Integrated Arctic Observation System

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Deliverable 3.14

First implementation and data: Ocean and sea ice

Data delivery and report on results of the distributed systems for ocean and sea ice

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13	SMHI		**36**	RIHMI-WDC	
14	USFD		**37**	NIERSC	
15	NUIM		**38**	WHOI	
16	IFREMER		**39**	SIO	
17	MPG		**40**	UAF	
18	EUROGOOS		**41**	U Laval	
19	EUROCEAN		**42**	ONC	
20	UPM		**43**	NMEFC	
21	UB		**44**	RADI	
22	UHAM		**45**	KOPRI	
23	NORCE		**46**	NIPR	
			47	PRIC	

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EXECUTIVE SUMMARY

This document, ***First implementation and operational use of the observing systems. Data delivery and report on results of the ocean and sea ice system***, describes autonomous components of the Arctic observing system for ocean and sea ice measurements that were implemented during the first field season under INTAROS. Instruments and platforms described in D3.4 drift freely on the sea ice or in the water column (ice tethered platforms, ice buoys and floats), move along preprogrammed tracks (gliders) or measure autonomously at fixed locations (deep ocean moorings). An autonomous sensor package (FerryBox) and drone-based sensors are used to collect observations from the ships of opportunity. This document is intended to:

- Review current status of autonomous mobile and fixed observing platforms and sensors used for collecting ocean and sea ice observations in the Arctic during the first INTAROS field season;
- Describe an ice tethered IAOOS-Equipex platform used for combined physical, atmospheric and sea ice measurements in the central Arctic Ocean and provided data;
- Describe new deep ocean BGC mooring deployed for the second INTAROS field season in the deep Nansen Basin;
- Describe SIMBA (Snow and Ice Mass Balance Array) platforms for sea ice measurements, deployed with INTAROS contribution and data provided by them;
- Describe deployment of new biogeochemical sensors for the FerryBox (pH/carbonate sensor, spectral absorption sensor and microplastic sampler) developed under INTAROS and provided data sets;
- Describe results from new endurance glider lines established under INTAROS in Fram Strait and north of Svalbard;
- Describe INTAROS contribution to an array of BGC Argo floats in the Baffin Bay observatory and data provided by the floats.

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1. Introduction

The knowledge of physical and biological processes in the Arctic Ocean is limited, because the ice cover severely hampers observations, both in the upper layers and deep waters. There is a severe lack of *in situ* multidisciplinary, in particular biogeochemical data for the Arctic Ocean and significant patterns of the Arctic ecosystem are not currently well monitored. Autonomous platforms for distributed observations (e.g. moorings, floats, ice-based observatories and gliders) can contribute year-round measurements over extended time periods from the most under-sampled regions of the Arctic Ocean.

The extensive overview of the current status of autonomous distributed platforms and systems for ocean and sea ice observations has been provided in the previous deliverable D.3.4. Selected components of this observing system were implemented during the first INTAROS field season, in some cases preceded by earlier pilot experiments in the previous year. To extend the upper ocean, sea ice and atmospheric measurements in the central Arctic, one ice-tethered IAOOS-Equipex platform was deployed during the icebreaker Oden cruise ARCTIC2018. A deep ocean mooring equipped with BGC sensors was deployed for the second INTAROS field season in the central Nansen Basin. INTAROS contributed to the array of over 30 SIMBA (Snow and Ice Mass Balance Array) buoys deployed in 2018 and 2019 during four campaigns on the central Arctic Ocean (NABOS 2018, CHINARE 2018, CAATEX 2019 and MOSAiC 2019). Additional broadband and spectral surface albedo measurements were collected over the Arctic sea ice from a vessel with use of drones adapted for this purpose under INTAROS to avoid the need of installing a measurement station on the ice. New sensors and samplers that include a microplastics sampler, a combined pH/CO_3 sensor, and an integrated sphere absorption meter sensor have been implemented for the FerryBox measurements along the endurance line between Tromsø and Ny Alesund. Microplastic samples and pH measurements have been collected with the FerryBox during several repetitions of the Barents Sea Opening line since July 2018 and their analysis is ongoing while CO_3 part of the system and integrated sphere absorption meter sensor are partially operational and undergo final refinement before operational implementation. Glider measurements along the endurance lines were established and implemented along the Atlantic water pathways to the European Arctic (in Fram Strait and north of Svalbard). In addition to standard variables (temperature and salinity), the gliders also provided measurements of BGC variables as dissolved oxygen content, chl-a and CDOM fluorescence, and particulate backscattering. Geostrophic upper ocean currents were derived from the glider measurements and flight model. INTAROS contributed to an array of BGC Argo floats in Baffin Bay observatory where 16 floats deployed in 2016-2019 provided over 1900 profiles of key ocean physical (temperature and salinity) and biogeochemical (chl-a, CDOM, particle backscattering, dissolved oxygen, nitrate concentration, and radiation in 380 nm, 412 nm, 490 nm and PAR) variables.

2. First implementation and operational use of the distributed observing systems for ocean and sea ice

2.1. IOPAN

Contributors: Agnieszka Beszczynska-Möller, Waldemar Walczowski.

2.1.1. Results of the first operational implementation

The comprehensive analysis of the current status of available ice-tethered platforms for ocean and sea ice measurements was performed during the first phase of the INTAROS project and its results are described in detail in the deliverable D3.4. Based upon the outcomes of this review, the collaboration with the French IAOOS EQUIPEX consortium was set up to acquire an IAOOS-Equipex ice-tethered platform (IAOOS stands for Ice Atmosphere Ocean Observing System), developed in Europe by the French IAOOS group under the EQUIPEX funding and successfully deployed in the Arctic Ocean by the French and German partners during the last two years. The main rationale for selecting the IAOOS platform included an extended package of sensors as compared to other ice-tethered platforms (e.g. WHOI ITP), competitive cost including a deployment support and data transfer (allowing for two units instead of one significantly more expensive WHOI platform) and strengthening the European development of ice-tethered observing technologies.

The IAOOS-Equipex platform deployed under INTAROS was equipped with three separate sensor packages, dedicated to atmospheric, ocean and sea ice measurements, including instrument package for atmospheric (microlidar and weather mast), ocean (CTDO profiler) and sea ice (SIMBA-type instrument) measurements. Deployment support including deployment hardware was provided by the IAOOS group and the platform costs also included satellite data transmission to the land station. The IAOOS platform was built for deployment on drifting sea ice in the Arctic region and designed both to remain on top of sea ice floes and to float at the ocean surface.

The IAOOS-Equipex platform sensor package for the upper ocean measurements included Ice-tethered profiler based on Argo-float technology, with inductive NRT data transmission, capable to work in polar environment, equipped with conductivity, temperature, pressure and dissolved oxygen sensors, scanning up and down from about 5 m depth below the ocean surface to the 600 m depth and taking vertical profiles of temperature and salinity once or twice a day (with autonomy up to 600 profiles). A surface buoy unit contained a GPS, Iridium transmitters, a processor and the lithium battery which guarantee a supply in energy for 2 years. The profiler moved along the 800 m long cable between the surface buoy and the deadweight, assuring possibly vertical position of a cable.

The atmospheric sensor package of the IAOOS-Equipex platform included a weather mast equipped with temperature sensor and atmospheric pressure sensor capable to work at low temperatures ranges and a microlidar (autonomous lidar system with a high efficiency laser diode based system) with optical fiber based system, satellite modem for data transmission, GPS sensor for positioning and accelerometers implemented in the platform to detect the tilt angles.

The sensor package for sea ice and snow measurements of the IAOOS-Equipex platform included ice mass balance instrument with a thermistor chain of 5 m, hanging through air, snow, sea ice and ocean, comprising solid-state sensors measuring temperature profiles with 2 cm resolution. The package was equipped with a single-chip microcontroller (e.g. Microchip PIC) and satellite modem for data transmission.

The INTAROS IAOOS-Equipex ice-tethered platform was deployed on 8th of August 2018 during the Swedish icebreaker Oden cruise ARCTIC2018 in the central Arctic Ocean as a part of the North Pole drift ice station. The IAOOS-Equipex platform was deployed in the Amundsen basin close to the North Pole at the position 89.5553°N and 38.009°E by the IAOOS-Equipex technician from LOCEAN and thoroughly checked for the proper functioning. The drift track is shown on Figure 2.1.1.

Figure 2.1.1 Drift trajectory of the INTAROS IAOOS-Equipex ice-tethered platform in 2018.
Red dots depict daily positions of the platform.

Unfortunately, the IAOOS-Equipex platform stopped to transmit data after 4 weeks after deployment, shortly after IB Oden left the ice station. There were no earlier signs of platform malfunctioning and the data stream was suddenly broken on September 14. While it is not possible to clearly identify a reason of this failure, the most likely explanation is enhanced activity of polar bears in the deployment region. A polar bear already approached the platform when IB Oden was still laying at the ice station (Fig. 2.1.2a), causing a small damage to the outer platform case (Fig. 2.1.2b). The damage had been repaired before the ship left but it is highly probable that the INTAROS IAOOS-Equipex platform was infested by polar bears more often after the ship departure and at the end the communication system was damaged, stopping any data flow from the platform.

a)  b) 

Figure 2.1.2 The INTAROS IAOOS-Equipex ice-tethered platform deployed in the Amundsen Basin (a) as approached by a polar bear and (b) with a trace of a damage to the outer case caused by a bear. Both photos: courtesy of Matthieu Labaste and Christine Provost (LOCEAN).

2.1.2. Description of provided data

The IAOOS-Equipex platform drifts on the ice floe (Provost et al., 2015) and measures the ocean, sea ice, snow and atmospheric variables using an ocean CTDO profiler (Koenig et al., 2016), an ice mass balance instrument SIMBA (SAMS ice mass balance for the Arctic; Jackson et al., 2013; Provost et al., 2017), and a weather mast and a microlidar for the atmosphere (Mariage et al., 2017). Data are transmitted via Iridium link and available in the near-real time (NRT). During the INTAROS deployment of IAOOS-Equipex platform data were transmitted once per day from August 19 to September 14, 2018. All data records from the platform were transmitted in NRT to IPEV and from there pushed to the IOPAN ftp server.

The IAOOS-Equipex ice-tethered platform sends a technical data set including the platform position every hour and sensor data are transmitted upon collection. Ocean data are collected with the CTDO profiler carrying a Seabird SBE41 conductivity, temperature, and depth sensor and a DO Aandera 4330 optode. Temperature sensor initial accuracy is ±0.002°C and stability is 0.0002/year. Conductivity sensor initial accuracy is ±0.002 and stability is 0.001/year. Pressure sensor initial accuracy is ±2 dbar and stability is 0.8dbar/year. Optical sensor for measuring the O2-concentration has the measurement range of 0-500 µM, resolution < 1 µM, accuracy < 8 µM or 5 %, and response time <25 sec.

The profiler was programmed to measure one profile per day. The raw conductivity, temperature, and depth data are averaged before data transmission and have a vertical resolution of 1 db. The raw data record of pressure, temperature, salinity includes: the platform IMEI number, day, month, year, hour, minute, second, cycle, profile, phase, average pressure, average temperature, average salinity. The raw dissolved oxygen data are averaged before data transmission and has a vertical resolution of 2 dbar. The raw data record from the DO optode includes: the platform IMEI number, day, month, year, hour, minute, second, cycle, profile, phase, average pressure, average phase C1, average phase C2P, average temperature.

SIMBA was equipped with a 5 m long chain cable hanging through air, snow, sea-ice and ocean comprising solid-state sensors that measured temperature profiles with 2 cm vertical resolution at approximately 0.1°C accuracy. It also featured a heating mode that provides a proxy for thermal diffusivity, which can be used to discriminate between different media, especially between snow and ice. Temperature was measured every 2 hours, while heating with a duration of 120 s was performed once per day.

The raw data record for temperature profile includes: the instrument IMEI number, Iridium transmission Serial Number, Iridium date UNIX, Iridium estimate latitude, Iridium estimate longitude, uncertainty in Iridium fix (kms), time of reception according to clock email system, sample period number, number of transmission in whole message, part of message this transmission represents, message type, time UNIX of sample according to clock in IMB, length of message in bytes, size of data, number of record in this transmission, serial number assigned to chain sensor, separation of chain sensors (cm), and temperature or temperature rises in °C for T0, T1,..., T240.

The raw data record for heated temperature profile includes: the instrument IMEI number, Iridium transmission serial number, Iridium date UNIX, Iridium estimate latitude, Iridium estimate longitude, uncertainty in Iridium fix (kms), time of reception according to clock email system, sample period number, number of transmission in whole message, part of message this transmission represents, message type, time UNIX of sample according to clock in IMB, length of message in bytes, size of data, number of record in this transmission, serial number assigned to chain sensor, separation of chain sensors (cm),total time of heating for heating cycle, duty cycle of heating (100=full power & 0=off),voltage applied to heaters (measured at end of cycle), temperature or temperature rises in °C for T0, T1,..., T240.

Microlidar profiles were measured every 6 hours. High frequency (5 to 10 kHz) operation along with a typical 10 minutes averaging sequence for each profile were adopted and four sequences a day were aimed at to allow a sampling of cloud properties compatible with inputs/outputs of meteorological model analyses (Mariage et al., 2017). The time duration of the sequence was chosen as a compromise between the optimization of the signal to noise ratio, the atmospheric variability, and the sampling need. In order to limit satellite communication costs each profile is only transmitted after averaging and summation, in progressively increasing altitude bins (Mariage et al., 2017). Accelerometers set in the instrument provided angle information concerning the tilt of the buoy. The raw data set from microlidar includes: the instrument IMEI number, day, month, year, hour, minute, second, transmission number MOMSN, x-tilt (xAtm in °), y-tilt (yAtm in °), backscattering signal in 327 progressively increasing altitude bins, backscattering signal sigma in 327 bins. ODC (optical depth sensor) data are provided twice per hour. Atmospheric pressure and air temperature are delivered once per hour. GPS position is provided once per hour and additionally for each SIMBA data record.

The raw data set from the INTAROS IAOOS-Equipex platform is stored and available upon request on the IOPAN ftp server (IP: 153.19.130.250, user: iaoos-data, password protected). The data processing is ongoing and the final processed data sets will be registered in the INTAROS data catalogue and submitted to the open data base in 2020.

2.1.3. Plans for the final implementation

A short-term lifetime of the INTAROS IAOOS-Equipex ice-tethered platform deployed during the first INTAROS field season resulted in a relatively low data return from an expensive platform. It was therefore the main argument for reconsidering a choice of observing technology for providing ocean and sea ice data from a deep basin of the Arctic Ocean during the second field season. Additionally, the entire process of purchasing and acquiring of the first platform from the IAOOS-Equipex consortium was highly demanding and time-consuming due to acquisition of a non-commercial product from a scientific group with no established procedure for an international sell (e.g. prolonged contract negotiations, lack of proper documentation). While an IAOOS-Equipex ice-tethered platform is a promising developing technology for atmosphere, ice, snow and ocean observations in the Arctic and it proved to provide valuable data published by the IAOOS-Equipex team (e.g. Koenig et al., 2016; Provost et al., 2017; Mariage et al., 2017; Athanase et al., 2019), the maturity (and in the first place availability) of a platform has not yet reached the level that let it be widely used by other partners from outside the IAOOS-Equipex consortium. Since the remaining funding in Task 3.4 did not allow to acquire commercially available but significantly more expensive WHOI ITP, other methods have to be considered to provide ocean and sea ice observations from the deep basins of the Arctic Ocean.

After a thorough analysis a decision has been made to employ a deep ocean mooring with a multidisciplinary cluster of physical and biogeochemical sensors for ocean and sea ice measurements in the deep region of the Arctic Ocean. Additional rationale to choose mooring deployment in the widely under-sampled but hardly accessible part of the Arctic Ocean was a close collaboration between INTAROS and the Norwegian-US CAATEX (Coordinated Arctic Acoustic Experiment) project. Building upon the planned CAATEX experiment with deployment of tomography moorings in the central Arctic Ocean in 2019 and their recovery scheduled for 2020, using the Norwegian Coast Guard icebreaker KV Svalbard, the deployment of a year-round deep INTAROS mooring in the Nansen Basin was selected instead deploying another ice-tethered platform during the second INTAROS field season.

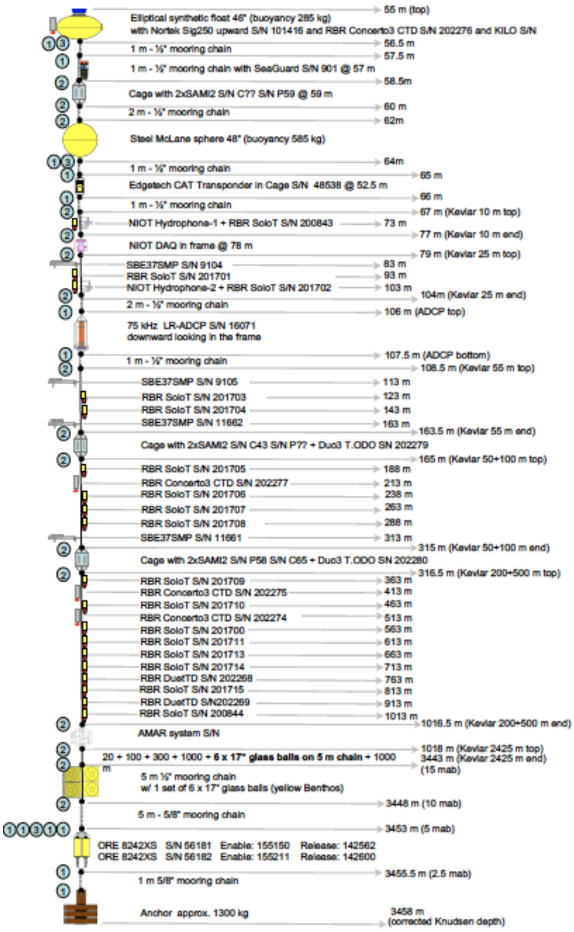

Figure 2.2.3 A schematic drawing of the INTAROS deep mooring deployed in 2019 in the Nansen Basin for the second INTAROS field season.

The INTAROS deep mooring labelled (according to the cruise naming scheme) NERSC-4 (Fig. 2.2.3) was equipped with the Nortek Signature 250 AD2CP for measuring the ocean currents in the upper layer and sea ice drift and draft (sea ice velocity and direction, and thickness of the ice submerged part as a proxy for ice thickness). Additionally, the deep mooring carries a TRDI LRADCP for ocean current profiling in the layer of a few hundred meters, nine instruments for ocean pressure, temperature, and salinity measurements (Seabird SBE37, RBR Concerto3 CTD and AADI SeaGuard), three instruments for dissolved oxygen and temperature measurements (RBBR Duo3 T.ODO and AADI SeaGuard, the latter also providing beam attenuation and point ocean current measurements), three clusters of double SAMI packages of pCO2 and pH sensors, 22 temperature sensors (RBR Solo3 or Duet3), AMAR passive acoustic recording system and NIOT acoustic passive receiving system with two hydrophones. The INTAROS deep mooring was a joint contribution from three INTAROS partners: IOPAN, NERSC and UiB-GFI with additional instrumentation from two external collaborators (FFI and NIOT). The mooring was deployed in the deep Nansen Basin at the position 81° 47.094'N, 022° 00.280'E and water depth of 3458 m on September 5, 2019 during the CAATEX'2019 cruise on the Norwegian Coast Guard icebreaker KV Svalbard. A recovery of the INTAROS deep mooring is scheduled for the CAATEX'2020 cruise in July/August 2020.

The deep INTAROS mooring will provide year-round ocean and sea ice observations, including ocean key physical (temperature, salinity, ocean currents) and biogeochemical (dissolved oxygen, pCO2 and pH) variables, and sea ice parameters (ice drift velocity and direction and ice draft) from the deep Nansen Basin. These observations can be linked to ocean and sea ice measurements in Task 3.2, together providing a comprehensive section of continuous observations from the upper shelf break across the continental slope to the deep Arctic Ocean basin.

References:

Athanase, M., Sennéchael, N., Garric, G., Koenig, Z., Boles, E., & Provost, C. (2019). New hydrographic measurements of the upper Arctic western Eurasian Basin in 2017 reveal fresher mixed layer and shallower warm layer than 2005–2012 climatology. Journal of Geophysical Research: Oceans, 124, 1091–1114. https://doi.org/10.1029/2018JC014701

Jackson, K., Wilkinson, J., Maksym, T., Meldrum, D., Beckers, J., Haas, C., & Mackenzie, D. (2013). A novel and low-cost sea ice mass balance buoy. Journal of Atmospheric and Oceanic Technology, 30(11), 2676–2688. https://doi.org/10.1175/JTECH-D-13-00058.

Koenig, Z., Provost, C., Villacieros- Robineau, N., Sennechael, N., & Meyer, A. (2016). Winter ocean-ice interactions under thin sea ice observed by IAOOS platforms during N-ICE2015: Salty surface mixed layer and active basal melt. Journal of Geophysical Research: Oceans, 121, 7898–7916. https://doi.org/10.1002/2016JC012195.

Mariage, V., Pelon, J., Blouzon, F., Victori, S., Geyskens, N., Amarouche, N., et al. (2017). Iaoos microlidar-on-buoy development and first atmospheric observations obtained during 2014 and 2015 Arctic drifts. Optics Express, 25(4), A73–A84. https://doi.org/10.1364/OE.25.000A73

Provost, C., Pelon, J., Sennéchael, N., Calzas, M., Blouzon, F., Desautez, A., et al. (2015). IAOOS (ice-atmosphere-arctic ocean observing system, 2011-2019). Mercator Ocean Quarterly Newsletter, 51, 13–15.

Provost, C., Sennéchael, N., Miguet, J., Itkin, P., Rösel, A., Koenig, Z., et al. (2017). Observations of flooding and snow-ice formation in a thinner arctic sea ice regime during the N-ICE2015 campaign: Influence of basal ice melt and storms. Journal of Geophysical Research: Oceans, 122, 7115–7134. https://doi.org/10.1002/2016JC012011.

2.2. FMI

Contributors: Bin Cheng, Roberta Pirazzini.

2.2.1. Results of the first operational implementation - SIMBA snow and ice mass balance buoy

The SIMBA (high-resolution Snow and Ice Mass Balance Array) ice mass balance buoys (IMB) are largely deployed during INTAROS field seasons (2018-2019). Compared with other types of IMB, SIMBA has a novel and cost-cutting design. It is a thermistor string based IMB buoy. The SIMBA consists of a high-resolution ice thermistor chain (2 cm sensor interval with a total length of about 4-5 m); flush-card data memory and data logger compartment; the GPS and iridium data transmission board; high-capacity alkaline batteries; housing and cables and a magnetometer is used to detect ice rotation.

The thermistor sting is vertically deployed. The vertical temperature profiles were measured 4 times a day through the air-snow-sea ice-ocean column. Identical small heating element is applied on each sensor. The heating element ensures that same amount of energy is applied on each sensor once per day. The measurement of each sensor temperature change after 60 s and 120 s, respectively, are carried out. The temperature change data together with vertical temperature profiles are used to derive snow depth and ice thickness. The SIMBA GPS measurements often configured to do the measurement every 2 hours, sometime in order for better investigate ice drift, GPS readings were carried out every half an hour. SIMBA applied Iridium satellite for data transmission. A total 16 SIMBA buoys have been deployed in the Arctic Ocean during the Chinese National Arctic Research Expedition (CHINARE) and the Nansen and Amundsen Basins Observational System (NABOS) field expeditions in late autumn 2018. Two SIMBA buoys have been deployed by Norwegian research vessel KV-Svalbard during CAATEX cruise at the North Pole. In late autumn 2019, 15 SIMBA buoys have been so far deployed during MOSAiC field campaign. Table 2.2.1 gives a summary of deployed SIMBA buoys during 2018-2019 Arctic field seasons. Figure 2.2.1 (a, b, c, d) shows the SIMBA drift trajectories. For better clarity, we group SIMBA drift trajectories upon expedition programs.

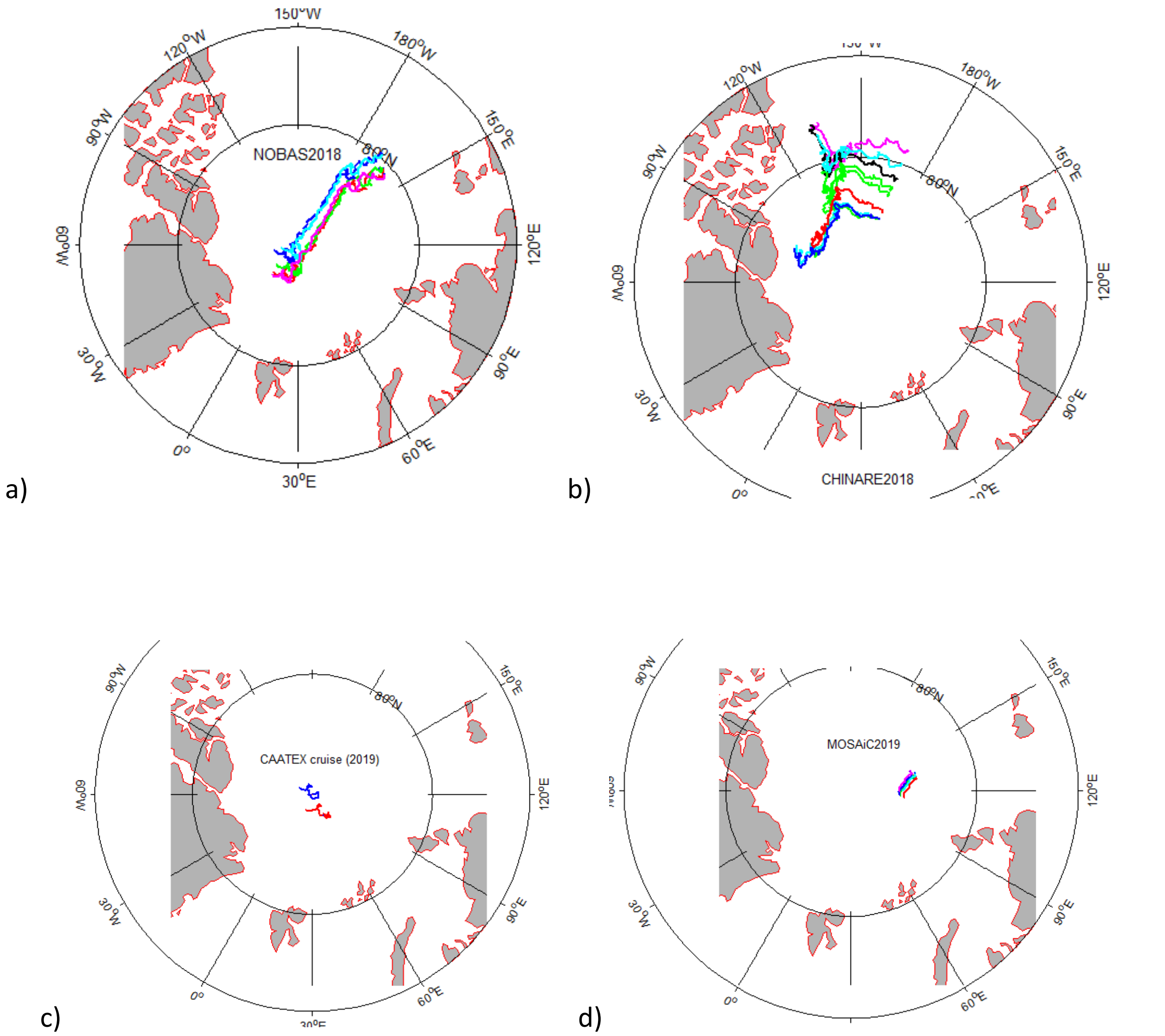

Figure 2.2.1 Drift trajectories for SIMBA buoys deployed during (a) NABOS 2018 cruise, (b) CHINARE 2018 cruise, (c) CAATEX 2019 cruise and (d) during MOSAiC 2019 campaign.

2.2.2. Results of the first operational implementation - drone-based surface albedo measurements in the Central Arctic

Surface broadband and spectral albedo measurements will be carried out in the Central Arctic in spring-summer-autumn 2020 during the MOSAiC field campaign.

The FMI broadband radiation station (Fig. 2.2.2) was installed over the MOSAiC drifting ice floe in October 2019 by Matthew Shupe and his colleague from the National Oceanic and Atmospheric Administration (USA). The data are collected every second, stored in the data logger attached to the station, and transmitted to the data center located on the Polarstern vessel.

The drone-based surface albedo measurements will be collected along the optical transect and in the UAV area (Fig. 2.2.3) during spring-summer-autumn 2020. The spectroradiometers and the pyranometers have been calibrated during summer and autumn 2019. The planned flights include long and short missions. In the long missions, the horizontal sections can be up to 1.5 km (beyond line of sight) flying at the lowermost allowed altitude (to get the highest possible spatial resolution), and at an altitude of about 50 m (to get ~50m wide transects of spatial averaged albedo). In the short missions, vertical profiles over one or few selected points (representative of the local albedo heterogeneity) will be made. The maximum altitude of the profiles will be ~1 km, to cover an area of ~500 m radius.

Figure 2.2.2. FMI broadband radiation station installed over the MOSAiC drifting ice floe.

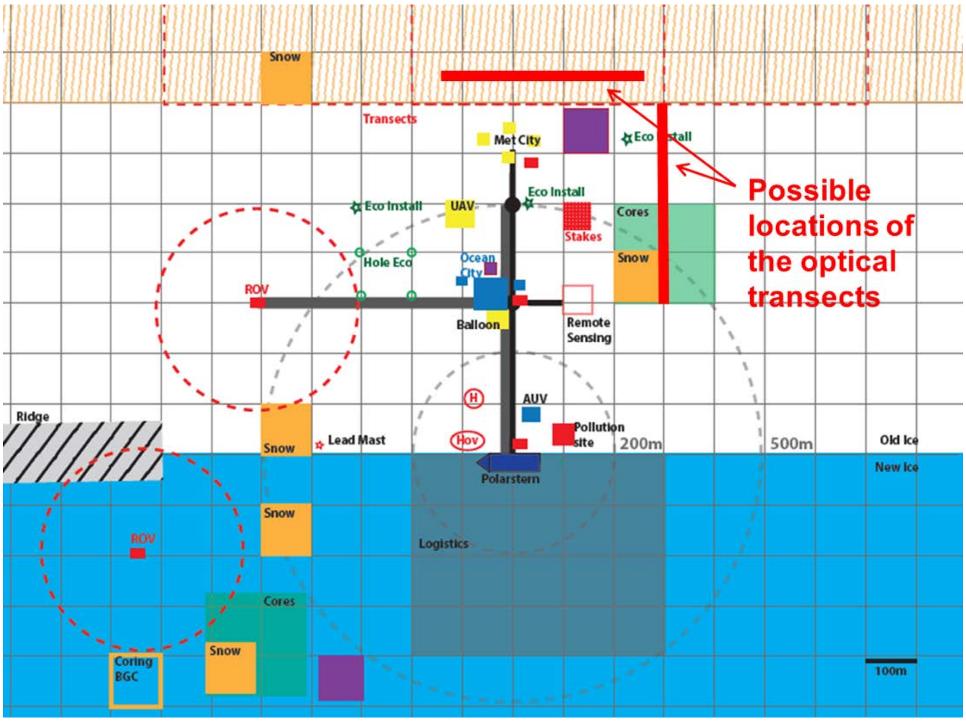

Figure 2.2.3 MOSAiC Central Observatory with the possible location of the optical transects where ground- and drone-based albedo measurements will be carried out.

2.2.3. Description of provided data - SIMBA snow and ice mass balance buoy

The SIMBA buoy data products include air temperature, snow/ice temperature, ocean temperature below ice bottom, snow depth and ice thickness derived from thermistor string temperature and temperature changes (heating temperature) measurement, and buoys drift trajectories recorded as GPS positions.

SAMS (SIMBA manufacture) currently sets up secure account for each SIMBA client, e.g.
https://simba.srsl.com/fmi/,
https://simba.srsl.com/pric/
https://simba.srsl.com/nmefc/

SIMBA temperature (air-snow-ice-ocean) field and heating temperature regime and GPS positioning data will be released for open access after quality control. Snow depth and ice thickness will be derived from temperature measurement according to Liao et al, (2018). The SIMBA measurements made during MOSAiC field campaign are part of the MOSAiC data.

Table 2.2.1 List of SIMBA deployments during the first INTAROS field season 2018-2019.

NABOS 2018												
SIMBA name	**IMEI**	**Starting position/date**			**Thickness (m)**			**Sensor Interface Position (SIP)**				
		Lat	**Lon**	**DATE DDMMYYYY**	**Hi**	**Hs**	**Hf**	**Air/ snow**	**Snow/ ice**	**Sea level**	**Ice bottom**	
FMI0404	300234064817090	80.44	161.93	16092018	1.82	0.004	0.25	20	20	32	111	v
FMI0502	300234065762510	80.76	163.18	14092018	2.39	0.0	0.29	32	32	47	152	v
FMI0503	300234065765720	80.49	168.40	11092018	2.53	0.0	0.3	31	31	46	158	v
FMI0504R	300234065174770	79.63	167.97	11092018	2.62	0.0	0.8	23	23	63	154	v
FMI0505	300234065171770	80.72	159.83	15092018	2.11	0.003	0.47	21	21	44	126	v
CHINARE 2018												
NMEFC0801	300234065179520	84.79	166.02	21082018	2.40	0.04	0.41	30	32	52	152	×
NMEFC0701	300234064876710	84.72	167.68	21082018	2.73	0.04	0.23	31	33	44	169	v
PRIC0602	300234064979710	82.63	167.36	15082018	3.65	0.05	0.36	22	24	42	207	v
PRIC0603	300234064593980	84.79	166.02	20082018	3.85	0.09	0.50	16	20	45	212	×
PRIC0604	300234064590990	84.58	162.17	23082018	1.45	0.05	0.14	25	27	34	100	v
PRIC0801	300234065173740	81.16	169.61	13082018	3.30	0.07	0.30	30	33	48	198	×
PRIC0802	300234065174780	84.08	166.99	18082018	1.34	0.04	0.09	24	26	30	93	v
PRIC0803	300234065175770	82.03	168.19	14082018	2.15	0.11	0.30	31	36	51	144	v
PRIC0804	300234065171760	84.73	167.68	21082018	1.85	0.08	0.2	20	24	34	116	v
PRIC0805	300234065179750	79.93	169.1	12082018	2.23	0.07	0.22	31	34	45	146	×
FMI0403	300234064918140	84.16	167.25	18082018	1.26	0.05	0.11	43	45	51	108	×
CAATEX cruise 2019 (KV Svalbard-North Pole)												
FMI0507	300234065172770	87.99	55.63	2482019	1.81	0.07	0.25	44	47	59	138	v
FMI17R	300234060795690	89.99	95.76	2182019	1.55	0.06	0.25	42	45	58	123	v

MOSAiC 2019												
FMI0406	300234064817930	84.89	133.22	07102019	0.35	0.05	0.03	37	41	42	59	V
FMI0508	300234065177750	84.87	135.80	07102019	0.81	0.14	0.01	29	36	36	76	V
FMI0509	300234065171790	85.05	137.84	07102019	1.57	0.1	0.09	18	23	27	101	V
FMI0510	300234065170760	85.11	136.20	08102019	0.8	0.1	0.02	28	33	34	73	V
FMI0601	300234068708330	84.92	131.26	05102019	1.8	0.15	0.12	34	41	47	131	V
FMI0602	300234068700320	84.99	134.48	11102019	0.75	0.05	0.03	31	33	34	80	V
FMI0603	300234068705280	85.12	136.15	09102019	0.45	0.06	0.02	32	35	36	77	V
FMI0604	300234068706760	84.74	135.84	11102019	0.7	0.1	0.03	31	36	37	71	V
FMI0605	300234068700290	85.05	139.03	09102019	0.97	0.13	0.05	26	32	34	80	V
PRIC0901	300234068706290	85.65	125.47	29102019	0.82	0.16	0.04	40	48	50	99	V
PRIC0902	300234068709320	84.99	134.99	07102019	1.06	0.1	0.06	23	28	31	81	V
PRIC0903	300234068701300	85.13	133.22	10102019	1.74	0.14	0.24	28	35	47	122	V
PRIC0904	300234068705730	84.99	135.03	07102019	1.31	0.15	0.07	26	33	36	101	V
PRIC0905	300234068706330	85.65	125.51	29102019	0.4	0.1	0.02	41	46	47	66	V
PRIC0906	300234068704730	85.01	132.78	05102019	1.44	0.13	0.08	22	28	32	100	V

Example of SIMBA data file (.csv)*

SIMBA GPS position (every 2 hours up to every 0.5 hour)

GPSDateTime	GPSLat	GPSLng
08/10/2019 19:00	*88.455133*	*1.205656*
08/10/2019 21:00	*88.45764*	*1.456218*

SIMBA temperature (every 6 hours)

TemperatureTime T0 T1 T2 ,,,,,,,,,,,,, T239 AirTemp

20/04/2019 23:00 -16.4375 -16.4375 -16.5 -1.75 -16.25

21/04/2019 05:00 -16.875 -16.9375 -16.9375 -1.8125 -16.6875

21/04/2019 11:00 - 16.1875 -16.1875 -16.1875 -1.75 -16.0625

SIMBA heating temperature (every 24 hours)

HeatingTime T0 T1 T2 ,,,,,,,,,,,,, T238 T239

21/04/2019 17:03 1.5625 1.75 1.75 0.625 0.875 after 60s

21/04/2019 17:03 2.4375 2.75 2.8125 0.75 1.0625 after 120s

A few selected SIMBA products are illustrated below on Figures 2.2.4 - 2.2.7.

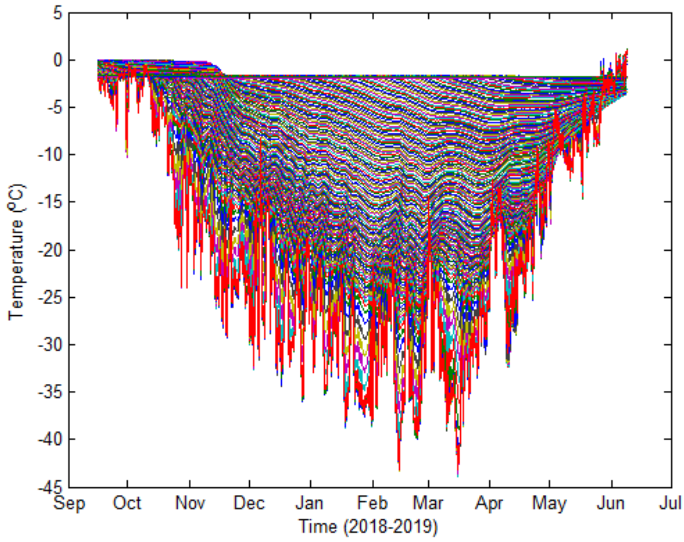

Figure 2.2.4 Time series of temperature in air-snow-ice-ocean
measured by the SIMBA thermistor string (240 sensors) + Tair (AirTemp) (red line).

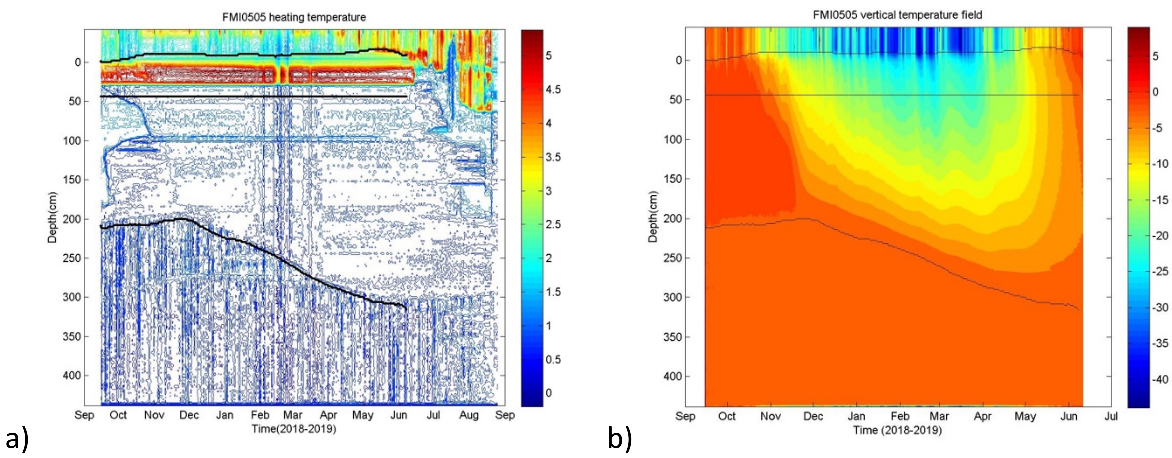

Figure 2.2.5 a) SIMBA heating temperature field. b) SIMBA temperature field. The black lines are snow surface (top), Initial freeboard (middle) and ice bottom (bottom). Zero level refers to initial snow/ice interface. The black lines in a) were derived by SIMBA algorithm. This is FMI0505 SIMBA buoy deployed during NOBAS2018.

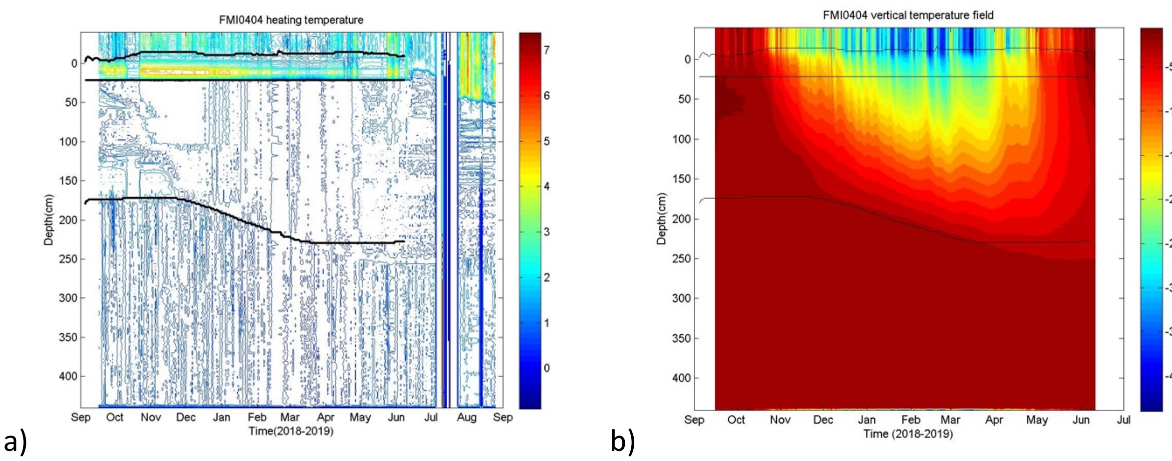

Figure 2.2.6 a) SIMBA heating temperature field. b) SIMBA temperature field. The black lines are snow surface (top), Initial freeboard (middle) and ice bottom (bottom). Zero level refers to initial snow/ice interface. The black lines in a) were derived by SIMBA algorithm. This is FMI0404 SIMBA buoy deployed during NOBAS2018. The heating temperature field can identify clearly snow surface and ice bottom. The SIMBA algorithm underestimate ice bottom from mid- March onward.

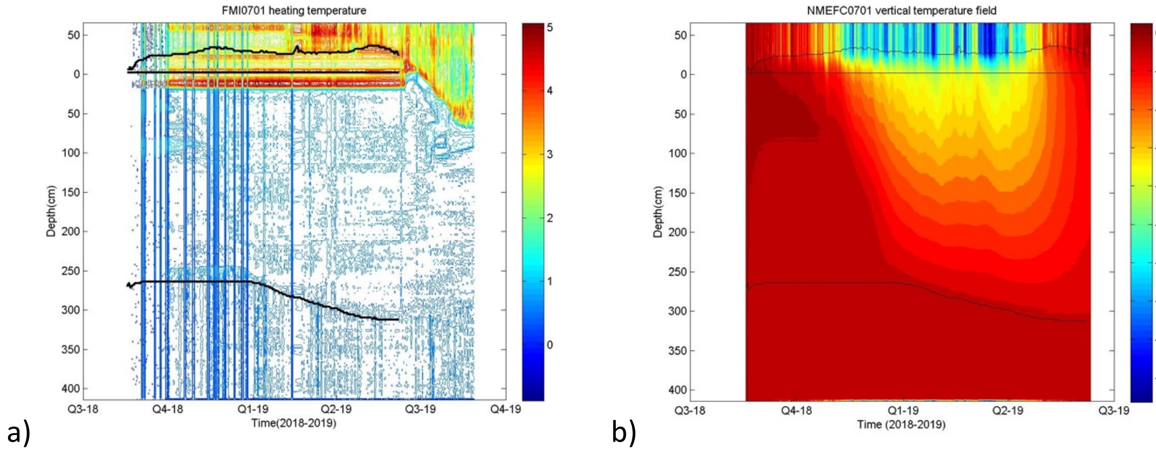

Figure 2.2.7 a) SIMBA heating temperature field. b) SIMBA temperature field. The black lines are snow surface (top), Initial freeboard (middle) and ice bottom (bottom). Zero level refers to initial snow/ice interface. The black lines in a) were derived by SIMBA algorithm. This is FMI0404 SIMBA buoy deployed during CHINARE2018. The heating temperature field can identify clearly snow surface and ice bottom.

SIMBA buoys have been also deployed prior INTAROS field season (Tian et al, 2016). Those SIMBA buoys data are also in our disposal.

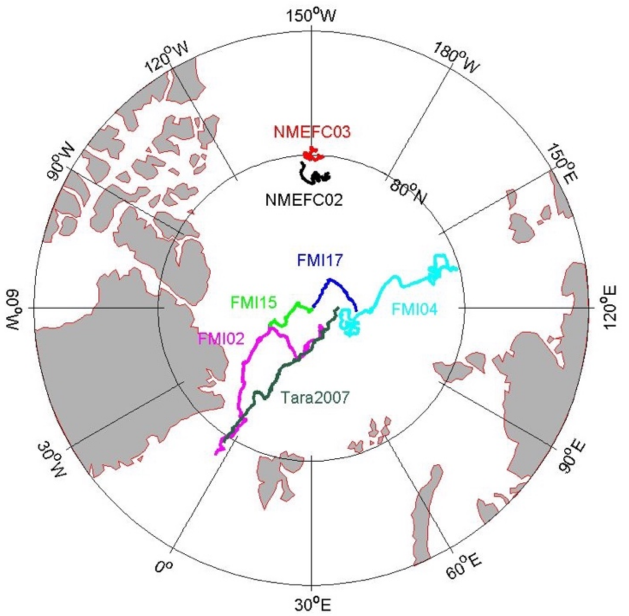

Figure 2.2.8 The drift trajectories of several SIMBA buoys in the Arctic Ocean prior to INTAROS field season. The drift trajectory of ship Tara (Gascard, et al, 2008) between May and November 2007 is shown in the figure as well.

2.2.4. Description of provided data - surface albedo data in the Central Arctic

The data collected in the MOSAiC project are temporarily stored in the central MOSAiC database, and from 1 January 2023 they will be made publicly available through the PANGAEA database.

2.2.5. Plans for the final implementation - SIMBA buoys

The MOSAiC field campaign is still going on and we have scheduled at least 6-8 SIMBA buoys to be deployed during the third leg of MOSAiC. The CHINARE2020 is another Arctic field campaign that most likely to be arranged in August 2020 and we have plan to deploy SIMBA buoys. For those field campaigns, the SIMBA buoys are in-kind contributions from INTAROS partners. The SIMBA deployment region/domain is still open and will be decided during the expedition cruises. The rule of thumb is to find thick and large undeformed ice floe so that to keep SIMBA buoys to be operated as long as possible.

2.2.6. Plans for the final implementation - surface albedo measurements

Surface albedo data from the FMI broadband radiation station and from the drone will be collected until October 2020. After the end of the expedition, the data will be first processed for quality check and corrections from artifacts, and then analyzed to relate the seasonal changes in surface albedo to the seasonal evolution of surface properties and surface energy budget.

References:

Gascard, J. -C. et al 2008, Exploring Arctic transpolar drift during dramatic sea ice retreat, EOS T. Am. Geophys. Un.,89, 21–22.

Liao, Z., Cheng, B., Zhao, J., Vihma, T., Jackson, K., Yang, Q., Yang, Y., Zhang, L., Li, Z. Qiu, Y. and Cheng, X. 2018 "Snow depth and ice thickness derived from SIMBA ice mass balance buoy data using an automated algorithm" International Journal of Digital Earth, https://doi.org/10.1080/17538947.2018.1545877.

Tian, Z., Cheng, B., Zhao, J., Vihma, T., Zhang, W., Li, Z. and Zhang, Z. 2016 Observed and modelled snow and ice thickness in the Arctic Ocean with CHINARE buoy data. Acta Oceanol. Sin., 2017, Vol. 36, No. 8, P. 66–75, DOI: 10.1007/s13131-017-1020-4.

2.3. NIVA

Contributors: Andrew King, Kai Sørensen, Bert van Bavel, Sabine Marty, Pierre Jaccard, Marit Norli, Elizaveta Protsenko

2.3.1. Results of the first operational implementation

A non-plastic microplastics sampler was constructed and developed for automated operation alongside a FerryBox sensor system. The sampler can hold three filters (~30 cm in diameter) and is typically outfitted with 500, 300, and 100 (or 50 µm) stainless steel filters. The dedicated pump (Iwaki, centrifugal) can push >900 L of seawater per hour, and flow rate is precisely measured using a digital flow meter. It was deployed in the Barents Sea Opening at the end of July where microplastics were collected from several transects between Tromsø and Ny

Ålesund. The samples were sent to the lab for processing and analysis; this includes digestion biological material (phytoplankton and zooplankton) and analysis by microscopy and Fourier-transform infrared spectroscopy for plastic type. Preliminary results indicate that the concentration of total microplastics was ~2-10 per m^3 seawater, with approximately 0.1-1.8 per m^3 seawater accounted for by particles, and the remainder and majority as fibers. The highest concentrations were observed near the Tromsø coast and Longyearbyen. This is as expected due to the high levels of human activity and sources of plastics in those regions.

A combined spectrophotometric pH/CO_3 system was built and field-tested in 2018 and further refined in 2019. The visible spectrophotometric technique for the pH portion of the sensor is complete, but we have encountered issues related to the CO_3 portion of the sensor that measures CO_3 using UV spectrophotometry. The UV components (both source and detector) in the prototype have been unstable and signal-to-noise ratio has been low. The pH part of the sensor is currently deployed on the Barents Sea FerryBox where data has been collected since June 2018 and awaits data QC/QA processing. The CO_3 part of the system is currently under troubleshooting and refinement in the lab.

The integrated sphere absorption meter sensor (TriOS OSCAR PSCIAM adapted to the Barents Sea FerryBox system) is now 80% operational in the lab with a series of software-controlled valves and pumps to fill and rinse the sensor with bleach, MQ, and an absorption standard (nigrosin). The sensor has not yet been deployed on the Barents Sea FerryBox due to a delay related to personnel.

2.3.2. Description of provided data

The sensors and samplers implemented in Task 3.4 include a microplastics sampler, a combined pH/CO_3 sensor, and an integrated sphere absorption meter sensor. Data that has been and will be collected from the sampler/sensors include time, latitude, longitude, temperature, salinity, chl a fluorescence, and fixed depth of 5m, in addition to the sampler/sensor specific data: microplastics concentration and material type by size fraction; seawater pH (total scale) and CO_3 ion concentration accompanied by analysis temperature; and absorption spectra from 360-750 nm. Data will be stored on NIVA data servers, the European FerryBox Database, and EMODnet Physics, and links will be provided to the INTAROS Data Catalogue.

2.3.3. Plans for the final implementation

All three sampler/sensor systems described in Task 3.4 are planned to be deployed on the Barents Sea FerryBox system for the second field season. Continued development and testing of the CO_3 portion of the pH/CO_3 sensor is underway, and a prototype software/hardware installation is being developed for the integrated sphere absorption meter sensor, and this sensor is planned for testing this winter at our field station, and subsequent deployment on the Barents Sea FerryBox.

2.4. CNRS-LOCEAN

Contributors: Marie-Noelle Houssais, Christophe Herbaut, Pierre Testor

2.4.1. Results of the first operational implementation

In order to monitor the Atlantic water flow through Fram Strait, CNRS-LOCEAN has carried out several glider missions in the west Spitsbergen Current since 2017. The goal is to provide high resolution snapshots of the Atlantic water flow at the main gateway to the Arctic Ocean in order to better assess the role of the mesoscale eddies and recirculations in setting the mean flow structure and associated transports to the Arctic. Regular monitoring is essential to estimate the statistical confidence on individual realizations while synoptic surveys are needed to ensure that short-term variability is properly sampled. Several monitoring programmes (in particular through a suite of EU funded programmes such as FP5-VEINS, FP6 ASOF-N and DAMOCLES) have been initiated in eastern Fram Strait, first with the AREX summer hydrographic survey programme led by Poland since the early 90s, and later by Germany through a mooring array across the strait at a single latitude (78°40'-78°50'N) which has been maintained (and still is) since the late 90's. However, these observations need to be supplemented in order to provide a high-resolution synoptic view of the regional circulation and transports.

Endurance glider lines, through their repetitive nature and their potential for high resolution data acquisition are an attractive tool for a systematic long-term regional monitoring. This approach was tested in the context of the Damocles project when gliders were deployed every summer between 2008 and 2012. The CNRS-LOCEAN endurance glider lines provide a continuation to this initiative. Gliders deployed during INTAROS are also equipped with additional sensors, measuring dissolved oxygen content, chl-a and CDOM fluorescence, and particulate backscattering.

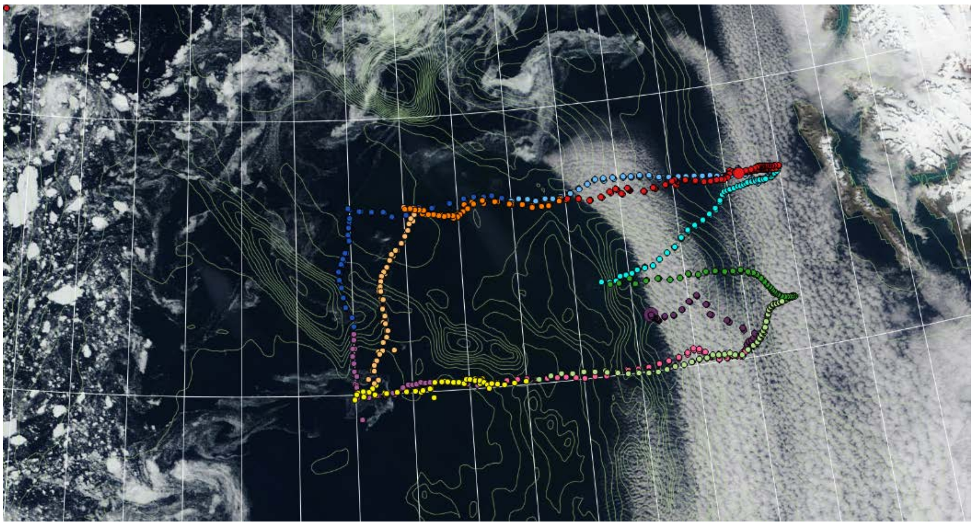

Figure 2.4.1 Trajectory of the glider during two repeat cruise tracks along a quadrangle extending between 78°N and 78°40'N and 2°E and 10°E. Each track was completed in about a month (Leg 1: 25 July - 30 August 2017, Leg 2: 30 August - 22 September 2017). Each color code corresponds to a different week. Sea ice MODIS image from 29 July 2017.

A first two-month long mission across eastern Fram Strait was realized with a single Slocum glider in July-September 2017. The mission provided a detailed picture of the hydrographic properties and current velocity in the upper 1000m (Fig. 2.4.1). Note that since our gliders are not designed to perform in ice-covered regions, monitoring is restricted to the summer season and to the eastern ice-free part of the strait (i.e. between the Svalbard shelf and the ice edge).

In summer 2018, the glider mission had to be cancelled after a few days for technical issues with the gliders. In summer 2019, it was planned to deploy two gliders, one to survey the same area as in 2017 and another to operate farther north to explore the structure of the AW current as it flows over the Yermak Plateau. Unfortunately, only one glider worked properly.

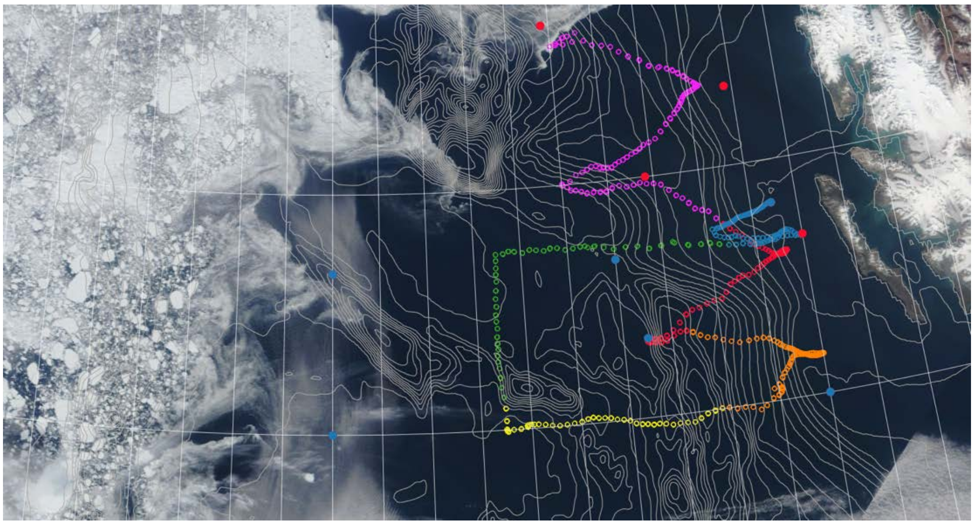

Figure 2.4.2 Trajectory of the glider in summer 2019. The glider first followed approximately the same trajectory as in summer 2017; it then proceeded to the North until it was recovered by KV Svalbard. Mission dates: 13 July - 08 September 2019. Sea ice MODIS image from 27 July 2019.

2.4.2. Description of provided data

Over the entire 2017 mission, a total of 978 profiles distant from each other by ca. 1-2 km depending on the maximum diving depth and the ambient current, were collected. The glider was set to dive to maximum depth of 1000 m. For each glider dive, the following set of ocean variables was measured at 1 dbar vertical resolution: pressure, temperature, conductivity, dissolved oxygen content, Chl-A and CDOM fluorescence, particulate backscattering coefficient (bbp700), with associated quality flags and uncertainties. Additionally, the depth-averaged velocity is retrieved from the glider trajectory.

Based on the two quasi synoptic surveys along almost identical paths, it is possible to describe the structure of the mean geostrophic current in the upper 1000 m and its along-slope evolution between 78°N and 78°40’N (Fig.3). Contrasted structures of the West Spitsbergen Current slope branch were observed between these two latitudes, with a weakening and downslope shift of the core of the current as it progresses northward. Substantial (on order of 3-3.5 Sv) along-slope divergence of the northward volume transports was found between 78°N and 78°40’N, mainly concentrated south of 78°15’N, which suggests that the main westward recirculation of the AW occurred in this latitude range.

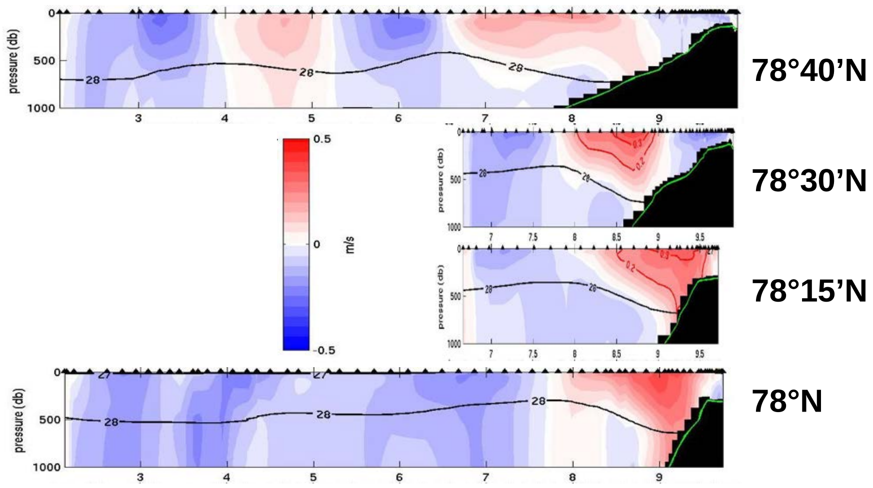

Figure 2.4.3 Absolute geostrophic velocity along four crossings at different latitudes in eastern Fram Strait: (top panel) 78°40’N, (upper middle panel) 78°30’N, (lower middle panel) 78°15’N and (bottom panel) 78°N. Velocities are based on CTD measurements and estimates of the 0-1000 m (or bottom) depth-averaged velocity. The black shading represents the upper Svalbard shelf-slope.

The observations collected in summer 2019 have not been extensively analyzed yet. Still, the situation appears to be in contrast to 2017. In particular the current over the slope at 78°40’N is much weaker than in 2017, which questions the continuity of the northward flow along the slope and the source of the flow farther north at 79°N (Fig. 2.4.4).

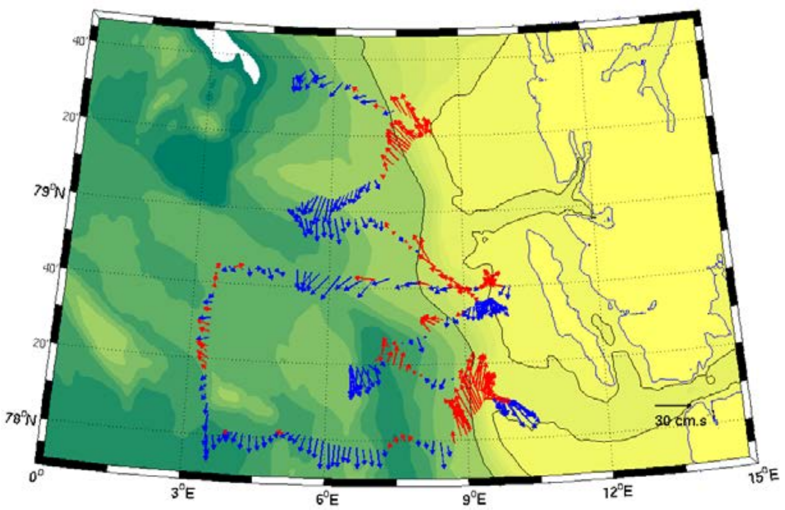

Figure 2.4.4 Depth integrated geostrophic velocity mapped along the glider trajectory in summer 2019.

2.4.3. Plans for the final implementation

Obviously, in view of the large contrast identified between our two years of data, more data are needed to document the variability in the strait, in particular the typical time scales and spatial scales of possible eddies and recirculations. We therefore plan to continue these endurance glider lines in eastern Fram Strait in summer during the oncoming years in order to improve the flow statistics and possibly better characterize the typical features (eddy tracking).

We will possibly use gliders with larger power autonomy so it will be possible to increase the number of realizations of a given line within the same season and also to extend the glider survey season toward the autumn when we know that the flow is stronger with enhanced mesoscale activity. Having two gliders operating at the same time will also allow for a wider survey area while ensuring synopticity.

2.5. CNRS-Takuvik

Contributors: Marcel Babin, Claudie Marec, Marie-Hélène Forget

2.5.1. Results of the first operational implementation

The contribution of CNRS-TAKUVIK to Task 3.4 is made through the monitoring of the biogeochemical properties of the Baffin Bay with the deployment of a fleet of bio-Argo floats dedicated to navigate in ice-infested waters. The overarching goal is to understand the processes that control the Arctic PSB (Phytoplankton Spring Blooms) as it expands northward and to determine its fate in the ecosystem by investigating its related carbon fluxes. The long-term objective is to determine the fate of the PSB in a changing AO (Arctic Ocean).

Year-long high-frequency time series of phytoplankton phenology and its drivers are required and BGC Argo floats are the complementary tools to remote sensing and oceanographic cruises for these studies.

To study the onset of a PSB event under melting sea ice in May to its conclusion within the SIZ in July, Takuvik has deployed BGC Argo floats (called ProIce, dedicated to polar environments) in Baffin Bay since the beginning of the program. The deployments are staggered in time (5 in spring 2016 in Baffin Bay, 7 in summer 2017, 2 in summer 2018, 2 in summer 2019). 5 deployments are scheduled in summer 2020 (in the meantime, some floats have been recovered and re-fitted to be deployed again).

The study focuses on Baffin Bay, which involves navigational challenges for floats in terms of bathymetry, ice coverage and circulation. Although the Proice floats are adapted to ice-infested waters, the experiment remains a real challenge. The real reason for the loss of some floats, at the beginning of the experiment remains unexplained, but we could diagnostic a mis-management of the grounding in the firmware that lead to 3 losses at least (this problem has been fixed).

In spite of this, more than 1900 profiles have been acquired so far with unprecedented sets of data with series measured under ice during wintertime (2 winters under ice for takapm016b, 1 winter under ice for takapm011b, takapm017b, takapm020b). Table 2.5.1 gives the amount of profiles acquired per float.

Table 2.5.1 Profiles provided by each PROICE float

	WMO number	**Date of first profile**	**Date of last profile**	**Number of profiles**	**Issue /comment**
takapm014b	**6902668**	09/04/2016	31/10/2016	99	Disappeared during 1st winter
takapm005b	**4901803**	09/04/2016	31/10/2016	98	Disappeared during 1st winter
takapm009b	**6902667**	09/07/2016	31/10/2016	99	Disappeared during 1st winter
takapm013b	**4901802**	09/07/2016	31/10/2016	98	Disappeared during 1st winter
takapm019b	**4901801**	30/05/2016	25/05/2017	363	(no BGC- payload only O2)
takapm008b	**6902669**	20/07/2017	03/11/2017	102	Disappeared during 1st winter
takapm012b	**4901805**	20/07/2017	12/08/2018	124	Recovered – refit
takapm006c	**4901804**	20/07/2017	29/07/2017	12	Lost after grounding
takapm015b	**6902670**	20/07/2017	05/11/2017	113	Surface-blocked on last descent
takapm017b	**6902829**	23/07/2017	9/04/2018	106	Destroyed upon recovery
takapm007b	**6902666**	23/07/2017	27/09/2017	70	Lost after grounding
takapm016b	**6902671** **6902953**	23/07/2017	29/7/2019	185	Remote firmware upgrade (change of WMO)
takapm020b	**6902897**	17/07/2018	12/10/2019	186	Recovered for refit
takapm011b	**6902896**	17/07/2018	31/05/2019	133	Flooded
takapm018b	**6902967**	14/07/2019	-	115 to date	Still operational
takapm004b	**4901806**	17/07/2019	02/09/19	8	Recovered for maintenance and refit

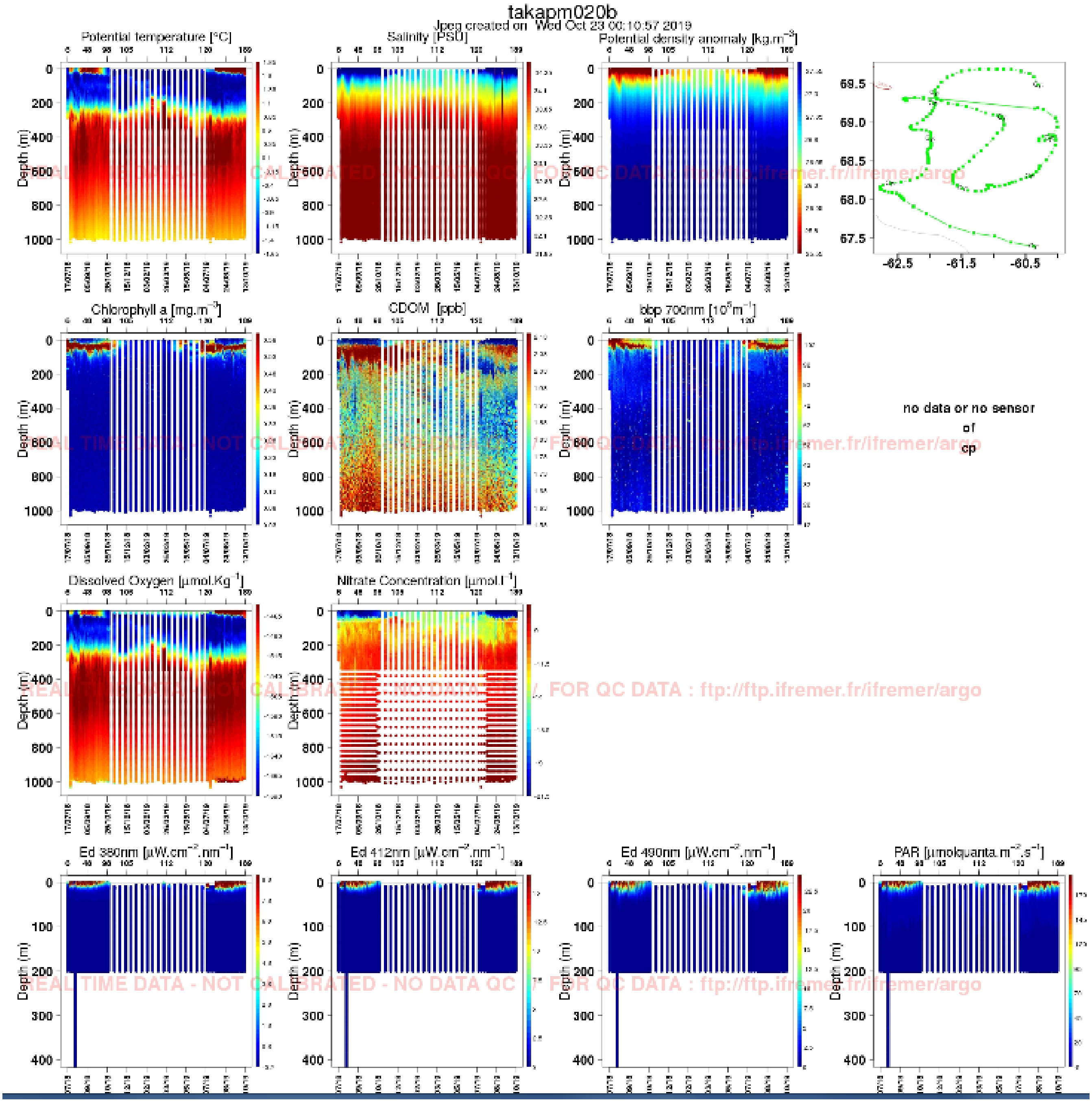

Figure 2.5.1 An example of 15-month long time series of data, including potential temperature, salinity, potential density, chl-a, CDOM, particle backscattering, dissolved oxygen, nitrate concentration, and radiation (380 nm, 412 nm 490 nm and PAR) from the BBGC ARGO float takapm020b.

2.5.2. Description of provided data

ProIce are BGC floats (biogeochemical) equipped with a CTD (conductivity-temperature-depth) Seabird41 unit, an Anderaa 4330 oxygen optode monted on a 30 cm stalk, a Wetlabs REM-A (combining OCR504 radiometer (380nm, 412nm, 490nm and PAR) and ECOTriplet for the observation of chlorophyll-*a* fluorescence, colored dissolved organic matter, and particle backscattering at 700nm (bbp), as well as a Satlantic SUNA V2 sensor. This payload gathers five of the six core biogeochemical Argo variables.

The floats profile at various rates according to the season with a daily rate since mid-July until mid-November (or earlier depending on ice cover), then with a frequency of one to two weeks.

Data acquired of the various parameters (pressure, temperature, salinity, dissolved oxygen, radiometry, chl*a* fluorescence, CDOM fluorescence, particles abundance and nitrates are precious (up to 2 years) time-series. They are available in real time (RT) and with free access from the ARGO data center (see links below).

To upload the real-time data : ftp://ftp.ifremer.fr/ifremer/argo/dac/coriolis/

To visualize the BGC Argo data : http://www.argodatamgt.org/Access-to-data/Argo-floats-dashboard or https://fleetmonitoring.euro-argo.eu/dashboard

Data go then through the process of the quality control for each parameter. QC-controlled data will later be available in the DM (delayed mode) in the ARGO data center.

2.5.3. Plans for the final implementation

5 more deployments are planned for 2020. One of these floats will be equipped with a new sensor dedicated to measure particle size and abundance (UVP6 by Hydroptics, Fig. 2.5.2). This will give a complementary information to characterize the ecosystem. The implementation of this sensor will be a "premiere" on an ARGO float in the Arctic Ocean. Depending on the recoveries of floats, additional deployments will be imagined in 2021.

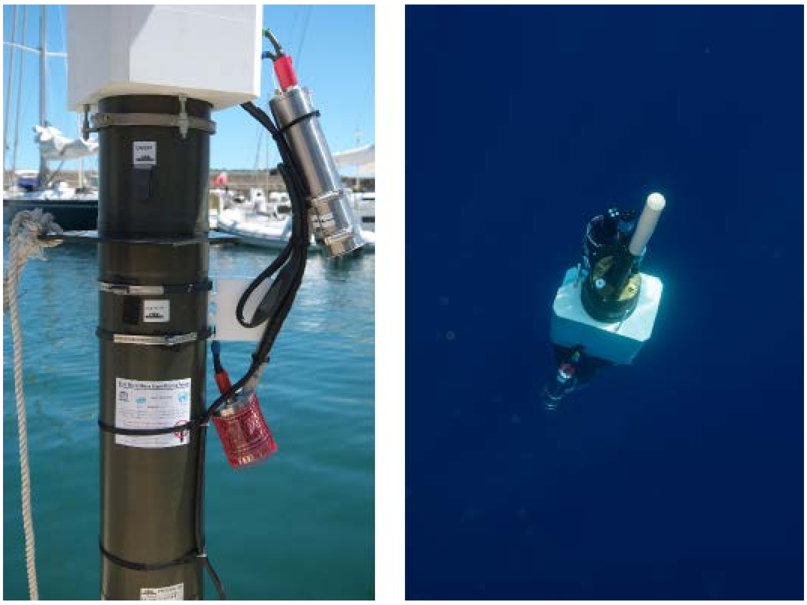

Figure 2.5.2 Proice Argo float equipped with an UVP6- (picture courtesy LOV2).

3. Future plans for the final implementation of the observing system

Ocean and sea ice observations have been collected with the IAOOS-Equipex ice-tethered platform in the central Arctic Ocean during the first INTAROS field season. For the second INTAROS field season a deep ocean mooring has been deployed in the Nansen Basin to provide year-round ocean and sea ice measurements in 2019-2020. For the future implementation of an observing system for ocean and sea ice in the central Arctic Ocean a combination of ice-tethered platforms and fixed ocean moorings can be recommended, based on the experience from INTAROS observations, gathered up to the date of this deliverable. SIMBA buoys for ice mass balance measurements have been successfully deployed in relatively big numbers in the central Arctic Ocean. 6-8 SIMBA buoys are planned to be deployed during the second INTAROS field season during two campaigns in 2020 (MOSAiC and CHINARE cruise). Surface albedo measurements with a fixed station on the ice floe and the drone-based surface albedo measurements along the optical transect and in the UAV area will be collected during the spring-to-autumn season in 2020 until the end of the MOSAiC field campaign. Microplastic sampling and pH measurements with the FerryBox system along the repeated line between Tromsø and Ny Alesund will be continued during the second INTAROS field season and further on. Operational implementation of the CO_3 part of the integrated pH/CO3 sensor and the integrated sphere absorption meter sensor for the FerryBox system will be completed in 2020 and new measurements of CO_3 ion concentration and absorption spectra from 360-750 nm will be collected in 2020. Deployments of gliders along the endurance lines in Fram Strait and north of Svalbard will be continued in the summer/ autumn 2020 with an attempt to increase the mission time. 5 BGC Argo floats, including one equipped with a UVP sensor for optical measurements of particles in the water column, will be deployed in 2020 in the Baffin Bay observatory and further deployments are foreseen, depending on floats' recovery rate.

4. Summary

The deliverable D3.14 provides an overview of distributed ocean and sea ice measurements, collected under the INTAROS Task 3.4 during the first field season and earlier in different regions of the Arctic Ocean, including the central Arctic Ocean, the Barents Sea Opening, Fram Strait and the deep Nansen Basin, and the Baffin Bay. Collected data sets encompass key ocean physical (temperature, salinity and ocean currents) and biogeochemical (dissolved oxygen, pH, pCO2, CO3, microplastic size fractions and concentrations, chl-a and CDOM fluorescence, nitrates, particle backscattering, absorption spectra) variables as well as sea ice properties (mass balance, thickness, ice drift) and atmosphere-snow-sea ice-ocean interfaces. The processing of *in situ* data collected during the first INTAROS field season is going on and when completed, the processed and quality controlled data products will be registered in the INTAROS data catalog and submitted to open data bases (for some of the Task 3.4 data sets the protection period is foreseen before the releasing the full data record). Data from Task 3.4 will be delivered to data management system (and future iAOS) in WP5 and exploited in WP6 for the demonstration actions.

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