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Anybody Can Make More Money If...

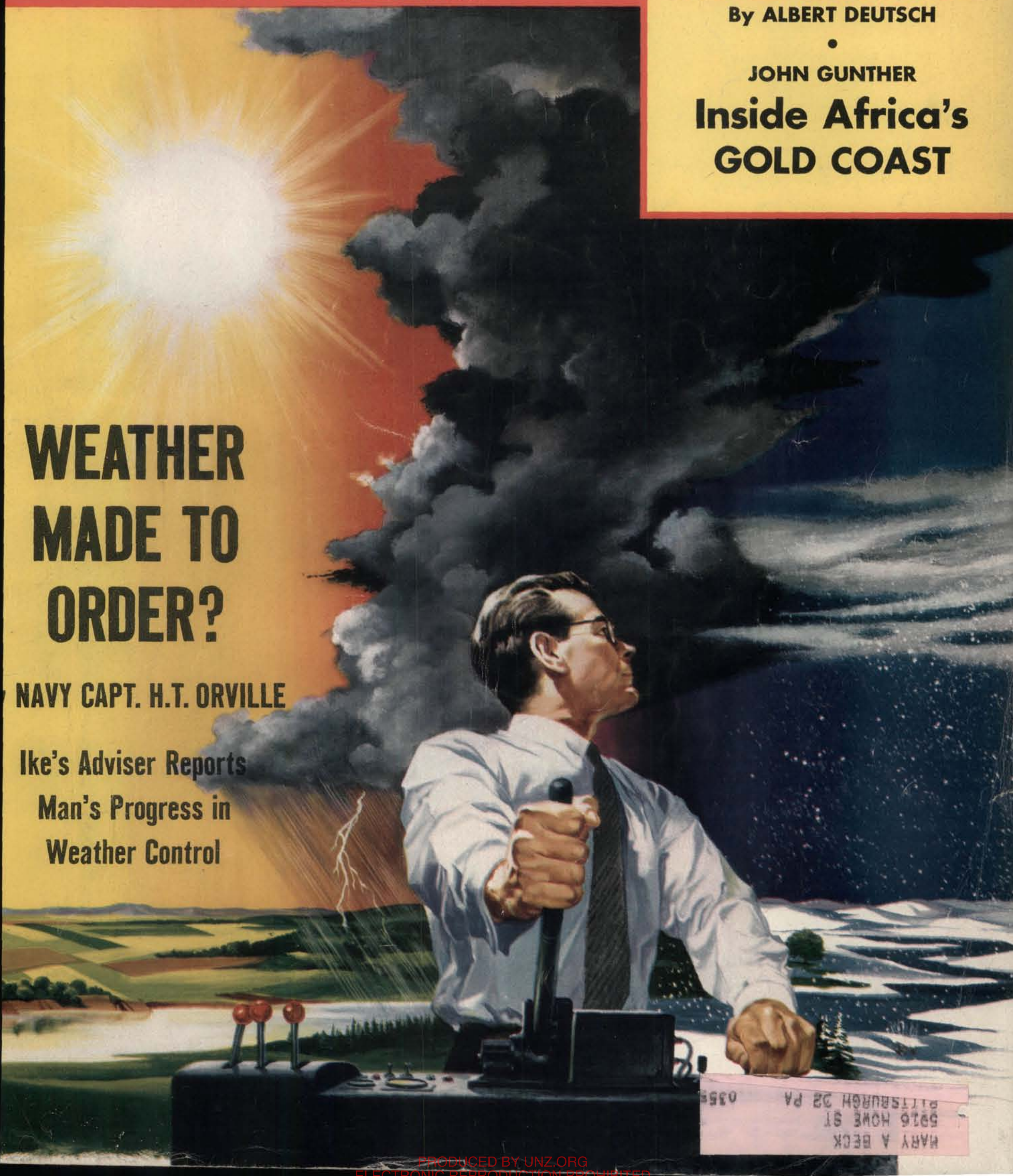
The Plight of the Honest Cop

VICE SQUAD

By ALBERT DEUTSCH

JOHN GUNTHER

Inside Africa's GOLD COAST



WEATHER MADE TO ORDER?

NAVY CAPT. H.T. ORVILLE

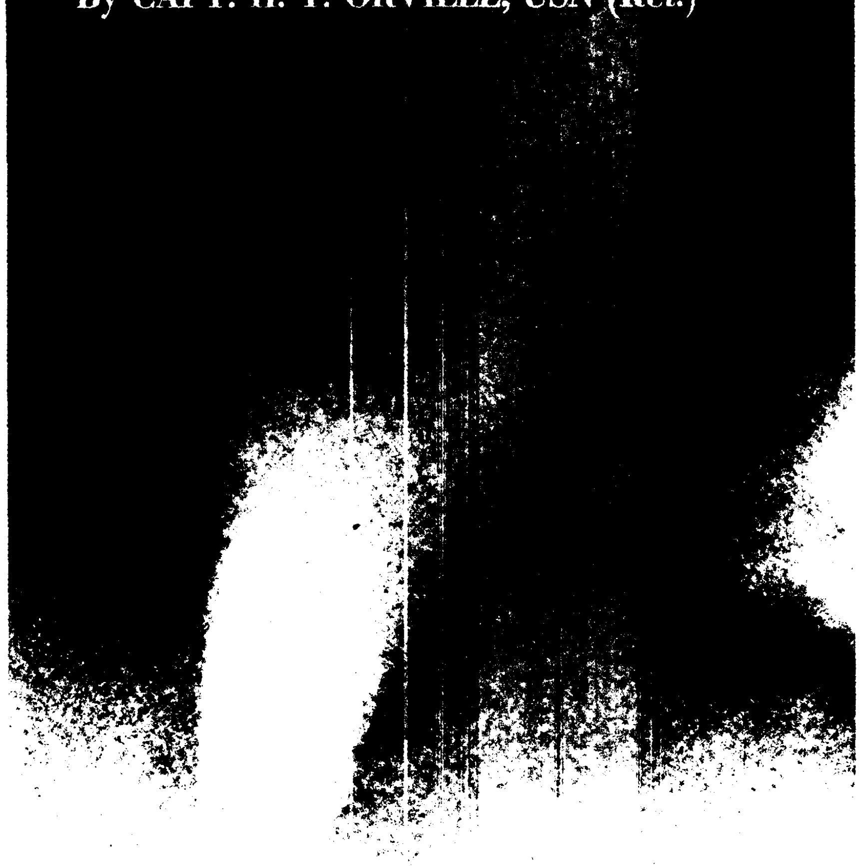
Ike's Adviser Reports Man's Progress in Weather Control

1545 HRS...TO HQ WEATHER CONTROL...THUNDERSTORM INDICATING POSSIBLE
TORNADO BUILD-UP OBSERVED EAST OF SAN ANGELO MOVING AT 45 KNOTS
TOWARD WACO...RECOMMEND DISSIPATION...AIRCRAFT ALERTED... TEXAS STA. ONE

WEATHER Made to Order?

Within 40 years, a top expert says, we may break up tornadoes and produce rain or snow virtually at will

By CAPT. H. T. ORVILLE, USN (Ret.)



A WEATHER station in southeast Texas spots a threatening cloud formation moving toward Waco on its radar screen; the shape of the cloud indicates a tornado may be building up. An urgent warning is sent to Weather Control Headquarters. Back comes an order for aircraft to dissipate the cloud. And less than an hour after the incipient tornado was first sighted, the aircraft radios back: Mission accomplished. The storm was broken up; there was no loss of life, no property damage.

This hypothetical destruction of a tornado in its infancy may sound fantastic today, but it could well become a reality within 40 years. In this age of the H-bomb and supersonic flight, it is quite possible that science will find ways not only to dissipate incipient tornadoes and hurricanes, but to influence all our weather to a degree that staggers the imagination.

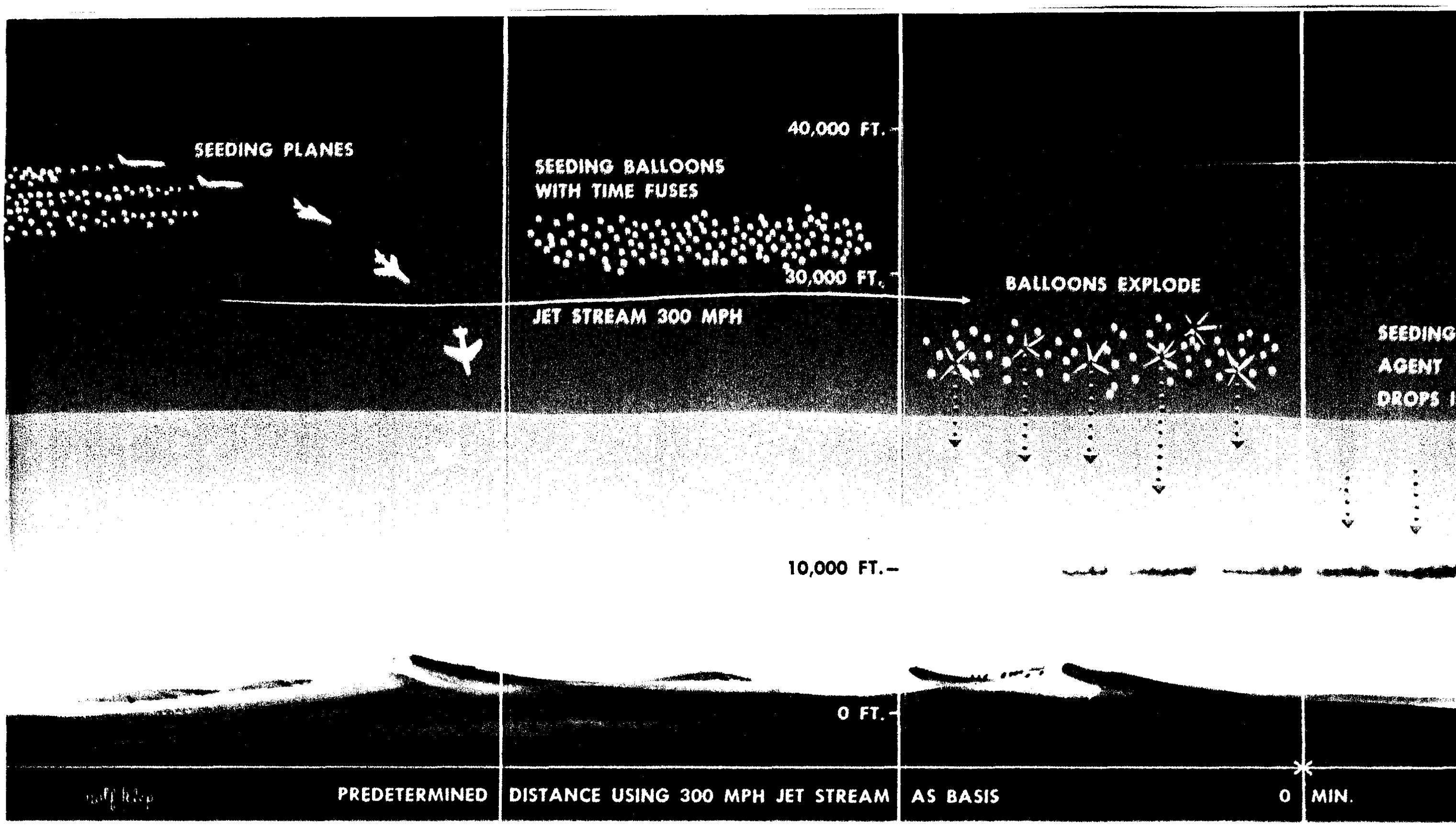
Indeed, if investigation of weather control receives the public support and funds for research which its importance merits, we may be able eventually to make weather almost to order.

By milking rain or snow from reluctant clouds at the proper time and place, we may be able to transform vast barren areas like the American dust bowl into fertile crop-productive land, drastically reducing famines the world over. Rain-on-order likewise could curb forest fires that destroy an average of 16,000,000 acres of timber in the United States every year.

We also might be able to prevent rain—for the farmer when he wants to dry his hay, for the fruit grower who fears fungus-promoting dampness, for the outdoor-sports promoter, even for sponsors of Sunday-school picnics.

Heavy thunderstorms may be moderated to lessen the hazards of floods, which cause $275,000,000 worth of property damage a year in the United States. Freezing rain, snow and sleet which stall surface traffic and damage communications lines may be drastically reduced. Hailstorms that wreck crops may be halted. Fogs that delay airline flights might be dispersed.

It is even conceivable that we could use weather as a weapon of warfare, creating storms or dissipating them as the tactical situation demands. We might deluge an enemy with rain to hamper a mili-



Weather control used as a military weapon: adapting civilian techniques to warfare, planes could drop balloons containing seeding crystals i

He's Weather Adviser to the President

Capt. Howard T. Orville, USN (Retired), is chairman of the Advisory Committee on Weather Control appointed by President Dwight D. Eisenhower to correlate information on weather-control experiments and to recommend ways of supervising future commercial operations in the field.

A graduate of the U.S. Naval Academy, Orville was awarded a master of science degree in meteorology by Massachusetts Institute of Technology in 1930 and has been active in weather work ever since. During World War II, he was weather adviser to the Secretary of the Navy, the commander in chief of the U.S. Fleet and the Chief of Naval Operations. He charted the weather for the historic first air raid on Tokyo led by General James Doolittle and was one of the principal weather advisers for the Allied invasion of North Africa.

Capt. Orville was one of the first to recognize the importance of radar in combating destructive storms; it was largely through his efforts that the Navy developed methods for locating and tracking hurricanes and typhoons by radar. In addition to his weather duties, he is at present a technical consultant to the Bendix Aviation Corporation's Friez Instrument Division.

Besides Orville, there are four other civilian members on the Advisory Committee on Weather Control. They are: Dr. A. M. Eberle, dean of agriculture of South Dakota State College; Lewis W. Douglas, former ambassador to Great Britain, now a prominent rancher and miner in Arizona; Kenneth C. Spengler, executive secretary of the American Meteorological Society; and Brigadier General Joseph J. George, U.S. Air Force Reserve, superintendent of meteorology of Eastern Air Lines. Charles Gardner is acting executive secretary of the committee.

tary movement or strike at his food supplies by withholding needed rain from his crops.

Countless other benefits could accrue from an efficient method of weather modification. My belief that many of these benefits could be obtained within 40 years is based upon my 26 years as a weatherman and upon an intimate knowledge of the development of cloud-seeding or rain-making techniques since the first successful operations in November, 1946, by Drs. Irving Langmuir and Vincent J. Schaefer of the General Electric Company.

Lest I appear overenthusiastic, though, let me sound a note of reserve. It is possible today to increase rainfall under certain favorable conditions, and to dissipate some types of fog.

We also have reports that hail has been reduced. But before we can hope to achieve all the benefits I have outlined, hundreds of meteorological unknowns must be solved at a cost of possibly billions of dollars.

My distinguished colleague, Dr. Sverre Petterssen of the University of Chicago, has remarked that our knowledge of precipitation is very meager indeed. And before we can hope to control the weather, we must learn what causes weather. To gain this knowledge would probably require an effort as large as the Manhattan Project for the development of atomic energy.

Mastery of the weather is theoretically possible if our research is expanded on that scale. I think that cloud-seeding in eight years has carried the technique of weather modification about as far as aviation progressed during its first eight years. If weather research continues to match the pace of air progress, I believe there's an excellent chance that the degree of weather control I have outlined can be achieved in four decades.

We will not have to wait 40 years, however, to derive much greater economic benefits from weather than we have today. While research on weather modification is progressing, there are interim steps which can and, I am confident, will be taken. These steps do not require the exhaustive and detailed research needed for weather control. They require only the application of electronic devices already in existence or under development. And while these steps will not give us control of the weather, they will give us an opportunity to mitigate its harmful effects through a *completely accurate* system of weather forecasting.

I think it entirely probable that, in 10 years, your daily weather forecast will read something like this:

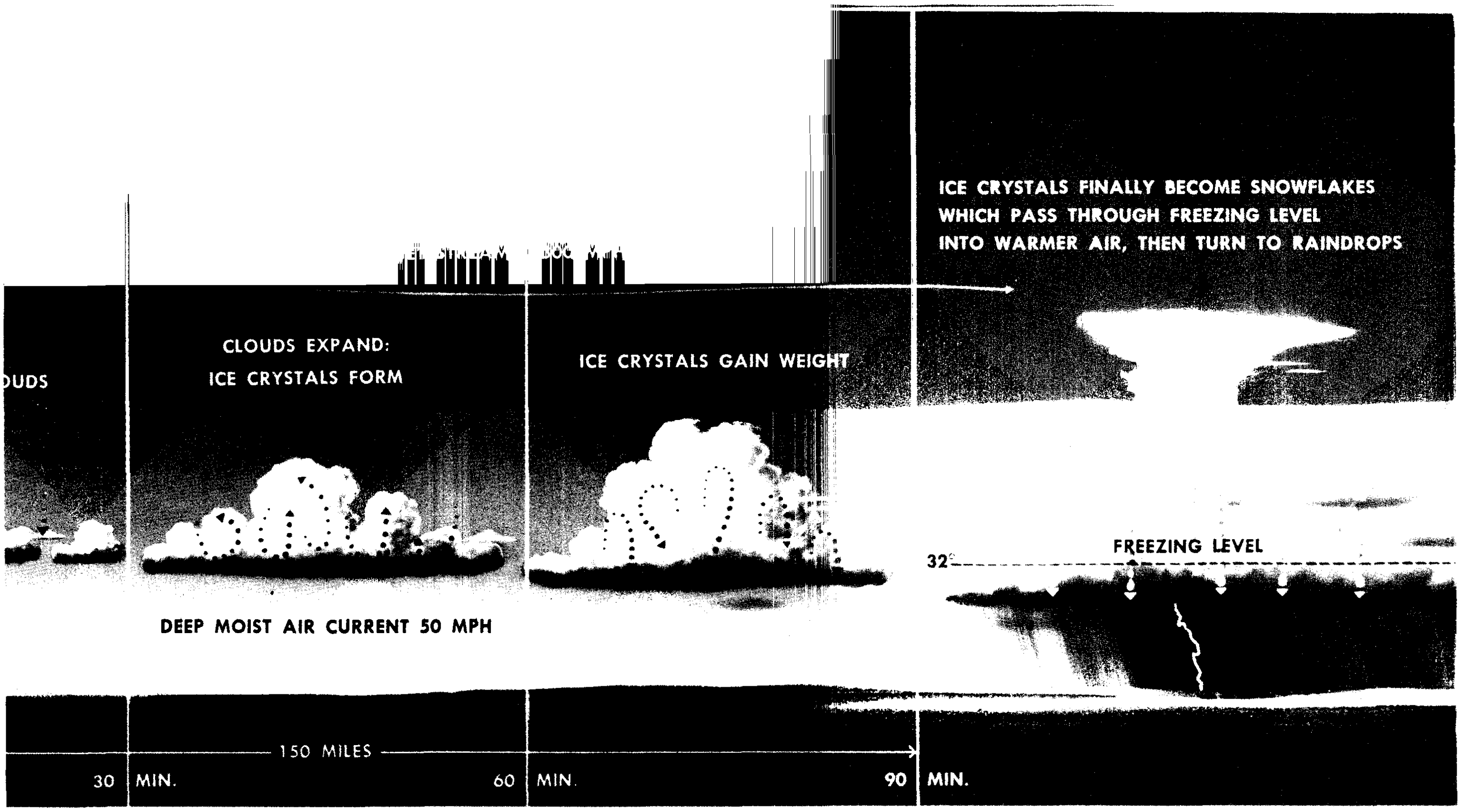
"Freezing rain, starting at 10:46 A.M., ending at 2:32 P.M." or "Heavy snowfall, seven inches, starting at 1:43 A.M., continuing throughout day until 7:37 P.M."

And the weather will adhere to that time schedule. Jokes about the weatherman's predictions will be obsolete, because his forecasts, based on an elaborate electronic system of reporting and analyzing data, will admit of no error.

Present-day U.S. Weather Bureau forecasts are extremely valuable. They provide annual economic benefits amounting to billions of dollars. They are 85 to 90 per cent accurate and are better than those issued in any other country in the world. But an electronic system could provide information not now available and greatly cut down the time needed to analyze reports.

I have proposed a multimillion-dollar program to set up an almost entirely automatic reporting and forecasting system. The money would be spent at the rate of several million dollars annually over the next 10 years. It would go primarily for the purchase of such modern electronic equipment as radar, radiosondes (small, balloon-lifted instruments which record temperature, pressure and relative humidity at all altitudes), television and "electronic brain" computers. The equipment would be installed at 35 weather-control headquarters stations and more than 300 subsidiary reporting stations across the nation.

A start already has been made on such a system. Texas is setting up a state-wide radar tornado-



h-speed upper-air current: When fuses explode balloons, crystals drop into clouds, absorb moisture and fall as rain—miring enemy transport

warning network which should be of tremendous value in saving lives and reducing storm damage.

Extension of a completely accurate weather-reporting and -forecasting system to cover the whole country could save hundreds of lives and billions of dollars a year. People in the path of a tornado could be warned in advance; surprise now accounts for most of the casualties and much of the damage in such storms.

Highway engineers could be consistently alerted hours in advance of a freezing rain or sleet storm and take appropriate steps to minimize traffic accidents. Municipal governments could be told of an approaching snowstorm, including *exactly* when it would arrive, how long it would last and how heavy the fall would be, so that they could mobilize their snow-clearance equipment and workers. (A single heavy surprise storm in December, 1947, cost the city of New York $6,600,000 for snow removal.)

Telephone and telegraph companies could be notified in advance of an impending storm which might damage their lines. Fruit growers now without a frost-warning service could be given adequate warning to get out their smudge pots. And you could move back the starting time of your Saturday golf game an hour because you would know it was going to stop raining at precisely 10:20 A.M.

Thus there may be a two-stage development in mastery of the weather: an interim period—which I think will come within 10 years—when we will be able to eliminate much of the uncertainty in weather forecasting, and a later period when we may actually be able to control some weather phenomena by extension of "cloud-modification" techniques.

The present method of "modifying" a cloud is known as "seeding" because it consists of introducing into the cloud certain particles which collect moisture and fall to the ground as rain or snow. It is used to increase precipitation over any designated area.

This system cannot be made to work at will. Nature must supply two basic requirements. First, the cloud to be seeded must contain an adequate supply of moisture. Second, the temperature of the upper portion of the cloud must be low, preferably well under 10 degrees Fahrenheit.

Seeding a cloud merely duplicates a process of nature. In nature, under such freezing conditions, tiny particles—dust from the earth's surface or salt wafted aloft from the oceans by air currents—enter the cloud. There infinitesimal cloud droplets begin to cling to them. As more and more droplets collect, the original particles become small ice crystals. When enough droplets cling to the crystals—and it is estimated that it takes 1,000,000 to make a normal-size snowflake—they become heavy enough to fall. If the air in the lower portion of the cloud is warm enough, the snowflakes melt and fall as raindrops.

In artificial rain making, dry ice or silver iodide crystals are introduced into the cloud. Their job is to take the place of the dust or salt particles and collect moisture enough to fall as snow or rain. The crystals may be dropped into a cloud from above, by airplane, or released from ground generators and carried upward by natural air currents.

Course of Cloud Must Be Considered

If rain is desired over a given "target area," the movement of the cloud must be taken into consideration. The "rain maker" computes the direction the cloud is traveling and its speed, then plants his dry ice or silver iodide particles at a point upwind from the target area, allowing a half hour to an hour for the moisture-collecting process.

Reports indicate that cloud-seeding has worked remarkably well on occasion. At other times it has failed for reasons we have not yet determined. That is why I emphasize the need for continuing research in this field.

How will we be able to prevent rain? Theoretically, by overseeding a cloud. If too many crystals should be introduced into a cloud, some scientists say, no single crystal would be able to collect enough moisture to fall. The result: the crystals would dissipate in the air after absorbing all the moisture in the cloud—and the cloud itself would evaporate. However, this theory has never been tested, and many scientists think that overseeding is impossible.

If later research does prove that overseeding can, in effect, dry up a cloud, we might be able to apply the same technique to clearing fog; a fog bank essentially is a cloud of tiny water particles in suspension. The technique also might help dissipate destructive storms in the build-up stage. Storms also may be curbed in another way—by normal seeding during the build-up stage to convert clouds into rain before they can build up violence.

Control of destructive storms, such as hurricanes, tornadoes and heavy thunderstorms with associated hail and lightning, would be a great help to mankind. Tornadoes alone have taken as many as 794 lives and caused $47,000,000 worth of property damage in a single year in the United States.

Proper seeding techniques also may go a long way eventually toward alleviating drought conditions, which in one year (1934) cost the United States an estimated $5,000,000,000. Water shortage has always been a problem in this country, particularly in the area west of the Mississippi. Much of the West depends on irrigation, and a water supply only 10 to 15 per cent below normal can mean disaster for farmers. Moreover a study made by the American Institute of Aerological Research in four Nebraska counties showed that each additional inch of rainfall boosted the value of crops in those four counties by $1,102,259.

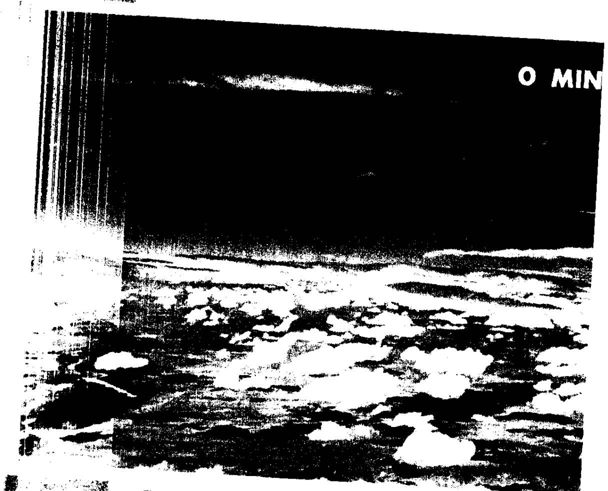
An excellent example of the value of weather-modification techniques in combating water shortages can be found in the work of Dr. Wallace Howell of Howell Associates, a Cambridge, Massachusetts, commercial "rain-making" concern. Hired by New York City during the water shortage of 1950-'51, Howell conducted 36 seedings over 31 weeks. During that period, the New York watershed area's rainfall was 14 per cent higher than that in surrounding, unseeded areas. The increased rainfall gave the New York reservoir system an extra 15,000,000,000 gallons of water—roughly a two-week supply.

Howell has conducted another interesting operation which points up a further use of weather modification. When a raging forest fire swept an area 50 by 100 miles near Forestville, Quebec, last August, he seeded the district for 10 days. Rain fell copiously and extinguished the fire.

Last winter Howell was engaged by the town of Manchester, Vermont, to develop snowfall in the area. The results of that operation have not yet been evaluated, but Howell believes that the data will show the attempt was successful. The money for his services was obtained by public subscription, for snow means ski enthusiasts who will bring needed business to the area.

About a dozen other firms are also working commercially in "rain making," offering to drain

ILLUSTRATED BY ROLF KLEP



Seeding cloud by plane: aircraft flew through one of these cumulus clouds spraying it . . .

precipitation from the clouds for a fee. Two of the best known are North American Consultants, of Pasadena, California, and the Water Resources Development Corporation, of Denver, Colorado. The Denver company is now doing an estimated gross business of more than a million dollars a year—a figure that Dr. Irving P. Krick, the president, says is "very small compared to what I know it is going to be."

Krick has a ready answer for skeptics. "What do they know?" he says. "They are the people who have little or no knowledge of weather modification, or base their judgments on a single unsuccessful experiment. Over the last five years, our company has operated more than 150 separate projects in 18 states and six foreign countries. We have amassed more than 200,000 hours of seeding experience in varying latitudes. We don't *think* we can increase rainfall—we know it."

Success with Dallas Drainage Basin

One of the most interesting of Krick's operations was for the city of Dallas, Texas, last year. In a six-month period ending in May, 1953, Krick operated 12 silver iodide ground generators for a total of 869 hours and 45 minutes in an area near Lake Dallas. A check of water storage on June 1, 1953—after the seedings—showed that water in the Dallas drainage basin had increased 363 per cent over the January 1st level. By contrast, four other nearby drainage basins ranged from a decrease of 22 per cent to an increase of 19 per cent during the same interval.

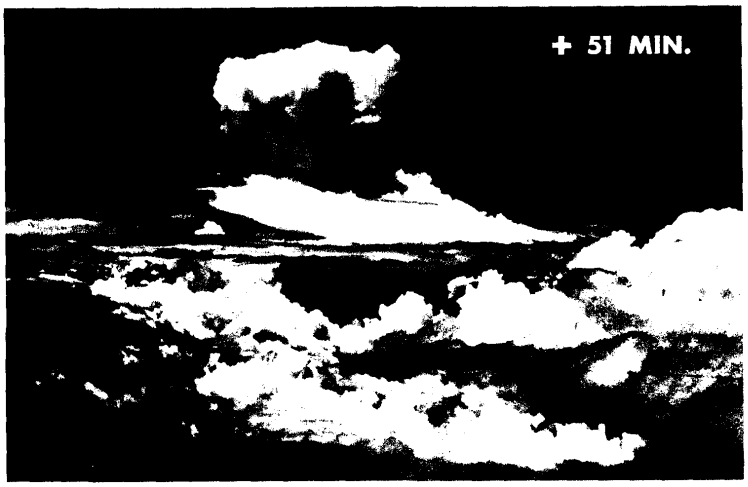
Statistics can always be interpreted in different ways, of course, and these might be considered suspect by the skeptics. But here's what the man who hired Krick, K. F. Hoefle, superintendent of the Dallas Water Works, has to say about the project:

"I personally am convinced that Dr. Krick's operations brought a substantial increase in our watershed area. In the six months following his seeding work we found a net gain in water storage almost equal to the total gain of the previous two years, when no seeding was conducted. It cannot be determined mathematically what portion of this gain was produced by Dr. Krick's efforts, but we demonstrated our confidence in his ability to increase rainfall by renewing his contract."

I have mentioned the possibility of using weather

CARL IWASAKI

Seeding a cloud from the ground: generator (shown being carried to field location by two employees of Water Resources Development Corp.) blows silver iodide particles into air



... with particles from an airborne silver iodide burner. The cloud top changed from white to a gray cirruslike structure and then it grew ...

... steadily in size. After 73 minutes, it had become a full-sized thunderstorm. General Electric conducted test in New Mexico

control as a weapon. In that realm, I defer to my colleague, Lieutenant Commander William J. Kotsch, a Navy meteorologist who has made a detailed study of the question.

Kotsch believes submarines could hamper enemy aircraft-carrier operations by seeding the area in which they were operating. The resulting precipitation would reduce the ceiling and visibility, effectively grounding the carrier's planes. On the other hand, a fleet—or a ground force—might hide from enemy aircraft in self-made weather.

Or take amphibious warfare. Suppose an assault area is covered by low clouds which would preclude the use of aircraft for ground support. If we can again assume that the theory of cloud dissipation by overseeding holds up, a submarine or two could dissipate the clouds.

Kotsch also points out that Russia would be at a disadvantage in any "strategic weather warfare," because weather characteristically moves from west to east. Just as long-range bombers move deep into enemy territory to destroy sources of supply, weather-control planes operating from Western European bases might be able to deluge any selected area of Russia with heavy rain, disrupting lines of supply or movements of armored units by causing truck convoys and tanks to bog down in mud.

Just how would the seeding planes operate? I believe they could drop time-fused balloons at a point determined by wind forecasts, perhaps several hundred miles from the target area. The balloons, carried by the jet stream, a high-speed upper-air current, would explode at a predetermined point where reconnaissance has shown moisture clouds to exist. The explosion would release crystals into the clouds. During the moisture-collecting process, normal lower-level winds would push the clouds toward the target area. If the preliminary computations prove correct, rain should start to fall just as the clouds drift over the designated area.

Attacking the Enemy's Food Supply

Weather modification might also be employed to strike at an enemy's food supply. Moisture clouds could be intercepted en route, overseeded and dried up, depriving crops of needed moisture and in time causing just as serious a military situation as lack of munitions.

These possible military uses of weather control are only theoretical. The Navy is not actively experimenting in this field because we have not yet achieved the mastery over the atmosphere which such operations require.

While weather-modification techniques are being developed, I feel we should go ahead with establishment of a completely accurate national electronic weather-reporting and -forecasting network. Electronic devices are needed not only to collect the information required to make weather forecasts completely accurate, but also to get the forecasts to the public much earlier. Today, the tremendous number of calculations involved in rapidly changing weather take so long to complete that conditions may have changed before the forecasts reach the public.

The more than 300 weather-reporting stations which I have recommended be utilized in the project would retain their present observation equipment, or, preferably, improved versions of it. In addition, they would be equipped with radar units of several types which would supply weather data not presently available.

This information would be relayed by television to a weather-forecast headquarters, translated into numbers and fed on punch cards into a master electronic "brain," such as is now being developed at the Institute of Advanced Study at Princeton, New Jersey.

After digesting, sorting out and correlating the information, the "brain" would punch out on cards a 24-hour forecast for each of the observation points. The cards would be fed into a tabulator which would print the information on maps. Without the computer, the calculations would require several hours.

The present model of the Princeton machine could handle weather data from as many as 361 observation points located about 200 miles apart—enough to cover the major part of the United States and Canada. The machine in 48 minutes can perform a million multiplications, 10,000,000 additions and 20,000,000 other arithmetic problems.

I first suggested the development of a radar tornado-warning system in a talk before the St. Louis chapter of the American Meteorological Society on April 22, 1953. Just two weeks earlier, Professor Glen Stout of the University of Illinois for the first time had taken a series of radar pictures of a tornado.

Subsequent investigation by Stout and by the weather scientists at Massachusetts Institute of Technology confirmed that a tornado indeed could be identified on a radar screen; it showed up as a V-shaped cloud with a twisting tail.

At Texas Agricultural and Mechanical College, meantime, Dr. John C. Freeman and Professor Archie Kahan had been conducting experiments in the application of radar to weather forecasting. On May 11, 1953, a student at the college noticed a peculiar comma-shaped echo on the radarscope and photographed it. The results of the earlier work at the University of Illinois and MIT had not reached the college, however, and no one recognized the echo for what it was—a tornado that a few minutes later struck Waco and killed 115 persons.

All these developments led to a decision by Texas scientists and civic leaders to set up a state-wide radar tornado-warning network. About the same time, the U.S. Weather Bureau fell heir to a number of war-surplus radar units which could be modified for weather use. The bureau was willing to make the sets available if someone would provide the money for the modification—about $10,000 a set. A fund-raising committee was organized. The members approached representatives of the 15 Texas cities which have major weather stations and so far 12 have agreed to pay for converting a set. The U.S. Weather Bureau will operate the system when it has been completed.

Tornado Warnings Long in Advance

"Our sets have a range of 200 miles," says Kahan, "and there is considerable overlap, so we hope to be able to track the precise speed and path of a tornado and give the folks in its way a good three- or four-hour warning. This should make for a terrific payoff in lives saved and property damage reduced.

"On the day of the Waco tornado, for example, the Weather Bureau was able to give the state police a brief alert. The principal of one San Angelo high school, with only a 15-minute warning, evacuated all his pupils to the ground floor. When the tornado struck, the entire top floor of the school was blown off. The only casualty to the forewarned pupils was one sprained ankle. I hate to think what the toll might have been."

I hope to see the Texas tornado-warning network extended to the entire country, for a tornado can strike anywhere—all 48 states have been visited by them. I am confident that the success Texas will enjoy in softening the tornado's punch will bring about public interest in the rest of the country.

Behind the radar-warning network, I hope to see the completely accurate electronic weather-reporting system developed. Meantime, research on weather modification will continue.

The degree to which it will progress is questionable. Perhaps some of the current theories on how to control weather will not prove feasible. On the other hand, continuing research in the field may produce some completely new developments, undreamed of today, which will permit even greater steps in weather mastery than the possibilities I have suggested.

Man may well be on the threshold of a new era in which he will disprove the adage that nothing can be done about the weather. ▲▲▲

The views expressed in this article are those of the author and do not necessarily reflect the opinions of the Department of the Navy.