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Shallow-Water Theory for Wave–Current–Bottom Interactions

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A new shallow-water theory valid for wave-current-bottom interactions with arbitrary depth and unsteady horizontal currents is derived by Hamilton's canonical equations for surface waves, which constitutes a systematic hierarchy of partial differential equations for linear gravity waves in the near shore region. The first and second members of this hierarchy, the Helmholtz equation and the mild-slope equations of Berkhoff (1972) for pure waves and of Kirby (1984) with current, are second order. The third member is fourth order but may be approximated by Miles & Chamberlain's (1998) fourth-order partial differential equation for pure waves which contains as a special case Chamberlain & Porter's (1995) modified mild-slope equation.

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