Karlsruhe Institute of Technology

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Master thesis – numerical

Identifying coherent vortices in turbulent flow fields

Background

Magnetic resonance velocimetry (MRV), particle image velocimetry (PIV) or direct numerical simulation (DNS) are very powerful experimental and numerical methods that can measure instantaneous three-dimensional vector velocity fields. They deliver very comprehensive information about the investigated flow that can be used to explain and unveil important fluid-dynamic phenomena. However, it is very challenging to exploit this incredible potential in turbulent flows, where reproducible flow features are hidden in the flow field behind random, chaotic turbulent velocity fluctuations. The information contained in three-dimensional, three-component flow fields is often too complex to be easily interpreted and the researcher relies on few global statistical flow properties to describe the flow. In this way, large part of the information about the flow field is not exploited. In this large amount of lost data lie many statistically relevant vortical structures which are related to the regeneration cycle of turbulence and of many properties of turbulent flows.

Content of the Thesis

This project aims at implementing a numerical code which is capable of identifying coherent vortices in turbulent wall-bounded flows, based on the concept of the so-called swirling strength (Gao, Ortiz-Duenas & Longmire (2011)). An already existing procedure will be improved to reliably identify the largest number of vortices possible, while keeping the number of false positive at a lowest. The vortices will be classified according to their mean direction, location and circulation. A series of three-dimensional flow fields of turbulent channel flows obtained via direct numerical simulation are made available to test the developed tool. The final aim is to characterize the mean vortex population of natural turbulent channel flows and quantitatively measure how particular flow control strategy aimed at reducing turbulence modify it. Therefore, a comparison of the vortex population in controlled and uncontrolled channels needs to be performed.

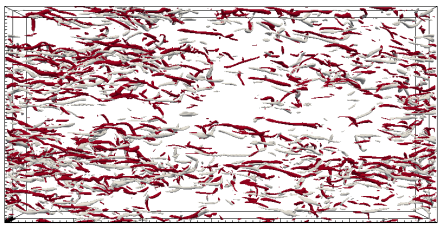

Abb.: Vortices near the wall of a turbulent channel flow

Requirements

basic knowledge in fluid mechanics and programming

Start: immediately

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