VOLUME 11 NUMBER 2 SPRING 1981

# noaa

# National Oceanic and Atmospheric Administration

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**COVER**

*Spring showers. The year's first warm temperatures can also bring snowmelt flooding. See the story beginning on page 6.*

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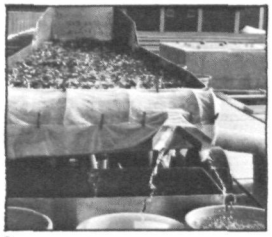

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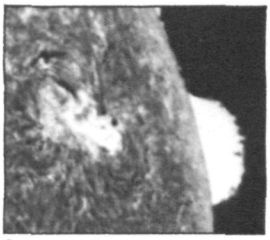

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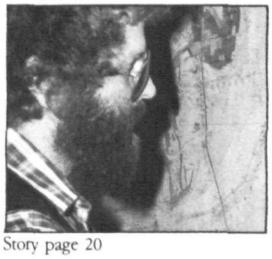

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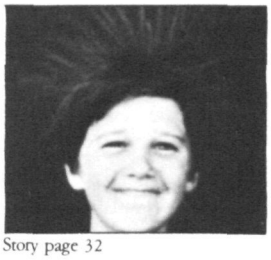

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Malcolm Baldrige
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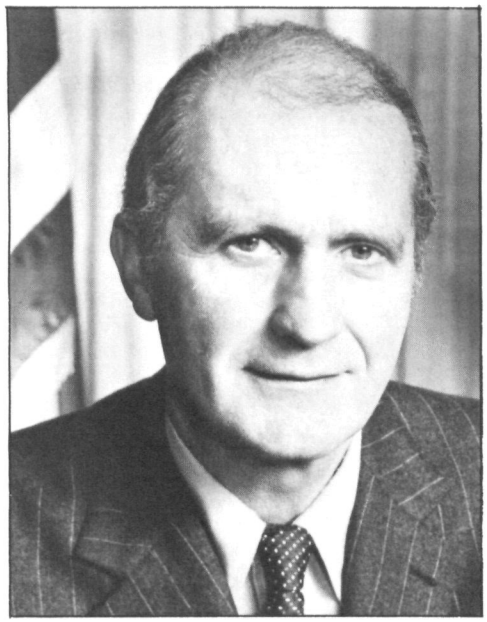
# A Commitment To Equal Opportunity For All



The full realization of equal opportunity for all persons without regard to race, color, religion, sex, national origin, age, or handicap is one of the important objectives of the Department of Commerce. It is both an official policy and a personal commitment of my administration as Secretary of Commerce. I intend to provide leadership which reflects this commitment.

We must work to assure that the policies and decisions made in the Department are nondiscriminatory, both in their intent and impact. The challenge of providing equal opportunity must be met in performing the mission of the Department as well as in employment. The programs we administer, the support we provide to business, and our participation in economic policymaking must reflect this commitment to equal opportunity. I will evaluate our performance as an equal opportunity employer by the results of employment decisions involving recruitment, hiring, and advancement.

Managers are responsible for making good faith efforts to resolve discrimination complaints informally. All employees are expected to cooperate in all aspects of the complaint process to ensure fair and impartial results. Managers and supervisors are expected to take the lead in establishing realistic affirmative action goals and in developing plans to achieve these goals. Goals and plans are to be developed with the advice and consultation of employees whose actions are required for implementation and whose lives will be affected.

I expect equal opportunity goals and plans to be an integral part of our overall management process. These goals will be linked to the SES and merit pay performance plans of managers. Both individual and organizational accountability will be assured by these plans.

With your support we can achieve equal opportunity in every program, policy, and action of the Department of Commerce.

## Winter watch for spring floods

# When The Snow Melts

Don Witten

Each spring, the cycle is repeated somewhere across the country's snowbelt. It begins with a single drop of water which minutes before had been frozen crystals of snow lying on the ground. Soon, the snow is soggy mush, melting rapidly to feed the swelling streams.

The river churns and grows as the multitude of feeder streams continue to drive their watery cargo into the main body of water. It is a mighty river now, rushing downstream with a powerful driving force, spilling over its banks to inundate the nearby communities and farms.

The transformation of a tranquil river into a destructive flood occurs hundreds of times each year across the United States. No region of the country is completely safe from the threat. On the average, 75,000 Americans are driven from their homes by floods each year.

Preparation of spring flood outlooks and river stage forecasts by the National Weather Service is particularly difficult in areas where most of the spring runoff is from melted snow. There is the basic problem of collecting enough good data in ground surveys to estimate accurately the water content of large snowfields which vary in depth and snow density.

The limitations of a ground-based snow survey are evident nowhere more than in the Great Plains states of the upper Midwest where vast flat snowfields can produce major runoff during the spring.

It was the 1969 record snowmelt floods in the Red River of the North and the Upper Mississippi and Missouri River Basins that provided the special impetus for NOAA to "find a better way" for the timely survey of large snowfield areas.

As a result of extensive research by the National Weather Service, the Airborne Gamma Radiation Snow Survey Program was organized. In essence, the effort required the development of an airborne radiation detection and information processing system, and the establishment of 300, 10-mile flight lines across North and South Dakota and western Minnesota.

"The basic technique is quite simple," explained Program Director Dr. Thomas R. Carroll of the North Central River Forecast Center, Minneapolis.

"It is based on the fact that the earth emits natural radiation, part of which is attenuated or blocked by snow. By making airborne surveys of the flight lines before and after snowfalls, we can produce immediate and highly accurate estimates of the snow-water equivalent on the ground."

The new technique was tested for several years in the upper Midwest before being used operationally for the first time during the winter of 1979-80.

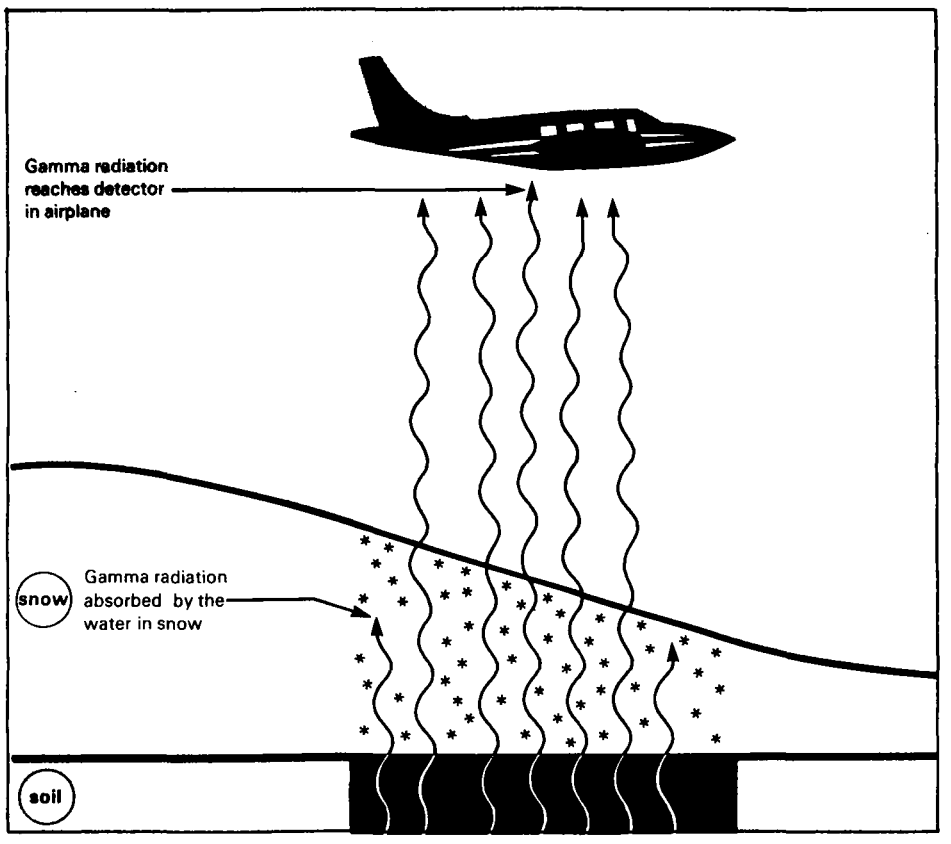
"The Airborne Snow Survey Program is now an integral part of the Weather Service river forecast procedures used for much of the upper Midwest," said Dr. Richard E. Hallgren, NWS Director.

"As such, it contributes significantly to our river forecast activities in that area which are vital to the daily lives and safety of over 100,000 people during the spring flood season," Dr. Hallgren added.

Snow-water equivalent data collected by the airborne snow survey program has become an essential ingredient for the Spring Flood Outlooks issued for the upper midwest by the regional River Forecast Centers in Minneapolis and Kansas City. These data, along with temperature and precipitation information, also are used in forecasting streamflow when a snowmelt flood threat exists.

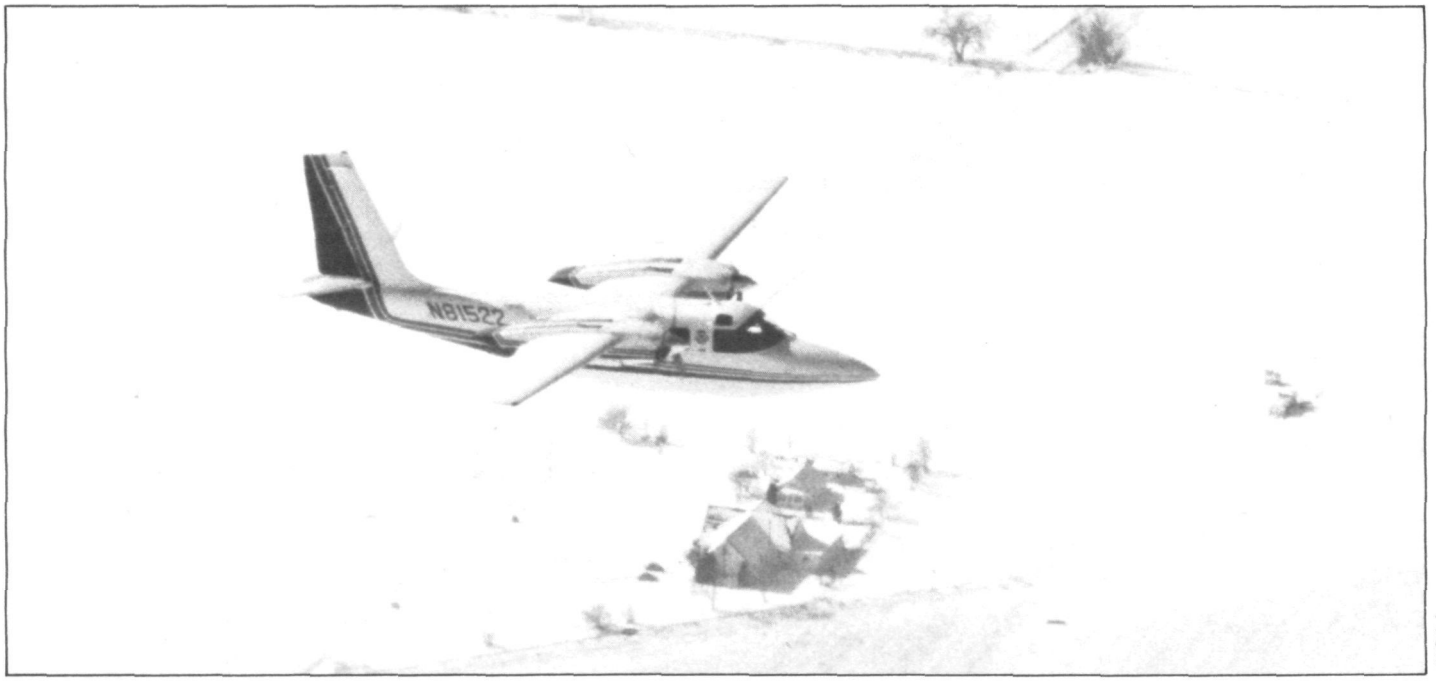
"In addition to warning the public against floods, the Spring Flood Outlooks and river flood forecasts are invaluable to those organizations that must prepare for spring flooding. These include: the U.S. Corps of Engineers, local Civil Defense units, the U.S. Soil Conservation Service, and other Federal, State, and local agencies," said Dr. Robert A. Clark, the NWS Associate Director for Hydrology.

Bob Barnicle, Service Hydrologist at the NWS Forecast Office in Bismarck, N. Dak., gives some insight into the problems posed by ground surveys: "It is a brutal job, both tiring and demanding. We are not always able to get into areas where there are large amounts of snow on the ground. It takes a




*The amount of natural radiation blocked by the snow is measured to give an estimate of snow-water equivalent on the ground. The instrumented plane flies at 500 feet.*

STOP
AHEAD

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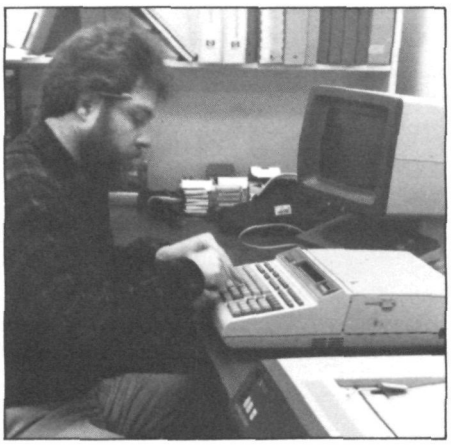


*Plotting their course on a survey mission are Lt. (j.g.) Mark Finke and Lt. Kenneth G. Vadnais. Dr. Thomas R. Carroll (above) transmits data from the Minneapolis river forecast center.*

snowmobile or a helicopter.

"When we do get into an area, we have to determine where to take representative snow samples to get an accurate average. Some areas are bare and others have large snow accumulation due to windblown drifts. We always know that the data we collect are not good enough."

Barnicle said that he was a skeptic at first, but that after seeing the airborne program in operation he has become a believer.

"The great thing about the airborne approach is that you get a good average of the snow-water equivalent for a large area, something that is impossible with ground surveys," Barnicle added.

To an observer collecting snow samples on the ground, the six-seated Aero Commander aircraft used in the survey missions could be a commuter between Fargo and Minot, N. Dak....except for the low altitude and unusual flight pattern.

As the aircraft approaches a flight line, it levels off at an altitude of 500 feet. From here, the onboard radiation sensors view a 1,000-foot wide swath of snowfield.

In the 5 minutes that the plane takes to fly the 10-mile long flight line, its sensors survey over two square miles of snowcover. Ground-based, snow sampling techniques require a dozen men working all day to obtain the same information.

"It takes us about 10 days to survey the entire network. This allows us adequate time to take into account those days when bad weather prevents flying," said Dr. Carroll.

Calibration flights are made over the entire network each fall. The network is again surveyed at least three times after snowfall before the spring snowmelt.

Leased in cooperation with NOAA's National Ocean Survey, the aircraft is flown by commissioned NOAA Corps officers under the supervision of Aircraft Commander, Lt. Kenneth G. Vadnais.

The detection package designed for use aboard the snow survey aircraft contains a gamma radiation spectrometer, computers, and data recorders. The spectrometer is sensitive primarily to high energy gamma radiation emitted from the upper eight inches of the earth's surface soil.

The Aero Commander aircraft also carries instruments to measure the atmospheric temperature and pressure as well as the plane's altitude. This data must be taken into account during the snow survey computations because of the attenuation effect of the atmosphere on the monitored radiation.

"One big advantage of the airborne snow survey technique is its high mobility," said Dr. Carroll.

"After the scheduled snow surveys were completed last spring, north central North Dakota was hit by a late-spring snowstorm on April 6 and 7. The Bismarck Weather Service Forecast Office reported depths in excess of 17 inches of snow so wet that it caused farm buildings to collapse under the weight. We immediately flew a special snow survey mission in the Souris River Basin and collected airborne snow-water equivalent information subsequently used to modify our forecasts of the expected runoff."

"As good a job as we do in evaluating the potential of spring flooding for the upper Midwest, however, we can always get hit in late season with a heavy rainfall or high temperatures which can cause abnormally rapid runoff," cautioned Dr. Carroll.

Salmon on the Columbia

# Mighty River—Important Fish

Hal Alabaster

A major tourist attraction in the Pacific Northwest—and one that residents also enjoy—is a visit to a salmon hatchery. At different times of the year, a hatchery visitor may observe spawning salmon returning from their odyssey to the sea, or watch as thousands of small fish are released to begin the long trip to maturity.

The National Marine Fisheries Service funds 23 salmon and steelhead rearing facilities on the Columbia River, operated by State fisheries departments and the U.S. Fish and Wildlife Service. While their efforts may result in an interesting and educational experience for the casual visitor, the impact of the hatcheries system is vital to the economic well being of the salmon fishing community of the Northwest. The Columbia River hatchery system, with nearly half of the total salmon and steelhead hatcheries on the West Coast, is the largest single system of its kind in the world.

The artificial breeding of salmon has been going on for a long time. As far back as 1872 Livingston Stone was sent to California by the U.S. Commission on Fish and Fisheries to obtain salmon eggs for shipment to the East Coast. In that year, he established the first Pacific fish cultural station on the McCloud River, named after the then Commissioner of Fisheries, Spencer F. Baird. While the main purpose of this first station was the shipment of eggs east, the Commission made a cooperative agreement with the State of California in which the State furnished part of the money for operating expenses in return for the station's releasing native fingerlings into the McCloud River.

Before early attempts to transplant Pacific salmon to the east were discontinued, Pacific Coast salmon had been planted in a large number of major streams on the Atlantic coast and in the Mississippi drainage areas. Some were moderately successful—from approximately 10,000 salmon fingerlings planted in Lake Quinsigamond, Mass., 600 fish were caught. But most attempts were failures; the selected waters were either too warm or too turbid for the fish. A few runs became established, but marginally—they either had so few returnees that they were not self-sustaining, or fishermen caught all the fish.

These early attempts created a large demand for eggs, resulting in construction of hatcheries all along the Pacific coastal States. After a short time, taking eggs for transportation east became secondary to augmenting runs in Pacific coast streams. From these beginnings emerged the Pacific coast salmon rearing facilities.

The passing years saw increased use of the fishery resource and the continuing degradation of the environment needed for the proper spawning and freshwater rearing of salmon. It became necessary to augment natural production, so as to maintain a viable commercial and sport salmon fishery.

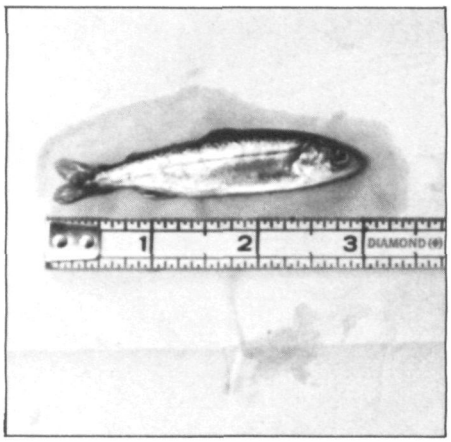
In 1949 the Columbia River Fisheries Development Program was initiated to counteract the severe loss of salmon and steelhead trout resulting from the expansion of water use projects in the Columbia River system. A cooperative effort of fish management agencies in the States of Oregon, Washington, and Idaho, and the Federal government, the program is administered by the Environmental and Technical Services Division of NOAA's National Marine Fisheries Service in Portland, Oreg.

Two major jobs were undertaken.

First was protection and improvement of the stream environment. This included improving the natural habitat by clearing obstructions from nearly 2,000 miles of streams feeding into the Columbia, building 87 fishways past natural barriers, and installing more than 500 screens in diversion ditches and canals.

Second, artificial production of fish was increased by upgrading salmon and steelhead hatcheries on the lower Columbia and its tributaries, and building new ones. In addition, studies have been undertaken to improve the efficiency of the hatcheries.

Pacific salmon and steelhead trout were naturals for hatchery production because their life histories allow successful hatchery propagation, and they have a historical importance to the economy of the United States. Over the past three decades, Pacific salmon have ranked first or second in



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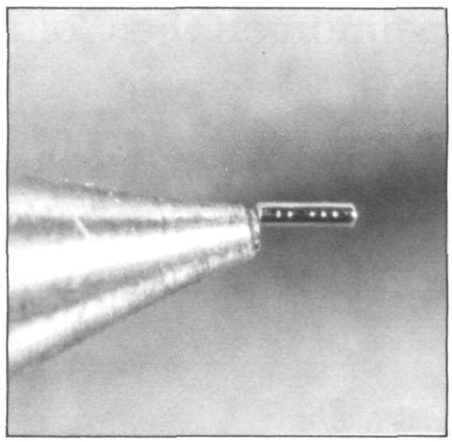
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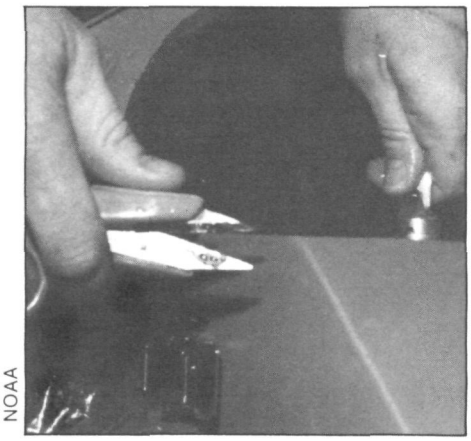
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landed value of commercial fin fishes to U.S. fishermen. The net economic value of salmon sport fishing in the United States was more than $77 million in 1970.

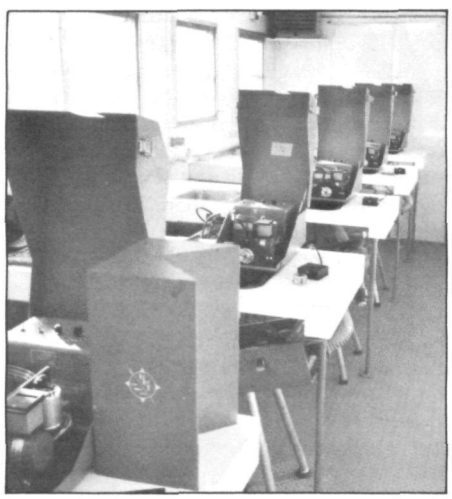
In 1962 scientists undertook a study to estimate the contribution and value of Columbia River hatchery-reared fall chinook salmon to the fisheries. The experiment was confined to the 12 hatcheries and 1 rearing pond that during the marking phase propagated nearly 90 percent of all the fall chinook salmon reared in the Columbia River system. Fall chinook were marked by fin removal for 4 consecutive years. The findings: Columbia River hatchery fall chinook salmon composed nearly one-half of the State of Washington commercial catch and one-third of the sports catch. The hatcheries are important.

Columbia River hatchery fish have been caught along the entire Pacific Coast from Alaska to northern California. One phenomenon uncovered by the study was that the majority of fall chinook salmon were caught off the coasts of Washington, British Columbia, and in the river itself, in spite of the fact that the river borders Oregon as well as Washington. Fall chinook from the Columbia River apparently migrate through northern waters during their time at sea.

The value of these hatchery reared fish offers a striking example of the worth of the hatchery program. The average value of the fall chinook from Columbia River hatcheries caught during the study amounted to approximately $4 million. The cost of the hatchery program during that period was $700 thousand. For every $1 spent on the effort, more than $4 was returned.

In 1979 changes in the sport and commercial fisheries, new developments in identification techniques, and new construction and renovation all served to establish the need for a new study of the Columbia River hatchery system. Moreover the data collected is used by Regional Fisheries Management Councils in making decisions, and further extensive use of the information is made in the U.S./Canadian negotiations regarding fishery catches by the two countries.

The task was given to National Marine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*In a mobile tagging facility (above) a number of stations speed the marking process. At the top of the page, the little salmon and the coded wire tag (greatly magnified in the center photo) are brought together in the hands of a fishery expert.*

Fisheries Service experts in Portland, Oreg. People from the Environmental and Technical Services Division there have had considerable experience in designing, organizing, funding and coordinating similar studies on the Columbia River. In light of these skills, the Columbia River Fishery Development Program was given the task of undertaking and 8-year study to update the information available on the contribution of Columbia River chinook to the Pacific salmon fishery.

The new study is a cooperative effort among the Bonneville Power Administration, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Oregon Department of Fish and Wildlife and the Washington Department of Fisheries. While 6 years remain until the effort is completed, important and significant steps have been taken. During the first year, more than 3.6 million fall chinook were marked and released at the various hatcheries along the river. A similar number will be marked in later years.

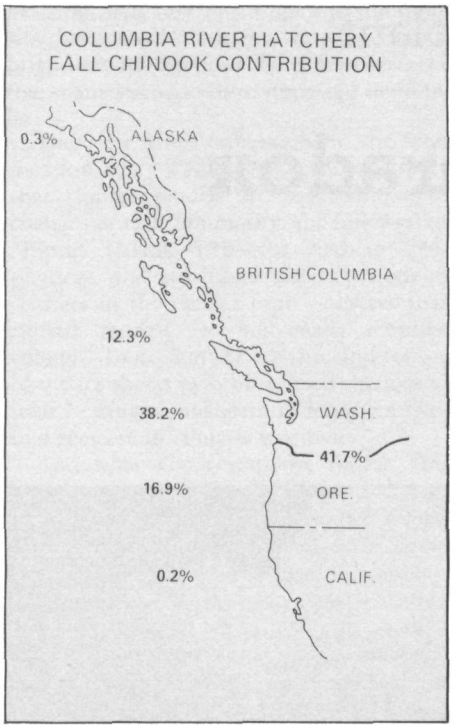
For such an operation, special procedures and additional equipment were required. The National Marine Fisheries Service constructed a mobile marking unit containing six tagging machines, six detectors and the necessary fish holding tanks. This self-contained unit permitted the quick and easy transport of equipment between the various hatcheries.

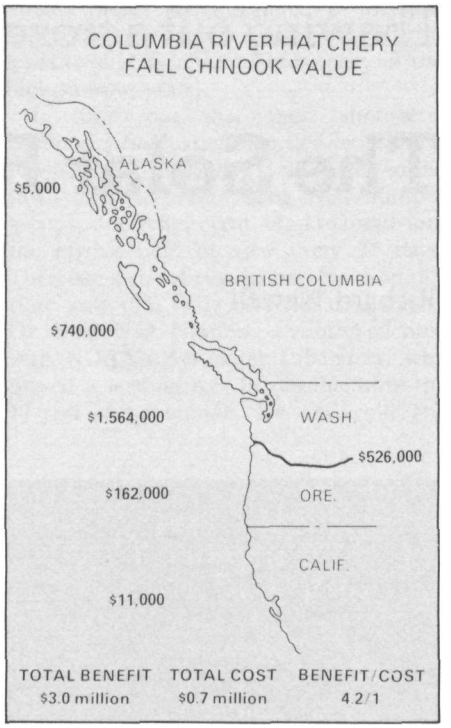
The marking will continue through 1982. The fall chinook at each facility will receive a distinctive mark, made by the removal of the adipose fin (the fleshy fin on the back near the tail) and will be tagged by the insertion of a coded wire tag in its nose.

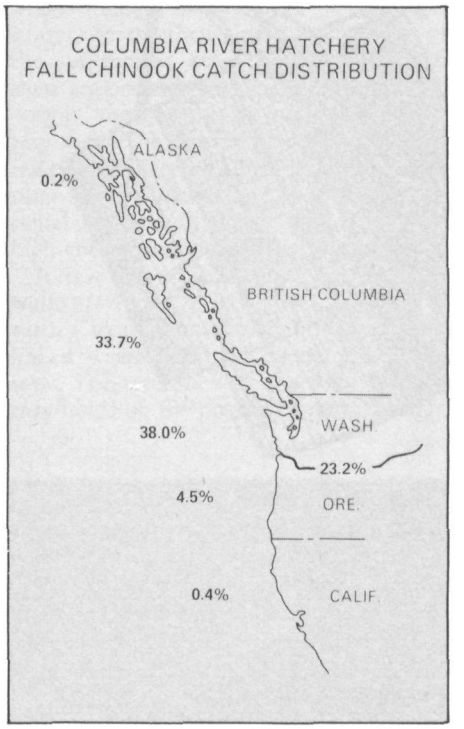
The coded wire tag is a piece of magnetized stainless steel wire one-half the diameter of a pencil lead and 1.1 mm long. The code is permanently notched in the wire in four longitudinal rows spaced at 90° intervals around the circumference. The notches are arranged in groups of six and each grouping represents a binary number. Each facility participating in the study is assigned a specific code and the codes are never repeated. There are 262,000 possible codes for the present tag length. Up to 10,000 tags are produced on about 12 m (40 ft) of stainless steel wire. The wire is then spooled much like fishing leader. The tagging machines cut the wire into the proper lengths and inject the tag into the cartilage in the nose of the small fish.

After their release, the passage of the migrating fish is monitored as they travel down the river. This monitoring provides an estimate of the survival rate from the time of release to the entry of the young fish into the ocean.

Recovery of the tagged fish will occur in the ocean and Columbia River sport and commercial fisheries from 1980 through 1986. Fishery agencies from Alaska to California will sample the catches for marked fish. It is too early to develop statistics, but the first recoveries of marked fish from this study are occurring this year, as the two year old fall chinook enter the river and begin their return to the hatcheries. Results will follow apace.




*The importance of Columbia River hatchery operations to the economy of the Pacific Northwest is indicated in these three charts. More salmon are caught in ocean waters off the coast of Washington than Oregon though the Columbia River borders both states.*

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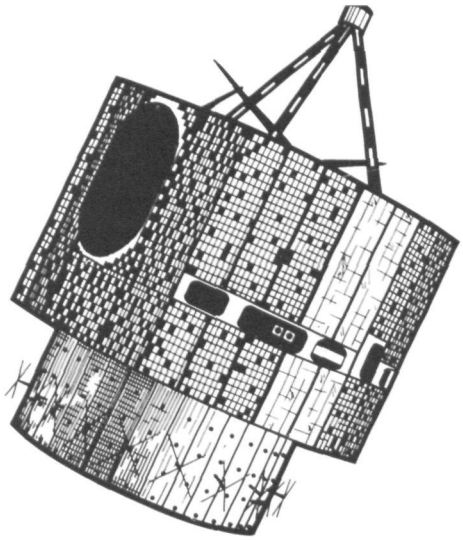
*At the back of a truckload of young salmon, a sampling machine selects those to be tagged. Fish are placed in the upper trough and a flow of water distributes them through the Y-shaped spouts to holding cans.*



Thawing out a frozen plant

# The Solar Paradox

Richard Newell

NOAA

*Thunderstorm activity appears to depend partly on the electrical effects of solar x-rays and protons. Satellites such as GOES help identify storm systems worldwide.*

In 1973, two climatologists spun their mathematical dials and turned down the sun. The dimming was almost imperceptible, just a few percent, but enough to ice the world over, in their computer model. The trouble was, when they turned up the sun again, the ice wouldn't melt.

This experiment has bothered astronomers ever since. They firmly believe that the sun had brightened gradually during the past five billion years, from about 70 percent of its present value. If such is the case, this experiment in climatology, reproducible even with today's models, would seem to imply falsely that the earth has always been covered with ice. The upshot, according to Cambridge astrophysicist Douglas Gough, is that scientists are faced with what has recently been called the "faint-sun paradox": either the astronomers are wrong or the climatologists are wrong.

Gough says that the long-term rise in solar luminosity, a straight-forward result of basic physics, is difficult to question. "It seems inevitable," he asserts, "that the climate model must be inadequate." Climatologists readily acknowledge that their numerical models are still in a primitive state, and that a satisfactory, self-contained climate theory does not exist. Ap-

parently, it is very much open to question whether small changes in the sun's brightness are the powerful climate-shapers that many scientists have suspected them to be.

There are other dimensions to the solar paradox too. While astronomers suspect that climate models are too sensitive to changes in solar luminosity, the followers of Milutin Milankovitch—the Serbian geophysicist who attributed glacial periods to changes in the earth's orbit—observe that climate models are not nearly sensitive enough. To explain the advance and retreat of the ice sheets by orbit-related changes in solar heating would seem to require a five-fold increase in climatic sensitivity.

And what about response times? This gets down to the nitty-gritty of sun-climate relationships—to the time lag between solar cause and atmospheric effect. Some reported effects have time lags of just a few hours—much faster than solar heating could allow. And yet, short-term changes are what long-term climate trends are made of.

Satellite observations of solar luminosity over the past few years have added another twist to the solar paradox. These observations have provided direct evidence that the sun's output of heat and light is fluctuating. However, the changes are quite small, and most importantly, may be out of phase with what the associated climate variations call for.

The strongest of these climate variations occur over the 11-year sunspot cycle. The elements of atmospheric circulation—pressure, temperature, wind, storm tracks, and even the height of the tropopause (the lid of the troposphere, the earth's weather layer)—have all been recently reported to change, over large areas, in step with the number of sunspots visible on the solar disk.

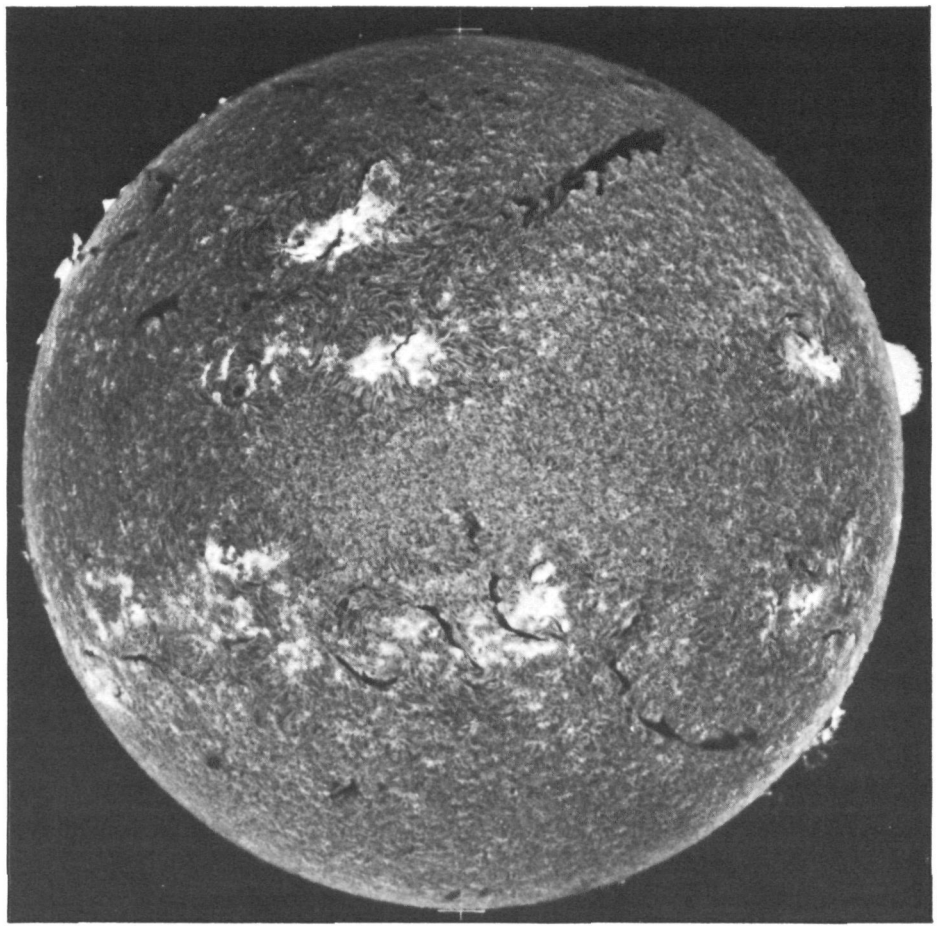
Researchers tend to agree that if these circulation changes represent a true sun-climate link, then that link must involve a form of solar emission that increases with the sunspot number. However, preliminary analysis of the thermal data from the satellites, Nimbus 6 (launched in 1975) and Nimbus 7 (launched in 1978), reveals that during the last upswing of the sunspot cycle, the sun's heat output was nearly constant. Nimbus investigators say that, if anything, a slight dimming may occur during the years of transition from sunspot minimum to sunspot maximum.

These sun-watchers surmise that the apparent long-term dimming is produced by the sunspots themselves. Day-to-day observations from Nimbus 6 and 7, as well as from the recent but short-lived Solar Maximum Mission satellite, have revealed that the sun dims by one or two tenths of a percent as sunspots move across its face. Apparently, the effect of the relatively cool, dark sunspots overshadows the effect of the areas of bright plage (rhymes with corsage), and the occasional solar flares, which also inhabit these "active regions" of the sun. The solar investigators suspect that all this leads to slightly reduced luminosity in the high-sunspot years.

It turns out that these short-term luminosity fluctuations are tied to a second sunspot cycle—a 27-day cycle geared to the sun's rotation rate. Long-lived sunspot groups, when they occur, tend to rotate into the earth's field of view every 27 days. There are signs of circulation effects on this time scale too. Early evidence comes from Dr. Gregory D. Nastrom, a visiting scientist with NOAA's Aeronomy Laboratory, who played a leading role in documenting the 11-year climate cycle. He and colleague A.D. Belmont show that the height of the 300-millibar pressure level (near the top of the troposphere) may be fluctuating over a range of about 50 meters (160 feet) every 27 days. Such pressure changes, increasing over some areas of the earth and decreasing over others, would produce changes in pressure gradients and global wind patterns. Nastrom emphasizes, however, that this is a preliminary finding with marginal statistical significance, and requires further work.

Over the years, several studies have pointed to a 27-day cycle in wind speeds, temperatures, and rainfall in various parts of the world. If such a cycle truly exists in the circulation of the troposphere—a cycle whose strength should peak in the high-sunspot years—then it must be the doing of the sun-spotted active regions. Although these regions are comparatively low in heat output, their output of other emissions is very high. The steadily glowing solar plage is a prolific source of x-rays and high-energy ultraviolet radiation, and so are the occasional solar flares, which sometimes emit high-energy protons as well.

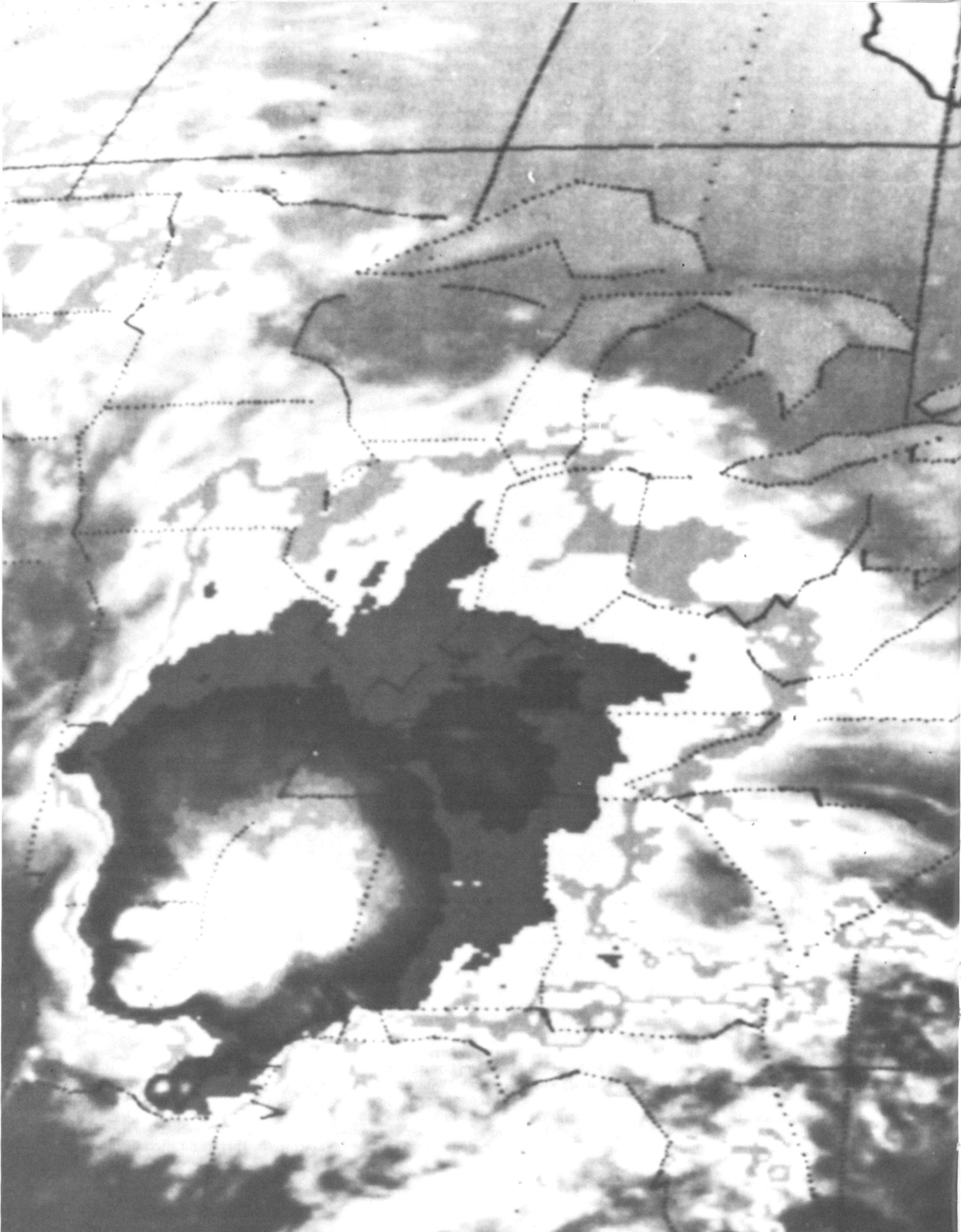
It may be that the sun's heat output, while providing the basic fuel supply for the earth's weather machine, is not the sun-linked weather-climate regulator that we seek. The resolution of the solar paradox may hinge on the possibility that the high-energy emissions are responsible for the observed climate changes. The question is, "Which emissions are the key ones, and how might they help to regulate the weather machine?"



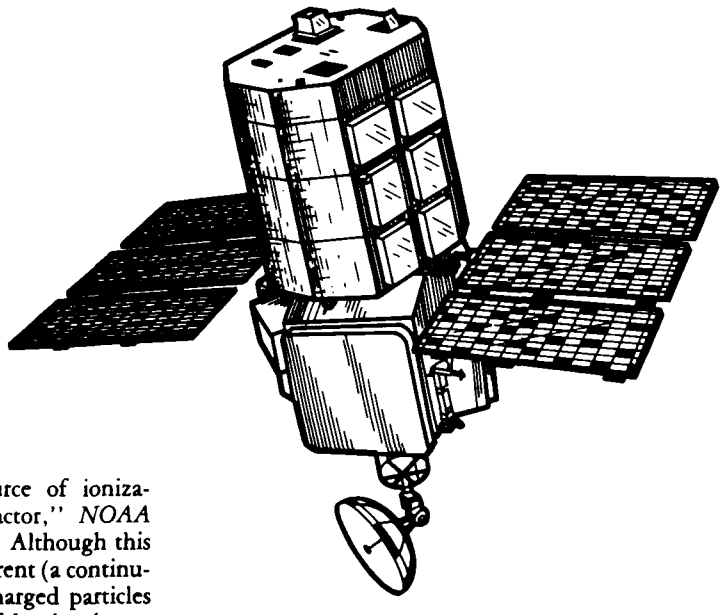
NOAA

*X-rays from solar flares and areas of bright plage produce changes in the earth's atmosphere which may effect our weather.*

Could it be the ultraviolet rays? They are known to produce and heat the ozone of the stratosphere. Some investigators suspect that the related changes in stratospheric temperatures and winds might be felt at lower levels. They might affect the structure



*The "Mesoscale Convective Complex" shown in this satellite infra-red photo is more than 100 times bigger than a single thunderstorm. These huge storms seem to be able to boost jetstream winds and modify the atmosphere's large-scale circulation. Data from the Solar Maximum Satellite (right) indicated that the sun dims a bit as sunspots occur.*



of the meandering planetary wind waves that penetrate far up into the stratosphere and are a primary shaper of regional climates. However, a National Research Council report issued in 1980 states that recent research does not support the idea that these long waves are sensitive to stratospheric changes.

Could it be the x-rays? They are known to increase the electrification at the base of the earth's ionosphere, some 60 kilometers high, and thereby stimulate the global electrical circuit. (High-energy solar protons, which take as little as 20 minutes to reach the earth, are even more powerful ionizers, but energetic proton flares are rather infrequent events.) The global circuit carries electrical current upward from the ground, through thunderstorms, to the base of the global ionosphere, where the current spreads out and then leaks back to the ground in fair weather areas.

There is reason to believe that the stimulation of the global circuit by x-rays from solar plage and flares can boost thunderstorm activity, even though the storms themselves are known to be the circuit's main driving force. This would be an electrodynamical effect comparable to that observed in a high school physics experiment involving a standard electrical generator (our laboratory "global circuit"): the mechanically driven rotor (thermally driven thunderstorm cell) of the generator (global circuit) can be made to speed up (intensify) if the electrical current in the generator's stationary windings (ionosphere —fair weather atmosphere—ground) is stimulated by an external force (magnetic field in the lab, versus ionizing particles or radiation in nature). In other words, our generator can also function as a motor.

Theoretical support for this electrodynamical sun-weather link came from the late Doyne Sartor of the National Center of Atmospheric Research. He concluded that the added storminess produced by this electrical supercharging of convective clouds would be quick to take hold (within hours) and slow to die off (several days), perhaps even persisting over the lifetime of the weather system.

Indirect support for this idea comes from the consideration of galactic cosmic-ray particles as an additional source of ionization (see "The Galactic Factor," *NOAA Magazine*, Sept.-Oct. 1980). Although this ionizing source is quite different (a continuing influx of high-energy charged particles from outer space is regulated by the changing magnetic fields of the solar wind and the earth), the climate-coupler would be the same: the global circuit and its thunderstorms.

Direct evidence for a link between solar x-rays and weather is hard to come by. Scientists are just beginning to conduct serious studies of the global circuit and the electrodynamics of thunderstorms. However, some provocative correlations have recently been established. Veteran sun-weather researcher Roger Olson of the Aspen Institute for Humanistic Studies has found that increased thunderstorm activity (measured in terms of daily geographical extent over the central and eastern U.S., using a maximum of one thunderstorm report per station per day), accompanies major solar flare events, as well as the rotation of large and active plage areas to within the earth's field of view. He explains that a perplexing additional factor is that the effect is more pronounced when the earth is within a solar wind sector whose magnetic polarity is negative. It may be that these particular magnetic sectors are more easily penetrated by galactic cosmic-ray particles, whose energizing effect on the global circuit would reinforce that of the x-rays.

Olson and others have also shown that vigorous plage and flare events, besides coinciding with increased thunderstorm activity, are followed within a matter of hours by significant changes in the large-scale atmospheric circulation, including its pressures, temperatures, and winds. If thunderstorms are the link between the sun's x-ray machine and the earth's weather machine, how is the storm energy channeled into large-scale circulation systems, including the globe-girdling planetary waves?

In 1958, tropical meteorologist Herbert Riehl suggested that giant thunderstorms, called "hot towers," could send warm, tropical air upward and then poleward to help equalize the earth's equator-to-pole heat imbalance—and energize our mid-latitude weather in the process. These giant thunderstorms have recently been identified as the building blocks of a newly discovered type of weather system called the "Mesoscale Convective Complex" (MCC).

Observations from NOAA's "GOES-East" satellite reveal that these storm systems occur frequently at both middle and low latitudes. Reinforcing the possibility that tropical thunderstorms may help to power the earth's weather machine, is the finding by Robert A. Maddox of NOAA's Office of Weather Research and Modification that midlatitude MCC outbreaks can lead to important changes in large-scale circulation systems within just a few hours.

Although Maddox is no advocate of sun-weather relationships, his work is clearly of interest to sun-weather investigators. He shows that the huge storm systems that frequently occur beneath peak jetstream winds can actually help to generate those winds. The persistent updrafts associated with these little-studied MCCs also increase the atmospheric pressures overhead, and probably even the height of the tropopause.

He states that these highly organized and long-lived systems interact with their large-scale environment in ways that may affect the future evolution of circulation features over much of the United States. Says Maddox, "Convective storms are typically considered to be controlled by the evolution and movement of large-scale circulation features. But since the larger-scale features may be significantly modified by such convective systems, 'chicken and egg' questions become extremely important."

His ongoing thunderstorm research has no proven sun-weather tie-in. Yet, who knows? It may provide sun-weather investigators with the information needed to explain some of their key correlations, involving thunderstorms and the large-scale circulations that shape our weather and climate. And that might bring us one step closer to resolving the solar paradox, in all its dimensions.

NOAA

*New England fishermen. You see them in all the tourist gift shops: bearded, pipe in hand, wearing a yellow slicker. Or you hear the barroom legends: hard workers, hard drinkers. When you conjure up the wives, you see them pacing the widow's walk or standing on the rocky shore waiting. The picture is probably of a hardy, capable woman, even tough.*

*Some romance is bound to color our impressions of the people involved in commercial fishing. In reality, the stereotypes are as farfetched as stereotypes usually are. Just as the majority of fishermen fail to fit the plaster casts in tourist shops, fishermen's wives also fail to conform to expectations. Call it Yankee individualism or human nature, fishermen's wives are as different from each other as all of them are different from other women. At least this appears to be the case in one southern New England fishing community.* **

**From the original study

Fishermen's families

# The Proud Women Of Galilee

Fran Danowski*

Chris Duerr

*Little kids' games are the same everywhere, but stacks of lobster pots, nets and twine, sea anchors, and other gear identify the yard of the fisherman's family.*

Chris Duerr

The winter of 1980-'81 made the front pages of newspapers in the northeast. The coldest weather in years brought record breaking low temperatures and wind chill factors dangerous to domestic plumbing and exposed skin.

Media in coastal areas reported on the weather from a slightly different angle. The cold, ice, and wind kept commercial fishing vessels at home unusually early in the season. Crews were seen chipping boats out with shovels and boat hooks. Since few fish were being landed, prices reached record highs and stayed there. Fishermen drank gallons of coffee, exchanged news and waited nervously for a break in the weather.

What didn't make the news, however, was the fact that fishermen's wives, as well, were anxiously awaiting a return to whatever normalcy they've learned to expect in their unusual way of life.

Late in the winter of 1978 I began researching this way of life at the port of Galilee in southern Rhode Island. Over the phone I took directions to fifty different residences within a 25-mile radius. Once I found the neighborhood, there was rarely a problem locating the homes of fishermen's wives. There were usually plenty of clues both inside and outside the house to indicate the occupation and preoccupation of the household. Stacks of lobster pots, nets and twine, sea anchors, and even boats are found in many yards while nautical books, ships' clocks, models, paintings, and photographs of fishing boats decorate interiors. The interview schedule I had prepared was estimated to take about one hour but response and related discussion turned out to average 2½ hours. Very few women declined the opportunity to talk at length about what it's like to be married to commercial fishermen.

I certainly felt immersed in the subject as I was welcomed into homes, frequently located near the water, where decor set the stage and the background sound by day was the radio transmission of on-the-boat fishermen's talk and in the early evening, the snores of exhausted husbands asleep in another room. Younger and older children were often present and joined in the conversation. Once I spent the afternoon with a mother and daughter who were both married to fishermen (fishing tends to run in families). Occasionally, husbands joined us to add their comments. In fact I was very lucky that winter when bad weather cancelled one particular fishing trip. Pleased with myself to find the address in the dark and arrive on time, I drove up to the house with a flourish and immediately and with a great crunch sank through a large icy patch right up to the axle. I would have been stuck until spring if the fisherman of the house hadn't been around with his heavy duty truck to pull me out.

Fishermen's wives had a lot to say about their husbands' jobs. Their most emphatic message is that it is very different from other occupations. The most glaring difference is the irregularity of schedule. It is not simply as irregular as New England weather; it also depends on fishing quotas, the condition of the equipment, market prices, and the whim of the captain. "Normal" households move from breakfast to dinner, from weekend to weekend, with regular stops at holidays. None of these benchmarks work for the fishing family. All that can be predicted for their entire year is that the fishermen will be out more in the good weather than in bad.

Because the men are frequently at sea, the responsibility of maintaining a safe and comfortable home life falls largely on the women's shoulders. Now if the fisherman's wife had crashed through that previously mentioned icy patch while her husband was working, she would have had to find a way out herself. A consistent complaint about the husband's absence has to do with problems and emergency situations. Ironically, crises rarely seem to occur when husbands are at home. Pipes freeze, break, and flood the house, children fall and break limbs, everybody gets the flu at once only when husbands are out fishing. Coping alone and maintaining household continuity are everyday tasks for fishermen's wives.

There is another effect of the irregular schedule which is not always understood by the non-fishing community. Because profit depends on so many unpredictable variables, captains and crew must take advantage of every possible fishing trip. If that trip conflicts with birthdays, weddings, school graduations, or the like, it simply cannot be helped. One of the most difficult things a new fisherman's wife must adjust to is the fact that you cannot make plans. When a fishing trip interferes with a social occasion, women either learn to attend without their husbands or learn to live with disappointment. Many a fisherman's wife has attended more than her share of little league games alone or has acted as her family's sole social ambassador on important occasions.

An irregular work schedule equals irregular pay. Even though most fishermen's wives claim that income is one of the best aspects of the job, they must become wizards at long range planning in order to maintain their family's standard of living. Health insurance, retirement plans, and tax withholding are not automatically provided. Both owner and crew families must individually plan for all benefits and contingencies.

Although the schedule or lack of one undoubtedly causes headaches, it is a tribute to positive thinking and healthy adjustment that many fishermen's wives can also manage to enjoy the unpredictability. Some say that it keeps things interesting and changing. Cancelled trips seem to give the whole family an impromptu holiday feeling. But even within this chaotic framework, the women find comfort in a routine of sorts. They know the average length of their husband's fishing trip and use that time to catch up on shopping and chores, to

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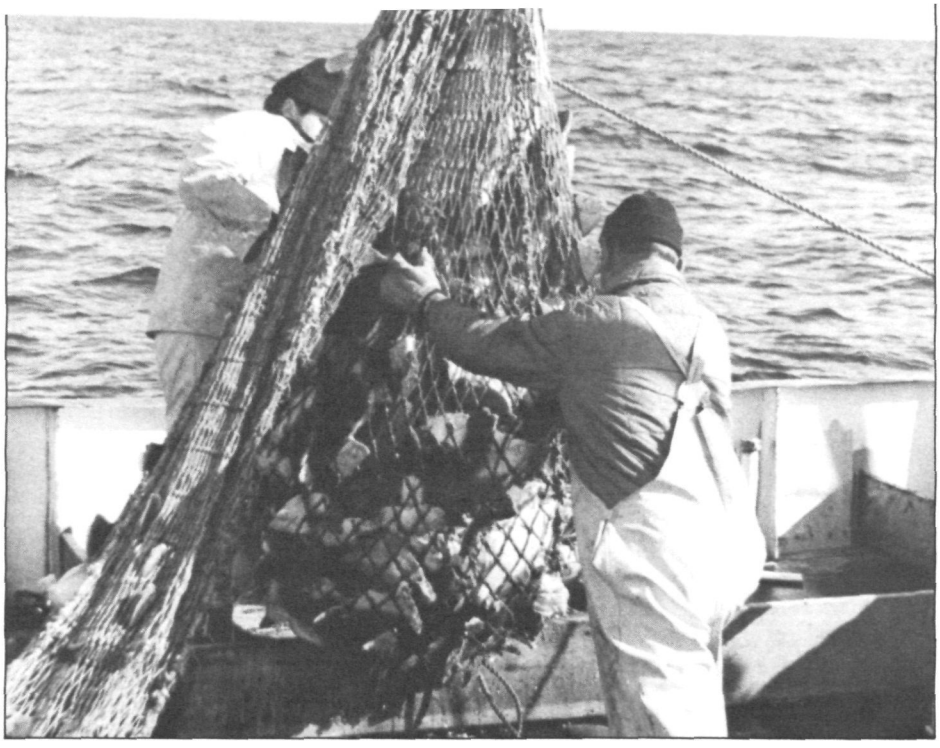
**The material in this article was gathered by Miss Danowski during a study she conducted for the University of Rhode Island, sponsored in part by NOAA. The study, Fishermen's Wives: Coping with an Extraordinary Occupation, URI Marine Bulletin 37, is available from URI, Marine Advisory Service, Publications Unit, Bay Campus, Narragansett, RI, 02882 ($2).*



URI

U.S. Travel Service

URI

*At sea a fisherman sleeps, eats, and works on his boat. It's hard and often dangerous work.*

visit with their friends, spend special time with their children, and to pursue their own activities and hobbies. They find the house is neater and the pace is more relaxed when their husbands are out fishing. When their husbands are home between trips, their time is reserved for family activities and togetherness. Meal times and children's bed times are apt to be irregular between trips and there is, of course, more cooking, cleaning up, and general commotion. When circumstances such as the harsh weather we recently experienced keep fishermen home for an unusually long time, things begin to get very uncomfortable. Fishermen get restless and don't know what to do with themselves. They really can't get involved with any projects or take short vacations because they may have to go back to work at any time. The women who have suspended their routines while their husbands are home are also under a strain. One woman recalled being in the middle of a remodeling project when some consistently bad weather kept her husband at home. She found his restless pacing around the boxes and materials very distracting. He was too preoccupied to help and, consequently, very much in the way.

During times like these, women who work are envied by fishermen's wives who don't. A job outside the home imposes a routine that allows a temporary escape from the irregularity of the home scene.

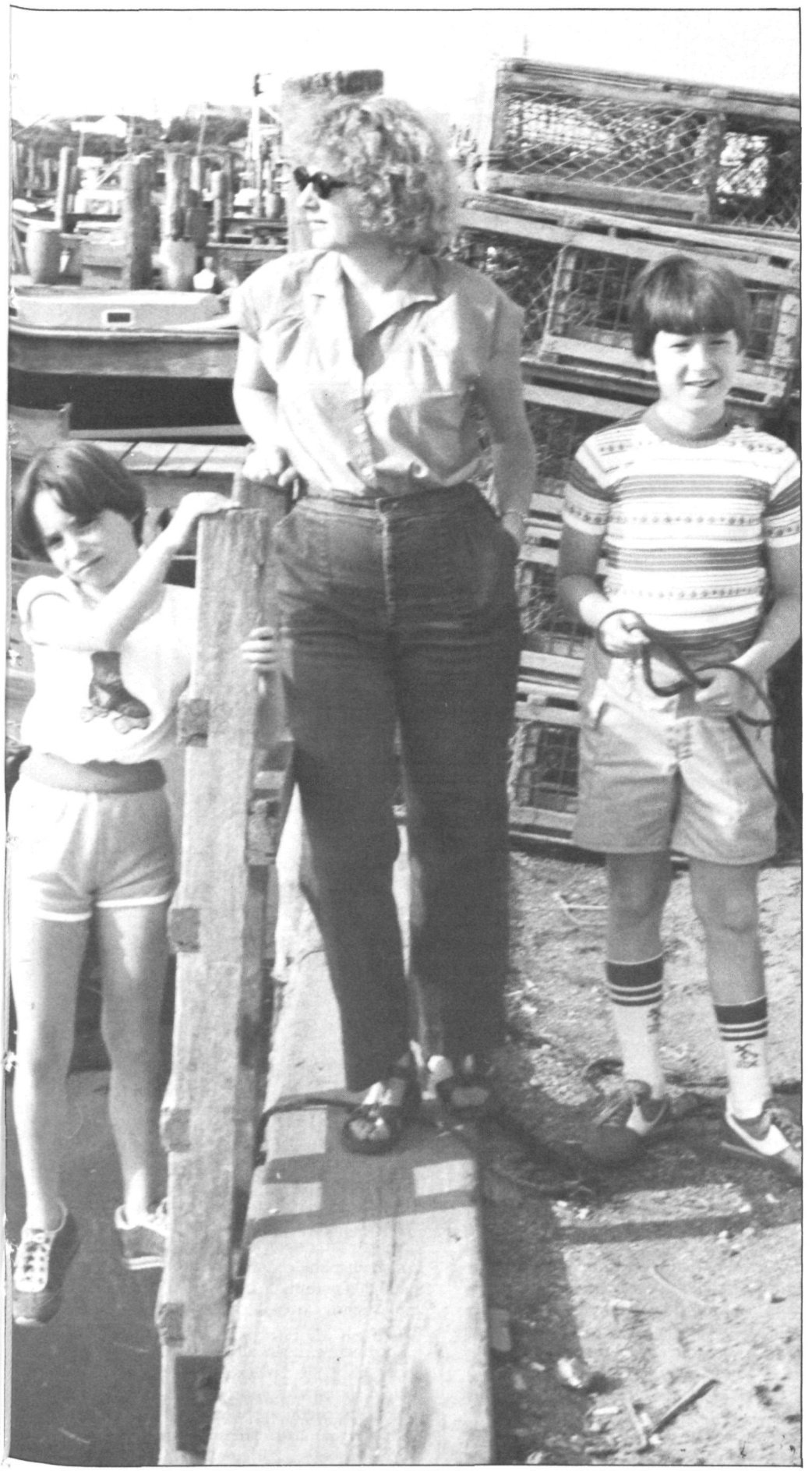
More important than the fact that the fishing schedule can be hazardous to finances, social plans, and domestic tranquility, is that the job itself is extremely dangerous. Fog, wind, and cold plague the New England coast and reports of boats lost in storms or disabled in collisions are all too frequent. Heavy equipment carried on board can malfunction or fail in severe weather. In the winter, ice flows can damage wooden hulls, and there is danger of capsizing if icing makes the boat top heavy.

Early in marriage when women are adjusting to having much time alone, they also have a lot of time to think about their husbands' safety. A frequent cure for excessive worry is keeping busy. This becomes easier when family demands increase and it is the mother's responsibility to maintain an atmosphere of normalcy. As a fisherman nears retirement, wives have new cause for concern. In their later years fishermen have valuable experience to rely on, but they no longer have the stamina or quick reaction time of their youth. Women may see their husbands coming home more and more exhausted as the years go by and worry more about their safety. In addition, retirement brings together a husband and wife who are totally unused to each other's consistent companionship. Both lose the opportunity to retreat into their own domains.

When you marry a New England fisherman, you marry a distinct and unavoidable way of life. Your honeymoon is liable to be on his boat. When your children are born, someone else may have to bring you to the hospital. You listen to weather reports constantly. If a hurricane is approaching, you close up the house while he sees to the boat. If you go out to dinner, you're home early just in case there'll be a 4 a.m. call to work. You become very sensitive about the price of fish, offshore drilling and government regulations. More than likely you have relatives and in-laws who are also involved in the industry.

You put up with a lot of worry and responsibility but you also have the pleasure of seeing your husband enjoy his work and you have the closeness of sharing in his work in a very real and productive way. Many fishermen's wives serve as land-based partners, locating and obtaining boat parts and supplies, assisting with records and bookkeeping, and keeping track of new government regulations and hearings. Idealistically, the women also share some of the romance of the job. It's man against the elements, it's a gamble, it's exciting, individualistic and independent work. It may sometimes be different in alarming and distracting ways, but it is also somewhat exclusive. Not everyone can fish for a living; the way of life is different enough to make it a bit mysterious to land-based workers.

That mysteriousness is one of the reasons this study happened. Stereotypes and misconceptions about the fishing business still exist even in coastal areas. Some people look at the price of fish and assume that fishermen are rich and footloose bachelors who wear yellow slickers and don't work hard because it's all mechanized anyway. Or people may think fishing families are unfriendly because they don't always show up when they're invited to something. Both



Chris Duerr

*Ashore, the stereotypical seaman's wife, watching and waiting on a widow's walk, has given way to a busy independent woman, often helping run the business.*

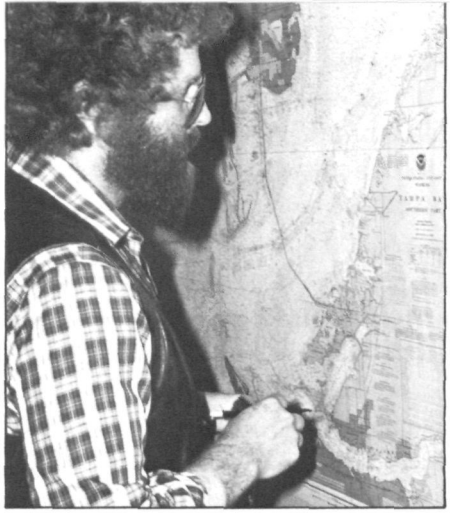
the job and the people involved are poorly understood.

The National Science Foundation granted the Universities of Rhode Island and Maine the opportunity to improve that understanding through a study of the social and cultural aspects of fisheries management in New England. Of the Galilee sample of fishermen, about 75 percent are married. A couple of pilot interviews made it clear that no study of New England fishing would be complete without including the perspective of the fishermen's wife. This information is important on both a local and national level. As the industry changes, community members, schools and support services need to understand the complex equilibrium of the fisherman's family which may be threatened by change. Government agencies must be aware of how factors such as family involvement and participation will interact with new policies such as restricted licensing.

Most initial research efforts result in more questions than answers. This project is no exception. The port of Galilee is unique in several ways. Boats are virtually all owner operated and crew members are independent. Do wives react to fishing in the same ways when their husbands are unionized workers of company boats? The Galilee fishermen and their families are characterized as "Yankee." It would be interesting to conduct this same kind of study in other ports where European ethnicity may affect the findings.

Are independent women attracted to independent fishermen or is independence adaptive behavior which develops after marriage? What about the general category of dangerous jobs with erratic schedules? Do oil riggers' wives or truck drivers' wives, for example, have anything in common with fishermens' wives? Many possible avenues of inquiry have been opened and this work barely scratches the surface.

The Two Hundred Mile Act has significantly altered the activities of commercial fishermen. Indications are that government licensing and quotas together with declining fish stocks, economic pressures and ecological threats will continue to change the industry and the people in it. Already some other New England ports are shifting from the independent mode of operation to the security of union-protected jobs and company owned boats. The small independent fishing operation may be an endangered phenomenon. So, in a sense, the study of this way of life described to me by independent fishermen's wives with both reservations and enthusiasm is valuable as an historic record.



NOAA

## Tough test for response team

# Fighting Chemicals In Tampa Bay

Roland D. Paine

A million and a half gallons of perfume additive? Nancy Maynard frowned skeptically as she compared the Coast Guard report of the sunken barge's cargo with information from a chemical data bank.

In the cheerless cold predawn of December 12, NOAA's hazardous materials response team was pulling itself together to lend scientific support to the fight against a chemical spill of unknown size and seriousness in Tampa Bay. The first call for help had come from the Coast Guard to the Boulder-based team at 6:15 a.m. Team members struggled out of bed and sped to work, putting together the fragments of information from the Coast Guard's Marine Safety Office in Tampa, querying computers, poring over chemical reference manuals, phoning team members and chemist-consultants throughout the Nation.

The first information given to the team reported that the contents of the barge were "cinnamein" and "ammonium nitrate-phosphate." The Captain of the Port of Tampa asked the NOAA scientists to look into the chemicals and give him an estimate, as soon as possible, of the hazards he might be facing.

He also asked that the NOAA Scientific Support Coordinator leave for Tampa as soon as possible to assist and, if necessary, assemble a scientific response team on scene.

NOAA

Within an hour and a half of that first call, the Boulder group had accessed a computerized data bank, got information on both cinnamein and another chemical with a similar name, cinnamene, and called back to the Tampa Coast Guard with recommendations for handling and safety.

Cinnamein, they surmised, was probably not the cargo—a constituent of perfume, it is unlikely to be shipped in such quantities. More likely the chemical was cinnamene, another name for styrene. This is the stuff that polystyrene cups, and a host of other common products, are made from, and in its liquid form it poses definite dangers to the marine environment if spilled.

The other chemical posed an even greater problem. There were three possibilities—that it was indeed ammonium nitrate-phosphate, as reported, but chemist consultants called this highly unlikely; that it was ammonium phosphate, which is used in fertilizers and not likely to cause serious problems; or that it was ammonium nitrate, which is highly explosive and very dangerous. If it were the latter, a huge lethal bomb existed in the ship channel in Tampa Bay, where a collision had sunk the barge and its cargo of chemicals.

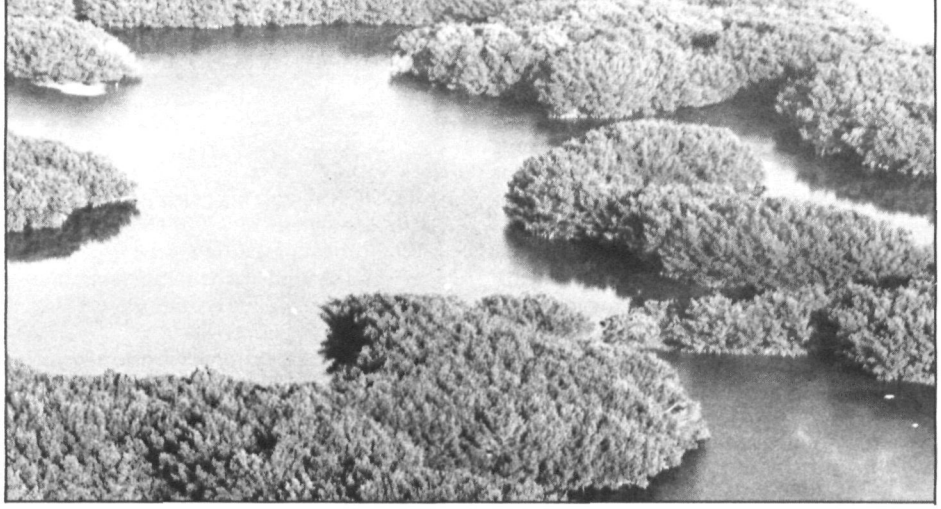
Having identified the potential for danger, the NOAA scientists advised the Coast Guard to keep all shipping out of the channel and establish a 3½ mile restricted area around the site.

The Coast Guard followed this advice. The Florida Marine Patrol also pitched in, sending boats and an aircraft to patrol the area and warn away possible onlookers.

Shortly after noon a call from Tampa confirmed that the contents of the barge were 8,400,000 pounds of ammonium phosphate and slightly over 1,500,000 gallons of styrene.

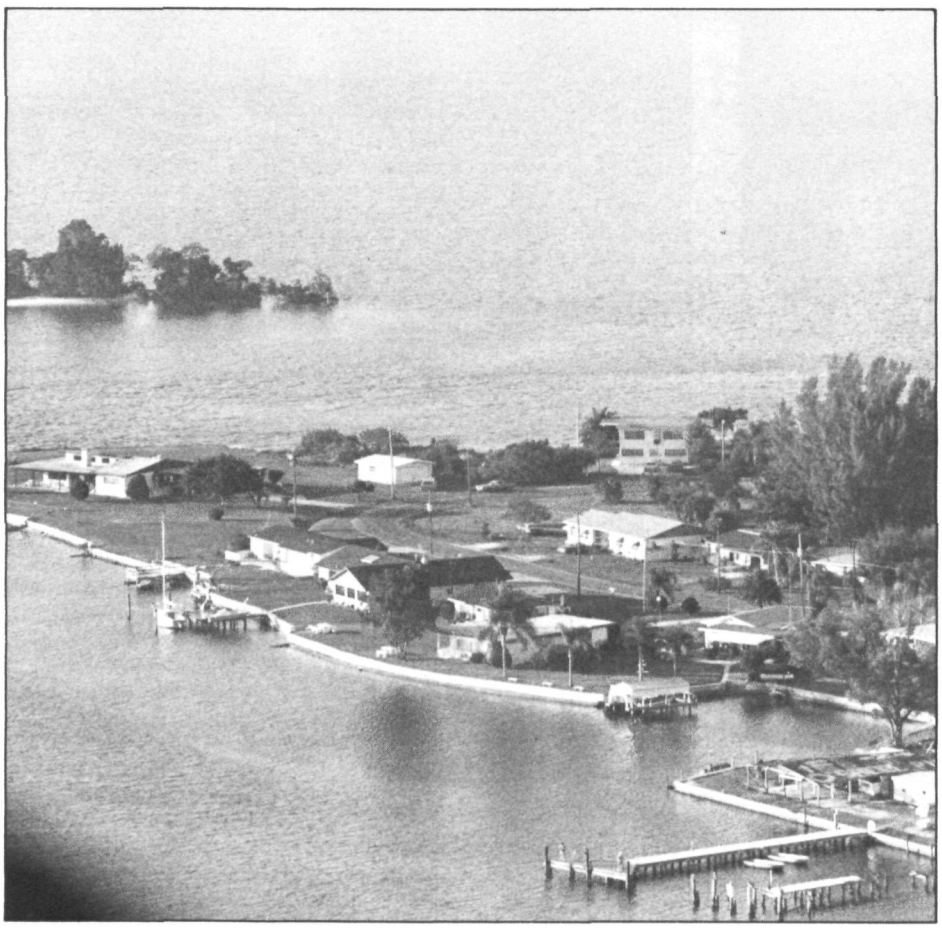
Fortunately, it was all a drill, the opening hours of a six-day exercise designed by NOAA to test and improve its capability to respond to chemical spills.

NOAA has had extensive experience in oilspill response, ranging from the *Argo*



NOAA

*Dr. Jerry Galt (opposite left) assesses probable trajectory of spilled chemicals on a nautical chart of Tampa Bay. A spill would have varying and potentially serious effects on a diverse environment, including port and industrial facilities, extensive mangrove thickets where wildlife abounds and waterside residential areas.*



NOAA

*Merchant* wreck off Nantucket to the Ixtoc I disaster, but it had little practical experience in fighting chemical spills. The two differ in many ways; for example, oil can be seen on the water, while chemicals frequently cannot. So the Office of Marine Pollution Assessment fashioned the mock spill, wrote a script, and —with the cooperation of the Coast Guard and the State of Florida—challenged its system and its personnel, looking for weak spots that needed strengthening, trying to anticipate the unanticipated, and training its people on the special kinds of problems that chemical spills might offer.

The participants knew ahead of time that a drill would be held, but they did not know the nature of it, nor the location. Indeed, a couple of them had become convinced that the mock spill was going to take place in Alaska, and they had parkas and mukluks all packed when the call came to go to Florida.

David Kennedy, a NOAA contractor who frequently acts as Scientific Support Coordinator (SSC) and who was to be SSC for the drill, was in New Orleans when the call came for him to go to Tampa. Dr. Jerry Galt, Seattle-based computer modeler whose special expertise is forecasting the trajectory of spilled materials, was with Kennedy and soon followed him to Tampa.

Kennedy left New Orleans as quickly as he could, finding a plane to Atlanta and, later in the day, to Tampa, where he took over a rapidly developing situation and began assembling the kind of scientific team required on scene when a real spill occurs.

By the evening of that first day, the script provided that the company that "owned" the imaginary barge was not prepared to undertake its removal, so the Coast Guard assumed control of the situation, activated its Gulf Strike Force, and contracted for barges for offloading the chemicals. Its On-Scene Coordinator gave Kennedy, in his capacity as SSC, some tough—and realistic —requests:

- Please determine if the nature of the cargo poses anything other than the obvious risks to survey divers.
- Provide further refinements of previously requested trajectories, through midnight of the next day.
- Provide an initial evaluation of coastal and marine resources at risk in the vicinity of the wreck site.
- Attend and give assistance with press interviews this evening.

To conduct the exercise, Judith Roales of the Office of Marine Pollution Assessment and John Robinson of the hazardous materials response project enlisted the aid of a contractor, Environment & Ecology, Inc., which helped outline the detailed script and provided two staffers to work with Roales and Robinson on the moment-to-moment unfolding of the spill sequence. On occasion they would also role-play—for example, acting as the contractor's representative to answer questions about the cargo.

Kennedy set up his response headquarters in a motel meeting room; in an adjoining room the drill monitors—Roales, Robinson, and Craig Hooper of NOAA, Ann Rooney-Char of the Virginia Institute of Marine Science, and Scott McCone and Julia Schwartz of E&E Inc.—conducted the

drill. They followed the script and the actions of the response team carefully. When the opportunity arose, they occasionally added an item to the proceedings, sometimes a roadblock or red herring designed to throw the scientists off the track, sometimes an event that was—in the terms of the drill—"real".

Though a simulation, it was designed to be as realistic as possible. Even the local news media's cooperation was enlisted. After a first-day interview with Robinson on the purposes of the exercise, a local television team, at the request of the drill monitors, agreed to wait for Kennedy—then at the Tampa airport on his way to the scene—and stage a mock interview with him.

He arrived a short time later, tired after a long and frustrating day of trying to get from New Orleans to Tampa while keeping up with the unfolding events as best he could by telephone. He walked into the motel meeting room, unslung a bag from his shoulder, and was just about to greet the NOAA people in the room when bright lights were switched on, a microphone was thrust in his face, and a TV reporter smoothly said: "Mr. Kennedy, we understand that there is a serious chemical spill in Tampa Bay and that you are in charge of the scientific team working on it. Can you give our viewers an estimate of what the situation looks like, and just how dangerous it is?"

It was an ad lib injection into the exercise, but a realistic one. The mock interview was conducted with a thoroughly surprised Kennedy just as if the videotape were to be aired on the late evening news show. To his credit, Kennedy answered carefully and helpfully, not once showing the annoyance that he felt nor hazarding guesses about a situation where he did not have the latest information. It was a good object lesson for others in the room who themselves will likely be SSC's in the future.

Tension sometimes ran high during the exercise, just as it sometimes does during real situations. The drill monitors working in the adjoining room, and periodically popping into the SSC's headquarters with new information or new demands, became known to the hard-pressed scientific response team members as "the enemy", mostly but perhaps not entirely in jest.

The hypothetical nature of the situation also led to lighter moments. Galt returned one day from an overflight (real) of the wreck site where he "observed" the chemical slick (simulated) on the water. When Lt.(j.g.) Steve Fabian, the young Coast Guard officer (real) acting as On-Scene Coordinator (simulated) asked him to describe the slick, Galt paused, and with a small smile allowed that he'd do his best, though he found it "a bit difficult, under the circumstances, even to see it." The roar of laughter from monitors and scientists alike showed that he had defused any tension the moment might have held.

The team assembled for the exercise included both NOAA staffers and contractors with numerous skills that could be brought to bear. Where possible, they carried out their duties just as if the spill had been real. For example, Geoffrey Scott—a young scientist from Research Planning Institute (RPI), Columbia, S.C., brought down some 200 oysters in a cooler, built trays out of 2x4's and screen, and spent a long and wearying day in a small boat emplanting them in the Bay. Had the spill been real, the oysters would have been used to monitor water quality and track the spread of chemicals.

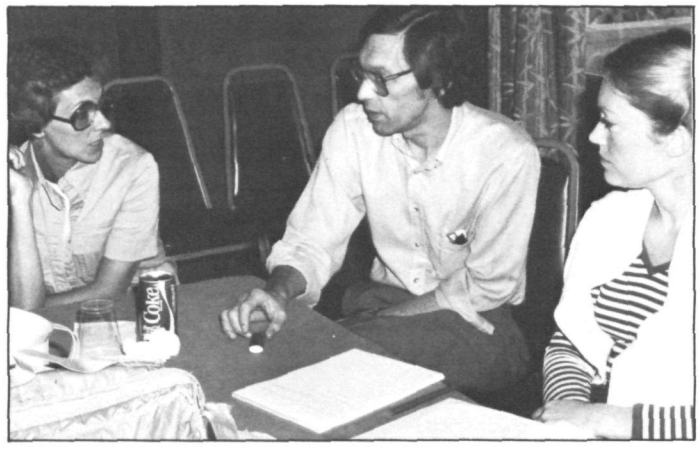
The RPI aircraft was pressed into service both by program monitors, who used it to drop drift cards marking the position of some of the spilled chemicals, and by the response team to carry out some of their surveillance activities.

A "fish kill" introduced into the situation was correctly assessed by the scientific team as not having been caused by the styrene, but by an oxygen deficiency in the water.

Earlier preparations by the hazardous materials response team frequently paid off during the drill. For example, the team had identified numerous chemists around the country who had expertise in specific kinds of compounds and who had indicated a willingness to provide consultation in case of an emergency. When the group in Boulder, on that first morning, decided that they might be dealing with "cinnamene" rather than "cinnamein", they found in their index a chemist from Louisville, Ky., who had some experience in an earlier cinnamene spill. By telephone they tracked him to a barber shop, where from the chair he gave them the best information he could—and later, his haircut completed, he returned to his laboratory, consulted his references, and called Boulder back with further details.

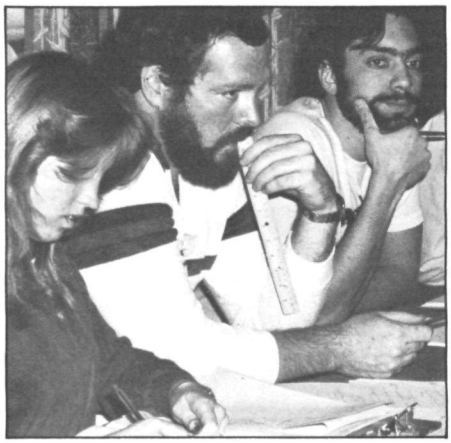
At the end of the exercise a day-long debriefing was held, when team members analyzed their activities, compared notes with the program monitors, and began the process of correcting the problems that had been uncovered.

NOAA




NOAA

*Some participants: (left) NOAA's Lt. (j.g.) Jay Rodstein and Will Ernst with RPI's Dr. Jacqueline Michel; (above) "the enemy", NOAA's Judith Roales and John Robinson with VIMS' Ann Rooney-Char; (opposite top) NOAA's Debbie Payton, David Kennedy (contractor), and Bob Pavia; and (opposite bottom) Coast Guard Lt. (j.g.) Steve Fabian and E&E Inc.'s Julia Schwartz.*



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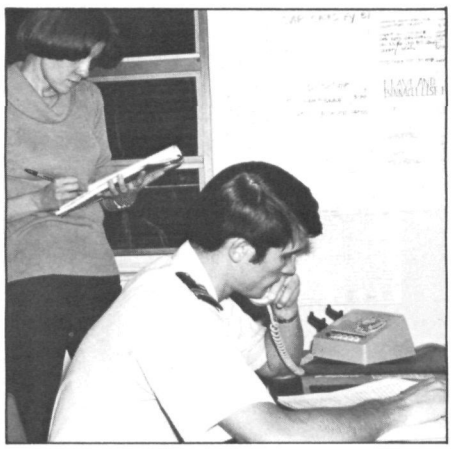


NOAA

Such as:

When the Coast Guard called the Office of Marine Pollution Assessment in Boulder at 6:15 a.m., the answering service attendant did not have instructions about what to do in an emergency; she suggested that the Coast Guard call back "in a couple of hours, when the day shift is on." (Fortunately for the drill, NOAA people working with the Coast Guard had the account number and were able to get through to Nancy Maynard to get the exercise underway. The answering service will be provided with the necessary information for the future.)

When the inital call was made, the script provided that the Coast Guard could, if requested, give further specific information about the spill. The team members did not ask some of the questions then, so they didn't possess all the information they might have had. Later they called back with queries. (From now on, appropriate team members will carry with them at all times a check-list of questions to ask.)

One team member had a long drive through the mountains from home to office, where he used a computer terminal to search for urgently needed chemical information. During this critical period he was out of communication with the rest of the team and his expertise was unavailable. (It was recommended that he be provided with a computer terminal in his home—and with a telephone line dedicated to that terminal, so that he can be consulted while he is using the computer.)

When the team members arrived in Tampa, they found that some services they needed, such as rental helicopters for flying over the site, were not available; nor was Coast Guard air support available. While they were able to use the RPI aircraft, that was a piece of luck—RPI might have elected to send its team to Tampa by commercial aircraft. (Each NOAA SSC will contact all the ports in his area, through the Coast Guard, to find out what services and networks of assistance might be available.)

Capt. Roy Dash, the Coast Guard officer who in the event of a real spill would have been On-Scene Coordinator, spoke briefly at the closing debriefing, complimenting the team members on a well-run and useful exercise, and commenting that he was pleased to know that help of that nature would be available to him should he need it. The Office of Marine Pollution Assessment in Washington, and its hazardous materials response group in Boulder and around the country, are studying the operation, learning from it, and working hard on preparations for the next spill. The lessons they have learned from the Tampa exercise will help them do a better job when the problem becomes real.

# Tampa Bay Drill Spill Participants

The skills and experience of a wide variety of people were brought to bear on the Tampa Bay exercise, both to devise and conduct the drill and to simulate the response. Major players included the following:

### Drill Monitors ("The Enemy")

Judith Roales, Office of Marine Pollution Assessment, NOAA-Rockville

John Robinson, Hazardous Materials Response Project (HazMat), NOAA-Boulder.

Craig Hooper, HazMat, NOAA-Boulder.

Scott McCone, Ecology & Environment, Inc., Chicago.

Julia Schwartz, Ecology & Environment, Inc., Dallas.

Ann Rooney-Char, Virginia Institute of Marine Science, Gloucester Point.

### The Response Team

David Kennedy, contractor to NOAA, Seattle.

Dr. Nancy Maynard, HazMat, NOAA-Boulder.

Robert Pavia, HazMat, NOAA-Boulder.
Lt. (j.g.) Jay Rodstein, HazMat, NOAA-Boulder.

Will Ernst, HazMat, NOAA-Boulder.

Alan Johnson, HazMat, NOAA-Boulder.

Michael Thompson, HazMat, NOAA-Boulder.

Dr. Jerry Galt, HazMat, NOAA-Seattle.

Debbie Payton, HazMat, NOAA-Seattle.

Lt. Cdr. Burl Wescott, HazMat, NOAA-Anchorage.

Susan McDonnold, HazMat, NOAA-Anchorage.

Tom Reppert, National Weather Service, NOAA-Silver Spring.

Kurt Hess, National Weather Service, NOAA-Silver Spring.

Fred Crosby, National Weather Service, NOAA-Tampa.

Rosalie Redmond, Office of Public Affairs, NOAA-Boulder.

Dr. Jacqueline Michel, RPI, Columbia, S.C.

Dr. Erich Gundlach, RPI, Columbia.

Dr. Geoffrey Scott, RPI, Columbia.

Dr. Edward Overton, University of New Orleans.

### Cooperating Organizations

Capt. Roy Dash, U.S. Coast Guard, Tampa.

Lt. (j.g.) Steve Fabian, U.S. Coast Guard, Tampa.

Dr. William Fehring, Port Authority, Port of Tampa.

Jeff Taylor, Department of Environmental Regulation, State of Florida.

Richard Healey, Department of Natural Resources, State of Florida.

Major Jack D. Thompson, Florida Marine Patrol.

Sgt. Calvin E. Dixon, Florida Marine Patrol.

### Staff

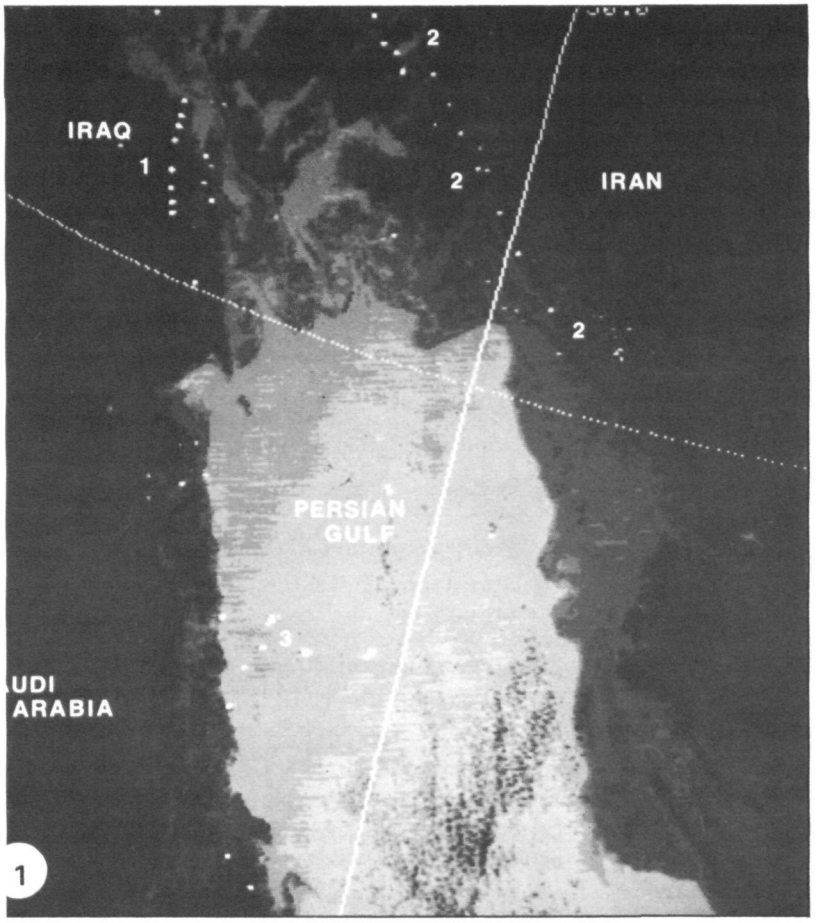
Capt. William Barbee, Office of Marine Pollution Assessment, NOAA-Rockville.

Karon Gleason, HazMat, NOAA-Boulder.

Roland Paine, Office of Public Affairs, NOAA-Rockville.

# VIEW FROM SPACE

## Persian Gulf Hot Spots

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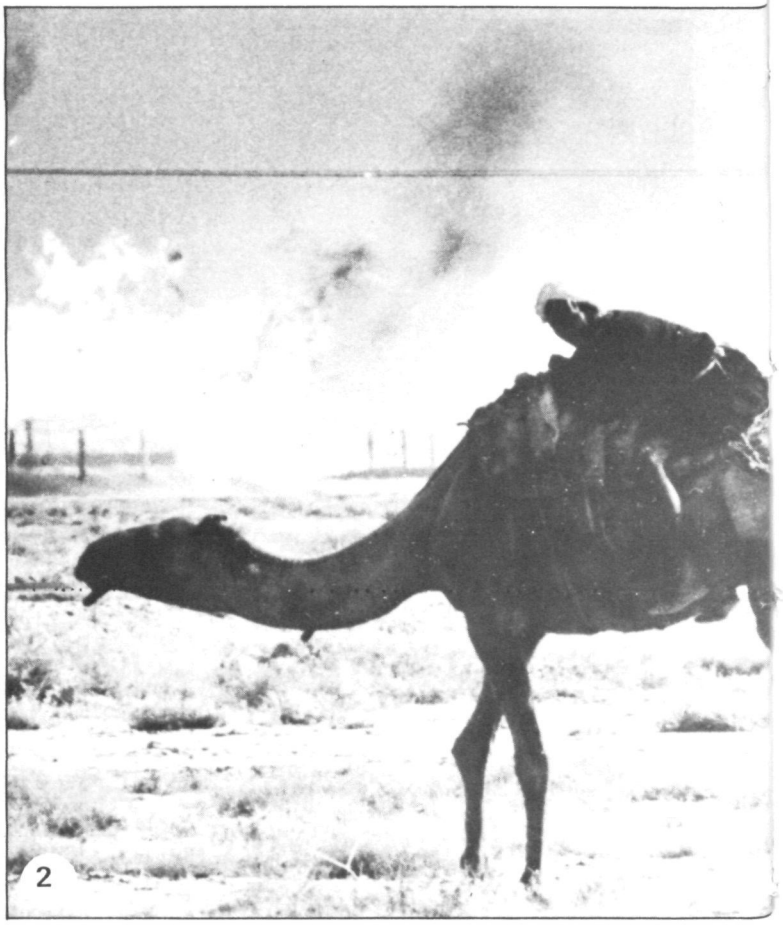


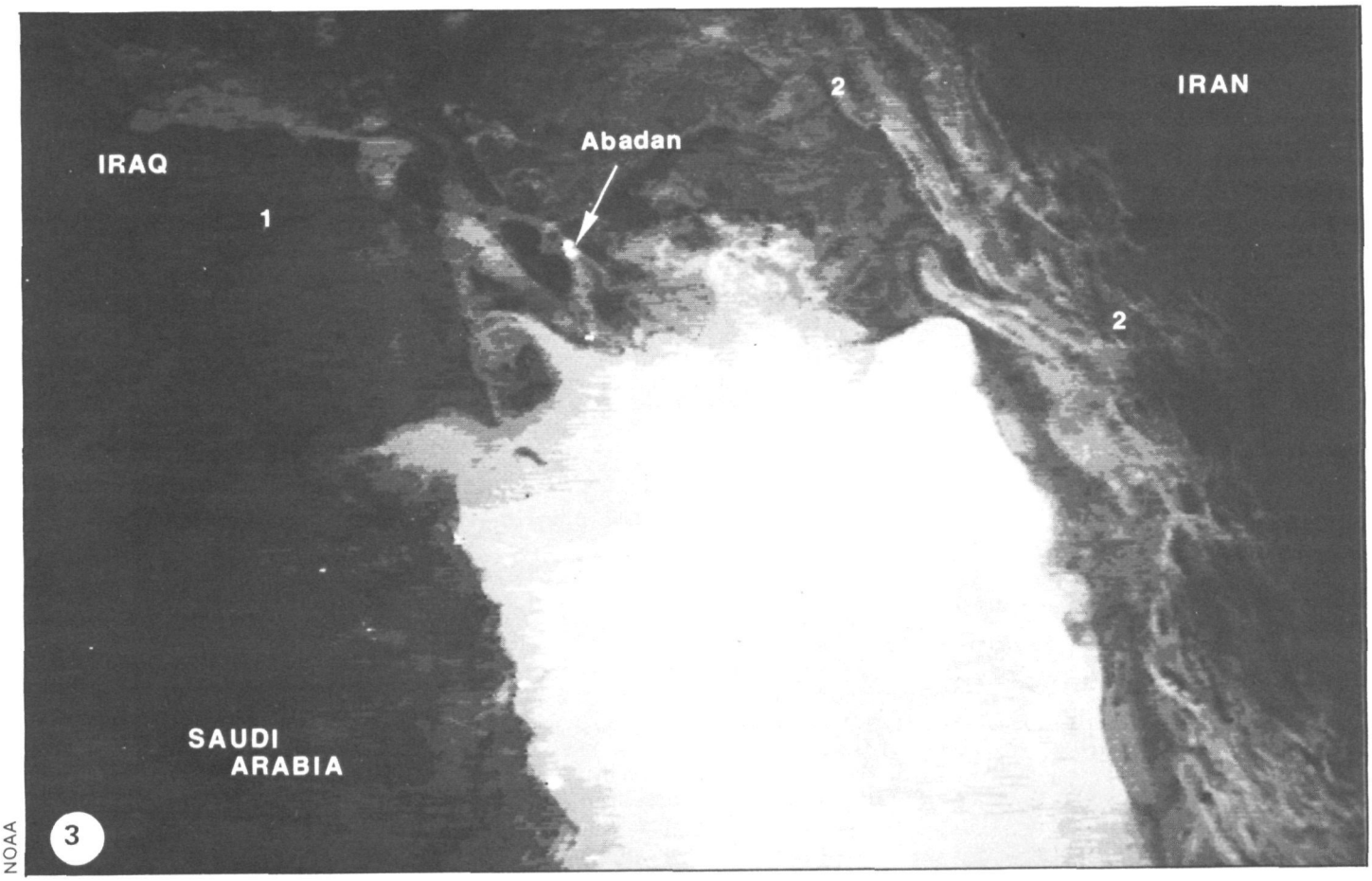
Wide World

The sensitivity of thermal infrared sensors aboard NOAA's polar orbiting satellites is demonstrated in these two images of the Persian Gulf area, obtained March 4 and November 2 of last year.

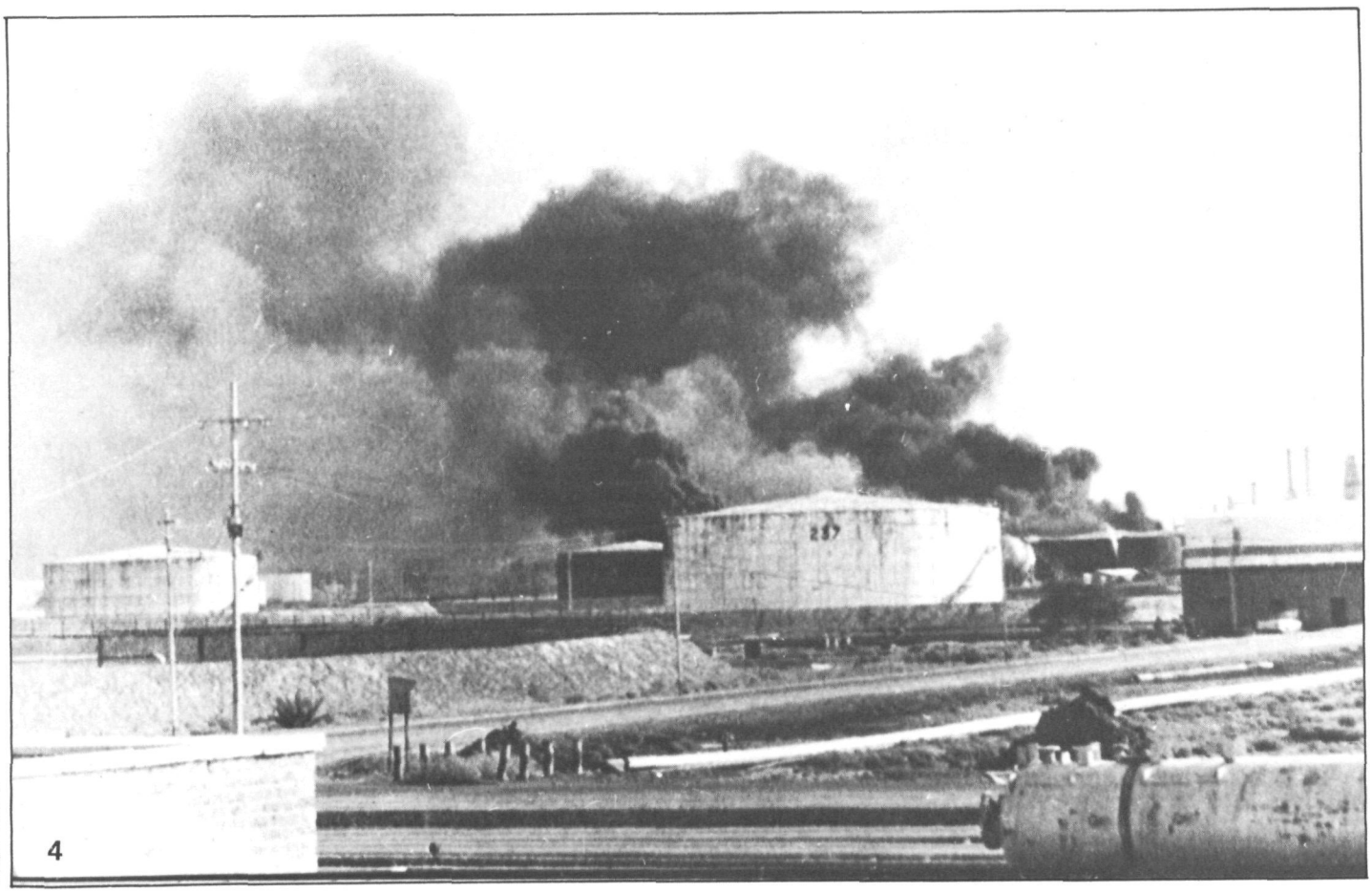
Michael Matson and Dr. Jeff Dozier, scientists with NOAA's National Earth Satellite Service, came upon the imagery while checking the sensitivity of the 3.8 micron therman infrared sensor carried on NOAA-6, and noted differences between the two images. Further examination revealed that the November image did not have nearly as many "hot" spots on it as did the earlier imagery. The sensor is particularly sensitive to hot targets such as gas flares from oil wells, and Matson and Dozier determined that explained the difference.

White dots in the numbered areas on the March 4 imagery (Picture 1) are major gas flares (Picture 2). Area 1 is in the Rumaila and Zubair Iraqi oilfields; Area 2 is in the Ahwaz, Marun, Aghi Jari, and Gachsaran Iranian oilfields; and, Area 3 is in the offshore Safiniya oilfields of Saudi Arabia.

The November 2 imagery (Picture 3) shows essentially the same area about a month after the outbreak of fighting between Iran and Iraq. The flares in Areas 1 and 2 are no longer present, due either to voluntary shutdown of the flaring or to military destruction of the oilwells. But the port city of Abadan, site of the world's largest oil refinery, shows up as a "hot" image on the November imagery but not the March picture. At the time of the November image, the refinery and oil storage areas at Abadan were burning from military attacks (Picture 4).



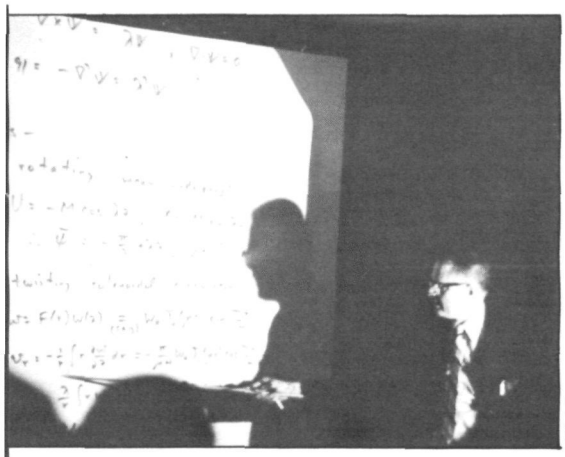

NOAA




Wide World

# Building New Worlds In A Computer

Louise Purrett-Carroll



NOAA

NOAA

*Enjoying coffee in the courtyard of the new GFDL computer building, (opposite) participants in the Laboratory's anniversary symposium take a break from formal sessions. (above) Douglas Lilly of the National Center for Atmospheric Research describes some of the important equations in circulation modeling and Aksel Wiin-Nielsen, Secretary-General of the World Meteorological Organization outlines the spread of numerical weather prediction in Europe.*

A silver anniversary is a fine occasion for throwing a party, and scientists at NOAA's Geophysical Fluid Dynamics Laboratory did so—their own kind of party.

To celebrate the 25th anniversary of the laboratory in Princeton, New Jersey, some 250 of the world's leading authorities in the complex field of geophysical fluid modeling gathered at the lab for a symposium on the past progress and future hopes for the science.

The symposium was held in the cavernous main room of a just-finished building designed to house the new computer the laboratory hopes to acquire in the next couple of years. The new building, connected to the main laboratory by glass-walled ramps that enclose a courtyard, seemed somehow appropriate for the occasion, symbolizing both a beginning and a kind of culmination.

Numerical modeling of geophysical fluids is one of those esoteric-sounding sciences that, often without our knowing it, work behind the scenes in our daily lives. The geophysical fluids are the earth's atmosphere and oceans, and modeling their behavior has made modern weather forecasting possible.

A numerical model is a set of mathematical equations, based on physical laws, that describes the behavior of a phenomenon. It creates an artificial "world" that can be manipulated to see how various changes would affect it or how present conditions came to be. Such models have profoundly altered meteorology, oceanography, and other sciences, and are presently used routinely by weather forecasting centers throughout the world. They just began to exist about 25 years ago.

The NOAA laboratory traces its roots back to the Princeton Institute for Advanced Study and such pioneers as the eminent mathematician, John von Neumann. Von Neumann and others had been using early computers to simulate the atmosphere and make crude weather predictions. The laboratory was founded in October 1955, as part of the U.S. Weather Bureau. Later, it became one of the Institutes for Environmental Research when they were formed in 1965 as part of the Environmental Science Services Administration. Originally located in Washington, D.C., the laboratory returned to its spiritual home, Princeton, in 1968. When NOAA was created in 1970, it became one of the new agency's Environmental Research Laboratories.

The silver anniversary symposium was to focus on the development of the science of modeling of geophysical fluids. None of the main speakers was from the Princeton laboratory, though many inevitably had past links with it. Dr. Douglas Lilly, who discussed modeling of medium-scale processes like thunderstorms, had worked in the laboratory when it was part of the Weather Bureau; Dr. Jule Charney, charged with the task of looking into the future of the science, was a force behind the lab's founding.

But it seemed difficult to separate the development of the science from the development of NOAA's laboratory; to discuss developments in the field without noting the work of the scientists in Princeton.

There is some vagueness about just when numerical weather modeling began. Dr. Aksel Wiin-Nielsen, Secretary-General of the World Meteorological Organization told the gathering that numerical weather prediction began in Princeton and that the growth of the science and propagation of its techniques were stimulated by scientists there. Dr. Francis Reichelderfer, retired Chief of the Weather Bureau, said that in researching the history of GFDL for his speech he "got back as far as Aristotle."

The original goal of what is now GFDL was to use numerical modeling to make forecasts of weather and climate. But as often happens, that goal involved many intermediate goals, and the work of the laboratory has branched into many areas.

One of the first things the new laboratory did was develop a realistic model of atmospheric circulation, one that became a prototype for most general circulation models constructed at GFDL and elsewhere. Much of the laboratory's energies are still

NOAA

devoted to improving such models, seeking better ways to incorporate convection or turbulence, providing a sharper "lens" to see smaller and more distant events.

Work on weather prediction itself has always been closely intertwined with development of models. Extended prediction experiments—4-day forecasts and, later, 2-week forecasts—were performed with a model that simulated circulation in several layers of the atmosphere. Now the ambitions of the laboratory have expanded again, to forecasts of up to 4 months.

In 1975, work began on developing a new, high-resolution model of the general circulation of the atmosphere from the ground to a height of 50 miles (80 kilometers). The model is being applied to predicting the dispersion of effluent from a fleet of supersonic aircraft or radioactive fallout from nuclear tests in the atmosphere.

The general circulation models have proven valuable also for research on long-term weather: climate. The Geophysical Fluid Dynamics Laboratory has been a pioneer in the use of these models for climate research, and has developed a hierarchy of climate models.

Progress in tropical meteorology seems to have suffered from both observational limitations and prejudice. When the GFDL was founded, the tropics were thought of as a dull, hot, humid place with occasional showers, worthy of attention only when they produced hurricanes that invaded middle latitudes.

In recent years, interest in paleoclimatology—study of past climates—has increased. These studies not only shed light on how major climate changes occur, but provide unique tests of the models' ability to simulate large climatic changes.

The laws of physics provide the framework of the models; data from the "real world" test them. Jule Charney of MIT spoke of legitimization. A new born child that resembles its grandfather bears a stamp of legitimacy. In the same way, we know a model is "legitimate" if it resembles the thing it purports to imitate. So some scientists at the NOAA laboratory concentrate on processing real atmospheric and oceanic data into a form for use in the models, and on collecting and analyzing data from the field and from laboratory experiments.

NOAA

*Early days of GFDL are recalled in this photo made nearly 20 years ago showing Dr. Joseph Smagorinsky (left) and Dr. F.W. Reichelderfer (former head of the Weather Service) examining a computer-produced elevation contour map.*

Over the past several years, the Princeton laboratory has been preparing a 15-year set of global data for the period May 1958 through April 1973.

In climate and weather studies the oceans cannot be ignored indefinitely. They provide much of the atmosphere's moisture, and are tremendous transporters of heat. Dr. Francis Bretherton of the National Center for Atmospheric Research discussed progress in our understanding of ocean circulation and its relationship to the atmosphere. All the pioneering work in ocean modeling, he said, was done at GFDL.

Early on, the oceans group at GFDL made computations and compilations of wind stresses over the world oceans that became a standard reference in ocean modeling research. The laboratory is also analyzing the general circulation of the world oceans from observations.

A three-dimensional ocean circulation model constructed at the laboratory has been widely adopted by other laboratories. Ocean modeling has dealt with the spectacular seasonal reversal of ocean currents in the Indian Ocean caused by the Asian monsoon; what causes El Niño, the sudden warming of waters off Peru; where pollutants injected at a point might go.

The next step is a joint model of ocean and atmosphere. The first coupled oceanic and atmospheric general circulation model, constructed at GFDL in 1969, allowed researchers to analyze effects of ocean circulation on climate. By 1975, the researchers had constructed and analyzed a joint model with a realistic configuration of the continents. Later versions had seasonal variations.

Over the years, the main interest of the laboratory's scientists has been in large-scale dynamics of the atmosphere and oceans. But gradually research developed on the smaller scale motions that are a part of them. One of these "smaller motions" that is of great interest for its own sake is the hurricane. Understanding of hurricanes has grown explosively in the past few decades. In 1900, researchers say, everyone thought hurricanes were very thin phenomena, only 100 meters or so high. We now know hurricane clouds tower miles above the ground. Observations provided new data on hurricanes. In 1945, the spiral bands of precipitation were discovered by radar. The 50's saw theories of hurricane formation. The 60's brought numerical models of hurricanes including, in 1963, the first successful two-dimensional model. In 1970, a program was established at GFDL to concentrate on the life cycle of tropical cyclones and help improve their prediction. The last decade has seen a great increase in the quality of data on hurricanes, and a corresponding improvement in their simulation.

Also over the last decade, GFDL has developed models of "mesoscale" phenomena, from single clouds to frontal systems. Researchers there have done a three-dimensional simulation of an observed frontal squall line, and a new model now under development will allow them to focus on a particular disturbance to study the environmental conditions that lead to severe storms. Turbulence in the lowest layer of the atmosphere and the surface layers of the ocean has become an active area of study.

Originally, says NCAR's Doug Lilly, mesoscale events were thought to be too brief and too small to measure and analyze in time to aid a forecast. But now, he says, there has been much progress in studying such events as mountain waves, which give rise to high winds on the leeward sides of mountain ranges, and "supercell" storms that produce tornadoes.

Perhaps the broadest challenge in the field of geophysical fluid modeling is to formulate a general theory of the circulation of planetary atmospheres—one that applies not only to earth but to other planets. Dr. Conway Leovy of the University of Washington pointed out that many of the planets in our solar system are now "accessible" for such study. Each planet explored so far—each that has an atmosphere—seems to have its own style of atmospheric circulation, he says. The most striking feature of Venus' circulation, for example, is rapid rotation of the atmosphere at the level of its clouds—about 30 to 40 miles (50 to 70 kilometers) up from the surface. The clouds are a key element in that planet's circulation, absorbing most of the sun's energy before it reaches the surface.

Data on Mars from the Viking lander show that the planet is not warmest at the equator, as might be expected, but that there is a "hot belt" that migrates. Nevertheless, that planet, says Leovy, provides a nice laboratory model of the influence of solar heating on circulation. The time is ripe for modeling of Venus and Mars, he believes. Researchers at the Princeton laboratory have already done extensive modeling of Jupiter's atmosphere, which seems to be the most relevant to understanding our own.

As NOAA's Princeton laboratory has grown and tackled more complex problems, its main tool, the computer, has kept pace. Over the years, the laboratory has used a series of increasingly powerful computers. In 1974 it acquired a Texas Instruments Advanced Scientific Computer, three thousand times more powerful than the one it began with in 1956 and one of the fastest computers in the world. And soon a new, still faster computer will occupy the empty hall where the symposium was held.

The symposium culminated in a banquet at which the laboratory's director, Dr. Joseph Smagorinsky, was presented a Presidential award for Meritorious Executive.

Throughout the past two days, Smagorinsky himself had tried to stay in the background, but just as it was difficult to separate the development of geophysical fluid modeling from the history of the Princeton laboratory, so it was impossible to separate the history of the laboratory from the man who helped establish it and has guided it for its entire 25 years.

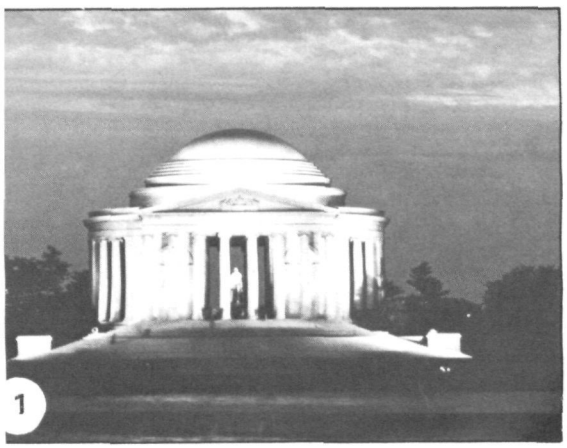
Dr. Francis W. Reichelderfer, Chief of the Weather Bureau when the lab was founded, enumerated the things necessary for organization of such a laboratory (a computer, good staff, input of data, and administrators to get funding) and recalled how he'd been asked to forecast weather for planning of the Allied invasion of Europe in 1944, and how Smagorinsky had once told a high-ranking U.S. official: "sometimes our forecasts are wrong, but our methods are accurate."

NOAA

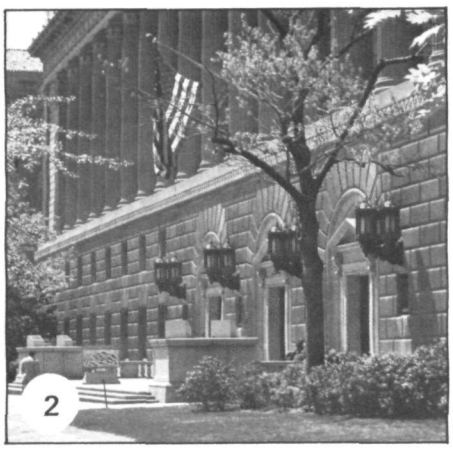
*The main building of the Geophysical Fluid Dynamics Laboratory in Princeton.*

# CITY SCAPE

## Nearly Washington




National Park Service

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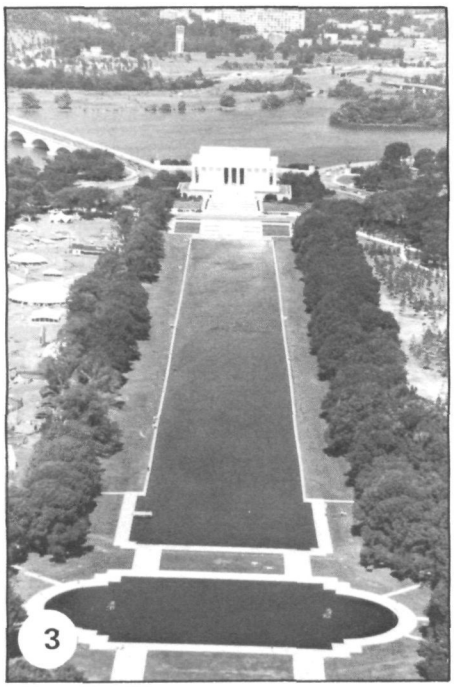
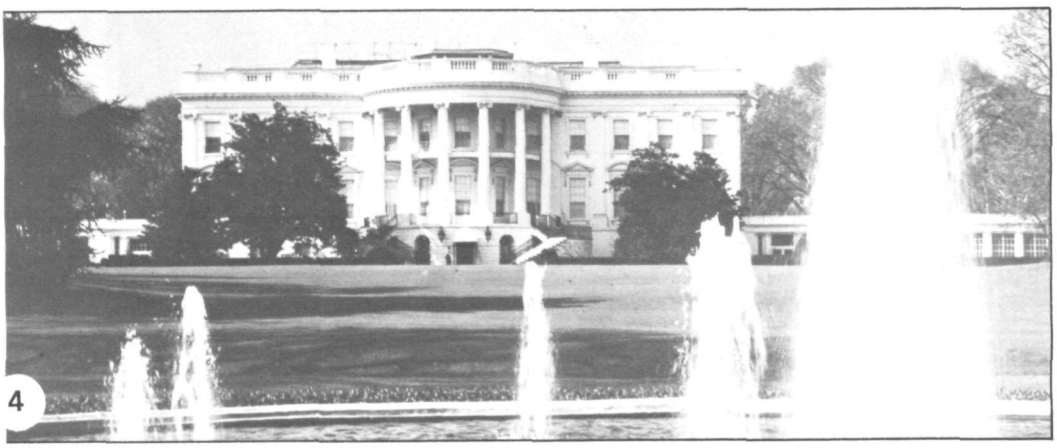
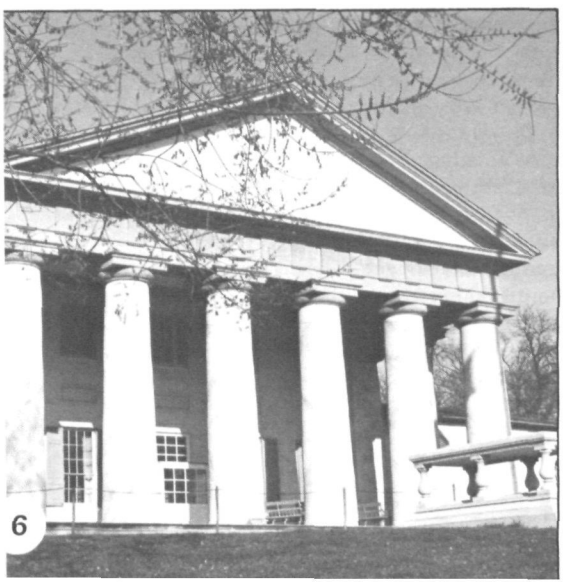



U.S. Travel Service



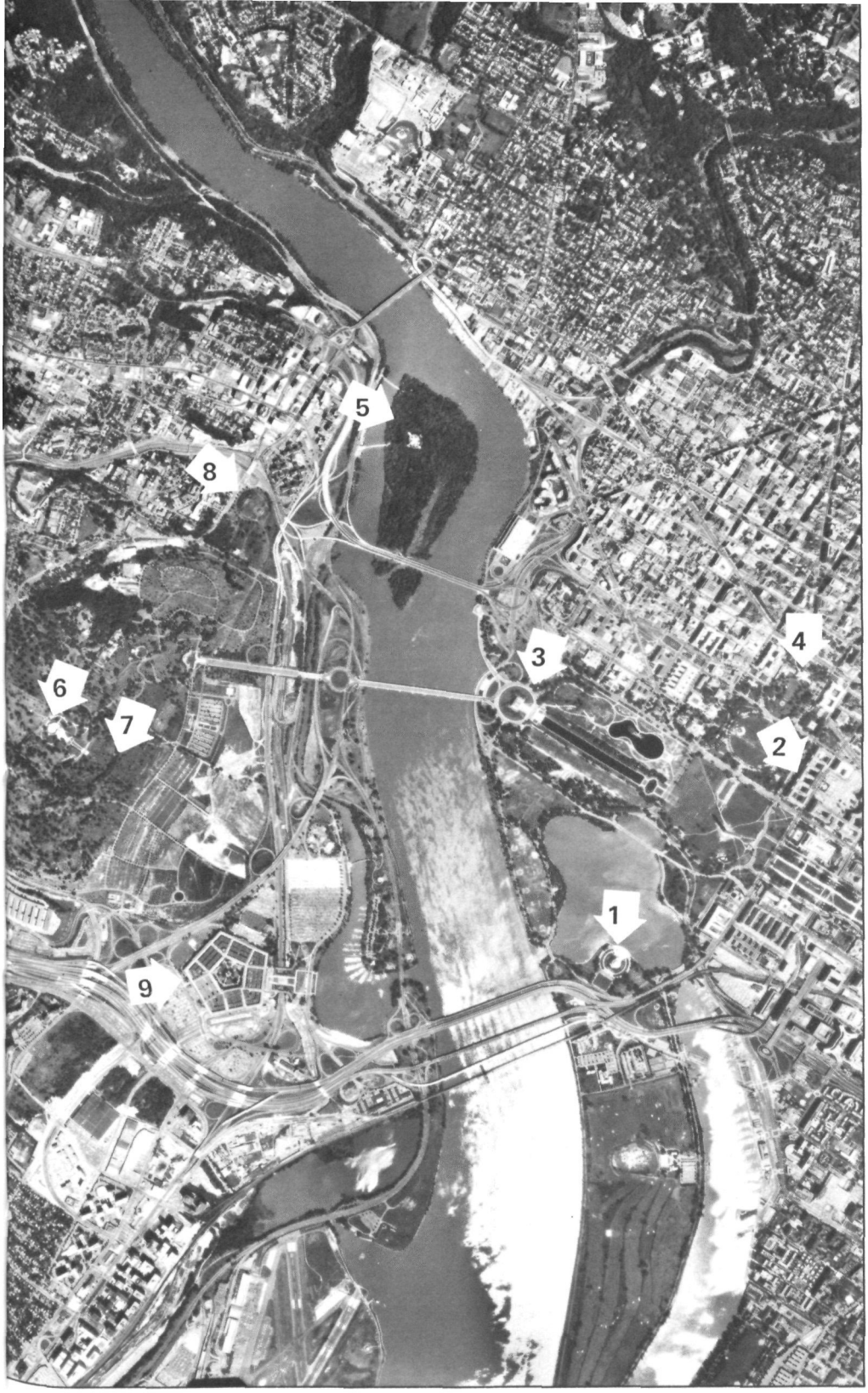

U.S. Travel Service

National Park Service




National Park Service

Dept. of the Army



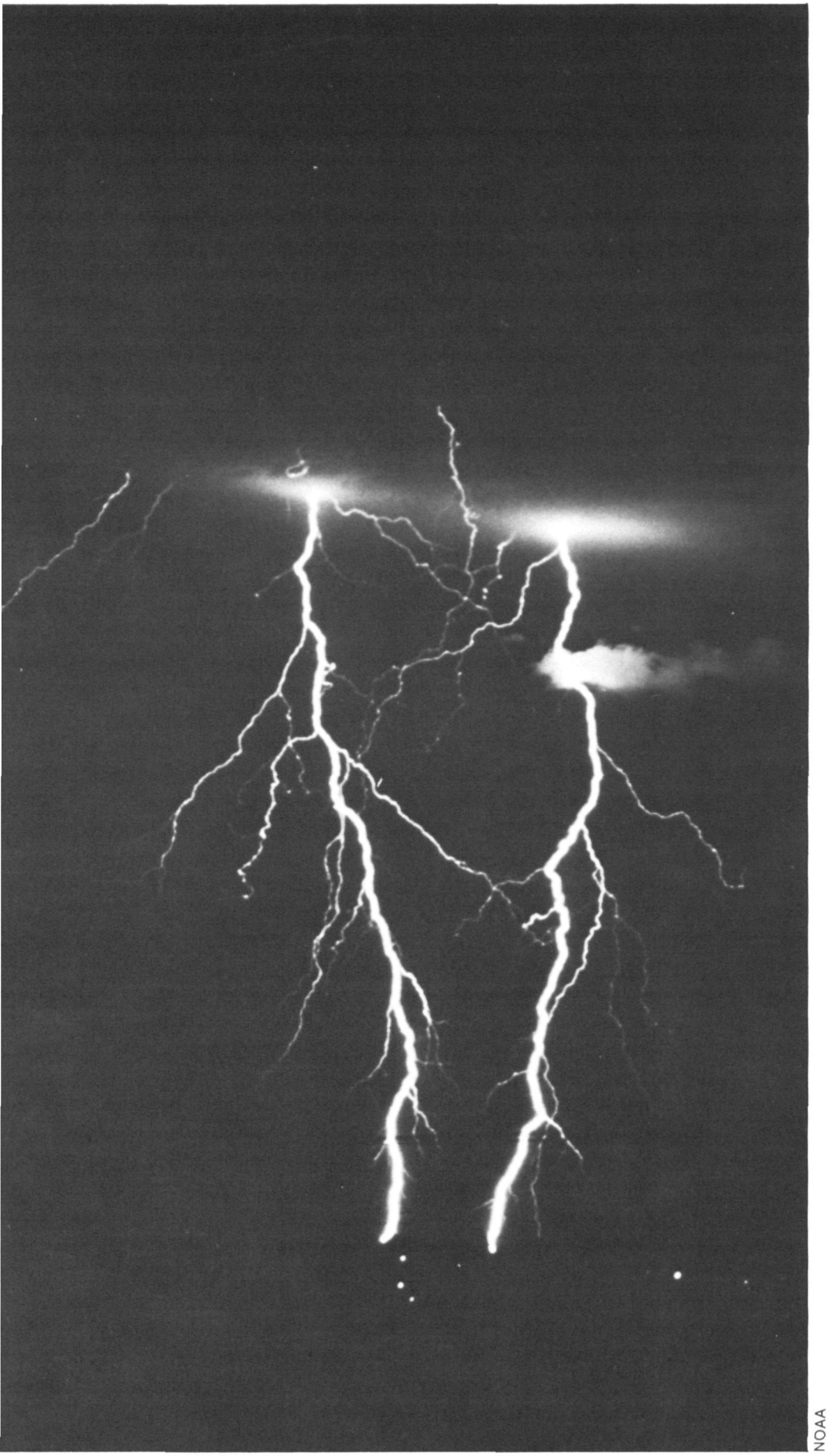
NOAA — Ralph Kresge

U.S. Air Force

Scenes of Washington, D.C.'s famous buildings, parks, and monuments are common enough. In fact, it's hard to take a photograph in the District of Columbia without some familiar landmark of the Nation's Capital in the background. This National Ocean Survey aerial photo taken from 17,400 feet as part of the aeronautical charting program is no exception.

But across the Potomac River from such well-known sights as the Jefferson Memorial (1), the Department of Commerce (2), the Lincoln Memorial (3), and the White House (4) lie other, equally famous features, not quite—but nearly Washington.

"On the Virginia side," (but actually in the District of Columbia) the bare patch on heavily-wooded Roosevelt Island is a monument to Theodore Roosevelt (5). The antebellum Arlington House (6) looks down on verdant Arlington National Cemetery (7). To the north, on a circular mound sits the proud Marine Corps Memorial (8), and to the south is the unmistakeable shape of the Pentagon (9) with its vast parking areas. Snaking its way south past the Pentagon is Shirley Highway—part of the major interstate highway system that runs down the east coast from Maine to Florida.



NOAA

Tourist traffic at Moro Rock was heavy on that sunny August afternoon in 1975. Hundreds of visitors had climbed the long, winding trail to the summit of the rounded granite outcropping, for a clear view of the scenic Kaweah River Valley in California's Sequoia National Park.

Only a few sightseers spotted the dark clouds in the distance. Minutes later, heads turned as a loud clap of thunder shattered the peaceful scene. A buildup of ominous black clouds was heading straight for the rock.

Large drops of rain began to fall, but many climbers, so close to the top that they did not want to turn back, continued. The rain turned to hail, peppering straight down and bouncing off the rocks. Then a blinding white light filled the sky, and the air exploded like a bomb. Boulders shattered. Several people were knocked to the ground.

Lightning struck Moro Rock at 4:15 p.m. One person died, one was permanently disabled, and six others were either struck by lightning or flying rocks.

William E. Cobb, a lightning expert with NOAA's Air Resources Laboratories, in Boulder, has studied this incident. His many years of thunderstorm research have sharpened his concern for public safety, and taken him on a search for ways to reduce the approximately 210 lightning-caused deaths that occur each year in the United States.

"I calculated that the top of Moro Rock stands to be hit by a lightning strike of average intensity once each 20 years," said Cobb. He based his estimate on the thunderstorm frequency in that vicinity (2.6 storms per year, according to the National Weather Service) and the average cloud-to-ground stroke rate that can be expected.

"A 'superbolt' such as struck Moro Rock

If your hair stands on end, watch out!

# Lightning At Moro Rock

in August 1975 could be expected there perhaps once in a hundred years," he said. Although Bill Cobb considers that Moro Rock is by no means a danger zone, he points out that this incident shows how people can put themselves in jeopardy without realizing it. "Of course, the approach of the thunderstorm was their first clear signal," he said. "But in this case there were other signals too."

He points to a picture taken at the summit about 5 minutes before the fatal lightning stroke. It shows two young people, their hair standing on end due to the intense static electricity in the air. "Ignorance is bliss, as these smiling faces indicate," Cobb remarks. "These kids were very foolish to stand there like lightning rods, waiting for disaster. You can see how the lines of force are concentrated around their heads, from the way their hair stands up. I estimate that they were experiencing an electric field exceeding 80,000 volts per meter, as compared to a normal, fair-weather electric field of 100 volts per meter.

"Fortunately, the youngsters left the summit shortly before the bolt struck. The man who was seriously hurt was still on top at the time. Strangely enough, the man who was killed was halfway down the side, standing under a rock ledge."

Cobb explains that, for the most part, lightning protection for the general public comes in the form of a set of safety rules published by the National Weather Service and occasionally in the newspapers following a fatal accident. Those rules can be lifesavers, he says, but they're often ignored. He thinks more should be done. "Except in very extreme cases," he explains, "we cannot 'sense' electric fields. Certainly there are research institutions and scientific companies capable of designing and marketing successful lightning warning devices that could be used at places like beaches, golf courses, and national parks."

Michael W. Maier, a researcher with NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, believes in the early warning concept too. He thinks we should be tracking thunderstorms and warning people of their approach.

"Here in Florida, more than twice as many people are killed by lightning than by hurricanes and tornadoes combined," Maier says. "Hurricane Camille made headlines because she killed 256 people in just a few hours. In terms of lightning fatalities, the United States has a 'Camille' nearly every year. But since we lose just one or two people at a time, the problem hasn't had as great an impact."

Maier has helped to pioneer the use of a thunderstorm tracking system based on the mapping of lightning strokes. A direction-sensitive antenna at each of two stations homes in on the magnetic field radiated by the cloud-to-ground strokes. The lightning is mapped where the two bearings cross. "A large number of these inexpensive direction-finding stations are now in place throughout the western United States to aid in forest fire detection," he said. "This could be the first step toward the development of a national thunderstorm-warning network, to serve the general public."

Another useful approach is to do for locations across the United States what Bill Cobb did for Moro Rock—calculate lightning stroke probabilities. Maier explains that the National Climatic Center in Asheville, N.C., is doing just that. It is preparing a national lightning hazard climatology, by tabulating the number of thunderstorm-hours per year for individual weather stations, and then applying the frequency of cloud-to-ground lightning strokes expected in a typical thunderstorm, as determined by Maier and his co-workers. This work, sponsored by the Nuclear Regulatory Commission, will help builders and planners to estimate the lightning hazard of a particular area.

"Another thing about lightning hazards," Maier says, "is that strokes occasionally come out through the edge of a thundercloud, sometimes hitting the ground miles from the storm." This holds true for 8 to 10 percent of Florida's lightning strikes, he says. "Since Florida's storms are often small and widely scattered, 'bolts from the blue' are more of a problem here than in other parts of the country."

As with all thunderstorm experts, Maier's interest in lightning goes beyond its deadliness. He wants to know how lightning ties in with the structure and evolution of storms. "The connection between lightning and the dynamics of severe storms is poorly understood," he says, "the reason being that we lack definitive observations." He uses the new lightning-mapping system to help fill this data gap.

Nowhere is more being done to solve the riddle of thunderstorms than at Norman, Oklahoma, home of NOAA's National Severe Storms Laboratory. This may well be the world's leading center for the study of the electrical aspects of severe storms. Dr. W. David Rust describes the major objective of its Storm Electricity Group in much the same terms as Maier used: "Our goal is to try to understand the electrical aspects of severe storms in the context of the co-evolving dynamics and meteorology. We're trying to put the whole package together."

To help achieve this goal, the laboratory uses two powerful Doppler radars, for

*Near disaster at Moro Rock, these young people posed for their picture and then left—minutes before a deadly lightning bolt crashed into the hilltop.*

NOAA

highly accurate observations of precipitation and winds. "By combining our Doppler radar observations with lightning data gathered by various instruments, including a discharge mapping system and conventional radar, we can compare lightning activity with storm structure," Rust explains.

When storms don't come to Norman, the laboratory sends an instrumented van to intercept them. The van, used in cooperation with the University of Mississippi, carries devices needed for reliable electrical measurements, including movie and sound equipment. "We prefer to use the mobile lab near NSSL so we can tie the data in with our Doppler radar observations," said Rust, "but the weather doesn't always cooperate."

Another of the laboratory's activities includes a special brand of lightning-hazard research—the routing by conventional radar of a NASA research aircraft to active lightning areas within thunderstorms. A specially instrumented F-106 is being used to study the flow of lightning-induced currents in aircraft. Rust points out that new-generation aircraft will be less metallic and will rely heavily on computer-controlled systems, making them more vulnerable to lightning.

With all their flash detectors and storm probes, do scientists really know what sparks a lightning bolt? Rust replies that the flash is an attempt to relieve the electrical stress built up in thunderclouds. He explains that this stress results from the generation of electrical charges, and their separation into areas of positive and negative charge. "Although these charging processes are thought to be closely tied to storm convection and precipitation, we are a long way from understanding exactly how clouds become electrified," he says. "Relating cloud electricity to cloud dynamics is what modern severe storm research is all about."

Bill Cobb suspects that at least part of the answer to the lightning problem may lie far above the thunderclouds—as far as the sun. In November of 1978, Cobb launched a series of balloon-borne "electrosondes" from Amundsen-Scott Station in Antarctica. Just by chance, the first balloon was released 7 hours before a solar flare occurred. A subsequent sounding measured fair-weather air-to-earth electrical currents more than 70 percent above normal, from the surface to the stratosphere, evidence that atmospheric electricity is directly influenced by the sun.

"Scientists have long suspected that thunderstorms regulate electricity throughout the global atmosphere," Cobb says, "but it now appears that solar particles and radiation can be important partners in this process. It's quite possible that sun-induced surges in electrical activity may even increase lightning strokes in thunderstorms, and also affect their rain-producing efficiency."

A variation on this theme was recently announced by Dr. Ralph Markson, of the Massachusetts Institute of Technology. He has presented evidence that galactic cosmic ray particles can also regulate the atmosphere's electric field. Furthermore, he found that the penetration of these high-energy particles into the atmosphere is inversely proportional to the speed of the ever-streaming "solar wind" of charged particles, and its imbedded solar magnetic field, past the earth.

Solar effects on lightning and thunderstorms? To Bill Cobb, that's an intriguing question. But he wishes that people would ask themselves a more personal one—not just "Why does lightning strike?", but "Where and when will it strike next?".

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There really is no lightning season. Lightning can strike any time, any place—even miles from the cloud where it originated. Here are some common sense safety rules:

- When a storm is in the area, get indoors or in a car (not a convertible), bus, or truck. But don't touch metal parts.
- Inside a house, avoid using the telephone except during emergencies. Lightning current can travel through phone lines into receivers.
- If caught outdoors and unable to reach a safe building or vehicle:
- Stay away from water and from metal objects, including golf clubs and wire fences.
- Do not seek shelter under a lone tree in a wide-open area. Isolated trees, particularly tall ones, are natural lightning rods.
- Avoid projecting yourself above the surrounding landscape, as by standing on a hilltop, in an open field, on the beach, or fishing from a small boat. If on a larger boat or one with a cabin, get below deck.
- If you feel your hair stand on end, indicating that lightning may be about to strike, quickly crouch down.

Remember that people struck by lightning may be revived by prompt first aid. Mouth-to-mouth and cardiopulmonary resuscitation techniques can be learned from local Red Cross and Heart Association chapters.

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*William E. Cobb, lightning expert with the Air Resources Laboratories looks on as Dr. Rudolf Pueschel adjusts an electric field sensor on a NOAA research aircraft.*

*Fresh, frozen, or canned—shrimp is a delight to the palate. Fine quality canned shrimp adds distinction to any menu; and best of all, the cleaning and cooking have been done in the canner's kitchen. Keep "can-venient" shrimp at your fingertips for speedy, twist-of-the-wrist mealtime magic. Canned shimp is crisp from the ocean—delightful—delicious—and de-veined—the ultimate in convenience. Singing in salads, sparkling in sandwiches, appealing in appetizers, and crafty in casseroles.*

# Shrimp Is Super

## GULF SHRIMP SALAD

3 cans (4½ or 5 ounces each) shrimp
2 cups cooked rice
1 cup sliced celery
½ cup chopped parsley
¼ cup sliced ripe olives
½ cup mayonnaise or salad dressing
2 tablespoons French dressing
2 tablespoons lemon juice
1 teaspoon curry powder
Salad greens

Drain shrimp. Cover shrimp with ice water and let stand for 5 minutes; drain. Cut large shrimp in half. Combine rice, celery, parsley, olives, and shrimp. Combine mayonnaise, French dressing, lemon juice, and curry powder; mix thoroughly. Add mayonnaise mixture to shrimp mixture; toss lightly. Chill. Serve on salad greens. Serves 6.

## CURRIED SHRIMP SANDWICHES

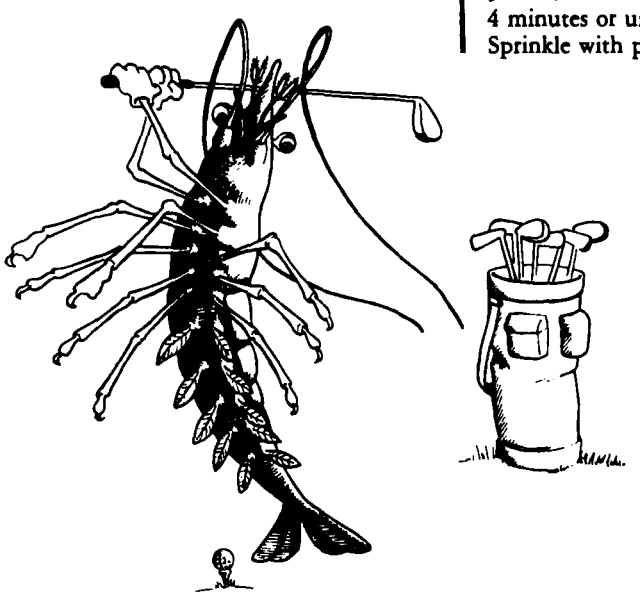
3 cans (4½ or 5 ounces each) shrimp
¼ cup butter or margarine, melted
1 egg, beaten
¼ cup milk
¼ teaspoon salt
Dash curry powder
6 slices bread
Paprika

Drain shrimp and rinse with cold water. Chop shrimp and fry in butter for 3 minutes. Combine egg, milk, and seasonings. Pour over shrimp and cook until thick, stirring constantly. Toast bread on one side. Spread shrimp mixture on untoasted side of bread. Place on a broiler pan about 3 inches from source of heat. Broil for 2 to 4 minutes or until lightly browned. Sprinkle with paprika. Serves 6.

## SHRIMP PIZZA

3 cans (4½ or 5 ounces each) shrimp
⅓ cup chopped onion
3 cloves garlic, finely chopped
½ cup melted fat or oil
3 cans (6 ounces each) Italian style tomato paste
⅓ cup chopped parsley
1½ teaspoons oregano
3 unbaked pizza crusts (9 inches each)
¾ pound Mozarella cheese, thinly sliced

Drain shrimp and rinse with cold water. Cook onion and garlic in fat until tender. Add tomato paste and simmer for 5 minutes. Remove from heat; add parsley and oregano. Place pizza crusts on well-greased baking pans. Cover each crust with ⅓ of the sauce, ⅓ of the shrimp, and ⅓ of the cheese. Bake in a hot oven, 425 °F., for 20 minutes or until crust is brown and cheese melts. Makes 3 pies. Serves 6.



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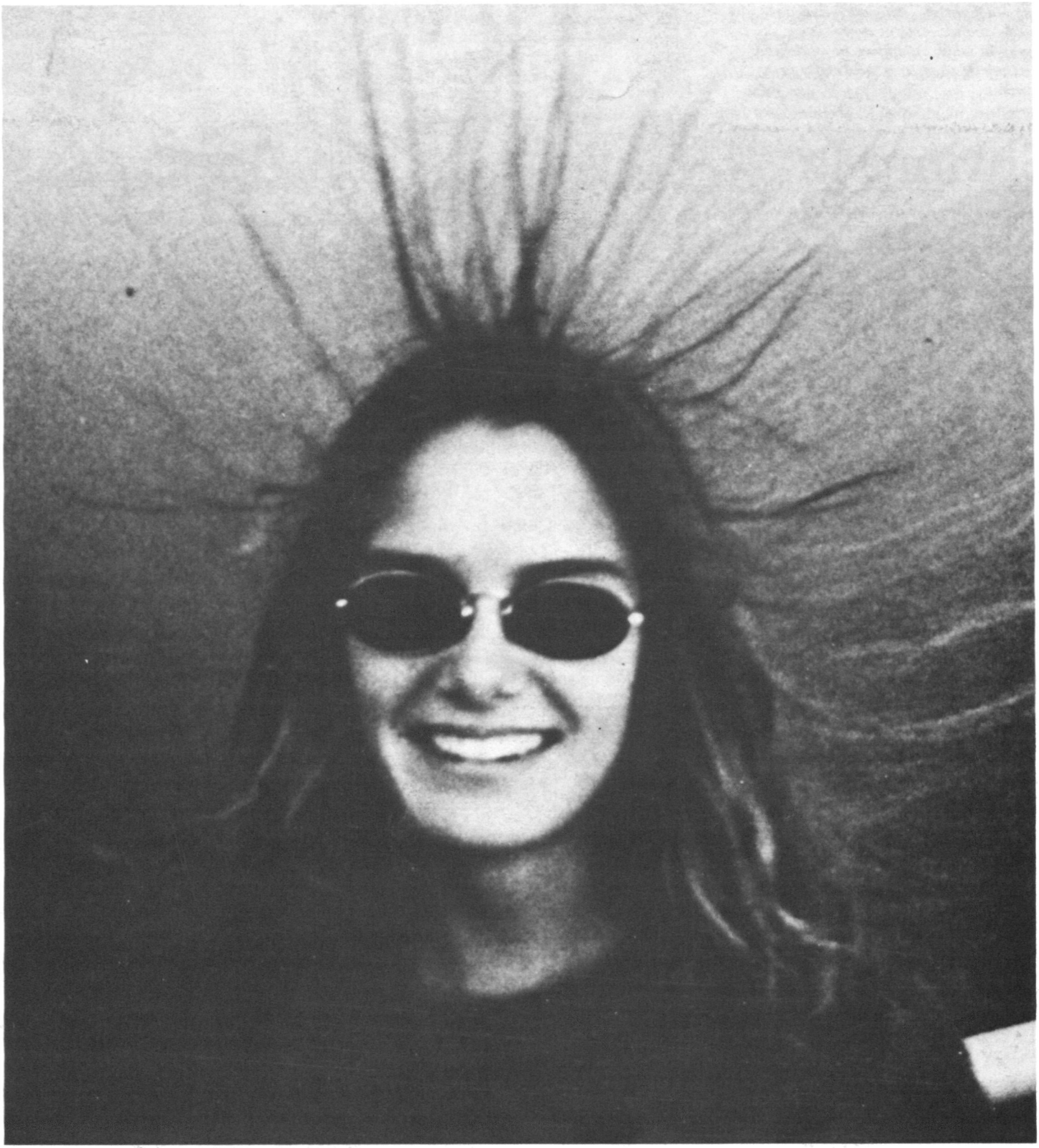

It's not really something to smile about. See the story on page 32.