific independent assessment