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Tank Experiment for Backscattering Measurements from Rough Bottom Interfaces

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1. Introduction

Sound propagation in shallow water undergoes acoustic interactions with both sea surface and bottom interfaces, causing reverberation effects. Especially, in case of a downward refracting sound speed profile, the important ray paths consist of the bottom-interacting paths. There have been several efforts to investigate the physics of bottom scattering mechanisms [1-4]. In general, the high-frequency backscattering from ocean seafloor consists of scattering at the water-sediment interface and scattering caused by inhomogeneities below the sediment interface. It is important to measure the bottom roughness profile to understand the bottom scattering mechanisms. The bottom roughness spectra have been estimated using a variety of techniques, including electrical resistivity probe, sidescan sonar, stereo photography, laser line scanning, and multi-beam echo sounder.[1, 5-8]

In this study, to investigate the relationship between the bottom roughness and the bottom backscattering at rough bottom condition, bottom interface roughness and 50-kHz bottom backscattering strengths were measured for two-different types of roughness, which were artificially formed on a sandy bottom in the water tank. The measured bottom backscattering strengths will be discussed in comparison with the model predictions obtained using the measured rougness spectra in this paper.

2. Estimation of Bottom Roughness Spectra

Bottom backscattering experiments were made in a water tank (dimension: 5×5×5 m). The bottom consists of a sand layer with mean grain size of 0.9 ϕ, where $\phi = \log_2 (d/d_0)$, d is the grain diameter in millimeters, and d_0 is the reference length, equal to 1 mm. The sand bottom was divided into two parts with different bottom roughness types (smooth and rough interfaces).

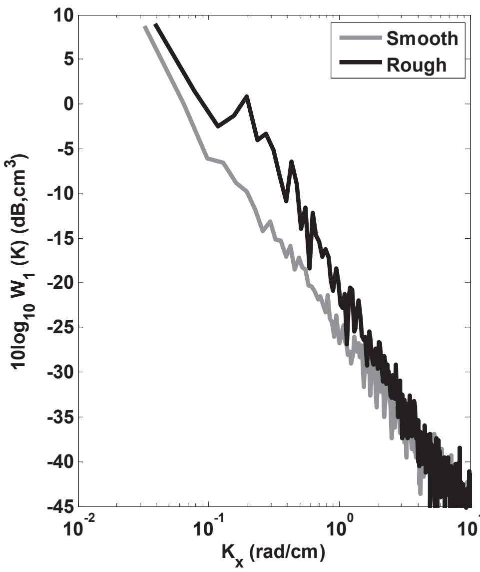

Fig. 1 1-D Mean power spectra of smooth bottom (gray line) and rough bottom (black line).

To measure the bottom roughness profiles, a 5-MHz directional transducer (A309R, PANAMETRICS) was positioned at 5-9 cm above the bottom interface, and moved out at steady speed of about 1.0 cm/sec. The 1-dimensional (1-D) profiles of roughness interfaces were estimated by the arrival time analysis of echo signals returned back from the interfaces, and then were Fourier transformed to obtain the roughness power spectrum (**Fig. 1**)

3. Measurements of Bottom Backscattering Strengths

Bottom backscattering strengths as a function of grazing angle were measured using a 50-kHz directional transducer (TC2116, RESON). The

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transducer was deployed about 1 m above the bottom interface. A 0.2-ms-long continuous wave (CW) was used as a source signal, which was repeatedly transmitted into 30 different sub-areas on the bottom for each grazing angle.

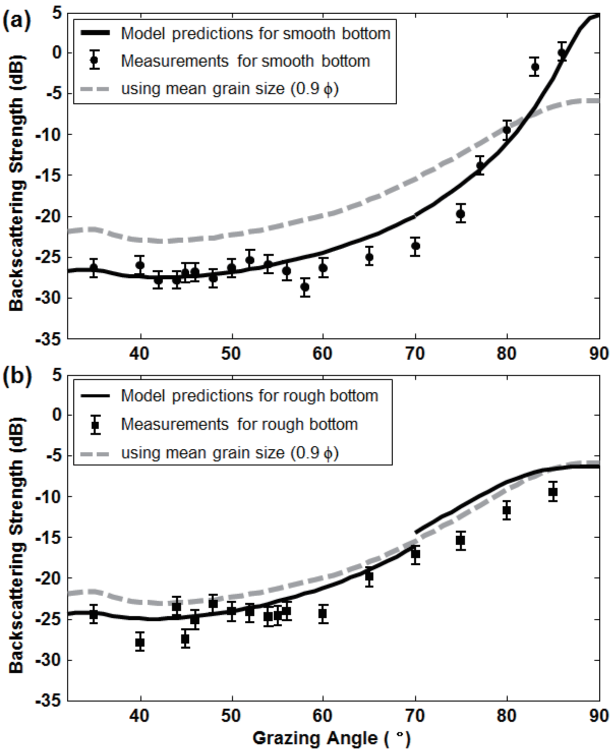

Fig. 2 Measured bottom backscattering strengths compared with the model predictions for (a) smooth and (b) rough interfaces. Dashed line represents the model output predicted using mean grain size only as a input parameter. Solid line is the model outputs predicted from the theoretical model using the measured roughness parameters.

Figure 2 shows comparisons of the measured backscattering strengths with a theoretical model predictions obtained by the APL-UW high-frequency scattering model [1]. The measured backscattering strengths were in reasonable agreement with the model predictions obtained using the measured roughness spectra for both smooth and rough bottom cases. However, model outputs obtained using the grain size only did not match well with the measurements.

In conclusion, the results showed that the bottom interface profile was a predominant contributor to bottom scattering in case of sandy bottom.

Acknowledgment

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References

1. D. R. Jackson and M. D. Richardson: *High-Frequency Seafloor Acoustics*, (Springer, New York, 2007).
2. H. La and J. W. Choi: J. Acoust. Soc. Am. **127** (2010) EL160.
3. D. R. Jackson and K. B. Briggs: J. Acoust. Soc. Am. **92** (1992) 962.
4. K. L. Williams, D. R. Jackson, D. Tang, K. B. Briggs, and E. I. Thorsos: IEEE J. Oceanic Eng. **34** (2009) 388.
5. K. B. Briggs : IEEE J. Oceanic Eng. **14** (1989) 360.
6. D. Tang : IEEE J. Oceanic Eng. **29** (2004) 929.
7. W. K. Stewart, D. Chu, S. Malik, S. Lerner, and H. Singh : IEEE J. Oceanic Eng. **19** (1994) 599.
8. A. P. Lyons, T. Akal, and E. Pouliquen : Proceedings Oceans'98 (1998) 129.
9. C.-C. Wang, B. T. Hefner, and D. Tang : IEEE J. Oceanic Eng. **34** (2009) 466.