9th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMA2024)
June 3-7, 2024, Lisbon, Portugal

20 YEARS OF PARTIALLY-AVERAGED NAVIER STOKES EQUATIONS: PROGRESS, CHALLENGES, AND FUTURE

TRACK NUMBER 800

FILIPE S. PEREIRA[*], BRANISLAV BASARA[†], STEFAN WALLIN[°]

[*] Los Alamos National Laboratory
Los Alamos, New Mexico, USA
fspereira@lanl.gov

[†] AVL List GMBH
Graz, Austria
branislav.basara@avl.com

[°]KTH, Engineering Mechanics
Stockholm, Sweden
stefanw@mech.kth.se

Key words: PANS, Modeling & Simulation, Turbulence Prediction.

ABSTRACT

The modeling and simulation of turbulent flows of practical interest is challenging due to the complex physics and wide range of scales. Direct numerical simulation (DNS) and large-eddy simulation (LES) are the ideal formulations to predict this class of flows as they resolve all or most turbulent flow scales. The high degree of resolution is responsible for the high-fidelity of these simulations, but also for their computational cost, which is excessive for engineering applications in the foreseeable future. This limitation made the Reynolds-averaging Navier-Stokes equations (RANS) the workhorse of engineering computational fluid dynamics. RANS model is expected to represent the physics of all turbulent scales through a closure model, reducing the simulations' cost significantly. However, developing robust and accurate closures to model all turbulent scales is difficult and limits the accuracy of RANS in numerous flows of current practical interest. In 2003, Girimaji [1,2] proposed the partially averaged Navier Stokes equations (PANS) method to bridge the spectral gap between DNS/LES and RANS and combine their main advantages. Such an objective is accomplished by only resolving the flow scales not amenable to modeling, and representing the remaining through a turbulence closure. This feature enables the concept of accuracy on demand, responsible for PANS' efficiency (cost vs accuracy) and success among CFD practitioners. After 21 years, PANS application in engineering problems is still growing and is becoming important to many engineering fields: automotive, combustion, offshore, or materials mixing. This mini-symposium celebrates the 21st anniversary of PANS. It aims to bring together PANS developers and users to promote discussions about the model's current state, progress, challenges, and future directions. Thus, we invite contributions from experienced and new users using PANS in any areas of fluid mechanics.

REFERENCES

[1] S.S. Girimaji, R. Srinivasan, E. Jeong, "PANS Turbulence Model for Seamless Transition Between RANS and LES: Fixed-Point Analysis and Preliminary Results", *In Fluids Engineering Division Summer Meeting*, FEDSM2003-45336, pp. 1901-1909, (2003).

[2] S.S. Girimaji, "Partially-Averaged Navier-Stokes Model for Turbulence: A Reynolds-Averaged Navier-Stokes to Direct Numerical Simulation Bridging Method", *J. Appl. Mech.*, Vol. **73(3)**, pp. 413–421, (2006).