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Validation of 3-dimensional ocean acoustic propagation models from benchmarks to global problems

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The ocean is an excellent medium for the propagation of low frequency sound, so much so, that the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) can monitor all the world's oceans for nuclear tests with a small number of hydroacoustic stations (with multiple underwater hydrophones for triangulation) distributed around remote regions of the earth. The classification and localization system has been developed based upon 2-dimensional (2D) acoustic models, were the effects of horizontal refraction and diffraction have been ignored. These effects have been shown to have a large impact on the energy received behind (and reflected from) islands and seamounts. To demonstrate the maturity of modern 3-dimensional (3D) models, a set of test-cases were developed including: a benchmark (5°) wedge, a shallow water twin conical seamount case, a deep-water long-range island and seamount and the reconstruction of the acoustic propagation from the estimated source location of the hydroacoustic anomaly associated with the loss of the ARA San Juan off the coast of Argentina in 2017 to a receiving IMS hydroacoustic station. The models compared include two 3D Parabolic equations and the Bellhop3D raytrace algorithms. Comparisons show quantitative agreement between the models. The expectation is that this validation will provide a way forward to incorporate various combinations of these models into the CTBTO detection, classification and localization processing algorithm.