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Wave Breaking Dissipation in Wave/Current Interactions

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We derive a model that captures the dissipative effects due to wave breaking on wave/current interactions. The specific type of wave breaking we focus on is known as white-capping. These are very short-lived events, when compared to the larger spatio-temporal scales of waves and current, in waters deeper than the shoaling region. The velocity field is modeled in terms of a deterministic and a stochastic component. The determination of the stochastic component of the velocity field could, in principle, be done by empirically fitting a stochastic model to spatio-temporal observations of white-capping events. Here, however, we use a Gaussian model for the ocean surface and develop a methodology for the estimation of certain kinematic properties of wave groups that have been found to indicate the occurrence of white-capping events. The momentum contribution of several random small-scale perturbations associated to white-capping events is then computed and up-scaled to oceanic current scales. Under the assumption that at long time scales the breaking velocity field is approximately additive to the waves and the currents, the model shows that waves affect the momentum, by contributing and modifying the vortex force and the Bernoulli head; they also modify the balances at the air/sea interface. The breaking velocity will couple to the velocity, the vorticity, as well as its gradient and thus will lead to nonlinear interactions. We have also added, by way of a proposition, that white-capping will also affect the transfer of stresses in the water column, by affecting the thickness of the surface mixed layer, thus enhancing diffusion of momentum.
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