

A Simple Diffuse Interface Approach to Complex 3D Free Surface Flows

Michael Dumbser
University of Trento
Laboratory of Applied Mathematics
Via Mesiano, 77, I-38123 Trento (TN), Italy

A reduced, weakly compressible three-equation version of the Baer–Nunziato model for compressible multiphase flows is proposed for the simulation of complex 3D free surface flows. The model is closed by the Tait equation of state for water and can be implemented easily into existing compressible codes based on high resolution shock capturing finite volume schemes. Since the proposed model is fully three–dimensional, it includes the fluid accelerations in gravity direction and hence does not assume a hydrostatic pressure distribution, like the classical shallow water equations.

Furthermore, the 3D two–phase model can naturally deal also with breaking waves. To solve the system of conservation laws of mass and momentum coupled with the non–conservative evolution equation of the fluid volume fraction, a high order path–conservative one–step WENO finite volume scheme is applied, together with a new generalized Osher–type Riemann solver at the element inter–faces. The accurate Riemann solver in combination with a high order finite volume approach leads to a simple but sharp resolution of the free surface.

A thorough comparison of experimental reference data with the computational results obtained for a large set of three–dimensional test cases shows the suitability of the present approach for the accurate simulation of complex three–dimensional free surface flows. The use of a compressible flow model allows the method to simulate both, low speed and high speed free surface flow problems, which makes the approach applicable to a very wide class of environmental and industrial free surface flow problems.

References:

[1] M. Dumbser. A Simple Two-Phase Method for the Simulation of Complex Free Surface Flows. *Computer Methods in Applied Mechanics and Engineering*, 200:1204–1219, 2011

[2] M. Dumbser. A Diffuse Interface Method for Complex Three-Dimensional Free Surface Flows. *Computer Methods in Applied Mechanics and Engineering*, 257:47–64, 2013

[3] M. Dumbser and V. Casulli. A Staggered Semi-Implicit Spectral Discontinuous Galerkin Scheme for the Shallow Water Equations, *Applied Mathematics and Computation*, in press, DOI: 10.1016/j.amc.2013.02.041