ECMWF
Copernicus
Procurement

Invitation to Tender

Copernicus Climate Change Service

Improved treatment of the stratosphere in C3S reanalyses

Volume II: Specification of Requirements

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1 Introduction

ECMWF, as the Entrusted Entity for the Copernicus Climate Change Service (C3S), invites Tenders for development activities to assess and improve the treatment of the stratosphere in climate reanalyses. This will be achieved by completing developments in the ECMWF Integrated Forecasting System (IFS) and performing assimilation experiments with observations of upper atmospheric temperature and humidity. This work will assess the quality of ERA6 temperature and humidity in the upper atmosphere shortly after production and evaluate a method for correcting model biases in the stratosphere in early periods of future reanalyses using information from the data-rich modern era. To support the validation of these developments, high-quality in-situ observation data records shall be acquired. This document describes the scope and technical requirements for C3S2_620, addressing the development work required to assess the current C3S reanalysis and improve future C3S reanalyses.

The objective of this contract is to improve the analysis of the stratosphere in C3S reanalyses by preparing and evaluating observational datasets which will be used to constrain temperature and humidity fields in the stratosphere and lower mesosphere as well as completing and testing the IFS developments required to assimilate this data. One output of this phase of the work will be a timely assessment of the performance of ERA6 in the stratosphere shortly after production is complete for the initial streams (2006-2026). A second aim of this work is to assess the effectiveness of model bias correction methods applied to earlier epochs in reanalysis, for deployment in future C3S reanalyses.

All of this work will require close collaboration with ECMWF scientists, facilitated through scheduled (*visiting scientist*) visits to ECMWF offices in Reading and Bonn, and followed up by independent remote development work by the Successful Tenderer. The necessary support and training will be provided to the Successful Tenderer to complete this work.

All relevant results to date from C3S contracts are available to Tenderers, including documentation, on request via the messaging board on the e-Procurement Portal, as can additional technical clarifications.

The activities proposed here will deliver a comprehensive assessment of the ERA6 stratospheric temperature and humidity analysis as well as delivering fully evaluated extensions to the IFS to allow the assimilation of new observations of temperature and humidity in the recent period (2004-present) as well as the data sparse past (1970s-1990s).

ECMWF intends to award a single Framework Agreement for a period of maximum 30 months, which shall be implemented via a single Service Contract expected to commence in Q2 2026.

2 Technical requirements

The overarching aims of the activity are: to evaluate the quality of upper atmospheric (upper stratospheric and lower mesospheric [USLM]) temperature and humidity fields in ERA6; and to develop and evaluate methods to improve the analysis of those fields throughout the entire reanalysis period for future C3S global reanalyses.

The specific, top-level, objectives therefore are to:

- Assess the quality of the ERA6 USLM analysis by assimilating, in independent experiments, observational datasets never used before in ECMWF reanalyses: SSMIS upper atmospheric sounding radiances for USLM temperatures from 2013-2023; Nimbus-6 PMR observations from 1976-78; Level 2 (L2) water vapour profiles derived from limb-sounding observations covering both the modern period (EOS-Aura MLS: 2004-2025 [REF-1] and UARS MLS from 1991-1993) and the early satellite period (from the Nimbus series of instruments LRIR, LIMS and SAMS, 1975-1983).
- Develop and optimise the capability in the IFS to assimilate new observations in the recent period (2004-2025) as well as in the data sparse past (1975-1993). An important part of the activities will be the

development and testing of significant new features in the IFS, working collaboratively with scientists at ECMWF.

- Assess the effectiveness and accuracy of model bias corrections, derived from the model error estimate analysed by the weak-constraint (WC) formulation of 4DVar currently used in the IFS, in earlier epochs (1970-1983), using early satellite sounding data (Nimbus-6 PMR) for temperature, and L2 data from early limb sounding missions (Nimbus-6 & -7 LRIR, LIMS and SAMS) for water vapour.
- Deliver in-situ observation data records that are suitable to support the aforementioned investigations.
- Deliver recommendations on the strategy to achieve further improvements in the fidelity of the representation of the stratosphere in future C3S reanalyses, based on the results obtained.

2.1 Scope of Service

The Successful Tenderer shall:

- Collect and make available relevant datasets produced as part of ongoing C3S activities at EUMETSAT and Spascia. Specifically these are: (from EUMETSAT) the L1B radiances from the F-17 SSMIS sensor from 2015-2025, complete with the meta-data required to model the Upper Atmospheric Sounding (UAS) channels of SSMIS (channels 19-24) using the community radiative transfer model RTTOV, and; (from Spascia) the L2 water vapour concentration profiles from the LRIR, LIMS and SAMS limb sounders from the Nimbus-6 & -7 satellites during the period 1975-1994.
- Collect and make available, with corresponding data policies, observational data from high-altitude in-situ data records, specifically those from stratospheric balloon campaigns (EOLE [REF-2], HIBISCUS [REF-3], VORCORE [REF-4], PRE-CONCORDIASI & CONCORDIASI [REF-5] and STRATEOLE-2 [REF-6 & -7]) as well as appropriate (in terms of temporal coverage, geographical coverage and overall data quality) rocketsonde datasets, using a representation that enables onward data service [REF-9]. Although the central focus of this contract will be the exploitation of satellite sounding data, the aim here is to obtain high-altitude in-situ observation data sets for future validation studies within C3S, and also to make available these datasets for subsequent (*i.e.* outside of the contracted work) incorporation into the C3S data store for exploitation by the wider C3S user-base.
- Identify and obtain the best available global UARS MLS L2 water vapour concentration profile datasets for the period 1991-1993 (noting that EOS-Aura MLS data from 2004-2023 is already available at ECMWF).
- Evaluate stratospheric water vapour fields from the most recent periods of the ERA6 reanalysis (2006-2026) by running extended (multi-year) observing system experiments in which the independent data from EoS-Aura MLS data is assimilated. As an initial step, the calculation of observation minus calculated values, based on the ERA6 production run analyses should be used to gain insight into both observation data quality and the performance of the ERA6 reanalysis.
- Complete development work in the IFS to assimilate UAS SSMIS observations, using the Zeeman capability in RTTOV, and perform assimilation experiments to evaluate the impact of the data in multi-year observing system experiments.
- Evaluate USLM temperature fields from the most recent periods of the ERA6 reanalysis (2006-2026) by running extended (multi-year) observing system experiments in which the independent data from F-17 SSMIS UAS channels are assimilated. As an initial step, the calculation of observation minus calculated values, based on the ERA6 production run analyses should be used to gain insight into both observation data quality and the performance of the ERA6 reanalysis.
- Complete IFS development work and necessary adaptations required to enable the assimilation of early satellite sounding data from the PMR sensor carried on Nimbus 6 from 1975-1978. As an initial step, the

calculation of observation minus calculated values, based on the ERA6 production run analyses should be used to gain insight into both observation data quality and the performance of the ERA6 reanalysis.

- Complete IFS development work and necessary adaptations required to enable the assimilation of early satellite limb-sounding data from the LRIR, LIMS and SAMS sensors carried on Nimbus 6 and 7 from 1975-1983.
- Complete and evaluate early period observing system experiments (1975-1983 and 1991-1993) in which observational data from PMR, LRIR, LIMS, SAMS and UARS MLS is assimilated. As an initial step, the calculation of observation minus calculated values, based on the ERA6 production run analyses should be used to gain insight into both observation data quality and the performance of the ERA6 reanalysis.
- Evaluate the model error forcing [REF-8] derived from weak-constraint 4D-Var (run in modern-era experiments) in early period (1975-1983, 1991-1993) observing system experiments.

2.2 Specification of Work

The main elements of the work can be summarised as:

- Improve the representation of temperature and water vapour in the USLM in the IFS analysis by developing the capability to assimilate previously unused observations in the modern period (2004-2025) over multi-year timescales. These observations are brightness temperatures from the F17 SSMIS instrument (temperature in the USLM) and EOS-Aura MLS (water vapour in the stratosphere). Multi-year assimilation experiments will be used to estimate model errors in temperature and a neural net will be trained [REF-8] based on these experiments, to enable the state-dependent estimation of the model errors for earlier periods (1950-2004). This work builds on existing capability in the IFS to assimilate SSMIS lower atmospheric temperature and humidity sounding channels & MLS L2 water vapour profile information. These developments will establish the capability to assimilate these observations in future generations of ECMWF reanalyses.
- Obtain and make available in-situ observation datasets (see examples detailed in REFS-2 through 7) for future validation of C3S reanalyses and for exploitation by the wider C3S user-base, insofar as these datasets can be obtained and made public.
- Using the newly developed capability to assess the accuracy of the stratospheric and lower mesospheric temperature and humidity analyses from the initial production runs of the ERA6 global reanalysis (2006-2026), due to be complete towards the end of 2026.
- Develop the capability to assimilate early satellite sounding data with information on USLM temperatures (the Nimbus-6 Pressure Modulator Radiometer [PMR], 1976-1978) & stratospheric water vapour (Nimbus-6/7 LRIR / LIMS SAMS – from 1975-1983).
- Evaluate the impact of deploying the state-dependent model error estimates derived from the modern-era (2004-2025) experiments in earlier periods (1976-1983) using the independent observations from PMR / LRIR / LIMS / SAMS.

These elements define tasks 1-5 set out in more detail below:

Task 1: Collate satellite and in-situ observation data.

This task includes two parts relating to satellite and in-situ observations. **For the satellite observations**, modern period information on upper stratospheric and mesospheric temperatures will be obtained from F-17 SSMIS for the period from 2012-2025 and for stratospheric water vapour, EoS-Aura MLS operational from 2004-present and UARS MLS from September 1991 – April 1993.

The assimilation of the upper atmospheric sounding channels of SSMIS (channels 19-24) is complicated by the effect of the Zeeman splitting of the highest peaking channels (channels 19-21). Accurate fast modelling of these channels using the community radiative transfer model (RTTOV) requires, in addition to the

predictors used for the lower peaking channels (normally derived from model background temperature and water vapour profiles in addition to the viewing geometry), predictors computed from the local geomagnetic field and the viewing geometry ('**B.k'**). The quantities required to calculate these predictors have been derived and added to the meta data in a new dataset being developed by EUMETSAT as part of an ongoing C3S Agreement. The data for F17 SSMIS (2012-2025) will be available, in BUFR format, in January 2026 as an input to the work described here. The UAS channels from the other SSMIS platforms (F-16 launched 2003, and F-18 launched 2009) are unsuitable for this application due to a failure of the UAS channel frequency stabilisation for those channels.

For the assimilation of water vapour information in the stratosphere, initial experiments have been conducted in the IFS at ECMWF using both radiosonde humidity and water vapour profiles derived from EOS-Aura MLS observations for several post-2020 periods. EOS-Aura MLS observations are archived (in BUFR format) and available at ECMWF from 2004-2023. For this task the Successful Tenderer should identify and obtain the best available dataset of UARS MLS water vapour retrievals (September 1991 – April 1993) and liaise with ECMWF to coordinate the format conversion to BUFR format as required by the IFS.

For the early period (1975-1983) early satellite sounding observations have been rescued, reformatted and assessed relative to the ERA5 reanalysis for the Nimbus-6 Pressure Modulator Radiometer and the Nimbus-4 & -5 Selective Chopper Radiometer (SCR) through previous C3S Contracts. Observational data in NetCDF format, and documentation in the form of an Algorithm Theoretical Basis Document (ATBD), is available on request to interested Tenderers. PMR brightness temperatures have information on temperature throughout the stratosphere and mesosphere and one channel of SCR (Channel 1) has information on upper stratospheric and lower mesospheric temperatures. The ongoing C3S Satellite Data Rescue contract aims to deliver a set of RTTOV coefficient files based on the best available modelling of the instrument.

An ongoing extension of the above contract (C3S2_314) aims to recover, reformat and assess water vapour retrievals from the early limb sounding instruments LRIR, LIMS and SAMS detailed in Table 1. Preliminary version of these datasets will be available to the Successful Tenderer from November 2026 and finalised datasets available from November 2027.

Sensor	Satellite	Period	Primary sensitivities	Availability
Modern-era L1 Upper atmospheric sounding brightness temperatures				
SSMIS	F17	Nov 2013 – Dec 2025	Temperature	EUMETSAT, Jan 2026
Modern-era L2 Water vapour profiles				
MLS	UARS	Sep 1991 - Apr 1993	Water vapour	TBD by contractor
MLS	EOS-Aura	Aug 2004 - Dec 2023	Water Vapour	ECMWF ECFS
Early infrared sensors				
PMR	Nimbus-6	1975-1976	Stratospheric temperature	Spascia Ltd / ICARE, Univ. Lille
SCR	Nimbus-4 & -5	1970-1974	Stratospheric temperature	Spascia Ltd / ICARE, Univ. Lille
Early limb sounding data				
LRIR	Nimbus-6	June 1975 - Jan 1976	Temperature, water vapour, ozone	Spascia Ltd / ICARE, Univ. Lille - from Nov 2026
LIMS	Nimbus-7	Oct 1978 - May 1979	Temperature, water vapour, ozone	Spascia Ltd / ICARE, Univ. Lille - from Nov 2026
SAMS	Nimbus-7	October 1978 - June 1983	Temperature, water vapour, ozone	Spascia Ltd / ICARE, Univ. Lille - from Nov 2026

Table 1: List of sensors addressed in the Contract.

For the in-situ observations, the task consists in the recovery, reformatting to standard units and form defined by REF-9, and delivery to C3S of an in-situ observation dataset that is suitable for assessment of the work to be carried out in the numerical experiments. The sources to be considered are the stratospheric balloon campaigns detailed in REFS-2 through 7, insofar as data access can be obtained for this purpose as

an appropriate subset of available historical rocketsonde measurements. The dataset to be delivered shall preferentially be in CSV format, or as parquet file(s), representing a two-dimensional table, where each row is a single-level, single-time, single-position, single-variable observation report entry as described per REF-9. In-Situ Supporting Documents (ISSD) to be delivered are indicated in Table 2. Information about observation uncertainties, harvested from existing documentation, in the data and/or documentation will be an advantage.

Deliverable	Name	Content	Example
ISSD1	Data policy manifest	States the conditions of use. Mixed conditions are possible, in case of multiple sources.	REF-10
ISSD2	Data source inventory	Table (CSV file), where each source identifier is assigned a name and the citation(s) to be employed.	REF-11
ISSD3	Station inventory	Table (CSV file), indicating for each station or platform: identifier(s) and corresponding identification referential(s), location (or location range in case of moving platform) in WGS-84 coordinates, observables included, temporal range, and vertical range.	REF-12
ISSD4	Product User Guide	Describes the dataset, input data sources, known limitations.	REF-13
ISSD5	Algorithm Theoretical Basis Document	Describes the steps undertaken to create the dataset from input data sources.	REF-14

Table 2: In-Situ Supplementary Documents. These are necessary to enable integration of the in-situ observation data into the Climate Data Store.

Deliverables required: Datasets in NetCDF or BUFR format for F-17 SSMIS, UARS MLS, Nimbus-4 and -5 SCR, Nimbus-6 PMR, Nimbus-6 LRIR, Nimbus-7 LIMS and SAMS, UARS MLS, Dataset of high-altitude in-situ observation data with supporting documentation (data policy manifest, source inventory, station inventory, product user guide, algorithm theoretical basis document).

Task 2: Develop adaptations to IFS to assimilate UAS channels from F17 SSMIS.

Make developments necessary for the assimilation of SSMIS UAS channels (19-24, or a subset of those channels), based on input SSMIS BUFR data provided by EUMETSAT. Perform initial (3-6 month) observing system experiments in which F17 SSMIS UAS channels are assimilated and compare with control experiments without these channels. Evaluate differences in the analysed temperature fields. Run longer, multi-year (2-3 year) experiments, assimilating SSMIS observations in runs at ERA6 (14km) resolution sometime during the 2013-2025 timeframe. The exact period will be established in consultation with the C3S/ECMWF Climate Reanalysis Team based on the status of the ERA6 production streams from 2006-2026. Evaluate differences between this experiment and the main ERA6 production run. These experiments will use the weak-constraint formulation of 4D-Var and will produce estimates of the model error. This will be used in a later task (Task 4) to derive a state-dependent predictive model of the model error which will be tested in earlier epochs and validated using early satellite sounding data. This element will require close collaboration with the C3S/ECMWF reanalysis team based in Bonn, facilitated through two 2 week visiting scientist visits during 2026 at the ECMWF Bonn Offices. Prior experience of working within the IFS is an advantage, but training will be provided to the Successful Tenderer without this experience.

Deliverables required: Tested IFS-branch and documentation on the changes implemented. A report summarising the results of the initial experiments and the assessment of the upper stratospheric and lower mesospheric temperature analysis relative to ERA6.

Task 3: Develop adaptations to IFS to assimilate L2 water vapour retrievals from UARS and EOS-Aura MLS.

Building on the recent developments in IFS cycle 50R1 (the capability to assimilate water vapour profiles in the stratosphere) the Successful Tenderer will make the necessary adaptations to the IFS to run experiments in reanalysis mode assimilating MLS observations from (UARS and EOS-Aura) MLS for selected multi-year periods in the timeframes 2004-2023 and 1991-1993. The exact periods will be established in consultation with the C3S/ECMWF Climate Reanalysis and Data Assimilation Methodology Teams based on the status of the ERA6 production streams from 2006-2026. As for Task 1 the Successful Tenderer will evaluate differences between this experiment and the main ERA6 production run.

These experiments will use the weak-constraint formulation of 4D-Var and will produce estimates of the analysed model error. This will be used in a later task (Task 5) to derive a state-dependent predictive model of the model error which will be tested in earlier epochs and validated using early satellite sounding data.

This element will thus require close collaboration with the ECMWF Data Assimilation Methodology Team based in Reading, and the C3S/ECMWF Climate Reanalysis Team based in Bonn facilitated through three 2-3 week visiting scientist visits during 2026 and 2027 at ECMWF Reading (2) and Bonn Offices (1). Prior experience of working within the IFS is an advantage, but training will be provided to the Successful Tenderer without this experience.

Deliverables required: Tested IFS-branch and documentation on the changes implemented. A report summarising the results of the initial experiments and the assessment of the stratospheric humidity analysis relative to ERA6.

Task 4: Develop adaptations to the IFS to assimilate observations from the Nimbus-6 Pressure Modulated Radiometer (PMR).

This activity builds on ongoing developments in the (July 2025 – June 2028) C3S2_314 contract on the rescue and assessment of early satellite datasets. Part of this contract involves the development of IFS capability to assimilate PMR (passive infrared) observations, including the development and refinement of RTTOV fast model coefficient files. The work involved here additionally should involve testing the neural network model error forcing (NN-MEF) derived from the modern era experiments assimilating the SSMIS UAS channels. The aim is to evaluate the accuracy of the upper stratospheric and lower mesospheric temperature analysis in ERA6-like experiments with and without the NN-MEF applied during the period covered by PMR operations (1976 -1978). The output of this set of experiments will inform the approach to be used for next generation C3S reanalyses.

Deliverables required: A report on the experiments conducted including: an assessment of the effectiveness of the NN-MEF derived from modern era WC-4DVAr experiments in improving the USLM temperature analysis; and assessment of any identified deficiencies in the PMR observational data and/or the radiative transfer modelling of PMR.

Task 5: Develop adaptations to the IFS to assimilate observations from the Nimbus-6 and -7 limb sounding missions (LRIR, LIMS and SAMS) providing information on stratospheric humidity.

This activity builds on ongoing developments in the (July 2025 – June 2028) C3S2_314 contract on the rescue and assessment of early satellite datasets. Part of this contract involves the development, assessment and delivery of data records for L2 retrievals of stratospheric humidity derived from these instruments. A preliminary version of these datasets will be available in November 2026, and a final version in November 2027. The Successful Tenderer should aim to commence work based on the preliminary version, available by November 2026. Development work in the IFS should follow as closely as possible the scheme established for MLS L2 retrievals as established in Task 4.

The aim is to evaluate the accuracy of the stratospheric humidity analysis in ERA6-like experiments during the period covered by Nimbus-6/-7 limb sounding data (see Table 1, 1975-1983) as well as UARS MLS in the period September 1991 – April 1993. The output of this set of experiments will inform the approach to be used for next generation C3S reanalyses.

Deliverables required: A report on the experiments conducted including: an assessment of any identified deficiencies in the early limb sounding data, an assessment of the humidity fields in ERA6-like experiments in the early period covered by the limb sounding humidity observations.

Partitioning of effort across tasks

The following table presents guidelines for the distribution of the effort between the tasks (and associated work packages). To support planning and resourcing, we have included an estimated share of effort for each

task. These figures are provided as guidelines only and are intended to help Tenderers understand the relative workload and likely distribution of work across the various activities. Tenderers are free to propose their own allocation of effort, provided all requirements are adequately addressed.

WP/ Task	Guideline
Task 0 - Management & coordination	5%
Task 1 – Collate satellite and in-situ observation data	20%
Task 2 – IFS Developments & experimentation with SSMIS Upper Atmospheric Sounding observations	20%
Task 3 – IFS Developments & experimentation with MLS humidity observations	25%
Task 4 – IFS developments & experimentation with model error forcing - temperature (PMR/SCR observations)	15%
Task 5 – IFS developments & experimentation – humidity (LRIR, LIMS and SAMS)	15%

Table 3: Guideline for the distribution of effort to be devoted to the tasks.

2.3 Summary of Deliverables and Acceptance Criteria

Deliverable #	Deliverable Name	Criteria	Metric and Tolerances/ [due date]	Approving authority
C3S2_620_D1.1.1 /	**[Task 1] Input satellite observations** ([D1.1.1])	Provision of input satellite data & supporting documentation	Delivery to target schedule of both data and documents / [Start + 6 months]	C3S Technical Officer
C3S2_620_D1.1.2/	**[Task 1] Input in-situ observations data** ([D1.1.2])	Provision of input in-situ data	Delivery to target schedule of data / [Start + 9 months]	C3S Technical Officer
C3S2_620_D1.1.3/	**[Task 1] Input in-situ observations supporting documents** ([D1.1.3])	Provision of input in-situ supporting documentation	Delivery to target schedule of documents / [Start + 24 months]	C3S Technical Officer
C3S2_620_D1.1.4 /	**[Task 1] Input satellite observations** ([D1.1.4])	Provision of consolidated input satellite data & supporting documentation	Delivery to target schedule of both data and documents / [Start + 28 months]	C3S Technical Officer
C3S2_620_D2.1.1 /	**[Task 2] Develop IFS adaptations for SSMIS UAS Channels** ([D2.1.1])	Provision of tested branch & JIRA ticket in ECMWF confluence page detailing scientific testing results	Delivery to target schedule. / [Start + 12 months]	C3S Technical Officer
C3S2_620_D3.1.1 /	**[Task 3] Develop IFS adaptations for UARS and EOS-Aqua MLS L2 H2O profile retrievals.** ([D3.1.1])	Provision of tested branch & JIRA ticket in ECMWF confluence page detailing scientific testing results	Delivery to target schedule. / [Start + 12 months]	C3S Technical Officer

C3S2_620_D4.1.1	**[Task 4] Develop IFS adaptations for Nimbus-6 PMR.** ([D4.1.1])	Provision of tested branch & JIRA ticket in ECMWF confluence page detailing scientific testing results	Delivery to target schedule. / [Start + 18 months]	C3S Technical Officer
C3S2_620_D5.1.1	**[Task 5]: Develop IFS adaptations for Nimbus-6 & -7 limb sounding water vapour profiles from LRIR, LIMS and SAMS.** ([D5.1.1])	Provision of tested branch & JIRA ticket in ECMWF confluence page detailing scientific testing results	Delivery to target schedule. / [Start + 24 months]	C3S Technical Officer

Table 4: 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).

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 contract shall be in English. Unless otherwise specified the specific contract Deliverables shall be made available to ECMWF in electronic format.

3 Other 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 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.

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. **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.

3.3 Key Performance Indicators (KPIs)

The Successful Tenderer 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. The proposed KPIs shall be SMART (specific, measurable, actionable, realistic and time bound). The Successful Tenderer shall report to ECMWF on these KPIs as part of the Quarterly and Annual Implementation Reports. For C3S2_620 these should reflect the primary relevance of the datasets provided – in improving the representation of the upper stratosphere and lower mesosphere in future global reanalyses. The final set of KPIs may be refined in the contract negotiation phase and updated regularly with ECMWF during the contract.

3.4 Stakeholder Involvement

The Successful Tenderer 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.

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).

3.5 Provision of Data to the Copernicus Climate Data Store

As the primary use for the Level 1 and Level 2 satellite datasets and conventional data 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 annually. The Successful Tenderer will be granted a non-exclusive licence to use them for any purpose.

3.6 Supporting User Engagement

While user engagement and training activities are not part of the scope of ITT C3S2_620, the Successful Tenderer shall accommodate for eventual needs in providing technical and scientific expertise in support of these activities. The Successful Tenderer shall specify in the Tender 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. 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.

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 5: 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 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.
- A proposed payment plan shall be provided as part of the proposal. The payment plan shall be based on regular payments for routine services work packages and shall be based on milestones completion and associated deliverables for development related activities.
- 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 subcontractors 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 subcontractors.
- 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.

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 (eg.WP0, *cf*. template in Volume IIIB Section 4.5). 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:

WP0 Contractual Obligations Template				
#	*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 1] *YYYY being the Year n-1. Shall include:*	Annually on 15/01

			• Quarterly Implementation Report Q4 YYYY ; YYYY *being the Year n-1* • *Preliminary financial information YYYY ; YYYY being the Year n-1*	
D0.y.z-YYYY	Tenderer	Other	Annual Implementation Report YYYY [Part 2] *YYYY being the Year n-1*	Annually on 28/02
D0.y.z-YYYY	Tenderer	Report	Annual Implementation plan YYYY *YYYY being the Year n+1*	Annually on 30/09
D0.y.z	Tenderer	Report	Final report	At the end of the contract
D0.y.z-YYYY	Tenderer	Other	Copy of prime contractor's general financial statements and audit report YYYY *YYYY being the Year n-1*	Annually

Table 6: Administrative and Programmatic Deliverables

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

5 Additional information

5.1 References

[REF-1] Lambert, A., Werner, F., Read, W. G., Froidevaux, L., Schwartz, M. J., Wagner, P. A., Daffer, W. H., Livesey, N. J., Pumphrey, H. C., Manney, G. L., Santee, M. L., Valle, L. F. M., Knosp, B., Vuu, C., and Gluck, S. (2022). Version 5 Level-2 Near-Real-Time Data User Guide (Tech. Rep. JPL D-48439). Jet Propulsion Laboratory, California Institute of Technology. Available at: https://mls.jpl.nasa.gov/data/NRT-user-guide-v5.pdf

[**REF-2**] The Eole Balloon Campaign, 1971-1972, (more than 400 flights), Southern Hemisphere Data, http://dx.doi.org/10.25326/195w-y071

[**REF-3**] The Hibiscus Balloon Campaign, 2004, (6 flights), Tropics, http://dx.doi.org/10.25326/yayc-b561

[**REF-4**] The Vorcore Balloon Campaign, 2005, (27 flights), Antarctic https://doi.org/10.1175/2007JTECHA948.1

[**REF-5**] Pre-Concordiasi, 2010, (3 flights) & Concordiasi: 2010, (19 flights), Antarctic https://doi.org/10.1175/2009BAMS2764.1

[**REF-6**] Stratéole-2 (C0): 2019, 8 flights, Tropics,

https://doi.org/10.14768/7396b9ec-582f-4be2-8c37-c34ef41247a7

[**REF-7**] Stratéole-2 (C1): 2021, 17 flights, Tropics, https://doi.org/10.14768/c417e612-015d-4812-9b59-294a6570c7c3

[**REF-8**] Bonavita, M., & Laloyaux, P. (2020). Machine learning for model error inference and correction. *Journal of Advances in Modeling Earth Systems*, 12, e2020MS002232. https://doi.org/10.1029/2020MS002232

[**REF-9**] C3S, 2025: CDM-OBS-Core: An abstraction of the CDM-OBS model for data service provision via the Climate Data Store. https://confluence.ecmwf.int/x/VbGnHg

[**REF-10**] C3S Global land surface atmospheric variables from comprehensive in-situ observations version 2.0.0 data policy manifest, https://object-store.os-api.cci2.ecmwf.int/cci2-prod-catalogue/licences/global-land-observations-data-policy/global-land-observations-data-policyv2_9dcbb2c0a104e7d56a2fbbd559e0e4b3decc46d9b695496f8ebce0e7ae6c839a.pdf

[**REF-11**] C3S Global land surface atmospheric variables from comprehensive in-situ observations version 2.0.0 source inventory,

https://confluence.ecmwf.int/download/attachments/576392638/sources_v2.0.0.psv?version=1&modificationDate=1758540391538&api=v2

[**REF-12**] C3S Global land surface atmospheric variables from comprehensive in-situ observations version 2.0.0 station inventory for sub-daily observations, https://confluence.ecmwf.int/download/attachments/576392638/sources_v2.0.0.psv?version=1&modificationDate=1758540391538&api=v2

[**REF-13**] C3S, 2025: GNSS IPW: Product User Guide and Specification (PUGS), https://confluence.ecmwf.int/x/oJH-EQ

[**REF-14**] C3S, 2025: GNSS IPW: Algorithm Theoretical Basis Description (ATBD), https://confluence.ecmwf.int/x/rZH-EQ

5.2 Acronyms

ATBD	Algorithm Theoretical Basis Document
CDR	Climate Data Record
CDS	Climate Data Store
C3S	Copernicus Climate Change Service
CM SAF	EUMETSAT Climate Monitoring-Satellite Application Facility
DMSP	Defense Meteorological Satellite Program
ECMWF	European Centre for Medium-Range Weather Forecasts
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FCDR	Fundamental Climate Data Record
ITT	Invitation to Tender
MOOC	Massive Open Online Course
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NOAA CLASS	NOAA Comprehensive Large Array-data Stewardship System
NWP SAF	EUMETSAT Numerical Weather Prediction Satellite Application Facility
PMR	Pressure Modulator Radiometer
RT	Radiative Transfer
RTTOV	Radiative Transfer for TOVS
SSMIS	Special Sensor Microwave - Imager/Sounder
SSU	Stratospheric Sounding Unit