



AOS & CICS Newsletter

Winter 2016

Volume 10, Number 1

Modeling a Living Planet: A Symposium in Honor of Jorge L. Sarmiento

Friends and colleagues of Jorge Sarmiento, the George J. Magee Professor of Geoscience and Geological Engineering, Professor of Geosciences, will convene a symposium in honor of his 70th birthday from March 14-15, 2016. The symposium will be held in the Frick Chemistry Lab/Taylor Auditorium on Main Campus.



George J. Magee Professor of Geoscience and Geological Engineering, Professor of Geosciences Jorge L. Sarmiento

The symposium celebrating the research of Jorge L. Sarmiento, “Modeling a Living Planet,” will highlight Sarmiento’s groundbreaking work in ocean biogeochemistry as well as new research directions inspired by his scientific curiosity. Weaving together ocean circulation, the global carbon cycle, ocean elemental cycling, and ocean biogeography, through the consideration of

the range of physical and temporal scales, the program will cover interactions among the physical, geochemical, and biological aspects of the climate system.

The symposium will open with remarks by longtime collaborator Bob Key, an AOS research oceanographer and Sarmiento’s first postdoc. Anand Gnanadesikan, an associate professor at Johns Hopkins University and a former postdoc of Sarmiento’s, will present an overview of the symposium format. Over the course of the two days, invited talks will provide a broad context for panel discussions and poster sessions that will address five topics related to Sarmiento’s major research interests: Ocean ventilation – From the North Atlantic to the Southern Ocean; Dance of the elements – What chemistry tells us about life on earth; *Life in silico* – How we are doing at modeling changing ocean ecosystems; The breath of life – A changing carbon cycle; and Climate Policy: Impacts and mitigation.

The Symposium will honor Sarmiento’s scientific contributions in these areas as well as his contributions to graduate and postdoctoral education. Valued colleagues will share their expertise, among them former mentor Wally Broecker, Sarmiento’s Ph.D. adviser at Columbia University, former AOS Senior Scientist Kirk Bryan, his postdoc adviser, and Niki Gruber, a former postdoc with whom he coauthored the textbook *Ocean Biogeochemical Cycles* (2006). Sessions will be facilitated by former and current Sarmiento Group members. Presenters will include leading researchers from around the globe, many of whom are former Ph.D. students or postdoctoral researchers who were mentored by him during his more than 35 years on the AOS faculty. A celebratory dinner following the symposium’s first day will be held at Nassau Inn in Princeton.

Program in Atmospheric and Oceanic Sciences (AOS) & The Cooperative Institute for Climate Science (CICS)

Inside this issue:

<i>Symposium in Honor of Jorge Sarmiento.....</i>	<i>1</i>
<i>GFDL Celebrates 60 Years of Excellence.....</i>	<i>2</i>
<i>Winter 2016 Poster Expo.....</i>	<i>2</i>
<i>Workshop Examines Trait-Based Approaches to Ocean Life.....</i>	<i>3</i>
<i>Artistic Tribute to Suki Manabe.....</i>	<i>4</i>
<i>Ronald J. Stouffer Symposium.....</i>	<i>4</i>
<i>Global Team Efforts Results in GLODAPv2.....</i>	<i>5</i>
<i>Persad Brings Science to Underrepresented Youth.....</i>	<i>6</i>
<i>Nereus Workshop Explores Adaptation.....</i>	<i>6</i>
<i>Research in Action.....</i>	<i>7</i>
<i>AOS & CICS News</i>	<i>8</i>

TigerTransit/Shuttle Services
Operating on Spring Schedule:
<http://www.princeton.edu/transportation/troutes/ForrestalSpring2016.pdf>

Sarmiento's research interests include the global carbon cycle, the use of chemical tracers to study ocean circulation, and the impact of climate change on ocean biology and biogeochemistry. Many of his scientific contributions have been on the role of the Southern Ocean in determining the air-sea balance of carbon dioxide during glacial and interglacial climate change, oceanic uptake of anthropogenic carbon and its sensitivity to climate change, and the resupply of nutrients to the upper ocean north of 30°S. He has served as the Director of the Southern Ocean Carbon and Climate Observations and Modeling program (SOCCOM), since the initiative's launch in 2014. In addition to SOCCOM Director, he has held and currently holds various prominent posts. He has served as the Director of the Cooperative Institute for Climate Science (CICS), since its inception in 2003, and served as director of the AOS Program from 1980-1990 and from 2006-2015.

The symposium is presented with support from Princeton University's Office of the Dean of the Faculty, the Department of Geosciences, the AOS Program, and CICS.

Further information about the symposium and registration details can be found at: <http://aos.princeton.edu/jls/>. ■

GFDL Community Celebrates 60 Years of Excellence

Contributed by Maria Setzer, GFDL Communications Director

The Geophysical Fluid Dynamics Laboratory (GFDL) was founded in 1955, when Dwight D. Eisenhower was President of the United States. The first signs of the feasibility of numerical weather prediction began accumulating in the 1950's, in large part the result of work conducted by a group of scientists at the Institute for Advanced Study, of which Joseph Smagorinsky was a young member. It quickly became apparent that the same technique could be used to study climate, or the "general circulation" of the atmosphere. GFDL was established to pursue this goal, initially as part of the U. S. Weather Bureau in Washington D.C., with Joe Smagorinsky as the founding Director.



Ko Barrett, Deputy Director, NOAA's Climate Program Office with AOS Faculty Member Isaac Held at GFDL's 60th Anniversary Symposium

Last November, the GFDL community celebrated the lab's sixtieth anniversary with a two-day scientific symposium. Attended by over 200 researchers, the symposium highlighted the lab's past achievements and current efforts, and featured discussions of what lies on the horizon. GFDL's Director, V. "Ram" Ramaswamy, opened the symposium before introducing a videotaped congratulatory message from NOAA's Administrator, Kathryn Sullivan. Dr. Sullivan praised the lab as a "cornerstone of excellence," chronicling many of the lab's pioneering achievements and how they have benefited society.



Left to Right: Elena Shevliakova (GFDL), Lori Bruhwiler, (NOAA, Earth Systems Research Laboratory), and Anjuli S. Bamzai (National Science Foundation) at GFDL's 60th Anniversary Symposium

Presentations and panel discussions on the first day of the symposium focused on GFDL's scientific legacy, the lab's close and historic partnership with Princeton University, and recognition of former lab directors. The afternoon was punctuated with presentations of current research efforts. The second day featured panels of speakers discussing a future vision for the lab -- strategies for advancing climate modeling, the future of climate change

research at GFDL, how the IPCC might evolve and, with it, the lab's role.

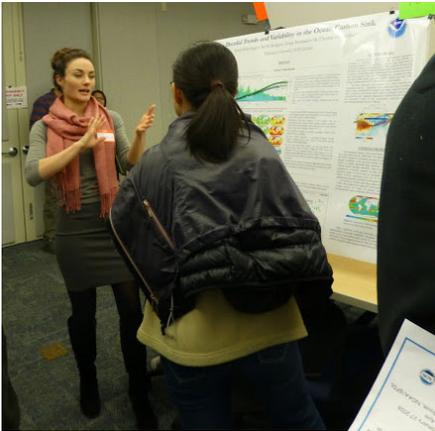
The symposium brought together GFDL and AOS/CICS scientists with colleagues from Princeton University, Yale, MIT, Scripps Institution of Oceanography, University of Miami, University of Wisconsin, University of Washington, University of Arizona, Texas A&M, Imperial College London, National Taiwan University, and many other academic institutions. Scientists from AAAS, NASA, DOE, the U.K. Met Office, NWS, NMFS, and other parts of NOAA also came to the symposium. Many speakers and attendees were GFDL or AOS/CICS alumni. NOAA's Assistant Administrator for Oceanic and Atmospheric Research, Craig McLean, who offered remarks at the start of the symposium, later observed that he found it, "remarkable how so many global experts have spent time purposefully at GFDL during some portion of their careers, and how these current and past residents have defined the state of the science."

This two-day symposium was held November 2nd and 3rd, 2015, at the Taylor Auditorium in Frick Chemistry Laboratory at Princeton University. GFDL moved to Princeton in 1967, and the connection with Princeton University since then has proven to be essential for GFDL. Laboratory scientists have contributed time to graduate education; many leaders in climate research have been trained by GFDL mentors working within the AOS Program. The AOS Program has also facilitated a substantial postdoctoral visitors program that is essential to the laboratory's vitality and recruitment of young scientists. ■

Celebrating the Breadth of GFDL/AOS/CICS Research

The broader GFDL community is distinguished by the breadth and quality of its research. A sampling of this work was on display at the winter 2016 Poster Expo, held on January 27, 2016. This is GFDL's third time hosting the event, previously hosting the Expo in July of 2014 and January of 2015.

The event brought together many of GFDL's local partners – Princeton University (AOS & CICS), UCAR Visiting Scientists, and Engility. Over one half of the Expo's 28 posters were presented by representatives of the AOS Program and CICS, including graduate students, postdoctoral research associates, and research scholars. Collaborators from Columbia University, Emory University, Scripps, South Central Climate Center, and NOAA/NMFS presented their research for the first time since the event's inception.



AOS Graduate Student Sarah Schlunegger discussing her research

The Expo provides a forum for presenters to share their work, discuss research methods and results, participate in an open dialogue about cutting-edge advances in their research field, and build relationships and possible cross-disciplinary collaborations.



AOS Associate Research Scholar Levi Silvers explaining his research to Karen Paffendorf, a software engineer in the Modeling Systems Group at GFDL

Poster presentations spanned a wide array of familiar and emerging topics, including polynyas and Arctic and Antarctic sea ice, aerosols, heat waves, aridity and stream-flows on land, 21st century projections of ocean carbon uptake, and marine ecosystem dynamics.

“We were especially pleased to note that word of the Poster Expo is spreading regionally as we had visitors coming all the way from Philadelphia to attend the event, as well as collaborators from other institutions presenting their work at the Expo for the first time,” said GFDL Physical Scientist Jasmin John, who conceived the event in 2014.

Approximately 50 colleagues from the local community and beyond attended the event, in addition to the 28 presenters, among them GFDL scientists, colleagues from Princeton and Rutgers, and a large delegation from Philadelphia Water.



Associate Research Scholar Jingqiu Mao shares his research with GFDL Director V. Ramaswamy

John was joined on the organizing committee by GFDL Physical Scientist Fanrong Zeng, Cathy Raphael, a GFDL scientific illustrator, and AOS Associate Research Scholar Sulagna Ray. The organizers hope that future events will continue to attract both local and regional presenters and attendees, and aid in fostering interactions and collaborations among colleagues across multiple disciplines. As in past years, feedback from the event will be used to guide the planning of future Poster Expos.

For further details, including a listing of posters presented at the Winter Expo, please visit the GFDL/AOS/CICS Poster Expo webpage:

< <http://www.gfdl.noaa.gov/poster-expo>>.



Workshop Examines Trait-Based Approaches to Ocean Life

The trait-based approach to ocean life is emerging as a novel framework for understanding the complexity, structure, and dynamics of marine ecosystems, but also their broader significance, according to AOS Associate Research Scholar Andrew Barton. “Rather than considering species individually, organisms are characterized by essential traits that capture key aspects of functional diversity.”

At the peak of fall foliage in the White Mountains, nearly 90 scientists, including students, postdoctoral scholars, scientists, program managers, and foundation representatives convened for the “Trait-based Approaches to Ocean Life” Workshop at the Waterville Valley Resort in New Hampshire. Barton co-organized the workshop, held October 5-8, 2015, as a follow-up to a successful first meeting in Copenhagen in August of 2013.

The workshop showcased abundant examples of how the trait-based approach to ocean life provides a powerful framework for understanding the complexity and dynamics of marine ecosystems. Organisms from marine viruses, bacteria, plankton, jellyfish, and fish were represented at the workshop.



Opening Comments by AOS Associate Research Scholar Andrew Barton (Credit: Wilton Burns)

Invited speakers shared recent developments in trait-based science from terrestrial systems, marine fisheries, zooplankton, and molecular ecology. Contributed talks and plenary discussions centered on coherent themes; chief among

these were measuring and detecting traits, biogeography of traits, and linking observations and models. In addition to the plenary program and poster sessions, numerous small group discussions and informal “chalk talks” were held to maximize participant interaction.

Workshop participants covered many disciplines, including theoreticians, numerical modelers, experimentalists, satellite oceanographers, and microbial biologists, with numerous participants spanning multiple disciplines. AOS Associate Research Scholar Colleen Petrik, Colin Kremer, an AOS visiting research collaborator (Yale), Nicolas Van Oostende and Bror Johnson, associate research scholars in Geosciences, EEB Postdoctoral Research Associate George Hagstrom, and Ken Andersen, a visiting fellow in EEB (Technical University of Denmark), were among the participants.



Trait-based Approaches to Ocean Life Workshop Participants (Credit: Wilton Burns)

“I have never attended a workshop where I was more interested and actively engaged in every presentation and group discussion,” Petrik said. “I was astonished by how pervasive trait-based approaches were in lab, field, and modeling studies from viruses all the way up to fishes. Workshops like this one will no doubt lead to highly collaborative and comprehensive research.”

“The workshop encouraged the development of meaningful interactions between modelers, theorists, and scientists making or aggregating fundamental trait observations,” said Barton. “These new lines of communication between methodological perspectives have helped to facilitate the development of a common ‘trait’ language.”

In addition to building a strong interdisciplinary network for scientists

studying trait-based approaches to ocean life, the workshop also highlighted the need for robust investment in making and aggregating individual lab, field, or satellite measured trait observations since such meta-analyses provide a powerful tool to unveil relationships between traits and their environment. The workshop served as an incubator for several review and synthesis papers, according to Barton, and as the impetus for several new data and stewardship efforts, including a global trait database and trait-based model repository and inter-comparison project.

The workshop was sponsored by the Ocean Carbon and Biogeochemistry (OCB) program, the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the Simons Foundation, and the Gordon and Betty Moore Foundation. ■

An Artistic Tribute to Suki Manabe

Giving British post-conceptual artist Liam Gillick carte blanche to create a work of art about climate change in the lead up to the 2015 Paris Climate Change Conference (COP 21) was nothing too out of the ordinary for an artist renowned for his interventions in public spaces. Forty-two panels throughout Paris's Gare du Nord railway station honoring AOS Senior Meteorologist Syukuro (Suki) Manabe and his pioneering contributions to climate science, however, is nothing short of extraordinary.



"The Logical Basis" by Liam Gillick Open to the public-- Nov 27, 2015 - Nov 27, 2016 (Credit: SNCF/David Paquin)

The exhibition, which coincided with COP21 held in Paris November 30 – December 11, 2015, integrates equations from Manabe's single-most cited paper released 48 years ago and easily his most influential. “The artwork took the form of

equations from the paper and written on the walls - an unbelievable yet amazing way to celebrate the pioneering research on global warming and the eminent scientist behind it,” said V. Ramaswamy, director of GFDL.



"The Logical Basis" by Liam Gillick (Credit: Lauren Koellermeier, NOAA)

Initially stunned by the artwork displayed in what is considered to be a central rail hub in Paris, Ramaswamy had to blink a few times to make sure that what was before his eyes was not a figment of his imagination. Luckily for all those who pass through the Paris station, it was not; “The Logical Basis” installation will remain open to the public until November 27, 2016.

Manabe is one of the world's leading scientists in numerical modeling of climate and climate change. For more than five decades he has worked at GFDL, where he pioneered the use of computers to simulate global climate change and natural climate variations. These breakthroughs have helped provide the foundation for the modern science of climatology. ■

The Ronald J. Stouffer Symposium Planned for June

To commemorate Ron Stouffer's distinguished 38-year career at GFDL, a symposium is being planned for June 6, 2016 at GFDL. Considered one of the leading climate modelers in the world, Stouffer, a retired senior research climatologist and group head of the Climate and Ecosystems Group at GFDL, uses complex numerical models to study and predict the behavior of the Earth's climate system.



Ronald J. Stouffer, retired NOAA/
GFDL Physical Scientist

While the agenda is still in the early planning stages, symposium organizers are planning three forward-looking sciences sessions to include scientific talks relating to climate change and community assessments thereof; climate-related talks on regional patterns, variability, sea level rise, and the carbon system; and presentations on additional topics on which Stouffer's career has had a demonstrable impact. The full-day symposium will culminate in a dinner in Stouffer's honor to be held in the Smagorinsky Seminar Room, GFDL.

"Ron has endowed a rich legacy that extends from pioneering research in multiple facets of climate science to Earth System science in recent years," said V. Ramaswamy, director of GFDL.

Stouffer first came to GFDL in 1977 from the Pennsylvania State University where he received both Bachelor's and Master's degrees in Meteorology. During his tenure at GFDL, ending in 2015, he has worked closely with Syukuro (Suki) Manabe, who was the first scientist to develop a numerical model that joined the atmosphere and ocean into a single coupled model to represent the Earth's climate system. Stouffer has published a number of ground-breaking papers and has authored over 120 papers on global climate change. A notable contribution has been his ongoing leadership of both model development within GFDL and community synthesis efforts through the Coupled Model Intercomparison Project (CMIP) and the Intergovernmental Panel on Climate Change (IPCC).

In addition to his responsibilities as IPCC chapter author, Stouffer is a member and chair of the World Climate Research

Program (WCRP) Coupled Model Intercomparison Panel (CMIP), an editor of the journal, *Climate Dynamics*, and has received a number of awards, including the WMO Norbert Gerbier-Mumm International Award (1999), the NOAA Administrator's Award (1996, 2008), the Department of Commerce Gold (2002), Silver (2005) and Bronze (2007) medals, and five NOAA Distinguished Authorship Awards. He is a fellow of the American Geophysical Union and the American Meteorological Society and also a Pennsylvania State University Alumni Fellow.

Further details about the symposium can be found at the following website, which will be continually updated as additional information becomes available: http://www.gfdl.noaa.gov/earth_system_science_stouffer_symposium. ■

Global Team Effort Results in GLODAPv2

Over the past decade, the science community has witnessed the completion and publication of several ocean carbon data synthesis products. These products are useful for quantifying the flux and inventory of oceanic CO₂ and its sensitivity to climate change. None of the previous efforts have, however, produced a fully unified global data product.



The newly released GLODAPv2 (*Global Ocean Data Analysis Project version 2*) contains the most comprehensive and rigorously quality controlled ocean interior data product for marine biogeochemistry studies. According to AOS Research Oceanographer and GLODAPv2 team member Bob Key, the main goal of GLODAPv2 was to create a single high-quality internally consistent global data product containing CO₂-relevant ocean interior measurements from ship-based surveys.

The undertaking includes data from 724 scientific cruises that had measurements of

inorganic carbon and/or other carbon relevant parameters, covering the global ocean between 1972 and 2013. Twelve core parameters (salinity, oxygen, macronutrients, seawater CO₂ chemistry parameters and halogenated transient tracers) have been subjected to extensive quality control, including systematic evaluation of biases between cruises. Highlighting the comprehensive nature of GLODAPv2, Key noted that the product includes data from approximately one million individual seawater samples. Included in GLODAPv2 are data assembled from the original GLODAP, data from CARINA (CARbon IN the Atlantic), and PACIFICA (PACIFIC ocean Interior Carbon), and data from an additional 168 cruises. This new version is not a simple merge of previous collections and some new data, but represents a completely recalibrated data product that is internally consistent with respect to measurement bias.

A major update of the original GLODAP, GLODAPv2 consists of three elements: (i) a data base with original cruise data, as submitted by individual data providers but updated to WOCE Exchange format, (ii) a merged data product, with measurement biases removed for key biogeochemical variables, and (iii) a mapped climatology of (ii) consisting of global 3D fields of the seawater distribution of CO₂ chemistry and other parameters. Key and his collaborators suggest that analysis of GLODAPv2 parameters will allow for quantitative assessment of biogeochemical changes and feedbacks between climate change and the ocean system. Future updates of GLODAPv2 are expected on shorter time intervals than previously, however, these intermediate updates will be expansions obtained by calibrating new data to GLODAPv2. When sufficient new data have been obtained, a new global recalibration will be executed.

GLODAPv2 is the result of a multi-year global team effort funded by EU-IP CARBOCHANGE, US NASA, the SCOR-IOC International Ocean Carbon Coordination Project (IOCCP) and many other projects, programs and organizations. The GLODAPv2 database is freely accessible and available at:

<http://cdiac.ornl.gov/oceans/GLODAPv2/>. ■

Persad Brings Science to Underrepresented Youth

AOS Graduate Student Geeta Persad cannot contain her passion and enthusiasm for science – and that’s a good thing for a group of California high school students. On February 9, 2016, Persad’s excitement about science led her to San Francisco, where she ran a workshop as part of the California Academy of Science’s Careers in Sciences (CiS) Intern Program, a multiyear, year-round science internship and youth development program for young people from groups typically underrepresented in the sciences.

Persad led an hour and a half long workshop in which she taught 9th-12th grade students about climate modeling and aerosols, in addition to talking about what her day-to-day work is like as a climate scientist. She also taught them about the science of the El Niño Southern Oscillation. The students then participated in a group exercise where they plotted the time series of Pacific sea surface temperature anomalies and, based on that, presented their thoughts on ENSO variability and predictability, not a typical activity for students who may not previously have envisioned themselves as scientists.



AOS Graduate Student Geeta Persad discussing the Ph.D. process with two CiS participants (Credit: Cal Academy)

“The workshop was amazingly fun and such an excellent reinforcement of why I went into climate science,” Persad said. “The students were really engaged and asked lots of questions.” Some of the

questions, such as – “Is El Niño bad or good?” – may seem rather simple on the surface; however, in Persad’s view, they are “interesting manifestations of the way we talk about climate phenomena.”

Not one to dismiss any form of scientific inquiry, when one student asked whether climate models could be used to study what would happen with climate change if population collapsed due to a zombie apocalypse, Persad told him that, as far as she knew, that scenario had not yet been studied, but potentially could be, with the help of an integrated assessment model. “He seemed interested in being the first person to pursue that line of research,” Persad added.

This was not the first visit to the Cal Academy for Persad. In October of 2015, she participated as an Expert Scientist in the Climate Game Jam held at the Academy. Despite her busy schedule in preparation for her Ph.D. defense in May, Persad jumps at chances like these to get kids excited about science. After all, nothing is as contagious as sheer enthusiasm.

Created in 1996, the Careers in Science (CiS) Intern Program provides San Francisco youth from communities traditionally underrepresented in STEM (Science Technology Engineering Mathematics) fields with opportunities to immerse themselves in the sciences. CiS provides hands-on science and youth development experiences at the Academy and outdoors, while also exposing interns to professional role models and mentors who are leaders in their disciplines. ■

Nereus Workshop Explores Adaptation

In early December, concern surrounding adaptation to global change in ocean and fisheries brought together a group of international cross-disciplinary experts from the Nereus program, a program launched in 2010 to further our knowledge of how best to attain sustainability for our world’s oceans. The meeting was held on the Forrester Campus December 3-5, 2016.

Along with their institutional partners, representatives from Princeton University

came together to discuss the current state of knowledge on adaptation in oceans and fisheries to climate changes, to identify research gaps in our understanding of adaptation with respect to future oceans and fisheries, to explore the types of biophysical and social adaptations that are important to consider and model, and to develop a research framework to incorporate adaptation into global ocean, marine biogeochemistry and ecosystem, and fisheries models.

Nereus Fellows Rebecca Asch, Natasha Henschke, and Colleen Petrik were joined by Nereus PI Jorge Sarmiento, the George J. Magee Professor of Geoscience and Geological Engineering, Professor of Geosciences, Charlie Stock, a GFDL research oceanographer, AOS Visiting Research Collaborator Colin Kremer, James Watson, a former Nereus fellow, former AOS Research Associate Eric Galbraith, and other global experts affiliated with the Nereus program to engage in constructive conversations regarding adaptation to global change.

In a series of 10-minute talks, Asch, Petrik, and Henschke focused respectively on the biophysical adaptations of phenology, zooplankton and fishes, and gelatinous zooplankton. Stock discussed expected oceanographic changes in relation to adaptation, and Kremer described the biophysical adaptations of phytoplankton. Galbraith’s invited talk highlighted technological progress – what is considered by many to be the main driver of change in the global fishery, and a critical consideration for future adaptation as continued progress at the current rate is expected to lead to the depletion of many fish stocks. Watson described a few different coupled natural-human systems, with emphasis on how fishermen adaptations to changing fish locations and abundances to maximize profit short-term may be maladaptations for the long-term health of the ecosystem.

Throughout the workshop, participants found common points of discussion and highlighted the challenges in addressing ocean/fisheries adaptation. They hope to build on and complement these efforts by creating a strategic plan for studying adaptation further in the context of Nereus research and by framing synthesis papers on adaptation to global change in oceans and fisheries.

“The workshop touched on all aspects relevant to fishery adaptations to climate change, including climate, plankton, fishes, fishery management, and ocean law,” said Petrik. “Despite such a broad range of topics, the workshop fostered many productive discussions that concluded with the development of a single research framework for approaching adaptation in natural and social systems. This framework centers on identifying the drivers, constraints, objectives, mechanisms, and outcomes of adaptation for each system of interest. The natural system outcomes act as constraints on the social system, thereby coupling the two frameworks. We consider the development of this overarching framework as a significant contribution from the workshop, which will serve as a springboard for the second Nereus Report as well as future research and publications.”

The Nereus Program is a global interdisciplinary initiative between the Nippon Foundation and the University of British Columbia. In addition to the Nippon Foundation and UBC, the Program is comprised of several other partner institutions, including the University of Cambridge, Duke University, Princeton University, Stockholm University, United Nations Environment Programme-World Conservation Monitoring Centre, and Utrecht University. The Program is built around three core objectives: to conduct collaborative ocean research across the natural and social sciences, to develop a network of experts that can engage in discussion of complex and multifaceted questions of ocean sustainability, and to transfer these ideas to practical solutions in global policy forums. ■

AOS & CICS

Research in Action

[This column is intended to focus on AOS & CICS research accomplishments and milestones, past, present, and future. In this issue, we highlight the accomplishments of AOS Postdoctoral Research Associate Ben Mater who spent nearly one and a half years in the AOS Program.]

Ben Mater joined the AOS Program in August 2014 as a postdoctoral research associate to study internal wave-driven mixing in the ocean. Working with Bob

Hallberg, Sonya Legg, and others in GFDL’s Ocean Group, Ben focused on how to represent the ocean’s internal gravity waves – a relatively small-scale phenomenon – in relatively low resolution global climate models.



Former AOS Postdoctoral Research Associate Ben Mater

In particular, Ben focused on internal waves generated by tidal flow over topography that can propagate thousands of kilometers across ocean basins before breaking into turbulent mixing – the so called internal tides. “Internal tides are particularly important to climate dynamics because they provide roughly half the energy required to drive the ocean’s overturning circulation,” Mater explains.

Ben is a member of a Climate Process Team (CPT) which brings together world experts of theoretical, observation, and modeling backgrounds to study this very important process. “It has been a very exciting project to work on because of how relevant internal tide-driven mixing is to the climate,” said Mater. “Moreover, it has been extremely rewarding to draw upon the knowledge of all of these great scientists of the CPT and at GFDL and Princeton to develop a parameterization that’s actually going to be used in a climate model!”

Ben’s parameterization, currently implemented in GFDL’s MOM6 ocean model, predicts where internal tides are generated, where they propagate, and where they might be breaking into turbulent mixing. “The scheme is based on the classic ideas of ‘ray tracing’ that have been used in the surface wave community for years, but never before in the context of internal waves in a climate model,” Mater said. “It will serve as a framework that can be adapted as we learn more about the internal tide.”

Ben’s work on internal waves in the ocean is the latest edition to his varied work in

the field of environmental fluid mechanics. Prior to coming to Princeton, Ben received a Masters of Engineering from the University of Louisville with a focus on river restoration and headwater streams impacted by coal mining. After working as a research engineer in the headwaters and wetlands of Kentucky for four years, Ben went west to study fluid mechanics and small-scale turbulence at Colorado State where he received his Ph.D. in Civil and Environmental Engineering. After finishing his Ph.D. and returning from a chance oceanographic cruise in the Bay of Bengal, Ben found himself headed to Princeton. “When I first came to Princeton, I sometimes felt like an engineer masquerading as an oceanographer, but when it comes down to it, it’s all just fluid mechanics, and I’ve greatly extended my repertoire during my time here,” explained Mater. “I am very grateful to have been given the opportunity to join such a great research community. I am especially grateful for all the great connections I’ve developed with my fellow postdocs.”

“Ben did a great job of systematically pulling together information about internal wave propagation and breaking and synthesizing it into a framework that should be both robust and extensible,” said Hallberg. “Ben’s work represents a significant advance in our efforts to replace empirical parameterizations of ocean mixing in our climate models with physically based representations.”

Hallberg noted that ocean mixing is important for the climate system’s response to forcing changes, and a physically based approach is essential if scientists are to accurately project how the climate system will operate in regimes that (by definition) they have never before had the chance to observe.

“On a more personal level, Ben was a great colleague to work with, and we will all miss having him just down the hall,” Hallberg added.

After working with AOS/GFDL for nearly a year and a half, Ben headed back to Colorado where he accepted a senior engineering position in the field of computational fluid dynamics with Alden Research Laboratories. In his new position, he will be tackling an array of flow-related problems related to fish passage, sediment transport, thermal plumes, river stability, and nuclear reactors

– to name a few. In his free time he will be enjoying the mountains with his wife, Lindsey, and his dog, Wendell. ■

AOS & CICS News

Congratulations to **He Wang** who successfully defended his Ph.D. Thesis “Large Scale Impacts of Subarctic Channel Flows and Deep Water Formation in Climate Models” on January 5, 2016.

[Climate Change Triggering Changes in Marine Phytoplankton Communities](#)

A new study led by AOS Associate Research Scholar **Andrew Barton** suggests that climate change is triggering changes in marine phytoplankton communities that could have a long-term effect on marine food webs. 87 different species of marine phytoplankton found in the North Atlantic were studied, comparing the organisms' mean historical (1951-2000) and projected future ranges (2051-2100). Most marine phytoplankton are projected to move poleward as climate changes, and the shifts may be driven by changes in mixed layer depth, temperature, salinity, light, and nutrients. The [findings](#) appear in the *Proceedings of the National Academy of Sciences (PNAS)*.

[Managing Marine Resources Using Climate Predictions](#)

A recent [NOAA news release](#) showcases the seasonal to decadal prediction project led by AOS Associate Research Scholar **Desiree Tommasi, Charlie Stock**, a GFDL research oceanographer, and AOS Faculty Member **Gabe Vecchi**, in collaboration with scientists from across NOAA. The topic was the focus of a multi-day workshop, held in Princeton, in June of 2015.

[Food for Thought: Building Confidence in Projections of the Responses of Marine Resources to Climate Change](#)

To improve our understanding of future changes in living marine resources (LMRs) and the resulting risk of impacts to ecosystems and societies under changing

ocean conditions, the authors of a new [study](#), published recently in the *ICES Journal of Marine Science*, synthesize knowledge of how to address different sources of uncertainty by drawing from climate model intercomparison efforts. The study was led by William Cheung (Nereus Program/UBC) and coauthored by **Thomas Frolicher**, a former AOS postdoctoral research fellow, AOS Postdoctoral Research Associate **Rebecca Asch, Malin Pinsky**, a visiting research collaborator (EEB), AOS Research Scholar **Keith Rodgers, Ryan Rykaczewski**, a former AOS associate research scholar, AOS Faculty Member **Jorge Sarmiento**, GFDL Research Oceanographer **Charlie Stock**, a former AOS associate research scholar, former AOS Postdoctoral Research Associate **James Watson**, et al.



Highwire Earth is a new student-initiated blog at Princeton University focused on sustainable development. AOS Graduate Student **Jane Baldwin** recently wrote an article for the newly launched blog:

<https://medium.com/highwire-earth/a-precious-puzzle-of-expanding-deserts-cb3e93b19ef8#.x0oz428zb>.

[Princeton Research Day](#)

This spring, a new event will be held to celebrate the research and creative endeavors by Princeton undergraduates, graduate students and postdoctoral researchers. **Princeton Research Day** will feature talks, posters, performances, art exhibitions and digital presentations from students and postdocs across the disciplines. The event will be held May 5, 2016 from 1 p.m. to 5 p.m. at Frist Campus Center.

To learn more, visit the PRD16 web site at: <http://researchday.princeton.edu>.

[PEI-STEP Fellowship 2016 Information Session - March 3, 2016](#)

Lunchtime Q&A Session. This two-year program enables participating graduate students to explore the environmental policy dimensions of their doctoral

research. To attend, email RSVP to Angela Petsis: apetsis@princeton.edu by March 4th, 2016.

[Enhanced Warming of the Northwest Atlantic Ocean under Climate Change](#)

Enhanced warming of the Northwest Atlantic Ocean under climate change is among the findings from a new [paper](#), led by AOS Visiting Research Collaborator **Vince Saba**, published January 8 in the *Journal of Geophysical Research*. The CO₂ doubling response from CM2.6 shows that upper-ocean temperature in the Northwest Atlantic Shelf warms at a rate nearly twice as fast as the coarser models and nearly three times faster than the global average. AOS Faculty Members **Steve Griffies, Tom Delworth, Gabe Vecchi**, and **Rong Zhang** are among the study's coauthors.

[DCMIP-2016 Workshop](#)

The third quadrennial workshop and summer school for the Dynamical Core Model Intercomparison Project will take place this summer at NCAR. This is an opportunity for young scientists interested in global dynamical cores, physics-dynamics coupling, or broad issues in the development of global weather and climate models to learn more about how the dynamics are formulated and how the solvers are designed. It also presents an opportunity to learn different philosophies in numerical model design, as well as to get excellent hands-on familiarity with a real dynamical core and its test cases. Applications from postdocs and graduate students are being accepted until March 14th. Travel funding is available. For more information, see the website at: <https://www2.cisl.ucar.edu/events/summer-school/dcmip/2016/dcmip-2016>.

AOS Graduate Student **Jaya Khanna** talks about her latest work on deforestation on the official blog of the American Geophysical Union:

<https://blogs.agu.org/geospace/2015/12/18/rainforests-not-so-rainy-cutting-trees-cuts-rainfall/>.

Mark your calendar for a conference that will span the scope of CLIVAR science under the main theme of "**Charting the Course of Climate and Ocean Research**" on September 18-25, 2016 in Qingdao, China. Abstracts for the main conference and the Early Career Scientist Symposium, poster clusters, and travel grants are due March 15. Town hall proposals should be submitted by June 15.

For more information, visit:
<<http://www.clivar2016.org>>.

Alumni News

Gang Chen, a former AOS graduate student, has accepted a position as an associate professor in the Department of Atmospheric and Oceanic Sciences at UCLA, effective January 2016. He was previously an assistant professor in the department of Earth and Atmospheric Sciences at Cornell University. Gang earned his Ph.D. degree in August 2007 under the mentorship of **Isaac Held**.

Former AOS Graduate Student **Eric Staehling** is the author of a recent paper published in *The Science Teacher*, a peer-reviewed practitioner journal published by the National Science Teachers Association. The paper describes a lesson on the greenhouse effect in which high school students explore blackbody radiation and Wien's law using probeware and online simulations, a departure from many tabletop experiments currently implemented in classrooms (to demonstrate the greenhouse effect) that do not actually model the intended phenomenon.

<http://www.nsta.org/store/product_detail.aspx?id=10.2505/4/tst15_082_09_50>.

Arrivals

Jie He arrived in November from the Rosenstiel School of Marine and Atmospheric Science, University of Miami. He is working with Gabe Vecchi as a postdoctoral research associate.

Michael Wolovick, a postdoctoral research associate, began working with Olga Sergienko in early January. Michael comes to us from the Lamont-Doherty Earth Observatory, Columbia University.

Marjolein van Huijgevoort arrived in mid-February from the University of Aberdeen, Scotland. She is working with Chris Milly and Elena Shevliakova as a postdoctoral research associate.

Alexandra Jones, a postdoctoral research associate, began working with David Paynter and V. Ramaswamy in mid-February. Alexandra comes to us from the University of Illinois.

Brandon Reichl will arrive in early March from the University of Rhode Island. He will be working with Steve Griffies and Elena Shevliakova as a postdoctoral research associate.

Lakshmi Krishnamurthy will arrive in early March from UCAR/GFDL. She will be working with Gabe Vecchi as an associate professional specialist.

Kieran Bhatia will arrive in March from the Rosenstiel School of Marine and Atmospheric Science, University of Miami. He will be working with Gabe Vecchi and Tom Knutson as a postdoctoral research associate.

Departures

After a long and distinguished career at Princeton and GFDL, AOS Senior Meteorologist **Kirk Bryan** relocated to Montana with his wife, Harriet.

In December, we said goodbye to AOS Postdoc **Ben Mater**. Ben accepted a Senior Computational Fluid Dynamics (CFD) Engineer position at Alden Research Laboratories in Colorado.

AOS Associate Research Scholar **Martin Jucker** has accepted a research fellow position at the University of Melbourne. He will be leaving the AOS Program in mid-March.

Birth Announcements

Congratulations to **Adele Morrison**, an AOS postdoctoral research associate, and her husband, Morgan, on the birth of their son, Griffin Arthur, on November 8, 2015.

Congratulations to **Wei Zhang**, an AOS visiting associate research scholar, and his wife, Min, on the birth of their daughter, Amy, on December 13, 2015.

Congratulations to **Andrew Barton**, an AOS associate research scholar, and his wife, Georgia, on the birth of their daughter, Evelyn Iris, on December 22, 2015.

*AOS Program
Princeton University
300 Forrestal Road, Sayre Hall
Princeton, NJ 08540*

*Phone:
(609) 258-6047*

*Fax:
(609) 258-2850*

*We're on the Web!
<<http://www.princeton.edu/aos/>>*

*Editor: Joanne Curcio
Email: jcurcio@princeton.edu*