

Acoustic Navigation and Communications for High-latitude Ocean Research (ANCHOR) Workshop

Call for Participation

27 February – 1 March 2006, University of Washington, Seattle, U.S.A.
<http://iop.apl.washington.edu/projects/anchor/index.html>

Summary

Recent community reports on autonomous and Lagrangian platforms and Arctic observing identify the development of under-ice navigation and telemetry technologies as one of the critical factors limiting the scope of high-latitude measurement efforts. An NSF-sponsored workshop will address these needs, bringing together international participants from the fields of acoustic navigation and telemetry, arctic oceanography, acoustical oceanography and autonomous platforms. Workshop participants will begin the coordinated definition of an acoustic navigation and telemetry system capable of supporting a diverse range of Arctic observational activities. Efforts will focus on comprehensive system design, including specifications for components comprised of mature technologies and identification of areas requiring additional development.

Background

Geographic remoteness, severe operating conditions and issues associated with ice cover have hindered high-latitude measurement efforts and thus limited our understanding of polar and subpolar regions. Recent advances in autonomous platforms (profiling floats, drifters, long-range gliders and propeller-driven vehicles) promise to revolutionize ocean observing, providing unprecedented spatial and temporal resolution for both short-duration process studies and multi-year efforts designed to quantify long-timescale environmental changes. This new generation of platforms facilitates access to logistically difficult regions where weather and remoteness challenge conventional techniques, making them attractive for polar applications. These platforms could provide basin-wide sampling in ice-covered regions, operate near the ice-water interface and, when combined with moorings and ice-tethered platforms, provide a multi-node store-and-forward network to maximize data return from the entire suite of vehicles. Autonomous platforms could provide efficient, extended-endurance measurements at the temporal and spatial scales needed to address many SEARCH ocean and ice science goals.

Reports from recent community workshops (Instrumentation for Arctic Ocean Exploration, 2002; Ice-Based Observatories, 2004; Autonomous and Lagrangian Platforms and Sensors- ALPS, 2003) identify under-ice navigation and telemetry as important enabling technologies whose development would allow high latitude research to benefit from new platform technologies that are becoming operational in ice-free waters. Navigation and telemetry for the current generation of platforms relies on absolute positioning (GPS) and global communications (Iridium, ARGOS, ORBCOMM) provided by orbital systems that are poorly suited for many high-latitude applications where partial or complete ice cover restricts access to the sea surface. The ALPS workshop report noted that acoustic systems for both under-ice navigation and telemetry are technologically feasible, but will require significant infrastructure to provide basin wide coverage. The Arctic Instrumentation Workshop report lists under-ice navigation as an 'over-arching technical challenge that presently limits most types of Arctic research'.

The Ice-Based Observatories Report provides one vision of how acoustic systems could be embedded in an integrated Arctic observing system to support navigation and telemetry under ice. Two specific system objectives are : 1) provide reliable, several times per day, basin-wide navigation signals and 2) provide a network for data telemetry that offers a high probability of connection for navigable vehicles and some reasonable probability of encounter for drifting platforms. Participants in the Ice-Based Observatories workshop defined a system composed of three elements, each based on particular acoustic frequencies and protocols.

1. At the basin scale, a relatively small number of bottom moored, large, low-frequency (20 - 50 Hz) sound sources could be used to ensonify the entire basin, broadcasting navigation signals on fixed, several times-per-day schedules.
2. At the next level, observatory elements, primarily ice based observatories (IBO), with a surface expression (providing GPS and satellite telemetry) would carry mid-frequency (200 - 1000 Hz) sound sources that broadcast scheduled signals coded with position. With their position determined by a combination of these signals and those from the low frequency system, mobile platforms could use the coded position information to home to the IBO. Floats, with no ability to home, could still make use of this system for positioning redundancy.
3. Finally, IBOs and mobile platforms would carry high frequency (10 - 30 kHz) acoustic modems for short range homing and data transfer.

Workshop goals

Workshop participants will focus on the design and technical specifications for basin- to small-scale Arctic (under-ice) navigation and telemetry systems, potentially comprised of both mature and developmental technologies. Smaller-scale systems are already under development, but do not involve the full suite of elements required to achieve the vision outlined above. Significantly, the recently-funded European Union DAMOCLES project involves an extensive Arctic observing program that will require navigation and telemetry for autonomous platforms operating beneath the ice. DAMOCLES acknowledges that developing, deploying and operating a basin-scale system will require effort and support from the researchers and funding agencies of multiple nations, and thus anticipates a collaborative effort. Projects undertaken as part of the approaching International Polar Year may also involve navigation and telemetry elements. The workshop will establish ongoing coordination of the diverse efforts to maximize interoperability of the resulting systems.

Although motivated by outstanding Arctic science issues, the workshop agenda will concentrate on technical objectives. The primary objective is to produce a specification from which research teams could begin implementing components of the Arctic navigation and telemetry system. Among the specific questions to be addressed in achieving this objective are:

- Is the three tier model described above the right approach? Can the functionality of the low and intermediate frequency systems be combined? Do we need significant telemetry capability at intermediate frequencies? Should timing signals be included in the telemetry?
- What knowledge gaps must be addressed to inform the final choice of protocols and frequencies? How does propagation range change as a function of frequency? How does ice cover modulate acoustic telemetry? How does the severity of ice-induced modulation vary with frequency?

- What specific technologies (e.g. hardware, encoding and signal processing techniques) will be used in the system? What protocols might be used for intermediate frequency position encoding? How much bandwidth can we expect from inexpensive, readily available sources? Is there an emerging standard for high frequency telemetry? What should transmission and interrogation schedules be?

Additional tasks include coordination with efforts to define acoustics contributions to lower latitude ocean observatory efforts and discussion of marine mammal impacts and permitting issues.

Organization and logistics

The Arctic Navigation and Telemetry Workshop will be held in Seattle from 27 February to 1 March 2006. Additional information will be posted on the website and distributed by email over the coming months. As a starting point for discussion the workshop will be initially organized around the three-tiered acoustical system described above. This suggests working groups focused on:

- Low frequency navigation.
- Intermediate frequency navigation and homing with limited telemetry.
- High frequency, short range telemetry.
- Platforms (floats, gliders and actively driven AUVs).
- Marine mammal monitoring and protection.
- Synergistic acoustical oceanography applications.

Participants knowledgeable in acoustic navigation, acoustical oceanography, marine mammal acoustics, acoustic telemetry, high-latitude oceanography, and float, glider, and AUV developers and operators are particularly encouraged to attend. Participants actively working on technology development in a relevant subject area may be asked to give a brief presentation about the state-of-the-art in that area.

The workshop will produce a report that features a detailed technical specification for the navigation and telemetry system. Selected issues may be targeted for additional study. We will also use the workshop to develop communication and decision making procedures for the Arctic navigation and telemetry community. This will facilitate coordinated responses to proposed specification changes and strengthen the long-term cohesiveness of the resulting system. Successful implementation of a large-scale Arctic navigation and telemetry system will rest largely on continued communication between the diverse research groups.

References

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