103° in the shade; six cases of sunstroke, one fatal. Thornton, Ind., 11th, 104° in the shade, highest ever known; no sunstrokes. Charleston, Ind., 11th, 103° in the shade; two cases of sunstroke, one fatal. Connersville, Ind., 11th, 104° in the shade; two cases of sunstroke. Alton, Ill., 11th, one fatal sunstroke. Sidney, Ohio, 11th, 103° in the shade; one fatal sunstroke. Madison, Ind., 11th, one fatal sunstroke. Columbus, Ind., 11th, one fatal sunstroke. Clinton, Ill., 12th, maximum temperature for past 10 days 102° to 108°; hottest ever known, all business suspended; no sunstrokes. Danville, Ill., 102° in the shade; 4 cases of sunstroke, all laborers suspended work; warmest in 15 years. New Castle, Ind., 12th, one fatal sunstroke. Bluffton, Ind., 12th, 104° in the shade; 10 cases of sunstroke, none fatal. Knightstown, Ind., 12th, two cases of sunstroke, none fatal. Peru, Ind., 12th, hottest for many years, no sunstrokes. Tuscola, Ind., 12th, 100° to 105° in the shade, several cases of sunstroke, none fatal. Indianapolis, 9th, 3 cases of sunstroke, 2 fatal; 10th, 104°, 8 cases of sunstroke, 3 fatal; 11th, 100° at 4 p. m., 8 cases of sunstroke, 4 fatal; 12th, 99°, 7 cases of sunstroke, 2 fatal. Southport, Ind., 12th, 1 fatal sunstroke. Wheeling, W. Va., 12th, 1 fatal sunstroke. Chicago, 8th, 12 sunstrokes, 4 fatal. Assumption, Ill., 8th, 1 fatal sunstroke. Paxton, Ill., 8th, 1 fatal sunstroke.

Frost.—Campo, Cal., 1st, light; Crows Nest, Mont., 17th, light, 18th, heavy; Fall River, Mass., 5th, heavy; Carson City, Nev., 3d, light; Coalville, Utah, 8th.

PRECIPITATION.

The general distribution of rain-fall for July, 1881, is shown on chart No. III, from the reports of over 500 stations. From the table in the left hand corner of the chart is obtained a monthly average for each of the various districts, determined from the records (covering a period of many years) of Signal Service stations, and also a comparison of the present month with such averages. Upon examination of the chart and a comparison with the records of July for previous years, it is found that there is a general deficiency over the country east of the 100th meridian, being most marked in Tennessee and the Ohio valley. Within this large area of unusual deficiency for the month, there is a small area of remarkable excess, 4.69 inches, covering the Upper Mississippi valley; there are small excesses in the South Atlantic states and in the Upper Lake and Northern Pacific Coast regions. Although no precipitation was reported during the month throughout California west of the Serria Nevadas, the condition is normal. Over the Plateau regions and at the Rocky Mountain stations the usual irregularity of distribution prevails. In southeastern Arizona and southern New Mexico an unusually heavy precipitation was recorded for the month.

Deviations from the Average Precipitation for Several Years.—Illinois: Anna, this July is the only month during the past 18 years, that has no record of rainfall. *Maine*: Gardiner, monthly rainfall 0.38 inch above the mean for past 45 years. *Missouri*: St. Louis, Missouri Weather Service reports: monthly rainfall, 1.70 inches below the normal. *New York*: North Volney, monthly rainfall, 1.18 inches below the mean for the past 13 years.

Special Heavy Rains.—1st, Wilmington, N. C., 4.48 inches; Smithville, N. C., 2.85; Elsworth, N. C., 2.25, in 1 hour and 15 minutes. 3rd, New Orleans, La., 3.11 in 1 hour and 15 minutes, 4th, San Gorgonio, Cal., 0.94, in 1 hour and 30 minutes. 6th, Elmira, Ill., 1.23, in 39 minutes. 6th and 7th, Ames, Ia., 4.70. Dubuque, Ia., 2.17, in 2 hours. 9th, El Paso, Tex., 6.50 in 2 hours. 9th and 10th, De Soto, Nebr., 2.80. 10th, Dubuque Ia., 3.32; Logan, Ia., 3.00; Ames, Ia., 4.55; Clear Creek, Nebr., 1.25, in 25 minutes. 11th, Ames, Ia., 5.35; Port Jervis, N.Y., 1.62, in 1 hour and 30 minutes; Elsworth, N. C., 2.00, in 1 hour; Patterson, N. J., 0.50, in 4 minutes. 12th, Ft. Scott, Kan., 3.80; Flemington, W. Va., 2.00, in 2 hours; Detroit, Mich., 2.23 in 1 hour. 13th, Carroll, O., 12.00, in 3 hours, (estimated.) 14th, College Hill, O., 2.50, in 4 hours. 19th, Port Eads, La., 2.96; Omaha, Nebr., 1.00, in 20 minutes. 20th, Mallory Lake, Hillsdale Co., Mich., 0.90, in 10 minutes; Niles, Mich., 3.08; Augusta, Ga., 1.28, in 1 hour and 5 minutes. 20th and 21st, Coldwater, Mich., 3.90. 21st, Madison, Wis., 4.32; Riley, Ill., 2.03, in 45 minutes; La Crosse, Wis., 5.00; Cresco, Ia., 2.18, in 1 hour; Langanore Mills, Bernon Co., Wis., 7.00, in 14 hours. 21st and 22nd, North Lewisburg, O., 4.50; Niles, Mich., 3.60, in 10 hours; Ft. Supply, Ind. Ty., 5.10. 22nd, Columbus, O., 2.24, in 9 hours; Elsworth, N. C., 1.25, in 2 hours and 30 minutes; Helvetia, W. Va., 2.91, in 10 hours; Memphis, Tenn., 0.81, in 20 minutes; Silver City, N. Mex., 2.03, in 1 hour. 24th, Guttenburg, Ia., 0.63, in 30 minutes; La Crosse, Wis., 0.75, in 8 minutes. 25th, Antrim, N. H., 4.33; Ashland, N. H., 3.60; Belmont, N. H., 3.08; Rowe, Mass., 3.00, in 12 hours; Auburn, Ala., 1.05, in 30 minutes. 25th and 26th, Grafton, N. H., 3.40; Lake Village, N. H., 2.89; Weir's Bridge, N. H., 3.74; Bristol, N. H., 4.29; Wolfboro, N. H., 3.00; Williamstown, Mass., 3.75. 26th, Tucson, Ariz., 3.00, in 6 hours and 44 minutes. 27th, Wilmington, N. C., 2.97; Smithville, N. C., 2.81; New Orleans, La., 1.13, in 42 minutes. 28th, Ft. Barrancas, Fla., 1.17, in 30 minutes. 30th, Denver, Colo., 1.10, in 20 minutes. 31st, Atco, N. J., 3.00, in 5 hours; Dyberry, Pa., 1.00, in 15 minutes.

Largest Monthly Rainfalls.—Ames, Ia., 16.31 inches; Wilmington, N. C., 12.40; Cedar Key, 11.86; Smithville, N. C., 10.65; Dubuque, 10.53; Port Eads, 10.44; Mt. Washington, 9.93; Macon,

N. C., 9.70; Silver City, N. M., 9.62; Logan, Ia., 9.50; Helvetia, W. Va., 9.48; Madison, 9.47; Fort Supply, Ind. Ty., 9.34; La Crosse, 8.86; Cape Henry, 8.57; Niles, Mich., 8.48; El Paso, 8.17; Auburn, N. H., 7.92; Rockford, Ill., 7.72; Flemington, W. Va., 7.60; Cresco, Ia., 7.59; Elsworth, N. C., 7.37; Hudson Mich., 7.14; Independence, Ia., 7.10; Johnsontown, Va., 7.00; New Orleans, 6.97; Coldwater, Mich., 6.75; Clear Creek, Neb., 6.58; Pikes Peak, 6.55; Norfolk, 6.47; St. Augustine, Fla., 6.38; De Soto, Neb., 6.35; Portsmouth, N. C., 6.33; Antrim, N. H., 6.23; Fort Barrancas, Fla., 6.21; Beloit, Wis., 6.20; Hatteras, N. C., 6.16.

Smallest Monthly Rainfalls.—In California, throughout the San Joaquin and Sacramento valleys and westward to the ocean, the precipitation varied from 0.00 to 0.03 inch; south of Tulare Lake, along the line of the S. P. R. R., to the 115th meridian, no rain fell during the month, although no less than 18 stations reported regular observations. Over the Sierra Nevada Mountains, along line of the C. P. R. R., east of Sacramento to the Nevada state line, eight stations reported, at only one of which rain fell, viz; Truckee, 0.18 inch. Elsewhere, the smallest rainfalls are reported as follows—Elko, Nev., 0.01 inch; Corinne, Utah, and Ashwood, Tenn., 0.02; Texas Hill, Ariz., 0.03; Fort Concho, Tex., 0.04; Beowawee, Nev., 0.05; Reno, Nev., Fort Totten, D. T., and St. Meinrad, Ind., 0.10; New Harmony, Ind., 0.11; Laredo, Jacksboro, and Clarksville, Tex., 0.12; Boise City, 0.13; Cairo, Ill, 0.18; Yuma, Ariz., and Hot Springs, Nev., 0.20; Austin, Tenn., 0.20; Salt Lake City, Utah and Smithville, Dak., 0.21; Pioche, Nev., and Terry's Landing, Mont., 0.23; Terrace, Nev., 0.29; Port Angles, Wash. Ty., 0.30; Point Pleasant La., 0.31; Carson City and Otego, Nev., 0.34; Fort Scott, Kan., and Madison Bks., N. Y., 0.38; Fort Keogh, Mont., 0.39; Fort Pembina, Dak., and Fort Douglas, Utah, 0.40; McPherson Bks., La., 0.43; Greensboro, N. C., 0.45; Thornville, Mich., 0.47; and St. Vincent, Minn., 0.48.

Rainy Days.—The number varied in New England from 8 to 21; Middle Atlantic states, 7 to 15; South Atlantic states, 6 to 17; East Gulf states, 6 to 17; West Gulf states, 4 to 14; Ohio valley and Tennessee, 5 to 17; Lower Lake region, 8 to 12; Upper Lake region, 5 to 12; Upper Mississippi valley, 1 to 12; Missouri valley, 5 to 11; Red River of the North valley, 6 to 11; Texas, 1 to 12; Rocky Mountains, 5 to 16; Middle Plateau, 0 to 10; Southern Plateau, 2 to 20; California, 0 to 4; North Pacific coast region, 8 to 13.

Cloudy Days.—The number varied in New England from 3 to 11; Middle Atlantic states, 3 to 10; South Atlantic states, 2 to 12; East Gulf states, 1 to 7; West Gulf states, 1 to 7; Ohio valley and Tennessee, 0 to 4; Lower Lake region, 2 to 5; Upper Lake region, 2 to 7; Upper Mississippi valley, 0 to 7; Missouri valley, 1 to 8; Red River of the North valley, 3 to 7, Texas, 0 to 6; Rocky Mountains, 2 to 10; Middle Plateau, 0 to 7; Southern Plateau, 0 to 12; California, 0 to 6; North Pacific coast region, 6 to 11.

Snow.—Missoula, Mont., 31st, snow was clearly seen on several of the highest peaks in the main range of Bitter Root Mountains, among the most prominent being Lo Lo. Dayton, Wash. Ty., 6th, light snow fell on mountains 10 miles to the southeast.

Rain from a Cloudless Sky.—Wooster, Ohio, 30th, at 9 p. m.

Hailstorms were of frequent occurrence in the various districts, the most destructive being reported as follows: Lawrence, Mass., 4th, 2.40 p. m., most violent ever known here; for about ten minutes hail-stones fell the size of English walnuts; damage to private residences, mills, green-houses and work shops, is estimated at thousands of dollars; fruit trees terribly injured. South Framingham, Mass., 4th, heaviest for many years; great damage to crops and window glass; one florist lost 800 panes from his green-house. Tewksbury, Mass., 4th, very destructive; crops and fruit trees badly damaged; in one hot-house 3,000 panes of glass broken; windows at the State Asylum damaged to the amount of several hundred dollars. Lynn, Mass., 4th, 12.40 p. m., hail-stones, size of cherries, largest ever seen here before; much damage to vegetable and farm crops. Flemington, W. Va., 16th, three miles north of station a strip of ground half a mile wide and six miles long was badly damaged by hail, which lay in heaps upon the earth; fruit trees stripped of foliage, tobacco and corn destroyed, and other crops more or less damaged. Brockton, Mass., 21st, hail-stones varied from half an inch to one and a half inches in diameter; damage to window glass very severe: all the large factories suffered heavy loss; reports from surrounding agricultural towns indicate an immense amount of damage. Phillips, Me., 21st, hail-stones of all sizes and shapes, square, long, round, and varying in size from walnuts to near a man's fist; great damage to crops and buildings. Abington, Mass., 21st, hail-stones size of large hickory nuts; considerable damage to crops. Winona, Wis., 11th, hail-stones size of hen's eggs, trees stripped of foliage, and large quantities of window glass broken. Cumberland Co., Me., 26th, 5.30 p. m., passed from SW. to NE. through the townships of Falmouth, Cumberland and Yarmouth, for a distance of about 20 miles; width of path from one and a half to two miles. The central part of the storm belt was the most destructive, and within the limit of a quarter of a mile every crop was literally cut to pieces. Whole fields of grass were buried beneath the tremendous fall of hail, orchards were completely stripped of foliage and small limbs, and, in some instances, trees 18 inches in diameter were broken off "like pipe stems." Every house in the line of the storm had its windows completely riddled. The hail-stones varied in size from large

marbles to hen's eggs, and fell in such quantities that, at some points of the storm path, on the following morning, they were gathered to the depth of two feet, and again, even as late as noon, some portions of the wagon roads were covered with a "perfect bedding of hail-stones." The loss to the farming community is estimated at $30,000. No such storm has ever visited this section since 1833, when the hail was about as large, and the path identical. Hadley, Me., 21st, most violent and destructive storm within the memory of the oldest inhabitant; all glass on the north sides of buildings, where not protected, was broken; Tobacco and corn crops a total loss; trees were stripped of their foliage, and, in some instances, those having a diameter of about one foot, were twisted or broken off: dead birds were found under almost every tree. Sparta, Ky., 21st, hail-stones size of hen's eggs, causing great damage to fruit and corn. St. John, N. B., 21st, great damage to crops in parts of Kent county, particularly in the parishes of Richibucto and Welford. Hadlyme, Conn., 21st, most violent since July 28th, 1838, when half the windows in the town were destroyed, and much other damage done. Hail-stones size of large walnuts; the damage to farming industries will reach many thousand dollars.

RELATIVE HUMIDITY.

The percentage of mean relative humidity for the month ranges as follows: New England, from 68 to 90; Middle Atlantic states, 56 to 81; South Atlantic states, 53 to 82; East Gulf states, 68 to 76; West Gulf states 56 to 77; Ohio valley and Tennessee, 58 to 76; Lower Lake region, 64 to 72; Upper Lake region, 63 to 74; Upper Mississippi valley, 61 to 75; Missouri valley, 64 to 74; Red River of the North valley, 59 to 73; Texas, 52 to 62; Middle Plateau, 30 to 42; Southern Plateau, 43 to 61; California, 33 to 77; Oregon, 46 to 64; Washington Territory, (Olympia,) 71. *High stations* report the following percentages not corrected for altitudes: Pike's Peak, 69.0; Santa Fé, 55.0; Cheyenne, 55.8; Denver, 47.6; Mt. Washington, 81.8.

WINDS.

The prevailing winds during the month of July, 1881, at Signal Service stations, are shown on chart No. II by arrows, which fly with the wind. Between the 82d and 92d meridians, *westerly*. Along the South Atlantic coast, *southeast*, and on the Middle Atlantic and New England coasts, *southwest* to *northwest*. In the Western Gulf states and Missouri valley, *east* and *south*. Over Texas and the eastern Rocky Mountain slope, *south* and *southeast*. In the Plateau regions, *southerly*, and along the Pacific coast, *westerly*.

Total Movements of the Air.—The following are the largest total movements at the Signal Service stations: Mt. Washington, 14,442; North Platte, 11,319: Hatteras, 10,543; Portsmouth, N. C., 10,175; Moorhead, 9,657; Chincoteague, 9,434; San Francisco, 9,384; Kittyhawk, 9,082; Ft. Sill, 8,904. The *smallest* are: La Mesilla, 1,406; Silver City, 1,910; Phœnix, 1,989; Memphis, 2,063; Florence, 2,351; Lynchburg, 2,526; Uvalde, 2,596; Springfield, Mass., 2,641; Roseburg, 2,688; Lewiston, 2,709; Nashville, 2,721; Augusta, 2,728; Fredericksburg, 2,837; San Antonio, 2,850; Morgantown, 2,855; Tucson, 2,861.

High Winds.—Winds of 50 miles per hour and over were reported as follows: On summit of Mt. Washington, 13th, 14th, 16th; maximum velocity, 60 miles, NW., 13th. On summit of Pike's Peak no high winds were reported during the month, the maximum, 40, SW., occured on the 10th. Sandusky, 56, NW., 12th. Cape May, 60, SW., 14th. Kittyhawk, 60, N., 7th.

Local Storms.—Few storms of this character have occurred during the month, at least those particularly destructive, and, except the violent tornado at New Ulm, Minn., none accompanied with any unusual demonstration of force or attended with great loss of life and property have been reported. On the afternoon of the 15th, the terrible tornado which visited portions of southern Minnesota, appeared first as a violent northwest storm over the western portion of the state and eastern Dakota, in the vicinity of Big Stone and Traverse Lakes. With increasing energy the storm traveled southeasterly down the valley of the Minnesota river, desolating portions of the following counties: Big Stone, Lac Qui Parle, Swift, Chippewa, Renville, Sibley, Brown, Nicollet and Blue Earth. The general atmospheric conditions preceding and accompanying the formation of this storm, are given as follows: Since the 10th there had prevailed, with remarkable persistance, an area of comparatively low pressure over the western portions of Iowa and Minnesota, and the eastern portions of Nebraska and Dakota. There was considerable variability in the barometric readings within the area of low during this period, ranging, as they did, from 29.65 to 29.96. At midnight of the 10th, the winds, throughout the four states above mentioned, were from N. to E., with temperatures ranging from 57° to 74°. On the following morning, with the advent from Saskatchewan valley of an area of low pressure, the barometer fell from 0.03 to 0.18 inch below the normal, followed over Iowa and Nebraska by a veering of winds to the SE., occasional light rains and slowly rising temperature. Eliminating the element of diurnal change, there was noted the steady advance northward of a high thermal belt, coupled with the significant constancy of southerly winds south of parallel 45° and of W. to NW. winds to the northward as far as Manitoba. These conditions continuing unabated, there appeared on the afternoon of the 15th