

ECMWF Copernicus Procurement

Invitation to Tender



Copernicus Climate Change Service

Support for Climate Reanalysis including
Satellite Data Rescue

Volume II: Specification of Requirements

ITT Ref: C3S2_314_bis
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1 Introduction

ECMWF, as the Entrusted Entity for the Copernicus Climate Change Service (C3S), invites tenders for activities to support climate reanalysis by extending the coverage and quality of input data from the data-sparse past, as well as supporting the integration of this new data in the ECMWF Integrated Forecasting System (IFS). This document describes the scope and technical requirements for C3S2_314_bis, addressing satellite data rescue.

The objective of this contract is to prepare a selection of early satellite data records for use in future climate reanalyses. Activities in C3S2_314_bis shall build on the outcomes of previous Satellite Data Rescue Service Contracts in Copernicus Phase 1 (COP1, C3S_311C Lot 1, 2018-2021) and Phase 2 (C3S2_314, 2022-2024), as well as on the earlier FP7 ERA-CLIM and ERA-CLIM2 projects (www.ecmwf.int/en/research/projects). In COP1, datasets for a list of instruments prioritised by the ERA-CLIM projects were recovered, assessed and delivered to ECMWF. Several additional issues, detailed in supporting documents (Draft Algorithm Theoretical Basis [ATBD] documents), were identified which require additional analysis and development work, beyond the scope of COP1. The consolidation of the products delivered in COP1, to facilitate their assimilation in global reanalyses, was an important aim of the COP2 contract, C3S2_314. A second objective involved the recovery and assessment of new datasets from additional sensors identified in earlier projects and confirmed in the data inventory activity of COP1. The further consolidation of these datasets, including support for the assimilation of these datasets in the ECMWF Integrated Forecasting System through targeted developments in the IFS, is an important goal of this contract. Requirements for the recovery, development and assessment of several new datasets have also been identified and form an additional set of requirements set out in this ITT.

All relevant results to date from COP1 and COP2 are available to Tenderers, including documentation, on request via the messaging board on the e-Procurement Portal, as can additional technical clarifications.

The products prepared and delivered in C3S2_314_bis shall be used as input for future climate reanalyses, including the next-generation C3S global reanalysis, ERA6, which is scheduled to go into production in 2025.

ECMWF intends to award a single Framework Agreement for a period of maximum 36 months, which shall be implemented via a single Service Contract expected to commence in Q2 2025.

2 Technical requirements

The objective is to extend the coverage and quality of input satellite data records available for climate reanalysis, and to improve the impact of such data. A key aim is to provide direct support for targeted developments of the ECMWF Integrated Forecasting System to enable the assimilation of key datasets in the early-epoch (pre-1979) production streams of ERA6, due to commence in 2026. The requirements also include the development of forward modelling capability, quality control and bias correction schemes.

2.1 Scope of Service

The Successful Tenderer shall:

- Consolidate and maintain a complete inventory of known candidate satellite data records requiring data rescue, including those which were the subject of the COP1 and COP2 Satellite Data Rescue contracts;
- Improve, consolidate and deliver updated data records and documentation for sensors investigated in the COP1 and COP2 Data Rescue Contracts (C3S_311C Lot 1 and C3S2_314);
- Deliver and test developments in the IFS required to assimilate the data delivered from COP1 and COP2, working in close collaboration with scientists from ECMWF;
- Obtain, assess, develop and deliver datasets for additional historical sensors, including limb sensors;
- Assess, develop and improve forward modelling capacity for early-era satellite observations using RTTOV;

- Perform detailed evaluation of the geo-location of the data, and improve where appropriate and possible;
- Consolidate guidance on quality control and bias modelling for the datasets addressed, using approaches including: (1) comparison with state-of-the art reanalyses; (2) inter-sensor co-registration, to gain additional insight into data quality and bias characteristics, and; (3) through comparisons with independent observations such as radiosondes and rocket-sondes.
- Provide any other guidance needed to prepare the data for use in reanalysis and/or for validation purposes;
- Provide the datasets in NetCDF4 format, together with comprehensive technical documentation in the form of Algorithm Theoretical Basis Documents (ATBDs) to include, as annexes, product user guides;
- Liaise and collaborate with EUMETSAT and relevant EUMETSAT Satellite Application Facilities (SAFs), as well as other data providers as needed.

2.2 Specification of Work

The list of satellite data records in Table 1 serves as the basis for the specification of work in Tasks 2-5. Task 1 involves the further development of an inventory of early satellite data sets, building on work carried out in COP1 and COP2. The work required to consolidate or prepare each of these data records for use in reanalysis is presented in Table 2 and in the associated notes.

The details of the task specifications listed in Table 2 are derived from the outputs of the COP1 Satellite Data Rescue activity, including the definition of the work to be done for the consolidation of already available datasets (items colour coded blue). These datasets and their description, in the form of draft Algorithm Theoretical Basis Documents (ATBDs) are available to Tenderers, on request.

For new datasets (items colour coded green for all, or most, tasks) listed in Table 2, the Successful Tenderer is expected to verify the current status of each data record and ascertain plans and timelines of any parties currently working on improving the data record. Tasks 1-5 are specified below:

Task 1: Satellite data rescue inventory. Maintain and extend an up-to-date global inventory of known satellite data records that require some form of data rescue, as a resource for coordination of current and future data rescue activities. The scope of this document covers sensors from satellites where the launch of the first sensor (where sensors formed part of a series of similar instruments) was prior to 1979.

The data inventory [INV-1] developed in the first two phases of the C3S programme (COP1 and COP2) shall be maintained and updated following feedback from ECMWF and other users as well as from findings from the work performed in the contract and elsewhere.

The Successful Tenderer will liaise with the Technical Officer (TO) and C3S Communications Team to ensure the inventory is fit-for-purpose, comprehensive and meets the C3S branding and format requirements for distribution *via* the C3S webpages.

The inventory shall contain descriptive information about each data record, its physical state and location, stewardship, available documentation, any existing assessments and applications, potential value for climate reanalysis, and any other useful information to help clarify information content and potential value of the data records. The current documents shall be supplemented with an appendix that records issues and requirements for development work for each instrument based on the experience gained in the contract and previous activities.

Sensor	Satellite	Period	Primary sensitivities	Availability
Early infrared sensors				
PMR	Nimbus-6	1975-1976	Stratospheric temperature	Univ. Oxford, Met Office and ECMWF
IRIS	Nimbus-4	1970-1971	Temperature, humidity and trace gases	Nimbus-4 at NASA (copy at ECMWF)

VTPR	NOAA-2 → -5	1972-1979	Temperature and humidity	ECMWF (used in ERA-40 and JRA-55)
SSH*	DMSP F-1 → F-4	1977-1980	Temperature and humidity	NASA
SI-1*	Meteor-28 and -29	1977, 1979	Temperature, humidity and trace gases	EUMETSAT
HRIR *	Nimbus-1,-2,-3	1964-1970	Cloud cover and surface emission	NASA
MRIR*	Nimbus-3	1969-1970	Water vapour, clouds, surface and atmospheric temperature	NASA
SIRS	Nimbus-3,-4	1969-1971	Temperature profiles	NASA
THIR *	Nimbus-4 → -7	1970-1985	Water vapour and surface	NASA
SCR	Nimbus-4,-5	1970-1974	Stratospheric temperature	Univ. Oxford, ECMWF, NASA
MRSR	Tiros-7	1963-1965	Stratospheric temperature	NASA
Early microwave sensors				
SMMR *	Nimbus-7	1978-1987	Sea-ice, TCWV, ocean surface wind, cloud LWP	CM SAF
SSM/T-2*	DMSP F-11,-12,-14 and -15	1994-2005	Upper tropospheric humidity	EUMETSAT, NOAA
SSM/T*	DMSP F-4, F-8→F-15	1979-2004	Upper air temperatures	NOAA
NEMS	Nimbus-5	Dec. 1972 to Oct 1973	Lower stratospheric and tropospheric temperature profiles	NASA
	Nimbus-6	June 1975 to May 1976	Lower stratospheric and tropospheric temperature and H2O profiles	NASA
SCAMS	Nimbus-6	June 1975 to May 1976	Lower stratospheric and tropospheric temperature and H2O profiles	NASA
ESMR*	Nimbus-5	Dec 1972 – May 1977	sea ice	NASA
Early limb sounding data				
LRIR	Nimbus-6	June 1975 - Jan 1976	Temperature, water vapour, ozone	NASA
LIMS	Nimbus-7	Oct 1978-May 1979	Temperature, water vapour, ozone	NASA
SAMS	Nimbus-7	October 1978- June 1983	Temperature, water vapour, ozone	NASA

Table 1: List of sensors addressed in the Contract. Note: for sensors marked with (*) the scope of the work is limited, as set out in Table 2 below.

Deliverables required: Database, supported with a user-friendly interface from the C3S website, containing the satellite data rescue inventory; annual updates; documentation. A first version of the database and documentation shall be delivered within 12 months of the start of contract.

Task 2: Provision of consolidated satellite datasets for use in reanalyses. The work to date on sensors covered in COP1 (**HRIR** on Nimbus I, II and III, **MRIR** on Nimbus II and III, **SIRS** on Nimbus III and IV, **IRIS** on Nimbus IV, **PMR** on Nimbus VI, **VTPR** on NOAA 2 to 5, **THIR** on Nimbus IV to VII, and **SSU** on NOAA satellites) and COP2 (**SCR** on Nimbus 4 and 5, **NEMS** on Nimbus 5, **SCAMS** on Nimbus 6, **ESMR** on Nimbus 5) has led to the generation of NetCDF files with added quality flag information and improved geolocation, and to ATBD documents [ATBD-1 to -11] with detailed analyses of the instrument performance. The data sets will be further consolidated with a view to the use of these data streams for assimilation and/or validation in ERA6. Additional files made recently available by NASA, and not yet treated in COP1 and COP2, should be included (THIR, HRIR). This task also covers updates of the RTTOV coefficients for the COP1 and COP2 sensors.

This task will be carried out in close collaboration with Task 3, concerned with the integration of the highest priority datasets, delivered to date, into the IFS.

Deliverables required: Consolidated datasets, technical documentation in the form of ATBDs, preliminary assessment of potential use in reanalysis.

Task 3: Integration of historical satellite data into the IFS. The production of the early-epoch streams of ERA6 (pre-2000) will start at the beginning of 2026, leaving time during 2025 for the preparation of data from

historical sensors for assimilation into the reanalysis. In 2025 an effort will be extended by the Successful Tenderer to participate in preparing the early historical satellite data (sensors from COP1 and COP2) identified in Table 2 for integration into IFS and for evaluating the impact of each new dataset. The work will include conversion of historical data from NetCDF format into BUFR, making changes to the IFS to process the new data, followed by running data assimilation experiments (including variational bias correction) as well as running diagnostic tools to evaluate the impact. A series of dedicated, hands-on training workshops will be organised by ECMWF to allow the Successful Tenderer to acquire a sufficient level of expertise in the relevant IFS tools and methodologies. This will include: familiarisation with the ECMWF High Performance Computer Systems, training in code management tools, basic training in the NWP suite, and *code sprint-type* workshops to collaboratively deliver the developments required to process these new datasets in the IFS. Tenderers should include costs related to three such workshops to be held at ECMWF, each lasting 5 days (1 week). These workshops comprise:

- An initial workshop in Reading (notionally by Q2 2025) aimed at initial familiarisation with key technical tools (HPC access, code management and familiarisation with the IFS) to be scheduled around the first available ECMWF training course.
- A second workshop (Reading or Bonn) in Q2/Q3 2025 concerned with familiarisation with the specific areas of code and scripts where developments are required & commencing initial developments in the IFS aimed at assimilating the highest priority datasets for assimilation in the IFS (drawn from the sensors: VTPR, PMR, NEMS, SCAMS, SCR).
- A third workshop (Reading or Bonn) in Q3/Q4 2025 aimed at completing the code and scripts developments required for launching assimilation experiments and commencing initial experiments in the IFS.

This work will be supplemented by further development work, carried out at the Successful Tenderer's own premises, to make the necessary progress with the required developments. This aspect of the work will be supported (remotely, *via* Teams meetings) by relevant technical expertise at ECMWF.

Deliverables required: A report on each workshop detailing progress achieved, outstanding issues to be resolved, and summary plans for the next phase of the work in advance of subsequent workshops.

Task 4: Rescue, development and assessment of additional historical sensors on early satellite platforms. In COP1 and COP2 the sensors identified as most beneficial for assimilation studies were prioritised and analysed. Nevertheless, recent new developments in the assimilation of limb sounding data at ECMWF make it worthwhile to explore data from several remaining instruments, including limb and nadir sounding data, on the earliest satellite platforms (TIROS, Nimbus), in order to recover, document and evaluate their performance for future generations of reanalyses given the pace of developments in this area, but also because they have particular advantages that will prove beneficial for the validation of ERA6. These sensors are:

- The **Medium Resolution Scanning Radiometer** placed on Tiros 2, 3, 4 and 7 has the advantage of covering the very earliest periods in the satellite era, between 1960 and 1965, and thus the period with some of the earliest Earth observations from space. The data for Tiros 2-4 have serious quality issues, with only periodic data availability, however data from Tiros 7, covering a two-year period from June 1963 and June 1965 are reported to be of better quality and, in addition, contain a temperature channel sensitive in the lower stratosphere (with peak sensitivity around 20km). Calculating observation-minus-model differences (O-A) for this instrument should confirm the usefulness of these early datasets. The latter calculation shall require the development and production of new RTTOV coefficients.
- **Limb sounders:** Given the recently demonstrated benefit in assimilating limb L2 humidity data in improving the analysis of stratospheric humidity in the IFS, it is of interest to explore the potential benefit of using data from three early limb sounders flown on the Nimbus 6 and 7 satellites.
 1. **LRIR (N6)** – The **Limb Radiance Inversion Radiometer** was the first IR radiometer to observe the atmosphere in the limb configuration. The LRIR channels were devoted to measuring high resolution

vertical profiles of temperature, H₂O and O₃ from the lower stratosphere (~15 km) up to the lower mesosphere (~60 km). Level 2 products as well as radiances are provided for a period from 14 June 1975 till 7 January 1976 with a vertical resolution of 2km.

2. **LIMS (N7)** – The **Limb Infrared Monitor of the Stratosphere** on Nimbus 7 provided high resolution profiles of trace gases from the lower stratosphere up to the lower mesosphere (vertical resolution of 1.8km for H₂O). LIMS measured atmospheric emissions in limb configuration in six spectral regions: 9.6µm O₃ band, 6.3µm NO₂ band, 6.2µm H₂O band, 11.3µm HNO₃ band, and two channels in the 15µm CO₂ band. The data are available for a period from 25 October 1978 till 30 May 1979.
3. **SAMS (N7)** - The **Stratospheric and Mesospheric Sounder** used the pressure modulation technique to extend the profiles up to the mesosphere. The L2 data are available at vertical resolution of 10 km for an almost 5-year period from October 1978 to June 1983.

For LRIR and LIMS which have simple spectral response functions (SRFs), dedicated L2 inversion studies should be performed to confirm the validity of the L2 products provided with the original data.

The general approach to the rescue, development and assessment of these datasets should follow the methodology developed for the data records delivered in the COP1 and COP2 contracts, summarised below.

- The recovery, re-formatting and archiving of the data in modern data formats (NetCDF).
- The development of quality flagging schemes for the data.
- Implementing improvements in the datasets, for example through improved geolocation and improved spectral and radiometric calibration.
- Assessing and improving the radiative transfer modelling of these data records, an essential component for the assimilation of the data.
- Assessing the quality of these data records with respect to independent datasets (for example from rocket-sonde observations) wherever possible.
- Assessing the quality of the data with respect to *state-of-the-art* atmospheric reanalyses (ERA5) through radiative transfer modelling.
- Assessing the performance of bias correction models (for Tiros-7 MSRS) in correcting biases in the data, in advance of in-house assessments at ECMWF.

Deliverables required: Archived datasets, technical documentation in the form of ATBDs, preliminary assessment of potential use in reanalysis.

Task 5: Improved datasets for early Microwave sensors. During the COP2 activities, methods were developed to assess several different calibration models for the microwave sounding data from the MSU instrument. In addition, methods were developed to optimise the coefficients of these calibration models, and to analyse corrections to nominal spectral response functions.

In this task, the approaches developed in COP1 will be applied to other early microwave sounders, assessed during COP2 (NEMS and SCAMS). The work will require the development of radiative transfer modelling capability.

Deliverables required: Updated ATBDs for NEMS and SCAMS detailing the optimised calibration model, associated coefficients and optimised spectral response functions. Preliminary assessment of potential use in reanalysis. Updated datasets incorporating the optimised calibration model, and spectral response functions and radiative transfer coefficients.

Sensor	Task						
	2 (Consolidation of COP1 & COP2 datasets)					3 (IFS developments)	
	2 (a) Data provision	2 (b) Quality assessment	2 (c) RT modelling	2 (d) Quality control	2 (e) Bias modelling & assessment	3(a) IFS development (priority)	3(b) OSEs (priority)
Early Infrared Observations							
PMR [1]						✓ (1)	✓ (1)
IRIS						Complete	
VTPR [2]						Complete	✓ (1)
SIRS [3]						✓ (1)	✓ (1)
SSH [4]						✓ (2)	✓ (2)
SI-1 [5]						✓ (2)	✓ (2)
SCR [6]						✓ (1)	✓ (1)
MRSR [7]	✓	✓	✓	✓	✓	← Task 4	
Early Microwave Observations							
NEMS [8]			✓ Task 5			✓ (1)	✓ (1)
SCAMS [9]			✓ Task 5			✓ (1)	✓ (1)
Reprocessed Radiance Observations							
MSU [10]			✓				✓ (1)
Limb Sounding Observations (Level 2 products): Task 4							
LRIR	✓	✓	N/A	✓	✓		
LIMS	✓	✓	N/A	✓	✓		
SAMS	✓	✓	N/A	✓	✓		

Table 2: Tasks to be addressed in this contract. The tasks shaded in blue denote consolidation of tasks carried out in COP1 & COP2. Tasks in green denote new activities, either involving IFS developments and related observing system experiments (OSEs), or for the generation and assessment of datasets for new limb sounding sensors. For the IFS developments and related OSEs, the highest priority activities are those in dark green [1] and should be the focus of the work programme during the first half of the contract (2025 and Q1 & Q2 2026) and those in light green [2] are lower priority and should be addressed in the second half of the contract (Q3 2026 - Q4 2027).

Supplementary Notes on Table 2:

[1] The PMR dataset was developed in COP1 and consolidated in COP2. The tasks here are to: (1) further consolidate the dataset and associated RT modelling, as required, and; (2) complete IFS developments and testing through targeted observing system experiments.

[2] The VTPR dataset was developed in COP1 and consolidated in COP2, largely through improved geolocation of the data. The code and scripts are in place to assimilate VTPR data in the IFS, and VTPR data was assimilated

in ERA5. The tasks here are to: (1) further consolidate the dataset and associated RT modelling, as required, and; (2) complete IFS developments and testing through targeted observing system experiments.

[3] The SIRS dataset was developed in COP1 and consolidated in COP2. The tasks here are to: (1) further consolidate the dataset and associated RT modelling, as required, and; (2) complete IFS developments and testing through targeted observing system experiments.

[4] The SSH dataset was developed in COP2 by EUMETSAT. The tasks here is to complete IFS developments and testing through targeted observing system experiments. The priority assigned here is (2), as the work will form part of the core plan of work for the C2S Climate Reanalysis Team during 2025-2027. Inclusion of the task here provides redundant capacity to complete this work.

[5] The SI-1 dataset was developed in COP2 by EUMETSAT. The data is only available for several weeks in 1977 and 1979. The tasks here is to complete IFS developments and testing through targeted observing system experiments. The priority assigned here is (2), as the work will form part of the core plan of work for the C3S Climate Reanalysis Team during 2025-2027. Inclusion of the task here provides redundant capacity to complete this work.

[6] The SCR dataset was developed in COP2. The tasks here are to: (1) further consolidate the dataset and associated RT modelling, as required, and; (2) complete IFS developments and testing through targeted observing system experiments.

[7] The Medium Resolution Scanning Radiometer (MRSR) dataset would have to be developed within this contract for the first time, following the approach to data recovery, assessment and archiving followed in the COP1 and COP2 contracts.

[8] The NEMS dataset was developed in COP2. The tasks here are to: (1) further consolidate the dataset and associated RT modelling, as required, and; (2) complete IFS developments and testing through targeted observing system experiments.

[9] The SCAMS dataset was developed in COP2. The tasks here are to: (1) further consolidate the dataset and associated RT modelling, as required, and; (2) complete IFS developments and testing through targeted observing system experiments.

[10] The MSU dataset was developed in COP2. This involved the evaluation of several possible calibration models and the optimisation of fast RT model coefficients, based on an analysis of spectral shifts. The tasks here are to: (1) further consolidate the dataset and associated RT modelling, as required, and; (2) complete IFS developments and testing through targeted observing system experiments.

2.3 Summary of Deliverables and Acceptance Criteria

Deliverable #	Deliverable Name	Criteria	Metric and Tolerances/ [due date]	Approving authority
C3S2_XXX_D1.1.1 / C3S2_XXX_D1.1.2 / C3S2_XXX_D1.1.3	[Task1] Data Inventory (initial [1.1.1] and 2 annual updates [1.1.2 & 1.1.3])	Provision of updated database & supporting updated documentation	Delivery to target schedule of both database and documents / [Start + 1 year, +2 years, +3 years, resp.]	C3S Technical Officer
C3S2_XXX_D2.1.1 - D3.1.n /	[Task 2] Updated ATBDs For consolidated datasets from Phases 1 & 2 [D2.1.1-2.1.n]	Relevant sections of consolidated ATBD complete [D2.1.1-2.1.n] Successful Scientific review by C3S TO.	Conformance to ATBD template to be agreed at contract negotiation. [D2.1.N: start + 2 years 6 months];	C3S Technical Officer

<p>C3S2_XXX_D3.1.1 /</p> <p>C3S2_XXX_D3.2.1/ to C3S2_XXX_D3.2.N/</p> <p>C3S2_XXX_D3.2.1/ to C3S2_XXX_D3.2.N/</p>	<p>[Task 3] Integration of datasets into the IFS</p> <p>D3.1.1 Report on first orientation workshop</p> <p>D3.2.1- D3.2.N Report on progress and plans for priority sensors 1-N from 2nd workshop.</p> <p>D3.3.1- D3.3.N Report on progress and plans for priority sensors 1-N from 3rd workshop.</p>	<p>Participation in workshops, development of IFS code and scripts, and production of progress reports.</p> <p>Report & review by C3S TO</p>	<p>D3.1.1: Attendance at initial training workshop for specified staff (by Q2 2025)</p> <p>D3.2.1 - D3.2.N: Initial data assimilation (departure) statistics produced from initial tests (by Q3 2025)</p> <p>D3.3.1 - D3.3.N: Assimilation experiments completed and impact analysed (by Q4 2025)</p>	<p>C3S Technical Officer</p>
<p>C3S2_XXX_D4.1.1 - D5.1.4 (draft)</p> <p>C3S2_XXX_D4.2.1 - D4.2.4 (final)</p>	<p>[Task 4] Rescue, development and assessment of (four) new datasets.</p> <p>Updated ATBDs for new sensors [draft: D4.1.1-4.1.4 & final: D4.2.1-4.2.4]</p>	<p>Relevant sections of draft ATBD complete [D4.1.1-4.1.4]</p> <p>Final version [D4.2.1-4.2.n]</p> <p>Successful Scientific review by C3S TO.</p>	<p>Conformance to ATBD template to be agreed at contract negotiation</p> <p>[D4.1.X: start + 2 year; D4.2.X: start+ 2 year 6 months]</p>	<p>C3S Technical Officer</p>
<p>C3S2_XXX_D5.1.1/2 - D5.2.1/2</p>	<p>[Task 5]: Improved datasets for early Microwave sensors (NEMS and SCAMS)</p> <p>Updated ATBD to include details of optimised calibration model and spectral response functions. [D5.1.1 [NEMS] & D5.1.2 [SCAMS])</p> <p>D5.2.1 & D5.2.2. Updated datasets in NetCDF format</p>	<p>Relevant sections of draft ATBD complete [D5.1.1-5.1.2]</p> <p>Updated datasets available [D5.2.1-5.2.2]</p>	<p>Conformance to ATBD template to be agreed at contract negotiation</p> <p>[Start + 2 years]</p> <p>[start+ 2 years 6 months]</p>	<p>C3S Technical Officer</p>

Table 3: Summary Table of Technical Deliverables

Tenderers should provide a complete set of deliverables to suit their proposed work plans and should use the numbering format for deliverables as described in Volume IIIA – Pricing and Deliverables (Deliverables list sheet).

3 General Requirements

3.1 Schedule

A detailed time plan and schedule shall be included in the tender response. The proposed time plan and schedule shall address the main tasks, inputs, outputs, intermediate review steps, milestones, deliverables and dates. Regular/monthly progress meetings will be held with ECMWF during the contract to assess contract status, risks and actions.

ECMWF is required 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's 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 (for more details please see Volume V Framework Agreement for this ITT).

3.2 Meetings

ECMWF will organise meetings at 12- to 18-month intervals to bring together all C3S service providers. The Successful Tenderer is expected to attend these meetings. The Successful Tenderer is required to attend monthly 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 the Successful Tenderer and shall be included in the tendered price. The cost of organising and attending any additional meetings required to carry out the contracted activities shall also be covered by the Successful Tenderer and shall be included in the tendered price.

3.3 Key Performance Indicators (KPIs)

Tenderers shall propose a small set of meaningful Key Performance Indicators (KPIs) which enable ECMWF to monitor and assess the progress of the contract in meeting the overall objectives set. For C3S2_314_bis these should reflect the primary relevance of the datasets provided – in supporting the use of the rescued satellite data in future global reanalyses. The Tenderers shall provide preliminary versions of the completed tables as part of their Tender. The final set of KPIs may be refined in the contract negotiation phase.

During the contract implementation, all KPIs shall be duly reported by the contractor in the Quarterly Implementation Reports (QIR) in accordance with their frequency of delivery.

3.4 Payment Plan

The 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).
- It is recommended to have Payment Milestones, and therefore payments, with an anticipated date of completion every 6 months.
- 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.

3.5 Stakeholder Involvement

Tenderers should take account of the dependencies and relationships (of the programme of work) to relevant activities at ECMWF and EUMETSAT which support the development and testing of reanalysis systems and reflect these dependencies in the scheduling of deliverables where appropriate.

3.6 Data and IPR

As the primary use for the Level 1 satellite datasets delivered by this contract is to serve as input to C3S reanalyses it is not envisaged that the data will be served through the CDS, but that access to the datasets and documentation will be open to C3S users through clear documentation and links on the C3S website.

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 Tenderer's production system. The identity and ownership of such exceptional components will be passed to the European Union via ECMWF annually. The successful Tenderer will be granted a non-exclusive licence to use them for any purpose.

A distinction ought to be made between:

- those datasets (or relating documentation) specifically created as a result of this ITT, which, as Deliverables, will be fully owned by the EU, and
- pre-existing datasets (or documentation), which are simply brokered / made accessible as part of the services.

Such brokered datasets (or documentation) will continue to be owned by their original owner. The successful Tenderer will licence the relevant brokered data/documentation to ECMWF/EU or will procure on behalf of ECMWF a licence directly from the owner. Such licence will ensure the best available terms of accessibility and redistribution, bearing in mind the purpose of the Copernicus Programme and the free and open terms of accessibility and redistribution, established for Copernicus products in the Copernicus Data Regulation (see respective definition in Volume V Clause 1.2). At a minimum, the successful Tenderer shall grant, or procure on behalf of ECMWF, the right for the brokered datasets (or documentation) to be made available via the Climate Data Store (CDS) on terms consistent with any applicable specifications of ECMWF and the Copernicus Data Regulation. The successful Tenderer will be responsible to provide the license terms to ECMWF in a suitable format in order for ECMWF to make the brokered datasets (or documentation) available via the CDS. The successful Tenderer will inform ECMWF of any updates to such terms. In this case, ECMWF is procuring a service, rather than the datasets (or the documentation) themselves.

The proposal shall thus provide a clear distinction between both cases by setting the nature of:

- the datasets (or relating documentation) specifically created as a result of this ITT to "Dataset" or "Report",
- the brokered datasets (or relating documentation) made accessible as part of the service to "Brokerage Dataset" or "Brokered Report".

Please note that, in both cases, the bidder shall warrant that it has all necessary rights to either pass on ownership to the ECMWF/EU or, alternatively, that it has all necessary rights to grant the required license to

ECMWF and the EU in respect of brokered datasets (or documentation), as described above. Please refer to the ITT Volume V (Framework Agreement) for further details of the license required.

3.7 Supporting User Engagement

While user engagement and training activities are not part of the scope of this ITT, Tenderers should accommodate for eventual needs in providing technical and scientific expertise in support of these activities. Tenderers should specify in the response the experts intended to be allocated to provide this support.

Requests to support activities may include, for example, the requirement 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;
- 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.

4 Tender Format

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.

4.1 Page Limits

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

<i>Section</i>	<i>Page Limit</i>
<i>Executive Summary</i>	2
<i>Track Record</i>	2 (for general) and 2 (per entity)
<i>Quality of Resources to be Deployed</i>	2 (excluding Table 1 in Volume IIIB and CVs with a maximum length of 2 pages each)
<i>Technical Solution Proposed</i>	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)
<i>Management and Implementation</i>	10 (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 4: 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 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 large-scale projects. The Tenderer shall describe the experience of the Service Manager and of 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.

4.2.5 Management and Implementation

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.

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

- Monthly teleconferences with ECMWF and a proposal for involvement of ECMWF in major contract reviews shall be provided as part of the management plan.
- 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. The table below provides the template to be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for the management work package (WP0). All milestones and deliverables shall be numbered as indicated and document deliverables shall be periodically updated and versioned as described in the table.

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

Deliverable / Milestone ID	Responsible	Nature	Deliverable / Milestone title	Due date
List of deliverables				
WP0-QIR-YYYYQQ	Tenderer	Report	Quarterly Implementation Report YYYYQQ <i>YYYYQQ being the previous quarter (e.g. 2024Q3)</i>	Quarterly on 15/04, 15/07 and 15/10

WPO-AIR1-YYYY	Tenderer	Report / Other	Annual Implementation Report for year YYYY – Part 1 including both: <ul style="list-style-type: none"> · the Quarterly Implementation Report YYYY Q4 and · the requested preliminary financial information for year YYYY <i>YYYY being the Year n-1</i>	Annually on 15/01
WPO-AIR2-YYYY	Tenderer	Report	Annual Implementation Report for year YYYY – Part 2 <i>YYYY being the Year n-1</i>	Annually on 28/02
WPO-FIR	Tenderer	Report	Final Implementation Report	Not later than 60 days after the end of contract and once all other activities duly performed
WPO-AIP-YYYY	Tenderer	Report	Annual Implementation Plan for year YYYY <i>YYYY being the Year n+1</i>	The first one 14 days after the start of the contract and then Annually on 30/09
WPO-FIN-YYYY	Tenderer	Other	Copy of Prime Contractor’s general financial statements and audit report for year YYYY <i>YYYY being the Year n-1</i>	Annually, not later than on 15/12
WPO-IC	Tenderer	Other	Proof of insurance coverage	At the end of the first month
List of milestones				
WPO-KOM	Tenderer	Presentation and MoM	Kick-Off Meeting	Not later than 30 days after the start of contract
WPO-PRMxx	Tenderer	Presentation and MoM	Progress Review Meeting #xx <i>xx being the iteration number of the PRM</i>	As detailed in 4.2.5
WPO-C3SGA-YYYY	Tenderer	Attendance	C3S General Assembly YYYY	Annually, not later than on 15/12

Table 5: Administrative and Programmatic Deliverables

Tenderers shall provide preliminary versions of the completed tables as part of their response.

5 Additional information

5.1 References

[REF-1] Hersbach H, Bell B, Berrisford P, et al. The ERA5 global reanalysis. *Q J R Meteorol Soc.* 2020; 146: 1999–2049. <https://doi.org/10.1002/qj.3803>

[REF-2] Saunders, R., P. Rayer and P. Poli, 2017: Update on Satellite Datasets for ERA-CLIM2. ERA-CLIM2 deliverable D3.9, available at, https://drive.google.com/open?id=1ZhWfmmUq8GPG4Lh7_RyRImyH3vdJIsD

[INV-1] C3S2-D314_1.2.1_2023Q4_202402_Satellite_Data_Rescue_Inventory_v1.0.docx

[ATBD-1] C3S2_D314_3.2.3_NEMS_ATBD_v1.0.docx

[ATBD-2] C3S2_D314_3.2.1_SCAMS_ATBD_v1.0.docx

[ATBD-3] C3S2_D314_3.2.4_ESMR_ATBD_v1.0.docx

[ATBD-4] C3S2_D314_3.2.2_SCR_ATBD_v1.0.docx

[ATBD-5] C3S2_D314_6.1.2_SIRS_ATBD_v1.0.docx

[ATBD-6] C3S2_D314_6.1.1_IRIS_ATBD_v1.0.docx

- [ATBD-7] C3S2_D314_5.1.3_PMR_ATBD_v1.0.docx
- [ATBD-8] C3S2_D314_5.1.3_THIR_ATBD_v1.0.docx
- [ATBD-9] C3S_D311c_Lot1.1.5.1.1_MRIR_ATBD_v1.0.docx
- [ATBD-10] C3S_D311c_Lot1.1.5.1.1_HRIR_ATBD_v1.0.docx
- [ATBD-11] C3S_D311c_Lot1.1.5.1.1_SSU_ATBD_v1.0.docx
- [ATBD-12] C3S_D311c_Lot1.1.5.1.1_VTPR_ATBD_v1.0.docx

5.2 Acronyms

AMSU	Advanced Microwave Sounding Unit
ATBD	Algorithm Theoretical Basis Document
AVHRR	Advanced Very High Resolution Radiometer
C3S	Copernicus Climate Change Service
CDR	Climate Data Record
CDS	Climate Data Store
CIMSS	Cooperative Institute for Meteorological Satellite Systems
CM SAF	EUMETSAT Climate Monitoring-Satellite Application Facility
COP1	First phase of the Copernicus Programme (2014-2020)
COP2	Second phase of the Copernicus Programme (2021-2027)
DMSP	Defense Meteorological Satellite Program
ECMWF	European Centre for Medium-Range Weather Forecasts
ERA-CLIM	European Reanalysis of Global Climate Observations
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FCDR	Fundamental Climate Data Record
FIDUCEO	Fidelity and uncertainty in climate data records from Earth Observations
HIRS	High-resolution Infrared Radiation Sounder
HRIR	High-resolution Infrared Radiometer
IRIS	Infrared Imaging Spectrograph
ITT	Invitation to Tender
MOOC	Massive Open Online Course
MRIR	Mid-Infrared Instrument
MSU	Microwave Sounding Unit
MVIRI	Meteosat Visible Infra-Red Imager
NASA	National Aeronautics and Space Administration
NOAA CLASS	NOAA Comprehensive Large Array-data Stewardship System
NOAA	National Oceanic and Atmospheric Administration
NWP SAF	EUMETSAT Numerical Weather Prediction Satellite Application Facility
PMR	Pressure Modulator Radiometer
RT	Radiative Transfer
RTTOV	Radiative Transfer for TOVS
SIRS	Satellite Infra-Red Spectrometer
SMMR	Scanning Multichannel Microwave Radiometer
SSM/I	Special Sensor Microwave/imager
SSM/T	Special Sensor Microwave - Temperature
SSMIS	Special Sensor Microwave - Imager/Sounder
SSU	Stratospheric Sounding Unit
TCWV	Total Column Water Vapour
THIR	Temperature-Humidity Infrared Radiometer

TIROS	Television Infrared Observation Satellites
TOVS	TIROS Operational Vertical Sounder
VTPR	Vertical Temperature Profile Radiometer