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Center for Coastal Physical Oceanography, Old Dominion University

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Identifying Different Flow Constituents in Estuaries

The Center for Coastal Physical Oceanography (CCPO) has just wrapped up a three-year (1996-1998) collaborative research program on the transverse structure of currents in the James River Estuary. The program was funded by the U.S. National Science Foundation to **ARNOLDO VALLE-LEVINSON**, assistant professor at CCPO; Kuo-Chuin Wong at the College of Marine Studies, University of Delaware; and Kamazima Lwiza at the Marine Science Research Center, State University of New York at Stony Brook. **CHUNYAN LI**, research assistant professor at CCPO, has collaborated with the above PIs in the analysis and interpretation of the data, which were collected by at least 60 people. One of the contributions of this program has been the presentation of a method to separate tidally-driven from density-driven subtidal flows.

Theory of density-driven flow

In many narrow estuaries, the major contributions of subtidal flow come from the effect of the tide and density-driven flow. The pioneer work of Pritchard (e.g., 1952) and Hansen and Rattray (1965) revealed that the density-driven estuarine circulation is such that the freshwater flows out of the estuary on the surface while the heavier seawater flows into the estuary from below. When the transverse depth variation is significant, as in most coastal plain estuaries, the transverse variation of turbulence and bottom friction will cause this conventional estuarine circulation to be "tilted" (Wong, 1994): the flow pattern changes from one with pure vertical shear to one with lateral shear. Since the horizontal pressure force due to a horizontal density gradient is proportional to the local depth, the tendency of the heavier seawater to replace the lighter freshwater landward is stronger in the channel than over the shoal. The subsurface

landward flow thus tends to be concentrated in the channel. As a result, the return flow tends to be on the shoal.

Theory of tidally-driven flow

Although the above density-driven estuarine circulation has been observed, the nonlinear tide in most estuaries makes the circulation much more complicated in reality. Considering the effect of the tide alone, most estuarine tide is in the form of progressive or partially progressive surface waves. The surface elevation is on the order of 0.5-1 meters and the water depth is 10 meters (as in the case of James River). Because of the progressive nature, the surface elevation is close to high water during flood and close to low water during ebb. This asymmetry causes a net inward transport on the surface and a return flow below the surface--a pattern just opposite of the conventional estuarine circulation due to density gradient alone. When considering the transverse depth variation, the tidal flow asymmetry over the shoal is more remarkable than that in the deeper water. Thus more inward flow is over the shoal than through the deeper water. The inward flow of water from the surface in this nonlinear process will generate a seaward pressure gradient to drive an outward flow for mass to balance. Since the surface elevation in a narrow estuary has only a small lateral variation, the depth-integrated longitudinal pressure force is mainly dependent on the depth, which is greater in the channel than over the shoal. As a result, a larger return flow occurs in the channel than over the shoal. The net effect of tidally driven flow is therefore a landward flow over the shoals and a seaward flow in the channel (Li and O'Donnell, 1997). An extreme case of this type of subtidal flow is when the shoal is so shallow that it becomes a drying sandbank which only experiences the flood phase of the tide. Under this condition, it is easier to understand why the tidally driven net flow over the shoal should be landward. The tidally driven flow thus competes with the density-driven flow when there is a transverse depth variation and the existence of both tide and density gradient.

The question

In the James River Estuary, both tidal forcing and density gradient are important. What we see in the observational data is, therefore, a superposition of the two different flow patterns (other forcing, such as wind stress, is usually small in narrow estuaries under fair and moderate weather conditions and thus neglected). A practical question is raised: how can we identify the flow constituents caused by a nonlinear tide and density gradient? If we can separate and study different flow constituents under different conditions from the observational data, we may obtain a better understanding of the mechanisms driving the subtidal circulation and be one step closer to the ultimate goal of predicting estuarine circulation and related flux as based on information of the tidal amplitude and phase and river discharge.

The answer

The key to identifying both the tidally-driven and density-driven flows from observations is that both the tidal forcing and the density gradient vary with time. With some uncertainty, we know how the flow responses to the change of tidal forcing and density gradient. In mathematics, the uncertainty is represented by some coefficients to be determined. If enough observations are made, we may directly infer the coefficients from the data. A simplest case is such that the river discharge does not vary significantly over a spring-neap tidal cycle (14 days). If we further ignore the interaction between density gradient and tidal mixing (for the sake of a simplified presentation), i.e., density gradient is only dependent on river discharge, then the variation in the subtidal flow from the spring tide to the neap tide is mostly caused by the effect of the tide. Based on these assumptions, it follows that the density-driven flow constituent is unchanged during this period of time. By subtracting the total subtidal flow of neap tide from that of the spring tide, one may obtain the difference of tidally-driven flow between the spring tide and the neap tide. The effect of density-driven flow is eliminated in this special case. Since the tidally-driven flow (averaged over one tidal cycle) is almost linearly dependent on the tidal forcing (or amplitude of elevation at the mouth) (Li and O'Donnell, 1997), the tidally driven flow during both spring tide and neap tide can be inferred by a simple scaling. The density-driven flow is then obtained by subtracting the tidally-driven flow from the total flow, either during the spring tides or the neap tides. This method can be further generalized to allow a variable river discharge and the interaction between density gradient and tidal mixing (Li et al., 1998).

The application: tidally-driven and density-driven flows in the James River

The application of this method to the James River Estuary yielded results consistent with known theories and observations. The results showed that both the tidally-driven (Figure 1) and the density-driven (Figure 2) flow constituents were highly dependent on the lateral variation of the water depth. It showed seaward flow over the channel for the tidally-driven flow and seaward flow over the shoal for the density-driven flow. The landward flow was over the shoal for the tidally driven flow and over the channel for the density-driven flow. The maximum of the subtidal flow over the shoal was at the surface, and the maximum of subtidal flow in the channel was below the surface. For both flow constituents, there was a surface maximum over the shoal and a subsurface maximum in the channel. This was particularly clear for the density-driven flow, a pattern predicted by Wong (1994) with a conceptual model of partially and well-mixed estuaries. In the James River Estuary, for the time period studied, the tidally-driven constituent during spring tides had a similar order of magnitude as that of the density-driven constituent. Since the two constituents had opposite patterns of exchange flows, the total subtidal flow during spring tides (Figure 3) was smaller than that during the neap tides (Figure 4). Because the subtidal current during the spring tides was a result of the difference of two functions of similar magnitude, the correlation of subtidal current with the bathymetry was not well established. In contrast, the subtidal current during the neap tides had a clearer correlation with the bathymetry and resembled the pattern of a pure density-driven flow since the tidally driven flow was at its minimum. The study also shows that not only the tidal mixing may weaken the density-driven flow but also the tidally-driven flow competes with the density-driven flow, which results in a weak subtidal flow during spring tides. For more information on the James River project, please visit our web page at http://www.ccpo.odu.edu/arnoldo.

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Notes from the Director

Having just returned from a very productive trip to Chile, I was thinking how alike scientists are all over the world. We really have a common bond, a common language. Those of us working in the coastal ocean also have a common attitude towards multidisciplinary work. Whether our work is focused on pure physics or pure stock assessment, we all realize that the system is complicated, the system is being changed by human activity, and the system is important to humankind.

The part of Chile where the CCPO Chilean research group is focusing has some of the most productive waters in the world; the region of Concepcion yields nearly 4 percent of the annual world catch alone. Thus anything we learn about the region will no doubt have impact on resource management. This same holds true for work by CCPO researchers in the Arctic, Antarctic, or Chesapeake Bay. All oceanographers working on the coastal ocean are doing important work that will soon have an impact on decision makers. In Chile, the fast growing tree farm industry on land and the salmon farming in the ocean will have significant impacts on the Chilean coastal waters. We hope our research will help the

Chileans preserve their unique terrestrial and oceanic habitats.

Larry P. Atkinson
Director, Center for Coastal Physical Oceanography

Student Profile: J. MICHAEL FOUGEROUSSE

J. MICHAEL FOUGEROUSSE graduated summa cum laude with a B.S. in biology from Old Dominion University in 1997. As an undergraduate at ODU, Mike worked as a research assistant under the direction of **Dr. Glenn F. Cota**. During this time, he spent four weeks in the Canadian Arctic doing research for satellite validation.

After graduation, Mike chose to pursue oceanography further by enrolling in the graduate program at Old Dominion University. Since, his research activities have involved satellite validation with a 2-1/2 week cruise to the Laborador Sea in 1998 aboard the *CCGS Hudson* and another 4 weeks in the Canadian Arctic in August of 1998. Presently, he is teaching introductory oceanography lab classes.

Upon graduation in May of 1999, with a M.S. in oceanography, Mike wishes to continue his pursuit of oceanography by gaining employment in ocean forecasting, specifically fisheries applications, or a related field. He plans to return to academia, after a short break, to seek a doctoral degree in fisheries management.

When he isn't in the field, Mike enjoys toying with saltwater tropical aquariums and spending a day saltwater sportfishing. Along with his father, Mike has spent countless hours aboard the 24' *Sea Biscuit* chasing saltwater gamefish from the Chesapeake Bay to the Norfolk Canyon.

A New Face at CCPO: MIKE DINNIMAN

MIKE DINNIMAN arrived at CCPO in November 1998 to begin work with **John Klinck** as a research scientist. Prior to CCPO, Mike spent five years working in flight similation before returning to school and receiving a M.S. in meteorology in 1996 from the University of Maryland. He then worked for the Raytheon STX Corporation at the Oceans and Ice Branch of the NASA Goddard Space Flight Center. At NASA, he worked for Dr. Michele Rienecker on several projects involving the use and development of different numerical ocean general circulation models. At CCPO, Mike is assisting Dr. Klinck with various numerical modeling studies and is currently concentrating on modeling circulation near submarine canyons.

In Mike's spare time, he enjoys participating in many sports (especially basketball and running), and he keeps hoping to some day develop more arc on his jumper. Mike also thinks cable television is unfairly maligned, since it will allow him to watch the resurgence of Virginia basketball next season.

Former CCPO Student Wins Thesis Award

On February 20-22, 1999, **EDDIE HASKELL**, received the 1999 Master's Thesis Award at the 1999 Conference of Southern Graduate Schools (CSGS) in Charleston, South Carolina. His master's thesis is titled "Modeling Plankton Community Structure Under Environmental Forcing On the Southeastern U.S. Continental Shelf." For his efforts, Eddie received a trip to the conference and 500.

CSGS is an organization of over 200 graduate schools in 15 states of the southeastern region of the United States. Every year, the conference selects one master's thesis on the basis of clarity of style and presentation, scholarship, research methodology, and contributions to the field or discipline. The 1999 award was selected from submissions between fall 1996 and summer 1998, in the fields of mathematics, physical sciences, and engineering.

Eddie graduated in December 1997 from CCPO, unaware that the College of Sciences had nominated him for this award. Eddie's wife, Heather, was able to accompany Eddie to the conference in her unofficial capacity as CCPO photographer (her work seen here of Eddie receiving his award).

Eddie is currently working at CCPO full-time as a research associate with **Eileen Hofmann** (who was also Eddie's M.S. advisor), while continuing his education at Old Dominion University.

Puzzler

The purpose of the Puzzler is to record thought-provoking questions and problems that have appeared on comprehensive, qualifying, and candidacy exams. Readers are encouraged to submit their own favorites, as well as to attempt to answer all questions. All communications should be directed to: **wizzard@ccpo.odu.edu**. *Wizzard* will acknowledge the sources of all questions/problems used and will publish selected throught-provoking (not necessarily correct) answers to previous submissions.

No answers were submitted to the last *Puzzler*, **Question 98.4**, which was posed by **LOUIS CODISPOTI**. For **Question 98.4**, Lou says that an albatross is excellent at soaring flight, and so is a vulture. Why then does the albatross have high aspect ratio wings and the vulture low aspect ratio wings?

Lou is miffed that a chemical oceanographer posed a simple problem that was too difficult for the dynamists. He thinks they should spend less time on thermodynamics and more time on observing nature. Lou and *Wizzard* will keep this problem open until the next issue. There are free lunches for the first five correct answers to **Question 98.4**.

Question 99.1. Question 99.1 is a question submitted by Curt Mobley of Sequoia Scientific, Seattle. At sea level on a clear day at noon, the solar irradiance in the "blue" window (425-475 nm) where clean water is most transparent is about 50 W m-2. How much of this irradiance will reach a depth of 1000 meters in the clearest ocean water? How does this compare with the irradiance at sea level at night? At what depth would there be only 1 photon m-2s-1 left? If you measure the light at the bottom of the deep ocean (at 4000 m, say), you find that 107 photons m-2s-1. Where does that light come from? Please email *Wizzard* your answer.

1999 Blue Crab Bowl is Another Success!

This year's Blue Crab Bowl was held on February 27 at the Virginia Institute of Marine Science. The first place team is from Lord Botetourt High School, Daleville, VA (pictured). The team will go on to compete at the national ompetitiion to be held April 10-12 in Washington, DC.

Presentation at AAAS Sparks National Public Radio's Attention

The scientific program for the 1999 meeting of the American Association for the Advancement of Science (AAAS), held in Anaheim, CA, January 21-26, included a special symposium entitled, "Diseases in the Oceans: A New Environmental Challenge?" Diseases are recognized to be important factors in regulating marine ecosystem structure and this symposium was designed to highlight the impact of marine pathogens in reshaping marine community structure, in serving as reservoirs for human disease, and in affecting commercially important fish and shellfish. This latter point is of interest to CCPO scientists, **EILEEN HOFMANN** and **JOHN KLINCK**, who have been working with Susan Ford and Eric Powell from the Haskin Shellfish Research Laboratory on the development of mathematical models to describe the effect of the diseases, Dermo and MSX, on Eastern oyster (*Crassostrea virginica*) populations. Because of this research, they were invited to participate in the symposium at AAAS and **EILEEN HOFMANN** was

elected (or coerced?) to attend the meeting and make a presentation on results from this research. Thus, the abstract for the talk was submitted, travel arrangements were made, and the talk prepared.

Up to this point, this was a fairly standard scenario for participating in a scientific meeting. However, about one week prior to the meeting, Eileen received a call from a member of the staff for the National Public Radio (NPR), Talk of the *Nation Science Friday* program, hosted by Ira Flatow. This staff member told her that "Diseases in the Ocean" had been chosen by NPR as a topic to be featured in the first hour of the *Science Friday* program, which would broadcast live from the AAAS meeting. Their work on shellfish diseases was to be included in the discussion by having Eileen join the panel during the broadcast. Other panel members were Dr. Drew Harvell (co-convenor of the symposium) from Cornell University, Dr. John Porter from the University of Georgia, and Dr. Rita Colwell, Director, National Science Foundation.

Eileen's first response was, "Wow, I get to meet Ira Flatow," which was quickly followed by, "Oh no, it's national radio." However, the *Science Friday* staff has a procedure that makes it relatively painless for panel participants. A couple of days before the program, a staffer did a preinterview over the telephone in order to develop a list of questions for Ira Flatow to ask the panelists. (Radio interviews are not as impromptu as they sound.) This gave some confidence that there would be one or two questions that could be answered with some authority. Also, once NPR took an interest in diseases in the ocean, so did many other media outlets, such as local and national newspapers. The cascading effect was most impressive.

At the AAAS meeting, NPR took over one of the hotel ballrooms and turned it into a radio studio. The panelists were outfitted with large headphones and instructed on how to speak into a microphone without "popping their p's." The program then began with the standard *Talk of the Nation* introduction and NPR news segment, after which Ira Flatow initiated and maintained a lively panel discussion with what seemed to be no effort. Other participants at the AAAS meeting made up the audience for the program and were allowed to ask questions of the panelists, following the opening discussions. Questions were also asked by listeners who called into the program. The call-in questions were perhaps the most interesting because these were from people without a science background but a strong concern for what diseases are doing to marine ecosystems.

Some of the comments made by the panelists clearly indicated the importance of diseases in marine systems. Many of the diseases responsible for coral reef deterioration are from new pathogens that have not been identified and from pathogens originally found only in terrestrial systems which have now made the leap to marine organisms. MSX disease was responsible for 90 percent oyster mortality in Long Island Sound in summer 1998 and the species of Vibrio, that causes cholera in humans, was a water-borne component that is transported by copepods. One panelist suggested that dieases in marine systems are now such a problem that there is a need for a structure similar to the Center for Disease Control to track the many epizootics that are occurring and to provide a central point of contact for those studying diseases in marine systems.

Overall, participating in the Science Friday panel was a positive experience, and Eileen was very impressed by the knowledge and professionalism of the individuals who work with the program. Also, exposure through this type of media is crucial to making the public aware of environmental issues, in general, and of diseases in the ocean, in particular.

The only disappointing aspect of the experience was that many NPR stations did not broadcast the *Science Friday* program because of the decision to provide continuous coverage of the Senate impeachment trial. However, the issues associated with diseases in the ocean will not go away, and we can wait for the rebroadcast of the program at a later date.

Some Remembrances and Hopes from a Former Student Now in the Canary Islands

by Jose Pelegri, Dean of the Facultad de Ciencias del Mar

A few weeks ago, I got an email message from **Carole Blett** (CCPO administrator and *CCPO CIRCULATION* editor) asking me to update my personal data. I was happy to get this message from Carole. I do believe it is great that CCPO keeps track of its former students, so I rapidly replied indicating some minor corrections in telephone numbers and adding that I'm now the Dean of the Facultad de Ciencias del Mar (School of Marine Sciences) in the Universidad de Las Palmas de Gran Canaria. As a result, Carole asked me to write some personal impressions for the *CCPO CIRCULATION* on how I got to become the Dean here and how I feel in this position. So here we go.

Before getting into what I'm doing in the Canary Islands, I would like to briefly recall how I got to Old Dominion University and some of my impressions there. Before moving to the University, in fall 1988, I had been working in the Venezuelan oil industry for eight years as an oceanographer, two of these years doing a M.S. at Oregon State University with an industry fellowship. In early 1988, I wrote a letter to **Dr. Gabriel Csanady** (now retired), who had moved from Woods Hole to Old Dominion, and I asked him about possibilities to register in the Ph.D. program while working on one of his projects. His response was positive and very encouraging, and as a result, I moved to Norfolk with my family. I remember Gabe picking me and my family up at the airport when I arrived with lots of luggage, my pregnant wife, and my one and a half year old daughter. This was the beginning of my stay at Old Dominion. Gabe and Joyce, his wife, were great to us, and so were many people at the University. I remember a few days later, at Old Dominion, when **Dr. Larry Atkinson** (director of CCPO) explained to me about all the good things of email, and I was wondering if it was free!

My four years at Old Dominion and CCPO were quite a fruitful scientific and personal experience. It was also an international experience. At the old Oceanography building, I shared an office with Andras Kapolnai from Hungary and Scott Condie from Australia, and Eichii Oka, from Japan, was next door. Down the corridor were Bill Indest, **Glen Wheless**, and John Moisan, all Americans, and Sunny Wu from China and Ana Martins from Portugal, among others. Scott left and his room was taken by Ajoy Kumar from India.

There was a lot of excitement going on around the creation of CCPO. I particularly recall Larry, Gabe, and **Denny Kirwan** quite nervous about it. And finally, in 1991, and after some indecision, it happened, and we moved to Crittenton Hall on 52nd Street, the home of CCPO. There I shared room with Andras. I seem to recall that Bill Indest was the first to graduate after the creation of the Center, then a few more graduated, and on September 14, 1992, I did.

Gabe, Larry, and Denny were all on my dissertation committee, together with John Bane from the University of North Carolina. Gabe was very happy about my graduation, and we had a party at his place. I brought shrimp cooked Spanish style, and I still recall Denny being impressed on how good shrimp could be. Gabe gave me an "Old Domino" certificate on Doctor of Reinterpretation, signed by himself as the "Maxwell Demon." The name of the "degree" was motivated by the fact that I initially had an error in my calculations which led me to some "interesting" interpretations, then I realized the error and the interpretation totally turned round. Gabe seemed to like this skill!

I moved from Old Dominion to the Canary Islands, Spain, in September 1992 with a visiting professor position at the Facultad de Ciencias del Mar (FCM) in the Universidad de Las Palmas de Gran Canaria (ULPGC). I was quite happy to get to the Canary Islands, which are located off northwest Africa. My wife's family is from these islands, and I had been here several times since 1983. The weather is fantastic (mean temperatures oscillate between 18 and 25C all year long), and the people are very friendly. It also seemed to have the potential of being an "oceanographically" fascinating place: the relatively cold Canary Current going through and creating many mesoscalar structures, coastal upwelling off the African continent, meddies passing by, north and south central Atlantic waters merging with Antarctic intermediate water and Mediterranean water, and many more.

After three years as a visiting professor, I finally got a permanent position as a Profesor Titular de Universidad. Since my arrival, my main goal had been to establish a physical oceanography group and to get funding mainly from the Spanish government and the European Union. Each year, I've also been teaching an annual undergraduate course in fluid mechanics, five hours per week addressed at junior students in a Marine Sciences degree, plus a semester graduate course per year alternating Mixing Processes in Geophysical Fluids and The North Atlantic Subtropical Gyre.

All these, combined with a few graduate students, kept me quite busy, hence I had never thought about acquiring a more administrative position. But sometimes things turn out in a way you don't expect. The former Dean was ending his four-year period in July 1998 and a number of colleagues convinced me to apply for the position. The Dean, together with two Vicedeans and a Secretary, is in charge of all the academic and extracurricular matters of the undergraduate students taking the degree in Marine Sciences and has some responsibility in the graduate courses and the promotion of the research groups in Marine Sciences. It is worth mentioning that there are three main orientations in the undergraduate degree: Oceanography and Climate, Living Resources, and Coastal Marine Environment. These orientations clearly go from scientific to technical and administrative related jobs, which causes quite a range of different types of courses. Since there are only three universities in Spain offering this five-year undergraduate degree, and we are located at a wonderful island, we have almost 1,000 students!

Making the community aware of the importance of the marine environment, particularly in an archipelago, the professional promotion of the students was quite a challenge. We felt we had to make the community aware of the importance of the surrounding ocean in climate, aquaculture, coastal planning, etc., and we had to renew the degree curricula, making it flexible for the student to design his own marine sciences related job. In particular, we felt that it was extremely important to incorporate a number of extracurricular, marine sciences related practices and activities outside the university, which could motivate the students and provide them with some key professional experience. We also felt necessary to push the graduate degree programs, providing an attractive offer of a high-quality degree to the Spanish-speaking community. This undoubtedly had to be based on internationally-recognized interdisciplinary research, and the first step was to make people realize that only by joining efforts we could accomplish this goal.

So I made up my mind, and last June I applied for the Dean position. The way a Dean is elected in Spain is through a democratic vote by all lecturers in the School (we have over fifty lecturers) plus some representatives of the administration personnel and the undergraduate and graduate students. There was another candidate with much more experience than I in this sort of responsibility position but, fortunately or not, I got elected!

During these six months there has been a lot of work, and so far, only a few accomplishments. Hopefully there will be more to come, but something I have clear is that all of life's important achievements, such as getting a Ph.D. or becoming a good parent, mean a lot of dialogue, service, effort, perseverance and hope. A responsibility position is no exception, and it requires all these ingredients, with a good dose of confident hope perhaps being the most important attitude for pursuing a personal and collective goal.

There are government plans for having a Sea Campus in a few years, which is to become an excellence academic and research center. Meanwhile we have to work every day creating consciousness of the importance of marine sciences within the University and in the social community, trying to improve the quality of everyday classes and doing the best in our research. Step by step, aiming at a goal but not getting discouraged by the size of the task or any inconveniences that may arise, knowing when to persevere and when to take a diversion. Just as I did when working on my classes and dissertation at CCPO, following the example and advice of Gabe, Larry, Denny and **John Klinck**, among others. This is a principal attitude I learned at CCPO, and indeed, I try to practice it every day in my current position of responsibility towards many students.

Distinguished Visitor: CURT MOBLEY and the Ocean Optics Course

CCPO is pleased to have had **DR. CURTIS D. MOBLEY** here to teach an intensive short course on Ocean Optics from February 15th to March 5th. Curt is a leading optical oceanographic modeler who loves to teach. He is author of a graduate-level textbook called "Light and Water: Radiative Transfer in Natural Waters," numerous publications, and the creator of "Hydrolight," the premier radiative transfer modeling software package. Curt has taught similar courses at the University of Southern California and at INPE in Brazil to rave reviews, and he also helps team-teach the University of Washington's Optical Oceanography summer course at Friday Harbor, which is arguably the best ocean optics summer course in the world. Students have consistently identified him as one of the best lecturers at Friday

Harbor. He is well prepared with lots of lecture notes and has the gift of making complex things seem simple. Curt made his Hydrolight software available to students during the course, so they can run simulations of real world problems to gain insight. His enthusiasm was obvious to students and seems to be infectious.

Curt worked briefly at the Chesapeake Biological Laboratory and participated in Chesapeake Bay cruises, so he is not a stranger to this part of the world. He did his Ph.D. in meteorology at the University of Maryland and then headed west. As a postdoc with NOAA PMEL in Seattle, he had a pivotal experience. The late Rudy Preisendorfer, who wrote the benchmark 6 volume treatise on Hydrologic Optics, was just down the hall. Rudy convinced him to turn his considerable talents to ocean optics and the rest is history. Hydrolight Version 4.0 is now being used by optical oceanographers around the world for basic and applied research. Curt has held research positions at the University of Washington, at the Jet Propulsion Lab, and in private industry, and he was manager of the Oceanic Optics Program at the Office of Naval Research from 1989 to 1991. He is currently a senior scientist and Vice President of Sequoia Scientific, Inc. in Seattle. He goes to sea when they let him, and when not sitting behind a computer, he can often been found wandering the slot canyons of southern Utah, mountain biking in the desert, or sea kayaking.

During his stay, Curt is also working with **Dr. Glenn F. Cota**, research associate professor at CCPO. Curt and Glenn are running simulations of Glenn's bio-optical data sets on snow, sea ice and seawater from the Arctic collected with support from ONR and NASA. Curt was instrumental in getting an Accelerated Research Initiative on Sea Ice Electromagnetic Properties approved while he was at ONR. Curt and Glenn participated in the main ONR field program on sea ice near Barrow, Alaska in 1994. The field folks were impressed that Curt and another modeler were willing to freeze their butts off to collect field data. Curt had bronchitis and almost got pneumonia but struggled valiantly with a prototype instrument to acquire the first beam spread functions measured along horizontal paths within the ice. This BSF data proved to be very useful in understanding the scattering properties of ice.

Students and faculty associated with Curt's course wish to thank the co-sponsors, **Larry Atkinson**, the Director of CCPO; **Terry Hickey**, the Dean of the College of Sciences; and **Robert Ash**, the Associate Vice President for Academic Affairs. This has been a very special academic opportunity.

Just the *facts* . . .

Awards

A. G. E. HASKELL, 1999 Master's Thesis Award, 1999 Conference of Southern Graduate Schools (CSGS), Charleston, South Carolina, February 20-22, 1999. (See article this issue.)

A. VALLE-LEVINSON, 1998 Editors' Citation for Excellence in Refereeing for Journal of Geophysical Research, American Geophysical Union at the 1999 Spring Meeting, Boston, MA.

Graduates

M.S.: R. MOODY, December 1998; non-thesis; Advisor: **L. P. Atkinson**.

Grants/Contracts Awarded

G. F. COTA, "Arctic Shelf and Basin Productivity," National Science Foundation, $273,000.

G. H. WHELESS, "Defining and Implementing Requirements for a National Virtual Ocean Data System (NVODS)," Office of Naval Research, $298,380.

Presentations

T. D. CLAYTON and **E. E. HOFMANN**, "A Simple Nutrient-Based Open-Ocean Ecosystem Model Including *Trichodesmium spp.*," ASLO Meeting, Santa Fe, NM, February 1-5, 1999.

L. A. CODISPOTI, "The Oceanic Nitrogen Cycle and Global Change: An Idea Whose Time Has Come?" Biogeochemistry of the Arabian Sea: Synthesis Modelling, Bangalore, India, January 18-20, 1999.

J. M. Morrison, North Carolina State University; **L. A. CODISPOTI**; **S. GAURIN**; B. Jones, University of Southern California; V. Manghanani, North Carolina State University; and Z. Zheng, Univerrsity of Southern California, "Seasonal Variation of Hydrographic and Nutrient Fields During the U.S. JGOFS Arabian Sea Process Study," Biogeochemistry of the Arabian Sea: Synthesis Modelling, Bangalore, India, January 18-20, 1999.

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ADK's Words of Wisdom

When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong.

When, however, the lay public rallies round an idea that is denounced by distinguished but elderly scientists and supports that idea with great fervor and emotion--the distinguished but elderly scientists are then, after all, probably right.

A. C. Clarke (Clarke's Law)

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