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Multiple forward scattering through an ocean waveguide with 3-D random inhomogeneities

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Analytic expressions have been derived for the mean and spatial covariance of the acoustic field multiply forward scattered though a stratified ocean waveguide containing 3-D random surface or volume inhomogeneities [Ratilal and Makris, J. Acoust. Soc. Am. 118, 3532-3559 (2005)]. These expressions are further used to derive the temporal coherence of an acoustic signal propagated through 3-D random inhomogeneities. Field moments are given in terms of moments of the scatter function density of the 3-D random inhomogeneities, which enables straightforward application to a broad range of 3-D scatterers. Here we give examples of the attenuation, dispersion and loss of temporal coherence expected after multiple forward scattering through (1) random internal waves in both continental shelf and deep ocean environments, (2) fish schools, and (3) random wind-generated bubbles in continental shelf and surf-zone area. We show that 3-D scattering effects become important when the Fresnel width exceeds the cross-range coherence scale of the inhomogeneities, and can lead to substantial power loss.