E201/ME160 UC Berkeley Ocean Engineering Seminar

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Breaking waves: the dynamics of droplets and the effects of surfactants

By

Dr. Martin Erinin

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Friday, February 9th, 2024, Room: 3110, Etcheverry Hall
2:30- 4:00 PM

Abstract:

Breaking waves play a key role in controlling the exchange of mass, momentum, and energy between the ocean and the atmosphere. Because wave breaking is a highly non-linear and transient phenomena, a number of physical processes associated with it are poorly understood and modeled. In this talk, I will present two topics related to breaking waves. First, through laboratory experiments in a large-scale wind wave tunnel, and using a custom designed high-speed and high-resolution inline holographic system, I will characterize the dynamics and statistics of droplets with diameters ranging from 30 to 4000 micrometers. I will discuss how the droplet velocity and acceleration statistics can be interpreted as a combination of recently emitted droplets and droplets being transported by the turbulent boundary layer. This transport can be represented by a transient transport model for inertial droplets. These results at relatively high wind speed have implications for the modeling of tropical cyclone intensification. Second, I will discuss the role of surfactants on breaking waves. While surfactants are common on the ocean surface, and their impact is related to biological activity and pollution, our fundamental understanding of their effect on breaking waves and fluxes is limited. We show, through the use of carefully controlled laboratory experiments, which vary surfactant concentration, and through numerical simulations, that the effects of surfactants on a plunging breaking wave is controlled by the surface tension gradients. The surface tension gradients are shown to be caused by surface compression and dilatation during the focusing of the breaker and induce Marangoni stresses along the wave crest, which significantly modify the breaking process. Surprisingly, the ambient surface tension of the undisturbed water surface plays a secondary role.

Speaker Biography:

Dr. Martin Erinin is a Postdoctoral Research Scholar in the Mechanical and Aerospace Engineering Department at Princeton University working with Luc Deike. Previously, he obtained his undergraduate and Ph.D. in Mechanical Engineering from the University of Maryland in 2020 working with Jim Duncan. His research focuses on experimental study of free-surface and multiphase flows and is often supported by numerical computation and theory. Most recently he has been interested in studying droplet generation and the dynamics of breaking water waves as well as the transport of droplets in a turbulent boundary layer. Martin was recently recognized as a 2023 Rising Star in Mechanical Engineering.

Hosted by: Prof. Reza Alam, (reza.alam@berkeley.edu)