ESRIN

DOCUMENT

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Arctic+ Salinity

Statement of Work

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1 INTRODUCTION

1.1 Scope

This activity is part of ESA's [URL1] Scientific Data Exploitation Element, a component of the Earth Observation Envelope Program (EOEP-5), aiming to reinforce the scientific component of the ESA Living Planet programme. Scientific Data Exploitation aims at responding to the needs of the EO and Earth system science communities in terms of innovative methods, new products open science tools, and new Earth science results. This Statement of Work (SoW) establishes the tasks to be performed within the Arctic+ Salinity.

This document will be part of the contract and shall serve as an applicable document throughout the execution of the work. It presents the background and objectives of the project, the tasks to be undertaken by the Contractor, the deliverables to be produced and the schedule of milestones to be achieved. During execution of the project, the Contractor shall comply with the requirements and tasks set out in this document.

This activity is a direct response to some of the major discussion points gathered during the ESA/CliC scientific consultation meeting on Earth Observation and Arctic Research Priorities held on 20 January 2015 at the Fram Centre in Tromsø, Norway.

The meeting aimed at reviewing and discussing the existing scientific knowledge gaps and research priorities areas for the Arctic where EO may contribute for the next decade.

The outcome of this workshop was reported in a document [URL4], which will contribute to guide ESA's scientific activities on Arctic research for the time frame 2017-2021.

This Activity aims at contributing to on-going ESA activities to explore the potential of EO data to quantify freshwater fluxes in the Arctic.

1.2 Structure

The document is organized in five sections:

- Section 1: introduces the project. It outlines the scope of the procurement and the structure of the document; this section also lists the common reference documents as well as the web sites that are relevant for this procurement;
- Section 2: presents the problem faced and establishes the objectives of the project;
- Section 3: provides a generic description of the project tasks;
- Section 4: contains management and reporting activities;
- Section 5: includes the schedule and milestones.

1.3 Reference Documents (RDs)

The following documents can be consulted by the Contractor as they contain relevant information:

[REF1] Yoo, J., and D'Odorico, P. (2002). Trends and fluctuations in the dates of ice break-up of lakes and rivers in northern Europe: The effect of the North Atlantic Oscillation. J. Hydrol., 268(1-4), 100-112.

[REF2] Schindler, D. W., and Smol, J. P. (2006). Cumulative effects of climate warming and other human activities on freshwaters of Arctic and Subarctic North America. Ambio, 35(4), 160-168.

[REF3] Intergovernmental Panel on Climate Change (IPCC). (2013). Climate change 2013: The physical science basis. Contribution of working group I to the fifth assessment report of the Intergovernmental Panel on Climate Change [stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, New York, 1535 pp. doi: 10.1017/CBO9781107415324

[REF4] Zdanowicz, C., Smetny-Sowa, A., Fischer, D., Schaffer, N., Copland, L., Eley, J., and Dupont, F. (2012). Summer melt rates on Penny Ice Cap, Baffin Island: past and recent trends, and implications for regional climate. J. Geophys. Res., 117, F02006, doi: 10.1029/2011JF002248

[REF5] Lenaerts, J. T. M., Van Angelen, J. H., Van Den Broeke, M. R., Garnder, A. S., Wouters, B., and Van Meijgaard, E. (2013). Irreversible mass loss of Canadian Arctic Archipelago glaciers. Geophys. Res. Lett. 40, 870-874, doi: 10.1002/grl.50214

[REF6] Rignot , E., Velicogna, I., van den Broeke, M. R., Monaghan, A., Lenaerts, J. T. M. (2011). Acceleration of the contribution of the Greenland and Antarctic ice sheets to sea level rise. Geophys. Res. Lett. 38, L05503, doi: 10.1029/2011GL046583

[REF7] Shepherd, A. et al. (2012). A Reconciled Estimate of Ice-Sheet Mass Balance. Science, 30, 1183-1189; doi: 10.1126/science.1228102

[REF8] Bhatt, U. et al. (2013). Recent declines in warming and vegetation greening trends over pan-Arctic tundra. Remote Sens., 5, 4229-4254, doi:10.3390/rs5094229

[REF9] Surdu, C. M., Duguay, C. R., Brown, L. C., & Fernández Prieto, D. (2014). Response of ice cover on shallow lakes of the North Slope of Alaska to contemporary climate conditions (1950-2011): Radar remote sensing and numerical modeling data analysis. The Cryosphere, 8(1), 167-180.

[REF10] Baeseman, J, and Fernández Prieto, D (eds.). (2015). ESA-CliC Earth Observation and Arctic science priorities.

[REF11] Massom, R. A., Eicken, H., Haas, C., Jeffries, M. O., Drinkwater, M., Sturm, M., Worby, A. P., Wu, X., Lytle, V. I., Ushio, S., Morris, K., Reid, P. A., Warren, S. G., and Allison, I. (2001). Snow on Antarctic Sea Ice, Reviews of Geophysics, 39(3), 413– 445.

[REF12] Stroeve, J. C., Box, J. E., Wang, Z., Schaaf, C., and Barrett, A. (2013). Re-evaluation of MODIS MCD43 Greenland albedo accuracy and trends, Remote Sens. Environ., 138, 199–214, doi:10.1016/j.rse.2013.07.023

[REF13] Armitage, T. W. K. and Davidson, M. W. J. (2014). Using the interferometric capabilities of the ESA Cryosat-2 mission to improve the accuracy of sea ice freeboard retrievals. Trans. Geosci. Rem. Sens., 51, 529–536, doi:10.1109/TGRS.2013.2242082, 2014

[REF14] Kern, S., Khvorostovsky, K., Skourup, H., Rinne, E., Parsakhoo, Z. S., Djepa, V., Wadhams, P., and Sandven, S. (2015). The impact of snow depth, snow density and ice density on sea ice thickness retrieval from satellite radar altimetry: results from the ESA-CCI Sea Ice ECV Project Round Robin Exercise. The Cryosphere, 9, 37-52, doi: 10.5194/tc-9-37-2015

[REF15] Woodgate, R. A., Stafford, K. M., and Prahl, F. G. (2015). A Synthesis of year – round interdisciplinary mooring measurements in the Bering Strait (1990 - 2014) and the RUSALCA years (2004 - 2011). Bering Strait mooring synthesis for oceanography, RUSALKA, 1 (34).

[REF16] Doble, M. J. (2009). Simulating pancake and frazil ice growth in the Weddell Sea: A process model from freezing to consolidation. Journal of Geophysical Research 114. doi: 10.1029/2008JC004935. issn: 0148-0227

[REF17] Hasselmann, K., et al. (1973). Measurements of wind-wave growth and swell decay during the Joint North Sea Wave Project (JONSWAP), Deutch. Hydrogr. Z. Suppl. A8, 12, 95 pp.

[REF18] Thomson, J., and W. E. Rogers (2014). Swell and sea in the emerging Arctic Ocean, Geophys. Res. Lett., 41, 3136–3140, doi:10.1002/2014GL0599

[REF19] Kohout, A. L., Williams, M. J. M., Dean, S. M., and Meylan, M. H. (2014): Storminduced sea-ice breakup and the implications for ice extent. Nature, 509, doi: 10.1038/nature13262, 604-607

[REF20] Kwok R, Cunningham GF. 2015 Variability of Arctic sea ice thickness and volume from CryoSat-2. *Phil. Trans. R. Soc. A* **373**: 20140157.

[REF21] Tilling, R.L., Ridout, A., Shepherd, A., Wingham, D.J. *Increased Arctic sea ice volume after anomalously low melting in 2013*, Nature Geoscience, Vol. 8, August 2015 doi:10.1038/NGEO2489

1.4 Relevant Websites

[URL1]	ESA web site: www.esa.int
[URL2]	SMOS web site: https://earth.esa.int/smos
[URL3]	http://due.esrin.esa.int/stse/files/document/Arctic_Agenda_2015_v8.pdf
[URL4]	Arctic+ Snow (Snow on sea ice): http://www.isardsat.pl/arctic+snow
[URL5]	Arctic+ Ice (Sea ice mass): http://www.isardsat.pl/arctic+ice
[URL6]	Arctic+ ArcFlux (Freshwater fluxes): http://www.arcflux.eu
[URL7]	Arctic+ Year of Polar Prediction: http://arctic-plus.inversion-lab.com

1.5 Acronyms and Abbreviations

AD	Applicable document
ADB	Actions database
AMOC	Atlantic Meridional Overturning Circulation
ATBD	Algorithm theoretical basis documents
BRO	Brochure
CliC	Climate and Cryosphere
DIR	Directory
DS	Dataset availability
DS-UM	Dataset user manual
DVP	Development and validation plan
EC RTD	European Comission Directorate General for Research and Innovation
EDS	Experimental dataset
EMI	Electromagnetic Interference
EO	Earth Observation
EOEP	Earth Observation Envelope Program
ESA	European Space Agency
FR	Final review

FWF	Freshwater fluxes
GCOS	Global Climate Observing System
IAR	Impact assessment report
ITT	Invitation to tender
IPP	Year of Polar Prediction
KO	Kick-off
MR	Monthly report
MTR	Mid-term review
MV-TN	Modelling and validation technical note
NDVI	Normalized Difference Vegetation Index
PAR	Preliminary analysis report
PGICs	Peripheral glaciers and ice caps
PM	Progress meeting
PMP	Projetc management plan
RD	Reference document
RB	Requirements baseline
SAR	Synthetic Aperture Radar
SIAR	Scientific and impact assessment report
SMOS	Soil Moisture and Ocean Salinity
SoW	Statement of work
SR	Scientific roadmap
TDP	Technical data package
TN	Technical note
VIR	Validation and intercomparison report
VR	Validation report
WCRP	World Climate Research Programme
WP	Work package
WS	Workshop minutes
WWRP	World Weather Research Programme

2 PROJECT BACKGROUND AND OBJECTIVES

2.1 Background

The Arctic is a complex region, encompassing different physical and biogeochemical processes and interactions among several components of the Earth system (e.g., sea ice, ocean, glaciers, ice caps, the Greenland Ice Sheet, snow, lakes and river ice, permafrost, vegetation, complex interactions with the atmosphere, people, etc.). Changes in the Arctic have a strong impact on the Earth's climate system, the global energy budget, the ocean circulation, the water cycle, gas exchanges, sea level, and biodiversity (AMAP, 2011). Considering that all of Earth's inter-connected components respond to changes in air temperature, the Arctic is a sensitive indicator of climate variability and change.

The global climate system is revealing evidence of rapid change, largely amplified over recent decades [REF1; REF2; REF3]. Possible explanations exist, with several stating that current changes complement one another and lead to cascading effects on a global scale; other changes may function individually and act as local or regional climatic contributing factors. In both situations, the explanations may refer to either natural variability of the climate system or to anthropogenic-related drivers. In this context, the Arctic region, highly sensitive to climate variations and extremely responsive to external forcings, is experimenting rapid changes. Understanding the different processes, its variability and the different feedback mechanisms within the Arctic system, (i.e. interactions between ocean, sea ice, atmosphere and land) represents a mandatory step towards better predictions, EO being a critical tool to provide part of the required observations.

As reported [REF3], observed changes in the Arctic show that over the last three decades (1979-2015) the Arctic sea ice has continued to decrease in extent at a rate of 3.5-4.1 % per decade, with loss of perennial ice extent occurring at a rate of 11.5% (±2.1%) per decade. At the same time, average winter ice thickness has decreased by 1.3-2.3 m (1980-2008), this being consistent with the decrease in perennial and multi-year ice extent. Satellites have revealed that peripheral glaciers and ice caps (PGICs) have continue to shrink worldwide, with most of the ice loss occurring for glaciers in Alaska, the Canadian Arctic and the periphery of the Greenland ice sheet [REF4; REF5]. Satellite data, complemented by climate modelling, also suggests that mass loss from the Greenland Ice Sheet has been accelerating since mid-1990s [REF6; REF7] and is now one of the largest mass contributor to sea level rise. Satellite records (1967-2012) also show that the annual mean snow-cover extent in the Northern Hemisphere has decreased significantly, with the greatest change occurring in June (-40% to -66%) [REF3]. Satellite records of NDVI since 1982 have shown increasing greenness over large parts of the Arctic where summer warmth has increased [REF8], consistent with ground-based and airborne observations of increases in forest-type vegetation. The limited observations of freshwater ice in lakes and rivers indicate that due to later freeze-up and earlier break-up, the duration of the lake-ice season has shortened. For example, model simulations and satellite synthetic aperture radar (SAR) observations for over 400 lakes near Barrow, North Slope of Alaska indicate that between 1991-2011, lake-ice season duration decreased by ~1 day per year, lake ice thickness declined by a total of 18-22 cm, and fewer lakes froze to the bed (grounded ice), with an overall reduction in grounded ice of 22% [REF9]. Following an increase in permafrost temperatures in most regions during the last decades, general ice-rich permafrost degradation has been observed from both *in situ* and satellite observations, with significant changes in the Russian European North. [REF3].

Despite considerable research progress in understanding the Arctic region over the last decades, many gaps remain in observational capabilities and scientific knowledge. These gaps limit present ability to understand and interpret on-going processes, prediction capabilities and forecasting in the Arctic region, thereby hampering evidence-based decision making. Addressing these gaps represents a key priority in order to establish a solid scientific basis for the development of future information services for the Arctic.

In this context, on the 20th January 2015, ESA and the Cryosphere project of the World Climate Research Programme (CliC-WCRP) organised a scientific consultation meeting in Tromsø with the main objective of gathering recommendations from the scientific community on the most pressing priorities for Arctic research, where EO may contribute in the coming decade. The workshop resulted in a report [REF10] listing a number of different priority areas that will contribute to establish a strong focus on Arctic research in the next components of ESA EO programmes for the period 2017-2021.

In order to put words in actions, ESA and EC RTD have recently put in place a strategic partnership on the Arctic. The scope of the strategic partnership is to coordinate activities, align work programmes in fields of common interest and to have a coherent work plan and activities to be carried out with the objectives of supporting the definition and implementation of the future EU Arctic Policy, contributing to the creation of an integrated observation system for the Arctic, establishing a European Arctic science programme, and enabling the development of Arctic climate services.

In this context, ESA launched in 2016 the Arctic+ initiative. Arctic+ aims at advancing towards the achievement of some of the most pressing priorities in Arctic science, where EO and ESA data may contribute. In particular, the main overarching initiative objective is threefold:

1) Supporting the development of novel EO-based products and enhanced data sets responding to the needs of the Arctic science community;
2) Fostering new Earth system scientific results addressing the main priority areas of Arctic research, where space technology may provide a valuable input;
3) Preparing a solid scientific basis for stating larger development activities addressing the priorities of the Arctic science community in the timeframe 2017-2021.

This shall require the collaboration among the different scientific communities involved in Arctic process studies, modellers and EO experts, as well as coordinating with existing EC-RTD and national projects addressing Arctic science.
So, far, Arctic+ includes four feasibility projects:

- Arctic+ Snow (Snow on sea ice) [http://www.isardsat.pl/arctic+snow]
- Arctic+ Ice (Sea ice mass intercomparison) [http://www.isardsat.pl/arctic+ice];
- Arctic+ ArcFLux (Freshwater fluxes) [http://www.arcflux.eu];
- Arctic+ YOPP (Contributions to the Year of Polar Prediction) [http://arctic-plus.inversion-lab.com].

This ITT, Arctic+ Salinity aims at complementing the above set of activities.

2.1.1 Specific Objectives for the Arctic+ Salinity project

Freshwater fluxes (FWF) play an important role in ocean stratification and circulation. In the Arctic and sub-polar North Atlantic, they are also important for marine productivity. Changes in ocean circulation, in the strength of the Atlantic Meridional Overturning Circulation (AMOC) in particular, can have impacts on the climate system at global scale. As a consequence, oceanographic observational transects have been established to monitor the strength of the AMOC at key latitudes. However, these observations provide limited information on the causes of change. Large fluxes of freshwater are transported out of the Arctic Ocean each spring via sea-ice export through the Fram Strait. Riverine runoff into the Arctic Ocean (the riverine coastal domain) is also a key contributor to the FWF and nutrient balance of the Arctic that can be better estimated by a combination of satellite altimetry, river outline mapping, near-simultaneous space imagery, and *in situ* measurements.

In the last two decades, FWF from the Greenland Ice Sheet and Canadian Arctic have been steadily increasing into both the Arctic and North Atlantic Oceans. Finally, precipitation-evaporation (P-E) also plays a central role in modulating the FWF and, as a consequence, the hydrography of the region. Observational evidence from both satellites and *in situ* data indicates significant changes in the freshwater balance of Arctic seas.

Sea surface salinity may provide a key piece of information to better characterise freshwater fluxes in the Arctic. The Soil Moisture and Ocean Salinity (SMOS) mission provides measurements of surface salinity and its dynamics at global scale. However, L-band low sensitivity to salinity variations in high-latitude cold waters represent a significant challage for SMOS application over this specific region.

In this context, the primary objectives of Arctic+ Salinity are:

- Establish a link with the Arctic+ ArcFlux team [http://www.arcflux.eu] to explore potential synergies to be exploited during the project.
- Explore, develop and validate novel approaches to generate accurate sea surface salinity measurements on the Arctic from SMOS and SMAP missions;
- Generate a long-term dataset (SMOS and SMOS/SMAP) covering at least the full SMOS life time;
- Perform a thorough scientific analysis of the dataset investigating the observed dynamics and its links with Arctic processes (ocean circulation, land-ocean freshwater flows, E-P);
- Explore together with river flow data and other datsets (e.g., E-P, Greenland water flows, glacier flows) and models new approaches (including data assimilation) to connect salinity dynamics to land-ocean fresh water fluxes at regional scale targeting quantification of freshwater fluxes.
- Develop a scientific roadmap for future research activities.

3 GENERIC DESCRIPTION OF THE PROJECT TASKS

In the following, a generic description for each of the tasks to be carried out in the context of *Arctic+ Salinity* is provided. Any possible departure from the presented structure shall be properly justified by the Contractor.

The project shall be completed within a maximum of 18 months from kick-off.

- Task 1: Scientific Requirement Consolidation;
- Task 2: Dataset collection;
- Task 3: Development and Validation;
- Task 4: Scientific Analysis and Impact Assessment;
- Task 5: Scientific Roadmap.

Task 1: Scientific Requirements Consolidation
Description: In this task, the Contractor shall consolidate the preliminary scientific requirements for the project. This shall include: • Establish a link with the ArcFlux team to explore potential synergies to be exploited during the project (Contact person: Louise Sandberg Sørensen, e-mail: slss@space.dtu.dk). • A detailed review, assessment and analysis of the main scientific challenges, knowledge gaps and scientific problems to be addressed in the project. • A survey of all accessible associated datasets (space, airborne and *in situ*) to be used for development and validation (problems such as the lack of sufficient datasets shall be investigated and practical solutions identified); • A survey of accessible models to be used in the subsequent taks of the project. • An analysis and identification of the best candidate test areas to be used in successive tasks for development and validation of the prototype products. This shall include a complete analysis and description of the available data over those test areas. This Task shall be complemented by a consolidated risk analysis pointing out which risk areas could affect the final success of the project nd the proposed solutions. On the basis of such analysis, the Contractor shall then derive a consolidated, coherent and complete view of the scientific and operational requirements associated with the topic in consideration. Moreover, the Contractor shall describe in detail the technical and scientific constraints for the methods and models to be developed.
Deliverables: • Requirement Baseline (RB): This document shall capture the outcome of the above tasks and preliminary analysis, and include a complete and detailed description of the information requirements concerning the project. The RB will represent the basis for all the activities to be carried out during the project.

Task 2: Dataset Collection

Description:

A database of suitable products based on Earth Observation (EO), airborne, *in situ* data and relevant ancillary information shall be collected over the areas of interest in order to perform the required work. The database shall be made accessible, in the limits of the different data licences, on a project webpage and described in detail in a user manual.

Any restrictions in the use of any type of datasets (e.g., proprietary campaign data) shall be communicated to ESA in due time.

The datasets shall be used in later tasks for development and validation purposes.

Deliverables:

- Dataset;
- Dataset User Manual: this document provides a detailed description of the dataset as well as related metadata.

Task 3: Development and Validation

Description:

In this task, the Contractor shall explore, analyse, develop, test and select the necessary methods and algorithms to derive the required based products and develop the target test cases relevant to the project.

Major scientific efforts shall be devoted to this task to perform a thorough experimental analysis on different test sites in order to develop the suitable algorithms and novel prototype products.

The final methods and algorithms shall be selected on the basis of a detailed experimental analysis of the potential alternative methods and approaches supported by a sound inter-comparison and validation.

In this context, a detailed experimental error analysis for testing and verifying all the different implementation choices and ultimately evaluate the accuracy and reliability of the developed methods and products shall be carried out under different sites, assumptions or conditions that could affect or influence the performances of the methods and the final accuracy of the products.

A detailed description of the final version of the algorithms (including related data sources, processing steps and output data) shall be reported by the Contractor in the form of an ATBD. This shall also include a scientific analysis of the results driving to specific development choices and trade-offs (including technical considerations justifying the selected methodologies).

In addition, a detailed cross-comparison of the resulting products/estimates with existing EO-based equivalent/alternative datasets shall be performed in order to gain a thorough understanding of the range of validity, limits and benefits of the different existing products in the relevant thematic area.

The Contractor shall also report a detailed description of the error and validation analysis as well as the cross-comparison experiment exercise into the Validation Report (VR).

Deliverables:

- ATBD: This document shall describe in detail all the algorithms, methods and models implemented for theproject. The report shall also include all related input data and its sources, processing steps and output data. In addition, this document shall report a scientific analysis of the results driving to specific development choices and trade-offs for all the algorithms implemented for developing the whole suite of target products. Technical considerations justifying the selected methodologies shall be also provided.
- Product VR: This document shall describe all the experimental error analysis and validation activities carried out.

Task 4: Scientific Analysis and Impact Assessment

Description:

On the basis of the developed methodology, the target prototype products shall be generated (hereinafter called experimental dataset) and the proposed application shall be demonstrated over a number of selected areas and suitable time frames including a regional assesment.

The geographical areas and the time frames to be covered by the dataset shall be representative of the faced scientific problem and application, allowing a complete demonstration of the feasibility of the proposed methodology and its potential value in terms of scientific and operational potential returns. This should include:

- A thorough scientific analysis of the dataset investigating the observed dynamics and its links with Arctic processes (ocean circulation, land-ocean freshwater flows, E-P);
- Explore together with river flow data and other datsets (e.g., E-P, Greenland water flows, glacier flows) and models new approaches (including data assimilation) to connect salinity dynamics to land-ocean fresh water fluxes at regional scale targeting quantification of freshwater fluxes.

This experimental dataset shall be integrated into the project dataset generated in Task 3 and the user manual shall be updated accordingly. The experimental dataset shall be publicly available via the project website.

On the basis of the resulting dataset, the Contractor shall interpret, analyze and quantify the impact and benefits of the results obtained in the context of the Arctic processes quantification and understanding. This shall include:

- Comparison of the results with existing and current state of the art results quantifying the improvement of the development methods and models;
- Analyse the errors/uncertainties;
- Investigate the potential of the derived product to enhance the current knowledge and state-of-the-art in the context of Arctic fresh water fluxes;
- Determine the benefit and impact of the obtained results on the specific test areas considered in the project in close collaboration with the relevant scientific and user communities;
- Determine the general potential benefit and impact of the results on the scientific and operational areas addressed by the project.

Deliverables:

- Experimental dataset publication on the web;
- Updated dataset user manual;
- Impact Assessment Report (IAR): This document shall collect the final findings and results of the Impact Assessment.

Task 5: Scientific Roadmap

Description:

In this task, the Contractor shall define a Scientific Roadmap for fostering future developments aimed at transferring the outcomes of the *Arctic+* project into future scientific activities for the time frame 2017-2021 and where applicable, into pre-operational services in the future. In this context, the consultation with scientific and existing operational organisations which operated in the Arctic is considered fundamental. Note that at least the following issues shall be considered:

- Providing a critical analysis of the project results obtained vs. the specific scientific objectives of the project and the chalages associated it.
- Identifying the required additional scientific work and developments to further advance towards achiving the overarching scientific objectives of the project and the Arctic+ initiative;
- Identify potential observational gaps (satellite, in-situ) that may be addressed in the future by novel products, new datasets, in-situ campaigns and or even future missions;

- Investigate the potential for integrating the project results into existing or planned large scientific initiatives;
- Define a solid scientific agenda and development and evolution plan for the project in the timeframe 2019-2021.
- Identify and coordinate with the relevant projects and teams at international, EC and national level that may be relevant for a potential project evolution in the time frame 2019-2021, ensuring that the proposed roadmap fits within planned projects and initiatives in preparing the future;
- Defining a potential plan for fostering a transition from research to operational activities, when relevant;

Deliverables:

- Scientific Roadmap (SR): This document shall define strategic actions for expand the work done under Arctic+ towards larger scientific activities in the period 2017-2021 in support of Arctic research.

4 MANAGEMENT, PROMOTION AND COORDINATION

4.1 6.1 Promotion and coordination

The Contractor shall:

- Promote the Project(s) results within the relevant scientific and/or operational communities;
- Promote the resulting products, methods and datasets to the user community;
- Represent the project at scientific conferences and other international forums through scientific presentations and exhibitions;
- Based on the results provide multimedia content to be used for communication, educational and promotional purposes, such as image files, animations, presentation slides, etc.;
- Submit at least one paper to an international peer-reviewed journal.

In addition and as a minimum, the following items shall be delivered (the contents and format of all promotional material shall be submitted to ESA for approval):

Project Website: before the end of Task 1 a website for the project shall be developed. The contents of the website shall be submitted to ESA for approval. This website shall also provide a direct access to the different products and datasets developed during the project. This shall include an internal webpage (password protected, accessible to ESA and consortium members) for supporting management and documentary activities.

The project webpage content shall be maintained and updated by the Contractor at least every month to include updated deliverable items and content for the duration of the contract.

The Contractor shall also coordinate with the relevant projects and teams at international (e.g., CliC), EC (e.g., existing projects or project originated from the future calls on the Arctic under the Horizon 2020 WP 2016-17 – expected to be published in October 2015) and national level that may be relevant for the project and in particular for preparing a SR (Task 5) for further developments in this domain, ensuring that the proposed activities are well coordinated with existing projects and initiatives in preparing the future.

4.2 6.2 Management and reporting

The Contractor shall provide at least the following management deliverables:

- Monthly Executive Summary Progress Reports (maximum one page);
- Final Report for public access;
- Executive summary of the project summarising relevant achievements.

The schedule of planned activities shall comply with the milestones reported in the table below. In addition, a Progress Meeting (PM) will take place every three months (by video or teleconference).

The following meetings shall be planned:

Meeting name	ID	Venue	Schedule
Kick Off Meeting	KO	N/A	KO (by teleconference)
Mid-Term Review	MTR	Contractor premises	KO+9 months
Final Review	FR	ESRIN	KO+18 months

The Contractor shall provide electronic versions of all presentations, hand-outs, deliverables, reports and presentations for each progress meeting **at least one week** in advance of the meeting, via the website. All material required to conduct the meeting shall be accessible by all participants of the meeting (ESA and others).

The Contractor shall provide electronic versions of all final presentations and meeting minutes (including presentation slides and word processor documents) made at every meeting at the project website within 2 weeks following each progress meeting.

Electronic copies of the hand-outs used during each progress meeting, including at least the meeting agenda, a contact list for all meeting attendees and minutes from the previous progress meeting, shall be provided by the Contractor.

The following table summarises the deliverables for all the tasks:

Activity	Deliverable
Scientific Requirement Consolidation	• Requirement Baseline (RB)
Dataset Collection	• Dataset • Dataset User Manual
Development and Validation	• Algorithm Theoretical Basis Documents (ATBD) • Product Validation Report (VR)
Scientific Analysis and Impact Assessment	• Experimental Dataset • Updated Dataset User Manual • Impact Assessment Report (IAR)
Scientific Roadmap	• Scientific Roadmap (SR)
Promotion	• Project website • Publications • Presentations • Communication material
Management	• Executive Summary Progress Reports • Final Report • Executive Summary

5 DATA ACCESS

It is the responsibility of the Contractor to secure access to the relevant data sets (i.e. satellite or campaign) required for this activity. Bidders or team members who are not already registered users of ESA data may register by following instructions found on the Earth Observation Data Access portal (https://earth.esa.int/web/guest/pi-community/apply-for-data). Further information may be obtained by sending an e-mail to eohelp@esa.int.

It is worth noting that the work to be performed in *Arctic+* will require the availability of additional data sources (satellite data, ancillary information and airborne or *in situ* measurements) beyond ESA data. Accordingly, the Contractor shall have granted access to the required data sets to perform the project.

All potential restrictions in the use of the non-ESA, or non-ESA third party missions, data used in the project shall be communicated to ESA in due time.

Data procurement can be quoted, but all the procurement with the ESA budget will be property of ESA and will only be put at the disposal of the Contractor in the framework of the project. Terms and conditions from the Data Distributors are to be fully understood and strictly fulfilled.

Due to the Research and Development (R&D) nature of the present activity, the Contractor shall explore the possibility of acquiring non-ESA data required for the project at an R&D compatible price.