

Framework Service Contract EEA/DIS/R0/20/001 Lot 1 for Services supporting the European Environment Agency's (EEA) cross-cutting coordination of the Copernicus programmes in situ data activities – Observational data

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# **Arctic Data Progress Report Workplan ID: 8**

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## Executive Summary

A dedicated Work Package on Arctic Data under the COINS service contract with Copernicus In Situ Coordination Activity led by EEA has during the reporting period (September 2020 – October 2021) delivered:

- A catalogue on time-limited research projects with an Arctic focus funded over the past 10-15 years by EU, national and regional funding sources
- An Arctic Marine Data Portal in cooperation with EMODnet, CMEMS INSTAC and EuroGOOS and work on ingesting data – initially from icebreaker expeditions and research projects is in progress.
- Identification of more than 13.000 individual atmospheric composition dataset. Work has started to ingest these data into relevant archives.
- An analysis of the potential use of emerging ocean observation technologies for model validation.

Additionally, work has been devoted to:

- Initiate a dialog with ASIAQ, Greenland and Landsvirkjun, Iceland to find ways to make their data available to Copernicus
- Identify ways towards opening for Russian data – this has been unsuccessful up to now. Progress will most likely require high-level diplomacy
- Refining requirements for in situ observations in the Arctic to be included in CIS<sup>2</sup>
- Follow and influence Arctic focussed planning and initiatives in international organisations.

For the second Service contract period the Arctic WP suggests to focus on:

- Harvesting of Arctic in situ data to relevant Copernicus data portals – split in the following groups:
  - Online data
  - Offline data
  - Identify and collect data from before 1992
- Establishing requirements for in situ observations of essential variables in the Arctic in close dialog with the Copernicus Services and Satellite community
- Information campaign on the importance of in situ observation and free data exchange

## Introduction

The Copernicus Services and Space Component did at different occasions in 2018 raise a strong concern on the timely availability of sufficient and relevant in situ data from the Arctic region to:

- Maximize the exploration of present and future Copernicus Sentinels
- Produce and validate products from the Copernicus Services – CMEMS, C3S, and CAMS

The Copernicus In Situ Coordination Activity did consequently in 2019 implement an analysis of:

- Requirements for meteorological, ocean incl. sea ice and cryosphere in situ data in the Arctic region by Copernicus Services and Space Component.
- Existence and availability of the requested data incl. identification of condition for accessing restricted data (payment, limitation in use etc).
- Identified gaps.

The analysis was reported in December 2019<sup>1</sup>. The report recommended three follow-up activities for immediate initiation:

**1. Prepare a catalogue of on-going and former Arctic time-limited (research) observation campaigns.**

Objective: Make relevant observations performed by research projects during the last 10-15 years readily available to Copernicus, mainly for validation and reanalysis purposes.

Scope: Primarily FP7 and H2020 research projects; secondly regional and national campaigns as well.

**2. Establish a Data Rescue Task Force**

Objective: Prepare a prioritised list of organisations and institutions identified under (1) with a view to improving the availability and accessibility of observations made during R&D measurement campaigns. Focus shall be on those possessing data meeting Copernicus crosscutting requirements.

**3. Improve access to Russian data from the Polar region**

Objective: Define and implement an approach that aims at improving the cooperation between Copernicus and Russian data custodians and owners possessing essential observations from the Polar region with the purpose of making those observations readily available to Copernicus for validation and reanalysis purposes.

Work on the first of these three activities was initiated January 2020, but implementation was compromised by the COVID 19 situation, so the analysis was not fully finalised by the end of the previous Copernicus In Situ Coordination Framework contract June 2020.

For this reason and the fact that Copernicus 2.0 have identified the Arctic as a special focus area, EEA decided to have a continued focus on an improved access to in situ data from the Arctic Region during the first service contract period under the new Copernicus In Situ Coordination Framework contract.

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<sup>1</sup> <https://insitu.copernicus.eu/library/reports/CopernicusArcticDataReportFinalVersion2.1.pdf>

An Arctic Data Work Package with the objective to improve the availability, quality, timeliness and accessibility of essential in situ data from the Arctic region was set as part of the Service Contract.

The work in the COINS Arctic Data WP has been divided into six Tasks:

Task 7.1: Finalise work on Arctic Project catalogue

Task 7.2 Unlocking of Arctic Project Data

Task 7.3 Russian data – in cooperation with WP8 (Data licensing activity)

Task 7.4 Assessing potential of emerging observations for Copernicus Arctic service

Task 7.5 Requirement mapping – link to CIS<sup>2</sup> activity

Task 7.6 Follow and influence activities in SAON ROADS, Arctic Data Committee, IOC Ocean Decade, WMO arctic programs and GEO Cold Region

Overview of the activities and achievements within these six tasks during the period September 2020 – October 2021 will be reported in the following chapters.

## 1. Arctic Project Catalogue

During January-June 2020 an activity within the Copernicus In-Situ Coordination Group was carried out with the goal to make relevant Arctic in-situ observations performed by research projects during the last 10-15 years readily available to Copernicus, mainly for validation and reanalysis purposes.

To address this goal the project focussed on:

- Preparing a catalogue over relevant time-limited projects with an Arctic focus within the domains of atmospheric chemistry, cryosphere, ocean, and meteorology. Focus was on:
  - o EU-funded projects - FP7 and H2020 (2007 -now),
  - o regional and national funded projects
- For each project identifying:
  - o If and which in-situ data has been collected?
  - o Where data are stored?
  - o Are data freely available, e.g., available to Copernicus?
- For data not available to Copernicus identify the limitations for a free data exchange.

A preliminary report was delivered by the end of the first Copernicus In Situ Coordination Framework Contract June 2020. The collection of relevant information was however not fully implemented due to the COVID 19 pandemic change in working conditions, so the work was continued as part of the new Copernicus In Situ Framework Contract (COINS Contract) that started September 2020.

The following activities has been implemented since September 2020:

- A few newly started H2020 projects has been added to the catalogue together with more details on some of the projects already included in the catalogue
- The report was updated accordingly.
- The report and project catalogue were sent to CAMS, C3S, CMEMS, ESA and EUMETSAT for review and commenting – only CMEMS responded.
- Final corrections to the report were introduced based on the received feedback.
- The final version of report and project catalogue was delivered to EEA February 2021.

This task is regarded as completed.

## 2. Data Ingestion

This task is regarded as a contribution to the suggested second activity on “Establish a Data Rescue Task Force” and include three components in this contract period.

### 2.1 Marine Arctic Data Portal

At the Polar Data Forum III (PDF III) in November 2019 the Copernicus In Situ Coordination Group, EMODnet Physics, CMEMS INSTAC and EuroGOOS organised a workshop on marine data from the Arctic Ocean. Recent surveys performed by Copernicus In Situ Coordination Group and the INTAROS project has revealed severe gaps in the present Arctic Observing System – especially the central Arctic, but also gaps in timely availability and quality of existing observations and in the availability of data from both European and non-European countries. A major part of the marine observations in the Arctic are funded via time-limited research projects with limited capacity for data management. The workshop recommended to establish a “Marine Arctic Data Portal”.

The abovementioned organisations subsequently took the initiative to establish such a Data Portal with the purpose:

- To be a one-stop- shop for Arctic Marine in situ data easily accessible and freely available for any users.
- Support European data integrator infrastructures (CMEMS, EMODnet and SDN) with relevant data.
- Unlock existing data from a variety of projects not yet freely exchanged.
- Display performance of Arctic Ocean Observing System.

It was agreed to use the EMODnet Physics platform for the purpose since it can provide straightforward access to centrally-curated circumpolar datasets and metadata records and a cooperative agreement between CMEMS INSTAC and EMODnet ensures data ingested into the Arctic Marine Data Portal are fully available to the Copernicus community.

The portal was implemented during 2020 and launched via a virtual kick-off meeting for invited participants on 20 November 2020 and an open webinar on 27 November 2020.

The portal is available on: <https://arctic.emodnet-physics.eu/>

The portal aims at:

- Stimulate further data sharing
- Helping scientists find the data they need to answer key questions.
- Allowing research planners and program coordinators to explore the spatial and temporal distribution of observing platforms using the map interface. This knowledge will help them to identify gaps that need to be filled in the observing system.
- Allowing researchers to easily and rapidly explore the data to test its suitability for their needs using the plotting tools for the datasets.



To speed up the ingestion of ocean data to Marine Arctic Data Portal SMHI, who is a leading partner in EMODnet, joined as a partner in the COINS Arctic WP during summer 2021. Their work has focused on:

- Establishing a M2M (machine-to-machine) connection (ERDDAP) with ETT, EMODnet Physics technical hub. This to enable direct, fast, redistribution of data to EMODnet and hence Copernicus INSTAC.
- Establish and implement collaborating with the Swedish Polar Research Secretariat to access data from all previous expeditions, both from the Arctic and Antarctic, from the icebreaker Oden. Data from 2002 till now will be considered for data ingestion.
- First dataset received is from the Oden's 2018 expedition and CTD data but also other parameters are available. For a full parameter list see: [https://s3.sto3.safedc.net/polar-datalager/Oden/Arctic\\_Ocean\\_2018/data/public\\_documents/Odendata%20Parametrar%20List%202018-2019.pdf](https://s3.sto3.safedc.net/polar-datalager/Oden/Arctic_Ocean_2018/data/public_documents/Odendata%20Parametrar%20List%202018-2019.pdf). Ingestion of these data has started and will be followed by other Oden expeditions.
- EMODnet Physics is about to sign an MoU with the ARICE, Arctic Research Icebreaker Cons, <https://arice-h2020.eu/> project. This will enable further access to data from icebreakers in the Arctic and hence to Copernicus

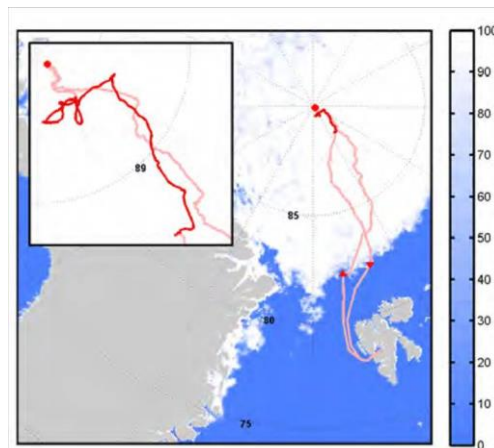


Figure 2.1 Oden 2018 expedition

Based on the Project Catalogue (see Chapter 1) and the ongoing EMODnet Data Ingestion project work on ingesting much more data into the Marine Arctic Data Portal will be carried out beyond 2021. Figure 2.2 shows the data entered into the portal during March 2021.

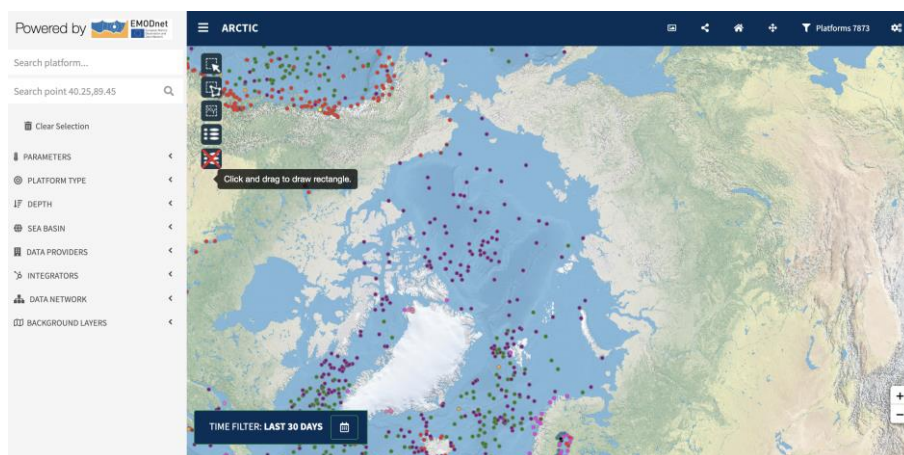


Figure 2.2 Arctic Marine Data Portal data entries October 2021.

## 2.2 Reanalysis data/ASIAQ and Landsvirkjun

In the Copernicus Arctic Regional Reanalysis (CARRA) project, the meteorological institutes involved have committed themselves to acquire as much as possible relevant observation data for the purpose of including these data into the reanalysis or for the purpose of system validation. The CARRA reanalysis product is available in Copernicus Climate Data Store (CDS) covering the period from 1997 to 2021. Recently this period has been extended back in time to cover the period from 1991 to 1996. Data from this period will, according to the plan, be made available on CDS before the end of 2021.

The reanalysis is performed with a regional setup of DMI's operational weather model, Harmonie, with a spatial resolution of 2.5 km covering Greenland and Iceland. Observation data from more than 400 stations are used in CARRA. This includes data from GTS (WMO's Global Telecommunication System), GC-NET (Greenland Climate Network), PROMICE (Programme for Monitoring of the Greenland Ice Sheet) and data from ASIAQ Greenland Survey's observational network in West Greenland and data from the Icelandic National Power Company, Landsvirkjun. Most of these observation data are publicly available except those from ASIAQ and Landsvirkjun. To address this issue, COINS and EEA have engaged in dialogue with ASIAQ and Landsvirkjun to explore the possibilities and conditions under which their data may be made available to the Copernicus Services and in particular to the Copernicus Climate Change Service (C3S).

ASIAQ is part of the Department for Finances and Nordic Relations in Greenland's Self-Government. ASIAQ's financial model is based partly on sales of surveys, consultancy, feasibility studies and observation data. ASIAQ provides, however, observation data free of charge to non-profit, collaborating research and development institutions. In this way, historical data from 16 stations, going back to 1997, were provided free of charge to the CARRA project under an agreement between ASIAQ and DMI about the exchange of data for non-commercial usage for research and education and with a clause that these data may not be given to a third party. Landsvirkjun is operating a number of weather stations in Iceland in additions to those operated by the Icelandic Meteorological Office (IMO). IMO is maintaining all these stations in an agreement with Landsvirkjun and data, including those from Landsvirkjun's stations, are stored at IMO. It is the opinion of EEA and COINS that ASIAQ's and Landsvirkjun's data are of great relevance to the Copernicus Services in general and to C3S in particular.

The status, as of now, of the dialogue between EEA, COINS and ASIAQ is such that:

- ASIAQ has provided a complete metadata overview of their weather stations and estimates of time and resources required to make their data available to Copernicus Services.
- Landsvirkjun together with IMO is finalising a metadata overview of Landsvirkjun's weather stations and estimates of time and resources required to make their data available to Copernicus Services.
- Provided an agreement can be reached between EEA and ASIAQ, respectively, Landsvirkjun, data will, as a first step, be made available exclusively to the Copernicus Services. This implies that, e.g., general users of CDS products will not be given access to ASIAQ's data.

Ongoing dialogues are focusing on finding ways by which ASIAQ and Landsvirkjun may become adequately compensated for their expenses related to making their data available to the Copernicus Services.

## 2.3 Atmospheric composition homeless data

As a follow up of the outcome of The Arctic Data Report (Buch et al, 2019) and in parallel to the ongoing work in WP2 “Homeless data”, effort has been put into the following activities:

- Detection of old offline data archives and thoroughly review of these.
- Established contact with station managers to reveal if there are instruments with data which are not reported to current archives, or instruments that are planned installed in the nearest future.
- Reformatting of data and populating of current archives (EBAS <http://ebas.nilu.no/> and EVDC <https://evdc.esa.int/> )

Good progress has been made and more than 13 000 individual datasets from around 10 different measurement principles have been discovered so far. Out of these, we have selected the ozonesonde data as prioritized dataset for adding to existing archives. Based on feedback from the ECMWF we will not go further backwards in time than year 2000 for the historical data ingestion. It is planned that the next CAMS global reanalysis will also just go back as far as 2003.

There is a collaboration between COINS and UHEL (University of Helsinki) for adding non-reported particle data from 5 or 6 European stations to EBAS. These are ongoing measurements or new instrumentations to be set up in the nearest future.

The work has progressed with direct contact with the PIs and data reportes. Longer ozonesonde time series are added to the EVDC archive at <https://evdc.esa.int/> and for a few stations the data are also made available in Near-Real-Time.

Effort is being put on adding uncertainties to the existing data.

COINS Arctic WP has participated in the ATMO-ACCESS <https://www.atmo-access.eu/> meetings and contributed to setting up a survey for scooping the needs of a homeless data reporting tool as an online self-service for “homeless” unreported data fitting into the ACTRIS, IAGOS and ICOS data archives. The surveys will be reviewed end of October, but preliminary results shows that out of 6 responders 1 has still unreported data from the Arctic.

SIOS <https://sios-svalbard.org/> has discussed to add a task in the SIOS remote sensing working group to explore if there are homeless Cal/Val data from Svalbard that can be released to support the work of COINS. The draft workplan for 2022 for SIOS remote sensing working group (RSWG) is currently being discussed and will be agreed on early November.

As SMHI has entered the Arctic WP and added the icebreaker data to the project, it is was investigated if any of the ships has performed atmospheric measurements during their cruises. So far there is no evidence of such data.

The work is summarised in detail in the separate WP2 progress report.

### 3. Russian Data

The Arctic Data Report (Buch et al., 2019) demonstrated that a large number of environmental observations are collected and stored in Russia, but access to these Russian data are extremely limited and calls for a dedicated action to free more critical observations in cooperation with Russian authorities. This was the reason for formulating action 3 (see Introduction) aiming at improving access to Russian data from the Arctic region.

Activities to address this activity includes:

- Attempt to find key high level Russian representatives to contact. This has been done in cooperation with Willie McCairns, ECOMET, who have good contacts via WMO engagement. A potential good candidate was identified but he did not react to inquiries, so no positive result so far.
- Via participation in Arctic research projects, Russian partners have been contacted to discuss the issue, but these persons do not have authority to address the matter since decisions are, in our understanding, taken at higher national political levels.
- Colleagues from research projects and European Research Infrastructures (pers. comm.) have been contacted to learn about their experience. They share the same frustration as the COINS consortium on the getting access to Russian data.

A temporary conclusion is that no real progress has been made and that this is a rather difficult problem that most likely has its roots in the global political situation with strong political tensions between Russia and the western world. Further progress will therefore require high level EU diplomacy. It was on this background interesting to learn that EU Polar Expert Group III has access to Russian data as a priority and pursue the matter via their contact network. It is hoped that COINS can join forces with them.

## 4. Assessing potential of emerging observations for Copernicus Arctic Services

An analysis of the usability of temperature and salinity measurements obtained from instruments mounted on fishing gear and on marine mammals for ocean model validation has been performed. The fishing gear observations have several advantages, i.e., they are operational, accessible in near real-time, high spatial resolution and covering both coastal and offshore waters. The marine mammal observations are also operational, have high spatial and temporal resolution and covering pan-Arctic waters, especially marginal ice zone, coastal and offshore waters, and provide quite good temporal coverage in winter months. These features are complementary to traditional research vessel observations, which are of low frequency and mainly covering the summer months and open waters.

In the analysis observed water temperature and salinity data from fishing gears and marine mammals are compared with the CMEMS ARC MFC analysis and 12 hour forecast data and CMEMS global reanalysis product, respectively. No quality problems are found in the available observations. The validation results show that the fishing gear and marine mammal observations are valuable and unique for identifying model error features in the Arctic coastal and marginal seas, providing hints for further model improvements. In general, it can be concluded that the instruments used for oceanographic observations from fishing gears and the animal borne instruments are of documented and satisfactory quality to be used for modelling purposes

A Technical Report (She et al., 2021) presenting the observational instrumentation, data and data quality, used model data and the model validation results has been prepared. The report was reviewed by CMEMS ARC MFC and INS TAC. After a consultation meeting with Mercator Ocean International, the comments from CMEMS have been implemented. The final version was delivered to EEA September 2021.

This task is regarded as completed.

## 5. Requirement Mapping

The **Copernicus In Situ Component Information System (CIS<sup>2</sup>)**. This is a database which is intended to provide a detailed overview of all in situ datasets used by the Copernicus Services and to identify possible gaps. It relates the in-situ requirements expressed by the Copernicus Services and Satellite Component to in situ datasets and their providers, in order to provide a clear picture of what data is already available and what would be needed to deliver improved and more reliable products and monitoring services. It has been populated, for each Copernicus Service Product, with the specific technical details of the relevant in situ data requirements and with the relevant available datasets associated with them, their level of compliance with the requirement, and other relevant information.

COINS Arctic WP has initiated work to conduct (together with the relevant Copernicus Services) a critical review of the requirements for all essential in situ variables in the Arctic, as reflected in the CIS<sup>2</sup> data base. This is done with respect to spatial and temporal resolution, data quality, underlying timelines etc. The records of data providers in CIS<sup>2</sup> will also be reviewed with respect to specific arctic aspects. The review has been initiated, but not yet completed. It is expected that this work can be completed when the detailed content of the Services portfolios has been established for Copernicus 2.0.

So far information on requirements for the Arctic Regional Reanalysis (CARRA) has been achieved. CARRA's requirements for meteorological variables are already well represented in the CIS<sup>2</sup> database. However, a requirement for snow related variables was expressed as well. These are so far not available from CIS<sup>2</sup> and will be added after some further discussion of the details. A dialogue on this has been established with Anna Frey at FMI, who has considered the requirements for snow related variables expressed by the other services, not specifically in the Arctic but globally.

Also, the In-Situ Requirements identified by the Polar Expert Group established by DG-DEFIS in support of the new Sentinel missions have been compared to the information currently recorded in CIS<sup>2</sup> and the following gaps have been identified:

- Requirements for Ocean dynamic variables are represented in CIS<sup>2</sup>
- Requirement for Ocean colour is not represented in CIS<sup>2</sup>
- Requirements for sea-ice variables are represented in CIS<sup>2</sup>, except for iceberg drift
- Requirements for snow depth is represented in CIS<sup>2</sup>
- Requirements for land-ice variables are not represented in CIS<sup>2</sup>

Work is in progress, and other institutions will be contacted as well.

## 6. Follow and influence international organisations

It has been regarded important to follow ongoing planning and implementation of in situ observation incl. data management in other organisation and projects in order to identify possible new data sources and articulate Copernicus requirements and expertise. During the reporting period (September 2020 – October 2021) the WP members has been actively engaged in a number of activities which is shortly summarised in the following.

### 6.1 UN Ocean Science Decade – Arctic Action Plan

On 5 December 2017, the United Nations declared that a Decade of Ocean Science for Sustainable Development would be held from 2021 to 2030. The Ocean Decade provides a common framework to ensure that ocean science can fully support countries to achieve the 2030 Agenda for Sustainable Development. The implementation includes regional action plans.

The initiative for the Arctic started with a one-day Policy - Business - Science Dialogue meeting in Tromsø as part of the Arctic Frontiers conference in January 2020. This was to be followed by a three-day workshop in April in Copenhagen where the Action Plan should be developed. Due to the COVID-19 pandemic, this was transformed into a series of online workshops held in October and November of 2020 for which working groups organized around the seven Decade Societal Outcomes were established. An initial draft of the Arctic Action Plan was made accessible for consultation and feedback by all sectors from 13 March – 11 April 2021, the COINS Arctic Data WP provided comments to the Action Plan including an overview of the activities performed by the Copernicus In Situ Coordination Group regarding Arctic Data.

### 6.2 SAON Arctic Data Committee

In 2014 SAON established the Arctic Data Committee (ADC) with the overarching purpose to promote and facilitate international collaboration towards the goal of free, ethically open, sustained and timely access to Arctic data through useful, usable, and interoperable systems.

Due to the Corona lock down the ADC met virtually four times during the past year. The meetings were centred around three working groups:

1. Federated Search
  - a. Share developments in the area of metadata aggregation with particular focus on [schema.org](https://schema.org)
  - b. Discussion of linking [schema.org](https://schema.org) to other metadata standards and services (e.g. ISO 19115/ OGC CSW)
  - c. Identify key shared metadata vocabularies in use
2. Vocabularies and Semantics.
  - a. Determine how to work on the Best Practices part of science on [schema.org](https://schema.org)
  - b. Work on Time, space, and other sections of science On [Schema.org](https://schema.org) not addressed at PDF III



- c. Understanding the process for contributing to community ontologies (e.g. ENVO)
3. Data Policy.
    - a. At the third Polar Data Forum a process was initiated to update and align the data policies of IASC, SCAR, SOOS and potentially other polar science groups. The aim was to move this process forward by forming a group to work on objectives and core principles of an updated, polar data policy document.

The COINS Arctic Data WP took part in the Data Policy discussion that resulted in formulation of a document with the title: ***“Alignment of Polar Data Policies - Recommended Principles”***.

ADC is also responsible for organising the “Polar Data Forum” conferences and the fourth conference took place 20-24 September 2021.

### 6.3 Polar Data Forum

The Polar Data Forum (PDF) is a place where polar data holders get together and make more use of data. The Forum has two main components:

- the Conference, where the border between funding, policy and data is explored through presentations and posters
- Workshop Sessions & Hackathons, where the Polar Data Community opens the dialogue to make progress on their shared objectives.

Polar Data Forum IV (PDF IV) took place as a virtual meeting 20-24 September 2021. PDF IV was collocated and co-organised with the 2nd Southern Ocean Regional Workshop for the UN Decade of Ocean Science for Sustainable Development (UNDOS). It therefore focused on data management issues that can support UNDOS activities in the Southern Ocean, as well as broader polar data management issues. Acknowledging that the data needs for the Southern- and Arctic Ocean have many commonalities and many science organisations collect data at both ends of the world, focus was on developing solutions that work for both the Arctic and Antarctic.

The Arctic WP was represented in the organising committee and the Marine Arctic Data Portal was presented at the meeting.

### 6.4 Arctic Science Ministerial planning

A series of webinars has been organized over the winter 2020-21 in order to increase transparency of the Arctic Science Ministerial (ASM) science process and to provide additional opportunities for scientists, Indigenous Peoples and Arctic research stakeholders to further engage with the science and proposed actions leading up to the Third Arctic Science Ministerial in Tokyo, Japan in May 2021. The webinar series has been organized as a joint effort between the ASM3 organizers in Iceland and Japan and the European Polar Board. Each webinar is available on the European Polar Board YouTube page and a written summary are available on the ASM3 website.



Identified actions needed to address gaps and barriers relating to ASM3 Themes:

- Observe - Observing networks; Data sharing – towards implementation.
- Understand - Enhance understanding and prediction capability on Arctic environmental and social systems and its global impact.
- Respond - Sustainable development; Evaluation of vulnerability and resilience; Application of knowledge.
- Strengthen - Capacity building; Education; Networking; Resilience – prepare the next generation.

## 6.5 EU Polar Cluster

The EU Polar Cluster is a network of Horizon 2020 and a Framework Programme 7 funded polar projects with the objective to bring the insights from various areas of expertise together in order to provide one entry point to EU funded Polar research. The cluster merges a broad spectrum of research and coordination activities – ranging from the most up-to-date findings on permafrost and sea ice, from enhancing observation to improving predictions, and from networking research stations to coordinating access to icebreakers.

The Cluster is fostering international cooperation, in reporting on the impacts of climate change on the Arctic's fragile environment, in promoting sustainable development and in cooperating with policy makers, indigenous peoples and local communities, business and NGO representatives and other societal actors.

The EU Polar Cluster has formed five Task Groups:

- Policy advice
- Data
- Stakeholders
- Education
- Communications

EuroGOOS actively follow the work in the EU Polar Cluster via its engagement in the INTAROS project.

## 6.6 Polar Expert Group

The Polar Expert Group (PEG) was established by the European Commission in 2017 to define the requirements for a Polar mission and its observation priorities. The PEG supports the definition of the Arctic Monitoring component of Copernicus 2.0.

April 2021 the third PEG report was issued ([Copernicus new PEG Group report published](#)). The report in particular provides a complete analysis of the requirements for Arctic in-situ data to complement the Copernicus High Priority Candidate Missions as well as the Next Generation Sentinels proposed for Copernicus 2.0. The analysis covers the observational domains Marine, Land, Climate and Atmosphere.

Regarding in-situ data the Polar Expert Group recommends:

- continuous, stronger international cooperation/coordination (including all EU Member States, WMO and Arctic States) and encouraging national investments/effort to develop and maintain platforms and equipment. In-situ data used for research and operational services, in the polar regions, shall be free and open, following standardised data formats.
- that requirements for Fiducial Reference Measurements become an integrated part in the Mission Requirements and consequently in the design phase of new Sentinel missions.

The Arctic WP will follow the implementation of the Polar Expert Group recommendations

## 6.7 WMO Arctic Programs

Following the reorganisation of the WMO Technical Commissions, the following groups are currently specifically addressing polar/arctic/cryosphere aspects:

At the high-level the polar activities are still overseen by EC-PHORS (Executive Council Polar and high-mountain observations, research and services Panel of Experts). EC-PHORS has a number of Working Groups, in particular the Polar Space Task Group and the Observations Task Team. For organisation and membership, see

- <https://community.wmo.int/governance/executive-council/executive-council/executive-council-members/polar-and-high-mountain-observations-research-and-services-panel-experts>

Affiliated with EC-PHORS is the Global Cryosphere Watch Steering Group, with a number of working groups, including the GCW Observations Working Group, see

- <https://community.wmo.int/governance/executive-council/executive-council/executive-council-members/polar-and-high-mountain-observations-research-and-services-panel-experts/global-cryosphere-watch-steering-group>

Under the Infrastructure Commission (INFCOM) you will find the Expert Team on Cryosphere Observations from Space (ET-COS), see

- <https://community.wmo.int/governance/commission-membership/commission-observation-infrastructures-and-information-systems-infcom/commission-infrastructure-national-representatives/infcom-management-group/standing-committee-earth-observing-systems-and-monitoring-networks-sc-2>

and the Study Group on WMO Cryosphere Crosscutting Functions: Global Cryosphere Watch (SG-CRYO), see

- <https://community.wmo.int/governance/commission-membership/commission-observation-infrastructures-and-information-systems-infcom/commission-infrastructure-national-representatives/infcom-management-group/study-group-wmo-cryosphere-crosscutting-functions-global-cryosphere-watch-sg>

Under the Services Commission (SERCOM) no working groups are specifically considering arctic matters.

The WMO Research Board (<https://community.wmo.int/governance/commission-membership/research-board>), oversees the Polar Prediction Project, see

- <https://community.wmo.int/governance/commission-membership/research-board/wwrp-scientific-steering-committee/polar-prediction-project>

Arctic Regional Climate Centre Network (ArcRCC) - RCCs are Centres of Excellence that assist WMO Members in a given region to deliver better climate services and products including regional long-range forecasts, and to strengthen their capacity to meet national climate information needs.

ArcRCC is currently in a demonstration phase.

- <https://arctic-rcc.org/>

## 6.8 INTAROS project

The Arctic WP members have been engaged actively in the H2020 INTAROS projects and a couple of activities are highly relevant for the Copernicus In Situ Coordination work in the Arctic Region.

### Stakeholder consultation

The INTAROS Stakeholder Task Team has in 2020-21 focused on:

- Successful dialog meetings were performed with 12 **European Research Infrastructures** revealing a good insight in their Arctic engagement, strategies and priorities for in situ observation, data management, focus on best practices, technology development, cooperation and coordination among themselves, funding situation and willingness to engage in future Arctic Observing System.
- More than 100 sensor and instrument manufacturers were invited to respond to a web-based technology survey – disappointingly only 16 companies responded. The survey showed that there are a group of sensor and instrument manufacturers that have experience, capability and interest in participating in innovation of new technology in the harsh Arctic environment.
- The marine and maritime management authorities expressed great interest in gaining environmental data from the Arctic region. Especially timeseries and trends are of importance, but also data in support of reliable ecosystem modelling was highlighted

Details can be found in:

<https://intaros.nersc.no/sites/intaros.nersc.no/files/D1.7%20Stakeholder%20activities%20year%204-5-Final-sub.pdf>

### Requirements for in situ observations in the Arctic

INTAROS launched in August a Revised Requirement Report aiming at:

- Capitalise on INTAROS achievements
- Take note of recently articulated user need from the EU and international organisations
- Define more concrete requirements for the identified essential variables
- Address gaps in the present observing system

Requirements for in situ observations address resolution in space and time, quality and timeliness. Users of data generally have clearly articulated needs for time resolution, quality and timeliness, while defining the spatial resolution gives rise to serious considerations because:

- There is a need to find a balance between what ideally would be “nice to have” and what is feasible to achieve from a technical, logistic and especially economic point of view
- There is still a debate among scientists on how to address the spatial resolution:
  - A gridded format with fixed horizontal and vertical distances between observation points
  - Identifying key location with great impact and representativeness

Requirements for atmospheric, ocean and land essential variables has been identified and discussed using the WMO OSCAR and Copernicus Systems – both using a gridded approach – as a baseline for a critical review.

The performed requirement and gap analysis results in the following recommendations:

- Ensure work towards a robustly substantiated definition of spatial resolution in an Arctic observing system involving analytic tools such as numerical models (OSE's and OSSE's), cost and feasibility studies
- Establish an international coordination and governance structure involving nations, SAON, WMO, IOC, EU Copernicus and representatives of Indigenous Peoples and Local Communities to:
  - Ensure a forum for dialogue between users of Arctic information, observation program leaders and sensor and application developers to understand evolving needs and capacities
  - Secure long-term coordination and continuation of measurements
  - Ensure sustained funding to a fit-for-purpose Arctic Observing System
  - Enhance and optimize multidisciplinary observations
  - Ensure open and free real time data exchange following the FAIR principle
  - Increase involvement of Indigenous Peoples and Local Communities in data collection and data integration
  - Promote training and teaching as a key value and fundament for capacity building
- Initiate data rescue activities to ingest existing data presently not freely available incl. Russian data
- Pursue innovative cost-effective technological solutions for Arctic observations securing continuous Near Real Time data flow from this harsh environment also during wintertime

Details can be found in:

[https://intaros.nerisc.no/sites/intaros.nerisc.no/files/D1.9\\_Revised%20requirement%20Report\\_sub.pdf](https://intaros.nerisc.no/sites/intaros.nerisc.no/files/D1.9_Revised%20requirement%20Report_sub.pdf)

## 7. Summary and conclusions

The COINS Arctic Data WP has during the reporting period September 2020-October 2021 accomplished several of the tasks outlined for the contract period:

- The Project Catalogue has been reviewed by relevant Copernicus Services, ESA and EUMETSAT, updated, finalised and delivered to EEA
- A Marine Data Portal has been setup in cooperation with EMODnet, CMEMS INSTAC and EuroGOOS, and the process of ingesting data is initiated in close cooperation with EMODnet. Initially focus is on data from icebreaker expeditions and research projects.
- Contacts to the Greenland authority ASIAQ and the Icelandic institution Landsvirkjun has been established to find ways to make their data available for Copernicus. A dialog to solve this issue is ongoing involving EEA and the Arctic WP.
- More than 13.000 individual atmospheric composition data sets from the Arctic Region has been identified and are in the process of being ingested into relevant archives – work is done in close cooperation with WP 2 “Homeless Data”. Further data sources is being investigated in cooperation relevant partners.
- An analysis on the potential to use emerging ocean observing technologies for model validation has been performed and reported. The analysis showed that simple and cheap instrumentation mounted on fish trawls and marine mammals constitute a valuable data source.
- COINS Arctic Data WP has actively followed and influenced Arctic focussed planning and initiatives in international organisations to promote Copernicus interests.

Additionally, there have been worked on:

- Opening up for Russian data – this has not been very successful up to now
- Refining requirements for in situ observations in the Arctic Region to be included in the CIS<sup>2</sup> data base. The Copernicus Services has been contacted and they have expressed interest in a dialog on this issue when the new Copernicus contract has been signed. In situ data requirements for satellite observation validation articulated by the Polar Expert Group are being addressed.

The Arctic WP suggests for the second Service Contract period to focus on:

- Harvesting of Arctic in situ data to relevant Copernicus data portals – split in the following groups:
  - Online data
  - Offline data
  - Identify and collect data from before 1992
- Establishing requirements for in situ observations of essential variables in the Arctic in close dialog with the Copernicus Services and Satellite community
- Information campaign on the importance of in situ observation and free data exchange

## References

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