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Retention of oil droplets rising in a stratified fluid: Part 2. Dynamics[1] TRACY MANDEL, DE ZHEN ZHOU, University of California, Merced, LINDSAY WALDROP, Chapman University, MAXIME THEILLARD, DUSTIN KLECKNER, SHILPA KHATRI, University of California, Merced — During the Deepwater Horizon oil spill in 2010, about 5 million barrels of petroleum were discharged from the Macondo Well into the Gulf of Mexico. Oceanographic studies (McNutt, 2012) have estimated that approximately 40 percent of that oil was trapped beneath the ocean surface, primarily in regions with strong oceanic density gradients. The present work aims to quantify and explain retention of an oil droplet rising through a transition between two homogeneous-density fluids. Using laboratory experiments, we examined droplet behavior for a range of drop densities, drop sizes, and ambient stratification profiles. A droplet is significantly slowed by its interaction with the ambient stratification over a characteristic timescale, which coincides with the decay of the trailing column of entrained fluid. These dynamics are independent of the far-field nature of the droplets wake. This timescale over which fluid is entrained is found to be dependent on the drop Froude number. Significant retention only occurred for $Fr < 1$, suggesting that retention is primarily a function of the ratio of the buoyancy timescale $(1/N)$ to the drop motion timescale (d/U), and that trapping dynamics are dominated by the effects of stratification.

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