



AOS & CICS Newsletter

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AOS Welcomes Professor Gabriel Vecchi and Assistant Professor Laure Resplandy

The AOS Program extends a warm welcome to Gabriel Vecchi and Laure Resplandy who joined our faculty in March.



Professor Gabriel Vecchi

Vecchi, a professor of Geosciences and PEI and a familiar face on the Forrestal Campus as the former head of the climate variation and predictability group at GFDL, includes climate science; extreme weather events; mechanisms of precipitation variability and change, with an emphasis on El Niño; ocean-atmosphere interaction; and detection and attribution among his many research interests. He is also involved in improving the science of predicting regional climate impacts, concentrating on hurricanes and extreme rainfall events.

Since information on extreme weather, such as hurricane activity, at a regional scale is of substantially greater societal

value than is a focus on large-scale or basin-wide measures of activity, Vecchi is also working to refine understanding to better describe small-scale impacts and to capture the effects of flooding and storm surge.



Assistant Professor Laure Resplandy

An assistant professor with a joint appointment in Geosciences and PEI, Resplandy, a biogeochemical oceanographer, brings a strong background in physical oceanography and climate science to the AOS Program. Her research focuses on understanding how climate and ocean physics influence marine biogeochemistry and ecosystems and how these changes can impact the climate.

Her research will examine three themes: how the variability from global scale down to small spatial scales influences environmental factors like CO₂, O₂, and pH in the ocean; how past, present, and future regional changes influence the global ocean and climate; and how these changes impact ecosystems. Resplandy's approach is to design and develop numerical models (from ocean regions to global climate system) and statistical tools to interpret in-situ and satellite observations.

“Both Gabe and Laure will be tremendous assets to the AOS Program and its students; we are fortunate to have such an accomplished pair joining our faculty,” said AOS Director Stephan Fueglistaler.

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

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TigerTransit/Shuttle Services
Operating on Summer Schedule:
<http://www.princeton.edu/transportation/routes/ForrestalS17.pdf>

Vecchi holds a Ph.D. in physical oceanography from the University of Washington and has been a lecturer at both Princeton and Rutgers University.

Prior to coming to Princeton, Resplandy was a postdoctoral researcher at Scripps Institution of Oceanography at the University of California at San Diego. She earned her Ph.D. in oceanography at the University of Paris-Sorbonne. ■

Climate Engineering Workshop Planned for August

Climate engineering will be the topic of the fifth annual AOS Program Workshop, generously supported by AOS Faculty Member Isaac Held's BBVA Foundation Award, scheduled from August 28 – 30, 2017 at GFDL. The yearly workshop aims to broaden the knowledge of the members of the AOS community to diverse fields in climate science and its related disciplines, with invited speakers as rising scientists in their field, and to foster discussion between the graduate students and invited speakers on emerging research areas.

This summer's workshop will specifically focus on the use of models to develop, test and understand how climate engineering, on regional to global scales - in the atmosphere and the ocean - could potentially offset negative consequences of anthropogenic climate change. Workshop organizers, including AOS Graduate Students Jenny Chang, Shawn Cheeks, Aaron Match and Sarah Schlunegger, hope to address the issue of what we know (state-of-the-science), what we do not know yet, and what are the unknowables.

Confirmed invited speakers for the three-day event include: Simone Tilmes, NCAR; Peter Irvine, Harvard University; and David Koweeck, Carnegie Institution for Science. Tilmes' scientific interests cover the understanding and evaluation of chemical, aerosol and dynamical processes in chemistry-climate models. Irvine conducts research on the climate and broader impacts of solar geoengineering and works to put those findings into perspective with the risks posed by climate

change. Using tools from chemistry, biology, physics and math to conduct his research, Koweeck studies coastal ecosystems, including coral reefs, kelp forests, and seagrass meadows to understand how to manage, protect and restore these critically important places for coastal communities.

Similar to last summer's workshop, the workshop is structured so that each of the invited speakers presents a plenary lecture to the GFDL/AOS community, leads two student-directed tutorial sessions on a specific aspect of climate engineering, and leads three small group discussion sessions with graduate students and postdocs. There will also be one student-led session on each of the three days and numerous opportunities for casual interaction among the speakers and AOS students, postdocs and faculty.

"We are very excited for this year's summer workshop," Cheeks said. "Our aim with climate engineering as a topic was to provide discussions that bring a different perspective to familiar concepts. The speakers' expertise touch on many of the topics actively studied in AOS and GFDL, so there should be something for everyone."

Open to the entire GFDL/AOS community, the public seminars will be held in GFDL's Smagorinsky Room on each day of the workshop and posted on GFDL's website. The agenda and logistical details will be finalized in the coming weeks. Questions related to the Workshop may be directed to the Committee. ■

Griffies and Legg: A "DynOPO" Duo

For eight weeks this spring (southern hemisphere autumn), the British *Royal Research Ship (RRS) James Clark Ross*, became home to AOS Faculty Members Stephen Griffies and Sonya Legg as they made their way from Punta Arenas, Chile, to the Orkney Passage portion of the Southern Ocean. The cruise was part of the Dynamics of the Orkney Passage Outflow (DynOPO) project, a collaboration between the British Antarctic Survey (BAS), the University of Southampton and the National Oceanography Centre (NOC) (funded by the UK Natural Environment Research Center), and Woods Hole

Oceanographic Institution and Princeton University (funded by the National Science Foundation).



RRS James Clark Ross steaming south in calm seas

DynOPO aims to investigate the flow of Antarctic Bottom Water (AABW) into the Atlantic Ocean through the Orkney Passage, a submarine valley that connects the Atlantic Ocean to the Weddell Sea and allows the movement of abyssal water masses. Griffies was invited to participate on the cruise in his capacity as an ocean modeler and theorist with experience and interests in Southern Ocean science. Legg is one of the DynOPO principal investigators, focusing on numerical modeling of the dense flow over topography in this region. On the cruise, she spent some time using model output to help plan the observations, and comparing model output with observational sections, although rough seas and 50-60 knot winds near the end of the cruise made computer work difficult.

"At one point, a few of us rolled off chairs, falling flat, only to rise again as if nothing much had happened," Griffies posted in a blog documenting his experiences. "It is amazing how a new norm can be defined among the chaos of a pitching and rolling ship."



RRS James Clark Ross encounters rough seas

“Our first major science task on the cruise was to deploy a mooring for Kurt Polzin from Woods Hole,” Griffies said. “Mooring offers us an array of data with a relatively small amount of invested people-time. They are the bread and butter of long-term observational oceanography and climate science. Their time series capture the many time scales of ocean phenomena, from the seconds of random turbulent fluctuations, the hours of tidal motions, the seasonal fluctuations of currents, the interannual variations from the Southern Annular Mode and El Niño / Southern Oscillation, and the decadal and longer time scales of climate change.” The mooring deployment/recovery was in the realm of the experienced technicians, according to Griffies, since it was more physically and technically challenging than some of the other tasks and required a great deal of experience on the deck next to rolling high seas.

The science party also concentrated on around-the-clock CTD (conductivity-temperature-depth) operations. “The CTD, which measures conductivity (to deduce salinity), temperature and pressure from surface to bottom as it is lowered and raised on a wire from the ship, was used continuously as the ship moved slowly along a line (a “tow-yo”), to allow us to see the fine spatial scales of the fluid motions near the underwater sills and ridges,” Legg explained. “The tow-yo CTDs have revealed some intriguing oceanographic features that will undoubtedly occupy brain cells for years to come,” said Griffies.



Sonya Legg preparing the CTD rosette for its next deployment

As leader of the night watch (midnight to 8am), Legg assigned tasks, in addition to communicating with ship officers on the bridge about night watch observations consisting of CTD profiles as well as a Vertical Microstructure Profiler (VMP), which measures turbulence levels down to the ocean’s bottom, at most stations.

“Doing the night watch is like trying to adjust to a new time zone (about 8 hours jet lag), but without the change in daylight hours to help you,” Legg noted. The ship also spends more time in transit during the night and weather can be more problematic, making instrument recovery difficult. Some downtime is spent analyzing the newly obtained data. This preliminary data analysis motivates refinements to the measurements taken on the remaining days of the cruise.



Stephen Griffies on deck with a VMP

“We have sometimes used the time when we’re unable to make oceanographic measurements due to weather, to better map the bottom topography,” said Legg. “On one occasion our new topography data led us to move a planned CTD station into a more interesting location, and at this ‘rogue station’ at the deepest point of a ridge, we found strong flows and very cold bottom water.”

Both Griffies and Legg participated in CTD-related work. Unlike Legg’s, Griffies’ work took place during what he described as the “civilized” shift, from 8am to 4pm. By the expedition’s end, science measurements of the deep ocean were completed at 120 stations in roughly seven weeks. “The CTD cast numbered 120, taken to more than 5000 meters, was our final ocean measurement for the cruise,” Griffies noted. “That happened on 1 May to the west of Coronation Island in the South Scotia Sea.”



Stephen Griffies with Coronation Island in the background

The team of researchers also used an ADCP (acoustic doppler current profiler) to measure current velocities, in addition to specialized instruments for measuring temperature variance. There were also a total of four Argo floats deployed during the cruise, which added to the nearly 4000 such floats around the planet. Argo floats record basic properties of the ocean such as temperature, salinity, pressure, from the surface to 2000m depth.



Stephen Griffies and Sonya Legg next to “Princeton” Argo Float just prior to deployment in the Weddell Sea

Throughout the expedition, the researchers used a combination of instruments deployed from the ship, instruments moored to the seafloor, as well as measurements made by Boaty McBoatface, an autonomous underwater vehicle (AUV). The submersible explored the Antarctic Bottom Water zones in water that has been measured among the coldest and deepest places on the planet. Its overall mission was to study the effects of climate change in the Antarctic, taking water flow and underwater turbulence data from the Orkney Passage at depths up to 3,500 meters. Scientific moorings anchored in the area already gather some data, but the sub’s mobility and autonomy means it can now build a full, three-dimensional picture of what’s happening many hundreds to thousands of meters below the surface.



Boaty McBoatface makes a splash.

“The data from Boaty are unlike most other oceanographic datasets,” noted Griffies. “Rather than moorings (which offer time series at a fixed point in X-Y-Z) or CTDs/VMPs (which provide vertical profiles at a fixed location in X-Y), the AUV retrieves properties along its moving position roughly 100m off the bottom. For the DynOPO project, which is focused on the deep overflow waters through Orkney Passage, the data offer us a hugely valuable and unique perspective on dynamics in this region of the deep ocean.”

The abyssal waters of the world ocean have been warming steadily over the last few decades, according to Professor Alberto Naveira Garabato from the University of Southampton, the lead scientist of the research cruise. “Establishing the causes of this warming is important because the warming plays an important role in moderating the ongoing (and likely future) increases in atmospheric temperature and sea level around the globe,” said in a University of Southampton press release just prior to the cruise.



Sonya Legg in "iceberg alley" (south of the Orkney Islands)

From the perspectives of Legg and Griffies, the DynOPO expedition not only accomplished what it set out to do in terms of mapping the undersea currents that play a critical role in regulating our planet’s climate, but also was transformative for many of the scientists aboard the ship.

“This cruise has been an eye opener for me intellectually, exposing my science to new ways of thinking and doing,” said Griffies. “I have been like a kid in a candy store.”

“The cruise gave me new respect for the challenges of observing the deep ocean at remote high-latitude locations, and for the technicians and ship’s crew who tackle these challenges head on,” Legg said. “Experiencing icebergs and whales close-up were the non-scientific rewards for a long trip away from home on rough seas.”

“My exposure to unfiltered and raw natural forces was exhilarating, humbling, astonishing ...,” added Griffies. “I have been in wilderness before, but not on a ship for eight weeks in the most remote and unforgiving ocean on the planet. This experience has taught me lessons about nature and self that will live on.”

Read more at:

<<https://dynopocruise2017.blogspot.com>>.



Hsieh Wins First Prize Art of Science 2017

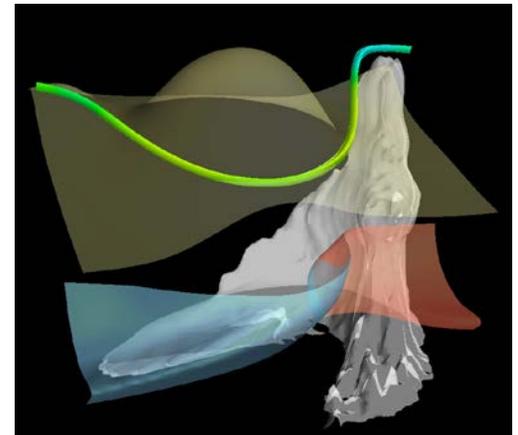
The greatest scientists are artists as well.
-- Albert Einstein

AOS Graduate Student **Tsung-Lin Hsieh** was awarded first prize at the Princeton Art of Science 2017 Exhibit on May 5, 2017. The Art of Science exhibition explores the interplay between science and art. The exhibit consists of 44 images and 16 videos of artistic merit created during the course of scientific research. He joins first-prize winner Martin Jucker, a former AOS postdoctoral research fellow, who won the award in 2013.

Art of Science is intended to spur debate among artists about the nature of art, opens scientists to new ways of “seeing” their own research, and serves as a democratic

window through which the general public can appreciate both art and science — two fields that for different reasons can feel threatening to the non-expert, according to the exhibit’s originators.

The 2017 competition drew more than 170 submissions from a wide range of disciplines, with images and videos by undergraduate and graduate students, faculty, alumni and staff. Entries, including “Clash of Air Masses,” Hsieh’s winning 3D visualization of a baroclinic eddy and the flow from his simulation, were chosen for their aesthetic excellence as well as scientific or technical interest by a distinguished panel of judges. The panel included James Steward, director of the Princeton University Art Museum; Emmet Gowin, professor of visual arts in the Lewis Center for the Arts, emeritus, and Jeffrey Whetstone, professor of visual arts. Emily Carter, Dean of the School of Engineering and Applied Science, acted as master of ceremonies during the exhibit opening.



Clash of Air Masses
Tsung-Lin Hsieh, AOS Program

For Hsieh and the other participating researchers, visually communicating the beauty inherent in scientific investigations is a natural outgrowth of their work. “Visualizing data in 3D has helped me better understand the structure of the eddy and the flow pattern,” said Hsieh. “In the image the white surface is the condensate contour, showing deep clouds in the warm sector and shallow clouds marking the boundary layer top in the cold sector. The upper level jet stream meanders around the yellow isentrope.”

Art of Science 2017 is sponsored by the David A. Gardner ’69 Fund in the Council of the Humanities, and by the School of Engineering and Applied

Science. The exhibit is co-sponsored by the Lewis Center for the Arts, Princeton Institute for Computational Science & Engineering, the Andlinger Center for Energy and the Environment, Council on Science and Technology, Lewis-Sigler Institute for Integrative Genomics, and the departments of Astrophysical Sciences, Chemical and Biological Engineering, Civil and Environmental Engineering, Physics, Psychology, Computer Science, Electrical Engineering, and the Program in History of Science. Prizes are provided by the Office of the Dean for Research. This is the eighth Art of Science competition hosted by Princeton University.

The exhibit will remain on display through the end of the year in the Friend Center Atrium on the University campus. The 2017 online gallery will be available for viewing by midsummer. ■

GFDL Hurricane Science Symposium Honors Decades of Success

Contributed by Maria Setzer, GFDL Communications Director

GFDL recently hosted a Hurricane Science Symposium, to celebrate the lab's seminal contributions to hurricane forecast research and model development. Participants commemorated nearly five decades of successful research and development at GFDL, to employ a regional numerical model for hurricane forecasting. Numerous speakers described continual improvements that have kept GFDL at the forefront of hurricane modeling and pushed the boundaries for the entire field, since development began in the 1970s.

The GFDL Hurricane Model, which has served as an operational forecasting tool since 1995 for both the National Weather Service and the U.S. Navy, was retired from operations this year. Morris Bender, research scientist for hurricane modeling and science at GFDL for more than 40 years, also retired at the end of last year. This was a fitting time to reflect on past accomplishments, and to preview new

developments in hurricane forecasting led by GFDL.



At the symposium, Isaac Ginis, Tim Marchok, Robert Tuleya, and Morris Bender (pictured, left to right) each received a "Certificate of Appreciation" for 22 years of service to the National Weather Service, developing and supporting the GFDL hurricane model.

The half-day symposium brought together GFDL hurricane scientists as well as collaborators who contributed to GFDL's forecast model over many decades. Among the collaborators, Steve Lord (former Director, National Weather Service's Environmental Modeling Center) observed, "I am very proud of what the GFDL hurricane group accomplished and honored to be part of it."

Steve and Sundararaman Gopalakrishnan (Lead Scientist, NOAA's Hurricane Research Division) each moderated half of the symposium. Vijay Tallapragada (Chief, National Weather Service's Global Climate and Weather Modeling Branch) gave a talk about the impact of GFDL hurricane modeling on the larger community modeling efforts, while Mark DeMaria (Chief, National Hurricane Center's Technology and Science Branch) discussed the evolution of hurricane track and intensity guidance at the National Hurricane Center. Former GFDL scientists who are currently at University of Wisconsin, University of Rhode Island, and University of Miami, described how their involvement in the development of the GFDL hurricane model continued to influence their work after they left GFDL. Many colleagues from Princeton University and Rutgers University also attended the symposium, among them AOS and CICS researchers. ■

SOCOM Annual Meeting Held on Main Campus

Driven by the desire to unlock the mysteries of the Southern Ocean and to determine its impact on climate, a group of cross-disciplinary experts from the Southern Ocean Carbon Climate Observations and Modeling (SOCOM) program converged on Main Campus in mid-May to review the progress of the past year and plan for the future of the NSF-sponsored initiative. The annual meeting was held May 9-11, 2017 in Aaron Burr Hall on Main Campus.



Participants at the 2017 SOCOM Annual Meeting at Princeton University (Credit: Joellen Russell, University of Arizona)

Led by CICS Director Jorge Sarmiento, the SOCOM Project was launched in 2014 with a mission to drive a transformative shift in the scientific and public understanding of the role of the vast Southern Ocean in climate change and biogeochemistry through a combination of innovative, float-based observations and a high-resolution modeling program. SOCOM draws on the strengths of co-investigators at 13 institutions at universities, research institutions, and government laboratories around the U.S.

Now entering Year 4 of the project, SOCOM researchers have: deployed a growing observation network with biogeochemical floats in all three basins of the Southern Ocean measuring pH, nutrients, and oxygen; made all of the float data publicly available in near-real time via the SOCOM website and the Argo data system; developed a high-resolution biogeochemical Southern Ocean State Estimate (B-SOSE) that is now

assimilating float data; developed and published a technique for estimating pCO₂ from float pH measurements, enabling calculation of ocean carbon fluxes in this poorly observed region; initiated a Southern Ocean Model Intercomparison Project (SOMIP) with major climate modeling centers; published manuscripts on SOCCOM technology and early results, including in an upcoming SOCCOM special issue of *JGR-Oceans*; and successfully transferred SOCCOM float and sensor technology to the commercial float industry.

At the heart of the meeting agenda were SOCCOM's major themes – Observations, Modeling, and Broader Impacts. Members of the observations team, led by Lynne Talley (UCSD/Scripps Institution of Oceanography) reported on work with international partners to deploy biogeochemical profiling floats and results from analyses of the float data. AOS researchers Seth Bushinsky, Lionel Arteaga, and Haidi Chen presented findings on Southern Ocean oxygen fluxes, carbon export, and heat and carbon storage, while Alison Gray showed results that suggest the existence of large, previously undetected fluxes of carbon dioxide out of the Southern Ocean in winter.



SOCCOM

Southern Ocean Carbon and Climate Observations and Modeling

“The SOCCOM floats have dramatically increased the amount of biogeochemical data we have from the Southern Ocean,” Sarmiento said. “The team efforts to build and deploy floats, along with our modeling efforts, are providing amazing resources for the community.”

The modeling team led by Joellen Russell of the University of Arizona presented results of their efforts to improve our understanding of controls on Southern Ocean biogeochemistry and predictions of future climate change, including a Southern Ocean Model Intercomparison Project that has been initiated with the help of colleagues at GFDL. As part of this

session, AOS' Carolina Dufour gave a talk on her work comparing air-sea CO₂ fluxes between a number of models and SOCCOM observational estimates.

For the broader impacts theme, Climate Central's Heidi Cullen moderated a session on SOCCOM's outreach efforts on a research cruise from Punta Arenas, Chile, to McMurdo Station in Antarctica that was documented by the non-profit journalism and research organization. The effort resulted in hundreds of photos and hours of video footage that will be used to create a free-standing website on the Southern Ocean for educational purposes.



Outreach team members Ted Blanco (left) and Greta Shum (middle) of Climate Central accompanied Observations Co-Lead Steve Riser (University of Washington) on an Antarctic float deployment cruise. (Credit: Climate Central)

The meeting marked the halfway point for the SOCCOM project, which is funded through September 2020. Assessing the initiative's progress, Sarmiento remarked “we have made great progress monitoring ocean health in real-time, and we are excited about the discoveries the next three years will bring.”

Visit the SOCCOM website <http://socom.princeton.edu> to learn more and to access data and resources. ■



Climate Engineering Workshop
August 28th – 30th

GFDL/AOS Scientists named Recipients of AGU Awards

**Contributed by Maria Setzer, GFDL
Communications Director**

AOS Faculty Member Larry Horowitz, leader of GFDL's Atmospheric Chemistry and Climate Group, has been honored with AGU's Ascent Award for Atmospheric Sciences this year. Gabe Vecchi, formerly of GFDL and now with Princeton University, was also named as a recipient of the Ascent Award. The Atmospheric Sciences Ascent Award rewards exceptional mid-career scientists in the atmospheric and climate sciences. Honorees are recognized for demonstrating excellence in research and leadership in his or her field.

Karin van der Wiel, until recently a postdoctoral research associate mentored by Sarah Kapnick at GFDL, is the winner of AGU's James R. Holton Award this year. The Holton Award recognizes outstanding scientific research and accomplishments of early-career scientists. David Neelin '87, a former AOS graduate student, was awarded the Bert Bolin Global Environmental Change Award/Lecture. The award recognizes the ground breaking research and/or leadership in global environmental change of mid-career scientists.

AGU award recipients are selected for their innovative research, important contributions to promoting better understanding of their scientific fields, and meritorious work and service to their communities. They will be formally recognized at the 2017 AGU Fall Meeting.

Larry Horowitz is an expert in tropospheric chemistry and chemical transport modeling of gas-phase and aerosol trace species, who has led the effort to build GFDL's chemistry-climate model (AM3). Gabe Vecchi is now a professor in the Department of Geosciences and the Princeton Environmental Institute at Princeton University and serves as faculty in the AOS Program. Karin van der Wiel left GFDL late last year to return home, as a postdoctoral research scientist at the Royal Netherlands Meteorological Institute

in the Netherlands. David Neelin, professor of Atmospheric and Oceanic Sciences, heads the Climate Systems Interaction Group at the University of California, Los Angeles. ■

Baldwin Discusses Climate Science on Capitol Hill

On March 21, 2017 AOS Graduate Student Jane Baldwin took part in the seventh annual Climate Science Day on Capitol Hill in Washington, D.C. This non-partisan event, a joint effort of an intersociety Climate Science Working Group (CSWG) comprised of more than a dozen scientific associations and consortia, provides an opportunity for scientists of many disciplines to build relationships and provide members of Congress and their staffs with access to the best possible climate science information.

With the focus on building relationships, not on lobbying for research funding or particular policy issues, Baldwin, part of the American Geophysical Union (AGU) contingent, joined 25 other scientists on Capitol Hill. These conversations were an opportunity for scientists to share information about climate change research with their district representatives, and with others, and are a vital component of AGU's efforts to bridge the gap between legislators and professional scientists. Such relationships are vital to ensuring that the best science is used when formulating policy.



L to R: AOS Graduate Student Jane Baldwin & Rutgers Professor Dave Robinson, a state climatologist for New Jersey, on Capitol Hill

The New Jersey delegation included Dave Robinson, a Rutgers professor and state climatologist for New Jersey, and Lexi Schultz, a public affairs director for AGU. They met with staff from the offices of Representatives Bonnie Watson Coleman, Leonard Lance, Chris Smith, Frank Lobiondo, Senators Cory Booker and Robert Menendez, and the House Committee on Science, Space, and Technology. Baldwin and her team also met in person with Representative Rodney Frelinghuysen, who is now the Chair of the House Appropriations Committee. He was quite enthusiastic about science, according to Baldwin, and asked Baldwin many questions about climate modeling, leading to a fruitful discussion.



L to R: Dave Robinson, Representative Frelinghuysen, Jane Baldwin, & Lexi Schultz, public affairs director at AGU

“There are so many ways climate science is important for New Jersey -- from coastal resilience to understanding snow storms and heat waves -- it was a pleasure getting to exchange on these issues and many others on the Hill,” Baldwin said. Such relationships are vital to ensuring that the best science is used when formulating policy.

The various delegations were solely focused on making themselves available as resources to those responsible for crafting federal science policy and their staffers, if they face questions related to climate science. Impressed by the diverse expertise of the other Climate Science Day participants, Baldwin noted, “I did make a point of emphasizing the important work done at AOS/GFDL.”

Baldwin's research interests focus on how large-scale atmospheric dynamics influence regional climate, with an eye to climate change and policy applications.

Advised by Gabe Vecchi, professor of geosciences and the Princeton Environmental Institute (PEI), her dissertation research examines the impacts of mountains on precipitation features including deserts and monsoons. Baldwin also researches the risk of heat waves with Albert G. Milbank Professor of Geosciences and International Affairs Michael Oppenheimer; professor of geosciences and international affairs; and director, STEP, through her PEI-STEP fellowship.

Climate Science Day participating organizations are members of the CSWG and include the American Association for the Advancement of Science, American Chemical Society, American Geophysical Union, American Meteorological Society, American Society of Agronomy, American Society of Plant Biologists, American Statistical Association, Council on Food, Agricultural, and Resource Economics, Crop Science Society of America, Geological Society of America, National Ecological Observatory Network, Society for Conservation Biology, Soil Science Society of America, University Corporation for Atmospheric Research, and others. ■

AOS Researchers Inspire Young Women to Pursue Science

Inspiring young women to enter STEM (Science, Technology, Engineering and Mathematics) fields was the primary objective of the Princeton Plasma Physics Laboratory's (PPPL) Young Women's Conference (YWC) held at Frick Chemistry Laboratory on March 23, 2017. AOS researchers were among the 60 volunteers from PPPL and Princeton University at the conference, the 16th hosted by PPPL and the largest gathering to date with girls coming from schools throughout New Jersey as well as Pennsylvania.

Although the number of women in STEM fields has doubled in the past two decades, according to the National Science Foundation, they still make up only 29 percent or less than one-third of the STEM workforce. AOS Researchers Seth Bushinsky, Haidi Chen and Alison Gray,

along with AOS Graduate Student Anna Trugman, did their part to encourage girls to embrace their scientific curiosity and to pursue their dreams. CICS/AOS interactive displays were among the more than 30 exhibits available to the seventh- to tenth-grade girls for hands-on science activities and demonstrations.

“I think it’s important for young students, especially middle school/high school ages, to interact with scientists in order to learn about the types of questions that we ask and to have real life examples of scientists, both male and female,” Bushinsky said. “This seems especially important for young women, given the gender gap that exists at many levels in academia.”

Students visiting the CICS/AOS exhibit learned how acidification changes the buffer capacity of the ocean through a demonstration in which students blew bubbles into water that either had lemon juice or baking soda added, exploring the relationship between CO₂ and ocean acidification. They also participated in an experiment using ice cubes, colored with dye, melting in freshwater or saltwater that demonstrated some of the dynamics of sea ice, including that temperature and salinity determine the density of seawater. Fellow exhibitors showcased everything from plasmas to building models of the DNA of a virus.

“I also think it’s a good idea for publicly-funded scientists to practice explaining the relevance of their work to people of all ages,” added Bushinsky. The YWC, he said, “certainly was a worthwhile thing to do and I’m glad PPPL does events like that.”

The 600 young women in attendance also listened to talks by female engineers, before coming together in Richardson Auditorium for a keynote address by NASA Aerospace Engineer Aprille Ericsson, the first African-American woman to receive a Ph.D. in mechanical engineering from Howard University. “If I ever wondered about what people thought about me, I would never have become a rocket scientist,” she told the young women in the audience. She shared her belief that humans could travel to Mars in their lifetime if future scientists tackle some major challenges over the next few decades. “We need you guys to develop new launch vehicles that will get us there,” she added. A lofty goal, no doubt, but to

their credit the 2017 YWC participants seem up for the challenge.

The 17th annual Young Women’s Conference in STEM is scheduled for Thursday, March 22, 2018. ■

Nereus Annual Meeting Held at Princeton

A group of cross-disciplinary experts gathered at Mountain Lakes House in Princeton June 9 to 11 for the Nippon Foundation-Nereus Program annual meeting. The Program, a global interdisciplinary initiative created to further our knowledge of how to best attain sustainability for the world’s oceans, was launched in 2011 with three core objectives: conducting collaborative ocean research across the natural and social sciences, developing a network of experts that can engage in discussion of complex and multifaceted questions of ocean sustainability, and transferring these ideas to practical solutions in global policy forums and public engagement.

The meeting featured a series of panels highlighting various research areas, with presentations from Nereus fellows on their research projects and the possible connection to other Nereus Program research and goals, followed by collaborative panel discussions. Among the participants were AOS Faculty Member Jorge Sarmiento, a Nereus principal investigator, GFDL Research Oceanographer Charlie Stock, a Nereus co-principal investigator, AOS Associate Research Scholar Colleen Petrik, a Nereus fellow, and Rebecca Asch and Natasha Henschke, Nereus alumni.

Sarmiento, together with Nereus Program Director of Science William Cheung, moderated the opening panel on changing oceans and ecosystems which examined what future biodiversity and ecosystem functions may look like under climate change and other human drivers. Presentations by Petrik and Henschke focused on how marine species are adapting to their changing oceans, with Stock leading the discussion surrounding the challenges surrounding this issue and potential ways forward. Remaining panels included: multi-scale human impacts, the

crux of economics and society, fishing in changing oceans, the push for cooperative policy, and the changing meaning of “sustainable development.”

Splitting into discussion groups on the afternoon of the 9th and 10th, meeting participants focused on new research projects as well as followed up on existing collaborations with the hope of fostering productive discussions that will serve as a springboard for future research. An advisory panel and steering committee meeting took place in the early evening during both full days, just prior to the reception dinners at Mountain Lake House and the Nassau Inn.

The meeting followed the United National World Ocean Conference in New York where Nereus members presented on the co-benefits of meeting Sustainable Development Goal 14: Life Below Water to other Sustainable Development Goals. These co-benefits were recently published in a report by the Nereus Program titled “Oceans and Sustainable Development Goals: Co-Benefits, Climate Change and Social Equity” <http://www.nereusprogram.org/sdg-report/>.

“The Sustainable Development Goals were one of the central themes of this year’s meeting,” said Petrik. “Several of our discussion groups focused on these goals with the aim of using Nereus research to better quantify ocean-based solutions for meeting the goals and the involved trade-offs. Another principal topic of the meeting was comparing and integrating the modeling work of our group. Several models of fish and fishing have been developed by the Nereus Program and it is now time to compare them so that we can begin giving recommendations for future fisheries management under climate change. It was very exciting to see how far the Nereus Program has come in just the two years I have been a Senior Fellow. I think that we are now poised to actually start transferring our research to policy making.”

Nereus participating institutes include: the Nippon Foundation; the University of British Columbia, Institute for the Oceans and Fisheries; Duke University, Marine Geospatial Ecology Lab; Princeton University, Atmospheric and Oceanic Sciences; University of Cambridge; Geography Department; UNEP – World

Conservation Monitoring Centre; Stockholm University, Stockholm Resilience Centre; Utrecht University, The Netherlands Institute for the Law of the Sea; and Expansion Partners. New Expansion Partners include Rutgers University and the University of South Carolina, home to former AOS postdoctoral scholars and new Nereus PIs Malin Pinsky and Ryan Rykaczewski respectively. ■

Ocean Fun Days 2017 Draws Thousands to Jersey Shore

Despite a chill in the air on the opening day of Ocean Fun Days, thousands were drawn to the Jersey Shore for a weekend of interactive fun and education on Saturday, March 20th, at Island Beach State Park, and on Sunday, March 21st, at the New Jersey Sea Grant Consortium (NJSGC) on Sandy Hook.

AOS Faculty Members Sonya Legg, who coordinated the outreach effort at Princeton, and Steve Griffies were joined by Bing Pu (AOS), Angel Adames (UCAR), Tsung-Lin Hsieh (AOS), Jane Smyth (AOS) and Shiv Priyam Raghuraman (AOS) at the CICS/AOS exhibit to lead hands-on experiments demonstrating iceberg melting and ocean acidification. They were one of over 50 exhibitors presenting at the 2017 event, joining forces with fellow scientists and environmentalists from around the state to promote ocean awareness and improved coastal stewardship.



L to R: AOS Associate Research Scholar Bing Pu & AOS Graduate Student Tsung-Lin Hsieh

Attendance was very good both days, with perfect sunny weather on Sunday, according to Legg, associate director of

CICS. Display tables were jam-packed with children and families eager to try their hand at tabletop scientific inquiry. Celebrating its fourteenth year, Ocean Fun Days gave the young people in attendance the opportunity to learn firsthand from marine scientists, researchers and environmentalists who possess a vested interest in the oceans and the scientists an opportunity to get out from behind their desks to a more natural venue to share their passion.

“Our hands-on experiments attracted a lot of kids,” said Hsieh, an AOS graduate student. “They always seemed to have new questions to ask, and some of them I had never thought about how to explain before! I thank Sonya for creating this opportunity for us to talk with kids about science. It was a fun day at the shore.”



L to R: AOS Graduate Student Shiv Priyam Raghuraman & UCAR Postdoctoral Researcher Angel Adames

“I was very glad to participate in this “fun” event, said Pu, an AOS associate research scholar. “It gave me a chance to talk to people outside of the scientific community, to answer their questions about climate sciences, and to explain to them how climate change could affect us through simple yet meaningful experiments.”

Other eco-friendly activities included seining, bird walks, beachcombing, fiddler crab races and tours of Sandy Hook’s legendary lighthouse, in addition to an open house at the NOAA/National Marine Fisheries laboratory. Hosted by Project Terrapin and the Marine Academy of Technology and Environmental Science (MATES), the release of diamondback turtle hatchlings into their natural habitat was new this year at Island Beach State Park and no doubt memorable to those who were fortunate enough to witness it.

“I’m grateful to the volunteers who came out to lend their expertise,” Legg said. “I believe we get as much out of the experience as those who visit our table.”

Ocean Fun Days is presented by founding sponsor New Jersey Natural Gas, in partnership with New Jersey Sea Grant Consortium, Asbury Park Press, New Jersey Department of Environmental Protection, New Jersey Division of Parks and Forestry, National Park Service and the National Oceanic and Atmospheric Administration. ■

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 Associate Research Scholar Carolina Dufour who spent 4 ½ years in the AOS Program.]

After four and a half years as a postdoc and associate research scholar in the AOS Program, Carolina Dufour departed Princeton at the end of May. Working with Jorge Sarmiento and Stephen Griffies, Carolina studied the Southern Ocean, its role in the climate system and response to climate change. She investigated in particular the role of oceanic processes, including ocean mesoscale eddies, on carbon uptake, sea ice and transport of water masses and climate relevant tracers. Soon after she arrived, a team of GFDL scientists, in collaboration with Sarmiento’s team, set themselves a modeling challenge: running the high-resolution climate model CM2.6 with a biogeochemical module called miniBLING. “I learned a lot from my involvement in this multi-institution modeling project,” Carolina said. Since the release of these unique simulations, numerous papers have been published advancing our understanding on various aspects of the climate system and its response to climate change.

“It was a pleasure to have Carolina in the group,” said Sarmiento. “Her scientific contributions were excellent, and her organizational and analytical skills were essential for including biogeochemistry in the CM2.6 model simulations. We wish

her the very best as she starts her new job as a professor at McGill.”



*AOS Associate Research Scholar
Carolina Dufour*

On her experience in the AOS department, Carolina said, “Working in the AOS Program has been an invaluable experience for me. I will always be extremely grateful for the chance I was given to be exposed to the many facets of a researcher's life.” She added, “I very much enjoyed the welcoming and vibrant AOS community, which I will dearly miss.”

“Carolina was a trusted collaborator during her 4+ years at Princeton. She has superb physical insights, analysis skills, and general understanding of oceanography,” said Griffies. “I learned heaps while working with her, and feel very proud of the work we did together. I hope to continue our collaboration as she embarks on a new life at McGill University.”

Carolina is heading to the department of Atmospheric and Oceanic Sciences at McGill University in Montreal, Canada, where she accepted an assistant professor position. She hopes to keep some strong collaborations with Princeton and GFDL colleagues and to visit Princeton regularly. Carolina will miss the “stimulating environment of Princeton and the beautiful campus, with its nice beach volleyball courts.” ■

AOS & CICS News

Congratulations to **Anna Trugman** who successfully defended her Ph.D. Thesis, "Understanding the Roles of Climate, Disturbance, and Functional Diversity in the Terrestrial Carbon Cycle: Linking

Mechanisms from Regional to Global Scales," on May 22, 2017.

Congratulations to **Nicholas Lutsko** who successfully defended his Ph.D. Thesis, "Aspects of Eddy Momentum Fluxes in the General Circulation of the Troposphere," on June 1, 2017.

Congratulations to AOS Graduate Student **Elizabeth Yankovsky** who has been awarded an NSF graduate research fellowship. She will begin the position in the fall, and her research will focus on the dynamics of dense water formation and transport in the continental shelf regions of the Arctic Ocean and on improving representations of these processes in large-scale global climate models.

Congratulations to **Young (Paul) Yi**, a Princeton student in Geosciences, who recently graduated. He spent two summers working with AOS Faculty Member Sonya Legg for both his junior project and his senior thesis. AOS Faculty Member Bob Hallberg also advised him for his senior thesis. Paul was supported by a PEI fellowship, and received the department Sampson prize for environmental geosciences. Paul will be working with AOS Research Scholar Keith Rodgers this summer, and then going on to Stanford for graduate school.



L to R: Sonya Legg and Paul Yi at Class Day Dinner in Guyot Hall

For a full list of Geosciences students supervised by AOS faculty for their senior theses, see:

<http://www.princeton.edu/geosciences/news/archive/?id=17867>.

AOS Graduate Student **Spencer Clark** and AOS Alumnus **Spencer Hill** announced the introduction of the “aospy” Python

package, after 2+ years of development and their own personal use. An open source Python package, “aospy” provides tools for automating analyses of netCDF climate data across different simulations (or observational datasets), physical variables, time ranges, and many other parameters. For more information:

<http://aospy.readthedocs.io/en/latest/>

[New Model Helps Predict Regional and Seasonal Sea Ice Extent](#)

Scientists have developed a new method to forecast the extent of sea ice in some regions of the Arctic up to 11 months in advance. The new approach was detailed in a [study](#) published recently in the journal *Geophysical Research Letters*. **Mitch Bushuk** (UCAR) led the research while he was an AOS postdoc. His coauthors include **Gabe Vecchi**, professor of geosciences and PEI; **Rym Msadek** (CNRS/CERFACS); and **Mike Winton, Rich Gudgel, Anthony Rosati** and **Xiaosong Yang** (NOAA/GFDL).

[Climate Process Team on Internal-Wave Driven Ocean Mixing](#)

The Climate Process Team on Internal-Wave Driven Ocean Mixing has published an [article](#) on recent advances in the understanding of internal-wave driven turbulent mixing in the ocean interior, along with new parameterizations for global climate ocean models and their climate impacts. AOS Faculty Members **Steve Griffies, Bob Hallberg, Sonya Legg**, as well as **Benjamin Mater, Angélique Melet, and Maarten Buijsman** (formerly AOS), are among the paper's coauthors.

[In Retrospect \(Nature\): Highlights a Classic 1967 Paper by Manabe and Wetherald](#)

A classic [paper](#) in 1967 by climate modelers **Syukuro (Suki) Manabe**, an AOS senior meteorologist, and Richard Wetherald, reported key advances in climate modelling that enabled a convincing quantification of the global-warming effects of carbon dioxide — laying foundations for the models that underpin climate research today.

[On the Seasonality of Arctic Black Carbon](#)

AOS Graduate Student **Zhaoyi Shen** is the lead author of a recent [study](#), published in the *Journal of Climate*, that analyzes the seasonal cycle of Arctic black carbon, an important component of Arctic haze. The authors find that the seasonal cycle is mostly attributable to seasonal variations in wet removal rather than in the large-scale circulation. The paper's coauthors include AOS Faculty Members **Yi Ming**, **Larry Horowitz** and **V. Ramaswamy** and **Meiyun Lin**, an AOS research scholar.

[Current Climate Change Measurements Mask Trade-Offs Necessary for Policy Debates](#)

Scientists and policymakers use measurements like global warming potential to compare how varying greenhouse gases, like carbon dioxide and methane, contribute to climate change. Yet, despite its widespread use, global warming potential fails to provide an accurate look at how greenhouse gases affect the environment in the short and long-term, according to a team of researchers from Princeton University, the Environmental Defense Fund and Harvard University. **Ilissa Ocko**, a climate scientist at the Environmental Defense Fund and a former AOS graduate student, is the lead author of the [study](#) published in *Science*.

[Mark your Calendars ... Upcoming GFDL Symposium:](#)

GFDL Science Symposium, featuring the latest research activities at the Lab. The Symposium is planned for the first week in November.

Arrivals

Anders Damsgaard arrived in early April from Scripps Institution of Oceanography. He is working with Olga Sergienko and Alistair Adcroft as a postdoc. **Xiao Liu** arrived in early June to work with John Dunne as a postdoc. She comes to Princeton from the University of Southern California.

Prof. **Jianjun Yin** arrived in early July for a six-month sabbatical. He is from the

Department of Geosciences at the University of Arizona and will be working with Steve Griffies.

Houssam Yassin, one of our incoming graduate students, arrived in early July to work with Steve Griffies.

2017 CICS Summer Interns:

Mick Lee (University of Maryland), hosted by Chris Blanton, Niki Zadeh and Balaji; **Haylie Mikulak** (University of Nebraska), hosted by Sarah Kapnick; **Sarah Nickford** (Stonybrook), hosted by Sonya Legg; **Katie Boaggio** (College of New Jersey), hosted by Shannon Rees; **Daniel Lloveras** (University of Miami), hosted by Xiaosong Yang; **Stephanie Lin** (Cornell), hosted by Baoqiang Xiang; and **Caroline Cardinale** (Hun School), hosted by Robert Hallberg.

PEI Summer Undergraduates working with the Sarmiento Group:

Rebecca Barber (Princeton), who is working with Seth Bushinsky; **Kimberly Peterson** (Princeton), who is working with Haidi Chen; and **Nicole Rinaldi** (Princeton), who is working with Keith Rodgers and Sarah Schlunegger.

Welcome Back!

Pablo Zurita-Gotor, a returning faculty member from the Universidad Complutense de Madrid, arrived in late June. Pablo will be working with Isaac Held throughout the summer.

We welcome back **Gabriel Lau**, a former faculty member and GFDL scientist, who will arrive in mid- July to work with his AOS/GFDL colleagues through the end of August.

Departures

Mitch Bushuk, an AOS postdoc, accepted a visiting scientist position with UCAR; he continues to have an office at GFDL.

Yohan Ruprich-Robert accepted a position at the Barcelona Supercomputing Center (BSC), effective September. He left Princeton at the end of April.

Weiyao Yao, an AOS postdoc, accepted a software engineer position with

Bloomberg. She left Princeton at the end of April.

AOS Associate Research Scholar **Carolina Dufour** accepted a position as an assistant professor at McGill University. She left the AOS Program at the end of May.

Gustavo Mastrococco Marques, an AOS postdoc, left the AOS Program at the end of May. He accepted a project scientist position at NCAR.

Max Popp, an AOS associate research scholar, accepted a postdoctoral position at the Laboratoire de météorologie dynamique (LMD), France. He left Princeton in late June.

AOS Associate Research Scholar **Alison Gray**, a member of the Sarmiento Group, left the Program at the end of June. She accepted a position as an assistant professor in the School of Oceanography at the University of Washington.

Birth Announcements

Congratulations to AOS Postdoctoral Research Associate **Nathaniel Chaney** and his wife, Allison, on the birth of their son, Andrew Isaac, on April 15, 2017.

Congratulations to AOS Postdoctoral Research Associate **Ping Zhai** and her husband, Tao, on the birth of their son, Chris, on May 16, 2017.

Congratulations to AOS Postdoctoral Research Associate **Dawei Li** and his wife, Jiacan, on the birth of their son, Aiden, on May 28, 2017.

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