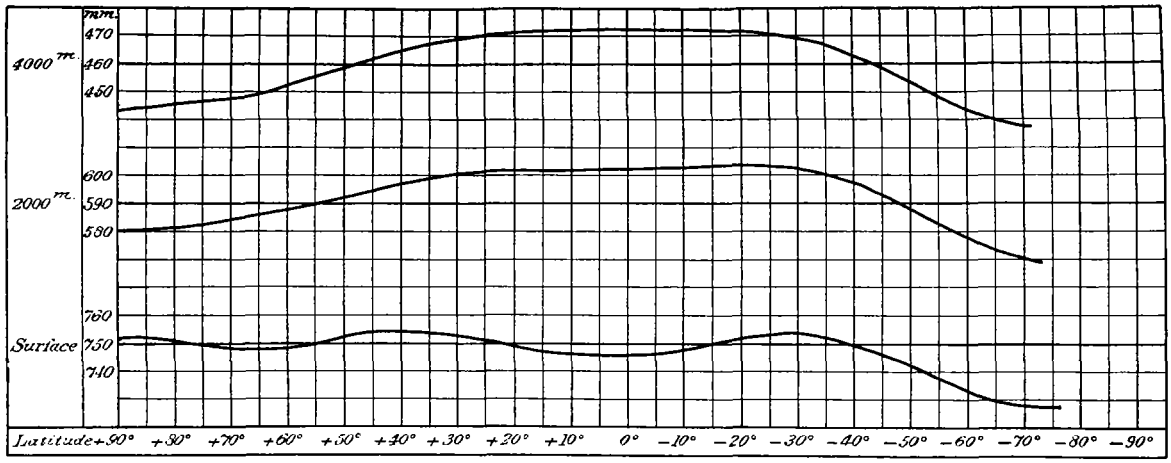

FIG. 20.—Pressures at different latitudes (Ferrel) and altitudes (Sprung).

It is my purpose to work out the data for the temperate and the tropical zones now in the possession of the Weather Bureau and applicable to the North American Continent, along the lines here indicated. The attempt to bring these laws of the general and the local circulations into a harmonious numerical scheme will require considerable labor, but it is believed that it can be accomplished. The data contained in my reports, while apparently somewhat disconnected, are in reality all contributory to my solution of the problems of atmospheric circulations both of the earth and of the sun, together with the connections between them. It is proper to determine carefully the separate portions of the work, i. e., the velocities and temperatures of the strata in motion as dependent upon observations, before trying to put them together in a final synthesis. It is only necessary to have in mind the general plan of development, as here outlined, in order to keep the several portions in harmonious relations with each other.

CLIMATOLOGY OF COSTA RICA.

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

[For tables see the last page of this REVIEW preceding the charts.]

Notes on the weather.—On the Pacific slope, the rainfall was without exception much above the normal. Violent and cold winds have been blowing almost continually, accompanied by mist and rain, which greatly hindered the coffee picking. In San José, pressure temperature and relative humidity were normal, but the rainfall exceeded six times the mean amount for the past fifteen years, 63 millimeters (2.48 inches) and eight days against 10 millimeters (0.39 inches) and three days. Notwithstanding the frequence of rain, the hours of sunshine were above the normal 220.3 against 199.6. The few reports received from the stations of the Atlantic slope indicate a remarkable scarcity of rain in contrast with the diluvial showers of December, 1903.

Notes on earthquakes.—January 14, 2h 37m a. m., slight shock E–W., intensity II, duration 6 seconds; 6h 35m p. m., tremors, apparently E–W., intensity I, duration 3 seconds. January 15, 3h 54m p. m., very slight shock E–W., intensity I, duration 4 seconds; 4h 45m p. m., tremors. January 16, 6h 59m p. m., strong shock E–W., intensity III, duration 2 seconds. January 20, 9h 21m a. m., strong shock E–W., intensity III, duration 6 seconds; 9h 2m p. m., slight shock E–W., intensity I, duration 2 seconds; 9h 18m p. m., shock E–W., intensity II, duration 10 seconds. January 23, 8h 40m p. m., strong shock E–W., intensity III, duration 10 seconds. January 24, 1h 46m a. m., slight shock E–W., intensity II, duration 4 seconds. January 25, 11h 17m p. m., slight shock E–W., intensity I, duration 3 seconds. January 31, 10h 43m p. m., slight shock ENE–WSW., intensity II, duration 3 seconds.

ANNUAL CLIMATOLOGICAL SUMMARY FOR HAWAII.

By R. C. LYDECKER, Territorial Meteorologist.

The following is the rainfall for the year 1903 as gaged at the several stations of the Weather Bureau. The heaviest rainfall during the year was at Nahiku, Maui, at an elevation of 1600 feet. The rainfall here was 319.80 inches, or practically 26.6 feet. The next heaviest rainfall was at Puuohua, Hawaii, at an elevation of 1050 feet, 244.20 inches, or upwards of 20 feet.

Least rainfall, U. S. Magnetic Station, Sisal, Oahu, 8.19 inches.

Approximate percentage of district rainfall as compared with normal: Hawaii, Hilo district, 100 per cent; Hamakua, 110; Kohala, 98; Waimea, 86; Kona, 95; Kau, 62; Puna, 89; island of Maui, 130; island of Oahu, Honolulu district, 72; Nuuanu, 96; Koolau, 67; Ewa, 60; island of Kauai, 72.

Stations.	Elevation.	Amount.
HAWAII.		
HILO, e. and ne.	*Feet.*	*Inches.*
Waiakea	50	118.89
Hilo (town)	100	132.01
Kaumana	1,250	174.41
Pepeekeo	100	112.85
Hakalau	200	129.68
Honohina	300	145.40
Puuohua	1,050	244.20
Laupahoehoe	500	170.30
Ookala	400	105.53
HAMAKUA, ne.		
Kukaiau	250	97.29
Paauilo	300	75.34
Paauhau	300	60.37
Honokaa (Mill)	425	68.45
Honokaa (Meinicke)	1,100	91.52
Kukuihaele	700	75.04
KOHALA, n.		
Niulii	200	53.60
Kohala (Mission)	521	51.92
Kohala (Sugar Co.)	270	48.45
Hawi Mill	700	51.34
Puakea Ranch	600	38.07
Puuhue Ranch	1,847	38.88
Waimea	2,720	35.00
KONA, W.		
Holualoa	1,350	56.11
Kealakekua	1,580	63.22
Napoopoo	25	31.25
Hoopuloa	1,650	45.96
Hoopuloa	2,300	65.37
KAU, sc.		
Kahuku Ranch	1,680	24.42
Honuapo	15	19.32
Naalehu	650	29.05
Pahala	810	24.97
Volcano House	4,000	67.44
PUNA, e.		
Kapoho	110	72.41
Pahoa	600	121.10
MAUI.		
Waiopae Ranch	700	11.95
Kaupo (Mokulau) s	285	72.23
Kipahulu	308	80.32
Nahiku	1,600	319.80
Haiku	700	85.40
Kula (Erehwon)	4,500	35.06
Kula Waiakoa	2,700	18.70

Stations.	Elevation.	Amount.
MAUI.—Cont'd.	*Feet.*	*Inches.*
Puunomalei	1,400	87.40
Paia	180	53.76
Haleakala Ranch	2,000	60.46
Wailuku	250	28.97
OAHU.		
Punahou (W. B.), sw	47	32.68
Kulaokahua (Castle), sw	50	22.00
Makiki Reservoir	120	32.57
U. S. Naval Station, sw	6	18.34
Kapiolani Park, sw	10	14.02
College Hills	175	38.50
Manoa (Woodlawn Dairy) e	285	95.60
Manoa (Rhodes Gardens)	360	125.95
Insane Asylum	30	28.19
Kalihi-uka	485	98.29
Nuuanu (W. W. Hall), sw	50	35.58
Nuuanu (Wyllie street)	250	54.75
Nuuanu (Elec. Station), so.	405	56.08
Nuuanu (Luakaha), e	850	145.73
U. S. Experiment Station	350	45.19
Kaliula	1,150	95.08
Tantalus Heights (Frear)	1,360	107.22
Waimanalo, ne	25	28.31
Mamawili, ne	300	68.42
Kaneohe	100	41.51
Ahuimanu, ne	350	73.59
Kahuku, n	25	19.40
Wahiawa	900	35.62
Ewa Plantation, s	60	12.40
U. S. Magnetic Station	45	8.19
Waipahu	200	9.30
Moanalua	15	27.85
KAUAI.		
Lihue (Grove Farm), e	200	32.06
Lihue (Molokoa), e	300	33.61
Lihue (Kukaua), e	1,000	71.19
Lihue (Kilohana)	400	38.25
Kealia, e	15	16.66
Kilauea Plantation, ne	325	47.34
Hanalei, n	10	80.51
Waiawa	32	10.35
Eleele	150	20.86
Wahiawa (Mountain)	3,000	142.45
McBryde (Residence)	850	53.41
Lawai (Government Road)	450	61.92
Lawai, w	225	26.60
Lawai, e	800	58.98
Koloa	100	29.87

Summary of observations at the Weather Bureau station, Honolulu, Hawaii, for 1903.

Latitude 21° 18′ north. Longitude 157° 50′ west. Ground above sea, 43 feet. Thermometer above ground, 9; barometer 7 feet. Rain gage above ground, 1 foot. Exposure southwest.

Month.	Precipitation.				Temperature.											Barometer.							Humidity means.						Direction of wind						Cloudiness in tenths.	
					Average, 1903.							Normal mean.	1903.			Average, 1903.				Normal mean.	1903.															
	1903.	Normal.	No. days.	Normal.	6 a. m.	9 a. m.	2 p. m.	9 p. m.	Min.	Max.	Mean.		Lowest.	Highest.	Mean daily range.	9 a. m.	3 p. m.	9 p. m.	Mean.		Highest.	Lowest.	Grs. of moisture per c.ft.	Normal.	Mean dew point.	Mean normal.	Relative humidity.	Normal humidity.	NE. quadrant.	SE. quadrant.	SW. quadrant.	NW. quadrant.	Normal days of trade wind.	Wind force.		Normal cloudiness.
January..	4.05	3.10	12	16	67.0	71.8	74.4	68.0	63.5	75.5	69.8	70.3	56	79	12.0	30.070	29.970	30.047	30.020	29.972	30.22	29.72	5.89	6.27	60.5	62.5	73.8	76.7	15	7	4	5	14	2.1	4.5	4.4
February.	5.86	5.48	12	15	64.1	69.1	71.9	66.2	61.3	73.2	67.3	70.2	53	76	11.9	30.048	29.957	30.034	30.003	29.966	30.21	29.66	5.24	6.24	57.0	62.5	71.4	76.7	17	0	5	6	15	2.7	4.7	4.9
March	1.03	3.76	9	18	63.0	70.4	73.0	66.1	61.3	74.5	67.3	70.7	56	78	13.2	30.011	29.930	30.004	29.970	30.010	30.17	29.77	5.32	6.05	57.5	61.5	72.3	71.7	15	1	10	5	18	1.8	4.2	4.6
April	2.35	2.90	25	17	69.1	74.1	75.7	70.9	67.0	77.0	71.9	72.5	61	82	10.0	30.042	29.968	30.047	30.005	30.029	30.15	29.88	6.22	6.42	62.3	63.5	72.8	73.0	27	2	1	0	20	3.2	5.1	5.1
May	1.86	2.68	25	19	71.3	76.3	78.3	72.9	69.0	80.0	74.2	74.1	66	83	11.0	30.078	30.010	30.082	30.044	30.030	30.15	29.94	6.39	6.53	63.2	63.9	69.7	72.5	26	4	1	0	24	3.0	4.8	4.4
June.....	1.36	1.52	15	19	72.9	78.1	80.7	74.3	69.9	82.2	76.0	76.0	65	85	12.0	30.017	29.961	30.016	29.989	30.009	30.12	29.98	6.74	6.83	64.9	65.0	70.1	70.7	28	0	2	0	26	2.3	3.8	4.0
July.....	2.08	1.72	22	19	72.8	78.8	81.6	73.7	72.8	83.0	77.6	77.3	70	87	10.2	30.025	29.976	30.016	30.000	29.995	30.09	29.91	6.73	6.81	65.0	65.0	67.9	68.5	30	0	0	1	29	3.1	3.2	4.0
August ...	2.48	1.97	24	18	75.4	78.8	82.5	76.3	72.8	83.4	77.9	77.7	70	85	10.5	30.032	29.971	30.026	30.001	29.980	30.08	29.94	7.07	7.01	66.5	66.0	70.0	68.5	31	0	0	0	29	2.1	4.1	4.0
September	5.74	1.98	19	18	75.0	79.1	81.5	76.0	72.6	83.0	77.5	77.5	69	84	10.3	30.024	29.957	30.023	29.991	29.968	30.08	29.90	6.96	7.06	66.1	66.0	69.7	68.5	30	0	0	0	26	2.3	3.5	4.0
October...	2.17	2.76	17	19	72.0	77.3	79.2	74.0	70.3	80.4	75.1	76.2	64	83	10.1	30.007	29.938	30.004	29.972	29.968	30.07	29.72	6.87	7.06	65.6	66.0	73.9	70.5	23	2	6	0	22	2.2	4.3	4.3
November	2.26	5.15	16	17	70.8	75.9	77.6	72.5	69.2	78.9	73.6	73.8	63	82	9.7	30.028	29.953	30.019	29.990	29.958	30.10	29.85	6.49	6.93	63.8	65.7	73.1	75.8	25	0	5	0	17	1.3	3.5	4.8
December.	1.44	3.92	11	16	68.0	74.6	77.6	71.0	67.0	78.4	72.2	71.5	62	80	11.4	30.035	29.960	30.022	29.998	29.969	30.13	29.84	6.42	6.32	63.5	63.0	75.8	73.8	24	0	7	0	16	1.0	2.9	4.4
Year....	32.68	36.95	207	211	70.1	75.4	77.8	71.8	68.1	79.1	73.4	74.0	53	87	11.0	30.035	29.963	30.028	29.999	29.988	30.22	29.66	6.36	6.63	63.0	64.2	71.7	72.2	291	16	41	17	256	2.3	4.05	4.37

Temperature mean = (6 + 2 + 9) ÷ 3. Observations are taken in standard time of 157° 50′ west of Greenwich.
Pressure corrected for temperature and reduced to sea level, and the gravity correction −.06, applied. Mean = (9 + 3) ÷ 2.
Direction of wind. Each quadrant includes the cardinal point to the right of it, i. e., NE. includes E., etc. Force of wind, Beaufort scale, and during daylight.

JULIUS R. FREDERICK.

Julius R. Frederick was born at Dayton, Ohio, July 21, 1852, Thirteen years later he entered service as a messenger in Chicago, and within six years he became, successively, a brakeman, fireman, and engineer in the employ of the Pennsylvania Railroad, and remained in the last-named position until 1874, when, as a participant in the great strike, he left the company's service, although offered a life position to remain. He enlisted in the Army September 11, 1876, and served through the Sioux and Nez Perces wars. His superior physique and the good judgment and courage displayed by him in those wars doubtless prompted his assignment to the Lady Franklin Bay Expedition in April, 1881. The story of that unfortunate voyage bears frequent mention of Frederick's name in words of praise, admiration, and gratitude. A single incident, taken from the official report, will perhaps best illustrate his character. While at Camp Clay, on the last fearful days of that expedition, it was thought necessary to make an effort to recover 100 pounds of beef left at Bairds Inlet the year before. For this service Frederick and another member of the expeditionary force volunteered, Lieutenant Greely consenting reluctantly, fearing fatal results to the men in their enfeebled condition. They set out on the 6th of April, and, after encountering severe storms, reached their destination only to find no trace of the beef. Sadly disappointed, but courageously, they set out on their return. In a short time his companion began to fail, and soon died in Frederick's arms. After burying him as best he could, Frederick resumed his journey to camp. He says at this time he felt more like remaining to perish by the side of his companion than like making another effort; but the thought of those who would be sent out to find him if he did not return spurred him to continued exertions, and he reached camp on the 13th.

Frederick distinguished himself in this disastrous journey, and brought in the entire load hauled out by the two, and, remarkable to say, did his work on the scanty ration of 6 ounces of meat and 6 ounces of bread, not availing himself of the additional increase authorized in case of extraordinary circumstances.

Among other encomiums from his commanding officer, is the following:

His extremely valuable services as one of the supporting party to the "Farthest North", as engineer at the critical point of our retreat, as cook during the terrible winter, and as hunter and general worker in the more disastrous spring, all showed the stamp of no ordinary man.

Frederick entered the meteorological branch of the Signal Corps August 1, 1884, by transfer from the line of the Army, and, by an act of Congress, approved June 21, 1902, was placed on the retired list of the Army as a first-class sergeant, Signal Corps.

After his transfer he was first detailed for special duty at Portsmouth, N. H., and afterwards at Washington, D. C., and on the 9th day of February, 1885, he was assigned as assistant at Indianapolis, Ind., where he remained in the Signal and Weather Bureau Services until the time of his death, January 6, 1904, enjoying the respect and esteem of all who knew him.—*D. J. C.*

NOTES AND EXTRACTS.

METEOROLOGY IN SERVIA.

The meteorological service of Servia was organized by Prof. Milan Nedelkovitch, and has been maintained by his personal efforts since 1887, when the observatory was founded at Belgrade. Step by step he has added stations of the second order, until now there are 18 of these, 4 of which are furnished with self-registering apparatus for pressure, temperature, and rain. There are also 44 stations of the third class, and 117 of the fourth. The annual appropriation for expenses is 10,000 francs for the salaries of observers and necessary expenses at the central observatory and the other stations; 2000 francs for the printing of the monthly bulletin; 3000 or 4000 francs for those primary schools that maintain meteorological stations; 10,000 or 12,000 francs for the various local governments (corresponding to our counties and cities) to defray their expenses in the matter of meteorology. The regular publications of the central observatory are the monthly bulletins and the annual volumes. The bulletin gives, in that detail which is demanded by modern climatology, all monthly data relative to the atmosphere, not only the pressure, moisture, temperature, cloudiness, wind, and rain, but also in many cases the records of the heliograph and the actinometer, and especially the temperature of the soil at various depths beneath the surface, 24 in all, from 0.01 meter (0.4 inch) down to 24 meters (78 feet). This is undoubtedly the most important series of soil temperatures ever yet undertaken, and arrangements should be made for keeping it up indefinitely for as many years as possible. We ought, however, to add that as a check against the uncertainties of deep thermometers, it is very desirable that electric thermometers, more especially the thermophone of Warren and Whipple, be established at several different depths and read simultaneously with the Lamont mercurials.

The Arago-Davy actinometer, or bright bulb and black bul