The maximum duration of sunshine recorded during any one month was 89 per cent of possible at Balboa Heights in January, 1915, and the least duration of sunshine for any month was 15 per cent at Balboa Heights in May, 1913.

Prevailing cloud types.—The cumulus form of lower clouds are most numerous during the dry season and the strato-cumulus, stratus, and nimbus forms during the rainy season. All of the common types of upper clouds are well represented throughout the year, but in the rainy season they are frequently obscured by the lower clouds.

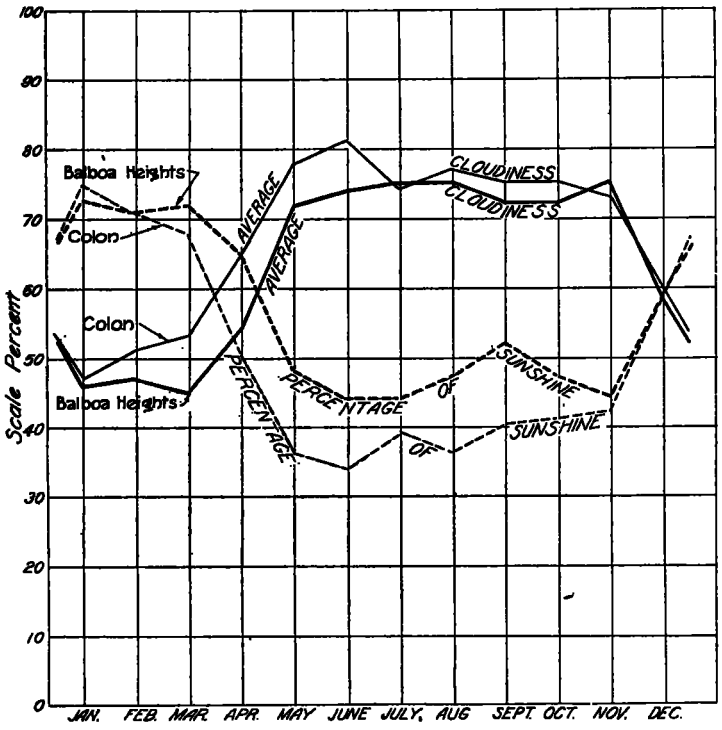

FIG. 1.—Average monthly conditions of cloudiness and sunshine in the Canal Zone.

Comparisons.—Compared with conditions in many sections of the United States, cloudiness in the Canal Zone is relatively heavy, especially during the rainy season; but prevailing rainstorms usually are of short duration, followed by clearing weather and sunshine and the cloudiness is so broken and intermittent that there are very few days with *no sunshine*. But when general storms visit the Isthmus (such as "Northers") there may be periods of two or three consecutive days with the sun entirely obscured.

The average number of days *without sunshine* during the past 12 years has been about 12 per year on the Pacific side and 10 on the Atlantic side. The longest consecutive period of authentic record in the Canal Zone without sunshine is about four days.[1]

The average number of clear days per year has been 36 at Balboa Heights and 54 at Colon; partly cloudy days 172 at Balboa Heights and 166 at Colon; and cloudy days, 157 at Balboa Heights and 145 at Colon. A clear day being one with average cloudiness of three-tenths or less; partly cloudy, from four-tenths to seven-tenths; and cloudy, eight-tenths or more.

The attached table and diagram show average monthly conditions of cloudiness and sunshine in the Canal Zone.

Average monthly cloudiness and percentage of possible sunshine—Canal Zone.

	Cloudiness—per cent of sky obscured.[a]			Sunshine—per cent of possible.[c]	
	Balboa Heights, Pacific coast (13 years).	Culebra, interior (7 years).[b]	Colon, Atlantic coast (11 years).	Balboa Heights, Pacific coast (12 years).	Colon, Atlantic coast (12 years).
January	47	49	46	75	73
February	51	50	47	71	71
March	53	47	45	68	72
April	65	63	54	50	65
May	78	77	72	36	48
June	81	81	74	34	44
July	74	80	75	39	44
August	77	78	75	36	47
September	75	77	72	40	52
October	75	79	72	41	47
November	73	80	75	42	44
December	60	61	58	59	59
Year	67	68	64	49	56
Dry season	54	52	48	66	70
Rainy season	74	77	72	41	48

[1] Based on records from automatic electric sunshine recorders. These records are not always absolutely accurate, being subject to errors due to improper adjustment of instrument, lagging, etc., but they are considered the best available.

[a] Cloudiness records are from bi-hourly eye observations.

[b] Station closed in 1914.

[c] Sunshine records are from automatic electric sunshine recorders, expressed in percentage of possible. In the Tropics possible sunshine, or the duration of daylight, varies but little from month to month, since there is little variation in the length of day and night throughout the year.

HUMIDITY AND HOT WEATHER.

By H. G. CORNTHWAITE, Acting Chief Hydrographer.

[Balboa Heights, Canal Zone, Mar. 15, 1920.]

In a general way it is well known that conditions of humidity and wind movement are important factors in ameliorating or aggravating the depressing effects of hot weather. The maximum temperature recorded is therefore not an adequate measure of the temperature actually felt by the human body. For example, a temperature of 90° F. with high humidity and no wind seems very hot and oppressive, while the same temperature with a low degree of humidity and a fresh breeze seems relatively cool and refreshing.

For want of a better term the temperature actually felt by the human body may be called the *sensible* temperature. The reading of the wet bulb thermometer is not an exact measure of the sensible temperature, but it is the best measure available, as it represents the temperature of a moist body exposed to the breeze in process of cooling through the agency of evaporation.

The effects of humidity and wind movement on the *sensible* temperature may be explained as follows:

With a high degree of humidity the air is nearly saturated with invisible vapor, and its capacity for taking up additional moisture is small; consequently, the rate of evaporation is slow and the evaporating surface is cooled but slightly.

With a low degree of humidity the capacity of the air for taking up additional moisture is large, which favors a rapid rate of evaporation and extensive cooling of the evaporating surface.

Increased wind movement induces a more rapid rate of evaporation, with a resulting increase in its cooling effect, and also tends to cool the body by the removal of heat by conduction and convection.

Also, it is probable that high humidity has a depressing physiological effect upon the human body that is not

susceptible of exact measurement, but, as stated above, the readings of the wet bulb thermometer are considered the best measure available of the temperature actually felt by the human body.

It is very interesting to compare climatic conditions in Panama with conditions in various sections of the United States on this basis. Average daily maximum shade temperatures and the computed maximum daily sensible temperatures (wet bulb) for the month of July are presented in the following table:

Stations.	Actual average daily maximum temperature for July.	Computed average maximum sensible temperatures for July (wet bulb).
	°F.	°F.
Balboa Heights, C. Z	87	79
Cristobal, C. Z	84	78.5
Mobile	90	77.7
New Orleans	89	77
St. Louis	87	73
Phœnix	104	72
Kansas City	86	72
New York	82	70
Chicago	80	69
El Paso	94	68
Fresno	100	66
Denver	86	64
San Francisco	64	57

It should be noted that maximum *shade* temperatures only are used in the above table. No attempt is made to estimate the superheating effects of the sun on bodies exposed to direct solar radiation.

It will be seen that the *average* daily maximum July temperatures are much higher in many sections of the United States than in Panama, but the maximum *sensible* temperatures are higher in Panama than anywhere in the United States, due to the prevailing high humidity. Midsummer conditions of temperatures and humidity in the Gulf States more closely approach the conditions that prevail in Panama.

Dry season sensible temperatures in Panama are about 3° F. lower than those of the rainy season, due to the lower humidity and higher wind movement that prevails in the dry season. This explains the less oppressive character of our dry-season weather.

The high sensible temperatures and hot, humid atmospheric conditions that prevail in Panama would seem to be productive of frequent cases of sunstroke and heat exhaustion, but such is *not* the case. Canal Zone vital statistics covering the past 13 years show but two deaths from sunstroke, one in Panama and one in Colon. The total number of cases of heat exhaustion reported among the entire population of about 120,000 during this 13-year period was only 21, and none of these cases proved fatal.

While deaths from overheating are extremely rare in Panama, it is undoubtedly true that the habitual lassitude and inefficiency of tropical labor is due in large measure to the prevailing conditions of temperature and humidity.

Sufficient data are not available upon which to base an exhaustive study of this subject, but it is thought that, in general, cases of sunstroke and heat exhaustion are relatively rare both in *extremely humid* hot climates and in *arid* hot climates. It is in the *moderately humid* warm climates, such as prevail in central and eastern sections of the United States, that cases of sunstroke and heat exhaustion are most prevalent. Such cases seem to occur more frequently in large cities, probably being aggravated by the excessive radiation of heat from street paving, sidewalks, and masonry walls, and also by the lack of free air circulation in congested districts. Undernourishment and low vitality of the patients may be contributory causes.

Conditions of humidity powerfully affect plant life also. The blighting effects of the withering hot winds of Kansas that carry damage or destruction to growing crops are due more to *moisture deficit* than to *high temperatures*.

The needs of animal and plant life differ, and, generally speaking, the conditions of heat and humidity most favorable for luxuriant plant growth (warm and humid) are relatively unfavorable for human health and comfort.

The average maximum temperature records and the corresponding wet-bulb readings at stations in the United States used in the accompanying table were taken from a Weather Bureau report on "Relative Humidities and Vapor Pressures over the United States" by Mr. Preston C. Day, published as MONTHLY WEATHER REVIEW SUPPLEMENT No. 6. Wet-bulb temperatures corresponding to the daily maximum temperatures were computed from the daily maximum temperatures and the relative humidity.

COMFORTABLE TEMPERATURES.

By W. KÖPPEN.

[Abstracted from *Das Wetter*, July-August, 1918, pp. 116-117.]

The temperatures at which the greatest comfort is felt are those in the neighborhood of 18° C. Out of doors, temperatures are considered comfortable when they lie between 14 and 18° C. at night, and between 18 and 22° in the daytime. A person who would live the year around in such temperatures, however, would have to travel so much if he remains at sea-level, that he would have little time in a given locality to establish a home.

In the northern hemisphere in the vicinity of Europe, he would gradually move north from Cairo in January, February, and March; in April he would be in Seville; in May he would go northward to Greece or Italy; in July to London, Christiania, and Helsingfors; and through the second half of the year he would retrace his journey. In the East, he would find himself in January in Calcutta, in March in Hongkong, in May in Peking and Tokyo, and thence up the coast.

Such traveling as this, however, is not practical and the person who would seek to maintain a comfortable temperature throughout the year must do it by means of ascending and descending the mountains of his vicinity.—*C. L. M.*

OPTIMUM TEMPERATURE FOR HUMAN ENERGY.

By ELLSWORTH HUNTINGTON.

[Abstract translated from *La Nature Supplement*, Mar. 22, 1919.]

Prof. Ellsworth Huntington has published in the *Proceedings of the National Academy of Sciences* a study of this subject based on statistics.

1. If the temperature of the seasons in which the death rate is lowest is noted, it is found, in the cities of the United States as well as in those of Europe and Asia, a minimum in the springtime and in the autumn, when the mean daily temperature is in the neighborhood of 18° C.

2. If the maximum of work obtained from laborers in various factories extending from Connecticut to Florida is investigated, it is found that this maximum is obtained where the temperature oscillates about 17° C.

3. Finally, if, with a dynamometer, the muscular force of workers is measured during several seasons, it is found that the maximum efficiency occurs with a temperature of 16 to 19° C.