Karlsruhe Institute of Technology

Institute of Fluid Mechanics

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bachelor / master thesis – numerical

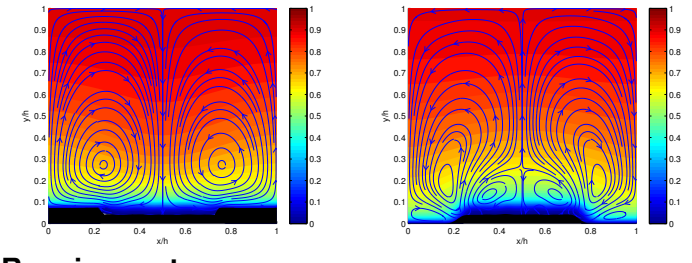
Secondary vortices over spanwise heterogeneous roughness

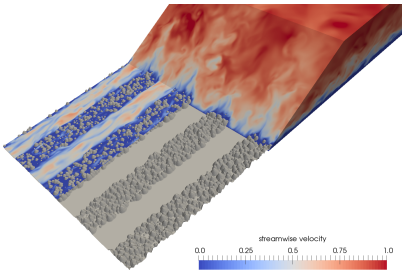
Background

Turbulent flows over rough surfaces are important in the industry since almost every industrial surface is to a certain extent rough. Examples include pipe flow, gas turbines, IC engines and open channels to name a few. It is also well known that heterogeneously distributed roughness can introduce large scale secondary flows of Prandtl's second kind, which extend out of the roughness sublayer and significantly alter the mean-velocity profile, friction factor and heat transfer coefficient. However, the underlying mechanism of the secondary vortex formation and it's dependence on the rough surface properties is not yet entirely clear.

Content of the Thesis

An investigation of heterogeneously distributed roughness has to be carried out with the available implementation utilizing direct numerical simulation (DNS), where roughness elements are resolved using immersed body method. Due to the large simulation size, the computation will be executed on a high-performance computing cluster (HPC) in parallel mode. Based on the results, the effect of roughness surface properties on secondary vortices formation is to be analyzed in order to clarify the impact of roughness spacing, mean roughness height and statistical moments of roughness height distribution. Evaluation and analysis of flow topology for time-averaged and instantaneous velocity fields have to be performed on the generated data-sets. Statistical analysis of flow topology includes application of critical point analysis and proper orthogonal decomposition (POD) technique. The final aim of the thesis is to link the roughness properties to the secondary motions and eventually develop a simplified homogeneous volume-force based model for the representation of secondary vortex formation.





Requirements

basic knowledge in turbulent flows

Beneficial skills

CFD, Linux, Fortran, Matlab

You will learn

methods of scientific research, flow topology analysis, HPC, POD

Start: immediately

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