TP 1 – Gravity Waves

Please write a report (2-5 pages) on this activity containing your figures, results and some discussion of the different experiments: this will be used as CC for this UE. You should explain briefly what experiments you performed, what the results show, and discuss the physical processes that are involved.

Below is the text for Part 1 of the activity. Part 2 (Ray tracing) will be distributed later.

Part 1: Waves in a shallow water model

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

Download and run the model

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

wget jgula.fr/Fluid/rsw.py

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

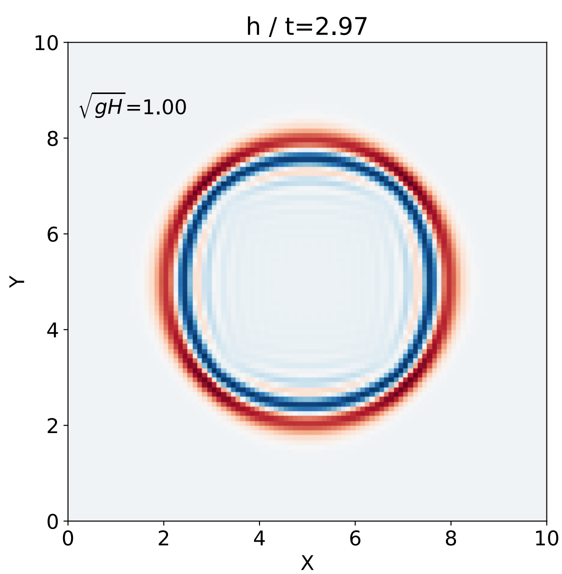
module load anaconda3/2019.07

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 (.npz) 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 (.npz) 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 as a function of H
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. Deformation and non-linear effects

Define an initial perturbation in the form of a local plane wave with a chosen wavenumber k propagating along the x direction. A plane wave is defined by: $\eta = Acos(kx - \omega t)$

a) Choose k and H to be in the "shallow-water" approximation. Check what happens if you increase or decrease k by a factor of 5.
b) Check what happens when you are not in a linear regime anymore (i.e. the initial perturbation is not small).

Do the same for an initial perturbation in the form of a rectangular function.

3. 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.

4. Rotation

Check what happens when you include rotation for the geostrophic adjustment.