

Abstract Submitted
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The Craik-Leibovich Vortex Force as a Skin Effect¹ ZIEMOWIT MALECHA, GREGORY CHINI, University of New Hampshire, Program in Integrated Applied Mathematics, Durham, KEITH JULIEN, University of Colorado, Department of Applied Mathematics, Boulder — The CraikLeibovich (CL) equations are a surface-wave filtered version of the instantaneous NavierStokes equations in which the rectified effects of the surface waves are captured through a so-called “vortex force” term:the cross-product of the Stokes, or Lagrangian, mass drift associated with the filtered surface waves and the filtered vorticity vector.For locally generated wind waves, the Stokes drift is very strongly surface confined.In this scenario, the induced body force may be represented as a surface, or skin, effect. Using matched asymptotic analysis in this limit, we derive effective boundary conditions (BCs) for the flow beneath the Stokes drift layer (i.e. in the bulk of the mixed layer). We establish the regime of validity of the resulting formulation by performing linear stability analyses and numerical simulations of both the asymptotic model and the full CL equations for a variety of vertical Stokes drift profiles.The effective BC formulation offers both theoretical and computational advantages, and should be particularly useful for LES of Langmuir turbulence for which the need to resolve very small scale near-surface flow structures imposes severe computational constraints.

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