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Asymptotically Reduced Equations for Weakly Three-Dimensional Langmuir Turbulence[1] GREG CHINI[2], University of New Hampshire, KEITH JULIEN[3], University of Colorado at Boulder — Ocean observations, numerical simulations and theoretical considerations all suggest that Langmuir circulation (LC) is characterized by counter-rotating vortical structures elongated in the wind direction. We identify the source of this downwind invariance by exploring the Craik–Leibovich (CL) equations modeling LC in the physically-relevant large Re_s limit; here, the Stokes Reynolds number Re_s is based on the Stokes drift velocity of the surface waves and on the depth of the mixed layer. Inspection of the CL equations reveals that the CL vortex force dominates the flow physics when $Re_s \gg 1$, and vortices aligned with the wind direction are preferred. Using multiscale asymptotics, we leverage this limit to derive a reduced set of PDEs governing weakly 3D Langmuir turbulence. Linear and secondary (i.e. nonlinear) stability studies show that the reduced equations economically capture the key 3D instabilities.

[1]GC gratefully acknowledges funding from NSF CAREER Award 0348981.
[2]Mechanical Engineering Department
[3]Department of Applied Mathematics

Greg Chini
University of New Hampshire

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