Numerical Solution Of The Shallow Water Equations

Holl. Zusammenfass.
Hydrodynamics of the Equatorial Ocean.
Mathematical Aspects of Numerical Solution of Hyperbolic Systems
Robust Numerical Methods for Shallow Water Flows and Advective Transport Simulation on Unstructured Grids
A numerical method for the time-dependent shallow-water equations in a watercourse extended with an artificial water domain
Numerical Methods for the Solution of the Shallow-water Equations in Meteorology
Numerical Solution of Shallow Water Waves

Rapidly-varying free surface flows that arise for example from; rapid reservoir releases, dam-breaks, mud slides, tidal bores, storm surges, tsunamis and flows over variable topography, are characterized by abrupt changes in the water depth. These changes produce vertical acceleration of the fluid particles. These vertical accelerations manifest as a series of oscillating waves, called dispersive waves, which follow abrupt changes in the water surface. These dispersive waves can have a significant influence on the water depth which impacts on the area inundated by these flows. A systems of equations that are capable of describing dispersive waves are the Serre equations. They are applicable to a wide range of problems involving small to large amplitude waves in both shallow and relatively deep water. For practical problems, these equations must be solved using computer programs. Unlike the shallow water wave equations, the Serre equations contain terms which makes the solution of the Serre equations computationally expensive. A large number of efficient and accurate computer programs have been developed for solving the shallow water wave equations. Unfortunately, the shallow water wave equations are not capable of modelling dispersive waves. Because the shallow water wave equations are a subset of the Serre equations, it should be possible to adapt these efficient computer programs to solve the Serre equations. This has been achieved by rewriting the Serre equations in a form that resembles the shallow water wave equations. Efficient computer programs used to solve the shallow water wave equations have been adapted to solve the reformulated Serre equations. Results from these computer programs are validated using an analytical solution, laboratory flume data and the simulation of the dam-break problem. Two hypothetical examples, one that includes bathymetry and the second involving the circular dam-break problem in two-dimensions, are also used to validate the computer programs. Most of these problems involve rapidly-varying flows that produce dispersive waves. Solving the Serre equations is only slightly more expensive than solving the shallow water wave equations. Comparing the results from the solution of the Serre equations with the solution of the shallow water wave equations, demonstrates the importance of including dispersive terms when simulating rapidly-varying flows. The examples demonstrate the accuracy, robustness and versatility of the Serre equations in modelling dispersive waves. The computer programs developed are simple to implement, efficient and stable for a range of problems, including rapidly-varying free surface flows.

This thesis is concerned with the analysis of various methods for the numerical solution of the shallow water equations along with the stability of these methods. Most of the thesis is concerned with the background and formaulation of the shallow water equations. The derivation of the basic equations will be given, in the primative variable and vorticity divergence formulation. Also the shallow water equations will be written in spherical coordinates. Two main types of methods used in approximating differential equations of this nature will be discussed. The two schemes are finite difference method (FDM) and the finite element method (FEM). After presenting the shallow water equations in several formulations, some examples will be presented. The use of the Fourier transform to find the solution of a semidiscrete analog of the shallow water equations is also demonstrated.

Numerical Methods for the Three-dimensional Shallow Water Equations on Supercomputers

Mathematical Theory and Numerical Solution for a Two-dimensional System of Shallow-water Equations

A Numerical Method for Extended Boussinesq Shallow-water Wave Equations

Numerical Solution of the Shallow Water Equations of Quadtree Grids

A suite of seven test cases is proposed for the evaluation of numerical methods intended for the solution of the

shallow water equations in spherical geometry. The shallow water equations exhibit the major difficulties associated with the horizontal dynamical aspects of atmospheric modeling on the spherical earth. These cases are designed for use in the evaluation of numerical methods proposed for climate modeling and to identify the potential trade-offs which must always be made in numerical modeling. Before a proposed scheme is applied to a full baroclinic atmospheric model it must perform well on these problems in comparison with other currently accepted numerical methods. The cases are presented in order of complexity. They consist of advection across the poles, steady state geostrophically balanced flow of both global and local scales, forced nonlinear advection of an isolated low, zonal flow impinging on an isolated mountain, Rossby-Haurwitz waves and observed atmospheric states. One of the cases is also identified as a computer performance/algorithm efficiency benchmark for assessing the performance of algorithms adapted to massively parallel computers. 31 refs.

This work has been selected by scholars as being culturally important, and is part of the knowledge base of civilization as we know it. This work was reproduced from the original artifact, and remains as true to the original work as possible. Therefore, you will see the original copyright references, library stamps (as most of these works have been housed in our most important libraries around the world), and other notations in the work. This work is in the public domain in the United States of America, and possibly other nations. Within the United States, you may freely copy and distribute this work, as no entity (individual or corporate) has a copyright on the body of the work.As a reproduction of a historical artifact, this work may contain missing or blurred pages, poor pictures, errant marks, etc. Scholars believe, and we concur, that this work is important enough to be preserved, reproduced, and made generally available to the public. We appreciate your support of the preservation process, and thank you for being an important part of keeping this

knowledge alive and relevant.
Numerical Methods for Atmospheric and Oceanic Sciences
Numerical Solution of the Shallow Water Equations
Numerical Solution of Hyperbolic Differential Equations
Shock-Capturing Methods for Free-Surface Shallow Flows
Numerical Methods for the Shallow Water Equations

The performance of both iteration methods is accelerated by a technique based on smoothing. Both explicit and implicit smoothing is examined. It turns out that the unconditionally stable method is more efficient than the conditionally stable methods."

This book presents the theory and computation of open channel flows, using detailed analytical, numerical and experimental results. The fundamental equations of open channel flows are derived by means of a rigorous vertical integration of the RANS equations for turbulent flow. In turn, the hydrostatic pressure hypothesis, which forms the core of many shallow water hydraulic models, is scrutinized by analyzing its underlying assumptions. The book’s main focus is on one-dimensional models, including detailed treatments of unsteady and steady flows. The use of modern shock capturing finite difference and finite volume methods is described in detail, and the quality of solutions is carefully assessed on the basis of analytical and experimental results. The book’s unique features include: • Rigorous derivation of the hydrostatic-based shallow water hydraulic models • Detailed treatment of steady open channel flows, including the computation of transcritical flow profiles • General analysis of gate maneuvers as the solution of a Riemann problem • Presents modern shock capturing finite volume methods for the computation of unsteady free surface flows • Introduces readers to movable bed and sediment transport in shallow water models • Includes numerical solutions of shallow water hydraulic models for non-hydrostatic steady and unsteady free surface flows This book is suitable for both undergraduate and graduate level students, given that the theory and numerical methods are progressively introduced starting with the basics. As supporting material, a collection of source codes written in Visual Basic and inserted as macros in Microsoft Excel® is available. The theory is implemented step-by-step in the codes, and the resulting programs are used throughout the book to produce the respective solutions.

The Numerical Solution of a Parabolic System of Differential Equations Arising in Shallow Water Theory

˜Theœ Numerical Solution of the Shallow Water Wave Equations by the Lax-Wendroff Method

Numerical Solutions to the Shallow Water Equation as Applied to a Local Meteorological Forcast Problem

Mathematical Theory and Numerical Solution for a Two-dimensional System of

Shallow Water Equations

Numerical Simulation of Shallow Water Waves

A guide for atmospheric and oceanic sciences courses primarily and also for students of applied mathematics, mechanical & aerospace engineering.

This work has been selected by scholars as being culturally important, and is part of the knowledge base of civilization as we know it. This work was reproduced from the original artifact, and remains as true to the original work as possible. Therefore, you will see the original copyright references, library stamps (as most of these works have been housed in our most important libraries around the world), and other notations in the work. This work is in the public domain in the United States of America, and possibly other nations. Within the United States, you may freely copy and distribute this work, as no entity (individual or corporate) has a copyright on the body of the work. As a reproduction of a historical artifact, this work may contain missing or blurred pages, poor pictures, errant marks, etc. Scholars believe, and we concur, that this work is important enough to be preserved, reproduced, and made generally available to the public. We appreciate your support of the preservation process, and thank you for being an important part of keeping this knowledge alive and relevant.

Numerical Solution of the Shallow-water Equations

The Numerical Solution of One-dimensional Shallow-water Problems Using the Taylor-Galerkin Method

Numerical Methods for Shallow-Water Flow

Numerical Solution of the One-dimensional and Cylindrical Serre Equations for Rapidly Varying Free Surface Flows

Numerical Solution of the Shallow Water Equations by a Finite Element Method

A wide variety of problems are associated with the flow of shallow water, such as atmospheric flows, tides, storm surges, river and coastal flows, lake flows, tsunamis. Numerical simulation is an effective tool in solving them and a great variety of numerical methods are available. The first part of the book summarizes the basic physics of shallow-water flow needed to use numerical methods under various conditions. The second part gives an overview of possible numerical methods, together with their stability and accuracy properties as well as with an assessment of their performance under various conditions. This enables the reader to select a method for particular applications. Correct treatment of boundary conditions (often neglected) is emphasized. The major part of the book is about two-dimensional shallow-water equations but a discussion of the 3-D form is included. The book is intended for researchers and users of shallow-water models in oceanographic and meteorological institutes, hydraulic engineering and consulting. It also provides a major source of information for applied and numerical mathematicians.

Within this monograph a comprehensive and systematic knowledge on shallow-water hydrodynamics is presented. A two-dimensional system of shallow-water equations is analyzed, including the mathematical and mechanical backgrounds, the properties of the system and its solution. Also featured is a new mathematical simulation of shallow-water flows by compressible plane flows of a special virtual perfect gas, as well as practical algorithms such as FDM, FEM, and FVM. Some of these algorithms have been utilized in solving the system, while others have been utilized in various applied fields. An emphasis has been placed on several classes of high-performance difference schemes and boundary procedures which have found wide uses recently for solving the Euler equations of gas dynamics in aeronautical and aerospatial engineering. This book is constructed so that it may serve as a handbook for practicians. It will be of interest to scientists, designers, teachers, postgraduates and professionals in hydraulic, marine, and environmental engineering; especially those involved in the mathematical modelling of shallow-water bodies.

Analysis of the Numerical Solution of the Shallow Water Equations

Dispersive Shallow Water Waves

Numerical Solution of the General Shallow Water Sloshing Problem

Numerical Solution of Partial Differential Equations

Numerical Solution of the Shallow-water Equations on a Beach Using the Weighted Average Flux Method

The first of its kind in the field, this title examines the use of modern, shock-capturing finite volume numerical methods, in the solution of partial differential equations associated with free-surface flows, which satisfy the shallow-water type assumption (including shallow water flows, dense gases and mixtures of materials as special samples). Starting with a general presentation of the governing equations for free-surface shallow flows and a discussion of their physical applicability, the book goes on to analyse the mathematical properties of the equations, in preparation for the presentation of the exact solution of the Riemann problem for wet and dry beds. After a general introduction to the finite volume approach, several chapters are then devoted to describing a variety of modern shock-capturing finite volume numerical methods, including Godunov methods of the upwind and centred type. Approximate Riemann solvers following various approaches are studied in detail as is their use in the Godunov approach for constructing low and high-order upwind TVD methods. Centred TVD schemes are also presented. Two chapters are then devoted to practical applications. The book finishes with an overview of potential practical applications of the methods studied, along with appropriate reference to sources of further information. Features include: * Algorithmic and practical presentation of the methods * Practical applications such as dam-break modelling and the study of bore reflection patterns in two space dimensions * Sample computer programs and accompanying numerical software (details available at www.numeritek.com) The book is suitable for teaching postgraduate students of civil, mechanical, hydraulic and environmental engineering, meteorology, oceanography, fluid mechanics and applied mathematics. Selected portions of the material may also be useful in teaching final year undergraduate students in the above disciplines. The contents will also be of interest to research scientists and engineers in academia and research and consultancy laboratories.

Numerical Solution of the Shallow-water EquationsNumerical Methods for Shallow-Water FlowSpringer Science & Business Media

A Standard Test Set for Numerical Approximations to the Shallow Water Equations in Spherical Geometry

Nodal Integral Methods for the Numerical Solution of the Shallow-water Equations

An Introduction

Shallow Water Hydraulics

Numerical Methods for the 3D Shallow Water Equations on Vector and Parallel Computers

This monograph presents cutting-edge research on dispersive wave modelling, and the numerical methods used to simulate the propagation and generation of long surface water waves. Including both an overview of existing dispersive models, as well as recent breakthroughs, the authors maintain an ideal balance between theory and applications. From modelling tsunami waves to smaller scale coastal processes, this book will be an indispensable resource for those looking to be brought up-to-date in this active area of scientific research. Beginning with an introduction to various dispersive long wave models on the flat space, the authors establish a foundation on which readers can confidently approach more advanced mathematical models and numerical techniques. The first two chapters of the book cover modelling and numerical simulation over globally flat spaces, including adaptive moving grid methods along with the operator splitting approach, which was historically proposed at the Institute of Computational Technologies at Novosibirsk. Later chapters build on this to explore high-end mathematical modelling of the fluid flow over deformed and rotating spheres using the operator splitting approach. The appendices that follow further elaborate by providing valuable insight into long wave models based on the potential flow assumption, and modified intermediate weakly nonlinear weakly dispersive equations. Dispersive Shallow Water Waves will be a valuable resource for researchers studying theoretical or applied oceanography, nonlinear waves as well as those more broadly interested in free surface flow dynamics.

The application of the method of characteristics for the numerical solution of hyperbolic type partial differential equations will be presented. Especial attention will be given to the numerical solution of the Vlasov equation, which is of fundamental importance in the study of the kinetic theory of plasmas, and to other equations pertinent to plasma physics. Examples will be presented with possible combination with fractional step methods in the case of several dimensions. The methods are quite *general and can be applied to different equations of hyperbolic type in the field of mathematical physics. Examples for the application of the method of characteristics to fluid equations will be presented, for the numerical solution of the shallow water equations and for the numerical solution of the equations of the incompressible ideal magnetohydrodynamic (MHD) flows in plasmas.*

Numberical Solution of the Shallow-water Equations on Distributed Memory Systems [microform]

Theory, Modeling, and Numerical Methods

Numerical Solutions to the Shallow Water Equations as Applied to a Local Meteorological Forecast Problem

Efficient Numerical Methods for the Shallow Water Equations on the Sphere

Implicit Numerical Solution of Unsteady Flows in Open Channels and Shallow Water Basins

This important new book sets forth a comprehensive description of various mathematical aspects of problems originating in numerical solution of hyperbolic systems of partial differential equations. The authors present the material in the context of the important mechanical applications of such systems, including the Euler equations of gas dynamics, magnetohydrodynamics (MHD), shallow water, and solid dynamics equations. This treatment provides-for the first time in book form-a collection of recipes for applying higher-order non-oscillatory shock-capturing schemes to MHD modelling of physical phenomena. The authors also address a number of original "nonclassical" problems, such as shock wave propagation in rods and composite materials, ionization fronts in plasma, and electromagnetic shock waves in magnets. They show that if a small-scale, higher-order mathematical model results in oscillations of the discontinuity structure, the variety of admissible discontinuities can exhibit disperse behavior, including some with additional boundary conditions that do not follow from the hyperbolic conservation laws. Nonclassical problems are accompanied by a multiple nonuniqueness of solutions. The authors formulate several selection rules, which in some cases easily allow a correct, physically realizable choice. This work systematizes methods for overcoming the difficulties inherent in the solution of hyperbolic systems. Its unique focus on applications, both traditional and new, makes Mathematical Aspects of Numerical Solution of Hyperbolic Systems particularly valuable not only to those interested the development of numerical methods, but to physicists and engineers who strive to solve increasingly complicated nonlinear equations.

This is the 2005 second edition of a highly successful and well-respected textbook on the numerical techniques used to solve partial differential equations arising from mathematical models in science, engineering and other fields. The authors maintain an emphasis on finite difference methods for simple but representative examples of parabolic, hyperbolic and elliptic equations from the first edition. However this is augmented by new sections on finite volume methods, modified equation analysis, symplectic integration schemes, convectiondiffusion problems, multigrid, and conjugate gradient methods; and several sections, including that on the energy method of analysis, have been extensively rewritten to reflect modern developments. Already an excellent choice for students and teachers in mathematics, engineering and computer science departments, the revised text includes more latest theoretical and industrial developments.

Shallow Water Hydrodynamics