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A wetting and drying algorithm for non-hydrostatic models with combined pressure/free-surface

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A wetting and drying algorithm for numerical modelling of three-dimensional free-surface flows is proposed and analysed. In contrast to other wetting and drying methods it is specifically designed for the non-hydrostatic Navier-Stokes equations. It makes use of different boundary conditions applied to the surface boundary of the computational domain, depending on whether it is considered to be wet or dry. This allows the use of a horizontally fixed mesh and therefore expensive remeshing procedures are avoided. However, a simple and cheap vertical mesh adaptation is performed to accurately represent free-surface movements. Finally, a positive water level is ensured in dry regions by maintaining a thin fluid layer. The spatial discretisation is done using the finite element method on a non-uniform, unstructured mesh and an implicit timestepping is applied for the temporal discretisation. The latter allows large timesteps and in particular there is no constraint of how many mesh elements can be dried or wetted in a single timestep.

The resulting scheme is implemented and tested in the Imperial College Ocean Model [Piggott *et al*, 2008], a fully unstructured, non-hydrostatic ocean model and proved to be stable and accurate on a wide range of testcases. These features are illustrated on a demanding test in an idealized domain with known analytical solution. In addition, a tsunami run-up simulation onto a complex three-dimensional beach is presented. Its input data is based on laboratory experimental data of the Hokkaido-Nansei-Oki tsunami that struck Okushiri Island, Japan, in 1993 with an run-up height of up to 30 m.

References

M.D. Piggott, G.J. Gorman, C.C Pain, P.A. Allison, A.S. Candy, B.T. Martin and W.R. Wells, “A new computational framework for multi-scale ocean modelling based on adapting unstructured meshes”, *International Journal for Numerical Methods in Fluids*, vol. 56, pp. 1003-1015, 2008