

The turbulence along and beneath a free surface

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Abstract: The free-surface dynamics of natural bodies of water determines transport properties at the global scale, e.g., the uptake of CO₂ and the spreading of floating plastics in oceans, rivers, and lakes. Those properties are not easily predictable even in the seemingly simple case of a flat free surface confining homogeneous turbulence. In the presence of sizeable surface deformations, the problem is complicated by the mutual transfer of energy between the bulk flow and gravity-capillary waves. When the latter are driven by wind shear, the coupling enters a new dimension as the mean flow, waves and turbulence exchange energy with each other. I will touch upon fundamental aspects of free-surface turbulence, ranging from the case in which the bulk flow barely deforms the surface; to a condition where it corrugates it dynamically; to the one in which turbulence is created and modulated by wind and waves on the edge of breaking. Those flows are investigated with a suite of experimental facilities and leveraging high-resolution imaging. While the laboratory cannot reproduce full-scale dynamics found in nature, the gained insight can inform novel strategies for modelling and sensing of the upper ocean.

Biography: Filippo Coletti is Professor of Experimental Fluid Dynamics at ETH Zurich, where he has been since 2020. Previously he was McKnight Land-Grant Professor of Aerospace Engineering & Mechanics at the University of Minnesota, which he joined in 2014. He performed his doctoral studies at the von Karman Institute for Fluid Dynamics and at the University of Stuttgart, where he obtained his PhD in 2010, and was postdoctoral fellow at Stanford University between 2011 and 2013. He received the CAREER award in 2015 from the US National Science Foundation and Consolidator grant in 2022 from the European Research Council. He is a fellow of the American Physical Society and associate editor of Journal of Fluid Mechanics. He founded and co-organizes the Fluid Mechanics Tour of the Alps, an itinerant seminar series featuring the world's top fluid mechanicians. His research interests focus on multiphase flows, which he studies with a range of experimental approaches and with applications to environmental, biomedical, and industrial problems.

