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Advances in Direct and Large-Eddy Simulations

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This Special Issue contains extended versions of 17 papers, selected from a total of 115 contributions presented at the ERCOFTAC Workshop Direct and Large-Eddy Simulation (DLES13), held in Udine, Italy in October 28–30, 2022. The DLES Workshop series, which started in 1994, focuses on modern techniques designed to simulate turbulent flows based on a partial or full resolution of the instantaneous turbulent-flow structures, including Direct Numerical Simulation (DNS), Large-Eddy Simulation (LES) and hybrid models combining LES and Reynolds-Averaged Navier–Stokes (RANS) approaches.

In the 28 year-long history of the Workshop, a significant evolution of the topics can be observed. In the first few editions, most of the contributions dealt with the study of canonical problems and the development of the DNS and LES methodologies, mostly in the context of single-phase flows. In recent years, the complexity of the phenomena that are computationally tractable has increased considerably. It is now possible to handle increasingly complex geometries and multi-physics phenomena — for example, combustion and heat transfer, two- and three-phase interactions, and turbulence modulation by large solid particles or deformable bubbles and drops, all of which require auxiliary models, whether within RANS, LES or hybrid LES-RANS methodologies. These models must be sufficiently accurate, but at the same time, computationally affordable for industrial use. Detailed experimental data that can be used for validation purposes are often lacking, and therefore the validation of closure models for these complex phenomena still relies in many cases on DNS. As with other fields of scientific knowledge, the amount of data being used is increasing at an exponential rate thanks to the growing capacity of modern computers, alongside significant progress in computational techniques as well as in closure modelling. Also, there is a rapid increase in the exploitation of data assimilation and machine learning for the development of turbulence models, in the context of both LES and hybrid approaches. DLES13 thus offered an opportunity to survey and discuss recent advances on all the above fronts and in a variety of different application areas. The contributed talks addressed a number of new challenges and open questions posed by the increasing

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complexity of the simulated problems and the use of turbulence-resolving approaches in an engineering context, both in academic research and industrial practice.

This Special Issue aims to provide an archival record of some of the best papers presented at DLES13. These carefully selected papers were subjected to the same rigorous review process as that followed for any other manuscripts submitted to FTaC. They cover methodological aspects — i.e., advances in numerical methods, subgrid-scale modelling, boundary conditions, post-processing and data analysis, and new methodologies for complex phenomena — and applications in several fields — namely, multiphase and reactive flows, particle-laden flows, hypersonic flow of dense gases, flow in porous media, aerodynamics of aerofoils and wings, bluff-body and separated flows, transition, roughness, and shock/boundary layer interaction in transitional flows. In this respect, the present Special Issue is closely consonant with the aims and ethos of FTaC.

The Guest Editors wish to thank all authors and reviewers for their contributions towards making this Special Issue a valuable addition to the literature on the methodology and applications of DNS and LES.

The Special Issue Guest Editors.
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