Multipurpose Acoustic Networks in the Integrated Arctic Ocean Observing System.

Hanne Sagen, NERSC

- **INTAROS and the EU cluster of Arctic projects**
- **The potential of multipurpose acoustic systems in theArctic**

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INTAROS

EU's Arctic project cluster 2016-2017

EU PolarNET
Coordination action (AWI)

INTAROS
observing systems
(NERSC)

APPLICATE
Modelling – forecasting
(AWI)

Arctic permafrost
(start in 2017)

BLUE ACTION
Modelling – forecasting
(DMI)

Infrastruture projects: ENVRI, INTERACT, ACTRIS, ICOS, EPOS, ++

European Commission

INTAROS

INTAROS – Integrated Arctic Observation System

A project funded by EC - H2020-BG-09-2016

Coordinator: Stein Sandven
Nansen Environmental and Remote Sensing Center, Norway

The objective is to develop an efficient integrated Arctic Observation System by extending, improving, and unifying existing and evolving systems in the different regions of the Arctic

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Barcelona Supercomputing Center
Arctic Research Centre
Aarhus University
Armines
Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung
CNRS
DNV·GL
DTU Technical University of Denmark
eurocean
EuroGOOS European Global Ocean Observing System
Ilmatieteen Laitos Meteorologiska Institutet Finnish Meteorological Institute
NIERSC
GEUS
GFZ Helmholtz Centre Potsdam
Grønlands Naturinstitut
Helsingin Yliopisto Helsingfors Universitet University of Helsinki
Institute of Marine Research
IBPAN
Ifremer
Uniwersytet Śląski w Katowicach
cen
Mines ParisTech
Armines
Instytut Geofizyki Polskiej Akademii Nauk
Politécnica
Maynooth University National University of Ireland Maynooth
Max Planck Institut for Biogeochemistry
Max-Planck-Gesellschaft
NERSC Nansensenteret
NIVA Norwegian Institute for Water Research
NORDECO Nordic Agency for Development and Ecology
norut Northern Research Institute
NUI Maynooth
RADI
ФГБУ «ВНИИГМИ-МЦД»
Scripps Institution of Oceanography UC San Diego
SMHI
Stockholm University
terradue 2.0
The University Of Sheffield.
Universität Hamburg Der Forschung | Der Lehre | Der Bildung
University of Bergen
Université Laval
Universität Bremen
UNIS
Woods Hole Oceanographic Institution

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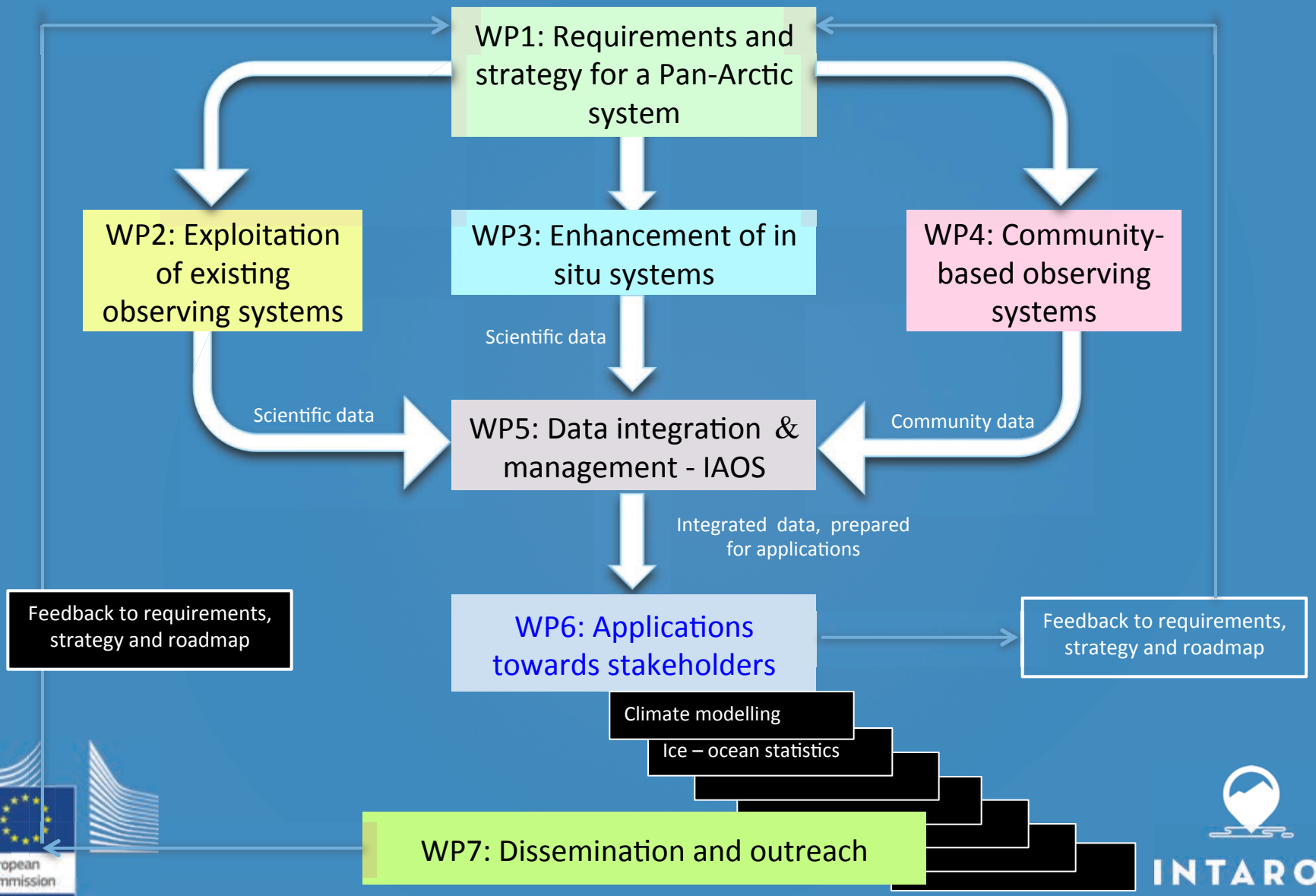
Workpackage structure



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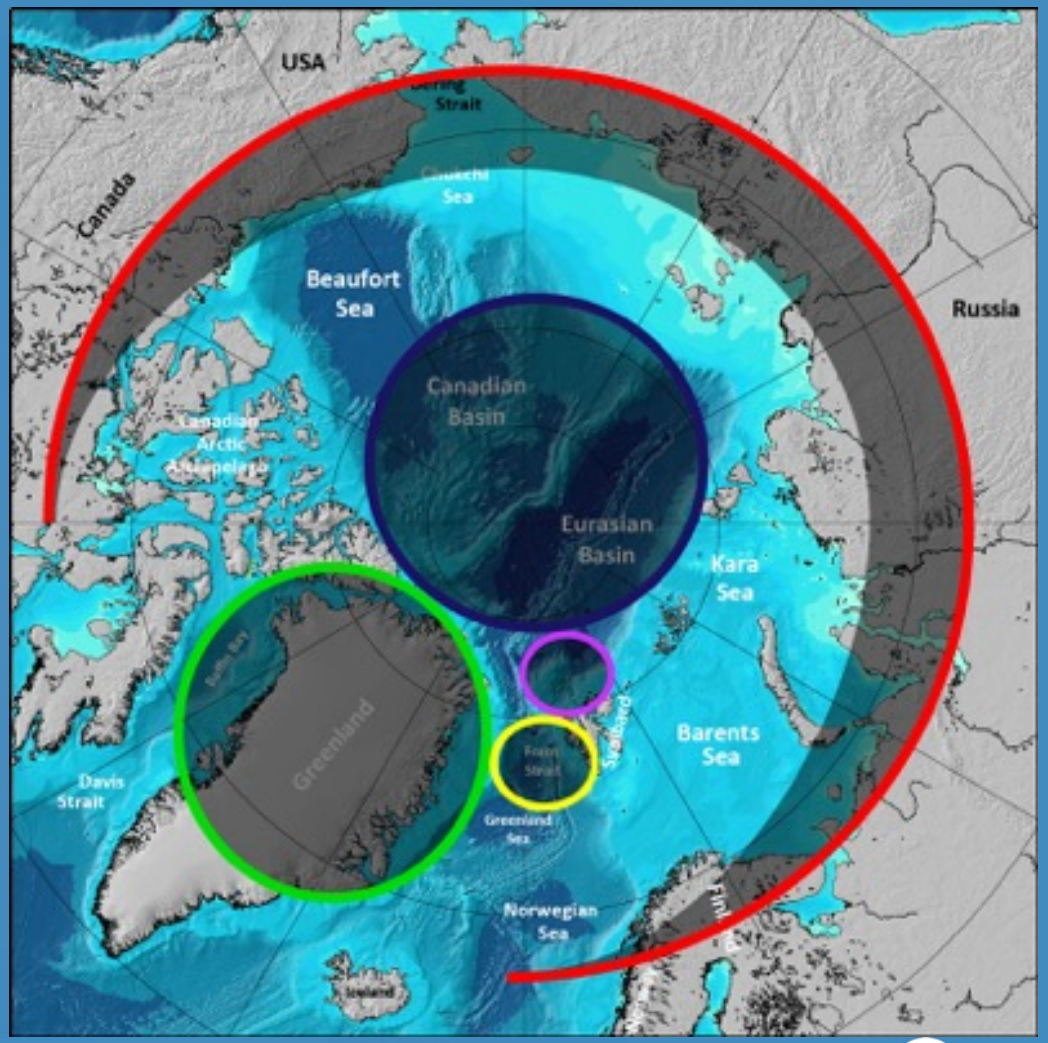
Focus areas in INTAROS

Experiment areas:

- Coastal Greenland/Baffin Bay
- North of Svalbard towards the deep Nansen Basin
- Fram Strait and Kongsfjorden
- Central Arctic: Distributed systems for ocean and sea ice
- Pan-Arctic region: Distributed systems for atmosphere and land



Main gap:
The ocean under the Arctic Sea Ice

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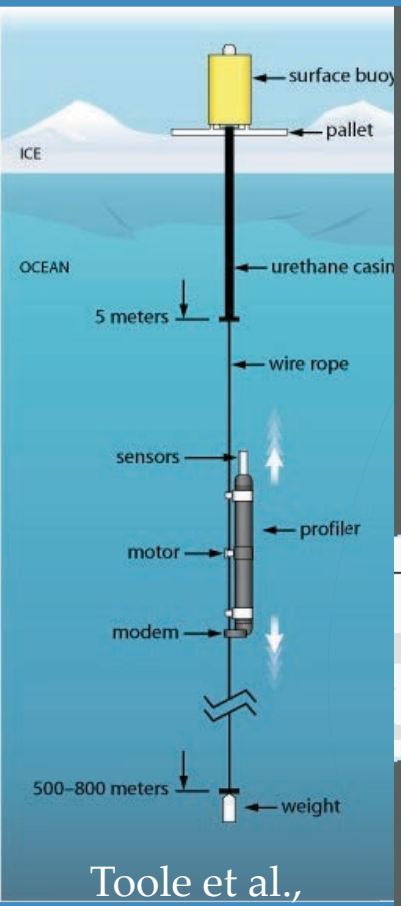
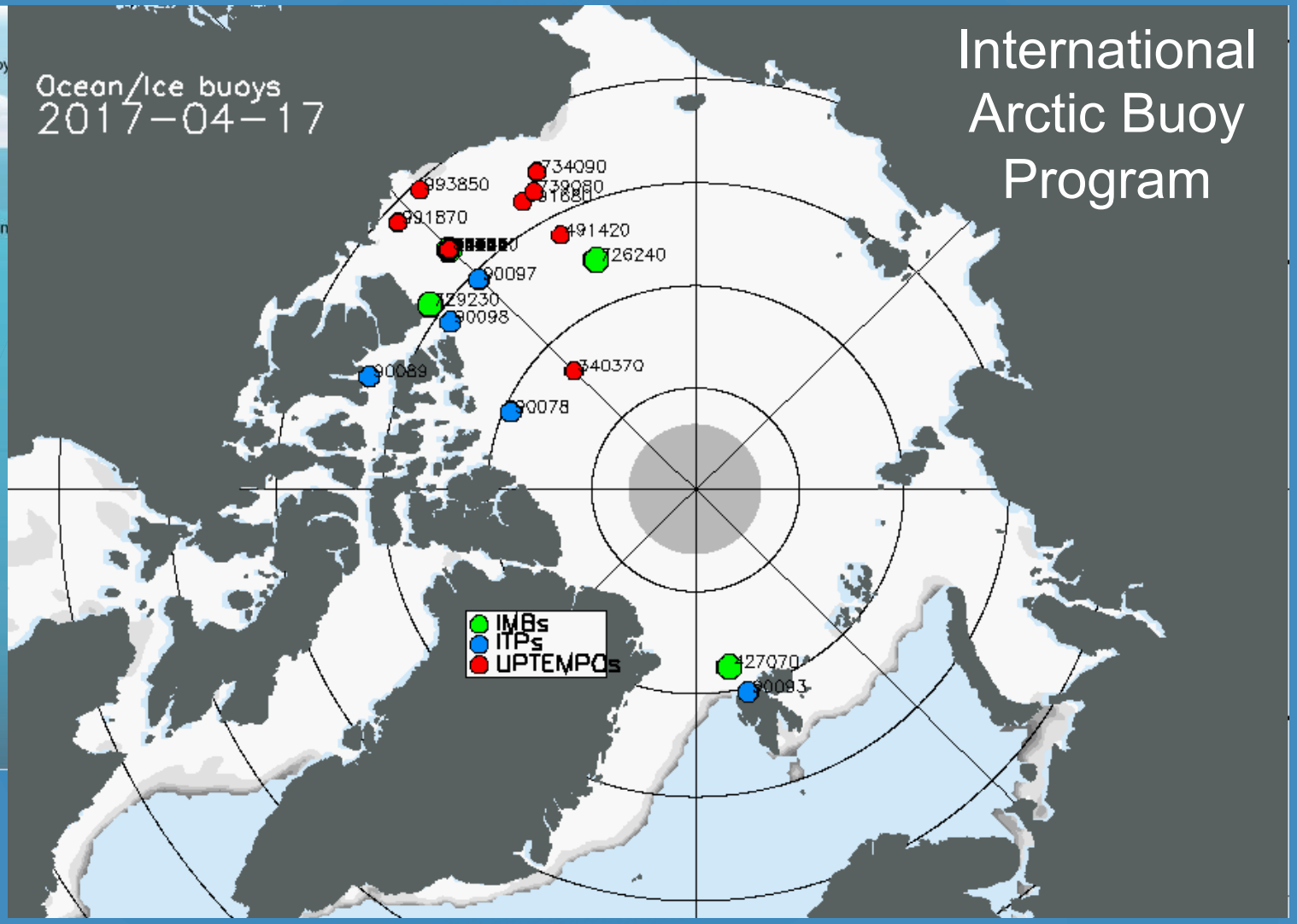
Ocean/Ice buoys transmits data in real time



Toole et al., 2011



International Arctic Buoy Program

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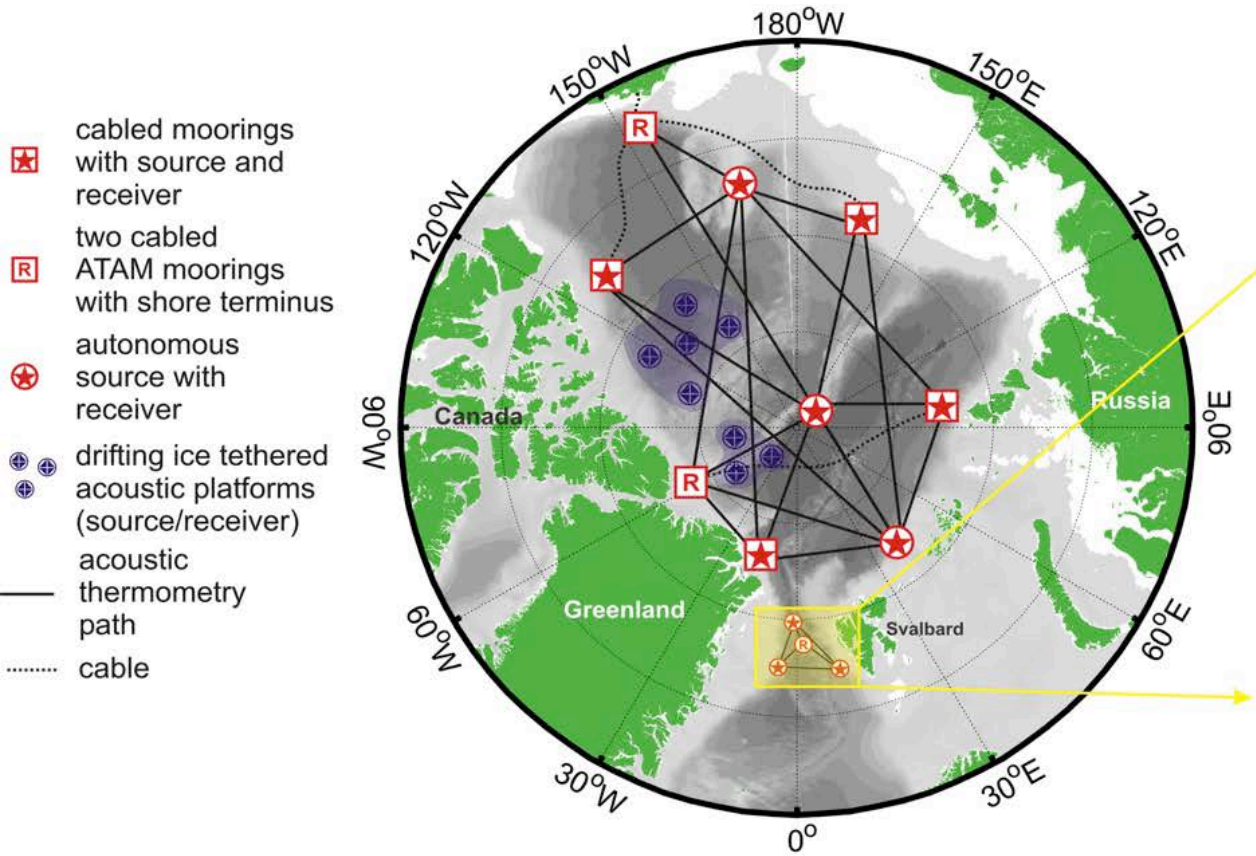
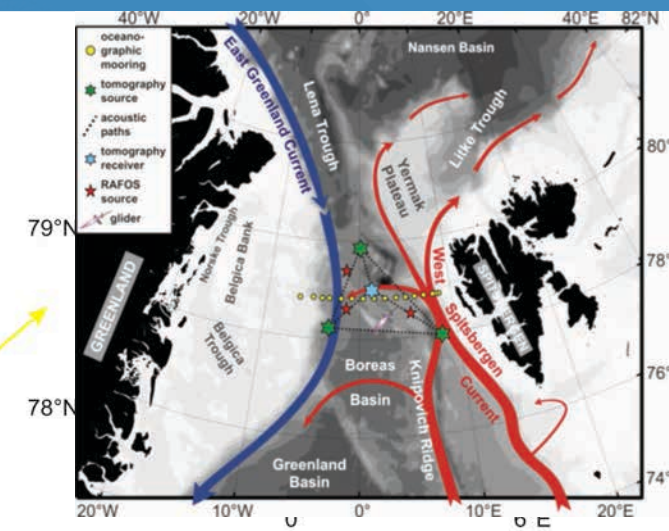
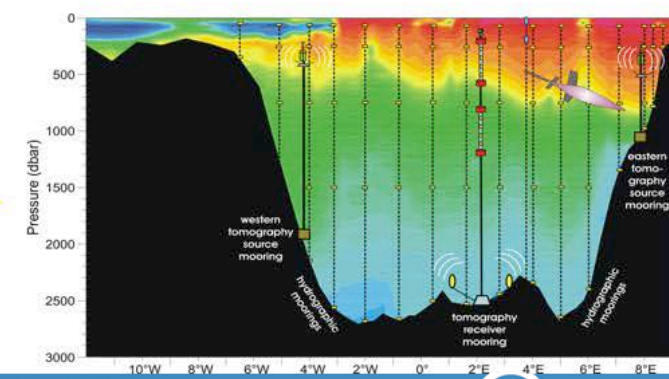
Multipurpose acoustic network in the Arctic - Drifting systems nested into a large scale system of fixed moorings







See Mikhalevsky, Sagen, Worcester et al.2015

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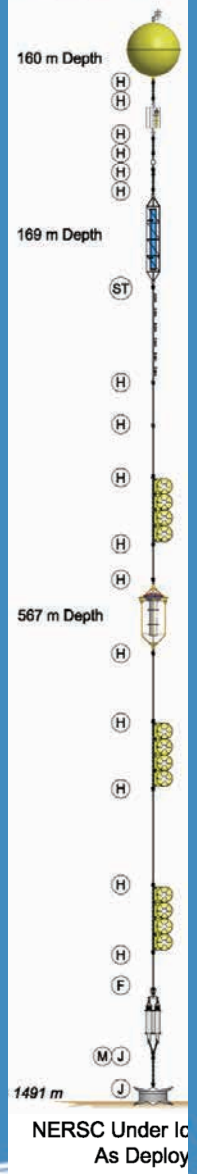
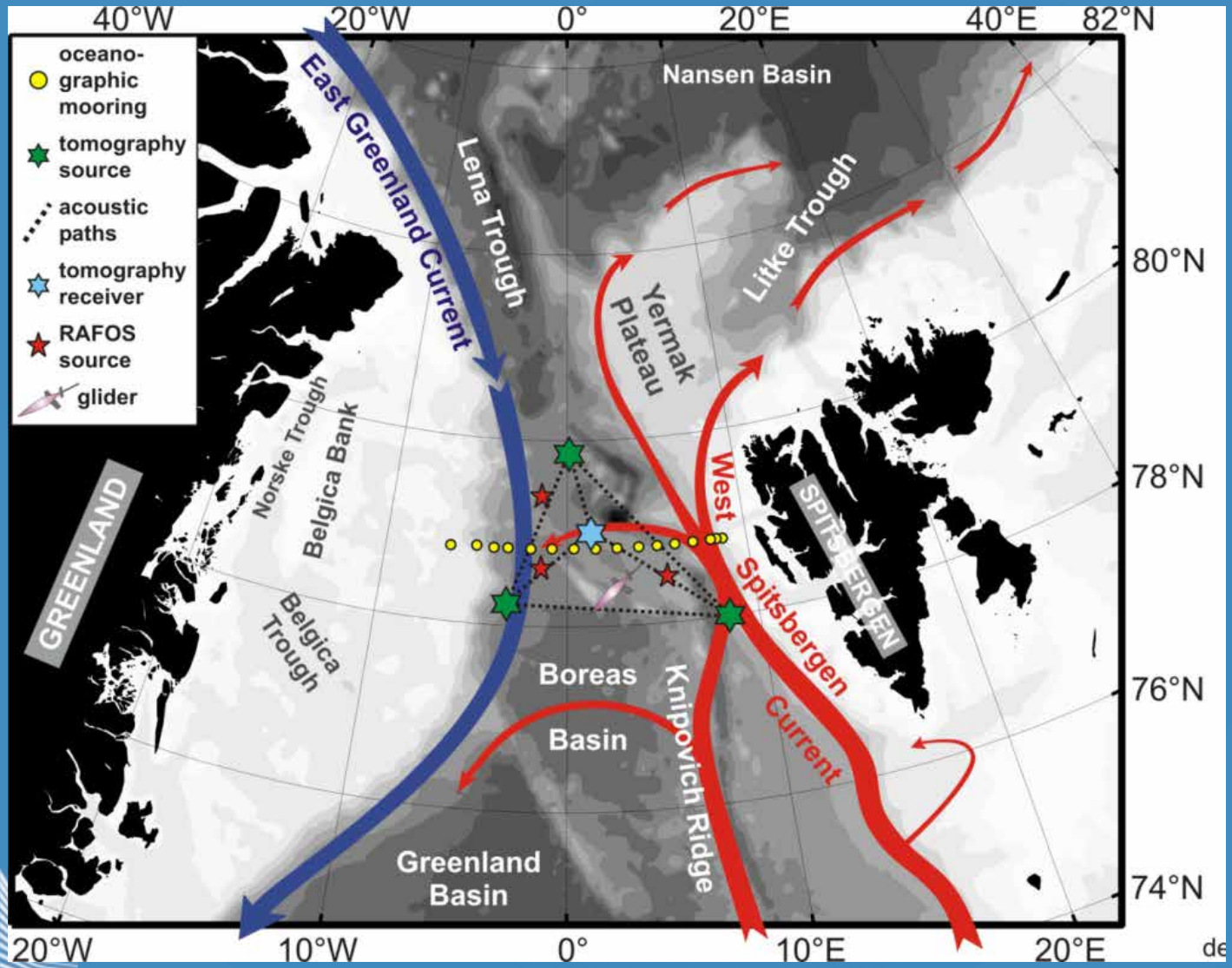
Multipurpose acoustic network in the Fram Strait





Sagen et al. 2017

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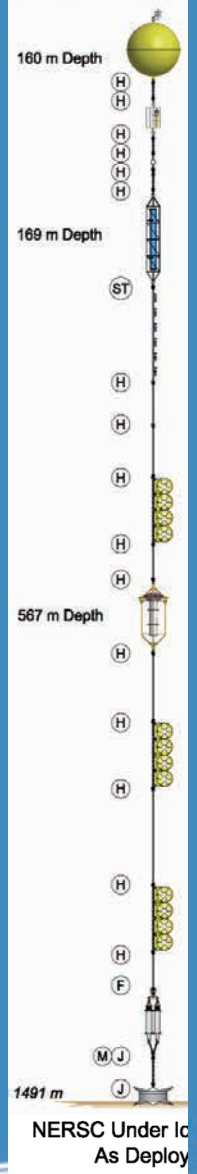
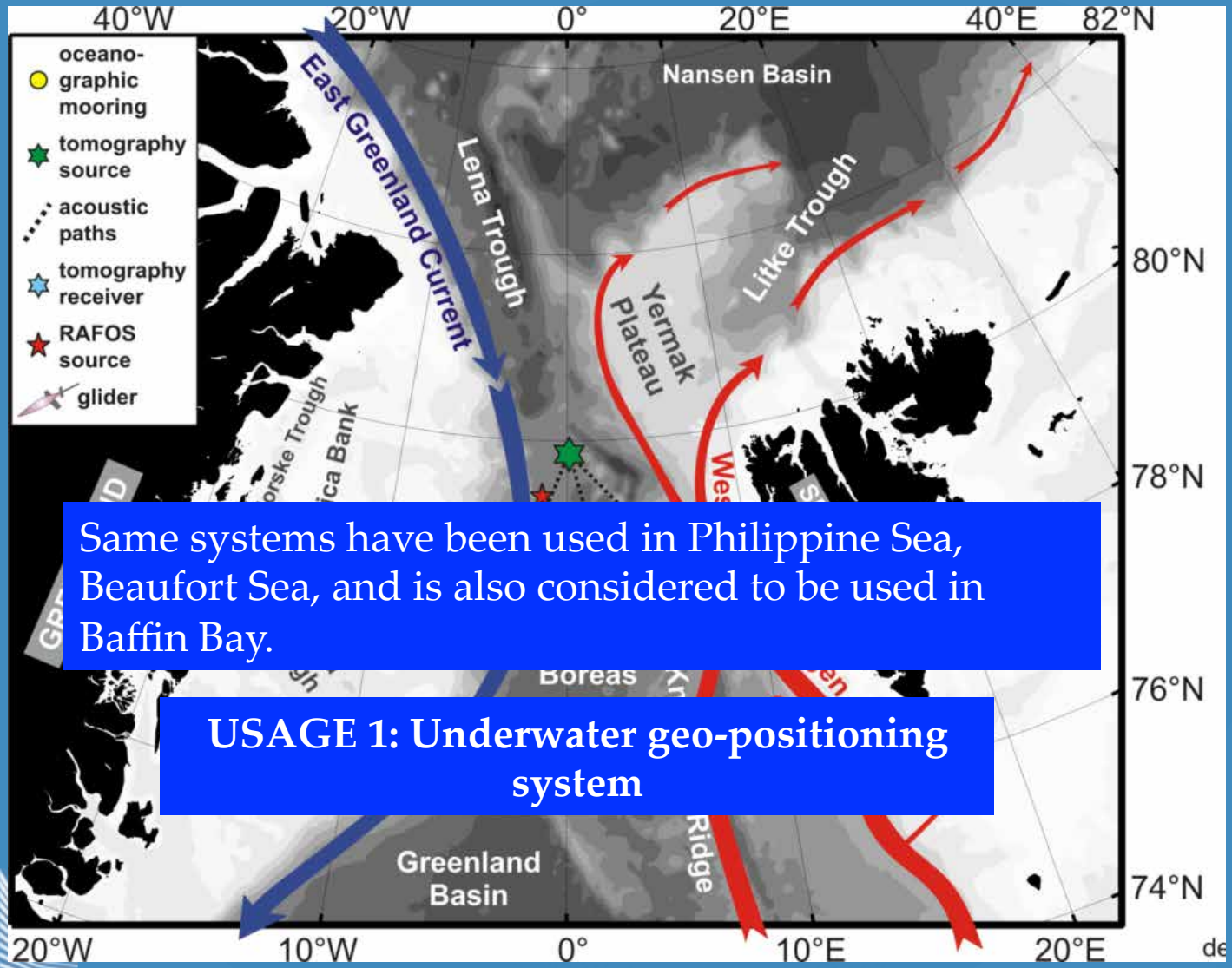
Multipurpose acoustic network in the Fram Strait

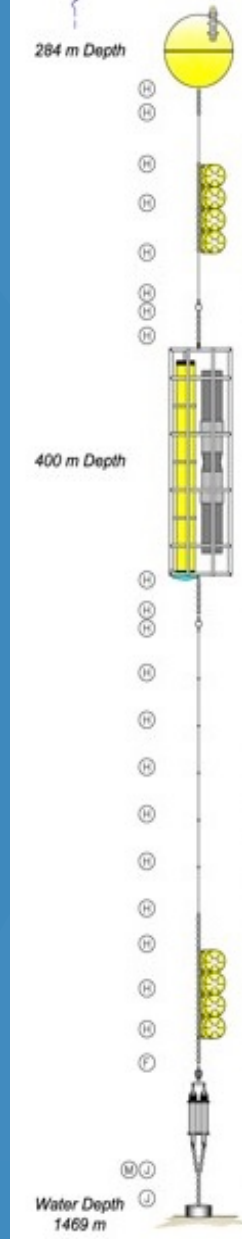




Same systems have been used in Philippine Sea, Beaufort Sea, and is also considered to be used in Baffin Bay.

USAGE 1: Underwater geo-positioning system

Sagen et al. 2017



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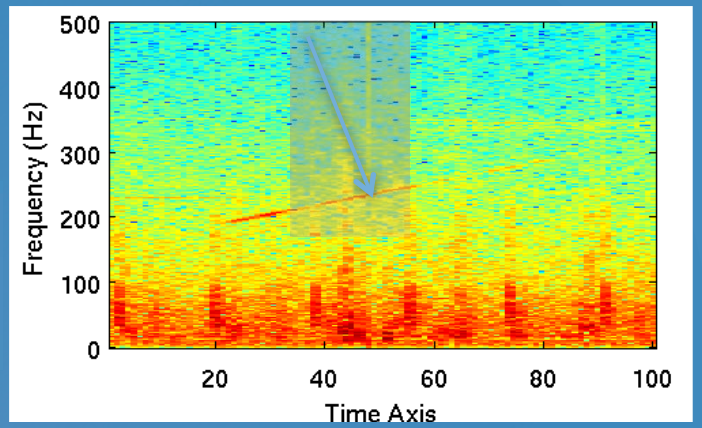
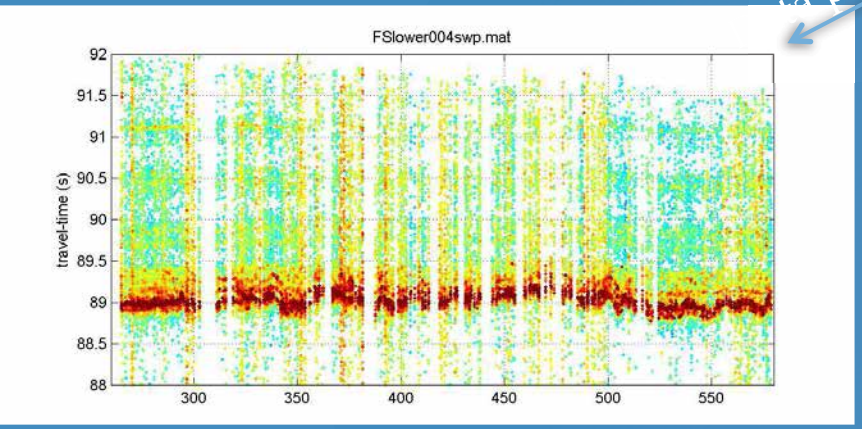
USAGE 2: Acoustic thermometry ("production line")

Objective: Measure the depth range average temperature (130 km x 1000 m) of the West Spitzbergen Current 8 times a day.

Reception of Source signal



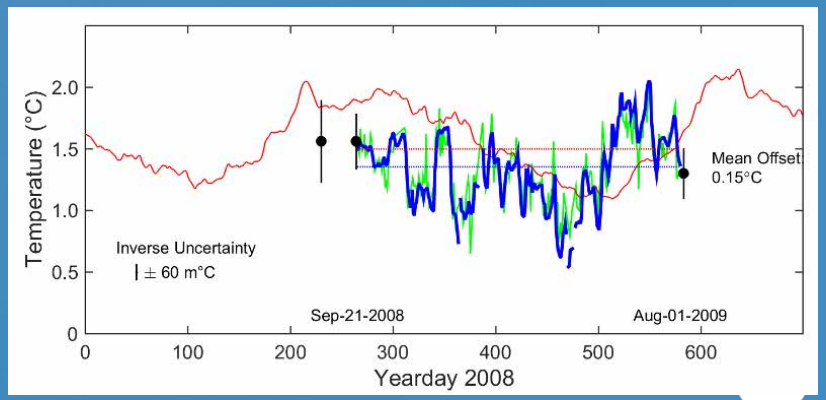
processing



Year long time series of travel times over 130 km

Inversion

Time series of mean temperature over 130 km at accuracy 50 m degree C

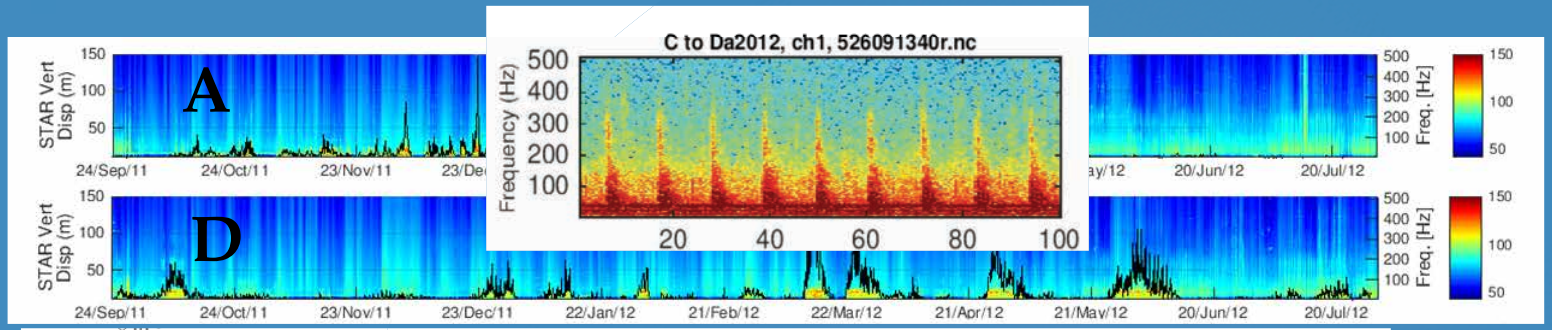


Dushaw et al. 2016 a,b,c; Sagen et al. 2016

INTAROS

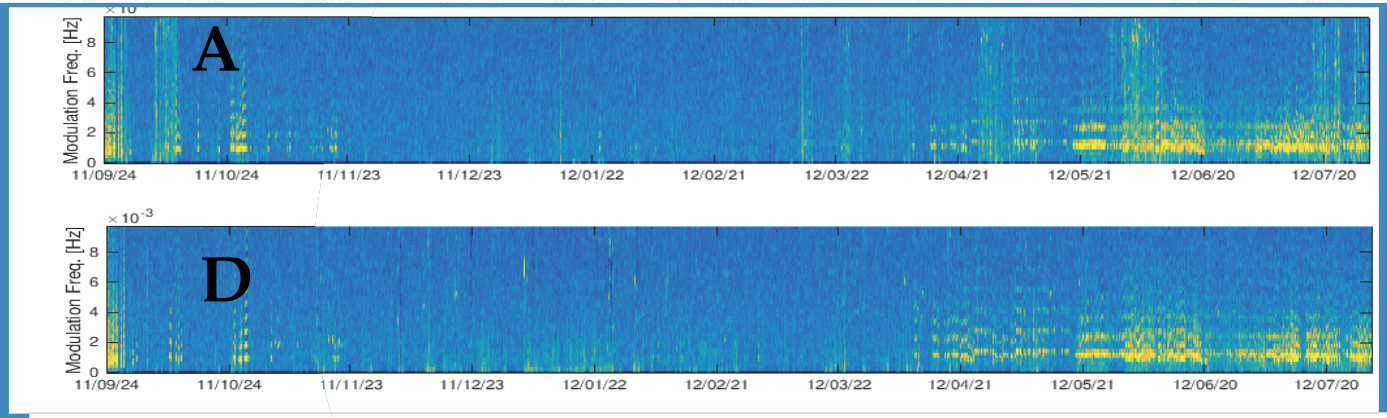
USAGE 3: Passive acoustic recordings: **Noise** in the ocean is an indicator in the Marine Strategy Framework Directive

- **Seismic airgun signals**

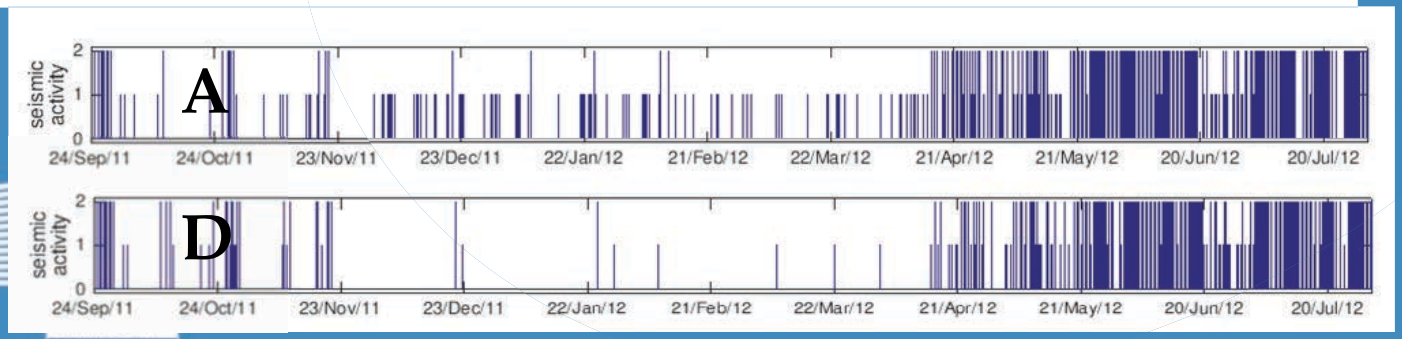


d≈373 m

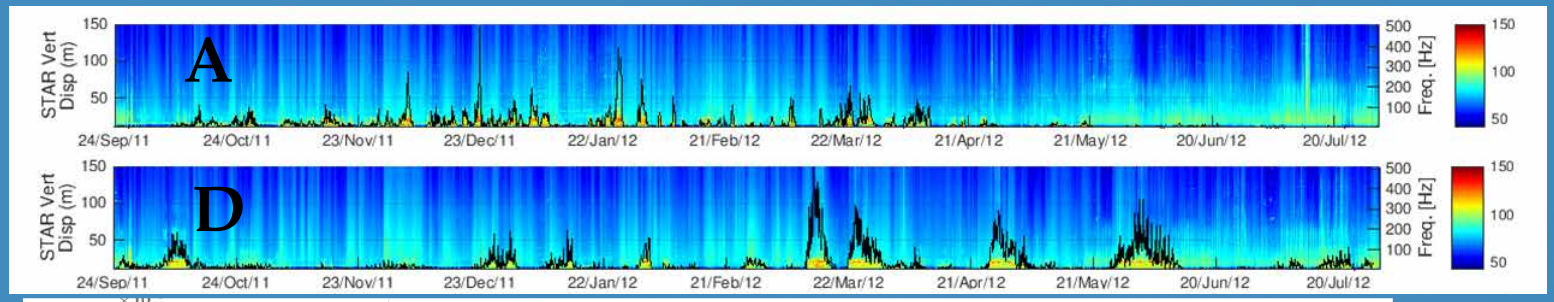
d≈260 m



A. Yamakawa, 2016



USAGE 3: Passive acoustic recordings: **Noise** in the ocean is an indicator in the Marine Strategy Framework Directive



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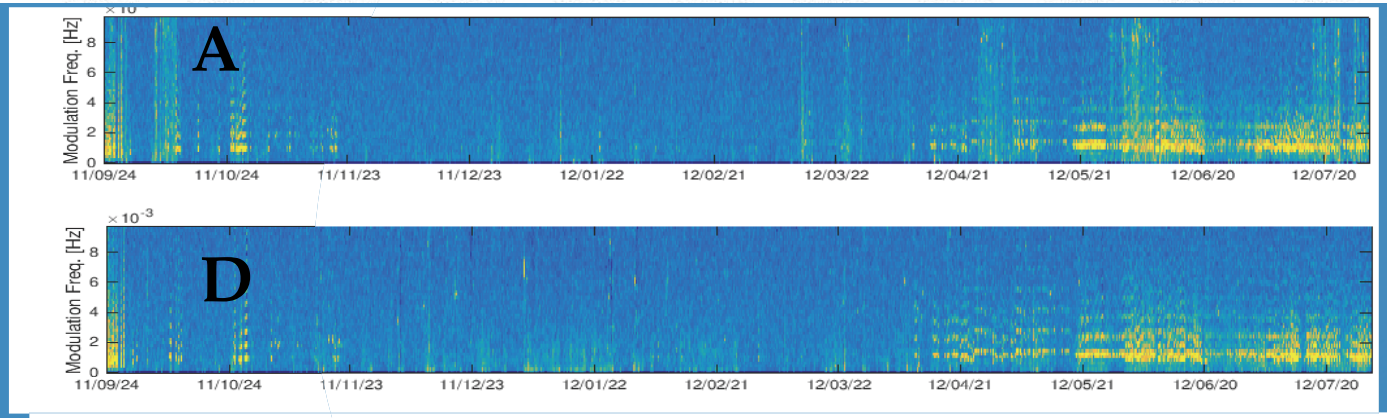

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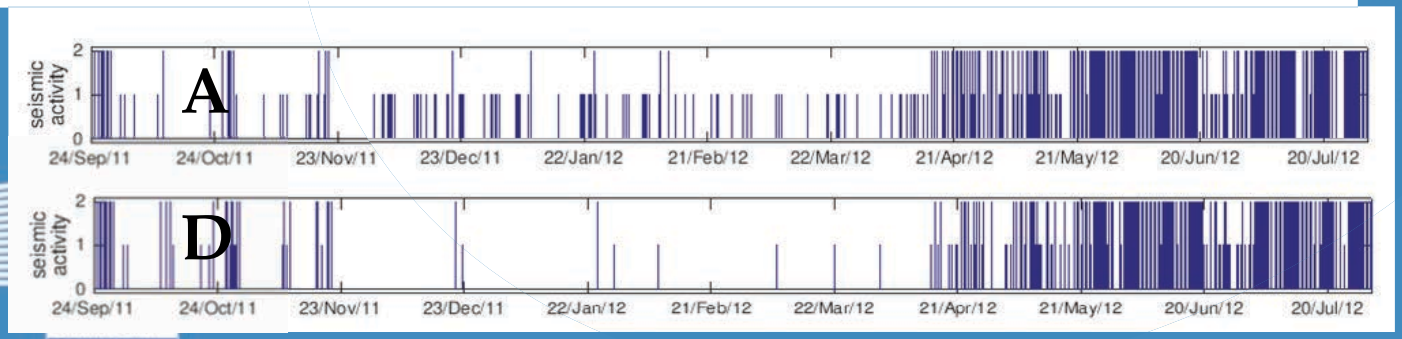

Summary

Use of gliders and floats (e.g. modified ARGO, RAFOS) in ice covered regions relies on implementation of acoustic infrastructure.

Fixed underwater acoustic network provide:

- Under water geo-positioning system (UW – GPS) for all users
- Listening system to monitor the acoustic environment
- Mean ocean temperature along fixed sections (thermometry)

Drifting acoustic networks are cheaper more accurate as long as the float or the glider is within range , but limited to specific experiments and users.

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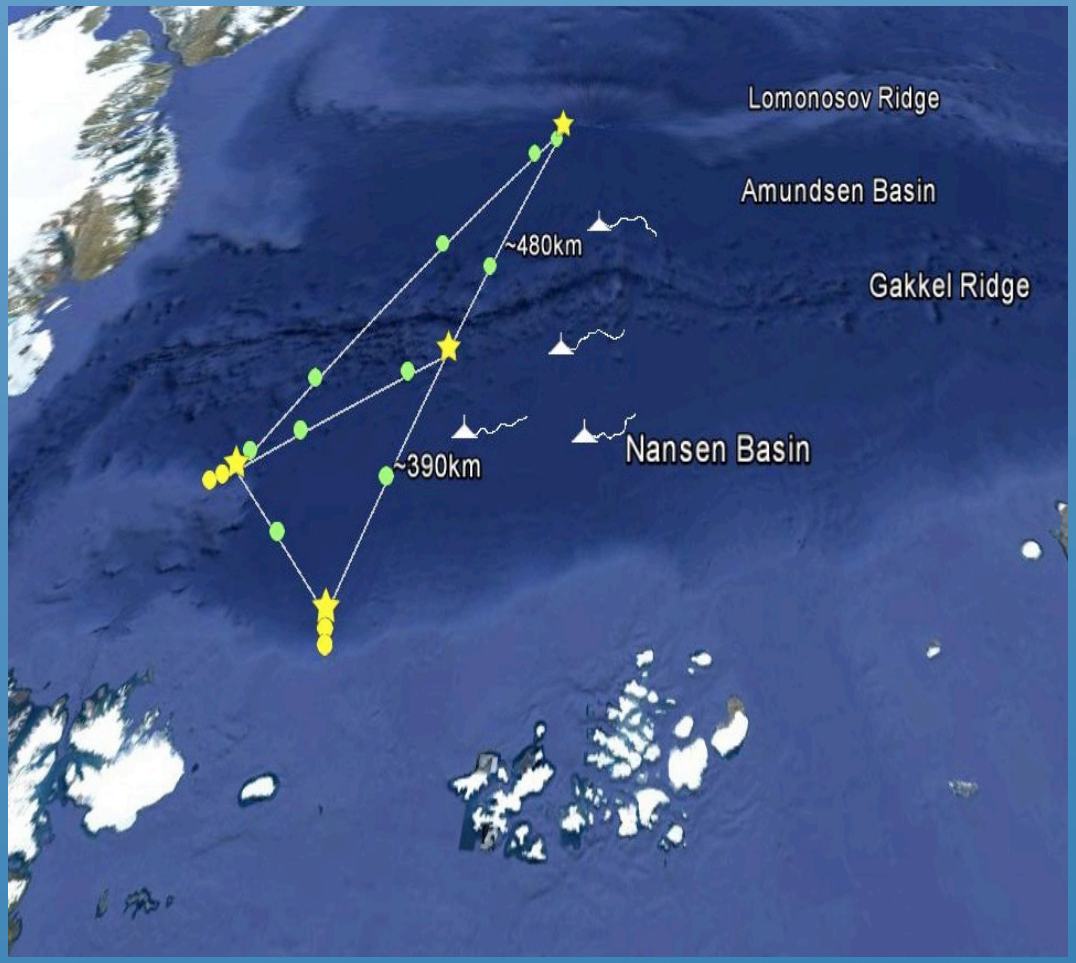
INTAROS

RI-Proposal: Norwegian Arctic Multidisiplinary Observatory (Linked to INTAROS)

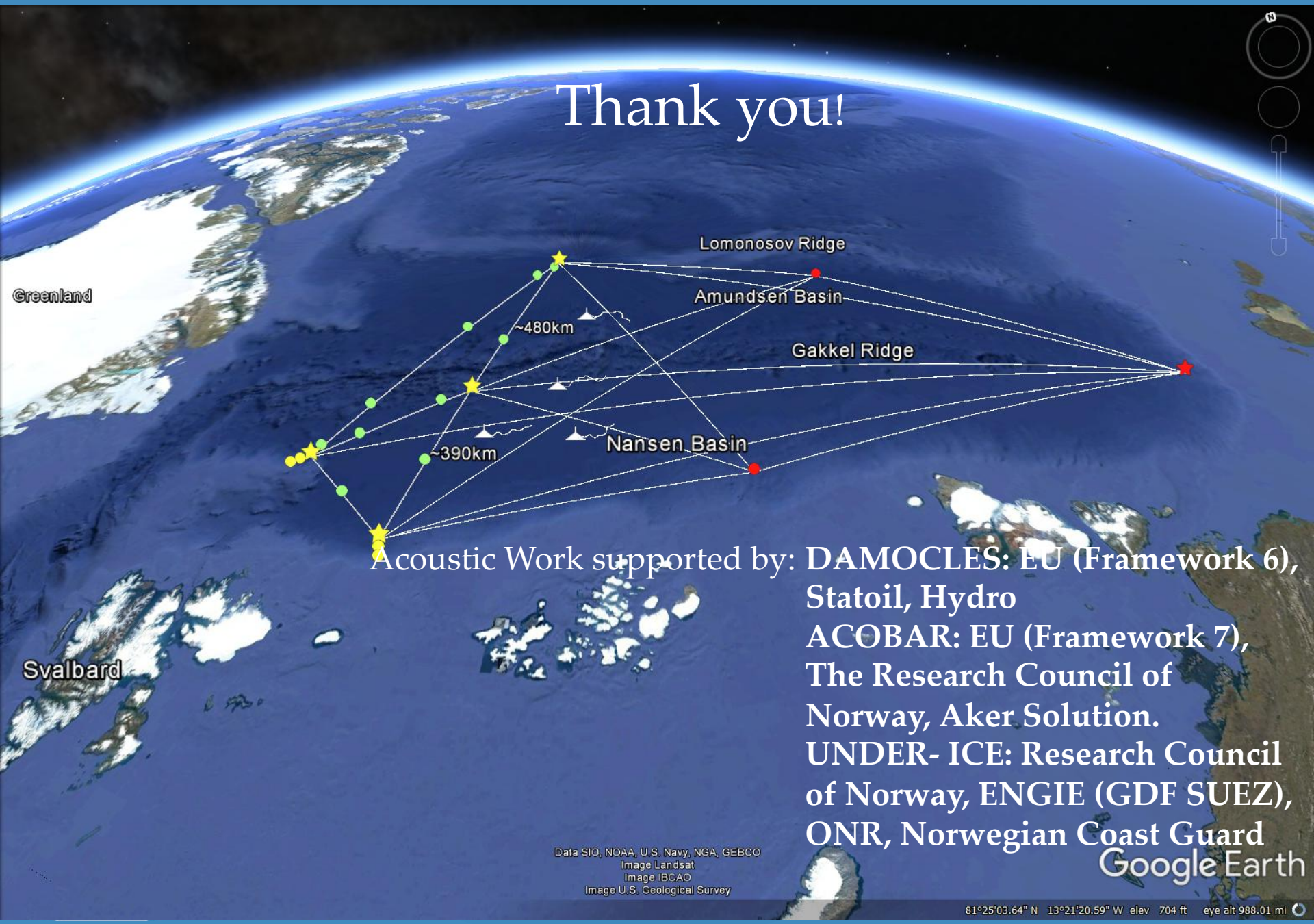
Coordinator: NERSC
Partners:

- University in Bergen
- (GFI, GEO, NOL)
- Institute of Marine Research
- Norwegian Polar Institute
- University Center in Svalbard
- Norwegian Defense Research Establishment



Yellow stars are the acoustic network complementing the standard oceanographic moorings (yellow dots) on the shelfs. Green dots are ocean bottom seismometers.

Thank you!



Acoustic Work supported by: **DAMOCLES: EU (Framework 6), Statoil, Hydro**
ACOBAR: EU (Framework 7), The Research Council of Norway, Aker Solution.
UNDER- ICE: Research Council of Norway, ENGIE (GDF SUEZ), ONR, Norwegian Coast Guard