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INTERFACE STABILISED FINITE ELEMENT METHOD FOR FREE-SURFACE GEOPHYSICAL FLOWS

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ABSTRACT

Our experience in using conventional stabilised finite element methods for free-surface geophysical flows is that the selection of stabilisation parameters such that the resulting simulation is stable and not excessively dissipative is difficult. Particularly for free-surface waves in geophysical flows which travel long distances, excessive dissipation can fundamentally disturb (or even extinguish) the processes of interest. Discontinuous Galerkin methods generally perform better for such problems, at the cost of a significant increase in the required computational effort. This increase in cost can be prohibitive.

A stabilised formulation for incompressible free-surface flows is presented which draws on the strengths of both continuous and discontinuous Galerkin methods. Upwinding of the advective flux at interfaces is incorporated, without the introduction of global discontinuous functions. The formulation is shown to stabilise both the advection term and the incompressibility constraint in a unified framework. Unlike most conventional stabilised finite element methods, no flow-dependent stabilisation parameters are introduced. A variety of free-surface flow problems are presented which demonstrate various aspects of the model, particularly stability with negligible energy dissipation. Example problems include the test case of an oscillating inviscid flow in a U-tube and the propagation of surface waves due to a submarine landslide.