Mass Transfer at the Ocean-Atmosphere Interface: The Role of Wave Breaking, Droplets, and Bubbles

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Physical processes at the ocean-atmosphere interface have a large effect on climate and weather by controlling the transfer of momentum and mass. Without wave breaking, transport between the ocean and the atmosphere is through slow conduction and molecular diffusion, while wave breaking is a transitional process from laminar to turbulent flow. When waves are breaking, the surface experiences dramatic changes, with sea spray ejection in the atmosphere and air entrainment into the ocean water. In this talk, I will discuss recent efforts in my group toward improving our understanding and modeling of sea spray production through a multi-scale approach. We combine detailed laboratory experiments and numerical simulations on turbulent multiphase flows, including wave breaking, bubble break-up in turbulence, and spray production by bubble bursting together with a statistical description of breaking waves to develop a general theoretical framework. This framework aims to account for the very large range of scales involved in the process, from wave statistics scales of order of km, O(1m-1km), to wave breaking dynamics, O(1-10m), air bubble entrainment, bubble dynamics in turbulence and finally bubble bursting at the first surface, O(microns to mm).

Luc Deike is an Assistant Professor in the Department of Mechanical and Aerospace Engineering and the High Meadows Environmental Institute. Luc Deike joined the faculty in the winter of 2017, he came from the University of California-San Diego, where he has served as a postdoctoral researcher at the Scripps Institution of Oceanography from 2013 to 2016. Deike received his Ph.D. from the University Paris Diderot in 2013 and his M.Sc. and B.Sc. from the École Normale Supérieure in Paris. He received the NSF CAREER award in 2019. His current research focuses on fundamental fluid dynamics with an emphasis on multi-scale systems, motivated by their importance in environmental and industrial applications, including wind waves dynamics at the ocean surface, gas transfer and spray generation by surface breaking waves in the ocean, and multi-phase turbulent flows.

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