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

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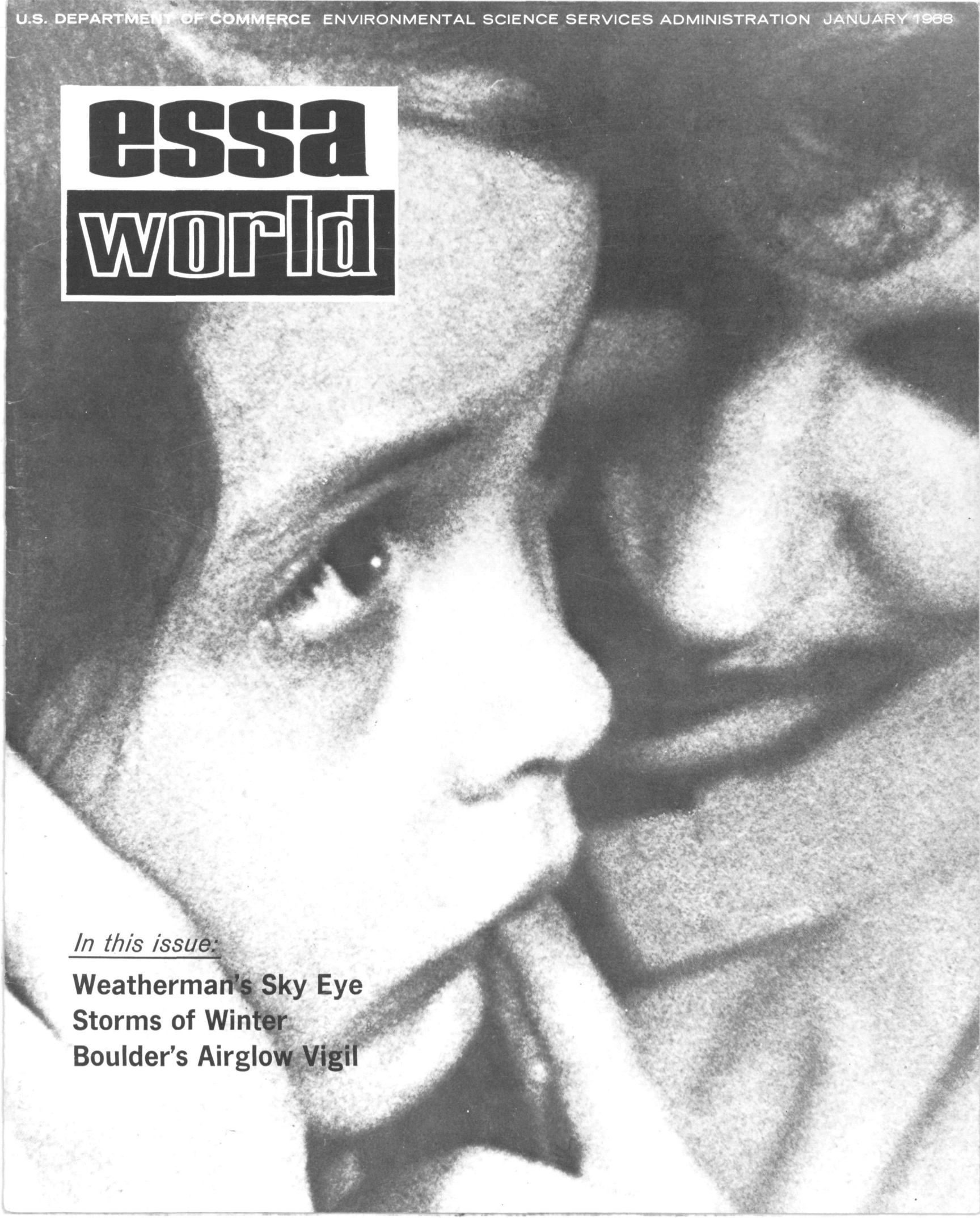

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Weatherman's Sky Eye
Storms of Winter
Boulder's Airglow Vigil

National Oceanic and Atmospheric Administration

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U.S. DEPARTMENT OF COMMERCE, Alexander B. Trowbridge, Secretary
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, Dr. Robert M. White, Administrator
Dr. Werner A. Baum, Deputy Administrator

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COVER
The cover photo is a dramatic scene from the new ESSA film, "Tornado!"
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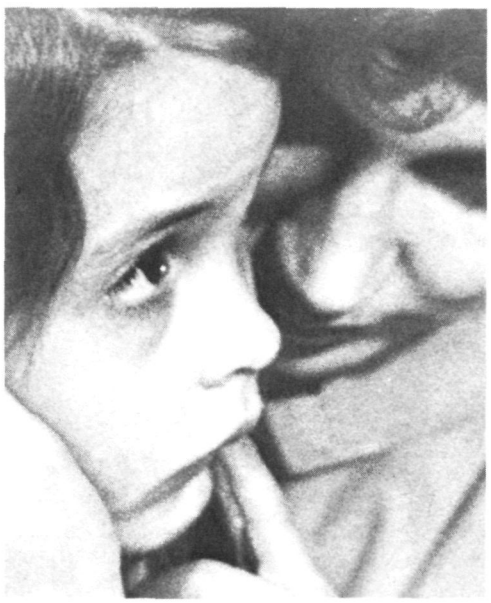

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The Second "S" in ESSA

An Editorial

There were only seven million souls in the United States when the Coast and Geodetic Survey was born in 1807. By 1870, when the national weather service came into being, we were fewer than 40 million. Today, the Nation's population has passed the 200 million mark — and ESSA serves them all.

The scope of our responsibility almost beggars the imagination. It ranges from the sun to beneath the ocean floor. Our people labor literally over the globe; our satellites traverse the skies and our ships the seas.

ESSA gathers and issues information on the weather, our rivers and oceans, the size and shape of the earth, the seismic activity beneath it and the solar flares in the space around it.

ESSA warns of the tornado, the hurricane, the flood, the blizzard and other natural hazards, including the potential for air pollution. We fashion the charts vital to the safety and efficiency of marine and air navigation, and maintain the precise geodetic control network essential to mapping and engineering. ESSA has a great many more services, and is a national depository of information about our physical environment.

Behind these front-line services, affecting everybody from astronaut to housewife to aquanaut, is ESSA's research, the stuff of which our tomorrows are made. In ESSA, science and service are effectively joined. Each serves the other; both serve the Nation.

In ESSA, we are the stewards of a vital public trust. And in that trust, we take a singular satisfaction: what we do, and how well we do it, matters to every American. In a world where so much labor lacks real meaning, this makes us fortunate indeed. □

Stratospheric secrets are probed by the rocket,

The Weatherman's Sky Eye

By Frederick G. Finger and Roderick S. Quiroz*

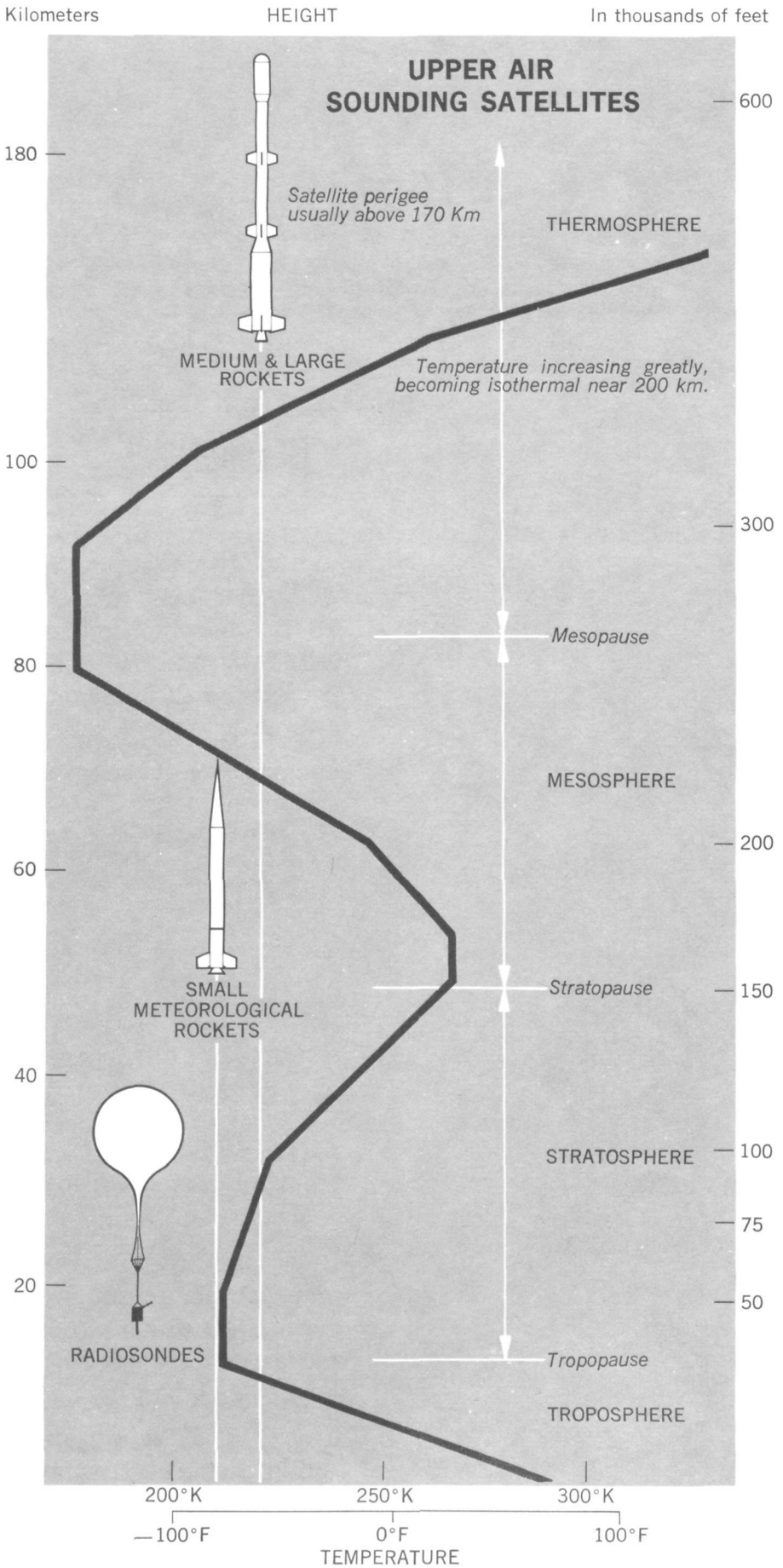
Only 20 miles up is a region whose meteorological mysteries are just now beginning to be understood.

Up to this level the radiosonde, a balloon-borne instrument, gives daily measurements of temperature, pressure, and wind over hundreds of locations around the world.

Above about 100 miles, instruments on weather satellites "look down," providing valuable data on the cloud cover and temperature of the lower atmosphere; and from observed changes in the orbits of satellites the state of the atmosphere at satellite altitudes can be deduced. But in the great intervening region, 20 to 100 miles, the puzzle of atmospheric behavior is hard to unravel.

For this region a time-honored device —the rocket—is the principal means of directly sounding the secrets of the atmosphere. The small "meteorological" rocket, in particular, has proven of great value in gathering information to at least 200,000 feet (40 miles).

Rocket measurements, together with data from high-altitude radiosondes, have contributed greatly to our knowledge of the weather of the stratosphere. Some of the discoveries made possible with these data are:



* *(Frederick Finger is Chief of the National Meteorological Center's Upper Air Branch. Roderick Quiroz is Senior Research Meteorologist.)*

—The stratosphere above 60,000 feet at times is marked by rapid wind and temperature changes, on a scale rarely observed at the ground.

—The polar area from 60,000 to 180,000 feet, although colder in winter than the more southern latitudes, is warmer in summer.

—Warming events, whose triggering mechanism remains a mystery, are first seen in the upper stratosphere and propagate downward with diminishing size. They also appear to have a profound effect on the concentration of electrons in the ionosphere.

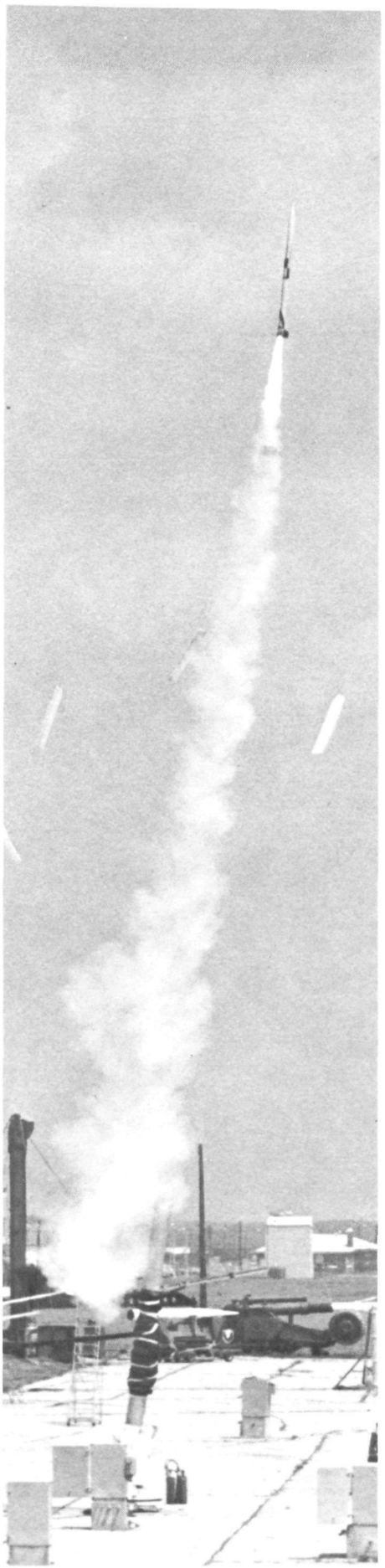
—The stratosphere's large-scale weather systems intensify slowly with altitude.

—Jet stream winds often greater than 200 miles per hour are observed near the top of the stratosphere.

These are only the more recent contributions which rocket meteorology has made to the weatherman's arsenal of information, with every indication that the near future will find the rocket playing an even more exciting role.

As a research instrument, it is not new. Big rockets reaching heights greater than 300,000 feet have been used to sound the atmosphere since the 1940's. Much of what we know concerning the chemical composition and the detailed temperature structure of the upper mesosphere and lower thermosphere has resulted from rocket experiments. Indeed, many "firsts" in our knowledge of the atmosphere have been scored with rockets, such as the extent of penetration into our atmosphere of x-rays emitted from solar flares, the sampling of dust layers in the upper atmosphere, the presence of tremendous wind shears just above the mesopause (about 260,000 feet), and the discovery that the temperature at the mesopause in high latitudes may be as much as 200° F warmer in winter than in summer!

Because of very high costs and complicated data processing, it has not been feasible to use big rockets on a routine basis. Instead, smaller instrumented rockets have come into popular use. A network of stations over North America was established in 1959 by the Army, Navy, Air Force and NASA. Since then, several thousand observations have been taken. The soundings provide detailed measurements of the wind and temperature. Other important information such as pressure and density may be derived when the rocket data are merged with data obtained from support radiosonde observations. The combination of individual radiosonde and rocketsonde observations taken at nearly the same time allows a vertical profile of the various atmospheric parameters to be drawn from the earth's surface up to about 200,000 feet.

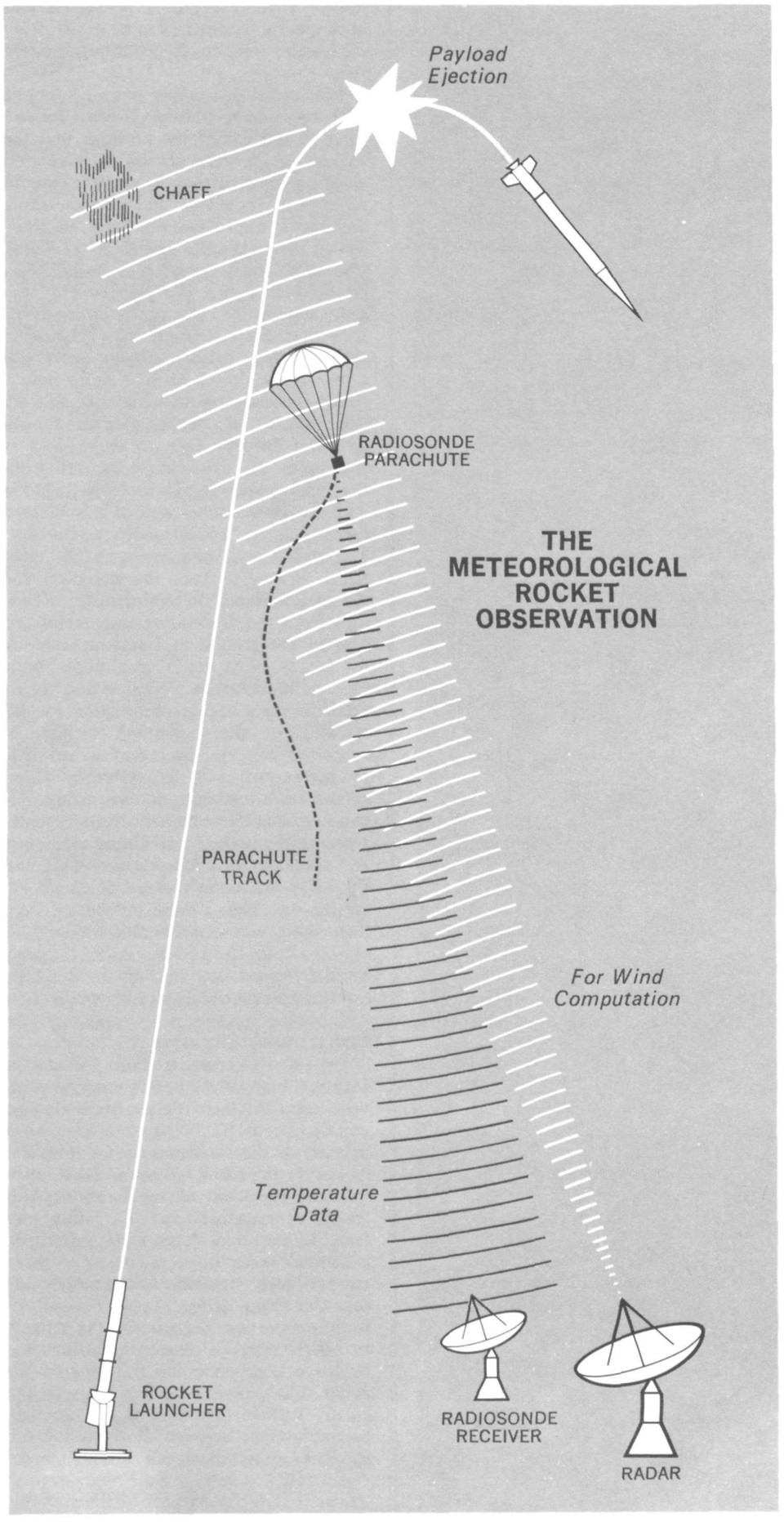


Small meteorological rocket being launched at Wallops Island, Va. Styrofoam wedges (falling away) help to stabilize rocket during launch.

For drawing weather maps, synoptic data must be available. It was decided early in the life of the network that the rocket obseravtions should be taken on a synoptic basis; that is, observations at all stations should be taken on the same day and at approximately the same time. The Upper Air Branch (UAB) of the ESSA Weather Bureau's National Meteorological Center has pioneered in several aspects of stratospheric analysis, including the construction of high-level maps. Before these maps are described, a few words should be said about how a rocket observation is taken. It follows this pattern: the rocket reaches apogee at about 200,000 feet or above, and at this point the nosecone separates from the main body. A parachute is included with the nosecone as well as a miniature radiosonde or "rocketsonde" instrument. The rocketsonde contains a special electrical resistance-type thermometer for the measurement of temperature. Readings from the descending instrument are sent to the ground at frequent intervals by means of a radio transmitter built into the rocketsonde. Wind is also measured during a rocket observation by the tracking of the parachute (which is metalized to provide radar reflectivity) by high-accuracy radar systems. These systems are capable of measuring extremely small horizontal displacements, permitting accurate wind measurements. An alternate method of determining the wind depends upon the use of chaff. At apogee the chaff, a large number of very fine, short wires or metallic ribbons, is released from the rocket. As in the case of the parachute, the chaff cloud is tracked by radar to determine the wind.

High-Level Weather Maps

Before rocketsonde data became a reality, high-level radiosonde reports were used to show the stratospheric circulation up to 100,000 feet. Maps drawn as early as the International Geophysical Years (1957–1959) showed that pronounced seasonal changes take place within the stratospheric circulation pattern. In addition, large-scale midwinter warmings occur on occasions, and these extraordinary temperature changes affect the entire stratosphere. The warming phenomenon has aroused the interest of meteorologists, since there is some evidence that when the warming events occur, changes also take place near the earth's surface. The hint that there may be interactions between the high and the low atmosphere and that these interactions could possibly aid weather forecasting has provided part of the stimulus



for continued research of the stratosphere.

The stratospheric weather maps during the late 1950's and early 1960's were analyzed by hand. Manual analysis is extremely slow, however, and since high-level data contain a larger percentage of errors than the lower-level data, the analyst is often burdened with the decision of what data to believe. During the beginning of the International Years of the Quiet Sun (1964–1965), personnel of the Branch in cooperation with NMC developed a system for analyzing the stratospheric charts by computer. The computer program can perform the data checking and construction of analyses more accurately and much more quickly than the human analyst. The human is thus freed of these tedious time consuming tasks and now contributes to monitoring the computer program to ensure that all of the data have been properly handled and further, gives him valuable time to devise improvements in this analysis program. This objective computer analysis—manual monitoring program has been used operationally on a daily basis since January 1964.

From the very beginning, research done with the aid of the stratospheric charts continually pointed to the need for analyses at higher and higher altitudes. Results of these studies made it clear that large-scale stratospheric events such as midwinter warmings are more pronounced at levels above 100,000 feet. The importance of rocket data thus became evident, and special analysis methods were developed to extract from these observations the greatest possible amount of information. Of primary importance was the use of the lower-level maps as a foundation for the rocket maps. The methods also called for a complete accuracy check of all rocket data, including a comparison with the data obtained by support radiosondes. This comparison can be made in the so-called overlap region, since the radiosonde produces data to near 100,000 feet and the descending rocketsonde gives data to well below that level.

The maps have greatly increased our understanding of the stratosphere and lower mesosphere. Among the findings of interest are:

The stratosphere above 60,000 feet is marked at times by rapid wind and temperature changes.

The polar area from 60,000 feet to 180,000 feet is colder than the more southern latitudes in winter, but warmer during the summer.

The large-scale weather systems of the stratosphere intensify slowly with altitude.

Warming events are known to affect the entire stratospheric layer, but despite much investigation, this phenomenon

still has not been completely described. Rocket data have shown that the warmings are first seen in the upper atmosphere and propagate downward with diminishing amplitude. However, the mechanism that triggers them remains to be identified.

Warmings affect not only the stratosphere but according to recent evidence they also have a profound effect on the concentration of electrons in the ionosphere. (The ionosphere consists of several altitude regions with large numbers of electrons.)

The extensive collection of stratospheric maps now available allows UAB to perform another vital task: for a number of years the Branch has been designated the World-Wide Warning Center for stratospheric warming alerts. Many researchers have a strong interest in the warming phenomenon, and some types of investigations require rocket data at the time a warming is taking place. The Branch keeps careful watch on the stratosphere in both hemispheres and makes forecasts ("warnings") of major warmings so that the appropriate equipment can be made ready for use. An example of a warning message follows:

WBC-20 MAR 1965—IQSY GEOALERT-STRATWARM BEGINS IN GREENLAND MOVING NORTH NORTHWEST, MODERATE.

In view of the high cost of observational experiments keyed to major stratospheric warmings, the importance of UAB's mission in this regard becomes apparent.

There is, as stated earlier, evidence of interactions between the high and low atmosphere. Moreover, important changes in the rate of absorption of solar radiation are possible. These factors, operating together or separately, are generally thought to be responsible for certain stratospheric events. Research relates these events with the vertical and horizontal transport of energy. Ultimately the knowledge gained is expected to increase our understanding of the atmosphere, hastening the improvement of forecast procedures.

Reported data not in the form of weather maps also provide an important source for research studies. Long-term records of radiosonde data have been used to determine the daily temperature variation due to the influence of the sun. Everyone is familiar with the daily change of surface temperature which in most places, reaches a maximum in mid-afternoon and a minimum in early morning. In the free atmosphere, away from the influence of the earth, this change is found to be quite small.

For example, at 100,000 feet the daily change is only about 2°F, compared to about 10° to 30°F at the earth's surface. However, at extreme heights of the atmosphere the picture is very different. From studies of satellite orbital data it is well known that the temperature and density of the thermosphere above about 500,000 feet undergo tremendous diurnal variations. When medium solar activity prevails, for example, the early afternoon density at a height of 400 miles is about 1000 percent greater than the density in the early morning. The equivalent temperature change during the same period is a whopping 700°F!

Thus there is considerable interest in the magnitude of daily variations at heights between the stratosphere and thermosphere. From 100.000 feet the daily temperature variation increases to several degrees at 150,000 feet, according to results obtained from rocket data. Further investigation will be needed to ascertain conditions at mesospheric altitudes.

Other periodic variations are examined, including such features as the curious semi-annual variation of wind in the upper stratosphere over low latitudes. This cycle results in winds from the east in January and July and from the west around April and September. This is in contrast to the basic summer (easterly) and winter (westerly) pattern that prevails over much of the hemisphere. The semi-annual variation incidentally, is found at higher altitudes than the well-known "quasi-biennial" cycle. This cycle, characterized by an alternation between easterlies and westerlies approximately every thirteen months, has been studied intensively by meteorologists of ESSA and other organizations.

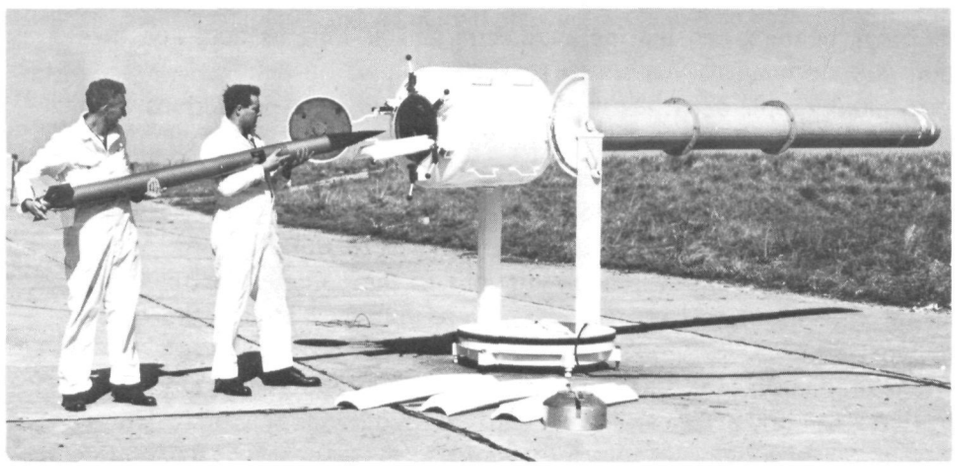
Another important area of endeavor is the depiction of atmospheric variations that will affect supersonic transport (SST) aircraft operations. The series of stratospheric maps based on radiosonde data, described earlier, should serve as an excellent point of departure for the analyst of variations along SST routes and for developing forecasting procedures.

For re-entry space vehicles, especially those returning in an undulating trajectory, a parameter of great importance is the air density. This parameter and its variations have been studied in depth, and work progresses on several important problems.

The full potential of the high-altitude synoptic maps described here is yet to be realized. One major difficulty with the charts has been the necessary restriction of the analysis area to North America, since the major concentration of rocket stations is in that area. However, weather services of various nations are rapidly becoming interested in the use of rockets as part of meteorological data-gathering systems. Indeed, several services have already begun to use the rocket. It is hoped that in a very few years sufficient information will be available for the construction of Northern Hemisphere charts at rocket altitudes.

Our optimism should probably be tempered with some caution. A few problems persist. Occasionally observed differences in temperatures measured by conventional radiosondes and by rockets in the region of overlap (near 100,000 feet) have yet to be fully explained. Moreover, at the highest altitudes routinely reached by the rockets, about 200,000 feet, various factors are known to contribute to error in the recorded temperatures. Fortunately, many people are now studying methods of improving these temperatures and of extending the observational ceiling to even higher altitudes.

The next few years should see exciting developments in the observational coverage and in the methods of measurement. We are at last beginning to close in on some of the problems of the upper atmosphere. As our knowledge of the high atmosphere increases, so will our understanding of weather events closer to the ground. □



Meteorological rocket being inserted in launcher at Wallops Island, Virginia.

A CENTURY OF TIDE PREDICTION

Four men in the Federal Government forecast natural events hundreds of years in the future. Their task: to predict the flow and ebb of the ocean tides that bathe the shores of the Nation.

They can tell you when the tide will come in and when it will go out next year, next century, or many more years from now. For good measure, they can throw in the past.

On the Federal payroll they appear as physical oceanographers, and their job is to prepare the tide and tidal current prediction tables for the Atlantic, Gulf, and Pacific coasts. They and their predecessors have been doing it for 100 years, for this is the centenary of the publication of the first tide prediction tables by the Coast and Geodetic Survey.

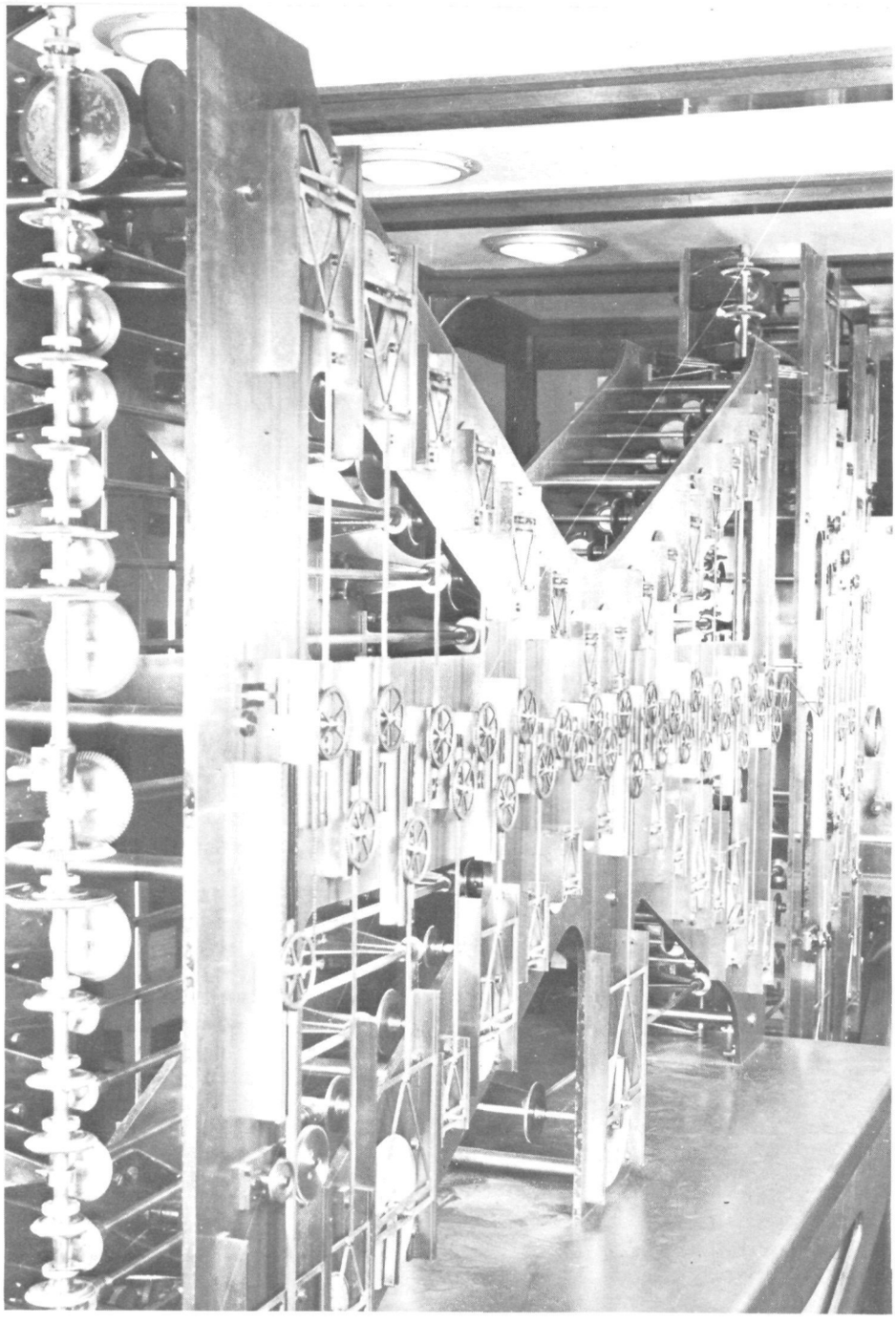
And they and their successors will probably continue to do so for hundreds of years to come, as long as there are fishermen, boaters, and marine engineers; and as long as man goes to the sea for sport and recreation and sustenance.

Unlike almost all other oceanographic activities in the United States, tide predictions are the responsibility of one organization — the Coast and Geodetic Survey.

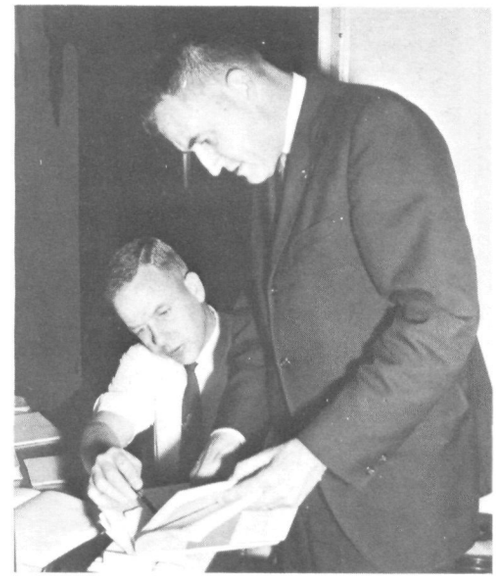
The first volumes of tide predictions were issued in 1867. There were two volumes and they contained predictions for 143 places in the United States. For 1967, there were four volumes containing predictions for 8073 locations in the United States and abroad.

In 1890, the Coast Survey included tidal current predictions in the volumes for the first time and in 1923 tidal current predictions were issued as a separate volume. Today, the tidal current predictions appear in two volumes.

The tide and tidal current prediction tables are prepared in the Oceanography Division, headed by Steacy D. Hicks. Work is done in the Tide and Tidal Current Predictions Section by Donald C. Simpson, the section chief; John Groth; James Lanehart; and Charles Muirhead. They are now working on the 1969 tide and tidal current prediction tables, to be issued in mid-1968.



Predecessor of the Computer, the Tide Prediction Machine that began operation in 1912.



Steacy Hicks, Chief, Oceanography Division plans a publication with Don Simpson,

Oceanographer Robert Cummings checking tide notes for C&GS charts.

John Groth, Oceanographer, assembling a computer program deck.

The ocean's tides and currents affect the fishing industry, both sports and commercial; water sports, including swimming, scuba diving and surf riding; boating, both recreational and commercial; amphibious military operations; marine engineering; and the future economic development of the vast continental shelves off the coasts.

Development of tide prediction tables is a lengthy process. The first stage involves observing the height of the tides at various places along the coasts every hour for at least one month, preferably a year. Some observations have been underway for many years. At New York, the tides have been monitored continuously since 1893.

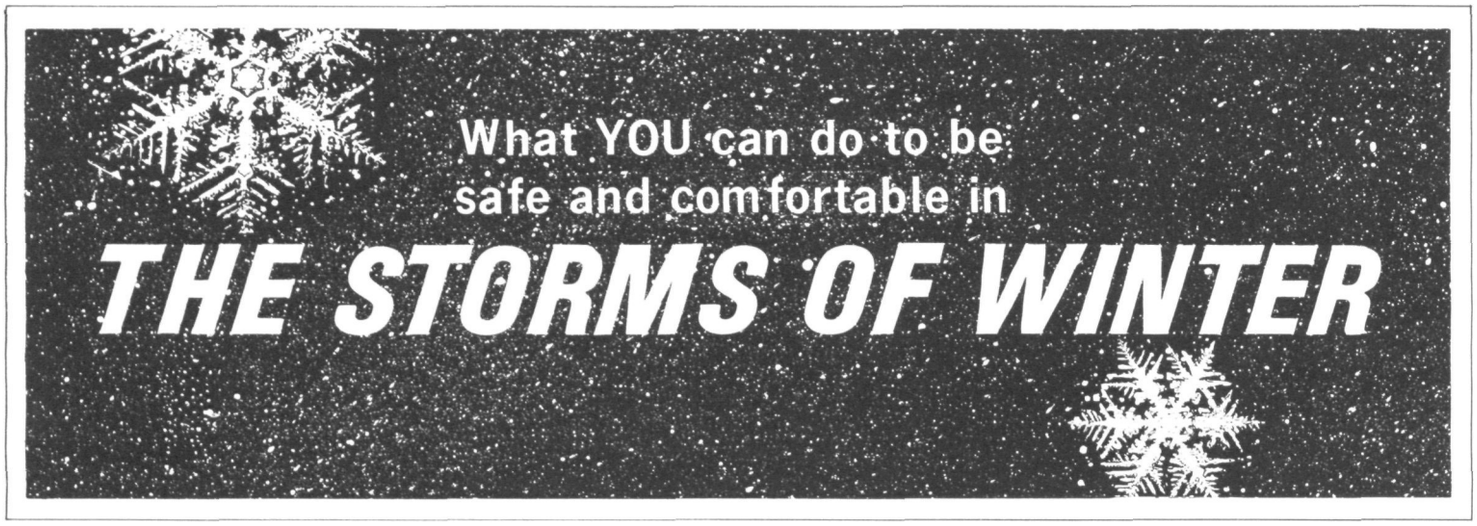
These data are subjected to a mathematical analysis which results in the formulation of tidal (or harmonic) constants, numbers which are constant and do not change with time.

The tidal constants, together with astronomic data on the relative positions in the future of the sun, moon, and earth, are fed into electronic computers. From this the tide and tidal current predictions are obtained.

The tide predictions are published in the following volumes: East Coast of North and South America, including Greenland; West Coast of North and South America, including Hawaii; Europe and the West Coast of Africa, including the Mediterranean Sea; Central and Western Pacific Ocean and Indian Ocean.

The tidal current predictions are published in these volumes: Atlantic Coast and North America, and Pacific Coast of North America and Asia.

The predictions for the United States, including its possessions and Pacific Trust Territories, are determined by the Coast Survey; the balance, by other nations. □



In September, the sun leaves the Northern Hemisphere, its perpendicular rays drifting south of the Equator. Until the sun's return in March polar air rules the northern continental atmosphere pushing back the tropical warmth of summer. It is autumn, then winter, a season broken by intervals of fine weather and by the seasonal parade of winter storms snow-dumping, ice covering, blood-chilling paralyzers of cities, trappers of travelers, takers of life, destroyers of property.

The storms are generated, as are many of the thunderstorms of summer, from disturbances along the boundary between cold polar and warm tropical air masses, the fronts where air masses of different temperatures and densities wage their perpetual war of instability and equilibrium. The disturbances may become intense low pressure systems, churning over tens of thousands of square miles in a great counter-clockwise sweep.

In the Pacific, these disturbances form along polar fronts off the east coast of Asia and travel northeastward toward Alaska. But some, particularly those forming along the mid-Pacific polar front, take a more southerly track, striking the United States as far south as Southern California. Few Pacific disturbances cross the Rockies, but some do, redeveloping to the east. One region of such redevelopment lies east of the Colorado Rockies; the storms which come out of that region are called Colorado Cyclones. Another region of storm redevelopment is east of the Canadian Rockies from which come the so-called Alberta Cyclones. Both types take an eastward path, their most frequent ones converging over the Great Lakes. The Lakes themselves are generators of severe local winter storms, and forge others from northward-drifting disturbances originating over the Gulf of Mexico and our southern plains.

(Editor's note: This article is excerpted from a new ESSA brochure, "Winter Storms", in the interest of public safety.)

On our east coast, winter storms often form along the Atlantic polar front near the coast of Virginia and the Carolinas and in the general area east of the southern Appalachians. These are the notorious Cape Hatteras storms — noreasters — which develop to great intensity as they move up the coast, they drift seaward toward Iceland where they finally decay.

For some parts of the United States—the Northern Rockies, for example—storms with snow followed by cold are a threat from mid-September to mid-May; during one of the colder months from November to March, it is not unusual for eight separated storms to affect some area across the continent. Intense winter storms are frequently accompanied by cold waves, ice or glaze, heavy snow, blizzards or a combination of these; often, in a single winter storm. Precipitation type changes several times as the storm passes. Their common feature is the ability to completely immobilize large areas and to isolate and kill persons and livestock in their path. In our northland, the severity of these storms makes their threat a seasonal one. Farther south, the occasional penetration of severe winter storms into more moderate climates causes severe hardship and great loss of warm-weather crops.

Nearly everyone east of the Pacific coastal ranges remembers significant winter storms – days of heavy snow, interminable blizzard, inconvenience, economic loss and sometimes, personal tragedy. Winter brings them all. For Wyoming or Kansas or Texas the blizzard of 1888 was one of the worst on record. The period January 11-13, in that year brought the most disastrous blizzard ever known in Montana, the Dakotas, and Minnesota, combining gale winds blowing snow and extreme cold into a lethal destructive push from the Rockies eastward. The eastern seaboard got its big storm the same year. March 11-14, 1888, saw the seaboard from Chesapeake Bay to Maine stricken with a blizzard that dumped an average of 40 inches of snow over southeastern New York and southern

New England. The storm killed 200 in New York City alone; total deaths were over 400.

But the year 1960 is nearly as memorable. A storm during January 29-31, 1960 brought paralyzing blizzard conditions from Virginia to New England with low temperatures extending southward to central Georgia. This storm caused more than 50 deaths, marooned thousands, and dislocated both government and private activities for at least one day. About a month later, March 2-5, a four-day blizzard dropped up to three feet of snow across the Dakotas, Minnesota, Nebraska, and adjacent areas. Winds gusted to more than 100 miles per hour, snow drifted to more than 30 feet. At least 15 persons, and more than 100,000 head of livestock were killed by the storm.

Winter storms do not have to shatter climatological records to be killers. Their danger persists from year to year. From 1936 through 1960, snowstorms caused more than 3,000 deaths, directly and indirectly. Of these reported deaths, about 1,000 were attributed to automobile and other accidents; about 800 to overexertion, exhaustion, and consequent fatal heart attack; about 350 to exposure and fatal freezing; and the rest to such miscellaneous causes as home fires, carbon monoxide poisoning in stalled cars, falls on slippery walks, electrocution from downed wires, and building collapse. The greatest number of snow-related deaths—354—in this period occurred in 1960: 1958 is second with 345 deaths. About one half of the total reported deaths occurred in New England, New York, and Pennsylvania.

ESSA issues timely warnings against hazards from the atmosphere and ocean hurricanes, tornadoes, severe storms, floods, and tsunamis. As winter drops its cold mantle over North America, meteorologists in ESSA's Weather Bureau work to detect the disturbances which may become severe winter storms, and develop warnings against the storms' approach.

FREEZING RAIN, FREEZING DRIZZLE AND ICE STORMS

Key words in ESSA Weather Bureau messages identify the type of weather expected over a given area. The terms explained below will help you estimate the precautions you will need for winter storms.

Freezing rain or freezing drizzle is rain or drizzle occurring when surface temperatures are below freezing (32° Fahrendeit, F). The moisture falls in liquid form but freezes upon impact, resulting in a coating of ice glaze on all exposed objects. The occurrence of freezing rain or drizzle is often called an ice storm when a substantial glaze layer accumulates. Ice forming on exposed objects generally ranges from a thin glaze to coatings about an inch thick, but much thicker deposits have been observed. For example, ice deposits to eight inches in diameter were reported on wires in northern Idaho in January 1961, and loadings of 11 pounds per foot of telephone wire were found in Michigan in February 1922. It has been estimated that an evergreen tree 50 feet high may be coated with as much as five tons of ice during a severe ice storm. A heavy accumulation of ice, especially when accompanied by high winds, devastates trees and transmission lines. Sidewalks, streets, and highways become extremely hazardous to pedestrians and motorists—over 85 percent of ice-storm deaths are traffic-related. Freezing rain and drizzle frequently occur for a short time as a transitory condition between the occurrence of rain or drizzle and snow, and therefore usually occur at temperatures slightly below freezing.

Some of the most destructive ice storms have occurred in the southern states, where neither buildings nor crops are designed with severe winter conditions in mind. The most damaging ice storm in the United States was probably that which struck the southland from January 28 to February 4, 1951, causing some $50 million damage in Mississippi, $15 million in Louisiana, and nearly

Continued

$2 million in Arkansas; this storm also caused 22 deaths. The region of greatest incidence, however, is a broad belt from Nebraska, Kansas, and Oklahoma eastward through the middle Atlantic and New England states.

Ice storms are sometimes incorrectly referred to as *sleet storms*. Sleet can be easily identified as frozen rain drops (ice pellets) which bounce when hitting the ground or other objects. Sleet does not stick to trees and wires; but sleet in sufficient depth does cause hazardous driving conditions.

The Weather Bureau uses the terms *ice storm, freezing rain*, and *freezing drizzle* to warn the public when a coating of ice is expected on the ground and on other exposed surfaces. The qualifying term *heavy* is used to indicate ice coating which, because of the extra weight of the ice, will cause significant damage to trees, overhead wires, and the like. Damage will be greater if the freezing rain or drizzle is accompanied by high winds.

SNOW

The word *snow* in a forecast without a qualifying word such as *occasional* or *intermittent*, means that the fall of snow is of a steady nature and will probably continue for several hours without letup.

Heavy snow warnings are issued to the public when a fall of four inches or more is expected in a 12-hour period, or a fall of six inches or more is expected in a 24-hour period. Some variations on these rules may be used in different parts of the country. Where four-inch snowfalls are common, for example, the emphasis on heavy snow is generally associated with six or more inches of snow. In other parts of the country where heavy snow is infrequent or in metropolitan areas with heavy traffic a snowfall of two or three inches will justify a heavy snow warning.

Snow flurries are defined as snow falling for short durations at intermittent periods; however, snowfall during the flurries may reduce visibilities to an eighth of a mile or less. Accumulations from snow flurries are generally small.

Snow squalls are brief, intense falls of snow and are comparable to summer rain showers. They are accompanied by gusty surface winds.

Blowing and drifting snow generally occur together and result from strong winds and falling snow or loose snow on the ground. *Blowing snow* is defined as snow lifted from the surface by the wind and blown about to a degree that horizontal visibility is greatly restricted. *Drifting snow* is used in forecasts to indicate that strong winds will blow falling snow or loose snow on the ground into significant drifts. In the northern plains, the combination of blowing and drifting snow, after a substantial snowfall has ended is often referred to as a *ground blizzard*.

Blizzards are the most dramatic and perilous of all winter storms characterized by low temperatures and by strong winds leaving large amounts of snow. Most of the snow accompanying a blizzard is in the form of fine, powdery particles of snow which are whipped in such great quantities that at time visibility is only a few yards.

Blizzard warnings are issued when winds with speeds of at least 35 miles per hour are accompanied by considerable falling or blowing snow and temperatures of 20°F or lower are expected to prevail for an extended period of time.

Severe blizzard warnings are issued when blizzards of extreme proportions are expected and indicate wind with speeds of at least 45 miles per hour plus a great density of falling or blowing snow and a temperature of 10°F or lower.

COLD WAVE

COLD WAVES are another common form of winter storm. A *cold wave warning* indicates an expected rapid fall in temperature within a 24-hour period which will require substantially increased protection to agricultural, industrial, commercial, and social activities. The temperature falls and minimum temperatures required to justify cold wave warning vary with the changing of the season and with geographic location. Regardless of the month or the section of the country, a cold wave warning is a red flag alert to the public that during a forthcoming forecast period a *change to very cold weather will require greater than normal protective measures.*

CHILL INDEX

STRONG WINDS combined with low temperatures cause a very rapid cooling of exposed surfaces. Unprotected portions of the body, such as the face or hands, can chill rapidly and should be protected as much as possible from the cold wind. A very strong wind combined with a temperature slightly below freezing can have the same chilling effect as a temperature nearly 50°F lower in a calm atmosphere. Arctic explorers and military experts have developed a term called the *wind chill factor*, which states the cooling effect of various wind and temperature combinations. In certain areas, the Weather Bureau issues this information as the *wind chill index*. The following descriptive scale compares a 20°F temperature with different wind speeds.

Wind with Temperature 20°F	Wind-Chill index (Equivalent Temperatures)	Forecast Descriptive Term
10 mph	2°F	Very Cold
20 mph	—9°F	Bitter Cold
35 mph	—20°F	Extreme Cold

Hazardous Driving (Travelers') Warnings are issued to indicate that falling blowing or drifting snow, freezing rain or drizzle, sleet or strong winds will make driving difficult.

Livestock (Stockmen's) Warnings alert ranchers and farmers that livestock will require protection from a large accumulation of snow or ice, a rapid drop in temperature, or strong wind.

SAFETY RULES - for WINTER STORMS

Common-sense safety rules will help you when the winter storms arrive. Play it safe; remember and use these rules:

Keep ahead of the winter storm by listening to the latest ESSA Weather Bureau warnings and bulletins on radio and television.

Check battery powered equipment before the storm arrives. A portable radio or television set may be your only contact with the world outside the winter storm. Also check emergency cooking facilities and flashlights.

Check your supply of heating fuel. Fuel carriers may not be able to move if a winter storm buries your area in snow.

Check your food and stock an extra supply. Your supplies should include food that requires no cooking or refrigeration in case of power failure.

Prevent fire hazards due to overheated coal or oil burning stoves, fireplaces, heaters or furnaces.

Stay indoors during storms and cold snaps unless in peak physical condition. If you must go out, avoid overexertion.

Don't kill yourself shoveling snow. It is extremely hard work for anyone in less than prime physical condition, and can bring on a heart attack, a major cause of death during and after winter storms.

Rural resident: Make necessary trips for supplies before the storm develops or not at all: arrange for emergency heat supply in case of power failure: be sure camp stoves and lanterns are filled.

Dress to fit the season. If you spend much time outdoors, wear loose-fitting, light-weight, warm clothing in several layers; layers can be removed to prevent perspiring and subsequent chill. Outer garment should be tightly woven, water repellent, and hooded. The hood should protect much of your face and cover your mouth to ensure warm breathing and protect your lungs from the extremely cold air. Remember that entrapped, insulating air warmed by body heat is the best protection against cold. Layers of protective clothing are more effective and efficient than single layers of thick clothing: and mittens, snug at the wrists, are better protection than fingered gloves.

Your automobile can be your worst enemy — during winter storms. Get your car winterized before the storm season begins. Everything on the checklist shown here should be taken care of before winter storms strike your area.

—Ignition system
—battery
—lights
—tire tread
—cooling system
—fuel system
—lubrication
—exhaust system tight
—heater
—brakes perfectly
—adjusted
—wiper blades
—defroster
—snow tires installed
—chains
—antifreeze
—winter-grade oil

Keep water out of fuel by maintaining a FULL tank of gasoline.

Be equipped for the worst. Carry a winter storm car kit, especially if cross country travel is anticipated or if you live in the northern states.

Suggested Winter Storm Car Kit: blankets or sleeping bags, matches and candles, empty 3-pound coffee can with plastic cover, facial tissue, paper towels, extra clothing, high-calorie, nonperishable food, compass and road maps, knife, first aid kit, chains, shovel, sack of sand, flashlight or signal light, windshield scraper, booster cables, two tow chains, fire extinguisher, catalytic heater, axe.

Winter travel by automobile is serious business. Take your travel seriously.

☐ If the storm exceeds or even tests your limitations, seek available refuge immediately.

☐ Plan your travel and select primary and alternate routes.

☐ Check latest weather information on your radio.

☐ Try not to travel alone; two or three persons are preferable.

☐ Travel in convoy with another vehicle, if possible.

☐ Always fill gasoline tank before entering open country, even for a short distance.

☐ Drive carefully, defensively.

IF A BLIZZARD TRAPS YOU DON'T PANIC

Avoid overexertion and exposure. Exertion from attempting to push your car, shovel heavy drifts and perform other difficult chores during the strong winds, blinding snow, and bitter cold of a blizzard may cause a heart attack even for persons in apparently good physical condition.

Stay in your vehicle. Do not attempt to walk out of a blizzard. Disorientation comes quickly in blowing and drifting snow. Being lost in open country during a blizzard is almost certain death. You are more likely to be found, and more likely to be sheltered in your car.

Keep fresh air in your car. Freezing wet snow and wind-driven snow can completely seal the passenger compartment.

Beware the gentle killers: carbon monoxide and oxygen starvation. Run the motor and heater sparingly, and only with the downwind window open for ventilation.

Exercise by clapping hands and moving arms and legs vigorously from time to time, and do not stay in one position for long.

Turn on dome light at night, to make vehicle visible to work crews.

Keep watch. Do not permit all occupants of car to sleep at once.

PROTECT LIVESTOCK

Blizzards take a terrible toll in livestock. For both humane and economic reasons, stockmen should take necessary precautions in advance of severe winter storms.

Move livestock, especially young livestock, into sheltered areas. Shelter belts properly oriented and laid out, provide better protection for range cattle than shed type shelters, which may cause cattle to overcrowd with consequent overheating and respiratory disorders.

Haul extra feed to feeding areas before the storm arrives. Storm duration is the largest determinant of livestock losses. If the storm lasts more than 48 hours, emergency feed methods are required. Range cattle are hardy and can survive extreme winter weather providing they have some non-confining type of shelter from the wind and are able to feed at frequent intervals.

Autopsies of cattle killed by winter storms have shown the cause of death to be dehydration, not cold or suffocation. Because cattle cannot lick enough snow to satisfy their thirst, stockmen are advised to use heaters in water tanks to provide livestock with water and feed after prolonged exposure to winter storm conditions. ☐

Can a blithe spirit find contentment in Government service?

One did, for

THREE SHORT, HAPPY MONTHS

By WILLIAM A. STANLEY, Coast and Geodetic Survey

How would the Coast and Geodetic Survey deal with a draftsman who was habitually late, frequently absent, given to graffiti, and inclined to doodle on its official charts?

You guessed it. But today, after more than a century, such a man remains one of that august agency's most highly regarded alumni.

He was James McNeill Whistler, famed for his magnificent portrait of his mother and for many other works of art. But to his superiors in the survey, where the first evidence of his artistic potential was expressed in its charts, he was trouble with a capital T.

A native of Lowell, Massachusetts, born July 10, 1834, he belonged to a family of soldiers, Scotch-Irish by decent. At the age of seventeen, after spending some time in St. Petersburg, where his father was carrying on an engineering assignment for the Czar, he entered West Point. He spent three years there, departing in his senior year due mainly to his disinterest in obeying rules, chief of which had been his lack of promptness.

His father's plan was to apprentice him to a friend who had connections with a locomotive works in Baltimore, Maryland, and where his stepbrother George was then employed. Whistler soon saw enough of the locomotive works, however, to know that he did not want to be an apprentice, and it was not long before he left Baltimore and headed for Washington, D.C.

In November 1854, after he tried to enter the Navy, his ability as a draftsman induced another friend of his father's to recommend him for a position in the engraving department of the U.S. Coast Survey. He was appointed on November 7, 1854, and at the age of 20 began a short but colorful employment with the Federal Government.

It has been reported that Whistler remarked, "I shall always remember the courtesy shown me by that fine Southern gentleman Jefferson Davis, through whom I got my appointment with the Coast Survey." Whistler continued, "It was after my little difference with the Professor of Chemistry at West Point that it was suggested—all in the most courteous and correct West Point manner—that perhaps I had better leave the Academy." With an introduction by Jefferson Davis he reported to Captain Benham, his new Coast Survey boss, who assigned him to the position of draftsman at the salary of $1.50 a day.

In the Coast Survey, then located on the northwest corner of New Jersey and C Street, SE., Whistler, the draftsman, was considered a playboy of sorts as he performed the duties of an assistant in the cartographic section of the Survey; even in those permissive days when offices closed at 3:00 p.m. and it was quite the custom to send out the messenger for a bucket of ale. Whistler would engage his time by drawing caricatures and sketches in unconventional places somewhere in the building. It was said that he would bring an extra hat to the office and when a superior came looking for him he would find his hat on the peg, assuming then that James was in the building. However, it is said he was wearing the other hat on his way to a nearby tavern.

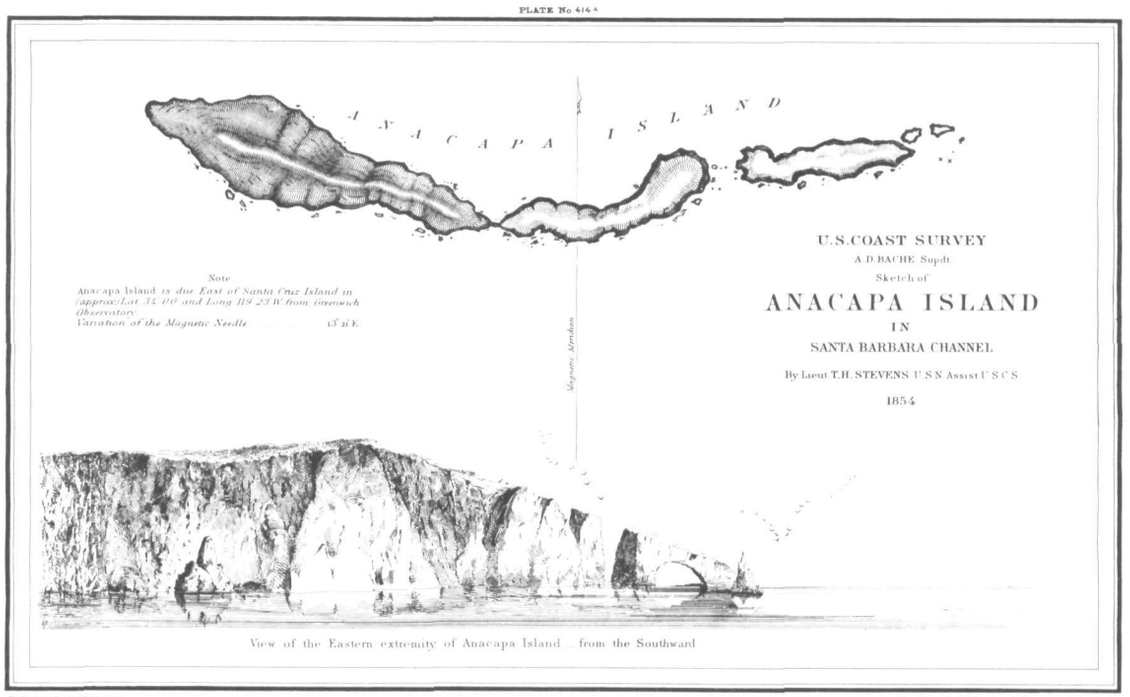
During his stay he was regarded as a person who could not adjust himself to any form of regular routine. He would say "It was not that I was late; the office opened too early." He worked only intermittently on his assignments and took great delight in occupying his time with odd sketches on any available fabric that presented a suitable surface—an envelope, or a copper-plate upon which he might have been assigned to engrave a chart.

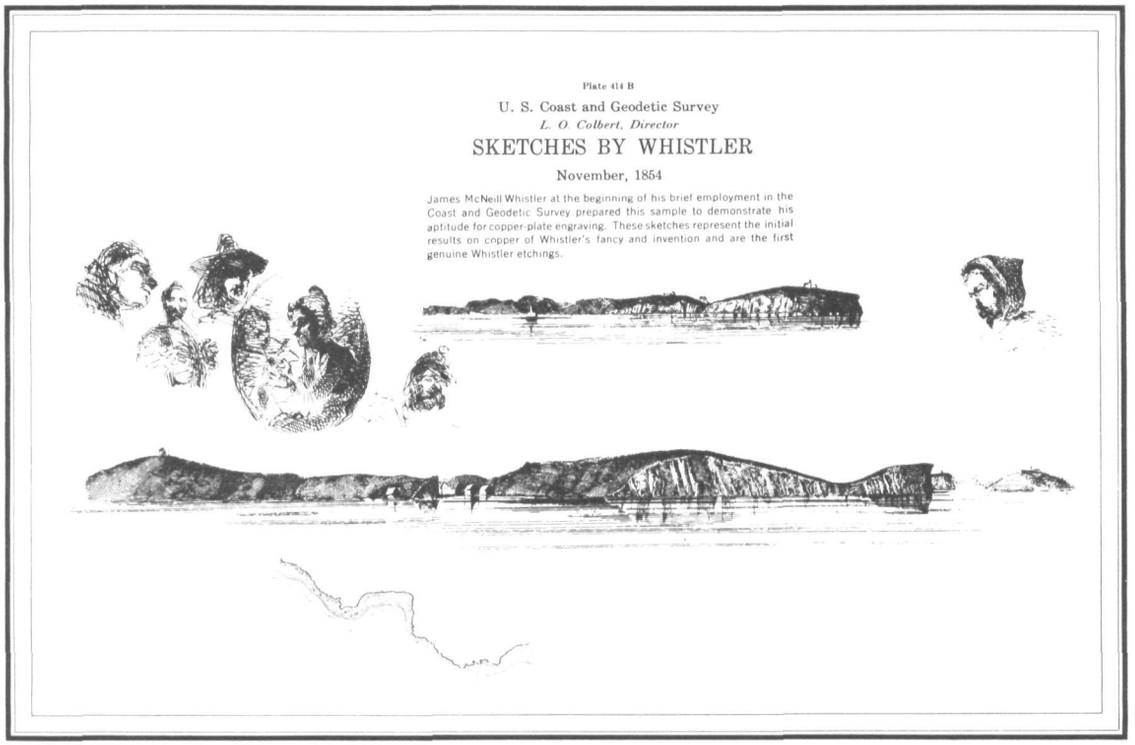
Whistler sometimes drew uncomplimentary images of the Bureau officials on the bare white walls leading to the Superintendent's office. He would not overcome the temptation to stop frequently on his way up or down the stairs to correct, change, or add to his caricatures.

This was a time of uncertainty for him, when visions of his real career were beginning to form. In the brief period of less than four months Coast Survey employment, from November 1854 to February 1855, one fact was certain; he had no ambition to become a permanent government employee.

John Ross Key, fellow draftsman in the Coast Survey, and the grandson of Francis Scott Key, recalled in later years that he and Whistler roomed in a house of Thirteenth Street, near Pennsylvania Avenue and that Whistler usually dined in a restaurant close by on Pennsylvania Avenue. He also lived for a while in a house at the north-east corner of Twelfth and E Streets, NW., a two-story brick building which is no longer standing. His rent was ten dollars a month at the rooming house, a considerable sum in the light of his small government pay.

He produced two works which have been referred to by historians as "Coast Survey No. 1" and "Coast Survey No. 2, Anacapa Island" (engraved by J. Whistler, J. Young, and C. A. Knight). The latter, which includes an etching by Whistler of the headline of the eastern extremity of Anacapa Island, California, has been reproduced and issued as Coast and Geodetic Survey plate number 414A, but there is no record of the former.





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These two plates are not, however, Whistler's first efforts as a copperplate engraver in the Coast Survey. Upon his entrance to duty he received technical instructions in the art of etching and copper engraving, which are reflected in a series of practice sketches. First place should be accorded to those which are the initial efforts on copper of his fancy and invention, and the first genuine Whistler etchings. The sketches are in the shapes of little heads that intrude on the blank spaces of the copper above and around two neatly engraved views of portions of the coast of Boston Bay. At intervals, while doing the topographical view, he paused to etch on the upper part of the copperplate the vignette of a soldier's head, a suggestion of a portrait of himself as a Spanish hidalgo and an etching of a motherly figure which has attracted considerable interest in recent years. The original copper engraving is regarded as priceless. It was donated to the Freer Gallery of Art, where it is now displayed. A photographic negative was obtained by the Survey, from which copies have been reproduced as plate 414B. This plate and 414A provide unique examples of his accomplishments before his artistic ability was known.

Legend has it that on occasion he would also give play to his genius by inserting drawings of dignified and scientific characters that might not have been in the original plan of a seacoast; however, no one could prove it. It has also been reported, but this cannot be verified either, that late in 1854 he engraved a sketch of a portion of the Atlantic coast. This drawing in copper is said not only to include some graceful sea serpents and beautiful mermaids but also several large and smiling whales. His Coast Survey supervisor reportedly told him that if he ever again desecrated on the Survey's charts with animal life, he would be discharged.

His next assignment was the sketch of Anacapa Island, previously described, showing the natural bridge which the waters of the Pacific Ocean had carved. Whistler did the work with extra care. He finished his pictorial view in approved style, although to him it looked humdrum. With his extreme feeling of personal frustration when not allowed to express himself freely, and with due consideration given to his job, he had to fix it— and fix it he did. He added two flocks of gulls sailing gracefully over the rocky headland as if heading south for winter quarters. These gulls may be seen today on plate 414A. When informed of wrongdoing and confronted with possible discharge Whistler replied, "Surely the birds don't detract from the sketch. Anacapa Island couldn't look as blank as that map did before I added the birds."

Due in large part to tardiness, James McNeill Whistler in mid-February 1855 terminated his employment with the U.S. Coast Survey and went off to Paris and London to achieve undying fame as one of the world's great artists. He is now known the world over, and by some authorities has been acclaimed the greatest of American artists. During his early training in the Coast and Geodetic Survey, he came in contact with some of the most talented engravers in the country.

As his legend is handed down from one generation to another of Coast Survey personnel, there is a feeling of pride that the Agency helped, even briefly, to launch one of the great careers in American art. □

ESSA's Weather Bureau is on the scene in those tense, dangerous hours

WHEN THE FORESTS BLAZE

By SUMNER BARTON
Weather Bureau

A small paper sign pasted on his protective metal helmet read "FIRE BOSS." Robert H. Tracy, the badge of the U.S. Forest Service pinned on his olive shirt, stepped into the van, squeezed between the table and the bench and sat down.

His eyes showed signs of weariness but there was a look of determination on his face. This was a momentary respite from a continuing ordeal, combatting a massive, threatening forest fire in the vast timberlands of Oregon.

Tracy took out his pipe and started to fill it. He glanced upward across the table to John Coparanis, the Weather Bureau's youthful-looking fire weather forecaster.

"How's it look?" asked Tracy.

Coparanis answered quickly. "The winds will be light and variable tonight and the humidity will show a recovery to 70 percent. However, a high pressure ridge is building up and the subsidence will reduce the humidity range tomorrow. The winds will stay to the west from 8 to 15 miles an hour with some gusts."

Tracy's face was expressionless as he heard the forecast. The winds were not unfavorable, but he would have preferred higher humidity. He knew the subsidence meant that the air aloft would descend in a typical high pressure process and this would cause it to get warmer and drier. It could have been worse, however, and his men, 1100 of them, had been making progress in the round-the-clock battle to contain an 8000-acre (13 square miles) fire in the Willamette and Deschute National Forests roughly 150 miles by car from Portland, Ore.

Historians were saying that 1967 was the worst forest fire year in half a century. Uninterrupted hot, dry weather over four months made the woodlands tinder-dry, vulnerable to every lightning stroke or spark.

Forestry men in the Pacific Northwest strained every resource to meet the challenge of close to 2500 fires, large and small, in the forests of Washington, Oregon, Idaho and Montana. More than a quarter of a million acres had succumbed to the flames during August and September.

"Fire Boss" Tracy had sat long enough on this Saturday. He was the commanding officer of this fire fighting regiment and he was responsible for planning the strategy and directing his men in combat against the enemy.

Timber is basic in the economy of the Northwest. As much as two-thirds of the region's payroll depends upon it. When logging companies are forced to suspend operations during periods when the sparks and fuel from their equipment are considered a hazard, millions of dollars each day are lost.

Tracy was well aware of his obligations. He started to rise from his seat.

"How important are the Weather Bureau's fire weather forecasters to you?" he was asked. He sat down again. Forecaster Coparanis, a native of Haverhill, Mass., who had chosen to settle in the West, looked at him intently, waiting for his answer. So did "Mr. Fire Weather" himself, W. R. "Bill" Krumm, who had left his coordination office in the Weather Bureau's Western Region headquarters at Salt Lake City to guide this writer through the mountains of towering Douglas fir, ponderosa pine and spruce.

"The weather support," said Tracy, "is vital, absolutely vital, to our operations. We are taking full advantage of it to fight this fire."

Standing beside Tracy was Forest Supervisor Spencer T. Moore, who was even more emphatic. "On-the-spot weather advice is the greatest improvement that has been made in the technique of fighting forest fires."

This commendation for Weather Bureau cooperation was to be heard again and again. Forestry Service officials are quick to point out that weather is the only variable factor in fire control. The composition and reactions of the combustible material (fuel) are known. The techniques for checking fires are well established. The one element that varies is the weather, especially the wind and humidity, and knowledge of that can save lives and determine the success or failure of a fire-fighting operation.

The forestry men were sincere in their praise and offered few suggestions for improvement in current weather dissemination procedures, but almost to a man, in headquarters and in the field, they expressed a need for expanded mountain weather research to help them define with greater precision the atmospheric effects upon fire.

Tracy and his associate, Moore, finally left the van, which was on the spot at the fire fighting base camp which was set up at a vast Winter sports clearing known as the Hoodoo Ski Bowl.

This was no ordinary van, although from the outside it looked like a conventional camper mounted on a truck. Small and inconspicuous, it could be identified by lettering on the outside that read, "Department of Commerce, Environmental Science Services Administration, Weather Bureau."

It was a camper, all right, but completely modified for its mission—the gathering of weather data from its own and surrounding areas and the preparation of forecasts critical to the fire fighters.

The Western Region of the Weather Bureau has 20 of these mobile units, assigned to 18 fire weather offices in eight states. These are always on the ready during

Continued

(Left) A Forest Service plane drops fire-retarding chemicals in advance of a raging blaze in the Northwest. Wind information obtained from the mobile units help determine the most effective areas of operation.

the fire season and are dispatched to the scene of a blaze at the request of state and national forestry agencies, including the Department of Interior's Bureau of Land Management as well as the Department of Agriculture's Forestry Service. Between April 15 and July 10, one of the units is sent from Boise, Idaho (which has two) to Albuquerque, New Mexico, to give coverage to a ninth state.

A fire weather meteorologist is dispatched with each mobile unit, which is equipped with radio by which it receives hourly reports of sectional weather conditions from the parent fire weather offices as well as a small facsimile machine which, via radio, provides selected maps depicting the nation's weather.

In addition, the meteorologist has his own instruments to measure wind, temperature and humidity at his location.

He has, in fact, a Weather Bureau station on wheels.

By radio, facsimile and his own observations, he has the information and guidance by which he can prepare immediate forecasts as required. His area of responsibility is extremely small scale, the fire to which he is assigned, but he must have a large input of data to concentrate his efforts productively.

The mobile unit procedure, sending a weather station where it is needed, is unique to forest fire fighting. The idea was conceived in the 1930's in California but its development can be attributed to Krumm, a native Missourian who has been with the Weather Bureau since 1929 and has a background of 26 years in the fire weather division.

Krumm is a name known in forestry circles throughout the West for his dedicated activity in behalf of weather service for fire control. He is fully versed in every phase of forest fires and he explains the background and problems with such clarity and patience that a listener becomes an enthusiastic supporter of the program so ardently advanced by Director Hazen H. Bedke and other members of the Weather Bureau's Western Region.

The mobile weather units offer an example of small scale meteorology functioning to the utmost usefulness, concerned with limited areas where the need is greatest.

Changes in wind and humidity can cause a forest fire to spread madly. The fire control director must be aware of any potential changes and they check with the mobile unit at their camps before deciding upon the tactics of the moment.

There is a psychological advantage, too, in having a meteorologist on the scene. It gives the fire fighters an opportunity to discuss the coming weather man to man, more satisfactory to them than the impersonal liaison of teletypewriters or telephone.

The combustible material on the forest floor responds quickly to humidity changes. The sensitivity is so great that a mere few percentage point change in relative humidity can determine whether or not a fire will start or, if started, whether it will enlarge. When the humidity is above 40 percent, for example, the fine fuels will become moist enough to resist fire. Under that figure, conditions become increasingly difficult. Oregon law requires logging operations west of the Cascades to suspend when the humidity drops under 30 percent.

Wind is more important and more complex. When the air blows over the ridge of a mountain, rapid determination must be made on the possibility of the wind breaking off and running down the slopes and valleys to fan existing fires.

Winds from the East in Western Oregon and Western Washington are feared most

Forest Service fire-fighter executes the strategy developed by the "fire boss" after consultation with the fire weather meteorologist.

because these are the chinook or foehn variety, sliding down the mountain with high velocity, getting warmer and drier during their descent. The moisture value (dew point) drops so low that the relative humidity may be under 10 percent. This can mean disaster.

Downdrafts from dry thunderstorms probably have caused more loss of life among fire fighters than any other single weather development. These can intensify the fire so that it flares to the tops of the trees, a situation called "crowning", and the blaze goes out of control. In addition, since downdraft winds may blow in a different direction than the previously prevailing wind, the chances are good that the fire will take off on a new tangent, trapping unsuspecting fire fighters in what had been a relatively calm area.

Krumm points out that a cigar-shaped fire may, under a condition of shifting winds, become a huge, raging inferno, advancing on a broad front.

The fire weather offices that dispense the mobile units from the various cities are themselves the core of the Weather Bureau operation. They are established in the same building with forestry headquarters or not far removed. Staffed with specialized meteorologists, they advise the home front of weather conditions that could bring about forest fires, they prepare pertinent forecasts, they stay in close contact with mobile units, providing them with observational data funneled in from forest lookouts and other stations and also relaying the fascimile charts that come in from Washington.

Typical of these is the fire weather office at Portland, Oregon, which was on the route of our trip to the Willamette forest area. This is staffed by four men headed by Harold S. Ayer, a 17-year veteran of the fire weather service, much of his time spent in research. Others with him are Coparanis, who was out with the mobile unit; Jack H. Oller and Robert Lynott, who was in the employ of of the U.S. Forest Service.

"In all my years in this business, I have never seen such a long duration of dry weather," Ayer said. "Nor have I seen so many fires. There have been worse fires in the past, but not so many."

The fire weather office keeps a sharp eye out for wind shifts. "It is rare," Ayer said, "that an East wind will develop without the knowledge of the forecaster. We can predict 95 percent of them 24 hours in advance."

Adjoining the weather office was the Washington and Oregon headquarters of the Forest Service, a close tie-in that seemed to function with the greatest harmony.

Alfred E. Spaulding, deputy director of the Pacific Northwest Region of the Forest Service, and Kenneth D. Wilson, fire control director, had given up their weekend to plan general strategy in their critical war on fire.

Spaulding lauded his neighbors. "The fire weather people," he said, "are a very important part of our whole setup."

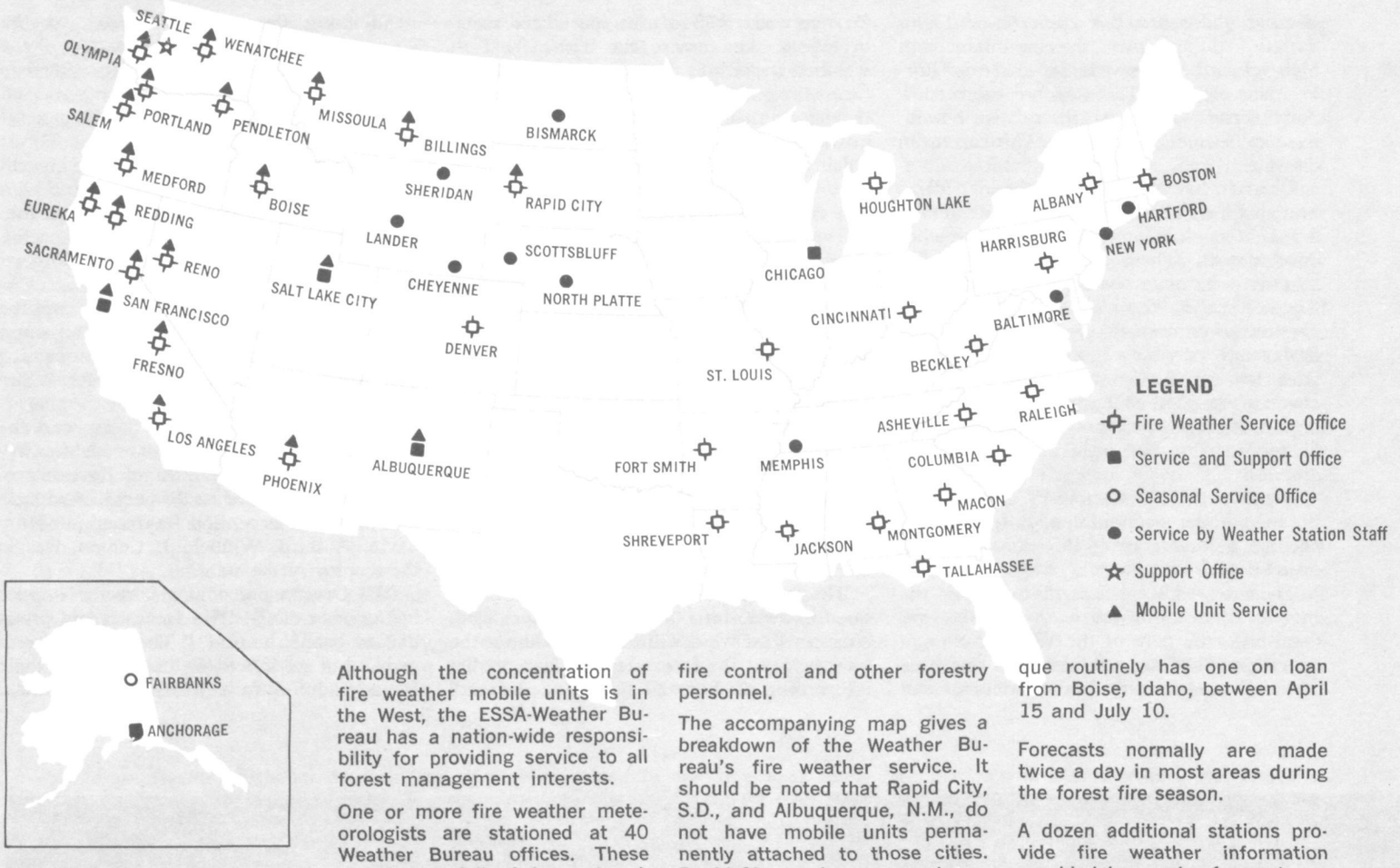
Wilson, lighting a cigar, picked up the theme. "We have learned to depend upon them 100 percent in deciding our manning and movements throughout the forest fire season," he said.

The trip carried down to Salem and the headquarters of the Oregon state forestry department. Here the Weather Bureau provides two meteorologists, Robert Kirkpatrick, who was in charge, and Raymond W. Dunnavin. A third, Winfield J. Centen, was in the employ of the state.

The Oregon fire control director stopped by for a briefing. "The forecasts are pretty darned good," he said. " They goof once in awhile but so do we. We depend upon them for our administrative decisions." *Continued*

W. R. Krumm, Fire Weather coordinator for the Western Region. (Top left) Fire weather mobile units provided by the ESSA Weather Bureau for on-the-spot reports of atmospheric conditions fire-fighters need. (Left) Fire-fighting camp at the Hoodoo Ski Bowl in Oregon's Willamette National Forest showing some of the 1150 men fighting an 8000-acre blaze. (Top right) Jack H. Oller of the Portland, Oregon, WB Fire Weather Office sends radio reports to mobile units at fire sites. (Right) Harold S. Ayer, also of the Portland WB Office, refers to forecast board to determine degree of fire danger.

WEATHER BUREAU FIRE WEATHER SERVICE



Although the concentration of fire weather mobile units is in the West, the ESSA-Weather Bureau has a nation-wide responsibility for providing service to all forest management interests.

One or more fire weather meteorologists are stationed at 40 Weather Bureau offices. These provide specialized forecast, advisory and warning services to fire control and other forestry personnel.

The accompanying map gives a breakdown of the Weather Bureau's fire weather service. It should be noted that Rapid City, S.D., and Albuquerque, N.M., do not have mobile units permanently attached to those cities. Rapid City receives one on transfer when needed and Albuquerque routinely has one on loan from Boise, Idaho, between April 15 and July 10.

Forecasts normally are made twice a day in most areas during the forest fire season.

A dozen additional stations provide fire weather information provided by regular forecast personnel.

An Easterner unfamiliar with the Pacific Northwest has a distorted image of forest fires in that vast, mountainous region. He is from the populous part of the country where a relatively small roaring fire can threaten cities or towns only a few miles apart.

The forests in the Northwest cover millions of acres of uninhabited mountains. The Washington-Oregon region of the U.S. Forest Service protects 25 million acres. The state of Oregon protects another 15 million. Add to these the vast expanses in Idaho, Montana, California, Nevada, New Mexico, Arizona and Utah. The picture changes. Here is an economic lifeline to most of these states.

A 10,000-acre fire may seem like small potatoes in this wide spread where the trees grow so profusely, but it must be checked as quickly as possible to prevent loss of valuable timber.

How is it possible for the Weather Bureau to service so large a territory with 20 mobile units? This responsibility falls in the lap of Krumm who, in Salt Lake City, acts as coordinator for the fire weather offices.

He engages in military strategy, moving the mobile units from one area of control to another depending on the needs of the moment, much as a general deploys his troops. For example, during the peak of forest fire activity during August and early September, the mobile unit that normally works out of Salt Lake City was sent to the big Sundance fire in Idaho. One from Missoula, Mont., also went to Idaho, as did one from Phoenix and one from Reno.

It would be possible to send all the units to one state if that were necessary, but during the height of the 1967 activity, 12 of the 20 mobile units were sufficient to meet the demands placed upon the fire weather service. When a fire is believed under control, the forestry service releases the unit and it returns to home base, ready to depart again upon call.

The Pacific Northwest is the region of coniferous trees, the evergreens such as Douglas fir, pine and spruce. Historically, huge crowning forest fires have occurred in coniferous forests. It is in these forests that fires start and not, as in much of the East, in the leaf or deciduous trees.

The needles from the evergreens combine on the ground with the mosses, brush and grass into an accumulation known as "duff." This is the fine fuel in which fires start and spread. Extremely sensitive to moisture, it can roar into flame when the air is dry.

Some fires in the Northwest are caused by man—from the gasoline and sparks in a logging camp, a golf cart engine, a plane crash or a vehicular accident. More than 75 percent, however, are caused by lightning.

"Dry thunderstorms with chinook East winds and dry cold fronts are the big dangers in the timberlands of the West," said Krumm. "A dry thunderstorm is one in which the rain that falls from it dries up before it reaches the ground. The lightning associated with it comes through, unfortunately. Then the fires start.

"This becomes a potentially disastrous situation when the dry East winds begin pouring down the mountains, sucking up the moisture from the fine fuels. Then, if the winds get strong enough, the fire is likely to crown (reach the tops of the trees) and the fire fighters are in real trouble. The best present we can give them is rain." □

"TORNADO!"

"TORNADO!", a new ESSA-Weather Bureau color film, is being given public release this month, with premieres planned in several major cities.

The film, many months in the making, is designed to acquaint the public with the dangers of this awesome natural hazard, and to emphasize the safety precautions to be taken to reduce the toll in death and injury.

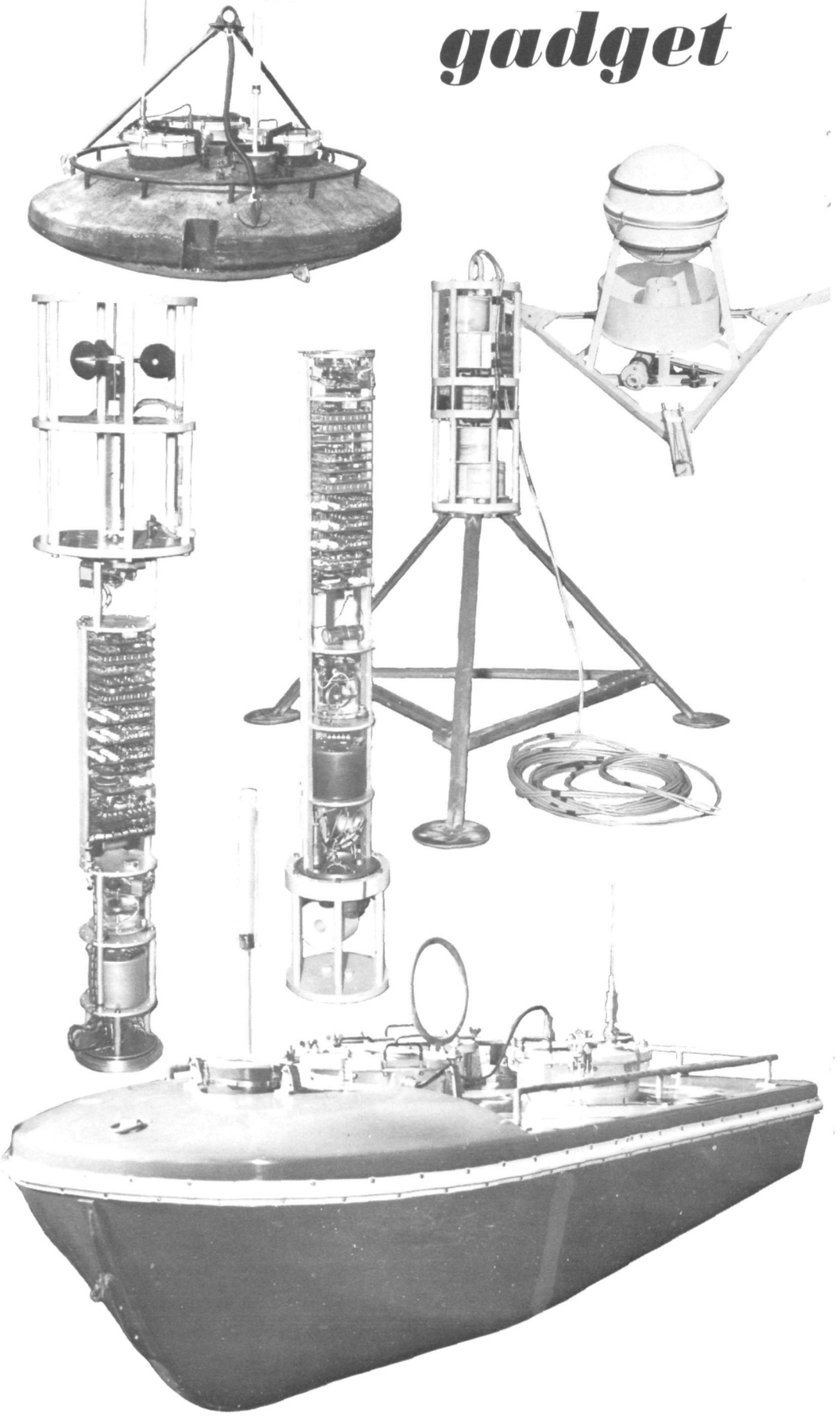
"Tornado!", which succeeds a black-and-white production viewed by many millions across the nation over a period of years, provides probably the most complete film record of tornadoes ever offered to the public. Color footage from Nebraska, Texas, Missouri and Kansas outbreaks shows in dramatic detail the fury of this storm. Production crews journeyed to Kansas City and Chicago for location shooting.

The film was written for ESSA by Coe-Peacock and produced by ASTRA Films Inc., of Washington. Jeff Baker, ESSA radio-TV-film officer, was executive producer.

It will be shown on TV, before schools, clubs and other audiences as a part of the agency's continuing programs in public safety. The front cover of this issue of ESSA *World* is from the movie, and other photos from its making appear here. □

a can-do Coast Survey unit has an amazing

specialty / the impossible gadget



"Bring us your problem and we'll solve it."

This might well be the slogan of the Coast and Geodetic Survey Engineering Division.

The problems posed to this group by the Survey's ships, field parties, and operating divisions, by other ESSA components, and by private industry include such puzzlers as:

How can we station delicate recording instruments in mid-ocean, 100 feet below the surface, in water a mile or more deep? *Answer:* Build a stable underwater platform held to the sea bottom by steel cables and buoys.

How can we speed the surveying of America's last frontier—the 800,000-square-mile continental shelf off the U.S. coasts? *Answer:* Develop an unmanned automated device which will do the surveying for you—24 hours a day.

Under Division Chief Thomas J. Hickley, these problems are tackled by 18 engineers, physicists, geophysicists, and mathematicians, assisted by 31 electronic technicians, instrument makers, draftsmen, and administrative personnel. Each new task is a challenge to their knowledge, experience, and ingenuity.

Some problems can be solved quickly; others involve years of painstaking work before the best solution is found. For example, more than five years have been spent in developing the underwater stable platform from which tides, currents, waves, and the earth's magnetic field can be measured.

Recently, the platform's instrument capsule was replaced with a new one—while the platform remained in place in the sea. In this capsule a transducer, which ordinarily records the distance to the bottom of the sea, operates upside down to record the distance to the crest of the waves. The "trick of the week"—fitting the equipment into the capsule—was performed in the Engineering Division's Instrument Section.

The instrument shop is a beehive of activity, with many projects in various stages of completion. Chief Edmund C.

Duringer and his assistants are constantly called upon to fabricate items of all sizes, shapes, and materials. Jobs are done from design drawings, from samples and pictures, or from such simple instructions as "Fix this so it will work."

Most of the Division's projects result in the development of a prototype article, with plans and specifications adequate for securing bids on identical items. Some—like the platform—are completed entirely within the Division.

For other projects, the Division does the design work, prepares specifications for parts, and completes the assembly. In this way, they developed the new narrow-beam and stabilized echo sounders for the USC&GS ships DISCOVERER, OCEANOGRAPHER, and SURVEYOR. These devices restrict the area from which data is gathered to a small, definite area directly beneath the ship.

In a third category of projects, the Division uses commercially available component parts, modified by the supplier or by the Division itself. When the equipment is installed, staff representatives go along as "trouble shooters"—to make sure it works properly and to instruct personnel in its use.

Equipment completed entirely within the Engineering Division includes: One of the first electronic positioning indicator (EPI) systems, developed 20 years ago. Besides serving as the agency's primary offshore navigation device, it was used to assist a telephone company in laying a cable between Seattle and Alaska. Later, the Division was asked to build a number of the units for the Navy, which used them in Arctic oceanographic research.

Helmholtz coils for magnetometers. Since these were unavailable, the Division built five. They still are not available

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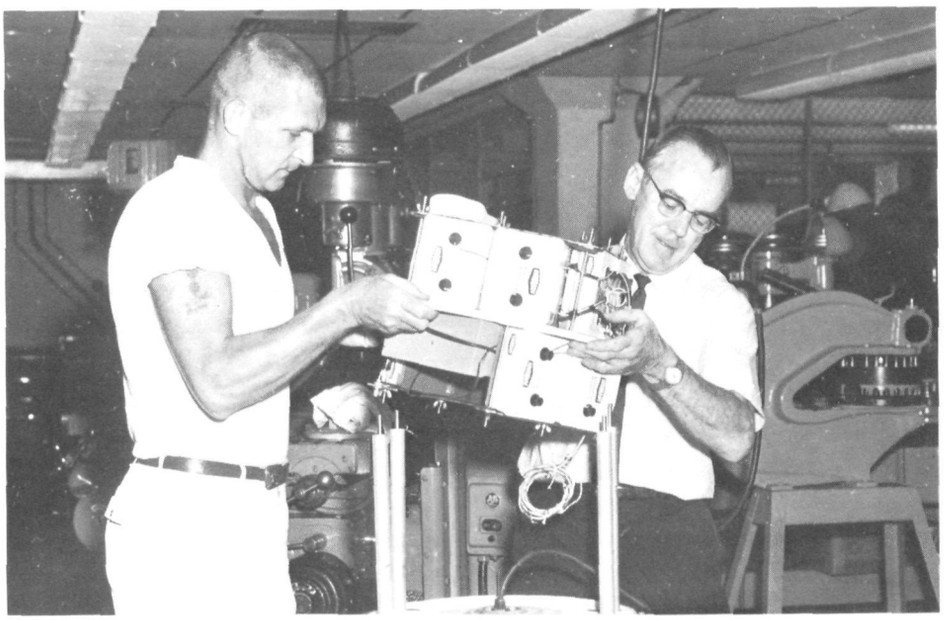
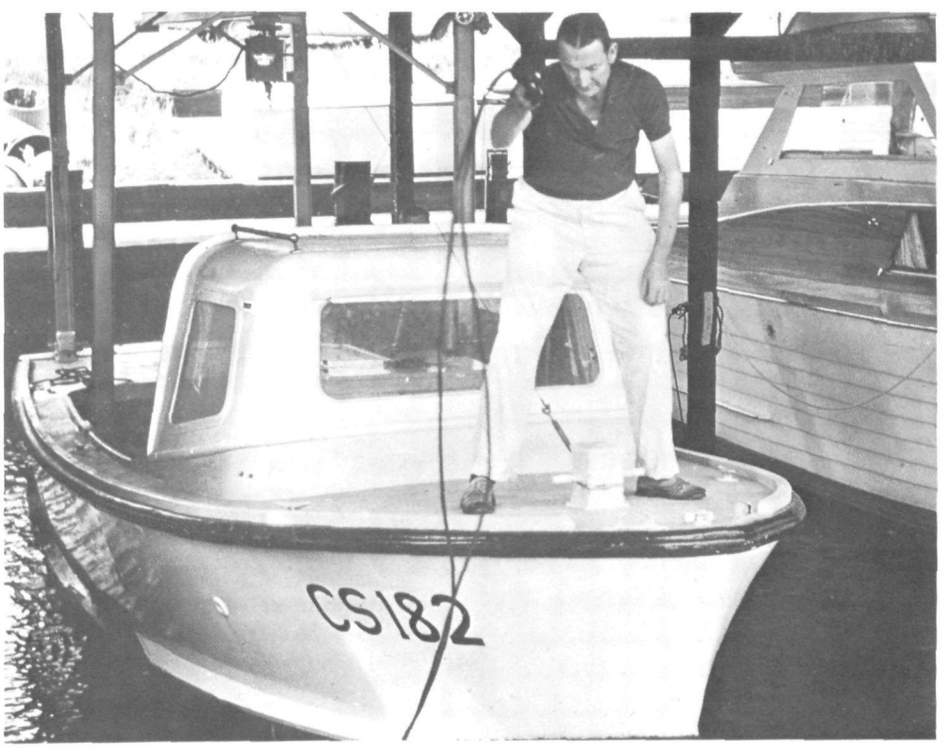
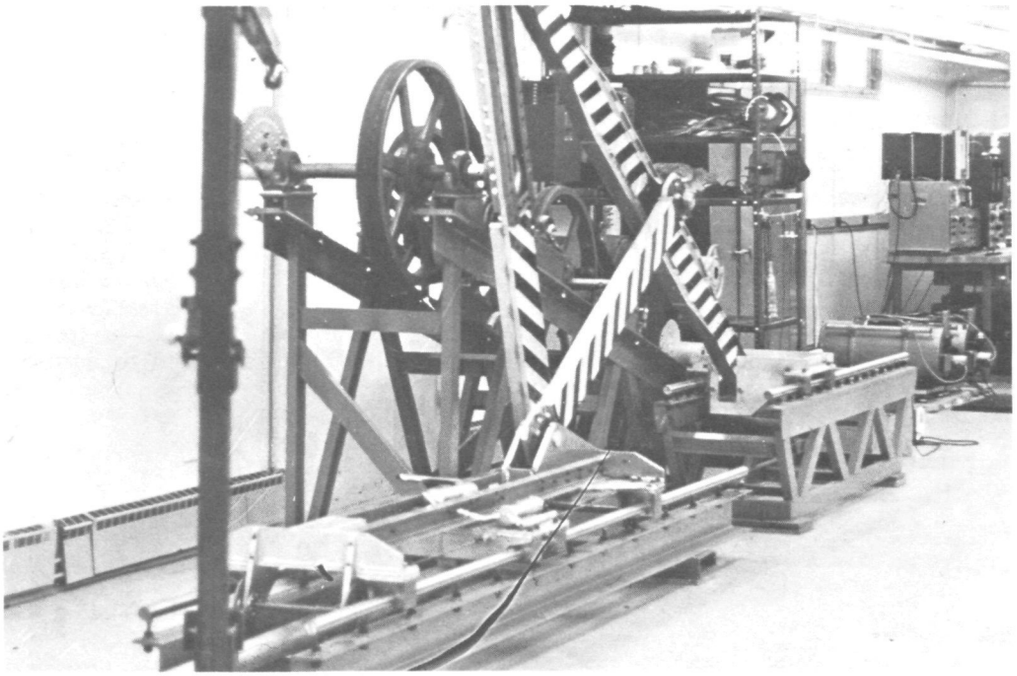




(Top left) Instrument Maker John R. Jennings (left) and Mechanical Engineering Technician William H. Leimbach preparing the wave-height recorder for installation on the underwater stable platform. John Jennings donned scuba gear to oversee the positioning of capsule on the platform. (Left) Norwood E. Sherron aboard one of the two 26-foot launches available for exclusive use in testing instruments and systems in the sea environment. The launches and smaller craft provide the proving-ground laboratory for engineers and scientists away from their drafting boards.



Gravity meter equipment installed at the Coast Survey's Beltsville (Md.) Calibration Site, which eliminated the need for the Coast Survey to send its shipboard gravity meters to manufacturers to be checked for accuracy. Designed by Mechanical Engineer James C. Fitz, the table incorporates a simulated wave action.

Shown above with (l. to r.) Instrument Maker Salvatore Caltabiano, Electronic Engineer Charles W. Iseley, Anthony J. Goodheart, Chief, Ocean Engineering Branch, and Instrument Maker Thomas F. Hammett, is the Division's most recently developed system, which has successfully recorded tides in water a mile deep.

commercially, but C&GS personnel at the Fredericksburg Geomagnetic Center have made some, using specifications provided by the Division.

The Bubbler Tide Gage. The gage does not require a tide well, and can be used in areas where wells are difficult to install.

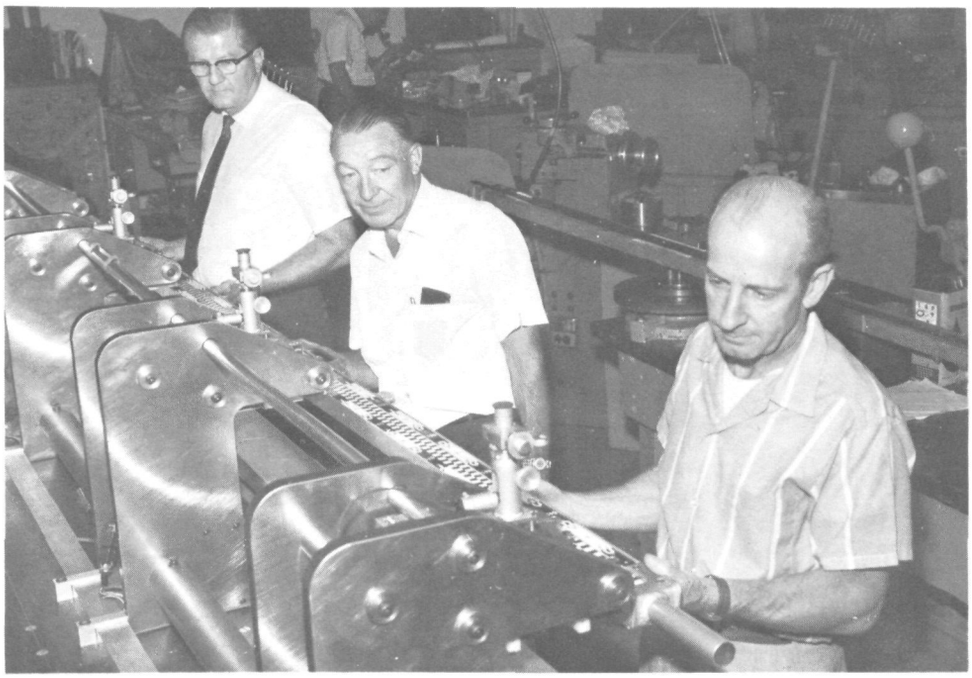
The Laser Geodimeter. The first system of measuring precise distances with the laser beam as a light source was made by revamping a geodimeter and installing the laser tubes and mirrors.

Equipment designed and built by the Division, using parts built to its specifications, includes: a system for recording tides a mile underwater. It can be tethered on lines with a marker buoy on the surface, or dropped over the side of a ship to make measurements for a predetermined time and then float to the surface.

A release system incorporating acoustical telemetering principles. This system will enable a ship on the surface to communicate with an instrument on the ocean bottom, to check on the instrument's operation, and to command it to release its anchor.

Much of the Division's effort goes into the development of various buoy systems, which automatically record and transmit data to a mother ship or to shore. One of these, the TICUS (for Tidal Current Survey) system, has successfully passed all tests and was used last summer by the USC&GSS Ship MARMER for a survey of Long Island Sound.

Another, the ODESSA (Ocean Data Environmental Science Services Acquisition) system also has passed field trials and completed a 30-day survey in the Potomac River. ODESSA measures the temperature, salt content, and depth of the water and the speed and direction of



Thomas J. Hickley, Chief, Engineering Division. (Left) Instrument Makers George W. Morthland, Edmund C. Duringer and Donald E. Linthicum, (l. to r.) testing level-rod tape scribing bench for microscopic accuracy.

its currents as well as barometric pressure, air temperature, and wind speed and direction.

A third bouy system has revolutionized the Coast Survey's current-metering operations. It incorporates an internal magnetic-tape-recording system which produces a record which can be fed directly into a computer.

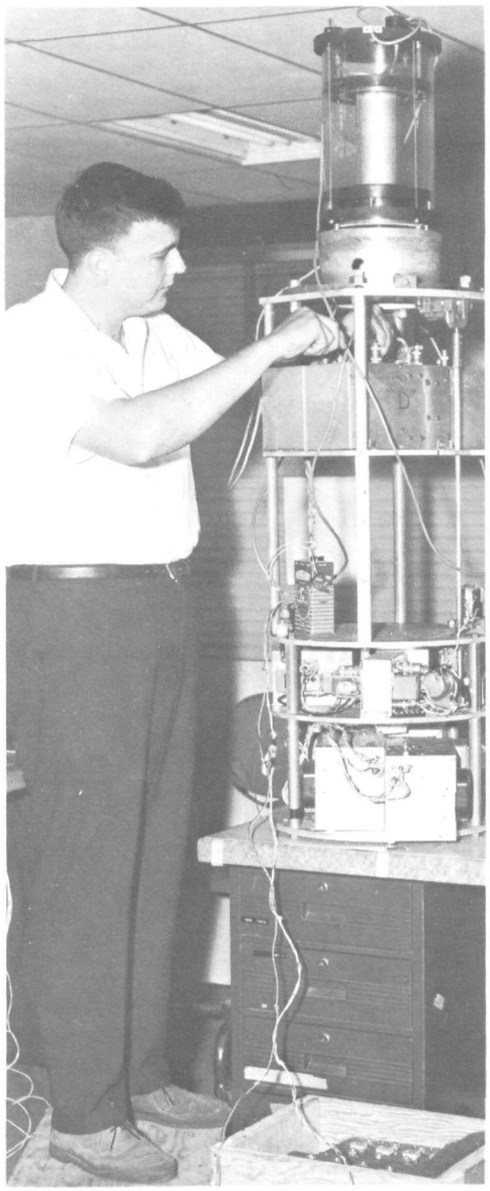
The ESSA Commissioned Officers assigned to the Engineering Division, Lieutenants Floyd S. Ito and Clifford A. Wells, are engaged in testing an automated system in which remotely controlled hydrographic survey launches sound the ocean floor and telemeter the information to a mother ship. When perfected, this system promises exploration of the continental shelf.

The Division's achievements stem from the skills and knowledge of its staff, their field experience and its flexible staffing arrangements.

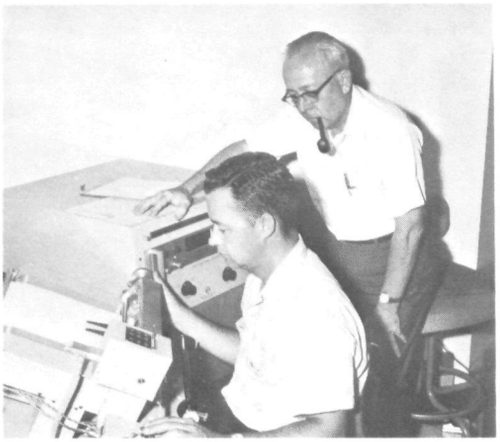
Its personnel hold degrees in science and engineering from the Alaska, Idaho, Maryland, Minnesota, Montana, Brigham Young, Catholic, George Washington, Misissippi State, Northeastern, Susquehanna, Texas A&M, and Yale universities; from the City College of New York; Massachusetts, Munich, and Vienna institutes of technology; and Virginia Polytechnic Institute.

The men of the Engineering Division are field-oriented. They have been there, and they know the problems from actual experience. It is estimated that between them they have more than 100 years' experience in field operations.

Finally, they are assigned to a project according to its requirements and their talents and experience. Every project is a team problem of interest to, and the responsibility of everyone. □



Karl H. F. Schaffrath (left) and Donnie B. Miller see a demonstration by Gordon J. Walker of the adaptation of the laser to the conventional geodimeter.



Designer Ole K. Schmidt watches Instrument Maker Donny R. Sharp test the Monogram Scanner which speeds up production of tide prediction tables. (Left) Electronic Technician Carl W. Reed assembling underwater sensoring equipment.

A mechanical whiz-kid at Suitland's NMC is

THE FORECASTER'S FRIEND

Microfilm scanners read map pictures on film chips mounted on computer aperture cards.

A technological revolution in weather forecasting is under way.

The event that triggered it was the invention of the modern large-scale computer, the machine that performs the millions of calculations necessary to describe how the atmosphere will behave.

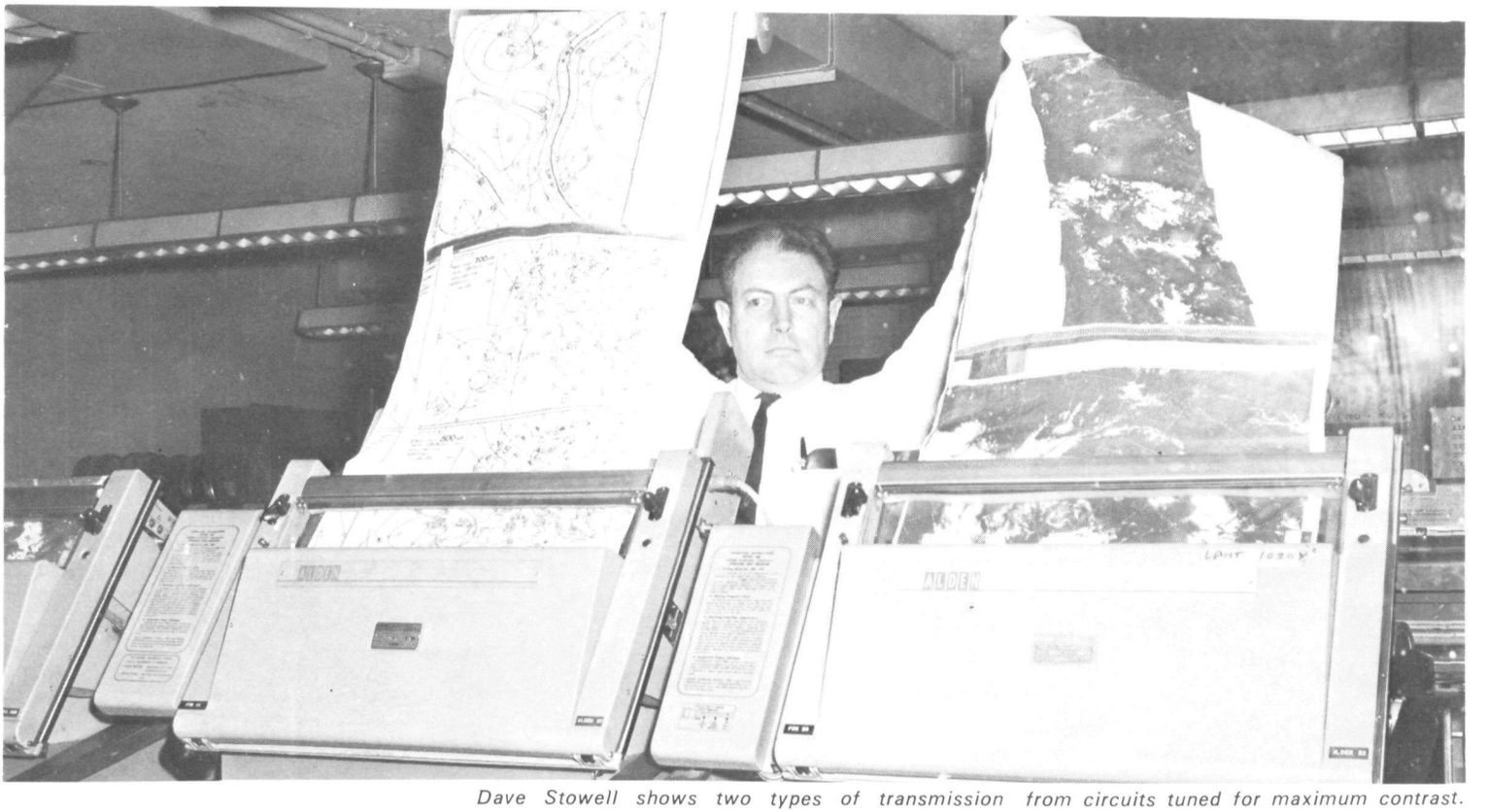
In the past 13 years, the Weather Bureau's National Meteorological Center at Suitland, Maryland, has made significant advances in computer, or numerical, forecasts as techniques and computer capability have increased.

Since July of 1966, it has consistently broken or tied previous records in its surface (sea level) forecasts and has had comparable successes in upper atmosphere predictions.

Dr. Frederick Shuman, Director of the Center, emphasizes that all of this is not the work of the computer alone. Man still plays the dominant role since he not only instructs the computer, but has the element of judgment that cannot be fed into a computer.

"We have not yet been able to produce a numerical sea-level forecast which the analyst cannot successfully modify," he said. "This is the interesting aspect of the National Meteorological Center — the successful mix of man and machine."

"Man by himself and machine by itself make sea-level forecasts of about equal quality," he said. "But when the two are combined, a superior product results.



Dave Stowell shows two types of transmission from circuits tuned for maximum contrast.

"As one meaningful measure of the superiority of the mixed product, the 48-hour sea-level prediction of today has skill equal to the 30-hour predictions made before the era of numerical weather prediction. Thus, we have gained an 18-hour advantage through the use of numerical weather prediction.

"We can now forecast for the day after tomorrow with almost the same skill as we used to forecast for tomorrow."

A new model is being applied in forecast ranges up to six days. "Its skill has not as yet been determined," he said.

The progress in weather prediction is closely tied to the advances in computer technology, according to Dr. Shuman.

"It is testimony to the difficulty of the weather forecasting problem that it was sought out as one of the earliest for investigation with the new computing tool," he said.

Numerical weather specialists speak freely in terms of models that are applied in computer calculations. By models they mean the equations or the writing down in mathematical form the fundamental physical laws governing atmospheric behavior. For readers with a scientific bent, these are the first law of motion, the first law of thermodynamics, the law of conservation of mass, and the equation of state for an ideal gas.

Difficulties arise first in obtaining all of the observational data required by the mathematical equations to achieve desired results and then in acquiring computers large and fast enough to perform millions of computations required to solve the equations over an entire hemisphere within operational time limitations.

These obstacles necessitated radical simplification of the fundamental equations through neglect of many terms describing various physical effects. Subsequently, modeling became increasingly improved and there was an accompanying upsurge in forecast accuracy.

The first landmarks in numerical procedures were the barotropic model and the three-level baroclinic model.

The barotropic is the simplest since it describes behavior of an atmosphere in which the temperature at every point is determined completely by the atmospheric pressure at that point.

In the real atmosphere, the distribution of temperature is somewhat independent of the distribution of pressure. For example, low pressure may be observed in both polar and tropical regions at a time when temperatures may differ by as much as 100 degrees F.

Obviously, the barotropic model was not adequate and a model was required to permit the description of both the temperature and pressure fields.

This requirement can be satisfied by mapping (plotting) the height of two or more surfaces of constant pressure, 500

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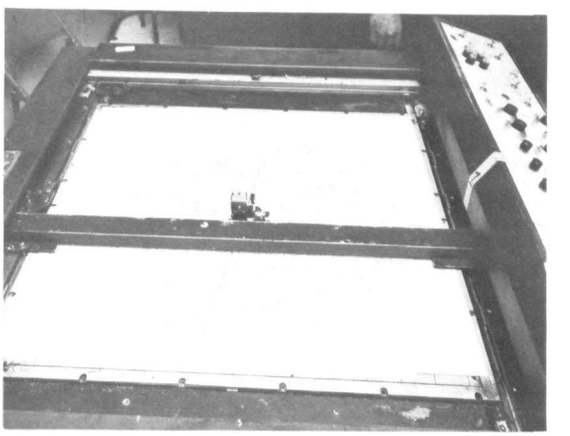


The curve follower machine can draw a hemisphere map in about 4 minutes.

Scanners read black and white areas from satellite pictures to send NMC charts. More than 20 facsimile circuits go to all parts of the globe.

Surface study by analysts William French Margaret Supplee and Bill Rammer, from satellite cloud pictures.

Technician Jim Dodge defines information into line symbols from a machine made chart prepared for transmission via facsimile.

and 200 millibars (18,000 to 35,000 feet), for instance.

The distribution of the difference in the height of two pressure surfaces serves to specify the distribution of temperature within the atmospheric layer lying between these two pressure levels. This immediately is a gain over the barotropic.

Models that take into account temperature distribution are called baroclinic. These have a major advantage over the barotropic in that they can predict the generation of storms whereas the barotropic only serve to predict the movement and decay of storm systems.

The most refined of the baroclinic models is that which is currently used at the National Meteorological Center. Instead of three constant pressure levels as in its previous baroclinic model, NMC now uses six levels, vastly more sophisticated. The more information that can be obtained and computed through the depth of the atmosphere, the greater the accuracy of the output.

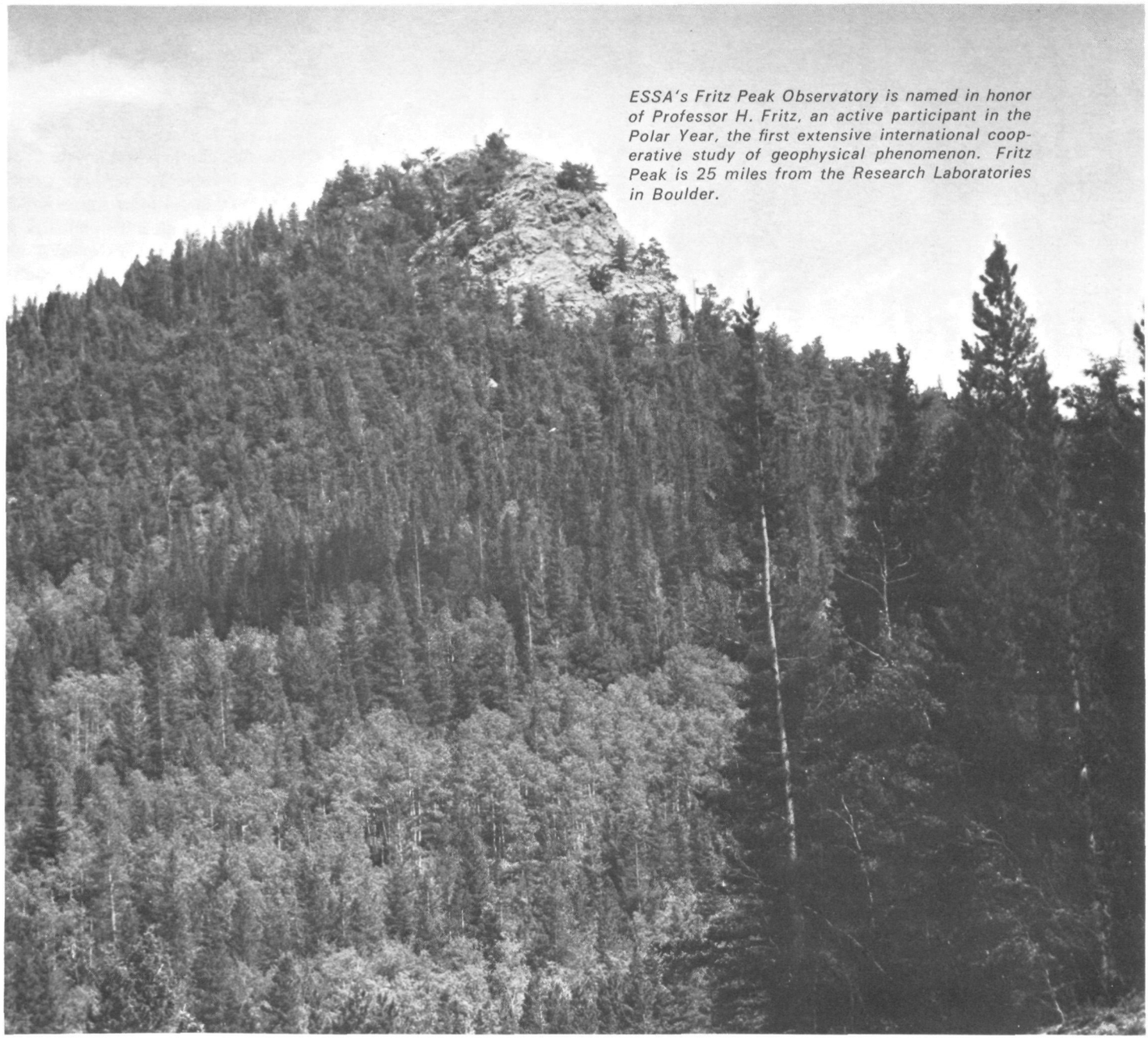
The new NMC form is called the six-layer primitive equation (PE) model in which "primitive" means "original", not "ancient", and refers to the most common and fundamental form of the equations of physics. Development of the earlier models started with more complex forms of the equations which were then simplified, neglecting small terms. Neglect of these small terms has long been suspected as a source of forecast error. It turns out to be much easier to revert to the primitive equations than to take into account all of the terms in the complicated equations used in earlier models.

The PE model uses data at six pressure levels, permitting a detailed description of both pressure and temperature. But one thing is missing. What about moisture?

This factor was added this year with the inclusion in the PE model of what is described as the effect of the "feedback of latent heat." This process takes into account the fact that heat is released when water vapor in the atmosphere condenses. The heat provides additional storm energy, and the condensed water assumes the forms of clouds and rainfall.

The latent heat addition has had the encouraging result of refining the movement and intensification of surface low-pressure (storm) systems.

"The weather prediction problem in relation to computers has been likened to a gas which fills all available space no matter how much its container is expanded," said Dr. Shuman. "Progress has undoubtedly been paced by computer development. If acceleration of growth of computer power should slacken, progress in weather prediction would be slowed. A pessimistic view is not justified, however. Full advantage has not yet been taken of the present generation of computers and much more powerful machines are on the horizon." □



ESSA's Fritz Peak Observatory is named in honor of Professor H. Fritz, an active participant in the Polar Year, the first extensive international cooperative study of geophysical phenomenon. Fritz Peak is 25 miles from the Research Laboratories in Boulder.

By JOANN TEMPLE
ESSA Research
Laboratories

The decor? Colorado baroque. The mission? Modern as tomorrow

ESSA's Fritz Peak Observatory is a curious mix of photometers, snowshoes, computing equipment, and a decor reminiscent of the Victorian Age.

The observatory is housed in an isolated mountain lodge of Fritz Peak 25 miles from the Aeronomy Laboratory in Boulder, Colorado. Michael Gadsden, Chief of Optical Aeronomy, and his seven staffers commute daily from Boulder and, in winter months, the trip through Boulder Canyon and into the Colorado Rockies can be difficult.

Once they've dug their way in and settled down in the ornately wall-papered upstairs rooms left by the previous owners, the Fritz Peak staff becomes involved in a wide range

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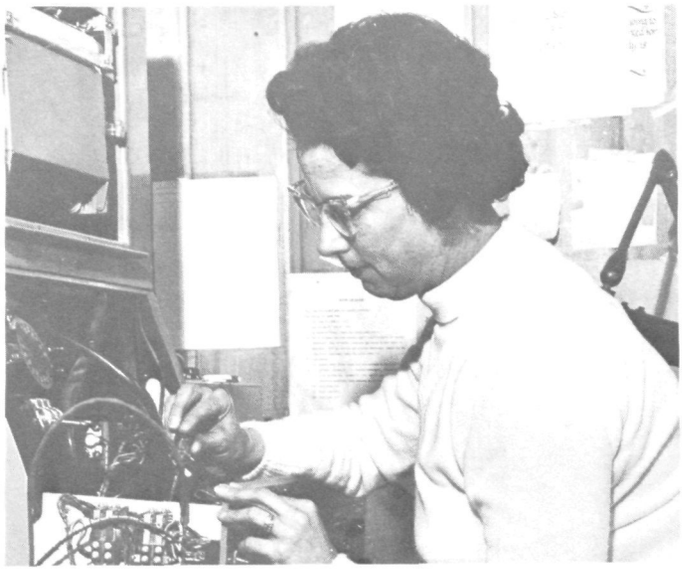
BOULDER'S AIRGLOW VIGIL*

* *Airglow: Light from the nighttime sky that originates in the high atmosphere and is associated with photo chemical reactions of gases by solar radiation (Webster).*



(Top) H. Virginia Blacker calibrates standard lights and filters for other airglow observatories. This measurement, developed at ESSA's Fritz Peak Observatory, is available free to any researcher in the world. (Right) Hanzel L. Crawford scales charts in front of the once-festive fireplace of Fritz Peak Observatory. (Below) Charles M. Purdy operates a photometer atop Fritz Peak 9000 feet above sea level.

of scientific activities. On the first floor, past snowshoes and shovel stored in glass display cabinets, H. Virginia Blacker calibrates standard lights for other airglow observatories around the world. Data processing equipment dominates the large stone fireplace on the second floor, while the third floor is given to offices and scientific equipment receiving readings from the instruments at the top of Fritz Peak. From 9000 feet above sea level, these instruments have an unobstructed view of the entire sky and yield atmospheric data on such varied things as nightglow, low-latitude aurora, and the behavior of meteors and interplanetary dust.

For two weeks of each lunar month, Fritz Peak operates on a 24-hour-a-day observing schedule. Charles Purdy, Edward Marovich, Jerry Smith and Orrin Mills perform this task.

Observations of night airglow made at stations around the world are usually concerned with determining a line of the visible light spectrum which is isolated from any other background light by use of narrow interference filters. Thus, the accuracy of night airglow observations depends not only on a practical standard source of light for comparison, but also on calibration of the filters.

In the hope that standardization of lights and filters will lead to useful new airglow data, the Fritz Peak Observatory offers to calibrate light sources and filters for researchers around the world. Mrs. Blacker has had customers from as far away as the University of Botswana, Lesotho, and Swaziland in the small African nation of Lesotho.

Fritz Peak needs only two days to perform the measurements on a light source and four filters. With airmail both ways, the light and filters are away from their photometers for a maximum of two weeks. Like Fritz Peak, many airglow observatories are on a two-week-per-month observing sched-

ule through the last and first quarters of the moon. Even the maximum two-week measuring period does not then interfere with an established observing program.

At twilight, both evening and morning, the upper atmosphere is in transition. The photochemical and ionospheric regions of the atmosphere are ending a period of prolonged sunlight or darkness and are therefore in the process of changing. The progress of these changes can be used to study either the daytime or nighttime condition of the atmosphere.

One spectrographic observation which is greatly enhanced at twilight is that of red-arc aurora. This low-latitude aurora was first recognized during the International Geophysical Year (1957-1958). Records from Fritz Peak for eleven years, from 1955 through 1965, were re-examined to check on the occurrence of these unusual aurora which occur through a theoretically forbidden energy transition of oxygen. The light emitted by oxygen after colliding with a high-energy particle is usually a yellow-green color which can appear white when mixed with other colors as in the usual aurora or northern lights. Study of the red auroras offers the possibility of deeper physical understanding of processes in the magnetosphere and the F-region of the ionosphere.

The red auroras—variously called mid-latitude arcs, M-arcs, red arcs, and SAR-arcs—tend to persist for most of the night when they occur. Although a definite correlation is not established, red arcs do tend to occur at sunspot maximum and Fritz Peak expects to see an occasional one next year, with many chances of observation in 1969 through 1971.

Since Fritz Peak is the only observatory constantly watching for this phenomenon, when a red arc occurs the observatory staff immediately informs interested satellite experimenters such as those with instruments aboard NASA's Orbiting Geophysical Observatories and the Topside Sounder spacecraft.

Much of Fritz Peak's nightglow or airglow work is associated with interest in sodium in the upper atmosphere. Sodium and other metal atoms have been noticed in the upper atmosphere for many years. For as many years, scientists have debated theories about how these atoms got there. Meteors and interplanetary dust offer the two most logical sources for metals in the upper atmosphere.

Extra-terrestrial atoms released into the upper atmosphere are of interest to many scientific disciplines. Meteoric material may be responsible for a number of atmospheric phenomena including the occasional glowing, noctilucent clouds which reflect sunlight from below the horizon.

Recent theories suggest that ablation, a boiling and sputtering process where a solid passes directly to a gas, of small meteors may account for the metal atoms detected in the atmosphere. Dr. Gadsden theorizes that much of the sodium population comes from meteors with radii of only a few ten-thousandths of an inch. Many such meteors orbit the Sun in the same direction as the Earth and are swept up by the Earth. They ablate some 55 miles above the Earth's surface. This meteor influx seems to be greatest near the equator about 6:00 p.m.

Meteors moving in the opposite direction enter the atmosphere at higher velocities on the dawn hemisphere and ablate some 15 miles higher in the atmosphere. The morning influx is less than the evening one.

If this theory is correct, the observed abundance of sodium in the atmosphere should increase towards 6:00 p.m., at all but the highest latitudes. Until recently, daytime measurements of the sodium population were impossible.

Jacques Blamont, a physicist in France, developed a Zeeman photometer which can detect the faint emission lines of sodium even when they are masked by an overpowering background of scattered sunlight. Gadsden has recently adapted this Zeeman photometer in observations of the sodium dayglow and Fritz Peak is now making such measurements. A 24-hour picture of the density of atomic sodium as a function of altitude may provide some answers to the puzzle about metals in the atmosphere. □

Dr. Michael Gadsden adjusts the twilight spectrometer by the glow of yellow sodium light. In addition to the work at Fritz Peak, Gadsden is involved in studies with VHF backscatter radar, eclipsed observations and low-level aurora in polar regions. Early next year, an airborne experiment is planned over the polar cap.

ESSA NEWS BEAT

New Research and Training Center

Colorado University, ESSA Form Institute

Formation of a cooperative institute for research and training in the environmental sciences has been announced by the University of Colorado and ESSA.

The "Cooperative Institute for Research in Environmental Sciences," to be known as CIRES, will involve several departments of the university and ESSA's Research Laboratories in Boulder.

CIRES will be devoted to research and advanced training in continuum mechanics, geophysical fluid dynamics, solid earth and planetary geophysics, including geochemistry; and plasma science including magnetohydrodynamics. While focusing on theoretical problems, CIRES' research may also include field investigations and instrumentation, experimentation, and documentation and bibliography.

This work is expected to advance man's understanding of the weather, his ability to make two-week forecasts accurately, and his ability to beneficially modify the weather. It is also aimed at increasing man's knowledge of the planet's geological history and present-day dynamics, possibly making it easier for scientists to predict the earth's future. Another area that will gain from the work of CIRES will be ionospheric research, with a resultant benefit in telecommunications.

CIRES, which will be housed at the University, has three major purposes:

Dr. Joseph R. Smiley, President of the University of Colorado, Dr. Robert M. White and Dr. George S. Benton, signing agreement establishing CIRES.

To provide a means for increasing effectiveness of research and teaching in the environmental sciences through close collaboration between CU and ESSA.

To provide a center for collaboration of environmental science research workers from Boulder, the Nation, and throughout the world.

To provide a means for training personnel for research in the environmental sciences.

The initial phase of development of CIRES will be under the guidance of a steering committee composed of five representatives of the University and five from ESSA. Dr. George S. Benton, Director of ESSA's Institute for Environmental Research (IER), is chairman of the committee.

Commerce Fellows Named For 67-68

Eight ESSA men are participating in the Department of Commerce Science and Technology Fellowship Program for '67-68.

After an intensive educational and orientation program, they will work in other agencies, in activities related to their specialities. The Fellows, and their agency assignments for the coming year, are: ESSA — Howard L. April, Department of State. Weather Bureau — Edward W. Bison, Office of State Technical Services, Commerce; Arthur R. Kneer, National Bureau of Standards. Coast Survey — Frank H. Branca, National Bureau of Standards; Everett H. Ramey, Office of Hydrology, Weather Bureau. National Environmental Satellite Center — Jerry C. Glover, National Aeronautics and Space Council; Holmes S. Moore, President's Commission on Marine Science, Engineering and Resources. ESSA Research Laboratories — Paul I. Wells, Office of World Weather Systems, ESSA.

ESSA Artists Winners In Commerce Show

ESSA employees carried off numerous honors in the Fifth Department of Commerce Art Show, sponsored by the Commerce Welfare and Recreation Council.

ESSA winners in the five cateories were: Oils — Joanne Dvorak, first prize. Water colors — Helen B. Vogt, second prize; Beulah Ramey, third prize and honorable mention. Pastel drawings and graphics — Robert G. Hall, first prize; Shirley Harnish Ganse, second prize; Arthur F. Lamay, third prize; and Edward F. Beisel and Dorothy E. Allen, honorable mention. Sculpture — Dorothy E. Allen, first prize; Joanne Dvorak, second prize; and Wendell P. Taylor, third prize. Ceramics — Vernon Dvorak, second prize; and Joanne Dvorak, third prize. Edward F. Beisel also won the popular vote prize, which was offered for the first time. Mrs. Alexander B. Trowbridge, wife of the Secretary of Commerce, presented the awards.

4.5-Million-Square-Mile Photos

ESSA 6 LAUNCHED AT WESTERN TEST RANGE

ESSA 6 — a new weather satellite offering cloud pictures to anyone, anywhere, equipped to receive them — was successfully launched from NASA's Western Test Range at Lompoc, Calif., on Nov. 10, at 12:45 p.m.

The polar orbiting satellite's two automatic picture transmission cameras will photograph the earth's cloud cover every six minutes and will automatically send the pictures to any properly equipped ground station with a 2150-mile range.

Each photograph will cover an area of four and one-half million square miles.

ESSA 2 and ESSA 4, the new spacecraft's older sisters in the TOS system, have transmitted a total of 80,000 photographs in this manner. The value of the instant weather pictures is demonstrated by the increasing number of ground stations equipped to receive them. When ESSA 4 was launched in January 1967, 180 APT receiving stations were in operation around the world. Since that time, the number has increased to 305 — 216 in the United States and 89 in other nations. Weather services of 45 foreign nations receive and use the photographs each day. Among the other users are 26 universities, an estimated 25 to 30 U.S. television stations, and private citizens who have built their own receivers.

Today, APT receiving stations are operating on every continent, as well as aboard ships at sea. The instant weather pictures have been especially valuable in improving local forecasts and briefing pilots, since they provide up-to-the-minute information on weather conditions over a large area around the receiver. At New York's Kennedy Airport, APT pictures are used routinely in the flight clearance procedure.

The TOS system, financed by ESSA and managed and operated by ESSA's National Environmental Satellite Center, provides both global and local cloud-cover pictures every day New launches are scheduled as needed to assure both types of coverage. The system began operation in February 1966, with the launching of ESSA 1 and ESSA 2. Pictures taken by ESSA 1, ESSA 3, and ESSA 5 are stored for transmission to ESSA's two Command and Data Acquistion stations, and are used in central analysis of global weather. ESSA 2 and ESSA 4, which the new spacecraft will replace, are equipped with Automatic Picture Transmission camera systems.

Responsibility for construction and launching of the new satellite was assigned by NASA's Office of Space Science and Applications to the Goddard Space Flight Center. The Astro-Electronic Division of RCA constructed the satellite.

The improved Delta launch vehicle, built by the McDonnell-Douglas Corporation, was used to place the satellite in orbit.

See photos on back cover.

EDS' Degree Days Statistics Useful

One daily statistic computed at ESSA weather offices hits the householder right in his pocketbook.

That statistic is the degreee day, a useful measure of cold. When day and night temperatures average 65 degrees or higher, most buildings require no heat. But for every degree of average temperature below 65, more fuel is needed to maintain comfort.

To provide a precise measure of the demand for fuel, every degree of daily temperature below 65 is considered to be one degree day. Thus, a day with a mean temperature of 35 degrees would be computed as 30 degree days. It would require twice as much fuel for heating as a day with a mean temperature of 50 (15 degree days).

So valuable has the degree-day concept become that daily or monthly totals are routinely computed for all temperature observing stations in the ESSA-Weather Bureau networks. Past degree-day records are used by fuel companies in planning their storage needs. Daily figures are used in scheduling fuel deliveries.

When a short test run by his oil supplier shows that Mr. Jones' new house needs one gallon of fuel oil for every 4.4 degree days, delivery schedules are matched to this burning rate. Each day, the dealer logs in the daily degree days from ESSA observing stations. When the total reaches 440, it's time for another hundred gallons to be delivered.

With gas or electric heat, the system dispatcher must ensure that consumption does not exceed capacity. Each area dispatcher has a critical degree-day load dependent on the local climate and marketing conditions, peak demand costs, and other factors. When daily degree days exceed the critical value, less essential industrial activity is curtailed. Low-priority users accept a lower off-peak rate in exchange for the agreement to shut down when degree days reach a certain level.

The impact of a cold spell is enormous. Fuel costs in a service area may easily total $5,000 to $10,000 for each degree day. Forecasts by the Weather Bureau are immediately converted to degree-day estimates. Private meteorologists refine their services to include hourly or peak degree-day rates, trends, and changes to suit the needs of industrial clients. Under such conditions, the official Weather Bureau measurement of temperature becomes very critical.

Maps of degree days for each month of the year are published by ESSA's Environmental Data Service. January is the coldest month and hence shows the greatest degree-day values in nearly all areas. The annual map shows that fuel consumption in central Wisconsin (A) would be about double that of extreme southern Illinois (B) and about four times greater than that in south central Alabama (C) — if building construction and living habits in the areas were similar. Since such factors are not constant, these ratios are modified by actual experience.

Comparisons of fuel consumption in a single area are more accurate. For example, March fuel costs in the Middle West average about 70 percent of the costs for January. In Chicago the coldest six months, ranked in order of decreasing coldness, are January, December, February, March, November and April.

ESSA Research Arm Is Reorganized

ESSA's research element has been reorganized and renamed. The Institutes for Environmental Research have become the ESSA Research Laboratories.

Its primary components are 12 laboratories and the Research Flight Facility. One laboratory will still be an institute. Within the office of Dr. George S. Benton, Director, are an Office of Programs and an Office of Technical and Administrative Services.

In formation of the ESSA Research Laboratories, a management layer has been removed to give laboratory heads a direct communications channel to the Director, eliminating the four Institutes through which the laboratories have reported, and to encourage interdisciplinary cooperation between scientific fields.

Located in Boulder, Colo., are the Space Disturbances Laboratory, Aeronomy Laboratory, Wave Propagation Laboratory, Atmospheric Physics and Chemistry Laboratory and the Institute for Telecommunication Sciences. The latter retains Institute designation to maintain continuity as the central Federal agency for research and services in support of the Nation's telecommunications industry. Also based in Boulder, with branches in San Francisco and Rockville, Md., are the Earth Sciences Laboratories.

Outside Boulder are the Atlantic Oceanographic Laboratories, the National Hurricane Laboratory and the Research Flight Facility in Miami; the Pacific Oceanographic Laboratories in Seattle; the National Severe Storms Laboratory in Norman, Okla., the Air Resources Laboratories in Washington, with branches in Cincinnati, Oak Ridge and Las Vegas; and the Geophysical Fluid Dynamics Laboratory in Washington, D. C.

Many staff functions have been grouped in the new Office of Programs. The Office of Administrative and Technical Services (formerly the Office of Administrative and Support Services) will provide all administrative and technical services for the ERL and will also be responsible for services to the National Bureau of Standards' Boulder Laboratories.

ESSA Personnel Changes Announced

Numerous personnel changes have taken place throughout ESSA in recent weeks. Among those of note are the following:

DR. ELDON E. FERGUSON has been appointed director of ERL's Aeronomy Laboratory, succeeding Dr. E. K. Smith. Dr. Ferguson, who has headed ITSA's Atmospheric Collision Processes Section, received his Ph.D. in physics from the University of Oklahoma. Before joining the Boulder Laboratories in 1962, he worked in private industry, and for the Naval Research Laboratory, and served on the faculty of the University of Texas. In 1965, he received the Commerce Gold Medal for his work on the atomic and molecular processes in the upper atmosphere.

REAR ADMIRAL NORMAN E. TAYLOR has succeeded Rear Admiral Harold J. Seaborg as Director of the C&GS Pacific Marine Center in Seattle. Admiral Taylor is a veteran of 24 years with the C&GS, and formerly commanded the USC&GSS SURVEYOR. He served as Deputy Director of the Pacific Marine Center from February 1964 to June 1966, when he was named executive officer of the SURVEYOR and subsequently commanding officer in October 1966. Admiral Taylor is a graduate of Washington State University with a mechanical engineering degree.

DR. JOACHIM P. KUETTNER, formerly Chief Space Scientist at NESC, has been named ERL's Director of the Office of Advanced Research Projects. Prior to joining ESSA, Dr. Kuettner was Director of the Mercury-Redstone Project and the Saturn-Apollo System's Office at NASA's Marshall Space Flight Center.

CAPTAIN RAYMOND M. STONE has become C&GS West Coast Field Director, relieving Captain Emmett H. Sheridan. Capt. Stone, previously Associate Director of the C&GS Office of Hydrography and Oceanography, is a 27-year career officer. He is a former commander of the USC&GSS HYDROGRAPHER and MARMER.

COL. WILLIAM S. BARNEY, retired Air Force officer, recently joined the staff of the Office of World Weather Systems as a Program Coordination Officer, after 30 years in Air Force meteorological operations.

BARBARA J. MCKAIN has been appointed meteorologist-in-charge of the WB Airport Station at Norfolk, Nebr. Miss McKain is the second woman MIC now heading a WB station. She joined the Weather Bureau at Norfolk in 1943.

LOTHAR A. JOOS has been selected as the Regional Climatologist for the WB's Central Region. Mr. Joos is a former State Climatologist for Illinois.

CDR. GERALD L. SHORT is the new Chief of Operations at C&GS' Pacific Marine Center. Cdr. Short was formerly commanding officer of the USC&GSS PATHFINDER.

KEITH W. VEIGAS has become chief of the WB Eastern Region's Scientific Services Division succeeding Silvio G. Simplicio. Mr. Veigas holds a master's degree in meteorology from New York University.

HOWELL M. BUTLER, geophysicist, is chief of the Palmer Seismological Observatory in Alaska. Mr. Butler received his B.A. degree in geology from Louisiana Polytechnic Institute in 1955, and joined the C&GS in 1960.

EDWIN G. KITTLESON has been named administrative officer of the C&GS Pacific Marine Center in Seattle. Mr. Kittleson has been in the Federal Government since 1937.

PAUL E. WOOLARD, formerly head of the WB office in Agana, Guam, has been selected to head the Pacific Missile Range Weather Unit at Barking Sands, Hawaii. Mr. Woolard joined the Weather Bureau in 1951.

MRS. WILMA AMANTE of ESSA's Administrative Operations Division has been named Chief, Support Services Section, succeeding Wayne Sulecki. Mrs. Amante entered the Weather Bureau in 1952.

CARL A. VON HAKE is acting chief of the C&GS Seismology Investigations Branch in the absence of James F. Lander, who has accepted a year's fulltime university assignment.

Wilma Amante

Dr. Eldon E. Ferguson

Dr. Joachim P. Kuettner

Barbara J. McKain

Rear Admiral Norman E. Taylor

Carl Von Hake

Effects of Great Alaskan Earthquake Recorded By Survey

The great Alaskan earthquake of March 1946 was so powerful that mountains subsided, the seabed rose 50 feet in one area, and the shock waves tore boats from their moorings along the Gulf of Mexico.

The Mississippi River rose 1½ to 5 feet, and water sloshed over the top of a swimming pool in Atlantic City, N.J.

At Hilo, Hawaii, the seismic sea wave caused by the great quake caused the water to rise more than 12½ feet and in Antarctica, the tsunami was recorded 22½ hours later.

More than three years have elapsed since the earthquake struck Alaska. Seismologists are still gathering information on its effects. Some of their findings are incorporated in a technical report issued by ESSA, the work of geophysicist Mark G. Spaeth and oceanographer S. C. Berkman of the C&GS.

They have found that:

1. Mountains on Kodiak Island and near Prince William Sound subsided 7 feet or more.
2. The ocean floor rose in a 480-by-127 mile area. The highest uplift was 50 feet, the greatest ever recoded, between Kodiak and Montague Islands.
3. Shock waves caused the earth to vibrate with enough strength to generate seiches as far away as Key West, Fla.

Widespread, though relatively minor damage was caused along the Gulf coast in an area extending 340 miles from Houston, Tex., to Lake Borgne, La., and inland as far as Baton Rouge, La., 90 miles from the Gulf. At New Orleans, a sudden rise of 1½ feet in the Mississippi River caused vessels at the dock to break from their moorings.

4. Of the 131 fatalities, only nine occurred outside the areas hit by the tsunami. Of the 131, there were 15 outside Alaska, including 11 in Crescent City, Calif., and 4 in Newport, Ore.
5. The tsunami caused an estimated property loss of 101 to 105 million dollars. Kodiak City, Alaska, sustained the greatest damage, approximately 31 million dollars.
6. The highest point reached by the surging waves was 220 feet above sea level near Valdez, Alaska, where a slice of land approximately 4000 feet long and 600 feet wide fell into the sea.

Sea Floor Tested In Maine Gulf

Tests designed to determine the ocean floor's ability to support structures have been conducted by ESSA in cooperation with the University of Illinois' geology department.

The unique program employed new instrumentation developed by the University with financing by the Office of Naval Research.

The tests were carried out at a depth of about 885 feet in the Wilkinson Basin, approximately 60 miles east of Boston in the Gulf of Maine, by scientists from the Marine Geology and Geophysics Laboratory of ESSA's Atlantic Oceanographic Laboratories, and from the University.

Dr. George H. Keller, laboratory director, was in charge. Collaborating with him was Dr. A. F. Richards of the University of Illinois Department of Geology. The tests were conducted from aboard the USC&GSS DAVIDSON, commanded by Lt. Cdr. K. William Jeffers.

Keller said the tests involved an entirely new approach to the study of the mass physical properties of ocean sediments. It consisted of developing and testing instrumentation capable of measuring these properties directly in the sea floor to a depth of 10 feet below the sea bottom.

Previously, he explained, studies of this type have only been conducted in the laboratory on samples taken from the sea floor. This program allows all the testing to be carried out directly in the sea floor, thus increasing the reliability of the data and reducing the testing time in the laboratory.

Three unique instruments have been developed to measure sediment shear strength, bulk density and water content, and pore pressure.

Data collected during the study serves two major purposes. It provides engineering data on the strength and bearing capacity of submarine sediments which are required before any sizable installation can be placed on the sea floor. This area of concern is increasing in importance as we begin to develop habitats for man and extend oil well drilling platforms further from shore. Second, it provides a new approach to the study of diagenesis (the process whereby mud or sand becomes rock over thousands of years). This process is not yet fully understood.

In the tests, the shear strength of the sediment was measured by driving a four-bladed vane into the sea floor and applying a torque (or twisting force) sufficient to cause the sediment's strength to fail. The maximum torque was then recorded and related to the sediment's shear strength.

To determine the sediment's bulk density, a two-prong probe was used, housing a gamma emitting source (cesium 137) in one prong and a scintillation detector in the other.

These prongs were used interchangeably from an aluminum tower, 14 feet high and 8 feet wide at its base, which was lowered to the sea floor to provide a platform from which the probes were operated. Once the tower reached the bottom, a motor in its framework was energized to drive the probe (vane or density) into the sediment. When the vane was used, an additional motor cut in to provide the necessary torque. The entire operation of the probes and recording was controlled by cable from aboard the ship.

MINI-WEATHER SYSTEM, MIGHTY MIDGET, UNDER TESTING

A new achievement in miniaturization is the development by the Weather Bureau, of a complete weather observing system small enough to fit into a suitcase.

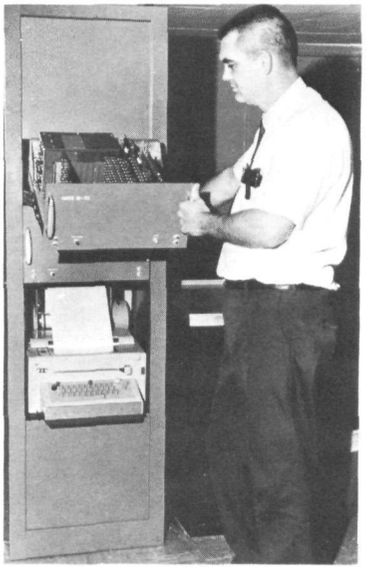
AMOS III-70 weighs only 50 pounds and fits into a standard Weather Bureau rack drawer roughly 19 inches deep, 19 inches wide, and 9 inches high.

The name "AMOS", derived from Automatic Meteorological Observing System, is applied to a series of Weather Bureau programs relating to automatic data gathering.

A prototype of the new automatic station has been sent to the Weather Bureau's Test and Evaluation Laboratory for a year's functional assessment. Operational use in the field is planned for 1970, if resources permit, as a replacement for the original AMOS III, which is 10 times larger and far less versatile.

AMOS III-70, built with the most advanced integrated circuitry, composes standard teletypewriter messages from information provided by a variety of weather instruments. At the proper moment, these reports are fed into the national weather teletypewriter network.

This is expected to be of value in the dissemination of weather observations for general and specialized forecasting use, especially for aviation interests which receive hourly teletypewriter reports of conditions throughout the nation.



Electronic Technician Donald M. Edwards with Amos III-70.

The new system has advantages over older models in cost, reliability, and size. When production is in full swing, the sets will cost approximately $6000, exclusive of sensors (observation instruments) and installation charges.

The program now calls for installation at existing weather stations to assist busy observers and to provide information during hours when those stations would otherwise be unmanned. Also under consideration is the potential for acquiring information from locations too remote for manned observation platforms, such as mountain and ocean areas.

In its present configuration, the automatic station can translate data from seven observational sensors into usable teletypewriter information. These are temperature, dew point, wind direction, wind speed, precipitation occurrence (is it raining now?), precipitation accumulation, and altimater setting (a value used by pilots for takeoff and landing).

The set is designed, however, to include various types of information that may be inserted by an observer. Extra sections have been built in to allow insertion of six more observational readings in future expansion.

The system was developed by the Equipment Development Laboratory's Processing and Display Section under the direction of Richard H. Waters.

The functional requirements for the system were established by the Weather Bureau's Data Acquisition Division and the Systems Plans and Design Division.

ESSA Aerial Addition: A Buffalo Bird

The newest addition to ESSA's arsenal of scientific aids is a Buffalo.

A Buffalo, in this case, is an airplane — a De Havilland declared surplus by the Air Force and turned over to NASA, which in turn transferred it to ESSA.

The two-engined ship, with a 36,000-foot ceiling, will be used in the Coast and Geodetic Survey's aerial photography program. Its interior will accommodate three aerial cameras, infrared sensors, and special navigation and ranging devices. Conversion will take approximately a year.

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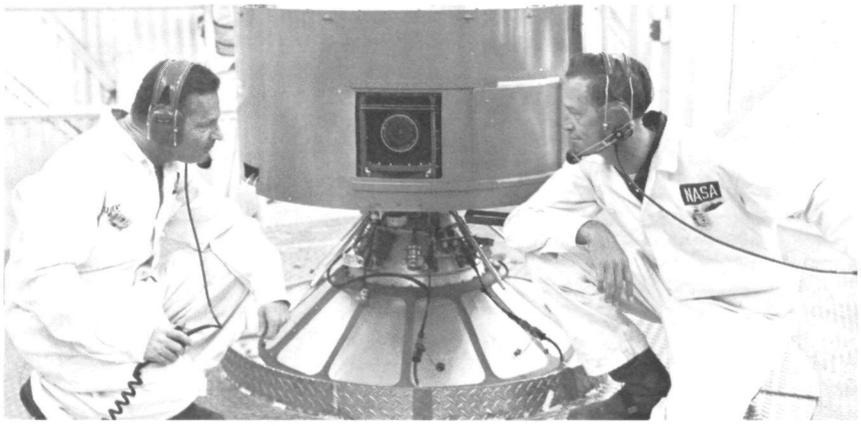
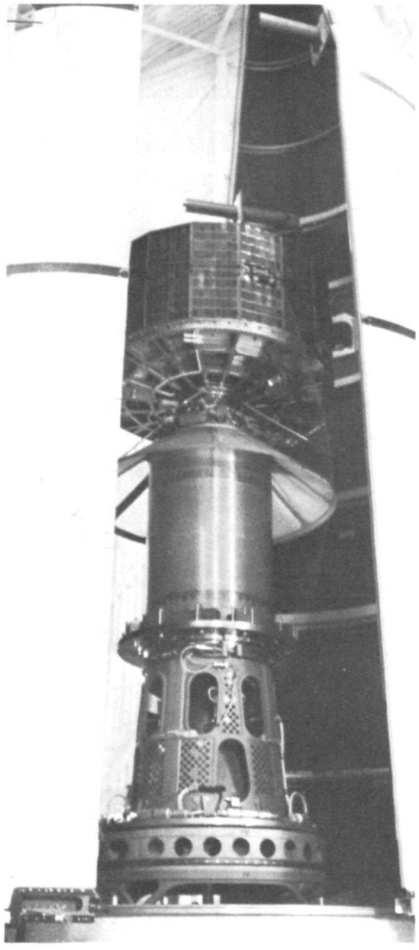
ESSA 6 went into orbit November 10th

(Story on page 33)

Checkout





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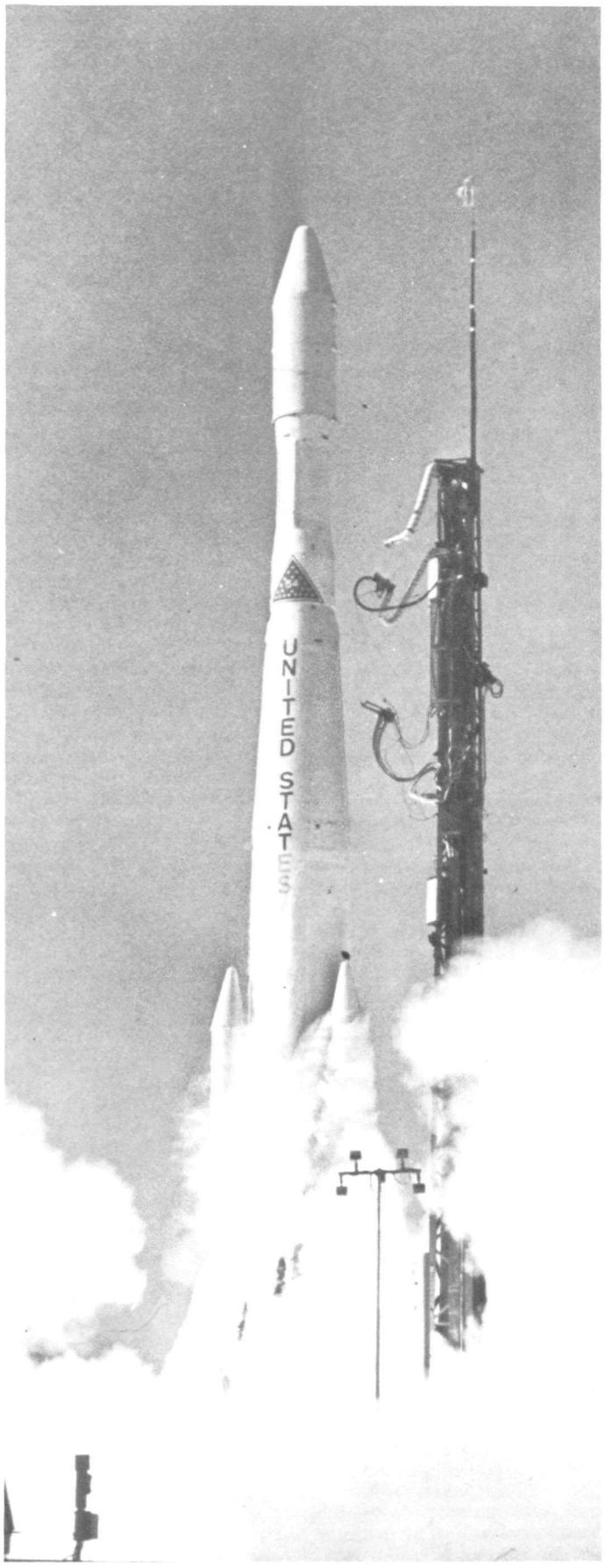

Blast-off