Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

Subsurface Droplet Size Distribution generated as breaking waves entrain an oil slick[1] CHENG LI, JESSE MILLER, JOSEPH KATZ, Johns Hopkins University — Breaking waves are a primary mechanism for entraining and dispersing oil spills. Knowledge of the resulting droplet size distribution is crucial for predicting the transport and fate of this oil. In this on-going experimental study, a controlled oil slick of varying viscosity (μ_d), density (ρ_d), interfacial tension (σ), and thickness δ =0.5mm are entrained by waves of varying energy (E_w). The changes to droplet size over time, from seconds to hours, are measured at several locations using multi-resolution holography, which covers sizes ranging from μm to mm. Using dispersants to reduce σ, the Webber number, $We= E_w\delta/\sigma$, and Ohnesorge number, $Oh= \mu_d/(\rho_d\delta\sigma)^{0.5}$, are varied from 6 to 813 and from 0.09 to 0.95, respectively. Droplets smaller than the turbulence scale (2-30 μm – diameter), are generated by "micro-threading". Their size distribution becomes steeper and their total number increase substantially with decreasing interfacial tension. For slopes smaller than -3, measured for σ around 10^{-1} mN/m, the volumetric size distribution decreases with diameter, i.e. most of the oil breaks into micron-scale droplets. For high interfacial tension oil, the concentration of small droplets increases with wave energy, but this effect diminishes as σ decreases. Droplets larger than 100 μm are generated by turbulent shear. Hence, their number is impacted by μ_d and E_w. Increasing We from 6 to 15 (Oh from 0.09 to 2.95) increases the initial number of droplets by up to 5 times, but the distribution slopes remain largely similar.

[1]Supported by Gulf of Mexico Research Initiative (GoMRI)

Cheng Li
Johns Hopkins University

Date submitted: 01 Aug 2016 Electronic form version 1.4