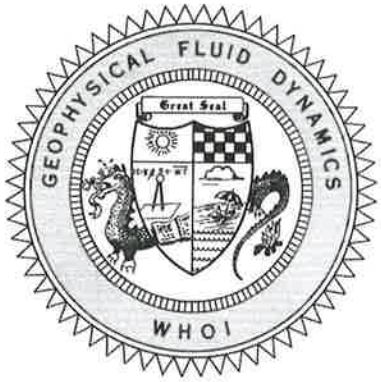


Dear Colleague:

Please find enclosed the announcement for the 2023 program in Geophysical Fluid Dynamics (GFD) at the Woods Hole Oceanographic Institution and the 2022 GFD Newsletter. In 2023 the program commences with two weeks of Principal Lectures focusing on **"GFD on Other Worlds."** The lecturers will be **Heather Knutson** (Caltech), who will concentrate on recent observations from other worlds, and **Geoff Vallis** (University of Exeter), who will review our theoretical understanding of GFD on other worlds.

Please bring this announcement to the attention of graduate students in your department who might be interested in applying for fellowships in the program. The fellowships are intended for graduate students who have completed their graduate coursework and are just beginning their research, but all qualified applicants are seriously considered.

The activities of the fellows are described in the announcement. Please note that fellows are expected to participate for the full 10 weeks of the program.

We expect to award 10 fellowships from a very competitive pool of applications. Fellows are selected by vote of the GFD faculty. Many factors are considered in the selection process, including scientific and creative ability, geographical and disciplinary diversity, and the likelihood that the GFD experience will have a strong positive influence on the career of the fellow. The GFD program is deeply committed to diversity in the choice of fellows and we particularly encourage applications from women and members of underrepresented groups.

Further information about the 2023 program and a summary of the earlier programs can be obtained from the GFD website: https://gfd.whoi.edu/

Yours sincerely,

Tiffany Shaw

Pascale Garaud and Tiffany Shaw
2023 GFD Co-Directors

Fellowships in Geophysical Fluid Dynamics

at

Woods Hole Oceanographic Institution

June 20 to August 25, 2023

Since 1959 the GFD program has promoted an exchange of ideas among researchers in the many distinct fields that share a common interest in the nonlinear dynamics of fluid flows in oceanography, meteorology, geophysics, astrophysics, applied mathematics, engineering and physics. Each year, the program is organized around a ten-week course of study and research for a small group of competitively selected graduate-student fellows. The overall philosophy is to bring together researchers from a variety of backgrounds to provide a vigorous discussion of concepts that span different disciplines, and thereby to create an intense research experience. For the student fellows, the centerpiece of the program is a research project, pursued under the supervision of the staff. At the end of the program, each fellow presents a lecture and a written report for the GFD proceedings volume. Over its history, the GFD Program has produced numerous alumni, many of whom are prominent scientists at universities throughout the world. The interdisciplinary atmosphere of the Program is the ideal place for young scientists to learn the habits of broad inquiry, of speaking to others with very different backgrounds and viewpoints, and of seeking answers in unfamiliar places.

The Program commences with two weeks of Principal Lectures focusing on a particular theme in GFD. For 2023, the theme is **"GFD on Other Worlds"** and the lecturers will be **Heather Knutson** (Caltech), who will concentrate on recent observations from other worlds, and **Geoff Vallis** (University of Exeter), who will review our theoretical understanding of GFD on other worlds.

Up to ten competitive fellowships are available for graduate students. Successful applicants will receive stipends of $7,793 and an allowance for travel expenses within the United States. A small number of unpaid fellowships may also be available for strongly qualified students who can support themselves financially. The application deadline is February 1, 2023. Awards will be announced by March 31, 2023. We seek applicants from all areas of Geophysical Fluid Dynamics, and particularly encourage applications from women and members of underrepresented groups. It is expected that fellows will be in residence for the full ten weeks of the program, and that visitors will spend extended periods of at least one week participating in the program. Further information and application forms may be obtained at **https://gfd.whoi.edu**, or by writing to: gfd@whoi.edu

Prospective visitors should contact Tiffany Shaw at tas1@uchicago.edu,
or Pascale Garaud at pgaraud@soe.ucsc.edu

The GFD Program is funded by the National Science Foundation and the Office of Naval Research

GFD Newsletter 2022

Faculty of Walsh College

The 2022 GFD Photograph

The Structure of the Summer

Having been rudely interrupted for a couple of years, the GFD program returned to repopulate Walsh Cottage in 2022. Participants had to get over the shock of the Cottage's renovation, featuring extensive air conditioning, a highly strung bean-to-cup coffee machine, and actually comfortable office chairs. Fortunately, although there were a few Covid cases in participants through the summer, there was no transmission at the Cottage. Throughout the summer the Cottage (and its porch) was once again a hive of activity, with traditional lively discussion and debate about geophysical fluid dynamics not being suppressed in the slightest in the seminar room by the precautionary mask-wearing policy.

Data-Driven GFD was the theme at the 2022 Program, and Professors Peter Schmid (PSE, KAUST) and Laure Zanna (Courant Institute, NYU) were the principal lecturers. In a tag-team tour-de-force they introduced the audience to an impressive range of data-driven techniques to gain real insight into underlying sampled physical systems, including of course our changing climate. They both continued the tradition of expanding on the lectures with the fellows over lunch, and Peter exploited remote working technologies to remain deeply involved with several fellows' projects, and even returned for the fellows' presentations at the end of the summer.

At the beginning of August, Heidi Nepf (MIT) gave a fascinating and well-received Sears Lecture on "Coastal Vegetation and Coastal Flows: Restoration, Climate Mitigation and Adaptation". Stefan Llewellyn Smith and Colm-cille Caulfield co-directed the summer, with Stefan doing most of the heavy lifting as Colm-cille was often distracted from his GFD duties, even though there wasn't even a Men's Soccer World Cup on. A good number of long-term staff members still ensured that the fellows never lacked for guidance, in science and softball, though the Dynamos were distinguished more for enthusiasm and team spirit than clutch hitting...or fielding...

Anders Jensen worked his usual magic in the Lab, dealing inventively with ever expanding gel balls and (still) recalcitrant coastal plumes with typical good humour, and Janet Fields and Julie Hildebrandt smoothly ran the program as always, not least making sure that there were fresh masks for the forgetful!

The principal lecturers: aka the dynamic duo of data

GFD Dynamos Rookies of 2022: Winless but Willing

And then my eigenvalue shot off to infinity...

Fellows' Reports

Ruth Moorman, California Institute of Technology
Continental Shelf Waves around a Pseudo-Iceland

Tilly Woods, University of Oxford
Fun with Squishy Balls: Theory and Experiments on Deformable Porous Media

Claire Valva, New York University
Understanding Invariant Solutions of the Korteweg-de Vries Equation

Rui Yang, University of Twente
Equatorial Ocean Dynamics on Enceladus Driven by Ice Topography

Iury Simoes-Sousa, U. Massachusetts Dartmouth
Stochasticity of Turbulence

Ludovico Giorgini, Stockholm University
Statistical Analysis of Multidimensional Dynamical Systems

Sam Lewin, University of Cambridge
Experiments on the Instability of Buoyancy-driven Coastal Currents

Kasturi Shah, Massachusetts Institute of Technology
Scaling with the Stars: Emergence of Self-organised Criticality in Low Péclet Flows

Squishy splats from Balmforth's blaster

Schedule of Principal Lectures

June 21 (PS): Review of Data-decomposition Based on Linear Algebra

June 22 (LZ): Spatio-temporal Decomposition of Time Series

June 23 (PS): Transfer Operator for Data Analysis (part 1)

June 24 (PS): Transfer Operator for Data Analysis (part 2)

June 27 (LZ): Forced Response from Climate Statistics

June 27 (PS): Uncertainty, Outliers, Predictability

June 28 (LZ): Bayesian and Markovian Approaches to Data Analysis

June 29 (LZ): Discovering Equations and Operators from Data

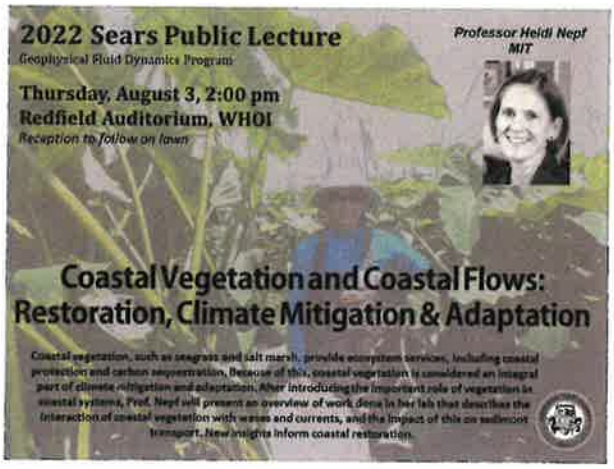
June 30 (PS): Advanced Approaches in Signal Processing

July 1 (LZ): Advanced Approaches in ML for Physics

Fellows new and old(er) plugged in on the porch

Elizabeth doesn't buy what Peter and Jason are selling

Mattia faces the masked music after his seminar



Heidi Nepf's super Sears Lecture on swaying seagrass

Team Triathlon: GFD's First (R) and Third (L)

Sam explains baroclinic instability to Joe P...

Old age and treachery beat youth and exuberance

The GFD Faculty

The GFD Faculty handles the scientific and administrative duties of the school. This group is made up of members of the scientific community, across several disciplines, united by their interest in GFD. These are the faces to be seen at GFD over future summers, and their research interests help to define the scientific direction and flavor of the Program.

Neil Balmforth *University of British Columbia*
Oliver Buhler *New York University*
Colm-cille Caulfield *University of Cambridge*
Claudia Cenedese *W. H. O. I.*
Eric Chassignet *University of Miami*
Gregory Chini *University of New Hampshire*
Glenn Flierl *M. I. T.*
Pascale Garaud *U.C. Santa Cruz*
David Goluskin *University of Victoria*
Karl Helfrich *W. H. O. I.*
Alexis Kaminski *University of California, Berkeley*
Richard Kerswell *University of Cambridge*
Norman Lebovitz *University of Chicago*
Stefan Llewellyn Smith *U. C. San Diego*
Philip Morrison *University of Texas at Austin*
Joseph Pedlosky *W. H. O. I.*
Tiffany Shaw *University of Chicago*
Bruce Sutherland *University of Alberta*
Jean-Luc Thiffeault *University of Wisconsin*
Mary-Louise Timmermans *Yale University*
John Wettlaufer *Yale University*
John Whitehead *W. H. O. I.*
Megan Davies Wykes *University of Cambridge*

Gone, but not forgotten

The GFD Website

The lecture notes and reports will eventually be available online at `gfd.whoi.edu`. The GFD website also contains:

- lecture and seminar schedules
- electronic versions of proceedings and newsletters
- lists of alumni and visitors
- application materials
- picture galleries of life at GFD
- useful information and links.

Contributions

The GFD program has established an endowment fund to help support the program in the future and for a specially funded position intended to help finance the extended visit of a key participant, such as the summer's Principal Lecturer. The fund is administered by WHOI. If you would like to contribute, please send your check (made payable to WHOI) to

Woods Hole Oceanographic Institution
GFD Fund, MS 40
Woods Hole, MA 02543

Donations can also be made by credit card by calling the Development office at 508-289-4895.

Please send comments to `cpc12@cam.ac.uk` or `sgls@ucsd.edu`. The GFD Program is funded by the National Science Foundation.

Data-driven directing