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Retention of oil droplets rising in a stratified fluid: Part 1. Kinematics[1] DE ZHEN ZHOU, TRACY MANDEL, University of California, Merced, LINDSAY WALDROP, Chapman University, MAXIME THEILLARD, DUSTIN KLECKNER, SHILPA KHATRI, University of California, Merced — During the 2010 Deepwater Horizon oil spill, about 5 million barrels of petroleum discharged from the Macondo Well into the Gulf of Mexico. Oceanographic studies (McNutt, 2012) estimated approximately 40 percent of that oil was trapped beneath the ocean surface, primarily in regions with strong oceanic density gradients. This work aims to quantify and explain retention of an oil droplet rising through a transition between two homogeneous-density fluids. Our laboratory experiments analyzed the rising motion of single droplets penetrating a finite stratification between salt-water and freshwater. We compared droplet behavior for a range of drop densities, drop sizes, and ambient stratification profiles. We observed that droplets experienced significant slowdown as it passed through the stratification. We characterized the droplet slowdown by delineating two droplet motion timescales: entrainment time, the span of time droplet velocity was less than the upper layer terminal velocity, and retention time, the span of time the droplet was retained in the transition layer. We observed a strong relationship between the two metrics, where retention time is a function of the length of time that dense fluid is entrained and the magnitude of the droplet's slowdown.

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