VOLUME 8 NUMBER 2 APRIL 1978

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National Oceanic and Atmospheric Administration

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A Message From The Secretary Of Commerce

The United States now has had one year of experience with the Fishery Conservation and Management Act of 1976, which went into force March 1, 1977. The Act brought all fisheries within 200 nautical miles of our shores under American jurisdiction, in order for fishery resources to be conserved and managed for the benefit of all.

Clear progress has been made toward achieving these goals. Last year's catch by U.S. fishermen was approximately the same as in preceding years. Foreign fishing declined dramatically, however, giving depleted stocks an opportunity to begin rebuilding. We expect a modest increase in the U.S. catch during 1978.

The Act reserves the allowable catch off our coasts to U.S. fishermen, permitting foreign vessels to catch only prescribed amounts in excess of the U.S. catch. As U.S. fishing increases, foreign fishing in the 200-mile conservation zone will continue to decrease.

We are not the first nation to restrict foreign fishing within 200 miles of the coast. Other nations have extended their territorial seas to 200 miles and attempted to control or license foreign fishing within these boundaries. But the United States was the first country to extend its jurisdiction with legislation that explicitly recognized the worldwide need to conserve and manage this important protein source. As a consequence, the Act has served as a model for the more than 40 other nations that have subsequently established their own 200-mile fishery zones.

The Act established Regional Fishery Management Councils. A new and interesting experiment in government, the Councils prepare Fishery Management Plans to cover specific fisheries, subject to Commerce Department approval, and the Federal Government enforces the regulations adopted under these plans.

Since their formation, the eight Councils have prepared plans under which the National Oceanic and Atmospheric Administration can regulate foreign and U.S. fishing in the 200-mile conservation zone. Until final plans have been completed and approved, the fisheries are regulated under Preliminary Fishery Management Plans, which regulate foreign—but not U.S.—fishing in the zone.

Shipbuilding in the southeast and along the Gulf Coast has increased as a consequence of the Act. These new fishing vessels are being used in all parts of the country, reflecting confidence in the future of the industry. Investments are being made in vessels, gear, and processing equipment on the west coast, now that the hake fishery has opened to our fishermen.

With the Fishery Conservation and Management Act, the United States has demonstrated world leadership in establishing a rational and farsighted fishery management program. In this first year, NOAA has managed the zone admirably. The years to come will bring new challenges and opportunities, and I am confident that they will be met with good judgment, wisdom and efficiency.

Juanita M. Kreps
Secretary of Commerce

Conservation Today, Abundance Tomorrow

Restoring America's Fisheries: First Year Report

By GERALD D. HILL, JR.

ON MARCH 1, 1977, the United States began enforcing the most comprehensive fishery law in the 200 years of American history.

The Fishery Conservation and Management Act of 1976 (FCMA) made it mandatory for the United States to conserve and manage the vast fishery resources that are found within 200 miles of its coasts. The law asserts the right of the United States to say whether U.S. or foreign fishermen may catch the fish, where they may catch them, and in what quantities to ensure conservation of these national resources. Although the initial impact of the law was felt quickly by the many foreign nations that had been tapping our waters which contain about 12 percent of the world's supply of fishery products, domestic fishermen now realize that the law applies to them as well.

Just as the name of the law implies, its primary purpose is to conserve and manage the resources found within the two million square mile area. Conservation will be obtained by sound and logical management of the resources.

Sounds simple! Conserve the resource and you will have one to manage. Manage the resource properly and you are conserving it so that future generations will have an abundant supply of fishery products.

The Act established a new and entirely different management mechanism from anything that had ever been adopted by the U.S. Government. It established eight regional Fishery Management Councils to prepare Management Plans on which the Secretary of Commerce bases regulations to manage the various species of fish found within the Councils' geographical areas of concern.

The concept is unique in that the members of the Councils are selected from people who are most involved in the fisheries themselves, thus their actions affect themselves as well as others who have a direct interest in the fisheries. Some members are selected by the Secretary of Commerce from lists of qualified individuals nominated by the Governors of the States involved. Members are selected by the Secretary to give the Council an across-the-board representation of all interests—commercial and recreational fishermen, members of the fishing industry, conservationists, consumers, members of professional groups, as well as representatives from academia.

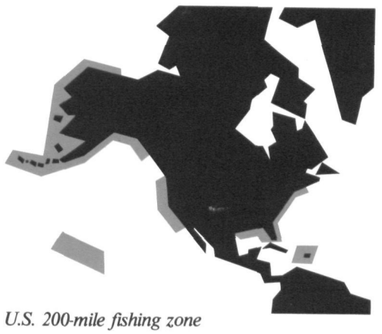
In addition to the appointed members, each Council has permanent voting and non-voting members. The principal State official with marine fishery management responsibilities and the Regional Director of the National Marine Fisheries Service, whose region is in the Council area, are voting members of the Councils. The Regional or Area Director for the U.S. Fish and Wildlife Service, the Commander of the local Coast Guard District, and the Executive Director of the Marine Fisheries Commission in the area, as well as a representative of the State Department, are non-voting members of each of the Councils. The number of members of each of the Councils varies from seven to 19, depending on the number of States in the Council and the number of at-large members as established by the Act.

The Councils are doing well in the comparatively short time that they have been in existence, when one considers the totally new concept in their organization, composition, and management techniques.

Since their inception in September 1976, the Councils have hired staffs, obtained facilities, established subcommittees, and begun an active program of preparing Fishery Management Plans. Fishery Management Plans are developed by the Councils to manage species within their areas and may apply to both foreign and domestic fishermen. As of early February 1978, the Councils had prepared three Fishery Management Plans that have been approved by the Secretary of Commerce with implementing regulations issued. In addition, at least another 35 plans are in various stages of preparation.

The first Fishery Management Plan was prepared by the New England Regional Council to manage the cod, haddock, and yellowtail flounder in the waters off the northeast Atlantic coast. Other plans developed in 1977 were for commercial and recreational salmon off the northwest coast, and surf clams and ocean quahogs off the Atlantic coast. Plans for Tanner crabs in the Bering Sea and groundfish in the Gulf of Alaska are expected to be implemented soon.

Photo: Black Star



U.S. 200-mile fishing zone

In developing the Management Plans, the Councils must determine, among other things, the optimum yield of the species, the expected catch by U.S. fishermen, and then state the amount of the species that is available to be allocated to foreign fishermen who apply to catch the fish. After the plan is sent to the Secretary of Commerce for approval, it is judged against the seven national standards, consistency with the Fishery Conservation and Management Act, and other applicable laws; and if it meets these criteria, it is approved and the Department of Commerce issues regulations to implement the plan. If it is not approved, the plan is returned to the Council with suggestions for changes that will make it acceptable.

Success of the Fishery Conservation and Management Act can be measured in several ways—conservation of the various resources, reduction of the number of foreign fishing vessels within 200 miles of our coasts, the impact that the law has had on recreational and commercial domestic fishermen, and how well the U.S. is developing uses and markets for species that have not been used to any great extent by U.S. fishermen in the past.

It is believed that the decline in valuable fish stocks has been stopped in most cases and greatly reduced in others. Fishing pressure has been reduced by controlling the number of vessels fishing, by restricting fishing areas, and by shortening fishing seasons. The total catch of some stocks has been curtailed by allowing fishing only for the amounts that scientists estimate are safely available to be caught. In some cases, the amounts have been reduced drastically. As an example, the amount of Atlantic mackerel available in 1977 was 88,000 metric tons; in 1978 it is 15,500 metric tons. Other species such as sablefish and herring in the North Pacific; perch and sablefish in the Gulf of Alaska; and hakes, herring, groundfish, and surf clams in the Atlantic have also been placed under stringent regulations to permit stocks to recover and increase.

The monthly average of the number of foreign fishing vessels off our coasts in 1977 has declined about one-third from the number of ships sighted each month in 1976. In 1977 the United States issued permits to 712 foreign fishing vessels and 229 for-

eign fishing support vessels off all our coasts. However, only 780 are known to have been in the zone. As of early February 1978, the United States had issued 632 fishing vessel permits and 267 fishing support vessel permits for a total of 899 foreign fishing vessels permitted within our conservation zone in 1978. This total may increase slightly, but is not expected to exceed the number issued in 1977.

The law requires that several steps be taken before a foreign country can fish within our 200-mile zone. The Department of State, with cooperation from NOAA, negotiates a Governing International Fishery Agreement (GIFA) with any foreign country wishing to fish within our 200-mile zone. If the foreign nation agrees to the terms and conditions specified in the Act, the Agreement is entered into and sent by the President to the Congress for review.

After a Governing International Fishery Agreement is entered into, the foreign nation submits vessel permit applications to the Department of State. A single application is submitted for each vessel, giving a detailed description of the vessel and of the contemplated catch by species and by ocean area.

The Department of States provides copies to the Congress, the Coast Guard, the appropriate Councils, and a copy with recommendations to NOAA's Assistant Administrator for Fisheries. The Assistant Administrator also receives recommendations from the Regional Councils and the Coast Guard.

The Assistant Administrator reviews all recommendations pertinent to the application and, after consultation with the Department of State and the Coast Guard, may approve such application. The conditions and restrictions on the approval of the application, and the billing for applicable fees, are sent to the foreign nation through the Department of State.

Vessel permits are prepared by the National Marine Fisheries Service and transmitted through the Department of State to the foreign nation, for issuance by the foreign nation to each of its fishing vessels.

Before a permit can be issued, there must be a Management Plan in effect for those species that the foreign nation is requesting to catch. Because the Councils were not completely organized before March 1, 1977, the Secretary prepared and issued 13 Preliminary Fishery Management Plans so that foreign fishing could begin. One other plan and implementing regulations were issued in early 1978. These plans regulate only foreign fishermen and will be replaced as the Councils develop Fishery Management Plans covering these species.

Permit fees of $1.00 per gross registered ton for each foreign fishing vessel; 50 cents per gross registered ton, not to exceed $2500 per vessel, for vessels that only process fish; and $200 per vessel for support vessels that neither catch nor process fish are charged. In addition, each foreign nation with fishing vessels in the zone will be charged a poundage fee of 3.5 percent of the total dockside value of the fish allocated to and caught by the foreign nation.

Photo: Black Star

In 1978 the United States expects to collect about $10.1 million from the poundage fees, based on the dockside value of the fish taken, and $1 million from the vessel permit fees. When observers are placed aboard foreign fishing vessels, observer costs are collected.

Hand-in-glove with the reduction in the number of ships is the reduction of the amount of fish that the foreigners caught in 1977. In 1976, it is estimated that the total foreign catch within 200 miles of our shores was about 2.6 million metric tons. In 1977, foreign nations were allocated a total of 2.1 million metric tons. It appears from very preliminary catch figures that the foreign nations did not take their total allocation, and caught approximately 1.7 million metric tons.

Most species allocations for 1978 have been reduced even below the levels set for 1977. In 1978, foreign allocations amount to approximately 1.9 million metric tons. The greatest reduction in the allocations for 1978 occurred off the Atlantic Coasts where the amount allocated has been reduced to less than half of last year's allocation. The major reason is the reduced amounts of Atlantic and river herring available. Quotas of all other species available to foreign fishermen in the area also have been reduced.

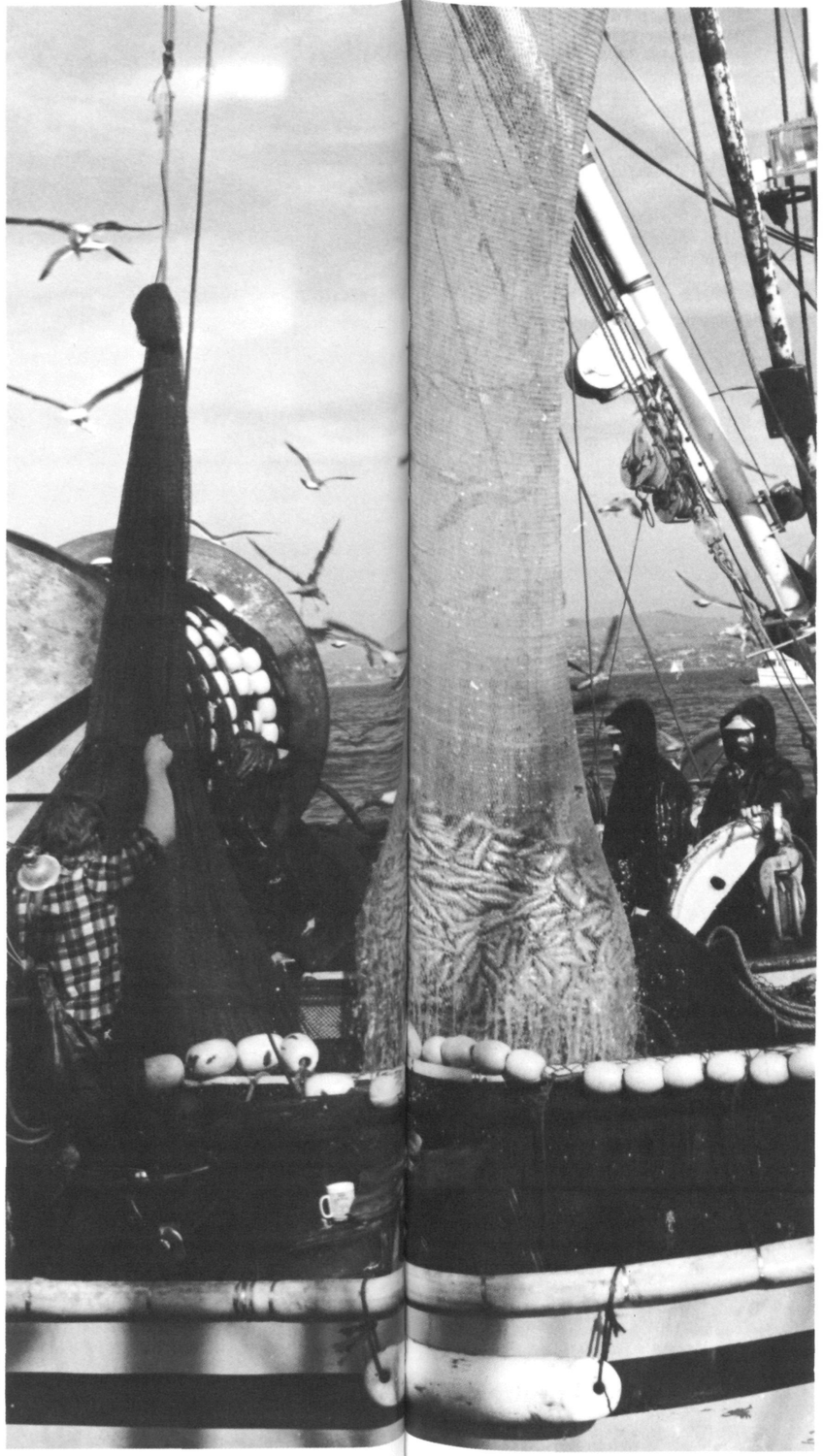


Photo: Black Star

Photo: Black Star

Reductions in the allocations off the Pacific coasts and in the Gulf of Alaska also have been made for 1978. The only area in which the allocation was increased was the Bering Sea and the Aleutians area. In this area, the increase was about 42,000 metric tons over the approximately 1,371,000 metric tons for 1976. This increase is due primarily to an increase in the flounders and Atka mackerel that are available to be caught. These two species are not caught on any large scale by U.S. fishermen.

Both within and beyond the Fishery Conservation Zone, the catch by U.S. fishermen remained about the same for 1976 and 1977, about 2.5 million metric tons. However, of the 12 major species which were controlled by Management Plans and caught by both U.S. and foreign fishermen, the 1977 domestic catch increased slightly over the 1976 catch.

The greatest increase in domestic catch in 1978 is expected to occur off the Atlantic coast, where U.S. fishermen are expected to catch more than 42,000 metric tons of fish than was estimated for them during 1977. The major increase in catch is expected to be silver hake and squid. Increased catches of about 37,000 metric tons are expected in the Gulf of Alaska, primarily Pacific cod and pollock. Off the California, Oregon, Washington coasts, increases in the catch of Pacific hake are expected to raise the domestic catch by over 35,000 metric tons. The smallest increase is expected in the Bering Sea and Aleutian Islands area where domestic fishermen expect to catch about 9,000 metric tons more herring than they have in past years.

The FCMA, obviously, has had an impact on the foreign nations. They have lost some of the opportunity to fish in the once rich fishing grounds off our coasts resulting in a loss of fish to which they are accustomed as well as the revenue obtained from the fish. In the future it is expected that foreign fishing will continue to decline as U.S. fishing increases. As a result some foreign countries are interested in entering into agreements with some domestic fishermen to supply the foreign processing vessels with U.S.-caught fish. Also, there may be an increase in foreign efforts to obtain ownership of fishing operations and processing plants in the United States.

The law also has had an impact on domestic fishermen although the impact to date has not been as great as it has been on foreign fishermen.

As more and more Fishery Management Plans are developed by the Councils and implemented by regulation, domestic fishermen will see an increase in the regulations which govern the amounts, times, and places that they may catch fish. The very nature of regulations probably will cause some con-

Photo: Black Star

flicts and frustrations by the fishermen until they understand that the purpose of the regulation is to prevent overfishing and as they become more accustomed to the regulations.

As the plans are produced and implemented, and as the U.S. industry grows, there should be a decrease in foreign competition for the available fish since domestic fishermen get first chance at any fish that are available within the 200-mile zone. As the competition declines and the number of foreign ships in our waters is reduced, there should be a decline in the number of conflicts between U.S. and foreign fishermen.

Another impact of the Act is the opportunity of fishermen to participate in the development of Fishery Management Plans. This is an important factor that some fishermen do not realize fully. The purpose of the Council structure is to establish a mechanism for the people who are most affected by the Act to be able to voice their opinions in the formation of plans and regulations. By participating in the preparation of plans, fishermen provide the Councils with information and knowledge needed to develop the plans; and at the same time it permits fishermen to learn of the complex problems of determining the optimum yield of a species, allocating fish stocks, and preparing sound regulations.

The Act is expected to continue to impact on domestic fishermen by stabilizing and increasing the harvest of fish, by developing a more viable domestic fishing industry and providing more recreational fishing opportunities.

Another gain for the United States through the Act has been our ability to place our own observers on board foreign ships for weeks at a time. We have learned a great deal about their fishing methods, obtained some badly needed biological data, and have been able to monitor closely foreign compliance with the regulations governing their fishing off our coasts. In 1977, we had observers on about 34 percent of the foreign vessels off Alaska and the North Pacific areas, and about 50 percent off the Atlantic coast.

Another of the major undertakings of implementation has been the enforcement effort of the fishery agents of the National Marine Fisheries Service and the Coast Guard. During the year these two agencies have made over 1500 boardings on foreign and domestic fishing vessels.

The boarding parties inspect for compliance with all regulations governing fishing in our conservation zone. During these boardings, 350 citations and 108 violations were issued to foreign vessels, and 130 citations and over 200 violations to domestic fishermen. Citations are issued for minor infractions of the regulations and carry no monetary penalty. Violations are for more serious offenses and can result in administrative fines, and even in seizure of the vessels and/or cargo.

Although the Act is only one year old, there are indications that it is helping our

own fishermen.

For a number of years, Cuba caught snapper and grouper off the west coast of Florida. NOAA estimates the Cubans operated 50 vessels in this fishery and took an estimated 4-5 million pounds of snapper and grouper each year prior to implementation of the Act. There have been no sightings of Cuban vessels off the west coast of Florida since the law went into effect. One can assume that an additional 4-5 million pounds of snapper and grouper are available to the domestic fleet because of the new law; however, this cannot be substantiated statistically at this time. The charter boat fleet operating out of St. Petersburg did have very good catches of grouper last summer.

There are indications that shipbuilding along the South Atlantic and Gulf coasts has increased. These ships are being used in all parts of the country and indicate a feeling of confidence in the future of the fishing industry. This increase cannot be attributed to the Act exclusively, but one could assume that it has played a part in the increased production of fishing boats.

There are indications that investments are being made in vessels, gear, and processing equipment on the west coast now that our fishermen are becoming active in the hake fishery there.

Domestic firms know they will have the first chance at this large resource if they demonstrate the capability to catch and use it. They no longer need to fear that their investments will have a short economic life span if the resources become the target of heavily capitalized and subsidized foreign fleets. With a more secure resource base, these entrepreneurs have a better incentive to develop the tools, techniques, and markets for a profitable domestic fishery, with beneficial impacts on income and employment. Similar results can be expected in many areas of the United States in the future.

Other indications are an increased interest by banking and brokerage companies in financing fishing operations and vessels in the Northwest, and the expansion and new construction of processing plants in Alaska to process groundfish caught in Alaskan waters.

The conservation measures begun in 1977 offer a bright future for U.S. fisheries. These measures will permit depleted fish stocks to recover, prevent overfishing, assure us of future supplies, and provide options for future generations to decide how the stocks will be used and managed.

The Fishery Conservation and Management Act of 1976 was not expected to solve all the problems of our nation's fisheries during the first year of implementation, and it certainly has not. It has, however, given this nation a good start in rebuilding its fisheries; and, despite the many problems associated with the new concept, it has shown that progress can be made. It has established the United States as the world's leader in fishery management and conservation. □

Photo: Black Star

By MARGIE O'RIORDEN *

FLIGHT INTO A HURRICANE

APPROPRIATELY ENOUGH, it was pouring rain in Miami when I climbed aboard the Orion for a research flight into Hurricane Anita on September 1, 1977. Two years before, I had written the Hurricane Center asking if I could accompany a mission as a writer. Dr. James McFadden, Director of Flight Operations for the Research Facilities Center wrote back promptly inviting me along "when a weather situation develops."

Until this September, the tropics around Florida remained quiet. I had almost given up hope. Then "Anita" developed out of a tropical wave in the Gulf of Mexico. The morning of September 1st found Anita a newly born hurricane, another developing wave over Florida (hence the rain), and me with a strong hunch. I was at the airport as my husband's partner was readying their Cessna 310 for a trip to Miami. Something clicked in my mind and I hurriedly phoned the Research Facilities Center. Dr. McFadden's secretary said, "Why, yes, there's room on a flight leaving at noon if you can be here by then." There was not time to change clothes or pack the overnight kit she had said to bring, so I hopped on the 310 in old shorts, shirt and tennis shoes and off we went. They say opportunity knocks but once . . . I may not have been dressed right for it, but such a series of coincidences overrode my dress code.

The Research Facilities Center provides flying scientific laboratories for a wide variety of atmospheric weather experiments and research under the direction of the National Oceanic and Atmospheric Administration (NOAA). Such projects as cloud seeding, hurricane tracking and research into weather cause, effect and patterns are contributing to knowledge of beneficial weather modification. Much of the manpower is supplied by the NOAA Officer Corps, a group of elite engineers, scientists, and pilots who staff oceanographic ships, research laboratories, and aircraft.

I dashed through the rain into a large hangar at Miami International where the RFC is headquartered. The first man I met turned out to be Duncan Ross of the Sea/Air Interaction Lab, who had commandeered this mission in order to study and forecast the waves and storm surge of the hurricane at landfall. The plane was ready to leave, so we climbed aboard, and were towed outside the ramp area. Dr. James McFadden installed me in the "Visiting Scientist" chair behind the pilot, and introduced me to the crew. It was my first time in the cockpit of a transport category plane, and I was entranced with everything. The crew was busy with our IFR clearance and their checklists. Takeoff was fascinating; the co-pilot calling out V-speeds, the turbine amazingly quiet even at full power, then "rotation," and the nose lifted ponderously, followed a few seconds later by the main gear. We were on our way.

Each of the flight crew had his Airline Transport Rating. Dave Turner was Aircraft Commander, flying right seat for half the trip. Capt. Jerry Saladin, a professional NOAA captain, flew left seat now. Alex Ricci was the Flight Engineer, and Cdr. Tom Garrish was the Flight Navigator.

The Lockheed WP-3D Orion is a tougher and more powerful airplane than its predecessor, the Electra. It was developed for USN anti-sub warfare. As equipped for NOAA, it is worth more than $8,000,000. It operates up to 30,000 feet, flies between 180 and 325 knots with dash speeds up to 400 knots. There are four Allison T-56A-14 Turboprops with a SHP of 4,600 each. Max takeoff weight is 135,000 lbs. with a range of 3,250 nautical miles at 20,000 feet and ten hours flight time with a two-hour reserve. It was equipped with nose weather radar, C-band blister mounted belly radar, and X-band tail radar. It has a nose mounted gust probe and wing probes. Generators on three engines provide electrical power for all scientific systems.

Once established en route at 18,000 feet (a 2½ hour flight at 325 knots) Dr. McFadden took me on a tour of the plane. Each man or team had a station and highly

* *Margie O'Riorden is a member of The Ninety-Nines, Inc., an international organization of women pilots. This article is reprinted by permission from The 99 News, official publication of the organization.*

UNITED STATES DEPT. OF COMMERCE

technical equipment to monitor and operate. Dr. McFadden's job aboard today was to coordinate the timing and planning of each experiment, as well as operate the computer teletype and UHF which connected us with the RFC Office, the National Weather Service and the Air Force. There was a huge Teledyne Ramchek computer system using dual disks for intake, storage and dissemination of all the weather systems, operated by Eddie Brunson. There were several cloud physicists aboard probing cloud molecular structure, although this mission carried less cloud equipment than the WC-130B Hercules. The primary mission belonged to Duncan Ross. He operated a large laser wave beam mounted below deck on the bottom fuselage. A door slid open, revealing the tossing sea below. Also incorporated was an infrared sea surface temperature radiometer. All this information was immediately read out on computer screens and sheets, then stored on the disks in the main computer system. Every possible type of information was available: wave heights, sea temperature, pressure, air temperature and dewpoint, and much more I was barely able to comprehend. There were several electronics experts aboard to monitor the vast and complex electrical system. Thankfully, also available was a large, fully-stocked galley, with delicious, hot fried chicken, sandwiches, coffee, etc., as well as an immaculate head. Safety lockers were full of the latest life rafts and vests, although Dr. McFadden said matter-of-factly as I was signing a release form, "Let's be practical. If we have to ditch, there is little chance of survival in seas like this." At that time I thought hard about my family safely at home awaiting my return.

Cdr. Tom Garrish, Flight Navigator, was originally a Civil Engineer who joined the NOAA Officer Corps. He had spent eight months at the Air Force School of Navigation to learn his present job. He was responsible for 15-minute position fixes, using two Delco Carousel IV Inertial Navigation systems, updated by a Northrup Omega Loran and a Teledyne-Ryan Doppler Navigation system. All these systems double check each other and are fed into the main navigation computer which selects the most accurate system, and redirects the remaining ones with any error. The Navigation Computer provides a constantly updated readout on several screens of the current latitude, longitude, TAS, GS, wind direction, wind speed, drift and drift angle required to hold course, as well as pertinent weather system results. This in turn is fed into the Flight Director, which of course incorporates HSI and two Radar Altimeters, as well as Angle of Attack indicators. And Cdr. Garrish also possesses a periscopic sextant for sun or star sightings. I was dazzled by the array of navigation systems.

As we entered the outer perimeter of the hurricane, the classic spiral feeder bands showed clearly on radar. The pilot imposed "Condition Five" (all crew at stations with seatbelts on) and descended to 500 feet above the now stormtossed Gulf. We were in and out of ragged scud; the sea whipped white and rain-slashed below; the pilots now hand-flying the plane; rain sliding in rivers across the windshield. The turbines obscured any noise from the storm. It had been what I called bumpy for awhile; now the plane settled into a steady pitching, vibrating from stem to stern. I understand that the motion was much more pronounced in the back of the plane!

The crew discussed what kind of pattern Duncan wanted to fly for his wave tests. "Oh . . . just head across the eye, find a 60-knot band and fly it for awhile," he said casually. The pilots used radar to determine the entry place into the eye; entering at an angle to avoid the stress of sudden wind direction change. Windspeed picked up as we approached the eye. The navigator called out wind speed, direction, drift and drift angle constantly. The pitching increased to bucking; the plane shivered steadily; oxygen masks and lifebelts swung back and forth; the huge engine surged as they automatically adjusted to a fixed power setting.

When the winds registered 110 knots, the plane jolted through into the eye. Within five seconds, it was so calm, we could have served coffee. I peered out at the wall of misty cumulus towering out of sight. The sun struggled to break through; windspeed had dropped to 25 knots; sea level pressure was 940.2 millibars. Since the eye was only 18 miles across (a tight well-developed hurricane) we almost immediately plunged back into the western eyewall.

"Condition Five," yelled the pilot, and the navigator sang out, "Wind 350 degrees at 125 knots." The pilots held a straight course while flying through turbulent rain bands; only making 30-degree banks as necessary to set up the pattern for Duncan's tests when we were "in the clear" between rain bands.

I know radar doesn't "show" turbulence, but these pilots certainly were able to predict and find calmer areas. We flew around and across the storm eye for the next hour. "My teeth are rattling," someone complained. "It's not my teeth I'm worried about," someone else replied, so Dr. McFadden agreed that a "rest stop" was in order. The pilots found a calm area between rain bands where we climbed to 1000 feet, and everyone took turns at rest and refreshment for 15 minutes.

Then it was Condition Five again, and another two hours of shuddering, bucking runs back and forth upwind and downwind. The top wind measurement was 138 knots; the highest wave was 50 feet. Conversation was usually technical, but once someone said, "That sure is a pretty picture down there." A sailing fan, no doubt. Dr. McFadden called me on the intercom, "You sure are lucky; this is the most productive flight yet. This storm is a classic." He told me that the day before, it had been poorly developed, with lots of lightning, and several antennae had been struck.

At 7 p.m. we headed east back across the eye for Florida, after giving fixes to yet another NOAA plane on its way to take over surveillance.

I was by now numb and bone-weary with excitement and all the new things I had been introduced to. As we hit the eastern eyewall again, the pilots warned of a particularly bad rain band ahead. Sure enough, after two teeth-jarring jolts, we were all slammed helplessly down into our seats, then lifted out again. Loose items floated into the air, then crashed and tinkled back down. If my teeth hadn't been clenched, I would have bitten my tongue off.

As we settled back into normal moderate turbulence, Dave Turner asked cheerfully if everything was all right in the back. The navigator calmly announced, "That was 40 meters per second" (approximately 7,000 feet per minute updraft). "Wind now 190 at 140." Night fell as rapidly as the winds as we flew eastward, climbing back to 25,000 feet. The cockpit was a pool of red light and calm talk. Now I heard about the several "close ones" various crews had experienced on other flights, yet there has never been a lost plane or an accident.

I was deeply impressed with the professionalism, dedication and close-knit comradeship of the crew and scientists. They were so obviously a group of men doing exactly what they wanted to do in life. Even under rough flying conditions or when electronic problems caused delays, everyone maintained a light but efficient attitude. While I felt humbled by the brilliance and competency of the scientists, I was awed by the skill of the pilots. It was far more than skill: it was artistry. Not only were they hand-flying the plane in dangerous conditions, but in ten long hours of solid IFR, I never saw weariness or tension affect their flying.

Dr. James McFadden has been with NOAA for 12 years. He has a Doctorate in Meteorology from the University of Wisconsin, where he also minored in Oceanography. He first worked for the Sea/Air Interaction Lab, and has been with RFC for eight years. He has been Director of Flight Operations for two years.

It was still raining over south Florida. Scattered thunderstorms showed on radar; lightning flashed silently around us as we descended. We broke out of the clouds at 700 feet on an ILS to 9L at Miami, and the glittering rain-wet tawdriness of the sprawling city reflected dully from the cloud ceiling. I was roused out of my daze to admire the crisp professional approach and landing. As the beautiful engines each spooled down to an unnatural silence back on the ramp, I realized that this had been one of the greatest adventures of my life. There were not words to describe my gratefulness to all these fine people. I will never feel quite the same person as before, having shared in such a world has enriched me. □

Commercial success — just over the horizon

Acres and Acres of Shrimp

By LAURA COLUNGA*

TEXAS — the name brings to mind wide-open spaces, sprawling ranches and acres of fertile farmland. But near the Lone Star State's more than 1,000 miles of coastline, much of the land is not ideal either for farming or ranching. Research at Texas A&M University indicates that a great deal of land, perhaps as much as a million acres, might be put to good use in raising a new crop for Texas—shrimp.

The Texas coast's relatively mild winters and flat plains and the availability of salt water from its many bays and inlets make it a good place for shrimp mariculture—the raising of shrimp in saltwater-filled ponds, says Dr. Jack C. Parker, coordinator of the Texas A&M Sea Grant College Program's mariculture projects.

"There is no question that shrimp is going to be commercially viable in Texas," Parker says. "The big question is how soon can it be accomplished." Many questions about shrimp mariculture—where to locate the ponds and how to construct them, what to feed the shrimp, how to harvest the crop—have already been answered.

A team of scientists from Texas A&M and the University of Houston, working in cooperation with the National Marine Fisheries Service and industry, have been working since 1968 toward the day when shrimp farming will be a commercially feasible enterprise in Texas.

Texas A&M's experimental shrimp mariculture ponds are located at Angleton, near Galveston Bay and at Flour Bluff (near Corpus Christi), adjacent to the Laguna Madre.

Production of *Penaeus setiferus,* the white shrimp native to the Gulf of Mexico, has recently averaged between 800 and 1,000 pounds per acre, and Parker reports that these figures are sufficient to demonstrate commercial feasibility for this species. But even more impressive are the production figures for a species of white shrimp not found in the Gulf—*Penaeus vannamei*—a native of the Pacific Coast of South America.

The average production per acre for the South American shrimp has been close to 2,000 pounds, and one production system in 1973 yielded 4,500 pounds per acre. Despite *Penaeus vannamei's* excellent production capabilities, a significant hurdle must be crossed before raising them in captivity becomes commercially feasible.

That hurdle is: How can a supply of seed stock be obtained?

The problem of obtaining seed stock of the native Gulf of Mexico shrimp for the Texas A&M experiments was solved last year when the mariculturists, in cooperation with Sea Grant marine advisory personnel and local shrimp fishermen, located a good spawning site off the Texas coast. Mated female shrimp were captured and brought to the National Marine Fisheries Service hatchery at Galveston, where they spawned. The young were reared to postlarval (seed stock) size in hatchery tanks and then stocked in the coastal ponds to grow to edible or bait size.

At an average cost for collection and delivery of less than $20 per mated female shrimp, Parker feels the method works well enough to stock a commercial hatchery. In theory, a single mated female can produce larvae sufficient to provide 200,000 seed shrimp, or post larvae.

But the method of obtaining seed stock of

** Laura Colunga is Managing Editor,, Texas A&M Sea Grant Program*

the native *Penaeus setiferus* is impractical for obtaining stock of *Penaeus vannamei,* whose spawning grounds are miles away along the Pacific coast of Central and South America.

Seed stock for experiments with the South American species was brought to Texas from Panama, where the Ralston Purina Company operates a shrimp hatchery and pilot production system. Obtaining seed stock in this manner is simply too expensive for a commercial operation located in the United States. What is the alternative?

The ability to control the entire life-cycle—growing the shrimp to sexual maturity, mating, spawning and raising them to the seed-stock stage—is the key, says Parker. It is this maturation process that will now be one of the major emphases of the Texas A&M Sea Grant mariculture program, he says.

Some success has been met in this complicated and delicate process. In 1974, Sea Grant biologists working at Corpus Christi achieved mating and spawning in captivity of a few shrimp. The parent animals were among a prime crop of six-inch specimens harvested the year before from a three-pond pilot production unit at the Corpus Christi facility, which is located adjacent to Central Power and Light Company's Barney M. Davis power station.

After spending the winter at the NMFS Laboratory in Galveston, the shrimp were returned in the spring to ponds at the CP&L generating station. By mid-summer, these shrimp had reached maturity and some had mated and spawned. Success, however, was limited and it was finally concluded that facilities were needed to house large holding tanks in which temperature and photoperiod (amount of light) could be controlled.

Tank systems will allow better control of maturation and mating and will be a convenient means of introducing rations specifically prepared to nurture maturing females. When mated females are obtained, they will be shipped to a hatchery, where they can be spawned and the offspring raised to seed-stock size. These seed shrimp are put into ponds in the spring, grown through the summer to about five to six inches long, and harvested in late October. Among these shrimp, those exhibiting outstanding growth are selected for overwintering as brood stock for future generations.

In the wild, shrimp move out of shallow water in the winter to avoid low or freezing temperatures. Heated water is needed to overwinter shrimp in captivity, and using the heated effluent from CP&L's generating station successful overwintering has been accomplished in ponds with survival up to around 50 percent. When a solar heating system similar to a greenhouse is added, 75 percent of the brood stock survive.

The other major effort the Texas A&M scientists will be pursuing is increased production of the native white shrimp, Parker says. Although current levels are sufficient for a commercial operation, he feels they can be improved. The technology developed here can be used to work for even higher yields of the South American species, he noted.

Photos - Robert Bunting

A tub of shrimp is displayed by Dr. Jack C. Parker (l.), coordinator of the Texas A& M University Sea Grant shrimp mariculture program, and Barney M. Davis of Central Power & Light Co. (above). Fred Conte of the mariculture program (left) displays two big specimens of pond-grown shrimp.

Studies have shown that the ponds are a very good environment for the shrimp.

"The shrimp have access not only to the supplemental ration that we put in the ponds, but also to all the nutrients already present—worms, other crustacea and other materials in the water," he says.

The "shrimp chow" is a specially-prepared ration developed by the Ralston Purina Company, a supporter of the mariculture program since its beginning.

Shrimp feed on the bottom and tend to "nibble" their food, leaving it and returning to it later. Rations available when the project was begun, principally catfish feed, did not hold together long enough in the water. Ralston developed a ration that stays together for 10 to 15 hours in water, and sinks to the bottom of the ponds.

Early versions of the feed contained about 50 percent protein, but experiments showed that the protein content could be lowered to 20 to 25 percent with no change in growth. Fish meal, shrimp meal and soybean meal are the principal ingredients.

As the mariculturists work on clearing that final hurdle of maturation in captivity, economists with Texas A&M's Department of Agricultural Economics are tackling such problems as investment characteristics of a commercial shrimp mariculture operation, costs and returns and marketing strategies.

Researchers in the University's College of Veterinary Medicine have been studying diseases that threaten shrimp in captivity and developing preventative control measures and studying immunization possibilities, particularly with brood stock.

The outlook is optimistic. "The technology is available," says Parker. "We need to refine that technology so that we can control the life cycle on a demand basis, and then we'll have a system that potential commercial shrimp farmers can use." □

Charles Peirce: scholar, cartographer, mathematician and metrologist

An American Philosopher

By WILLIAM A. STANLEY *

CHARLES PEIRCE, who died all but unknown in 1914, a sick, frustrated, poverty-ridden man, is today honored as one of the most original and versatile thinkers America has ever produced.

Philosophers honor him as the founder of pragmatism, logicians for his role in developing symbolic logic, mathematicians for his work in algebra, psychologists for his advances in perception theory, linguists for his contributions to the founding of semiotics (the theory of signs), and NOAA's National Ocean Survey as one of its pioneering scientists.

Born Charles Sanders Peirce (pronounced Purse) on September 10, 1839, he later added a second middle name, Santiago—Spanish for "St. James"—in honor of his friend and supporter William James. He was the second son of Benjamin and Sarah Hunt (Mills) Peirce, of Cambridge, Massachusetts, where he manifested an early interest in science. At the age of eight he began of his own accord to study chemistry, and at twelve he set up a chemical laboratory, experimenting with Liebig's bottles of quantitative analysis.

Young Peirce was stimulated during his childhood both by acquaintance with his parents' friends in the scientific, legal, and literary professions, and by the rigorous education given him by his father. Benjamin Peirce, who later became Superintendent of the U.S. Coast Survey (forerunner of the National Ocean Survey), was one of America's foremost mathematicians, Perkins Professor of Astronomy and Mathematics at Harvard University. He was also an inspiring and unconventional teacher, and a man of forceful character who supervised his son's education to such an extent that Charles Peirce could later say, "he educated me, and if I do anything in life it will be his work." Indeed, the young Peirce learned to read and write without the usual methods of instruction.

Benjamin Peirce trained his son in the art of concentration. From time to time they played rapid games of cards, from ten in the evening until sunrise, the father sharply criticizing every error. His main educational efforts with his son, however, were directed toward mathematical understanding.

The rigorous training was not immediately apparent when Charles Peirce entered Harvard University, in 1855, where, at the age of twenty-six he was awarded a bachelor of arts degree, one of the youngest in his class. But his scholastic record was poor. Undeterred, he went on to obtain a second degree of bachelor of science in chemistry, *summa cum laude,* the first of its kind. At Harvard, he ranked in the bottom fifth of his class. Despite his scholastic ups and downs, he was recognized as a student of exceptional promise.

Peirce's early interest in the sciences of fundamental natural phenomena was paralleled by his enthusiasm for the study of logic, the science of reasoning. His interest in science moved from chemistry to mathematics, and he sought training in the mathematically developed fields of physical science, including astronomy, physics and geodesy. Peirce's initial encounters in the physical sciences came from work he accomplished for his father.

Benjamin Peirce was employed as a part-time field investigator for the U.S. Coast Survey aiding in astronomical observations while holding his professorship at Harvard. It was this event that laid the groundwork for Charles Peirce's scientific career in the Federal government. In the summer of 1859, the Coast Survey employed young Peirce in a temporary position, similar to that of his father. The Coast Survey of that period was the nation's principal institution for research in the physical sciences in the United States. Charles Peirce readily developed technical expertise in geodesy and was appointed to a permanent position on July 1, 1861. For the first several years, he assisted his father with computations for the Coast Survey of the longitude of American astronomical stations with respect to European astronomical stations, for observations of the moon. His bent for astronomy began to show, to the point where he corrected computations made earlier by his father.

Charles Peirce was extravagant with

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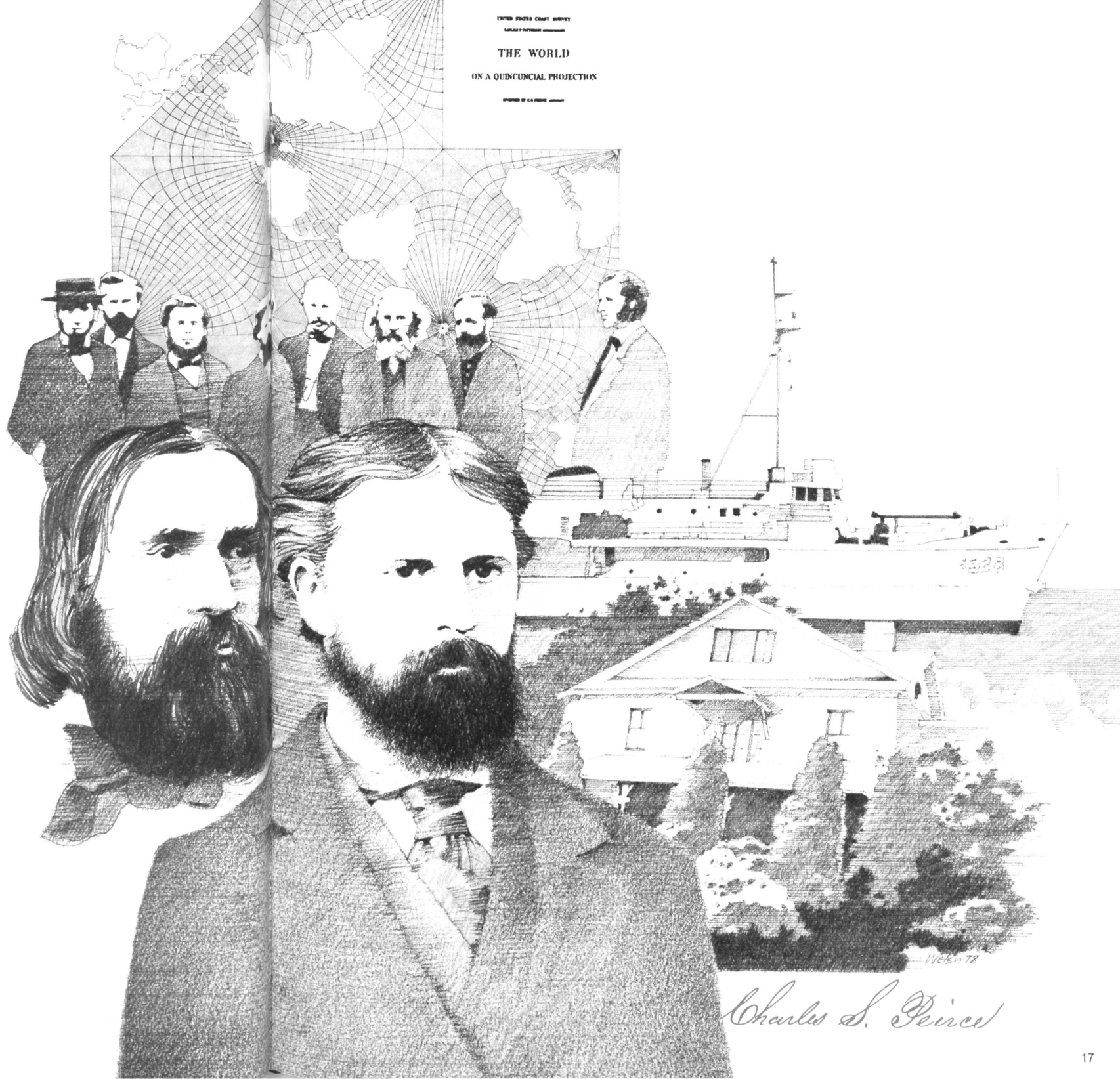


money and had little interest in controlling his economic problems. While involved with the Coast Survey's tasks at Harvard, he took on lectures in 1864-65 at the College on the philosophy of science and joined a select group which included Ralph Waldo Emerson and James Elliott Cabot.

In 1867 Charles Peirce was assigned by the Superintendent of the Survey, Alexander Dallas Bache—great-grandson of Benjamin Franklin — to the Harvard Observatory. While there, he observed and measured for the first time several new lines in the spectrum of the Aurora Borealis.

Also during this period, he was assigned to a party which observed the eclipse of the sun in the United States in 1869. His father's eminence as a mathematician prompted the elder Peirce's appointment as Superintendent of the U.S. Coast Survey that same year. Charles Peirce was assigned additional duties by his father when he joined Benjamin Peirce's U.S. delegation for the observation of the eclipse of the sun in the Mediterranean on December 22, 1870.

Charles' professional ability was shortly recognized with his assignment to photometric research, work that would lead him into perhaps the most important period of his government career. On November 30, 1872, his father instructed him to assume charge of the pendulum operations of the agency. His gravity work with pendulums led him to Europe, where he made observations on the oscillations of the pendulum in Geneva, Paris, and Berlin, and other locations. Three years later, while continuing his gravity investigations, he was asked to attend an international geodetic conference as the first American delegate so honored. Although he was appreciative of his European associates' recognition, he soon raised their eyebrows when he published a report on pendulum experiments and announced a hitherto undetected inaccuracy in the previously accepted standards for experiments on pendulums.

By the time of his return to the United States two years later, the dust had settled and his fellows in Europe had had the opportunity to investigate his results. Peirce received a vote of approval from the scientific community and was acknowledged both for having greatly increased the "correctness" of the studies and for his originality in pendulum work. He built upon this foundation in his later involvement with astronomy, gravimetry, spectroscopy, and geodesy.

As seen by Peirce, cartography had a practical application to those sciences and was related to his career. Peirce became interested in map projections in part because of what he called a lack of proper representation of the earth's surface on a flat piece of paper. Peirce pointed out that Mercator's map "represents all the surface of the earth by a strip, infinitely long . . . so that places near the poles are magnified . . . to be many times larger than the real surface that they represent." His interest in map making was further demonstrated in a report to Superintendent Patterson, dated July 17, 1879. He wrote that "the theory of conformal map projection has been studied with reference to its use in the study of gravity; and a new projection has been invented." Charles Peirce had added yet another credit to his growing list of achievements.

The first Coast Survey building in the District of Columbia, at New Jersey and C streets, where Charles Peirce did his work.

The Peirce projection was first called "quincunx," according to his entry in the Century Dictionary of 1889 which carried his article on "projections." Although archive records are not clear as to the date of completion of the projection, Peirce's article gave the date as 1876. Indeed, by February 26, 1877, he had reported to the Superintendent on the projection.

The "Quincuncial Projection," as it finally came to be known, has evolved through the ensuing decades as a basic cartographic tool, and was used by the Coast and Geodetic Survey for an international air route chart. Its characteristic of presenting conformal configuration of land areas with the whole sphere represented on repeating squares is ideally suited to approximate great circle routes. The straight lines of the air routes did not distort the land shape, thus achieving perfect balance. Today the National Ocean Survey, through its Physical Science Services Branch, offers a color reproduction of the quincuncial projection of the world for educational purposes.

At this time—the later part of the nineteenth century—quantitative science, which requires exact standards of weights and measures, was given a firm foundation by the establishment of an International Bureau of Weights and Measures in France. Also during this period Peirce left his mark on the bureaucracy and emerged as an established leader in geodesy. The U.S. Coast Survey also formally identified its responsibilities, from the 1871 Act, for a geodetic transcontinental connection and altered its name to the "U.S. Coast and Geodetic Survey."

From its inception, the Survey had been deeply involved with weights and measures. Colonial America under British rule used weights and measures of English origin. The principal units were the yard, the avoirdupois pound, the gallon and the bushel. These units were embodied in standards that were more or less authentic copies of the English standards. When a Swiss mathematician, Ferdinand Rudolf Hassler, was selected to head the new agency to be known as the "Survey of the Coast" (renamed the U.S. Coast Survey in 1836), he was directed to incorporate the U.S. control of weights and measures into his organization. Thus in November 1830 Hassler assumed the Directorship of the Office of Weights and Measures as part of the U.S. Coast Survey.

As the study of weights and measures evolved over the next 50 years, it came to rest with Charles Peirce who, on October 1, 1884, became the "Assistant in Charge" of the Office of Weights and Measures. He continued with this assignment until February 22, 1885, after which, for reasons unknown, he abruptly declined to serve. During this period a Joint Commission of Congress was formed under the Chairmanship of Senator William B. Allison "to consider the present organization of the Signal Service, U.S. Geological Survey, U.S. Coast and Geodetic Survey, and the U.S. Hydrographic Office of the Navy Department." On January 24, 1885, the hearings included testimony from Charles Peirce who stated, "the Office of Weights and Measures at present is a very slight affair, I am sorry to say." He proposed that the Office should be empowered to give certificates for weights and measures and a stronger organizational structure be considered. In view of his experience in metrology, Peirce was appointed to the Committee of Weights and Measures of the National Academy of Sciences. In 1888 he was also appointed by the President to the Assay Commission for United States Coinage.

Increasingly interested in philosophy, and increasingly dissatisfied with his government work, Peirce resigned from the Coast and Geodetic Survey on December 31, 1891, after 30 years of service. His efforts, however, had begun a movement that eventual-

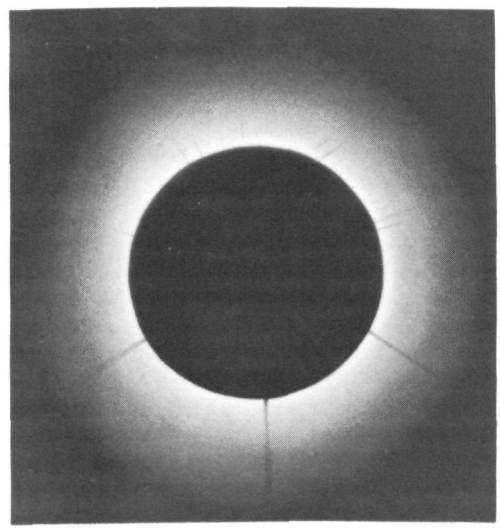
ly led in 1901 to the creation of a separate agency, known today as the National Bureau of Standards.

Charles Sanders Peirce closed a chapter of his life with his departure from government, and with his wife Juliette returned to his beloved homeplace "Arisbe," which he named after one of the Trojan cities mentioned in Homer's Iliad. Arisbe is located in eastern Pennsylvania near the town of Milford, a few miles south of Port Jervis, New York. When the Peirces bought the house in 1888 it was a small square Victorian structure. Under Juliette's direction they enlarged it, adding extensions to the front and rear and a third floor where Peirce had planned to teach young students philosophy. Arisbe became the focal point of Peirce's energy, the place where he spent the last twenty-six years of his life writing most of the important works of his career.

Peirce began writing early in the morning and frequently ended in the wee hours of the following morning. At Arisbe he prepared the descriptions of his pioneering work in philosophy. He wondered why human beings have any knowledge at all; and in particular, he wanted to understand how people manage to increase the accuracy of their ideas. He wrote, "in my own mind all of my work has been exclusively the study of how to find out the truth, which is the business of reasoning in a broad sense."

During these long days and nights at Milford, Peirce's ponderings gave rise to the culmination of his years of thought, and provided the hallmark of philosophical identity, which he called Pragmatism. Peirce founded a whole new and important concept in philosophy, a uniquely American philosophical entity whose teachings stimulated international movements of thought. The theory of pragmatism clarified the conceptual stages used in philosophical discussion, by identifying "meaning" with "practice."

In 1898 William James, a noted American psychologist and philosopher of the period, first publicly used the term "pragmatism" and acknowledged Peirce's priority in the creation of the doctrine and the name it bears. Peirce disagreed with James' definition of pragmatism. In fact, when James heard Peirce lecture on the subject in 1903, he confessed that he did not understand him. Peirce soon rebelled against what he felt to be the twists that James and others gave his philosophical movement, and in 1905 coined the term "pragmaticism," which Peirce said would be "ugly enough to be safe from kidnappers." Although upset with those who distorted his doctrine, he continued to develop his views and to school supporters of his thinking. He was a firm believer in the dependence of logic on ethics, argued as early as 1868 against individualism and egoism, and furthered social theories of reality and logic. His most important published philosophical contributions were contained in a series of five articles written for the Monist (a philosophical publication) between January 1891 and January 1893.



A technical sketch (above) of the sun's corona as seen at Catania, Sicily, by the first Mrs. Peirce, and (below) Charles Peirce and second wife Juliette at their home Arisbe.

Charles Peirce had the opportunity to teach for only eight years during his lifetime. His longest academic connection was with the Johns Hopkins University, where he was a lecturer on logic from 1879-1884.

Molded from childhood into rigid patterns of thought, and graced with far-reaching insight into life, Peirce was often tormented by events. From his early adulthood he was plagued with trouble ranging from educational to marital. His first wife, Harriet Melusina Fay, was older than he, and like him had boundless energy. She joined him in his scientific work, was respected in Cambridge circles, and distinguished herself as an organizer and writer. They were divorced in 1883, and soon thereafter he married Juliette Froissy of Nancy, France, with whom he lived until his death on April 19, 1914.

To Bertrand Russell, Peirce appeared "a volcano spouting vast masses of rock, of which some, on examination, turn out to be nuggets of pure gold." During his lifetime Peirce had only one book credited to his genius — "Photometric Researchers," published in 1878. After his death, Harvard's philosophy department, which had no place for him while he lived, found room for his papers which his wife sold in December 1914 to help meet his debts. Although his papers were unpaginated, and his life disorganized, his contribution was immeasurable. Eight volumes of his papers were published between 1931 and 1958. An additional four volumes of mathematical papers were edited by a Hunter College professor emeritus, Carolyn Eisele, in 1976.

What Charles Sanders Santiago Peirce could not attain in life, he achieved in death. Peirce scholars are found the world over. On May 6, 1963, the U.S. Coast & Geodetic Survey launched from Mobile, Alabama, a coastal survey ship, christened the C.S.S. Peirce in honor of its famous employee. During the United States bicentennial year, symposiums were held at Johns Hopkins University in his honor. A C.S. Peirce Bicentennial International Congress was conducted in Amsterdam the same year.

Peirce was a thinker's thinker—a man with a message and a Philosopher of Science. Today the Peirce Society, along with the National Park Service and several other state and federal agencies including NOAA's National Ocean Survey, await action by the Congress on a House Resolution that would establish a Charles S. Peirce National Historical Site in the Delaware Water Gap National Recreation Area. The project would restore Arisbe as a center for philosophy and as an historical exhibit, a montage of those sciences Peirce so ably touched. □

NOAA's "Unbender"

Hyperbaric Chamber Saves Lives In Miami

By CARL POSEY

Try this one for nightmares:

You've spent the afternoon scuba-diving along the shallow sides of a coral reef off the Florida Keys. It's a way of rejuvenating yourself after a year's labor in an inland city, and you've been diving now, oh, four years, no, more like five. You feel pretty experienced, comfortable in the sea, now that you've run up the equivalent of ten workdays underwater.

Now, back in the boat and heading for shore, you begin to feel a little shaky, and you're touched by fear. The class that put you into a scuba raised your consciousness about diving hazards, and all the bad things that happen if you come up with your lungs full of expanding compressed air. You pick back through today's dive, searching for the source of the pain evolving in your chest . . . you were careful coming up, you exhaled . . . you can't put your finger on the problem, and the pain is worse, your vision blurred . . . maybe it's a heart attack. . . .

Unconscious, you're passed from family to rescue squad to chopper, hurried to a coastal city's hospital, where emergency-room people listen to accounts of your symptoms, and then begin to treat you like any other stroke victim.

What they can't know is that you weren't able to exhale all the compressed air. Some of it got trapped in scar tissue your lungs retain from a forgotten childhood brush with TB, and bubbled into your cardiovascular system, the bubbles rising brainward, plugs that will seal tiny blood vessels, block the flow of oxygen and nutrients to quadrants of the brain. While hospital personnel try to rescue you from your "stroke," the bubbles are shutting you down. . . .

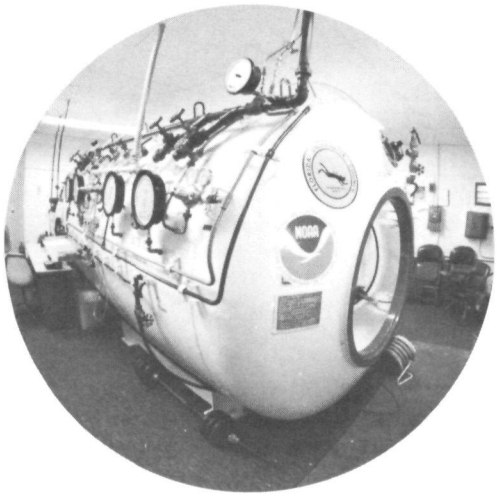
No one knows how often this bad dream —or, rather, this terminal reality—happens around America's coasts. But it needn't happen in Miami anymore. A tank-car-sized metal cylinder, enameled in gleaming hospital white, has made the difference, and now the word is out along the Gulf coast and down through the Keys and Caribbean: get them to NOAA-Miami's unbender.

The unbender is an 18-foot-long, nine-ton recompression chamber that can take an ailing diver back to pressure depths of as much as six atmospheres—six times sea-level atmospheric pressure, or about 90 pounds per square inch—then gently bring the victim back to lower pressures, flush away the damaging gases with pure oxygen, and reclaim the body from the bubbles that can incapacitate or kill it. In two years, the NOAA chamber has helped 66 people with decompression sickness, a family of disorders caused by moving rapidly from a high-pressure environment to a low-pressure one—disorders that range from mild physical discomfort to debility, coma, death.

Three years ago, the hyperbaric life-saver in Miami was a rusted iron tank at the Brooklyn Navy Yard. Now it constitutes the heart of a $150,000 system, provided partly by NOAA and partly by the community through the Florida Underwater Council. NOAA's Richard Rutkowski was the prime mover behind the transformation, a role that has won him many awards, including his agency's Public Service Award in 1976.

"After the Navy shut down its recompression chamber at Key West," Rutkowski explains, "the diving community came to Stew (Dr. Harris B. Stewart, Jr., director of the Atlantic Oceanographic and Meteorological Laboratories) for help in getting a hyperbaric chamber. There hadn't been much response elsewhere. Having no chamber. . . ." He pauses; then, "No one knows how many undiagnosed diving accident cases die in hospitals being treated as stroke victims.

"But now the divers are more conscious of the problem, and they know about the chamber. They come from as far away as



ERL Diving Officer Richard Rutkowski (facing page) inside the "Unbender"; and (above) the recompression chamber at its Southeast Fisheries Center location on Virginia Key, Miami — across the street from the Atlantic Oceanographic and Meteorological Laboratories.

Sharing vigil over victim inside the chamber are (from left) NMFS' Gerry Webb, Dade County Fire Lt. Reynolds, NOAA Lt. Cdr. Ron Ellers, and Yvonne Harper of the Florida Underwater Council.

Victim is hurried into recompression chamber by Dade County fire and rescue paramedics and a dive doctor.

Honduras, and out in the Gulf and Caribbean."

The trouble that brings them to the facility on Virginia Key is caused by retention of compressed gas in the body. A diver descending with a scuba breathes compressed air regulated to equal water pressure, so that with each breath the diver's body is pressurized against the crushing pressure outside. The oxygen in the compressed air is burned off in body cells, and exhaled as carbon dioxide. But nitrogen, which constitutes nearly three-quarters of the air mixture, is inert in the body, and so gets stored in tissues, especially the fatty tissues, like the lipid cells of the nervous system.

Ascending, one moves from a high-pressure environment to a low-pressure one. Pressurized air in the body now begins to expand, crowding out of the tissues to be exhaled. The lungs are like balloons rising through the atmosphere—with decreasing outside pressure, the expanding air within will stretch them unto bursting. So it becomes important for the diver to exhale on the way up, and ascend slowly enough to ensure that the body can free itself of the compressed gases inhaled on the way down.

One penalty for not purging these expanding gases is that nitrogen bubbles congregate in bone joints, causing the painful contortions called the bends, or gather in the respiratory system, causing the symptoms divers know as the chokes. For both disorders, the only cure is to be taken to depth again—in a hyperbaric chamber—and then gradually returned to normal pressure slowly enough to permit the body to purge the nitrogen.

The other, more serious penalty, is the creation of air embolisms—bubbles of air forced into the blood stream when expanding air in the lungs ruptures the delicate alveoli (air sacs) and enters the tiny capillaries which feed them. Once in the bloodstream, the air bubbles tend to rise toward the brain, where they become effective plugs for the small vessels feeding oxygen and nutrients to areas of the brain—volumes of tissue that can be irreversibly damaged by five minutes' oxygen starvation. Drowning aside, an embolism is the worst accident that can befall a scuba diver.

Pilots are also prime victims of "bubble trouble." Six of the 69 cases treated thus far in the Miami chamber have been military aviators, shot to sudden high altitude by rapid depressurization of a cockpit.

But the difference in environments, Rutkowski points out, makes the diver the more likely candidate. "The first 33 feet in the ocean gives you the same change in pressure that you get going from sea level to 70,000 feet. You can come up holding your breath from as litle as two or three feet and get an air embolism."

So the emphasis at the chamber is on diving, a subject that has pervaded Rutkowski's life for some 25 years. He has trained in commercial diving schools, been a Navy diver, and participated in most of the kinds of operations that humans can accomplish under water. He writes articles on diving, works with the community and dive shops on safety, and teaches evening classes of basic scuba. Although one would not say he looks like a diver, there is a feeling that this middle-sized, muscular man has been shaped by his hard line of work in the same way that farmers and stevedores are shaped by theirs. And bent? He grins. "Not that I know of."

At present, Rutkowski is diving officer for the Environmental Research Laboratories, a member of NOAA's Diving Safety Board, and the NOAA diving training officer for the east coast. "We run an interim course," he says, "from basic to advanced, to make sure the scientists can use their diving equipment in our research environment. They work in rivers, inlets, canals, badly polluted areas. They have to be able to go off a ship in mid-ocean and be working divers. They have to know how to use diver's tools. So we go for fourteen days, from about eight in the morning to about ten at night."

Running the chamber is very much a community undertaking. The operation itself is carried out by the Atlantic Oceanographic and Meteorological Laboratories, and led by Rutkowski. But the chamber is located across the street, at NOAA's Southeast Fisheries Center. Support for the facility comes partly from NOAA's Manned Undersea Science and Technology office, partly from AOML, and partly from contributions from the community, made through the Florida Underwater Council.

The chamber facility must also be a medical center and is essentially an extension of nearby Jackson Memorial Hospital. Three doctors from Jackson—hyperbaric physicians, or "dive doctors," qualified to work in the chamber's pressurized environment—are on call, as are paramedics, also pressure-qualified, from Dade County Fire and Rescue. Members of the Florida Underwater Council also participate.

Because the range of effects is great, patients take many roads to the Virginia Key chamber. Some divers correctly identify mild symptoms—joint pain, perhaps some blurring of vision—and walk in for treatment. Generally, divers with bubble trouble turn to Dade County Fire and Rescue, which consults one of the Jackson dive doctors; if chamber treatment is in order, the patient is flown in by the Coast Guard or Air Force, or hurried to Virginia Key by ambulance.

Once there, the treatment is much the same, varying mainly in length, which is determined by the severity of the case.

"For victims with gas embolisms, first we take them down to six atmospheres," Rutkowski says, "in an effort to reduce the size of the bubbles . . . the size of the plugs in their bloodstream. At six atmospheres you're breathing six times the amount of oxygen you get at sea level, and this helps offload the culprit gas.

"We can't put them on pure oxygen at that pressure depth because oxygen is toxic below 60 feet. So we bring them back up to a pressure depth of 60 feet and put them on pure oxygen. This drives oxygen into areas that are starving for it, and continues to offload the bubbles."

It takes seven people to run the chamber, including a chamber boss inside. One person operates the system from a panel outside, surrounded by pressure gauges telling how much, of what kind of gas, at what pressure, composes the pressure environment. The chamber is equipped to furnish compresed air, mixed gases (deep saturation dives use helium and other gases for breathing), and pure oxygen. "You can't use electricity in there when you're using pure oxygen," Rutkowski says, "so everything has to be mechanical. We also wear special clothing for the oxygen environment."

A lock at one end of the chamber permits people to enter and leave the unit while it is pressurized. This ability to hold several people at one time greatly enhances the system's utility. Many hospitals have hyperbaric chambers, but they are only large enough for one body, which isolates the patient from the physician. Such small, "coffin-type," hyperbaric chambers are generally limited to three-atmospheric pressures, and intended for use in other hyperbaric therapies, not for diving accidents.

These other therapies have made the NOAA chamber useful to a broader segment of the community than its divers. Some bacterial infections—gas gangrene and tetanus, for example—are caused by bacteria which cannot survive in an oxygen environment. Two of the cases treated in the chamber have been intense, virtually inoperable gangrene, which the hyperbaric facility has helped arrest. In one of these, the large size of the enclosure permitted the physician to perform surgery under hyperbaric conditions.

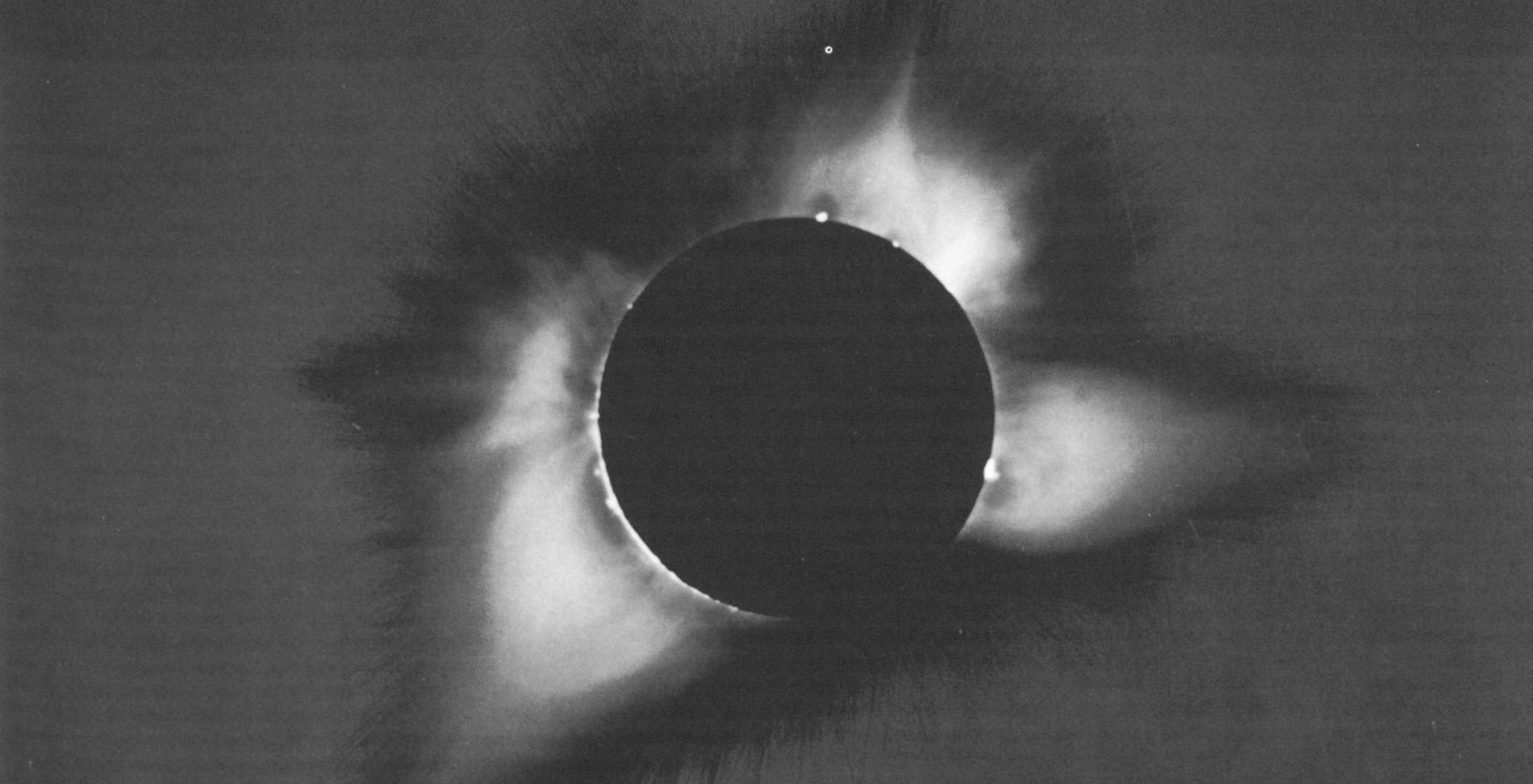
"There are lots of situations besides diving accidents in which the chamber can help," Rutkowski notes. "Sometimes a patient embolizes during open heart surgery, or from a chest wound. There are industrial accidents, where high-pressure air gets introduced somehow and a person embolizes."

But the vast majority of the patients passed through the NOAA facility are divers, a fact that, in Rutkowski's view, illuminates a major diving safety problem.

"Hyperbaric medicine really hasn't played the role it should in determining whether a diver should be diving," he says. "Most people get pre-diving physicals, but a lot of them get their physicals from doctors who know nothing about diving problems. You can do everything perfectly on a dive and get an air embolism because of some tubercular scar tissue on your lungs. Some people just shouldn't be diving.

"We see a lot of hits where people go flying too soon after a dive. We get victims who've gone out with colds and other respiratory disorders. We get very few commercial divers. Our patients are mainly amateur sport divers who've stayed down too long, or misused a diving table . . . something like that. They're just inadequately trained."

Dick Rutkowski, and his unbender, are doing all they can to fix that. □



THE MAUNDER MINIMUM

By CDR. RICHARD E. NEWELL, NOAA CORPS

Vast worldwide glacier expansions are associated with a dearth of solar activity - sunspots and flares -- a cyclical phenomenon whose occurrence in the 17th century is known as the Maunder Minimum.

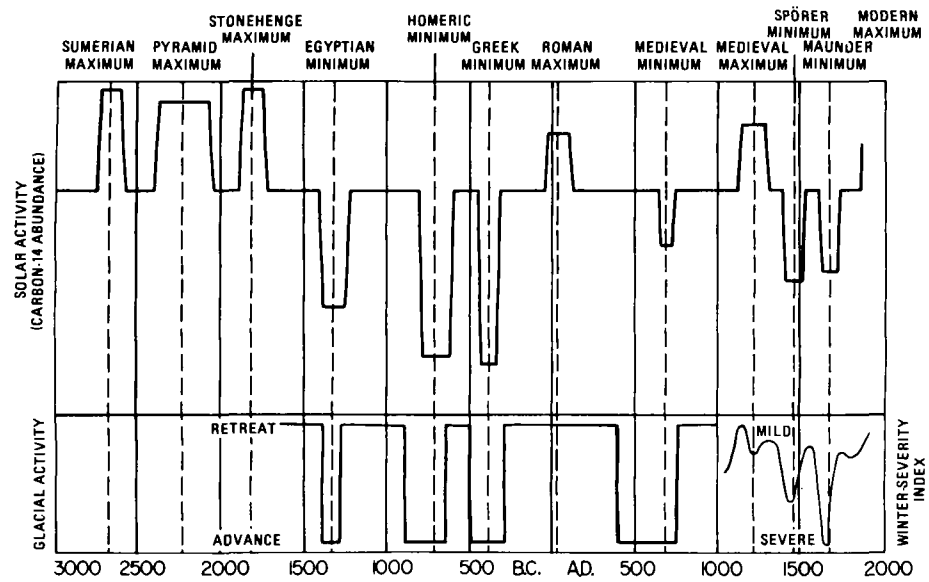
In the middle of the 17th century, what scientists call solar activity all but ceased. For 70 years there was a dearth of sunspots and flares. For 32 of those years, not one spot was seen on the sun's northern hemisphere, and for periods of up to 10 years there were none on the sun's southern hemisphere either. That was the solar picture three centuries ago, as best we know it from old records and new scientific findings.

This phenomenon has recently been named the "Maunder Minimum," after the English astronomer who, in 1894, tried to draw attention to this unusual period and point out its importance for our understanding of the sun and its earthy effects. He saw that this strange twist in the sun's history could be of special value to scientists in search of connections between solar activity and changes in the earth's magnetic field, or even its weather.

We now know that the Maunder Minimum corresponds almost exactly with the coldest period of the Little Ice Age—that period of long, severe winters from about 1550 to 1850, when the glaciers of Europe and North America advanced farther than they had since the Great Ice Age ended 150,000 years earlier.

By using the Minimum as a calibration point, studies of the radioactive isotope carbon-14 in tree rings have enabled scientists to extend solar history back to about 5000 B.C. When carbon-14 anomalies are compared with the advance and retreat of glaciers, a striking resemblance is seen—a remarkable fit between solar activity and global climate over periods of 50 to several hundred years. At least twelve features are apparent in the carbon-14 record, each as prominent as the Maunder Minimum. For, as far back as the climate record extends, there is a tendency for every decrease in solar activity to be accompanied by a glacier advance, and for every rise to signal a time of glacier retreat. One of these decreases (the Spörer Minimum) coincides with the only other extreme dip in Little Ice Age temperatures.

Climate variations seem to rise and fall in response to the long-term level of solar activity, measured from the abundance of carbon-14 in the growth rings of the bristlecone pine. Variations shown here are based on the advance and retreat of Alpine glaciers and on records of winter severity from Paris and London. (Diagram by permission of Dr. John Eddy and Scientific American).



An impressive correlation is one thing, but a real physical connection is another. Did a waning of solar output produce the Little Ice Age, a period actually more typical of the earth's history than the benign conditions of the past 100 years? If so, how did it happen—what physical mechanism was at work? Could some vital clue have arrived on the wings of the solar wind, that fine mist of charged particles that races past the earth at hundreds of kilometers per second?

Dr. Steven Suess, a member of the Interplanetary Studies group of NOAA's Space Environment Laboratory in Boulder, has just taken a step toward resolving this problem. As he puts it, "If there is a definite physical connection between the Maunder Minimum and coincident terrestrial changes, then it is desirable to understand what the solar wind and interplanetary magnetic field were like during that period." Accordingly, he has come up with an estimate of interplanetary conditions near the earth during the time of solar quiet, when the Little Ice Age was in full swing.

His estimate grows out of his study of the corona, the faintly luminous outer envelope of the sun. Most of the corona is composed of arcades of closed magnetic field lines that hold the hot coronal plasma fast. But Suess focuses his studies on low-density regions called coronal holes—wellsprings of the bulk of the solar wind. Here, the magnetic field lines open up to space, releasing high-speed streams of solar plasma that spiral out from the rotating sun like water spirals out from a rotating sprinkler. This outpouring of solar particles drags the sun's field lines with it, extending them to and beyond the earth. Once they leave the sun behind, these field lines are collectively called the interplanetary magnetic field (IMF).

Coronal holes are almost always found at the sun's poles, sometimes branch down to the equator, and usually persist for months. These "holes" have two important features in common with the magnetic poles of the earth—they are always embedded within great unipolar magnetic regions, and they are places where field lines arch outward toward space. Frequently, there appears to be an even stronger bond. In the course of each 27-day solar rotation, a coronal hole may make a kind of magnetic link-up with the earth's magnetosphere, via the IMF. This is believed to happen when the IMF within a high-speed solar windstream somehow merges with those high-latitude geomagnetic field lines that arch to our sunward interplanetary border.

The greater the merging rate, the more solar particles penetrate the magnetosphere and the more disturbed it is. Merging occurs so rapidly in the presence of these high-speed streams that the level of geomagnetic activity rises sharply. These recurring geomagnetic disturbances are a major source of solar control over our terrestrial environment.

Compared to solar flares—enormous eruptions of energy usually associated with sunspot groups—coronal holes generate energy on a slow-and-steady basis. But their output is still prodigious. They work like hydromagnetic wind machines to send gale-force streams tearing along at speeds of more than a million and a half miles per hour (700 to 800 kilometers per second) through space. For a deeper knowledge of these high-speed streams, Suess used coronal hole data from the earth-orbiting flight of Skylab during 1973-74 to model the wind-machine process mathematically. His model says that the sun's magnetic field not only "makes" the hole, but also produces the high-speed streams. A hole forms when the field lines open up to space, and the speed of the particles rushing from it is boosted in proportion to the region's field strength.

Suess explains that these coronal features are a basic part of the familiar 11-year sunspot cycle. However, coronal hole activity is greatest on the downswing of that cycle, after most of the sunspots and flares have come and gone. Although sunspots, flares, and coronal holes are quite different in structure and time of occurrence, they all share the same root—the underlying, driving force is the sun's magnetic field.

What were the solar wind and its IMF like during the 70-year-long Maunder Minimum? To answer this question, Suess used several solar wind models, together with a legacy of solar evidence recently made available by astronomer John Eddy, foremost student of that period. First, the carbon-14 tree ring data show that galactic cosmic rays reaching the earth's atmosphere were quite intense—not blocked off by a vigorous IMF. This is consistent with the absence of sunspots, indicating that the solar roots of the IMF were probably weak. Moreover, there were no reports of well-defined, easily visible corona during the eclipses of that time, and there was a long gap in reports of aurora in our middle latitudes.

After putting all the information together, Suess concludes that the Maunder Minimum solar wind would have had a very ordinary profile, defined by the simplest and quietest conditions. This was a time when the solar wind machines were shut down. Not only must the IMF have been much weaker and smoother than today, the solar wind near the earth was about as suppressed as it could be—about 275 kilometers per second, he calculates—and the particle density must likewise have been very low, about three per cubic centimeter.

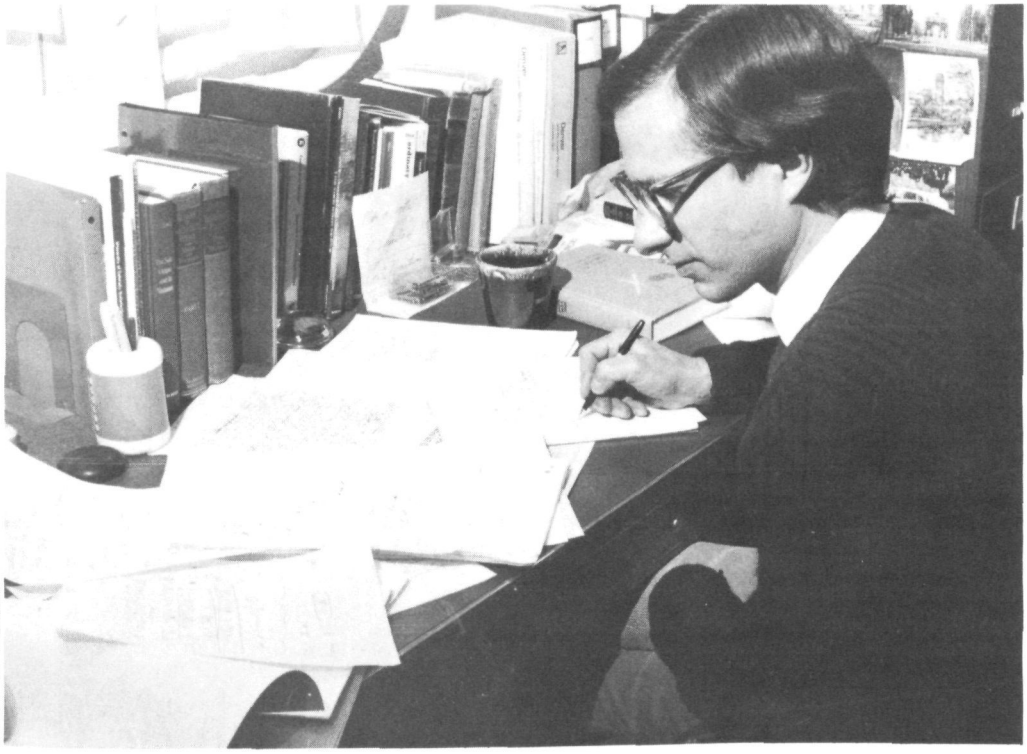


Photo J. Barfield

Dr. Steven Suess of NOAA's Space Environment Laboratory explains how modern knowledge of the solar wind, combined with indirect evidence of the Maunder Minimum, enables us to estimate the Minimum solar wind and speculate about the earthly effect.

Suess cautions that his solar wind theories are just that—theories. Nonetheless, there is general agreement that the Maunder Minimum solar wind must certainly have been quite different from today's.

The IMF stands out from these other solar wind properties because of its key role in several recent and important sun-weather studies. "Of all the suggested solar-weather relationships," Suess declares, "by far the strongest cases have been made for the 20-year climate variation and for the change in atmospheric circulation that accompanies the passage of interplanetary magnetic sector boundaries (separating regions of opposite polarity). These correlations imply either that the IMF modifies the weather or that the IMF is the signal for an additional fundamental change in the solar output which modifies the weather. The 20-year period corresponds closely to the 22-year magnetic solar cycle, and nothing else, and the sector boundary relationship is directly observed."

This 22-year solar cycle is the so-called double-sunspot cycle or Hale magnetic cycle. It is based on the observation that the polarity of sunspot magnetic fields, and of the sun itself, changes with each 11-year cycle, reverting to the same polarity about every 22 years.

The corresponding climate variation has been examined by many scientists, one of the foremost being Dr. J. Murray Mitchell, NOAA's senior climatologist. With the help of scientists at the University of Arizona's Laboratory of Tree-Ring Research, he found a very strong match between drought in the western United States and the 22-year solar magnetic cycle, using data going back to 1700. The area covered by drought tends to reach a maximum about two years after every other minimum in the 11-year sunspot cycle.

The other possible solar effect that Suess refers to involves our day-to-day weather. The moving force in this case appears to be the sun's magnetic structure—a large-scale pattern that typically brings four IMF sectors sweeping past the earth during each 27-day solar rotation. These sectors can be traced back to the same magnetic "continents" that spawn coronal holes.

When well-defined sectors pass the earth, a clear-cut change is seen in the circulation of the winter atmosphere. Each passage is accompanied by reduced atmospheric vorticity (rotary motion), determined by measuring all the low pressure centers (storm systems) in the Northern Hemisphere. The vorticity takes a temporary drop of about 10 percent, reaching a minimum one day after each sector boundary passage.

Both of these sun-weather correlations have been shown to be reliable at a confidence level of 95 percent or better. If clear-cut IMF changes are tied to changing weather patterns, and the sun's well-marked magnetic cycle is tied to recurring changes in climate, then might not the presumably strong, long-lasting changes in the solar magnetic field and IMF of the Maunder Minimum tie in with the major shift in climate that we call the Little Ice Age?

Suess admits that this is a possibility, but he leans toward an idea recently elaborated by Dr. John Eddy: these Maunder Minimum magnetic changes probably occurred in parallel with more powerful changes in solar radiation, the two reflecting a more fundamental change occurring deep within the sun.

Suess will not speculate further. "We just don't have enough information yet to nail these connections down," he says. This conservative approach is becoming typical of today's solar-weather researcher, probably because the field is being drawn into the mainstream of modern science, where each investigator makes it his business to know what others in the field are doing. There has been other progress too; space-age strides in our ability to monitor the sun and solar wind, and the development of more sophisticated analysis techniques. This has all combined to produce a recent upsurge of promising, high-quality research. After generations of skepticism arising from shaky claims and questionable arguments, this field of science is gaining a new prominence.

The skeptics themselves are helping to turn things around.

Each piece of supporting research that Suess has described has dealt with important findings produced by skeptics-turned-believers. Dr. Murray Mitchell, investigator of the 20-year drought cycle, was himself a skeptic. He admits that "as recently as five years ago when Walt Roberts (Dr. Walter Orr Roberts, formerly Director of the National Center for Atmospheric Research) was giving a talk about 20-year cycles, I thought 'I'll believe it when I see it.' Well, now I believe it. This correlation is obviously not spurious, not a fluke. It's really happening."

A more aggressive stance was taken by Dr. Colin Hines, a prominent atmospheric physicist who doubted the far-reaching claim that some weather changes were linked with magnetic sectors in the solar wind. After a good deal of in-depth testing, he and a colleague announced that "we sought several means of undermining the credibility of this claim, but have been obliged to admit its reliability." Their work amounted to a rigorous independent verification that this solar connection is probably real.

Finally, Dr. John Eddy, the man who redirected attention to the Maunder Minimum and its implications, has stated, "As a solar astronomer, I felt certain that it (the prolonged sunspot minimum) could not have happened, and my interest in history made the prospect of cross-examining Maunder's assertions an appealing one." Following that wide-ranging investigation, Eddy became the leading proponent of a strong climatic link with the Minimum and similar solar changes through history.

With Suess, skepticism was never a factor. He undertook this research simply because it intrigued him and was a natural extension of his previous work. "As a fluid dynamicist, I've always been interested in weather systems and how they work," he says.

He trusts that his estimate of that solar wind of three centuries past will be of some value to the new breed of scientist—skeptics included—who are challenged by the sun-weather puzzle. □

NOAA Profile

Beau Stubblefield, mathematician:

Solving the Human Equation

By JOAN VANDIVER FRISCH

BEAUREGARD STUBBLEFIELD'S heart was pounding by the time he reached the seventh floor landing of S. H. Kress's department store building in downtown Houston, but the climb had been worth the effort. Directly ahead of him was the object of his ascent—a worn porcelain drinking fountain with NO SIGN overhead. As sweat streamed down his face in the hot, muggy building, the young black boy drank the cool, refreshing water in the quiet hallway, shielded from the din of traffic in the busy Texas metropolis below.

Since then, "Beau," as he is called by his friends, has shaped his career around the concept that all people should be treated as equals. And he intends to carry out this policy as the new equal employment opportunity manager at the Environmental Research Laboratories in Boulder, Colo.

Before joining NOAA in October 1976 as a fulltime mathematician in the laboratories' Office of the Director, Stubblefield had been a full professor of mathematics at Appalachian State University in Boone, N.C. During his 25-year career as a math professor, Stubblefield assisted students of various ethnic backgrounds in their efforts to compete in the graduate mathematics program at major American universities. As a U.S. Department of Health, Education, and Welfare senior national teaching fellow, he headed a team of mathematicians who designed mathematics text materials for the disadvantaged students, to help them compete successfully with students with better educational opportunities.

"Most people do not realize the discrepancies and hardships involved in obtaining an education that were encountered by minorities such as blacks in this country before the Civil Rights Act of 1964 forbade such discrimination," Stubblefield says. "For example, the segregated schools where I grew up were never issued new textbooks when changing times made the books obsolete. Instead, taxes paid by my parents and all other people in the school district bought new textbooks for the white segregated schools and their out-of-date books were passed on to the black schools. The teachers gave us sheets of sandpaper to rub off the previous owner's name."

And, according to Stubblefield, he and his fellow students also were discriminated against in monetary terms within the school district. Although white students were routinely bussed by the school district to their segregated schools in the Houston Independent School System, Stubblefield and his friends were forced to pay bus fare on city busses to reach the segregated schools within the same district.

Educational discrepancies were also apparent when one got to college, as Stubblefield found out from personal experience.

"When I graduated at the top of my class, both at Booker T. Washington high school in Houston, and at Prairie View College, part of the Texas A & M system, I thought that I could compete with anyone in my field," he says. "Although I had also completed work for a M.A. in math from Prairie View before entering graduate school at the University of Michigan, I learned that graduates of black colleges could not compare favorably with graduates of white colleges because of inferior academic preparation."

At that time Stubblefield also learned that no student housing was available for American black students although black foreigners from Jamaica and Africa were allowed to occupy the same housing as white graduate students.

Dr. Beauregard "Beau" Stubblefield (facing page), equal employment opportunity manager at ERL...and (below) as a solemn five-year old...

a high school graduate just facing the prospects of college...

and with plans to marry and re-enter the University of Michigan graduate school.

For these reasons he dropped out of graduate school after one year to prepare himself and others for entrance to major white universities.

After spending six years as a watchmaker, Stubblefield returned to graduate school at the University of Michigan. He subsequently received both M.S. and Ph.D. degrees in mathematics there. Since then he has authored several texts on mathematics and taught at the University of Michigan, Texas Southern University in Houston, Oakland University in Rochester, Michigan, and Appalachian State University. He also spent four years as an exchange professor in mathematics at the University of Liberia in Monrovia, a port city in West Africa.

Despite the eradication of some of the more glaring educational discrepancies between black and white schools in recent years, Stubblefield feels that school districts have a long way to go before equality of education is realistically achieved.

"While most elementary and secondary schools now have integrated teaching staffs, the quality of teaching is still not equal," he says. "The common practice is to send the mediocre white teachers to predominantly black schools and transfer the top black teachers to the predominantly white schools.

"Bussing students to other schools may help speed up the process of achieving equality in education. While the practice itself is as distasteful to black parents as to whites, it seems to be the quickest method for bringing about equal educational opportunities for all students because white parents will see to it that their children obtain equal educational facilities, faculties, and services at any school.

"Federal, state, and local government agencies, and the business community also have a long way to go before equality in employment for all segments of the population is achieved," continues Stubblefield. "That's why equal employment opportunity programs such as the one we have in NOAA and at the Environmental Research Laboratories are still needed, and why I accepted the position of EEO manager here."

Stubblefield does not share the view—once a prevailing view—that qualified minorities and women cannot be found for middle and upper grade level positions in the Federal government. As the laboratories' EEO manager, he intends to prove it.

Early support for his view comes from recent visits he made to three very different universities: Howard University in Washington, D.C., the University of Michigan at Ann Arbor, and Southern University in Shreveport, Louisiana.

"At Howard," he recalls, "I recruited six possible candidates, two of them with Ph.D. degrees. On the second trip to Michigan we found eight prospective minority employees, four with Ph.D. degrees. In Shreveport we recruited four minority candidates who were well-qualified for scientific positions in the Environmental Research Laboratories."

While Stubblefield sees real possibilities in attracting talented members of minorities to Federal service, he stresses that the hiring agency, not the prospective employees, must be the active partner in the recruiting process.

"This task could be partially accomplished within ERL and similar organizations," he says, "by contacting scientists who are willing to combine recruiting of minorities and women during their travels to professional meetings and university campuses."

At his desk at ERL, Beau Stubblefield takes a call on the Affirmative Action Plan that he drew up for the laboratories.

For example, if a scientist were visiting an educational institution to give a seminar, he could simultaneously find out if there were any minorities or women who were graduating in a science or other field of interest to the laboratories and give the names to Stubblefield upon his return.

"I would then plan follow-up recruitment steps which would include assisting the prospective employees with their placement on the Civil Service register, with their rating by the Civil Service Commission, and matching the new recruits with open positions with NOAA's Environmental Research Laboratories," he says.

"Our recruitment efforts consist of several steps," he says. "First we must identify minorities and women who may be interested in government employment." To accomplish this objective, each laboratory and program area office is now requested to submit the names of two scientists who will combine recruiting during their scientific trips.

"As far as commitment goes, if managers and directors of laboratories will dedicate themselves to equal employment opportunity activities in the same sense as they do science, we would essentially have no need for an equal employment opportunity office and program," Stubblefield says. "Now, however, pressure is being put on them from top administration officials at NOAA in Rockville and locally here at ERL to insure that each individual employee recognizes his or her responsibility to act positively in carrying out this responsibility."

For example, he says, part of the 1978 Affirmative Action Plan states that each of the Environmental Research Laboratories and program offices must supply a quarterly interim report of its affirmative action accomplishments and intentions to the equal employment opportunity office in Boulder. In addition, each laboratory and program office will now be rated by the director or deputy director of the Environmental Research Laboratories or an outside federal agency. The first such rating must be done by June 1, 1978.

Furthermore, according to Stubblefield, all promotions and/or appointments to GS-15 level positions and above will be reviewed by the NOAA administrator's office from the standpoint of their equal employment opportunity and affirmative action qualifications.

"But that is not all," Stubblefield points out, "NOAA Administrator Frank has also gone on record that equal employment opportunity will be considered as a factor in all supervisor performance and evaluation awards for all main line components.

"Joseph Fletcher, ERL's deputy director, put additional teeth in this directive. Now, any ERL supervisor or program area manager must have a good equal employment opportunity evaluation to obtain an in-grade step increase. He is also planning to link future EEO evaluations with cash awards and promotion considerations for supervisory positions.

"In addition, each laboratory director is required to evaluate his own program every three months and report this to the ERL-EEO office in the form of accomplishments to date and future intentions when accomplishments have not yet been made," Stubblefield explains.

Using his math expertise, he plans to computerize the equal employment opportunity program at ERL within a year.

"At that time, managers and lab directors will be able to inquire about their own programs and laboratories by calling up and requesting the information and the system will give them immediate answers," he explains. "In addition they will be advised of any equal employment deficiencies by automatic computer readout letters."

Yet how much did Beau Stubblefield and his brothers and sister accomplish on their own before equal employment and educational opportunities were part of national policy?

Present careers indicate positive accomplishments but not without some delays along the way. Of four children born to his mother, a teacher in the Houston public school system, and father—a watchmaker who had to curtail his own education at the end of the fourth grade—two sons completed graduate studies for Ph.D. programs in math and chemistry at major white universities. A third son, Elwyn, finished three years of college and is now a foreman at Chrysler Motors in Detroit, and the only daughter, Iris, is now a vice-principal at a secondary school in Houston.

However the pathway to education, especially graduate school, was not as smooth as it is now. In 1944 when Beau applied to four university graduate schools, he did not hear from any of them. But after driving all the way from Houston, Tex., to Ann Arbor, Mich., on faith that he would be accepted, he was admitted.

His wife, Barbara, also struggled to complete her education. While working at a full time job during the day, she attended Wayne State University at night in Detroit until she received her bachelor's degree in elementary education. She has taught in the elementary school systems since then in both Pontiac, Mich., and Liberia, West Africa.

Beau's older brother, Cedric, also applied to a major white university after W.W. II, and was turned down despite outstanding undergraduate scholastic records. After delaying his graduate school education for five years, he applied and was accepted at the University of Iowa's department of chemistry in 1952.

"But times have changed," Stubblefield says.

When his oldest daughter, Barbara, 25, applied for admittance to several major universities, she was accepted immediately at both Michigan State and the University of Michigan. After earning a B.A. degree in economics from the University of Michigan, she has since completed work for a master's degree in business administration from the University of California at Berkeley with the aid of two scholarships. She is now working as an account executive for International Business Machines in San Francisco.

Beauregard, Jr., 21, was accepted at the University of Chicago when he was only a junior in high school. Benjamin, 19, has just completed a stint with the United States Marine Corps and will probably enter college this fall. Daughters, Brenda, 17, and Belinda, 15, are both enrolled in high school.

"The future seems bright," Stubblefield says. "I see a positive direction given to equal education and employment programs." □

New radar solves blind spot problems

The Worse the Weather the Better It Works

By LOUISE PURRETT-CARROLL

A radar created by NOAA scientists may eventually become part of a system to replace the weather balloons that forecasters have used for decades, or detect hazardous wind shear at airports.

The radar, called a Doppler FM-CW (frequency-modulated, continuous-wave) radar, is the work of scientists in NOAA's Wave Propagation Laboratory, one of the Environmental Research Laboratories in Boulder. In nearly continuous tests over the past year, the radar has proven its ability to detect winds in clear air, and perceive atmospheric structures too small to be detected by most radars. It also lacks a radar's usual blind spot—the lowest layer of the atmosphere, where many important events occur —and works in all kinds of weather. In fact, the worse the weather, the better the radar works.

Most radars, explains Dr. Russell Chadwick, one of the FM-CW's creators, send out a pulse that hits a target and returns. The distance to the target is calculated from the time it takes the signal to make the round trip. A single antenna does double duty as transmitter and receiver. After the pulse is sent out, the antenna switches to a listening mode to recieve the return signal, then transmits again. The FM-CW has two antennas, resembling giant bongo drums. One transmits a continuous microwave signal that sweeps up and down a range of frequencies, the other simultaneously receives return signals. Instead of measuring the time delay between outgoing and return signals, the FM-CW measures the difference in frequency. This gives it some distinct advantages over pulse radars.

Because of its on-off mode of operation, a pulse radar is farsighted—it is blind to anything closer than about a half mile, because of the distance the pulse travels during the time it takes to switch the antenna from transmission to reception. In the atmosphere, a lot can happen in the space of a half mile. A major plane crash at Denver's Stapleton International Airport has been blamed on an intense wind shear region only a few hundred feet across. "A clear-air pulsed radar along the runway, which is probably where it would have been," Chadwick points out, "would have missed the wind shear."

Because the FM-CW is always transmitting and always receiving, it can see right down to the ground.

Conventional radar beams must hit some solid object, or reflector. To track winds, such a radar must be able to detect some wind-borne object. The Doppler FM-CW in contrast, can sense movements of "clear" air. "In blue-sky conditions," says Chadwick, "we use discontinuities in the atmosphere cause by turbulence. During rain or snow, we use reflections from the percipitation." The radar's range does depend to a certain extent on atmospheric conditions. In tests on clear summer days in Colorado, the researchers could always "see" over a mile (two kilometers), and sometimes as far as three miles (five kilometers). In winter, the range is shorter, less than half a mile (800 meters). The seasonal difference, Chadwick explains, is because there is more moisture in the air in summer. There is more of another valuable reflector, too—flying insects. "They serve as reflectors, so the range is better. We are well aware that there are many insects in Colorado." In winter, the air is dryer, clearer, and harder to "see."

The Doppler FM-CW is also capable of a much finer resolution than most radars—down to 5.5 yards (5 meters). This fine resolution is necessary to see certain atmospheric structures, such as the wave-like motions atop a temperature inversion. For measuring winds, a resolution of 100 yards (91 meters) will do.

The NOAA radar is actually an unusual application of a fairly common type of radar. FM-CW's, says Dr. Earl Gossard, head of the meteorological radar program, are used as altimeters in airplanes, for example, where their function is simply to measure the distance to the ground. Chadwick, Dr. Richard Stauch, and colleagues, however, have given the radar something extra—the ability to measure winds which cause a Doppler frequency shift.

This unique power seems paradoxical, and until the NOAA group actually did it, it was widely thought to be impossible to get doppler winds from an FM-CW radar, says Gossard. The problem seems to be that the very nature of FM-CW radar is incompatible with application of the Doppler principle. The principle behind Doppler radar is that waves reflected from a moving object undergo a frequency change, called the doppler shift. A conventional, pulse radar can be used to measure the velocity with which an object is moving toward or away from it by the frequency shift of the return signal. But the FM-CW already uses frequency shift to measure distance. "The problem was how to derive two types of information from the same property when the 'target' is continuous in range," says Gossard. Since FM-CW can see things that other radars can't, "the possibilities for a Doppler FM-CW that could sense winds as well were very attractive. But it was generally thought to be impossible for atmospheric targets."

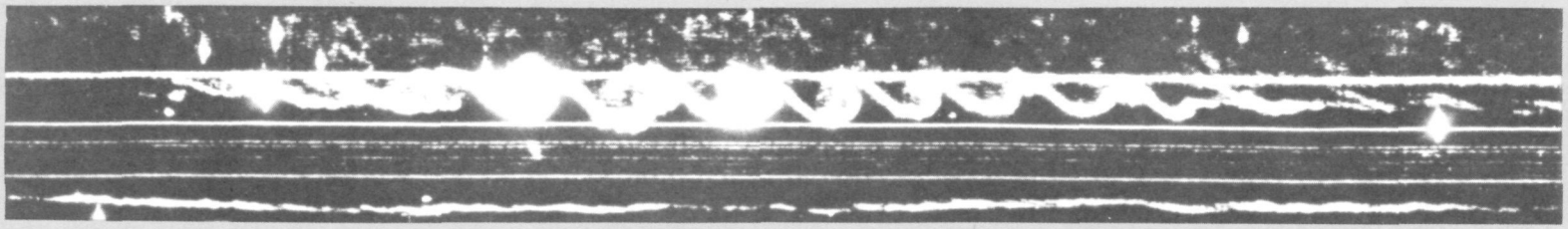
The solution lay not in changing the radar hardware, but in changing the way the output is processed. The researchers found a way to separate the effects of range and motion mathematically in a given frequency shift. The data are processed by a minicomputer in a trailer accompanying the antennas. A real-time color display on a screen shows the winds at different locations within the radar's field of view.

High-powered conventional pulse radars can have greater range than the current model of the NOAA FM-CW. But the researchers point out that the more versatile Doppler FM-CW can be manipulated to trade range resolution for range. "If the signal is weak, or if you want to increase range, you can reduce range resolution. And you can do it quickly. This is impossible with pulse radar."

Much of the development work on the radar, says Chadwick, was supported by the Air Force, which is seeking a wind shear warning system for airports.

Chadwick, Kenneth P. Moran, and other scientists in Gossard's group, gave the radar its first operational tests beginning in February 1977. For 24 hours a day, in all kinds of weather, the radar scanned the air from a hill near Boulder. In July, the radar was moved to the air field at Buckley Air National Guard base east of Denver, and again worked continuously, until October. During the Buckley tests, Chadwick recalls, there was at least one instance where the radar clearly showed strong wind shear across the runway.

Next summer, the radar will be taken to the Boulder Atmospheric Observatory east



The wave-like motion above a temperature inversion is easily seen when clouds are present, as in the photo above. In clear air, however, these movements have heretofore been virtually indistinguishable— until the appearance of a versatile radar developed by scientists at NOAA's Wave Propagation Laboratory. With a resolution of two meters, it shows the movements as on the tracing below the photographs. This new Doppler FM radar, below, has two antennas, one to transmit, one to receive an echo.

of town, where its impressions of what's happening in the atmosphere will be compared and calibrated with actual wind measurements made by instruments mounted on the Observatory's 300-meter tower.

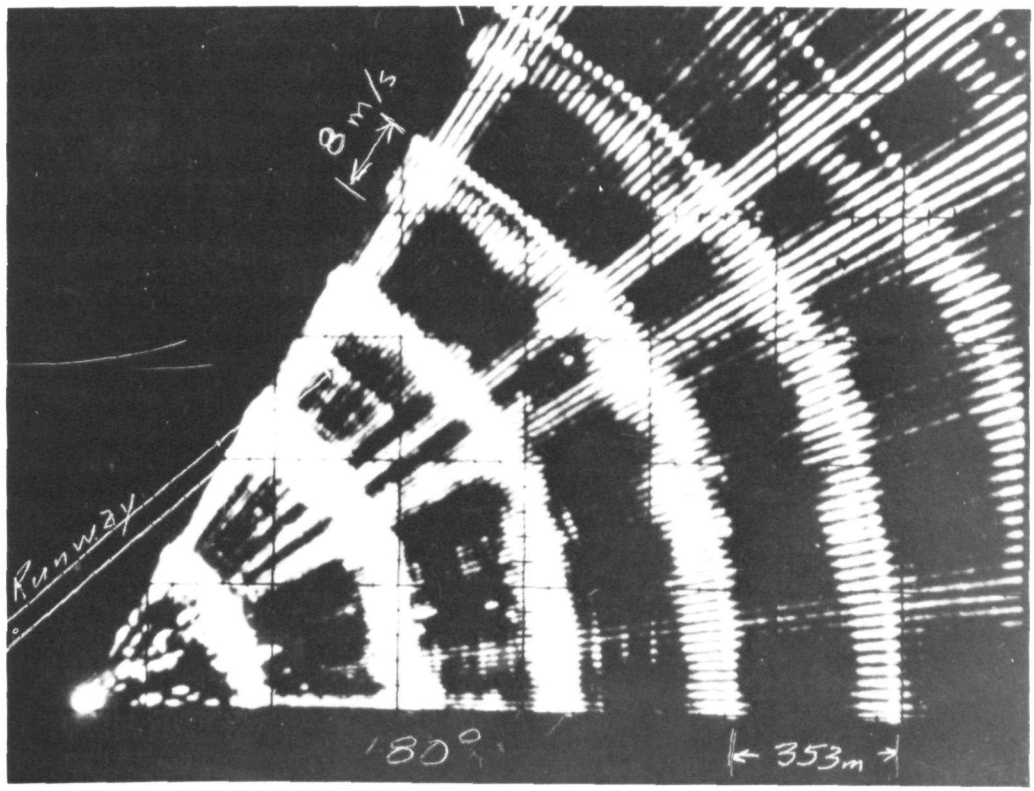
The radar has other broad applications, Gossard and Chadwick believe. Scientists in the Environmental Research Laboratories are considering it as one component of a system that might eventually replace radiosondes—the instrumented balloons that present meteorological services launched to measure upper-ir pressure, temperature, humidity, and winds. These measurements are added to those from surface instruments and to satellite images to help generate forecasts.

The present balloon system, which is used by NOAA's National Weather Service, dates back to World War II, says Dr. Donald Beran, and NOAA has been pondering whether to simply upgrade this system or replace it with something entirely different. Beran heads the Wave Propagation Laboratory's Remote Sensor Applications Group, and is responsible for transferring the experimental technology developed by the other parts of the lab to day-to-day operational uses. "If someone asked us two years ago whether an automated, ground-based system could replace the radiosonde, we'd have said no. But now we think it is possible, and the development of the Doppler FM-CW is one of the things that makes the difference."

Twice daily, at noon and midnight Greenwich time, upper air stations all over the world launch radiosonde. It floats upward, radioing back air pressure, temperatures, and humidity. Meanwhile, a radar tracks the balloon's progress to get an idea of prevailing winds. This means that forecasters must make their predictions on the basis of measurements taken 12 hours apart, measurements along a single line through the atmosphere. A remote sensor can make continuous observations of the constantly changing weather, and scan a large area almost simultaneously. Further, point out Gossard and Chadwick, "they can't track the balloons in high winds. In fact, they don't even launch if winds are over 35 miles (56 kilometers) an hour." But Chadwick has measured winds of 80 miles (128 kilometers) an hour with the Doppler FM-CW during one of Colorado's wind storms. Some balloons are also prematurely lost to bad weather.

The remote sensing system would have economic advantages, too, the researchers say. Each radiosonde costs about $150, points out Gossard. The balloons are launched twice a day, and not recovered. The ground equipment needed for launching and tracking the balloons, he continues, costs about $80,000. "It's a World War II item, but that's what it costs in the catalogue." Gossard believes a remote sensing system would pay for itself in a year or two.

"The FM-CW has capabilities that would be very important to the task of replacing the radiosonde," says Beran. "It would, of course, be one component of a total system which could include other types of radar, lidar (laser radar) and radiometers. And this is only the ground-based portion of a total system that could involve satellites, as well, to give an integrated picture of an entire region or continent. What's important is the output, not the devices."



Record of radar field tests near a runway at Buckley Field, east of Denver. The radar was located at the lower left of the photo; arcs of dots are range markers 323 yards apart, and short white lines represent the wind. Their displacement from the line of range markers is the velocity of the wind toward (left of marker) or away from (right of marker) the radar.

Gossard points out that before it could replace the radiosonde, the Doppler FM-CW's range would have to be increased. "What we have now are 8-foot [2.4-meter] dishes radiating only 100 watts, which is about the same as a light bulb. To reach the heights we'd like—up to the stratosphere—we'd need a kilowatt or two of power, and larger dishes." Such a radar would not be portable, as the present one is, but it would not have to be.

The Doppler FM-CW could help provide more than wind profiles for this effort. "You have to remember that one of the things the radiosonde measures is temperature," says Gossard. "There is a remote temperature sensor that's been around a long time—a radiometer. But these have no distance sense; pointed upward into the atmosphere, all they can tell you is the total temperature along the instrument's line of sight." But meteorologists need to know the temperature at different heights. Generally, scientists use a mathematical technique to infer a temperature profile from radiometer results. "Given a profile of temperature," explains Gossard, "it is fairly easy to figure what a radiometer would detect. But in practice you have to invert that process to look at what the radiomeer sees and figure out the temperature profile. There are various inversion methods for doing this, including one developed by Neall Strand and Ed Westwater in this lab. They all require certain specific information from the radiometers, usually the radiometer measures the same area at several different frequencies, or uses one frequency at sereval different elevation angles.

"But recently it was realized that if you add one more bit of information—height information from a radar—you can get vastly improved temperature resolution aloft from the radiometer."

"For example," adds Chadwick, "the radar may detect an inversion, and that would give you a height scale."

Another temperature sensing technique would combine the Doppler FM-CW with another remote sensor, an acoustic sounder. Since sound travels through the atmosphere at a rate that is related to temperature, the acoustic sounder could send a pulse of sound upward, while the FM-CW measures the rate of ascent of the acoustic pulse. "The only trouble is that winds can offset the acoustic pulse, so we can't use it anymore. So it only works on calm days. But it does work; we've done it," says Chadwick.

As with any new tool, the possible applications for the Doppler FM-CW are just beginning to be discovered. But Gossard is already cetrain that the new radar's versatility, and its ability, unlike most remote sensors, to work in all kinds of weather, assure it a central role in any remote sensing system aimed at predicting weather or detecting its hazards. □

STORM DAMAGE

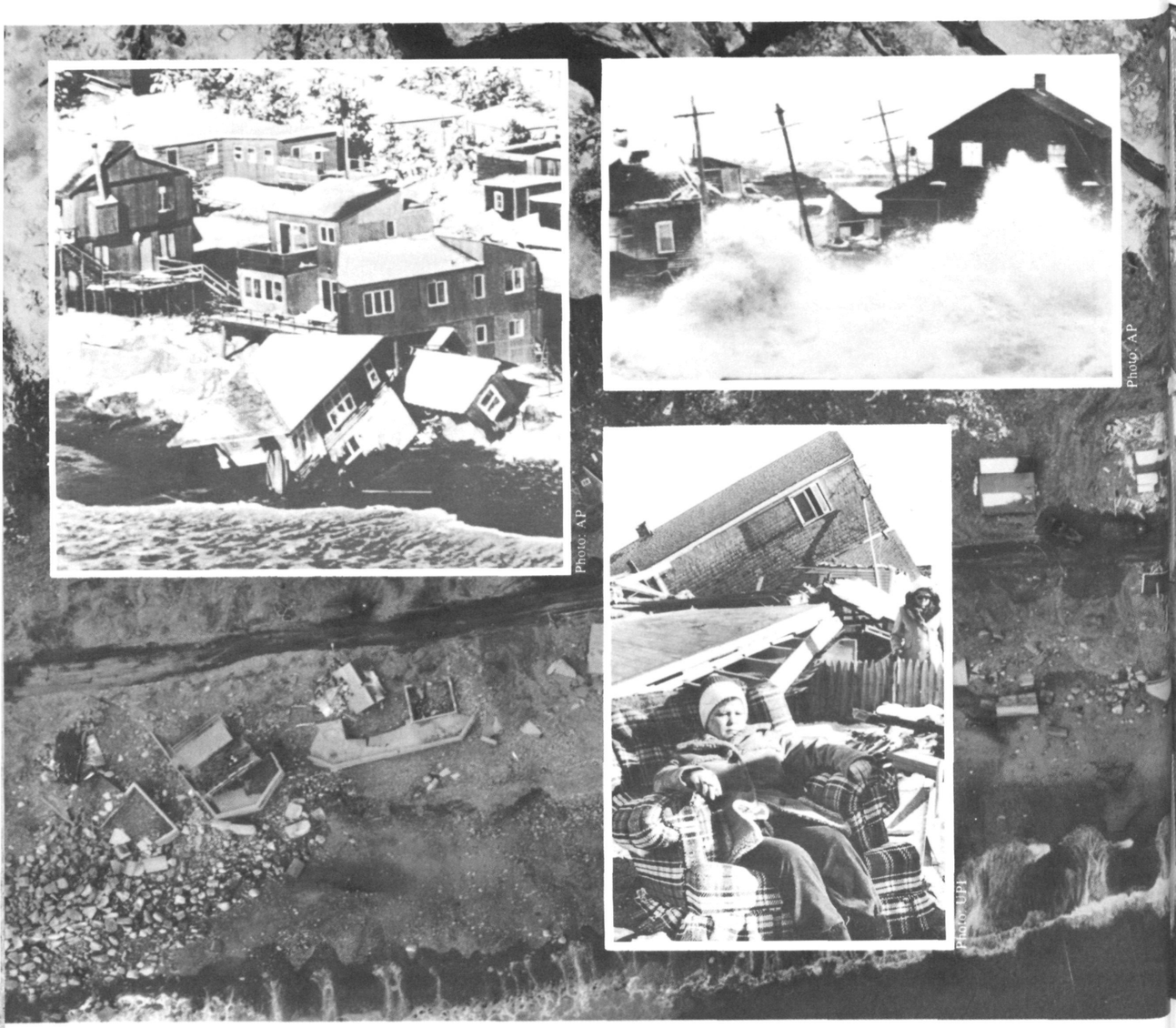
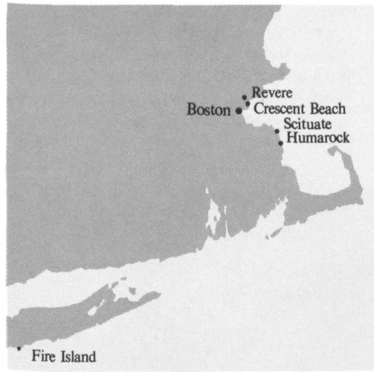


Photo: AP

Photo: AP

Photo: UPI



"It was one of the worst storms of the century," said Cdr. James Collins, Chief of the National Ocean Survey's Coastal Mapping Division which had just completed an extensive aerial photographic assessment of the most devastating storm to hit Massachusetts in its history.

Accompanying Cdr. Collins on the February flight from Andrews Air Force Base near Washington, D.C., were Robert W. Knecht, Acting Assistant Administrator for Coastal Zone Management; John T. Smith, Chief of the National Ocean Survey's Photographic Operations Branch; and Rick Coleman of NOAA's National Weather Service. The pilots were Lt. Cdr. Bradford B. Meyers and Lt. Cdr. Arthur N. Flior.

The photograph covering both pages below vividly records the high/low water mark along a section of the Scituate, Mass., beach which suffered millions of dollars of damage to beachfront property. Houses are tilted and jammed together in the photo (far left) while the tremendous force of the storm is shown as the surf pounds beachfront property in the Peggoty Beach section of Scituate. Barbara Smith, 22, sits in an armchair, one of the only items to escape devastation that was her home in Scituate.

Two Nahant, Mass., residents paddle a small boat down Spring Road to assist flooded neighbors (top left). In Revere, Mass., U.S. Army personnel stand on a disabled carrier that had been attempting to rescue residents waiting in doorway; homes at Ocean Beach on Fire Island (NY) (lower left) were among the casualties left by the pounding surf which hit the area. In the vicinity of Fourth Cliff, north of Humarock, Mass., the bulldozers push sand and rock back to the beach to halt the erosion caused by high tides and driving winds.

Photos: UPI

At Crescent Beach, Mass., (top right and below) extensive damage to sea walls and property can be assessed from these two aerial photos. Waves from an angry sea pound Minot Light House (upper left), aftermath of one of the worst storms to hit the Northeast in this century.

The information gathered from the NOAA photographic mission will be used to update NOS nautical charts and to provide data to Coastal Zone Management which will be used in assisting authorities in the reconstruction of damaged areas, and for storm damage prevention and coastal evacuation programs.

ENTER AFOS: NEW NATIONAL WEATHER NET NEARS

By EDWIN P. WEIGEL

The National Weather Service's revolutionary new data-handling system known as AFOS is now going into place.

AFOS stands for *A*utomation of *F*ield *O*perations and *S*ervices. The installation of minicomputers and TV-type displays at the Pittsburgh Weather Service Forecast Office this spring marks the opening wedge in what will become in three years a nationwide network of more than 200 automated weather offices linked together in an 11,620-mile circuit.

AFOS will do away with the present system of teletypewriters and facsimile machines and the enormous quantities of paper they generate and substitute an all-electronic system in which weather information from the minicomputer systems will be displayed on TV-like screens.

It will free forecasters of much of the drudgery they must perform now and enable them to provide a greatly expanded and accelerated weather service to the nation at no increase in manpower. It will be especially helpful in speeding storm and flood warnings to people making critical, split-second decisions involving lives and property.

No longer will it be necessary for forecasters to spend vast amounts of time tearing off, sorting and posting paper teletypewriter messages and paper maps. A weather map will arrive on station in about 1/40th the time it takes on paper—15 seconds instead of 10 minutes. Messages will arrive 30 times as fast—3,000 words per minute instead of 100.

A message will go from one station on the main circuit to the station most remote from it in about 25 seconds, with error checks at an average of 24 places between them.

Installation of the AFOS system is to take place at three levels. The first level consists of the sophisticated automation of the 52 Weather Service Forecast Offices, three National Centers (the National Meteorological Center, the National Hurricane Center, and the National Severe Storms Forecast Center), and 14 River Forecast Centers. The National Centers and Forecast Offices will be linked together by the 11,620-mile National Distribution Circuit—a full-duplex communications line of telephone quality. The River Forecast Centers will be served with high-speed spur circuits.

The second level will be extension of AFOS into each Forecast Office's area of responsibility (generally a state), by automation of about 150 Weather Service Offices, with similar but simpler equipment. Messages between these smaller offices and the Forecast Offices also will move by high-speed communications links, in a "star" configuration.

The third level will be integration into AFOS of the 150 or so remaining Weather Service operational sites, and will be accomplished for the most part by operating them as remote terminals from the computers at the first and second-level stations.

Each of the 52 Forecast Offices will act as the collection point for all weather data acquired within its area. It will store the data locally and pass it on to all other weather offices. Thus the AFOS program contrasts sharply with previous trends in computerized data-handling in that it decentralizes the processing rather than centralizing it. Minicomputers have made this possible.

Each automated station will have at least one minicomputer. The minicomputers will have a built-in memory of 128,000 to 192,000 characters (letters or numbers), plus at least 10 million characters in storage on disks. Data will be available from minicomputer memories instantaneously; from disks in less than a tenth of a second.

Forecasters will have available a tremendous variety of weather maps and messages they can call up within seconds to aid them in preparing forecasts and warnings. To keep the data manageable, the minicomputers will be programmed to pull off the National Distribution Circuit only that data a Forecast Office wants. Information that has outlived its operational usefulness will be automatically purged.

The AFOS system will be enhanced by other automated devices and systems in existence or being developed—such as automatic weather-observing stations, digitized radar, and computer-assisted measurements of the upper air. These linkages will allow fast and frequent observations of changes taking place in the weather.

Russell G. McGrew, chief of the AFOS implementation staff at Weather Service headquarters, says that after the initial installation in May at Pittsburgh, new installations should be initiated at a rate of six to eight a month, until the system is complete, targeted for November, 1980. "We should be fully operational at all sites four to six months after that," he says.

Weather Service officials are well aware that the AFOS system is going to take some getting used to, and have made plans for making the transition as smooth as possible. Already, between 250 and 300 Weather Service personnel have received a preliminary introduction to AFOS at the Experimental Facility at Weather Service headquarters.

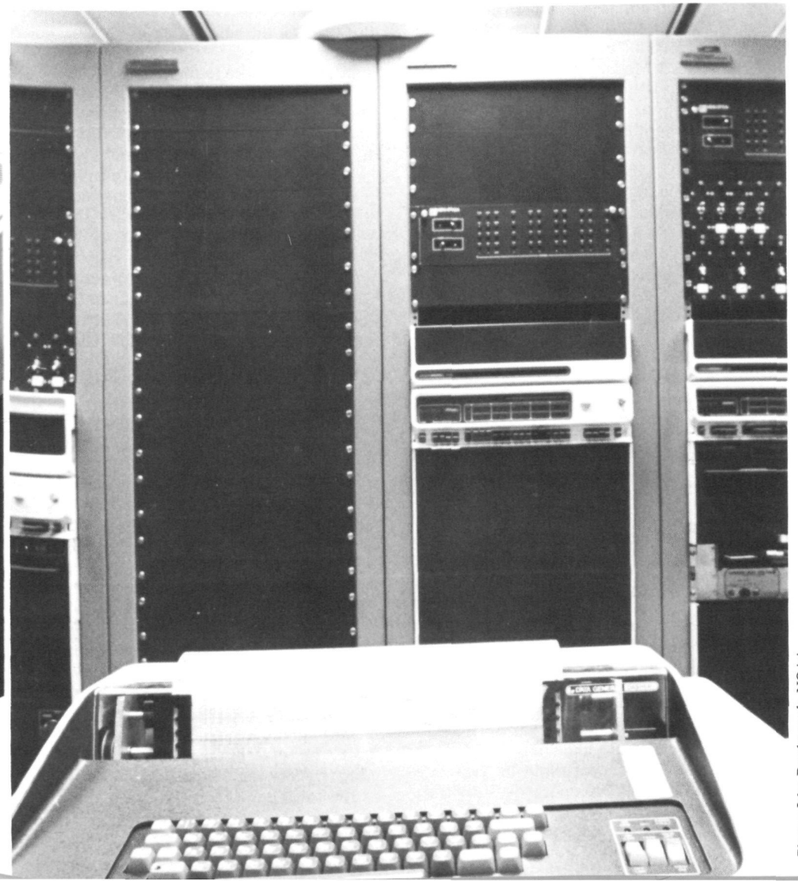
"Reactions so far have been very positive," says McGrew. He explains that as the early field installations come on the line, the first three months will "involve a lot of systems checkout, because for the first time we will have a lot of different places tied together, with live data flowing through field communications lines.

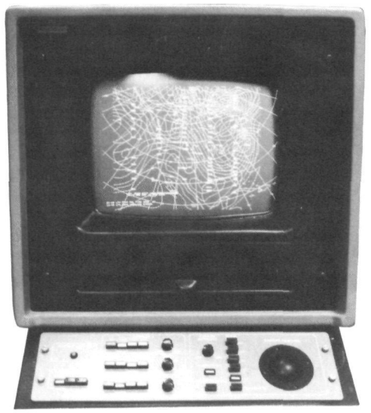
"During those first three months, our people will be getting formal training in the use of AFOS equipment but they won't be putting data through the system.

"Then, during the next three months, station personnel will start actually putting data through AFOS, but they will still have available their teletypewriter and facsimile equipment, for certain tasks. Finally, during a third three-month period, we will start pulling the old equipment out of the stations."

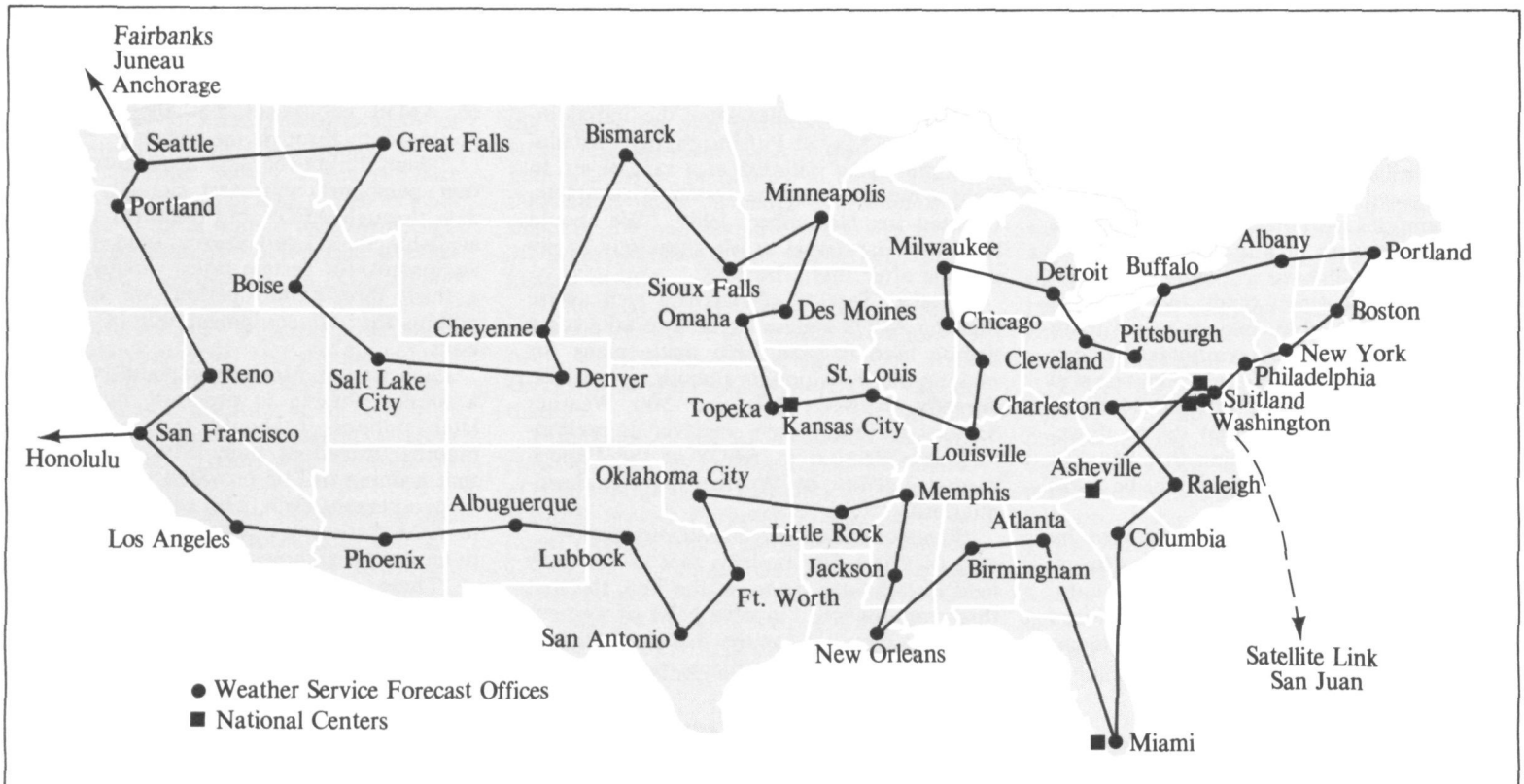
Each station, McGrew explains, will have a similar phasing in program, but for the later stations it should last four to six months instead of nine. McGrew explains that training will be provided by four teams of two persons each, who will be dispatched to field stations as installations are made, to impart their knowledge to their colleagues.

"These are Weather Service personnel, most of them with extensive field experience. They have been busy building up the curricula here at headquarters, preparing the





Photos: John Roseborough, NOAA



AFOS National Distribution Circuit "Computers talking to computers"

workbooks to use when they visit the stations."

Any special hurdles to overcome? "I think the hardest job for our people will be to change the way they think and do the little things. Up until now, it has been sort of a rote process. They move along the walls, looking at certain charts and flipping through them, going through their sequence boards. Now they will have to learn what to do to bring certain messages and images up on the tubes in the sequence they want. It isn't difficult, but the old habits are so ingrained that for some it will be a bit difficult to form new habit patterns."

The planners realize that there has been some uneasiness about being "glued to a chair." Says McGrew: "We have tried to get away from that. At first, one almost got the impression that the forecaster walked in and strapped on his seatbelt and eight hours later got up out of he chair.

"Now we're aiming more toward sharing of the consoles, by jobs. We're also advocating the arrangement of consoles so that group discussions can take place, centered on what is being displayed. We think of it as an island type of philosophy, involving the basic thinking-through of the forecast in a group, followed by dispersal of group members to terminals to prepare the individual forecasts and messages.

"Also, the software programs are being written to allow for periodic relief. We're working toward a scenario that will allow the forecaster to keep only a general eye on the situation on a day that he expects to be relatively uneventful—for reassurance more than anything else. Perhaps he might want to be alerted only if the ceiling drops below 5,000 feet at some upstream station. He can have the computer programmed to let him know that without continuously monitoring the tube. He could be over at another desk reading NOAA Magazine, and merely glance up at a screen from time to time to monitor what's going on. So he wouldn't be tied precisely to the machine, but he would have a means of learning about a significant change."

Will audible alarms be used? "For a real warning situation there's a buzzer that goes off. And there's a flashing red light on the console. We've been urged to go to all kinds of tones and sounds, but we're trying to hold down the variations in audible alarms as much as possible, because if you have too many you tend to much up the situation and endanger the effectiveness of the prime purpose. We're looking at lights only and blinking messages, that type of thing—devices that will tell the forecaster he should go to the console and review the situation but won't reach out and grab him at the lunch counter only for him to find out it's just a mediocre happening."

McGrew explains that the graphics being provided for AFOS by Ford Aerospace & Communications Corporation are much better than the system installed earlier in the Experimental Facility. "Beyond the actual display quality, they have much more flexibility. In the overlays, for example, the forecaster has independent control over the configuration of the lines—whether they're dashed, dotted or solid—and he also has separate controls over the intensity. If his overlays begin to look like spaghetti, and he wants to reduce the confusion, he can fade one set of them out, temporarily, and then bring it back without having to recall it. This is one part I think they'll like. Then, too, there's the improved ability to zoom portions of images.

"Suppose you're looking at the total North American chart. Well, you can only plot so many stations on a chart of that scale. Now, when you zoom a certain portion, you have the ability to add more stations after you zoom, and get more data for the area you're interested in, because, as opposed to the previous system, you can zoom the chart without zooming the data on it.

"Another factor we've been paying a lot of attention to is helping forecasters review their material in the sequence they personally prefer. Some like to do it one way, others in a different way. With charts and clipboards, a forecaster walks back and forth along the wall, looking first at one, then another, in his own set pattern, or perhaps two or three patterns depending on the situation. With AFOS he can set up the sequence ahead of time—perhaps put today's 500-millibar chart on tube one; overlay yesterday's 500-millibar chart; then overlay someting else. Then on tube two he puts all the observations for Missouri; on tube three something else. He can enter that sequence in the computer and give it a name, perhaps his own name. Then tomorrow when he comes, in, all he has to do is call it up by that name and the whole operation takes place automatically. It's a sort of macro-instruction for the computer. And he can change it any time he wants to, by merely redefining the sequence of events. Furthermore, he can manage the time intervals either by "saying" to the computer, proceed to the next step when I strike a key on the

Photos: John Roseborough, NOAA

Art Hanson, AFOS contract monitor for the Weather Service, explains associated computer system to Dr. Richard Hallgren (right) and Dr. George Cressman, NWS Director, as contractor representative looks on.

keyboard, so that he can hold a given step as long as he likes, or he can instruct it to operate by fixed time intervals. Put this up for 15 seconds, the next step for 20 seconds, and so on.

"Thus each forecaster in a weather office can have his own preferred way of doing things built right into the system."

McGrew says that a major change in the design of the AFOS system has been the addition of a second minicomputer for each Forecast Office. "One of the computers will handle the communications, the so-called front-end computer, and the other will handle all the office operations, the manipulation of data. At the same time the storage capacity has been increased to 128,000 characters in the front end and 129,000 characters in the other processor. And we've increased storage capacity on disks from 10 million to 20 million characters."

Another big change is in backup capability. Initially, it appeared that if the station's one and only minicomputer was shut down, the Forecast Office was out of business, temporarily, and would have to have its computer's memory refreshed by a neighboring office when it came back into operation.

"Now," says McGrew, "we have two levels of backup. For example, if something happens to one of the minicomputers, the other computer can do both jobs. It will be somewhat less responsive, but it can do all of the work. Then, if both computers go out, one of the consoles in the station can receive and transmit data by acting as a remote terminal to the AFOS Systems Monitoring and Coordination Center (SMCC) at Suitland, Md. That's a second level of backup operation before you're out of business."

He adds that the concept of the SMCC "has been developed a lot over the past few years. It has become the key to refreshing the memory of any station once it's been down, and is the host to all emergency remote operations. It also maintains a data file of traffic for 30 days which serves to respond to requests for recent data and as a backup to the on-line system at the National Climatic Center.

"The SMCC is the heart of the system."

Maintenance of AFOS equipment will be carried out by the Weather Service's own electronic technicians, says McGrew. "The initial cadre has completed a two-month course at the Ford facility and equipment is being installed at the National Weather Service Technical Training Center in Kansas City, where similar courses will be conducted.

"Also, we'll add new electronic technicians for AFOS, around 70 of them. There will be at least one new technician for each Forecast Office area and many of our other electronic technicians will get a degree of training of AFOS equipment.

All in all, the AFOS program is working out very close to the plans laid out for it several years ago. Says McGrew: "When I reread the article written for NOAA Magazine in October, 1973, I was struck by how much concept of the system has remained the same as described then. The differences are in detail."

So the prophesy delivered at that time by Weather Service Director George P. Cressman is coming true. He said:

"Containment of the Federal payroll has become a bipartisan goal of both the executive and legislative branches of our Government. Yet, in supplying weather services to the nation, our main problem is a shortage of employees. There are so many things to be done, and we can't get the new manpower needed. The only solution is automation — automation of the more routine and repetitive work we have to do. That trend will continue under AFOS. And the taxpayer will get more weather service for his dollar."

In fact, according to Dr. Richard E. Hallgren, who was one of the prime movers in the AFOS program and is now NOAA's Acting Assistant Administrator for Oceanic and Atmospheric Services, the 40-million-dollar AFOS program "is expected to pay for itself through increased efficiency and productivity within eight years." □

Seated at console, Dr. Richard Hallgren beams delightedly at technological advances demonstrated.

NOAA's Office of Coastal Zone Management Asks

WHO CARES?

By VALERIE A. GILLEN

THE TOWNSPEOPLE were gathered in the high school auditorium for a public hearing on the possibility of coastal zone management in their area. An elderly woman, who somehow had become fearful that "government" would place a population limit on her village of 640, rose in anger.

"What happens," she insisted, "if my grandson is Number 641?"

Public hearings on coastal zone management frequently begin with such questions. The concept of coastal zone management *initially means many things to many people* —and if a coastal zone management program is to succeed, it must be fully understood, accepted, and supported by those it directly affects. Citizen participation is an essential part of the decision-making process.

An important way to obtain participation is through public meetings and hearings. The first of two basic steps in citizen participation in the coastal zone management process is information—making sure that the people potentially affected understand the problems and the procedures. Meetings are held—often vigorous and sometimes stormy—in which the program is explained, problems analyzed, and questions answered.

The second step is involvement, where citizens actively articulate coastal problems and plan an important role in discovering proper solutions through coastal management.

Public participation in coastal zone management provides an accurate statement of the needs that the program will address—the real issues. Questions such as "what will it mean to me?" need to be answered. Commercial fishermen in an area will know if the water quality is so bad that their catch is dropping, or if there are wetlands being destroyed that are important breeding areas. Recreational boaters will know if they have enough access to the water. They'll know if the publicly owned boat ramps are maintained adequately, if there are enough, and if there is adequate parking space available. Landowners along the shore will know if they are having erosion problems.

The way to get to the real issues is to ask those people most directly affected—the citizens living on and using the coastline. These issues are communicated to the state staff developing the program through public involvement and should become the basis for deciding what the state's coastal zone management program should deal with.

The Federal Coastal Zone Management Act requires public participation in every phase of development of a coastal management program. It requires that the public be involved in the planning from the beginning, and that the state staff work not only with those who come forward to participate, but also seek out those who don't—especially those who may be materially affected by coastal management. States are required to work directly with local governments and provide these units of government with an opportunity to participate in the program development.

Part of NOAA's responsibility, through the Office of Coastal Zone Management, is to ensure that the states have done the job seeking out the appropriate private interest groups and that the program has given them an opportunity to participate. OCZM has taken this to mean that the states are to have an open process. The newly promulgated regulations for program approval establish the minimum level of performance acceptable for public participation responsibilities.

States are encouraged to develop advisory committees from major private and public interest groups. Organizations such as the League of Women Voters, The Sierra Club, the local Audubon Society, port authorities, local governments, electric utilities, oil and gas industries, boating interests, and commercial fishing, are typical. These committees vary from state to state. In some, the committee advises the state program staff. In others, it may advise the governor's office on its views of the progress of the program, or the legislature. The advisory committee makes significant decisions and its vote often guides the staff, governor's office, or legislature on how the state should develop the program.

At a minimum, public hearings must be held with formal and adequate notice. These meetings are held at key milestones of the program's development. They give the public an opportunity to comment formally on the program. When the state prepares a draft document of its coastal zone management program, it is mailed for review to major constituents, other state and federal agencies, and to public libraries—all with adequate notice of its availability so that people have a chance to read the program.

Conclusions on the value of public participation can be derived from CZM's experience. In one state, each coastal county was asked to form a representative group of citizens to identify the problems it thought the program should address. Secondly, the groups were to develop the policies and goals which should guide the program. These coastal councils worked independently and then together to come up with more than 30 policies and goals. At that point, it was a program of the people. The people who live and work on the coastline or use it for recreation created it—not bureaucrats.

The policies and goals were turned over to the state and the councils were dissolved. Coastal citizens kept waiting to hear what was going on, but the communication line had been broken and the state's greatest supporters had become its worst enemies. The state then had to return to "square one" and repeat the process of getting the citizens involved, a time consuming task.

Communication throughout the process is a major aspect of public participation. The program should reflect the views of the people from the beginning to the end. If that communication is broken, as it was in this case, the job becomes more difficult. The state program staff eventually went from door to door, held small meetings at local libraries, schools, and churches—all to ensure the people that their work had not gone to waste. Without effective communication between the program and its people, it runs the risk of not dealing well with relevant issues, and raising fears of government meddling.

Many states have asked people who live and work on the shore, to help them in the job of "communicating." This makes it easier for shorefolk to relate to the communicator. Local people tend to have more visibility, use familiar idion, know the problems and where the opposition is coming from, than strangers.

This approach provides an accurate account of the needs that the program will address. The people on the shores understand the program, begin on a factual basis, and are comfortable with what is going on because of their background.

Misunderstandings tend to happen without this early communication. A developer may be afraid that if coastal management is begun in his state, he may not be able to develop where he wants to. In that sense, he may feel that he has lost some of his entrepreneurial freedom. Then the question may be whether there is a public benefit in controlling that freedom.

Developers in coastal communities may build houses in areas that are subject to periodic hurricanes or flooding. The unsuspecting buyer purchases in the off season and next year the house may be underwater or blown down by a hurricane force wind. Most developers don't operate that way, and often welcome the order and predictability that comes with a coastal management program.

Commercial and recreational fisheries benefit if development is directed away from important wetlands or recreational areas. In some cases, an individual may be given a permit to do a recreational home development near the shore but in exchange he must allow part of the land to be made available for public access. It then serves both needs: the developer can build and the public gets access to the beaches.

These issues are examples of an issue far broader than the coastal zone—the relative rights of the property owner and the public. Since well before the Supreme Court spoke in 1926, in the case of Euclid v. Ambler, courts have been defining the rights and responsibilities of property owners. They serve as stewards as well as proprietors. Their right to reasonable use of their property does not extend to the point where it infringes upon their neighbors, or endangers the public health and welfare. In some rural areas this kind of potential for conflict has not been an issue. However, as more people come to an area and more pressures are placed on the coasts, better definitions of what can and can't be done are both necessary and useful. Coastal zone management provides a focus for these efforts to work out the ground rules.

The nature of these issues makes communication necessary. Many states have mailing lists of user groups and interested citizens who want to be kept informed on how the program is developing, notices of meetings, hearings, and events. Most states have regular communication through informal newsletters.

Many states have surveyed citizens to learn their concerns and an indication of who is interested and wants to be kept informed.

The media are helpful in communicating with the people on the coast. Many programs have developed films, or used radio and television spots to explain coastal issues and the state's process of dealing with them.

Texas developed a film called "People on the Coast." It depicted conversations with various types of people about what they thought the shores should be used for—people from the oil community, fishermen, swimmers, boaters, environmentalists, bird-watchers, and hunters. The film became an illustration of the breadth of concerns that the people of Texas have about their coast.

The League of Women Voters has helped in many states' public participation programs. Chapters serve as an entity to organize and conduct public information activities. The Office of CZM —issued a grant to the national League of Women Voters' Education Fund which in turn provided resources to the states to conduct public information activities on coastal problems. They worked with school programs, state representatives, local officials, and other organizations. The league is often able to assist CZM in attracting the right people for information meetings. In Rhode Island, for example, the state chapter of the League of Women Voters sponsored a boat tour for interested citizens and state legislators to discuss coastal problems.

Some states have made information meetings fun to attract more people. Virginia and Connecticut held "Coastal Awareness Days" which included such events as coastal exhibits, lectures, movies, a boat parade, fishing tournaments, bird walks, and special cruises. These events were coordinated by the state CZM officials with substantial assistance from a number of voluntary groups, institutions, government agencies and businesses . . . all working to continue this flow of information.

The Office of Coastal Zone Management works with the states in helping them to meet their requirements for public participation and serves as a conduit to share success stories and evaluate failures. The CZM staff encourages the states and serves as a clearinghouse by arranging meetings on a regional basis to share ideas and concerns. The OCZM encourages full participation and direct involvement by environmental, community, marine and trade groups, builders; agriculture interests, consumers, and other user groups. The OCZM deals directly with the national headquarters of these groups, and works with states to assure this encouragement can filter down to the local chapters with success.

Now that many coastal zone management programs are passing through the development stage and entering the implementation phase, this free flow of information and communication takes on even more importance. The states must continue to involve the people affected by the program. Some have feedback programs to evaluate the public's impressions on the job the program is doing. This need for participation will never end. When the approved program gets down into operation and the states use the newly available levels of Federal assistance to carry out the policies by working with the people along the coasts, involvement and communication with affected interests becomes very real very fast.

When the Office of Coastal Zone Management is preparing to approve a program, therefore, it holds its own hearings in the state. The citizen voice is helpful in determining whether the program should be approved, modified, or disapproved, and how the Federal assistance should be used by the state.

The future of coastal zone management will rely heavily on what the public thinks about it. When Congress considers the future of coastal zone management it will be evaluating the benefits produced by state programs. It will want to ensure that the programs are making a difference "on the ground." And that difference cannot be made without the active involvement of the people who populate the coasts to identify the issues, help develop the state policies to address them, and make sure the policies are carried out.

As described by Robert W. Knecht, Assistant Administrator for the Office of Coastal Zone Management; "In our opinion, the role of the public and involved private interests is crucial to the continued success of Coastal Zone Management. This role will never diminish in importance, it will only grow as the program expands to meet new challenges." □

THE TIROS-N TWINS ARE COMING

By W. JOHN HUSSEY *

LATER THIS YEAR, if existing schedules are met, two new NOAA spacecraft will be in service, orbiting the earth from pole to pole and providing users of satellite products with much greater amounts of data and more reliable information.

The first two spacecraft of the TIROS-N series—the third generation polar satellite system—will carry into space new environmental instruments that are major technological advances over those on board the ITOS series spacecraft they will replace. New capabilities offered by the TIROS twins include higher resolution day and night cloud cover observations on a local and global scale, improved observations of vertical temperature and water vapor profiles on a global scale, and—for the first time on a polar environmental satellite—a high capacity data collection, relay, and platform location system.

The first spacecraft in this new series, bearing the designation TIROS-N, will be launched in July on a U.S. Air Force Atlas launch vehicle from Vandenberg Air Force Base in California.

In October, the second of the pair, NOAA-A, will be hurled aloft, designated as NOAA-6 once in orbit. For a brief period of time the two-spacecraft TIROS-N system—operated by NOAA's National Environmental Satellite Service (NESS)—will overlap the current NOAA-5 ITOS satellite, launched July 29, 1976, to assure uninterrupted polar satellite services.

A total of four pairs of spacecraft are planned for the series through 1985, launched roughly at the rate of one pair every two years after the launches of TIROS-N and NOAA-A. NOAA-G, the last planned for this series, is scheduled for launch in May 1984 and thus will ensure polar satellite services into 1986. Initial planning has begun for the fourth generation of polar spacecraft (TIROS-O perhaps?) to be ready by 1985 to continue the uninterrupted acquisition of data from the earth's atmosphere, from its surface, and within its near space.

The TIROS-N spacecraft is a pentahedron—a five-sided, box-like structure, 12.2 feet (3.71 meters) long and 6.2 feet (1.88 meters) across. Four of its sides are equal in size and have thermal control louvers, while the fifth (bottom) side is wider and accommodates the earth-facing communications antennas and some of the earth-viewing sensors. The spacecraft will weigh a total of 3106 pounds (1409 kilograms) at launch, approximately four times heavier than the present ITOS satellites. Its weight, less expendables, at launch is 1620 pounds (737 kilograms).

At one end of the central body, known as the Equipment Support Module, is the Reaction Support Structure which includes the last stage launch injection motor, an attitude control propulsion subsystem, and a boom-mounted solar cell array that produces the power to operate the spacecraft. The solar array is 124.9 square feet (11.6 square meters) in size, and is motor driven to rotate once per orbit, so it will continuously face the sun during the daylight portions of the orbit.

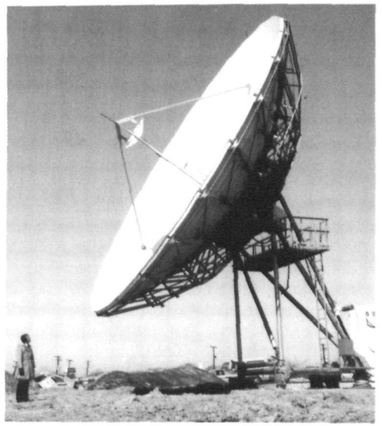
At the other end of the central body is a highly stable Instrument Mounting Platform on which are mounted the attitude control sensors and the instruments whose scan directions must be controlled with high accuracy. With the exception of the Space Environment Monitor (SEM), all instruments face the earth when the satellite is in its mission mode. The earth-oriented instrument platform will be controlled to within ± 0.2 degrees of the local geographic reference for all axes.

The design life for this new operational spacecraft is two years. During the lifetime of the series, new sensors or instruments will be added or substituted for others. Taking this into account, the spacecraft's design permits a growth of up to 25 percent in terms of weight, volume, power, command, and telemetry capabilities.

The four primary spacecraft instrument systems are the Advanced Very High Resolution Radiometer (AVHRR), the TIROS Operational Vertical Sounder (TOVS), the Data Collection System (DCS), and the Space Environment Monitor (SEM).

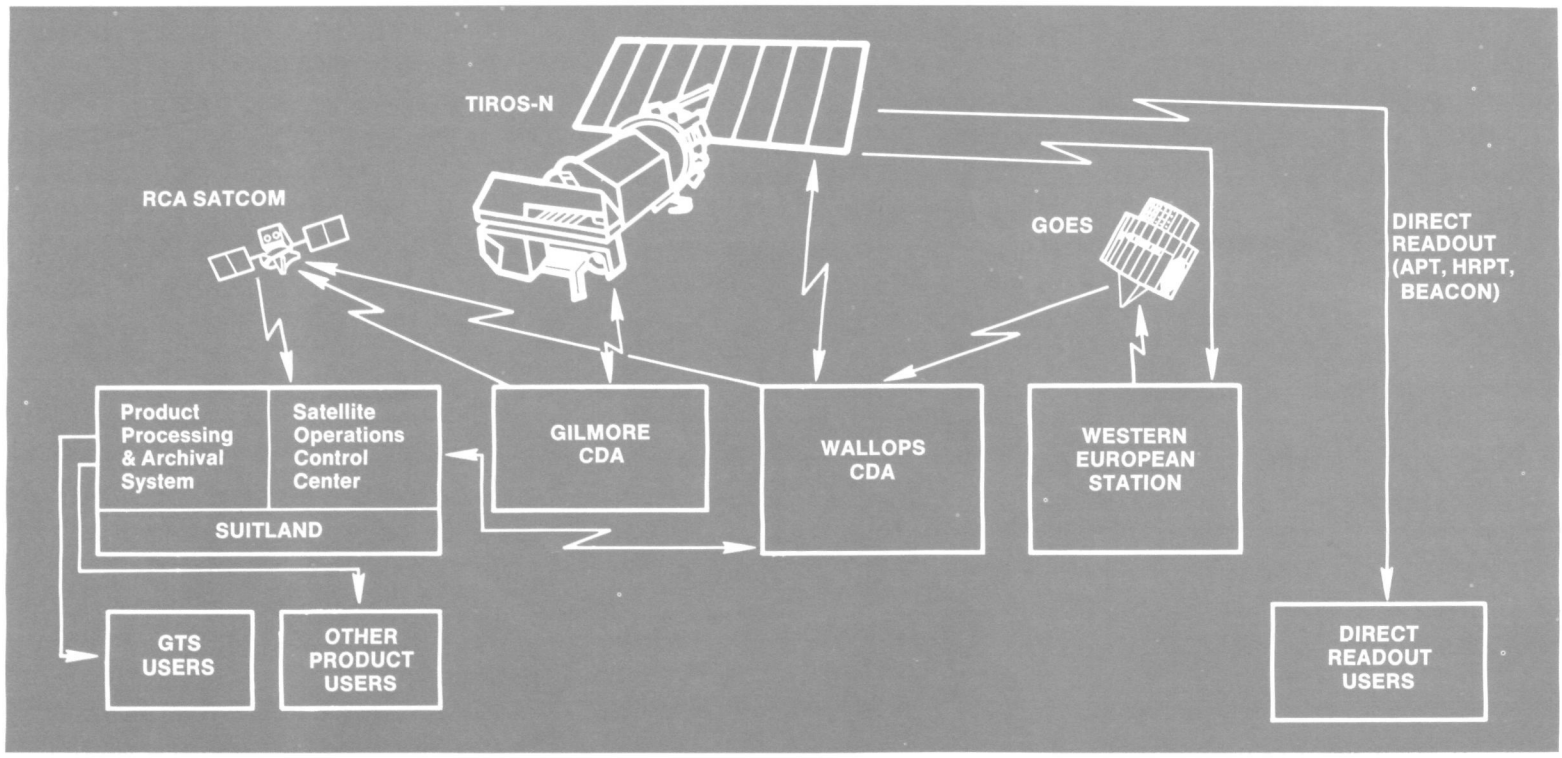
The Advanced Very High Resolution Radiometer will provide image data for real-time transmission to both Automatic Picture Transmission (APT) and High Resolution Picture Transmission (HRPT) users, and for storage on the spacecraft tape recorders for later playback. Thus, it will continue, as well as improve upon, the present NOAA-5 services related to stored and direct readout of radiometric data for day and night cloud mapping, sea surface temperature mapping and other oceanographic and hydrologic applications.

Data from the AVHRR instrument will be available from the satellite in four operational modes. The first is direct readout of visible and infrared data to ground stations of the Automatic Picture Transmission (APT) class, worldwide, at four kilometers resolution. Currently, more than 800 APT stations are operating throughout the world, of which about 350 are government-owned facilities. The second mode is direct



John Hussey, NESS TIROS-N Ground System Project Manager, inspects the 36 ft. (11 meter) antenna in Suitland. This is the primary communications terminal for all incoming TIROS-N data at the Suitland processing facility.

* *W. John Hussey is TIROS-N Ground System Project Manager, National Environmental Satellite Service*



TIROS-N operational system elements showing SATCOM and GOES communications links.

readout of all spectral channels to ground stations of the High Resolution Picture Transmission (HRPT) class, worldwide, at 1.1 kilometers resolution. HRPT ground stations have been established in the United States, Canada, France, West Germany, India, Saudi Arabia, Yemen, Iran, Norway, Brazil, Japan, the People's Republic of China, New Zealand, United Kingdom and Belgium. The third mode is global on-board recording of four kilometers resolution data from all spectral channels for commanded readout and processing in the NOAA central computer facility at Suitland. The fourth mode is on-board recording of data from selected portions of each orbit at the highest resolution (1.1 kilometers) of all spectral channels, also for central processing.

The AVHRR instrument for TIROS-N and the next two spacecraft is sensitive in four spectral regions or channels. A future change in the instrument design will add a fifth channel in the 12 micrometer region. The resulting five channel instrument, called AVHRR/2, is planned for flight on the third spacecraft in the series, NOAA-C, and alternately thereafter through NOAA-F.

Channels 1 and 2 will be used to discern clouds, land-water boundaries, snow and ice extent, and when data from the two channels are compared, an indication of ice/snow melt inception. The data from Channel 4 will be used to measure cloud distribution, day and night, and to determine the temperature of the radiating surface. Channels 3 and 4 will be used to determine the sea surface temperature, making it possible to remove an ambiguity introduced by clouds filling a portion of the field-of-view. Channel 5, included on the AVHRR/2 instrument, will further enhance sea surface temperature measurements in the tropical areas.

The TIROS Operational Vertical Sounder (TOVS) system combines data from several complementary sounding instruments aboard the spacecraft: the High Resolution Infrared Radiation Sounder (HIRS/2), the Stratospheric Sounding Unit (SSU), and the Microwave Sounding Unit (MSU).

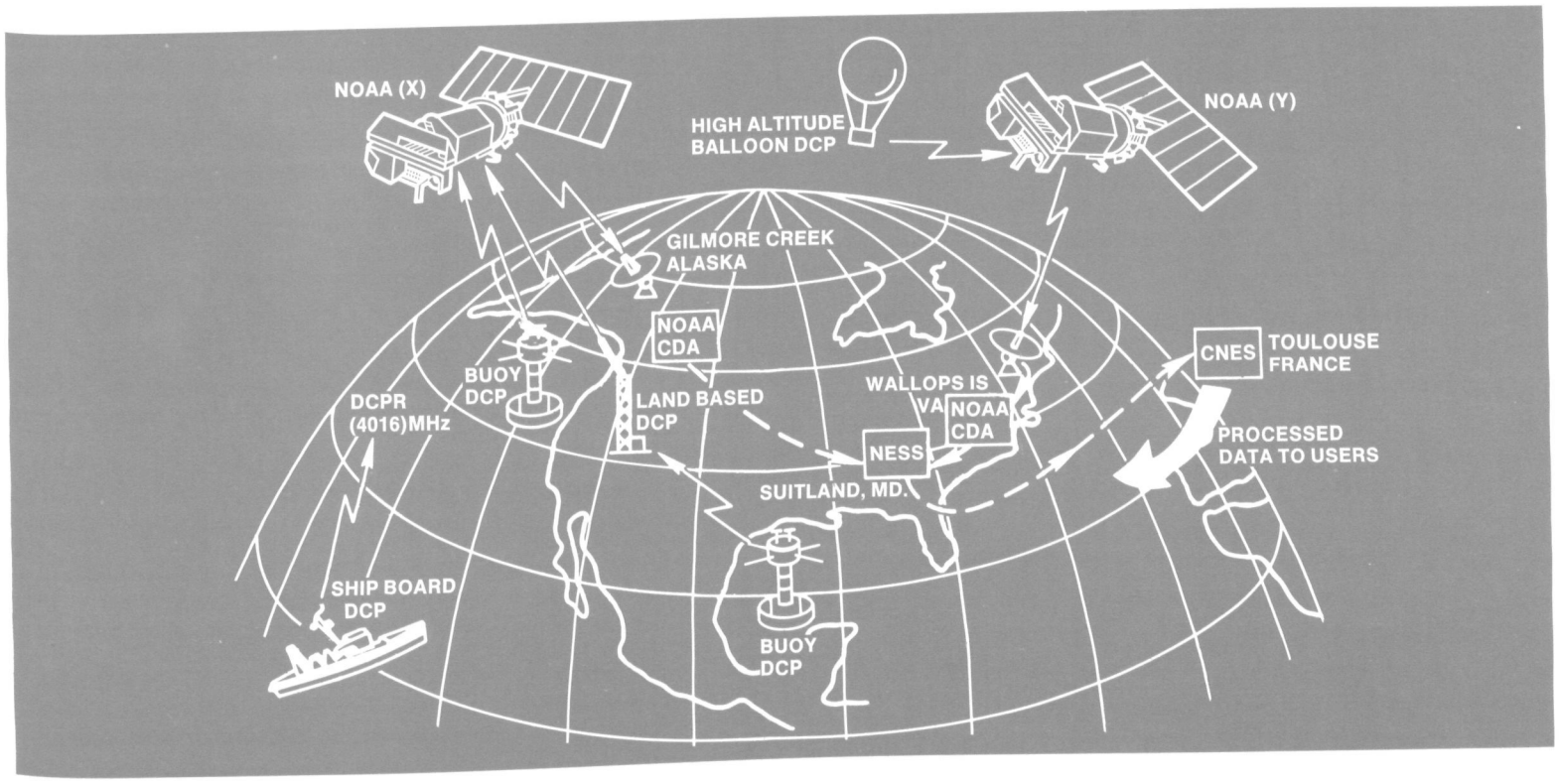
The primary sounding instrument providing tropospheric data, HIRS/2, is sensitive to energy from the visible to the carbon dioxide (CO_2) region of the infrared spectrum. It is designed to provide data that will permit calculation of temperature profiles from the surface to the top of the earth's atmosphere (1 millibar level), water vapor content at three levels of the atmosphere, and total ozone content. The SSU instrument, which is also sensitive to energy in the CO_2 portion of the infrared spectrum, will provide temperature information from the stratosphere. This instrument is being provided by the Meteorological Office of the United Kingdom. The third instrument, the MSU, is sensitive to energy in the oxygen region (53 GHz) of the microwave spectrum and will be used in conjunction with the two infrared instruments. The microwave data it provides will permit computation to be made in the presence of clouds, since measurements in this region are generally unaffected by non-precipitating water droplets. This is the first microwave instrument to be flown operationally aboard a NOAA spacecraft.

The Data Collection System on-board TIROS-N, provided by the Centre National d'Etudes Spatiales (CNES) of France, is known as the ARGOS Data Collection and Platform Location System. It will provide two new services not currently in NOAA's geostationary satellite (GOES) data collection system: determining the location of free-floating buoy and balloon platforms by using an inverse Doppler technique, and acquiring platform data from any place in the world, but most advantageously in the polar regions beyond radio reception range of the geostationary satellites.

The remote platforms will transmit continually, and as the spacecraft passes within range of a platform during its orbit, it will receive and record the successive transmissions. Once the spacecraft comes within range of a NOAA Command and Data Acquisition Station—at Wallops Island Va., and near Fairbanks, Alaska—it will play back the recorded data to the ground facility. On the ground the data will be forwarded to Suitland, where the ARGOS data will be separated from other incoming spacecraft telemetry data and relayed to the CNES Processing Center at Toulouse, France. There, the platform locations will be computed and the data prepared for relay to the appropriate user. The French will determine the platform location to an accuracy of three to five miles (five to eight kilometers).

The satellite-borne ARGOS system also will provide for the immediate rebroadcast of data received from platforms so located that both the platform and the reception site are simultaneously in view of the satellite. The data in this direct broadcast mode will not permit platform location computations. However, for some fixed platforms this may provide a simpler method of obtaining data regionally than going through the present geostationary systems. In polar regions, it will be the only method available.

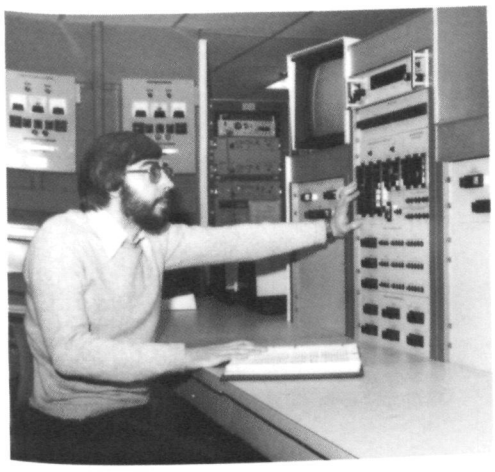
The Space Environment Monitor (SEM) instrument will measure solar proton flux,



ARGOS Data Collection and Platform Location System.

alpha particle and electron flux density, energy spectrum, and total particulate energy distribution at spacecraft altitude. The three detectors included within this instrument are the Total Energy Detector, the Medium Energy Proton and Electron Detector, and the High Energy Proton and Alpha Detector. They measure the intensity of particles in the various energy bands, including protons, electrons, ions, and alpha particles. This instrument will augment the measurements currently being made by NOAA's geostationary GOES satellites.

The data from the SEM will be extracted from the data stream, combined with location parameters at the Suitland data processing center and transmitted to NOAA's Space Environment Laboratory (SEL) at Boulder, Colo., headed by Dr. Donald J. Wilson—all within one hour of the spacecraft readout. At the SEL in Boulder the TIROS-N data, along with GOES data, will be used to monitor the state of solar activity, which has a significant effect on terrestrial communications, electrical power distribution, and high altitude flight in aircraft such as the Concorde SST.

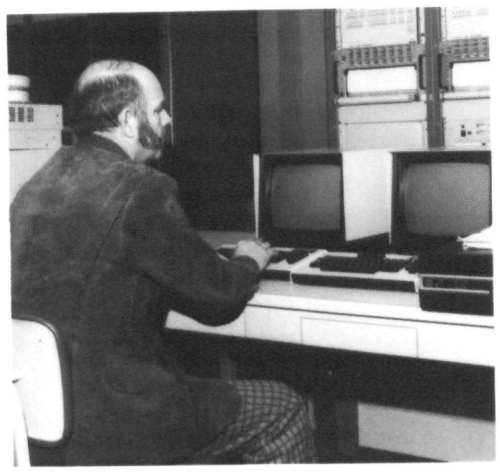


SOCC Controller James Budd at TIROS-N Controller's console, from which two operational TIROS-N type spacecraft will be controlled.

The initial TIROS-N spacecraft will be launched into an afternoon orbit with local equator crossing ascending at 3 p.m. local time. It will be in a near polar, sun synchronous orbit at an average altitude of 540.6 miles (870 kilometers), as compared with the average 938.9 miles (1511 kilometers) altitude of NOAA-5. The orbital period will be 101.6 minutes for TIROS-N, as compared with NOAA-5's 115 minutes, allowing 14.2 orbits per day. The second spacecraft, NOAA-A, will be at 517.6 miles (833 kilometers) to avoid extended periods of readout conflict, with equator crossing descending at 7:30 a.m. local time.

The time period during which data can be acquired during passes of each spacecraft will be reduced about 35 percent compared to NOAA-5, and fewer passes of a single satellite will be within acquisition range. Direct readout APT stations will be able to acquire at least two daytime and two nighttime passes from each spacecraft. The afternoon satellite will satisfy the majority of needs for visible pictures. The morning satellite will contain the earth's shadow in a large part of the visible imagery in the winter hemisphere. However, quantitative requirements such as sea surface temperature observations are obtained from the thermal infrared data, and thus are not affected by availability of visible imagery or orbit times.

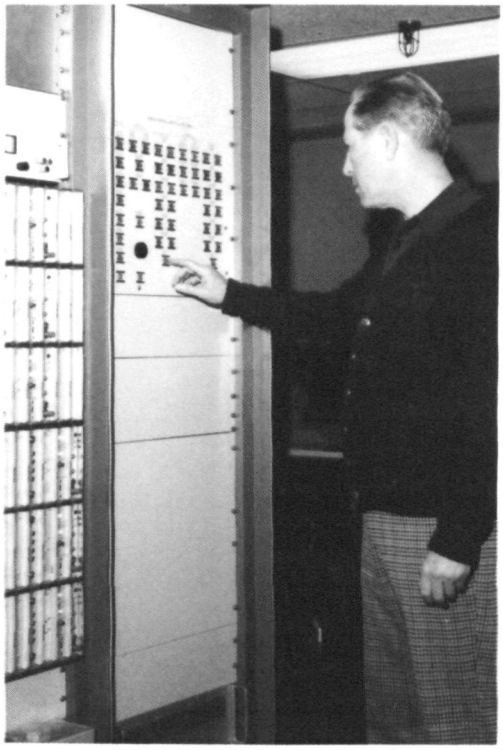
The two primary Command and Data



SOCC Shift Supervisor Jim Nichols at the TIROS-N Spacecraft Engineer's Console.

Acquisition (CDA) stations are at Gilmore Creek near Fairbanks, Alaska, and Wallops Island, Va. The Gilmore CDA is under the guidance of Everitt Kendall, and Wallops is managed by Lloyd Tourville, both of NESS. The spacecraft programming and commanding will originate at the Satellite Operations Control Center (SOCC) in Suitland, under the direction of Al Butera, also of NESS. Commands, spacecraft telemetry, and environmental data will be relayed between the SOCC and the CDA's through a commercial communications satellite, RCA's SATCOM in geostationary orbit at 119 degrees West longitude. The CDAs communicate with the spacecraft using their S-band communication link, and readout the data stored on the satellite's digital tape recorders.

The TIROS-N Ground System consists



SOCC Controller Paul Carroll at controls of the Suitland terminal of the RCA American communications system.

of two major subsystems, the Data Acquisition and Control Subsystem (DACS) and the Data Processing and Services Subsystem (DPSS). The DACS includes components at the two NESS CDA stations, at the SOCC, at the Western European Station (WES) in Lannion, France, and at the Satellite Field Services Station (SFSS) in San Francisco. All the DPSS components are in the NOAA facility at Suitland.

The DACS includes all components necessary to command and control the spacecraft, monitor its "health" via housekeeping telemetry, and to retrieve and transmit the spacecraft environmental data to the DPSS processing and data handling facility. This subsystem was developed under the leadership of Tom Karras, DACS Project Manager with NESS. The delivery of TIROS-N data from Wallops and Gilmore to Suitland is accomplished using the RCA American Communications, Inc., commercial satellite communications network. This system, which includes recently installed Earth Stations at Suitland and Wallops, will deliver the data to the SOCC at the remarkably high rate of 1.33 million bits per second. The data is immediately passed on to the DPSS subsystem for initial processing.

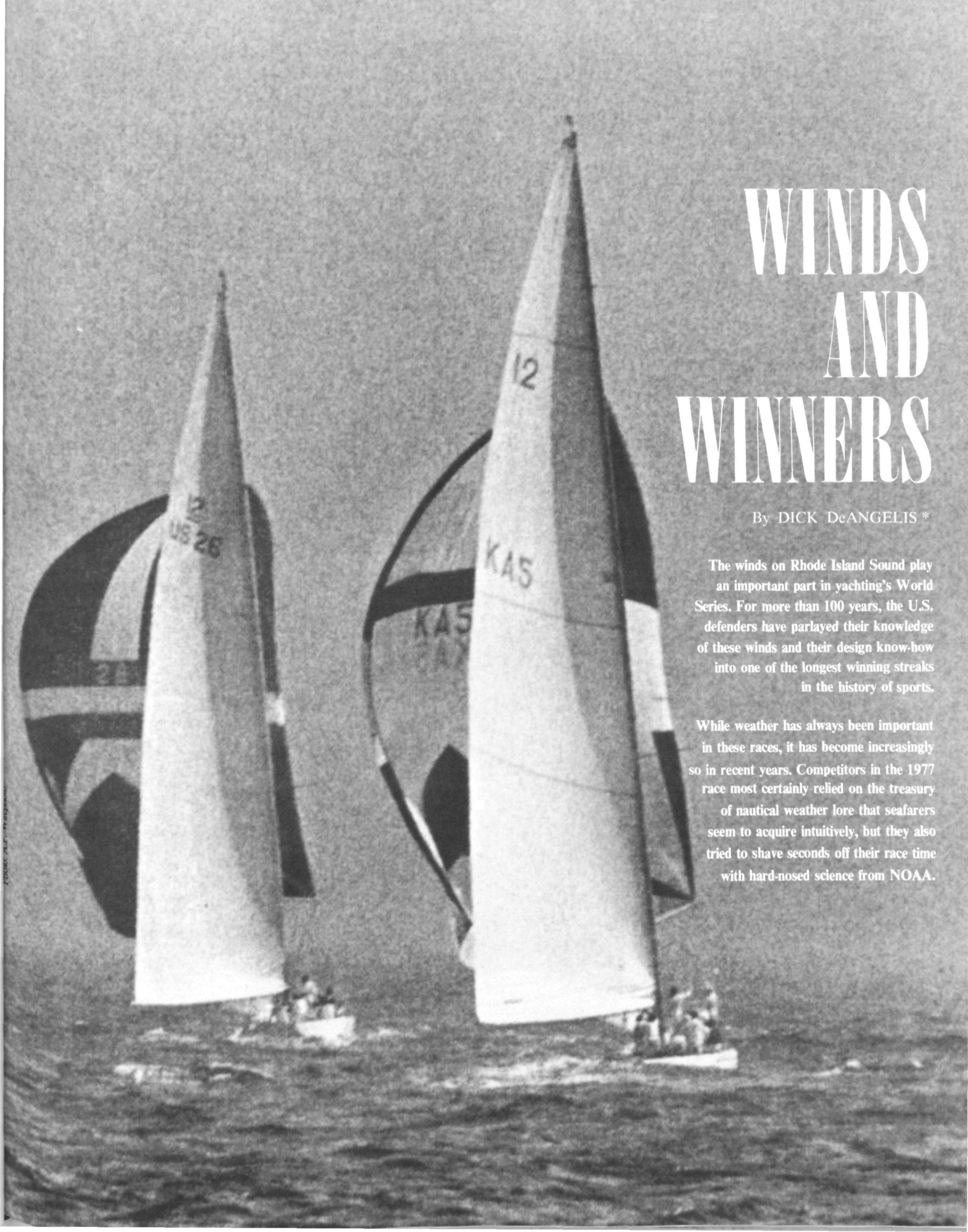
During three sequential orbits, and occasionally four on some days, the spacecraft is out of range of both NOAA CDA stations. To eliminate the resultant time delay in the receipt of the high priority sounding data during the "blind" period, a Western European readout station is being established at Lannion, France, as a joint venture of the United States and France. This station will acquire the stored sounding data and transmit it to the United States, using the Data Collection System of the eastern GOES satellite at 75 degrees West longitude. Use of this additional readout station will reduce periods when the TIROS-N satellite is out of contact with the ground to a maximum of one orbit per day.

The DPSS subsystem was developed under the leadership of Larry Hyatt, DPSS Project Manager of NESS. It ingests the raw satellite data, and preprocesses and stores it along with appended auxiliary information such as earth location and quality control parameters. This subsystem consists of several unique segments of high speed computers, intermediate disk storage units, and a mass data storage system. The storage system, called TBM II, has an on-line storage capacity equivalent to that of 1000 average computer tapes or 460 IBM 3330 type disk packs. Thus, all the data obtained from a single TIROS-N type spacecraft for a 24-hour period can be stored on a single tape, which will be archived by the Satellite Data Services Branch under the direction of Gene Hoppe of NOAA's Environmental Data Service. The TBM II utilizes standard, two-inch-wide "television type" video tape. Rapid access to any record on the tape is achieved by performing address searches at tape speeds of 1000 inches per second, both forward and backward. Searching at such a high speed, coupled with up to six simultaneous accesses, is the equivalent of searching through 300 average computer tapes per second!

As previously mentioned, the TIROS-N series satellite will carry a number of radiometric instruments providing an extremely large volume of digital data for the derivation of quantitative and imagery products. NOAA is committing considerable resources toward producing a variety of sounding products, oceanographic and hydrologic products, heat budget products, and an array of mapped and gridded imagery products. The products derived from the quantitative processing of digital radiometric measurements will be processed in the NOAA IBM 360/195 central computer facility at Suitland and distributed to users worldwide via the Global Telecommunications System and throughout the United States via National Weather Service communications.

TIROS-N is an excellent example of international cooperation in space for peaceful purposes. As mentioned, two of the onboard arrays of instruments—the SSU and the DCS—are being provided by the United Kingdom and France, respectively, while France is operating a Western European readout station. The sounding data it receives and transmits to the United States will be used in products distributed worldwide by the NWS National Meteorological Center. Also, SSU and DCS data will be transmitted immediately direct to the United Kingdom and France for use in those nations' meteorological data processing facilities. Thus, TIROS-N will be a major contributor of environmental data to several countries for immediate use, and to the EDS satellite archive which makes its data available to researchers throughout the world upon request. □

NESS Physical Scientist Frank Porto at the tape drives of the new NESS mass data storage system, the SDC TBM II. This system will archive all of the TIROS-N and NOAA-6 digital data on standard two-inch video tape.



WINDS AND WINNERS

By DICK DeANGELIS *

The winds on Rhode Island Sound play an important part in yachting's World Series. For more than 100 years, the U.S. defenders have parlayed their knowledge of these winds and their design know-how into one of the longest winning streaks in the history of sports.

While weather has always been important in these races, it has become increasingly so in recent years. Competitors in the 1977 race most certainly relied on the treasury of nautical weather lore that seafarers seem to acquire intuitively, but they also tried to shave seconds off their race time with hard-nosed science from NOAA.

The Environmental Data Service provided historical wind data and statistics to the University of Rhode Island for use in briefing race participants. And, of course, the National Weather Service—with backup from the National Environmental Satellite Service—was much in demand and twice-a-day specific marine weather observations and forecasts from the Weather Service Office at Providence, R.I., on NOAA Weather Radio.

In the early days of the America's Cup weather factors were often offset by a host of other factors. In the 1851 race in England, where the schooner America won the Cup from the Royal Yatch Squadron, her superior design overcame the crew's lack of knowledge of local winds, tides, and currents.

In the early defenses of the Cup, sponsored by the New York Yacht Club, the yachts themselves were variable, as schooners ranged from 30 to 300 tons. A somewhat subjective time handicap had to be computed before a winner could be declared. The race itself took place in lower New York harbor amidst heavy ship traffic.

In the first challenge (1870), the British had to compete against 23 defenders. Even after the series became a match race, the New York Yacht Club reserved the right to select the defender from one of four boats on the morning of each race—a decided weather advantage. Gradually, however many of the variables and inequities were eliminated. In 1930 the course was moved to the open waters off Newport, where ship traffic was lighter and the breezes steadier. In 1964 the course was laid out to meet Olympic standards.

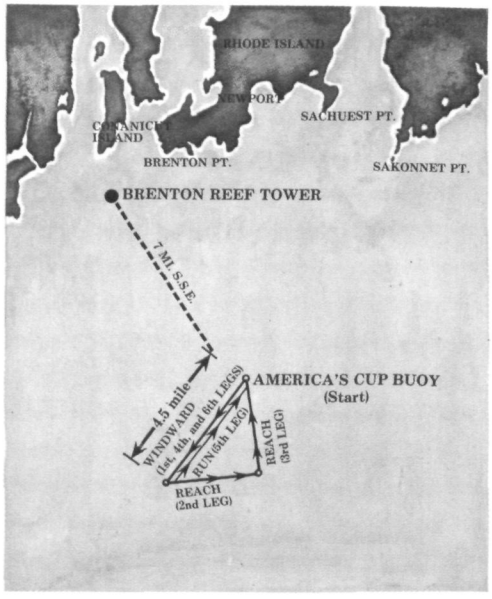
The boats changed too. The original schooners gave way to sloops. In the 1920's a required design formula was introduced, doing away with the need for time handicaps. These large J-class sloops were replaced in the 1950's by the more affordable 12-meter yachts. The 12-meter design formula takes into account such speed-producing factors as length, sail area, width (beam), and distance from the waterline to the deck. The measurements are cranked into a formula, and the result must not exceed 12 meters. Today's yachts are about 65 ft. long, with a displacement of about 27 to 37 tons.

As the variables are eliminated, weather becomes more important. Back in 1967 Australia's Dame Pattie, at her best in a breeze, was defeated as much by the week-long winds and waves from Hurricane Doria as she was by the Intrepid. In 1977, the American defender Courageous, skippered by Ted Turner, saw a huge 5-minute lead go to waste in the second race against the Australia as light winds prevented completion of the 24.3-mile course in the alloted 5½ hours, The Courageous was just 550 yards from the finish line when the gun sounded.

In the 1977 semifinals challenger trials, the Swedish boat Sverige lost a race to the other Australian challenger, Gretel II, when she was dismasted in 30-knot winds and 8-foot seas. She was ahead by 2½ minutes at the time.

Tank testing, computer technology, and photographic techniques have improved the design of hulls and sails. The modern 12-meter yachts have been so refined that they are often designed to perform best in certain wind conditions. After analyzing 100 years of weather records off Newport, the Australians designed the Australia to perform best in light-to-moderate winds, while they redesigned the Gretel II to peak in light winds. Design characteristics, however, are often offset by the matching strategy.

The races are run over a 24.3-mi Olympic standard course, involving six legs. The first, fourth, and sixth legs are sailed to windward—against the wind. The second and third legs, called reaches, are sailed at about a 90 degree angle to the wind. The fifth leg is a run with the wind back to the America's Cup buoy before the final windward or weather leg.



In match racing, unlike fleet racing, strategy is crucial even before the start. At the 10-minute warning gun, each crew tries to gain control by sailing on the other's tail, resulting in a circle chase. More important than getting to the starting line at the gun is getting there ahead and to the windward of your opponent. Once the race is underway, the strategy is do everything possible to hinder your opponent's progress. The trailing boat maneuvers for clear air, while the lead boat tries to block her. This usually results in a close match, and winning margins of 1 minute are considered large.

On the windward legs this maneuvering leads to exciting tacking duels. Tacking involves sailing your boat from one side of the wind to the other in order to make headway. On the downwind legs—the reaches and the run—the spinnakers, long nylon, parachute-like sails, are set and a gybing duel ensures. The trailing boat tries to get between her opponent and the wind. Her sails would then create a wind shadow that would blanket the leader. In this duel the boat astern has the advantage of picking her own time to gybe. The leader must follow immediately to keep clear wind. The final weather leg provides the fairest test in the most equal wind conditions. This often leads to a dog-eat-dog finish, where second place is a nice way of saying last. In one of this year's trails the Courageous nosed out the Enterprise by 0.5 second.

Since 1870 there have been 23 attempts to wrest the America's Cup from the New York Yacht Club. All have failed. In fact, the defenders have lost only 7 of the 81 races in the long series. The British have been the

Photo: A.P. Wirephoto

Australia, left above, leads Sverige by 1 minute 45 seconds, on her way to a fourth straight win and selection as the 1977 America's Cup challengers. She lost, four straight, to the U.S. entry Courageous, skippered by Ted Turner, who gets the traditional winner's dunking (right).

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* *Dick DeAngelis is with the National Oceanographic Data Center.*

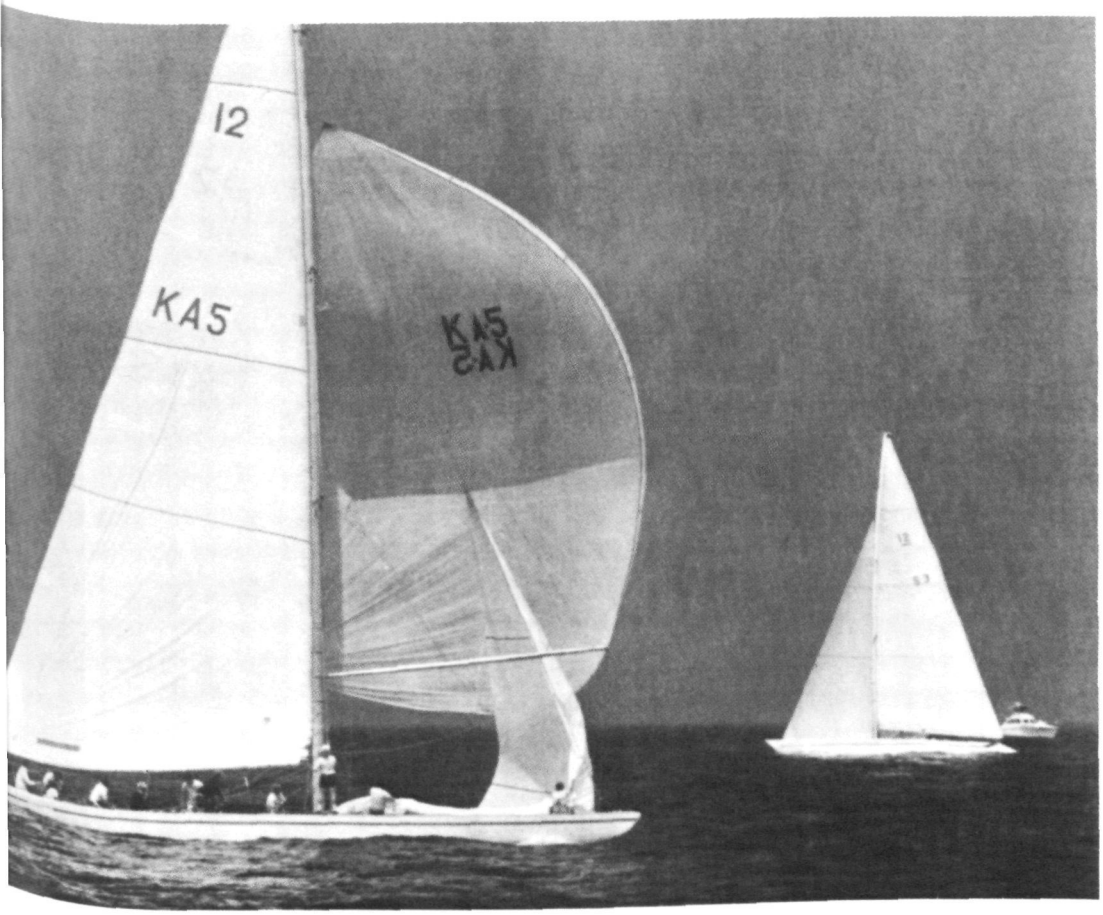


Photo: A.P. Wirephoto

The America's Cup races each involve six legs on various points of sail (above). The Swedish entry, Sverige, was dismasted in 30 knot winds (below) and had to be towed back to Newport, R.I.

most persistent challengers. Recently the Australians have been the major contender. This year they were joined by France and Sweden.

After summer-long trials, the New York Yacht Club picked the Courageous to be the defender over two newer boats—the Enterprise and the Independence. The Australia won the right to race her in an elimination tournament among the foreign challengers.

While the Courageous performed well in all winds during the trials, she was at her best when winds were less than 12 knots. Under these conditions she suffered only two setbacks in eighteen attempts. When winds were 12 knots or more she scored seven wins against five defeats. Although originally rumored to the contrary, light winds became her forte.

Meanwhile, the Australia, designed for light-to-moderate winds, was sweeping past the other challengers. Her worst loss was a 4-minute beating in 6- to 8-knot winds by the Gretel II—the boat designed for light winds. This was the first hint that the Australia might be vulnerable under such conditions. The suspicion was reinforced the following morning when the Sverige trounced her in 8- to 11-knot breezes. These were Australia's only two losses during the trials. She looked particularly strong on the few occasions when winds exceeded 12 knots.

Photo: A.P. Wirephoto

Before the finals began on September 13th, it generally was acknowledged that the Americans were the odds-on favorite. Ted Turner and his crew were more experienced. The quality of their sails was vastly superior to that of the foreign-made ones, and the rules forbade the Australians from using sails made from American material. The odds were stacked against the challenger.

The first race of the final series, on the 13th, took place under a gun-metal sky, with winds blowing from 10 to 17 knots. On the first leg, the Australians tossed away an early lead with a poor choice of sails. The Courageous added to this advantage by quickly changing to a lighter jib as winds slackened. The Australia gained on the second weather leg, but by this time the lead was too great and the winds had dropped off. Courageous came home with a lead of 1:48.

After the non-race on the 15th, in which light winds plagued the Australia throughout, winds picked up on the 16th, for the second race. This was the Australians' best race. During the encounter it became obvious that they were competitive in moderate breezes. Two unnecessary jib changes on the first leg cost the Australia some 90 seconds and very possibly the race. The Courageous increased this lead to 2:38 in light winds at the end of the second reaching leg. Then, as the winds picked up, the Australia began to come back. She gained 30 seconds on the second windward leg and picked up another 62 seconds on the run. On the final leg the boats were close enough for a real tacking duel, and the winds were blowing at 15 knots. The Australia threw 24 tacks at the Courageous and appeared to be closing water. Any kind of tactical error or sailing mistake could have cost Ted Turner and his crew the lead. They made none. The winning margin for the Courageous was 1:03.

The Australians could have asked for a lay day following this race, but they didn't, so the third race took place in light winds that averaging 8 knots; it was no contest, as the Courageous sailed in by 2:32.

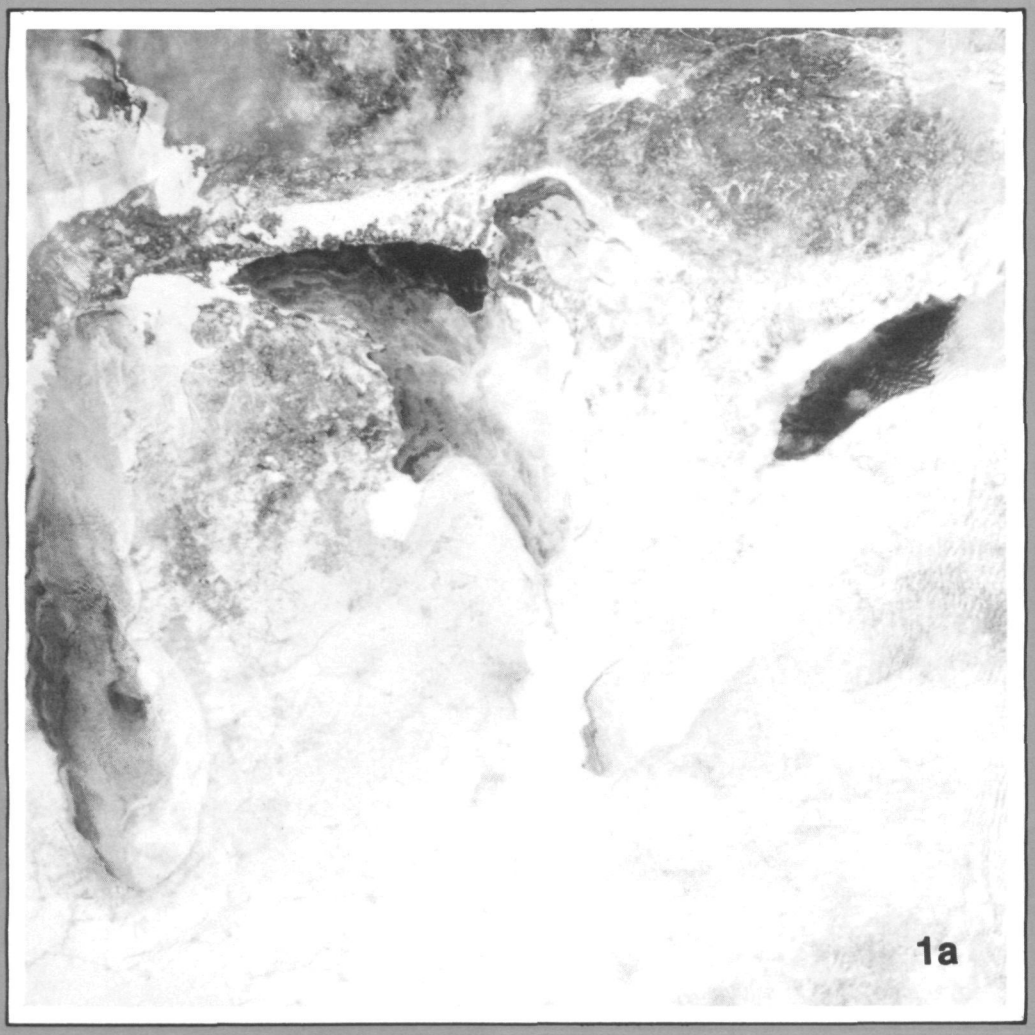
The Aussies now realized that their only hope was for stronger winds. Alan Bond, owner of the challenger, remarked "If the wind comes up just a couple of knots, it's a marked difference. The boat springs to life. We'd like to have at least 10 knots of wind." The results of the trials and the final series up to this race showed that they would need winds of about 15 knots or more.

After conferring with skipper Noel Robins, Bond decided not to ask for a lay day, since the forecast was for 10 to 20 knot winds, lightening the following day. Ted Turner was willing to race in any weather. At the start of the fourth race conditions looked good for the Australians, as winds were 14 knots. However, they soon dropped below 10 knots and this, combined with a tactical error, quickly ended any hopes of a victory. On the fourth leg, the Courageous increased its lead from 56 seconds to 2:11 and finished with a 2:25 advantage.

The 4-0 rout seems decisive. It was generally agreed that the Courageous had the better crew, better sails, and smarter tactics. However, when the winds blew fresh with speeds of 15 knots or more, the Australia was very competitive. Unfortunately for the challenger, such conditions did not occur often, and when they did they did not persist. The following week there were several days of persistent winds in the 20- to 25-knot range. Whether these conditions would have compensated for the American crews' experience is difficult to say, but every indication is that it would have been a much closer series.

When the New York Yacht Club finally looses possession of the America's Cup, it may well be the wind that will carry it away. □

Was the winter just past as brutal as that of the year before? Certainly the people of the northeast—hammered by the worst winter storm in that part of the country since 1888—and those in the midwest could argue the point. Whatever the determination, the weather last January and February was of major concern. NOAA's role in forecasting the weather, and observing the results, was strengthened by its satellites, and pertinent imagery from the east coast geostationary spacecraft—GOES-2—and from the polar-orbiting NOAA-5 is presented on these pages.



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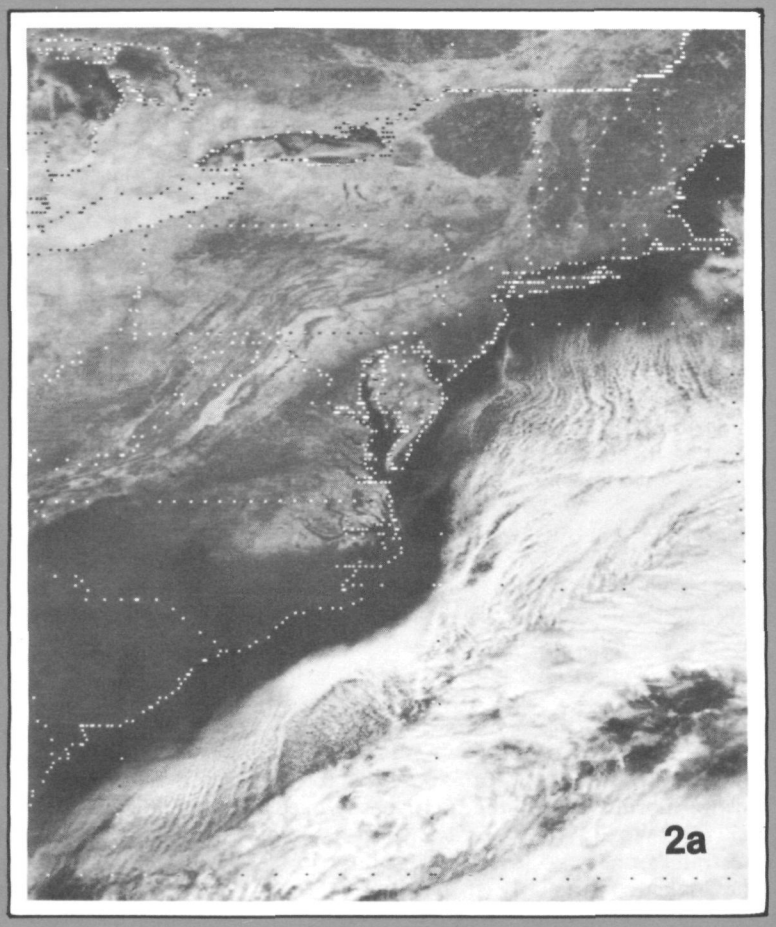
THE VIEW FROM SPACE



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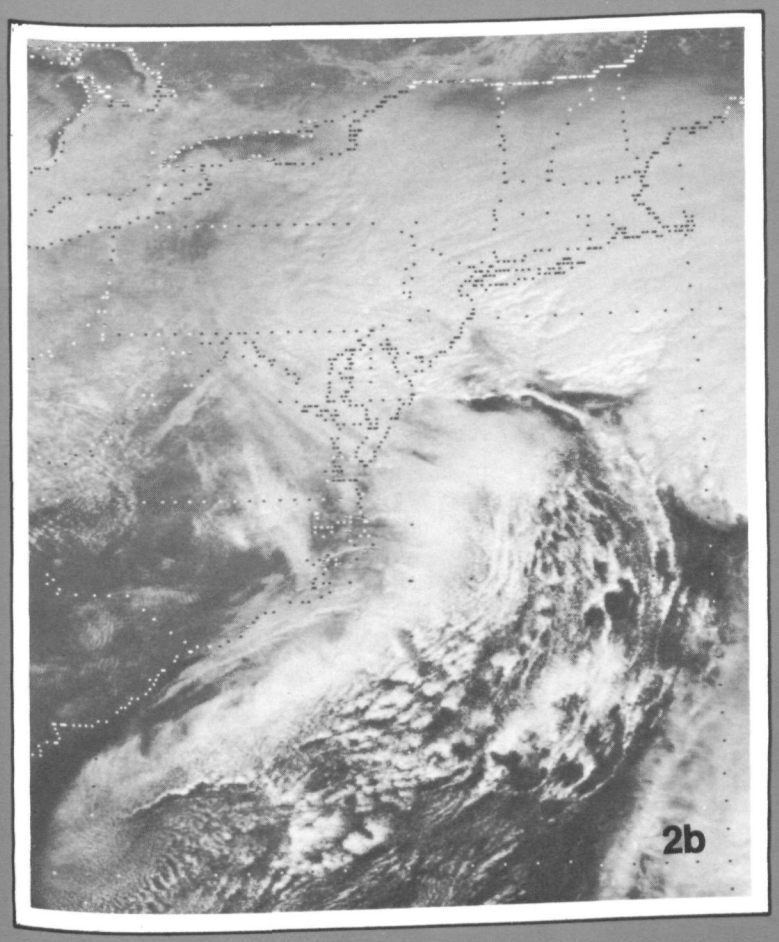
1 In February, 1977 (Image A), Lakes Michigan, Superior, Huron, and Erie were choked with ice. This past February (Image B) however, only Lake Erie—the most shallow of the Great Lakes and always the first to freeze over—was frozen, with open water dominating the other lakes. Both images are from NOAA-5.

2 The northeast's worst winter storm in 90 years was caused by a deep low pressure area becoming stationary off the New York-New Jersey coasts on February 6. Two days before that, snow cover in the area (Image A) was most noticeable in the Shenandoah Valley and in western Pennsylvania and New York. New England and the Adirondacks appear snow-free, but only because dense coniferous forests hide the snow from the satellite's view. On February 6 (Image B) the storm struck, its clouds obscuring most of the northeast. By February 8 (Image C) the area was cloud-free, giving the satellite an excellent view of new, heavy snow cover throughout the entire area north and east of Virginia.



Sea Grant Project at Viginia Tech is

Spreading the Seafood Story

By MARY C. HOLLIMAN *

"I'VE LIVED near the seacoast all my life, and my husband and I love to fish, but it never occurred to me to include seafoods in my home economics classes—I guess partly because there just isn't any material on seafoods in the textbook we're using," reported one member of a Seafood Products class for Home Economics teachers in Hampton, Virginia, last summer.

Said another, "I'll be far more tolerant than I used to be when I find a piece of shell in crab meat, now I've learned how hard it is to pick a crab!"

"I've been catching and chopping up fish for years—but now I know how to fillet one—and I can demonstrate filleting to my students," said a third.

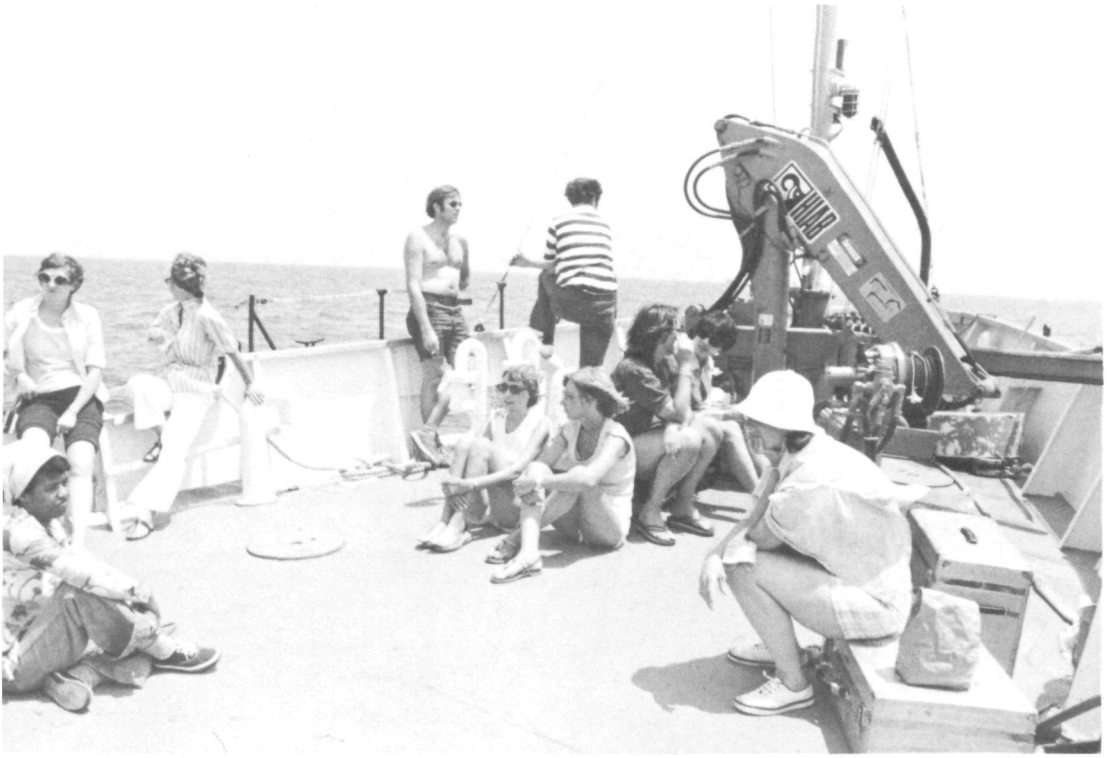
"Now that I know how to eat crab and lobster, I'll stop avoiding such dishes when I eat in a restaurant—and I'll be able to show my students how, too," said another teacher who had never handled a fresh fish or shellfish before, though she's spent her life near the seacoast.

They were enrolled in seafood products courses offered in Hampton, Virginia Beach, and Norfolk over the past several years by members of the Food Science and Technology Department of Virginia Polytechnic Institute and State University and NOAA's National Sea Grant Program at Virginia Tech.

While lack of information about seafoods is not limited to home economics teachers, a Sea Grant-funded project at Virginia Tech proposes to begin with them in order to educate the public to the values of marine food products.

"In one of the most widely used home economics textbooks, 62 pages out of 526 (11.8 percent) are devoted to meats and poultry, only eight (1.5 percent) to fish and shellfish," reports Anita H. Webb, one of the project directors. "Another high school text-

* *Mary C. Holliman is editor of the Virginia Marine Times and with the Sea Grant Program at Virginia Polytechnic Institute and State University.*



Basking in the sun, members of Hampton seafood class (above) relax during tour of Chesapeake Bay fishing operations aboard RV Linwood Holton. Janis Burnette (above right), Virginia Tech graduate research assistant, weighs seafood samples as part of technical analysis, and Virginia Sidwell (right) of NMFS explains her research on nutritional quality and composition of seafoods.

book discusses meats and poultry in ten pages and fish and shellfish in two—fewer than half of one percent of the pages in the book."

College level textbooks used in home economics classes display a similar inadequacy; one book of 645 pages devotes 49 to meats and poultry, only nine to fish and shellfish.

With so little material available, no wonder teachers and students are ill-informed.

If seafoods are to be utilized to meet the nation's and the world's food needs, misunderstandings, misinformation, and lack of information and know-how must be overcome.

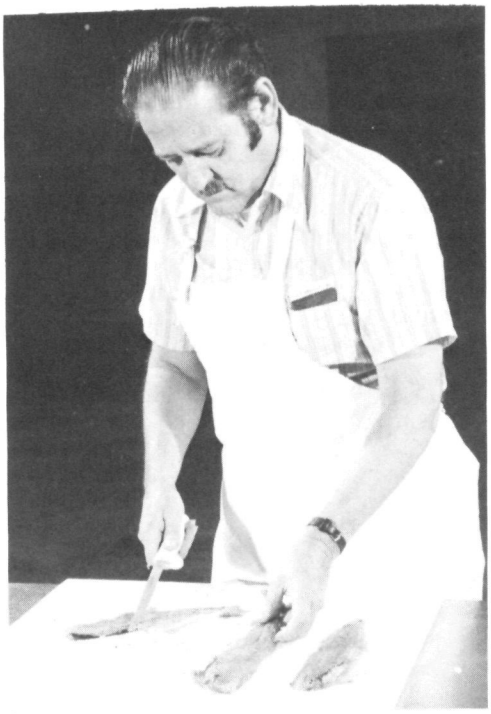
Virginia is an appropriate area to begin an effort to meet this need, because Virginia's seafood industry has been drastically affected by this prevalent lack of information and by misinformation. After the Kepone pollution in the James River was discovered, the State suffered a serious loss in sales of all seafoods, including scallops, surf clams, lobsters, and other species found only in ocean waters. The problem is that not only consumers but also extension agents, educators, public officials, and news reporters lack the necessary information and understanding.

A major goal of the Virginia Tech project is to develop teaching materials for use in the public schools to remedy this inadequacy. The other Virginia Tech professionals besides Webb (Department of Home Economics Education) involved in various aspects of this comprehensive approach include George J. Flick, R. V. Lechowich, and Donn R. Ward of the Food Science and Technology Department and W. L. Shell, Department of Vocational and Technical Education.

Seafood Products Manual, a textbook for college level courses, is being prepared by John Long and Flick. It gives basic consumer information on market forms, nutritional values, standards of identity, grading, and how to select, clean, prepare, serve, freeze, can, or smoke various species.

Such topics will be the subjects of other teaching aids to be prepared by the project directors and assistants including videotapes, posters, teacher guides, lesson plans, movies, slides, and student learning packages. Materials will be prepared for all levels of the curriculum, including elementary through high school, college, graduate, and teacher in-service training courses.

But the project isn't limited to the classroom. Because only a minority of students



Marilyn Hellinger (left), Home Economist in Seafood Marketing in Maryland, demonstrates methods to Hampton home economics teachers. Think Fish! is theme of a Sea Grant Teacher study by Carol Whitaker and Anita H. Webb (above) of Virginia Tech's Department of Home Economics, here examining visual aids explaining their paper. John Bradshaw demonstrates the fine art of fileting.

enroll in home economic courses, the project leaders plan to develop a model for supplementing the classroom instruction with other educational activities for the whole school population.

One of the unique aspects of the Virginia Tech project is its attention to the School Food Service workers. Webb tells the "horror" story of the school which served frozen fish sticks which had merely been thawed instead of cooked, and reports that all too frequently frozen seafood products are inadequately cooked before serving, so that children receive—and leave on their plates—unappetizing food, and thus learn to dislike seafoods.

"We recognize that the schools cannot prepare and serve fresh oysters or lobster in their lunch programs," says Webb, "because of both time and cost. But we feel that frozen seafood products can be much better utilized than they have been." So manuals will be prepared to aid school food service workers in choosing seafood products that will meet the requirements of the school lunch program, as well as manuals for proper storage, preparation, and serving of seafoods. Recipes suitable for institutional use will be compiled.

Several supervisors of school food service personnel in Virginia are members of the advisory committee which will evaluate the manuals prepared by Webb and her staff. Workshops will be held to train workers in local school systems to prepare seafoods properly and utilize them more effectively not only in school lunches but also in special meals sometimes prepared in the schools.

A prototype graduate-level course in Seafood Products was offered to Hampton Home Economics teachers in the summer of 1977. Organized, coordinated, and partly taught by Flick and Donn R. Ward, of the Seafood Processing Research and Extension Unit in Hampton, the course was designed to expand the teachers' awareness of marine food products so they would feel more comfortable teaching about seafoods.

Course activities included practice in cleaning and filleting fish, picking crabs, shucking oysters, as well as a boat tour of Hampton Roads and Chesapeake Bay to observe firsthand several kinds of fishing operations—harvesting crabs from pots, dredging for clams, purse seining for menhaden, and using gill and pound nets.

"For me and my husband, a fishing trip is a holiday," said one teacher near the end of the boating day. "It never occurred to me before how much time a commercial fisherman must spend just getting to and from his fishing spot each day. I guess I'll have a better appreciation of fresh fish or oysters I buy from now on."

The course is being revised and expanded and will be offered again in summer 1978 in the Hampton area.

One other aspect of the comprehensive project is getting the newly developed materials into use. Two school systems—Roanoke and Hampton, one coastal and one non-coastal—have begun pilot-testing the first teaching materials during this 1977-78 school year. The course work will be evaluated, improved, and offered to other school systems in the future. □

Sea Fare

Spring is a time for renewal, and what better way to renew family ties than a reunion? Tempt them in from all over the country for a get-together featuring a seafood smorgasbord offering a delicious variety of dishes. The menu, from the National Marine Fisheries Service's National Fisheries Education Center: a Relish Dish, Fish in Foil, Shrimp Macaroni Casserole, Tuna Barbecue, Fish Salad Bunwiches, Salmon-Kidney Bean Salad, Applesauce Cake with Caramel Frosting, Hot Coffee or Iced Tea.

A Family Affair

Fish-In-Foil

8 pounds cod, pollock, haddock, whitefish, or other fish fillets, fresh or frozen
1½ cups margarine or butter
1½ cups all-purpose flour
2 tablespoons salt
1½ quarts hot milk
¾ cup lemon juice
1½ teaspoons paprika
½ teaspoon black pepper
1½ quarts chopped celery
1½ quarts chopped green pepper
1½ pints chopped onion
25 tomato slices
½ cup chopped parsley

Thaw fish if frozen; wash and dry fillets; cut into 25 serving portions (approximately 5 ounces each). Cut 14-inch lengths of heavy-duty aluminum foil. Melt margarine in large heavy saucepan or pot. Stir in flour and one-half of the salt. Add milk all at once and cook, stirring constantly, until thick. Stir in lemon juice and paprika. Place one piece of fish on greased center of each piece of foil. Sprinkle each piece of fish with salt and pepper. Arrange an equal amount of celery, green pepper, and onion on each piece of fish and top with a tomato slice. Or use one of the topping combinations (right) with tomato slice. Spoon an equal amount of sauce over each tomato slice. Fold edges of foil up over center and make a secure double fold. Fold ends over in a double fold. Place packages on large baking sheets or shallow baking pans. Bake in hot oven, 425 degrees F., 40 minutes. To serve, place bag on plate; snip foil with scissors to form a criss-cross in center of package. Turn edges back; sprinkle with parsley. Eat directly from foil. 25 Servings.

Onion-Carrot Topping

6 medium-size onions, sliced
24 medium-size carrots, peeled and cut into thin strips

Arrange equal amounts of onion slices and carrot strips on each piece of fish.

Shrimp and Mushroom Topping

1½ pounds small mushrooms, sliced
1½ cups margarine or butter
1½ pounds small, cleaned Alaska or Maine shrimp

Saute mushrooms in margarine; combine with shrimp.

Fish Salad Bunwiches

4 pounds halibut, pollock, cod, or other firm fish steaks or fillets, poached and chilled
2½ cups finely chopped celery
2⅔ cups mayonnaise or salad dressing
½ cup sweet pickle relish, well-drained
¼ cup finely chopped onion
¼ cup lemon juice
1 teaspoon salt
25 toasted hamburger or sesame buns
25 lettuce leaves

Flake fish; add celery. Combine and mix salad dressing or mayonnaise, pickle relish, onion, lemon juice, and salt. Add to fish-celery; mix carefully. Cover bottom half of each bun with a lettuce leaf and top with a scant ⅓ cup salad mixture. Cover with bun tops. 25 Servings.

Salmon-Kidney Bean Salad

2 cans (1 pound each) salmon
or
4 cans (6½ or 7 ounces each) tuna-in-oil
2 cans (1 pound each) kidney beans, drained
2 cups chopped sweet pickle
2 cups chopped celery
1 cup chopped onion
6 hard-cooked, chopped eggs
2 cups mayonnaise or salad dressing
⅓ cup pickle liquid
3 tablespoons prepared mustard
Salad greens

Drain tuna or salmon; break into large pieces. Combine all ingredients; toss lightly. Refrigerate for 1 hour to blend flavors. Portion with a No. 8 scoop (½ cup) and serve on salad greens. 25 Servings.

Shrimp-Macaroni Casserole

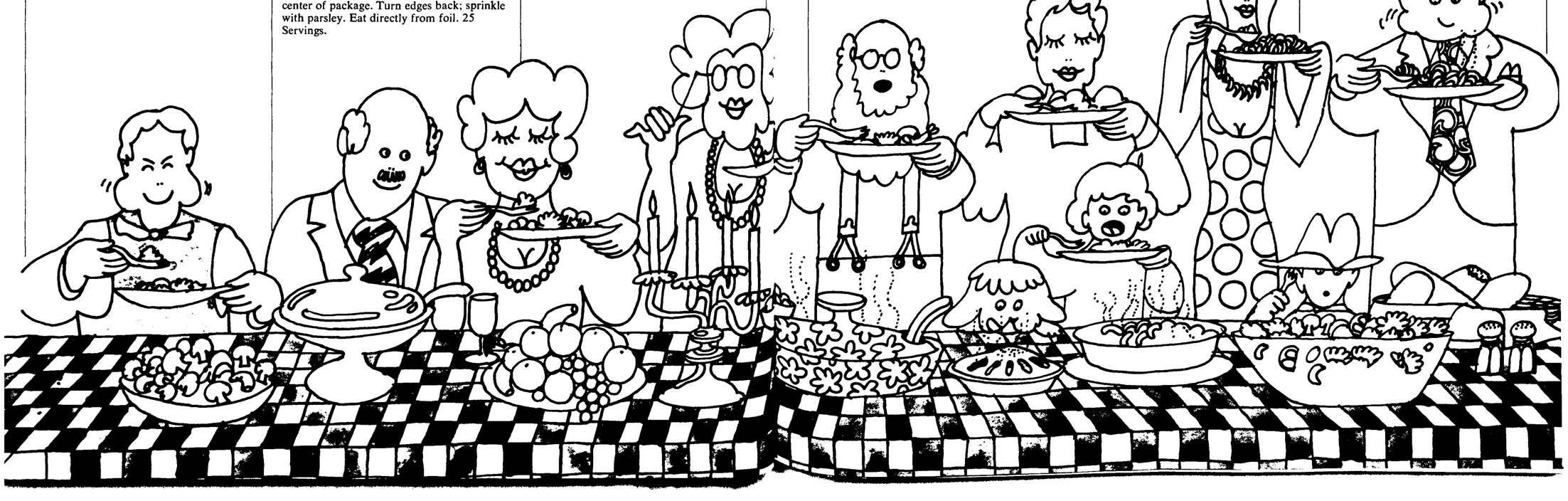
1½ pounds cooked, peeled, and deveined shrimp, fresh or frozen
1 pound tomatoes (25 slices)
1 pound uncooked macaroni
2¾ quarts boiling water
1½ tablespoons salt
3 tablespoons margarine or butter
½ cup all-purpose flour
1 tablespoon salt
2 teaspoons dry mustard
1 quart hot milk
1½ quarts grated cheese
1 cup grated cheese for topping

Thaw shrimp if frozen; if large, cut into ½ inch pieces. Wash and slice tomatoes, crosswise, allowing 1 slice for each serving. Add macaroni to boiling, salted water, and stir. Cook for 14 to 16 minutes or until tender. Drain. Rinse with water to remove excess starch. Melt margarine; blend in all-purpose flour, salt, and mustard. Stir into hot milk. Cook for 5 to 10 minutes or until thick, stirring constantly. Blend in the cheese. Combine macaroni, cheese sauce, and shrimp. Pour into well-greased baking pans. Arrange tomatoes over top of shrimp mixture: sprinkle with cheese. Bake at 350 degrees F. (moderate), for 40 minutes or until cheese is melted. 25 Servings.

Tuna Barbecue

9 cans (6½ or 7 ounces each) tuna-in-oil
3 cups catsup
2 cups chopped celery
1 cup chopped onion
½ cup Worcestershire sauce
½ cup vinegar
½ cup packed brown sugar
¼ cup tuna oil or other oil
1⅓ tablespoons powdered dry mustard
25 toasted hamburger rolls
½ cup margarine or butter

Drain tuna; reserve oil. Break into large pieces. Combine catsup, celery, onion, Worcestershire sauce, vinegar, sugar, oil, and mustard in saucepan; mix. Bring to a boil. Reduce heat and simmer covered 30 minutes, stirring occasionally. Add tuna and continue cooking, uncovered, 10 to 20 minutes, stirring carefully to keep tuna in chunks. Portion with a No. 8 scoop (½ cup) of barbecue between halves of a toasted, buttered roll. 25 Servings.



noaa/update

ERL Testing Wind Shear Detector

A sensor installed in the cockpits of airplanes to measure heat of air columns in the flight path ahead may someday warn pilots of dangerous wind shear near airport runways.

Two scientists with ERL's Atmospheric Physics and Chemistry Laboratories, Drs. Fernando Caracena and Peter M. Kuhn, are studying the potential of an infrared radiometer as a wind shear detector. The device measures the infrared radiation, or heat, emitted by an air column.

Caracena and others believe that thunderstorm downdrafts, and the gust front that precedes the wedge of cold air as it moves across the land, are causes of hazardous wind shear, a sudden shift in the speed or direction of winds. At least three airliner crashes in recent years were caused by thunderstorm-associated wind shear.

Since the outflow from a storm is colder than the surrounding air, Caracena reasoned that horizontal temperature gradients could provide a way of detecting low-level wind shear. Other scientists, he said, have demonstrated a relationship between changes in temperature across a gust front and the intensity of low-level wind shear.

Instrument technology to provide a warning already exists, according to Kuhn. He has been working with infrared detection of atmospheric temperature, and believes a relatively inexpensive infrared radiometer in the cockpit of an airplane would give the pilot a direct warning of wind shear along his flight path.

Wind shear drove this DC-10 into the ground at Logan International Airport in Boston. ERL scientists are working on a way to provide early warning of this dangerous atmospheric turbulence.

Kuhn pointed out that a plane landing would pass through a steady, but gradual, "normal" increase in temperature, because the temperature of the atmosphere normally decreases about half a degree Celsius with each 328 feet (100 meters) of altitude. In a gust front/wind shear situation, there would be a more sudden and drastic change. This was proven in an actual test when a radiometer aboard a descending plane detected a 3.6-degree-Fahrenheit (two-degree-Celsius) temperature discontinuity over a mile away.

Computer tests conducted by Kuhn demonstrated that the instrument could easily detect temperature changes of nine degrees Fahrenheit (five degrees Celsius) in a narrow band at distances of up to six miles (9.5 kilometers) and distinguish these sudden changes from the "normal" temperature change. This would give a pilot enough time to prepare for a shift in winds.

Blacks' Heritage Celebrated During Awareness Week

Black Heritage Week, February 13-17, was the first in a series of Awareness Weeks newly designated by NOAA Administrator Richard A. Frank.

During the week, NOAA celebrated the wealth of contributions Black Americans have made to our society, our life, and to NOAA.

The kickoff day—February 13—featured a program at the Department of Commerce Auditorium.

A number of activities throughout the Washington, D.C., area were sponsored during the week culminating with a Soul Luncheon.

Mr. Frank has announced the establishment of a series of Awareness Weeks to be celebrated within NOAA. In addition to Black Heritage week in February, there also will be American Indian Week in April, Asian/Pacific Americans Week in June, Hispanic Heritage Week in September, Handicapped Week in October, and Women's Week in November.

Mr. Frank said: "I am sure each of you would agree that NOAA's EEO situation has been improving each year. However, NOAA is still highly under-represented with minorities and women in all of our scientific and professional disciplines. I would like to solicit your help and support of the new awareness programs by encouraging active participation."

25 Stations

Network Detects Magnetic Substorms

Several times each day, a substorm is apt to break loose far out in the earth's magnetic field, producing auroral displays and blocking radio signals.

To keep close track of these disturbances, the most extensive collection of up-to-the-minute magnetic field data ever assembled is now flowing into ERL's Space Environment Laboratory in Boulder, Colo. The data come from 25 magnetometer stations in four special network chains across the Americas and the Pacific.

The reporting system is a part of the International Magnetospheric Studies project, a worldwide survey of the earth's plasma environment lasting through 1979. The reports will help scientists decide when to initiate elaborate IMS research experiments, involving balloons, rockets, and satellites. SEL's space forecasters also will use the data to alert their regular scientific and commercial customers to substorm onsets.

Rapid reporting of the farflung observations is made possible by two recent technological advances: acquisition of ground-based magnetic data in digital rather than graphical form, and transmission of the digital data to SEL/Boulder by NOAA's geostationary satellites. In the past, direct transmissions of magnetic data to SEL came only from magnetometers on the satellites themselves.

The way the information is displayed will be almost as helpful to forecasters as its quick availability. SEL's computerized Data Acquisition and Display System, SELDADS, will automatically present data for each chain of stations together, in easy-to-use stack-plotted form.

The waiting period for processed data now will be shortened by several months. Every month, SEL will generate microfilm and computer tapes of edited data and forward them to World Data Center A in Boulder.

NHC In Miami Aides Students

With the support and cooperation of NOAA's Motion Picture Service, Rockville, the EEO Committee at the National Hurricane Center in Miami, Fla., has provided Science/Career Opportunity Programs for 6,000 students of public and private schools in the Dade and Broward (County) area since October 1977. Occupational specialists, teachers, and the students themselves, have helped to develop NHC's program by providing constructive feedback to the EEOC. As part of this project, 20 of NOAA's films were reviewed and rated for classroom suitability at the 6th- through 12th-grade levels.

President Appoints 18 New NACOA Members

President Carter has announced the appointment of 18 persons to be members of the National Advisory Committee on Oceans and Atmosphere. They are:

For terms ending June 30, 1978:

Werner A. Baum, chancellor of the university and professor of geography at the University of Wisconsin;

Marne A. Dubs, director of ocean resources for the Kennecott Copper Corporation;

Alfred A. H. Keil, Ford professor of engineering at Massachusetts Institute of Technology;

Michael R. Naess, senior executive vice president and director and chief operating officer, Services Group, for Zapata Corporation in Houston, Texas;

George M. Sullivan, mayor of Anchorage, Alaska;

Jack R. Van Lopik, dean of Louisiana State University's Center for Wetland Resources.

For terms ending June 30, 1979:

Sarah Chasis, staff attorney for the Natural Resources Defense Council in New York;

H. J. Cofer, Jr., president and chief executive officer of Rich-SeaPak Corporation;

Donald L. McKernan, director of the Institute for Marine Studies and professor of marine affairs and fisheries at the University of Washington (also designated chairman of the Committee);

Sharron Stewart, of Lake Jackson, Texas, a member of the Energy Development Fund, Energy Conservation Task Force, and the Governor's Energy Advisory Council;

James B. Sullivan, founder and co-director of the Center for Science in the Public Interest, Washington, D.C.;

Warren M. Washington, senior scientist and group leader at the National Center for Atmospheric Research in Boulder, Colorado.

For terms ending June 30, 1980:

Louis J. Battan, director of the Institute of Atmospheric Physics and head of the Department of Atmospheric Sciences at the University of Arizona;

John A. Biggs, former director of the Washington State Department of Ecology;

Albert W. Gatov, vice president of the San Francisco Metropolitan Transportation Commission and chairman of its Seaport Policy Commission subcommittee;

Otto Klima, vice president and general manager, Re-entry and Environmental Systems Division, General Electric Company;

John A. Knauss, dean of the Graduate School of Oceanography at the University of Rhode Island;

Evelyn F. Murphy, secretary of environmental affairs for the Commonwealth of Massachusetts (also designated vice chairman).

SCORPIO Data System Introduced

The Library and Information Services Division (LISD) of EDS' Environmental Science Information Center is one of the first Federal libraries to gain on-line access to a special group of Congressional files. The files are part of the SCORPIO system (Subject-Content - Oriented - Retriever for Processing Information On-line), developed by the Library of Congress to meet special information needs of members of Congress, their staffs, and the public.

The files that LISD are able to search for NOAA managers and scientists include three legislative information files, the *Bill Digests* for the 95th, 94th, and 93rd Congresses.

LISD also has access to the public Bibliographic Citation File, references to significant current periodical articles, pamphlets, GPO publications, U.N. documents, and special interest publications. This file is created by the Congressional Research Service Library Services Division and permits LISD to compile selective bibliographies on topics that the Congressional Research Service considers high-interest or vitally important issues.

The computerized Library of Congress Catalog can also be searched on-line with the availability of the new system. This file covers over 725,000 items catalogued by the Library of Congress since 1969.

Also available, more efficiently with SCORPIO, is the National Referral Center file, which LISD currently accesses through another source. This file directs the user to organizations willing to provide information on science and technology topics. More than 10,000 organizations are covered.

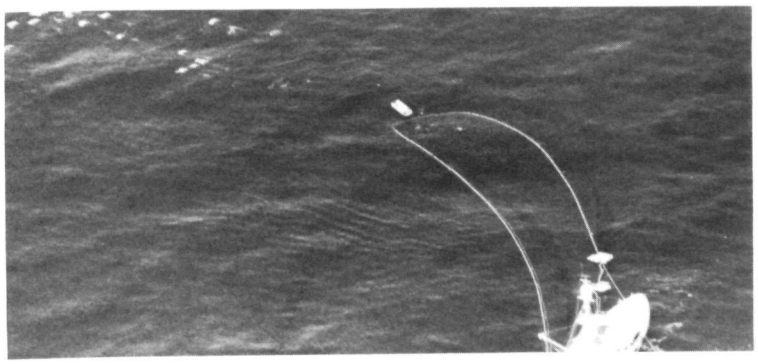
Hughes Aircraft To Get Contract For Three GOES

Hughes Aircraft Company's Space and Communications Group in El Segundo, Calif., has been selected for negotiation of a contract of about $33 million to build the next three GOES spacecraft for NOAA.

The geostationary satellites are developed and procured for NOAA by NASA, which made the selection. The spacecraft, before launch, will be designated GOES-D, E and F, and, after launch, GOES-4, 5, and 6. GOES-D is scheduled for launch in 1980.

Capable of being launched either by a Delta rocket or from the Space Shuttle once it is operational, the latest satellites in the SMS-GOES series will carry a Visible infrared spin scan radiometer Atmospheric Sounder (VAS). This improved instrument will produce day and night cloud cover images. VAS also can produce vertical soundings, and this capability will be evaluated soon after GOES-D launch to permit an assessment of its operational value.

Incidental Kill Rate For Porpoise Lowered



Porpoise (splashes at top) are freed from a tuna net. The National Marine Fisheries Service has set a steadily decreasing number of these mammals which may be killed incidental to the tuna catch.

The number of porpoises that may be killed by U.S. tuna fishermen incidental to their fishing operations has been set at 51,945 in 1978, 41,610 in 1979, and 31,150 in 1980 under regulations published by the National Marine Fisheries Service.

Other major changes to regulations, issued under the Marine Mammal Protection Act of 1972, require the yellowfin purse seine fishermen to install a porpoise apron system—a chute-like area in the back of the nets designed to permit porpoises to escape—in 1978.

Additionally, certificates of inclusion, under permits to engage in yellowfin purse seine fishing operations on porpoise, are being issued to both the vessels, through the vessel owners, and vessel operators rather than the vessel operators only, as was the practice.

Rules have been established to allow amendments to the regulations and permits through informal rule-making during the three-year period, rather than using a formal hearing by an Administrative Law Judge each year, unless major changes are proposed. In this event, a formal hearing may be required.

The new regulations, effective January 1, 1978, are expected to achieve a 50 percent reduction in porpoise mortality by 1980 from the 1977 quota of 62,429.

Ice-Age Africa Mostly Arid, Lab Computer Model Shows

Computer experiments by Dr. Syukuro Manabe and colleagues at NOAA's Geophysical Fluid Dynamics Laboratory in Princeton, N.J., show the last ice age resulted in sand dunes and desert claiming tropical continents. They also indicate the ice age could have been caused by a change in the earth's orbit.

In one experiment, Manabe and Douglas Hahn, another scientist with ERL, used an advanced computer model of the atmosphere to recreate conditions during the last ice age, 18,000 years ago.

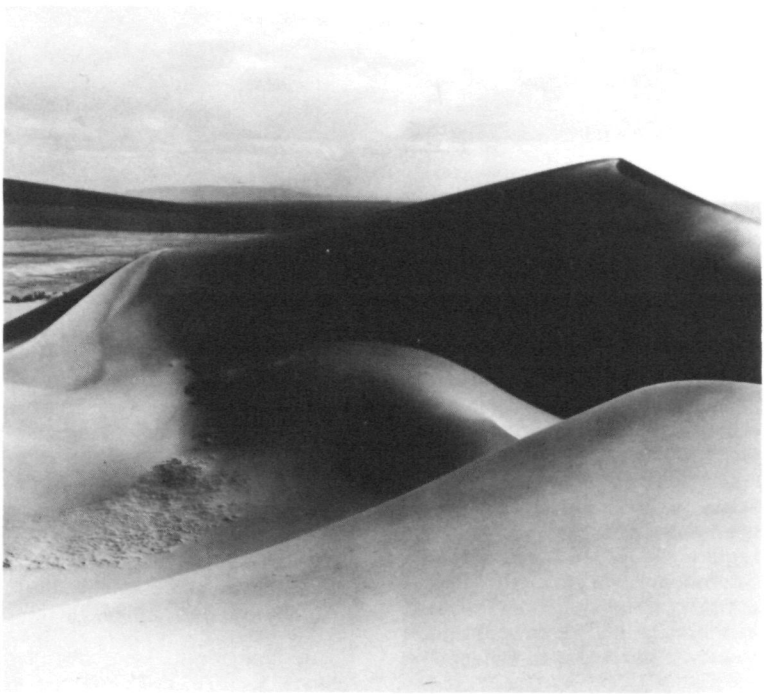
According to the model, both the rate of evaporation and of rainfall during the ice age summer were smaller than today. However, the difference in climate was not uniform: the tropical oceans received more rain, while the tropical continents were more arid during the ice age.

The aridity of tropical continents, Manabe said, is corroborated by geologists, who have found evidence that during the last ice age the Sahara extended much farther toward the Equator, with sand dunes covering the northern portions of tropical Africa, where grassy savannah now reigns.

But what caused the ice ages? There are now many theories about the causes, according to Manabe. An ice age may occur as a manifestation of a long-term fluctuation of climate, part of an interactive oscillation, he explained. Another theory is that ice ages were caused by changes such as the tilt of the earth's axis of rotation and the eccentricity of the earth's orbit.

The orbital theory has been tested by feeding many sets of past orbital parameters — which can be precisely calculated—into a highly simplified mathematical model of the ocean-atmosphere system.

There were some discrepancies between the results from the model and from the geological record. But on the whole, the scientists believe, a substantial portion of a climatic variability on the time scales they studied can be attributed to the atmosphere's response to disturbances in the earth's orbit.



National Park Service Photo

This is how much of now-lush tropical Africa might have looked 18,000 years ago during the last ice age. NOAA experts are exploring the past using a computer model of the atmosphere.

NOAA Participants Active At January AAAS Meeting

NOAA and the Interior Department's Fish and Wildlife Service (FWS) have signed an agreement expected to provide improved services to the country's landowners and land and water users.

The agreement, by NOAA Administrator Richard A. Frank and FWS's Director Lynn A. Greenwalt, establishes formal cooperation between NOAA's Marine Advisory Service programs and those of the Fish and Wildlife Service, especially in such activities as wetlands research and assistance to water users.

Cooperation, according to the agreement, will include such areas of mutual concern as the preparation of educational and research programs, the dissemination of information to the public, and the exchange of data routinely collected by field agents in the course of their research.

A similar agreement was signed late last year between the Fish and Wildlife Service and the Agriculture Department's Extension Service.

Cooperation among the three Federal agencies is not new. The Fish and Wildlife Service has been active in working with the Extension Service for more than 40 years, and there has been considerable cooperation between the Marine Advisory Service and Extension Service ever since the former was created in 1966.

The creation of the formal agreement, however, is taken as a salutory sign by those concerned with U.S. water resources.

EDS Catalog Lists Special Charts, Bathymetric Maps

A new catalog of special purpose charts and bathymetric maps has been published by National Ocean Survey, indexing bathymetric maps, and marine boundary maps, and charts.

Also indexed for the first time are Tidal Current Charts, Marine Weather Service Charts, Storm Evacuation Maps, and orthophoto maps of Florida's coastal zone. Included are insets indexing Offshore Mineral Leasing Area Maps, Geophysical Maps, and the International Hydrographic Bureau (IHB)-supported General Bathymetric (plotting) Charts of the Oceans (GEBCO).

The catalog, "Map and Chart Catalog 5—Bathymetric Maps and Special Purpose Maps," is available free to the public. It may be obtained from the National Ocean Survey, or from local marine supply agents.

California Survey May Help USGS Quake Prediction

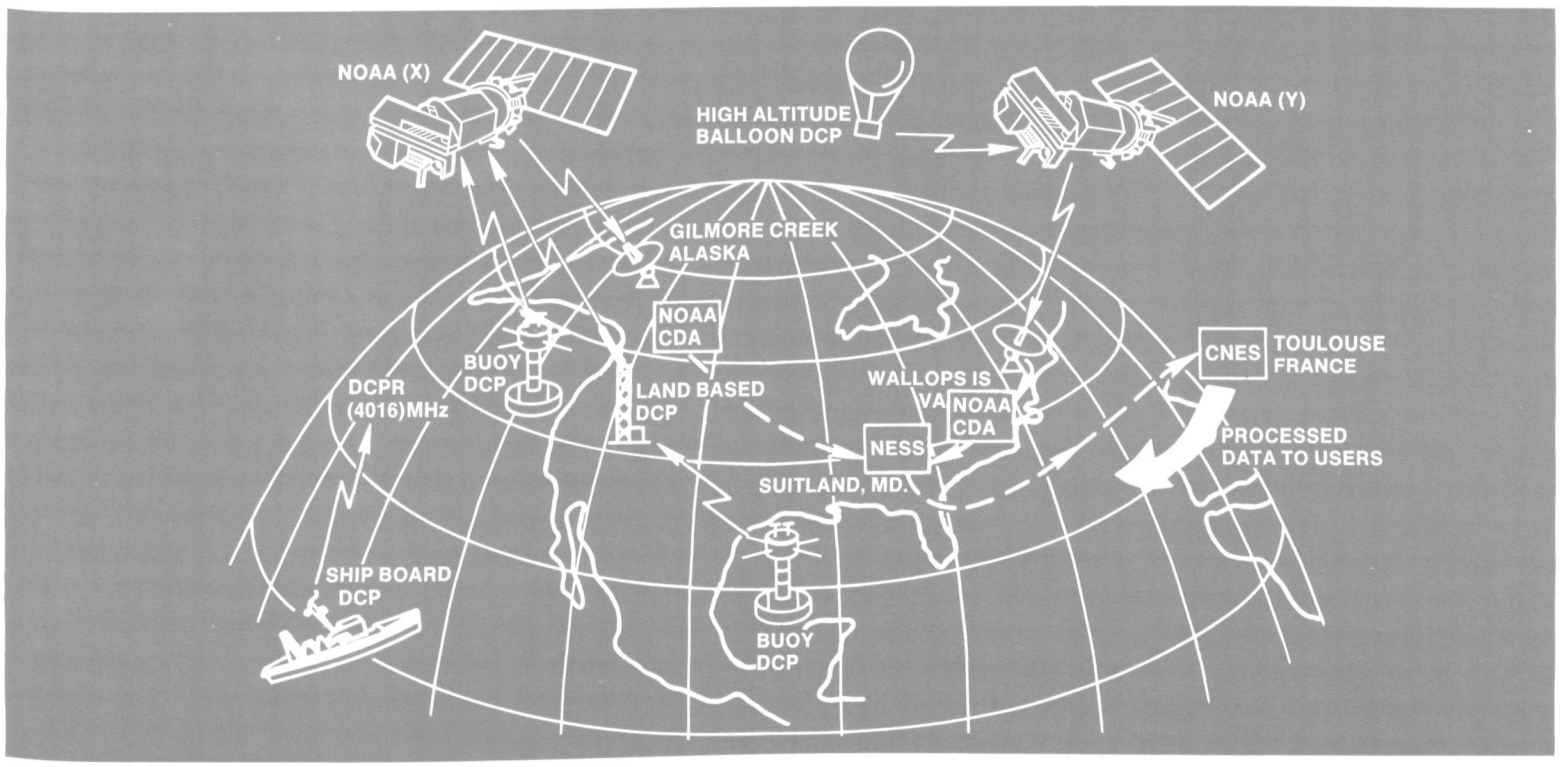
A massive, 2,500 mile survey in Southern California to probe crustal motion over the San Andreas and Garlock faults, conducted by National Ocean Survey's National Geodetic Survey and the U.S. Geological Survey (USGS), began in January.

According to Dr. Muneendra Kumar, Project Manager from NGS, the results obtained from this project should help the U.S. Geological Survey in fulfilling its goal of developing an earthquake prediction capability.

The $1.5 million, multiagency project involves 18 leveling and five gravity teams from NGS and the USGS. In addition, leveling teams from Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties, Los Angeles City, the Los Angeles Water and Power Department, and the Metropolitan Water District of Southern California are assisting.

The survey extends from Avila Beach in the west to Blythe in the east, and from Goldstone in the north to San Diego in the south. It will be used to establish an instantaneous datum for Southern California and to determine the extent and nature of crustal movements in the area.

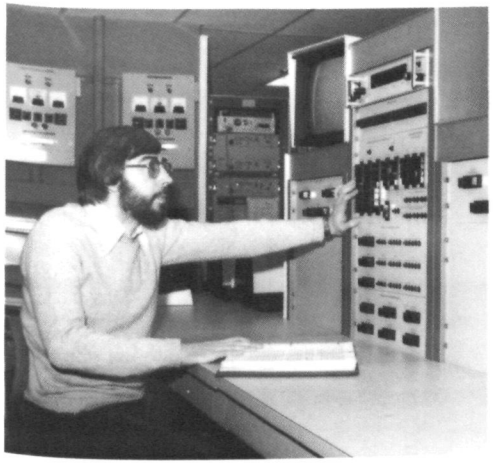
Related studies conducted during the survey are dealing with ocean "tilts": observations made by oceanographers and geodesists that the sea surface is not horizontal, but is on a slope. Measurements made by scientists from the two specialties do not agree, and data from the survey project will be used in an attempt to determine why.



ARGOS Data Collection and Platform Location System.

alpha particle and electron flux density, energy spectrum, and total particulate energy distribution at spacecraft altitude. The three detectors included within this instrument are the Total Energy Detector, the Medium Energy Proton and Electron Detector, and the High Energy Proton and Alpha Detector. They measure the intensity of particles in the various energy bands, including protons, electrons, ions, and alpha particles. This instrument will augment the measurements currently being made by NOAA's geostationary GOES satellites.

The data from the SEM will be extracted from the data stream, combined with location parameters at the Suitland data processing center and transmitted to NOAA's Space Environment Laboratory (SEL) at Boulder, Colo., headed by Dr. Donald J. Wilson—all within one hour of the spacecraft readout. At the SEL in Boulder the TIROS-N data, along with GOES data, will be used to monitor the state of solar activity, which has a significant effect on terrestrial communications, electrical power distribution, and high altitude flight in aircraft such as the Concorde SST.

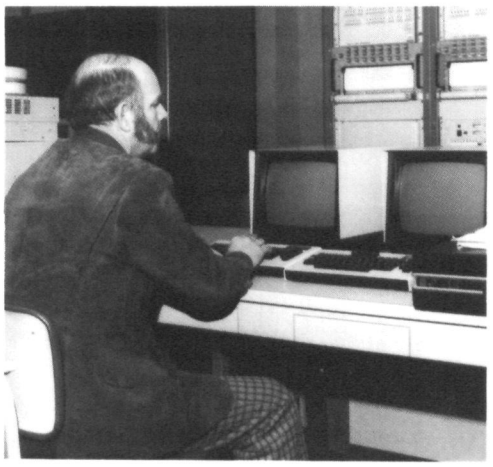


SOCC Controller James Budd at TIROS-N Controller's console, from which two operational TIROS-N type spacecraft will be controlled.

The initial TIROS-N spacecraft will be launched into an afternoon orbit with local equator crossing ascending at 3 p.m. local time. It will be in a near polar, sun synchronous orbit at an average altitude of 540.6 miles (870 kilometers), as compared with the average 938.9 miles (1511 kilometers) altitude of NOAA-5. The orbital period will be 101.6 minutes for TIROS-N, as compared with NOAA-5's 115 minutes, allowing 14.2 orbits per day. The second spacecraft, NOAA-A, will be at 517.6 miles (833 kilometers) to avoid extended periods of readout conflict, with equator crossing descending at 7:30 a.m. local time.

The time period during which data can be acquired during passes of each spacecraft will be reduced about 35 percent compared to NOAA-5, and fewer passes of a single satellite will be within acquisition range. Direct readout APT stations will be able to acquire at least two daytime and two nighttime passes from each spacecraft. The afternoon satellite will satisfy the majority of needs for visible pictures. The morning satellite will contain the earth's shadow in a large part of the visible imagery in the winter hemisphere. However, quantitative requirements such as sea surface temperature observations are obtained from the thermal infrared data, and thus are not affected by availability of visible imagery or orbit times.

The two primary Command and Data Acquisition (CDA) stations are at Gilmore Creek near Fairbanks, Alaska, and Wallops Island, Va. The Gilmore CDA is under the guidance of Everitt Kendall, and Wallops is managed by Lloyd Tourville, both of NESS. The spacecraft programming and commanding will originate at the Satellite Operations Control Center (SOCC) in Suitland, under the direction of Al Butera, also of NESS. Commands, spacecraft telemetry, and environmental data will be relayed between the SOCC and the CDA's through a commercial communications satellite, RCA's SATCOM in geostationary orbit at 119 degrees West longitude. The CDAs communicate with the spacecraft using their S-band communication link, and readout the data stored on the satellite's digital tape recorders.



SOCC Shift Supervisor Jim Nichols at the TIROS-N Spacecraft Engineer's Console.

The TIROS-N Ground System consists

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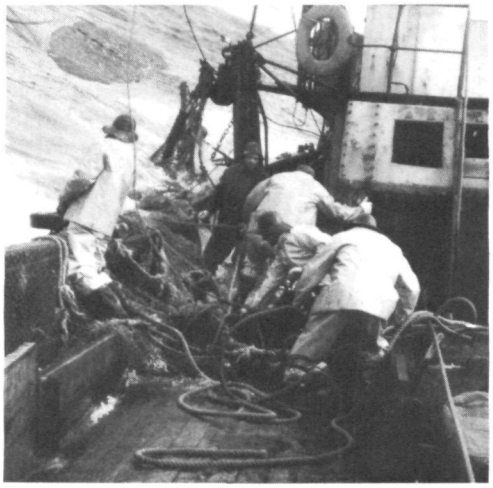
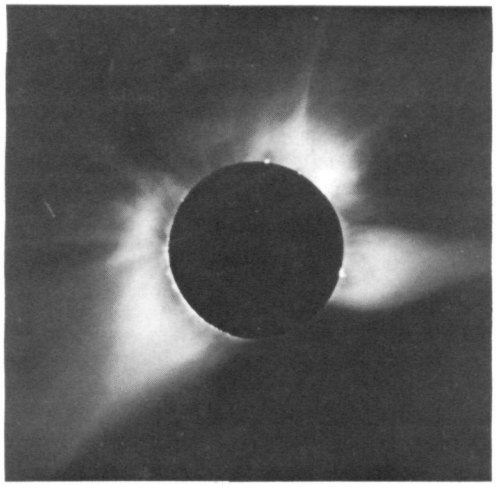


Restoring America's Fisheries: First Year Report (page 4)



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Hyperbaric Chamber Saves Lives in Miami (page 20)

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