Title: Numerical Analysis of Shallow-Water Equations

Short Abstract:

The world is governed by natural laws many of which can be expressed by a system of PDEs. An important example are the Nervier-Stokes equations that, together with the Continuity Equations form a system of 6 coupled PDEs which describe fluid flow in 3D. these equations are difficult to solve even approximately. This system can be simplified using The Shallow Water Equations (SWE). SWE are of fundamental interest in several contexts. In one sense, the ocean can be thought of as a shallow-water description over the surface of the Earth. The atmosphere can be also thought of as a relatively thin layer of fluid (gas) above the surface of the Earth.

To understand the motion in the shallow-water limit, in this project, we will introduce the concept of a streamfunction ψ and vorticity ω as dependent variables and how they are coupled to one another through the streamfunction-vorticity formulation and how to solve these equations numerically using Finite Difference and Spectral Methods.

Aims: This project is suitable for students who are interested in numerical analysis and mathematical programming and their use in solving/simulating partial differential equations. This project allows the student to understand the mathematical background of Finite Difference and Fourier Transform Methods and to write a MATLAB code to apply it on two-dimensional partial differential equations.

References

[1] Kutz, N. J., "*Data-driven modelling & scientific computing: methods for complex systems & big data*", Oxford university Press, 2013.

[2] Fromm, J. E., "*The Time Dependent Flow of an Incompressible Viscous Fluid"*, Meth. Comput. Phys, 3, 345-382 (1964).