

Acoustic Communications and Navigation for Under-Ice Sensors

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2009 Funded Project

Ocean and Climate Change Institute

What were the primary questions you were trying to address with this research? (Or, if more appropriate, was there a hypothesis or theory that you were trying to prove or disprove?)

We wanted to learn whether it was possible to perform acoustic communications in Arctic waters to support autonomous vehicles and sensors. While we had performed initial experiments at standard frequencies used by commercial systems, lower frequency systems had not been explored for communications.

What have you discovered or learned that you didn't know before you started this work?

We learned during experiments performed between Greenland and Spitzbergen that long-range acoustic propagation at 700 Hz was feasible in what is called the 'marginal ice zone', where broken ice fields persist into late summer.

What is the significance of your findings for others working in this field of inquiry and for the broader scientific community?

The implication is that it will be possible to communicate acoustically with remote systems at ranges up to approximately 100 km. While the data rates are low (tens of bits per second at most), any communications are better than none, in particular when monitoring a remote, unmanned, underwater vehicle.

What is the significance of this research for society?

The research performed within this project is for technology development that supports remote exploration of the Arctic using underwater vehicles, including gliders. These remote platforms provide a view into the physical oceanography in areas where it is difficult or impossible to operate manned platforms. The measurements made in these areas by gliders and vehicles are used to update models that can predict heat flux in the Arctic.

What were the most unusual or unexpected results and opportunities in this investigation?

We were actually surprised to see signals at the very long range during the Spitzbergen experiment. The sound traveling through the upper layer of water under the ice interacted with the surface, scattering from the rough underside of the ice. While we expected all of the signal to be eventually lost, at the frequency we used, the losses were low enough so that significant signal was present at 100 km.

What were the greatest challenges and difficulties?

Conducting experiments in this environment is very challenging. We had to design new equipment to contain the data acquisition system, which also had to be polar bear proof!

When and where was this investigation conducted? (For instance, did you conduct new field research, or was this a new analysis of existing data?)

We did three field campaigns, one out of Barrow, Alaska, with a REMUS vehicle, the second on a cruise with a Norwegian icebreaker out of Spitzbergen, and the third from a Navy Ice Camp 200 miles north of Deadhorse Alaska in March of 2011.

What were the key tools or instruments you used to conduct this research?

A sound generator and a set of data recorders were used for these experiments, along with acoustic arrays that were suspended from the ice. During one experiment we had to cut the cables to the receivers hanging from the ice because helicopter time was so short and the systems had to be recovered quickly.

Is this research part of a larger project or program?

By its nature this is an element of a larger piece of technology, but at present we are still working to integrate it with actual platforms. At present we have been using prototypes, but the time is coming to develop a real-time operational capability.

What are your next steps?

Already this year we submitted a proposal to the Office of Naval Research for a new Arctic initiative where we will play a key role in providing acoustic communications and navigation capability for underwater gliding vehicles and oceanographic floats. We passed the first hurdle, which was being asked to submit a detailed proposal, which is still being evaluated. In the meantime we continue to look for additional opportunities.

Have you published findings or web pages related to this research? Please provide a citation, reprint, and web link (when available).

We presented a poster at the AGU meeting in 2007 prior to this project to introduce the concept and our approach. More recently a paper was presented by Morozov at a European acoustics conference.

Please provide photographs, illustrations, tables/charts, and web links that can help illustrate your research.

These photos are from a cruise aboard the K/V Svalbard, a Norwegian ice breaker that we were fortunate enough to be invited to join in 2010. WHOI engineer Peter Koski worked with the crew and science party from both Norway and Germany to conduct a successful acoustic communications experiment.









