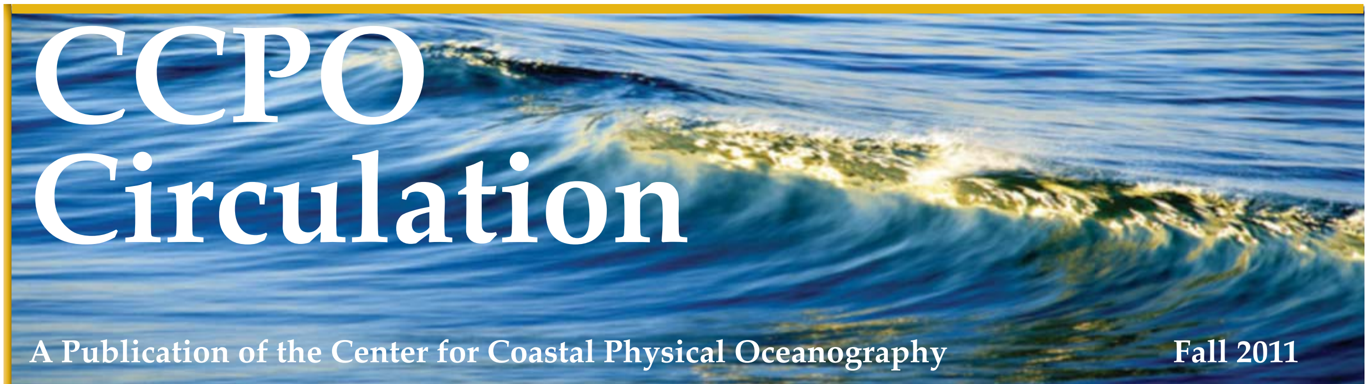

CCPO Circulation

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In this Issue:

Langmuir Circulations

By Dr. Chester E. Grosch

Langmuir circulations (LC), often occurring in the wind- and wave-driven surface mixed layer of lakes and oceans, consists of pairs of parallel counter-rotating vortices (or cells) oriented approximately in the downwind direction (Figure 1). Originally characterized by Langmuir (1938), Langmuir cells are now generally accepted to be the result of the interaction between the wind-driven shear current and the Stokes drift current induced by surface gravity waves (Thorpe, 2004).

Langmuir cells are among several flow phenomena generating turbulence in the upper ocean; others include wind- or tidal-driven shear flows, buoyancy-driven convection, and wave breaking. As with all turbulent flows, Langmuir turbulence encompasses a range of spatial and temporal scales. Amongst the larger spatial scales in Langmuir turbulence are those of the cells which extend in the downwind direction for tens of meters to kilometers and are separated by distances ranging from meters to as much as a kilometer (Thorpe, 2004). As might be expected, a cell is neither steady nor uniformly spaced but rather interacts with itself and other cells. In general, Langmuir turbulence is an important process for vertical mixing over a wide range of scales as well as for transport when combined with a horizontal shear current.

A model for the generation of LC was first proposed by Craik and Leibovich (1976). It consists of a vortex force (the Craik-Leibovich force or C-L force) in the momentum equations modeling the nonlinear interaction between the Stokes drift, driven by the surface waves, and the vertical shear of the current; specifically, it is the vector cross product between the Stokes drift velocity and the flow vorticity.

Figure 1. Langmuir circulation indicated by foam streaks on Rodeo Lagoon in Marin Headlands, Golden Gate Recreation Area, CA. The lagoon is approximately 100 meters wide at this location and streaks are estimated to be about 8-10 meters apart. The ocean is to the right of the pictured area and wind was blowing from the ocean parallel to the axis of the lagoon. The tide was flowing into the Lagoon through a channel in the sandbar at the entrance. Note the wave crests roughly perpendicular to the streaks. The photo was taken by L.J. Grosch with an iPhone on August 8^{th}, 2011 while walking the Miwok Trail with C.E. Grosch. Further discussion of Rodeo Lagoon, including observations of Langmuir streaks, is available at Wikipedia.

The derivation of the C-L force is subtle, requiring low-pass time filtering or wave-phase averaging in order to filter out the high frequency surface waves. The averaging is not ensemble averaging so that the resulting equations are not of the RANS (Reynolds-averaged Navier-Stokes type. However, because of the low-pass time filtering, these equations cannot represent the complete range of space and time scales of a turbulent flow, and thus would not be appropriate for carrying out direct numerical simulations (DNS) of flows with LC. Instead, these equations can only represent a range of scales from the largest eddies to those just above the filter cut-off, and thus can be thought of as the large eddy equations. Thus a numerical simulation using these equations is a Large-Eddy Simulation (LES).

A group at CCPO, **C.E. Grosch** and **G. Martinat**, along with a former CCPO scientist, Y. Xu, and together with colleague, A.E. Tejada-Martinez and his students at the University of South Florida, and others have been carrying out LES of LC driven by surface wind stress and/or pressure gradient driven flow (tidal flow) for a number of years with support from NSF. *(Article continued on page 2; citations listed on page 3.)*

Details of the numerical method, the subgrid-scale closure, the temporal and spatial discretization, the grid stretching function and the finite difference stencils are given in Tejada-Martinez and Grosch (2007) and Tejada-Martinez et al. (2009). Our most recent research has focused on the detailed dynamics of the flow in the very near bottom and surface regions. We have discovered that Langmuir circulation disrupts the log-layer of the mean velocity profile while leaving the viscous sub-layer profile unchanged.

The discovery of the log-layer in the mean velocity profile within the turbulent boundary layer and close to a solid boundary was due to Th. von Karman in the early 1930s. The log-layer structure of the mean velocity profile can be understood by considering the dynamics of the flow near a solid boundary. Very close to a solid boundary the flow dynamics depend on only two parameters, the stress on the boundary, τ, and the kinematic viscosity coefficient, ν. A velocity scale, the friction velocity, u_*, is defined by $u_*^2 = \tau/\varrho$ with ϱ the density. A viscous length scale, z_*, is then defined as $z_* = \nu/u_*$. Very close to the solid boundary, in the viscous sublayer, the mean velocity profile, $U(z)$, is linear,

$$\frac{U}{u_*} = \frac{z}{z_*} .$$

The viscous sublayer extends from the solid boundary to $z/z_* = 5$ to 7. Th. von Karman showed that in the region $30 \approx z/z_* \approx 100$ the mean velocity profile had a logarithmic shape,

$$\frac{U}{u_*} = \frac{1}{\varkappa} \ln \frac{z}{z_*} + B,$$

where ϰ is von Karman's constant (= 0.41 ± 5%) and B a constant. One consequence of the existence of the log-layer is that the mean dissipation rate, ε, in this region varies as

$$\varepsilon = \frac{u_*^3}{\varkappa z}$$

If the boundary is rough, the viscous length scale, z_*, is simply replaced by the roughness height, z_0. The existence of the viscous sub-layer and the log-layer has been confirmed by many experiments and DNS.

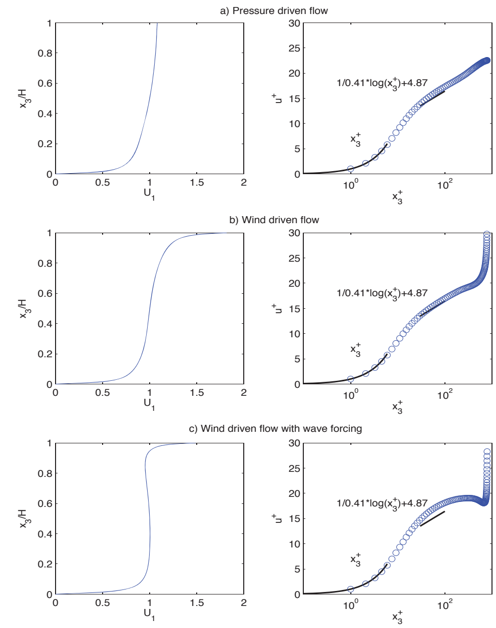

Figure 2.
Mean streamwise velocity profiles as a function of depth. The left panels show $U_1 \equiv U / U_1^c$ versus $x_3/H \equiv z/H$ with U_1^c the mean velocity at mid-depth, H/2. On the right is $u^+ \equiv U/u_*$ versus $x_3^+ \equiv z/z_*$. The solid line is the log profile plotted in $30 \le x_3^+ \le 100$. Two different vertical scalings are used in this Figure. The x_3/H scale shows the profile in the usual, undistorted form. The x_3^+ scaling emphasizes the inner region of the boundary layer highlighting the viscous sub-layer and the log-layer. The circles mark the values of the mean profiles at the grid points.

Figure 2 (Martinat et al., 2011) is a plot of the mean velocity profiles from our LES for three cases; (a) pressure gradient driven flow, (b) surface shear stress driven flow without waves (i.e., without the C-L vortex force) and (c) surface shear stress driven flow with waves (i.e., with the C-L vortex force). The semi-log plot emphasizes the near bottom boundary region of the flow. In all cases the total stress on the bottom is the same so that the flows are dynamically similar. The thin boundary layers on the bottom (case a) and on the bottom and surface for the other cases are apparent. In all cases the viscous sub-layer is seen with five grid points in it, with the first at $x_3^+ = z/z_* = 1$. In cases (a) and (b) it can be seen that there is a log-layer in $30 \le x_3^+ \le 100$. However, in case (c) with wave-forcing Langmuir circulation via the C-L vortex force, the log-layer is disrupted; the profile is curved rather than linear on the semi-log scale. Results for other cases where the pressure gradient and the surface stress were coincident or were normal to each other were shown in Martinat et al. (2011, not shown here). The results were the same as for the cases shown here; the presence of the C-L vortex force disrupted the log-layer. This occurred for both the components of the mean velocity profile when the pressure gradient was normal to the surface stress.

We concluded that in all cases, Langmuir circulation disrupts the log-layer of the mean velocity profile while leaving the viscous sub-layer profile unchanged. The mechanism of the distruption is that Langmuir cells are large-scale structures and enhance mixing generating a wake-like region stretching down through the would-be log-layer region and into the buffer region above the viscous sublayer. This causes a "law of the wake" like behavior. The law of the wake in boundary layers has been attributed to large-scale structures and consequent mixing (Coles, 1956). It seems that similar dynamics are driven by Langmuir circulation.

Our results showing that Langmuir circulation disrupts the log-layer have important implications for turbulence parameterizations commonly used in regional or general circulation models. The changes in the balance terms of the TKE equation (not shown here, see Martinat et al. (2011) for details) caused by the waves may require a rethinking of the modeling. In addition, the usual calibration of one and two-equation turbulence parameterizations is partially based on assumptions that are valid within the log-layer (Umlauf and Burchard, 2003, 2005) but may not be consistent with the presence of Langmuir circulation. Our results indicate that new calibrations consistent with log-layer disruption by Langmuir circulation should be pursued. We are currently studying this. *(See page 3 for citations.)*

Notes from the Director

John Klinck

Travel is an essential part of science these days and the group at CCPO is doing its share. Some travel is required to accomplish a task such as Tal Ezer teaching ocean modelers in China or Stefanie Cumberledge learning about sea ice in Svalbard. Eileen Hofmann travels to guide an international program. Some of us travel locally on the R/V *Slover* to let middle school students and Boy Scouts experience oceanography. Even during holiday travel, we cannot seem to get away from our work as Chester Grosch illustrates with his serendipitous observation of Langmuir cells. Finally, we all seem to be doing more traveling (or collaborating) virtually through network video links to save time and money. However we do it, travel lets us share our accomplishments with others and bring back new ideas. Thanks to all for your time and efforts.

CCPO Researcher Invited to Train Ocean Modelers at a New Ocean Dynamics and Climate Center in China

Tal Ezer, Professor of Ocean, Earth and Atmospheric Sciences at CCPO, spent two weeks in June 2011 in Qingdao, China. He was invited to the opening of the new Ocean Dynamics and Climate Center, a regional training and research center established by the Intergovernmental Oceanographic Commission of UNESCO and managed by the First Institute of Oceanography of the State Oceanic Administration of China. The center provides training on ocean dynamics, air-sea interaction and numerical modeling to young scientists, particularly from developing countries in the region. The first regional training on ocean models was held June 10-16, 2011, with participation of 10 world-leading ocean modelers as lecturers (including Ezer) and some 70 trainees selected from countries including Australia, China, Indonesia, Korea, Malaysia, Peru, Russia, Thailand and Vietnam. He is likely to return to China for the annual training in the following years. Prior to the training course, he attended the Third International Workshop on Modeling the Ocean (IWMO-2011), June 6-9, 2011, which was also held in Qingdao, and included some 100 scientists from over 20 countries. This meeting followed on the Second IWMO meeting hosted at CCPO and organized by Tal Ezer in May 2010 (a special issue of refereed papers from this meeting was co-edited by Ezer and published this summer in the journal, *Ocean Dynamics (*Ezer et al. 2011).

Picture taken in front of the First Institute of Oceanography building with the lecturers (Tal Ezer, first row, 9th from the left) and trainees.

Cont'd. from page 2, Langmuir Circulations citations:

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Thorpe S., "Langmuir Circulation." Annu. Rev. Fluid Mech., 36, 55-79, 2004.

Tejada-Martinez, A.E. and Grosch, C.E., "Langmuir turbulence in shallow water. Part 2. Large-eddy simulation", J. Fluid Mechanics, 576, 63-108, DOI: 10.1017/S0022112006004587, 2007.

Tejada-Martinez, A.E., Grosch, C.E. and Gatski, T.B., "Temporal large eddy simulation of unstratified and stably stratified turbulent channel flows", Int. J. Heat and Fluid Flow, 28, 1244-1261, DOI: 10.1016/j.ijheatfluidflow.2007.06.002, 2007.

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Umlauf, L. and Burchard, H., "A generic length-scale equation for geophysical turbulence models", J. Marine Res. 61, 235-265, 2003.

Umlauf, L. and Burchard, H., "A generic transport equation for the length scale in turbulent flows", in Marine Turbulence, Eds. Baumert, H.Z., Simpson, J.H. and Sundermannn, J., 188-196, Cambridge University Press, 2005.

CCPO: A Season of Outreach

Curtis Barnes demonstrates how water samples are collected using a CTD to 8th grade students from Christ The King School.

For most of its 20-year history, CCPO has maintained a strong commitment to educational outreach activities. In late May, CCPO scientists arranged for Dr. Ari Friedlaender from the Duke University Marine Laboratory in Beaufort, NC, to make a presentation on whales to the entire student body (grades K-8) at Christ The King School. The students were fascinated by the videos of Dr. Friedlaender's whale-tagging research. Late May also brought the Boy Scout Oceanography merit badge program, which included scouts from Troop 2806 in Midlothian, VA, aboard the R/V *Fay Slover.* CCPO personnel **Eileen Hofmann** and **Julie Morgan** were assisted with the program by Melissa Phillips (OEAS graduate student) and Karen Akaratoric (Biology Department student). As always, the crew of the *Slover* — Captain Richard Cox; Curtis Barnes, Equipment Specialist; and Becca Ostman, Mate — provided support and helped make the merit badge program a fun experience for the scouts. CCPO scientist **John Klinck** oversaw a shore-based program for the scouts that had to wait for their turn on the *Slover.* During July, Eileen Hofmann participated in the Beazley Foundation-funded RiverQuest summer camp program that was developed by Dr. Daniel Dickerson and Stephanie Hathcock from the Department of STEM Education and Professional Studies at Old Dominion University. She helped with land-based activities during the time that groups of students went out on the R/V *Riptide* (OEAS small boat) to sample the Lafayette River. In August, CCPO personnel Julie Morgan, Eileen Hofmann, and John Klinck participated in a Boy Scout Oceanography merit badge program that was developed by Bob Heitsenrether and Joe Colby from the NOAA/National Ocean Service Center for Operational Oceanographic Products and Services in Chesapeake, VA. The group from CCPO provided two hands-on activities. The first focused on oceanographic equipment and the scouts had the opportunity to measure salinity using refractometers. The second consisted of aquaria with various animals, such as oysters, snails, and crabs, from local estuarine waters. Julie Morgan assisted with an activity in which the scouts built buoys. The requirement was that the buoy actually had to float! Overall, almost 400 children were involved in these various outreach activities.

CCPO People Profiles

Stephanie Paul
CCPO Office Manager

Stephanie Paul comes to CCPO as the office manager with a background in program management, continuing education and event planning, and graphic design. Her duties at CCPO include editing the center newsletter, *CCPO Circulation,* website maintenance and design, and office coordination. Following graduation from Old Dominion University with a Bachelor of Arts degree in communications and minor in political science, Stephanie worked for VOLUNTEER Hampton Roads as community relations manager. Originally from the Philadelphia area, Stephanie then returned there to work for the American Institute of Architects (AIA) Philadelphia as director of programs and events. At AIA Philadelphia, she implemented the chapter's annual design competition and awards, planned continuing education programs, and coordinated various events and committee activities for member architects. Most recently, Stephanie has done freelance graphic design, event planning and program management. Stephanie enjoys spending her free time on the beach with her husband, two sons, daughter, and chocolate lab, Charlie.

William Boll
Graduate Research Assistant

William Boll graduated from Georgia Institute of Technology in Atlanta, GA, in 2009 with a Bachelor of Arts degree in physics. While there, he taught recitation courses, ranging from Calculus I-III and Physics I-II. He volunteered in a graduate optics lab as an undergraduate research assistant in the Georgia Tech Observatory. Currently working towards his M.S. degree at Old Dominion University, William is also a teaching assistant for undergraduate oceanography labs. His main topic of focus is internal waves and determining the driving forces behind them. William's work initially began with Ann Gargett, a previous ODU/CCPO faculty, who deployed a VADCP off the coast of New Jersey in 2003 seeking to capture Langmuir cells within the water column. Armed with unique data and the guidance of **Chester Grosch** as his advisor, his aim is to characterize internal wave structures from that location. When he is not processing data and trying to reconstruct measurements, he enjoys playing hockey on the weekends. His future plans are to pursue a Ph.D. in physics in a field related to fluid dynamics and one day hold a research position at an accredited university while continuing to teach various courses.

Above the Arctic Circle: Sea Ice in Svalbard

Stefanie Cumberledge, CCPO Ph.D. student at the University Center in Longyearbyen, Svalbard

For two weeks this summer, CCPO Ph.D. student **Stefanie Cumberledge** traveled to Longyearbyen, Svalbard, and participated in a summer school, *Role of sea ice in the climate system,* with 48 other graduate students and postdoctoral researchers from around the world. The school was sponsored by ResClim (www.resclim.no) and held at the University Center in Svalbard (UNIS) (Figure 1). Svalbard is an Arctic archipelago (see map, Figure 2) that supports miners, academics, and tourists (Figure 3). Longyearbyen, a Norwegian town of about 2000 people, is located at 78°N, approximately halfway between Norway and the North Pole.

Figure 1. University Center in Svalbard (UNIS)

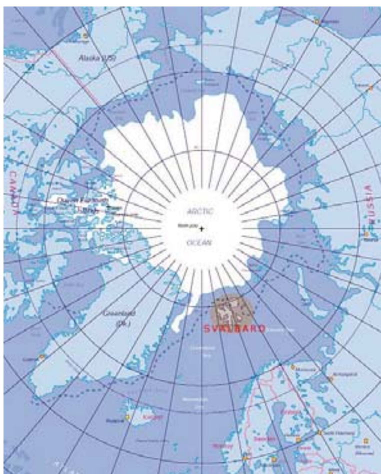

Figure 2. Map showing location of Svalbard in relation to the Arctic Circle.

In her limited free time, Stefanie toured the town and took several trips to see the wonders of Svalbard. The students took a boat trip to visit a glacier and the abandoned Russian mining settlement, Pyramiden. The participants also had dinner one evening in a traditional round hut, heated by a central fire and ate some excellent reindeer stew. Stefanie was both relieved and disappointed that they did not see a single polar bear.

The lectures on sea ice started with the basics: how ice forms and crystallizes and the impact of salinity on the freezing of ice. Then a variety of experts in the field gave overviews on different aspects of sea ice. There were lessons about fresh water cycling in the Arctic, thermodynamics and the salinity of sea ice, the optical properties of sea ice, and the difference between sea ice formation in the Arctic and the Antarctic. Stefanie also learned how sea ice can impact the global climate system, why it is difficult to represent in climate models, and that a response to a climate trend is amplified in polar regions. Several more specific topics came up as well, including turbulence at the sea ice edge, the effects of tides on sea ice in a polynya, paleo and historical records of sea ice, and remote sensing. Overall, the lecturers presented a view on sea ice that was both broad and deep.

Figure 3. Cruise ship entering harbor. Fjord mountain in the distance.

There were three sessions of group work held based on the weeks' lectures. The first session involved building a simple sea ice model using Matlab and observing the changes to that model when the students varied or fixed different parameters. The second session was a look into online databases of climate model results. The participants examined different model results and compared trends with actual data to see which models were better. The third session, and probably Stefanie's favorite, was modeling the climate in a coffee cup. In this session, there were approximately 10 groups total, and each group was assigned a different task. One group did theoretical work with climate equations, another used Matlab to model the coffee cup, several groups experimented with actual coffee cups, one group was in charge of media relations (i.e., taking pictures), and the last represented the IPCC (Intergovernmental Panel on Climate Change) and gathered data in a report. This final session really taught the students about real-life research. Each group chose different standards for measuring. They were short one thermometer, so one group represented a less developed country with limited funding, and no one finished in time to give the IPCC a full data set.

All of the students who attended presented a poster of their work and four gave oral presentations; many were first-year Ph.D. students. It was encouraging for everyone to see so many people going through the same phase of graduate study, hear about future plans and learn how they got to this point. Friendships were made with both the students and the lecturers, and many are now connected on Facebook. It was definitely a great way for Stefanie to enjoy two weeks of vacation, learn a lot about sea ice, and get a jump-start on being involved in the sea ice community.

Appointments/Awards

Hofmann, E.E., Member, NAS/NRC Polar Research Board, 2011-2014.

Graduates

Tian, Tian, M.S., Thesis Title: Model-based Analyses of Nitrogen Cycling on the Middle Atlantic Bight Continental Shelf, August 2011, Advisor: E.E. Hofmann.

Kamel, Mahmoud, M.S., Thesis Title: The Effect of an Offshore Wind Turbine Array on Circulation in an Idealized Coastal Ocean, August 2011, Advisor: J.M. Klinck.

Publications

Dinniman, M.S., J.M. Klinck and **E.E. Hofmann**, The influence of surface winds on Circumpolar Deep Water transport and ice shelf basal melt along the West Antarctic Peninsula, *Journal of Climate,* 2011, submitted.

Dinniman, M.S., J.M. Klinck, and W.O. Smith, Jr., A model study of Circumpolar Deep Water on the West Antarctic Peninsula and Ross Sea continental shelves, *Deep-Sea Research II*, 58, 1508-1523, doi:10.1016/j.dsr2.2010.11.013, 2011.

Ezer, T., L.-Y. Oey, X. H. Wang, and H. Xue, Editorial- The 2nd International Workshop on Modeling the Ocean (IWMO-2010), *Ocean Dynamics*, doi:10.1007/s10236-011-0470-z, 2011.

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Hofmann, E.E., D.P. Costa, and J.J. Torres, The US Southern Ocean GLOBEC Program, *Current*, 27, 19-23, 2011.

Hofmann, E.E., P.H. Wiebe, D.P. Costa, and, J.J. Torres**,** Co-Editors, *Understanding the Linkages between Antarctic Food Webs and the Environment: A Synthesis of Southern Ocean GLOBEC Studies, Deep-Sea Research II,* 58(13-16), 2011.

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Martinat, G., Y. Xu, **C.E. Grosch,** and A.E. Tejada-Martínez, LES of turbulent surface shear stress and pressure-gradient-driven flow on shallow continental shelves, *Ocean Dynamics*, Online First™, July 19, 2011.

Presentations

Ballerini, T. and **E.E. Hofmann,** "Analysis of the role of the Antarctic krill in the marine food web of Marguerite Bay, Western Antarctic Peninsula", poster presentation, Advances in Marine Ecosystem Modelling Research Symposium, Plymouth, England, June 27-30, 2011.

Cavanagh, R.D., E.J. Murphy, **E.E. Hofmann,** and N.M. Johnston, "Coordinating international research on Southern Ocean ecosystems: implementation of the ICED Programme", poster presentation, ESSAS Open Science Meeting, Seattle, WA, May 22-26, 2011.

Cavanagh, R.D., E.J. Murphy, **E.E. Hofmann,** and N.M. Johnston, "Coordinating international research on Southern Ocean ecosystems: implementation of the ICED Programme", poster presentation, Advances in Marine Ecosystem Modelling Research Symposium, Plymouth, England, June 27-30, 2011.

Corlett, W. B. and **T. Ezer,** "Preliminary analysis on the interannual shifting of the Caribbean current", Undergraduate Research Symposium, Old Dominion University, Norfolk, VA, February 12, 2011.

Dinniman, M.S. and **J.M. Klinck**, "The influence of surface winds on Circumpolar Deep Water transport and ice-shelf basal melt along the west Antarctic Peninsula", International Glaciology Society and FRISP meeting on Interaction of Ice Sheets and Glaciers with the ocean, La Jolla, CA, June 7, 2011.

Dinniman, M.S., J.M. Klinck, and A.K. Wahlin, "The importance of short duration wind events on intrusions of Circumpolar Deep Water onto Antarctic continental shelves", 6th Antarctic Meteorological Observation, Modeling and Forecasting Workshop, Hobart, Australia, June 23, 2011.

Dinniman, M.S., P. St-Laurent, and **J.M Klinck,** "What controls the time scale of Circumpolar Deep Water intrusions onto Antarctic continental shelves", IUGG, Melbourne, Australia, July 2, 2011.

Ezer, T., W. Heyman, and C. Houser, "High-resolution simulations of flow-topography interactions near coral reefs and potential implications for Caribbean fish spawning aggregations", The 3rd International Workshop on Modeling the Ocean (IWMO-2011), Qingdao, China, June 8, 2011.

Garner, T., "High Frequency RADAR Activities at Old Dominion University", poster presentation, Fifth Radiowave Operators Working Group meeting," Santa Barbara, CA, April 26-27, 2011.

Hofmann, E.E., "Physical-biological models and recruitment process: examples from marine systems", Physical-Biological Coupling Workshop, Detroit, MI, August 16-17, 2011.

Hofmann, E.E., S. Beauvais, and L. Maddison, "The IMBER Project", poster presentation, ESSAS Open Science Meeting, Seattle, WA, May 22-26, 2011.

Hofmann, E.E., S. Beauvais, and L. Maddison, "The IMBER Project", poster presentation, Advances in Marine Ecosystem Modelling Research Symposium, Plymouth, England, June 27-30, 2011.

Hofmann, E.E., F. Castruccio, D.B. Haidvogel, **J.M. Klinck,** R.L. Mann, D.M. Munroe, **D. Narvaez,** and E.N. Powell, "Interactions of behavior, growth and circulation on dispersal of marine larvae", Advances in Marine Ecosystem Modelling Research Symposium, Plymouth, England, June 27-30, 2011.

Hofmann, E.E., M.S. Dinniman, and **J.M. Klinck,** "The influence of surface winds on Circumpolar Deep Water transport and ice shelf basal melt along the western Antarctic Peninsula", poster presentation, ESSAS Open Science Meeting, Seattle, WA, May 22-26, 2011.

Klinck, J.M., "Model results of Circumpolar Deep Water intrusion on the Ross and West Antarctic Peninsula Shelves", invited presentation, Workshop on Oceanographic Studies of the Amundsen Sea, University of Gothenburg, Gothenburg, Sweden, April 26-May 1, 2011.

Klinck, J.M. and **M.S. Dinniman, "**Oceanic processes associated with delivery of warm water under ice shelves", International Glaciology Society and FRISP meeting on Interaction of Ice Sheets and Glaciers with the ocean, La Jolla, CA, June 5-10, 2011.

Klinck, J.M., M.S. Dinniman, and **E.E. Hofmann,** "The influence of surface winds on Circumpolar Deep Water transport, ice shelf basal melt, and nutrient supply along the western Antarctic Peninsula", poster presentation, Advances in Marine Ecosystem Modelling Research Symposium, Plymouth, England, June 27-30, 2011.

Martinat, G., C.E. Grosch, and A.E. Tejada-Martinez, "LES (Large Eddy Simulation) of turbulent surface shear stress and pressure gradient driven flow on shallow continental shelves", poster presentation, Seventh International Symposium On Turbulence and Shear Flow Phenomena (TSFP-7), Ottawa, Canada, July 28-31, 2011.

Murphy, E.J., **E.E. Hofmann,** R.D. Cavanagh, T. Ballerini, **A. Piñones,** N.M. Johnston, and S. Hill, "Comparisons of Southern Ocean ecosystems", poster presentation, ESSAS Open Science Meeting, Seattle, WA, May 22-26, 2011.

Murphy, E.J., R.D. Cavanagh, **E.E. Hofmann,** S. Hill, N.M. Johnston, P.N. Trathan, A. Constable, D.P. Costa, M. Pinkerton, **J. Klinck,** D. Wolf-Gladrow, and K.L. Daly, "Developing integrated models of Southern Ocean food webs", ESSAS Open Science Meeting, Seattle, WA, May 22-26, 2011.

Scully, M.E., "The physical modulation of seasonal hypoxia in Chesapeake Bay", Marine Science Department seminar, University of North Carolina at Chapel Hill, March 23, 2011.

Scully, M.E., "Estuarine turbulence modeling", Chesapeake Community Modeling Program, Hydrodynamic Modeling Workshop, Smithsonian Environmental Research Center, Edgewater, MD, June 10, 2011.

Scully, M.E., "Physical controls on hypoxia in Chesapeake Bay", Coastal Ocean Fluid Dynamics Laboratory Seminar, Woods Hole Oceanographic Institution, August 19, 2011.

Shahab, M. F., G. Lehnasch, **T.B. Gatski,** and P. Comte, "Post-shock downstream evolution of turbulent boundary layer based on quadrant analysis", XXth Congres Francais de Mecanique, Besancon, France, August 28-September 2, 2011.

St-Laurent, P., J.M. Klinck, and **M.S. Dinniman**, "Role of coastal troughs in the transport of heat to ice shelves", oral presentation, International Glaciology Society and FRISP meeting on Interaction of Ice Sheets and Glaciers with the ocean, La Jolla, CA, June 6-10, 2011.

St-Laurent, P., J.M. Klinck, and **M.S. Dinniman**, "Role of coastal troughs in the transport of heat to ice shelves", poster presentation, Coastal Ocean Modeling Gordon Research Conference, Mount Holyoke College, MA, June 26-30, 2011.

Thais, L., **T.B. Gatski,** and G. Mompean, "Some dynamical features of the turbulent flow of a viscoelastic fluid", 7th International Symposium on Turbulent Shear Flow Phenomena, Ottawa, Canada, July 29-31, 2011.

NEWS BRIEFS

In January 2010, **Eileen Hofmann** was appointed as the chair of the Scientific Steering Committee for the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) Project. The IMBER Project is an international global change research program that is co-sponsored by the International Geosphere-Biosphere Programme and the Scientific Committee on Oceanic Research. The central goal of IMBER is to provide a comprehensive understanding of, and accurate predictive capacity for, ocean responses to accelerating global change and the consequent effects on the Earth System and human society. The primary responsibility of the chair is to work with the SSC to coordinate and facilitate the activities of the IMBER regional programs, working groups, national programs, and contributing projects to ensure that the project science goals are met. More information on the IMBER Project can be found at http://www.imber.info/.

Center for Coastal Physical Oceanography (CCPO)
Fall 2011 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. Lectures begin at 3:30 p.m., with a reception prior at 3 p.m. 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_fall2011.html.

Date	Speakers
September 12	Isaac Ginis, University of Rhode Island
September 19	Pierre St-Laurent, CCPO, Old Dominion University
September 26	James Hench, Duke University Marine Laboratory
October 3	Joyce Hoffmann, Dept. of English, Old Dominion University
October 10	No Seminar, Old Dominion University Fall Break
October 17	Lou Codispoti, UMCES Horn Point Laboratory
October 24	Court Stevenson, UMCES Horn Point Laboratory
October 31	Alexander Bochdansky, Dept. of Ocean, Earth and Atmospheric Sciences, Old Dominion University
November 7	Karen Heywood, University of East Anglia
November 14	Kelly Halimeda Kilbourne, UMCES Chesapeake Biological Laboratory
November 21	Eileen Hofmann, CCPO, Old Dominion University
November 28	Holly Gaff, Dept. of Biological Sciences, Old Dominion University

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