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Phase-conditioned turbulent statistics of an immiscible buoyant jet in the near-field[1] XINZHI XUE, LAKSHMANA DORA, JOSEPH KATZ, Johns Hopkins University — Simultaneous applications of PIV and PLIF in a refractive index matched facility provide the velocity and phase distribution in the near-field of an immiscible buoyant oil jet in water. Close to the nozzle, vertical momentum exchange occurs as water is entrained and oil ligaments extend outward. Kevin-Helmholtz vortices form in the water with their centers located at the tip of oil ligaments. Further downstream, the momentum diffuses in both phases as the oil fragments into compound droplets. The spreading and decay rates of the centerline oil fraction are lower than those of the axial momentum. Comparison to a single-phase jet at the same Re shows that the transition from azimuthal shear layers to self-similar profiles of velocity and Reynolds stresses occur earlier in the oil jet. The phase-conditioned turbulence reveals differences in velocity and all Reynolds stress components. The peripheral turbulence in the water is higher near the jet exit, but lower at 6-7 diameters downstream, the latter owing to the intermittency of entrained water. Shear production dominants the turbulence production in the periphery of the jet fragmentation region. Near the centerline, the TKE production rate, hence the turbulent kinetic energy, is higher in in the water.

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Xinzhi Xue
Johns Hopkins University

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