

## GFD Newsletter 2019

### Faculty of Walsh College



*The 2019 GFD Photograph*

As usual, laboratory experiments were facilitated by able support from Anders Jensen. Janet Fields and Julie Hildebrandt made sure that the administrative side of the summer ran smoothly. We continue to be indebted to W.H.O.I. Academic Programs Office, who once more provided a perfect atmosphere.

### *Schedule of Principal Lectures*

Monday, June 17: *Motivation and basic concepts (SW)*

Tuesday, June 18: *Quantifying ocean mixing and ocean turbulence: frameworks, technologies and practicalities (SW)*

Wednesday, June 19: *Rates and mechanisms: what we observe and interpret from observations of mixing and turbulence in the ocean Interior (SW)*

Thursday, June 20: *Introduction to turbulence theory for stratified flows (CC)*

Friday, June 21: *Effects of stratification and/or shear on turbulence and their description by nondimensional parameters (CC)*

Monday, June 24: *Mixing mechanisms in forced and freely-evolving flows (CC)*

Tuesday, June 25: *Mixing modeling and parameterization in stratified turbulence (CC)*

Wednesday, June 26: *Open questions and controversies in stratified turbulent mixing research (CC)*

Thursday, June 27: *Challenges in and promising approaches for connecting theory to observation (SW and CC)*

Friday, June 28: *Future directions for research into stratified turbulence and ocean mixing processes (SW and CC)*

SW = Stephanie Waterman; CC = Colm Caulfield

### *The Structure of the Summer*

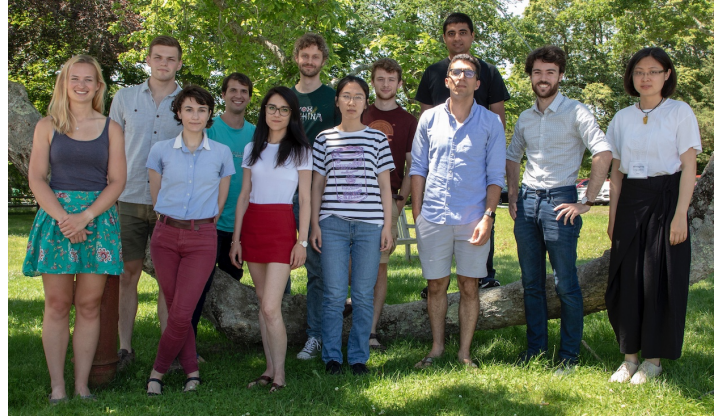
The 2019 Geophysical Fluid Dynamics Summer Study Program started on June 17th and the topic this year was *Stratified Turbulence and Ocean Mixing Processes*. The principal lectures were given by Professors Stephanie Waterman (University of Victoria) and Colm-cille Caulfield (University of Cambridge). Colm covered the theoretical aspects of stratified turbulence, from simple scaling laws to sophisticated, modern numerical results. Stephanie kept the enthusiastic audience grounded with her lectures on ocean mixing processes, observations, and their many technical challenges.

Claudia Cenedese, Bruce Sutherland and Karl Helfrich were co-directors. The summer was marked by a large number of long-term staff numbers, as well as one of our largest-ever audience for the principal lectures (necessitating an overflow room). The staff members and many long-term visitors ensured that the fellows never lacked for guidance, and the seminar series was filled by a steady stream of more than 30 talks on topics as diverse as microgravity snow and hydrothermal megaplumes.



Our Principal Lecturers, Colm and Stephanie, and co-Directors, Bruce, Claudia and Karl

As always, the focus for the faculty is the guidance of the GFD Fellows through their summer research projects. The fellows are strongly encouraged to work in areas unrelated to their PhD thesis topics and to engage with as many of the faculty and visitors as possible. The reward for all involved is the final week of the summer when the fellows give lectures on their projects, which are as widely varied as the fellows' backgrounds.



The fellows (l-r): Lois, Channing, Kelsey, Andre, Alessia, Jelle, Wenjing, Jeremy, Anuj, Houssam, Samuel, and Wanying

## Fellows' Projects

Houssam Yassin, Princeton University  
*Sensitivity of the ocean's deep circulation to westerly winds*

Channing Prend, Scripps Institution of Oceanography  
*Eddy mixing of biogeochemical tracers*

Andre Paloczy Filho, University of California San Diego  
*Reduced models for wave-balanced flow interactions*

Jeremy Parker, University of Cambridge  
*Exploiting sum-of-squares optimization for chaotic Hamiltonian systems*

Wanying Kang, Harvard University  
*Symmetry breaking on the Enceladus ice shell*

Lois Baker, Imperial College London  
*Interaction between internal modes and their superharmonics*

Kelsey Everard, The University of British Columbia  
*Free convection with large viscosity variations*

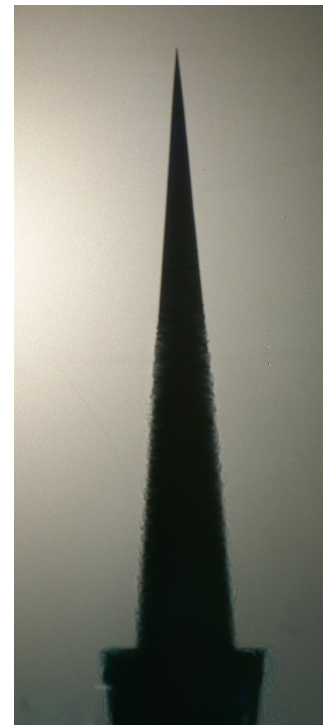
Anuj Kumar, University of California Santa Cruz  
*Maximal heat transport in Rayleigh-Benard convection: reduced models, bifurcations, and polynomial optimization*

Alessia Ferraro, Ecole Polytechnique Federale de Lausanne  
*Exploiting marginal stability in slow-fast quasilinear dynamical systems*

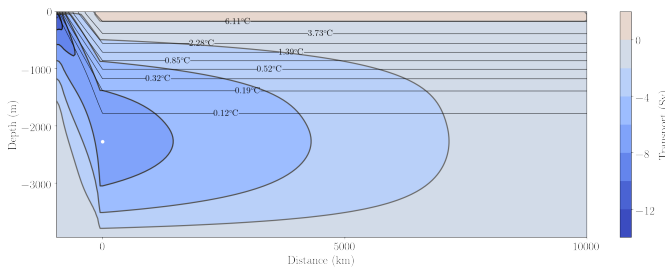
Samuel Boury, ENS de Lyon  
*A mushy source for the geysers of Enceladus*

Jelle Will, University of Twente  
*Optimal mixing of a passive scalar field in Kolmogorov flow*

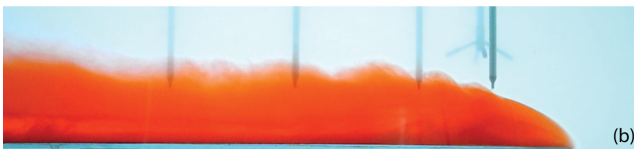
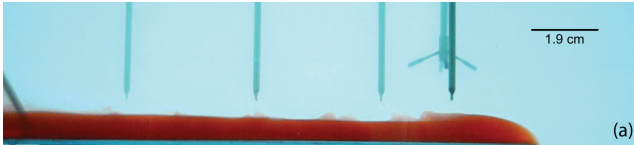
Wenjing Dong, New York University  
*Structure and stability of flow around noncircular islands*



Kelsey's candy convection



*Houssam's overturning*



*Jeffrey, Claudia and Jim's steady gravity currents*



*Late summer afternoon on the Landfall deck*



*A close and satisfying victory*

## *In Memorium*

Sadly, this summer the GFD Program lost one of our co-founders, George Veronis of Yale University. George helped to establish the program in 1959 and was an active leader and participant in every summer since. As a testament to this dedication, George shared the 2008 AGU Award for excellence in Geophysical Education. His many scientific accomplishments were recognized by his membership in the American Academy of Arts and Sciences, as a Fellow of the American Geophysical Union, a member of the Norwegian Academy of Science and Letters, and as a member of the U.S. National Academy of Sciences. Among his legacies with the GFD Program is the Dynamo softball team. George was an avid participant and felt strongly that fellows and faculty sharing time away from research playing softball added immeasurably to the success, both near and long-term, of the fellows and the program. He will be deeply missed.



*George Veronis*

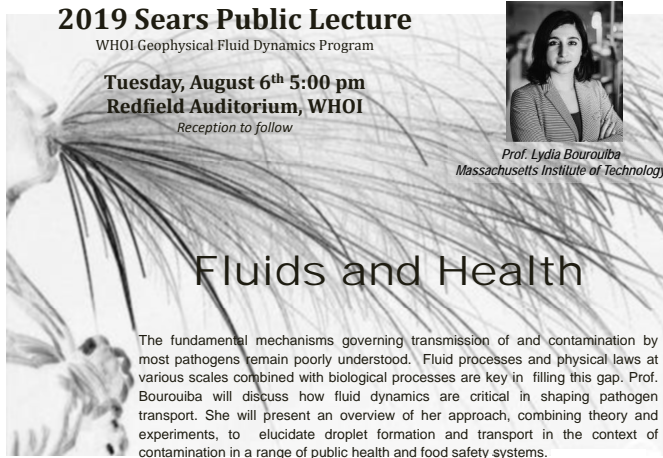
## *Softball Report*

The season of softball provided a welcome antidote to the hard work of the summer, with the weekly games framed by sun, humidity, circumhorizontal arcs (fancy rainbows), ospreys, and post-match swims. The 2019 Fellows readily took to the game, often organizing their own practice sessions at Bell Tower. Their talents grew throughout the season. Remarkable and reliable connections were made from Jelle and Anuj at short-stop and third base over to Jeremy on first. Kelsey emerged with a zen-like way of pitching. One outstanding debacle saw the Dynamos score two runs off an accidental bunt. In all, the Dynamos claimed one hard-fought victory, and one technical victory – but who's counting anyway. All bets were on the Fellows going into the Staff v Fellows game, given their practice and enthusiasm. However, the Staff turned out in great numbers and, with unforeseen talents, won the match. As usual, softball continued as a joyful part of the GFD summer.

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## The Sears Public Lecture

The 2019 Sears Public Lecture was delivered by Professor Lydia Bourouiba, of the Massachusetts Institute of Technology, on “Fluids and Health”. Lydia’s entertaining and interesting talk introduced the audience to, among several topics, the fluid mechanical details of a sneeze. Everyone was motivated to get their flu shot!



**2019 Sears Public Lecture**  
WHOI Geophysical Fluid Dynamics Program

**Tuesday, August 6<sup>th</sup> 5:00 pm**  
**Redfield Auditorium, WHOI**  
*Reception to follow*

**Fluids and Health**

The fundamental mechanisms governing transmission of and contamination by most pathogens remain poorly understood. Fluid processes and physical laws at various scales combined with biological processes are key in filling this gap. Prof. Bourouiba will discuss how fluid dynamics are critical in shaping pathogen transport. She will present an overview of her approach, combining theory and experiments, to elucidate droplet formation and transport in the context of contamination in a range of public health and food safety systems.

*Prof. Lydia Bourouiba*  
Massachusetts Institute of Technology

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## The GFD Faculty

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, *Florida State University*  
 Greg Chini, *University of New Hampshire*  
 Charles Doering, *University of Michigan*  
 Glenn Flierl, *M. I. T.*  
 Pascale Garaud, *U.C. Santa Cruz*  
 Karl Helfrich, *W. H. O. I.*  
 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*  
 Edward Spiegel, *Columbia University*  
 Bruce Sutherland, *University of Alberta*  
 Jean-Luc Thiffeault, *University of Wisconsin*  
 Mary-Louise Timmermans, *Yale University*  
 John Wettlaufer, *University of Oxford*  
 Jack Whitehead, *W. H. O. I.*

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 varied research interests help to define the scientific direction and flavor of the Program.

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## The GFD Website

The lectures notes and reports are available online at [gfd.whoi.edu](http://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.

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## 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 a Principal Lecturer, or a long-term stays by junior members of the scientific community. The fund is administered at WHOI under the guidance of Claudia Cenedese. 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 or suggestions about this newsletter or the GFD Program to [ccenedese@whoi.edu](mailto:ccenedese@whoi.edu).

The GFD Program thanks the National Science Foundation for many years of financial support. The Woods Hole Oceanographic Institution also provides support, including the use of the historic Walsh Cottage.