

ECMWF Copernicus Procurement

Invitation to Tender



Copernicus Climate Change Service

Maintenance and Extension of C3S Windstorm
and Storm Surge Services

Volume II: Specification of Requirements

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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 variability and 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 reanalyses, 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).

2 Context

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.

The C3S Storm Surge products provide harmonised information on extreme sea levels along European coastlines, driven by mean sea level, tides, storm surges, and waves. They are based on reanalysis datasets (a global tides and storm surges model forced by ERA5) from which statistical indicators such as percentiles and return periods are derived using extreme value methods. These indicators underpin large-scale coastal flood hazard and risk assessments. In addition to historical reanalysis (currently 1979–2025, with potential extension), the service supports projections of extreme sea levels under future climate scenarios, enabling downstream assessment of changing coastal flood risk under sea-level rise and evolving storm patterns.

2.1 The Climate Data store

The backbone of the C3S is the cloud-based Copernicus Climate Data Store (CDS; <https://cds.climate.copernicus.eu/>) that provides users with a single point of access to quality assured climate and meteorology data. The datasets may be stored in different data centres worldwide or in remote servers, but this complexity will be transparent to CDS users. C3S data is offered with open access and is free to use under the Copernicus data licence. Data are properly documented and enriched by appropriate quality attributes provided by the EQC (Evaluation & Quality Control). All CDS data and tools are accessible from the C3S website as well as via open Application Programming Interfaces (APIs).

The CDS data catalogue 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 forecasts, climate model simulations, and a variety of derived climate impact indicators. Multiple datasets will be available in each category, e.g., for most of the Global Climate Observing System (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. Several entry catalogues are relevant in the context of this tender, including the global reanalysis and climate projections

2.2 Earthkit

Earthkit is an open-source python (<https://earthkit.ecmwf.int>) project led by ECMWF, providing powerful and easy-to-use tools for working with earth system data. Earthkit is designed to accelerate weather and climate science workflows by simplifying tasks such as data access, processing, analysis, and visualisation. It

offers a modular suite of interoperable components built on trusted Python libraries such as NumPy, Xarray, and Matplotlib, while also integrating smoothly with ECMWF's operational software stack and the wider scientific Python ecosystem. Earthkit provides easy access to ECMWF data services including CDS and ADS datasets, along with a range of tools to process, analyse and visualise them. The development design of earthkit is modular and open source to encourage contributions from the wider community and contracted partners. The packages are well documented and available for the whole world to use. Introductory documentation is available in the following link <https://earthkit.readthedocs.io/en/latest/index.html>.

3 Contract summary

This Invitation to Tender (ITT) invites Tenderers to submit Tenders for two distinct Lots: Lot 1 – Maintenance and extension of the Operational Windstorm Service, and Lot 2 – Maintenance and extension of operational storm surge products. Specific details for each Lot are provided in the relevant sections of this document.

Tenderers are invited to submit their Tenders for either one or both Lots. Please note that the expertise required for each Lot strongly differ. In cases where a Tenderer opts to submit Tenders for both Lots, it is mandatory that each Tender is presented as a separate submission, with its own set of documents, including but not limited to, technical proposals, pricing tables and any required supporting documents. Tenderers must ensure that the submissions for each Lot are independently viable and stand on their own merits. At the same time, Tenderers should indicate what synergies, including cost savings, can be achieved should more than one Lot be awarded to them.

Tenderers shall include in their Tender any necessary computing and storage needs and associated estimated costs. The CDS may offer some cloud resources, subject to evaluation at the negotiation phase.

4 Lot 1: Maintenance and extension of the Operational Windstorm Service

This activity aims to maintain and further develop the operational windstorm climate service, which is primarily designed to support the insurance and risk management sector. The objective of this Lot is to ensure the continued operational delivery, scientific robustness, and strategic extension of the Operational Windstorm Service under C3S, including preparation for ERA6, enhancement of derived indicators, and development of user-oriented applications and demonstrators.

4.1 Specific background

The Operational Windstorm Service is a Copernicus Climate Change Service (C3S) offering dedicated to professional users, particularly those involved in insurance, reinsurance and climate risk assessment applications. The service was first released in 2025 and includes a core dataset together with prototypes of two user-facing applications. The underlying dataset is the **Windstorm tracks and footprints derived from reanalysis over Europe between 1940 to present** dataset, which has the following key characteristics:

- It is a pan-European windstorm dataset produced under the Copernicus Climate Change Service (C3S) within the Operational Windstorm Service.
- It covers windstorms associated with extra-tropical cyclones (ETCs) from 1940 to the present, based on the ERA5 reanalysis.
- It provides storm tracks, representing the spatial and temporal evolution of individual windstorm systems.
- It includes windstorm footprints, defined as gridded maps of maximum 10 m wind gusts for each identified storm event.
- A downscaled footprint product at approximately 1 km spatial resolution is available to provide

- enhanced local detail.
- The dataset includes storm summary indicators (e.g. storm frequency, severity indices), aggregated at annual and/or regional scales.
- Two automated storm-tracking algorithms (Hodges and TempestExtremes) are used for storm detection and characterisation.
- The dataset is updated monthly as new ERA5 reanalysis data become available.

The service supports climate analysis, risk assessment, and sectoral applications, particularly for insurance and financial risk management.

The dataset is accompanied by two prototype applications designed to help users explore, visualise, and navigate the complexity of the data.

4.2 Scope of the service

The service is highly valued by its user community. The scope of this activity shall therefore include the following elements:

- Maintain the current service and extend it with new products, statistics, methods, and time scales, based on the collection and analysis of user requirements (including exploration of AI-based methods).
- Introduce an additional level of quality control to ensure the suitability of the products for C3S climate reporting activities.
- Contribute to the [European State of the Climate \(ESOTC\)](#)¹ report writing, **if the products are included in a specific section of the report** (see Section 7.6).
- Prepare the service for the transition to ERA6, including assessing impacts on existing products and workflows.
- Expand and support the user base, with particular emphasis on the needs of the catastrophe modelling and insurance communities.
- Ensure coordination and technical consistency with Lot 2, in particular regarding storm surge products and related hazards (see Section 6).
- Maintain, improve, and further develop the prototype applications associated with the service.
- Support the effective use of the service outputs and design them so they can be integrated into other services and applications (e.g. climate risk assessment workflows).
- Generate, update, and maintain training and user support materials.
- Support, where required, the activities of the Copernicus Communication and User Engagement teams, including selected outreach and dissemination actions.

4.3 Technical requirements

Tenderers for Lot 1 are invited to propose a coherent set of work packages addressing the technical tasks described below. The proposed work shall ensure the continued operational reliability, scientific robustness, and future evolution of the Enhanced Operational Windstorm Service.

4.3.1 Debug and Maintenance of the extra-tropical cyclone (ETC) diagnostics based on ERA5 and prepare extension to ERA6

The Successful Tenderer shall ensure the continuous operational delivery, maintenance, and evolution of the ETC diagnostics and associated products currently based on ERA5 reanalysis and prepare their transition to ERA6.

¹ <https://climate.copernicus.eu/ESOTC>

4.3.1.1 *Products to be maintained*

The following products and components shall be maintained:

- The CDS dataset [Windstorm tracks and footprints derived from reanalysis over Europe between 1940 to present](#)²
- Two prototype applications, which shall be maintained and further developed. Maintenance shall ensure that the applications:
 - remain fully operational at all times;
 - are updated following any changes to the underlying datasets;
 - are promptly restored in coordination with C3S in the event of technical issues.
- Jupyter Notebooks associated with the windstorm dataset, intended to support advanced and expert users.

4.3.1.2 *Maintenance and quality assurance tasks*

The Successful Tenderer shall:

- Ensure ongoing operational maintenance, monitoring, and troubleshooting of the products listed above, including timely updates of regularly maintained products.
- Identify, diagnose, and resolve issues affecting the datasets, their CDS catalogue entries, associated documentation, underlying code, and Jupyter Notebooks.
- Review, validate, and, where necessary, correct post-processing and spatial filtering criteria applied to the ETC diagnostics, ensuring that high-impact European windstorms are not inadvertently excluded.
- Perform scientific completeness and consistency checks, including validation against known recent high-impact European windstorms.
- Assess the implications of the diagnostics for use in climate assessment products, in particular the C3S European State of the Climate (ESOTC).

4.3.1.3 *Methodological development and innovation*

The Successful Tenderer is expected to:

- Explore, test, and benchmark **AI-based methods** for the identification, tracking, and characterisation of extra-tropical cyclones and associated windstorms, with the objective of reproducing the existing algorithm-based diagnostics.
- Ensure that any AI-based approach is:
 - physically consistent;
 - fully documented;
 - rigorously evaluated against the current ERA5-based methodology, including sensitivity to post-processing and filtering choices;before any consideration of operational implementation.

4.3.1.4 *User and operational support*

The Successful Tenderer shall provide Level 2 user support, by responding to user queries when escalated by the C3S User Support team.

4.3.1.5 *Preparation for ERA6*

The Successful Tenderer shall prepare the migration of the CDS catalogue entry and associated workflows to **ERA6**, including:

² <https://cds.climate.copernicus.eu/datasets/sis-european-wind-storm-reanalysis?tab=overview>

- targeted testing of storm detection, tracking, and post-processing using the initially available ERA6 data;
- assessment of the sensitivity of the ETC diagnostics to changes in resolution, model formulation, and data availability.

4.3.2 Service extension

The Successful Tenderers shall extend and further develop the Operational Windstorm Service beyond its current capabilities. The proposed work shall address the following elements.

4.3.2.1 Geographic extension

Extend the current service, which is presently limited to a European domain, to cover the entire Northern Hemisphere midlatitudes and, where technically and scientifically feasible, the Southern Hemisphere midlatitudes. The extension shall ensure methodological consistency with the existing European products while accounting for regional differences in storm characteristics and data availability.

4.3.2.2 Extension of variables and derived products

- Add cumulated precipitation associated with windstorm events, to provide complementary hazard information alongside wind gusts.
- Introduce return period estimates for key variables relevant to windstorm risk, ensuring methodological consistency and suitability for risk assessment applications.
- Ensure the products are well suited for the downstream community in their delivery (e.g. insurance premiums are typically reviewed and adjusted on an annual basis).

4.3.2.3 Enhancement of windstorm statistics for **downstream risk and catastrophe modelling**

Develop and assess methodologies to enhance windstorm statistics for downstream use in risk and catastrophe modelling applications.

Tenderers shall propose scientifically robust approaches to **increase the effective sample size** of windstorm events derived from reanalysis, while preserving physical consistency and relevance for impact assessment. Approaches may include, but are not limited to:

- resampling techniques (e.g. **UNSEEN-type methods, exploiting large ensembles of physically consistent realizations of the same climate state**);
- generation of **synthetic windstorm events**;
- perturbation- or analogue-based approaches; and
- **AI-based generative methods.**

Proposed methodologies shall be:

- benchmarked against the existing ERA5-based windstorm dataset;
- evaluated for physical realism and statistical robustness; and
- fully documented, including assumptions, limitations, and suitable for downstream modelling by different user communities, such as the catastrophe modelling one.

Where relevant, consistency with existing CDS products (e.g. synthetic windstorm event datasets) shall be assessed and documented.

4.3.2.4 Development of extra-tropical storm indicators for reanalysis and climate projections

This activity consists of considering an ensemble (e.g., CMIP6 or CMIP7 when available) multi-decadal climate simulations to derive undergoing and expected changes in ETC statistical properties during current and future periods (e.g., 2021-2050 or 2071-2100) compared to a reference historical period statistics. It is expected that the Successful Tenderer will develop and assess extra-tropical storm-related indicators suitable for both historical reanalysis datasets (e.g. ERA5, ERA6) and climate projection datasets (CMIP / CORDEX based).

Indicators will be used to characterise windstorm activity, intensity, frequency, and potential impacts; they will be physically meaningful and interpretable and computable without relying on the explicit identification or tracking of individual real storms.

Indicators shall be based on gridded or regional diagnostics, such as exceedance-based metrics, spatial aggregates, persistence measures, or footprint-based indicators.

Proposed indicators shall be assessed for:

- robustness and statistical stability;
- interpretability and relevance for climate change assessment; and
- consistency across historical reanalysis and projected climate datasets.

Documentation shall clearly describe methodological choices, assumptions, limitations, and relevance for downstream climate services and risk applications.

4.3.2.5 Consistency with Copernicus climate projections and large ensembles

Ensure methodological consistency with Copernicus Climate Change Service Atlas products, in terms of selected climate models. Proposed methods and indicators shall be designed to remain robust and adaptable in the context of evolving background climate models and ensemble configurations.

4.3.3 User Engagement strategy and identification of users

- Development of a user engagement strategy, with the identification of relevant user communities (e.g., insurance and reinsurance companies, EIOPA or equivalent policymakers) interested in the adoption of windstorm extremes information, that ensure stakeholder interaction, collection of user requirements and evolving needs along the contract, as well as ensuring the engagement.
- Engage with catastrophe modelling community, that are already using the product and may help shape its evolution.
- Identification together with ECMWF of further relevant users for co-development of real case studies and demonstrators relevant for their decision-making processes months and seasons ahead, as described in section 4.3.4.
- Co-development of specific case studies that meet the real requirements in terms of extreme windstorm information. These case studies will serve to evaluate the benefits or limitations in the use of windstorm products for the specific cases.
- The findings from the analyses of the previous case studies must be clearly communicated and thoroughly documented, regardless of whether the results are positive (indicating an added value in the use of the current and enhanced products for the specific case study) or negative (indicating a limitation in the use for the specific case study).
- Delivery of lessons learned and best practices in the use of products for the insurance and risk assessment sector from the online demonstrators, including what can and cannot be achieved with them, along with recommendations on how to scale evolve to provide a service that meets the needs of a wider community of users. This should include recommendations on the applicability of, and modifications required by, the demonstrators for those different decision-making needs.

4.3.4 Co-development of online demonstrators

For those case studies that demonstrate an added value, the results should be transformed into online demonstrators, following these specifications:

- They should delivery operational products that are regularly updated.
- They should contain a visual component (e.g. graphical products, web-application, etc.). This application should be co-designed with champions users and ECMWF in a way that brings value to their decision-making process.

- The dataset behind the products and metrics visualised through the online demonstrator should be delivered to C3S via CDS. This delivery of data should be designed in a way that it can be automatically maintained even after the contract ends.
- The workflows and methodologies for analysing outputs, evaluating skill, and generating related products behind the demonstrators should be accessible to users and must include complete documentation.

4.3.5 Co-design of dissemination material, training elements and EQC

- Delivery of training and dissemination materials co-defined with champion users and ECMWF, that might include interactive webinars, fact sheets, training events and any other material that covers gaps identified during the contract. Presentation of the products at specific events agreed with ECMWF (only one event per year is expected).
- The bidder shall accommodate for eventual needs in providing technical and scientific expertise in support to ECMWF training activities. Requests to support activities may be raised to 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.
- Additionally, the Successful Tenderer is expected to also liaise with the contractors in charge of the C3S Evaluation and Quality Control (EQC) component.
- Additionally, the Successful Tenderer should setup and provide content (including text, tools, and materials developed within the contract) for a C3S website to create a continuously updated web presence for the service.

4.4 Deliverables

Tenderers are invited to propose a set of deliverables which achieve the key outcomes described above, following the guidelines in section 7.3.

5 Lot 2: Maintenance and extension of operational storm surge products

The objective of this Lot is to ensure the continued operational delivery, scientific robustness, and strategic extension of the Operational Storm Surge Climate Service under C3S, including preparation for ERA6, enhancement of derived indicators, and development of user-oriented applications and demonstrators.

5.1 Specific background and scope of the service

C3S currently provides storm-surge / extreme sea-level products derived from global hydrodynamic modelling, delivering time series of coastal water levels (tide + surge + mean sea level contribution) and related diagnostics for coastal flood-hazard applications³. The underlying modelling is based on a Global Tide and Surge Model, forced with ERA5 reanalysis for the historical component, and complemented by climate-projection products and derived indicators in the CDS catalogue.

The objective is to transform the existing dataset(s) and indicators into an operational, regularly updated service, with robust QA and clear documentation, and to extend and restructure the climate-projections **component** so that indicators are derived consistently from a broad set of CMIP simulations available in the CDS and aligned with the C3S Atlas, while also preparing for ERA6.

5.2 Technical requirements

Tenderers for Lot 2 are invited to propose a coherent set of work packages addressing the technical tasks

³ <https://cds.climate.copernicus.eu/datasets/sis-water-level-change-timeseries-cmip6?tab=overview> and <https://cds.climate.copernicus.eu/datasets/sis-water-level-change-indicators-cmip6?tab=overview>

described below. The proposed work shall ensure the continued operational delivery, scientific robustness, and strategic extension of the Operational Storm Surge Climate Service under C3S.

5.2.1 Maintenance and operational running

Maintenance of the storm surge service shall ensure the continued availability, consistency, and scientific integrity of the existing products, including variables, formats, spatial and temporal coverage, and CDS interfaces. While the current service is based on a specific hydrodynamic modelling framework, the maintenance requirement is defined in terms of products and functionality rather than a fixed underlying model implementation.

Current basis: The reanalysis product provides global time series of sea-level related variables (including storm surge residual and total water level) generated by a state of the art Global tides and surge model with ERA5 forcing, with outputs at sub-daily resolution (e.g., 10-minute, hourly, daily maxima) and NetCDF delivery. The current dataset does not update.

5.2.1.1 Required operational capability

The Successful Tenderer shall:

1. Generate an operational chain to update the current product with NRT delivery and ensure continuous operational delivery of the reanalysis-based products at least of the same quality and resolution of the current ones, including monitoring timely restoration after issues. Tenderers **may propose alternative modelling frameworks or updated model versions** for the generation of these products, provided that:
 - the resulting outputs are scientifically equivalent or improved;
 - methodological changes are fully documented;
 - impacts on historical consistency, uncertainty, and interpretation are clearly assessed and even if continuity with previously released products is not fully preserved, it is at least fully documented and appropriately versioned.

Any proposed change of underlying model shall be subject to scientific validation, benchmarking against the existing products, and approval by ECMWF/C3S prior to operational adoption.

Implement an operational update cycle, with updates at least monthly (or as agreed with ECMWF/C3S), to incorporate newly available reanalysis data and keep the catalogue current.

Implement quality assurance and control (QA/QC) procedures appropriate for operational dissemination (consistency checks, completeness checks, outlier detection, metadata validation, and verification against known historical high-water events where feasible).

2. Maintain and update CDS catalogue entries, documentation, and user guidance so changes are traceable and reproducible.

The Successful Tenderer shall prepare the product chain for ERA6, including:

- impact assessment on forcing fields, resolution, and availability;
- targeted “early ERA6” testing of the end-to-end workflow (forcing → modelling/post-processing → delivery);
- documented sensitivity assessment and a migration plan for operational adoption once ERA6 becomes available at scale.

5.2.2 Exploration of AI-based methods

In addition to physics-based modelling approaches, the Successful Tenderer shall explore the potential use of AI-based methods for the generation, emulation, acceleration, or post-processing of storm surge and extreme sea-level products.

AI-based approaches may include, but are not limited to:

- surrogate or emulation models for hydrodynamic simulations;
- AI-assisted post-processing, bias correction, or downscaling;
- hybrid approaches combining physical models and machine learning.

Any AI-based method shall be:

- physically consistent and scientifically justified;
- rigorously evaluated against the existing physics-based products;
- assessed for robustness, stability, and suitability for operational use.

The exploration of AI methods shall not compromise the continuity or reliability of the operational service.

Clear documentation shall be provided describing assumptions, limitations, training data, and performance relative to established modelling approaches.

5.2.3 Maintenance and evolution of indicators and derived products

The CDS also provides statistical indicators (e.g., percentiles and return periods, including confidence bounds) for total water levels and surge levels.

The Successful Tenderer shall:

- Maintain the indicator generation chain (including downstream processing, delivery, validation and documentation within the C3S operational context);
- Ensure indicators remain consistent across updates (versioning, methodological traceability, and backward compatibility where possible);
- Provide clear documentation of methods, assumptions, limitations, and uncertainty treatment (e.g., extreme value methodology, confidence intervals, sensitivity to record length);
- Expand on the indicators, if needed by the user community.

5.2.4 Service extension

5.2.4.1 Coordination with Lot 1

The Successful Tenderer for this Lot is expected to contribute to the coordination efforts undertaken under Lot 1 and ensure technical consistency for relevant joint products and related hazards (see Section 6).

5.2.4.2 Restructuring the climate-projections component (CMIP breadth + Atlas alignment)

Current issue to address: The existing projections component is based on a HighResMIP subset (CMIP6 experiment) for the projections period, which is too narrow for “multi-model / Atlas-style” climate assessment and sectoral risk applications.

Requirement: The successful tenderer shall restructure the projections work so that storm-surge / sea-level indicators can be produced and assessed from a broad selection of CMIP6 simulations available in the CDS and up to 2100 and CMIP7 simulations when they become available, using a design that is robust to evolving model availability and ensemble composition.

This must be aligned with the C3S Atlas philosophy (transparent model selection rules, consistent periods/scenarios, robust ensemble statistics, and reproducible processing).

Expected technical elements.

- Define and document a model/ensemble selection strategy (eligibility criteria, scenario coverage, temporal windows such as near-term/mid-century/end-century, handling of multiple realizations).
- Define a consistent approach for ensemble aggregation and uncertainty characterisation (e.g., model spread, internal variability proxies, robustness metrics consistent with Atlas practices).

- Ensure methodological consistency and traceability between:
 - historical reanalysis indicators (ERA5/ERA6), and
 - future indicators derived from CMIP ensembles, including clear separation of drivers (mean sea level contribution vs surge/tide variability) where relevant to the product design.
- Design of indicators with a subset of users / use cases co-defined with C3S.

5.3 Other activities

Consistent with the existing approach, the Successful Tenderer shall provide:

- updated training and example workflows (e.g., notebooks demonstrating retrieval, visualisation, detrending, percentile/return-period calculations, and interpretation);
- Level-2 support when escalated by the C3S User Support function;
- setup and provide content (including text, tools, and materials developed within the contract) for a C3S website to create a continuously updated web presence for the service;
- contribute to the ESOTC report writing, if the products are included in a specific section of the report (see Section 7.6).

5.4 Deliverables

Tenderers are invited to propose a set of deliverables which achieve the key outcomes described above, following the guidelines in section 7.3.

6 Joint products and cross-Lot coordination (Lot 1 & Lot 2)

Users in the insurance, reinsurance, and catastrophe modelling sectors frequently require integrated hazard information combining extreme windstorms (Lot1) and associated storm surges (Lot2), particularly for the assessment of compound coastal flood and wind damage risk. Such users benefit from the joint interpretation of windstorm characteristics (e.g. track, intensity, footprint) together with coastal water-level extremes driven by storm surges.

6.1 Scope of joint products

The Successful Tenderers for Lot 1 and Lot 2 shall ensure coordination and technical consistency to enable the development and maintenance of joint windstorm–storm surge products. These joint products shall build upon the windstorm event catalogue and diagnostics developed and maintained under Lot 1 and the storm surge and extreme sea-level products developed and maintained under Lot 2.

Joint products may include, but are not limited to:

- event-based joint diagnostics, linking individual windstorm events from the Lot 1 catalogue with corresponding storm surges and coastal water-level information extracted from Lot 2 dataset, where relevant;
- compound hazard indicators describing the co-occurrence or joint severity of extreme winds and elevated coastal water levels, for selected relevant events in the Lot1 catalogue;
- regionally aggregated statistics relevant for insurance and catastrophe modelling applications (e.g. frequency of joint exceedances, joint return periods, or conditional probabilities);
- example workflows or demonstrators illustrating the combined use of windstorm and storm surge information for coastal risk assessment;
- Jupyter Notebooks may also be developed for specific cases.

6.2 Technical principles

When a windstorm event is associated to storm surges, the information from the storm surges data shall be extracted and added to the windstorm event description. For those cases we expect the production of joint information that shall adhere to the following principles:

- Joint products shall use harmonised spatial and temporal definitions, event timing, and metadata conventions across Lots, for consistency.
- Joint products shall clearly reference and remain traceable to the underlying Lot 1 and Lot 2 datasets, without duplicating or modifying the authoritative source products.
- Joint products shall be designed so that updates to the underlying windstorm or storm surge products can be propagated without extensive re-engineering.
- Scientific robustness: Any joint indicators or statistics shall be physically meaningful and supported by documented methodology and validation.

6.3 Coordination requirements

Tenderers for Lot 1 and Lot 2 shall describe in their proposals how coordination across Lots will be ensured, including data exchange, methodological alignment, and version control.

ECMWF will facilitate cross-Lot coordination where necessary, but Successful Tenderers shall be responsible for the technical implementation of agreed joint products within their respective Lots.

Joint activities shall not duplicate work already covered under individual Lots but shall leverage the complementary strengths of each service.

6.4 User focus and communication

Joint products shall be designed with a focus on insurance and risk-modelling user needs, using terminology and outputs that are compatible with existing catastrophe modelling workflows.

Documentation and examples shall clearly describe what joint products can and cannot be used for, including limitations related to compound hazard interpretation.

7 General Requirements

7.1 Implementation Schedule

For each Lot, ECMWF intends to award a single Framework Agreement for a period of maximum 28 months, which shall be implemented via a single multi-annual Service Contract expected to commence in Q3 2026.

Tenderers are expected to provide a detailed time plan and schedule as part of the tender response. The proposed time plan and schedule shall address the main tasks, inputs, outputs, intermediate review steps, milestones, deliverables and dates. Regular progress meetings will be held with ECMWF during the contract to assess project status, risks and actions.

7.2 WP0: Management and Coordination

This work package includes overall responsibility for day-to-day service management and coordination.

The following contract management aspects shall be considered and as needed briefly described in the proposal:

Plans for the mandatory reporting on implementation and forward planning.

Meetings (classified as tasks and listed in a separate table as part of the proposal):

- Organise quarterly teleconference meetings to discuss C3S service provision, service evolution and other topics, prepare corresponding summary minutes of these meetings and maintain a list of agreed actions and their status.
- ECMWF organises annual C3S General Assemblies. The Successful Tenderer is expected to attend these meetings with maximum 2 team members and contribute to discussions related to the topic of this ITT.
- Tenderers can propose additional contract internal meetings (e.g. kick-off meeting, regular meetings to monitor contract performance) as part of their response. Most such meetings should be held by remote participation.
- **Travel Prices:** Travel prices should be based on the [European Commission's calculator](#) [Table 3: Unit cost per distance band for air or combined air/rail travel, Commission Decision C(2024)5405], and consider a daily subsistence allowance not to exceed €300. Travel prices must reflect estimated actual costs and **must not include any profit margin**. If the proposed travel prices deviate from these reference values, a clear justification must be provided.

Quality assurance and control: the quality of reports and Deliverables shall be equivalent to the standard of peer-reviewed publications. The timely delivery as well as final quality check of the deliverables shall be ensured by the Successful Tenderer (in terms of content, use of ECMWF reporting templates for deliverables and reports (Microsoft Word), format, deliverable numbering and naming, typos...); all reports in this project shall be in English. Unless otherwise specified the specific contract Deliverables shall be made available to ECMWF in electronic format.

Communication management (incl. external and internal communication). Any external communication activity must be agreed with the ECMWF Copernicus Communication team in advance. This includes, but not exhaustively, communication planning, branding and visual style, media outreach, website and social media activity, externally facing text and graphical content and events. Agreed activity would also need to be evaluated and reported on once complete so that success measures and KPIs could be provided to the European Commission (cf. Clause 2.4.6 of the Framework Agreement).

Set of Key Performance Indicators (KPIs) suitable for monitor contract performance. The proposed KPIs shall be SMART (specific, measurable, achievable, relevant and time-bound). The Successful Tenderer shall report to ECMWF on these KPIs as part of the Quarterly and Annual Implementation Reports. The proposed set of KPIs is expected to be updated regularly with ECMWF during the contract.

In particular, the KPIs shall focus on measuring the performance of the service. These shall include but are not limited to a) system performance (e.g. uptime rate, response time), b) search effectiveness (e.g. match rate of search results linking to reasonable CDS datasets and resources; supported by expert knowledge), and c) user satisfaction.

Risk Management: The proposal shall include a risk register that describes identified risks for each work package, along with a mitigation strategy for each of the identified risks. This mitigation strategy shall be composed by both preventive and corrective measures. The risk register shall be updated regularly by the Successful Tenderer, and any update (related to new risks, likelihood or impact) shall be reported during the progress review meeting, as well as part of the quarterly and annual implementation reports.

Resources planning and tracking using the appropriate tools.

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 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 on Sub-contracting has been flowed down to all their subcontractors.

Management of personal data and how this meets the requirements of Clause 2.8 on Personal Data Protection and Annex 6 of the Framework Agreement.

List of minimum deliverables and milestones required as part of WPO, covering the contractual and financial reporting obligations towards ECMWF in line with the Terms and Conditions of the Framework Agreement (cf. Clause 2.3 and Annex 5):

WPO Deliverables				
<i>Deliverable#</i>	<i>Responsible</i>	<i>Nature</i>	<i>Title</i>	<i>Due</i>
D0.y.z-YYYYQQ	Tenderer	Report	Quarterly Implementation Report QQ YYYY <i>QQ YYYY being the previous quarter</i>	Quarterly on, 15/04, 15/07 and 15/10
D0.y.z-YYYY	Tenderer	Report	Annual Implementation Report YYYY [Part 1] <i>YYYY being the Year n-1. Shall include:</i> <ul style="list-style-type: none"> Quarterly Implementation Report Q4 YYYY ; <i>YYYY being the Year n-1</i> <i>Preliminary financial information YYYY ; YYYY being the Year n-1</i> 	Annually on 15/01
D0.y.z-YYYY	Tenderer	Report	Annual Implementation Report YYYY [Part 2] <i>YYYY being the Year n-1</i>	Annually on 28/02
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, at the end of June (deliverable with no associated cost)
D0.y.z	Tenderer	Report	Final report	At the end of the contract

Table 1: WPO Deliverables

WPO Milestones			
<i>Milestone#</i>	<i>Title</i>	<i>Means of verification</i>	<i>Due</i>
M0.1.1.MX	Progress Review meeting with ECMWF / Payment milestones	Minutes of meeting	At each Payment Milestone due date (~every 6 months)
M0.1.2.MX	Kick off meeting	Minutes of meeting	Month 1
M0.1.3.MX	Attendance to XXX meeting (e.g. General Assembly)	Minutes of meeting	Due one month after the meeting

Table 2: WPO Milestones

7.3 Deliverables and Milestones

Deliverables should be consistent with the technical requirements specified in this document. 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. The details will be agreed at the negotiation stage.

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

Milestones should be designed as markers of demonstrable progress in service development and/or quality of service delivery, as applicable. They should not duplicate deliverables.

Tenderers shall complete the relevant table in Volume IIIA as part of their Tender, 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.

ECMWF will provide the templates for reports and plans at the beginning of the contract. Reporting documents should be short and factual, following the guidance which will be provided by ECMWF during negotiations with the Successful Tenderer. Contract management and technical coordination is expected to amount to approx. 7-10% of the planned use of the resources.

7.4 Code delivery and documentation

All workflows, methodologies, and software developed under this activity, including those for output analysis, skill evaluation, product generation, and online demonstrator support, shall be fully accessible to users and delivered to ECMWF.

The Successful Tenderer shall ensure that all software development is strictly consistent with the **ECMWF Codex** (see github.com/ecmwf/codex). The Codex serves as the authoritative set of guidelines for development best practices at ECMWF and by its contractors. Of particular emphasis:

- **Software Management Plan (SMP):** A formal Software Management Plan must be established at the project's inception, following the templates and examples provided in the [Codex SMP section](#).
- **Contribution Workflow:** Delivery via Pull Requests (PRs) to ECMWF-managed repositories, subject to peer review and compliance with ECMWF's automated CI/CD pipelines. See [External Contributions](#). When merged into the main code base, these PR's constitute part of the deliverables of the project, for purposes of audit and traceability.
- **Containerised Deployment:** To enable the long-term production and operation of operational workflows, the processing workflows shall be integrated into the ECMWF computing environment and infrastructure. The responsibility for this technology transfer lies with the Successful Tenderer, who shall work in close collaboration with ECMWF staff and adhere to the principles described in the Codex ([Containerisation](#)), in particular leveraging Helm and a specific repository structure.
- **Documentation:** Comprehensive documentation shall be provided to ensure reproducibility, maintainability, and long-term operational sustainability. See [Documentation and Training](#).

Whenever possible, the software and workflows shall make use of and contribute to existing ECMWF software frameworks, such as Earthkit. If functionality is found to be missing, the Successful Tenderer shall work in close collaboration with ECMWF developers to implement it into such frameworks (e.g. Earthkit), if appropriate.

Where feasible, workflows should be designed to enable other users to inspect, reproduce, adapt, and extend them, ideally through C3S-hosted Jupyter Notebooks, linked from the service pages.

7.5 Contribute to L2 support to Copernicus User Support Team

The objective of this task is to provide specialised support to users of the delivered products and services.

ECMWF has a well-established centralised User Support to provide multi-tiered technical support to all users of C3S data, products, tools and services. A service desk system is used for ticketing user requests and distributing these requests to specialists as needed. Dedicated staff at ECMWF promote and maintain self-help facilities (Copernicus Knowledge Base (CKB), user forum, FAQs and tutorials, etc.) and also provide individualised support on technical queries related to the CDS, data formats, data access, etc. In addition, ECMWF staff members provide specialised scientific support to address questions related to its industrial contributions to C3S, e.g., in the areas of global reanalysis and seasonal forecasting.

All C3S contractors are expected to contribute to the delivery of multi-tiered technical support for the data and/or services they provide. The Successful Tenderer shall provide expert (Level-2) support through a) the Jira ticketing system with agreed KPIs (for example, 85% of Level-2 tickets should be resolved within 15-business days), and/or b) the [user forum](#)⁴ by monitoring topics and providing responses. The Successful Tenderer shall provide an email address which acts as the single contact point.

7.6 Contribution to the ESOTC report

If any product produced and/or maintained under this contract is selected for inclusion in a section of the ESOTC report, the Successful Tenderer shall support the preparation of that section.

The Successful Tenderer shall:

- Review and analyse the relevant datasets in advance of the first annual ESOTC coordination meeting, typically held between October and December.
- Lead the drafting of any section that relies on products developed under this contract, adhering to guidance provided by the ECMWF ESOTC team.
- Engage with domain experts, including the organisation and facilitation of meetings required to discuss scientific content and ensure the robustness of the proposed material.
- Prepare the draft text in line with the timelines and editorial deadlines set by the ESOTC editorial team, who retain final authority on the published version.
- Attend relevant ESOTC meetings, including those organised by the ESOTC leadership team and any additional meetings necessary to ensure the successful delivery of the assigned section.

These activities shall be treated as **optional tasks**, and Tenderers are requested to include the associated activities and costs in their proposals. ECMWF will formally trigger these tasks only when applicable.

7.7 Communication

The Successful Tenderer shall support ECMWF in its communication activities for the C3S services, where they are related to the activities described in this ITT. Additional activities such as C3S website news items, C3S brochures and flyers, may be discussed on a case-by-case basis during the contract implementation.

7.8 Key Performance Indicators

The Successful Tenderer 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 Tender, 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.

In particular, KPIs shall focus on measuring the performance of the service. These shall include but are not limited to a) system performance (e.g. uptime rate, response time), b) search effectiveness (e.g. match rate of search results linking to reasonable CDS datasets and resources; supported by expert knowledge), and c) user satisfaction.

⁴ <https://forum.ecmwf.int/>

7.9 Payment Plan

Tenderers can propose a Payment Plan in ITT Volume IIIA “Pricing and deliverables” (cf. Excel spreadsheet “Payment Plan preparation”):

- The Payment Milestones should relate to the deliverables and milestones delivered during the corresponding Payment Milestone period (e.g. the payment covering the period January-June would only relate to the deliverables and milestones whose due dates are part of the same period).
- The frequency of Progress Review Meetings might be adapted to synchronise with the anticipated date of completion of each Payment Milestone.
- In case of request for a payment at contract signature, please note that this should be duly substantiated (e.g. in terms of necessary investment prior to implementation or during first weeks/months for ensuring the initial set up of the project). It is necessary to relate this payment to activities subject to other Payment Milestones.

8 Tender Format and Content

General guidelines for the Tender are described in Volume IIIB of this ITT. 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.

8.1 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
<i>Executive Summary</i>	2
<i>Track Record</i>	2 (for general) and 2 (per entity)
<i>Quality of resources to be Deployed</i>	2 (excluding Table 1 in Volume IIIB and CVs with a maximum length of 2 pages each)
<i>Technical Solution Proposed</i>	2 + 3 per Work package (Table 2 in Volume IIIB, the section on references, publications, patents and any pre-existing IPR is excluded from the page limit and has no page limit)
<i>Management and Implementation</i>	6 (excluding Table 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 3: Page limits

8.2 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.

8.2.1 Executive summary

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

8.2.2 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.

8.2.3 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.

8.2.4 Technical Solution Proposed

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

8.2.5 Management and Implementation

As part of the general project management description, and in addition to the guidance provided in Volume IIIB, Tenderers shall consider the elements described in Section 7.2 above.

9 Additional Information

9.1 Acronyms

ADS	Atmospheric Data Store
AI	Artificial Intelligence
API	Application Programming Interface
C3S	Copernicus Climate Change Service
CDR	Climate Data Records
CDS	Climate Data Store
CI/CD	Continuous Integration / Continuous Deployment
CKB	Copernicus Knowledge Base
CMIP6/7	Coupled Model Intercomparison Project Phase 6/7
CORDEX	Coordinated Regional Climate Downscaling Experiment
ECMWF	European Centre for Medium-Range Weather Forecasts
ECV	Essential Climate Variable
EIOPA	European Insurance and Occupational Pensions Authority
EQC	Evaluation & Quality Control
ERA5/6	ECMWF Reanalysis 5/6
ESOTC	European State of the Climate
ETC	Extra-Tropical Cyclone
FAIR	Findable, Accessible, Interoperable, Reusable (data principles)
FAQ	Frequent Asked Questions

GCOS	Global Climate Observing System
ICDR	Interim Climate Data Records
IPR	Intellectual Property Rights
ITT	Invitation To Tender
KPI	Key Performance Indicator
NRT	Near-Real Time
PR	Pull Request
QA/QC	Quality Assurance / Quality Control
SMART	Specific, Measurable, Achievable, Relevant, Time-bound
SMP	Software Management Plan
UNSEEN	UNprecedented Simulated Extreme ENsemble method (Thompson <i>et al.</i> , 2017)
WPO	Work Package 0