Preface

This volume contains the 2023 Annual Research Briefs that summarize the research activities at the Center for Turbulence Research (CTR) in its thirty-seventh year of operation. Central scientific objectives of CTR are the fundamental understanding of complex, multi-physics turbulent flows and the development of physical models and computational and experimental tools for multi-scale analysis and prediction of engineering systems.

The volume contain twenty-five reports spanning topics ranging from physics-based studies to practical applications of advanced algorithms. The first group of papers describe data-driven modeling for realistic flow geometries and fundamental flow phenomena. Progress in the area of turbulent reacting flows as well as from the Stanford Predictive Science Academic Alliance Program (PSAAP) III activities, which is focused on the simulation of a laser-ignited rocket combustor, follow. The next papers cover two-phase flows, beginning with a discussion on benchmark data for compressible multiphase flows, which is an outcome of a PSAAP workshop held at Stanford. Studies on hypersonic flows cover analysis and models for boundary layers with reaction and non-equilibrium effects. Fundamental aspects of flow physics in canonical and biomimetic wall turbulence and in the atmospheric boundary layer are considered in the next reports. The final group of reports describe applications of LES to complex flows and discussion of the Reynolds number scaling and computational requirements for simulations of non-equilibrium wall bounded turbulent flows.

The investigations reported in this volume have been supported by a number of different organizations. These include the Department of Energy's National Nuclear Security Administration (NNSA) through the Advanced Simulation and Computing (ASC) Program, along with the National Aeronautics and Space Administration (NASA), Office of Naval Research (ONR), and the Boeing company. Many high-fidelity simulations reported in this volume used resources of the Oak Ridge Leadership Computing Facility, which is supported by the Office of Science of the Department of Energy.

We are delighted that this year we received a Center grant from the U.S. Office of Naval Research, with support from three Directorates. This multi-directorate engagement positions CTR to investigate multi-physics turbulent flows across a broad spectrum of problems in the areas of environmental and geophysical sciences, as well as those pertaining to hydrodynamics and aerodynamics. Stanford faculty in the newly established Doerr School of Sustainability will be actively involved in the CTR Programs moving forward. CTR is thrilled to begin this new partnership, which also enables an expanded program of professional development and outreach alongside its long-running activities.

Last year CTR hosted fourteen resident Postdoctoral Fellows and three Visiting Scholars. The CTR roster for 2023 is provided in the Appendix, along with the membership of the CTR Steering Committee. The 20th biennial CTR Summer Program is planned for June-July of 2024.

It is a great pleasure to thank Catrin Hunter and Vi Nguyen for their help in the day to day operation of CTR and Carlos Gonzalez and Susan Dorman for their help producing these Briefs.

This volume is available online at the CTR website: `http://ctr.stanford.edu`.

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