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Short Range Sound Propagation Characteristics at Shallow Hashirimizu Port

浅い走水港における短距離の音波伝搬特性

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1. Introduction

Ocean environmental monitoring is with acoustic method is one of the useful way to monitor wide area at one time. Because the effect of the environmental changes of the acoustic travel path reflect to the travel time of acoustic and its attanuations, it is possible to get average changes of the travel path. Especially, changes of temperature and current speed have large effect to the travel time. Acoustic tomography method make it possible to get spatial changes of temperature and current speed in the ocean with several transeivers[1)]. It is great advantage over other monitoring method because it is impossible to monitor wide area at one time using traditional mothods like thermocouples[2-4)].

We have put a pair of transievers at Hashirimizu port in Yokosuka since 2006, intermittently[5-7)]. The distance between the transievers is only about 120 m and the depth around the area is about 5 m. The 7th order M-sequenced signal with 80 kHz career frequency was transmitted reciprocally. As the travel distance is very short and the very shallow area, the received sound include not only the direct signal but also many reflected signals from bottom, surface and banks around the port. As the travel time difference of those reflected signals and direct signals were very short so it was really hard to clearly separate them[6)]. But in some part, it became possible to separate in several groups. In this paper, we will show the result of peak tracking from the correlated signals.

2. Experiment

The transducers were located on the bank of Hashirimizu port in Yokosuka. The port is surrounded by breakwaters so heavy ship noises from the Tokyo Bay were all shut down by the breakwaters. The port connected to the Tokyo Bay at the left top of Fig. 1. So, it is very calm port except some snapping shrimp noises. The transducers were set about 1m from the bottom of the sea near the bank. All equipment which includes

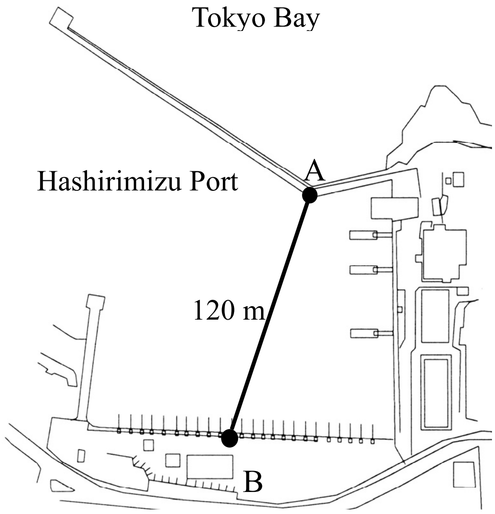

Fig. 1 Map of the experimental area

function generator, power amplifier, filters, AD/DA converters, GPS receiver, and computer, were put in a watertight container. The power for the equipment was supplied by cable from the land. The recorded sound was stored in a HDD of a PC and transferred by LAN cable to the land. Therefore, it is possible to continue the experiment for long term. GPS receiver provides accurate pulse so that the systems can be synchronized with each other. A transducer sends 4 times repeated 7th order M-sequence phase modulated signal which is created at a function generator and amplified to a suitable level when the trigger signal occurs. At the same time, the opposite system starts recording received signal from the transducer by the trigger signal. The received signal is filtered and stored in a computer. As it should send the same time from both system to get the reciprocal sound propagation data, it is impossible to switch the sending and receiving within a second. Therefore, the systems change their task, sending and receiving, 30 s after the first sound propagation event. As there is 30 s time delays in the reciprocal sound propagation data, we will ignore the delay in signal analysis. It is important to know the environment changes around the experimental area to understand the effects to the sound propagation.

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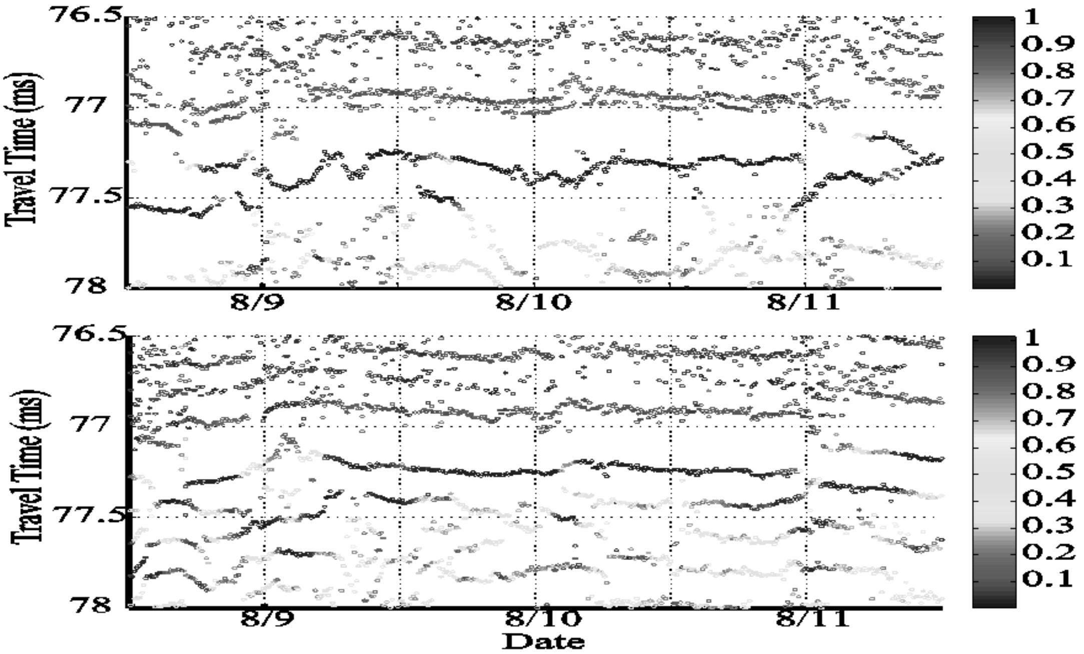

Fig. 2 Peaks of correlated signals from the location A to B (upside), and B to A (downside) in Fig. 1.

A conductivity, temperature and depth (CTD) profiler was located near the transducer.

3. Results

Received signal were correlated with the sample signal, removed career frequency and calculated amplitude component. Then peaks of the amplitude component indicate the travel time of the direct propagated signal and other reflected signals. Since these analyses, it is required to track one peak travel the same path among the experimental period. To track the correct peak, all peaks were marked on each amplitude component of cross-correlated signal as shown in Fig. 2 shows the time series of the peaks of amplitude component from 9th to 12th of August. Although the data were recorded every 5 minute, this figure shows data of every 20 minutes. The time resolution is also reduced for display. Each correlation signals were normalized with its maximum value. We could confirm several peak lines through the experiment period. The received reciprocal peaks pattern was quite different. It may cause by the difference of seabed reflections. Especially, the time series of the biggest peak were completely different movement in reciprocal results. On the other hand, the small peaks before the biggest peak look similar in reciprocal propagations. The reciprocal travel time difference of the small peaks was quite small. The time series of the small peaks almost follows the changes of water temperature shown in Fig. 3. It may possible to estimate flow along the propagation path using these reciprocal travel times.

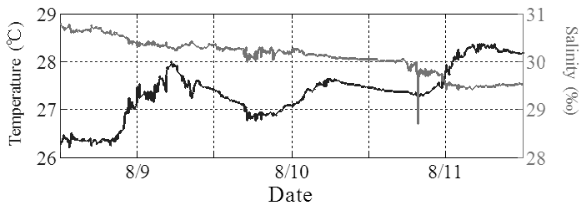

Fig. 3 Temperature and salinity at the port

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