INTAROS WP3
In situ observing systems

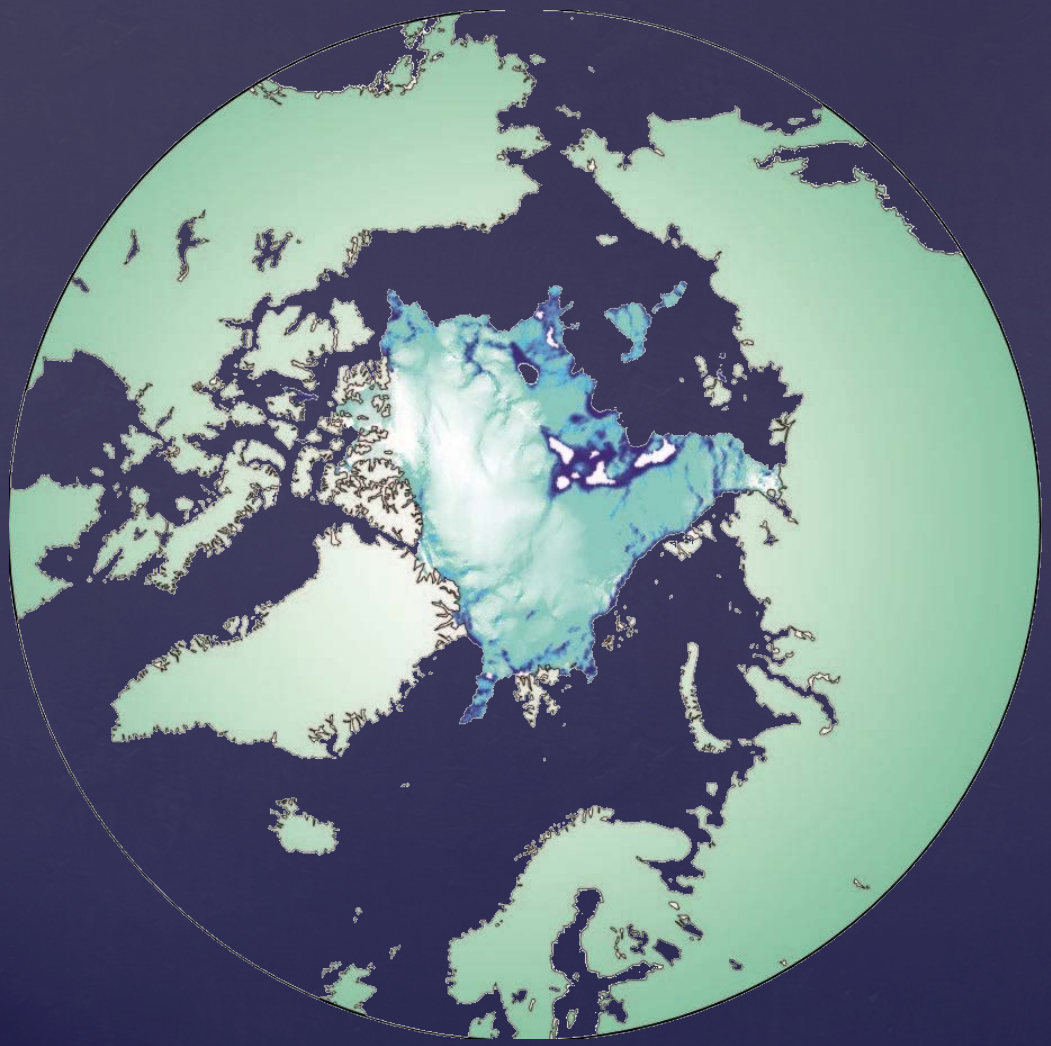
Agnieszka Beszczynska-Möller, IOPAN (lead)

Peter Voss, GEUS (co-lead)

WP3 main goal and ambition:
to improve critical gaps in the existing observing systems
by integration of new and mature technologies
for multidisciplinary Arctic observations

Integrated Arctic Observing System INTAROS

A project funded by the European Commission
2016-2021 (5 years)



Main objective:

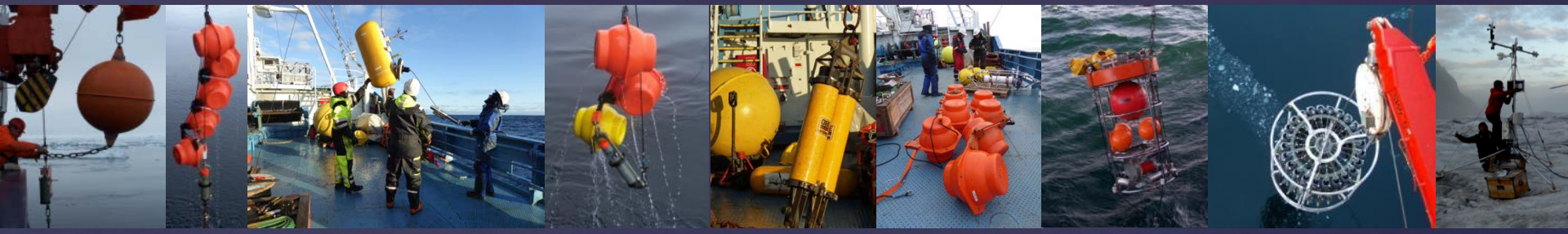
build an efficient integrated Arctic Observation System by

- **extending,**
- **improving**
- **unifying**

existing systems in the different regions of the Arctic.

WP3 main objectives:

- To improve critical gaps in the Arctic observation system
- To build additional capacity of pan-Arctic monitoring networks

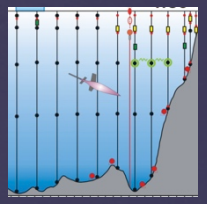


- make best use of existing reference sites and distributed observatories providing the critical data for Arctic climate and ecosystems, but still missing multidisciplinary dimension or technical advancement

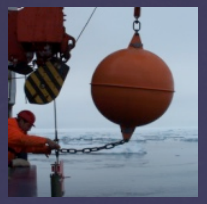
How to achieve them...

- extend temporal and geographic coverage of available infrastructures and add new key geophysical and biogeochemical variables through implementing novel technologies integrated with standard observations

WP3 specific objectives:



Develop and integrate autonomous and robust *in situ* systems for year round measurements of key variables



Deploy mature and new sensors and *in situ* platforms in selected reference sites and distributed observatories

Extend existing ocean and land infrastructures with multidisciplinary measurements by adding new biogeochemical sensors

Deliver geophysical, biogeochemical and biological data products for data integration (WP5), demonstration studies (WP6) and stakeholders consultations (WP7)

INTAROS WP3 *In situ* observing systems

Task 3.0
Scientific and operational coordination

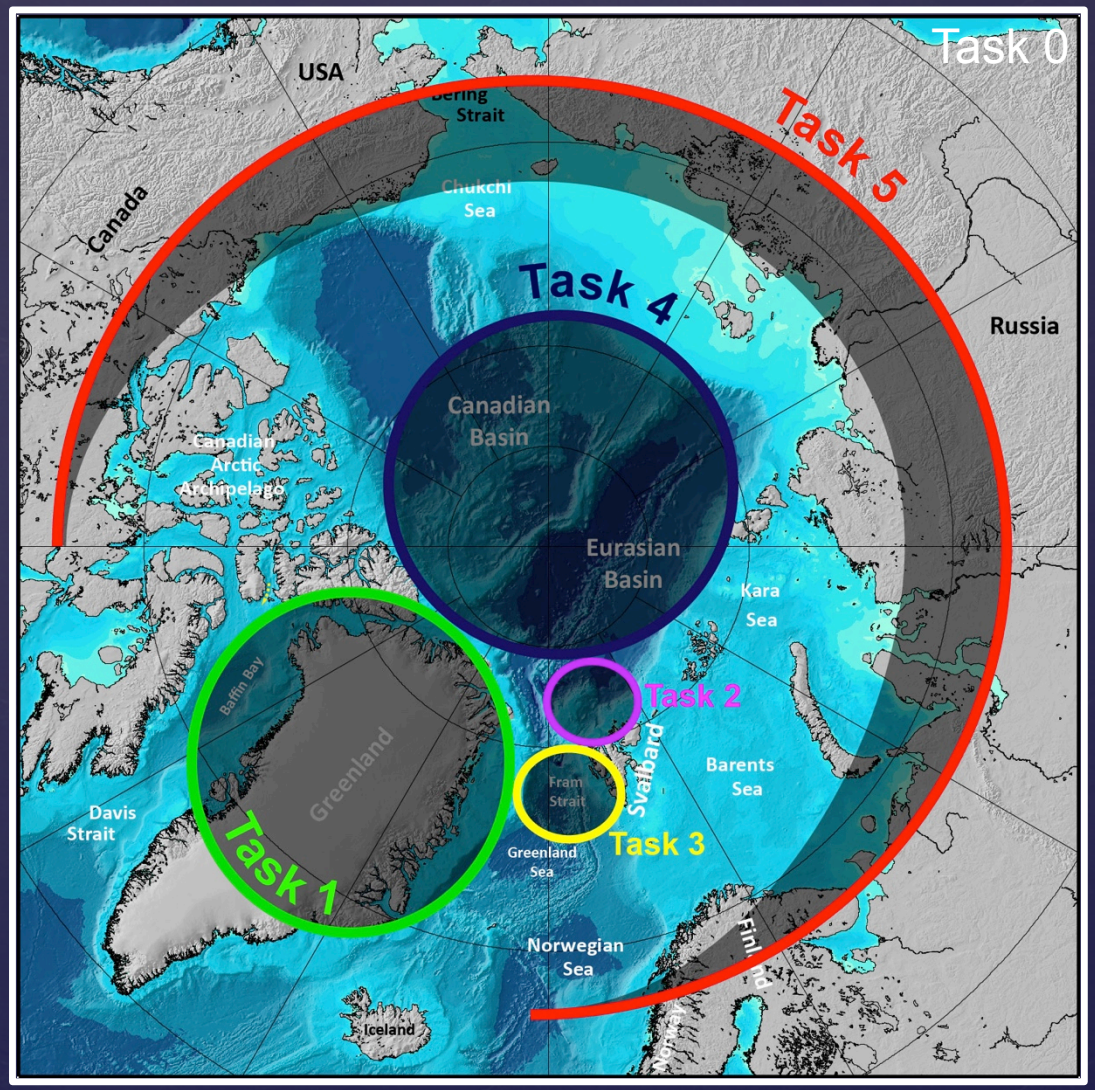
Task 3.1
Coastal Greenland

Task 3.2
North of Svalbard towards the deep Nansen Basin

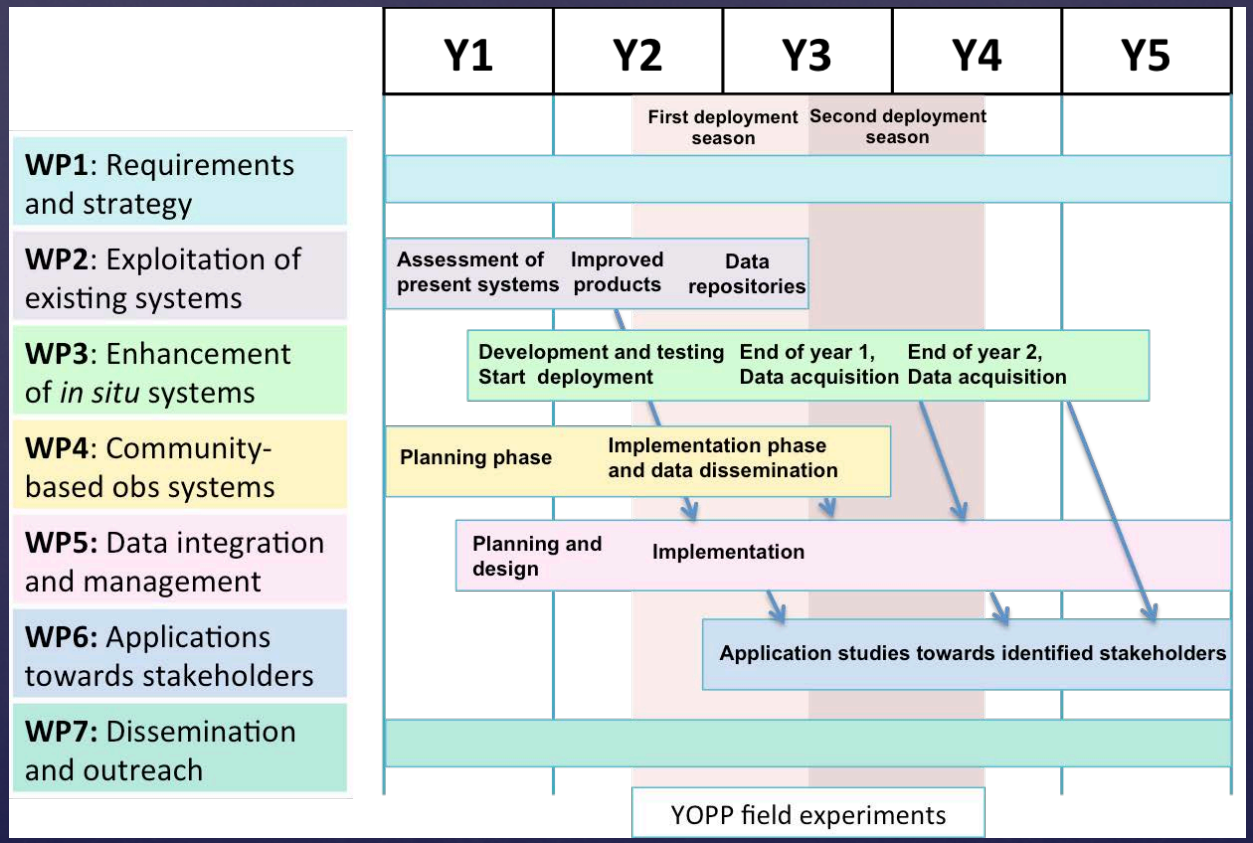
Task 3.3
Fram Strait

Task 3.4
Distributed systems for ocean and sea ice

Task 3.5
Distributed systems for atmosphere and land



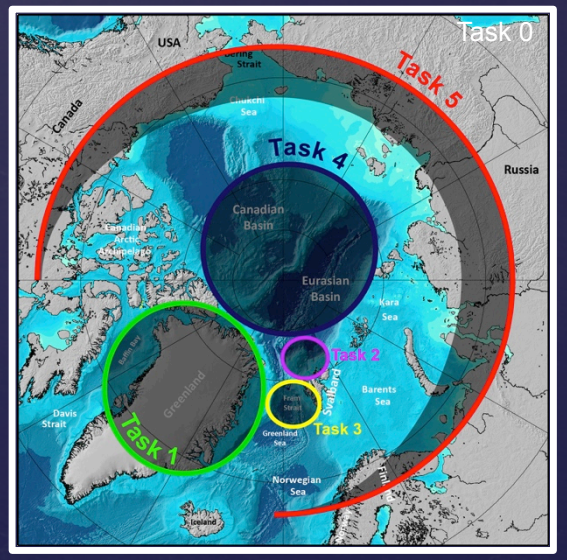
- Phase 1: Development of new technologies and integration of multidisciplinary sensors for autonomous in situ monitoring systems in the Arctic (M1-18).
- Phase 2: Implementation of integrated multidisciplinary sensors and platforms for year-round measurements in the selected reference sites and distributed observatories (M19-48)
- Phase 3: Preparation and delivery of preprocessed new data to WP5 and WP6 (M19-54, overlap with Phase 2 due to the NRT data delivery from some sensors)



INTAROS WP3 *In situ* observing systems

Task 3.1
Coastal Greenland:

- ocean moorings with freshwater focus in NE Greenland (AU)
- properties of snow cover on sea ice in NE Greenland (GEUS/AU)
- surface pCO2 and ocean acidification in the Greenland coastal zone (AU)
- on-ice weather station network for snow-water equivalent (GEUS)
- precise positioning system for ice sheet dynamics (GEUS)
- novel ground penetrating radar system for ice sheet (UPM)
- multidisciplinary acoustic observatory in Young Sound with passive acoustic (CNRS-IUEM)
- a suite of sensors for automated monitoring of bio-optical and biogeochemical properties of the coastal ocean at Baffin Bay observatory (CNRS-Takuvik)



Task 3.1
Coastal Greenland:

- ocean moorings with freshwater focus in NE Greenland (AU)

oceanographic mooring will be placed in the inner fjord near the Ice Sheet

key physical parameters such as temperature, salinity, turbidity, fluorescence and PAR coupled to detailed biological measurements from existing monitoring program, under INTAROS extended with instruments (SBE CTD sensors, releasers, camera system for snow and ice coverage) and mooring hardware/material

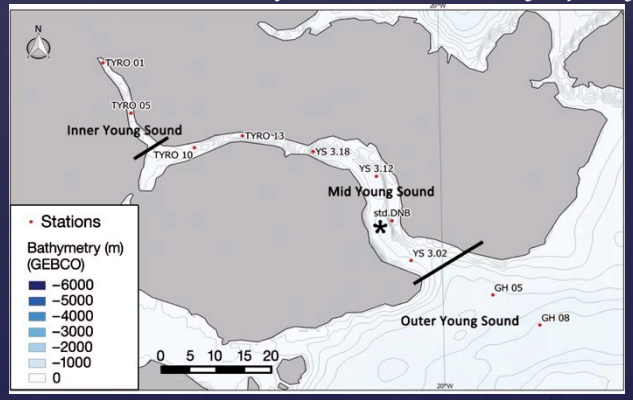
- surface pCO2 and ocean acidification in the Greenland coastal zone (AU)

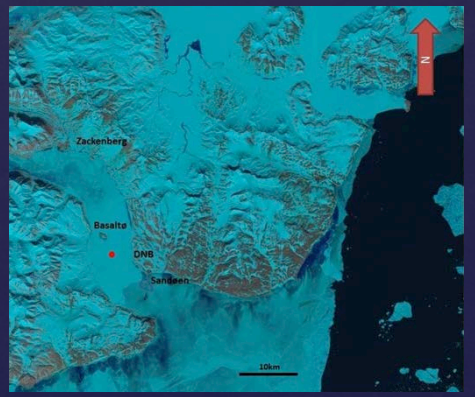
under INTAROS instruments for pCO2 and pH provided

- multidisciplinary acoustic observatory in Young Sound with passive acoustic (CNRS-IUEM)

one-week long campaign will be carried out every summer
two hydrophones recorders: one dedicated to a "high frequency" band (from 10 Hz to 50 kHz) and the second dedicated to ultra-low frequencies (from 0.01 Hz)
deployed/recovered in order to provide a continuous acoustic monitoring

Young Sound fjord (74°18'N, 10°15'W), NE Greenland, ice-covered for about 280 days per year

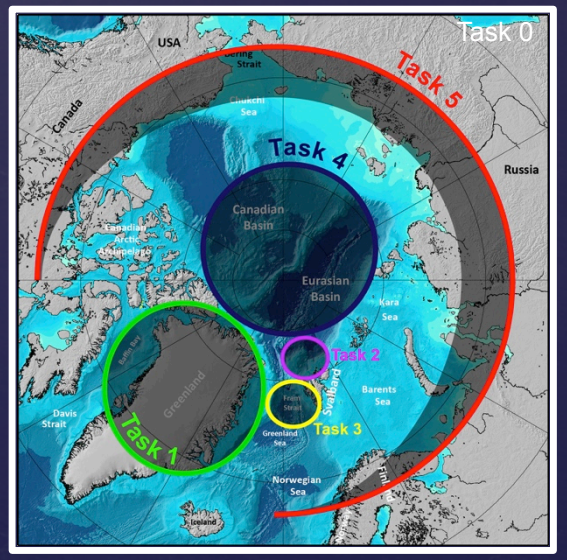




INTAROS WP3 *In situ* observing systems

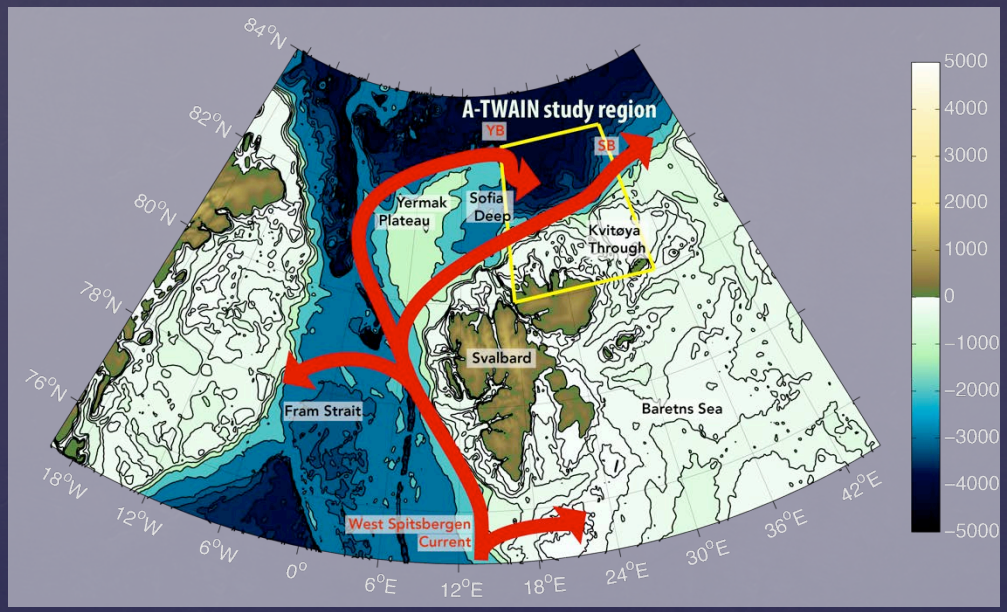
Task 3.2
North of Svalbard towards the deep Nansen Basin:

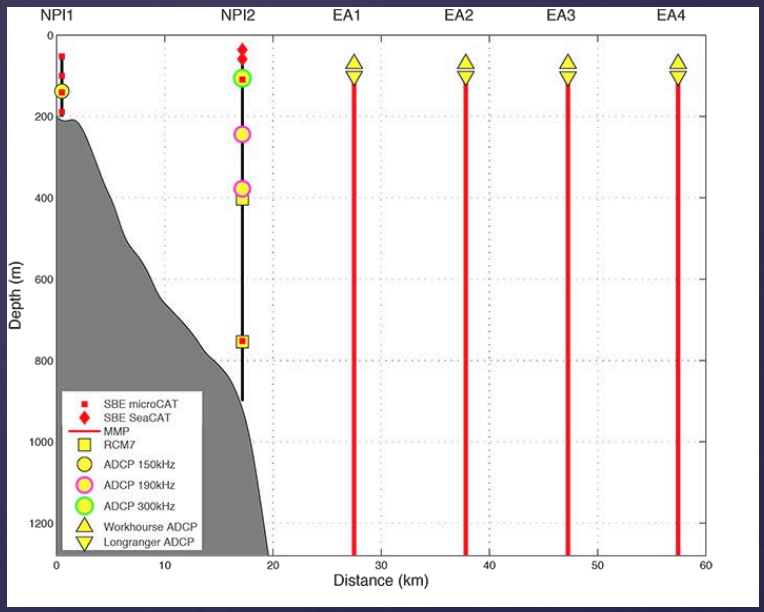
- array of multidisciplinary moorings with profiling instruments and point measurements of ocean physical variables (IOPAN, CNRS-LOCEAN, IMR)
- a suite of biogeochemical measurements and sampling (UiB-GFI)
- novel pCO2 and pH sensors for carbon system variables (UiB-GFI)
- autonomous passive contaminant samplers (NIVA)
- sediment traps, underwater vision profiler, FRRF fluorimeter (AWI)
- combined ADCP-echosounders for currents and zooplankton (IMR)
- upward-looking sonars for sea ice (UiB-GFI)
- bottom pressure recorders (UNIS)
- passive acoustics recorders for ocean soundscape in the Arctic (NERSC)
- ocean bottom seismometers for solid Earth processes and geohazards (GEUS/UiB-GEO)



Task 3.2
North of Svalbard towards the deep Nansen Basin

Building on the A-TWAIN moored array deployed since 2012 under the project 'Long-term variability and trends in the Atlantic Water inflow region'
Main partners IMR and NPI, collaborating partners WHOI, IOPAN

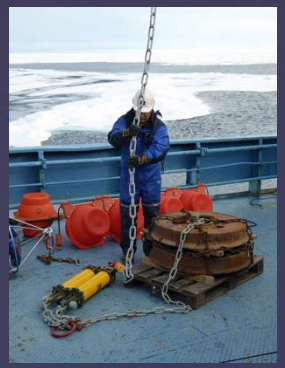


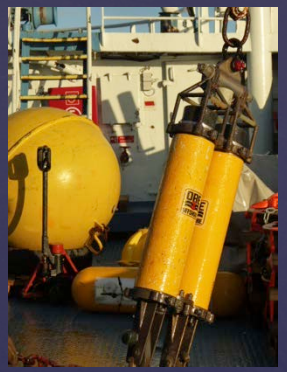


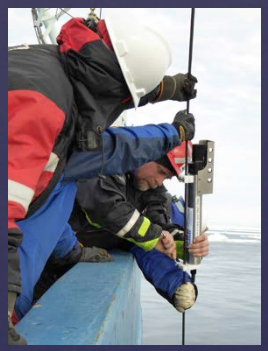
Map and array scheme from http://atwain.whoi.edu/php/index.php

2012-2013: 9 moorings (8 recovered)
2013-2015: 5 moorings (4 recovered)
2015-2017: 3 moorings deployed

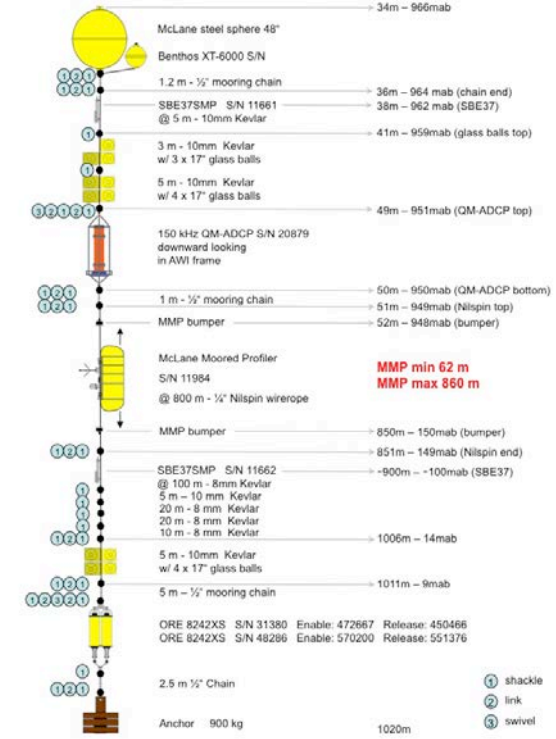
Task 3.2
North of Svalbard towards the deep Nansen Basin

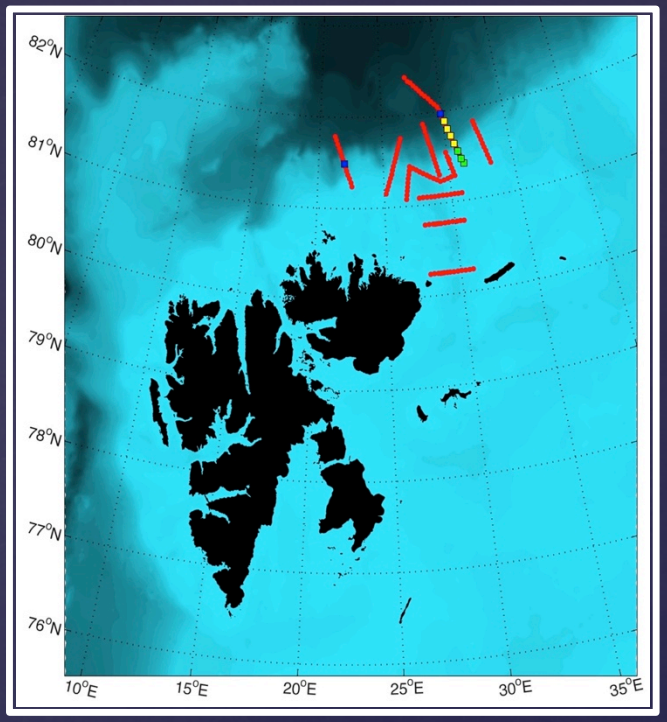


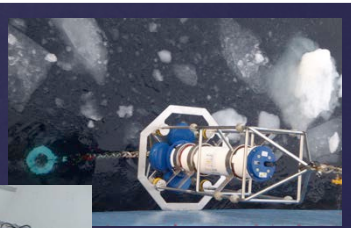


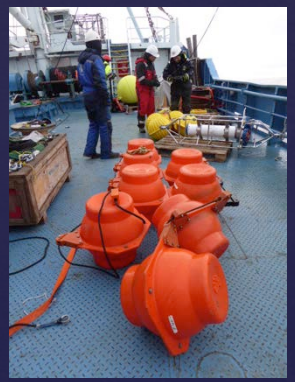


Mooring ID	IOPAS6	Latitude	80° 44.65'N
Deployed	17.08.2014 15:13 UTC	Longitude	015° 54.29'E
Recovered		Water depth	1020 m (echosounder),1070 m CTD

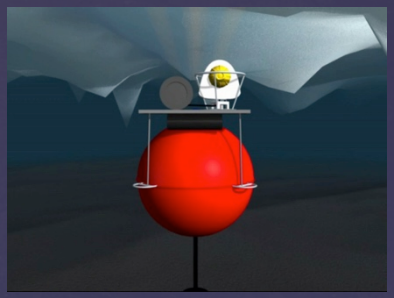








Task 3.2
North of Svalbard towards the deep Nansen Basin



Arctic Winch

QM-ADCP

ASL Ice Profiler

Bottom pressures sensors

SAMI pCO2

SAMI pH

SUNA V2 UV nitrate sensor

Underwater Vision Profiler

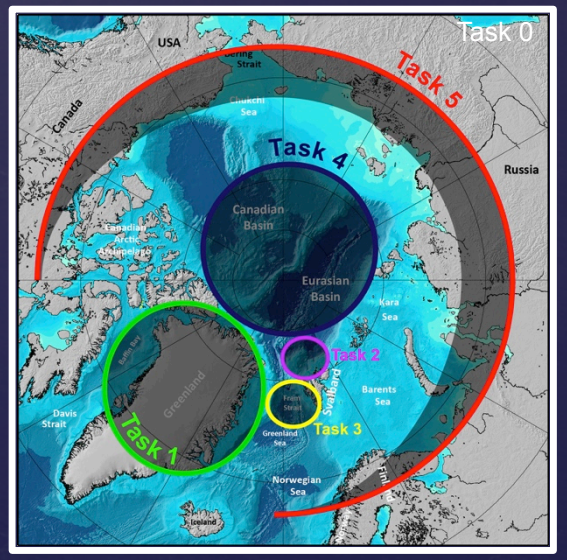
Sediment trap

FRR Fluorymeter

INTAROS WP3 *In situ* observing systems

Task 3.3
Fram Strait:

- extending the LTER observatory Hausgarten with experimental autonomous system for impacts of ocean acidification on benthic biology arcFOCE - Arctic Free Ocean Carbon Enrichment (AWI)
- real-time measurements of pCO2 and pH, monitoring of carbon cycle parameters in Kongsfjorden (CNRS-LOV)
- directional acoustic system to monitor benthic species and dynamics of sea ice and icebergs in Kongsfjorden (CNRS-UIEM)



INTAROS WP3 *In situ* observing systems

Task 3.3

Fram Strait – arc FOCE - Arctic Free Ocean Carbon Enrichment

extending the LTER observatory Hausgarten with experimental autonomous system for impacts of ocean acidification on benthic biology

envisaged system will build on a FOCE system for studies of deep-sea benthic communities (dpFOCE) developed by Monterey Bay Aquarium Research Institute

adapt the existing deep-water system at MBARI to greater water depths, extremely low temperatures, and autonomous operation (no cable connection to land!)

installation and maintenance of the arcFOCE system will be done during regular cruises to the LTER observatory HAUSGARTEN

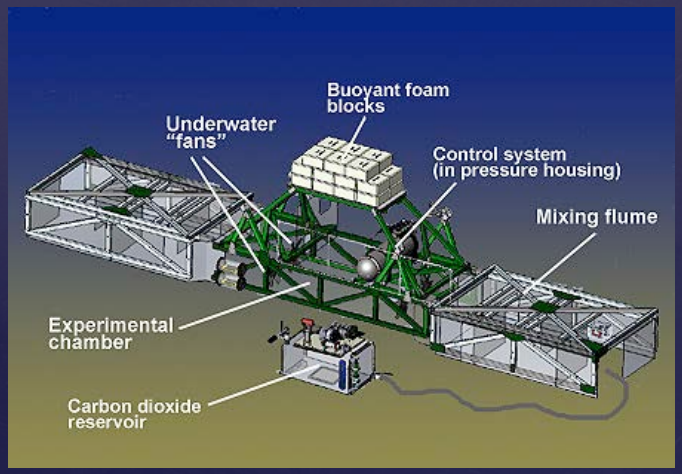


Photo and scheme from the FOCE experiment in the MBARI
http://www3.mbari.org/mars/science/foce.html

INTAROS WP3 *In situ* observing systems

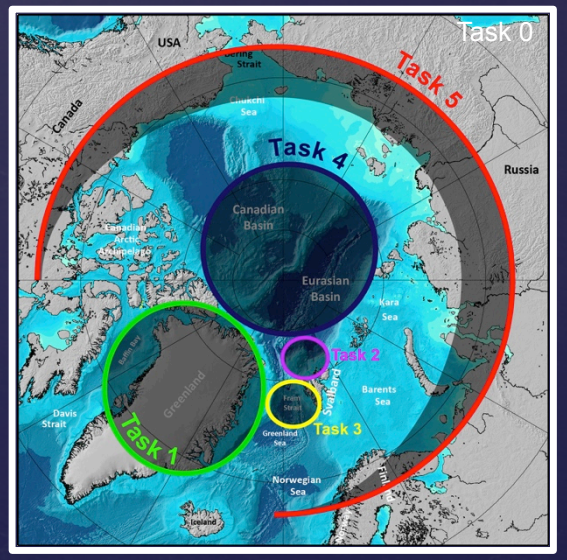
Task 3.3

Fram Strait: time-series for the carbonate chemistry of Arctic coastal waters in Kongsfjord as part of the AWIPEV Underwater Observatory (CNRS-LOV)

Two components: continuous real-time measurements of pCO_2 and weekly discrete measurements of dissolved inorganic carbon and total alkalinity

Plan to extend the ocean acidification time-series with daily, automated measurements of total alkalinity - under INTAROS a pH sensor for continuous measurements

Expertise of CNRS-LOV on ocean acidification and FOCE systems could be useful to the arcFOCE experiment planned at Hausgarten



INTAROS WP3 *In situ* observing systems

Task 3.3

Fram Strait: directional acoustic system to monitor benthic species and dynamics of sea ice and icebergs in Kongsfjorden (CNRS-UIEM)

An acoustic station in the Richard Laguna (79°00'N, 11°40'E) in Kongsfjorden, west Svalbard

Kongsfjorden site will take benefit of the infrastructure and logistics of the German-French AWIPEV station at Ny-Alesund

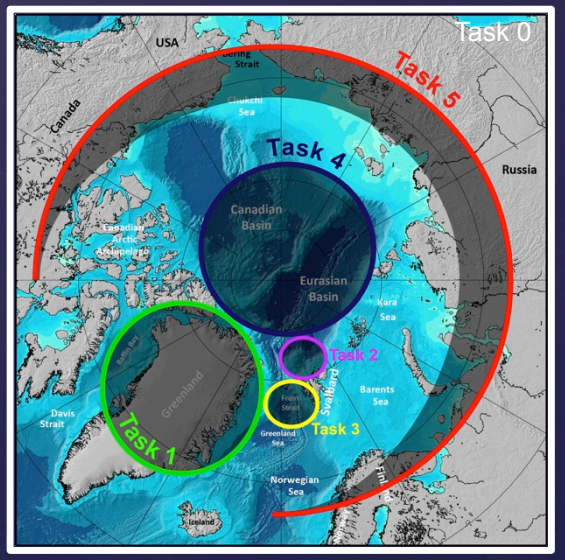
Directional acoustic systems with hydrophones will be deployed during summer campaigns on an annual basis

Two accelerometers will be set on bivalves to monitor the activity of this key benthic species

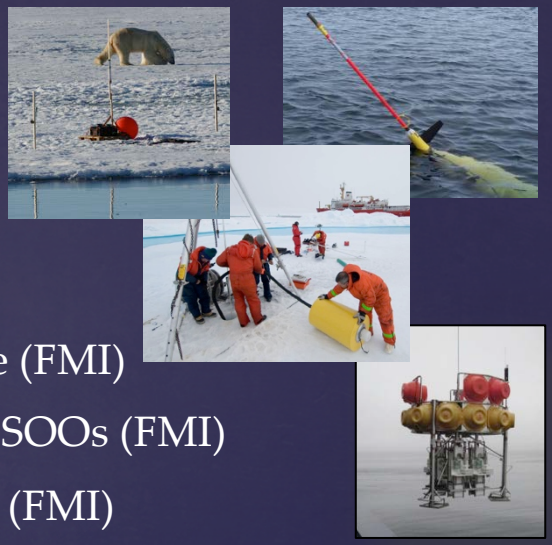
Two hydrophone recorders similar to Young Sound:

a "high frequency" band (from 10 Hz to 50 kHz)
an ultra-low frequencies (from 0.01 Hz)

will be recovered/redeployed performed during two one week summer campaigns

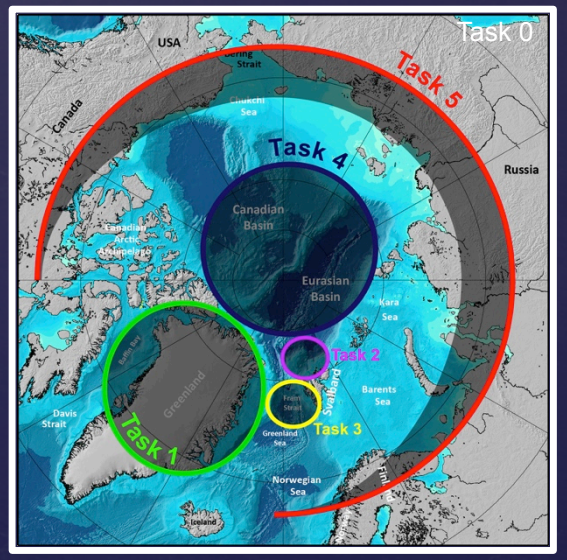


INTAROS WP3 *In situ* observing systems



Task 3.4
Distributed systems for ocean and sea ice:

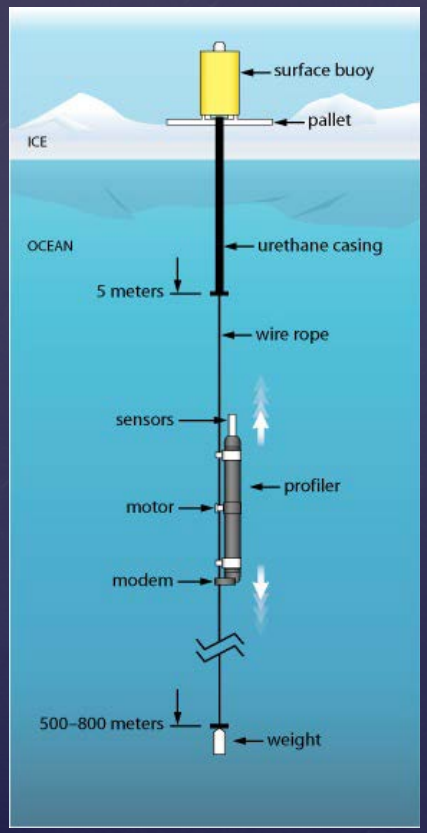
- ice-tethered platforms for measurements of ocean physical variables with meteorological and biogeochemical sensors for multidisciplinary ITP measurements (IOPAN)
- sea-ice mass balance buoys clustered with ITPs and standalone (FMI)
- measurements of snow properties and ABL observations from SOOs (FMI)
- quadrocopter measurements of broadband and surface albedo (FMI)
- novel sensors for FerryBoxes (ocean acidification and carbonate chemistry, inherent optical properties, microplastic sampler) (NIVA)
- endurance glider lines in the open water Arctic regions (CNRS-LOCEAN)
- BioArgo floats in Baffin Bay (CNRS-Takuvik)

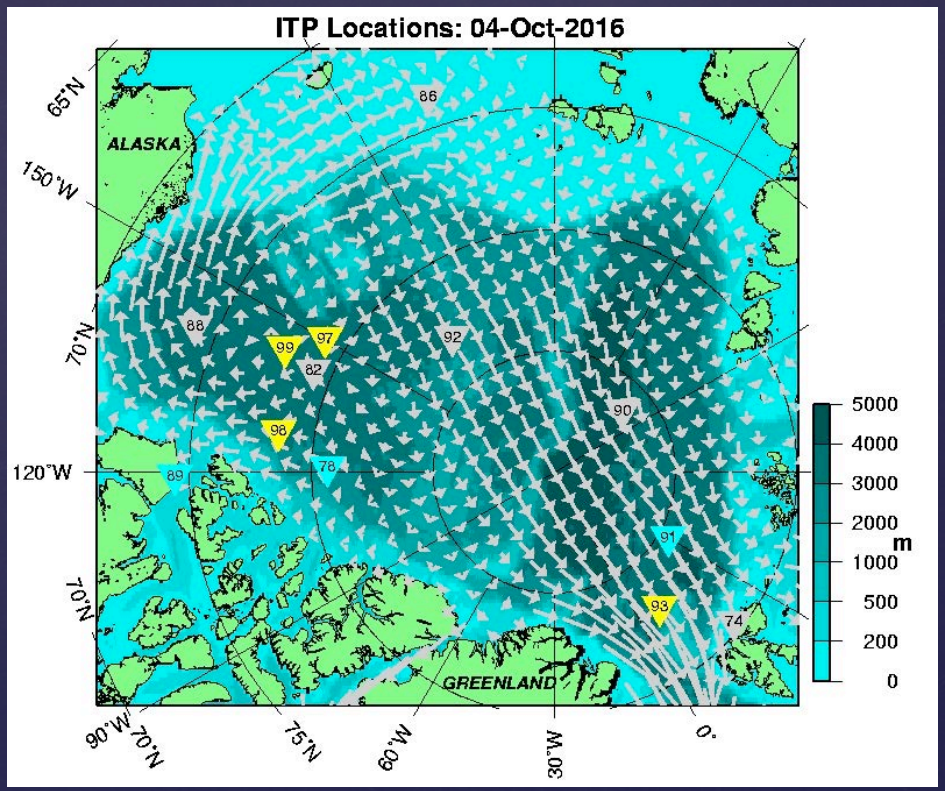


INTAROS WP3 *In situ* observing systems

Task 3.4
Distributed systems for ocean and sea ice:

- ice-tethered platforms for measurements of ocean physical variables (one) and with biogeochemical sensors for multidisciplinary measurements (one) (IOPAN)



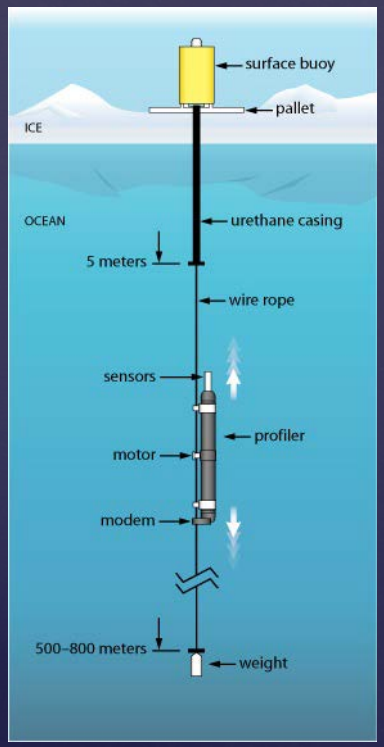


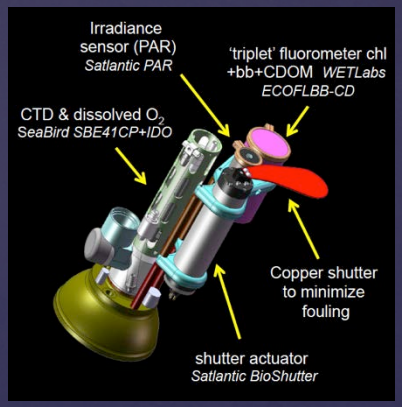
Ice-Tethered Profiler schematic and map of active ITPs from the WHOI ITP website: http://www.whoi.edu/website/itp/overview

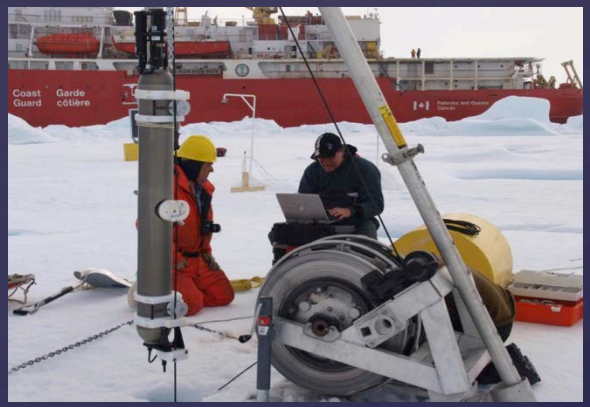
INTAROS WP3 *In situ* observing systems

Task 3.4
Distributed systems for ocean and sea ice:

- ice-tethered platforms for measurements of ocean physical variables (one) and with biogeochemical sensors for multidisciplinary measurements (one) (IOPAN)







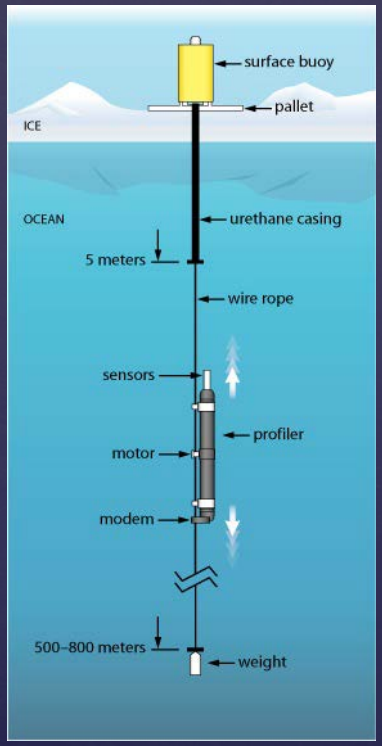
From
Laney et al., 2014
and
Laney et al., 2015

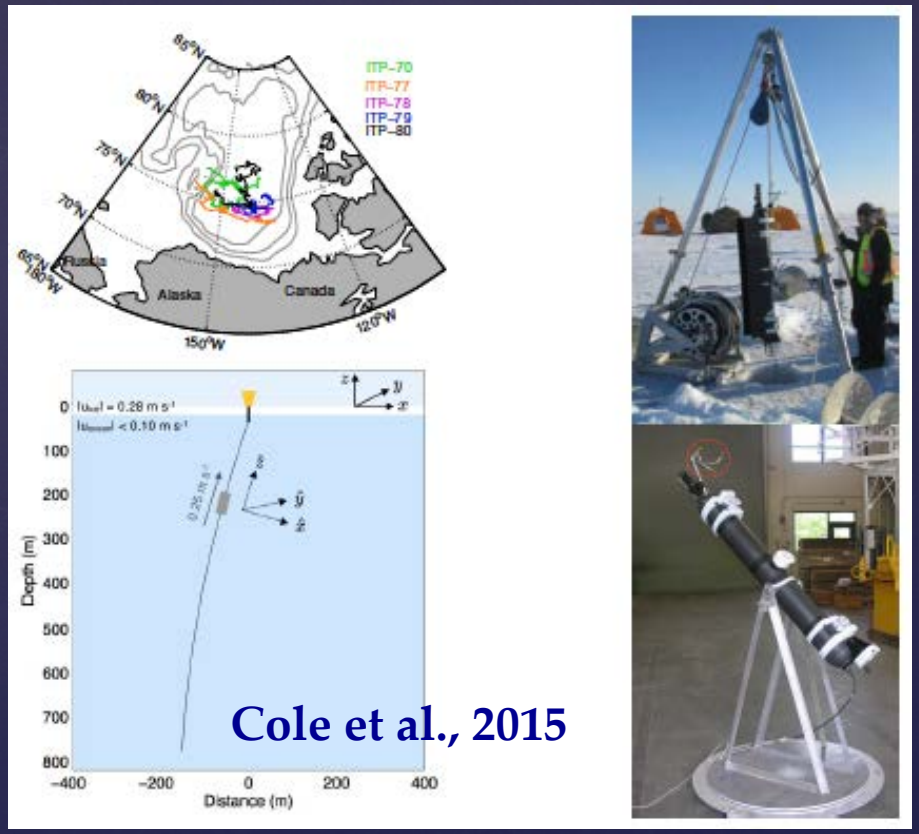
- Customized 'triplet' fluorometer (ECO FLbb-CD, WETLabs Inc.) to measure chlorophyll fluorescence, dissolved organic matter fluorescence, and optical scatter
- Radiometer (light levels)
- Copper shutter: for biofouling
- 'Smart' microcontroller to simplify integration of sensors & commercial McLane ITP

INTAROS WP3 *In situ* observing systems

Task 3.4
Distributed systems for ocean and sea ice:

- ice-tethered platforms for measurements of ocean physical variables (one) and with biogeochemical sensors for multidisciplinary measurements (one) (IOPAN)



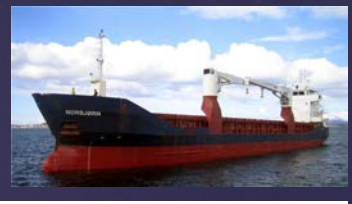


ITP-V includes a velocity sensor (Modular Acoustic Velocity Sensor (MAVS), IMU, and fin to align the velocity sensor into the flow (Photos and map from Cole et al., 2015)

Task 3.4
Distributed systems for ocean and sea ice:

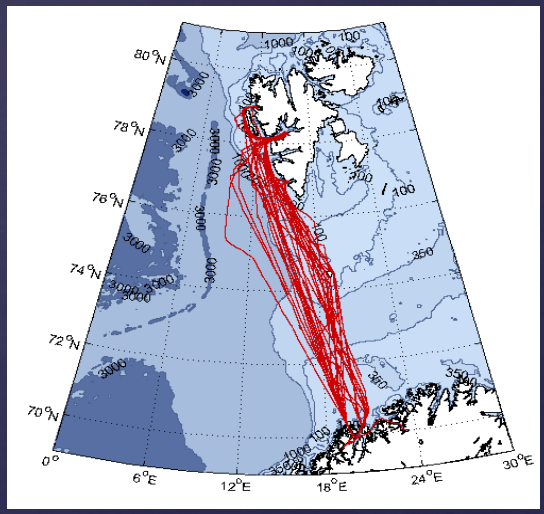
- novel sensors for FerryBoxes (ocean acidification and carbonate chemistry, inherent optical properties, microplastic sampler) (NIVA)

30-35 round trips/year



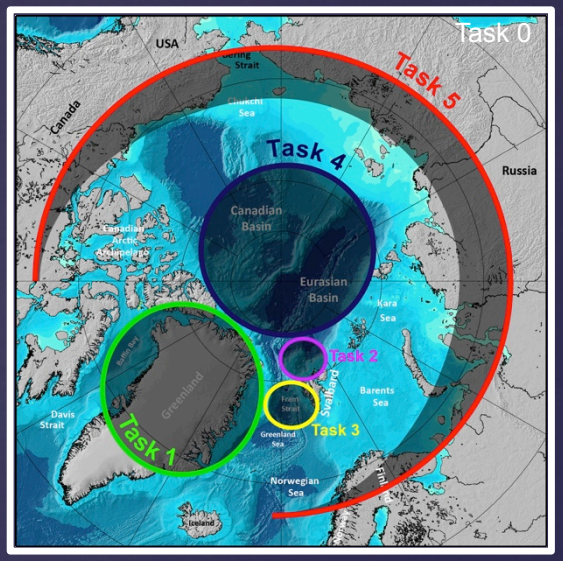
Existing MS Norbjørn Ferrybox system:

- Wind sensor at deck (True wind speed and direction, Gill instruments)
- Air temperature (Optional). Weather stations?
- Above water radiance/irradiance (TriOS Ramses Ed, Ld, Lu)
- Temperature and salinity (Seabird SBE45)
- Oxygen sensor (AADI Optode)
- Chlorophyll-a fluorescence (TriOS)
- Turbidity (Polymetron or AML)
- Organic material (CDOM-fluorescence, TriOS)
- Oil-fluorescence (Optional, TriOS)
- pCO2 sensor (Franatech/NIVA)
- pH sensor (NIVA-WAG system)
- CO3 (New sensors)
- Refrigerated water sampler (ISCO, 14*1 litre)
- Fixed point sampling or on events
- Advanced analysis and calibration
- NRT data to NIVA
- QC at NIVA > ArcticROOS dataportal
- Delayed mode data > ArcticROOS
- Continuous Plankton Recorder (From SAHFOS)



INTAROS WP3 *In situ* observing systems

Task 3.5
Distributed systems for atmosphere and land:



- extending continuous monitoring of atmospheric GHGs with additional trace gases and isotopes measurements (automated flask sampling system) at atmospheric stations in East Siberia
- vertical profiles of ABL state variables from airborne measurements along the Alaskan and Canadian Arctic
- a sequence of measures within a transect of observations sites in the Barrow site cluster (de-icing system for atmospheric instruments, novel temperature sensing system, new soil diffusivity system for trace gases)
- novel *in situ* and remote sensing of snow physical properties (novel technology to monitor snow thermal conductivity at several heights, extension of measurements along a latitudinal transect in the Eastern Canadian Arctic, drone-based pulsed LIDAR observations)
- new systems for improved ground-truthing of satellite remote sensing products in the Northern Finland (automatic spectro-albedometer, VNA-based radar system to monitor soil, snow and surface vegetation properties)
- semi-autonomous system for atmospheric observations (basic meteorology, surface flux, cloud observations) in the central Arctic for icebreaker Oden and SOOs

WP2

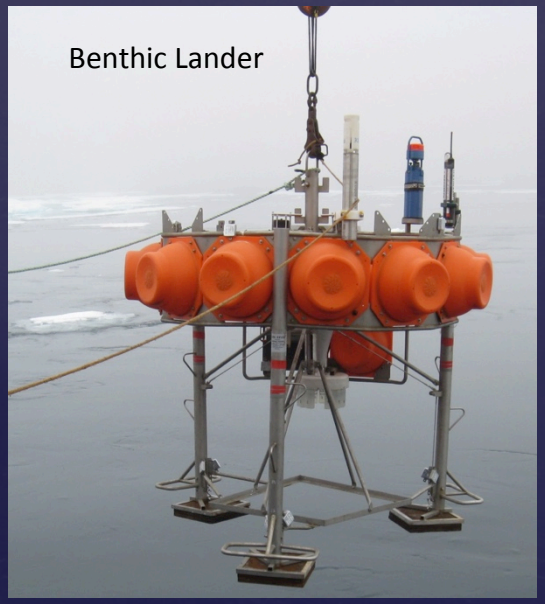
Exploitation of existing observing systems: ocean and sea-ice observations

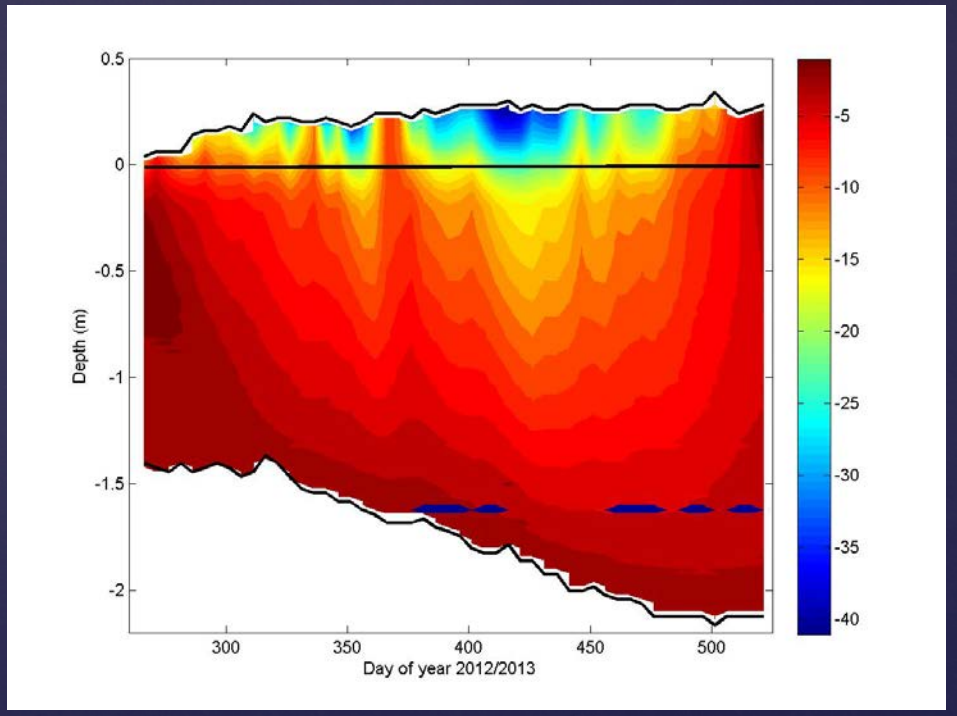
(from WP leader Roberta Pirazzini, FMI)

Task 2.1 Analyze strengths, weaknesses, and gaps of the existing observation networks and databases.

Ocean and sea ice

Evaluation of data from moored arrays, mobile platforms, tide gauge network, on-ice measurements, ocean bottom-mounted sensors, and remote sensing.

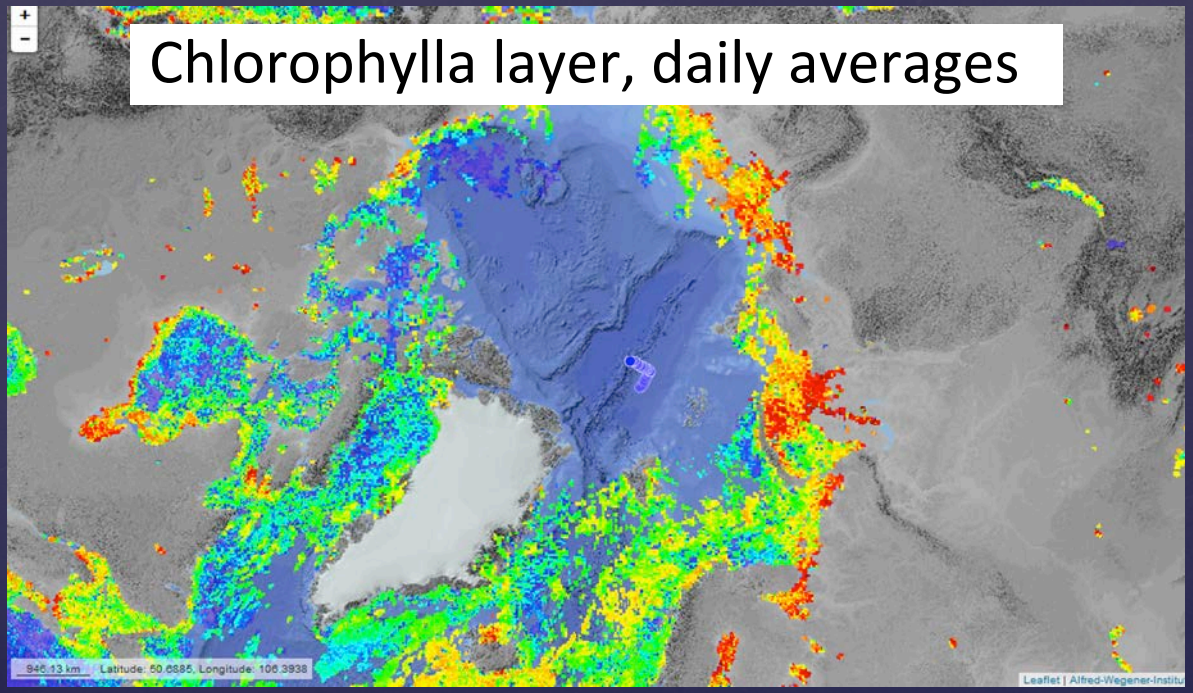




Time series of vertical profile of snow and ice temperature from Arctic buoy

Task 2.2 Exploit selected datasets in order to increase the quality and number of data products

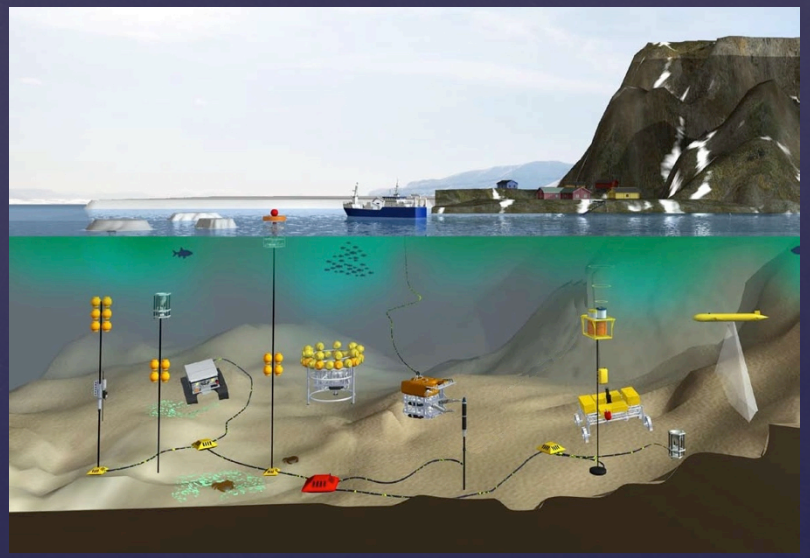
Ocean and sea ice

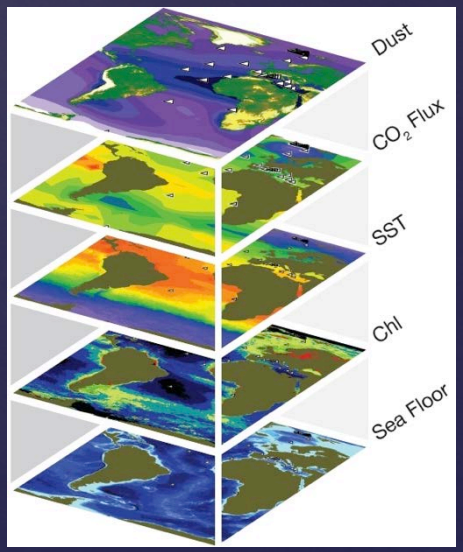


- Harmonization and combination of existing datasets
- Development of routines to retrieve new ocean and sea ice satellite products with improved accuracy and resolution

Task 2.3 Enhance standardization of data and metadata to ensure that best practices are followed and integrate sparse in situ data into established networks, preparing their delivery to the iAOS

Ocean and sea ice





Provision and integration of sea ice and ocean data collated from various open ocean observatories

Synthesis

Recommendations on:

- how to fill the gaps, improve the sampling strategies and data management
- How to sustain and further enhance the integration of multidisciplinary data repositories.

Maturity assessment of the existing observing systems