

## SOME PROBLEMS OF THE WEATHER MAN

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When we meet friend or stranger the opening topic of conversation usually pertains to the weather. This has probably been true back through the centuries, but our ancestors had rather vague ideas concerning the causes of atmospheric phenomena. Even as late as one hundred years ago the law of storms was not understood. As the knowledge of weather and climate increased there came a demand for some organized effort to study these problems and render service to the public, until now the meteorological service is a part of nearly every government. To the late Professor Cleveland Abbe, with the backing of the Cincinnati Chamber of Commerce, is due the inauguration of the present system of telegraphic weather reports. The service was begun on September 1, 1869, with thirty stations reporting. The Weather Bureau was originally a part of the Signal Corps of the United States Army, but in 1890 it was transferred to the then new Department of Agriculture.

The activities of the Weather Bureau at the Central Office in Washington are distributed among a number of divisions, each under the direction of a supervising official. The stations in the field, however, must handle many phases of the work. The major portion of the duties at the Springfield station are in connection with the Climatological Service. One station in each state is designated the section center. The Springfield office directs the work of the 81 meteorological substations, issues bulletins containing the data from these stations, publishes a weather-crop report for Illinois each Wednesday, and supervises the distribution of forecasts in the State.

Through the public-spirited cooperation of nearly five thousand men and women—just such citizens as Messrs. Bonnell, Colyer, and Oglevee of this organization—the climatological service through its cooperative observers has been established in almost every nook and corner of the country, and even extended into Alaska, Hawaii, and the West Indies. The reports from these stations are in great demand. The problem is to “carry on”, and

to extend the service into remote and inaccessible places where it is difficult to secure observers but where records are needed to aid settlers in developing the country. Before leaving this subject I wish to make mention of Mr. John West James, who maintained a most excellent record at Riley, near Marengo, covering a period of 54 years on the same farm, never losing more than a day or two at a time, and only terminating his services when called by death. Observations taken by officers of ships at sea are more complete than those made by the co-operative observers on land. They were formerly delivered to the Weather Bureau at the termination of the voyage, but are now forwarded by radio.

No weather service can function without suitable meteorological instruments. Some of the instruments in use at the first order stations have undergone no change in more than twenty-five years, because they are fulfilling every demand. Others have been improved from time to time and new instruments of various kinds have been devised. Professor Marvin, the Chief of the Weather Bureau and one of the foremost authorities on meteorological instruments, has designed a weekly recording rain gage. This instrument can be placed in an inaccessible or remote place, and a continuous precipitation record maintained by making weekly trips to the gage to change the record sheet and empty the water. Many efforts have been made to devise a gage that will secure a true catchment of snowfall in windy weather. It is the hope of meteorologists that this problem will be solved. Through experiments in the wind tunnels of the Bureau of Standards it has been found that the Robinson four-cup anemometer records too much wind, and stations are to be supplied with a three-cup pattern that has been selected from a number that have been tested. The Instrument Division has recently brought out a combined thermograph and telethermoscope. The thermograph is operated in the office instead of in the shelter outside, but it records the out-of-door temperature. Unfortunately this can not be operated at a distance of more than 65 feet from the outside mechanism.

Seismological investigations and the study of volcanos have been transferred to the Coast and Geodetic Survey and the Geological Survey, respectively, but solar radiation investigations are being continued by the Weather Bureau. Observations are made at Washington, D. C., Madison, Wis., Lincoln, Neb., and Santa Fe, N. M. These studies are very helpful to illuminating engineers. The Owen's dust counter is used to make a survey of the dust content of the atmosphere, employing airplanes for the observations aloft. It has been found that the dust content is greater near the surface than aloft, and that there are more dust particles over industrial centers and cities like London than in places similar to Washington. In dust count determinations made in October and November, 1923, at Washington, the number of dust particles per cubic centimeter on cloudy mornings varied from 480 at the surface to 33 at 10,000 feet elevation. Studies to determine the effect of weather conditions on plant growth are being constantly made by the Division of Agricultural Meteorology. This division supervises the special crop region services and issues on Wednesdays both state and national weather-crop bulletins. In his effort to secure all publications pertaining to meteorology and allied sciences the librarian has a collection of some 40,000 books and pamphlets, the most complete meteorological library in existence. As a source of further information the Bureau issues the "Monthly Weather Review". This publication is the clearing house for the exchange of ideas and facts concerning weather and climate. Contributions are offered by both American and foreign writers, many of them being devoted to theoretical meteorology.

Floods take a heavy toll in damage to property and hindrance to business. The forecaster cannot prevent the floods, but he can issue warnings of flood stages so that the people along the rivers may save their property and adjust their business affairs. The forecasting of flood stages is a complex problem, because of the uneven distribution of rainfall, the melting of snow, the condition of the soil as it affects runoff, the breaking of levees, and the discharge from tributary streams. Yet, river forecasts are the most accurate made. The prin-



cipal rivers are divided into districts, each under a Weather Bureau official and with its gaging and rainfall stations. The St. Louis district is the largest. At the time of the Illinois River flood in 1922 the St. Louis official, on April 16th, predicted a crest stage of 25.1 feet for Beardstown. Four days later the crest stage, 25.1 feet, occurred, exceeding all previous records for high water at this place. As funds permit, the river and flood service will be extended gradually to many of the smaller streams.

The meteorologist, having secured a fair knowledge of the conditions at the surface, desired to learn more about the upper air. Although kite flying was begun in 1898, it is only in comparatively recent years that aerological investigations have been conducted in a systematic manner. Aerological stations are now in operation in Indiana, Nebraska, North Dakota, Oklahoma, South Carolina, and Texas. The Army and Navy maintain similar stations in various parts of the country and the Weather Bureau and these services exchange observations and reports. When weather conditions permit, kites are sent aloft carrying instruments that give continuous record of pressure, temperature, humidity, and wind. At times as many as five or six kites are flown in tandem. When records at higher elevations are desired, sounding balloons are sometimes sent up daily for a period of days, with a recording instrument attached. These balloons are inflated with only sufficient gas to cause them to burst at high elevations. A parachute allows the recording mechanism to reach the ground in safety; a note attached instructs the finder to return the instrument to a designated Weather Bureau station. Sounding balloons have reached altitudes of more than 19 miles, approximately three times the height attained by Major Schroeder in an airplane. One of the newer developments is the pilot balloon. These small balloons do not carry instruments. They are liberated at 4 p. m., 75th meridian time, at the aerological station and at certain Weather Bureau offices. At some places flights are made at 8 a. m. also. Having determined the ascensional rate by the double theodolite method, the balloons are now observed through a single

instrument. The altitude and azimuth are noted every minute until the balloon is lost to vision. Computations are then made of the wind velocity and direction at various altitudes, and they are telegraphed to the district forecasters. These, of course, are essential in the preparation of aviation forecasts, and are helpful with the surface forecasts because the wind aloft has considerable bearing on surface conditions. There is much to learn about the upper air, and it is likely that improved methods will be developed for its survey.

Without doubt the activity of the Weather Bureau in which the business man and the general public are most interested is the issuance of weather forecasts. To the mariner, the farmer, and the shipper of perishables the forecasts are indispensable, and they even become a part of the preparations for picnics and automobile trips. The money saved by cold wave warnings in the Chicago forecast district in a single season more than equalled the cost of operating the entire Weather Bureau a year. For more than fifty years the forecasts have been made from synoptic charts. Probably there has been some improvement; at least the percentage of accuracy for the service averages 88.4 per cent. Radio has stepped in and greatly aided that very important work of the forecaster, where lives and property are at stake, the predicting of those tropical storms known as West Indian hurricanes. Many of these disturbances develop near the Cape Verde Islands, drift westward with the trade winds, ever seeking a place to break through the Azores high pressure belt. Reaching the western side of this belt, where the pressure is lower, they recurve to the northeastward, passing up the Atlantic coast or entering the Gulf of Mexico. The storms are hundreds of miles in extent, great whirls with wind velocities as high as 120 to 140 miles per hour, but the velocity of translation of the whole storm is sometimes quite slow. Before the days of radio they were sometimes "lost" over the ocean, the land stations showing little evidence of the location. Now observations are taken regularly on all U. S. Shipping Board vessels and many others. These are radioed to the Weather Bureau at Washington, giving the ship's position.

Weather maps are then prepared for the ocean as well as for the land, and forecasts of the location, extent, and probable movement of the hurricane are broadcast to the vessels at sea. The navigators can then set their courses to avoid the worst of the storm.

Among some of the newer forecast developments mention should be made of the harvest-weather, fire-weather, and fruit-frost service. The first is for the farmer; the second for the forest ranger, the forecaster warning him when conditions are favorable for timber fires. The Bureau has eight meteorologists and observers on duty in the citrus orchards of southern California. Thermometers and thermographs are placed at numerous places among the trees. These are read frequently during the night, and when the meteorologist on duty gives the word the oil heaters are lighted. It is not a smudging proposition. The temperature of the air is actually raised that number of degrees that will bring it above the frost danger line. Orchard temperatures have been raised as much as eight or ten degrees by this method. Later in the season these men go to the apple orchards of Idaho, Oregon, and Washington.

What of the future? Our Bureau does not, ordinarily, attempt to make forecasts for more than 36 or 48 hours, although the Washington office prepares a weekly forecast based on telegraphic reports from the entire northern hemisphere, Siberia excepted. The Canadian Government is establishing radio weather stations near the Arctic Ocean, and it is hoped that a similar station will be installed at Point Barrow, Alaska. These will be very helpful to the forecaster. But will it ever be possible to prepare seasonal forecasts? Scientists are studying periodicities and the relation of sunspot phenomena to weather recurrences. It has been found that certain seasonal pressure conditions over the Pacific Ocean influence the temperature of the water of the Japan current, and this in due time affects the air temperature along the California coast. Professor Marvin, the Chief of the Weather Bureau, refuses to say that long range or seasonal forecasts will not some day be made. This is one of the tasks of the meteorologist of the future, and is one of the most important problems of the weather man.