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A Hyperbolic Nonlinear Wave Model Based On The Stream Function Formulation

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Although virtually all nearshore wave-forecasting models are based on the mild-slope (<0.05) approximation, their applications sometimes involve steep slopes (reefs have slopes >0.2). Following Kirby (1986), theoretical works on the linear steep slope problem resulted in a number of linear formulations (Massel 1993), and nonlinear interaction models (Kaihatu 1995). These models have the problem that across-spectrum coupling requires an adequate description of the low-frequency band, where the mild slope approximation is invalid. An alternative 3-dimensional, "quasi"-stream-function formulation was introduced recently by Kim (2004), which satisfies the mild-slope approximation unconditionally, with an expansion involving triad interaction proposed by Toledo (2009). In this study, we derive a hyperbolic approximation of the Toledo (2009). The stream-function formulation is expanded in the frequency domain using a WKB-type approximation. The resulting phase-resolving triad-interaction model provides a framework for the description of directional waves propagating over arbitrary slopes and reduces to the previous velocity-potential function formulation for mild slopes. Current efforts focus on the development of numerical implementations of the model, and numerical validation, using laboratory data simulating reef waves, and field observations.