

THE COMPARISON OF TEMPERATURE WITH MAGNETIC HORIZONTAL FORCE.

By Prof. F. H. BIGELOW.

In response to the request of the Chief of the Weather Bureau, the directors of the observatories at Toronto, Washington, and San Antonio have courteously undertaken to forward to the Bureau, as promptly as possible, certain data from their magnetograms, namely, the mean ordinates for the day from twenty-four hourly readings of the horizontal force, the declination, and the vertical force, uncorrected for instrumental errors and changes of temperature. On days exhibiting very disturbed magnetic conditions the hours and the values of the maximum and minimum ordinates are given.

The object in collecting these data is to institute a comparison between the crude magnetic readings, particularly of the bifilar, and the temperature changes at meteorological stations in the Northwest. Ultimately such comparisons will show how far unreduced magnetic observations may be available for determining the direction and the intensity of the temperature variations and other weather conditions before these become fully developed, as given by the isotherms and isobars of the daily weather maps. It has already been shown that weather and magnetism conform on the average to a normal type, but the problem of the synchronous changes from day to day is still under advisement as a practical feature in forecasting. The original data are presented on Chart V in a slightly reduced form, without further comment, thus offering the reader an opportunity for individual study.

The columns headed Calgary, Williston, and Sioux City give for each day, respectively, the mean of the 8 a. m. and 8 p. m. observations of temperature at the following groups of stations:

Calgary for Minnedosa, Qu'Appelle, Prince Albert, Swift Current, Medicine Hat, Battleford, Edmonton, Calgary.

Williston for Valentine, Yankton, Huron, Pierre, Moorhead, Bismarck, Williston.

Sioux City for Springfield, Mo., Kansas City, Wichita, Concordia, Omaha, Sioux City.

The average temperature for each group is reduced back to the origin, W. 115°, N. 55°, by a correction for eastward drift (see Amer. Jour. Sci., Dec., 1894). The first differences of these numbers are taken; then the monthly mean of the first differences for slope; then the variations on the slope; then these latter are added successively throughout the month and the accumulated sums give the ordinates of the curve for each group; the mean of these three groups is taken and gives the curve in the upper part of Chart V; the monthly mean of the ordinates is added with reverse sign to reduce to a true datum line. Thus, the eastward drift and the slope have been eliminated, and the variations reduced to a zero base line.

The magnetic data are treated in the same way as the temperatures. The curve as plotted is the mean of the ordinates of the three stations. It has been found that at least five magnetic observations are required to eliminate local conditions and to give a true value of the external impressed field, though seven are better. By inspecting the columns it will be seen that local variations disturb the curves in certain cases. Hence, as the data now exists, the comparison can give only partially accurate curves as to detail, though the main features may be expected to appear.

SPECIAL FEATURES OF THE DECEMBER CURVES.

The temperature and magnetic force variations need no correction for slope; San Antonio is reduced for amplitude by the factor $\frac{1}{2}$; the mean temperatures are reduced to a zero datum line by +1, and the mean magnetic force by -2.

The 26.68 day period began on December 20.26.

Light magnetic disturbances were reported from San Antonio on December 13, 14, 15, and 16.

INLAND NAVIGATION.

STAGE OF WATER IN RIVERS.

The following table shows the danger point and the highest and lowest stages for the month of December, 1894:

Heights of rivers above low-water mark, December, 1894.

Stations.	Danger-point on gauge.	Highest water.		Lowest water.		Monthly range.
		Height.	Date.	Height.	Date.	
<i>Red River.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>
Shreveport, La.	29.2	4.2	27	5.5	2-4	1.3
<i>Arkansas River.</i>						
Fort Smith, Ark.	22.0	1.4	5, 6, 10, 11	0.1	1	1.3
Little Rock, Ark.	23.0	4.7	12	2.3	1	2.4
<i>Missouri River.</i>						
Pierre, S. Dak.	13.0					
Sioux City, Iowa	18.7					
Kansas City, Mo.	21.0	6.9	27	4.3	21	2.6
<i>Mississippi River.</i>						
St. Paul, Minn.	14.0					
La Crosse, Wis.	10.0	3.1	7-9, 12, 13	1.0	1	2.0
Dubuque, Iowa	16.0	2.2	13-16	0.3	4-28	1.9
Davenport, Iowa	15.0	1.8	28	0.2	6	2.0
Keokuk, Iowa	14.0	1.2	20	0.5	4	1.7
Hannibal, Mo.	17.0	1.4	21, 22	0.8	3	2.2
St. Louis, Mo.	30.0	3.7	5	1.5	30	2.2
Cairo, Ill.	40.0	12.6	21	4.6	1	8.0
Memphis, Tenn.	33.0	5.9	25	0.1	1, 2, 4	6.0
Vicksburg, Miss.	41.0	5.1	30	4.0	1	9.1
New Orleans, La.	13.0	3.7	28	2.5	10	1.2
<i>Ohio River.</i>						
Parkersburg, W. Va.	38.0	12.0	15, 16	5.0	1	7.0
Cincinnati, Ohio	45.0	19.4	18	6.8	4, 5	12.6
Louisville, Ky.	24.0	10.0	20	3.8	6, 7	6.2
<i>Cumberland River.</i>						
Nashville, Tenn.	40.0	13.6	17	1.2	4, 6, 7	12.4
<i>Tennessee River.</i>						
Chattanooga, Tenn.	33.0	11.2	14, 15	0.9	2-8	10.3
Knoxville, Tenn.	29.0	7.9	14	0.0	1, 2	7.9
<i>Monongahela River.</i>						
Pittsburg, Pa.	22.0	9.2	14	2.8	30	6.4
<i>Savannah River.</i>						
Augusta, Ga.	32.6	25.0	14	5.3	3	19.7

Heights of rivers—Continued.

Stations.	Danger-point on gauge.	Highest water.		Lowest water.		Monthly range.
		Height.	Date.	Height.	Date.	
<i>Willamette River.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>
Portland, Oregon	15.0	6.8	12	2.6	28, 29	4.2
<i>Alabama River.</i>						
Montgomery, Ala.	48.0	15.4	15	0.1	7-9	15.5
<i>James River.</i>						
Lynchburg, Va.	18.0	2.6	14	0.0	4, 9, 29	2.6
<i>Sacramento River.</i>						
Red Bluff, Cal.	22.0	21.5	21	1.0	2	20.5
Sacramento, Cal.	25.0	20.0	31	9.2	1, 5	10.8

* River frozen.

† Record for 28 days.

‡ Record for 27 days.

ICE IN RIVERS AND HARBORS.

Albany, N. Y., 24th, navigation on the Hudson River closed to-day.
 Buffalo, N. Y., navigation closed 25th.
 Cairo, Ill., ice floating in river 28th; on the 29th navigation temporarily closed on Mississippi River, and running ice in that river and the Ohio River; 30th, navigation impeded on Ohio River.
 Chicago, Ill., 10th, navigation closed.
 Cleveland, Ohio, floating ice 28th to 31st, and navigation closed 31st.
 Des Moines, Iowa, 23d, river frozen.
 Detroit, Mich., navigation closed 20th.
 Duluth, Minn., navigation closed 7th.
 Grand Haven, Mich., 31st, ice in river.
 Green Bay, Wis., 10th, navigation closed.
 Harrisburg, Pa., 28th, river frozen.
 Keokuk, Iowa, Mississippi river frozen 29th.
 La Crosse, Wis., 25th, floating ice in river; 27th, river gorged on east side, but west channel clear.
 Marquette, Mich., 4th, navigation closed.
 New Brunswick, N. J., navigation on Raritan River closed by ice 29th.
 Louisville, Ky., 31st, floating ice in river.

Parkersburg, W. Va., 28th, running ice in Ohio and Kanawha rivers; 29th, ice in Kanawha River; 30th, considerable running ice in Ohio River.

Pittsburg, Pa., navigation closed on the Monongahela River 29th, and on the Ohio River 30th.

Port Huron, Mich., 14th, last up-boat of the season passed up the lake to-day; the last boat going down the lake 19th; 28th to 31st, floating ice on lake and in St. Clair River.

Rochester, N. Y., Erie Canal closed to navigation 1st.

Sandusky, Ohio, navigation closed 16th.

Sault Ste. Marie, Mich., navigation closed 6th.

Sioux City, Iowa, navigation closed 28th.

Toledo, Ohio, navigation closed 27th.

Bluffton, Mo., 28th, floating ice in Missouri River.

Miami, Mo., 28th, Missouri River blocked by ice.

Lynch, Nebr., 25th, navigation on Missouri River closed.

Niobrara, Nebr., 29th, teams crossing the ice on Missouri River.

Pierre, S. Dak., Missouri River frozen during the month.

Muscatine, Iowa, 28th, heavy floating ice in Mississippi River.

Marietta, Ohio, floating ice in Ohio River 29th to 31st.

Paducah, Ky., 29th to 31st, running ice in Ohio River.

North McGregor, Iowa, 15th, ice moved out of Mississippi River; 26th, river closed at 4.30 a. m.

St. Joseph, Mo., ice in Missouri River, 2d; river clear of ice at 3 p. m., 6th; 27th, running ice.

Portsmouth, Ohio, floating ice in Ohio River 29th to 31st.

Wheeling, W. Va., 27th to 31st, floating ice in Ohio River.

Kansas City, Mo., 28th, floating ice in Missouri River; 29th, river frozen.

Dubuque, Iowa, 29th, Mississippi River frozen.

Davenport, Iowa, 1st to 6th, ice in Mississippi River; 29th, river frozen.

Cincinnati, Ohio, 29th, Ohio River partly frozen.

Chester, Ill., 28th, ice in Mississippi River.

Le Claire, Iowa, Mississippi River frozen 1st to 6th; river clear 7th; river frozen 27th.

Hermann, Mo., 12th, navigation closed on Missouri River; 28th, heavy floating ice; 30th, river gorged at 11 a. m.

Freeport, Pa., 29th, floating ice in Allegheny River; 30th, river closed.

Greensboro, Pa., 29th, navigation closed on Monongahela River.

Lock No. 4, Pa., Monongahela River frozen 28th; 29th to 31st, running ice.

SUNSHINE AND CLOUDINESS.

GENERAL REMARKS.

The quantity of sunshine, and therefore of heat, received by the atmosphere is a fundamental factor in meteorology; the quantity received by the atmosphere as a whole is very nearly constant from year to year, but the proportion received by the surface of the earth depends largely upon the absorption by the atmosphere and varies with the distribution of cloudiness. The sunshine is now recorded automatically at about 38 regular stations of the Weather Bureau, either by its photographic or its thermal effects. The cloudiness is recorded by personal observations at all stations and is given in the column of "average cloudiness" in Table I.

SUNSHINE.

An instrumental record of sunshine has been kept during the month at 16 stations by means of the photographic sunshine recorder and at 24 stations by means of the thermometric sunshine recorder; the results of these observations are given in Table IV, for each hour of local mean time (not seventy-fifth meridian time). The stations recording the largest percentages of sunshine between the hours of 11 a. m. and 1 p. m. were: Key West, 92; Denver, 85.5; Norfolk, 82.5; New Orleans, 78; Vicksburg, 77.5. The stations having the least percentage between those hours were: Cleveland, 27; Portland, Oreg., 31; Rochester, 33.5; Spokane, 35; Tucson, 39.5.

The general average percentage for the whole month is given in the next to the last column of Table IV. The highest percentages were: Key West, 79; Denver, 73; Norfolk and Dodge City, 71; Savannah, 70; Baltimore, 66; New Orleans, 65; Galveston and New Haven, 63. The lowest percentages were: Cleveland, 25; Rochester, 28; Portland, Oreg., 30; Spokane, 33; Seattle and Columbus, Ohio, 37; Tucson, 39.

CLEAR SKY.

The average cloudiness between sunrise and sunset, as based on numerous personal observations, is given for each Weather Bureau station in Table I; the complement of this average cloudiness gives the observer's estimated percentage of clear

sky and these latter numbers are given in the last column of Table IV.

COMPARISON OF SUNSHINE AND CLEAR SKY.

The sunshine registers give the duration of direct sunshine whence the percentage of possible sunshine is derived; the observer's personal estimates give the percentage of area of clear sky. It should not be assumed that these numbers should agree, and for comparative purposes they have been brought together, side by side, in the following table, from which it appears that, in general, the instrumental record of percentages of duration of sunshine is almost always larger than the observer's personal estimates of percentages of area of clear sky; the average excess for this month is 3 per cent for photographic records and 6 per cent for thermometric records. Attention has lately been called to a similar excess in the records of the observers in India.

Difference between instrumental and personal observations of sunshine.

Photographic stations.	Instrumental.			Thermometric stations.	Instrumental.		
	Instrumental.	Personal.	Difference.		Instrumental.	Personal.	Difference.
Denver, Colo.....	73	65	8	Key West, Fla.....	79	67	12
Dodge City, Kans.....	71	63	8	Norfolk, Va.....	71	55	16
Savannah, Ga.....	70	63	7	Baltimore, Md.....	66	55	11
Galveston, Tex.....	63	62	1	New Orleans, La.....	65	55	10
Santa Fe, N. Mex.....	60	51	9	New Haven, Conn.....	63	55	8
Kansas City, Mo.....	59	57	2	Wilmington, N. C.....	53	45	8
Bismarck, N. Dak.....	58	55	3	St. Louis, Mo.....	53	45	8
Memphis, Penn.....	55	50	5	Vicksburg, Miss.....	53	45	8
Helena, Mont.....	49	49	0	Philadelphia, Pa.....	53	45	8
Eastport, Me.....	50	35	15	Washington, D. C.*.....	55	45	10
Cincinnati, Ohio.....	45	40	5	Des Moines, Iowa.....	55	45	10
San Diego, Cal.....	42	42	0	Boston, Mass.....	55	45	10
Tucson, Ariz.....	39	32	7	Salt Lake City, Utah.....	52	40	12
Spokane, Wash.....	33	26	7	Little Rock, Ark.....	51	39	12
Portland, Oreg.....	30	43	-13	San Francisco, Cal.....	48	26	22
Cleveland, Ohio.....	25	31	-6	Chicago, Ill.....	45	44	1
				Louisville, Ky.....	45	35	10
				New York, N. Y.....	45	35	10
				Portland, Oreg.....	43	43	0
				Buffalo, N. Y.....	39	29	10
				Detroit, Mich.....	38	34	4
				Columbus, Ohio.....	37	37	0
				Seattle, Wash. r.....	37	35	2
				Rochester, N. Y.....	28	28	0

No record for Portland, Me. *Formerly a photographic now a thermometric register. Record for 29 days.

OBSERVATIONS ON THE GREAT LAKES.

REPORTS FROM U. S. LIFE-SAVING STATIONS.

Through the co-operation of the General Superintendent of the Life-Saving Service and the Secretary of the Treasury, the Weather Bureau has received monthly reports for the

month of December, from the keepers of 24 U. S. Life-Saving Stations on the Great Lakes.

REPORTS FROM VESSELS.

The Lake Marine Section, Forecast Division, has received reports from the captains of 60 vessels navigating the Great Lakes.