Proposal for Minisymposium at CFC2023: Data-driven closure models for RANS and LES

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ABSTRACT

Data-driven closure strategies for both RANS and LES have garnered significant interest in the last years. Their attractiveness stems from the demonstrated capabilities of machine learning algorithms to generate efficient low-dimensional, non-linear function approximations from data points and to identify relevant features. Physical or mathematical constraints can be implemented strongly (e.g. through deep kernel methods) or weakly (through cost function penalties), and the methods scale well on GPUs both in training and inference [1,2]. These properties have lead to a range of problem-specific applications of data-driven modelling strategies both to LES and RANS; however, a generally successful model or method has not been found yet. This is not helped by the fact that there is a considerable debate on the role of these methods in conjunction with classical PDE solution methods – on the one end of the spectrum, they are seen as alternative solution methods to the Navier-Stokes equations themselves (e.g. PINNs), while on the other end their task might be to select a model parameter in an otherwise classical RANS scheme.

In this minisymposium, we plan to bring together researchers concerned with all aspects of data-based subgrid and closure modelling applied to aero- and hydro-dynamic turbulence. We invite contributions on theoretical advances such as stability and convergence of the proposed methods, successful applications to RANS and LES, strategies for dealing with model-data inconsistencies and large-scale fusion of machine-learning methods and PDE solvers on HPC systems. By including all of these aspects into our symposium, we hope to contribute to forming a clearer picture of the potential of data-driven turbulence closures and their integration into the simulation landscape.

REFERENCES

[1] Turbulence Modeling in the Age of Data: Karthik Duraisamy, Gianluca Iaccarino, Heng Xiao. Annual Review of Fluid Mechanics 2019 51:1, 357-377.

[2] A Perspective on Machine Learning methods in Turbulence Modelling: Andrea Beck and Marius Kurz. GAMM-Mitteilungen44.1 (2021): e202100002.