

Finite Elements for Shallow Water Equations: Stabilized Formulations and Computational Aspects

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Abstract

In this paper we present a space-time finite element formulation for problems governed by the shallow water equations. A linear time-discontinuous approximation is adopted, and linear three node triangles are used for the spatial discretization. Computational aspects are also discussed. It is shown that an edge-based data structure turns out to be a very fast and efficient way to solve the non-linear system of equations. Numerical examples are shown, illustrating the quality of the solution and the performance of the method.

1 Introduction

In this paper we are interested in the numerical solution of the so-called vertically averaged (2DH) model of the shallow water equations (SWE) which satisfactorily describes the hydrodynamics (circulation of water) in a class of well-mixed estuaries and coastal embayments. One of the major numerical difficulties associated with the SWE is its convection-dominated character. Many numerical procedures rely on characteristic or semi-lagrangian [13] based methods in order to circumvent this drawback. Another way to deal with this problem, in its full Eulerian description, is to use stabilized finite element methods [4,9,10,11]. In this work we adopt this methodology, using a space-time variational formulation for the non-conservative form of the SWE, written in terms of velocity-celerity

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