Preface

The twelfth biennial Summer Program of the Center for Turbulence Research was held during the period July 6th-August 1st, 2008. This year we hosted 56 participants from 7 countries. As in the past, the participants were selected based on their research proposals and the scientific interests at CTR. There has been considerable emphasis recently at CTR on prediction of complex multi-physics effects in turbulent flows, and this was clearly reflected in the technical venue of the 2008 Program.

This proceedings volume contains 32 papers which were divided into six groups: Hypersonics, Numerical Modeling and Verification, Multiphase Flows, Combustion, Acoustics, Turbulence Physics and Modeling. Brief summaries of the accomplishments of each group are provided in the overviews that precede the grouped papers. The first group of papers address the emerging area of hypersonics. This is a topic of considerable interest at CTR. The overarching problem of the Predictive Science Academic Alliance Program (PSAAP) at Stanford is a validated and verified numerical simulation of a hypersonic vehicle with scramjet propulsion system. The papers in this group cover important areas in hypersonic research ranging from laminar/turbulent transition with practical relevance to heat loads on hypersonic vehicles, to the effects of detailed chemistry in high Mach number flows with applications to atmospheric re-entry problems.

Verification and validation of numerical solutions is at the core of predictive science. The four papers in the Numerical Modeling and Verification group discuss the linkage between subgrid scale modeling and truncation error of numerical schemes for compressible turbulent flows, the use of the method of manufactured solutions to establish the order of accuracy of a commonly used numerical algorithm, numerical parameters and simulation infrastructure for conjugate heat transfer problems and the use of data assimilation techniques to improve the predictive capability of turbulent flow simulations.

As in the 2006 Summer Program, we devoted a group to multi-phase flows which is of particular interest to combustion applications where liquid fuel and gas interact. The focus of this group was largely on numerical methods and models that track the dynamics of the complex phase interface geometry. The six projects in the accompanying Combustion group ranged from fundamental studies and modeling of soot formation, flame/turbulence interaction and combustion instabilities to numerical simulations of realistic combustors. The main focus of the Acoustics group was on assessment of the predictive capabilities of the acoustic source and propagation methods. The applications of interest were trailing edge noise from airfoils and indirect combustion noise in gas-turbine engines. The projects in the Turbulence Physics and Modeling group included development and testing of novel closure models for RANS and LES methods, and fundamental studies of the effect of dynamic wall roughness on wall-bounded flows and efficacy of steady state simulations for Reyleigh Bernard convection.

One of the important features of the CTR Summer Programs are the weekly tutorials delivered by invited speakers. This year four tutorials were given in the general theme of the Summer Program: Scramjet Propulsion (A. Auslender); Numerical Methods for Complex Flows (F. Ham); Uncertainty Analysis in Turbulent Flow Simulations (G. Iaccarino); and Combustion Instability (X. Wu). In addition, this year for the first time, we had two adjoining workshops to the Summer Program: One on Hypersonics which took place in the week prior to the Summer Program, the other on Uncertainty Quantification

during the summer program. These workshops and the final presentations of research accomplishments were attended by a number of colleagues from universities, NASA, DOE laboratories and industry.

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