ONR Arctic Program Research Thrusts

1. Generation of **new observing technologies and methods** (platforms, sensors, communications) that will enable persistent observational capabilities in the Arctic

2. **Improved basic physical understanding** of the Arctic environment and the important coupled processes that drive evolution and predictability in the Arctic region

3. Development of **fully-integrated Arctic System Models** incorporating the ocean, sea ice, waves and atmosphere for improved prediction at longer lead times, including the use of satellite SAR data for assimilation into integrated models

In the Beaufort and Chukchi Sea, the presence or absence of Arctic Sea Ice is *the* critical operational parameter
Acoustic Navigation and Communication
Infrastructure for Autonomous Platform Operation in Ice-covered Environments

- Satellite nav & comms
- Human in the loop – high latency remote control.

Acoustic nav & comms – underwater GPS.
- Operate for months, years without human intervention.

Acoustic Multilateration in Baffin Bay

Surface ducting in many polar regions limits acoustic range to ~100 km.
Warm Pacific layer in Beaufort creates sound channel, allows long-range propagation.

Frequency Regimes

- 10 kHz Data transfer
- 1 kHz Regional nav & command transmission
- 100 Hz Basin-scale nav

Glider Receptions vs depth and range

Beaufort Sea: Sound channel supports 500 km range
First-Generation Drifting Observing System – Marginal Ice Zone Program

Exploit Complementary Capabilities of Autonomous Instruments

- Improve physical understanding of rapidly changing Arctic environment – processes and feedbacks shifting.
- Mix of ice-based and mobile instruments spans open water, partial ice cover and solid pack ice.
- System drifts with ice – persistent (8 months) operation.
- Ice-based mobile (drifting) acoustic sources allow navigation under ice, w/out surface access.
- No communication path through ice – instruments must find open water to access satellite comms.
- Fast & light logistics – no reliance on large ships. Scalable.

Strengths & Weaknesses

- Ice-based instruments essential for collocated atmosphere-ice-ocean observations (and for data exfil from beneath the ice).
- Drifting platforms disperse, making it difficult to provide long-term (many months, years) acoustic navigation.
- Mobile assets required for ocean sampling that spans pack to open water.
Fixed and Mobile Assets – Stratified Ocean Dynamics of the Arctic

- Understand how the upper Beaufort Sea, particularly stratification and sea ice, responds to changes in inflow and surface forcing.
- Mobile instruments operate within broad field of moored (fixed) assets that provide acoustic infrastructure and sampling.
- Ice-based instruments deployed to drift through mooring array.
- Good for sustained focus on fixed geographic sites.

Moored and Mobile Instruments Maintain Focus on Fixed Domain

- Long-Endurance Gliders
- Ice-Based Instruments

Strengths & Weaknesses
- Effective for achieving long-term, sustained ocean measurements.
- Fixed sites provide stable acoustic navigation array, but difficult to service large area due to short (300-400 km) range.
- No communication path through ice – instruments must find open water to access satellite comms.
Arctic Mobile Observing System (AMOS)

Persistent, year-round monitoring, event-driven sampling/response

- Data exfiltration and control for instruments operating under ice through ‘gateway’ buoys that bridge ice-ocean interface.
- Store and forward network of mobile instruments.
- Robust, broad acoustic navigation:
  - Long-range (trans-basin) very low frequency (35 Hz) beacons – ‘underwater GPS.’
  - Range and bearing from single 900 Hz beacons on gateway buoys – expand utility of drifting systems.
- Persistent presence, multi-scale sampling – gliders, floats & fast UUVs operating with ‘gateway’ buoys.
- Situational awareness and control center – in situ environmental data, remote sensing, numerical predictions inform decisions.
Arctic Mobile Observing System (AMOS)
HEALY (26 JUL – 28 AUG)
Chief Sci: Jason Gobat (jgobat@uw.edu)
- Recover 4 2021 AMOS moorings.
- Deploy 8 AMOS moorings.
- Deploy IGB-H.
- Deploy gliders to follow IGB-H using VLF and moored array.
- Dock REMUS to IGB-H.

SIKULIAQ (14 SEP – 28 OCT)
Chief Sci: Luc Rainville (lucrain@uw.edu)
- Recover VLF mooring.
- Rendezvous with IGB-H, recover REMUS.
- REMUS open water testing.
- Glider and float open water testing.
- Science sampling during Freeze up?
- APEX floats 1 and 2.
- SGX glider recoveries/deployment
- Possible shelf mooring deployments for NOAA-PMEL.