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Center for Coastal Physical Oceanography, Old Dominion University

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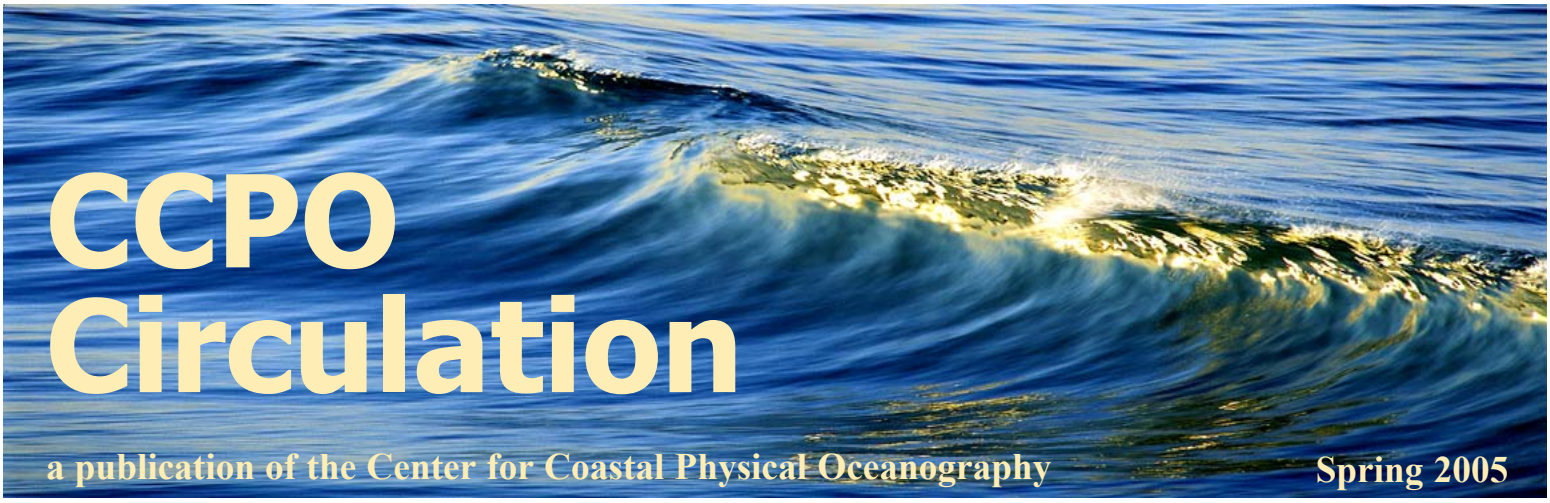

CCPO Circulation

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In this issue:

Large Eddy Simulation of Langmuir Circulation in Shallow Water

by Dr. Chester Grosch

Professor of Oceanography

Professor of Computer Science

Langmuir circulation consists of pairs of parallel counter-rotating vortices (or cells) oriented approximately in the wind direction and often occurs in the wind- and wave-driven surface mixed layer of lakes and oceans. The presence of Langmuir cells is most readily marked by the presence of lines of foam and/or algae on the water surface. Although there were earlier reports of "streaks" on the ocean surface, Langmuir cells were first described by Langmuir in 1938. His observations can be summarized by: 1) the wind generates vortices and not convective instability; 2) the downwelling motion under the surface convergences is more intense than the upwelling; and 3) the downwind motion of the water at the surface convergences is faster than outside the convergence zone.

Since Langmuir's description, there have been many additional observations, comprehensively summarized in S. Leibovich's 1983 review article and, very recently, by A.S. Thorpe in 2004. Improvements in instrumentation, including vertical profilers and backscatter, sidescan and

(continued on page 2)

Langmuir supercells provide a possible explanation for these dark lines in a turquoise sea, observed on a shallow Bahamian shelf by Old Dominion University's Dick Zimmerman and David Burdige. Divers found that the dark bands, aligned roughly with the wind, were made up of slightly negatively buoyant algae, possibly swept into bottom convergences associated with Langmuir cells just as surface foam is swept into their surface convergences. The observed line spacing of roughly three times the water depth is consistent with LEO-15 observations and modeling of Langmuir cells that fill the entire water column. Photograph by Laura Bodensteiner, Moss Landing Marine Laboratories.

Doppler sonar observations of bubble clouds, have led to, in Thorpe's words, "a radical change in understanding the phenomena." In addition, since about 1995, there have been a few large-eddy simulations (LES) of Langmuir circulation in the surface mixed layer of the deep ocean, and the results of these have also helped increase our understanding of the complexity of the phenomena. Langmuir circulation is now believed to be a turbulent process driven by the interaction of waves and currents.

Very recently, **Ann Gargett,** professor of oceanography, and **Judith Wells**, postdoctoral research scientist**,** using a five beam VADCP in shallow (approximately 15 M) water at LEO-15 off the southern coast of New Jersey, observed Langmuir circulation cells. As far as we know, these are the first observations made in shallow water. As Gargett et al. noted in their 2004 *Science* article, the observations showed Langmuir circulation cells extending throughout the entire water column during strong wind and wave forcing. These observations showed downward advected clouds of air microbubbles originating at the surface and upward advected bottom sediments. In parallel with the observations, **Andres Tejada-Martinez**, postdoctoral research scientist**,** and I have been carrying out LES of Langmuir circulation in shallow water.

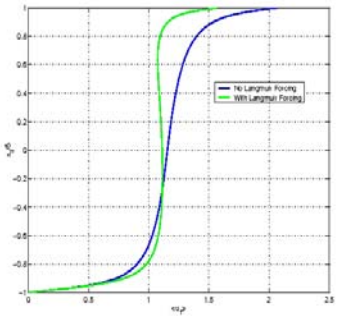


Figure 1. *Mean profile of the streamwise velocity component as a function of depth for LES of wind stress driven flow with and without the Langmuir forcing. The depth (0 to -H) has been scaled by the half depth and mapped into -1 to 1 to facilitate the computation.*

LES is based on resolving the large, energy containing eddies and modeling the rest of the spectrum. LES is a well-known numerical approach. However, the key to successful application of LES methodology to simulating Langmuir circulation is the correct incorporation of the forcing mechanism which drives the circulation. A theoretical model of Langmuir circulation was first proposed by A. D. D. Craik and S. Leibovich in 1976. This model has a Langmuir force, given by the cross product of the Stokes drift velocity of the waves and the current vorticity, added to the Navier-Stokes equations. In both theoretical and prior LES calculations for deep water, it was shown that the Langmuir force resulted in the quantitative and qualitative reproduction of all of the observed features of Langmuir circulation.

Our LES was driven by a wind stress at the surface in addition to the Langmuir force whose Stokes drift incorporated wave frequency and amplitude; both the stress and the values of the wave parameters were chosen to be consistent with the observations of Gargett and Wells. A stretched grid was used to resolve the free surface and bottom boundary layers. The mean velocity profile resulting from our LES is shown in the first figure. As compared with a LES without the Langmuir force, the profile is very uniform throughout most of the water column with thin surface and bottom boundary layers. The effect of the Langmuir circulation is to homogenize the water column in the mean.

Contours of the vertical and cross-stream distribution of the mean turbulent velocity fluctuations are shown in the second figure. In this figure, the panels show, from top to bottom, the streamwise, the vertical and the cross-stream velocity components. These have been averaged in time as well as over the streamwise length of the computational domain and the corresponding mean velocity components have been subtracted. The vertical axis is height from the bottom and the horizontal axis is the cross-stream distance. Overall, the flow has a single cell structure in contrast with a flow without the Langmuir force (not shown) which had a double cell structure. (Doubling the width of the computational box resulted in two cells.) In addition, the extrema of these fluctuating components are from two to ten times greater than those of a flow without the Langmuir force (again, not shown).

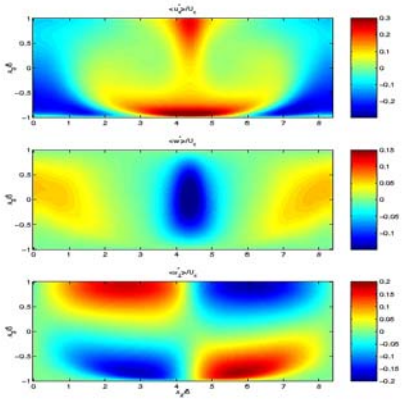
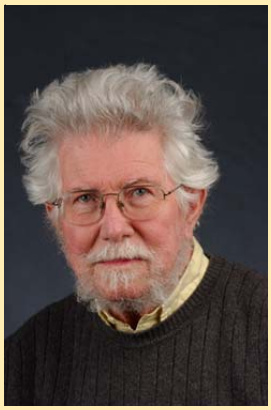


Figure 2. *Contours of the vertical and cross-stream distribution of the mean turbulent velocity fluctuations. The panels show, from top to bottom, the streamwise, the vertical and the cross-stream velocity components. The depth (0 to -H) has been scaled by the half depth and mapped into -1 to 1. The width is also scaled by the half depth.*

As seen in the figure, the flow has an intensification of the positive streamwise fluctuating component near the surface and near the bottom, in close agreement with the observations of Gargett and Wells in 2005 and Gargett et al. in 2004. A region of positive streamwise velocity coincides with a region of negative vertical velocity and vice-versa. Regions of positive vertical velocity are upwelling limbs and negative vertical velocity are downwelling limbs. At mid-depth, the ratio of spanwise length of the upwelling limb to spanwise length of the downwelling limb is 1.6, in close agreement with the observed value of 1.5. Finally, the magnitude of the velocity in the downwelling limbs is greater than in the upwelling limbs in both the observations and in the simulation.

LES of Langmuir circulation in a shallow water wind-driven current showed major changes in the turbulence dynamics as compared to the case without Langmuir forcing. The presence of Langmuir forcing results in intense turbulent, streamwise vortical structures with strong streamwise jets near the surface and bottom. The net effect is a major enhancement in vertical mixing. As pointed out by Thorpe, the effects of Langmuir circulation are important enough to be included in ocean mixed layer and general circulation models. This has not yet been done, presumably because of the difficulty in parameterizing them. This is a difficult problem but we have begun a study of it.



Dr. Grosch wins the University Faculty Research Award

by Dr. John Klinck

Scientists gather information, determine relationships, and create tools for observing and understanding nature. Most scientists consider questions that pique their interests; creative scientists often have a wide range of interests.

Dr. Chester E. Grosch, who has been part of CCPO from the beginning, displays such a range of interests. He has won this year's annual Faculty Research Award from Old Dominion University for a research career spanning three decades. His early interests involved the fluid dynamics of surface waves, which expanded to boundary layers and dynamical instability. He was active in the early days of computational fluid dynamics which led to a study of numerical methods, programming techniques and calculating on multiple, linked computers. His interests further expanded to turbulence, compressible flow and combustion. Recent papers analyze trends in long term observations and their relationship to climate change. His most recent research is large-eddy simulation (LES) of Langmuir circulation in shallow water.

However varied, and incomplete, this list of interests may be, a compelling characteristic of Chet's work is his willingness to work with colleagues and students, as evidenced by the author list on his publications. Chet displays the character of a true academic. He has read widely and has studied some exotic problems. He is an interesting participant in almost any conversation; I learn something every time he speaks, whether the topic is physics, opera or sports.

CCPO is privileged to have Chet as a member. We congratulate him on his award and look forward to many stimulating discussions.

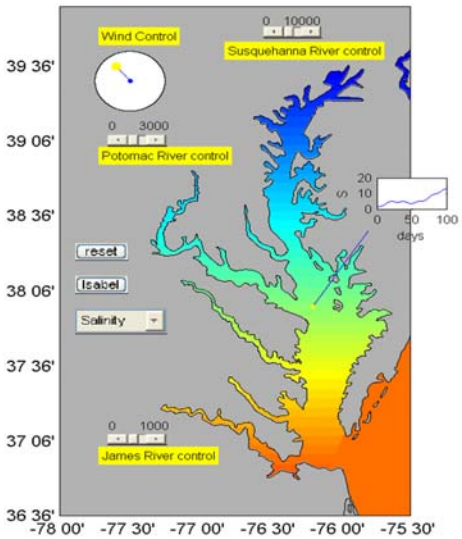
The Chesapeake Interactive Modeling Project: Bringing Numerical Models to the Public

by Dr. Jay Austin

Numerical models of ocean circulation have long used primarily by oceanographers, and at that, only useful to those who are willing to make a serious commitment of time in order to learn how to use them effectively. They require a certain degree of programming expertise, and, until the last few years, all but the smallest models have required specialized computing facilities. Most of all, they require patience; typically, numerical models are run in an asynchronous mode, where a user sets up initial conditions, describes forcing conditions, compiles and runs the model, and then displays stored model fields. This process takes days, weeks or even months, depending on the complexity of the model. These limitations have put numerical modeling off limits to all but the most committed.

The Chesapeake Interactive Modeling Project, currently funded by the Office of Research at Old Dominion University, is attempting to remove these barriers. We have formed a collaborative team of investigators (**Mike Dinniman**, **Liz Smith**, and myself at CCPO, and Jessica Crouch, Lee Belfore, and Yuzhong Shen at the Virginia Modeling, Analysis and Simulation Center) to develop a relatively simple but informative model of the Chesapeake Bay, which can be run on a commercially available PC platform, and will use a graphical user interface which will allow the user to adjust parameters such as freshwater runoff and wind forcing and observe the response in real-time. The challenge of this project, beyond the considerable coding that is going into the graphical front end, is striking a balance between model fidelity and speed, so that the model reproduces the physics of estuarine circulation faithfully, but does so quickly enough to retain the interest of a casual user. While this initial phase is focusing strictly on hydrodynamic forcing, I anticipate that subsequent funding will allow us to incorporate simple biological models. These would allow a casual user to, for example, drag chicken farm icons over to the Eastern Shore and observe the impact on oyster populations, or change land use distribution in Pennsylvania and see how the added nutrients or sediment impacts the ecosystem of the bay. Also, once the interface is designed, it should be relatively straightforward to apply the framework to other marine systems, such as the San Francisco Bay, Puget Sound, or Lake Superior.

We have two target audiences in mind for the initial stage of this project. The first is museum-goers. We envision kiosks in science museums and aquaria running the model, with accompanying text to enhance the experience by giving the user some insight into the processes being demonstrated. The second audience is the classroom, at a wide variety of levels. Such a model could be used in K-12 classrooms, and by invoking user-selected levels of sophistication in the types of forcing and outputs, could be useful in undergraduate and even graduate education. In a subsequent stage, I am interested in adapting these techniques to the needs of researchers, who could use interactive models to develop intuition about a particular system by interacting with it in real time before applying more stringent modeling techniques. With advances in computing technologies and the maturation of numerical models, these sorts of techniques should allow us, over time, to allow a far wider audience of casual users access to numerical models as a teaching tool, and also allow researchers to be less distracted by the mundane details of numerical modeling and allow us to focus more fully on science.



A conceptual screenshot of a graphical interactive user interface for a numerical model of the Chesapeake Bay

Notes from the Director

The Center for Coastal Physical Oceanography is an abstract entity to many, but it is really a group of people with various backgrounds, levels of experience, personalities and motivations. The Center is also a creative engine that fosters expansion of our understanding of the processes at work in our world. The Center depends on creative, motivated people to be successful.

Our contributions are often limited to the arcane world of technical literature. It is important that others in the University and the general public hear about the high quality of the people at the Center. The recent University Annual Faculty Research Award presented to Chet Grosch is an important recognition of his contribution. Many faculty and research scientists are invited to science panels providing steering, oversight and evaluation which is implicit recognition of their value. Graduate students contribute to the Center by the research that they do, the papers they write and the meetings that they attend. Most of the Ph.D. students continue their careers after graduation in postdoctoral or faculty positions, a testament to their quality.

Awards recognize individuals and provide them a moment in the spotlight. This recognition of individuals reflects well on all of us and the work that we are doing. Keep up the good work.

John M. Klinck

CCPO People Profiles

Dick Moody has been a staff member at CCPO for five years. After retiring from the NOAA Corps with the rank of Commander in 1988, Dick tried his hand at the corporate world, working in sales for Kraft Foods for eight years. Missing the intellectual stimulation of the sciences, Dick found his old friend **Larry Atkinson** as the oceanography department chair at Old Dominion University and decided to upgrade his 30-year old B.S. in biological oceanography by becoming a student once again. After an interesting couple of years attaining an M.S., Dick became the Old Dominion University liaison to the NOAA-at-Nauticus office in downtown Norfolk. When **Arnoldo Valle-Levinson** needed help with his Chesapeake Bay and estuarine field work, Dick jumped at the chance to get back into "operational oceanography." Two years later after various ADCP operations and instrument deployments/recoveries aboard university, private research, and government vessels from North Carolina to Maryland (and one cruise in the East China Sea), his attention turned to the new vessel being built to replace the R/V *Linwood Holton*. Dick obtained a Captain's license from the Coast Guard and became the interim captain of the new vessel, R/V *Fay Slover,* overseeing itsconstruction in Somerset, MA. He then brought the vessel to Norfolk, operating it for the first seven months. **Captain Richard Cox** was then brought on board to operate the R/V *Fay Slover*, and Dick stayed on as Marine Superintendent, with responsibilities for scheduling, budget, and finance for *Fay Slover* and the small boats of OEAS, with an occasional stint as relief captain.

Dick is probably proudest of helping to successfully steer a resolution last year by the University to establish a channel and pier at the Sailing Center location on the Elizabeth River in order to accommodate *Fay Slover* and other small-to-medium class research vessels. Although years away, it will be part of a larger Tidewater marine complex planned by the University which will focus on marine interests of the region.

Michael Ott came to CCPO as a post-doc in July of 2004. He grew up in a small town in central Labrador. As an undergraduate, he studied physics and math at the University of Waterloo and participated in the cooperative program where he researched holographs at Ontario Hydro. He also studied magnetohydro-dynamics at Technische Universiteit Eindhoven in the Netherlands. Michael earned his Ph.D. in physical oceanography at the University of Victoria, focusing on the dynamics of fjord-type estuaries. After three years at Oregon State University studying coastal wind-driven transport and mixing, he is happy to return to estuarine research, incorporating observations, dynamical studies, and numerical modeling. His wife, Laura, has an M.A. in history, and when their 2 year-old son, Jared, is not keeping him busy, Michael enjoys camping, watching hockey, and swimming, especially in the ocean. Norfolk is the first place he has lived where the ocean is not too cold for long swims.

Chesapeake Bay Governor's School, Warsaw Campus Wins Blue Crab Bowl in Dramatic Overtime Finish

In a cliffhanger race that ran into overtime, the Chesapeake Bay Governor's School, Warsaw Campus, emerged as champion in the **Blue Crab Bowl,** held Saturday, February 12 at the Virginia Institute of Marine Science campus at Gloucester Point, VA.

The Blue Crab Bowl is a Virginia regional academic tournament focusing on ocean science. Eighty students from 16 high schools statewide spent the day in heated competition. The winning team from Tappahannock landed an all-expenses-paid trip to the 8th Annual National Ocean Sciences Bowl (NOSB®) in Biloxi, MS to compete against 24 other regional champions where an expected 2,000 students will represent 375 high schools from around the country.

Blue Crab Bowl 2005 Champions from the The Chesapeake Bay Governor's School for Marine and Environmental Science in Warsaw. Pictured at far left is the team Coach, Kevin Goff.

Organized as a round-robin, double elimination contest, the Blue Crab Bowl uses questions designed by marine scientists to test the students' knowledge of oceanography, geology, biology, and maritime history. Participation in the bowl with the guidance of their teacher coaches not only broadens the students' awareness and understanding of the oceans, but also provides a forum for students who excel in math and science to receive regional and national recognition for their diligence and talent.

Chesapeake Bay Governor's School, Warsaw played back-to-back competitions, both requiring overtime tie-breaking questions in order to take the laurels. Hot on their heels in second place was Bishop Sullivan Catholic High School of Virginia Beach. Third place went to Maury High School of Norfolk, and Fauquier High School in Warrenton held fourth place. The awards were presented by Dr. Cynthia Suchman, Assistant Director of Virginia Sea Grant, the agency funding the uniquely-crafted ceramic "crab bowls."

The Blue Crab Bowl is a cooperative effort between the Department of Ocean, Earth, and Atmospheric Sciences, the Center for Coastal Physical Oceanography, Old Dominion University, and the Virginia Sea Grant Marine Advisory Program at the Virginia Institute of Marine Science, College of William and Mary. **Liz Smith** and **Anne West-Valle** of CCPO are co-directors of the bowl. More than 60 faculty, staff and graduate students from both institutions donated many hours of their time to ensure the success of this exciting event. CCPO personnel who volunteered during the event were: **Ann Gargett**, **Sinan Husrevoglu**, **Michael Ott**, **Mayra Riveron-Estianzaga**, **Joe Ruettgers**, **David Salas**, **Robert Tuleya**, **Arnoldo Valle-Levinson**, and **Judith Wells**.

Eighth Grade Class Trip on the R/V *Fay Slover*

The eighth grade science class from Christ The King (CTK) School in Norfolk, VA, took a short cruise on Old Dominion University's research vessel, the R/V *Fay Slover*, on April 19. The cruise came about because Ms. Jan Mislan, the eighth grade science teacher at CTK, stresses hands-on experiences as a way to provide students with a better understanding of the concepts and ideas that are taught in the classroom. Twenty-one CTK students were met on board the R/V *Slover* by Mates **Laura Gibson** and **Patrick Curry** and Captain **Richard Cox**. CCPO scientists, **Olga Polyakov** and **Eileen Hofmann**, and program specialist, **Julie Morgan**, went along to answer questions and to provide assistance. Additional support was provided by Carolyn McKenna and Father Brian Rafferty from CTK School.

Two eighth grade students from Christ The King School prepare to deploy a plankton net from the stern of the R/V Fay Slover

After a safety briefing, the R/V *Slover* got underway for a short trip down the Elizabeth River. During the first part of the cruise, the CTK students learned about oceanographic equipment and ship operations. On the return portion, the students did a CTD cast, a plankton net tow, a bottom mud grab, and collected water by hanging Niskin bottles on a wire. The students deployed and retrieved the equipment with the assistance and oversight of **Laura Gibson** and **Patrick Curry**. Checking out the net sample with a microscope was fun for everyone because a plankton bloom in the Elizabeth River provided many different organisms for viewing. The bottom mud sample, which contained many worm tubes, was thoroughly examined.

The cruise on the R/V *Slover* was the start of a marine sciences-oriented science module for the eighth grade students at CTK School. This is part of a larger effort by Ms. Mislan and other faculty to introduce marine science concepts into the overall curriculum at CTK School.

Meeting & Workshop Reports

Southern Ocean GLOBEC Workshop

A workshop was held at CCPO, January 6-8, 2005, which had the objective of facilitating the development of synthesis and integrative studies of the extensive multidisciplinary data sets that were collected as part of the U.S. Southern Ocean Global Ocean Ecosystems Dynamics (SO GLOBEC) field programs. The workshop, which was attended by about 25 science investigators, started with presentations that provided updates on analyses and modeling efforts that have been ongoing since the end of the field program. Some of these results are reported in volume 51 of *Deep-Sea Research II*, which was published in December 2004. Following the presentations were discussions about continued analyses and modeling of the SO GLOBEC data sets. These discussions led to identification of overarching research themes related to understanding the physical environment, overwintering strategies of Antarctic krill, habitat use and predator-prey interactions, and processes that allow biological hot spots to form and persist. Research programs designed to address these themes are now being developed. These synthesis and integration studies of the SO GLOBEC data set are part of a larger effort being undertaken by the U.S. and International GLOBEC programs.

ChesTech: Chesapeake Bay Technical Service Providers Meeting

As more and more emphasis is placed nationally on real-time observing, the technical problems that face observers in the Chesapeake Bay become more daunting. The increased technical demands are placed not only on the Principal Investigators at various institutions around the Bay, but disproportionately on technical staff who are actually designing, constructing and deploying the real-time observing systems. However, the "techs" rarely, if ever, meet each other at regional meetings, which tend to be attended largely by scientific faculty. After a particularly enjoyable visit to the Virginia Institute of Marine Sciences, during which **Jay Austin**, research assistant professor, spent quite a bit of time talking with their technical staff (and wishing that the Old Dominion University techs were along to ask the right questions), he decided to do something about it.

On January 10, CCPO hosted the first ChesTech meeting. There were roughly 35 participants, with people from as far away as Horn Point Labs and UNC Wilmington. There were five presentations, one from each of the five labs (**Chris Powell** for Old Dominion University, Todd Nelson for VIMS, Randy Cone for HPL, Mark Bushnell for NOAA OSTEP, and Chris Heyer for Maryland DNR), discussing the nuts and bolts of their experience with real-time systems. These presentations were met with lively discussion, and allowed participants to identify challenges common to all of the groups, such as wireless communications. These presentations were followed by a discussion of data management and the upcoming CBOS-CEID (Cooperative Expansion and Integration Demonstration) deployments of real-time wave measurement systems in the Bay by Old Dominion University, HPL, and VIMS. Many people have expressed a strong desire to hold these technical service meetings on a regular basis, hopefully with a more specific focus than that of this introductory meeting. The continued open exchange of technical experience will more quickly lead to a better Chesapeake Bay Observing System.

QARTOD II: Waves & Currents

From February 28-March 2, the second workshop on the Quality Assurance of Real-Time Ocean Data (QARTOD) II: Waves and Currents for the coastal ocean observing community was hosted by **Larry Atkinson** of the Center for Coastal Physical Oceanography and Mark Bushnell of NOAA OSTEP at Nauticus, the National Maritme Center and the Sheraton Hotel. Over 70 participants from federal and state governments, academia, and industry attended the workshop. The meeting addressed *in situ* currents, remote currents (high frequency radar), and waves.

QARTOD II participants at the Sheraton in Norfolk, VA

All working groups were asked to answer the following specific questions relevant to their topic:

- What real-time quality control tests should be applied?
- What categories of real-time quality descriptor flags should be applied?
- What real-time metadata descriptors should be applied?
- What real-time calibration flags should be applied?
- What common data formats should be applied?
- Additional requirements associated with the Data Management and Communications (DMAC) Plan?
- Next steps and roadblocks to implementation of QA/QC?

There were discussions regarding the role of this group in the overall Ocean.US DMAC process. The group felt that it would be worthwhile to become the real-time data group within the DMAC organization.

Publications

Kim, H.-C. and **E.E. Hofmann**, "Evaluation and Derivation of Cloud-Cover Algorithms for Calculation of Surface Irradiance in Sub-Antarctic and Antarctic Environments," *Antarctic Science*, **17**, 135-150, 2005.

Knutson, T., **R.E. Tuleya**, W. Shen, and I. Ginis, "Impact of climate change on hurricane intensities," in Hurricanes and Typhoons: Past, Present, and Future, R. Murname and K. Liu, eds. Columbia University Press, pp. 408-439, 2004.

Tejada-Martinez, A.E. and K.E. Jansen, "On the interaction between dynamic model dissipation and numerical dissipation due to streamline upwind/Petrov-Galerkin stabilization," *Computer Methods in Applied Mechanics and Engineering*, **194**, 1225-1248, 2005.

Presentations

Carr, M.-E., **M.A. Friedrichs**, and M. Schmeltz, and the PPARR3 group, "A comparison of global estimates of marine primary production from ocean color," oral presentation, Ocean Color Research Team Meeting, Portland, OR, April 12-14, 2005.

Christian, J.R., and **M.A.M. Friedrichs**, "Recent developments in data assimilation in ocean biogeochemistry," oral presentation, Canadian Meteorological and Oceanographic Society 39th Annual Congress: Sea to Sky, Vancouver, British Columbia, Canada, May 2005.

Dinniman, M.S., **J.M. Klinck**, W.O. Smith, Jr. and **E.E. Hofmann**, "The Influence of Sea Ice Cover on Circulation and Nutrient Processes in a Numerical Circulation Model of the Ross Sea, Antarctica," poster presentation, 2005 Gordon Research Conference on Polar Marine Science, Ventura, CA, March 13-18, 2005.

Flye Sainte-Marie, J., F. Jean, C. Paillard, **J.M. Klinck**, **E.E. Hofmann**, S.E. Ford, E.N. Powell, "Modeling brown ring disease in the Manila clam (*Ruditapes philippinarum*): the individual host model," oral presentation, National Shellfisheries Association Meeting, Philadelphia, PA, April 10-14, 2005.

Ford, S.E., E.N. Powell, J. Flye Sainte-Marie, F. Jean, C. Paillard, **J.M. Klinck**, and **E.E. Hofmann**, "Brown ring disease: the integrated model," oral presentation, National Shellfisheries Association Meeting, Philadelphia, PA, April 10-14, 2005.

Friedrichs, M.A., R.R. Hood, **J.D. Wiggert**, and E.A. Laws, "Assessing the costs and benefits of increasing ecosystem model complexity using data assimilation," oral presentation, 2005 Aquatic Sciences Meeting, ASLO, Salt Lake City, UT, February 20-25, 2005.

Friedrichs, M.A., R. Hood, and the Regional Ecosystem Modeling Testbed Team, "The regional ecosystem modeling intercomparison project," oral presentation, European Geosciences Union Meeting, Vienna, Austria, April 25-29, 2005.

Gargett, A.E., "Ocean turbulence: observation and interpretation," seminar presentation, Aerospace Engineering Department, Old Dominion University, Norfolk, VA, February 25, 2005.

Hofmann, E., **Friedrichs, M.** and the U.S.ECoS Science Team, "U.S. Eastern Continental Shelf Carbon Budget: Modeling, Data Assimilation, and Analysis," poster presentation, Ocean Color Research Team Meeting, Portland, OR, April 12-14, 2005.

Hofmann, E.E., **J.M. Klinck**, and E.N. Powell, "Estimating hard clam (*Mercenaria mercenaria*) age-length from a theoretical model," oral presentation, National Shellfisheries Association Meeting, Philadelphia, PA, April 10-14, 2005.

Hofmann, E.E., "Modeling Larval Transport," seminar presentation, University of Maryland Center for Environmental Science, Horn Point Laboratory, Cambridge, MD, December 8, 2004.

Hofmann, E.E., "Modeling marine plankton distribution and transport," Marine Environmental Biology Section Seminar, University of Southern California, Los Angeles, CA, January 18, 2005.

Hofmann, E.E., "Antarctic Research," oral presentation, Altrusa International, Tidewater Chapter, Norfolk, VA, March 21, 2005.

Hofmann, E.E., "Shellfish Diseases and Ecological Health," guest lecture, Human Health and Global Environmental Change Course, Harvard Medical School/Harvard School of Public Health, Boston, MA, March 8, 2005.

Paillard, C., F. Jean, J. Flye Sainte-Marie, S.E. Ford, E.N. Powell, **J.M. Klinck**, and **E.E. Hofmann**, "An integrated approach to bacteria-bivalve interactions: development of a vibriosis model in Manila clams," oral presentation, National Shellfisheries Association Meeting, Philadelphia, PA, April 10-14, 2005.

Powell, E.N., K. Alcox, J. Kraeuter, **J.M. Klinck**, and S.E. Ford, "The Delaware Bay oyster beds of New Jersey; Compensatory recruitment, depensatory mortality, and reference point-based management," oral presentation, National Shellfisheries Association Meeting, Philadelphia, PA, April 10-14, 2005.

Royer, T.C., "Alaskan Oceanography: Past, Present and Future – A Personal Perspective," keynote speaker, Alaska Marine Science Symposium, Anchorage, AL, January 25, 2005.

Tejada-Martinez, A.E., "Approximations and models of the subgrid-scales in large-eddy simulation," invited seminar, Institute

(continued on page 8)

Presentations cont'd.

for Computational Engineering and Sciences, University of Texas, Austin, TX, March 31, 2005.

Tuleya, R.E., "Using Computer Models to Forecast Present Day and Future Hurricanes," oral presentation, ExxonMobil Research and Engineering, Warren, NJ, February 17, 2005.

Tuleya, R.E., "Hurricane Model Transitions to Operations at NCEP/EMC," oral presentation, NCEP/EMC National Center for Environmental Prediction/Environmental Modeling Center, Camp Springs, MD, March 8, 2005.

Valle-Levinson, A., "The role of friction and Earth's rotation on water exchange in semi-enclosed basins," oral presentation, University of Florida, Gainesville, FL, February 28, 2005.

Wiggert, J.D., A.G.E. Haskell, G.-A. Paffenhöfer, **E.E. Hofmann**, and **J.M. Klinck**, "Sustaining Copepod Populations Under Oligotrophy: The Role of Feeding Behavior," oral presentation, 2005 Aquatic Sciences Meeting, ASLO, Salt Lake City, UT, February 20-25, 2005.

Committees

Hofmann, E.E.
Attended the University-National Oceanographic Laboratory System (UNOLS) Council meeting, Washington, DC, March 29-30, 2005.

Hofmann, E.E.
Attended North American Carbon Program Science Steering Group meeting, Washington, DC, April 28-29, 2005.

Hofmann, E.E.
Attended U.S. GLOBEC Science Steering Committee meeting, St. Petersburg, FL, May 4-6, 2005.

Ph.D. Students

Salihoglu, B., "Modeling the Effects of Physical and Biogeochemical Processes on Phytoplankton Species and Carbon Production in the Equatorial Pacific Ocean," December 2004, Advisor: E.E. Hofmann. Taken a position at LEGOS/CNRS in Toulouse, France.

The researchers and staff of the Center for Coastal Physical Oceanography are involved in many outreach projects in our region, Hampton Roads. Recently, students from a local school, Christ The King in Norfolk, VA, participated in a field trip on the R/V *Fay Slover*. In the above image, two eighth grade students assist R/V *Fay Slover* Mate Patrick Curry in lowering a Niskin bottle to collect a water sample for observation.

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