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Hamiltonian Boussinesq Model with Sheared Currents

O. Bokhove and E. Gagarina
University of Twente, Applied Mathematics, Enschede, Netherlands (o.bokhove@math.utwente.nl)

We are interested in the prediction of wave-current interactions around the surf zone at beaches. It is the shallow zone of wave breaking and white capping from the breaker line to the beach shore. The surf zone starts where the nonlinearity of the incoming waves becomes strong enough to outweigh dispersion. We formulate the (Hamiltonian) dynamics of a new water wave model, which contains both the shallow water and the potential flow models as limiting systems. This new model is Hamiltonian away from the localized discontinuities in bores and hydraulic jumps. The variational model derived by Cotter and Bokhove (2010) is equivalent but the variables used therein may not have been the most convenient ones.

Our aims are thus threefold: (i) to cast the variational model in a Hamiltonian structure, also dealing with the gauge freedom observed in the variational model, and to augment the new model locally with bores; (ii) to derive and test a compatible, finite element discretization of the new model including bores; and, (iii) to validate model calculations with wave breaking against experiments, including our own. The first aim has been reached. The second aim concerns the derivation and implementation of a numerical discretization inheriting the variational or Hamiltonian structure of the continuum model. We have a working variational finite element discretization in the potential flow limit of our new model. The last aim in principle includes our experiments of wave breaking in a Hele-Shaw laboratory beach set-up, and the bore-soliton-splash. We report the (interim) progress on our three aims.

C.J. Cotter and O. Bokhove. Variational water-wave model with accurate dispersion and vertical vorticity. *J. Eng. Math.* **67**, 33–54, 2010.