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High-frequency broadband acoustic scattering for investigating double- diffusive convection

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Polar regions, with their supercooled and relatively fresh surface water, are highly susceptible to the diffusive regime of double-diffusive convection (DDDC). The fluxes associated with DDDC can play a significant role in their heat/buoyancy budgets. The use of high-frequency acoustics as a tool to map the extent and evolution of DDDC in the ocean is explored through a series of laboratory 200-300 kHz broadband acoustic backscattering measurements. Pulse compression signal processing allows centimeter-scale interface thicknesses to be rapidly and remotely measured, and the evolution, and ultimate merging, of multiple centimeter-scale interfaces to be observed. Combining the acoustically measured interface thicknesses with knowledge of the relatively-constant temperatures within the surrounding layers allows the estimation of DDDC fluxes. Thus, broadband acoustics offers a rapid and remote method to infer fluxes, without the need for time-consuming microstructure measurements, suggesting that this technique could benefit field studies of DDDC. Using simple models to extrapolate to the thermohaline steps typically found associated with DDDC in polar regions, diffusive-convection interfaces are predicted to scatter at measurable levels in many areas. Narrowband (120 and 200 kHz) acoustic backscattering observations of two scattering layers in the Western Antarctic Peninsula support this prediction.