New technology reveals the Arctic's secrets

Stein Sandven of the Nansen Environmental and Remote Sensing Center in Norway tells International Innovation about an exciting new project that will aid research in the remote and inaccessible areas of the Arctic Ocean

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TO CONSTRUCT OCEAN observing systems for the polar regions is a particular challenge, not least because of the harsh environment including sea ice. The Arctic Ocean lacks adequate observing systems, and technologies such as Argo floats are not suitable for use in ice-covered seas. This lack of data causes severe uncertainties in detection of temperature and salinity changes, understanding of ocean-ice interactions and in modelling of processes and climate. During the International Polar Year from 2007-2009, several new instruments and platforms for ocean observations were deployed and ACOBAR (ACoustic Technology for OBserving the Interior of the ARctic Ocean) plans to develop some of these technologies further.

PROJECT OBJECTIVES

ACOBAR's main objective is to develop an acoustic system for monitoring of the interior of the Arctic Ocean. The project will collect 3D observations of properties and transport of water masses in the Fram Strait, using an acoustic tomography array, consisting of source and receivers, in combination with Acoustic Ice-Tethered Profilers (AITPs), oceanographic moorings and profiling gliders. Navigation of gliders under the ice by use of acoustic signals from the tomography sources will be developed and tested. Data transmission by acoustic modems from underwater platforms to the surface for downloading to ships will be demonstrated. The AITPs are deployed on ice flows with underwater sound source, hydrophones, modems and satellite communication, allowing near real-time data transmission via satellite. ACOBAR will also help establish a new Arctic Ocean Observing System.

METHODOLOGY

The basic principle of acoustic tomography is that sound signals travels faster in warm water than in cold water, and faster with the current than against the current. Acoustic tomography uses precise measurements of acoustic travel times between pairs of acoustic sources and receivers. Through inversion techniques, internal ocean temperature can be retrieved with an accuracy of 0.01°C over a 200 km distance. In the same way, precise measurements of average current velocities can be determined from the difference between reciprocal travel times produced by simultaneous transmission of acoustic pulses in opposite directions along an acoustic path.

The benefits are: It permits rapid and repeated measurements over large ocean areas for climate and process studies: It measures average properties between moorings – spatial integration suppresses small variability that can contaminate point measurements: Provides depth resolution due to acoustic multipath and provides and powerful constraint for circulation models due to the integral nature of tomographic data.

In 2010 a multi purpose system for acoustic tomography, navigation of gliders and positioning of floats will be implemented in the Fram Strait, headed by Dr. Hanne Sagen at NERSC. The system consists of three acoustic transceiver moorings in a triangle configuration, with a receiver mooring in the middle. The system will obtain 3 D acoustic tomography data, and provide acoustic signals for underwater navigation of gliders and positioning data for underwater floats. Acoustic travel time data from the tomographic system demonstrates it strength when it is employed in conjunction with numerical ocean circulation models and data assimilation. This is a primary focus in ACOBAR. The tomographic data will be quality checked validated against standard oceanographical measurements from ships and moored profilers. The results ACOBAR attains from this scheme will be used to improve the ocean-observing capability in the polar oceans and will thus contribute to build Arctic Regional Ocean Observing System (Arctic ROOS), a component of the Global Ocean Observing System (GOOS).

In addition to NERSC, the ACOBAR experiments are supported by Alfred Wegner Institute for Polar and Marine Research, Scripps Institution of Oceanography, Woods Hole Oceanographic Institution, Université Pierre et Marie Curie, Aquatec Telemetry Limited, OPTIMARE, ENSIETA, ACSA, Applied Physics Laboratory, University of Washington, University of Bergen, and the Norwegian Coast Guard vessel KV Svalbard. The project will strengthen European expertise in underwater acoustic navigation, communication, data transmission and tomography. The project will also promote use of underwater acoustic technology for monitoring the ocean, transferring data and navigate gliders and other underwater platforms. The technology will be used to build a long-term ocean monitoring system for the polar oceans.

IMAGES: DIPLOYMENT AND RECOVERY OF EQUIPMENT IN THE FRAM STRAIT