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Predicting The Intrusion Layer From Deep Ocean Oil Spills
DAYANG WANG, AARON CHOW, E.ERIC ADAMS, Massachusetts Institute of Technology — Oil spills from deep ocean blowout events motivate our study of multiphase plumes in a water column. Key to understanding the long-term fate of these plumes is the ability to predict the depth and persistence of intrusion layers. While intrusion layers from multiphase plumes have been studied under stagnant conditions, their behavior in the presence of crossflow, especially in mild crossflow, remains poorly understood. The classical classification of plume behavior identifies two regimes: crossflow-dominant and stratification-dominantbut it does not account for the interplay between the two effects, leaving the transition region unexplored. We conduct laboratory tank experiments to investigate the behavior of intrusion layers under the simultaneous action of crossflow and stratification. Our experiments use an inverted frame of reference, using glass beads with a range of sizes to simulate oil droplets. We find that crossflow creates enhanced mixing, which in turn leads to a shallower intrusion layer of the released fluid (correspondingly, a deeper layer in the case of a deep ocean blowout). We develop a mathematical formulation that extends previous models to account for crossflow effects, and use field observations to validate the analytical and experimental findings.

Dayang Wang
Massachusetts Institute of Technology

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