Assignment X

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Set-up

In this assignment the flow over a cylinder was studied at Reynolds number 50. The mesh used in the simulations is depicted in Figure 1 and it consists of $200 \times 200 \times 500$ cells in the $x-, y-$ and $z-$directions, respectively. Most of the cells are in the immediate vicinity of the cylinder.

On the inlet boundary (left) the velocity was set to a fixed value of $U_z = 1$ and zero gradient boundary condition was used for the pressure. At the outlet boundaries, pressure was fixed to zero while velocity was set to a zero gradient. At the surface of the cylinder the no-slip condition was used.
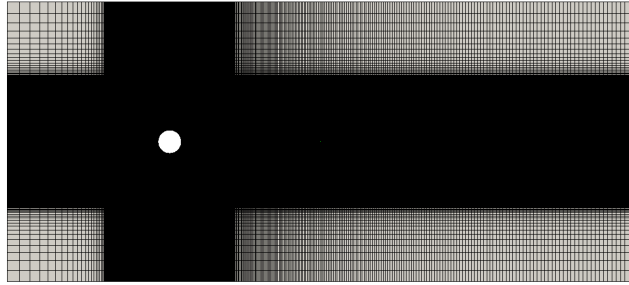

Figure 1: An overview of the mesh used.

Results

Figure 2 shows the vorticity field at time $t = 1.3$. As can be seen from the figure, the well-known Karman vortex street is formed in the wake of the cylinder. This causes the lift and drag forces to oscillate as a function of time.

The velocity profiles from $1D$ and $2D$ downstream of the cylinder are presented in Figure 3. The agreement between the simulations and measured reference data (dashed lines) is very good.
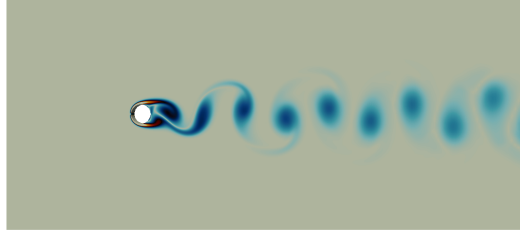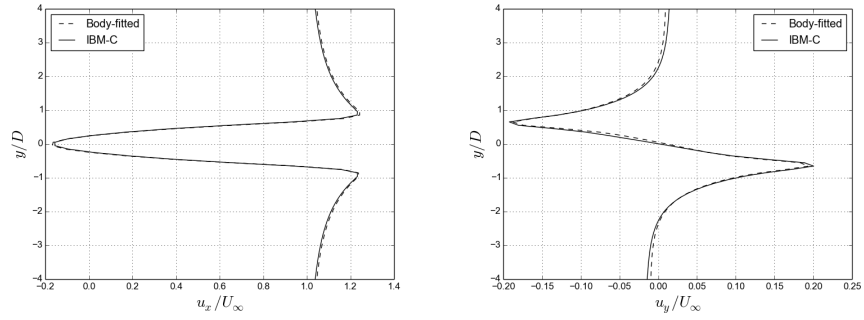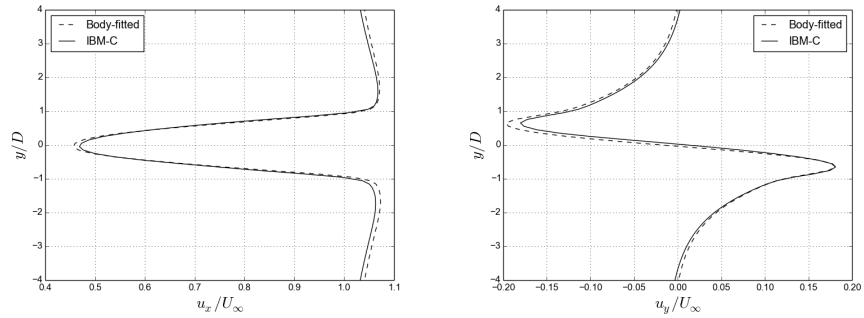
Figure 2: A snapshot of the vorticity field.

(a) $1D$ downstream from the cylinder center.

(b) $2D$ downstream from the cylinder center.

Figure 3: Time-averaged velocity profiles 1D and 2D downstream.

Answers to additional questions

Is the flow laminar or turbulent? The flow is laminar.

Did you notice any difference between method A and method B? Yes, the simulation diverged when method A was used. Therefore, the only results presented here are those obtained with method B.

If you were to make the mesh denser would the results look better? Theoretically, yes. However, as the mesh was already quite dense and the agreement between the simulations and reference data was already good, there would be no reason to do this. Moreover, it is likely that the simulation results are already in the error range of the measurements.