Comparison of OpenFOAM and EllipSys3D for neutral atmospheric flow over complex terrain

The flow solvers OpenFOAM and EllipSys3D are compared in the case of neutral atmospheric flow over terrain using the test cases of Askervein and Bolund hills. Both solvers are run using the steady-state Reynolds-averaged Navier–Stokes k–turbulence model. One of the main modeling differences between the two solvers is the wall-function approach. The OpenFOAM v.1.7.1 uses a Nikuradse’s sand roughness model, while EllipSys3D uses a model based on the atmospheric roughness length. It is found that Nikuradse’s model introduces an error dependent on the near-wall cell height. To mitigate this error the near-wall cells should be at least 10 times larger than the surface roughness. It is nonetheless possible to obtain very similar results between EllipSys3D and OpenFOAM v.1.7.1. The more recent OpenFOAM v.2.2.1, which includes the atmospheric roughness length wall-function approach, has also been tested and compared to the results of OpenFOAM v.1.7.1 and EllipSys3D. The numerical results obtained using the same wall-modeling approach in both EllipSys3D and Open-FOAM v.2.1.1 proved to be almost identical. Two meshing strategies are investigated using HypGrid and SnappyHexMesh. The performance of Open-FOAM on SnappyHexMesh-based low-aspect-ratio unstructured meshes is found to be almost an order of magnitude faster than on HypGrid-based structured and high-aspect-ratio meshes. However, proper control of boundary layer resolution is found to be very difficult when the SnappyHexMesh tool is utilized for grid generation purposes. The OpenFOAM is generally found to be 2–6 times slower than EllipSys3D in achieving numerical results of the same order of accuracy on similar or identical computational meshes, when utilization of EllipSys3D default grid sequencing procedures is included.

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