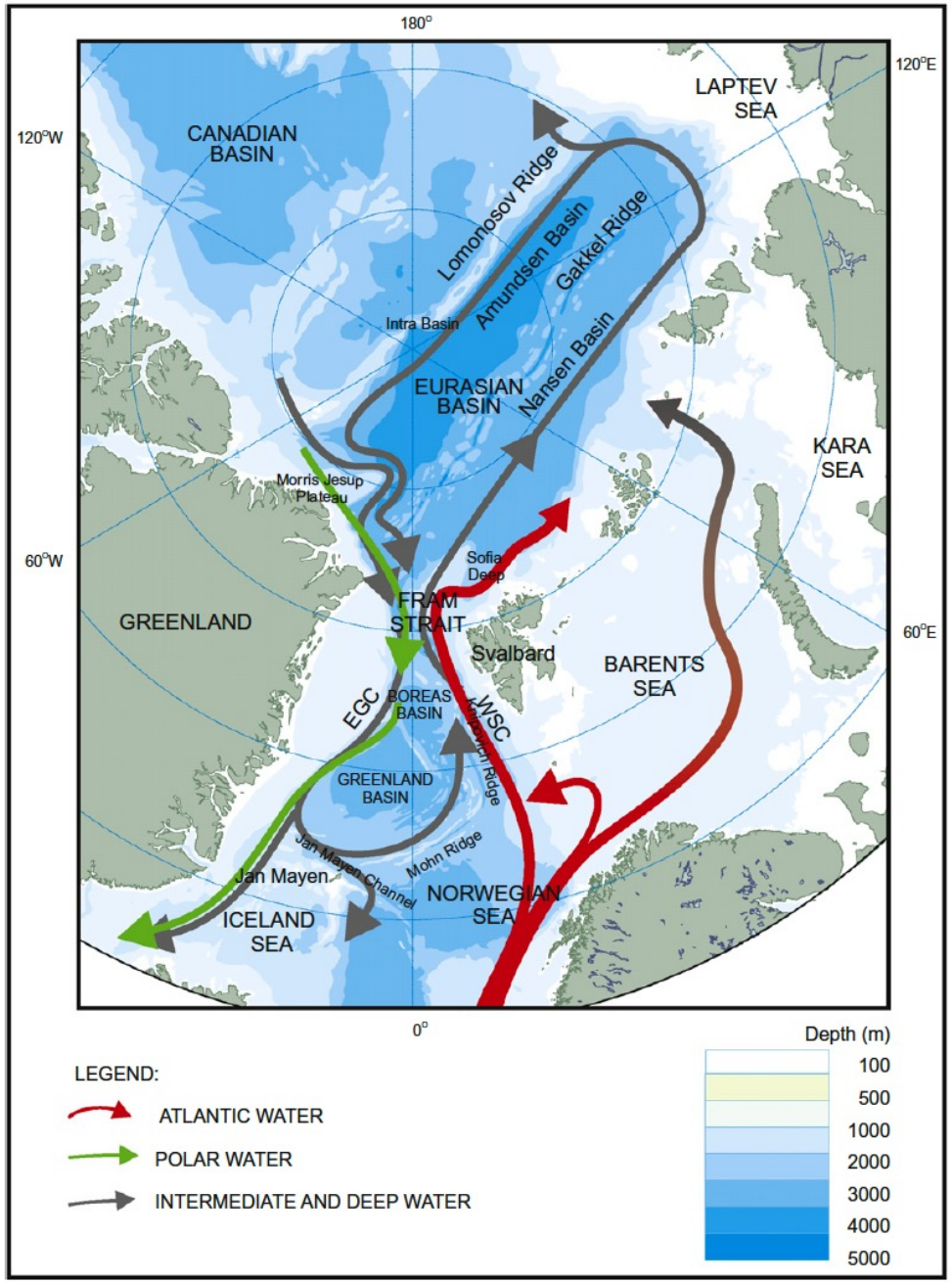
The need for scientific observations in the Arctic Ocean

Hanne Sagen and Stein Sandven

Nansen Environmental and Remote Sensing Center, Norway



HiAOOS

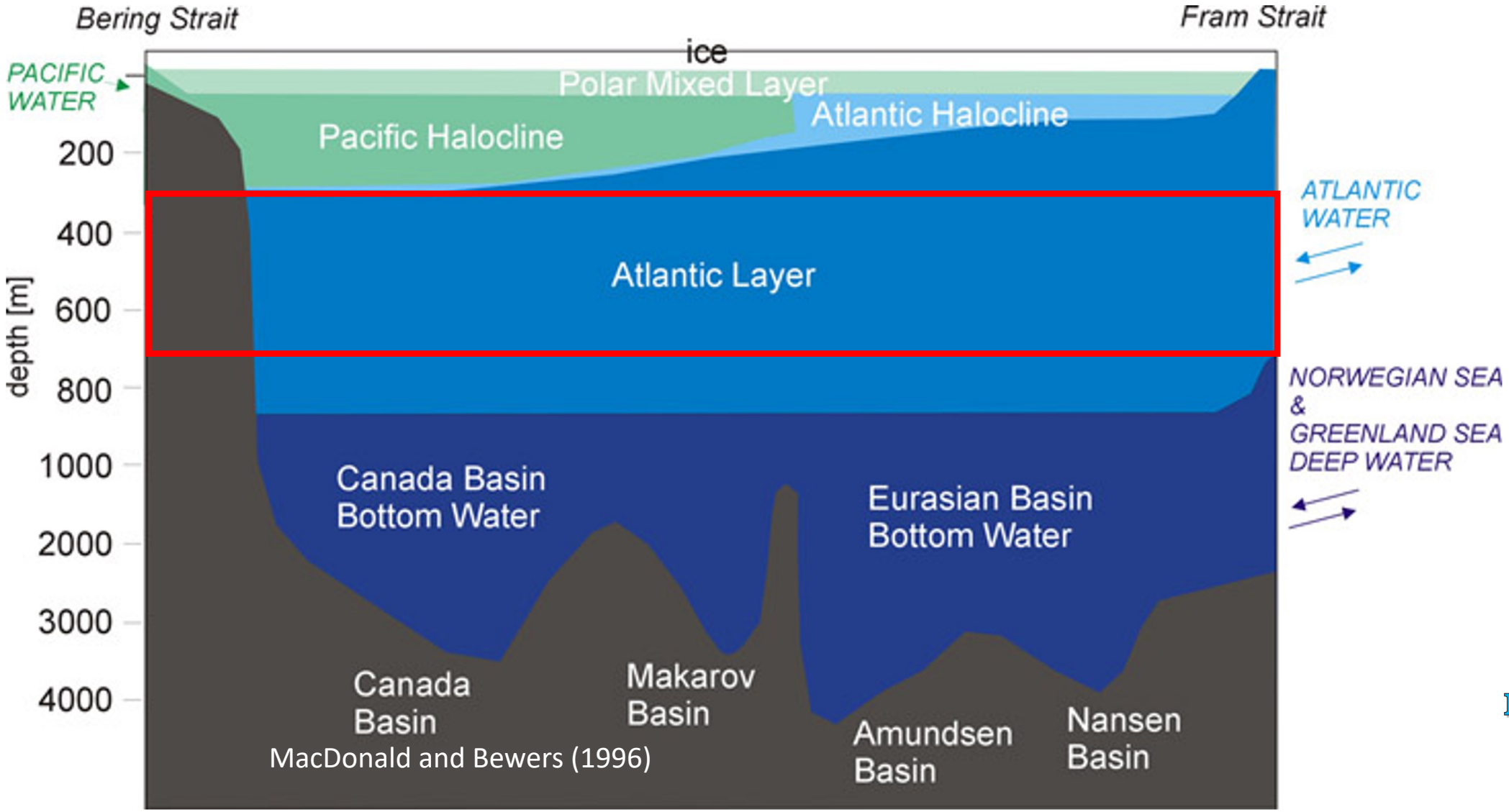
INTAROS

CAATEX
Coordinated Arctic Acoustic Thermometry Experiment

NERSC

What is happening with the ocean under the sea ice?

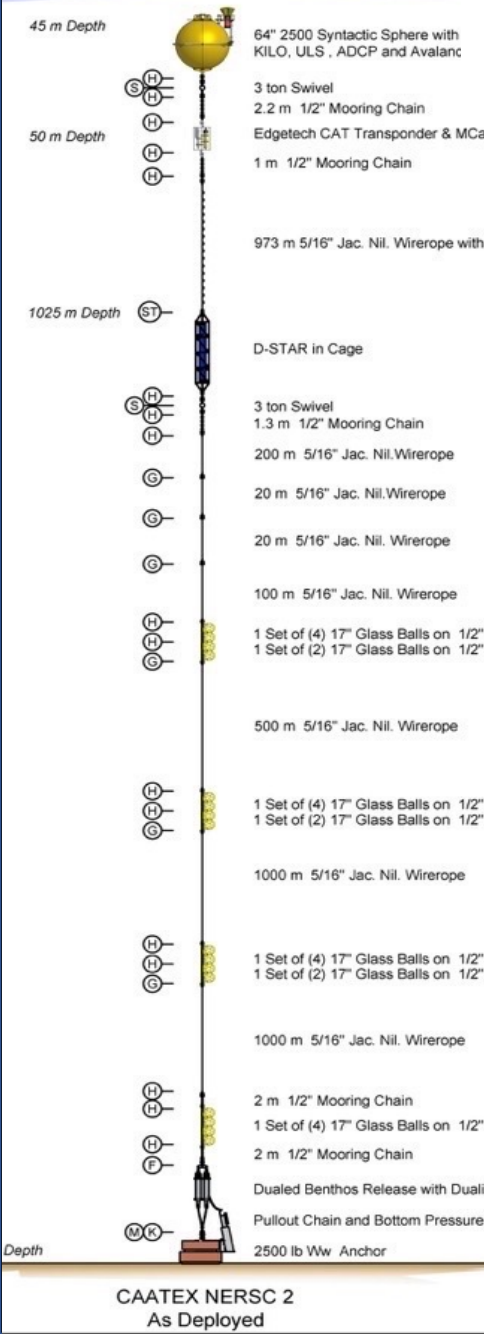
How well does the ocean climate models (e.g., CMIP6) represent the ocean under the sea ice?



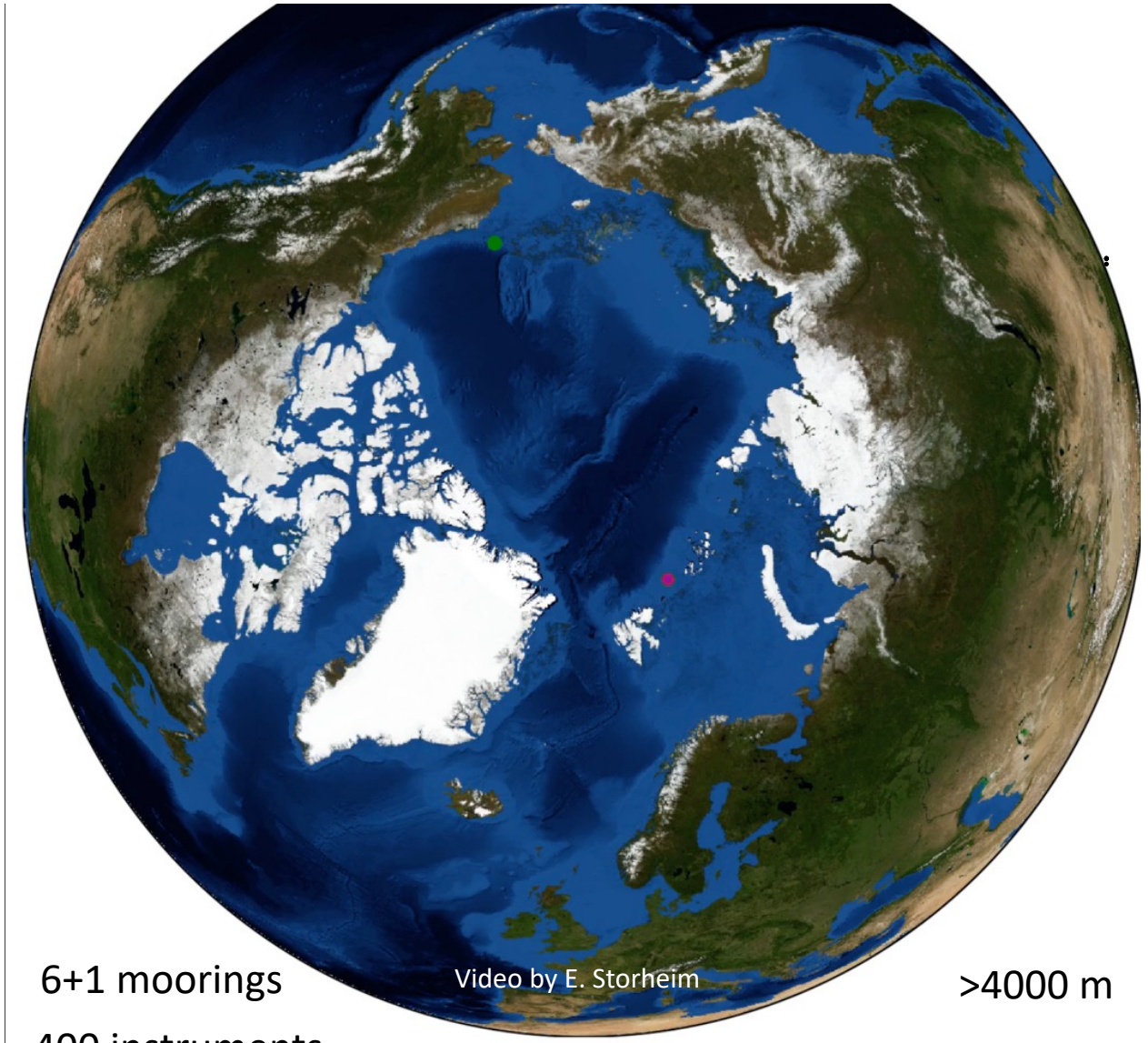
NERSC

Coordinated Arctic Acoustic Transmission Experiment - CAATEX (2018-2022)

4 Receiver moorings



CAATEX NERSC 2
As Deployed



6+1 moorings

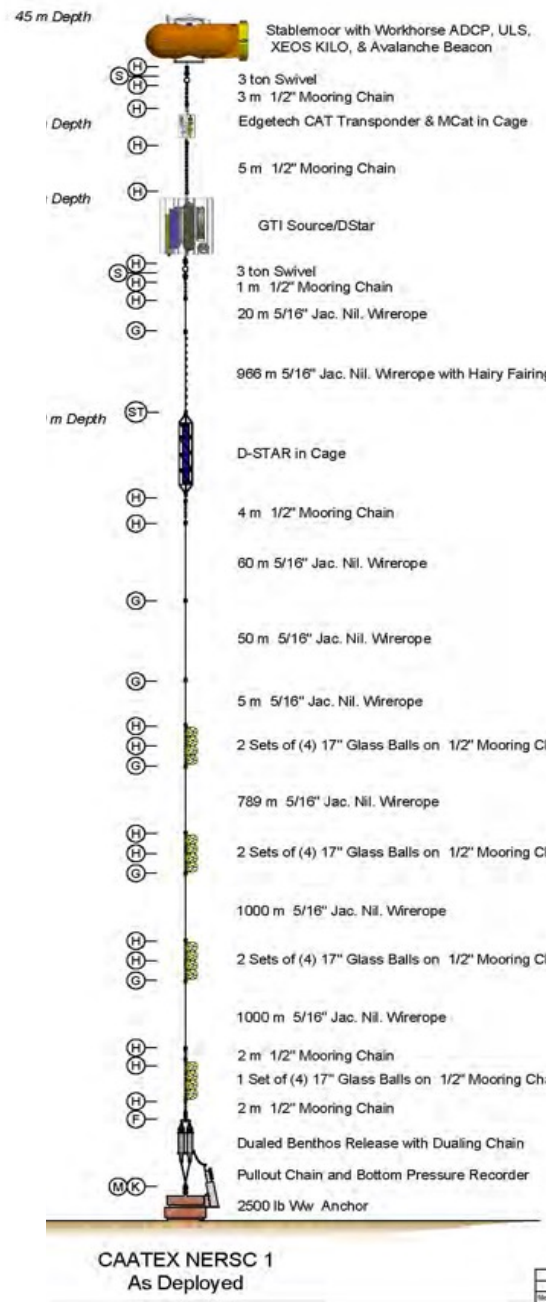
400 instruments

Video by E. Storheim

>4000 m

1 year deployment

2 Source/receiver mooring



CAATEX NERSC 1
As Deployed

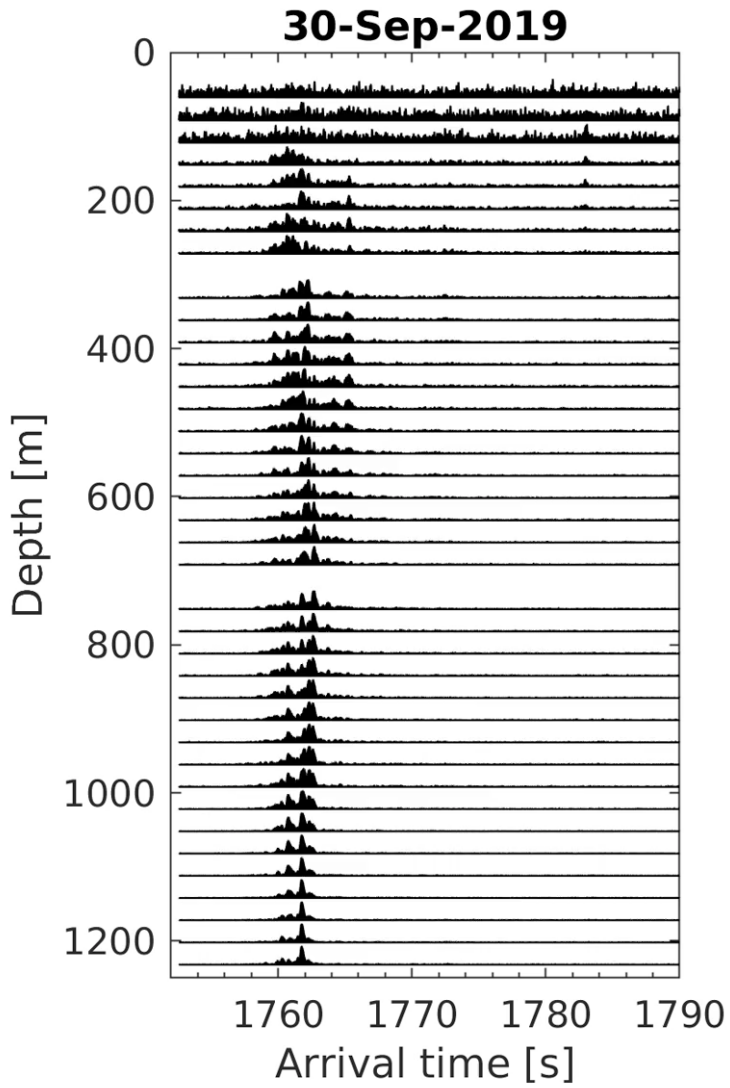
Mooring recovery in the Beaufort Sea

CAATEX
Coordinated Arctic Acoustic Thermometry Experiment

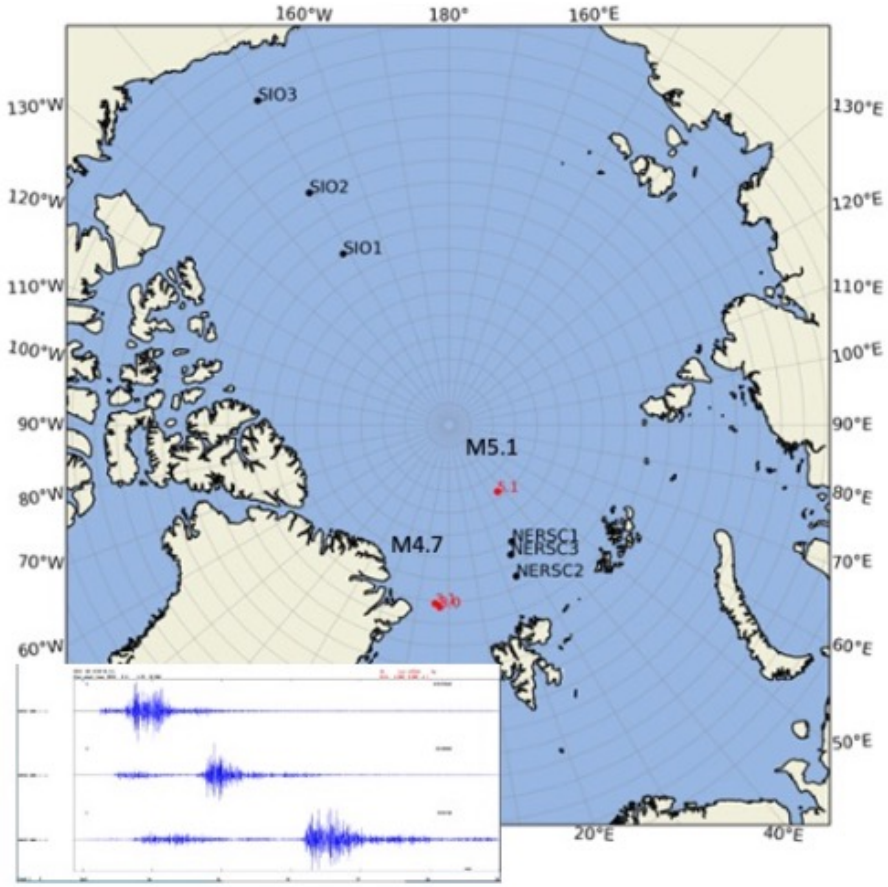
Roy Arne Salater,
TV 2 news 25 November 2020

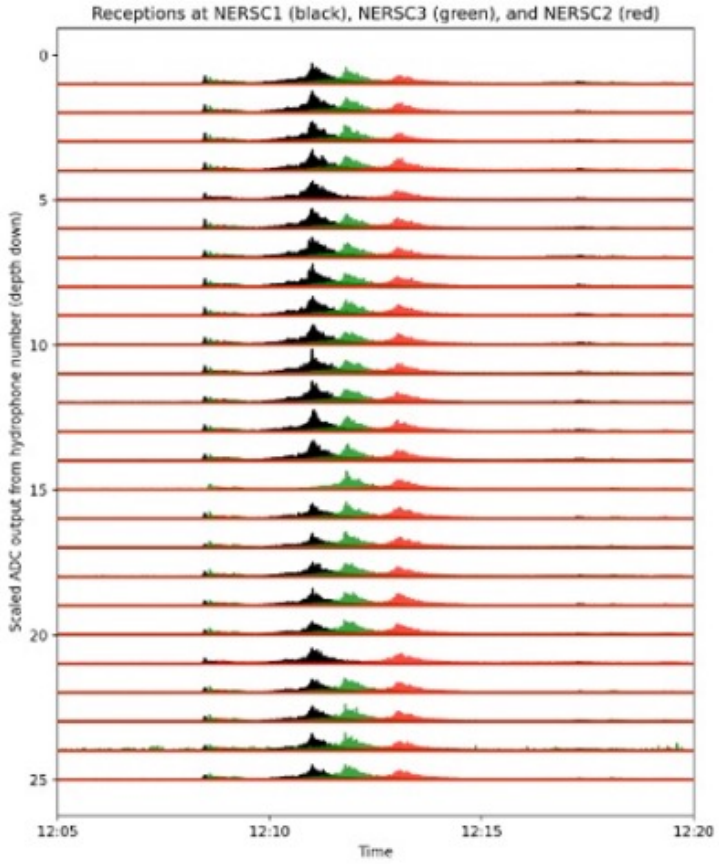
Acoustic data from CAATEX

Acoustic travel times at 2600 km



Earthquake received on all CAATEX moorings



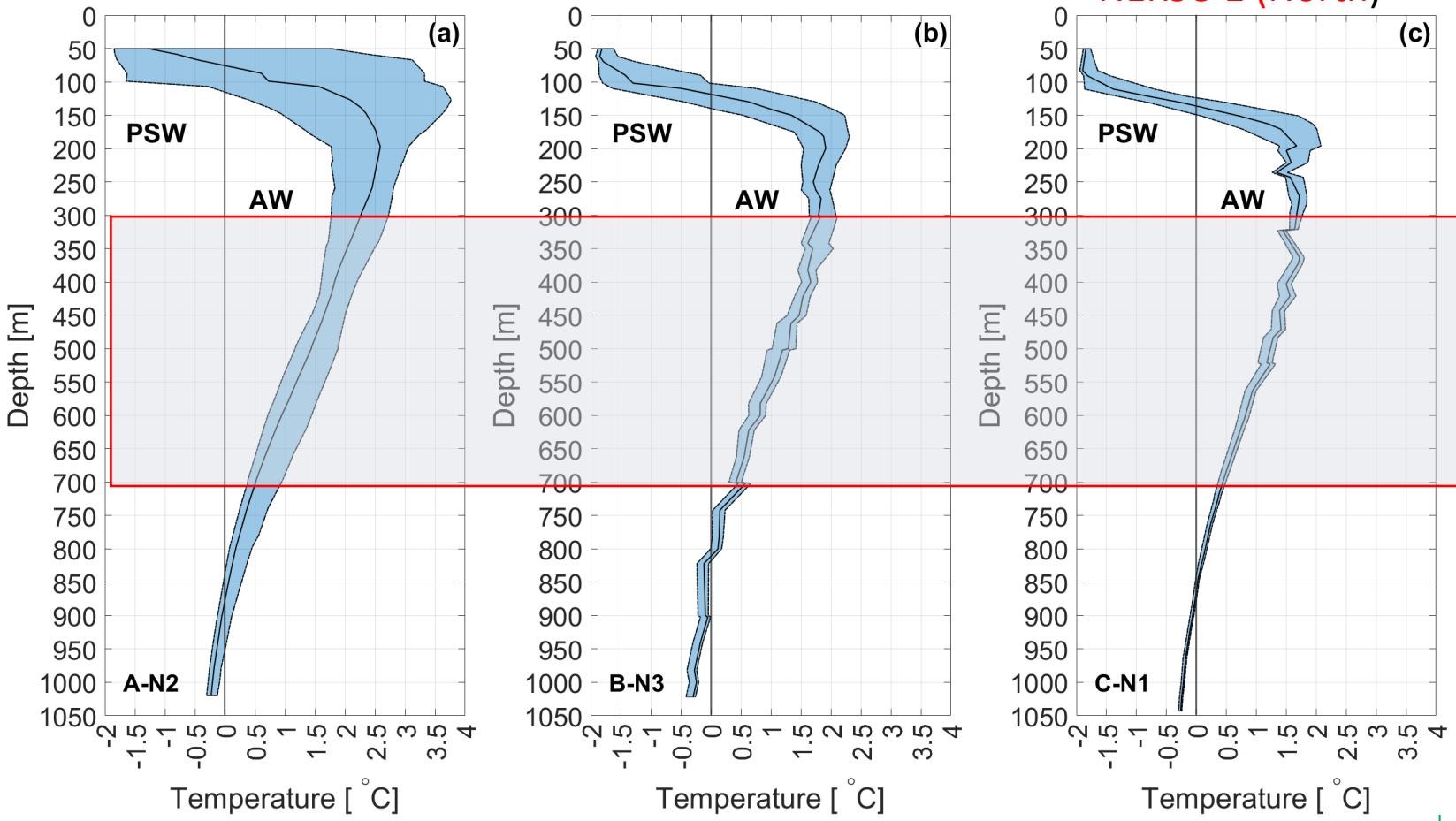


CAATEX
Coordinated Arctic Acoustic Thermometry Experiment

NERSC

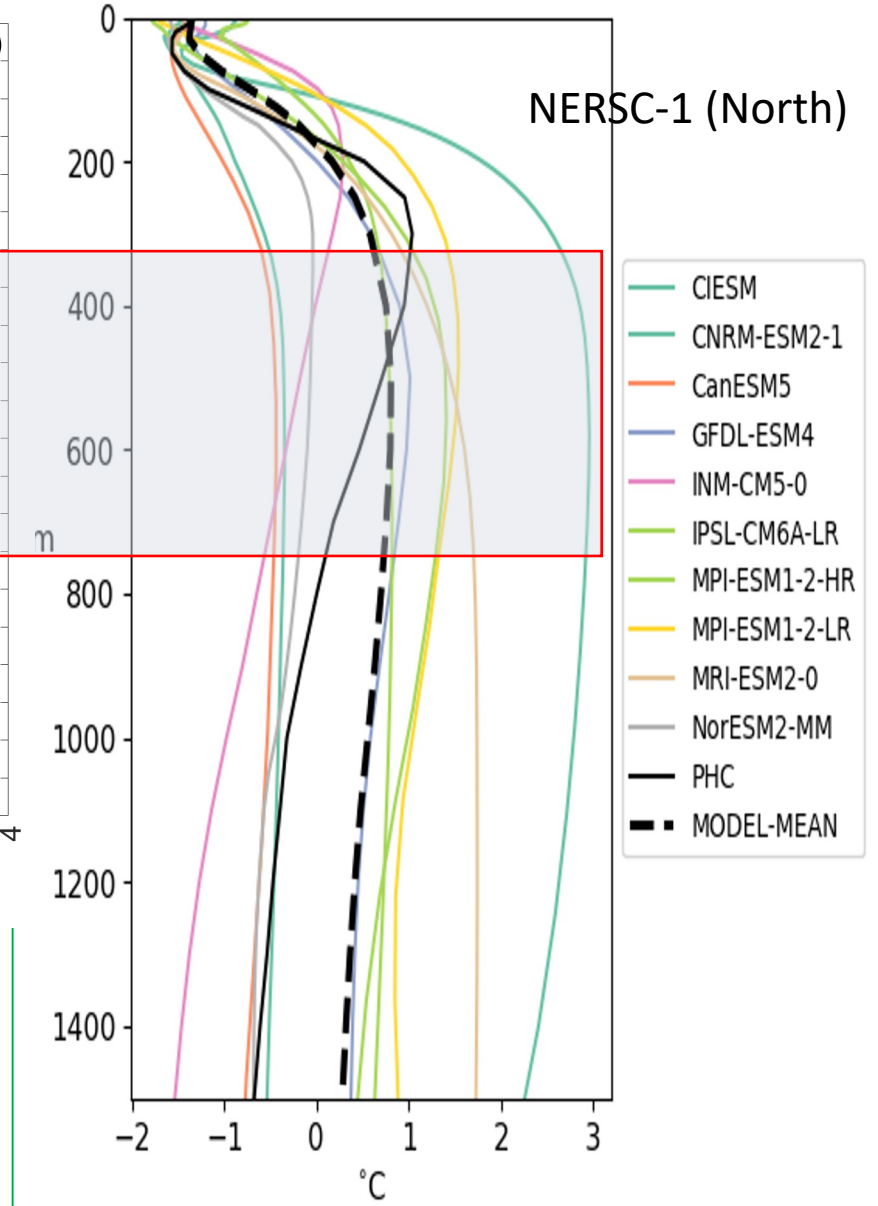
Ocean temperature profiles from moorings and climate models

NERSC-2 (South)



NERSC-1 (North)

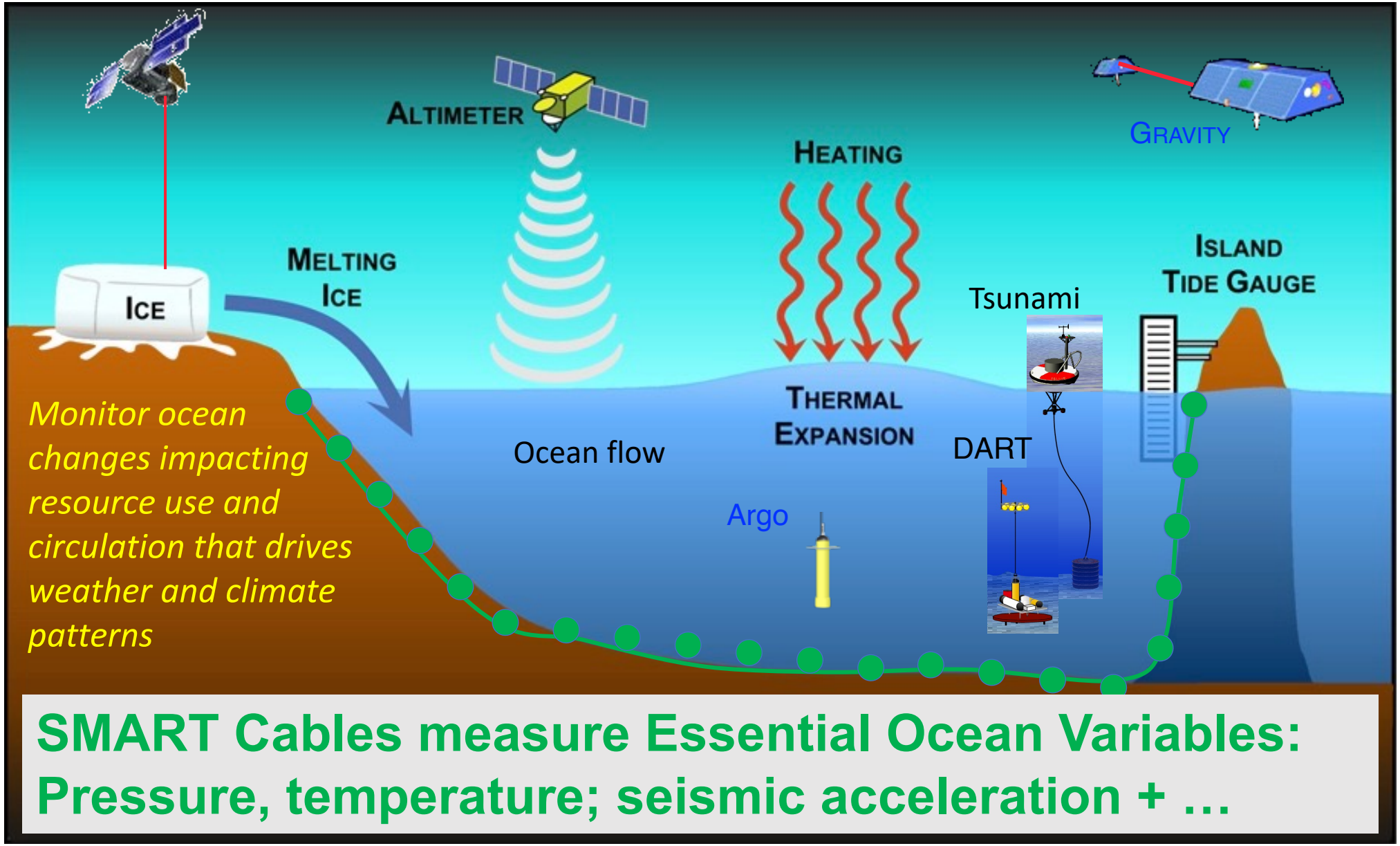
Long-term mean temperature



CAATEX

Coordinated Arctic Acoustic Thermometry Experiment

Ocean Observing Tools



SMART Cables measure Essential Ocean Variables: Pressure, temperature; seismic acceleration + …

Now:
Very *few bottom obs*

Future:
Add SMART Cables Augment and complement present

Howe et al., 2022, Front. Earth Sci. 9:775544. doi: 10.3389/feart.2021.775544

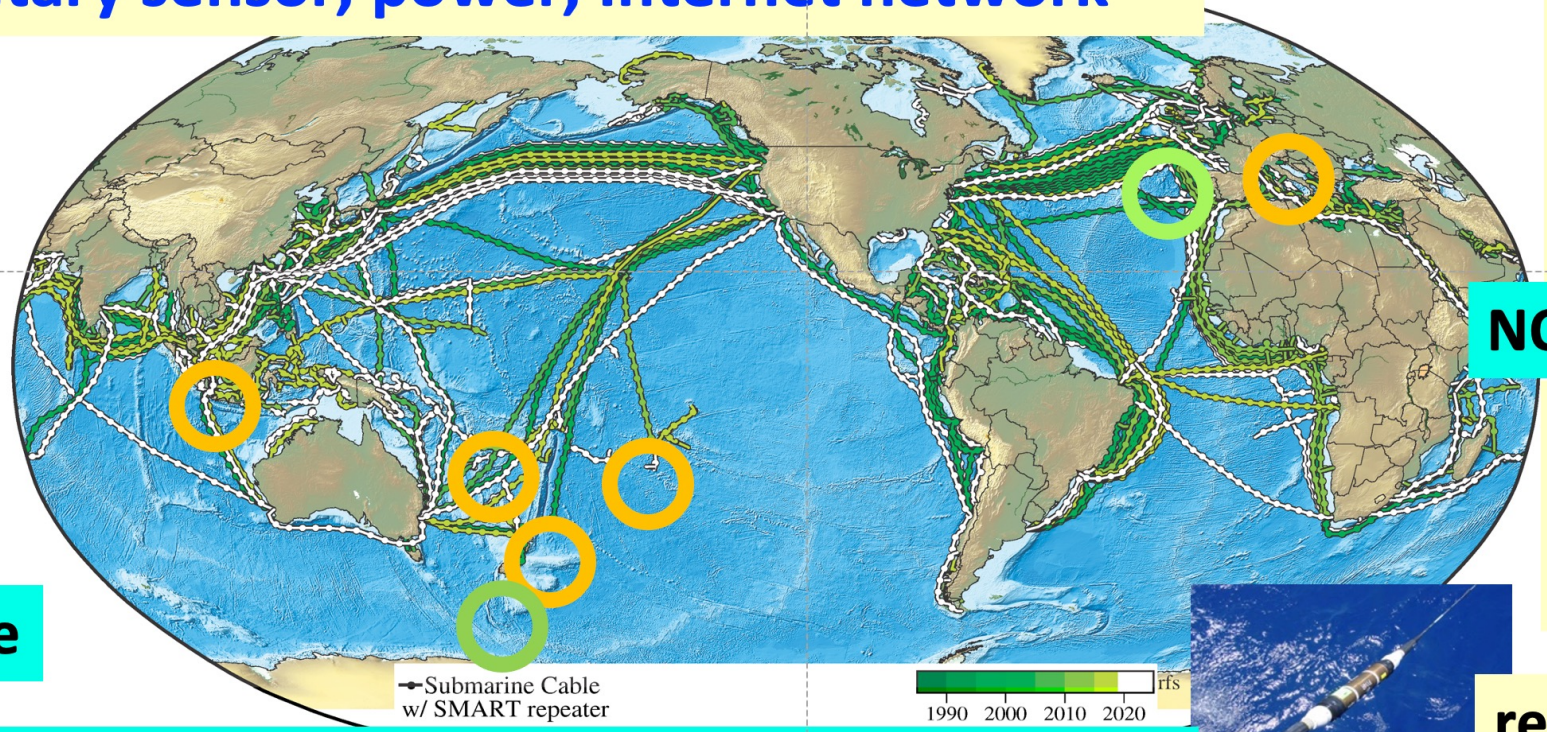
Adapted from Nerem, 2016

SMART Subsea Cables

Global Array: Climate, Oceans, Sea Level, Earthquakes, Tsunamis

Create a Planetary sensor, power, Internet network

1st order addition to Ocean-Earth observing system



Share submarine cable infrastructure
Telecom + science
€ $

NO Interference

1.2+ Gm
~20,000 repeaters
20 year refresh

UN Decade

repeaters ~70 km

Know the environment – protect the network

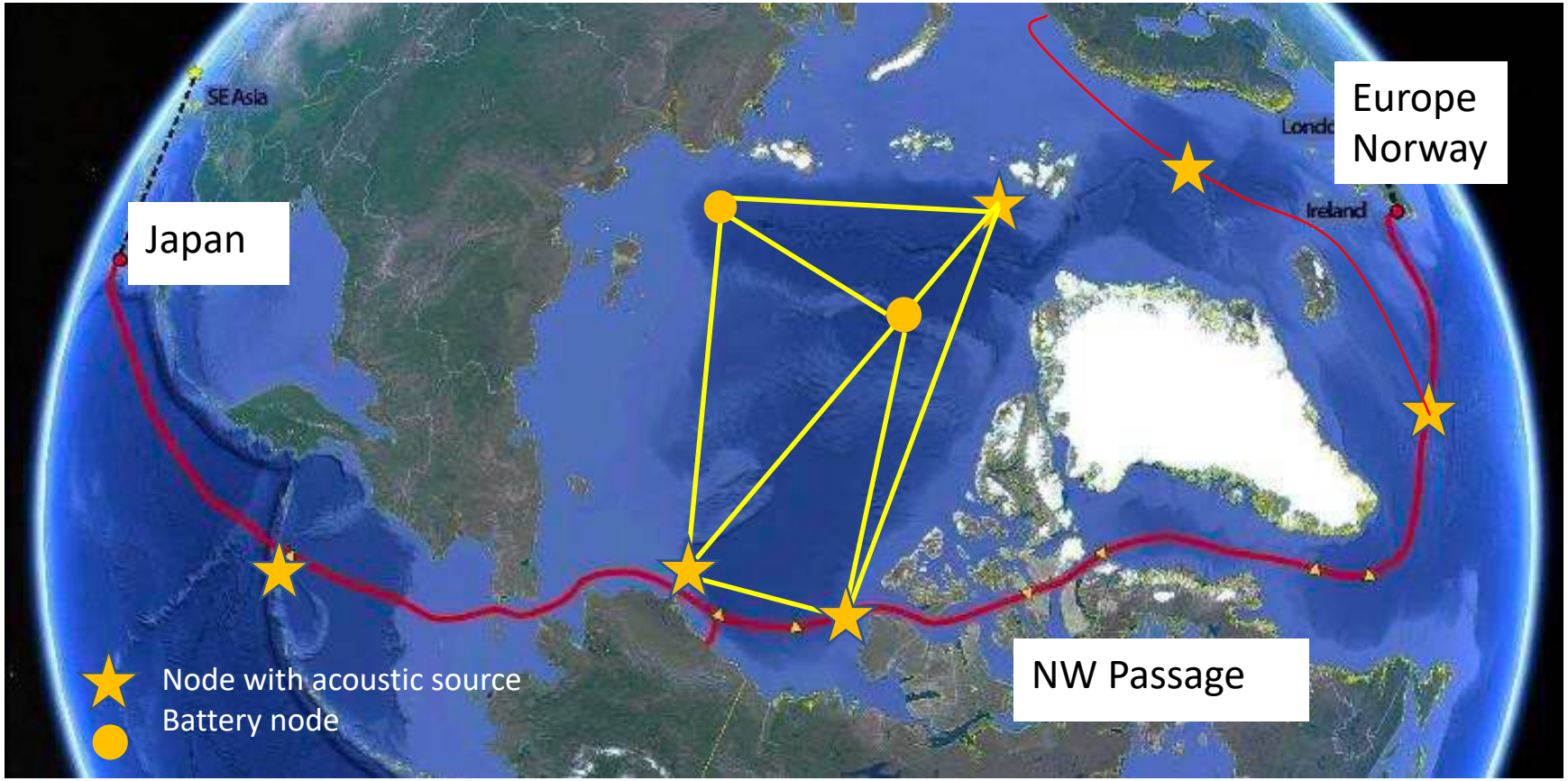
CAM: 3700 km, Gov't, install 2024 → SMART Continent/Lisbon-Azores-Madeira ring

Bottom pressure, temp seismic acceleration

Howe et al., 2022, Front. Earth Sci. 9:775544. doi: 10.3389/feart.2021.775544

Phase 1 - Arctic Express – SMART +

- Bottom water temperature, pressure, seismic acceleration entire length (SMART base)
- Add Hydrophones in SMART the entire length – marine mammals, geophysics, acoustic thermometry
- Add nodes/acoustic sources (and VLAs and AUVs) –
  - Norway, Svalbard
  - Mid Atlantic Ridge
  - N Alaska
  - Shemya
- Atlantic Meridional Overturning Circulation, thermometry – N Atlantic
- Tsunami, earthquakes, thermometry, western Pacific
- Trans Arctic - climate



https://www.rcinet.ca/eye-on-the-arctic/2021/12/22/arctic-internet-fiber-asia-europe/

SMART – 10-15% incremental cost over telecom

Nodes – compare with DONET, ONC, OOI cabled arrays

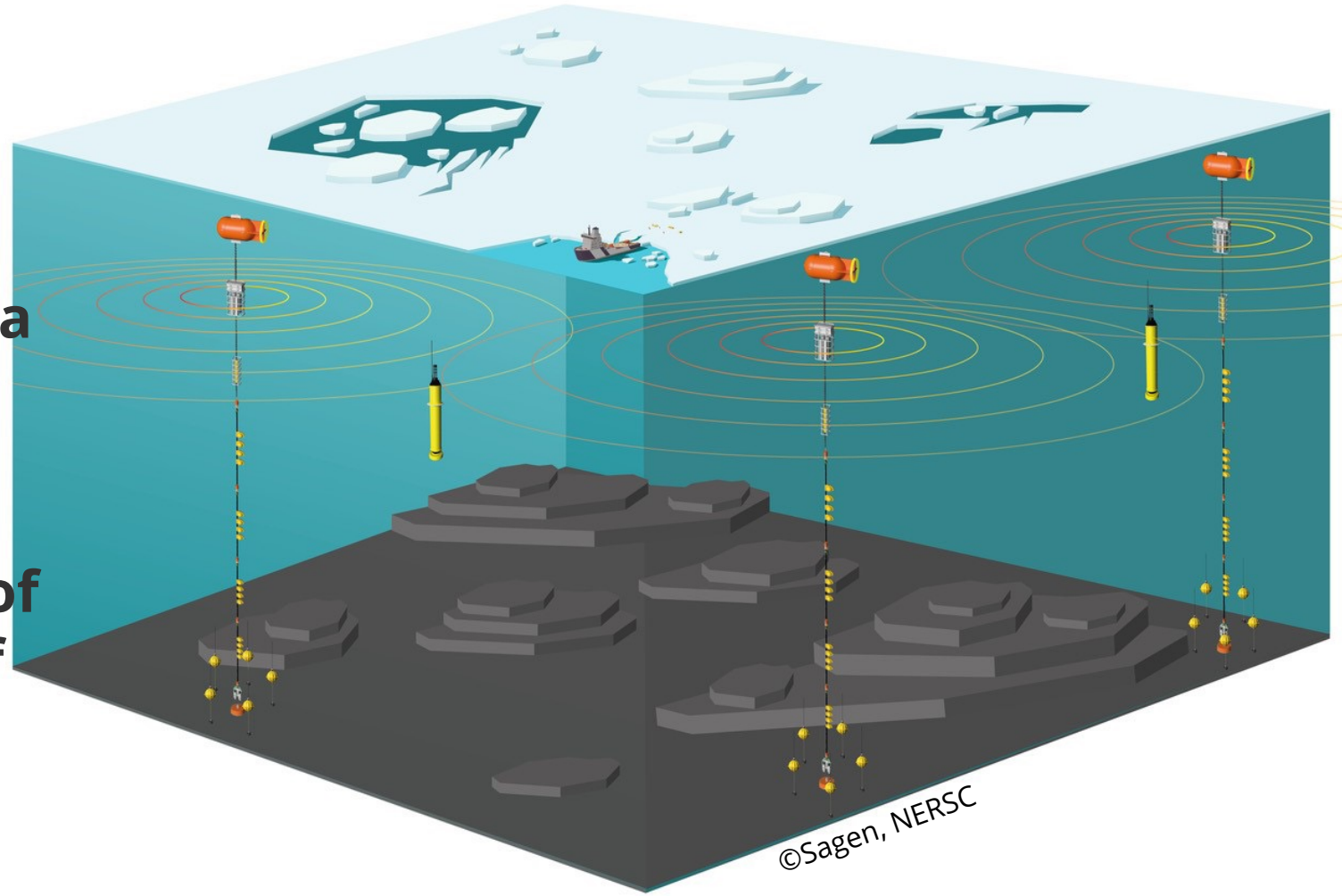
HiAOOS

HIGH ARCRTIC OCEAN OBSERVING SYSTEM

Horizon Europe project 2023-2027

Coordinator: Hanne Sagen, Nansen Environmental and Remote Sensing Center

The **network of multipurpose moorings** will provide **point measurements of ocean and sea ice and active and passive acoustic data** for several applications, including **acoustic thermometry, geo-positioning of underwater floats, detection of marine mammals, geohazards and human generate noise.**



HiAOOS

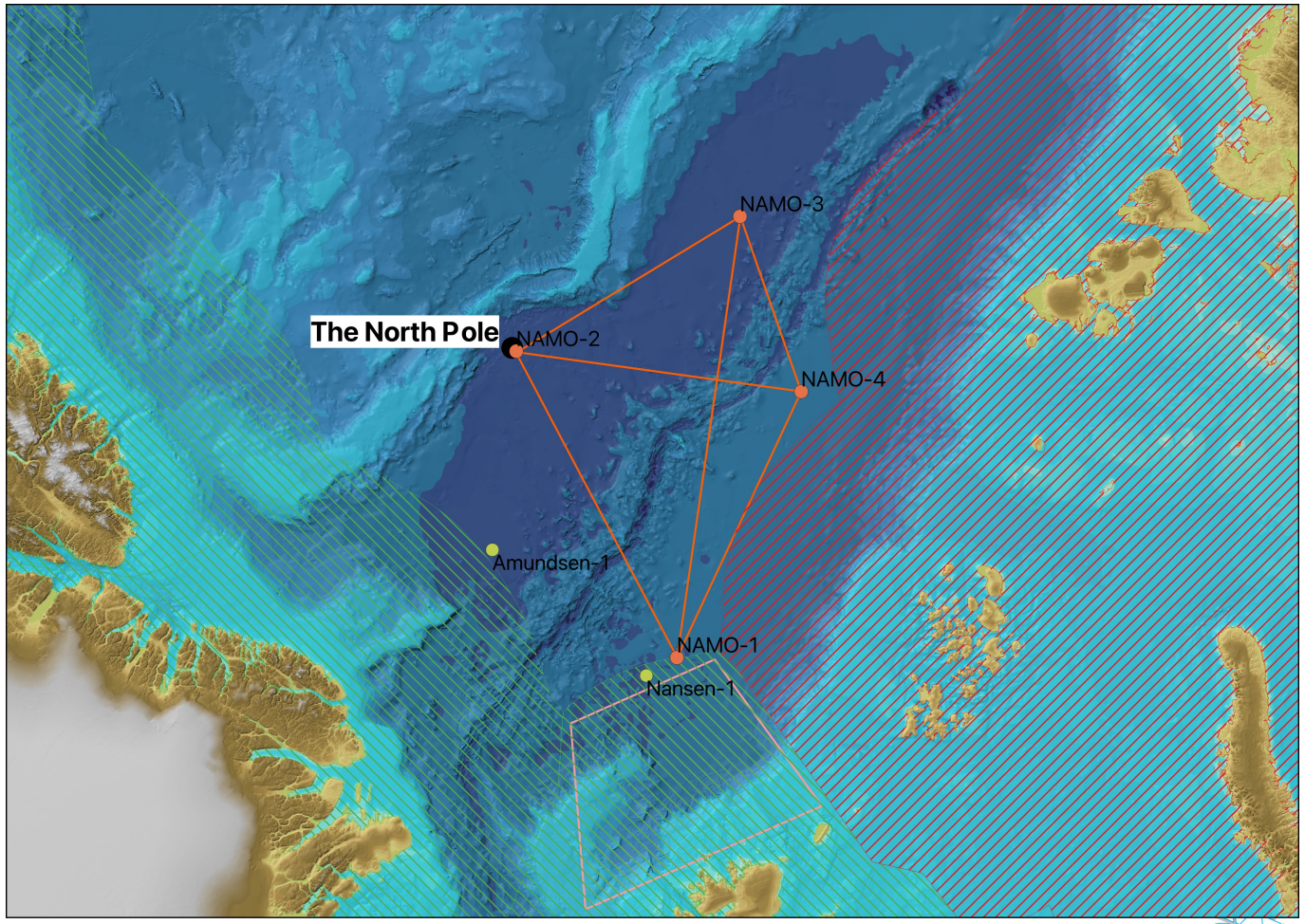
EXPERIMENT | AREA & SCHEDULE

2023 Pre-investigation and testing of equipment.

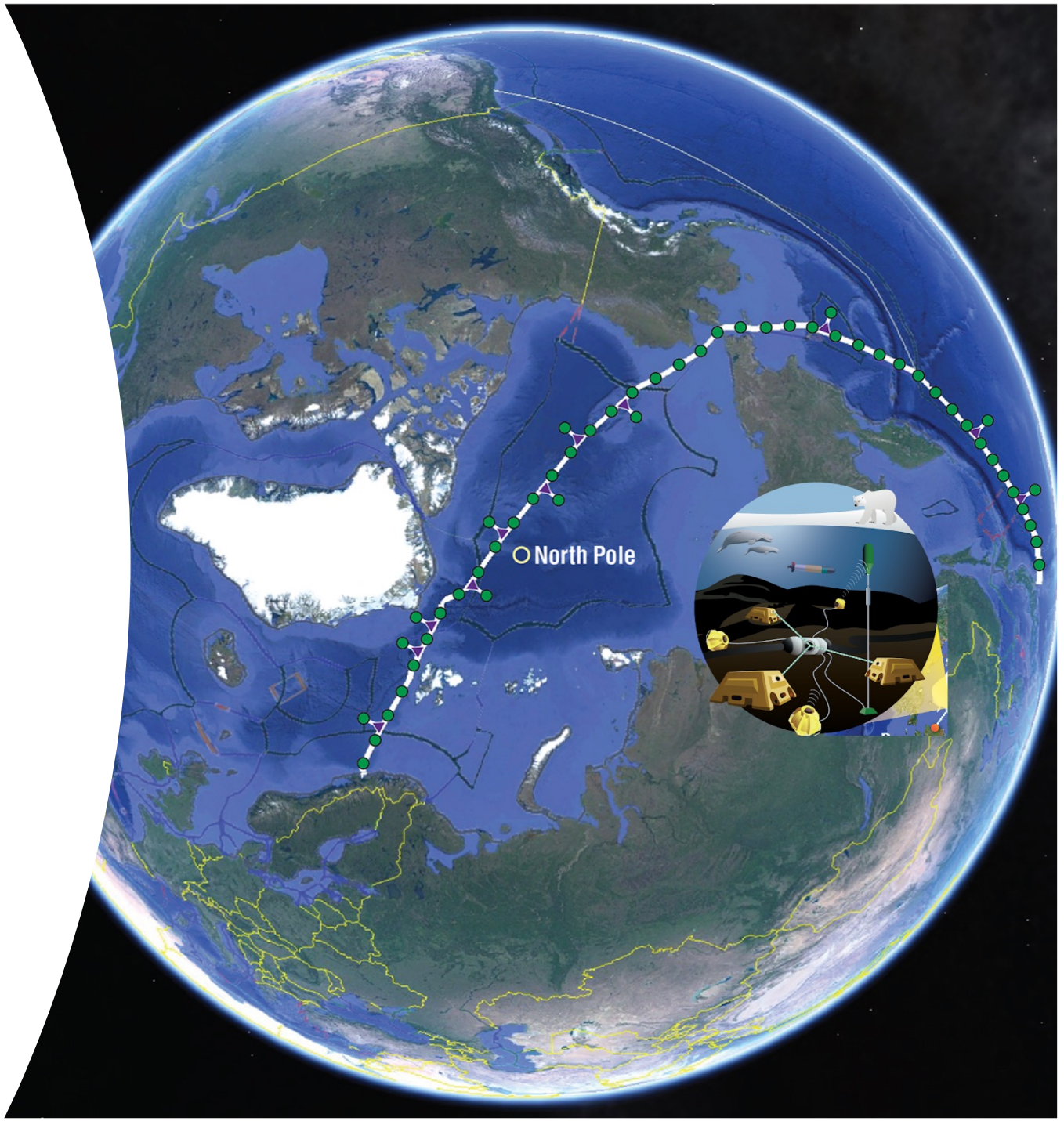
2024 Deployment of mooring network in the Nansen and Amundsen Basin. Testing of new tech near Bergen.

2025 Deployment of regional network North of Svalbard with new mooring technology. Testing of acoustic receiver buoys drifting with the ice.

2026 Full recovery of the mooring systems.



The HiAOOS mooring network NAMO 1- 4, and test area for new generation of moorings.



The AOOS vision

Trans Arctic Smart Cables combined with UW-GPS will form a backbone of the Arctic Ocean Observing System (AOOS).

The AOOS needs to leverage from strong research and world leading subsea/offshore/communication technology

NERSC

Building sustained - robust Arctic ocean observing “system of systems”

(1) Build on broad national and international collaboration and coordination in the pan-Arctic region (Organization)

(2) Robust observing platforms and sensors, facilitate for sustained year-round operation (Resource: adapt world leading technology from subsea and offshore industry)

(3) Operationalize the data delivery chain building on distributed and interoperable databases (Resource: Involve IT industry, and telecommunication)

(4) Sustainability of the ocean observing systems, and funding mechanisms (resource: learn from the space programs)