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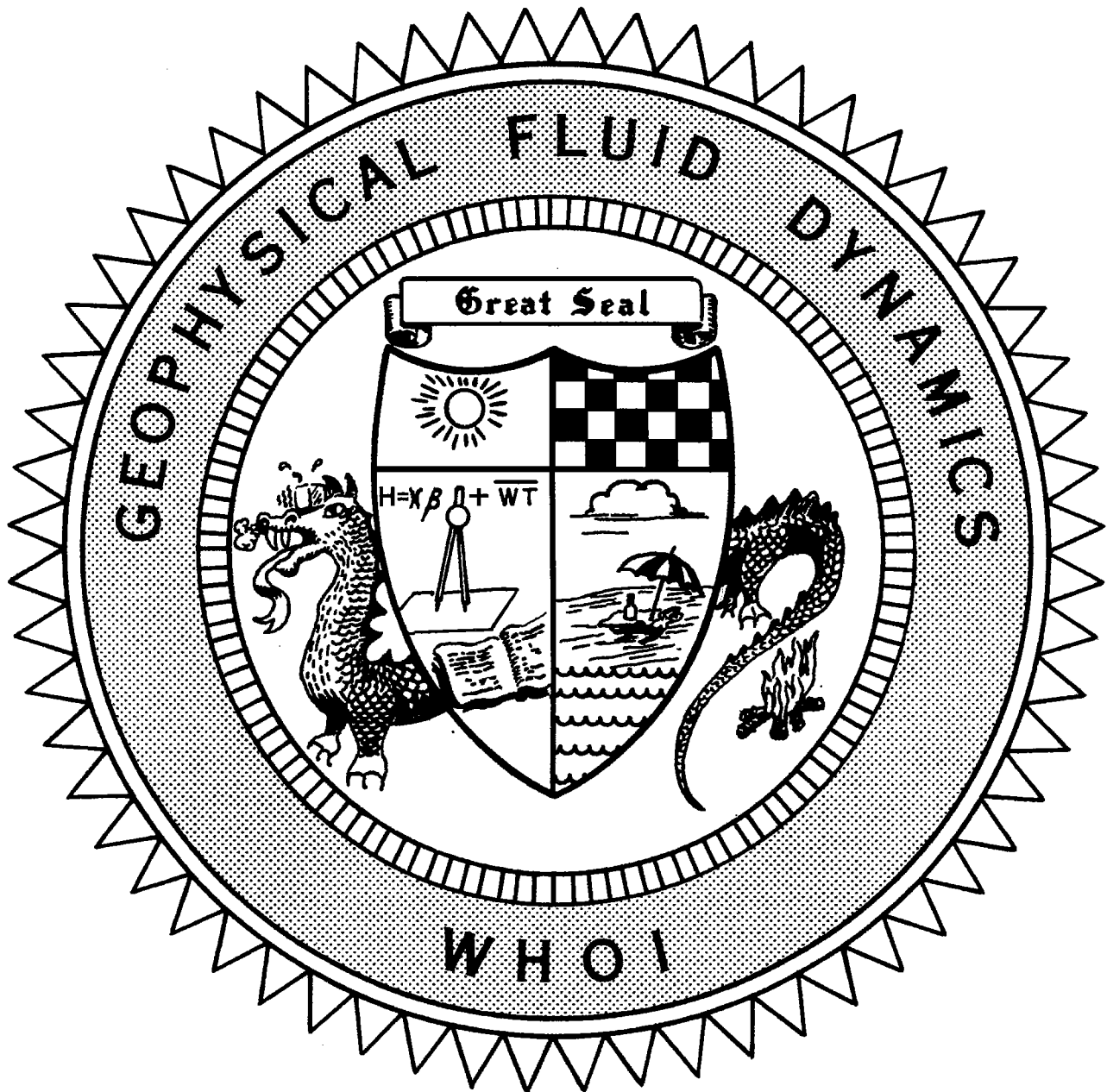
Woods Hole Oceanographic Institution

WHOI-2000-07

C.2

Stirring and Mixing

**1999 Summer Study Program  
in Geophysical Fluid Dynamics**



Course Lectures  
Fellows Project Reports



WHOI-2000-07

**Stirring and Mixing: 1999 Program of Summer Study  
in Geophysical Fluid Dynamics**

by

Neil J. Balmforth, Director  
William R. Young, Principal Lecturer  
Janet Fields, Administrator  
Jean-Luc Thiffeault and Claudia Pasquero, Editors

July 2000

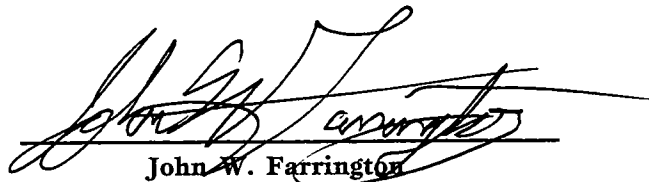
**Technical Report**

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John W. Farrington

Associate Director for Education  
Dean of Graduate Studies





## PREFACE

Mixing and Stirring took place at the 1999 Geophysical Fluid Dynamics Summer Study Program. William R. Young (Scripps Institution of Oceanography) gave the principal lectures, with Ray Pierre-Humbert (the University of Chicago) adding two special lectures (only one was scheduled; the second was given at the request of the audience). These lectures served us an introduction to the general physical principles of the subject and its many applications in a large number of fields, and provided us with essential mathematical technology.

As usual, we had a variety of seminars throughout the weeks following the lectures, covering the many subjects in which mixing and stirring plays a role. Week 4, organized by Jim Ledwell (Woods Hole Oceanographic Institution) with great success, focussed the attention of the participants on the oceanic problem. Several visitors came to participate solely in this week, and we saw many familiar faces from past summers.

This year was also the 40th birthday of the Program. In celebration, the Oceanographic Institution graciously held a picnic for all the participants, for the people at Woods Hole connected to the Program, and for any fellows from previous summers that were able to visit for an afternoon. George Veronis gave a memorable speech with a historical perspective. The picnic ended with a customary sight - a GFD softball game - and the afternoon, thanks to W.H.O.I., was a very pleasant experience.

This year's fellows proved to be a group that meshed together especially well (including group triathlons each morning for the hardier fellows). Their academic accomplishments can be viewed elsewhere in this volume. One notable feature of their efforts is that they are all, pretty uniformly, commendable projects; sometimes, it has to be admitted that the program doesn't work for everyone, but this year, I think it worked as well as it could. Consequently, I think this summer was notably successful.

Special thanks go to Bill Young for his tireless efforts in preparing and giving the principal lectures, and for advising so many of the fellows. This summer could not have been so successful without Bill. Also, Eric Chassignet and Glenn Flierl spent many selfless hours with the computers, and Jack Whitehead dealt magnificently with many administrative matters throughout the whole year preceding the Program. Jean-Luc Thiffeault and Claudia Pasquero must be thanked for their important contributions to creating this volume.

And last, but by no means least, I thank W.H.O.I. Education, who continue to provide a perfect atmosphere in which to run the program. I specially thank Marcey Simon for all her efforts to organize the program, and our two staff assistants, Veta Green and Janet Fields, who stepped in to replace the veteran, Lee Campbell, when she moved off to other enterprises.

N. J. Balmforth  
Director

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## 1999 GFD FELLOWS, STAFF AND VISITORS

### Fellows

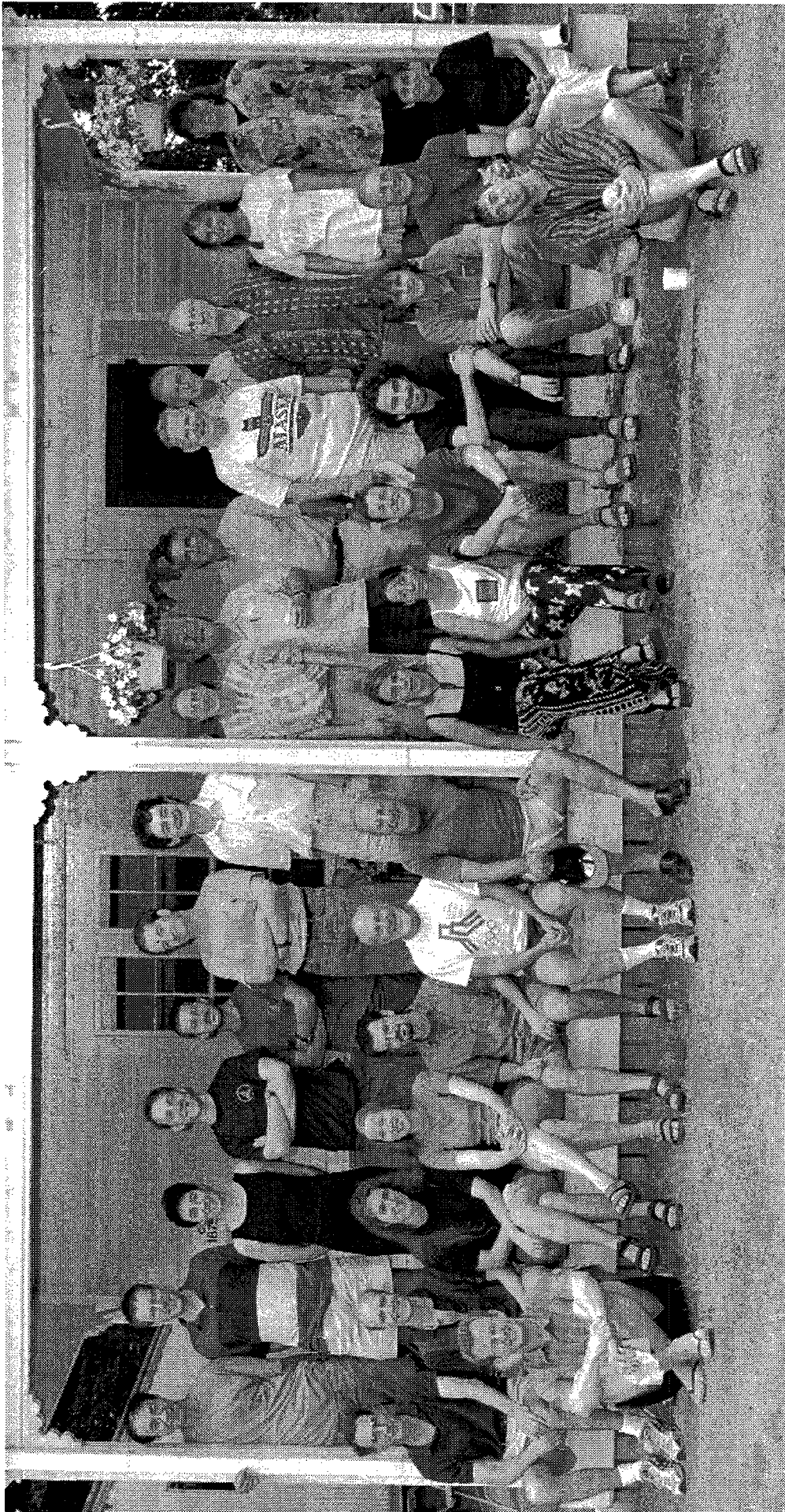
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Jennifer A. MacKinnon	University of Washington
Meredith M. Metzger	University of Utah
Jeffrey M. Moehlis	University of California at Berkeley
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Joseph LaCasce	Woods Hole Oceanographic Institution
Norman R. Lebovitz	University of Chicago
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Melvin Stern	Florida State University
Esteban Tabak	New York University
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Louis Tao	Columbia University
Jean-Luc Thiffeault	Columbia University
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Martin Visbeck	Lamont-Doherty Earth Observatory, Columbia University
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John Wettlaufer	University of Washington
Jack Whitehead	Woods Hole Oceanographic Institution
Jonathan Wylie	Woods Hole Oceanographic Institution
Huijun Yang	University of South Florida
William R. Young	Scripps Inst. of Oceanography, Univ. of Calif., San Diego



1999

**Standing (left to right):** Yuan-Nan Young, Raffaele Ferrari, Paola Cessi, Stefan Llewellyn Smith, Francesco Paparella, Jost-Diedrich Graf von Hardenberg, Rupert Ford, Meredith Metzger, Claes Rooth, Rick Salmon, James Anderson, Louis Howard, Willem Malkus, Claudia Cenedese, Janet Fields

**Seated on porch (left to right):** James Ledwell, Jeffrey Moechlis, Jennifer MacKinnon, Jennifer Curtis, Jean-Luc Thiffeault, Joe Keller, George Veronis, Claudia Pasquero, Pascale Garaud, David Osmond, Roberto Sassi, Eric Chassignet, Jack Whitehead, Sonya Legg

**Seated on ground (left to right):** William Young, Neil Balmforth

**Not pictured:** Hassan Aref, Andrew Bernoff, Emmanuel Boss, John Bush, Misha Chertkov, Predrag Cvitanovic, Sarah Dance, Charles Doering, Glenn Flierl, Blanca Gallego, Christopher Garrett, Anand Gnanadesikan, Karl Helfrich, Yongyun Hu, Eric Kunze, Joseph LaCase, Norman Lebovitz, Trevor McDougall, Richard McLaughlin, Philip Morrison, Bruce Morton, Walter Munk, Jeffrey Parsons, Raymond Pierrehumbert, Lorenzo Polvani, Kurt Polzin, Antonello Provenzalle, Anthony Roberts, Roger Samelson, Raymond Schmitt, Edwin Schneider, Edward Spiegel, Melvin Stern, Esteban Tabak, Amit Tandon, Louis Tao, John Toole, Stewart Turner, Eli Tziperman, Geoffrey Vallis, Martin Visbeck, John Wettlaufer, Jonathan Wylie, Huijun Yang

