PhD course: LES and DES using an in-house Python code, 7.5 hec

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1 CFD course

1.1 Background

For many flows, Large-Eddy Simulation (LES) and Detached-Eddy Simulations (DES) is a suitable option although it is much more expensive. Still, in many industries (automotive, aerospace, gas turbines, nuclear reactors, wind power) DES is used as an alternative to RANS. In universities, extensive research has been carried out during the last decade(s) on LES and DES.

1.2 Aim

Unfortunately, most engineers and many researchers have limited knowledge of what a LES/DES CFD code is doing. The object of this course is to close that knowledge gap.

1.3 When?

This PhD course is given every second year (2021, 2023, . . .) in Study period 3 and 4 . If you want to take part, register on the course by sending me an Email. The course page can be found at PhD course: LES and DES using an in-house Python code

1.4 Lectures

There will be no lectures. There will be one meeting (1-2 hours) every second week. In these meetings the students have the opportunity for questions and discussion. The first meeting will take place in week 1 (Study period 3).

2 Part I

The **pyCALC-LES** code will be used. The report is found here. Do the Workshop in that report. Present your work in a report.

3 Part II

Here you should carry out a larger project using **pyCALC-LES** . Below I give some suggestions.

- Implement the EARSM turbulence model [1].
  - Use it first in pure RANS (1D channel flow)
  - Next, use it as an SGS model (periodic channel flow of $Re_\tau = 500$) [2, 3].
  - If you have time, do also DES where EARSM is used both in the LES region and in the URANS region.
- Implement the dynamic SGS model [2]
  - Do channel flow at $Re_\tau = 500$ [3]
- Heat transfer.
  - Do it first in pure RANS (1D channel flow). There's a suitable flow case in [4]
  - Next
    - do the same simulation as in [4] (but use a coarser mesh than in that paper)
    - or do natural convection flow in a cavity [5]
- Atmospheric boundary layer with forest
- Define your own project

References

[1] S. Wallin and A. V. Johansson. A new explicit algebraic Reynolds stress model for incompressible and compressible turbulent flows. *Journal of Fluid Mechanics*, 403:89–132, 2000.

[2] M. Germano, U. Piomelli, P. Moin, and W. H. Cabot. A dynamic subgrid-scale eddy viscosity model. *Physics of Fluids A*, 3:1760–1765, 1991.

[3] A. Rasam, S. Wallin, G. Brethouwer, and A.V. Johansson. Improving separated-flow predictions using an anisotropy-capturing subgrid-scale model. *International Journal of Heat and Fluid Flow*, 65:246–251, 2017.

[4] L. Davidson, D. Čuturić, and S.-H. Peng. DNS in a plane vertical channel with and without buoyancy. In K. Hanjalić, Y. Nagano, and M. J. Tummers, editors, *Turbulence Heat and Mass Transfer 4*, pages 401–408, New York, Wallingford (UK), 2003. begell house, inc.

[5] S.-H. Peng and L. Davidson. Large eddy simulation for turbulent buoyant flow in a confined cavity. *International Journal of Heat and Fluid Flow*, 22: 323–331, 2001.