



## **SIOS Marine Network: 2<sup>nd</sup> workshop summary**

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## Introduction

Svalbard Integrated Arctic Earth Observing System (SIOS) is an international consortium that cooperates to develop and maintain a regional observing system in and around the Norwegian archipelago of Svalbard in the European High-Arctic. Svalbard is an ideal platform for environmental research due to its location, accessibility and well-developed infrastructure leading to establishment of high-quality research programmes by many institutions. SIOS brings together the existing research infrastructure and resulting data of its currently 26 members from 9 nations into a multidisciplinary network dedicated to addressing Earth System Science questions related to environmental change. The focus lies on cross-disciplinary processes and interactions between the spheres that make up the Earth system (biosphere, geosphere, atmosphere, cryosphere, and hydrosphere). The central node of SIOS is the SIOS Knowledge Centre (SIOS-KC), which delivers and coordinates services to the SIOS community.

SIOS publishes an annual report on the State of Environmental Science in Svalbard (SESS report), compiled by authors from the multidisciplinary and international scientific community. The report summarises the state of current knowledge of key Earth System Science parameters in the Svalbard region, highlights unanswered questions and gaps in observations, and eventually recommends research priorities for the following year(s). The SESS report is an important mechanism for developing the integrated observing system and prioritising funding needs. It is also an important outreach tool towards stakeholders and policy makers.

In the first SESS report, published in 2019, two of the chapters highlighted the need for closer collaboration between the owners and operators of the various marine infrastructures in the Svalbard region (Cottier et al, 2019 and Bensi et al, 2019). In addition, SIOS-KC has received requests from the marine science community for support to accessing ship time and help to service moorings. In response to this the SIOS marine infrastructure network was initiated. The network was launched in a workshop organised by SIOS-KC in collaboration with key partners in November 2020. A summary of that workshop is available on the SIOS website (SIOS, 2020). One of the outcomes was the need for greater harmonisation of the variables collected by the researchers from different institutions in various locations in the Svalbard region. This was the topic of the second workshop of the network.

## Summary of workshop 7<sup>th</sup> December 2021

The second workshop of the SIOS marine infrastructure network was held online on Tuesday 7<sup>th</sup> December 2021 (SIOS, 2021). The workshop was organised and planned by SIOS-KC, Manuel Bensi (National Institute of Oceanography and Applied Geophysics), Arild Sundfjord (Norwegian Polar Institute), Frank Nilsen (University Centre in Svalbard) and Agnieszka Beszczynska-Möller (Institute of Oceanology Polish Academy of Sciences). 52 people registered for the workshop and at the most

42 people were in attendance on the day. The following is a summary of what was presented and discussed at the workshop.

### Marine infrastructure presented

The marine infrastructure that was presented during the first workshop is shown in figure 1 and is described in the summary report of the first workshop (SIOS, 2020). The presenters from the first workshop were invited to provide an update at the second workshop. There were nine such updates given as listed in table 1. The slides for the presentations may be accessed on the SIOS website (SIOS, 2021).

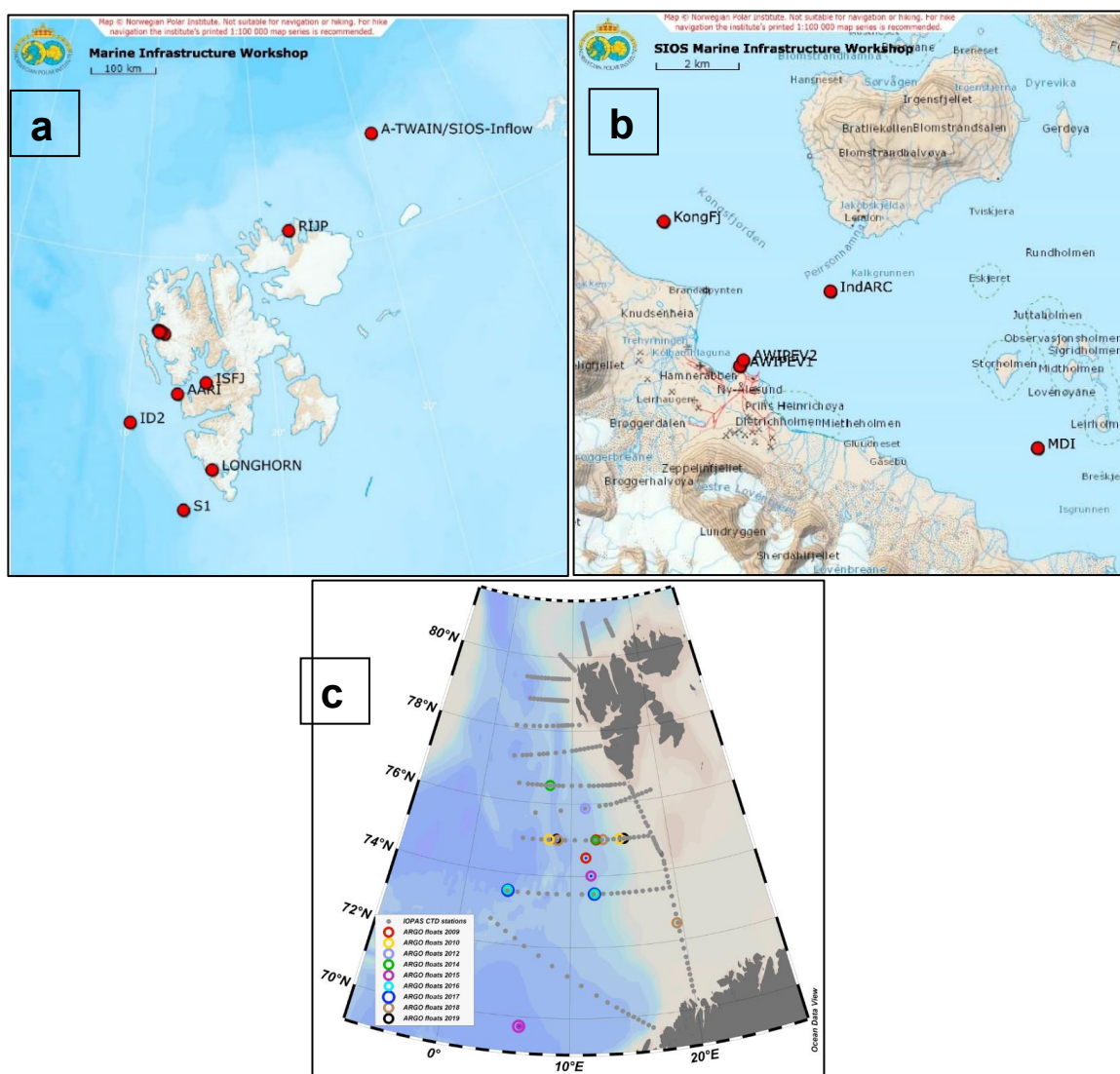


Figure 1: Maps of Svalbard showing a and b) the mooring and other infrastructure presented at the marine infrastructure workshop and c) AREG cruises and Locations of deployments of ARGO-Poland floats by Institute of Oceanology Polish Academy of Sciences. The dots in Kongsfjorden in figure 1a represent several moorings, as shown in figure 1b. The Isfjorden moorings from UNIS are represented by only one dot for simplicity.

Table 1: List of the marine infrastructures presented at the second marine infrastructure workshop. The slides used in the presentations can be accessed on the SIOS website (<https://sios-svalbard.org/MarineWorkshop2021>). Where available, a hyperlink to the entry of the infrastructure in the SIOS Observation Facility Catalogue (<https://sios-svalbard.org/sios-ri-catalogue>) is included in the table.

<b>Name of infrastructure</b>	<b>Responsible Institution(s)</b>	<b>Country</b>	<b>Presenter</b>
AREX cruises	Institute of Oceanology Polish Academy of Sciences (IOPAS)	Poland	Agnieszka Beszczyńska-Möller
ARGO Poland	Institute of Oceanology Polish Academy of Sciences (IOPAS)	Poland	Agnieszka Beszczyńska-Möller
<a href="#">A-TWAIN/SIOS Arctic Ocean Inflow Observational Node</a>	Norwegian Polar Institute (NPI), Institute of Marine Research (IMR)	Norway	Arild Sundfjord
<a href="#">Mooring S1</a>	National Institute of Oceanography and Applied Geophysics (OGS)	Italy	Manuel Bensi
<a href="#">Mooring ID2</a>	National Institute of Oceanography and Applied Geophysics (OGS)	Italy	Manuel Bensi
Rijpfjorden mooring	Scottish Association for Marine Science (SAMS) / UiT Arctic University of Norway (UiT)	United Kingdom / Norway	Finlo Cottier
<a href="#">Kongsfjorden marine observatory</a>	UiT Arctic University of Norway (UiT)	Norway	Finlo Cottier
<a href="#">AWIPEV-COSYNA Mooring</a>	Alfred-Wegener-Institute, Helmholtz Centre for Polar and Marine Research (AWI)	Germany	Philipp Fischer
<a href="#">AWIPEV Underwater Observatory</a>	Alfred-Wegener-Institute, Helmholtz Centre for Polar and Marine Research (AWI)	Germany	Philipp Fischer
<a href="#">IndARC mooring</a>	National Centre for Polar and Ocean Research (NCPOR)	India	Divya David
<a href="#">Mooring Dirgibile Italia</a>	National Research Council of Italy (CNR)	Italy	Leonardo Langone
Ship-based spring bloom monitoring	Alfred-Wegener-Institute, Helmholtz Centre for Polar and Marine Research (AWI)	Germany	Clara Hoppe
AARI oceanographic buoy	Arctic and Antarctic Research Institute (AARI)	Russia	Anastasia Tarasenko
MV Ulla Rinman	Norlengs	Germany	Philipp Grözinger

## **SIOS core data – what next for marine variables?**

The SIOS Scientific Integration and Data Officer, Ilkka Matero, presented an introduction to the open and FAIR (Wilkinson et al, 2016) data sharing principles of SIOS and to SIOS Core Data (SCD). SCD are defined as variables that are needed to scientifically assess the state of the environment in Svalbard and are being made available through the SIOS Data Management System (SDMS) with a commitment to deliver data for a minimum of 5 years. In the first list of core data nine variables were identified that could be classed as SCD for the marine sphere, and a further 11 were identified in the SCD workshop in November 2020. Of the nine marine variables first identified, five are currently being collected by a SIOS member institution in a way that meets all the criteria for being classed as SCD. Details of the marine SCD are given in the slides from the presentation on the SIOS website (SIOS, 2021).

The focus for the SIOS Data Management Service is to help SIOS member institutions to deliver their candidate SCD to SDMS and to increase harmonisation and standardisation of the data being delivered. The service can provide one-on-one advice to data providers on how to share their data in a standardised way. SIOS also provides tools on its website to help scientists convert their data sets to a standardised format or validate their NetCDF files against the CF and ACDD conventions: <https://sios-svalbard.org/DMtools>.

FAIR gives an indication of data availability, not data quality. A quality statement must be included in the metadata, and the community should work towards standardised data quality procedures. Some data quality control can be automated, e.g. checking positions and times are within the scope of the instrument deployment. Other factors, such as quality of the data themselves and checking for data errors, needs to be checked by specialists. SIOS could consider making regional maps of e.g. temperature that could be used for quality control purposes to check for outliers in the data.

There is a gap between the willingness to share data and the ability to do so among many scientists. With the correct support and tools making it easy to standardise data many more data sets could be made available to the community.

## **Harmonising marine observations**

### **Arctic PASSION**

Arctic PASSION is a newly supported Horizon 2020 project which aims to improve and better integrate existing observations in the Arctic. One initiative is to establish a system of better coordination and collaboration in the European sector of the Arctic Ocean. This will follow the example of the Pacific Distributed Biological Observatory (DBO) system (NOAA, 2021). The Pacific DBO was set up by coordinating existing long-term monitoring and short-term projects going to the same areas and doing similar measurements. They agreed a set of standards and established coordinated transects through annual meetings. The idea is to import this kind of system to

Europe. This will start in earnest in 2022, when the sections where moorings are needed will be identified. The system will build on existing procedures for data collection, processing and sharing from several projects (Synoptic Arctic Survey, Nansen Legacy etc.). Web based interfaces will be developed for protocols and data. Invitations will be sent for a full day workshop during Arctic Science Summit Week which is open to all interested parties. The data and planned programmes from Svalbard area should be collected and presented as a regional contribution to this wider system for the European Arctic.

In the coastal environment there are very few long-term monitoring projects, so scientists rely on project based data on physical parameters to provide the context for biological data. If these data are collected regularly and in a standardised format then they can eventually become a longer time series. Small scale projects that focus on process understanding are not excluded, but longer time series that are part of an observational system are the most useful in the context of Arctic PASSION and SIOS. Combining long-term observations with process studies is a major challenge and could be an issue to be addressed by the SIOS Marine Network. Both are important but the applications of the data are different.

### **Harmonisation of CTD data**

Short-term measurements are hard to combine, but a project in the Kongsfjorden flagship to combine CTD data is seeking to address this. Many scientists are collecting profiles of temperature, salinity, density, chlorophyll, and turbidity in the fjord on cruises, even when these are secondary or supporting data sets. If the profiles can be easily uploaded with appropriate metadata they can be shared with other scientists and used to create a longer time series, fill gaps in data sets and explore seasonal and environmental change. A portal is being created as part of the FACE-IT project for this purpose. Data can be uploaded by the scientists themselves or by instrument owners (e.g. King's Bay). The portal must be easy to use to encourage widespread use. A concerted effort must be made to collect historical data and to encourage upload in future on an annual basis. A similar approach could be beneficial in Isfjorden where there is also a concentration of activity.

Quality control must be carried out by the scientists as soon as possible after data collection and before uploading the datasets to the portal. AWI is carrying out annual intercomparison between their own CTD and the one owned by King's Bay. High quality, planned and long-term data are being collected as part of ongoing initiatives, but the opportunity data collected as part of other campaigns is harder to quality control, as the scientists that are collecting them are not motivated to work on them if they are not the focus of their own research. The planned data portal is a low effort means of ensuring this type of data is not lost, into which uploading profiles and basic metadata is easy enough to encourage those collecting opportunity data to make this effort. Quality control is more difficult; in the short-term quality flags is the most feasible option, and maybe annual quality control of the gathered data by the community / Kongsfjorden flagship. The data should then be converted to a format that could be shared through SIOS.

## Quality control of data

The challenges of harmonising marine variables can be divided into several categories including:

- Choice of instrument
- Measurement protocols
- Data processing
- Procedures for quality control of data

It is interesting to gain an overview of how the scientists from different institutions are currently collecting marine variables, as a starting point. A focused set of recommendations or best practice for marine variables within SIOS would be beneficial to make coordination and data sharing easier. The marine network should also support development of the marine variables in the SIOS core data process, as harmonising data collection is part of this process.

## Data formats and standards

It would be useful to establish which vocabularies are being used by scientists in the SIOS network to ease data sharing. Data from long- and short-term projects should be harmonised and standardised so that data are collected and recorded in the same way, making it easier to combine data. SIOS recommends using the file format NetCDF following the climate and forecast convention (CF) for oceanographic data. It is also important to use standards for metadata, for example following the Attribute Convention for Data Discovery (ACDD).

Many scientists see the value of using the NetCDF format but are not capable of working with it. This is where data managers at their institution and at SIOS can help by providing tools and advice. There is only a small amount of coding required, so the obstacle is often smaller than non-specialists think. Tools for converting data to a standardised file format and other useful information for harmonising marine observations were shared in a Padlet (available at <https://padlet.com/siossvalbard/vnzhg4egotw5vidp>), which collects contributions from the participants at the workshop.

## SESS recommendations and optimising marine observations in SIOS

After three annual State of Environmental Science in Svalbard (SESS) reports the Science Optimisation Advisory Group (SOAG) has initiated a process to prioritise and implement the many recommendations listed by the reports' authors. The recommendations from the individual chapters are being synthesised to one report which will be a roadmap for the future development of SIOS. The recommendations relevant to the marine environment may be divided into 4 categories:

- Recommendations for new studies to be conducted in and around Svalbard
- Recommendations for new methodologies and technical solutions



- Recommendations for data processing and sharing
- Recommendations for long-term observations

The SESS recommendations synthesis report also identifies what is needed to achieve the goals of the recommendations, including:

- Harmonisation and cross-disciplinary investigations
- Developing marine environment observation infrastructure

SOAG is developing the following initiatives for moving forward with this task:

1. Revised SIOS Infrastructure Optimisation report:
  - Provide a time frame for implementation of recommendations (1-10 year goals)
  - Focus on multidisciplinary
  - Identify actions to be taken
2. Possible implementation actions:
  - SIOS access calls
  - grant proposals
  - networks
  - workshops and training
  - handbooks and articles preparation
  - core data handling

Those that are interested in contributing to the effort to implement the recommendations from the SESS reports can contact their SOAG representative or SIOS-KC.

Further details on SESS recommendations for the marine environment may be found in the presentation slides which can be accessed on the SIOS website (SIOS, 2021).

## Conclusions and recommendations

This network could develop a scientific paper or scientific data paper covering, for example, one of the following suggested topics:

- Deep sea and surface currents around Svalbard
- Overview and future perspective of marine infrastructure and data collected around Svalbard.

There will be a session dedicated to discussing how to move forward with a joint paper during Polar Night Week, Thursday 27 January 2022 at 15:00. Please register to Polar Night Week to attend this meeting: <https://sios-svalbard.org/PolarNightWeek>.

The SESS report is an important opportunity to develop some of the concepts discussed in the workshop further. One example could be a chapter on how to harmonise CTD data from Svalbard. The deadline to apply to contribute to the 2022 SESS report is 14 January 2022 and details may be found on the SIOS website: [https://sios-svalbard.org/SESS\\_Issue5](https://sios-svalbard.org/SESS_Issue5).

The SIOS Marine Network should contribute to the development of the European Arctic DBO coordinated by Arctic PASSION. It should also support the work of the Kongsfjorden flagship to harmonise CTD data from Kongsfjorden and consider expanding this initiative to other areas such as Isfjorden.

The input of experts from this network is important to several efforts from SIOS to optimise the observing system, including SIOS Core Data, the SESS recommendations synthesis report and updated Infrastructure Optimisation report.

Members of this network are encouraged to store their data in a repository that is compatible with the FAIR guiding principles. The recommended file format is NetCDF-CF. Standardised metadata following ACDD is also recommended. The SIOS data management service can give advice on how to share data through SDMS.

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