Preface

This volume contains the 2002 Annual Progress Reports of the postdoctoral fellows and visiting scholars of the Center for Turbulence Research. In 2002 CTR sponsored 18 resident Postdoctoral Fellows, 12 visiting scholars and 5 doctoral students and hosted 10 Research Associates. The 35 reports contained in this volume cover a wide range of subjects representing NASA's wide ranging interests. The papers are roughly classified into six different groups, although many treat two or more subjects. In addition, in the summer of 2002, CTR sponsored its ninth biennial Summer Program which was the largest ever with fifty participants from ten countries. A separate volume containing the proceedings of this Summer Program was published earlier this year.

Turbulent combustion remains the largest component of the CTR's core program. This program and several related activities at CTR are supported by NASA's Ultra Efficient Engine Technology Program. It is also intimately connected with the Department of Energy's ASCI program at Stanford which develops the technology for numerical simulation of realistic aircraft engines using state of the art massively parallel computers. In combustion modeling the attention has been directed to the modeling of higher levels of complexity such as spray dynamics, radiation and soot formation. Major aircraft engine manufacturers have shown considerable interest in this program; in particular, a significant active collaboration exists between CTR and the Pratt & Whitney Corporation. CTR's combustion program is essentially based on the large-eddy simulation technique, LES, which is actively being pursued at CTR for this and many other applications. Important accomplishments in LES included simulations with three-dimensional filters, which result in grid independent calculations (that is why we call it "true" LES), and the development of the methodology for integration of LES and Reynolds Averaged computations. Optimization techniques are being studied and used for the important problem of wall boundary conditions for LES as well as for optimal shape design for aeroacoustic and aerodynamic performance gains.

Turbulence in geophysical and astrophysical applications is receiving increased attention at CTR and is expected to occupy a larger fraction of the CTR's core program. We believe that CTR is poised to contribute significantly to this area especially by providing improved subgrid scale models, high fidelity numerical methods, advanced computer programing tools and insights in turbulence physics in multi-phase and reacting flows. CTR is broadening its scope of research to more general non-linear multi-scale phenomena. One such area is computational biology which is a fast developing field involving very intensive computing. This year the work at CTR focused on cardiovascular fluid dynamics using imaging techniques, and aerodynamics of natural phenomena. Hypersonic transition with real gas effects is of interest to NASA for space transportation and is an area of active research at CTR.

We thank Millie Chethik and Marlene Lomuljo-Bautista for their day-to-day management of the Center. Special thanks are due to Dr. Massimiliano Fatica for his help with the final preparation of this report.

We dedicate this volume to the memory of the enormous contributions of Charles David Pierce. Charles was a student and later a Research Associate at CTR. His dissertation was the pioneering step that launched CTR's program in large eddy simulation of turbulent combustion. Charles' legacy computer codes and original ideas in modeling turbulent combustion and numerical methods remain at the heart of CTR's research enterprise.

Parviz Moin
Nagi N. Mansour
Peter Bradshaw (editor)

This volume is available as a .pdf file on the Web at http://ctr.stanford.edu