Preface

This volume contains the 2010 annual research briefs of the postdoctoral fellows, research staff and visitors of the Center for Turbulence Research (CTR). This year CTR sponsored its thirteenth biennial Summer Program, its largest ever, with eighty-three participants. A separate report of the proceedings of the Summer Program was published earlier. CTR's multi-physics flow research is supported by the Advanced Simulation and Computing (ASC) Program of the Department of Energy, the Fundamental Aeronautics Program of NASA, and the Department of Defense.

The first report in this volume is motivated by the need for a better understanding and consequent ability to control noise generated by supersonic exhaust jets. Understanding the mechanics of turbulent jet noise and its mitigation remains a high priority research area at CTR. The next group of papers are concerned with numerical simulation of spatially evolving turbulent boundary layers. In particular, there is a renewed interest in the problem of wall modeling for practical implementation of the large eddy simulation technique in high Reynolds number external aerodynamic flows.

Prediction and quantification of uncertainties in the HyShot II scramjet experiment is the overarching problem of the ASC Program at Stanford. The next group of papers are concerned with this multi-physics complex system and the related hypersonic flows. This program, which also includes several experimental studies, relies on the Reynolds Averaged approach as the method of choice largely because of the demanding computational requirements of the uncertainty quantification effort. High fidelity simulations, such as LES, are then used for fundamental analysis of the system components and validation of the Reynolds Averaged computations.

Development of numerical methods and suitable boundary treatments for general compressible flows and hypersonic flows in particular is taken up next. Several papers on large eddy simulation (LES) are grouped together. Large eddy simulation is becoming more affordable for prediction of complex turbulent flows. New insights have been gained for LES of turbulent flows with shock waves and transitional flows. The next group of papers deal with prediction of turbulent combustion, scalar mixing and the closely related two-phase turbulent flows. Computation of turbulent reacting flows involve numerous assumptions and models and therefore remains a research frontier for the foreseeable future. The last group of articles reports on studies of flow physics at disparate scales using numerical simulations: dynamics of red blood cells and platelets, and turbulent convection and acoustic sources in the Sun of our solar system. These are good examples of multidisciplinary research at CTR where the tools developed for engineering applications are being utilized effectively for fundamental studies in different areas.

Thanks are due to Sara Bedin and Deborah Michael for their day to day management of CTR. The CTR roster for 2010 is provided in the Appendix. This volume is available at the CTR site on the worldwide web (`http://ctr.stanford.edu`).

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