

Measurement of low-frequency underwater noise by a self-recording hydrophone

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I. INTRODUCTION

Ambient noise in the sea is used for monitoring wind speed and rainfall on the sea surface, as well as for tracking whale migration routes. In particular, low-frequency ocean noise has recently been of concern with relation to the behavior of marine mammals [1]. Low-frequency ambient noise in the deep sea has been increasing over the past few decades due to increasing ship traffic [2]. Mechanical noise such as flow noise and cable strumming noise may be induced if low-frequency ocean noise is measured by cabled hydrophone in high current areas [3]. A self-recording hydrophone was developed to use for measuring low-frequency underwater noise in a shallow sea with strong current. The configurations and specifications of the self-recording hydrophone are introduced, and measurement results of low-frequency ocean noise using the self-recording hydrophone are presented.

II. EXPERIMENTAL MEASUREMENTS

Low-frequency underwater noise at a site on the coast of the South Sea of Korea was measured for one day in October 2006. Measuring instruments were arranged as shown in Figure 1. The self-recording hydrophone was deployed on the sea bed about 1 km from a research vessel. Two cabled hydrophones from the vessel were suspended at depths of 40 m and 20 m, respectively. The self-recording hydrophone consists of a hydrophone sensor, filters and amplifiers, a CPU with an analogue to digital converter and a controller, memory, clock, and batteries. The hydrophone sensor receives underwater sound waves and converts them to electric signals when the hydrophone turns on by a controller through a clock. The signal is filtered and magnified by the filters and the amplifiers. Then the signal is digitized by 16 bits and with 4096 Hz by the analogue to digital converter and is stored in the memory. Wind speed, current velocity, and ship traffic were measured during noise measurement as environment variables. Wind speed was measured at an interval of 1 minute by an anemometer. Current speed was measured at an interval of 5 minutes by an ADCP (Acoustic Doppler Current Profiler) and ship traffic was observed at an interval of 5 minutes by a portable radar. Ocean noise spectrum data in a frequency range of 10 Hz to 1000 Hz were acquired by averaging for 30 seconds at an interval of 5 minutes if there was no ship traffic within a 5.6-km radius around the site.

III. RESULTS

Figure 2 shows mean noise spectrum level measured by the self-recording hydrophone. In this figure, mean noise spectrum levels measured by the cabled hydrophones are also shown. In the frequency range of 64 Hz to 1000 Hz, the noise spectrum levels measured by the self-recording hydrophone were almost the same as the levels by the cabled hydrophones. But in the frequency band of 10 Hz to 63 Hz, the noise spectrum levels measured by the self-recording hydrophone were 3 dB to 25 dB lower than the levels by the cabled hydrophones. This tendency was remarkable in the frequency range of 10 Hz to 25 Hz. Figure 3 shows ocean noise level at 20 Hz and 100 Hz versus current velocity. And in this figure, the correlation coefficient (r) is also shown when the noise level is approximated to linear regression on the current velocity. The 100-Hz noise level and the 20-Hz noise level measured by the self-recording hydrophone were not related to the current velocity, but the 20-Hz noise level measured by the cabled hydrophones was closely related to the current velocity. Flow noise and cable strumming noise seem to be added in the 20-Hz noise level measured by the cabled hydrophone. Figure 4 shows ocean noise level at 20 Hz and 100 Hz versus wind speed. The noise level at 100 Hz and 20 Hz frequency was not closely related to the wind speed.

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IV. CONCLUSIONS

A self-recording hydrophone was developed to measure low-frequency ocean noise. The measurements of low-frequency noise in a shallow sea where current was relatively strong were shown to be reasonable.

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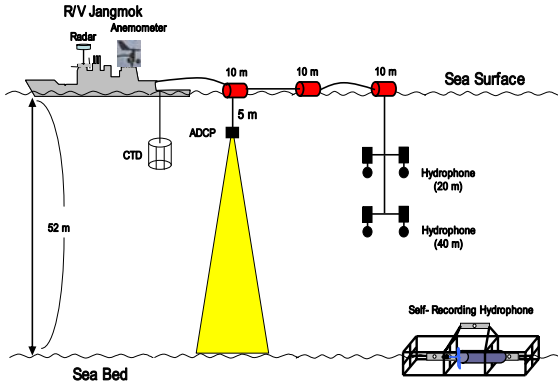


Figure 1. Arrangement of measuring instruments.

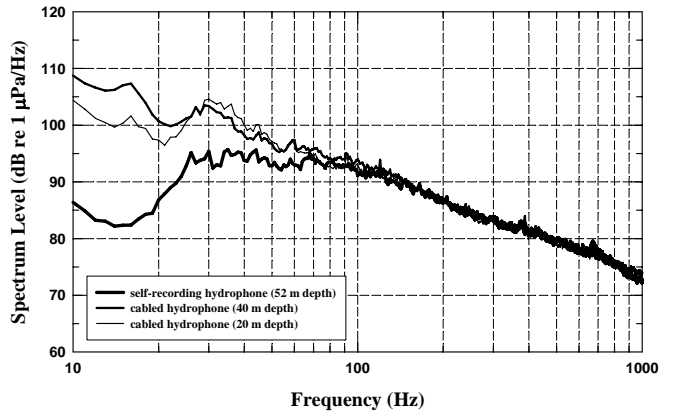


Figure 2. Averaged underwater noise spectrum level.

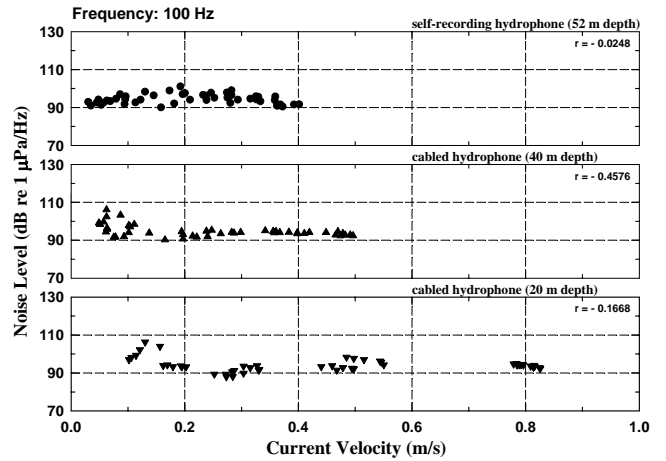
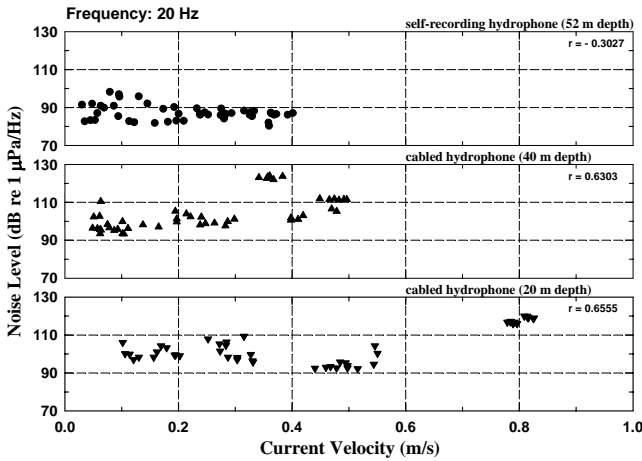


Figure 3. Underwater noise level at selected frequency versus current velocity.

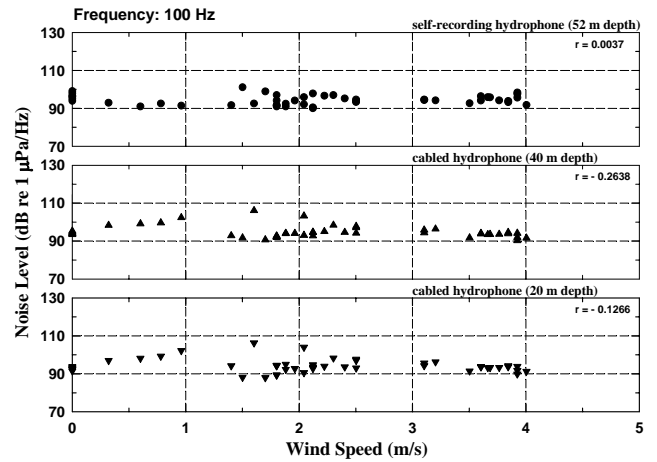
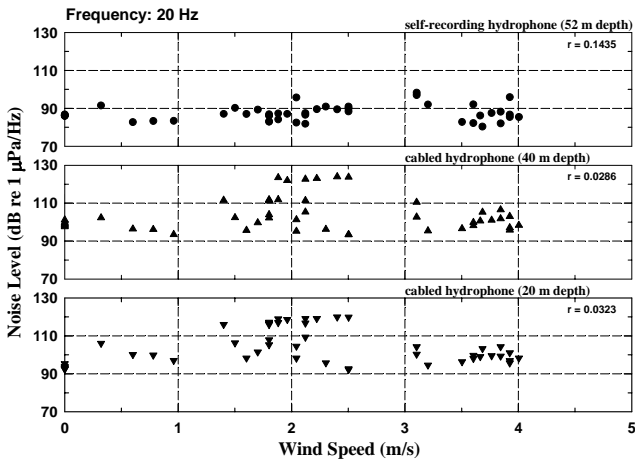


Figure 4. Underwater noise level at selected frequency versus wind speed.