EuroCryoClim Pilot Project
Technical Proposal

ITT/RFQ: PRODEX/Norway
Proposal : EuroCryoClim Pilot Project
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1 INTRODUCTION

1.1 BACKGROUND

Air temperature measurements show a clear trend of global climate warming during the last decades. According to the European Environment Agency, temperatures are predicted to increase by 1.4–5.8°C globally and 2.0–6.3°C in Europe by the year 2100. The Arctic temperature has increased at almost twice the rate compared to that of the rest of the world over the same period. It has been generally agreed internationally that climate monitoring is urgently needed in order to quantify and better understand the climatic changes taking place. Therefore, climate monitoring has been put at the top of the agenda by the UN and in the international Earth observation initiatives GEO and GMES.

Europe, with its location close to the Arctic and along the northern part of the Gulf Stream, is vulnerable to climate change. Europe has a long tradition and high international reputation in research and development leading to new and effective Earth observation techniques, in particular retrieval algorithms for cryospheric variables related to sea ice, glaciers and snow. Also, several European countries have a long heritage in polar exploration and research, and have significant political interests in regions of both poles. With the historical, political, scientific and technological background Europe has, it would be natural to provide a significant contribution to climate monitoring – focussing on the cryosphere. In addition to being an extremely valuable contribution to global climate monitoring, such an initiative will strengthen Europe's position in Earth observation – operationally and for scientific research and development.

1.2 PROJECT VISION

This document proposes a pilot project for the EuroCryoClim initiative proposed by a group of Norwegian organisations (Norwegian Computing Center (NR), Norwegian Meteorological Institute (met.no), Norwegian Water Resources and Energy Directorate (NVE) and Norwegian Polar Institute (NPI)) and facilitated by the Norwegian Space Centre (NSC). The vision of the EuroCryoClim initiative is to develop new operational services for long-term systematic climate monitoring of the cryosphere. The system and services proposed will be designed to be integrated into the planned international system of systems for global monitoring (GEOSS) – the part of the system aimed for climate monitoring. Based on scientific and technological results from several past and current projects, it is proposed to develop a network-based system building on standards and communication languages identified by GMES and GEO for the global system of systems. The network of processing chains and databases (the nodes) will be hosted by mandated organisations in order to ensure long-term and stable operation. The development of this system will draw on the pool of institutions that has developed the current knowledge and technology base for remote sensing of the cryosphere and data processing and management. Our ambition is that the new system we will develop, including the web-based service and the new and accurate climate products, will represent a significant contribution to the very important task of monitoring the development of the climate on our planet.

1.3 AIM OF THE PILOT PROJECT

The aim of the EuroCryoClim Pilot Project is to prepare the ground for a successful development of an operational monitoring system and service in the main project. The pilot project will identify the user needs, develop the design of the system, develop a demonstrator of the system and climate demonstration products, promote the initiative and establish contacts with key users and other key organisations, and develop a work plan for the main project.

2 ABBREVATIONS AND ACRONYMS

AG	Advisory Group
CDP	Climate Demonstration Product
CDS	Climate Data Server
COP	Conference of Parties
CP	Climate Product
DWS	Demonstrator Web Service
ECV	Essential Climate Variable
EO	Earth Observation
GCOS	Global Climate Observing System
GEO	Group for Earth Observation
GEOSS	Global Earth Observation System of Systems
GMES	Global Monitoring for Environment and Security
IGOS	Integrated Global Observing Strategy
IP	Implementation Plan
met.no	Norwegian Meteorological Institute (Meteorologisk Institutt)
NPI	Norwegian Polar Institute (Norsk Polarinstitutt)
NR	Norwegian Computing Center (Norsk Regnesentral)
NSC	Norwegian Space Centre (Norsk Romsenter)
NVE	Norwegian Water Resources and Energy Directorate (Norges Vassdrags- og Energidirektorat)
OSI SAF	Ocean & Sea Ice Satellite Application Facility
SAF	Satellite Application Facility
UNFCCC	United Nations Framework Convention on Climate Change

3 REFERENCE DOCUMENTS

[RD-1] Second Report on the Adequacy of the Global Observing Systems for Climate in support of the UNFCCC. WMO/TD No. 1143. (2003)

[RD-2] Implementation for the Global Observing System for Climate in support of the UNFCCC. WMO/TD No. 1219. (2004)

[RD-3] Systematic Observation Requirements for Satellite-based Products for Climate. Supplemental details to the satellite-based component of the GCOS IP. WMO/TD No. 1338. (2006)

[RD-4] Satellite Observation of the Climate System. CEOS response to GCOS IP, (2006)

[RD-5] Integrated Global Observing Strategy (IGOS) Cryosphere Theme report. (2007)

[RD-6] GCOS SST & Sea Ice Working Group activities on sea ice

[RD-7] Project vision for the development of a European contribution to a global cryospheric climate monitoring system – EuroCryoClim (2007)

[RD-8] Outline of a Technical Solution to a Global Cryospheric Climate Monitoring System, Technical White Paper (2006)

[RD-9] Global Monitoring for Environment and Security (GMES): Establishing a GMES capacity by 2008 - (Action Plan (2004-2008)). Communication from the Commission to the European Parliament and The Council. Brussels, 3 February 2004.

[RD-10] From Observation to Action—Achieving Comprehensive, Coordinated, and Sustained Earth Observations for the Benefit of Humankind, Framework for a 10-Year Implementation Plan. Framework document for GEO Summit II, 24 April 2004.

[RD-11] EuroClim, final project report. EuroClim report no. D26.

4 PROJECT OUTLINE

This chapter starts by describing the background and motivation for the proposed project, then continues by explaining how it could contribute to the global systems of systems for Earth monitoring, and finalises by giving an overview of the main current ideas for the EuroCryoClim system.

4.1 BACKGROUND AND MOTIVATION

It has generally been agreed at the international level in the last few years, politically as well as scientifically, that climate monitoring is urgently needed in order to quantify and better understand the climatic changes as they take place. Climate monitoring is put at the top of the agenda by the UN, currently coordinated by WMO's GCOS initiative. Climate monitoring is also at the top of the agenda of GMES (EC, 2003) and GEO (GEO, 2004). However, climate monitoring is still undergoing the first drafting phase with very few operational space-based services present. Large international processes are currently trying to co-ordinate various international initiatives and strongly encourage the establishment of new services for systematic, operational climate monitoring.

Europe, with its location close to the Arctic and along the northern part of the Gulf Stream, is vulnerable to climate change. This has been recognised for a long time in research programmes. Europe runs large national and international programmes for climate research and is well recognised for international achievements in climate sciences. Several European countries have a long tradition and high international reputation in research and development leading to new and effective Earth observation techniques. Norway has in particular taken an international lead in Earth observation algorithm development for remote sensing of the cryosphere – sea ice, glaciers and snow. Important, recent international projects include OSI SAF, EuroClim and GlobICE.

With the historical, political, scientific and technological background indicated above, it would be natural that Europe provides a significant contribution to global climate monitoring – focussing on the cryosphere. In addition to being an extremely valuable contribution to the upcoming multinational venture of global climate monitoring, such an initiative will strengthen Europe's position in Earth observation, both operationally and for scientific research and development.

This document proposes a pilot project to prepare the ground for a project bringing current Earth observation methodology and technology for remote sensing of the cryosphere from algorithms and prototype systems into operational services run by mandated organisations – an extremely valuable contribution to long-term systematic climate monitoring of the cryosphere. The proposed project is conformant with the vision of European cryospheric climate monitoring in [RD-8].

4.2 A CONTRIBUTION TO GEOSS AND GCOS

Although global monitoring of climate variables is currently addressed by many initiatives – like GCOS, GMES and GEO – there will in practice not be many global monitoring systems doing the same. Current coordination activities will ensure that a huge network of smaller systems is assembled – a system of systems. GCOS is defining the principles for such a system based on current scientific knowledge [RD-2 and RD-3] based on the needs expressed by UNFCCC [RD-1]. GMES [RD-9] will implement much of the European part of the system, which represents a significant European contribution to GEO's Global Earth Observation Systems of Systems (GEOSS) [RD-10]. GCOS has identified the most important variables to be monitored, the so-called Essential Climate Variables [RD-2]. In order to be able to detect and correctly quantify subtle changes in climatic variables, GCOS has specified how such measurements should be taken and handled by a set of rules – the Climate Monitoring Principles [RD-3].

A contribution to global climate monitoring needs to follow GCOS' principles as well as the standards and system architecture currently being developed and specified by GMES and GEO. Therefore, it is important to establish links to the most important initiatives and processes ongoing to be fully compatible with the global system of systems emerging.

4.3 UPFRONT IDEAS FOR THE SYSTEM AND SERVICE

One of the main ideas behind a global system of systems is that operational global monitoring of the Earth system is an all too large endeavour for any single organisation. The solution is to assemble a system of components from interested national and international parties worldwide in a concerted way. One of the main tasks is to let these components – individual monitoring systems for parts of the Earth system – be able to communicate with each other and share data. With common communication languages and data standards, the individual systems can be coupled into a network. Users can be provided access to this network through web portals – web services – that searches and retrieves data without bothering the user with where and how the data is stored. When established, such a system will be extremely powerful and flexible.

Hence, a contribution to a global system of systems needs to be a set of "nodes" that can be networked to other systems. The nodes can also be integrated with other portals, e.g., for national applications and services. This means that the nodes can be components in several networks.

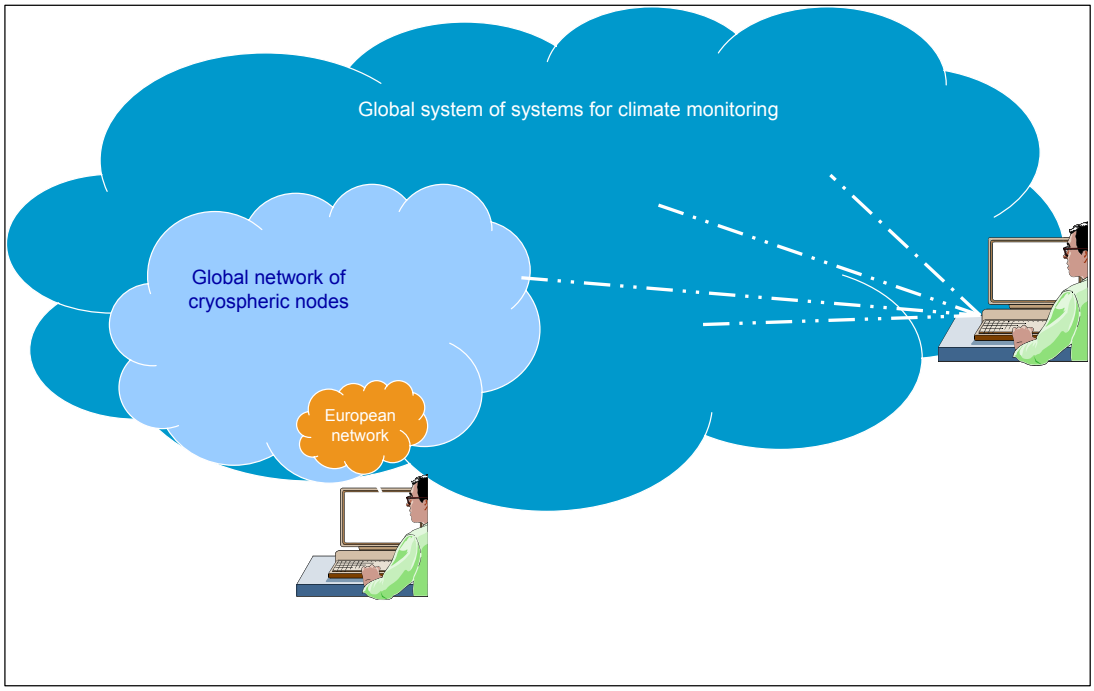

Figure 1. A network of European cryospheric monitoring nodes as a set of components in a global system of systems for climate monitoring

Technology for a networked approach of climate monitoring was developed and demonstrated in the EuroClim project [RD-11]. A Norwegian contribution to the European network shown in Figure 1 could be four cryospheric database nodes hosted by three mandated organisations (met.no, NPI and NVE), as illustrated in Figure 2. Algorithm development, validation and technological implementation of these nodes would greatly benefit from drawing on most of the knowledge and technology base developed by the relevant part of the Earth observation community in Norway.

The envisioned main functionality and requirements for the system are:

- The services of the system should be provided as a web service
- The web service should follow state-of-the-art one-stop-shop principles for spatial data
- The service should be free of charge for non-commercial applications
- The product production chains and the corresponding databases should be distributed and hosted by mandated organisations
- The databases should be integrated over the Internet in a seamless and scalable network, which is open for inclusion of other databases/sub-services in the future
- The system tools should be state-of-the-art open solutions following international standards (like OPeNDAP and OpenGIS)
- Integration with geographic tools like Google Map should be considered

There is added value from expanding the first version of this system with expertise and resources from more European countries. An example is the Geological Survey of Denmark and Greenland (GEUS), who established a prototype system for monitoring Greenland in the EuroClim project. GEUS has recently received a national mandate as well as the necessary funding to further develop this monitoring service for the Greenland ice sheet.

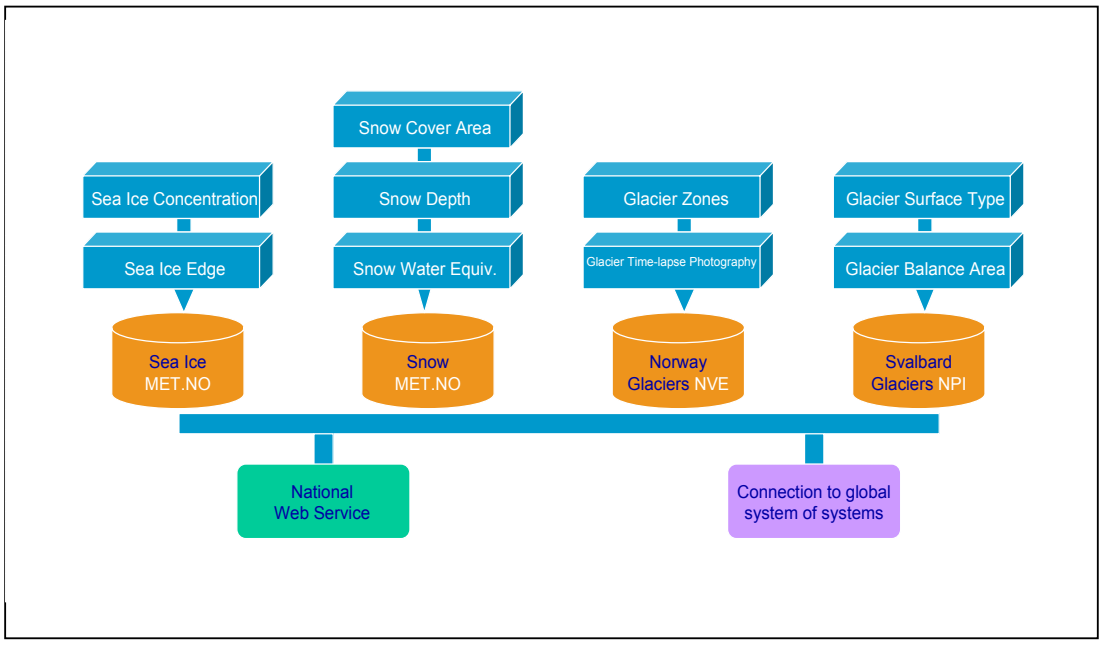

Figure 2. Initial overall system architecture idea for the Norwegian part of a European cryospheric climate monitoring system

Table 1 shows the initial idea for a product portfolio from the Norwegian part of the system with parameters as envisioned currently. The column ECV refers to the Essential Climate Variables (ECVs) as defined by GCOS [RD-3].

Table 1: Initial idea for a product portfolio for the Norwegian part of the system

ECV	Name	Coverage	Frequency	Res.	Time span	Prov.
	Sea Ice					
O.1	SIC - Sea Ice Concentration	Bipolar	Daily	10 km	1978-present	Met.no
O.1	SIE - Sea Ice Edge	Bipolar	Daily	10 km	1987-present	Met.no
	Snow					
T.3	SCA - Snow Covered Area (PMR)	Global	Daily	10 km	1987-present	Met.no
T.3	SCA - Snow Covered Area (optical)	Regional	Daily	1 km	TBD	Met.no
T.3	SCA - Snow Covered Area (multi-sensor)	Regional	Daily	1 km	TBD	Met.no
T.3	SWE - Snow Water Equivalent (PMR)	Regional	Daily	10 km	1987-present	Met.no
T.3	SD - Snow Depth (PMR)	Regional	Daily	10 km	1987-present	Met.no
	Glacier – Norway					
T.2.1	GAO - Glacier Area Outline	Norway	1-5 years	30 m	1910-present	NVE
	GSL - Glacier Snow Line	Norway	1-5 years	30 m	1910-present	NVE
	GFL - Glacier Firn Line	Norway	1-5 years	30 m	1910-present	NVE
	GLO - Glacier-dammed Lake Outline	Norway	1-5 years	30 m	1910-present	NVE
T.2.1	GTP - Glacier Time-lapse Photo	Norway	Annual	N/A	1910-present	NVE
	Glacier – Svalbard					
T.2.1	GST - Glacier Surface Type	Svalbard	Annual	30 m	1992-present	NPI
T.2.2	GBA - Glacier Balance Area	Svalbard	Annual	30 m	1992-present	NPI

5 PROJECT WORKPLAN

The following sections describe the overall project structure and process as well as each work package.

5.1 PROJECT WORK PLAN STRUCTURE

The project work is split into six work packages:

- WP 1: Requirement analysis and specification
- WP 2: System and service design
- WP 3: System demonstrator
- WP 4: Implementation planning
- WP 5: Promotion and outreach
- WP 6: Project management

WP 1, 2 and 3 represent the core work packages of the project. The work starts with WP 1 identifying and analysing the user needs. The resulting requirement specification is the basis of the system and service design being carried out by WP 2. The user interface of the web service to be developed as well as the climate products to be delivered by the system will be made concrete as a web service demonstrator and climate demonstration products. The demonstrator web service and products will be discussed with representatives of key user groups. The system and service design (WP 2) is completed when the demonstrators made by WP 3 are accepted by the users.

WP 4, 5 and 6 will be carried out in parallel in most of the lifetime of the project. WP 4 constitutes the development of a work plan for the main project. A preliminary plan will be available at the mid point of the project period, and the final plan will be completed at the end of the project period. WP 5 will carry out promotion and outreach work in order to establish a dialogue with other key initiatives and organisations with the goal of having these as well as the broad user groups to accept and recognise the services to be delivered by the system. Technical and administrative project management will be carried out by WP 6.

5.2 PROJECT WORK PACKAGES

Here follows an overview of the work packages. Additional details are provided in the Management Proposal.

5.2.1 WP 1: Requirement analysis and specification

The purpose of this work package is to identify the user requirements for the portfolio of cryospheric climate products to be delivered by the EuroCryoClim system and to specify the user requirements for the system's web service delivering these products and specific services related to the products.

The specific tasks are to:

1. Retrieve user requirements
2. Retrieve requirements and recommendations set by other key organisations
3. Identify implicit system requirements
4. Retrieve information about relevant existing services
5. Compare the requirements to the existing services
6. Develop a product requirement specification
7. Develop a service requirement specification

The type of products and services will be limited to those inline with the vision of the project, i.e., to that set by intentions and policy of the service providers behind this project. This is outlined in RD-7. User requirements will in general be retrieved from "umbrella organisations" representing groups of users and that already have a broad and clear overview of user needs in general. Examples of such organisations are EEA and GCOS. There are also other key organisations setting requirements, in particular GEO.

5.2.2 WP 2: System and service design

Based on the outcome of WP 1, this work package will develop the design of the system and the service producing and providing the products and services related to the product portfolio.

The specific tasks are to:

1. Perform algorithm review and develop guidelines for new algorithms
2. Identify data sources and related limitations and restrictions
3. Identify system and data standards to adopt
4. Clarify interfacing to other services, in particular GEOSS
5. Develop system architecture and system design
6. Develop a service validation protocol

The algorithm guidelines will be based on an assessment of the state of the art for retrieval algorithms for the products specified. Long-term data delivery (for the past and future), in order to be able to deliver products where climate change already can be detected and quantified, will be taken into consideration. The project should stick to open standards as far as possible. Relevant recommendations in INSPIRE will be analysed and taken into consideration, as well as recommendation set by umbrella organisations like EUMETSAT. As the system to be developed is a contribution to GEOSS, it is necessary to clarify all technical issues in order to secure that the system could easily be interfaced to GEOSS. Since GMES is the main European contribution to GEOSS, harmonisation with GMES might also be needed.

The system architecture and design developed will be inline with iterative and incremental system development (not the "waterfall" approach), as this has proved to result in better systems and more

easy adaptation to changing user requirements. This means that system architecture and system design developed in the Pilot Project has to be interpreted as the result of the first iteration of the design work. The design will be further revised as feedback is repeatedly received from the users and key organisations under the course of the project.

The service validation protocol will specify in detail how the system is to be tested and how the service is to be validated in order to test the system against the user requirements.

5.2.3 WP 3: System demonstrator

The main purpose of this work package is to develop a system demonstrator. The aim of developing a demonstrator is to set the project in a position to clarify functionality of the web service and contents of the products at an early stage. The actual web service and products could then be developed more rapidly with fewer trial-an-error iterations with the users leading to the final web service and products.

The specific tasks are to:

1. Develop climate demonstration products
2. Develop demonstrator web server
3. User evaluation of products and web service

The Climate Demonstration Products CDPs) will have a design and content equivalent to real climate products to be delivered by the operational system, but the content will not necessarily represent the real world as the retrieval algorithms and processing system are not yet developed. As an exception, full grade climate products (CPs) will be tried developed within this pilot project for sea ice. This will be possible by building on work already carried out by the OSI SAF [RD-7].

The Demonstrator Web Service (DWS) will contain the functionality and have an appearance like the operational system, but most of the support system behind the Graphical User Interface (GUI) will be missing. Therefore, the DWS will only be able to demonstrate the general functionality for a limited set of cases based on data processed in advance by other means. The DWS will as far as possible be built using full-grade web tools (in contrast to mock-up tools) in order to be able to apply the DWS software directly when implementing the full system in the main project.

The development process will be steered by the feedback from the Scientific and Technical Advisory Group and key user organisations involved in WP1. The user evaluation will be based on sample products, tests of the web service and documentation.

5.2.4 WP 4: Implementation planning

A successful completion of the Pilot Project is intended to be followed by the Main Project. The Main Project will implement the EuroCryoClim system according to the findings in the Pilot Project. The purpose of this work package is to develop a detailed work plan for the implementation of the system, including the development of the cryospheric variable retrieval algorithms needed.

The work plan will include mechanisms for expansion of the foreseen system, e.g. by including monitoring of the Greenland ice sheet through inclusion of a new service provider with similar aims as the service providers behind this proposal. The work plan will also include a description of similar mechanisms for future system extension, including outlines of new products, if the users linked to the Pilot Project express strong interest in additional types of products (including other variables), which could be developed at a later stage when resources, methodology and/or technology allow.

5.2.5 WP 5: Promotion and outreach

The EuroCryoClim service will not be successful if it not widely accepted and recognised by key users, organisations representing various user groups and organisations representing producers and providers of other climate products. This work package is to develop promotional material (like an

open web page and a brochure) as well as establishing and running a dialogue with key organisations that will be crucial for the success of the service to be developed (like GCOS, GEO and IGOS).

5.2.6 WP 6: Project management

This work package will carry out the management of the project:

1. Lead the process of carrying out the work plan
2. Monitor project progress
3. Report project progress
4. Carry out progress meetings