EXPERIMENTAL STUDY OF WAVE-INDUCED LONGITUDINAL VORTICES

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ABSTRACT: Wind-driven currents in estuaries, lakes, and the ocean are often observed to include strong longitudinal vortices, known as Langmuir cells. To test experimentally the theory developed by Craik and Leibovich that these cells arise through wave-current interactions, we superimposed mechanically generated waves on a turbulent channel flow. Our results show that streamwise vortices can form through wave-current interaction described by Craik and Leibovich: The vertical component of the mean vorticity can be rotated by the sheared Stokes' drift current of the waves to produced longitudinal vorticity. In the present configuration, the main sources of vertical vorticity are the boundary layers on the sides of the channel. Nonetheless, given the fact that longitudinal vortices like these enhance mixing, our experiments suggest that wave-current interactions can contribute significantly to near-surface mixing in many water bodies. Thus, the connection between waves and mixing that Keulegan and Brame sought to make when they studied mixing by wind waves does seem to exist, albeit with a somewhat different physical basis than they described.