

Fall 1993

Circulation, Fall 1993

Center for Coastal Physical Oceanography, Old Dominion University

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Palmer Long-Term Ecological Research (LTER)

STUDYING AN ECOSYSTEM DOMINATED BY ICE

In fall 1990, the U.S. National Science Foundation established the first Antarctic Long-Term Ecological Research (LTER) site at Palmer Station, which is one of three U.S. Antarctic research stations and is located on Anvers Island (64°40'S, 64°00'N), about midway down the Antarctic Peninsula. The Palmer LTER was the eighteenth site to join the LTER Network, and it is anticipated that this program will continue for ten years. The LTER program recognizes the need for long term observations in order to distinguish interannual and cyclic trends and patterns in ecological systems. Furthermore, the LTER program includes many different ecological systems, from grass prairies to tundra, all of which conduct research in five core areas so that comparisons can be made between these systems and ecological generalities can be derived.

The Palmer LTER focuses on the pelagic marine ecosystem in the Antarctic and the ecological processes that link the extent of annual pack ice to the biological dynamics of different trophic levels. Pack ice may be the primary physical factor affecting the structure and function of this polar ecosystem. It has been suggested that interannual cycles and trends in the annual extent of pack ice impact all levels of the Antarctic marine food web, from total annual primary production to breeding success in seabirds. Thus, the overall objectives of the Palmer LTER are to:

- document interannual variability in the development and extent of annual pack ice;
- document interannual variability in life history parameters of primary producers and populations of key species from different trophic levels, and to quantify the processes underlying this variation;
- construct models that link ecosystem processes to physical variables that simulate the spatial and temporal relationships between representative populations; and
- use mathematical models to predict and validate the impacts of altered periodicities in the annual extent of pack ice on ecosystem dynamics.

The Palmer LTER consists of six components that are centered at three universities: University of California-Santa Barbara, Old Dominion University, and University of Hawaii. These components focus on primary production and bio-optical modeling of primary production; phytoplankton and nutrient dynamics; distribution, abundance and ecological physiology of secondary producers, in particular Antarctic krill (*Euphausia superba*); seabird population dynamics and reproductive ecology; dissolved organic carbon and microbial processes; and hydrography, coastal circulation and physical/biological modeling, which is the component that is based at CCPO.

To provide an observational basis for addressing the Palmer LTER research objectives, an intensive sampling program has been undertaken. This consists of a series of core measurements that are made every austral spring and summer in the near vicinity of Palmer Station at approximately weekly intervals.

Additional information is obtained from an annual research cruise that covers a region of about 400 km by 200 km around Palmer Station. The measurements are further supplemented by longer duration process cruises that cover an area that extends about 200 km offshore and 900 km along the western Antarctic Peninsula. Additional shorter cruises provide observations during other times of the year, such as the austral winter. These cruises provide seasonal observations of the processes underlying interactions between ice cover and the Antarctic marine food web.

To date, two austral spring/summer cruises have taken place, November 1991 and January-February 1993. CATHY LASCARA, a Ph.D. student at CCPO working with the Palmer LTER, participated in these cruises. One of the longer duration process cruises took place in March-May 1993, and DAVID SMITH, BRUCE LIPPHARDT (both Ph.D. students at CCPO), and EILEEN HOFMANN (CCPO) faculty member and a PI in the Palmer LTER participated in this cruise. JOHN KLINCK, a CCPO faculty member and Palmer LTER PI, just returned from participating in an austral winter cruise (August-September 1993). The observations from these cruises are being analyzed by researchers

at CCPO to obtain an understanding of the circulation and water mass distribution in the Palmer LTER region and how this affects the distribution of Antarctic krill. This will then provide input for a series of circulation and circulation-biological models that are being developed for the Palmer LTER at CCPO.

Fall 1993 Ph.D. Graduates

ANDRAS KAZMER KAPOLNAI was born in Hungary on May 17, 1962. He and his wife, Csilla, have a two-year old daughter named Vivian. Andras started his undergraduate studies in 1981 at the University for Heavy Industry, Miskolc, Hungary, where he majored in geophysics. He received his degree (which corresponds to a M.S. degree) in 1986, and his thesis was about the acoustic exploration of manganese nodules on the seabeds. After graduation, he joined a seismic research company in Budapest, where he was involved in 3-D seismic data processing. Andras was about to join a German seismic company in 1988 when he was accepted for Ph.D. studies at Old Dominion University under G. T. Csanady. The goal of Andras' s dissertation is to determine the tropical Atlantic' s role in the global heat balance. The method of investigation is an analytical study of a coupled oceanic-atmospheric boundary layer system. The model sea-level wind field is driven by the regionally important heat sources. The oceanic boundary layer model examined the behavior of the warm water mass balance, equatorial upwelling rate, storage of warm water in the equatorial basin, warm water escape, and transport out of the basin. The warm water transported northward (from the equatorial basin) influences the hemispheric energy balance and the location of the InterTropical Convergence Zone and the heat sources, which in turn influence the wind field. Andras would like to find a university position after graduation, so that he could continue his "own exploration of the oceans." He is most interested in the research of oceanic and atmospheric boundary layer processes, air-sea interaction, global change and climate, and mathematical modeling of ecosystems.

SUNNY YU WU was born in Quanzhou, Fujian Province and grew up in Beijing, China. She and her husband, Xiutian Zhao, have a little boy named Leon Zhao, who turned three in October. Sunny received her B.S. from Shandong College of Oceanology in Qingdao, China, where she majored in physical oceanography. After graduating from college in 1984, Sunny worked as a technical editor at Science Press in Beijing for two and a half years. In 1987, Sunny came to Old Dominion University to study under Larry Atkinson. Her thesis will be entitled, "On the low-frequency current and thermal variabilities along the Southeastern U.S. continental shelf edge." Current and temperature records collected over that area have revealed oscillations with periods longer than the local inertial period. What is the nature of these oscillations? What physical mechanisms govern these oscillations? With these questions in mind, Sunny analyzes sets of current and temperature data collected along the shelf edge, using empirical orthogonal function analysis technique in frequency domain. The information gained from the spatially and temporally coherent signals will be compared with properties of wave motions predicted by theoretical studies. The overall objective of this study is a better understanding of the circulation in the vicinity of the shelf edge, which plays an important role in the exchange of water masses across the continental margins. Upon graduation, Sunny will begin work with Dr. Shenn-Yu Chao at the Horn Point Environmental Laboratory, University of Maryland, as an assistant research scientist. She will be working on research projects related to topics such as western boundary currents and circulations in estuaries and other coastal waters, using numerical modeling techniques.

Scientists Meet in Galway, Ireland for International Conference

Approximately 50 scientists from across the world met at the University College in Galway, Ireland, on September 20-22 for the international conference, "Fractals, Chaos, and Predictability in Oceanography and Meteorology." Sponsors of the conference included the American Geophysical Union, the American Meteorological Society, International Association for the Physical Sciences of the Oceans, the European Geophysical Society, and the Royal Irish Academy. Financial support was provided by the Office of Naval Research. A.D. KIRWAN, JR., of CCPO, was the convener.

The primary purpose of the conference was to assess developments in prediction of oceanographic and meteorological flows since the last assessment in 1973. Determining the role of chaos in predictive models was one of the general questions that participants addressed. Sessions were held on establishing limiting factors for atmospheric, oceanic, and climate prediction, the quantification of chaotic and stochastic processes, and distinctions between different types of nonlinear flow phenomena.

Several faculty and graduate students from Old Dominion University and CCPO reported on recent developments. Below is a list of those presentations:

CHESTER GROSCH, "Absolute Convective Instability in the Equatorial Current-Undercurrent."

JOHN HOLDZKOM II, "A Comparison of Resonantly and Stochastically Forced Solutions to a Hydrodynamic Model." Co-authors are A. D. Kirwan, Jr. of CCPO and Stanford Hooker of NASA/Goddard Space Flight Center, Greenbelt, Maryland.

A.D. KIRWAN JR., "Rotating Modons in a Stratified Ocean: A Dynamical Systems View." Co-authors are Bruce Lipphardt, Jr. of CCPO and Richard Mied of Naval Research Laboratory, Washington, DC.

A.D. KIRWAN, JR., "A Historical Perspective on Prediction of Atmospheric and Oceanic Flows."

BRUCE LIPPHARDT, "Analysis of Particle Trajectories for a Baroclinic Rotating Modon." Co-authors are A. D. Kirwan, Jr. of CCPO and Richard Mied of Naval Research Laboratory, Washington, DC.

CAITLIN MULLEN, "Surface Flow Structure of the Gulf Stream from Composite Imagery and Satellite-Tracked Drifters." Co-author is A. D. Kirwan, Jr.

MICHAEL TONER, "Invariant Manifolds and Bifurcation Parameters of a Toy Climate Model." Co-author is A. D. Kirwan, Jr.

These papers and other conference papers will be published in early 1994 in the new European Geophysical Society journal, *Nonlinear Processes in Geophysics*.

GLOBEC Workshop Held CCPO

Recently, the International GLOBAL Ocean ECosystem Dynamics (GLOBEC.INT) Science Steering Committee (SSC) identified the Southern Ocean as a potential research site. The unique characteristics of the Antarctic marine food web make the Southern Ocean an ideal environment in which to test many of the GLOBEC core hypotheses which consider the effects of variability in the physical environment on the dynamics of marine animal populations. Consequently, the international GLOBEC SSC recommended that a workshop be held to define the scientific rationale and to begin the development of an implementation plan for an international Southern Ocean GLOBEC program.

This recommendation led to a workshop entitled, "GLOBEC.INT Southern Ocean Planning Workshop," that was held, under the auspices of the international GLOBEC program, at CCPO June 15-17, 1993. EILEEN HOFMANN served as the workshop coordinator, and JULIE R. MORGAN assisted with the logistics. Approximately 30 scientists, who represented 10 nations with interests in Antarctic programs, attended the workshop. The working group discussions and recommendations are summarized in a report that will be available fall 1993. A second workshop is anticipated to further develop these recommendations.

Distinguished Visitor

Dr. Linda Lawson

During the coming year, LINDA LAWSON will be a Visiting Scientist at CCPO and will be working with Eileen Hofmann on data assimilation techniques. Linda is on a non-instructional assignment (NIA) from East Tennessee State University (ETSU), where she is a professor in the mathematics department. ETSU is a predominantly undergraduate liberal arts university, located in Johnson City, Tennessee and is one of the principal campuses in the Tennessee statesystem. Linda's research interests are in graph theory and mathematical modeling, and her time will be divided between these two areas. Her visit is funded by the National Science Foundation's Visiting Professorship for Women

(VPW) program, ETSU's NIA program, the NSF Division of Ocean Sciences, and the Old Dominion University Research Foundation.

The goal of Linda and Eileen's project is to study the application of data assimilation techniques to the problem of incorporating ocean color measurements into physical-biological models. This study is well-matched with Linda's research background, which includes many years of modeling experience while she was with the Atlantic Oceanographic and Meteorological Laboratory's (AOML) Sea-Air Interaction Division and Ocean Acoustics Division. Most recently, Nova University's Oceanographic Center and Robert Long, AOML, on applying the adjoint technique to an optimization problem involving ocean surface wave-modeling as part of a program sponsored by NSF.

This proposed research is designed to be a companion project to an on-going effort directed by Eileen. This research represents a first step in the construction of a complex marine ecosystem model that combines several physical and biological systems with the techniques of data assimilation and optimization. This will be accomplished by the development and implementation of a series of numerical models of marine systems making use of variational methods incorporating the adjoint technique. The significance of this project is that it will provide a basis for incorporating vast amounts of data obtained from the Coastal Zone Color Scanner and data expected from SeaWiFS into marine systems models. Additional activities in Linda's plans for the coming year include participating in the Visiting Scientist Lecture Series, serving on the dissertation committee for graduate student, Yvette Spitz, planning a reading independent study for the spring, and participating in numerous informal seminars.

Notes from the Director

This marks the third year of the existence of the Center for Coastal Physical Oceanography (CCPO) and the introduction of our newsletter, CCPO Circulation. The purpose of CCPO Circulation is to inform the research community and our sponsors of our activities. We will highlight research projects, Center news, accomplishments of our students, activities sponsored by the Center, awarded grants, published and presented papers, and meetings attended.

In this inaugural edition, I would like to reflect on the Center and where I see it going. Starting this Center was an experience few of us will witness and even then, probably only once. For a start, take 30 very busy people and make them even busier. To continue the Center's success, we must do essentially three things: develop a setting and infrastructure that will permit excellent research, hire excellent staff and faculty, and recruit outstanding students.

The setting, Crittenton Hall, with its water view and oak trees, is no doubt the best site on campus. Within the building, there are areas for conversation and quiet reading and other areas for workshops and conferences. The technical infrastructure consists of computer systems and software. Because we started with nothing, we had the great opportunity to become state of the art within a year. Our system is, I'm sure, the envy of many other researchers. Because of it, we have attracted researchers from all over the world.

Where are we going? I envision a research group large enough to become catalytic. This means it generates projects of international quality. This also means we can support basic services and salary support for research faculty. The size of a group that can do this is probably in the 60 to 100 range. With time, I am sure we will get there. Estimates right now suggest we will be at 60 people by 1996 (a 100 percent growth in five years).

Larry P. Atkinson
Director
Center for Coastal Physical Oceanography

Just the Facts...

Grants Awarded

A. D. KIRWAN, JR., "Center for Parallel and Distributed Scientific Computing," \$145,870, Office of Naval Research

G. T. CSANADY, "Oil Spill Risk Analysis Based on Statistical Kinematics with Empirical Input," \$98,290, Department of Interior

G. T. CSANADY, "Review of Shelf Circulation: Shelf Domains and Conceptual Models," \$41,040, Office of Naval Research

E. E. HOFMANN (with Charles R. McClain, NASA), "Assimilation of Ocean Color Measurements Into Physical-Biological Models," \$75,000, NASA

A.D. KIRWAN, JR., "Nonlinear Secondary Oceanic Flows: Their Role in the Transport of Mass Momentum and Energy," \$90,000, Office of Naval Research

A. D. KIRWAN, JR., "Numerical Modeling Study of the Gulf of Mexico Basin: Skill Assessment," \$25,026, Naval Research Laboratory

Presentations

LARRY ATKINSON, director, "Eastern USA Coastal Processes and Global Change," The Inter-American Workshop on Oceanic, Coastal and Esmarine Processes in the Temperature Zone, Montevideo, Uruguay, August 2-4, 1993.

MARGARET DEKSHENIEKS, graduate student, "Modeling the Vertical Distribution of Oyster Larvae *Crassostrea virginica* Considering Growth and Behavioral Responses to Changes in Environmental Conditions," The National Shellfisheries Association Meeting, Portland, Oregon, May 30-June 3, 1993. Co-authors are Eileen Hofmann and John Kinck of CCPO and Eric Powell of Texas A&M University.

JERRY MILLER, research assistant professor, "Long-Term Observations of frontal Variability in the Vicinity of the Chesapeake Bay Mouth," The 1993 Gordon Research Conference on Coastal Ocean Circulation, Plymouth, New Hampshire, June 13-18, 1993.

ARNOLDO VALLE-LEVINSON, research assistant professor, "Effects of Bathymetry, Oscillating Barotropic Forcing and Vertical Mixing on Estuary/Ocean Exchange," The 1993 Gordon Research Conference on Coastal Ocean Circulation, Plymouth, New Hampshire, June 13-18, 1993.

EILEEN HOFMANN, associate professor, "Process Modeling Across Disciplines," The 1993 Gordon Research Conference on Predictive Theory in Biological Oceanography, Colby-Sawyer College, New London, New Hampshire, August 16-20, 1993.

GLEN WHELESS, research assistant professor, "The Effects of Wind on a Buoyancy-Driven Estuarine Plume," The 1993 Gordon Research Conference on Coastal Ocean Circulation, Plymouth, New Hampshire, June 13-18, 1993.

Visiting Scientist Lecture Series

During the academic year, CCPO invites several distinguished scientists to present seminars on general coastal oceanography topics. The lectures take place in Room 109, Crittenton Hall, Old Dominion University, on Mondays at 3:30 p.m. EILEEN HOFMANN, associate professor, coordinates the lecture series, with the assistance of BEVERLY MITCHELL. Below is a schedule of lectures for the 1993 fall semester. Please contact Beverly at (804) 683-4945 for more information or if you would like to be on the mailing list for announcements. Lecture topics are announced one week prior to each lecture.

SEPTEMBER 13
Jerry Miller, CCPO

OCTOBER 25
John Brubaker, VIMS

SEPTEMBER 20
Chris Mooers,
University of Miami

NOVEMBER 1
Dick Lambert, NSF

SEPTEMBER 27
Glen Wheless, CCPO

NOVEMBER 8
Mark Meyers, VIMS

OCTOBER 4
Goran Bjork,
Gotteberg, Sweden

NOVEMBER 15
James O'Brien,
Florida State U.

OCTOBER 11
A.D. Kirwan, Jr.,
CCPO

NOVEMBER 22
Warren Wiscombe,
NASA/GSFC, MD

OCTOBER 18
Jim Yoder,
U. of Rhode Island

NOVEMBER 26
Linda Lawson,
East Tenn. State U.

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