The 9th International Conference on Coasts, Ports and Marine Structures (ICOPMAS 2010)
Tehran, Iran, 29 Nov.-1 Dec. 2010

Numerical Solution of Shallow water Equations to Simulate Shallow Liquid Behavior

[Mahmoud . Rostami Varnousfaaderani]
[Mohammad Javad . Ketabdari]

Keywords: ***Shallow water equations (SWE), Shallow liquid behavior, Numerical solution techniques***

Abstract

Shallow water equations can properly approximate fluid motion when its density is homogenous and depth is small in comparison to characteristic horizontal distances. They can simulate coastal processes, reducing complicated three and two dimensional problems to two and one dimensional, respectively. In this paper a model of shallow liquid behavior is simulated numerically, deriving the governing equations from shallow water equations. The model is defined by a pair of partial differential equations which is solved by different numerical solution techniques. The governing equations are discretized in time and space. Spatial discretized equation is solved using Fast Fourier Transform, Gaussian Elimination, LU Decomposition, or Iterative Methods. The performance of these techniques on shallow water simulation with regards to execution time and accuracy is discussed. The results showed that LU Decomposition have the best speed with very good accuracy.

Introduction

The Shallow water equations (SWE) are a system of hyperbolic/parabolic PDEs, governing fluid flow in coastal regions, estuaries, rivers and channels. They can be used to predict tides, storm surge levels and coastline changes from hurricanes, ocean currents, and to study dredging feasibility and open chanel flow [1]. Also arise in atmospheric flows and debris flows. Recently some researchers used this equations to model corner and Kelvin waves [2].

The general characteristic of shallow water flows is that the vertical dimension is much smaller than the typical horizontal scale. In this case it is averaged over the depth to eliminate the vertical dimension. They are derived from the Navier-Stokes equations (NSE), which describe the motion of fluids. The NSE are in turn derived from the equations for conservation of mass and linear momentum. There are four basic steps to get SWE:

1. *Derive the NSE from the conservation laws.*
2. *Ensemble averages the NSE to account for the turbulent nature of ocean flow.*
3. *Specify boundary conditions for the NSE for study domain.*
4. *Use the BCs to integrate the NSE over depth [3, 4].*

In this study the governing equations are considered associated with shallow fluid modeling which are derived from SWE. The intended application here is the flow of the earth's