Msc Thesis

Title: **Verification and Validation of Overset and Sliding interface CFD methods**

Requirements: Fluid Mechanics, Numerical Methods, Linux
Knowledge on CFD, grid generation, Paraview, Python, HPC is a pre
Duration: 6-9 months
Location: IST and WavEC-Offshore Renewables (www.wavec.org) (Lisbon, Portugal)
Supervisors: **Prof. Luís Eça, Dr. Guilherme Vaz (WavEC), Eng. Sebastien Lemaire (UoS, MARIN)**

Description

For simulating complex flow behaviours around objects (like offshore structures, ships etc.), body motion is an essential component of the simulation. Motion can be of many sorts, from a propeller or wind turbine blades rotating, to a ship or a superstructure having 6 degrees of freedom etc. To accomplish movements of bodies in CFD several methods can be employed; sliding-grid (SG) and overset-grids (OG) methods are two of them that will be tested and compared in this project [2,3]. Both methods are available in the CFD solver ReFRESCO (www.refresco.org), an open-community solver developed by MARIN (marin.nl) and its associated entities (IST, WavEC, University of Southampton, etc.). ReFRESCO [3] is specially verified and validated for several problems of the maritime world.

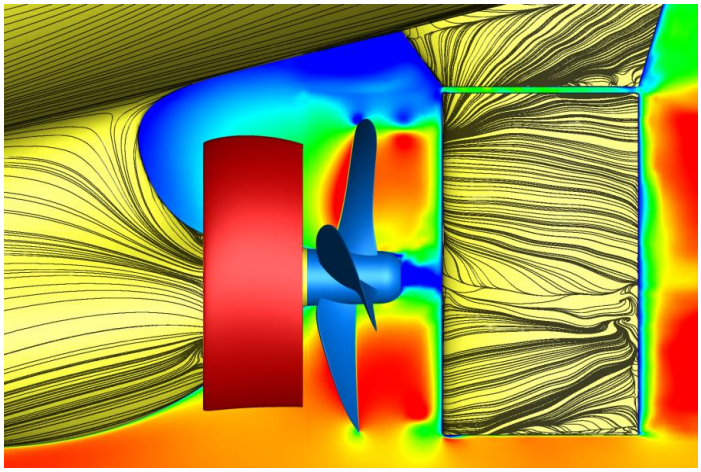

Figure 1: Ship propulsion analysis using sliding or overset grids.

Both methods involve geometry operations, interpolation schemes, communication between parallel processes, modification to discretization and solvers. Moreover, they have an overhead in CPU time and they can decrease the accuracy of the basic CFD solver. In order to fully characterize these methods, Verification and Validation (V&V) exercises for simpler cases than the ones presented in Figure 1 are crucial. In this project we intend to compare the pros and cons of each of these methods for different analytical and manufactured solutions (already existing [4]), and different grid layouts. In particular, detailed V&V studies are envisaged for the following situations:

- Study of time-step, grid refinement, interpolation and other SG/OG options.
- 2D Convection-diffusion cases, with fixed and moving grids.
- 2D Couette, Taylor Vortex, steady and unsteady, with fixed and moving grids.
- 2D/3D, steady/unsteady RANS manufactured solutions.
- Solution Verification and Validation for a rotating cylinder.

All analytical and manufactured solutions already exist. The student will have access to local and external cluster HPC resources. He/she will be seated at WaVEC-Offshore Renewables and/or IST. At the end of this work, and depending on the work progress, a conference and/or a Journal paper is envisaged.

Bibliography

1. Lemaire, S., Vaz, G., & Turnock, S. (2019). On the Need for Higher Order Interpolation with Overset Grid Methods. 22th Numerical Towing Tank Symposium (NuTTS),.
2. Vaz, G., Rijpkema, D., & Lloyd, T. P. (2016). Interfaces Techniques in ReFRESCO (MARIN Report 70059-5-RD).
3. www.refresco.org
4. Eça, L., Klaij, C. M., Vaz, G., Hoekstra, M., & Pereira, F. (2016). On code verification of RANS solvers. Journal of Computational Physics, 310(January), 418–439. https://doi.org/10.1016/j.jcp.2016.01.002