FOSSEE Case Report 1- Transitional Modelling of flow over flat plate

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Objective

The objective of the present work was to simulate the T3A ERCOFTAC case (Flow over flat plate), using the Gamma-Re-Theta model

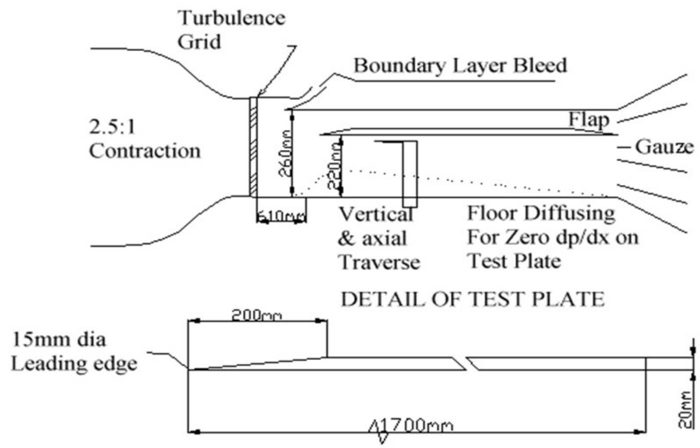
Multiple numerical settings were tested and the optimum configuration was determined.

Problem Statement

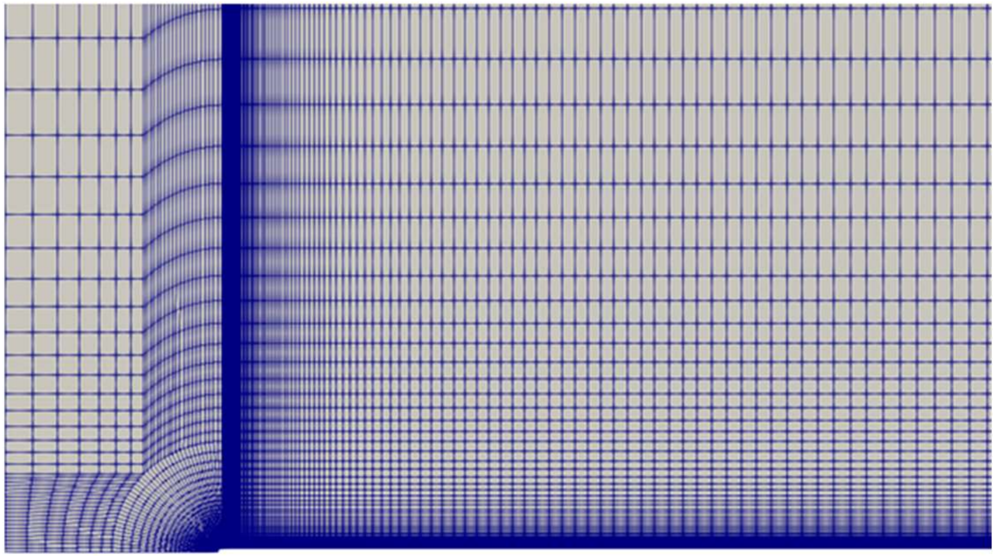
Flat plate transitional 2D boundary layer flows with or without pressure gradient, and no temperature variations.

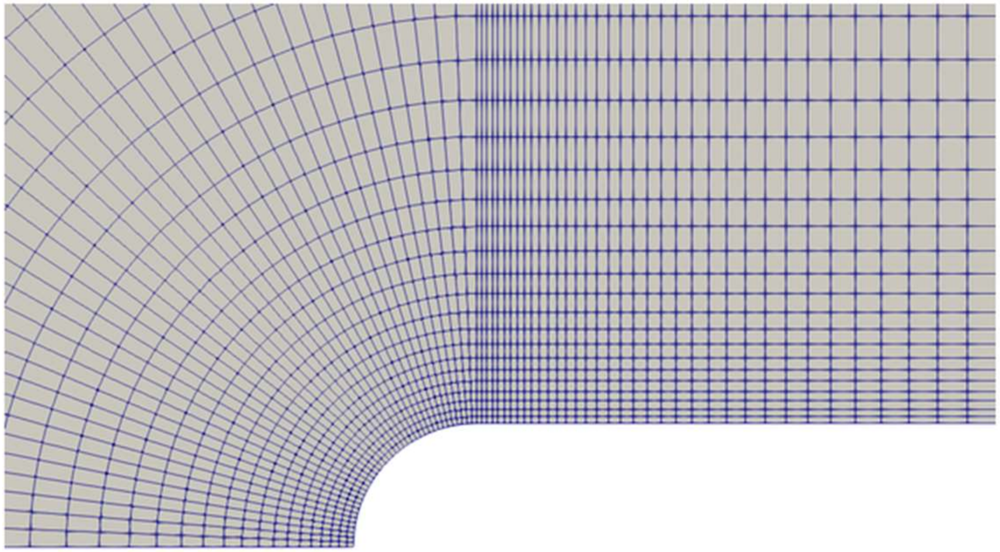
Free stream turbulence intensity was set to 3.3% and velocity magnitude equal to 12 m/s in the x direction [4].

Kinematic viscosity was set as 1.5×10^{-5} m^2/s. Details of the experimental setup and the flat plate are shown in the figure below.



Mesh and Geometry

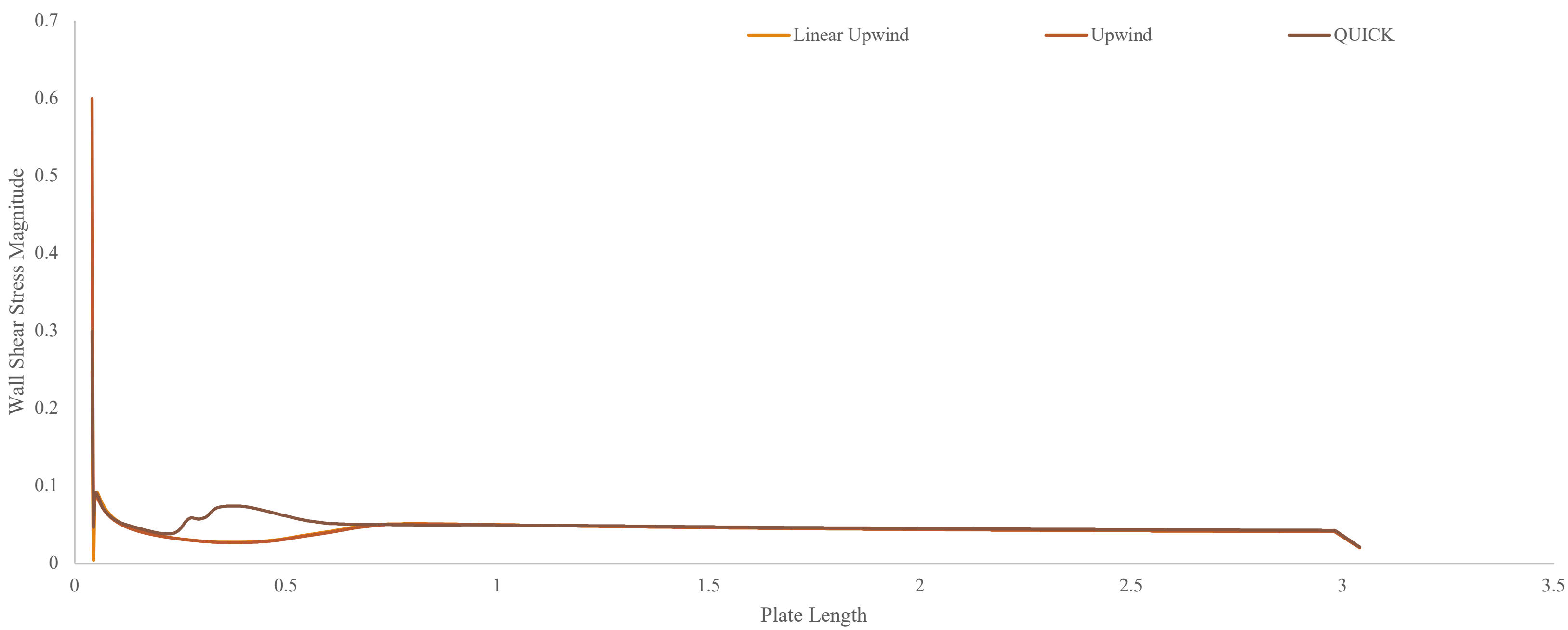




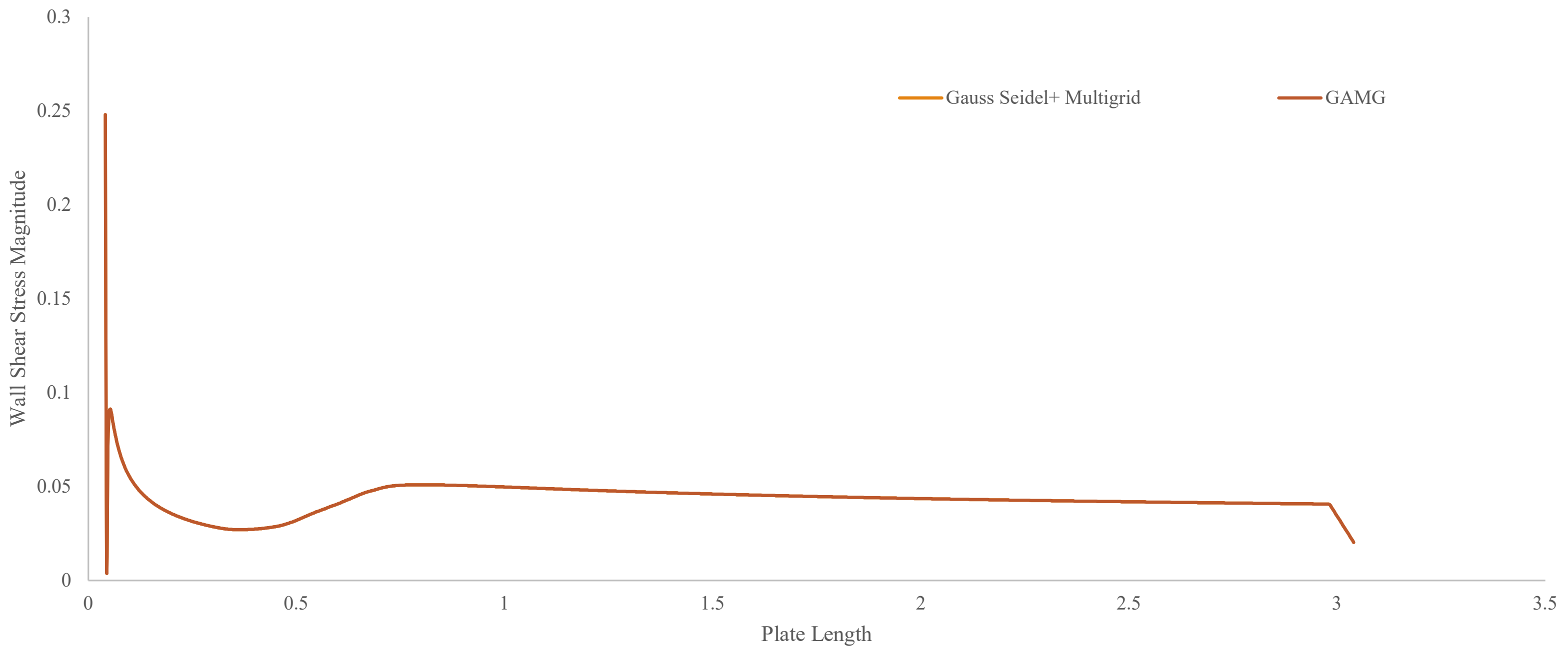
Configurations tested and convergence

Sr. No.	Divergence Scheme	Solver	Pressure Velocity Coupling Algorithm	Relaxation Factors	Convergence	Residual Targets
1	linearUpwind	Pressure: GAMG Rest -GaussSeidel	SIMPLE	0.9 for all equations	Yes, 269 iterations	10^{-5} for pressure, 10^{-6} for velocity, 10^{-4} for other variables
2	upwind	Pressure: GAMG Rest- GaussSeidel	SIMPLE	0.9 for all equations	Yes, 281 Iterations	10^{-5} for pressure, 10^{-6} for velocity, 10^{-4} for other variables
3	QUICK	Pressure: GAMG Rest- GaussSeidel	SIMPLE	0.9 for all equations	No	10^{-5} for pressure, 10^{-6} for velocity, 10^{-4} for other variables
4	linearUpwind	GAMG	SIMPLE	0.9 for all equations	Yes, 193 iterations	10^{-5} for pressure, 10^{-6} for velocity, 10^{-4} for other variables
5	linearUpwind	GAMG	SIMPLE	0.3 for pressure, 0.7 for other variables	No	10^{-5} for pressure, 10^{-6} for velocity, 10^{-4} for other variables
6	linearUpwind	Pressure: GAMG Rest- GaussSeidel	PIMPLE	0.3 for all equations	Solution Diverging	10^{-5} for pressure, 10^{-6} for velocity, 10^{-4} for other variables
7	linearUpwind	GAMG	PIMPLE	0.3 for all equations and 0.8 for final iteration	No	10^{-5} for pressure, 10^{-6} for velocity, 10^{-4} for other variables

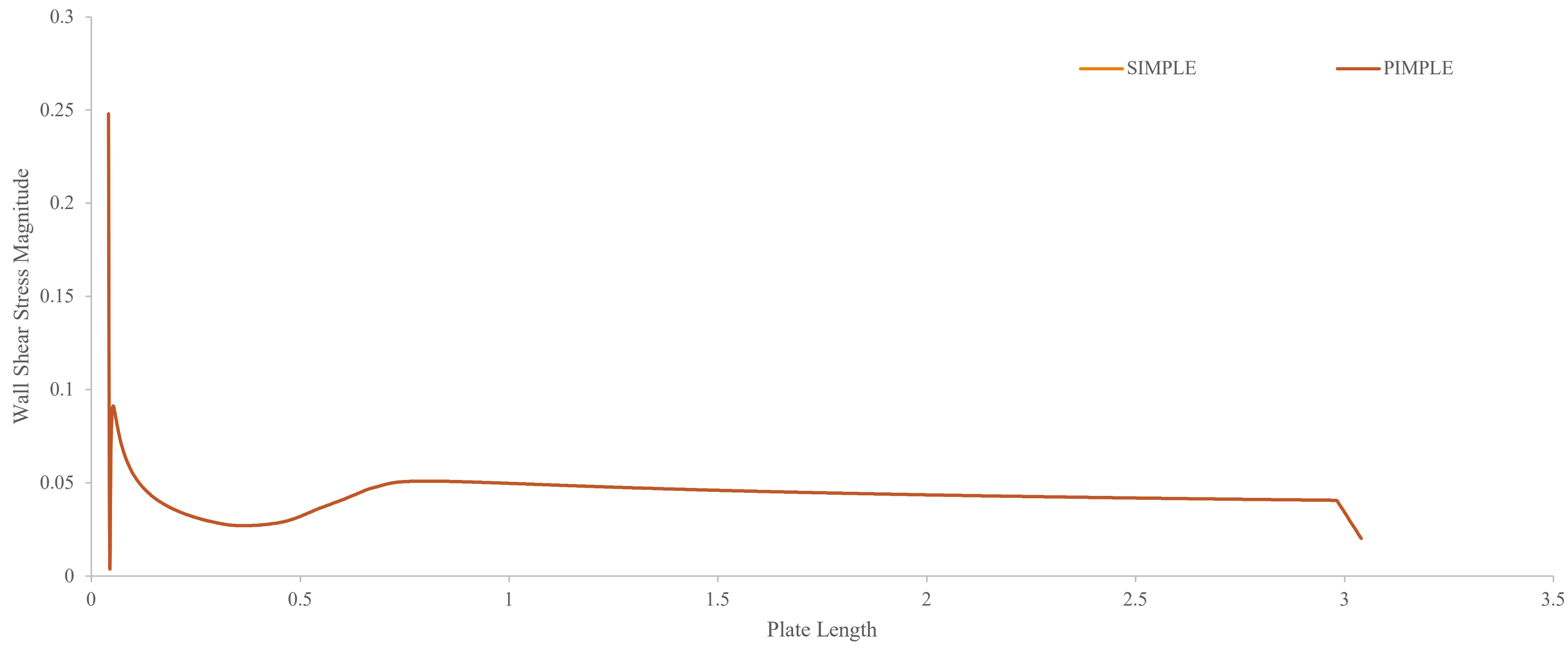
Results – Divergence Schemes



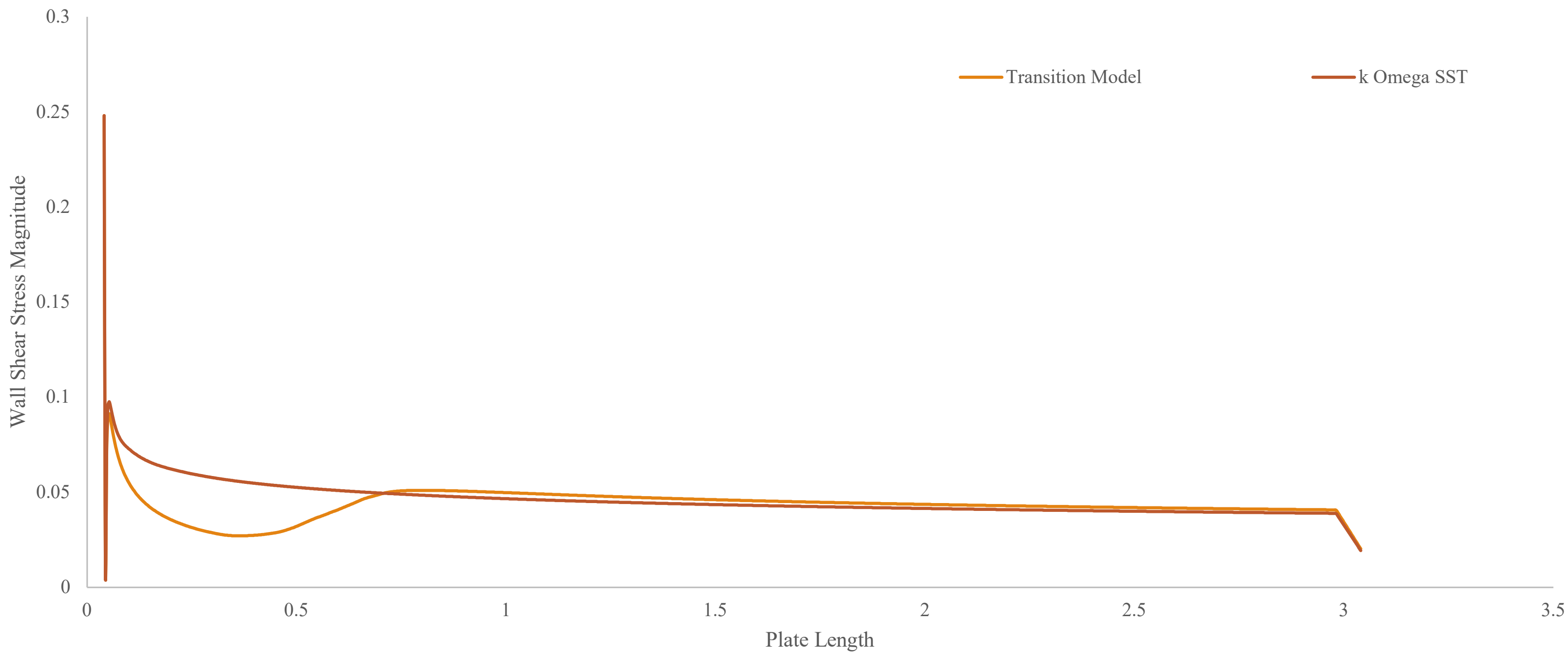
Results- Solver Comparison



Results- Pressure-Velocity Coupling Algorithms



Results- Turbulence Model comparison



Conclusions

Linear Upwind proves to be the best divergence scheme, providing the most accurate results and reasonable convergence rates

GAMG proves to be the best solver to use, providing the highest rate of convergence

SIMPLE algorithm proves to be the best pressure velocity coupling algorithm, providing accurate results with lesser computational cost.

References

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