Dr. Julian McCreary, Center Director and Professor of theoretical physical oceanography, does not go to sea, nor does he have any desire to do so. As he explains his type of oceanographic studies, "Experimental oceanographers go to sea and collect data, but theoretical oceanographers remain on land and develop mathematical models that simulate the observations." McCreary's primary field of interest has been the modeling of equatorial and coastal circulations. He was initially attracted to these fields because linear models seemed to work so well in describing many phenomena in both regions. In simple terms, a linear model has equations of motion that are simplified considerably, so much so that often pencil and paper, rather than a computer, can be used to solve them. According to McCreary, "The agreement of the observations with linear theory is really remarkable. For example, equatorial and coastally trapped waves are well known to be linear phenomena. But in addition, apparently the basic dynamics of the steady currents, like the equatorial and coastal undercurrents, are also largely linear."

Recently, McCreary has been interested in how the more complex nonlinear terms, which are neglected in linear models, affect equatorial and coastal currents. An important consequence of the nonlinear terms is that currents can become unstable coastal currents that are generated by the alongshore wind field at eastern ocean boundaries of the ocean (such as the California coast).

A fourth project, carried out with Ph.D. student Hyong Lee and Dr. David Enfield (NOAA/AOML, Miami), examines the ocean circulations driven by the intense, mountain-pass winds that appear off the west coasts of Mexico and Central America. The research for this study is well underway, and a manuscript describing the first part of the research already has been submitted to the *Journal of Marine Research*.

**SPOTLIGHT** in this issue of *Currents* is on Hyong Lee and his research with Dr. McCreary. In the next two issues, the focus will be on the work of Yasushi Fukamachi and Zuojun Yu.
MOUNTAIN PASS JETS GENERATE OCEAN PHENOMENA

According to Ph.D. student Hyong Lee, two models (one linear, one nonlinear) that he is working on with Drs. Julian McCreary and David Enfield (NOAA/AOML, Miami) show very high correlation with observations.

The sites of interest are the Gulfs of Tehuantepec and Papagayo, on the Pacific side of Mexico and Costa Rica. To set the scene, satellite observations taken in wintertime tell Lee that strong wind jets are literally funneled through inland mountain passes for 3 to 5 days, creating an anticyclonic ocean gyre offshore. Through the models, Lee will attempt to simulate the actual events.

In the models, as the wind strengthens, a current is directed offshore. This offshore drift forces upwelling along the coast, causing a drop in local sea level that can be large and rapid. Sea surface temperature (SST) drops as well. When the wind finally weakens, the current is directed onshore and the coastal ocean readjusts toward its original state.

Meanwhile, throughout the wind event, cyclonic and anticyclonic gyres spin up offshore. The anticyclonic gyre intensifies and develops a circular shape. After the event, the gyre rapidly propagates westward and its layers thicken, while the cyclonic gyre virtually disappears.

"Generally speaking," Lee explains, "our models can produce three interesting phenomena: sea level and SST drop at the coast, and an anticyclonic gyre is generated offshore." Most importantly, however, "these events are very closely related to the observations! For example, the speed of the westward-propagating gyre in the Gulf of Papagayo is about 10.3

kilocenters per day (km/day) in the models, which is close to the observed speed of about 13 km/day." The diameter of the gyre also is close to that in the observations (300 km in the model, 280-300 km observed). Thus the three researchers have succeeded in analytically and numerically simulating actual events with two theoretical models.

All of this is very encouraging to Lee, who feels that he has picked a good thesis topic -- "because it's working!" After a year or so of writing, we should be able to call him Dr. Lee!

(Continued on page 5)
Summer Courses Announced

The summer course schedule for the Institute of Marine and Coastal Studies has been finalized. The term extends from July 5 to September 16.

OC-5603 Marine Chemistry (CORE)/3 credits. A study of the properties, composition and origin of seawater; the importance, distributions, relationships and cycling of the major inorganic nutrients, dissolved gases, trace metals, and organic compounds; and the use of radiotracers for water mass dating. Taught by Dr. Curtis Burney, Center Faculty. (Thurs., July 7.)

OC-6190 Marine Indicator Organisms/3 credits. A study of techniques for discerning environmental characteristics and changes from biological information. Focus is on organism/ environmental scaling techniques, bioassay, dynamical biological oceanography, state-of-the-art technology, quantitation, use of species versus biotic communities as indicators, and the handling of multivariate data. Taught by Dr. Gary Kleppe, Center Faculty. (Wed., July 6.)

OC-6200 Aquaculture/3 credits. A practical, hands-on course on the culture of most popular freshwater and marine species. Emphasis is on those species from the U.S. and abroad, including catfish, tilapia, shrimp, and clams, among others. Modern methods for raising each species will be emphasized, along with aquaculture practices basic to all species. Taught by Dr. Bart Baca, Adjunct Faculty. (Tues., July 5; Mondays thereafter.)

WILL PVC REEFS ENTICE GROWING GRUNTS?

Master's student Kate Edgerton hopes to show that juvenile grunts (Haemulon sp.) are attracted to artificial reefs, just as their elders are. So far, she offers, there is a void in the literature in studies on juvenile recruitment to artificial reefs. She is setting out to fill that void.

Her interest in the subject was whetted last November, when she attended a conference in Miami on artificial reefs. There she learned that artificial reefs of all descriptions are used primarily to attract and harvest fish. One recommendation that emerged from the conference was that research remains to be done in the design of artificial reefs in order to increase larval and juvenile recruitment to a specific site.

Edgerton soon will move from the idea stage in her thesis proposal to the production stages of her field project. She plans to build 103 table-shaped PVC "reefs" of varying heights: 6", 12" and 18". She wants to observe whether juvenile grunts of increasing size are attracted to structures of ascending vertical relief.

"Fish in general," she explains, "are attracted to structure, but we don't know what parameters of a structure attract juvenile grunts." In the upper Florida Keys, Edgerton plans to set up her PVC reefs close to or adjacent to the coral reefs. Adult grunts live in this shallow-water region and feed in the surrounding grass flats. Because larval grunts have a short pelagic stage, artificial reefs placed near large grunt populations should attract the juveniles.

Why this particular species of fish? "Grunts are important because they are an excellent source of protein and a good food fish," responds Edgerton, who has an M.A. in Foods and Nutrition and knows whereof she speaks. "Grunts can be exploited, because they live in shallow water and can be easily trapped. They are eaten frequently in the West Indies and the Caribbean." She adds that they are studied most in the Virgin Islands.

Edgerton enters the next phase of her studies knowing that her research will contribute to the general body of knowledge about juvenile grunts as well as about the use of artificial reefs in their recruitment.
BLEACHED CORAL PHENOMENON UNDER STUDY

Last July marine researchers noticed that Caribbean corals were losing their natural pigmentation and becoming bleached. It has been learned that these incidences were not just local phenomena, but were occurring throughout the Caribbean, as far north as Florida and as far south as Venezuela.

In December Drs. Richard Dodge and Gary Kleppel attended a scientific meeting in St. Croix to discuss the bleaching "event." There was concern because the bleaching tended to indicate that living plant cells, called zooxanthellae, probably were being removed from the corals in whose tissues they lived. These plants normally provide the coral with some of the "food" that they make by photosynthesis. As a result of bleaching, a major source of nutrition was being denied the corals.

The reasons for the desertion of the plants remain unclear. Under suspicion are the abnormally high water temperatures that occur periodically. In the Galapagos Islands in the Pacific, for example, during the devastating El Nino warming period of 1982-83, over 95% of the corals in the upper 20 meters bleached and died. Would this happen to corals in the Caribbean region as well? "Even if they didn't die from the bleaching," Dr. Dodge reasons, "bleaching is a stress factor, and this could leave animals susceptible to perturbations from natural or unnatural environmental factors."

The consensus reached at the St. Croix meeting was that monitoring should be continued, or initiated immediately, in order for researchers to understand the course of the "event," i.e., are corals dying, recovering, or remaining stable?

Preliminary results obtained subsequent to the meeting indicate that corals in many areas of the Caribbean are recovering. However, bleaching is still prevalent in some areas, e.g., on reefs off Southeast Florida.

In December, a mini-project was conducted on Broward's reefs by Dodge and Kleppel and graduate student Carol Reese. Three corals were collected for study: one totally bleached, one partially bleached, and one totally unbleached. Growth analyses indicate that the bleached specimens had not grown since about July, when bleaching began. It also is suspected that the bleached corals were not eating phagotrophically (by mouth).

In the laboratory, three sets of measurements were made for this study. Dodge used X-radiography to determine the amount of coral skeleton that had been laid down since July. Kleppel assessed the status of three types of pigments from: (1) zooxanthellae algae that live inside the coral animals, (2) algae that bore into the coral skeletons, and (3) the coral animal itself. (The latter type can occur only if the animal feeds phagotrophically.) Reese determined the number of coral polyps in the coral head as well as the number of zooxanthellae living in the coral tissues. Her findings indicate that (1) the same number of coral polyps exist in the bleached and unbleached corals; (2) about four times more algae exist in the normal coral than in the bleached coral; and (3) the algae pigments had decreased in two respects: fewer pigments per square centimeter of coral, and fewer

(Continued on page ______)
Dr. Russell Snyder, Professor of Physical Oceanography, has completed preparations for his third research cruise to the Bahama Banks under a grant funded by the National Science Foundation. He will be making tests of a wave-measuring array that he and his technicians have designed and constructed.

"Each time we go out we have a new model of the system to try out," Snyder explains. "At this point we think we have got the system about set, but we'll find out for sure in a couple of weeks."

Basically, the array consists of 10 small floats linked together horizontally, but each float is free to move independently up and down with the water surface (see photo below). Pressure sensors suspended from the floats send signals that are digitized and recorded. This information then is telemetered to the vessel, where it is archived using a P.C.

To explain the significance of the array device, Snyder continues: "Later on, we take those 10 signals, do some rather involved data processing, and from that we can estimate what frequencies are present in the wave field and in what direction the waves are traveling."

Knowing how the wave field evolves is of primary importance to scientists and sailors alike. We look forward to learning the results of this cruise, which will be reported in the summer issue of *Currents*.

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Ted Tankard, Dr. Russell Snyder, and Laszlo Nemeth ready solar panel for cruise.

The wave-measuring array, being tested on dry land.

Plots showing the response of the nonlinear model to Papagayo wind forcing: sea level, currents, and SST.
SEA SURVIVAL COURSE
IN TENTH YEAR

Ask Major Wayne Williams (USAF, ret.) sometime about Coast Guard-approved life vests, or cruise ship safety preparedness, or the horrors of hypothermia (also airline safety, but that's another story). Then steel yourself for the answers. Williams savors holding forth on how ill-prepared we all might be in the face of an emergency at sea (include lake, stream, river). And he is right!

After ten years of teaching his sea survival course in the Center boat basin (not to mention the many years he did so for the Air Force), Williams remains an avid advocate of water safety and spends most of his waking hours trying to save lives. He counts among his thousands of students airline crews, private pilots, commercial vessel crewmen, offshore oil personnel, and just plain Sunday boaters.

"We prepare boaters and sailors to have accidents and to live through them," he explains. "We do that by addressing the physiological, psychological, environmental, and equipment problems" that go along with floating on the water or flying over it.

Although the survival course is over in a day, its contents are not trivial. Students spend half of that day in the classroom and the other half primarily in the water, experiencing hands-on survival techniques. They scramble onto airline life rafts, dangle above the water in simulated helicopter lifts, fashion flotation devices out of their clothing, learn everything about flares and other distress signals, and test the many varieties of so-called life vests.

"The general thrust," says Williams, "is that most boaters have safe voyages, whether inland or offshore. But thousands don't. Those who do have accidents are usually inadequately prepared to cope with the most basic survival needs." He cites individual flotation devices as a pet example.

Then he gets serious. "Last year (1987) 70 million Americans engaged in recreational boating. There were about 9 thousand reportable accidents involving significant damage to property, or fatalities. There were about 11 hundred of those in 1987. Surf conditions can change rapidly. And water temperatures, which can have a great bearing on accident survival, vary with both location and season."

The message is simple: All of us who ply the waters for whatever reasons need to be prepared for any eventuality. Ask the captain of a tugboat that sank in the Caribbean in 1982. He would tell you that he attributes the survival of the 8-man crew entirely to their having taken Williams' course.

Information about the course can be obtained by mail or by calling Mr. Williams at (305) 920-1909. Discounts are offered to groups and to families who attend together. Individuals are welcome, but a group of at least 6 is required for scheduling purposes.
(Continued from page 4)

Pigments per alga. The latter circumstance indicates that the photosynthesis apparatus of the algae may have been modified. "When coral bleaches," muses Kleppel, "one thinks only that there are fewer algae. But, for the first time, our data indicate that in addition, pigments are not being produced by the algae for some reason. This means that a physiological change is occurring in the algae. The last point is that there appears not to have been any growth in the bleached coral, and the normal coral grew as it should have."

In a project to be funded by Broward County, Dodge, Kleppel and Reese plan to collect more coral from the same reefs to see whether the coral is recovering and, if so, at what rate.

The three researchers will present a joint paper in Sarasota, Florida, May 24-27, at a meeting of the Association of Island Marine Labs of the Caribbean. Their paper is entitled "The Physiological Implications of Bleaching of Corals, Southeast Florida." Stay tuned for further reports on bleached coral!

Multi-Disciplinary Volume Published

Dr. Gary Kleppel is co-editor of a recently released volume entitled Marine Organisms as Indicators. Physics, mathematics, and biology are interfaced in 18 papers dealing with some of the oldest measurement systems used in oceanography: indicator organisms. Dr. Kleppel also is one of the contributing authors. The publisher is Springer-Verlag, New York.

JOIN US IN AN OCEANOGRAPHIC ADVENTURE!

We are pleased to announce the reactivation of membership in the Oceanographic Center Association. By providing financial support for the Center's research and academic programs, you can participate with faculty, staff, and graduate students in the scientific adventure. As an Associate you would be welcome to visit the Center, have access to the Richardson Library, and be invited to attend our regular seminars. Another privilege of membership is receiving newsletters and other publications. A special "Day of the Oceans" will be held each year for our Associates so that you may get a first-hand look at our facilities and activities.

How can you become an Associate? Simply return the form provided below to Dr. Richard Dodge at the address given on the front of this newsletter. If you wish to call us, the number is (305) 920-1909.

We are planning to hold a meeting of the Associates this fall; we will send you the details as soon as we hear from you.

YES! I want to become an Associate of the Oceanographic Center. Please send more information.

NAME

ADDRESS

PHONE

Typical coral head in the Florida Straits.
A SEA CHANGE

In April the Oceanographic Center was pleased to accept a generous donation from Dr. Charles and Lucy Forman, valued friends of the Oceanographic Center. The gift came in the form of 12 beautifully mounted, framed and signed pen and ink prints (limited edition of 100) by artist Guy Harvey. When displayed in the proper sequence (we need a longer wall!), the sketches portray Hemingway's *The Old Man and the Sea*, starting with old Santiago trudging through his sleepy village by the sea and concluding with a wrenching portrayal of his skeletal "catch" bobbing in the surf. Dr. Forman previously had donated to us two original water color paintings by Harvey that depict a favorite subject: denizens of the deep in action.

Two sketches of the Hemingway saga.