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Normal Mode Propagation over Range-Dependent Seabed with Weak Shear Rigidity

Oleg A. Godin
Physics Department, Naval Postgraduate School,
Monterey, California 93943, USA
oagodin@nps.edu

Weak shear rigidity of stratified marine sediments has a much stronger effect on dispersion of bottom-interacting normal modes and especially on sound attenuation than it is predicted assuming a homogeneous seabed [1]. The effects originate from the compressional-to-shear wave conversion, with the strongest conversion occurring at interfaces where density is discontinuous within the sediment. In range-independent waveguides, shear wave interference within thin sediment layers leads to rapid, quasi-periodic variation of modal attenuation [1] and group speed [2]. Weak shear rigidity gives significant contributions to sound attenuation [1] and leads to large changes in the group speed [2] in range-independent waveguides even when the soft sediment layers are thin compared to the compressional wave wavelength. This paper presents results of an analytical study of the shear wave-induced perturbations in the normal mode phase, travel time, and attenuation in range-dependent waveguides when water depth and/or sediment layer thickness vary gradually with range. We show that the effects of weak shear rigidity manifest differently at long-range propagation in range-dependent and range-independent waveguides. Frequency dependencies of the adiabatic normal mode travel time and attenuation are found to be highly sensitive to range dependence of the seabed layering. Gradual variation of the sediment layer thickness with range is found to have an effect akin to frequency averaging or artificially increased shear wave absorption. Implications of these findings for quantifying weak shear rigidity by acoustic means will be discussed.

Keywords: ICTCA 2023; unconsolidated sediments; shear waves; normal mode dispersion.

References

[1] Godin OA. Shear waves and sound attenuation in underwater waveguides. J Acoust Soc Am 2021; 149:3586–98.
[2] Cristini P. Personal communication. 2022.