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Clustered scatterers: the effect on the mean acoustic field

Thomas Weber

University of New Hampshire, Ctr. for Coastal and Ocean Mapping, 24 Colovos Road, Durham, NH 03824,
USA

Clustering, or spatially dependent correlation in the fluctuating number density of discrete scatterers of sound, is commonly found to occur in nature. In the ocean, clustering can occur as a result of scatterer entrainment in fluid flows, as in the case of particles and bubbles, or, in the case of fish, as a result of the behaviour of the scatterer. In either case, the presence of clustering can dramatically alter the effect of the scatterers on acoustic fields from that which would be predicted from the same scatterer population but without clustering. The effect of scatterers on the mean acoustic field is often treated using an effective medium wave number. In this paper, a modification to the effective medium number that accounts for clustering is presented and examined for the case of propagation through bubble clouds. Attenuation predictions over a broad range of frequencies (10-350 kHz) using observations of bubble clustering under oceanic breaking waves will be discussed.