Interdisciplinary Research Programs in Geophysical Fluid Dynamics

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LONG-TERM GOALS

The long-term goals are to train new scientists to conduct research, and to enhance the abilities of experienced research workers in geophysical fluid dynamics. This field is fundamental to the field of numerical forecasting of ocean, atmosphere and environment and prediction for a wide range of application in the oceans, atmosphere and geology.

OBJECTIVES

To help graduate students formulate and tackle innovative research problems in GFD. To promote an exchange of knowledge and ideas between investigators in the different scientific disciplines that deal with the dynamics of stratified fluids, rotating fluids, fluid with phase changes and non-Newtonian fluids. To formulate tractable, important problems which are presently at the fringe of our understanding in the field of Geophysical Fluid Dynamics. To serve as a clearing-house for the mathematical, experimental and computational techniques which serve astrophysics, climate science, geodynamics, meteorology and oceanography.

APPROACH

We conduct a summer study school of ten weeks duration each summer. The participants are graduate student Fellows, visiting graduate students and visiting scientists. The first two weeks consist of ten principal lectures in the summer's topic conducted by an expert in that area. Lectures by associated

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14. ABSTRACT
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participants follow at a rate of roughly one or two per day for the remaining weeks except for the last week, when student Fellows present their results. About 10 graduate students are admitted as Fellows, selected from a pool of applicants from many disciplines who are in their second to forth year of graduate school. Fellows receive a stipend for the full ten weeks. A Fellow conducts a research project under the guidance of the staff, provides a written project report, and orally present results in the tenth week. The Fellows also prepare note of the principal lectures. Several other graduate students visit for shorter periods to listen to lectures and interact with the staff. The staff and faculty (comprised of all of the visiting scientists) are continually renewed throughout the summer, although there is a core faculty who remain for the entire summer. Most of these participants receive partial travel support from the program, but some participate for free. The lecture notes and the written report of the Fellows' projects are contained in a volume that is distributed in print form and is available on the GFD website.

The program is governed and run by a faculty comprised on many leaders in the field. Their names are:
Neil Balmforth Department of Mathematics, University of British Columbia
Oliver Buhler Courant Institute, NYU
Claudia Cenedese Woods Hole Oceanographic Institution
Eric Chassignet RSMAS/MPO, University of Miami
Steve Childress, Courant Institute, NYU
Charles Doering Department of Mathematics, University of Michigan
Glenn Flierl Department of Earth, Atmospheric and Planetary Sciences, MIT
Karl Helfrich Woods Hole Oceanographic Institution
Louis Howard MIT, Florida State University, and Duke University
Joseph B. Keller Stanford University
Rich Kerswell Department of Mathematics, University of Bristol
Norm Lebovitz Department of Mathematics, University of Chicago
Stephan Lewellyn-Smith, Scripps Institution of Oceanography, UCSD
Willem Malkus Department of Mathematics, MIT
Philip Morrison Physics Department, University of Texas at Austin
Michael Proctor DAMTP, Cambridge University
Antonello Provenzale Istituto di Scienze dell'Atmosfera e del Clima, CNR Italy
Rick Salmon Scripps Institution of Oceanography, UCSD
Ed Spiegel Astronomy Department, Columbia University
Melvin Stern Department of Oceanography, Florida State University
Jean-Luc Thiffeault Department of Mathematics, Imperial College, London
George Veronis Department of Geology and Geophysics, Yale University
John Wettlaufer Departments of Geology and Geophysics & Physics, Yale University
Jack Whitehead Woods Hole Oceanographic Institution
William Young Scripps Institution of Oceanography, UCSD

TASKS COMPLETED

The subject of this year's principal lectures was “Perspective and Challenges in GFD” with ten principal lecturers who are active leaders in the field. Their names and lecture titles are :
Stephen Childress, New York University, “Dynamo Theory and GFD”;
Stefan Fauve, Ecole Normale Superieure, “Dynamo Theory”;
Charles Doering, University of Michigan, “Convection, Stability and Turbulence”;

Christopher Garrett, University of Victoria, “Ocean Mixing and Tidal Power”;
Kerry Emanuel, MIT, “Waves and Vortices Driven by Interfacial Fluxes”;
Raffaele Ferrari, MIT, “The Oceanic Energy Cycle”;
Raymond Pierrehumbert, University of Chicago, “Climate Dynamics”
Herbert Huppert, Cambridge University, “Geological Fluid Mechanics”
John Marshall, MIT, “GFD Experiments in Climate”
Timour Radko, Naval Postgraduate School, “Double-Diffusive Convection”

Fellows names, main interests, university affiliations and titles of their projects were:
Christopher Cawthorn, University of Cambridge, England,"Close encounters of the viscous kind: first contact in a viscous fluid";
Sylvain Barbot, Scripps Institute of Oceanography, "Models of volcanic tremors & singing icebergs";
Celine Guervilly, Universite’ of Joseph-Fourier, France, “Toy model of the solar radiative zone";
George Hagstrom University of Texas at Austin, "Bounds for shear-stress driven flows";
Malte Jansen, Massachusetts Institute of Technology, "On the interaction of eddies with large-scale topography";
Christophe Gissinger, Ecole Normale Superieure "Energy and dissipation in MHD systems"
Amrita Shravat Oxford University, England, "Experiment on mixing induced by a horizontal disc";
Yutian Wu, Columbia University, "Equilibria of diffusive moist static energy balance models";
Toby Wood, Univ of Cambridge, England, "(Huge) problems with surface tension";
Ian Hewitt Oxford University, England, "Continual skipping on water";

RESULTS

The Principal Lectures and Fellows' reports are the tangible results. They are available as a technical report and on the web. A number of published papers typically result from the program, many are listed on the web page.

IMPACT FOR SCIENCE

Many staff, fellows and visitors express their enthusiasm at the end of each summer. This ends the 50th year of the program and the founders received an award from the American Geophysical Union for the program. The first PI of this grant nominated the founders for this award and solicited letters from eight international leaders in Meteorology, Applied Math., Oceanography and Earth Science. The letters illustrated how the program has made immense difference to their own careers and to those of a number of their students who attended as fellows. The citation summarizes

“Each year the program admits approximately ten graduate student fellows. The fellows prepare a summary of the principal lectures and then each fellow solves an original, research problem, reporting his or her results at the end of the program. Softball games and pizza nights relieve the work pressure and promote an atmosphere of teamwork and informality. The student fellows are assigned two small offices, but they are more likely to be found working in the computer trailer, or on the front porch. Some projects are great successes and others sputter, but most are original and creative. Many fellows acquire lifelong contacts and colleagues. Well over 60% of the fellows have become faculty members although others are successful at business, and one is even in Congress. Coverage is international, and there is a sizeable percentage of women, who have become leaders in their respective fields.”

The staff pays close attention to each fellow and works to make each fellow achieve a good project in conjunction with a suitable advisor. The Dean's office also has the Fellows evaluate the program, and many comments are similar to those given here.

RELATIONSHIPS TO OTHER PROGRAMS

We estimate that typically 20-50% of the student projects become included in their thesis or postdoctoral work and/or result in publications. The program does not follow the Fellows' research after the summer is finished although individual staff members often remain involved with the Fellows' continuation of their projects past the end of the summer. All staff members are active research workers, so numerous related projects exist.

FIGURES/PICTURES

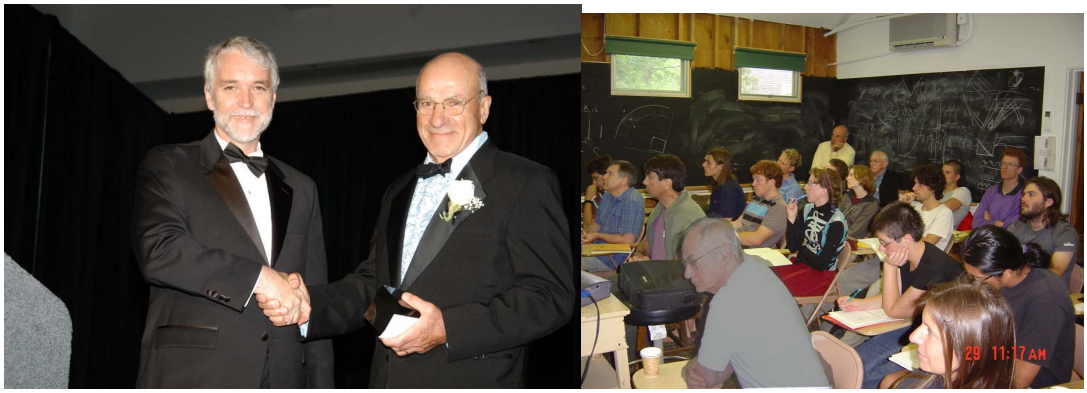

Figure 1. On the left, George Veronis accepting the Excellence in Education Award from AGU president Tim Killeen. Right, a rapt audience of attendees at a lecture.

REFERENCES

Various features of the program are listed on website http://www.whoi.edu/page.do?pid=7937. This includes a list of past Fellows, the titles of the lectures, a list of participating scientists, a yearly newsletter, and recent past volumes (containing lecture notes and the fellows' project reports).

PUBLICATIONS

Lecture notes and fellows reports are listed in the above website.

HONORS

J. A. Whitehead of Woods Hole Oceanographic Institution received the Henry M. Stommel Research Award from the Americal Meteorological Society in 2007.

The founders of the GFD program (the original Steering Committee) received the American Geophysical Union "Excellence in Education Award" on May 29, 2008. The founders are Henry Stommel (dec.), Willem Malkus, George Veronis, Melvin Stern, Edward Spiegel, Josept Keller and Louis Howard.