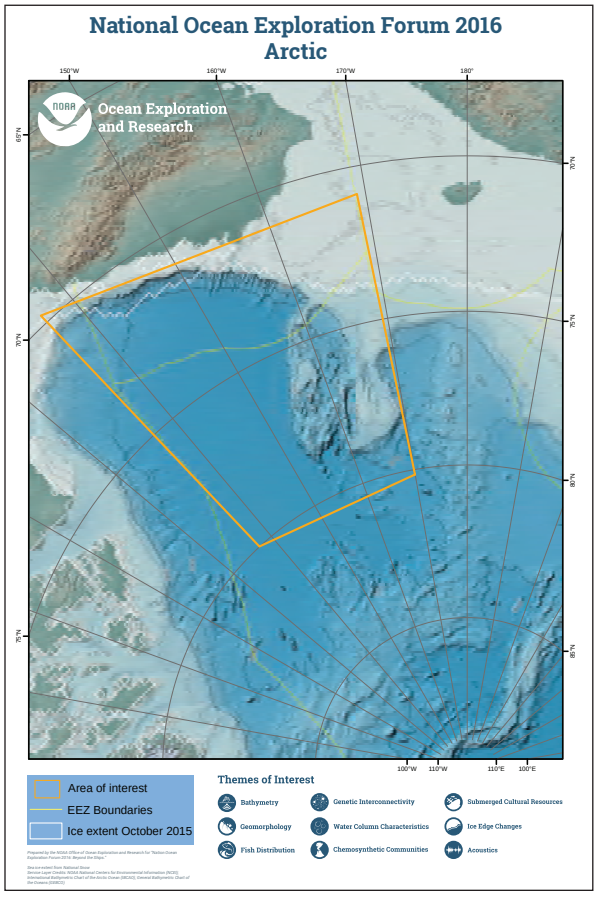
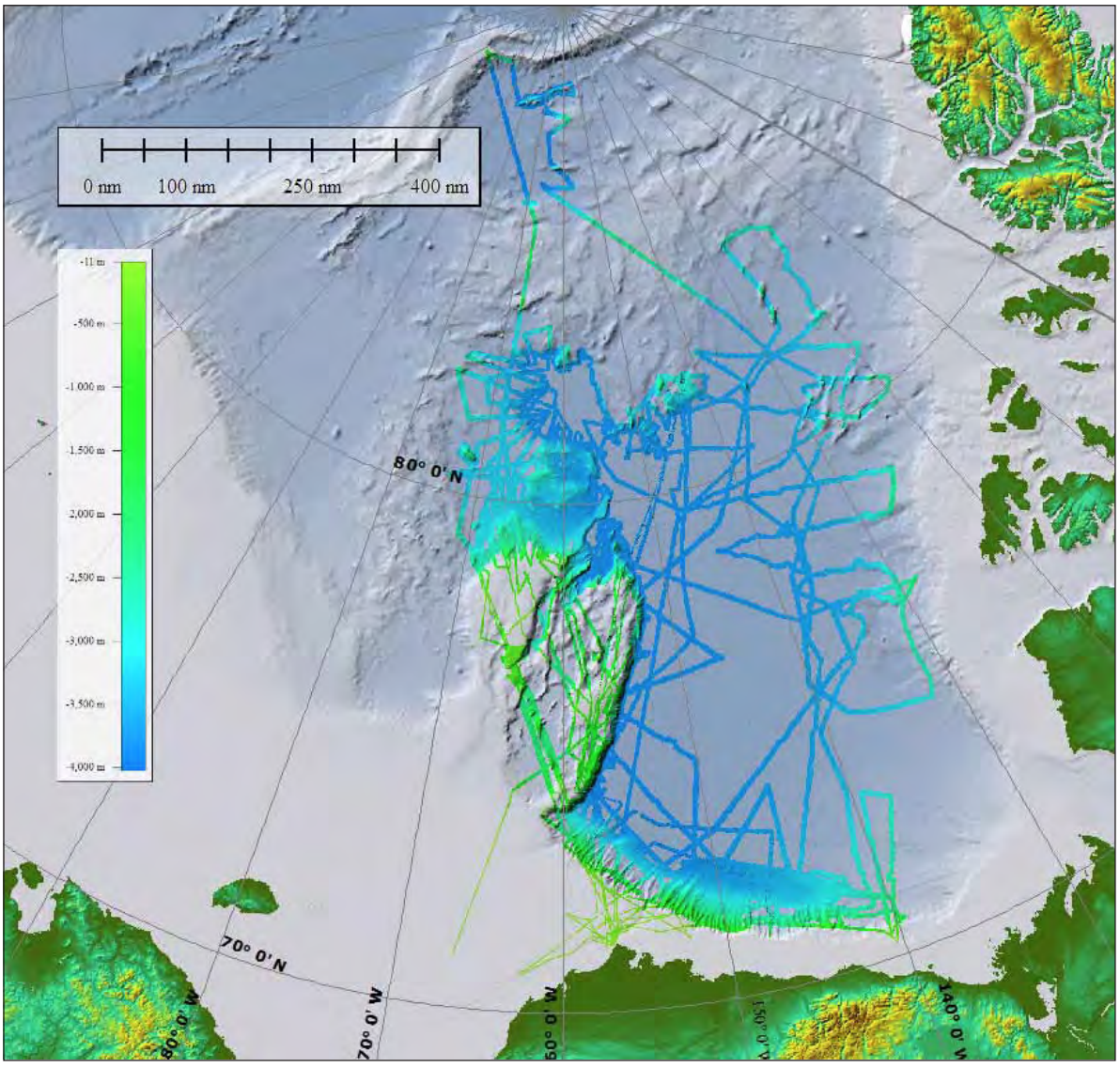
U.S. Arctic Campaign Scenario

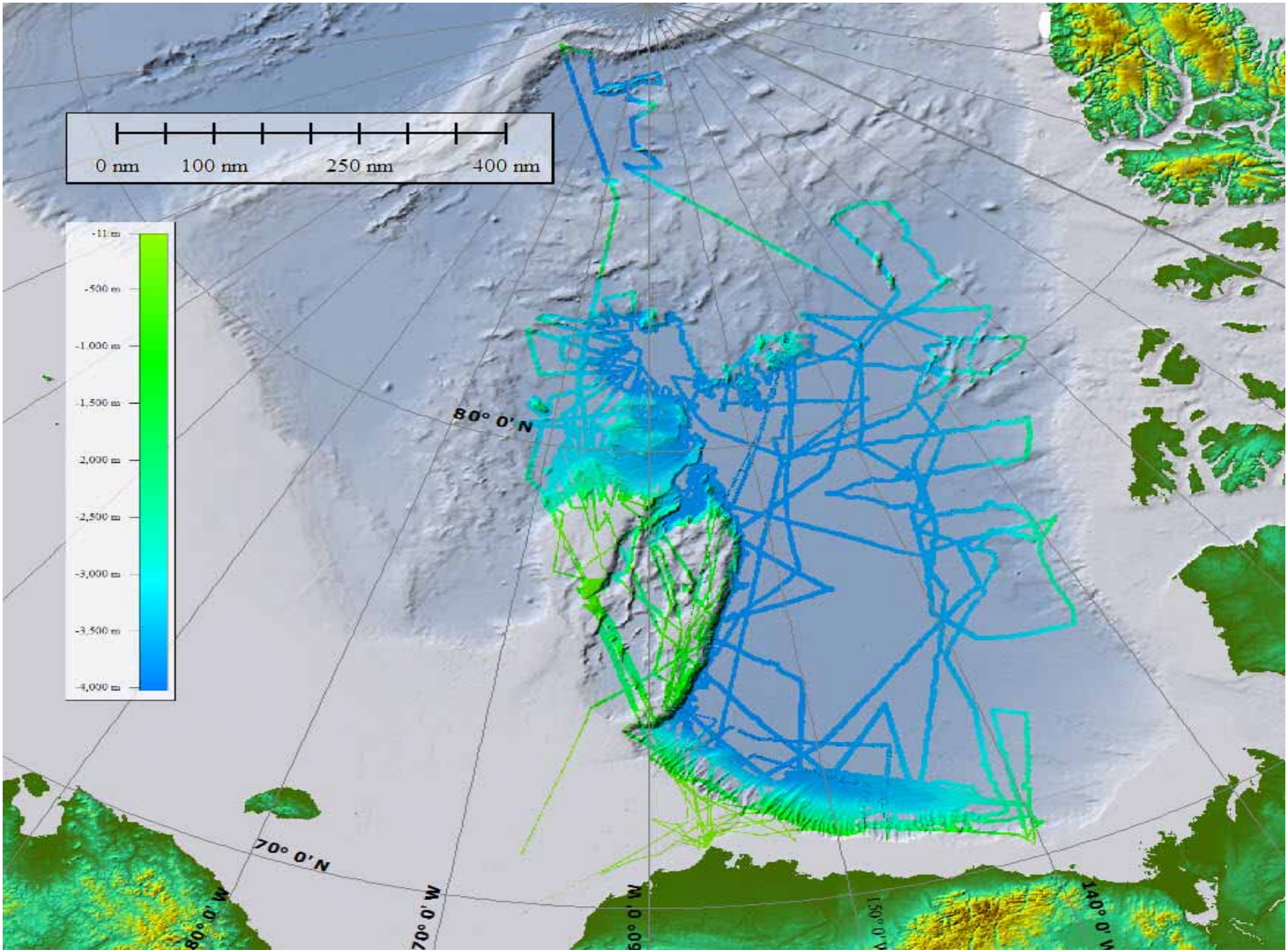
INTRODUCTION: Two independent Breakout Groups met in two sessions to consider emerging technologies to enable ocean exploration campaigns that may occur in the U.S. Arctic in the next decade. A map of the notional campaign scenario area is presented below. Drs. Larry Mayer (University of New Hampshire) and Frank Herr (Office of Naval Research) led one of the groups while Drs. James Thomson (Applied Physics Laboratory, University of Washington) and Jeremy Mathis (NOAA Arctic Programs) led the other. Other forum participants moved among the several Breakout Groups during the course of their discussions. Lists of participants and their provi-sional group assignments made at registration are available (click here for Breakout Rosters). PowerPoint slides delivered by each Breakout Group follow.



Arctic Breakout Group
led by

Dr. Larry Mayer (University of New Hampshire) and
Dr. Frank Herr (Office of Naval Research)



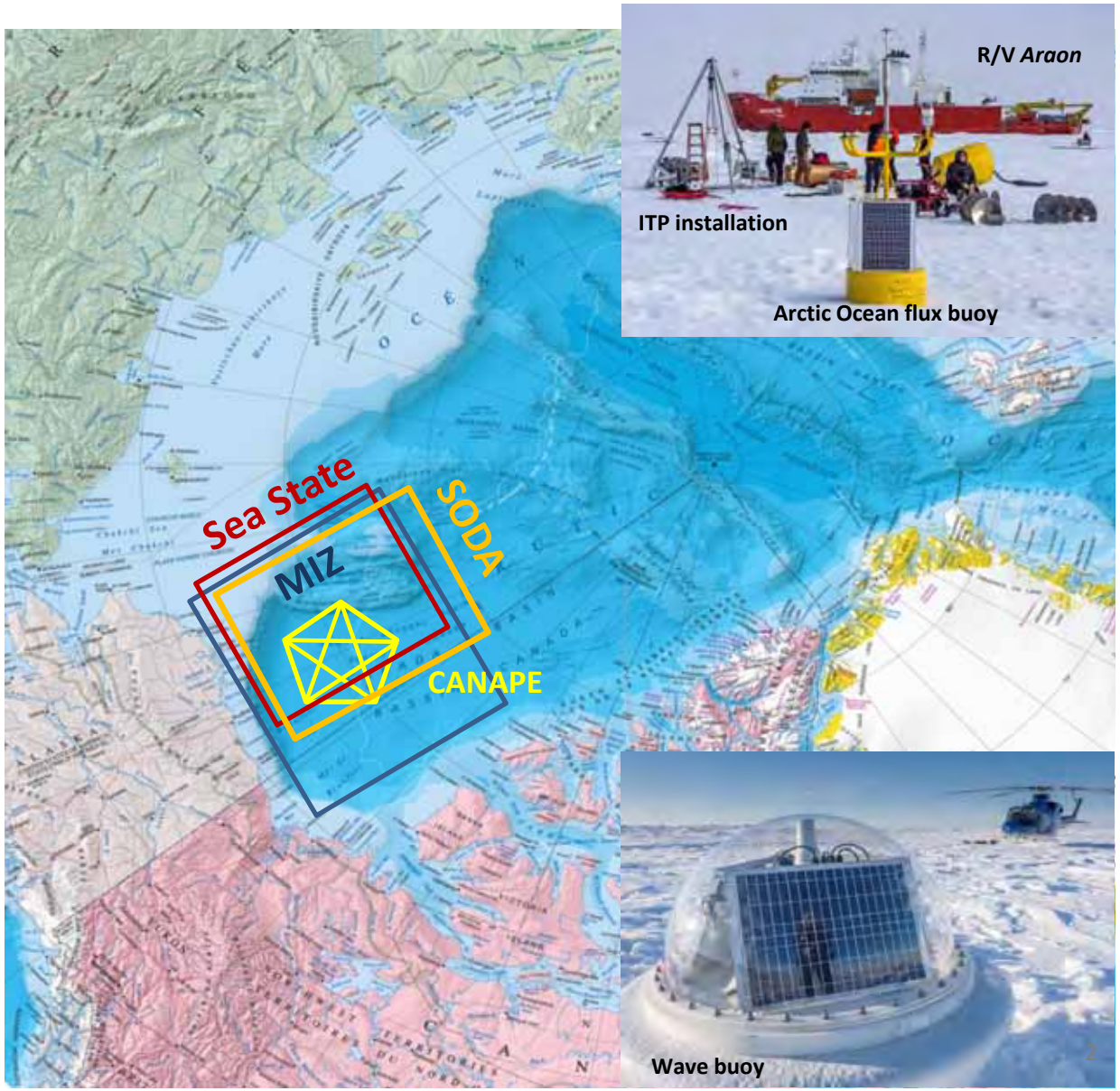

0 nm
100 nm
250 nm
400 nm
-11 m
-500 m
-1,000 m
-1,500 m
-2,000 m
-2,500 m
-3,000 m
-3,500 m
-4,000 m
80° 0' N
70° 0' N
70° 0' W
150° 0' W
140° 0' W

ONR S&T Initiatives in the Arctic

(2012-2020)

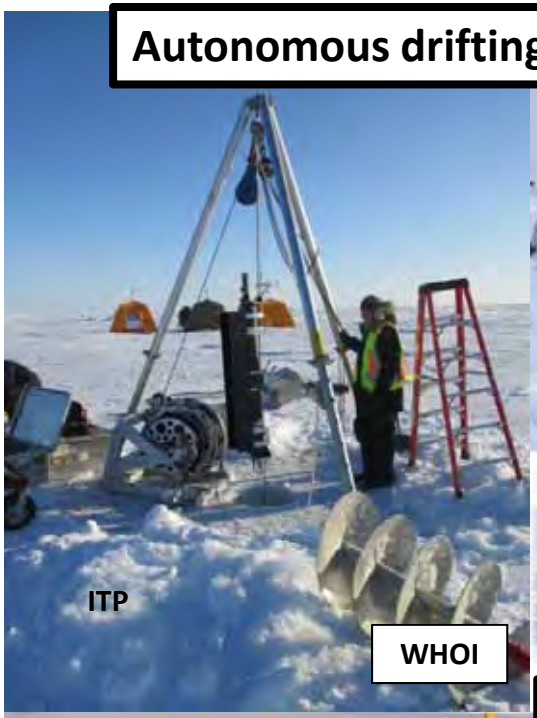
- **Arctic & Global Prediction Program**
- **Ocean Acoustics Program**

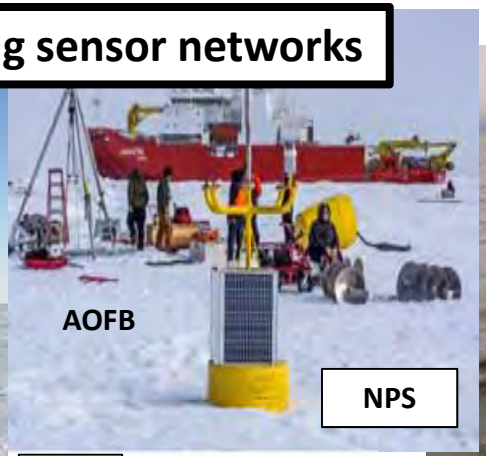
- **Marginal Ice Zone (MIZ) DRI *(2012-2016)***
  2014 Field Program
- **Sea State & Boundary Layer Physics DRI *(2013-2017)***
  2015 Field Program
- **Canada Basin Acoustic Propagation Experiment (CANAPE) *(2015-2017)***
  2015, 2016-2017 Field Programs
- **Stratified Ocean Dynamics in the Arctic (SODA) *(2016-2020)***
  2017-2019 Field Programs
- **Arctic Mobile Observing System (AMOS) *(2017-2021)***
  2018-2020 Field Programs

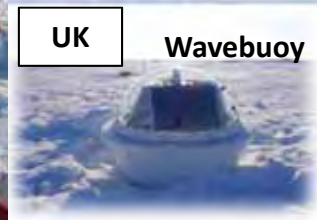


ONR Arctic Experimentation

Autonomous drifting sensor networks

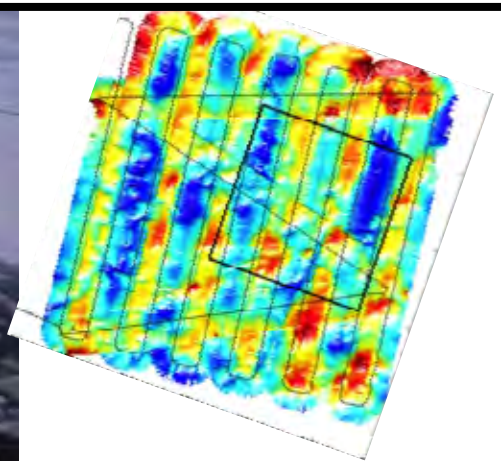


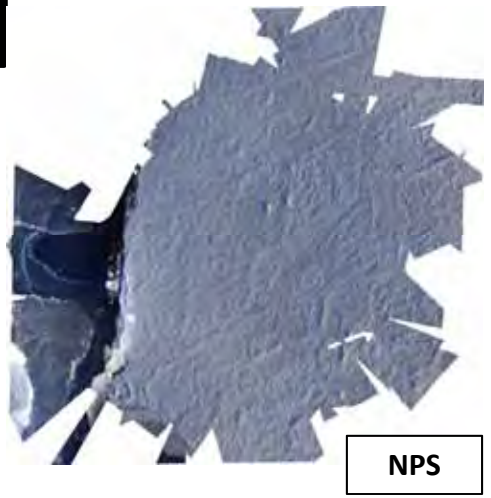




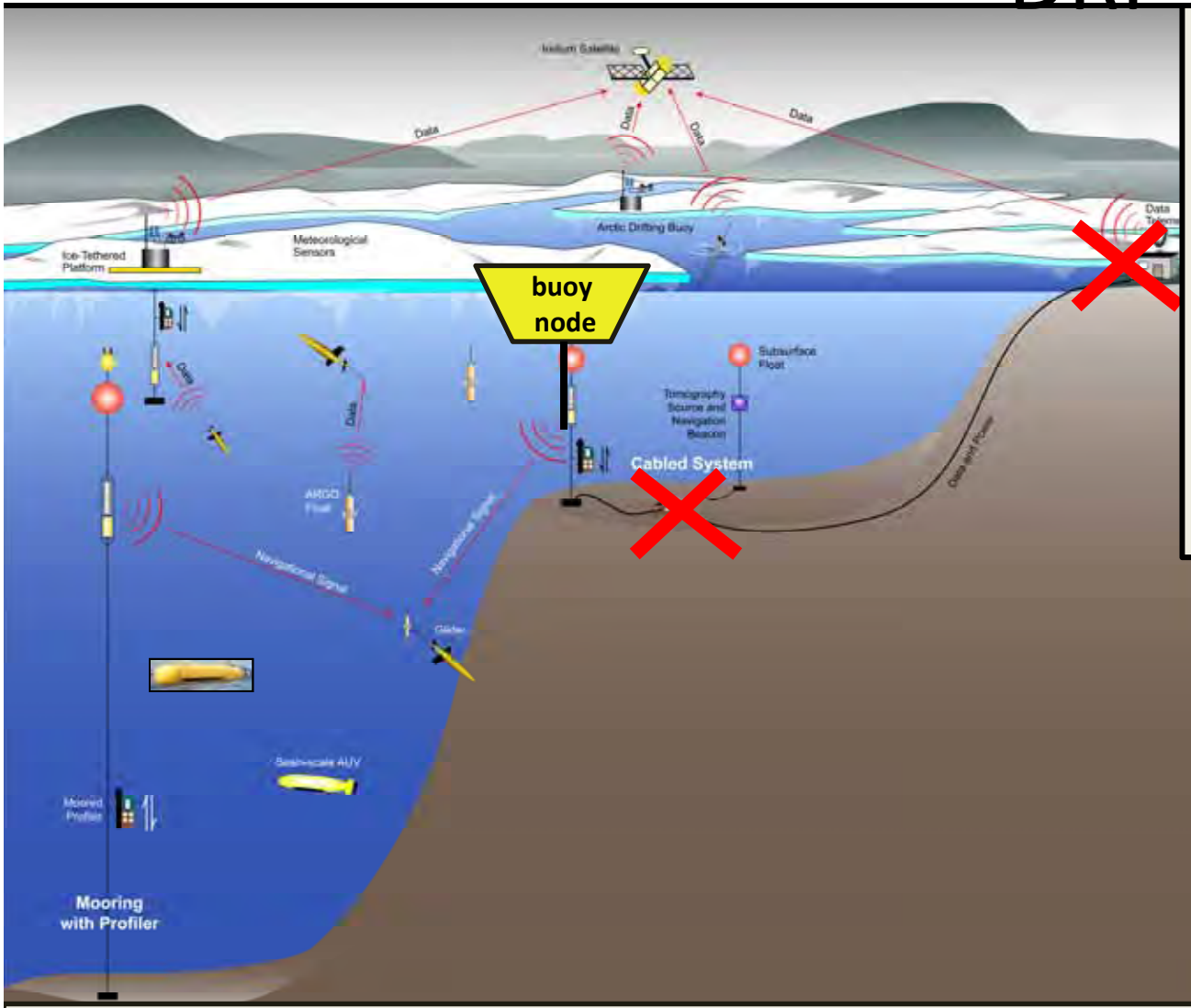
Under-ice acoustic navigation

UUV/ROV/UAS mapping and other sensing





Arctic Mobile Observing System DRI



Enable a mobile maritime observing system that can be deployed anywhere in the Arctic using floating or ice-tethered buoy nodes that will provide persistent observational capabilities with sustained power and communications, and without the need for a cabled system.

A variety of mobile unmanned autonomous platforms operating from each node will provide an extensive footprint of oceanographic and cryospheric observing capability

Arctic Breakout Group
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Duration is Exploration™

NOEF Arctic B

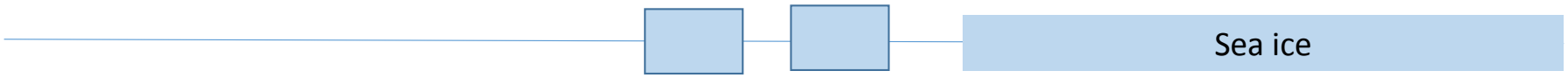
Persistent autonomous observations of the changing Arctic

- Why
  - DOD /security
  - Rapid change… exploring unknown in time
  - Mid-latitude weather connections
  - Commercial interests (e.g., minerals, fisheries, oil and gas, shipping routes)
- What
  - Constrain spatial & temporal sampling… monitoring vs exploring?
  - Identify physical, biogeochemical (bio is most exploratory) provinces
  - Exploring feedback loops (processes driving change)
- Where
  - Whole arctic? Big challenge
  - Beaufort & Chukchi seas (trapezoid)
  - Need a focus region(s) or province(s)

Persistent autonomous observations of the changing Arctic

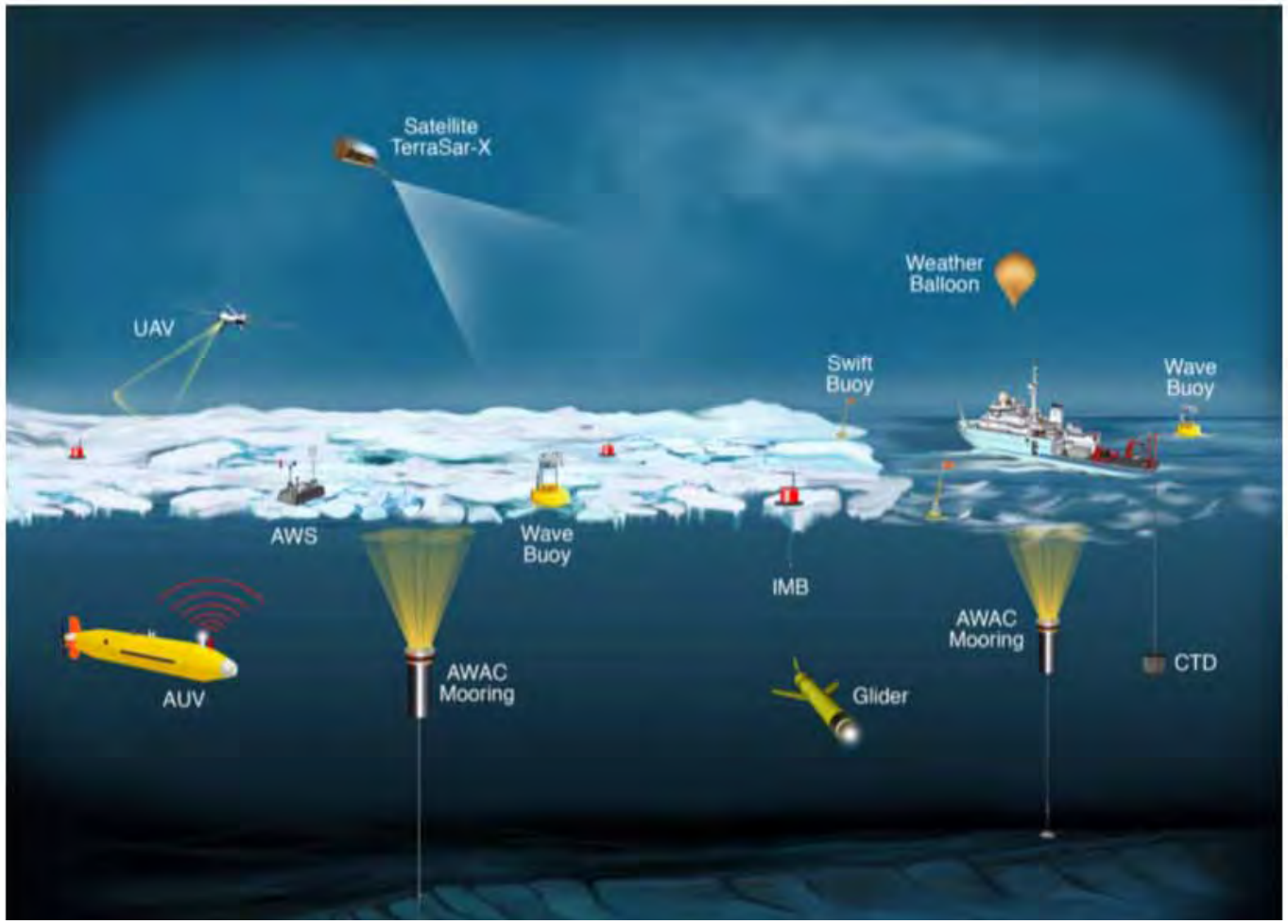
- How (smarter autonomous assets for longer)
  - Float swarms (phased): ARGO for Arctic, acoustic tracking/coms, winter dormant mode
  - AUVs: longer missions (energy sources), smarter navigation (acoustic under-ice array… infrastructure)
  - ASVs: longer missions, adaptive sampling (e.g., ice-edge tracking)
    - Hybrid, AI + pilots,
  - UAV: mapping
  - Animal tagging (as sensor platform)
- Data types
  - Low res: water sampling
  - High res: video and sonar (selective sampling)
    - Bioacoustics, short range for highest res

Ice edge campaign… move with province(s)

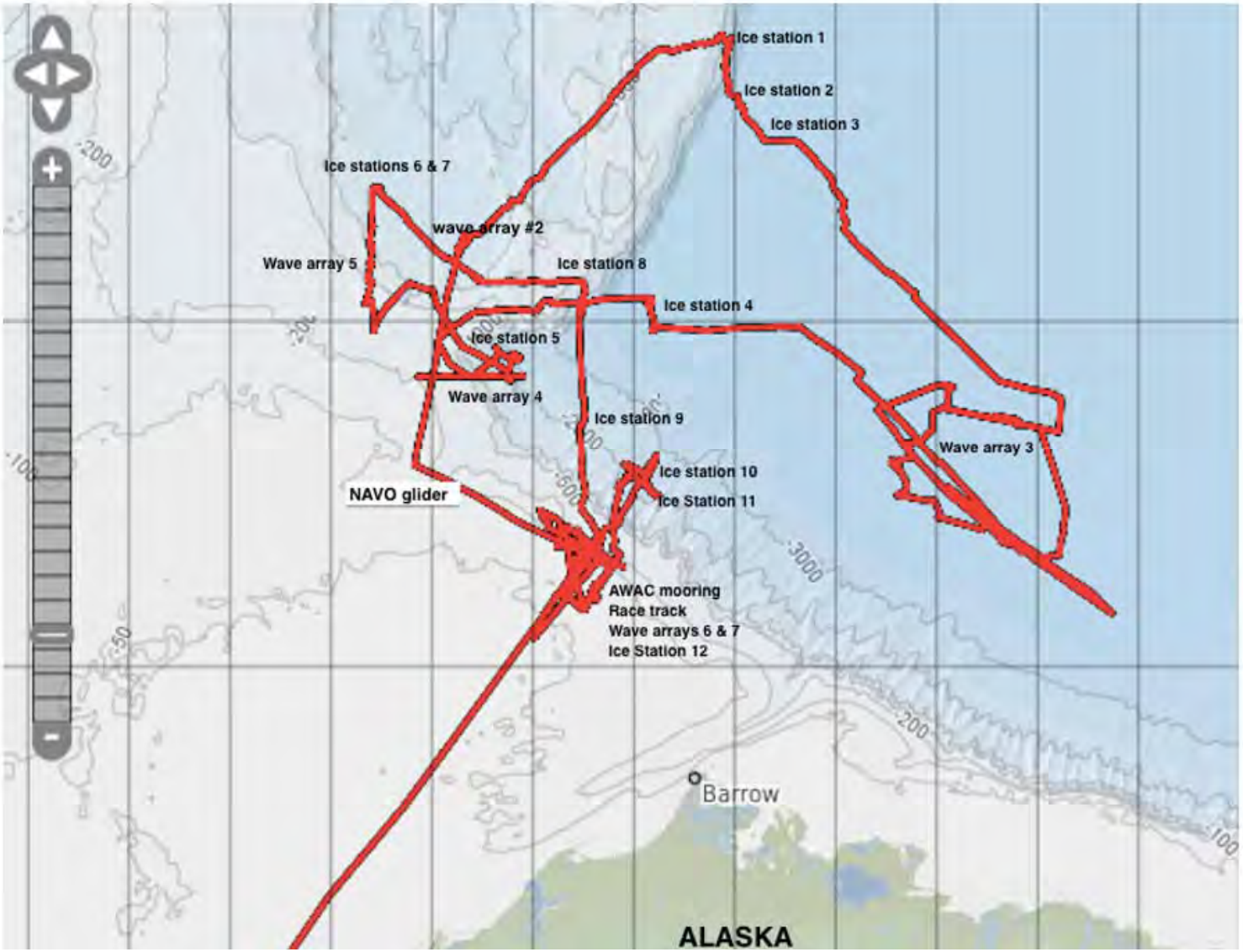


- Track the ice edge (horizontal and vertical) for a whole annual cycle
  - Ship-, ice-, air- and dock-based deployments
  - Some recoveries (needed for HR data), some expended… water based
- Similar to Arctic Sea State (ONR program), but with
  - More persistence (duration)
  - More autonomy (smarter assets and adaptive sampling)
  - More biogeochemical focus

Dream big… How to upscale? NOAA led inter-agency phased float swarm
100 to 1000s of autonomous assets (mobile)
Need navigation array
International collabs


Satellite
TerraSar-X
Weather
Balloon
UAV
Swift
Buoy
Wave
Buoy
AWS
Wave
Buoy
IMB
AWAC
Mooring
CTD
AUV
AWAC
Mooring
Glider

throughout the trip according to weather/wave forecasts and ice conditions.

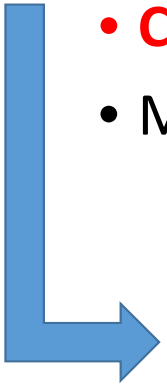


Exploring and Monitoring an Environment in Transition

Exploring and Monitoring an Environment in Transition

Geographic Provinces

- Beaufort gyre: deep (re)circulation
- Coastal & shelf break: terrestrial input,
- Chukchi shelf: shallow, Bering Strait influence,
- **Chukchi borderlands: marine minerals, water masses mixing**
- Mid-ocean ridge: isolated biology? Collab with euros



- Emphasize mapping, looking for resources and habitats
- AUV bottom mapping… beyond the ship(s)

Parking lot

- What has been mapped? Where is the methane?
- Marine arch?
- Fiber pipe? (telcom is coming/arriving to north slope)
- Tele-presence (more polar coverage coming… O3b in 10+ yrs)
- Funding?
- Engagement, stakeholders (e.g., AEWC)
- Logistics (which ships deploy, service, recover)
  - Ships of opportunity