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Friction-Induced Roll Motion in Short-Crested Surface Gravity Waves

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ABSTRACT

Induced streaming due to deep water surface gravity waves propagating at oblique angles to each other is studied theoretically on the basis of a Lagrangian description. The ocean is slightly viscous, and the primary waves are maintained at constant amplitude by a suitably adjusted small wind stress distribution at the surface. The induced secondary motion in the nonrotating case consists of parallel rolls with axes aligned along the wave propagation direction, and a horizontally undulating Stokes drift. Surface convergence in the roll motion occurs at lines through nodal points of the primary wave system, and downwelling occurs below them. The surface value of the undulating Stokes drift has a minimum at these nodal points if the angle between the crossing waves is less than 76.4°. If this angle is larger than 76.4°, the Stokes drift at the surface has a maximum here. The roll motion described in the present paper is discussed in connection with the basis for the recent theoretical development of Langmuir circulations. Finally, a solution for the steady, horizontally averaged drift current in a rotating ocean is presented.

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