ECMWF Copernicus Procurement

Invitation to Tender



Copernicus Climate Change Service Volume II

Enhanced Operational Windstorm Service

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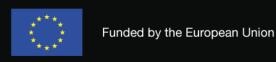




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1 Introduction

Copernicus is the European Union's flagship Earth-observation programme created to achieve operational monitoring of the atmosphere, oceans, and continental surfaces. It aims to provide reliable, validated information services for a range of environmental and security applications. The Copernicus Climate Change Service (C3S) responds to environmental and societal challenges associated with climate change. The service gives access to information for monitoring and predicting climate change and thus helps support adaptation and mitigation. C3S produces and brokers a wide range of data and products describing the past, present, and future of the climate system. This includes global and regional reanalysis, Essential Climate Variables (ECVs), near-term climate predictions, climate projections and a variety of sectoral climate information. The data are offered to users through the C3S Climate Data Store (CDS) and the Atmosphere Data Store (ADS).

CDS and ADS are instances of the same underlying core infrastructure (generically referred to as Climate Atmosphere Data Store – CADS infrastructure). Designed as a distributed system and an open framework, this shared infrastructure provides web-based and API-based retrieve facilities to a wide catalogue of datasets, applications, and other digital information. It also provides a development platform (CADS-toolbox) which allows the creation of web-based applications operating on the datasets and products available in the catalogues.

The CADS-toolbox is a platform that can be used by developers to create web-based applications that use the datasets and products available in the CDS and ADS catalogues. These applications are subsequently made available to end-users. Users are given some control over the applications by interacting with web form elements. For instance, enabling selection of a range of dates or a geographical area of interest, which are then used to parameterise the application.

2 Context

During the first phase of the Copernicus Programme (COP1), through the Sectoral Information System (SIS) activities, C3S addressed the needs of multiple sectoral users both in Europe and at the global level. Under the second phase of the Copernicus Programme (COP2) operational SIS activities will cover the water, energy, insurance, and agriculture sectors. This tender relates to the Insurance sector.

The C3S windstorm service has been designed to provide primary users, including the insurance sector, reinsurers, and insurance industry service providers, access to a catalogue of historic windstorm events within Europe. The catalogue characterises the temporal and geographic distribution of potentially destructive windstorm events over Europe.

This contract will continue the development of the windstorm service leading to operationalisation of the production of products on C3S infrastructure and demonstration the applicability of C3S windstorm information to user community.

2.1 Description of the existing C3S Windstorm Service

The C3S Windstorm service has delivered two catalogue entries in the CDS that meet the initial requirements from the Insurance industry at the time of the proof-of-concept contracts in COP1. These datasets have been published in the Climate Data Store, and included:

1. Synthetic windstorm events for Europe from 1986 to 2011, These are a physically realistic set of plausible windstorm events based on the modelled climatic conditions. This synthetic dataset is not designed to reproduce actual historical observations but as a comparator for the stochastic event sets generally used for windstorm risk analysis in the insurance industry.

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- 2. Indicators on European winter windstorms and their economic impact derived from ERA5 reanalysis. This dataset Includes:
 - a. Windstorm tracks
 - b. Windstorm footprints
 - c. Summary indicators
 - d. Risk & loss indicators

The windstorm variables are based on the ERA5 reanalysis are published here1. The dataset is generated by statistical models: Storm tracks were identified in ERA5 reanalysis data using an automated cyclone tracking algorithm based on those windstorms that made landfall and exceeded a simple wind intensity criterion. Windstorm footprints provide maximum 3-second wind gust data at 10m height covering the 72-hour period since the windstorm is first identified. The footprints are statistically downscaled from the ERA5 31km grid to a 1km grid using multiple linear regression to estimate wind gusts.

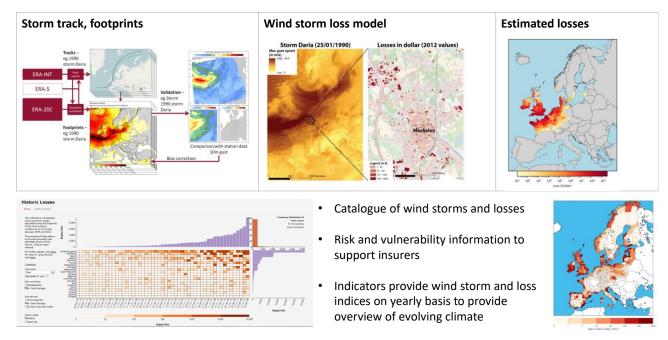


Figure 1: Overview of the current Windstorm service offering. Note that the figures are from the offline WISC portal and not representative of an operational application.

2.2 Limitations of the current windstorm service

User feedback within past C3S activities and the past limitations associated with toolbox functionality have identified limitations with the current windstorm service offering that will be addressed with this tender, namely:

- The current catalogue is not up to date with no windstorms after March 2021;
- The current catalogue does not utilise the full ERA 5 archive back to 1950's;
- Only winter windstorms are included (October March);
- Windstorm data products are produced 'offline', and not taking advantage of the updated CADS infrastructure and enhanced CADS-toolbox;
- The current offering does not include a toolbox application allowing users to explore the windstorm catalogue (note that due to CADS modernisation an application using the new infrastructure will only be publishable Q4 2023, see 2.4).

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https://cds.climate.copernicus.eu/cdsapp#!/dataset/sis-european-wind-storm-indicators?tab=overview

Moreover, the past windstorm activities have responded to requirements from insurance sector. In reality very strong winds may cause relevant damage in (and relevant to):

- Infrastructure and forestry;
- Contribute to spread forest fires;
- Dry out the soil through enhancement of evaporation.

The impact depends on other factors besides wind speed; therefore, indices are often used to identify areas at risk of wind damage. The current service does not offer information on how extremes in winds may be used to identify such areas for different sectors: agriculture, transport, forest, urban, energy (see for example this work under review: https://nhess.copernicus.org/preprints/nhess-2022-159/). The aim of this contract is to broaden the scope of the user base and provide windstorm products for multiple sectors and use cases.

2.3 The enhanced Windstorm Service

The focus of this contract is to enhance the products derived from reanalysis, specifically indicators 2. a, b, c listed in 2.1 and address the limitations summarised in 2.2. This contract will not update the synthetic event set for Europe from 1986 to 2011, nor the risk and loss indicators derived from reanalysis developed in COP1. activities. The risk and loss indicators were developed using non-C3S data and serve as an example of how C3S data can be used to develop downstream (value added) data services and will **not** be developed within this contract.

2.4 The Climate Data Store and the Toolbox

The backbone of the C3S is the cloud-based CADS that provides users with a single point of access to quality assured data on climate. The datasets may be physically located at various data centres around the world, or stored in the cloud, but such complexity will be invisible to users. All data is open and free, properly documented and enriched by appropriate quality attributes provided by the EQC (Evaluation & Quality Control). The Copernicus license ensures the data can be used by anyone for any purpose. To facilitate the transformation of data into tailored information products, the CADS-toolbox facilitates creation of python scripts and applications close to the data. All C3S data and CADS-toolbox functionality will be accessible from the CDS as well as via open Application Programming Interfaces (APIs).

CDS DATA CATALOGUE. The CADS infrastructure underpins the CDS, and provides access to climate datasets via a searchable catalogue. Categories of data include Climate Data Records (CDRs) and Interim Climate Data Records (ICDRs), quality-controlled archives of in-situ climate observations, reprocessed satellite data records, data from climate reanalysis, seasonal forecast data, output from climate model simulations, and a variety of derived climate impact indicators. Multiple datasets will be available in each category, e.g., for the majority of GCOS Essential Climate Variables (ECVs), on global or regional domains, with varying spatial resolutions and temporal coverage, from different data providers, based on different methodologies, etc.

CADS TOOLBOX. The CADS-toolbox provides users with the ability to create interactive web applications tailored to their needs using CDS datasets. The CADS-toolbox contains a variety of software tools for combining C3S datasets and performing basic operations on the data, including functions for interpolation and re-gridding, simple statistical calculations, visualisation, text manipulation, etc. The CADS-toolbox is designed to be extendable. The CADS-toolbox will, like the current toolbox, uses a Common Data Model to represent different types of datasets available in the CDS catalogue. This allows data and tools to be combined into scripts that can be executed on-line. An Application Editor is available to parametrise python scripts using widgets to create interactive web application. The CADS-toolbox includes a mechanism for tracking the provenance of information products created in scripts, creating datasets and applications. Since the 2018 release, the current instance of the toolbox environment has evolved to enable the development of a wealth of applications to support the C3S's activities.

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TOOLBOX MODERNISATION. The current instance of the CDS and the toolbox are currently undergoing modernisation as the Climate Atmosphere Data Store (CADS). This modernisation in the setup and in the functionalities of the infrastructure is expected to lead to significant technical and functional improvements for development of applications and user experience. From 2023 it is expected that python scripts produced by contractors to develop datasets or applications will be utilising the new CADS infrastructure. This CADS-toolbox update will allow C3S users (and contractors) to develop datasets and web applications based on scientific Python libraries. Contractors will make use of C3S tools where possible, and to contribute to them where there may be extra functionality required. To achieve this, the CADS-toolbox provides the opportunity for developers to contribute to CADS-toolbox libraries (for example downscaling packages, or in this instance python scripts to determine storm tracks and footprints). The python scripts should be interoperable with NumPy and xarray and be based on best practice (peer reviewed scientific methodologies, fully traceable and documented). Note, that the CADS-toolbox is under development – with a version incorporating SciPy, Numpy, xarray (...) available at the time of writing, however, the completed version of the CADS toolbox that includes interactive application development libraries will be finalised Q4 2023 (expected).



Figure 2: Overview of updated toolbox offering.

3 Contract summary

This ITT covers the provision of one contract to update winter windstorm indicators for Europe from 1979 to present derived from reanalysis.

ECMWF intends to award a single framework agreement for a period of 24 months (2 years), which shall be implemented via a single service contract (subject to negotiation) that is expected to commence in Q3 2023.

3.1 Summary of activities

The successful Tenderer will:

- Deliver an enhanced Windstorm service at the European scale, covering windstorm data about the
 past climate characterised by the ERA 5 reanalysis. The dataset should be developed on the CADS
 infrastructure adopting a transparent workflow (python script(s)) implemented in the CADS toolbox.
- Provide level 2 support to the Copernicus User Support: responding to user support queries, contributing to FAQ and knowledge base articles.
- Collect feedback on already published datasets/applications in the CDS and provide a gap analysis of
 the insurance information made available to users to steer the service design in terms of them.
 Evolving user requirements should be considered to refine the information provided and the service
 evolution.
- Provide full documentation and continued maintenance of any delivered products.

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• In conjunction with Copernicus User Engagement section, engage with relevant user communities, address downstream market needs, and prepare specific case studies to demonstrate the added value of the insurance products into users' and their value chains.

This enhanced windstorm service shall provide new and extended information to that already available through the current C3S Windstorm service. Enhanced operational aspects include:

- Extension of the historical data period back to 1941.
- Delivery of interactive applications.
- Operational development of windstorm indicators to ensure NRT provision of data as and when a windstorm event has been identified from ERA 5 reanalysis.
- With support from CUE, engage with user communities to assess needs, updated gap analysis and the develop case studies specific to the insurance industry.
- Review existing service offering to define and implement, if appropriate, additional exceedance thresholds to identify additional storms relevant to insurance users (i.e., at present a wind gust of 25m/s has been implemented).
- Engage and support C3S Evaluation Quality Control (EQC) activities to implement quality assurance framework to ensure implementation of a transparent workflow to produce windstorm indicators (e.g., reanalysis to storm footprint).

3.2 Other high-level objectives

- The services enhancement responds to the requirements of current windstorm users and, where
 possible, trying to anticipate emerging needs and opportunities for new sectors and users, including
 collection of feedback on already existing CDS products.
- The delivered products and the associated information should support C3S activities in developing a hub of information to support the assessment and characterisation of climate extremes across multiple climate perils (river flooding, pluvial flooding, drought, heatwaves etc.), see point 6) in section 4.1.
- The services must be efficient in the way they are computationally implemented and run.
- The services must be presented in a clear way, they must be maintained and fully documented.

4 Technical Specification

The enhanced windstorm service will produce timely, high-quality products and information on wind extremes. The overarching aim of this contract is to produce traceable, clearly documented, and high-quality windstorm information. The service will be based on pre-existing C3S data and developed on (ultimately) CADS infrastructure, including the software development platform (CADS-toolbox), which allows for the creation of python scripts to develop datasets and web-based applications, operating on the datasets and products available in the CDS catalogue.

The service builds on stakeholder engagement and requirements acquired through user engagement from past SIS insurance activities. The bidder is asked to propose elements to address the limitations to the current service, listed in the previous section 2.2.

Timescale. The new data provision must cover the historical timescales, by making use of ERA 5 reanalysis back extension for the past and ensuring that recent windstorm events of relevance to the user community are identified readily and included in the windstorm catalogue.

The solution shall be based on data that are in the CDS. External (open access) data may be used for evaluation purposes but must be agreed with ECMWF. The enhanced service may provide different information at different timescales, if relevant to user communities.

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Any **source of uncertainty** associated with the data or with the approach, as well as products limitations, should be fully documented and properly referenced. Any bias-adjustment and downscaling method should be implementable using the toolbox and be properly documented.

Toolbox Applications. Relevant toolbox applications designed to stimulate service user uptake and covering all timescales must be created and published. Any tools developed within this contract shall be delivered along with example python scripts. All applications developed by the successful Tenderer will need to be compliant with the standards of the CADS. To be published, an application needs to be scientifically robust, meaningful, UX (user experience) optimized, usable, working and bug free. Publishing is supported by established procedures. Please refer to: <u>Tool publication</u>². Toolbox applications are not foreseen to be developed prior to Q4 2023 due to the CADS-toolbox development.

Case studies. Develop at least 2 case studies, demonstrating the added value of the service (see Task 4 in section 4.1 below).

Engagement with specific users. Engage with a selection of users to shape the service and advertise it further on.

The successful Tenderer will subsequently be given access to all existing material available from the current operational windstorm service implementation.

4.1 List of Tasks

Based on the above requirements, this is the list of required tasks:

1) Provision of data to the Climate Data Store

Windstorm data covering the required space and time scales with adequate spatial and temporal resolution must be delivered to the CDS together with the code (python scripts) to run on CADS infrastructure. The adequacy of the space and time resolution is based on data availability and user needs at the European scale. Data delivery includes the provision of data and files containing abstracts, detailed descriptions of dataset, variables, etc., following the integration process detailed here³.

It is foreseen that the Windstorm data catalogue will be updated periodically following identification of windstorm events. The contractor should determine the possibility of automatic updates to the Windstorm catalogue. C3S has successfully demonstrated the use of CADS-toolbox scripts in the update of C3S catalogue entries (see <u>agromet indicators</u>). This contract encourages a similar approach where code is run on CADS infrastructure to ensure production of windstorm indicators.

2) Development of Applications

All applications must be developed in the CADS-toolbox. All applications are to be delivered through the ECMWF's Jira system specifying the project CDSAPP (link4) in the first field of the form, with the prime contractor or an assigned person in charge of making the publication request and acting as the responsible part to ensure that the material provided is fit for the purpose. The delivery of an application or set of applications does not grant the publication itself. Applications which are aimed to be published in the CDS should have undergone extensive internal review by the successful Tenderer to ensure delivery of quality applications which are optimised in terms of performance prior to final review and publication by technical teams at ECMWF. This review process will cover many aspects including evaluation of adequateness of the application in terms of usability, accuracy, description of input and output variables, appearance, coding

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² https://confluence.ecmwf.int/display/COPSRV/How+to+contribute+to+the+toolbox

³ https://confluence.ecmwf.int/display/COPSRV/If+you+are+a+provider+of+data

⁴ https://jira.ecmwf.int/servicedesk/customer/portal/8

standards and style, functionality, and scientific quality. The Tenderer shall ensure that a sufficient provision is made to cover this activity.

The successful Tenderer is responsible of de-bugging and updating published python scripts, calling libraries developed within the CADS-toolbox environment and data within the CDS.

The successful Tenderer is responsible for implementing version control and a source code content management system, including management of the repository. This will ensure code is available to C3S during and after the contract.

3) Consistency with respect to the current windstorm service

By collecting feedback on already published datasets/applications and through a gap analysis, Tenderers shall demonstrate in their proposal how the new service will be an improvement on the existing one, by considering the limitations mentioned in section 2.2. Tenderers shall describe how the currently existing information may be integrated, improved, maintained, superseded, or may co-exist with the new one.

4) Case studies

The contractor will undertake a literature review to define best practice of how windstorm products can be used to add significant value to other sectors and user communities. This activity may define relevant storm related indices and thresholds for use in transport, agroforestry, etc, (and (ultimately) through the implementation of selected damage functions and ultimately provide these via the CDS catalogue or application).

Based on this review the contract will develop at least 2 case studies, demonstrating the added value of the enhanced windstorm service and how engaged users can utilise data and/or tools developed within this contract in their own workflows.

The case studies should cover different user communities. An indication of the proposed case studies to be developed within the contract shall be provided in the proposal. Case studies shall be refined at the early stage of the contract with input from ECWMF technical officer and Copernicus user engagement team (ECWMF) and updated throughout the evolution of the service.

5) Providing material for the C3S Climate Intelligence Team

One of the users of the windstorm data is the C3S Climate Intelligence Team who want to use these data to be able to give a near-real time or yearly update of how specific climatic events may impact sectoral activities (such as energy, finance, or insurance) and how these compare within a historical perspective. It is required to co-define specific indicators and relevant associated information for this monitoring activity and, in cooperation with ECMWF, how and where to make maps and graphs of indicators available for the annual state of the climate reports (ESOTC).

6) Catalogue of Extreme Events

During 2023 ECWMF is planning to tender activities to support the development of a catalogue of extreme events. The catalogue is envisaged to provide C3S users with an historic perspective of selected extreme events (heat waves, floods, ...,) derived from CDS data catalogue and near-real time observations and reanalysis datasets. The catalogue of extreme events will provide users with information on past hazards extent, duration, magnitude, and associated summary indicators. As windstorm experts, the contractor will provide support to the creation of a user-oriented catalogue of extremes, providing sector specific information related to extreme windstorms.

7) Elements for service evolution

The successful Tenderer shall be responsible for the synthesis of user requirements to provide recommendations for the evolution of the windstorm service. Based on the successful Tenderer's knowledge of the sector, literature review, and an analysis of collected user requirements from the C3S user requirement

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database (URDB) and those captured from Copernicus engagement, user intelligence and associated activities, the contractor will undertake gap analysis. This gap analysis will provide recommendations for new scientific developments that assure the evolution of windstorm products. It is foreseen that the contractor will consider new requirements throughout the 24-month contract, with high priority / impact being implemented according to available resources.

8) Bug fixing and maintenance of all service elements

The contractor shall be responsible of debugging and maintaining the datasets, the toolbox applications, the case studies, and all material delivered, as well as updating relevant user guides and associated documentation, as required.

The contractor will ensure **quality of all scripts** used to generate and publish datasets and applications, through an internal quality control procedure to be delivered together with datasets and applications. As detailed in point 2 above, quality includes aspects such as optimised performance of the software, adequateness of the applications and scripts in terms of usability, accuracy, description of input and output variables, appearance, coding standards and style, functionality, and scientific quality.

9) Support to Copernicus User Engagement activities

While broader user engagement and training activities are not part of the scope of this contract (except those activities defined in 4), the successful Tenderer shall accommodate for eventual needs, and support Copernicus User Engagement activities in providing technical and scientific expertise in support of these activities. Tenderers shall specify in their proposal the experts intended to be allocated to provide this support.

Requests to support activities may be raised on, for example:

- Contribute with content specific input to training, education, and capacity building material: development and/or review of learning resources in the domain of the contract, participation in train-the-trainer events and MOOCs.
- Contribute with content specific input to user-oriented communication material such as slides, story maps and user testimonials.
- Contribute and attend User Uptake workshops and stakeholder meetings. Presentations may be asked to be provided.
- Input to the URDB with user requirements, as well as sharing needs and aspirations as raised by potential new user communities.
- Provide input to conceptional assessments and developments of specific user engagement plans and actions as launched by ECMWF.
- Provide input to user stories and user testimonials.

A small, dedicated budget shall be allocated in the pricing table to accommodate for these needs. Details on the expected activities and the budget shall be refined during the negotiation phase.

10) Contribute to L2 support to Copernicus User Support Team

See section 4.2.1.

11) Contribute to the C3S Evaluation and Quality Control (EQC)

See section 4.2.2.

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4.2 Other requirements

4.2.1 Quality control, support, and documentation

Quality control procedures (including automatic procedures) shall be put in place to check the quality of data before transmission to ECMWF. The precise methods should be proposed by Tenderers and will be agreed as part of the negotiations. In the case of ECMWF detecting possible problems with the data, providers are required to give timely support to resolve problems quickly, and at the latest 24 hours before the product release date. Each data and application version needs to be documented, at a level which defines how the data/application were produced and allows users to understand version changes. The data providers will be responsible for making this documentation available as required.

The contract shall provide support to C3S on several fronts.

- 1. Technical support to the CADS team, on matters related to the operation of the infrastructure. As this is a service with operational status, this means timely responses in case of problems detected using an efficient workflow to get the answer and the possible fixes quickly.
- 2. Support to specific user questions which relate to the hosting, archiving and the quality control of the original data and which go beyond the expertise of Copernicus User Support (CUS). A procedure should be defined and implemented, to accommodate such requests and provide timely answers. Level-2 support is provided through the Copernicus User Support (operating a Jira ticketing system) with agreed Key Performance Indicators (KPIs; for example, 85% of Level-2 tickets should be resolved within 15-working days). The contractor shall provide an email address which acts as the single contact point.
- 3. Maintenance of the data documentation, which is provided to the users through the CDS and that is an integral part of the CDS catalogue entries. Detailed documentation for the operators regarding the whole production and archiving chain must also be provided.
- 4. Support to the Evaluation and Quality Control function. The contractor shall coordinate with and support the work of the EQC function, e.g., reviewing EQC material produced independently, guidance to users. (See section 4.2.2)
- 5. Ensure quality of all deliverables, including publishable datasets / scripts, through performing and documenting checks and tests ahead of publication;
- 6. Support is also required for related C3S activities, including communication and outreach. While for most such cases the needs on this contract are expected to be minimal, consideration should be given to allowing resources to cover these aspects. Any communication activity related to this work must be agreed with the ECMWF Copernicus Communication team in advance. This includes, but not exhaustively covers, communication planning, branding and visual style, media outreach, website, and social media activity, externally facing written and graphical content and events.
- 7. Transfer knowledge to user support by making contributions to the knowledge base. This will include creating and updating user documentation and FAQs (based on user feedback and queries). Such documentation should be available in HTML format.
- 8. Provide support to users through the user forum upon requests.

The contract management activities shall be managed in separate work package; the structure and content expected from this work package are described in the next section.

4.2.2 Evaluation and Quality Control

Published datasets will need to be evaluated by the EQC activity (Evaluation & Quality Control). The Copernicus Climate Change Service offers an Evaluation & Quality Control Function, which provides quality assurance and fitness for purpose information for all of data, tools and applications published by C3S (https://climate.copernicus.eu/quality-assurance-copernicus-climate-change-service).

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The C3S Evaluation and Quality Control (EQC) function has been designed to provide assessments of the technical and scientific quality of all C3S products and services, including their value to users. This function is being performed by independent evaluators within a separate contract, in close coordination with the service providers.

The contractor will produce products that are in line with the quality assurance criteria set out by the EQC function and will also liaise with EQC (both C3S and its contractors) as appropriate. A consultation process is foreseen between EQC evaluators and the successful Tenderer before the start of the EQC workflow to define the respective quality assurance reports (QARs) to be produced including their level of granularity. It is envisaged that the contractor will provide general support to the EQC function to facilitate EQC assessment on those artefacts that are public and published applications (and datasets) within the CDS.

4.2.3 Data and IPR

It is a condition of EU funding for C3S that ownership of any datasets developed with C3S funding passes from the suppliers to the European Union via ECMWF. Ownership will pass from the date of creation of the datasets. Suppliers will be granted a non-exclusive license to use the datasets which they have provided to C3S for any purpose. All software and products used by the successful Tenderer to produce the C3S datasets will remain the property of the successful Tenderer, except for those components which are acquired or created specifically for C3S purposes, with C3S funding, and which are separable and useable in isolation from the rest of the successful Tenderer's production system. The identity and ownership of such exceptional components will be passed to the European Union annually. The successful Tenderer will be granted a non-exclusive license to use them for any purpose.

4.2.4 Key Performance Indicators

Contractors shall report to ECMWF on a set of Key Performance Indicators (KPIs) suitable for monitoring various aspects of service performance (by using the template included in Volume IIIB). The KPIs shall be designed to quantify various aspects of quality of service against the requirements described in this document. As part of the bid, Tenderers shall specify a proposed set of KPIs appropriate for the service, e.g., relating to operational service delivery, quality, data access, user support, user satisfaction, etc., aligned with the requirements expressed above. These initial specifications shall be refined together with ECMWF during the first 6 months of the contract.

5 Deliverables and milestones

Deliverables should be consistent with the technical requirements specified in section 4. A deliverable is a substantial, tangible, or intangible good or service produced as a result of the contract. In other words, a deliverable is an outcome produced in response to the specific objectives of the contract. Deliverables are subject to acceptance by the technical contract officers at ECMWF.

All contract reports and documentation for this ITT 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 HTML) via the Copernicus Deliverables Repository portal. For deliverables which nature is "Data" or "Software" the mean of verification shall be tagged repositories and/or .zip/.tar files. The details will be agreed at the negotiation stage.

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

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

Tenderers shall complete the relevant table in Volume IIIA as part of their bid, which includes the details of deliverables and milestones for all work packages and the schedules for each work package. Volume IIIA will be used by Tenderers 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.

The work shall be structured by the following set of Work Packages as outlined in the next sub-sections.

5.1 Work Package 1: Development of Indicators

This Work Package will start to deliver data following a consolidation period of **up to** six months (from the start of contractual activities). A maximum of six months will allow the contractor to define and implement peer reviewed, robust, and efficient scripts to derive high quality windstorm products using the CADS infrastructure. Internal QA procedures will be established to ensure all data products delivered for publishing have undergone routine quality assurance (data and metadata).

Following the initial set up phase and a gap analysis, the data delivery is expected to commence at month 6. At which point, contractor will ensure delivery of data products necessary for CDS ingestion which required support for publication of data products in the CDS and maintenance of the catalogue entries.

Below is a list of the minimum data deliverables expected in WP1. Note that these deliverables do not fully account for the technical specifications included in this ITT. It is expected that Tenderers will need to consider the additional requirements and define additional deliverables and/or milestones according to their proposed technical solution and resources available.

Minimum Deliverables required:

WP413.1 Deliverables						
#	Туре	Title	Due			
D413.1.1	Report	М3				
lData -		Windstorm data products from ERA5 archive, including back extension and publication in the CDS	M6/M9			
D413.1.3	Data	Operational production of windstorm dataset and publication in the CDS	M9 (starting) and periodically there after (contractor to propose schedule in proposal)			

5.2 Work Package 2: Development of Workflows, Use Cases

This Work Package will ensure the development of user relevant interactive application(s) (using toolbox scripts) for visualising windstorm products using the CADS-toolbox. Any application will be accompanied with documentation. It is expected that the CADS-toolbox applications package will be developed in time for application development during Q4 2023. The contractor will support CADS-toolbox development with additional tools and functions as required to ensure realisation of a windstorm application(s). Therefore, the expectation is to realise the publication of the windstorm application(s) soon after this release date in Q4 2023.

The contractor will demonstrate the added value and use of windstorm data by developing two use cases. These use cases can be co-defined by the contractor, with approval by ECMWF. The use cases may be based on functionality built on toolbox, for example a user case could implement tailored damage functions,

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implement new formatting to demonstrate the value of contractual activities for a specific user / community. In addition, the outcomes of the use cases are expected to be published on the C3S website as a web article and/or interactive story map together with material for social media posts in addition to any implemented toolbox scripts.

Below is a list of the minimum deliverables expected in WP2. Note that these deliverables do not fully account for the technical specifications included in this ITT. It is expected that Tenderers will need to consider the additional requirements and define additional deliverables and/or milestones according to their proposed technical solution and resources available.

Minimum Deliverables required:

WP413.2 Delive	WP413.2 Deliverables					
#	Туре	Title	Due			
D413.2.1 Report Application manager		Application management plan and implementation schedule	M3			
D413.2.2	Code / report	Windstorm application(s)	M6/12			
D413.2.3	Other	lUse Case(s)	To be defined within the contract			

5.3 Work Package 3: Quality Control, User Guidance and Support

Quality control procedures (including automatic procedures) shall be put in place to check the quality of data before transmission to ECMWF. The precise methods should be proposed by the Contractor, responding to sections 4.2.1 and 4.2.2, and will be agreed as part of the negotiations. In the case of ECMWF detecting possible problems with the data, providers are required to give timely support to resolve problems before the product publication in the CDS. Each data and application version needs to be documented, at a level which defines how the data/application were produced and allows users to understand version changes. The data providers will be responsible for making this documentation available as required.

The contract shall provide support to C3S activities on several fronts including those related to user support, EQC, climate intelligence, user engagement and training and other C3S contracts that require windstorm products and expertise, including:

- 1. Technical support to the CDS / CADS-toolbox teams, on matters related to the operation of the infrastructure. As this is a service with operational status, this means timely responses in case of problems detected using an efficient workflow/script to get the answer and the possible fixes quickly.
- 2. Update of documentation, which is provided through the CDS, including known issues with the dataset, and other material aimed at users of windstorm products.
- 3. Upkeep of web pages with up-to-date information about the data services developed withing this contract, including known issues with the dataset, displays of production targets and measures of progress.
- 4. Contribution to development of training material for C3S users if required.
- 5. Contribution to C3S communication and user engagement activities (including providing technical and scientific expertise) and particularly support of climate intelligence activities including annual state of the climate reports. Support is also required for related C3S activities, including communication and outreach. While for most such cases the needs on this contract are expected to be minimal, consideration should be given to allowing resources to cover these aspects. Any communication activity related to this work must be agreed with the ECMWF Copernicus Communication team in advance. This includes, but not exhaustively covers, communication planning, branding and visual style, media outreach, website, and social media activity, externally facing written and graphical content and events.

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- 6. Contribution to C3S Climate Intelligence Activities, by providing relevant indicators for the annual state of the climate reports (ESOTC).
- 7. Providing support to the creation of a C3S SIS user-oriented catalogue of extreme events.

Below is a list of the minimum deliverables expected in WP3. Note that these deliverables do not fully account for the technical specifications included in this ITT. It is expected that Tenderers will need to consider the additional requirements and define additional deliverables and/or milestones according to their proposed technical solution and resources available.

Minimum Deliverables required:

WP413.3 Deliverables and Milestones				
#	Туре	Due		
D413.3.1	Report	Update of technical support/documentation/user guide	M6/12/M24	
D413.3.2	Report	User support activities	M6/M12/M24	
D413.3.3	Report	Input to EQC activities	M12/M24	
Engagement activitie Report Engagement activitie Routine tasks on qui		Report on Communication, Climate Intelligence and User Engagement activities	M12/M24	
		Routine tasks on quality control, user guidance and support Means of verification: brief technical note	Semestrial	

5.4 Work Package 0: Management and implementation

This Work Package includes overall responsibility for service management and implementation. In addition, the work package shall include coordination on a technical level between the C3S COP2 activity on extremes and other Copernicus activities, namely user engagement and climate Intelligence. This coordination will be overseen by the technical officers in charge of these contracts at the ECMWF side and the responsible task leaders identified by the contractor.

Deliverables required:

WP413.0 Deliverables				
# Responsible Nature		Nature	Title	Due
D413.0.y.z- yyyyQq ⁵	Tenderer	Report	Quarterly Report QQ YYYY; QQ YYYY being the previous quarter	Quarterly on 15/04, 15/07 and 15/10
D413.0.y.z-YYYY	Tenderer	Report	Annual Report YYYY [Part 1]; YYYY being the Year n-1 [QIR for Q4 and Annual Financial Report]	Annually on 15/01
D413.0.y.z-YYYY	Tenderer	Report	Annual Report YYYY [Part 2]; YYYY being the Year n-1	Annually on 28/02
D413.0.y.z Tenderer Report Final report		Final report	60 days after end of contract	
D413.0.y.z-YYYY	Tenderer	Report	Annual Implementation Plan YYYY; YYYY being the Year n+1	Annually on 30/09
D4130.y.z-YYYY Tenderer Other Co		Other	Copy of prime contractor's general financial	Annually

⁵ Deliverables (and Milestones) shall be numbered as per the following format D413.X.Y.Z (MX.Y.Z), where X is the WP number, Y is the task number and Z is the Deliverable (Milestone) number in this task. Deliverables delivered annually should be numbered D413.X.Y.Z-yyyy, where yyyy is the year, the Deliverable refers to (e.g., D413.X.Y.Z-2022, D413X.Y.Z-2023). Deliverables delivered quarterly should be numbered DX.Y.Z-yyyyQx, where yyyyQx is the quarter of the year the Deliverable refers to (e.g., D413.X.Y.Z-2023Q1). The same numbering format shall be applied for Milestones. Continuous deliverables at higher frequency can be labelled in the same way as quarterly deliverables.

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		statements and audit report YYYY; YYYY being	
		the Year n-1	

WP413.0 Milestones					
#	Responsible	Title	Means of verification	Due	
M413.0.y.z-Px	Tenderer	Review meeting with ECMWF	Minutes of meeting	At each Payment Milestone due date	
M413.0.y.z-Px	Tenderer	Risk Register	Compliance with Clause 2.1.2.2	15 days from the Effective Date	
M413.0.y.z-Px	Tenderer	Updated KPIs (list, targets) after review with ECMWF	KPI list updated in the WP0 reports	6 months after start of contract	

6 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.

6.1 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.

Section	Page Limit
Executive Summary	2
Track Record	2 (for general) and 2 (per entity)
Quality of resources to be Deployed	2 (excluding Table 1 in Volume IIIB and CVs with a maximum length
	of 2 pages each)
Technical Solution Proposed	20 + 3 per Work package (Table 2 in Volume IIIB, the section on
	references, publications, patents and any pre-existing IPR is
	excluded from the page limit and has no page limit)
Management and Implementation	6 (excluding Table 4 and Table 5 in Volume IIIB) + 2 per each Work
	package description (Table 3 in Volume IIIB)
Pricing Table	No limitation

Table 1: Page limits

6.2 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.

6.2.1 Executive summary

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

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6.2.2 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.

6.2.3 Quality of Resources to be Deployed

The Tenderer shall propose a team that meets at least the following requirements:

- A senior team member with more than 5 years of experience in managing activities related to this ITT (referred to as Service Manager). This person will be the point of contact on technical matters.
- A team member with experience of managing projects and contracts of this type and size (referred to as Contract Manager). This person will be the main point of contact for administrative matters.
- Team members with demonstrated experience in performing activities related to the various aspects of this ITT.

These team members shall be involved in the activities of this ITT at a minimum level of 10% of their total working time.

6.2.4 Technical Solution Proposed

The Tenderer is expected to provide a short background to the proposed technical solution to demonstrate understanding of the solution proposed, as well as an exhaustive and detailed description of the proposed technical solution and its organisation into work packages. See also section 5.

6.2.5 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).

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 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) and briefly describe them in their proposal:

- Contractual obligations as described in the Framework Agreement Clause 2.3 and Annex 5 on reporting and planning.
- Meetings (classified as tasks and listed in a separate table as part of the proposal):
 - ECMWF will host monthly teleconference meetings to discuss C3S service provision, service evolution and other topics.
 - ECMWF will organise annual C3S General Assemblies. The successful Tenderer is expected to attend
 these meetings with key team members covering the topics that are part of this ITT.
- A check on the quality of the deliverables should be made by the prime contractor before submission to ECMWF (to cover contents, use of relevant ECMWF reporting templates, format, deliverable numbering and naming, punctuation, spelling and grammar, etc).
- Resource 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).

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- A list of subcontractors describing their contribution and key personnel shall be provided, as well as backup names for all key positions in the contract. Tenderers shall describe how the Framework Agreement, in particular Clause 2.9 has been flowed down to all their subcontractors.
- Management of personal data and how this meets the requirements of Clause 2.8 and Annex 6 of the Volume V Framework Agreement.

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