Shallow water equations

Given in Kantha-Clayson2000[3]

$$
\begin{cases}
\frac{\partial Hu}{\partial t} + \frac{\partial Huu}{\partial x} + \frac{\partial Huv}{\partial y} - fHv = \nu H\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) - gH\frac{\partial \eta}{\partial x} + \frac{\tau_x^w}{\rho_0} - \frac{\tau_u^b}{\rho_0} \\
\frac{\partial Hv}{\partial t} + \frac{\partial Hvu}{\partial x} + \frac{\partial Hvv}{\partial y} + fHu = \nu H\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right) - gH\frac{\partial \eta}{\partial y} + \frac{\tau_v^w}{\rho_0} - \frac{\tau_v^b}{\rho_0} \\
\frac{\partial \eta}{\partial t} + \frac{\partial Hu}{\partial x} + \frac{\partial Hv}{\partial y} = 0
\end{cases}
$$

Bottom stress [5]

$$\tau_u^b = \rho_0 C_D u_b \sqrt{u_b^2 + v_b^2}$$

Bottom drag coefficient [4]

$$C_D = k/\ln\left(\frac{z_B - z_0}{z_0}\right)^2$$

z_0 roughness length

Numerical Solution Of The Shallow Water Equations

I. M. Navon

Numerical Solution Of The Shallow Water Equations:

Numerical Methods for Shallow-Water Flow C.B. Vreugdenhil,2013-03-09 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 **Numerical Solution of the Shallow-water Equations** F. W. Wubs,1988 *Numerical Solution of the Shallow Water Equations* David L. Whitfield,1996

Numerical Solution of the Shallow-water Equations Friederik Wilhelm Wubs,1987 **Shallow Water Hydrodynamics** W.Y. Tan,1992-08-17 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 Numerical Solution of the Shallow Water Equations by a Finite Element Method Nikolaas Praagman,1979 **Numerical Solution of the Shallow Water Equations by a Finite Element Method** Niek Praagman,1979* Analysis of the Numerical Solution of the Shallow Water Equations Thomas A. Hamrick,Naval Postgraduate School (U.S.),1997-09-01 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 **Nodal Integral Methods for the Numerical Solution of the Shallow-water Equations** Brian Edward Mays,2003 *Numerical Methods for the Shallow Water Equations* Andreas Bollermann,2011 *Numerical Methods for Shallow Water Equations* Andrew Yershov,1998 Shallow Water Hydrodynamics Weiyan Tan,1992 Efficient Numerical Methods for the Shallow Water Equations on the Sphere William Sawyer,2006 **Numerical Solution of the Shallow Water Equations of Quadtree Grids** Sergio Cruz León,1997 Shallow Water Hydrodynamics Wei-Yan Tan,1992 *Towards Efficient Techniques for Solutions of the Shallow Water Equations* Owen Thomas DeGennaro-Ransom,2016 Research was conducted in order to develop more efficient solution techniques for the Shallow Water Equations SWE for naturally occurring free surface flows in natural and engineered channels Methods relating to numerical solution of the two dimensional equations utilizing graphical processing units GPU as the main computational device and combined one and two dimensional schemes are presented and tested Different numerical methods were investigated for inclusion to the model General requirements for the proposed schemes included the ability to be solved using a finite difference conservative solution algorithm on a fixed rectangular grid and the ability to both withstand and provide reasonable approximation of shocks and bores within the solution domain Two such schemes were investigated that met initial criteria A graphical processing unit GPU implementation of the well established MacCormack method and a selectively under relaxed implicit method Both methods included the addition of a TVD total variation diminishing term to help maintain stability around high gradient flow areas The implicit method incorporates an algorithm for selectively under relaxing the iterative process to maintain stability in the presence of shock interfaces The value of the Courant number and the frequency at which the TVD term was incorporated were constantly updated during the computation to achieve optimal speed of execution while maintaining stability The method was tested against published results from experiments and from computations employing alternative algorithms and the results obtained demonstrate both the economy and accuracy of the proposed algorithm The MacCormack based scheme was chosen for both optimizing procedure attempts Methodology was tested that allowed for one and two dimensional TVD MacCormack equation coupling reducing grid size dependency for the solution domain while permitting simultaneous calculation of both one and two dimensional domains and the explicit finite difference formulation of the solution methodology was well suited for inclusion into simultaneous GPU calculation Cell alignment and cell neighbor management is shifted from matrix to array form which allows for a new framework optimally constructed for inclusion of the dimensionally coupled solution scheme The code contains adaptive time stepping based on maximum local Courant number and special wetting drying schemes to maximize stability while maintaining accuracy The method was tested against published results showing it s effectiveness in minimizing computational resources while comparing well with experimentally derived results The coupled code is tempered for insertion into a parallel computing array Ultimately while dimensional coupling provided a slight optimization in terms of computational efficiency the dimensional interface methodology and limited domain types the solution technique was constructed for restrict it to a specific use tool The extension of the MacCormack method to GPU processing ultimately proved more useful showing speed increases of 4 40 times depending on the domains geomorphological characteristics

Numerical Methods for the Solution of the Shallow-water Equations in Meteorology I. M. Navon,1979

Mathematical Aspects of Numerical Solution of Hyperbolic Systems A.G. Kulikovskii,N.V. Pogorelov,A. Yu. Semenov,2000-12-21 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 *Numerical Methods for Atmospheric and Oceanic Sciences* A. Chandrasekar,2022-11-10 A guide for atmospheric and oceanic sciences courses primarily and also for students of applied mathematics mechanical aerospace engineering **Numerical Solution of the Shallow-water Equations on a Beach Using the Weighted Average Flux Method** G. Watson,1992

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