METEOROLOGY

Long-Range Forecasting

Present Predictions More Than 36 Hours Ahead Seldom Go Wrong; Hope Is for Two-Week Forecasts

By DR. FRANK THONE

WEATHER has long been synonymous, in the minds of mankind, with undependability. Changeable as an April day, wild as the wind, uncertain as rain in summer, unguessable as the weather—these and a thousand other like sayings reflect the popular feeling that of all things weather is most capricious, mutable, unstable, unpredictable.

But on that last word, unpredictable, science files a demurrer. The whole elaborate set-up of the Weather Bureaus of the United States and other lands, with their many hundreds of staff members and many thousands of unpaid volunteer cooperators, is predicated on man's ability to predict the weather, at least up to a certain point.

True, we all make jokes about the weather man's bad guesses. But do we not likewise make jokes about slip-ups on the part of doctors, preachers, professors and all other people who make their livings by more or less expert knowledge and skill? The whole point about jokes of this kind is that the professional man is usually right. If his slip-ups were more than merely occasional and exceptional, they wouldn't be jokes: if the doctor sent *all* his patients to the graveyard we'd chase him out of his profession—and we might hang him into the bargain. So the continued existence of the Weather Bureau after more than half a century of watching the weather, and its ever-increasing importance in aviation, commerce, agriculture and many other fields, is of itself an argument that the weather really is predictable.

36-Hour Forecasts

Present successful forecasts do not attempt to get much more than 36 hours ahead of the game. Sometimes the weather man has a pretty good idea what the weather will be like in 48 hours or more, but as a rule he is reluctant to be very specific about it; like all normal humans, he doesn't like to "stick out his neck" unnecessarily.

Yet it would be a tremendous advantage, measurable in terms of billions annually, if we could get at least a general idea of the weather as much as two weeks ahead. Farmers would be able to plan for plowing and planting, merchants for shipping and selling, promoters for games and parades—in fact, practically every human activity could be far better ordered and organized than is now possible.

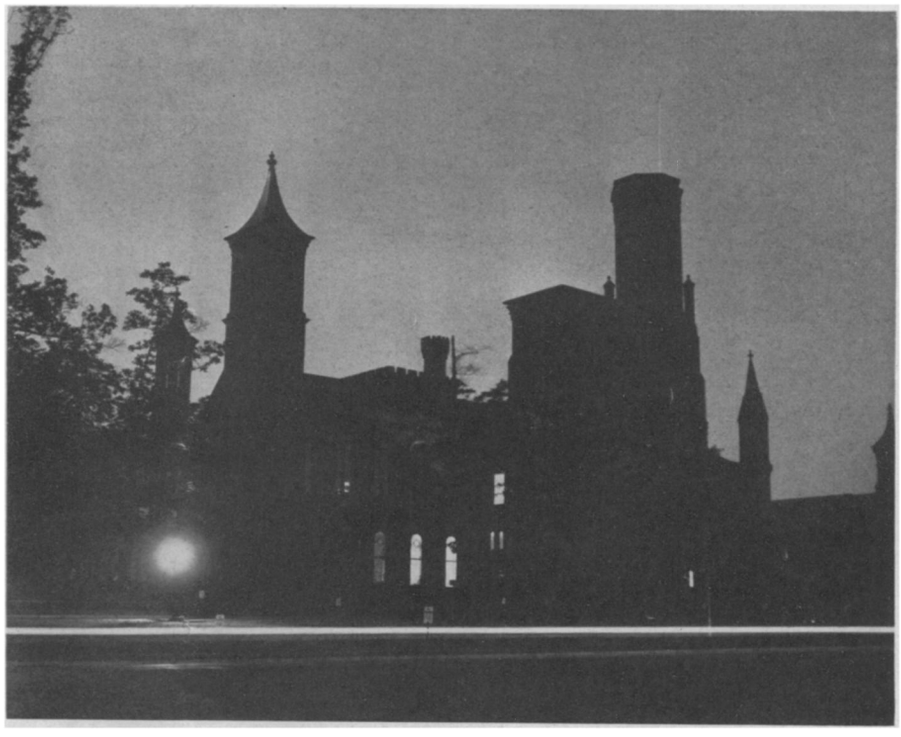
It is this as yet unsupplied demand for a longer foreknowledge of the weather that was responsible for the Farmers' Almanacks of long-past generations and that is still responsible for the innumerable unscientific long-range forecasters, all the way from local gaffers with goosebones (or rheumatism in their own bones) who take their pay in prestige only, down to outright commercial quacks who impress gullible businessmen with important-sounding pseudo-scientific language.

Is there any real hope of satisfying this age-old and very practical wish? Will long-range weather forecasts ever be possible on a really sound and scientific basis?

There are many meteorologists, prominent in their profession, who are very conservative in their attitude. They will not declare dogmatically that "It can't be done;" for the world has lately seen too many impossible things become commonplaces almost overnight to leave any safety in that position. But they are quite candidly very, very skeptical.

Facing these doubters, in the forums of scientific discussion, are other scientists who are at least willing to take a try at the business. Some of them have been at work on one lead or another for many years. But until recently no concerted effort has been made to get all ideas together and give them all a critical and impartial test.

Now at last it is to be undertaken by two Government agencies working in close cooperation—the U. S. Weather Bureau and the Smithsonian Institution. All ideas and suggested methods that look even a little promising are up for



HOME OF RESEARCH

Moonlight view of Smithsonian Institution, where sunlight's effects on earth's weather are under the scholarly scrutiny of Secretary Charles G. Abbot.

GETTING NEWS

Sending a small balloon aloft to explore the air masses above a mountain. Its movements are watched and plotted with the aid of the instruments (theodolites) on the tripods.

examination. It is fully expected that some, perhaps most, will not live up to first promises, and will therefore have to be discarded. But if even one or two methods in the end prove valid, the search will have paid for itself many times over. And if every one of them disappoints, at least it can be set down definitely that they all had their day in court.

This field day for long-range forecasting methods is to be carried through largely because of the strong personal interest of Henry A. Wallace, Secretary of Agriculture. A farmer himself, he has the farmer's direct and highly practical interest in the weather. A scientist also, he believes in trying things out—skeptical until good evidence is in hand, but open-minded to conviction if proof can be produced for even an unlikely idea. Finally, he has taken his own turn at the riddle of weather-making factors, in a statistical study made several years before he came to Washington to sit in the Cabinet of President Roosevelt.

Pool Information

In the search, he is well and ably seconded by the Chief of the Weather Bureau, Willis R. Gregg. Several of Mr. Gregg's colleagues in the Bureau have been devoting a good deal of time to the study of weather-making factors, and the organization offers good facilities for pooling their information and seeing what coordinations can be worked out.

At the same time, the Secretary of the Smithsonian Institution, Dr. Charles G. Abbot, has been given an appropriation of $200,000 by Congress, to push further his studies of variations in solar radiation and their possible connection with weather changes on the earth.

Seven Paths

With this set-up, then, at least seven paths to possible success in long-range forecasting are to be explored. They are, in summary:

1. Total solar radiation
2. Ultraviolet radiation
3. Weather cycle studies
4. Weather correlation studies
5. Planetary position correlations
6. Ocean temperature correlations
7. Airmass analysis.

The first two are the care of Dr. Abbot and his colleagues of the Smithsonian Institution. The rest are being looked into by the U. S. Weather Bureau.

The study of solar radiation has been Dr. Abbot's companion day and night for a good many years. Like many other more distant lights in the heavens, our sun is a variable star, pouring out more light and heat at given times than it does at others. We do not notice this ourselves, because the total radiation is so great that we are insensitive to the relatively small percentage of the fluctuations.

But Dr. Abbot's studies have convinced him that the earth's atmosphere as a whole is more sensitive to solar variations than are our eyes. Certain weather changes, he says, regularly follow increases in the sun's radiation as measured on the earth, and their opposite changes follow decreases.

The best places to set up the sensitive radiation-measuring instruments used in Dr. Abbot's studies are on the tops of desert mountains. For some years the Smithsonian Institution has maintained three such observatories, one at Table Mountain in California, one at Mt. Montezuma in Chile, and a third, more recently established, on Mt. Saint Catherine on the Sinai peninsula, between Egypt and the Holy Land. On a peak near this mountain—it might indeed have been on Mt. Saint Catherine itself—Moses received the Tables of the Law.

The new appropriation which the Smithsonian has received will make it possible to bring this chain of mountaintop observatories up to a total of ten. The sun will never set on Smithsonian observers, checking his every mood and variation and seeking hints therein for the solving of weather's ancient riddle.

Invisible Rays Variable

Dr. Abbot's long studies have disclosed one hitherto unsuspected fact: that the invisible ultraviolet rays vary a great deal more in intensity than do the visible rays. This lead is being followed up zealously, for several reasons. It is not known yet whether the weather changes are as closely correlated with ultraviolet variations as they are with variations in visible sunlight. But if they are, it is obviously easier to study their wider range than to measure the narrower shifts of the visible rays.

Also, it may greatly reduce the expense of studying solar variations, even possibly to doing away altogether with the costly remote observatories on desert mountaintops, where life is lonely and hard for the devoted little staffs of observers. For ultraviolet radiation can be recorded by small balloons sent up into the stratosphere, bearing light-weight automatic instruments to record photographically what they "see," or perhaps to transmit their "observations" by automatic radio back to the ground station. Experiments with such balloons and instruments are now on the Smithsonian schedule.

Weather cycle studies, one of the series of researches undertaken by the U. S. Weather Bureau, are based on the belief that the weather, unlike history, repeats itself. This is perhaps the favorite type of long-range weather study;

many workers in many lands have been at it for years. Some of them have claimed success in discovering cycles of returning weather of the same type, ranging from a few days to several centuries. J. B. Kincer, who has carried on a good deal of original investigation on his own account in this particular field, is directing the cycle investigation for the Weather Bureau.

Weather correlation studies are based on the obvious fact that weather does not come in separate pieces, like stones in a mosaic, but as a flowing continuity, like paints in a picture. Each kind of weather ties in with the neighboring kind, in a world-wide web of mutual influences. It has been claimed, especially by British scientists in India, that places far apart, like India and Australia, have definitely traceable connections with each other's weather. U. S. Weather Bureau scientists are also looking into this work, on which a considerable mass of data has been accumulated.

The planets are so remote from the earth that a connection between their positions and weather on the earth would at first seem downright fantastic —almost smacking of astrology. Yet when Henry Wallace and his colleague Larry Page some years ago made a statistical study, they found an apparent correlation between weather and the positions of the major planets, especially Jupiter. When Jupiter, earth and sun were all on or near the same straight line in space, certain conditions prevailed; when Jupiter was around on the opposite side of the sun, the weather was "opposite," too.

Planets Repel Spots

At the time, Mr. Wallace offered no positive explanation, except a suggestion of influence due to the gravitational pull of Jupiter, which is a thousand times as massive as the earth. But within the past few weeks Dr. Fernando Sanford of Palo Alto, Calif., has stated that three other planets, Mercury, Venus, and our own earth, apparently chase the sunspots around to the opposite side of the sun —and sunspots have persistently figured in all kinds of weather-influence studies. Dr. Sanford suggests that this sunspot-repelling effect may be due to like electrical charges on the sun and the planets. If this is true of these three planets, possibly the other planets may have a similar influence.

This planetary-influence hypothesis is still very much up in the air; for Messrs. Wallace and Page did not carry their investigation beyond the weather at one station—Des Moines, Iowa—and the whole problem has been lying dormant for several years. Now, however, it is being dusted off and will have to go through the mill of re-examination, extension to other stations, and careful scientific criticism.

Ocean temperature correlations are also on the books for study. This work was pioneered in this country by Dr. George E. McEwen of the Scripps Institution of Oceanography, who for a number of years has based quite successful seasonal forecasts for southern California on the ocean temperatures off the coast during the summer months. The U. S. Weather Bureau has undertaken the same kind of studies for the Gulf and Caribbean areas, under the leadership of Giles Slocum. Steamship and airline companies are cooperating enthusiastically.

A final activity of the Weather Bureau that is already in full operation is air-mass analysis. This is a relatively new thing in weather forecasting, having been developed in Norway during the World War and adapted to American conditions since that time, notably at the Massachusetts Institute of Technology. The Weather Bureau has a key station for air-mass studies at Fairbanks, Alaska, where an airplane goes to a high altitude every day, carrying self-recording instruments under its wing. A second station exists at Fargo, N.D., and the Canadian government has arranged for cooperation at a station in between these two, at Fort Smith on the Mackenzie river. Eventually, too, the chain may be extended into Siberia, through cooperation with the Soviet Government.

Science News Letter, September 12, 1936

PSYCHOLOGY-PHYSIOLOGY

Hearing Apparatus Sets Own Limit on Pitch and Loudness

A NEW explanation of why hearing for deep tones falls off so rapidly as the pitch is decreased below the lowest notes of ordinary musical instruments was presented to scientists at the meeting of the American Psychological Association. Dr. Ernest Glen Wever and Dr. C. W. Bray, research team of Princeton University, famous for first "listening in" by telephone on the hearing apparatus of an animal, reported new findings from experiments conducted in collaboration with Dr. C. F. Willey.

Tapping the electric responses in the ear, this time of a guinea pig, the investigators studied what happened when tones of 5 to 60 cycles were sounded. The hearing of tones below 15 cycles is distorted; the overtones are greatly favored relative to the fundamental tone. It was also found that for these low tones there may be more than one volley of nerve impulses per cycle.

If, as these scientists have concluded from previous experiments, the perception of pitch, of low tones at least, depends upon the frequency of the volleys of nerve impulses, these extra volleys in the case of the low tones would make them appear higher in pitch and automatically place a lower limit upon perceived pitches.

The hearing apparatus also sets its own limit upon the loudness of sounds which it is possible to perceive, it appears from this same investigation. The results show that for any given tone, the maximum response of the ear's cochlea may be reached at an intensity below that which causes any harm to the ear. It is not pain or actual damage to the ear that sets the limit to the intensity of sounds that we can "take in;" that limit is set by the mechanism of hearing itself, the investigators concluded.

Science News Letter, September 12, 1936

ASTRONOMY

Model of Moon Displayed At the Franklin Institute

See Front Cover

LENDING charm to the scientific model of the moon built by her father, little five-months-old Verne Carlin Spitz posed as the "Baby in the Moon" for the photograph on the front cover of this week's SCIENCE NEWS LETTER.

The model, constructed by Armand N. Spitz of Newtown Square, Pa., is intended to show the phases of the moon as seen through a powerful telescope. It will be demonstrated during this month at Franklin Institute.

Science News Letter, September 12, 1936