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

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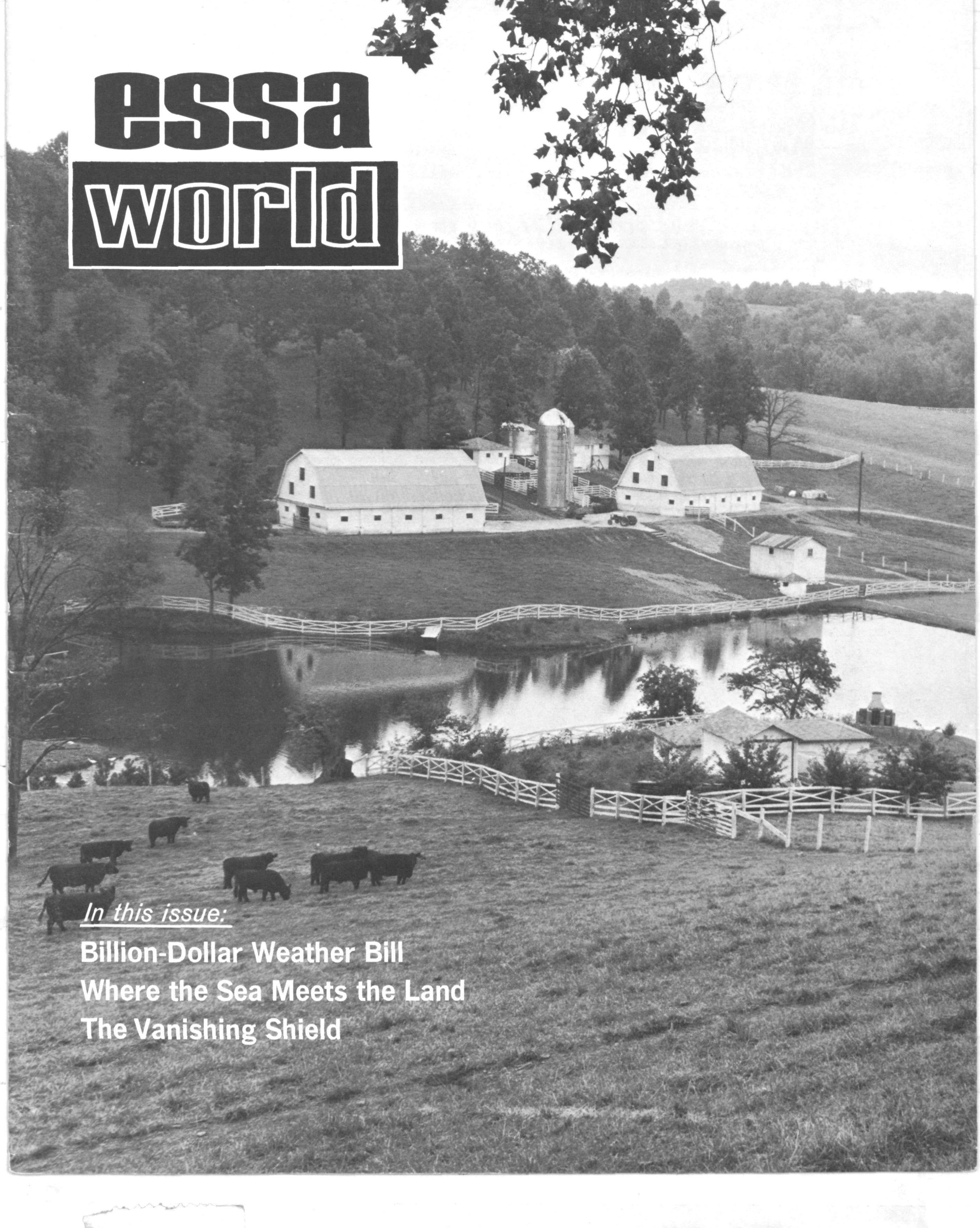

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APRIL 1968 VOLUME 3 NUMBER 2

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COVER
ESSA's mission in weather support of farm operations is symbolized on the front and back covers.
Photo by U.S. Department of Agriculture

STANLEY B. EAMES
Director, Public Information

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Art Director

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ROBERT M. WHITE
ADMINISTRATOR

A Message from the Administrator

In the past few months, I have visited ESSA facilities in Chicago, San Diego, Seattle and Miami, conferring with our people about the tasks before us.

It is a stimulating experience to be on the front line, where so much of the environmental mission is accomplished. At the same time, I was struck by the realization that the gulf between Washington and our far-flung posts is more than a geographic one. Not only do our installations dot the globe but our people are engaged in highly diverse missions.

A geodesist in Kansas is doing something quite different from an ESSA Commissioned Corps officer on a ship; a meteorologist on a Pacific island from the seismologist in Maryland; the oceanographer in the Red Sea from the weather forecaster at Memphis.

One of our great challenges in ESSA is to heighten the comprehension within our own family of the close interconnection of our tasks. Each not only makes a valuable contribution to the safety and welfare of the people of America; each is closely related to the other in terms of our environmental mission.

One of the purposes for which ESSA was formed was to permit and encourage interdisciplinary collaboration, not only for the sake of economy and efficiency but for the scientific and technical progress sure to evolve from it. Whenever I see new evidence of such collaboration, I find it heartening.

There is no question that the future will bring more of it. For example, the oceanographer and the meteorologist require ever-increasing cooperation and coordination if each is to do his most effective work: the very nature of our planet dictates it.

A striking example is the Barbados Oceanographic and Meteorological Experiment, a national scientific effort to be conducted east of the island of Barbados in 1969. Together with representatives of other Federal agencies and the university community, Coast and Geodetic Survey ships and crews, ESSA Research Laboratories oceanographers and Weather Bureau meteorologists will join forces in a historic project — the first comprehensive study of the interaction between the atmosphere and the ocean.

A similar instance is a plan, approved by the National Council on Marine Resources and Engineering Development, that ESSA's weather satellites be employed to determine the positions of warm and cold currents in the oceans through radiometer measurement of sea temperatures. The information will be recorded by the National Environmental Satellite Center and distributed in map form to national and international meteorological and oceanographic interests.

Yet another way in which our efforts will serve multiple purposes is seen in a planned expansion of the National Meteorological Center's services. Procedures initially used by the Navy have been employed to determine sea heights for the benefit of weather forecasters in the field. Upon completion of testing, these techniques will be used to provide information for the NMC's prediction models.

There are many other ways in which we can, and shall, work more closely between scientific disciplines. I urge everybody in the ESSA family to search actively for new ways to bring this about in every possible area of effort.

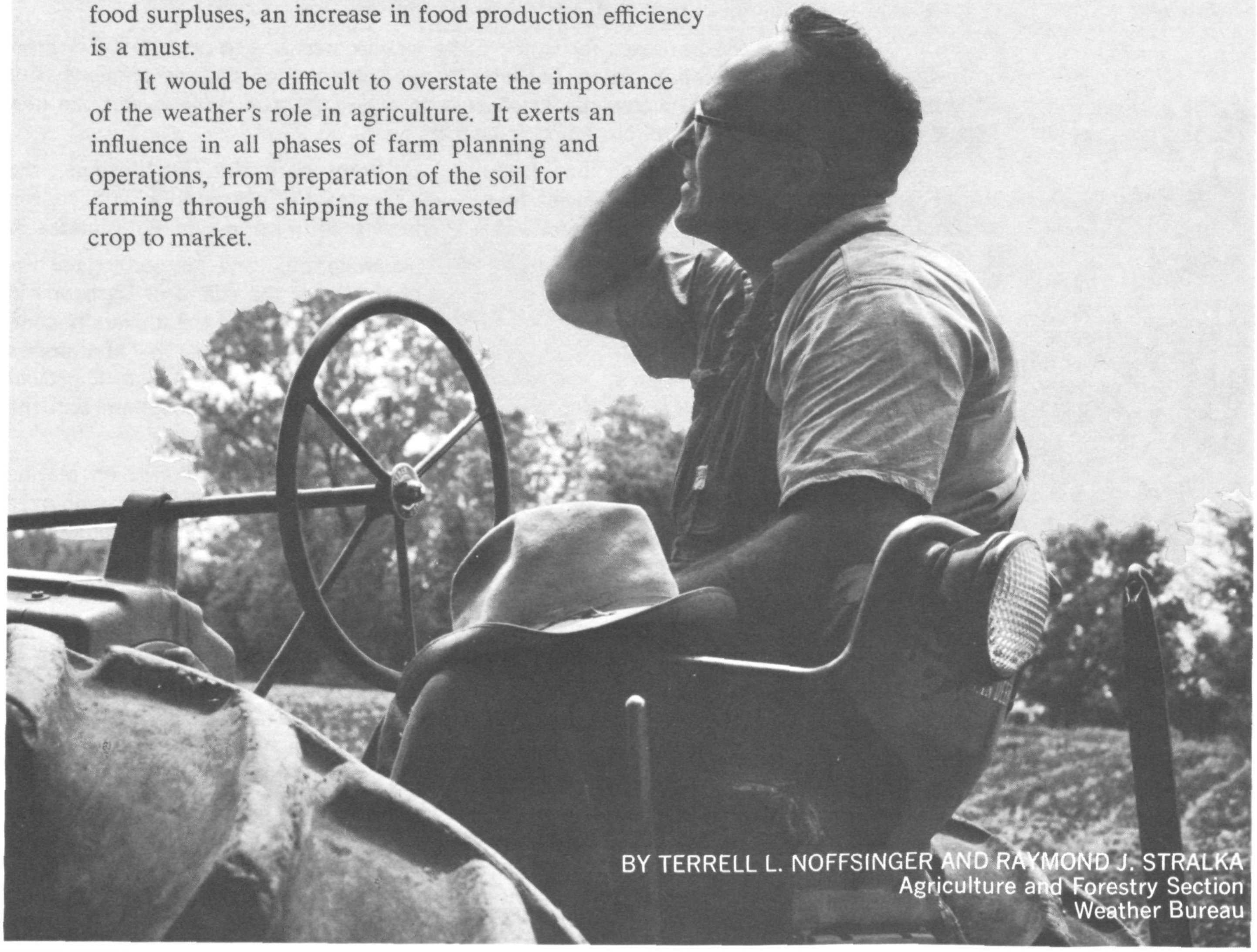
Expansion of a Federal service is planned to cut the farmers'

BILLION-DOLLAR WEATHER BILL

WHEN, in 1798, Thomas Malthus prophesied that people would multiply faster than their food supply, he was being more realistic than he dared imagine. Today over half the world's people suffer from hunger or malnutrition and there is a steadily increasing gap between supply and need.

In working toward the vital balance between food and people, the United States has become by far the greatest food producer the world has ever known. But a stand-pat attitude would be folly. With our ever-increasing population (currently 200 million), reduction in farm acreage by expanding urban development, and depletion of existing food surpluses, an increase in food production efficiency is a must.

It would be difficult to overstate the importance of the weather's role in agriculture. It exerts an influence in all phases of farm planning and operations, from preparation of the soil for farming through shipping the harvested crop to market.



BY TERRELL L. NOFFSINGER AND RAYMOND J. STRALKA
Agriculture and Forestry Section
Weather Bureau

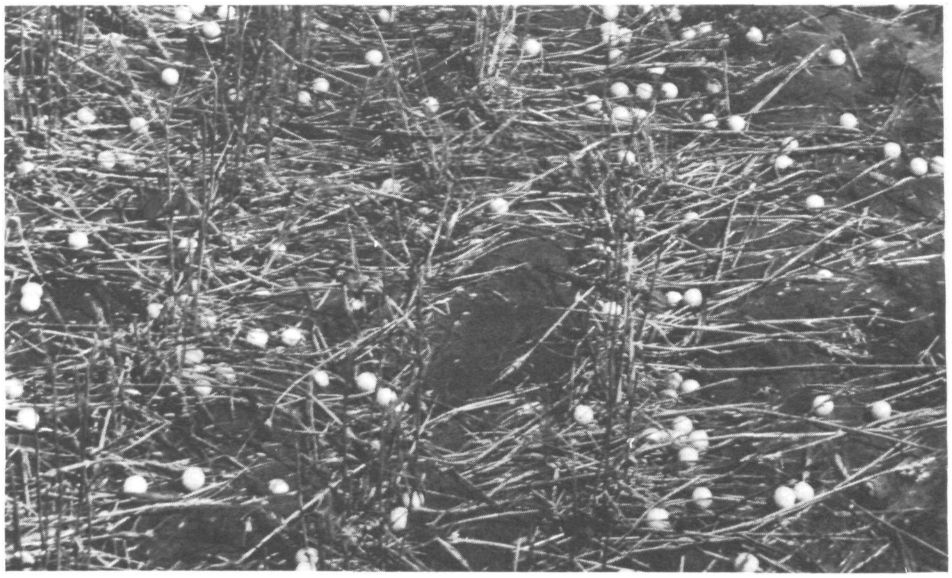
The Weather Bureau has a major responsibility in providing necessary weather data for use in agricultural planning and in assuring that those engaged in agricultural production receive the best possible meteorological advice and information.

Currently the Bureau's Agricultural Weather Service is operating in 12 areas of the United States in which there are valuable concentrations of weather-sensitive crops. Under a Federal Plan for National Agricultural Weather Service prepared by the Weather Bureau and the Department of Agriculture, complete weather coverage for agricultural activity in all 50 states is anticipated.

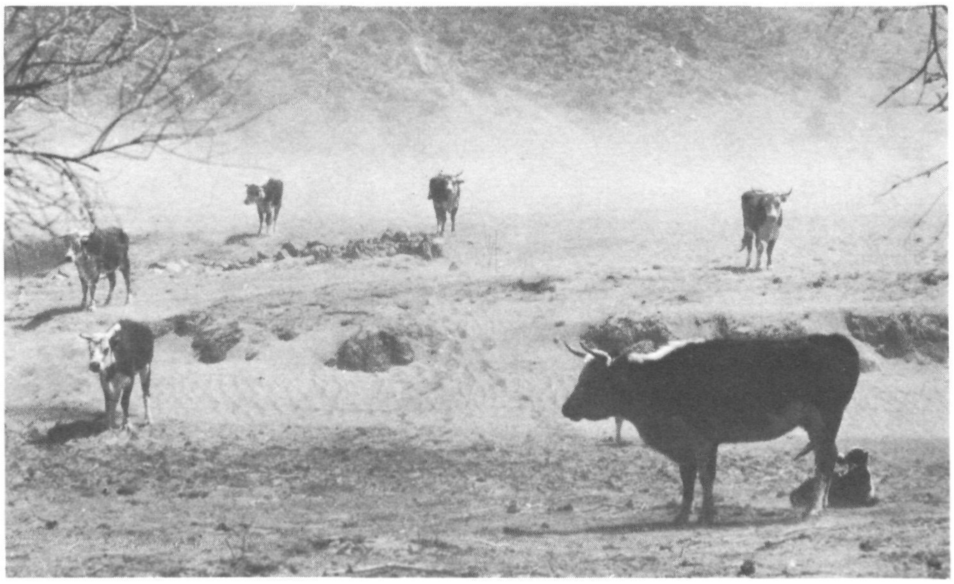
Through the Agricultural Weather Service, communities and individuals are provided with short- and long-range planning information and certain other specialized services by integrating available meteorological talent with that of Federal and State agricultural specialists in colleges of agriculture, agricultural experiment stations, extension services, and other components of Federal and State Departments of Agriculture.

The related programs of forecasting and interpretation, data collection, and dissemination are performed at Agricultural Weather Forecast Offices and Agricultural Weather Service Offices.

Agricultural Weather Forecast Offices make general agricultural forecasts covering a two-day period (with an outlook for the third day). These forecasts are issued three times daily — in the early morning, around noon, and in the evening — to provide guidance in managing farm operations on a day-to-day basis. The forecasts include such elements as expected cloudiness, percent of the area which will receive rain and how much will fall, wind speed and direction, dew duration and intensity, and the range of high and low temperatures. In certain areas, Weather Forecast Offices provide specific operational forecasts such as spraying and dusting forecasts, and daily drying forecasts for hay. In producing their forecasts, the Weather Forecast Offices use guidance material received from the National Meteorological Center in Suitland, Md., Area Forecast Centers' synoptic reports, and special observations received daily from agricultural cooperative weather observers. Also, observations from weather radars located in their area are used in issuing advisories on the movement and intensity of showers.

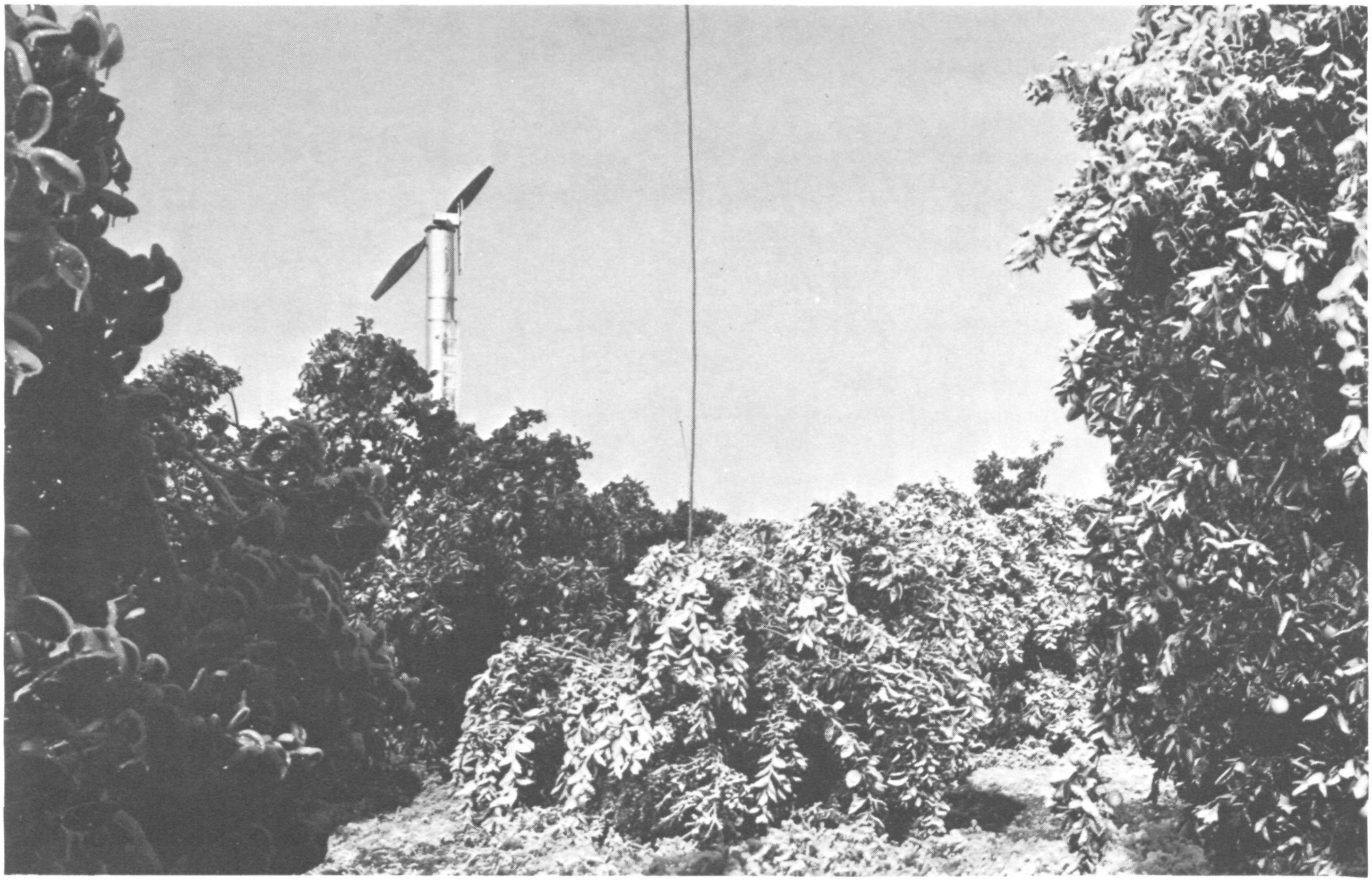


Close-up of hail in damaged Texas wheat field.



Drought conditions bring suffering and loss of life to livestock.

Flooding destruction to farmlands.



Wind machines can give 5 degrees' protection to citrus groves in danger of freezing.

Sprinkler system in Avon Park, Florida, is operated day and night following 22-degree temperature to give crop frost protection.

Agricultural Weather Service Offices have an interpretive (as opposed to forecasting) function. These facilities are staffed by Weather Bureau Advisory Agricultural Meteorologists and are generally co-located with a Federal or State Agricultural Experiment Station. Through joint action, detailed knowledge of such factors as crop-weather relationships, life cycles of pests, and cultivation techniques is used to produce explicit interpretive guidance to agricultural operations.

For example, on a daily basis (five times a week) a farm weather summary is issued as a supplement to the general agricultural forecast providing an evaluation of the effects of the predicted weather on agricultural operations in progress or planned. In addition, agricultural interpretation of the five-day weather outlook is given three times weekly, and twice monthly for the 30-day outlook.

Joint specialized agricultural advisories, designed with the immediate problems of the local area in mind, also are prepared in support of such critical operations as pest control, irrigation, harvesting, and defoliation. The Advisory

Successful crop dusting requires forecast of wind, visibility and ceiling.

Agricultural Meteorologist may also conduct technical studies relevant to agriculture-weather relationships involving microclimate of agricultural areas; growth, yield, and quality of crops; agricultural pests; soils; farm animals; and, to a lesser extent, wildlife.

Climatological studies provided by the Weather Bureau and the Environmental Data Service, relating the long-term probabilities of the weather elements to agricultural practices, supplement the forecasting services. These studies are published and made available to farmers and county agents as a permanent reference to be used in conjunction with the forecast service. This information is useful in seasonal operations (for example, planting and defoliation), and in such long-term planning as determining the capacity required of supplementary irrigation systems.

Because of concentrated growing areas, high-acre value, and extreme sensitivity of fruit crop to frost conditions, a specialized fruit-frost service is currently being provided for growers, primarily in Florida, California, Arizona, Washington, and Oregon.

The effectiveness of this service, which was developed before the generalized agricultural service previously described, has had a strong influence on the development of expanded service to other agricultural users. The fruit-frost service's structure varies with the areas served depending on local climatological factors. It is centralized, for example, in Florida (at Lakeland) and decentralized in the western states. In the West, trained forecasters from the Pomona, Calif., Weather Bureau Office are temporarily stationed in fruit-producing areas during the winter and move north to Oregon and Washington, with the advancing spring season. Forecasts for such factors as the minimum temperatures expected at key points, wind, cloud cover, and temperature inversions are issued during the critical season for the particular crops concerned. This information is vital for growers who must take immediate control measures when damaging frost conditions (cold, calm, and clear) are forecast. The fruit-frost service is generally operated on a cooperative basis with states, counties, or local growers' organizations providing active support such as the special temperature observations required from field locations.

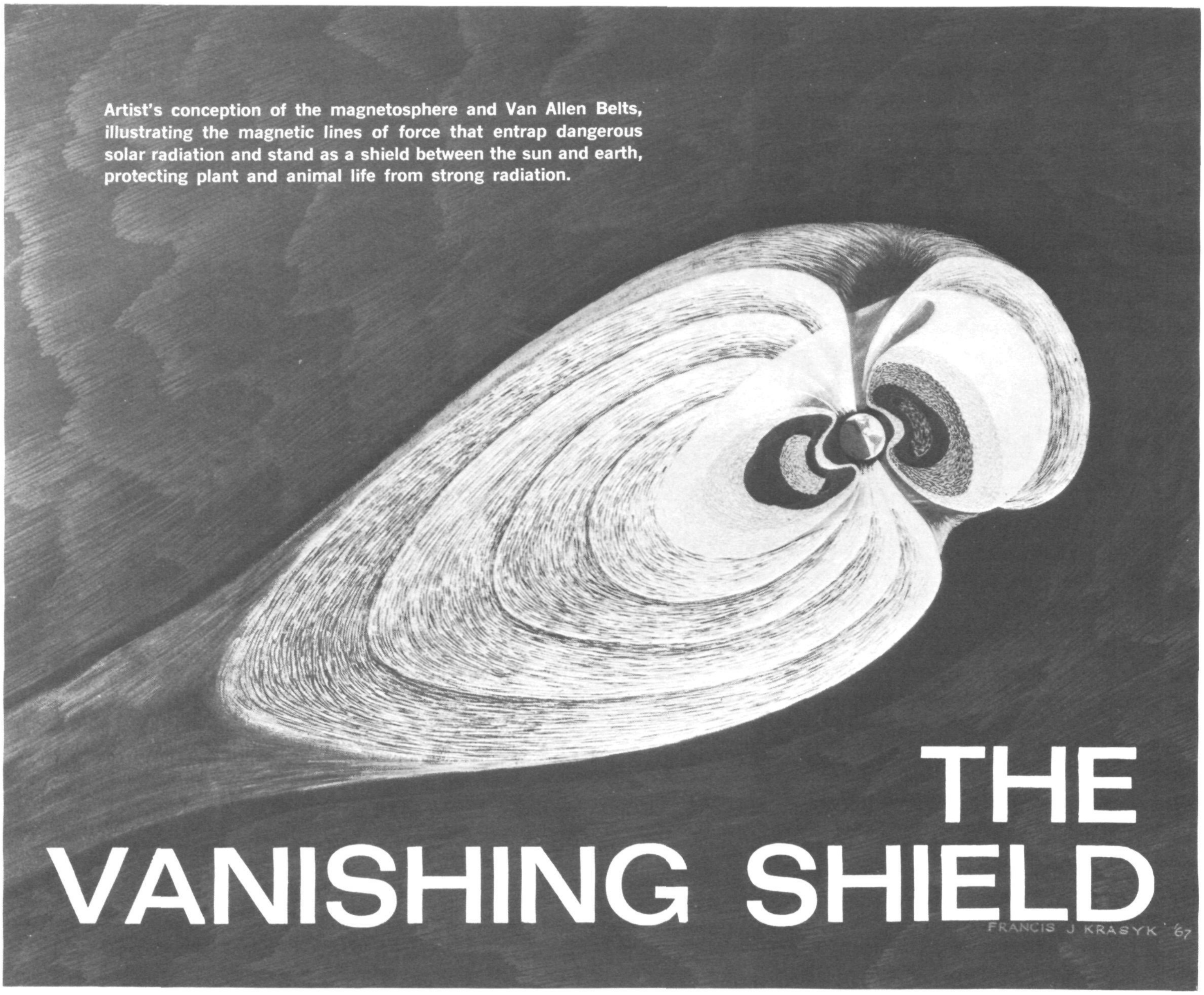
Farmers sometimes base their whole livelihoods on these predictions. One Florida citrus grower spent $55,000 burning oil when frost was forecast for his groves. A pepper farmer once dug up all his plants and moved them inside when low temperatures were predicted at Lakeland. A few days later, he replanted them and was virtually the only man with peppers for sale in his area later that season.

One of the prime requirements of the Agricultural Weather Service is an adequate network of observing stations. About 20 such cooperative stations in each area being served by the Agricultural Weather Service provide such information as temperature and humidity of the air, air motion, sunshine and radiation, soil temperature and moisture, and hydrometeors and other water balance factors.

Routine agricultural observations from these stations are taken in the early morning and are telephoned to the nearest Weather Bureau Office where they are placed on the ESSA Weather Wire for dissemination. These reports are an essential supplement to the Weather Bureau's overall observing network and aid the Agricultural Weather Forecast Office and Agricultural Service Office in the preparation and verification of forecasts and advisories. Also, these observations provide valuable data for agricultural-meteorology technical studies and for the development of improved forecasting techniques.

Beneficial results from any weather service cannot be realized unless a direct link with the user is available by which weather information can be effectively distributed. The Agricultural Weather Service reaches the user in a variety of ways, the most common being the news media and agricultural agencies. To improve the dissemination of agricultural weather information, the ESSA Weather Wire is used. This network insures that vital weather data is made available to mass media with the least possible delay.

Weather-related crop losses are estimated to cost the Nation's agricultural interests between $1 billion and $2 billion annually. There is every reason to believe this loss can be cut sharply by the forthcoming expansion of the Agricultural Weather Service. □



Artist's conception of the magnetosphere and Van Allen Belts, illustrating the magnetic lines of force that entrap dangerous solar radiation and stand as a shield between the sun and earth, protecting plant and animal life from strong radiation.

THE VANISHING SHIELD

By RUSSELL B. STONER, ESSA Research Laboratories

Radiation may change human life drastically in the 30th Century

Life on earth may have to adapt to strange and difficult conditions during the next two thousand years. The magnetic fields which shield the earth from solar and cosmic radiation are weakening toward an expected reversal, and loss of this shield could result in radiation mutation of plant and animal life and in widespread climatic changes.

Dr. Keith L. McDonald has proposed that heat released from the solid inner core is vented into the fluid core near the polar regions, and that this polar concentration of released heat causes fluid motions which destroy the magnetic field. McDonald, a research physicist for the ESSA Research Laboratories, expects a period of at least one thousand years when the magnetic fields will not be an effective shield against radiation.

Streams of radiations emitted by the sun bombard the earth when disturbances occur on the great gaseous ball around which our planet revolves. When this radiation reaches the earth, it is trapped by the magnetic field which arches far above the land, air, and sea where man lives and works. These areas of captured radiation are the Van Allen Belts. The magnetic lines of force which entrap the radiation stand as a shield between the sun and earth, protecting plant and animal life from the effects of the strong radiation.

The earth's magnetic field is not constant, however. Conclusive evidence has been found that the field varies in strength and reverses itself irregularly. Since 1670 A.D., the strength of the field has decreased by approximately 15 percent. A study by McDonald indicates that the present rate of decay in the field strength will substantially cancel the dipole magnetic field by the year 3991 A.D.

For 500 years before this date, the strength of the field will be so small that increasingly larger amounts of the solar radiation will reach the earth's surface. An additional 1000 to 2000 years will pass before the field will be strong enough to shield the earth effectively from the radiation bombardment.

Proof that reversals have occurred can be demonstrated by studies of lava flows. When the molten lava cools, magnetic materials within the rock are aligned with the magnetic field of the time. Studies of samples from lava have found layers in which the magnetic field is of opposite polarity from the present field.

The study by McDonald is based on data gathered from 1830 to 1965. The analysis of this data indicates that a steady decline in the strength of the dipole magnetic field is occurring. McDonald explains that this decrease is due to changes in fluid motions in the earth's core. Heat of radioactive decay within the solid inner core is released into the outer fluid portion in greater amounts near the geographic poles, destroying the dipole magnetic field. The field cannot regain strength until this concentration dissipates.

As the dipole magnetic field decreases, local magnetic fields are increasing. They may eventually result in auroras occurring over the U.S., Tibet, or West Africa, for example. These fields may decline too as the main field becomes smaller, removing the possibility that local umbrellas of radiation shielding will remain when the dipole field disappears.

Speculation about the changes in the physical and biological environment which might result from the decline and reversal of the magnetic field is subject to debate. Some scientists expect the changes to be minor; others view them as potentially catastrophic.

Changes in radiation levels can be expected, but the atmosphere will continue to offer protection. The actual increase may vary from none at the poles to as much as a doubling at the equator. Mutation of living organisms due to increased radiation is problematic, according to some authorities, although Robert J. Uffen of the University of Western Ontario suggests major genetic changes can be expected.

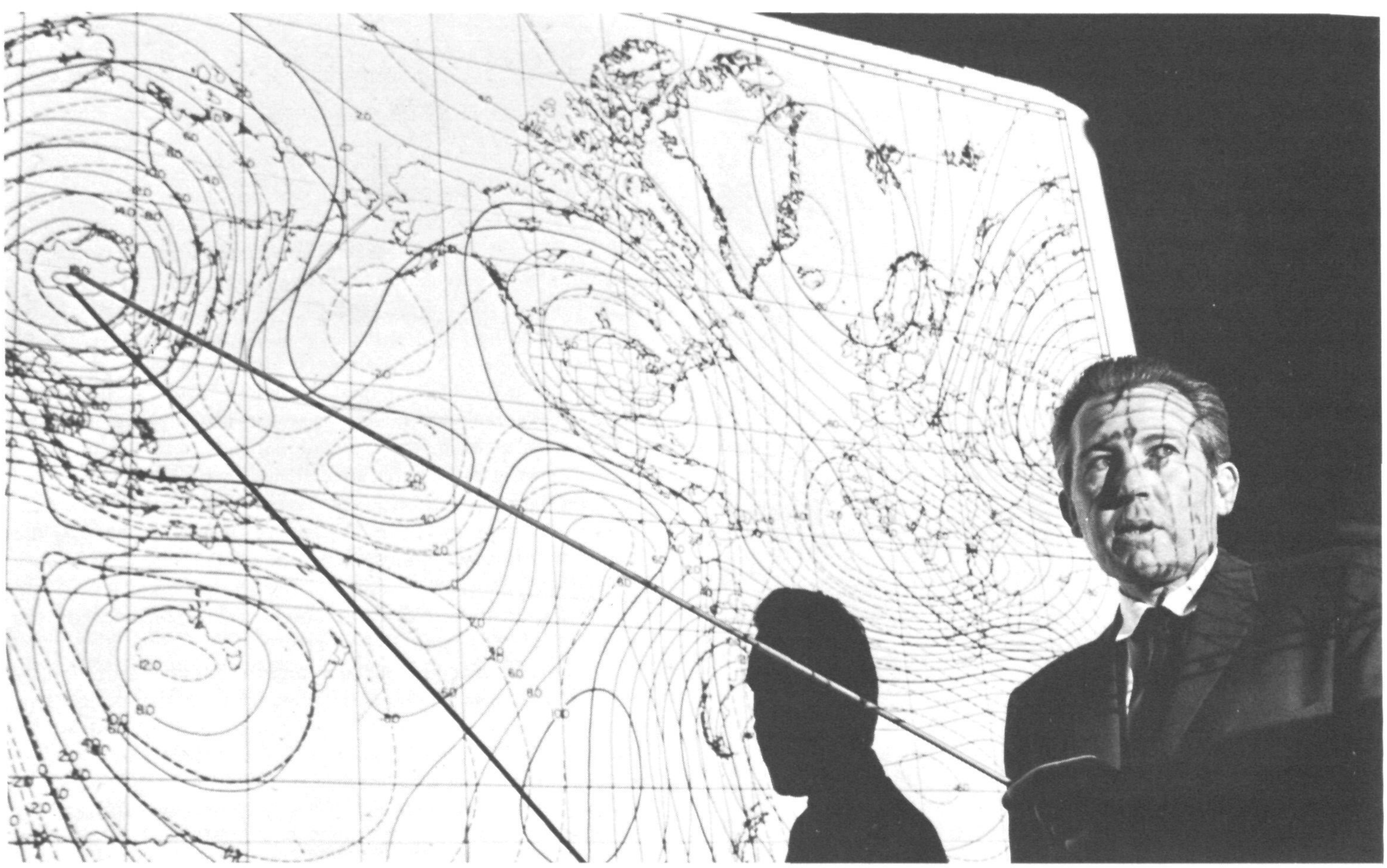
Less total radiation will be collected in the earth's environment if the magnetic fields are removed. These fields extend some 60,000 miles from the earth, capturing streams of energetic particles, many of which would pass by if the fields were not present.

If local magnetic fields are not cancelled during the reversal, larger amounts of radiation will be collected than if the total fields were removed. This radiation would filter down to the surface where the lines of force originate, much as radiation now reaches the earth at the geomagnetic poles. This might focus radiation in some areas more than others. A higher mutation rate might then be expected in the areas of heavier radiation.

Possible climatic changes might result from the decline of the dipole field with more noticeable results on plant and animal life than that due to radiation. During periods of intense solar bombardment, changes in atmospheric pressure and the direction of jet streams have been observed near the poles. If these changes were not confined to the polar regions by dipole field, major changes in atmospheric circulation might occur with drastic changes in the weather resulting. Increases or decreases in ionization in the ionosphere and in the production of ozone could have large effects in temperature retention by the earth. Lush valleys could become barren wastes, deserts might bloom, ice caps might cover the land, or the present polar caps might melt, raising the sea level over coastal towns.

The period between reversals of the magnetic field are so far apart that no one knows what to expect. The last reversal occurred some 700,000 years ago, making it difficult to find direct evidence of physical or biological changes which can be ascribed to that event with any certainty. □

Dr. Keith McDonald, ERL physicist, points to a local anomaly in the magnetic field. World map shows local magnetic fields in 1835 and 1965, demonstrating changes over 130 years.



Boeing Photo

WHEN a pilot unfolds a new aeronautical chart, published by ESSA's Coast and Geodetic Survey, he has before him the accurate, up-to-date product of the efforts of some 600 Survey employees.

His chart is one of more than 30 million produced and distributed each year by the Survey's Office of Aeronautical Charting and Cartography. The story of an aeronautical chart — from design and data gathering to reproduction and distribution — is one of scheduling, coordination, and cooperation.

The various chart series fall into two basic categories, VFR and IFR, explains Granville K. Emminizer, chief of the Office's Aeronautical Chart Division.

VFR charts, used for flying under the Federal Aviation Administration's Visual Flight Rules, have aeronautical information applied over a topographical base map. These charts are updated every six or twelve months.

IFR charts, for flying under the FAA's Instrument Flight Rules, include departure charts, en route high altitude and low altitude charts, instrument approach charts, and

Thirty million charts a year for SAFETY IN THE SKIES

aircraft position charts for long intercontinental routes. Except for shorelines and topographical features which would show clearly on a plane's radar, they contain only aeronautical information. The en route charts are updated, reprinted, and distributed every 28 days.

Data for the charts are collected by the Aeronautical Information Branch, the recognized authority on flight hazards. The Branch's staff of 14 aeronautical information specialists, headed by Edward P. Devine, are all experienced in cartography or navigation. Through the FAA's "pony" teletypewriter circuit, they receive the National Flight Daily Digest containing all the previous day's information on flight hazards, navigation aids, airports, and changes to air space. Each item in the Daily Digest is entered in the branch's records, which include index cards for all airports, showing the hazards at each, the navigational aids, and the numbers of the aeronautical charts affected by each change. In addition, the hazards section keeps current files of the more than 14,000 obstructions above 250 feet or in glide paths, and the airports section maintains complete official five-year history files on every airport. Copies of the Daily Digest are passed on to the cartographers and compilers responsible for the accuracy of VFR and IFR charts.

Revision of a visual chart begins with the collection of all available topographical information for the area. This material is gathered, analyzed, evaluated, and verified by the Visual Chart Branch's 75 cartographers, technicians, and aids, under branch chief Bernard F. Cooke. It includes base maps from Government agencies, drainage and reservoir informa-

(Left) Victor J. Mosesso checking shelf stock of charts.

Changes in airspace, airports, navigational aids, and flight hazards are recorded daily by the Aeronautical Information Branch, headed by Edward P. Devine, left. At right is F. G. Travis, chief of the aeronautical data section.

Mrs. Willie Caviness, a cartographic technician in the Radio Facility Chart Branch, applies changes to a controller chart. This series of 54 charts, used by FAA air traffic controllers, is revised every 28 days.

Frederick O. Diercks, C&GS Associate Director, Aeronautical Charting and Cartography, and Gordon B. Littlepage, Jr., Planning and Operations Officer, examine a new visual chart. Before June, 27 in the series will be available.

Glenn Ball, right, chief of the Instrument Approach Procedure Chart Branch, discusses methods of depicting an official FAA instrument procedure with Mrs. Carrie Argyropias and Paul Carter in the Compilation Section.

tion, obstruction data, airport survey plans, aerial photographs, and geodetic data from the Survey's Geodesy Division.

The previous edition of the chart is flight checked by an ESSA officer pilot and a cartographer, who fly over the charted area looking for discrepancies and changes.

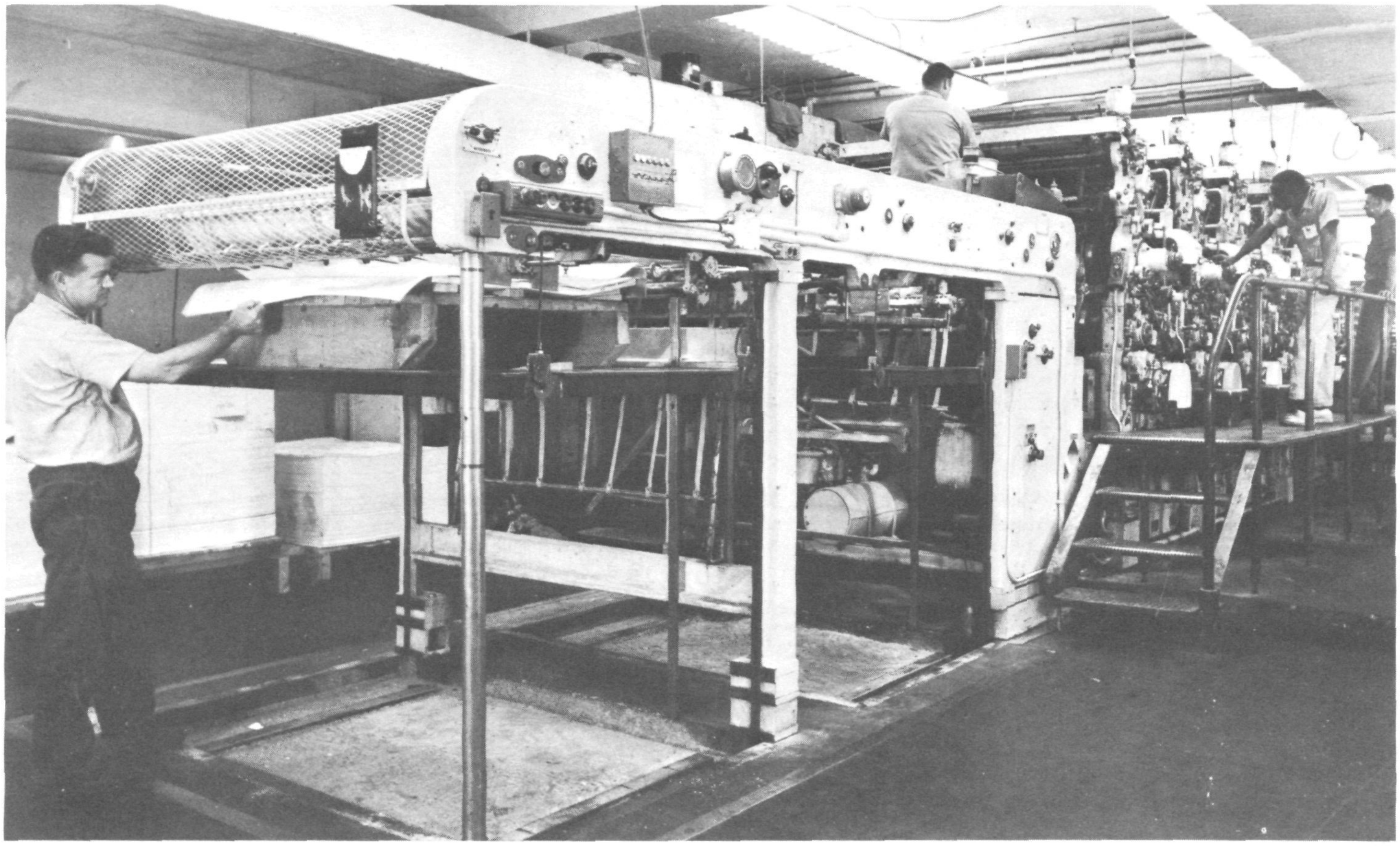
From the assembled data, the Visual Chart Branch selects the features to appear on the new edition. These are converted to the chart's scale, color-coded, and applied to the chart "manuscript."

The Visual Chart Branch produces sectional charts, local charts, world aeronautical charts, jet navigation charts, planning charts, and aircraft position charts, as well as the U.S. Postal Zip Code Map and the maps and charts used by the Weather Bureau.

IFR charts are prepared by two groups — the Instrument Approach Procedure Chart Branch and the Radio Facility Chart Branch.

The Radio Facility Chart Branch produces all the en route and area charts required by a pilot — flying under instrument flight rules in controlled air space below 45,000 feet — from the time he leaves one airport until he is ready to approach another.

These charts, covering the 50 states and portions of Canada and the Caribbean, contain information on navigational aids, airway structure (the highways of the air), positive radar control, air route traffic control centers, the positions in the air from which pilots may — or must — contact FAA traffic controllers, minimum flight altitudes, selected airports, and reserved air space. *continued*



The Office's Reproduction Division prints all of the Coast Survey's aeronautical and nautical charts. The 70 employees in the presswork branch, headed by Frederick A. Fowler, work three shifts a day, five or six days a week. The largest of the shop's five presses, above, prints five colors simultaneously on 5,500 sheets an hour, and costs $70 an hour to operate. Shown above, left to right, are Earl R. Webb, Donald P. Murray, Alexander Gibson, and Gleason S. Henry.

Every fourth Wednesday, branch chief Albert O. Schmitz and his staff of 55 cartographers, cartographic technicians, air navigation information specialists, and clerical personnel, must have all 156 of these charts revised and ready for printing.

During the preceding 28 days, staff cartographers have been applying new information to the charts. Each cartographer is responsible for specific charts. He ensures that all changes are made as they are received, and that no information is missed.

The Radio Facility Chart Branch also produces Central Altitude Reservation Charts used in controlling VIP aircraft and SAC operations, and special chartlets when military exercises or other operations are held in airways. The chartlets are published in the FAA Airman's Information Manual.

Instrument Approach Procedure Charts provide pilots with the information needed for orderly transition from en route flight to a landing under instrument flight rules.

Glenn Ball, chief of the Instrument Approach Procedure Chart Branch, and his staff of 48 produce and maintain 1,140 instrument approach charts for more than 1,000 airports throughout the United States and its territories and possessions.

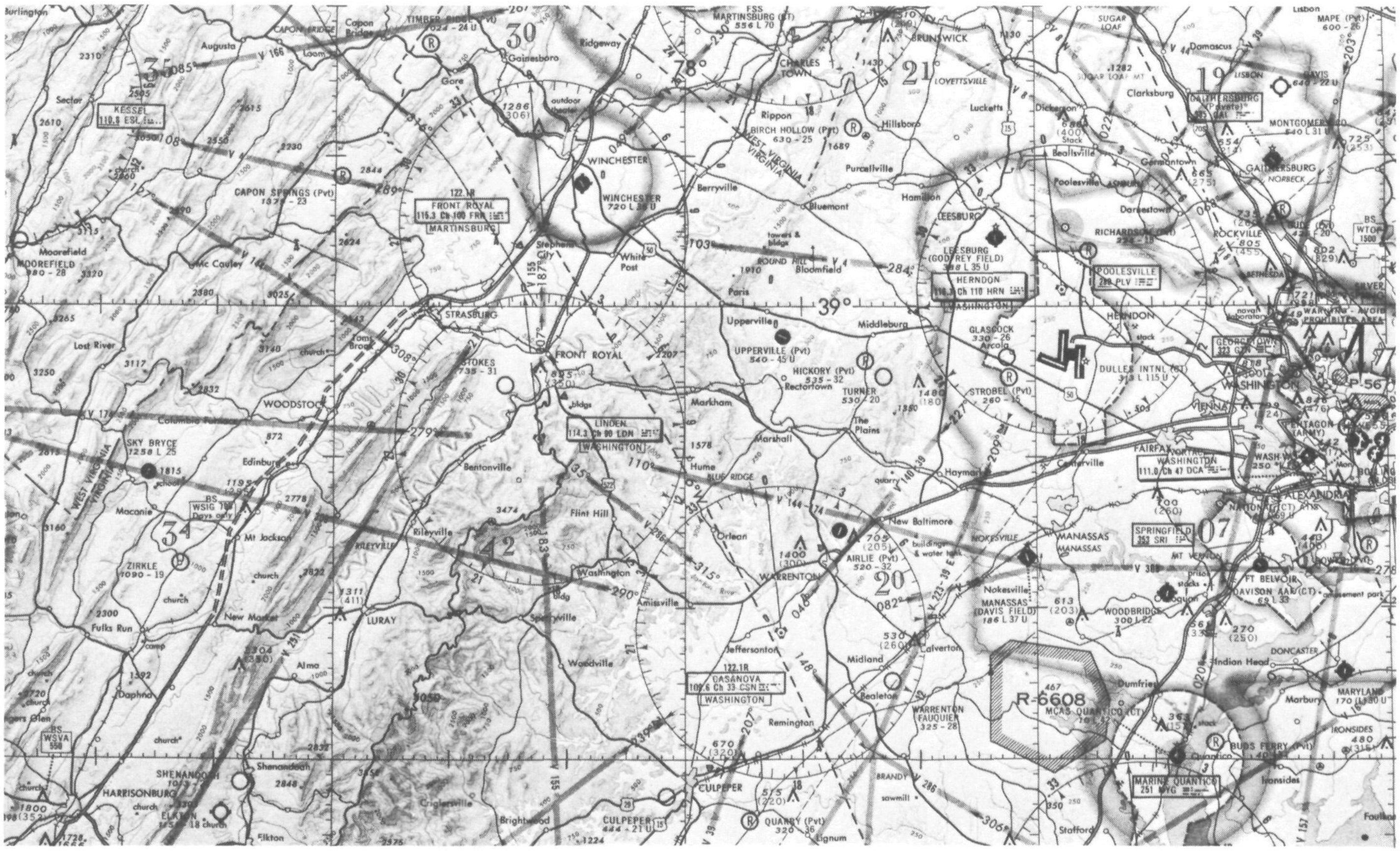
Every Thursday, approximately 60 new or amended charts are ready for printing. They must be in the hands of users by Saturday of the following week.

Essentially, these charts portray the instrument approach paths prescribed by the FAA. They include detailed information on the navigational aids which guide aircraft safely to the runways, as well as airport diagrams showing runway patterns, lengths, and widths, taxiways, rotating lights, lighting, obstructions, and minimum safe altitudes.

All of the cartographers' products are printed in the Office's Reproduction Division, where about 250 lithographers and administrative, quality control, and plant maintenance personnel work to a minute-by-minute schedule, under the direction of C. Walter Lane, Jr.

After a chart is printed, the race to meet the deadline becomes the problem of Robert D. Goodrich and the 140 people of the Distribution Division. Within four days, the charts are mailed to 30,000 subscribers. The list includes airlines, private pilots, 800 C&GS chart agents, the Survey's chart distribution offices in New York City, Kansas City, San Francisco, and Anchorage, and the FAA, which distributes charts in Alaska.

Through these sources, the pilot obtains his chart — as new as today's newspaper and as close to "zero error" as 614 Survey employees can make it. □



NEW VISUAL AERO CHART

Represents Major Advance

An aeronautical chart that simulates terrain is the greatest single advance in charting technology in two decades.

It represents the culmination of 40 years of work by the Coast and Geodetic Survey's Office of Aeronautical Charting and Cartography.

Col. Frederick O. Diercks, Associate Director of the Survey for Aeronautical Charting and Cartography, hails the new visual navigation chart as "a big step forward" in making the airways safer.

"A pilot can look at one of the new charts," Diercks explains, "and orient himself by what he sees, because the portrayal of the terrain emphasizes land forms by relief shading and includes contours, elevation tints, and spot elevations.

"The shaded relief gives the illusion of height. Instead of just the words, 'Mt. ————,' the mountain's shape and varying heights are clearly visible on the chart."

The new visual navigation chart is now in production and several of the series have already been distributed. The entire series of 37 sectional charts, covering the conterminous United States, will be completed in 1970 and will replace 87 existing sectional charts of the country which have been produced by the Coast and Geodetic Survey since 1930. The new charts are on the same scale (1:500,000). Similar charts are being issued for Alaska.

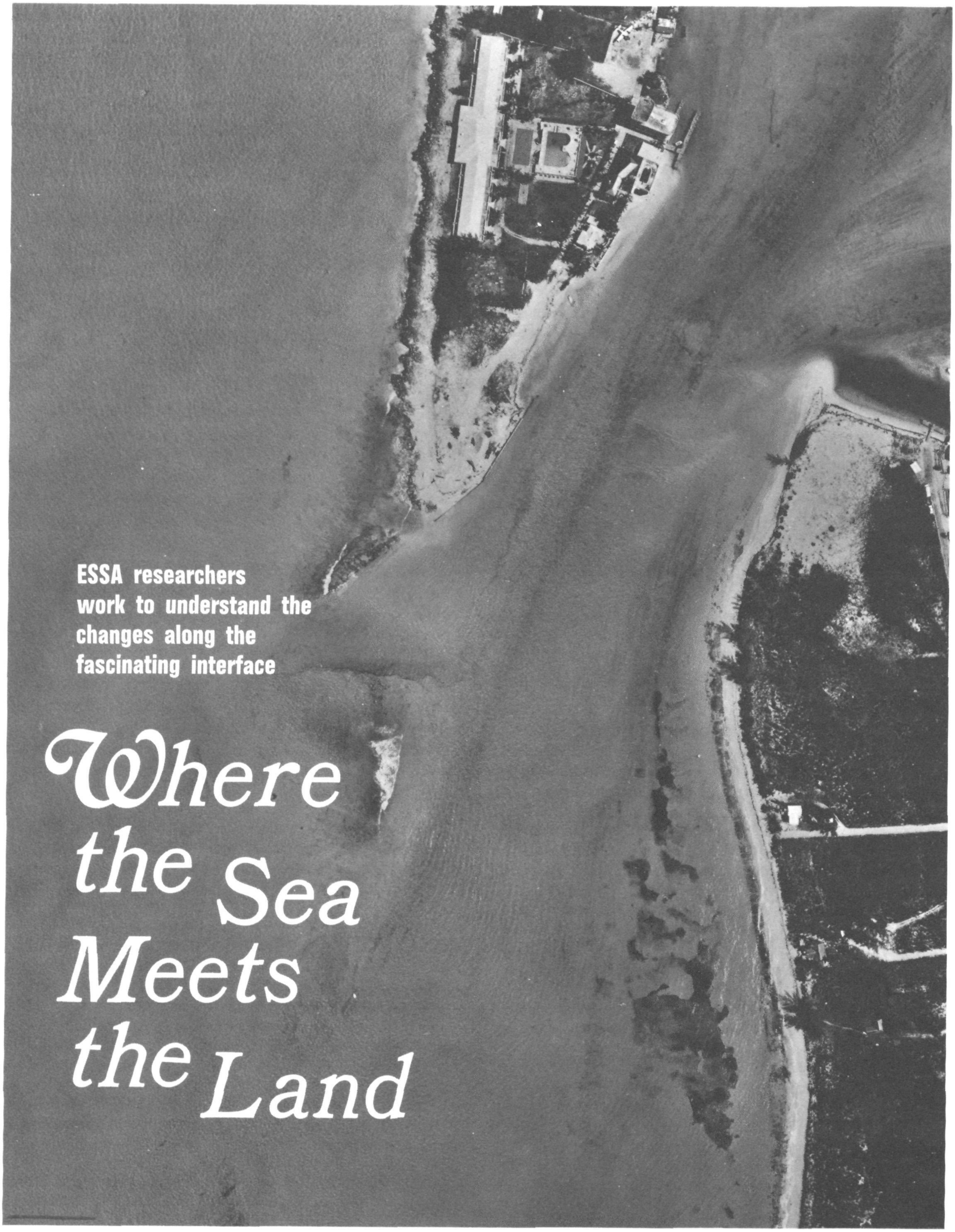
In addition to portraying the terrain by relief shading, the new visual navigation charts have other advantages.

The pilot, in preflight planning, can study his chart and select certain landmarks as check points.

He can easily determine minimum safe flying altitudes, because the charts show the highest elevation in each half-degree of latitude and longitude.

Symbols, line weights, and type faces have been chosen for legibility with a minimum of clutter. The new charts are sized and folded for more convenience and easier storage in a cockpit. They are now printed on both sides of the sheet in a way that allows easy transition from side to side and between adjoining charts.

These charts meet new Government specifications developed by the Inter-Agency Air Cartographic Committee, composed of representatives of the Departments of Commerce and Defense and the Federal Aviation Administration. Detailed specifications for the charts were developed by a task group which included representatives of the three agencies, under the chairmanship of Bernard F. Cooke, chief of the Visual Chart Branch, Aeronautical Chart Division. Prototypes for the new charts were prepared by the Division's Research Group, under the direction of Frank E. McClung. □



ESSA researchers work to understand the changes along the fascinating interface

Where the Sea Meets the Land

IN LATE August 1966, Hurricane Faith lathered the Atlantic, north of Haiti, sending powerful waves far beyond her circumscribed violence. To some — such as the swimmers who were to drown in rip currents coursing through the surf at Wrightsville Beach, North Carolina — these waves held an ominous promise. To others — like the scientists and technicians of the Land and Sea Interaction Laboratory, of ESSA's Atlantic Oceanographic Laboratories — they provided a rare opportunity for the study of exceptional breakers and their forceful effects on beaches.

On August 29, when the first waves of Hurricane Faith began to crash in on the beach at Virginia Beach, Virginia, swimmingsuit clad LASILites, led by laboratory director Dr. Wyman Harrison, were poised for action, ready to struggle into the churning surf on an around-the-clock schedule of observations that would numb them for 20 straight days. Their objective would be to amass data on winds, waves, tides, currents, and sea-water properties — enough data to permit them to explain the dramatic shift from significant beach deposition to radical beach erosion as a hurricane approaches shore.

On September 1, far to the north of Cape Cod, LASIL oceanographer Dr. Robert Byrne,* was waiting with time-lapse cameras and a series of wave gages to make photographs and electrical traces of the giant breakers that would come hulking over the outer bar near Truro, Massachusetts.

Once the mighty waves had subsided, the cast of swimmingsuit players would return to its offices for the drudgery of preparing thousands of bits of data for computer analysis. It would be nearly a year after Faith had blown through the North Atlantic that an ESSA computer would grind out an equation which would — in just one line of cryptic symbols — give a precise formulation of how hurricane waves can modify a beach. And Dr. Byrne, poring over his photographs a few weeks after the waves had subsided, would find to his amazement that the huge waves that had passed over Cape Cod's outer bar had been disturbed in such a way that somehow, without even breaking, they had each reformed into several smaller waves. His precise traces obtained from the wave gages would eventually add an important new wrinkle to oceanographers' understanding of the ways that large waves "deform" in shallow water.

* *Then of Woods Hole Oceanographic Institution.*

The foregoing illustrates the major part of LASIL's mission of putting land-sea interactions on a quantitative basis. Although formerly it was known, for example, that long, low waves tended to move sand onto a beach and that short, high waves eroded beaches, LASIL has gone the extra mile by developing equations that tell *how* long and *how* high the waves will be before beach erosion or deposition begins. Such quantitative information is vital to engineers and others whose design of coastal structures must be based upon a precise understanding of the relationships involved.

A variety of tools — some primitive, some elegant — are used to accomplish LASIL's objectives.

Lt. John Boon, assigned to LASIL from the C&GS, is working on his master's thesis in a cooperative program between LASIL and the Virginia Institute of Marine Science. He is studying the movement of beach sand using fluorescent sand grains and a "cookie cutter" on a pipe. He dumps a vial of dyed sand in the surf and then, at timed intervals, he and several Girl Scout volunteers dash back and forth into the brine to pick up plugs of sand with the cookie cutter. The plugs, marked for identification, are taken back to the laboratory where ultraviolet (black) light is shined upon them, and the fluorescent grains in each sample are counted. From these data, and information on wave activity and currents, Boon can develop equations for the speed and direction of beach sand movement under different conditions. *continued*

LASIL technician E. W. Rayfield samples hurricane surf at Virginia Beach. (Left) The inlet between North and South Bimini, B.W.I. (Right) Lt. John Boon with Girl Scout volunteers who aided research project on movement of beach sand.

Vastly more elegant that Lt. Boon's cookie cutter is the C&GS's "ODESSA" system used by LASIL in a study of the interaction between tidal currents, underwater sand waves, and the transport of fluorescent sand grains. The study was conducted in a tidal inlet between the islands of North and South Bimini in the Bahamas. "ODESSA" is a complete system of telemetering oceanographic sensors and with it LASIL monitored the inlet currents at 16 points.

In deploying the "ODESSA" system, it was first necessary to mount the sensor packages rigidly on tripods at the Lerner Marine Laboratory on North Bimini. These tripods were taken one by one on a workboat to the proper points in the inlet, where they were emplaced during slack water. Electrical cables from the sensors were then connected to recording units on shore. Once running, the "ODESSA" faithfully kept track of the speed and direction of the currents as water rushed in and out of the inlet.

The most exciting part of the inlet study involved keeping track of the movement of sand waves on the floor of the inlet. For this, it would be necessary for the LASIL workers to become "menfish." Donning SCUBA or HOOKAH gear, the oceanographers first placed a rigid, 200-foot "ruler" on the bottom, oriented perpendicular to the crests of the sand waves and made perfectly level. Then, as the current waxed and waned, flooded and ebbed, LASIL menfish made repeated runs back and forth along the ruler with underwater movie cameras. There, 20 feet down in the crystal clear Bahamian water, they trapped the motion of foot-high dunes and pearly-white sand as the sea floor undulated rhythmically along in the direction of the currents.

LASIL staged something of an underwater ballet in order to freeze the movement of individual sand grains which — by their skipping over the backs, crests, and steep fronts of the dunes — cause the downcurrent motion of the dune forms.

Choreography for the sampling runs involved a lead player who cut open tubes of fluorescent sand laid out on the bottom parallel to one of the dune crests. At precisely timed intervals, this leader would signal three other SCUBA-dancers holding paint rollers. These diver-dancers would press the roller on the bottom and glide off over a prescribed downcurrent course, unrolling a plastic film covered with silicone grease. At the end of the 60-foot-long "stage," the film was expended and the divers would kick to the surface. Another diver would then flutter to the stage and coax the plastic film up off the bottom. In a skiff on the surface, a "stagehand" would reel the film out of view of the audience of lobsters, grouper, and an occasional barracuda.

Study of the brilliantly fluorescent grains on the LASIL tapes is permitting testing of a backlog of theoretical and laboratory work on sediment transport by currents. Thus, LASIL's research program carries forward a vital environmental approach to understanding the various interactions along the boundary where the sea meets the land. □

(Right) Hurricane Faith waves attacking the shore of Cape Cod. Photo was taken on Sept. 2, 1966 at Truro, Mass., from seaside cliffs 130 ft. in elevation. The waves shown have deformed to multiple crests in passing over the off-shore bar. The waves in the foreground, about to break, are about seven feet in height. (Below) LASIL staff members set an ODESSA sensor in place at Bimini, B.W.I.

Science, service, safety—
the Coast and Geodetic Survey
delivers them in

THE TRACKLESS EMPIRE

Photo courtesy American Airlines

BY RAYMOND WILCOVE
Coast and Geodetic Survey

HALFWAY around the world after leaving the East Coast on her globe-girdling scientific expedition, the USC&GSS OCEANOGRAPHER changed hands, figuratively at least. When she reached the Indian Ocean, she began reporting to her ultimate destination, the Survey's Pacific Marine Center.

When an earthquake shakes Siberia or Chile or the Fiji Islands, the National Tsunami Warning Center in Honolulu goes on the alert. When a tide gage at the tip of the Aleutian Chain behaves strangely, seismologists at the Palmer, Alaska Observatory go into action.

These apparently unrelated events, thousands of miles apart, are a way of life for the Coast and Geodetic Survey. For the Pacific, from the West Coast to the Japanese Islands and beyond, and from Alaska to Antarctica, constitutes one of its major domains.

Here its ships, its observatories, its laboratories, its field parties, its tide stations — and the men who man them — watch over the restless ocean and its seismic "ring of fire," survey the coasts and inlets of the five American states which touch it, and probe the depths of the waters which make up the earth's largest sea.

To what end? To help protect the hundreds of millions of people who dwell along its shores and sail upon its water. To alert them to the dangers of seismic sea waves or tsunamis, generated by undersea earthquakes. To safeguard the sailor and the passenger and the ocean cargo from navigational hazards.

The Coast and Geodetic Survey, the nation's oldest scientific body, whose existence dates back to 1807, has been working in the Pacific Ocean since American jurisdiction was extended over the West Coast following the 1846-48 Mexican War. In 1867, when the U.S. took possession of Alaska from the Russians, its personnel were there. And when the Hawaiian Islands became part of the United States in 1898, Coast Survey plans for charting its waters were quickly extended 2400 miles from America's mainland.

Carrying out the activities of the Coast and Geodetic Survey in the Pacific are various facilities. Largest among them is the Pacific Marine Center in Seattle, Wash., whose Director is Rear Adm. Norman E. Taylor. PMC is operational headquarters for Coast Survey ships deployed in the Pacific. The ships engage in hydrographic and oceanographic activities. They include the DAVIDSON, OCEANOGRAPHER, SURVEYOR and PATHFINDER, all based at PMC, and the McARTHUR, based at Honolulu. Two ships under construction, the FAIRWEATHER and RAINIER, will be based at PMC after completion.

Housed at PMC also is ESSA's Pacific Oceanographic Research Laboratory, directed by Theodore V. Ryan. In Seattle also, at the University of Washington, is the Joint Oceanographic Research Group, of which Dr. Robert Burns is chief. These agencies work closely with PMC.

PMC personnel number approximately 375, including Erwin O. Kittleson, the administrative officer; Paul M. Fisher, technical assistant to the Director; Graham Mathes, chief of the Procurement and Supply Branch; Freel W. Hubbard, chief of the Personnel Branch; Lt. Cdr. George M. Poor, Acting Chief, Processing Division and Projects Officer; Capt. Gerald L. Short, chief of Operations; Henry Shek, chief of the Facilities Division; William M. Martin, chief of the Conventional Data Processing Branch; and Lt. (j.g.) Jack L. Wallace, chief of the Electronic Data Processing Branch.

The Coast Survey maintains West Coast offices also at San Francisco, headed by Capt. Raymond Stone, and Los Angeles, whose chief is LCDR Robert A. Trauschke, but their jurisdiction extends largely landward rather than seaward.

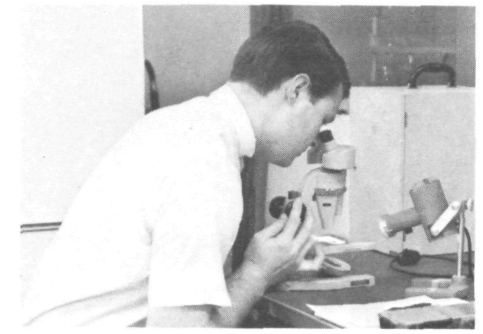
Numerous Coast Survey activities are centered at Honolulu. Chief of them are the various operations connected with tsunami warning and research. Cdr. Robert C. Munson is the Pacific Field Director in Honolulu. He also serves as director of the International Tsunami Information Center, which alerts Pacific Basin nations whenever a potentially dangerous tsunami has been generated, and is tsunami advisor to the State of Hawaii.

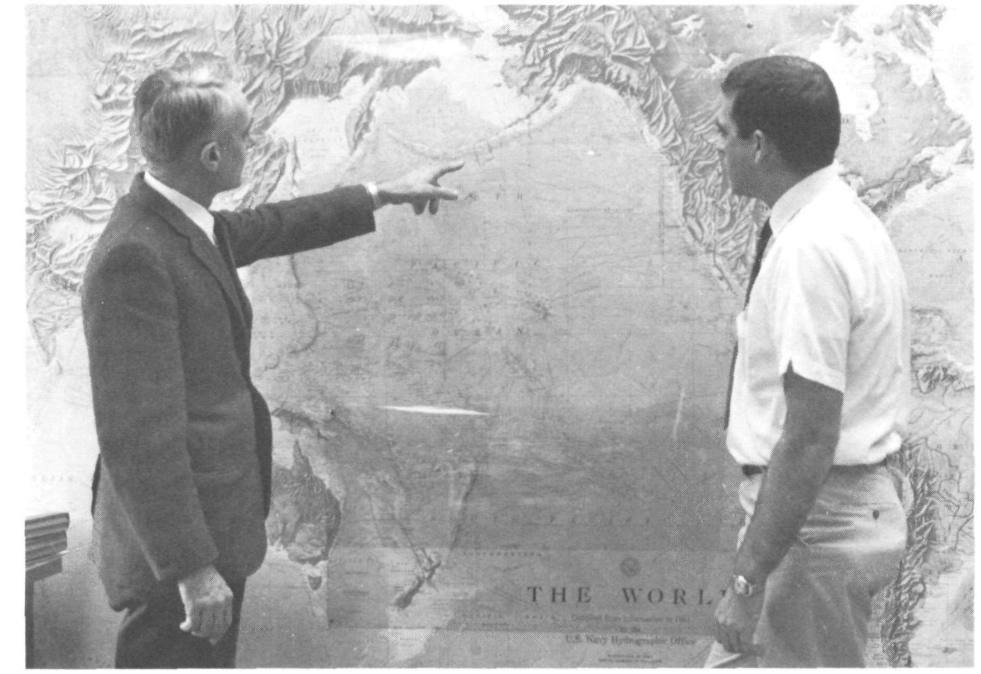
As Director of the ITIC, Munson is responsible for the operations of the National Tsunami Warning Center. The National Tsunami Warning Center, headed by LCDR James S. Midgley, consists of the Honolulu Observatory at Ewa Beach, Hawaii, nerve center of the Tsunami Warning System, and the Pacific Tide Party. The latter is responsible for the maintenance of tide stations throughout the Pacific as part of the warning system and maintains liaison between the Warning System and U.S. military authorities in Hawaii.

The Honolulu Observatory is directed by Herman J. Wirz. The Observatory maintains a 24-hour watch and reports to the Warning Center the detection of earthquake-generated tsunamis anywhere in the Pacific. It also serves as a reporting station to the National Earthquake Information Center at Rockville, Maryland. Assisting Wirz at the Observatory are LCDR Donald R. Tibbit, Ronald L. Viets, John J. Minsch, Frank K. Takenouchi, Charlotte Lacuesta and Arthur Tanaka.

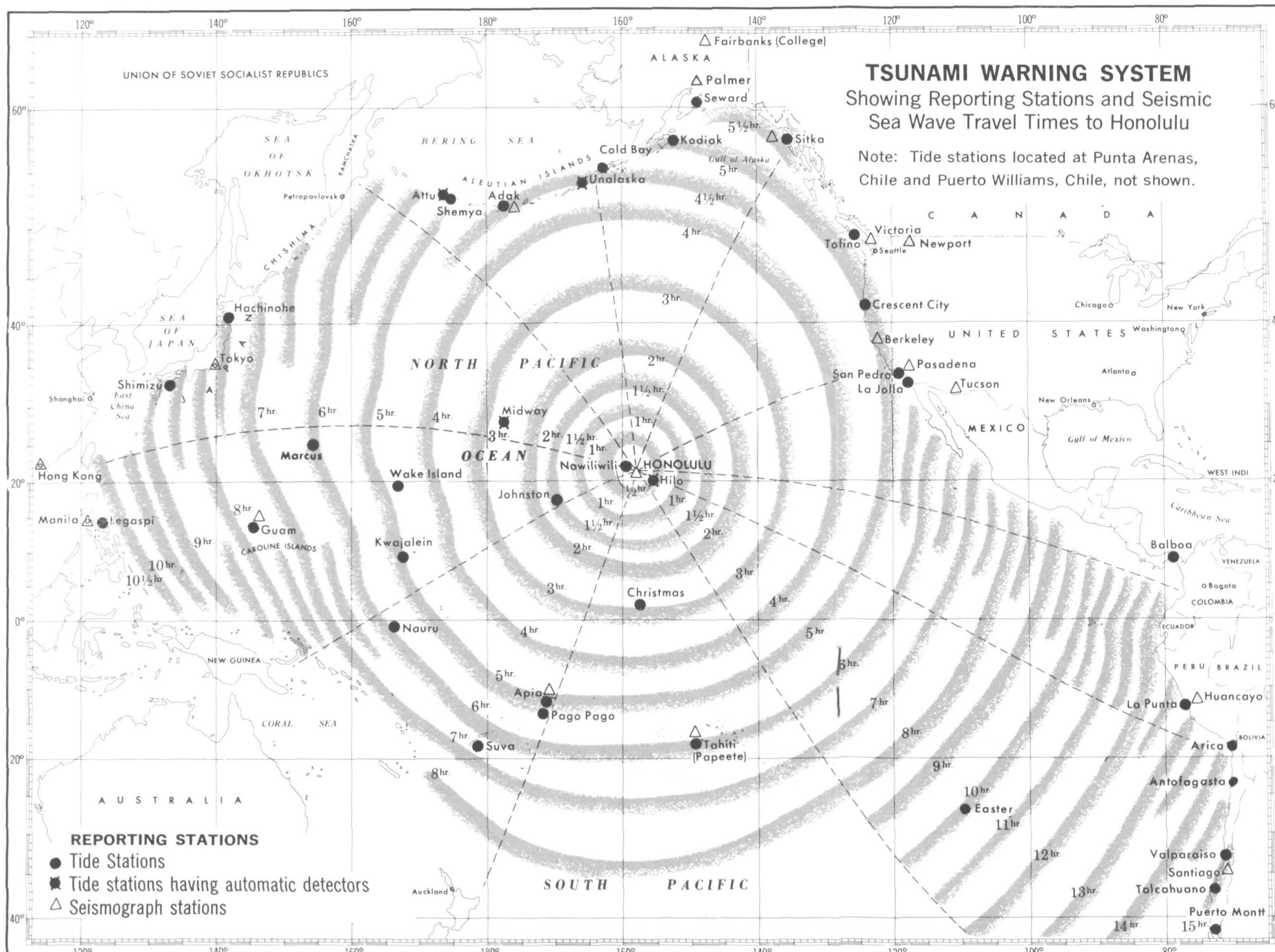
The Pacific Tide Party personnel—Lt. Richard H. Allbritton, Chief, Lt. Leland Reinke, and Mickey Moss — travel more than 100,000 miles annually in performing their tide gage maintenance program.

Munson also keeps an eye on the Joint Tsunami Research Effort, a cooperative research program of ESSA and the University of Hawaii. The group is headquartered at the Hawaii Institute of Geophysics. It is engaged in researching the tsunami's character in deep water through measurements made in the open sea and is conducting hydrodynamic studies to determine the changes which occur as the tsunami reaches coastal areas. The research group consists of Dr. Jim Larsen and Dr. Gaylord Miller, research oceanographers; Dr. Harold Loomis, research mathematician; and Thomas Sokolowski, seismologist.





Micro fossils from sediment samples are studied by Geologist Fred Naugler revealing oceanic characteristics in past geological ages. (Left) Pacific Marine Center facilities in the heart of Seattle, Washington. The moored vessels are, from left to right: PATHFINDER, SURVEYOR, BOWIE, HODGSON, PATTON and LESTER JONES. (Right) T. V. Ryan, Director of the Pacific Oceanographic Research Laboratory, discusses the west flowing Alaska Stream with Pat Laird, Physical Oceanographer.



Assisting Munson in the Pacific Field Office are Joseph K. Alina, program management assistant; George Pararas-Carayannis, oceanographer; Harold Y. Arita, clerk; Dorothy G. Hubbard, secretary; and Richard F. Hanson, surveying technician.

Warnings are issued to Hawaii, Alaska, Washington, Oregon, California, and American Samoa, and to these foreign participants: Canada, Tahiti, Japan, Taiwan, Philippines, Fiji Islands, Chile, Hong Kong, New Zealand and Western Samoa.

The warning system began operating in 1949. It consists of 18 seismological stations and 39 tide stations. The seismological stations are located at Honolulu; Apia, Western Samoa; Berkeley and Pasadena, Calif.; Palmer, Adak, Sitka, and College, Alaska; Guam, Mariana Islands; Hong Kong; Lima, Peru; Manila, Philippines; Papeete, Tahiti; Santiago, Chile; Tokyo, Japan; Tucson, Arizona; Newport, Wash.; and Victoria, British Columbia, Canada.

The tide stations are situated at Adak, Attu, Cold Bay, Kodiak, Seward, Shemya, Sitka, and Unalaska, Alaska; Crescent City, La Jolla, and San Pedro, Calif.; Apia, Western Samoa; Balboa, Panama Canal Zone; Easter Island, Arica, Talcahuano, Puerto Montt, Punta Arenas, Puerto Williams, Antofagasta and Valparaiso, Chile; Christmas Island; Guam; Hachinohe and Shimizu (Tosa), Japan; Hilo and Nawiliwili, Hawaii; Johnston Atoll; Kwajalein Atoll; Marshall Islands; La Punta, Callao, Peru; Legaspi, Philippines; Marcus Island; Midway Island; Nauru Atoll; Pago Pago, American Samoa; Papeete, Tahiti; Suva, Fiji; Tofino, B.C., Canada; and Wake Island.

An integral part of the Tsunami Warning System is the statewide tsunami network in Alaska, which became operational last September. The system permits more rapid warning to coastal areas in Alaska of impending seismic sea waves. It consists of the Palmer Observatory, the system's headquarters, and two seismic auxiliary observatories near Palmer; seismological observatories at Sitka, College and Adak; and tide stations at Shemya, Adak, Unalaska, Cold Bay, Kodiak, Seward and Sitka. The observatory is directed by Howell M. Butler. Assisting Butler are John G. Sindorf and George W. Carte, geophysicists, and Bruce W. Thompson and Wayne J. Jorgensen, electronics technicians. Field operations of the Coast and Geodetic Survey in Alaska are coordinated by the Office of the Alaska Field Director in Anchorage, headed by Capt. Howard S. Cole. □

ESSA and NASA scientists run a 100,000 mile aerial search

TO FIND A GHOST

By JOANN TEMPLE, ESSA Research Laboratories

High-flying ESSA scientists have joined with NASA to drive a "ghost" from the skies. Invisible from both the ground below and satellites orbiting above the atmosphere, it was suspected to lie about 10 miles above the earth. Sensitive scientific measurements of the sun and sky radiation had tentatively identified the "presence" as thin, invisible cirrus clouds at high atmospheres.

Earth-orbiting satellites carry infrared radiometers and spectrometers to gather data on terrestrial radiation which is ultimately translated into terms of temperatures on earth, cloud top heights, and profiles of atmospheric temperature, radiation, and water vapor.

An invisible cloud layer in the upper atmosphere would absorb some of the radiation emitted and reflected from earth, and meterological information deduced from satellite measurements could be wrong. Since a satellite viewing the earth through an invisible cloud layer could report Chicago, Tokyo, or Moscow as much as 10 degrees F. cooler than they actually are, exploring the existence and nature of any invisible atmospheric layer is extremely important to satellite meteorologists.

Of equal interest to ESSA is the possibility that changes in this layer would cause pronounced climatic changes on earth. Dr. Peter M. Kuhn, of ESSA's Atmospheric Physics and Chemistry Laboratory, estimates that if a high-level dust or haze layer persisted continuously over an area such as Denver for three out of every four days, the average temperature would rise some 1.5 degrees F. Extrapolated further, a similar temperature rise over the whole earth could have drastic effects, including increased melting of the polar ice caps, summer flooding of the coastline areas of the world, and major redistributions of rain and snow.

ESSA and the National Aeronautics and Space Administration began a cooperative study on a mutually interesting subject—the "invisible" cloud layer. NASA's Ames Research Center, Moffett Field, California, provided Dr. Helmut K. Weickmann, Director of APCL, Dr. Kuhn and his ESSA team space on the agency's Convair 990, the fastest commercial jet in the world. Equipped for scientific studies, this flying laboratory can range worldwide, cruising at 640 miles per hour at altitudes up to 41,500 feet.

Scientific instruments on the jet searched for invisible cirrus in a sky where, because of the jet's speed, the sun appeared to stand still and provided a constant radiation background. The speed of the NASA plan allowed continuous measurements over a slice of atmosphere almost 4000 miles long. After 100,000 miles of such searching for invisible cirrus, the ESSA team has concluded than when cirrus exists, it is visible.

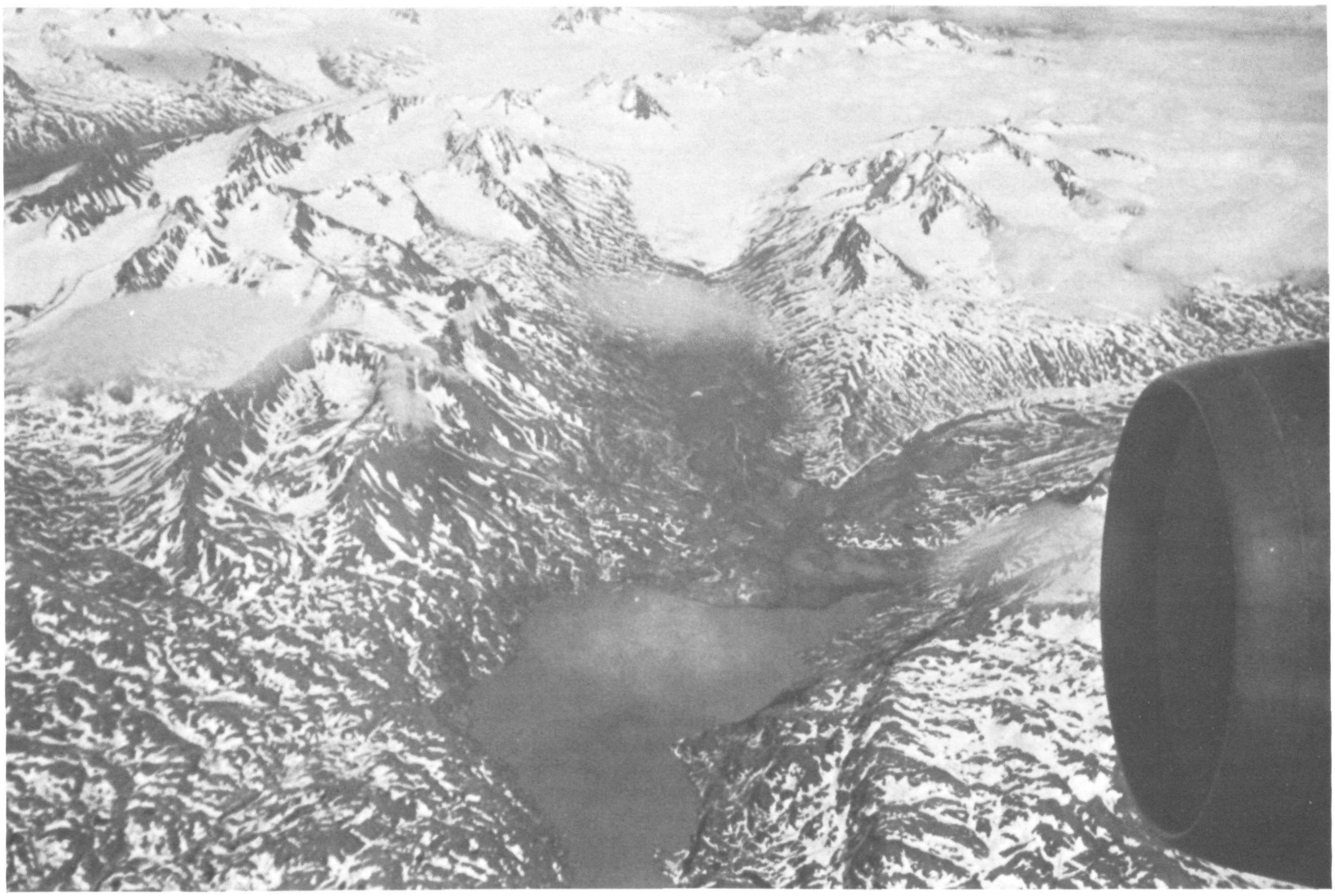
The atmospheric ghost is dead.

Yet another atmospheric phenomenon does exist which is of equal concern to ESSA. Jet contrails, volcanic ash, and towering thunderheads can influence the radiation budget and contribute to climatic changes. Volcanoes will blast ash some 40,000 feet straight through the tropopause boundary into the stratosphere. Supersonic jets inject tiny combustion particles and water vapor into this same atmospheric layer. Thunderheads stretching many thousands of feet upward can carry ice particles to extraordinary heights. Such particles, along with combustion products and water vapor at high altitudes can pollute the stratosphere and affect the "greenhouse" or heat-trapping ability of the atmosphere.

The joint NASA-ESSA project is studying the greenhouse of the earth. The "roof" of this greenhouse is low at the earth's poles and slopes upward to some 50,000 feet at the equator. Flying as close as possible to the "roof" of this invisible greenhouse, scientists can examine its structure for variations in thickness or holes. If holes do exist, they would really be heat leaks important to the atmosphere's heat balance. Unintentional changes in the stratosphere may well change the structure of the earth's greenhouse, and continuing pollution would plug natural heat leaks. More and more pollution is occurring in the stratosphere. For example, returning space vehicles disintegrate and burn in the upper atmosphere and military jets make regular treks at such high altitudes. Within a few years, commercial supersonic transports will be flying at 65,000 feet and the regular passage of such planes could spread the invisible haze, perhaps increase it, and eventually modify weather patterns on earth.

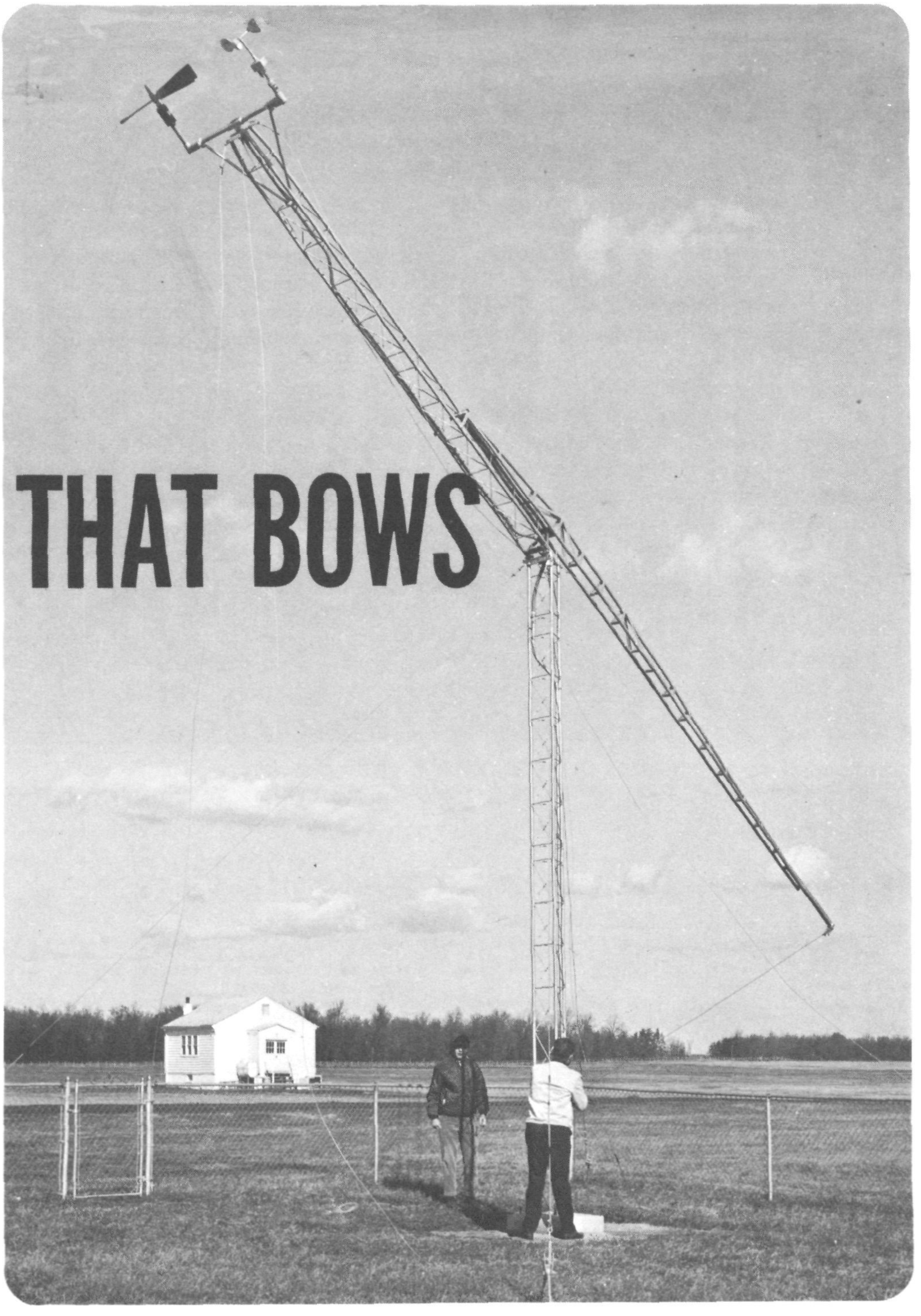
This possibility of inadvertently modifying our weather is a problem which scientists in ESSA's Atmospheric Physics and Chemistry Laboratory are coming to grips with through many projects including continuing experimentation aboard the NASA 990. □

Dr. Peter M. Kuhn (left) and Thomas Harris of ESSA's Atmospheric Physics and Chemistry Laboratory are shown here aboard the NASA 990 aircraft. Dr. Kuhn is making final adjustments in his radiometer directing mirror system which is mounted on the aircraft window insert in his lap. (Below) Thin cirrus clouds are visible here 20,000 feet above the snow-packed glaciers of Alaska's formidable Brooks Range. The NASA-ESSA flying laboratory was cruising at 37,000 feet when this cirrus was sighted.



What's New in Climatology?

THE TOWER THAT BOWS



BY PATRICK HUGHES
Environmental Data Service

THEY stand 10 meters high and bow from the "waist," bringing their instrumented heads within easy reach. The idea, of course, is to eliminate the necessity of having to climb 33 feet to service their sensors.

These special fold-over towers will be installed at most of the cooperative stations comprising ESSA's Reference Climatological (or Bench Mark) Station Network. Besides the obvious safety factor, there is the convenience of working comfortably on the ground — rather than precariously perched upon a steel superstructure where, if you forget a tool or need a part you don't happen to have with you, well . . . you're just up a tower.

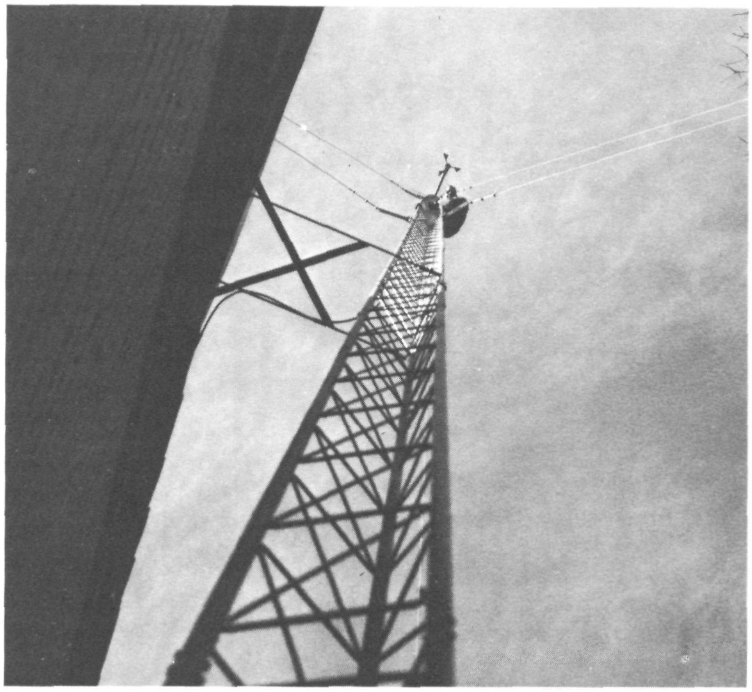
In the late '50s the Weather Bureau experimented with tilting towers but found them extremely difficult, even dangerous, to operate. Their tower, however, was hinged at the base so that the whole weight of the steel structure had to be laid down. The Environmental Data Service's fold-over tower is hinged in the middle and has a balancing boom which acts as a counterweight when the upper section is lowered (via a winch and cable). It is specifically designed for safety and ease of handling.

Each tower will provide a stable platform for a modified F104 anemometer and F005 windvane in winds up to 100 mph. EDS ordered 11 fold-over towers for installation last summer, including one for the nearby bench mark station at Sterling, Virginia.

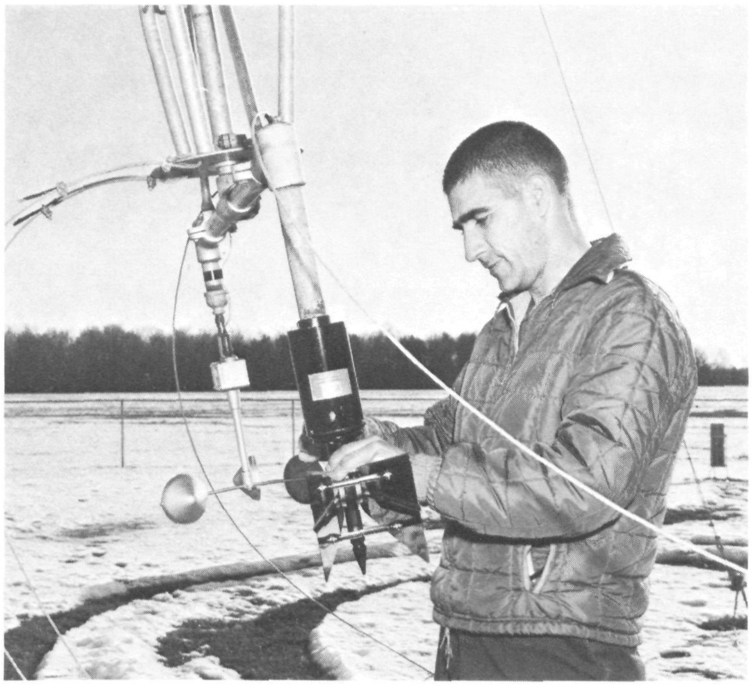
Bench mark stations are specifically selected to monitor climatic change. They are manned by cooperative observers under agreements with other Federal and State agencies, universities, farm experimental stations, and similar activities. Station sites must meet strict criteria as to stability of location and freedom from the influence of environmental changes other than climate. These criteria are not met by Weather Bureau, FAA (FSS), or special supplemental stations, which exist to serve real-time needs. The location, the environment, the observational methods, and the equipment of such stations are subject to frequent change; in the cooperative observer network also, exposures change, and urban influences increase. About half of these stations undergo one or more significant changes in less than 10 years, clouding or erasing the evidence of climatic change.

Since about 1940, a general warming trend has evidently yielded to a cooling one in most parts of the world. In the eastern United States, this trend did not set in until about the mid-50s. Now, however, it appears that we also are involved in a cooling tendency that began a decade earlier in other parts of the world.

It is essential to be able to detect these trends and to measure their magnitude. They take place very, very gradually, and many years of observations made in an undisturbed environment are required to study



Dr. J. Murray Mitchell, EDS project scientist for climatic change inspects the wind equipment atop the 70-ft. (non-folding) tower, erected in his own backyard.



With the boom completely lowered, the wind instruments are readily accessible to Dick Bollinger of ESSA's Sterling Test and Evaluation Laboratory.

them adequately. Approximately 60 well-selected and well-distributed stations (less than 1% of the total meteorological reporting system) are sufficient to sample historical climatic variations in the United States, and to serve as a primary reference network for the observations of other meteorological and climatological stations. To date 33 stations have been selected for the Reference Climatological Station Network, including one each in Alaska, the Hawaiian Islands, and Puerto Rico. More are to be added later.

EDS' Office of Field Services is charged with the collection of climatic data through the bench mark and other ESSA sampling networks. Dr. J. Murray Mitchell, Jr., of EDS' Laboratory for Environmental Data Research, as Project Scientist for Climatic Change is concerned with the nature, causes, and effects of climatic fluctuations in the past century and in earlier historical times. He is also the man responsible for the observational standards and procedures of ESSA's bench mark network. In this regard, Dr. Mitchell cites as one formidable problem, the difficulty of obtaining simple, highly accurate, and extremely durable instrumentation, commenting, "There seems to be a preoccupation with costly, complicated electronic equipment with elaborate, minute-by-minute computation capabilities — all necessary perhaps for real-time meteorological operations, but useless for the study of long-term climatic trends. As a result, there is an expertise gap which we have had to bridge, starting almost from scratch, to design simple equipment with a very good performance as regards mean time between failures."

Since each bench mark station uniquely represents a relatively enormous geographic area, missing data cannot be extrapolated from other stations. Once observations are missed, the gap in the climatological record — the standard against which other meteorological observations are to be evaluated — cannot be easily bridged.

All bench mark stations are currently equipped to measure temperature and precipitation. Eventually, the Environmental Data Service hopes to add recording instruments for these elements, as well as evaporimeters, solar and net radiation integrators, soil-temperature and humidity measuring systems and, of course, 10-meter tilting towers, each crowned with an anemometer and windvane. These latter, in turn, will be connected to a specially-developed recorder, a wind (vector component) accumulator.

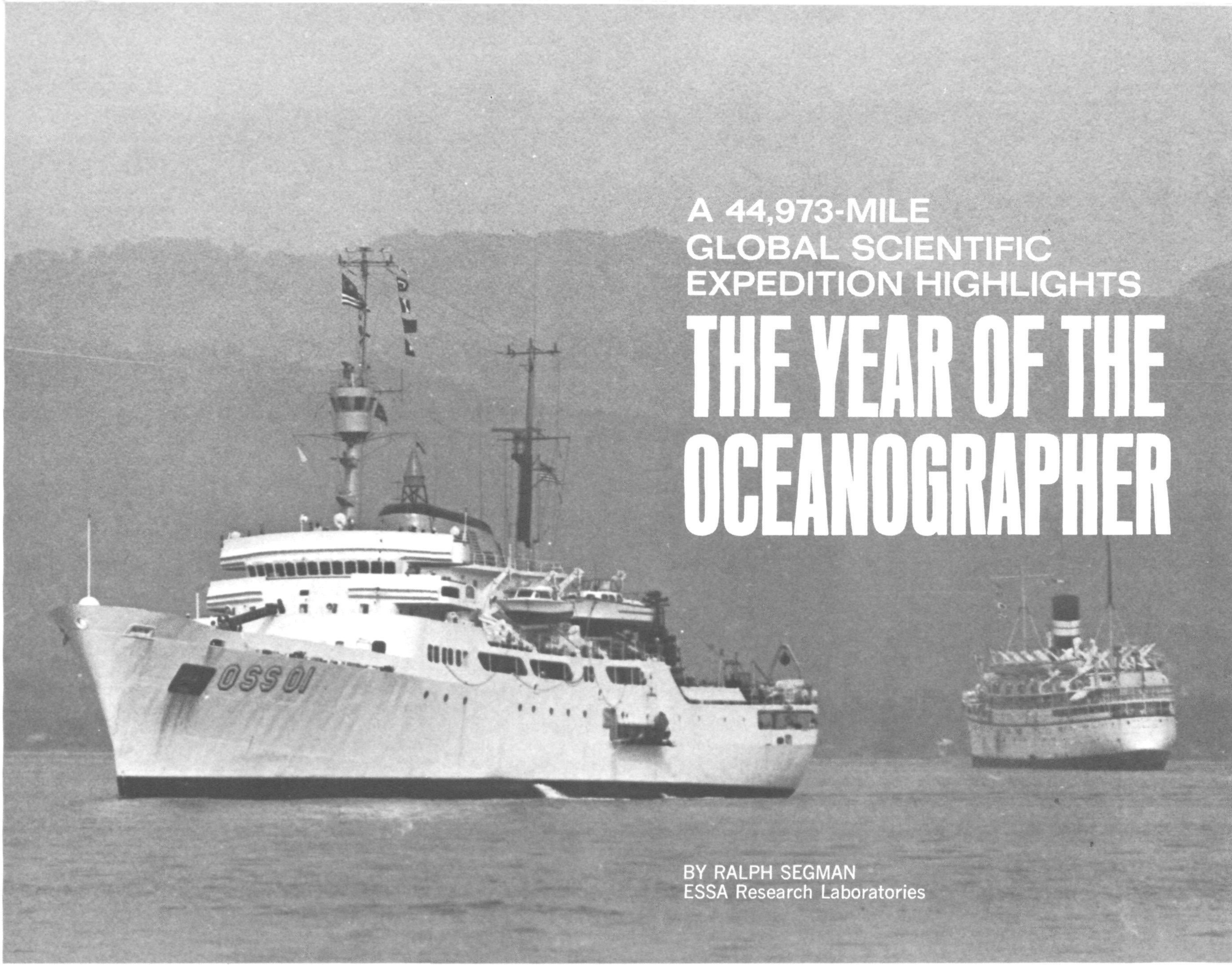
The resultant wind accumulator will automatically provide total (resultant) winds for the four cardinal points of the compass — which will be used to calculate the NET movement of air over the station — and the total air movement. These parameters will be read off once each 24 hours. The accumulator will be reset to zero on the last day of each month.

For many climatological purposes, the resultant wind is a more fundamental measurement than the mean wind and prevailing direction routinely computed at Weather Bureau Airport Stations, since it measures the mesoscale, rather than the microscale ventilation, an essential factor in the study of air-mass climatology and of such more down-to-earth environmental problems as air pollution.

Resultant winds are regularly computed from the punched cards of Weather Bureau Airport Stations by EDS' National Weather Records Center in Asheville, N.C.; these are necessarily averages of only 8 (3-hourly) one-minute visual observations per day, and their accuracy is uncertain. The accumulator-recorded resultant winds, on the other hand, represent a continuous integration of wind components over the 24-hour period. A study currently underway is designed to evaluate the computed resultant wind by comparing it with the integrated accumulator product.

In a recent study, Dr. Reid Bryson, Professor of Meteorology at the University of Wisconsin, concluded that resultant winds can be used as the basis of a highly-promising approach to climatic classification. Dr. Bryson has found it possible to correlate zones of resultant wind convergence with the boundaries between the U.S. corn and wheat belts, and with the edge of the Canadian boreal forest. In this event, the resultant wind data from a network of stations — such as the Reference Climatological Station Network — would make it possible to map year-by-year fluctuations of these climatic zones and their boundaries.

Meanwhile, Dr. Mitchell, waiting impatiently, has erected a 70-foot tower (non-folding) of his own in his backyard. On it he has mounted the same wind equipment (connected to the same accumulator) being installed at the bench mark stations. Dr. Mitchell hopes to learn quite a bit about resultant winds and about the performance of the equipment he played so large a part in developing long before the last tilting tower has been erected. □



A 44,973-MILE GLOBAL SCIENTIFIC EXPEDITION HIGHLIGHTS

THE YEAR OF THE OCEANOGRAPHER

BY RALPH SEGMAN
ESSA Research Laboratories

Photos by Gary Bailey

THE white bow hissed through cold, calm waters in the Strait of Juan de Fuca — OCEANOGRAPHER was approaching home for the first time. A low, expectant rumble rose out of the engine room. To the east stood the snowy Olympic Mountains, an inspiring vision for men who had been at sea more than eight months.

After two days at anchor off Port Townsend for a sprucing-up, USC&GSS OCEANOGRAPHER swung into Puget Sound and sailed toward her introduction to her home port, Seattle. It was December 11, 1967.

Earlier that year, March 31, OCEANOGRAPHER steamed out of Jacksonville, Florida, heading eastward toward Seattle on a global expedition that would take her nearly 45,000 nautical miles. Key people aboard were Vice Admiral H. Arnold Karo (retired director of ESSA's Coast and Geodetic Survey), who served as expedition leader and personal emissary of both Vice President Hubert H. Humphrey and ESSA Administrator Robert M. White; and Captain Arthur L. Wardwell. Chief scientists on the various legs (representing oceanographic components of the ESSA Research Laboratories) were: Dr. Robert Burns and Theodore V. Ryan, Pacific Oceanographic Laboratories, Seattle; and Feodor Ostapoff, Dr. Robert Dietz, Dr. George H. Keller, and Alfred W. Anderson, Atlantic Oceanographic Laboratories, Miami.

During the 257 days between Jacksonville and Seattle, 75 visiting scientists representing 18 nations worked aboard the OCEANOGRAPHER. The American scientists came from eight ESSA laboratories, eight other federal laboratories, and seven universities. According to Admiral Karo:

"Two things specifically surprised our visiting scientists. One was the completeness of the ship's equipment and the professionalism and competence of the shipboard personnel. Never before had they had the experience of reporting aboard shortly before sailing and being able to start their research programs within an hour or two after sailing."

In the same vein, Dr. Burns said, "The abilities of the ship's technical staff and the flexibility of scheduling enable the scientist to come aboard without elaborate preparations and without a staff of his own."

The second thing that impressed scientists, Admiral Karo said, "was the inherent accuracy of the operations, especially the knowledge of the precise location of the ship at all times. This (satellite navigation) was something entirely new . . . in the annals of scientific research at sea . . ."

Dr. Burns also praised the OCEANOGRAPHER's capability for carrying on a great variety of measurements simultaneously, such as bathymetry, geomagnetics, gravity, and seismic reflection profiling, all of them more accurate with satellite navigation. The stability of the ship allowed work to go on in seas that could swamp other ships. The 15-knot cruising speed and 13,000-mile range made the ship a more efficient vehicle for scientific investigation.

Not to be discounted was the habitability of the OCEANOGRAPHER. The roominess, showers, laundry facility, and other creature comforts helped the scientists, especially those with the constitutions of landlubbers, to perform longer hours and more fruitfully than on less modern vessels.

During what may have been the longest shakedown cruise in history, the OCEANOGRAPHER revealed some problems. Anti-roll tanks, designed to use water as ballast shifting from port tanks to starboard tanks for counteracting rolling motions, did not work effectively. The center well proved an unexpected problem to men and equipment (as one crewman put it: "Did you ever get hit on the head by a ship?") and was rarely used. Subsurface observations through the bow port became a matter of peeking between barnacles; the port was not popular among the scientists. Although the computer successfully controlled and monitored ship operations, it did not perform to expectations in processing scientific data. Despite these relatively few bugs, some of which will be corrected, the OCEANOGRAPHER was regarded by all who sailed her as a queen of a ship.

What the OCEANOGRAPHER accomplished in a purely statistical way is remarkable:

- Nautical miles traveled: 44,973
- Nautical miles of bathymetry (depth measurements): 41,766
- Nautical miles of magnetics: 32,596
- Nautical miles of gravity measurements: 35,069
- Nautical miles of seismic reflection profiles: 2,469
- Nautical miles of towing for plankton samples: 3,000
- Grab samples: 64
- Core samples: 81
- Bathythermograph (temperature) lowerings: 947
- Scientific stations (ship stops for ½ to 36 hours): 285
- Nansen casts (combined temperature and water samples): 122
- Satellite navigation fixes: 1,581
- Water samples (excluding Nansen): 580
- Meteorological radiosondes (balloon launched): 199
- Receptions of ESSA satellite automatic cloud-cover picture transmissions: 150
- Air samples: 210

Many other scientific tasks were performed, ranging from four sediment samples for bacteriological study to virtually continuous monitoring of ice nuclei concentration, atmospheric ozone, and sunshine.

The eventual measure of success of the voyage will be the amount of additional understanding of the world oceanic regions that can be attributed to the scientific program. In contrast with some of the earlier global oceanographic expeditions, few startling or unexpected discoveries were made. This is probably a strong indication that oceanography has come of age. Rather than simply exploring and stumbling onto new features and phenomena, much of our work has been directed toward getting answers to specific questions. These are questions that must be answered before we can hope to reach an objective of forecasting the behavior of the ocean, of modification of harmful aspects of the ocean, and of reaching a full development of the potential of the ocean as a source of food, minerals, and energy.

The data and samples will continue being processed and analyzed for some time to come. Some preliminary scientific findings are very interesting, however.

For example, a fracture zone, which had been suggested by seismic activity in the Mid-Atlantic Ridge, was found to cut across the ridge at a depth of 4475 meters. It was found that the central rift valley, running along the ridge, was fractured to the extent that its two faces were offset by 150 kilometers. The ridge-rift region is one of the sites of seafloor spreading, a phenomenon included in the theory of continental drift.

Passing through the Red Sea, the OCEANOGRAPHER discovered a hot spot at the bottom, the fourth such area in that sea. The first 3 hot spots were confined to a 10-square-mile area, while the "Oceanographer Deep" was discovered at a depth of 4800 feet 340 miles to the north. The ESSA scientists, led by Ostapoff on the Red Sea leg, also investigated in detail the Atlantis II Deep. Ostapoff said the temperature at the surface was 84 degrees F. and dropped off normally to 72 degrees at about 5500 feet, some 600 feet above the seabed. The temperature then started to rise with depth until it reached 118 degrees 30 feet off the bottom.

On the Penang (Malaysia)-to-Fremantle (Australia) leg, Dr. Burns and Dr. Robert Dill of the U.S. Naval Electronics Laboratory, San Diego, found evidence that sea level may once have been 1100 feet lower than it is today. The key discovery was an ancient beach at that depth off western Australia.

An extensive relic beach terrace, a little more than 500 feet below the surface, had previously been examined by Dr. Dill along southern California. In order to explain such a drop in sea level, Dr. Burns said, scientists have used the mechanisms of heavy clouding, ice ages, and ground saturation as means of keeping water away from the sea. And their reasoning gets them down about 500 feet, no more. "I wish we could say the Australian continent has subsided the remaining 600 feet," Dr. Burns said. "But it is considered a stable

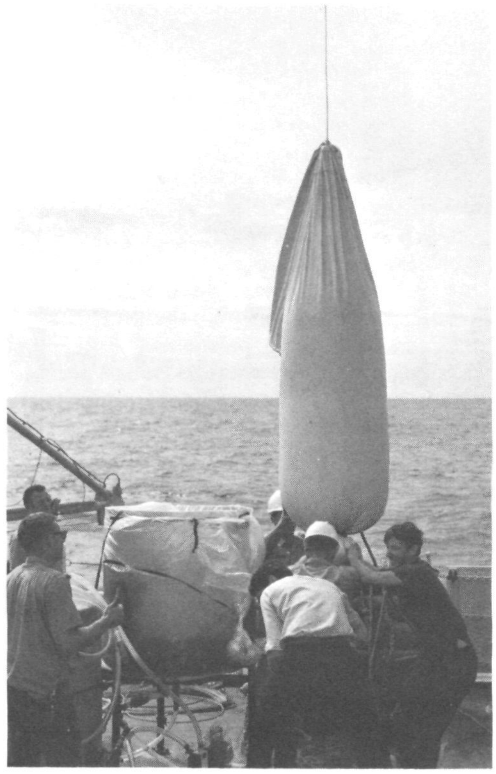
continued

Receiving Dr. Yvonne M. Freitas, University of Bombay, were Expedition Director Vice-Admiral H. Arnold Karo (Ret.) and Captain Arthur Wardwell. Captain Wardwell retired shortly after completion of expedition.

Scuba diver with a safety line, going over the side of the OCEANOGRAPHER while in the Tasman Sea, to free an oceanographic cable which became fouled in a propeller.

Clifford Milligan and Elmer Larsen, streaming a plankton net in the South Pacific Ocean. This net is towed behind the ship at slow speeds, to collect small marine creatures.

John I. Lockfaw and Lt. (j.g.) Terry C. dela Moriniere launching the STD sensor in the Arabian Sea to record continuous profile of salinity, temperature, sound velocity, and depth.



Bringing aboard the large volume water sampler. This large plastic bag is lowered to great depths to collect samples of ocean water for the purpose of chemical analysis.

land mass. It is unlikely that Australia could rise or fall anywhere near that amount."

The submerged beach terraces, including the one at the 500-foot level, suggest that at least for one short period the sea level had dropped that low. Although Dr. Dill has studied the beach terraces off California from the Deep Star 4000, one of the growing family of small research submarines, the discovery off Australia was made with a new narrow-beam stabilized echo sounder. Burns said the finding raises some questions: Is it really a beach terrace? Is it the same type as the shallower ones? Does it prove an 1100-foot drop in sea level? If so, what happened to the missing water? Laboratory analysis will be made to try to date material they dredged up from the terrace area and give them a start toward answers. Dr. Burns said he would like to drop down in a deep submersible and see the terrace for himself, should such a vehicle become available in the next few years.

One of the most hotly-contested theories in geophysics is that once there was a supercontinent riding across the face of the earth, and that this great land mass was subjected to enormous forces arising from the earth's hot plastic interior, forces that shaped today's continents and placed them where they are at the moment. Gondwanaland, which is what the theorists call their ancient continent after the Gondwana region of central India, was slowly pulled apart by these forces. Analogous forces may be seen in the surface movements of a slowly boiling pot of soup. For millions of years the pieces of Gondwanaland have drifted. Australia, India, and Antarctica are thought to be among the offspring of this hypothesized mother of continents.

The theorists differ in their views of bygone supercontinents and long-term continental drift. Basically, the views are three:

1. There was a single supercontinent, Panagea (universal continent).
2. There were two supercontinents, Gondwanaland (composed of what are now Australia, India, Antarctica, South America, Africa, and Malagasy), and Laurasia (North America, Europe, and Asia).
3. The continents remain essentally unchanged and there is no such thing as continental drift.

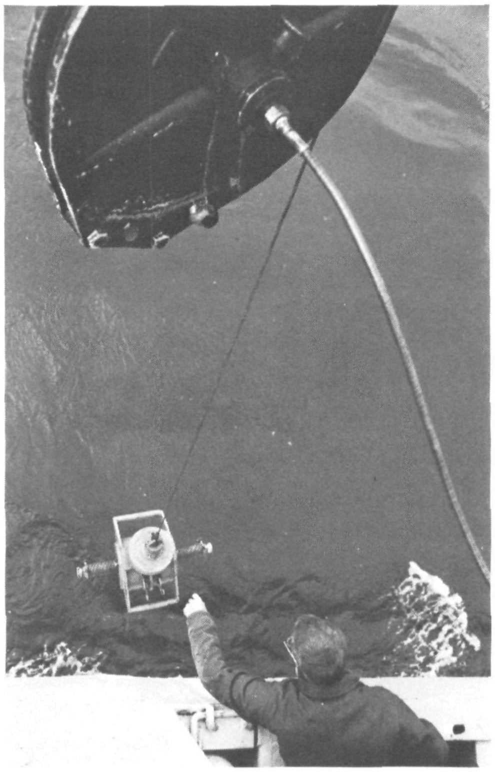
One of the advocates of the two-continent theory is Dr. Dietz, who was chief scientist during OCEANOGRAPHER's Fremantle-to-Sydney leg. In a preliminary report he said, "Existing information has suggested to me that India was once adjacent to western Australia, and Antarctica fit into the Great (Australian) Bight, with Tasmania hooking into the Ross Sea (in Antarctica)."

The major objective of Dr. Dietz' survey was to delineate roughly the true western and southern continental margins of Australia. He believes the margins lie off-shore at a depth of 6000 feet. Once these edges are mapped they can be matched against those of the sibling continents to see if there is a close fit.

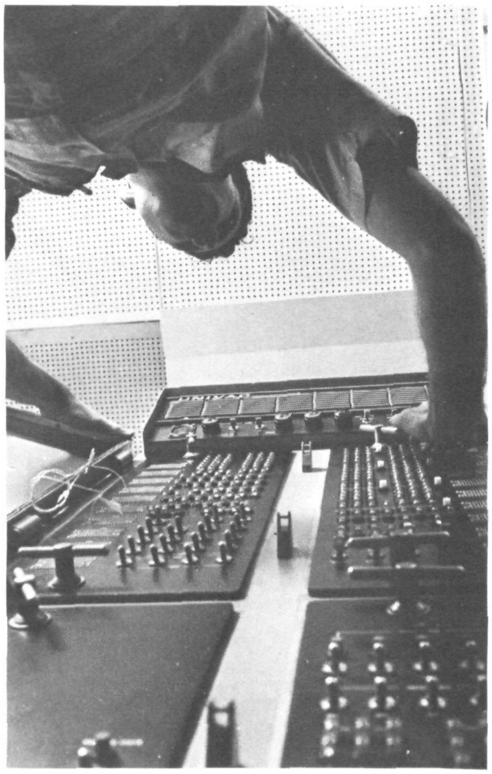
"It is premature to comment with certainty on our results," Dr. Dietz reported. "My first impression is, however, that we have enhanced the goodness-of-fit of this jig-saw puzzle in relation to the critical (6000-foot) contour."

Other information that was collected by Drs. Burns and Dill during the OCEANOGRAPHER's previous leg, covering part of the western Australia continental margin, may prove something of a problem to Dietz, who had requested that they make measurements for him. Drs. Burns and Dill found four different types of continental margin, varying from a simple "chopped-off" edge, through two transitional types, to a gradual slope. Dr. Burns feels that the Dietz hypothesis accounts only for the chopped-off variety of margin. He points out that the findings he made with Dill do not "shoot down" the Dietz theory, but may call for minor modifications.

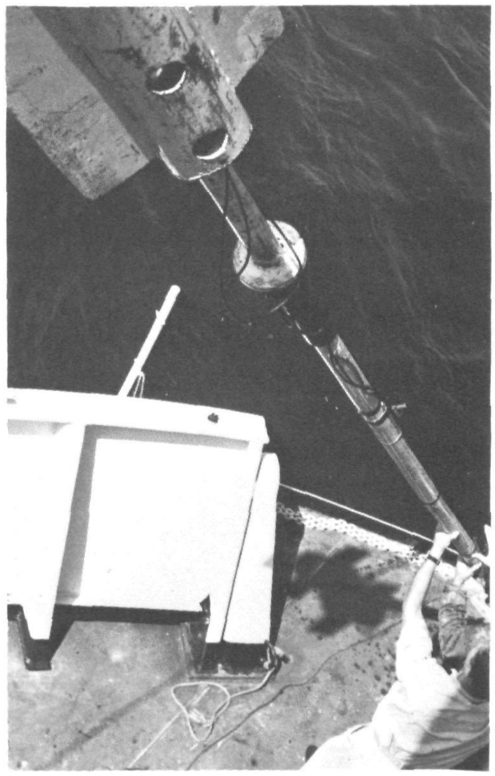
Drs. Dietz and Burns both were ecstatic about the precision they were able to reach



Technician lowers a grab sampler in the Andaman Sea. This spring loaded device scoops up a sample from the ocean bottom as soon as it makes contact.



Crew member checking computer which is used for data collection and processing. The computer is also used for monitoring engine room operations.



Launching heat probe in the Tasman Sea, between Australia and New Zealand. Probe measures temperature variation near ocean bottom and returns with core sample.

using the OCEANOGRAPHER's navigation system. Said Dr. Dietz: "With satellite navigation, the greatest breakthrough in deep sea navigation since the compass and the chronometer, we can determine our position within two-tenths of a mile."

There is some promise that within the next decade, improvements in geodetics and satellite navigation will bring the accuracy to a few centimeters. Should such precision come to pass, earth scientists will be able to settle the continental drift question by direct measurement, since proponents of the theory estimate that the continents move ½ to 2 centimeters a year.

A team of American, Australian, and New Zealand scientists, headed by the Sydney-Wellington leg chief scientist Ryan, discovered a north-flowing countercurrent under the East Australian Current (EAC). They also found a ribbonlike layer of warm water lying across the surface of the EAC. Ryan feels that these two previously unknown features will have a significant bearing on our understanding of circulation balance and heat transport in the Tasman Sea. In addition, Paul Grim of the Pacific Oceanographic Laboratories, analyzed heat and magnetic data indicating that the bottom of the Tasman Sea, suspected of being a site for seafloor spreading, is now inactive.

The nearest approach to exploration (as opposed to oceanographic experimentation) was made during the Wellington-Valparaiso leg, under the scientific leadership of Dr. Keller. The OCEANOGRAPHER sailed straight along the 35 degree South latitude, a little known region of the Pacific Ocean, making a continuous bathymetric, magnetic, and gravity profile.

The bottom was considerably more rugged than anticipated during the eastern two-thirds of the crossing. Twenty-five seamounts ranging up to 11,000 feet above the ocean floor were discovered, and this was only along the 35th parallel. Few abyssal plains were discovered. And unexpectedly hard bottom sediments were found when coring was attempted.

Another finding by Dr. Keller's scientists was a series of steplike fractures in the seabed. The heights of the steps ranged between 900 and 1200 feet. In each case, seamounts were associated with the zone of uplift, an unusual relationship.

What the OCEANOGRAPHER's scientists have done will fill volumes; the above accomplishments are only early highlights of the expedition. More will be published in scientific journals around the world, month by month.

And as Admiral Karo said:

"Scientists — our own and the invited foreign and American — come and go, but the ship and her operating crew, technicians, and officers continue on. They and the ship were the backbone and the real heroes of the expedition."

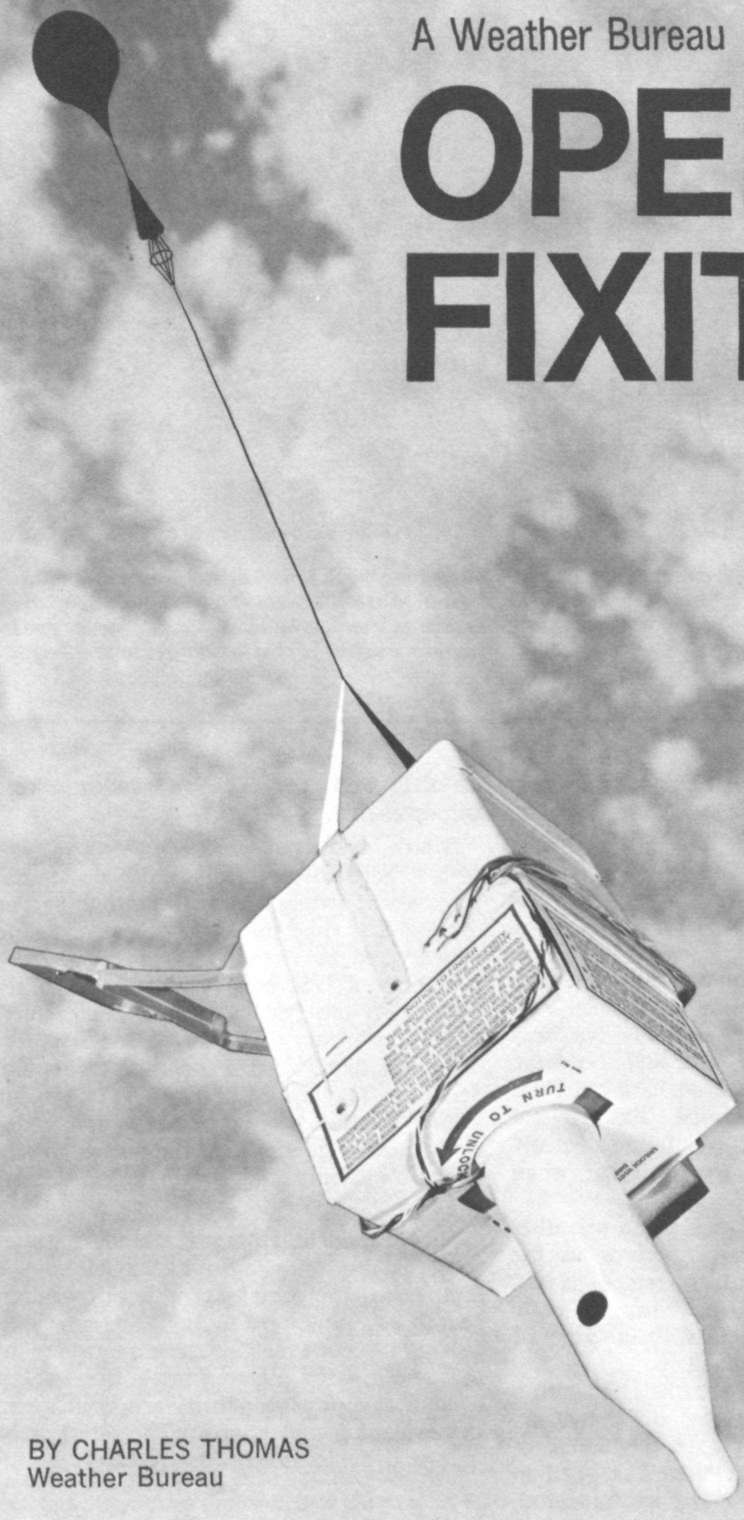
Seattle chose to greet OCEANOGRAPHER with a hero's welcome. As the sleek, majestic vessel swung around her home harbor for the first time in her young career, she was greeted by sirens, a floating geyser of a fireboat, a U.S. Navy hydrofoil, and fireworks. At the Pacific Marine Center pier, there were plenty of warm reunions. Everybody was happy. At a dockside ceremony, Senator Magnuson (Washington), Dr. White, Seattle Mayor Braman, and other distinguished guests had kind words to say about the ship and all who sailed aboard her.

Vice President Humphrey made a statement as the ship began its global voyage that is as appropriate now as it was on March 31, 1967. He said: "Your new ship OCEANOGRAPHER has no peer anywhere in the world. She demonstrates the vitality of our government-industry-academic team in developing and applying the latest technological achievements for research. . . .

"We will await your return to Seattle, confident that our hopes and aspirations will be fulfilled, confident that an ever-growing number of nations will join with us in extending the frontiers of the unknown, and confident that the oceans will provide us with new bounty to sustain all mankind." □

A Weather Bureau Center Saves Taxpayers' Funds in

OPERATION FIXIT



The small, weatherbeaten white box was battered and recent rains had all but obliterated the legend printed on its side, but it had a scientific look about it, with its molded plastic sections and protruding color-coded wires. More curious still, it was attached to a little parachute.

So the group of boys who came upon it while hiking in Oregon's Crater Lake National Park took it home, deciphered the faded instructions, and dutifully mailed it to Joliet, Illinois. In doing so they unwittingly became part of a Weather Bureau program which is saving the American taxpayer over $150,000 each year.

The box found by the boys was a Weather Bureau radiosonde, a balloon-borne instrument which measures temperature, atmospheric pressure, and humidity as it rises through the air, and relays this information back to the ground by a small, built-in radio transmitter.

The radiosonde is the heart of the Weather Bureau's upper-air observation program. More than 300 are launched from stations around the world each day. Most are lost forever as they fall into the sea and in remote or uninhabited areas. But 25 percent, like the one found in the Oregon park, find their way back to the Weather Bureau, and, through the Bureau's Reconditioning Center in Joliet, can be flown again. (One record-making radiosonde was flown, recovered, and reconditioned seven times.)

The average cost to recondition one of

BY CHARLES THOMAS
Weather Bureau

these radiosondes is $6. A new one costs around $15. The Weather Bureau's Engineering Division, under which the Joliet Center operates, estimates it has saved the Bureau $3 million on radiosonde reconditioning alone since the program began 22 years ago. The number of these instruments reconditioned during this period approaches the 400,000 mark.

Radiosonde reconditioning is just one facet of the Center's mission.

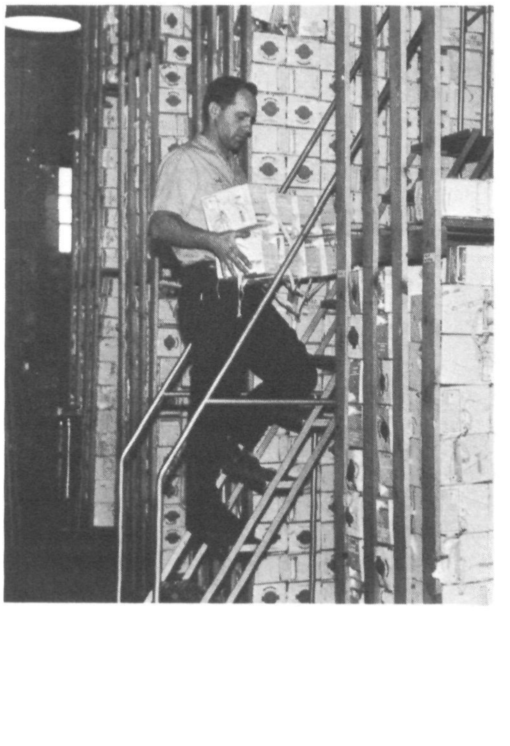
In 1964, during a major reorganization of the Weather Bureau just before the formation of ESSA, the Joliet facility opened its Instrument Branch and began reconditioning a variety of other weather instruments. While some repair jobs are still done in the Engineering Division at the Weather Bureau's Silver Spring headquarters, this type of work, for the most part, has been consolidated at Joliet. The Center has taken over the responsibility for 91 components including instruments ranging in complexity from thermometers to radar systems.

The Reconditioning Center's staff, headed by Glenn M. Miller, a 29-year Weather Bureau veteran who has been in charge of the facility since it opened in 1945, includes a twelve-man radiosonde group, a three-man instrument unit, and three administrative personnel.

At Joliet, "reconditioning" means much more than replacing a worn shaft or resoldering a broken electrical connection.

After initial troubleshooting checks and more obvious repair work is completed, each piece of equipment is carefully inspected and tested. In many cases, the instruments require elaborate calibration. A number of components must undergo rigid tests in the Center's versatile environmental chamber which is capable of producing practically any combination of air pressure, temperature, and humidity. In short, every effort is made to make each piece of equipment like new before it leaves the Center; right down to the removal of any oily fingerprint from the casing of an outgoing radiosonde. □

Wayne N. Storch calibrates radiosonde pressure units in the environmental simulator. (Left) Joseph R. Gnavi, Xavier L. Ezell and Wyan N. Stockdell in the production line operation that speeds radiosonde reconditioning. (Below) Verl L. Stockdell adds to the supply of overhauled radiosondes that will fly again.



ESSA scientists capture the oceans and atmosphere in the

COMPUTERIZED ENVIRONMENT

BY ANN K. COOK

Temperatures in the stratosphere are rising, higher and higher. It is a simulated stratosphere, part of the Geophysical Fluid Dynamics Laboratory's latest mathematical model of the atmosphere's general circulation.

Puzzled, Dr. Syukuro Manabe examines the computer printout, mentally reviewing possible errors in the model's theories or in the program.

But there is no error. The model, he finds, is simulating one of the sudden warmings which occur in the actual stratosphere.

Laboratory scientists have come another step closer to developing a model — a structure of physical laws translated into mathematical equations — which faithfully reproduces the behavior of the earth's atmosphere and oceans.

Dr. Manabe heads the Laboratory's general circulation project. Another group, led by Dr. Kirk Bryan, is developing models of ocean circulation. Together, Bryan and Manabe and their staffs are working on a more comprehensive model embodying the combined behavior of air and sea, the earth's fluid envelope. Another major area of the Laboratory's research, an experimental prediction project using real data, is directed by Dr. Kikuro Miyakoda.

Dr. Joseph Smagorinsky has been Director of the Laboratory since its creation in 1955. Originally part of the Weather Bureau, it is now one of ESSA's Research Laboratories. Through the years, its staff has grown from two to more than fifty, and thirteen of these hold doctorates.

"Our goal," says Dr. Smagorinsky, "is to expand man's basic knowledge of the atmosphere and oceans, by expressing accurately the physical laws which govern their behavior.

"When we have a framework which is capable of reproducing and simulating the evolutions of the atmosphere and the oceans, we can use this framework to learn just how far in advance their behavior is predictable. The next logical step is to use these mathematical frameworks to make predictions."

In the meantime, the Laboratory's work continually produces results with practical applications in operational computer forecasting. The staff works closely with the Weather Bureau's National Meteorological Center, which conducts the operational program. (The National Meteorological Center performs research in the development of numerical models which provide guidance for the service forecasters.)

In constructing their mathematical models, the Laboratory scientists select a system of physical laws that are assumed to govern the movements and evolutions of the atmosphere or the oceans or both. The physical laws are expressed in terms of differential equations; these are analyzed numerically and programmed as computer instructions.

The computer is also provided with information on the state of the air or sea at the time the experiment begins. Except in the experimental prediction project, synthetic data is used.

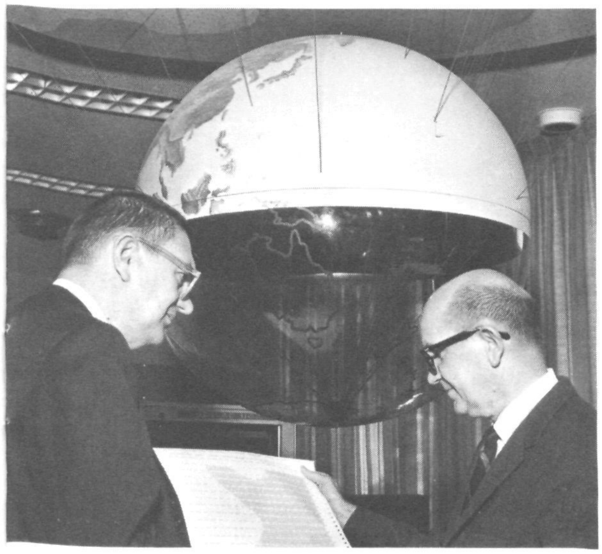
Primed with instructions and information, the computer solves the mathematical formulas, calculating the movements of the fluid in a series of time steps. It makes a forecast for the first time interval and uses the result to proceed to the next interval, for as long as the experiment continues. For purposes of calculation, the earth is divided into rectangular grids, and the equations must be solved at every point on the grid for every time step.

The first model ever developed in the Laboratory described the motions of the atmosphere between the Equator and 64° North latitude, on just two vertical levels and at only 1300 points in each level. Simple as it was, this early model successfully accounted for some of the most important large-scale properties of the atmosphere's wind systems and middle latitude storms, and the role both play in maintaining the heat balance of the atmosphere.

Today, the most complex models describe the changes in four variables—wind speed and direction, temperature, and humidity—at points about 170 miles apart around the globe and on 18 levels. Thus, the computer has more than 700,000 pieces of information—four for each of 180,000 points on the surface or in the atmosphere. To simulate a single day's weather, the computer must perform more than 40 billion operations. An experiment of this complexity requires 50 percent longer than the simulated time—36 hours for one day's weather. Small wonder that the Laboratory's two powerful UNIVAC computers are kept busy around the clock.

"There are two main and crucial obstacles to further scientific development and to its full and rapid exploitation for practical application," Dr. Smagorinsky points out. "One is computational. Computers must be at least 100 and possibly 1000 times faster than the best in existence today.

"The other is lack of data. The structure of the global atmosphere and oceans must be better defined through observation.



Howard Engelbrecht (left), director of the computational facility, and Roderick Graham, executive assistant to the GFDL director, examine the latest computer results.

Joseph L. Burns operates a console in the laboratory's computer facility.

"For predictions of a week or longer," Dr. Smagorinsky says, "data from the entire global atmosphere and in the oceans are necessary. The models must be of full general circulation complexity. Indeed, for such time spans, and longer into seasons, it will be unavoidable that dynamical models for the entire fluid envelope of the earth be used."

Many research projects underway in the Laboratory anticipate future modeling needs. These include studies of the processes involved in formation of fronts, as well as basic investigations of the dynamics of thermal convection, to understand why cumulus and thunderstorm clouds form and how they modify the atmosphere. Special observational studies are made of global data to establish the important structural properties of the atmosphere and oceans.

The increasing accuracy of general circulation models, together with the advent of weather satellites, provided the impetus for the World Weather Program. Forecasting daily weather changes far in the future demands the ability to simulate, by means of computer, the behavior of the atmosphere over extended periods.

The models can also aid in determining the most effective and economical observing network for the World Weather Watch. They can be used in assessing the effectiveness of various observing platforms and techniques, and the potential benefits to be derived from data of different kinds and densities.

In support of the World Weather Program, the Laboratory is developing an experiment in global weather prediction, using actual data gathered in March 1966. One purpose of this experiment is to estimate the penalty of existing deficiences in the observing system, such as the scarcity of data from the Southern Hemisphere.

The Laboratory's computers are humming with experiments to determine how far in advance the atmosphere can be predicted. According to Dr. Smagorinsky, these sophisticated models demonstrate that the ultimate limit of predictability of individual large-scale storms is definitely longer than two weeks and perhaps longer than three.

When theoretical models have become accurate enough to be used in prediction, they can also be applied to investigations of weather modification, inadvertent as well as intentional. Where and how is the atmosphere sensitive to external influences? Could its behavior be altered with the relatively small sources of energy available to man? Through simulation in the theoretical models, the scientists may learn what would happen to world weather and climate if, for example, artificial clouds were created to reflect more sunlight away from the earth; if more carbon dioxide were released to the atmosphere; or if more forests were converted to agricultural land or cities.

The models have a variety of other potential applications, such as studying the large-scale dispersion of pollutants in atmosphere and oceans.

The modeling techniques originally developed to simulate the large-scale atmosphere and oceans are expected to be fruitful in attacking related problems. They can logically be applied to the motions of the higher atmosphere, where magnetic and ionization effects are important. They can also be used to study, understand, and predict the character of the atmospheres of other planets and even, perhaps, the sun.

In September 1968, the Laboratory, its staff, and its computers are scheduled to move from Washington to a new home on Princeton University's James Forrestal Campus. "The move to Princeton," says Dr. Smagorinsky, "will provide an opportunity for our research workers to participate in the academic process and to enhance their productivity and diversity, while contributing to the training of creative scientists." □

Dr. Miyakoda (right) and Daniel Hembree examine a computer portrayal of hemispheric circulation. (Photo right) Dr. Bryan, Dr. Manabe, and Dr. Smagorinsky confer on plans for a model of the combined behavior of the atmosphere and ocean.

essa NEWS BEAT

Three months and 20,000 miles —

USC&GSS DISCOVERER MAKES ATLANTIC VOYAGE

The Coast and Geodetic Survey Ship DISCOVERER early this year was engaged in a three-month, 20,000-mile expedition, gathering information from the depths of the South Atlantic.

The expedition was part of a long-range deep-sea scientific program by the Environmental Science Services Administration, parent body of the Coast and Geodetic Survey in the U.S. Department of Commerce.

It took the ship from Miami, Fla., to Tristan da Cunha in the South Atlantic to deliver the personnel and equipment of a Coast Survey satellite triangulation team; to the west coast of Africa, including Dakar (Senegal), Abidjan (Ivory Coast), and Cape Blanc (Mauretania); then back across the Atlantic to Cape Hatteras and return to Miami. The ship left Miami January 4 and was scheduled to return April 2.

During February and March, as part of its geophysical investigations off the west coast of Africa, the DISCOVERER searched for evidence that the continent might once have been connected to North America as part of an ancient supercontinent.

Dr. Robert S. Dietz, a research oceanographer at ESSA's Atlantic Oceanographic Laboratories in Miami, was chief scientist during the west African portion of the trip.

Similar surveys were made last year along the east coast of South America and off Australia by the USC&GSS OCEANOGRAPHER, sister ship of the DISCOVERER. Both ships are highly automated and equipped with sophisticated electronic oceanographic equipment.

The DISCOVERER, which is commanded by Captain Lorne Taylor of Okanogan and Seattle, Wash., also conducted extensive geophysical surveys during her trip along the South American coast and in the South Atlantic.

1967 Spectacular Weather Year

Hurricanes, tornadoes, floods and snowstorms, some of record proportions, highlighted the Nation's weather in 1967, according to the Environmental Data Service.

A total of 837 tornadoes raked the United States, causing 117 deaths and many millions of dollars in damage. It was the third worst year in recorded history for these deadly storms, topped only by 1965's record 898 and the 864 reported in 1957.

Tornado deaths were reported in the following states: Illinois, 59; Minnesota, 14; Missouri, 8; Mississippi, 7; Texas, 7; Alabama, 5; Oklahoma, 4; Iowa, 3; Kansas, 2; Florida, 2; Tennessee, 2; Wisconsin, 2; Maryland, 1; Louisiana, 1.

The North Atlantic hurricane season got off to a slow start, but when it had ended, the toll was 68 dead and damage estimated at $208 million. Six hurricanes roamed the Atlantic waters but most of the grief and destruction was caused by one — Beulah. With winds reaching 150 miles an hour and rains causing devastating floods, she dealt all but nine of the 68 hurricane deaths during her 18-day lifetime.

The American Red Cross made the following breakdown of the damage: homes — 542 destroyed, 25,890 damaged. Mobile homes — 198 destroyed, 477 damaged. Farm buildings — 607 destroyed, 1146 damaged. Boats — 110 destroyed or damaged. Small businesses — 520 destroyed or damaged. Much of the damage came from record-breaking flooding from rivers and streams south of San Antonio, Texas. Weather Bureau warnings were credited with saving a large number of lives.

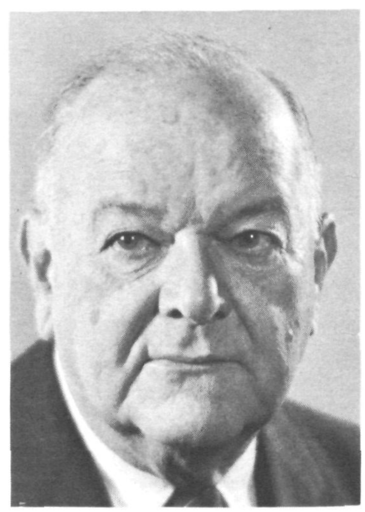
The other 1967 Atlantic hurricanes were Arlene, Chloe, Doria, Fern and Heidi.

However, there was a 74 percent reduction, worldwide, in the number of earthquake fatalities compared to the previous year, with 796 fatalities from 16 shocks in 11 countries. The United States had no earthquakes deaths in 1967, although 296 earth tremors were felt in this country.

Severe flooding and harsh winter weather were experienced in numerous areas of the country.

But the weather was not all bad. Drought conditions in the West and Northeast were considerably eased, and rainfall was adequate for agriculture.

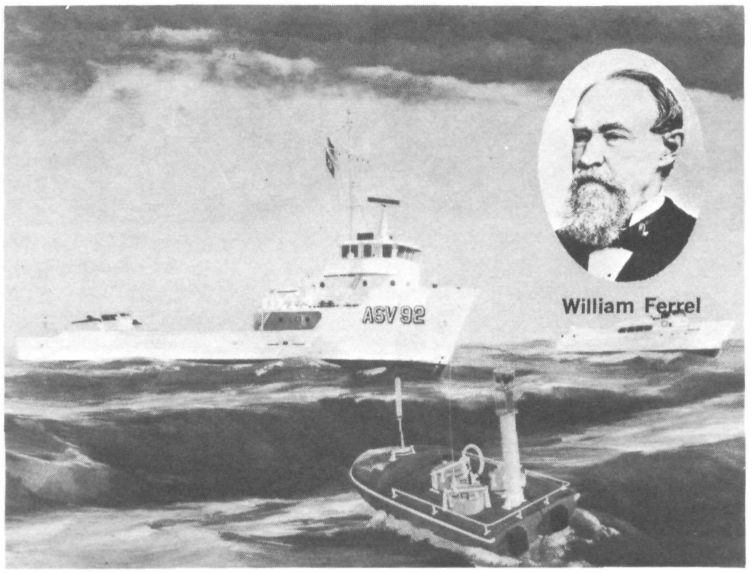
New Secretary Of Commerce



Appointed Secretary of Commerce by President Johnson is C. R. Smith, former board chairman of American Airlines. He succeeds Secretary Alexander B. Trowbridge, who resigned.

Survey Pioneer Honored

Auxiliary Survey Ship, Ferrel, Slated



An auxiliary survey vessel under construction for the Federal Government will be named in honor of Professor William Ferrel — a pioneer scientist of the 19th century who contributed greatly to the knowledge of tidal phenomena.

The 133-foot, 289-ton ship will be used in a program to determine circulatory current patterns in the coastal and estuarial waters of the east and gulf coasts. The first vessel to be built in the United States specifically for such investigations, the FERREL and her 59-foot auxiliary buoy tender will be operated by ESSA's Coast and Geodetic Survey.

The FERREL will serve as the base ship for the TICUS (tidal and current survey) system, a current station assembly and central base monitoring and recording system developed by the Coast and Geodetic Survey. She will receive telemetered information from the TICUS buoys, tend the buoy systems, and transport the equipment from site to site.

The auxiliary tender will perform additional functions which cannot be accomplished by the deeper-draft survey vessel. These functions include adjustment, repair, and relocation of buoys and their electronic sensors after the initial installations have been completed. Of the FERREL's complement of 16, four will man the auxiliary tender.

A device of a special design never employed before for vessels of this size will enable the auxiliary tender to moor alongside the FERREL. The tender will be stabilized in the water so that personnel and material can be transferred from one ship to another.

ESSA Scientists Receive Honors

Five ESSA scientists have recently been named to major meteorological posts.

Dr. George S. Benton, director of the ESSA Research Laboratories, Boulder, Colo., was installed as President-elect of the American Meteorological Society in ceremonies at the AMS' 48th annual meeting in San Francisco. The AMS, founded in 1919 to develop knowledge of meteorology, is an international scientific society with more than 80 local chapters throughout the United States and seven foreign countries.

Two senior scientists of the ESSA Research Laboratories have been elected Fellows of the American Meteorological Society.

Dr. Helmut K. Weickmann, director of the Atmospheric Physics and Chemistry Laboratory (APCL) in Boulder, and Dr. Joanne Simpson, chief of APCL's Experimental Meteorology Branch in Miami, Florida, were elevated to the degree of Fellow by the membership of the AMS at the recent national meeting in San Francisco.

To be elected a fellow of the 49-year-old scientific society, a person must have made outstanding contributions to meteorology, climatology, or atmospheric sciences. No more than 25 members are so honored each year.

Newton A. Lieurance, director of Aviation Affairs, was elected President of the Commission on Aeronautical Meteorology of the World Meteorological Organization at the Final Plenary Session of the CAeM-IV held in Montreal. The CAeM advises the WMO on technical matters related to the application of meteorology to aeronautics and the provision of meteorological services to international air navigation.

Bernard Zavos, chief of the National Environmental Satellite Centers Planning and Coordination Group, has been appointed Special Assistant to the Secretary-General of the World Meteorological Organization for World Weather Watch Management and Coordination.

New Service Office Opened By EDS

The Environmental Data Service has opened an Agricultural Climatology Service Office at U.S. Department of Agriculture headquarters, to provide on-the-spot climatological information to local laboratories and offices of the Agriculture Department. The office, which began operation on Feb. 15, is headed by Dr. Gerald L. Barger. Assisting Dr. Barger is John L. Baldwin, who has edited the *Weekly Weather and Crop Bulletin* for 23 years. The *Bulletin* is now compiled in the new agricultural service office.

James R. Wait, ERL senior scientist, has been praised by Chester Bowles, U.S. Ambassador to India, for his work on a recent trip to New Delhi, where he conducted a two-week seminar and monitored ESSA-sponsored research on radio propagation. "Dr. Wait contributed greatly to the status of American science in India," Ambassador Bowles reported to the State Department.

Contract Given For 11 Radars By Nadwarn System

A contract for eleven high-powered weather radars has been awarded by ESSA as part of the Natural Disaster Warning System to improve detection and warning of tornadoes, hurricanes, snowstorms, and other environmental hazards.

The $1,641,156.00 contract for the WSR-57M radar systems was awarded to the Raytheon Company of Waltham, Massachusetts.

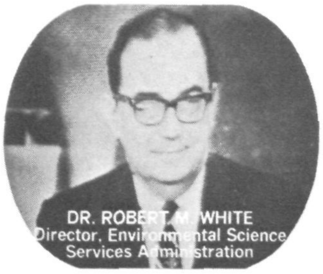
The radar instruments are scheduled for installation within the next 18 months in the vicinity of Garden City, Kansas; Grand Island, Nebraska; Midland, Texas; San Antonio, Texas (at Hondo); Springfield, Missouri (at Monett); Waycross, Georgia; Nashville, Tennessee; Green Bay, Wisconsin; Denver, Colorado; Medford, Oregon; and Bristol, Virginia/Tennessee.

The new radars will improve weather service by providing ESSA-Weather Bureau forecasters with continuous surveillance of the location, intensity, and movement of severe storms and heavy rain or snow within a radius of more than 100 miles. Weather radar vastly extends the area which can be observed from a single location and supplies vital information for public weather warnings and for short-range forecasts for air routes, airports, and metropolitan areas.

Purchase and installation of the eleven new instruments is a major step in the nationwide Natural Disaster Warning system, a plan instituted by ESSA to improve detection, warning, and community preparedness for the multitude of hazards the environment presents

Under the NADWARN plan, ESSA last year established teletypewriter networks in 16 states to bring warnings of natural hazards directly to press, radio, and television outlets in 789 communities. The agency also expanded its flood warning services and strengthened warning systems for such phenomena as seismic sea waves and solar disturbances.

Tornadoes, hurricanes, blizzards, floods, seismic sea waves, and other violent outbursts of nature now take an estimated 500 to 600 lives each year in the United States. They cause annual economic losses between $11 billion and $15 billion. The NADWARN system, in full operation, is expected to cut the death toll in half and to reduce economic losses by at least $100 million a year.



The ESSA Story Featured on a Two-hour Nation-wide Broadcast

Millions of Americans learned of ESSA's programs for protection against natural hazards during a two-hour special, "The Unfriendly Earth," on NBC's "Today" Show March 1. Interviewed by host Hugh Downs were Dr. Robert M. White, Administrator; James M. Klaasse, Associate Director, Seismology and Geomagnetism, Coast and Geodetic Survey; Dr. Robert H. Simpson, Director, National Hurricane Center; Reinhard Schmidt, Director, Washington Forecast Center; and Allen Pearson, Director, National Severe Storms Forecast Center, Weather Bureau.

Weather Bureau Helps Wyoming In Fish And Game Management

Millions of visitors each year soak in the beauty and hospitality that makes Wyoming big — the snow crested peaks, forested hills, lakes and streams, and the popular national and state parks.

The sportsman planning a hunting trip to Wyoming is promised an abundance of game. The Wyoming Game and Fish Commission has the responsibility over the world's largest herds of antelope and elk. Mule deer, hundreds of thousands of them, roam the Big Country. And then there are whitetail deer, black and grizzly bear, moose and bighorn sheep.

More than 20,000 miles of streams and 5,000 lakes make Wyoming a fishing paradise and together with the hunting, the State Game and Fishing Commission is busy the year round.

And that's where ESSA comes in.

The public weather and aviation forecasts from the Lander Weather Bureau station are bread and butter to the Commission. Its long range forecasts help plan the area census of game, so important in the management of wildlife. The Commission needs to line up pilots, aircraft and observers weeks in advance of the three-week summer game census. Weather Bureau forecasts are used to schedule the period when winds and sky will be just right for the operation.

The daily forecasts, last minute air-turbulence forecasts, and upper air reports are used to guide the Commission in the restocking of the lakes to insure quality fishing. Most of the lakes are located in deep canyons with mountains arising abruptly around the lakes.

Rawinsonde observations made by the Weather Bureau help pilots schedule fish-dropping missions. The fish are flown in by the Commission's small planes up the canyons where the winds can be treacherous. Fish are released at an altitude of 150 feet to allow them to nose over before slicing into the cold, deep water.

24 ESSA Scientists to Frozen South In Research Programs

Twenty-four ESSA scientists will participate in the current U.S. Antarctic Research Program. Three units will be represented on the white continent — the Coast and Geodetic Survey, the Weather Bureau, and the Research Laboratories.

Their work is being financed with $794,600 in grants from the National Science Foundation.

Fourteen will spend the winter in Antarctica, remaining until around December 1968; the balance will conduct their research during the Antarctic summer.

Three ESSA scientists will act as the scientific leaders at the Byrd, McMurdo and South Pole Stations. They are Gregory S. Richter, of Donora, Pa., at Byrd Station; Richard R. Przywitowski, of Drexel Hill, Pa., at McMurdo Station; and Harold L. Coleman, Jr., of Minneapolis, Minn., at Pole Station. A fourth, Norman W. Peddie, of Cleveland, Ohio, will serve as an oversnow traverse leader.

Personnel of the Coast and Geodetic Survey will operate magnetic and seismological observatories. The scientists will also periodically calibrate their continuous-recording instruments through standardization observations.

Scientists of the ESSA Research Laboratories will study high latitude upper atmospheric physics, including ionospheric studies, aurora and micropulsation. One will conduct a boundary layer study over the sea and ice pack.

Weather Bureau scientists will conduct research in atmospheric physics and meteorology and will provide operational support to U.S. Navy aircraft during the austral summer flying season.

The following ESSA scientists are participating in the Antarctic Research Program:

Summer Party

Coast and Geodetic Survey: Norman W. Peddie, Cleveland, Ohio (South Pole-Queen Maud Land Traverse).

ESSA Research Laboratories:

Continued next page

ESSA Takes Over An Observatory In Tennessee

A seismological observatory near McMinnville, Tenn., formerly operated by the Department of Defense, has been transferred to ESSA.

Transfer of the $500,000 facility was made by the Advance Research Projects Agency. The observatory will be operated by ESSA's Coast and Geodetic Survey. Its equipment includes seismological devices so sensitive that if the earth moves six-millionths of an inch, they can record it.

The McMinnville Observatory brought to 25 the number of seismological and geomagnetic observatories operated by the Coast and Geodetic Survey. They extend from the Arctic to the South Pole and from Puerto Rico to the western Pacific.

Chief of the Observatory is Leonard E. Kerry, of Gorom, La. He will be assisted by two geophysicists and an electronics technician.

24 ESSA Scientists (continued)

Martin Sponholz, Milwaukee, Wis. (FUJI); John Jones, Elmhurst, Ill.(Pole, Byrd, Plateau, McMurdo); John H. Taylor, Schenectady, N.Y. (Vostok).

Weather Bureau: Karl R. Johannessen, Silver Spring, Md., and Howard D. Hobart, Silver Spring, Md. (to inspect meteorological programs at the Byrd and Pole stations); Robert M. Jones, Indian Rocks Beach, Fla. (Byrd); Howard R. Say, Jr., St. Petersburg, Fla. (Byrd); Charles S. Dzuira, Levittown, Pa. (Pole); and Russell F. White, Worcester, Mass. (Pole).

Wintering Party

Coast and Geodetic Survey: Lawrence A. Buennagel, Indianapolis, Ind. (Byrd); Robert T. Soond, Cleveland, Ohio (Plateau); Fred Wallace Walton, Bethesda, Md. (Pole).

ESSA Research Laboratories: Frederick M. Cady, Mayville, N.Y. (Byrd); Richard F. Przywitowski, Drexel Hill, Pa. (McMurdo); Hain Oona, West Coxsackie, N.Y. (Pole).

Weather Bureau: Michael S. Kramer, Totowa Boro, N.J. (Byrd); Gregory S. Richter, Donora, Pa. (Byrd); George C. Thode, Tacoma, Wash. (Byrd); Harold L. Coleman, Jr., Minneapolis, Minn. (Pole); Kenneth R. Howell, Bricktown, N.J. (Pole); C. H. Stanton Massey, Pacifica, Calif. (Pole); Melvin L. Fields, Capitola, Calif., and Ellie H. Pittman, Jr., Tuscaloosa, Ala. (USNS ELTANIN).

ESSA Personnel Announcements

Dr. Robert H. Simpson has become Director of the Weather Bureau's National Hurricane Center in Miami. Prior to his Miami assignment, he was Associate Director for Meteorological Operations at WB headquarters in Washington. Dr. Simpson is the organizer of the Weather Bureau's Project Stormfury.

James B. Jones was appointed chief of the Planning and Coordination Group, National Environmental Satellite Center.

Cdr. Robert C. Munson has been named Pacific Field Director of the Coast and Geodetic Survey. For the past two years, Cdr. Munson has been on assignment at the Colorado School of Mines. Prior to that, he served as commanding officer of the USC&GSS BOWIE, HODGSON, and SOSBEE. Cdr. Munson joined the Coast Survey in 1951.

Cdr. Herbert R. Lippold, Jr., formerly chief of the Geodesy Division's Technical Planning and Operations Branch, has been named chief of the Satellite Triangulation Division at C&GS headquarters. Cdr. Lippold will supervise C&GS satellite triangulation teams engaged in the establishment of a worldwide geodetic network.

Lt. Cdr. Robert A. Trauschke is the Coast Survey's new chief of the Los Angeles Field Office, following the retirement of Roy M. Sylar. Cdr. Trauschke, a graduate of the University of Massachusetts, has served on various Coast Survey vessels, including the USC&GSS WAINWRIGHT, HILGARD, EXPLORER, PATHFINDER, and WHITING. Prior to his new appointment, he was operations officer of the EXPLORER.

Capt. John O. Phillips became commanding officer of the USC&GSS OCEANOGRAPHER following the retirement of Capt. Arthur L. Wardwell. Prior to his appointment, Capt. Phillips had served as Chief of Geodesy and commanded the USC&GSS PATHFINDER. A civil engineer, he graduated from Carnegie Institute of Technology in 1941. In 1960, he received the Commerce Department's Gold Medal for exceptional service.

Cdr. Gerard E. Haraden, formerly the operations officer of the USC&GSS OCEANOGRAPHER, is now the ship's executive officer. Cdr. Haraden joined the Coast Survey in 1951 following graduation from the University of Maine.

Lt. Cdr. Wayne L. Mobley has assumed command of the hydrographic survey ship, USC&GSS WHITING. Lt. Cdr. Mobley's most recent assignment was as acting Projects Officer at the Pacific Marine Center.

John P. Lee has been named Meteorologist-in-Charge of the WB Airport Station at the Kwajalein Test Site in the Pacific. Mr. Lee is a professional member of the American Meteorological Society. He holds a master's degree from Memphis State University.

Lanny R. Wilson, geophysicist, is chief of C&GS' Magnetic Observatory in Boulder, Colo. Mr. Wilson previously served as acting chief.

Cdr. Sidney C. Miller, former commanding officer of the USC&GSS WHITING, has replaced Cdr. Hubert W. Keith as C&GS representative at the U.S. Army Artillery and Missile School, Fort Sill, Okla.

Cdr. Hubert W. Keith has been placed in charge of the Coast Survey's ship base in Miami.

Clem D. Richardson, Jr., meteorological technician, has been appointed Official-in-Charge of the Waco, Texas Weather Bureau Airport Station. Richardson's appointment is the first of its type under a new Weather Bureau policy opening OIC positions to meteorological technicians at grades above GS-9, thus extending the career ladder for this group.

Cdr. John B. Watkins, Jr., has been appointed commanding officer of the Coast Survey's newest vessel, the USC&GSS FAIRWEATHER. Cdr. Watkins has served aboard the USC&GS Ships HILGARD and SURVEYOR and as commanding officer of the HODGSON and PATHFINDER. While chief of the airport surveys section at C&GS headquarters, he received the Commerce Department's Silver Medal for meritorious service. □

CDR. GERARD E. HARADEN

JAMES B. JONES

CDR. HUBERT W. KEITH

JOHN P. LEE

CDR. HERBERT R. LIPPOLD, JR.

CDR. SIDNEY C. MILLER

CDR. WAYNE L. MOBLEY

CDR. ROBERT C. MUNSON

CAPT. JOHN O. PHILLIPS

LT. CDR. ROBERT A. TRAUSCHKE

CDR. JOHN B. WATKINS, JR.

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