# Preface

This volume contains the 2020 Annual Research Briefs that summarize the research activities at the Center for Turbulence Research (CTR) in its thirty-fourth year of operation. Foremost scientific objectives of CTR are the fundamental understanding of turbulent flows and the development of physical models and computational tools for multi-scale analysis and prediction of engineering systems. In addition, CTR has a long-standing tradition of facilitating collaboration and the exchange of scientific ideas by bringing together key individuals in research fields related to turbulent flows. These synergistic collaborations have resulted in many technical advances over the years, including the development of the Dynamic Subgrid-Scale Model for large-eddy simulations (LES) of turbulent flows during the 1990 CTR Summer Program. On the occasion of the thirtieth anniversary of that development, this volume begins with a brief account of how the Dynamic Subgrid-Scale Model came about during the 1990 CTR Summer Program.

The remaining thirty-three reports contained in this volume are arranged as follows. The first report is focused on recent fundamental work and open research questions in hypersonic turbulent flows at high enthalpies. New concepts and applications of wall modeling for LES is taken up in the next group of reports. This area has received renewed attention at CTR since the 2018 Summer Program when it was demonstrated that accurate prediction of forces in realistic aircraft geometries was possible at surprisingly low computational cost. Jet noise and characteristic boundary conditions for compressible flows are the focus of the second group of reports. Fundamental studies of turbulent and transitional flows, including closure modeling using machine learning and uncertainty quantification, are collected in the next group. The second half of this volume is devoted to studies of multi-physics turbulent flows including combustion and multi-phase flows. These include combustion noise, supercritical flows, turbulent breaking waves, elasto-plastic deformation of solids in high-speed flows, and interfacial instabilities.

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 Air Force Office of Scientific Research (AFOSR), Office of Naval Research (ONR), and National Aeronautics and Space Administration (NASA).

Last year CTR hosted sixteen resident Postdoctoral Fellows. The CTR roster for 2020 is provided in the Appendix. Also listed are the members of the CTR Steering Committee, which has met quarterly to act on fellowship applications.

It is a great pleasure to thank Pamela Nelson Foster and Vi Nguyen for their help on the day to day management of CTR.

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

Parviz Moin
Javier Urzay