higher than the normal in 1897; the deviations in the month of May reached 8° to 11° C. at St. Petersburg; the monthly mean being the highest that had been observed in one hundred and fifty years; it was the same case at Archangel, according to a series of observations for eighty years. On the other hand, the spring and the beginning of the summer of 1899 were, in the northwest portions of Russia, much colder than usual; in the month of May there were days having a deviation of from 5° to 8° C., and the temperature was below the normal during twenty-one *consecutive* days.

From these results it may be concluded that Lake Ladoga, which undoubtedly belongs to the type of temperate lakes, according to the classification of Prof. F. A. Forel, is placed in this series very near to the line which separates this type from that of the polar lakes, which always have an inverse thermic stratification.

The stratum where the thermic fall is due to the diurnal variation of the temperature of the shallow strata is produced was lower down in 1897 than in 1899. This is well explained by the fact that in 1897 the entire mass of the water of the lake was much warmer than in 1899.

RECENT PAPERS BEARING ON METEOROLOGY.

W. F. R. PHILLIPS, in charge of Library, etc.

The subjoined list of titles has been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau:

Annales de Chimie et de Physique. Paris. 7me séries. Tome 22.
Violle, J. Rapport sur la radiation, présenté au comité météorologique international, à Saint-Pétersbourg, en 1899. Pp. 329–370.

Gaea. Leipzig. 37 *Jahrg.*
Wollny, E. Ueber den Einfluss der Pflanzendecken auf die Wasserführung der Flüsse. (Schluss). Pp. 220–223.
Klein, H. J. Strenge Winter. Pp. 223–233.

Annalen der Physik. Leipzig. Vierte folge. Band 4.
Pockels, F. Zur Theorie der Niederschlagsbildung an Gebirgen. Pp. 459–480.

Himmel und Erde. Berlin. 13 *Jahrg.*
Assmann, R. Die modernen Methoden zur Erforschung der Atmosphäre mittels des Luftballons und Drachen. (Schluss folgt). Pp. 241–260.

Nature. London. Vol. 63.
—— Red Rain. Pp. 471–472
Pellew, E. Variations of Atmospheric Electricity. P. 491.

Symon's Meteorological Magazine. London. Vol. 36.
Curtis, R. H. Pressure of the Wind. (Concluded). Pp 17–19.

American Journal of Science. New Haven. 4th series. Vol. 11.
Penfield, S. L. Stereographic Projection and its Possibilities from a Graphical Standpoint. Pp. 1–24, 115–144.
Bigelow, Frank H. The Magnetic Theory of the Solar Corona. Pp. 253–262.

Popular Science Monthly. New York. Vol 58.
Dexter, E. G. Suicide and the Weather. Pp. 604–617.
Cochrane, C. H. Recent Progress in Aerial Navigation. Pp. 616–624.

Astrophysical Journal. Chicago. Vol. 13.
Nichols, E. F. On the Heat Radiation of Arcturus, Vega, Jupiter, and Saturn. Pp. 101–141.

Annales de Géographie. Paris. 1901.
Woeikof, A. De l'influence de l'homme sur la terre. (Premier article). P. 97–114.

Zeitschrift für Gewässerkunde. Leipzig. Band 3.
Wollny, E. Ueber den Einfluss der Pflanzendecken auf die Wasserführung der Flüsse. Pp. 345–362.

Comptes Rendus. Paris. Tome 132.
Arctowski, Henry. Sur les périodes de l'aurore australes. Pp. 651–654.

La Nature. Paris. 29me année.
Plumandon, J. R. Le tir au canon contre la grêle. Pp. 266–267.

Meteorologische Zeitschrift. Band 18. *Wien.*
Mohn, H. Einige Bemerkungen über die Schwerekorrektionen der Barometerhöhen. P. 49–53.
Woeikof, A. Platzregen und grosse tägliche Regenmengen. Pp. 53–75.
Schreiber, —. Beiträge zur Hagelthеorie. Pp. 58–70.
—— Vorläufige Mittheilung über die internationale Ballonfahrt vom 8 November, 1900. P. 71.
—— Vorläufige Mittheilung über die internationale Ballonfahrt vom 10 Januar, 1901. P. 71.
Valentin, J. Temperatur-Beobachtungen der österreichischen Ballons bei der internationalen Fahrt vom 8 November, 1900. P. 72.
Hann, J. Klima der Westküste von Marokko, Mogador. P. 76.
Lachmann, G. Ueber eine merkwürdige Blitzform. P. 80.
Kassner, C. Bequeme Berechnung der Koëfficienten der Bessel'schen Formel. P. 81.
Kassner, C. Eine Analogie der irisirenden Wolken.. P. 82.
—— Resultate der meteorologischen Beobachtungen in Belle Isle (Neufundland). P. 83.
—— Zum Klima von Syra. P. 83.
—— Versuche über den Verlust der Ladung elektrischer Flüssigkeiten durch Verdämpfung. P. 84.
Elster, J. Messungen der elektrischen Zerstreuung in der freien atmosphärischen Luft an geographisch weit von einander entfernt liegenden Orten. P. 85.
Wedell-Wedellsborg, P. S. Notiz über die Ursachen der säkulären Variationen des Erdmagnetismus. P. 88.
Halm, J. Breitenvariation, Erdmagnetismus und Sonnenthätigkeit. P. 89.
Taudin-Cabot, J. J. Grüstrahlung. P. 90.
—— Zum Klima des arktischen Nordamerika. P. 90.
Mac Dowall, Al. B. Säkulare Schwankung? P. 92.
Chistoni, C. Ueber den Regenfall in Modena 1830–1896. P. 93.
Prohaska, K. Feuerkugel in Pöllau, Steiermark.
Hepites, Stefan. Ausserordentlicher Regenfall in Rumänien. P. 94.
—— Druckfehler-Berichtigungen. P. 95.

CLIMATOLOGY OF COSTA RICA.

Communicated by H. PITTIER, Director, Physical Geographic Institute.

TABLE 1.—*Hourly observations at the Observatory, San Jose de Costa Rica, during February*, 1901.

Hours.	Pressure.		Temperature.		Relative humidity.		Rainfall.		
	Observed, 1901.	Normal, 1889–1900.	Observed, 1901.	Normal, 1889–1900.	Observed, 1901.	Normal, 1889–1900.	Observed, 1901.	Normal, 1889–1900.	Duration, 1901.
	660+ *Mm.*	660+ *Mm.*	° *C.*	° *C.*	%	%	*Mm.*	*Mm.*	*Hrs.*
1 a. m.	4.75	4.02	16 82	16.31	78	83	0.0	0 0	0.00
2 a. m.	4.37	3.56	16.31	16.05	81	84	0.0	0.0	0.00
3 a. m.	4.15	3.35	16.04	15.81	81	84	0 0	0.0	0.00
4 a. m.	4.17	3.31	16.17	15.67	80	84	0.0	0.1	0.00
5 a. m.	4.34	3.55	16.00	15.56	80	84	0.0	0.0	0.00
6 a. m.	4.74	3.94	15.51	15.43	84	84	0.0	0.1	0.00
7 a. m.	5.04	4.34	16.26	16.11	80	82	0.0	0.0	0.00
8 a. m.	5.30	4.67	18.65	18. 8	66	74	0.0	0.0	0.00
9 a. m.	5.62	4.90	21.18	20.45	57	66	0.0	0.0	0.00
10 a. m.	5.72	4 90	23.41	22.70	53	60	0.0	0.0	0.00
11 a. m.	5.42	4.53	24.94	23.89	49	57	0.0	0.0	0.00
12 m.	4.90	4.08	26.01	24.79	46	55	0.0	0.0	0.00
1 p. m.	4.21	3.57	26.27	25.18	48	54	1.0	0.0	0.33
2 p. m.	3.61	3 01	25.84	24 96	49	55	0.2	0.0	0.33
3 p. m.	3.36	2.58	24.86	24.24	54	58	0.0	0.1	0.00
4 p. m.	3.37	2.58	23.29	22.77	59	60	0.0	0.1	0.00
5 p. m.	3.58	2.76	21.16	21.16	66	68	4.3	0.1	0 67
6 p. m.	3.97	3.13	19.56	19.49	72	74	3.0	0.0	1.00
7 p. m.	4.46	3.65	18.76	18.35	76	79	0.1	0.1	0.08
8 p. m.	4.85	4.10	18 28	17.90	76	80	0.0	0.1	0.06
9 p. m.	5.24	4.44	17.91	17.46	77	81	0.0	0.7	0.00
10 p. m.	5.42	4.63	17.56	17.12	76	82	0.0	0.1	0.00
11 p. m.	5.44	4.61	17.38	16.74	77	83	0.0	0.0	0.00
Midnight	5.19	4.36	16.93	16.51	79	84	0.0	0.0	0.00
Mean	664.63	663.86	19.80	19.27	69	73	.....	.....	.....
Minimum	661.70	659.35	12.30	8.20	25	.....	.....	.....	.....
Maximum	667.70	667.72	31.60	32.00	98	.....	4 3	.....	.....
Total	.....	.....	.....	.....	.....	.....	8.6	1.5	2.41

REMARKS.—The barometer is 1,169 meters above sea level. Readings are corrected for gravity, temperature, and instrumental error. The dry and wet bulb thermometers are 1.5 meters above ground and corrected for instrumental errors. The hourly readings for pressure, wet and dry bulb thermometers, are obtained by means of Richard registering instruments, checked by direct observations every three hours from 7 a. m. to 10 p. m. The hourly rainfall is as given by Hottinger's self-register, checked once a day. The standard rain gage is 1.5 meters above ground.

TABLE 2.

Time.	Sunshine.		Cloudiness observed, 1901.	Temperature of the soil at depth of—				
	Observed, 1901.	Normal, 1889-1 00.		0.15 m.	0.30 m.	0.60 m.	1.20 m.	3.00 m.
	Hours.	Hours.	%	° C.	° C.	° C.	° C.	° C.
7 a.m.	3.68	11.25	40	20.64	21.05	20.91	20.32	20.79
8 a.m.	20.67	22.76						
9 a.m.	20.96	22.08						
10 a.m.	19.38	21.18	40	21.14	21.10	20.94	20.34	.....
11 a.m	20.11	21.42						
12 m	18.55	21.21						
1 p.m	19.75	21.29	50	21.94	21.37	20.97	20.36	.....
2 p.m.	20.31	21.82						
3 p m	19.92	21.45						
4 p.m.	20.05	19.12	60	22.16	21.61	21.02	20.38	.....
5 p.m.	13.98	14.56						
6 p.m.	2.67	4.27						
7 p.m.	.....	.....	60	22.04	21.64	21.10	20.43	.....
8 p.m.	.....	.....						
9 p.m.	.....	.....						
10 p.m.	.....	.....	50	21.66	21.61	21.27	20.50	.....
11 p.m.	.....	.....						
Midnight	.....	.....						
Mean	.....	.....	48	21.60	21.40	21.04	20.39	.....
Total	200 03	220.37	.....	.....	.....	.....	.....	.....

Evaporation.—During the daytime, in January, observations incomplete; in February, 90.0^{mm}. During the nighttime, January, observations incomplete; February, 25.7^{mm}.

Notes on earthquakes at San Jose.—February 3, 7:20 a. m., small shock, west-northwest to east-southeast; intensity, 1; duration, ±2 seconds. February 12, 10:34 a. m., light oscillation, northeast to southwest; intensity, 1; duration, ±2 seconds. February 14, 5:21 p. m., light oscillation, east to west; intensity, 1; duration, ±3 seconds. February, 16, 7:23 a. m., tremors; 7:55 a. m. and 6:52 p. m., light shock, northwest to southeast; duration, 5 seconds; intensity, 2; people ran out into the streets. February 22, 7:14 p. m., slight shock, northwest to southeast; intensity, 1; duration, ±3 seconds; 8:08 p. m., slight shock, northwest to southeast; intensity, 1; duration, ±3 seconds. February 24, 7:55 a. m., tremors. February 25, 1:30 a. m., sensible shock, west-northwest to east-southeast; intensity, 2; duration, 10 seconds. February 26, 12:15 a. m., light shock, west-northwest to east-southeast; intensity, 1; duration, ±3 seconds. February 28, — a. m., very light shock, east-northeast to west-south-west; intensity, 1; duration —.

Notes on the weather at San Jose.—Generally warm and windy, wind from northeast. Rain almost daily through the gaps in the northern cordillera, reaching San Jose on the 16th.

TABLE 3.—*Rainfall at stations in Costa Rica*, 1901.

Stations.	January.		February.	
	Amount.	No. rainy days.	Amount.	No. rainy days.
	Mm.		Mm.	
1. Boca Banano	265	17	98	11
2. Limon	304	19	72	9
3. Swamp Mouth	.....	.....	131	10
4. Zent	.....	.....	.....	.....
5. Gute Hoffnung	411	15	106	14
6. Siquirres	406	10	45	4
7. Guapiles	340	13	114	8
8. Sarapiqui	.....	.....	.....	.....
9. San Carlos	301	19	67	14
10. Las Lomas	521	16	131	10
11. Peralta	335	11	65	4
12. Turrialba	.....	.....	.....	.....
13. Juan Vinas	159	14	40	10
14. Santiago	.....	.....	.....	.....
15. Paraiso	.....	.....	.....	.....
16 San Rafael C	.....	.....	.....	.....
17. Tres Rios	2	1	5	1
18. La Palma	.....	.....	.....	.....
19. S. Francisco G	7	2	9	1
20. San Jose	4	2	9	1
21. La Verbena	.....	.....	5	2
22. Alajuela	0	0	1	1
23. Nuestro Amo	.....	.....	11	2

FROST FIGHTING.

By ALEXANDER G. MCADIE, Forecast Official.

During the past five years the Weather Bureau Office at San Francisco has been called upon to give particular attention to the problem of lessening the injury to fruits by frost. By direction of the Chief of the Weather Bureau, during the year 1900 the forecast official for the southern half of the Pacific slope made an extensive journey through California, with the special purpose of studying the methods of protecting deciduous fruits from frost. This journey was the natural outgrowth of the excellent work inaugurated by Mr. W. H. Hammon, formerly professor in the Weather Bureau, while in charge of the San Francisco office. During the years 1897, 1898, and 1899 the unusually dry winter conditions, with frequent and prolonged frosts and lower temperatures than had been previously reported in many of the chief fruit growing centers of southern California, made it imperative that some steps should be taken to minimize the injury to citrus fruits by frost. The problem as presented to the forecast official was of a twofold nature: first, a study of the conditions preceding frost, so that he might with reasonable certainty give timely warning to the fruit growers; second, a study of the methods, means, and devices for protecting fruit from injury by low temperatures. The first has been solved with a fair measure of success. In the second problem the Weather Bureau had the valuable assistance of certain practical fruit growers, who willingly and readily tested the various devices proposed for smudging and cheerfully gave this office the benefit of the many practical experiments made by them in smudging, irrigating, heating, and covering. A bulletin on Frost fighting, by Alexander G. McAdie (Bulletin No. 29), was issued on March 13, 1900, and nearly three thousand copies distributed to those most interested in fruit growing. A previous bulletin (No. 23) upon Frost, when to expect it and how to lessen the injury therefrom, had been issued by the Weather Bureau on November 10, 1898, by Prof. W. H. Hammon, while a Farmers' Bulletin, No. 104, by Prof. E. B. Garriott, Notes on Frost, was issued June 15, 1899, which treated of frost protection in general.

It has become evident in California that the fruit grower must possess a degree of intelligence certainly as high as is demanded in any one of the usual vocations of life. The successful orchardist must be a skilled farmer and a good business man and, at the same time, be familiar with the chief principles of modern science. He must be chemist, entomologist, and physicist, as well as fruit grower. In the matter of protecting his crops from frost, for example, he must know exactly what method is best suited for his crop, for the locality, and for the season, and be prepared to act promptly, or else the greater portion of the year's profits will vanish in the course of a few hours.

In what follows extensive use will be made of Bulletin No. 29, since experience has shown that the principles of frost fighting, laid down therein, are essentially correct. While this bulletin was written chiefly with a view of protecting the citrus fruit crops of California, particularly of the section south of the Tehachapi, from frost, the principles hold, as a general rule, for the protection of deciduous fruits also.

In October and November, 1900, an attempt was made to extend the benefits of the Weather Bureau work in connection with frost, to the fruit growers of central and northern California, particularly to the growers of almonds, apricots, peaches, prunes, pears, apples, grapes, and figs. Many fruit ranches were visited, and the details of losses by frost gathered from ranch superintendents and others, together with all data available relative to the exposure of the fruit, the lay of the land, and the lowest temperatures. The following facts stand out prominently from the general mass