Shallow water model

Validation

Edgar Gago Carrillo

Polytechnic University of Catalonia

edgargc.upc@gmail.com

November 20, 2018

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola Superior d'Enginyeries Industrial, Aeroespacial i Audiovisual de Terrassa

Overview

Geometry

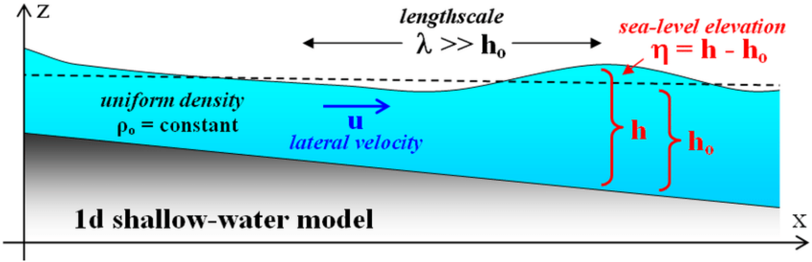

Figure: Shallow water model scheme

SW model

SW equations

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} - fv = -g\frac{\partial \eta}{\partial x} \tag{1}$$

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} - fv = -g\frac{\partial \eta}{\partial y} \tag{2}$$

$$\frac{\partial \eta}{\partial t} + u\frac{\partial (uh)}{\partial x} + v\frac{\partial (vh)}{\partial y} = S(x, y, t) \tag{3}$$

Halo

Some problems about the Halo:

- Visualize the halo and it's function
- Implementation the halo on the code

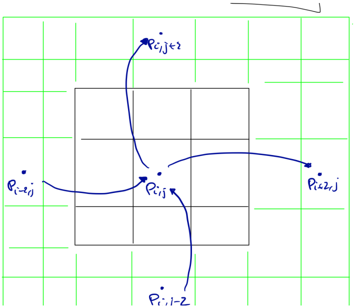

Figure: Halo scheme

Validation conditions

- $L = 1$
- $H = L$
- Mesh = [10 50 100 200 500 700 1000]
- $\Delta x = \frac{H/L}{mesh(1,i)}$
- $t = 1$

- Problems with MATLAB matrix creation method
- Operators to simplify some operations

Validation equations

P1,P2

$$P_u1 = -\frac{\partial(uu)}{\partial x} - \frac{\partial(uv)}{\partial x} \tag{4}$$

$$P_u2 = u(\frac{\partial u}{\partial x} + `\frac{\partial v}{\partial y}) \tag{5}$$

$$u(x,y,t) = sin(2 \cdot \pi \cdot x) \cdot cos(2 \cdot pi \cdot y) \cdot t \tag{6}$$

$$v(x,y,t) = cos(2 \cdot \pi \cdot x) \cdot sin(2 \cdot pi \cdot y) \cdot t \tag{7}$$

$$h(x,y,t,D) = cos(2 \cdot \pi \cdot x) \cdot cos(2 \cdot pi \cdot y) \cdot t + D \tag{8}$$

Error evaluation

$$Error(\Delta x(1,i)) = \frac{\sum_{i,j}^{N,M}(num_{i,j} - sym_{i,j})^2}{\Delta x(1,i)} \tag{9}$$

P2

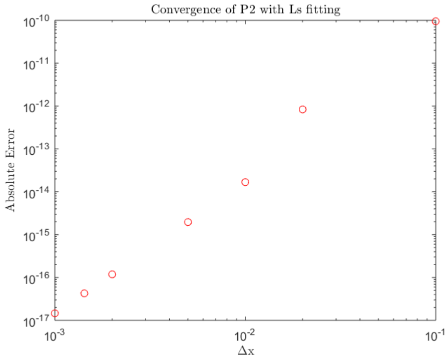

Figure: Convergence of the advection term P2

Problems when trying to visualize the errors

- Solution = error mesh.
- Method to visualize the results obtained

P1

Problems when trying to visualize the errors

- Method to visualize the results obtained
- Error programming the TVD in one index
- sym function MATLAB

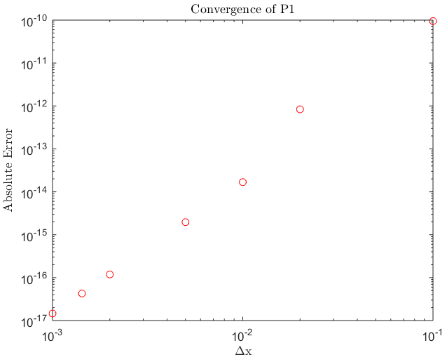

Figure: Convergence of the advection term P1

η

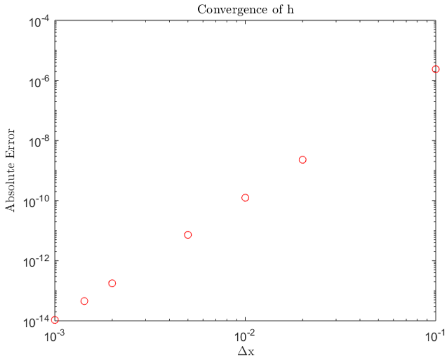

Figure: Convergence of the advection term P1

Problems when trying to visualize the errors

- Same to P1 because of the similarity of both methods

Initial conditions

Ones the program is tested a simulation has been done in order to visualize the effect of a single perturbation and it's evolution.

- Single perturbation as an integer value at eta in $t = 0$
- N = M = 20
- T = 100 s
- L=H=1

- $\eta(5, 5, 1) = 4$

Water drop

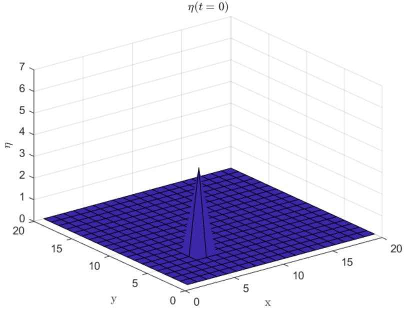

Figure: $\eta_{t=0}$

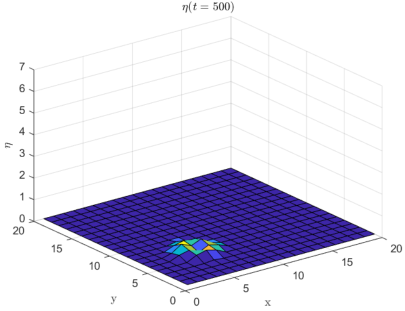

Figure: $\eta_{t=200}$

Water Drop

Thank you for your attention