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Development of a 3D wave-current interaction formulation

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A three-dimensional formulation based on Generalized Lagrangian Mean (GLM) method is developed to simulate the mean motion of fluid particles under impact of both surface waves and mean flow. The new formulation is applicable from the water bottom to the mean water surface level, and is valid from the deep ocean to coastal areas. Particularly, the formulation is expressed in term of quasi-Eulerian mean velocity, which is the result of GLM velocity minus the Stokes drift. Therefore, it is easy to implement the formulation to existing hydrodynamic models.
The new formulation is valid for both irrotational and rotational waves. Moreover, in this study, the turbulent stress tensor is obtained mathematically. Finally, a 2DV numerical model is developed to test with adiabatic condition (non-breaking waves propagating over a hump) (Bennis et al., 2011), and validated with experimental data obtained in a flume test with observations of wave heights, set up and current profiles throughout the nearshore and surf zone (Boers, 2005).

Bennis, A.-C., Ardhuin, F., & Dumas, F. (2011). On the coupling of wave and three-dimensional circulation models: Choice of theoretical framework, practical implementation and adiabatic tests. Ocean Modelling, 40(3), 260-272.

Boers, M. (2005). Surf zone turbulence, PhD thesis, Delft University of Technology.