6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 15 June 2018, Glasgow, UK

# INDUCED HIGH ASPECT-RATIO SENSITIVENESS OF MESH NON-ORTHOGONALITY AND SKEWNESS CAUSED BY A CENTROID CALCULATION METHOD BASED ON SUB-TRIANGLE AND FACE-PYRAMID WEIGHTING

**S. Zhao[1], B. Stoevesandt[2] and J. Peinke[1]**

[1] ForWind – Center for Wind Energy Research, Institute of Physics, Carl von Ossietzky University of Oldenburg, 26129 Oldenburg, Germany
[2] Fraunhofer Institute for Wind Energy and Energy System Technology (IWES), 26129 Oldenburg, Germany

**Key words:** *aspect-ratio, non-orthogonality, skewness, face centre, face area, cell centre, cell volume*

In computational fluid dynamic (CFD), the discretization of the computational domain is a fundamental step. There are several criteria to determine the quality of the mesh generated for the finite volume method. Meeting those criteria has a direct effect on the results of the computing process afterwards. The mesh non-orthogonality and skewness are two of these important criteria to measure the quality of the mesh for the computing accuracy and convergence cost.

Within the finite volume method, the centres and areas of faces, and the centres and volumes of cells need to be calculated from the mesh. As these quantities are directly influencing the later calculations, properties like non-orthogonality and skewness defined from them reflect how well the physical system can be resembled after discretization. Hence, on top of the deterministic factors from the mesh, methods of the calculation of these quantities have influence on the results and computing cost as well. When dealing with high aspect-ratio cells, such influence could be dramatic.

In this paper, a type of high aspect-ratio induced sensitivity of non-orthogonality and skewness on non-tetrahedral mesh caused by centroid calculation will be discussed. The centroid calculation method based on sub-triangle and face-pyramid weighting, which is currently utilized by OpenFOAM will be compared with other calculation methods(such as simple geometric centre). Some dramatic non-orthogonality and skewness difference based on identical mesh will be shown. Demonstration will be given from a simple two-cell mesh, to mesh with 10+ million cells. A series of tests are conducted to get a baseline understanding of the high aspect-ratio sensitivity of the centroid calculation method from OpenFOAM. Some baseline parametrization will be made to categorise the types of cell that may cause the induced sensitivity of the method. Further more, the actual effects on the simulation results from centroid calculation will be shown and discussed.