ECMWF Copernicus Procurement

Invitation to Tender

Copernicus Climate Change Service
Volume II

New Generation Copernicus pan-Arctic Regional Climate Reanalysis

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1 Introduction

ECMWF as the Entrusted Entity for the Copernicus Climate Change Service (C3S) invites tenders for the production of pan-Arctic regional reanalysis. Within its first phase (Cop1: 2015 – 2020), the Service consolidated many years of preparatory research and development to deliver a range of operational services. In its second phase (Cop2: 2021 – 2027) these services are further consolidated, improved and expanded to address all the existing and emerging requirements.

The procured work shall build on the achievements of the corresponding Cop1 activities for the Arctic, which is the Copernicus Arctic Regional Reanalysis (CARRA). The aim of this present procurement is to create a new generation of Arctic regional reanalysis.

The regional reanalysis datasets are required to generate high-resolution, physically consistent, gridded estimates of Essential Climate Variables that will complement the information available from lower-resolution global reanalyses. This document describes the technical requirements for the pan-Arctic regional reanalysis products to be delivered, as well as other information needed to prepare the tender.

This ITT is for a contract to generate and deliver regional reanalysis products for the entire Arctic region using one single domain (pan-Arctic). The scope of activities of the contract includes:

- development of a production system for regional reanalysis;
- preparation and quality control of observations and other input data;
- reanalysis production, post-processing and quality assurance;
- public publication of datasets in the C3S Climate Data Store (CDS) which includes provision of adequate documentation;
- user guidance and user support via the C3S Service Desk;
- management, implementation and coordination.

C3S shall take ownership of all regional reanalysis products delivered by this contract. The contract can include support for high-performance computing as required for production, but production on the ECMWF's High Performance Computing Facility (HPCF) is a possibility as well. Permanent archiving of the data products is included in the contract with preference of the use of ECMWF's MARS archiving system. Tenderers shall provide all information required to publish reanalysis products via the CDS. This includes a dataset overview and adequate documentation such as hands-on user guides and detailed technical and scientific specifications.

Tenders will be evaluated based on the requirements described in the following sections. Tenderers are encouraged to submit proposals that demonstrate the ability to deliver high-quality operational services with a strong foundation in science, research and development.

An overview of the Arctic regional reanalysis activities carried out during Cop1 can be found at https://climate.copernicus.eu/copernicus-arctic-regional-reanalysis-service.

The results of this Cop1 activity, including additional technical clarifications can be provided on request via the ECMWF e-procurement portal messaging board.

2 Technical requirements

2.1 General requirements

Regional reanalysis data products are needed for C3S to provide consistent information on a variety of ECVs for the purpose of monitoring the state of the climate and to support development of climate-related information products for users, including those with economic interests in the region. The reanalysis shall be produced using a single model-based data assimilation system to ensure temporal consistency of its

products. The system shall include quality assessment during production and post-production, e.g. based on comparison with alternative C3S ECV products derived from observations and/or global reanalyses.

Data products shall:

- include estimates of multiple ECVs that are consistent in time and space;
- include consistent, preferably dynamic estimates of uncertainty based on explicit statistical assumptions on background and observation errors;
- accurately represent observed climate variability and change;
- provide precomputed daily and monthly mean values to users;
- provide continuous updates based on most recent observations and timely updates at short delay with respect to real time.

The regional reanalysis data products must improve on the current activity, and hence they could provide added value

with respect to alternative products derived from observations:

- complete and consistent coverage of regional (sub)domains;
- ECV estimates that are physically and dynamically coherent.

with respect to global reanalyses:

- provide data at a higher spatial resolution;
- provide improved estimates of surface parameters by using enhanced model representations of surface fluxes;
- assimilate observations that are not used in global reanalyses;
- improve the representation of extreme values and extreme events.

They shall improve on the Copernicus Arctic Regional Reanalysis (CARRA) that was produced in Cop1. As a minimum, improvements shall include at least two of the following aspects, with possible additional innovative improvement aspects proposed by the Tenderer:

- temporal and/or spatial extension;
- improved data assimilation and/or model representation;
- improved uncertainty estimation;
- improved horizontal and/or vertical resolution of upper-air reanalysis;
- increased horizontal resolution of land-surface products through, for example, further dynamical downscaling;
- ingestion of improved forcing and/or surface boundary conditions;
- improved handling of physical processes.

Consistency among the C3S-produced regional and global reanalyses shall be optimized, by

- the use of ERA5 output to provide lateral boundary conditions;
- preferably, ingesting consistent external model data such as atmospheric forcing from CMIP6 data;
- preferably, sharing information on the usage and quality control of input observations.

Information content of reanalysis data products shall be transparent and fully traceable by

- making available a set of documents containing all input data records with full traceability to data source and data set versions;
- generating reports/records for all assimilated observations including data departures, data quality indicators, estimated observation errors, estimated bias adjustments, and any other information needed to assess how observations were used in the reanalysis. This so called observation feedback information shall be stored in ODB2 format and preferably archived in ECMWF's MARS archive.

The successful Tenderer shall document:

- the numerical weather prediction (NWP) and data assimilation system used in the reanalysis;
- dedicated set-up choices for the applied NWP model;
- the input datasets used including the physiographic datasets and the ingested type of observations;
- the anticipated strengths and weaknesses of the entire reanalysis dataset.

2.2 Specific requirements

ECMWF intends to award a single multi-annual framework agreement (maximum duration 48 months) for the generation of regional reanalysis products for the Arctic. Only proposals will be considered that offer solutions based on the concept of a single-domain pan-Arctic reanalysis.

In particular:

- the reanalysis system shall assimilate the main components of the Arctic observing system, including satellite data;
- the reanalyses shall make good use of complementary observations on surface properties in the region, e.g., related to snow, glacier and sea ice;
- the reanalysis shall go back in time at least to 1991 and reach to present time, this to provide a consistent climatology for the WMO reference period of 1991-2020;
- the horizontal grid spacing would be preferably equal or lower than the present 2.5 km grid resolution for the European areas of the CARRA Arctic produced in Cop1;
- the temporal resolution of data products shall be at least hourly and commensurate with key processes affecting climate change in the region.

2.3 Specification of work

The following work packages are recommended. This list should be considered as guideline and not as a strict formal requirement. The cost of the administrative reporting (quarterly and annual reports, implementation plans etc.) shall be limited to a maximum of 10% of that of the total human resources.

2.3.1 Work package 1: System development

Design, implementation, testing and optimisation of the regional reanalysis production system. Implementation of tools for handling input observations, application of data selection rules, quality control checks and bias adjustments; implementation of diagnostic tools for system performance monitoring. Definition of output parameters and products (including daily and monthly means), implementation of post-processing tools, converting data formats, etc. Development of quality assurance checks on data products. Development of operational schedules and routine procedures, response protocols to system failures, changes to input data streams, implementation of system upgrades, etc.

Deliverables required: system implementation and associated documentation, system development reports.

2.3.2 Work package 2: Input data preparation

Preparation of all input data for reanalysis production, including observations for data assimilation, boundary conditions and forcing data for the data assimilation system, lateral boundary constraints for the regional reanalysis, geographical reference data and any other input data needed for reanalysis production. Gathering, formatting, merging and transformation of data as needed to prepare for data assimilation. Preliminary quality assessments of input observations, implementation observation operators for data assimilation, specification of observation errors, development of bias corrections and any other preparations needed to optimise the impact of observations on the reanalysis.

Deliverables required: Input data infrastructure and associated documentation; reports describing the ingestion of datasets.

2.3.3 Work package 3: Reanalysis production

Scheduling of production tasks, system performance monitoring, fault detection and problem solving. Routine quality assurance of reanalysis output based on a range of diagnostics post-processing of reanalysis output and output data management. Delivery of data products necessary for CDS ingestion; support for publication of data products in the CDS and maintenance of the catalogue entries.

Deliverables required: production of the reanalysis; system performance in quarterly reports; preparation of CDS ingestion including the provision of dataset overview and documentation (reports on detailed technical and scientific specifications); provision of observation feedback information in ODB2 format.

2.3.4 Work package 4: User guidance and support

Update of documentation and other material aimed at users of regional reanalysis data products. Development and upkeep of web pages with up-to-date information about the reanalysis production, including known issues, displays of production targets and measures of progress. Contribution to development of training material for C3S users. Provision of scientific advice and technical support to users via the ECMWF Support (see Section 3.3.3), support and contribution to the C3S evaluation and quality control function (EQC), contribution to C3S communication and user engagement activities (including providing technical and scientific expertise) and particularly support to C3S climate intelligence activities including on-demand support to the annual state of the climate reports.

Deliverables required: hands-on user guides; user support material, full evaluation of the dataset, contribution to C3S reports.

2.3.5 Work package 0: Management and implementation

This work package includes overall responsibility for day-to-day service management and implementation. See Section 4.2.5 below for general requirements on activities and reporting for this purpose.

In addition to these work packages the Tenderer shall include coordination on a scientific and technical level with the global reanalysis activities taking place at ECMWF. This coordination will be guided by the technical officers in charge of the contract at the ECMWF side. Coordination of reanalysis activities shall cover a broad range of technical issues including use of observations and other input data, aspects of data assimilation, performance diagnostics, data formats and data management practices, etc. The goal of the coordination is to ensure optimal quality and consistency among the global and regional reanalysis data products as delivered to C3S, to avoid duplication of work, and to share resources where possible.

3 General requirements

3.1 Schedule

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

ECMWF has to prepare annual Implementation Plans, which must be approved by the European Commission before they can enter into force. The implementation plans will take full stock of service reviews, performed thoroughly on an annual basis, as well as of the continuously evolving user requirements and corresponding service specifications. The successful Tenderer shall therefore provide each year for ECMWF approval, an updated detailed plan of proposed activities including Deliverables and Milestones, using the Work Package

table template in Volume IIIB, which will form part of this Implementation Plan. The successful Tenderer has to report on a quarterly and annual basis.

3.2 Meetings

ECMWF will organise annual meetings to bring together all C3S service providers. The successful Tenderer is expected to attend these meetings. The Tenderer is also expected to attend teleconference meetings to discuss C3S service provision, service evolution and other topics that cut across different aspects of C3S. The cost of attending these meetings shall be covered by each successful Tenderer and shall be included in the tendered price. The cost of organising and attending any additional meetings shall also be covered by each successful Tenderer and shall be included in the tendered price. It is recommended to use virtual online meetings as much as possible.

3.3 Deliverables

Deliverables required for each task are outlined in section 2 (though the list there might not be exhaustive and should be considered as general guideline). These can be in the form of documents or reports, datasets or databases, web services and user support. Requirements for each type are described in the following subsections.

3.3.1 Documents and reports

All reports shall be produced in English, and the quality of reports and deliverables shall be similar to the standard of peer-reviewed publications. Unless otherwise specified in the specific contract, deliverables shall be made available to ECMWF in electronic format (PDF/Microsoft Word/Microsoft Excel or compatible). Public-facing documents, such as user guides, can be based on html.

3.3.2 Datasets

Regional reanalysis data products generated by the Tenderers shall be stored in the MARS or other designated servers at ECMWF or at the Tenderer's site and made available via the CDS. Access to the complete reanalysis dataset shall be granted under Copernicus licence. The Tenderer shall assist in the data integration process for the CDS. Data formats to be used shall be agreed with ECMWF. Examples of acceptable formats are WMO GRIB edition 1 and 2, or NetCDF files conforming to CF-1.6, or greater. Every dataset and/or service provided shall be documented using the appropriate metadata standards (e.g. ISO 19115).

Data and IPR: It is a condition of EU funding for C3S that ownership of any datasets developed with C3S funding passes from the suppliers to the European Union via ECMWF. Ownership will pass from the date of creation of the datasets. Suppliers will be granted a non-exclusive licence to use the datasets which they have provided to C3S for any purpose.

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

3.3.3 User support

ECMWF has established a centralised ECMWF Support to provide multi-tiered technical support to all users of C3S data, products, tools and services. The ECMWF Support is used for ticketing user requests and distributing these requests to specialists as needed. Dedicated staff at ECMWF provides basic support in the

form of self-help facilities (FAQs, knowledge bases, tutorials etc.) as well as individualised support on technical queries related to the CDS, data formats, data access etc.

All C3S contractors are expected to contribute to the delivery of multi-tiered technical support for the data and/or services they provide. Such specialised user support shall take the form of direct response to individual user queries via the ECMWF Support facility, as well as contributions to FAQs, user guides and knowledge bases.

As part of the bid, tenderers shall describe the level of user support service on ECMWF Support tickets (for example, 90% of Tier-2 requests answered within 5 working days), with sufficient flexibility to be improved depending on user requirements. Tenderers shall also address development of user guides and any other form of user support or user learning services, such as video tutorials, training materials, user workshops, etc.

3.4 Communication

All communication activity must be agreed with the ECMWF Copernicus Communication team in advance. This includes, but not exhaustively, communication planning, branding and visual style, media outreach, website and social media activity, externally facing written and graphic content and events. Agreed activity also need to be evaluated and reported on once complete so that success measures and KPIs can be provided to the European Commission. The regional reanalysis datasets might be used for the monthly climate summaries prepared by C3S and particularly for the annual European State of the Climate communications.

3.5 Quality assurance

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

3.6 Key Performance Indicators

The KPIs shall be designed to quantify different aspects of quality of service against the requirements described in this document.

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

4 Tender Format and Content

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

4.1 Page limits

As a guideline, it is expected that individual sections of the Tenderer's response do not exceed the page limits listed below. These are advisory limits and 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	30 (Table 2 in Volume IIIB, the section on references, publications, patents and any pre-existing IPR is excluded from the page limit and has no page limit)
Management and Implementation	10 (excluding Table 4 and Table 5 in Volume IIIB) + 2 per each Work package description (Table 3 in Volume IIIB)
Pricing Table	No limitation

Table 1: Page limits

4.2 Specific additional instructions for the Tenderer's response

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

4.2.1 Executive summary

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

4.2.2 Track Record

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

4.2.3 Quality of Resources to be Deployed

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

4.2.4 Technical Solution Proposed

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

4.2.5 Management and Implementation Plan

The Tenderer shall provide a detailed implementation plan of proposed activities for the duration of the framework agreement. Deliverables should be consistent with the technical requirements specified in section 2. The number of milestones is not restricted, but they should be designed as markers of demonstrable progress in service development and/or quality of service delivery. Adjustments to the proposed implementation plan can be made on an annual basis depending on needs for service evolution, changed user requirements, or other requirements as agreed between the European Commission and ECMWF.

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

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

As part of the general contract management description, the Tenderer shall include the following elements in line with the reporting and planning requirements as laid down in the Terms and Conditions of the Framework Agreement.

Deliverables for work package 0 shall include the following administrative and programmatic reports:

WP0 Contractual Obligations				
#	*Responsible*	*Nature*	*Title*	*Due*
D0.y.z-YYYYQQ	Tenderer	Report	Quarterly Implementation Report QQ YYYY *QQ YYYY being the previous quarter*	Quarterly on 15/04, 15/07 and 15/10
D0.y.z-YYYY	Tenderer	Report	Annual Implementation Report YYYY – Part I, includes technical activities in Q4 and the Preliminary Information (report) of year N-1; *YYYY being the Year N-1*	Annually on 15/01
D0.y.z-YYYY	Tenderer	Report	Annual Implementation Report YYYY – Part II, *YYYY being the Year N-1*	Annually on 28/02
D0.y.z	Tenderer	Report	Final report	60 days after end of contract
D0.y.z-YYYY	Tenderer	Report	Implementation plan YYYY *YYYY being the Year N+1*	Due 14 days after contract start
D0.y.z-YYYY	Tenderer	Report	Implementation plan YYYY *YYYY being the Year N+1*	Annually on 30/09
D0.y.z-YYYY	Tenderer	Other	Copy of prime contractor's general financial statements and audit report YYYY (Audited Institute Financial Statements) *YYYY being the Year N-1*	Annually, as soon as available, estimated by June 30th of year N.

Table 2: Administrative deliverables

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

5 List of Acronyms

C3S	Copernicus Climate Change Service
CARRA	Copernicus Arctic Regional ReAnalysis
CDS	Climate Data Store
CMIP6	Coupled Model Intercomparison Project phase 6

Cop1	Previous phase; Copernicus Delegation Agreement until June 2021
Cop2	Current phase; Copernicus Contribution Agreement started in July 2021
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasts
ECV	Essential Climate Variable
EDA	Ensemble of Data Assimilations
ERA5	European ReAnalysis generation 5
EU	European Union
FAQ	Frequently Asked Questions
HPC	High Performance Computing system
ISO	International Organization for Standardization
ITT	Invitation to tender
KPI	Key Performance Indicator
MARS	ECMWF Meteorological Archival and Retrieval System
NWP	Numerical Weather Prediction
PDF	Portable Document Format
WP	Contract Work Package