Implementation of a multipurpose Arctic Ocean Observing System

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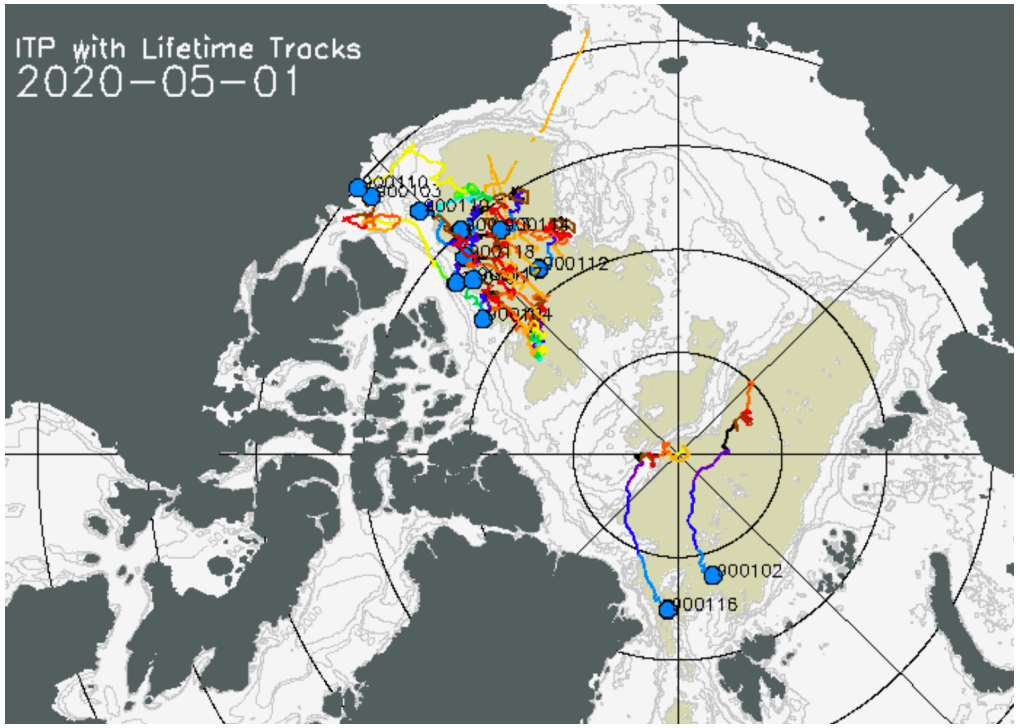
CAATEX
Coordinated Arctic Acoustic Thermometry Experiment

INTAROS

The central Arctic Ocean

- The central Arctic Ocean is one of the least observed oceans in the world. This ice-covered region is challenging for ocean observing with respect to technology, logistics and costs.
- Many physical, biogeochemical, biological, and geophysical processes in the water column and sea floor under the sea ice are difficult to observe and therefore poorly understood.



http://iabp.apl.washington.edu/maps_daily_oceanbuoys.html

Photo: NERSC

Recommendation from OceanObs19

- By 2029 the Arctic should prominently demonstrate that it has a fully developed, implemented, and sustained ocean observing systems that meets at a minimum, earth system prediction needs- but also meets other Arctic critical Arctic Societal Benefit Needs (Lee et al. 2019)

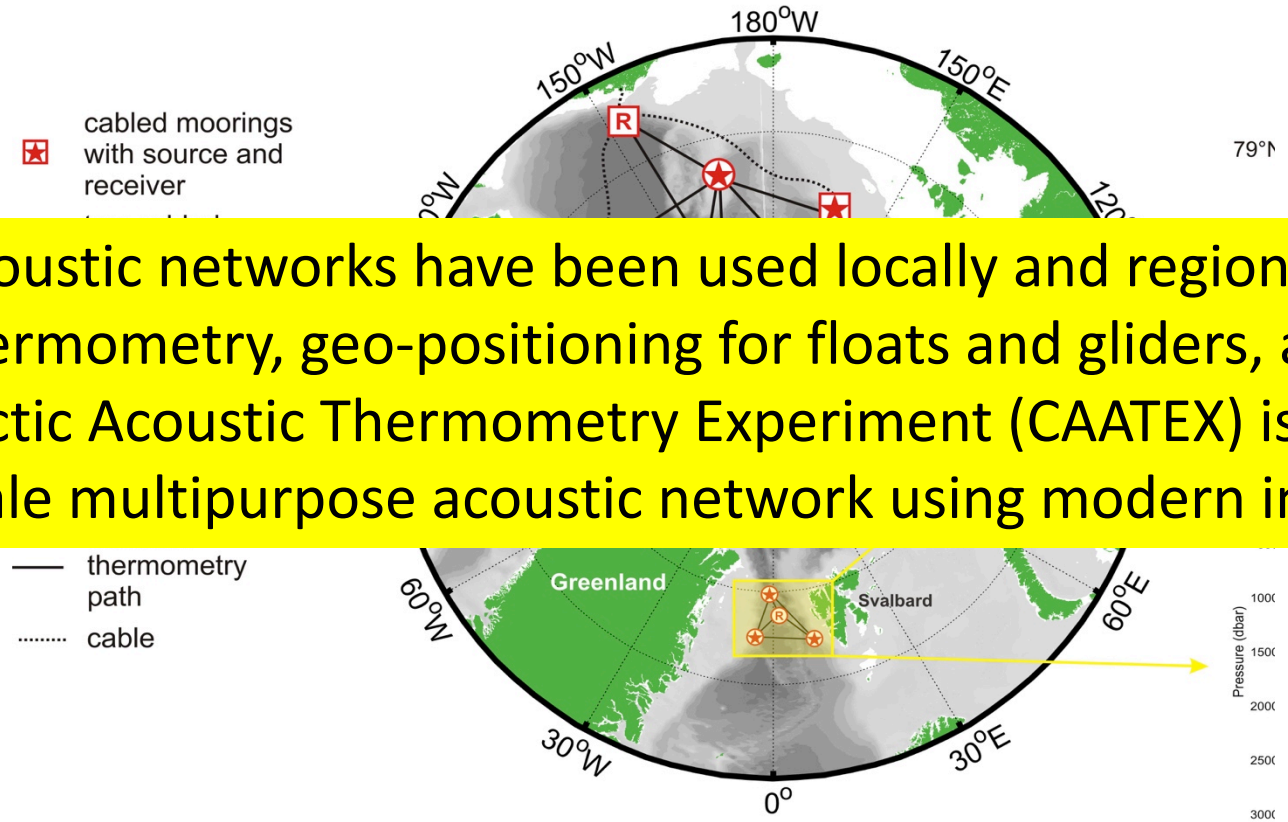
Challenges (technology and sustainability)

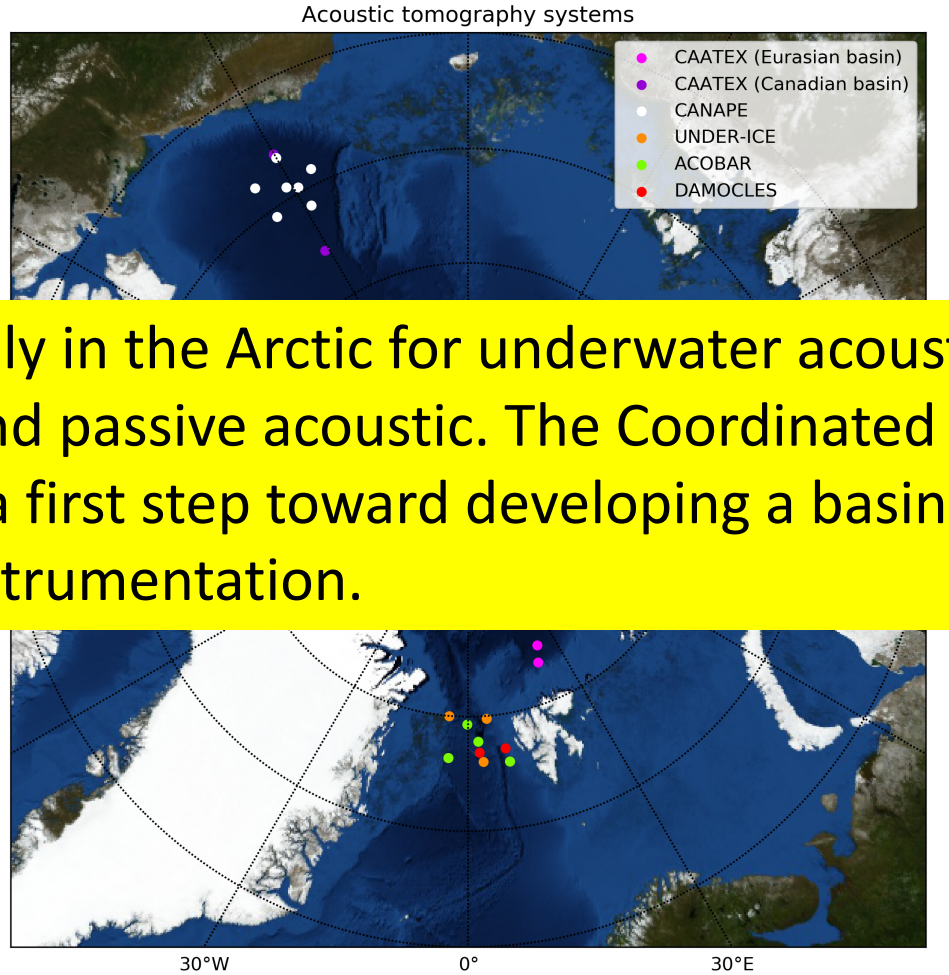
- Autonomous observing platforms used in the ice-free oceans such as Argo floats, gliders, and autonomous surface vehicles cannot yet be used operationally in ice-covered Arctic regions.
- Real time data from ocean under the ice is limited to a few drifting ITPs. ITPs have to be replaced on a regular basis.
- Year-round ocean data from fixed moorings are available in delayed mode. Moorings need to be recovered to be refurbished and for download of the data.
- Operationalization of the data chain from instruments into the data repositories

Recommendation from OceanObs19

- To improve the Arctic Ocean Observing capability OceanObs19 recommended ‘to pilot a sustained multipurpose acoustic network for positioning, tomography, passive acoustics, and communication in an integrated Arctic Observing System, with eventual transition to global coverage’ (Howe et al. 2019).

Multipurpose Acoustic Networks in the Integrated Arctic Ocean Observing System





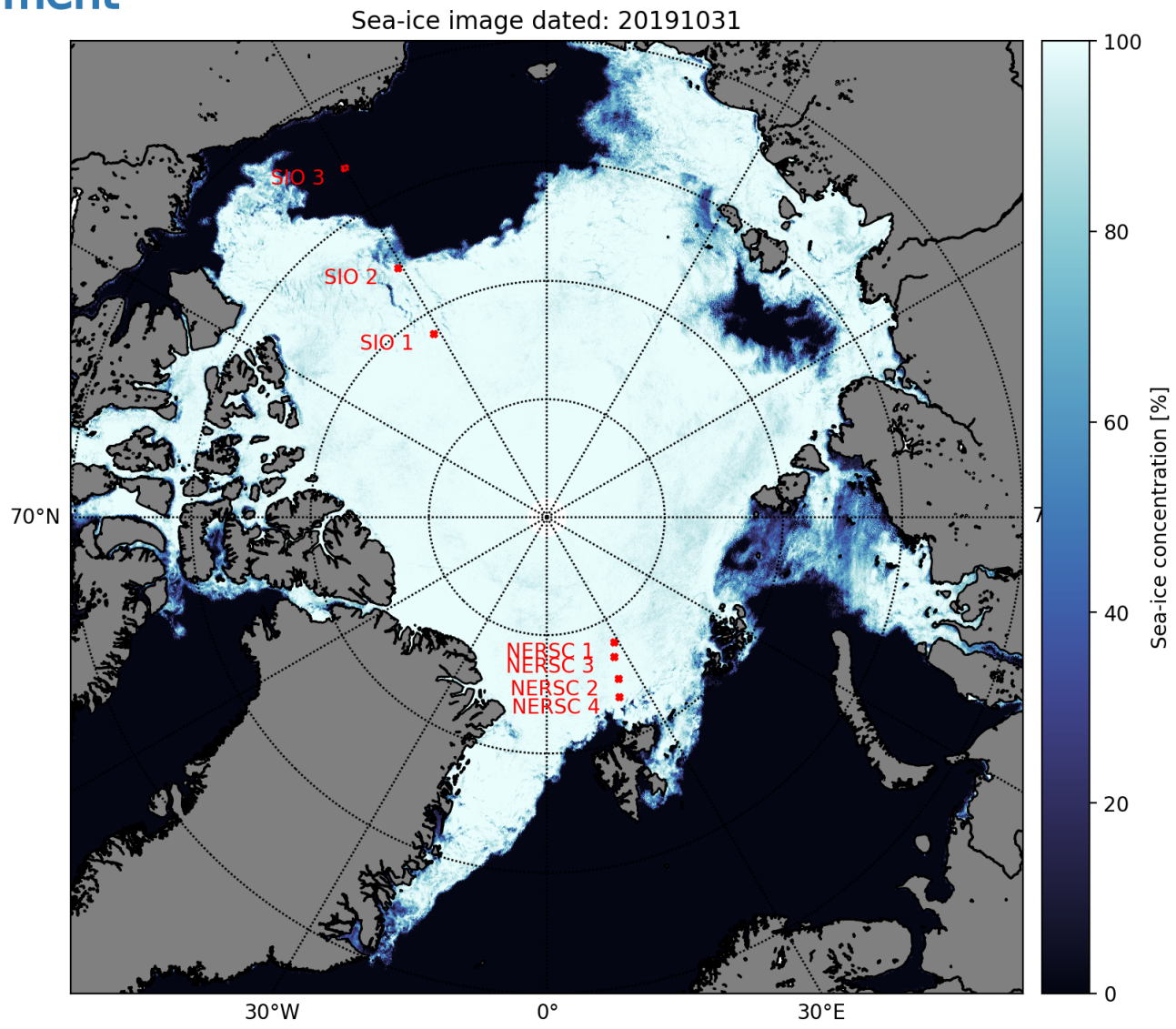
Acoustic networks have been used locally and regionally in the Arctic for underwater acoustic thermometry, geo-positioning for floats and gliders, and passive acoustic. The Coordinated Arctic Acoustic Thermometry Experiment (CAATEX) is a first step toward developing a basin-scale multipurpose acoustic network using modern instrumentation.

A future underwater acoustic network – UW-GPS for floats and gliders, listening system, and to measure averaged temperature and current. (Ref. Mikhalevsky, Sagen, Worcester et al.2015, Howe et al. 2019, Lee et al. 2019)

CAATEX

Coordinated Arctic Acoustic Thermometry Experiment

1) Collect new ocean observations covering the central Arctic Ocean
2) Obtain new knowledge about the decadal changes in heat content of the central Arctic Ocean
3) Improve our understanding of uncertainties in heat content estimates from climate models



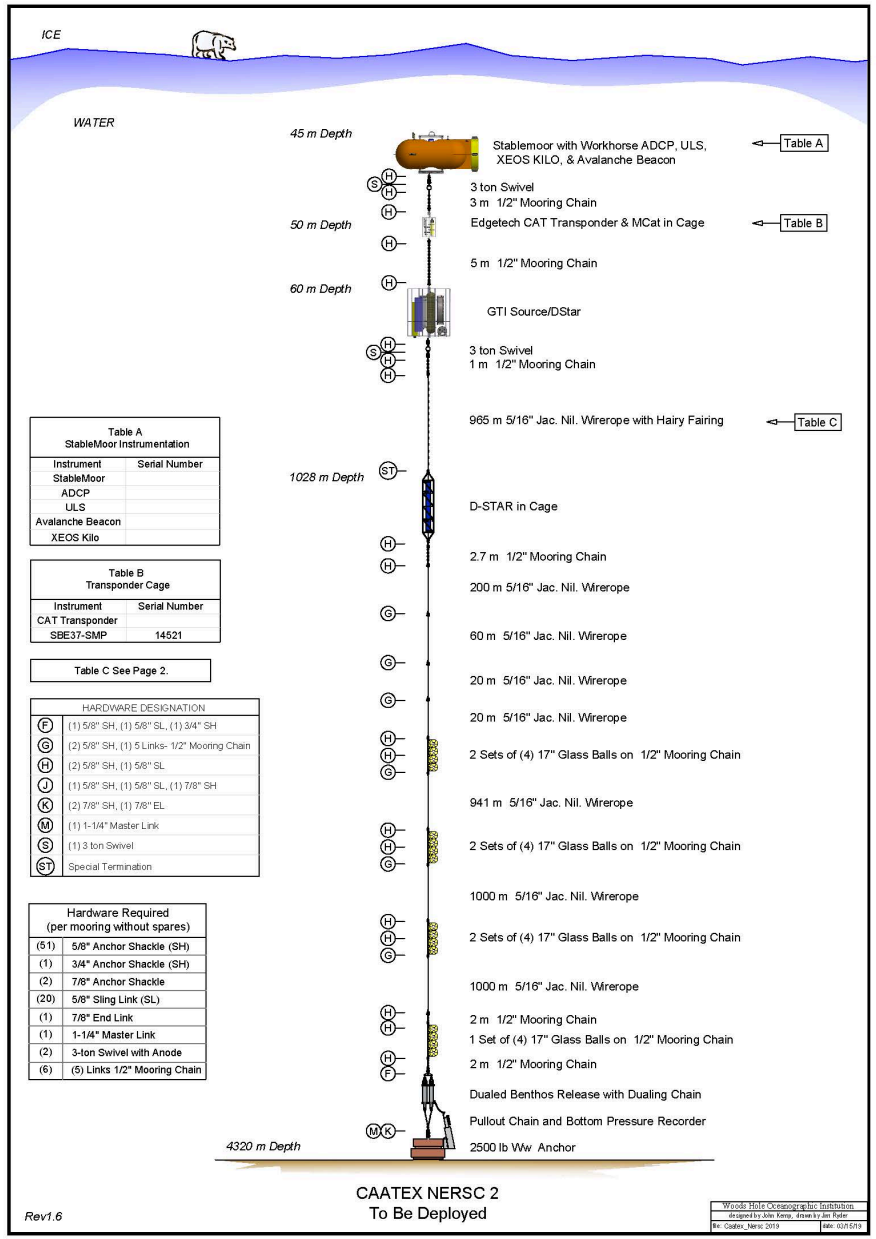
Ice concentration map from University of Bremen (G. Heygster)

USCGC Healy
Cruise period
3.9-14.10 2019
Lead: M. Dzieciuch

KV Svalbard
Departure/Return
Longyearbyen
14.08 2019- 9.9 2019
Lead: Hanne Sagen

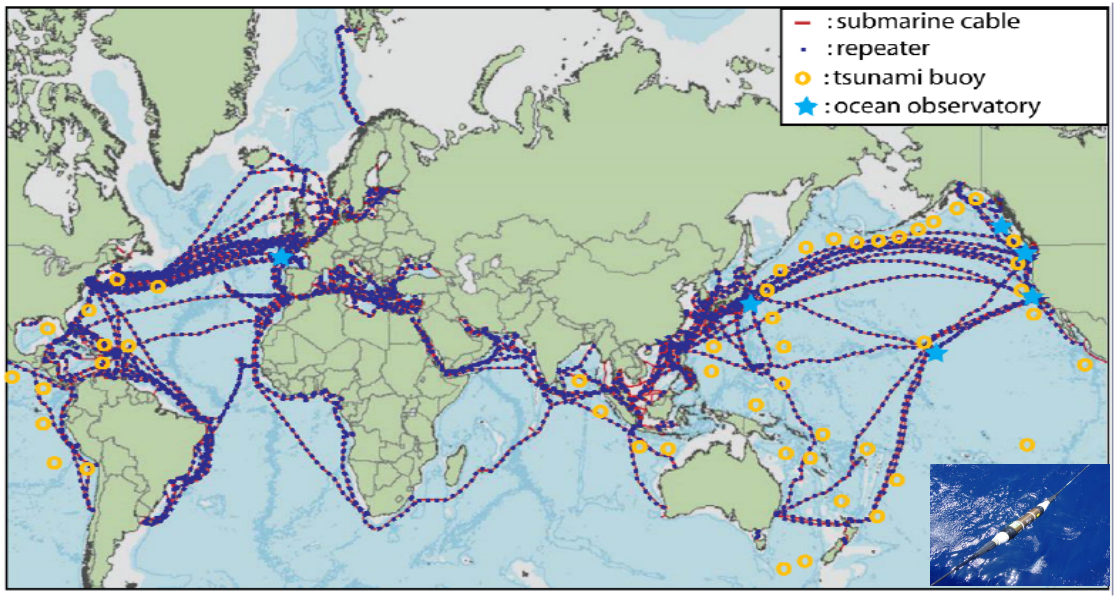
Future Fixed Multi-purpose observing networks

- Acoustic network combined with multidisciplinary sensors.
- Acoustic network will provide acoustic thermometry, underwater geo-positioning system, and vertical receiver arrays for passive acoustics.
- Acoustic networks (regional and basin wide) will support extension of ARGO program into the central Arctic Basin, as well as provide infrastructure for use of gliders in key regions.
- Oceanographic instruments integrated into the acoustic moorings will provide multi disciplinary point measurements at each fixed mooring location.
- Challenge: Subsurface moorings deliver data in delayed mode.

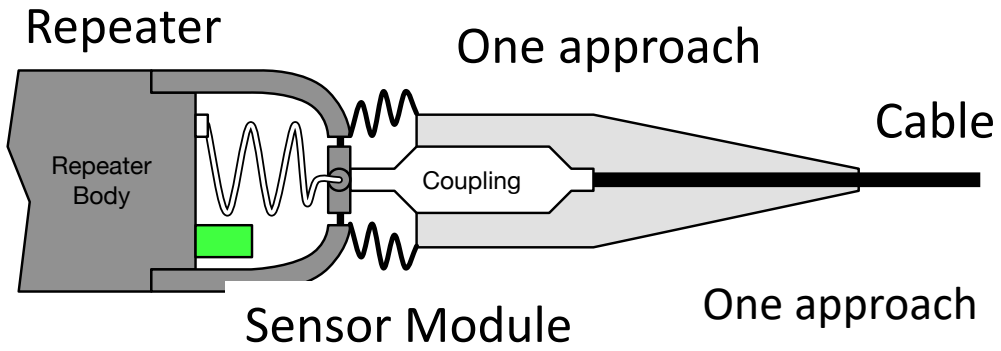


SMART Cables - Basic Concepts (Howe et al, 2019)

Climate, Oceans, Sea Level
Earthquakes, Tsunamis Global array



SMART cables: first order addition to the ocean-earth observing system, with unique contributions that will strengthen and complement satellite and in-situ systems



Install routinely on new cables
Deploy by cable ship, no maintenance

- **Telecom + science, shared infrastructure, $ ↓**
- Cable repeaters host sensors, not to interfere
- Potential: global spanning, trans-ocean, 1+ Gm
  ~10,000+ repeaters (~100 km)
  10-25 year refresh cycle
- Initially: **bottom pressure, temperature and acceleration**; supplement later (fiber sensing…)

https://www.itu.int/en/ITU-T/climatechange/task-force-sc/Pages/default.aspx

John You, Nature, 2010 – *Harnessing telecoms cables for science*

Cables –recommendations from OceanObs19

- At OceanObs19 it was recommended to transition (telecom+sensing) SMART subsea cable systems from present pilots to trans-ocean implementation, to address climate, ocean circulation, sea level, tsunami and earthquake early warning, ultimately with global coverage.
- Cabled observatories, either stand alone or branching from a hybrid system, could provide power and real time communication to support connected water column moorings and sea floor instrumentation as well as docking mobile platforms.

Future – Arctic Ocean Observing System

- An international consortium of leading scientists in ocean observing with experience in state-of-the-art technologies on platforms, sensors, subsea cable technology, acoustic communication and data transmission plan will be formed as a recommendation from OceanObs19 Research Coordination Network (Pearlman et al. 2020)
- The INTAROS project is presently developing a Roadmap for an integrated Arctic Observing System, where multipurpose ocean observing systems will be one component.

Acknowledgement

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