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Acoustic scattering from double-diffusive microstructure

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Laboratory measurements of high-frequency broadband acoustic backscattering (200-600 kHz) from the diffusive regime of double-diffusive microstructure have been performed. This type of microstructure, which was characterized using direct microstructure and optical shadowgraph techniques, is identified by sharp density and sound speed interfaces separating well-mixed layers. Acoustic backscattering measurements were performed for a range of physical parameters controlling the double-diffusive microstructure. The echoes have been analyzed in both the frequency domain, providing information on the spectral response of the scattering, and in the time domain, using pulse compression techniques. High levels of variability were observed, associated with interface oscillations and turbulent plumes, with many echoes showing significant spectral structure. Acoustic estimates of interface thickness, obtained for the echoes with exactly two peaks in the compressed pulse output, were in good agreement with estimates based on direct microstructure and optical shadowgraph measurements. Predictions based on a one-dimensional weak-scattering model that includes the actual density and sound speed profiles agree reasonably with the measured scattering. A remote-sensing tool for mapping oceanic microstructure, such as high-frequency broadband acoustic scattering, could lead to a better understanding of the extent and evolution of double-diffusive layering, and to the importance of double diffusion to oceanic mixing.