로스해 수중음향관측

NOAA
(National Oceanic and Atmospheric Administration)

제　　출　　문

극지연구소장 귀하

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The Ross Sea Hydrophone Triad

To : Chief of Korea Polar Research Institute

This report is submitted as the final report of Term 2 of the Ross Sea Hydrophone Project of the KOPRI sponsored Terra Nova Bay Science Collaboration project.

10/21/2016

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Name of Entrusted Organization: Pacific Marine Environmental Laboratory
Office of Atmospheric Research
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US Department of Commerce
Entrusted Researcher in charge: Dr. Robert Dziak

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Summary

Term 2 Report: 2015.7.1-2016.5.31

I: Introduction

The U.S. National Oceanic and Atmospheric Administration - Pacific Marine Environmental Laboratory will provide the data from two arrays of three hydrophones (referred to as a "Triad") to be moored near the Terra Nova Bay-Drygalski Ice Tongue region of the Ross Sea, Antarctica. The instruments will record continuously at a sample rate of 500 Hz (1-250 Hz band pass) and with a 16-bit A/D resolution.

Recently, through an NSF sponsored project in the Lau Basin, NOAA/PMEL and NCSU developed a unique method to efficiently detect previously unknown volcano-seismic activity using only a small aperture (2 km) horizontal array of hydrophones. The compact footprint of this array eliminates lengthy ship transit times, and PMEL engineered advances in microprocessor time keeping allow the three sensors to operate autonomously (without being connected via a cable). Data processing utilizes a correlation detector that provides a temporal record of when coherent acoustic energy is received at the array and from what azimuth the energy arrives. The precision of these azimuthal estimates is within a few tenths of a degree, more than sufficient to identify geophysical acoustic sources at ranges of up to ~10°.

The main goal of our project is to do a first-order analysis of the hydrophone records for seasonal patterns of ice flow and breakup near Terra Nova Bay, as well as any volcano-acoustic signals produced Mt. Melbourne and/or Mt. Erebus

II: R&D Implementation and Results

In this Term our implementation plan was to deploy the Triad array during the Aaron research cruise from 08-16 December 2015. We chose 3 mooring deployment sites near the edge of the Drygalski Ice Shelf (Figure 1).

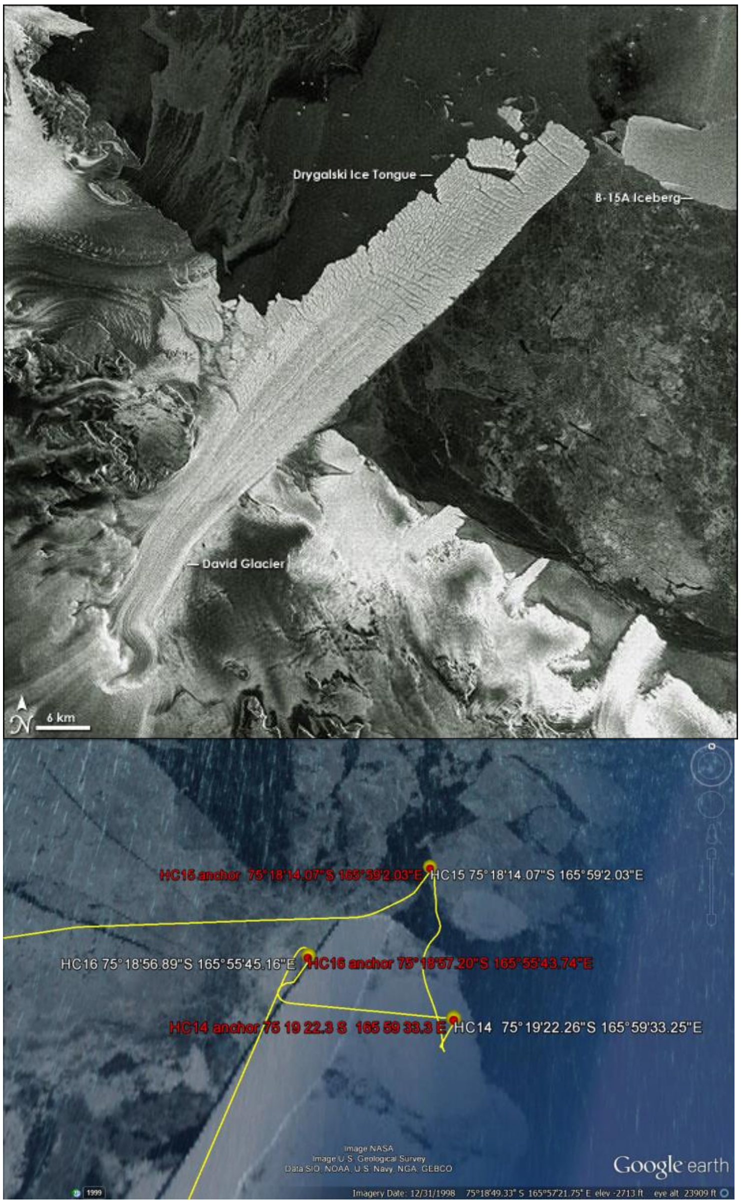

Figure 1: Satellite image of Drygalski Ice shelf (top). The location of the three hydrophone mooring (bottom) deployed during 2015 Araon cruise.

The research team involved and onboard the Araon in December 2015 include the Korean Polar Research Institute (KOPRI) Extreme Geophysics Group (EGG) and Paleoclimate Groups, the National Oceanic and Atmospheric Administration (NOAA) Acoustics Group, the Lamont Doherty Earth Observatory (LDEO) Air Sea Interactions Studies (OASIS) Group, Australian Maritime College (AMC), National Institute for Water and Atmospheric Research (NIWA).

This discussion will focus only on the NOAA hydrophone mooring deployments that were directed by the Chief Scientist and Araon Captain and crew.

The research cruise began 8 December, and the NOAA mooring deployment started at ~10:30 local on 10 December 2015. The first hydrophone deployed was at HC15. The deployment area was first surveyed using multibeam to provide a good characterization of the seafloor morphology. The mooring line was laid out on the deck, followed by Yalex line (low friction line to reduce strumming). An additional 50m of Yalex was added to the mooring to ensure hydrophone was at a water depth < 500m. HC15 was then deployed in 838m of water 13:44 on 10 December 2015. No workboat survey to provide detailed location of mooring was performed due to communication issues between science party and ship. Anchor was also dropped on mooring target location, not past the mooring site as originally planned.

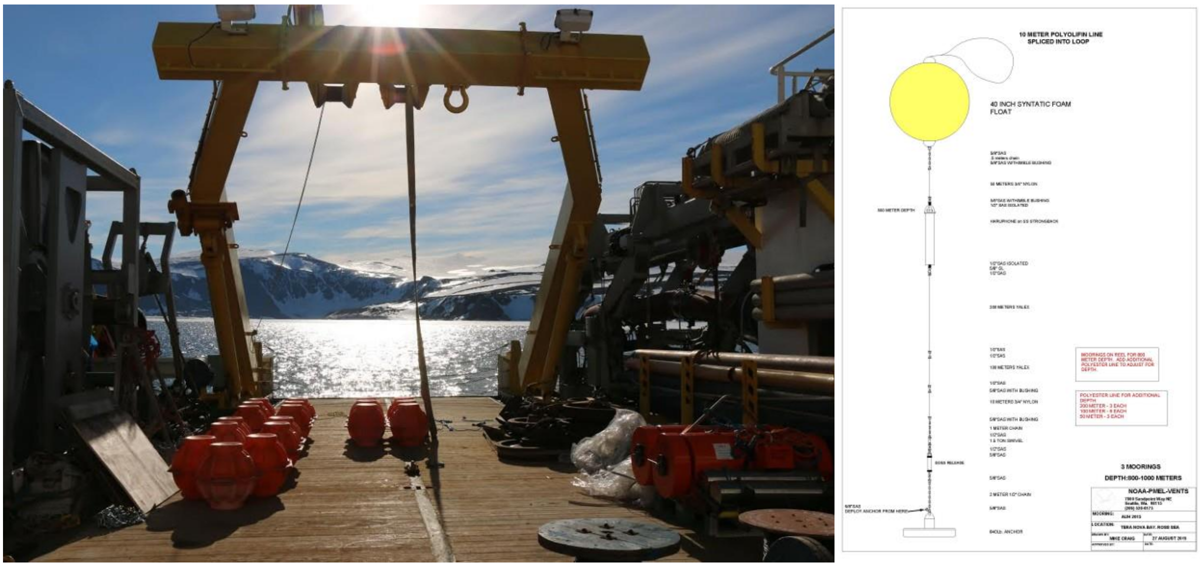

Figure 2: Left, floats and mooring line splayed out on fantail of R/V Araon. Right, detailed diagram of moorings deployed near Drygalski ice shelf.

The ship next proceeded to HC14 in afternoon of 10 December. Another multi-beam survey was performed at the mooring location. Survey indicated depth was 810 m. No Yalex line was needed to add to the length of the mooring. Anchor deployed at 15:01 10 Dec 2015 local time at target mooring site, not past the site due to communication issues.

Lastly, the ship proceeded to HC16. Multi-beam survey indicated depth was 830m. Added 50 m yalex line to adjust for mooring depth. Deployed H16 at 16:27 local on 10 December 2015.

III: Degree of R&D Goal Achievement and Contribution from Outside Research Group

The research cruise was an 100% success as all three hydrophone moorings were deployed near the intended deployment targets. The three locations are listed in the table below. The target location was the original, intended, deployment position. The anchor drop location was the actual deployment location of the anchor from the ship. A detailed transponder survey will be required during the 2017 research cruise in order to tightly constrain the locations of the moorings.

Mooring Name	Release Number	Water depth (m)	Target lat&Lon	Anchor Lat&lon
HC15	50932	838	75° 18’ 14.1” S 165° 59’ 02.0” E	75° 18’ 14.1” S 165° 59’ 02.0” E
HC14	50927	810	75° 19’ 22.3” S 165° 59’ 33.3“ E	75° 19’ 22.3” S 165° 59’ 33.3“ E
HC16	50933	830	75° 18’ 56.9” S 165° 55’ 45.2“ E	75° 18’ 57.2” S 165° 55’ 43.7“ E

IV: Future Research plan

Following the successful deployment of the three NOAA hydrophone moorings, additional time aboard the R/V Araon is required in 2017 to recover the hydrophone moorings to then retrieve and analyze the data. The project will need at least 1-3 days of dedicated time on the Araon in 2017 in order to perform an acoustic survey to determine the precise locations of the hydrophone moorings, then recover the moorings. Moreover, this project has been approved for deployment of an additional hydrophone triad (for a total of 6 hydrophone moorings) and one additional deployment year. Thus we plan to recover three hydrophone moorings in February 2017, and redeploy six total hydrophone moorings in two triads. The final recovery of the two triads will need to occur in 2018. Once again, a detailed transponder survey of the two triad arrays is needed to derive mooring locations, and ship time during 2017 and 2018 cruises needs to be allocated for this.

Our hydroacoustic work support an overall KOPRI research focus on the Terra Nova Bay Polynya. Polynyas, large areas of open water surrounded by sea ice, act like "windows" that expose the relatively warm ocean to the colder atmosphere. Although polynyas only cover a small fraction of the ocean surface, the transfer of heat and water vapor is so large that they play a significant role in the climate system leading to modifications of both atmosphere and ocean properties. The absence of an insulating sea ice barrier allows for energy and moisture exchange to rapidly warm and moisten the atmospheric column directly above and downwind of the polynya, altering regional atmospheric circulations. In the ocean the effect of the polynya is the massive production of salty, freezing point shelf water (high-salinity shelf water; HSSW) that is the prime ingredient in the formation of the globally important Antarctic Bottom Water (AABW) and associated ventilation of the world ocean.

The Terra Nova Bay polynya is a classic example of a coastal polynya, and is the focus of the proposed research. Atmospheric forcing on the ocean at the Terra Nova Bay polynya modulates the formation of HSSW, the dense end-member of the Ross Sea AABW. AABW plays a central role in the Southern Ocean driven global thermohaline overturning circulation. The TNB polynya is formed by the co-location of the strong katabatic forcing in conjunction with the sea-ice blocking by the Drygalski Ice shelf – the seaward extension of the David Glacier. In addition to blocking of sea ice, this significant glacial feature modulates buoyant coastal currents. This upstream water is a precursor to TNB and serves as the preconditioned ocean state for the TNB katabatic wind forcing that generates HSSW within the polynya.

The polynya related research questions we will address with the hydrophone data are: 1) Do the katabatic winds and movement of sea-ice during polynya formation have a detectable ocean sound signature? 2) Does flow of the Drygalski ice shelf into TNB produce hydroacoustic signals and what is the character and seasonal variation of these signals?

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