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Center for Coastal Physical Oceanography, Old Dominion University

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OLD DOMINION UNIVERSITY
Center for Coastal Physical Oceanography
IDEA FUSION

CCPO CIRCULATION

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Phytoplankton Responses to Nutrient Enrichment in High and Mid-Latitude Seas

Pierre St-Laurent

As a postdoctoral researcher at CCPO I had the opportunity to broaden my research interests and to become involved in multidisciplinary projects. I currently work on two National Science Foundation (NSF)-funded projects examining the effects of nutrient enrichment in very different environments, the Amundsen Sea (Antarctica) and the Mid-Atlantic Bight (northwest Atlantic). The projects are motivated by a similar concern that changes in the nutrient supply over the last decades are affecting the marine environment and particularly the lower trophic levels. Although the algal response to nutrient enrichment has been largely studied in the past, it remains a challenge to predict how these natural environments will evolve over the next 50 or 100 years. This is particularly difficult in locations where observational data are scarce and even the "baseline" is not well constrained (e.g., the Amundsen Sea).

The two projects involve multiple scientific disciplines ranging from the cryosphere to atmospheric chemistry. I experienced for the first time a collaborative work where everyone has a profound understanding of their respective fields but a more basic understanding of each other's specialty. It is stimulating to know that the project depends on this synergy among the participants and that we constantly need to push our own scientific boundaries to move forward. Such multidisciplinary projects are also in line with efforts from funding agencies to balance basic disciplinary research with projects that have direct benefits to society or address societal issues.

The first project started in July 2015 and is titled "Investigating the Role of Mesoscale Processes and Ice Dynamics in Carbon and Iron Fluxes in a Changing Amundsen Sea (INSPIRE)". This NSF Office of Polar Programs-funded project is led by ODU and focuses on the processes behind the unusually large phytoplankton bloom taking place in the Amundsen Sea Polynya (Antarctica). The Amundsen Sea (AS) is often featured in the news as a site where the Antarctic Ice Sheet is rapidly melting because of its contact with warm ocean water (Rignot et al., 2013).

The warm water mass (modified Circumpolar Deep Water, mCDW) originates from the Antarctic Circumpolar Current that "hugs" the shelf break along the eastern AS (Fig.1). mCDW circulates onto the continental shelf through large glacial troughs and ultimately reaches the floating ice sheet (St-Laurent et al., 2015). The melt of the floating ice sheet in the AS generates hundreds of gigatons of meltwater each year. *(Continued on page 2)*

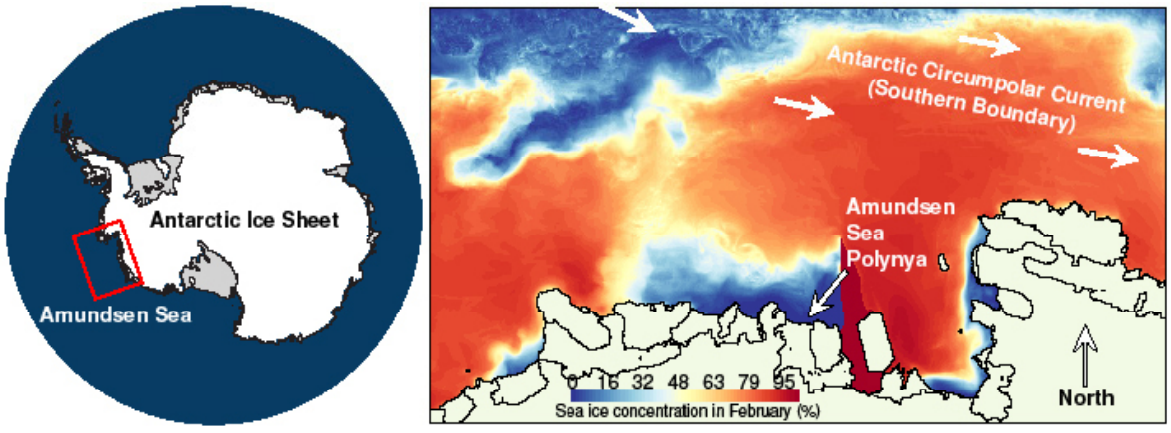


Figure 1

Letter from the Director

Dear Reader,

The activities at CCPO continue to expand well beyond the original focus on coastal physical oceanography; or, maybe it just seems that way from articles in this issue. Pierre is working with biological and chemical processes in coastal circulation models in two very different locations: Antarctica and the Middle Atlantic Bight. These projects look at drifting organisms, processes in marine ecosystems and influences of physical processes on biology and chemistry in the marine environment.

Rising sea level in the local area continues to lead CCPO in new directions. Dr. Diane Horn visited CCPO for the past semester showing how the science of rising sea level is used by business and the insurance industry. We are often encouraged to apply science to social issues; here is a situation with a clear connection between the two. The comments made by Secretary of State John Kerry during his recent visit to the area shows the importance of rising sea level on national security as well as our local businesses and infrastructure.

All of these activities provide an important lesson to us on the need to do good science, but to also collaboarate with others to use these ideas/results to address more general social issues.

Sincerely,

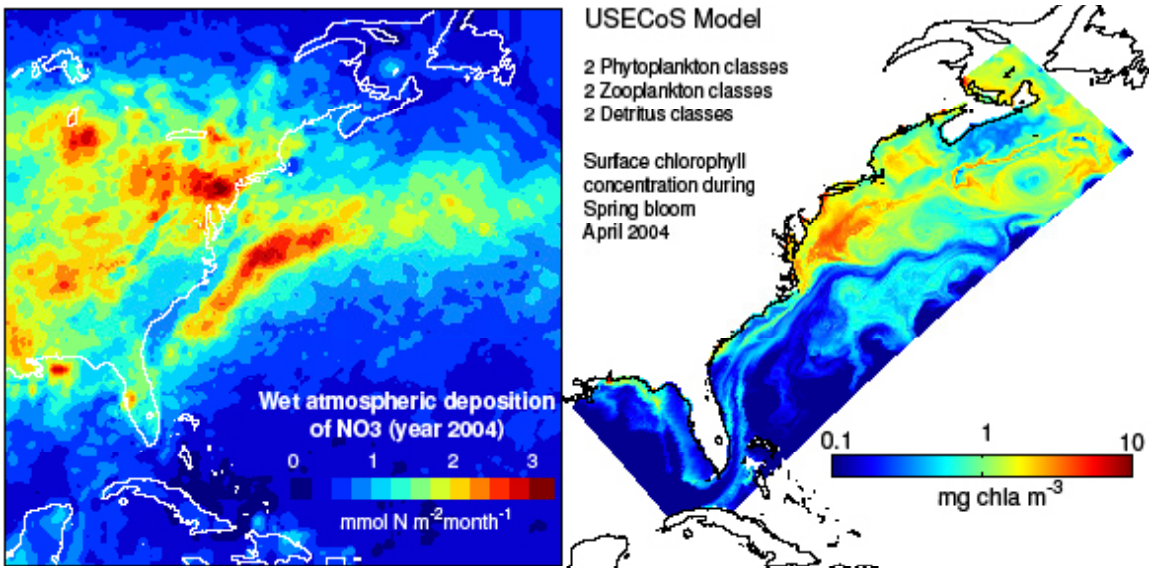
John Klinck
Professor of Oceanography
Director, CCPO

Phytoplankton Responses to Nutrient Enrichment in High and Mid-Latitude Seas, Cont'd.

This glacial meltwater is rich in iron, a micro-nutrient that often limits phytoplankton production. The goal of INSPIRE is to model the seasonal phytoplankton bloom of the Amundsen Sea Polynya (ASP) and to understand the relative importance of physical and biogeochemical drivers such as this iron enrichment. The project is a collaboration between modelers (E.Hofmann and myself at ODU) and a group of researchers that extensively sampled the ASP during the summer of 2011: P. Yager (UGA), R. Sherrell (Rutgers) and S. Stammerjohn (U. Colorado). The preliminary results of the project highlight the important role of the variable sea ice cover that dictates light availability in the ASP (Fig.1). The model also highlights the complex pathway of the iron-rich meltwater that is carried westward by the coastal circulation.

The second project is titled "Deposition of Atmospheric Nitrogen to Coastal Ecosystems (DANCE)" and is led by R. Najjar (Penn State) in collaboration with ODU (M. Mulholland, P. Sedwick) and VIMS (M. Friedrichs). Its goal is to study the effects of Atmospheric Nitrogen Deposition (AND) on the phytoplankton production in the oligotrophic waters of the eastern U.S. This area is particularly susceptible to AND since it is downwind of important sources of atmospheric nitrogen (notably power plants). It also receives more than 20cm of rain per month on average which leads to a significant input of nitrogen (Fig. 2). The project includes a field campaign that took place in 2014 (with one CCPO grad student on-board, **S. Mack**) and a modeling component that provides regional and historical context for the data. *(Continued on page 3)*

Figure 2



Phytoplankton Responses to Nutrient Enrichment in High and Mid-Latitude Seas, Cont'd.

For this modeling component we use a 3-D biogeochemical model of the U.S. East Coast (Hofmann et al., 2011; Fig. 2) with realistic atmospheric deposition fields obtained from the Community Multi-scale Air Quality model (CMAQ) developed by the EPA. Experiments with wet AND over the period 2004-2008 show that the primary productivity is significantly enhanced during the summer period (i.e., when surface nitrate concentrations are very low). During this period, AND events increase the surface primary production by 15% and the depth-integrated production by 7%. AND has a small effect over the rest of the year as nutrients are more abundant. These results suggest that anthropogenic emissions of nitrogen can have a significant impact over the marine environment in this part of the world ocean.

Further Reading:

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St-Laurent, **P.**, **J. Klinck**, and **M. Dinniman**, 2015. Impact of local winter cooling on the melt of Pine Island Glacier, Antarctica, *J. Geophys. Res.*, vol. 120(10), p. 6718-6732, doi:10.1002/2015jc010709.

Hofmann, E.E., B. Cahill, K. Fennel, M.A.M. Friedrichs, K. Hyde, C. Lee, A. Mannino, R.G. Najjar, J.E. O'Reilly, J. Wilkin, and J. Xue, 2011. Modeling the Dynamics of Continental Shelf Carbon, *Annu. Rev. Mar. Sci.*, vol. 3, p. 93-122, doi:10.1146/annurev-marine-120709-142740.

Websites:

INSPIRE: http://pages.globetrotter.net/pierrestlau/inspire.html

DANCE: http://sites.psu.edu/dance2014/

ohjustswimmingly.com

Just Swimmingly: Top 3 Blog Posts of Fall

Stefanie Mack Presents: Tales of grad student life in oceanography. A mix of science and survival skills.

1. Taking the scenic route

Some days I wonder why it's taken me so long to finish graduate school. This post gets a bit personal as I work my way through current musings on the benefits of graduate school, and why staying longer may be helpful for my career, given that I use the time wisely. Although I'm still not sure if it is worth the hit to my pocketbook, I'm focused on getting the most out of it I can, and still finishing up by May. See full blog.

http://www.ohjustswimmingly.com/2015/10/taking-the-scenic-route/

2. John Kerry at ODU

On November 10, Secretary of State John Kerry visited ODU to give a speech on climate change and introduce a new task force focused on the effects of climate change on national security. While it was great to hear a top U.S. government official state that climate change is caused by us and we need to do something about it, other parts of his speech didn't feel quite right. In this post, I reflect on some of the main points he brought up from the perspective of a climate scientist. See full blog.

http://www.ohjustswimmingly.com/2015/11/john-kerry-at-odu/

3. Job Search Strategy

I've taken quite a unique approach to job searching, mostly because I've been looking at job offerings for several years now. I've just recently started to apply for postdocs, and in the interest of clarity and defeating imposter syndrome, I've posted my current strategy as well as the outcomes of the applications I've submitted so far. It seems to me that there is no one right way to do this process as it depends on many personal factors. But, the more you know about everyone else's strategy and choices, the better you can refine your own. So here's mine. See full blog.

http://www.ohjustswimmingly.com/2015/09/job-search-strategy/

Researching and Experiencing Flooding

Dr. Diane Horn, Reader in Coastal Geomorphology, Birkbeck College, University of London

Dr. Horn standing in front of a 20 meter flume in London

As I write this, I'm coming to the end of my sabbatical from Birkbeck College, University of London, which has allowed me to work at CCPO for three months on research projects related to flooding. During my time at ODU, I've also had the chance to experience flooding close-up, rather than just as an academic subject. There was a torrential downpour in my first week here and by the time I got across campus, I had to wade to my car. Not knowing the roads that usually flood, I then took the wrong route home and found myself with no choice but to drive through water of unknown depth. I know from my contacts in the insurance industry that 6 inches of water is enough to float a car, so I had to hope that the rental car was up to it (it was). A few weeks later I got to experience the challenges of driving in Norfolk with very high tides. This time, colleagues in CCPO told me how to avoid the flood water on my way home. My next new experience was preparing in case Hurricane Joaquin made landfall near here. Living at the north end of Virginia Beach, I made a point of checking the storm surge maps just in case. Luckily we escaped Joaquin, and although there were big waves, the biggest impact on my local beach was wind-blown sand.

I have been fortunate to spend two extended periods of time at ODU. My first visit to ODU was in May and June 2013 as the first visiting scholar under the Climate Change and Sea Level Rise initiative. I worked with Michael McShane in the finance department on a comparative study of flood insurance in the U.S. and the U.K. This research was well-timed, as long-standing flood insurance schemes in the U.S. and the U.K. were in the process of moving from subsidised premiums for properties in high flood risk locations to actuarially sound pricing. In fact, the new U.K. flood insurance scheme was announced on the day I flew back from Norfolk to London. I spent most of the trip trying to find wi-fi and find out what had been announced, and I wrote quickly as soon as I got back, which resulted in a paper in Nature Climate Change. I came to ODU this time to work on two projects, continuing the research on flood insurance and working on a new project on cities and sea level rise funded by the U.K. Natural Environment Research

50th Street in Virginia Beach on Oct. 4, 2015

Council in partnership with Arup, a global firm of consultants and engineers, under the Arup Global Research Challenge program. The aim of the overall project is to produce a "roadmap" to guide practitioners through the process of analysing coastal flood risk in urban areas. My part of the research project is to evaluate adaptation policy approaches, in order to give coastal city managers and their consultants a methodology to assess the risks and uncertainty posed by sea-level rise and identify the most suitable adaptation responses for a given city. During my visit, I had the chance to present some of this work at both the CCPO and MARI research seminar series and the Hampton Roads Adaptation Forum. The adaptation forum was particularly helpful, as it gave me a chance to hear the views of people who are actively managing the impacts of flooding. I also gave a research seminar at the University of Alabama, which was a really interesting experience as I was there the day before Homecoming; I've never seen a football stadium which holds over 100,000 before. I will also present some of the material from the Arup project at the American Geophysical Union meeting in San Francisco in mid-December.

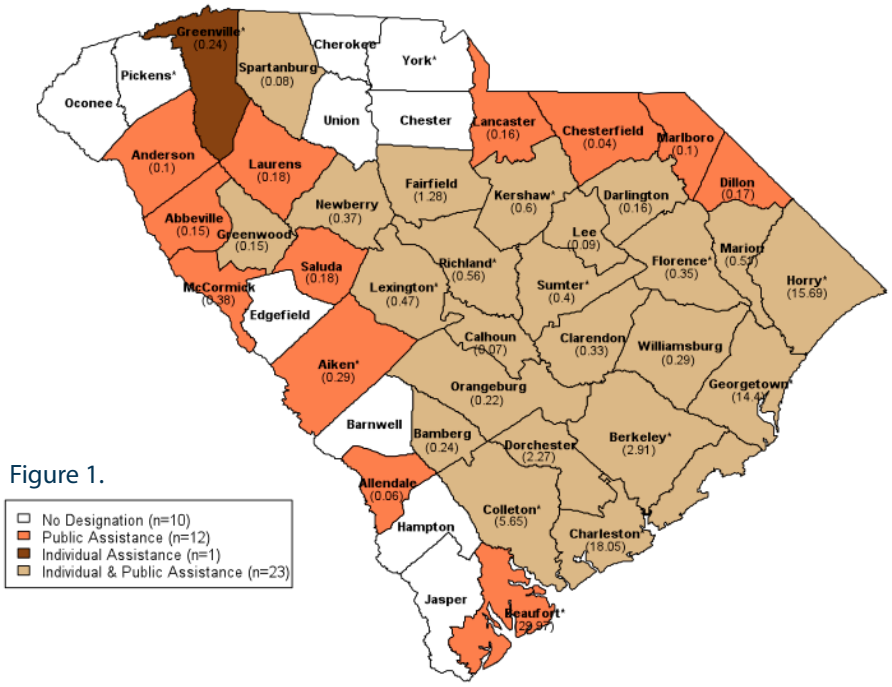

Figure 1.

I ended up working on an unexpected project following the South Carolina floods in October, when we discovered that only 2.9% of the population have flood insurance (fig. 1). After floods like this, many people are surprised to find that their standard homeowners insurance doesn't cover flood damage, and that flood insurance must be purchased as a separate policy through the National Flood Insurance Program (NFIP). In fact, we found out that private insurance companies may end up spending more money sending people out to inform policyholders that they aren't covered for floods than they pay out in claims. Although the South Carolina floods aren't likely to add to the NFIP debt, given the low number of policies in the flood-hit counties, taxpayers are still on the hook. At the time of writing, FEMA has approved disaster assistance of nearly $140 million to uninsured residents and $28 million to the state. I'm writing a paper now with Michael McShane (Finance Department) and Wie Yusuf (School of Public Service) to make recommendations on how more people could be encouraged (or compelled) to buy flood insurance.

I've really enjoyed my time here, and the opportunity to collaborate with researchers in CCPO, MARI and CCSL-RI. The other highlights of my time at ODU were the visits of John Kerry, U.S. Secretary of State and Michelle Obama, First Lady of the U.S., the weekly CCPO and MARI seminars – and of course, cookie time on Wednesday afternoons in CCPO!

Dr. Horn's article on flood insurance was featured on the cover of Nature Climate Change. See full article, http://www.nature.com/nclimate/journal/v3/n11/full/nclimate2025.html.

JUST THE FACTS

Publications, Presentations, Awards & Recognition

Publications

New Blog: **Atkinson, L.P.**, blogs for *Weather Underground* at http://www. wunderground.com/blog/lpocean/show.html.

Becchetti, F.D., **S. Mack**, W.R. Robinson and M. Ojaruega, Colliding nuclei to colliding galaxies: Illustrations using a simple colliding liquid-drop apparatus. *American Journal of Physics*, 83(10), 846-856, 2015.

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Ezer, T. and **L. Atkinson**, Sea level rise in Virginia- causes, effects and response. *Virginia Journal of Science*, Virginia Academy of Science Publ., to be published, 2015.

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Feng, Y., M.A.M. Friedrichs, J. Wilkin, H. Tian, Q. Yang, **E.E. Hofmann**, J.D. Wiggert, R.R. Hood, Chesapeake Bay nitrogen fluxes derived from a land-estuarine ocean biogeochemical modeling system: Model description, evaluation and nitrogen budgets. *Journal of Geophysical Research – Biogeosciences*, DOI: 10.1002/2015JG002931, 2015.

Flynn, K.J., M. St John, J.A. Raven, D.O. Skibinski, J.I. Allen, A. Mitra and **E.E. Hofmann**, Acclimation, adaptation, traits and trade-offs in plankton functional type models: Reconciling terminology for biology and modelling. *Journal of Plankton Research*, fbv036, 2015.

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Martinat, G., **C.E. Grosch** and **T.B. Gatski**, Modeling of Langmuir circulation: Triple decomposition of the Craik - Leibovich model. *Flow, Turbulence and Combustion*, 92, 395-411, DOI: 10.1007/s10494-013-9496-2, 2014.

McGillicuddy, D.J., P.N. Sedwick, **M.S. Dinniman**, K.R. Arrigo, T.S. Bibby, B.J.W. Greenan, **E.E. Hofmann**, **J.M. Klinck**, W.O. Smith, Jr., **S.L. Mack**, C.M. Marsay, B.M. Sohst, and G.L. van Dijken, Iron supply and demand in an Antarctic shelf ecosystem. *Geophysical Research Letters*, 42, 8088-8097, doi:10.1002/2015GL065727, 2015.

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Piñones, A., **E.E. Hofmann**, **M.S. Dinniman**, and **L.B. Davis**, Transport and fate of Euphausiids in the Ross Sea. *Polar Biology*, doi:10.1007/s00300-015-1798-5, 2015.

Plag, H.-P., Adaptation to sea level rise: Protecting against, or preparing the coastal zone for, inundation? *Tap Into Virginia*, 6(2), 41-50, 2015.

Plag, H.-P., Extreme volcanic eruptions — The global population may not be prepared. Column 9, On The Edge, *ApoGeo*, 30(2), Spring 2015, 10-15, 2015.

Plag, H.-P., Finding the message in the facts — Has humanity evolved into the most extreme hazard, and anthropogenic cataclysm? Column 10, On The Edge, *ApoGeo*, 30(3), Summer 2015, 8-11, 2015.

Plag, H.-P., The slowly developing disaster of sea level rise — Our responsibility: Preparing the coasts for large-scale inundation. Column 8, On The Edge, *ApoGeo*, 30(1), Winter 2015, 13-15, 2015.

Powell, E.N. and **E.E. Hofmann**, Models of marine molluscan diseases: Trends and challenges. *Journal Invertebrate Pathology*, doi:10.1016/j.jip.2015.07.017, 2015.

Powell, E.N., **J.M. Klinck**, D.M. Munroe, **E.E. Hofmann**, P. Moreno and R. Mann, The value of captains' behavioral choices in the success of the surfclam (*Spisula solidissima*) fishery on the U.S. Mid-Atlantic coast: A model evaluation. *Journal Northwest Atlantic Fisheries Science*, 47:1-27, 2015.

Sinha, N., A.E. Tejada-Martinez, C. Akan and **C.E. Grosch**, Towards a K-profile parameterization of Langmuir turbulence in shallow coastal shelves, *Journal of Physical Oceanography*, In press, 2015.

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Presentations

Cheng, Y.C., H.-P. Plag, T. Ezer, B.D. Hamlington, "Fluctuation of annual sea level cycle and sea level rise acceleration in China Seas," 9th Coastal Altimetry Workshop, Reston, VA, October 19, 2015.

Cheng, Y.C., **H-P, Plag, T. Ezer, B.D. Hamlington**, "Variations of observed correlations between satellite altimetry and tide gauge data along the U.S. east coast," Ocean Surface Topography Science Team Meeting 2015, Reston, VA, October 21, 2015.

Ezer, T., "Assessing the hazards and impacts of sea level rise in Virginia," Workshop on Mitigation and Adaptation Research in Virginia, Suffolk, VA, August 11, 2015.

Ezer, T., "Sea level rise and increased flooding in Hampton Roads", Department of Architecture, Hampton University, Hampton, VA, September 1, 2015.

Hofmann, E.E., "IMBER and Future Earth," oral presentation, OCB 2015 Summer Workshop, Woods Hole, MA, July 20-23, 2015.

Hofmann, E.E., "Projected changes and Southern Ocean food webs", oral presentation, IMBER IMBIZO IV, Trieste, Italy, October 27-30, 2015.

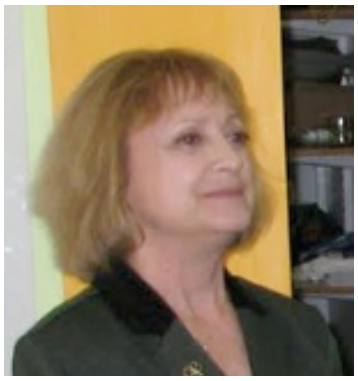
Plag, H.-P., "Adaptation to sea level rise: Protecting the coastal zone against, or preparing it for innundation?", lecture given at HoHai University, Nanjing, China, October 19, 2015.

Plag, H.-P., "Assessing Future Sea Level Rise and Mitigating the Impacts on the Coastal Zone," Lecture given at Ningbo University, Ningbo, China, October 22, 2015.

Plag, H.-P., "Observing, dissecting, and forecasting local sea level variations," lecture given at HoHai University, Nanjing, China, October 19, 2015.

CCPO SPOTLIGHT

Judy Hinch, Graduate Student



Judy Hinch received a B.S. from University of Hartford in chemistry and worked in the chemical industry in Connecticut for several years, married and had a son, and then moved to Virginia in 1988. In 1994, she graduated from Old Dominion University with an M.S. in health sciences and immediately went to work for Virginia OSHA. A single mom by this time, she worked for the state for 12 years before going to work for EVMS in the Safety Office, then worked for Sentara in occupational health. She worked in private industry as well, in environmental, safety and occupational health before returning to ODU last fall. Her interest in addressing climate change drove her back to academia, and to **Dr. Hans-Peter Plag**, who helped her gain admission into the Engineering Management program. Her adviser is Dr. C. Ariel Pinto, and she plans to study sea-level rise and flooding issues here in Norfolk and impacts on businesses that are in the flood zones. Wie Yusuf has also agreed to be on her dissertation committee. Judy volunteers with several environmental organizations and also enjoys birding, traveling and square dancing.

The Center for Coastal Physical Oceanography &
The Mitigation & Adaptation Research Institute Present:

SPRING 2016 SEMINAR SERIES

Join us on Mondays at 3 p.m. for a reception prior to the 3:30 p.m. seminar to hear expert speakers address topics focused on aspects of our changing climate.

JAN. 25	GAVIN SMITH Dept. of Homeland Securoty - Coastal Resilience Center of Excellence University of North Carolina at Chapel Hill
FEB. 01	DICK ZIMMERMAN Ocean, Earth & Atmospheric Sciences Old Dominion University
FEB. 08	A. BRAD MURRAY Division of Earth & Ocean Sciences Nicholas School of the Environment Duke University
FEB. 15	EILEEN HOFMANN Center for Coastal Physical Oceanography Old Dominion University
FEB. 22/29	NO SEMINARS 22 Ocean Sciences Meeting 29 Ocean Sciences Followup
MARCH 07	NO SEMINAR 07 ODU SPRING HOLIDAY
MARCH 14	SOPHIE NOWICKI NASA Goddard Space Flight Center Greenbelt, MD
MARCH 21	NICOLAS CASSAR Nicholas School of the Environment Duke University
MARCH 28	SARA MAXWELL Biology Department Old Dominion University
APRIL 04	DONGLAI GONG Dept. of Physical Sciences Virginia Institute of Marine Sciences College of William & Mary
APRIL 11	KIRSTIN DOW Dept. of Geography University of South Carolina

For more information, please contact Julie Morgan at julie@ccpo.odu.edu. For abstracts and biographies, visit ccpo.odu.edu/seminars.
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John Klinck, Director
Miasia Osbey, Chief Editor
Julie Morgan, Content Editor

CCPO SPOTLIGHT

Eric Jabs, CCPO Graduate Student, Discusses Climate Change with U.S. Secretary of State

Eric Jabs, PhD candidate in oceanography, was part of a group of eight ODU students selected to have lunch with U.S. Secretary of State John Kerry on Nov. 10, 2015. Secretary Kerry was visiting ODU to give an address on climate change, and also make significant policy statements for the administration regarding future executive branch actions. During his speech on the effects and significance of climate change, Secretary Kerry called out the importance of ODU's Pilot Program (more formally called the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project). After his speech, John Kerry shared lunch with the students plus Dr. Morris Foster, vice president for research, and Ray Toll, director for coastal resilience research.

During lunch the flow of conversation primarily was on the students' areas of study and interests. After explaining to the Secretary that his dissertation research was measuring the social capital among the pilot project members, Jabs asked the Secretary what brought him to ODU. He affirmed that the location for the address was chosen for the significance of what the pilot project is doing, as well as recognition of the gravity of the threat here in Hampton Roads. The Hampton Roads region has the worst case of sea level rise/subsidence on the East Coast, and second only to New Orleans in the country by magnitude.

Furthermore, the heavy concentration of critical national infrastructure in Hampton Roads makes the successful mitigation of the threat a natural priority. As a student, Jabs is grateful to ODU for providing the opportunity to interact with Secretary Kerry, as well as the flexibility to craft an interdisciplinary PhD program that blends oceanography, maritime management, and public policy.

Photo courtesy of the U.S. Department of State