Volume 13, Number 2 Summer 1983

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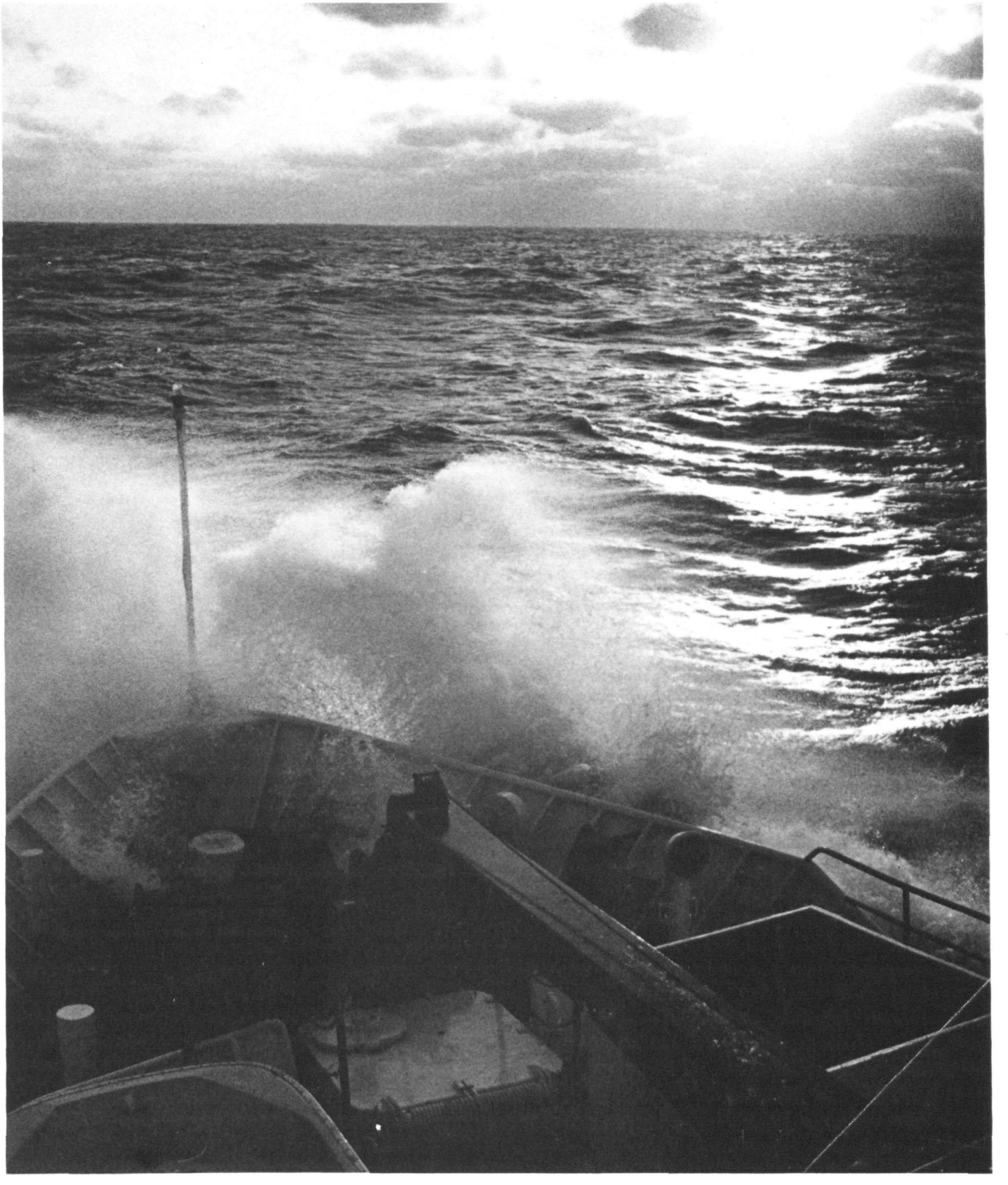

National Oceanic and Atmospheric Administration

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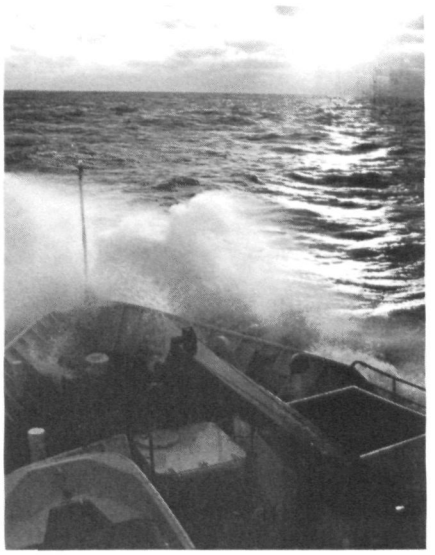

COVER: The NOAA Ship Peirce bucking Atlantic swells. See story beginning on page 26.

TO OUR READERS

NOAA Magazine, formerly a quarterly, will be published twice a year. The next issue is scheduled for early 1984. Information on new and continuing subscriptions is available from the U. S. Government Printing Office at the address below.

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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
Dr. John V. Byrne, Administrator

A. Joseph LaCovey
Director, Public Affairs

Thomas B. Calhoun
Art Director

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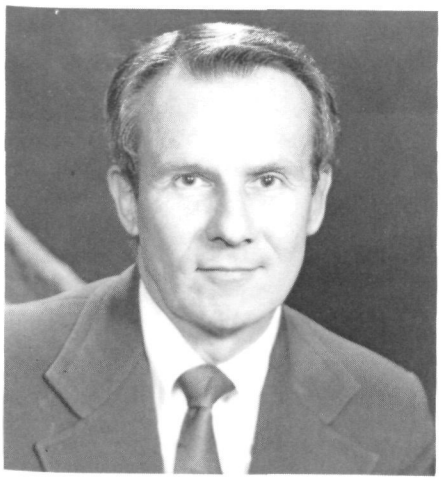
Editorial



John V. Byrne

New Ways of Doing Business—For NOAA and the Nation

On June 1, President Reagan proposed the establishment of a Department of International Trade and Industry.

I believe this proposal deserves strong support from the Congress and the private sector.

Creation of the new Department of International Trade and Industry will mean that for the first time in trade matters, a single Cabinet department will be responsible for both making policy and implementing it, as is the case for in other Executive Departments.

Trade means jobs. The Nation's total trade in goods and services now stands at 22 percent of Gross National Product, and every $1 billion worth of trade produces 25,000 jobs. Five million U.S. jobs depend on exports, and about 40 percent of our farmland is planted in crops for export. On the other hand, reduction in exports has caused nearly half the rise in unemployment since 1980.

The new Department's basic responsibilities will be the trade policy and negotiations now carried out by the Office of the United States Trade Representative. It will get analytical and policy support by picking up from the Department of Commerce its related economic and business elements. With only about 20 percent of the existing Commerce Department included, the new Department will become one of the smallest in Government, far easier to manage.

Most of the remaining parts of Commerce will be folded into other agencies. NOAA will become a separate agency.

The reorganization thus not only will give U.S. trade policy a strong, focused organization for the first time, but will achieve for NOAA the independent role originally envisioned for it. The 1969 Stratton Commission Report, *Our Nation and the Sea*, recommended the creation of "a major new civilian agency. . . to be the principal instrumentality within the Federal Government for administration of the Nation's civil marine and atmospheric programs."

A number of important advantages derive from independent agency status for NOAA:

- implementation of NOAA decisions on such important issues as fisheries, deep seabed hard minerals, and marine mammals will be speeded up;
- NOAA will be placed on an equal footing with other scientific and technical agencies such as NASA and the National Science Foundation;
- NOAA will gain the freedom to bring issues directly to the White House when necessary;
- in the White House and Office of Management and Budget decision processes, NOAA programs and budgets will be considered along with those of other scientific and natural resource agencies.

It should be noted that this trade reorganization plan is a complete package. The establishment of NOAA as an independent agency is tied to the approval of the new Department of International Trade and Industry.

If approved, President Reagan's reorganization proposal will change the way we do business. Nationally it will realign our governmental machinery to help American businesses compete more effectively in the world marketplace. In our own organization, it will create a stronger, more responsive National Oceanic and Atmospheric Administration.

It is a forward-looking fine plan for NOAA and the Nation.

John V. Byrne

Newsline

Weather Outbreaks: At Least It Was Warm

As an article on El Niño in this issue will point out, the winter and spring behind us have visited death, destruction, and tremendous losses on many parts of the world. NOAA officials have worked to warn the Nation of the dangers of tornadoes and hurricanes during the present season. Something new has been added, too, in public service; As another article in this issue explains, probabilities of hurricane conditions will be included in public advisories after August 1 for local officials who must make critical evacuation decisions well in advance of warnings. In the midst of it all, a positive note: the National Weather Service's warnings well in advance of the disastrous flooding this spring were remarkably fine. And, for whatever reason, we had the warmest winter since 1953-54, saving the Nation's gas, oil, and electric heating customers $2.3 billion.

Unique Nautical Chart Published by NOS

The Nation's first nautical chart using a homogeneous system of ultra-precise, Earth-centered geographic positions, has been published by the National Ocean Service. It maps Navassa Island, a small U.S. possession 30 miles west of Haiti. The system, called the North American Datum of 1983, updates an extensive network of reference points under continuous development since 1807. The network's points form the basic reference framework for latitude, longitude, direction, and point-to-point distances throughout the United States and for several nations in the western hemisphere. More than 100,000 reference points have been added to the network since 1927, according to Capt. John D. Bossler, chief of the National Geodetic Survey Division.

Second Climate Forecast Center Set Up

The National Climate Program Office has announced establishment of an experimental climate forecast center at NASA's Goddard Laboratory for Atmospheric Sciences. The second of the centers called for by the National Climate Program Act, it will investigate the potential for forecasting seasonal temperature and precipitation characteristics, using numerical methods in dynamic models of the Earth's ocean-atmosphere system. The first center, at Scripps Institution of Oceanography, concentrates on statistically-based methods.

Eating Certain Fish Favors Heart Health

Eating more fish naturally high in polyunsaturated fats may lower substantially your chances of a heart attack, according to Dr. Maurice Stansby of the Northwest and Alaska Fisheries Center. The polyunsaturates found in fish oil differ chemically from those in vegetable oils, apparently accounting for a decrease in the tendency of blood platelets to clot. Some of the readily available species moderately high in this oil are salmon, herring, Atlantic mackerel, canned albacore and bluefin tuna, rainbow trout, mullet, and sablefish—variety enough for any gourmet.

Two New Sky Eyes Working for NOAA

Two new weather satellites are at work aloft for NOAA. NOAA-8, launched March 28 from Vandenberg Air Force Base, Calif., uses visible and infrared light in sending images to NESDIS and scores of worldwide ground stations. The polar orbiter is notable for global search-and-rescue instrumentation. The second, GOES-6, which was launched April 26 from Cape Canaveral, Fla., makes repetitive observations of the Earth and its atmosphere from high above the Equator.

Foreign Fleets Taking Fewer Fish

Foreign fishing fleets took 1.4 million metric tons of fish and shellfish from the 200-mile U.S. fishery conservation zone last year—14 per cent less than in 1981 and 16 per cent below the average for the past 5 years. The combined catch by U.S. and foreign vessels in the zone was 2.5 million metric tons, off 9 per cent from 1981; U.S. fishermen harvested 43 per cent of that total, up from 39 per cent in 1981. Japan, with 1.1 million metric tons, continued as the leading fishing nation in the U.S. zone. The U.S. catch was valued at $2.39 billion, virtually the same as 1981. Record U.S. catches of lobster, oysters and menhaden, along with increased landings of cod, flounders, jack mackerel, sablefish, and red hake helped offset drops in catches of crabs, tuna, shrimp, and salmon.

Weather Stress Index Devised for NOAA

The time-honored wind-chill factor has been refined into a new register of misery—the weather-stress index. Developed by NESDIS and the University of Delaware, it adds humidity to temperature and windspeed figures used to calculate wind chill. Then, using statistically normal conditions as a benchmark, it measures the change from normal to provide the new index. It will be used to generate weather-stress maps which are expected to be useful to industry, recreation, transportation, medicine, and agriculture.

Lightning Poses Danger to Golfers, Others

On the summer safety front, NESDIS points out that outdoor activities, and particularly golf, are dangerous when lightning is in the air. Although deaths and injuries from lightning were below recent national averages last year, lightning-related casualties on golf courses surged upward. Six deaths (8 percent of the total) and 14 injuries (8 percent) were recorded. Other outdoor sports that saw one or more lightning deaths included hunting, softball, motorcylcing, horseback riding, hiking, canoeing, and snorkeling. In connection with water sports, NOAA reminds swimmers to beware of rip currents—strong, concentrated outflows of water brought in by waves which sweep people seaward. The key to survival: don't fight it; simply swim parallel to the shore until you're free of the current. ■

Wild Weather From the Troubled Trades

Roland Paine

On the west and Gulf coasts, there was gloom and sometimes consternation, as high winds and huge rainstorms caused hundreds of millions of dollars damage in California, Oregon, and Washington during the past fall and winter season. Heavy surf eroded beaches, sending homes into the ocean. Property damage in California for February alone was estimated at more than $200 million, and April flooding caused more than 50,000 persons to leave their homes in Louisiana, Mississippi, and Tennessee.

But on the east coast a relatively mild winter saved homeowners and businesses about $2.5 billion in reduced use of energy for heating.

These effects, and many others throughout the world, have been linked to recurrence of an intermittent climatic anomaly known as El Niño.

It is a meteorological and oceanographic phenomenon, which when it is very strong—and the El Niño of 1982-83 has been one of the strongest on record—can have far-flung and devastating effects on the economies and populations of nations around the world.

It starts far off in the south Pacific.

Setting the Stage

Normally trade winds over the northeast and southeast Pacific converge near the Equator, and move toward Indonesia. This continuing westward flow of air drags the surface water westward, resulting in a buildup of sea level in the western Pacific and a lowering in the east.

The relatively warm surface water layer is very deep in the western Pacific, while along the South American coast it is very shallow or disappears entirely. At such times the deeper cold water, rich in nutrients, upwells to the surface and supports a sizable fish population.

But every so often, at irregular intervals, the equatorial easterlies diminish, then change direction and blow from west to east. The normal pressure slope along the Equator flattens out, and may reverse, with pressure rising over the Indonesian region and falling in the east. This large scale atmospheric sloshing or seesaw of surface pressures, which was discovered in the 1920's, brings with it several consequences:

- The sea level begins a return to a more horizontal position;
- The eastward-flowing equatorial counter-current strengthens, and as the water makes its long journey back across the Pacific under the hot tropical sun, it continues to get warmer;
- The ocean-wide layer of warm surface water becomes shallower in the western Pacific and deeper along the coast of South America, where it suppresses the upwelling of the cold water. El Niño is under way.

First Effects

Its most widely known immediate effect is the warming of coastal water

along Peru and northern Chile, where the lack of nutrients caused by the halt to the upwelling in turn causes the local anchoveta and other fish populations to die off or migrate. Local fishermen suffer the often-serious consequences.

It is in this Spanish-speaking area that the name "El Niño" originated, because the warming usually comes near the Christmas season; El Niño, The Child, refers to the Christ Child.

Across the equatorial Pacific, patterns of wind, pressure and large-scale rainfall shift eastward. Both low-pressure and high-pressure regions weaken. Normally dry areas in the central and eastern equatorial Pacific are hit by heavy rainfall, while in the west much of eastern Australia and Indonesia are deprived of normal rain and suffer drought.

In one sense, nobody was quite ready for the 1982-83 El Niño, because it came unexpectedly early. As early as May of 1982, NOAA satellite data seemed to indicate a rise in sea surface temperatures in the western Pacific and Indian Oceans. In June and July the trade winds collapsed, the large scale changes in rainfall occurred—less in Indonesia, more further east.

In September satellite data suggested a sharp rise in sea surface temperatures, and this was confirmed by research ships in the area and by a network of data buoys.

Observers Ready

But in another sense, scientists were readier for this event than for any previously. Through work with the Equatorial Pacific Ocean Climate Studies (EPOCS) program, and a NOAA plan to conduct research on the next El Niño whenever it should occur, there were ships, data buoys, aircraft, and scientists in the area to collect baseline and other data. Members of a National Science Foundation program, PEQUOD, were making measurements in the central and western Pacific, and an NSF-funded biology program was under way along the coast of Peru.

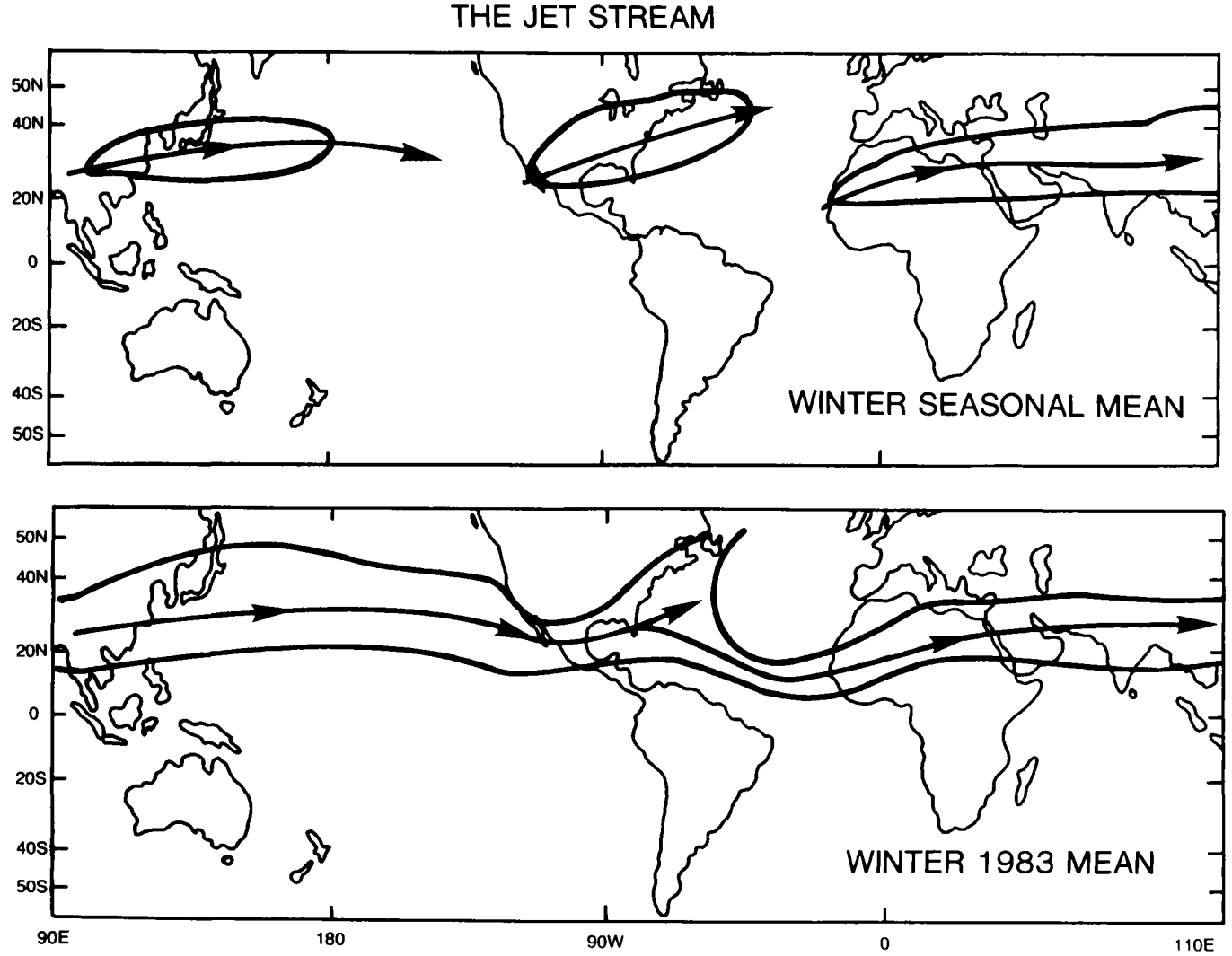
NOAA satellite data provided the early warning. And observations were begun in September by scientists on the NOAA ship Researcher, together with 17 drifting buoys that had been used in the EPOCS program.

So partly as a result of lucky timing, and partly as a result of good scientific planning, the data collected during this event is far superior to any in the past.

Through a complex chain of events known as teleconnection, the changes in the atmospheric and ocean south of the Equator affect the northern Pacific. Stronger than normal jet streams may appear in both hemispheres, as happened during this event, and vary from their usual course.

In the northern hemisphere the jet stream was diverted southward to a great arc along the U.S. west coast, across the Gulf of Mexico, and back up the east coast.

During the winter of 1983, the weather influencing jets streams shifted slightly to the south and joined in continuous bands.



First to feel the effects of El Niño are the fishermen of Peru and northern Chile who gave phenomenon its name.

El Niño Reaches North

As the weather systems moved eastward, steered by the strong and dislocated jet stream, they brought wet spells and storms from California to the Gulf states.

In the northeast Pacific the typical Gulf of Alaska wintertime low pressure region was much stronger than normal, and at times generated offspring lows to the southeast, bringing destructuve winds and tides that were added to the rainstorms of the California coast.

With the continuation of the unusual regime into the spring, Gulf moisture combined with cold northern air to produce the great February snowstorm and the succession of rainstorms that have followed it.

Other effects, in the U.S. and around the world:

- Crops have been severely affected in the Nation's fresh fruit and vegetable supply areas. Parts of the $200 million annual strawberry crop could not be harvested. Citrus crops, especially oranges, lemons, and tangelos, suffered serious loss of quality. Lamb and calf losses were high due to muddy fields.
- At least 30 deaths have been attributed to the storms since December.
- Heavy rains in January through March in Cuba destroyed 8,000 hectares of tobacco and more than 500,000 tons of sugar cane.
- A prolonged dry spell in Hawaii resulted in restricted water use, though no serious crop damage occurred.
- Summer drought over large areas of Mexico reduced water supplies, harmed grazing, and cut coarse grain production 33 percent from 1981's record levels. The value of crop losses relative to normal production was as much as $500 million.

Southeatern Australia experienced record drought, and hundreds of brush and forest fires have leveled entire towns while temperatures soared.

Famine Threatens Indonesia

Up to one million people face hunger and perhaps famine in eastern Indonesia because of crop losses due to long term drought.

In South America during the last 3 months of 1982 and first 3 months of 1983, the worst rains and flooding in 50 years occurred in Ecuador and the northern provinces in Peru, while, ironically, the southern parts of Peru experienced heat waves because of the dissipation of the normal low level cloud cover. There were also major dislocations in the fishing industry, a characteristic of El Niño, as the warm water suppressed the upwelling. By the end of the year sea surface temperatures were as much as 10 degrees Fahrenheit above normal along the coast of Chile and Peru.

And as late as June 1, 1983, while the far western Pacific had about settled back to normal, El Niño characteristics such as high sea surface temperatures, after dropping briefly, seemed to be on their way back up again.

Plans for a major decade-long international research program into this complex climate phenomenon are now being drawn up. The major purposes are to improve long range weather forecasts on a seasonal or year-to-year time scale, to tailor climate data products for industry and government, and to produce increasingly realistic models showing how natural environmental and human forces influence living marine resources. ■

Science's Window to the Underwater World

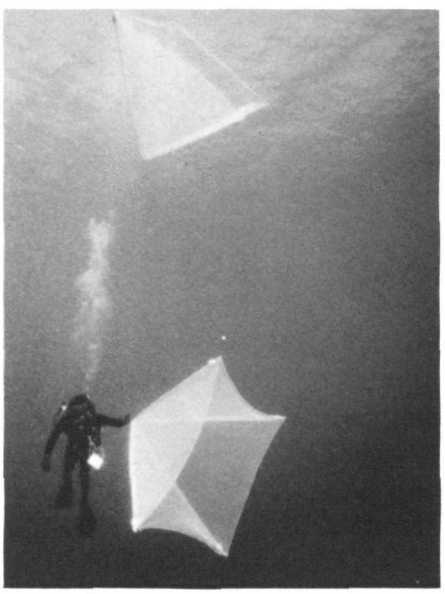
Brian Gorman

Except for the spire of an unfinished and abandoned church thrusting out from the woodlands a half-mile to the northeast, the view from Fairleigh Dickinson University's underwater research facility on Salt River Bay along the north shore of St. Croix is exactly as Columbus found it on his second voyage to the New World in 1493. Small stands of mangroves rim the Bay. Farther back up the hills, lush tropical vegetation, draped with epiphytes, is interspersed with evergreens and thorn woodlands. The sun is suprisingly gentle despite the island's location only 18 degrees north of the Equator.

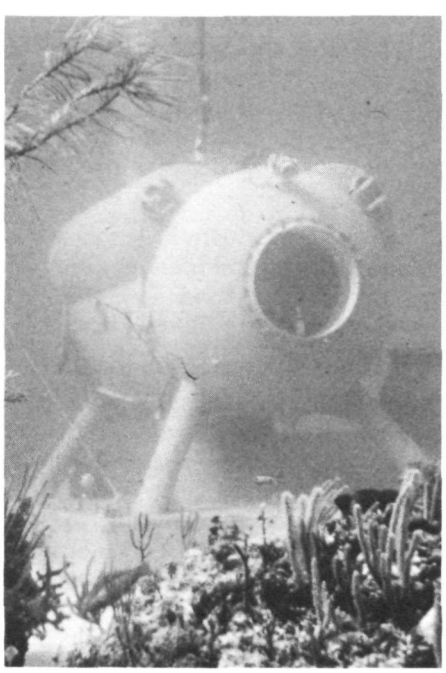
Salt River Bay is tucked into the middle of an extremely narrow underwater shelf that runs all along the north shore of this island. The Bay forms a north-south running submarine canyon about a quarter-mile across and plunging thousands of feet into the clear Caribbean before it reaches even a mile offshore. The steeply sloped east and west walls of the canyon are composed principally of coral and they form a natural underwater laboratory that since 1977 has housed NOAA's Undersea Laboratory System, known as Hydro-Lab, the name its builder, Perry Oceanographics, gave it when it was constructed in 1961.

Undersea Operations Base

Hydro-Lab, still owned by NOAA but now managed through Fairleigh Dickinson's West Indies campus, headquartered miles to the east, rests 50 feet below the transparent water of the Bay where it has served as an operations base and cramped living quarters for scores of four-person teams of scientists and divers from all over the world who visit annually to spend up to 7 days in the cylinder.



A Hydro-Lab diver examines a parasol mid-water reef structure designed to attract sports fish. Below, the undersea laboratory.



In spite of its spartan size, 16 feet long and 8 feet in diameter, Hydro-Lab has most of the amenities of a shipboard research lab: hot and cold running water, three 6′-7″ bunks, a microwave oven, 6′-4″ headroom, storage compartments, even a trash compactor.

On the surface, permanently hovering above the habitat and tethered to it by an umbilical cord, is the lab's 23-foot-long, fiberglass life support boat, providing fresh air, electrical power and communications to the divers below. The 24-hour-a-day drone of its diesel engine and its gleaming white hull are all that break a Cruzian spell in the middle of Salt River Bay.

A battery-powered emergency system in the Hydro-Lab can provide 72 hours of back-up power, more than twice what divers need for decompression, should the power supply aboard the life support boat fail.

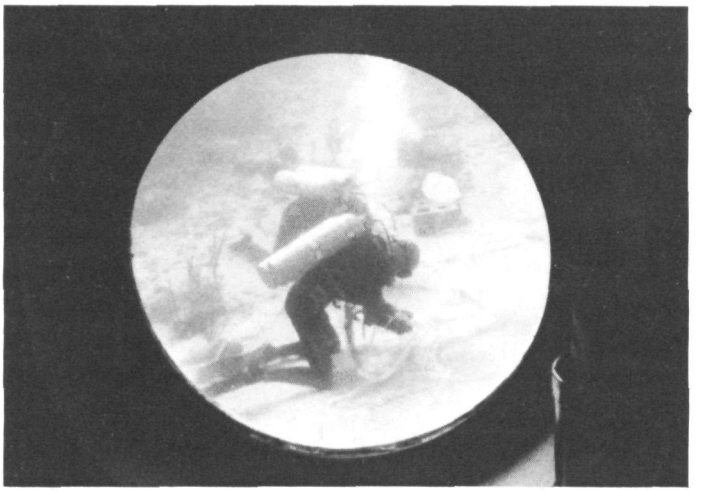
Lifeline to the Surface

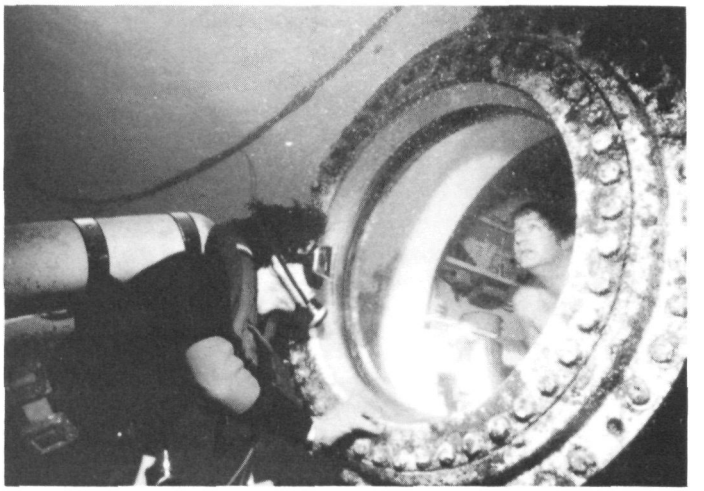
Several times a day, the divers receive food, scientific gear, books and other equipment, "potted" down from the surface in a special, water-tight container.

"Food is a very important consideration," says Fairleigh Dickinsen's Dr. William Schane, the on-site physician who checks out all divers, both before and after every mission and whose wife, Joann, prepares all the meals for the divers as well as for the support staff on shore.

"You use up a lot of energy working underwater," according to Dr. Schane. "We find the divers consume between 3,500 and 4,000 calories a day during a typical mission."

The equipment divers use during the 16 missions Hydro-Lab runs each year is





Looking out and looking in. At left, a diver assembles a streamer structure. At right, Andre Landry checks with Ian Workman inside Hydro-Lab.

basic scuba gear, although there is an extraordinary concern with safety: double tanks, back-up regulators, constant radio checks back on shore both during the dives and throughout decompression.

"Everything here is oriented to the bottom," says Dr. Schane. "Most scuba divers are used to thinking that if something goes wrong, safety is at the surface. We have to change that attitude: safety is at the bottom (in the Hydro-Lab). You're no longer an aquatic mammal: you're a fish."

The reason for this reorientation is a simple one. After remaining at 50 feet for about 12 hours, the diver's system is saturated with an increased amount of dissolved nitrogen. Sudden surfacing could bring on a painful and life-threatening case of the bends.

A Team Focus

Early last February, two researchers from NOAA's National Marine Fisheries Laboratory in Pascagoula, Miss., principal investigator Ian Workman and John Watson, left behind some drizzly winter Gulf Coast weather to fly to St. Croix. They were joined by fellow researcher Dr. Andre Landry from Texas A&M University at Galveston and by John Blackwell from NOAA's diving office in Rockville, Md.

Once at the Hydro-Lab they would use the unique facilities to field test some disarmingly simple artificial reef structures. Workman, a fisheries biologist and project manager had been with the Pascagoula Laboratory since 1978, and this would mark his third mission in Hydro-Lab.

Artificial reefs are a relatively new tool to being used to improve sport fishing. Junk cars, sunken Liberty ships, even offshore oil rigs are known to attract, and thus concentrate, populations of fish.

The artificial reefs on the St. Croix mission would be a little different, however. These would be mid-water reefs, anchored to the bottom and floating dreamily about half-way up the water column. Furthermore, they would be made very cheaply from readily available PVC pipe, simply assembled and easily moved. "And," says Workman, "because we'd be working out of Hydro-Lab, we'd be able to actually see how fish were attracted to the structures: what kinds of fish, how long they'd stay, how they'd behave."

Like a Broken Jungle Gym

The artificial structures themselves didn't look very sophisticated. Some resembled more parts of a child's broken Jungle Gym, festooned with strips of Mylar. Others, aptly named parasol reef units, looked like oversize umbrellas.

The idea, however, was not to build something pretty, but to attract some of the mid-water fish abundant in the nearby coastal waters.

"Artificial reefs generally don't increase the fish population," explains John Watson, who came to the Fishery Service's Pascagoula Lab in 1970, where he has worked on designing gear to reduce incidental bycatch in shrimp trawls. "But they do tend to concentrate it, luring fish away from natural reefs and other habitats and aggregating them in an area that's easier for people to fish."

Typically it is the small baitfish that tend to be attracted to the artificial reefs first. They, in turn, can attract desirable sportfish. Studies have shown that when artificial reefs are used as attractants, gamefish catch rates are measurably higher in adjacent waters.

Three different artificial reef designs were used at each of three sites during the 7 days of the mission. In addition, divers set out two other structures, a reflective luminescent streamer reef and a reflective luminescent parasol, within view of Hydro-Lab so that they could be observed constantly, day and night.

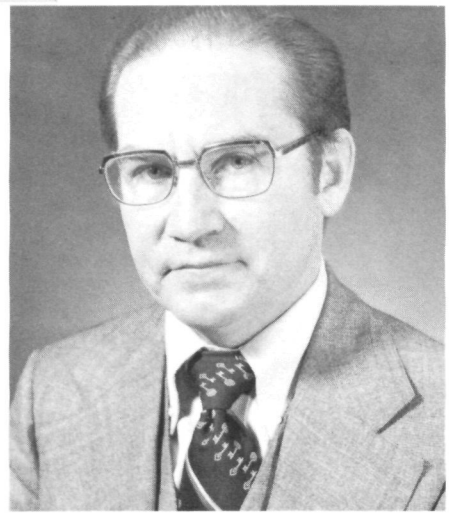
"Fantastic" conditions

Conditions for making observations were, in Workman's words, "just fantastic," with underwater visability well over 75 feet during the 59 "excursions" divers made from the habitat. Two to four times each day a pair of divers would spend about 3 hours observing the artificial reefs, counting and identifying fish and observing their behavior. After more than 97 hours of observation time, Workman and his team had counted well over 7,000 individual fishes representing 21 different species. Typically fish concentration would grow throughout the morning, peak at noon, and then trail off by afternoon.

Perhaps the most remarkable event during the mission was the siting of blackfin tuna, which may have been attracted to the area of increased concentrations of baitfish. It was only the second time in 5 years that blackfin had been seen there. The underwater diving team left some of the artificial reefs in place at the end of the mission and recent reports from the staff at Hydro-Lab indicate that blackfin tuna still are being observed from the surface, and that king mackerel are more common there now than in the past. ■

Interview: Dr. Ned Ostenso

Seeking Cures For "Programmatic Myopia"



Dr. Ned Ostenso heads the National Oceanic and Atmospheric Administration's research efforts.

Q. How has the reorganization of NOAA affected the research components?

A. The purpose of the reorganization is the strengthen NOAA's position in fundamental research in those areas that are pertinent to our mission, and to remove any programmatic myopia that might come from coupling development and application to the more fundamental areas of research. So I'm taking it as my operating philosophy that the reorganization is for us to make a stronger commitment to fundamental research.

Q. Will the necessary applied research then be undertaken by the other main components of NOAA—that is, you may begin something in OAR, and when it develops to the point of being particularly useful, it might be taken over by, for example, the National Weather Service?

A. Our intent is that all of our research will find its way into application. What's at issue here is where is the trade-off point. Now from my past experience in the Department of Defense, there are a whole series of trade-off points. They go from basic research to exploratory development to advance development to prototype and they have this separated by a series of budget categories, more than they do by organizational elements *per se*. It's clear that the intent of this administration is to shift the boundary between discovery and application and put the greater burden of transfer on the service sector, so that the research sector doesn't become overly pre-occupied with the transfer process. There's no question but what we still have the responsibility to make sure the transfer takes place, so it's just an incremental shift of the relationship between research and NESDIS, NWS, NOS and NMFS.

Q. How do you determine the most important research areas—do they come from the scientists saying this is an exciting frontier we would like to get into, or do they come, for example, from the Weather Service saying we think we are going in this direction and we need some help because there are some basic things we simply don't understand?

A. This is a process that goes on every day, and it's hard to codify in the rigid flow diagram sort of thing. To the extent that it can be institutionalized, we have set up our own process that is what we euphemistically refer to as "bin reviews", each bin representing one of the nine major product lines we feel we are working toward. We might have a review in, for example, air quality, which is one of our product lines. It's a NOAA-wide review process: and as appropriate we bring in outside experts—it's an effort to expose to the whole NOAA family what is ongoing in our research area in that specific product line. The service Line Offices are involved both as participants and of course as the audience. The review is not organizational, it's product oriented. At the end of the review we do have an organizational aspect, where each of the service Line Offices stands up and comments on what their needs are and how they view this body of ongoing research as it fits their needs and projections. So this provides a very intimate feedback loop between the researchers and the services. And that's how we try to institutionalize this exchange.

Another mechanism we have is joint management like we do with PROFS—OAR, NESDIS and the Weather Service have formed what we refer to as a "troika" for joint management research efforts of common interest to us.

Q. Is there much participation by industry and by universities—other than Sea Grant—in NOAA research?

A. One of the things we try very hard to do in OAR is to distinguish clearly among the relative strengths and weaknesses of our in-house laboratories, academia, and industry. Each one of these tools for getting our job done has its individual unique strengths and weaknesses.

To put it oversimply: you turn to industry when you pretty well define the problem and the issue is getting the specific answer to an identified problem. We're buying a service.

In dealing with academia we are looking for new inputs, new ways of doing things; we're dealing with a population to whom we have no long-term commitment as we do an employee. This gives us a great deal of flexibility. By the same token they don't have an explicit dependency on us which gives them, in turn, a great deal of freedom. We're buying attention.

With our in-house activities we are essentially buying people, we're buying long-term attention to long-term problems.

What we should be doing in-house is tackling those problems that involve synthesis of disparate data, addressing problems that are long-term and large-scale, and providing the continuity that is required to make sure that research, wherever it comes from, ends up in a product that's useful to society. Ancillary to that, there are some activities that are so closely coupled to governmental responsibilities—such as regulation and rulemaking—that they require the imprimatur of the Federal Government. Another function of our laboratories is to provide a body of expertise that is available to us. As tasks arise, we give a lot of attention as to which is the proper

implementer of that task: industry, academia, or our own laboratories.

Q. What is the situation with respect to the Sea Grant program now; as an integral part of NOAA's research, is the network generally thriving and healthy?

A. Maybe there are two answers to that question. The first issue when Sea Grant was formed in 1966 was to develop Sea Grant programs that were both institutionally and intellectually viable and healthy. Having largely done that, now the problem is to make the network itself function as a national program. We have had substantial success in the past few years, having gone through the first hurdle. The network does get together three times a year, where the Sea Grant directors set up priorities and plan their programs. In the interim they do it in a more formal way by specific work groups that lay out documents that state priorities and strategies for achieving them. Participating in this, of course, are industry and other NOAA elements as appropriate. The greatest personal satisfaction that I have, to answer your specific question, is seeing Sea Grant start to take on the character of a network of healthy programs and viable national programs.

Q. And there is a lot of communication amongst the National Office and the Sea Grant programs at the universities as to directions of research and common areas of interest?

A. Oh yes. A couple of specific but different kinds of examples: We've got a very coherent program in marine corrosion that involves a number of participants from different universities and industry. The program is well-managed and we have an industry advisory group aiding central coordination. Another example is a retreat we had with the Southeast Fisheries Region. All the laboratories were there and the senior management from the region who met with the Sea Grant directors from Texas around the Gulf up through the Carolinas. We discussed problems of common interest and developed an agenda of things we were going to work together on.

Q. Where are we going these days in weather modification? That was a subject of great interest some years ago, but it seems to have slowed down.

A. The weather modification program did attract attention some years ago; it started out on a reasonable premise which history proved to be not very viable—that we could short-circuit the time and enormous amount of research that was required to understand the physical processes, and instead go directly to a more empirical approach, a statistical approach, of doing things and measuring the consequences of doing them without understanding the processes that were actually involved. It was hoped that by this abbreviated method we could implement a program that would enhance the agricultural benefit of weather and diminish its destructive forces, even though we didn't fully understand the processes.

Q. It means that we had to go back to more basic research?

A. What we found out from several years of effort was that this was an unrealizable expectation. As we faced up to that realization, our weather modification program took on more and more of the character of basic meteorological research, cloud physica, thermodynamics, and things like that. As the public became more and more aware of the deficiences in the short-circuit approach, we erred probably in not making it clear enough that our program had shifted substantially and that it was largely no longer a "weather modification" program as narrowly defined but rather it was a research program looking at the basic phenomena which, if understood, could lead us to weather modification.

Q. Finally, what do you think are the most exciting, most promising areas of research that the NOAA laboratories are generally working on?

A. It's hard to narrow the list down, but let me identify some relatively new areas that have collectively caught our attention in trying to put together major new thrusts by reallocation of our intellectual and fiscal capital. One of these is looking at those environmental parameters, oceanographic and meteorological, that affect the first order problem of fisheries management—the survival of an individual year class. The sciences of fisheries, meteorology, and oceanography have now matured to the point where, for the first time, we feel intellectually prepared to address this very difficult problem. We do have for a number of species now, we think, a protocol for doing discrete experiments that will answer this most fundamental problem.

The basic problem we've had is that the environmental data are very discrete and the fisheries data, based largely on catch statistics, are translated down the calendar several years in scale and smeared out in time, so now the issue is looking at discrete environmental effects that result in the downstream catch effect. Probably our best example so far is our work that's been done on blue crab recruitment in Chesapeake Bay.

Another area that we're excited about is the newly discovered processes that are going on in seafloor spreading. First of all, it's first-class science, major breakthroughs in biology, chemistry, and geology. They have enormous impact on metal resources, our understanding of ocean pollution and the ocean's assimilative capacity. . . and there has been the discovery of whole new life forms that no theory and no intelligent biologist could have predicted existed on this earth. The impact of that for new drugs and extracts is potentially enormous.

A third area is looking at the combination of ocean sensing techniques in ensembles of approaches for measuring on a time, space and financial scale the key physical and dynamical aspects of the ocean. This could open a whole new chapter in the concept of ocean services to industry and society.

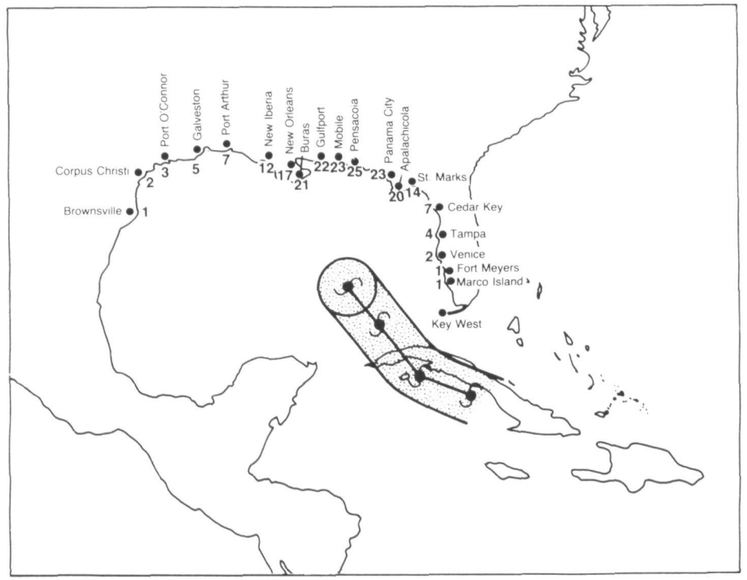
And finally, is the substantial progress that is being made in ocean and atmospheric climate; breakthroughs in the understanding of the sluggish, and therefore more predictable processes in the ocean, as how they impact on the less sluggish, and hitherto less predictable inter-seasonal climate of the atmosphere. I should point out that Don Gilman's prediction for last winter, which was right on target—which was orthogonal to conventional wisdom. . .

Q. Orthogonal?

A. Orthogonal, right angles. It was the first prediction we've made involving oceanographic data. All the commercial people were predicting just the opposite. So we feel now that we know enough to ask the right questions, and construct experiments to give us the answers to these questions. ■

A New Tool for Hurricane Decision-Makers

Don Witten



Using 1979's Hurricane Frederic as an example, this map shows probabilities of landfall when the storm is a little less than 24 hours from shore. The highest probabilities are between Applachicola, Fla., and Buras, La., where there is a one in four chance that the hurricane eye will pass within approximately 65 miles.

Hotels, condominiums, and private homes have sprung up along the Gulf and Atlantic Coasts, often with little thought of the dangers posed by hurricane storm tides. Such areas could be cut off from inland escape routes before evacuation in the face of a killer storm could be completed.

It's devastatingly simple. There just isn't enough time. Studies of Galveston, Tex., southern coastal Florida, and the Florida Keys estimate evacuation times of 24 to 36 hours. Uncertainties in hurricane forecasting, however, limit NOAA's National Weather Service to 24 hours advance warning of where a hurricane is expected to come ashore. Put another way: total evacuation time exceeds available warning time.

Exploding populations along the entire Gulf and southern Atlantic coastlines pose a serious problem for local officials in major metropolitan areas. When a hurricane threatens, how do you evacuate the many thousands of people from danger areas when moving time is greater than warning time? And even with 24-hours warning from the Weather Service, there is an average error in predicting landfall of 120 miles along the Gulf Coast and 140 on the Atlantic Seaboard.

It was in light of this dilemma that NOAA decided to issue public, long-range forecasts of hurricanes in the form of probabilities generally well before 72 hours in advance of anticipated landfall. In essence, the probabilities describe in percentages the chance that a storm's center will pass within about 65 miles either side of 44 listed locations from Brownsville, Tex., to Eastport, Me. They will be included in all public advisories issued on hurricanes and tropical storms developing in the Atlantic, Caribbean and Gulf of Mexico beginning this hurricane season.

Recognizing Uncertainties

The probabilities represent the uncertainties in hurricane forecasting. They were developed by comparing the forecast position of hundreds of storms with the actual position of where the storms ended up.

"Considering the errors in long-range hurricane forecasting, local officials and managers of coastal and offshore industries need some means of making objective decisions about evacuation and suspension of operations during a hurricane threat," said Dr. Neil Frank, Director of the National Hurricane Center.

"In using the probabilities effectively, the decision-makers can develop thresholds for action based on their own unique problems and the risks involved," he added.

Frank offers the following example in describing the uncertainties in hurricane forecasting: A storm in the Gulf of Mexico, forecast to be over New Orleans in 72 hours, poses nearly an equal threat to Beaumont, Tex., and Panama City, Fla. This represents about 400 miles of the coastline. The error for a 72 hour forecast increases to 650 miles along the Atlantic coast.

Why such significant errors in hurricane forecasting?

Jim Campbell, Emergency Warning Meteorologist at National Weather Service headquarters explains that the major problem is "insufficient observational data on the environment surrounding a hurricane." This limits the forecaster's ability to determine the winds that steer the hurricane and how these change with time.

Major Strides In Storm Tracking

Major strides have been made in the detection, monitoring, and observation of hurricanes in the past 40 years. Organized reconnaissance of detected storms by cooperating Air Force aircraft was initiated in the 1940's, followed in the next decade by a network of coastal radars to monitor hurricanes near the land. By the 1960's, satellites were available. Today, NOAA research aircraft flying out of the Research Facilities Center in Miami, make direct measurements in hurricanes to learn more about these powerful storms.

As these new tools of technology were being developed, tropical meteorologists also were improving their ability to forecast the movement of hurricanes. Concurrently, there was rapid increase in the concentration of population and industry along the Gulf and Atlantic coastlines.

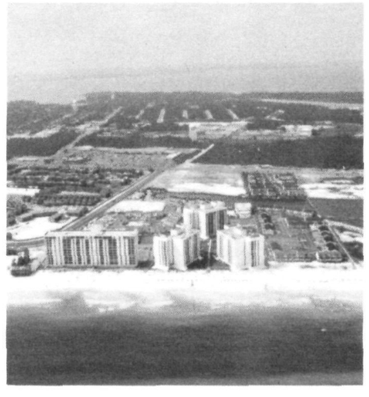
"Since the late 1960's, we have reached a plateau and do not anticipate any significant improvements in hurricane forecasting during the next decade, barring any unforeseen breakthrough," Frank said.

"It is clear that local decision-makers in large metropolitan areas on the coastline need more information about their hurricane risk prior to the 24-hour warning," he said.

As useful as probabilities can be, they do not take into account changes in the intensity or speed of a hurricane. They only indicate where the storm is thought to be headed.

"Probabilities would not have been much help to the local officials in Key West, when the famous Labor Day storm of 1935 struck," said Frank.

"It started as a tropical storm as it moved over Andros Island in the Caribbean Sea. Thirty hours later it became the most powerful storm ever to hit the United States. With winds estimated at 115-200 miles an hour, the hurricane drove 18 feet of water over the Keys, drowning 408 people," he added.



Assessing a Hurricane Threat

There are two main points to remember when using the probabilities to assess a hurricane threat, according to Frank. First, the probabilities issued for one location should be compared with those of neighboring areas. Locations with higher probabilities are under a greater threat from an advancing hurricane.

In addition, coastal residents should be sensitive to increasing probabilities. Locations with increasing probabilities are at a greater risk than those with stable or decreasing percentages.

The maximum probability of a hurricane striking a specific coastal area is 10 percent in a forecast issued at 72 hours before expected landfall. The risk for such an area will increase to 20 to 25 percent in a 36-hour forecast, and to 35 to 45 percent with a 24-hour forecast. Only when the storm is about 12 hours from this area will the percentages increase to 60 to 70 percent.

Due to the lower percentages, coastal residents may be ordered to evacuate from a big storm when the percentages are 20 percent or less.

General concern about the public's perception of low hurricane probabilities led the National Weather Service to commission Dr. Jay Baker of the Florida State University in Tallahassee, to conduct a public reaction study in St. Petersburg, Fla.

Dr. Baker's study showed that even low probabilities were perceived as indicating a risk in the absence of a hurricane watch or warning—issued respectively at 36 and 24 hours before landfall.

"It was clear from the findings that during a watch or warning people respond more to the advice of local officials than to the probabilities alone," Dr. Baker said.

Educating Local Decision-Makers

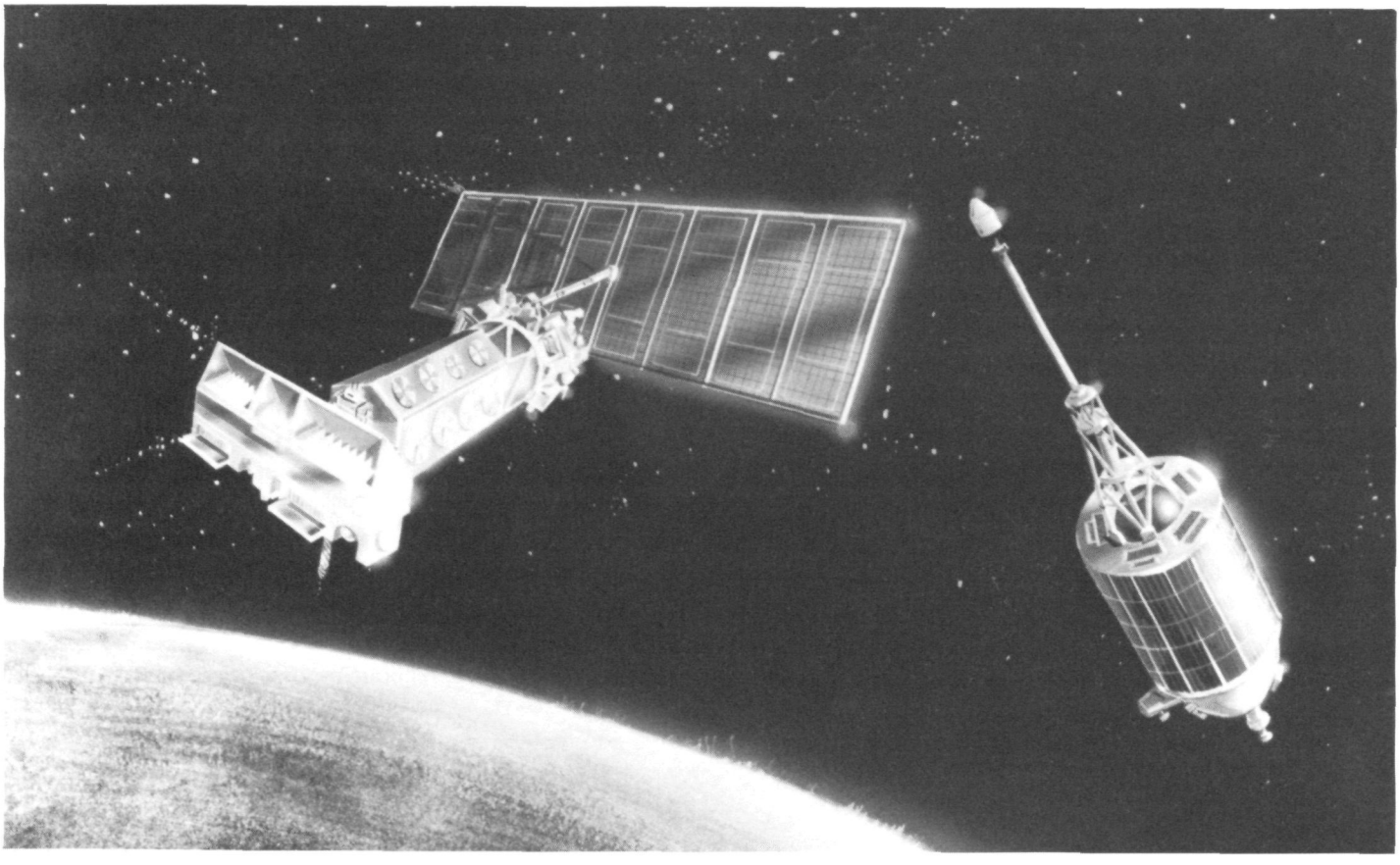
Once the decision was made to issue hurricane probabilities the National Weather Service undertook an aggressive educational program for the primary users of probabilities—the local decision-makers. This effort was conducted by Dr. Michael Carter, a sociologist on loan to NOAA from Colorado State University.

"Training sessions will be conducted to help local officials best understand how the probabilities can be used in making local evacuation decisions," said Dr. Carter.

"They will also help local officials interpret probabilities for the public to elicit appropriate response to evacuation orders," he added.

The true value of hurricane probabilities may not be realized until the next major hurricane threatens a large concentration of people living along the coastline. When they are put to the real test, however, NOAA hurricane forecasters believe they could be the extra edge needed to avert a major disaster. ■

Trouble Spotter In Space



Gerald D. Hill

At 9 a.m. PDT, September 9, 1982, a small private plane with three men aboard left Dease Lake for a flight to Dawson Creek, British Columbia.

They were searching for the son of one of the men who had disappeared on an earlier flight across the rugged Canadian terrain.

One hour and 45 minutes later as the plane flew up a blind valley, it stalled and crashed into a heavily wooded valley surrounded by 7,000-8,000 foot mountains. The nose of the plane came to rest on the ground with the tail in the 50 foot trees. They were 30 miles off their intended flight path.

All survived. However, they suffered broken bones and multiple scratches and bruises. Searchers, alerted by the failure of the downed craft's pilot to "close" his flight plan, failed to see or hear any signs of them.

But 31 hours later, all three were lifted out of the crash site by rescurers who estimated that it would have been an additional 3 or 4 days before the area might have been searched again if they had not been aided by the newest technique for search and rescue—SARSAT.

SARSAT—Search And Rescue Satellite Aided Tracking—is a project designed to demonstrate the use of satellites to save lives by reducing the time required to locate and rescue air and maritime distress victims.

The rescued Canadians were the first to profit from the new system but not the last to be aided by SARSAT.

- Another downed Canadian plane with two people (one survivor) was found within 2½ hours after their first Mayday call.
- A single-engine plane, in which two people were killed, was found in New Mexico.
- Three crewman of a capsized catamaran were saved 300 miles off the New England coast.
- Five people on board a grounded 36-foot sailboat were saved in Bahamian waters.
- A crashed plane was found by the satellite only 1,500 feet from the end of the runway in Martinsville,

In the photo opposite, Bernard J. Trundell, who heads the SARSAT program for NASA, explains the system to Civil Air Patrol and media representatives. The tripod holds an antenna and a Emergency Locator Transmitter. Trundell holds a receiver. The drawing above is of NOAA-E (left) and the Russian COSMOS satellites.

False Alarms A Problem

The pilot of a small aircraft who puts down in a bumpy landing may cause a problem for SARSAT without even knowing it. The jolt can set off a signal accidentally without the knowledge of the operator—in turn triggering the search and rescue process described in this article.

Approximately 97 percent of all distress signals received at the U.S. Mission Control Center at Scott Air Force Base, Ill., prove to be false alarms. In a single day, the base's Inland Search and Rescue unit reported 40 spurious distress signals. With some 250,000 private aircraft in the United States, the possibilities for unintended alarms is enormous.

As a result of the high false alarm rate, authorities find it necessary to check whether an aircraft has been reported missing in the area from which the distress signal is coming before sending out their search parties. ■

Va. All six people on board died in the crash.

Cooperative Venture

The new search and rescue program is a cooperative project involving the United States, Canada, France, and the Soviet Union. Search and rescue instruments will be carried on three NOAA polar-orbiting satellites.

Canada is providing a transponder for each NOAA satellite and a ground station. France is providing a receiver/processor for each satellite and a ground station. The United States is providing integration of the instruments and launching the spacecraft as well as providing three ground stations. All three countries are conducting performance test and evaluation of the system. NASA is the U.S. project manager for the SARSAT experiment.

Canada and France together are investing approximately $24 million, the U.S. approximately $29 million, and the Soviets several millions. Norway and the United Kingdom will assist in evaluating the system.

Original plans called for NOAA and the Soviets to launch their SARSAT and COSMOS satellites in 1982, however NOAA's previously launched satellites continued to operate effectively beyond their designed life time, so no replacement was necessary. The Soviet satellite was launched in June 1982 and evaluation of the system began last September. The Soviet satellite has been used in all search and rescue missions to date.

The first U.S. satellite to carry the search and rescue instruments was NOAA-E, launched in late March. It is a polar-orbiting satellite, flying at altitudes of more than 500 miles.

The trigger for the downed aircraft rescues is an Emergency Locator Transmitter (ELT). The ELT, required by law on all general aviation aircraft, is constructed to transmit a signal automatically on impact or manually. Similar devices, Emergency Position-Indicating Radio Beacons (EPIRB) that can be activated manually or by immersion in water, are carried on some ocean-going vessels. The two devices can transmit continuously for 48 hours on two radio channels that are reserved worldwide for aeronautical and marine distress calls. In the United States, ELT's are carried on more than 200,000 airplanes and more than 6,000 EPIRB's are installed on ships.

Pre-SARSAT Gaps

However, before the satellite system, detection of these signals depended on overflying aircraft to monitor the signals on a voluntary basis which provided irregular coverage at best. Unless the aircraft is within 185 miles of the distress location there is little chance for detection. The largest gaps in the coverage are in remote areas where rapid response to accidents is most needed.

Regulations require aircraft flying over open water for long periods of time to monitor the emergency channels. Unfortunately there are no similar requirements for flights over land.

The number of times a signal can be detected by satellite depends on the number of satellites flying. With one satellite the maximum time between successive detections would be 12 hours at the equator. If four were operating at the same time, distress signals would be detected in a very few hours.

The ELT and the EPIRB use two frequencies—121.5 and 243 MHz. Because they were designed to be detected by overflying aircraft and to be low cost units, the signals cannot be processed on the satellites. The emergency transmitter and the ground station must be in view of the spacecraft and the signals must be relayed immediately to the ground station. Present transmitters can provide a location of the distressed plane or ship to within 10 miles.

Despite the limitations of the 121.5/243 system, it has improved emergency beacon detection and location by providing regular systematic coverage of the earth.

Both of the emergency transmitters send a distinct "wow-wow" modulated tone signal on one or both of the emergency distress channels. These signals provide an immediate alert and homing

signals to assist the rescuing forces to locate the distressed aircraft or ship. The distress location is determined by measuring the Doppler shift between the satellite (with its precisely known orbit) and the distress signal.

Future Improvement

In addition to the 121.5/243 MHz ELT's and EPIRB's in the field the COSPAS and SARSAT satellite systems also provide an advanced system which could offer substantial improvements in the future. This system uses experimental ELT's and EPIRB's operating at 406 MHz and the signals are processed on board the spacecraft allowing for a global coverage mode.

There are three main subsections in the COSPAS/SARSAT systems: the emergency beacons, the repeater/processor on the satellite, and the ground station. The system has two different coverage modes; regional, using 121.5 and 243 MHz, and global, using 406 MHz. On NOAA-E, a repeater data system (furnished by Canada) relays 121.5, 243 and 406 MHz signals. An onboard signal processor (furnished by France) receives the 406 MHz signals, processes and records the data, and transmits it to a ground station immediately and also at a later time in the playback mode.

The NOAA-E satellite relays the distress signals to ground local user terminal stations located in Kodiak, Alaska; Point Reyes, Calif.; Scott Air Force Base, Ill.; Ottawa, Canada, or Toulouse, France. The playback data are relayed to NOAA stations at Wallops Island, Va., and Fairbanks, Alaska. The Soviets operate ground stations at Moscow, Archangelsk, and Vladivostok. Playback of data from the COSMOS spacecraft is made to each of the local user terminals.

The U.S. Air Force operates the Mission Control Station and one ground station at Scott Air Force Base, Ill. The U.S. Coast Guard operates the ground stations in California and Alaska. The Air Force and the Coast Guard also direct the search and rescue missions from these three ground stations using rescue forces stationed throughout the country. All nations' ground stations track both satellites with coordination between the two satellite systems accomplished by the U.S. Mission Control Center and the Soviet Control Center in Moscow.

Distress Signal Stored

Global coverage is obtained by using a radio frequency of 406 MHz with new experimental ELT/EPIRB transmitters. This will be possible because the radio signals from the distressed plane or ship will be stored on the satellite's on-board computers and at a later time be transmitted to a ground station that is in full view of the satellite.

When using this frequency, the spacecraft send the information to the NOAA Command Data Acquisition station. From there it goes to NOAA's Satellite Operations Control Center which relays it to a SARSAT Mission Control Center. The appropriate Rescue Coordination Center is then notified.

This system can be used for regional or global coverage and will be able to locate the distress site within 1 to 3 miles. When the system is fully operational, it will be capable of detecting and locating 200-300 distress signals at a time.

Survivors of air crashes will have a better chance of being found quickly if the aircraft is equipped with the new SARSAT system.

During regional coverage, the satellite will cover an area of approximately 4,000 kilometers in diameter from the center of the receiving station. Under the global system all areas of the earth will be covered since the information can be stored on the satellite and sent to earth at a later date.

The system using 406 MHz is based on proven meteorological data collection technology. In addition, the system has been used to demonstrate its lifesaving capability in several sailboat search and rescue experiments. Satellites were used to track a Japanese adventurer while he treked by dog sled across the Greenland ice cap to the North Pole. They tracked a number of sailboats during a European race in 1979 and tracked both the successful and unsuccessful "Double Eagle" transatlantic balloon flights.

Added Features

The 406 MHz beacons have higher power and better frequency stability and are specifically designed to take advantage of the satellite detection system. In addition to location, the system indicates whether the signal is from a ship or aircraft, its country of origin, the nature of the distress or the elapsed time since the accident occurred and the registration of the vessel or the aircraft.

Of course the major purpose of the system is to save lives. Studies have shown that those who survive an airplane accident have less than a 10 percent chance of survival if the rescue is delayed more than 48 hours. However, if the rescue can be made within 8 hours, their chance of survival is over 50 percent. This would hold true with marine disasters especially when the survivors have been injured. Not only do those in distress benefit from a rapid rescue, but the people involved in the search and rescue operations are exposed for a shorter period of time to the hazardous conditions they frequently encounter.

Studies have shown that a fully operational system would probably save more than 1,400 lives and save more than $152 million in search time in general aviation between now and the end of the century. During the same time it is expected that an additional $187 million and 285 lives would be saved in the maritime area.

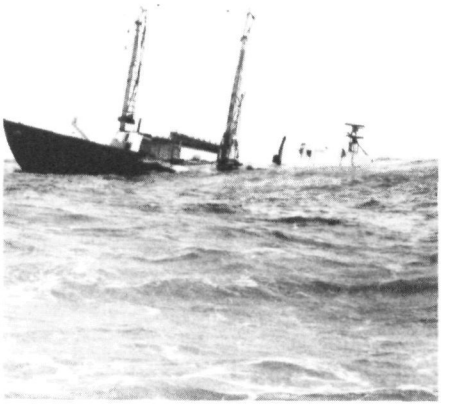
High "G-Force" Activation

The emergency transmitters are normally located in the tail section of the aircraft; however, they may be installed anywhere on the plane and many are found in the cockpit. They are activated by the "G-force" usually experienced in a crash. Also they can be activated manually and many times by a hard landing causing a false alarm.

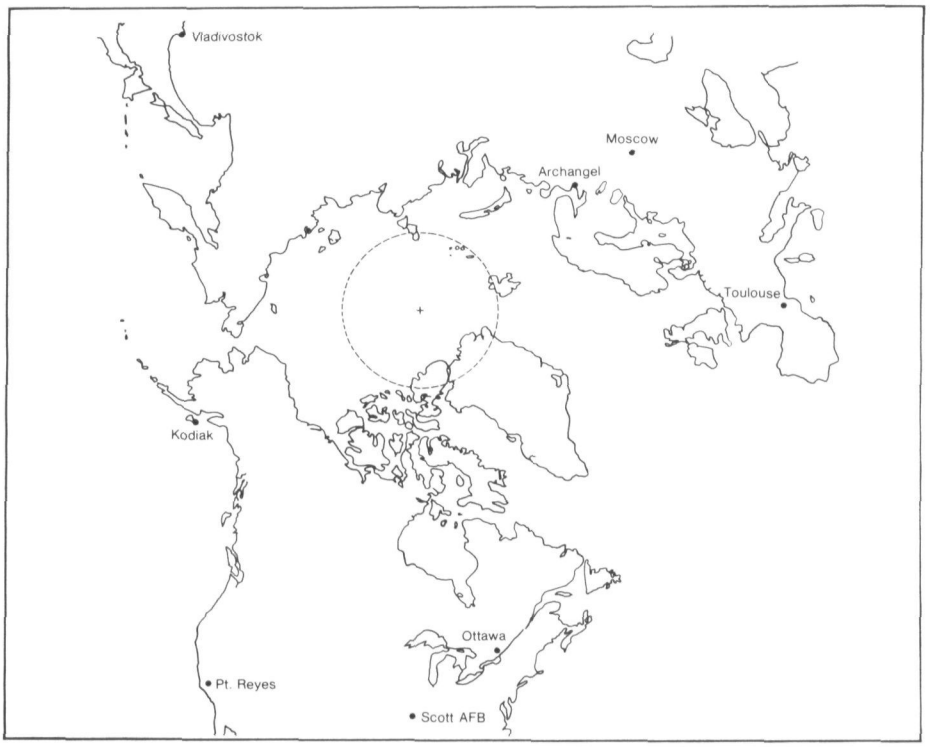
Aviators play an important part in the success of the system. Over the past few years approximately 97 percent of all distress calls are false alarms. Pilots should make sure that the ELT is rigidly installed to the airframe of the plane and it should be tested periodically for a very short period of time (within 5 minutes after each hour). Leaving the system on sends a false distress signal and discharges the unit's battery which may be needed in an emergency. The last thing a pilot should do when leaving his plane is to listen to the 121.5 MHz channel on his VHF receiver to be sure his ELT is not on and if he hears a signal report it to FAA.

Although SARSAT is still an experimental program, it has proven to be a lifesaver, involved in 19 peoples lives in the few short months it has been in operation. With more satellites in the system it will prove to be even more helpful to aviators and mariners in distress. ■

A fully operational SARSAT system would save hundreds of lives which otherwise would be lost to m arine disasters over the next few decades. SARSAT also cuts costly search time. The system can provide the location of a ship or plane in distress to within a 5- to 10-mile radius.



SARSAT LOCAL USER TERMINAL STATIONS



Stations in the U.S.S.R., France, Canada, and the United States cooperate in the SARSAT program. Distress signals to any of the user terminal stations set off an immediate search and rescue effort.

Directions

NOAA Administrator Calls for 'Year of the Oceans'

Keynoting the Coastal Zone 83 conference June 1 in San Diego, Administrator John V. Byrne proposed that 1984 be "The Year of the Oceans".

In his far-ranging speech, Dr. Byrne called for State governments and private interests to exercise leadership in their areas of interest to provide the Nation with strong ocean and coastal programs, and he pledged that NOAA will assume its share of leadership. He gave numerous examples of forward-looking NOAA efforts in science and service.

Excerpts from his speech follow.

It is a pleasure and a privilege to speak to this conference today, at a time when our Nation's ocean and coastal management programs are beginning to be reviewed in many arenas. We have not had a thoroughgoing reassessment since the time of the Stratton Commission report in 1969. Many things have changed since then, not the least of which is the change in direction of the United States Government.

We are restoring to the States and to private initiative activities that had drifted into the Federal sphere. The economy is now clearly on the mend. These factors are encouraging the necessary investments by industry. They also give Federal and State governments leeway to turn from immediate economic problems to a consideration of opportunitites for the future.

On March 10, President Reagan issued a proclamation declaring an exclusive economic zone up to 200 miles off the coast. Within it, the United States will exercise jurisdiction for the purpose of exploring, exploiting, conserving, and managing natural resources.

Also within the Executive Branch, the proposal to form a new Department of International Trade and Industry has brought with it the proposal to make NOAA an independent agency.

Much is going on in Congress. Legislation has been introduced to implement the President's proclamation, and to address a full plate of related issues—definition of the outer continental shelf, deep seabed minerals, ocean thermal energy, marine pollution, fisheries, and others.

This assembly, Coastal Zone 83, is an important example of the ferment occurring in the private sector. And in August, at the Oceans 83 conference, all the recommendations of the Stratton Commission will be reviewed and updated.

We now have an unparalleled opportunity to define and clarify the Nation's ocean and coastal goals, and rally the support needed to achieve them. I propose that we, and all who are interested in coasts and oceans, make next year, 1984, the Year of the Oceans.

I propose that those of you in State government seize the opportunities provided as the Federal Government withdraws from your areas of jurisdiction, exercise the leadership required to fill the vacuum, and provide the Nation with strong modern coastal and oceanic programs for your shores.

I propose that those of you in the private sector renew your commitments to effective oceans programs, and exercise your leadership to bring them about through the vigor and creativity that is uniquely yours.

And I pledge that we in NOAA will assume our share of leadership, by making more effective those programs in science and service that we can best provide . . . and by ensuring that our policy determinations benefit from the widest exposure to advice and criticism from those affected.

Only with active participation and guidance by the private and State sectors can we in the Federal sector discharge our duties efficiently and responsibly.

I believe that the Year of the Oceans will help us achieve a consensus about needs to be met and programs to be undetaken. And I believe that it will enable us to move into the 21st Century with our National directions clear, and with science and technology on track to meet the challenges that lie ahead.

Let me be specific about some of the initiatives NOAA is taking, looking toward the Year of the Oceans and what we believe to be the needs of the future.

Scientific research is one of the areas I have referred to as being an appropriate NOAA activity. We are fortunate in having excellent scientists in the atmospheric and oceanographic sciences, and in many areas of fishery biology. The knowledge and skills that they possess can often be linked to provide solutions to problems broader than might be met in their single disciplines. One such problem promises to be among our most exciting fields of research in the late 1980's.

Fish stocks are large or small, in general, depending on how well the juveniles survive to become adults. Only recently have scientists discovered how heavily this survival depends upon physical oceanographic factors such as currents, turbidity, and salinity, as well as biological factors such as predation.

Our oceanographers and fishery biologists are now pursuing joint research on the factors that influence juvenile survival. Recent advances have put us on the threshold of major predictive capabilities for several important fish stocks.

We think the Year of the Oceans will see important advances toward our goal of increasing the catch of our fishing industry.

Estuarine research is another area of great practical value.

The Nation's estuaries are important to the fishing industry, the environmental community, recreational boaters, and people who go to the beach.

The Galveston laboratory of the National Marine Fisheries Service has found that juvenile brown shrimp use estuarine spartina marsh grass exclusively as a habitat. When it is flooded, at high tide, more than 90 percent of the juveniles are found there. They apparently use it both as a place to hide from predators and for feeding and increased growth.

And the Beaufort fisheries laboratory has recently reported something that may explain how much of the vast amounts of energy locked up in estuarine vegetation is utilized by fish. Our scientists analyzed the material that juvenile menhaden feed on, guessed that it was spartina grass, ground some up and fed it to juvenile menhaden, which digested and thrived on it. This is the first evidence that the fish can utilize the plants directly.

Directions

Any management decisions about development and preservation of estuaries, to be soundly based, must certainly take into account research findings such as these.

The elusive nexus between science and service is well demonstrated in another kind of project that we hope to get started on during the Year of the Oceans. You may recall the Coastal Zone Color Scanner, an experimental instrument still operating on the old Nimbus 7 spacecraft. Its products clearly show the areas of large phytoplankton bloom that mean good fishing, sediment transport in estuaries, and details of oceanic circulation. With infrared added, they show thermal upwelling and areas of thermal pollution.

We would like to put a next-generation Ocean Color Instrument on our polar orbiters. The Improved Tiros-N spacecraft now available have room to accommodate it—and NASA is also interested.

Satellites are high technology items, but we don't confine high tech to outer space. We plan to combine it with modern management practices to make major improvements in what used to be low tech operations. In ports, for example.

So we have recently launched Project PORTS—Port Objectives for Real Time Systems. We are working with the marine transportation industry and the Nation's leading port and waterway authorities to assess NOAA's services and products to them.

We are beginning with systems to provide real time tide and water level information to ships entering and leaving harbors. To these will be added data on currents, waves, and weather, and possibly ice information in northern latitudes. We are also thinking about electronic display of digital nautical chart information.

Indeed, we can envision the day when a ship entering a harbor will display the appropriate nautical chart on a CRT screen on the bridge. Real-time information on its exact position, other traffic, water depths, currents, and similar data will also be displayed. The navigator will have a moving image of everything he needs for accurate and safe navigation under any conditions.

We have also taken a first step toward dramatic improvement in service to the marine community. In October we will open, in Seattle, NOAA's first Ocean Services Center—a one-stop facility for a full suite of NOAA products and services. The center's customers will include commercial and sport fishermen, merchant marine captains, shippers, recreational boaters, and operators of offshore oil rigs.

The center will incorporate all NOAA products and services. Staff from all the major line offices will serve the public. Both operational and retrospective information will be available—marine weather warnings and forecasts, nautical charts and related products, fishery trade and marketing information, access to environmental data bases, and satellite data.

The center will avoid conflict or competition with private industry. When prototype products begin to create viable markets, transfer to the private sector will be encouraged.

There is another serious and growing National problem along the coasts—that of coastal hazards. Planners and managers are becoming increasingly aware, not only of the perils of hurricanes, coastal storms, and flooding, but of the mounting danger as more and more people relocate into coastal areas.

We have identified coastal hazards as one of four high priority areas of emphasis for our expanded program of technical assistance to the states.

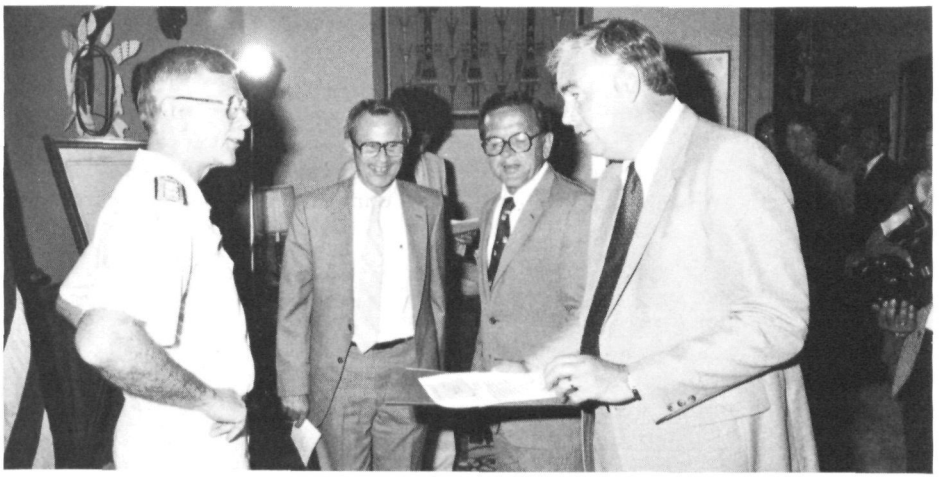
We are also working to improve coordination between our disaster preparedness and mitigation efforts. The National Weather Service is looking at several ways to improve its warning services.

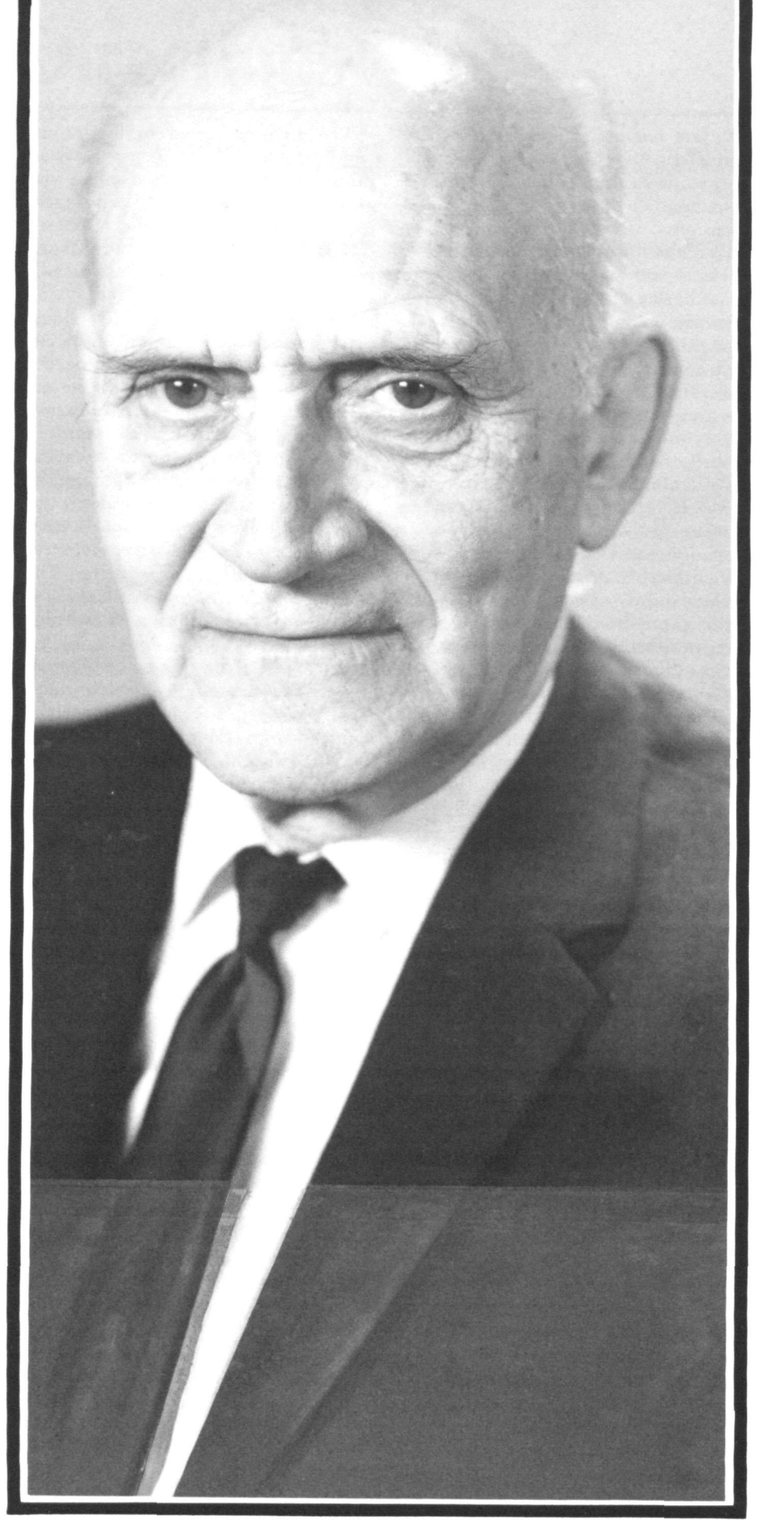
The latest generation of the Weather Service's storm surge model, called SLOSH—Sea, Lake, and Overland Surges from Hurricanes—computes both the height of the surge and the extent of flooding of bays, estuaries, and land areas. Work is on schedule to adapt it to an initial priority list of 21 high-risk basins.

So we in NOAA propose to make the Year of the Oceans a landmark year for improving our services to industry and the public . . . We are looking for your participation and advice. And we are looking forward to working closely with you in a highly productive Year of the Oceans, and beyond.

New Chart for Alaska's North Slope

In a ceremony in the Nation's Capitol Building, NOAA Administrator Dr. John V. Byrne (second from left), accompanied by R. Adm. Kelly E. Taggart, Acting Assistant Administrator for the National Ocean Service, presents commemorative copies of the first chart in the new series of seven North Slope nautical charts to assist Alaska in its development of the area's natural resources to Alaskan Senators Ted Stevens (third from left) and Frank Murkowski (right). ■





"The Chief"

Francis W. Reichelderfer 1896-1983

Earl G. Droessler
Chief, University Affairs Program

Dr. Francis W. Reichelderfer, a world statesman in meteorology, died peacefully in his sleep at the age of 87 in his Washington, D.C., apartment on January 26, 1983. A friendly, trustful man, known to all of his associates as "Reich" or "the Chief", he served as Chief of the United States Weather Bureau (now NOAA's National Weather Service) from September 1938 until he retired in 1963.

In the 1920's as a young officer in the Navy he was convinced that meteorology would become a great science and service; and he worked and lived to see that day. He was sent to Norway by the Navy to expand his education in meteorology and to study the new frontal theory being developed at the Bergen school. The theory already had led to important advances in techniques to improve weather map analysis and weather forecasting. Reichelderfer visited for 6 months in Norway, learning first-hand the principles and forecast techniques of the Bergen school. He returned to America with a tightly written handbook for Navy weather analysts which he entitled "Report of Norwegian Methods of Weather Analysis." The Weather Bureau also circulated copies of the report to its meteorologists, and later credited the report as having much to do with the adoption of frontal analysis methods in the United States.

In the Fall of 1938, Willis Gregg, then Chief of the U.S. Weather Bureau, died suddenly and the Secretary of Agriculture convened an advisory committee to choose his successor. Reichelderfer, still in the Navy and at sea on the battleship Utah, was a natural choice because of his meteorological achievements. Within a few months he was appointed by President Franklin D. Roosevelt, confirmed by the Senate and installed as the Chief of the Weather Bureau, beginning a 25-year period of remarkable leadership.

At that time there was a total staff of between 150 and 200 at the Weather Bureau headquarters in Washington D.C., and another 1,500 to 2,000 working at the regular weather stations throughout the country. In Reichelderfer's view the Bureau had not managed to keep up with the rapid advances in meteorology, so the challenge and opportunity presented to him were such as few men are afforded.

One of the first things the new Chief did was to speed up and strengthen the Weather Bureau changeover to frontal analysis and forecasting. He also started inhouse training for the forecasters in the Norwegian methods he had studied earlier in his career. More graduate meteorologists were recruited by the Bureau and greater attention was paid to the relevant physics and mathematics associated with weather analysis and forecasting. These early steps continued to be key to the improvement of the weather services throughout the years of Reichelderfer's leadership.

Reichelderfer moved to improve public weather forecasting and warning services; he also strengthened associations with the military meteorologists. Four public forecasts a day were prepared by the Bureau meteorologists, rather than just two. By 1940, recorded telephone weather forecasts were introduced in New York, Washington, D.C., Baltimore, Detroit and Newark. The automatic telephone in New York City was soon handling over 58,000 calls a day. During World War II, the Weather Bureau was designated a war agency, and Reichelderfer became a member of a powerful committee established to direct and coordinate civilian and military activities. The wartime cooperation between military and civilian meteorologists carried over long after the war ended and led to rapid changes in American and global weather services. The postwar adaption of WWII developments reshaped the horizon of meteorology as Reichelderfer and his staff sought out and adapted every available technological improvement for the weather services.

Weather radar was one of the more significant applications to meteorology to come out of WWII. Radar can reveal the location and movement of clouds and storms, and by the mid 1940's the Weather Bureau had established a network of modified military weather surveillance radars to cover the Midwest tornado belt and the hurricane-vulnerable Atlantic and Gulf coasts. The success of this venture resulted in the Weather Bureau's development of its own advanced meteorological radar system in the late 1950's, which now covers the entire country.

Like other meteorologists, Reichelderfer thought that mathematical analysis might lead to more accurate weather forecasts. The Weather Bureau was one of several Government agencies that supported the pioneering work on numerical weather predictions carried out at the Princeton University Institute for Advanced Study, beginning in 1946. After 6 intensive years of research, it became clear that computer weather forecasting was a practical operational possibility and a Joint Numerical Weather Prediction Unit (JNWP) was established in the Weather Bureau in 1954. This development required the combined effort of the Weather Bureau, Naval Weather Service and the Air Weather Service, an effort that Reichelderfer championed at meetings with his military colleagues. Each weather service provided a share of money and manpower needed for the operation, and within a few years the JNWP was turning out operational forecasts twice a day.

Perhaps, the earth orbiting weather satellite program contained the most promising and far-reaching technology introduced into the Weather Bureau under Reichelderfer's administration. During a reflective interview in his retirement years he said that one of the most significant advances made during his government service was the success of the TIROS I weather satellite that operated for several months during 1960 and took nearly 23,000 pictures of the Earth and its cloud cover. The global information from the satellites again demonstrated that meteorology is an internationally dependent science; just as the development of the 120 national weather services of the World Meteorological Organization (WMO) always has required a great deal of close international collaboration. In this arena Reichelderfer was clearly a world leader. He was a key planner in the creation of the World Meteorological Organization, a working component of the United Nations. He served as the first president from the United States until he retired in 1963. It is in part due to his efforts that the WMO continues today as a smoothly functioning organization for carrying out regional and global cooperative programs on weather observations and research.

Chief Reichelderfer's 25 years saw the Weather Bureau grow from a small agency with limited personnel and equipment into the most effective national meteorological service in the world. He respected and recognized the assistance he received from his loyal staff and from the thousands of Weather Bureau employees and volunteer weather observers in cities and hamlets across the country.

Meteorologists will remember that he served as President of the American Meteorological Society for 2 years, 1940-41. Many remember that the Bureau under the Chief was a rewarding place to work. But above all they remember Reich for his gracious human qualities. As one of his senior meteorologists put it recently: "he was a true gentleman in every sense of the word." ■

VIEW FROM SPACE

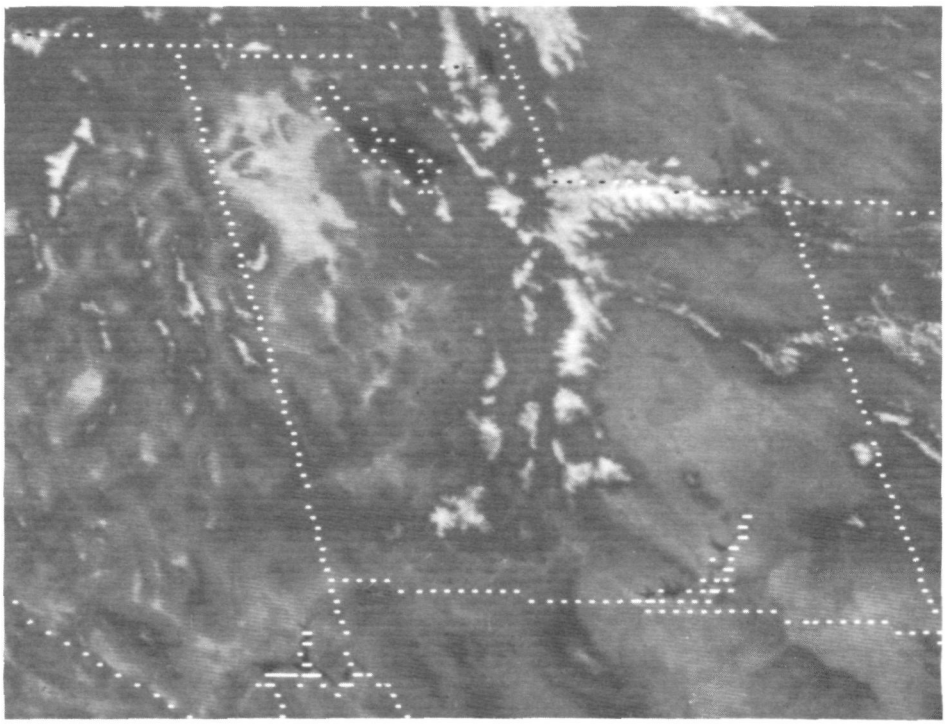
Snowcapped Mountains Spell Trouble

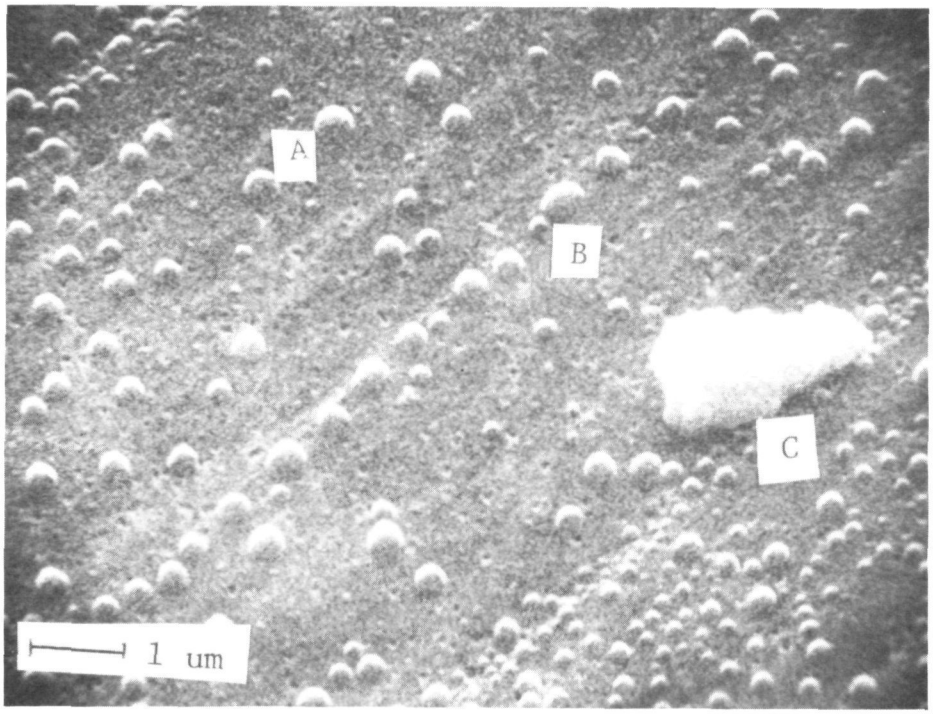
Flooding in many parts of the western United States in late spring came not so much from heavy rainfall as from the melting of the snow which accumulated during the winter months.

The satellite image made by one of NOAA's Geostationary Operational Environmental Satellites (GOES) shows the extent of the mountain snowpack in late May. Salt Lake City, on the southeastern shore of the Great Salt Lake (outlined), lies in the ominous white shadow of the snowy Wasatch Range and Uinta Mountains to the east.

The accompanying photo was made June 4 in downtown Salt Lake City. A giant whirlpool has formed over a blown out manhole, as volunteers rush to divert floodwaters on State Street. The city attempted to lessen the effects of high water by maintaining controlled channels on main downtown streets.

In spite of such efforts, the spring snowmelt floods in the west caused millions of dollars in damage. ■





Sulfuric acid (A and B) dominates this electron micrograph of volcanic debris. Above, arctic landscape below the haze.

Penetrating the Arctic Haze

William J. Brennan

If some scientists at NOAA's Environmental Research Laboratories in Boulder, Colo., are looking both happy and somewhat glassy-eyed these days, there appears to be justification for both. Starting off innocently enough early this spring on what at the time appeared to be a straight-forward investigation of the "arctic haze,"—a mass of pollutants that forms each winter and early spring above the Arctic Circle—the scientists returned 5 weeks later with:

- The finding of a "lost" ice island first inhabited 31 years ago by an Air Force officer destined to become a senior scientist with NOAA;
- The collection of the first significant amount of debris in the arctic from a Mexican volcanic eruption;
- Confirmation that stratospheric air is injected into the troposphere in the high arctic;
- Data to confirm a mechanism by which nature may contribute to acid rain;
- The suggestion that volcanic debris in the stratosphere may have an effect on the "polar vortex," which can cause frigid temperatures in Europe and North America;
- Measurements of an ocean carbon dioxide "sink" in the Norwegian Sea;
- The first-ever dropwindsonde data traversing the Iceland low;
- Identification of a previously unrecognized Brooks Range-North Slope jet stream;
- Identification of an existing lee wave off the east coast of Greenland; and, in keeping with the arctic haze study's original purpose,
- "Immense amounts" of data expected to provide some answers to the arctic haze impact on the arctic climate.

The pay-off of what was an important but modest study by the Geophysical Monitoring for Climate Change Division of Air Resources Laboratory has NOAA scientists champing at the bit to race down the new avenues of investigation opened up by the arctic haze experiment.

Lost and Found

One outcome of the arctic haze investigation doesn't demand any particular research follow-up; the finding of the "lost" ice island.

The story of the island—known to the scientific community as T-3 and Fletcher's Ice Island—goes back to 1952 when Air Force Lt. Col. Joseph O. Fletcher and two companions were landed on the 200-square-miles of glacial ice to establish a scientific and weather station there. The belief, confirmed in the 25 years that followed, was that an island floating around the Arctic Ocean would well serve both scientific needs and those of weather forecasters.

Some 6 or 7 years ago, the island was abandoned. Now it has shrunk to about 21 square miles in size, and its first inhabitant of record, Col. Fletcher, is Dr. Fletcher, a highly-regarded, semi-retired climate researcher with the same NOAA facility from which was launched the expedition which relocated the island. Since last October, T-3 has not been identifiable on satellite pictures, which were being used to trace its meanderings through the arctic ice pack, and had been considered "lost." Somewhat routinely, the arctic haze research team was asked to keep an eye out for it while flying over the ice pack, and on a flight from Thule, Greenland, they located it on radar.

The relocation of the island may, however, be purely academic. Fletcher is convinced that sometime this summer "his" island will "come out" of the Arctic Ocean, drift southward into the North Atlantic, and melt, dumping assorted reminders of former occupation by humans—such as a wrecked C-

Investigators Dr. Russell Schnell (left) and Dr. Melvin Shapiro plan a data-gathering flight into the arctic haze.

47 aircraft, the shells of abandoned buildings, empty oil drums and the like—into the ocean.

While possibly the best "human interest story" to come from the arctic haze investigation, the locating of Fletcher's Ice Island pales by comparison to the scientific significance of other findings. Which of these is most important depends upon an individual's area of concern.

Stratospheric Intrusions

To research meteorologist Melvyn Shapiro of NOAA's Wave Propagation Laboratory, the possible effect upon the polar vortex of particles freed from the stratosphere by a stratospheric intrusion has huge priority for further study.

The polar vortex, he explains, is a feature of the arctic atmosphere from which sudden outbreaks of cold air originate, producing frigid temperatures at lower latitudes. The volcanic particles suspended in the stratosphere not only block heat from the sun reaching the earth, but may also contribute to cooling the stratosphere above, he said. Shapiro plans to investigate a possible link between the enhanced cooling and the outbreak of polar air into the mid-latitudes.

It was Shapiro's recognition of a meteorological phenomenon not previously studied in the high arctic that led to the collection of significant amounts of debris from the volcanic eruption of Mexico's El Chichon during the month-long arctic investigation. Using data from NASA's Nimbus-7 satellite, he saw indications that stratospheric instrusions might be occurring there even as the arctic haze study was going on. A stratospheric intrusion, as its name implies, is an intrusion—or injection—of stratospheric air into the troposphere below. In effect it brings the lower limits of the Arctic stratosphere, usually about 6 miles above the earth's surface, down within reach of a large research aircraft.

If this were happening in the arctic, Shapiro reasoned, and if the NOAA P-3 research plane carrying the scientists on their arctic study could fly through the intrusion, stratospheric air samples could be collected and analyzed. Vectoring the plane with the aid of Nimbus-7 data, Shapiro found not one, but three intrusions where the nearly unreachable stratosphere was as low as a very managable 3½ miles. Obviously, air samples were taken and in-flight preliminary analysis revealed characteristics that made everyone on the aircraft turn their thoughts momentarily away from arctic haze to El Chichon dust.

Dire Predictions Downplayed

El Chichon, erupted several times during the spring of 1982 with such force that its debris was rocketed high into the stratosphere, beyond reach of normal air sampling methods. From some quarters came predictions of dire consequences, but NOAA climatologists were more conservative; the anticipated climate impact, they said, would be a modest change in temperature—a fraction of a degree Celsius—averaged over the globe.

While other scientists, relying on satellite data, balloon-collected samples of El Chichon debris, and high-altitude aircraft sampling such as the NASA U-2 program, have announced findings, the arctic haze aircraft-collected samples are of a quantity and duration that will permit intense analysis and evaluation, leading to additional information on what is floating around over the world's heads.

The NOAA analysis is being done at the Environmental Research Laboratories by Dr. Farn Parungo, using an electron microscope and an X-ray energy spectrometer. While the stratosphere normally has only 35 particles of dust per cubic centimeter of air, the samples gathered from the middle of an arctic stratospheric intrusion contain more than 2,000 particles per cubic centimeter. More importantly, there were large numbers of sulfur-bearing droplets believed to contain sulfuric acid; not enough, it appears, to affect significantly the acidity of rain falling on the earth, but enough to substantiate that

nature is, indeed, a contributor to the acid rain problem.

Even without the variety of ancillary findings from the arctic haze experiment, Dr. Russell Schnell of the joint NOAA-University of Colorado Cooperative Institute for Research in the Environmental Sciences program, who was the experiment project director for NOAA, feels he shepherded a successful investigation.

Pollution Effects "Significant"

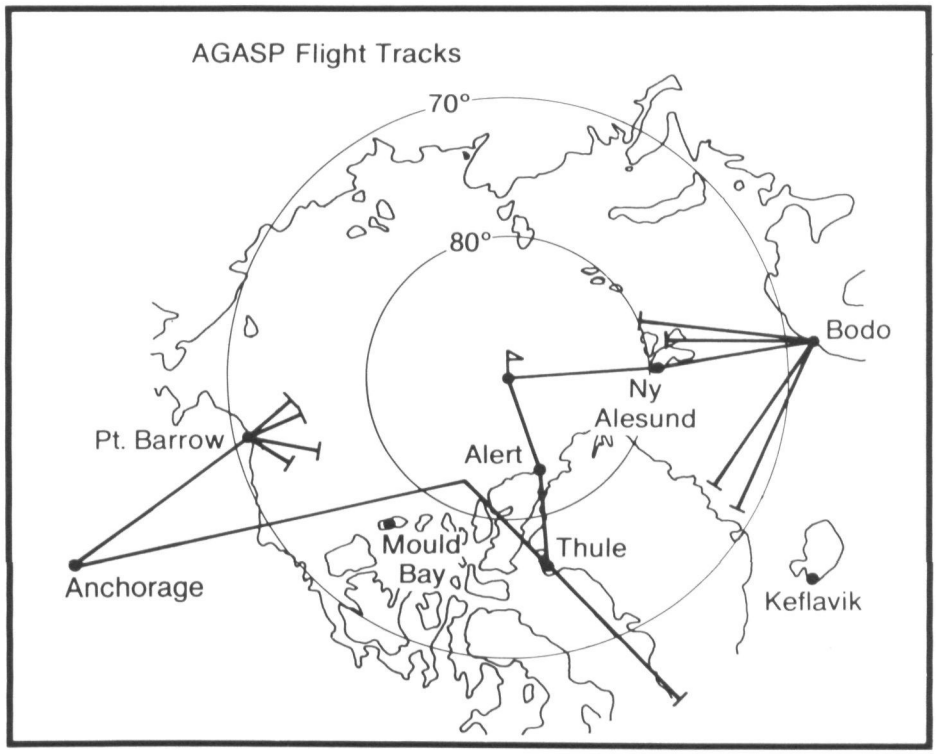
"Considerable laboratory work and computer modeling needs to be finished, of course, before we'll be able to estimate what impact the haze is having on the arctic climate," Schnell said. "But preliminary results of radiation studies done during the flights from Alaska, Greenland, and Norway indicate the pollution is absorbing significant amounts of solar radiation."

The haze—really masses of polluted air—works its way into the arctic each winter and early spring from probable sources in Europe and Asia, with possible lesser amounts from North America. It was encountered on every one of almost a score of flights across the polar ice cap, at altitudes from 90 feet up to 18,000 feet. On occasion it was measured to 28,000 feet. Patches of pollution were spread over hundreds of square miles, in layers of varying density, Schnell said.

On a special mission flown from Norway, the research team obtained measurements they expect will let them determine the rate at which carbon dioxide in the arctic atmosphere is being absorbed by a Norwegian Sea "sink." Such sinks in oceans throughout the world, it is believed, regularly absorb carbon dioxide from the atmosphere. This oceanic absorption, scientists believe, plays a major role in removing excess carbon dioxide from the atmosphere. Computer model studies indicate that increased carbon dioxide in the atmosphere from human activity would cause a "greenhouse" climate warming.

Yet another goal of the arctic flights was to determine how representative measurements of the haze by ground-based instruments in an arctic air sampling network actually are. During flights from Alaska, Schnell said, readings from the research aircraft instruments confirmed measurements recorded by land instruments at the Barrow GMCC Observatory, a NOAA baseline monitoring station on the northern Alaska coast. ■

Abandoned some years ago, the scientific base on Fletcher's Ice Island was re-discovered by the arctic haze research team. The island may disappear forever this summer as it drifts south out of the Arctic Ocean.



This map shows the flight paths taken by the research aircraft. Aided by satellite imagry, the NOAA researchers found three intrusions where the stratosphere was "pushed" low enough for the plane to fly through on data-gathering missions.

On A Voyage to America's Heartland

Ryck Lydecker

(On May 16, 1983, the NOAA hydrographic survey vessel Peirce left the Atlantic Marine Center in Norfolk on a voyage to its summer project area—nearly in the heart of the North American continent, western Lake Superior. To get there, the ship sailed a 3,000 mile course up the Atlantic Seaboard, through the St. Lawrence River, and across four of the five Great Lakes. In all, the Peirce passed through 17 locks, crossed over 12 tunnels, and went under or through 41 bridges to arrive 602 feet above sea level at her destination in Duluth, Minn. Excerpts from the journal of the author, who sailed with the ship on its journey inland, provide fascinating insight into shipboard life and the workings of a modern scientific survey ship on a mission for NOAA.)

May 16 (*1228 Hours*) Ens. Roslyn Harris is the Officer-of-the-Deck for this anticlimactic departure from the fuel pier at Craney Island. Backing away, the Peirce swings slowly around, heading for the channel. Heavy traffic. Waiting to merge. The freeway in slow motion.

The ship has already had its proper send-off from the Atlantic Marine Center. At 1008 the ship had backed into the Elizabeth River to the arm waving, moist eyes and quiet stares that attend any ship's departure. But the necessary stop less than 3 miles downriver to take on fuel has tempered the drama of this leaving.

After more than 2 months of a biweekly grind, running surveys in Delaware Bay, the Peirce has had just 10 days in port to prepare for its next mission, 3 months of hydrographic surveying in Lake Superior.

Tug with empty barge in tow inbound, heading toward us. Two tugs wait idly off our starboard bow to pick up the barge. The swap is made abeam; clear now, we work slowly into the main channel.

Ahead, our sister ship, the Whiting, should be nearing Buoy 19 and moving into the South Auxiliary Channel, heading for the open sea. An hour apart, we are following identical tracks over *National Ocean Service Chart No.* 1222—outbound; Norfolk Harbor Reach, swing northeast, then east, past Old Point Comfort and into Thimble Shoal Channel—pencil lines plowing through a sea of tiny numbers, symbols and shapes. Course lines that change direction abruptly near small black diamonds or magenta tear drops. Lines of record carrying notations of positions passed, of points yet to achieve.

But 2 miles off Cape Henry, the pencil lines diverge, the Whiting's canting off to the south on a course for the Bahamas, that of the Peirce beginning an angular swing to the north. Identical ships taking opposite directions, to opposite extremes, but for precisely the same purpose: to ensure the accuracy of the nautical charts that they, and all of maritime commerce and recreation, depend upon to navigate safety and efficiently in U.S. waters.

(1530 Hours) "Left 10 degrees to zero-four-zero."

"Left 10 degrees to zero-four-zero, aye. . . Zero-four-zero, checking zero-five-one."

"Very well."

With that exchange, Ens. Harris has headed the Peirce into the open sea and set the course for the start of a 14-day voyage that will take the ship to the heart of North America.

May 17

Dawn comes as blessed relief. The ship is still being hammered by head seas but they are smaller now; the storm—and the night—are behind us. The crew begins to set things right. Of 40 people aboard, only a few were spared; even some of the oldest salts were seasick.

The wind shift, from light southerly with a gentle following sea, to hard northwest, came suddenly. Though not unanticipated, thanks to the National Weather Service's marine forecast of early afternoon, the shift came with startling speed that evening. "It was as if you'd just turned the corner," someone had said. Indeed, it was.

The front came through like the midnight freight, cranking the anemometer up to 20, then 25 knots, within minutes, while the barograph went the other way. The wind went to 35, then gusts to 40 knots. Two small waterspouts appeared close off the starboard bow. By dinner time, then well out to sea off the Virginia coast, the Peirce had begun the sickening rise-and-plunge motion that would get far worse during the night.

Only 10 of the crew had showed up for the evening movie. By the end of the first reel, six were left. After the second reel, the violent pitching had left only the projectionist among the living—and he was soon called to the bridge to relieve the lookout of the watch who was simply too sick to carry on.

And so it went. The wind hit 50 knots during the night. But by noon, the storm is an unpleasant memory. Clear, sunny weather off New Jersey. Abandon ship and fire drills in the afternoon, plus the

Opposite page, work and leisure en route. Above, leaving a lock on the St. Lawrence Seaway. Below left, the launch team surveying to find a safe route around a grounded freighter in the Welland Canal. Below, the survey crew uses the time in transit to complete work on the ship's previous assignment, surveying the Delaware Bay.

Clockwise from above, Duluth's Aerial Bridge welcomes the Peirce; plotting the ship's course on one of the 83 charts used in the transit; picture taking in the Welland Canal; Detroit skyline; a TV news team interviews Cdr. Simmons on arrival in Duluth.

maneuverings of three jet fighters overhead and several pods of whales in the sea around us, took the mind off any lingering effects.

May 18

Sunrise over Cuttyhunk Island. Delightful cruise up Buzzards Bay and through the Cape Cod Canal. By afternoon the Cape is falling astern and the Gulf of Maine lies ahead.

In the Plot Room, the survey technicians go over their "homework" from Delaware Bay. Running data tapes, checking soundings, preparing the final field sheets from that survey.

The work goes on. The time at sea allows the survey crew to clear the deck, so to speak; to be ready for the summer's work on Lake Superior.

May 20

Land. We actually touched land—for 20 brief minutes during the transit of the canal at Canso Strait dividing Nova Scotia. Bright, quiet morning. A string of cars and trucks watch us silently from either side of the swing bridge as we pass through. The calm edges of the harbor seem littered with lobster pots.

Later, as the wind increases and we leave the lee of the land, it could get uncomfortable. But except for a brief time during the night when the rolling increases, the passage across the gulf is uneventful.

May 21

(0627 Hours) Passed farthest north (49° 23′ 12″). Five days out, offshore Pointe-a-la-Fregate, Quebec, the Peirce is 752 miles north of AMC. Turned the corner for the long southwesterly run up the St. Lawrence River. Brief applause from the watch.

Masses of floating kelp now punctuate the gray surface. To starboard something surfaces, disappears. Whales. We sight half a dozen or more; small, black, hooked fins. Consensus: pilot whales.

Rain shower ahead makes a gray day grayer, blotting out the Gaspe headlands to the south, snow still clinging to the mountains beyond.

After lunch, the 12-hour pilot call is made to Les Escoumins. ETA at the pilot station, 2330. Later, CO checks his estimated schedule, made up 1200 miles ago, a week before leaving port. "ETA first pilot: 5/21, 2300 hrs." Not bad.

Ninety-three pilots of the Laurentian Pilotage Authority make an average of 110 transists annually on the river between Les Escoumins and Quebec City, the first of three legs requiring pilots. Our first pilot, Capt. Claude Carrier, picked up just before midnight. This stretch is the longest; 12 hours.

Despite the repetition, Pilot Carrier, says he never gets bored. "Every ship is different. Different officers, different crews, different food—but, yet, the same river."

The different ships pass us, heading for the sea we have left behind: Monrovia. Dunkirk. Manila. Algiers. Montreal. Singapore.

At Quebec, the river is flecked with pleasure boats enjoying the bright, but still cool Sunday. The pilot launch dances briefly alongside as Capt. Sirios trades places with Carrier. Peirce passes below the imposing Chateau Frontenec, beginning the second leg on the river, 70 miles to Trois Rivieres.

(1532 Hours) Passing Cap Charles, Quebec, the wind spreads out the colors festooning a flagpole perched on a bluff 100 feet above the river. Figures appear beneath it, waving. Among the flags is the Stars and Stripes. Chief Quartermaster, Ed Jaynes, steps to the aftermast. The U.S. flag ashore dips and we answer in kind as a loudspeaker directed out over the river plays "The Star Spangled Banner."

Capt. Sirois explains that a certain Mr. Duhamel is responsible for this pleasant welcome. For years, Sirois says, Duhamel has been saluting foreign vessels that pass his home by flying their national flags. And if the ship replies by dipping its ensign, he plays the national anthem of that country in its honor.

May 23

(0241 Hours) Rain. Monteal; entering St. Lambert Lock, first of four locks around Lachine Rapids. Total lift, 144 feet.

Peirce is now in St. Lawrence Seaway. Third pilot leaves us here. Because the Seaway is a joint U.S./Canadian venture, and the Peirce is a government vessel, we are not required to have pilots. Pilots may be taken at captain's discretion, but we opt to go it on our own ("My philosophy is to let the junior officers get the ship handling experience," says the Pierce's CO, Cdr. Walter Simmons.)

(1300 Hours) Pass U.S. Canadian border; New York State now is to port, Ontario to starboard. Snell Lock, Eisenhower, Lock, Iroquois Lock—stairstepping our way into the continent. Total lift, 90 feet.

May 24

Sunrise, Lake Ontario. First of the four Great Lakes we shall traverse, end-to-end. Could be the open sea; no land is in sight. A fresh, cold wind kicks up the lake.

(1230 Hours) Arrive Port Weller, entrance to the eight-lock Welland Canal that will take Peirce around Niagara Falls. Little traffic and the ship goes through, lock-by-lock, with no delays: Enter the concrete cavern, dead slow. Small faces appear at the lock wall, 40 feet overhead. Heaving lines drop to the deck, returning skyward in seconds, the ship's hawsers in tow.

Massive steel gates close behind. The "dragon of the lock" bellows from openings in the wall as unseen valves are opened. The water boils as the Peirce begins to rise slowly, then faster.

Within 5 or 6 minutes, the crew is looking down on the lock tenders, the hawsers are hoisted aboard and the gates ahead open into the next lock. The procedure repeats. Seven hours later and 326 feet higher, the Peirce is ready to enter Lake Erie.

The ship passes slowly along the seawall at Port Colborne, marking time for the freighter, Lake Nipigon, heading in from the lake, to clear the breakwaters. But the freighter doesn't turn at the channel marker. It bears straight for the inside breakwater instead.

We quickly heave-to as the message comes over the radio that the Lake Nipigon has lost its engines and cannot steer. The freighter lets go both anchors but comes to rest in the shoal water behind the breakwater, its stern swinging across the channel—our exit is blocked.

By late evening, we are resigned to it. The Lake Nipigon, loaded with iron ore, is hard aground and taking on water. The channel is completely blocked. Three down-bound ships are now anchored out in the lake and the radio tells us that up-bound traffic is stacking up in the canal. The mess deck jokes about "waiting for the tide to take her off" aren't funny anymore. Peirce will lose at least half a day.

May 25

With daylight comes the plan. Our chart of Port Colborne entrance shows a minimum depth outside the channel, behind the Lake Nipigon, of 18 feet. The Peirce draws 11. The solution is obvious.

But, just to be sure—we're in the hydro business, after all—we decide to run a mini-survey of our own. With permission from the Seaway, we launch one of the ship's two hydro boats. Lt. Robert Mandzi, with two seaman, runs a "quick-and-dirty" survey, finds the safest path around the grounded vessel, and leads the Peirce out. By 1100 Hours we are underway, steaming past nine ships now anchored offshore.

May 26

Arrived U.S. Coast Guard station, Cleveland, during the night. By noon refueling is complete, but departure is not until 2300. The crew takes advantage of first shoreleave. Some have family and friends here. Lt. George Leigh and Alice Whitaker, our Yeoman Assistant, are natives and thus, our resident experts. In the afternoon, Port Director C. Thomas Burke, arrives to officially welcome the ship.

May 27

"If it's dawn, this must be Detroit." Crossing Lake Erie at night puts us through the constricted and busy Detroit River/Lake St. Clair/St. Clair River passage in daylight. By mid-afternoon, we're done bucking the 3-knot current, entering Lake Huron for another open lake passage during the night.

May 28

Arrive De Tour Passage at dawn. Morning fog patches hanging among the islands burn off quickly, presenting a clear, crisp, perfectly still morning. Peirce snakes its way northward among the heavily forested islands and arrives at Sault Ste. Marie locks by mid-morning. Lake Superior, the final leg, lies ahead.

Soon the trees on Whitefish Point show up, stacked tip-to-tip, twice their real height, a mirage of the magic of warm air over cold water. Other ships contort in the refraction layer. One becomes a fat rectangle with no superstructure at all. Another has no hull, only deck houses.

The bright sun and calm winds provide optimal conditions for refraction. The strange phenomenon throws vague shapes over the horizon at us that the radar says are ships as much as 38 miles away. But by evening, the sky clouds over and a light northeast wind picks up.

May 29

The northeast wind kicked up during the night as promised by the forecast, and the last day of the voyage dawns cold and raw with a swell that will be building in the open lake. Wisconsin's Apostle Islands, site of part of last summer's survey work, are visable only as darker shades of gray in the mist. Devil's Island Light, appearing briefly through the gloom, reminds us that the voyage is nearly over.

(1456 Hours) The Peirce slides through the Duluth Ship Canal as a loudspeaker at the Canal Park Visitors Center recites the ship's vital statistics for those hearty souls who refuse to let the weather spoil their ship-watching. A TV crew records our arrival for the evening news. NOAA comes to town. The work's about to begin. ■

Vacationing At The Beach? Take NOAA Along

If you're taking a vacation this year at the seashore, NOAA stands ready with services that can help you have a safe, enjoyable holiday.

NOAA offers a number of vacation planning aids, many of them free, and services to coastal residents and visitors.

For instance for nine coastal localities, NOAA can provide recreational climate brochures identifying the best months for water-based recreation (such as boating, fishing, or swimming) in the area and the number of days of good weather to expect for these activities in any 1 month. The brochures provide detailed information on average temperatures and rainfall, wind direction and speed, sunlight, and other climatic factors. Most of them also list recreational facilities. Brochures are available for New York's Lake Erie, the western Michigan shore, Lake Ontario, North Carolina, southern New Jersey, San Francisco Bay, coastal Mississippi, eastern Long Island, and Puerto Rico.

NOAA's *Water Temperature Guide to Atlantic Beaches* provides bi-weekly average temperatures from April through October for thirty-five representative East Coast U.S. beaches. The guide can be used to identify the best swimming and fishing seasons off particular beaches. The text identifies comfortable swimming temperatures, and a table shows the water temperatures preferred by a variety of popular game fish.

Individual copies of the recreational climate brochures or the water temperature guides write Resort Guides, National Oceanographic Data Center, NOAA, Washington, DC, 20235.

NOAA assists in maintaining a network of attractive marine and estuarine sanctuaries. Ferries or glass-bottomed boats operate at some sanctuary locations. The marine sites may also be visited by divers. Details are contained in National Marine Sanctuary and National Estuarine Sanctuary brochures available from Sanctuary Programs Division, National Ocean Service, NOAA, Rockville, MD, 20852.

For boaters, including sailboaters, NOAA produces a full range of nautical charts, including small craft nautical charts for the East and Gulf Coasts; a full range of tide tables, tidal current tables, and tidal current charts; also, a full range of marine weather services charts. The small craft nautical charts show locations for obtaining supplies such as fuel, groceries, and tackle, and services such as moorings, campsites, and repairs. Also available are a publication explaining nautical chart symbols and abbreviations, a publication providing practical tips for the recreational mariner, and a small craft training chart. Further descriptions and ordering information are contained in catalogs broken down by region, as follows: Catalog No. 1, Atlantic and Gulf Coasts; Catalog No. 2, Pacific Coast, including Hawaii, Guam, and Samoa Islands; Catalog No. 3, Alaska, including the Aleutian Islands; and Catalog No. 4, Great Lakes and Adjacent Waterways. The catalogs are available from Distribution Division, National Ocean Service, NOAA, Riverdale, MD, 20840.

Boaters, vacationers, and anyone else for whom the most accurate, up-to-the-minute weather information is important, should have a radio that can pick up NOAA Weather Radio broadcasts. NOAA Weather Radio stations, operated by the National Weather Service, issue continuous VHF-FM programs of local forecasts and warnings, radar summaries, observations, sea conditions, and other weather information. Travel and recreation forecasts are issued in selected areas and may include air and water temperatures, wave heights, wind velocities, sunlight and, driving conditions. A brochure listing NOAA Weather Radio locations and frequencies can be had by writing Public Services Branch, National Weather Service, NOAA, Silver Spring, MD, 20910.

No one expects bad weather on their vacation, but face it: A serious storm such as a hurricane could threaten any area of the Nation's Atlantic or Gulf coasts during the late summer months. Storm evacuation maps are available from NOAA. Write for Catalog No. 5, Bathymetric Maps and Special Purpose Charts, Distribution Division, National Ocean Service, NOAA, Riverdale, MD, 20840.

The serious scuba diver should own the bible of the sport, *The NOAA Diving Manual,* covering physics and physiology of diving, general and emergency procedures, training of divers, equipment, breathing media decompression, aquatic animals hazardous to divers, first aid, and other subjects. The manual is sold (ask them for the latest price) by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 20402.

Another service for the sport diver is a 24-hour hotline for emergency consultation on scuba diving accidents sponsored by NOAA and other Federal agencies. The emergency number is 919-684-8111. Ask for the Diving Accident Network at Duke University Medical Center. Collect calls will be accepted for genuine emergencies.

Films on the coastal environment, marine phenomena, the work of NOAA oceanographers, along with tips on catching and preparing fish produced by NOAA's National Marine Fisheries Service, can be borrowed from the agency. Write Film Catalog, Office of Public Affairs, NOAA, U.S. Department of Commerce, Washington, DC, 20230.

This office also offers a variety of publications on water safety and severe weather precautions.

A bit of planning, with NOAA's help, can make a vacation at the beach safer and more fun. ■

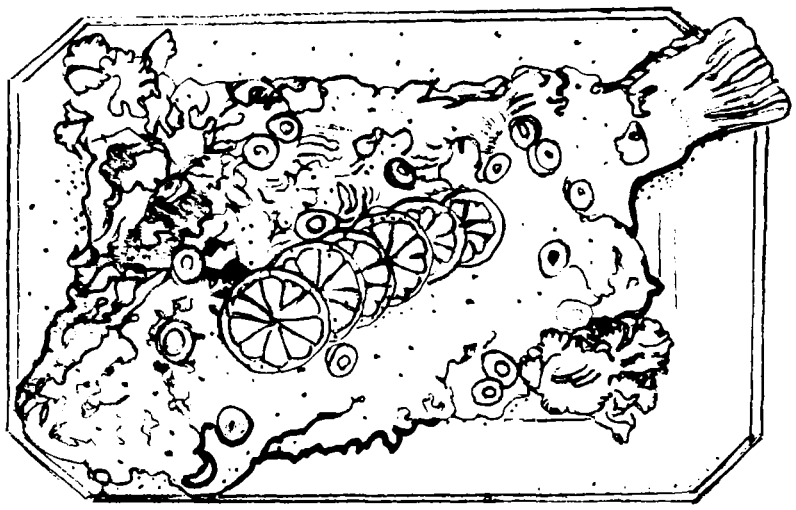
Succulent Summer Salmon

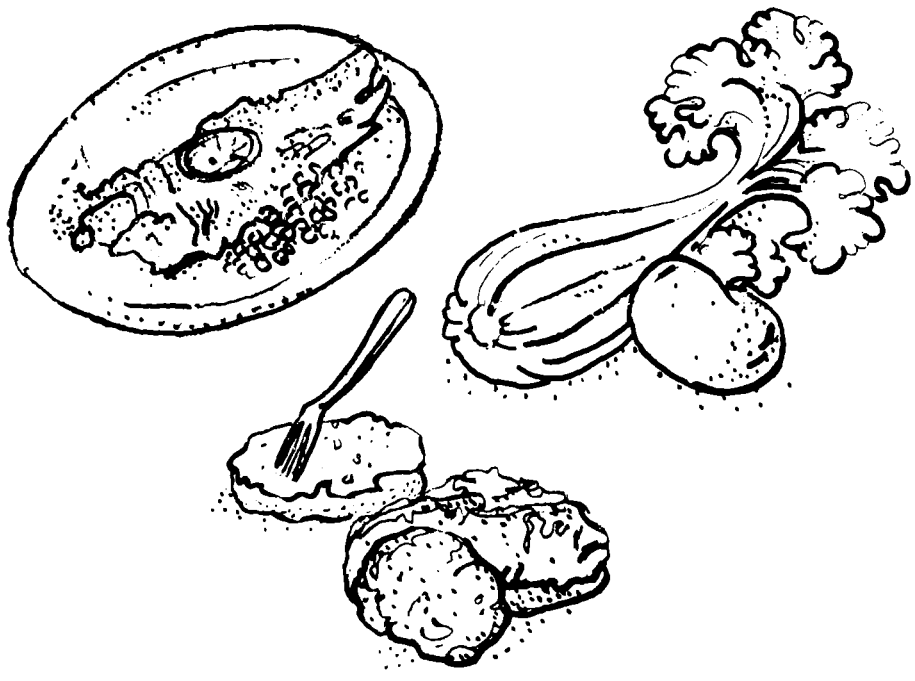
Before Clarence Birdseye came along in the 1920s with a commercially successful method of freezing vegetables and later other foods, all but the very wealthy depended on the seasons to provide fresh food, locally raised and in abundance. Some of us still wait for that first special day in spring when asparagus arrives, knowing that the long winter's wait will be well worth it, or for that afternoon in summer when local tomatoes, plump and red and vine ripened, appear at the greengrocer's for the first time.

There's a seasonality to fish and shellfish too of course, as we all know. In many areas, the oyster season begins in September and runs through April. In early spring, shad and river herring, known in some areas as buckies, begin to swim upstream to the delight of net dipping fishermen on thousands of riverbanks.

But summer—traditionally the Fourth of July, but in many areas later—is reserved for the confluence of three perfect examples of seasonal abundance: salmon, new potatoes, and fresh peas.

Fortunately for us, and Mr. Birdseye's efforts notwithstanding, relatively cheap air freighting makes fresh salmon available in markets throughout the country all summer. And the good earth and local sunshine provide green peas and new potatoes cheaply and in quantity.





POACHED SALMON WITH GREEN PEAS AND POTATOES

1 whole salmon, about 4 pounds, cleaned and preferably with the head still on
1 stalk celery
1 cup dry white wine or white vermouth
1 carrot, scraped
6-8 whole peppercorns
1 tsp. salt
Three or four whole sprigs of parsley

Wash the salmon throughly in cold water. Place in a dish on the rack of a fish poacher or on a rack in a roasting pan just large enough to hold the salmon. Add the remaining ingredients and enough cold water to just cover the fish. Over moderate heat, bring the water to a gentle simmer, no hotter, cover and reduce heat so that the liquid bubbles occasionally, but never actually boils. Cook about 15 minutes per inch, measured at the thickest part of the fish. A 4-pound salmon should poach for about 18-20 minutes.
Carefully remove the rack from the fish poacher, allow to cool for 3 or 4 minutes and then slide the salmon onto a serving platter. Remove the skin from the top or public side of the fish, blot up any poaching liquid that may have drained into the platter, and serve immediately with parslied potatoes and buttered green peas, either surrounding the fish—if the platter is large enough—or separately.

Serve with a loaf of crusty French bread and a full-bodied, dry white wine.

Serves 6 to 8. ■

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Jeffrey Ambroziak (right) of Springfield, Va., won a 3-day oceanographic cruise on the NOAA ship Mt. Mitchell—one of the top awards given at the 34th International Science and Engineering Fair, May 8-14, in Albuquerque, N. Mex.

Ambroziak won the first prize for his science exhibit entitled "Principal Component Simplification of Satellite Data for Non-lambertian Surfaces." A student at Lake Braddock Secondary School in Burke, Va., the 16-year-old built a device using a photographic light meter to measure light reflection patterns for various surfaces through 25 separate viewing angles.

His first prize was presented by Dr. Michael Chinnery (left), Director of NOAA's National Geophysical and Solar-Terrestrial Data Center. Dr. Chinnery also presented the second place award, a $50 Savings Bond, to Hillary Alexandra (second from right), 17, of Waterford, Va., for her entry titled "A 2-Year Study on the Effects of Acid Rain in Loudoun County."

Mary Rita Barry, 18, of Taylorsville, Ill., won NOAA's third place award for her study of "Aerosols and the Ozone Layer." The three winners also received an engraved plaque and a letter of congratulations from NOAA Administrator John V. Byrne. ■