occasionally. The necessity of these additional methods is proved by the fact that the average height of nimbus and strato-cumulus from theodolite measurements alone is considerably more than 1,000 meters, while measurements with kites show that on more than half of the days on which these clouds are present their bases are below 1,000 meters and usually below 500 meters. The reason is that low clouds are so indefinite in form, or cover the sky with such a uniform veil, that it is impossible to measure them with theodolites or photogrammeters.

EXCESSIVE PRECIPITATION IN THE UNITED STATES.

By ALFRED J. HENRY, Chief of Division.

Vast sums of money are expended each year in the construction of sewers and drainage systems. In the designing of main sewers for large areas a thorough knowledge of the vicissitudes of rainfall of the region, particularly as regards the intensity and duration of the heavier falls, is essential.

A number of quite heavy rainstorms occurred during the past year, and in a number of cases the capacity of the sewers was not equal to the task of discharging the accumulated storm waters. Failure of sewers to carry off flood waters is not a new problem in municipal engineering, though it has cost in damage to property and resulting litigation many thousands of dollars.

At the request of a number of civil and municipal engineers, Prof. Willis L. Moore, Chief of Bureau, has directed that statistics of unusually heavy rains be published in greater detail than heretofore. The facts and figures herein presented may be considered as a first attempt to draw some useful deductions from the records of automatic rain gauges in use at Weather Bureau stations.

Excessive rains naturally fall into two broad classes, (*a*) rains of great intensity and short duration, and (*b*) light intensity and long duration. Of these two classes, those of the first are by far the most damaging and destructive. In extreme cases 95 per cent of the downpour may quickly find its way into natural or artificial drainage channels. A rainfall of one-half inch in linear depth represents about 11,312 imperial gallons per acre. Assuming that in extreme cases only 5 per cent is absorbed, it is easily seen how great a quantity of water must flow into the drainage channels.

On the Pacific Coast, particularly the coast of Washington and Oregon, where the annual rainfall is greater than in any other portion of the United States, excessive rains of class *a* are not prevalent. The rain of this region falls principally between September and May, the colder part of the year, when convectional overturning in the atmosphere is least active.

The most favorable conditions for the sudden condensation of a vast quantity of water vapor are conceived to be (1) a strong vertical temperature gradient; (2) high surface temperature and humidity, in fact, the general conditions of humidity and instability of the atmosphere necessary to the formation of thunderstorms and tornadoes.

The most violent rains of class *a*, and, at the same time, those of which the least is known, are the so-called cloudbursts of the mountainous and arid regions of the west. These storms are not confined to any particular state or region but may occur in mountainous localities throughout the entire territory bounded by the British possessions on the north, the Mexican border on the south, the foothills of the Rockies on the east and the Sierras on the west. In the true cloudburst the rain seems to pour down rather than fall in drops, and, as a rule, the downpour of water covers an extremely small area. It often happens that the downpour occurs over rather narrow basins or on mountain slopes whose outlets are canyons or gorges leading to a valley or plain below. In these cases almost the entire amount of water quickly finds its way into the drainage channel, and, as a result, a wave of water rushes down the outlet with considerable velocity and in sufficient volume to destroy everything in its path. Such a flood wave almost swept away the town of Eureka, Nev., in 1874, and caused the loss of 15 lives. A far greater disaster occurred in Bear Creek Canyon, Colo., in July, 1896. Thirty lives were lost and property valued at more than $100,000 was destroyed.

The amount of rain that falls in one of these torrential downpours has never been ascertained. A cloudburst passed over the edge of the little town of Palmetto, Nev., in August, 1890. A rain gauge that was not exposed to the full intensity of the storm caught 8.80 inches of water in an hour. In August, 1891, two storms passed over Campo, Cal., within a few minutes of each other. The second storm was a veritable cloudburst. The observer succeeded in measuring the rainfall of the first shower and a portion of the second. Eleven and a half inches were measured within an hour. The rain gauge and support were carried away by the torrent of water in the second storm and the full record was not obtained.

The great majority of excessive rains (class *a*) in the United States occur east of the one hundred and fifth meridian, and principally in the summer months. They are most frequent in connection with summer afternoon thunderstorms, but occasionally occur in the track of West India hurricanes. They are more abundant on the Gulf and south Atlantic coasts than at inland points.

In Table A there are given the essential facts concerning each excessive rain of which permanent record was made during 1896, at stations equipped with self-recording rain gauges. Columns 1 and 2 give the total duration of the storm; column 3, the total depth of rainfall; columns 4 and 5, the beginning and ending, respectively, of the excessive rate; column 6, the amount of rain that fell before the excessive rate began. In the succeeding colums the accumulated amounts of rainfall are given for each successive five minutes of the storm's duration up to fifty minutes, and in ten and twenty minute periods thereafter.

It is possible to determine from the details thus presented whether or not rain falls at a uniform rate and how long such rate continues, and also the approximate time when the flow in the sewers shall be at a maximum for any given rate.

It is generally assumed that in heavy showers the intensity, i, varies inversely as the duration, t, and a number of formulæ have been suggested to express the relation between i and t. From an examination of the data in Table A, it would seem to be extremely doubtful whether a relation sufficiently definite to admit of expression by mathematical formulæ exists. The general principle that rains of the highest intensity exhaust themselves quickly holds good, but the fact remains that the total duration of the storm bears no simple relation either to the rate or linear depth of rainfall.

Percentage of cases in which the maximum intensity of rainfall occurred within five to sixty minutes from the beginning of the storm.

Maximum intensity occurred.	Washington.	Savannah.	St. Louis.
	Per cent.	*Per cent.*	*Per cent.*
Within 5 minutes from beginning of storm....	17	10	32
" 10	21	20	30
" 15	20	21	8
" 20	5	13	5
" 25	8	7	2
" 30	9	10	2
" 35	5	5	2
" 40	5	1	8
" 45	2	4	5
" 50	1	5	5
" 60	6	3	2

The periods of very great intensity are of short duration and may occur at any time during the continuance of the storm. There may be two and even three periods of great intensity in a single storm separated by intervals of light

rain. The table above shows the time of occurrence of the maximum intensity, counting from the beginning of the storm, of all storms that occurred at Washington, D. C., during the period 1881–1896, and at Savannah, Ga., and St. Louis, Mo., 1889–1896.

In Table A, which follows, the amounts given in column 6 are always included in those of column 3. Whenever possible the full record of the storm before the beginning of the excessive rate, but not after, has been given in the columns under "Depths of precipitation, etc."

TABLE A.—*Showing the accumulated amounts of precipitation for each five minutes during all storms of* 1896 *in which the rate equaled or exceeded* 1.00 *inch per hour, at all stations of the Weather Bureau furnished with self-registering gauges.*

Station and date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time as indicated.												
	From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
	1	2	3	4	5	6														
Baltimore, Md.																				
July 21, 1896	9.15 p.m.	11.58 p.m.	2.05	9.20 p.m.	10.40 p.m.	0.05	0.21	0.35	0.46	0.58	0.62	0.64	0.67	0.70	0.83	0.95	1.18	1.77	.....	.....
September 19, 1896	4.55 p.m.	5.40 p.m.	1.00	5.15 p.m.	5.40 p.m.	0.05	0.25	0.60	0.85	0.92	0.95	.....	.....	.....	.....	.....	.....	.....	.....	.....
Chicago, Ill.																				
May 25, 1896	1.37 a.m.	3.50 a.m.	1.46	3.08 a.m.	3.25 a.m.	0.09	0.01	0.09	0.52	1.07	1.26	1.29	1.31	1.32	.....	.....	.....	.....	.....	.....
August 6, 1896	6.05 a.m.	7.35 a.m.	1.18	6.05 a.m.	6.45 a.m.	0.00	0.10	0.30	0.36	0.62	0.90	0.99	1.04	1.17	.....	.....	.....	.....	.....	.....
Cincinnati, Ohio.																				
July 20–21, 1896	9.45 p.m.	12.20 a.m.	1.93	9.48 p.m.	10.27 p.m.	0.02	0.14	0.30	0.42	0.55	0.82	1.00	1.05	1.12	1.16	1.19	1.23	.....	.....	.....
Cleveland, Ohio.																				
April 30, 1896	3.25 p.m.	5.00 p.m.	1.64	3.27 p.m.	4.00 p.m.	0.05	0.28	0.58	0.88	1.13	1.23	1.38	1.49	1.53	.....	.....	.....	.....	.....	.....
June 8, 1896	11.00 a.m.	12.55 p.m.	1.87	11.12 a.m.	11.47 a.m.	0.04	0.04	0.19	0.49	0.79*	1.04*	1.31*	1.56	1.68	1.73	1.76	.....	.....	.....	.....
Denver, Colo.																				
July 25, 1896	3.52 p.m.	4.22 p.m.	1.02	3.57 p.m.	4.22 p.m.	0.05	0.05	0.30	0.60	0.78	0.95	1.02	.....	.....	.....	.....	.....	.....	.....	.....
Detroit, Mich.																				
June 25, 1896	5.50 p.m.	6.40 p.m.	1.19	5.58 p.m.	6.28 p.m.	0.05	0.15	0.45	0.85	1.00	1.07	1.14	.....	.....	.....	.....	.....	.....	.....	.....
July 26–27, 1896	8.15 p.m.	5.00 a.m.	2.62	8.17 p.m.	8.58 p.m.	0.02	0.38	0.57	0.68	0.91	1.13	1.30	1.43	1.63	1.70	1.73	1.78	.....	.....	.....
Dodge City, Kans.																				
April 16, 1896	4.45 p.m.	5.46 p.m.	1.26	5.05 p.m.	5.40 p.m.	0.05	0.05	0.15	0.40	0.65	0.80	0.97	1.12	1.20	1.25	.....	.....	.....	.....	.....
July 18, 1896	1.45 a.m.	2.35 a.m.	1.18	1.45 a.m.	2.15 a.m.	0.00	0.19	0.35	0.59	0.78	0.91	1.00	1.06	1.11	.....	.....	.....	.....	.....	.....
Galveston, Tex.																				
March 15, 1896	8.00 a.m.	6.00 p.m.	2.17	11.20 a.m.	11.47 a.m.	0.35	0.10	0.30	0.37	0.47	0.62	0.75	0.82	0.85	0.88	0.90	1.00	1.12	1.18	1.22
July 11, 1896	12 noon	3.30 p.m.	1.67	2.07 p.m.	2.52 p.m.	0.32	0.30	0.45	0.57	0.65	0.77	0.90	0.98	1.04	1.10	1.13	1.23	.....	.....	.....
Indianapolis, Ind.																				
May 25, 1896	5.40 a.m.	6.05 a.m.	1.01	5.40 a.m.	6.05 a.m.	0.00	0.30	0.50	0.90	0.93	1.01	.....	.....	.....	.....	.....	.....	.....	.....	.....
September 18, 1896	10.20 p.m.	11.40 p.m.	1.78	10.25 p.m.	11.10 p.m.	0.05	0.05	0.20	0.42	0.55	0.80	1.00	1.30	1.50	1.65	1.73	1.78	.....	.....	.....
Jacksonville, Fla.																				
March 11, 1896	6.20 a.m.	10.15 a.m.	1.20	8.38 a.m.	9.07 a.m.	0.10	0.14	0.20	0.35	0.85	0.90	1.01	.....	.....	.....	.....	.....	.....	.....	.....
June 4, 1896	2.35 p.m.	4.55 p.m.	2.49	2.58 p.m.	3.50 p.m.	0.12	0.07	0.14	0.47	0.92	1.30	1.57	1.58	1.60	1.71	1.79	1.99	2.19	2.34	.....
June 19, 1896	3.05 p.m.	5.40 p.m.	1.35	3.05 p.m.	3.55 p.m.	0.00	0.30	0.61	0.70	0.77	0.82	0.85	0.87	0.89	1.00	1.15	.....	.....	.....	.....
August 4, 1896	1.20 p.m.	2.20 p.m.	1.21	1.30 p.m.	2.02 p.m.	0.05	0.04	0.26	0.44	0.69	0.81	0.91	1.04	1.12	1.15	1.18	.....	.....	.....	.....
August 26, 1896	3.04 p.m.	6.15 p.m.	2.09	3.17 p.m.	4.00 p.m.	0.15*	0.05*	0.11*	0.20*	0.34*	0.50	0.85	1.07	1.20	1.50	1.65	1.80	.....	.....	.....
Jupiter, Fla.																				
January 25, 1896	5.25 p.m.	10.30 p.m.	2.18	6.40 p.m.	7.21 p.m.	0.35	0.03	0.06	0.10	0.16	0.30	0.43	0.51	0.66	1.06	1.36	1.56	.....	.....	.....
July 10, 1896	4.00 p.m.	10.30 p.m.	2.17	8.00 p.m.	8.40 p.m.	0.97	0.10	0.35	0.55	0.59	0.67	0.75	0.90	1.10	.....	.....	.....	.....	.....	.....
September 9, 1896	10.30 p.m.	12 noon	1.35	10.30 a.m.	11.12 a.m.	0.00	0.07	0.24	0.51	0.73	0.88	0.96	1.01	1.10	1.14	1.17	.....	.....	.....	.....
Kansas City, Mo.																				
May 31, 1896	5.55 a.m.	7.25 a.m.	1.17	6.28 a.m.	6.38 a.m.	0.10	0.80	1.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
July 18–19, 1896	3.30 p.m.	7.20 p.m.	5.54	3.50 p.m.	5.05 p.m.	0.10	0.05	0.15	0.40	0.65	1.00	1.30	1.52*	1.72*	1.87*	1.99*	2.22*	2.57*	.....	.....
Key West, Fla.																				
November, 7, 1896	2.20 p.m.	4.10 p.m.	1.00	2.56 p.m.	3.41 p.m.	0.14	0.05	0.10	0.22	0.32	0.34	0.35	0.45	0.65	0.82	0.86	.....	.....	.....	.....
Little Rock, Ark.																				
June 2, 1896	10.25 a.m.	11.35 a.m.	1.11	10.43 a.m.	11.08 a.m.	0.05	0.25	0.50	0.75	0.95	0.99	1.03	1.05	.....	.....	.....	.....	.....	.....	.....
October, 29, 1896	8.20 a.m.	11.45 a.m.	1.75	10.29 a.m.	10.54 a.m.	0.79	0.06	0.33	0.46	0.60	0.66	0.70	0.73	0.76	0.79	0.82	0.91	.....	.....	.....
Louisville, Ky.																				
June 23, 1896	4.17 p.m.	4.53 p.m.	1.37	4.30 p.m.	4.46 p.m.	0.05	0.20	0.65	1.20	1.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
July 4, 1896	5.52 p.m.	9.35 p.m.	4.60	6.08 p.m.	7.40 p.m.	0.15	0.06	0.15	0.70	1.20	1.52	1.70	1.90*	2.06*	2.22*	2.38*	2.70*	3.43*	4.15*	*4.35
Nantucket, Mass.																				
July 6, 1896	8.05 p.m.	10.25 p.m.	1.41	9.23 p.m.	10.23 p.m.	0.25	0.12	0.24	0.37	0.42	0.46	0.49	0.55	0.60	0.64	0.75	1.15	.....	.....	.....
Nashville, Tenn.																				
May 31, 1896	1.15 p.m.	2.25 p.m.	1.24	1.46 p.m.	2.20 p.m.	0.15	0.05	0.08	0.20	0.31	0.40	0.64	0.79	0.90	1.12	1.22	.....	.....	.....	.....
July 2, 1896	3.37 p.m.	6.13 p.m.	1.32	4.52 p.m.	5.46 p.m.	0.10	0.05	0.19	0.44	0.60	0.72	0.76	0.78	0.80	0.85	0.97	1.21	.....	.....	.....
July 12, 1896	3.58 p.m.	5.15 p.m.	1.50	3.58 p.m.	4.26 p.m.	0.00	0.12	0.30	0.60	0.82	1.05	1.11	1.12	1.13	1.14	1.15	1.30	1.50	.....	.....
New Orleans, La.																				
March 10, 1896	2.30 p.m.	9.20 p.m.	1.81	6.27 p.m.	7.08 p.m.	0.30	0.06	0.15	0.25	0.30	0.35	0.40	0.48	0.65	0.95	1.05	1.09	.....	.....	.....
March 18, 1896	1.10 p.m.	6.30 p.m.	2.32	2.11 p.m.	3.00 p.m.	0.25	0.11	0.16	0.30	0.65	0.92	1.05	1.22	1.35	1.44	1.50	1.55	.....	.....	.....
April 9, 1896	1.20 p.m.	2.20 p.m.	1.57	1.20 p.m.	1.50 p.m.	0.00	0.15	0.40	0.72	1.12	1.45	1.51	1.55	.....	.....	.....	.....	.....	.....	.....
April 14, 1896	1.30 p.m.	7.40 p.m.	1.52	3.45 p.m.	4.31 p.m.	0.15	0.04	0.21	0.44	0.60	0.64	0.67	0.79	0.96	0.99	1.07	1.11	.....	.....	.....
September 2, 1896	8.25 a.m.	2.15 p.m.	3.33	9.45 a.m.	10.40 a.m.	0.65	0.04	0.09	0.15	0.24	0.34	0.46	0.62	0.92	1.23	1.44	1.67	.....	.....	.....
New York, N. Y.																				
July 6, 1896	12.32 p.m.	1.30 p.m.	1.06	12.32 p.m.	1.10 p.m.	0.00	0.20	0.42	0.60	0.83	0.89	0.94	0.99	1.01	.....	.....	.....	.....	.....	.....
Norfolk, Va.																				
June 9, 1896	2.47 p.m.	3.50 p.m.	1.45	2.47 p.m.	3.28 p.m.	0.00	0.25	0.40	0.55	1.00	1.17	1.26	1.35	1.44	.....	.....	.....	.....	.....	.....
June 22, 1896	5.13 p.m.	6.40 p.m.	1.32	5.13 p.m.	5.40 p.m.	0.00	0.10	0.37	0.66	1.00	1.06	1.10	.....	.....	.....	.....	.....	.....	.....	.....
July 16, 1896	7.25 p.m.	8.35 p.m.	1.04	7.30 p.m.	8.00 p.m.	0.05	0.05	0.33	0.58	0.80	0.87	0.95	1.01	.....	.....	.....	.....	.....	.....	.....
Omaha, Nebr.																				
August 15, 1896	6.30 p.m.	7.54 p.m.	1.68	6.37 p.m.	7.00 p.m.	0.05	0.35	0.70	1.10	1.45	1.62	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pittsburg, Pa.																				
August 13, 1896	7.50 a.m.	11.40 a.m.	2.22	8.33 a.m.	9.31 a.m.	0.10	0.07	0.25	0.50	0.85	1.05	1.13	1.21	1.29	1.37	1.44	1.70	.....	.....	.....
Portland, Me.																				
September 6, 1896	3.15 a.m.	5.00 p.m.	5.21	7.30 a.m.	8.20 a.m.	1.93	0.12*	0.24*	0.36*	0.48*	0.58	0.80	0.98	1.13	1.26	1.53	1.58	1.73	1.84	1.97
St. Louis, Mo.																				
May 27, 1896	5.43 p.m.	10.05 p.m.	2.89	6.04 p.m.	7.23 p.m.	0.01	0.08	0.17	0.33	0.49	0.72	0.85	0.93	0.99	1.05	1.23	1.33			
				7.00 p.m.	7.35 p.m.	0.12	0.23	0.66	0.70	0.70	0.70	0.71	0.71	0.71	0.76	0.83	1.01	1.16	1.35	1.43
St. Paul, Minn.																				
August 4, 1896	12.08 a.m.	12.38 a.m.	1.58	12.08 a.m.	12.38 a.m.	0.00	0.10	0.46	0.84	1.24	1.44	1.58	.....	.....	.....	.....	.....	.....	.....	.....
August 9, 1896	4.15 p.m.	5.10 p.m.	1.07	4.15 p.m.	4.55 p.m.	0.00	0.06	0.19	0.39	0.59	0.61	0.68	0.85	1.00	1.07	.....	.....	.....	.....	.....
Savannah, Ga.																				
April 24, 1896	5.30 p.m.	8.45 p.m.	1.30	7.06 p.m.	7.27 p.m.	0.20	0.05	0.10	0.13	0.15	0.20	0.45	0.67	0.80	0.87	0.93	1.03	1.10	1.25	.....
July 7, 1896	9.45 a.m.	11.10 a.m.	1.34	9.55 a.m.	10.13 a.m.	0.05	0.02	0.05	0.30	0.65	0.90	1.05	1.10	1.11	1.12	1.13	1.15	1.30	.....	.....
August 18, 1896	5.45 p.m.	10.45 p.m.	2.68	8.33 p.m.	8.56 p.m.	1.46†	0.25	0.50	0.70	0.95	1.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
August 26, 1896	4.30 a.m.	5.35 a.m.	1.63	4.42 a.m.	5.19 a.m.	0.10	0.05	0.08	0.15	0.27	0.38	0.62	0.97	1.25	1.45	1.57	1.63	.....	.....	.....
Vicksburg, Miss																				
April 13, 1896	1.30 p.m.	7.15 p.m.	1.63	1.36 p.m.	2.20 p.m.	0.05	0.04	0.16	0.36	0.60	0.66	0.78	0.84	0.90	0.96	1.02	1.07	.....	.....	.....
June 6, 1896	8.25 p.m.	9.55 p.m.	1.60	8.34 p.m.	8.57 p.m.	0.05	0.03	0.08	0.35	0.60	0.80	1.00	1.06	1.08*	1.10*	1.14*	1.18*	1.26*	1.34*	.....
October 22–23, 1896	9.45 p.m.	8.15 a.m.	1.38	5.31 a.m.	5.46 a.m.	0.55	0.19	0.45	0.61	0.65	0.68	0.72	0.76	.....	.....	.....	.....	.....	.....	.....
Washington, D. C.																				
August 13, 1896	5.20 p.m.	8.24 p.m.	1.78	6.20 p.m.	7.00 p.m.	0.05	0.14	0.33	0.75	0.95	1.15	1.34	1.45	1.52	1.57	.....	.....	.....	.....	.....
Wilmington, N.C.																				
August 3, 1896	1.25 p.m.	3.45 p.m.	1.19	1.58 p.m.	2.20 p.m.	0.05	0.10	0.50	0.75	0.90	1.06	1.07	1.08	1.09	.....	.....	.....	.....	.....	.....

*Partly estimated. †Fell in three short heavy showers of about equal amounts, at intervals of nearly 1 hour.

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