

Summer 2001

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Center for Coastal Physical Oceanography, Old Dominion University

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# CIRCULATION

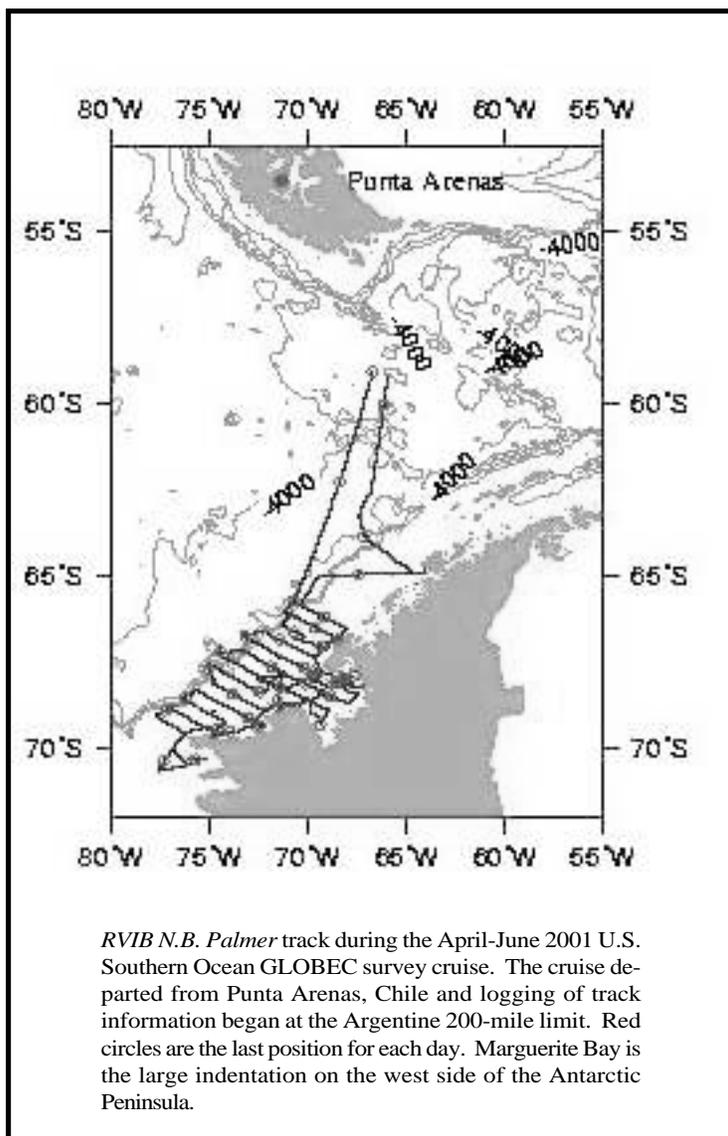
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## OCEANOGRAPHIC RESEARCH IN THE ANTARCTIC

After a long wait in Miami, Florida and about 30 hours at the mercy of the airlines, CCPO graduate students, **BARIS SALIHOGLU** and **ROSARIO SANAY**, and CCPO professor, **EILEEN HOFMANN**, arrived at Punta Arenas, Chile, from where we were to depart via an oceanographic research vessel for the Antarctic Peninsula region. Punta Arenas is a small city, huddled at the water's edge at the base of the Andes Mountains, located near the tip of South America. Even though we experienced no change in time zone, our trip from Norfolk, Virginia to Punta Arenas covered more than a quarter of the way around the Earth. We left Norfolk on a pleasant spring day in mid-April and arrived in Chile in the austral fall. Punta Arenas was a change from spring in Norfolk, with strong winds, cold temperatures and cloudy skies that threatened snow. This portion of South America is, after all, called Tierra del Fuego (Land of Fire), so named because of the persistent low cloudiness. The scenery was stark, consisting of a landscape with few trees and giving the impression of being wind-swept most of the time.

We went to Punta Arenas so we could participate in the first survey cruise for the U.S. Southern Ocean Global Ocean Ecosystems Dynamics (SO GLOBEC) program. This pro-



*RVIB N.B. Palmer* track during the April-June 2001 U.S. Southern Ocean GLOBEC survey cruise. The cruise departed from Punta Arenas, Chile and logging of track information began at the Argentine 200-mile limit. Red circles are the last position for each day. Marguerite Bay is the large indentation on the west side of the Antarctic Peninsula.

gram, which is funded by the U.S. National Science Foundation Office of Polar Programs, has as its primary scientific objectives: 1) to describe and understand the circulation of the waters that overlie the continental shelf of the western Antarctic Peninsula and its effect on Antarctic krill (*Euphausia superba*) distribution and on sea ice formation, and 2) to examine the factors that govern Antarctic krill survivorship and availability as food to higher trophic levels, including seals, penguins, and whales. The U.S. SO GLOBEC field program consists of joint survey and process cruises in April-May and July-August in 2001 and 2002. The process cruises are on board the *RV Lawrence M. Gould*; the survey cruises are on the ice-breaker *RVIB Nathaniel B. Palmer*. Two additional mooring deployment cruises in March 2001 and March 2002, bringing the total number of cruises in this program to ten.

Our role in the survey cruise was to make the hydrographic measurements, collected with a Conductivity-Temperature-Depth/Rosette (CTD) system, which will allow the circulation of the study region to be described. The hydrographic observations are a primary data set for the

overall SO GLOBEC program. Because this is the first survey cruise, the hydrographic

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Continued on Next Page

data will also provide a baseline for future cruises.

In addition to the group from CCPO, other members of the hydrographic team were Sue Beardsley and Bob Beardsley from the Woods Hole Oceanographic Institution; Susan Howard from Earth and Space Research; Aparna Sreenivasan from the University of California, Santa Cruz; and Mark Christmas from the National Geographic. Our group was also responsible for data sets from the Acoustic Doppler Current Profiler (ADCP) system, expendable bathythermograph probes (XBTs), expendable CTDs (XCTDs), the meteorological sensors, the underway surface water observations, and chlorophyll, oxygen and salinity samples from water collected at each CTD cast. This made for a busy cruise.

We spent a few days in Punta Arenas, loading the ship, checking our research equipment, getting special heavy clothes to wear during the cruise, and drinking pisco sours. The scientific crew for the process and survey cruises is composed of people from a number of universities and scientific disciplines. So, we also met those we did not know and caught up on events with those that we did know. We also started finding our way around the *RVIB Nathaniel B. Palmer*, which would be our home for the next two months. As part of learning about the ship, we met the ship's crew and learned who did what and who was especially important to our well being, such as the ship's cook.

Given the scientific objectives of the U.S. SO GLOBEC program, the survey cruise is a multidisciplinary undertaking. The research groups represented on the cruise set up equipment for measurements ranging from temperature and salinity to phytoplankton productivity to krill and to penguins, birds, and whales. Some groups finished in a few hours and were left to offer their services to the other groups or to spend time shopping at the stores in town. Our efforts during the port call were directed at ensuring that our primary instrument, the CTD system, was working.

The day before departure, we moved from hotels in Punta Arenas into our respective quarters on the *Palmer*, which are spacious by research vessel standards. After departing Punta Arenas, we sailed east along the Straits of Magellan before

turning south. The waves were moderate, the winds were fresh, and the passing landscape was beautiful. We saw many birds and some dolphins but little else during the transit along South America. One of the first activities that occurred after leaving port was to have a fire drill. Fire on board ships is a serious problem and, as a result, everyone was required to undergo training about what to do in case of a fire. We also received instruction and practiced getting into survival suits and the lifeboats. Survival times in the frigid Antarctic waters are short before hypothermia becomes fatal.

After leaving the protected waters of South America, we steamed south across Drake Passage towards our first scheduled sampling site, which was north of Marguerite Bay (see map). The Drake Passage crossing gave our first sampling of Antarctic weather when we encountered winds of 25+ knots and 18 to 20 foot seas. Our four-day transit across Drake Passage was rough, and it provided a good test of how well we had secured our sampling gear and how well the scientific crew handled seasickness. The CTD group began XBT sampling after leaving the 200-mile limit of Argentine waters, which provided a nice realization of the Polar Front in Drake Passage.

Our real work started with a CTD cast at the first station, which was just off the shelf break (see map) to the north of Marguerite Bay. Because this was our first station, we encountered all of the problems that are associated with learning new things; however, it all eventually worked. Following the CTD cast, the other groups on board tried out their sampling systems, which consisted of a Multiple Opening/Closing Net and Environmental Sampling Sensing System (MOCNESS) with nine 1-m<sup>2</sup> nets and the Bio-Optical Multifrequency Acoustical and Physical Environmental Recorder (BIOMAPER II). The approaches used at the first station were refined during the next few stations and we eventually settled into a pattern that served us well for all 84 stations that were done during the cruise.

Most of the days were cloudy, foggy, and overcast, which made viewing the scenery difficult and for tiresome working conditions. Also, the days were shortening throughout the cruise, and by the end of the cruise, we had only about four hours of daylight, or more correctly twilight. However, on the clear days, when we were near the continent, the scenery was outstanding.

The landscape is a beautiful blend of many colors and, at many of the inner stations, we also saw seals, birds, penguins, and whales. The mountains on the Antarctic islands are tall and steep, standing at the edge of the water. The majestic landscape was striking and most everyone wandered out on deck to take pictures and enjoy the view, in spite of the cold temperatures.

After a week or so, we had established a routine and had become comfortable with what needed to be done. The CTD group was divided into two watches of 12 hours each, which provided some regularity to our life once sleep patterns adjusted. Much of the time on watch was spent collecting data and archiving it in computer files, in sample bottles, or in the freezer for later analysis. We all got very good at filtering water for chlorophyll samples.

After about four weeks of sampling, much in 40+ knot winds and heavy seas, we arrived at our final station at the southern-most part of the station grid. After this station, the activities of the CTD group diminished a bit, which allowed us to catch up on data analysis and archiving. However, this was a short-lived break because we then started a series of focused studies that were designed to provide insight into Antarctic krill distribution, the coastal current in Marguerite Bay, and the feeding ecology of seals and whales. We also deployed two Automatic Weather Stations on small islands in Marguerite Bay, which will provide the first continuous meteorological observations from this region.

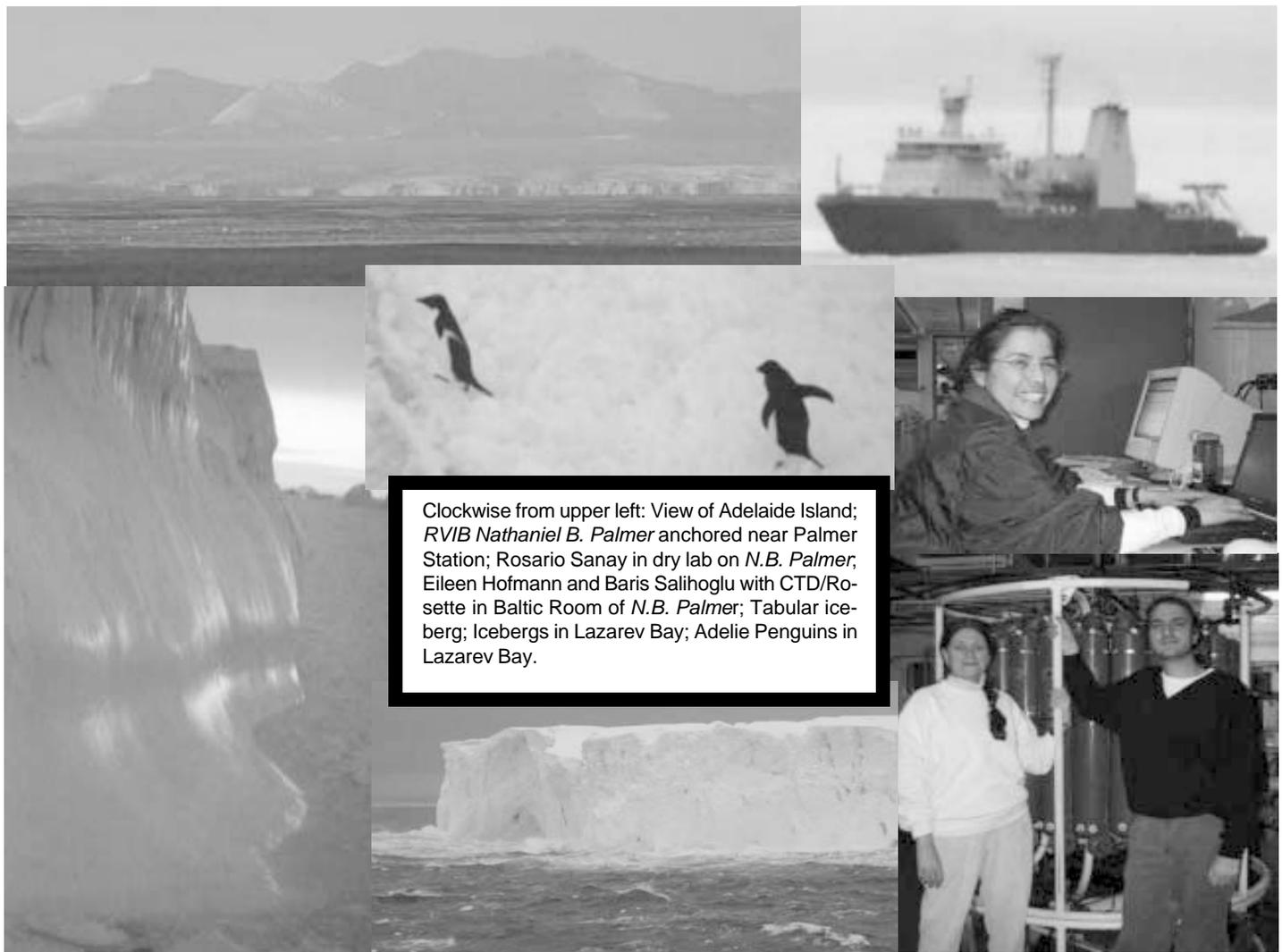
Two fun activities took place during the second half of the cruise. The first was a short visit to the Argentine Base, San Martin, which is on a small island off the Antarctic continent. Our Argentine hosts provided a tour of their station and a wonderful buffet lunch. We had a great time and were sorry when it was time to leave and return to the ship. The second event was the arrival of King Neptune. Much of our cruise took place above the Antarctic Circle and for many members of the scientific crew, including CCPO students, **BARIS SALIHOGLU** and **ROSARIO SANAY**, this was their first time crossing this important line in the ocean. Thus, scientific activities were halted long enough to have a traditional circle crossing ceremony. Once again, King Neptune let us pass after expressing his displeasure at being disturbed.

## NOTES from the Director.....

Another summer has passed. I, the person, turned sixty and am thinking what I will do with all my accumulated experience and knowledge. I, the global citizen, am concerned about global change and how society will deal with it, attending an International Geosphere-Biosphere Program meeting will do that to you. I left that meeting feeling that our observational capabilities and our understanding of ocean systems are woefully lacking. Nothing short of order of magnitude increases in observing, field experiments and new biogeochemical sensors will suffice. As I note in this issue there is a real chance that this may happen. I hope so.

**Larry Atkinson**  
*Director, Center for Coastal Physical Oceanography*

## Images from U.S. Southern Ocean GLOBEC



# STUDENT PROFILE

## Bettina Fach

**BETTINA FACH** is a CCPO graduate student who took up the challenge of mastering Unix machines and programming after deciding that working as an environmental engineer was just not interesting enough.

Never much interested in school as a youngster, Bettina had one high school teacher, a Catholic nun, who managed to get her attention and made math, physics, and biology her favorite subjects for the years to come. This led her to eventually start studying environmental engineering on the North Sea coast of Germany.



Fascinated more with the ocean than her engineering classes, she soon wondered if one could combine studying both. In an attempt to do so, she started an internship at the local Senckenberg Institut, a marine geology and biology research institute. There she was introduced to the theories of sediment transport in the backbarrier tidal flats of the Wadden Sea and had the chance to participate in several week-long cruises on the North Sea on the institute's research vessel. She finished her engineering degree (Diplom-Ingenieur) in early 1996, after writing her thesis in collaboration with the Senckenberg Institute, and continued to work there. She got involved in a project to assess the environmental impact of drilling for a pipeline in the German national park, Wadden Sea, where she became intrigued by the great influence of physical processes on the ecosystem and the power of numerical models to simulate them.

Bettina then left Germany to discover more of the world of modeling and to work with **EILEEN HOFMANN**, CCPO professor. Under the guidance of professors here at CCPO, NOAA/NODC, and the British Antarctic Survey, Bettina works on modeling the transport and survival of krill (*Euphausia superba*) in the Scotia Sea and its environs. Krill is an important organism in the Southern Ocean ecosystem, where it has a pivotal role in the food web and variations in its abundance have an effect on krill-dependent higher trophic level predators, such as penguins and seals. One highlight of her studies was the opportunity last year to get away from her desk for two months and participate in the Synoptic Survey cruise in the Scotia Sea on the British Antarctic Survey research vessel, *James Clark Ross*. In her free time, she enjoys reading, swimming, and playing with her crazy parrot, Jojo. Bettina plans to complete her Ph.D. next spring, and she would like to continue modeling in a postdoctoral research capacity.

# QUOTES FROM THE FIELD

**“Theorems are carefully stated and proofs are mercifully omitted. (It avoids the fallacy, popular among mathematicians, that one cannot use what one cannot prove, as if one needed to understand the reasons for the dynamical stability of a bicycle before one could ride it.)”**

*J.C. Polkinghorne*

**Quote from a review of “Mathematics Applied to Physics,” Ed. E. Rouline, which appeared in *Journal of Fluid Mechanics*, vol. 44, page 622, 1970.**

*Submitted by Chet Grosch, CCPO*

**Please send in your favorite quote, preferably by or about oceanographers, to [julie@ccpo.odu.edu](mailto:julie@ccpo.odu.edu).**

## BEST WISHES!

**CCPO *Circulation* wishes a fond farewell to former co-editor, JOY HAYES MCQUAY, who was also the grants administrator at CCPO since 1999. Joy has moved to the Baltimore, MD area with her husband, Dr. Nathaniel McQuay. She has accepted a position as a sponsored programs administrator at the Space Telescope Science Institute (STScI).**



## THE WHITE OCEAN

by Baris Salihoglu

I had a couple of worries when I first decided to join the Antarctic cruise. First of all, it was a completely new experience for me since I haven't been on a long cruise other than some short Mediterranean cruises. Second, being a hot-blooded Mediterranean guy from Turkey, I was definitely not used to high seas and cold weather and this was going to be *a winter cruise in the Southern Ocean!* Before the cruise, I had to pay really high phone bills because I spent hours on the phone trying to convince people back home that I'm *really* going to Antarctica and they shouldn't worry that polar bears would eat me there.

After rubbing Magellan's foot in Punta Arenas (PA), three heroes from CCPO (**EILEEN HOFMANN**, **ROSARIO SANAY**, and **BARIS SALIHOGLU**) started sailing towards the wild seas awaiting us. The *RVIB Nathaniel B. Palmer* is a magnificent ship, with its roomy labs, unlimited computer facilities, professional technicians, humorous officers (not only humorous, they were also very cooperative and highly professional), and good cooks. With its sauna and gym, it was more like a five-star resort than a research cruise ship! The only down part (for me) was the narrow bunks, which made me feel claustrophobic. The first night on the boat was quite unpleasant for me in that respect. Of course, half the lamb that I ate in PA before going to bed was also likely to blame.

In spite of all my antipathy towards taking "Dramamine", I had to join the family of "high" scientists on the second day of the cruise. Luckily enough, this was only for a day and on the third day of the cruise, I was sea-acclimated. From then on, even the highest seas were unaffectionate.

Many things amazed me during the cruise, two of which I will mention. The first is that this cruise showed me what "oceanography is a team work" means. The whole crew on that boat was a team composed of many subteams, like the CTD team, MOCNESS team, BIOMAPER team, etc. Even these subteams had some sub(sub)teams like the day and the night shifts. Each member of the team not only had to work in harmony with its subteam members but had to work in coordination with the other teams, as well. This is more complicated than it sounds. Other than the human factor, each team also had to struggle with unexpected factors, like extreme weather and instrument failure. Each team and its members had to be flexible enough to fill the gaps when another team was experiencing such problems in order to minimize time waste.

The second one was the extraordinary beauty of the nature. It was "extraordinary" not only because it was gorgeous, but it was also very different. Under "normal" conditions you may find the beauty of the **blue sea** or the **white ice** fascinating, but in the Antarctic ocean, one discovers the beauty of the **white ocean** and the **blue ice**.

Towards the end of the cruise, Rosario and I had the chance to join the bird group and had the honor of chasing Adelie penguins and stealing their lunch. It was a major discovery in oceanography to figure out that penguins do not consume Italian food, nor Mexican food.

As we started steaming back towards PA my heart started hurting as if I was leaving a very close friend behind me. That crystal ocean definitely managed to charm my soul.



**TOP:** Sunset beyond icebergs in Lazarev Bay. **BOTTOM:** View of bergie bits off of Argentina's San Martin Base. (Photos taken by B. Salihoglu.)



Continued from Page 2

After forty-four days, we finally reached the end of the sampling and turned to the north and began the transit back to Punta Arenas. During the transit home, we occupied ourselves with data analysis, cruise report writing, packing, and getting our data sets in order. The northward trip across Drake Passage was again rough, but we all knew we were headed home. The CTD group continued to make XBT measurements across Drake Passage; we just could not pass up the opportunity to add to our database.

We arrived in Punta Arenas, ready to undo all that we had done on the way in. We returned our warm clothes (well used as they were), unloaded the ship, and stored some of the heavier and larger equipment in a local warehouse for the next SO GLOBEC cruise, taking place in July and August of this year. CCPO scientists, **JOHN KLINCK**, **SINAN HUSREVOGLU**, and **HAE-CHEOL KIM** participated in this cruise.

On the April-May survey cruise, we were fortunate to have Mark Christmas from the National Geographic as a participant. Mark provided dispatches describing the cruise activities to the National Geographic web site, which gives a wonderful chronicle of the first of the U.S. SO GLOBEC survey cruises and is fun to read. This site and additional information about the U.S. Southern Ocean GLOBEC program, daily and weekly cruise reports, and program activities can be found at: [http://www.ccpo.edu.edu/Research/globec\\_menu.html](http://www.ccpo.edu.edu/Research/globec_menu.html) and <http://www.nationalgeographic.com/sealab/antarctica>.

## New Staff Member

### *BETH MILLER*

**ELIZABETH (BETH) MILLER** Elizabeth (Beth) Miller came to work for CCPO in July 2001 as an administrative and program/office services specialist. She is responsible for managing the



receptionist office and arranging travel for the faculty, staff and visitors. Other duties include ordering supplies and maintaining the appearance of the grounds and building. She is also the distribution manager of *CCPO CIRCULATION* and assists with the coordination of the CCPO Seminar Series

Beth recently moved to Virginia from Hawaii. She says that living in Hawaii was like no other place she had ever been. "You are stuck on a rock in the middle of the Pacific Ocean, where you drive around in circles until you're dizzy. Being there was wonderful and I learned a great deal from the locals." But the things that she misses the most are the weather, scenery, and the friends she made there. Her husband, Jason, is in the Navy and was stationed on the USS San Francisco, SSN-711. Jason was recently chosen for the Seaman to Admiral Program, which allows him to go to Old Dominion University for four years to obtain a degree and then become a Commissioned Officer.

Before joining the group here at Crittenton Hall, she worked as a Temporary Agent with a local staffing service, Apple One, in Chesapeake. There, she had the opportunity to work for a mortgage company. Working for temporary staffing services has given Beth a better understanding of how businesses run and how to adapt to the changes. She also learned a number of skills from these various places. It has allowed her to better herself and to utilize skills that she had already to become an asset to these companies.

Beth was born and raised in Washington. She enjoys music (singing, most of all), spending time with her family, traveling, and reading. An avid bowler, Beth recently won a N.A.B.I. tournament in Mechanicsville, VA, bringing home a cash prize, jacket, and trophy. She plans to continue her education at Old Dominion University in the near future, intending to major in music with a minor in finance. Beth and Jason have been married for six years and have two beautiful children, Arionna Jordan (AJ), who is five years old, and Chase, who is seven months old. "Being a military wife is really hard at times; being a single parent six months out of the year is not easy when you are used to having someone to help you out. You learn to adjust and get on with the everyday things. Being away from your family back home doesn't help either, but there is always the phone. But I can honestly say that I wouldn't change it for anything. Where else can you travel, live, and see the world for free?"

## Ocean Observing

by Larry Atkinson, Director

This summer, I will start a project funded by the National Science Foundation (NSF) to assist in developing ocean observatories, long-term time series, and ocean observing systems. As many of you know, NSF will be investing considerable resources in observing systems in the coming decades. The need for better ocean observing systems has been growing for many years. Recent reports, such as "Ocean Sciences at the New Millennium" (NSF, 2001), have clearly stated the case.

I believe it is possible for ocean sciences to make great progress in ocean observing at this unique time. The reasons include the following:

- Public and business communities have realized that changes in the global climate significantly effect our society.
- Congress has formed an Ocean Caucus to promote better understanding of ocean issues.
- New insights such as hydrothermal vent systems and data coming from satellite and buoys show that we have much to learn about the ocean and what we learn has economic significance.
- The Presidential-appointed Oceans Commission will move ocean sciences to a new level of political awareness and may recommend significant changes in Federal support.
- The National Ocean Partnership is making a difference in how ocean science is funded. It is a new model.
- Ocean observing efforts will be coordinated through OCEAN.US.

If we cannot increase funding for ocean sciences with this support, it will be decades before we have the chance again.

So, what will I be doing? My specific tasks are the following:

- Provide organization and leadership for two workshops to bring disparate participants together for strategic discussions on the future technology and tools, sampling design, and developing ideas for common data formats and reporting so that all future data streams can be consistent and available in near real time.
- Provide technical advice on science issues to the newly created NOPP Interagency Ocean Observation Office (OCEAN.US).
- Provide coordination between federal planning and the academic and user communities including research, operational, and educational interests in a series of meetings both to explain the aims of these activities and to promote feedback.
- Extend coordination internationally to planning activities such as the Global Ocean Observing Systems (GOOS) and Global Ocean Data Assimilation Experiment (GODAE).

This sounds terribly bureaucratic! But what will I really be doing? I see my role as keeping research and education on the table and in the discussion as the systems are developed.

The vision is that oceanographers will be able to 'see' the ocean much as meteorologists 'see' the atmosphere. Data will be readily available so that experiments and long-term observing can be planned correctly and conducted effectively.

If you have any comments on this topic, please contact me.

#### Relevant WWW sites are:

OCEAN.US: [www.ocean.us.net](http://www.ocean.us.net)

GODAE: <http://www.bom.gov.au/bmrc/ocean/GODAE/>

GOOS: <http://ioc.unesco.org/goos/>

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# Just the *facts* ...

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## NOTEWORTHY NEWS

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**SALIHOGU, B.** The first Turkish oceanographer to land on the continent of Antarctica and to visit San Martin Station, the Argentine base, as part of the U.S. Southern Ocean GLOBEC cruise on the *RVIB Nathaniel B. Palmer*; May 29, 2001.

## GRADUATES

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**PH.D.: CACERES, M.**, "Transverse Variability of the Flow and Density in Inlets of Southern Chile," August 2001, Advisor: **A. VALLE-LEVINSON**. Mario has accepted a position at the Servicio Hidrografico y Oceanografico de la Armada in Chile.

**PH.D.: CLAYTON, T.D.**, "*Trichodesmium* spp: Numerical Studies of Resource Competition, Carbohydrate Ballasting, and Remote-Sensing Reflectance," August 2001, Advisor: **E.E. HOFMANN**. Tonya has accepted a Mendenhall Postdoctoral Research Fellowship from the U.S. Geological Survey (USGS).

**M.S.: SARKAR, N.**, "Hydrographic Variability on Decadal and Interdecadal Scales in the Northern Gulf of Alaska," August 2001, Advisor: **T. ROYER**. Nandita is continuing her studies at CCPO in the Ph.D. program.

## PRESENTATIONS

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**ATKINSON, L.P.**, K.K. Li, and R. Quinones, "Ocean margins and the global carbon assessment: status and continental task team activities," Invited presentation, IGBP Open Science Meeting, Amsterdam, The Netherlands, July 2001.

**ATKINSON, L.P.**, "Circulation, mixing and the distribution of re-mineralized nutrients." Invited presentation, Coasts: Coastal Ocean Advanced Scientific and Technical Studies Conference, Paris, France, August 8-11, 2001.

**AUSTIN, J.**, "Spatial and Temporal salinity variation in the Chesapeake Bay: an analysis of two time series." Poster presentation, Gordon Research Conference on Coastal Circulation, Colby Sawyer College, New London, NH, June 12, 2001.

**COTA, G.F.**, "Arctic ocean color: Perspectives and prospects." Virginia Institute of Marine Science, Gloucester Point, VA, April 13, 2001.

**COTA, G.F.**, "Arctic marine ecology." Norfolk Collegiate Lower School, Norfolk, VA, May 8, 2001.

**COTA, G.F.** and J. Comiso, "Climate change in the Arctic: Ecosystem responses." San Diego, CA, May 21-24, 2001.

**COTA, G.F.**, "Climate change in the Arctic: Ecosystem responses." SEARCH Biocomplexity workshop, Seattle, WA, June 19-21, 2001.

**DINNIMAN, M.S.** and **E.E. HOFMANN**, "Development of regional physical-biological models for the Ross Sea and West Antarctic Peninsula." JGOFS Synthesis and Modeling Project Principal Investigators Workshop, Woods Hole, MA, July 16-20, 2001.

**DINNIMAN, M.S.** and **J.M. KLINCK**, "Modeling flow over steep topography with strong stratification: the circulation around Astoria Canyon." 2001 Terrain-Following Coordinates Ocean Models Users Workshop, Boulder, CO, August 20-22, 2001.

**FRIEDRICHS, M.A.M.** and **E.E. HOFMANN**, "Physical control of biological processes in the Central Equatorial Pacific: a data assimilative modeling study." NASA Oceanography Scientific Conference, Miami, FL, April 3-5, 2001.

Carr, M-E., **M.A.M. FRIEDRICHS**, and J. Campbell, "Primary Production Algorithm Round-Robin 3 (PPARR3): An exercise to evaluate algorithms that estimate primary production from ocean color." Ocean Color Research Team Meeting, San Diego, CA, May 21-24, 2001.

**FRIEDRICHS, M.A.M.** and **E.E. HOFMANN**, "Physical control of biological processes in the Central Equatorial Pacific." Ocean Color Research Team Meeting, San Diego, CA, May 21-24, 2001.

**FRIEDRICHS, M.A.M.**, "Regional ecosystem model testbeds: A JGOFS Synthesis and Modeling Project." U.S. JGOFS Synthesis and Modeling Project Summer Meeting, Woods Hole, MA, July 16-20, 2001.

**GARGETT, A.E.**, "NEPTUNE and the Perfect Storm." Poster presentation, The Oceanography Society 2001 Meeting, Miami, FL, April 4, 2001.

**GARGETT, A.E.**, "Velcro measurements of turbulence kinetic energy dissipation rates." Bedford Institute of Oceanography, Nova Scotia, April 24, 2001 and Horn Point Environmental Laboratory, Cambridge, MD, May 10, 2001.

**VALLE-LEVINSON, A.**, "The paradoxical tropical estuary of Central America." Poster presentation, Gordon Research Conference on Coastal Circulation, Colby Sawyer College, New London, NH, June 14, 2001.

**VALLE-LEVINSON, A.**, "Wind-induced exchange at the entrance to the Chesapeake Bay." University of South Carolina, Columbia, SC, February 2001.

