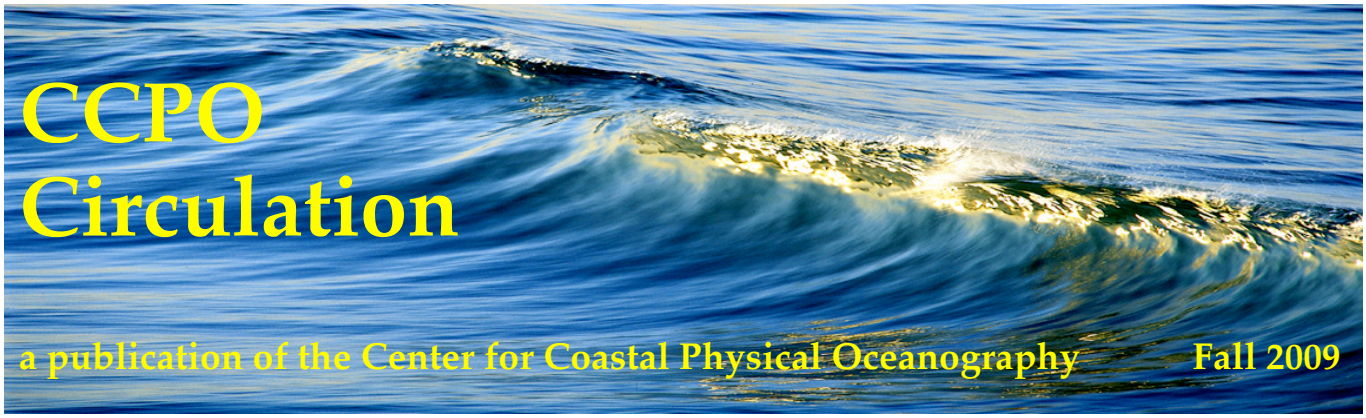

Vol. 16, No. 1

In this issue:

SIMULATION AND MODELING OF TURBULENCE

DR. TOM GATSKI

Turbulence is omnipresent in our daily lives and it is a phenomenon that is not yet fully understood. From the solar wind in the vast expanse of the universe to our own atmosphere and oceans, turbulence and turbulent flow play a pivotal role. As important as understanding the fundamental phenomenon is the ability to predict and subsequently control such flows. My primary research focus over the last two decades has been on the development of prediction models for such flows as well as on their direct numerical simulation (DNS).

This work has been mainly focused toward external aerodynamic applications, and it is an area where many of the model enhancements have taken place. Nevertheless, geophysical flows have also embraced many of these methods from Reynolds-averaged Navier-Stokes (RANS) methods to large eddy simulation (LES) techniques. The latter methodology is ideally suited to oceanographic applications in flow fields where a spectral separation of scales exist. While averaged and filtered methods, such as RANS and LES, may be the only option in practical flow fields, DNS offer the possibility of studying turbulence through a solution of the instantaneous conservation equations. While computationally intensive, with the grid points often numbering in the 10^8 range, some wall-bounded flows are amenable to solution. One advantage of such flow simulations is that they can yield structural characteristics not easily understood by other techniques.

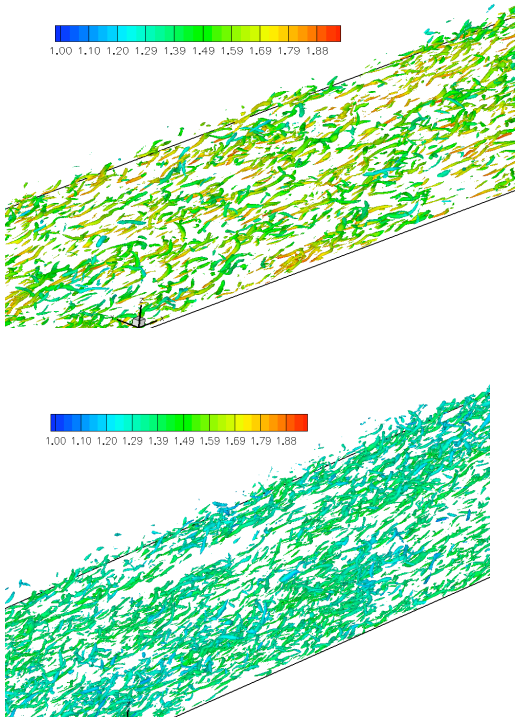

Figure 1: Q-criterion vortex structures in supersonic boundary layer flow at $M_\infty = 2.25$: (top) adiabatic wall condition; (bottom) isothermal (cold) wall condition.

In Figure 1, the Q-vortex criterion $(= 0.5\left[|\mathrm{W}|^2 - |\mathrm{S}|^2\right]$, where $\mathbf{W}$ is the

rotation rate tensor and **S** is the strain rate tensor) is shown for the DNS cases of a supersonic boundary layer flow at a free stream Mach number of 2.25 under adiabatic and isothermal (cold) wall conditions. The vortex structures in the figure are colored by mean temperature. Contrasting the two cases, the expected reduction in overall temperature levels in the isothermal case is seen; however, a structural change occurs between the adiabatic and isothermal cases as well. Although DNS are optimal in the sense that modeling is not required (although high-order algorithms are required), they are limited to relatively low-Reynolds number cases. In the supersonic boundary layer flow shown in Fig. 1, the free-stream momentum thickness Reynolds number is $\sim 5 \times 10^3$. Thus, direct simulations of practical flows are not possible for the foreseeable future.

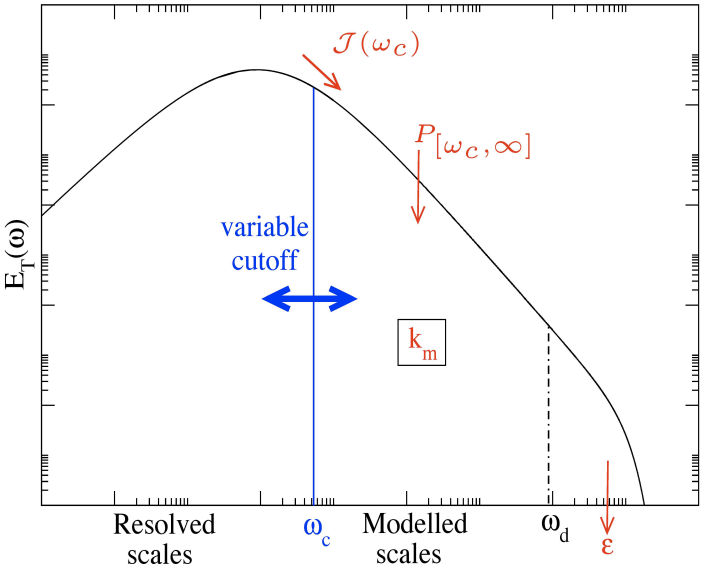

Figure 2: Sketch of spectral filter cutoff for eddy resolving methods.

The necessity to include some level of modeling of unresolved scales of motion leads to filtering methods, such as LES and hybrid RANS-LES, that are generally termed scale resolving or eddy resolving methods. As such, they capture larger scale (low wavenumber or frequency) motions of the flow and attempt to model the dynamic interactions between these large scale and unresolved small scale motions. While most of these formulations have been cast in the spatial domain, there has been research in the adaptation of such methods to the temporal domain. The underlying concept in spectral space is shown in Figure 2, in which the unresolved scales fall below the frequency cutoff of ω_c and these scales require modeling which needs to account for energy flux, $J(\omega_c)$, production, $P_{[\omega_c,\infty]}$, and dissipation, ε (below the frequency cutoff of ω_d). Such methods are ideally suited for studying ocean dynamics involving Langmuir circulations, whose spectral scales lie above that of the small scale turbulence.

While filtering methods allow for the direct computation of some range of resolved scales of motion, the traditional RANS methods simply decompose the flow into a mean part and an unresolved part in which all the scales of motion are modeled. Such methods have been well documented and range from the high-order Reynolds stress models to the more commonly used two-equation and one-equation models. Such methods have long been the basis of development for the General Ocean Turbulence Model (GOTM).

We are looking at the possibility of utilizing one or all of these methodologies in the solution of relevant ocean and atmospheric problems.

CCPO Researcher Earns Award

Congratulations to **Malcolm Scully**, who was selected as the 2009 winner of the Cronin Award for Early Achievement by the Coastal and Estuarine Research Federation (CERF). Malcolm, an assistant professor at CCPO, received the Cronin Award at the CERF biennial scientific conference, which was held November 1-5 in Portland, Oregon. According to CERF, the "Cronin Award is named for Dr. L. Eugene Cronin, Sr., the first president of ERF and a significant contributor to estuarine science and our organization. This award recognizes significant accomplishments of an estuarine scientist who is in the early stages of his/her career development. The recipient will have shown great promise with work carried out during the first six years past the PhD [sic]."

My Journey to Antarctica

by M. Andrea Piñones

The second of the last three cruises of the PATEX (PATagonian EXperiment)-VII, part of the Brazilian SOS-Climate (Southern Ocean Studies for Understanding Global Climate Issues) - project was scheduled to depart from Punta Arenas, Chile the evening of January 2, 2009. After emergency surgery for a member of the crew, the ship was ready to leave port the following evening. Our ship, the R/V *Ary Rongel*, is part of the Brazilian Navy, and is equipped with oceanographic equipment, laboratories and human support to conduct research in high latitude environments. The vessel is used as main support by the Brazil Antarctic Programme, carrying supplies and providing support to the scientists and personnel of the Brazilian Antarctic base, Comandante Ferraz, on King George Island, which is in the South Shetland Islands.

Andrea on board the R/V *Ary Rongel*, which was anchored in Admiralty Bay, King George Island in front of the Brazilian Antarctic Base.

We departed from the Punta Arenas Port and navigated through the Strait of Magellan towards the Patagonian shelf, south of the Falkland Islands. Once there, intensive day and night sampling was done with the aim of studying physical and biogeochemical processes, and the relationship between phytoplankton communities and the optical properties of the ocean along the Patagonian shelf break.

During the cruise, we occupied 28 stations distributed along the shelf break. Station locations were based on information from ocean color satellite images from the previous day, which allowed tracking of high concentrations of coccolithophorids. However, the persistent cloud cover in the region made defining exact locations for the stations difficult and affected the ability to do accurate predictions of the algal bloom location. The position of the stations was also limited by the international maritime boundaries of the region.

A multidisciplinary set of experiments and sampling was done at each station. Twenty-three researchers, led by chief scientist, Dr. Virginia Tavano Garcia from University Federal do Rio Grande, worked on different sets of experiments and different aspects of data collection. These included CTD measurements, deployment of radiometric buoy and light sensors (visible radiation), deployment of optical equipment (in the ocean), primary production experiments, analysis of nutrients, atmospheric particle counts, filtering for atmospheric trace elements, and recording of light through water at several wavelengths. Marine mammal and seabird sightings, as well as continuous plankton recorder (CPR) measurements, were also part of the activities during the cruise. The marine mammal observations were overseen by Dr. Manuela Bossoi from University Federal do Rio de Janeiro (UFRJ) as part of the Census of Antarctic Marine Life (CAML).

After sampling the Patagonian shelf, we began our journey to Antarctica. The forecast was favorable for crossing the Drake Passage, so after 48 hours, we reached Admiralty Bay located south of King George Island in the South Shetland Islands. During the passage to Antarctica, the ocean was very friendly. Old stories from crew members really frightened the first time visitors of the Southern Ocean, especially me, but with beginner's best luck, not only was the trip peaceful, but the seabird and whale sightings were also incredible.

Once in Antarctica, we had the opportunity to visit the Brazilian base, which is home to approximately 60 scientists and military personnel all year around. We were received with a welcoming reception by the "Comandante" [sic] of the base and later invited to have a tour around the base. Everyone there seemed quite busy doing maintenance and renovations for the visit of the members of the Brazilian Parliament that would take place few days later.

Our trip back home began after this visit. The scientific crew was scheduled to leave Antarctica by aircraft from the Chilean Antarctic base, Presidente Eduardo Frei. We navigated from Admiralty Bay towards Maxwell Bay and waited for the aircraft, a Hercules, to take us home from Antarctica. As a Chilean citizen, I was thrilled to visit "Villa Las Estrellas", a residential area that has a school, a bank, a hospital and other services to support the 80 to 150 people (depending on the season) who live there.

Another view of Admiralty Bay, with the R/V *Ary Rongel* in the background and a Gentoo penguin in the foreground.

After more than two weeks from the beginning of our journey from Punta Arenas to Patagonian waters and Antarctica, a few hours of seasickness, hundreds of pictures, some Portuguese words and many new friends, I left Antarctica grateful and happy to have received such a wonderful opportunity. I would like to gratefully acknowledge the invitation I received from Dr. Carlos Garcia from University Federal do Rio Grande to be part of this journey, and especially the help and support of my advisor, Dr. Eileen Hofmann.

CCPO POSTDOCTORAL RESEARCHER PROFILES

Tosca Ballerini

My research interests focus on the Southern Ocean ecosystem, and, in particular, on Adélie penguins and food webs. Adélie penguins are one of the most abundant top predators in the Southern Ocean. With the current climate warming, various factors can affect their populations in Antarctica. For example, the current trend of diminished winter sea ice can lead to habitat loss, competition with species more adapted to live in ice-free areas, and also diminished food availability. Some of the penguin prey are known to live in close association with sea ice, and a decrease of winter sea ice extent and duration will affect the penguins due to less food.

I studied Adélie penguins during my three years of doctoral study in the Department of Environmental Sciences at the University of Siena in Italy. As part of my Ph.D. research, I collaborated with the Italian Antarctic Research Program, taking part as a field biologist on a three-month expedition to the Adélie penguin colony of Edmonson Point in the Ross Sea, Antarctica. In order to determine the various factors associated with changes in mortality and breeding success in the penguins from our study population, we worked with individually marked birds for which we knew sex and age. The data collected during 11 years of work have been used to build some mark–recapture models and a matrix populations model that I developed in collaboration with the Seabird Ecology Group at the Mediterranean Institute for Advanced Studies in Mallorca, Spain. The main result we found from the population of Edmonson Point is that penguins survive better in the winter when there is an average extent of sea ice in the Ross Sea. According to the model simulations, the study population could rapidly decrease if the sea ice were to disappear in the Ross Sea, most likely as a result of loss of their winter sea ice habitat.

Climate change may impact not only single species, but it is likely to affect whole ecosystems, changing abundances of various species and therefore altering food webs processes. One interesting approach to study this subject is the construction of the End-to-End food web models, where all the components of a food web are described in one single mathematical model, starting from the inorganic nutrients and the primary producers, and going up to primary and secondary consumers, including the top predators such as seabirds and marine mammals. Understanding the functioning of an ecosystem can be important in order to predict possible consequences of environmental changes and can serve in the management of the ecosystem (for example, informing the fisheries).

I started to study food webs in November 2008, when I joined the research group of Dr. Eileen Hofmann at CCPO. We are currently working in the synthesis phase of the U.S. GLOBEC program, which involves four study regions: the Northwest Atlantic, the Northeast Pacific, the Gulf of Alaska, and the Southern Ocean. About 25 people participate in this project and I am currently developing the mathematical models for the Southern Ocean food web. It seems to me that the most challenging part of this project is putting together all (or a good quantity of) the information available on the various species/trophic groups that make up the ecosystem. I feel very fortunate to collaborate with a large group of people who are experts in different areas and can help give answers to the various questions that arise during the modeling process. One of the ultimate goals of this project is to develop similar mathematical models for the four study regions, to be able to compare them in terms, for example, of primary and secondary productivity, sustainable fishery extraction, and to get insights into different ways that climate change may affect them.

Guillaume Martinat

I arrived at CCPO in July 2008 to collaborate with Dr. Chet Grosch after graduating with a Licence and Maîtrise of applied physics from the Université de Rennes 1 and then earning a Master of Science and a Doctor of Science in fluid dynamics at the Institut National Polytechnique de Toulouse, which is now part of Université de Toulouse in France.

The first aspect of my research concerns diffusion at high Schmidt number through turbulent gas-liquid interface that occurs in many geophysical or industrial processes. It is for example the basic situation encountered in the exchange of soluble gas like CO_2 between the atmosphere and the oceans. In such conditions, two different process are responsible of the absorption of the gas by the liquid: first a diffusive process takes place in the immediate vicinity of the interface and is due to the gradient of concentration of the gas into the liquid. Second, a renewal, advective

process takes place, helping maintaining a high concentration gradient at the interface by bringing fresh water from the bottom to the top of the water column.

We aim to study the impact of the Langmuir circulation, which is a phenomenon of longitudinal pairs of counter rotating vortices occurring in wind and wave driven surface sheared flows, on the renewal process. The Langmuir cells are generated via the Craik-Lebovitch vortex force, modeling the interaction between the Stokes drift (induced by surface waves) and the shear current. Simulations are made using a hybrid spectral-finite difference solver, using Large Eddy Simulation (LES) for the turbulence modeling.

A second aspect of my research is made via collaboration with Institut de Mécanique des Fluides de Toulouse and Institut de Mathématiques de Toulouse of Université de Toulouse in France. One goal of that collaboration is to develop a fluid-stucture interaction finite elements solver using the getfem++ C++ library. Secondly, we aim to investigate with that solver the behavior of the flow past a cylinder rotating around its own axis at low Reynolds number, using direct numerical simulation.

CCPO SEMINAR SERIES

During the academic year, CCPO invites distinguished scientists to present seminars, which take place in Room 3200, Innovation Research Building 1, Old Dominion University on Mondays at 3:30 PM. A reception is held prior to the seminar at 3:00 PM. Eileen Hofmann, professor of oceanography, coordinates the seminar series. Specific topics are announced one week prior to each seminar; abstracts can be found at www.ccpo.odu.edu/seminars.html.

Fall 2009 seminar speakers

September 14	Luis Hückstädt, University of California, Santa Cruz
September 21	Joe Rieger**,** Elizabeth River Project, Norfolk, VA
September 28	A.D. Kirwan, Jr., University of Delaware
October 5	James Pierson**,** UMCES Horn Point Laboratory
October 19	Lora Harris, UMCES Chesapeake Biological Lab
October 26	Eric Powell, Haskin Shellfish Research Lab, Rutgers University
November 2	Eileen Hofmann**,** CCPO
November 9	Mark Bushnell, NOAA
November 16	Marina Marrari**,** NASA Goddard Space Flight Center
November 23	Fei Chai, University of Maine
November 30	Tim Wilkins**,** Paliria Energy, Inc.

Spring 2010 seminar speakers

January 25	William Dewar, Florida State University
February 1	Ruoying He, North Carolina State University
February 8	Tosca Ballerini, CCPO
February 15	Daniel Dickerson, Old Dominion University
March 1	Raghu Murtugudde, University of Maryland
March 15	John Klinck, CCPO
March 22	Guillaume Martinat, CCPO
March 29	Miguel Palmer, Mediterranean Institute for Advanced Studies/CQFE
April 5	David Allen, US Global Change Research Program, Washington, DC
April 12	Pete Sedwick, Old Dominion University

Publications

Chen, H., F. Qiao, **T. Ezer**, Y. Yuan, and F. Hua, Multi-core structure of the Kuroshio in the East China Sea from long-term transect observations, *Ocean Dynamics*, 59, 1616-7228, doi:10.1007/s10236-009-0182-9, 2009.

Ezer, T. and H. Liu, Combining remote sensing data and an inundation model to map tidal mudflat regions and improve flood predictions: A proof of concept demonstration in Cook Inlet, Alaska, *Geophysical Research Letters*, 36, L04605, doi:2008GL036873, 2009.

Friedrichs, M.A.M., M.-E. Carr, R. Barber, M. Scardi, and the PPARR team, Assessing the uncertainties of model estimates of primary productivity in the tropical Pacific Ocean, *Journal of Marine Systems*, 76, doi:10.1016/j.jmarsys.2008.05.010, 2009.

Gargett, A.E., Couette vs. Langmuir circulations: Comment on "On the helical flow of Langmuir circulation—Approaching the process of suspension freezing" by Dethleff, Kempema, Koch and Chubarenko, *Cold Regions Science and Technology*, 56, 58-60, 2009.

Gargett, A.E. and T. Garner, Determining Thorpe scales from ship-lowered CTD density profiles, *Journal of Atmospheric and Oceanic Technology*, 25(9), 1657-1670, 2008.

Gargett, A., A.E. Tejada-Martínez, and **C.E. Grosch**, Measuring turbulent large-eddy structures with an ADCP. 1. Vertical velocity variance, *Journal of Marine Research*, 66(2), 157-189, 2008.

Gregg, W., **M.A.M. Friedrichs**, A.R. Robinson, K. Rose, R. Schlitzer, and K.R. Thompson, Skill assessment in ocean biological data assimilation, *Journal of Marine Systems*, 76, doi:10.1016/j.marsys.2008.05.006, 2009.

Jolliff, J., J.C. Kindle, I. Shulman, B. Penta, **M.A.M. Friedrichs**, R. Helber, and R.A. Arnone, Summary diagrams for coupled hydrodynamic-ecosystem model skill assessment, *Journal of Marine Systems*, doi:10.1016/j.marsys.2008.05.014, 2009.

Legg, S., Y. Chang, E.P. Chassignet, G. Danabasoglu, **T. Ezer**, A.L. Gordon, S. Griffies, R. Hallberg, L. Jackson, W. Large, T. Ozgokmen, H. Peters, J. Price, U. Riemenschneider, W. Wu, X. Xu, and J. Yang, Improving oceanic overflow representation in climate models: the Gravity Current Entrainment Climate Process Team, *Bulletin of the American Meteorological Society*, 90(5), 657-670, 2009.

Narváez, D.A. and A. Valle-Levinson, Transverse structure of wind-driven flow at the entrance to an estuary: Nansemond River. *Journal of Geophysical Research*, 113, C09004, doi:10.1029/2008JC004770, 2008.

Powell, E.N., **J.M. Klinck**, K.A. Ashton-Alcox, and J.N. Kraeuter, Multiple stable reference points in oyster populations: biological relationships of the eastern oyster (*Crassostrea virginica*) in Delaware Bay, *Fisheries Bulletin*, 107, 109-132, 2009.

Powell, E.N., **J.M. Klinck**, K.A. Ashton-Alcox, and J.N. Kraeuter, Multiple stable reference points in oyster populations: implications for reference point-based management, *Fisheries Bulletin*, 107, 133-147, 2009.

Savidge, W.B., **A. Gargett**, R.A. Jahnke, J.R. Nelson, D.K. Savidge, R.T. Short, and G. Voulgaris, Forcing and dynamics of seafloor-water column exchange on a broad continental shelf. *Oceanography*, 21(4), 130-135, 2008.

Scully, M.E., W.R. Geyer, and J.A. Lerczack, The influence of lateral advection on the residual circulation: A numerical modeling study of the Hudson River estuary, *Journal of Physical Oceanography*, 39, 107-124, 2009.

Soniat, T.M., **E.E. Hofmann, J.M. Klinck**, and E.N. Powell, Differential modulation of eastern oyster (*Crassostrea virginica*) disease parasites by the El-Niño-Southern Oscillation and the North Atlantic Oscillation, *International Journal of Earth Sciences*, 98, 99-114, doi: 10.1007/s00531-008-0364-6, 2008.

Stow, C.A., J.K. Jolliff, D.J. McGillicuddy, Jr., S.C. Doney, **M.A.M. Friedrichs**, J.I. Allen, K.A. Rose, and P. Wallhead, Skill assessment for coupled biological/physical models of marine systems, *Journal of Marine Systems*, 76, doi:10.1016/j.marsys.2008.03.011, 2009.

Tejada-Martinez, A.E., **C.E. Grosch, A.E. Gargett**, J.A. Polton, J.A. Smith, and J.A. MacKinnon, A hybrid spectral/finite-difference large-eddy simulator of turbulent processes in the upper ocean, *Ocean Modelling*, 30, 115-142, 2009.

Presentations

Atkinson, L. and **J. Blanco**, Measurement and model requirements for offshore wind energy, 2009 American Meteorological Society Summer Community Meeting, Norman, OK, August 10-13, 2009.

Dinniman, M., Differences in the fate of Circumpolar Deep Water advected onto the continental shelf in the Ross Sea and West Antarctic Peninsula, Antarctic Climate and Ecosystems Cooperative Research Centre, University of Tasmania, Hobart, Tasmania, July 2009.

Dinniman, M., J. Klinck, and W. Smith, Jr., Difference in the fate of Circumpolar Deep Water advected onto the continental shelf in the Ross Sea and the West Antarctic Peninsula, oral presentation, Third GLOBEC Open Science Meeting, Victoria, British Columbia, Canada, June 22-26, 2009.

Dinniman, M., A. Piñones, E. Hofmann, and **J. Klinck**, Circulation on the Western Antarctic Peninsula: Implications for biological production, Commonwealth Scientific and Industrial Research Organization Marine and Atmospheric Research Hobart Laboratories, Hobart, Tasmania, July 2009.

Ezer, T., Applications of circulation and inundation models to support biological and environmental studies, Workshop on modeling the ocean: dynamics, synthesis and prediction, Taipei, Taiwan, February 23-26, 2009.

Friedrichs, M.A.M, E.E. Hofmann, B. Cahill, K. Fennel, D. Haidvogel, K. Hyde, C. Lee, A. Mannino, C. McClain, R. Najjar, J. O'Reilly, D. Pollard, S. Signorini, J. Wilkin, and J. Xue, Eastern U.S. continental shelf carbon budget: integrating models, data assimilation and analysis, North American Carbon Program, San Diego, CA, February 17-20, 2009**;** Ocean Color Research Team Meeting, New York, NY, May 4-8, 2009; and Ocean Carbon and Biogeochemistry Workshop, Woods Hole, MA, July 20-24, 2009.

Gargett, A.E., Adventures with a 5-beam ADCP: Turbulent mixing and transport processes on shallow shelves, Skidaway Institute of Oceanography, Savannah, GA, January 28, 2009.

Gargett, A.E., Langmuir circulations and their effects on the geology and biology of coastal shelf seas, National University of Ireland, Galway, April 6, 2009.

Hofmann, E.E., Understanding Disease Resistance in Estuarine Populations and Response to Climate Change, invited seminar, College of Science and Technology Distinguished Lecture Series, Texas A&M University-Corpus Christi, Corpus Christi, TX, January 23, 2009.

Hofmann, E.E., Southern Ocean GLOBEC Synthesis, oral presentation, Third US GLOBEC Pan-Regional Synthesis Workshop, Boulder, CO, February 17-20, 2009.

Hofmann, E.E., Understanding and Monitoring Climate Change in the Southern Ocean Mesopleagic Environment, invited presentation, Workshop on Monitoring Climate Change Impacts: Establishing a Southern Ocean Sentinel Program, Hobart, Tasmania, April 20-24, 2009.

Hofmann, E.E., Synthesis of Southern Ocean Food Webs, GLOBEC Seminar Series, National Oceanic and Atmospheric Administration, Silver Spring, MD, April 29, 2009.

Hofmann, E.E., Synthesis of Southern Ocean Food Webs, seminar presentation, National Science Foundation, Arlington, VA, April 30, 2009.

Hofmann, E.E., Antarctic Oceanography, seminar presentation, Eagle Ridge Middle School, Ashburn, VA, May 8, 2009.

Hofmann, E.E., Climate Impacts on the Southern Ocean Ecosystem, invited presentation, Workshop on Applying IPCC-class Models of Global Warming to Fisheries Prediction, Princeton, NJ, June 15-17, 2009.

Hofmann, E.E., The Southern Ocean Global Ocean Ecosystems Dynamics Programme, oral presentation, Third GLOBEC Open Science Meeting, Victoria, British Columbia, Canada, June 22-26, 2009.

Hofmann, E.E. and E.J. Murphy, Spatial and Temporal Operation of Southern Ocean Food Webs, invited presentation, OCB Scoping Workshop on New Frontiers in Southern Ocean Biogeochemistry and Ecosystem Research, Princeton, NJ, June 8-11, 2009.

Hofmann, E.E. and E.J. Murphy, Modelling Krill Biology and Ecology – Current Status, oral presentation, Third GLOBEC Open Science Meeting, Victoria, British Columbia, Canada, June 22-26, 2009.

Hofmann, E.E., F. Werner, and E. Murphy, Physical-biological Coupling in Marine Ecosystems, invited presentation, Third GLOBEC Open Science Meeting, Victoria, British Columbia, Canada, June 22-26, 2009.

Hofmann, E.E., J.M. Klinck, M.S. Dinniman, and W.O. Smith, Understanding and Monitoring Climate Change in the Southern Ocean Mesopelagic Region, Southern Ocean Sentinel Workshop, oral presentation, Hobart, Tasmania, April 2009.

Hofmann, E.E., J. Klinck, D. Bushek, S. Ford, X. Guo, E. Powell, D. Haidvogel, and J. Wilkin, Understanding Disease Resistance in Estuarine Populations and Response to Climate Change, oral presentation, Delaware Estuary Science and Environmental Summit, Cape May, NJ, January 11-14, 2009.

Klinck, J., M. Dinniman, and L. Padman, Large scale context for oceanic processes on the west Antarctic Peninsula, oral presentation, Third GLOBEC Open Science Meeting, Victoria, British Columbia, Canada, June 22-26, 2009.

Liu, H. and **T. Ezer**, Integration of Landsat imagery and an inundation model in flood assessment and predictions: A case study in Cook Inlet, Alaska, The 17th International Conference on Geoinformatics, Fairfax, VA, August 12-14, 2009.

Narváez, D., J.M. Klinck, E.E. Hofmann, E.N. Powell, and D. Hedgecock, The effect of immigration on disease resistance in an oyster population: A model study, poster presentation, Delaware Estuary Science and Environmental Summit, NJ, January 11-14, 2009.

Narváez, D., J. Klinck, E. Powell, **E. Hofmann**, J. Wilkin, and D. Haidvogel, Dispersal patterns of Oyster Larvae at Delaware Bay: A modeling study, National Shellfisheries Association 101st Annual Meeting, Savannah, GA, March 23-26, 2009.

Piñones, M.A., E. Hofmann, M. Dinniman, and **J. Klinck**, Circulation on the Western Antarctic Peninsula: implications for biological production, poster presentation, Third GLOBEC Open Science Meeting, Victoria, British Columbia, Canada, June 22-26, 2009.

Saba, V.S., **M.A.M. Friedrichs**, M.-E. Carr, and the PPARR team. The challenges of modeling marine primary productivity over multiple decades: A case study at BATS and HOT, Ocean Color Research Team Meeting, New York, NY, May 4-8, 2009; and Ocean Carbon and Biogeochemistry Workshop, Woods Hole, MA, July 20-24, 2009.

Scully, M.E., Wind-driven Modulation of Dissolved Oxygen in Chesapeake Bay 2009, University of Maryland Center for Environmental Science, Horn Point Laboratory, May 20, 2009.

Scully, M.E., The Dynamics and Structure of a Coastal Plain Estuary Revisited: The Importance of Tidal Nonlinearities to the Subtidal Estuarine Momentum Balance, 2009 Gordon Research Conference, Coastal Ocean Circulation, Colby-Sawyer College, New London, NH, June 11, 2009.

Shahab, M.F., G. Lehnasch, **T.B. Gatski**, and P. Comte, DNS of a Spatially Evolving, Supersonic Turbulent Boundary Layer Flow Over a Cooled Wall, paper presentation at the Sixth International Symposium on Turbulence, Heat and Mass Transfer, September 14-18, Rome, Italy, 2009.

Shahab, M.F., G. Lehnasch, **T.B. Gatski**, P. Comte, and A. Shams, Statistical Evaluation of the Shock Wave Boundary Layer Interaction Phenomenon, paper presentation at the XIXème Congrès Français de Mécanique, Marseille, France, August 24-28, 2009.

Tian, T., Results of three-dimensional model simulation analyses for US eastern continental shelf, US-ECoS project team meeting, Providence, RI, March 19-20, 2009.

Tuleya, R., Hurricane Model Transitions to Operations at NCEP/EMC: A Joint Hurricane Testbed (JHT) Program, 63rd Interdepartmental Hurricane Conference, St. Petersburg, FL, March 2009.

Tuleya, R., Tropical cyclone models at landfall, Hurricane Diagnostic and Verification Workshop, National Hurricane Center, Miami, FL, May 5, 2009.

Xue, J., **M.A.M. Friedrichs**, B. Cahill, K. Fennel, **E. Hofmann**, J. Wilkin, A. Mannino, and R. Najjar, The effect of river freshwater discharge on US Eastern continental shelf carbon cycling (USECoS), Ocean Color Research Team Meeting, New York, NY, May 4-8, 2009; and Ocean Carbon and Biogeochemistry Workshop, Woods Hole, MA, July 20-24, 2009.

Xue, J., C. Lee, **M.A.M. Friedrichs**, **E.E. Hofmann**, B. Cahill, K. Fennel, D. Haidvogel, K. Hyde, A. Mannino, C. McClain, R. Najjar, J. O'Reilly, D. Pollard, S. Signorini, and J. Wilkin, Eastern U.S. continental shelf carbon budget: integrating models, data assimilation and analysis, Chemical Oceanography in a Changing World, Savannah, GA, February 22-24, 2009; and Coastal Ocean Carbon Cycling, Xiamen, China, March 6-8, 2009.

Appointments & Awards

Ezer, T., promoted in May 2009 to a tenured Professor of Ocean, Earth & Atmospheric Sciences.

Gargett, A.E., Outstanding Reviewer in 2008, *Cold Regions Science and Technology*.

Narváez, D., selected to participate in the summer colloquium, Marine Ecosystems and Climate: Modeling and Analysis of Observed Variability, Boulder, CO, August 2-14, 2009.

Smith, E.A., convener of the User Requirements Review Workshop for the Chesapeake Inundation Prediction System, Falls Church, VA, February 9, 2009.

Smith, E.A., chaired session (Methods and Tools for Engaging Regulators and Natural Resource Managers in Ecosystem Based Management) at Ecosystem Based Management in the Chesapeake and Other Systems Symposium, Baltimore, MD, March 22-25, 2009.

Smith, E.A., chaired semi-annual membership of the Chesapeake Bay Observing System (CBOS), Norfolk, VA, May 4, 2009.

Tuleya, R., appointed as a Self Supporting Research Professional (SSRP).

Summer intern gains valuable experience at CCPO

Elizabeth Moncure, a junior math major and intended marine science minor at Smith College in Massachusetts, was fortunate to spend 10 weeks this past summer interning at Old Dominion University's (ODU) Center for Coastal Physical Oceanography (CCPO) and Rutgers University's Haskin Shellfish Research Laboratory (HSRL). With the help of **Eileen Hofmann**, CCPO Professor of Oceanography, and **Olga Polyakov**, CCPO Research Scientist, she has worked on a project mapping the live and dead oyster populations of two major Delaware Bay oyster beds and the percent mortality.

She began the summer at HSRL, where she spent four weeks helping in a re-survey of the Delaware Bay oyster beds. The re-survey began this year with two beds and will continue for 10 years with 10% of the Delaware Bay oyster beds being re-evaluated each year, thus verifying that the beds' quality level is accurate. Elizabeth spent her time in the field collecting 132 bushels of oysters on a boat at 4 AM, with Kathryn Ashton-Alcox and Jennifer Gius of HSRL. Back in the lab, she experienced the process of sorting the oyster bushels and recording volumes and weights.

During the remaining six weeks, she was at CCPO, where she became familiar with MATLAB and GMT. Using these two tools, she was able to map the number of live and dead oysters throughout the oyster beds and also calculate and map the percent mortality. Elizabeth will ideally continue working on this project by comparing the 2009 mortality percentages with the 2008 mortality data and thus obtain an estimate of the annual mortality rate of the Delaware Bay oyster population and an understanding of the environmental and/or biological factors contributing to the oyster mortality.

Elizabeth saw the summer as a wonderful learning process, as she's experienced the methods of collecting and analyzing data, and definitely come to appreciate the amount of labor that is required to complete a project. She would like to thank everyone at CCPO and HSRL, as well as Smith College and NOAA, both of which helped fund her summer internship.

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