

Master's thesis FS 2023



Head: Prof. Dr. Robert Boes Supervision: Yannick Marschall

3D-numerical simulations around roughness elements

3D-numerical simulations to quantify the flow physics in rivers or around hydraulic structures became popular in recent years as a result of the availability of growing computational power. Due to the high complexity of the geometric boundaries in rivers, i.e. the bathymetry or roughness elements placed on the river bed, several simplifications and assumptions have to be made in order to keep the computational cost affordable. This includes the assumption of a flat water surface, time-averaging of the flow field, i.e., *(unsteady) Reynolds-Averaged Navier-Stokes* simulation (URANS), or the usage of wall models. Highly resolved numerical simulations such as *Large-Eddy Simulations* or *Detached-Eddy Simulations* (DES) are often not feasible (Fig. 1).



Fig. 1: Visualization of flow field around a wall-mounted ellipsoidal object from a DES

In this project, URANS and DES will be carried out using the computational fluid dynamics software Star-CCM+ (developed by Siemens). Therefore, the student will setup multiple simulations, including the design of the 3D geometries of the roughness element, creating the mesh, defining initial and boundary conditions as well as performing the post-processing. By comparing the outcome of the simulations, the influence of some of the assumptions described above on relevant quantities such as drag and lift forces will be evaluated. The goal is to find ways to manipulate the simulation cases with simplification in such a way that similar results can be achieved as in the simulations without the simplifications. The computational power to perform the simulations will be provided by VAW. Programming skills (Matlab or Python) are recommended for data analysis purposes. Strong interest in fluid dynamics and numerical modelling is required.

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| Remarks: | Individual project, thesis can be written in English or German Programming skills (Matlab or Python) recommended |