Ambient noise in the Bransfield Strait and the Drake Passage, Antarctica: Temporal and spatial variations

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INTRODUCTION

In November of 2005, NOAA/OSU began long-term hydroacoustic monitoring of the waters in the Bransfield Strait–Drake Passage region using an autonomous hydrophone (AUH) array. The primary objective is to detect, locate, and analyze the distribution of earthquakes in the region where little previous information exists. From the tropic to the mid-latitude areas, noise from ship traffic, wind, rain, earthquakes, and biological activities dominate the low-frequency spectrum. In the polar region, however, our first year result indicates that ice noise plays an important role in the total noise budget and seasonal noise level variations. We discuss preliminary analysis on the spatio-temporal variation of the 2005–2006 ambient noise in the Bransfield–Drake Passage region and compare these results with the data from the past AUH deployments in other regions.

UNDERWATER ACOUSTIC NOISE IN THE SOUTHERN OCEAN

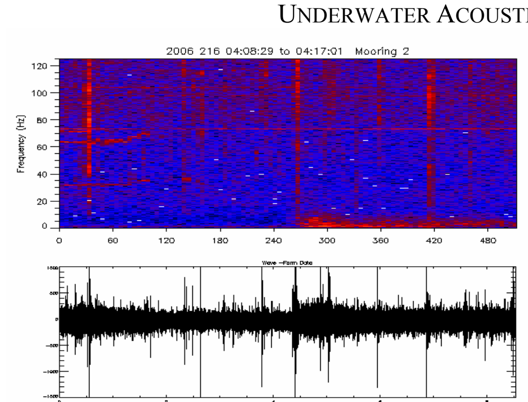
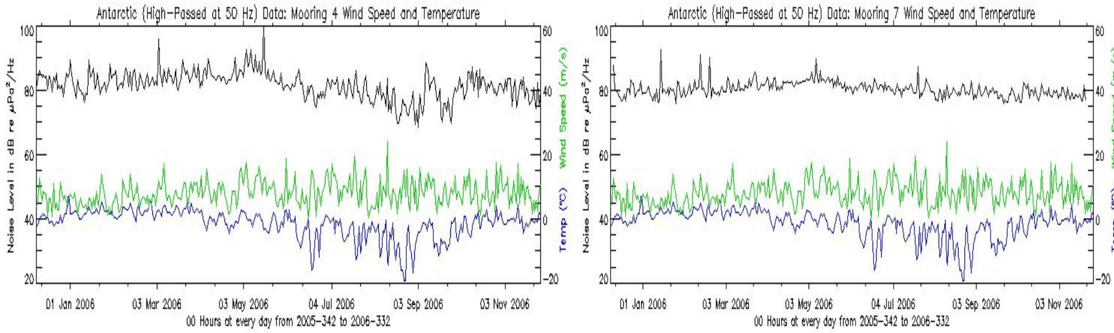


Figure 1. Spectrogram (top) of the mooring 2 data and corresponding time series (bottom) on day 216, 2006.

A total of seven AUHs were deployed from *R/V Yuzhmorgeologiya* including six in the Bransfield Strait and one in the Drake Passage. Each AUH was moored at 500 m below the water surface with a low stretch cable with an anchor on the seafloor. All instruments recorded the acoustic data continuously for one full year at 250Hz sampling rate with 2-byte resolution.

Figure 1 is the spectrogram and time series at mooring 2 on the date 216 (Aug. 3), 2006. The 2005–2006 data indicate that there are two types of ice noises; one is generated by an iceberg and characterized as a long-lasting tone accompanied by a series of harmonic overtones at integer spectral spacing [*Taladier et al.,* 2006]. On the left corner of the spectrogram, two trailing end of base tone of 32Hz and the second harmonic of the ice tremor are visible. The origin of this ice tremor was determined to come from A-53 iceberg near Clarence Island (~200km from the mooring). The other type is a wide-band impulsive noise caused by fissuring and cracking due to thermal deformation and/or wind stress [*Pritchard,* 1990]. Between 40 Hz and 120 Hz, impulsive wide-band signals are present in the background but it appears that there is no recognizable pattern. These spike-like signals are ubiquitous at all hydrophone locations. Average noise energy densities between 50 and 110 Hz at two moorings were plotted as a function of date for one year from November 2005 to November 2006 (Figures 2a and 2b). The wind speed and the air temperature records at the nearby S. Korean Antarctic base, *King Sejong Station* (62°13'S,58°47'W), were also plotted for comparison. At all the moorings the trend was a gradual increase of the ambient noise starting in mid October as the austral spring begins and the ice starts thawing. The upward trend of the noise level continued through the end of austral fall until April when the air temperature started falling below freezing. The noise level was highest in mid May. The lowest noise level was found in August through September, which coincided with the lowest air temperatures of 2006.



(a) Mooring 4 inside the Bransfield Strait (b) Mooring 7 in the Drake Passage (open sea)

Figure 2. Ambient noise levels at two hydrophone moorings off Antarctica (black) with wind speed (green) and air temperature (blue) records at *King Sejong Station* (62°13'S,58°47'W).

For comparison, the noise levels from the past AUH deployments were plotted in Figure 3. The average noise level at the EPR (East Pacific Rise - red) was about 70 dB with almost no seasonal changes, whereas off Antarctica (mooring 4) was 70–90 dB (light blue). The Mid Atlantic Ridge (MAR-32^{o}N, 33^{o}W) was roughly 75–90 dB (Green) with frequent noise level changes, which is likely related to heavy ship traffic in the region. In the Gulf of Alaska (50^o–145^{o}W), the noise level was 77–85dB, which is slightly lower than the MAR value. In both regions in the northern hemisphere, the noise minimum occurred during the summer months, and the highest noise levels were observed in spring.

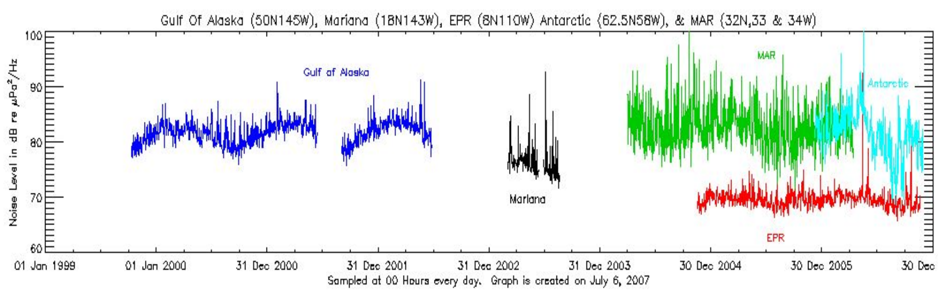


Figure 3. Ambient noise levels in μPa^2/Hz (50-110Hz average) in different oceans

DISCUSSION

The Bransfield Strait and the Drake Passage off Antarctica exhibit a relatively high level of the low-frequency ambient noise. There is clear evidence that the air temperature influences the ambient noise level in the polar region. As glaciers, icebergs, ice sheets, and ice floes thaw or refreeze as the temperature rises above or falls below freezing, the processes appear to generate and project impulsive wide-band cracking sounds into the water column making the polar region a noisy place. As a result, there is a definite seasonal pattern in noise level with noise maximum in May and the minimum in August to September. The wind speed seems to influence the noise level as well. Whether it is due to an increased occurrence of ice breakups by the wind stress or increased frequency of the breaking waves remains unclear. The noise level in the Drake Passage fluctuates less than that measured inside the Bransfield Strait due to the fact that the hydrophone was in the open sea. Despite the distance from the Antarctic continent, the ambient noise level was still the same as that measured inside the Bransfield Strait and of the same seasonal pattern. This suggests the ice noise from Antarctica may not be negligible in the total noise budget of the world's waters and to some degree may contribute to the increase of the world-wide noise level.

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