THE SCIENCE OF WEATHER FORECASTING

Willis L. Moore, Chief of the Government Bureau, Tells About Cold Waves and the Methods of Anticipating Storms.

"FAIR weather cometh out of the North," declared the friend and adviser of Job, who was doubtless as good an authority on the meteorology of his region as he was on the uses of affliction.

But in our latitude and longitude, according to Willis L. Moore, Chief of the United States Weather Bureau, it is the Northwest, our own ambitious Northwest, that is the hatching place of most of the storms that rush across our own land, and then, with all the vigor of an ex-President, sweep across the Atlantic and make the peoples of Europe take notice.

The way this comes about and a thousand other things are told by Prof. Moore in a book on "Descriptive Meteorology," soon to be published by the Appletons. The volume provides a comprehensive introduction to this, which has so recently become one of the most important and useful of the modern developments of science, and is intended primarily for those who wish to study it seriously. But there is much in it of interest to the man in the street who just likes to know things.

Those northwest storms, for instance, for whose coming we keep an apprehensive eye all Winter and after whose going we breathe a sigh of relief, are mainly due to the Rocky Mountains. Running north and south through the western portion of North America, they tend to check the eastward flow of air through the lower strata, moving with the motion of the earth. But they do not prevent the flow of warm currents from the south and of cold currents from the north, the results of equatorial heating and polar cooling, to which are due the permanent hemispherical circulations.

When this warm current meets the cold current, usually somewhere up in the Northwest, through the action of gravity a circulation sets in, causing the heated air to overflow the colder and the colder to overrun the heated; and as all this is taking place on the surface of a rotating sphere vortex motions are produced.

The presence of the mountains in the midst of these vast whirling areas, checking the free eastward flow, makes all the more violent the conflict of currents necessary to the breeding of storms.

"The region of the most vigorous mixing processes in either hemisphere and the area upon which the most active cyclonic circulation takes place," is the way Prof. Moore describes that portion of North America.

Thus born among the peaks of the Rockies, the storm is whirled eastward on the wings of the world, stimulating the consumption of coal and the trade in furs.

"If the elevation of the Rocky Mountain plateau in North America," speculates Prof. Moore, "were one-half of what it is, and if the mountain chains were leveled away, or even trended to the east and west instead of to the north and south, the vaporous atmosphere of the Pacific, which decreases in density rapidly with elevation, would flow far into the interior of the continent, and by absorbing the heat of the sun during the day and restricting radiation from the earth at night, markedly decrease the severity of cold waves and other changes in temperature."

But these cold waves, like most disagreeable things, are good for us. And here again comes in the wisdom of Job's *comforter*, this time without any limitations or perversions due to locality. For he assured the afflicted one that "the wind passeth and it cleanseth them." And that, it seems, is what the cold wave does to the foul places of the earth. The cold air of which it is composed has come hurtling down from high up in the earth's atmospheric envelope, to which the microbe has not yet aspired and where dust and smoke are not. It contains but a small portion of water vapor, and, pure and dry and moving rapidly, it acts like a spray of high-pressure air turned upon a dirty rug.

"Few people realize," says the author of "Descriptive Meteorology," "that the cold wave has an important therapeutic value. It scatters and diffuses the carbonic acid gas exhaled by animal life and the fetid gas emanating from decaying organic matter. Its dense air not only gives more oxygen with each inspiration of the lungs but the high electrification that always accompanies it invigorates man and all other animal life."

The air of these cold waves contains a higher percentage of ozone than is ordinarily found in the air that is breathed by man, and this gas, while injurious and even fatal in condensed form, is stimulative and sanitary in the small percentages found in nature. Its presence, therefore, adds to the beneficial effects of the cold wave.

Prof. Moore makes some brief comments on the effect of climate on man that, taken in connection with these facts concerning cold waves, are very suggestive. "Climate," he says, "is the most potent of all factors in the environment of races. It is climate and soil, plus heredity and form of government, that produce either vigorous or weak peoples."

The making of the weather map each day is the basis of all weather forecasting. This is how it is done: Each morning at 8 o'clock, seventy-fifth meridian time—that of New York—which is about 7 o'clock at Chicago, 6 o'clock at Denver, and 5 o'clock at San Francisco, the observers at some 200 stations throughout the United States and the West Indies take their observations, noting the temperature, the humidity, the rainfall or snowfall, and the cloudiness.

Then for half an hour or more the telegraph wires hum with the messages sent back and forth until each important station has the reports of all the others. At the stations where the charts are made for the study of the forecast official, as, for instance, at the central office in Washington, as fast as the reports come in they are turned over to the forecast division. Here there are clerks with blank charts, each of whom copies a particular part of all the reports.

One constructs a chart showing the changes in temperature during the preceding twenty-four hours. Broad red lines separate the colder from the warmer regions and narrow red lines inclose areas showing changes in temperature of more than ten degrees. The narrow lines generally run in oval or circular form, showing that atmospheric disturbances operate in the form of great progressive eddies.

A second clerk takes the barometric changes and constructs another chart by the same methods. Here the narrow red lines will inclose spaces in which the barometer is either rising or falling. If through a great expanse of territory all the barometers are rising, the air in that region is cooling and contracting and allowing that of adjacent warmer sections to flow in at the higher levels. If over another considerable area the barometers are falling, the air above them is flowing away to cooler regions. This chart is of particular importance because it gives in great measure the first indication of the formation of storms, and also because it shows whether the storm centres are increasing or decreasing in intensity.

A third clerk constructs two charts, one showing the humidity of the air and the other the cloud areas, with the kind, amount, and direction of the clouds at each station. Still another makes "the general weather chart," showing for each station the air temperature and pressure, the velocity and direction of the wind, the rainfall or snowfall since the last report, and the amount of cloudiness

These several charts enable the forecast official to hold in his mind's eye a picture of the great ocean of air above the United States, with all its agitations, and, knowing how these moving pictures have varied from day to day in the past, he can estimate how this eddy is likely to progress during the next twenty-four hours, or even longer, and what effect that oncoming wave of high or of low pressure is likely to have.

If a cyclonic disturbance, or area of low pressure having a more or less spiral movement of air throughout a large region, is being formed, its centre is at the point where the barometer readings are lowest. Toward this centre the air is blowing in, like water flowing down inclined planes, from all the surrounding regions were the air pressure is higher.

This storm will be like a great eddy or vortex in the air carried along by the general easterly movement of the atmosphere. But it is not a deep eddy. Horizontally it may extend from Washington to Denver, and yet it may not affect the air for more than three or four miles above the surface of the earth. This entire vast disk of whirling air is in accurate nomenclature a cyclone—a word much misused in popular speech to denote what is really a tornado—and close behind it follows an anticyclone, or area of high atmospheric pressure, also moving eastwardly. In this region the air flows downward from high altitudes instead of upward from the warm and humid earth, and is therefore drier and colder.

The cyclonic or low pressure area may be accompanied by precipitation and it may not, or precipitation may occur in some portions and none in others. It is in this latter case that its forecasting is difficult, since precipitation does not always show that relation to the areas of equal barometric pressure as do temperature, wind velocity, and direction. That is why a forecast of rain or snow may fail for a portion of a State, or for the whole State, although in other respects the forecast proves true.

Cyclones and anticyclones usually alternate, their areas moving eastward at the average rate of 600 miles a day. Their speed, however, is greater in Winter than in Summer. Storms move faster also in the northern portion of the United States than they do in the southern. Four-sevenths of all the storms of this country come from the north plateau region of the Rocky Mountains and pass eastward, producing but scant precipitation. The most of the remaining three-sevenths are first defined further to the southward, whence they move northeastward, usually causing bountiful precipitation, over the Lower Mississippi and on to New England. Thus it appears that, wherever the storms originate, they are pretty sure ultimately to seek out New England before they pass out to sea.

Storm conditions in the northern hemisphere fall into three types. The three Winter months and March are dominated by swiftly moving storms of great area and wide oscillations of temperature and much precipitation. The three Summer months and September are characterized by ill-defined storms of sluggish movement that bring many local rains of small area. October and November in the Fall, and April and May in the Spring, are transition periods between these two types.

The season of the hot wave is approaching, and Prof. Moore wards off all personal responsibility for the exasperated discomfort which so soon follows his bureau's predictions by this explanation of what causes it:

"In Summer there come periods of stagnation in the drift of the highs and the lows. At such times if a high pressure area sluggishly rests over the South Atlantic Ocean between Bermuda and the coast of the United States, and a low over the northern Rocky Mountain region, there will result what is popularly known as a warm wave, for the air will slowly and steadily flow from the southeast, where the presure is greater, toward the northwest, where the pressure is less, and, receiving constant accretions of heat from the hot, radiating surface of the earth, without any cyclones to mix the upper and lower strata, will finally become abnormally heated.

"This superheated condition of the lower stratum continues until the high over the ocean dies out or drifts away to the east, and the low pressure area in the northwest begins to gyrate as a cyclone and moves eastward, mixing in its course strata of unequal temperatures, and causing cool thunder showers."

The New York Times
Published: April 3, 1910