



Invitation to Tender

Destination Earth Programme

Destination Earth Adaptation Modelling Framework

Volume II

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1. Introduction

Destination Earth (DestinE) is an initiative of the European Commission under the EU Digital Europe programme [RD1]. By pushing the limits of computing, weather and climate sciences, DestinE is a cornerstone of the European Commission's efforts to boost Europe's digital capabilities and the Green Deal actions on climate change and to prevent environmental degradation. It aims at supporting climate change adaptation policies and decision-making for reducing the impacts of extremes.

DestinE will deploy several highly accurate thematic digital replicas (digital twins) of the Earth system to monitor and simulate natural and human activities as well as their interactions, to develop and test scenarios that would enable more sustainable developments and support European policy making. DestinE is intended to unlock the potential of observations and both physics-based and data-driven models for achieving a breakthrough in the resolution and realism of the simulation of Earth-system components.

The European Centre for Medium-Range Weather Forecast (ECMWF) implements two high-priority digital twins for DestinE – one on climate change adaptation and one on weather-induced and geophysical extremes. These are developing enhanced simulation systems, informed by observations, based on a new generation of Earth system models. These enhanced systems will not only allow to more realistically represent the Earth system but will also produce information at precisely those scales where the impact of climate change and extremes are felt and where key processes are observed thus allowing users from impact-sectors to access and exploit such information for their specific application.

Rooted in both the European Commission's Green Deal and the Digital Strategies, DestinE will contribute to solving a range of societal challenges in Europe and globally. A prerequisite for success of DestinE will be the effective guidance of its orientation, development and implementation by the needs and requirements of user groups. For the first phase of DestinE the European Commission has determined that public policy user groups should be prioritized in this context.

The EU strategy on adaptation to climate change¹, adopted in February 2021, emphasises the importance of adaptation modelling and the need to advance on adaptation modelling, risk assessment and management tools, and on dissemination, notably building on the Climate-ADAPT platform as a reference for knowledge on climate adaptation [RD2]. The strategy identifies the Digital Europe programme, which includes DestinE, as an instrument to close knowledge gaps on climate impacts and resilience and the mainstreaming of climate adaptation into macro-fiscal policy, nature-based solutions for adaptation, and local adaptation action.

The European Environment Agency (EEA) has been tasked by the Commission to support the implementation of the EU Adaptation Strategy. In particular, EEA implements and evolves the Climate-ADAPT platform and prepares the European Climate Risk Assessment mandated by the EU Adaptation Strategy. EEA seeks to expand Climate-ADAPT by further interactive tools to support the design and monitoring of adaptation actions at different levels. This includes simulation tools to understand the impact, including economic, environmental, health and other impacts and considering any resulting regional or social equalities.

1.1. Definitions

General definitions can be found in Volume I. Definitions specific for this Invitation to Tender (ITT) are given below. For a general DestinE glossary please refer to [RD3].

Application: An action, information product, or service, which makes use of one or more DestinE DT services or outputs as an input.

¹ https://climate.ec.europa.eu/eu-action/adaptation-climate-change/eu-adaptation-strategy_en#tab-0-2

Digital Twin (DT): Actionable digital representation of a physical system (for DestinE: in the context of an Earth system approach to extremes and climate change adaptation) that simulates the system behaviour at temporal and spatial scales relevant to decision-making in target sectors. A Digital Twin combines Earth-system models and Earth observations as well as advanced data analytics to monitor and predict environmental change, test scientific hypotheses and help to define adaptation scenarios. A DT is a self-standing DestinE system component offering a seamless production service of actionable knowledge for users that results from the fusion of observational and simulated data (from the physical Earth system to the impacts of change on relevant assets). Users interact with digital twins at different levels: where primary simulation-observation data are generated and combined, where such data can be accessed and upgraded with user specific models, tools and data to create user specific information, and where such information is turned into decision and policy making.

Impact Sector: Policy domain in which the outputs of the DT are expected to enhance the ability to predict the effects of different policy scenarios and support the implementation of policies. Possible impact sectors include, for example, water management, agriculture and forestry, renewable energy management, air quality management, urban development, maritime or air transport, biodiversity protection, disaster risk mitigation, and climate impact assessments.

Service: Provision of technological capabilities, resources, methodologies, data and tools, including their management across a variety of digital infrastructures. DestinE handles and innovates complex workflows related to Earth system information generation and delivery, facilitates the management of complex monitoring, prediction and projection systems, and makes components available for use in different digital contexts to enable rich interaction in the wider digital environment. The services developed and implemented by DestinE provide free and open access to tools, software and platforms.

Users: Institutions or individuals interacting with the DestinE core Service Platform (DESP), Data Lake (DEDL) and/or a DT, thus exploiting DestinE capabilities, output products or services to achieve their objectives. These may include researchers, agencies implementing policies, or more generally civil society (companies, media, NGO, etc.). DestinE user institutions ingest DestinE output data for further processing in their own applications. These are typically expert users, e.g. in research, national hydro-meteorological services or environment agencies. DestinE is initially aimed at professional public sector users but is planned to evolve to encompass a wider user base including the scientific communities and the private sector.

2. Background

2.1. DestinE structure and implementation

DestinE is funded by the European Union's Digital Europe programme and is implemented through a partnership between ECMWF, ESA, and EUMETSAT. The objective of this initiative is to develop – on a global scale – a highly accurate digital model of the Earth to monitor and predict the interaction between natural phenomena and human activities. In doing so, DestinE supports the European Union in achieving sustainable development objectives and contributes to the Green Deal and Digital Strategies.

The entities implementing DestinE coordinate their efforts on the development of use cases and demonstrators. The goal of this effort is to support the implementation of complementary and collaborative projects. Proposals submitted in response to this tender should dedicate resources for the coordination with related projects funded by other entities in DestinE.

The first phase of DestinE, the implementation phase 1, covers the period 15 December 2021 – 14 June 2024. In this phase, the main building blocks of the infrastructure required to reach DestinE's ambitious goals are configured and deployed and their capability demonstrated:

- The DestinE core Service Platform (DESP; responsibility ESA) for providing a large number of users with access to observations, simulations and models, evidence-based policy and decision-making tools, applications and services, based on an open, flexible, scalable and evolvable secure cloud-based architecture.
- The DestinE Data Lake (DEDL; responsibility EUMETSAT) for handling the storage and access requirements for any input and output DestinE data that is offered to DestinE users via seamless access through the DESP including near-data processing to maximize throughput and service scalability.
- The Digital Twin Engine (DTE; responsibility ECMWF) consisting of generic software infrastructures for extreme-scale simulation and data fusion, data handling and machine learning that allow exploiting the latest digital infrastructure technology for operating Earth-system digital twins.
- The two high-priority Digital Twins (DTs; responsibility ECMWF) for generating high-quality simulations and combining simulations and observations of the Earth system at unprecedented accuracy to serve the EU's Green Deal policy priorities:
 - Weather-induced and geophysical extremes DT for providing capabilities for the assessment and prediction of environmental extremes at very high spatial resolution and close to real-time decision-making support at continental, country, coastline, catchment and city scales in response to meteorological, hydrological and air quality extremes.
 - Climate change adaptation DT for providing capabilities to support climate adaptation policy and scenario testing at multi-decadal timescales aiming at a real breakthrough at the level of reliability at regional and national levels.

Already during the first phase of DestinE a number of use cases are realized, which demonstrate how DestinE may be used for different applications [RD4]. Examples include the applications in hydrology, renewable energy production and energy system modelling, air quality and urban heat extremes, among others.

In the following phases of DestinE, these building blocks will further evolve to enhance capabilities, add further thematic foci, ingest the latest scientific developments and observational information, and make use of the emerging digital infrastructure ecosystem supported by the Digital Europe programme in Europe.

The present ITT only relates to ECMWF's contribution to DestinE.

2.2. DestinE DT capabilities

During phase 1 of DestinE, ECMWF and its contractors are establishing the two high-priority DT, on weather-induced extremes and on climate change adaptation.

The DT on weather-induced extremes will support decision-making at continental, country, coastline, catchment and city scales in response to meteorological, hydrological and air quality extremes. It aims to combine global with configurable (in terms of geographical extent, spatial resolution, temporal refresh and coverage, model components, boundary conditions, data assimilation), on-demand regional weather, hydrology and air-quality simulation and observation capabilities to drive user defined applications. The DT output will include meteorological variables (notably the ECMWF open data [RD5], e.g., air pressure, temperature, wind, humidity, atmospheric water content, clouds, precipitation, solar and thermal radiation) and represent kilometre scales or finer, produce predictions up to 5 days ahead and have (sub-) hourly data sampling.

The DT on climate change adaptation will deliver globally coupled Earth-system simulations at a qualitatively new level of resolution and interactivity. The DT will produce multi-decadal (up to 2040/2050), (4-5) kilometre scale numerical Earth-system simulations from two separate modelling systems, namely the

ECMWF Integrated Forecasting System² and the ICON³. The DT will provide selected model output variables characterising the evolution of the different Earth-system components. An observation-based assessment framework for the purpose of Earth-system model assessment and uncertainty quantification will be part of this DT. For selected time slices, the DT on climate change adaptation will also generate ensemble simulations to assess extremes.

Both DT will already include elements of co-design with component models from impact sectors such as water management, agriculture and forestry, renewable energy management, air quality management, or disaster risk mitigation to demonstrate the benefit of the advanced DT framework for weather induced extremes and climate change adaptation-related policy and decision making. DT design and data output therefore prepare for the integration of further application-oriented use-case components and value adding. The configurations of the two DT are currently being developed and will be finalized by the end of phase 1.

An initial data portfolio of DestinE is included in Annex to this tender. This includes output data from the DT and other relevant data needed by DestinE services.

Technical information on the interfaces provided by the Digital Twin Engine is available in [RD6].

2.3. DestinE partnership with the European Environment Agency

The implementing entities of DestinE (ECMWF, together with ESA and EUMETSAT) are establishing a broad and continuous dialogue with users and other stakeholders, including from ECMWF and EU member states, to guide the implementation and evolution of DestinE. EEA has been identified as a key partner with potential to help develop DestinE to support critical European policy needs.

EEA has identified the need for an appropriate adaptation framework where it would be necessary to include adaptation or resilience metrics and policy user requests. ECMWF intends to involve EEA in guiding the work performed under the contracts resulting from this tender to ensure maximum alignment with EEA tasks under the EU Adaptation Strategy.

2.4. Related activities and projects

The activity benefits from other initiatives, past and present, though no formal dependencies are foreseen between the contracts concluded under this tender and these other activities.

ECMWF is realising a number of DestinE use cases for different impact sectors, including renewable energy, air quality, and flood risk management as well as flood risk assessment [RD4].

ECMWF has also been realising a collection of use cases and demonstrators in the context of its Copernicus activities [RD7, RD8].

Similarly, ESA has conducted a series of activities as precursors to DestinE and potential future ESA programmes, both on thematic and technology aspects, including on climate impact, forestry, food systems, hydrology, Antarctica, ocean and the Alps, and is planning to implement a number of use cases for DestinE starting in 2023.

The EU Mission on Adaptation to Climate Change [RD9] aims at supporting more than 175 EU regions, cities and local authorities in their efforts to build resilience against the impacts of climate change. A range of activities, including the expansion of Climate-ADAPT and projects funded under the Horizon Europe framework programme, support the implementation of this mission.

² <https://www.ecmwf.int/en/research/modelling-and-prediction>

³ <https://code.mpimet.mpg.de/projects/iconpublic>

2.5. Reference resources

- [RD1] Destination Earth websites of the Commission and joint DestinE website <https://digital-strategy.ec.europa.eu/en/policies/destination-earth>
<https://www.destination-earth.eu> (expected to go online end of March 2023)
- [RD2] Climate ADAPT platform (<https://climate-adapt.eea.europa.eu/>)
- [RD3] ECMWF Destination Earth Glossary <https://stories.ecmwf.int/destination-earth-glossary/>
<https://www.ecmwf.int/en/about/what-we-do/environmental-services-and-future-vision/destination-earth>
- [RD4] ECMWF Destination Earth webpages <https://www.ecmwf.int/en/about/what-we-do/environmental-services-and-future-vision/destination-earth> and <https://stories.ecmwf.int/destination-earth/>
- [RD5] Open data at ECMWF <https://www.ecmwf.int/en/forecasts/datasets/open-data>
- [RD6] Documentation for Digital Twin Engine: <https://digital-twin-engine.readthedocs.io/en/latest/#documentation>
- [RD7] Sectoral impacts of the Copernicus Climate Change Service <https://climate.copernicus.eu/sectoral-impacts>
- [RD8] Use cases of the Copernicus Atmosphere Monitoring Service <https://atmosphere.copernicus.eu/use-cases>
- [RD9] EU Mission on Adaptation to Climate Change https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/adaptation-climate-change_en
- [RD10] Climate ADAPT Country Profiles <https://climate-adapt.eea.europa.eu/en/countries-regions/countries>
- [RD11] Climate ADAPT Adaptation Support Tool <https://climate-adapt.eea.europa.eu/en/knowledge/tools/adaptation-support-tool>
- [RD12] Climate ADAPT Economic losses and fatalities from weather- and climate-related events in Europe <https://climate-adapt.eea.europa.eu/en/knowledge/economic-losses/economic-losses-on-weather/>

3. Contract summary

This tender aims at placing two separate contracts to develop a framework for adaptation modelling under climate change in the context of DestinE. Under each of the contracts a demonstrator shall be conceptualized and implemented for one specific adaptation domain. One contract (lot 1) will focus on flood risk management, with a focus on prevention, mitigation and recovery strategies. The second contract (lot 2) will focus on the heat stress under climate change scenarios, with a focus on public health management. Both contracts will both contribute to developing a common adaptation modelling framework for DestinE, and at the same time demonstrate its implementation for the two specific domains of the lots.

Each of the contracts shall deliver an interactive tool that supports decision-makers in investigating different adaptation options, to be co-designed with a representative group of users. These tools shall exploit the capabilities provided by the Digital Twin on Climate Change Adaptation, implemented under contract of ECMWF. They are also expected to rely on data and services available to the decision makers

involved. These data may include, for example, data and services in the Copernicus Climate and Atmospheric Data Store (CADS) and other Copernicus Services (notably the Land Monitoring Service, Emergency Management Service and Marine Service) or information compiled by the European Environment Agency (EEA) in the Climate-ADAPT platform, which is the EU Knowledge portal on Adaptation [RD2].

Existing developments and use cases, notably the use cases included in the developments of the Digital Twins and other activities contracted by ECMWF [RD4] shall be considered as relevant context and appropriate linkages and coordination with these activities shall be foreseen. It is expected that the contracts to be funded under this ITT will focus on adaptation modelling, the support of storyline analyses and will engage further users.

Each contract shall identify and simulate specific story lines for adaptation , quantify the costs of these and define needs and suggestions for potential future projections by the Earth System models in DT Climate.

Both contracts shall contribute to jointly defining a generic adaptation modelling framework that can be implemented successively starting in Phase 2 of DestinE. They shall also include stakeholder engagement activities to ensure that both the demonstrators and the framework will be relevant to a larger group of potential users.

Criteria for selection will be the technical capacity of the tenderer to implement the demonstrator, the credibility of the user scenario and user involvement.

The contracts will also serve to guide the further evolution and development of DestinE in future phases. Successful tenderers will therefore be expected to contribute to relevant workshops and requirement definitions, including at technical level.

Two separate contracts are foreseen, each of them led by one prime contractor, which may engage with one or more subcontractors. Tenderers may submit more than one bid, but both lots will not be awarded to the same bidders.

Any bid shall include a contractual option to cover the coordination effort for preparing the adaptation modelling framework. This will be contracted by ECMWF only for one of the lots.

ECMWF expects the two contracts to cumulatively not exceed a maximum total price of €450,000, with each lot having a maximum total price of €200,000 excluding the mandatory option.

Tenders will be technically assessed in two parts. Part 1: the Lot excluding the mandatory option. Part 2: the mandatory option inclusive of any WPO related effort and costs. Each Lot/option will be awarded to the highest scoring Tenderer under the respective Lot/option. Elements such as budget availability and overall value for money will be taken into account when awarding the option.

4. Technical specification

This ITT addresses Tenderers that develop interactive technical solutions to support policy decisions on adaptation choices in the domains of

Lot 1: Flood risk management (with a focus on prevention, mitigation and recovery strategies), and

Lot 2: Heat stress exposure (with a focus on public health management).

Solutions developed must integrate with DestinE System Components and exploit the novel data, services and capabilities of the DestinE DT Climate Change Adaptation [RD6].

Specific key deliverables for each contract are:

- A. A report describing the adaptation challenge in the sector (lot 1: flood risk management, lot 2: heat stress exposure) and corresponding relevant adaptation options;

- B. A technical design specification (document);
- C. An interactive demonstrator implementation (software and corresponding documentation);
- D. Adaptation Modelling Framework for DestinE (document)

These are described in detail in subsections 4.1-4.4. In addition to these deliverables, successful Tenderers will be required to engage with targeted users and their wider user communities, contribute to requirement definition, and communication activities of DestinE.

Please refer to section 4.6 for further expected deliverables for the contracts.

Bidders should explain in sufficient detail how they will develop their work toward delivering the technical elements on the deliverables specified below.

4.1. Report on the Adaptation Challenge and relevant adaptation options

The report should set out the climate change related issue and corresponding adaptation options and pathways that are considered and discussed in the specific sector. This shall be developed more generally in the Adaptation Modelling Framework (see below, 4.4). It shall describe the institutions tasked with developing, conceiving, deciding on, planning and implementing adaptation measures related to the climate change impact (i.e., flood risk or heat-stress related impacts). The report shall describe the main adaptation options considered and define those that will be simulated in the demonstrator to be developed.

Where possible and meaningful, the report shall identify needs or requirements for future configurations of DT Climate that might support the optimal assessment of the adaptation options that are considered. These might relate to time periods of interest, parameters, climate scenarios, quality indicators, etc.

Targeted users and demonstrated adaptation modelling should focus on the European Union, its Member States, or regions within them, excluding overseas territories. Tenderers are encouraged to connect to relevant other ongoing activities at European, national and sub-national levels, e.g. ongoing activities in the context of the EU Mission on Climate Adaptation, under DestinE, Copernicus or Horizon Europe, and define corresponding synergies, as appropriate [RD9, RD10]. Connections should be made to relevant networks and communities of practice and European regions involved in other activities under the EU Mission.

The report shall also describe how cost of actions can be compared to costs of inaction in order to support the decisions on different adaptation options or pathways in a quantifiable and comparable way. Noted that there is no currently agreed methodology in place, the contractor should propose the most suitable methodology considering the following:

- the effects of the most significant climate hazards (also multi-hazards or compounds) in the region, on which action should be taken in the specific domain, should be included.
- The adaptation options proposed are in line with already existing options in the regions [RD10]. Co-benefits and tradeoffs must be properly analysed.
- The adaptation options should include at least three options covering the domains of nature-based solutions (NBS), technical/engineering (e.g., dikes) and soft measures (early warning systems)

The report shall present a story-line on how the users are expected to use the demonstrator and how they would benefit from the specific new capabilities provided by DestinE, including specifically how this will improve on the status quo.

The report shall identify known needs and requirements by users that must be considered in developing and assessing adaptation options. Such needs could be at technical level, but also qualitatively, where quantitative requirements are not understood sufficiently. Such requirements are expected to include information content, time and spatial coverage, timeliness, format, interactivity, presentation, accuracy

and quality of the cost estimates and underlying physical models. These should be refined further during the contract duration.

Tenderers should outline the challenge and prevalence as well as key stakeholders in their offer. The offer should also explain the intended work to substantiate this, which may include further specification of user needs and desk research on approaches and stakeholders. The offer should also discuss the approach taken towards selecting a suitable valuation/comparison methodology.

4.2. Technical Design Specification

Successful Tenderers shall deliver a document defining the technical design of an interactive demonstrator to be developed under the contract (see next section). That demonstrator shall be an interactive web application to be run on DESP and that could be run potentially elsewhere. This demonstrator shall implement the approach described in the Report on the Adaptation Challenge (see previous section), which shall be aligned with the needs of the user.

Specifically, the Technical Design Specification

- Sets out the adaptation scenario storylines implemented in the demonstrator
- Defines the required input data and information specifications including their sources and interfaces. Note that these are expected to include both,
 - output products of the DT Climate, and
 - other data, e.g. data available from the [Copernicus Climate and Atmospheric Data Store](#) or data provided by the users themselves, including socio-economic data.

The bid should list sources, available quality indicators, and access provision of all required data. Since the DT Climate output data are only expected to become available during the period of the contract, the design shall foresee the use of existing data for the initial development, e.g. available via the Copernicus Climate and Atmospheric Data Store, the Global Flood Forecasting System or the European Flood Awareness System, both provided in the context of the Copernicus Emergency Management Service.

- Defines the analytical and modelling methodologies that will be implemented for the demonstrator to run the adaptation scenarios. Tenderers shall define clearly in the bid, which software components exist and which will need to be newly developed or adapted.
- Defines an approach for the valuation of different adaptation options or pathways to be explored, i.e.
 - How will the cost/impact and benefits of different options or pathways be measured and compared?
 - What benchmark will be used for a valid reference for today's climate and non-action?

A relevant benchmark may be, for example, selected for regions with sufficiently documented past events, where subsequent adaptation measures taken have led to corresponding changes in impact of later events. The Climate-ADAPT platform provides data that may be useful in this context [RD10]. Tenderers are also encouraged to suggest any relevant data source available to them to define the benchmark. Any data necessary for this approach should be available for use in the demonstrator and must be identified already in the bid.

- Defines the user interface and any integration with existing interfaces already in use at the users.
- Specifies the technical requirements that must be met to satisfy the needs of users for supporting their decision-making, including infrastructural capability and service provision requirements.
- Defines the output data, metadata and services, including how these are accessed by users.

- Defines performance indicators for the demonstrator, including, but not limited to, indicators on timeliness, throughput, robustness, availability. These indicators shall reflect the needs and requirements of the users.
- Defines uncertainty quantification and quality indicators to be applied.
- Provides an analysis of operational feasibility within the context of DestinE with a particular focus on software and processes, as well as a roadmap for implementation.

Where the demonstrator has specific requirements on interfaces and functionalities of DestinE, these shall be discussed with ECMWF.

The technical design will be the reference for the demonstrator to be implemented under this contract (see following subsection) by the successful Tenderers.

A Technical Design Specification document must be delivered by the successful Tenderers.

4.3. An interactive demonstrator implementation

The successful Tenderers are expected to deliver a fully functional implementation of the demonstrator based on the accepted Technical Design Specification. Since the DT Climate is being developed in parallel there is a risk that the interfaces to DT Climate may not be fully available or operational for this implementation. This risk should be considered and managed by successful Tenderers in their work.

To the extent possible the implementation shall be based on open-source software and be managed as an open-source project on a public repository (e.g., on GitHub, GitLab, etc.), and hosted under a dedicated domain to be identified by ECMWF. The possibility to host the demonstrator also on Climate-ADAPT shall also be foreseen [RD11]. Where the Tenderers intend to use proprietary software or data with licenses restricting the use of the software or output, this must be agreed specifically with ECMWF, since it may impede the continued development, extension and exploitation of the results in the future evolution of DestinE.

The implementation shall be developed and tested on systems and infrastructures available to the Tenderers, which may include available resources, e.g. on the Copernicus DIAS or other platforms for hosted processing close to large relevant data holdings. The resources and their present use by the Tenderers shall be described.

The implementation shall be reproducible by ECMWF and the required software and required data shall be delivered to ECMWF, including any required licenses (cf. section 5.5 of this Volume II).

An Implementation Report documenting the full implementation of the demonstrator shall be delivered by the successful Tenderers.

4.4. Adaptation Modelling Framework for DestinE

The successful Tenderers shall develop a generic Adaptation Modelling Framework for DestinE. This framework shall

- a) Describe the need for adaptation modelling in different domains, outline the policy context, relevant decision makers;
- b) Outline relevant usage scenarios for DestinE;
- c) Define data, information and service needs that could potentially be supported by DestinE capabilities, including relevant quality requirements (timeliness, reliability, uncertainty, etc.);
- d) Identify data, information and service input needed for the usage scenarios and the availability of those. This will generally include both physical parameters and socio-economic data;
- e) Specify needs and requirements for future configurations of the DT Climate Earth System Models that would best support adaptation modelling in the different domains;

- f) Specify interfaces and tools to be supported – both any that may already be in use in institutions and those that would need to be developed.

The framework shall include and build on a **substantial engagement activity and interactions with EEA** and other key stakeholders (see following section). This framework shall draw on experience of implementing the concrete adaptation modelling demonstrators on flood risk and heat impacts, which at the same time are expected to be examples for application of this framework. Stakeholders from related developments in DestinE and beyond should be involved and invited to contribute. These developments notably include the applications/use cases realized in the framework of the activities funded under ECMWF contracts realizing the DT on-demand Extremes, DT Climate Change, and the use case contracts on urban heat stress and compound flood risk mitigation and climate adaptation ([RD4]).

Tenderers should explain the approach to engaging relevant stakeholders in defining the framework in their offer. This is expected to include a combination of desk research, workshops and potentially interviews and surveys with selected stakeholders. Credibility and effectiveness of this engagement will be an important selection criterion.

A document outlining an Adaptation Modelling Framework for DestinE shall be delivered, which may then be used to guide future developments in DestinE.

4.5. User engagement and communication

Broad user communities must contribute effectively to define an adaptation modelling framework that is general enough to serve broad user communities in the future. Also, the demonstrators for adaptation modelling developed under the contracts foreseen can become compelling examples of how DestinE supports decision making in the context of climate change adaptation.

The Tenderers are therefore expected to include effective user engagement as part of their work. They are further expected to support ECMWF and the European Commission in overarching DestinE user engagement and communication activities. To this end, successful Tenderers will be required to:

- Support workshops and other events organized by ECMWF, the Commission or other parties by presenting their work;
- Advertise the demonstrators in relevant fora and communications (publications, websites, newsletters, social media, workshops, conferences, etc.) within the relevant sectors;
- Contribute to the ECMWF and European Commission communication work on DestinE as required.

Specifically, the successful Tenderers shall deliver at a minimum:

- A description/story map of the demonstrator suitable for presentation on the web, including text and visuals (updated regularly);
- Presentation material on the demonstrator and the progress on developing the adaptation framework to be maintained up-to-date over the duration of the contract;
- Regular posts on/for relevant social media channels within the impact sector;
- A short video presentation of the demonstrator for inclusion on a DestinE web presence.

A plan for community engagement and communication activities carried out by the Tenderers shall be included in the proposal. An initial version will be agreed with ECMWF during negotiation and will form part of the contract. The implementation of this plan and any subsequent update will need to be agreed with ECMWF on a regular basis during the contract implementation. This includes, but does not exhaustively cover, communication planning, contributions to DestinE media outreach, websites and social media activity, externally facing written and graphical contents and events.

4.6. Deliverables and milestones

At a minimum the successful Tenderers are expected to deliver:

Deliverable	Section reference	Format	Due
Report on the adaptation challenge and relevant adaptation options	4.1	Document	KO + 3 months
A Technical Design Specification	4.2	Document	KO + 6 months
Interactive demonstrator implementation	4.3.	Software, data access, and corresponding documentation	KO + 14 months
Implementation report	4.3	Document	KO + 14 months
Contributions to a Adaptation Modeling Framework for DestinE	4.4	Contributions to document	KO + 16 months
<i>(mandatory option)</i> Adaptation Modelling Framework	4.4	Document	Outline: KO + 6 Final draft: KO + 16 months Final: KO + 17 months
Communication material to support ECMWF communication: <ul style="list-style-type: none"> – Website content – Presentation – Social media content – Video 	4.5	text and visuals ppt or compatible posts	KO + 1 months (plus updates every 3 months) KO (plus regular updates, as needed) Regular

Further deliverables may be defined by the Tenderer based on the requirements above. The Tenderer is encouraged to limit the number of any further deliverables and milestones to a reasonable amount so that their preparation, review and revision remains manageable.

Each deliverable shall have an associated resource allocation (person-months and financial budget). The total of these allocated resources shall amount to the requested budget associated with payroll as detailed in Volume IIIA of this ITT.

Milestones should be designed as markers of demonstrable progress in capability development and/or quality of capability delivery, as applicable. They should not duplicate deliverables and should not have any cost associated to them.

5. General requirements

5.1. Implementation schedule

ECMWF intends to award two contracts for a maximum duration of 18 months each, expected to commence by August 2023.

The Tenderer is expected to provide a detailed schedule as part of the tender response. The proposed schedule shall address the main tasks, milestones and deliverables. Regular progress meetings will be held with ECMWF during the contract to assess contract status, risks and actions. A perspective on possible future developments beyond the contracted period is also highly desirable.

5.2. Meetings

5.2.1. Physical / face-to-face meetings

A kick-off meeting will be held at ECMWF premises in Bonn no later than one month after contract signature. Key personnel from the successful Tenderers should plan on being there, while additional people could attend via web-conference if necessary.

At least one physical progress meeting shall be foreseen in the offer at an advanced stage of implementation (indicatively, KO+12). The location of this meeting will be agreed between ECMWF and the contractor, preferably at the premises of EEA (Copenhagen) or a targeted user institution.

A final meeting shall also be foreseen at the end of the contract. ECMWF may decide to combine the final meeting with meetings of related contracts in the frame of a larger event.

To the extent this can be organized efficiently, these physical meetings should be coordinated between the two lots.

Tenderers should also foresee active participation in at least three relevant physical events over the duration of the contract in the DestinE context. This must include participation in the DestinE User eXchange meetings, which should be assumed to take place in November 2023 (Bonn) and Q3/2024 (Brussels).

5.2.2. Regular meetings by web-conference

The successful Tenderers are expected to organize monthly progress meetings by videoconference, prepare corresponding summary minutes of these meetings and maintain a list of agreed actions and their status.

Successful Tenderers may also be invited to contribute to additional technical working groups on issues relating to the requirements and evolution of DestinE. These are expected to be held generally by web-conference.

5.3. Documents and reports

All project reports shall be produced in English. Unless otherwise specified in the specific contract, deliverables shall be made available to ECMWF in electronic format (Microsoft Word/PDF/Microsoft Excel or compatible), via the DestinE Deliverables Repository portal; the details will be agreed at the negotiation stage.

Please refer to Clause 2.3 and the Annex 5 of the Volume V Agreement for details on Reporting Obligations.

5.4. Graphical material and content for communication

All content shall be produced at least in English, unless specifically agreed by ECMWF. Additional languages may be used if justified. The successful Tenderers shall ensure that all material (text, visuals, videos, etc.) is duly licensed for use by ECMWF and the European Commission.

Outreach activities will be organised by ECMWF during the period of the contract. In such instances, the successful Tenderers will be approached by ECMWF for support on developing and delivering contents.

Successful Tenderers shall not establish their own brand for the selected demonstrators but rely on and use DestinE and ECMWF pre-defined wording and branding. A communications package (including guidelines, logos and templates) will be provided by ECMWF at the start of the contract.

5.5. Data and IPR

It is a condition of EU funding for DestinE that the ownership of any deliverable (as defined in Volume V Agreement) developed with DestinE funding passes from the suppliers to the European Union via ECMWF. Ownership will pass from the date of the creation of the deliverable.

All pre-existing materials (e.g. software and products) used by the contractor to produce the DestinE deliverables will remain the property of the successful Tenderer. The successful Tenderers will have to provide a royalty-free, non-exclusive, worldwide, perpetual and irrevocable license to those pre-existing materials to the European Union and ECMWF.

Developments or modifications to pre-existing materials which constitute deliverables and are acquired or created specifically for DestinE purposes will be owned by the European Union. The pre-existing materials upon which these deliverables are based will be licensed to the Union unless there is an agreement on the transfer of ownership to the European Union.

Upon request, suppliers may be granted a non-exclusive licence, at the discretion of ECMWF and subject to the approval by the European Commission, to use the deliverables which they have provided to ECMWF.

6. 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.

6.1. Page limits

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

<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>	1 (excluding Table 1 in Volume IIIB and CVs with a maximum length of 2 pages each)
<i>Technical Solution Proposed</i>	10 (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>	4 (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 1: Page limits

6.2. Specific additional instructions for the Tenderer’s response

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

6.2.1. Executive summary

The Tenderer shall provide an executive summary of the proposal, describing the objectives, team and summarising the proposed technical solution, user engagement and capability demonstration.

6.2.2. Track record

The Tenderer shall demonstrate for themselves and for any proposed subcontractors that they have experience and knowledge relevant for the proposed solution. This includes experience in relevant projects in the public or private sector at national or international level as well as engagement with – and access to – relevant user communities in the targeted impact sector of the use case.

User institutions that are part of the bid shall describe their mandates and roles, including in formal and informal impact sector fora.

ECMWF may ask for evidence of performance in the form of certificates issued or countersigned by the competent authority.

6.2.3. Quality of resources to be deployed

The Tenderer shall propose a team providing the skills required for developing, demonstrating and evaluating the solutions complying with technical requirements set out in Section 4. The team shall include a dedicated Project Manager with experience in the technical management of similar-size projects. The Tenderer shall describe the experience of the Project Manager and the technical project team in performing activities related to all aspects of this tender.

6.2.4. Technical solution proposed

The Tenderer shall give an introduction to demonstrate their understanding of the DestinE context and the specific requirements of this tender.

The Tenderer shall describe the objective of the demonstrator, relevant policy context, define the user groups involved and specify the addressable adaptation needs in the impact sector.

A separate sub-section shall include a particular focus on complementarity to existing Services, notably in the context of Copernicus and relevant national services.

This section shall describe the proposed technical solution and identify the qualitative and quantitative improvements expected from DestinE for developing climate adaptation measures.

A separate sub-section shall be included on user engagement to describe how the Tenderers will ensure effective links with relevant user communities. This should further contain a perspective on how the adaptation modelling framework could benefit user communities beyond the end of the contract.

This section shall also include information on other third-party suppliers that are proposed for delivering the technical solution.

6.2.5. Management and implementation plan

The Tenderer shall provide a detailed implementation plan of proposed activities for the duration of the contract. Deliverables should be consistent with the technical requirements specified in Section 4.

The Tenderer is requested to include management and implementation activities within a dedicated work package (WPO). The number of milestones is not prescribed, but they should be designed as markers of demonstrable progress in capabilities development and/or quality of capability delivery to keep progress monitoring manageable.

Adjustments to the proposed implementation plan can be proposed by the successful Tenderer during the course of the contract, but must be agreed to by ECMWF.

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

- Semestrial, annual and final reports shall be provided in accordance with the Volume V Agreement Clause 2.3 and Annex 5.
- An annual work plan is expected to be agreed at negotiation for 2023. The work plan for 2024 shall be provided in August 2023.
- Monthly video-conferencing with ECMWF and a proposal for involvement of ECMWF in major project reviews shall be provided as part of the management plan. The contractor is responsible for the organisation of such meetings, including provision of minutes and maintaining a list of agreed actions.

- If relevant, a list of sub-contractors and details of their contribution, key technical personnel involved in the contract, legal names and addresses shall be provided. The Tenderer shall describe how the Volume V Agreement, in particular Clause 2.9, has been communicated to all their sub-contractors.
- The Tenderer shall describe in the Proposal the management of personal data and how this meets the requirements of Clause 2.8 and Annex 6 of Volume V Agreement.

The table below provides the template to be used by the Tenderer to describe the complete list of deliverables, milestones and schedules for this work package. All milestones and deliverables shall be numbered as indicated. All document deliverables shall be periodically updated and versioned as described in the table. Tenderers shall provide preliminary versions of the completed tables as part of their bid.

Deliverables for this work package shall include the following reports:

WP0 Contractual Obligations Template			
#	Nature	Title	Due
D0.y.z-YYYY	Report	Semestrial Implementation Report (January-June YYYY) YYYY being the Year n This includes a specific Financial Report	Annually on 15/07
D0.y.z-YYYY	Report	Annual Implementation Report YYYY YYYY being the Year n-1 This includes a specific Financial Report	Annually on 15/01
D0.y.z	Report	Final Implementation Report	60 days after end of contract
D0.y.z-YYYY	Report	Annual Work Plan YYYY YYYY being the Year n+1	Annually on 31/08
D0.y.z-YYYY	Other	Copy of prime contractor's general financial statements and audit report YYYY, YYYY being the Year n-1	Annually (no-cost associated)

6.2.6. Key performance indicators

The successful Tenderers shall report to ECMWF on a set of Key Performance Indicators (KPIs) and performance targets for the activities covered by this ITT and taking the requirements described above into account. The KPIs and performance targets, to be proposed by the Tenderer in the bid, will be agreed in contract negotiation and may be updated by mutual agreement, if necessary.

KPI shall be measurable indicators on the key outputs of the work. The shall include

KPI name	Means of verification	Target	reported
Technical			
Design meets user requirements	Feedback from users, including EEA	Achieved	Technical Design document due date
Demonstrator functional verification successful	Implementation report documents successful testing and documents alignment with requirements	Successful testing	Demonstrator due date
Demonstrator uses DestinE APIs to retrieve DT Climate output	Implementation report	Achieved	Demonstrator due date

Socio-economic dataset used in demonstrator	Implementation report	To be proposed by Tenderer	Demonstrator due date
User satisfaction	User feedback collected	Positive feedback from users	End of the contract

User engagement

Number of stakeholders engaged	Meeting protocols and workshop reports	To be proposed by Tenderer	Every 3 months
Number of user engagement events organized	Event reports	To be proposed by Tenderer	End of the contract
Number of user participants at engagement events organized	Event reports	To be proposed by Tenderer	End of the contract
Number of presentations at workshops, events organized by others	References	To be proposed by Tenderer	Every 3 months
Number of user requirements identified	Report	To be proposed by Tenderer	End of the contract
Number of surveys and respondents	Report	To be proposed by Tenderer	End of the contract

Communication

Number of views on website	Web analytics	To be proposed by Tenderer	Every 3 months
Number of social media posts, likes and shares	Analytics	To be proposed by Tenderer	Every 3 months

Contract management

Timely implementation of the contract	Dates of milestones and timely submission of deliverables	100% on time	monthly
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Tenderers should propose additional KPI to fully cover the focus of their bid.

Annex: DestinE data portfolio

The DestinE data portfolio has not been fully defined and is expected to evolve with progressing development and in response to user needs. The following lists the current variables and datasets expected to be available from DestinE.

A.1 DT Climate Adaptation data portfolio

ID	DTCC-01	
Description	Digital Twin Climate Change Adaptation	
Availability policy	<ul style="list-style-type: none"> 30 years rolling archive 	
Data access	<ul style="list-style-type: none"> DESP API 	
Geographical area	Global	
Geometry	Globally gridded data	
Time resolution	Depending on parameter: hourly, 3-hourly, daily, monthly	
Update frequency	Daily-to-monthly	
Dissemination	DestinE DESP	
Provisional variables	Name	Frequencies
	<u>Atmosphere (2D and column integrations)</u> total precipitation, snowfall 2 metre temperature total cloud cover 10 metre U wind component 10 metre V wind component 100 metre U wind component 100 metre V wind component snow depth 2 metre dewpoint temperature surface sensible heat flux Surface latent heat flux Surface solar radiation downwards Surface net thermal radiation Surface net solar radiation Skin temperature carbon dioxide brightness temperature skin temperature TOA incident solar radiation Surface thermal radiation downwards Surface thermal radiation downwards Top net thermal radiation evaporation Total column cloud ice water Total column cloud liquid water <u>Atmosphere (19 pressure levels: 1000, 925, 850, 700, 600, 500,</u>	1, 3, 6- hourly, monthly
		6-hourly,

	400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10, 5, 1) U component of wind V component of wind Temperature Relative humidity Geopotential	monthly
	<u>Sea ice</u> Sea ice area fraction Sea-ice thickness Sea ice velocity along x Sea ice velocity along y	daily, monthly
	<u>Ocean</u> Sea surface temperature Sea surface height Sea surface practical salinity Vertically integrated meridional volume transport Northward sea water velocity Eastward sea water velocity Ocean potential temperature ocean salinity	daily, monthly
User defined / flexible variables	Variables related to user application that can be flexibly defined, e.g. related to hydrology, air quality, extremes indices, etc. which may be produced directly from user-defined plugins as part of the DT	Single

6.3. Weather-induced and Geophysical Extremes DT

Availability policy	<ul style="list-style-type: none"> • 2 weekly rolling archive • selected data at full resolution to be kept throughout Phase 1 (fields in bold in the list below) 	
Data access	<ul style="list-style-type: none"> • DESP API 	
Geographical area	Global	
Geometry	Globally gridded data, formatting (latitude-longitude, other to be decided)	
Horizontal resolution	1-4 km	
Time coverage	4 days	
Time resolution	Sub-hourly (3 hourly for fields kept throughout phase 1 – or hourly for 1 or 2 days only)	
Update frequency	Daily	
Dissemination	DestinE DESP	
Data format	Grib2	
Initial variables (list to be refined during Phase I)	Name	Variable Type
	10 metre U wind component 10 metre V wind component 2 metre temperature	Single and Surface fields

	<p>Mean sea level pressure</p> <p>Runoff</p> <p>Surface pressure</p> <p>Total column water</p> <p>Total Precipitation</p> <p>Mean zero-crossing wave period</p> <p>Mean wave direction</p> <p>Mean wave period</p> <p>Peak wave period</p> <p>Significant wave height of combined wind waves and swell</p> <p>Soil temperature</p>	
	<p>10 metre wind gust since previous post-processing</p> <p>100 metre U wind component</p> <p>100 metre V wind component</p> <p>2 metre dewpoint temperature</p> <p>Accumulated freezing rain</p> <p>Average potential temperature in the upper 300m</p> <p>Averaged total lightning flash density in the last 6 hours</p> <p>Convective available potential energy</p> <p>Convective inhibition</p> <p>Convective precipitation</p> <p>Convective rain rate</p> <p>Eastward turbulent surface stress</p> <p>Friction velocity</p> <p>Instantaneous 10 metre wind gust</p> <p>Instantaneous total lightning flash density</p> <p>Large scale rain rate</p> <p>Large scale snowfall rate water equivalent</p> <p>Large-scale precipitation</p> <p>Northward turbulent surface stress</p> <p>Precipitation type</p> <p>Sea ice area fraction</p> <p>Sea surface temperature</p> <p>Simulated satellite images</p> <p>Snowfall</p> <p>Surface net solar radiation</p> <p>Surface net thermal radiation</p> <p>Surface solar radiation downwards</p> <p>Surface thermal radiation downwards</p> <p>Top net solar radiation</p> <p>Top net thermal radiation</p> <p>Total cloud cover</p> <p>Total column cloud liquid water</p> <p>Total column vertically-integrated water vapour</p> <p>Vertical integral of eastward water vapour flux,</p> <p>Vertical integral of northward water vapour flux</p> <p>Visibility</p> <p>Volumetric soil water layer 1</p> <p>Volumetric soil water layer 2</p> <p>Volumetric soil water layer 3</p> <p>Volumetric soil water layer 4</p>	
	<p>Divergence</p> <p>Geopotential height</p> <p>Specific humidity</p> <p>Relative humidity</p> <p>Temperature</p> <p>U component of wind</p> <p>V component of wind</p> <p>Vorticity (relative)</p>	<p>Pressure</p>

User defined / flexible variables	Variables related to user application that can be flexibly defined, e.g. related to hydrology, air quality, extremes indices, etc. which may be produced directly from user-defined plugins as part of the DT	Single
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A.2 On-demand Extremes

Description	DestinE on demand extremes output	
Geographical area	On-Demand within Europe	
Geometry	Polar stereographic, Lambert conical tangent projection or mercator projection depending on the latitude	
Vertical coordinate	Hybrid levels, number of levels ~100	
Vertical coverage	From surface to ~ 10hPa	
Expected domain size	Up to 2000x2000x137 (x,y,z) grid points	
Horizontal resolution	500-1000m	
Time coverage	36-48 hours	
Time resolution	5 minute - hourly, applies to both initial time and output resolution	
Update frequency	On-Demand	
Data format	GRIB2, ccscds_packing	
Size	8 GB per forecast file every 5 min x 60 h ~ 6 TB (2000 x 2000 grid points)	
Initial output variables	10m U wind component 10m V wind component 10m Max Gust, u-component 10m Max Gust, v-component 2m Temperature 2m Maximum Temperature 2m Minimum Temperature Surface pressure Mean sea level pressure 2m Relative Humidity 2m Specific Humidity Total column water	Single and Surface fields

	<p>Total Precipitation Total solid Precipitation Precipitation type Graupel precipitation rate Snowfall Snow depth water equivalent</p> <p>Global radiation flux Long wave radiation flux Shortwave radiation flux LW net clear sky rad SW net clear sky rad Global (horizontal) irradiance Direct normal irradiance Global irradiance in clear sky conditions Direct normal irradiance in clear sky conditions</p> <p>Total cloud cover Low cloud cover Medium cloud cover High cloud cover</p> <p>Water Evaporation Sensible heat flux Mixed layer depth CAPE SST Visibility Land-sea mask</p>	
	<p>Temperature U wind component V wind component Specific humidity Specific cloud liquid water content Specific cloud ice water content Specific graupel Turbulent Kinetic Energy Geopotential Relative humidity Total cloud cover Geometrical vertical velocity</p>	<p>Pressure levels</p> <p>50, 100, 150, 200, 250, 300, 400, 500, 700, 800, 850, 925, 1000</p>
	<p>Temperature U wind component V wind component Specific humidity Specific cloud liquid water content Specific cloud ice water content Specific graupel Turbulent Kinetic Energy Relative humidity Total cloud cover Geometrical vertical velocity</p>	<p>Height levels</p> <p>15, 30, 50, 75, 100, 150, 200, 250, 300, 400 and 500 m</p>

	Risk of icing at height level	
Initial surface fields on tiles, not yet in GRIB2	SURFEX variables	Standard variable names
	X002T2M_P X002TG1 X002WG1 X002DSN_T_P X002TC X002WRVN X001T2M_P X001TG1 X001TG10 X001WG1 X001WG10 X001DSN_T_P SFX.T2M_WAT SFX.TS_WATER SFX.H_SNOW SFX.H_ICE SFX.T2M_TEB SFX.TROAD1 SFX.TWALL1 SFX.TROOF1 SFX.TCANYON SFX.QCANYON SFX.T2M_SEAICE SFX.HC_SEAICE SFX.DSN_T_ICE	T2m forest Top soil temperature Top soil moisture Snow depth Canopy air temperature Intercepted snow T2m open land Top soil temperature 10th layer soil temperature Top soil moisture 10th layer soil moisture Snow depth T2m lake Water surface temperature Snow depth Ice thickness T2m urban Top road temperature Outer wall temperature Top roof temperature Street canyon air temperature Street canyon air humidity T2m sea ice Acc ice sensible heat flux Snow depth
Constant fields	Surface Geopotential Land sea mask tile/patch distribution Land use Wind power per grid cell: <ul style="list-style-type: none"> • Number of turbines • (if possible) hub height • (if possible) rotor diameter • (if possible) power production capacity 	
Air quality	NO2 O3 PM10 PM2.5 SO2	
Hydrology	Discharge from rivers or streams Water runoff and drainage rate Snow depth water equivalent	
Renewables	Instantaneous wind power production Accumulated wind power production Global irradiance on tilted surfaces Accumulated PV yield	

Uncertainty estimation	Probabilistic predictions in terms of quantiles O(10), threshold probabilities and/or scenarios of <ul style="list-style-type: none"> • wind speed at 10m, and wind power turbine height • gust at 10m • precipitation for various accumulation periods (1h, 3h, 6h, 12h, 24h) • Power production These may (likely) also be maximised in time/space. Pure deterministic post-processing may also be provided.
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A.3 Auxiliary data sets available via the DestinE Data Lake

DE dataset ID	Dataset description	Dataset provider	DE dataset access
DestinE referenced datasets			
<u>Copernicus Satellites</u>			
<i>Sentinel-1 Data</i>			
Sentinel-1 Level 1 SLC	Copernicus Space Component Data access		DEDL Fresh Data Pool (Last 2 years rolling archive) Federation Access (Previous data not available in DEDL Fresh Data Pool)
Sentinel-1 Level 1 GRD	Copernicus Space Component Data access		DEDL Fresh Data Pool (Last 2 years rolling archive) Federation Access (Previous data not available in DEDL Fresh Data Pool)
<i>Sentinel-2 Data</i>			
Sentinel-2 Level 1C: Top-Of-Atmosphere reflectances in cartographic geometry	Copernicus Space Component Data access		DEDL Fresh Data Pool (Last 2 years rolling archive) Federation Access (Previous data not available in DEDL Fresh Data Pool)
Sentinel-2 Level 2A: Bottom-Of-Atmosphere reflectances in cartographic geometry	Copernicus Space Component Data access		DEDL Fresh Data Pool (Complete dataset) <i>Gradual ramp-up during Phase I</i>
<i>Sentinel-3 Data</i>			
<u>Sentinel-3 Land</u>			
Sentinel-3 Level 2 OLCI Land Colour Full Resolution	Copernicus Space Component Data access		Federation access
Sentinel-3 Level 2 OLCI Land Colour Reduced Resolution	Copernicus Space Component Data access		Federation access

Sentinel-3 Level 2 Land - Sea and Land Surface Temperature Radiometer (SLSTR)	Copernicus Space Component Data access	Federation access
Sentinel-3 Level 2 Land	Copernicus Space Component Data access	Federation access
<u>Sentinel-3 Marine</u>		
Sentinel-3 L1B OLCI Full Resolution	EUMETSAT Big Data Services	Federation access
Sentinel-3 L1B OLCI Reduced Resolution	EUMETSAT Big Data Services	Federation access
Sentinel-3 Level 2 Ocean Color Full Resolution	EUMETSAT Big Data Services	Federation access
Sentinel-3 Level 2 Ocean Color Reduced Resolution	EUMETSAT Big Data Services	Federation access
Sentinel-3 L1B Radiances and Brightness Temperatures	EUMETSAT Big Data Services	Federation access
Sentinel-3 L1B SRAL	EUMETSAT Big Data Services	Federation access
Sentinel-3 Level 2 Altimetry Global	EUMETSAT Big Data Services	Federation access
<i>Sentinel-5P Data</i>		
Sentinel-5P Level 1 and Level 2	Copernicus Space Component Data Access	DEDL Fresh Data Pool (Complete dataset)
<u>Copernicus Services</u>		
<i>Copernicus Climate Change Service (C3S)</i>		
<u>In-situ and Satellite observations</u>		
Seasonal forecast daily and subdaily data on single levels	Copernicus CADS	Federation access
Seasonal forecast subdaily data on pressure levels	Copernicus CADS	Federation access
Seasonal forecast anomalies on single levels	Copernicus CADS	Federation access
Seasonal forecast anomalies on pressure levels	Copernicus CADS	Federation access
Seasonal forecast monthly statistics on single levels	Copernicus CADS	Federation access
Seasonal forecast monthly statistics on pressure levels	Copernicus CADS	Federation access

Carbon dioxide data from 2002 to present derived from satellite observations	Copernicus CADS	Federation access
Glaciers distribution data from the Randolph Glacier Inventory for year 2000	Copernicus CADS	Federation access
Glaciers elevation and mass change data from 1850 to present from the Fluctuations of Glaciers Database	Copernicus CADS	Federation access
Methane data from 2002 to present derived from satellite observations	Copernicus CADS	Federation access
UERRA regional reanalysis for Europe on single levels from 1961 to 2019	Copernicus CADS	Federation access
Sea ice monthly and daily gridded data from 1978 to present derived from satellite sensors	Copernicus CADS	Federation access
Sea level daily gridded data from satellite observations for the Black Sea from 1993 to 2020	Copernicus CADS	Federation access
Sea level daily gridded data from satellite observations for the global ocean from 1993 to present	Copernicus CADS	Federation access
Sea level daily gridded data from satellite observations for the Mediterranean Sea from 1993 to 2020	Copernicus CADS	Federation access
Water quantity indicators for Europe	Copernicus CADS	Federation access
Water quantity indicators for European catchments	Copernicus CADS	Federation access
<u>Reanalysis</u>		
ERA5 hourly data on singles levels from 1979 to present	Copernicus CADS	Federation access
ERA5 hourly data on pressure levels from 1979 to present	Copernicus CADS	Federation access
ERA5 monthly averaged data on single levels from 1979 to present	Copernicus CADS	Federation access

ERA5 monthly averaged data on pressure levels from 1979 to present	Copernicus CADS	Federation access
ERA5-Land hourly data from 1950 to present	Copernicus CADS	Federation access
ERA5-Land monthly data from 1950 to present	Copernicus CADS	Federation access
<i>Copernicus Atmosphere Monitoring Service Data (CAMS)</i>		
CAMS global reanalysis (EAC4)	Copernicus CADS	Federation access
CAMS global emission inventories	Copernicus CADS	Federation access
CAMS global reanalysis (EAC4) monthly averaged fields	Copernicus CADS	Federation access
CAMS global inversion-optimised greenhouse gas fluxes and concentrations	Copernicus CADS	Federation access
CAMS European air quality reanalyses	Copernicus CADS	Federation access
CAMS global radiative forcing	Copernicus CADS	Federation access
CAMS global radiative forcing - auxilliary variables	Copernicus CADS	Federation access
CAMS global greenhouse gas reanalysis (EGG4)	Copernicus CADS	Federation access
CAMS global greenhouse gas reanalysis (EGG4) monthly averaged fields	Copernicus CADS	Federation access
CAMS European air quality forecasts	Copernicus CADS	Federation access
CAMS global atmospheric composition forecasts	Copernicus CADS	Federation access
CAMS solar radiation time-series	Copernicus CADS	Federation access
<i>Copernicus Marine Service (CMEMS)</i>		
<i>Marine datasets are restricted to Global area in initial version.</i>		
Global Ocean 1/12° Physics Analysis and Forecast updated Daily	Copernicus Marine	Federation access
Global Surface Chlorophyll Concentration from Satellite observations (daily average)	Copernicus Marine	Federation access

Reprocessed L3 (ESA-CCI)10		
Global Ocean 1/4° Physics Analysis and Forecast updated Daily	Copernicus Marine	Federation access
Global Ocean Biogeochemistry Analysis and Forecast	Copernicus Marine	Federation access
Global Ocean Waves Analysis and Forecast	Copernicus Marine	Federation access
Global ocean low and mid trophic levels biomass content hindcast	Copernicus Marine	Federation access
Global Ocean Waves Reanalysis WAWERYs	Copernicus Marine	Federation access
Global Ocean Ensemble Physics Reanalysis - Low resolution	Copernicus Marine	Federation access
Global Ocean Ensemble Physics Reanalysis	Copernicus Marine	Federation access
Global Ocean- Real time in-situ observations objective analysis	Copernicus Marine	Federation access
Global Ocean- Delayed Mode gridded CORA- In-situ Observations objective analysis in Delayed Mode	Copernicus Marine	Federation access
Global Ocean- in-situ Near real time observations of ocean currents	Copernicus Marine	Federation access
Global Ocean 3D Chlorophyll-a concentration, Particulate Backscattering coefficient and Particulate Organic Carbon	Copernicus Marine	Federation access
Global Ocean Surface Carbon	Copernicus Marine	Federation access
Nutrient profiles vertical distribution	Copernicus Marine	Federation access
Global Total Surface and 15m Current (COPERNICUS-GLOBCURRENT) from Altimetric Geostrophic Current and Modeled Ekman Current Processing	Copernicus Marine	Federation access
Global Total Surface and 15m Current (COPERNICUS-GLOBCURRENT) from Altimetric Geostrophic Current and Modeled Ekman Current	Copernicus Marine	Federation access

Reprocessing		
Multi Observation Global Ocean Sea Surface Salinity and Sea Surface Density	Copernicus Marine	Federation access
Multi Observation Global Ocean 3D Temperature Salinity Height Geostrophic Current and MLD	Copernicus Marine	Federation access
Global Observed Ocean Physics 3D Quasi-Geostrophic Currents (OMEGA3D)	Copernicus Marine	Federation access
Global Ocean Chlorophyll, PP and PFT (Copernicus-GlobColour) from Satellite Observations : Daily (Near Real Time)	Copernicus Marine	Federation access
Global Ocean Chlorophyll, PP and PFT (Copernicus-GlobColour) from Satellite Observations: Daily (Reprocessed from 1997)	Copernicus Marine	Federation access
Global Ocean Chlorophyll, PP and PFT (Copernicus-GlobColour) from Satellite Observations: Monthly and Daily Interpolated (Near Real Time)	Copernicus Marine	Federation access
Global Ocean Chlorophyll, PP and PFT (Copernicus-GlobColour) from Satellite Observations: Monthly and Daily Interpolated (Reprocessed from 1997)	Copernicus Marine	Federation access
Global Surface Chlorophyll Concentration from Satellite observations (daily average) Reprocessed L4 (ESA-CCI): monthly	Copernicus Marine	Federation access
Global Ocean NRRS, BBP, CDM, KD, ZSD, SPM (Copernicus-GlobColour) from Satellite Observations: Daily (Near Real Time)	Copernicus Marine	Federation access
Global Ocean, Ocean Optics Products (daily average) Reprocessed L3 (ESA-CCI)	Copernicus Marine	Federation access
Global Ocean NRRS, BBP, CDM, KD, ZSD, SPM (Copernicus-GlobColour) from Satellite Observations: Daily (Reprocessed from 1997)	Copernicus Marine	Federation access

Global Ocean NRRS, BBP, CDM, KD, ZSD, SPM (Copernicus-GlobColour) from Satellite Observations: Monthly and Daily Interpolated (Reprocessed from 1997)	Copernicus Marine	Federation access
Global Ocean NRRS, BBP, CDM, KD, ZSD, SPM (Copernicus-GlobColour) from Satellite Observations: Monthly and Daily-Interpolated (Reprocessed from 1997)	Copernicus Marine	Federation access
Global Ocean - Arctic and Antarctic - Sea Ice Concentration, Edge, Type and Drift (OSI-SAF)	Copernicus Marine	Federation access
Global Ocean - High Resolution SAR Sea Ice Drift	Copernicus Marine	Federation access
Global Ocean Sea Ice Concentration Time Series REPROCESSED (OSI-SAF)	Copernicus Marine	Federation access
GLOBAL OCEAN GRIDDED L4 SEA SURFACE HEIGHTS AND DERIVED VARIABLES NRT	Copernicus Marine	Federation access
GLOBAL OCEAN MEAN DYNAMIC TOPOGRAPHY8	Copernicus Marine	Federation access
Global Ocean - Sea Surface Temperature Multi-sensor L3 Observations	Copernicus Marine	Federation access
Global Ocean OSTIA Sea Surface Temperature and Sea Ice Analysis	Copernicus Marine	Federation access
Global Ocean Sea Surface Temperature Multi Product Ensemble (GMPE)	Copernicus Marine	Federation access
Global Ocean OSTIA Diurnal Skin Sea Surface Temperature	Copernicus Marine	Federation access
Global Ocean OSTIA Sea Surface Temperature and Sea Ice Reprocessed	Copernicus Marine	Federation access
ESA SST CCI and C3S reprocessed sea surface temperature analyses	Copernicus Marine	Federation access
GLOBAL OCEAN L3 SPECTRAL PARAMETERS FROM NRT SATELLITE MEASUREMENTS	Copernicus Marine	Federation access

GLOBAL OCEAN L3 SIGNIFICANT WAVE HEIGHT FROM NRT SATELLITE MEASUREMENTS	Copernicus Marine	Federation access
GLOBAL OCEAN L4 SIGNIFICANT WAVE HEIGHT FROM NRT SATELLITE MEASUREMENTS	Copernicus Marine	Federation access
Global Ocean Wind L4 Reprocessed Monthly Mean Observations	Copernicus Marine	Federation access
Global Ocean Daily Gridded Sea Surface Winds from Scatterometer	Copernicus Marine	Federation access
Global Ocean Daily Gridded Reprocessed L3 Sea Surface Winds from Scatterometer	Copernicus Marine	Federation access
Global Ocean Wind L4 Near real Time 6 hourly Observations	Copernicus Marine	Federation access
Global Ocean L4 Reprocessed 6 hourly Observations	Copernicus Marine	Federation access
<i>Copernicus Global Land Service (CLMS)</i>		
Copernicus DEM - Global and European Digital Elevation Model (COP-DEM)	Copernicus Land	DEDL Fresh Data Pool (Complete dataset) <i>Gradual ramp-up during Phase I</i>
Global 10-daily Normalized Difference Vegetation Index 333M	Copernicus Land	DEDL Fresh Data Pool (Complete dataset) <i>Gradual ramp-up during Phase I</i>
Global 10-daily Normalized Difference Vegetation Index 1KM	Copernicus Land	DEDL Fresh Data Pool (Complete dataset) <i>Gradual ramp-up during Phase I</i>
Vegetation Indices, daily	Copernicus Land	DEDL Fresh Data Pool (Complete dataset) <i>Gradual ramp-up during Phase I</i>
10-daily Burned Area 300M (V3)	Copernicus Land	DEDL Fresh Data Pool (Complete dataset) <i>Gradual ramp-up during Phase I</i>
10-daily Burned Area 300M	Copernicus Land	DEDL Fresh Data Pool (Complete dataset) <i>Gradual ramp-up during Phase I</i>
CORINE Land Cover	Copernicus Land	DEDL Fresh Data Pool (Complete dataset)

		<i>Gradual ramp-up during Phase I</i>
Global 10-daily Fraction of Vegetation Cover 333m	Copernicus Land	DEDL Fresh Data Pool (Complete dataset) <i>Gradual ramp-up during Phase I</i>
10-daily Dry Matter Productivity 333M from 2014 to present	Copernicus Land	DEDL Fresh Data Pool (Complete dataset) <i>Gradual ramp-up during Phase I</i>
10-daily Gross Dry Matter Productivity 333M	Copernicus Land	DEDL Fresh Data Pool (Complete dataset) <i>Gradual ramp-up during Phase I</i>
<i>Copernicus Emergency Service (CEMS)</i>		
Fire danger indices historical data from the Copernicus Emergency Management Service	Copernicus Emergency	Federation access
River discharge and related forecasted data by the Global Flood Awareness System	Copernicus Emergency	Federation access
River discharge and related historical data from the Global Flood Awareness System	Copernicus Emergency	Federation access
Reforecasts of river discharge and related data by the Global Flood Awareness System	Copernicus Emergency	Federation access
Seasonal forecasts of river discharge and related data by the Global Flood Awareness System	Copernicus Emergency	Federation access
Seasonal reforecasts of river discharge and related data from the Global Flood Awareness System	Copernicus Emergency	Federation access
River discharge and related forecasted data by the European Flood Awareness System	Copernicus Emergency	Federation access
River discharge and related historical data from the European Flood Awareness System	Copernicus Emergency	Federation access
Reforecasts of river discharge and related data by the European Flood Awareness System	Copernicus Emergency	Federation access

Seasonal forecasts of river discharge and related data by the European Flood Awareness System	Copernicus Emergency	Federation access	
Seasonal reforecasts of river discharge and related data by the European Flood Awareness System	Copernicus Emergency	Federation access	
<u>ISIMP Data</u>			
TBD	Climate forcing data	ISIMP	Federation access
TBD	Socioeconomic forcing data	ISIMP	Federation access
<u>IAGOS Data</u>			
TBD	Atmospheric composition	IAGOS	Federation access
<u>EuroStat Data</u>			
Population distribution: Population on 1 January by age, sex and NUTS 2 region	EC EUROPA Data Store	Federation access	
Population distribution: Population on 1 January by age group, sex and NUTS 3 region	EC EUROPA Data Store	Federation access	
Population change - Demographic balance and crude rates at regional level (NUTS 3)	EC EUROPA Data Store	Federation access	
Greenhouse gas emissions from agriculture	EC EUROPA Data Store	Federation access	
Share of energy from renewable sources	EC EUROPA Data Store	Federation access	