

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

F.L.B. Ribeiro⁽¹⁾, A.C. Galeão⁽²⁾, R.G.S. Castro⁽²⁾, L. Landau⁽¹⁾

⁽¹⁾ *Programa de Engenharia Civil, COPPE / Universidade Federal do Rio de Janeiro, Caixa Postal 68506, Rio de Janeiro, RJ, 21945970, Brasil*
Email: fernando@coc.ufrj.br, landau@lancc.ufrj.br

⁽²⁾ *Laboratório Nacional de Computação Científica, Rua Lauro Müller 455, Rio de Janeiro, RJ, 22290-160, Brasil*
Email: acng@lncc.br, sanabria@lncc.br

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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Table of Contents Finite Elements Computational Aspects

1. Understanding the eBook Finite Elements Computational Aspects
 - The Rise of Digital Reading Finite Elements Computational Aspects
 - Advantages of eBooks Over Traditional Books
2. Identifying Finite Elements Computational Aspects
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Finite Elements Computational Aspects
 - User-Friendly Interface
4. Exploring eBook Recommendations from Finite Elements Computational Aspects
 - Personalized Recommendations
 - Finite Elements Computational Aspects User Reviews and Ratings
 - Finite Elements Computational Aspects and Bestseller Lists

5. Accessing Finite Elements Computational Aspects Free and Paid eBooks
 - Finite Elements Computational Aspects Public Domain eBooks
 - Finite Elements Computational Aspects eBook Subscription Services
 - Finite Elements Computational Aspects Budget-Friendly Options
6. Navigating Finite Elements Computational Aspects eBook Formats
 - ePub, PDF, MOBI, and More
 - Finite Elements Computational Aspects Compatibility with Devices
 - Finite Elements Computational Aspects Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Finite Elements Computational Aspects
 - Highlighting and Note-Taking Finite Elements Computational Aspects
 - Interactive Elements Finite Elements Computational Aspects
8. Staying Engaged with Finite Elements Computational Aspects
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Finite Elements Computational Aspects
9. Balancing eBooks and Physical Books Finite Elements Computational Aspects
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Finite Elements Computational Aspects
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Finite Elements Computational Aspects
 - Setting Reading Goals Finite Elements Computational Aspects
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Finite Elements Computational Aspects
 - Fact-Checking eBook Content of Finite Elements Computational Aspects
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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