U.S. DEPARTMENT OF COMMERCE ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION OCTOBER 1968

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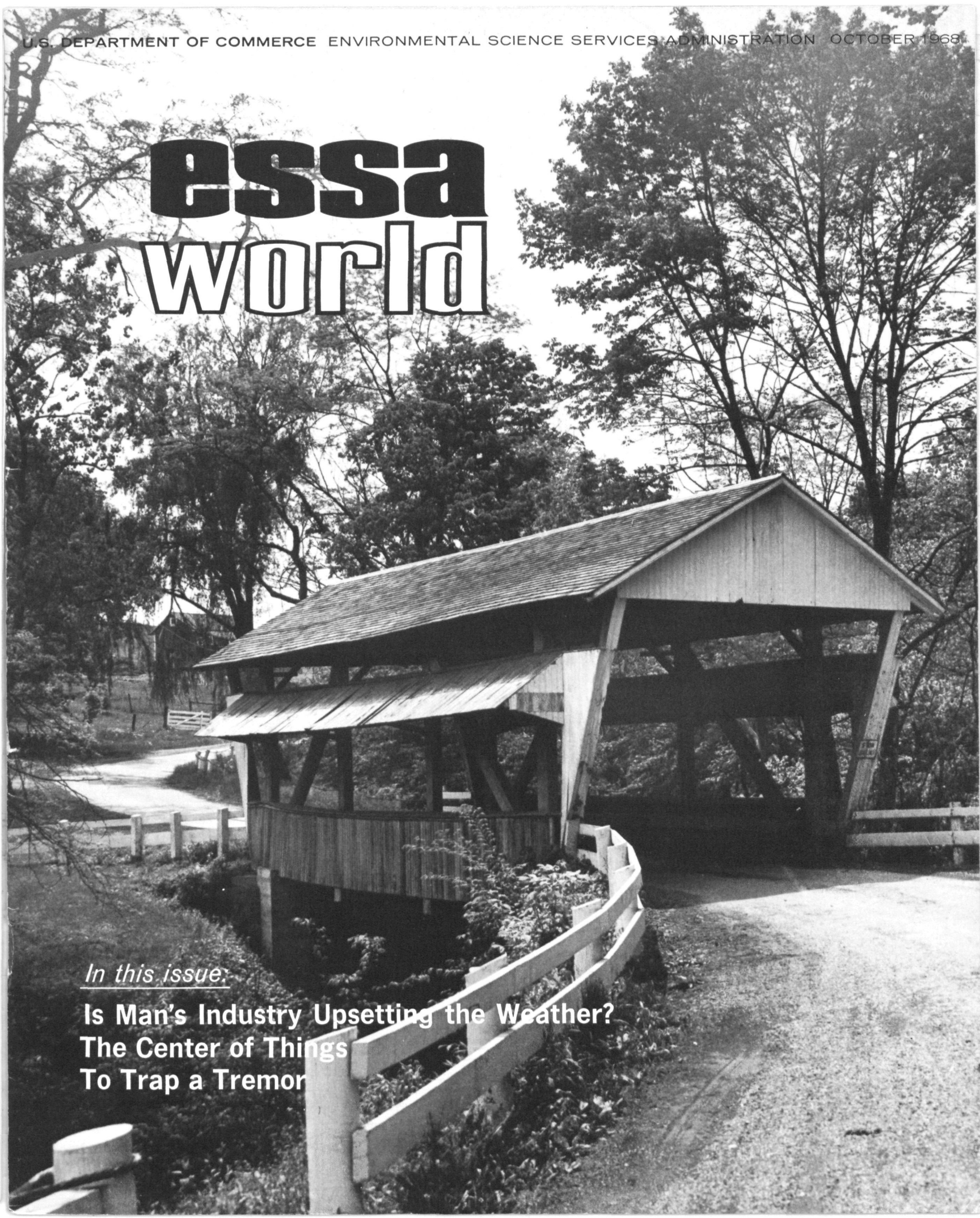

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Is Man's Industry Upsetting the Weather?
The Center of Things
To Trap a Tremor

National Oceanic and Atmospheric Administration

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U.S. DEPARTMENT OF COMMERCE, C. R. SMITH, Secretary
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, Dr. Robert M. White, Administrator
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COVER
This month's cover shows the environmental beauty *of an October scene.*

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STANLEY B. EAMES
Director, Public Information

MAX M. CHESY
Art Director

ROBERT M. WHITE
ADMINISTRATOR

A Message from the Administrator

People are measured by their achievements in America perhaps more than anywhere else on earth. The respect in which we are held by our colleagues and friends is to a large extent measured by the kind of job we do.

This is vital to the democratic concept of our republic. It is significant that what we call "a good job" is not measured by money alone. A good job is any steady employment, from the blue collar to the highest level, which affords pride of accomplishment. It affords considerably more than the material things its salary buys; it helps a man to know who he is and what he is. It provides the base on which he builds not only his family life, but his place in the sun. It is a basic right, in the American working world, to get off to an even start with one's fellows, and to develop according to one's capacity within the limitations of a job. Every American should expect no more and settle for no less. Denial of the right to a job, to pleasant treatment on the job, or to the advancement it may hold, on the basis of race, color, creed or sex, constitutes a theft far graver than the theft of property. It is a crushing denial of the freedom we prize so highly.

As a scientist and as Administrator of a scientific agency, I am dedicated to the principles of reason and objectivity. By any test within these principles, job discrimination is untenable. But there is an even more basic test here: the simple difference between right and wrong. By this yardstick, job discrimination is worse than untenable; it is evil.

There have been some very dark chapters in our country's history. We must take positive and constant action to counter past discrimination and the long, bitter years of opportunity lost. These efforts can be accomplished through action plans which have been provided for every ESSA installation. These plans must be vigorously pursued. I call upon every employee in a supervisory position to be alert for every opportunity to wipe out job injustice wherever it may exist, and I call upon those not in positions of authority to further these principles through their actions and attitudes. □

R M White

A climatologist asks

Is Man's Industry Upsetting World Weather?

BY J. MURRAY MITCHELL JR.
Environmental Data Service

ALMOST daily we can read in the newspapers of rampaging weather somewhere in the world. As these words are written, the dateline is Bombay; the grim story, 1500 persons left dead in floods. Last week it was Santiago and a report of new economic chaos wrought by the worst drought in Chile in a hundred years. Last year, just a few of the more remarkable weather events closer to home were: a near-record annual total of 837 tornadoes reported nationwide . . . the heaviest rains to hit southern California in thirty years . . . a break in the five-year-long drought that had dwindled water supplies for the thirsty New York metropolis to a virtual trickle . . . one of the most violent hurricanes (Beulah) ever to strike the Texas coast . . . and so on, and on.

And to add further mystery to the endless drama of weather, the world appears to be in the throes of a general climatic fluctuation. During the past quarter century our planet is believed to have been cooling off by a fraction of a degree, and winters to have become a bit harsher in both North America and Europe. In contrast, between the end of the 19th century and about the time of World War II a warming trend had held sway, with average temperatures edging gradually higher by about one degree F.

Not many years ago, before the new cooling trend was detected, Sunday supplements blared dire predictions that the polar ice caps were going to melt, and our coastal cities would be inundated by rising sea levels. Nowadays, one can occasionally read of the threat of an onrushing ice age instead!

Many people are wondering about these curious moods of the weather. One moment we are pacified by some meteorological expert with the thought that we are observing nature doing what comes naturally—that in the eyes of the weather historian these atmospheric vagaries are nothing new. The next moment we are jolted by the warning of another expert that man has lately emerged as a potent geophysical force on our planet—that in one way or another his activities may be upsetting the delicate natural balance of the atmosphere to bring about new, unnatural weather hazards.

Can both be right? Up to a point their divergent views need not be contradictory, but beyond that only one will be vindicated in the end. Let's take a look at the situation in perspective.

It should be realized that if there is anything unusual about the weather, it is that somewhere and in some respect it is always *unusual*. History clearly tells us that this has always been so. Calamitous weather events, and the human anguish they so often cause, will continue to make news in the years ahead just as they have in the past. The space-age meteorologist may often be unable to forewarn more than a day or two ahead when and where natural weather disasters will strike, but in retrospect he is not the least surprised that they happen nor that they happen as frequently as they do. When someone blames them on nuclear testing or air pollution, he is not overly impressed because by searching back through his file of historical weather data he can find precedents for nearly all of them.

There are other considerations, too. For one thing, weather records in many parts of the world—including our own—are rather too short for the purpose of establishing reliable statistical

bounds of weather behavior. Some years ago, one of my Weather Bureau colleagues who maintained a nearby cooperative climatological station often walked past our office on rainy mornings with the jaunty remark, "Well, we broke another rainfall record today." That elicited nothing but smiles. You see, we all knew that the station had been established only two years before! But this illustrates a point. Even in a record 50 years long, consisting of a variety of weather elements, it is more likely than not that each additional year of "normal" weather variability will bring at least one new weather extreme of some sort. Indeed, weather records are broken almost every day somewhere in the United States, and when they are it doesn't necessarily mean that the climate has gone haywire.

Equally important is the fact that as modern society increases in complexity it finds itself sensitive to unusual weather in entirely new ways, often with significant economic consequences. It sometimes happens that a weather event which is not so unusual meteorologically can have an unprecedented social or economic impact that lends it an aura of uniqueness. In this way an idea can take root that the climate has overstepped its established bounds when in fact it has not and new grist is added to the mill of the weather going to the dogs.

These, then, are some of the ways in which man can sometimes misinterpret nature, and over-react to its vicissitudes. But a growing number of atmospheric scientists who have their eyes pretty wide open in this respect are suspicious nevertheless that our present-day climate is not quite what it would have been in the absence of the human race on our planet. Their suspicions are not founded in any concrete evidence of human intervention in weather processes. Not yet anyway. Rather, they arise from a newly acquired comprehension of the forces that shape weather and climate—forces that are clearly coming within modern man's power to alter significantly in a variety of subtle, unintended ways.

By and large, it all began with the dawn of the atomic age. Some scientists were so impressed at the time with the newly unleashed power of the atom that they wondered aloud if atomic testing had somehow wrought meteorological vengeance upon our planet. (The weather, of course, was on the rampage back in the 1940's too.) They imagined that the furious heat of the atomic fireball could drive the atmosphere into excited activity over long distances, just as it was observed to do locally. If that wasn't so, perhaps the dust kicked into the upper atmosphere by the explosion, coupled with unnatural cloud formations that might have followed, was altering the distribution of the weather-driving heat of the sun. And failing that, they could point a long finger of suspicion at the radioactive debris poured into the atmosphere by the explosion, arguing that this could be upsetting the natural electric field of the air or in some other way altering the efficiency with which cloud droplets coalesce into rainfall.

But these fears of atomic influence on the weather could never be substantiated. The bomb tests came and went. Atmospheric radioactivity waxed and waned. Still the weather seemed to go on behaving as usual—which is to say, unusual. Since adoption of the international test ban treaty, this whole

continued

matter, which had once received so much attention, has been all but forgotten.

Meanwhile, fears of a different kind of human influence on world weather have taken over. At an ever accelerating pace man is bringing a variety of changes to his environment which, if they have not yet had much impact on large-scale weather, they are almost certain to have in the future.

For one thing, man has brought striking changes to the face of the earth. He has manipulated millions of acres of landscape by clearing forests for crops and pasture, by backing up huge artificial lakes for power and water supplies, by irrigating vast stretches of desert and wasteland, and by paving his cities and highways. Inasmuch as weather and climate are certain to be conditioned by the character of the earth's surface, among other things through its influence on the disposition of solar energy impinging upon it, there can be no doubt that man has altered atmospheric conditions in the process. At present these alterations are likely to be very modest in degree, and local in extent.

But how far can man go in transforming the earth's surface to suit his needs before the individual weather effects fuse into a bona fide change of climate? At some stage, one can expect the large-scale atmospheric wind system to become involved in the change. Then indirect climatic influences might spread many hundreds or thousands of miles distant.

As yet there is no convincing evidence that even the largest land management projects in the world are imposing significant long-distance effects on climate. However, we should face the very real possibility that bigger projects to come, or the aggregate influence of a greatly increased number of smaller projects, could eventually strain the atmospheric energy balance to a point where the weather of whole continents could settle into new and unfamiliar patterns. Fortunately such massive projects take many years to plan and build. Before they become faits accomplis, it is likely that our quantitative theory of climate will have improved sufficiently for us to predict their weather effects in detail. Projects found likely to breed undesirable weather could be vetoed in advance of construction.

Another facet of man's growing influence on environment is the prodigious quantity of waste matter that he is pouring into the atmosphere. In large part this derives from the thousands of mills and power plants, the hundreds of millions of automobiles, and the millions of domestic furnaces, which have in common a voracious appetite for coal, gasoline, fuel oil, and other kinds of fossil fuels. One of the products of combustion of such fuels is carbon dioxide gas—more than six billion tons of it every year. In addition, man is loading the air with an increasing tonnage and ever widening variety of other chemical wastes, including smokes, dusts, hygroscopic particles, toxic fumes, and occasionally radioactive materials.

In our cities, where the sources of air pollution are most highly concentrated, these waste materials are being generated at a rate that taxes the capacity of the atmosphere to remove them before they accumulate into drab palls of smoke and smog. This is one of the reasons that the climate of our cities is bearing less and less resemblance nowadays to that of our rural countryside. But what concerns us here is that in a less obvious way we may have started to overload the world's atmosphere as a whole, to the possible detriment of weather on a far vaster scale.

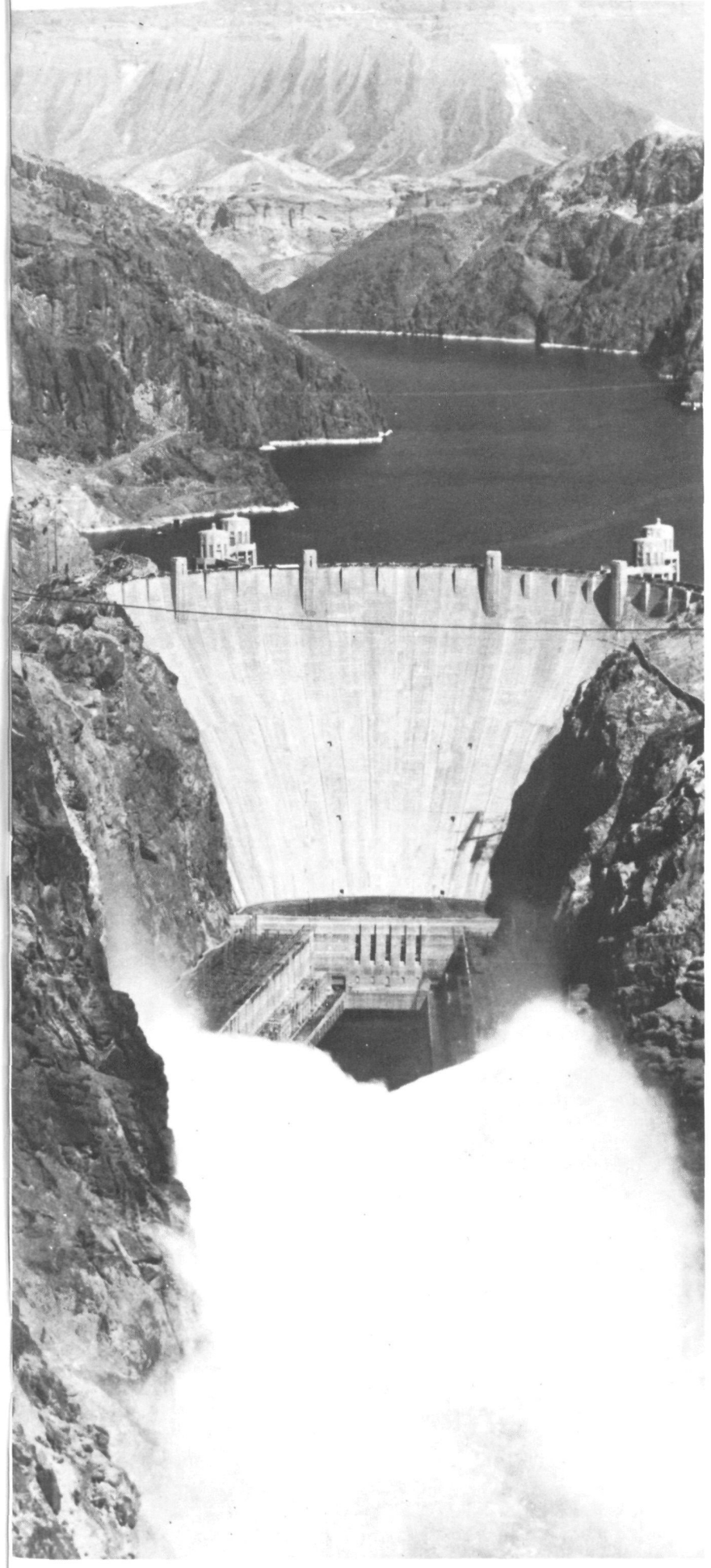
The story of carbon dioxide has a special significance to world weather. Of the six billion tons of it added to the atmosphere each year by the burning of fossil fuels, most are trapped there. A fraction emigrates to the oceans, but only a fraction. Trees and other green plants take up a considerable amount each day by photosynthesis, but as soon as they rot or burn they yield it to the air again by oxidation. So the concentration of carbon dioxide in the air we breathe has been edging upward by measurable amounts ever since the end of the 19th century. The world atmosphere is holding somewhere between 10 and 15% more of this gas today than it was holding a century ago—thanks to man.

The meteorologist cares about carbon dioxide for a very good reason. Although the gas is a rather minute constituent of air (about .03% by volume), it is a very efficient absorber of thermal (infrared) radiation. Like water vapor, it tends to trap heat inside the atmosphere, and according to recent calculations by Dr. Syukuro Manabe of ESSA's Geophysical Fluid Dynamics Laboratory it keeps world climate nearly 20 degrees warmer than would be the case in the total absence of the gas. Dr. Manabe's studies also tell us that a 10% increase in the atmospheric content of carbon dioxide would raise temperatures in the lower atmosphere by about ½ degree F, a figure that approaches the worldwide temperature increase actually observed since the 19th century.

Thus a very good case can be made for ascribing the lion's share of the great climatic warming during earlier decades of this century to man's consumption of fossil fuels. But once again our main concern is for the future. In the next few decades, the rate of consumption of fossil fuels is projected to accelerate further until finally nuclear power and electricity take over as our principal sources of energy. Indeed, if future climatic changes should be determined above all by the continuing increases of atmospheric carbon dioxide expected to follow, the climate of our planet might well be warmed an additional two or three degrees by the end of the 20th century. But at the same time, the atmospheric wind circulation might find it necessary to adjust in some ways to this warming, to result in other unforeseen weather changes as well. The meteorologist must be prepared to anticipate these changes before they arrive, and Dr. Manabe and his colleagues are among those now tooling up for the job with the help of ESSA's giant electronic computers.

We have already said that the world is in a cooling phase. At first glance this would seem to contradict what we have been saying about the weather effects of carbon dioxide, since presumably there has been no letup in the long-term accumulation of this gas in the atmosphere. However, if it is true that we have not yet identified the basic causes of these contemporary ups and downs of climate, we know enough about the climate-shaping forces in our environment to suspect that there are many causes. Sometimes these conflict to produce a small net change of climate, and sometimes they act in concert to produce a large change. At the moment, something else may be offsetting the warming effect of carbon dioxide. For example, the sun itself might be cooling down slightly, at a time when it is starting to simmer down in terms of sunspot numbers and other kinds of solar activity. If the sun should be cooling off, the earth would certainly be cooling with it.

But many people are wondering if yet another kind of human activity is responsible for this worldwide cooling, and not a natural environmental change at all. They have in mind some of the other forms of air pollution we have mentioned, namely the smokes, dusts, and other particles that man is disgorging along with carbon dioxide. In their view, we might be



Man is bringing a variety of changes to his environment by backing up huge artificial lakes and irrigating vast stretches of desert and wasteland.

witnessing an atmospheric tug-of-war between these two kinds of pollution, with the smoke finally gaining the upper hand.

If they are right, it means that the pollution particles so conspicuous over our cities and industrial complexes are spreading into a nebulous veil that is virtually encircling the world. Robert A. McCormick, of ESSA's Air Resources Laboratory assigned to the Public Health Service in Cincinnati, and his colleagues have cited some alarming evidence that this has actually started to happen. Russian meteorologists have arrived at the same conclusion. Dust is turning up in greater quantities in the atmosphere over such places as Davos, Switzerland, and Mauna Loa Observatory in Hawaii, where measurements are thought to be fairly representative of conditions in the atmosphere at large.

These changes in atmospheric dust content are readily detected in observations of the intensity of direct sunlight. Their weather effects might follow from either of two properties of the dust.

One effect of dust is to scatter solar radiation on its way toward the earth's surface. Most of this scattering is in a forward direction, so that what heat is lost out of the direct solar beam is largely offset by an increased brightness of the rest of the sky. But a tiny portion of the sun's heat is back-scattered into space before it has a chance to reach the surface. Another tiny portion may be absorbed in the dust layer, and that also fails to reach the surface. In the view of Mr. McCormick and of Dr. Reid Bryson of the University of Wisconsin, the net effect could be a significant cooling of climate, of just the kind we have been observing in recent years.

Another effect of dust might be to encourage an abnormal formation of ice-crystal clouds in the atmosphere's upper levels, by providing an abundance of sublimation nuclei where nature's own supply of such nuclei is deficient. In support of this idea, Dr. Vincent Schaefer of the State University of New York at Albany has drawn attention to the phenomenon of "false cirrus," a thin ice-crystal cloud that sometimes grows out of the condensation trail of a high-flying jet aircraft, and that may in time cover the entire sky. Nucleating particles in the jet's exhaust are believed to trigger the initial ice-crystal formation, after which the cloud spreads in a chain reaction of further crystal formation. Dr. Schaefer believes that false cirrus may become a chronic problem along the world's airways, especially in the 1970's when great numbers of fuel-gulping supersonic transports will take to the skies. There is no question that aircraft can create clouds in this way. I have seen them do so. But it doesn't happen very often, and when it does I strongly suspect that prevailing weather conditions are such that the clouds would rather soon have developed anyway, by natural means. Moreover, the ways in which cirrus clouds—either natural or man-made ones—can alter weather on a large scale are quite limited. Of all the types of clouds, cirrus clouds have the least influence on the planetary heat balance. Only when they become uncommonly dense, or when they form at unnaturally high altitudes, are they likely to play an important part in weather processes. There is, then, little basis as yet for supposing that the supersonic fleets of tomorrow will upset world climate. But with the complexity of the atmosphere being what it is, we would do well to keep a wary eye on the situation.

Weather and climate are among man's most valuable natural resources. If indeed he is capable of influencing it, whether accidentally or deliberately, he can ill afford to forge into the future without a clear understanding of his impact upon it. □

Castle Rock may be small; on the other hand, its in

The CENTER OF THINGS

BY RAYMOND WILCOVE
Coast and Geodetic Survey

Prior to the admission of Alaska and Hawaii to the Union, the geographic center of the United States was determined by the C&GS to be near Lebanon, Kansas, and after their admission, the center shifted to Butte County, South Dakota.

"The flags of Spain, France, and the U.S.A. have proclaimed their sovereignty over this area, the center of the great buffalo ranges of the 19th century where the Texas longhorns have replaced the buffalo and the homesteaders took over from the nomadic Indians."

The weeds grow thick around the small concrete marker set in the ground in the heart of the Kansas grass country. A wandering cow may graze around it and the rare farmer who happens across it may give it only a passing glance. Yet the marker and the brass plate imbedded in it are unique, for they represent the "Geodetic Center of North America."

They mark the beginning reference point for all property lines throughout the United States, Mexico and Canada and for all city, county, state and international boundaries.

The "triangulation station," as it is technically known, is located at Meades Ranch, in Osborne County, 12 miles north of Lucas, Kansas, on private property. A recommendation has been submitted to Congress to acquire the area on which the marker is established so it may be developed as an historical site.

Confusion sometimes arises over the significance of the Meades Ranch station. Some mistake it for the geographic center of the United States or North America. It is neither. A geodetic center is not analogous to a geographic center. In 1891, when the triangulation station was established by the Coast and Geodetic Survey, it represented the geodetic center of the then 43 states. Subsequently, it became applicable to the entire North American continent.

The triangulation station at Meades Ranch is the point from which all geodetic computations are made for latitude and longitude of North America. The latitude and longitude of the station are, respectively, 39° 13′ 26″ .686 North and 98° 32′ 30″ .506 West. Hence, Meades Ranch is the geodetic center of the North American continent and has no geographic significance whatever.

But if Meades Ranch is not the geographic center of the United States or North America, then what is?

Actually, there is no way to determine the exact center of either the continent or the United States. Locating the geographic center of any irregular area on the earth's surface is a precarious business. There is no finite solution and none of any scientific consequence.

Several methods of approach are available. The one employed by the Coast and Geodetic Survey is probably best termed the center-of-gravity method. Imagine that a map of the area for which the geographic center is to be determined has been placed on a piece of cardboard of uniform thickness and that this is cut carefully along the outline of the map. The center of gravity of this map outline, or what might be called the geographic center, is that spot at which the map will balance on a single point.

Using this method, the geographic center of the United States has been determined as being 17 miles west of Castle Rock, Butte County, South Dakota, or latitude 44° 58′ North, longitude 103° 46′ West, within a 10-mile radius in any direction.

The Chamber of Commerce at Belle Fourche, South Dakota, the only sizeable community in the area in comparison to Castle Rock, which has a population of 10,487, has taken note of this and has proclaimed itself "Center of the Nation," but has carefully pointed out in its literature that the geographic center is actually 20 miles north.

At this northern point, as designated by the Coast and Geodetic Survey, there is a roadside park where tourists gather to have their pictures taken beside a marker which proclaims "CENTER OF THE UNITED STATES." The marker, erected by the South Dakota Highway Department and the Belle Fourche Chamber of Commerce in 1959, reads:

"For generations the accepted Center of the United States was near Smith Center, Kansas. The advent of Alaska, by mathematical wizardry, shifted it into Butte County, South Dakota, and with the addition of Hawaii it was again relocated a few miles further Southwest at the approximate joinder of 44° 58′ North with 103° 46′ West, which in fact is located 1/10 of a mile DUE EAST from this marker.

"South Dakota has long claimed to be the approximate center of North America with a monument and marker north of Pierre to prove it. The flags of Spain, France, and the U.S.A. have proclaimed their sovereignty over this area, the center of the great buffalo ranges of the 19th century. The Gros Ventres, Cheyennes, Crows and Sioux waged their never ending forays and wars hereabouts. Verendrye, the first white man, passed close to this point to the east in 1743. The Custer Expedition of 1874, on their homeward journey, also passed close by and in 1876 General George Crook, with his starving horsemeat eaters, after the battle of Slim Buttes enroute to succor in the Black Hills, passed close by. Shortly thereafter, Texas longhorns replaced the buffalo and homesteaders took over from the nomadic Indians. Butte County, once with 7883 square miles, was whittled down to 2266 square miles in 1908, still a tenth larger than Delaware. South Dakotans prosper under their State Motto, 'Under God the People Rule,' and are mighty happy to have the great United States spread out equally to the far corners of the compass around this point."

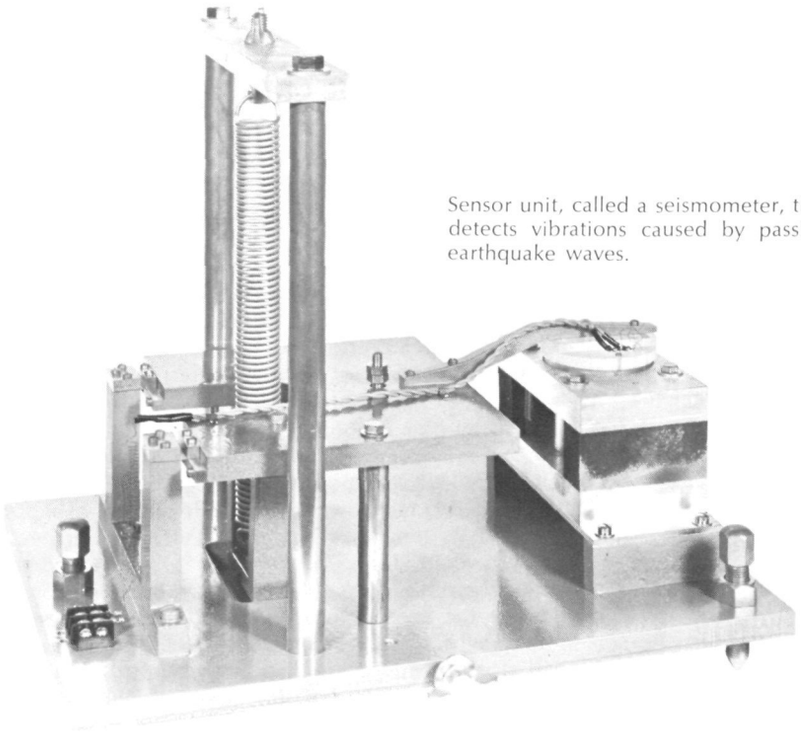
Prior to the admission of Alaska and Hawaii to the Union, the geographic center of the 48 conterminous states was determined by the Coast and Geodetic Survey to be near Lebanon, Kansas, at latitude 39° 50′ North, longitude 98° 35′ West.

When Alaska was admitted to the Union, the geographic center of the 49 states shifted about 439 miles northwest to a point about 11 miles west of Castle Rock, at approximately 44° 59′ North, longitude 103° 38′ West.

Later, when Hawaii became the 50th state, the geographical center of the nation was determined as being on the great circle connecting the geographic centers of the 49 states and Hawaii at a point where these areas would "balance." The inclusion of Hawaii affected the computations very little since its area is only about 1/560 of that of the 49 states. The geographic center of the 50 states thus shifted about six miles west-southwest to approximately 17 miles west of Castle Rock, and historically significant Meades Ranch, Kansas, the "Geodetic Center of North America," thereby yielded to geographically important Castle Rock, South Dakota, America's approximate geographic center. □

Coast Survey seismologists eavesdrop on the earth

To Trap a Tremor



Sensor unit, called a seismometer, that detects vibrations caused by passing earthquake waves.

"FIRST catch your rabbit," says an ancient recipe for rabbit stew.

Modern seismology faces a similar problem: to determine where major tremors are most likely to occur and to position instruments there so one can eavesdrop on Mother Earth when she quakes.

It is a problem whose solution, at least for the present, lies in the past. Earthquakes, like history, tend to repeat, in general geographic terms, and therein lies the scientist's hope of trapping them on graphs.

Government seismologists pore over records dating back scores of years, sometimes centuries, in their hunt for prime areas in which to plant instruments recording the strong motions of earthquakes. The results have been so good that today the Coast and Geodetic Survey has approximately 600 instruments strategically located, awaiting rumbles which will add to its already considerable store of knowledge.

Eventually, it is hoped, the program may advance the state of the art to the point where damage from Nature's tremors can be reduced, perhaps even eliminated, by the design and construction of earthquake-resistant structures.

Since the first instrument was installed in 1932, more than 100 records of major earthquakes have been obtained. Six months after installation of the instruments began, the world's first strong-motion records were obtained during the disastrous 1933 earthquake at Long Beach, Calif.

The program is carried out from San Francisco by the Seismological Field Survey, headed by William K. Cloud. Strong-motion instruments are now installed in nine states (California, Oregon, Washington, Montana, Nevada, Utah, Arizona, Alaska, Connecticut) and in eight Central and South American nations (Guatemala, San Salvador, Costa Rica, Colombia, Venezuela, Ecuador, Peru, Chile).

The instruments — accelerographs and seismoscopes—are generally installed in tall buildings, although they are to be found also at dams, bridges, and atomic reactors. They are triggered by any nearby earthquake which is at least 3.5 to 4 on the Richter scale, a mathematical method of defining the size of earthquakes. These minimum-size shocks are quite small; for comparison purposes, the 1906 San Francisco earthquake measured 8.3 on the Richter scale and was about 10,000,000 times as large as a magnitude 3.5 tremor.

As the machines are triggered, they record the earthquake's effect on the foundation material and on various levels of the structures. These records are studied by seismologists and the data is furnished to engineers, architects, and others interested in designing and constructing safe structures in earthquake areas. Various findings have been incorporated in building codes.

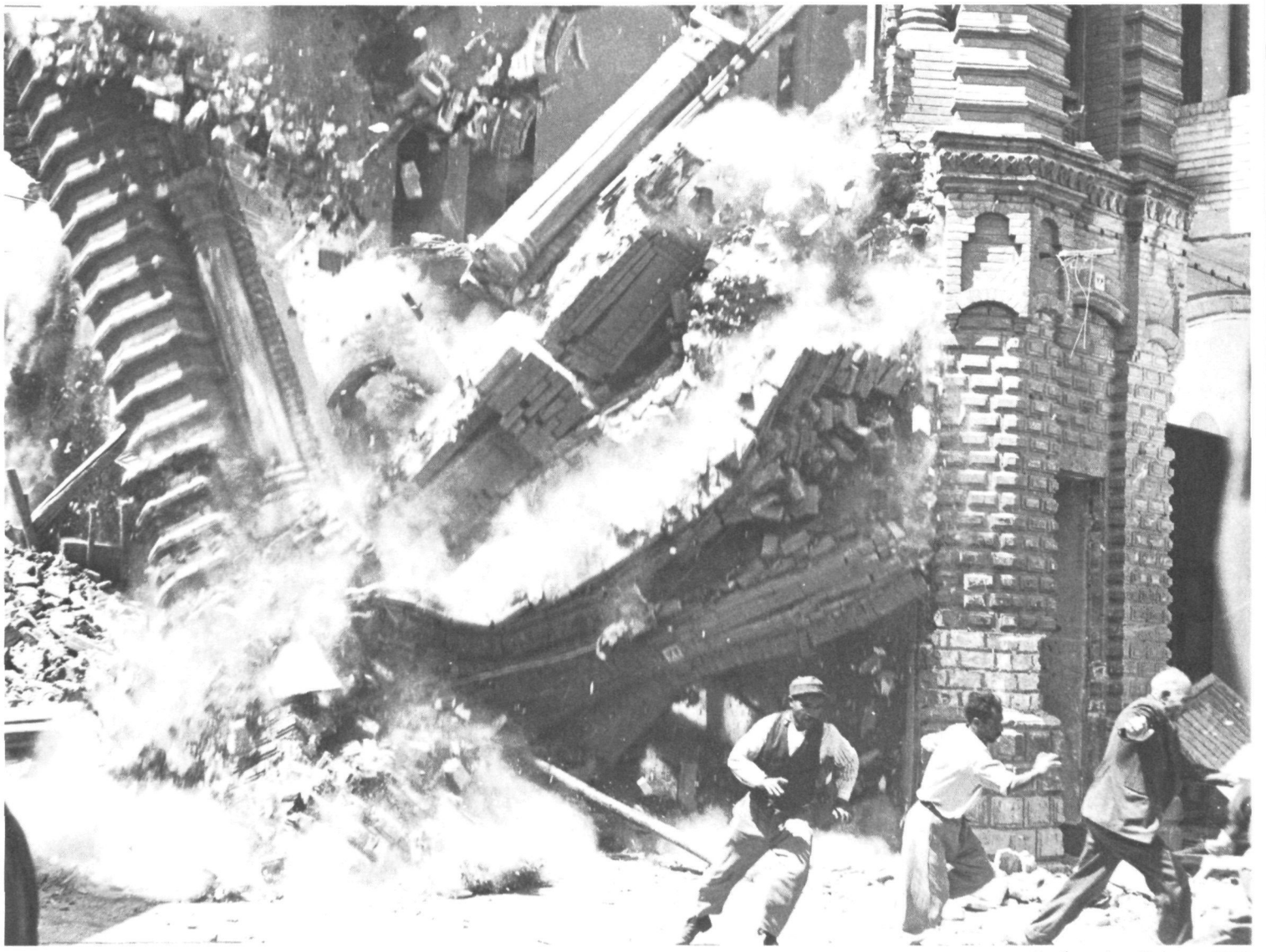


Photo by J. Zamanian

Earthquake, Tehran, 1965

Two communities in California, Los Angeles and Beverly Hills, have enacted strong-motion instrumentation ordinances which are expected to be duplicated in many areas of the state. The Los Angeles ordinance requires that three instruments be placed in each newly constructed building (in the basement, mid-building, and on a top floor) "over six stories in height with an aggregate floor area of 60,000 square feet or more and every building over 10 stories in height, regardless of floor area."

The records "freeze" earthquake motion in a form that allows engineers to duplicate it either physically on shaking tables or mathematically in computers to test response of various types of structures to an earthquake.

From a study of these records may come the answers to such questions as: what happens to a structure when a strong earthquake affects it? how strong must buildings be to withstand strong earthquakes? what type of earthquake is most likely to occur in various localities? what is the response of reinforced concrete buildings, compared to different types of construction? what is the response of structures constructed on hard rock versus those placed on piles or compacted fill? These are but a few of the many questions the strong motion program is designed to answer.

The sites for strong motion instruments are constantly being reviewed. As of last June 30, they were located as follows:

California—San Diego, El Centro, San Onofre, Perris, Los Angeles, Isabella, Cholame, Terminus, Monterey, Pine Flat, Bishop, Los Banos, San Francisco, Stockton, New Hogan, Hawthorne, Sacramento, Coyote, Oroville, Chilcoot, Black Butte, Ferndale, Eureka.

Oregon—Green Peter Dam, Portland.

Washington—Ross Dam, Seattle, Tacoma, Olympia.

Montana—Columbia Falls, Helena, Butte, Bozeman.

Utah—Logan, Flaming Gorge.

Nevada—Hoover Dam, Mohave.

Arizona—Alamo, Glen Canyon.

Alaska—Shemya, Adak, Cold Bay, Kodiak, Seldovia, Seward, Anchorage, McKinley, Fairbanks, Cordova, Yakutat, Juneau, Sitka, Ketchikan.

Connecticut—Haddam.

Guatemala—Guatemala City.

El Salvador—San Salvador.

Costa Rica—San Jose.

Venezuela—Caracas.

Colombia—Bogota.

Ecuador—Quito.

Peru—Lima.

Chile—Santiago.

This unique network has produced nearly all the available records of damaging motion during earthquakes. That the network exists is the indirect result of American engineers attending the 1929 World Engineering Congress in Tokyo and the direct

continued

result of Coast and Geodetic Survey efforts in cooperation with the engineering profession.

During the Tokyo meeting, engineers were afforded an opportunity to study work of the Japanese in applying earthquake knowledge to the design of structures. Many of the engineers returned home convinced that the United States should focus more attention on engineering aspects of seismology, particularly on the development of suitable instruments for recording strong motion.

Since earthquakes are a nationwide problem, Federal aid was enlisted through the Department of Commerce. The responsibility for implementing the program suggested by the engineers was assigned to the Coast and Geodetic Survey, since this agency had previous experience in operating seismographs at a network of stations at various locations throughout the U.S.

The program began in 1931 with top priority given to the development of instruments. Considering that the instruments were to measure motion of character and amplitude as yet unknown, success of the development is considered remarkable. Many of the instruments designed and constructed at this time are still in operation, with only minor modifications over the years. As in most seismographs, the strong-motion machines use pendulums for measuring. These are used because their motion relative to the ground can be made to approximate closely the actual motion of the ground in terms of acceleration, velocity, or displacement.

After development of the instruments, California was selected as a laboratory in which to begin field operations because conditions, both as to type and frequency of earthquakes, were considered optimum for probable immediate economic return from the investigation. Six months later, the seismologists had their first strong-motion records from the Long Beach earthquake.

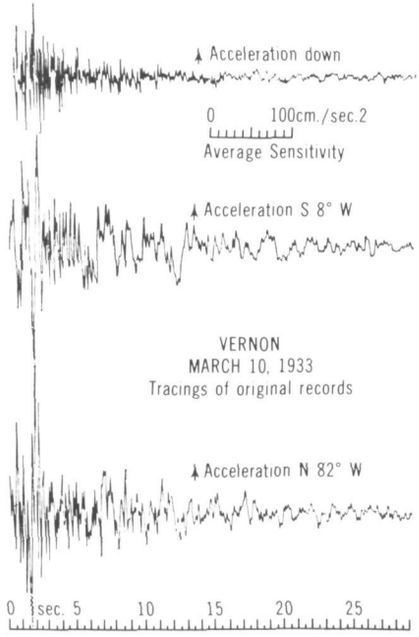
Included in the more than 100 records of major earthquakes obtained to date, one of the most unusual was that procured 300 feet from where an earthquake faulted the ground surface, near Parkfield, Calif. This occurred June 27, 1966.

Motion of the pendulums during the earthquake indicates that the ground acceleration reached the highest level ever recorded—*16 feet per second per second.*

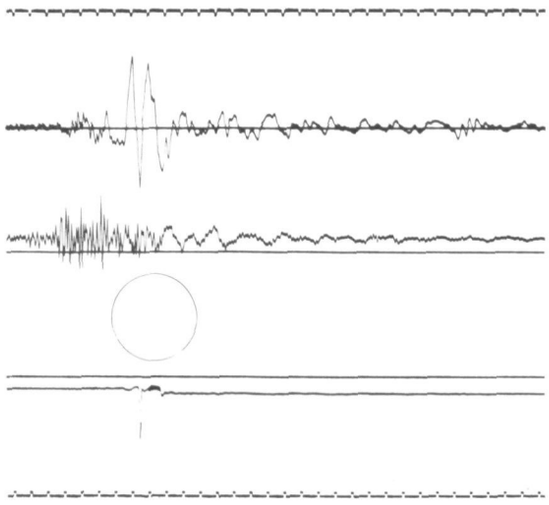
Growth of the network of strong-motion seismographs is due in large measure to the widespread cooperation received from many interested institutions and individuals. The Seismological Field Survey manages and maintains the network, but over 50 per cent of the instruments were purchased by outside organizations and practically all space for the instruments is contributed by property owners. Manufacturers also have contributed by developing commercially available instruments that require little space and sell for as low as $1650. Earlier instruments were custom made, required more space, and cost over $4000. □

Photo by Gordon Chesy

A Los Angeles ordinance requires that earthquake sensor instruments be installed in newly constructed buildings six stories or taller.

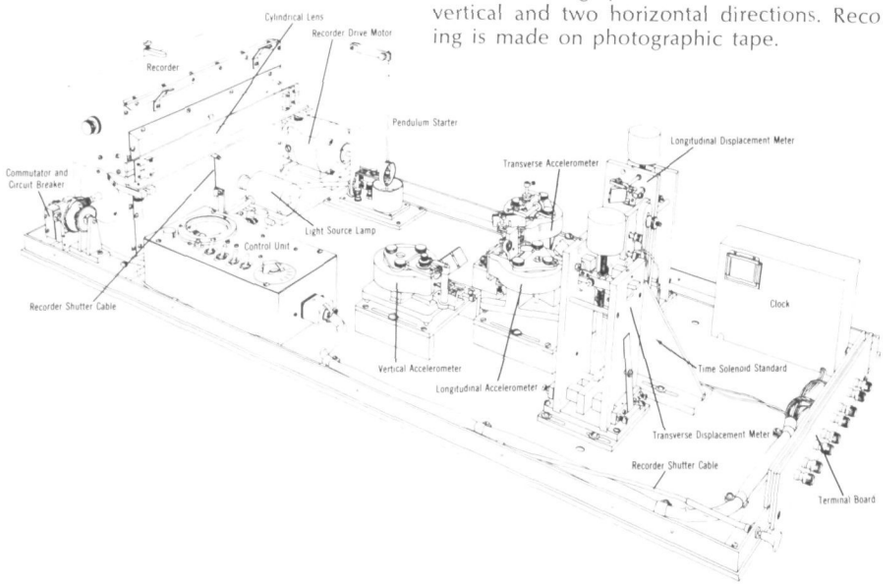


Tracings of the world's first records of motion responsible for damage during an earthquake.



Acceleration records obtained 300 feet from a rupture zone on the San Andreas fault during the July 27, 1966, Parkfield, California, earthquake. Acceleration of ½ gravity is the highest recorded to date.

Coast and Geodetic Survey standard strong-motion seismograph records acceleration in the vertical and two horizontal directions. Recording is made on photographic tape.



39 YEARS OF SERVICE

The clergy's loss was the country's gain

His mother would have liked an Episcopal clergyman in the family, but instead he studied engineering and joined the Coast and Geodetic Survey.

"I guess I didn't get the call," said Rear Admiral James C. Tison, Jr. But his family should have been satisfied with his choice of careers, for he became the Director of the nation's oldest scientific agency.

Now, on the eve of retirement after a distinguished 39-year career, the Admiral looked back over those years.

The country was about to face an economic decline that would go down in history as *the* Depression when Tison, then almost 21, was graduated from The Citadel in Charleston, S.C., with a degree in civil engineering. It was 1929, the year the stock market crashed, and 12 million breadwinners would find themselves unemployed before things got better.

"I was a budding engineer with a fellowship offered me as a job with the American Bridge Co.," recalled Tison. He broke into a quick smile. "So I joined the commissioned corps of the Coast and Geodetic Survey.

"Frankly, I don't know what I would have done if there hadn't been a depression after I got out of school and after I entered the C&GS," he said. "I might well have tried the Coast

continued

Survey and then private industry. But I didn't because I couldn't, and I've never been sorry.

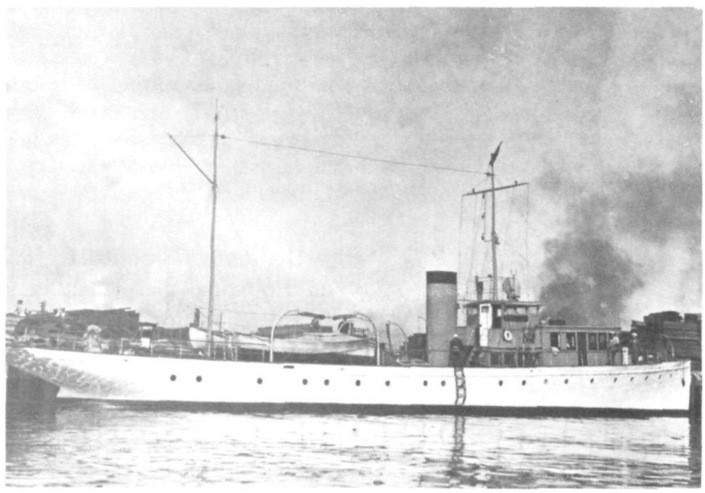
"Oh, there were times during my early years in the commissioned corps when I thought of quitting. In fact, I had no intention of staying when I joined the Coast Survey. Looking back, however, I'm glad I didn't get out.

"If I had, I would have missed what has been a very rewarding experience, not only to be of service to my country, but the chance to serve with what I consider to be one of the most dedicated, conscientious, responsible groups of people it has ever been my pleasure to know."

Would he urge a young man now to join the commissioned corps? He would. "It could provide a most satisfying career, but it would depend largely on the individual. It can be a most interesting and challenging career, if he makes it so." He repeated the last words for emphasis.

What of the sea? Should a young man who joins have "a feeling for the sea?" The Director laughed. Recalling the years he had spent at sea during his career, he commented: "I don't consider myself a dedicated sea-going man in spite of that."

"Mind you," he continued, "I've enjoyed going to sea, but you don't have to have the sea in your blood to join. You just have to make up your mind that you're going to be on sea duty part of the time and ask yourself whether you're prepared to be away from home for weeks and months at a time. Of course, if you can't stand getting seasick. . . ."



Ensign James C. Tison, Jr., served on the USC&GSS NATOMA as Junior Officer in his first six months in the commissioned corps.

Tison said his greatest pleasure as Director has been in "trying to steer the Coast Survey, keeping in mind as I did so a proper future for the agency and the work that it does."

What of the future for this old-line agency, whose existence dates back to 1807?

The Director foresaw a great future for the work it is doing. "The future of the agency itself," he added "will depend entirely on decisions to be made in the future on how best to organize for getting a job done.

"If the government becomes involved in oceanography in a really big way, which is a distinct possibility, then Congress will probably feel the present program is too fragmented, that the work should be more consolidated." Tison noted that some 20 agencies are involved, in one way or another, in oceanography.

On August 15, 1957, Commander James C. Tison, Jr., Geodetic Liaison Officer with the Directorate of Range Development at Patrick Air Force Base, Florida, was awarded the Commendation Ribbon by Major General D. N. Yates, Commander of the Air Force Missile Test Center.

"Under those circumstances, it is difficult to say what role the Coast Survey would play, but I am convinced that come what may, it would mean a greater role for the talents the Coast Survey has."

Tison stressed one essential requirement "if we're to continue giving the service that's required by our rising population." That, he said is increased automation and new methods and systems to speed up the work and increase volume.

"We've been constantly working toward this end," he said. "It's always difficult, and hazardous, to prognosticate the future. We've built 10 new ships for our fleet during the past few years. Will we need more in the future? Sure we will, but not necessarily just like those of the past. A great deal depends on technical advances which may make it possible to dispense in some degree with ships as we know them today."

Tison saw the possibility of using small submarines, both in lieu of ships and as an adjunct to those which continue in operation. He foresaw a bright future also for buoys and satellites.

"We've been doing much work on buoys in recent years," he remarked. "They may eventually take over much of the work being done at sea today from ships."

"We've got to automate in numerous fields," he emphasized, "or we'll be unable to keep up with the growing demand. Most important of all, we're going to have to automate our nautical charting program, from the gathering of data to the processing and right through to the publishing of charts. We began 161 years ago as a nautical charting agency and this is still one of our most important tasks."

To that end, said the Director, experiments designed to speed the process by using smaller, faster, and more automated craft are now underway. These experiments include work with completely automated launches and with high-speed, electronically equipped launches manned by reduced personnel.

But there will still be a need for the larger ships, stressed Tison, for surveys in Alaskan waters and in the deep sea.

He said at least two major problems now confront the Coast Survey. One of them is the agency's inability to use the talents of skilled men assigned to ships for shore jobs requiring the same skills. "With the exception of the commissioned corps," he said, "it is not feasible to transfer skilled personnel from aboard ships to posts ashore."

Tison cited an example of what he termed "the weakness of an inflexible personnel system." He said: "If there is an efficient electronics technician, or survey technician, aboard a ship, you can't place him in a similar post on shore and give him a few years' relief from sea duty. We need electronics specialists in geodesy and elsewhere, but the man aboard ship is a special employee and he would have to transfer to an entirely different classification to accept a position on shore."

The second major problem facing the Coast Survey, said Tison, is continuing to provide essential services to the public in the face of the budgetary and personnel restrictions now in force. "This," said the Director, "is a real and pressing problem which gives every indication of getting worse before it gets better."

Tison has noted important changes in the Coast Survey in the almost four decades he has served with it. "The Coast Survey has become a much more forward-looking agency, especially in recent years," he said. "It is no longer business as usual. There is less emphasis on doing things the way we did them before. The agency is looking forward now, instead of backward. It's more progressive and more in keeping with the times.

Commissioning of the USC&GSS OCEANOGRAPHER on July 13, 1966. With President Johnson and Mrs. Johnson are Admiral H. Arnold Karo, on the left, Captain Arthur Wardwell, and Admiral Tison.

"There have, of course, been some drastic organizational changes in the Survey, especially in the last decade," the Director pointed out. "The biggest change within the agency itself was the effort to do away with the fragmentation which existed for so many years in the organizational structure."

"Under the old structure," explained Tison, "too many officials reported directly to the Director. Why, when we had a staff meeting, there were so many, you couldn't get them all into the room. But we've consolidated our operations along program lines and we have a much better and efficient organization as a result."

Another major change in the agency, Tison recalled, was renewed emphasis on research and development. "There was a time when the Coast Survey excelled in this," said Tison. "Some of the first scientific work in the United States, such as in geodesy, mathematics, map projections, and the theory of tides, was done here. Then, over the years, we began to pay less attention to it." Corrective action started during the early 1960s, he said, and now once again, research and development play an important role in the agency's activities.

The biggest change of all, continued the Director, was the reorganization which resulted in the formation of the Environmental Science Services Administration in 1965.

Tison termed the creation of ESSA "a major step in the right direction."

"I believe very firmly in the ESSA concept," he stated. "It broadens the horizon for everyone in the environmental sciences. The tie-in between the Coast Survey and the Weather Bureau, for example, is very important. It can have only beneficial results. If progress is to be made in the environmental sciences, it must come through some form of organization such as ESSA."

Tison leaned back in his chair and looked across the room toward the stern visage of Ferdinand Hassler, the Swiss engineer who first headed the Coast Survey and whose portrait adorns the wall opposite the Director's desk.

"I'm looking forward to my retirement," he said.

His plans? He chuckled. "I don't know. I've been too busy to think about them. I'll decide after I retire."

One of the first things he would do, he thought, was "mend my fences."

Wouldn't that be a little late?

"Oh, I don't mean those fences," he said, laughing. "I mean the fence on my property."

"That, and other things I've always wanted to do should keep me busy for a while," he continued. "I may even turn to beachcombing—you pick up interesting things on the beach!"

With that he concluded and pointed to the door. "Get out. If I don't get busy and finish my work, I may not be able to retire." □

Pushing a control button to launch a new scientific computer facility is Admiral Tison photographed through the "porthole" of a reel of magnetic tape.

The Hurricane Priest

"WE HAVE just received from the Reverend Father Viñes, the learned director of the Meteorological Observatory of The Royal College of Belén, the following important communication that we hasten to make known to the public before the time of our evening edition. . . . We are very near to the vortex of a hurricane."

This message, which appeared in *La Voz de Cuba* on October 19, 1876, predicted when and where the hurricane would strike, and urged the people to take necessary precautions. Father Viñes' warning was heeded throughout Cuba, for he was a renowned hurricane forecaster, and his warnings had already saved many lives.

In his day, the Reverend Benito Viñes was the greatest authority on Atlantic hurricanes. His contributions to both theory and forecasting techniques, as well as the pioneer warning service and observational network he established, laid the foundation for ESSA's present-day hurricane warning system. From the 1870's through the first decade of the 20th century, Father Viñes was, in fact, "Father Hurricane," and his words and warnings were heeded by all.

Father Benito Viñes came to Cuba in 1870 to serve as director of the Belén Observatory, in Havana. His education, including training in physics, was completed in France after he escaped the Spanish Revolution of 1868.

Father Viñes performed a vigorous daily routine with little assistance. This included observations of environmental phenomena every hour from 4 a.m. to 10 p.m., an international observation at 7:30 p.m. and, in times of special need, an observation every hour of the day and night. The data recorded included pressure, temperature (normal, maximum, minimum, and wet and dry bulb), water vapor tension, relative humidity, direction and velocity of the wind, cloud heights, and magnetic, electric, and optical elements. The accuracy and care with which Father Viñes recorded this data reflects the importance he placed upon it. His annual reports included monthly, daily, and hourly summaries of these elements, and were in demand throughout the world. This work, which might well have consti-

BY RICHARD M. DeANGELIS
Environmental Data Service

tuted a full career for most men, was but a part of Father Viñes' activities.

Having heard in Europe, and now seen first hand, the terrible devastation wrought by hurricanes, Father Viñes took it upon himself to discover ways to help the people of Cuba escape the wrath of these killer storms. He had little to work with. He had to rely heavily on the 12-year records of the observatory, old newspaper accounts, and countless stories of past storms. A true scientist and investigator, he would be found at the scene of Cuban hurricane disasters, rummaging through the debris and questioning survivors. Everything was painstakingly recorded. Father Viñes' insight and persistence shortened decades of work into the span of a few years.

His first recorded forecast was printed on September 11, 1875—two days before an intense hurricane ravaged the entire southern coast of Cuba. Many lives were saved, and word of this remarkable Jesuit meteorologist spread rapidly.

On September 14, 1876, Father Viñes predicted the future path of a violent hurricane. The captain of the sailing vessel LIBERTY ignored the warning and his ship was wrecked when he sailed directly into the path of the storm. The following September the little priest wired Barbados of an approaching hurricane still out in the Atlantic Ocean. He then contacted Puerto Rico and told them not to fear as the storm would pass well to the south of the island; at the same time he warned Santiago de Cuba ". . . it will reach you on the 24th, be on your guard." Everything happened as Father Viñes had predicted. The *Buletin Mercantil* (October 5, 1877) of Puerto Rico wrote: "Father Viñes, whose voice for us has the authority of an oracle, calmed our souls with his timely notice. He well deserves the European reputation that he enjoys. Spain should be proud of him."

Father Viñes' accurate predictions won him praise and offers of help. By 1877 he was able to begin a small hurricane reporting network throughout Cuba and on a few of the other Caribbean islands. Steamship companies offered him free transportation for his investigations and ordered their ship captains to pull into the nearest port and cable the Observatory whenever the weather looked threatening. Railroad companies also offered him transportation, and telegraphic service was put at his disposal.

This same year—1877—after six years of study, Father Viñes gave to the scientific world his greatest work: *Apuntes Relativos a los Huracanes de las Antilles.* Published by the United States weather service as *Practical Hints in Regard to West Indian Hurricanes,* it sold out three large printings within a few years.

Father Viñes was the first to suggest that the clouds well in advance of a hurricane could locate the storm center, and was also the first to forecast hurricane movement on the basis of cloud movement. The Pilot Chart of the U. S. Hydrographic Office printed and reprinted the laws of Father Viñes. The May issue of the 1889 Pilot Chart reads: "These important laws, established by the study and long experience of Father Viñes, should be thoroughly understood by every navigator and utilized by shaping his course so as to avoid a hurricane."

In 1886 Father Viñes wrote, in reply to a query from the Havana Chamber of Commerce, "For my part I am desirous only of serving all so far as service is rendered possible by my poor health and the limited means at my disposal; nor do I wish other recompense, after that which I hope from God, than to be of use to my brethren and to do my little share for the advancement of science and the good of humanity." The Chamber of Commerce, however, along with several private concerns decided to reward and extend Father Viñes valuable service by financing the completion of his observational network throughout the Antilles. Today, this network is still an integral part of ESSA's hurricane warning system.

In July of 1893, at the request of the Chicago Exposition, Father Viñes completed a detailed treatise on the hurricane circulation. Three days after he mailed the paper, on July 23, 1893, the hurricane priest died. So beloved and revered was he that the Havana newspaper *La Lucha* published a special edition to describe "The Last Hour and Death of Father Viñes."

On October 6, 1900, Willis L. Moore, Chief of the Weather Bureau, wrote in *Collier's Weekly* that ". . . probably the Reverend Benito Viñes gave more intelligent study to the investigation of tropical cyclones than any other scientist."

It was the kind of tribute that undoubtedly would have meant much to a man of God whose whole life was also an example of service to man. □

In September of 1877, Father Viñes wired Barbados of an approaching hurricane still out in the Atlantic Ocean. He then contacted Puerto Rico and told them not to fear as the storm would pass well to the south of the island; at the same time he warned Santiago de Cuba ". . . it will reach you on the 24th, be on your guard." Everything happened as Father Vines predicted.

How to Track a Hurricane

Thousands of persons along the Atlantic and Gulf coasts not only follow the progress of hurricanes through newspapers, radio, and television—they track them on charts provided by the ESSA Weather Bureau.

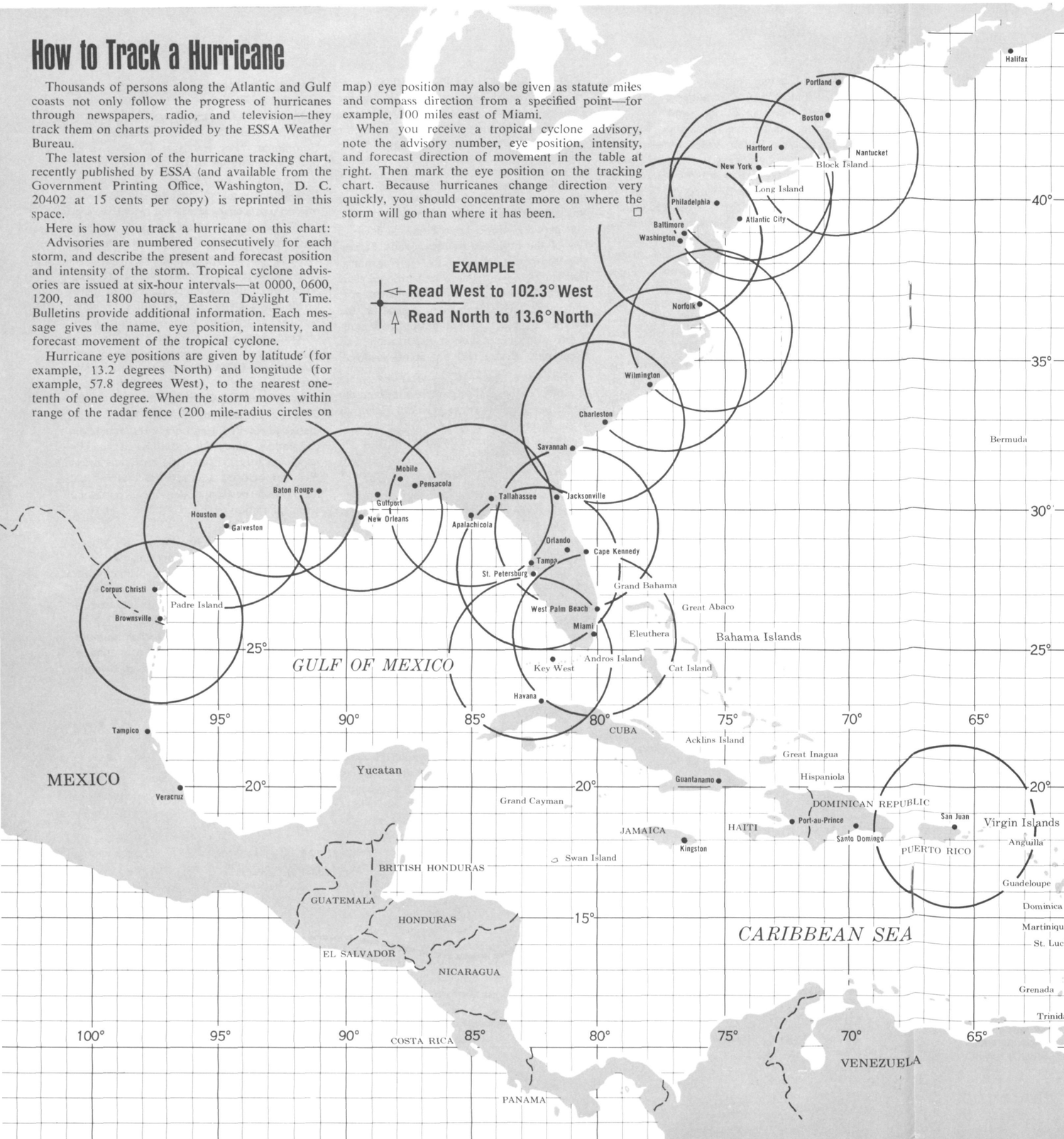
The latest version of the hurricane tracking chart, recently published by ESSA (and available from the Government Printing Office, Washington, D. C. 20402 at 15 cents per copy) is reprinted in this space.

Here is how you track a hurricane on this chart:

Advisories are numbered consecutively for each storm, and describe the present and forecast position and intensity of the storm. Tropical cyclone advisories are issued at six-hour intervals—at 0000, 0600, 1200, and 1800 hours, Eastern Daylight Time. Bulletins provide additional information. Each message gives the name, eye position, intensity, and forecast movement of the tropical cyclone.

Hurricane eye positions are given by latitude (for example, 13.2 degrees North) and longitude (for example, 57.8 degrees West), to the nearest one-tenth of one degree. When the storm moves within range of the radar fence (200 mile-radius circles on map) eye position may also be given as statute miles and compass direction from a specified point—for example, 100 miles east of Miami.

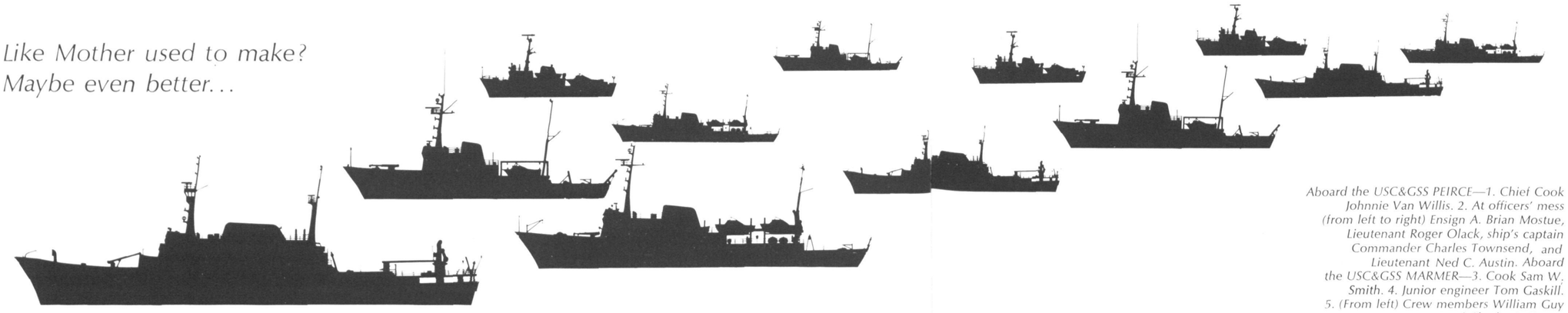
When you receive a tropical cyclone advisory, note the advisory number, eye position, intensity, and forecast direction of movement in the table at right. Then mark the eye position on the tracking chart. Because hurricanes change direction very quickly, you should concentrate more on where the storm will go than where it has been. □



Storm Name	Advisory Number	Position						Maximum Wind (mph)	Central Pressure (inches Hg.)	Forward Speed (mph)	Direction	Forecast			
												Movement		Intensity	
		Date	Time (EDT)	Latitude (°N)	Longitude (°W)	Miles	from					Forward Speed (mph)	Direction	Increasing	Decreasing

MEALTIME ON THE ESSA FLEET

Like Mother used to make?
Maybe even better...



THIS may be giving away a secret, but did you know that the men aboard ESSA's fleet of ships raid the larder at night?

There's a special refrigerator for late night snacks. It gives the men at sea that home touch, just like at Mother's. Well, almost.

It's all part of keeping the crew happy. Margaret F. Kerr, Property and Supply Officer at the Coast and Geodetic Survey's Atlantic Marine Center, Norfolk, Va., says:

"A ship runs on fuel, the men on food, and generally good food on a vessel gives it a good name and a happy crew."

Lt. Cdr. George A. Maul of the USC&GSS DISCOVERER, the pride of ESSA's Atlantic fleet, confided that "each mess has a small galley of its own with a refrigerator specially designed for raiding."

But it takes more than a snack at night to keep a man's stomach full. This is a report on what is being done to provide the approximately 740 officers and crew aboard the 13 Coast Survey vessels with three square meals a day, as well as a late night snack.

Men at sea are essentially "meat-and-potato boys." They work hard, their hours are long, and they need food that will stick to their ribs. What do they get?

Based on reports from the ships, the cuisine aboard the vessels of the ESSA fleet is good. The main dishes include turkey, steak, chicken, roast pork, roast beef, baked ham, lobster, shrimp, and baked salmon. For a lengthy trip, such as the eight-month global cruise of the OCEANOGRAPHER, there are also such items as beef liver, frankfurters, bacon, sausages, veal, duck, haddock, halibut, oysters, and scallops.

The main dishes are "always served with all the trimmings," reminded Lieut. Richard J. Wenstrom of the PATHFINDER. On the PEIRCE, such a meal would include tossed salad, baked turkey with bread dressing, giblet gravy and hot rolls, cranberry sauce, iced tea, and strawberry shortcake. "Though this is an elaborate meal," said Ensign Kenneth W. Sigley, "the only unusual fact about it is how often these dishes are actually prepared."

Meals aboard ESSA ships are not related to the size of the vessel. Here is a typical day's menu aboard the WHITING, as reported by Lieut. Bernard N. Mandelkern:

"Breakfast is generally served from 0700 to 0745 (7 to 7:45 a.m.). Fruit juices, cereals, bacon and hot cakes or French toast are served each day. . . . Lunch is served about 1200 (Noon) and dinner at about 1700 (5 p.m.). These two meals offer such entrees as steak, chicken, roast pork or beef, baked ham and many others. A choice of two entrees is available at most meals. . . . We serve six or seven variations of potatoes. Cheese or other sauces are frequently offered."

The ships were asked, "What is the men's favorite food?" The replies varied. Lt. Cdr. Maul declared that "the favorite food on board is coffee—without any question," with more than 35 gallons consumed each day. Thanksgiving, he added, always brings a special meal and this year's menu had roast turkey, baked Virginia ham, "and a whole mimeographed page of appetizers, vegetables, and desserts."

The piece de resistance aboard the MARMER is apparently hamburgers, according to Lieut. Ronald E. Nortrup, who declared that Sam Smith, "the well-seasoned cook," knows 1001 ways of preparing them. Nortrup added with a nod in the direction of the ship's steward, that Clarence Hunter has a specialty, Hunter's Sauce, which graces many a salad. The best testimonial to their results, claimed Nortrup, was the 2735 pounds aggregate weight of the 14 men on board.

There is apparently one meal which is held in low regard. Maul said it's the best known meal on a ship, "the one served just after the ship passes the jetty and heads into rough water.

"For some mystical reason," said Maul, "it always consists of fried pork chops, french fried potatoes, and fried squash, just what an already queasy stomach needs to set the mood of the day." Chefs and stewards, take note!

The task of keeping a vessel adequately supplied with provisions and with arranging suitable menus is the responsibility largely of each ship. It is usually handled by the Steward Department.

A ship is a community of people who are jacks of all trades and masters of two. Everyone is an expert on food, which makes it interesting for the Steward Department. On a large Coast and Geodetic Survey

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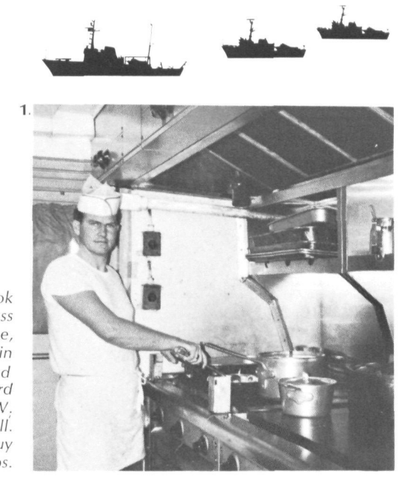

1.

Aboard the USC&GSS PEIRCE—1. Chief Cook Johnnie Van Willis. 2. At officers' mess (from left to right) Ensign A. Brian Mostue, Lieutenant Roger Olack, ship's captain Commander Charles Townsend, and Lieutenant Ned C. Austin. Aboard the USC&GSS MARMER—3. Cook Sam W. Smith. 4. Junior engineer Tom Gaskill. 5. (From left) Crew members William Guy and Charles J. Capps.

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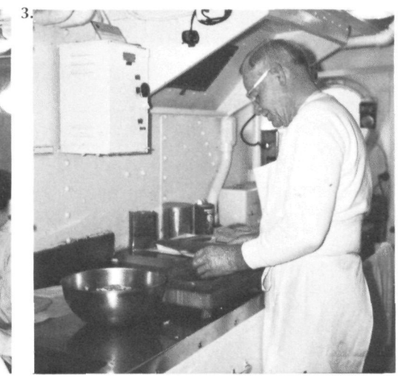

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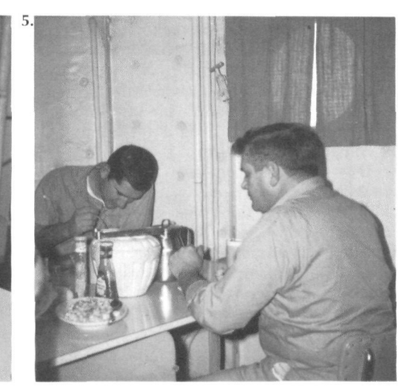

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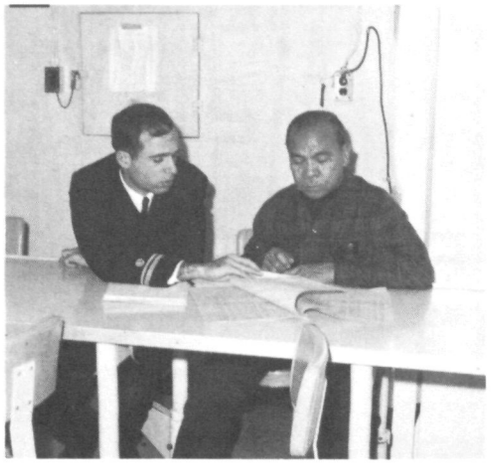

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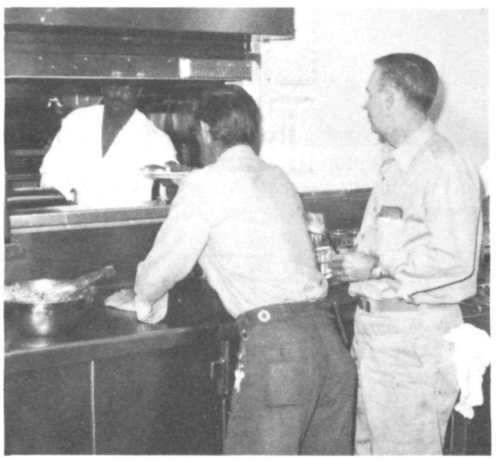

6.

Aboard the USC&GSS DAVIDSON—1. Lieutenant Bernard N. Mandelkern and Chief Steward Cipriano V. Golingo preparing menus and ordering provisions. 2. Foodstuffs being delivered to the ship. 3. Assistant Cook Marcus Smith preparing a meal. 4. Commanders A. William Hayes and K. William Jeffers, and Lieutenant Kenneth H. Voigt dining in wardroom mess. 5. Mess line in crew's mess. 6. Chow time for the crew.

vessel such as the DISCOVERER, 20 per cent of the crew are members of this department, the largest on board. Besides preparing and serving meals for as many as 115 hungry people, the stewards purchase and store the provisions, launder the linens, maintain the staterooms and wash the dishes.

Four separate messes are maintained on the DISCOVERER: Mess for the commanding officer (the captain usually dines alone), the Wardroom Mess for the officers and scientists, the CPO Mess for the chief petty officers and technicians, and the Crew's Mess for the petty officers and crew. (A fifth and somewhat clandestine mess also operates for those who prefer to make their own coffee or their own wheat germ and bran flakes.)

The situation is similar aboard the USC&GSS PATHFINDER, a somewhat smaller vessel. Five messes exist aboard this ship for her complement of 84 men, the same as for the DISCOVERER, except that the petty officers and crew eat separately. However, here each mess is served from one centrally-located galley, whereas, on the DISCOVERER, each mess has a small galley of its own. The Steward Department of the PATHFINDER is responsible for cooking and serving all meals, ordering and storing provisions, and added Lt. Wenstrom, the ship's public information officer, "maintaining a clean galley." The Steward Department aboard the PATHFINDER consists of the chief steward, Cornelius Quinanola, assisted by Eugene Roiles, chief cook; Rollando Villaron, second cook, and Harvey Nacua, steward.

Arrangements on smaller vessels are somewhat different. On the USC&GSS DAVIDSON, for example, there are just two messes, with the food for all personnel prepared at the same time. The meals are served in the Wardroom Mess for the commanding officer, officers and guest scientists and in the Crew's Mess for the chief petty officer, petty officers, and seamen.

"Feeding at sea is handicapped by the environment faced by the cooks," pointed out Lt. Mandelkern, the ship's public information officer, who also serves as the Wardroom Mess treasurer. "The food must be purchased weeks in advance and the menus must be prepared before the ship sails. This requires considerable planning. When you're at sea, you can't run down to the grocer for some forgotten item or call on neighbors to borrow sugar.

"The galley is probably smaller than the kitchen in most American homes. Imagine the problem involved in four cooks trying to prepare a meal for 37 hungry men in such a restricted area, especially while the ship is taking 30-degree rolls. Anything not bolted down slides around and topples over, including the cooks. The frequent sound of breaking china serves as a constant reminder of the trials and tribulations of the ship's Steward Department."

The overall operation on board the DAVIDSON is supervised by the chief steward, Cipriano V. Golingo, who is also responsible for purchasing food and preparing menus. The preparation of the food is carried out by Chief Golingo along with the chief cook, Silvino Villaron, and the second cook, Marcus Smith. Rudolph W. Bazemore, the messman, serves in the Wardroom Mess and assists the cooks. Mandelkern reviews the menus, making revisions or suggestions, and prepares the mess bills for the officers and visiting scientists, who must purchase their food. The crew members receive their meals as part of their employment.

The USC&GSS MARMER, a still smaller vessel, feeds 14 to 17 men. Lt. Nortrup, the ship's PIO, reported that the men are fortunate, however, in that they have a cook, Sam Smith, with 27 years experience in the Coast Survey and a steward, Clarence Hunter, with 22 years of Navy experience.

On a medium-sized vessel such as the USC&GSS PEIRCE, the same food is prepared for all the people aboard. Two messes are served, in the Officers Wardroom and in the crew's quarters. Johnnie Van Willis and Charles Howard, the chief cooks, are responsible for the food. Isaac Williams, the messman, serves the food and maintains the staterooms as well. The three are apparently on good terms with the ship's personnel, because Ens. Sigley, the PIO, reported that "the ability to prepare meals for an average of 32 persons while at sea and to remain in the good graces of all is indeed an art of both culinary and social skills."

Preparing the food on a large ship such as the DISCOVERER is a major task. It requires a fully equipped butcher shop, a bake shop, the main galley (with four ranges and ovens) and even a soup kitchen with two kettles, each capable of making 40 gallons. Gleaming stainless steel counters and utensils are kept spotlessly clean.

Storing the food also presents a major problem. The DISCOVERER can store sufficient provisions for 150 days. To accomplish this, two decks of a compartment are required. The dry provisions deck has four large storerooms and the reefer flat has a freezer room, a fruit and vegetable room, and a dairy products chill room.

The PATHFINDER can store a 60-day supply. Dry provisions are kept in two large storerooms; fruits, vegetables and dairy products in one large refrigerated compartment; and meats and seafoods are stored in a large freezer compartment.

Sanitation also presents a problem in the storing of provisions. On the PEIRCE, the freezer compartments are defrosted monthly. They are then washed with ammonia and the doors left open to rid the compartment of the smell of meat and ammonia.

The most onerous task for the Steward Department is loading provisions on board. On the PEIRCE, it means carrying up and down ladders about $900 worth of food each time the ship goes on a normal 10-day cruise. The supplies must be taken to the dry store and freezer compartments on three decks. Aboard the larger ships, the task is less burdensome. When the OCEANOGRAPHER left Jacksonville, Fla., last year for its global trip, the provisions were brought to the ship over a five-day period by numerous trucks and other vehicles and swung aboard the vessel by a crane. The OCEO has a capacity of 2848 cubic feet for frozen food and 9056 cubic feet for storing non-frozen food.

During lengthy trips, some food, such as bread and pastries, must be prepared aboard ship, because freezer space can not be allotted for these. Fresh fruits and vegetables must be purchased along the way and clearance must be obtained from the doctor aboard before they can be used. Agents in each port of call arrange for the supplies so that the men of ESSA's fleet are continually well fed. □

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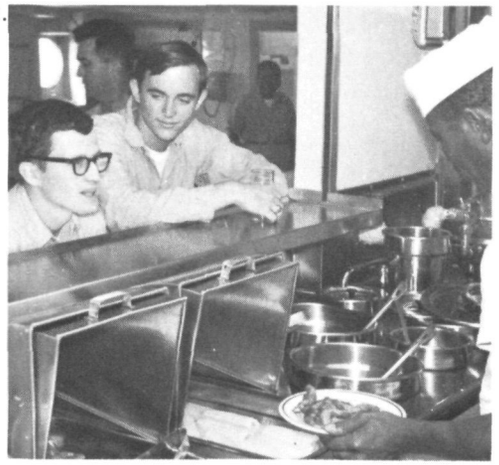

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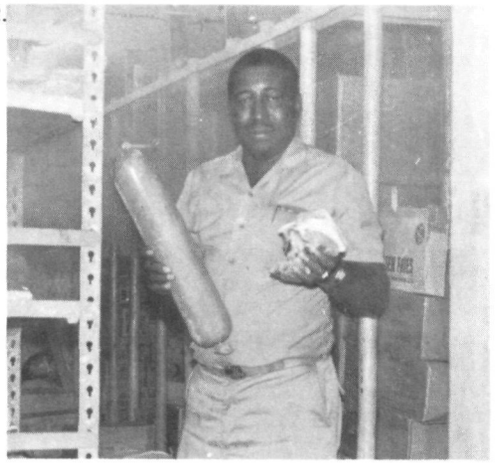

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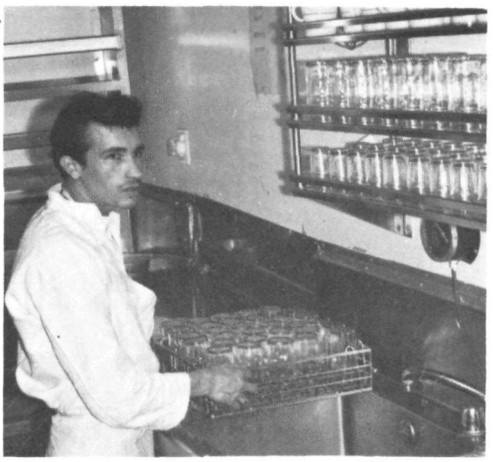

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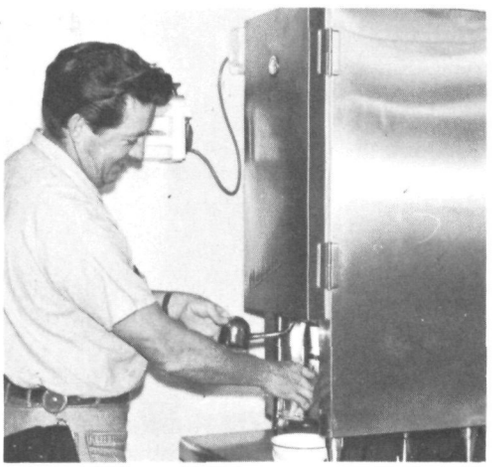

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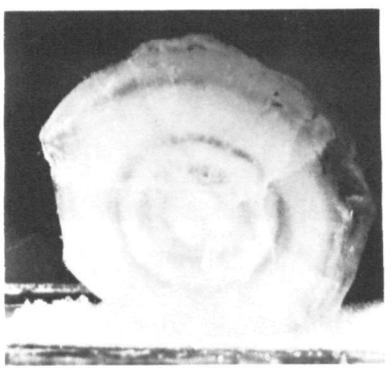
Aboard the USC&GSS DISCOVERER—1. John Daughry, ship's baker serves Fred Libby and Jim MacDonald. 2. Chief Steward Junior Gray in the freezer room. 3. Jim Santiago in one of the two dishwasher rooms. 4. Self-service in the crew's mess. 5. Ed Hannen, ship's carpenter, draws a glass of cold milk from the dispenser. 6. Jim Berridge preparing a light luncheon in the wardroom galley. 7. Noon meal in the wardroom.

Promising efforts are under way for the suppression of



HAIL-SCOURGE OF THE CENTURIES

By JOANN T. TEMPLE
ESSA Research Laboratories

HAIL, a scourge of farmers and property owners for centuries, has been variously attacked by prayer, church bells, and cannon fire.

Modern efforts, proceeding along both theoretical and practical lines, have at last offered hope of suppressing some of the damaging effects of hailstorms, if not the actual storm itself.

ESSA Research Laboratories' Atmospheric Physics and Chemistry Laboratory, as the only federal organization whose main mission is weather modification research, has contributed much to the National Hail Modification Research Project sponsored by the National Science Foundation. In addition to their work on a physical model for hail development, APCL researchers recently completed a six-week intensive study of summer hail storms on Colorado's high plains.

The Colorado location was chosen because hail storms there are frequently isolated from other weather and easy to study throughout their life history.

A specially instrumented DC-6 aircraft, operated by the ESSA Research Flight Facility, Miami, Florida, was on duty with the Colorado project. Regarded as a complete meso-meteorological observation system, this aircraft flew around hailstorms to analyze air movements through the storm, determine the number of individual hail cells within the storm (meso-structure), and study nearby atmospheric conditions.

The DC-6 is equipped with a digital data recording system capable of recording meteorological observations every second during flight, and circumnavigation of the actual storm cell provided much detail on the air flow through the storm.

The most important observation of the ESSA study was that these storms apparently suppress their own hail formation mechanism by natural ice formation. Dr. Helmut K. Weickmann, APCL director, explains the paradoxical process in this way:

"Intensive natural ice formation occurs at the upper cloud levels where the temperature reaches −21°F and below. The ice crystal cloud forms what is called the 'anvil,' or the spread-out upper part of the thunderstorm. If the upper-level winds are sufficiently strong to blow the anvil downwind, only the largest ice particles fall back into the updraft and grow to hailstones. If the upper winds are weak, many of the ice particles fall back into the updraft and, competing for the cloud water, they all remain small and melt before they reach the surface. These weak storms then suppress their own hailstone generating mechanism."

This observation, qualitative as it still is according to Weickmann, justifies as no other observation the correctness of the basic concept that seeding can suppress hail.

APCL's physical model of how hailstones develop theorizes that each hailstone is formed by two different cloud environments. The first environment forms the hail embryo. The second forms the hail shell. Embryos are small frozen particles suspended in a cumulus congestus cloud before a full updraft has been developed. Once the updraft begins, the hail shell stage starts as cloud moisture deposits on the embryos and hailstones begin to grow.

Since the formation of hail depends on the number of hail embryos, changing the number of nuclei in the cloud will alter its hail production. Natural freezing nuclei such as dust, smoke, and pollution particles provide a base for the cloud's water to freeze on. Artificially increasing the number of freezing nuclei in the individual cloud is the presently accepted way to modify hail storms. This is called "seeding." Successful seeding will cause a larger-than-normal number of ice crystals to form with each embryo getting less of the total water available in the cloud. This results in more but smaller hailstones that either melt as they fall or cause little damage on the ground.

APCL's physical model of hail formation requires seeding at an early stage in the life of the hail cell so that a greater number of embryos will form. Successful modification of hailstones therefore requires the ability to accurately identify a hail-producing cloud early in its life.

No large scale operational hail suppression project has yet been organized in the United States on a continuous basis. However, the continuing programs of ESSA, the National Center for Atmospheric Research, Colorado State University, South Dakota School of Mines and Technology, Illinois State Water Survey, and others have laid good groundwork for a national hail suppression project in the very near future.

Dr. Weickmann notes that hail suppres-

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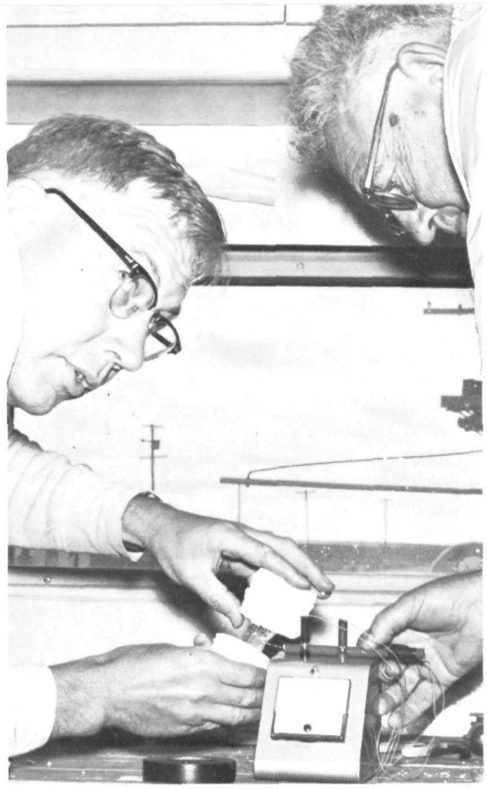

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sion, as any other attempt at weather modification, must be grounded in a scientifically sound model produced by basic research and confirmed by extensive field observations such as his group recently completed. He says:

"Hail suppression is not necessarily a futuristic plan. We have reason to believe that it is already possible to suppress some of the damaging effect of hailstorms but we are as yet unable to analyze the effect of any treatment. Continued work on the nature of these storms is therefore required since only a deeper understanding of the hail process will lead to total hail suppression, at least for the isolated types of storms, possibly within the next decade."

The costs of such hail suppression would be high, but the benefits could be considerably higher. In an average year, hail costs the United States some $300 million in property and crop losses. Although wind and water damage also occur in hailstorms, the hailstones themselves are often solely responsible for the damage. The largest insured property loss from a single hailstorm was $14,300,000.

A recent article published in the Russian journal *Meteorology and Hydrometeorology* cites cost figures for the much-publicized Russian effort at suppressing hail in the Caucasus. It claims that hail damage was reduced 75-80 percent below normal at a cost of about 70 cents per acre of protected crop land. If these figures are right, the returns from hail suppression outweigh the costs by 30 to 1. □

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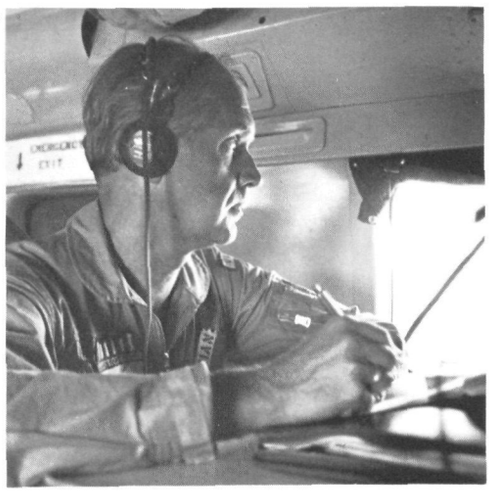

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1. *HAIL ONE, the Research Flight Facility DC-6 as it was known during the recent hail study in Colorado, is shown here making a low-level calibration flight some 30 feet over an electrically charged wire strung 40 feet above the ground. The wire allowed ESSA scientists to adjust their airborne equipment against a known electric field. Once calibrated in a series of such low-level flights, the equipment aboard the aircraft was used to measure electricity in the air around actual thunderstorms. This aircraft was one of several used in the six-week joint study by ESSA, Colorado State University, and the National Center for Atmospheric Research.*

2. *Since hailstones can yield some information about the storm from which they fell, ESSA scientists collected stones from the same storms that were studied in the air. Shown here aboard one of the mobile freezer vans used for collecting these stones are Byron B. Phillips (left), assistant director of the hail project, and H. James Wells, both of APCL. Some measurements of the stones' internal temperatures such as shown here were made in the field immediately after their fall. Later, the stones were brought back to the laboratories in Boulder for study and final correlation with the storm characteristics measured from the aircraft.*

3. *Dr. Helmut K. Weickmann, director of the Hail Project, is shown here aboard the RFF DC-6 directing the aircraft's movement around a hailstorm. Later computer analysis of the recorded flight data yielded a map of the aircraft's flight track with the winds at flight level superimposed. With this information, scientists are able to evaluate the amount of air flowing in and through the storm in relation to the cell structure of the storm as recorded by the aircraft radars.*

4. *Dr. Heinz Kasemir, senior scientist in APCL, is shown here measuring the electrical characteristics of a Colorado thunderstorm from his vantage point aboard an ERL research aircraft circling the storm.*

Weather forecasting gets
a big lift from

A NETWORK OF FRIENDS

BY WESLEY IRVIN AND ROBERT W. McCASLIN
Data Acquisition Division, Weather Bureau

A MORE diverse group you'll never meet. And chances are they'll never meet either, though they all have something in common.

There's an Air Force lieutenant in Alaska and a Coast Guard seaman on the Great Lakes. There's an FAA controller in Salt Lake City and the flight officer of a jet flying from London to New York.

Diverse, certainly; but there is a link between these men and hundreds like them. They all help to feed the Weather Bureau's almost insatiable appetite for meteorological observations. In doing so, they help themselves, for the Bureau repays such cooperation with improved forecast and warning services.

The lieutenant, the seaman, the controller, and the flight officer are representative of some of the organizations, both federal and private, which help the Weather Bureau gather information. In some instances they are the only source of the valuable data they provide.

For example, though the Weather Bureau has been expanding its network of weather radars, installations in the mountainous regions of the western United States are particularly difficult and costly, and it will likely be years before an effective "screen" of these special purpose radars can be set up in the west. Yet the need for radar coverage in this area is now. The very terrain features that make radar installations difficult also limit the number of observation posts, and weather data for the intermountain states is quite sparse. Through its ability to scan hundreds of square miles almost simultaneously, a radar can spot forest-fire-producing dry thunderstorms and flood-producing rains that might otherwise not be reported because of the wide separation of observers in the mountains. Tracking winter storms and providing enroute weather information to aviators are other obvious needs.

A happy solution to this western data gap has been found. The Federal Aviation Administration operates an interlocking network of powerful radars to follow and control air traffic over the United States. Controllers at strategically located Air Route Traffic Control (ARTC) Centers can view the return from some half dozen radars covering several states simultaneously. The ability of these radars to pick up rainfall echoes is excellent—so good, in fact, that special electronic circuitry is necessary to prevent weather display from interfering with air traffic display.

The weather display, of course, was just what the Weather Bureau needed so the question was asked, "Can the FAA radars be used for weather detection without compromising their primary mission of air traffic control?"

In the summer of 1966, a pilot project was initiated at the Salt Lake City ARTC Center. The FAA provided radarscopes for the use of two Weather Bureau men, and agreed to commit the radars to weather surveillance whenever it would not interfere with their air traffic control work. The Weather Bureau arranged to transmit radar weather information to forecasters and to provide on-the-spot weather briefings to FAA personnel.

The pilot project was a success. Despite the lack of height and intensity data normally available from weather radar, Weather Bureau meteorologists at the ARTC Center developed skills which permitted them to estimate intensities and because of the ready availability of pilot reports of enroute weather, the radar information could be supplemented, and the heights of weather systems could also be determined with some accuracy.

The FAA found benefit in the regular weather briefings which the Weather Bureau personnel could provide. Weathermen at the center gathered all available weather data, including observations, analyses, and forecasts from Weather Bureau teletypewriter and facsimile circuits, pilot reports to the center, and weather information gleaned from the radars. All of this varied information was fused into one source of up-to-the-minute weather information for a large area. This proved invaluable, not only to aviation interests, but to fire-weather forecasters, hydrologists, and public warning forecasters.

In April of this year, a similar program was established at the ARTC Center at Palmdale, California. Thus, the operations by small Weather Bureau staffs at only two ARTC Centers now provide information from radars spread from the Canadian border southward to southern California. Plans are underway to expand this program to yet another data-sparse area in Arizona and New Mexico through the ARTC Center at Albuquerque.

The weather reports from pilots mentioned above are another example of a cooperative effort in weather observing.

Every day there are thousands of airplanes flying somewhere around the world and many of these planes regularly fly through areas where for some reason or other it has been impractical to establish weather observing stations—on the high seas, for instance. For years pilots, particularly of commercial aircraft, reported significant weather they encountered in flight. This was useful information to other pilots and the passing around of these pilot weather reports was a sort of mutual aid effort.

With the growth of transoceanic aviation, the collection and use of weather reports from aircraft became particularly important as the very few surface-based observing locations over ocean areas did not begin to provide the details essential to effective air navigation. As a result, concentrated efforts were made to collect all possible aircraft reports (AIREPS) at the major international terminals for use in services to the overseas flights.

Arrangements have been made through the International Civil Aviation Organization and the World Meteorological Organization for the international exchange of AIREPS, and these organizations have worked out standard formats and codes for use of pilots to facilitate the making of these reports.

In the United States, AIREPS are transmitted to the Weather Bureau at six centers—San Juan, New York, San Francisco, Anchorage, Honolulu, and Miami—where they are screened and assembled into bulletins. These bulletins are then relayed to the National Meteorological Center (NMC) in Suitland, Maryland, and they are disseminated internationally by the New York and Miami centers.

When the information is encoded properly AIREPS can be handled directly in computer programs at NMC. A recent survey

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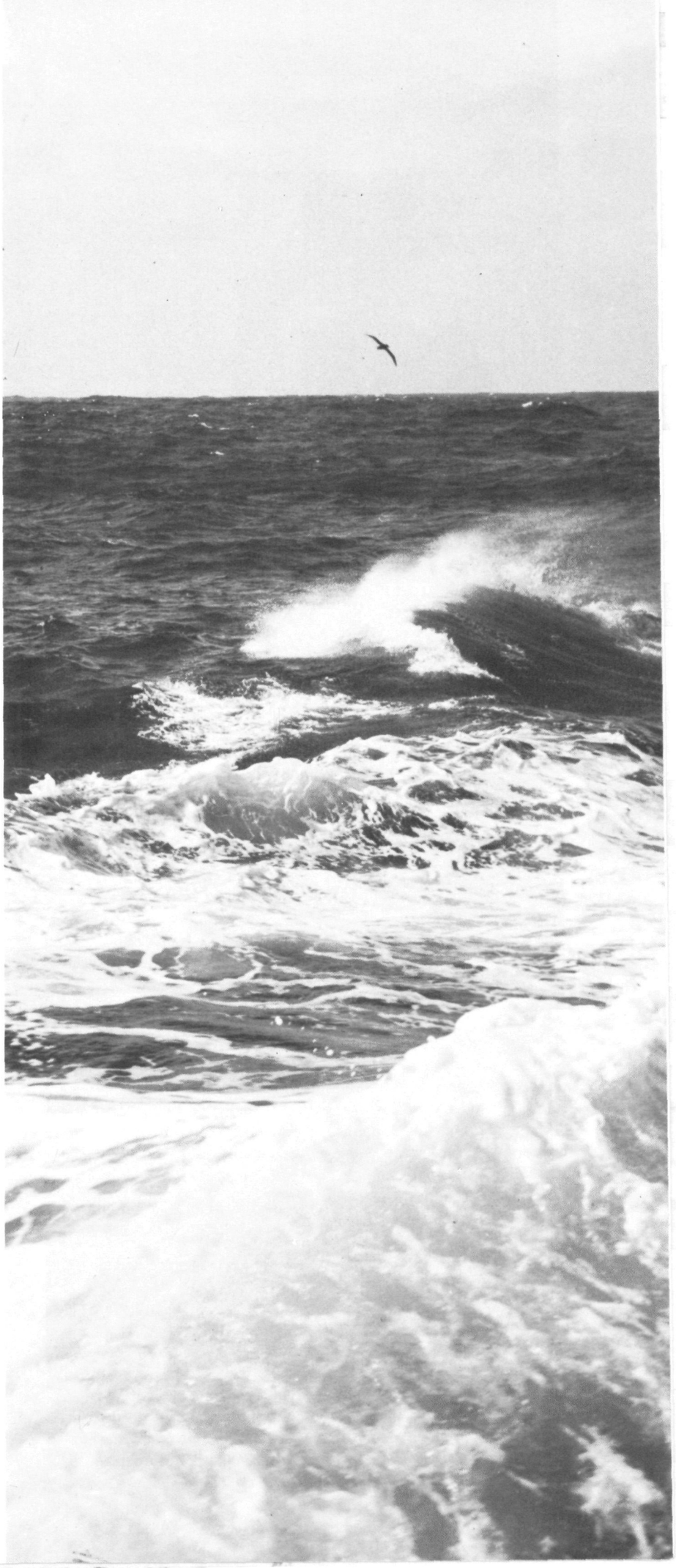
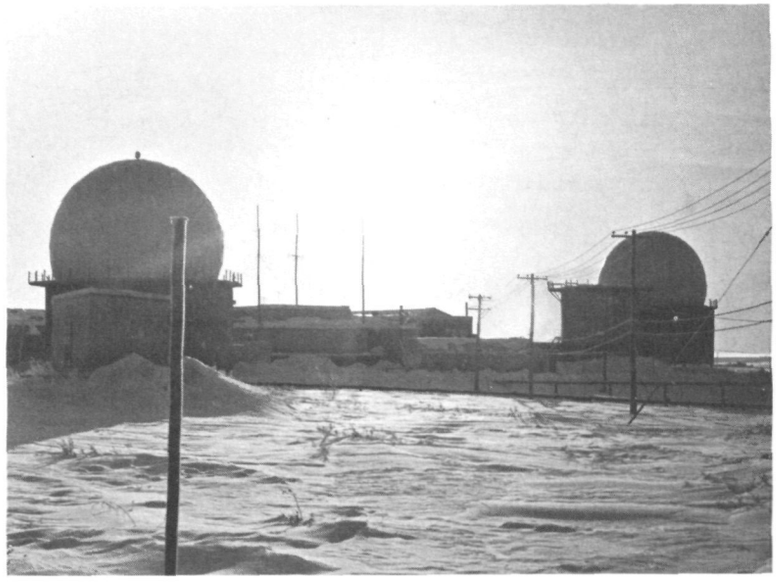


For years, pilots of commercial aircraft flying over the high seas and other areas in the world where it has been impractical to establish weather observing stations, have reported significant weather they have encountered in flight. This information is collected at major international terminals and disseminated by the Weather Bureau through AIREPS.

Devon B. Smith of the Weather Bureau at an FAA radarscope at the Salt Lake City Air Traffic Control Center. (Right) Weather Bureau-Air Force cooperation makes possible the use of radars for vast areas in Alaska that would be otherwise completely void of observational data.



Radar meteorological technician James Boudreaux placing composite map in scanner for transmission on overlay network. (Left) Air Force radar station at Kotzebue is one of a number providing weather data in Alaska.

shows that on the average 89 usable AIREPS are received at Suitland each hour. This means that there are more than 2,000 bits of otherwise unobtainable information being made available for the NMC's forecast programs each day.

Still another invaluable source of observation data is found in the local microscale cooperative networks set up along this nation's coasts and inland waterways. In exchange for a small expenditure in simple instrumentation, the Weather Bureau is receiving a wealth of information which is essential for weather services to marine interests. These local networks are in addition to the long-standing cooperative arrangements for obtaining observations from ships at sea.

At about 80 Coast Guard facilities on both coasts and on the Great Lakes regular synoptic weather observations are taken and transmitted to the Weather Bureau. At land installations, light station (lighthouse), and air bases Coast Guard personnel help fill shoreline gaps in the weather observing network.

A less formal system for obtaining coastal weather data is found in the number of marinas, yacht clubs, and other marine-oriented enterprises whose reports to the Weather Bureau as to weather and the state of the sea are passed on to other marine interests—in some areas via Weather Bureau owned and operated radio stations broadcasting 24 hours a day. An example of such cooperation is the give and take between the Weather Bureau and a private meteorological concern in the Miami area. Oceans Observations, Inc., operates a telephone weather service to boatmen, broadcasts over local radio outlets, and maintains a radio watch for many of the local fishing and pleasure boat operators. In exchange for weather information of interest to the boatmen, this firm relays to the Weather Bureau pertinent information collected via radio from craft afloat.

As far as weather observations are concerned, Alaska is a weatherman's nightmare. Here is a state about 1/5 the size of the "lower 48" with a total population which compares with that of Richmond, Virginia.*

This would leave vast areas completely void of observational data were it not for a Weather Bureau-Air Force agree-

*(According to the 1960 census, Alaska led Richmond by only about 6,000 citizens.)

Photo by Louis Micheal

ment in which radars of the Alaskan Air Command are used for weather observing.

Basically the program is quite simple. Each of a number of remote Air Force radar stations involved in the program makes several radar weather observations each day and telephones them directly to the Anchorage Weather Bureau on a set schedule. They will also call at other times if they feel they can furnish significant information between scheduled calls. In this way the Weather Bureau has accurate, up-to-date information on weather conditions in areas that can be observed only by radar. In addition to the benefits to the general public and aviation interests, these radar reports are of extreme value to fire-weather meteorologists in preparing their summer fire-weather forecasts and also assist hydrologists in determining both the extent and intensity of precipitation for use in flood forecasting.

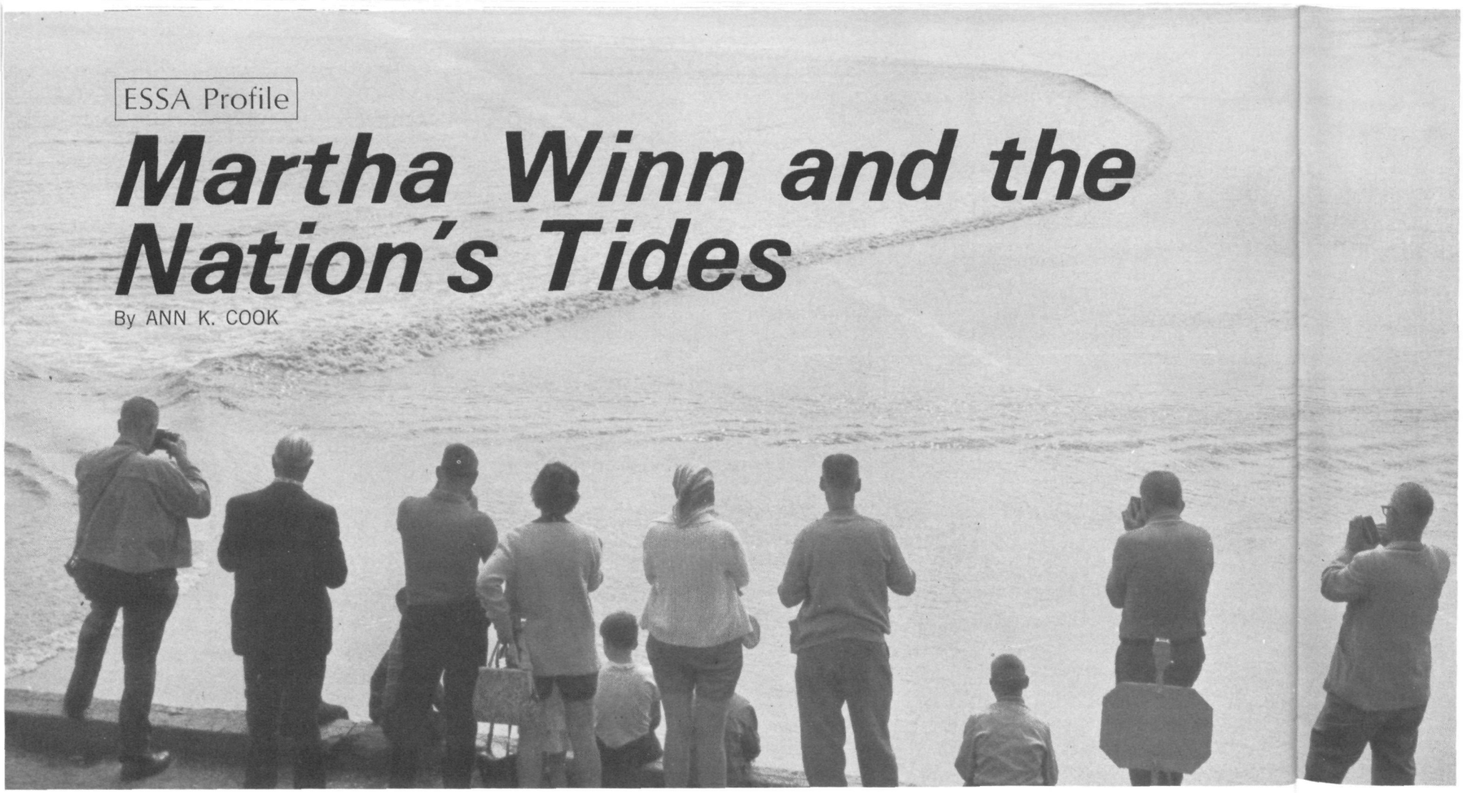
The programs mentioned here are just a few of a number of cooperative efforts in weather data acquisition which benefit all concerned. While the Weather Bureau's data appetite is far from satisfied, these programs certainly help to ease the hunger pangs. □

(Above) Coast Guard lighthouses and offshore light towers transmit regular synoptic weather observations to the Weather Bureau. (Below) A less formal system of obtaining weather data is from marinas and yacht clubs.

ESSA Profile

Martha Winn and the Nation's Tides

By ANN K. COOK



Spectators along the shore of the Chignecto Bay, New Brunswick, Canada, witness a tidal bore—a wall of churning water produced when outgoing and incoming tidal currents mix in the narrow channel.

Martha Winn, who heads the Coast and Geodetic Survey's Tides Section, is a lady who finds beauty in the perfect cosine curve of a tide record.

Her bent for science was acquired from her father, who was a science teacher. "I can remember simple experiments going on at home from the time I was six," Miss Winn recalls. "One time, my dad set out 100 carrot seeds on damp blotting paper and had me remove them as they sprouted. This was my introduction to percentages."

A graduate of the Women's College of the University of North Carolina with a major in mathematics, she joined the Tides Section in 1943, when a number of women were being hired for scientific positions to replace men who had entered the service.

After twenty-five years—five as chief of the section — Miss Winn is enthusiastic about her job. Much of its fascination, she says, is the fact that the work is unique.

Each month, the section receives records from more than a hundred tide gages. Some are small rolls with punched holes indicating water levels at 6-minute intervals; others are wide paper rolls on which the arcing rise and fall of the tides have been traced.

Under Martha Winn's direction, the staff of ten oceanographers in the Tides Section checks all these records, readying them for tabulation by semi-automatic equipment or by computer. For each of the hundred gages, the Section computes monthly mean values of tidal planes and ranges needed for oceanographic research.

Routinely, the section's tide analyses are used by the Tide and Tidal Current Predictions Section as a basis for predicting future tides, and by the Datum Planes Section in determining mean sea level—the basis for all U.S. elevation measurements on land.

After a destructive storm tide or tidal wave, the section puts aside other work until records from the affected areas have been analyzed. The need for such information is urgent, but the demand often continues years later. In 1968, the section is still filling requests for records of the storm surge of March 1962, which damaged the east coast from New England to Florida.

From hydrographic survey parties, the Section receives short-period tide records which it processes to find mean low water—the reference point for depth measurements on nautical charts. Results of these records are used in the several thousand secondary listings in the tide tables.

"The variety of people who use tide records is amazing," according to Miss Winn. "Among them are engineers, businessmen, manufacturers, and lawyers, as well as shipping firms, insurance companies, and sanitation interests. Nowadays, the oil companies and the states concerned are very interested because tidal records are the principal basis for determining offshore boundaries. Right now we are operating gages in the oddest places—from our point of view—to help solve legal problems."

She is realistic about the travel opportunities she has missed because she cannot perform the heavy work of installing tide gages. Although most of this is done by field parties or ship personnel, in emergencies the Tide Section's male staff members may do some field work. Two days after the 1964 earthquake, they were in Alaska to begin a massive tidal survey of the Alaska coast. "I was proud that they were able to act so quickly," Miss Winn declares.

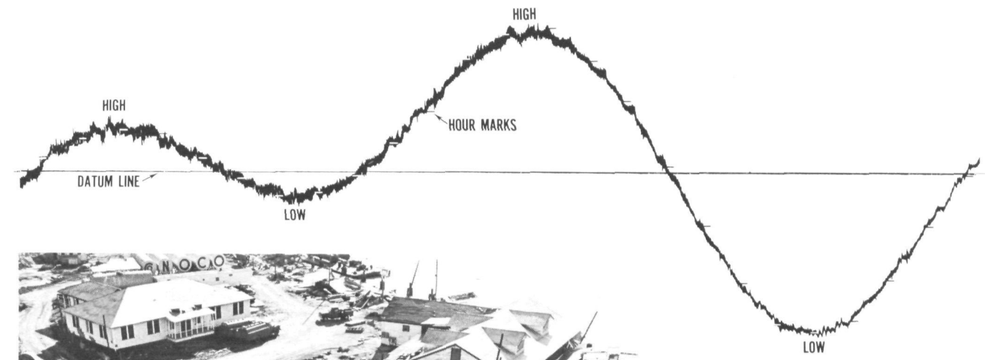
The work of the Tides Section holds historical as well as immediate interest. Tide measurement in this country dates to pre-Revolutionary days, when harbors had to be charted to stop the toll of wrecks of ships bringing badly-needed supplies to the colonists.

"Every so often," Miss Winn reports, "we are asked about the stage of the tide during some event of the past. The oddest request I can remember came from someone whose ancestor supposedly had been burned as a witch near Salem. He was trying to verify a family legend that the victim's kinfolk had rowed up the nearby stream at night to retrieve her body. They were risking their own lives because, if they were caught, they too would be burned. The stream was navigable only when the tide was near high water, and we were asked when high water occurred on this one day back in the latter part of the 17th century. We were able to compute the answer, but we never learned the decision about the truth of the story."

At home, Miss Winn lives as quietly as she can with four pet cats sharing her restored townhouse on Washington's Capitol Hill. She enjoys the theater, opera, and classical music, and plays bridge regularly.

Her secondary scientific interest is archeology—an interest she must satisfy by reading about all the great finds and diggings. "If I were starting now," she muses, "I think I would find the choice between oceanography and archeology somewhat difficult. But I discovered oceanography first and the die was cast." □

A TIDAL GRAPH FOR ONE DAY



(Above) High and low water marks recorded on the coast in the vicinity of San Luis Obispo County, California. (Left) The Tides Section is still filling requests for records of the storm surge of March 1962, which damaged the east coast from New England to Florida.

At home, Martha Winn relaxes with Li'l Scout, one of her four cats. (Left) She checks the Tide Section's automatic card punch equipment.

essa NEWS BEAT
U.S. DEPARTMENT OF COMMERCE ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION

Nygren Is Named Associate Administrator; Jones Succeeds Tison In Coast Survey

Rear Admiral Don A. Jones, USESSA, former ESSA Associate Administrator, has been appointed Director of the Coast and Geodetic Survey, succeeding Rear Admiral James C. Tison, who retired September 1 after a 39-year career in the agency. Admiral Jones' post was assumed by Rear Admiral Harley D. Nygren, former commanding officer of the USC&GSS SURVEYOR.

Admiral Jones, born in 1912 in Waldron, Mich., was graduated in 1933 from Michigan State University. He joined the Coast Survey that year. During World War II, he served with the Coast Artillery and the Office of Strategic Services, going from the rank of ensign to lieutenant-commander. Returning to the Coast Survey, he served at sea and in charge of geodetic surveys.

He was transferred to the State Department in 1957 as project chief for geodetic control surveys in Ethiopia, remaining there until 1961. His work in Ethiopia brought him the Department of Commerce's Exceptional Service Award.

He became Associate Director of the Coast Survey for Hydrography and Oceanography and, on Jan. 1, 1967, was appointed Associate Administrator of ESSA by Administrator Robert M. White. He is affiliated with numerous professional organizations and has been widely published in geodetic journals.

Rear Admiral James C. Tison

Rear Admiral Don A. Jones

Rear Admiral Harley D. Nygren

Admiral Nygren, born in 1924, was graduated from the University of Washington in 1945, and received a degree in mechanical engineering from that institution in 1947. During World War II, he served in the Navy as an enlisted man. He joined the Coast and Geodetic Survey in 1947.

He has served on numerous geodetic field parties, and on ships from the Arctic to the Antarctic. He returned to the University of Washington in 1959 for a one-year course in oceanography. In 1962, he was named Assistant Chief of the Coast Survey planning staff, and was appointed chief in 1964. Upon the formation of ESSA in 1965, Admiral Nygren was appointed Deputy Director and Chief Planning Analyst for Service Programs in the Office of Planning and Program Evaluation. In September 1966, he transferred to the USC&GSS SURVEYOR.

Admiral Tison became the Coast Survey's 16th Director in 1965. Born in Hampton County, S. C., in 1908, he was graduated from The Citadel in 1929 as a civil engineer, and entered the Survey's commissioned service (now the ESSA Commissioned Corps) that year. He transferred to the Air Force in 1942 as a captain, remaining through 1949. He served in the South Atlantic Theater and at USAF headquarters in the Office of the Assistant Chief of Staff for Operations, and advanced to the rank of colonel.

He returned to the Coast Survey in 1950. From 1955 to 1957, he was geodetic officer for technical liaison at the Air Force Missile Test Center in Florida. He attended the Industrial College of the Armed Forces in 1958-59, and that year became Assistant Director for Administration. He was advanced to Deputy Director in 1961.

Dr. John W. Townsend, Jr., (left) was sworn in as ESSA Deputy Administrator by C. R. Smith, Secretary of Commerce, on July 18.

all in the family PERSONNEL NOTES

Paul H. Kutschenreuter, former ESSA Deputy Assistant Administrator for Plans and Programs and Chief, User Affairs Group, is now Director of the Weather Bureau's Pacific Region. Since joining the Weather Bureau in 1926, Mr. Kutschenreuter has served in ten states. From 1950 to 1955, he was Director of the WB's Eastern Region. A professional member of the American Meteorological Society, he has been appointed U.S. delegate to meetings of the World Meteorological Organization in several foreign countries. Mr. Kutschenreuter is a former president of the WMO's Commission for Synoptic Meteorology.

Dr. Benjamin Davidson has been appointed Scientific Director for the Barbados Oceanographic and Meteorological Experiment (BOMEX) in ESSA's Office of World Weather Systems. Dr. Davidson, a former U.S. Army Air Corps weather observer and forecaster, has served as research meteorologist at the Air Force Cambridge Research Center; as a professor on the faculty of NYU; and as a consultant and advisor to government, industry, and academic institutions.

Dr. Burt Morse of the Philco-Ford Corporation has joined the Synoptic Meteorology Branch of NESC's Meteorological Satellite Laboratory, where he will be working on mathematical models of hurricanes and other dynamic features. Dr. Morse formerly taught mathematics at the University of New Mexico.

Ray E. Jensen has been designated ESSA State Climatologist for North Dakota. Mr. Jensen, who is engaged in a graduate degree day program at North Dakota State University, was formerly stationed at WB Central Region Headquarters.

Earl L. Kuehnast has become the new Minnesota State Climatologist. Mr. Kuehnast, a retired Air Force colonel, was formerly a military climatologist and an Air Force pilot.

Ronald L. Raetz has been appointed Regional Hydrologist at the Weather Bureau's Western Region Headquarters. Mr. Raetz previously served as Assistant Regional Hydrologist at Salt Lake City, Utah, and principal assistant at the Tulsa River Forecast Center.

Hurtis Smith has been named Meteorologist-in-Charge of the Norfolk Weather Bureau airport station. Mr. Smith joined the Weather Bureau in 1956 at the National Meteorological Center and has also served at New Orleans, the Washington, D. C. Forecast Center, and Columbia, S. C., before transferring to Norfolk as the station's principal assistant in 1966.

Rue E. Rush, chief of the WB Pacific Region's Weather Analysis and Prediction Branch since 1965, has been selected Meteorologist-in-Charge of the Raleigh, N. C., Weather Bureau airport station.

James L. Pruter is the new Official-in-Charge of the Weather Bureau airport station at Majuro, Marshall Islands, Pacific Trust Territory. Most recently assigned to the WBAS Lihue on the island of Kauai, Mr. Pruter entered the Weather Bureau in 1957 and spent his first ten years with the Fairbanks and Annette, Alaska, weather stations.

John H. Quinlan, formerly stationed at the Wilmington, Del., Weather Bureau airport station, is the Official-in-Charge of the WB facility at Port Erie Airport, Erie, Pa. Mr. Quinlan joined the Bureau in 1948 at New York City and has served at Wilmington since 1955.

Lester L. Benson, formerly stationed at WBO, Lakeland, Fla., is the new Official-in-Charge at Ft. Myers, Fla. Mr. Benson began his Weather Bureau career in 1943 at Meridian, Miss.

Richard A. Foster, a 22-year Weather Bureau veteran, has become Official-in-Charge of the Greenville-Spartanburg (S.C.) airport station. He was previously stationed at Youngstown, Ohio.

Milton L. Rudd, acting chief radar technician at Palmdale, Calif., has been selected as Official-in-Charge of the Winnemucca, Nev., WB airport station. Mr. Rudd entered the Bureau at San Juan, P.R., in 1952.

Jesse J. Halsey has been named Official-in-Charge at the Fort Wayne, Ind., Weather Bureau airport station. A 21-year Bureau veteran, Mr. Halsey has been a forecaster at Fort Wayne since 1948.

Frederick H. Day has been named Official-in-Charge of the Sault Ste. Marie Weather Bureau airport station. Mr. Day has been in charge of the Weather Bureau facility in Cold Bay, Alaska, for the past five years. He is a University of Colorado graduate and has served in Alaska for nine years.

John W. Fassler has been named chief radar meteorologist of the recently commissioned Palmdale, Calif., Weather Bureau Radar Unit. Mr. Fassler's previous post was at Glasgow, Mont., where he served as Meteorologist-in-Charge.

Clyde C. Holmes was named chief airport meteorologist at the San Francisco International Airport when the Weather Bureau Forecast Center moved to Redwood, Calif. Mr. Holmes has been with the Bureau since 1940, except for a three-year tour with the Navy during World War II. He began his career at Fresno, Calif., but has spent the past 20 years in the Bay Area.

Mark J. Schroeder, Meteorologist-in-Charge of the Riverside, Calif., Fire Weather Research Office, is heading the Forest Fire Danger Project at the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colo. Mr. Schroeder, a 27-year Weather Bureau veteran, has extensive experience in fire-weather forecasting in the Chicago district and has spent the last 13 years in fire-weather research in Calif.

Kenneth L. Calder, internationally known for his work in the field of atmospheric diffusion, has joined the meteorology program of the National Center for Air Pollution Control (NCAPC), Cincinnati, Ohio. The meteorology program is staffed with personnel assigned by ESSA.

Lt. Cdr. Charles K. Townsend has been named chief of Coast Survey's Technical Planning and Operations Branch, replacing Lt. Cdr. James Collins, who has been appointed Scientific Officer to Dr. Hellmut H. Schmid, Director of C&GS's Geodetic Research and Development Laboratory.

Cdr. Lavon L. Posey has succeeded Cdr. Philip J. Taetz as chief of ESSA's Commissioned Personnel Branch. Cdr. Posey was previously executive officer of the USC&GSS PATHFINDER.

Cdr. Gerard E. Haraden has replaced Capt. Howard S. Cole as field director of Alaskan operations for the Coast Survey. Prior to his present appointment, Cdr. Haraden was executive officer aboard the USC&GSS OCEANOGRAPHER.

Cdr. Dewey G. Rushford has been named head of the Coast Survey's New York Field Office. Commander Rushford joined the Coast Survey in 1948 following his graduation from Harvard University. He subsequently served on 11 Coast Survey ships, as commanding officer of three; and with various geodetic field parties in the United States. Prior to his present appointment, Cdr. Rushford was chief of the Operations Division of the Survey's Mid-Continent Field Office in Kansas City, Mo.

Capt. Steven L. Hollis, chief of the Operations and Requirements Division of the Office of Hydrography and Oceanography, has been appointed Coast Survey representative in support of the Barbados Oceanographic and Meteorological Experiment (BOMEX).

Leonard E. Kerry has been assigned chief of the Coast Survey's seismological observatory at Adak, Alaska. Mr. Kerry has served as chief of the McMinnville observatory since 1967.

Reino Kangas has been named chief of the Coast Survey's seismological observatory at McMinnville, Tenn. Mr. Kangas has served as chief of the Adak Observatory in the Aleutian Islands since 1966.

Capt. Eugene W. Richards, former Coast Survey representative on the staff of the Maritime Administration supervising the construction of the USC&GSS RESEARCHER, has been appointed commanding officer of the USC&GSS SURVEYOR. Capt. Richards joined the Commissioned Corps after receiving a degree from the University of Washington. Capt. Richards has seen duty on nine Coast Survey vessels, including command of three of the ships. He also served as Alaska Field Director in Anchorage, Alaska, with an Arctic field party, with geodetic survey groups in the U.S., as operations officer at the Pacific Marine Center, Seattle, Washington, and as projects officer at Coast Survey Headquarters.

Lt. Cdr. J. Austin Yeager has been appointed commanding officer of the USC&GSS PEIRCE. Lt. Cdr. Yeager joined the Coast Survey in 1959 following graduation from Auburn University. He was awarded a master's degree in 1966 from Purdue University. Prior to his new appointment, he was chief of the Satellite Triangulation Division, Coast Survey Headquarters.

Cdr. Robert E. Williams has been appointed commanding officer of the USC&GSS RAINIER, and Lt. Cdr. Robert L. Sandquist has been named the ship's executive officer. For the past two years, Cdr. Williams has served in Jacksonville, Fla., as the Coast Survey's liaison officer on the staff of the Maritime Administration. He is a 1950 graduate of the University of Wyoming and a 19-year veteran of the Coast Survey. Lt. Cdr. Sandquist was previously stationed in Miami, Fla., with the Research Flight Facility. Prior to that, he piloted a Coast Survey photogrammetric field party plane. Lt. Cdr. Sandquist joined the Coast Survey in 1959 following graduation from Colorado State University.

Twenty-Nine Cooperative Observers Cited for Service to Weather Bureau

Twenty-nine volunteer weather observers, from Alaska to Puerto Rico, have received the Weather Bureau's 1968 Thomas Jefferson and John Campanius Holm Awards. The awards are made annually to honor voluntary observers for outstanding achievement.

The Weather Bureau has more than 12,000 volunteer observers who make and record daily observations. The information these observers gather is processed and published by the Environmental Data Service, and is invaluable in recording the Nation's climate. Most observers serve without pay, although a few receive small payments for special assignments.

Five observers received Thomas Jefferson Awards for unusual and outstanding accomplishments in the field of meteorological observations. This award is named for Jefferson because the statesman-scientist took an almost unbroken series of weather observations from 1776 to 1816.

Volunteer weather observers receiving the 1968 Thomas Jefferson Award are:

Thomas Fleming, Ashwood, Tenn.
Milford L. Noon, Nogales, Ariz.
Roger C. Rice, Los Banos, Calif.
Mrs. Tirzah L. Spiggle, Woodstock, Va.
Mrs. Sarah M. Taylor, Merrill, Miss.

Mr. Fleming is the latest member of a grandfather-mother-son combination which has been taking weather observations at Ashwood, Tenn., for 112 years. Mr. Noon, now 58, began taking weather observations at Nogales, Ariz., when he was 15 years old. For 37 years, Mr. Rice has not missed a single day of recording the weather at Los Banos, Calif. Mrs. Spiggle has kept the official record of weather at Woodstock, Va., for over a half-century. For most of this period, she did not have the convenience of a telephone and her reports had to be carried to a telegraph office regardless of weather conditions. Mrs. Taylor, the volunteer at Merrill, Miss., began her observations in 1918.

The John Campanius Holm Award for continued excellence commemorates the first known systematic weather observer in the American colonies. In 1644 and 1645, the Reverend Campanius made records of the climate, without the use of instruments, near the present site of Wilmington, Delaware.

Receiving the John Campanius Holm Awards for 1968 were:

Edward Brams, Amistad, N. Mex.
Joseph L. Bridges, Dilley, Ore.
Mrs. Ivy S. Buchanan, Mapleton Depot, Pa.
Mrs. Iva I. Burns, Hollis, Okla.
Salvador Carbonell, Puerto Real, P.R.
Elton C. Dagwell, Mackinaw City, Mich.
Mrs. Ellen A. Davis, McIntosh, N. Mex.
Thomas W. Eliason, Jr., Chestertown, Md.
Charles F. Ford, Greenbrier, Ark.
Mrs. Frances K. Fry, Newport, Pa.
Earnest L. Harner, Xenia, Ohio
Rolf Hanson, Montpelier, N. Dak.
Oliver W. Holmes, Rockland, Me.
Thomas E. Lewis, Liberty, Tex.
Herbert J. Link, La Porte, Ind.
Mrs. Gladys May, Mays Mill, Vt.
John E. McCulloch, Buchanan, Va.
Mrs. Ruth S. Moore, Bradford, N.H.
Sheldon Segevan, Wainwright, Alaska (posthumous)
Rev. Norman M. Sorensen, Pioche, Nev.
D. Tellinghuisen, Allison, Iowa
Francis Tingey, Woodruff, Utah
Thomas A. Walker, Timpanogos Cave, Utah

ESSA, Navy, Air Force Alert For 1968 Stormfury Season

More than 200 men and as many as 14 planes of ESSA, the Navy, and the Air Force will be on the alert through October 15, waiting to see if they can lessen the violence of hurricanes.

Project Stormfury is a joint ESSA/Navy program of scientific experiments designed to explore the structure and dynamics of hurricanes and tropical storms. Under the leadership of Dr. R. Cecil Gentry, of ESSA's National Hurricane Research Laboratory in Miami, Florida, the Project is attempting to learn if it is feasible to moderate the fury of hurricanes or perhaps steer them away from land.

Stormfury scientists hope to upset the balance of forces near the eye of the hurricane by injecting silver iodide in the wall of the hurricane near the eye and, in so doing, redistribute the energy concentrated there. For the 1968 hurricane season, seeding was authorized in the southwestern Atlantic, the Caribbean Sea, and the Gulf of Mexico giving the Project much greater chance for their experiments than any time since the Project was established in 1962. This year, conditions permitting, clouds near the hurricane eye will be seeded five times during an eight-hour period.

Dr. R. Cecil Gentry, Project Stormfury Director, pores over operational problem from airborne vantage point in dry run.

Estuarine Service Is Launched In Maine Bay

ESSA has launched the Nation's first estuarine prediction service, which, it is hoped, may become a valuable aid in pollution control. It will be conducted as a one-year pilot project for the Penobscot River and Bay Estuary in Maine.

The predictions will be made by the Coast and Geodetic Survey, with vital river discharge forecast and advisory information provided by the Weather Bureau's Hydrology Division.

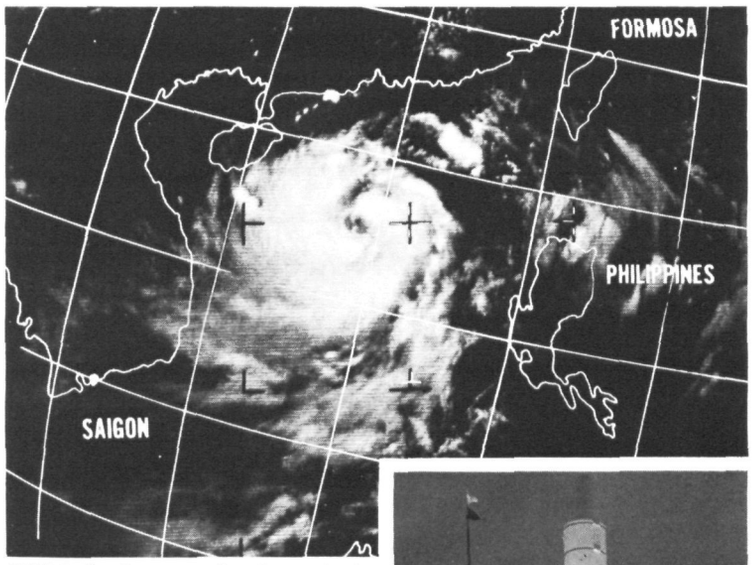
Advance forecasts will be issued the third and eighteenth of each month on the rate at which possible pollutants pass through the estuary, computed through the modified tidal prism concept developed by B. H. Ketchum, of the Woods Hole (Mass.) Oceanographic Institution.

The flushing rate, as it is termed, is the average time fresh water or suspended matter (potential pollutants) will remain in various parts of the estuary. These predicted rates will give the number of days required for fresh water or suspended matter to travel from selected points past the outer end of the pilot area at a line extending from Cape Rosier to Little Harbor. The points are at lines drawn across the estuary at Bangor, Hampden, Winterport, Bucksport, Fort Point, southern tip of Sears Island, Belfast to Castine, and Northport to Orrs Cove.

The forecasts will be issued to the following Maine outlets: the Governor's office for distribution to local municipalities and industries; the University of Maine at Orono and Portland and the university's marine laboratory at the Ira C. Darling Center for Research, Teaching and Service, at Walpole; and the Maine Department of Sea and Shore Fisheries in Augusta and West Boothbay Harbor.

The forecasts will also be furnished to these Federal agencies: Federal Water Pollution Control Administration in Boston, Mass., and Washington, D. C.; the Bureau of Commercial Fisheries in West Boothbay Harbor, Maine; and the Public Health Service and Bureau of Sport Fisheries and Wildlife in Washington, D. C.

New Weather Satellite, ESSA 7, Is In Orbit, Sending Photos



ESSA 7 photograph of tropical storm Shirley taken over the South China Sea on its 44th orbit of earth.

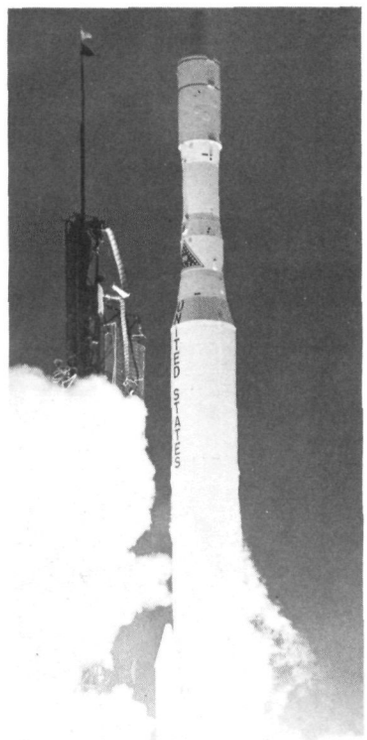
ESSA 7—the seventh spacecraft in the operational weather satellite system — was launched by NASA from the Western Test Range at 7:25 a.m. EDT, August 16, and attained the best orbit of any satellite in the system to date. The nearly perfect sun-synchronous orbit has an average height of 900 statute miles. Its annual drift rate of less than 4 minutes is equivalent to the monthly drift rate of previous spacecraft.

The new satellite replaces ESSA 5 as the primary stored data vehicle in the operational system. Although one of its two Advanced Vidicon Camera Systems has failed, the other can provide forecasters with global coverage of the earth's weather every day. Like ESSA 3 and 5, the latest spacecraft contains an array of atmospheric radiation sensors which measure the global distribution of solar radiation reflected by the earth and its atmosphere, and also the long-wave radiant energy emitted by the earth.

Since the operational system began in February 1966, ESSA's National Environmental Satellite Center has sent more than 3000 warnings, based on the satellite photographs, to nations threatened by dangerous storms. In addition to locating tropical storms, hurricanes, typhoons, and cyclones, the pictures are used to estimate the intensity of storms. These estimates have proved to be reasonably accurate and are especially valuable in areas where no other information is available.

The seventh ESSA spacecraft, like its predecessors in the TOS system, is a cartwheel satellite of the TIROS type. It rolls along in orbit like a wheel, and each of the two cameras looking out through its rim points directly toward the earth once during every revolution. In a nearly polar, sun-synchronous orbit, approximately 887 statute miles above the earth's surface, the satellite views weather all over the earth once every 24 hours, photographing a given area at the same local time each day.

Sixteen satellites of the TIROS type have been launched successfully since TIROS I—the first weather satellite—was orbited on April 1, 1960. All spacecraft from TIROS III on have equaled or exceeded the operational lifetime for which they were designed.



ESSA 7 blast-off at Western Test Range, Lompoc, Calif.

Linda Richards, KRON-TV weathercaster, Mayor Robert Bury and Dr. George P. Cressman, WB Director, in a flag-raising ceremony at dedication of the new Redwood City, California, Weather Bureau Forecast Center.

WEATHER WATCH SUPPORTED BY THE CONGRESS

In keeping with the Concurrent Resolution passed by Congress on May 29, supporting the World Weather Watch, President Johnson has issued a memorandum to all participating agencies directing their cooperation in the program.

The program, sponsored by the World Meteorological Organization, constitutes one of the largest and most complex scientific and technological projects ever attempted on an international scale.

In his statement, President Johnson asked the Secretary of Commerce "to continue to coordinate our national efforts in this program by: providing a forum for consultation and coordination among the interested Federal departments and agencies and with the National Academy of Sciences and the National Academy of Engineering; (and) developing annually in cooperation with the participating agencies a coordinated plan setting forth the proposed participation by Federal agencies in the World Weather Program for the following fiscal year."

The plan is to be submitted to Congress by March 1 of each year. Departments and agencies participating in the program are: Departments of Commerce, Defense, Interior, State, Atomic Energy Commission, NASA, National Science Foundation, and the Agency for International Development. The Office of World Weather Systems has been established within ESSA to provide a focus for the Federal effort in this program.

ESSA's third anniversary open house drew large crowds across the nation during the week of July 15. Visiting ERL's Space Disturbance Forecast Center is Mrs. Donald G. Brotzman, wife of the Colorado congressman. With her are Robert W. Knecht (left) and Alan H. Shapley of ESSA.

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Rear Admiral John C. Bull, USESSA, 59, Director of the Coast and Geodetic Survey's Atlantic Marine Center in Norfolk, Va., died suddenly in Washington, D. C., September 3, after a distinguished career in the Federal service.

Born April 2, 1909, in Georgetown, S.C., he was graduated from The Citadel, Charleston, S.C., in 1930, with a bachelor's degree in civil engineering. He joined the Coast and Geodetic Survey after graduation.

During World War II, he served with the U.S. Army in the European theater and was awarded the Bronze Star and the Croix de Guerre with silver star.

Returning to the Coast Survey after the war, he served on numerous ships in the survey fleet, spent two years as liaison officer at Fort Bragg, and attended the Armed Forces Staff College. He was Chief of the Hydrography Branch of Coastal Surveys and Assistant Chief of the Photogrammetry Divison. He commanded the USC&GS Ship EXPLORER in 1963 on its duties with the International Cooperative Investigation of the Tropical Atlantic.

In 1964, he became head of the Coast Survey's Norfolk District Office and, when the Survey became part of the Environmental Science Services Administration in 1965, he was named Director of the Atlantic Marine Center and East Coast Field Director. He was promoted to the rank of Rear Admiral, USESSA, on January 1, 1967.

Adm. Bull was a member of the Army-Navy Country Club, the Army-Navy Club, the Norfolk Rotary Club, the U.S. Power Squadrons, and the Hampton Roads Foreign Commerce Club, and served on the Board of Directors of the Federal Executive Association, the Interagency Board of U.S. Civil Service Examiners, and the Board of Directors of the Hampton Roads Post of the Society of American Military Engineers.

Adm. Bull is survived by his wife, the former Coralee Kitchings, of the home address—3372 Gunston Road, Alexandria, Va.,—and a son, Dr. John C. Bull, Jr., of Baltimore, Md.

Last rites were held on Saturday, Sept. 7, in St. Helena's Episcopal Church, Beaufort, S.C.

IN MEMORIAM

REAR ADMIRAL JOHN C. BULL, USESSA
1909-1968