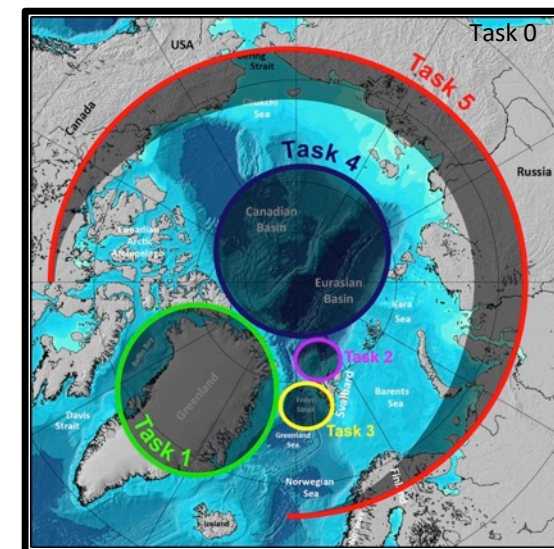


INTAROS WP3 *In situ* observing systems

Task 3.2

North of Svalbard towards the deep Nansen Basin:

- array of multidisciplinary moorings with profiling instruments and point measurements of ocean physical variables (IOPAN, CNRS-LOCEAN, UiB-GFI)
- $p\text{CO}_2$ sensors for carbon system variables (UiB-GFI)
- NO_3^- sensors for nutrients (UiB-GFI, AWI)
- autonomous passive contaminant samplers (NIVA)
- Octopus system for biological measurements with underwater vision profiler (UVP) and ECO triplet (AWI)
- upward-looking dual use ADCPs/sonars for currents and sea ice draft and drift (IOPAN, UiB-GFI)
- bottom pressure recorders (UNIS)
- combined ADCP-echosounders for currents and zooplankton (IMR)
- ocean bottom seismometers for solid Earth processes and geohazards (GEUS/UiB-GEO)



The multidisciplinary moored array preliminary results operated by the Task 3.2 partners

- The INTAROS field seasons 2018-2020 in the entrance to the Arctic Ocean north of Svalbard is completed
- The mooring array was deployed successfully in August 2018 with KV Svalbard and retrieved KV Svalbard in August/September and with RV Kronprins Haakon in September and November 2019 and some of moorings were redeployed.
- Data are now being processed and their quality will be assessed following the present best practices for all the different measured variables
- The goal is to prepare the final data products for delivery to WP5 and WP6, but at this point of time they can be regarded as preliminary results, i.e. “raw data directly downloaded from different sensors”
- We have obtained a full annual multivariable cycle of data from August 2018 to December 2020 in INTAROS. In addition there is data collected before INTAROS that will/can be used in synthesis.
- Data on solid earths physics (earthquakes related to fracture zones and faults)
- Acoustics monitoring of the mean temperature and its potential changes on a basin-wide scale will be available in 2020+
- Status for the plans in WP6 will be presented by task leaders later today and tomorrow

The multidisciplinary moored array preliminary results operated by the Task 3.2 partners

- The first INTAROS field season 2018-2019 in the entrance to the Arctic Ocean north of Svalbard is completed
- The mooring array was deployed successfully in August 2018 with KV Svalbard and retrieved KV Svalbard in August/September and with RV Kronprins Haakon in September and November 2019
- Data are now being processed and their quality will be assessed following the present best practices for all the different measured variables
- The goal is to prepare the final data products for delivery to WP5 and WP6, but at this point of time they can be regarded as preliminary results, i.e. “raw data directly downloaded from different sensors”
- We have obtained a full annual multivariable cycle of data from August 2018 to August 2019
- This includes solid earths physics (earthquakes related to fracture zones and faults)
- Acoustics monitoring of the mean temperature and its potential changes on a basin-wide scale will be available in 2019
- End of July to medium August 2020, KV Svalbard, successfully retrieval of moorings under extreme ice condition
- September to December 2020, cruises with RV Kronprins Haakon and KV Svalbard concluded the field season
- We have also excess to turbulence data and carbon cycle data collected with RV Polarstern during the MOSAiC expedition. Particular important to excess the performance of the SAMI pCO₂ sensors

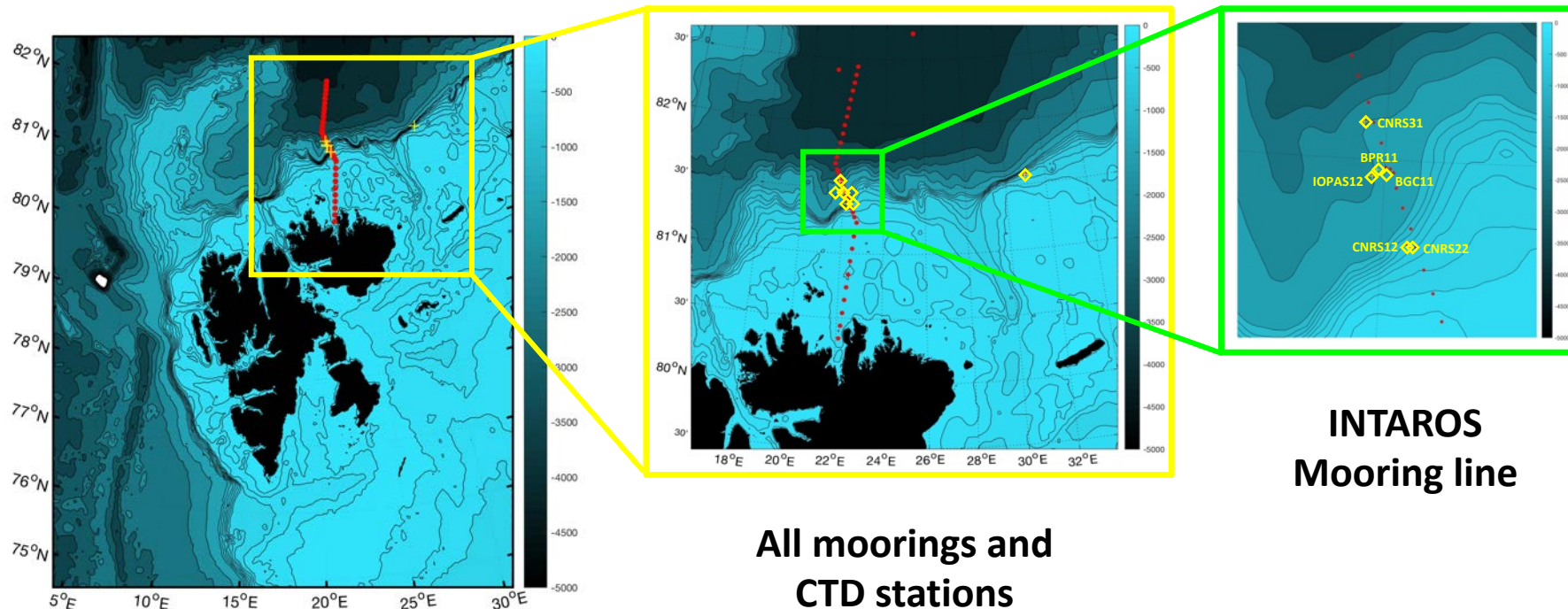
In general delays and changes in plans of operation is caused by the COVID 19 situation

Task 3.2 North of Svalbard towards the deep Nansen Basin



INTAROS cruise 2018 (Tromsø-Longyearbyen-Longyearbyen) on the Norwegian Coast Guard icebreaker KV Svalbard, July 30 - August 20 Six INTAROS partners: NERSC, UiB, IOPAN, CNRS-LOCEAN, AWI, NIVA

- Deployment of Ocean Bottom Seismometers in Fram Strait
- Recovery and deployment of moorings north of Svalbard
- CTD, optical, biogeochemical and turbulence measurements on stations



All moorings and
CTD stations

INTAROS
Mooring line

UiB 2.1 activities in Task 3.2 in 2020:

- Processing of mooring data collected in 2018-2019 and 2019-2020 continued.
- Assessment of CO₂ data quality in conjunction with the sensor manufacturer and in-lab tests continues.
- Helped recover several moorings during the CAATEX 2020 cruise aboard the KV Svalbard on 17th of July to 9th of August 2020 and did a partial repeat of the CTD transect done in 2018. Of particular relevance to UiB's activities was the recovery of the NERSC4 mooring with biogeochemical sensors.
- Processing of pCO₂ observations from the MOSAiC expedition commenced and will be used to complement INTAROS's observations of Arctic Ocean carbon cycling dynamics.



2.1. UiB-GFI

Contributors: Truls Johannessen, Nicholas Roden, Are Olsen, Tor de Lange, Harald Sodemann, Alexandra Touzeau and Lars Henrik Smedsrud

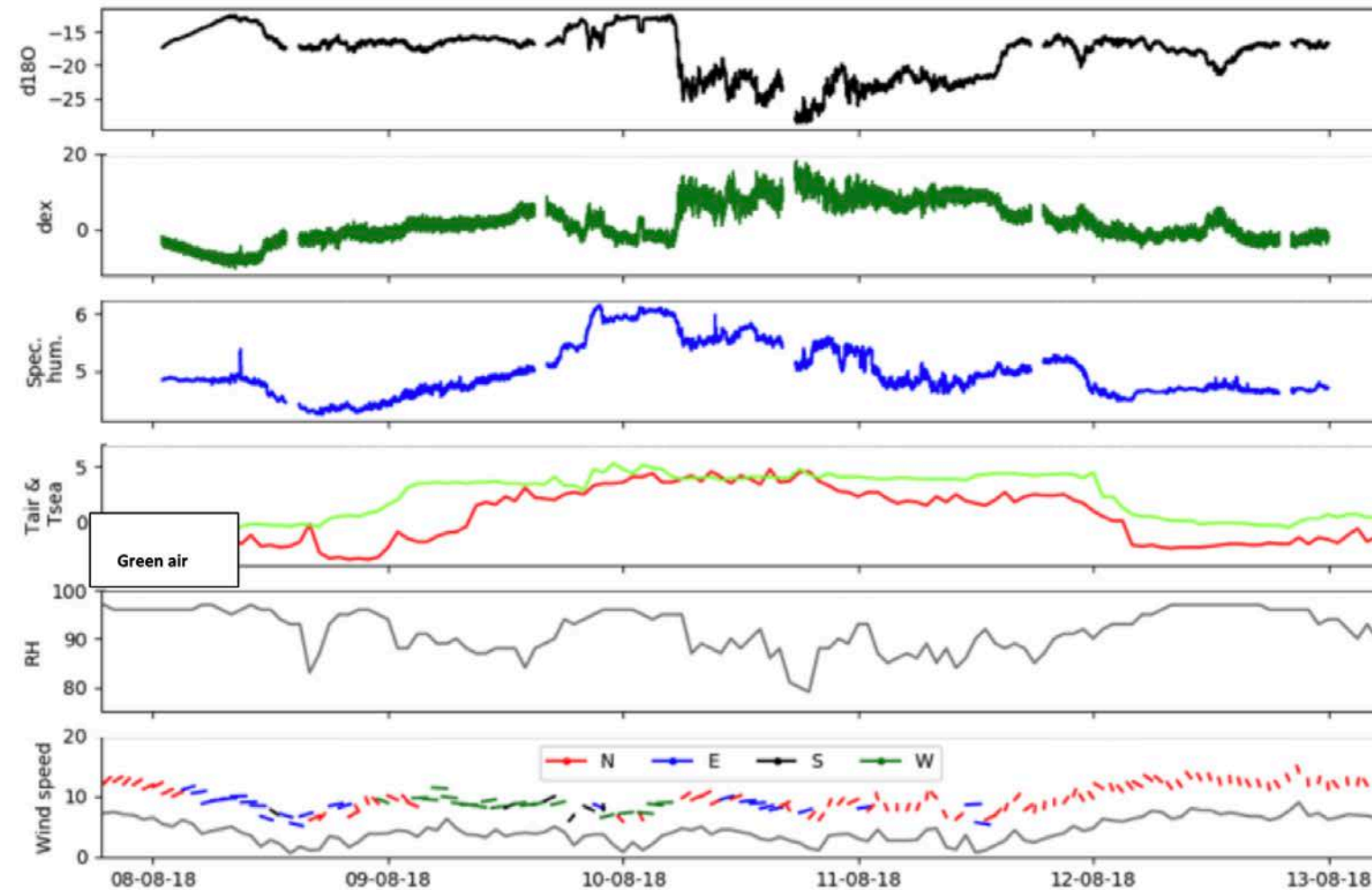
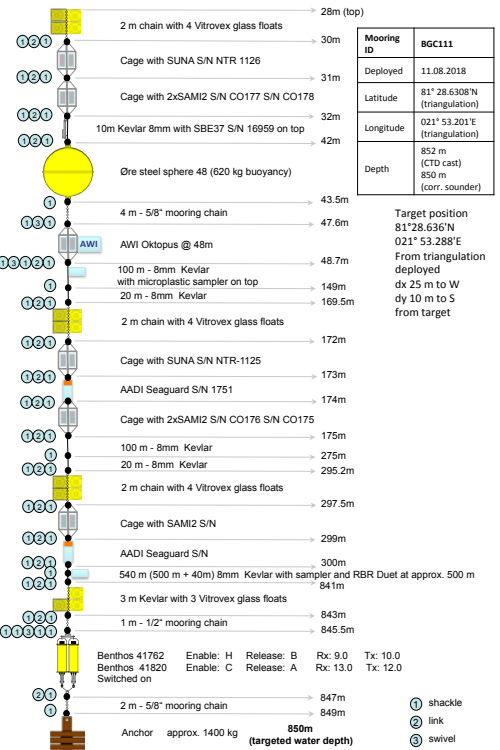


Figure 2.1.2: Time series of isotopes and ship meteorological variables during the first INTAROS cruise (showing 8th to 13th of August 2018). From top to bottom: $\delta^{18}\text{O}$, d-excess, specific humidity from laser instrument; air and sea temperatures, relative humidity and wind speed and direction from the ship.

2.1. UiB-GFI

Contributors: Truls Johannessen, Nicholas Roden, Are Olsen, Tor de Lange, Harald Sodemann, Alexandra Touzeau and Lars Henrik Smedsrud



Mooring ID	BGC111
Deployed	11.08.2018
Latitude	81° 28.6308' N (triangulation)
Longitude	021° 53.201' E (triangulation)
Depth	852 m (CTD cast) 850 m (corr. sounder)

Target position
81°28.636'N
021° 53.288'E
From triangulation
deployed
dx 25 m to W
dy 10 m to S
from target

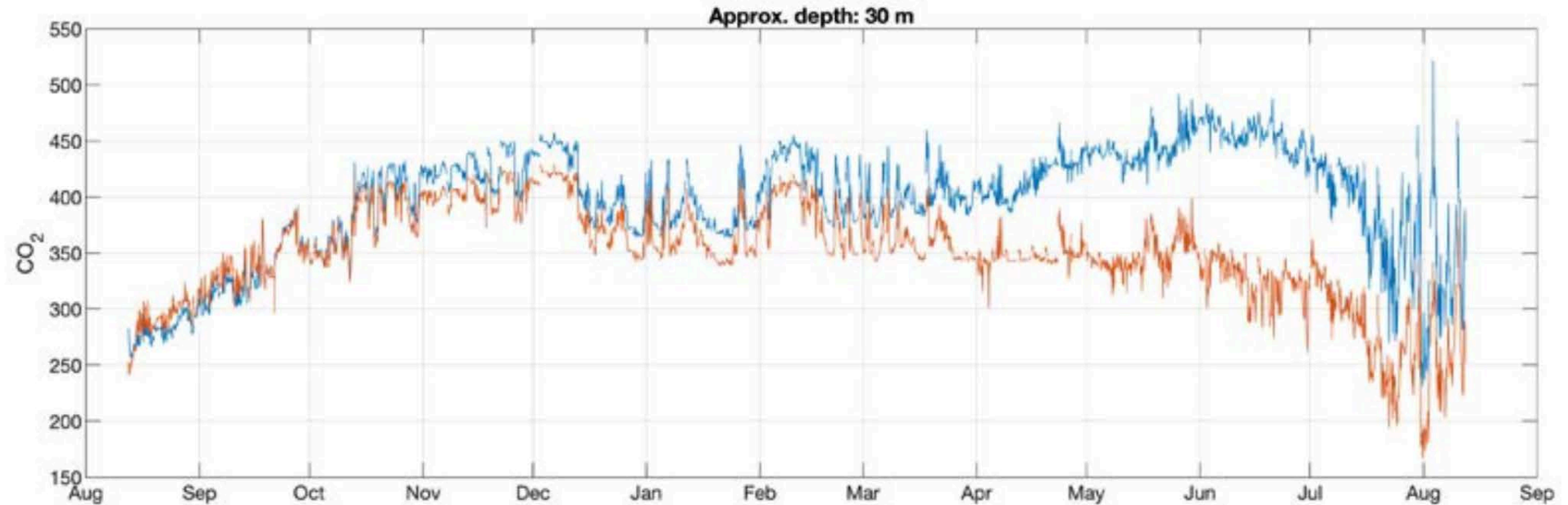


Figure 2.1.4: pCO₂ data measured from the SAMI-CO₂ sensors from three different depths. For redundancy, two sensors were used at each of the two shallowest depths

Motivation: Biogeochemistry INTAROS SSC meeting

No data not completely true

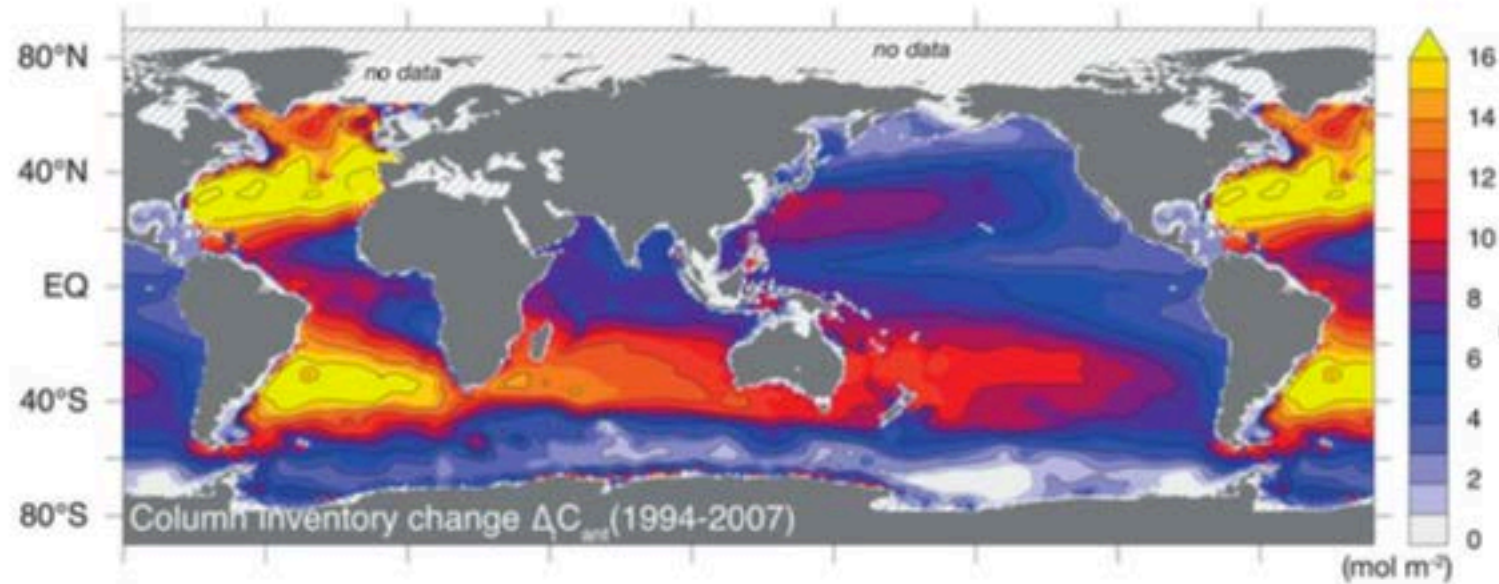


Figure 1.1: Global C_{ant} inventory estimated with the eMLR(C^*) method. The Arctic Ocean and Nordic seas are left out (Gruber et al., 2018).

Collaboration between IOPAN and UIB-GFI

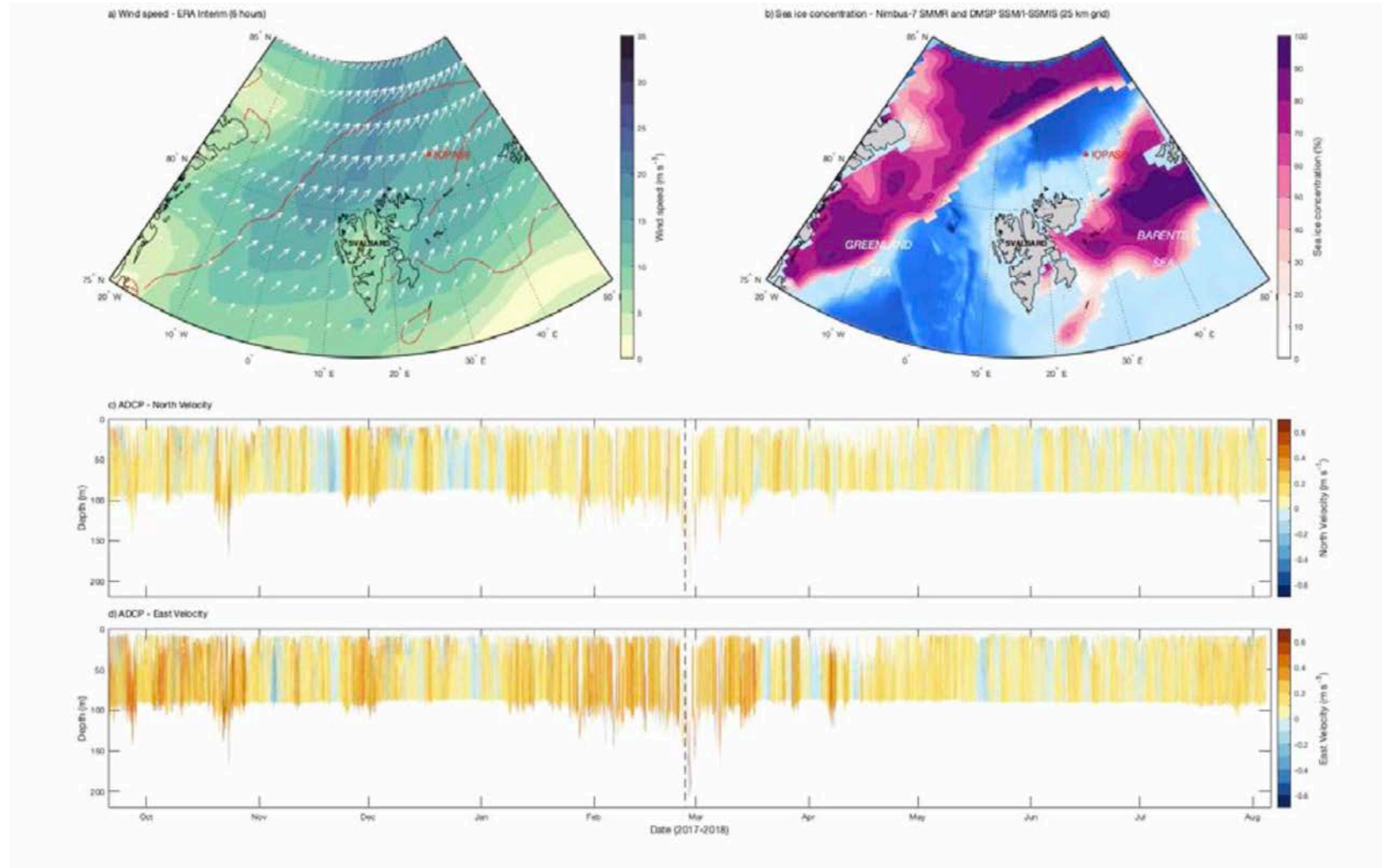


Figure 2.1.5: Windspeed, sea ice concentration and current velocity from the IOPAS11 mooring location north of Svalbard. The first two panels show the a) windspeed estimates from the ERA-Interim atmospheric reanalysis product (the red line shows sea ice extent) and b) sea ice concentration from satellite observations for the region on the 26th February 2018. This date is represented by a dashed line in panels c) and d), which show the full timeseries of north and east current velocity measurements from the ADCP.

2.2 IOPAN activities in Task 3.2 in 2020:

- Processing of mooring data collected in 2017-2018 and 2018-2019 continued.
- Assessment of data quality and establishing/tuning the best practices for different variables is ongoing.
- Mooring IOPAS13 deployed in 2019 at the INTAROS line at 22°E was successfully recovered from KV Svalbard on 24th of October 2020 during the CAATEX 2021 Beaufort cruise.

Delays due to COVID-19 and mitigation measures:

- Later than planned (late autumn instead of summer) recovery of the mooring IOPAS13, mooring recovered due to unexpected but very fortunate opportunity of the CAATEX 2021 Beaufort cruise;
- Participation of IOPAN in the summer cruise not possible thus no new deployments of moorings;
- Some delays in submitting first data sets to IOPAN repository due to the lockdown/limited personnel;

Data produced and access in data repositories:

- Data are now being processed and their quality is under assessment (see summary on the next slide)

Exploitation of the results:

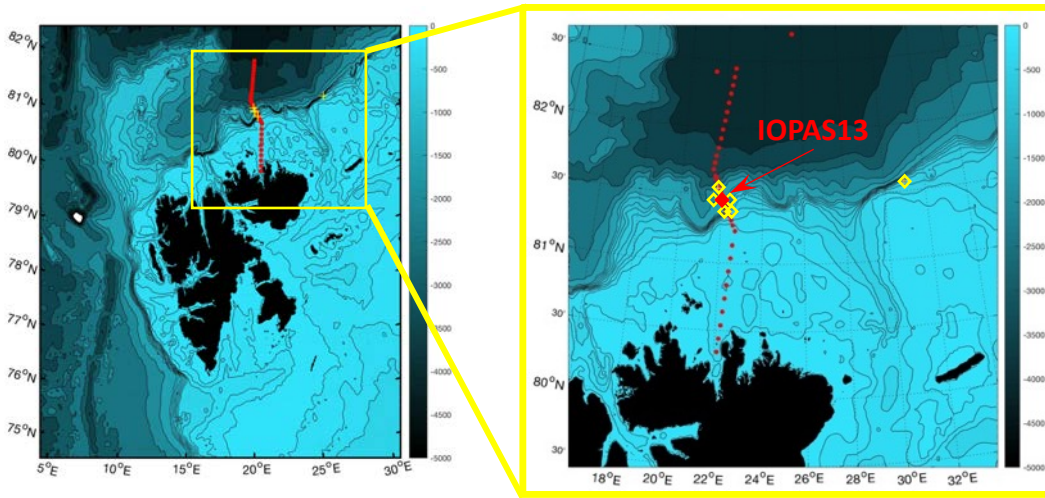
- Time series of physical variables will be used in Task 6.3 to obtain ocean and sea ice statistics from hourly and daily to seasonal and interannual time scales
- Final data products will be used for ocean climate, process studies, validation of models and remotely sensed products

Completion of work in 2021:

- Finalizing processing of INTAROS mooring data and their submission to IOPAN data base for open access
- Deployment of two IOPAN moorings to sustain the INTAROS moored measurements north of Svalbard (in autumn 2021 from RV Kronprins Haakon in collaboration with the A-TWAIN/Nansen Legacy projects)

Mooring IOPAS13

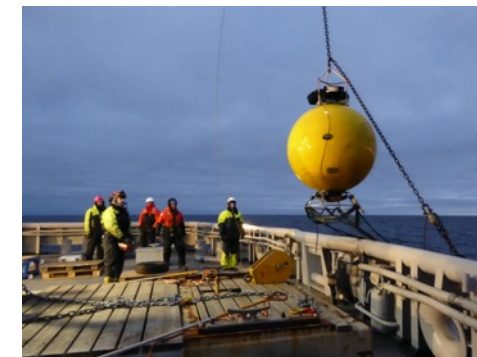
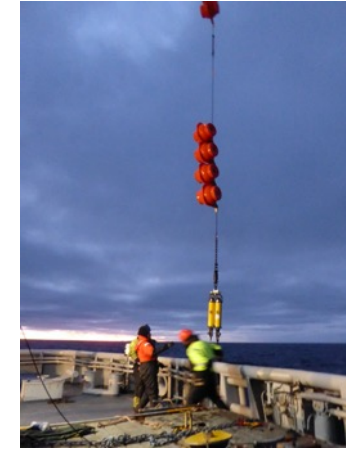
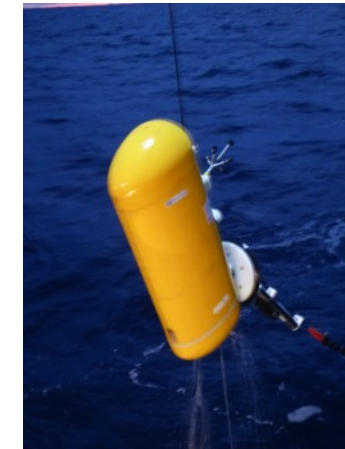
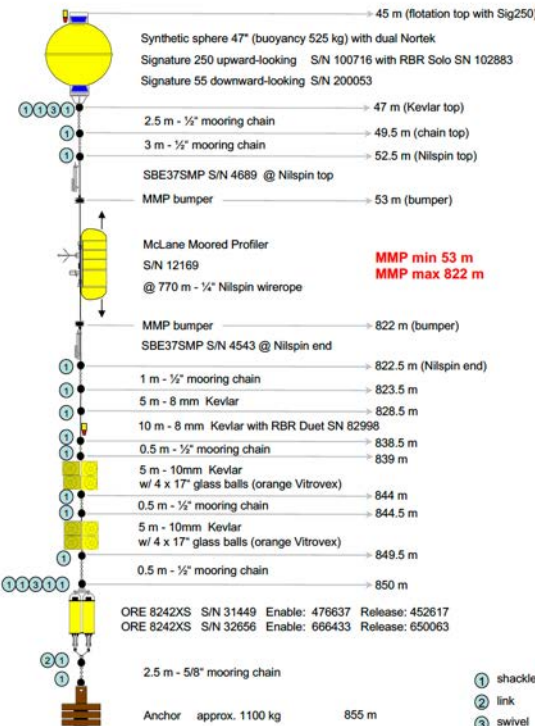
- Deployed in November 2019 from RV Kronprins Haakon in full ice cover
- Recovered end of October 2020 from KV Svalbard in open water



Mooring ID	IOPAS13	Latitude	81° 29.163'N
Deployed	24.11.2019 23:15 UTC	Longitude	021° 56.264'E
Release method: lowered to bottom, released with acoustic release		Water depth	855 m

Mooring equipped with:

- Moored McLane Profiler (temperature and salinity profiles)
- Nortek Signature 250 upward-looking (ocean currents profiles, sea ice drift and draft)
- Nortek Signature 55 downward-looking (ocean currents with mid-range/high resolution and long-range/lower res)
- SeaBird SBE37 Microcats (point measurements of T and S)



All instruments returned full data sets

Mooring recovery in open water during the CAATEX 2020 Beaufort cruise



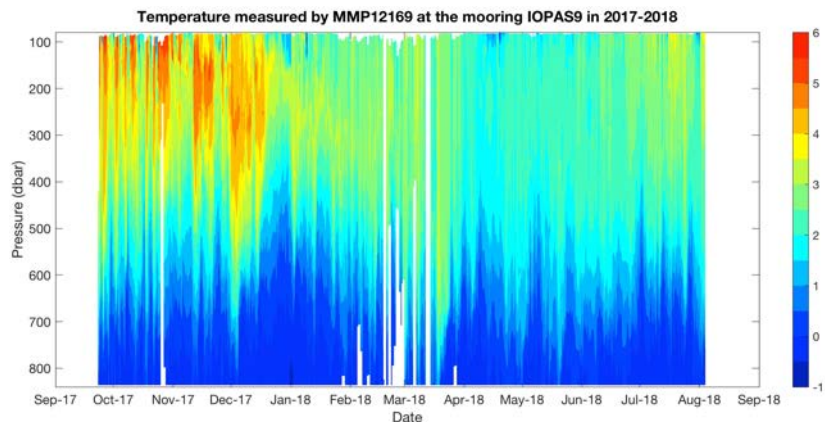
Summary of INTAROS data collected by IOPAN moorings in Task 3.2 in 2017-2020

Instrument/location/ duration	Measurement type	Variables measured	Temporal resolution	Vertical resolution	Vertical range	Data processing
MMP times series (4 sets): IOPAS11@22°E 2017-2018 IOPAS21@31°E 2017-2018 IOPAS12@22°E 2018-2019 IOPAS13@22°E 2019-2020	Profiles	Temperature Salinity Currents	12 h	2 m bins	750 m @ 22°E 900 m @ 31°E	Not standard but some recommendations exist
QMADCP time series (2 sets): IOPAS21@31°E 2017-2018 IOPAS22@31°E 2018-2019	Profiles	Currents Temperature (point)	1 h	4 m bins	250-300 m	Standard General best practices exist for ADCPs
SBE37 time series (12 sets): IOPAS11@22°E 2017-2018 (2) IOPAS21@31°E 2017-2018 (4) IOPAS22@31°E 2018-2019 (4) IOPAS13@22°E 2019-2020 (2)	Point	Temperature Salinity	10 min	-	-	Standard Best practice exist
Signature 55 time series (3 sets): IOPAS11@22°E 2017-2018 IOPAS12@22°E 2018-2019 IOPAS13@22°E 2019-2020	Profiles	Currents Temperature (point)	1 h/6 h	6 m/12 m bins	400-500 m/ 800-900 m	Not standard but some existing best practices for ADCPs can be adopted
Signature 250 time series (5 sets): IOPAS11@22°E 2017-2018 IOPAS21@31°E 2017-2018 IOPAS12@22°E 2018-2019 IOPAS22@31°E 2018-2019 IOPAS13@22°E 2019-2020	Profiles	Currents Sea ice drift Sea ice draft Temperature (point)	1 h / 1 min	4 m bins	60-80 m/120m (ice)	Still experimental, very challenging
RBR Solo/Duet time series (12): IOPAS22@31°E 2018-2019 (11) BGC1@22°E 2018-2019	Point	Temperature	5 sec	-	-	Standard

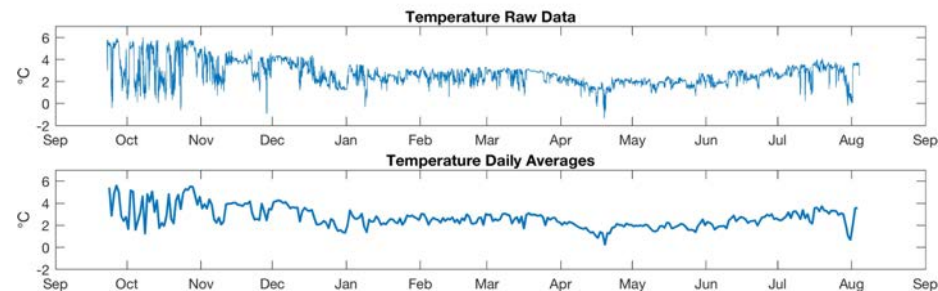
Data will be available from the IOPAN data base after processing is finalized and we obtain DOI (ongoing process)



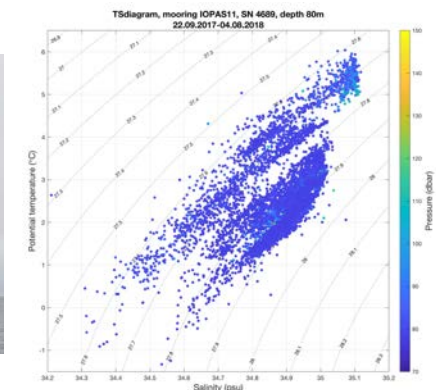
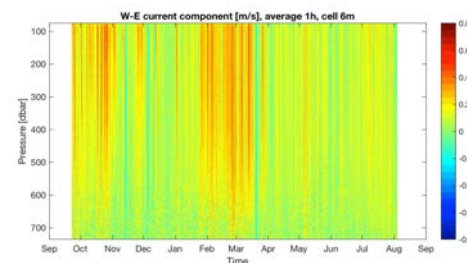
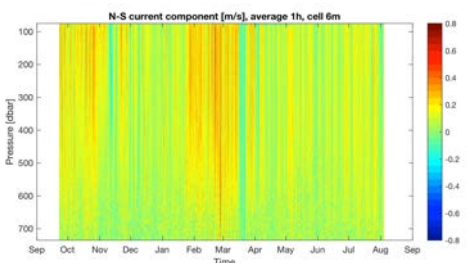
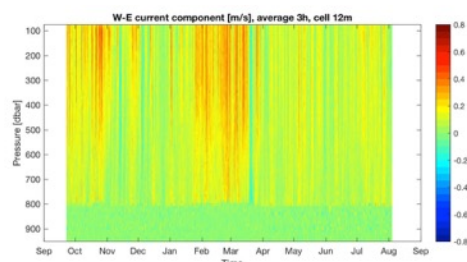
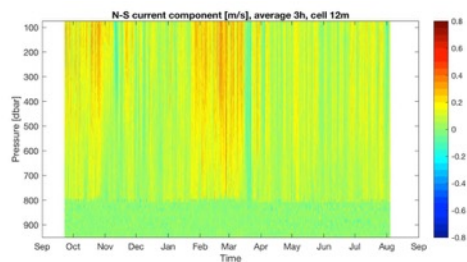
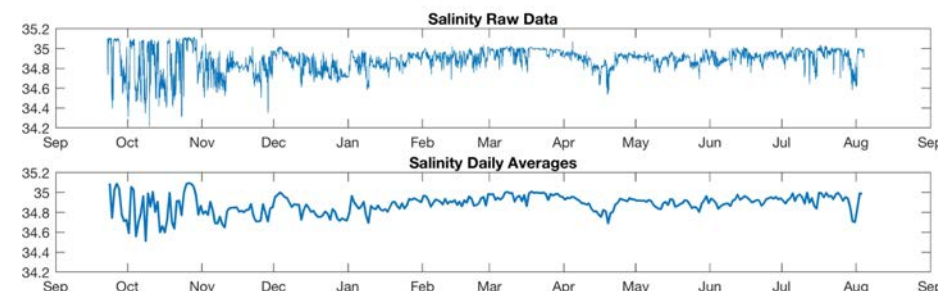
Examples of mooring data collected by IOPAN in Task 3.2 in 2017-2020



Time Series of Temperature at mooring IOPAS11, depth 80m, instrument SN 4689
Position: 81°29.39'N 022°00.23'E Start: 22.09.2017 14:00 End: 04.08.2018 06:00



Time Series of Salinity at mooring IOPAS11, depth 80m, instrument SN 4689
Position: 81°29.39'N 022°00.23'E Start: 22.09.2017 14:00 End: 04.08.2018 06:00



2.3. NIVA

Contributors: Luca Nizzeto, Ian Allan

Table 2.3.1: Locations and sampling depths of microplastic samplers.

Samples	ID/depths	Coordinates		Depths	Cage type(s)	Passive samplers
		Longitude	Latitude			
1	500 m	022° 16.00'E	81° 23.00'N	2 depths (50 m below surface, 300m)	Jerico-next Ptfе holder	SR
3	850 m	21°50.00'E	81°29.00'N	2 depths (50 m and 500m)	Jerico-next Ptfе holder	SR
5	1500 m	022° 15.00'E	81° 36.00'N	3 depths (50 m, 800 m and 1300 m)	Jerico-next Ptfе holder	SR

NIVA: Passive samplers were recovered by partners and sent to NIVA's lab. Extraction and analysis of contaminants from the passive samplers underway.

2.4. IMR

Contributors: Angelika Renner

- The Nortek Signature100 for ocean currents and biological monitoring will be deployed in November 2019 alongside the A-TWAIN mooring array at 31° E on the 800 m isobath. Recovery and redeployment are planned for late summer 2020.
- **IMR** successfully recovered in September 2020 the INTAROS Signature 100 that was deployed alongside an ATWAIN A800 mooring and another Signature 100 (part of the RCN-funded SIOS InfraNor project) in November 2019. The INTAROS S100 covered the lower part of the water column (approximately ~800 - to 400 m) and recorded for the entire deployment period. The SIOS S100 was programmed to cover the upper 400 m, but unfortunately suffered a memory failure. Both instruments were redeployed together with the A800 mooring after change of battery and memory card. Next turnover is planned for November 2021. The data from the INTAROS S100, together with data from the other instruments, has been extracted and is now being prepared for storing in the NMD depository and analysis. The recovery was made during the IMR/VNIRO (Russia) Barents Sea ecosystem cruise, during which a large amount of other observations, relevant for T6.2, also were made.

2.5. AWI

Contributors: Anya Waite, Andreas Rogge

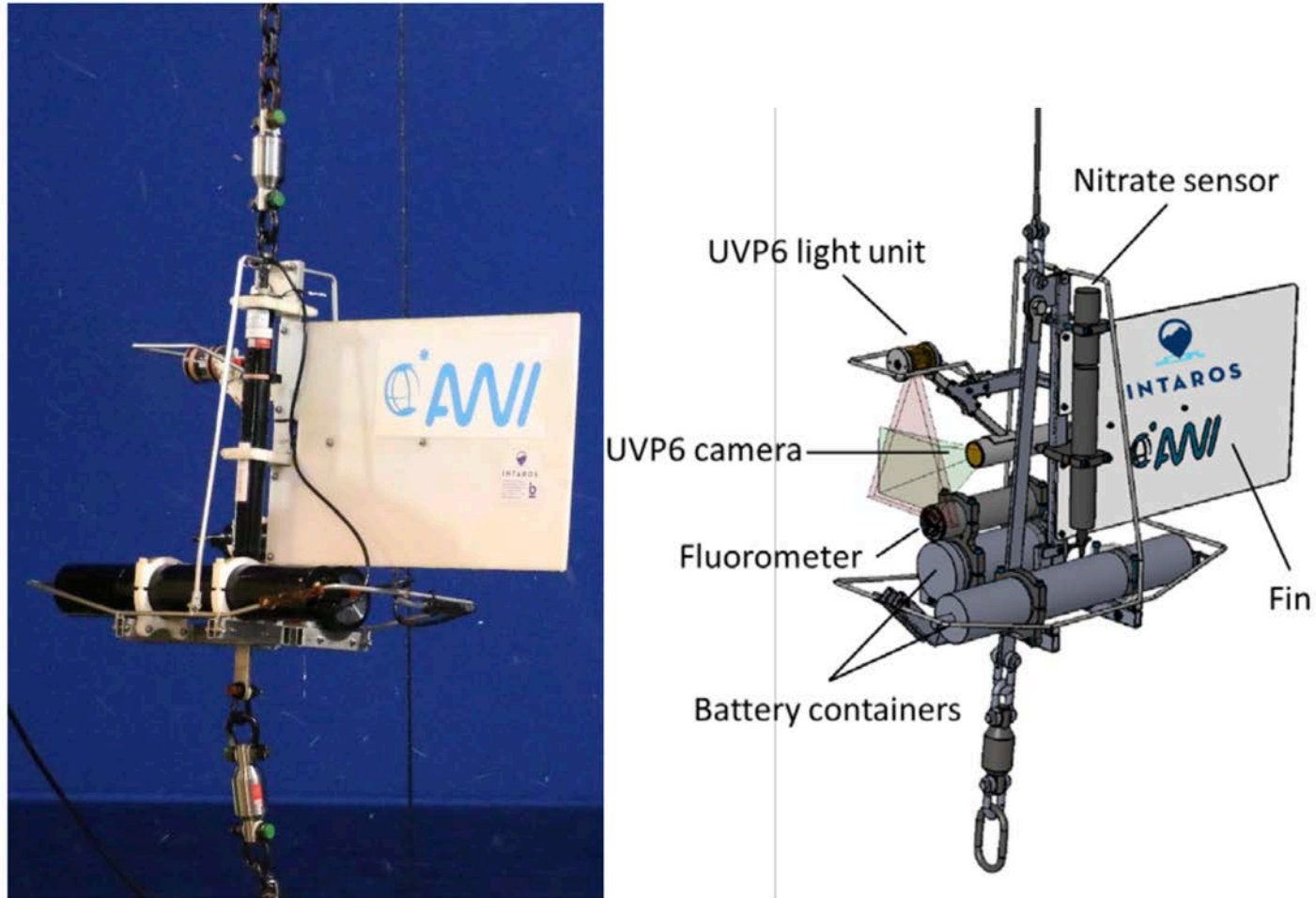


Figure 2.5.1: The deployed sensor package: left picture shows system during recovery (credit: Helge Bryhni, UiB). Right picture describes the individual compounds.

2.5. AWI

Contributors: Anya Waite, Andreas Rogge



Figure 2.5.2: Example images of zooplankton and aggregates based on measurements from the UVP 5 hd from the Siberian shelf region. Due to a smaller sampling volume and a higher camera resolution, the image quality of the deployed UVP 6 system will be even higher. Scale bars represent 2 mm.

2.5 AWI

Suna and Octopus data from BGC11 deployed in 2019 is available and processed. In sum: Everything seems to be well taken care of.

Octopus system for biological measurements with
underwater vision profiler (UVP) and ECO triplet (AWI)

The ECO Triplet-w is configured for
Biogeochemical measurements of chlorophyll and FDOM fluorescence and red backscattering

AWI: No activities in the reporting period.

2.6. UNIS

Contributors: Frank Nilsen, Marcos Porcires

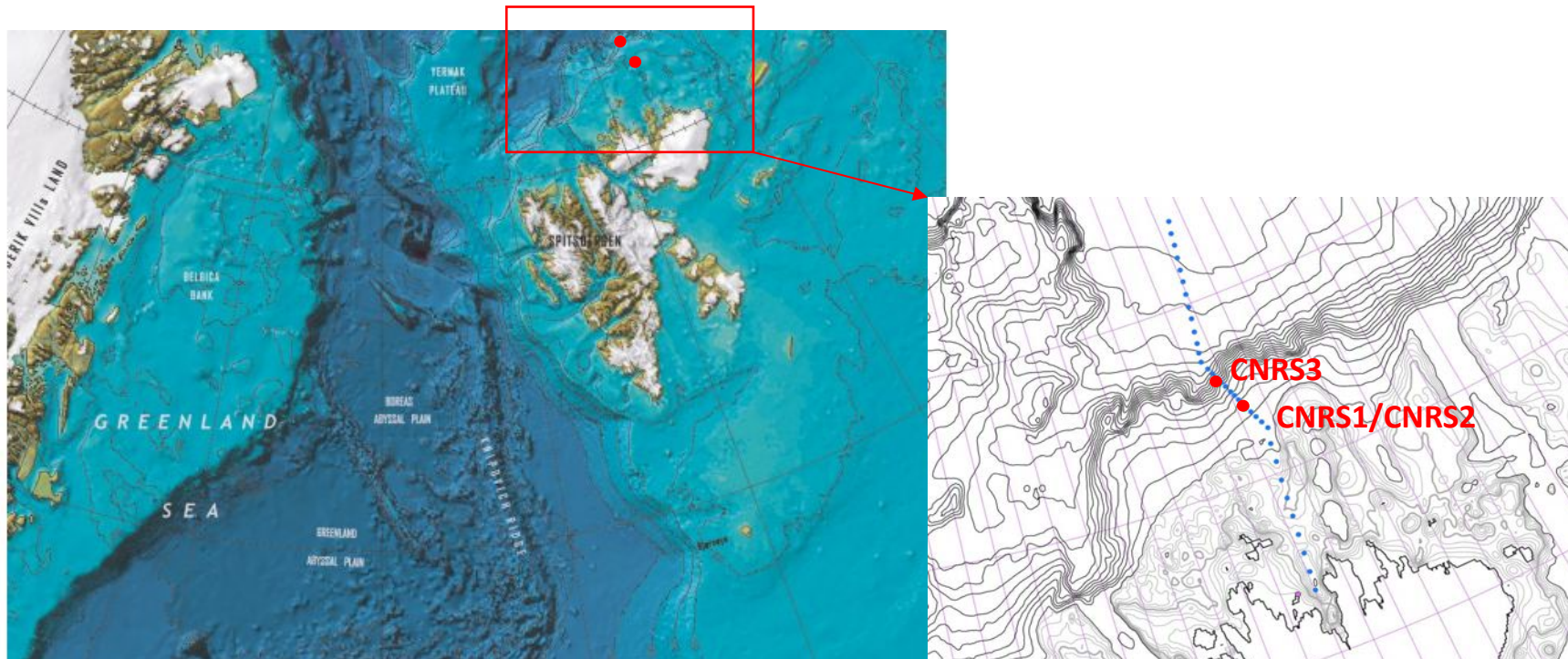
- Moorings have not yet been recovered due to problematic sea ice cover north of Svalbard, making a recovery process unsafe. The recovery is scheduled for the RV Kronprins Haakon cruise in November 2019 and 2020
- Retrieved in November 2019 and 2020 as planned

UNIS: No activities in the reporting period.

2.7 CNRS-LOCEAN

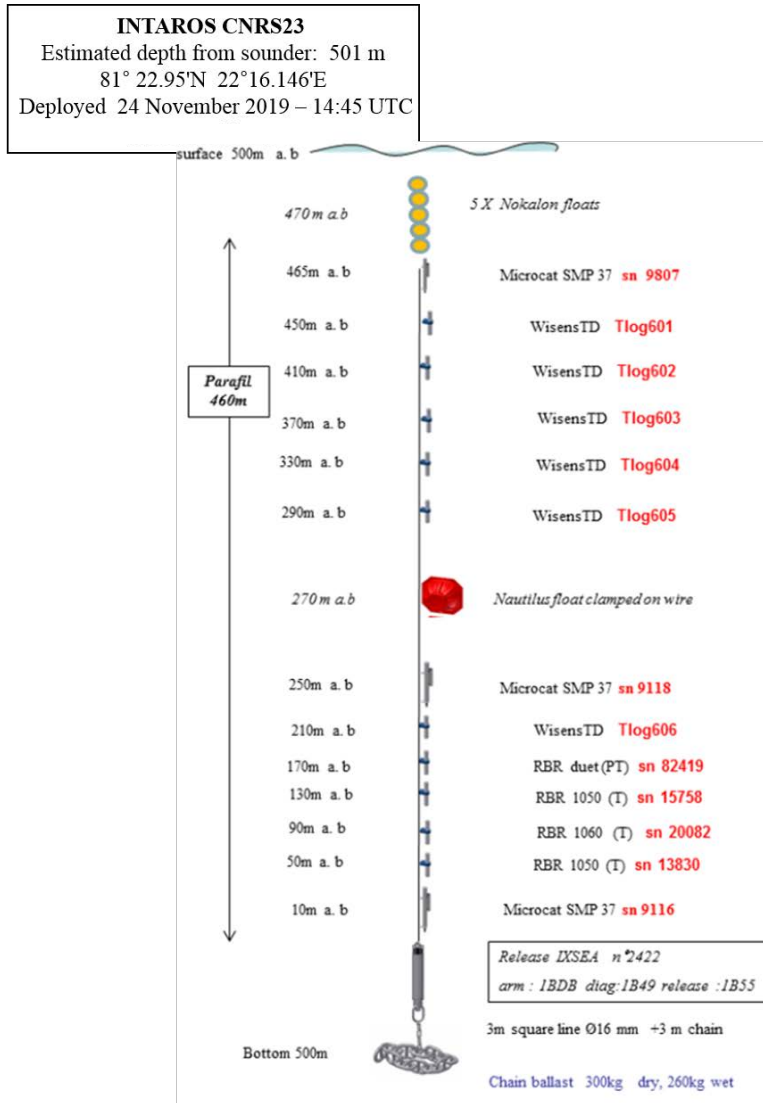
Task 3.2 Mooring network North Svalbard

- Contribution to the INTAROS mooring network at $\sim 22^\circ\text{E}$
- Two mooring sites : bottom depth 500 m (CNRS1/CNRS2) and 1500 m (CNRS3)
- Summer 2020 : recovery of CNRS3 (first deployed in 2018) during CAATEX 2020
- CNRS2 left in water (first deployed in 2017 and refurbished in 2018 and 2019)
- No deployment of CNRS1 (was recovered in 2019)



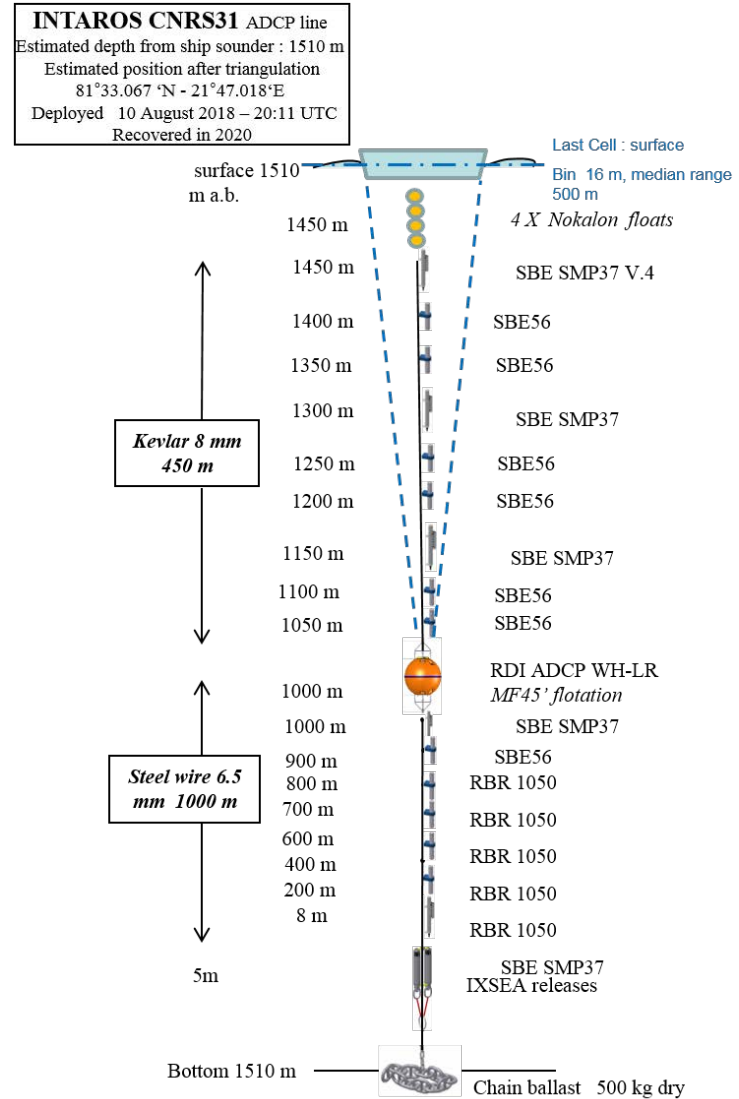
CNRS2

Not recovered, still recording



CNRS3

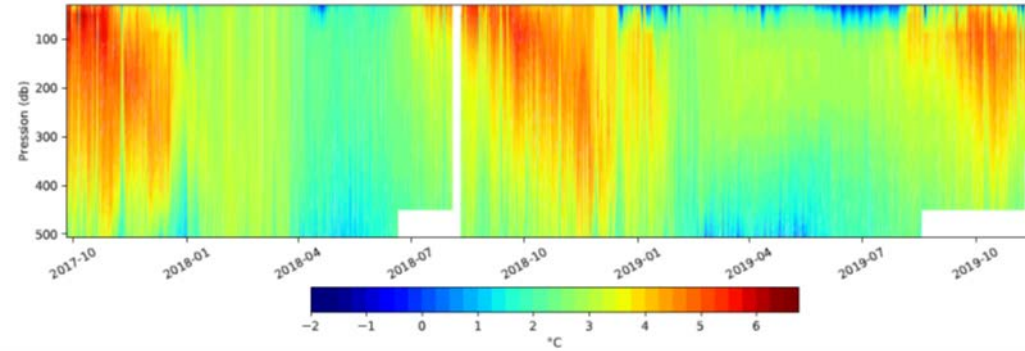
Recovered on July 23 2020



Temperature (CNRS2)

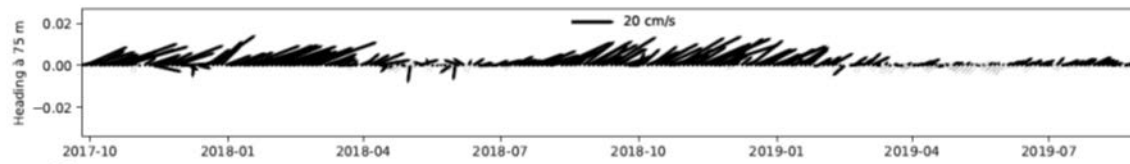
Sept. 16 2017 – Aug. 3 2018

Aug. 10 2018 – Nov. 24 2019

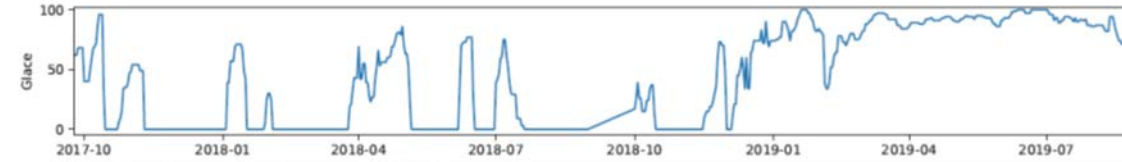


Current velocity (CNRS1)

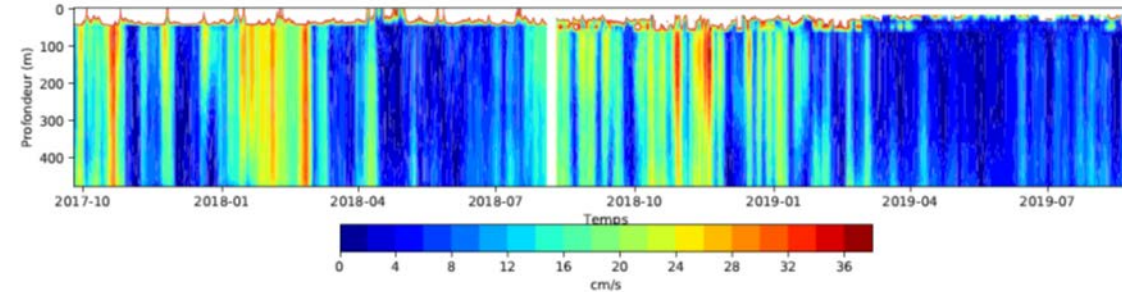
75 m



Sea ice concentration



Current speed



2.8. NERSC and international partners SIO, WHOI and NPGS

Contributors: Hanne Sagen

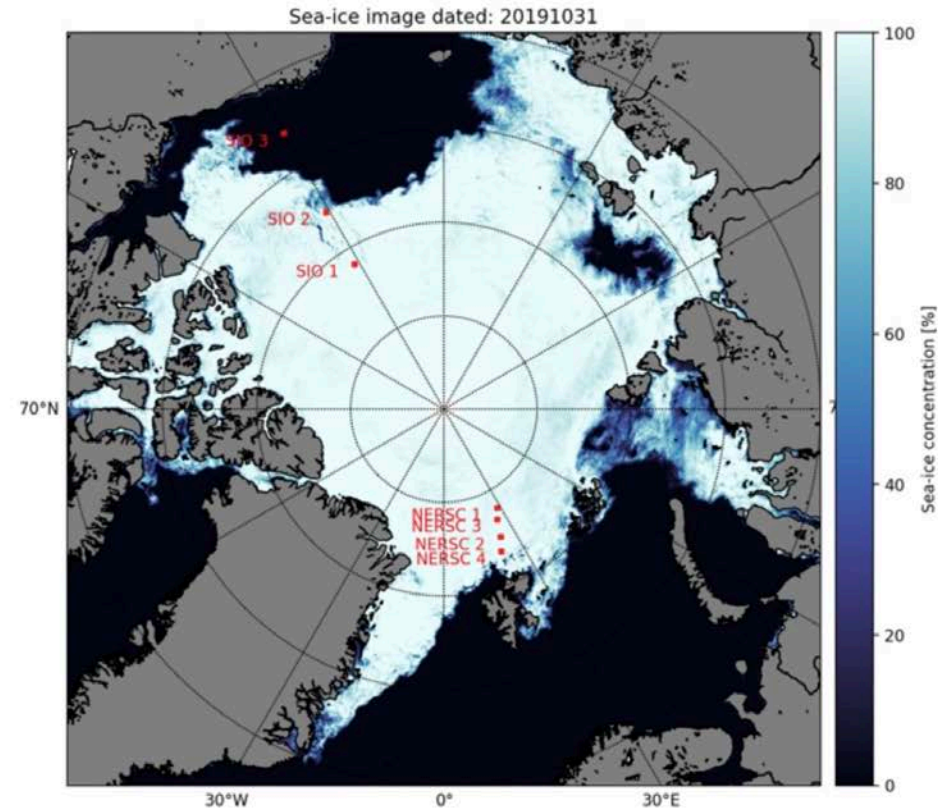


Figure 2.8.1: The geometry of the 2019–2020 CAATEX experiment. The acoustic transceivers are located at SIO1 and NERSC1. There are four vertical receiving arrays: SIO2, SIO3, NERSC2, and NERSC3. The SIO 1-3 were deployed by the Scripps Institution of Oceanography from the USCGC *Healy*. NERSC 1-4 were deployed from the Norwegian Coastguard Icebreaker KV Svalbard. The mooring at NERSC4 has conventional oceanographic instrumentation and funded by INTAROS and own contributions. All of the NERSC moorings are in the Nansen Basin south of the Gakkel Ridge; ice conditions prevented deployment further north. The sea-ice concentration on 31 October 2019 is from the Advanced Microwave Scanning Radiometer 2 (AMSR2) dataset provided by the University of Bremen (Source: <https://seaice.uni-bremen.de/sea-ice-concentration/>).

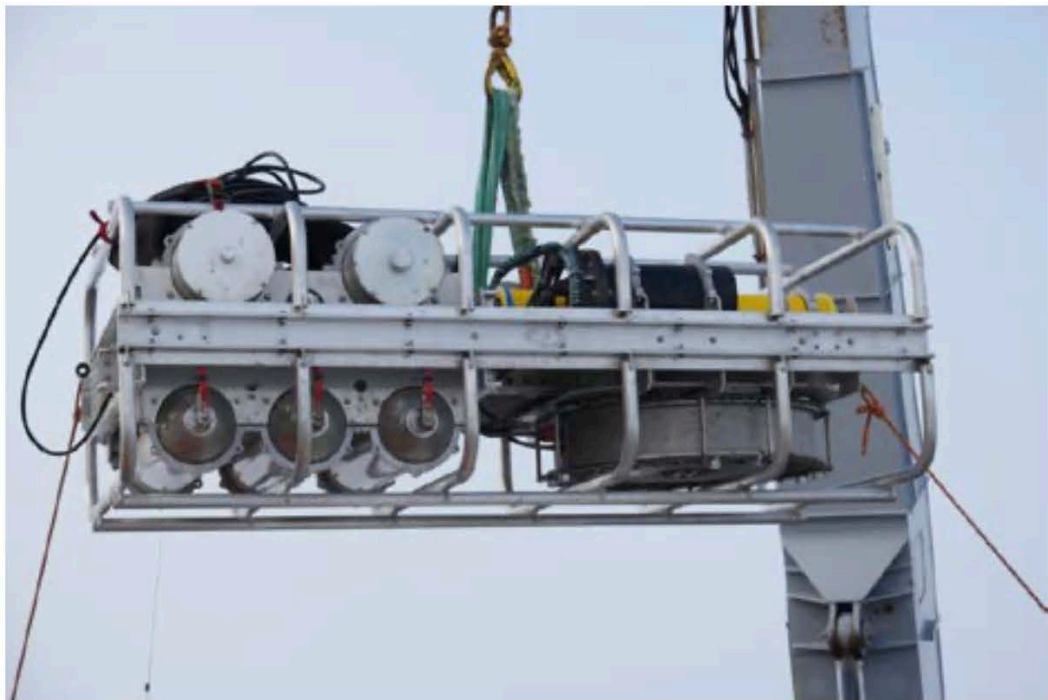
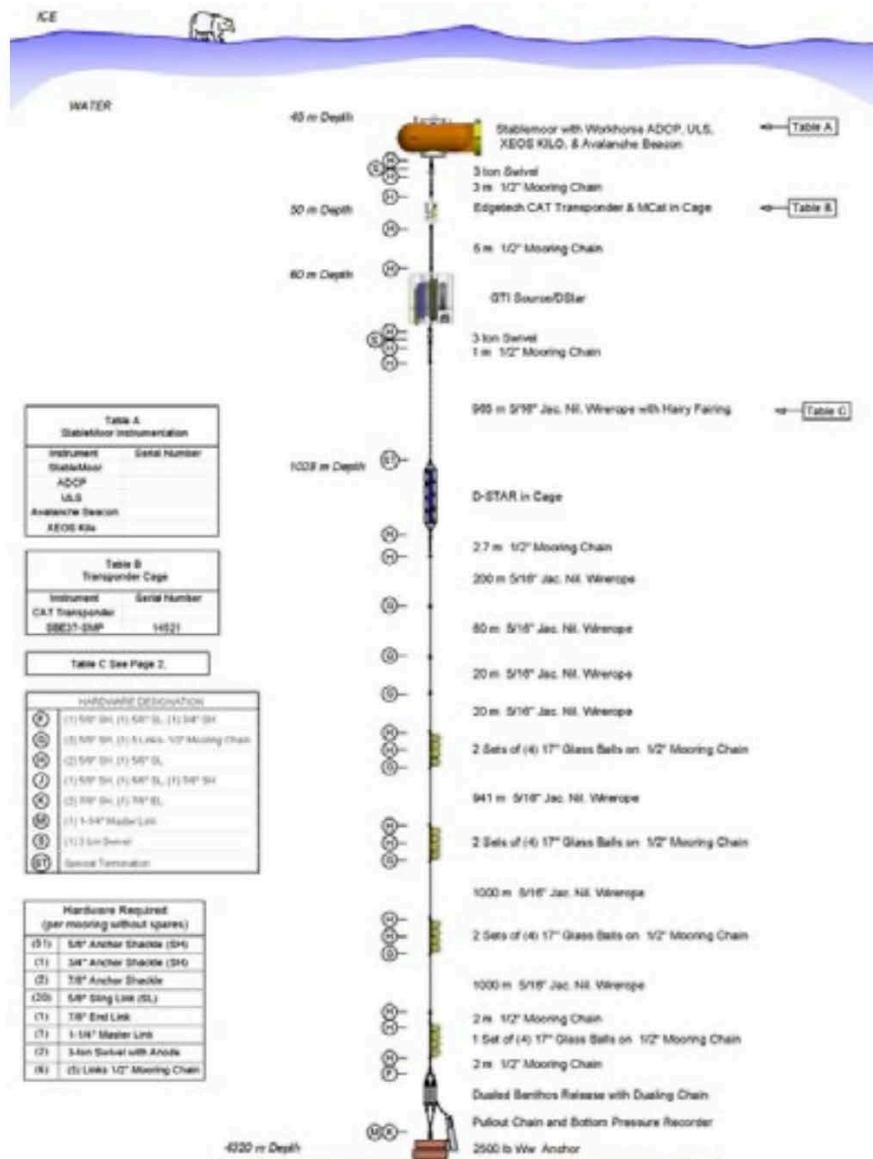
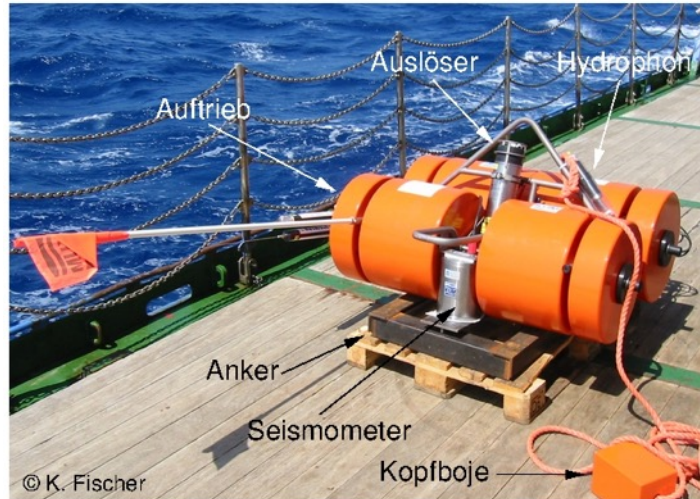


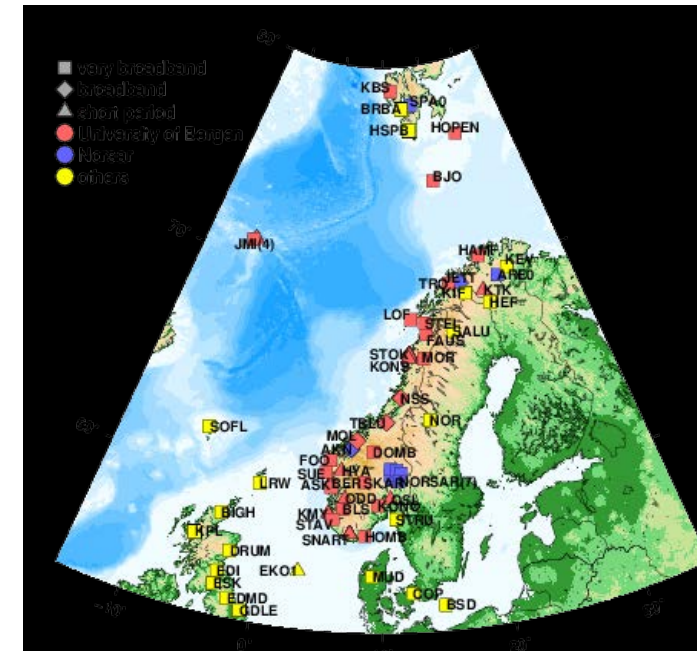
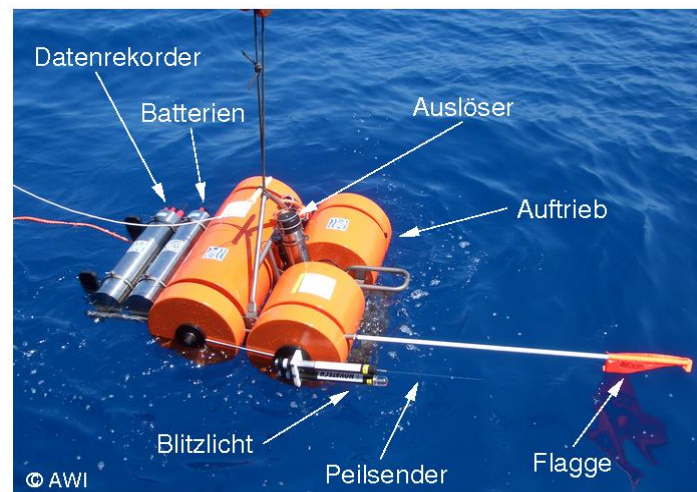
Figure 2.8.2: To the left the mooring design of the source mooring, and below the Geo-spectrum source used in the mooring. All NERSC moorings are heavily equipped with 55 instruments for acoustics and for oceanographic measurements.

2.9. UiB-GEO and GEUS

Contributors: Mathilde Sorensen, Zeinab Jeddi, Peter Voss, Thomas Funck



- **Ocean Bottom Seismometers (OBS) for solid Earth processes and geohazards**
- **Three OBS deployed in August 2018 during KV Svalbard cruise in the northern Fram Strait**





INTAROS seismology

OBS data

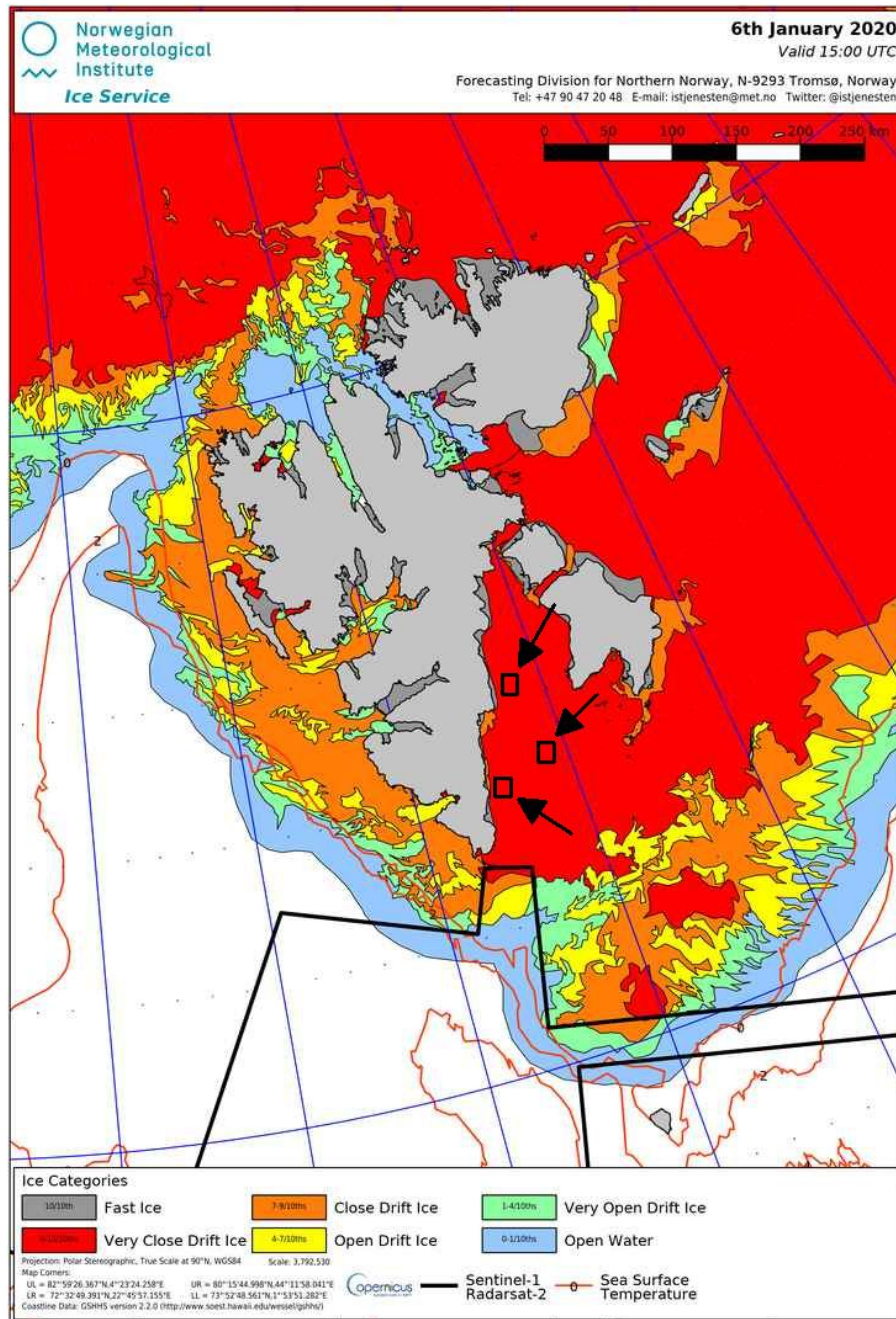
2019 summer cruise:

Recovery of OBS (INOB1,2,3).

Redeployment of OBS instruments in Storfjorden.

Plan summer 2020:

Recovery of OBS instruments in Storfjorden.



INTAROS seismology

OBS data

Instruments are now operating under ice cover.

Processing of the data recovered in 2019 and 2020 is ongoing.

UiB-GEO and GEUS: Data processing has continued at both institutions for the three OBS instruments, which were deployed in the Fram Strait during August 2018 – August 2019, and a paper is in preparation with expected submission in December 2020. The new data will be added to the INTAROS earthquake catalog, hosted by UiB-GEO. UiB-GEO recovered two of the three OBS instruments that were deployed in Storfjorden near Svalbard in 2019 during a summer school on KV Svalbard in June 2020, arranged as part of the UAK project. The third instrument did not release from the anchor due to technical problems. An attempt will be made to recover the instrument with ROV during a cruise in June 2021.

WP3.2 North of Svalbard towards the deep Nansen Basin



- The majority of data from the different platforms covering ocean physics, chemistry and biology including microplastic are being processed and partly delivered to WP5. The quality control have revealed some problems with SAMI pCO₂ data and the microplastic data. There is some delay in mooring recovery and for this reason data processing due to the COVID 19 situation.
- **IMR** successfully recovered in September 2020 the INTAROS Signature 100 that was deployed alongside an ATWAIN A800 mooring.
- An interesting seismic event that otherwise would not be recorded has been documented by the ocean bottom seismometers deployed in the Fram Strait in 2018-19.
- Data from ocean acoustic, moorings that could not be retrieved this year because of extreme sea ice condition.
- Recovery and redeployment are planned for late summer 2020, but due to extreme ice condition again some of this work is postponed to 2021 and will be followed up in the CAATEX project.
- Main goal for WP3 task 3.2 is to synthesise and publish results, and feed back information needed for WP5, WP6 and WP1 the **ROADMAP**.
- ***More specifically: Now it is time to synthesize our work, assess the scientific outcome and to publish our results***