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# PALAOA: BROADBAND RECORDINGS OF THE ANTARCTIC COASTAL SOUNDSCAPE

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## INTRODUCTION

The coastal ocean of Antarctica is among the most pristine oceanic regions on earth. It provides an excellent location to obtain baseline acoustic data with little to no contribution by anthropogenic noise. Long-term acoustic recordings from the Southern Ocean have so far been obtained by moored recorders along the Antarctic Peninsula (Sirovic et al. 2004). Limited storage capacity, however, allowed only detection of low-frequency sounds, whereas higher frequency signatures lay outside the recorded spectral range. Similar data are unavailable altogether for the eastern Weddell Sea. To obtain broadband recordings from this remote region, an acoustic listening station, PALAOA (**P**erenni**AL** **A**coustic **O**bservatory in the **A**ntarctic Ocean or Hawaiian "whale") was constructed at 70.5°S, 8.2°E on the Ekström ice shelf 15 km north of Germany's Neumayer Base.

## METHODS

PALAOA's design was guided by demanding prerequisites: perennial, 365/24, autonomous operation, real-time data access, and wide-frequency and dynamic coverage. Four hydrophones were deployed through holes melted through the 100-m-thick floating ice shelf. The signals are digitized up to 192 kHz/24-bit resolution. Data are buffered locally and continuously transferred to Neumayer Base by a WLAN link. A compressed audio stream is transmitted via satellite link at 24 kbit/s in near real time to the Alfred Wegener Institute for Polar and Marine Research (AWI), Germany. It is accessible to the public at http://www.awi.de/acoustics/livestream. PALAOA's power consumption of about 53 watts is generated autonomously by solar panels, wind generators, and a methanol fuel cell.

## RESULTS

During the first year of its operation, PALAOA recorded sound from a wide range of sources: (a) vocalizations from various marine mammal species, (b) low-frequency noises (<150 Hz) correlated with ocean tides, (c) transient but frequent broadband noise caused by ice shelf calving and ice motion/break-up, (d) occasional anthropogenic noise from research vessels, and (e) a singular acoustic event caused by the collision of two icebergs in April 2006 roughly 40 km offshore. The received levels of the latter signal exceeded by far the dynamic range of the recording system for more than 10 minutes. The analysis of the signal implied a source level well above 202 dB re 1μPa @ 1 m (rms).

Calving events of the ice shelf occurred year-round, generating prominent acoustic signatures with durations of a few seconds and rise times on the order of 100 ms. From this type of data, a library of nonbiological sounds is being developed within the scope of this study that will describe their characteristics in frequency and time dimensions along with estimates of frequentness and source levels.

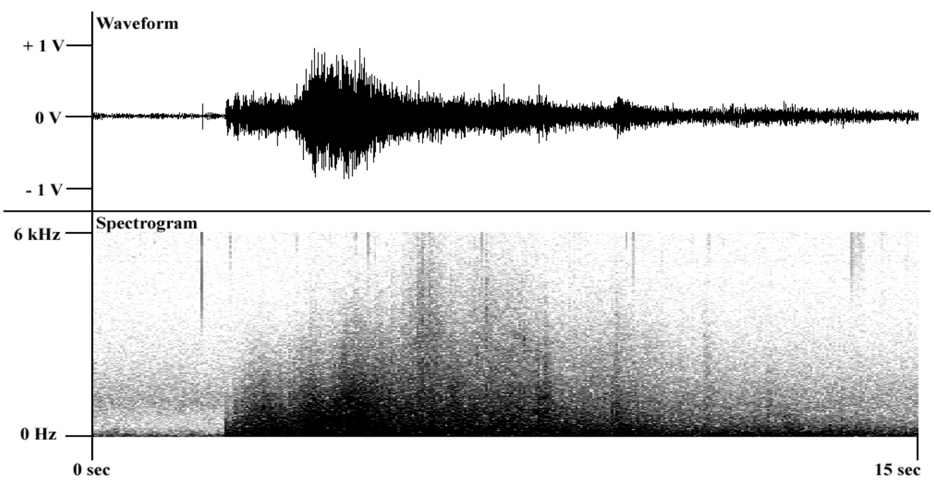


Figure 1. Waveform/Spectrogram of ice shelf calving recorded with PALAOA Station (25-Hz high-pass filtered)

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# AMBIENT NOISE AND ITS SIGNIFICANCE TO AQUATIC LIFE

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## INTRODUCTION

Underwater ambient noise is the background noise from all sources, although it usually does not include sounds from close sources that are individually identifiable, such as a passing ship or a nearby singing whale. Ambient noise provides a basic limitation on the use of sound by aquatic animals because they have to detect acoustic signals of interest against the ambient noise background. Because ambient noise levels vary over a wide range, the distances at which sources are audible also vary substantially. Ambient noise plays a significant part in the acoustic behaviour of aquatic animals. Natural ambient noise is the baseline noise exposure experienced by aquatic animals, and comparison with the underwater noise from human activities may help us to understand the effects of anthropogenic noise.

## SOURCES AND COMPONENTS OF AMBIENT NOISE

The main sources of ambient noise are (a) sea surface noise: the noise of wind and wave action at the surface, usually referred to as wind-dependent noise, and rain noise; (b) biological noise: the noise of fish, whales, and invertebrates; and (c) traffic noise: the noise of distant shipping (Knudsen et al. 1948; Wenz 1962). Wind-dependent noise is the noise breaking waves, but noise levels correlate better with wind speed than with any measure of wave height or sea state. Traffic noise is the background rumble from the many ships in an ocean basin and does not include contributions from ships close enough to be identified individually (Wenz 1962). Ships at long distances can contribute to traffic noise if the propagation of sound is good; so many ships in an ocean basin produce significant traffic noise levels.