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Numerical simulation of breaking waves and Langmuir circulation

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Long streaks of foam and debris are often observed on wind-driven water surfaces. These are caused by Langmuir circulation, which can be thought of as an array of vortices of alternating sign whose axes are aligned with the wind direction. Together with wave breaking, Langmuir circulation is an important source of vertical mixing in the upper ocean.

In the past, numerical simulations of Langmuir circulation have been limited to rigid-lid models where surface-wave effects are parameterized. Consequently, these studies are not able to address wave breaking and its influence on the generation of Langmuir circulation. In the present study, (non-)breaking waves and the generation of Langmuir circulation are simulated by solving the full three-dimensional Navier-Stokes equations, while the free surface is tracked with a volume-of-fluid method.

Results show that the model is capable of reproducing observed features of Langmuir circulation, e.g. its unsteadiness and nonuniform spatial distribution. Moreover, the influence of breaking events on the strength of the Langmuir circulation will be discussed.