MSc. Thesis Proposal

Title: Verification of wave propagation in deep water and in a wave pool using CFD

Supervisors

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Introduction

Motivation

The correct modeling of ocean waves is of interest for many practical applications, e.g. offshore platforms, coastal structures, wave pools, or wave energy devices. For wave energy devices in particular, this modelling is of special interest, not only in extreme wave events (survivability), but also to obtain accurate predictions of the power output. Typically, wave modelling in such applications is done using fast linear potential flow methods, which can be used to simulate a large number of metocean conditions within a reasonable time and cost frame. While these methods can be extended to include some higher order effects, CFD viscous solvers are the natural choice for highly non-linear problems such as the wave breaking dynamics in wave pools. These CFD methods are more accurate but require significantly larger computational times.

Existing work

A CFD solver (ReFRESCO) was used to carry out a verification and validation of a 2D wave propagation in deep water (Lima, 2021). Setting the study to 2D allowed to explore a large number of parameters and establish a numerical setup that can now be upgraded for three dimensional simulations.

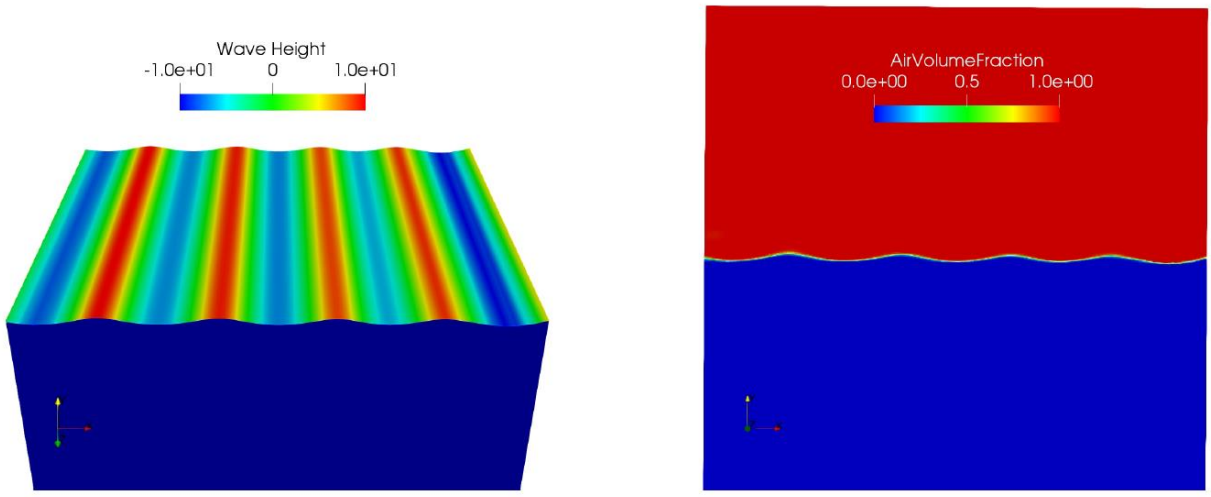

Figure 1: 2D linear wave propagation in deep water (Lima, 2021).

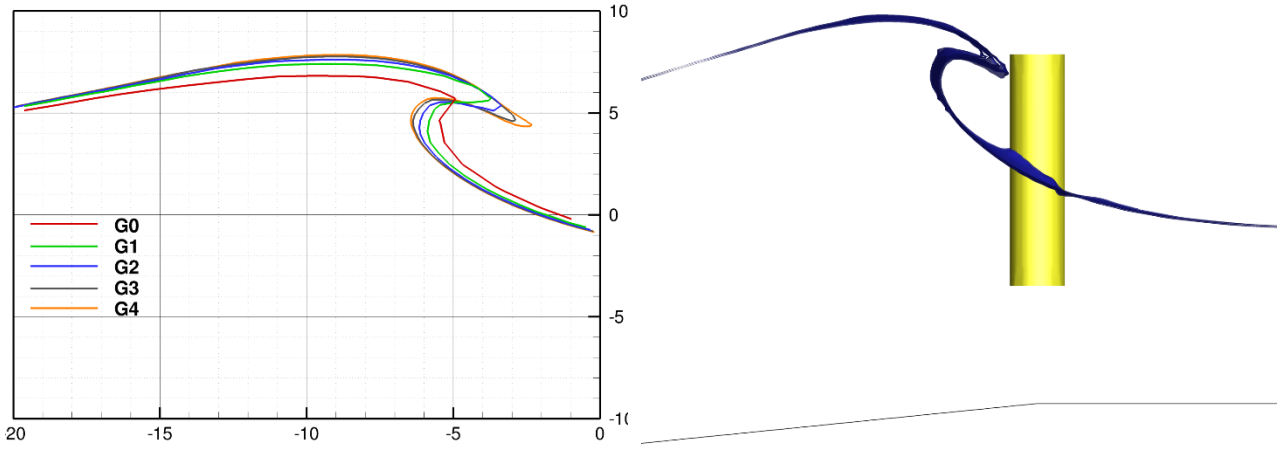

Figure 2: Grid convergence study of a 2D breaking wave (left) and the same wave slamming into a monopile (right).

Objectives

The verification and validation work already carried out in 2D will be extended first for 3D calculations in deep water, and then for breaking waves in shallow water (wave pool):

- Carry out a verification and validation study for a 3D wave propagation case, building upon the existing 2D knowledge:
  - Confirm the impact of grid topology observed in 2D study
  - Impact of grid refinement in the third dimension
  - Confirm the impact of time step size observed in the 2D study
  - Confirm the impact of iterative convergence observed in the 2D study
- Compare results with the 2D study, to derive guidelines for 2D and 3D wave simulations using CFD
- Assess the impact of turbulence in the wave dissipation as the wave travels throughout the domain.
- Extend the verification study for a breaking wave in shallow water, which represents a wave pool type application.

Requisites

Applicants must have:

- General knowledge on CFD.
- Coding experience with python or similar.

Good to have:

- Linux experience.
- Latex experience.
- Git experience.

Added value to have:

- Knowledge on uncertainty quantification.

Location

blueOASIS (www.blueoasis.pt) offices at Oeiras or Ericeira
Edificio D.Pedro, Quinta da Fonte, R. Malhões, 2770-071 Lisboa
R. Prudêncio Franco da Trindade 4, 2655-344 Ericeira

The student is invited to join the team in the office when the supervisor is present (at least three days per week).

Companies Involved

blueOASIS is a young team with more than 45 years of combined knowledge and experience on Aerospace, Mechanical, Naval and Maritime engineering. The multicultural and multidisciplinary team is committed to make our oceans safer and greener, using state of the art numerical and data science tools. BlueOASIS focuses on renewable energies, ocean cleaning, decarbonization, sustainable offshore structures and green ships optimization.

References:

Lima, E. N. (2021). *Verification of a 2D Wave Model.* MSc Thesis. Retrieved from https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1128253548922619