Abstract Submitted
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Droplet Impact onto an Immiscible, Floating Oil Layer: Splash Behavior and Droplet Sizes[1] DAVID MURPHY, CHENG LI, VINCENT D'ALBIGNAC, DAVID MORRA, JOSEPH KATZ, Johns Hopkins University — The high speed impact of a raindrop on a fluid surface at $\mathrm{We_d} = \rho \mathrm{u}^2\mathrm{d}/\sigma > 2000$ affects environmental processes like marine aerosol production. High speed imaging shows that a floating immiscible oil layer, such as a crude oil slick, modifies the splash behavior. Tests performed for a wide range of layer thicknesses (h), viscosities, and surface and interfacial tensions facilitate behavioral categorization in terms of $\mathrm{We_h} = \rho_\mathrm{h}\mathrm{u}^2\mathrm{h}/\sigma_\mathrm{h}$ and $\mathrm{ReFr_h} = \rho_\mathrm{d}\mathrm{u}^3\mathrm{d}/\mu_\mathrm{h}\mathrm{gh}$, where h and d subscripts refer to layer and droplet properties, respectively. Included are multi-layer/level crowns, and due to the high Oh= $\mu/(\rho\sigma\mathrm{d})^{1/2}$ of oil, formation of an intact ejecta sheet within 50 μs after impact, which subsequently ruptures to form aerosolized oil droplets. High speed holographic microscopy provides the size and spatial distributions of airborne droplets, which are bimodal with peaks at 50 and 225 μm. Small droplets (50 μm) are ejected primarily at shallow angles and remain at low elevation by microligament breakup within the first 50 μs of impact. Larger droplets (225 μm) are ejected at a steeper angle and produced later by breakup of larger ligaments protruding vertically from the splash crown. Small droplet frequency at high elevation increases when crude oil is introduced, mostly as satellite droplets resulting from the large ligament breakup.

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