Activity 1 – Gravity Waves in the Shallow water model

You will be required to write a report on this activity containing your figures and answers to the different questions. The report is **due Friday, Feb. 8th**.

Introduction

During this activity, we will use a code resolving the shallow-water equations to illustrate some properties of the surface gravity waves.

Get and run the model

A python script resolving the shallow-water equations is available here:

wget http://stockage.univ-brest.fr/~gula/Fluid/rsw.py

It requires numpy, matplotlib and numba, which are available with anaconda:

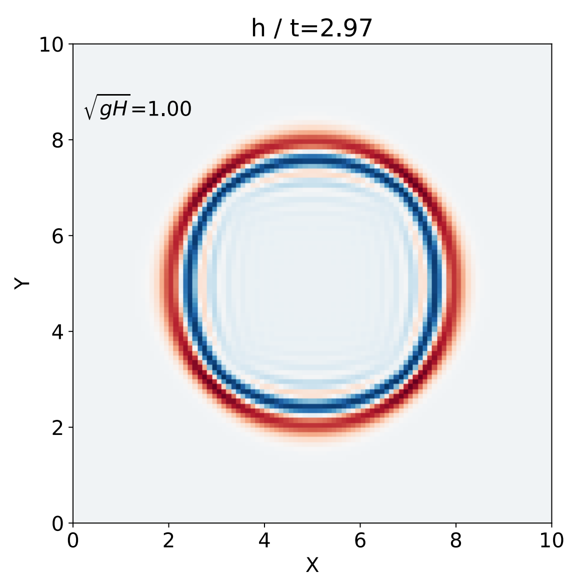
module load anaconda3/4.4.0

It is run by doing:

python rsw.py

You can customize the size and resolution of the domain (Lx,Ly,nx,ny), depth (Hmax), coriolis parameter (f), duration of the run (tend), the type of topography, initial condition, etc.

By default, the code will output an animation and a pdf of the final state for the free surface height hC. It will also output a numpy file (.npy) containing the free surface height and horizontal velocities. You can use (and modify if you need) the figure plotted during the execution of the script or use the outputted data (.npy) to generate your own figures. You can also modify the code to output data at any time step or using another format (netcdf, hdf5) if you prefer.



Gravity waves experiments

1. Propagation speed

a) Run experiments of a geostrophic adjustment with a flat bottom and different depths H. Check how the propagation speed changes.
b) Create your own topography (see examples such as topography = 'jump') to illustrate the different propagation properties of the waves depending on the depth of the flow.

2. Long-waves versus short-waves

Define an initial perturbation in the form of a local plane wave with a given wavenumber k propagating along the x direction.

a) Choose k and H to be in the "long-wave" approximation. Check what happens if you increase or decrease k by a factor 4.
b) Choose k and H to be in the "short-wave" approximation. Check what happens if you increase or decrease k by a factor 4.

Define an initial perturbation in the form of a rectangular function.

c) Check what happens to the signal for the "long-wave" and "short-wave" cases. You may need to run the model a little longer to see the difference more clearly.

3. Non-linear effects

Check what happens when you are not in a linear regime anymore.

4. Refraction of waves

Define an initial perturbation in the form of a local plane wave with a given wavenumber k propagating along the x direction. Add a topography jump at an angle. Check and explain what happens to the refracted wave.

5. Rotation

Check what happens when you include rotation for the geostrophic adjustment and the local plane wave propagation. Are the effects different for long and short waves? Explain why.