If we select from the whole number of individual storms those shorter periods during which a very high rate was maintained, and plot the rates per hour as abscissæ in a system of rectilinear coordinates we obtain, after connecting the points so plotted, a curve of probable maximum intensity.

Thus we find that at Washington during the last 16 years the highest rate per hour for any

5	consecutive minutes	was	7.50	inches,	September	3, 1882.
10	"	"	5.10	"	"	16, 1888.
15	"	"	4.50	"	June	27, 1881.
20	"	"	3.90	"	"	27, 1881.
25	"	"	3.60	"	"	27, 1881.
30	"	"	3.15	"	"	27, 1880.
40	"	"	2.75	"	"	10, 1876.
50	"	"	2.30	"	"	10, 1876.
60	"	"	1.98	"	"	10, 1876.
120	"	"	1.23	"	July	26, 1886.

Chart VII shows the curves of probable maximum intensity for Washington, *a*, and Savannah, *b*, constructed in the manner indicated. It is proper to add that Mr. J. de Bruyn Kops, Assistant Engineer, Savannah, Ga., independently formed a similar curve for that city during the summer of 1896. The full line curve has been reproduced from Ex. Doc. No. 445, 51st Congress, 1st Session—Report upon the Sewerage of the District of Columbia, Washington, D. C., 1890

The combined records of excessive rainfall in the cities of Boston, Providence, New York, Philadelphia, and Washington, representing observations for an aggregate of about 70 years, were used in constructing the last-named curve..

The conclusion to be drawn from the similarity of the curves is that, in general, the highest intensity of any individual storm will not greatly exceed the limits marked by the separate curves. It must be remembered that the curves are in a sense composite, being made up of fragments from the storms of greatest intensity and do not, therefore, represent a continuous storm of the intensity shown.

MEMORABLE SNOWSTORMS IN SOUTH DAKOTA.

By S. W. GLENN, Local Forecast Official, Huron, S. Dak. (dated February 20, 1897).

Photographs showing the remarkable snow drifts in the city of Huron, S. Dak., having been received by the Chief of the Weather Bureau from Mr. Glenn, he was requested to make a report on this subject and the Editor has the pleasure of submitting the following as received from Mr. Glenn:

The meteorological features at Huron, S. Dak., during January, 1897, were remarkable because more precipitation occurred by far than during any other January since the station was established (July 1, 1881), and also because one of the steadiest and most persistent periods of very low temperature that ever visited the station (though not the most extreme) prevailed during the third decade. The total precipitation during the month was 2.87 inches, an excess over the normal of 2.38 inches. The total depth of snowfall was 26.7 inches. During the winter of 1880–81 there was very heavy snowfall and old residents state that at the end of February the average depth of snow in the vicinity of Huron was 3 to 4 feet, but the January snowfall was not as heavy as that of the current January.

Storms of more or less severity, commonly known as blizzards, occurred on the 1st, 2d, 3d, 4th, 16–17th, and 23d–24th.

From the 23d to 29th, inclusive, the daily mean temperature ranged from 4° to 22° below zero, with steady fresh to brisk and high northwest winds, until afternoon of 29th, when the wind veered to southeast and the weather began to moderate.

The most noteworthy storms occurred on the 2d to 4th and 16–17th. A dry snow began at 10.20 p. m. of the 2d and continued until about 4 a. m. of the 3d; beginning again at 9.10 a. m. of 3d, it continued until 10.20 p. m, of the 4th. By 8 p. m. of the 3d 5 inches of snow had fallen and by 8 p. m. of the 4th an additional 10.5 inches. On the 3d the wind movement averaged 32 miles per hour; on the 4th, 40 miles per hour, with a maximum velocity on both days of 50 miles, from the northwest. During the 3d, in the daytime, the air was at times so full of fine, dry snow that objects, such as buildings, 50 feet away, were distinguishable only by outline. In the late afternoon and at night the air was at times literally full of flour-like snow as dense as fog and it was dangerous for persons to be out, especially in the more sparsely built up portion of the city, as the swirling snow was blinding and bewildering. There were several instances at night of persons losing their way for a time in the residence portion. During the night of the 3d the air was highly charged with electricity and contact with stoves or other metal produced a spark and quite a shock. For a time the tips of three twigs were illuminated by bright sparks and it is authentically stated that in some instances trees (box alder variety) appeared as though illuminated by numerous tiny electric lights.

This storm continued on the 4th without abatement until 3 p. m., when there were signs of its force breaking. The snow ended at 10.20 p. m., making, practically, a storm of forty-eight hours' duration. The snow drifted heavily and by the evening of the 4th there were drifts in the principal streets from 4 to 16 feet deep. Local business was almost entirely suspended, railroad and other traffic abandoned and complete train movement impossible for several days after. In some cases business houses could not be entered until a passage way was cut through the snowdrifts. Over the residence district, barns, sheds and other outbuildings were more or less, and in some cases entirely, covered.

The snow was so very fine and dry that it penetrated buildings through the slightest openings, more so than in any other storm in the history of the town. In the country there was some loss of live stock, principally sheep, by sheds caving in with the weight of the snow, and the snow drifting into the buildings and smothering the stock. The storm of the 16–17th was not so marked in point of precipitation, nor was the wind force so great. The average wind movement on the 16th was 15 and on the 17th 26 miles per hour, with a maximum velocity of 46 and 47 miles, from north and northwest. Snow began at 10.30 a. m. of the 16th, and the storm gradually increased. By 4 p. m. it was severe and augmenting, becoming very heavy in the night, with much fine, dry snow and a steady gale from the northwest. All trains on the railways were abandoned and business generally suspended. The drifts of snow were greatly augmented and only one side (east) of the principal business street was available for team service. The snow ended after midnight of the 16th, but began again at 9.50 a. m. of the 17th and ended at 3.30 p. m About 6 inches of snow fell during this storm, and although in general respects it was similar to the first storm there was no electricity in the air and the snow was not quite so dense and penetrating. It demonstrated to the railway companies that regular train service in the State for the remainder of the winter would be very doubtful, as the cuts through the drifts made by plows after the preceding storm were literally filled and the snow as tightly packed as originally, and that they were liable to be filled by every high wind moving the loose snow on the ground.

These storms have been compared by many with the memorable blizzard of January 12, 1888, during which so many fatalities occurred. While the storm of the 2d–4th was severe in point of snow and duration, it could not be compared with the one of 1888, which was accompanied by rapidly falling temperature and occurred so suddenly that those away from home in the country had no opportunity to seek shelter, even the nearest, comparatively, and the air was at once filled with fine, dry and blinding snow, with a severe gale. The storm of 2d–4th began on Saturday night and Sunday, when most farmers were at home, and increased so gradually that those away from shelter had ample time to protect themselves. The one in 1888 was preceded by unusually mild conditions, which tempted farmers long distances to water stock and procure fuel and other necessaries, after having been confined closely to home by preceding severe weather. The following is an extract from the Daily Journal of the Weather Bureau station at Huron, S. Dak., for January 12, 1888, showing how suddenly the storm broke, the markedly sudden and rapid increase in wind force, and the sudden and rapid fall in temperature:

"The southerly gale of yesterday and last night continued, with light snow, until 6 a. m., when the gale began to abate; at 12 noon its velocity was 24 miles per hour; between 12.35 and 12.40 p. m. it had subsided to 12 miles per hour, with a light snow and a damp atmosphere, the sky being obscured in patches by nimbus clouds; at 12.42 p. m. the air was perfectly calm for about one minute; the next minute the sky was completely overcast by heavy black clouds, which for a few minutes previously had hung along the western and northwestern horizon, and the wind veered to the northwest and blew with such force as to render the position of the observer on the roof unsafe. The air was immediately filled with snow as fine as sifted flour. The wind veered to the northeast, then backed to the northwest in a gale, which in three minutes attained a velocity of 40 miles an hour. These conditions continued steadily all day and until 4 a. m. of the 13th, when the gale began to abate, and the snow soon after ceased. At noon of the 12th the temperature was 20° and at 10 p. m. —17°, and fell to —28° during the night. The wind averaged from 45 to 50 miles and attained an extreme velocity of 60 miles per hour. The number of lives lost in this (Beadle) county was 11, and a considerable number injured."

Although the 1888 storm is probably better remembered by the people of the State and country, because of the great number of fatalities in the Northwest, it is likely that the one of April 13 to 16, 1873, was one of the most severe that ever occurred in South Dakota. It is generally known as the "Custer Blizzard," because General Custer, United States Army, was encamped at that time at Yankton, S. Dak. Gen. A. W. Greely, in his volume, American Weather, says of this storm: "The wind blew at Yankton, S. Dak., from 13th to 16th, inclusive, for

a continuous period of nearly one hundred hours, at an average velocity of 39 miles per hour, and on April 15 the velocity for the entire twenty-four hours was over 52 miles per hour. This hurricane-like wind was accompanied by fine drifting snow, which was like sand, and so filled the air that one could not see a dozen yards. The Seventh Regiment, United States Cavalry, was encamped at Yankton at the time, and for more than forty-eight hours officers and men alike were obliged to seek shelter in the houses of the citizens."

The atmospheric conditions attending the storm of January 12, 1888, are thus described in the Weather Bureau MONTHLY WEATHER REVIEW for that month: "On the morning chart of the 12th an area of high pressure appeared north of Montana. On this chart was also shown a well-defined area of low pressure central near Cheyenne, Wyo., the subsequent course of which was to the southeast till central near Concordia, Kans., at 3 p. m., then rapidly to the northeast. At 10 p. m. of the 12th the area of high pressure had extended to the southeast over Montana, Dakota, and Nebraska, while the pressure at its center had increased to 30.60 inches, the center of the area of low pressure before mentioned being located at La Crosse, Wis., and bounded by an isobar of 29.60 inches, there being a difference of pressure of 1.3 between the centers of the two areas, separated by about 1,200 miles. This marked difference in pressure caused winds of from 30 to 50 miles an hour, accompanied at some stations in Montana, Dakota, and Nebraska, by snow, which, with a fall of from 30° to 60° in temperature during the twenty-four hours preceding the 10 p. m. observation of the 12th, helped to make a violent storm in which many lives were lost and large numbers of cattle perished."

There is much similarity in the movement of the storm center in this and the storm of January 2–4, 1897. The latter did not move nearly so fast, to which can be attributed the length of the storm and the great amount of precipitation. On the morning of the 2d an area of low pressure, with a tendency to move northeast, was central near Little Rock, Ark., by the morning of the 3d it was central over Iowa, and on the morning of the 4th was over the Great Lakes, while persistently high pressure to the west and northwest of it, with a barometric gradient of from 0.90 to 1.00 inch, was present all of the time.

On the morning of the 2d a fall of from 20° to 30° in temperature had occurred over portions of the Dakotas, Nebraska, Iowa, and Minnesota, and it was still colder and temperature near zero at Huron on the morning of the 3d. It was but natural that the area of low pressure, beating its way northeast against this cold current, and high pressure north and west of it, should lose much more than the usual amount of the moisture. On its north and west sides that it was drawing from southern latitudes, in its slow progress toward the Lakes, falling in the form of snow over eastern South Dakota, which country was in unusually favorable position in relation to the formation and progress of the low area to receive the excess of its precipitation.

NOTES BY THE EDITOR.

THE EARLY HISTORY OF THE THERMOMETER AND BAROMETER.

In the Annual Report of the Chief Signal Officer for 1887 will be found a "Treatise on Meteorological Apparatus and Methods," which is usually bound up separately as Part II of the Report, and in which the Editor has brought together some information with regard to the history and development of various apparatus. Since then important contributions to this subject have been made by Gerland, and more recently Dr. Hellmann has laid us under still further obligations by including in his reprints of meteorological classics a volume on the history of the barometer and thermometer. At a recent meeting of the German Meteorological Association, in Berlin, Dr. Hellmann made the following remarks with regard to this volume, which are quoted from the Berlin *Vossische Zeitung:*

It considers the history of meteorological instruments in that it publishes the correspondence of Torricelli with Ricci on the measurement of atmospheric pressure, and also the description of the thermometer and hygrometer given by the Academy del Cimento in Florence. Torricelli's letters are of the greatest importance in the study of the history of the barometer. They treat of the experiment with quicksilver made by Viviani in the year 1643 in Florence at the suggestion of Torricelli, and are the only proof of this discovery, since Torricelli himself never published any other account. They are dated June 11 and 28, 1644, and show that Torricelli already knew at that time that the mercury in the tube changes its height because the air is sometimes heavier and denser, sometimes lighter and rarer. They also show that he made the experiment with a view to obtaining an instrument with which to observe the atmospheric changes. The news of Torricelli's experiment reached France through a letter from Ricci as early as 1644, but it was only in the summer of 1646 that the experiment was successfully accomplished, apparently because they could not earlier obtain the glass tubes needed to actually carry out the barometric test.

The report of the Academy del Cimento relates to the early history of the measurement of heat and moisture. It can not now be determined with absolute certainty who made the first attempt to measure the temperature, but it is probable that it was Galileo, who, stimulated by the Greek author, Heron, made a thermoscope at the end of the sixteenth or beginning of the seventeenth century. Possibly the physician, Santorio, in Padua, had, independently of Galileo, made thermoscopes that he applied first to practical medicine, as in the measurement of fever; also to scientific purposes, as in the measurement of the heat radiated from the moon. Santorio also was influenced by Heron's writings, so that in the invention of the thermometer we have presented to us the extremely rare case of the first beginnings of physical measurements being stimulated and expedited by the science of classical times. The first description and drawing of the new instrument was given by Biancani, who also first used the word "thermoscope" in the year 1620, whereas the word "thermometer" is found for the first time in a small book by the Jesuit Jean Leurichon, in the year 1624. There is little that is reliable that can be said as to the next following period in the history of the development of the thermometer. We only know that already, in 1632, the French physician, Jean Ray, instead of Galileo's air thermoscope, used water thermometers whose tubes were not, indeed, closed at the top, and that probably in 1641 the Duke Ferdinand II of Tuscany, first conceived the idea of closing the tube at the top so as to exclude the air, thus giving to the thermometer essentially the form in which it was afterwards known under the name of the "Florentine thermometer." Improvements in the instrument were made by the Academy del Cimento (that is to say the Academy of Experimentation which was founded in 1657 in Florence by Leopold, the brother of the reigning Grand Duke, and which, after 10 years' existence, was dissolved in consequence of the elevation of the Prince to the College of Cardinals). The most important results of the experimental work done by the Academy were recorded in a day book from which source the Secretary of the Academy, Lorenzo Magalotti, drew the material for his famous work *Saggi di naturali esperienze fatte nell' Academie del Cimento.*

[A complete English translation of this work was published by the Royal Society of London under the title of: Essays of Natural Experiments made in the Academy del Cimento, under the Protection of the Most Serene Prince Leopold of Tuscany. Written in Italian by the Secretary of that Academy. Englished by Richard Waller, Fellow of the Royal Society. London, I. T. Printed for Benjamin Alsop at the Angel and Bible in the Poultrey, over against the Church, 1684.]

The volume recently published by Dr. Hellmann reprints the first two chapters of the *Saggi*, as also drawings of three thermometers, namely, the so-called large, hundred-scale, the smaller, fifty-scale, and a very complicated spiral thermometer. The weakest point in the construction of these thermometers, which were very rapidly distributed throughout Europe, was the establishment of the scale, since the academicians knew only one fixed point, that of the melting point of snow, which occurred at about 13.5° on these thermometers. Nevertheless, in consequence of the excellent work of the glass blower, these instruments were very reliable and comparable among themselves.

A REPRINT OF EARLY METEOROLOGICAL CHARTS.

Among his recent "neudrücke," or reprints of classics in meteorology and terrestrial magnetism, Dr. Hellmann has published a volume illustrating the progress of meteorological chartography, in which he reprints (1) the first wind chart, which was prepared by Edward Halley in 1686, and which is also the oldest of all meteorological charts; (2) the first chart of isotherms, which Alexander von Humboldt published