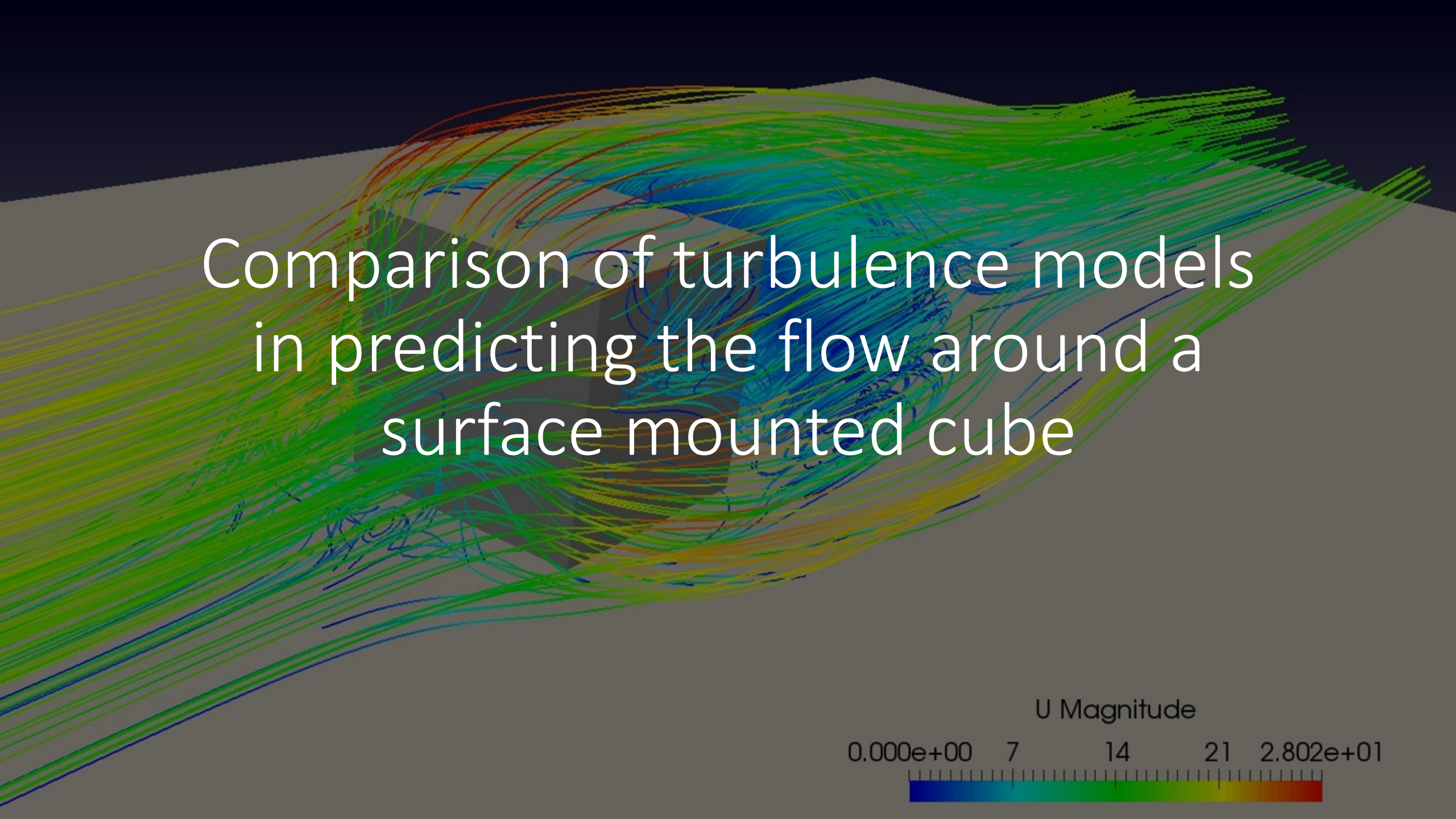
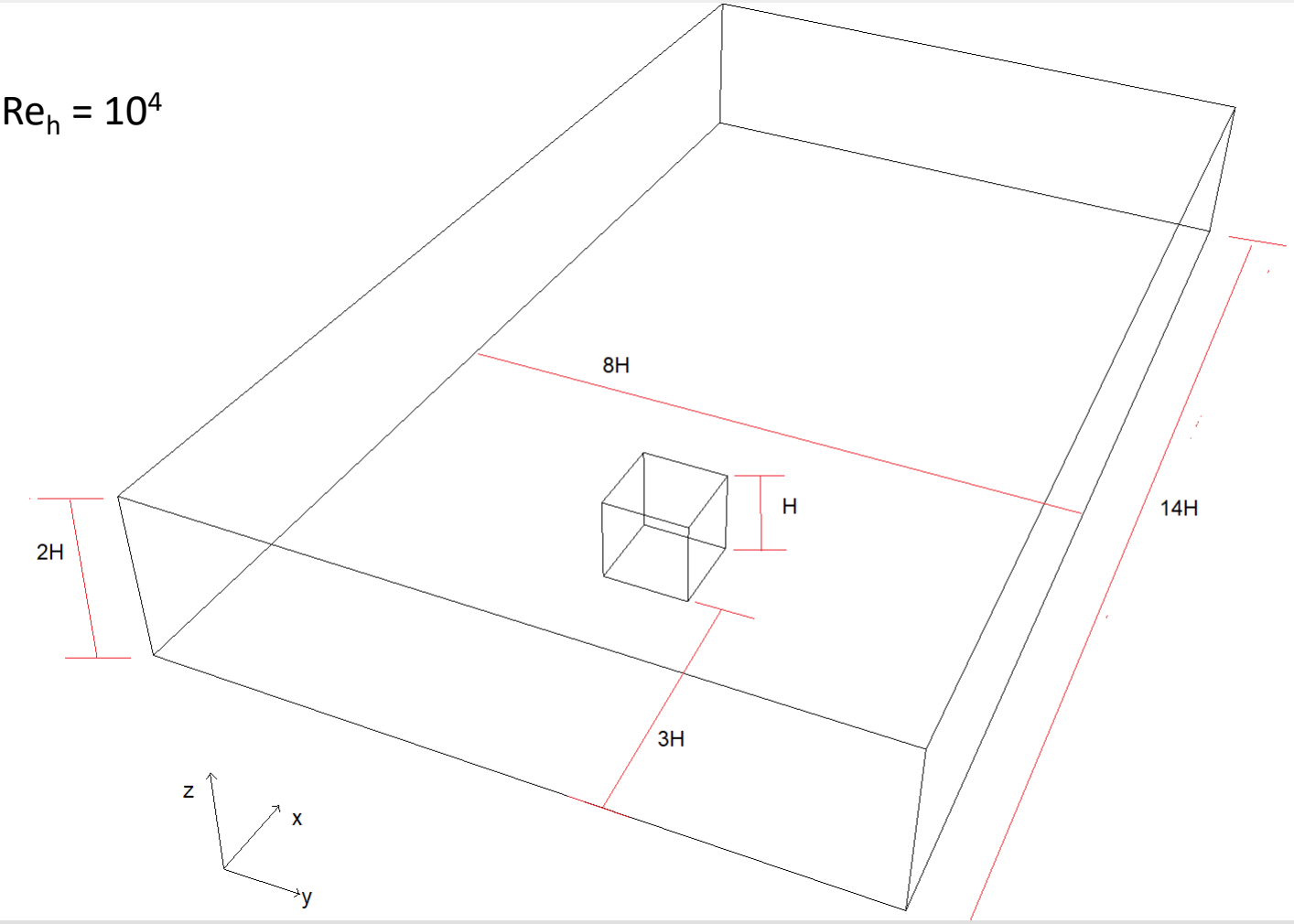
Comparison of turbulence models in predicting the flow around a surface mounted cube



Geometry

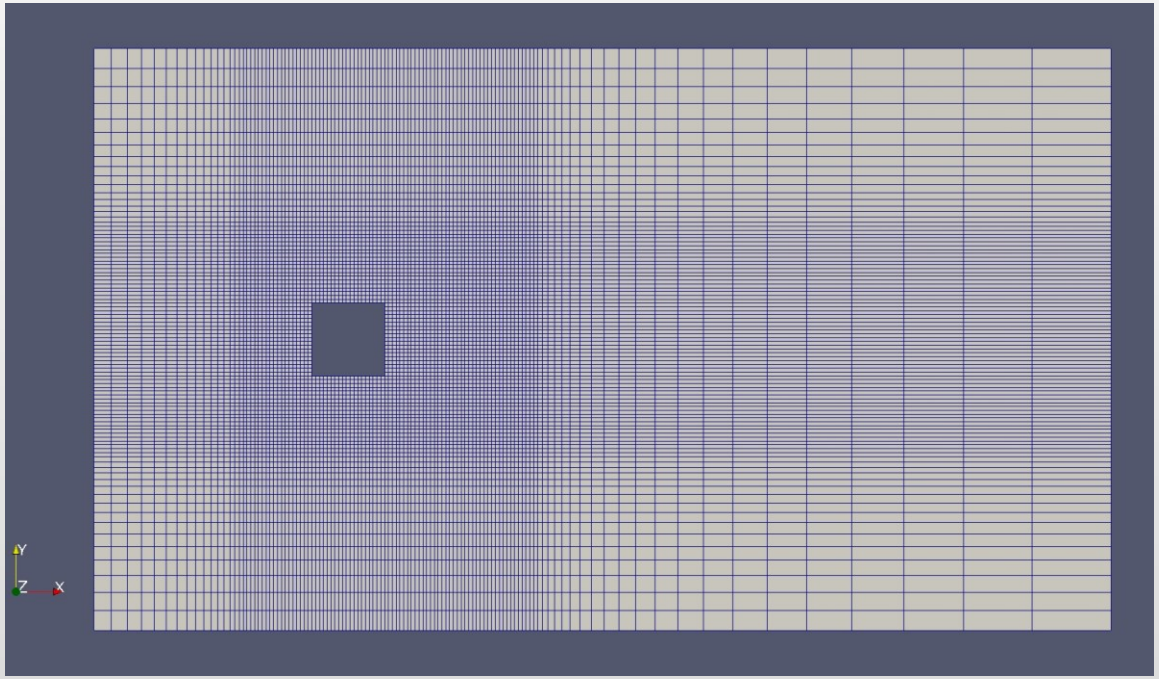
$Re_h = 10^4$



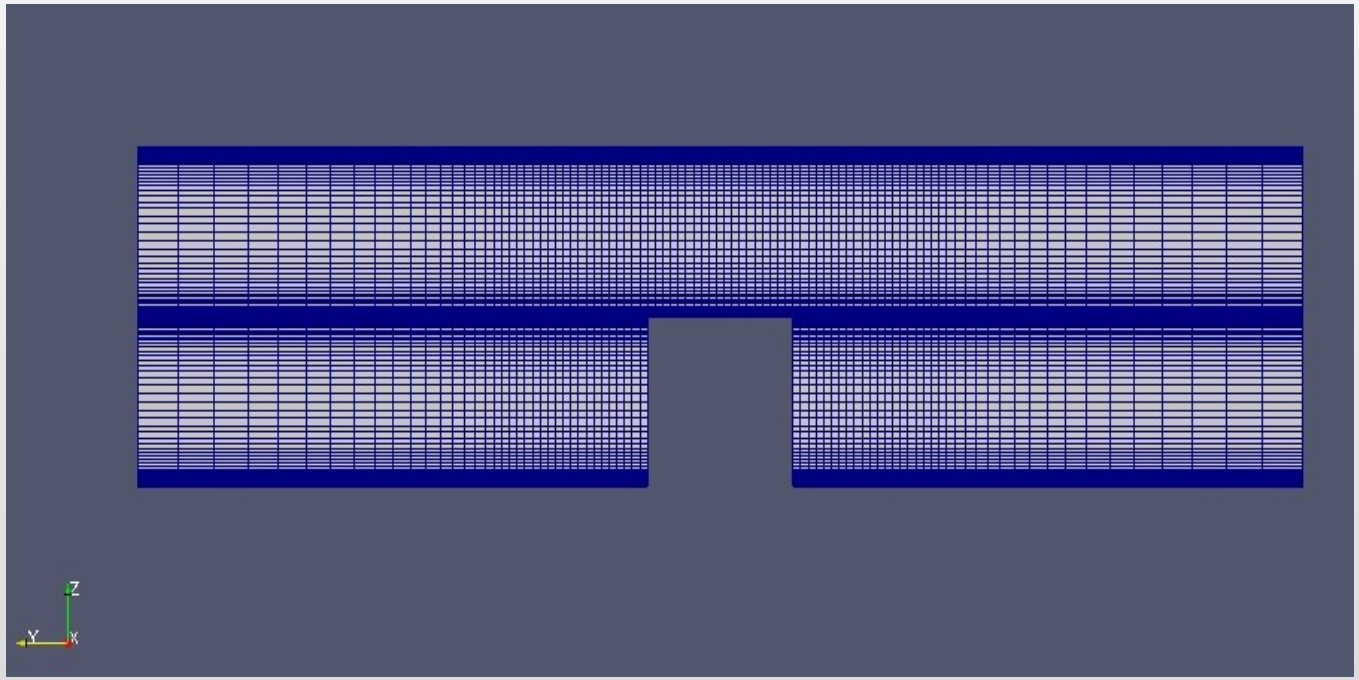
Bottom, top and cube are walls
Sides are symmetry

Meshing

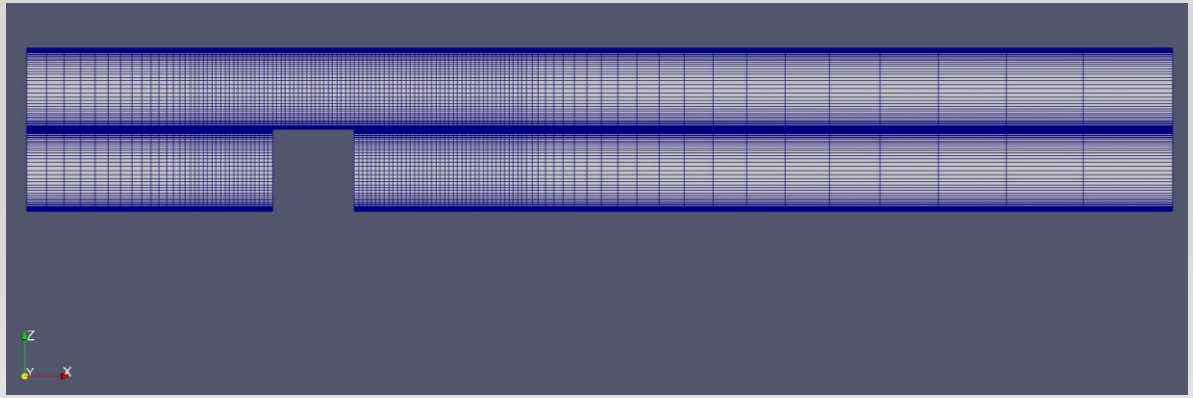
Top view



Front view



Side view



Boundary and initial conditions

K-epsilon

	Inlet	Outlet	Sides	Bottom	Top	Cube
U	MappedFixedValue	zeroGradient	Slip	NoSlip	NoSlip	NoSlip
P	zeroGradient	fixedValue	Slip	zeroGradient	zeroGradient	zeroGradient
k	MappedFixedValue	zeroGradient	Slip	kqRWallFunction	kqRWallFunction	kqRWallFunction
epsilon	MappedFixedValue	zeroGradient	Slip	epsilonWallFunction	epsilonWallFunction	epsilonWallFunction
nut	calculated	calculated	Slip	nutUWallFunction	nutUWallFunction	nutUWallFunction

Table 1. Boundary condition for the k-epsilon case.

K-omega SST

	Inlet	Outlet	Sides	Bottom	Top	Cube
U	MappedFixedValue	zeroGradient	Slip	NoSlip	NoSlip	NoSlip
P	zeroGradient	fixedValue	Slip	zeroGradient	zeroGradient	zeroGradient
k	MappedFixedValue	zeroGradient	Slip	kqRWallFunction	kqRWallFunction	kqRWallFunction
omega	MappedFixedValue	zeroGradient	Slip	omegaWallFunction	omegaWallFunction	omegaWallFunction
nut	calculated	calculated	Slip	nutUSpaldingWallFunction	nutUSpaldingWallFunction	nutUSpaldingWallFunction

Table 2. Boundary condition for the k-omega SST case.

Realizable k-epsilon

	Inlet	Outlet	Sides	Bottom	Top	Cube
U	MappedFixedValue	zeroGradient	Slip	NoSlip	NoSlip	NoSlip
P	zeroGradient	fixedValue	Slip	zeroGradient	zeroGradient	zeroGradient
k	MappedFixedValue	zeroGradient	Slip	kqRWallFunction	kqRWallFunction	kqRWallFunction
epsilon	MappedFixedValue	zeroGradient	Slip	epsilonWallFunction	epsilonWallFunction	epsilonWallFunction
nut	calculated	calculated	Slip	nutUWallFunction	nutUWallFunction	nutUWallFunction

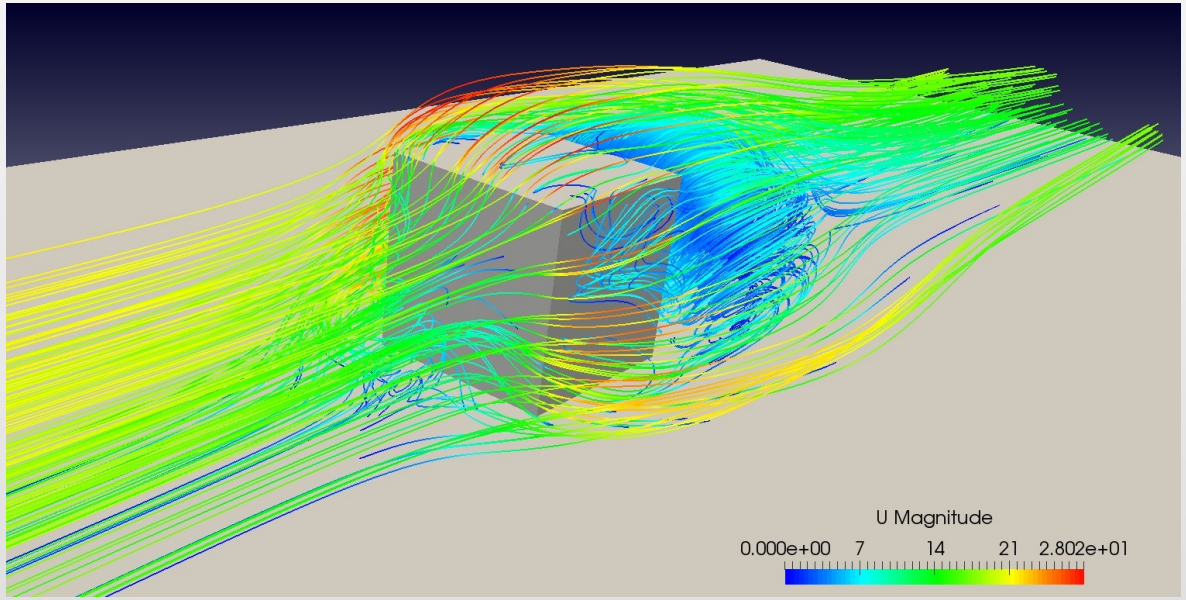
Table 3. Boundary condition for the Realizable k-epsilon case.

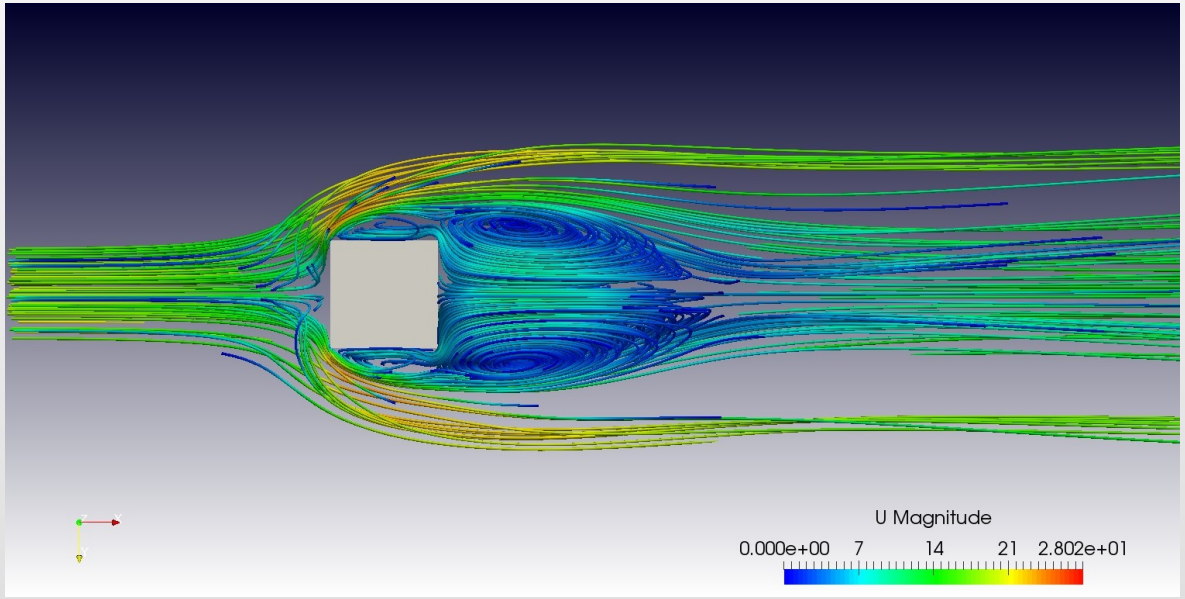
Discretization schemes

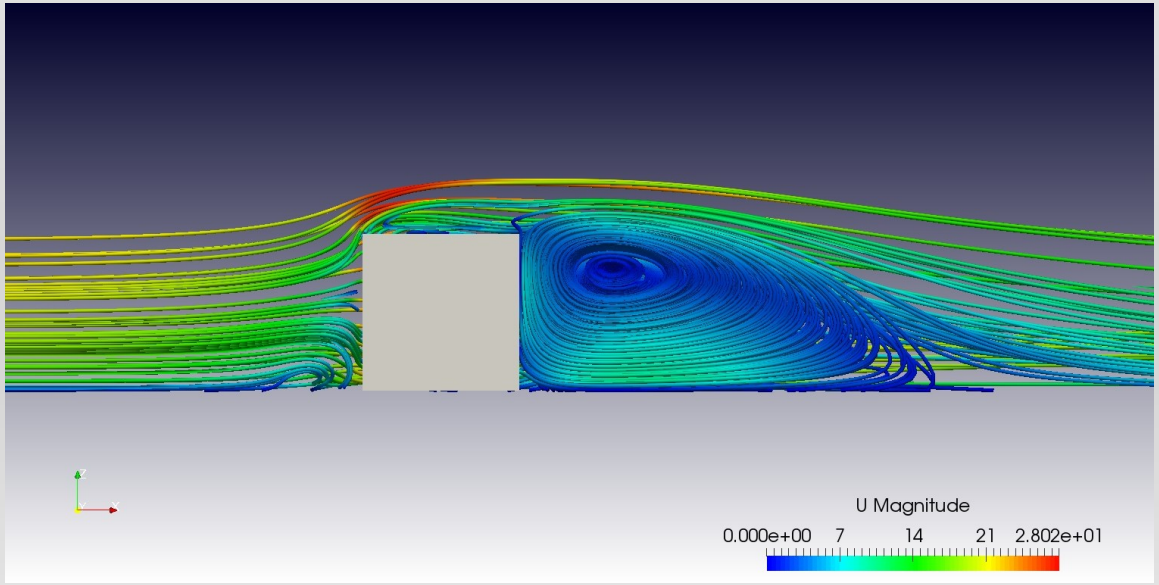
Model	Time derivative	Divergence	Gradient	Laplacian	N. of cells
K-epsilon	Steady state	Gauss linearUpwind	Gauss linear	Gauss linear corrected	1359319
K-omega SST	Steady state	Gauss linearUpwind	cellLimited Gauss linear	Gauss linear corrected	5210750
Re_k-epsilon	Steady state	Gauss linearUpwind	Gauss linear	Gauss linear corrected	1422807

Results

K-epsilon

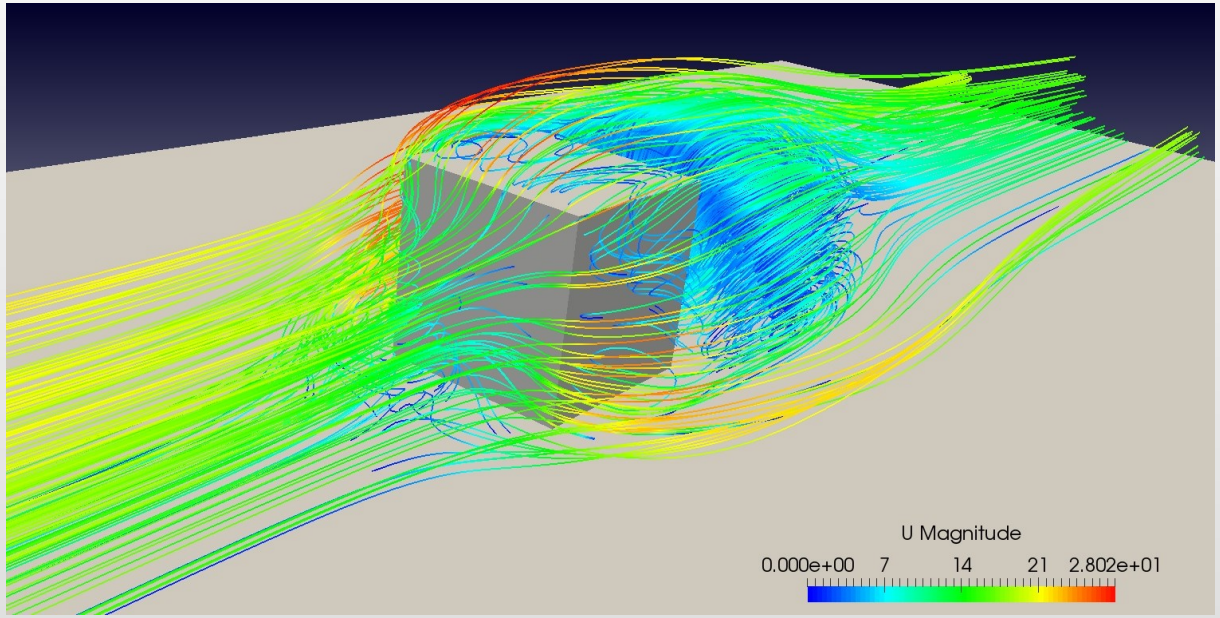


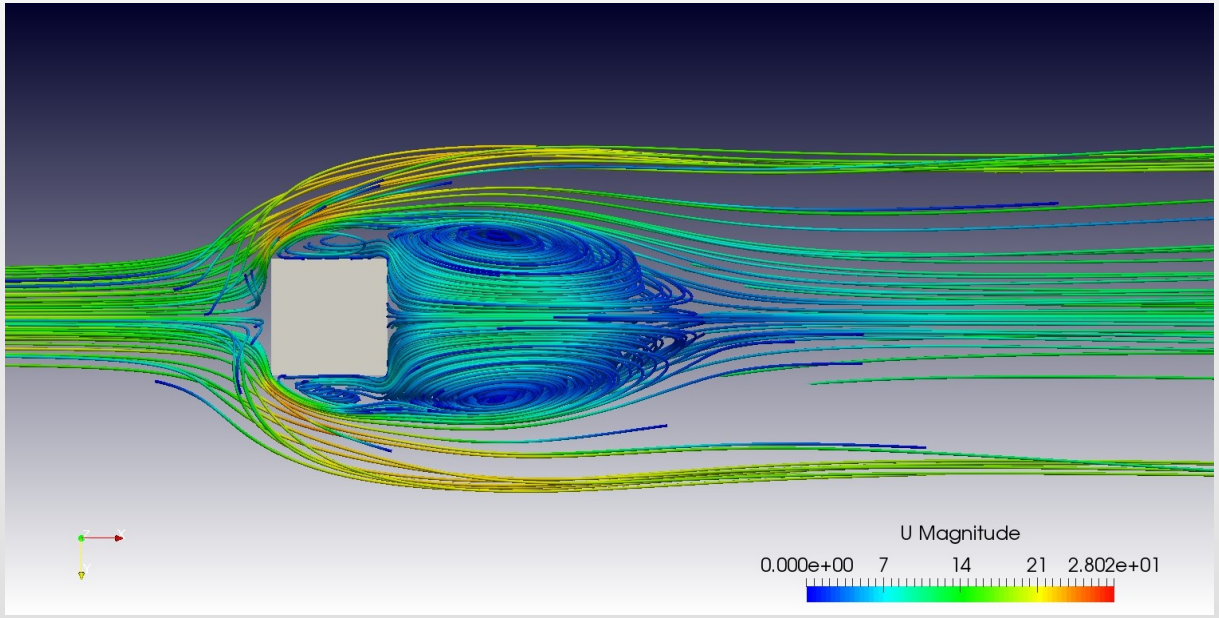


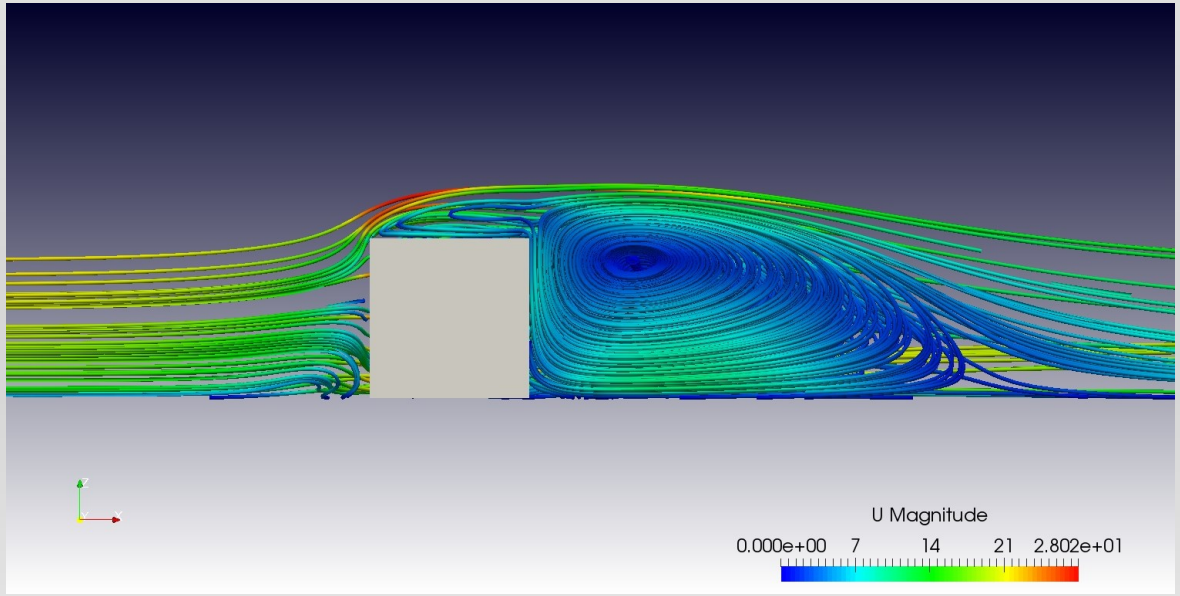


Results

Re_K-epsilon

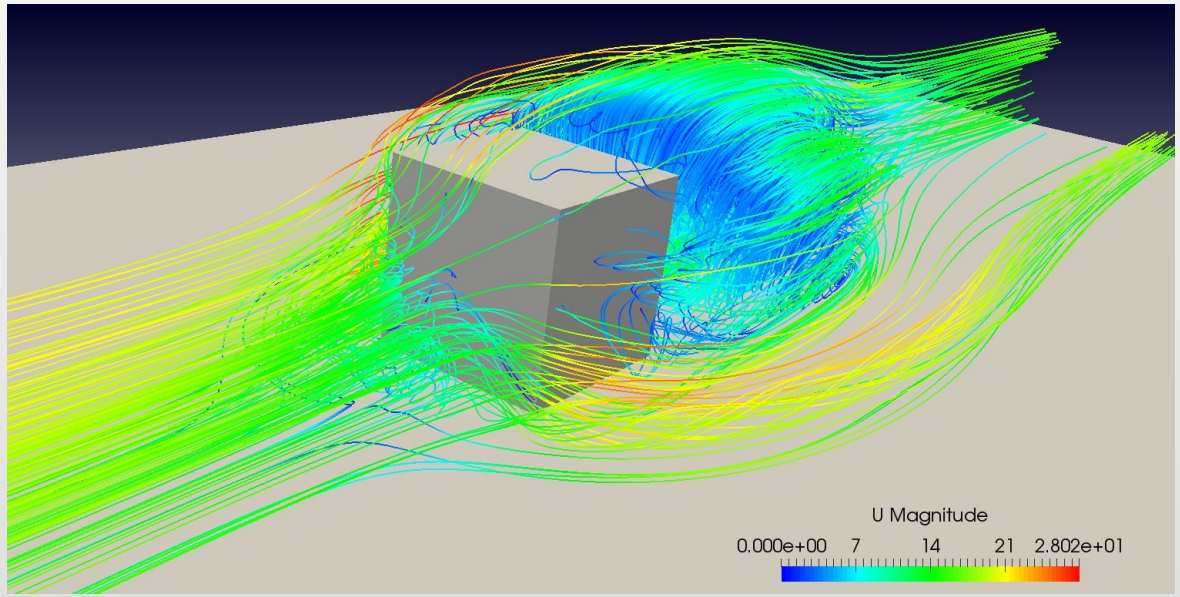


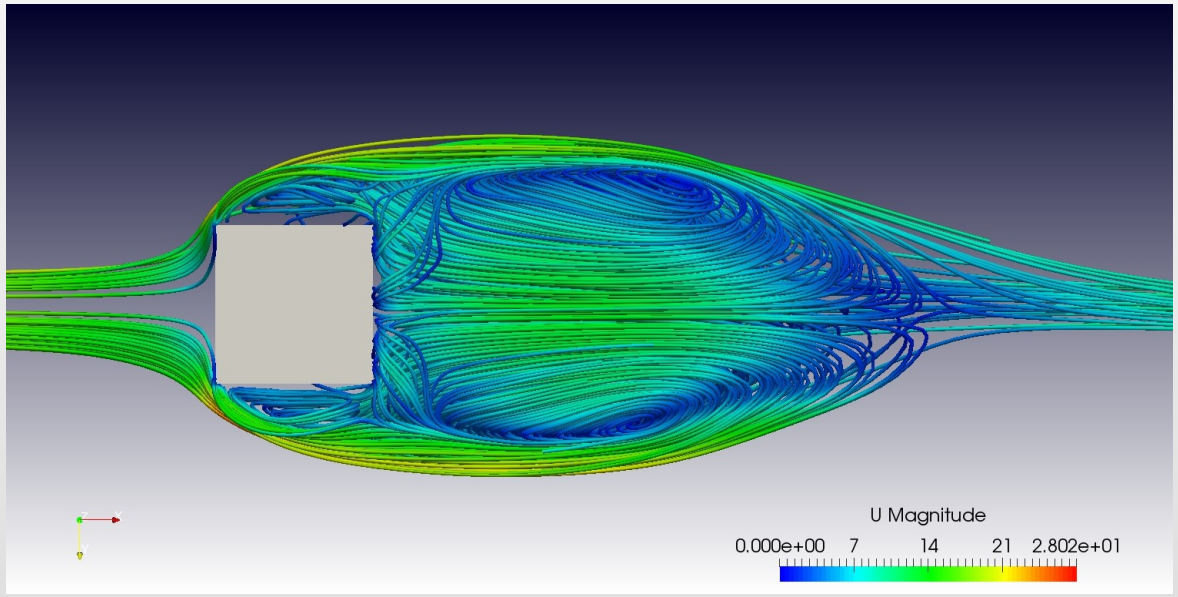


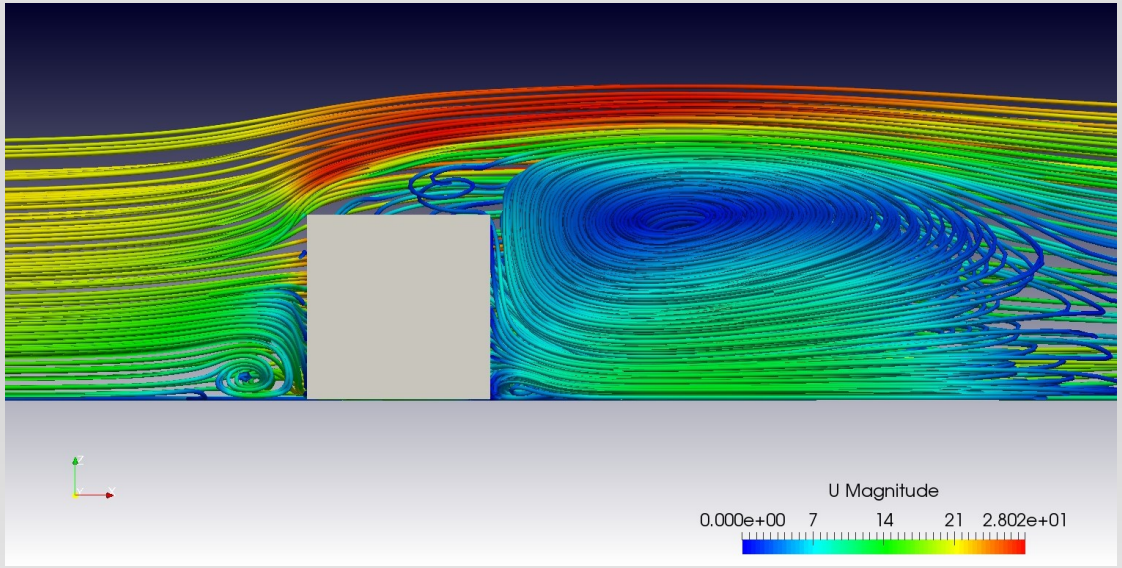


Results

K-omega SST

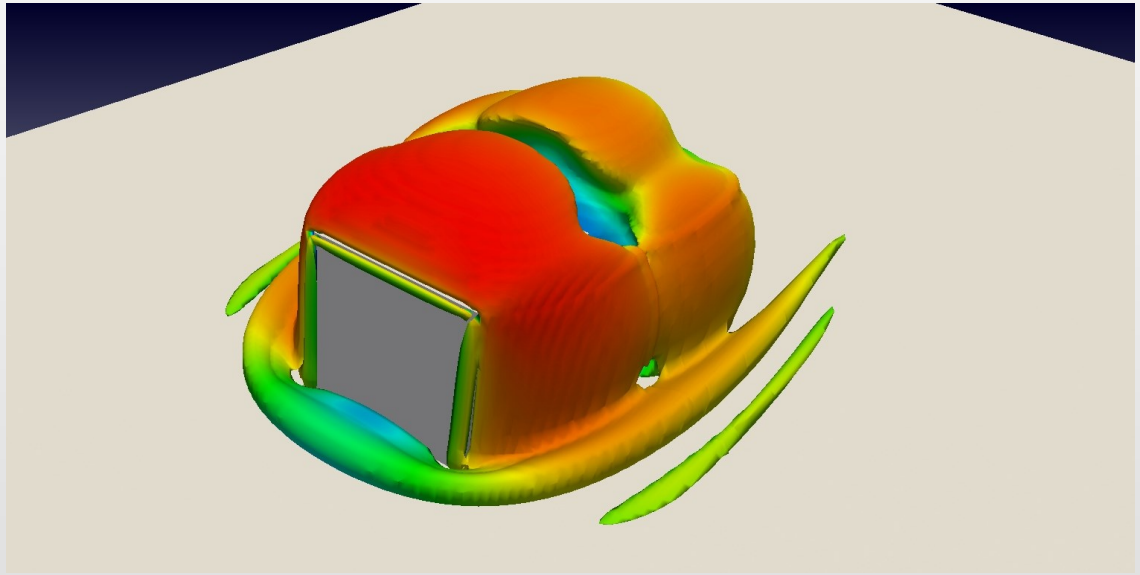




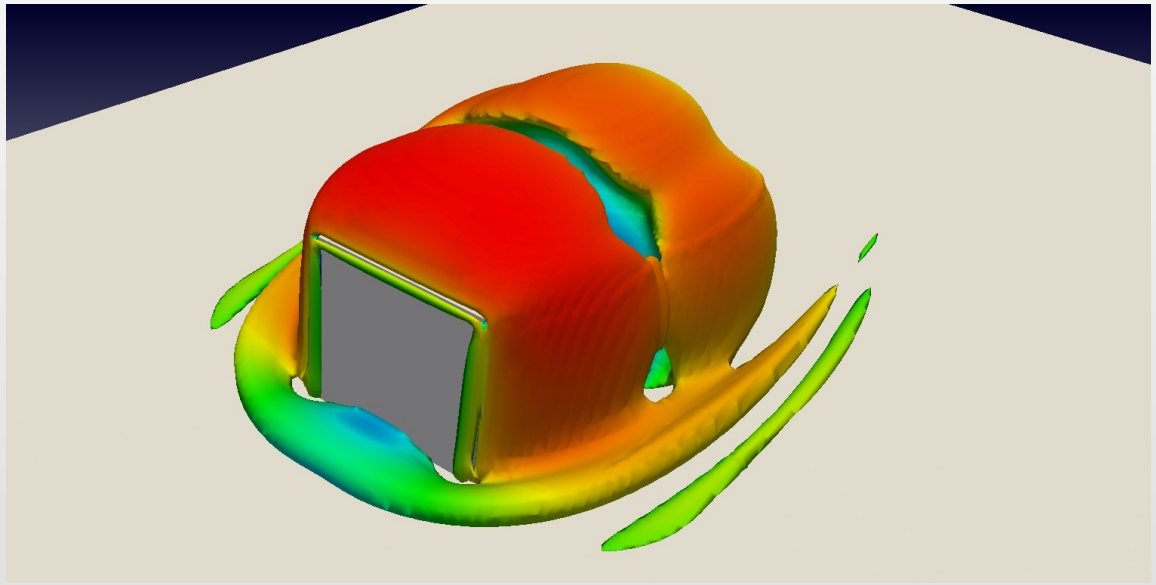


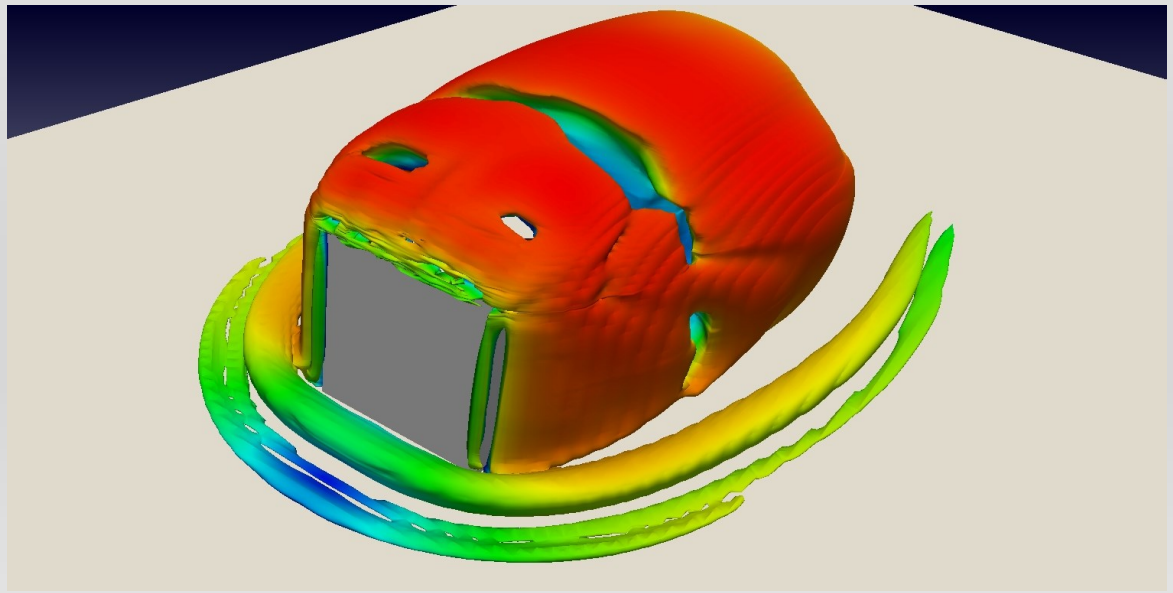
Results

K-epsilon



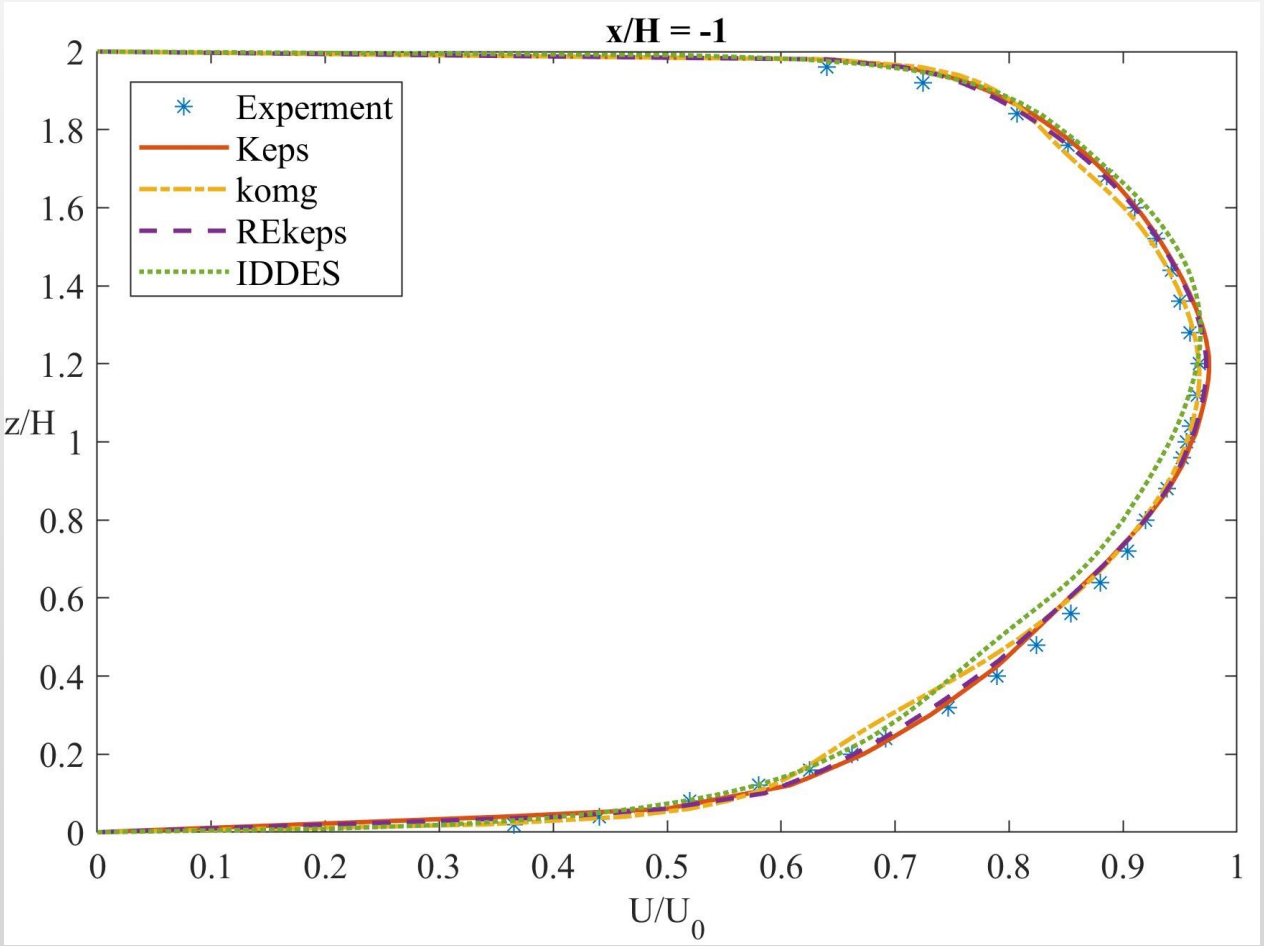
Re_K-epsilon

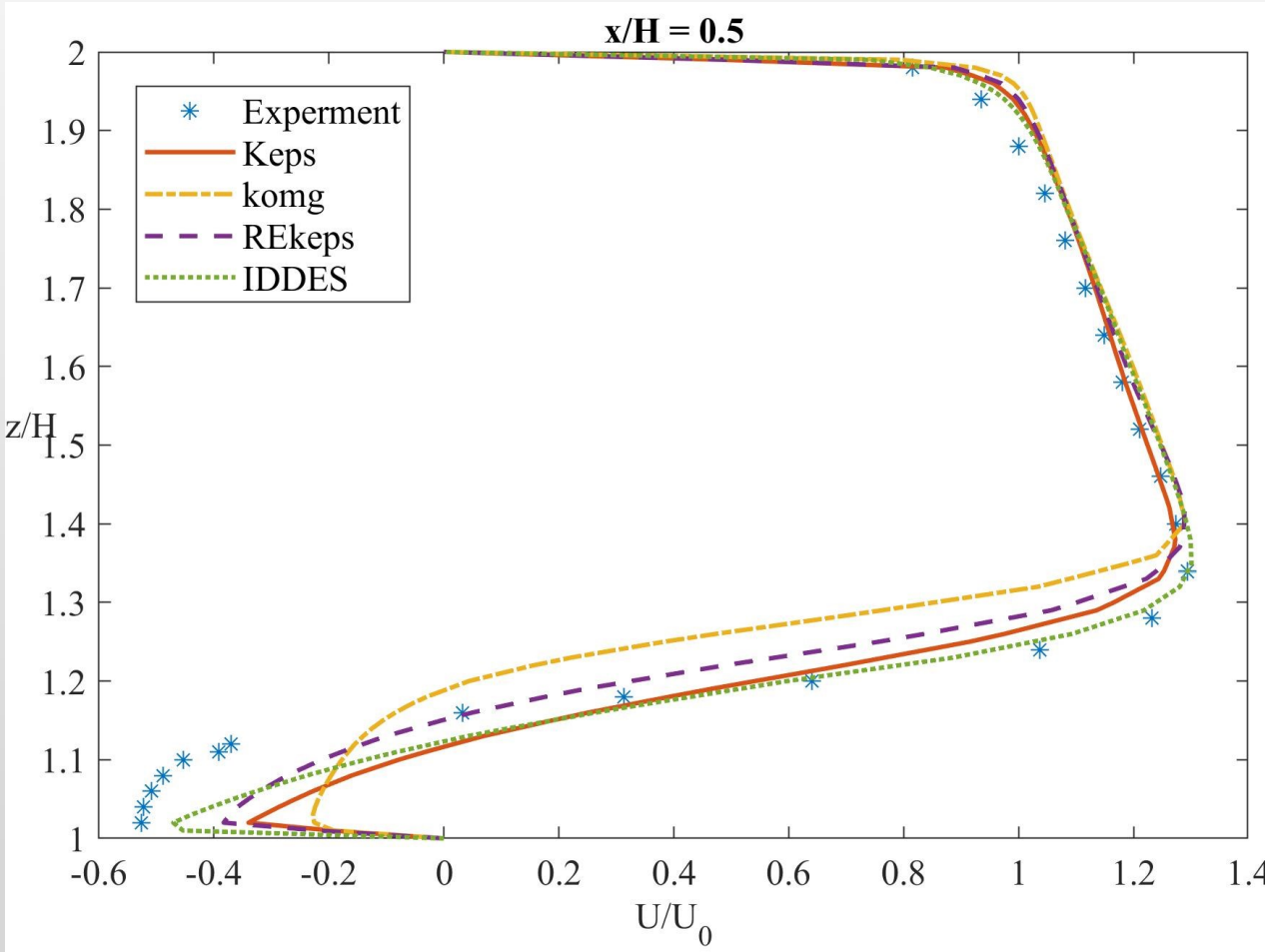




K-omega SST

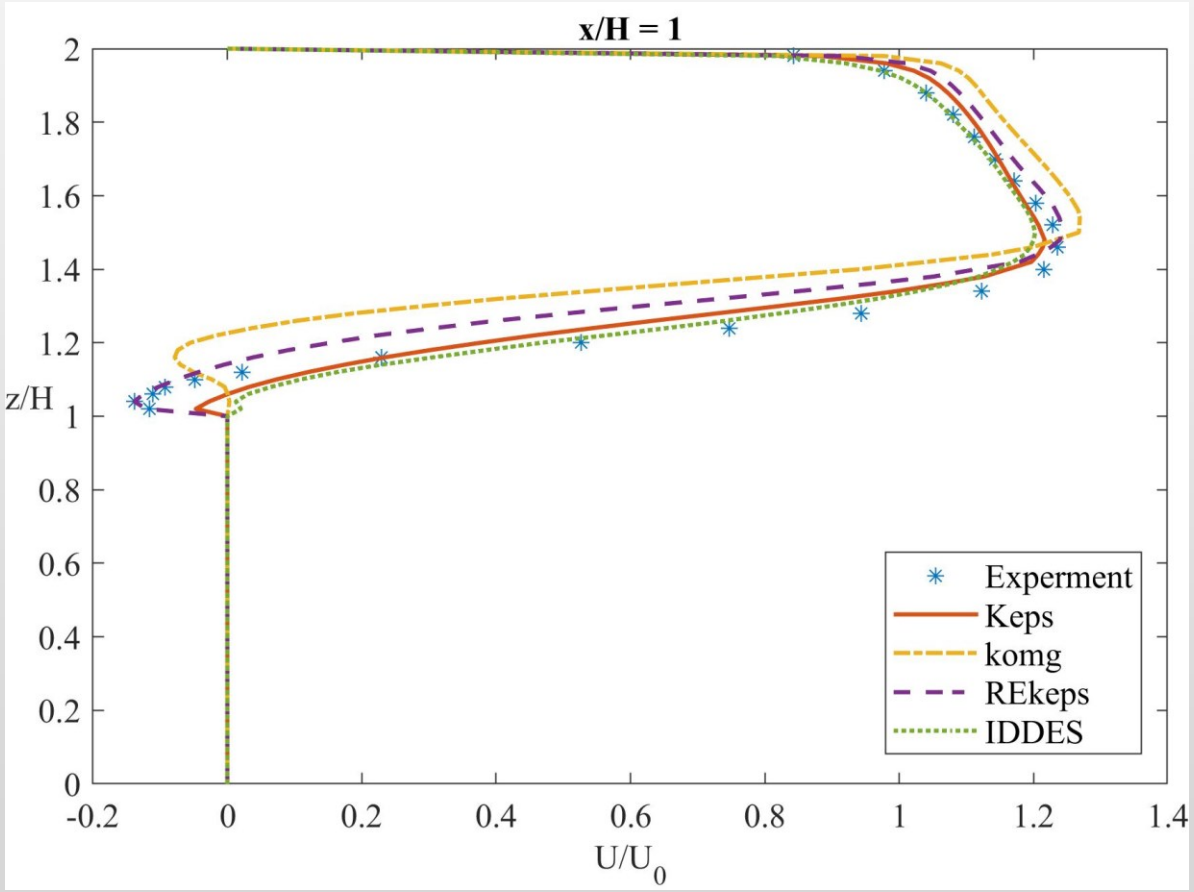
Results

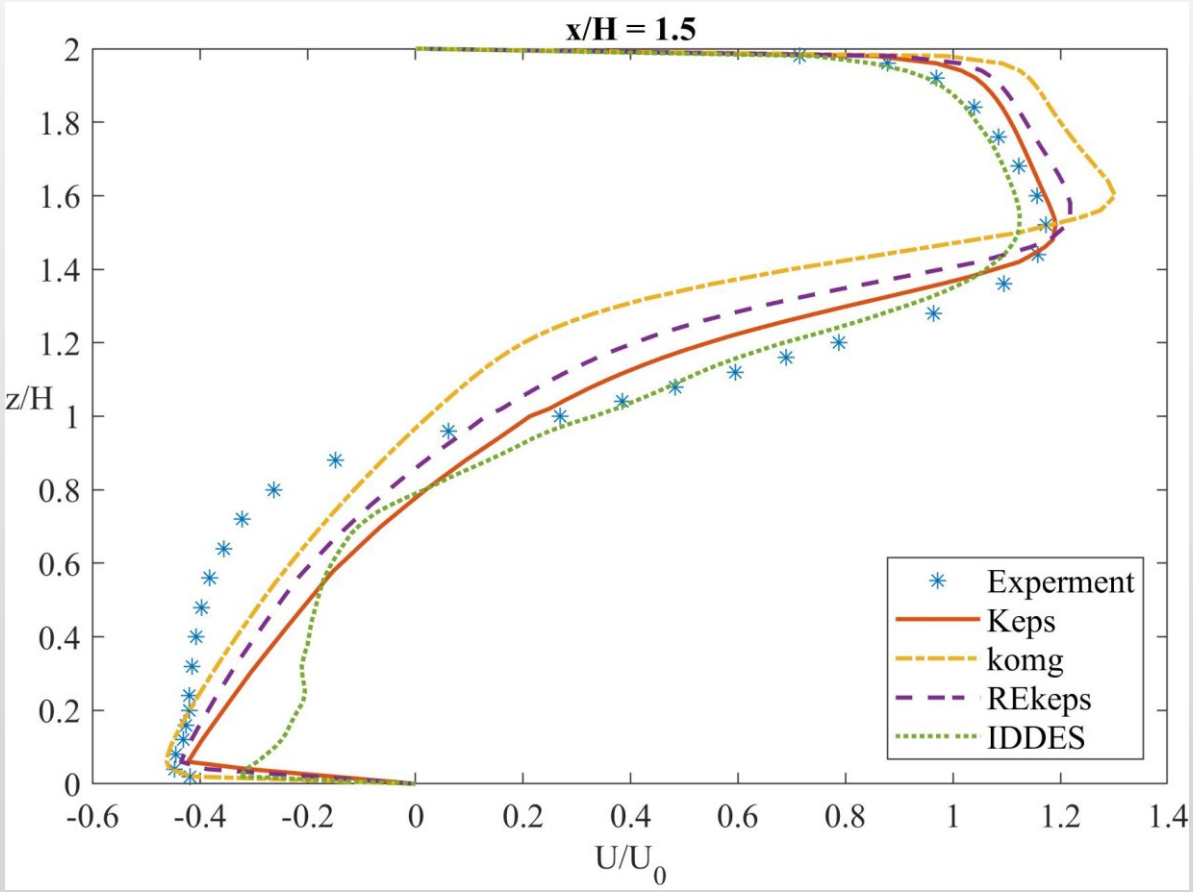




Results compared with experiment data: Martinuzzi R. and Tropea C. - *The Flow around Surface Mounted Prismatic Obstacles Placed in a Fully Developed Channel Flow*. Journal of Fluid Engeneering, 115 (8) (1993), pp 85-91.

Results





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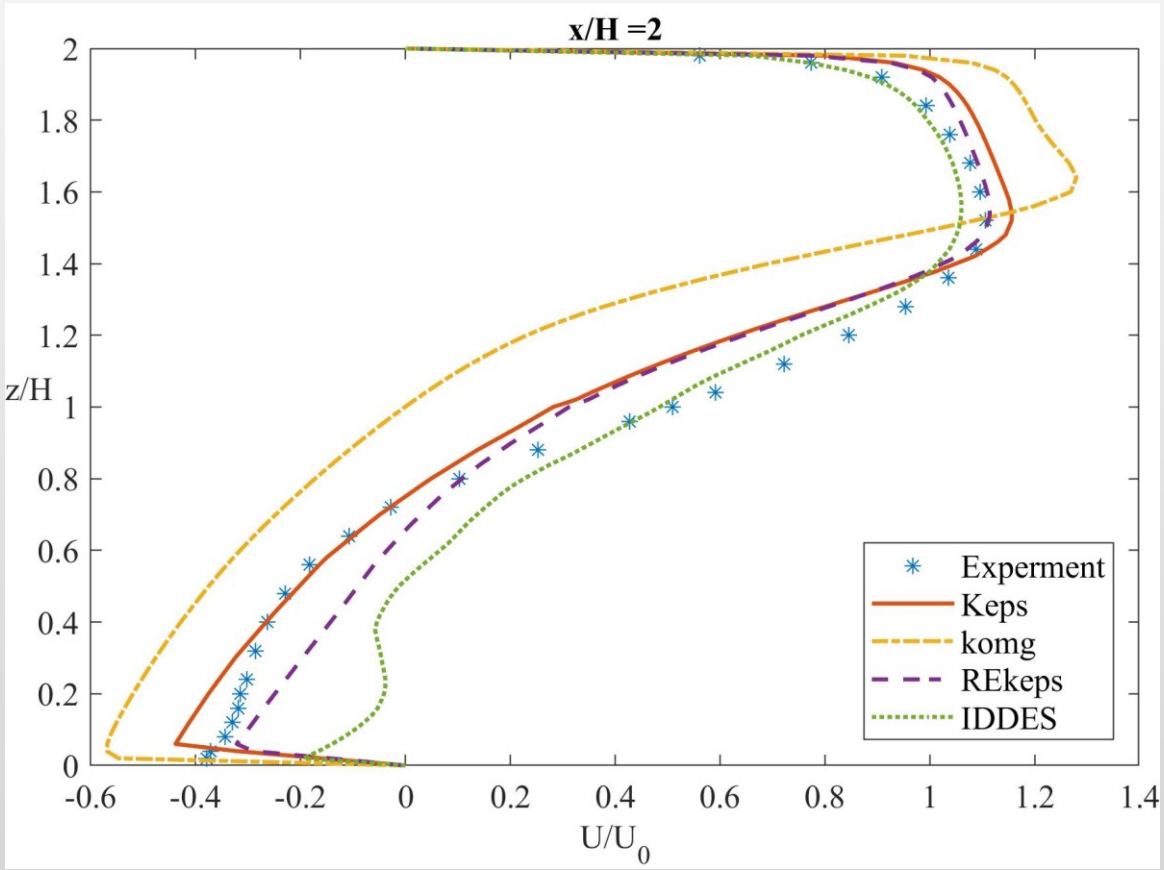

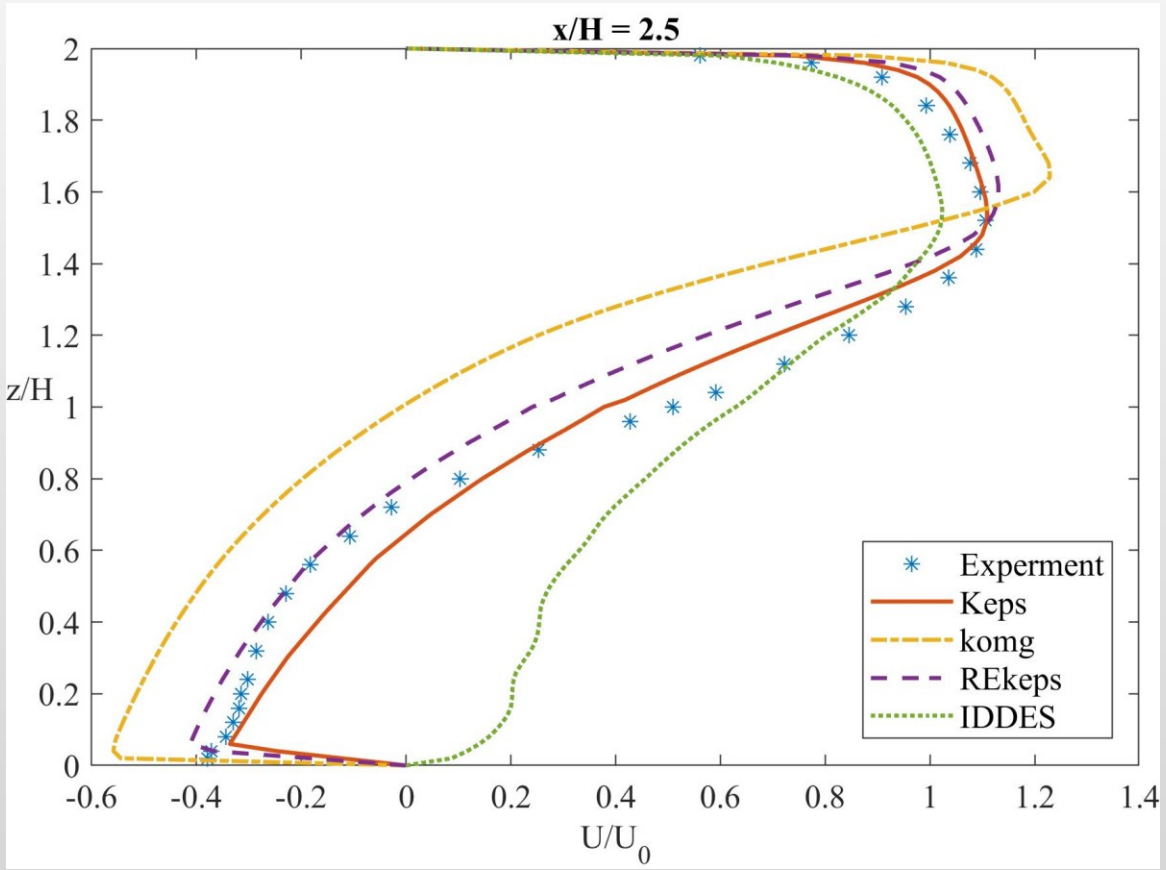

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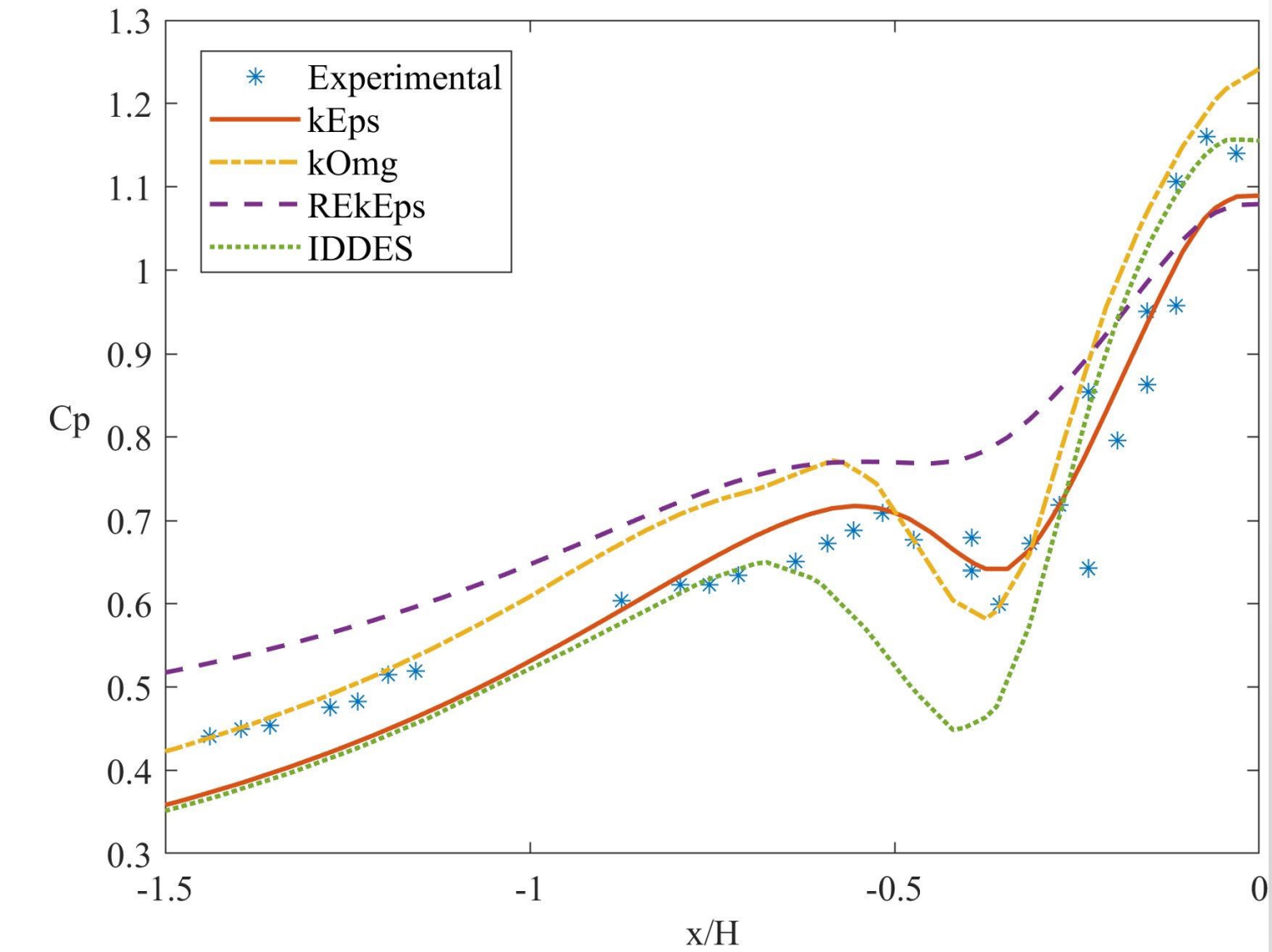

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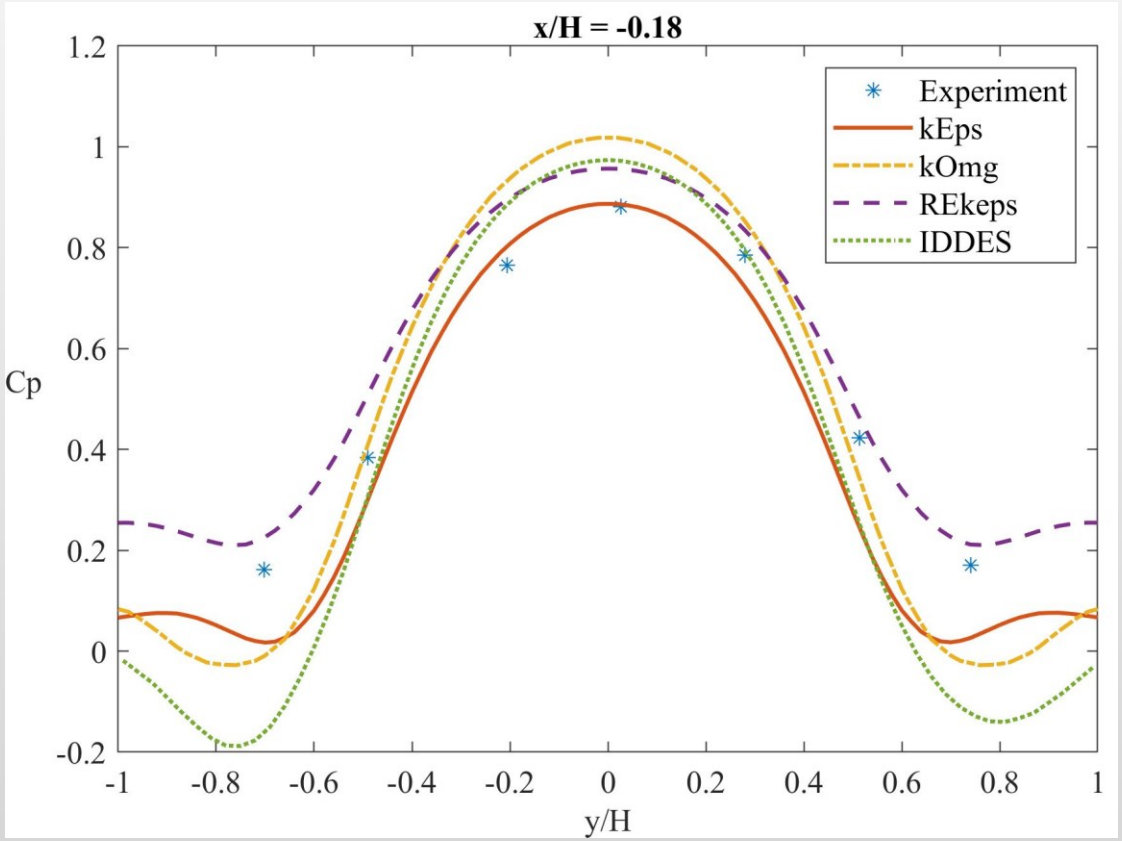

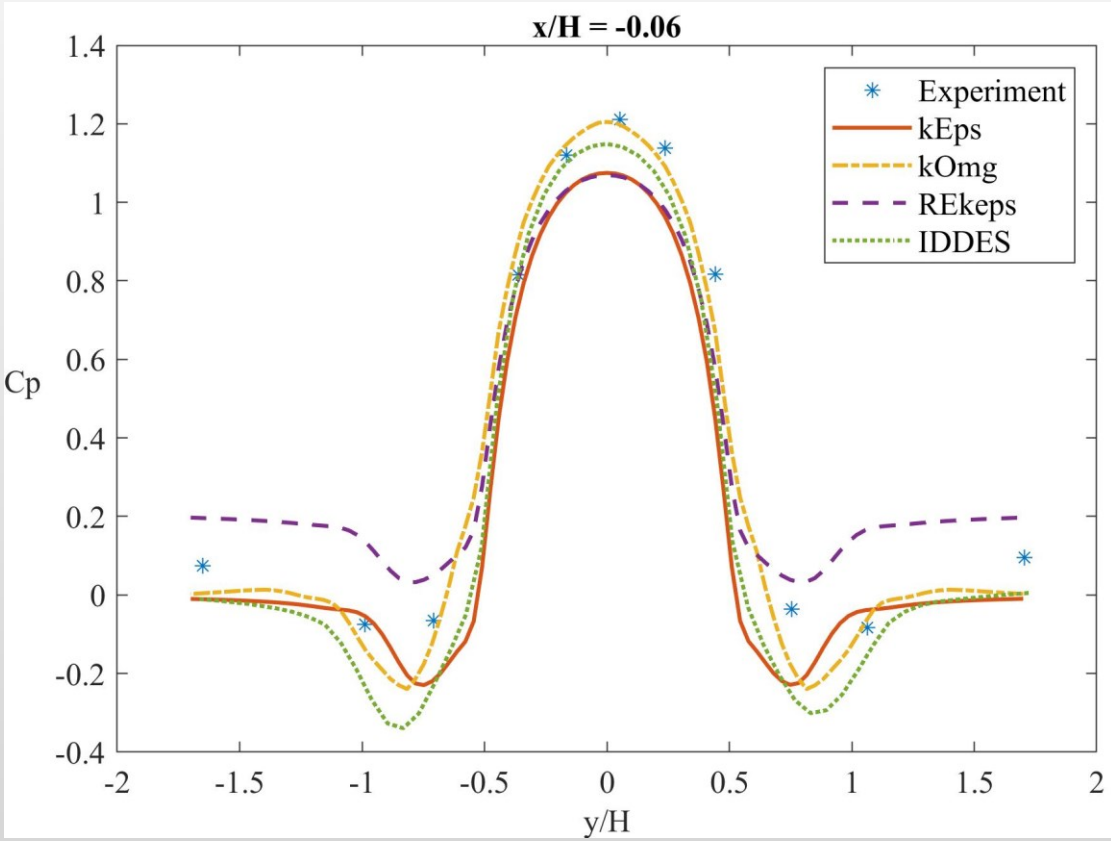

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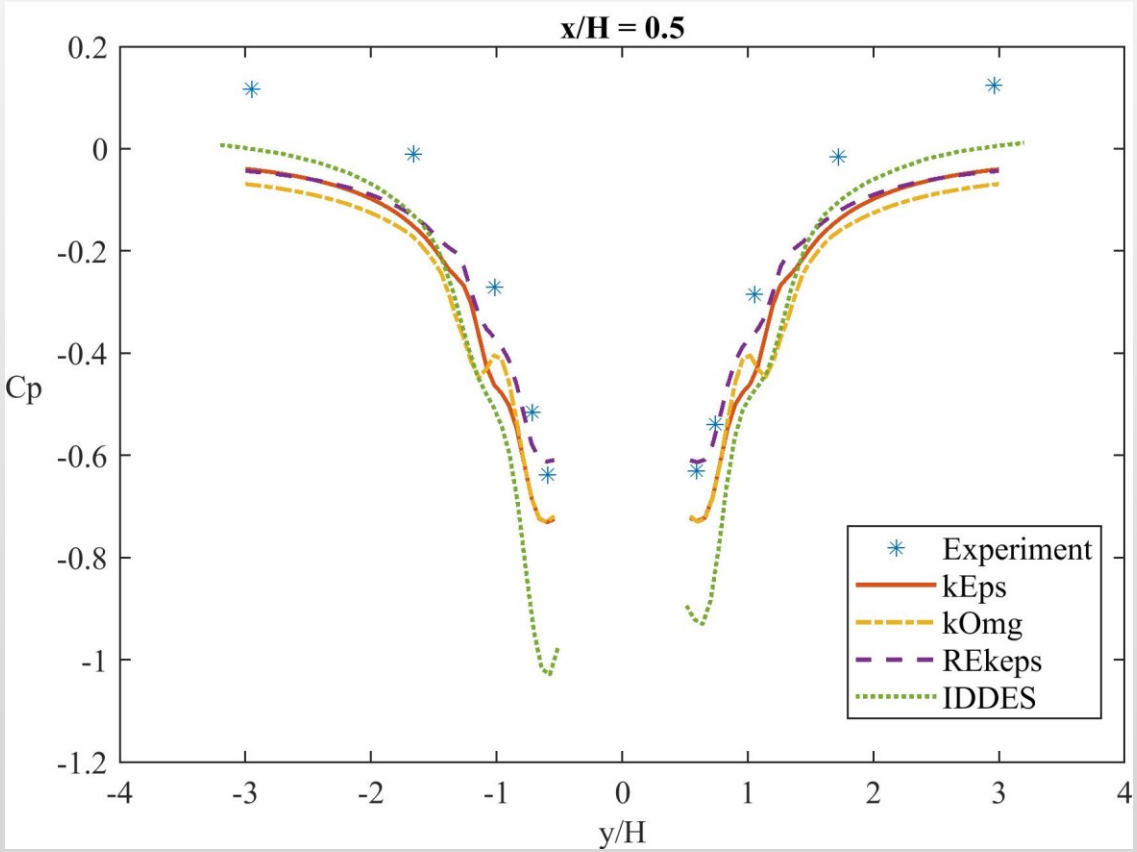

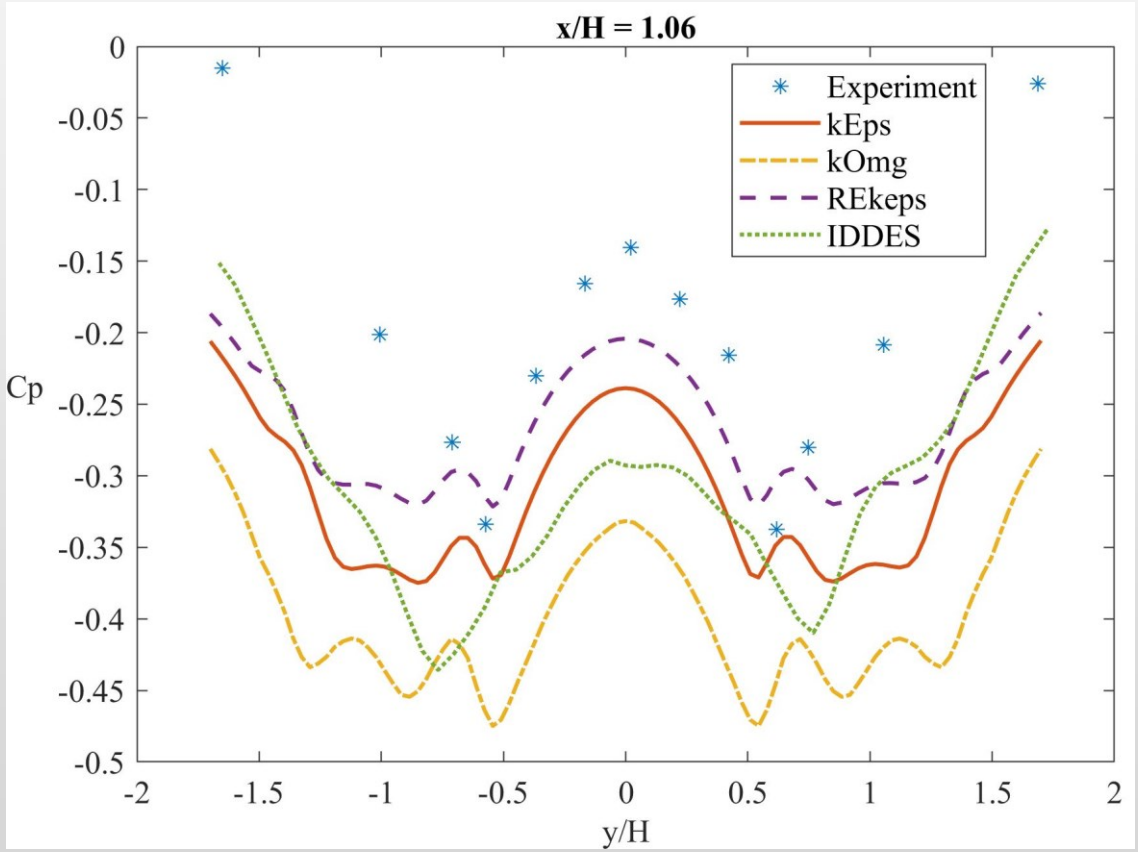

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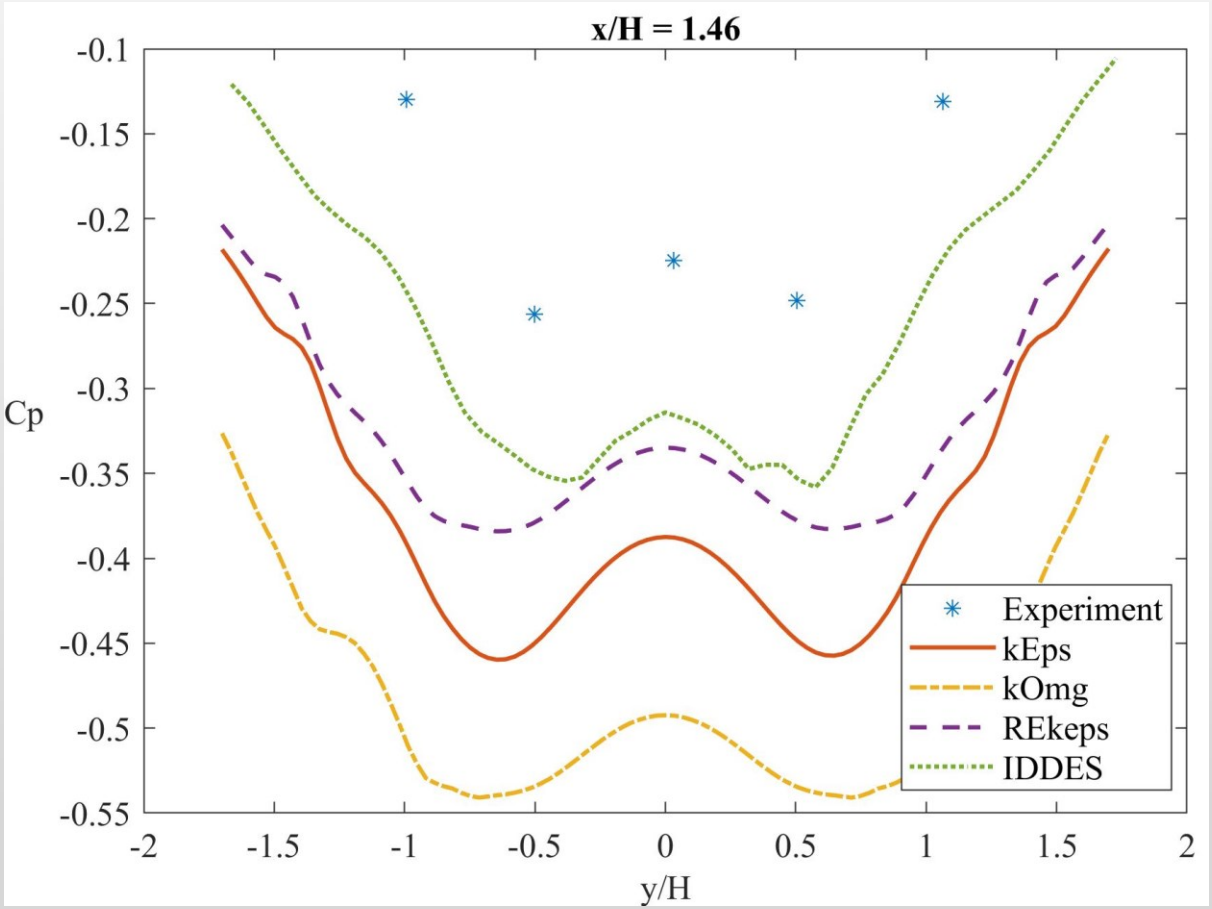

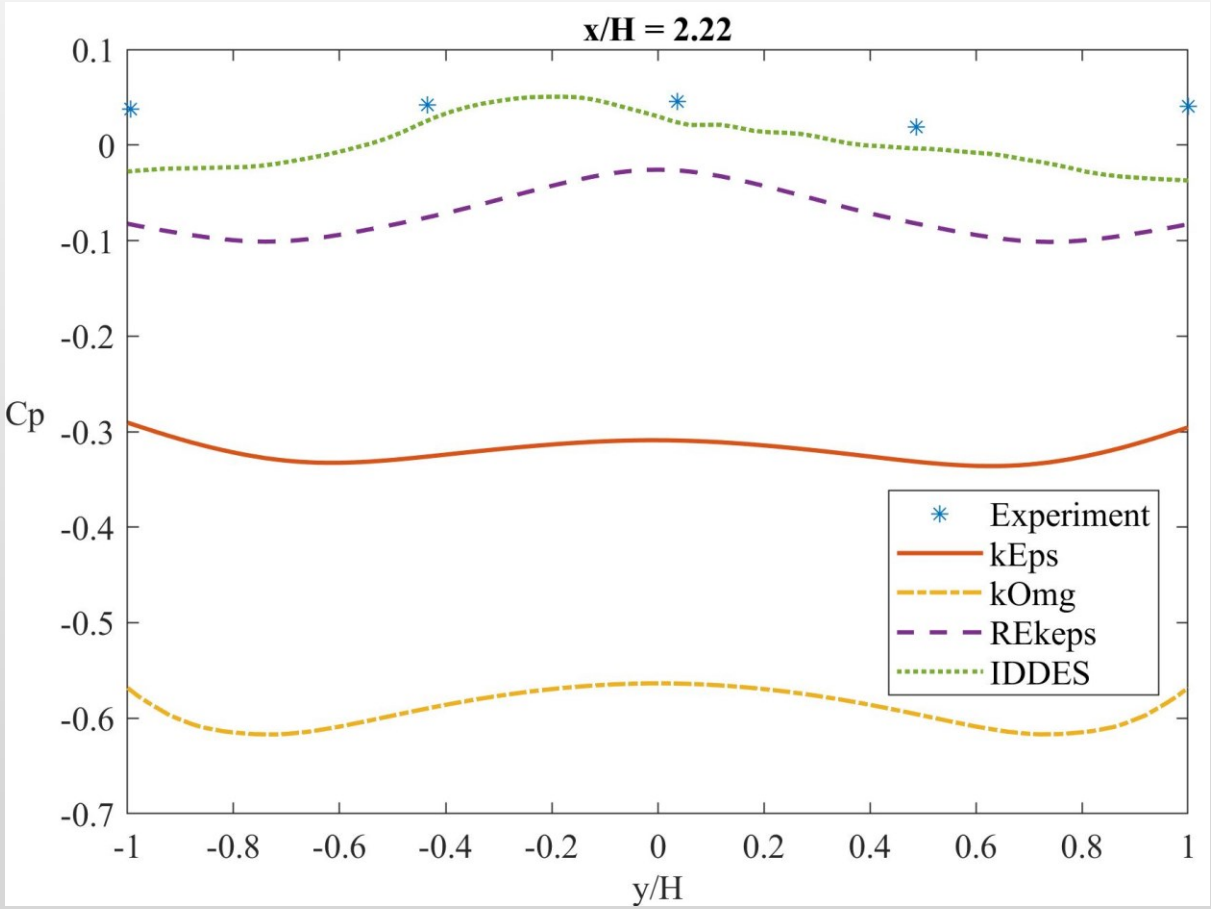

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Conclusion

- The reuslts are obtained after benchmarking done for different configurations related to numerical schemes and meshing, looking for the best compromise between computational cost and accuracy of the solution.
- The reported results are in agreement with those reported in literature (Ariff et al., 2009, Lakehal and Rodi, 1997, Krajnovic and Davidson, 2002).
- It must be emphasized that the accuracy of the solution is dependent on a number of solver variables, such as mesh configuration, numerical schemes, convergence criteria, under relaxation factors and turbulence models employed.
- Different flow regions have different “best” models for their flow prediction.

Thank you