

# **Planetary Boundary Layers in Atmospheres, Oceans, and Ice on Earth and Moons**

Final Report on KITP Program, April 2, 2018– June 22, 2018

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## **1. Program & Conference Summary**

### *a. Goals & Themes*

This Program and accompanying Conference focused on planetary boundary layers, with the primary objective of bringing together theoretical, observational, and model-based researchers from across sub-disciplines to share work and perspectives, draw new connections between research areas, and apply their collective experience to important problems that are of common interest due to relevance in the study of Earth or Extra-terrestrial Systems behavior – including Large Eddy Simulation (LES), asymptotic analysis of governing equations, complex wave dynamics, and mixing parameterizations (details below).

Complex boundary dynamics and the exchange of energy, mass, and other important quantities across an interface between media are fundamental concerns in many fields. The properties of thin boundary layers in adjacent media can exert a controlling influence on exchanges. In geophysical and astrophysical contexts, the transition between boundary layers is often accompanied by a phase change (liquid to gas, solid to gas, liquid to solid, gas to plasma). Through spray, bubbles, melting/freezing, and other vigorous mixing or forcing, the coexistence of multiple phases can become important. During this 3-month Program and embedded 1-week Conference, such processes were addressed in the contexts of climate, weather and environmental concerns on Earth; gas giants; solar dynamics; and ice-covered moons.

Exciting connections were made between boundary layers and applications that improve understanding and prediction of natural disasters, including air quality and wind-induced fire hazards in Santa Barbara, and the recent debris flows (“mudslides”) in Montecito. Drifters measuring the dispersal of pollution in coastal boundary flows—important for pollution and biology—were also discussed. Recent and concurrent observations of these local boundary layers formed an important and exciting grounding for discussions at the meeting.

Throughout the program, significant discussions focused on specialized phenomena that exist only within the boundary layers--such as waves, turbulent mixing, atmospheric convection, certain cloud types, ice cliffs/icebergs, and oceanic submesoscale dynamics. Recognition of methodological commonalities across subfields, such as LES techniques and asymptotic mathematical approaches, fomented fresh perspectives and “technology transfers” between disciplines, leading to some exciting project outcomes (more details below).

Consequences and techniques for parameterization of boundary layer processes in large scale modeling of the climate system, suns, and planetary bodies were discussed. Approaches proven in the atmosphere were considered for the ocean, approaches in the ocean were considered for solar dynamics, and so on. The broader impact of these exchanges will continue to evolve through implementation of the discussed developments in climate and weather models.

*b. Specific Accomplishments*

Some key scientific problems that were actively and productively addressed in a variety of disciplinary contexts, throughout the Program and Conference, are briefly described below.

**Large Eddy Simulation (LES)** – Presentations on ocean, atmosphere, and solar convective processes falling into this category framed questions in each sub-discipline. Techniques — like finite volume, spectral, particle-in-cell, and others — were introduced and contrasted in speed, accuracy, and pathologies. Consequences of sub-grid scheme selections were discussed. Access to supercomputing was facilitated through participants who were advised to plan in advance.

**Asymptotic Analysis of governing equations** – Typically, boundary layers have one scaling, while the interior of fluids or spheres have another. Important links between asymptotic scalings and Generalized Lagrangian Mean theory were introduced and discussed. Large-scale ocean and atmospheric waves in the asymptotic limit of small Rossby and Froude numbers, were demonstrated to be interesting geophysical examples of topological insulators. Mathematical techniques underlying matched asymptotics were illustrated in a 3-part tutorial examining the slow damping of ocean waves propagating over a flat bottom under asymptotically weak viscous effects and resulting in streaming transport within the boundary layer. *This problem, though in some sense “classical”, was worked out for the very first time to this asymptotic order through this series of presentations, and is to be published as an educational tutorial by the presenter and a student from the program.*

**Wave dynamics** – Waves in the atmospheric boundary layer, ocean surface, and ocean interior were presented and discussed using asymptotic analysis and modeling techniques. The state-of-the-art in wave-current coupling was discussed. Limitations of the approach and accuracy of different representations were productively debated. Many student and junior scientist projects were stimulated by this discussion.

**Development of mixing parameterizations, particularly of Langmuir (i.e., wave-driven) mixing in the oceanic boundary layer** – Many of the participants attended the meeting because of this topic in particular. A cross-comparison between all existing Langmuir and non-Langmuir mixing models in development globally was designed as a primary outcome of the meeting. *Virtually all groups worldwide working on Langmuir parameterization were represented in person during the program. At no other time has such a wide synthesis of these groups been possible, and the KITP facilities and program proved ideal for this purpose.*

*c. Organization*

Each week, the talk schedule was responsive to the participants present. Synergistically, running themes, such as LES and Asymptotic Methods, were repeated and touched on by a series of speakers, typically once per week. Break-out groups on specific topics, e.g., wave dynamics, a student study group, ocean mixing, Generalized Lagrangian Mean theory, Lagrangian

observations, and others, spontaneously formed and reported back to the whole group through joint or representative presentations.

A wide diversity of physicists, geoscientists, and mathematicians participated in the meeting; studying atmosphere, ocean, and cryosphere on earth, as well as gas giants, solar physics, and ice-covered moons. All anticipated sub-disciplines were represented, including both senior and junior researchers. The program provided a relaxed-but-focused forum in which issues and techniques from each discipline could be discussed and elucidated in-depth. The close interaction among participants both broadened their perspectives and lead to new, interdisciplinary collaborations and establishment of short- and long-term future research agendas.

Public lectures, on topics of local and global concern and diversity in science, were a hallmark of the program and conference. The speakers featured world experts in climate, weather, and planetary sciences, as well as junior faculty from UCSB.

Social events, such as group dinners; hikes; trivia, snooker and ping-pong tournaments; and a Friday pub gathering helped to solidify the group and deepen interactions. These events were aided by the selected social coordinator or organized by volunteers each week. These activities provided opportunities for productive respites and casual interactions between potential collaborators.

## **2. Projects, Papers, Proposals, & Collaborations**

Multiple collaborations were initiated, solidified, or maintained through this Program, and a number of papers were started or completed. Plans were also made for collaborations on upcoming proposals. *Detailed itemized lists of collaborations, projects and deliverables are included farther below in section 6.* Many papers benefitting from the Program or Conference have already been published/submitted, with more to be completed in the coming year.

## **3. Participation & Diversity Outreach**

The Program and its associated Conference had broad participation, with attendees from across North America, Europe, and Asia, as well as from UCSB's own Bren School, and Geography and Physics departments. These included 11 women, who played important roles in the program. The Conference had 70 participants, including 15 women. Many Conference attendees were not participants in the longer Program. Participants in both included a number of junior affiliates, whose active participation even included leading some of the program outcome papers.

### *a. General efforts to reach scientists*

Early organization included direct emails to 200+ potential participants and announcements in the following forums:

- Social media (Facebook, LinkedIn) Oceanography and Earth Science groups
- National Weather Service Atmosphere and Ocean Dynamics (NWS AOFD) listserv
- Woods Hole Oceanographic Institution Geophysical Fluid Dynamics (WHOI GFD) mail list
- Community Earth Systems Model (CESM) participants mailing list
- USCLIVAR newsletter

- CLIVAR Bulletin (December 2016)
- APS Topical Group Physics of Climate (GPC) Newsletter and an email to 580 GPC members
- APS Meetings webpage

*b. Efforts targeted at recruiting underrepresented scientists*

Underrepresented groups were also identified, and efforts were made to ensure awareness of the program in those communities. These included

- Posting to Mentoring Physical Oceanography Women to Increase Retention (MPOWIR).
- Emails sent to relevant department heads at predominantly women's colleges, including the Bryn Mawr College Physics Department and Spelman College Mathematics Department.
- Emails sent to relevant department heads and individual researchers at multiple historically black colleges, including Spelman College, Howard University, Hampton University, Morehouse College, and others.
- An email / announcement distribution request sent to the National Society of Black Engineers.
- Emails sent to multiple specific potential Program candidates known personally to committee members, who also happened to be female or of color, to encourage them to apply to the Program, some of which applied and played significant Program / Conference roles:
  - Julie Castillo-Rogez (JPL) was successfully recruited as a Scientific Advisor for topics related to extraterrestrial planets;
  - Juan Restrepo (Oregon State), Joao Teixeira (JPL), Surendra Adhikari (JPL), Keith Julian (U. Colorado), George Philander (Princeton), Yongxiang Hu (LaRC), Gudrun Magnusdottir (UCI), Krista Soderlund (U. Texas), Simona Bordoni (Caltech), and Laure Resplendy (Princeton) were all Conference speakers.

*c. Addressing issues of diversity within the Program, Conference, & field-at-large*

All individual scientists listed in 3b, and some others that received and declined invitations, are as (and in some cases more) qualified to participate in a KITP program as those participants from well-represented groups. Some – George Philander, for example – have made groundbreaking contributions to the field. However, embarrassingly, our organizational committee discovered during a brainstorming process for determining Conference invitees that our initial lists included few women, and almost no persons of color. Moreover, working list severely lacked diversity, indicating likely unconscious and affiliation bias on the part of the organizers. *This led to several in-depth discussions during planning among committee members and KITP administrators on diversity, and a broader exploration (via internet search, documents published by NSF and organizations like MPOWIR, personal inquiries, etc.) of the demographics in boundary layer physics and the reasons behind them.*

While, admittedly, there had been clear, initial reflexive tendencies by committee members to think of potential invitees more similar to themselves (affiliation bias), it was also discovered that *the global boundary layer community is notably lacking in women and people of color, even relative to other areas of the Earth and Planetary Physical Sciences. For this reason, we added a special session to the Conference on understanding this lack of diversity, why it is significant, and how participants, as prominent/rising members of the community, might improve matters.*

The special diversity Conference session featured talks by George Philander (Princeton,

ACCESS) and Ashanti Johnson (CEO Cirrus Academy, Mercer U., formerly U. Texas), and included a time block devoted to discussion. Feedback was predominantly positive, especially from participants with a particular interest in STEM education or who are active in public outreach. A small number of participants expressed mixed views, the nature of which reinforced the topics raised are sorely needed in the boundary layer and STEM communities. Some feedback indicated, indirectly, that a broader range of communication strategies is needed to reach some community members on these issues.

#### **4. Suggestions for Future Programs**

We were disappointed that a number of female applicants who were accepted into the program ended up declining. This included 5 anticipated Conference speakers, who had accepted invitations during the year prior to the Conference, but later withdrew. We discussed some of the possible reasons for this with the staff, including the difficulty of long visits having a different impact on family roles by gender. *The timing of the Program, and in particular, the scheduling of the 1-week Conference in late May – when many K-12 schools and colleges hold finals, graduation ceremonies, and other significant events – likely contributed to this, and should be considered when planning future programs.*

An additional concern is that while most Conference participants seemed to find the diversity session beneficial, a few participants might have felt uncomfortable or singled-out. A pending African American invited speaker withdrew altogether, almost immediately after his committee contact mentioned the diversity session and that it would be nice to have his input in the discussion. Additionally, Conference participants of color *other* than the 2 diversity-session speakers opted to not attend the session, despite being present at most science sessions. While some aspects of these events might be coincidental, further discussion was declined. This raises questions regarding how to best-approach KITP's goal of supporting demographic, as well as disciplinary, diversity within a given Program. *While our committee and KITP administrators feel the overall impact on our Conference was beneficial, such that future programs might also benefit from similar events, care is needed in planning and it is likely critical to have a diverse program coordination team. Future program committees considering diversity events are encouraged, but cautioned to carefully consider their approach. Including an experienced university diversity liaison in the planning discussions and invitations might be helpful.*

In the end, however, the boundary layer Program and Conference attracted a strong and diverse cross-section of planetary boundary layer scientists, all primary objectives were met, and – as discussed below – both the Program and Conference were scientifically quite productive. This is reflected in exit reports and participant enthusiasm for future potential events.

#### **5. Program Success**

All of the participants and the organizers very strongly felt that the program was a resounding success. For many of the participants, this was the first time they have participated in a KITP program. All of them immensely enjoyed and appreciated the venue, staff, and the informal format of the program – as expressed in their exit reports and in person to the organizers. Many wrestled productively with hard questions, were able to generate new ideas, and forged new collaborations. Most left the program feeling they had learned a lot, were armed to move

forward with new ideas, and that they would enjoy participating in future, similarly-run programs at KITP.

On behalf of all the participants, including the affiliates, we wish to thank everyone at the KITP (the director, deputy director, permanent members, advisory board, and the administrative and technical staff) for approving the program, for providing excellent advice on how to make it a success, and/or for directly helping to actually make it so. This includes the incredible assistance that we received with Conference organization and other logistics from KITP's managerial and business support staff, as well as from the facilities and food services, some of whom exceeded expectations in making the program run smoothly and to be enjoyable for all participants. We look forward, with great anticipation, to the next opportunity to participate in a KITP program!

## **6. Deliverables**

### *a. Partial list of projects worked on during the program*

- Monsoon intraseasonal oscillations and fronts in the Bay of Bengal: Adams, Fox-Kemper & Tandon.
- Mesoscale eddy parameterization: Bachman, Ferreira, Doddridge & Fox-Kemper and Bachman, Bishop & Aluie, LaCasee.
- Ocean boundary layer mixing parameterization: Li, Fox-Kemper, Reichl, McWilliams, Hara, Belcher, Harcourt, Ayet, Villas Boas
- Instabilities & mixing: Bachman, Grisouard, Bishop & Wenegrat.
- Mixed layer eddy dynamics: Bachman, Ferreira, Menemenlis & Fox-Kemper.
- High resolution simulations: Bryan, Menemenlis & Liu.
- MITgcm dynamic viscosity model: Doddridge, Bachman, Ferreira & Fox-Kemper.
- Comparison of different boundary layer parameterizations: Fox-Kemper, Li, Reichl, Hara, Belcher, McWilliams & Harcourt.
- Polar amplification: Magnusdottir & Kushner.
- History of the quasilinear approximation (per suggestion by McWilliams): Marston & Tobias.
- Asymptotic methods: Phillips, Chini, Restrepo
- Santa Barbara downslope winds: Carvalho, Ohlmann, Marston
- Solar convection: Lecoanet, Fox-Kemper, Chini
- Large Eddy Simulation: Harcourt, Li, Boeing, Fox-Kemper, Matheou,
- Wave modeling: McWilliams, Fox-Kemper, Li, Romero, Restrepo, Arduin, Cavaleri
- Wave observation: Romero, Arduin, Cavaleri

### *b. Partial list of new collaborations initiated during the program*

- Impact of boundary layer processes on climate: Ayet, Ferreira, Villas Boas, Li, and Fox-Kemper
- Diagnosis of topological waves in the climate system: Ayet, Shapourian, and Marston

- Airflow about ocean gravity waves: Ayet, Hara, Husain.
- Entrainment of air into superficial sea layer: Cavaleri, Hara & Restrepo.
- Homotopy approach: Cho, Restrepo, Chini & Webb.
- Wave – mean flow dynamics: Cho, Kushner, Lawrence & Marston
- Turbulence: Cho & Pouquet.
- Phytoplankton / surface boundary interactions: Ferreira & Olhmann.
- Diffusion and transport in GFD turbulence: Kushner & Smith.
- Librational instability in a rotating cylinder: Smith & Lecoanet.
- Convection and Langmuir turbulence: Lecoanet & Chini.
- New algorithm to find fixed points of cumulant expansions: Chini, Michel & Marston.
- Stratocumulus clouds: Mitchell, Bretherton, & Stevens.
- Upper ocean radiant heating parameterization: Ohlmann & Reichl.
- Lagrangian observations of ocean surface currents: Ohlmann, Balwada & Smith.
- Causes of “sticky water” in coastal ocean: Ohlmann & Restrepo.
- Vertical transport of viruses: Chini & Richards.
- Shear generated turbulence: Richards & Matheou.
- Tropical basins: Bryan & Richards.
- Sediment laden flows: Meiburg & Tandon.
- Generation mechanisms for a bore in surface ocean: Tandon & Wenegrat.
- Potential for space-based (as opposed to airborne/shipboard) remote sensing of ocean surface boundary layer profiles: Hu, Halkides & Menemenlis

*c. Partial list of publications in preparation, submitted, or accepted*

- Ayet & Chini: tutorial on asymptotic methods
- Cavaleri: paper on “Large waves in the southern ocean.”
- Cho: paper with Woosok Moon.
- Fox-Kemper: Symmetries of advection vs. diffusion and constraints on mesoscale ocean turbulence, in preparation.
- Grisouard & Lecoanet: Radiation of internal waves from a symmetric instability.
- Hara, Husain & Sullivan: “Boundary layer turbulence over surface waves in a strongly forced condition – LES and observation.”
- Hay, S., P. J. Kushner, R. Blackport, and K. E. McCusker, 2018: On the Relative Robustness of the Climate Response to High-Latitude and Low-Latitude Warming. *Geophysical Research Letters*, **45**, 6232–6241, doi:10.1029/2018GL077294. [Carried out revisions and finalized paper for publication.]
- Boggs, K. J. E., R. C. Aster, P. Audet, G. Brunet, R. M. Clowes, C. D. de Groot-Hedlin, E. Donovan, D. W. Eaton, J. Elliott, J. T. Freymueller, M. A. H. Hedlin, R. D. Hyndman, T. S. James, P. J. Kushner, K. D. Morell, C. D. Rowe, D. L. Schutt, M. G. Sideris, M. Ulmi, F. L.

- Vernon, and N. West, 2018: EON-ROSE and the Canadian Cordillera Array – Building Bridges to Span Earth System Science in Canada. *Geoscience Canada*, 45, 97–109, doi:10.12789/geocanj.2018.45.136. [Final submission.]
- Oudar, T., P.J. Kushner, J.C. Fyfe, M. Sigmond: Did anthropogenic aerosols drive the early 2000’s warming slowdown? *Geophys. Res. Letters*, *in review*. [Submitted.]
  - Henderson, G., Y. Peings, J. Furtado, P. J. Kushner: The impact of northern hemisphere snow cover variability and change on extratropical circulation. *Nature Climate Change*, *in review*. [Wrote paper with coauthors, submitted paper.]
  - Magnúsdóttir finalized a paper with a graduate student that has now been accepted by GRL (Labe et al 2018: Contributions of ice thickness to the atmospheric response from projected Arctic sea ice loss).
  - Marston, Oishi, and Tobias, “Generalised Quasilinear Approximation of the Interaction of Convection and Mean Flows in a Thermal Annulus” (published);
  - Skitka, Fox-Kemper & Marston, “Reduced-order quasilinear boundary-layer turbulence modeling” (in preparation).
  - Ocampo Torres: writing up a manuscript associated with the atmosphere-ocean boundary-layer, in particular related to the turbulence generated by non-breaking ocean waves.
  - Ohlmann: Wrote a review paper “Penetrating Shortwave Radiation” accepted for publication in the Encyclopedia of Ocean Sciences.
  - Pizzo & McWilliams: Waves interacting with shear flows.
  - Pouquet: Papers submitted to *Eur. Phys. Lett* and *Phys. Fluids*.
  - Transport under Progressive Waves, Jorge Ramirez, Juan M. Restrepo, Luc Deike, Ken Melville, to be submitted 2018 to *Physics of Fluids*
  - Air Entrainment as a Damping Mechanism of Gravity Waves by Rain, Alex Ayet, Luigi Cavaleri, Juan M. Restrepo, in preparation.
  - Gradient Sensing via Cell Communication, Dallas Foster, Collin Victor, Brian Frost, Juan M. Restrepo, submitted *J. Theoretical Biology* (2018).
  - Modelling the Mass Exchange Dynamics of Oceanic Surface and Subsurface Oil, Jorge Ramirez, Saeed Moghimi, Juan M. Restrepo, Shankar Venkataramani, under revision, *Ocean Modelling* (2018).
  - “Energy and Flux Budget Theory for Atmospheric Turbulent Convection: Surface Layers”, by Zilitinkevich S., Elperin T., Kleorin N., Rogachevskii I., in preparation (2018).
  - “Energy and Flux Budget Theory for Atmospheric Turbulent Convection: CBL- Core”, by Zilitinkevich S., Elperin T., Kleorin N., Rogachevskii I., in preparation (2018).
  - Romero, L., 2018a: Spectral distribution of wave breaking fronts. In Preparation.
  - Romero, L., 2018b: The wind-wave spectrum and approximations for coupled models. In Preparation.
  - Romero, L., J. C. Ohlmann, E. Palla`s-Sanz, and P. Pe´rez-Brunius, 2018: Observations of horizontal dispersion over the inner-shelf. In Preparation.



- A. B. Villas Boas, F. Ardhuin, A. Ayet, M. A. Bourassa, P. Brandt, B. Chapron, B. D. Cornuelle, J. T. Farrar, M. R. Fewings, B. Fox-Kemper, S. T. Gille, C. Gommenginger, P. Heimbach, M. C. Hell, Q. Li, M. R. Mazloff, S. T. Merrifield, A. Mouche, M. H. Rio, E. Rodriguez, J. D. Shutler, A. C. Subramanian, E. J. Terrill, M. Tsamados, C. Ubelmann, and E. van Sebille. Integrated observations and modeling of winds, currents, and waves: requirements and challenges for the next decade. In *Oceanobs19: An Ocean of Opportunity*. Frontiers in Marine Science, October 2018. submitted.
- A. Bodner, B. Fox-Kemper, L. Van Roekel, J. McWilliams, and P. Sullivan. A perturbation approach to understanding the effects of turbulence on frontogenesis. *Journal of Fluid Mechanics*, January 2019. Submitted.
- B. Pearson, J. Pearson, and B. Fox-Kemper. Relation between structure functions and cascade rates in anisotropic two-dimensional turbulence. *JFM Rapids*, December 2018. Submitted.
- C. Gommenginger, B. Chapron, A. Hogg, C. Buckingham, B. Fox-Kemper, L. Eriksson, F. Soulat, C. Ubelmann, F. Ocampo-Torres, B. B. Nardelli, D. Griffin, P. Lopez-Dekker, P. Knudsen, O. Andersen, L. Stenseng, N. Stapleton, W. Perrie, N. Violante-Carvalho, J. Schulz-Stellenfleth, D. Woolf, J. Isern-Fontanet, F. Ardhuin, P. Klein, A. Mouche, A. Pascual, X. Capet, D. Hauser, A. Stoffelen, R. Morrow, L. Aouf, O. Breivik, L.-L. Fu, J. Johannessen, Y. Aksenov, L. Bricheno, J. Hirschi, A. C. Martin, A. P. Martin, G. Nurser, J. Polton, J. Wolf, H. Johnsen, A. Soloviev, G. A. Jacobs, F. Collard, S. Groom, V. Kudryavstev, J. Wilkin, V. Navarro, A. Babanin, M. Martin, J. Siddorn, A. Saulter, T. Rippeth, B. Emery, N. Maximenko, R. Romeiser, H. Graber, A. A. Azcarate, C. Hughes, D. Vandemark, J. da Silva, P.-J. V. Leeuwen, A. Naveira-Gabarato, J. Gemmrich, A. Mahadevan, J. Marquez, Y. Munro, S. Doody, and G. Burbidge. Seastar: a mission to study ocean submesoscale dynamics and small-scale atmosphere-ocean processes in coastal, shelf and polar seas. In *Oceanobs19: An Ocean of Opportunity*. Frontiers, November 2018. submitted.
- Q. Li. *Langmuir Turbulence and Its Effects on Global Climate*. PhD thesis, Brown University, June 2018.
- J. Pearson, B. Fox-Kemper, R. Barkan, J. Choi, A. Bracco, and J. C. McWilliams. Impacts of convergence on Lagrangian statistics in the Gulf of Mexico. *Journal of Physical Oceanography*, January 2019. In press.
- Qing Li, Brandon G. Reichl, Baylor Fox-Kemper, Alistair J. Adcroft, Stephen Belcher, Gokhan Danabasoglu, Alan Grant, Stephen M. Griffies, Robert Hallberg, Tetsu Hara, Ramsey Harcourt, Tobias Kukulka, William G. Large, James C. McWilliams, Brodie Pearson, Peter Sullivan, Luke Van Roekel, Peng Wang, Zhihua Zheng 2019: Comparing Ocean Boundary Vertical Mixing Schemes with Langmuir Turbulence. *Journal of Advances in Modeling Earth Systems*. In preparation.

## 7. The Conference: Frontiers in Oceanic, Atmospheric, and Cryospheric Boundary Layers

As indicated at multiple junctures above, a 5-day conference, entitled “Frontiers in Oceanic, Atmospheric, and Cryospheric Boundary Layers” was held during May 21-25, 2018, mid-way through the 3-month Program. The focus of the Conference was closely entwined with that of the long Program, with an agenda designed to inject fresh and relevant subject matter into on-going Program discussions and themes, while providing Conference participants from outside the long Program a taste of what it is like to be a visiting scientist at KITP. Some long-term visitors also used the Conference as an opportunity to touch base in person with collaborators from outside the Program on progress they made while at KITP.

As mentioned in section 3, there were 70 participants, including both senior and junior researchers. There were 20 invited speakers from all over the world. The detailed Conference agenda is appended farther below. Additional details are included in relevant sections above, where objectives and outcomes parallel, or are intertwined with, those of the 3-month Program.

Overall, the conference was scientifically productive, supportive of Program goals and evolving projects, and received very positive feedback from participants.

One unique aspect of this Conference was the incorporation of a special session on issues of diversity and retention in Earth and Planetary sciences, discussed above (where it was most relevant) in sections 3 and 4.

## 8. List of Meetings, Talks, Discussions, and Seminars

### *Program*

<i>Time</i>	<i>Speaker</i>	<i>Title</i>
4/03, 9:30am	Baylor Fox-Kemper (Brown University & KITP) Brad Marston (Brown University & KITP)	<a href="#">Welcome/Orientation[Podcast][Aud][Cam]</a>
4/04 2:00pm	Brad Marston Brown Univ & KITP	<a href="#">Topological Origin of Equatorial Waves[Podcast][Aud][Cam]</a> KITP Colloquium
4/05, 1:30pm	David Ferreira University of Reading & KITP	<a href="#">The oceanic boundary layer in models: our (unfortunate) reliance on parameterizations[Slides][Podcast][Aud][Cam]</a>
4/06, 12:30pm	Leila Carvalho Gert-Jan Duine (UCSB)	<a href="#">Boundary layer processes associated with Sundowner windstorms in the Santa Ynez Mountains, CA (Discussion)[Podcast][Aud][Cam]</a>
4/09, 10:00am	Steff Böing University of Leeds & KITP	<a href="#">LES is More[Slides][Podcast][Aud][Cam]</a>

4/10, 10:00am	Leonel Romero UCSB	<a href="#"><u>Observations and Modeling of Wave-Current Interactions[Slides][Podcast][Aud][Cam]</u></a>
4/11, 10:00am	Greg Chini University of New Hampshire & KITP	<a href="#"><u>Asymptotics Tutorial[Podcast][Aud][Cam]</u></a>
4/12, 1:30pm	Dimitris Menemenlis Jet Propulsion Laboratory & KITP	<a href="#"><u>LLC4320--A Global Simulation of the Ocean at 2km Horizontal Grid Spacing[Slides][Podcast][Aud][Cam]</u></a>
4/13, 12:30pm	Igor Rogachevskii Ben Gurion University of the Negev & KITP	<a href="#"><u>Stably Stratified Atmospheric Boundary Layers[Slides][Podcast][Aud][Cam]</u></a>
4/16 12:15pm	James McWilliams UCLA & KITP	<a href="#"><u>The computability of planetary circulations[Podcast][Aud][Cam]</u></a> KITP Blackboard Lunch
4/17, 10:00am	Baylor Fox-Kemper Brown University & KITP	<a href="#"><u>LES is More at the Mesoscale (Discussion)[Podcast][Aud][Cam]</u></a>
4/18, 10:00am	Greg Chini University of New Hampshire & KITP	<a href="#"><u>Asymptotics Tutorial II[Podcast][Aud][Cam]</u></a>
4/19, 1:30pm	Scott Bachman (National Center for Atmospheric Research) David Ferreira (University of Reading)	<a href="#"><u>Ocean Mesoscale &amp; Submesoscale Eddies Discussion[Podcast][Aud][Cam]</u></a>
4/20, 4:00pm	All Participants	Journal Club
4/23, 10:00am	W.R.C. Phillips Swinburne University & KITP	<a href="#"><u>GLM to CLG (Generalized Lagrangian Mean)[Podcast][Aud][Cam]</u></a>
4/24, 9:30am	Zhiyu Liu Xiamen University & KITP	<a href="#"><u>Measuring (small-scale) Turbulence in the Ocean[Slides][Podcast][Aud][Cam]</u></a>
4/25, 10:00am	Greg Chini University of New Hampshire & KITP	<a href="#"><u>Asymptotically Damping a Shallow Water Wave[Podcast][Aud][Cam]</u></a>
4/26, 1:30pm	Amit Tandon University of Massachusetts Dartmouth & KITP	<a href="#"><u>Boundary Layers in the Bay of Bengal[Slides][Podcast][Aud][Cam]</u></a>
4/27, 12:30pm	Nicolas Grisouard University of Toronto & KITP	<a href="#"><u>Internal Waves[Podcast][Aud][Cam]</u></a>
4/27, 4:00pm	Nick Pizzo et al.	Journal Club

<i>UCSD &amp; KITP</i>		
<i>4/30, 10:00am</i>	<i>Nick Pizzo UCSD/Scripps Institution of Oceanography &amp; KITP</i>	<a href="#"><u><i>Breaking Waves &amp; Mass Transport -- pedagogical talk[Slides][Podcast][Aud][Cam]</i></u></a>
<i>5/01, 9:30am</i>	<i>Tetsu Hara (University of Rhode Island &amp; KITP) Alex Ayet (ENS Paris &amp; KITP)</i>	<a href="#"><u><i>Wind turbulence over surface waves[Podcast][Aud][Cam]</i></u></a>
<i>5/02, 10:00am</i>	<i>Igor Rogachevskii Ben-Gurion University of the Negev &amp; KITP</i>	<a href="#"><u><i>Convection[Slides][Podcast][Aud][Cam]</i></u></a>
<i>5/03, 1:30pm</i>	<i>Joseph LaCasce University of Oslo</i>	<a href="#"><u><i>On baroclinic modes, without and with a mean flow[Podcast][Aud][Cam]</i></u></a>
<i>5/04, 12:30pm</i>	<i>James Brasseur University of Colorado</i>	<a href="#"><u><i>Transition in Atmospheric Boundary Layer Turbulence Structure from Neutral to Moderately Convective Stability States[Podcast][Aud][Cam]</i></u></a>
<i>5/04, 4:00pm</i>	<i>All Participants</i>	<i>Journal Club</i>
<i>5/07, 10:00am</i>	<i>Daniel Lecoanet Princeton University &amp; KITP</i>	<a href="#"><u><i>Convection and Entrainment in Stars -- pedagogical talk[Slides][Podcast][Aud][Cam]</i></u></a>
<i>5/08, 10:00am</i>	<i>Dhruv Balwada (New York University &amp; KITP) Carter Ohlmann (UCSB)</i>	<a href="#"><u><i>Lagrangian Observations[Slides][Podcast][Aud][Cam]</i></u></a>
<i>5/10, 1:30pm</i>	<i>Brandon Reichl Princeton University &amp; KITP</i>	<a href="#"><u><i>Ocean Surface Boundary Layer Parametrizations (for Climate Models)[Podcast][Aud][Cam]</i></u></a>
<i>5/11, 12:30pm</i>	<i>James Brasseur University of Colorado &amp; KITP</i>	<a href="#"><u><i>Nonequilibrium Response of the Daytime Atmospheric Boundary Layer to Forcing at the Mesoscale Best,[Podcast][Aud][Cam]</i></u></a>
<i>5/14, 10:00am</i>	<i>Raffaele Ferrari MIT</i>	<a href="#"><u><i>Ocean Bottom Boundary Layers and Meridional Overturning[Slides][Podcast][Aud][Cam]</i></u></a>
<i>5/15, 10:00am</i>	<i>Fabrice Ardhuin (PDG-ODE-LOPS / PDG- ODE-LOPS-SIAM) James McWilliams (UCLA) Baylor Fox-Kemper (Brown U.)</i>	<a href="#"><u><i>Wave Effects on Currents, Current Effects on Waves[Slides][Podcast][Aud][Cam]</i></u></a>
<i>5/07, 10:00am</i>	<i>Daniel Lecoanet</i>	<a href="#"><u><i>Using Dedalus, a flexible, Python-based, spectral</i></u></a>

	Princeton University & KITP	<a href="#">PDE solver[Podcast][Aud][Cam]</a>
5/16, 10:00am	Stuart Bishop North Carolina State University	<a href="#">The impact of mesoscale eddies on air-sea interaction in the oceanic mixed layer[Podcast][Aud][Cam]</a>
5/17, 1:30pm	Gudrun Magnusdottir UC Irvine & KITP	<a href="#">Changes in mid-latitude atmospheric circulation in ensembles of climate projections: What role Arctic Amplification compared to other processes in a warming climate?[Podcast][Aud][Cam]</a>
5/18, 12:30pm	Jacob Wenegrat Stanford University	<a href="#">Potential Vorticity in Boundary Layers[Slides][Podcast][Aud][Cam]</a>
5/18, 4:00pm	All Participants	BLAYERS Journal Club
5/29, 10:00am	William Anderson UT Dallas	<a href="#">Aeolian Boundary Layers on Earth and Mars[Podcast][Aud][Cam]</a>
5/30, 10:00am	K. Shafer Smith Courant Institute & KITP	<a href="#">Oceanic oxygen and eddy parameterization[Slides][Podcast][Aud][Cam]</a>
5/14 12:15pm	Stephen Belcher UK Meteorological Office & KITP	<a href="#">New Challenges for Climate Science Following the Paris Agreement[Podcast][Aud][Cam]</a> KITP Public Lecture
5/31, 11:00am	Luigi Cavaleri CNR / ISMAR & KITP	<a href="#">Rain on Generative Seas: What Nature Tells Us[Slides][Podcast][Aud][Cam]</a>
6/01, 12:30pm	Marcie Marston (Roger Williams University) Carter Ohlmann (UCSB) Kelvin Richards (U. Hawaii)	<a href="#">Biology in the Oceanic Boundary Layer[Slides][Podcast][Aud][Cam]</a>
6/04, 10:00am	Annick Pouquet NCAR	<a href="#">Turbulence and waves "but how much mixing"?[Slides]</a>
6/05, 10:00am	Kelvin Richards University of Hawaii & KITP	<a href="#">Equatorial Mixing[Slides][Podcast][Aud][Cam]</a>
6/11 12:15pm	Baylor Fox-Kemper Brown & KITP	<a href="#">Boundary Layers are the Boundary between What and What?[Podcast][Aud][Cam]</a> KITP Blackboard Lunch
6/12, 10:00am	Brad Marston (Brown University & KITP) Joe Skitka (Brown University & KITP)	<a href="#">Direct Statistical Simulation of Boundary Layers[Slides][Podcast][Aud][Cam]</a>
6/13, 10:00am	Georgios Matheou U. Connecticut	<a href="#">Large eddy simulation of the atmospheric boundary layer[Slides][Podcast][Aud][Cam]</a>
6/13 6:15pm	Sam Stevenson	<a href="#">Megadrought, Extreme El Niño, and California's</a>

	UCSB	<a href="#"><u>Climate Future[Podcast][Aud][Cam]</u></a> <i>KITP Friends Chalk Talk</i>
6/14, 1:30pm	Greg Chini (University of New Hampshire & KITP) Guillaume Michel (ENS Paris & KITP)	<a href="#"><u>Reduced Modeling of Stably Stratified Shear Flows[Slides][Podcast][Aud][Cam]</u></a>
6/15, 12:30pm	Juan Restrepo Oregon State University & KITP	<a href="#"><u>Nearshore Sticky Waters[Slides][Podcast][Aud][Cam]</u></a>
6/18, 10:00am	Eckart Meiburg UCSB	<a href="#"><u>Dynamics of Gravity and Turbidity Currents[Slides][Podcast][Aud][Cam]</u></a>
6/19, 10:00am	James Cho University of London & KITP	<a href="#"><u>Homotopy Analysis Method Applied to Some Boundary-Layer Problems[Podcast][Aud][Cam]</u></a>
6/20, 10:00am	Leila Carvalho UCSB	<a href="#"><u>Follow-up talk: Results of the SWEX-I observational campaign[Slides][Podcast][Aud][Cam]</u></a>
6/21, 1:30pm	Paul Kushner University of Toronto & KITP	<a href="#"><u>Sea Ice and Snow Influences on Climate[Slides][Podcast][Aud][Cam]</u></a>
6/22, 12:30pm	All Participants	<i>Closing discussion</i>

## Conference Schedule

### Monday, May 21, 2018

	Session: Planetary Circulations & Turbulence, Chair: Baylor Fox-Kemper (Brown U.)	
8:50am	Lars Bildsten (KITP)	<a href="#">Welcome</a> [Podcast][Aud][Cam]
8:55am	Baylor Fox-Kemper (Brown U.)	<a href="#">Introduction: A brief summary of KITP boundary layer program so far</a> [Podcast][Aud][Cam]
9:00am	Peter Sullivan (NCAR / UCAR)	<a href="#">Temperature fronts in stable boundary layers</a> [Slides][Podcast][Aud][Cam]
9:45am	Jim McWilliams (UCLA)	<a href="#">Oceanic boundary layer frontogenesis &amp; wave interactions</a> [Slides][Podcast][Aud][Cam]
10:30am	Morning Break	
11:00am	Keith Julien (CU Boulder)	<a href="#">Investigations of rapidly rotating, stratified &amp; nonhydrostatic flows</a> [Slides][Podcast][Aud][Cam]
11:45am	Leif Thomas (Stanford)	<a href="#">Symmetric Instability (SI)-Turbulence: A Unique Form of BL Turbulence</a> [Slides][Podcast][Aud][Cam]
12:30pm	Lunch Break	
2:00pm	Krista Soderlund (U. Texas)	<a href="#">Convective Dynamics of Icy Ocean Worlds</a> [Slides][Podcast][Aud][Cam]
2:45pm	Yong Hu (LaRC)	<a href="#">Ocean &amp; atmos. BL measurements from existing &amp; future space based lidar</a> [Slides][Podcast][Aud][Cam]
3:30pm	Afternoon Break	
	Session: Ocean Biophysics, Chair: Dimitris Menemenlis (JPL)	
4:00pm	Laure Resplandy (Princeton)	<a href="#">Carbon export in the ocean: gravitational, mixed-layer &amp; subduction pumps</a> [Podcast][Aud][Cam]
4:45pm	Kelvin Richards (IPRC)	<a href="#">The impact of marine viruses in a stirring and mixing environment</a> [Slides][Podcast][Aud][Cam]
5:30pm	SHUTTLE TO BWSCI	

### Tuesday, May 22, 2018

	Session: Clouds & Convection, Chair: Brad Marston (Brown U.)	
9:00am	Chris Bretherton (U. Washington)	<a href="#">Physical processes and pattern formation in cloudy boundary layers</a> [Slides][Podcast][Aud][Cam]
9:45am	Tapio Schneider (Caltech)	<a href="#">Unifying the modeling of BLs,</a>

		<a href="#">convection, clouds &amp; driving it with data[Slides][Podcast][Aud][Cam]</a>
10:30am	Morning Break	
11:00am	Joao Teixeira (JPL)	<a href="#">Subtropical Turbulence and Clouds: From LES to Climate Models[Slides][Podcast][Aud][Cam]</a>
11:45am	Jonathan Mitchell (UCLA)	<a href="#">Stratus and stable layers in the Solar System (boundaries optional)[Slides][Podcast][Aud][Cam]</a>
12:30pm	Lunch Break	
2:00pm	Sergej Zilitinkevich (Helsinki)	<a href="#">Revision of conventional theory of turbulence in essentially stratified flows[Slides][Podcast][Aud][Cam]</a>
	Session: Cryospheric Boundary Layers, Chair: Andy Thompson (Caltech)	
2:45pm	Vernon Squire (U. Otago)	<a href="#">Contemporary Chronicle of Ocean Wave/Sea Ice Interaction Research[Slides]</a>
2:45pm	Dimitris Menemenlis (JPL)	<a href="#">Don't let your PBL scheme be rejected by brine![Slides][Podcast][Aud][Cam]</a>
3:30pm	Afternoon Break	
4:00pm	G. Manucharyan (Caltech)	<a href="#">Submesoscale sea ice-ocean interactions in marginal ice zones[Slides][Podcast][Aud][Cam]</a>
4:45pm	Ian Eisenman (UCSD)	<a href="#">Iceberg dynamics in glacial and modern oceans[Slides][Podcast][Aud][Cam]</a>
5:30pm	RECEPTION	
6:00pm	SPECIAL EVENTS DINNER	
8:00pm	SHUTTLE TO BWSCI	

### Wednesday, May 23, 2018

	Session: Climate Linkages, Chair: Brodie Pearson (Brown U.)	
9:00am	George Philander (Princeton)	<a href="#">The Precarious Present: Is Global Warming Inhibiting an Incipient Ice Age?[Podcast][Aud][Cam]</a>
9:45am	Surendra Adhikari (Caltech)	<a href="#">Solitary Waves of Glacial Mass Loss Detected in Greenland Crustal Motion[Slides][Podcast][Aud][Cam]</a>
10:30am	Morning Break	
11:00am	Paul Kushner (U. Toronto)	<a href="#">Which burners heat up the Arctic atmosphere?[Slides][Podcast][Aud][Cam]</a>
11:45am	Simona Bordoni (Caltech)	<a href="#">Role of BL dynamics in large-scale</a>



[Hadley circulations & convergence zones](#)[\[Slides\]](#)[\[Podcast\]](#)[\[Aud\]](#)[\[Cam\]](#)

12:30pm Lunch Break

2:00pm FREE AFTERNOON \*\*Shuttle Available to BWSCI\*\*

Thursday, May 24, 2018

Session: Interdisciplinary, Chair: Qing LI (Brown U.)

9:00am Wes Patterson (JHU/APL)

[Exploring Europa : Jupiter's Ocean World](#)[\[Podcast\]](#)[\[Aud\]](#)[\[Cam\]](#)

9:45am Frank Bryan (NCAR)

[Mesoscale Air-Sea Interaction](#)[\[Slides\]](#)[\[Podcast\]](#)[\[Aud\]](#)[\[Cam\]](#)

10:30am Morning Break

11:00am Juan Restrepo (OSU)

[Defining a Trend in A Time Series: Can We Tell How Warm it's Getting?](#)[\[Slides\]](#)[\[Podcast\]](#)[\[Aud\]](#)[\[Cam\]](#)

11:45am Hussein Aluie (U. Rochester)

[Energy Pathways & Cascades in both Scale and Space: Ocean Applications](#)[\[Podcast\]](#)[\[Aud\]](#)[\[Cam\]](#)

12:30pm Lunch Break

2:00pm Tom Dunne (UCSB)

[Geophysical aspects of the 2018 Montecito debris flows](#)[\[Slides\]](#)[\[Podcast\]](#)[\[Aud\]](#)[\[Cam\]](#)

2:45pm Afternoon Break

Session: Diversity & Retention in Earth & Planetary Sciences, Chair: D. Halkides (ESR)

3:00pm George Philander (Princeton)

[The Hedgehog and the Fox A Nelson Mandela Perspective on Global Warming](#)[\[Podcast\]](#)[\[Aud\]](#)[\[Cam\]](#)

4:00pm Ashanti Johnson (Cirrus Acad)

[Diversity & retention of underrepresented groups in STEM & Earth Sciences](#)[\[Podcast\]](#)[\[Aud\]](#)[\[Cam\]](#)

5:30pm RECEPTION

6:00pm SPECIAL EVENTS DINNER

8:00pm SHUTTLE TO BWSCI

Friday, May 25, 2018

Session: Ocean Mixing, Chair: Shafer Smith (Courant Institute)

9:00am Andy Thompson (Caltech)

[Evolution & arrest of a turbulent stratified oceanic bottom BL over a slope](#)[\[Slides\]](#)[\[Podcast\]](#)[\[Aud\]](#)[\[Cam\]](#)

9:45am Stephen Belcher (U. Reading)

[The OSMOSIS](#)

		<a href="#">Project[Podcast][Aud][Cam]</a>
10:30am	Morning Break	
11:00am	All Participants	<a href="#">Open Discussion[Podcast][Aud][Cam]</a>
12:30pm	Lunch Break	
2:00pm	CONFERENCE ENDS - SHUTTLE TO BWSCI *Also available to SB Airport and SB Airbus, Goleta location (See Registration Desk BEFORE FRIDAY to sign up.)	

## Participant demographics

In KITP's anonymous survey, 55 participants reported their gender, 7 female and 48 male

48 filled out the demographic survey, reporting race, ethnicity, and disabilities. Of these:

- Two participants, 1 of whom is a US citizen, self-identified as Hispanic or Latino
- One participant identified as Black, 6 as Asian, 2 as more than one race, and 39 as white
- None reported disabilities.

## Program Participants

<b>Participant</b>	<b>Participation Dates</b>
Dr. Katherine Adams (UCSD)	April 30 - May 4
Prof. Hussein Aluie (Rochester)	May 14 - May 25
Dr. William Anderson (UT Dallas)	May 21 - June 1
Dr. Fabrice Ardhuin (IFREMER)	April 30 - May 17
Mr. Alex Ayet (ENS Paris)	April 8 - May 26
Dr. Scott Bachman (Cambridge)	April 16 - 20, May 14 - 18, June 11 - 15
Dr. Dhruv Balwada (NYU)	April 29 - June 2
Prof. Stephen Belcher (UKMET)	May 20 - May 31
Dr. Stuart Bishop (NC State)	May 7 - May 18
Mrs. Abigail Bodner (Brown)	May 19 - June 22
Dr. Steven Böing (Univ. of Leeds)	April 2 - April 20
Dr. James Brasseur (Colorado)	April 23 - May 11
Dr. Frank Bryan (NCAR)	May 7 - June 15
Dr. Leila Carvalho (UCSB)	April 2 - June 22
Dr. Luigi Cavaleri (ISMAR-CNR)	May 21 - June 8
Prof. Gregory Chini (UNH)	April 2 - June 22
Dr. James Cho (QMUL)	May 29 - June 22
Prof. Qinghua Ding (UCSB)	April 2 - June 22
Dr. Edward Doddridge (MIT)	May 14 - May 18
Prof. Raffaele Ferrari (MIT)	May 6 - May 19
Dr. David Ferreira (Univ. of Reading)	April 2 - May 25
Prof. Baylor Fox Kemper (Brown)	April 2 - June 22
Prof. Nicolas Grisouard (Univ. of Toronto)	April 15 - June 22
Dr. Daria Halkides (Earth and Space Research)	May 19 - May 26
Dr. Tetsu Hara (URI)	April 23 - June 22
Dr. Ramsey Harcourt (UW)	May 21 - May 22
Prof. Greg Huber (CZ Biohub)	April 2 - June 22
Ms. Nyla Husain (URI)	May 14 - June 1
Dr. Keith Julien (Colorado)	May 13 - May 24
Prof. Paul Kushner (Univ. of Toronto)	April 29 - June 22
Prof. Joseph Lacasce (Univ. of Oslo)	April 30 - May 4
Prof. Albion Lawrence (Brandeis Univ)	May 29 - June 22
Dr. Daniel Lecoanet (Princeton)	April 23 - May 18
Mr. Qing Li (Brown)	April 30 - May 25
Dr. Zhiyu Liu (Xiamen Univ.)	April 2 - April 27
Prof. Stefan Llewellyn Smith (UCSD)	April 30 - May 4
Dr. Gudrun Magnusdottir (UCI)	April 29 - May 20
Prof. John Marston (Brown)	April 2 - June 30
Dr. Georgios Matheou (JPL)	June 4 - June 15
Prof. James Mc Williams (UCLA)	April 2 - June 22

## Program Participants

<b>Participant</b>	<b>Participation Dates</b>
Prof. Eckart Meiburg (UCSB)	April 2 - June 22
Dr. Dimitris Menemenlis (JPL)	April 2 - May 25
Mr. Guillaume Michel (ENS Paris)	April 2 - June 15
Prof. Jonathan Mitchell (UCLA)	April 2 - June 22
Dr. Francisco Ocampo Torres (CICESE)	June 4 - June 22
Dr. Carter Ohlmann (UCSB)	April 2 - June 22
Prof. William Phillips (Swinburne)	April 16 - May 18
Dr. Nicholas Pizzo (UCSD)	April 2 - May 4
Dr. Annick Pouquet (NCAR)	May 29 - June 9
Dr. Brandon Reichl (Princeton)	April 30 - May 25
Prof. Juan Restrepo (Oregon State)	May 20 - June 23
Prof. Kelvin Richards (Hawaii)	May 14 - June 22
Prof. Igor Rogachevskii (Ben-Gurion Univ.)	April 5 - May 4
Dr. Leonel Romero (UCSB)	April 2 - June 22
Ms. Erica Rosenblum (Scripps Inst. of Oceanograph)	May 2 - June 22
Mr. Xiaozhou Ruan (Caltech)	May 1 - May 3
Dr. Tapio Schneider (Caltech)	April 2 - June 22
Mr. Joe Skitka (Brown)	May 14 - June 22
Prof. K. Shafer Smith (Courant Institute)	May 14 - June 1
Dr. Samantha Stevenson (UCSB)	April 2 - June 22
Dr. Amit Tandon (UMass Dartmouth)	April 16 - May 11
Dr. Andrew Thompson (Caltech)	June 4 - June 22
Prof. Steven Tobias (Univ. of Leeds)	April 2 - April 21
Mrs. Ana Beatriz Villas Boas (UCSD)	April 2 - May 27
Dr. Peng Wang (UCLA)	April 23 - May 12
Dr. Adrean Webb (Kyoto Univ.)	June 11 - June 22
Dr. Jacob Wenegrat (Stanford)	April 30 - May 25