

the observer's personal estimates give the percentage of *area* of clear sky. These numbers have no necessary relation to each other, since stationary banks of clouds may obscure the sun without covering the sky, but when all clouds have a steady motion past the sun and are uniformly scattered over the sky, the percentages of duration and of area agree closely. For the sake of comparison, these percentages have been brought together, side by side, in the following table, from which it appears that, in general, the instrumental records of percentages of durations of sunshine are almost always larger than the observers' personal estimates of percentages of area of clear sky; the average excess for May, 1896, is 8 per cent for photographic and 14 per cent for thermometric records.

#### ATMOSPHERIC ELECTRICITY.

Numerical statistics relative to auroras and thunderstorms are given in Table X, which shows the number of stations from which meteorological reports were received, and the number of such stations reporting thunderstorms (T) and auroras (A) in each State and on each day of the month, respectively.

*Thunderstorms.*—The dates on which reports of thunderstorms for the whole country were most numerous were: 11th, 237; 12th, 237; 13th, 223; 18th, 233; 19th, 256; 26th, 258; 28th, 254.

Thunderstorm reports were most numerous in: Illinois, 326; Iowa, 219; Missouri, 470; North Carolina, 245; Ohio, 345.

Thunderstorms were most frequent in: Kansas, 28 days; Nebraska and North Carolina, 27; Missouri and South Carolina, 26; Arkansas, Minnesota, and Ohio, 25.

*Auroras.*—The evenings on which bright moonlight must have interfered with observations of faint auroras are assumed to be the four preceding and following the date of full moon, viz, from the 22d to the 30th, inclusive. On the remaining twenty-two days of this month 203 reports were received, or an average of about 9 per day. The dates on which the number of reports especially exceeded this average were: 2d, 78; 3d, 19; 17th, 57; 18th, 17.

Auroras were reported by a large percentage of observers in: New Hampshire, 43; New York, 24; Minnesota, 30; Wisconsin, 78.

Auroras were reported most frequently in: Wisconsin, 10 days; Minnesota, 9; Iowa, 8; North Dakota and New Hampshire, 7; Michigan, 6.

#### CANADIAN REPORTS.

Thunderstorms were reported as follows: 1st, Saugeen;

2d, Toronto, Port Stanley; 3d, Rockcliffe, Port Stanley; 4th, Port Stanley, Saugeen, Swift Current; 5th, Yarmouth; 6th, Minnedosa, Qu'Appelle, Prince Albert; 8th, Winnipeg; 9th, Winnipeg, Minnedosa; 10th, Grand Manan, St. Andrews, Rockcliffe; 11th, Grand Manan, Port Stanley, Winnipeg, Qu'Appelle, Swift Current; 12th, Charlottetown, Port Stanley, Minnedosa; 14th, Port Stanley; 15th, Toronto, Saugeen, Port Stanley; 16th, Swift Current; 17th, Rockcliffe, Toronto, Port Stanley; 18th, Grindstone, Halifax, Yarmouth, Toronto; 19th, Port Stanley; 21st, Swift Current; 22d, Halifax, St. Andrews, Quebec, Swift Current; 23d, Minnedosa, Swift Current; 24th, Minnedosa; 25th, Toronto, Port Stanley, Saugeen, Parry Sound; 26th, Quebec, Port Stanley; 27th, Yarmouth, Saugeen; 28th, Toronto, Port Stanley; 29th, Halifax, Minnedosa, Swift Current; 31st, Yarmouth.

Auroras were reported as follows: 1st, Quebec; 2d, Halifax, Yarmouth, Charlottetown, Quebec, Montreal, Winnipeg; 3d, Father Point, Quebec, Port Arthur, Minnedosa, Battleford; 4th, Father Point, Winnipeg; 6th, Quebec, Winnipeg; 7th, Port Arthur, Winnipeg; 11th, Father Point, Quebec; 14th, Quebec; 15th, Father Point; 16th, Port Arthur, Montreal; 17th, St. Johns, Halifax, Yarmouth, Quebec, Montreal, Toronto; 18th, Quebec, Montreal, Winnipeg, Battleford; 19th, Quebec, Port Arthur; 20th, Grindstone, Prince Albert; 21st, Prince Albert; 22d, Prince Albert; 23d, Father Point.

#### INLAND NAVIGATION.

The *extreme and average stages of water* in the rivers during the current month are given in Table VIII, from which it appears that the only river which attained the danger line was the Mississippi, at La Crosse, Wis., which reached 10.7 on the 24th and 25th. But in consequence of the heavy rains in the lower Missouri watershed numerous small streams overflowed, especially in Kansas, Iowa, Illinois, and Missouri, and the Mississippi rose steadily up to the close of the month at all stations between St. Louis and Vicksburg.

#### METEOROLOGY AND MAGNETISM.

By Prof. FRANK H. BIGELOW.

The values of H given in the table of Chart V are to be added to 0.18250, those of D to 180', these numbers being the means for Toronto and Washington. A strong disturbance of the magnetic field occurred from May 2 to May 4, but did not effect the other elements. The circulation of the atmosphere was very stagnant from May 1 to May 13. A severe storm then occurred in the Lake Region, May 15 to May 17. A brisk eastward movement in the northern circuit set in about May 18, and continued to the end of the month.

### CLIMATE AND CROP SERVICE.

By JAMES BERRY, Chief of Climate and Crop Service Division.

The following extracts relating to the general weather conditions in the several States and Territories are taken from the monthly reports of the respective services.

Snowfall and rainfall are expressed in inches.

*Alabama.*—The mean temperature was 75.8°, or 2.5° above normal; the highest was 100°, at Tuscaloosa on the 25th, Pineapple on the 26th, and Union on the 31st; the lowest was 49°, at Valley Head on the 30th. The average precipitation was 3.44, or 0.51 below the normal; the greatest monthly amount, 6.32, occurred at Bermuda, and the least, 1.18, at Union.

*Arizona.*—The mean temperature was 72.4°, or 3.5° above normal; the highest was 117°, at Parker on the 26th and at Fort Mohave on the 27th, and the lowest, 22°, at Flagstaff on the 21st. The average precipitation was "trace," or 0.32 below normal; "trace" was the greatest amount recorded anywhere, and was reported from 16 stations, while no precipitation occurred at numerous other stations.

*Arkansas.*—The mean temperature was 74.4°, or 5.4° above normal,

and is the highest during the past fourteen years; the highest was 98°, at Helena on the 8th and at Camden on the 31st, and the lowest, 46°, at Keesees Ferry on the 2d. The average precipitation was 3.54, or 1.34 less than normal; the greatest monthly amount was 8.35, at Moss-ville, and the least, 0.76, at Luna Landing.

*California.*—The mean temperature was 61.2°, or 2.9° below normal; the highest was 124°, at Salton, in the desert regions, on the 27th, and lowest, 12°, at Bodie, in the high mountain regions, on the 10th. The average precipitation was 1.36, or 0.50 above normal; the greatest monthly amount, 10.03, occurred at Bear Valley, while none fell at numerous points.

*Colorado.*—The month was warmer than usual in all sections, except the extreme northwestern part of the State, where it was slightly cooler. The highest temperature was 100°, at Minneapolis on the 29th and at Delta on the 30th; the lowest, 10° below zero, occurred at Climax on the 14th. The average precipitation was 1.15, or 1.08 below normal; the greatest monthly amount was 5.60, at Longmont; no precipitation occurred at Saguache and only a "trace" at La Jara.

*Florida.*—The mean temperature was 74.7°, or 1.4° below normal; the

highest was 100°, at Clermont on the 19th, at McClenny on the 25th, at Grasmere on the 27th, and at Earnestville on the 31st; the lowest, 48°, occurred at McClenny on the 9th. The average precipitation was 2.73, or 1.62 below normal; the greatest monthly amount, 9.02, occurred at Myers, and the least, 0.54, at Key West. The various interests in all walks of life keenly felt the absence of the necessary moisture.

**Georgia.**—The mean temperature was 76.0°, or more than 4.0° above normal; the highest was 101°, at Brag on the 11th, and the lowest, 41°, at Eastman on the 9th. The average precipitation was 2.54, or about 1.25 below normal; the greatest monthly amount, 6.16, occurred at Fleming, and the least, 0.85, at Alapaha.

**Idaho.**—The mean temperature was 47.0°; the highest was 93°, at Lewiston on the 29th, and the lowest, 11°, at Swan Valley on the 11th and at Birch Creek on the 18th. The average precipitation was 3.03; the greatest monthly amount, 6.26, occurred at Idaho City, and the least, 0.43, at Challis.

**Illinois.**—The mean temperature was 69.5°, or 7.7° above normal; the highest was 98°, at Paris on the 10th, and the lowest, 41°, at Chemung on the 31st, and at Zion on the 19th. The average precipitation was 5.78, or 1.42 above normal; the greatest monthly amount, 13.21, occurred at Albion, and the least, 2.35, at Fort Sheridan.

**Indiana.**—The mean temperature was 69.3°, or 7.2° above normal; the highest was 96°, at Vincennes on the 10th and 11th, and the lowest, 44°, at Delphi on the 4th and at Hammond on the 20th. This was the warmest May on record. The average precipitation was 4.50, or 0.27 above normal; the greatest monthly amount, 8.55, occurred at Princeton, and the least, 1.97, at Columbus.

**Iowa.**—The mean temperature was 65.5°, or 5.8° above normal; the highest was 100°, at Cedar Rapids on the 6th, and the lowest, 34°, at Indianola on the 1st, at Glenwood on the 14th, and at Rock Rapids on the 19th. The average precipitation was 6.69, or 2.54 above normal; the greatest monthly amount, 11.79, occurred at Mount Ayr, and the least, 3.40, at Mount Vernon.

**Kansas.**—The mean temperature was 69.3°, or 5.1° above normal; the highest was 107°, at Macksville on the 24th, and the lowest, 30°, at Jaqua on the 12th. The average precipitation was 4.75. There was an excess of 2.09 in the eastern division and 0.40 in the middle division, while there was a deficiency of 0.77 in the western division. The greatest monthly amount, 12.67, occurred at Fort Scott, and the least, "trace," at Sharon Springs. On the 17th a tornado, originating in the northern part of Clay County, and passing northeast across Washington, Marshall, Nehama, and Brown counties, into Nebraska, destroyed much property and some life.

**Kentucky.**—The mean temperature was 72.2°, or 7.1° above normal; the highest was 106°, at Ashland on the 10th, and the lowest, 42°, at Lexington on the 30th. The average precipitation was 5.34, or 1.03 above normal; the greatest monthly amount, 11.78, occurred at Fords Ferry, and the least, 1.65, at Richmond.

**Louisiana.**—The mean temperature was 77.7°, or 4.2° above normal; the highest temperature was 101°, at Liberty Hill on the 31st, and the lowest, 53°, at Minden on the 1st. This was the warmest May on record. The average precipitation was 2.20, or 1.43 below normal; the greatest monthly amount, 4.89, occurred at West End, and the least, 0.14, at Venice.

**Maryland.**—The mean temperature was 65.8°, or 3.5° above normal; the highest was 96°, at Baltimore and Johns Hopkins Hospital on the 10th, at Westernport, Md., and Wilmington, Del., on the 11th, and at Van Bibber, Md., on the 18th; the lowest, 31°, occurred at Princess Anne on the 8th. The average precipitation was 3.20, or 0.73 above normal; the greatest monthly amount, 6.44, occurred at Seaford, Del., and the least, 0.87, at Green Spring Furnace, Md.

**Michigan.**—The mean temperature was 62.2°, or 8.0° above normal, and the highest mean temperature for May on record; the highest was 97°, at Three Rivers on the 8th, and the lowest, 25°, at Lathrop on the 20th. The average precipitation was 3.22, or 0.54 below normal; the greatest monthly amount, 8.10, occurred at Benton Harbor, and the least, 1.11, at Saginaw.

**Minnesota.**—The mean temperature was 60.9°, or 4.5° above normal; the highest was 93°, at Wabasha on the 8th, and the lowest, 23°, at Leech Lake Dam on the 4th. The average precipitation was 5.02, or 1.28 above normal; the greatest monthly amount, 10.60, occurred at Lambert, and the least, 2.57, at St. Cloud.

**Mississippi.**—The mean temperature was 77.4°, or 5.1° above normal; the highest was 110°, at Williamsburg on the 14th, and the lowest, 46°, at the same place on the 3d. The average precipitation was 2.71, or 1.44 below normal; the greatest monthly amount, 8.16, occurred at Leakesville, and the least, 0.41, at Brookhaven.

**Missouri.**—The mean temperature was 70.1°, or 6.4° above normal, and at many stations it was the warmest day on record; the highest was 96°, at Neosho on the 16th, and the lowest 32° (?) at the same station on the 2d. The average precipitation was 9.09, or 4.28 in excess of normal; the greatest monthly amount, 18.23, occurred at Osceola, and the least, 4.08, at Birch Tree. In many counties the heavy rains, in some instances amounting to cloudbursts, resulted in floods which did immense damage to property and crops and caused the loss of a number of lives. The Osage River and its tributaries were nearly as high as during the memorable flood of last December; and many other

streams, in different sections of the State, were as high, or higher, than ever before known. Thousands of acres of growing crops on bottom lands were ruined by the overflowing of the streams, and much corn on flat land was also drowned out. In all sections more or less damage was done on rolling land by the washing away of soil, and, in some instances, considerable corn was washed up.

**Montana.**—The mean temperature was 49.0°, or 4.0° below normal; the highest was 90°, at Billings on the 23d, and the lowest, 16°, at Butte. The average precipitation was 3.14, or 1.38 above normal; the greatest monthly amount, 7.32, occurred at Wibaux, and the least, 1.43, at Butte. Heavy rains were reported from all sections of the State, and at the close of the month the ground was thoroughly soaked, and many rivers were high, and many were overflowing their banks.

**Nebraska.**—The mean temperature was 63.6°, or 4.5° above normal; the highest was 102°, at Benkleman on the 29th, and the lowest, 25°, at Whitman on the 17th. The average precipitation was 4.03, or 0.42 above normal; the greatest amount, 13.77, occurred at Rulo, and the least, 0.56, at Kirkwood.

**New England.**—The mean temperature was 58.5°, or 3.0° above normal; the highest was 96°, at Lawrence, Mass., on the 10th, and the lowest, 22°, at West Milan, on the 1st. The average precipitation was 2.58, or 1.04 less than normal; the greatest monthly amount, 5.33, occurred at Norwalk, Conn., and the least, 0.90, at Stafford, Vt.

**New Jersey.**—The mean temperature was 65.3°, or 5.1° above normal; the highest was 98°, at Paterson on the 9th and 10th, and the lowest, 29°, at Charlotteburg, River Vale, and Allaire on the 1st. The average precipitation was 3.21, or 0.63 below normal; the greatest monthly amount, 4.54, occurred at Elizabeth, and the least, 1.62, at Camden and Friesburg.

**New Mexico.**—The mean temperature was considerably above the normal; the highest was 110°, at Rincon on the 28th, and the lowest, 13°, at Chama on the 13th. The average precipitation was below normal; the greatest monthly amount, 0.60, occurred at La Belle, while none fell at Eddy, Los Lunas, and Raton.

**North Carolina.**—The mean temperature was 72.2°, or 5.2° above normal; the highest was 99°, at Rockingham and Tarboro on the 11th, and the lowest, 39°, at Linville on the 30th. The average precipitation was 4.28, or 0.03 above normal; the greatest monthly amount, 11.22, occurred at Falkland, and the least, 0.52, at Southport.

**North Dakota.**—The mean temperature was 56.9°, or 23° above normal; the highest was 103°, at Larimore on the 7th, and the lowest, 22°, at Dickinson on the 19th. The average precipitation was 4.89, or 2.65 above normal; the greatest monthly amount, 8.61, occurred at Mayville, and the least, 1.98, at Bismarck and Fort Yates.

**Oklahoma.**—The mean temperature was 75.4°; the highest was 108°, at Arapahoe on the 30th, and the lowest, 3°, at Burnett on the 2d. The average precipitation was 3.79; the greatest monthly amount, 10.51, occurred at Vinita, and the least, 0.71, at Winnview.

**Pennsylvania.**—The mean temperature was 65.4°, or 5.9° above normal; the highest temperature recorded was 98°, at Aqueduct on the 17th, and the lowest, 31°, at Blooming Grove on the 1st. The average precipitation was 2.85, or 2.48 below the average; the greatest monthly amount, 6.30, occurred at Bethlehem, and the least, 1.19, at Cannonsburg.

**South Carolina.**—The mean temperature was 76.7°, or 7.7° above normal; the highest was 104°, at Gillisonville on the 11th, and the lowest, 42°, at Allendale and Georgetown on the 9th. This was the warmest May ever recorded in the State. The average precipitation was 2.74, or 1.62 below normal; the greatest monthly amount, 6.07, occurred at Pinopolis, and the least, 0.52, at Charleston.

**South Dakota.**—The mean temperature was 6.09°, or about 5.5° above normal; the highest was 110°, at Vermilion on the 7th, and the lowest, 22°, at Cross on the 15th. The average precipitation was 2.42, or 0.99 below normal; the greatest monthly amount, 5.80, occurred at Gary, and the least, 0.03, at Nowlin.

**Tennessee.**—The mean temperature was 73.0°, or more than 6° above normal; the highest was 96°, at Arlington on the 9th and at Brownsville on the 27th, and the lowest, 45°, at Bristol on the 28th. The past was the warmest May on record. The average precipitation was 3.81, or 0.25 below normal; the greatest monthly amount, 6.95, was recorded at Byrdstown, and the least, 0.80, at Brownsville.

**Texas.**—The mean temperature was 3.8° above normal; the highest was 110°, at Midland on the 24th, and at Rhineland on the 31st, and the lowest, 33°, at Hartley on the 21st. The average precipitation was 1.80 below normal; the greatest monthly amount, 4.13, occurred at Palestine, and the least, "trace," at Blanco, El Paso, Point Isabel, Hartley, and Rock Springs.

**Utah.**—The mean temperature was 51.0°; the highest was 104°, at St. George on the 28th, and the lowest, 12°, at Soldier Summit on the 14th. The average precipitation was 1.52; the greatest monthly amount, 4.22, was recorded at Park City, and the least, "trace," at Cisco.

**Virginia.**—The mean temperature was 68.7°, or about 4° in excess of normal; the highest was 98°, at Bonair on the 12th, 14th, and 25th, and at Buckingham and Smithville on the 11th; the lowest was 23°, at Guinea on the 9th. The average precipitation was 4.56, or 0.12 above normal; the greatest monthly amount, 10.61, occurred at Cape Henry, and the least, 1.43, at Stephens City.

**Washington.**—The mean temperature was 51.0°, or 3.4° below normal;

the highest was 93°, at Fort Simcoe on the 28th, and the lowest, 20°, at Cascade Tunnel on the 3d. This was the coolest May on record. The average precipitation was 3.21, or 0.62 above normal; the greatest monthly amount 7.74, occurred at Ashford, and the least, 0.53, at Kennewick.

*West Virginia.*—The mean temperature was 68.1°, or about 6.0° above normal; the highest was 95°, at Point Pleasant on the 10th and at Spencer on the 11th, and the lowest, 33°, at Beckly (Raleigh) on the 4th. This was the warmest May on record. The average precipitation

was 3.01, or about 0.75 below normal; the greatest monthly amount, 5.92, occurred at Fairmont, and the least, 0.65, at Beckly.

*Wisconsin.*—The mean temperature was 62.9°, or about 6.0° above normal; the highest was 93°, at Butternut and Prairie du Chien on the 6th, and the lowest, 29°, at Florence on the 20th. Heavy frosts occurred at several northern stations on the 31st. The average precipitation was 5.00, being slightly below normal in the southeastern counties and much above normal in the Grand River Valley; the greatest monthly amount, 9.35, occurred at West Bend, and the least, 2.44, at Delevan.

## SPECIAL CONTRIBUTIONS.

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- Japan.**—Annual Report Central Meteorological Observatory for the year 1894. Pt. I. Met. Observations in Japan. Tokio (1895). 4to. 201 pp. Chart.
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### THE DESTRUCTIVE FORCES OF HURRICANES AND THE CONDITIONS OF SAFETY AND DANGER.

Extracts from communication by GEN. E. P. ALEXANDER, of Georgetown, S. C. (dated May 29, 1896).

It is the purport of this article to set forth some of the practical conclusions and results of a study of the destructive forces of the tropical hurricanes which sometimes assail our Atlantic and Gulf coasts in the months of August, September, and October. The study was suggested by personal experiences and observations on several occasions, but more particularly in the storm of August 27, 1893, which destroyed over 2,000 lives and perhaps \$1,000,000 worth of property. Newspapers and magazines for months afterward teemed with accounts of the havoc wrought, and of the noble charities for the relief of the desolated communities to which the occasion gave rise. But the popular ideas of the dangerous forces of the hurricane as given by the published accounts are exceedingly vague and indefinite, exaggerated in some respects, and underestimated in others. One magazine, for instance, stated that many persons were killed by "sheer pressure and fury of the wind, not a bruise being found on their bodies." Such a statement is merely absurd. But to the ignorant it suggests mysterious and universal destruction, against which no precautions are of any avail.

In every hurricane there are many individuals who escape and many structures that withstand it. An intelligent study of the conditions surrounding these individuals and buildings will give us a fair measure of the force of the wind and waves and will suggest the most effective means of protection. Briefly, it may be said that the dangerous elements are so limited and precautionary measures are so simple and easy,