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Stokes drift induced by a ring wave on a shear current of linear depth dependence

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We investigate the weakly nonlinear dynamics of gravity ring waves at infinite depth under the influence of a shear current varying linearly with depth. The shear field makes this problem three-dimensional in nature and, though it cannot be treated using potential theory, a solution is permitted via integration of the Euler equations. These solutions are derived to second order of the perturbation amplitude, yielding the nonlinear mass transport effects (Stokes drift) in the ring waves. The shear field is found to interact with the wave perturbations in a way that alters the transient Stokes drift due to the ring wave, supplying directional dependence. Integrating numerically, we investigate this interaction and examine the mass transport away from the perturbation origin.

The shear field is observed to deform the otherwise circular transport it two ways. First, it alters the wave field emitted from the initial disturbance. Second, the Stokes drift generated at any specific wavenumber is modified by the shear interaction. Calculations of particle paths due to wave motion are shown, and we demonstrate how these become elliptical to linear order in deep water.