ICESHELF 2002 – UNDERWATER ACOUSTICS IN THE ARCTIC ENVIRONMENT

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1. INTRODUCTION

Iceshelf 2002 was an Arctic trial organized by Defence R&D Canada Atlantic (DRDC Atlantic), in collaboration with several government, industry, and university partners. The overall purpose of the trial was to test components and algorithms in support of the Rapidly Deployable Systems Technology Demonstration Project.

This Arctic trial was conducted on shore-fast ice west of CFS Alert, on the north coast of Ellesmere Island, in March-May 2002. Living and working in an Arctic environment is always a challenge. This trial involved setting up a camp on the ice, several kilometers from the base, and working from this camp over several weeks. It was logistically, physically, and scientifically a challenge.

This paper is not about the scientific objectives of this trial, but about the difficulties associated in carrying out underwater acoustic research in an Arctic environment.

2. LOGISTICS

For this trial we shipped approximately 12 tons of gear to our storage facilities in Alert. From there, we used skidoos and BV 205 tracked vehicles to carry everything necessary to set up a camp for 20 people on the ice, and conduct scientific experiments over a period of four weeks. The task was daunting.

Figure 1 shows Canadian Forces Station Alert, the most northerly permanently inhabited place in the world. The station was established in 1958; its population has varied widely since its inception, with ~220 people at its peak. Nowadays, approximately 60 people occupy the base year-round. Though some civilians live on the base (a contingent of Environment Canada maintain a weather station near Alert), it remains a military town that is resupplied almost entirely by military aircraft. Because of its northern status, the base has been the launching point of many North Pole or other northern expeditions, but needless to say, its access to civilian organizations requires a great deal of interaction with the military. DRDC is privileged in this respect because of its ties with the military.

Following a joint US-Canada trial of the 1990s, the Spinnaker project, DRDC maintains a storage facility in Alert. The Spinnaker building is a 446 m^2 area filled with Arctic gear: everything from skidoos to Arctic tents and stoves, scientific gear and ice drilling devices.

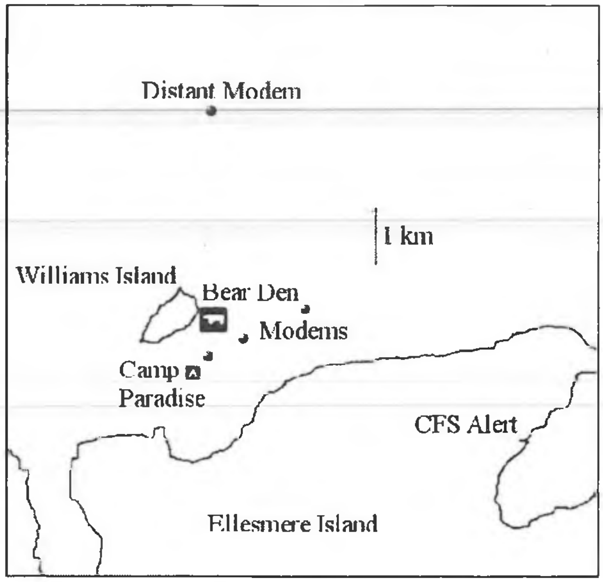

Fig. 1. The ice camp location near CFS Alert (Camp Paradise). The modem locations represent locations where gear was deployed through the ice.

Upon our arrival in Alert, a small skidoo party went on the ice to find a suitable location for the camp. We have to drill many holes through the ice to conduct our experiments, therefore it is worthwhile to spend extra time to find an area of annual ice. One-year old ice is roughly 1.5 to 2 m thick, and multi-year ice and ice ridges near Alert can be much thicker. Annual ice also tends to be smooth, simplifying the camp set up.

In 2002, we found an area 6 km from Alert, shown in Figure 1. Thirty-eight people participated in various parts of the Iceshelf 2002 trial, and a camp was set up for approximately 20 people on the ice. This camp, shown in the background of Fig. 2, included two scientific tents, a double battery/workshop tent, a tent for our remotely-operated vehicle, a fully-equipped kitchen tent, a food storage tent, 6 accommodation tents, and an under-appreciated "Hurritent" with toilet facilities. All of these tents are strong insulated nylon tents and, except for the food storage tent and the Hurritent, are heated with small oil stoves.

It took approximately 10 days, 15 people, a fleet of skidoos, and help from the base BV tracked vehicles to carry all the necessary supplies and set up the ice camp, at a temperature below –30°C.

3. THE ENVIRONMENT

The mean daily temperature in Alert varies from about −33°C in March to −12°C in May. To work in these temperatures requires many layers of bulky fur-laden clothing, making physical labor difficult and slow. High-caloric diets are required. Long restful pauses around warm meals punctuate the long days: by late March, the sun is up 24-h a day, and one often forgets how late it is.

The cold is hard on the people and on the equipment. At –35°C, many materials become too brittle to use. Tent covers shrink, wires and fuel lines break, oil thickens. As temperatures reach −40°C even some kerosene fuels gel.

Batteries lose capacity quickly in the cold. For small gear, the use of Nickel Metal Hydride batteries instead of the traditional alkaline batteries helps. Either type must be kept warm. For larger pieces of gear, car batteries or generators have to be used. Generators are difficult, if not impossible, to start after spending even a short time in the cold.

Years of experience are required to find out what will work and what won't in the Arctic environment. Equipment has to be built very rugged, with simple designs – what breaks will need to be fixed by someone wearing thick gloves.

4. THE SCIENCE

By far, the biggest challenge remains the sheet of ice between our camp and the ocean. To investigate acoustic propagation underwater, one needs to drill holes through thick ice. Over the years, DRDC has designed many tools to solve this problem.

For small holes (a few inches in diameter), DRDC has been using mechanical drills, either powered manually, or electrically. Drill stems are 2 or 4' long, with quick disconnect mechanisms. If the ice is very thick, tripods, such as the one shown in Fig. 2, are used to support the weight of the drill.

Fig. 2. A tripod is setup to support the weight of an ice drill; the ice camp is in the background.

Fig. 3. A hot water drill is used to cut blocks of ice. The cut area will be large enough the accommodate the Phantom: a large, remotely-operated vehicle used to deploy our gear underneath the ice.

For larger holes, a hot water drill was designed by DRDC. Cold water is pumped through a reservoir using a small electric motor, heated with a furnace burner, and redirected to the ice through various sized "cookie cutters". In Fig. 3, a 4-ft horizontal straight edge is used to cut the ice in blocks. These blocks are then pulled out with skidoos and an A-frame lifting device.

Once the holes are ready, the gear is lowered in the water. If the gear is meant to be deployed over a distance, such as a horizontal acoustic array, lines are used to pull the gear between holes. A remotely operated vehicle is used to carry the line between the holes.

For acoustic studies, it is vital to reduce our own contribution to noise. Electrical noise, from generators for example, is particularly difficult to isolate. During Iceshelf 2002, we used 50 car batteries wired in series-parallel to run the equipment. Generators ran at night to recharge the batteries. Our own acoustic noise, which can couple through the ice to the ocean, can also be a nuisance. Skidoos, generators, even people walking on the ice can trigger noise that will contaminate our acoustic datasets. Only a great deal of coordination can solve this problem.

5. CONCLUSION

You might conclude that Arctic work requires considerable expertise and logistical capability. Sometimes that may be difficult for small groups to achieve. DRDC has over 30 years of experience working in arctic conditions, and is always open to collaborative projects.

REFERENCES

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